

S02
**POSTHARVEST TECHNOLOGY
IN THE GLOBAL MARKET**
S02.001
**Deficit Irrigation of Iceberg Lettuce Improves
Shelf-Life of Fresh-Cut Product**
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As a result of increased water scarcity, the main producer countries of fresh produce are requested to reduce water consumption. However, as far as we known, a good water management has not been established yet. This is a priority for countries such as Spain with limited water sources. What is more, there is still a lack of information regarding the impact of deficit irrigation strategies on the quality of fresh produce. In the present study we evaluated the impact of 5 irrigation strategies on the quality and shelf-life of iceberg lettuce. The irrigation treatments applied during the growing season of iceberg lettuce at commercial conditions were two deficit treatments, -50% (910.2 m³/ha) and -25% (1395.6 m³/ha), two excess treatments, +50% (2730.6 m³/ha) and +25% (2305.8 m³/ha) and the regular amount of water applied by the farmers of the southeast area of Spain, control (1820.4 m³/ha). The impact of the different irrigation treatments was evaluated in fresh-cut lettuce processed following the commercial conditions applied by the fresh-cut industry and stored under active modified atmosphere packaging until the end of the shelf-life. The relative water content in the vegetable tissue significantly increased in lettuce irrigated with +50% of water when compared to -50%. However, no significant differences were observed for the crispiness coefficient (CC), determined using the texturometer TA-XTPPlus (Stable Micro Systems Ltd, UK) equipped with a Kramer cell. When the shelf-life of fresh-cut lettuce was evaluated, it was observed that lettuce irrigated with a deficit irrigation showed higher shelf-life than lettuce irrigated with an excess amount of water. Thus, it was determined that the use of deficit irrigation strategies in leafy vegetables can be beneficial not only from an environmental point of view, but also from the consumer point of view due to its impact on the quality of fresh-cut produce.

S02.002
**Effect of Six Apple Rootstocks on Storage Span
of Apple cv. Golab Kohanz**
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The effect of six apple rootstocks on fruit quality attributes and storability of 'Kohanz' apple after four months of regular storage at 2 °C with 85% relative humidity was studied. The 9-year old experimental trees on 'Kohanz' seedling (a commercial rootstock for Kohanz cultivar in Iran), B9, M9, M26, MM106, and MM111 were located at the Agricultural Research Station in Semirom (31° 25' N and 51° 34' E, Iran). Rootstock had significant impacts on storage life of fruit. Fruits from tree on B9 had the highest (5.46%) while those on MM106 the least (3.71%) water loss after storage. Reduction of quality attributes such as percentage of juice, soluble solids concentration, and firmness was lower in the fruits from trees on MM106 as compared to those on all other evaluated rootstocks in this experiment. This study could have a major potential for storage and marketing strategy among 'Kohanz' apple growers. MM106 is a free-standing rootstock which is readily available in Iran. By prolonging storage life of 'Kohanz' apple on MM106, this cultivar can be marketed when there is lower supply and thus, higher demand in the market and more profit.

S02.003
**Prediction of Spinach Quality Based
on Pre- and Postharvest Conditions**
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Despite advances in production and post-production processes for spinach, significant quality problems persist related to agronomic practices and storage conditions. Nitrogen amendments and water availability have a significant effect on the nutritional quality of spinach and yet their specific influence on overall post-harvest quality is poorly understood. Current agronomic practices in California include the application of 100 to 350 kg/ha total N. Preharvest and postharvest trials with field- and hydroponically-grown spinach were conducted to describe how these agronomic practices influence quality. Additionally, quantitative evaluations were performed to identify predictors of post-production quality at harvest and during storage. Preharvest nitrogen doses higher than 100ppm coupled with high temperature, and light quality reduced the overall quality of hydroponic spinach. Color (hue) of spinach grown under various N rates and stored at 7.5 °C (in perforated plastic packaging) did not predict the key phytonutrient composition and shelf life adequately. Shelf life was defined as a combination of visual hedonic quality score ≥ 6.5 (on a 9 point scale), decay < 1 %, and ascorbic acid concentrations ≥ 35 mg/ 100gfw. Ammonium accumulation, in part, more reliably anticipated the reduction of quality during storage. More accurate quality retention projections were achieved by combining ammonium concentrations with measurements of glutamine synthetase activity at harvest. Changes in respiration rates, chlorophyll and carotenoid concentrations during storage were poor indicators of postharvest shelf life. Total organic acids and sugar content >3.5mg/gfw were negatively correlated with quality retention. Cuticle thickness from all N treatments was identical and had no discernible correlation with shelf life. Although storage temperatures significantly affect quality retention in spinach, the initial quality at harvest is the main factor that influences postharvest outcomes. Spinach pre- and postharvest quality is best predicted by analysis of total organic acids, sugar concentrations and the relationship between ammonium and glutamine synthetase.

S02.004
**Tree Age Affects Kinnow Mandarin Peel
and Fruit Quality**
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Peel quality is indispensable to the external appearance and marketability of citrus fruit. Among many factors affecting citrus peel quality, tree age is the most important one, but remains unexplored so far. Present study was aimed at investigating the effect of tree age on peel and fruit quality of Kinnow mandarin (*Citrus reticulata* Blanco). Fruit harvested from trees of different age (3, 6, 18 and 35 years), growing at a commercial orchard in main citrus growing district (Sargodha, Pakistan), were analyzed for various physico-chemical quality characteristics as well as nutrient contents (macro and micro) in fruit peel. Tree age showed a pronounced effect on peel quality (smoothness, thickness and percentage), internal fruit contents (rag %, juice %, seed number and percentage) and fruit bio-chemical characteristics (acidity, pH, TSS, TSS: acidity, vitamin C, reducing sugars, non reducing sugars, and total sugars). Analysis of fruit nutrient contents also revealed differences in nutrient constituents of peel of fruit from different age group. Fruit from trees of different age groups were also compared for their respiration and ethylene production rates. A correlation matrix was developed for nutrient contents in peel and fruit quality characteristics. This paper describes the detailed account of tree age in relation to peel and fruit quality of Kinnow, the commercial mandarin cultivar from Pakistan.

S02.005

Pre- and Post-Harvest Management Practices to Extend Shelf Life of Sweet Cherry (*Prunus avium* L. cv. Lapin)

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The island state of Tasmania, Australia enjoys a cool, maritime climate well suited for production of quality cherries that mature over the mid-December to late-February period. The cherry industry in Tasmania has increased from boutique status, producing 200 tonnes in the late 1990's, to ca. 3000 tonnes in the 2008/9 season. Significant new plantings underpin forecasts of production increasing to 6000 tonnes in the 2012/13 season. Tasmanian growers enjoy area freedom from fruit fly status and currently export via air-freight to selective markets such as: Taiwan, Hong Kong, Japan, USA, Europe, India, Singapore, Malaysia and the Middle East. With significant new plantings bearing fruit in the near future industry are looking to increasingly utilise sea freight. The broad objective of our work is to investigate pre- and post-harvest management practices that may prolong the shelf life of sweet cherries. Further, the long term goal of this work is to identify characteristics of fruit at harvest that relate to shelf life and therefore suitability for sea freight. In the present study we report on the role of fruit size and mesocarp cell density on fruit shelf life. In the 2009/2010 season we manipulated crop load of entire trees by dormant bud thinning to leave one, two or three floral buds per spur along with an unthinned control to create a range in fruit size. Fruit will be harvested at commercial maturity and stored at 0 °C and 5 °C. Fruit quality attributes (e.g., weight, firmness, exocarp colour, total soluble solids, and acidity) will be assessed at weekly intervals over a 5-week period. In addition, at harvest, fruit mesocarp cell number and size will be assessed and related to fruit weight. The relationships among fruit weight, mesocarp cell size and number, and shelf-life will be discussed.

S02.006

Assuring Organoleptical Quality of Apricots

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Apricots are one of the earliest summer fruits harvested, and command high prices in the market. As a result often the fruit is picked before it is fully mature and has inferior flavour when ripe. To counteract this tendency, a study was made of maturity parameters to be used to determine the harvest of apricots in Israel. Three cultivars were taken from orchards in different parts of the country from multiple harvests and of different maturity as defined by their peel background color. They were examined for size, soluble solids content, titratable acidity, firmness and taste at harvest and after ripening, either with or without 2 or 3 weeks of storage. Storage at 0 °C and 1 °C were compared. In addition, the effect of a degreening treatment with ethylene on early harvested fruit was examined. The results indicate that for acceptable taste the fruits should be harvested with a soluble solids content of at least 11.5%, and that the ratio of soluble solids to titratable acidity at the time of consumption must be above 5. Storing the fruit at 1 °C rather than 0 °C for 20 days shortened the shelf life to 1 day at 20 °C rather than 3 to 4 days. Degreening of the fruit did not alter fruit internal quality, and so if the soluble solids were not high enough at harvest, the fruit had inferior taste. The recommendation for harvesting is to include soluble solids content to the already accepted measurements of fruit size and peel color.

S02.007

Influence of Planting Date and Mulching on Some Qualitative Traits of Processed Tomato (*Lycopersicon esculentum* Mill.)

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Tomato is one of the most important vegetable in the world and it was introduced in Europe in the XVI century. This crop can be used as fresh vegetable and in the

last century it started to be processed by food industries. For this reason breeders selected and improved many varieties in order to satisfy industries needs like yield aspects, harvest resistance, maturation time, shape uniformity and resistance to pests and diseases. In the last years, instead, breeders focused their attention to qualitative aspects because of the increasing awareness of consumers. Therefore they started to study how to increase the content of antioxidants, ascorbic acid, dry matter, pH and sugar content etc. This experience was aimed to study if mulch and planting date could affect the qualitative properties of different cultivar of processing tomato. Four varieties (AUG, NPT, SAF and TIZ), four planting date (T1, T2, T3 and T4) and two mulching treatments were compared. Samples were analyzed to determine peel resistance and flesh consistence, pH, titratable acidity, ascorbic acid, phenols, total antioxidant activity, sugars and cations and anions. From a quality point, results showed that TIZ was the best cultivar with interesting properties for processing. Mulch technique seemed to decrease the content of total phenols and the consistence of tomato fruits. Plots without mulch showed lower content of ascorbic acid. Also planting date affected tomato quality. T4 fruits, in fact showed the higher content of phenols, antioxidant activity, dry matter and colour. Structural properties of T4 fruits were good but lightly lower than T1 fruits.

S02.008

Maturity Index and Cold Storage Effects on Postharvest Quality of 'Packham's Triumph' and 'Rocha' Pears

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Pears have been grown in the South region of Brazil, where the climate conditions favour plants development and fruit set. The aim of this work was determine the harvest maturity index as well as maximum storage period of 'Packham's Triumph' and 'Rocha' pears that provide quality attributes maintenance. The fruit were harvested in commercial orchard every seven days (January, 27, February, 03 and 10, 2009) and flesh firmness was used as a maturity index (MI1: 76, MI2: 67 e MI3: 58 N). The fruit were stored at 1 ± 1 °C and 90-95% RH for 15, 30, 45 and 60 days and evaluated at the end of each storage period and after five days at room condition (24 ± 1 °C), simulating shelf-life period. Flesh firmness, water loss, peduncle dehydration, epidermis colour, soluble solids, titratable acidity and ratio were measured. 'Packham's' pears harvested at 1 and 2 maturity index have showed firmness loss from the first 30 days of cold storage, whereas fruit harvested at 3 maturity index kept the initial values, resulting in firmer fruit after the 60 days of cold storage (P<0.001). Fruit harvested in MI3 showed smaller percentual firmness loss after being 5 days at room condition, mainly after 45 and 60 days of cold storage. 'Rocha' pears harvested in MI1 and MI2 showed flesh firmness reduction during cold storage, which was intensified at room condition. Maximum values of water loss were around 6%. Fruit peduncles of both varieties dehydrated after 60 days of cold storage, but their colour remained green, independent of harvest maturity index. 'Packham's Triumph' and 'Rocha' pears harvested at MI3 and MI2, respectively, showed better quality attributes maintenance after 60 days of cold storage even after 5 days of shelf-life.

S02.009

New Foliar Calcium Treatments to Improve Shelf-Life and Quality of 'Calanda' Late Season Peach Cultivars

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Vitrescent dark spot is the main calcium-related physiological disorder observed in late season peach cultivars in the Ebro River Basin, Spain. This alteration implies the development of localised translucent and dark brown areas in the fruit mesocarp with no external symptoms to be seen until long after harvest. Late season peach cultivars are characterised by having a higher value and outstanding quality since they grow in bags, which are placed around them after fruit thinning. In this

study, Calanda peaches (cv. Calrico) were sprayed with calcium-containing solutions four times, every 15 days, since the beginning of May to the end of June just before bagging in 2009. The formulations applied to the fruit surface consisted of 120 mM Ca supplied as CaCl₂ or Ca-Propionate in combination with: (1, 2) 0.02% of a commonly applied polysorbate surfactant, (3, 4) 0.05% of an organo-silicon surfactant (OSS), (5, 6) 0.5% of a "food additive adjuvant" (FAA) and (7) control fruits. Following the application of treatments, samples were collected after 7 days and Ca, Mg and K concentrations were determined in the mesocarp and exocarp of fruits after wet digestion and by Atomic absorption/Emission Spectroscopy. After one month storage at 0 °C, the external appearance was ranked as well as the development of vitrescence and internal browning. With regard to peel and pulp calcium concentrations, significant increases were only recorded for OSS and FAA, CaCl₂ treated peaches on July 26th. One month after cold storage, the fruits from FAA CaCl₂ foliar applications led to the lowest vitrescent dark spot incidence as derived from the low index recorded for this treatment. Besides, regarding chilling injuries, in general, all treatments excepting Ca-propionate plus polysorbate, were effective in reducing the browning index value.

S02.010

Compositional, Optical and Physical Quality Change Postharvest in Grafted Watermelon [*Citrullus lanatus* (Thunb) Matsum & Nakai] Cultivars

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Change in physical, optical and compositional fruit quality attributes during storage at 25 °C was evaluated in four large-fruited, seeded watermelon cultivars (Celebration, Gallery, Pegasus, Torpilla) and a small-fruited, seedless cultivar (Extazy) grafted onto three hybrid rootstocks (TZ148, Bombo and N103) or grown self-rooted. In the large fruited cultivars all quality attributes examined, except flesh firmness, were mostly influenced by storage period. After one week at 25 °C lycopene content increased, flesh colour turned darker (lower L*) and more vivid (higher C*) while hue angle (h*), flesh firmness and total soluble solids (TSS) content remained stable. After two weeks of storage flesh firmness, TSS and lycopene content declined. Rind thickness reduced throughout storage. At the expense of thicker fruit rind, grafting was responsible for improved flesh firmness, higher lycopene content and darker reddish flesh colour (lower L*, h* and higher a*) during storage. Grafting was not significant in terms of TSS content. Choice of rootstock was not significant to any of the quality attributes examined. Cultivars Pegasus and Torpilla demonstrated the highest flesh firmness, cultivars Gallery and Pegasus the highest TSS content and the thinnest rind and cultivars Celebration and Torpilla attained the highest lycopene content. Throughout storage flesh colour remained most intensely red (higher C* and a* values) in cv. Celebration. Poor correlation with CIELAB colour components suggests that flesh colour darkness, intensity and affinity to reddish hue are not reliable criteria for watermelon sweetness and firmness. However, the intensity of red coloration (C* and a* values) may be more reliably regarded as an indicator of watermelon lycopene content. The small-fruited, seedless cv. Extazy exhibited outlying quality attributes and disparate postharvest behaviour with respect to the large-fruited cultivars. Its pronounced potential for long shelf-life is curbed only by its low TSS content after two weeks of storage.

S02.011

Post Harvest Quality of Fruits of Banana cv. Terra under Different Levels of Irrigation and Nitrogen

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This work had as objective to evaluate the effect of five levels of irrigation and nitrogen doses on characteristics of quality of banana cv. Terra fruits. Treatments consisted of five water depths (0,0; 0,08; 0,48; 1,12 e 1,52 of ETc) combined with

five nitrogen doses (43.6; 261.6; 436.0; 697.0 e 828.0 kg×ha⁻¹), applied by using a random block design with three replications. A Plan Puebla III matrix scheme with two factors and five levels per factor was used. There was no significant difference among soluble solids (SS), titratable acidity (AT), ratio (SS/AT) and pH means. There was no effect of the different water depths and nitrogen doses on the quality parameters of banana fruits, on the other hands, differences in physical characteristics were noticed in the fruits of the treatments.

S02.012

Radiation, Yield, and Fruit Quality of 'Gala' Apples Grown under White Hail Protection Nets

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Damages caused by hail storms on apple trees can be avoided by covering them with nets. However, the net might change the amount and quality of the light supplied to the trees and, therefore, it can affect yield and quality of the fruit. This research was carried out to assess these aspects on 12-15 years old apples trees of 'Gala/MM111 rootstock. The work was conducted along three growing seasons (2003/04 to 2005/06) in a low density orchard (at a spacing of 5.5 x 3.0m), in São Joaquim, State of Santa Catarina, Southern Brazil. The experiment followed a completely randomized block design, with two treatments (uncovered/control plants, and plants covered with white nets) and five replications (with the plant corresponding to the experimental unit). The photosynthetic photons flux density accumulated over the trees canopy along a day was reduced by 20%, while the red:far red ratio of the light inside the trees canopy was not affected by the covering net. The shade provided by the white net increased the total chlorophyll content (mg/m²) and the specific area (cm²/g dry weight) of the leaves. Fruit yield was not affected by the net. For fruits harvested at the commercial period, the net: reduced fruit density, flesh firmness, and soluble solids content; increased the starch index; and had no effect on titratable acidity, skin colour (background colour and blush area), severity of russetting, and number of seeds per fruit. Fruit grown under the covering net developed less sun burn, fruit flies injury and bitter pit. The results indicate that the hail protection net does not affect negatively fruit quality and yield of 'Gala', but it can enhance fruit maturity on the tree.

S02.013

Identification of Appropriate Postharvest Technologies for Small Scale Horticultural Farmers and Marketers in Sub-Saharan Africa and South Asia: Part 1. Objectives and Data collection Methods

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The objectives of the study were 1) to systematically assess and characterize the postharvest losses for key horticultural crops in four countries using field based measurements at the farm, wholesale and retail markets, in order to increase the knowledge base and identify priority postharvest problems that currently limit market access for small farmers and rural marketers, 2) to adapt and field test specific postharvest technologies that could solve priority postharvest problems, by conducting adaptive laboratory experiments and field trials in Sub-Saharan Africa and South Asia, and 3) to identify postharvest technology or extension interventions that would specifically address the identified priority problems and serve to reduce food and value losses, and that are of appropriate scale, cost effective, easy to use on a trial basis and capable of generating increased incomes by at least 30% for small farmers. A series of comprehensive postharvest assessments were undertaken in Ghana, Rwanda, Benin and India during 2009 in order to identify the % physical losses, quality changes and economic value of losses for 16 crops, and based upon these assessments, supplemented by interviews of the

various players along the value chains, the primary causes and sources of postharvest losses and quality problems were identified. Sampling, objective and subjective measurement of physical losses and quality parameters were conducted at the farm, wholesale and retail markets in each of the four countries by trained data collectors housed at 10 partner institutions. Ten (10) random samples were collected at each of the 3 levels of the value chain for each crop. Tomatoes were assessed in all 4 countries, mangoes in 3 countries, and the others in either one or two countries. Sample sizes and quality parameters varied by the type of crop. Sorting was done to determine the % damaged, % decayed and % with other defects within each sample. Rating scales were developed for visually assessing color changes, stage of ripeness, and degree of package protection. Objective measurements of firmness, SSC%, air temperature, pulp temperature and % RH were made using hand held tools in the field.

502.014

Appropriate Postharvest Technologies for Small Scale Horticultural Farmers and Marketers in Sub-Saharan Africa and South Asia: Part 2. Results of the postharvest Losses and Quality Assessments

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Sampling and measurement of postharvest losses and quality parameters at the farm, wholesale and retail markets, and interviews of key players along the value chains revealed a wide range of handling practices that contribute to high levels of physical and quality losses, as well as market value decreases, that need to be addressed in order to reduce waste and improve farmer incomes. Losses were determined to be related to one or more of 4 major factors: 1) Temperature: temperatures measured during harvest, handling, transport and marketing were much higher than those that are recommended for the produce for quality maintenance. The general lack of the use of shade contributes to high pulp temperatures and high water losses. Weight loss in Rwanda for leafy greens (amaranth in sacks) was measured to be an average of 11% over a time period ranging from 30 to 240 minutes after harvest. 2) Poor quality containers: packages were too big, too rough, and too flimsy to provide protection. The % mechanical damage for cabbage handled in sacks in Ghana was measured at 54% (Farm), 32% (Wholesale), and 45% (Retail). When a basket or sack of leafy greens was sorted in the wholesale markets in Benin, the average level of mechanical damage was determined to be 89.5%. 3) Poor field sanitation: promotes the spread of fungal and bacterial diseases and insect pests. For example, pre-sorting losses on the farm due to pest damage were very high for okra in India (18.5%) and for leafy greens in Benin (17.3%). 4) Time: The time it takes to reach the retail market varies widely, and damage increases over time. In India, the average loss in market value at the retail level due to decline in quality was 18% for litchis, 20% for mangoes and 31% for okra.

502.015

Appropriate Postharvest Technologies for Small Scale Horticultural Farmers and Marketers in Sub-Saharan Africa and South Asia: Part 3. Field Trial Results and Identification of Research Needs for Selected Crops

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Based upon findings on the causes of postharvest losses and quality problems for key horticultural crops in Sub-Saharan Africa and South Asia, more than 50 potential technical and/or extension based solutions were identified and investigated further. Field trials were conducted on 19 of these interventions, and cost/benefit analyses were conducted on 21 cases of improved handling, packing, storage and processing practices in India, Nepal, Ghana, Rwanda, Cape Verde and Benin, and in 81% (17 cases), the postharvest technologies were determined to be cost effective

and of appropriate scale for successful adoption and management by small scale horticultural producers and marketers in Africa and South Asia. Field work and these preliminary field trials led to the identification of research needs for selected crops, and recommendations are provided for future studies in small scale postharvest technology.

502.016

Development of Postharvest Handling Technology of Horticultural Produce in Malaysia and its Impact to the Industry

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Postharvest handling system is a vital and dynamic component of the agricultural industry in Malaysia. The system involves preparation, movement and quality maintenance of fresh produce right from harvesting until it reaches the consumers' tables. Postharvest handling chain includes harvesting, packinghouse operations, grading, packaging, storage, transportation, ripening, disinfestations and disease control. While the earlier development of postharvest handling technology was targeted mainly at reducing postharvest losses, the current activities are focused towards supplying safer and better quality produce for the market either domestically or for export. Many improvements and achievements have been made with regard to postharvest handling of horticultural produce in the country as proven by the expansion of the domestic and export markets. Recent advances in postharvest handling technology include further extension of storage life, non-destructive technique for internal quality determination, and suitable physical and chemical treatments for quality maintenance, minimal processing and shipment trials to new markets. Improvements on specific postharvest traits have also been made through agronomic practices and breeding programme including the use of genetic engineering. There are good cooperation among the research organizations with relevant government agencies and private sector both locally and internationally.

502.017

Onion Storage in India

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India is the second largest producer onion in the world accounting for 16 percent area and 10 percent of production. It is grown in 0.6 million hectare with production of 7.0 million tonnes. About 2.5 million tonnes of onion were stored annually to fulfill domestic and export demand. Onion is prevalently stored in on-farm stores under naturally ventilation for 4 to 5 months. The storage losses in these stores are high are due to the higher temperature and humidity. Apart from the storage conditions, there are several other factors such as genetic make up of varieties, cultural practices and post harvest factors which are responsible for higher storage losses. The number of outer scales, their firmness and short dormancy of existing varieties have impact of the storage losses. Manures and fertilizers and water regime during cultivation and rain during maturity period also affect the storability. The time and method of harvesting and curing also influence storage losses. Onion is stored in heaps in various types of storage structures in different onion growing regions. Earlier most of these structures are traditional type with improper ventilation. They were constructed with wooden logs/bantams with thatched roof and earthen floor. Some of them were permanent type with well sawed wood structure and Mangalore tile roofs. Now modified bottom ventilated storage structures are used in major onion growing regions. These structures are of variable capacity ranging from 5 tonnes to 50 tonnes and are made of galvanized iron frame and asbestos sheet / Mangalore tile roof, wooden floor and side walls. These are bottom ventilated and provided better ventilated and storage losses are comparatively lower in these structures. The cold storage of onion is very limited due to several factors such as higher cost, higher post storage sprouting etc.

S02.018

Açaí Berry Cold Chain along the Amazon Rivers, its Quality and Shelf Life Time

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Açaí (*Euterpe oleracea* Mart.) is a berry easily detached from the bunch that can provide up to four kilograms of fruits. Açaí berry has around 15mm diameter, and only 1mm of pulp. The pulp is extracted on a rubbing process with the aid of water. The amount of water and the processing time define the viscosity of the drink. That drink, in fact an emulsion, is an important food among the traditional populations on the Northeast of Para (Brazil). The nutraceutical properties of the drink contributed to create an international market that grows around 20% per year since 2001. Although the market demands, the transport technologies did not change along the amazonian rivers. The author participated of a fluvial trading expedition to buy açaí berries. The ship had a load capacity to 15 tons. The boat departed from Belém (01°27'S, 48°30'W) to Oeiras do Pará (2°00'14"S 49°51'12"W), and docked briefly at São Sebastião da Boa Vista (1°43'17"S 49°32'00"W) to buy sliced ice. The whole trip took five days and were transported 11,7 tons of fruit and 3 tons of ice. Before come back most of the fruits were stored on the basement with the ice, and part was maintained on the deck, shadowed. The temperature was measured in different positions within the load along the trip; the relative humidity was measured at one point in the load and; in the laboratory was measured the respiration of the fruit respect its water content and the storage temperature. This paper evaluate the transport technology respect the shelf life time and the quality of the fruit for industrial processing, and concludes the effectiveness of the cooling process.

S02.019

Acceptable Cooling Delays for Fresh Vegetables and Melons

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Small-scale vegetable growers often do not have infrastructure for cooling and may transport products to larger operations for cooling. Delays from harvest to cool may impact quality mainly due to water loss, high respiration rates and metabolite loss, and increased decay. Here we summarize various tests on fresh vegetables (beans, eggplant, summer squash, peppers) and melons to evaluate the impact of delays to cool on marketable quality (visual appearance, gloss, weight loss, color change, decay, defects, firmness). Products were harvested early in the morning, placed in perforated plastic bags in coolers with ice for transport to the laboratory. Products were then exposed to temperature and humidity conditions for different periods that are representative of California conditions for that product. Products were room cooled or hydro cooled, and evaluated after a postharvest regime of storage and retail display. Sutured (Tuscan) melons with 1% weight or less did not have suture browning, while fruit with 5% total weight loss had high incidence and severity of suture browning. Delays of 8 h at 37 °C resulted in increased suture browning. For non-sutured cantaloupe melons, delays of 4 hours or longer reduced quality when melons were stored for 2 weeks at 2.5 °C. Weight loss of mature-green bell peppers at 25 and 37 °C was 0.4 and 0.75% per hour, respectively. A weight loss of 2 to 4% reduced pepper firmness, gloss and visual quality. Color change was induced in peppers held for 12 hours at 37 °C. For eggplants, marketable quality was decreased with a 3% weight loss, achieved with a 3 hour delay at 37 °C or 6 h delay at 25 °C. Assessments of impact of delays to cool need to be done under typical harvest conditions for specific products, but for many vegetables, delays of 3-4 hours are sufficient to reduce marketable quality.

S02.020

Postharvest Loss Reduction on Cooking Tomatoes cv. MST32/1 Produced by Small Farmers in Mauritius

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Trials were carried out on cooking tomatoes cv. MST 32/1 locally known as Pomme d'Amour to evaluate the level of postharvest losses that occurred with small farmers using traditional systems of weekly harvesting the crop green. After three trials carried out at different times of year it was found that only around 25% of the fruit fully ripened within a week of harvest and also around a quarter of the total harvest crop was already lost to dehydration or disease. Improved handling methods by replacing deep wooden boxes with smooth sided plastic crates and keeping the crop on wooden pallet in shade whenever possible reduced losses and the use of "Ethrel" gave around 60% of the tomatoes fully ripened by the end of the week with total losses by weight reduced to about 20%.

S02.021

Cold Chain Strategy for Serbia

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A cold chain is a temperature-controlled supply chain. An unbroken cold chain is an uninterrupted series of storage and distribution activities which maintain a given temperature range. This cold chain assessment was segmented into three phases: 1) evaluate the existing cold chain for fruits and vegetables in Serbia; 2) identify key constraints to competitiveness within each key sector and element; and 3) create a strategic plan for improving the integrated cold chain in the near-term future. A representative sample of 45 cold storage facilities was generated in an attempt to tour a wide array of conventional chillers, conventional freezers and controlled atmosphere (CA), including Ultra-Low Oxygen (ULO) facilities. The total refrigerated and/or frozen capacity for storage at the 45 facilities was estimated at 100,000 MT. It was estimated by the technical team that this capacity was representative of about 1/5 to 1/4 of the total capacity for refrigerated or frozen storage in Serbia (500-600.000MT). A wide array of facilities exist in Serbia, with most being of the small- or medium-scale size, capable of storing between 150 and 2,500 MT of products, although some very large-scale facilities with capacities of nearly 11,000 MT are operating.

S02.022

Effects of Mechanical Injuries on 'Valencia' Oranges

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Mechanical injuries as impacts and compression forces are very common during after harvest handling procedures to prepare the citrus fruit for the fresh fruit market. In the present work, two experiments were conducted to evaluate impacts and compression forces on the quality of 'Valencia' oranges. Impacts equivalent to drops onto rigid surfaces from heights varying from 40 cm to 100 cm and compression forces equivalent to 31 N, 62 N, 125 N or 250 N were applied to freshly harvested oranges and the fruits were analyzed after seven days at room temperature for fruit color, ratio of soluble solids over titratable acidity and ascorbic acid contents. Fresh weight losses and incidence of decay and oleocellosis were determined as well. 'Valencia' oranges are not highly influenced by impact forces. However, all the applied compression forces altered significantly the sugars/acids ratio. The higher the compression the higher the internal quality changes. Ascorbic acid contents were not significantly altered as a consequence of mechanical damages. Compression forces beyond 62N result in the collapse of peel oil glands. A compression of 250N re-

sulted in 94% collapsed oil glands, though, that amount of damaged oil glands did not result in the appearance of oleocellosis. Valencia oranges seem to be less susceptible to peel injuries and albedo thickness might be accountable for that response.

502.023

Effects of Mechanical Harvesting and an Abscission Agent on Peel Integrity and Post-Harvest Decay of Late-Season 'Valencia'

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In Florida, the combined use of mechanical harvesters and the abscission agent CMNP (5-chloro-3-methyl-4-nitro-1H-pyrazole) for late-season harvesting (May-June) of 'Valencia' oranges has shown to be effective at removing mature fruit with minimal adverse effects on next year's crop. However, CMNP can cause fruit peel scaring, and there was no data available on how this scaring may reduce peel integrity and increase losses due to fruit crushing and/or decay prior to processing. In this study, three late-season harvest dates were tested in commercial groves during 2009. Harvesting treatments consisted of combinations of two ground speed (0.8 and 1.6 km per hour), two shaker head frequencies (145 and 185 cycles per minute) and CMNP foliar applications (3 days prior to harvesting) at 250 mg·L⁻¹ in a spray volume of 2810 L·ha⁻¹, plus mechanically harvested and hand picked controls. After harvesting, fruit samples were randomly collected from each block for peel resistance and postharvest decay evaluations. Peel resistance was determined by measuring both peel puncture force and fruit crushing force (kg). Fruit used to study post-harvest decay were stored at 27 °C and 50% relative humidity and evaluated at 0, 3 and 7 days. The results showed that peel resistance was not affected by mechanical harvesting combinations or CMNP application. Low correlations were found between fruit crush force and fruit weight, with a tendency to higher peel resistance in heavier fruit. No significant effects on post-harvest decay were found for any treatment as compared to hand-picked controls until day 3 of storage. CMNP caused a significant increase (4-5%) of post-harvest decay at day 7. The results indicate that CMNP can be safely used in combination with late-season mechanical harvesting under the conditions described in this study, without losses due to fruit crushing or decay for at least 3 days.

502.024

Characterisation of Air and Pulp Temperatures in 12 M Integral Reefer Containers Carrying Japanese Plums (*Prunus salicina* Lindl.) under Dual Temperature Shipping Regimes

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'Sapphire', 'Fortune' and 'Laetitia' (*Prunus salicina* Lindl.) plums were harvested at optimum maturity. Air- and pulp temperatures were logged at three heights in all 20 pallets in 12 m integral reefer containers. Containers were shipped from South Africa to Belgium under a dual temperature regime (2 days at -0.5 °C, 5 days at 7.5 °C and the remainder of the voyage at -0.5 °C). Fruit firmness was measured at harvest and after shipping, and the occurrence of internal defects after a shelf life period of seven days. Three processes were identified as important characteristics of pulp temperature recorded during commercial dual temperature shipping, viz. cooling down, heating up and over heating in the container. The order of importance differed by cultivar and the specific container's performance. Three distinct temperature zones were identified, wherein pulp temperature, time to heat up and time to cool down for each zone increased along the length of the container, across the width from left to right and in pallet height. Temperature variability was ascribed to variations in delivery air temperature, poor airflow and the effect of increased respiration rates. The cooling down process was identified as the most important process

discriminating the temperature zones. Fruit size had a significant influence on fruit firmness and total soluble solids prior to shipment. Variable temperature conditions within the 'Sapphire' and 'Laetitia' containers had a significant influence on fruit firmness post-shipment, where deterioration levels increased from the front to the door end of the container due to an increase in pulp temperature. Temperature variances within the 'Fortune' container had no significant influence on the fruit firmness post-shipment, confirming that 'Fortune' could possibly be classified as a suppressed climacteric cultivar. It could not be proven that variable temperature conditions resulted in significantly higher levels of fruit internal defects.

502.025

Using Computational Fluid Dynamics to Optimize the Design of One Layer Storage System for Tulip Bulbs

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Tulip bulbs are stored in containers, which are ventilated to a level of 300-500 m³ per m³ bulbs per hour to avoid high ethane concentration. The containers are positioned in an arrangement of 5-6 rows with 8-10 containers per row, each one on a pallet (one layer system), with an adjusted large box containing a ventilator. The air flows through the bottom canals of the containers, through the tulip bulbs and then escapes through a small slit at the upper side wall of each container. Ideally the ventilation rate should be equal through each container, although this is not the case. To overcome the nonuniformity the ventilation rate has to be adjusted to the container with minimal ventilation rate; therefore ventilation is set at a high rate to avoid risks. In this study a CFD model was used to investigate the potential energy saving by applying simple design improvements of the air inlet area. After the investigation of many configurations, the best results were given when a 40 cm plate was positioned just before the first row of the containers, at an angle of 47° from horizontal level and to a distance of 70 cm from the first pallet. In addition, by reducing the inlet area of each canal, the air flow per row becomes more equal. The improvements suggested by the CFD model were applied in a real commercial storage system. Experimental measurements have shown that the installation of the plate combined with 8% reduction of the air flow results an energy saving of 20%. By adjusting the air inlet area of each canal, energy saving of 55% could be achieved. The suggested improvements have been adopted by the growers, showing that CFD modelling is a useful tool to improve the efficiency of storage systems for tulips bulbs.

502.026

Effect of Different Precooling, Inner and Outer Packing and Cold Storing on Quality of Broccoli

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The effects of three different precooling methods [pressure cooling (PC), cold room cooling (CR), ice cooling (IC), inner [0.02mm polyethylene (PE), 0.06mm polyvinyl chloride (PVC), shrink film] and outer [expanded polystyrene cases (EPS) and corrugated paper boxes (CPB)] packing on the quality of broccoli during 44 days storage at (0±0.5) °C were studied. The results showed that the quality of broccoli that was pre-cooled by pressure pre-cooler and then packed with expanded polystyrene case was better than that by cold room cooler and ice and with corrugated paper box. The pre-cooling rate of pressure pre-cooling was faster than that of cold room cooling and ice cooling. During cold storage, the weight losses and yellowing index of broccoli increased gradually; the total soluble solid, chlorophyll and ascorbic acid contents decreased gradually; the broccoli packed with 0.02mm PE had the smallest weight losses and could maintain a high chlorophyll, soluble protein and ascorbic acid content; the broccoli packed with expanded polystyrene cases had lower respiration rate, peroxidase (POD) activity and yellowing index.

S02.027

New Sensor Technology for Sensitive Ethylene Detection

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A new electro-catalytic sensor for measurement of gaseous ethylene (C_2H_4) concentration in air is presented. The measuring principle is based on ethylene oxidation to CO_2 and H_2O on a gold-plated anode with weak sulphuric acid as catalyst, the small ethylene molecules are trapped in the pores of the gold-plated anode; the measurement consumes ethylene. During the warming-up phase, the unit automatically calibrates its zero by employing dried, ethylene-free gas from the built-in drying and potassium permanganate columns. Thereafter, the unit requires humidified calibration from gas supplied externally e.g. from a cylinder at a concentration of between 4-10 ppm C_2H_4 ; this end-point calibration is kept until switching off. The accuracy was 96-98% with a SD of 0.05-0.15 ppm C_2H_4 and a variation coefficient of 0.5-2%, when the calibration gas of 8 ppm C_2H_4 was measured after calibration. The measuring range is 0 -50 ppm C_2H_4 with an accuracy of +5% and displayed resolution of 1 ppb. For a 30 sec measurement, the instrument draws a ca. 150 ml gas sample and appears suitable for measurement of individual fruit in an open or closed gas system, single gas samples or traditional injection of a ca. 5 ml gas sample. Temperature and humidity (and as additional options CO_2 concentration, another gas or ethylene analogues like MCP) are displayed concomitantly. The reproducibility of the values was 93% with 3 subsequent measurements of a variety of fruits. The unit can be operated on mains or built-in battery providing up to 8 hours operation and weighs 4.5 kg, which makes it portable for *in-situ* ethylene measurement after calibration with an external gas supply and is elegant alternative to ethylene determination in a 10 ml sample from head space of jar after hours of accumulation, by gas chromatography.

S02.028

Energy Savings as Reduced Costs and Lower CO_2 Emission Using Smartfreshsm (1-MCP) on Red Delicious and Fuji Apples in Commercial CA Storage

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Applications of SmartFreshSM (1-MCP) in commercial CA rooms of Red Delicious and Fuji apple cultivars in 2 cooperatives of Trento Province with cooling of the fruits at night delivered economic savings in comparison to conventional CA storage due to the lowest cost of energy at night. The cooling periods to bring fruit to final storage temperature for 1-MCP fruits were 16 days for Red Delicious and 28 days for Fuji. After the fruits reached storage temperature (the same in 1-MCP and control rooms for each cultivar) the energy savings and associated costs continued to be recorded for CO_2 scrubbing which showed that the lower metabolism of 1-MCP fruits delivered savings both in terms of economics and in terms of CO_2 emissions, with a double benefit for the user and for the environment. The average emission of CO_2 (in kg of CO_2 / day/ton of apples) were 2.88 vs. 4.08 on Red Delicious and 1.29 vs. 2.84 on Fuji, respectively 29% and 55% lower emissions from 1-MCP fruits. The total economic savings, sum of the savings of initial cooling and the following CO_2 scrubbing up to the opening of the rooms, were respectively 269 euro (-28%) for Red Delicious 1-MCP room (ca. 6 months storage) and 432 euro (-34%) for Fuji 1-MCP room (7 month storage).

S02.029

1-MCP (SmartFreshSM) Contributes to Energy Saving in Apple Storage

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'Golden Delicious' apples are commercially stored in Israel, within 5-7 days after harvest, in a controlled atmosphere (1/5% O_2 , 2% CO_2) at 0 °C, following forced air pre-cooling and bin covering with perforated LDPE sacs. The last step is due to the high susceptibility of this cultivar to shriveling, due to water loss that arises from the difficulty in maintaining >95% RH at 0 °C in most commercial storage rooms. The objective of this study was to examine the hypothesis that application of 1-MCP to 'Golden Delicious' prior to storage would enable raising the storage temperature without incurring fruit softening, which in turn would facilitate maintaining a high RH and thus dispense with bin covering. In this manner energy would be saved in pre-cooling and refrigeration and the labour required to cover the bins would also be made redundant. Two trials, conducted in a commercial situation, demonstrated that 1-MCP -treated Golden Delicious apples could be stored for eight months at 1 °C, without pre-cooling and bin covering and with no loss of quality. To this end, a specific protocol of 1-MCP application for this cultivar, which also prevents the development of diffuse skin browning (DSB), was developed and will be described, together with its advantages and disadvantages.

S02.030

Evaluation of Four Pallet Compatible Boxes Developed for Mechanical Protection, Mixed Loads and for the Display of Fruits and Vegetables in Brazilian Markets

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Luengo (2005) developed four complementary packages dimensioned to foster mechanical injury protection during the transport and the commercialization of weighed packed fruits and vegetables. Each one of these boxes has a list of suitable fruits and vegetables they attend and as a group these boxes are pallet compatible even in mixed loads, which are highly demanded in Brazil. Developed to assure the product is not compressed during handling and transportation these boxes, at the same time, attend relevant Brazilian laws developed to improve the system logistic and ergonomometry. The evaluation of this compatibleness oriented group of boxes was done according to potential users responses to questionnaires, which were applied after demonstrative on site presentations. On a first questionnaire these boxes were evaluated according to the accumulated impressions they had about sizes, shapes and overall system compatibility using a crescent acceptance scale with of 1 to 9. In a second questionnaire different members of the market were asked about the intention they may have to buy or to use these boxes, if they become commercially available, in a crescent acceptance scale of 1 to 5. For vegetable producers, the scores obtained in these two questionnaires were on average 6.90, 7.13, 7.51 and 3.56, while for the wholesalers the scores were 5.33, 6.72, 8.11 and 3.05, respectively for size, shape, overall system suitability and for the potential market-ability that was inferred according to the buy/use intention score. The scores given by the evaluators of both groups were highly positive. The producers' scores were higher but contrasting the whole sellers score for the overall system suitability was outstanding, and this single aspect may be considered to be a main strength of this compatibleness oriented group of boxes.

S02.031

Relating Apple Volatile Biology with Aroma Perception during Fruit Maturation

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Aroma volatiles from fresh apple and other fruit can be considered to be a result of autonomous biological activity and biological activity resulting from cellular disruption, as during mastication. The lipoxygenase (LOX) pathway has been implicated in both autonomous and cell disruption-dependent processes. We investigated odor-active volatiles from 'Jonagold' fruit resulting from cellular disruption.

tion throughout maturation to better understand the relationship between volatile biology and perceived apple aroma. The study was conducted over 8 weeks and evaluations were twice-weekly. On each date, internal ethylene, CO₂ production, and volatile profiles for crushed, 1-methylcyclopropene (1-MCP) treated ('non-ripening') and control ('normally ripening') fruit were measured. Volatiles were assayed and sensory tests performed approximately two minutes after crushing. Unexpectedly, panelists were able to distinguish between non-ripening and normally ripening fruit more than two weeks before the onset of the ethylene and respiratory climacterics in control fruit. LOX-derived aldehydes cis-3-hexenal and hexanal were not detectable for whole fruit, consistent with its dependence on cellular disruption. For crushed fruit, however, aldehyde synthesis was, at first, extremely high for non- and normally-ripening fruit such that the concentration of both aldehydes was several hundred times higher than respective odor thresholds. Cis-3 hexenal remained constant throughout the experiment for non-ripening fruit, but declined markedly for normally ripening fruit, coincident with autocatalytic ethylene formation. Conversely, hexanal increased in normally ripening fruit at this time, but not in non-ripening fruit. Changes in these aldehydes occurred two weeks after perceived differences in aroma between 1-MCP treated and control fruit. The autonomously-produced ester butyl acetate increased coincident with panel detection of treatment differences, although the concentration of butyl acetate at this early stage of development was below the human olfactory threshold. The data for autonomous and disruption-dependent aroma volatiles do not explain sensory analysis results.

S02.032

Aroma Volatiles during Whole Melon Ripening in a Climacteric Near-Isogenic Line and its Inbred Non-Climacteric Parents

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A climacteric aromatic near-isogenic line (NIL) of melon (*Cucumis melo* L.) SC3-3-5-1 was obtained from non-climacteric parents: the Korean cultivar Songwhan Charmi accession PI161375 -SC-, and the cultivar Piel de Sapo -PS-. The aroma volatiles of individual fruit of the lines were stored at 19.4 °C and monitored during ripening by using headspace sorptive bar extraction and gas-chromatography mass-spectrometry. The compounds were grouped and plotted using area counts and relative percentage compared with total area counts of the compounds positively identified or the total headspace. By areas, the predominant compounds were esters in SC3-5-1 and SC, while acids and to a lesser extent aldehydes, ketones, terpenes and aliphatic compounds were noticeable in PS. In the non-aromatic SC, the relative levels of acetate and non-acetate esters were around 30-40% and 40-50%, respectively, reaching after 3 d at 20 °C a minimum in acetate and a maximum in non-acetate esters relative levels. In PS volatile acids increased during ripening with a peak after 5 d (40%), while the relative level of esters in PS slightly increased after 7 d. The PS aldehydes showed maximum relative level at harvest (35%) to decrease during the first 2 d after harvest. The PS terpenes linearly increased during ripening up to around 30%, and aliphatic compounds and ketones were below 20%. In SC3-5-1, the acetate esters linearly increased during ripening with a relative peak after 3 d concomitant with the onset of climacteric behaviour, a high increase in non-acetate esters and a drop in alcohols. After 6 d of ripening, the non-acetate and alcohol levels in SC3-5-1 returned to harvest levels. The area of acetate esters were two to three folds higher in SC3-5-1 than in SC. The SC introgression alone or interacting with the PS genetic background determined the aroma in the climacteric NIL SC3-5-1.

S02.033

Effect of Refrigeration on Tomato Aroma: A Biochemical and Sensory Analysis

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Fruits and vegetables quality standards have been established based mainly on physical quality parameters. However, in recent years, maintenance of the postharvest sensorial quality has gained importance for consumer acceptance. Refrigeration is the main postharvest technology to increase shelf life in horticultural products. Even though, optimal storage temperatures have been established for different commodities, there are few studies on the effect of low temperature on flavor. Fresh tomato characteristic flavor is the result of complex interactions between organic acids, soluble sugars and over 400 volatile compounds, derived from different biochemical pathways such as the catabolism of lipids, aminoacids, lignins and carotenoids. Alcohol dehydrogenase (ADH) is considered an important enzyme which contributes to flavor development by interconverting aldehyde and alcohol forms of volatiles originated from lipids and aminoacids. In this study, we analyzed the effect of the recommended storage temperature of tomato (12.5 °C) both in the physical quality and on the aroma profile determined by GC-FID and its correlation with ADH activity, gene expression and sensory evaluation. Refrigeration delayed loss of weight, firmness and color changes. Regarding the effect of refrigeration on the aroma volatile profile, changes were not detected until 6 days of storage compared to fruit stored at 20 °C. Refrigerated storage prevented the accumulation of some alcohols derived from lipids. A concurrent decrease on ADH activity and gene expression in refrigerated fruit might explain some of these changes. Discriminative sensory tests showed that the observed volatile changes were not detectable at 6 days of storage; however, a more prolonged analysis will be necessary to determine the effect of refrigeration on consumer flavor perception.

S02.034

Demonstration of New Biosynthetic Pathway for Precursors to Esters in Ripening Apple Fruit: Implications of ¹³C- Labelled Acetate Incorporation and Identification of New Genes

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In ripening apple fruit, we propose a new pathway that uses the starting products pyruvate and acetyl-CoA for the synthesis of precursors to branched- and straight-chain esters. This pathway not only provides for the synthesis of isoleucine but also for 3-, 4-, and 5- carbon fatty acids via the process of single-carbon fatty acid elongation. The incorporation of ¹³C- labelled acetate (1-¹³C, 2-¹³C, ¹³C₂) into esters and ester precursors synthesized by peel discs of 'Jonagold' and 'Red Delicious' apple [(*Malus sylvestris* (L.) Mill. var. *domestica* (Borkh.) Mansf.)] fruit supports this hypothesis. Labelled acetate was incorporated into isoleucine and esters containing 2-methylbutanoate, a degradation product of isoleucine. Further, propanoate, butanoate, pentanoate esters, and the acids citramalic and citraconic acid were labelled. In addition, we identified two novel genes for citramalate synthase (MdCIM1 and MdCIM2), which forms citramalic acid from acetate and pyruvate. The gene is a member of the 2-isopropylmalate synthase (IPMS) gene family. Purified His-tag CIM protein formed citramalate and 2-ethylmalate from the α -keto acids pyruvate and α -ketobutyrate, respectively, when acetyl-CoA was added. Its substrate specificity for α -keto acids in decreasing order was α -ketobutyrate, pyruvate, α -ketovalerate, and α -ketoisovalerate, which differed from IPMS. The hypothesized new pathway constitutes a conceptual shift in the regulation of ester biosynthesis suggesting that synthetic rather than degradation pathway for continuous precursor supply to aroma production may play an important role in ripening apple fruit.

S02.035

Lysophosphatidylethanolamine Effects Upon Volatiles and Quality of Fresh-Cut Galia Melon

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Wounding plant tissues increases the hydrolysis of phospholipids mediated by phospholipase D. Such action generally gives rise to C6 and C9 aldehydes and alcohols, which can be flavour-related in several crops. Lysophosphatidylethanolamine (LPE), a naturally occurring phospholipid, has been reported to inhibit phospholipase D, so it can provide a means to reduce quality degradation in fresh-cut fruit. LPE application to fresh-cut fruit may reduce membrane lipid degradation, but may also alter the aromatic profile, via suppression of lipid-derived volatile compounds. In this study, the potential effect of LPE upon quality and aromatic profile of fresh-cut melons was investigated. Galia-type melons (cv. Fiesta) were processed and vacuum-infiltrated with 200 ppm of LPE, packaged in polypropylene trays and stored for 7 days at 4 °C. Four replicate packages of LPE-treated melon cubes and untreated controls were sampled by 0, 1, 4 and 7 days in storage. Colour, firmness, soluble solids content (SSC), ethylene production, respiration rate and volatile production were measured. Volatile compounds were extracted via Stir Bar Sorptive Extraction and quantified via GC-MS. Color and SSC remained constant throughout storage. There was no significant effect of LPE upon colour, firmness, SSC, ethylene production and respiration rate. Esters, aldehydes and sulphur-containing compounds were the major volatiles in fresh-cut melon. LPE reduced most acetate (propyl acetate, isobutyl acetate, 3-methylbutyl acetate, 2-methylbutyl acetate, hexyl acetate and pentyl acetate) and non-acetate (ethyl 2-methyl propanoate, methyl 2-methyl butanoate, ethyl butanoate, ethyl 2-methyl butanoate and ethyl propanoate) esters, alcohols (eucalyptol, hexanol and benzene propanol) and aldehydes ((Z)-6-nonenal and hexanal) but had no effect on benzyl acetate, octyl acetate, 2-phenethyl acetate, ethyl hexanoate, methyl butanoate, (Z)-6-nonenol, (E)-2-nonenal, ethyl (methylthio) acetate and ethyl 3-(methylthio) propanoate. Therefore, LPE application, used as a membrane protective treatment, can have a specific inhibitory effect upon volatile compounds production by inhibition of lipid-breakdown products.

S02.036

Effect of Fruit Maturity and Cutting on the Respiration and Volatile Production of Apple Fruit

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Consumption of fresh fruit is increasing as consumers become more aware of their nutritional value and role in disease prevention. Apple fruit (*Malus domestica* Barkh.) is one of the most popular fruits consumed in the world and the production of fresh-cut apples has increased significantly in the past few years. However, fresh-cut products are highly perishable and challenges remain to preserve their eating quality during marketing, which includes appearance, colour, texture, flavour and nutrition. Processing, packaging and storage technologies have extended the visual quality of fresh-cut apple products, but have neglected flavour. Therefore, improvement in flavour quality is needed to meet consumer demand for more flavourful fruit. In order to understand the postharvest physiology and flavour biosynthesis in apple slices, 'Gala' and 'Ambrosia' apple fruit were harvested at three maturities. Following storage at 20 °C for two days, half the fruit was cut into apple slices (12 slices/apple) and their cores removed, while the other half was kept uncut to serve as the control. Both respiration and volatile content were measured 3, 6, 12, 24 and 48 h after cutting and were found to be significantly affected by both fruit maturity and cutting. Respiration was 3-fold greater in sliced compared to whole apples. In

total, 33 volatile compounds were identified and quantified. Total volatile production increased as a result of increasing apple maturity and cutting. Concentrations of straight chain esters, acetates and alcohols, including ethyl acetate and ethanol, were increased by cutting. Hexanoates and estragole increased with fruit maturity. However, neither fruit maturity nor cutting influenced branched chain esters or butanoates. These results provide new insights into the effects of fresh-cut processing on the flavour quality of apple products.

S02.037

Volatile Production, Precursors and Some Related Enzymes Affected by Ethephon and 1-Methylcyclopropene in Apple Fruit

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Effects of ethephon, and 1-methylcyclopropene (1-MCP) on volatile production, concentration of fatty acids and amino acids, activities of lipoxygenase (LOX) and Alcohol acyl-CoA transferase (AAT) in 'Starcrism' apple fruit were investigated during 20 days storage after harvest. The volatile profiles of 'Starcrism' apple fruit were dominated by esters and alcohols. Ethephon stimulated the production of internal ethylene, esters and alcohols in apple fruit. 1-MCP inhibited ethylene production and the total volatile concentration in fruit treated by 1-MCP was considerably lower with hexenal and hexanal as the dominant components. Concentrations of such free fatty acids (FA) as palmitic, linolenic, oleic, linoleic, stearic and erucic acid showed a decrease at first and then increased with onset of ethylene climacteric in untreated fruit. Ethephon treated fruit showed similar trend of these FA. But the increase occurred earlier. In 1-MCP treated fruit, these free FA showed a sudden increase and then decreased sharply to a low stable level. Isoleucine increased more than 5-fold while other amino acids decreased or remained constant during 20 days storage and the increase was enhanced by ethephon. Isoleucine concentration in ethephon treated fruit kept more than 3 times of the untreated fruit. Accumulation of iso-leucine was accompanied by increase of ethyl 2-methyl-butanoate production. But in 1-MCP treated fruit, isoleucine concentration was relatively stable and no ethyl 2-methyl-butanoate was detected. The facts suggested that regulating the supply of biosynthetic precursors of aroma volatiles by affecting the metabolism of fatty acids and amino acids may be the way of ethylene regulating production of aroma volatiles in apples.

S02.038

Influence of Volatile Compounds Emission and Standard Quality on Peach and Nectarine Consumer's Acceptance

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In order to increase fruit consumer's satisfaction, it is important to define eating quality of fresh peaches and nectarines on the basis of consumer requirements and acceptance. As related to eating quality, stone fruit flavour depends on a delicate balance of sugars, acids and aroma volatile compounds, with a number of additional factors, such as pulp texture, also influencing perceived quality. This research is focused on the evaluation of standard quality parameters and aroma volatile compounds of eleven peach and nectarine cultivars and their influence on consumer's acceptance. Fruit of 'Early Rich', 'Sweet Dream', 'Elegant Lady', 'August Red', 'Royal Glory', 'Honey Royal', 'Venus', 'Big Top', 'Nectagala', 'Honey Blaze' and 'Nectalady' cultivars were picked at commercial harvest, and analysed after remaining 2 days at 20 °C. A partial least square regression model (PLS1) was run, in an attempt to correlate volatile compound emission and standard quality parameters as X-variables to consumer's acceptance studied as Y-variable, and thus to find the variables having most weight on the discrimination between cultivars. Higher acceptance scores, expressed as higher degree of liking, were associated mainly to greater content of soluble solids and to higher emission of delta-decalactone, gamma-dodecalactone, 1-pentanol, butyl octanoate, pentyl acetate, 2-methylpropyl hexanoate and ethyl octanoate.

S02.039

1-MCP Prolongs the Shelf-Life of Guava (*Psidium guajava* L.) and Changes the Aroma Profile of Fruits

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Guava fruits are highly perishable and deteriorate within few days. Moreover, these fruits are highly aromatic to the point that some consumers don't purchase these guavas due to their 'disturbing' aroma. In the last years, guava cultivated in the West Bank, Palestinian Territories were subjected to various treatments to extend their shelf-life, as well as to reduce the negative impact of the strong aroma on the consumer's perception. Accordingly, various plastic films and 1-MCP were tested, in which plastic films were used to create modified atmosphere conditions. Various quality parameters were assessed and the aroma profile was investigated using SPME-GCMS approach. Results show clearly that 1-MCP significantly retard the ripening process, as indicated by greener, and firmer fruits compared to untreated fruits. The main consequence of this retardation is the prolonged shelf-life of these highly perishable fruits. Moreover, 1-MCP treatment resulted in a highly reduced biosynthesis of aroma volatiles. Further, it was evident the 1-MCP significantly altered the odour-volatiles composition. Among the investigated volatiles which will be discussed are the following: Ethyl Acetate, Ethanol, alpha-Pinene, Butanoic acid, ethyl ester, Acetic acid, butyl ester, Hexanal, 1-Butanol, 3-methyl-, acetate, .beta.-Myrcene, D-Limonene, Eucalyptol, gamma-Terpinen, beta.-trans-Ocimene, m-Cymene, and alpha.-Cubebene.

S02.040

Kinetics of Volatile Synthesis Following Cellular Disruption Associated with Masticated and Cut Fresh Apple Fruit

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During mastication and food preparation, cellular disruption of apple and other fresh fruit causes the mixing of cellular contents and induction of numerous chemical and enzymatic reactions not normally present in the intact tissue. Reactions associated with the lipoxygenase pathway result in the synthesis of significant quantities of volatile aldehydes, with the potential to contribute to alcohol, acid, and ester synthesis. These volatiles are known to impact aroma, herbivore, pathogen development, and insect predation. We wanted to determine if the kinetics of these reactions in apple changed with fruit ripening stage and if the changes in these parameters could impact the sensory quality of fresh fruit during consumption. Using a model system consisting of volatile collection chambers adhered to the surface of 'Jonagold' apple fruit, we found transient 'waves' of volatiles were produced. The initial wave was almost exclusively aldehyde products of the lipoxygenase pathway, which were then converted to alcohols, which, in turn, were incorporated into esters. The rate constants of these sequential reactions were estimated using mathematically-derived equations, providing a tool for comparing enzymatic capacities during ripening. The data indicate that lipoxygenase-derived aldehydes contribute to aroma of apple fruit during mastication, but alcohols and esters from these aldehydes do not. It is suggested that the impact of the lipoxygenase pathway on aroma is largely negative for apple during the eating experience.

S02.041

Effects of Pre-Storage Treatment at 20 °C on the Standard, Sensory and Aromatic Quality of 'Big Top' Nectarines

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A commercial controlled delayed cooling or pre-storage treatment at 20 °C was assessed to extend market life of the most important European nectarine cultivar. The treatment efficacy is depending on the cultivar and the period of exposure. 'Big Top'

nectarine fruits were subjected to pre-storage treatment at 20 °C for 0, 5, 10, 24 or 36 hours after harvest and stored at -0.5 °C for 10, 20 and 40 days. After cold storage, fruit were kept at 20 °C for three days to simulate retail shelf life. Volatile compounds with odour active, sensory attributes and standard quality parameters were determined thereafter. Nectarine volatiles were analyzed using a dynamic headspace system with Tenax trap, automated short path thermal desorption, and CG-FID and GC-MS. The composition of volatile compounds emanating from the fruit varied quantitatively and qualitatively with storage conditions. Data were subjected to Principal Component Analysis (PCA). The PCA model revealed which variables accounted most for the differences observed in the samples among treatments. Fruit from 10 and 24 h of the pre-storage treatment after 10 or 20 days of cold-storage showed higher flavour, juiciness and sweetness perception and soluble solids content, as well as greater concentrations of butyl propanoate, butyl hexanoate, 2-methylbutyl 2-methylpropanoate, 2-methylbutyl 2-methylbutanoate and pentyl hexanoate.

S02.042

Effects of an Additional Period under Cold Air After ULO Storage on the Standard, Sensory and Aromatic Quality of 'Golden Reinders'® Apples

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Volatile compounds released by apples make a major contribution to fruit aroma. Controlled atmosphere storage with low level of oxygen cause a decrease on the emission of most volatile compounds, and can have an impact on sensory quality. The aim of this work was to evaluate the influence of a short period under cold air after ultra low oxygen (ULO) storage on the emission of volatile compounds, standard quality parameters and sensory attributes in 'Golden Reinders'® apples. Apples were harvested at commercial maturity stage and stored for 19 or 30 weeks at 1 °C and 92 % relative humidity under ULO (1% O₂;1% CO₂) or ULO plus different periods (2 or 4 weeks) in cold air; after 7 days at 20 °C the fruits were analyzed. The results showed that 26 volatile compounds were increased by ULO+2w or ULO+4w atmospheres. For short-term storage (19 weeks), the ULO+4w atmosphere was the most efficient for increasing the volatile compound emission, whereas after 30 weeks, ULO+2w atmosphere was enough to achieve the enhancement. It should be remarked that some of these compounds are considered characteristic for this variety (presenting positive log odour units), and therefore, flavour was probably improved by these atmospheric conditions. As related to sensory quality, consumers scored equally fruits stored under the different atmosphere conditions. On the other hand, some sensory attributes (acidity, firmness and crispness) were scored with less intensity by a trained panel for fruits kept under ULO+4w conditions (after 30 weeks of storage). Standard quality parameters were maintained after storage (upper the minimum recommended values) for all the atmosphere conditions. Thus, ULO+2w atmosphere would be the optimum conditions to preserve the sensory and standard quality as well as to increase the volatile compound emission after 30 weeks-storage for 'Golden Reinders'® apples.

S02.043

Reduced Risk Control Options for Apple Postharvest Diseases in Long-Term Storages

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Blue mould caused by *Penicillium expansum* Link and gray mould caused by *Botrytis cinerea* are the two important postharvest diseases of apples in Canada in long term storages. In recent years, 1-methylcyclopropene (1-MCP) has shown tremendous potential in maintaining fruit quality in apples during storage. The objective of this study was to determine if 1-MCP effects the control of postharvest blue mould and gray mould with reduced risk postharvest fungicides, fludioxonil (a phenylpyrrole), and pyrimethanil (an anilinopyrimidine) on 'Empire' and 'McIntosh' apple fruits. The fruit that had been wounded immediately after optimum harvest for long-

term storage (as determined by internal ethylene content and starch staining) were treated with/without 1 $\mu\text{L}\times\text{L}^{-1}$ 1-MCP for 24 h at 0 °C. Control did not receive 1-MCP. In post-inoculation treatments, wounded apples were inoculated with 1 x 10⁴ conidia/ml of either TBZ-resistant *P. expansum* or *B. cinerea* and incubated for 18-20 h at 13 °C, and then drop treated with appropriate concentrations of fungicides. Treated fruit were incubated in cold storage at 2 °C for up to 6 months, or in controlled atmosphere (CA) storages for up to 5 months (McIntosh; 3 °C, 1.5% O₂ and 2.5 % CO₂) and 6 months (Empire apples; 1.7 °C., 2.5% O₂ and 2.5 % CO₂) and in a subsequent shelf-life study at 20°C for 7 days . Both fungicides were found effective against blue mould caused by TBZ (a benzimidazole)- resistant *P. expansum* and gray mould caused by TBZ (a benzimidazole)- resistant *B. cinerea* in apples in cold and CA storages. 1-MCP has neither positive nor negative effect on the control of blue mould or gray mould with postharvest fungicides.

S02.044

A Role for Reactive Oxygen Species in Postharvest Biocontrol

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Reactive oxygen species (ROS) play an important role in plant defense responses against pathogens. There is evidence that microbial biocontrol agents also induce a transient production of ROS in a host plant which triggers local and systemic defense responses. In this study, we explored the ability of yeast antagonists to induce defense-related oxidative responses in fruits. We observed that two antagonist yeasts, *Metschnikowia fructicola* and *Candida oleophila*, generate greater levels of super oxide anion (O₂⁻) on intact fruit surfaces (poor in nutrients) than when they are grown on a nutrient-poor agar medium. When the antagonists are applied to wounded fruit (rich in nutrients) accumulation of O₂⁻, detected by nitro blue tetrazolium staining, occurs more rapidly than when the yeast are grown on a nutrient-rich medium. Using laser scanning confocal microscopy, we also observed that the application of *M. fructicola* and *C. oleophila* into citrus and apple fruit wounds was correlated with an increase in H₂O₂ accumulation in host tissue. As early as 18 hours after inoculation, the level of H₂O₂ in inoculated, wounded tissue was 4-fold greater than in controls wounds inoculated only with water. Yeast continued to stimulate H₂O₂ production in citrus fruit up to 66 h after inoculation and H₂O₂ levels were still threefold above the control. Living yeast cells were detected in fruit wounds at this time point indicating the ability of *M. fructicola* to tolerate host ROS, which has been suggested to be an intrinsic characteristic of effective yeast antagonists. Collectively, our data along with our earlier report on the importance of H₂O₂ production in the defense response of citrus flavedo to postharvest pathogens indicate that the ability of yeasts to induce an oxidative response in fruit tissue may be an essential aspect of yeast species and strains that serve as effective postharvest biocontrol agents.

S02.045

Cross-Tolerance and Antioxidant Metabolism as Determinants of Resistance of Apple Fruit to Postharvest *Botrytis* Decay

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Consumers expect a year-round supply of disease-free, good quality fruit. In apple, the post-harvest storage properties and susceptibility to post-harvest phytopathogens of cultivars differ substantially. Unfortunately though, little is currently understood about the molecular/cellular basis for these differences. Recently we have

shown that higher fruit vitamin C (L-ascorbic acid, AsA), and antioxidant contents are positively correlated with several aspects of postharvest quality. For example, fruit from apple cultivars with a higher mean AsA content generally are less susceptible to post-harvest decay by the necrotrophic fungus *Botrytis cinerea*, and in pears, internal AsA contents correlate with the patterns of susceptibility to internal browning (Davey, *et al.*, 2007, Franck, *et al.*, 2003). This relationship between elevated antioxidant contents and the improved (a)biotic stress-resistance postharvest is probably related to the capacity of tissues to deal with the consequences of H₂O₂ production resulting from infection and storage stresses. Here we have carried out a detailed characterisation of fruit antioxidant metabolism in 2 apple cultivars differing in their susceptibility to infection with *Botrytis cinerea*. This includes an analysis of the major antioxidant metabolites, and their metabolising enzyme activities (catalase, superoxide dismutase, ascorbate peroxidase etc.). We show that pre-harvest exposure to high-light stress, can induce cross-tolerance to post-harvest *Botrytis* infection and have examined the relationship between metabolites, enzyme activities and disease susceptibility in different tissues to help identify the major determinants associated with induced resistance to *Botrytis* decay. In the long term it is hope that this information can be used to develop markers for improved post-harvest storage.

S02.046

Development of a Practical Method to Evaluate the Efficacy of Potassium Sorbate as a Germination Inhibitor of *Penicillium digitatum* Conidia for Potential Use in the Citrus Supply Chain

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Penicillium digitatum, the cause of green mould, is the most serious pathogen found in the citrus supply chain. Currently the disease is controlled using conventional fungicides including imazalil and thiabendazole but there is the risk of increased pathogen resistance or that the chemicals could be withdrawn. Residue levels of chemicals on fruit and the disposal of fungicide solutions are also problematic. Thus, there has been increasing research into the use of 'generally regarded as safe' (GRAS) chemical alternatives for controlling *P. digitatum*, including the food additive potassium sorbate (KS). Initially a practical, laboratory method was developed to induce conidial germination. Combinations of various fruit sugars with citric acid did not induce conidia germination. Three orange juices were trialled at 0.625% concentration with Minute Maid® and fresh Navel orange juice inducing conidia germination after 8hrs. With the germination medium established this was then amended with KS concentrations of 0.003%, 0.005% and 0.050% wt/vol., buffered at pH 4.5 and 5.5, and 1.18x10⁶ conidia/ml. After 9hrs at 25 °C all three KS concentrations gave EC95 concentrations at pH 4.5. At pH 5.5, 0.005% and 0.050% KS gave EC95 concentrations. The effect of pH on KS dissociation was evident. Germ tube measuring was evaluated as difficult compared to recording the percentage germination. The combination of 0.050% KS, buffered to pH 4.5 with 0.0625% Minute Maid® gave significant inhibition of conidia germination. The method developed combines the chosen components in solution, in reusable containers, to then give a visual indication of pathogen presence and germination inhibition results in approximately 9hrs. This technique may be of potential use in the citrus supply chain.

S02.047

Characterization of *Aureobasidium pullulans*, a Promising Biocontrol Agent for Postharvest Diseases

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In the last decades, biological control of postharvest diseases has become an important field of research. Postharvest decay of fruits and vegetables, occurred dur-

ing storage, transportation and commercialization, has a considerable economic impact. Many substitutes for chemicals have been proposed to control postharvest diseases; however, biological control using antagonists has proved to be one of the most promising alternatives. In previous studies, about 32 isolates of epiphytic microorganisms occurring on Rocha pear leaves and fruits were collected. The yeast-like fungus *Aureobasidium pullulans* revealed an important biocontrol activity both *in vitro* and *in vivo* of *Penicillium expansum* and *Botrytis cinerea*. The results obtained showed that, under optimum growth conditions, the antagonist was able to reduce the proliferation of *P. expansum* by 85-95%. To better characterize this antagonist, a molecular analysis was performed. For this, a fragment of rDNA including ITS regions was amplified and sequenced. The analysis of the sequences obtained confirmed the 'Rocha' isolate as *A. pullulans* var. *pullulans*. Currently the Rocha pear is harvested and stored in controlled atmosphere conditions. Thus, the effect of different concentrations of O₂ (2, 4, 21%) on the growth of *A. pullulans* was analyzed *in vivo*. After 7 days of incubation, in comparison with the control grown at 21% O₂, the reduction in the CFU was approximately 22% for 2% O₂ and only 7% for 4% O₂. Under cold storage conditions *A. pullulans* controlled blue mold by 56% and grey mold by 85%. The yeast population remained stable during storage. The results presented here point out *A. pullulans* as a good candidate for control of postharvest diseases on pears under storage conditions. Therefore, it is very important to continue the research to improve the efficiency of this antagonist and to extend its use to other fruits and vegetables and to other pathogens.

S02.048

Efficacy of a Combination Quarantine Treatment at 3 °C as a Potential Disinfestation Treatment for Queensland Fruit Fly (*Bactrocera tryoni* (Froggatt))

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Queensland Fruit Fly *Bactrocera tryoni* (Froggatt) (QFF) is a major quarantine pest for some Australian cherry producers, particularly as treatment to combat infestation can often affect fruit quality, restrict marketing flexibility and affect grower returns. Our previous work has shown that a combination treatment of 95% carbon dioxide (CO₂) at 0 °C for varying lengths of time before storage in air was effective at killing first instar QFF larvae whilst maintaining fruit quality. However the practicalities of maintaining constant 0 °C disinfestation temperature is difficult, particularly during transit, and industry would prefer to use a 3 °C disinfestation temperature. Therefore, a range of disinfestation and fruit quality experiments examined the effects of the combination of a short term high CO₂ treatment at 3 °C. A range of cherry varieties were infested with QFF and the fruit were treated with 95% CO₂ at 3 °C for varying lengths of time before storage in air. To examine if high CO₂ had any effects on fruit quality, storage trials were conducted. The results showed that a 95% CO₂ treatment at the beginning of the cold disinfestation period significantly reduced the time to kill first instar QFF. Storage trials showed that there were no adverse effects of the high CO₂ treatment on fruit quality across a range of treatment times, varieties with different removals. The results demonstrated that a short-term high CO₂ treatment at 3 °C temperature was effective in reducing the time in cold disinfestation without detriment to fruit quality during storage.

S02.049

Use of an 'Artificial' Fruit to Assess the Mortality of Queensland Fruit Fly Larvae Using Combination Disinfestation Treatments

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Market access is a major issue for the marketing of horticultural produce. Current quarantine treatments to control Queensland Fruit Fly (QFF), *Bactrocera* (Dacus)

tryoni (Froggatt) are costly and can take too long which can affect fruit quality, restrict marketing flexibility and affect grower returns. The current cold disinfestation treatment (in air) is 14 days whereas the storage and shelf life of many perishable fruits such as peaches, is less than 28 days. It is therefore imperative that new disinfestation methods which will use fewer chemicals be shorter in length and not affect fruit quality. We have previously shown that a combination treatment of high carbon dioxide treatment in combination with cold storage can increase the mortality of QFF in fruit without affecting fruits quality. However we need to develop a standardised test fruit to reliably reproduce and test different treatments, irrespective of seasonal fruit availability. In this study a standardised artificial fruit was developed using carrot media and tested using different CO₂ and temperature combinations. The results showed that the use of the artificial fruit was practical and gave good reproducible results. The results showed that a combined treatment CO₂ and cold disinfestation temperature successfully increased the mortality of first instar QFF.

S02.050

Cold Treatment of Argentinean Mandarins against Mediterranean Fruit Fly

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Mediterranean fruit fly (*Ceratitis capitata* Wied.) is an endemic pest in the citrus production areas of Argentina. Postharvest disinfestation with Methyl Bromide treatments are required to commercialize citrus into local market in Cuyo and Patagonia, regions where the insect is not present. However, Methyl Bromide was recognised as an ozone-depleting substance under the Montreal Protocol. Moreover its use can damage fruit quality. Cold treatments are considered an alternative to Methyl Bromide for postharvest and quarantine treatment of fresh fruits. However, citrus can be sensitive to chilling injury. Research was carried out to determine the effect of cold treatment on the external and internal quality of mandarins (*Citrus reticulata* Blanco) cultivars Murcott and Ellendale produced in the Argentinean northeast region. Fruits were harvested at commercial maturity and stored at two temperature levels, 1 °C±0.5 °C and 5 °C±0.5 °C during 15 days. Following the treatments, marketing conditions were simulated (a 1-week holding period at 20 °C). No chilling injury was observed on fruits for both levels of temperatures. Juice percentage and maturity index were not affected by treatments. In Murcott mandarins levels of ethanol were increased by cold treatment.

S02.051

Control of Postharvest Diseases by a New Yeast Biocontrol Agent

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The growing demand for reduction in the use of pesticides, and the development resistance by the major postharvest pathogens to chemical compounds has resulted in interest in biological control methods. The aim of the present work was to find new postharvest biocontrol agents for pome and citrus fruit. Epiphytic microorganisms isolated from fruit and leaves of different cultivars of pome and citrus fruit were screened for antagonistic activity against *Penicillium expansum* on pome fruit and *Penicillium digitatum* on citrus fruit. From all isolated microorganisms tested in antagonist properties against these pathogens, a new yeast species from *Metschnikowia* genera was selected. This yeast was very effective against *B. cinerea*, *P. expansum* and *R. stolonifer* on different varieties of apple and pears. Complete disease control or more than 80% was obtained on different cultivars of wounded apple fruits at 107 cfu/ml. Over the three years experiments in semi-commercial trials this new biocontrol agent provide excellent control against *P. expansum* under cold storage. More than 80% of control at 107 cfu/ml as also obtained on 'Lanelate' oranges. This biocontrol agent had a good growth capacity inside wounds but also on pome fruit surface at both room and cold temperatures. In conclusion this new biocontrol agent from *Metschnikowia* genera could be used as effectively on apple, pears and citrus fruit at the same concentration and in a high range of temperature,

this will facilitate the application of this biological control agent by the growers on packinghouses. Research is now in progress to examine different production medium, in order to optimise cell production.

S02.052

Control of *Monilinia* spp. on Peaches and Nectarines by Curing Treatments

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Monilinia spp. is the most important cause of brown rot on peaches and nectarines. In many countries, no postharvest chemical treatments of stone fruit are allowed and alternative postharvest treatments are urgently required. The effect of curing treatments at different temperatures, exposure times and relative humidity (RH) to control brown rot was studied. Three curing temperatures were tested (40, 45 and 50 °C) at different exposure times (ranging from 30 min to 6 h). Curing at 50 °C for 2 h successfully increased brown rot control (95%) after fruit were incubated at 20 °C and 85% RH for 5 d after treatment. Longer exposure time was required to achieve the same level of brown rot control at lower curing temperatures. Four relative humidity (RH) levels (60%, 80%, 90% and 99%) were also tested during curing at 50 °C for 1, 2, 3 and 4 h. The level of brown rot control at 99% or 90% RH for 3 or 4 h was the same, achieving control at higher than 95%. At lower RH levels (60% and 80%), more exposure time was required to achieve the same control as at the highest RH (90% and 99%). Complete control of disease development was achieved when four varieties of peach and nectarine fruit artificially inoculated with either *Monilinia laxa* or *M. fructicola* were cured at 50 °C for 2 h and 95-99% RH. This curing treatment had a positive effect on fruit quality, with significantly lower firmness loss in comparison with uncured fruit. No adverse effects were observed on fruit acidity and colour index. Postharvest curing of peach and nectarine fruit may be a suitable alternative to synthetic fungicides for postharvest brown rot control.

S02.053

Evaluation of the Use of Sulfur Dioxide (SO₂) to Reduce Postharvest Losses on Black and Green Fresh Figs

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Postharvest diseases limit the storage period and market life of fresh figs. The efficacy of sulfur dioxide (SO₂) applied by fumigation and/or by sulfur dioxide generating pads was tested for the control of postharvest diseases on several commercial black and green fig cultivars (*Ficus carica* L.). A protocol for the computer-controlled application of gaseous SO₂ has been developed which allows use of a very low specific concentration-time (CT) of SO₂ and simultaneous monitoring of the application progress. Currently, SO₂ is included in the Federal IR-4 program and residual studies are ongoing as a protocol for future registration on fresh figs. Rates of survival of most of the evaluated pathogens were low when exposed to SO₂ fumigation at 100 ppm at 20 °C, whereas higher rates were found at 0 °C. Therefore, further fumigations were carried out at 20 °C. After evaluating different warm SO₂ CTs, the best compromise between controlling decay and not causing skin damage was reached with 25 CT. The performance of warm fumigations, the use of SO₂ generating pads, the combination of pads and sulfur dioxide fumigations, and the use of repeated fumigations during the cold storage were also evaluated. All of the SO₂ treatments reduced the percentage of decay, thus extending the shelf life of fresh figs. However, in some cases, the use of SO₂ generating pads increased the incidence of bleaching on the figs' skin. Warm fumigation with 25 CT of SO₂ reduced the total number of colonies of all pathogens growing on the surface of the figs. In addition, the treatment decreased the percentage of fruit infected with *Alternaria* sp. and *Rhizopus* sp. Future work is being developed by our group on the use of SO₂ and on alternatives to SO₂ as tools to extend the shelf life of fresh figs.

S02.054

Antagonist Activity between *Aureobasidium pullulans* and *Penicillium expansum* in *Pyrus communis* L. cv. Rocha – Implications on the Resistance to Oxidative Stress

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Storage diseases, especially those caused by fungal pathogens, are responsible for substantial post harvest losses. However, as an alternative to fungicides, the use of antagonist yeasts appears to be a promising technology. In this context, the yeast-like fungus *Aureobasidium pullulans* has been proved to control post harvest pathogens on several fruits, namely *Penicillium expansum* Link (blue mold - the major producer of the mycotoxin patulin) on pears. This infection usually initiates in wounds during harvest and packing, being associated with free radicals synthesis (e.g., semiquinones and lipoperoxyl radicals) and reactive oxygen species (ROS). As reactive oxygen species and free radicals induce oxidative stress that can have many detrimental effects, any microorganism that attempts to colonize fresh wounds has to cope with oxidative stress caused as a consequence of wounding. In this work, the action of *A. pullulans* to control the post harvest pathogen *P. expansum* was investigated, considering the hypothesis that an effective antagonist should possess resistance to oxidative stress to ensure rapid colonization of wounds. For this purpose 'Rocha' pears (*Pyrus communis* L. cv. Rocha), harvested at the commercial maturity and stored for 5 months in cold chambers was used as a test system. After a characterization of the commercial maturity through a definition of the colour attributes (L*, a*, b* colour space), it was found that wounds inoculated with *A. pullulans* and infected with *P. expansum* showed reduced levels of hydroxyl radicals and a decreased membrane permeability, whereas H₂O₂ contents and lipids peroxidation did not show a clear trend and ethylene production increase. The metabolism of ROS is discussed considering the biocontrol implications on the retardation of tissues senescence and reduction of post harvest diseases.

S02.055

Transcriptome Analysis of the Differential Effect of 1-MCP on the Development of Chilling Injury in Peaches Harvested at Early and Late Maturities

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Stone fruit exports require cold storage in either air- or sea freight. Air freight is rapid but expensive and can drive fruit prices high. In contrast, sea freight is economically sound, but is undesirable as fruit may suffer chilling injury (CI) due to the prolonged time in cold storage. An understanding of the genetic factors that control or prevent CI in stone fruit is needed. This may lead to technologies that prevent CI thereby facilitating sea freight and more economic and sustainable transport of fruit. Treatment of peaches with 1-methylcyclopropene (1-MCP) increases the incidence of CI following long-term cool storage. However, no previous studies have investigated the effect of 1-MCP on the onset of CI in different maturity stages of peaches. We demonstrate through physiological data that the onset of CI following 1-MCP treatment and cool storage is dependent on the maturity stages of the peach. In immature peaches, CI is increased following 1-MCP treat-

ment and cold storage; however at a mature stage of harvest, 1-MCP treatment delayed the onset of CI following cold storage. Attempts to understand the differences in response to 1-MCP have been carried out using large-scale transcriptome analysis via μ -PEACH1.0, a peach-specific microarray. Genes differentially expressed in 1-MCP-treated fruit before and after cold storage, were clustered on the basis of their time (maturity stage) and pattern of expression. Four clusters were identified: two contain genes showing a similar pattern of expression (induction or repression following storage, 78 genes) in mature and immature fruit. The other two contain genes showing an opposing pattern of expression (154 genes) between the two maturities. Genes from the second group will be further evaluated to confirm their pattern of expression and to determine their possible role in the development of CI.

S02.056

Avocado (*Persea americana* Mill.) Postharvest Physiology Revisited

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While avocado fruit are exported over long distances from a number of countries, quality remains an issue, with variable ripening and internal physiological disorders remaining problematical. A better understanding of avocado physiology will assist in optimizing postharvest handling of avocado fruit. Therefore, an integrated study was conducted to clarify some aspects of postharvest physiology and the effect of reduced temperature storage and modified atmosphere. As avocado fruit quality is affected by water stress the effect of water as well as of ABA infusion on ripening was evaluated. Water reduced the variation in ripening rate while ABA increased it. Fruit water content, measured using near-infrared spectroscopy, increased during ripening. Storing fruit in micro-perforated polyethylene bags (polybags) improved fruit quality by reducing ethylene production, respiration, mass loss, heptose decline, and the activity of cellulase and pectin-methyl esterase (PME) during storage. Storing fruit in polybags increased cellulase activity after cold storage. Polybags furthermore had a mixed effect on PME activity, depending on storage temperature. Polygalacturonase (PG) activity seemed to be insensitive to storage conditions but activity increased earlier in more mature fruit. Polybags also reduced external chilling injury by reducing water loss. Fruit stored at 1 °C ripened slightly slower than those stored at 5.5 °C because of reduced enzyme activity during storage. Storing fruit at 1 °C in polybags has comparable effects to 1-MCP during storage, without the negative effect of delayed ripening post-storage. Furthermore, cold chain breaks severely reduced avocado fruit quality, although fruit physiological parameters return to levels prior to the break. A 24 h break (21 °C) in the cold storage resulted in a 45% loss of mannoheptulose. However, this negative effect of a cold chain break can be reduced by lowering the storage temperature to 1 °C and using polybags.

S02.057

Exploring the Involvement of Ethylene in the Regulation of Colour Changes in *Citrus* Fruit

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Citrus fruits produce minute amounts of ethylene during maturation and therefore have long been recognized as non-climacteric. Evidences indicate that ethylene is playing a role in the control of fruit maturation and for instance, application of the gas is a common postharvest practice to accelerate fruit coloration especially in early-harvested varieties. How endogenous ethylene is perceived and transduced during maturation of Citrus fruit, and whether the hormone is an inducer or its perception is required throughout maturation, are processes not yet elucidated. To investigate these questions, the ethylene action inhibitor 1-MCP (1-methylcyclopropene) was applied to mandarin fruit both on the tree and also after harvested, and changes in fruit colour, carotenoid content and composition, and expression of key genes of carotenoid biosynthesis were analyzed. Fruits were treated at three ripening stages: before initiation, at the onset and after peel degreening, and two varieties of mandarin displaying different rate of natural fruit coloration were used

(*Clemenules mandarin* and the hybrid Fortune). Application of 1-MCP to fruit on the tree was well effective inhibiting ethylene action, as evidenced by the reduced postharvest response to ethylene after treatment. Nevertheless, inhibition of ethylene action in fruit on and off the tree was not always accompanied by a delay in the rate of fruit coloration and by substantial changes in carotenoid content and composition. By contrast, expression of key carotenoid biosynthetic genes was much more sensitive to inhibition of ethylene action. Collectively, results indicate that ethylene mediates, at least in partially, the expression of genes associated with citrus fruit coloration, and the potential involvement of the hormone in the different physiological and molecular mechanisms operating during the process will be presented and discussed.

S02.058

Isoform Shift of ACC-Oxidase in Relation to Reduced Ethylene Production during Post-Harvest Storage of Tomato

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During ripening of tomato, fruit ethylene production increases autocatalytically (System II), and reaches a maximum around the orange/red stage. After harvest and during storage, fruit ethylene production decreases again to the basal level of System I. We investigated the underlying mechanism responsible for this decrease in ethylene production by means of a systems biology approach: which combines measurements at different levels, involving metabolites, enzymes levels and activity and gene expression. First we measured the *in vitro* activity of ACC-oxidase (ACO). In a second part we analyzed ACO gene expression by real time reverse transcription qPCR. Finally ACO protein levels were revealed by western blotting. Our results showed that ACO *in vitro* enzyme activity decreased during post-harvest storage, perfectly in accordance with total fruit ethylene production. Nevertheless, we observed that the ACO gene expression level did not decrease during storage but remained stable at a very high level. This trend was confirmed by western blots, showing the high abundance of ACO protein levels during storage. These blots also revealed two clear bands indicating the involvement of multiple ACO isoforms. During climacteric ripening a first isoform peaked and decreased again after the red stage. A second isoform increased much later (at the orange stage) and remained at high levels during post-harvest storage. These combined results indicate that different isoforms have different enzyme activities and are regulating different stages of fruit development. The differences between these isoenzyme activities occurring during ripening and storage are further investigated at the moment.

S02.059

Abscisic Acid Modulates Mango Fruit Ripening

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To investigate the role of abscisic acid (ABA) in mango fruit ripening, hard mature green fruits were dipped for five minutes in an aqueous solution containing 1.0 mM ABA and its inhibitor 0.2 mM [Nordihydroguaiaretic acid (NDGA)] and 'Tween 20' (0.05%) as a surfactant and allowed to ripen at ambient temperature (21 ± 1 °C). Untreated fruits were used as a control. The exogenous application of 1.0 mM ABA accelerated ethylene production, respiration rate, skin colour development and loss of fruit firmness springiness, cohesiveness, chewiness, adhesiveness

and stiffness as compared to the control and its inhibitor. NDGA-treated fruit exhibited reduced ethylene production and respiration rate (48.15% and 7.79%), respectively, as well as delayed loss of subjective fruit firmness and other textural properties of the pulp. Total sugars increased up to sixth day of ripening after treated with ABA treatments as compared to its inhibitor and control, whilst a reverse trend was recorded for total acids. In conclusion, the exogenous application of ABA increased ethylene production and respiration rate, loss of fruit firmness, skin colour development, advanced sugars accumulation and decreased levels of total acids and the reverse trends in these fruit ripening parameters with its inhibitor than control suggest that ABA play a key role in modulating mango fruit ripening.

S02.060

Main Characteristics of Polyphenol Oxidase of Asparagus lettuce

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Asparagus lettuce, a variant of lettuce widely cultivated in China, has an edible succulent stem which easily browns during storage and processing. Polyphenol oxidase (PPO) is one of the many agents bringing about the browning of vegetables and their products. In this study, the characteristics of partially purified PPO of fresh asparagus lettuce (purchased at a local market) were determined using the dynamics module of UV-visible spectrophotometer at 420nm and catechol as substrate. It was shown that the highest PPO activity with the phosphate buffer pH of 7.0, 6.5 or 6.0 appeared at 10 °C, 20 °C and 30 °C respectively. Thermal stability of PPO was investigated at pH 6.5 at various constant of temperatures from 40 °C to 90 °C using incubation time from 10 to 60 min. The result showed that the PPO activity has high activity below 70 °C. However, activity was reduced rapidly above 80 °C. In addition, effects of three kinds of antioxidants, vitamin(Vc), cysteine (L-cys) and citric acid on browning inhibition, total phenol content and total antioxidant activity (ABTS Methods) were measured. The results showed that all three kinds of antioxidants have suppression effects on the browning of asparagus lettuce. The optimum inhibitory concentrations were 0.025%, 0.02% and 0.8% respectively. Furthermore, the Correlation analysis between asparagus lettuce antioxidant activity and total phenol content presented that the dependability of the two factors was significant in presence of Vc or L-cys, which supposed that Vc and L-cys played a part in the inhibition of asparagus lettuce browning. In conclusion, the optimum temperature for PPO activity varied with pH conditions. Furthermore, antioxidants played a role in inhibiting browning by deoxidizing the PPO to protect total phenol. This study may be applied to improve asparagus lettuce processing.

S02.061

The Physiological, Molecular and Genetic Factors Associated with Postharvest Water Loss in Pepper Fruit

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Pepper (*Capsicum annuum* L.) is an important vegetable crop world-wide with much potential for increasing its market share. However, marketing is limited by the relatively short storability and shelf life of the fruit due to high water loss and decay development soon after harvest. Variation in postharvest fruit water loss (FrWL) is known in pepper but its biological basis is unknown. Therefore, our research is aimed to gain an understanding of the physiological, biochemical, and molecular factors controlling FrWL in pepper. Based on previous research we chose two parental lines that differ for FrWL to create segregating populations for this trait. We characterized fruits of both parents for cutin and wax content. Surprisingly we found that the high FrWL parent has higher total levels of cutin and wax than the low FrWL parent. Looking deeper into the cutin and wax composition, we found two important components that are at higher levels at the low FrWL par-

ent: 18-carbon length ω -OH acid and alkanes, in cutin and wax respectively. The presence of more alkanes in the low FrWL parent may contribute to reduced water loss because of more closely packed and less permeable crystalline regions in the cuticle. In addition to the biochemical differences in cuticle composition, histological analysis of fruit cuticles of the two parents revealed different cuticle structures. BC2 and BC2F2 populations were constructed and measured for FrWL as well as used for genotyping molecular markers to identify quantitative trait loci (QTLs) associated with FrWL; QTL analysis is currently underway. The prediction that the cuticle differences of both parents account for the variation in FrWL will be tested in the segregating populations.

S02.062

Nitric Oxide Signals Modulate Ethylene Level in Ripening Banana Fruit

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Nitric oxide (NO) is a signal molecule which can either be supplied using NO donors or elicited endogenously. For shelf life extension in banana fruit, ethylene regulation by NO was followed. Shelf life extension was evaluated based on kinetics of colour and texture changes during ripening in NO-treated and control fruits. Different NO donors such as Nitroso-R-salt, Nitroso-1-naphthol, sodium nitroprusside (SNP) and potassium ferrocyanide (a structural analogue lacking NO moiety) were screened. Soaking in water containing 1mM SNP for 3 hours improved textural properties, optimum colour formation and longer colour retention leading to 45% shelf life increase over the control, without significantly altering protein and carbohydrates profiles. The activities of major cellular enzymes, Polyphenol oxidase, Phenylalanine ammonia-lyase and Peroxidase, were down-regulated and ethylene emission was suppressed under SNP treatment. Since efficient NO is a complicated process, the endogenous generation of NO was accomplished using elicitation techniques where various NO-inducers/elicitors in different combinations were used. Among the NO inducers, putrescence and chitosan extended the shelf life of banana by 30 and 24% respectively over the control. Such retardation of ripening has been found to regulate ripening-pathway genes, NO metabolism, turn-over of Polyamines and Ethylene formation. These data have established that NO efficiently antagonizes the effects of ethylene and ethylene forming pathways in banana fruits.

S02.063

Expression of the RIN Gene Involved in Developmental Programme of Tomato Fruit Ripening

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Soon after the cloning and characterization of RIN gene (identified from the mutant rin which does not ripe) encoding a MADS-box group of transcription factor from tomato, the importance of the developmental programme was found to be essential for fruit ripening both in climacteric and non-climacteric fruits. To study the regulation of RIN gene expression we have analyzed the upstream of the RIN gene in Tomato cv. Pusa Ruby. The RT-PCR analysis revealed that RIN gene is expressed in both exocarp and pericarp regions of ripe fruits. The E.coli expressed and purified RIN protein was found to bind at upstream region of Expansin1 gene *in vitro* and by *in silico* analysis several putative MADS-box binding sites were found in the upstream regions of several other fruit ripening specific genes. Expression of ethylene responsive element (ERE) binding protein (EREBP or E4/E8BP) transcript was down regulated in rin mutant fruits. But expression of NOR, CNR, TAGL11 and MADSS5 (different from RIN) were normal in rin mutant fruits in comparison to normal ripe fruits. The upstream region of RIN gene was found to contain several light responsive cis-acting elements (LRE) along with anaerobic related box and circadian rhythm box. Therefore, the expression of the RIN gene

was studied and RIN expression was found to up-regulated during diffuse light condition and specific complexes were formed in nuclear extracts of the diffuse light treated nuclear Tomato fruits, as revealed from Gel mobility shift assay. The RIN gene expression was completely down regulated under anaerobic condition where as it was up regulated after cold treatment.

502.065

Gene Expression in Relationship to Ethylene Perception in Apple Fruit during Ripening and Senescence

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Apple fruit (*Malus domestica* Barkh, 'Golden Delicious') is a well known climacteric fruit and a good model to study fruit ripening and senescence. Ethylene plays an important role in regulating fruit ripening and senescence and directly influences the development of the eating quality of fresh apples, including appearance, colour, texture, and flavour. In this study, apple fruit harvested at the pre-climacteric stage were allowed to naturally ripen or ripening was stimulated by treatment with 36 µL/L ethylene for 24 h. Postharvest physiological indices including respiration, ethylene production and chlorophyll fluorescence were monitored for 21 days. Real-time PCR was employed to investigate gene expression in relation to ethylene perception and biosynthesis at day 0, 7, 14 and 21. The study was repeated over two seasons. After efficiency tests for all designed primers, 17 genes were selected to monitor gene expression. Through statistical analysis, including ANOVA and principle component analysis (PCA), 12 genes were found to change significantly. The ETR1, ETR2, ERS1, ERS2, CTR1, ERF1 and ERF2 genes were significantly up-regulated in fruit during ripening and after ethylene treatment. While the EIN2, EIN3 and ETR5 genes were unchanged during this study. The ACS-1 and ACO-1 genes were induced by fruit ripening and ethylene treatment. In contrast, the ACS-2, ACS-3, ACO-2 and ACO-3 genes were not affected. Analysis and identification of significant gene expression revealed that ethylene biosynthesis and perception during apple fruit ripening and senescence is associated with fruit ripening and responsive to ethylene treatment. This study demonstrated the complexity and dynamic changes of transcriptional profiles of ethylene perception and biosynthesis. The understanding of significant changes of these genes and their function may help to explore mechanisms controlling apple fruit ripening and their response to exogenous ethylene during ripening and senescence.

502.066

A Molecular and Metabolomic Approach to Studying Minimally Processed Peach (*Prunus persica*) Fruit

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Minimally Processed Fruits (MPF) are attracting the interest of food industry and the increasing favour of consumers. However, many problems are associated with the manufacturing, distribution, marketing and shelf-life of MPF. Limited information is available concerning physiological, metabolic and molecular responses to cutting or slicing of different fruit species and, within the same species, of varieties having different quality traits. We performed a comparative study among three varieties of peach characterized by different fruit ripening physiology and flesh texture properties. Stony hard (Ghiaccio3), Non-melting (Wilhelmina) and Melting (Fayette) varieties were minimally processed. Slices were analyzed at 0, 24, 48 and 72h after cutting. Ethylene evolution, colour and texture maintenance showed marked differences in the three varieties, indicating a different attitude in

terms of minimal processing. In order to better understand this different behaviour and identify molecular mechanisms and metabolic processes differentially activated in the three peach varieties following cutting, samples collected at 0 and 48h were used for large scale transcript analyses. Microarray (µPEACH1.0, Trainotti *et al.*, 2006, Plant Science) hybridizations revealed that a number of genes putatively involved in different biological processes were differentially expressed in the three varieties. In parallel, high-throughput metabolomics studies were performed on the same samples using GC-MS TOF. Data and analyses of this innovative and integrated approach on MPF are presented and discussed.

502.067

Ultraviolet Light-C: A Sanitising Method Used as a Tool to Increase Bioactive Compounds in Fresh-Cut Broccoli

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Fresh-cut broccoli is currently a very popular vegetable for consumption due to its convenience and nutritive properties, but it provides an ideal medium for microbial development. For that reason fresh-cut industry commonly uses NaOCl as disinfectant. However, certain problems with NaOCl usage is requiring research of ecofriendly alternative sanitation treatments as UV-C radiation. In this way, the effect of five pre-packaging UV-C radiation doses [1.48, 4.48, 9.01 and 15.02 kJ×m⁻² and 0 (as control non-radiated)] and 100ppm NaOCl on the quality and bioactive compounds changes of fresh-cut broccoli Tenderstem cv. (*Brassica oleracea* Italica Group × Alboglabra Group) over a shelf life of 19 days at 5°C was studied. Total phenolics content of radiated samples started to increase after 7 days at 5°C, showing at day 19 a positive correlation between radiation dose and phenolics content with the highest value for 15.02 kJ×m⁻² with approximately 1,100 mg chlorogenic acid equivalent 100 g⁻¹ fw compared to 0 kJ×m⁻² with 814 mg chlorogenic acid equivalent 100 g⁻¹ fw. Total antioxidant capacity showed a similar behaviour, increasing for 15.02 kJ×m⁻² in a 60% compared to non-radiated samples at day 19. General appearance of UV-C treated samples was better than untreated at day 19, with better colour, good turgency and no severe off-odors. On the other hand, UV-C radiation decreased mesophilic counts just after its application compared to non-radiated samples although NaOCl showed the highest reduction followed by 9.01 kJ UV-C×m⁻². Enterobacteria counts were lower for UV-C treated than non-treated samples at day 19. UV-C radiation also kept almost stable psychrophilic counts until day 16 while non-radiated samples increased. In conclusion moderate UV-C radiation can be an effective alternative to NaOCl for sanitising fresh-cut broccoli Tenderstem, preserving its quality and increasing its total phenolic content and total antioxidant activity.

502.068

Effect of Edible Coating and Modified Atmosphere Packaging on Enzymatic Browning of Fresh-Cut Apple

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Control of enzymatic browning represents a problem for the commercialization of fresh-cut apples. The main approach to inhibit browning is the use of antioxidants alone or in combination with modified atmosphere packaging (MA). The use of edible coatings with antioxidants can further increase the shelf-life of fresh-cut apples. Therefore, the effects of an edible coating with antioxidant activity and MA have been investigated in this work. Apple pieces were dipped in a coating composed by

soy protein isolate (SPI) and 0.5% cysteine, or in water as control. Samples were then packed in trays with air or two gas mixtures (MA-A: 15% CO₂ + 5% O₂; MA-B: 80% O₂), sealed with polypropylene films and stored at 5 °C for 10 days. In samples packed with air, a control treatment was also performed by macro perforating the polypropylene film to ensure no gas modification in the package. Changes in atmosphere composition, color (CIE L*a*b*), visual quality, and texture were evaluated. Coated samples controlled enzymatic browning showing higher L* and b* values, and lower a* values than uncoated samples. These samples were evaluated above the limit of commercialization during all the storage time by the judges. Coated apple pieces packed in the MA rich in O₂ (MA-B) showed the lowest a* value and were judged as the less browned after 10 days of storage. Coated apples presented higher firmness than uncoated samples. During storage, gas composition of the samples stored under ambient atmosphere with non-perforated film and samples stored under MA-A and MA-B showed an increase on CO₂ and a decrease in O₂. However, the decrease in O₂ was lower in coated samples than uncoated samples. The results indicate that samples coated with soy protein-based coatings packed in a MA rich in O₂ can extend shelf-life of fresh-cut apples.

S02.069

Efficacy of Electrolyzed Water to Inactivate Foodborne Pathogens on Fresh-Cut Apples

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Consumption of fresh-cut fruit has increased in the last years. This type of product is more susceptible to microbial contamination than entire fruit, for this reason disinfection is a very important step in fresh-cut processing. Chlorine is the most common disinfectant in fresh-cut industry but due to environmental and health risks caused by the use of this disinfectant there is a demand to develop new sanitizers. Electrolyzed water (EW) appears to be a promising alternative showing to be a broad spectrum microbial decontamination agent. Neutral electrolyzed water (NEW) and acidic electrolyzed water (AEW) can be used as microbial decontamination agents on fresh-cut fruits. Several studies have shown that EW can be effective in reducing pathogenic bacteria on the surface of fruits and vegetables. In this study, disinfection efficacy of AEW and NEW in fresh-cut apples were compared to that of sodium hypochlorite solution (SH) and distilled water. Fresh-cut apples were inoculated with a suspension of *Escherichia coli*, *Listeria innocua* or *Salmonella* at 10⁷ CFU/ml and treated with the different solutions. An assay with the combination of the three microorganisms was also made and the inoculum concentration of each pathogen was 10⁷ CFU/ml. Untreated fresh-cut apples were used as control in all assays. AEW was the treatment solution with more effective bactericidal activity. In general AEW100 had a stronger antimicrobial effect against the three foodborne pathogens either at time zero or 5 days after cold storage, showing that electrolyzed water treatment may be a solution to reduce the use of chlorine in fresh-cut fruit industry.

S02.070

Influence of Packaging on Loss of Aroma and Quality of Diced Red Onions

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The loss of desirable aroma and flavor of fresh-cut fruits and vegetables can limit their market life and consumer acceptance. Packaging can impact product flavor by affecting respiratory gas concentrations in the package as well as having direct interactions with the aroma volatiles released from the product. The objective of this study was to evaluate the effects of two packaging materials on the volatile composition and quality retention of diced red onions. Whole red onions were peeled,

sanitized, and diced in a commercial processing facility. Diced onions (200 g) were placed into ridged polylactic acid (PLA) containers or Golden Eagle VH-62 polyethylene (PE) bags. The PLA containers were sealed with intact or vented (single pin hole) PLA lids and PE bags were sealed with a heat sealer. Onion packages were stored at 4.5 °C and assessed after 7, 12, 14, 18, and 21 days for volatile content. In addition, package atmosphere composition, respiration rate, electrolyte leakage, pH, microbial quality, and sensory quality were assessed. After 7 days, the total headspace volatile content of onions stored in sealed PLA containers decreased by only 15% compared to 98% and 85% in the vented PLA containers and the sealed PE bags, respectively. The retention of volatiles was associated with a fresh onion odour. However, after prolonged storage off odours developed in association with anaerobic atmospheres and/or microbial growth. During the 21 days of storage, onion respiration rates increased 5- to 6-fold, electrolyte leakage doubled, and aerobic and anaerobic plate counts became unacceptable, exceeding 10⁶ cfu/g after 12 days. However, these parameters were not significantly affected by packaging treatments.

S02.071

A Simple and Rapid Colorimetric Detection of *Escherichia coli* in Fresh-Cut Mango Based on Gold Nanoparticle

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Pathogenic microorganisms associated with fresh-cut produce can cause disease outbreaks, thereby demonstrating the need for safety monitoring efforts to control risks associated with these products. We had developed a rapid colorimetric *Escherichia coli* detection method with high degree of accuracy for fresh-cut mango based on gold nanoparticle's plasmon property. Detection processes were based on an enrichment procedure made directly from fresh cut mango to enable DNA amplification without any sample pre-treatment such as DNA extraction following by the specific DNA amplification of *malB* gene at 65 °C isothermal temperature. DNA signals were measured visually through a color change of gold particle (20nm) after probe hybridized to the *malB* gene products. The method had a limit of detection at 10 copies of *E. coli* DNA per 50 g of sample. No cross-reactivity was observed from samples contaminated with other bacteria. Detection could be completed within 4 hours of operation including the enrichment process without the need of thermo cycler. This method constitutes a basis for a rapid yet simple and accurate detection of pathogenic bacteria suitable for field application.

S02.072

Fresh-Cut Fruit Industry in Malaysia: Status and Challenges

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Fresh-cut fruits are a growing sector of the food industry in many parts of the world. Its success depends greatly on several factors, especially the quality and consumers' confidence. Products are prepared in ready-to-eat form whilst retaining the organoleptic characteristics of fresh fruits in terms of aroma, flavor, taste, colour and texture. Appropriate method of preparation is obligatory in order to maintain their freshness. The preparation involves cleaning, washing, trimming, coring, slicing and other related steps of which many of these processes hasten the products to perish. Intensive research in the fresh-cut fruit processing has been conducted by using the government funding and also collaboration works with the private sectors. Presently, the technology for commercial handling of fresh-cut fruits, namely, durian, jackfruit and pineapples has been successfully developed. Export trial for fresh cut jackfruit and pineapple by air shipment to the Netherlands had been successfully conducted in 2006. This was followed by sea shipment trial of fresh-

cut durian to Hong Kong in 2008. A cold truck trial for exportation of fresh-cut durian, pineapple and jackfruit to Singapore was also successfully conducted in 2009. Depending on fruits, the fresh-cut products can be stored for 2-3 weeks at 2 °C. An effective quality assurance program has been incorporated in the technology development to ensure the products are safe for consumers. Currently, fresh-cut jackfruit has been exported regularly by four companies to Europe, Dubai and Singapore markets. Consumer demand for fresh-cut products is on the increasing trend, leading to further development and growth of the industry. This paper discusses the current status and challenges of the fresh-cut fruits industry in Malaysia. Issues involved in maintaining both quality and safety of the fresh-cut produce will also be emphasized.

S02.073

A Delay between Hot Water Treatment and Processing of Potato Tubers Reduces Browning Development on Fresh Cut Slices

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Oxidative browning is a serious quality limitation for fresh-cut potato (*Solanum tuberosum*) that has been successfully controlled by heat treatment in other commodities. The use of brief heat stress treatments using 55 °C water (HW) applied to 'Russet Burbank' tubers for 10, 20, 30 or 40 min prior to cutting was evaluated for potential to control tissue browning. Following heat treatment, tubers were cooled in 8 °C water for 10 min, drained, then held at 20 °C for 0 or 1 day before peeling and slicing. Control tubers were not previously immersed in hot water (N-HW). Sliced, rinsed, and blotted slices were placed in perforated plastic bags and stored at 5 °C for 6 days. Exposure to HW for 30 or 40 min caused severe heat injury. Browning developed in all treatments as indicated by color measurements and discoloration score (index of extent of discolored area on the slice surface) after storage. Hot water treatment for 10 min best reduced browning, but only when treated tubers were left intact for 1 day at 20 °C before cutting, as indicated by discoloration scores and changes in lightness, a^* , and hue angle values, which were significantly different than either the control or the other HW treatments. Generally, the severe browning that developed in N-HW slices was associated with significantly higher phenolic content after storage compared with day 0 (1.58 versus 1.27 $\text{mg}\times\text{g}^{-1}$ f.w.), as well as post-storage polyphenoloxidase (PPO) activity (10.47 Units/g f.w.) that was similar to initial activity (12.36 Units/g f.w.). On the other hand, HW treatment prevented phenolic synthesis during storage, resulting in significantly lower content (1.37-1.43 $\text{mg}\times\text{g}^{-1}$ f.w.) after storage compared with the N-HW slices (1.58 $\text{mg}\times\text{g}^{-1}$ f.w.) and reduced PPO activity (8.51-9.42 Units/g f.w.) compared with the initial activity before storage (12.36 Units/g f.w.).

S02.074

Assessment of Preservation by High Pressure Processing and Controlled Atmospheres of Fresh Cut Nectarines Halves with Different Pretreatments

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Fresh cut nectarines halves with two different pretreatments (treatment 1: 2% ascorbic acid; treatment 2: 2% ascorbic acid + 1% calcium lactate and control treatment: water) were packed to assess the self-life and quality effects after applying two independent preservation methods: (1) high pressure treatment and (2) controlled atmospheres. High pressure processing (HPP) can increase shelf life of nectarines for several months as a pasteurization effect is produced on fruit. Five high pressure treatments (200MPa, 300MPa, 400MPa, 500MPa, 600MPa, for 3min) were applied in order to optimize the best that combines less quality damage and more microbial inactivation. Controlled atmosphere (CA) and low

temperatures provide the maintenance of quality and shelf-life prolongation of fruit and vegetables. Three different atmospheric compositions were evaluated (A1: air; A2: 10% O₂ + 10% CO₂ + 80% N₂; A3: 10% O₂ + 90% N₂). Controlled Atmosphere containers were maintained at 4 °C and 90% humidity. Chemicals, color and textural changes were evaluated after the application of independent treatments; after one month of refrigerated storage of samples HP-treated. The same parameters were analyzed in the nectarines with the above pretreatments and after eleven days maintained under CA. Appearance changes are more intense after HPP than with CA. However, with HPP longer storage times are reached than with CA and this technology can substitute of thermal treatment as preservation technique.

S02.075

Impact of Postharvest Nitric Oxide and Putrescine Treatments on Strawberry Fruit Storage Life and Quality Attributes

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Effect of postharvest treatment with nitric oxide at different concentrations (0, 3, 5 and 8 $\mu\text{mol}\times\text{L}^{-1}$) and putrescine (at 0 and 2 $\text{mmol}\times\text{L}^{-1}$) on postharvest life and quality of strawberry (*Fragaria ananassa* Dutch. cv. Selva) fruit during 16 days storage at 2.5 °C was studied. Both nitric oxide and putrescine effectively maintained fruit firmness, total acidity, total soluble solids and overall quality. The highest total acidity and the lowest total soluble solids content were recorded in fruit treated with 2 $\text{mmol}\times\text{L}^{-1}$ putrescine and 5 $\mu\text{mol}\times\text{L}^{-1}$ nitric oxide, respectively. Nitric oxide was more effective than putrescine in retaining fruit quality and decreasing postharvest losses. Combination of putrescine with nitric oxide effectively enhanced the effects of nitric oxide in maintaining fruit quality during low temperature storage.

S02.076

Pre-Harvest H₂O₂ Applications Affect Postharvest Quality of Greenhouse-Grown Sweet Peppers

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Greenhouse-grown sweet peppers are considered chilling sensitive. This study investigated whether a pre-harvest application of H₂O₂ would benefit postharvest shelf life and quality when these fruits were stored at 2.5 °C, 5 °C, 7.5 °C or 10 °C for 28 days, followed by 21 °C for 3 days. Each fruit was observed for the severity of decay with a score of 0 (no decay) to 5 (severe decay with rot) twice a week (every 3 - 4 days). The first appearance of decay (score at 1) was considered to be the termination of shelf life. There were 2 experiments. Experiment 1 was conducted with a continuous H₂O₂ application for 37 days. Beneficial effects were observed with yellow peppers stored at 5 °C, but not with other cultivar-temperature combinations. H₂O₂ increased shelf life of yellow pepper from 21 to 30 days ($p=0.0205$) when stored at 5 °C. Decay index on the 31st day was reduced from 4.0 to 0.8 ($p=0.0023$), decay sum from 9.8 to 1.3 ($p=0.0003$), and decay increment from 1.8 to 0.5 ($p>0.05$). Experiment 2 was conducted with a 3-day pulse of H₂O₂ in each of 3 production seasons, and each application was followed by 3 consecutive weekly harvests. The data of each of 3 seasons and 3 harvests was averaged for the analysis of variance. In red peppers, shelf life was increased from 21 to 25 days ($p=0.0201$) and from 17 to 20 days ($p=0.0358$) when stored at 2.5 °C or 5 °C, respectively. In yellow peppers, the shelf life increased from 21 to 25 days ($p=0.0077$) when stored at 2.5 °C. The results suggested that H₂O₂ application during the production phase increased shelf life and reduced decay when peppers were stored at chilling temperatures of 2.5 °C or 5 °C.

S02.077

Effect of Cold Storage Duration on Shelf Quality Attributes of 'Bing' and Five Sweet Cherry Cultivars Developed in the Summerland Breeding Program

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Shelf quality attributes are a very important factor in determining consumer satisfaction with sweet cherries. Cherries are often put on the retail market after short term storage or cold container transport and so it is important to document the quality attributes after periods of storage that might occur during normal marketing. 'Bing', 'Cristalina', 'Lapins', 'Samba', 'Skeena' and 'Sonata' fruit were harvested at optimal maturity based on color charts. Fruit of each cultivar were divided into three lots; 1) no cold storage, 2) 2 weeks storage at 1 °C, and 3) 4 weeks storage at 1 °C in modified atmosphere box liners. Fruit from the three treatments were placed in 10 °C for five days in ventilated clamshell containers and quality changes were monitored. 'Lapins' showed the least decline in titratable acidity in cold storage, while 'Skeena' showed the greatest decline. Titratable acidity did not change over five days under shelf conditions for all six cultivars. Firmness increased significantly with time in cold storage for 'Bing', 'Lapins', and 'Samba', whereas the other three cultivars showed little change in firmness in storage. Firmness declined slightly for 'Bing', 'Cristalina', 'Skeena', and 'Sonata' when held under shelf conditions. Surface pebbling, a physical disorder increased with time in cold storage except in 'Skeena' and 'Sonata'. Pebbling severity only increased under shelf conditions for 'Bing', 'Cristalina', and 'Samba' only for fruit that had been placed into shelf conditions without cold storage. While the results reflect one year of data, they show that different sweet cherry cultivars have unique storage and shelf quality characteristics.

S02.078

Postharvest Heat Treatment Effectively Enhanced Antioxidant Capacity and Alleviated Chilling Injury in Kiwifruit (*Actinidia deliciosa* cv. Hayward)

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The effect of postharvest hot water treatment on antioxidant capacity and chilling injury of kiwifruit (*Actinidia deliciosa* cv. Hayward) during cold storage was studied. Fruit were harvested at commercial maturity and treated with hot water of 50 °C for 2 min and stored at 0 °C for 4 months. Fruit firmness, total soluble solids, total acidity, extend of chilling injury and total antioxidant capacity was determined during cold storage and at the end of shelf life. Results showed that hot water treatment significantly reduced the incidence of chilling injury and enhanced fruit total antioxidant capacity during cold storage and at the end of storage period the fruit treated with hot water had the highest total antioxidant capacity and the lowest chilling injury symptoms. Hot water treatment effectively maintained fruit quality during 4 months of cold storage. Fruit treated with hot water had the highest total acidity and were significantly firmer than controls.

S02.079

Proteomic Analysis of Orange Fruits Affected by Heat Treatment and Different Postharvest Storage Periods

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Heat treatment or curing is a common procedure prior to long time storage of citrus fruits. The aim of this study was to characterize changes at the molecular level induced by heat treatment on the proteome of orange fruit (*Citrus sinensis* L. Os-

beck). Following two-dimensional PAGE, more than 50 differential protein spots were detected in juice vesicle tissue among all comparisons made. Heat treatment significantly affected the abundances of 16 proteins, while 25 differential proteins were found along the storage period. Identification of these citrus proteins by mass spectrometry and annotation according to the NCBI and Viridiplantae ESTs data bases revealed that 27% were stress-related proteins involved in cell rescue, defence and virulence, 24% were involved in metabolism, 20% were found to be storage proteins, and 15% belonged to the biogenesis of cellular components; being the rest related to minor categories. The analysis of metabolites in flavedo showed an increase in sugar levels while, in turn, organic acids decreased markedly. Putrescine was only detected in treated flavedo, demonstrating the activation of defence mechanisms in this tissue. In order to analyse the changes produced in the antioxidant metabolism different enzyme activities were performed on both tissues. Results obtained in this respect would correlate to the absence of visual injuries in the fruit surface and would explain a defence response, involving H₂O₂ as a secondary messenger within the fruit. In conclusion, the present study provides the first analysis at the molecular level of citrus fruit responses to heat treatment.

S02.080

The Potential of Hot Water and Molybdenum Dips to Induce a Synergistic Sugar-Ascorbic Acid Interaction in Lemon Rind during Cold Storage

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Lemon fruit are sensitive to low temperatures during storage, resulting in potential chilling injury. This is particularly so where cold sterilization for phytosanitary purpose is required. It had been reported that ethanol soluble sugars in the rind play a role in stabilizing proteins and membranes under chilling conditions. Whereas ascorbic acid has been found to be major antioxidants during cold storage and can be converted into ethanol soluble sugars. Previous research has shown that a combination of hot water dips (HWD) and molybdenum (Mo) has potential to mitigate chilling injury. The purpose of this investigation was therefore to examine if the alcohol-soluble sugar and ascorbic acid concentration can be altered by such treatments, and if there is a synergistic interaction between sugars and ascorbic acid (AA) enhancing chilling resistance during cold storage. Fruit from two regions over the 2007 and 2008 growing season were obtained. Treatments included HWD at 47 °C or 53 °C for 2 min and 1µmol, 5µmol and 10µmol Na₂MoO₄·2H₂O for 30 min. Fruit were then stored at -0.5 °C for either 7, 14, 21 or 28 days, transferred to room temperature and thereafter evaluated weekly for chilling injury. Ethanol soluble sugars and AA were analyzed in the flavedo. The dominant soluble sugar was glucose, which was high in fruits without chilling symptoms. The lower glucose and higher AA concentration for Ukulinga fruit during 2008 harvest season clearly indicated a glucose-AA synergistic relationship and, therefore, high chilling resistance. Hot water dips at 53 °C and 1µM Mo dips seems to further enhance the glucose-AA relationship. However, the sugar-AA synergism was greatly affected by fruit location.

S02.081

Effects of UV-C Illumination on Antioxidant Capacity and Enzyme Activity in Blueberry Fruits

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Changes in antioxidant capacity and enzyme activity in blueberry fruit illuminated with different UV-C dosages were studied. Three UV-C illumination durations, 1 min, 5 min and 10 min, (0,43, 2,15 and 4,30 kJ×m⁻²) tested reduced the severity of decay during storage at 10 °C compared to the control. UV-C illumination for 5 and 10 min showed the best result for decay inhibition among all UV-C dosages. All UV-C dosages increased the phenolic content of blueberries as well. Blueberries illuminated with UV-C for 5 min showed higher total phenolic capacity. However,

control fruit had the highest anthocyanin content after 15 days storage at 10 °C. UV-C treatment for 5 min had the highest antioxidant capacity expressed as oxygen radical absorbance capacity (ORAC).

502.082

Aloe vera Gel as an Edible Coating Improved Post Harvest Quality and Shelf-Life of Lemon

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Fruits and vegetables remain as living tissue up to the time they are consumed fresh. Surface coatings can reduce weight loss and retard ripening and could therefore be valuable in developing more storability and distant export markets. Edible coating can be considered as a special form of Modified Atmosphere Packaging (MAP). Their application on the surface of horticultural products may limit gas exchange and moisture transpiration between the fruits and the surrounding environments and can be the toll to include antimicrobials and antioxidants in the edible film. Lemon fruits (*Citrus limetta*) were coated with *Aloe vera* gel alone or in combinations with imazalil and polyethylene plastic bags and then stored for 20, 40 and 60 days at 8 °C, and the subsequent shelf life was monitored at 20 °C. Fruit quality was evaluated by weight loss, firmness retention, visible decay, surface color development, titratable acidity and total soluble solid. Results indicated that uncoated fruits showed a rapid loss of functional compounds, the coating fruits with *Aloe vera* gel significantly decreased decay incidence and weight loss, and delayed the change in color, pH and titratable acidity. The beneficial effects of *Aloe vera* gel was more effective when combined by plastic bags. Consequently, *Aloe vera* gel coating, a simple and non-contaminating treatment, maintained the functional properties during postharvest storage of lemon.

502.083

Effect of Alginate as Edible Coating on the Plum Quality during Postharvest Storage

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Alginate edible coatings were prepared at two concentrations (1 and 3%), in which recently harvested plums (*Prunus salicina* Lindl. cv. Blackamber) were dipped during 2 minutes and then cold-stored for 7, 14, 21, 28 and 35 days plus a period of 4 days at 20 °C (shelf life). Both alginate treatments significantly inhibited the ethylene production, the efficacy being higher with alginate at 3% compared with 1%. The parameters related to the postharvest ripening such as colour (in both peel and pulp), softening, acidity loss and increase in ripening index were significantly delayed compared with control plums, the effect being also concentration dependent. In addition, the evolution of the phytochemical compounds with antioxidant activity was also delayed by these treatments. Thus, this natural compound could be used as an environmentally friendly postharvest tool to maintain plum fruit quality.

502.084

Influence of Organic Beeswax-Based Coating Emulsion on the Post-Storage Quality of Sweet Pepper, Mango, and Avocado Fruit

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Large quantities of fresh produce perish following long transportation tracks. Sweet pepper (*Capsicum annuum* L.) is extremely sensitive to water loss; firmness is lost after 4-6% of weight reduction. 'Ready-to-eat' mango (*Mangifera indica*) and avocado (*Persea americana*) fruit tend to soften and suffer from pathogens. Appropriate postharvest conditions ensure high produce quality during transportation period. Nevertheless, produce quality declines within few days later, often before arrival to final consumers.

Waxes have been developed and used for postharvest treatment in many fruit and vegetable species. However, the markets tend to reject synthetic coatings. Furthermore, excluding the shiny appearance provided by most waxes, their high viscosity might block gas exchange levels required for normal ripening processes, and fruits' interior quality declines. Here we report of the application of a novel formulation of natural beeswax emulsion to sweet pepper, mango, and avocado fruit at a commercial level. The application is integrated into working postharvest procedures with minimum modification of the apparatus involved. In sweet pepper, the shelf-life after 21d of cold-storage was extended from 3 to 6 days, maintaining 70% of the fruit at marketable firmness levels, comparing to 30% of control fruit. In mango, softening during shelf-life (after 11d in cold storage) was delayed by 1 day (cv. Maya) and 5 days (cv. Shelly), TSS didn't differ significantly, the levels of organic acids remained higher, and the frequency of interior collapse was much smaller in comparison to commercially-treated or control fruit. In avocado (cv. Ettinger) fruit after 14d of cold storage, the beeswax emulsion improved the peel resistance to penetration and the fruit sensory firmness, and significantly reduced the degree of pathogens' injuries. Beyond partial sealing of the fruit surface, the involvement of the beeswax emulsion in structural and biochemical processes in the peel of ripening fruit is under concurrent research.

502.085

Expression of Genes Encoding CTRS during Flower Opening in Two Cut Rose Cultivars with Different Longevity

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Ethylene plays an important role in wide-ranging aspects of plant growth and development, including fruit ripening, leaf and flower senescence. We investigated the expression pattern of two genes involved in the ethylene signal transduction pathway (RhCTR1 and RhCTR2) during flower opening stages in two *Rosa hybrida* cultivars "Black magic" and "Maroussia" respectively characterized by short and long vase life. The results demonstrated that the expression level of RhCTR1 in cv. Maroussia was significantly higher than cv. Black magic. RhCTR1 expression increased significantly during flower opening in both cultivars. A higher increase of RhCTR1 expression was detected in cv. Black magic with respect to that found in cv. Maroussia. No variation in gene expression was detected for RhCTR2 in both cultivars. It is shown therefore that the vase life of the two cultivars is correlated to the different expression of RhCTR1, but not to that of RhCTR2 whose behaviour is typical of a constitutive gene.

502.086

NAA and STS Effects on Bract Abscission, Respiration Rates and Carbohydrate Balance of Potted *Bougainvillea spectabilis* Willd.

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The aims of this work were to deepen the knowledge on the physiology of bract abscission in *Bougainvillea spectabilis* 'Killie Campbell' plants, in what relates to respiration and carbon balance. More specifically, using the variability induced on bract abscission under interior conditions by Silver Thiosulphate (STS) and/or Naphtalene Acetic Acid (NAA) treatments, the relationship between bract abscission and respiration rate of different plant parts was investigated. Bract respiration rate was significantly affected by treatment and postproduction day (PP). Plants sprayed with WATER presented the highest bract respiration rates, followed by intermediate values on plants treated with STS and STS+NAA and, the lowest respiration rates occurred on bracts sprayed with NAA. Bract respiration rate decreased

from day 10 to day 17 PP by approximately 50% (on average of all treatments) and was positively correlated with percentage of bract abscission. Treatments that had higher bract respiration rates were those with more non structural carbohydrates in the bracts. In the carbon balance for bracts alone, the treatments WATER and STS, showed the largest decrease in the content of total carbohydrates and had the highest consumption of carbohydrates through respiration per gram of bract dry weight. So, these were the bracts that needed to import a higher amount of carbohydrates per gram of dry weight, to stay alive. In the carbon balance for the whole mass of bracts and adjacent stems in an average plant, the treatments WATER and STS continued to allow for the largest decreases in total carbohydrate. However, and contradicting the results for bracts alone, the highest total consumption of carbohydrates by respiration was obtained for the NAA and STS+NAA treatments. It makes sense that bracts that last longer have lower individual carbon consumption while, at the plant level, the increased number of remaining bracts causes a higher overall expenditure.

S02.087

Physiological and Molecular Evaluation of Ethylene-Dependent Abscission of Leaf and Floral Bud in Miniature Roses *Rosa hybrida* L.

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The ethylene-induced organ abscission in miniature roses F1 progenies and their parent plants was evaluated and characterized. The expression of two ethylene receptor genes (RhETR1, RhETR3), and the signal transduction pathway (RhCTR1 and RhCTR2) were investigated in ethylene-sensitive and ethylene-tolerant rose genotypes in response to ethylene treatment. From population of two hundred and thirty-three F1 genotypes, two sensitive and three resistance genotypes were selected, based on the ethylene-induced leaf and flower bud abscission. Chlorophyll degradation and leaf chroma values significantly increased in sensitive genotypes compared to resistant genotypes when treated with ethylene for one week. After fortnight exposure to ethylene, chroma values did not change but chlorophyll content declined in two ethylene-tolerant genotypes. The expression of RhETR1 was increased by ethylene treatment in pedicels and petioles of one out of two ethylene tolerant genotypes. In petiole of this genotype, the expression of RhCTR1 was induced by ethylene too. Influence of ethylene on the expression pattern of RhETR3 and RhCTR2 genes did show neither in sensitive nor in tolerant genotypes. The expression of recently isolated gene Laccase (RhLAC) was also evaluated in this study. The ethylene-induced Laccase transcript showed a higher accumulation pattern in pedicel and petiole in ethylene sensitive genotypes than in tolerant. Based on this evidence the expression of RhETR1, RhETR3, RhCTR1 and RhCTR2 showed to be dependent on genotype. In contrast, highly increasing expression of Laccase transcript under ethylene treatment in sensitive genotypes is hypothesized to be related to the abscission process.

S02.088

Application of Portable NIR-AOTF to Forecast Distribution Life of *Zantedeschia aethiopica*

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Flowers of *Zantedeschia* were collected from Distribution Cooperative and placed immediately in water at 4 °C and 20 °C. NIR-AOTF was used daily for the spectra acquisition of water, stem (4 points at different heights), and curled petal. Spectrophotometer was also used to monitor the change of colour of stem and petal as well as the redox potential of water was measured. Bacteria content inside the stem and in the water was measured to correlate with NIR peaks. NIR was able to detect the change of water along the stem and in the petal and calibration curve was performed in order to forecast the shelf life of the flower. Water content of stem at different height was also correlated with presence of bacteria and with bacteria into the water.

S02.089

Possible Role of Sugars as Biomarkers of Vase Life in Imported Kenyan Cut Roses

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Rose cultivars have inherently different vase lives. The temporal change in non structural carbohydrates content is thought to be linked to vase life, but there remains a lack of research on defining any genotypic differences in this area. Hence, the aim of this study was to profile changes in fructose, glucose, sucrose and myo-inositol concentrations in four cut rose cultivars ('Akito', 'Sweet Akito', 'Red Calypso' and 'Valentino') and relate possible differences to physiological changes that occurred during vase life. Cut roses were grown in Kenya and flown to the UK as per standard commercial practice. Changes in sugars content in petal and foliage were measured at regular intervals during 7 days of vase life. Vase life of 'Akito', 'Sweet Akito', 'Valentino' and 'Red Calypso' roses were 6.7, 8.7, 11.3 and 13.0 days, respectively. During day 0 to day 4, 'Akito' and 'Sweet Akito' rose had higher fructose, glucose and myo-inositol content in petals compared to 'Red Calypso' and 'Valentino' roses whilst sucrose content was lower. In foliage, myo-inositol content of all cultivars declined during vase life whilst fructose and glucose could not be detected at day 7. After two days, sucrose content increased in all cultivars. The longest-lived cultivar, 'Red Calypso' rose had the highest sucrose content in both petal and foliage followed by 'Valentino' rose. It is suggested that genotypic differences in vase life may be related to higher endogenous sucrose. For bud opening, 'Red Calypso' rose was the only cultivar that completely opened. In addition, bud opening development of 'Valentino' rose was slower than for other cultivars. Content of fructose, glucose and myo-inositol in petal of 'Valentino' rose were lower than for other cultivars.

S02.090

The Role of Sugars during Opening and Senescence of Rose Petals in Plant and in Vase

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The relation between the sugar content variation and the opening and senescence of 'Charlotte' rose (*Rosa* sp.) variety was studied in buds attached to the plant, and in vase. The floral stems were obtained from a rose crop at Bogotá Savanna (Colombia). In the greenhouse floral stems in different stages of development (S3, S4 and S5) were periodically harvested. In laboratory, in vase, floral stems in stages of development (S4, S5 and S6) were periodically taken. S3 represents the cut point for exportation to US market, S4 floral opening, S5 visible symptoms of shriveling, and S6 senescence. For the same time period, buds in vase reach full senescence stage 6, while buds joint to the plant got to stage S4. Non reducer sugars (sucrose) and reducing sugars (glucose and fructose), were measured for both, floral stems joint to the plant and floral stems in vase. Similar increase and decrease of total sugars patterns took place in the buds' petals; nevertheless, peaks were obtained at different stages. At S5 stage, cultivation and vase petals present high contents of reducing sugars as respiration substrates. The results support the hypothesis that holds that the necessary sugars for floral opening of buds' petals joint to the plant are imported from one source and in buds in vase come from degradation of accumulated storages. The results do not allow explaining the role of sugar application on roses in post harvest.

S02.091

Postharvest Water Relations of the Magnolia Lotus Flower (*Nelumbo nucifera*)

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Lotus flowers (*Nelumbo nucifera* Gaertn.) are commercially sold as closed buds. The buds do not open if placed in water after harvest, and the outer petals show rapid blackening, resulting in a short vase life. We investigated whether these problems are due to adverse water relations. Cut stems exude copious latex, which might be a cause of xylem occlusion. Indeed, the rate of water uptake of the cut stems rapidly decreased from day 1 of vase life, whereas the rate of transpiration did not initially decrease. This strongly suggests an occlusion in the xylem. Exudation of latex from the cut stems can be prevented by cutting in water, let the latex flow out, and cut again within 1 cm from the previous cut surface. This treatment will open many xylem vessels not filled with latex. The treatment did not prevent the decrease in water uptake of the cut stems. A pulse treatment with citric acid reduced latex flow from the stems, but did not prevent the decrease in water uptake. These data suggest that latex is not the main cause of the xylem blockage. The inclusion of antibacterial compounds (8-hydroxyquinoline sulphate [HQS], dichloroisocyanuric acid [DICA] or silver nitrate) in the vase water did not prevent the decrease in water uptake. This suggests that bacteria blockage found in other cut flowers are not a main cause of the occlusion. Placing a plastic bag over the flowers decreased transpiration and water uptake and resulted in a delay of petal blackening. It is concluded that xylem occlusion is not the main reason for early petal blackening in lotus flower cut at bud stage.

S02.092

Effect of GA3 and BA on Postharvest Quality and Vase Life of Gerbera Cut (*Gerbera jamesonii* cv. Good Timing) Flowers

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The effect of gibberellic acid (GA3) and benzyladenine (BA) on the postharvest quality and vase life of gerbera cut-flowers was investigated. Freshly cut flower stems of gerbera cultivar 'Good Timing', with four outer disc florets open, were put in vases containing 0, 50, 100, 150, 200 or 300 mgxL⁻¹ GA3 and 0, 10, 25, 50, 100 or 150 mgxL⁻¹ of BA for 48 hr and then held in vases containing 2.5% ethanol and 3% sucrose. Vases were placed in chambers at 25 °C, relative humidity about 70% and were arranged in a Completely Randomized Design with three replicates. Data were recorded for vase life, fresh weight, solution uptake, membrane stability, total soluble solid over time and analyzed statistically. GA3 50 mgxL⁻¹ and BA 50 mgxL⁻¹ were the most effective treatments on vase life, fresh weight, solution uptake, membrane stability and total soluble solids of gerbera cut flowers.

S02.093

Response of Gibberellic Acid and Kinetin on Physiological and Bio-Chemical Changes during Vase-Life and Longevity of *Gladiolus grandiflorus* L. cv. Jessica

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An investigation about the role of GA3 and kinetin on physiological and biochemical changes in the fresh, fully grown petals and at petal senescence, to know the exact cause for senescence was carried out. *Gladiolus* corms were dipped for 24 hours separately after removing the tunica, in GA3 100ppm, 200ppm and kinetin 50ppm, 100ppm, respectively, a day before planting. The foliar spray in the respective treatment combinations was applied at 45 days after planting of corms. The spike of *gladiolus* cv. Jessica were cut at tight bud stage showing colour of one or two florets and kept in standard solution containing 4 per cent sucrose + 200ppm 8-HQC, maintaining the pH of standard solution around 3.5, physiological and biochemical changes during vase-life and longevity of the cut-spikes were undertaken for investigation. The physiological parameters viz. daily elongation, days to elongation of cut-spike, length & diameter of floret, water uptake and loss, qual-

ity parameters of spike were studied. All these characters were showed increased response and associated with pre-soaking + foliar spray GA3 100ppm followed by pre-soaking + foliar spray GA3 200ppm. The bio-chemical parameters that signify the longevity and advances of petal senescence such as water soluble protein, total protein, reducing sugar, total carbohydrate, starch, phenol, total anthocyanin and carotenoid were investigated and increased water soluble protein, reducing sugar, total carbohydrate and total anthocyanin and carotenoid contents whereas, decreased starch and phenol content under treatment combination pre-soaking + foliar spray GA3 100ppm were observed. However, during petal senescence, increased water soluble protein and phenol content whereas, decreased total protein, reducing sugar, total carbohydrate, starch, total anthocyanin and carotenoid contents and increased pH of standard vase solution as compared to fresh, fully grown petals were observed. These marked changes occurred during petal senescence signifies the probable cause for senescence of florets.

S02.094

Respiration and Physiological Changes during *Freesia* Flower Development and Senescence

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The respiration rate and several physiological and biochemical factors were studied during flower development and senescence in two cultivars of *Freesia hybrida*. A respiratory climacteric existed in the both cultivars during flower development and senescence, although some differences were observed. The pattern of respiration in tepals, stamens and pistils showed some differences between the two cultivars and two respiration peaks were observed in pistils for *Freesia hybrida* 'Shangnong Jinghuanghou'. In both cultivars, electrolytic leakage and MDA content increased in tepals as development and senescence progressed. However, MDA content in *Freesia hybrida* 'Shangnong Hongtaige' was much higher than that in *Freesia hybrida* 'Shangnong Jinghuanghou' at each stage. In both cultivars, SOD activity showed an early increase and later decreasing trend during senescence. Meanwhile, SOD activity in 'Shangnong Jinghuanghou' was significant higher than that in 'Shangnong Hongtaige'. The activity of POD showed a gradual increase before tepal wilting and decrease in wilted tepals for both cultivars. A higher POD activity also appeared in cultivar 'Shangnong Jinghuanghou'. The time of initial decreasing point of POD activity appeared later than that of SOD. During flower development and senescence, soluble protein and sugar content peaked at the early development stage then decreased dramatically and reached the bottom in the wilted tepals. Meanwhile, a significant difference of protein content was observed between the two cultivars. These results suggest that respiration and enzyme changes, membrane injury and loss of soluble compounds are associated with flower development and senescence in *freesias*.

S02.095

Micro-Structural Observation of Rose Peduncles Using Synchrotron-Radiation X-Ray Tomography (SRXT)

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"Bent neck" is an important postharvest problem for cut roses in which the upper peduncles bend prematurely just below the flower. Structural weakness of vascular bundles of the peduncle tissue could be a factor of the syndrome. The high resolution of the synchrotron-radiation X-ray tomography (SRXT) – not yet optimized for plant samples – should allow the *in-situ* investigation of the micro-structures of rose peduncles. Three rose cultivars of different bent-neck resistance were investi-

gated *in-situ* to examine the variety-specific micro-structures, and to evaluate the image quality produced and the degree of damage caused by different SRX beam energies (30, 40, 50, 60 keV). SRXT was conducted at BAM-line, BESSY at HZB, Germany. Due to the fact that the structural information was outlined by the phase-contrast effect and phase retrieval was applied in all cases to produce 3D density maps the resulting image quality was similar among all SRXT scans despite the different energies. SRXT clearly visualized the structural difference between each cultivar. The results may help to clarify whether there are structural differences in vascular bundles and parenchyma cells related to the occurrence of bent neck. The degree of radiation damage was investigated using chlorophyll fluorescence imaging. The fluorescence parameter Fv/Fm is known to indicate plant stress. Fv/Fm of the irradiated regions of the samples were below 0.3 pointing out after the SRXT scans that photosynthesis was no longer active in those stem parts. Colour changes of cells from green to brown also occurred, particularly from epidermis to vascular bundles.

S02.096

Effects and Mode of Action of Cytokinins Combined with Sucrose in Delaying Senescence of *Grevillea* 'Spiderman' Cut Flowers

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Cytokinins, known as senescence retardants, are often used as a means to extend the vase life of various cut flowers. The cytokinin effect is improved by addition of sugars, and extracellular invertase has been found to be an essential component of the cytokinin-mediated delay of leaf senescence. The aim of the present study was to examine whether a similar mode of action operates in improving quality of cut *Grevillea* 'Spiderman' cut flowers, which responded positively to cytokinins and sugars. We hypothesized that cytokinins act by increasing invertase activity, thereby increasing the sink strength of the flower, and/or by improving sugar uptake from the vase solution. Our results show that *G.* 'Spiderman' cut flowers reacted positively to dipping the inflorescences in cytokinin solutions, with thidiazuron (TDZ) being more effective than benzyladenine (BA), and their positive effect increased by provision of sucrose in the vase solution. This combined treatment delayed flower senescence and pigment (chlorophyll and carotenoids) breakdown in the perianth, improved the water balance of the cut flowering branches, and prevented floret abscission. Consequently, the vase life of the cut flowers was significantly extended. Additionally, a combined treatment of TDZ and sucrose enhanced sucrose transport from the vase solution to the inflorescences and increased sucrose hydrolysis in the florets and activity of the cell wall invertase. It seems, therefore, that the sink strength in *Grevillea* flowers is controlled by cell wall invertase. Our results suggest that the promising effect of the combined treatment of cytokinin and sucrose in delaying flower senescence of *G.* 'Spiderman' operates via the regulation of sink-source relationships.

S02.097

Postharvest Photooxidative Disorders in Canna Leaves

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Canna × generalis L.H. Bailey is widely used as a bedding plant in summer. Since canna plants are tolerant to high growing temperatures and resistant to many diseases, we focused on this plant as a new cut flower crop and investigated the postharvest characteristics of canna leaves. When aged single-leaf segments were harvested at noon on a fine day, inrolling and thereafter severe necrotic browning was observed within a few hours. However, young leaves harvested at the end of the night did not show symptoms of these physiological disorders and lasted more than two weeks in a vase of water. These observations indicate that photo inhibition by excessive light exposure before harvest is responsible for the occurrence of physi-

ological disorders, and aged leaves are more strongly affected by photo inhibition. To elucidate the mechanism of these photo oxidative disorders, we measured the chlorophyll fluorescence and antioxidant enzyme activities relating to photo oxidative stress. The quantum yield (Fv/Fm) of PS II was c. 0.75 at the end of the night in both aged and young leaves. As leaf exposure to light increased, Fv/Fm dropped and reached 0.2–0.3 at noon in aged leaves and 0.4–0.5 in young leaves. When the leaves were harvested at noon and kept at room conditions, Fv/Fm recovered, but it dropped again as the leaf began to brown. In intact aged leaves, superoxide dismutase (SOD) activity was higher and ascorbate peroxidase (APX) activity was lower than those in young leaves. As the browning proceeded after harvest, SOD activity was constant but APX activity sharply dropped. These results suggest that the increase in reactive oxygen species and the decrease in antioxidant enzyme activities are involved in the leaf browning disorder after harvest.

S02.098

Determination of Table Grape Rachis Quality by Image Analysis, Subjective Evaluation and Mass Loss Following Exposure to Different Water Vapor Pressure Deficit Regimens

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Table grapes lose water rapidly after harvest or storage, causing rachis desiccation and browning. The study was conducted to examine the effect of temperature and relative humidity on the rate of rachis browning using traditional methods and image analysis. The experiments were performed with 'Superior' and 'Thompson Seedless', two major white table grape cultivars. The grapes were stored at 10 °C or 20 °C and in low or high relative humidity (RH) creating 4 levels of water vapor pressure deficit (WVPD). In addition, at each WVPD the grapes were packed in punnets which were either open, closed with a low density polyethylene film or a micro perforated polyethylene film. After 2, 4, 7 and 11 days the grapes were measured for weight loss, berry firmness, rachis dry weight, rachis index, and the rachis photographed for image analysis. Image analysis gave similar patterns to subjective evaluations but changes in browning were recorded earlier. Rachis dry weight correlated well with browning by image analysis for 'Thompson Seedless' but not for 'Superior'. Likewise WVPD correlated with browning of 'Thompson Seedless' while temperature was the major factor affecting the browning of 'Superior' rachis. 'Superior' was more sensitive to rachis browning than 'Thompson' and it was characterized by a threshold type of deterioration in appearance above a specific WVPD range. As expected, shelf-life at 10 °C and high RH maintained the quality of the rachis at a very high quality compared to storage at 20 °C. Packaging mitigated the negative effects of the low RH for 'Thompson' at both 10 °C and 20 °C and for 'Superior' at 10 °C. These results should be valuable for practical purposes as well as for unbiased characterization of the processes underlying rachis deterioration during storage.

S02.099

Image Analysis to Calibrate French Bean (*Phaseolus vulgaris* L.) Pods

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In order to control the characteristics of a variety, bean breeders have to calibrate pods. This calibration is achieved manually; workers must pass pods through a sieve with holes of different diameters, each hole corresponding to a caliber. Pods are weighed, and a repartition in the different calibers in weight is given. This calibration is very tedious, moreover, there is an inter and intra-variability among the workers,

and the number of characteristics measured is limited. A new automatic method based on image analysis has been performed; in a limited time, it permits extracting and calculating different pod characteristics such as the length, the diameter and the curvature, it offers the possibility to conserve images which is helpful for the traceability of products, and it requires less labour than the current manual system. Moreover, a relation between the surface of pods and their weights has been found out, allowing the program to give directly the repartition in the different calibers in weight. An acquisition chain has been installed, it is composed of a mono CCD sensor camera, manually configured, with a backlight fluorescent system of 5000°K, a tripod and a computer. Images are taken in RAW format, which contrarily to the JPEG is not compressed and avoids edges effects. Images are pre-processed in order to eliminate the noise and are converted into binary images. Then algorithms principally based on morphological mathematics, are applied in order to calculate the different characteristics. The validation of the program has been performed on more than 150 batches of different varieties of French and butter bean pods all along 2008 and 2009. In this presentation, the image analysis system is described, the results obtained with the image analysis system are explained and compared to the manual system.

S02.100

Foodstuff Quality Evaluation by Magnetic Resonance Imaging Spectroscopy

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Foodstuff quality evaluation can be done by means of several analytical techniques. In the last years Magnetic Resonance Imaging (MRI) has become a popular analytical tool in food analysis. The unique property of non-destructiveness in producing high resolution spatial images of any internal section or volume of samples makes it an attractive approach in food science. Images can be obtained with different weighting factors (e.g. spin density, relaxation times, diffusion coefficient, etc.) chosen depending on the structural features to be highlighted. MRI has been successfully applied in postharvest monitoring, elucidation of internal morphology, histology, etc., of several foods, most likely fruits and vegetables. Changes occurring during ripening and postharvest as a function of temperature and atmosphere composition have been highlighted for hazelnuts and kiwifruit. For the latter the effect of Plant Growth Regulators on shelf-life was also assessed. Modifications induced by external agents, e.g. fungal invasion and use of bioavailable silicon-based fertilizer, were also successfully addressed by means of MRI. The quality of raw materials, e.g. frozen and fresh rennet for the production of buffalo mozzarella cheese, was investigated. MRI appears a very promising technique in food analysis, the difficulties in accessing instruments is a limiting factor; nevertheless the development of new generation spectrometers based on superconductors cryogenic liquid free designed for industrial environment might solve this aspect very soon.

S02.101

Assessment of Apple Texture Using Contact Acoustic Emission Detector (CAED)

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Texture attributes like crispness, crunchiness, hardness, juiciness and mealiness are important for fruits and vegetables because consumers associate them with freshness and wholesomeness. Most of these attributes are related to tissue fracturing being also the source of sound. Therefore a great deal of effort has been expended in the use and development of acoustic instrumental techniques for the meaningful estimation of texture attributes since many years. Among the acoustic methods, the contact acoustic emission, which is destructive, allows simulation of a vibration mode of sound propagation during food mastication. Lately, Contact Acoustic Emission Detector - CAED (Institute of Agrophysics PAS, Lublin, Poland) was

developed for a simple texture control method of apple testing intended to be applied in industrial or postharvest practice. In this work, CAED concept and an application of CAED for apple texture assessment are described. CAED allows measuring acoustic emission counts and firmness. The goal was to determine relations between the instrumental parameters and sensory texture attributes, and thereby to estimate the usability of CAED for apples testing. The experiment was performed using 20 cultivars of apples, stored after harvest up to one month in a simple cold storage followed by 5-6 days of shelf life. The experiment showed that CAED is particularly useful for evaluation of sensory crispness, crunchiness and hardness of apples. There is also significant correlation of acoustic emission counts obtained by CAED with juiciness, mealiness and overall texture. The results allow concluding that CAED is useful tool for instrumental evaluation of sensory texture attributes of apples.

S02.102

Possibilities and Limits for Non-Destructive Food Quality Differentiation on Organic and Conventional Apple and Wine Samples with the Gas-Discharge-Visualisation Method (Formerly Kirlian Photography)

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In our study we examined over 4 years and a large number of trials and commercial samples the possibilities and limits of the Gas-Discharge-Visualisation (formerly Kirlian Photography) method to differentiate in a non-destructive way inner quality parameters of apple and wine samples. The samples derived from different trials comparing organic vs. conventional production and from commercial retailers (same cultivar and harvest date). The interpretation of the GDV-Results were compared and correlated to standard analytical methods, other non-destructive methods as near infrared technique and fluorescence emission spectrography but also to sensorial assessments. With the GDV apparatus a digital picture is taken when the sample (put in complete darkness and exposed to a high-voltage electrical field) emits a gas "corona". The measurement is easily and rapidly made; no chemicals and very little electrical energy are necessary. By specific software the picture taken is quantitatively described by 9 different image parameters. These parameters are used for the statistical data analysis by principal component analysis and case-wise analysis of variance to decide whether the samples differentiate significantly or not. Apart from differentiation, correlation with standard quality parameters is of high interest. Our results with apple and wine samples over several years and trials show that GDV data mostly but not always can differentiate samples e.g. from organic or conventional production better than standard methods. The correlations with single standard analytical parameters e.g. sugar content, fruit flesh firmness, acidity, antioxidative potential and others was mostly low. However, if the standard parameters were combined to an index (correlating well with sensorial rating) correlations with an index formed by GDV-data was case-wise higher than R2 0.80. We consider the GDV method as worthwhile for further examination in view of its application in research and food industry.

S02.103

Chlorophyll a Fluorescence: a Fast and Low-Cost Tool to Detect Superficial Scald in 'Rocha' Pear (*Pyrus communis* L. 'Rocha')

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This study aimed to test whether the simplest chlorophyll a fluorescence param-

eters determined by a low-cost non-modulated fluorometer could provide fast, reliable and non-invasive tools for an early detection of superficial scald in 'Rocha' pear (*Pyrus communis* L. 'Rocha'). Fruit harvested before the optimal maturation stage and cold stored under ambient atmosphere for 7 months, (AN: 0 °C, HR 90–95,%) plus 2 (last ones) in controlled atmosphere conditions (AC: 0 °C, RH 90–95 %, 1.5 kPa O₂ + 0.5 kPa CO₂) (T), were compared to others harvested at the optimal maturation stage and cold stored under the controlled atmosphere conditions for 9 months (C), after being transferred to shelf-life (22±2 °C, 70 % HR). Conditions chosen before shelf-life provided two fruit groups with a different superficial scald developing pattern and seriousness: T fruit exhibited from the beginning of shelf-life the highest scald index (IE), while this disorder developed progressively in the C fruit. The progression of ripening events along shelf-life changed between the pear groups, although T and C fruit presented similar features by the 8th shelf-life day. Despite the similar chlorophyll content in both fruit groups, T showed a yellow colour from the beginning of shelf-life, as well as a lower b* value in respect to C, which was greener in the beginning and followed the normal yellowing process along shelf-life. The maximal photochemical yield of PSII (Fv/Fm), correlated with the developing pattern of superficial scald in 'Rocha' pear of both fruit groups, and not only the ripening process. Indeed, both the Fm and F0 changes, as well as the significant decrease (P<0.05) of Fv/Fm was shown to be a good indicator of this disorder presence and progress, suggesting it can be used in the early detection of superficial scald in 'Rocha' pear.

S02.104

Quantitative Analysis of Cut Surfaces of Brassicas by Means of Fractal Texture Fourier Image Analysis

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Appearance and texture changes related to tissue deterioration are commonly considered as measures of freshness and quality decline in fresh-cut research and industry. The cutting operation is one of the most limiting steps in the production of fresh-cut vegetable products. A smooth cut surface is desirable to avoid major damage to vegetable cells and reduce enzymatic browning, dehydration, discolorations or microbiological spoilage. A new approach to evaluate the cut's quality is presented in this work. It is based on the quantification of irregular colour patterns that emerge from the surfaces after slicing. Stems of Broccoli (*Brassica oleracea* L. var. *italica*) and cauliflower (*Brassica oleracea* L. var. *botrytis*) were cut using different methods (mechanical and manual) and different sharpness of the blade's cutting edge. Cut surfaces were captured by a computer vision system using a calibrated flatbed scanner and transformed into the CIE Lab colour space using a quadratic transformation function. To classify the different cuts two methods are proposed: one using mean L values (traditional method) and other using fractal dimension value (FD). This measure uses the Fourier fractal texture image analysis, in order to represent the complexity of lightness intensity distribution over the surface. Results show that fractal dimension value and their evolution with time provides the right index to difference between cutting conditions.

S02.105

Rapid Characterization of Apricot Fruit Quality Using Near and Mid-Infrared Spectroscopy: Study of the Model Robustness

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Our recent investigations showed the possibility of predicting internal quality parameters on intact apricot fruits using near-infrared (NIR, 800-2500 nm) and on apricot slurries in mid-infrared (MIR, 4000-650 cm⁻¹) spectroscopy (Bureau *et al.*, 2009a; 2009b). Our objective was now to study the robustness of the

models established in 2005 using a large phenotypic variability (eight contrasted cultivars, four maturity stages). By robustness we mean the possibility of using these models for fruits outside the original experimental set. Models were applied on about 180 hybrids coming from the crossing between 'Goldrich' and 'Monique' apricot cultivars studied over two successive years (2006 and 2007). For example, in 2006, the error of prediction obtained by NIR spectroscopy on intact fruits was 9.2% for SSC and 16.5% for TA. Using MIR spectroscopy on slurries this error was 6.1% for SSC and 8.6% for TA. The robustness of the models is discussed according to the phenotypic variability and the studied years. The infrared spectroscopy allows a considerable reduction of time of analysis compared to the current techniques. We have found that models established using a large phenotypic variability can be robust i.e. they can be applied to estimate with reasonable confidence the composition of fruits of different years or cultivars. This is highly relevant for applications in e.g. fruit sorting as the need for calibration, which has been a major drawback for transfer of these techniques to fruit analysis or fruit sorting, can be at least partly alleviated by a correct choice of the initial calibration set.

S02.106

Application of Multispectral Laser Light Backscattering Imaging to the Study of Quality in Non-Melting-Flesh Peaches

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The aim of the present study was to investigate the feasibility of using the histograms from peach fruits multispectral images to predict important quality attributes such as firmness, soluble solids content (SSC) and titrable acidity (TA). Two different clones of a very late, non-melting-flesh peach cultivars [*Prunus persica* (L.) Batch cv. Calanda] have been studied. Images were obtained by means a CCD Basler A312f camera for five selected laser wavelengths, using MATROX 8.0 software for the digital image processing. Exponential curves were fit to each image pixel-intensity histogram and different linear combinations of the corresponding curve coefficients were used in the PLS calibration of quality attributes.

S02.107

Strawberries Shelf-Life Evaluation by Magnetic Resonance Imaging Spectroscopy

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Magnetic Resonance Imaging (MRI), known for its medical and diagnostic applications, has received general acceptance in food science thanks to its non-invasiveness and non-destructiveness. The opportunity of studying foodstuff in its wholeness, without any chemical and/or physical preparation of the sample, makes MRI a powerful tool in food science, in particular for understanding the importance and function of each tissue and measuring quality-related parameters. Effects of a new bioavailable silicon fertilizer, in the form of stable monomeric orthosilicic acid, on strawberries cultivation were investigated by means of MRI. Different images were obtained: spin-density weighted images, in which signal intensity is directly proportional only to the water content and T2-weighted images, in which signal intensity is proportional to the transverse relaxation time, i.e. T2, that reflect water interactions with cellular substrate. Comparison of T2- and spin density-weighted MRI images has highlighted the variations of the internal morphology, in terms of cellular tissues arrangement and their wateriness. Samples treated with orthosilicic acid led to the formation of tissues with higher consistency, characterized by a longer shelf-life. Also transverse relaxation time values, extrapolated from the T2-weighted images, confirmed that the treatment with bioavailable silicon slows down the tissues deterioration process.

S02.108

An Adaptative Threshold Level for Segmentation of Grayscale Images of Mangoes Aiming to Weight Estimation and Grading by Image Processing

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Inside a packing house, tropical fruits need to be graded mainly according to their weight, normally using complex and expensive dynamic weighing systems. The development of a low-cost system to be used by small producers, from developing countries, is still a challenge, since the grading involves weighing while the fruit is moving. This work proposes a new threshold for segmentation of white background grayscale images of mangoes, improving the Otsu's Method used in MATLAB™. This will be further used in a low-cost system for mass estimation of mangoes (*Mangifera indica* L., cv. Tommy Atkins) passing on a simple conveyor belt. Ninety-six mangoes were acquired at the local market of Campina Grande, Brazil. A commercial digital camera (Sony™ P7) was fixed at the center top of a closed polystyrene box (50x50x50cm), all internal walls covered with white paper. Two 20W PL lamps illuminate the mango, manually placed at the center bottom of the box. Top view picture of the fruit, at rest, was taken. An off-line Matlab™-based software calculated the top area of the fruits using a new threshold formula: $y=x+x^*(m/k)$, where x :Otsu's threshold; m :mean intensity of the image previously segmented using the Otsu's algorithm; and k :experimental constant. Result showed low correlation (segmented area x actual mass) when using the default algorithm ($R^2=0.68$, $SD=48.5g$), mainly due to the poor segmentation of some low-contrast images (fruit colour dependent). The alternative proposed algorithm (with $k=1500$) greatly improved that correlation to $R^2=0.94$, $SD=20.5g$. In this controlled setup, better segmentation of the images with white background and better mass estimation of mangoes, individually and at rest, are possible when using a threshold based on an adaptative increased percentage of the automatic threshold used in MatLab™. They also indicate the possibility of their use for low-cost grading of mangoes dynamically, on a small conveyor belt.

S02.109

NIR Case Device Use in a Packinghouse and the Prediction of Post-Harvest Quality of 'Rocha' Pear and 'Gala' Apple

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In a packinghouse situation, the information on the evaluation of the performance of commercial near infrared (NIR) spectroscopy is limited. Between other criteria, fruit growers are pay according to fruit size and soluble solids content (SSC), and non destructive technology have been implemented to assess fruit internal quality, however, for some fruit quality attributes the validity of this technology may be questionable. Firmness, soluble solids content (SSC) and dry matter (DM) were assessed in pear 'Rocha' and 'Gala' apple through the performance of calibration equations by the comparison between the values of quality attributes obtained with destructive methods and the values predicted by the spectrophotometer NIR CASE (NIRS). In 2008 and 2009, 450 and 320 fruits of 'Gala' and 450 and 320 of 'Rocha' pear were tested, using destructive methods to validate NIR CASE predicted values and to calibrate the model. These fruits were from different growers, orchards, picking date, stages of maturation and storage conditions. Poor correlations were obtained between NIR CASE measurements and analytical data for pear and apple firmness in both years ($r^2=0.01$ to 0.53 , $bias=-4.82$ to 8.98 and $ME=-2.55$ to 0.11 for 'Rocha' pear and $r^2=0.1$ to 0.69 , $bias=-4.40$ to 6.55 and $ME=-3.25$ to

0.60 for 'Gala' apple). Better correlations of prediction were obtained between SSC predicted and analytical values for pear ($r^2=0.69$ to 0.90 and $ME>0.70$) and apple ($r^2=0.63$ to 0.81 and $ME>0.45$) in both years and excellent predictions of DM (% fresh weight) were obtained ($r^2 > 0.7$ and $ME>0.86$) in 'Rocha' pear in both years and in 'Gala' apple in 2009 ($r^2 > 0.7$ and $ME>0.64$). 'Rocha' pear and 'Gala' apple data from 2008 and 2009 seasons confirm accurate prediction of NIR CASE models for SSC and DM. However, predicted values for firmness demonstrate models based on NIRS spectrometry weren't suitable.

S02.110

Non-Enzymatic Antioxidant Activity of Skin and Flesh of Near-Isogenic Lines of Melon Linked to Postharvest Behaviour

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Skin and flesh properties at harvest play an important role in melon quality and both have been proposed as good sources of antioxidants. Most melon cultivars are not bred specifically for obtaining antioxidants or for postharvest purposes, and the genetic bases to design cultivars with better antioxidants or postharvest performance are not well known. We examined the link between skin or flesh antioxidant activity, polyphenol content, and climacteric behaviour. The plant material consisted of five climacteric and one non-climacteric near-isogenic line (NILs) of melon (*Cucumis melo* L.) and the non-climacteric parental 'Piel de sapo' as control. The skins were characterized by a high ability to scavenge free radicals and their higher polyphenol concentrations than the flesh, irrespective of the DPPH or ABTS method used to estimate antioxidant activity. A higher skin DPPH antioxidant activity was detected in climacteric NILs than in the PS or the non-climacteric one. Three climacteric NILs showed higher ABTS skin antioxidant activity than PS. Flesh polyphenol content or total antioxidant activity were similar in the NILs and PS, except two climacteric NILs with higher ABTS antioxidant activity and polyphenol content than PS. The possible link between these properties and other properties implicated in storability or fruit quality are discussed.

S02.111

Evaluation of Factors Affecting Shelf-Life and Quality Biomarkers of Imported Avocado Fruit

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Avocado is subtropical fruit with ever increasing demand in the UK market. All year round consumption is supported by a wide range of suppliers across the world. Inevitably disparities in preharvest conditions and differences in transit time result in undesired fruit quality variability through the year. In order to understand these differences a scoping study was undertaken on fruit imported in UK when not only demand but also customer complaints are higher request. Fruit were harvested in Peru and South Africa (SA) in April-March (early season), June (middle) and August (late). Avocado fruits were transported at 5 °C for 33-39 days when imported from Peru and for 25-36 days from SA. Each origin and season was individually investigated. During shelf life (18 °C) decrease in mesocarp firmness was assessed as an indicator of fruit ripeness. Fatty acid profile and sugars content was measured to evaluate if any differences in their concentration could discriminate between fruits from different origin or harvest. Generally, higher firmness characterised fruit coming from SA and a faster softening process was noticed in late season fruit. The main biochemical markers also changed according to origin and harvest time. For instance, results showed a higher ratio between monounsaturated vs. saturated fatty acids in fruit coming from SA (between 2.7 and 3.0) rather than from Peru (2.0-2.2). Moreover, the mannoheptulose content was higher in fruit from Peru when harvested early in the season ($106 \mu g \times mg^{-1}$). However, regardless of origin and harvest season mannoheptulose content declined with fruit ripening, adding evidence to the previously hypothesised role of C7 carbons in the regulation of avocado fruit ripening.

S02.112

The First Steps for Directed Breeding for Improved Postharvest Traits in Apple: Case Studies for Texture and Disorders

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The breeding of new cultivars with improved postharvest traits has largely been achieved to date using laborious empirical approaches. Commercial demands for new and improved cultivars, coupled with a more rapid turnover of cultivar plantations, means there is increasing pressure to produce better cultivars faster. Powerful new “global” approaches for transcriptomics, high-throughput sequencing, proteomics and metabolomics, overlaid with large germplasm resources and high density mapping techniques, provides an opportunity to further the understanding of postharvest processes and enable marker development for breeding. Progress in these approaches will be highlighted for texture and disorders in apples. For texture, there is increasing emphasis on consumer responsive traits such as crispness and juiciness, and not just relying on traditional estimates of texture as determined by the penetrometer. Germplasm resources (e.g. ‘Royal Gala x ‘Braeburn’ 600 seedling mapping population; ACC oxidase and polygalacturonase suppressed transgenics) with a large range of texture phenotypes, coupled with transcriptomics and increasing genomic sequence information, have advanced the understanding of the regulation of texture in apples. For disorders, there is a need to predict which fruit will develop disorders before storage. Most breeding screening approaches use a limited set of storage conditions (often air) to assess postharvest quality, which means disorders aggravated by controlled atmospheres and ethylene inhibitors (e.g. 1-methylcyclopropene) are often not known until the cultivar is fully commercialised. The strong influence of developmental and environmental factors on disorder susceptibility makes finding breeding markers for disorders a more challenging prospect than for traits such as texture. These two case studies highlight that the same biotechnological approaches may not work for all postharvest traits, and that tailored approaches may be required according to the relative dominance of genotypic, developmental and environmental factors.

S02.113

Development and Mapping of Molecular Markers for Candidate Genes Involved in Apple Fruit Texture

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Marker assisted selection (MAS) and breeding (MAB) have great promise for the development of new apple cultivars within classical breeding programs. Indeed, the application of molecular markers could significantly shorten the selection cycle and lead to substantial savings in money, manpower, space and time. However, in apple such markers are not yet a reality, mainly because most important fruit quality attributes are polygenic and encoded by multiple genes or genomic regions (QTLs). One of the most important fruit quality characteristics is the maintenance of fruit firmness during post-harvest storage. Upon ripening textural changes are induced in the fruit cortex tissue, which ultimately lead to fruit softening and the loss of crispness, juiciness and the occurrence of meakiness. In the present study, potential candidate genes (CGs) involved in determining fruit firmness were selected from both the literature as well as our own research program aimed at identifying genes that were differentially expressed during the onset and progress of fruit ripening. These CGs belong to functional

classes involved cell wall degradation, ethylene biosynthesis, signal transduction and perception as well as potentially regulatory genes up-regulated around the climacterium. We have developed a set of genetic markers for these CGs using different PCR-based strategies and have screened available germplasm for allelic diversity. In addition, where possible this CGs were mapped on to the available genetic linkage maps of the cultivars Telamon and Braeburn. Their linkage to QTL-regions for fruit firmness is discussed.

S02.114

Selection for Improved Fruit Texture and Storability in Apple

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Fruit texture is one of the major determinants within the concept of fruit quality in apple, and - together with tolerance to fungal storage diseases - also very important for the storability. For the scoring of fruit texture, mechanical measurements of firmness and stiffness have been used, as well as consumer scorings of variables defined as, e.g., hardness, crispness, granularity, sponginess, speed of breakdown and juiciness. In addition, DNA polymorphisms have been employed to identify QTLs (quantitative trait loci) responsible for fruit firmness at harvest and after storage, and to identify different alleles of major genes potentially involved in fruit ripening and/or fruit texture. We have screened several of these major genes in a set of approx. 200 apple cultivars, many of which represent old Swedish locally grown landraces. Comparison of DNA data for these cultivars with data for modern germplasm, investigated at our laboratory as well as reported in other studies, suggest a recent, intense selection for desirable alleles especially of the Md-ACS1 (1-aminocyclopropane-1-carboxylate synthase) locus. Frequencies of the three Md-ACS1 genotypes (1/1, 1/2, 2/2) as well as the relative allele frequencies (1 vs. 2), thus vary significantly depending on time of introduction of the investigated cultivars. The most frequent founding clones in apple breeding are ‘Cox’s Orange Pippin’, ‘Golden Delicious’, ‘Jonathan’, ‘McIntosh’ and ‘Red Delicious’. Only one of these, namely ‘McIntosh’ is homozygous for the non-desirable allele 1. Possibly, the impact of the other founding clones would not have reached its present magnitude if they had not carried the allele 2 for low ethylene production. This particular allele may thus be one of the most influential factors of modern apple breeding. A new project has also been initiated concerning the impact of fungal storage diseases, and levels of tolerance in different apple cultivars.

S02.115

Postharvest Behaviour of Native Pineapple Fruit and Golden MD-2 during Low Temperature Storage

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Pineapple is originated from tropical forest. Some native varieties are well appreciated by its flavor and sweetness and its market is growing around the world and in Colombian markets. The nutritional properties of the native varieties from the originated Amazonian forestry are less known and remain unexploited. The physiological behaviour of wild (native) pineapple variety from Vaupes (Colombia) and the Golden-MD2 were studied under low temperature storage. Fruit were harvested in half mature stage and stored at 4 °C, 8 °C and 20 °C for 20 days. Both pineapple varieties showed a non climacteric ripening pattern with low levels of respiration rate throughout storage irrespective of the temperature tested. Fruit stored at 4 °C both varieties suffered from flesh softening, shrivelling and mesocarp darkening (a symptom of chilling injury), particularly the native variety. Decay in the post-storage shelf life periods was particularly noticeable after storage at 4 °C in the native variety. The storage of native pineapple fruit at 8 °C

is recommended because this temperature kept better fruit quality by preventing chilling injury and flesh decay. When compared with storage at 20 °C, the fruit at 8 °C showed reduced sucrose and ascorbic acid losses without compromising normal fruit ripening during a post-storage shelf-life at 20 °C, particularly in the native variety.

S02.116

The Impact of 1-MCP Treatment on Mal d 1 Synthesis during Storage of Apple Fruit

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The most important apple allergen in Central Europe and North America is Mal d 1, a protein which belongs to the so called pathogenesis-related proteins (PR-proteins), subgroup 10. PR-10 is synthesized in response to environmental stress, pathogens and wounding. Several studies investigated a higher allergenicity of apple fruit after storage, which is due to higher Mal d 1 concentrations. For climacteric fruit, such as apple fruit, ethylene is a key regulatory molecule for ripening and senescence. The higher allergenicity might be related to ethylene action during storage. Synthetic cyclopropenes, like 1-methylcyclopropene (1-MCP), are inhibitors of ethylene action. The commercial use of 1-MCP has the potential to extend storage periods and quality of plant products, if applied in an optimal stage of ripeness. The aim of this study was to evaluate if 1-MCP application can decelerate Mal d1 synthesis during storage. Therefore fruits of different cultivars were stored for 8 and 14 weeks in a cold chamber (2 °C) and under controlled atmosphere conditions (CA-conditions). For evaluating the influence of this ethylene inhibitor on Mal d 1 synthesis half the fruits were treated with 1-MCP. The state of ripeness of the fruits was measured by determination the content of sugar and starch as well as firmness after 8 and 14 weeks of storage. Beside this, the ethylene release was defined after removal of storage. Treatment with 1-MCP resulted in higher penetrometer values in comparison to untreated fruits, lower starch and higher sugar content which indicate on a decelerated maturation. After eight weeks of storage, Mal d 1 contents in treated fruits were lower than in untreated fruits. After a storage time of 14 weeks treated fruits had significant lower Mal d 1 concentrations.

S02.117

Relationship between Contents of Pigments and Sugars in Fruit Peels of 'Red Fuji' Apples at Various Debaggging Times

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'Red Fuji' apples (*Malus micromalus* Makino) were used as the experimental materials, and the fruits were debagged 145 days after full bloom (DAFB), 152 DAFB, or 159 DAFB in the experimental treatments. The results showed that the contents of chlorophyll and carotenoids in the bagged fruits had undergone almost the same dynamic changes as those observed in the non-bagged fruits (control), except that the contents in the bagged fruits were considerably lower. In fruits that were debagged 145 DAFB and 152 DAFB, the anthocyanin content increased rapidly and exceeded that in the control fruits within 7 days. There were no significant differences in the contents of sucrose, glucose, or fructose between the fruits that were debagged and the control fruits. A significant correlation was found between the anthocyanin and sucrose contents of fruits that were debagged 145 DAFB ($r = 0.8732^{**}$), 152 DAFB ($r = 0.8433^*$), and 159 DAFB ($r = 0.9557^{**}$), as well as those of the control fruits ($r = 0.9162^{**}$). However, significant correlations between the contents of anthocyanin and glucose ($r = 0.7734^*$) or fructose ($r = 0.7198^*$) were observed only in control fruits. Based on the results of this experiment, we think that the appropriate debaggging time is 5–8 days before harvest, and that any practical technique for increasing sucrose content in fruits could promote fruit colouring.

S02.118

Consequences of Postharvest Handling for Flavour and Quality of Fresh Basil

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Basil (*Ocimum basilicum* L.) is an important culinary fresh cut herb used to flavour Mediterranean dishes. Postharvest handling is particularly critical for this species as its large, delicate leaves make it easy to damage, and it is susceptible to cold temperatures which can induce leaf blackening. However, basil is a popular choice by many consumers in countries where it cannot be grown locally, so the crop frequently undergoes a lengthy supply chain and shelf life. The impact of post-harvest handling on key characteristics such as senescence, respiration, ethylene evolution and flavour are not well studied. Results from profiling these parameters throughout the supply chain using pigment analysis, conductivity, gas analysis by GC and from using the European Life Science Trace Gas Facility, and GC-MS will be presented in this paper that illustrates how different physiological and biochemical changes result in a loss of quality for the consumer. We have also examined the consequences of perturbing the supply chain using a chilling period or different light levels, such as can typically occur if handling is sub-optimal. Flavour, which is the key reason behind consumer purchase of basil, is highly sensitive to postharvest handling, and ways in which crop quality can be preserved will be discussed.

S02.119

Effect of 1-Methylcyclopropene (1-MCP) on Quality and Storage Disorder of Sweet Persimmon After Exposure to Exogenous Ethylene

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Sweet persimmon 'Fuyu' were harvested from commercial orchards in S/Korea. Fruit(1-2Kg) were treated for 24 hours within 15 L chambers held in air, 5ppm, and 10ppm ethylene to keep good external appearance and market quality, respectively. After the treatment the fruit were held at 20 °C for 12h with 1-MCP ($5 \mu\text{L}\cdot\text{L}^{-1}$) and then stored at 0 °C (90-95% RH) for 60 days. Increase of respiration and ripening were not affected by exogenous ethylene application (5 and 10ppm) during the short exposure for 24 hours. However after exposure to exogenous ethylene, respiration and internal ethylene evolution were greatly affected by 1-MCP treatments. Peel blackening and flesh softening were most inhibited by 5ppm ethylene and subsequent 1-MCP ($5 \mu\text{L}\cdot\text{L}^{-1}$) treatments during the storage for 60 days.

S02.120

Effect of 1-MCP on ABA and Ethylene Metabolism during Ripening of Avocado cv. Hass Fruit

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Avocado (*Persea americana* Mill) is a typical climacteric fruit exhibiting a sharp rise in autocatalytic ethylene production during ripening. The importance of ethylene in avocado ripening has been extensively studied using the ethylene inhibitor 1-MCP. In contrast, little is known about the function of abscisic acid (ABA) in avocado ripening. As a consequence, the present study investigated the effect of 1-MCP (0.3 $\mu\text{L}\cdot\text{L}^{-1}$ for 16 h) on imported avocado cv. Hass fruit stored for 7 days at 12 °C. The temporal change in ethylene production, respiration and ABA concentration in mesocarp tissue in relation to differences in firmness and colour change was assessed. Ethylene production by control fruit increased steadily during storage and was significantly higher than for 1-MCP-treated fruit. Only at day 7 was ethylene production of fruit treated with the inhibitor higher than in controls.

Respiration rate reached a maximum on day 5 but was generally lower in 1-MCP-treated fruit than in controls. Predictably, ethylene-induced ripening was delayed by 1-MCP treatment, thus fruit remained firmer and greener than controls. Mesocarp ABA concentration, as determined by a newly developed LC-ESI-MS/MS method, increased as fruit ripened but concentrations were significantly affected by treatment since the highest ABA concentrations were recorded in control fruit. Results suggest that the physiological differences between 1-MCP-treated and untreated fruit may be, in part, mediated by changes in ABA metabolism. However, further investigation is required to clarify whether or not ABA directly influences ethylene synthesis and therefore ripening.

S02.121

Gamma Irradiation Dose: Effects on Spinach Baby-Leaf Ascorbic Acid, Carotenoids, Folate, Alpha-Tocopherol and Phylloquinone Concentrations

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Ionizing radiation of fruits and vegetables, in the form of gamma rays or electron beams, is effective in overcoming quarantine barriers in trade, decontamination, disinfestation and prolonging shelf life, but a void of information persists on ionizing radiation effects of vitamin profiles in individual foods. Baby-leaf sized spinach from commercial cultivars flat-leafed 'Lazio' and crinkled-leaf 'Samish' were grown, harvested, and surface sanitized according to industry practices. Baby-leaf spinach of each cultivar was packaged under air or N₂ atmosphere, representing industry practices, and then exposed to cesium-137 gamma radiation at 0.0, 0.5, 1.0, 1.5, or 2.0 kGy. Following irradiation, leaf tissues were assayed for vitamin (C, E, K, B9), and carotenoid (lutein/zeaxanthin, neoxanthin, violoxanthin, and beta-carotene) concentrations. Atmospheres and interaction of atmospheres by irradiation had little effect. Four phytonutrients (vitamins B9, E, K and neoxanthin) exhibited little or no change in concentration with increasing doses of irradiation. However, total ascorbic acid (vitamin C), free ascorbic acid, lutein/zeaxanthin, violaxanthin and beta-carotene all were significantly reduced at 2.0 kGy, and also, depending on cultivar, at 0.5 and at 1.5 kGy. Dihydro ascorbic acid, an indicator of stress – likely irradiation generated oxidative radicals – in general increased with increasing irradiation doses > 0.5 kGy.

S02.122

Ethylene Exposure After Dormancy Break is as Effective in Controlling Sprout Growth as Continuous Ethylene for Some UK-Grown Potato Cultivars

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Ethylene application can effectively extend potato storage life by suppressing sprouting incidence. An ethylene concentration of 50 µL×L⁻¹ (57.5 mg×m⁻³) has been approved by the Chemicals Regulation Directorate (CRD) in the UK for use in potato storage, but a continuous treatment of 10 µL×L⁻¹ is more commonly used by industry. Although ethylene can extend storage life, it has previously been shown to negatively affect the textural and taste characteristics of some potato cultivars. On the other hand, sprout growth also reduces the marketability of potatoes. In this study, the effect of ethylene on biochemical composition, texture and sprouting in two UK-grown potato cultivars viz. Marfona and Sylvana was investigated. Potato tubers were harvested and then slowly cooled from 15 °C to 6 °C over a two week period. Tubers were then placed in trays and stored in the presence or absence of continuous ethylene (10 µL×L⁻¹) at 6 °C at Sutton Bridge Experimental Unit (Lincs., UK). At dormancy break (10% eye movement of tubers assessed in air at 6 °C) a sub-sample from each treatment was transferred to either ethylene or no ethylene, resulting in four treatments: continuous ethylene, continuous air, transfer from ethylene to air and vice versa. All tubers were stored for six months. Ethylene-treated tubers contained higher sucrose, glucose and fructose concentrations than untreated ones. Firmness decreased with time with all treatments in tubers cv. Marfona, but not cv. Sylvana. Sprouting incidence was affected by treatment in tubers cv. Sylvana, but not in

cv. tubers Marfona. Moreover, ethylene application after dormancy break was as effective as continuous ethylene treatment for cv. Sylvana tubers only. The results suggest that ethylene applied after dormancy break can prolong storage for some UK-grown varieties.

S02.123

Storage Ability of Pistachio as Influenced by Temperature, Type of Packaging and Application of Anti Oxidant

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Fresh Pistachio has no a long shelf life period after harvest. It should be consumed in a short time period, if the storage condition is not prepared suitably. Both abiotic (temperature, humidity, light) and biotic factors (microorganisms) influencing shelf life of fresh pistachio. An experiment was conducted in 2008 at Iran's Pistachio Research Institute (IPRI). This was achieved to study the effects of temperature, kind of packaging and Vitamin C as an antioxidant the on shelf life of fresh pistachio. The experimental design was factorial in base of completely randomized block design (RCBD) in three replications. Factor A was different packaging. This was included of cellophane, polyethylene and polypropylene. Factor B was storage temperature which was included in three levels of 25, 17 and 4 °C. Factor C was ascorbic acid application in three concentrations (0, 5 and 10 ppm). The attributes consisting of fruit weight changes, contamination by insects and organoleptic tests (texture, colour, taste) which were measured every 3 days. The final result indicated; the best packaging was polypropylene and preservation in 4 °C and treatment with vitamin C at 20ppm concentration.

S02.124

Effects of Electron-Beam Irradiation on the Microbial Populations and Quality Characteristics of *Tuber aestivum* (Summer Truffles) Packaged under Modified Atmospheres

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Fresh summer truffles (*Tuber aestivum*) have a short postharvest shelf life due to several factors such as the bacterial growth, the development of a superficial mycelium, the dehydration, and the process of senescence. A combination of modified atmosphere packaging and irradiation would extend the shelf life increasing the possibility for a foreign market. The effects of two electron-beam irradiation doses (1.5 kGy and 2.5 kGy) on microbial populations (total mesophilic aerobes, *Pseudomonas* genus, Enterobacteriaceae family, molds and yeasts), quality characteristics (texture, colour, water content, water activity, weight loss and pH) and sensory attributes of summer truffles packaged under modified atmospheres with micro perforated film were monitored immediately after treatment, and weekly during 42 days of storage at 4 °C. Treatment with 1.5 and 2.5 kGy reduced the pseudomonads populations by 4.3 and 5.5 log CFU/g, respectively. Enterobacteriaceae counts decreased by 5.4 log CFU/g with 1.5 kGy and counts below the detection limit (<1.0 log CFU/g) were obtained with 2.5 kGy. Lactic acid bacteria and yeasts were less affected by the ionizing treatments and they became the dominant microbial populations throughout storage. The carbon dioxide levels inside the packages containing irradiated truffles were lower than those of the non-irradiated ones, suggesting a decrease in the respiration rate of the treated ascocarps. The irradiation treatments did not negatively affect the quality and sensorial characteristics of truffles and the 2.5 kGy-dose appeared to better preserve the characteristics of the fresh product. Thus, the shelf life of 2.5kGy-samples was prolonged from 42 days, doubling the storage period of non-treated samples.

S02.125

The Efficiency of 1-MCP to Delay Fruit Ripening of 'Rubidoux' Peaches is Reduced by Increasing the Partial Pressures of CO₂ during its Application

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According to some authors, the delay in ripening of peaches treated with 1-MCP is due to accumulation of CO₂ during its application. However, the effect of the 1-MCP can be inhibited by the presence of CO₂. This research was carried out to evaluate the effects of CO₂, during the treatment with 1-MCP (1 µL×L-1), on fruit ripening of 'Rubidoux' peaches. In addition, the effect of 1-MCP (1 µL×L-1) reapplication on fruit ripening was also investigated. The following treatments were used: no1-MCP + 0.1kPa of CO₂; 1-MCP + 0.1kPa of CO₂; 1-MCP + 2.5 kPa of CO₂; 1-MCP + 7.5kPa of CO₂; and daily applications of 1-MCP + 0.1 kPa of CO₂ for four days. The increase of CO₂ partial pressure during the treatment with 1-MCP reduced its efficiency in reducing respiration and ethylene production rates and delaying softening and skin colour change. Soluble solids content and titratable acidity were not affected by treatments. The effect of 1-MCP on softening and colour changes delay was reduced with the advance in time after treatment, possibly reflecting the biosynthesis of new receptors for ethylene.

S02.126

Pre-Storage Conditioning of NMF Peaches Using Directed Heat Stress Alone or Combined with 1-MCP to Maintain Appealing Sensory Characteristics during Postharvest Handling

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Non-melting flesh (NMF) peaches are better suited for shipping and long-term storage than traditional melting flesh (MF) peaches due to slower texture change and lack of excessive softening at the final stage of ripeness. Pre-storage hot water and 1-methylcyclopropene (1-MCP) applications have been reported separately to inhibit ripening of MF peaches; we hypothesized that hot water combined with 1-MCP may be more effective than either treatment alone in delaying softening and maintaining other sensory qualities. In this study, 'UF Sun' and 'Delta' peaches were immersed in water at 46 °C (HT), 100 µg/L of aqueous 1-MCP solution at 20 °C, or 100 µg/L of aqueous 1-MCP at 46 °C (HT+1-MCP) for 30 min then placed either directly at 20 °C for 5 days or placed at 20 °C after 14 days at 0 °C. The results indicate that HT peaches best retain their initial flesh firmness. HT and HT+1-MCP peaches had significantly lower ethylene production during early stages of ripening and gradually recovered to that of the control as ripening progressed. Suppression of softening at the beginning of ripening could be related to the reduced ethylene level. Although peaches treated with 100 µg/L of aqueous 1-MCP produced significantly lower ethylene than the control in both storage conditions, softening was not inhibited, suggesting a higher concentration is required to attain full saturation. Transient retention of flesh firmness followed by rapid softening was observed for HT+1-MCP peaches. HT was the major factor influencing firmness retention but that effect was lost in HT+1-MCP. Finally, HT and HT+1-MCP were potent in reducing % decay, especially in 'Delta' peaches. Future research will continue these investigations of the suppression of ripening of NMF peaches using higher concentrations of 1-MCP alone or combined with HT.

S02.127

Some Quality Attributes of Persimmon Fruit cv. Karaj as Affected by Deastringency Treatments

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Astringent persimmon fruits are usually treated with CO₂ enriched atmosphere or ethanol vapor to make them non-astringent and acceptable for consumers before delivery to the market. In this survey, effects of these treatments on some important fruit traits of persimmon (cv. Karaj), including soluble tannins, total carotenoids, ascorbic acid, and total sugars was investigated. Results showed that, CO₂ saturated atmosphere for 24 or 36 hours, as well as 7.5 or 10 ml/kg of 35% ethanol could reduce soluble tannin below the critical concentration for astringency taste (1000 ppm). Treatment with CO₂ for 36 hour, significantly (at 5% level) increased total carotenoid content of fruit compared to control. The treatments, especially ethanol treatments, considerably reduced ascorbic acid content, but did not change total soluble sugars. Persimmon fruits ripened naturally to provide non-astringent for consumers (commercially available in the market, nearly at senescence stage) were also compared with the treated fruits. These commercial fruits had higher soluble tannin than the critical astringent threshold, were lower in sugar content and in a very soft condition, significantly at inferior quality than the treated fruits.

S02.128

The Effect of Postharvest Silicon Application on 'Hass' Avocado Fruit Physiology

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Silicon (Si) has been used to minimize the adverse effects of biotic and abiotic stresses on fruit quality of various fruit crops. This study investigated the effect of silicon on fruit firmness, CO₂ production and ethylene evolution of 'Hass' avocado fruit. Four different sources of silicon (potassium silicate (KSil), Nontox-Silica (NTS), calcium silicate and sodium metasilicate) were used as postharvest dips. Fruit were treated with Si sources at concentrations ranging from 80ppm to 2940 ppm and subsequently stored at either -0.5, 1, 5 °C or room temperature (25 °C). Fruit dipped into KSil 80 (80ppm Si) showed the highest firmness. With respect to net CO₂ production, there were significant differences in temperature and treatment means. Fruit stored at -0.5 °C respired at a low rate whereas those stored at room temperature (25 °C) reached their respiration peak earliest. Overall fruits treated with silicon in the form of KSil 2940ppm produced the least amount of CO₂ thus had the lowest respiration rate while non-treated fruits (Air) had the highest respiration rate. Control fruits showed the highest ethylene evolution and those treated with KSil 2940 ppm the lowest. Using ultra-structural analysis (EDAX) it was found that Si passed through the exocarp into the mesocarp tissue in fruit treated with high Si concentrations (KSil 2940) while fruit dipped into very dilute Si solutions (80ppm and 160ppm) showed very little to no Si infiltration into the mesocarp. Treatments with NTS generally showed little Si infiltration. Postharvest application of 2940 ppm Si in the form of KSil seems to be most beneficial to maintain avocado fruit quality, probably due to suppression of respiration and a reduction in ethylene evolution.

S02.129

Mechanism of Corky Tissue Formation, an Internal Breakdown Disorder in Sapodilla [*Manilkara achras* (Mill) Fosberg] Fruits

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Studies conducted on the physiological disorder of sapodilla or sapota [*Manilkara achras* (Mill) Fosberg] known as corky tissue showed a direct relationship between

the incidence of disorder and the number of fruits/panicle. The moisture content of seeds from corky tissue fruits was lower than that of seeds from healthy fruits. The seeds in corky tissue affected fruits were less viable and took higher number of days for germination as compared to seeds of healthy fruits. Since sink capacity is related to seed viability, it was evident that the sink strength was reduced in corky tissue fruits as compared to healthy fruits. Preharvest application of PGRs like GA3 or paclobutrazol (PBZ) on fruit panicles having more than one fruit showed that corky tissue could be induced in fruits by reducing their sink strength. It was also evident that the loss of moisture from seeds during fruit development phase resulted in loss of seed viability as confirmed by measurement of dehydrogenase activity, DNA content and the levels of endogenous hormones like GA3, abscisic acid (ABA) and jasmonic acid (JA). Corky tissue incidence was also found to increase markedly under conditions of increasing evaporative demand, decreasing relative humidity and reducing soil moisture content showing that development of soil and atmospheric stress during fruit growth favored corky tissue incidence. The biochemical composition of fruits showed that the levels of total and reducing sugars were lower in corky tissue affected mesocarp as compared to healthy fruit and the starch content was higher in corky tissue affected fruits than the healthy fruits. The data clearly point to the predominant influence of inter-fruit competition in the formation of corky tissue in sapota cv. Cricket Ball. The biochemical and physiological mechanisms associated with corky tissue formation will be discussed.

S02.130

Are Reactive Oxygen Species (ROS) the Cause of Superficial Scald in Apples?

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Granny Smith (GS) apples are very susceptible to superficial scald, a chilling injury symptom, when stored in regular air at 0 °C for several months. For many crops, it has been shown that low temperature storage resulted in oxidative stress and chilling injury. Oxidative stress is caused by an increase in the production of superoxide anions, which leads to the generation of other dangerous reactive oxygen species (ROS) such as hydrogen peroxide and hydroxyl radicals. Application of low oxygen (LO₂) pretreatments at 20 °C, applied immediately after harvest or applied 1 week later after the fruit was stored at 0 °C, was effective in reducing superficial scald appearance in GS after 4 and 6 months of cold storage. Also application of ethanol vapours, the product of anaerobic stress, was effective in the reduction of superficial scald. The effectiveness of the LO₂ pretreatment in reducing superficial scald was similar to that of the commercial treatment using chemicals such as diphenylamine (DPA) or the ethylene inhibitor 1-methylcyclopropene (1-MCP). In order to study the involvement of ROS in scald appearance in GS apples, the levels of ROS were checked in two different ways: fluorometry and confocal microscopy using specific dye. It was found that only in control fruit the levels of ROS increased during shelf life following 4 months of cold storage, while, in LO₂ and ethanol treated fruits the levels of ROS remained lower. The low levels of ROS were correlative to the increase of catalase mRNA expression in the LO₂ and ethanol treated fruit after 4m at 0 °C plus one week of shelf life. It seems that ethanol vapours were as effective as LO₂ treatment in reducing ROS production. The increase in ROS production during shelf life in control fruit was in association with the increased intensity of the scald symptoms.

S02.131

Understanding the Role of Enzymatic and Non-Enzymatic Antioxidants in Chilling Injury of Japanese Plums

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Japanese plums (*Prunus salicina* Lindl.) are susceptible to chilling injury (CI) during postharvest cold storage. The degree of susceptibility to CI in plums depends upon

many factors including cultivar, harvest maturity, storage conditions (temperature and atmosphere composition), and duration of storage. The role of enzymatic and non-enzymatic antioxidants in providing protection against chilling stress in many fruits is well known, but this vital information about Japanese plums is not conclusive. Therefore, we investigated the effects of various factors, such as cultivar, harvest maturity, storage temperature and duration, on the development of CI in Japanese plums in relation to the levels of enzymatic and non-enzymatic antioxidants in fruit flesh. CI in Japanese plums appeared to be an oxidative phenomenon which involved the increased lipid peroxidation and the reduced capability of the primary antioxidant enzymes, superoxide dismutase, catalase, and peroxidase, to quench the increasing levels of reactive oxygen species (ROS) produced in response to prolonged chilling stress. The acclimatization response of Japanese plums to chilling stress as indicated by the increased levels of enzymatic and non-enzymatic antioxidants was too weak and slow to compensate for the presumed increased ROS production. The levels of antioxidants, ascorbate, glutathione and phenols, were strongly influenced by various factors under study. The activities of enzymes involved in the oxidation and recycling of ascorbate and glutathione could partially explain the changes in their concentrations and redox status. The oxidized forms of ascorbate and glutathione accumulated with the prolonged exposure to stress conditions. The development of oxidative stress during cold storage was reflected by the lipid peroxidation and the dynamics of enzymatic and non-enzymatic antioxidants. Our experimental results suggest a possible role of the antioxidants in providing protection against oxidative injury during cold storage of Japanese plums.

S02.132

Watercore Dissipation in 'Fuji' Apples by Pre-Storage Treatments

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Apples with severe watercore are rejected during market quality control inspections because affected fruit can develop alcoholic off-flavours and internal browning symptoms. The objective of this investigation was to use pre-storage temperature regimes and ripening inhibitor or promoter treatments to accelerate watercore dissipation without excessive loss in fruit firmness. Late harvest 'Fuji' apples with severe watercore were kept in air at 1 °C (2008), 3 °C (2007), 6 °C and 10 °C (2007 & 2008). Some fruit at 10 °C were also treated with 1-MCP and Ethephon. In 2009, fruit were held in CA at 1 °C, 3 °C, 6 °C and in air at 10 °C. Additional treatments were 1-MCP 24h after harvest or non-treatment followed by a 3 wk delay before CA application with the apples held during the delay at their respective storage temperatures. Flesh firmness and watercore assessments were made at-harvest, after the 3 wk delay and at 2, 4 and 6 months. Changes in flesh firmness and watercore were followed during 51 d storage. Fruit at 1 °C, 3 °C in air and fruit at 10 °C treated with 1-MCP showed nearly no change in flesh firmness while fruit at 6 °C in air softened between 7 and 9 N/cm² and untreated fruit at 10 °C lost around 10 N/cm². Watercore in 'Fuji' apples with and without 1-MCP or with ethephon treatments at 10 °C dissipated to acceptable levels after around 16 to 22 d, while apples at 1 °C, 3 °C and 6 °C showed acceptable watercore at 51 d, 29 d and 26 d respectively. When 'Fuji' apples have severe watercore at-harvest, one option is to treat them with 1-MCP and store at 10 °C in air for 20 d before CA storage. By these means the watercore will be reduced rapidly but fruit flesh firmness will generally be maintained at acceptable levels.

S02.133

Water Relations in Peel of Citrus Fruit as Affected by Postharvest Treatments Inducing Peel Pitting

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Citrus fruit are prone to develop postharvest physiological disorders in the peel

at non-chilling temperature, referred to as rind breakdown, rind staining or peel pitting, without compromising internal quality but decreasing fresh commercial value. Many of these alterations have been related to altered water relations within peel tissue. In some instances, waxing, processing through packing line and other postharvest practices aggravate incidence and development of the disorder. However, the impact of deleterious postharvest procedures in water potential and its components in the peel of citrus fruit is poorly understood. Mature 'Marsh' grapefruit have been used to examine changes in water, osmotic and turgor potential in three peel layers; flavedo, external and internal albedo of fruit subjected to different postharvest treatments known to induce postharvest peel pitting. Flavedo suffered the most remarkable changes in water potential during the different postharvest treatments. Osmotic potential underwent only minor variations during 2 weeks of storage period. Flavedo and albedo of packingline-processed grapefruit experienced higher decreases in water and turgor potential as compared to manually- processed fruit. Wax-coating altered and delayed the ability of flavedo and albedo to recover turgor potential after storage at high RH, and these effects were more pronounced in packing line-processed than in manually-processed grapefruits. As turgor potential decreased, the peel tissues became less capable to further water adjustment and turgor recovery. Interestingly, peel pitting was more severe in those fruit experiencing sharper variations in turgor potential. Collectively results associate variations in water status with postharvest peel pitting in grapefruits.

S02.134

Effect of Cold Acclimation and Exogenous Ethylene on Woolliness Related Enzymes in Peach Fruits during Cold Storage

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Woolliness is one of most common symptom of cooling-injury of peach fruit during cold storage. In this experiment, peach fruits (*Amygdalus persica* cv. Okubo) were stored at three methods immediately after harvest, 0 °C constant temperature, 8 °C for 5 days and then at 0 °C, and 50-80µL/L exogenous ethylene treatment after 15 days at 0 °C, to determine the effects of cold acclimation and exogenous ethylene on the activities of woolliness related enzymes such as polygalacturonase (PG), pectin esterase (PE) and lipoxygenase (LOX), as well as flesh firmness and fruit juice extraction during storage periods with or without 3 days of shelf-life at 23 °C-24 °C. The results are as follows: 1) LOX enzyme activity and PG enzyme activity were significantly positive correlated with woolliness, while the change of PE enzyme activity was not correlated with woolliness directly. 2) The symptoms of woolliness of peach fruits stored at 0 °C appeared after 4 weeks and they were not obvious under the cold acclimation storage and exogenous ethylene treated storage methods. 3) The methods of cold acclimation storage and exogenous ethylene treatment were decreased the PG enzyme activity and increased the LOX enzyme activity respectively, so these methods maybe retarded the woolliness to a certain extent, promoted the peach fruits to complete the after-ripening, and then preferably retain the peach fruits quality.

S02.135

Cell Wall Characterisation of Cracking-Affected 'Snow Queen' Nectarines

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Cracking in white-fleshed 'Snow Queen' nectarines (*Prunus persica* var. *nectarina*) represents a main factor limiting production of this cultivar in many growing regions. It has long been thought to be caused by osmotically-driven water penetration through the fruit surface, mainly by rainfall shortly before harvest. As a result, turgor of fruit increases to a degree hardly tolerated by the epidermal tissues. As cell walls are largely responsible of supporting the turgor pressure from inside the cells,

incidence of cracking may be partially dependent on their ultra structural composition. In this work, samples of both intact and cracked 'Snow Queen' nectarines were picked periodically around the commercial harvest date in order to elucidate if there were differences in cell wall composition and some cell wall-related enzyme activities between samples. Results showed that the amount of cell wall material was similar among samples. However, extracted yields of both covalently-bound pectin and matrix glycans fractions were significantly ($P \leq 0.05$) lower in cracked nectarines. Additionally, a lower content of uronic acids in covalently-bound pectin was also observed, while there were no differences in non covalently-bound pectin. Changes in cell wall composition were not directly related to observed modifications in the activities of cell wall-related enzyme activities, thus suggesting that predisposition towards cracking may be brought about from differences in cell wall synthesis events or earlier cell wall metabolism rather than latter modifications during fruit ripening.

S02.136

Effect of Pre and Postharvest Factors on Splitting in Radish (*Raphanus sativus*)

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Splitting in radish (*Raphanus sativus*) has a significant commercial impact to growers in terms of product wastage, additional handling/selection costs and rejections by retailers. Although the direct impact on the consumer is not known, it is possible that the split bulbs and drying of the split surface may reduce sales. Splitting generally occurs within 2 days of harvest after the radish has been placed in a low temperature environment. In a six month project, the effects of irrigation regime and post harvest conditions were studied using glass house grown Radish plants. Irrigation was adjusted with pots either receiving no additional water from 3 weeks before harvest, irrigated to field capacity 3 weeks before harvest, or irrigated to field capacity 3 and 2 weeks before harvest. Stomatal conductance (Gs) demonstrated significant treatment differences 1 week before harvest. At harvest the radish had top growth removed before being washed. Yield responded significantly to irrigation treatment with the lowest yield observed in response to water stress. Similar levels of splitting were observed for all three irrigation treatments. Overall, cold storage at 6 °C hastened the development of splits by one day compared to 0 °C and the proportion of split radish declined at higher humidity (RH%). The interaction between storage temperature and RH% was greatest at 0 °C with little effect of RH% observed at 6 °C storage. Delay in attaining storage temperature significantly increased observed splits. The findings suggest that radish should not be water stressed before harvest and rapidly moved to a high humidity cold store with a target temperature of 0 °C to minimise splits.

S02.137

Methyl Jasmonate Treatments Reduces Chilling Injury Symptoms of Banana

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Chilling injury (CI) is a major postharvest storage problem for tropical commodities. An experiment was conducted with banana (*Musa* spp., cv. Valery) treated with methyl jasmonate (MJ) before storing at low temperatures. Fruit in clusters were subjected to MJ (2 and 4 min) or without MJ (control) and stored at low temperatures (4 and 8 °C) for 24 days. The chemical treatments were successful at reducing CI symptoms of bananas. Fruit decay was reduced during subsequent ripening. MJ-treated fruits had lower mass loss and higher total soluble solids (TSS) than the control treatment. TSS was highest in 4 min treatment and control group had lowest TSS. The overall quality of MJ treated fruits was good with lower surface pitting and scalding compared with the control treatment. In the cold storage, the highest TSS and fruit colour was observed in 8 °C while highest firmness and total sugars was observed in 4 °C. The best results were obtained at storage temperatures of 8 °C and 4 min treated with MJ.

S02.138

Assessment of Bitter Pit Risk in 'Gala' Apples by Fruit Infiltration with Magnesium

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Bitter pit is a postharvest physiological disorder of apples, related to Ca deficiency, and aggravated by high levels of Mg, N, and K in the fruit. This work was carried out to assess the viability of fruit infiltration with Mg, for preharvest segregation of 'Gala' apples regarding the risk of bitter pit development during cold storage. Fruits were sampled in 50 orchards located in Southern Brazil, in 2003. Samples of 25 fruits per orchard were picked about 20 days before commercial harvest maturity, vacuum infiltrated (100 mm Hg/2 min) in 0.1 M MgCl₂ (with 0.3 M sorbitol and 0.05 % Silwet L-77) and then assessed for incidence (%) and severity (pits/fruit) of bitter pit like symptoms. Samples of 120 fruits were harvested in the same orchards, at the commercial maturity. In each of these samples, 100 fruits were stored in regular air cold storage for four months (0±0.5 °C /90-95% RH) and 20 fruits were analyzed for mineral content (Ca, Mg, K, and N). Cold stored fruit were assessed for incidence (%) and severity (pits/fruit) of bitter pit five days after removal from storage. There was a highly significant linear correlation ($r^2 = 0.69$; $p < 0.001$) between the incidence of bitter pit symptoms in Mg-infiltrated fruits and in cold stored fruits not infiltrated with Mg. There was a decrease in Ca and an increase in N contents with increases of incidence and severity of bitter pit in both, Mg-infiltrated and cold stored fruits. The results show that infiltration of 'Gala' apples with Mg before harvest maturity is a feasible method to segregate orchards regarding the risk of bitter pit development during cold storage.

S02.139

Predicting Bitter Pit in 'Golden Smoother' Apples

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Bitter pit is the most important physiological disorder in apples and therefore effective prediction methods would be beneficial for both the industry and individual growers. In 2008 and 2009 seasons, we evaluated several different methods to predict bitter pit at 40, 20 and 10 days before commercial harvest (dbh) in different orchards of 'Golden Smoother' apples. For each test date and orchard, a 40 fruit sample was vacuum infiltrated in a 0.05 M MgCl₂ solution for 2 minutes ('Mg'), immersed in a 2000 ppm ethephon solution for 5 minutes ('ethephon'), or left un-treated (the 'control'). Fruits from all these treatments were maintained at room temperature (20-25 °C). Bitter pit-like symptoms were evaluated at 5-7 day intervals on individual fruit. Finally, another 80 fruit sample was taken from each orchard at harvest to establish the real incidence of bitter pit after cold storage at 2 °C for 3 months. To estimate the predictive accuracy of each method, the bitter pit-like symptoms at 40, 20 and 10 dbh were related to the real incidence of bitter pit at postharvest. The incidence of real bitter pit at postharvest in 2008 (3%) was lower than in 2009 (23%). In both years, all 3 methods ('Mg', 'ethephon' and 'control') showed bitter pit-like symptoms 6-7 days after sampling and the highest percentages were observed at 20 dbh. In 2008, the 3 methods showed a high predictive accuracy from 40 dbh (Mg: $r^2 = 0.93$; ethephon: $r^2 = 0.97$; control $r^2 = 0.71$) while, in 2009, they showed high predictive power from 20 dbh (Mg: $r^2 = 0.81$; ethephon: $r^2 = 0.89$; control $r^2 = 0.68$). These results show that the 3 methods could be used to predict bitter pit from 40 to 20 dbh, although their accuracy could depend on the time of sampling and on year conditions.

S02.140

Commercial Apple CA Storage Temperature Regimes with 1-MCP (Smartfreshsm): Benefits and Risks

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Storage studies undertaken in 2008/09 with 'Gala' and in 2009/10 with 'Elstar', 'Gala' and 'Jonagold' show 1-Methylcyclopropene (1-MCP; SmartFreshSM) treated apples can still ripen slower even when stored under higher than normal controlled atmosphere (CA) storage temperatures to provide energy and cost savings and environmental (reduced carbon footprint) benefits. Our studies involved three commercial storage operations in Southern Germany where two comparable CA rooms were first filled with precooled fruit of similar origin and quality. One room was then treated with SmartFreshSM and held at a temperature set-point some 3 °C above the untreated room; CA atmosphere conditions were different for each cultivar but identical for both untreated and treated rooms. Energy balances were calculated separately for all rooms from the cooling and CA equipment run time records. Ripening behaviour and quality changes were monitored regularly during storage, and at storage removal fruit samples were either held in ambient air for 7 d or held in a simulated marketing chain followed by a short shelf-life period at ambient temperatures before quality parameters from both rooms were compared and sensory tests carried out. This paper presents our results with the above mentioned studies and will discuss both the benefits including a reduced carbon footprint but also the risks when storage regimes are changed, in particular, the cultivar specific risks for physiological storage disorders and rots.

S02.141

The Effects of 1-Methylcyclopropene (1-MCP) on Ripening of *Malus xdomestica* cv. Ellswood and *M. xdomestica* cv. Wellant during Controlled Atmosphere and Regular Atmosphere Storage

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The potential for commercial application of 1-methylcyclopropene (1-MCP) to inhibit ethylene action and maintain quality of two important commercial Irish apple cultivars, 'Ellswood' and 'Wellant' under different storage conditions was investigated. Preclimacteric apples were harvested and were immediately cooled at 4 °C and treated with SmartFresh™ (1-MCP) at 625 ppb for 24 hours. Following 1-MCP application, both treated and untreated apples were stored under regular atmosphere (RA) (3-4 °C and 95% RH) and controlled atmosphere (CA) A (8% CO₂, 13% O₂, 95% relative humidity [RH] and 1 °C) conditions for three months. The apples were evaluated for surface colour, firmness, soluble solids, malic acid and tannins. 1-MCP application in conjunction with either CA or RA storage maintained fruit flesh firmness and had higher levels of tannins relative to untreated apples. The concentrations of malic acid for the cultivar 'Wellant' were higher for 1-MCP treated fruits in CA conditions. Colour retention was improved only in 'Wellant' apples. 1-MCP and CA storage did not maintain soluble solid concentration in both cultivars compared to 1-MCP treated apples in RA conditions. The results indicate that application of 1-MCP delays ripening and maintain the overall quality of both apple cultivars.

S02.142

Modeling of the Ethylene Metabolism during Ripening and CA Storage of Jonagold Apple

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This work aims to develop a kinetic model to predict and simulate the ethylene me-

tabolism during ripening and storage of Jonagold apple. Two experiments were performed on Jonagold apple harvested in September 2008 and 2009. In a first experiment ethylene production as well as 1-aminocyclopropane-1-carboxylic acid (ACC), N-malonyl-ACC (MACC) and S-(5'-adenosyl)-L-methione (SAM) were quantified during the on-tree ripening of Jonagold apples. Additionally the *in vitro* activities of both regulating enzymes (ACC oxidase and ACC synthase) were monitored. Samples were collected for a period up to six weeks, starting from two weeks before the optimal harvest date. In a second experiment similar measurements were performed to study the effect of harvest date, storage time and the application of the ethylene blocker 1-MCP on the ethylene metabolism during storage under optimal CA conditions. Apples were stored up to 9 months. Firmness was assessed as a measure for fruit quality in both experiments. During on-tree ripening the SAM concentration increased only slightly while significant changes in ACC concentration and enzyme activities were observed. The application of 1-MCP resulted in clear differences in ethylene production rate, metabolite concentrations and enzyme activities during storage as compared to the untreated fruits. Based on the experimental data gathered during ripening and storage, a kinetic ethylene model was developed taking into account the underlying biosynthetic pathways. This contribution will discuss the experimental data and describe the performance of the developed model in more detail.

S02.143

Storage of Plums (*Prunus domestica* L.) in Controlled Atmosphere (CA) or Ultralow Oxygen (Ulo) Conditions

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Plum production is increasing in Norway. The aim of the production is to satisfy consumer demand for large high quality plums for fresh consumption in Norway as well as for export to countries in North-Western Europe. The packing houses and marketing organizations are looking for methods to keep the plums without losses and in acceptable condition for up to six weeks. As part of this work we have stored plums under CA and ULO-conditions. In the CA-storage O₂ was kept at 2% and CO₂ at 6%. In the ULO-storage both O₂ and CO₂ were at 1%. The temperature was kept at 2 °C during the six week storage period. Included in the experiments were plums of 9 cultivars: 'Edda' (early ripening Norwegian cultivar) and the more widely grown cultivars 'Opal', 'Mallard', 'Avalon', 'Excalibur', 'Reeves', 'Victoria', 'Jubileum' and 'Valor'. In previous work we found that softening and susceptibility to fungal diseases limited the shelf life of plums. It is also known the internal browning (jellying) is a limiting factor for long term storage of plums. All cultivars reacted positively to low O₂ storage condition by slower ripening (keeping firm and green). Cultivar differences were observed in the amount of internal damages in the fruit flesh and fungal diseases. However, as the cultivars ripen over a six week period, climatic conditions before harvest may influence the susceptibility to fungal decay. The storage experiments will be repeated the coming seasons.

S02.144

Effects of Map Combined with Chlorine Dioxide Gas Treatment on Fruit Quality and Storability of Table Grapes (*Vitis labruscana* cv. Campbell Early)

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This study was conducted to investigate the effect of modified atmosphere packaging (MAP) combined with decay inhibitors on physiological changes and storability in table grapes (*Vitis labruscana* cv. Campbell Early) during cold storage and transportation. Table grapes were packaged in 30µm LDPE film with 2% pinhole following the treatment of 2mg×L⁻¹ chlorine dioxide (ClO₂) gas for 15min and/or sulfur dioxide-generating sheets. After treatment, grapes were stored at 0±1 °C and RH >90% cold storage. Physiological changes and quality factors were monitored

during 90 days of storage. MAP combined with chlorine dioxide and/or sulfur dioxide pad treatment was effective in preventing grape decay and weight loss. Berry drop that is a serious problem during storage and transportation was remarkably reduced by MAP combined with chlorine dioxide. The respiration rates were significantly reduced immediately after this combined treatment, and the effect was maintained for 7 days. The treatment seems to prevent weight loss and berry drop of grapes during storage and transportation. However, ethylene production was higher in MAP with chlorine dioxide treatment than MAP treatment alone right after treatment. Chemical stress from the chlorine dioxide and/or sulfur dioxide treatment seems to be a causal factor of ethylene evolution but this response has no effect on quality of grapes during storage. Thereafter the respiration rates and ethylene production were similar in all treated grapes. There was no significant effect on titratable acidity and firmness in all treatment. Our data suggest that MAP combined with chlorine dioxide gas treatment is a useful tool for extending storability of table grapes by preventing decay, wilting and berry drop during storage and transportation.

S02.145

Effects of Short-Term N₂ Treatment and Modified Atmosphere Packaging on Quality of Peeled Water Bamboo Shoot (*Zizania caduciflora*) during Cold Temperature

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Peeled water bamboo shoot (WBS), where outer leaf sheaths are peeled, has rapid quality deterioration resulting in yellowing and hollowness and becomes one of the most important problems after harvested. To better understand the role of short-term N₂ treatment and modified atmosphere packaging in quality of post-harvested WBS, texture, visual quality and colour change were investigated during cold storage. Peeled WBS were exposed to humidified air or pure N₂ gas for 6 h, and then kept in enclosed into 0.045 mm thick polyethylene bags for 80 days in the dark at 2 °C with 90%-95% relative humidity. Shoots kept in humidified air was used a control. After 35 days of cold storage, the control quickly loosed the visual quality, appearance with heavy water immersion, green-yellowing and lot of browning spot. The MA packaging had also loosed the visual quality after 60 days at 2 °C. Shoots with treated pure N₂ for 6 h and MA packaging maintained better visual quality than the other treatments after 80 days during cold storage. With the reduce of visual quality, texture decreased during cold storage. Short-term N₂ treatment and MA packaging reduced the decrease in texture. Additionally, peeled WBS became green-yellow during cold storage, resulting in the decreasing of L value and a* value and increasing of hue angle. Pure N₂ for 6 h and MA packaging not only reduced the decrease in L value and a* value but also the increase in hue angle, slowing down the green-yellowing. These data indicated that short-term N₂ treatment and modified atmosphere packaging could be an effective method to delay the senescence and maintain the quality of water bamboo shoot after postharvest.

S02.146

Effect of Gas Composition on Quality and Storage Ability of 'Bravo de Esmolfe' Apple

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The aim of our research was to ascertain the conservation limits of cv. Bravo de Esmolfe apples in normal (NA) and controlled atmosphere (CA), concerning the commercial point of view. The fruits were produced in the northern region of Portugal at Estação Agrária de Viseu during the 2008/09 campaign. The fruits

were harvested at the commercial maturity on the 19th September 2008, and immediately transported to the Microcameras Controlled Atmosphere Experimental Unit (MCAEU, UTAD). One lot was analyzed taking into account quality parameters, respiration and ethylene production and the remaining lots were stored in chambers with normal and controlled atmosphere, named as CAstandard, LOW and ULO with gas concentrations (%O₂;%CO₂) respectively of (3±0.5:3±0.5), (2±0.5:3±0.5) and (1±0.5:3±0.5). After 220 days of storage and 7 to 14 days of shelf life, the fruits stored in NA had highest mass loss, less firmness, less acidity (malic acid), different colour (L* C* °H) and less sensory quality. The fruits stored in CA, had fewer changes in weight, acidity, firmness and colour. The sensory qualities were scored as good to very good, the respiration values were placed near the climacteric peak and ethylene production was also near the maximum production value, meaning that the fruits had good edible quality. It can be concluded that those fruits could be retained for 4 to 5 months under normal cold storage at 1±0.5 °C and 85±5% relative humidity. However, the fruits under CA might be stored for ca. 220 days with good commercial quality, keeping those optimal results even after a 7 to 14 days shelf life.

S02.147

Applicability of the MA-System Tiempocap® for Storage of Different Fruit Cultivars

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Controlled atmosphere storage can inhibit fruit ripening processes and enhance storability. Commercial CA-storage facilities actively control O₂ and CO₂ levels, but there are other systems such as MAP bags, where a “Modified Atmosphere” (MA) is maintained passively by fruit respiration. The ‘TiempoCap’ system is a new system which works in a similar way to MAP bags. A plastic bin (within a coolstore) is sealed with a cap, equipped with membranes with a specific permeability for O₂ and CO₂, so that inside the bin a modified atmosphere can be established and maintained. We tested the ‘TiempoCap’ system for the storage of: ‘Regina’ sweet cherries; ‘Elena’ plums; ‘Comice’ pears; and ‘Braeburn’, ‘Cameo’, and ‘Diwa’ apples. Besides flesh firmness, acidity and soluble solids we assessed taste as well as physiological disorders and fungal rots. The quality and freshness of the cherry stalks was also evaluated using quality analyses in the laboratory together with optical evaluations. In all experiments, the O₂ and CO₂ levels inside the bin were monitored during the whole storage period. The ‘TiempoCap’ System had a positive influence for sweet cherries especially on the quality and freshness of the stalks but it also increased rots, both effects being a result of the high humidity inside the box. The ‘TiempoCap’-System was not suitable for plums, as there was a disproportional high percentage of rots. The CO₂ level required for effective CA-storage of sweet cherries and plums is 12-15%; this level was not reached inside the box.

S02.148

Using Consumer Modified Atmosphere Packaging (MAP) to Maintain Quality of Green Beans during Sea Shipping Simulation Trial

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Sea shipping could be a valuable tool in increasing green beans exportation from Egypt specially with the dramatic increase in air shipping cost. On the other hand, using MAP as a secondary preservation method could be a valuable tool in reducing deterioration of exported green beans. This work was carried out to evaluate three consumer packages (the regular 500g perforated plastic bags, 250g and 500 MAP bags) in a sea shipping simulation experiment where all packages were stored for 15 days at 6° C for 15 days (average shipping period) plus 3 days at 10 °C (average market shelf display period). Respiration rate (for perforated bags) and gas composition (for MAP) were measured through out the experiment period and

at the end of the trial. Weight loss, colour and visual quality were also measured. The initial respiration rate for perforated bags was about 15 ml CO₂/kgxh and increased to about 20 ml CO₂/kgxh toward the end of the shipping period and reached about 25 ml CO₂/kgxh during the display period. As for gas composition, the two consumer MAP created an acceptable composition at the beginning of the experiment (about 3-5% CO₂ plus 17-19% O₂) but the 500g bags started to create unfavourable gas composition after about 15 days (10.7% CO₂ + 13.2% O₂) and after the display period CO₂ levels reached 18.9 % plus 5.4% O₂. On the other hand the 250g bag maintained the gas composition through out the storage period and finished up with 4.2% CO₂ plus 18.6% O₂ and after display period CO₂ level increased to 6.4% plus 16.7% O₂ but such increase didn't cause any noticeable deterioration. This work concluded that 250g MAP consumer bags could be successfully used in maintaining the quality of green beans when stored at 6 °C for 15 days plus 3 days at 10 °C.

S02.200

Conservation the of Quality of Italian Tomato Fruits Produced in Organic and Conventional Systems

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This work aim to determinate the quality of Italian tomato fruits produced in organic and conventional systems, they were produced under conditions of Distrito Federal, Brazil, packed and kept at room temperature (24 °C ± 2.0 and RH = 32% ± 2) and cold (12 ± 1 °C and RH = 73% ± 1) for 20 days of storage in the post-harvest laboratory of Embrapa Vegetables. Colour, firmness, titratable acidity, total soluble solids, vitamin C, lycopene, β carotene, total phenolic and total antioxidant activity were evaluated. Levels of lycopene, β carotene, vitamin C, acidity, phenolics and antioxidant activity were influenced by the crop system, time and temperature of storage. Fruits produced in the organic crop showed higher levels of Vitamin C throughout the storage as well as higher levels of soluble solids at 0, 10 and 20 days and antioxidant activity at 0, 5 and 10 days, regardless of the temperature. Fruits arise of conventional crop had higher levels of acidity at 5 and 15 days of room and cool storage. At 10, 15 and 20 days, there was no differences in levels of lycopene in the treatments evaluated.

S02.201

Quality of Tomatoes Production with Different Doses of Organic Compost

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Commercial and experimental tomatoes hybrids (San Vito, Giuliana, Jupiter, HEM031) were grown in organic system of production with four different doses of organic compost (6, 12, 24 and 40 t×ha-1) in experimental field of Embrapa Vegetables, District Federal - Brazil, and were harvested in 2008 July to evaluate the final quality. Analysis of colour, firmness, acidity, pH, soluble solids, sugars, vitamin C, lycopene, β carotene, levels of nitrate and microbiological evaluation were realized. In all fruits treated with doses of organic compost, there was absence of salmonellas and coliforms and nitrate content stay in the tolerated limits in all doses of organic compost. The higher values of pH were observed in HEM031 and lower in Giuliana, while in acidity, the lower value was observed for the hybrid HEM 031 and higher for Jupiter. The San Vito hybrid showed higher levels of nitrate, vitamin C, lycopene, a* (colour), firmness and total soluble solids and Jupiter the higher levels of sugars and β carotene. The hybrid San Vito showed maximum levels of total soluble solids, vitamin C, lycopene and a* for applications of 27.5, 24.16, 28.56 and 18.83 t×ha-1 of organic compost.

502.202

The Effects of Blanching on Biological Value of Endive (*Cichorium endivia* L.)

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Endive (*Cichorium endivia* L.), a leafy vegetables species widely grown in Western Europe countries, characterized by considerable nutritional value and a distinctive, slightly bitter taste, is still a minor crop in Poland. Introducing this species into cultivation will allow to extend the assortment of leafy vegetables in Polish market. The aim of the field experiments carried out in 2008-2009 was to assess the effect of blanching on biological value of two endive cultivars: de Meaux and Kalinka. For plants blanching there were used the following materials: Rollo foil, whitening caps and black agrotexile put over the plants for 7, 10 or 14 days prior to planting in order to exclude the light. In samples of leaves collected at the harvest time the content of vitamin C, chlorophyll and P, K, Ca and Mg was evaluated. Cultivars de Meaux and Kalinka considerably differed in content of investigated compounds. Irrespective of the investigation factors, in both years of the study de Meaux cv. characterized higher content of vitamin C, carotenoids, chlorophyll and all evaluated macronutrients. Regardless of the method and period of blanching, a substantial decrease of biological value of both evaluated cultivars was observed under influence of this factor. This effect however was lower in the case of the use of Rollo foil and the whitening caps in comparison to the black agrotexile cover. Excluding the light for 14 days caused a higher reduction of nutrients content than after 7 or 10 days of the cover. Blanching of plants was associated with the increment of nitrates content in both cultivars, especially when the agrotexile was used.

502.203

Effect of Eight Rootstocks on Fruit Size and Internal Quality of 'Salustiana' Sweet Orange Grown in Hot and Dry Climate of Southern Saudi Arabia

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In recent years, the Kingdom of Saudi Arabia had made significant efforts to utilize the available agricultural resources to reach self sufficiency in several agricultural products thus contributing to national food security. As an example, interest in citrus production begun in early 1970's but major breakthroughs were accomplished with the establishment of The National Centre for Horticultural Research and Development in 1981 to accompany the growing interest in citrus cultivation in the Najran region located in the Southern part of the country. Since then, the Centre has introduced and tested several citrus rootstocks and varieties to select scion/rootstock combinations that are most suitable for the region. The present work is a report of a study carried out to evaluate fruit quality of 'Salustiana' sweet orange (a mid-season variety) as affected by 8 rootstocks ['Carrizo' citrange, US-812, Citrus macrophylla (CM), 'Volkamer' lemon (VL), Smooth Flat Seville (SFS), Gou Tou, Sun Chu Sha (SCS) and 'Cleopatra' mandarin] and grown in the desert conditions of this region. The trees were planted in 2004 and cultural practices that are optimal for the region were used. Fruit size, peel thickness, fruit juice content, and juice sugar and acid levels were measured over the maturation period. Fruit size was largest for VL, SCS and CM and was smallest for 'Cleopatra' mandarin. Juice content was lowest for VL and highest for 'Carrizo'. Juice sugar content was lowest for CM and VL and highest for 'Carrizo' and US-812. Acidity was lowest for 'Cleopatra' mandarin and greatest for 'Carrizo' and US-812. Overall, by mid-October, fruit from all of the combinations had an acid content of 0.7-0.9% with a maturity index (sugar/acid contents) of more than 12. Data will be discussed in relation to the agroclimatic conditions of the region and to the consumer preferences.

502.204

Post Harvest Performance of Peach and Nectarine Grafted on Six New Rootstocks

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Peaches and nectarines grafted onto six new rootstocks were evaluated during the 2008-2009 growing season with the objective of discerning possible effects on fruit quality and post harvest performance. The scion varieties used in this trial were 'Rich Lady' and 'Ryan Sun' peaches, and 'Venus' and 'Ruby Diamond' nectarines. The rootstocks included Cadaman-Avimag, Viking, Atlas, GxN-15, GF-667, MRS 2/5 and Nemaguard (as a control). The trial was done using 8 yr-old trees from the Univiveros orchard, in Paine (Metropolitan Region, Chile). Fruit quality parameters including flesh firmness and soluble solids content were measured at harvest. Flesh firmness, palatability, mealiness and internal browning were measured after 15 and 30 days of cold storage at 0 °C, plus 4 days at room temperature (20 °C). For fruit quality at harvest, using data averaged from the four scion varieties, Viking had the highest accumulation of soluble solids (11%) with respect to the control, while GxN 15 had the lowest (9.8%). The GF 667 rootstock produced the firmest fruit and MRS 2/5 the softest. After 15 days of post harvest cold storage, GxN 15 had the firmest fruit, and MRS 2/5 had the softest, with both trends continuing after 30 days of storage. Viking had the highest incidence of mealiness at both 15 and 30 days post harvest. However, GF 667 was the rootstock with the highest incidence of internal browning at 15 days and MRS 2/5 at 30 days. Atlas had the lowest incidence of mealiness and internal browning at both 15 and 30 days post harvest.

502.205

Evaluation of a Box Transporter System Developed to be a Harvest Aid in Some Specific Fruit and Vegetable Production Areas of Brazil

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In Brazil fruits and vegetables are frequently harvested using package boxes, filled while they are manually pulled across the plant line. The procedure is weary for the workers and bad for the product that is contaminated with dirty particles from the crop and from the soil. Next, after over filling the workers handle these boxes some packaging or support point at the production site, sometimes with aid of precarious wheelbarrows. In this protected area some additional repacking usually occurs, a factor which adds new mechanical damages. In order to keep the product and the boxes clean while, at the same time, increasing the harvest efficiency, a box transporter to be used as a harvesting aid was developed to attend some particular Brazilian vegetable production systems. The value of this transporter for harvest and handling was assessed in terms of a walking distance index, in terms of an actual harvesting productivity and by means of qualitative questionnaires prepared to investigate the benefits of this harvest aid system among for the users. It was observed that the harvest using this box transporter increase the harvesting velocity, in average, 16.7%, reduced the total distance walked by the workers in 48.6% and increased the total harvested mass in 8.97%. Additionally, in an evaluation made using a crescent qualitative acceptance scale ranging from 1 to 9 the transporter ranked 6.7 considering the users impression about the box transporter size fitness, ranked 6.6 for the impression about the transporter shape and ranked 8.3 from the maximum of nine for the impression about the system overall performance. For marketability potential the buy/use intention was evaluated in a crescent acceptance scale ranging from 1 to 5 and in this scale the average score of 4.1 was also considered to be very interesting perspective.

502.206

The Use of Crates Diminishes Postharvest Quality Losses of Butterhead Lettuce

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Fresh vegetables are highly perishable products. Their shelf life is mainly influenced by temperature, and relative humidity (RH) and air surrounding composition. Among fresh vegetables, butterhead lettuce is one of the most widely consumed one. In Argentina, lettuce is harvested and packed in crates that are usually exposed to inappropriate conditions (high temperature and low RH) before and during moving from farm to distribution centres. In such conditions, the product undergoes changes that lead to quality losses and shelf life reduction, resulting in economic losses for producers. The objective was to describe the effects of exposure of both individual lettuce heads and lettuce crates, to two ambient conditions (optimal: 0-2 °C, 97-99%RH, and suboptimal: 20-22 °C, 60-62%RH) during 24 hours. Evaluated parameters were: weight loss (WL), water content (WC), chlorophyll content (C), ascorbic acid content (AA) and overall visual quality (OVQ). The factors considered in the analysis (packaging: none vs. crate; and environmental condition: optimal vs. suboptimal) significantly affect all quality indices. Lettuces exposed individually at optimal conditions registered the best quality parameters. However, the use of crates is necessary for transportation. The packing of lettuces in crates mainly brings deterioration in the texture of the product even under optimal conditions. In general, quality attributes resulted lower in lettuces at suboptimal conditions but the use of crate was favourable in this situation: weight loss was about 5.2% and reductions in AA (22.9%), C (19.2%), WC (1.5%) and OVQ (2 points) were registered in individual lettuces at suboptimal conditions, while the values for those indices in lettuces in crates were: 5.5% (weight loss), 17.5% (AA), 7% (C), 1.2% (WC) and 0.5 points (OVQ), respectively. The packing of lettuce in crates allows the development of a high humidity atmosphere (by respiration and transpiration) that compensates suboptimal relative humidity conditions.

S02.207

Evaluation of Postharvest Quality of Tomato Fruits (*Lycopersicon esculentum* Mill cv. Raf) under Different Ca²⁺/K⁺ Ratio in Soilless Culture Production System

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Postharvest quality of Tomato fruit could be evaluated by analysis of different internal and external parameters. According to this concept, fruit quality parameters as well Blossom-End Rot (BER) incidence were evaluated in tomato cultivar 'Raf'. Plants of tomato (*Lycopersicon esculentum* Mill cv. Raf) were grown on prelite substrate with three different Ca/K ratios in the nutrient solution. The water used for the nutrition had a pH=7,6 and chemical composition (mM×L⁻¹): 3.60 HCO₃⁻, 7.00 SO₄⁼, 16.81 Cl⁻, 0.40 K⁺, 4.24 Ca²⁺, 6.89Mg²⁺, 13.38 Na⁺ and 3.62CE dS×m⁻¹. Based on this water, nutrient solution was prepared with pH 6.0. From this solution three treatments were established by the following ratios of Ca/K: 0.50 (T1), 1.10 (T2), and 3.50 (T3) during production period. Obtained results showed that not only high concentration of Ca in nutrient solution decreased the severity of BER but also a high Ca/K ratio due to a low concentration of K also increased Calcium absorption as well its transportation in plants. These results inferred a reduction in the BER occurrence as we observed in the treatment three with a low average of 1, 44% unlike to treatment 1 that showed a higher percent (4, 07%) of BER. Same results were obtained in the concentration of Ca and K from foliar analysis of tomato plants that confirmed our former observations. Evaluation of fruits among six weeks of study showed significant differences in quality parameters as Total Soluble Solids (TSS) content, firmness, pH and titratable acidity.

S02.208

Effect of Boron Foliar Sprays on Quality Parameters of Apricot (*Prunus armeniaca* L.)

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Techniques to improve fruit firmness and quality in apricot would enhance market-

ability. Studies were conducted in three different varieties of apricot (*Prunus armeniaca*) to determine if pre-harvest foliar application of different concentrations of Boron and Retain® influences extent of physiological disorders, fruit yield and fruit quality characteristics. Treatments consisted of (i) four sprays of different concentrations of Boron in the form of Mycobar (20% boron). The first spray was performed at the petal fall stage and later sprays were applied at 7 day intervals. Plants sprayed with water served as controls. Boron application varied from 1.2 Kg×ha⁻¹, 1.8 kg×ha⁻¹, 2.4 kg×ha⁻¹ and 3 kg×ha⁻¹ on three different varieties of apricots namely Rival, Goldrich and Orange Red. All of the Boron sprays improved the flower clusters. Thus the sprayed trees were more healthy and productive. The different quality parameters such as fresh weight, dry weight, size, Brix ratio, Firmness, Titrable acidity were measured. The Boron levels at different stages of spraying were measured with ICP-MS. A significant reduction in the maturity period of fruits, an increase in yield and size of fruits, an increase in fruit sugar contents, and a decrease in fruit acidity were obtained.

S02.209

Quantification of Postharvest Damages in Strawberries in Brazilian Wholesale Market

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Strawberry (*Fragaria xananassa*) is a very perishable fruit, usually with a very short shelf-life of one or two days when at ambient temperature. Postharvest damages in strawberry fruits represent an important influence in the depreciation of the product in market. This research is focused in quantify and characterize the post-harvest damages in strawberry fruits from two outlets (CEASA and CEAGESP) of the state of São Paulo, Brazil. Thirty four surveys were carried out from June to November of 2007 to 2009, and 1% of the whole amount of boxes sold in six franchises of CEASA and CEAGESP was evaluated. The sampling was stratified on the basis of strawberry varieties; commercialize packages and the fruit origin. The physical and physiological damages and pre and postharvest diseases were quantified. Fruits containing unidentified lesions and rotten areas, without the occurrence of signs of pathogens, were kept in a wet chamber for 24 hours and analyzed for a week. In total, 32,718 fruits were evaluated. In CEASA, 59 and 14.2% of fruits and in CEAGESP, 41.6 and 49.4% were from the cultivars Oso Grande and Camino Real, respectively. The most frequent postharvest damages were diseases, with average incidence of 85%, followed by physical, 40% and physiological, 2%. Among the most frequent pathogens, there were fungi from the genders *Botrytis*, *Colletotrichum*, *Rhizopus* and *Cladosporium*, besides yeast that were not identified. In both wholesale markets, were verified that strawberries commercialized in packages without films presented less incidence of diseases than fruits in packages with films. Fruits commercialized in one layer also presented fewer diseases, excluding the fruits with long pedicel, which causes physical damages on nearby fruits. This occurrence allows the penetration of pathogens.

S02.210

Effect of Post-Harvest Environment on Quality Deterioration of Mango Fruits

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The purpose of the present study is to clarify the distribution environment of imported the mango fruits (*Mangifera indica* L.) from Thailand to Japan and to determine the physiological changes in stored mangoes as influenced by postharvest environment condition. Mango fruits, cv. Namdok Mai, Maha Chanok, and Chok Anan, were obtained from orchard at Phrao, Lam Pang, and Mae Jo, Thailand, respectively. The distribution environment (temperature, relative humidity

and transportation vibration condition) of the mango fruits imported from Phrao, Thailand to Fukuoka, Japan was measured with an accelerometer. Both fruits immediately after the harvest and fruits immediately after the distribution were stored respectively by 15, 25, and 35 degree C. The content of L-Ascorbic acid, sucrose, glucose and fructose, brix, hardness score and respiration rate were measured as indices of the quality deterioration of the mango fruits. CO₂ evolution rate and O₂ consumption rate of mango fruits after the distribution stored in storage chambers at 15, 25 and 35 degree C that was ventilated air at flow rate 100 ml×min⁻¹. Both CO₂ evolution rate and O₂ consumption rate of mango fruits increased with temperature increased. In the L-AsA content at the harvest, mango fruits harvested at Phrao and at Mae Jo were about 42 mg 100g F.W.⁻¹, on the other hand, fruits harvested at Lampang were about 30 mg 100g F.W.⁻¹. In comparison with the contents of L-AsA at harvest, the content of L-AsA after distributed deduced by about the half.

S02.211

The Effect of Pre-Harvest Cytokinin Application Total Phenolic Content and Polyphenoloxidase on Post Harvest Physiology of Cauliflower (*Brassica oleracea* L. *Botrytis*)

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In this study, the effect of 50 ppm cytokinin treatments prior to harvest and 5 ppm cytokinin (CPPU) treatments after harvest on curd quality of "Serrano F1" cauliflower cultivar stored at 2 °C, 90-95% relative humidity, under 3% O₂ + 3% CO₂, 5% O₂ + 5% CO₂ and 21 % O₂ + 0.03% CO₂ (Normal atmosphere) conditions for 60 days were determined at 20 days interval for two consecutive years in 2006-2007. In addition, shelf life was determined in curds kept at 20 °C for 48 hours. As a result, controlled atmosphere storage and cytokinin treatments were more effective on keeping of total phenolics loss (mg/100) and inhibition of polyphenol oxidase (PPO) enzyme activity (ml/unit) compared to under normal atmosphere conditions and controls. Curds could be stored successfully for 60 days under 3% O₂ + 3% CO₂ condition and it was observed that curd quality was maintained even after storage at 5 %O₂ + 5% CO₂ for 40 days and 48 hours shelf life. Under normal atmosphere conditions, curds could only be stored for 20 days. In general PPO enzyme activity and total losses in phenolics were lower in cytokinin treated cauliflower curds.

S02.212

Chemical Properties Alterations of Tomato Fruits Submitted by an Induced Compression

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Means of transportation, packaging, harvesting procedures, maturation at harvest, climatic conditions, and many others variable interferes directly the quality and post-harvest life of agricultural products. In Brazil, the packaging of tomatoes still uses the wooden box type "k", firstly used to transport fuel in World War II. In this type of package, the fruits are disposed randomly into the boxes being piled up later. The piling up of these boxes occurs during production and harvesting, as well during transport and final displacement to the consumer. This trend leads to quantitative and qualitative losses. Being that stated, researches with the goal to simulate the transport conditions of tomatoes are required to decrease the fruits mechanical damage, maintaining its quality and price. Being that stated, the present work aimed to evaluate the principal organoleptic characteristics of tomato fruits (cv. Pizzadoro) submitted to an induced compression, simulating the wooden boxes piling up during transportation. A specific weight per unit area of the original wooden box "k" was measured (12.5 g×cm⁻²), and later used to obtain the weight needed to

compress fifteen fruits inside small wooden boxes of (23×20×20) cm. This weight was 5 kg, being left over the fruits during 48 hours. After this treatment, these fruits and control fruits (without treatment) were stored under two temperatures: (15 and 25) °C. The following variables were measured throughout eighteen days of storage: colour, lycopene, total soluble solids and pH. Through the results, it was concluded that the treatment significantly altered all variables studied, except for pH and total soluble solids for fruits stored at 15 °C.

S02.213

Effect of Different Storage Conditions on Nutritional and Quality Parameters of Sweet Cherry 'Sweetheart'

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The sweet cherry 'Sweetheart' presented a short shelf life but is highly appreciated by consumers due to its organoleptic characteristics. Different storage methods were tested in order to study the maintenance of quality during a period of 27 days. Different storage conditions were used 1) cold conditions (1 °C and high humidity 95%), 2) cold conditions and polypropylene film bags (1 °C and high humidity 95%) (MA) and 3) controlled atmosphere (CA) (1 °C, 95% H.R., 10% CO₂ and 8% O₂). Quality parameters tested included external colour (L*, a*, b*), soluble solids content (TSS), and titratable acidity (TA). To evaluate nutritional quality, total anthocyanins, total antioxidant activity, and total phenolics were measured.

S02.214

Quality Indices Changes in Petioles of Celery Plant (*Apium graveolens* L.) Harvested in Different Physiological Stages

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Celery is a vegetable appreciated for their high fiber content and nutritional value; petioles leaves are preferred for consumption. The aim of this study was to determine quality changes in petioles leaves in plants of celery (*Apium graveolens* L. cv. Golden Boy) harvested in different maturity stage. Total weight (TW), total length (TL), total leaves number (LN) and petiole length (PL) were evaluated at eight physiological stages (80, 87, 94, 101, 108, 115, 122 and 129 days post-transplanting). Petioles quality of each zone that leaves belongs (external, middle or internal) were analyzed in terms of colour (hue, CIELab* colour space), texture (force to cut), total soluble solids content (TSS, by refractometer) and titratable acidity (TA, by titration). In the period of 80 to 129 days post-transplanting, TW and TL increased for 0.3 to 2 kg and 47.6 to 81.2 cm. TW reached a peak of 1.2 kg at 94 days post-transplanting; weight continued increasing after 115 days, coinciding with the onset of flowering. Similar results were found for TL. Leaves development was detected until the fourth harvest; number of internals increased in a greater extent and resulted higher than the other zones of the plant (5.0, 4.7 and 7.3 leaves in external, middle and internal zone, respectively). Hue and force to cut was similar in external and middle petioles and resulted higher than internals until the fifth and sixth harvest, respectively. Inflorescence differentiation was detected at 115 days after transplantation, causing an increase in texture, TSS and TA; major changes were determined in inner leaves, essentially in the last harvest. Considering the conditions of this study, optimum quality was achieved at 122 days post-transplanting because the quality and higher yield in terms of leaf number and PL; delayed harvest could be associated with lower quality plants as their greater fibrosity.

S02.215

Effect of Pre-Harvest Polyethylene Bunch Covers on Postharvest Quality and Behaviour of Tissue-Cultured Bananas (*Musa* spp.) cv. Williams

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Tissue culture technology has greatly enhanced banana production in the Kenya in the recent past by providing disease-free plantlets that are high yielders. Banana farming has moved from backyard to commercial farming hence the need to grow high quality fruits. Polyethylene bunch covers have been shown to improve yield, visual appearance and postharvest quality in bananas. However, there are contradictory reports on the effect of bunch covering on fruit quality. In Kenya, the effect of bunch covers has not been studied. The current study used perforated dull blue and shiny blue polyethylene covers on tissue-cultured bananas cv. 'Williams' to determine the effect of bunch covers on postharvest quality of the fruits. The covers were applied when the hands had started to turn upwards. The trial was carried out in a popular banana growing area of Maragwa and was replicated three times in a complete randomized design. Fruits were harvested at full three-quarter maturity, taken to the laboratory and ripened. Parameters measured at harvest and during ripening were individual and total sugars, chlorophyll, respiration and ethylene production, moisture content, weight loss, colour and firmness. Visual appearance of the fruits was evaluated at harvest while green life and shelf life were also evaluated. Results showed that bunch covers did not significantly ($p>0.05$) influence peel and pulp colour, firmness, moisture content, weight loss, total chlorophyll content, lightness and hue angle, individual and total sugars at harvest and during ripening. Bunch covers did not influence green life, shelf life and respiration rate while ethylene production was significantly ($p\leq 0.05$) influenced. Fruits grown covered were more visually appealing, cleaner and had minimal bruises compared to the unbagged fruits while fingers from top hands of bunches grown covered suffered sunburn irrespective of the bunch cover colour.

S02.216

Effects of Bagged Twice on Fruit Quality and Room Temperature Storage of 'Cuiguan' Pear

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Cuiguan pears were covered with paper bags once (fruits covered with big paper bags at 35days after full bloom) and twice (fruits covered with small paper bags at 20days after full bloom firstly, then covered with big paper bags at 45days after full bloom) respectively to study the effects of bagging mode on fruit quality and room temperature storage, the results showed as follow: Fruits bagged twice were brighter and more beautiful with less russet and invisible dots than fruits bagged once. Fruits bagged twice had higher soluble solids and lower titratable acid than fruits bagged once. Water losing rate and rot rate were lower in fruits bagged twice than in fruits bagged once during 13-day storage at room temperature, but fruit firmness was not difference in them. The results indicated that Cuiguan pears bagged twice was more helpful to produce top grade fruits than bagged once.

S02.217

A Harvest Index, Postharvest Handling, Packing and Storage Line Designed to Jiotilla (*Escontria chiotilla* Weber) Fruit

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Jiotilla fruit is native to La Mixteca Baja Oaxaqueña, Mexico, it is considered an exotic fruit due to the lack of knowledge about it in places far from its production site. In order to reasonably exploit the native vegetation in this arid region without perturbing the ecosystem and to help peasants obtain added value produce an exhaustive study was made of this barely known fruit. Jiotilla is a very perishable, valuable fruit which needs to be known and to extend its shelf life to be marketed far from its place of origin. Since it is a non-climacteric fruit a harvest index was designed to warrant its palatable quality. Colour is a misleading maturity parameter since jiotilla's pigments are betalains and betaxantins, which synthesis is promoted by sun rays, thus ripe fruits may have developed good quality parameters but not their characteristic colour or vice versa due to their position in the plant. Microscopy studies showed that the best parameters to consider as a harvest index is fruit size as it coincides with the development of good quality parameters such as TSS, pH and titratable acidity balance. Also a postharvest handling, packing and storage line was designed for jiotilla fruit. Fruits are delicate due to the presence of thin, scales in their skin, thus, a dry cleaning treatment was provided by means of fine brushes, followed by air cooling up to a pulp temperature of 20°C. Results show that fruits are sensitive to chilling injury, expressed by black spots in the peel, thus, they showed the best storage temperature at 10±1°C in plastic perforated containers where they can last up to 8 days longer than the non treated ones, as evidenced by their physiological weight loss, appearance, chemical and sensory quality parameters.

S02.218

High-Quality Carrots for Industry

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Carrot is the most important root vegetable in Finland. Today, consumers increasingly like to buy fresh ready-to-use products, such as washed and sliced carrots. However, processed and packed vegetables may offer a favourable atmosphere for microbes to grow, wherefore it is essential that the raw material to be processed is of a very high quality. In an ongoing project, we are developing methods that will enable growers to produce high-quality carrots. First, a test method is being developed for detecting the most harmful carrot spoiling microbe, *Mycocentrospora acerina*, originating from the soil and using carrot as well as many common weeds as a host. Because of the short growing season in Finland, carrots are harvested in September-October and stored for several months over winter. A long storage period gives a chance for the spoiling microbes to damage the yield. Furthermore, there are not any fungicides against *M. acerina*. In an earlier study, a simple system was developed for examining the amount of *M. acerina* in soil samples by using carrot slices as trapping plants. In the present study, we are further developing the test system to be used by growers. Second, we aim to establish the most favourable nutritional conditions in carrot cultivation by testing calcium and potassium fertilization in field experiments. In earlier studies, it has been shown that the amount of damaged carrots in storage varies greatly between storage batches and between years. It has also been observed that nutrients available for the plants during the growing season have an effect on the storage quality of carrots. The results of the present study will be useful for the growers and the vegetable processing industry alike.

S02.219

Okra Seed Production and Quality in Relation to Pod Maturity at Harvest

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A problem inherent to seed production of okra (*Hibiscus esculentus* L.) is that the presence of growing pods on the mother plant inhibits subsequent flower set and therefore restricts seed yield. When pods of cv. Veloudo were harvested at the stage of edible ripeness (5 days after flowering, DAF) flower set was 74%, but when pods were harvested for seed (35-40 DAF) flower set was only 52%. Pods increased in length and weight until 20-25 DAF at which time seeds also acquired their maximum size (fresh weight). However, at this stage seeds had a high moisture content (>85%) and germination was low (<5% at 20 DAF and <20% at 30DAF). The moisture content of seeds within the pod decreased to 50% by 40-50 DAF, at which time the percent germination was 50-60%. Seed harvested 55-60 DAF had a moisture content of about 10% and germination was >80%. When pods were cut into three sections of approximately equal length immediately after harvest, it was found that the moisture content of seeds within the distal section decreased earlier than that in the central or proximal regions of the pod. In addition, the seeds from the distal section germinated to a higher percent than those of the proximal section irrespective of the time of harvest. Soaking seeds in concentrated H₂SO₄ for 30 min. increased the germination of seed lots harvested between 40 and 60DAF, the effect of acid treatment being greater as the time between flowering and harvest increased. It is concluded that for okra seed production pods must ripen fully on the mother plant, even if this results in reduced yield.

502.220

Processing Efficiency of Different Broccoli Head Architectures

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The preparation of broccoli for frozen mixed vegetables is accomplished by separating the higher order branches and floral tissue from the main stem. Ideally, the majority of these segments will fall into a specific size category considered commercially desirable. Oversized segments require further dicing while grossly undersized segment are discarded as waste. Thirty heads from each of two cultivars 'Marathon' and 'Shamrock' sampled from two sections of the same crop were photographed from plan and elevation viewpoints before being segmented using an AEM Decora floretting machine (AEM Machinery Ltd., Lincolnshire, UK). Using image analysis, head diameter (mm), skirt height (mm), stem projection (mm) and curvature (e) were recorded for each inflorescence. After segmentation, individual pieces were assessed for stem and floret fresh weight (g), stem length (mm), orthogonal floret diameter (mm) and floret length (mm), with the total number of floret segments also being recorded. The inflorescence of 'Shamrock' was heavier, more compact and produced less stem material than that of 'Marathon'. There was no difference in curvature between these two shapes. When compared to 'Marathon', the segmentation of 'Shamrock' produced less floret pieces with a higher proportion of these having a diameter greater than the commercial specifications. While 'Marathon' produced more target sized segments, the efficiency of this segmentation was compromised by proportionally larger quantities of the less valuable stem material. The differences in processing efficiency between the two head shapes are postulated to be driven by the inflorescence's internal branch architecture, specifically by branch angle, branch iteration interval and internodal elongation.

502.221

Effect of Age of Harvest on Fruit Quality of Okra (*Abelmoschus esculentus* L.)

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The effect of harvest at ages varying from 3 to 8 days after fruit set on quality of okra cultivars viz; Selection 5, Shagun, Sinnova, Arka Anamika was investigated. The maximum fruit length, diameter, fresh weight, dietary fibre accumulated from 5 to 7 days of harvest after fruit set in all the cultivars. Sinnova produced maximum mean fresh weight (15.30g) of fruits compared to minimum mean

fresh weight in Arka Anamika (11.26 g). However mean dietary fibre (%) content of Sinnova was least (3.64%) and Arka Anamika maximum (4.88%). Ascorbic acid content of cultivar selection-5 and Shagun on 4th day of harvest was maximum and significantly higher than later period of harvest while Sinnova and Arka Anamika recorded highest ascorbic acid on 6th day of harvest. Gradation of fruits according to cooking quality indicated that fruits of 4 to 6 days were excellent.

502.222

Impact of Global Warming on the Storage of 'Gala' Apples

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It is generally assumed that climate changes have a large impact on plants and agricultural products. In perennial species, like fruit trees, the climate influences the vegetative growth and the flower and fruit developments. The aim of this study was to investigate the influence of global warming on the storage ability and the quality of the fruits of the cultivar 'Gala'. In the last three decades, the increase of the mean temperature during growing period (March to October) achieved 2.9 °C in the Valais (Switzerland). This warming was even higher in spring. Consequently, the harvest time of 'Gala' is currently 3 weeks earlier compared to the 70's. This climate change did not influence the physicochemical traits of the fruits, like firmness, titratable acidity, solid soluble content and starch at harvest time, as well as after 6-months storage. However, the years with warmer springs (2000 or 2007) conducted to lower storage ability with higher level of vascular breakdown and flesh browning. Furthermore, since several years, summers are also warmer (especially in the night), conducted to a shortened optimal harvest period or to difficulties to get well-coloured fruits. The harvests were subsequently delayed with the appearance of too ripped apples and higher storage disorders, like enhanced disruption of the epidermis and development of fungal diseases (e.g. in 2003). Our results suggest that global warming could lead to abandon 'Gala' production in Valais and to a replacement with later ripening cultivars in the future.

502.223

Red Apple Juice. Technical Solutions for the Development of a New, Innovative Product

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Because of low prices and saturated demand on the apple-juice market, there is need for the german fruit drink industry to insure its commercial effectiveness by creating a new, innovative product. That product has to combine new attractiveness for the consumer with higher effectiveness in production. A new option would be to introduce a natural breed of an apple "McIntosh" from Canada which gives its consumer attractiveness by its red juice with high nutritional value. Its potential to increase the effectiveness in production is given by its shape, called "Wjick" and shows the so called columnar growth, meaning the trunk has only a few side branches, so that the resulting fruits will grow close to the trunk. The plant has only 50 cm in diameter at a final height of 3 – 4 meters. The advantage of this kind of tree is that tree-cut is mostly unnecessary, agent reducing tunnel-spraying equipment can be used and harvesting maybe fully mechanised. To prove the suitability of that new cultivar system, different types of harvester and tunnel-spraying equipment, adapted for these special apple trees, has been and will be tested. Furthermore, the mechanization of all work procedures in the fruit juice production combined with GPS- and RFID transponder supporting systems opens the possibility to establish a chain oriented quality management system which fulfills the standards of legal regulations and trade partners. This and the possibility to get the Carbon-footprint of the product is an additional part of that future oriented production system.

S02.224

Household Characteristics and Weekly Expenditures on Fresh Fruit and Vegetables

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The per capita consumption of fruits and vegetables is high in the Republic of Korea. However, a large portion of vegetables in particular is consumed after being processed. For example, the traditional vegetable side dish, kimchi, includes fermented cabbage. But the increasing evidence from nutritional studies indicates substantial health benefits from eating fresh fruits and vegetables. Although rural Korean households continue to process a large volume of vegetables at home, urban households increasingly depend on purchased processed products. Therefore, the examination of expenditures on fresh fruits and vegetables provides a measure of fresh produce consumption. Using the data from a survey of 1,100 women residing in seven major urban centers of Korea, this poster reports the relationship between the level of weekly expenditures on fresh fruits and vegetables and selected household socio-economic and demographic characteristics as well as characteristics of respondents, who were the main food shoppers and prepares in their respective households. Results provide insights about the relative importance of selected characteristics useful in the formulation of marketing strategies and basic information for public policy adjustments aiming at increasing the consumption of fresh fruits and vegetables.

S02.225

Evaluation of Fruit Wastage at Portuguese Homes

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Fruit intake is an important part of a healthy diet and it is associated with numerous positive health outcomes. These include reduced risk of chronic diseases and benefits to weight management. A diet including regular amounts of fruit will provide antioxidants to help preventing free radicals from damaging the human body. It is well known that consumption of fruit in Portugal do not meet the international recommendations. Although several studies have already been developed concerning fruit consumption, there are few investigations focusing on the waste of fruit at homes. This study aims to assess the waste of fruit at consumers' homes in the north of Portugal. This investigation was followed by an online survey of 160 consumers randomly selected, which provided information on availability of fruit at homes, duration and place of storage at home, and frequency of fruit discard. Apples, pears, bananas and citrus were the varieties more frequently available at Portuguese homes at the moment of questioning, and also referred as the ones that more frequently deteriorate. Fruit shelf life at home is strictly determined by the maturity stage at the moment of acquisition. The frequency of fruit purchases is weekly. Results obtained on this study showed that consumers throw away fruit frequently. This high level of fruit's waste indicates that many consumers may fail to eat the fruit they anticipate they should eat during the week. Strategies should be developed in order to reduce fruit wastage at home, namely by informing consumers about specifications of storage for different fruit varieties as well as about the different patterns of duration at home.

S02.226

Effect of Non-Thermal Plasma on Ethylene Degradation

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The ethylene elimination is vital for the storage of fruit and vegetable. In this paper, a rod type dielectric barrier discharge (DBD) reactor was utilized. The parameters used in the evaluation included power consumption, flow rate, gap width, initial concentration and ozone content. Experimental results indicated that the highest

ethylene removal efficiency can be achieved at 15 W with the gas flow rate of 1.5 L/min and the gap width of 1 mm ; the ozone generated in discharge can accelerate the ethylene degradation, but when the power is higher than 20 W, the ozone content can have a sharply increase.

S02.227

Influence of Postharvest Heat Treatment of Tomatoes on Fruit Ripening and Decay Caused by *Fusarium verticillioides*

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Roma tomatoes at mature-green, breaker, turning, pink and light-red stages of ripening were subjected to single heating regime using hot air at 70 °C (HA70) or steam at 50 °C (ST50) for varying periods. The fruits had been previously scraped for 1cm length before inoculating with spores of *F. verticillioides*. Ripening and disease severity were monitored during storage at 30 °C and 95 – 98% relative humidity. HA70 significantly enhanced ripening in breaker fruits up to day 10 of storage. Treatment for 6 and 8 minutes promoted ripening most with the fruits reaching the intense red stage while control was still pink. HA70 for 4-12 minutes also promoted ripening of turning fruits with maximum colour development occurring in fruits treated for 10 minutes but there was no significant effect on pink fruits. Statistical analysis further showed that there was interaction between initial stage of ripening at exposure and HA70 treatment. Prestorage ST50 treatment of mature-green fruits however retarded colour development within 9 days. Greatest inhibition occurred in fruits exposed for 4, 6, 14, and 22 minutes where fruits ripened only to turning stage while control was already at red stage. However, ST50 enhanced ripening of breaker fruits within 10 days storage. Maximum promotion of colour development occurred in fruits treated for 12 minutes. Significant disease reduction occurred with ST50 on light-red fruits with maximum protection at 6-8 minutes where fruits remained disease-free for 18 days. Both HA70 and ST50 showed advantage in reducing disease on turning fruits. Results suggest that ripening is not inhibited in fruits that had passed the mature-green stage before treatment while appreciable disease control occurred in fruits at the later stages of ripening. Further investigation will be conducted on quality of heated fruits.

S02.228

Chilling Sensitivity of Papaya Stored under Modified Atmosphere

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The objective of this work was to study the development of chilling injury on papaya cv. Golden stored under modified atmosphere. The treatment was set up in groups of six fruits wrapped in low density polyethylene plastic bags of 0.25 mm in thickness. Within these polythene packages, two methods of modified atmosphere were arranged: the first method consisted in using sachets of ethylene absorber Always Fresh® and the second was carried out in packages without the ethylene absorber. The fruits were stored at 7 °C and 13 °C for a period of 5, 10, 15 and 20 days, and then evaluated at the end of each storage period. All the treatments were effective in maintain the fruit at pre-climacteric stage during the storage of 5, 10, 15 and 20 days. No pick of CO₂ production was observed during storage. Treatments containing the ethylene absorber were more efficient on the fruit preservation. At 7 °C, efficiency in controlling the chilling injury symptoms was higher with ethylene absorber. The electrolyte leakage test detected positively the presence of chilling stress, even under refrigerated condition. Controlling the chilling injury through the use of ethylene absorber enables to extent the advocated preservation period mentioned in the current literature.

S02.229

Alternative Methods for Controlling Damage Caused by Postharvest Diseases and Cold on 'Murcott' Fruits

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The aim of this study was to evaluate the efficiency of heat treatment during post-harvest of Murcott as a method that is harmless to the environment, promotes disinfection of pathogens and prevents chilling injury. Also, a comparative evaluation was made between the same treatments and other products using the conventional fungicides. The heat treatments were studied by using hot water with temperatures ranging between 48 and 56 °C, with a variation of plus or minus 1 °C. As control treatment, we used water at room temperature. The fruits were immersed in water for 2 minutes. After treatment, the fruits were arranged into two batches and kept under room temperature and cold chamber at 10 °C and RH of 90%. For comparison, three extra treatments were applied simultaneously: a) imazalil (20mL/10L water), b) baking soda (3%) and c) Sodium Carbonate (3%). Two treatments were applied: immersion of fruits considering pathogens from field and inoculation with spores of the pathogens previously isolated. For the evaluation of internal and external quality, fruits were sampled for determination of skin colour, texture, weight loss, juice yield, titrable total solids, total acidity and vitamin C. The determination of the sensitivity of the fruits subjected to cold was made by the exposure to temperatures inducing cold damage for a varying period of nearly one week. The best control of *Penicillium digitatum* was obtained using the fungicide Imazalil, followed by treatment of Calcium Carbonate and 52 °C in temperature. The temperature of 56 °C led to a higher incidence of cold injury. The average temperature of nearly 52 °C, which promotes a reduction in the appearance of diseases, does not change the intrinsic and extrinsic properties of fruits; in addition, it permits a greater resistance to storing fruits at low temperatures.

S02.230

Alternatives and Strategies for Control of Physiological and Pathological Post-Harvest Diseases of Baía and Pêra Sweet Oranges

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This study aimed to verify the efficiency of heat treatment and disinfection of pathogens towards the prevention of chilling injury, the post-harvest of sweet oranges Pêra and Baía, and to compare such treatment with other products that use conventional fungicides. The heat treatments were carried out by using hot water, at temperatures ranging between 48 and 56 °C. As control, we used a treatment with water at room temperature. The fruits were immersed in water heated at corresponding temperatures for 2 minutes. After treatment, the fruits were divided into two batches and kept in a cold room at 10 °C and RH of 90%. Three additional treatments were applied: imazalil (20mL/10L of water), sodium bicarbonate (3%) and sodium carbonate (3%). We evaluated two groups of fruits: immersion considering pathogens coming from the field and inoculation with spores of the pathogens previously isolated. For the evaluation of internal and external quality, fruits were sampled for determination of skin colour, texture, weight loss, juice yield, total solids, total acidity and vitamin C. The determination of the sensitivity of the fruit to cold after treatment was made by exposure to temperatures inducing cold damage for a time variable. The treatment of temperature at 52 °C proved to be the most promising for control of pathogenic fungi as well as to increase shelf life of fruits for

the control of chilling injury, when compared with other heat treatments. Although the application of imazalil showed better results to control *Penicillium digitatum*, it was close to those data obtained with 52 °C in temperature. To control *Phomopsis citri* and *Geotrichum candidum*, the treatment at 52 °C in temperature was more effective. The tests performed with sodium carbonate and sodium bicarbonate were less efficient. Does not change the intrinsic and extrinsic properties of fruits.

S02.231

Control of Fungal Diseases and Chilling Injuries in the Tahiti Lime Post-Harvest

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The Tahiti lime is very susceptible to post-harvest diseases and it is also highly sensitive to storage at low temperatures. The purpose of this paper was to verify the efficiency of the thermal treatment in pathogens disinfection and in preventing chilling injuries during the post-harvest of this cultivar, and to compare this treatment with others that use conventional fungicides. Thermal treatments were made with heat water, with temperatures ranging from 48 to 56 °C, for 2 minutes with variation of plus or minus 1 °C. The control treatment was made with water at room temperature. After the treatment, they were split into two batches. One of them was kept at room temperature, and the other in a cold chamber at 10 °C and 90% RH, the latter for nearly 45 days. For comparison purposes, three other treatments were made simultaneously, one of them using commercial dose imazalil; the second, using sodium bicarbonate (3%); and the third, using sodium carbonate (3%). Two fruit groups were analyzed: one treated by immersion, considering the pathogens from the field; and the other by inoculation with spores of the previously isolated pathogens. For the evaluation of the physical-chemical parameters of the fruits, the following were analyzed: peel colour, texture, weight loss, juice yield, total solids, total acidity and vitamin C. The fruit's sensitivity to cold temperatures after the treatment was determined by exposure to temperatures that induce chilling injuries. The analysis of the result was made by the Stagnostics statistics package. Thermal treatments, especially at 52 °C, resulted more promising in pathogenic fungi and chilling injury control, demonstrating higher efficacy than the conventional fungicide treatments. There was no change in intrinsic and extrinsic parameters as a result of the application of the different treatments.

S02.232

Control of Postharvest Brown Rot (*Monilinia fructicola*) of Peaches with Lime Sulphur

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Brown rot caused by *Monilinia fructicola* (G. Wint) Honey is an important disease of stone fruits, including peaches. Lime sulphur, a fungicide which has demonstrated curative ability against apple scab, has been registered for organic fruit production. The objective of this study was to determine the effect of lime sulphur as a postharvest fungicide in controlling brown rot caused by *M. fructicola* in Ontario peaches. Detached fruit from three cultivars of commercially immature and mature peaches (*Prunus persica* (L.) Batsch) from Ontario, Canada were tested: 'Loring' (late season cultivar) in 2008 and 'Harrow Diamond' (early season cultivar) peach and 'Redhaven' (mid season cultivar) in 2009. Each peach was wounded and then inoculated with 15 ul of *M. fructicola* (1X10⁴ conidia/mL) and incubated at room temperature. The peach fruit were then sprayed with a lime sulphur solution at a concentration of (3.45 a.i. of sulphur/mL) at 5, 10, or 24 hours after inoculation. After 5 days of incubation at 20 °C, brown rot disease incidence, diseased area, and diseased area with conidia were recorded. In all three cultivars, disease incidence was significantly lower in the fruit treated with lime sulphur (P = 0.05). There was no significant difference in the disease incidence among the three lime sulphur application times, 5, 10, or 24 hours after inoculation in all three peach cultivars. Mature fruit were significantly (P

= 0.05) more susceptible to infection than the immature fruit, suggesting the role of physiological age of the fruit tissue in disease development. Lime sulphur may have a potential to be included in the integrated pest management of postharvest brown rot in peaches in traditional and as well as in organic production.

S02.233

Minimally Purple Cabbage Processed and Stored in Different Packaging

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The minimally processed foods are growing in the market, thinking of the time savings and ease of food preparation. The aim of this study was to investigate the behaviour of the cabbage 'Red Dynasty' minimally processed and packed in four packaging. After minimally processed cabbage strips were placed in polyethylene terephthalate (PET) with cap; trays of expanded polystyrene (EPS), flexible film coated with polyvinyl chloride (PVC), 12 µm; film of low density polyethylene (70 µm) (LDPE) and polypropylene perforated (PP). Each package containing 200 grams of cabbage. Storage temperature was 5 ± 2 °C in a cold chamber. Evaluations were made every four days, totaling twelve days of storage. The parameters were evaluated to determine the mass loss; the general appearance; odor given off; change colour; presence of fungus; soluble solids; pH; acidity; vitamin C and anthocyanin. The PET and EPS+PVC package was more effective in maintaining the quality of cabbage minimally processed, due to lower weight loss and odor exhaled, for up to six days. The perforated PP package is not recommended because there was great product weight loss.

S02.234

Physical and Sensory Characterization of Edible Coatings Applied to Persimmon 'Mikado' (*Diospyros kaki*) Minimally Processed

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Edible coatings can be an important tool to ensure quality and increase the shelf life of persimmon minimally processed (MP). The experiment was conducted at Embrapa Food Technology, and the Federal University of Rio de Janeiro. It was analyzed four different types coatings: cassava starch (CS) (3.5% of cassava starch, 0.0135% of potassium permanganate, 0.0135% of calcium lactate, 1% of glycerol and 5% of polyethylene glycol 400, in relation to the weight of the main polymer); sodium alginate (SA) (1% of sodium alginate, 1500mg×g⁻¹ of potassium sorbate, 30mL×L⁻¹ of calcium chloride solution 0.4%, 0.5% of glycerol and 5% of polyethylene glycol 400, in relation to the weight of the main polymer); Carboxymethyl Cellulose (CMC) (1% of carboxymethyl cellulose, 0.25% of citric acid and 5% of polyethylene glycol 400, in relation the weight of the main polymer), and bovine gelatin (5% of bovine gelatin, 1500mg×g⁻¹ of potassium sorbate and 15%, of glycerol in relation to the weight of the main polymer). It was evaluated the thickness, permeability to water vapour, oxygen and carbon dioxide, the elasticity modulus and accomplished preliminary sensory analyses of minimally processed fruit treated with edible coatings. It was found that the CS coating showed a higher resistance and the SA the higher elasticity. The CMC coating showed the highest CO₂/O₂ ratio and the lowest permeability to water vapour. The CS coating showed the lowest CO₂/O₂ ratio and the highest water permeability. The sensory analysis indicated that the coatings CS and CMC were more adequate for being used on persimmon minimally processed.

S02.235

Determination of Time Exposure to Ethanol for Reducing Astringency of Persimmon 'Mikado' (*Diospyros Kaki*) for Minimally Processing

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The 'Mikado' Persimmon is very astringent fruit. This fruit requires an adequate process to reduce its astringency for have quality for being minimally processed (MP). The objective was evaluate the exposure time to alcohol vapour (AV) 70% (7.00 mL álcool×Kg⁻¹ fruit) to reduce the astringency of the fruit before the fresh cut process. The experiment was conducted with fruits from Sumidouro-RJ city. The fruits were transported to Embrapa Food Technology along the night to avoid high temperatures. The fruits were collected during seven days. At each harvest, fruits were selected, cleaned and submitted to different exposure times to the AV. The treatments were: T1 - 10 hours; T2 - 36 hours; T3 - 55 hours; T4 - 83 hours; T5 - 107 hours; T6 - 130 hours; and T7 - 155 hours. The fruit quality was evaluated through the following analyses: firmness, pH, total titratable acidity (TTA), total soluble solids (TSS), and total tannin contents. It was also accomplished the sensory analysis (SA) to determine the detection threshold of astringency correlated with the concentration of soluble tannin, in the pulp. The sensory analysis was accomplished using trained panelists. There were a decrease on firmness and soluble tannin concentration of the pulp with the increase of the exposure to alcohol vapour. There were variations in the TTA and the TSS contents over time of exposure to alcohol. It was observed, through sensory analysis, that astringency was felt, by the panelists, up to 0.8161 µg×100g⁻¹ of soluble tannin in the pulp. Regarding the firmness of the fruit, the more appropriate exposure time, to AV, was 55 hours. According to sensory analysis, the best time of exposure was 83 hours. However, it was found that with 83 hours of exposure to AV, the fruits did not show enough firmness for been minimally processed.

S02.236

Development and Acceptability Study of Jiotilla (*Escontria chiotilla* Weber) Marmalade

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Jiotilla (*Escontria chiotilla* Weber) is a native fruit from Oaxaca, Mexico. It is considered as a wild, exotic fruit which comes from a branched cactus. It is small with a 20 to 25 g weight, purple, fibrous pulp, with tiny black seeds. Its harvest season is from June through October. Three marmalade formulations were made in search of an alternative to provide this fruit with an added value which could allow local people to preserve it and market it. Developed marmalades should have good quality characteristics such as: firm texture, characteristic natural fruit colour and flavour, 68 to 70% TSS, a pH of 3 to 3.5 and without syneresis. Developed marmalades were made up of the following ingredients: jiotilla fruit pulp, sucrose, fructose syrup, pectin, citric acid and sodium benzoate. Two developed marmalades were eliminated due to their lack of natural features; that formulation which had firm texture and characteristic fruit colour, flavor, and with no syneresis was stored for 18 months at 22 °C. Physical-chemical and microbiological control was made in periods of 3, 6, 12 and 18 months, which resulted good quality products. Marmalade was made and stored during 3 months at 22 °C. Sensory evaluation compared to a commercial trade mark through an acceptance test by 50 consumer panelists who evaluated the following quality attributes: texture, colour, flavor and

aroma. Results were statistically analyzed through Friedman Test. Results show that consumers favourably accepted the marmalade in all its quality parameters, being thus the new developed marmalade preferred over the trade mark one. A marketing study was also made with 50 consumers from which 42% said they would buy this new marmalade in view that it is 100% natural and it came from a natural, exotic fruit, different from other traditional marmalades and with an attractive colour and flavor.

S02.237

Effect of Maturity Stage and Antioxidant Type on the Control of Enzymatic Browning of Fresh-Cut Persimmon 'Rojo Brillante'

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Persimmon fruit cv. Rojo brillante can be marketed as a fresh-cut commodity after removal of the astringency by application of high levels of CO₂. The application of antioxidants at an appropriated maturity stage can reduce the enzymatic browning and extend the shelf life of fresh-cut fruit. Persimmons were harvest at two maturity stages (MS) defined by external skin colour (MS1 with a colour index (CI) of 1.5 and MS2 with a colour index of 17.6, where CI=1,000*a/L*b). Persimmon pieces were dipped in different antioxidant solutions (1% ascorbic acid (AA), 1% citric acid (CA), 0.5% cysteine (Cys), and 0.5% calcium chloride (CaCl₂)) or in water as a control. Fruits samples were then packed in trays covered with polypropylene films in a normal atmosphere and stored at 5 °C during 8 days. Colour, firmness, visual and sensory quality were determined during storage. Fruits with MS1 had higher L* and lower a* values than fruits with MS2. Colour differences between persimmons dipped in the antioxidants and control samples were higher in MS1 than in MS2. At MS1, AA and CA were the most effective antioxidants controlling browning of cut persimmons; whereas, at MS2 CA lost effectiveness. Samples at MS1 were firmer than samples at MS2. At MS2, application CaCl₂ reduced firmness loss compared to the rest of the treatments during the first 4 days of storage. AA and CA were evaluated by the judges as the best treatments, extending the limit of commercialization up to 7 days; whereas the rest of the treatments were below that limit after 1 day of storage. The results show that persimmons 'Rojo brillante' at MS1 treated with AA or CA can be marked as a fresh-cut commodity.

S02.238

UV-C Radiation Affects Gray Mould Decay in Citrus

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Ultraviolet (UV) radiation induces the accumulation of a phytoalexin, scoparone (6, 7-dimethoxycoumarin), in the leaves and flavedo of Citrus. We examined the effects of UV-C radiation on gray mould (*Botrytis cinerea* Persoon) decay and scoparone accumulation in the flavedo of satsuma mandarin ('Silverhill Owari'), 'Kiyomi' tangor, Hyuga-natsu, and 'Eureka' lemon harvested in December. Specimens were inoculated with gray mould 4 days after UV radiation. Decayed fruits rapidly increased for 3-4 days after treatment in all control specimens except lemon. Most of the control specimens fermented 7 days after treatment. On the other hand, lemon hardly decayed in the same period. Compared with the control specimens, UV-radiated specimens tended to show no decay. UV radiation inhibited any further decay of the fruits. Satsuma mandarin showed inhibition of 3 days after inoculation. The inhibition in satsuma mandarin was evident within three days of inoculation. Decay in the UV-radiated satsuma mandarin was 40 – 60% less than in the control. In addition, decay was more suppressed in the UV-radiated 'Kiyomi' tangor than it was in the control specimens. We measured scoparone accumulation in the Citrus flavedo by high-performance liquid chromatography (HPLC). The accumulation

of scoparone in the flavedo changed after UV radiation and inoculation of gray mold. As a corollary, we conclude that UV radiation intensely affects gray mould decay and the accumulation of an antifungal substance, scoparone, in Citrus.

S02.239

Impact of Edible Coatings and Heat Mild Shocks on Quality and Shelf Life of Minimally Processed Broccoli (*Brassica oleracea* L.) during Refrigerated Storage

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The effects of edible coatings and heat mild shocks on quality aspects of refrigerated broccoli were studied. Minimally processed broccoli was coated with either chitosan or Carboxymethyl-cellulose combined or not with the application of a heat mild shock previous to coating for 90 s at 50 °C. Product was packaged in polymeric film bags and stored at 5 °C for 18 days. Quality parameters such as weight loss, texture, colour, ascorbic acid content, total chlorophyll content, oxygen consumption, browning potential and sensory quality, were evaluated during storage. Edible coatings exhibited a beneficial impact on the quality of broccoli by retarding weight loss, stem hardening and slowing down the yellowing and the decline in sensory quality. The application of a heat mild shock had a remarkable influence in reducing the enzymatic browning and delaying yellowing. Moreover, the combination of a heat mild shock and edible coating offer several advantages on broccoli, mainly in the retention of total chlorophyll reducing the florets yellowing but its impact to the rest of the quality parameters was similar to that of the edible coatings with no thermal treatment application. The results showed that the application of chitosan coating effectively maintained quality attributes and extended shelf life of minimally processed broccoli. Moreover, chitosan coating combined with a heat mild shock showed the best performance for long-term refrigerated storage of minimally processed broccoli.

S02.240

Effect of Edible Coatings Combined with Heat Mild Shocks in Preventing Microbial Deterioration of Fresh Cut Broccoli (*Brassica oleracea* L.)

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Demand of broccoli has increased greatly, as minimally processed vegetable, however the high perishability of the produce makes necessary the development of new preservation technologies. In this work, edible coatings and heat mild shocks have been proposed as postharvest treatments to prevent microbial deterioration of refrigerated broccoli. Minimally processed broccoli was coated with either chitosan or Carboxymethyl-cellulose (CMC) combined or not with a previous application of a heat mild shock during 90 s at 50 °C. Product was packaged in polymeric film bags and stored at 5 °C for 20 days. The evolution of microbial populations (mesophilic, psychrotrophic, enterobacteriaceae, total coliforms, molds and yeast and lactic acid bacteria) were studied during storage and fitted to Gompertz and logistic models. Results revealed that, at the end of the storage, chitosan coating significantly reduced all microbiological population counts, except acid lactic bacteria, in 1.5 order log respect to uncoated samples, while chitosan coating combined with a heat shock treatment showed a reduction of 2.5 order log. Moreover, a significant delay at the beginning of the exponential phase was observed for all the bacterial populations analyzed. On the other hand, CMC coating, with and without a previous thermal treatment, did not exert any antibacterial effect. Excellent agreement was found between experimental microbial counts and predicted values obtained from Gompertz and Logistic models. Kinetic modelling was found to be valuable for prediction of mi-

crobiological shelf life of broccoli during storage. Results showed that the application of chitosan coating effectively maintained microbiological quality and extended shelf life of minimally processed broccoli. According to the results, the use of the edible chitosan coating alone or in combination with a heat mild shock appear to be a viable alternative for controlling microbiological growth in minimally processed broccoli.

S02.241

In vitro Antifungal Effects of Crude Aqueous Extracts from *Camellia semiserrata* Chi Oil Residua against *Colletotrichum musae*

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Banana anthracnose (caused by *Colletotrichum musae*) is the most common postharvest diseases in south china. The most commonly used and effective strategy is post-harvest treatment of fruits with chemical fungicides. Because of growing concerns on potential harmful effects on the environment and human health the fungicides may have, there is a worldwide trend to explore non-chemically alternatives for postharvest pathogens. *Camellia semiserrata* Chi oil residua is the by-products of camellia oil pressed from the seeds of the plant. People for centuries have been found its antimicrobial activity against many kinds of microorganism. In order to provide evidence for its further exploring in fruit postharvest disease control, the *in vitro* antifungal effects of water extracts from the residua against *Colletotrichum musae* was studied in this research. Crude aqueous extracts of camellia oil residua was obtained by decoction, in accordance with the traditional mode of preparation. The effects of crude aqueous extracts on banana anthracnose mycelial growth were assayed by mixing with molten PDA agar to give a final crude aqueous extracts concentrations of 0, 0.5, 5, 20, 50 and 100 mg×ml⁻¹ respectively. Results revealed that crude aqueous extracts of camellia oil residua could markedly inhibit the radial mycelial growth of the fungi at a concentration of 5 mg×ml⁻¹ and above. The higher concentrations of crude aqueous extracts, the stronger antifungal activity of camellia oil residua is. Concentrations of 5 mg×ml⁻¹ could inhibit the mycelial growth by 85.8%, compared to the control. When the concentration of the crude aqueous extracts was up to 20 mg×ml⁻¹ and above, the red-brown spores became dark, and the mycelial of *Colletotrichum musae* died. This research indicates that there have antimicrobial ingredient in camellia oil residua, further research is needed to isolate and identify the antifungal ingredient, and to test its effects on *in vivo* banana anthracnose disease controlling.

S02.242

Microwave Application for Blanching and Drying of Cooking Tomato

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The applicability of microwaves to the drying and blanching processes of cooking tomatoes was examined. Drying treatment was performed using hot air (50 °C) and microwaves at 3 radiation powers (20, 50, and 100 W/g-dry sample), and the changes in drying rate and surface colour of the sample were measured and compared. The drying rate in all the microwave dryings was greater than that in the hot air drying, and the constant-rate and the falling-rate drying period were observed in the case of each microwave radiation power. Microwave drying caused a greater increase in lightness than hot air drying. Blanching treatment was performed using microwaves and the boiling water method, and changes in temperature, nutrients, and surface colour of the sample were measured and compared between the 2 methods. Microwave blanching required less time, resulted in higher retention of nutrients (ascorbic acid and lycopene), and caused less change in colour than boiling water blanching. These findings suggest the applicability of microwaves to the drying and of blanching processes involved in cooking tomatoes.

S02.243

Regional Studies of Pathogens Development on Stored Tomato Cultivars in the Middle East (Egypt, Jordan, Palestinian Authority and Israel)

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Knowing the type of decay-causing agents of tomato helps in identifying and adapting appropriate pre- and post-harvest treatment, leading to maintaining good quality, minimizing post-harvest losses and improving the competitiveness of products. Within the framework of the Middle East-Regional Agricultural Cooperation Program involving Denmark, Egypt, Jordan, Palestinian Authority and Israel; four research teams have investigated the susceptibility of different tomato cultivars to natural and artificial infections under two storage conditions ranging between 12 °C (cold storage) and -20 °C (room temperature). The samples were picked at different ripening stages: green, breaker, pink, and fully ripe, and inspected at different time intervals. Results showed: i) susceptibility of tomato to pathogen infection and rate of disease severity have been directly related to fruit ripening stage; ii) Infection and disease severity rate caused by *Botrytis cinerea* were more than those caused by *Alternaria alternata*; iii) Artificially inoculated tomato with *Rhizopus stolonifer* showed total loss at all tested maturity stages; iv) Although *Cladosporium* spp. and *Penicillium* spp. were identified on harvested fruit's skin using Petri dishes assay, those fungi did not cause any rot development during storage, as they are known to be saprophytic-non pathogenic fungi. However, *Botrytis* and *Alternaria*, which were hardly detected on Petri dishes, were found to be the main decay causing agents in harvested tomatoes. v) *Rhizopus stolonifer* and *Aaspergillus niger* fungi were found to cause decay of ripe red tomato, especially when tomato stored at room temperature. vi) In all countries, regardless the cultivars and the growing conditions, the main decay causing agents were *Botrytis cinerea* and *Alternaria alternata*, which infected the fruits by quiescent infections. An optimal field and storage pest management program would prevent decay development or minimize its severity.

S02.244

Improved Keeping Quality of Fresh-Cut Garlic Sprouts by Modified Atmosphere Packaging

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Influence of different packaging conditions on fresh-cut garlic sprouts shelf-life were studied during 15 days of storage at 4 °C. Fresh-cut garlic sprouts of 15-cm length were placed in hermetically sealed plastic bags: polyvinyl chloride (PVC), low-density polyethylene (LDPE) and polyethylene-perforated bags as control (air). The O₂ and CO₂ concentrations, soluble solid content (SSC), titratable acid (TA), ascorbic acid (AA), sensory quality and microbial quality were monitored. Compared to the control, both MAP treatments improved the sensory quality, avoid the loss of chemical quality contents, retard the growth of microorganisms. After 15 days at 4 °C within the PVC bags a steady-state atmosphere of 5.8 kPa O₂ + 7.0 kPa CO₂ was reached and fresh-cut garlic sprouts under these bags showed the best quality.

S02.245

The Population Dynamics of Contamination Microbes in Some Main Commercial Orange Juice in China

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One of the important quality factors is the microbial contamination which directly results in the juice spoilage. We investigate the dynamic changes of contamination microorganism populations in orange juices from four brands (A,B,C,D) being distributed in Chinese markets when they are stored at 3, 6, 9 and 12 months. According to the microbe test standard of State Food and Drug Administration, P. R.China issued in 2008, orange juices from three levels dilution (100, 10-1, 10-2) are separately spread on plates with media of PDA or PCA and are incubated at 28 °C for 5 days. The results indicate a low amount yeasts are detected only in 3 juice samples from two brands which produce gas and mainly induce papery container swelling. The concentrations of mould and bacteria vary few and keep the level of 0-3cfu/ml within 6 months, and rise gradually at 3-7cfu/ml and 6-9cfu/ml when stored at 9 month. After 12 months, mould concentrations arrive at 14-17cfu/ml, and bacteria concentrations reach to 12-18cfu/ml. Brand A is NFC juice in which no any yeasts are detected but other few microbes. In Band D juice, microbe populations increase quickly and yeasts are observed. All brand juices are permitted to sale on shelves for consumers safely drinking within 12 storage months because their microbe populations haven't exceed the national standards.

S02.246

Effects of Superatmospheric Oxygen Pre-Treatment on Fresh-Cut 'Rocha' Pear Quality

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The effects of treatment of whole 'Rocha' pear under high O₂ on subsequent quality and shelf-life of minimally processed fruit were assessed. Whole fruits were exposed to a superatmospheric oxygen level (ca 100%, initial concentration) at 5 °C for 30 days until minimal processing. Physical-chemical (soluble solids content, pH, titratable acidity, ascorbic acid content, whiteness index) and physiological parameters (respiratory activity), as well as sensory attributes (colour, firmness and general acceptance) were evaluated in pre-treated and non pre-treated (control) fresh-cut pear samples during storage at 5 °C (15 days). The exposure to high O₂ concentration was effective in delaying pericarp browning in fresh-cut fruit. The treatment induced browning delay, also sensorially observed by the judges and provided a 7 day long shelf-life extension when compared to control samples. The respiratory activity was significantly lower in the treated fruits than in untreated ones, suggesting that the use of this pre-treatment provides a metabolic activity lowering effect which could be important for the quality maintenance of the fresh-cut fruit. However, this pre-treatment also induced a significant loss of the initial ascorbic acid content (ca 40%) immediately after minimal processing. The other quality parameters analysed: pH, titratable acidity, total soluble solids and pulp firmness, were not affected by the super atmospheric O₂.

S02.247

Ozonated Water as an Alternative Decontamination Treatment to Chlorine in Fresh-Cut 'Rocha' Pear Processing

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The effect of ozonated water (0,5 ppm / 5 min, 5 °C) as a decontamination treatment alternative to chlorinated-water (150 ppm active chlorine/1 min, 5 °C) was evaluated in minimally processed pear (quarters). Fresh-cut fruit quality was studied just after minimal processing and during storage at 5 °C (13 days) by evaluating microbial load (total mesophilic aerobic, yeast and moulds and lactic acid bacteria counts), chemical parameters (soluble solids content and pH) and sensory attributes (colour, firmness and general acceptance). The relationships between sensory perception of undesired changes, microbial contamination threshold and chemical indices were investigated and compared between both sample types. No significant reduction of the initial microbial flora was observed in ozonated or in chlorinated fresh-cut pear. Both samples showed a very similar microbial development pattern (P>0.05) during storage for all tested groups. No significant changes (P<0.05) were observed regarding soluble solid contents and pH of fresh-cut samples decontaminated with chlorine or ozonated water during storage. Nonetheless, sensory quality of fresh-cut pear decontaminated with ozonated water was higher than that of the ones treated with chlorinated water.

S02.248

Yeast Strain Y1-3 for Biological Control of Blue and Green Mold on Citrus in Chongqing, China and its Identification

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Two hundred and ninety-six strains of micro-organisms, isolated from fruits and soil in Chongqing, China, were screened for antagonistic activity against *Penicillium italicum* and *P. digitatum* on citrus. One yeast strain Y1-3, isolated from loquat (Da wu xing) fruit skins, was found to be the most effective for controlling blue and green mould diseases. Biocontrol efficacy of Y1-3 was further evaluated against the two pathogens on Ponkan mandarin (Tai tian), early-maturing mandarin (Zao hong jin) and Jin orange (Bei bei 447). The results indicated that the absolute suppression of decay achieved with 1×10⁸cfu/mL suspension inoculated in wound was maintained throughout a 5-day period at 25 °C on Ponkan and early-maturing mandarin. Furthermore the suppression of decay was maintained 7-day period after pathogens and Y1-3 were inoculated on Jin orange at the same condition. Based upon a combination of morphology, biochemical assimilations, sequence analysis and homology comparison (Database: All GenBank +EMBL+DDBJ+PDB sequences), yeast strain Y1-3 was identified as *Candida quercitrusa* with 99.6% homology of 18S rDNA gene sequence.

S02.249

Effect of Antibrowning Agents on the Related Enzymes and Antioxidative Activity in Fresh-Cut Potato

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For the screening of anti-browning agents in fresh-cut potato, various compounds such as anti-oxidative agents, microbial metabolites and plant extracts were tested. Among them, KIF was shown at the concentration of 1% the highest anti-browning effect on fresh-cut potato at 5 °C. Anti-oxidative activity of KIF was higher than that of (the) other anti-browning agents. The activities of peroxidase and tyrosinase of cell free extracts of fresh-cut potato treated with KIF were 33-37% in comparison with that of control. Peroxidase of fresh-cut potato was identified by active staining by chromogenic substrate(o-dianisidine) and H₂O₂ after SDS-PAGE. Polyphenol oxidase(PPO) activity of fresh-cut potato treated with KIF was almost the same as the control treated with water. Phenylalanine ammonia lyase (PAL) activity was not found in cell free extract of fresh-cut potato. It assumed that peroxidase and tyrosinase were inhibited by KIF. Total phenol content has gradually increased during storage. The mechanism of anti-browning effect of KIF on fresh-cut potato must be investigated in detail.

S02.250

Effect of an Ethylene Inhibitor, Aminoethoxyvinylglycine, (AVG) on Glomerella Leaf Spot and Maturity of "Gala" Apples Cultivar

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SANTA CATARINA STATE UNIVERSITY, AV. MADRE BENVENUTA, 2007, 88.035-001, FLORIANOPOLIS, SANTA CATARINA, BRAZIL

The apple (*Malus domestica* Borkh.) is one of the most important fruit commercialized in Brazil and Santa Catarina State is the leading producer, covering approximately 45 thousand hectares. One of the most important factors that compromise this production is the summer diseases. Glomerella leaf spot (GLS) caused by *Colletotrichum* spp. is considered one of the most important diseases and it can cause crop losses as great as 50% in Southern Brazil. Apple trees cultivar Gala was sprayed four weeks before commercial harvest with aminoethoxyvinylglycine (AVG), at doses of 0; 62.5; 125, and 250 mg a.i./L⁻¹ and assessed for GLS incidence, severity and fruits maturation on tree. The GLS incidence and severity were affected by application of 125 e 250 mg a.i./L⁻¹ of AVG. Both incidence and severity were significantly increased between 28 and 35 days after AVG application and there was no significant difference between the treatments of 125 and 250 mg a.i./L⁻¹ doses of AVG. The most affected fruits attributes were the skin background colour, followed, in decreasing order, by soluble solids content, the starch index, skin red colour, the flesh firmness, titratable acidity and flesh firmness retention. The AVG at 250 mg a.i./L⁻¹ inhibited the late fruits growth.

S02.251

Using Anti-Browning Agents for Quality Maintenance of Fresh-Cut Mangoes

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Generally, the marketability of fresh-cut mangoes is limited by post-cutting degradation especially enzyme-catalyzed browning reactions. Many postharvest techniques have been attempted to prevent this phenomenon. In this research, the effect of anti-browning agents applied to fresh-cut mangoes on flesh colour quality was studied. Half-cut mangoes were subjected to ascorbic and citric acids dipping (AAD and CAD) at 0% (control), 0.5%, 1.5% and 2.5% for 2 min, respectively. Additionally, respiration rate, colour (such as lightness; L-value, hue angle, and total different colour; ΔE), brown pigment and acceptable scores of colour were monitored at 1 day intervals during storage at 10 °C for 4 days. Dipping treatments both AAD and CAD showed the suppression of the CO₂ production rate during the 4 days of storage. Colour attributes, brown pigment and acceptance score of flesh colour of dipped fresh-cut mangoes presented the smaller changes than that of control. Besides, this research indicated that CAD treatments showed more effectively control the colour changes in fresh-cut mangoes than AAD treatments.

S02.252

Short CO₂ Exposure for Inhibition of Postharvest Grey Mould of Pomegranate Fruit

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Pomegranate (*Punica granatum* L.) is an expanding crop due to the high antioxidant activity and benefits for human health provided by this fruit. As new markets based on the manufacture of derived functional food products are arising, longer storage life of fresh pomegranates is required. An important factor limiting storability is postharvest decay due to grey mould, caused by *Botrytis cinerea*. In Spain and other important producing areas no postharvest chemical treatments of pomegranate are allowed and alternative antifungal treatments are required. Exposure to

CO₂-enriched atmospheres is known to provide fungistatic effects against major postharvest pathogens. In this work, pomegranates cv. Mollar de Elche were artificially inoculated with *B. cinerea* and exposed 24 h later to 0 (ambient atmosphere, control), 15, 50 or 95 kPa CO₂ at 20 °C and 90% RH for 48 h. Exposure of fruit to 0 and 95 kPa CO₂ was also tested at 20 °C for 24 h or 35 °C for 48 h. Incidence and severity of grey mould were evaluated after 2, 5, 10 and 12 days of incubation at 20 °C and 90% RH. After 5 days of incubation, the incidence of grey mould on fruit treated with 95 and 50 kPa CO₂ at 20 °C for 48 h was 92 and 82% lower than on control fruit, respectively. These reductions were 60 and 47% after 10 days. At the end of the incubation period, the severity of grey mould on fruit exposed to 95 and 50 kPa CO₂ was reduced by 43 and 30% with respect to control fruit, respectively. Grey mould inhibition by treatment with 95 kPa CO₂ for 48 h was lower at 35 than at 20 °C. Exposure of pomegranates to 15 kPa CO₂ for 48 h or 95 kPa CO₂ for 24 h at 20 °C did not affect the development of grey mould.

S02.253

Luna Experience, a New Preharvest Fungicide in Pome Fruit Against Fruit Rot Decay After Storage

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Plant protection products are essential to cultivate a high quality pome fruit product. In this context Bayer CropScience developed a new fungicide called Luna Experience, with high potential against different pathogens in apple, pear and strawberry. The product is formulated as a suspension concentrate containing 200 g/L fluopyram and 200g/L tebuconazole. Fluopyram is a new active ingredient belonging to the chemical group of pyridinyl-ethyl-benzamides with a mode of action based on the inhibition of the Succinate Dehydrogenase in fungal respiration (SDHI's). Tebuconazole belongs to the chemical family of the Demethylation Inhibitors (DMIs). Both components are combined in a premix formulation with different biochemical modes of action resulting in a broad-spectrum activity and a resistance reduced risk for different target pathogens. Key fruit rot pathogens on apple and pear as *Botrytis cinerea* (gray mold), *Penicillium expansum* (blue mold) and *Neofabraea* spp. (lenticelrot) are included in the scope of Luna Experience. In concrete a preharvest spraying scheme in the orchard proved to be highly efficient against fruit rot decay in pome fruit in all small and large scale experiments with artificial or natural infection. As a consequence a proper protection during the storage period is guaranteed, offering a qualitative pome fruit product to the consumer throughout the whole year.

S02.254

Effects of *Ferula communis* and *Dittrichia viscosa* Plant Extracts on Post-Harvest Fungi: *in vitro* Screening

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Compounds from natural origin are generally assumed to be more acceptable and less harmful than synthetic ones. The aim of this research is to find new biologically active plant-derived compounds for the management of post-harvest diseases. *Ferula communis* and *Dittrichia viscosa* are perennial weeds in Mediterranean basin that have been used for different therapeutic purposes in traditional pharmacopeia. Plant extracts were obtained from air dried *D. viscosa* young shoots (DvA), flower (DvF) and *F. communis* aerial (FcA) roots (FcR) with n-hexane by using Soxhlet apparatus. Chemical compositions of plant extracts were analyzed by HPLC-DAD-ESI-MS/MS techniques. Major compounds in DvA extract are identified as flavonoids (inuviculide, tomentosin, 4h-tomentosin and ilicil acid) and costic acid derivatives (γ-costic acid and α-costic acid) while in FvA and FcR five daucanes

(acetoxo-ferutinin, lapiferin, oxo-jaeskeanadiol anisate, fertidin and ferutidin) and one coumarins (ferulenol) derivatives were found. Biological activities of plant extracts were studied in *in vitro* experiments; phytotoxic and antifungal activities were also evaluated. The phytotoxic effect of the extracts was tested on *Lolium perenne* and *Lepidium sativum* seeds. DvA extract showed the strongest phytotoxic effect on both tested seed species compared to the other extracts. Fungitoxic effect of the extracts was tested on the colonies and conidia of *Botryotinia fuckeliana*, *Penicillium digitatum*, *P. expansum*, *Monilinia laxa*, *M. fructigena* and *Aspergillus* spp. The extract from FcA showed the minor effect while DvA extract had the strongest fungitoxic effects against all tested fungi. FcR had a fungitoxic effect on the colony growth but was not able to inhibit the conidia germination. These distinctions can be due to the differences in chemical composition of plant extracts. FcR, DvA, and DvF extracts can be a potential source for the control of fungal rotting of fruits but further *in vivo* studies should be done to confirm these results.

S02.255

Regional Studies on Pre- and Post-Harvest Handling of Table Grapes

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Within the framework of the Middle East Regional Agricultural Cooperation Program funded by the Danish government, studies on pre- and post-harvest table grapes parameters; including harvesting date, pathogen infection, and storage conditions have been conducted. Regardless of the cultivars and the growing conditions in all participating countries (Egypt, Jordan, Palestinian Authority and Israel), results showed the susceptibility of fruit to infection and decay severity increased progressively as harvesting date delayed. Also, it turned out that the latent infection by *Botrytis cinerea* was the most harmful compared with that by *Rhizopus stolonifer* and *Aspergillus niger*. To control fungal growth, pre-harvest spray with variant concentrations of potassium and calcium salts (carbonate, chloride, nitrate and sulfate) showed a significant effect on *B. cinerea* growth, moderate effect on *A. niger*, and no effect on *R. stolonifer*. Concerning the post-harvest treatments, the maximum marketing shelf-life of table grapes stored at room temperature was only 8 days, while it reached 24 days when grapes stored (at 1 °C and 90-95% RH). However, storage of grapes (at 5 °C and 90-95% RH) using controlled atmosphere and SO₂ fumigation prolonged the shelf-life up to 90 days with overall acceptable cluster appearance, although, S-treatment did not eliminate all types of fungi. The major impact of S-pads was on growth of *Botrytis cinerea*, in which it eliminates almost completely the growth of this fungus.

S02.256

Postharvest Storage of 'Ponkan', 'Satsuma Okitsu' and 'Fremont' Tangerines and its Minimally Processed Products Using Refrigeration and Controlled Atmosphere

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This study aimed to evaluate the potential of postharvest conservation of tangerines 'Fremont', 'Satsuma Okitsu' and 'Ponkan'. The fruits were harvested when a ratio of 7 to 19 were reached and selected to standardize them by colour, size, and absence of injuries. At the experiments of conservation, it was used different temperatures (3 °C, 85%RH and 7 °C, 95%RH) and after each storage period, fruits were brought to ambient conditions (22 °C, 65%RH) for 3 days. The fresh-cut products were packed in polystyrene trays (22,4cm x 14,8cm x 3,7cm) coated with polyvinyl chloride (PVC) stretchable, with 0.014 mm of thickness, and in packages of transparent polyethylene terephthalate with lid, and capacity of 500 mL. The

fruits were analyzed by appearance, weight loss, respiratory rate, atmosphere inside the packages, rind and pulp colour, soluble solids, titratable acidity and ascorbic acid content. The experiments were conducted in a completely randomized design, arranged in a factorial design. The shelf life of tangerine 'Fremont', was limited to 42 days by loss of freshness. Its minimally processed products had 9 days of shelf-life for products packaged in PVC. The mandarins 'S.Okitsu' had 35 days of shelf-life at 7 °C, which was reduced to 28 days at 3 °C, limited by the loss of freshness. Its fresh-cut product had a shelf-life of 15 days, stored in PVC or PET. 'Ponkan' stored at 3 °C had a shelf life of 35 days, which was reduced to 28 days at 7°C, limited by loss of freshness. When minimally processed, its shelf-life lasted for 15 days, packaged in PVC or PET. The 'Ponkan' had a shelf-life of 35 days at 3 °C and 28 days at 7 °C. It was also limited by the loss of freshness. When minimally processed and stored in PVC or PET, its shelf life reached 15 days.

S02.257

Evaluation of Antioxidant Activity of Minimally Processed Garlic Cloves

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The use of garlic (*Allium sativum* L.) in therapeutic applications, particularly for prevention of cardiovascular diseases and as anti-carcinogenic, as well as in cooking, is widely disseminated throughout the World. This product is rich in sulphur compounds considered responsible for its therapeutic properties, with allicin being the most abundant, with a medicinal importance provided at levels above 4.5 mg per gram of dried garlic. However, sulphur compounds are very unstable, decomposing easily during the processing of garlic (Lawson *et al.*, 1990). The effect of different disinfection treatments, as alternatives to chlorine, has been investigated on the quality retention of minimally processed garlic stored at different temperatures. Previous studies have proven that freshly diced garlic cloves, sanitized by dipping in a 5% solution of H₂O₂, for 2 minutes, and stored at 4 °C, under ambient air, could adequately retain their quality up to 10 days (Veríssimo *et al.*, 2010). The present study aimed to evaluate the effect of disinfection with hydrogen peroxide against the classical use of hypochlorite, regarding antioxidant activity (DPPH method), total phenols (Folin-Ciocalteu method) and allicin content (HPLC method). Garlic cloves were peeled, washed in tap water at 0 °C and cut into small cubes: app. 0,5x0,5x0,5 cm, submitted to one of the following treatments: hypochlorite (OCl) or hydrogen peroxide (H₂O₂), and centrifuged to remove excess water, when needed. The samples were stored at 4, 8 and 12 °C up to 96 h. Results indicate a decrease in the levels of allicin over time of storage, and an increase of the antioxidant activity and total phenols. The use of hydrogen peroxide, when compared with hypochlorite has no significant effect on total phenols, while it has a detrimental effect on both allicin content, and antioxidant activity. Storage temperature had a significant impact on antioxidant activity, decreasing while temperature increases.

S02.258

Low Temperature Delays the Induction of Chitinase Isoenzymes Associated with Antifungal Activity in Cherimoyas

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In order to obtain a better understanding of the effect of low temperature on the active defense strategy of cherimoya (*Annona cherimola* Mill.) fruit, antifungal activity as well as induction levels of pathogenesis-related proteins PR-3 (chitinase family) were estimated in fruit stored at 6 °C. During cherimoya ripening, the study of the expression pattern of acidic and basic chitinase and 1,3-B-glucanase enzymes revealed that only those transiently induced isoenzymes were positively correlated with an efficient antifungal defense mechanism. This developmentally regulated resistance operated in two successive phases: (1) an induction of acidic isoenzymes

in ripe fruit, and (2) basic isoenzymes released by over-ripe fruit. In this work we have studied the effect exerted by low temperature storage in the induction pattern of two of these isoenzymes, one acidic of 25.8 kDa (AChi26) and one basic of 33.0 kDa (BChi33) chitinases. In this sense, the induction of AChi26, which was associated with the enhanced antifungal activity of the acidic protein extract in ripe fruit, was observed from 3rd to 5th day of storage at 6 °C. Likewise, the appearance of BChi33, correlated with the antifungal activity of the basic protein extract in over-ripe fruit, was delayed by low temperature, being induced after 9 days of storage. In spite of this delay, the induction pattern of these transient chitinases was associated with a significant antifungal activity in acidic and basic protein extracts. These results suggest that low temperature maintained the two successive defense phases and the effectiveness of this preventive defense strategy. Moreover, with a view to improve the knowledge of cherimoya physiology in these two phases, we have analysed the coordinated induction of antifungal chitinase isoenzymes with several metabolic compounds as hexoses or amino acids.

S02.259

Polyphenoloxidase Activity and Tissue Browning in Fresh-Cut 'Rocha' Pear as Affected by pH and Phenolic Substrate

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Cell rupture in fresh-cut processing allows phenolic substrates and polyphenoloxidase (PPO), previously sequestered in different organelles, to come in contact leading to undesirable colour development. However, it is not always clear how PPO activity and phenolic content relate to tissue browning. Our objective was to study the effect of pH and phenolic substrates on PPO activity and on tissue browning in fresh-cut 'Rocha' pear. This information may help to further develop food additives that maximize the quality of fresh-cut pear. Substrates 4-methyl catechol, caffeic acid, (+)-catechin hydrate, catechol, chlorogenic acid, dopamine hydrochloride, and pyrogallol, were prepared in citric acid-phosphate buffer at pH ranging from 3.0 to 8.0. PPO activity was assayed by measuring the rate of increase in absorbance at 420 nm wavelength at 25 °C. Pear slices were covered with the buffered phenolic solutions for 30 s and colour (CIE L*a*b*) change following 30 min at room temperature was assessed. pH optima for PPO activity depended on the phenolic substrate. Activity was optimal at pH 5.0 for catechol and 4-methylcatechol; pH 6.0 for chlorogenic acid; pH 7.0 for dopamine, caffeic acid, and catechine; and pH 8.0 for pyrogallol. High PPO activity at every pH tested was observed when catechol was used as substrate. Discrepancies were observed between the pH dependency of PPO activity and browning. Significant correlations were obtained between activity and L* or metric-hue difference (ΔH^*) over the pH range 3.0 to 8.0 except for chlorogenic acid. With this hydroxiphenol, the main PPO substrate in 'Rocha' pear, tissue browning was higher at pH 3.0 (higher ΔH^*), but PPO activity was very low at the same pH. Similarly with the other phenolic substrates, browning at pH 3.0 was higher than the corresponding PPO activity. The pH of additives for cut pear should be corrected to reduce browning potential.

S02.260

Anti-Browning Treatment of Minimally Processed Conference Pear of Different Maturity Stages by Means of Cysteine and 4-Hexylresorcinol

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Several types of chemicals are used for the control of enzymatic browning. Some of them directly inhibit the polyphenol oxidase (PPO) enzyme, by making the conditions unsuitable for the enzymatic browning reactions. Others can interact with the resulting products of the PPO action, hereby preventing the formation of coloured pigments (Garcia and Barrett 2002). In order to study the effect of antioxidant

treatments and / or texturizers on maintaining the quality of minimally processed pear, we studied different compositions of antioxidant baths applied at different stages of maturity of the pear (determined by physical and chemical parameters). When planning the antioxidant treatments the following five compounds were used in various combinations: ascorbic acid, citric acid, calcium chloride, 4-hexylresorcinol and cysteine. All treatments were performed by dipping the freshly cut slices into the different solutions for 10 minutes (working in pilot plant environment on 10 °C). The results were compared to a control batch immersed into a water bath before packaging. Moreover, as a second control, pear slices were immersed into a bath made with a commercial agent (NatureSeal of AgriCoat). 200 g of fresh-cut pear was packed into polypropylene trays closed by a film of medium permeability. Physicochemical quality (pH, soluble solids, texture, colour, acidity and respiration rate), sensory value and microbiological counts (total aerobic counts, moulds and yeasts) of the fresh-cut product were studied throughout storage. As the estimated shelf life of such products is usually between 7 and 15 days, tests were performed every 3-4 days, up to 15 days. The fresh-cut product was stored on 4 °C, in a humidified cool room. The experiment proved the importance of the maturity stage for making fresh-cut pear. Cysteine and 4-hexylresorcinol provided a good antioxidant treatment to prevent browning.

S02.261

Borage (*Borago officinalis*) Stems as a Minimally Processed Product. Evaluation of Shelf-Life in Different Packages

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Borage (*Borago officinalis*) is a very popular vegetable in the Ebro valley (Spain) owing to its gastronomic and nutritional qualities, but its market is not as widespread as should be expected. This vegetable is commercially available lightly processed, cut and packaged in expanded polystyrene trays covered with stretch PVC films. Modified atmosphere packaging (MAP) can be advantageous to extend the storage-life and to improve the quality of the current product, but little is known about the evolution of the properties of borage in MAP.

The present work studied the quality changes of borage stems as a function of packaging and development of the internal atmosphere composition. Three packaging conditions were tested at 4 °C: active MAP (with an initial gas composition of 5 % O₂-5 % CO₂-90 % N₂), passive MAP, and vacuum bags. Control samples consisted of unprocessed borage, as well as minimally-processed borage as can be found in the market.

Physicochemical, microbiological and sensorial analyses were carried out at the start and subsequently every third day. In the packaged samples firmness, pH, titratable acidity and weight loss varied slightly during storage. The sensorial evaluation awarded to the borage packaged in vacuum bags, after 6 days of storage, a score for overall quality which was lower than the value corresponding to the acceptability limit due to enzymatic browning and exuded liquid. The samples in active and passive MAP maintained their quality parameters with regards to colour and texture, but total mesophilic aerobic microorganism counts were higher than five logarithmic units after 9 days for passive MAP as well as after 12 days for active MAP, although the CO₂ concentration remained around 10%.

S02.262

Respiration Rate Changes in Fresh-Cut Non-Melting Flesh Peaches as Affected by Storage Time

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To design a modified atmosphere packaging suitable for minimally processed fruits it is necessary to know the respiration rate of the product. The respiration kinetics of fruit and vegetables is a complex task because large number of variables should be considered. Some of them as cultivar, degree of ripeness, storage temperature, O₂ and CO₂ concentrations inside the package have been extensively studied. However, the effect of length of time between harvest and processing still remains poorly

known. The aim of this study was to determine the influence of the storage time of the whole peaches on the respiratory kinetics of fresh-cut peach slices.

Peaches (cv. Calante) were harvested at commercial maturity stage and stored at 1 °C and 95 % RH during 21 days. Afterwards, whole fruits were washed in chilled water with sodium hypochlorite, drained, peeled, stoned and cut into slices. Peach slices were dipped in an aqueous solution at 2 °C containing 2 % ascorbic acid, 1 % citric acid and 1 % calcium chloride. Slices were then stored at 4 °C in a humidified air flow of 250 mL/min. Samples were withdrawn at 0, 6 and 12 days and subsequently the respiration rate was determined in a closed system. The respiratory rate of fruit slices obtained from peaches processed immediately after harvest was also determined to be used as a reference. The O₂ consumption and the CO₂ production were measured by GC.

The slices obtained from peaches processed immediately after harvest showed higher respiratory rate than those stored for 21 days. The respiratory rate for the samples kept in air-flow diminished during the first 6 days. However, after 12 days, the respiratory rate shows a sharp increase, probably associated to injury and senescence phenomena.

S02.263

Sanitation of Mushroom (*Agaricus bisporus*) by UV-C Light for Making Fresh-Cut

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Mushroom is traditionally considered as a product with high metabolic activity and as a result high sensitivity to mechanical damage and microbiological spoilage. The main postharvest problems with mushrooms are water loss, undesirable texture changes and microbial safety. The use of chemical agents with antimicrobial properties is one of the most common techniques used to control the growth of microorganisms in food (Lopez-Malo *et al.*, 2000). UV-C irradiation and novel antimicrobial treatments (such as peracetic acid, ozone, etc.) have a great potential because they may provide an alternative to sodium hypochlorite, a traditionally used, but much questioned industrial sanitation agent. This paper studies the effect of UV-C exposure time (from 0 to 6 minutes) on the reduction of microbial counts (aerobic mesophilic count) and colour change (cap and stem) during the shelf-life of whole mushrooms. Additionally, the antimicrobial potential of UV-C treatment is compared to sodium hypochlorite (100 ppm pH 6.5) that is traditionally used in food industry to reduce microbial load. Moreover, the importance of application method for hypochlorite treatment (spraying and dipping for different 30 to 120 seconds) was also tested. The significance of pre-washing by spraying or dipping in water (different immersion times) prior the antimicrobial treatment has also been investigated. Microbial reduction as a function of exposure time of UV-C light followed a saturation curve. Results suggest that pre-washing prior to the antimicrobial treatment is crucial for the proper antimicrobial functioning of the applied treatment. Moreover, pre-washing is necessary to remove the organic material from the mushroom surface in order to obtain a product with better appearance.

S02.264

Use of Peracetic Acid as Disinfectant for Fresh-Cut Apple

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Minimally-processed produce do not suffer any treatment that guarantees the total elimination of microorganisms. Currently, sodium hypochlorite is used to reduce microbial contamination. However, there is a growing concern about its use and new alternatives should be investigated. Peracetic acid (or peroxyacetic acid, PAA) has been shown as an alternative for fresh-cut leafy vegetables and its use is currently approved in USA by the FDA and EPA. The objective of this work was to study the effect of PAA at different concentration against the main foodborne pathogens on fresh-cut apple. Apple plugs were artificially inoculated with different strains of

Salmonella, *Listeria*, and *E. coli* O157:H7 and subsequently treated by dipping in a PAA solution. Pathogens' concentration was determined before and after the treatment and after 3, 6 and 9 days of storage at 10 °C. PAA treatment was compared with water, sodium hypochlorite and CitroX. Results demonstrated that, in general, the efficacy of PAA was better than that obtained with sodium hypochlorite, with reductions between 1.4 and 2.0 log units. It also controlled their growth at abusive temperatures (10 °C) without affecting visual appearance of fresh-cut apples. This study suggested that PAA could be an alternative to sodium hypochlorite to disinfect fresh-cut apples.

S02.265

Factors Affecting the Expression of the Mycotoxins in *Alternaria alternata*

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Alternaria fungi cause several diseases in Citrus, resulting in a substantial loss of production and a lower value product, which, in many cases, has to be rejected, leading to serious financial loss. HPLC-MS study revealed the presence of two *Alternaria alternata* mycotoxins involved in the evolution of brown spot in leaves and fruits of Fortune mandarin. These were identified as 3,7,9-trihidroxi-1-metil-6H-dibenzo [b,d] piran-6-ona, known as alternariol (AOH), and 3,7-dihidroxi-9-metoxi-1-metil-6H-dibenzo[b,d] piran-6-ona, known as alternariol monomethyl ether (AME). The increased expression of the above *A. alternata* mycotoxins was associated with the end of mycelial growth, high sporulation and an increase in hyphal melanisation. Biological assays involving the inoculation of Fortune leaves and fruits with the above mentioned toxins showed that both molecules caused necrosis in the inoculated citrus tissues, suggesting that the mycotoxins may be involved in the evolution of necrotic spot caused by *A. alternata* pv. citri. Using different isolates of *A. alternata*, pathogenicity studies were made in Fortune leaves and fruits. The results obtained permitted the different isolates to be classified according to their capacity to colonise citrus tissues. Analysis of the AME content of the different *A. alternata* isolates pointed to a positive correlation between the degree of pathogenicity and AME content. This suggests that AME is the principal mycotoxin involved in the development of necrosis in Fortune fruits.

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Detection of Latent Infections by *Colletotrichum* spp. in Immature Guavas

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Anthraxnose, caused by *Colletotrichum gloeosporioides* and *C. acutatum*, is one of the most important postharvest diseases in guavas (*Psidium guajava*). However, there is scarce information on the pathogen's capability to infect fruits during their development. The present study aimed to evaluate methodologies for detecting latent infections in immature fruits (2cm length) of guavas cultivar Pedro Sato. Fruits were harvested from an orchard presenting previous records of anthracnose; then, they were superficially disinfected with NaOCl (0.5%) for 5 min, washed in tap water, and immersed for 1 min in ethephon (0.1g/L), paraquat (3g/L), urea (50g/L), or water. Paraquat- and urea-treated fruits were washed for additional 3 min in tap water. Fifty fruits were used per treatment, and the experiment was repeated once. Treated guavas were incubated in sterile containers at 85% RH, 25 °C, in the dark. After seven days of incubation, *Colletotrichum acervuli* and conidia were visually detected in 97% ethephon-treated fruits, 96% paraquat-treated fruits, 56% urea-treated fruits, and 45% water-treated fruits. In the treatments with paraquat and ethephon, the pathogen was detected from the fifth day of incubation, two days

earlier than in the control (water). *Lasiodiplodia theobromae*, another post-harvest pathogen, was also detected but at a low incidence (2%). Thus, latent infection of anthracnose in guavas can be rapidly and accurately detected by treating the fruits with ethephon and paraquat.

S02.267

Microbiological Evaluation of the Industrial Processing of Pasteurized Açaí Pulp

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In recent years, the açaí, a native fruit of the Brazilian Amazon region, has been widely marketed not only in Brazil but also internationally. The Brazilian production is sold primarily to the United States of America, where açaí is mainly used in the formulation of functional beverages. In this work, a microbiological evaluation of the industrial processing of açaí was conducted in the city of Castanhal (in the state of Pará, Brazil); samples of water (before and after washing the fruits, after maceration, and CIP water) and pulp (after the steps of extraction and pasteurization) were collected. The analyses (fecal and total coliforms, mesophilic bacteria, molds and yeasts) were carried out in triplicates (water) and five replicates (pulp). According to the results, the washing water and the CIP water were not contaminated by fecal and total coliforms; the water collected after washing the fruits showed significant contamination by fecal and total coliforms; a high microbial load was still observed in the water after maceration. After the extraction of açaí pulp, a significant number of yeasts and molds (average of 100 CFU/g) and of mesophilic bacteria (average of 1000 CFU/g) were found, but these levels are within the acceptable range of the Brazilian legislation. In all pulp samples collected after pasteurization, the results obtained for yeasts and molds, as well as for mesophilic bacteria were estimated as < 10 CFU/g, indicating that the levels of contamination were low and confirming the efficiency of the pasteurization process.

S02.268

Wound-Induced Respiration and Ethylene Production in Fresh Cut Romaine Lettuce

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Understanding the physiological and biochemical processes induced by cutting can help in devising strategies to improve fresh-cut lettuce quality. We evaluated the response of Romaine lettuce to cutting temperature by cooling overnight and processing five, freshly harvested heads at 5 or 15 degrees. Undamaged, expanded leaves were immersed for 1 min in 5 or 15 °C chlorinated water (1.34 mM; pH 7), cut longitudinally then transversely into 2-cm wide pieces, re-immersed in chlorine solution, and the excess liquid removed with a salad spinner. Cut pieces from each head (100 g) in flow through systems were measured every 2 h for 24 h for O₂, CO₂, and C₂H₂ by gas chromatography. The CO₂ evolution immediately after cutting was approximately 3.5-fold higher at 15 °C than at 5 °C, and O₂ consumption was approximately 2.2-fold higher at 15 °C. The CO₂ evolution at 15 °C increased during the first 4 h after cutting and thereafter remained steady; at 5 °C, a small increase occurred during the first 8 h with a slight decline thereafter. The O₂ consumption at 15 °C increased during the first 3 h after cutting, decreased until hour 10, then remained steady or declined slowly. The O₂ consumption at 5 °C decreased by half during the first 12 h after cutting and changed little thereafter. The respiratory quotient (RQ) was < 1 during the first 8-12 h after cutting, rose and remained steady at approximately 1 for 8-10 hours at 5 °C and about 8 h at 15 °C, finally increasing to about 1.1 at 5 °C and 1.7 at 15 °C. Ethylene production was 6-fold higher at 15 °C than at 5 °C (0.12 versus 0.02 μL×kg⁻¹×h⁻¹) and did not change over time. These relative changes in CO₂ production and O₂ consumption suggest that non-respiratory oxidative reactions play a significant role in the post-cutting wound response of fresh-cut lettuce.

S02.269

Minimal Processing of Peach 'Aurora-1': Types of Cutting and Storage Temperatures

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Production of minimally processed fruit establishes a product class that is increasing in a fast and important way in the last years due to the nutritional appealing, and product consumption with convenience and security. This research evaluated conservation temperatures and different kinds of cuts, for the quality and shelf-life of minimally processed peach. Minimal processing consisted of washing, sanitization, peeling and fruit stone removal. In order to remove the stone, a longitudinal cut was made resulting in three types of products: halves, fruit divided in four and eight segments. Obtained slices were immersed in 2% ascorbic acid for 3 minutes. Then the products were packed in rigid polystyrene trays branded MEIWA M-54, coated with 14μm PVC film (Omnifilm™) (about 200g per pack). Treatments were divided into three batches, stored at 3 °C, 6 °C and 9 °C and 65% RH for 12 days, and evaluated every four days. The variables were appearance, fresh mass loss, coloration, O₂ and CO₂ determination, pH, acidity, soluble solids, soluble and reducing sugars, total and soluble pectin, ascorbic acid, peroxidase and polyphenol oxidase of enzyme activity. It is concluded that storage temperature of 3 °C provided to minimally processed products a higher maintenance quality, because of ripening evolution and senescence, and provided products with a better external appearance quality. It was also verified that the interaction between 3 °C temperature and eight sliced fruit segments showed a better product appearance with a higher soluble solids content.

S02.270

Effect of Anolyte Dipping on Microbial, Physicochemical, Sensorial Quality in Dates Fruits

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The Deglet Nour date, also known as "the date of the bright light" is well-known for its unique taste, its particular aroma, its yellow-golden colour and its nutritional value. In Tunisia, this variety is of higher market value and is the highest-valued variety on international markets. Tunisia is currently the 10th world producer and the first exporter of Deglet Nour. However, industrials often encounter quality problems (microbiological and physicochemical) which are enhanced by the long storage period. Actually, 5% of the dates stored is lost due to microbiological proliferation. The aim of this study is to ensure a good conservation of dates using anolyte solution in order to reduce initial bacteria populations, reduce its proliferation during storage and thus increase the shelf life of a better quality product. Anolyte is environmentally safe oxidizing solution that can be used as a biocidal agent. It combines washing, disinfecting and sterilizing agent features. After being used, it degrades spontaneously. In this work, the effect of anolyte water (pH (7-7.5), ORP(800-850 mV)) is studied, as an ecologically safe alternative for disinfecting dates fruits, particularly Deglet Nour variety. Dates were dipped in anolyte/water solutions at three different concentrations (1, 3 and 5%) and for different time exposures (0, 0.5; 1, 2, 3, 4 min). The percent reduction in the total bacteria count, yeast and molds were analyzed after each treatment. Microbial analysis after treatment showed a reduction of the total count of mesophilic bacteria of 90% and completely eliminated yeast and molds from date fruit. Tests showed no effect on pH value, firmness, sugar content, total soluble content and acidity of the product. In addition, sensory evaluation based on a triangular test showed no significant difference (P<0.05) for two parameters (taste; odor).

S02.271

Effect of Controlled Atmosphere Gases (CO₂, O₂ and Ethylene) on Growth and Survival of *Aureobasidium pullulans*

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Aureobasidium pullulans is one of the most common microorganism in pome fruits. Different biocontrol agents have been investigated with success and the yeast-like fungus *A. pullulans* (de Bary) Arnaud was reported to inhibit postharvest decay of fruit effectively. In our previous studies, an isolate of *A. pullulans*, obtained from leaves and fruits of 'Rocha' pear trees in Alcobça, showed antagonistic properties against *P. expansum* during cold storage of pear fruits. Currently the pear cv. Rocha is harvested and stored in controlled atmosphere conditions and in some cases the pears are matured by ethylene for its rapid marketing. At this moment, the effect of CO₂, O₂ and ethylene on the survival and growth of *A. pullulans* is not known. In this work, the effect of the different percentages of CO₂ (0.03, 2 and 4 %), O₂ (21, 4 and 2 %) and ethylene (0, 1.10-3 and 2.10-3 %) on *A. pullulans* inoculated in *in vitro* or *in vivo* has been evaluated. The three gases tested did not inhibit *A. pullulans* growth *in vitro*. However the higher concentration of CO₂ and the lower one of O₂ reduced the growth of colony surface of *A. pullulans* by 21% and 27% respectively at 7 days of incubation. The *in vivo* experiments consisted on inoculate pears with *A. pullulans* (2.5.106 CFU for wound). These fruits were stored at the same gaseous concentration tested in *in vitro*. The growth and survival of *A. pullulans* did not change during storage of 'Rocha' pears with different percentage of gases. These results demonstrate that *A. pullulans* efficiency is maintained when is exposed to conditions of storage in controlled atmosphere or in conditions of accelerated maturity by ethylene.

S02.272

Effect of Some Dip Treatments on the Nutritional Properties of Fresh-Cut Tomato and Pepper Through Storage

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Dipping in solutions of different compounds has been suggested as a successful method for maintaining quality (especially colour and texture) of fresh-cut products. In tomato, the effect of some dip treatments on the texture, colour and overall appearance has been reported. However, no information is available on the effect of these treatments on the quality of fresh-cut pepper as well as on nutritional parameters of both tomato and pepper. In the present study, tomato and pepper fruits were cut longitudinally in quarters, dipped in solutions of 2% citric acid, 2% ascorbic acid or 2% calcium lactate for 2 min, placed in trays covered with 15µ polyethylene film and stored at 4 °C for 10 days. Control fresh-cut fruits were untreated. At 0, 5 and 10 days, glucose, fructose, sucrose, ascorbic acid, total phenolics and antioxidant capacity were determined. The results for tomato showed that in fruits of the control after 5 days of storage glucose and ascorbic acid decreased by 92 and 71%, respectively, while at the end of storage antioxidant capacity increased by 109%. Fruits dipped in 2% ascorbic acid after 5 days of storage had higher glucose and phenolic content, while at the end of storage they had higher phenolic content and antioxidant capacity than both control and fresh fruits. From the other treatments only dipping in 2% citric acid affected glucose in a similar way with dipping in ascorbic acid. The results for pepper showed that in fruits of the control after 5 days of storage glucose and phenolic content decreased by 26 and 18%, respectively, while at the end of storage antioxidant

activity decreased by 26%. Dipping in 2% lactic acid prevented the reduction of glucose and antioxidant activity, while dipping in 2% ascorbic acid increased by 14% phenolics at the end of storage.

S02.273

Antagonist Activity between *Aureobasidium pullulans* and *Penicillium expansum* in *Pyrus communis* L. cv. Rocha - Implications on the Antioxidant Defense System

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The use of antagonist yeasts to control post harvest diseases appears to be promising, as an alternative to fungicides, being the yeast-like fungus *Aureobasidium pullulans* a wide-spread saprophyte in the phyllosphere that proved to control post harvest pathogens, namely the *Penicillium expansum*, on pears. This infection initiates in wounds during harvest and packing, in a close association with the synthesis of reactive oxygen species (ROS). In this context, as ROS induce oxidative stress that can have many detrimental effects, microorganisms that attempts to colonize fresh wounds has to cope with oxidative stress triggered as a consequence of wounding. During long-term storage at low-temperature, oxidative stress is alleviated through the interactions of superoxide dismutase and catalase that play an important role in the formation and degradation of H₂O₂ respectively, and ascorbate peroxidase and glutathione reductase that are involved in ascorbate regeneration. In this work, the action of *A. pullulans* to control the post harvest pathogen *P. expansum* was investigated, following the hypothesis that an effective antagonist possesses resistance mechanisms to oxidative stress. For this purpose, the interactions among ascorbate concentrations, as well as the kinetics of superoxide dismutase (EC 1.15.11), ascorbate peroxidase (EC 1.11.1.11), glutathione reductase (EC 1.6.4.2) and catalase (EC 1.11.1.6) were assessed on "Rocha" pears (*Pyrus communis* L. cv. Rocha) harvested at the commercial maturity and stored for 5 months in cold chambers. After a characterization of the commercial maturity through a definition of the colour attributes (L*, a*, b* color space), it was found that in infected wounds with *P. expansum* and inoculated with *A. pullulans*, the levels of ascorbate decreased whereas superoxide dismutase, ascorbate peroxidase, glutathione reductase and catalase increased. The antioxidant defense systems are discussed considering the implications on the metabolic retardation of tissues senescence.

S02.274

Antifungal Activity of Essential Oils on *Rhizopus* Rot of Peach

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Peaches have short shelf life under room temperature, partially due to their high respiratory rate and fast ripening process. *Rhizopus* rot, caused by *Rhizopus stolonifer* (Ehrenb.: Fr) Vuill., is one of the most destructive postharvest diseases of stone fruits. The potential of using essential oils instead of synthetic fungicides to control *Rhizopus stolonifer* on peach fruits is evaluated. The objectives of this study were to determine the antifungal activity of three essential oils on colony growth of *Rhizopus stolonifer*. We evaluated the inhibitory effect of Sage (*Salvia officinalis*), Zataria (*Zataria multiflora*) and Satureja (*Satureja hortensis*) essential oils on the growth of *R. stolonifer*. Three level of this EOs (concentrations of 120, 240 or 360 µl×l⁻¹) were tested *in vitro*. Results showed that there were significant differences between

used concentrations. The best results were zataria EO at concentrations 360 and 240 μL^{-1} with 96.17 and 91.85 % growth inhibition, respectively. and after them, *Satureja* at concentrations 360 and 240 μL^{-1} with 86.19% and 76.56 % growth inhibition, respectively.

S02.275

Microbiological and Physicochemical Behaviour during Storage at 4 °C of Prickly Pear (*Opuntia ficus indica* sp.) Juices Exposed to 3 Different Heat Treatments

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Cactus pear fruit (*Opuntia ficus indica*) in México ≈60 % is lost during storage because it is a highly perishable commodity and the major component is 85% water. The juice processing is a great alternative to preserve and reduce fruit loss. Microbial growth and physicochemical (°Brix, pH and absorbance) of pear cactus juice was evaluated. Juices containing seeds and without seeds, were subjected to heat treatment at different conditions (60 °C /30 min; 70 °C /15 min; 70 °C /30 min, 80 °C /10 min, 80 °C /20 min and 80 °C /30 min). Un-heated fruit juice was used as control and evaluations were carried out during 12 days storage at 4 °C. Microbial growth was assessed by evaluating total bacteria count. To yellow pigments, absorbance was measured using a spectrophotometer (480 nm), °Brix and pH were measured with a hand-held refractometer and a pHmeter, respectively. Un-heated control samples with seeds, presented a lower total bacteria count compare to control juices without seeds. Heat treated (80 °C/20 min) samples with seeds presented the higher bacterial reduction (4 log CFU/mL) respect to control samples. Heat treated (60 °C/30 and 80 °C/20 min) samples with and without seed showed significant differences ($p < 0.05$) of °Brix during storage compared with un-heated control samples. Un-heated control samples with seed and heat treated samples (70 °C/15min) without seed ($p < 0.05$) during storage no significant differences were observed presenting a pH of 5.95- 6.28 and 5.85-5.96, respectively. Heat treated (60 °C/30 min) samples with seeds presented high levels absorbance during storage compared with un-heated control sample. Heat treated samples without seeds presented significant differences ($p < 0.05$) the 9 and 12 days respect un-heated control sample. The formation of yellow pigments was approximately 3 greater times in the heat treated samples with seed compared samples without seeds, can be possible to the oxidation of fatty acids contents presents in the seeds.

S02.276

Biological Control through Anthagonist - Pathogen Interaction during Blue Mold Infection in the Pear

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The fungus *Penicillium expansum* is one of the most important pathogens of pear fruit, for which the yeast-like fungus *Aureobasidium pullulans* seems to be a potential antagonist. We aim to determine whether alterations in respiration rates and ethylene production measured after fruit wounding and infection by the microorganisms depend on the infectant and are part of a hypersensitive response to infection. Mature pears were maintained in a cold room at 0 °C for 2 weeks, 2 or 5 months. After storage, the fruits were wounded (controls) or infected with each or both fungi. The *Aureobasidium* strain was isolated in a portuguese orchard, maintained in NYDB and used as a water suspension at 3×10^8 cfu \times mL⁻¹. The *Penicillium* strain was isolated from infected fruits, maintained in PDA and used as a water suspension at 4×10^4 cfu \times mL⁻¹. Ethylene and O₂ production and consumption rates were determined between 4 and 120 hr after transfer to room tempera-

ture. Ethylene evolution in control (wounded and not wounded) fruits was similar, irrespective of the duration of room temperature incubation. On the other hand, fruits inoculated with *P. expansum* consistently showed faster rates of ethylene production. The hormone production was slow in fruits maintained in the cold for 2 weeks and did not change significantly with maintenance at room temperature. In 2 months fruits, ethylene production was equally slow, but suffer a sharp increase from 48 to 120 hr. Interestingly, fruits inoculated with both fungi showed slower ethylene production then with *P. expansum* alone. Respiration rate in fruits after 6 months storage also showed a sharp increase at 48 hr, irrespective of treatment. However, the dependence of the respiration rate on treatment was ambiguous. These results indicate that *Aureobasidium* decreases ethylene production due to infection by *Penicillium* and may have potential as an antagonist to this pathogen.

S02.277

Quality of Minimally Processed Cowpea

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In Brazil, cowpea is marketed as dried seeds, in fresh pods and unripe shelled grains. However, today minimally processed green shelled grains are unavailable in the market. The aim of this study was to determine the best packing and storage temperature for minimal processing green shelled cowpea grains. Esperança cultivar was chosen to perform this study because it combines green cotyledons and green testa that are traits desired for minimal processing. The fresh pods were sanitized in a sodium hypochlorite solution at concentration of 100 ppm for 10 minutes. Afterward, the grains were shelled by hand from the pods. Then, 120 g grains were placed in polystyrene trays and covered with 3 different types of films (PVC, PEBD, PP). These films were trialed at modified atmosphere. However, only for PEBD partial vacuum was applied. Grains were stored at 1, 5 and 10 °C for 9 days. Were evaluated gas composition inside the packages, mass loss, grain appearance, number of days for mold growth and odor after package opening. Treatments were arranged in a factorial design with 3 temperatures (1, 5 and 10 °C) and 4 storage periods (0 days, 3 days, 6 days, and 9 days). The data were submitted to ANOVA considering the means of the plots and were compared by Tukey test at 5% of probability. Results revealed that there was no loss of grain mass. Additionally, was found that over the days the grains were getting yellowed and darkened around the hilum. It was also found that condensation did not occur in trays covered with PVC film. In contrast, in trays covered with PEBD and PP films occurred condensation. As regards appearance, the grains that were stored at 1 °C and were placed in trays covered with PVC film kept its qualities for longer period.

S02.278

Anthocyanin Profiles and Caffeine Contents of Wet-Processed Coffee (*Coffea arabica*) Husks by HPLC-DAD-MS/MS

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The husks of coffee drupes, comprising the peel and the pulp, might be a potential source of food ingredients. Anthocyanin profiles have been previously described for fresh-processed husks of red Arabica cultivars. However, coffee husks darken very quickly, and their colour was reported to fade away rapidly. It has been assumed that the natural pigments (i.e. anthocyanins) are degraded in this process. Besides that, coffee husks contain ca. 1.3% (dry weight basis) caffeine, which might also be of interest if the husks are going to be used as a food ingredient. Therefore, a better understanding of the postharvest stability of anthocyanin and caffeine in coffee husks after de-pulping is of great interest for coffee processors. In this work, coffee husks from *Coffea arabica* L. were mechanically separated from the beans and immediately frozen in liquid nitrogen. In addition, husks that already started to brown were frozen three hours later. Samples were subsequently freeze-dried,

ground and extracted for two hours with acidified methanol after flushing with nitrogen to inhibit further browning. Anthocyanins were identified by HPLC-DAD-MS/MS and quantified after calibration with the corresponding standards. In both, fresh and brown husks, the major anthocyanins detected were cyanidin-3-rutinoside, cyanidin-3-glucoside and its aglycone. Contrary to literature reports, no loss in anthocyanin content was observed in the brown samples. Additionally, caffeine contents in the brown samples were highest. Therefore, surprising stability of anthocyanins and high caffeine contents in brown samples may support the utilization of coffee husks as a functional food ingredient. Thus, through the complete exploitation of by-products sustainable coffee production may be promoted.

S02.279

Influence of CO₂ Level on Quality Attributes of Fresh-Cut Artichokes

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The effect of high CO₂-atmospheres on quality of fresh-cut artichokes is described in this work. Freshly harvested artichoke heads (*Cynara scolymus* L. var. Catanese) were trimmed and cut into quarts. Samples were stored at 5 °C in air (control) and in air enriched with 5, 15, or 25% CO₂. Initially, and after 2, 4 and 8 days of storage, colour, overall appearance, weight loss, ammonia accumulation, and polyphenol oxidase activity (PPO) were monitored. Samples stored in 25% CO₂ showed a greater tendency to browning on the outer surfaces of the bracts (higher a* value and lower b* value, chroma, and hue angle), than samples stored in air, and in air plus 5 and plus 15% CO₂. Internal surfaces showed statistical differences only with respect to the luminosity (L* value), which resulted higher for sample stored in 5% CO₂ and lower for those stored in 25% CO₂. The weight loss in samples held in 5 and 15% CO₂ was significantly lower than in other storage conditions. Appearance score resulted not significantly different among all treatments, with samples scored above the limit marketability up to 4 days of storage. Ammonia accumulation, measured as an indicator of stress, was highest for samples stored in 25% CO₂. PPO activity was similar for all the treatments. Results indicated that atmospheres up to 15% CO₂ may result beneficial although higher concentrations should be avoided within modified atmosphere packages in order to maintain acceptable quality of fresh-cut artichokes.

S02.280

Degradation Patterns for External and Nutritional Quality Parameters of Fresh-Cut Melons

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Nutritional quality of fresh-cut produce is very important for the consumer. Its evaluation may be expensive and time-consuming for the industry, which conversely can easily determine changes in external appearance including colour. The aim of this work was to find some possible relationships between appearance attribute degradation and the retained nutritional content of fresh-cut melons. Melon pieces were stored for 8 days in air at 5 °C and 99% RH. Initially and after 1, 2, 3, 7 and 8 days of storage external (colour, appearance score) and internal (acidity, soluble solids, fructose content, vitamin C, phenolic, antioxidant activity) quality parameters were monitored. For each parameter a degradation curve over time was obtained, which was fitted in kinetic of zero and first order. The slope of the plot between quality attribute and time was the kinetic rate constant. For most of the quality parameters degradation patterns followed a kinetic of the first order, while hue angle, antioxidant activity and soluble solids could not be described by any significant kinetic. The appearance score showed the highest kinetic rate (0.17), followed by titratable acidity (0.09) and Vitamin C (0.06). Score 3 and 2, which were defined as the limit of marketability and edibility, respectively, were used as reference for comparing the percentage of quality changes over time. When melon pieces reached score 3 that corresponded to a 46% of initial variation, acidity increased of 39% and Vitamin C decreased of 20%. When score reached a value of 2 (64%

of variation), acidity increased of 73% and Vitamin C decreased of 30%. More investigation is needed to support and extend these results also to other varieties/commodities and in different conditions, in order to find simple quality indicators for the nutritional quality of fresh-cut produce, based on appearance degradation.

S02.281

Differences in the Factors Related to the Non-Enzymatic Browning among Three Pear Juice Concentrates

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No-enzymatic browning of pear juice concentrate are widespread which take place during processing and storage. Browning usually impairs the sensory properties of products due to associated changes in the colour, flavor besides nutritional properties. No-enzymatic browning resulted from oxidation of phenolic compounds and maillard reaction that occurs when mixtures of amino acids and reducing sugars are heated. Therefore, its control is essential to preserve the quality of the pear juice concentrate. In the present research 3 pear varieties 'Chili' (*Pyrus bretschneideri*), 'Housui' (*Pyrus pyrifolia*) and Xinli 7 (*Pyrus bretschneideri*) were used as materials to investigate the differences in the content and composition of phenolic, sugar and amino acid in pear concentrates from different pears, in order to reveal the mechanism of browning and to develop strategies that would keep the juice concentrate quality during storage. The composition of Phenolic and sugar was measured by high performance liquid chromatograph and amino acids were determined by amino acid auto analyser. Results showed that the browning degree of the juice concentrates from the 3 pear varieties were different significantly and the colour value from high to low was in the order of 'Chili' > 'Xinli 7' > 'Housui'. The contents of chlorogenic acid, caffeic acid and epicatechin in 'Chili' juice were higher than that of the other two varieties markedly and the contents of arbutin, rutin and quercetin among the 3 pear juice concentrates were insignificantly different. 'Chili' juice concentrate had the highest fructose contents and 'Housui' juice concentrate had the highest sucrose contents. The important amino acids were asparaginic acid, serine, glutamic acid, valine, alanine, and isoleucine and the asparaginic acid showed the highest contents in all the 3 concentrates.

S02.282

Sensory Quality and Antioxidant Activity of Fresh Cut Vegetables Stored under MAP

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Bioactivity of some food micronutrients has received increasing attention due to its potential antioxidant effect as free-radical scavengers, protecting against several diseases like breast, prostate and other cancers, cardiovascular disease, osteoporosis and menopausal symptoms. Ready to cook vegetables produced by careful selection, cutting and washing are a need of modern lifestyle and a requirement of many catering activities. In quality terms, it is crucial that these vegetables reach points of demand, such as markets, restaurants and caterings, fulfilling all sanitary standards, but, above all keeping their nutritional properties and consequent health benefits. In our laboratories studies are being carried out in fresh cut vegetables (lettuce, cauliflower, cabbage, broccoli, green beans and carrots). The main objectives are the determination of antioxidant activity of vegetables' bioactive compounds (spectrophotometry), the evolution of colour (Hunter Lab system) and pH (by potentiometry), since it is expected that these aspects may be responsible for the organoleptic changes during storage. Microbial evaluation (by plate count at 30 °C) is also being performed. All fresh vegetables come from local producers, and are washed, cut and packed under the following MAP initial conditions: air and combinations of 2.5, 5 and 10 % O₂ with 10, 20 and 30% CO₂, using N₂ to sum up to 100%. A high barrier and a permeable polyethylene film are also being tested for

each MAP condition. Storage temperature always kept at 5 °C. All parameters are being analysed at 0, 5 and 10 days storage and are always compared with the results of sensory evaluations carried out by a trained panel searching for defects. Results obtained for cabbage and carrots show a beneficial effect of MAP on the evolution of chemical, physical and microbiological characteristics during storage, mainly for gas combinations with low O₂ and high CO₂, and low barrier packaging materials.

S02.283

Effect of Heat Treatment on the Concentration of Sugars Present in Murcott Tangerine Juice

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The Murcott is from United States and its official name in that country is mandarin "Honey". Its fruits, known in Brazil as "Murcott" tangerine, are medium size, average weight of 140 g, are flat, with a small cavity in the central axis, with high potential for the production of juice as they present a juice yield around 50%. This work aimed to study the influence of pasteurization on the levels of sugar in the juice of "Murcott" tangerine. Samples of fresh juice were used as control. The fruits were properly washed and pulped. The juice obtained was centrifuged at 2000 rpm/15min, pasteurized in a heat exchanger surface scraped at 90 °C / 20s and 90 °C /40s and kept frozen until the analysis. The determination of sugars (sucrose, glucose and fructose) was performed according Macrae. Briefly, the juice samples were extracted by dilution with H₂O in ultrasound, filtered in sterile hydrophilic membrane (0.2 µm) and quantified in the chromatograph Waters Alliance 2695 equipped with a detector of refractive index Waters 2410, BioRad Aminex HPX-87C column (300 x 7.8 mm) at 85 °C, mobile phase 100% water, flow 0.6 mL / min and injection volume of 20µL, with external standardization. The statistical analysis was performed using the program XLSTAT 7.5, performing the ANOVA and subsequent Tukey test for comparison of means with a confidence interval of 95%. It was observed that the data obtained in the determination of sugars Murcott tangerine juice pasteurized under two different conditions, 90 °C /20s and 90 °C /40s, no significant difference (p ≥ 0.05) with each other and compared the results obtained for the juice fresh. However, an increase of 1.038% in the total concentration of sugars from the juice pasteurized at 90 °C /40s was observed when compared with the sample fresh.

S02.284

Selection of Herbal Plants for Development of Fresh-Cut Salad Products

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The objective of the present study was to select herbal plants as salad materials to develop new fresh-cut products. 18 herbal plants (13 leaves, 4 roots, and 1 tumour) growing in South Korea were used as salad materials. Although the herbal plants were eatable, they were not used as fresh-cut salad material, which were commercially developed. Freshly collected herbal leaves and shredded roots and tumour were washed in tap water for 90 seconds, dried with centrifugal dryer, and mixed with other fresh-cut vegetables (iceberg lettuce, romaine, carrot, and red cabbage). Samples were then packaged in PET tray and stored at 5 °C for 7 days. Selection of herbal plants for fresh-cut salad was based on quality (gas composition, discoloration, and off-odor), sensorial test (taste, appearance, and flavour), and microbial population. Fresh-cut products containing shredded roots had lower sensorial appearance score and higher microbial population compared to herbal leave products. Fresh-cut tumour, Ma salad had low score of appearance due to viscous materials. Five herbal leaves (Danggui, Jandae, Sumchorong, Korean native dandelion, and hydroponic ginseng leaves) were good salad materials with high score of taste and appearance and two fresh-cut products from wild leaves (Sanmaneul and Deoduk) had high flavour scores. Those seven fresh-cut products had ≤ 6 log CFU/g of total aerobic plate counts at the end of storage. The results indicated that the herbal leaves of the seven plants are potential materials for fresh-cut salad products.

S02.285

Effect of Environmental Friendly Sanitizers on the Quality Maintenance and Microbial Reduction of Fresh-Cut Iceberg Lettuce

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The effect of environmental friendly sanitizers on microbial growth and storage life of fresh-cut iceberg lettuce were studied. Fresh iceberg lettuce leaves were cut and washed separately in tap water, chlorine solution (50 and 100 µL·L⁻¹), 1.5 g·L⁻¹ calcinated calcium solution, 0.2% citric acid solution, 50% ethanol solution, and the combination of citric acid solution and 50% ethanol spray. Fresh-cut samples were then dried with centrifugal dryer, packaged in 80µm Ny/PE films, and stored at 5 °C. The ethanol solution dipping was the most effective treatment to reduce microbial population. However, ethanol solution induced severe injury of fresh-cut iceberg lettuce during the storage. Citric acid alone was not effective in reducing microbial population. However, the combination of citric acid and ethanol spray reduced aerobic microbial population and maintained good quality with high overall quality score at the end of storage. The results suggest that the combination of citric acid and ethanol spray could be an alternative to chlorine as an environment-friendly sanitizer for washing fresh-cut leafy vegetables.

S02.286

Sodium Metabisulfite Residues in Trimmed Young Coconut

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Trimmed young coconuts turn unattractively brown and are highly susceptible to mold growth. The use of sodium metabisulfite (SMS) could remedy these problems. However, SMS residue in coconut kernel may be harmful to the consumer. The effects of coconut husk, shell, maturity, SMS concentration and dipping duration on SMS residue were studied. SMS (3 % concentration for 5 minutes) penetrated only 4 mm deep into the husk at the stem end (eye site). It could penetrate less at the stylar end and at the circumference. If the entire husk was removed SMS could penetrate the shell as well. It was found that trimmed young coconut at 170 days after anthesis (DAA) maturity had a greater chance to have SMS residue than that at 185 DAA and 200 DAA, respectively. Trimmed young coconuts dipped in higher concentration and longer duration of SMS solution had higher chance to have SMS residue. It is recommended that young coconut should be of 185 DAA or older, with minimal peeling, leaving the husk at least 1 cm thick, and dipped in ≤ 3% and ≤ 5 minutes of SMS solution in order to keep the kernel free of SMS residue.

S02.287

Applied Research of Millipede *Bandeirenica caboverdus* (Diplopoda, Spirostreptidae) and the End of the Quarantine Restrictions

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The damages caused by the millipedes *Bandeirenica caboverdus* constitute a major problem for the horticultural sector in Cape Verde and were the fundamental reason for the internal quarantine measures undertaken by the Government. The transport of any plants, fruits and vegetables produced on the two infested islands (Santo Antão and São Vicente) was forbidden to the other islands of the Archipelago. The internal quarantine measures left the two islands isolated, without access to the markets in other islands for the increasing agricultural production. In order to solve the problem of export, a new Government Ordinance is under preparation. Some of the horticulture products from Santo Antão and São Vicente will be allowed for commercialization in other islands of the Archipelago after adequate

treatment and inspection. The main purpose of the present research work was to find the most effective method of treatment to be implemented in the Post-Harvest Centre. During the research, tubers, roots and fruits, previously infested with millipedes, were exposed to moderate heat (40 and 45 °C) or immersed in water at 26±1 °C, 40±1 °C and 45±1 °C for 10, 15 and 20 minutes. The immersion in water at 26±1 °C with sodium hypochlorite has also been tested. The conclusion appointed that the treatment of the potato, sweet potato, cassava, yam, carrot and tomato in water at 26±1 °C for 20 minutes results effective and removes 100% of millipedes. After this treatment, the tested products can be commercialized free of millipedes in the other islands of the Archipelago.

S02.288

The Effect of Clove Buds (*Eugenia caryophyllata*) Essential Oil on Thompson Seedless Grapes Berry Decay Control and Some Quality Characteristics during Storage Period

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The use of natural compounds such as essential oils is a newly growing idea in postharvest technology. In this study, Clove buds essential oil in vapour state and in concentrations of 0, 50, 100, 150, 300 and 450 ppm was studied for maintaining table grapes quality and controlling postharvest decay during storage period in three different experiments. First, the effect of different concentrations of essential oil on inhibition of mycelium growth of gray mould (*Botrytis cinerea*) was evaluated. In the second experiment, the effect of above mentioned concentrations on control of disease severity was investigated spraying *Botrytis* fungi spores on berries and keeping them at 15 °C, for 7 days. In the third experiment, the rate of decayed berries, soluble solids content, titratable acid and berry weight loss were evaluated at 1 °C of storage temperature, during 40 days of storage, in 10 days interval. The results showed that, there was no sign of phytotoxicity on treated bunches during cold storage time. There were significant differences between treatments in gray mould controlling *in vitro* and *in vivo* conditions. The 100% mycelium growth inhibition *in vitro* and control of gray mould severity in inoculated berries at shelf life with lower percentage of decayed berries in cold storage was seen under 450 ppm essential oil treatment. Soluble solids content increased during storage and it was significantly higher in control than in treated fruits. Essential oil significantly delayed the decline of titratable acid and weight loss while it was correlated with essential oil doses. At final evaluation date, most of panelists perceived slight-moderate presence of essential oil flavour on grapes. It seems that clove essential oil components, especially eugenol, with their antioxidant and antimicrobial activity's, delay the senescence of fruits.

S02.289

Time-Course Changes in the Fine Structure and Chemical Components of the Japanese Chestnut (*Castanea crenata* Sieb. et Zucc.) during the Gelatinization Process

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The main component of chestnuts is starch; therefore, it is essential that they are gelatinized by heating (cooking) before consumption. In general, chestnuts are cooked by boiling, steaming, or baking, and it is well known that these cooking methods considerably affect the palatability of this fruit. In this study, we investigated changes in the fine structure and chemical components of the chestnut during the gelatinization process and evaluated their relationship with the palatability of the fruit. For this experiment, we used Japanese chestnut cv. Tsukuba fruits, which were selected by weight (≈25 g) from lateral fruit at harvesting time. The selected chestnuts were cooked in a steamer (for steamed chestnuts) or oven (for baked chestnuts), and samples were collected at 10-minute intervals for 40 minutes. The collected samples were observed under a scanning electron micro-

scope, and the soluble sugars and starch content were analyzed. In baked chestnuts, gelatinization of starch was observed only in the outer region after 10 minutes of cooking. After 20 minutes of cooking, gelatinization of starch was also observed in the inner region of the chestnuts. As time progressed, cell contents were unified in the inner region of the chestnuts; this was caused by gelatinization of starch. In contrast, the outer regions of the chestnuts were dehydrated and solidified. After 10 minutes of steaming, starch was gelatinized more rapidly than after 10 minutes of baking. After 40 minutes of cooking, the chestnuts were completely and uniformly gelatinized. There were not steadily fluctuations in soluble sugars and starch content during cooking. On the basis of these results, we conclude that the texture of chestnuts is mainly influenced by the cooking method; baked chestnuts exhibit a firm texture caused by dehydration of the outer regions, and steamed chestnuts exhibit a soft texture.

S02.290

Influence of 1-MCP in the Lycopene Content in 'Paluma' and 'Pedro Sato' Guavas Minimally Processed

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Nowadays, we notice a change in the population eating due to the search for a healthy diet with practical food, such as fruits and vegetables minimally processed. The lycopene is a carotenoid pigment found in fruits and vegetables red colored, it is a potent antioxidant able to prevent vascular and degenerative diseases. The 1-MCP has shown to be an effective alternative in the control of senescence and in keeping and maintaining the quality of fruits and vegetables whole and minimally processed. The aim of the present study was to determine the effect of the use of 1-MCP in the lycopene content of guavas 'Paluma' and 'Pedro Sato', minimally processed and stored under refrigeration. The guavas were harvest according to degree of maturation in green-yellow and treated with 1-MCP at a concentration of 900 nL×L⁻¹ during 12 hours. They were then processed and stored at 5±1 °C. The fruits were examined every three days until nine days of storage with regard to lycopene determination. The contents of lycopene in 'Paluma' guava ranged from 37 µg×g⁻¹ in the beginning of the experiment to 47,6 µg×g⁻¹ in the end of the storage without significant differences during this period, and even significant difference compared to the control (without 1-MCP). The same behaviour was found in 'Pedro Sato' guavas with contents of 79,2 µg×g⁻¹ in the beginning and 75,1 µg×g⁻¹ in the end of the storage. This behaviour can be explained due to the fact that the fruits were stored under refrigeration. The temperature is one of the factors involved in the change of lycopene content of fruits and vegetables. It was observed, therefore, that the technology of 1-MCP doesn't interfere in the lycopene content of 'Paluma' and 'Pedro Sato' guavas, minimally processed, stored at 5±1 °C during nine days.

S02.291

Study of Microbiological Quality of 'Ambrunés' Sweet Cherry during Postharvest Storage

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The purpose of this work was to study the microbiological quality of the 'Ambrunés' sweet cherry during cold storage. Sweet cherries were hydro-cooled at a water temperature of 1 °C in a 1000 l immersion hydrocooler equipped with a water recirculation system. Sodium hypochlorite was added to the water to achieve a chlorine concentration of 100 µl×l⁻¹. Then, cherries were classified based on skin colour and size by automatic colour sorter and stored at 1 °C with 95% RH during 28 days. After 0, 7, 15, 21 and 28 storage days, microbial analyses of total meso-

philic aerobic, *Enterobacteriaceae* spp. coliforms, *Pseudomonas* spp, Lactic acid bacteria, moulds and yeasts, *Staphylococcus* spp. psychrotrophic bacteria and *Enterococcus* spp. were carried out. Yeast, psychrotrophic bacteria and *Pseudomonas* spp. were the most prevalent micro-organisms during all storage. Yeasts were a count between 0 and 28 storage days of 2×10^2 and 1.02×10^6 cfu \times g $^{-1}$, respectively. While psychrotrophic bacteria were a count between 0 and 28 storage days of <10 and 9.71×10^5 cfu \times g $^{-1}$ and *Pseudomonas* spp. were a count <10 and 7.50×10^4 cfu \times g $^{-1}$. However, average mould counts slightly exceeded 3×10^2 cfu g $^{-1}$ from 15 storage days. The *Enterococcus* spp. and *Staphylococcus* spp. were the microbial group with the lowest counts during the storage, in fact, *Enterococcus* spp. was not detected during storage. *Staphylococcus* spp. were a count between 0 and 28 storage days <10 and 8.33×10^1 cfu \times g $^{-1}$. Statistical differences were detected in storage, but were not detected among ripening stages. After 21 storage days under these conditions, fruit is not fit to be consumed, due to high microbial counts.

502.292

Conservation on Minimally Processed Swiss Chard (*Beta vulgaris* var. *Cycla*), American Lettuce (*Lactuca sativa* L.) and Purple Lettuce (*Lactuca sativa* L. var. *Veneza Roxa*) Storage in Different Packing Isolated or in Salad Mix Form

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The objective of this work was to study the physico-chemical and biochemical alterations of minimally processed Swiss Chard, American lettuce and purple lettuce, storage in individual form or component of salad mix in different packing. The minimally processed consisted of the following stages: selection, cleaners, cut, sanitization ($200 \text{ mg} \times \text{L}^{-1}$ active chlorine), rinse, centrifugation, packing and refrigerate conservation. The vegetables were storage in two types of packing: polyethylene of high density film and nylon poli film. Those packing's, which contained 50 g of product in individual form or 150 g of salad mix (50 g Swiss Chard, 50 g American lettuce and 50 g purple lettuce) storage at 5 ± 2 °C, for 15 days. Phenolic content, browning index, total titratable acidity, pH and polyphenol oxidase activity had been evaluated each five days. The total titratable acidity in Swiss Chard, American lettuce and purple lettuce presents values between 0,2 and 0,6 of citric acid g $^{-1}$ and presented opposing behaviour to the pH. The browning index was presented bigger in Swiss chard storage on individual form in both packing. The activity of polyphenol oxidase of the Swiss Chard when storage of individual form was higher than when storage of salad mix form during storage time. It was verified that the packing most adequate for the conservation of minimally processed Swiss chard, American lettuce and purple lettuce independent of the storage form (individual or salad mix) was nylon poli.

502.293

Storage of Half-Finished Vegetable Products

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Good quality is one of the main problems of every stage of vegetable storage. Quality changes of vegetables during storage have been investigated with instrumental methods. Regimes of storage time are determined, taking into account their influence on the structure-mechanical properties of the product. As the storage process of packaged vegetables is one of the most important, changes of physical and microbiological quality indices are determined just in this stage of technological process. The competence in food preparation technology is the necessary precondition for innovative food and service development, but the knowledge of food safety assurance encourages a food service manager to validate the technological processes from the viewpoint of food safety. Natural losses are characterized by losses of moisture which unfavourably influence the storage ability of live organisms. Using basic laws of physics, we obtain the process mathematical model. Taking into consideration ensuring of heat transfer from the product, it will be possible to

carry out successful storage of vegetables. It enables to perfect technological process of storage. Optimized and experimentally verified model will help to explain and predict physical processes in vegetables during storage.

502.294

Growth of *Penicillium expansum* in Different Naturally and Artificially Infected Apple Cultivars

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Penicillium expansum is the most dominant fungi causing spoilage of apples during storage and is a known producer of patulin. It is generally accepted that disease infection of apple mostly occur through wounds, although several studies have indicated that also healthy fruits can be attacked. In this study the growth of *P. expansum* and patulin production were investigated in 15 old and new varieties grown in Wadenswill Research Station in Switzerland. Methods to test the susceptibility against infection with *P. expansum* are described. Apples (10 per replicate) were inoculated by adding a 10 μ l droplet containing approximately 106 spores/ml either by surface stab wounding, or by placing the conidia suspension onto the end of the apple stems and into the stem basin, respectively. The patulin content was measured by LC-MS/MS using gradient elution after homogenisation and extraction of the apple samples with ammonium acetate followed by an ultrasonic bath for 30 min. The apples were incubated at room temperature for up to 25 days. Our results showed significant differences in infection pattern of *P. expansum* among the different tested apple cultivars, and that *P. expansum* penetrates the apple not only through wounds but also by invasion through the stem of healthy apples. The study was supported by the ISAFRUIT project financed by the EU Commission under the 6th Framework Programme.

502.295

Respiration Rate of Different Cutting Formats of Minimally Processed Summer Squash

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Demand for minimally processed vegetables (MPV) has increased in many industrialised countries in recent years due to changes in lifestyle and feeding people. MPV show a higher added value than the fresh vegetables from origin because they are "ready to eat". To maintain quality of MPV and extending shelf life after packaging, certain postharvest factors must be investigated, as it is the respiration rate (RR). RR is dependent on a number of factors including the format in which the MPV is packaged. In this work the RR of different cutting formats of summer squash (*Cucurbita pepo* L.) fruits are reported. Summer squash of a commercial variety grown in Almería (Southern Spain) were cut and introduced in glass bottles and their RR determined along a period of time at room temperature. The results obtained showed significant differences of the RR between formats. These results are important for selection of those varieties best suited to the industry of MPV.

502.296

Application of Alginate-Based Edible Coatings for Preservation of "Rocha" Pear Slices

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Application of edible coatings on fresh-cut fruits constitutes a potential aid in extending their shelf-life, as well as maintaining the high quality standards demanded by consumers. The main objective of this research was to evaluate the effect of alginate (A) coatings with different concentrations, containing ascorbic acid (AA) as antioxidant agent and glycerol (GLY) as plasticizer, on quality of 'Rocha' pear slices.

The two coating treatments tested were a solution of 0.5% (w/v) A + 50% (w/v) GLY + 1% (w/v) AA, and a solution of 1% (w/v) A + 50% (w/v) GLY + 1% (w/v) AA. The control treatments were a dipping solution of 1% AA and a dipping of plain water. After dipping, the slices of 'Rocha' pear were packed in clamshells with normal atmosphere and stored at 4 °C. Three replicated packages for each dipping treatment were analysed over 16 day storage, for weight loss, colour, texture and sensory analysis. The sensory analysis included a quantitative descriptive analysis (QDA) to firmness, colour, taste and off-odour as descriptors and an acceptability test to evaluate shelf-life. As storage time elapsed, there were significant changes in weight loss, colour and firmness brought about by all treatments, thus confirming the usefulness of these properties as quality indicators. The coating treatments were the most effective towards prevention of weight loss, browning and loss of firmness of sliced "Rocha" pears. The water dipping treatment was that with a higher decrease in terms of weight loss and firmness. The QDA panel results were in accordance with the instrumental colour and texture measurements and no off-odours were detected in the two coating treatments tested. The two coating treatments extended the shelf-life of "Rocha" pear slices compared to the control treatments.

S02.297

Storability of 'Green Dwarf' Coconut Fruits under Refrigeration and Modified Atmosphere

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This study aimed to evaluate the effect of refrigeration and modified atmosphere on the storability of green coconut fruit for water fresh consume. Fruits of 'Green Dwarf' coconut variety were harvested from commercial orchards in Paracuru, Ceará, Brazil, and transported to the Postharvest Physiology and Technology Laboratory at Embrapa Tropical Agroindustry, Fortaleza, CE. Upon arrival in the laboratory, fruits were submitted to the following treatments: 1 - Control = non treated samples; 2 - Film = wrapping in 15 µ PVC film; 3 - Wash = immersion for 10 minutes in Cl (NaOCl) 100 ppm in a shaking container followed by air dry; 4 - Wash + Film = combination between treatments 2 and 3, that is, washing followed by wrapping with film. Right after treatments, fruits were stored under refrigerated conditions (12±1 °C and 90±5 % R.H) and evaluated for mass loss, visual appearance and external color, and water turbidity, total soluble solids (TSS), soluble sugars (SS), reducing sugars (RS), titratable acidity (TA), pH, and sensorial analysis. Duration times were zero, 7, 14, 21, 28, and 35 days. For the quality experiments a factor design 4 x 6 (treatments vs. time) with four replicates (each fruit representing a replicate) were applied, while for the sensorial analyses experiments a 4 x 2 factor design, with 30 replicates (panelists) and two durations, 28 and 35 days, was applied. Green dwarf coconut fruits stored under refrigeration presented storability of 16 days. Combination of refrigeration and modified atmosphere greatly reduced mass loss, fruit wrinkling, and loss of green color enabling fruit storability of 35 days. Water from fruits submitted to washing and PVC film wrapping treatments, favored water acceptance.

S02.298

UV-C as a Postharvest Treatment of Citrus Fruit

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Green and blue moulds, due to the pathogenic action of two species of *Penicillium*, are the main responsible of orange losses during the period of postharvest. Chemical fungicides are commonly used to control them. However, the continuous use of these chemicals in commercial packinghouses has led to increase the number of resistant strains of pathogens. Furthermore, there is a growing concern among consumers about the possible harmful effect on the environment of these

molecules or their residual metabolites. Ultraviolet-C illumination (254 nm) could be used as an effective physical treatment to avoid *Penicillium* proliferation on citrus fruit. In this work UV-C illumination are propose as an alternative physical treatment to reduce citrus decay. The direct and indirect (elicitation) effects of UV-C in the pathogens were investigated. Fruits were subjected to different doses of UV-C illumination, before and after pathogen inoculation. Fruits were stored for 7 days at 20 °C and 1 month at 5 °C following 7 days at 20 °C simulating shelf-life period. After storage period the decay incidence of *Penicillium* was evaluated. Quality parameters as colour, weight, % juice were evaluated using destructive methods. The acidity and °Brix were evaluated using NIR non destructive technology, allowing to monitoring these parameters in the same fruits. Results will be discussed considering the direct and indirect responses in relation with the applied dose of UV-C.

S02.299

Application of X-Ray Microtomography Tool on an Hidration-Dehidration Study of Açai Berry

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The anatomy of the fruits of *Euterpe oleracea* is not well known and the little studies found in literature use classical microscopic techniques. On this paper the authors present the anatomic changes of the acai berry submitted to an hydration-dehydration process, and the changes were registered with the X-ray microtomography technique. Açai is not consumed in nature, its pulp is extracted on a rubbing process with the aid of water. The amount of water and the processing time define the viscosity of the resulted emulsion, a very appreciated food on the Nortest of Para (Brazil). Its market overcame the inertial growth in 1995 when the first lots arrived to the richest region or the country. At 2001 the frozen emulsion began to be exported. The intense growth of the market has demanded more efficient depulping processes, what motivated this study. The fruits are partially dehydrated during transportation and then rehydrated in the industry before rubbing, what was simulated in the laboratory with aid of an oven at 60 °C, and water immersion at 25 °C. The fruits were observed with the microtomograph SkyScan model 1172. The fruits were submitted to dehydration between 2.7 and 10%, and dried. Dehydrated fruits to about 4.9% presented few ruptures in the storage parenchyma, epidermis and anthocyanin parenchyma. A big retraction of the storage parenchyma that contain the lipids was observed about 7% of water loss. About 10% all tissues presented big shrinkages increasing the distance between monosteles. The embryo shrunked proportionally to the dehydration rate.

S02.300

Effect of Storage Pre-Conditioning and Duration on the Sensory Quality of 'Honeycrisp' Apple

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'Honeycrisp' is a relatively new apple cultivar, which was released by the Minnesota Agricultural Experiment Station in 1991. The fruit has outstanding flavour characteristics and can remain crisp for several months in storage. 'Honeycrisp' is also extremely susceptible to the storage disorders soft scald and soggy breakdown. To control these disorders it is common to pre-condition the fruit prior to cold storage with delayed cooling, 4-7 days at 10-20 °C. Postharvest application of 1-methylcyclopropene (1-MCP), an inhibitor of ethylene action, has also been shown to reduce certain storage disorders in apples. The objective of this study was to evaluate the effects of delayed cooling and/or 1-MCP treatment on the fruit sensory quality after 1, 4, or 6 months. 'Honeycrisp' apples were harvested twice within the commercial harvest window. Apple batches were then held in various regimes ranging from 0 to 6 days at 10 to 25 °C, and treated with or without 1-MCP (1 ppm for 24 hours at 3 °C). All fruits were then stored in ambient air or controlled atmosphere (1.7-2.0% O₂ + 2.0% CO₂) at 3 °C. A

sensory methodology was developed to enable comparison of the apple sensory profiles imparted by the different treatments. A list of 18 descriptors (12 flavours, 6 textures) was generated and defined by quantitative references to calibrate the use of the scale measuring the perceived intensity of these descriptors when assessing an apple sample. A group of 8 panelists selected for their sensory abilities and trained to utilize the developed methodology participated in this project. Effects of pre-conditioning treatments were already noticeable after 1 month, decreasing the perceived sweetness, juiciness and crispiness of 'Honeycrisp' apples. All the regimes resulted in higher bitterness, astringency and skin thickness of the fruits compared to '2 days at 25 °C'. The evolution of 'Honeycrisp' sensory profile will be further discussed.

S02.301

Impact of Atmospheric Plasma Treatment on Microorganisms on Plant Tissue

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Since several years a number of activities in the field of surface decontamination by using non-thermal plasmas are known. But although there are quite a few plasma based processes commercially available, the complexity of interaction between plasma and plant tissue are little examined. For decontamination two aspects have to be taken into account, the impact of i) UV radiation and ii) chemical active or toxic species (e.g. OH derivatives, NO derivatives, etc.). In this study, the investigations were performed using a plasma jet operated in argon at atmospheric pressure. The plasma jet was driven by radio frequency (27.12 MHz) at operating powers between 10 and 40 W. UV/VIS optical emission spectroscopy (OES) and infrared camera were used to characterize the plasma. Due to the operation of this plasma jet under atmospheric pressure conditions flow dynamics play a major role in transport processes of chemical active or toxic species. The effect of the plasma on different micro-organisms was investigated using conventional plate count methods and flow cytometry. The slope of the inactivation kinetics showed multi-phasic reduction properties for *Escherichia coli* on polysaccharide gel and could be described using available mathematical models. To study the interactions of plasma-immanent reactive species with secondary plant metabolites lamb's lettuce was exposed to the atmospheric pressure plasma jet. Pure flavonoids showed a strong time-dependent decrease, whereas the concentrations of the selected phenolic acids almost remained unchanged. Using lamb's lettuce as a very sensitive model produce chlorophyll fluorescence imaging analysis was applied to measure the local and temporal dynamics of the potential post processing effects of plasma jet operation on the physiological produce properties. The potential of this new method for processing of fresh foods will be discussed.

S02.302

UV-C Induced Disease Resistance and Delayed Ripening in Tomato Fruit with Prior Exposure to Selected Storage Stresses

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The induction of disease resistance and delayed ripening by hormetic doses of UV-C in postharvest crops has been well established. However, it is not known whether UV-C induced effects are similar when produce are transiently exposed to other abiotic storage stresses prior to UV-C treatment. It was hypothesized that UV-C induced effects in crops could be modified if crops are exposed to storage and handling stresses such as heat, cold, wounding and atmosphere (low O₂ and high CO₂), before administering UV-C treatment. Mature green tomato fruit were exposed to various storage stresses: heat (35 °C, 60 h); cold (1 °C, 7 days); N₂ atmosphere (24 h); high O₂ atmosphere (24 h); high CO₂ atmosphere (8 h); water stress (75% RH, 7 days); and wounding. After 24h, fruit were treated with hormetic UV-C dose of 3.7 kJ×m⁻² and stored at 13 °C and RH of about 95%.

Fruit ripening was monitored by colour measurement, and disease resistance was evaluated by inoculation of the fruit with *Botrytis cinerea* 12 days after treatment. Subsequent exposure of UV-C treated fruit to various stresses generally did not affect the UV-C induced delayed ripening or the disease resistance, with an exception that cold stress attenuated UV-C induced disease resistance. The enhanced delay in ripening by cold stress and diminished delay by heat stress were attributable to storage temperature history. Results suggest UV-C is a dominant stress and that UV-C induces disease resistance and delay of ripening in tomato fruit after they were transiently exposed to other stresses.

S02.303

Investigation and Presenting of Solutions to Reduce Postharvest Losses of Potato (*Solanum tuberosum*)

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Potato (*Solanum tuberosum*) is an annual tuber plant and as the most important species of *solanaceae* has a high economical value. Potato is the most important resources for starch and vitamin C in human nutritional diet. The harvest time vary between different varieties and usually when the colour of plant initiating to be yellow and dry is the harvest time of plant. Some of attributes of potato which is regarded in qualitative valuation vary due to type of consumption and depends to tuber size and shape, tuber skin colour, tuber flesh colour and quantity/quality of starch. Postharvest losses of potato are related to bruises and damages which are accruing through harvest operations and resulting to decrease of visual quality and nutritional value and increase of susceptibility to fungal rots such as *fusarium*, *alternaria*, *rhizoktonia* and *phytophthora* after harvest. Also, the production of solanin alkaloid and postharvest sprouting of potato during store are the major kind of potato losses that cause to decrease in nutritional and economical value. Curing is one of the treatments which are done after harvest to prevent of potato losses. The goal of this paper is to study of potato plant characteristics including nutritional value, stages of harvest operations and pre-harvest and post-harvest treatments of plant to present some methods for prevention of decay.

S02.304

Effect of Post Harvest Oxalic Acid Treatment on Physico-Chemical Composition and Keeping Quality of Mangoes

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Rapid ripening processes and post harvest diseases are serious causes of post harvest losses in mango fruit and limit transport of fresh mangoes. Oxalic acid extends the storage life of mangoes without any decay. The main objectives of this study were to understand the effect of oxalic acid on storage life and defects of Karthacolomban, and Vellaicolomban mangoes and assess the consumer acceptability. Mature green Karthacolomban and Vellaicolomban mangoes were harvested carefully in Muruganoor farm and a representative sample of 15 mango fruits with 3 replications were selected randomly. Those mangoes were dipped in 5mM oxalic acid for 10 minutes and another 15 mangoes were dipped in water as control. They were subsequently allowed to ripen at ambient temperature (30±4 °C and 70-75% RH). A representative sample of 5 mango fruits with 3 replications were selected randomly and used for physico-chemical analysis. Another set of fruits were used for sensory evaluation. Fruit weight, volume, moisture content, colour, total soluble solids and eating quality were not affected by oxalic acid dip treatment in both Vellaicolomban and Karthacolomban mangoes. Titratable acidity and pH of oxalic acid treated Karthacolomban and Vellaicolomban fruits were showed significant difference (p=0.05) compared to control. Firmness of oxalic acid treated fruits

was slightly higher than control while disease score was slightly low in oxalic acid treated fruits. Oxalic acid dip treatment extends storage life by 4 days in Karthacolomban and 3 days in Vellaicolomban mangoes without affecting taste and colour. Marketability of oxalic acid treated fruits was also high due to low disease score. These results indicate that oxalic acid dip treatment at low concentration can improve storage life of Vellaicolomban and Karthacolomban mangoes from Vavuniya at ambient conditions.

502.305

Effect of Pre-Harvest Treatment of Nitric Oxide on both Pre-Harvest and Post-Harvest Ripening and Post-Harvest Quality in Tomato

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Nitric oxide (NO) has been implicated in disease resistance to avirulent pathogen attack, however, NO is supposed to have effect on fruit ripening since it cross-talks with ethylene. To study this tomato plants (*Lycopersicon. esculentum* cv. No.4 Zhongshu) with florescence reaching 50d were injected 5mL sodium nitropruside (SNP) solution, NO donor, with concentrate 0.01mM, 0.02mM, 0.05mM respectively. The same volume distilled water was injected as control. The results showed that 0.01mM and 0.05mM SNP treatment could delay the fruit ripening before harvest, especially the 0.05mM SNP treatment. After treated tomato fruits which were picked up during green stage stored at 25 °C, RH 80%-90%, however, we found the efficacy of delaying ripening in 0.02mM and 0.05mM pre-harvest treatment with SNP was better. Subsequently the contents of lycopene, Vc, soluble sugar, titratable acid and soluble protein showed that there was no significant difference in quality between treatment and control no matter fruits matured before harvest or after storage. These results suggested that SNP pre-harvest treatment could significantly delay ripening in tomato fruits and wouldn't cause the quality worse.

502.306

Effect of Syrup Concentrations on Recovery and Organoleptic Quality of Dehydrated Kokum(*Garcinia indica* Choisy) and Effect of Pretreatments and Drying Methods on the Yield and Organoleptic Quality of Dried Kokum

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Kokum (*Garcinia indica* Choisy) is a slender evergreen tree found in the tropical rainforests of Western Ghats of South India from Konkan southwards towards Maharashtra, Karnataka, Goa and Waynad. Kokum is valued for the numerous medicinal properties like antihelmenthic and cardiotoxic, to cure piles and dysentery. Fruit rind is dried and used for culinary purposes and syrup dehydrated kokum is the by product after osmodehydration of kokum rind and is sold in the local market. Studies were conducted to assess the effect of different concentrations of syrup on the yield and quality of dehydrated kokum rind. Maturity of the fruit more or less coincides with the onset of monsoon season and sun drying is difficult. Hence lot of wood is used to dry the fruit rind on iron tawa. Hence studies were necessary to assess the effect of different pretreatments and drying methods like oven drying on the quality of dried kokum. Freshly extracted kokum fruit rinds were subjected to different drying methods like oven drying and sun drying after pretreatments like hot water blanching and Potassium Metabisulphite. The best organoleptic quality scores for dried kokum for overall acceptability (3.57) (on a 5.0 point hedonic scale) were recorded in kokum rinds blanched for 2 minutes + KMS 2% for 15 minutes + oven drying. Organoleptic evaluation of dehydrated kokum revealed that the highest scores for texture, flavour, taste and overall acceptability was recorded in rinds dehydrated with 70°B for 24 hours compared to control.

502.307

Effects of Curing Conditions on Quality of Dried Vanilla Beans

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Vanilla (*Vanilla planifolia* Andrews) is the world's most popular flavouring used by the food, pharmaceutical and cosmetic industries. Natural vanilla has an intense, fruity, floral fragrance that makes it a unique and universal flavouring. The distinctive flavour and aroma of cured vanilla beans is derived mainly from the phenolic compound vanillin, and other aromatic compounds. Vanillin is accumulated in green beans during maturation as glucovanillin, which is hydrolysed to free vanillin by endogenous glycosidases during curing to give the characteristic flavour of vanilla. The objective of this study was to determine the most suitable conditions for curing that yield cured beans with high concentrations of vanillin and other flavour compounds and with high sensory quality. Mature green beans were obtained from a commercial grower at Cairns, Queensland. Beans were either left unblanched and sweated at 45 °C or the beans were blanched in hot water at either 50, 55 or 60 °C for 3 minutes followed by sweating at 40 or 45 °C until they turned brown. After sweating the beans were dried to 45% of their fresh weight using an oven dryer at 50 °C. Vanillin concentrations were determined at different stages of the curing process. The concentrations of vanillin were low in green beans and there were no significant differences in vanillin content between treatments at the sweating stage. However, vanillin concentrations were higher in unblanched beans sweated continuously at 45 °C than in beans that were blanched at 50–60 °C then sweated. The beans cured continuously at 45 °C had an attractive dark-brown colour. These protocols enabled the production of cured beans that retained high concentrations of vanillin and a complex of other volatile compounds that impart unique aroma. Vanillin and other flavour compounds were assayed by HPLC and GLC. An untrained consumer panel was used to evaluate the flavour of cured beans.

502.308

Effect of Various Packaging Systems on Storage Life and Quality of Mushroom (*Agaricus bisporus*) during Storage Condition

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Mushrooms have a short postharvest shelf life compared to most vegetables, due to a very high metabolic activity and high water content, making them prone to microbial spoilage and to exhibit enzymatic browning. Various packaging systems was developed in our laboratory and evaluated for their suitability to extend storage life and improve the quality of mushroom. Fresh mushroom were packed in various packaging materials (Nano, Polypropylene, Ethylene scrubber+ Polypropylene). Mushroom were soaked for 1 min in hydrogen peroxide solution (6%) then packed and stored at 4 °C and 25 °C for 14 days. Ph, primary weight, secondary weight, colour, off odor, cap opening were determined at three days interval after storage for seven intervals. All treatments lose lower weight in comparison to control. Nano and polypropylene + ethylene scrubber packaging revealed significant reduction in Discoloration, browning. There are not pH reduction in polypropylene + ethylene scrubber and Nano packaging. Off odor wasn't produced in Polypropylene + ethylene scrubber packaging. Cap opening decreased significantly in Nano packaging. Storage at 25 °C accelerated, cap opening, pH reduction, browning and off odor. The result of this experiment shows that first polypropylene + ethylene scrubber then Nano are suitable packaging systems for mushroom storage.

S02.309

Shelf-Life Extension of Fresh Mushrooms (*Agaricus bisporus*) by Application of Hydrogen Peroxide and Browning Inhibitors

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The effects of different washing treatments combined with modified atmosphere packaging (MAP) on the quality and storage life of fresh mushrooms were determined. An experimental washing process for fresh mushrooms entailing immersion in H₂O₂ (6%), followed by application of different concentrations of anti-browning treatments involving citric acid and ascorbic acid was used. Whole fresh mushrooms were soaked for 1 min in hydrogen peroxide solution then citric acid(5%,8%,12%) or ascorbic acid(3%,6%,9%) solution then packed within polypropylene film and stored at 4 °C and 25 °C for 14 days. Ph, primary weight, secondary weight, colour, off odor, cap opening were determined at three days interval after storage for seven intervals. All treatments lose lower weight in comparison control. Citric acid (5%) and ascorbic acid (3%) treatments revealed significant reduction in browning, cap opening, there are not ph reduction in citric acid (5%) and ascorbic acid (3%) treatments. ascorbic acid (3%) produced the lowest off odor. But ascorbic acid (6%) caused the lowest browning during storage at 25 °C. Storage at 25 °C accelerated browning, cap Opening, ph reduction and off odor. The results of this experiment revealed that citric acid (5%) and ascorbic acid (3%) with hydrogen peroxide were suitable treatments for increasing storage life of mushroom when compared to control. The citric acid and ascorbic acid treatment had no deleterious effect on the sensory properties of sliced mushrooms.

S02.310

Shelf Life of *Solanum gilo* Fruits Affected by Ethylene and O₂ Absorbers

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This study evaluated the influence of temperature and polyvinyl chloride film (PVC) wrapping tray containing sachets of ethylene absorber KMnO₄ or oxygen absorber O-Buster (Oxyfree™ 504) on the shelf life of *Solanum gilo* Raddi (jiló) fruits stored at 5 °C. This fruit has a short postharvest shelf life due to fast yellowing, losing its commercial value. Mature green fruits were harvested and placed in polystyrene trays and wrapped with PVC film, comprising the following treatments: control tray wrapped only with PVC film; 1.0 g KMnO₄ sachet; 2.0 g KMnO₄ sachet; 3.0 g KMnO₄ sachet; 4.0 g KMnO₄ sachet and tray containing O-Buster sachet model FT-30. Accumulated weight loss reached an average of 7.3% after 14 days of storage. In all treatments, there was an increase of total soluble sugar content with a reciprocal decrease in starch content during the storage period of 14 days. Fruits from the control treatment had sharper decrease on total chlorophyll content through the storage period. Fruits wrapped with O-Buster absorber kept the fruit surface greener for longer period of time, followed closely by the trays with a 4.0 g KMnO₄ sachet. Chilling injury started to develop after three days at 5 °C, expect for the tray containing 4.0 g KMnO₄ or O-Buster sachets. Chilling symptoms during cold storage of the fruit included surface pitting, skin discoloration and browning. Fruits wrapped with PVC containing the O-Buster sachet maintained green colour and less chilling symptoms after being stored for 14 days.

S02.311

Cell Wall Modifications Following Cold Storage of Calcium-Treated 'Golden Reinders' Apples

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Firmness of apple (*Malus ×domestica* Borkh.) fruit depends largely on modifications in the cell wall structure of flesh tissue. Therefore, retardation of cell wall degradation throughout the marketing chain would improve value of fruit to consumers, as texture is one of the most important quality attributes of apples. In this work, 'Golden Reinders' apples harvested at commercial maturity were dipped in 2% (w/v) CaCl₂ and stored for 4 or 7 months at 1 °C and 92% RH under air. Cell wall composition and different cell wall-modifying enzyme activities were determined 0, 7 and 14 days after removal from storage in order to assess the effects of calcium treatment in fruit firmness and cell wall metabolism throughout the commercial life of produce. Multivariate analysis of data showed that firmness was strongly related to both the amount and the composition of cell wall material (CWM) in the flesh tissue. Regardless of storage period, CWM content was higher in CaCl₂-treated fruit. Concurrently, lessened pectin degradation was observed in treated apples, probably in relation to inhibited pectin methylesterase, polygalacturonase and pectate lyase activities. In consequence, firmness of treated apples was higher at the end of shelf life, with values above 44 N, the minimum value required for acceptable eating quality. Thus, applied calcium was an effective tool to maintain firmness of 'Golden Reinders' apples along 2 weeks subsequent to storage under cold air, even after long-term storage.

S02.312

Postharvest Quality of Mini Sweet Peppers as Affected by Several Types of Bulk Packaging

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The main goal of this research was to evaluate the efficacy of XF films for bulk packaging (2kg and 4 kg) in compared to microperforated PE (as control) on quality parameters and antioxidants activity on three type of mini sweet peppers (tinkerbell green, sweetbite orange and tinkerbell red) during 14 days storage at 7 °C and 3 d at 20 °C (shelf-life). Differences in atmosphere compositions developed in the three package types in spite of the same perforation level indicate that gas exchange properties of the packages were not solely dictated by perforation area, but were also affected by other factors, such as polymer nature, product weight and water condensation in the packaging material. The results show that packing pepper fruits in XF film (in bulk packaging- 2kg) resulted in the highest level of CO₂ and the highest-quality parameters. In all cultivars, PE films were significantly more effective in reducing weight loss and maintaining firmness fruit. Packaging in XF liners improved the better general appearance of the fruits, inhibited colour development, softening, and decay incidence, compared to the PE liner. In both bags, during two weeks storage on 7 °C, level of CO₂ did not exceed 2% because the bag was perforated, except during the shelf life (3days on 20 °C) when level of CO₂ was around 5% (XF film in bulk packaging with 2kg). The sweetbite orange fruits were observed very high susceptibility to percentages of decay and aggravation of physiological disorders in comparison with tinkerbell green and red fruit. After 2weeks storage at 7 °C + 3days shelf life on 20 °C total antioxidant activity slowly decreased in all cultivars, depend of film type and bulk packaging.

S02.313

Influence of Four Different Hydrothermal Treatments on Papaya Fruit

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Four postharvest hydrothermal treatments were applied on papaya fruit (*Carica papaya* L.) cv. Golden and the stress stimulated by the treatments was monitored by the ethylene (C₂H₄), carbon dioxide (CO₂) emission rates and fruit quality.

The postharvest hydrothermal treatment consisted in submerging alternately the fruits into two water baths, the first one with water at a temperature of 49 °C and the second at 12 °C. An increase in the emission rates of both gaseous species (C₂H₄ and CO₂) was observed as a response to the stress. Measurements of typical quality parameters as pulp firmness, pH, titratable acidity and total soluble solids were also carried out and correlated with the gases emission from the fruit.

S02.314

Differential Colour Development in Mature Green Tomatoes is Associated with Changes in the Antioxidant System After Cold or Heat Shock Treatment

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Cold shock treatment (CST) (0 °C, 3 h) and heat shock treatment (HST) (50 °C, 2 min) can cause variation in colour development in mature green tomatoes. To study the differential antioxidant system in mature green tomatoes after CST and HST, colour, malondialdehyde (MDA) and ascorbic acid (AsA) contents, as well as changes in antioxidant enzyme activities during storage at 20 °C and 10 °C were measured. CST accelerated colour change by 1 d at 20 °C and 3 d at 10 °C without chilling injury. Increase in colour development after CST differed from that observed in previous reports and may reflect higher MDA content, lower AsA content as well as lower superoxide dismutase (SOD) and peroxidase (POD) activities than controls during storage at both 20 °C and 10 °C. However, HST delayed colour development by 3 d at 20 °C and 5 d at 10 °C, decreasing MDA content under both storage temperatures. The activities of antioxidant enzymes, SOD and POD, with HST were higher than in controls during storage at 20 °C or 10 °C. These results suggest that CST and HST have the same effect on the antioxidant enzyme activities in mature green tomatoes at 20 °C or 10 °C storage, and imply that SOD and POD play important roles in the antioxidant system in mature green tomatoes after CST and HST when stored above 10 °C.

S02.315

Postharvest Shelf Life of Taro Rhizomes Affected by Storage Temperature and PVC Film

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Taro is a tropical rhizome crop with little information about the ideal condition for storage, contributing the losses observed during the commercialization. The use of plastic films and adequate temperature reduce the losses in many other fresh horticultural crops. This work had the goal to determine the effects of PVC film and temperature of storage on the postharvest of taro rhizomes. Plants of taro cultivar Japonês harvested after nine months of growth and the rhizomes were selected by size and a half placed in polystyrene trays covered with PCV film and the other half as controls. The trays with or without PCV film were stored at 5 °C, 12 °C and at room temperature for 126 days. The experiment was arranged in a complete random design, with three replicates containing six rhizomes each. At every 21 days it was analyzed the visual appearance, content of dry matter, starch, total soluble sugars (TSS), reducing sugars (RS) and non reducing sugars (NRS). The rhizomes stored at room temperature had acceptable visual quality for only 21 days after harvest with or without PVC film, showing high losses of fresh mass. At temperatures of 5 °C and 12 °C, the PVC film prolonged the visual quality above 21 days, with good quality up to 126 and 84 days, respectively. Although at 5 °C, there was reduction of starch and accumulation of TSS, in especial RS. The temperature of 12 °C was more effective in maintaining the visual appearance, which was able to inhibit the starch degradation and increase in TSS, being the more appropriated temperature for storage of taro rhizomes.

S02.316

Effect of 1-MCP Application on Postharvest Color and Quality Development of Apples ('Ildrød Pigeon')

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Color development and postharvest quality of the Danish apple cultivar 'Ildrød Pigeon' (IP) were investigated. IP is a small-fruited, red-colored cultivar with a characteristic aroma. It is harvested in mid-September, stored until early December and used for Christmas. Traditionally IP apples should be exposed to sun light after harvest for 8-10 days, in order to obtain a full cover of red over color. Nowadays apples can be treated with 1-MCP, an ethylene action inhibitor, which delays the ripening processes. 1-MCP is internationally becoming widely used and was registered in Denmark in 2008. Because light exposure and an optimal use of 1-MCP treatment might be conflicting, the first part of the current study investigated the effect of 1-MCP application and light exposure on post harvest anthocyanin synthesis. Bags were put on individual apples to disable light exposure while apples were on the trees treated with different nitrogen fertilizer levels. After harvest, lots of non-bagged and bagged apples were treated with 1-MCP. Subsets of 1-MCP treated and untreated apples were exposed to sun light for 7 days. Some of the untreated apples were treated with 1-MCP after the 7 days of light exposure. Blocking of ethylene action by 1-MCP might have an impact on the ripening processes, and therefore to apple quality development. The second part of the current study aimed to assess firmness, ethylene production, acidity and sugar content after a cold storage period depending on the timing of 1-MCP treatment and nitrogen fertilizer level.

S02.317

Effect of Pressure Precooling and Cold Room Precooling, Cold Storing on Quality of Sweet Corn

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Sweet corn cobs were precooled immediately after harvest using pressure cooler (PC) and cold room cooler (CR). Corn cobs without precooling served as control treatment. Both pressure precooled and room cooled corn cobs were stored under parallel and perpendicular orientations for 13 days at 0 °C. The quality attributes of sweet corn cobs were measured to assess the performances of pressure cooler and cold room cooler compared to non-cooling. Corn cobs precooled by pressure cooler reduced significantly the cooling time because the temperature of corn cobs were decreased using 6 hours by PC from 27.5 °C to 3.5 °C, while using 24 hours by CR from 27.5 °C to 4 °C. Other the other hand, pressure and cold room cooled sweet corn cobs kept a high standard of quality up to 13 days by conserving high total soluble solids and maintaining good quality index. During cold storage, the weight losses of sweet corn cobs increased gradually and the sugar contents and vitamin contents decreased gradually.

S02.318

The Effect of Salicylic Acid and Gibberellic Acid on Factors Affecting Ripening Time and Storage Life of Sweet Cherry cv. Mashhad

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Sweet cherry is a non climacteric fruit with capability of ethylene production during storage period. Factors that decrease ethylene production would increase its storage life. Important quality indices such as fruit color, weight and size, also could be improved by plant hormones application. In this research sweet

cherry fruits of Mashhad cv. was sprayed with different concentrations of Salicylic acid (0.5, 1, 2, and 3 mmol/l) and Gibberellic acid (0, 10, 20 and 30 ppm). Fruits were sprayed about three weeks before harvest when their color started to change from green to yellow. The experiment was performed in a completely randomized design with three replicates. The results showed that GA had less effect on decreasing ethylene production compared to SA, but did better on anthocyanine accumulation, fruit size and weight. GA treatment delayed fruit ripening but the color as an important ripening index, did not affect as ethylene did. During storage period the amount of anthocyanine in fruits increased due to hormone treatments whereas the ethylene production decreased compared to control fruits. The most important role of SA on sweet cherry post harvest condition is increasing phenolic compounds, antioxidants, fruit storage life, maintaining appearance quality and fruit stem green color as important quality indices.

S02.319

Seasonal Behavior and Aroma Volatiles Evolution in Passion Fruit After Harvest

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Fruits of the tropical and subtropical species passion fruit (*Passiflora edulis* Sims) comprise a unique and flavorful aroma. In Israel, the hybrid commercial cultivar Passion Dream (PD), is a cross between yellow and purple passion fruit. Generally, in Israel, passion fruit flowers twice a year and gives fruit twice a year in the summer and winter. In both seasons the fruit changes color, produces ethylene, and abscises so that ripe fruit is collected from the ground. In an ongoing breeding program we have developed additional lines with commercial potential. We identified a couple of lines, that changed color yet Remained on the Vine During the Winter (RVDWs). We show that for one of these lines (RVDW1), the fruit does not produce ethylene and displayed a non-climacteric character during the winter. The main change during storage is reduction in acidity in all lines except the RVDW1 line. The PD and all other climacteric lines had high levels of ethylene, ethyl and hexyl esters production. In the winter, fruit acidity in all lines was higher than in the summer. The RVDW1 line harvested in summer is less acidic and it produced ethylene leading to normal abscission, while in the winter it did not. The elevated ethylene production in the summer in RVDW1 resulted in higher ethyl and hexyl esters levels, in addition to production of methylated hexyl esters, probably because of the presence of S-adenosyl methionine (SAM) as methyl donor. Passion fruit has relatively high quantities of aroma volatiles including thioesters and Edulans, which contribute to its unique aroma. Cysteine and glutathione, which are the precursors for thioesters, comprise a relatively large amount in passion fruit juice as determined by Ellman's reagent. These high levels of free sulphhydryl (SH) content could be of health benefit to consumers.

S02.320

The Effect of Combination of Superatmospheric Oxygen and Heat Treatment on Postharvest Quality of Strawberry Fruit (*Fragaria xananassa* cv. Selva)

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An investigation was carried out to study the effect of heat treatment alone and in combination with superatmospheric oxygen on storage quality of strawberries. The factorial experiment was conducted using a randomized complete block design with three replications. Treatments included heat treatment at two levels (room temperature, 45 °C for 3h), cover in two levels (polyethylene and polyamide) and two different gas combinations (80% O₂+20% N₂ and Air). Fruits were stored at 0-2 °C and 90% Relative Humidity (RH) for up to 20 days followed by 24h at 25

°C and 70% (RH) to simulate market conditions. Samples were taken at 0, 5, 10, 15 and 20 days of storage. The results indicated that heat treatment application caused decrease in TA during storage. MAP significantly prevented weight loss and combination of two treatments was more effective in decay control. Neither heat treatment nor MAP affected ascorbic acid content during storage. A reduction in L* in heat treated fruit was observed however MAP except polyamide cover maintained fruit lightness. Air inside the packages along with polyethylene had led to induce red color development (a* value) of fruit while in combination with heat treatment avoided TSS increase. Polyamide caused sepal necrosis. However, MAP with air had not showed decrease in firmness whilst fruit softening in polyamide film with superatmospheric O₂ was maximum compared to controls and heat treated fruits.

S02.321

Package and Warm Water Treatment Affect the Low Temperature Storage Quality of Avocados

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Hall and choquette avocados were stored at 10 °C for 9 to 16 days until they were fully ripe. Ripe avocados were individually sealed in perforated polyethylene bags and packed in carton boxes followed by air stored at 1 °C. Fruits were sampled each week and analyzed the quality when the fruit recovered to room temperature. Quality parameters, including color of skin, color of flesh, and hardness of flesh, symptoms of chilling injury and decay of the fruits, were assessed objectively. The results showed that PE packed choquette avocados has longer storage limit than hall. Hall avocados entirely lose their commercial value after 3 weeks storage at 1 °C. Choquette avocados kept higher Hunter L value, lower Hunter a value and higher Hunter b value of flesh as compared to hall avocados during storage. No difference of the skin color was found between two varieties. Fruits were pretreated in 38 °C warm water for 30 min before ripening showed the best color of skin until the end of storage. Warm water pretreated avocado fruits also kept good color of flesh for 6 weeks stored at 1 °C.

S02.322

The Relationship of Suture Softening and Sugar Metabolism in Okubo Peach Fruit

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Ventral suture softening of peach reduces fruit quality and shortens the post-harvest period. In this study, we measured sucrose, glucose, fructose and sorbitol contents, and activity of sugar metabolism related enzymes activity containing acid invertase, neutral invertase, sucrose synthase, sucrose phosphate synthetase enzymes and sorbitol metabolism dehydrogenase which is a key enzyme in sorbitol metabolism (SDH) and sorbitol oxidase (SOX) in suture site of softening fruit and normal fruit at different developmental stages of peach cv. Dajiubao (*Prunus persica* L. Batch 'Okubo'). In the same time, we also analyzed the relationship of sugar accumulation and enzyme activity between the softening fruit and normal fruit. The results showed that sugar metabolism is one of the important factors that affected peach suture softening ;the suture of softening fruit was fast-growing at pit hardening stage and sugar metabolism and related enzyme activity were much stronger than that in the normal fruit, monosaccharide metabolism makes a key role in this stage, which is mainly regulated by neutral invertase. When in the stage III of fruit development, the process of sugar metabolism of softening fruit is much faster than that of normal fruit, in addition, in the early stage III, sugar metabolism in softening fruit is strong following abundant sucrose synthesized quickly. While in the later of this stage, the sugar accumulation has been reducing and the sugar content drops significantly in softening fruit, but it was not in normal fruit. It was seen that suture site begin softening while other part of fruit is immature. So we can conclude that sugar metabolism in disorder caused the suture softening in advance.

502.323

Effect of Ethanol and Hot Water on Postharvest Ripening of Persimmon

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Most of the Japanese persimmon fruits are not consumable at harvest due to firmness and astringency. In this research the effects of hot water treatment (45, 50, 55 and 60 °C) for 15 and 30 min and ethanol at concentration of 38% for 5 min on postharvest ripening and some physico-chemical properties of persimmon fruits were evaluated. Ripening dates of treated fruits were different. At ripening stage, weight loss increased in treated fruits. Firmness was lower in fruits treated with hot water at 45 °C and ethanol 38% than others. Hot water treatment at temperatures higher than 45 °C decreased total soluble solids (TSS). Total phenolic content (TPC) was decreased by temperatures higher than 55 °C.

502.324

Quality Oriented Breeding Using Sensory Attributes in Melon: The Case of Climacteric and Non-Climacteric Near-Isogenic Lines Obtained from Non-Climacteric Parents

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Sensory attributes of near-isogenic lines of melon derived from climacteric a near-isogenic line with introgression in linkage group III and others of the Korean accession PI 161375 (SC) in the genetic background of the parental line 'Piel de sapo' were studied. The objective of this study was to obtain information about the location of quantitative trait loci (QTLs) responsible of sensory traits evaluated at harvest by melon consumers. This information allows the development of new varieties in the future by transferring such QTLs to elite cultivars. The NILs with most pronounced climacteric behavior were clearly separated from the non-climacteric ones by triangle test. The sensory perception evaluated by consumers of different climacteric and non-climacteric NILs were studied using different techniques of multivariate statistics. Overall, taste and overall quality of the fruit were highly correlated. The climacteric NILs had higher aroma scores than PS, but lower texture, taste and overall quality scores, which was related to the different aroma profile of the NILs compared with the traditional PS, and to the softening induced by the climacteric behavior. Some of the multivariate statistics such as linear discriminant analysis or random forest analysis were particularly useful to discriminate NILs by climacteric behaviour.

502.325

Cold Treatments Do Not Prevent Blockage of Ripening in Conference Pears Treated with 1-MCP

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The application of 1-methylcyclopropene (1-MCP) in 'Conference' pears is problematic since the effect of the treatment often persists and the ripening ability is not recovered after a period of storage. To verify the determining factors for this problem, we tested the application of 1-MCP treatment in three different orchards at three harvest dates. Control and treated fruit (300 ppb 1-MCP) was stored in air at -0.5 °C during 3.5 months. After cold storage, fruit was kept for a shelf life period of 11 days at 20 °C. Firmness and the ethylene metabolism (ethylene and ACC production, ACS and ACO activity) were analysed. To avoid blockage of the ripening process in the fruit treated with 1-MCP and assuming that most of the winter varieties of pears require a cold period to induce their normal ripening capacity, we tested the effect of exposure to different times (7 or 14 days) at low

temperatures combined with 7 hours at room temperature (20 °C) immediately after harvest and before the 1-MCP treatment (300 ppb), thus presumably stimulating the production of endogenous ethylene and re-induce ripening. The 1-MCP treatment completely blocked the ripening in pears from the three orchards and harvest dates. During shelf life, control fruit softened whereas treated fruit did not, irrespective of the harvest date and orchard. Normal climacteric ethylene production was observed for all control fruit and total inhibition for treated fruit. Only for one orchard, a minor recuperation of ethylene production was observed at the latest harvest data. ACS and ACO activity and ACC levels were higher for the control fruit but there was no difference in ACC levels between orchards and harvest dates. The blockage of the ripening was not reversed with the cold treatments tested.

502.326

The Effect of Passive Modified Atmosphere Packaging on Storage Life and Quality of 'Takdane Mashhad' Sweet Cherry

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Fruit of important Iranian sweet cherry 'Takdane Mashhad' were packed into two different types of bags (low density polyethylene and polypropylene) as passive modified atmosphere packages and then stored in cold storage at 0 °C for 9 weeks. In addition to two packaging treatments, fruits with no packaging were used as control. Sampling was carried out each week. Results showed that weight loss was significantly higher in controls during storage but it was negligible in both bags. Fruit spoilage was increased steadily during storage period in fruits of controls and PP bags in contrast to LDPE bags, spoilage in LDPE bags was very low. Fruit firmness decreased during storage period but there were no significant differences between treatments in terms of firmness. Titrable acidity (TA) and TSS declined consistently over the storage period. Fruit stems remained green 65 days after storage in all treatments, and significant differences observed between control and the two packages. Acceptability remained high for 4-6 weeks of storage but decreased dramatically thereafter.

502.327

Effect of N₂ Treatment on Quality of Chinese Bayberry Fruit during Storage

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To investigate the effects of 100% pure N₂ treatment on quality of Chinese bayberry fruit during storage. The results showed that Chinese bayberry were exposed in pure N₂ for between 12h and 16h respiration rate and ethylene production rate were inhibited, delayed the decrease in titratable acidity and total carbohydrate contents but no obvious change in total soluble solids, reducing sugar and firmness of Chinese bayberry. The N₂ treatment significantly delayed the increased, though the membrane permeability was increased considerably with storage time. It also markedly inhibited in total anthocyanin and malondialdehyde (MDA) content, and maintained a high ascorbic acid content. The primary question is decay in Chinese bayberry during storage, N₂ treatment significantly reduced fruit decay for over 12h, but the Chinese bayberry were exposed in pure N₂ for over 24h, the fruit flavor will be changed because the production of not good flavour component. Conclusion: 100% N₂ treatment maintained quality in Chinese bayberry for between 12h and 16h.

502.328

Effect of Low Temperature on Quality and Physiological Changes in the Antioxidant System of Walnut (*Carya cathayensis* Sarg.) during Storage

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Walnut (*Carya cathayensis* Sarg.) were stored at 25±1 °C and 10±1 °C for 6 months and the effect of temperature on quality and physiological changes in the antioxidant system of walnut was investigated. The acid value and peroxide value of the oil extracted from the walnuts stored at 25±1 °C. were higher than the walnuts stored at 10±1 °C. Temperatures of 25±1 °C also increased MDA levels and superoxide anion generation in the walnuts. In contrast, activities of SOD, CAT and POD were higher in the walnuts stored at 10±1 °C during the storage. The results showed that the cold storage delayed lipid oxidation and kept the higher enzymatic antioxidant system of the walnuts.

S02.329

Mechanical Injury Size as a Determinant of the Tomato Fruit Respiration

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The agricultural losses can be defined as a reduction in the nutritional value of the product, quality or commercial value. Among the variables involved in mechanical losses, one that deserves study is the size of mechanical injury. To study the effect of the injury size were evaluated tomatoes healthy variety "Pizzadoro" (*Lycopersicon esculentum* Mill.) harvested mature, over 90% of the red. The selected fruits were sanitized, and divided into lots (six treatments and control). Each tomato was subjected to an injury in the equatorial region, with a pointed stainless rod to a depth of 5mm. The lesions had the following diameters: 0.4 mm, 0.8 mm, 1.5 mm, 3.5 mm, 6.5 mm and 12.2 mm. The respiration during storage at 25 ± 3 °C was measured with an infrared gas analyzer open circuit during eight days. Samples of 3 mL of air were injected to measure respiration in accordance with the increase in CO₂ concentration inside a glass of 900 mL, where the fruits remained closed for 60 minutes during the measurement period. Was used a randomized split plot design with five replications and subjected to analysis of variance. The treatment means were submitted to regression analysis and the comparisons were made by Tukey test (** <0.01). Respiration decreased gradually in all fruits, except in those with lesions larger than 3.5 mm. The typical decline in post-climacteric respiration was clearly interrupted in the fruits that received strong mechanical injuries. With this there was a second respiratory peak, starting three days after 12,2 mm injuries and five days after injury to the fruits of injured 6.5mm. Smaller injuries caused barely significant increase in the respiration rate and were not strong enough to modify the tail typical climacteric ripening.

S02.330

Preventing Pericarp Browning of Lychee with Hydrochloric Acid

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Lychee fruits (*Litchi chinensis* Sonn.) deteriorate rapidly once harvested, with pericarp browning being the most visible symptom. This study assessed the effects of immersion in different concentrations of hydrochloric acid (HCl) on pericarp color retention and postharvest conservation of lychees. 'Bengal' lychees were harvested with pericarp completely red and immersed for two minutes in HCl at concentrations of 0, 0.25, 0.5, 1 and 2 N. After the treatments, fruits were packed in polystyrene trays and covered with polyvinyl chloride film (PVC). The trays were stored in cold chamber at 10 ± 0.9 °C and 90 ± 5% RH. The fruits were assessed every 4 days over a period of 24 days. After 24 days of storage, fruits of all treatments showed weight loss of around 4.5%. Titratable acidity and soluble solids were reduced similarly in HCl-treated and untreated fruits. By the 16th day of storage, fruits treated with 2 N HCl showed non-significant changes in pericarp color (Hue angle and ΔE) in comparison with the harvest day. These fruits remained without visually perceptible change in color up to 24 days of

storage. Pericarp darkening began on the 4th day of storage in fruits untreated and treated with 0.25 and 0.5 N of HCl. At 24 days of storage, the mean loss of ascorbic acid in the pulp was 38% in fruits treated with 1 and 2 N HCl and 70% in fruits untreated or treated with 0.5 and 0.25 N HCl. The concentration of 1 N HCl kept the fruits in conditions for consumption for 12 days, and 2 N HCl for 24 days.

S02.331

Ripening of 'Ubá' Mango Using Ethylene and Calcium Carbide

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'Ubá' mango fruit is very appreciated in Brazil for juice production. Physiologically mature 'Ubá' mangoes were treated with ethylene or calcium carbide (CaC₂) aiming at accelerating and uniformizing fruit ripening. Fruits with mean weight of 133.8 ± 1.9 g were treated with concentrations of 0, 20, 40, 80 and 160 g CaC₂/chamber m³ and 0, 50, 100, 200 and 400 mL of ethylene/chamber m³, in chambers at 18.1 ± 0.7 °C and 90 ± 3% RH, for 24 h. After the treatment, the fruits were kept under the same conditions of temperature and RH, and were evaluated at 0, 1, 3, 6, 9, 12 and 15 days of storage. Ethylene and CaC₂ increased mass loss of the fruits. Mangoes treated with CaC₂ showed the respiratory climacteric peak at 3, 6, 9, 9 and 12 days of storage for the concentrations 160, 80, 40, 20 and 0 g/m³, respectively. Fruits treated with ethylene showed the peak at 3, 3, 6, 6 and 12 days of storage for the concentrations 400, 200, 100, 50 and 0 mL/m³, respectively. All concentrations of CaC₂ and ethylene accelerated the loss of firmness, the increase of soluble solids and carotenoids, the reduction of acidity and the change in color of skin and pulp. However, these products also increased electrolyte leakage and decreased ascorbic acid content. Fruits treated with ethylene showed sharper firmness loss compared with fruits treated with CaC₂. On the other hand, solute leakage was higher in fruits treated with CaC₂. Soluble solids content increased with increasing concentrations of CaC₂ and ethylene. The concentrations of 20 g of CaC₂ and 50 mL of ethylene per chamber m³ were sufficient to accelerate and uniformize ripening of 'Ubá' mango.

S02.332

The Study on the Use of Natural Compound, Gama, UV-C Radiation and Microwave Treatment on the Extending the Shelf Life of Mushrooms (*Agaricus bisporus*)

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In this experiment the effect of different treatments that contain mucilage of two medicinal plants include: *Malva sylvestris* (1%, 2% and 5%W/V), *Plantago psyllium* (0.5%,1%,2% W/V). Also the use of Gama radiation, contain 2 treatment ways, face to face to the source of Gama radiation with intensity of 15 microcurie during 1 hour and 2 hours, U.V-C radiation (5, 10, 15 Seconds) and microwave treatment (with power of 1000 W and 2450MHz) during 5 Seconds has been done and stored in refrigerator at 4 °C. This experiment was done on complete blocks design with 14 treatments and 3 repetitions. After 36 days, change in weight, shriving percent, color change, cap and stem disease percent, the percent of the cap opening and cap texture were measured. Then the consumer acceptance tested with 10 panelists. Result demonstrated that the highest shriving percent was detected in *Psyllium* mucilage (1%) and the lowest one in Gama radiation (1h). About color change the highest browning Was detected in Marshmallow mucilage (1%) and the lowest change in color was observed in U.V-C 15s. The lowest cap disease observed in U.V-C treatment at 15s and the highest one in Marshmallow mucilage (1%). with concentration in stem disease in section, the highest stem disease detected in

Psyllium mucilage (2%) and the lowest one in Marshmallow mucilage treatment (2%). In cap opening characteristic test, the lowest opening observed in U.V-C at 5s and the highest one detected in control treatment. The highest consumer acceptance was given to U.V-C treatment in 5s observed in GAMA radiation (1h) and marshmallow (0.5%). Regarding to weight loss which was being measured, the most weight loss was in U.V-C treatment (15s) and the highest weight loss was in *Psyllium* mucilage treatments (2%). The best treatment according to the mushroom maintenance was 15s U.V-C treatment.

S02.333

Effect of 1-MCP and Temperature on 'Songold' Plum Postharvest Quality: (1) After Refrigeration

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Non-uniform fruit colour within export consignments of plums compromises retailer and consumer satisfaction and therefore profitable marketing. This experiment was conducted to evaluate the effect of 1-methylcyclopropene (1-MCP) treatment and temperature on 'Songold' plum quality after refrigeration in order to achieve uniformity of fruit ripening and reduce energy expenses. *Prunus salicina* Lindl. cv. Songold, harvested at commercial maturity, were treated with SmartFresh™ (3.33% of 1-MCP) and submitted to three different storage conditions with 95% relative humidity: 0 °C (SF0), 8 °C (SF8), and 10 days at 0 °C, followed by 15 days at 8 °C and then 5 and 25 days at 0 °C to reach 30 and 50 days of storage, respectively (TT15). Untreated fruit stored at 0 °C (C0) and 8 °C (C8) were used as control. Skin colour, weight loss, flesh firmness, soluble solids content and titratable acidity were assessed at harvest and after 30 and 50 days of cold storage. After 50 days of cold storage, fruit exhibited their characteristic colour changing from green-yellow (SF0, C0 and TT15) to yellow-orange (SF8 and C8). Regarding flesh firmness, 1-MCP treated fruit (SF0, TT15 and SF8) and C0 fruit were "ready to buy" (18-25 N), while C8 plums were too soft (< 5 N) to be commercialized. Neither 1-MCP nor temperature affected soluble solids content and titratable acidity. TT15 and SF0 were the most effective treatments in maintaining fruit quality, and SF8 and C0 were equally effective in delaying the loss of weight and firmness; however TT15 and SF8 slightly improved colour uniformity among fruit. Moreover, TT15 and SF8 treatments would represent an energy saving in packinghouses.

S02.334

Post-Harvest Conservation of 'Paluma' Guavas in Two Maturation Stages under Two Temperatures of Storage

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This work aimed to establish the importance of maturation stage and the use of refrigeration, for the conservation of Paluma guavas. Fruit in mature and ripe stage were stored under ambient condition (21 °C and 85%RH) and 10 °C (85%UR). The fruit were evaluated for weight loss, appearance, rotting evolution, color of peel and pulp, pulp resistance, soluble solids, titratable acidity and ascorbic acid content. The fruit stored at 21 °C showed higher intensity of weight loss than those stored at 10°C. Mature guavas at 21 °C and 85% RH preserved its quality for 6 days, but at 10 °C and 85% RH, the preservation period increased to 15 days. Ripe fruit were preserved for 4 days at 21 °C, which was enlarged with refrigeration to 6 days. Mature fruit, at 21 °C, showed rotting in 6 days, while under storage at 10 °C decay happened in 18 days and mature in 9 days. The peel color of mature fruits, at 21 °C, showed increasing values of luminosity, indicating that its color became lighter and at 10 °C it showed constant values until the end of storage. The reduction in the values of hue angle indicates that mature fruits, kept at 21 °C, quickly

changed color from green to yellow. The pulp resistance of mature fruit reduced during storage, as a result of maturation process. In ripe fruits such reduction occurred more slowly, since they were less resistant. The color of guava's pulp became intense red for mature fruits. The soluble solids content were lower in ripe fruit at 21 °C, while in mature fruits, at 1 °C, it increased. The titratable acidity of the pulp showed an increase in fruits stored under refrigeration at 10 °C. The fruits kept at 21 °C and the mature kept at 10 °C showed an increased level of ascorbic acid. The ripe fruit at 10 °C maintained these levels.

S02.335

Effect of 1-Methylcyclopropene and/or Calcium Chloride Treatments on Storage Life and Quality Maintenance of Lingwu Jujube Fruit

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Lingwu Long jujube (*Zizyphus jujuba* cv. Mill) fruits were harvested at mature-green stages and then treated with 1.0 μLxL⁻¹ 1-methylcyclopropene (1-MCP), 1.0% CaCl₂ or their combination. All treatments were stored at room temperature (22±1 °C) and 80-90% relative humidity (RH) up for 15 days. Results indicated that 1.0 μLxL⁻¹, 1.0% CaCl₂ or their combination were effective in terms of senescence inhibition during storage and compared to control, the storage life was extended by 6, 4 and 9 days, respectively. 1-MCP and CaCl₂ treatment had a combined effect on the inhibition of ethylene production of Lingwu Long jujube fruit and on its microbial counts decrease as well. The combination of 1-MCP and CaCl₂ significantly inhibited polygalacturonase (PG) and polyphenoloxidase (PPO) activities. It also maintained higher concentrations of titratable acid and ascorbic acid.

S02.336

Effect of Ethanol Dipping on Decay and Postharvest Quality of Table Grapes during Cold Storage

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Grapes var. 'Kyoho' were harvested twice in 2007-2008 for two years from commercial orchards in S/Korea. After grading of 400-500g weight per each berry, freshly harvested table grapes were immersed for 10s in water (control), 10%, 20%, 30%, 40%, 50%, 60%, 70%, and 80% ethanol at 20 °C. After treatment the fruit were promptly dried to prevent berry and then stored at 0-0.5 °C (90-95% RH) for 60 days. The 50% ethanol maintained higher levels of firmness and bunch appearance after 60 days of storage at 0-0.5 °C than other concentrations of ethanol, while fruit after immersion in water at these temperatures softened rapidly. Some physiological quality parameters such as titratable acids, respiration, and ethylene were not impaired by ethanol dipping in 40, 50, 60%, which resulted in inhibition of berry decay. Immersion of 'Kyoho' grapes in 50% ethanol reduced the decay of berries similarly and by about 30% in comparison with that of control.

S02.337

Control of Onion Sprouting Using Natural Compounds and Heat Treatment

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The aim of this study is to evaluate onion sprouting behavior after using natural compounds and heat treatment for extending onion storage life. "White" culti-

var was used and the effect of burning basal plate (15, 30, 45 and 60s 100 °C), submerging in essential oils (EO) suspension of Black zira (*Bunium persicum*) and Clove (*Eugenia caryophyllata*) at 500 and 1000 ppm or fumigation with *Bunium persicum* essential oils (0, 25, 50, 100 and 150 ppm) was studied. The experiments were conducted in glass jar (3 L) during 50 days in room temperature (25±1 °C). Bulb weight, sprout length, fresh and dry weight of sprout, weight loss percentage, infected bulb and onion quality of the treated bulb were determined initially and after storage time. Results indicated that the lowest weight loss (3%/w) occurred in fumigation method and the highest one (60%/w) was observed in 45s burning. The growth of sprout was the highest (21cm) in submerging method in 500ppm Clove EO whereas 60s burning bulbs produced the lowest (1cm) sprout length. Fresh and dry weight of sprout/bulb was higher in 30s burning than 45s. The best quality of onion obtained in the treatment of 500 ppm Black zira EO by the method of submerging (21.67%) in contrary to fumigation treatments (85.23%).

S02.338

Effect of 1-MCP and Temperature on 'Songold' Plum Postharvest Quality: (2) After Shelf-Life

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The aim of this study was to evaluate the effect of temperature higher than the usual refrigeration temperatures on 'Songold' plums treated with 1-MCP, in order to save energy and to achieve uniformity of fruit ripening. For this purpose plums (*Prunus salicina* Lind. 'Songold'), harvested at commercial maturity, were treated with 600 ppb of 1-MCP (SmartFresh®, 3.33% of 1-MCP) and stored for 30 and 50 days under three different conditions with 95% relative humidity: 0 °C (SF0), 8 °C (SF8), and 10 days at 0 °C, followed by 15 days at 8 °C and then 5 and 25 days at 0 °C to reach 30 and 50 days of storage, respectively (TT15). Not 1-MCP treated plums were stored at 0 °C (C0) and 8 °C (C8) and used as control. Plum samples were removed from cold storage after 30 and 50 days and kept for 5 days at 20 °C (shelf-life). After that, they were analyzed for weight loss, flesh firmness, soluble solids content, titratable acidity and skin colour. 1-MCP treatment did not affect weight losses but it was effective in retaining pulp firmness. After 30 days plus shelf-life, 1-MCP treated fruit stored at 0 °C showed a flesh firmness "ready to buy", while SF8 were "ready to eat" and control plums were too soft. TT15 fruit exhibited the highest soluble solids content and acidity after 50 days of storage. 1-MCP helped to maintain characteristic fruit colour, no matter temperature, up to 30 days storage plus shelf-life, and after 50 days TT15 and SF0 fruit yet exhibited an acceptable colour. At 30 days of cold storage at 8 °C plus 5 days of shelf-life, 1-MCP allowed maintaining plum quality assuming an energy saving for packinghouses. At the end of storage only SF0 and TT15 fruit were still commercial.

S02.339

Short Hypobaric Treatment in Combination with 1-Methylecyclopropene Enhanced Strawberry Fruits Quality during Storage

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Strawberry (*Fragaria xananassa*) is a tasteful and fragrant fruit that has great nutritional value. However, the storage life of this beneficial fruit is about five days in 0 °C. Ethylene is one of the causes of the acceleration in the ripening and loss of the fruit after harvest. Thus, anti ethylene substances could increase storage life of fruits. 1-Methylecyclopropene (1-MCP) is a material which prevents the ethylene from reacting in quite low concentration and is easily consumed and does not exert

negative effects on the health of human being and the environments. The hypobaric storage is another useful method which preserving horticultural products with decreasing the density of the CO₂, O₂ and ethylene surrounding the fruits through a decrease in air ripening of the fruits. Therefore, the experiment was carried out in order to examine the effect of the provision of 1-MCP at concentration of 1 µL×L⁻¹ at 5 °C (for 16 hours) and low pressure air of about 0.2 atmosphere (for 2 hours) on the optical and physicochemical characteristics of the "Camarossa" strawberries during storage in cold storage (1 °C). According to the finding of the research, the highest firmness of fruits (7.95N) was seen in combined treatment (1-MCP and low pressure) which had significant difference with 1-MCP treatment alone, but in other attributes including TSS, TA, vitamin C, pH, relative anthocyanin and TSS/TA ratio there was no significant differences between treatments. The results obtained showed that positive effect of 1 µL×L⁻¹ MCP in combination with low pressure on the exterior appearance and physicochemical characteristics of the fruits was more than the low pressure air or 1-MCP alone.

S02.340

1-MCP Treatment Improved Quality and Shelf Life of Strawberry Fruits

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Strawberries are categorize among some of the most easily perishable fruits in the world although have great nutritional value. Ethylene is one of the causes of the acceleration in the ripening and loss of the fruit after harvest. Thus, anti ethylene substances could increase storage life of fruits. The discovery and use of 1-Methylecyclopropene (1-MCP) has provided a suitable opportunity for scientists and the use of 1-MCP in most non climacteric fruits has postponed any changes in them. Therefore, experiment was carried out to determine the effects of 1-methylecyclopropane (1-MCP) on shelf life and quality attributes of fresh strawberries. Fully ripe fruits cv. "Camarossa" were treated with 1-MCP at concentrations of 0 (control), 0.25, 0.5, 0.75 and 1 µL×L⁻¹ for 16 h at 5 °C. They were then kept individually in plastic boxes for 4 days in the dark at 20 °C and ca. 70 % relative humidity. 1-MCP treatment at concentration 0.75 µL×L⁻¹ tended to control fruit decay, maintain relative anthocyanine, TSS/TA and juice pH after 4 days at 20 °C. Fruit firmness, vitamin C, total soluble solid (TSS) and total acid (TA) was supper in fruits treated with 1-MCP (1 µL×L⁻¹) compared to the control. 1-MCP treated fruits were more acceptable owing to their better appearance. Based on the results, for cv. "Camarossa" the best results were found with 1 µL×L⁻¹ 1-MCP in respect of prolonging shelf life.

S02.341

Degreening of 'Satsuma Okitsu' Tangerine

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Fruit of 'Satsuma Okitsu' tangerine have similar aspects to 'Ponkan', with maturation period starting in January, and being able to supply the Brazilian market during off-season. Fruits of this cultivar have to be harvested with green peel, which is not well accepted by the market. Having this obstacle, this study aimed to evaluate the degreening of 'Satsuma Okitsu' tangerine using ethephon (2-chloroethyl phosphonic acid). The fruits were harvested with the stem end and when it reached the relation soluble solids / acidity around 7 - 19. They were immediately transported to the laboratory where it were selected to standardize them by color, size and absence of injuries. After selection, the fruits were treated with the Imazalil fungicide (200 mL×100 L⁻¹) for two minutes and after 24 hours these fruits were dipped in different concentrations of ethephon as Ethrel 240 (control, 250 ppm, 500 ppm and 1000 ppm). The fruits were analyzed every 3 days during 9 days of storage, by appearance, weight loss, hind color, soluble solids, acidity and ascorbic acid content. The experiment was conducted in a completely randomized design,

arranged in a factorial design. The results showed that the different doses reduced significantly ascorbic acid content, due to the effect of exogenous ethylene which accelerate the aging process of these fruits. It was observed that the 500 ppm Ethrel treatment provided the best flavedo or hind degreening which made these fruits turn orange with greater intensity. The fruits treated with 500 ppm had smaller weight loss, and presented 6 days of shelf- life at 18 °C.

502.342

Role of Brassinosteroids in Mango Fruit Ripening

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Brassinosteroids (BRs) are steroidal plant hormones and their implications in climacteric fruit ripening are poorly understood. Different concentrations (0, 30, 45 and 60 ng·g⁻¹ FW) of epibrassinosteroids (EBr) and 90 ng·g⁻¹ FW brassinazole (Brz) - an inhibitor of BRs biosynthesis were exogenously applied to hard mature green mango to investigate their role in climacteric fruit ripening. Following the treatments, fruit were allowed to ripen at ambient temperature (21 ± 1 °C). Exogenous application of BRs advanced climacteric ethylene production and respiration rate, whilst the exogenous application of Brz was not effective in delaying climacteric ethylene production and respiration rate during ripening. In addition, BRs application resulted in increased fruit firmness losses and improved skin colour during fruit ripening. However, at eating soft ripe stage, the fruit firmness did not differ significantly among treatments and control. The texture parameters of ripe fruit including cohesiveness, springiness, chewiness and adhesiveness were significantly influenced by the different concentrations of EBr than control but Brz-treated fruit exhibited higher values of these parameters than control and EBr treatments. The exogenous application of BRs and its inhibitor did not significantly affected SSC, TA, SSC:TA ratio and total sugars. Our preliminary results show that BRs did not play any pivotal role in mango fruit ripening.

502.343

Effects of Cover Film on the Physiological Indices Related Lipid Peroxidation of Post-Harvest 'Ultrared Del' Apple Fruit

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The aim of this paper was to determine the physiological changes of postharvest in 'Ultrared Del' apple fruit skin and the flesh of fruit by covering film, and the uncovering film was as control. The superoxide dismutase (SOD) and catalase (CAT) activities, the malondialdehyde (MDA) content a production of lipid peroxidation, the saturated and unsaturated fatty acid content and the index of the unsaturated fatty acid (IUFA) were measured. The results indicated as follows. Under same condition of storage, SOD and CAT activities, the unsaturated fatty acid content and the IUFA in fruit skin were higher than those in the flesh of fruit. The MDA content and the saturated fatty acid content were less than those in the flesh of fruit. During the storage period from 0-50 days, the SOD activities in the fruit skin and flesh of fruit increased from 0 to 40 days and then decreased, but SOD activity in the flesh of fruit under film-uncovering decreased after the storage 30 days. The CAT activity kept an increasing trend during this period. The MDA content increased slightly before the storage 20 days and then decreased significantly. During postharvest 50 days, the saturated fatty acid decreased and the unsaturated fatty acid content and IUFA increased especially after postharvest 20 days. In flesh, there were significant relationships between SOD activity, CAT activity and MDA content, between MDA content, the saturated and unsaturated acid content, and the IUFA with storage. The covering film on the orchard heightened effectively the SOD activity, CAT activity and the unsaturated fatty acid content and the IUFA, and reduced significantly the MDA content, the saturated fatty acid content in apple fruit. It could inhibit from senescence of 'Ultrared Del' apple fruit.

502.344

A Polyphenol Oxidase Gene Cloning and Expression in 'Chili' Pear during Fruit Development and Storage

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Polyphenol oxidase (PPO) is known to be responsible for the oxidative browning and the postharvest losses in many fruit and vegetables (Thipyapong *et al.*, 2007). It is critical to understand the mechanisms underlying the PPO gene expression pattern during the fruit development and storage, in order to develop strategies that would improve storage techniques. In the present research, the PPO gene expression pattern in a Chinese pear (*Pyrus bretschneideri* Rehd. cv. Chili) was investigated during the fruit development and storage. A cDNA fragment encoding PPO gene, i.e. Pc-PPO1 was isolated from the mature fruit of 'Chili' by RT-PCR amplification using a pair of degenerate primers. The homology between Pc-PPO1 from Chinese pear 'Chili' and Pc-PPO from Japanese pear was 99% in nucleotide sequence and 98% in amino acid sequence. The gene expression of Pc-PPO1 was examined by semi-quantitative PCR and real-time PCR. The results showed that during the fruit development, the Pc-PPO1 gene expressed extremely high 50 d after anthesis, and then decreased during the fruit development. Pc-PPO1 mRNA accumulated during the storage, and showed a peak 14 d after harvest. However, the Pc-PPO1 mRNA level 14 d after fruit harvest was much lower than the mRNA level 50 d after anthesis. The expression pattern of Pc-PPO1 was consistent with the PPO enzyme activity, with a high level 50 d after anthesis and a peak 14 d after harvest. Furthermore, Pc-PPO1 mRNA also showed a pattern similar to ethylene production rate (data not shown), which proved a role in the fruit senescence. More studies on the browning mechanisms of 'Chili' pear during fruit development and storage are being conducted for a better understanding of the pear fruit senescence.

502.345

Optimisation of the Postharvest Chain for Whole and Fresh-Cut Cauliflower

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Traditional storage regimes allow preserving the cauliflower up to one month. Extending the storage by the use of controlled atmospheres and by preparing a fresh-cut product can lead to better utilisation of the crop that can be especially useful in times of excess supply. The main quality problems occurring during cauliflower storage are: wilting, browning, yellowing of leaves, and postharvest diseases. The aim of this project was to develop the best postharvest practice possible to utilise the Calahorra Cauliflower grown under a Protected Geographical Indication. Firstly the cold chain from harvest till market was optimised by testing different pre-cooling methods, storage atmospheres and active films for packaging of individual heads to preserve quality and reduce microbial spoilage. Secondly, the fresh-cut processing was optimised by testing different antioxidant and antimicrobial treatments and optimising the packaging method by using active films with different active compounds and permeability and MAP to maintain the prime sensory quality and ensure microbiological safety during shelf life. Moreover, the aptitude of different varieties for modified atmosphere storage and processing for fresh-cuts was tested. The quality of cauliflower heads was judged by their compactness, colour of the curd, lack of granularity, state of leaves (turgidity and colour), dry matter content and firmness of the stalk. Microbiological safety was studied determining total bacterial and total fungal counts. Fresh-cut cauliflower quality was evaluated by the colour of florets and cut surfaces, firmness of the stem, dry matter content and total bacterial and fungal count. Rapid pre-cooling proved to be very important to maintain quality during storage especially for the late varieties. Individual packaging of the heads into an active foil with suitable permeability has increased the storage life of the product by improving microbial safety. Antimicrobial treatments as well as active foils have extended shelf life of the fresh-cut product.

S02.346

Use of 1-MCP to Extend the Postharvest Life of Greenhouse Caramba Tomatoes at Two Different Stages of Ripeness

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Caramba is a tasty tomato salad variety (*Lycopersicon esculentum* Mill., cv. Caramba) very appreciated in Spain, but its perishability (4-5 days of postharvest life) is a serious limitation to the expansion of its market. We have measured the sensory and analytical quality parameters of this variety to evaluate the effect of 1-methylcyclopropene (1-MCP) on greenhouse tomatoes. Commercially grown tomatoes were harvested at two different maturity stages according to the USDA standard tomato colour classification chart (pink and light red). Each batch was treated with 650 nL/L 1-MCP through 24 h at 12 °C and subsequently stored at 12.5 °C. The samples were analyzed on days 0, 7, and 12 with a subsequent shelf-life period of 5 days at 20 °C in each case. Maximum postharvest life of pink tomatoes was established at 7 days at 12.5 °C and 5 days at 20 °C. Ripening was delayed in MCP-treated pink fruits, but the treatment irreversibly inhibited the change in colour so tomatoes do not ever reach the optimal postharvest quality. In the case of light red tomatoes, 1-MCP reduced the respiratory rate and the ethylene production and minimized weight losses. The treatment resulted in a slight slowdown in colour (a*) change and had no effect on fruit softening or ripening index (SSC/TA). Postharvest life of non treated, light red tomatoes was limited to 5 days at 20 °C whereas the MCP treated fruit maintained its quality after 7 days at 12.5 °C and a subsequent period at 5 days at 20 °C.

S02.347

Potential Application of Salicylic Acid Treatments on Postharvest Horticultural Products

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The effects of salicylic acid (SA) treatments on physiological and quality parameters of postharvest horticultural products, including flowers, fruits and vegetables, were reviewed. The applications of SA extended shelf time of fresh cut flowers, which were *Oncidium* flowers, cut rose, yellow cut *Chrysanthemum*, etc. The mechanism was that exogenous SA alleviated respiration, increased corolla diameter, improved water absorbing, maintained flower water balance. SA performed effects on controlling post-harvest diseases caused by *Colletotrichum musae*, *Aspergillus niger* or *Curvularia lunata* in banana, *Botrytis cinerea* in kiwifruit, *Physalospora* in apple. SA gave good maintenances of fruit quality, i.e. decreasing loss of flesh firmness in apple, banana, peach, pear, persimmon, tomato, as well as decreasing loss of titratable acid, soluble solids or ascorbic acid in loquat, pear, tomato. The respiration of fruits was inhibited by exogenous SA in apple, mango, peach, and the peak of ethylene production in peach was delayed. The active oxygen metabolism of fruits was also affected by SA treatments. The activities of superoxide dismutase (SOD) and catalase (CAT) were increased or the contents of H₂O₂ and malondialdehyde (MDA) were decreased by SA in banana and loquat. The lignification and its related enzymes activities of loquat fruit, including phenylalanine ammonia lyase (PAL), polyphenol oxidase (PPO), cinnamyl alcohol dehydrogenase (CAD) and peroxidase (POD), were inhibited by SA. The effects of SA in various fruits were dependent of its concentrations applied. Fruit injuries were observed by extra SA in banana, mango, and peach.

S02.348

The Use of Cumulative Ethylene Production for Predicting Postharvest Pericarp Color and Firmness in Mature Green Tomatoes with Different Ripening Inhibitor Genotypes

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In the previous study we have demonstrated the clear relationship between postharvest cumulative ethylene production and pericarp color development and firmness change of mature green (MG) tomatoes cv. "Momotaro". LeMADS-RIN is known to encode transcriptional factor that controls ripening related genes and its mutation line (*rin/rin*) does not exhibit the ripening process like *ner* (never ripe). This study develops the prediction model (sigmoid function) of pericarp color development and firmness change by cumulative ethylene production and examines its feasibility to apply for varieties of tomato with different LeMADS-RIN genotypes. Four lines of MG tomato fruits, "Momotaro", "PK331", "PK353" and "KGM011" ("Momotaro" and "PK331" are wild type line (RIN/RIN), "PK353" is ripening inhibitor mutant line (*rin/rin*), and "KGM011" is F1 hybrid line (RIN/*rin*) between "PK331" and "PK353"), were tested for ethylene production rate, pericarp color development (a* value) and firmness change during storage at 25 °C. During storage, "PK331" fruits showed sharp increase in respiration, ethylene production, pericarp color development, and softening similar to "Momotaro" fruits. "PK353" showed very low level of ethylene production, pericarp color development, and firmness reduction. "KGM011", F1 hybrid line, showed intermediate ripening properties between wild type and *rin* mutant. These data indicated that ripening properties of tomato varieties are completely different, depending on genotypes. However, it was possible to predict the pericarp color development and firmness change by using sigmoid formula as the function of cumulative ethylene production except for "PK353". The correlation coefficients of this formula of both color and firmness are >0.95 (except "PK353"). In conclusion, this study suggested that the pericarp color and firmness change of MG tomato fruits can be estimated by a sigmoid formula based on cumulative ethylene production except for LeMADS-RIN mutant line (*rin/rin*).

S02.349

Biochemical Changes Occurred in the Pericarp of Litchi Fruit Treated with SO₂ to Avoid Browning

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Litchi (*Litchi chinensis* Sonn. cv. Huaizhi) pericarp browning is the main factor limiting the storage transportation and marketing of the fruit. SO₂ fumigation, the treatment followed by acid immersing in particular, efficiently protects the fruit from browning and has been introduced into the postharvest handling of the fruit. Surveying the changes evoked by the SO₂ treatment may help us to clarify the biochemical events related to browning. Control litchi fruit turned brown 2 days after stored at 20 °C in perforated plastic bags. Under the same condition, the fruit maintained red appearance for 6 days when treated with 2% SO₂ for 30 min followed by 8% HCl immersing prior to storage, while the fruit was bleached and turned brown lightly with SO₂ only. SO₂-HCl treatment significantly slowed down the decline of anthocyanin content in pericarp, while SO₂ alone enhanced the degradation of the pigment when compared to the control. The pH values dropped to 3.2 in the pericarp of the SO₂-HCl treated fruit, while the values maintained around 4.8 and 5.0 respectively in the SO₂-treated and control fruit. No significantly different pH values were detected among the aril of all treatments, indicating that the acid could not penetrate to the aril. SO₂-HCl treatment markedly inhibits the respiration of the pericarp tissue, while SO₂ alone lightly reduced the respiration. At the beginning of storage, faster water loss in pericarp was observed for the fruit

treated by SO₂ and SO₂-HCl, while at the end the water content decreased from 70 to 30% in the pericarp of both SO₂ treated and control fruit. SO₂-HCl treatment markedly inhibit the activities of anthocyanin degradation enzyme (ADE), peroxidase (POD), and polyphenol oxidase (PPO) in pericarp, SO₂ alone inhibit ADE activities but induced POD and PPO activities at the end of the storage.

502.350

Temperature and Water Loss Regulate Phenylpropanoid Genes in Skin Berry of "Aleatico" Grape Variety during Post-Harvest Dehydration Conditions

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Polyphenols and aroma profiles are an important quality aspects for sweet wine. Understanding what factors regulate berry secondary metabolites synthesis may help to improve quality and healthy value of this wine. To assess the effect of temperature and water loss (wl) on berry metabolism, even in post-harvest conditions, gene expression and metabolite accumulation were studied on bunches of "Aleatico" wine variety dehydrated (10, 20 and 30% of wl) at three different temperature: 10 °C, 20 °C and 30 °C, at constant RH conditions. Lowest temperature strongly up-regulated PAL and STS transcripts, and in relative minor extent CHI and DFR. Highest level of all genes of transcripts were reached at 20% wl. Similar trend was observed at 20 °C for all gene tested, except for DFR. This gene, at 20 °C, was wl up-regulated at 10% wl but progressively declines with the increase of wl. In the skin of berry exposed to 30 °C very low transcript levels were detected. Although results confirm the important role played by water loss on gene expression, temperature resulted to be the main regulative factor. Results concerning of accumulation of anthocyanins, resveratrol and catechins in berry skin and enzymatic efficiency analyses, the main regulative role played by temperature. Total polyphenols and phenolic acids, as well as, single compounds resulted significantly highest at 20% wl at 20 °C. Anthocyanins increased significantly at 10 °C and 20 °C but decreased at 30 °C. Results indicate that gene regulation and metabolite accumulation are contemporary affected by the two factors: temperature and water loss. However, from technical point of view the temperature at 20 °C resulted to be the most suitable conditions to improve healthy quality of sweet wine.

502.351

Packaging Use to Preserve 'Aurora-1' Peach in Two Maturity Stages

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The main objective of this research was to evaluate chemical and physical changes in 'Aurora-1' peach, harvested in two maturity stages, packed in different packaging and kept under refrigeration. Fruit were taken in two different maturity stages (mature green and mature), packed in four different packaging (control, PD-900TM, PVC and PET) and stored at 6 °C. The following variables were evaluated each eight days: peel and pulp coloration, accumulated fresh mass loss, firmness, appearance, disease occurrence, acidity, soluble solids contents, soluble and reducing sugars, total and soluble pectin, and percentage of solubilising pectin. During the experiment, it was observed that fruit postharvest life was influenced by packaging, and mature green fruits showed a lower disease occurrence. Fresh mass loss was lower in packed fruits. Peel coloration of mature green fruits got a characteristic color of mature peach at the end of storage time, noticing that PD-900TM provided a delay in coloration change. Packaging also influenced firmness providing a lower reduction than that for fruits under control for both harvest points. Organic acids decreased in fruits packed in different packaging and increased in the control ones. Sugar contents increased in control fruits, while

for packed fruits they increased until the eighth day and then decreased until the end of storage time. 'Aurora-1' peach did not show their quality compromised by packaging use, favoring an increase in his harvest life to 24 days, if compared with the control ones that lasted 16 days.

502.352

Pre-Harvest Gibberellic Acid (GA3) Application Effect on Firmness, Color and Overall Quality Parameters of Sweet Cherry cv. 0900 Ziraat

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The aim of this research was to identify the effects of different doses of pre-harvest GA3 treatments on overall quality parameters of sweet cherry cv. 0900 Ziraat during three weeks of cold storage. Concentrations of 10, 20, 30 mgxL⁻¹ of GA 3 were sprayed at pre-harvest while fruit color variation time and means of results were compared with the Control. Results showed that in all applications weight losses were increased, color change varied depending on application, stem color and firmness were maintained whereas pitting increased by the storage time. According to the results, different pre-harvest GA3 applications have positive effects on storage of sweet cherry cv. 0900 Ziraat.

502.353

Ozone Treatment as an Alternative Method to Improve Postharvest Performance of Kiwifruit

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The effect of ozone (O₃) treatment during cold storage on qualitative characteristics of kiwifruit (*Actinidia deliciosa* cv. Hayward) was investigated. Fruit were harvested at a maturity stage (tissue firmness ~ 6,2 kg, soluble solids sugars ~ 7.9%) and subsequently were cold stored (0 °C, RH 95%) a) in a chamber with catalytic combustion of ethylene and b) in a chamber with a continuous supply of ozone (0,3 µlxL⁻¹). Fruit were removed from cold storage after 1, 3 or 5 months and subsequently maintained at room temperature (20 °C) for up to 12 days. Tissue firmness, soluble solids sugars, titratable acidity, weight loss, color values (L*, Hue angle (ho) and C* values) and total antioxidant activity, determined with the FRAP (Ferric ion Reducing Antioxidant Power) assay and the DPPH (1,1-DiPhenyl-2-Picryl Hydrazyl) method, were monitored. Intriguingly, ozone-treated fruit were characterized by higher firmness retention, and lower weight loss compared to the other treatments. After removal from 5-month cold storage, ozone-treated fruits showed higher L*, ho and C* values in the external part of the fruit, illustrating a retardation in the deterioration of fruit quality and a lower percentage of weight loss compared to the other treatment. In addition, such fruits were characterized by higher antioxidant capacity at the 1st day after the removal from cold storage. Overall, the data of this study suggests that ozone treatment can be applied at a commercial scale in kiwifruit, as an alternative method to catalytic combustion of ethylene.

502.354

Quality of *Annona squamosa* L. Stored in Different Packages

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This work aimed to evaluate the post harvesting quality of custard apple (*Annona*

squamosa L.) fruits submitted to different sort of packages under refrigerated storage, in a 3 x 5 factorial randomized block design with three replications. The treatments of unpacked fruits (control), fruits individually packed into polyvinylchloride (PVC) film, and fruits packed in expanded polystyrene trays involved in PVC film were tested under five periods of storage (0, 4, 8, 12, and 16 days). Fruits were kept in a refrigerated store at 10 °C during the whole trial. Data of mass lose, pulp hardness, level of soluble solids (SS), total titrated acidity (TTA), pH, C vitamin, and water activity (WA) were recorded at harvesting day and following a 4 day frequency. Storage of custard apple fruits at 10 °C associated to an atmosphere modified by PVC film reduced significantly their mass lose. The modified atmosphere decreased the speed of fruits hardness lose along storage period, propitiating to them a 12 days post harvest life. Levels of soluble solids and total titrate acidity increased but not significantly during storage. All fruits presented reduction of the water activity (WA) during the storage period. It is concluded that the use of package for conservation of custard apple fruits only affected their physical aspects, but did not increase the conservation of their physic-chemical attributes.

S02.355

The Changes of Ethanolic Fermentation in Bell Pepper Fruit during Induction and Recovery from Low Oxygen Condition

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The changes of ethanolic fermentation were studied in bell pepper fruit during induction and recovery from low O₂ conditions at storage temperatures of 20 °C. When exposed to different O₂ concentrations for up to 3 days, acetaldehyde (AA) and ethanol (EtOH) were only induced in the fruit exposed to 0 % O₂. However, after the removal from 0 % O₂ and transfer to air, the AA and EtOH induced by 0 % O₂ declined to basal levels in an exponential manner for further 7 days. At 1 % O₂, AA and EtOH levels resulted similar to those in fruit held in air. The 0 % O₂ treatment resulted in a rapid accumulation of pyruvate. The pyruvate induced by 0 % O₂ significantly declined to basal levels when O₂ was increased from 0 % to air. At 1 % O₂, pyruvate levels resulted similar to those in fruit held in air. The pattern of pyruvate accumulation was coincident with a doubling of AA and EtOH levels. When exposed to different O₂ concentrations for up to 3 days, pyruvate decarboxylase (PDC) and alcohol dehydrogenase (ADH) activities were only increased in the fruit exposed to 1 % O₂. However, when the 1% O₂ exposed fruits were transferred to air for further 7 days, ADH activity maintained same level as the 1% O₂ treatment, whereas PDC gradually declined to basal levels. At 0 % O₂, PDC and ADH activities resulted similar to those in fruit held in air. The changes in the activities of these two fermentation enzymes did not necessarily correlate with the levels of corresponding end-products when the fruits were transferred from hypoxic to normal atmospheric conditions. Possible regulation of ethanolic fermentation during induction and recovery from low O₂ conditions is considered.

S02.356

Flavonols in Broccoli as Affected by Postharvest Light and Temperature

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Broccoli (*Brassica oleracea* var. *italica*) is a recognized health-promoting vegetable with decreased risks proven for cancer and coronary heart disease. This flower vegetable contains a wide range of bioactive compounds such as glucosinolates, vitamin C, carotenoids, hydroxycinnamic acids and flavonols. The latter compounds are potent free radical scavengers and are present at relatively high levels in fresh broccoli inflorescences. However, since harvested vegetables are still living structures, which continue to perform metabolic reactions, conditions during postharvest handling can have sub-

stantial impact on the content of health-related compounds. This study investigated the effect of postharvest light and temperature on the flavonol contents in broccoli. For this purpose newly harvested and film-wrapped broccoli heads were stored at 0 °C or 4 °C for 4 days in the dark to simulate the transport and wholesale phases and then the heads were transferred to 10 °C or 18 °C for 3 days to simulate the retail sales period. During this 3 day period, the broccoli heads were irradiated 12 h per day with three different intensities of visible light or a combination of visible light and UV-B radiation, or they were kept in the dark. Flavonol levels for individual broccoli heads were monitored non-destructively during the experiment using a Multiplex™3 sensor and expressed as relative epidermal UV-A absorbance FLAV Multiplex units. The flavonol level, measured at the end of the radiation treatments, was lower than after harvest for almost all broccoli heads. However, for broccoli stored in the dark increases of 6-23% were noticed. The results show that protection from light during postharvest handling of broccoli may have a positive effect on flavonol contents. The non-destructive measurements will be verified by quantitative HPLC analysis of flavonols.

S02.357

Some Physical Properties of Sour Cherry (*Prunus cerasus* L.) Fruit after Ethephon Application

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Generally, ethephon (2-chloroethyl phosphonic acid) is applied to reduce fruit removal force of cherries fruits. In this research, effect of ethephon at concentrations of 0 (control), 150, 225 and 300 ppm in 7 days before harvesting on fruit detached force from pedicle, pedicle detached force from shoot, fruits abscission percentage after shaking, fruits weight, flesh/pit ratio, fruit diameter, and fruit firmness on “Cigány meggy” and “Érdi jubileum” sour cherry cultivars were studied. By increasing of ethephon concentration, decreased fruit detached force from pedicle, pedicle detached force from shoot and fruits abscission percentage also fruit firmness. Fruits weight, flesh/pit ratio and in both cultivars increased. Ethephon concentration was increased significantly fruit diameter of “Érdi jubileum”, while it was not effective on fruit diameter of “Cigány meggy”.

S02.358

Development and Improvement of Protein Extraction Protocol and Bidimensional Electrophoresis in Stone Fruit

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Stone fruit is characterized for being very unstable. It gets damaged very quickly at room temperature. The use of low temperature storage to extend its life can cause negative consequences on fruit quality, due to the development of physiological disorders, known as chilling injury. Injury effect is greater in some varieties than in others, therefore injury seem to have a genetic component. Molecular processes knowledge enables the design of procedures to induce resistance or to decrease chilling injury sensitivity, in order to improve stone fruits postharvest and increase their quality. Bidimensional electrophoresis (2D) constitutes nowadays the most efficient method to separate proteins because it allows to separate hundreds, or thousands of proteins in an only experiment. The most critic step and key for the success of this technique is the extraction of proteins and preparation of the sample. An ideal Protocol must be reproducible, must allow the complete proteins extraction and it must minimize the presence of contaminants. In this work several protocols have been used to optimize protein extraction from fruits, suitable for large-scale 2D analyses, from sample of fruit, allowing to determine differences between the proteomes of healthy and damaged fruit. This study has showed that the procedures and protocols used for protein extraction, protein separation, gel staining and analysis, and protein identification have allowed the identification of the most

abundant proteins, and the comparison of the proteomes of stone fruit under the different storage conditions. With this proteomic studies we can establish changes in protein expression associated to the different experimental conditions. We conclude that; from the studied protocols, the version modified of Barent and Elthon (1992) has been the best for stone fruit. Currently, 2D electrophoresis seems to be the best method to compare proteins profiles (Rabilloud, 2002).

502.359

Antioxidant Activity and Vitamin C Are Not Affected by Degreening Treatment of Clementine Mandarins

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Degreening with ethylene is a common postharvest practice in citrus fruit. This treatment is commercially used worldwide to promote peel degreening in many citrus species, especially in early season fruit in which the pulp reaches maturity and becomes edible when the peel is still green, and also to achieve uniform external coloration in fruit submitted to external markets. Although nowadays degreening treatment is an option for both conventional and organic growers, there are some consumers and growers who dislike the idea of their produce having been exposed to it. The effect of ethylene during degreening on external color and shelf-life of the fruit it well studied, however, its effect on bioactive compounds such as vitamin C and on antioxidant capacity is not-well documented. In this study, the effect of ethylene during degreening treatment on nutritional quality of 'Clemepons' and 'Clemenules' clementine cultivars was investigated. Fruit were submitted to degreening treatment during 48h, 72h and 120h with or without application of ethylene. Following the treatment, fruit were stored at 20 °C during 7 days simulating shelf-life. Degreening treatment without ethylene reduced calyx senescence. Nevertheless, ethylene application improves color index compared to the treatment without ethylene. The ethylene application did not affect ascorbic acid, total vitamin C, dehydroascorbic acid content and antioxidant capacity of fruit from both cultivars. Degreening treatment with or without ethylene did not affect quality parameters.

502.360

Involvement of Antioxidant Activity in Flesh Browning of Astringent Persimmon

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Flesh browning caused by mechanical damage is one of the most important disorders during shelf-life of persimmon 'Rojo Brillante', which is an astringent cultivar. Our previous studies have shown that browning manifestation is influenced by the level of astringency of the fruit; in the present work the implication of polyphenol oxidase (PPO) activity and total antioxidant capacity was studied. Microstructural study of flesh browned tissue was also carried out. Astringent and non astringent fruit (fruit submitted to deastringency treatment) were mechanical damaged and stored for 15 days at 1 °C. Fruit no-mechanical damaged acted as control. Mechanical damage caused flesh browning in non-astringent fruit however this disorder was not observed in astringent fruit. Non-astringent fruit showed PPO activity slight higher than astringent fruit, nevertheless no differences were observed between damaged and control fruit. Non-astringent fruit showed much lower antioxidant capacity than astringent fruit. Total antioxidant capacity of the fruit seems to play a protective role in the manifestation of flesh browning of persimmon fruit. The microstructure study of non-astringent fruit showed the membranes of the flesh tissue affected after deastringency treatment, especially in tannin cells where the precipitation of the tannins occurred. The microstructure of damaged fruit tissue after storage showed the cell walls and the cellular cements degraded. The flesh browning observed could be attributed to the precipitated tannins which are visualised inside the cells or in the intercellular spaces.

502.361

Impact of Water Heat Treatment on Physical-Chemical, Biochemical and Microbiological Quality of Whole Tomato (*Lycopersicon esculentum* L., cv. Zinac) Fruits

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Water heat treatments (WHT) are used for disinfection purposes and to promote changes to the biochemical pathways involved in the ripening process, resulting in remarkable beneficial effects on fruits postharvest quality maintenance and storage life extension. The objective of this study was to determine an optimal WHT condition and evaluate its overall effects on tomatoes (*Lycopersicon esculentum* cv. Zinac) quality. Fruits were immersed in hot water at different temperatures (from 40 °C to 60 °C) and during different immersion time periods (2 to 30 min). WHT effects on fruit colour CIELab parameters (L*, a*, b* and °h), firmness (N), peroxidase (POD) and pectinmethylesterase (PME) enzyme activity, total phenolic content and microbial load [mesophylic and yeasts and moulds counts (Y&M)] were evaluated. After WHT no observable colour changes were denoted in all heat treated samples. At lower WHT, 40 °C – 50 °C, firmness maintenance was obtained when compared to untreated samples (16.08 N). Significant reductions on tomato fruits firmness were observed in treatments with temperatures higher than 55 °C. Both evaluated enzymatic activities were affected by the heat treatments. Regarding POD enzyme, an increase in activity was found with intensive WHT, while PME activity decreased at all tested conditions, with two exceptions (at 45 °C and 60 °C). WHT achieved an increase in phenolic content. The WHT 40 °C_30 min promotes the highest increase compared with control sample (c.a 27%). WHT at 50 °C -2min or 40 °C -30min promoted reduction of mesophylic and Y&M to undetectable levels, showing the effectiveness of these treatments to control the microbial development in tomato fruits. The WHT 40 °C_30min promotes maintenance of tomatoes quality with an increase of the phenolic content, and is an effective alternative decontamination procedure. Therefore, this treatment presents an alternative postharvest process for tomatoes fruits. WHT revealed to be beneficial to fruits quality as well as to extend its shelf life.

502.362

Chlorophyll Degradation during Leaf Senescence in Harvested Flowering Chinese Cabbage (*Brassica rapa* var. *parachinensis*)

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Flowering Chinese cabbage (*Brassica rapa* var. *parachinensis*) is one of the main leafy vegetables produced in China and popular with Chinese populations around the world. The rapid leaf yellowing after harvest limits the long distance transportation of the vegetable. In the present study, leaf senescence of flowering Chinese cabbage was manipulated by plant hormones, so as to set up an experimental system to characterize the correlation between senescence progress and chlorophyll degradation pathway. Treated by 6-benzyl aminopurine (6-BA), a synthetic cytokinin, the leaves of the cabbage remained green, retained approx. 59% of original chlorophyll and maintained the ratio of Chl a/ Chl b a around 3 after 6 days at 20 °C in perforated plastic bags. The cabbage turned yellow 3 days after ethylene treatment, contained only 5.77% of the original chlorophyll and the ratio of Chl a/ Chl b increased to 27 after 6 days in the same storage condition. Compared to the control, 6-BA retarded the progress of protein degradation and membrane peroxidation in the cabbages, and repressed the up-regulation of expression of SENESCENCE ASSOCIATED GENE 12 (SAG12), confirming that 6-BA delayed leaf senescence process. In contrast, ethylene accelerated protein degradation, membrane peroxidation and activated the transcription of SAG12, indicating that ethylene promoted senescence. Not correlated to the gradual decline in chlorophyll content, chlorophyllase activity

decreased with the progress of senescence in control, 6-BA and ethylene treated leaves, in which Ethylene lightly retarded the decrease. Mg-dechelataase activities increased during the senescence process in all treatments, and lower Mg-dechelataase activities were recorded in 6-BA than in the other treatments.

S02.363

Effect of Lightness and Darkness on Respiration Rate of Vegetables

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Each sample was stored in sequence under approximated room temperature (15 (20) °C), mild hypothermia (8 (15) °C), appropriate temperature (0 (10) °C), respectively, with the objective of investigating the effect of lightness and darkness on respiration of vegetable *in vitro*. The respiration rate of green pepper, tomato, broccoli, cauliflower and *Agaricus bisporus* was comparatively studied under lightness and darkness, respectively. The results showed that the respiration rate of green peppers, tomatoes and broccoli under lightness, comparing to darkness. and lightness had no significant effect on respiration rate of cauliflower and *Agaricus bisporus*. In addition, stored temperature played a positive role in the effect of lightness on respiration rate of vegetable *in vitro*.

S02.364

Optimization, Heat Stability and Kinetic Characterization of Pectinmethylesterase Enzyme from Tomato (*Lycopersicon esculentum* L.) Fruits

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Textural changes during fruit ripening have been attributed to pectin degradation caused by pectic enzymes, such as pectinmethylesterase (PME, EC 3.1.1.11). PME catalyzes the de-esterification of pectin, a complex mixture of polysaccharides, namely polygalacturonic acid methyl esterified, with the release of hydrogen and methanol, producing shorter chains and, causing drastic loss in firmness. Thus, control of PME activity in fruits aiming texture maintenance and/or improvement is extremely important to the food industry. However, PME activity and properties are depending on product, environmental and physico-chemical conditions such as pH and temperature. Therefore, the aim of the present work was to optimize and characterize PME assay from tomato (*Lycopersicon esculentum*, cv. Zinac), through optimum concentration of extraction solution, pH, temperature and substrate concentration as well as the thermal stability and kinetic behavior of tomato PME. The highest PME activity was found with a 1.0 M of NaCl extraction solution, with a 0.5% citrus pectin and revealed a optimum temperature at 60 °C at pH 8.8. The determined kinetic parameters were 0.712 U×mg⁻¹ and 0.011% for Vmax and kM, respectively. The low kM value for tomato PME describes the high affinity between enzyme and substrate (citrus pectin), whereas the obtained Vmax value relates to the enzyme quantity present in the reaction. The PME thermal stability study showed increasing PME activities at 50 °C (up to 17% for 10 min). At 60 °C, about 50% of the activity still remained after heating for 25 min, and PME was completely inactivated at 80°C after 10 min. These results provide useful information about the different factors that affect tomatoes PME activity and may be used as a tool for firmness control during postharvest handling and processing of this fruit.

S02.365

Effect of Different Fumigants on the Cold Storage of Table Grapes

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This research was carried out at the laboratory of post harvest physiology and cold rooms of the Department of Horticulture, Faculty of Agriculture, University of Ankara, Turkey in the period of 2007-2009. The aim of this research was to determine the effect of different fumigants on the cold storage of table grapes. 'Alphonse Laval' cvs was used in this study that was hand-picked from the Efem çukuru region of Menderes area of İzmir in Eagean Region. The experiment were conducted in "Randomized plot design" and parameters like the appearance, flavour, total soluble solid content, titreable acidity, SO₂ value, colour changing, decay rate and weight losses were measured fifteen days intervals. As a result of experiments in the period of 2007-2008 in Alphonse Lavallée grape cultivar has been stored successfully with SYS (slow release SO₂ generator) for 135 days and with Fumispore S application for 30 days and with Fumispore OPP application for 15 or 30 days. SYS application in the period of 2008-2009 has been stored successfully for 75 days. In the period of 2008-2009 has been stored successfully with Fumispore S and Fumispore OPP until 30 days.

S02.366

Hydrogen Peroxide Involved in Tomato LeMAPK1, 2, 3 and LeCBF1 Signaling Cascade Mediated by Low-Temperature Resistance

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The mitogen-activated protein kinases cascade, MAPK, is the most important signal pathway in eukaryotes. Similar to those MAPK cascades in animals and yeast, the tomato MAPK cascade also controls the growth, development, stress reactions by phosphorylation of the relevant proteins. As a signal molecule, it has been reported that hydrogen peroxide can activate the MAPK pathway in the *Arabidopsis thaliana*. Tomato is vulnerable to low temperature during the growth process due to its cold sensitivity. By comparing different treatments of tomato, such as MAPK inhibitor, hydrogen peroxide and MAPK inhibitor with hydrogen peroxide treatment at low temperatures. We found that the changes of LeMAPK1, 2, 3 and LeCBF1 have correlationship at transcription level; hydrogen peroxide can strongly enhance the induction of LeCBF1 transcription level and hydrogen peroxide can improve the tomato LeMAPK1, 2,3 at the transcription level as well.

S02.367

Effect of Postharvest Hot Water and UV-C Treatments on Ethylene Production in Persimmon Fruit cv. Karaj

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Hot Water (HW) and UV-C treatments are commonly used for increasing post-harvest life in various fruits. There is no sufficient information about effect of these treatments on persimmon fruit especially Iranian cultivars. Therefore in this study persimmon (*Diospyros kaki* L., cv. Karaj) fruits were treated by HW and UV-C and alteration in ethylene production, fruit firmness and color coordinates (L*, a*, b*) under these treatments were determined. UV-C treatments were applied at 0 (as control), 1.5 and 3kJ/m² and HW treatments applied at 25 (as a control), 45 and 50 degree Celsius for 20, 35 and 45 minute. Ethylene production rate were measured 12, 24 and 48 hours after treatments, and color coordinates and fruit firmness were determined 48 hours after treatments. Although ethylene production increased in fruits during the time course, results showed that UV-C as well as HW treatments had no effects on ethylene production and its increase during experiment was similar to control. There was no significant effect by HW and UV-C treatments on fruit firmness compared to control. Also, color determination revealed that L* and a* in 50 degree Celsius HW treatment were lower than that of 25 degree Celsius treatment (control). No significant difference was observed among HW treatments according to b*. In UV-C treatments were no significant difference in L* and b*, but a* in 1.5 KJ/m² was lower than control.

In conclusion, ethylene production in persimmon cv. Karaj was not affected by HW and UV-C treatments and changes in fruit traits under these treatments was because of other factors.

502.368

Influence of Maturity Stage on the Effectiveness of 1-MCP Treatment of 'Hayward' Kiwifruits during Storage

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'Hayward' kiwifruits were harvested at a commercial maturity stage with flesh firmness of 59 N (± 3.9), soluble solids content (SCC) of 11.5% (± 0.6), and titratable acidity (TA) of 1.4% (± 0.03): They were then divided in 3 groups and treated at different time during storage with 0.5 ppm of 1-MCP for 24 h. A first group was immediately treated (firm stage), a second group was stored at 0 °C for 40 days until 1-MCP treatment when reached a firmness of 36 N (± 1.9) (intermediate stage), while a third group was stored at 0 °C for 2 months until treatment when reached a firmness of 25 N (± 1.6) (soft stage). 1-MCP treated samples at firm stage were stored for 100 days at 0 °C, while fruits at intermediate and soft maturity stages were stored for 80 days, together with the respective untreated control fruits. Initially upon 1-MCP treatment and during storage, firmness, SSC, TA, respiration rate, vitamin C and total phenolic contents, and antioxidant activity were measured. Untreated firm samples showed a severe firmness loss, which, starting from 23% of the initial value at 20 days of storage, reached 44% and 85% after 60 and 80 days of storage, respectively; treated fruits only lost about 20% of initial firmness after 40 days. At the intermediate stage the effect of 1-MCP treatment resulted evident only after 40 days of storage, when treated samples resulted firmer (about 44%) than the control. Also at the soft stage 1-MCP treatment slowed down softening: firmness decreased of 60% and 54% of initial value for control and treated fruits, respectively during the first days of storage. 1-MCP treatment did not affect chemical composition, while it had a significant effect on respiration rate only for fruits of the soft stage.

502.369

Effect of Postharvest Hot Air Treatments on Ripening and Soluble Sugars in Banana Fruits, *Musa spp.* cv. Williams

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Post-harvest hot air treatments have been used traditionally for disinfection and disinfestations of commodities and have shown potential to impart tolerance to chilling injury in some commodities. In the present study, banana fruits were exposed to two hot air treatments (50 °C for 10 minutes and 40 °C for 60 minutes) and then stored for 3 weeks at chilling temperatures (8 °C). The fruits were evaluated for chilling injury symptoms and ripening-related physicochemical changes during and after cold storage. Hot air treatments significantly improved the fruits' tolerance to chilling temperatures but at the same time affected ripening-related changes in the fruits. Immediately after the treatments, the treated fruits exhibited significantly higher respiration rates while ethylene evolution was suppressed by as much as 5 times relative to the untreated controls. However, during cold storage and upon transfer from cold storage to ambient room conditions the treated fruits had similar respiration rates to untreated fruits, while ethylene levels were higher in the treated fruits. The ripening process was significantly impaired in treated and untreated fruits as reflected in high hue angles. Furthermore, the treated fruits failed to soften sufficiently, thereby maintaining higher pulp and peel firmness compared to the untreated controls at ambient room conditions. At the end of the 3-week cold storage period followed by ripening at ambient room conditions, the treated fruits had significantly higher levels of soluble sugars compared to the untreated cold-stored fruits. These findings show that hot air treatment offer a potential measure for im-

parting tolerance to chilling injury in banana fruits. However, application requires a delicate balance to achieve effective but non-injurious time/temperature combinations that ensure optimum ripening and high fruit quality after cold storage.

502.370

Exogenous Application of GA4/7, Paclobutrazol or Prohexadione-Calcium at Fruit Colour Break Stage Improves Rind Textural Properties of Sweet Orange

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The incidence of albedo breakdown in sweet oranges increases with the advancement of fruit ripening due to weakening of rind. We aimed to investigate the role of gibberellins in improving textural properties of the rind with exogenous application of GA4/7 and inhibitors of gibberellins biosynthesis. Fruits on the whole tree were sprayed with different concentrations (0, 30, 100, 300 mgxL⁻¹) of GA4/7, Paclobutrazol or Prohexadione-calcium following colour break stage. The experiment was laid out by following randomised block design, single tree experimental unit and included four replications. None of the treatments applied at advanced fruit ripening stage did not significantly reduce the incidence of albedo breakdown and affect the soluble solids concentrations and acidity. The exogenous application of GA4/7 resulted in improved textural properties of rind as reflected by fruit compression, rind hardness and tensile tests. The concentrations showed a linear trend for textural properties of rind. Contrarily, the exogenous application of Paclobutrazol or Prohexadione-calcium also showed positive effects on improving textural properties of rind but their extract mode of action and role of gibberellins in albedo breakdown at advanced stage of fruit ripening warrants further investigations.

502.371

Role of Oxidative Metabolism in the Onset of Senescence in Nectarine (*Prunus persica* L. Batsch) Fruits during Storage

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The oxidative metabolism has been implicated in the process of senescence as well as in a number of senescence-related disorders in a variety of organisms. In the present study, nectarines (*Prunus persica* L. Batsch) fruits were detached at commercial maturity from trees and placed under room temperature (24 °C) for 8 days. In order to study the effect of oxidative metabolism on the post-harvest senescence process, nectarine fruits were pre-treated with H₂O₂ before their exposure to room temperature. High respiration rate and ethylene productions were detected just after the treatments of fruit with H₂O₂ compared to the control. In addition, soluble solids content and titratable acidity was alter by H₂O₂ treatment during the 8 days period. Changes in the activity of the H₂O₂-scavenging enzymes unspecific peroxidase (POX), ascorbate peroxidase (APX), glutathione reductase (GR) were estimated immediately after harvest and during the experiment. Time dependent higher H₂O₂-scavenging enzymatic activities were found in H₂O₂-treated fruits during storage. In addition, polyphenol oxidase (PPO) activity was stimulated by post-harvest senescence and H₂O₂ treatment.

502.372

Use of Biodegradable Plastic Films for Packaging and Distribution of Strawberries in Piedmont (Italy)

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The cultivation of strawberries due to a low consistency of the fruit, high perishability and limited shelf-life needs in the post storage of a rapid product management in marketing. The composition of the atmosphere and the maintenance of low temperatures and high humidity of the environment conservation must be ensured throughout the production chain in order not to compromise the quality of the product. Respect for the quality of the product ends with the presentation for which assistance is required, specialization and orientation skills, to enable consumers to be accompanied, supported and rewarded at the moment of choice. To achieve this, a primary step of the production line is to be found in packaging that cannot be achieved through general systems but must be tailored and designed for the individual product fresh. The growing interest of consumers towards the issue of environmental sustainability in search of greener packaging solutions that do not pollute, are recyclable and at the same time maintaining unchanged the characteristics of the product. The aim of this work was to evaluate the influence of post-harvest strawberries on plastic films of different faces in terms of shelf life, maintaining the quality and nutraceutical packaging systems with traditional flexible packaging systems alternatives. The sample units were discarded flowpack 250 g of strawberries respectively covered with a traditional polypropylene film and Mater-Bi[®] (Novamont SpA), biodegradable and compostable film.

S02.373

Study of Quality Loss of Table Grape (*Vitis vinifera* L.) Rachis cv. Red Globe during Postharvest Storage

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The quality of table grapes (*Vitis vinifera* L.) is associated with both the berry and the rachis. Many reports have described the changes that grape berries undergo during postharvest storage, but rachis has not been the subject of similar studies. In the present report anatomical, physiological and molecular parameters were studied in table grape cv. Red Globe rachis stored at 0 or 20 °C. The activities of reactive oxygen species (ROS) scavenging enzymes (superoxide dismutase, catalase and ascorbate peroxidase) were measured after storage. However, data did not show a clear link between ROS scavenging enzyme and rachis deterioration. Cytokinin applications and controlled atmosphere treatments helped to reduce the rate of quality loss on rachis, indicating the participation of a senescence factor in addition to dehydration. Changes in rachis total RNA and anatomical changes observed before and after harvest supported the hypothesis that senescence-modulated effects are associated with rachis quality loss.

S02.374

Effect of a Short-Term CO₂ Treatment on Ripening and Quality of European Plum (*Prunus domestica*) during Ambient Air Storage

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Rapid ripening and softening of European plum (*Prunus domestica*) shortens shelf-life and restricts efficient fruit handling and transportation of ripe full tasting plums. In peach fruit, a short-term treatment with high CO₂ concentrations can

significantly slow fruit softening and as a result fruit quality is maintained. In previous work, the European plum cultivar 'Hanita' behaved as a climacteric fruit, while the cultivar 'Elena' behaved as a 'suppressed' climacteric fruit. In the present study, the effects of a short-term CO₂ treatment on fruit ripening and quality, specially on flesh firmness were investigated using the European plum cultivars 'Hanita' and 'Elena' during air storage at room temperature. After harvest, 'Hanita' fruit were divided into two groups (hard and soft) according to flesh firmness. 'Elena' fruit were harvested at an interval of 10 d. Fruit was treated with 30% CO₂ for 20 h, while untreated fruit were used as a control. After treatment, fruit were held in air at room temperature. Changes in fruit colour, flesh firmness, soluble solids and acidity as well as respiration and ethylene production were determined during storage. Short-term exposure to high CO₂ did not extend the shelf-life of 'Elena' plums, but accelerated the deterioration of 'Hanita'.

S02.375

A Tentative Typology of Apricot Fruit Maturation

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Fruit quality is a major characteristic in *Prunus* species. To optimize fruit quality of apricot, one of the main factors kept under control is the maturation period either on tree or after picking. Fast lack of firmness is detrimental to fruit commercialization. The fruit evolution depends on the production of ethylene and a large variation exists in apricot germplasm. In order to access a typology of the apricot cultivar behaviour a set of 13 contrasted apricot cultivars have been studied from 1995 to 2007: 12 climacteric varieties, including Monique, Goldrich and Bergeron, and an accession characterised by a very low levels of ethylene production and considered as "non climacteric" fruits. Ethylene production, colour and firmness have been concurrently monitored and a modelling approach has been applied in order to organise and structure the observed variations. A cultivar typology based on ethylene production has been established during the maturation phase. Three main parameters have been highlighted: (i) a climacteric status vs non-climacteric one, and among the climacteric cultivars, (ii) the maximum and (iii) the slope of the evolution of the ethylene production curve. The monitoring has been pursued during post-harvest and two main behaviours have been identified (i) one in which the evolution is the same as during maturation on the tree, and (ii) another one characterised by a significant boost in ethylene production during post-harvest. In addition, firmness character appeared to be a good indicator of the maturity of the fruits.

S02.376

Control of Potato Sprouting Using Natural Compounds

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In order to study potato sprouting behavior after using natural compounds and extending potato storage life, an experiment was conducted in research laboratory of Ferdowsi University of Mashhad. "Aula" cultivar was used in this study. Treatments included using Black zira (*Bunium persicum*) and Clove (*Eugenia caryophyllata*) essential oils (EO) in five concentrations (0, 25, 50, 100, and 150 ppm) by two methods (fumigation and submerging). Potato tuber weight, number of sprouts per tuber, fresh and dry weight of sprout, weight loss percentage, infection severity and tuber quality were determined initially and after storage time. The experiments were conducted in glass jar (3 L) during 50 days in room temperature (25±1 °C). Results showed that the lowest weight loss (0.94% w/w) occurred in the treatment of 100 ppm Black zira EO by the method of fumigation and the highest weight

loss occurred in control (4.75% w/w). The highest dry weight of sprout was obtained in the treatment of 25 ppm Black zira EO by method of submerging (0.92g/tuber) whereas the lowest dry weight of sprout was obtained in the treatment of 150 ppm Black zira EO by the method of fumigation (0.09g/tuber). The best quality of tubers obtained in the treatment of 25 ppm Black zira EO by the method of fumigation. The highest infected tuber was occurred in control (60.73%) and the lowest one was occurred in treated tuber with 50 ppm Black zira EO via the method of submerging (8.88%). In conclusion the best treatment for prevention of potato tuber sprouting in storage is using Black zira essential oil by the method of fumigation.

S02.377

Postharvest Behaviour of Purple Passion Fruit during Low Temperature Storage

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Purple passion fruit (*Passiflora edulis flavicarpa* Sims.) is a semi domesticated climber *Passifloraceae* originated from South America. Its exquisite flavor attracts consumers and it is widely grown in tropical and subtropical climates. The fruit is a promissory fruit to be exported from Colombia. Purple passion fruit suffers quality losses particularly during low temperature storage due to chilling injury and associated decay. Exported fruit shows uneven ripening during market chain. Fruits were harvested in three stages of maturity (green mature, half mature and full mature) and bagged in Xtend® before storage at 4 °C or 8 °C. The fruit showed climacteric pattern with high levels of respiration rate and ethylene production throughout storage at both temperatures. Epicarp shriveling, uneven ripening and decay were the most limiting quality drawbacks for purple passion fruit during storage. Also, the three stages developed chilling injury in the form of water-soaking symptoms during storage and at 4 °C shriveling. The fruit suffered a severe decrease in ascorbic acid content concomitant with a decrease in titratable acidity. Decay in the post-storage shelf life periods was particularly noticeable after storage at 4 °C in green and half mature fruits. The storage of purple passion fruit at 8 °C ±1 and 70% R.H is recommended for the stages of maturity tested because avoided chilling injury, reduced organic acid and total losses, and allowed normal fruit ripening during a post-storage shelf-life at 20 °C particularly in green and half mature fruit.

S02.378

Factors Affecting Longkong Fruit Abscission After Harvest

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Longkong (*Aglata dookkoo* Griff.) fruit at full-yellow stage (all fruit in a bunch were fully yellow) stored at 25°C began to abscise 1-5 days after harvest. Fifty percent abscission was observed after 8-14 days. In most case, longkong at commercial harvesting stage (full-yellow + 7 days) had lower abscission rate than that at full-yellow stage. Continuous exposure to ethylene, at 0.05 µL·L⁻¹ or higher, induced abscission. At 1 µL·L⁻¹ exposure all fruit abscised within 4 days. Dipping longkong in 200 mg·L⁻¹ NAA solution reduced fruit abscission by 50%. However, the effectiveness of NAA lasted only 5-7 days. After that the abscission increased rapidly to the same level as the untreated bunches. Higher NAA concentrations caused more fruit abscission. Ethylene production was found slightly lower in the 200 mg·L⁻¹ NAA treated bunches. NAA application was also found to reduce the effect of external ethylene treatment. Application of 1,000 nL·L⁻¹ 1-MCP for 6-12 hr at ambient condition reduced fruit abscission by 50% for 7-8 days during storage. Ethylene production of longkong fruit was reduced by half by 1-MCP treatment. The treatment also inhibited external ethylene effect.

S02.379

Evidence of Acidic Invertase as a Control Step of Sucrose Level during Ripening of Two Diploid Banana Fruit

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We previously shown that diploid dessert cultivars accumulate more sucrose during ripening on plant than diploid cooking cultivars, and that Acid Invertase (AIV) might be in this case important by correlating the ratio sucrose / glucose + fructose of fruit (Fils-Lycaon *et al.* 2008). To investigate the putative involved mechanisms, Sucrose Phosphate Synthase (SPS) and AIV, two enzymes involved in sucrose metabolism were studied in fruit of two diploid AA dessert (IDN110) and cooking (Sowmuk) bananas, during their development and postharvest ripening after acetylene treatment. From the green developmental to late ripening stages, SPS activity increased at comparable levels in both varieties from 107 to 222 µmoles of sucrose.h⁻¹·g FW⁻¹ for Sowmuk and from 68 to 168 and then after 106 µmoles of sucrose.h⁻¹·g FW⁻¹ for IDN110. Activity of AIV increased slowly in IDN110 fruit from 3 to 26 µmoles of glucose.h⁻¹·g FW⁻¹, and drastically in Sowmuk from 4 to 207 and then after 174 µmoles of glucose.h⁻¹·gFW⁻¹. At molecular level, the pattern of SPS and Cw-AIV mRNA accumulation was similar in both varieties during fruit development and ripening. SPS mRNA level increased transiently during the green developmental stage while that of Cw-AIV increased with ripening. Interestingly, at equivalent stages, the increase of Cw-AIV mRNA level was approximately 100-fold more in Sowmuk than in IDN110, which corroborates with the higher AIV activity measured for Sowmuk. As between the two varieties, no significant changes were observed for neutral invertase activity and for Susy gene expression and activity, our data strongly suggest that AIV activity constitutes a key step that controls the sucrose level during ripening of diploid banana fruit and that Cw-AIV gene contributes to this activity. Thus, Cw-AIV constitutes a target for the identification of molecular markers usable in breeding, and marker-assisted selection to improve quality traits of banana fruit.

S02.380

Influence of Cell Wall Calcium Content in Fruit Firmness during the Ripening of Plums (*Prunus domestica* L.)

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'Rainha Claudia Verde' is regional variety of *Prunus domestica* L. well adapted to a specific region in South of Portugal. In order to understand the reason for the different postharvest behaviour of this variety produced in different orchards, cell wall polysaccharides and cell wall calcium fruit content were studied during ripening in two consecutive years. During harvest period pectic fractions soluble in water, carbonate and KOH were prepared from alcohol-insoluble residue (AIR) of plums. Galacturonic and neutral sugars contents were measured during fruit ripening and fruit firmness was also evaluated. The calcium fruit level was determined in the AIR during harvest season as well as in dry matter. Fruit firmness was significantly higher in second year and it was probably related with calcium fruit content and pectic polysaccharides. Also between orchards there was a significant difference in calcium fruit content, and this might influence the overall fruit texture during postharvest. During fruit ripening water soluble pectic polysaccharides does not change significantly, which was in accordance with the small decrease in tissue firmness. The occurrence in the supernatant of the cellulosic residue of highly branched polysaccharides might be the consequence of matrix material associated with microfibrillar

phase. During ripening, it was not evident the depolymerization of hemicellulosic fraction. The loss of fruit firmness is a consequence of many cellular events which are influenced by external factors. The knowledge of calcium content in the cell wall and the pectic polysaccharides could be of great importance to predict fruit texture.

S02.381

Expression of Genes Encoding 1-Aminocyclopropane-1-Carboxylate (Acc) Synthase, Acc Oxidase, Polygalacturonase and Pectin Esterase during Development, Ripening and Softening in Persimmon (*Diospyros kaki* Thunb.) Fruit

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Persimmon (*Diospyros kaki* Thunb.) fruit soften easily and have only a short shelf life compared with apple. Fruit softening is closely related to ethylene synthesis and cell wall degradation. Gene expression of 1-aminocyclopropane-1-carboxylate synthase (ACS), ACC oxidase (ACO), polygalacturonase (PG) and pectin esterase (PE) in various strains of 'Saijo' persimmon fruits at several stages of development and postharvest was investigated by RT-PCR or real-time PCR. We generated a total of about 16,000 expressed sequence tags (ESTs) from randomly selected clones of different cDNA libraries of 'Saijo' persimmon fruit. Eight different PG and seven PE homologs were isolated from the persimmon ESTs. Based on phylogeny of Arabidopsis PGs, all persimmon-derived PG homologs are classified in the groups with high levels of expression in silique. Results of expression analysis using fruit at ripening stage showed that Dk-PG I and IV was ethylene dependent while Dk-PEs had low levels of expression. The mechanism of rapid fruit softening in 'Saijo' persimmon strains has been discussed, and some candidate marker genes are hopeful to be gained in future.

S02.382

High Temperature Treatment After Harvest of Satsuma Mandarins 'Miyagawa' (*Citrus unshiu* Marc.) for Reduction of Acidity

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Satsuma mandarin is main variety that occupies over 90% in Korean market. Recently, in order to raise soluble solid content of the fruits, soil-mulched cultivation is rapidly increasing. This cultivation technique, however, also raise acidity of the fruits and these acidic mandarins are not preferable to Korean consumer. Natural decline of acidity can be expected but takes long time which can induce skin puffiness and senescence. Therefore this experiment was carried out to reduce the acidity of mandarins after harvest. There were several treatments such as temperature, film, and then measured respiration rate, weight loss, decay rate, firmness, titratable acidity (TA), Soluble solids content (SSC) and sensory evaluation. TA showed about 0.19 to 0.27% decreases whereas temperature control showed only 0.05% for 10 days in low ambient temperature. SSC did not change during the treatment. Decay rate was markedly low even in high temperature and humidity due to previous sorting-out process. The freshness and firmness of the fruits decreased slightly after the treatment but did not affect the freshness for the appearance comparing to the temperature control. Sensory evaluation of off-flavor also showed slight increase but all treatments did not reach the value of 2 which is unacceptable quality.

However, the treatment without film showed significantly low firmness and high off-flavor level compared to the other treatments, which represents that film sealing has other effects except inhibiting weight loss. According to the results, high temperature treatment with an appropriate measure can reduce acidity in a short time while maintaining the SSC and freshness.

S02.383

Effects of 1-Methylcyclopropane on Postharvest Life and Quality of Tomato(cv. Suvari F1) Grown in Organic or Conventional Greenhouse Cultivation

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In this study, the effect of 1-methylcyclopropane (1-MCP) on postharvest quality and physiology of organic or conventionally greenhouse cultivated Suvari F1 tomatoes were investigated. Fruits in pink stage were harvested from Research and Implementation Area of Cukurova University (Adana/Turkey). Tomatoes belong to organic or conventional groups, were sorted into two equal parts for each group. Half of these groups were treated with 1-MCP in concentration of 1000 nL/l for 24 h at 20 °C, while the untreated remaining were considered as control. All fruit samples were stored at 10 °C with 90% RH for 14 days. During the storage period, weight loss, elasticity, skin color, lycopene, ascorbic acid, soluble solid content (SSC), titratable acidity (TA) and SSC/TA were evaluated with the interval of one week. According the results, in both cultivation conditions, 1-MCP significantly delayed skin color changes, lycopene synthesis and ripening index (SSC/TA). Elasticity values of organic fruits were higher than those of conventional fruits, whereas 1-MCP treatment maintained the elasticity of tomatoes compared to the control. Overall findings indicate that 1-MCP was significantly effective in delaying ripening and therefore drastically retarded the loss in general quality of (Suvari F1) tomatoes during storage.

S02.384

Postharvest Lecithin Application Improves Storability of Pomegranates cv. Primosole

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Husk scald is a form of chilling injury consisting in a superficial discoloration of the skin which generally does not affect the seeds (arils) or the white segments which contains the seeds, but in advanced stages of development can favor decay. Generally, husk scald develops faster at temperatures higher than those at which other forms of chilling injury occur. The aim of this work was to assess the impact of a treatment with a lecithin based commercial formulation (Xedabio) on the manifestation of husk scald of 'Primosole' pomegranates. Fruit were dipped in water or in 1% aqueous mixture of Xedabio, alone or in combination with the fungicide fludioxonil at 600 mgxL⁻¹, and stored at 8 °C and 90% RH for 6 or 12 weeks plus one additional week of simulated marketing conditioning at 20 °C and 65-70% RH. Weight loss, husk scald and decay were the main cause of commercial deterioration. Xedabio, especially in combination with fludioxonil, effectively maintained the commercial value of fruit during the first 6 weeks of storage and the subsequent week of simulated marketing conditions at 20 °C. However after 12 weeks of storage, weight loss and peel disorders drastically reduced visual appearance even in Xedabio treated fruit. Despite the severity of physiological disorders, minor changes occurred in nutritional compounds as well as in total polyphenols, anthocyanins and antioxidant capacity over the storage period in both treatments.

S02.385

Influence of Temperature and Relative Humidity Conditions in the Transpiration Rate of Fresh Oyster Mushrooms

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Oyster mushroom (*Pleurotus ostreatus*) is a common edible mushroom, highly appreciated for its unique flavour and nutritional composition. Once harvested, *Pleurotus* deteriorate rapidly at room temperature but their shelf-life may be extended by controlling storage temperature. One of the main problems affecting quality of mushroom is the high weight loss throughout the supply chain. Besides the quantitative aspect, related to severe reduction in produce weight, weight loss also affects the overall quality of fresh produce. In order to evaluate the effect of temperature and relative humidity (RH) of the air in the weight loss of mushrooms over storage time, transpiration rate, quantified by mushroom weight loss was evaluated for different combinations of temperature (6, 10 and 16 °C) and RH (86, 96 and 100 %). After temperature stabilization, fresh oyster mushrooms clumps were cutted with a short stem and sorted by size and appearance of the cap. For each RH level, four mushrooms were stored in 3 large containers for up to 175 h under ambient air conditions, at 3 different temperatures. RH of the test containers was independently controlled by using saturated salt solutions. Mushrooms for each combination temperature/RH were weighed at regular intervals, and respective transpiration rates were calculated. Experimental data revealed that both temperature and RH had significant ($p < 0.05$) effects on transpiration rate of fresh oyster mushrooms, with values ranging from 0.5 to 4 mg/g of fresh mushroom/h. Significant synergistic interaction effect were also identified.

S02.387

Effect of High CO₂ Treatment on Stored 'Deglet Nour' Date Fruit Quality

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The effect of High CO₂ treatment, as an alternative of methyl bromide, on 'Deglet Nour' date fruit quality was studied. Fruits were treated by 95% CO₂ during 24 hours and at 30 °C. The treatment was done before or after 6 months storage period at 1 °C and 80% relative humidity. Fruits were then transferred to 20 °C for 7 days and quality parameters were evaluated. Fruits treated before the storage period didn't show significant changes in color, firmness, solid soluble content, water activity and total phenols. However, a decrease in firmness values and water content, as well as higher SSC were observed when fruits were treated after the storage period.

S02.388

The Effect of L-Arginine Treatment on Induced Disease Resistance in Tomato

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Nitric oxide (NO), a major signal molecule of animal, plays a critical role in inducing resistance to fungal pathogen. There it is produced mainly by nitric oxide synthase (NOS), which catalyase NO and L-citrulline (Arg) formation from O₂ and L-arginine. To study the resistance induced by L-arginine and its cause, green mature tomatoes (*Lycopersicon. esculentum* cv. No.4 Zhongshu) were treated with 1mM Arg

at -35kPa for 0.5 min and incubated at 25±1 °C, 85-90% RH. Treatment with Arg reduced disease symptoms in tomato fruit soon after being inoculated with *Botrytis cinerea*. Along with the promotion of resistance against pathogen invasion, NO content and the activity of NOS were also induced by Arg in tomato. The activities of defensive enzyme, including phenylalanine ammonia-lyase (PAL), chitinase (CHI), β-1,3-glucanase (GLU) and polyphenoloxidase (PPO), were promoted by Arg. The gene expression of PR-I was also induced within 2h after treatment. Total phenol and flavonoid content increased significantly within 2 days. These results revealed the involvement of NOS in disease resistance response of tomato fruit, and the action of Arg on disease resistance was mainly due to its effects on NO biosynthesis and also defensive enzymes activities and gene expression.

S02.389

The Role of Ethylene in the Development and Postharvest Quality of Zucchini Fruits

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Zucchini is a non-climacteric fruit that is harvested immature when its length reaches 20 to 30 cm. The role of ethylene in the development, quality and conservation of fruits was investigated by analysing the production of ethylene, but also the content of ACC and ACO activity, as well as the expression of CpACS1 and CpACO1 genes at different stages of fruit development, and during the storage of fruits at 4, 12 and 20 °C for two weeks. The production of ethylene and the expression of CpACS1 and CpACO1 are maintained at low level throughout the different stages of fruit development, except during the abscission of floral organs, moment at which the production of ethylene is increased slightly. When fruits are stored for two weeks at 12 or 20 °C, ethylene production is maintained low. Nevertheless, when the storage temperature is 4 °C, fruits produce significantly much more ethylene, suggesting that prolonged chilling induces ethylene production in zucchini fruits. By using fruits from a commercial hybrid variety, stored under different temperature regimes for 7 and 14 days, we have compared quality related parameters (water loss, chilling injury and firmness) with ethylene production, ACC content, ACO activity and the expression of CpACS1 and CpACO. Fruit quality parameters and ethylene production were also measured in Bolognese and Vegetable Spaghetti, two inbred lines having high and low sensitivity to ethylene response. Results are discussed on the basis of possible role of ethylene on chilling injury and fruit quality.

S02.390

Carotenoid Accumulation and its Regulation by Ethylene during the Late Developmental and Ripening Stages of Valencia Orange

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Carotenoids are isoprenoid molecules that are synthesized by all photosynthetic organisms and also by some fungi and nonphotosynthetic bacteria. While the enzymology of the carotenoid biosynthetic pathways in plants and eubacteria is now reasonably well understood, understanding of the regulation of carotenoid biosynthesis in fruit peel is still rather poor. In this work, fruit late development and maturation process of Valencia Orange was divided into four yellowing period (P1, P2, P3, and P4) and three re-greening period (P5, P6 and P7). Peel color during the developmental process from P1 to P7 first turns from green to yellow, then to green again, which is consistent with the changes of carotenoid accumulation and PSY (Phytoene synthase), PDS (Phytoene desaturase) and ZDS (zeta-carotene desaturase) gene expression during this process. Ethylene could promote carotenoid accumulation, PSY and PDS gene expression in the peel of Valencia

Orange at yellowing stage, and no significant effects on ZDS gene expression was tested. Ethylene had the similar effects on PSY and PDS gene expression in the peel of Valencia Orange at the re-greening stage, but no visible effects on carotenoid accumulation. Results showed that carotenoid accumulation correlated well with PSY, PDS gene expression during the yellowing stage of Valencia orange, in which ethylene could promote carotenoid accumulation and PSY, PDS gene expression. However, at the re-greening stage, ethylene promoted PSY and PDS gene expression was not consistent with that of carotenoid accumulation. Results indicate that ethylene regulated expression of PSY, PDS, ZDS gene was also relevant with fruit development, the change of the total chlorophyll and carotenoid content in Valencia Orange peel as well.

S02.391

Relationship between Pectin-Methyl Esterase Activity and Softening in Tomato Fruits cv. Raf

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Raf tomato has a higher organoleptic quality than many current cultivars, but it is a fruit with a very short shelf-life, susceptible to chilling and mechanical injury during postharvest handling. Moreover in this fruit climacteric and ripening processes occur rapidly, particularly and colour change. The softening of the fruit is due to the action of several enzymes, such as pectinmethyl esterase (PME) and polygalacturonase which play a joint role in this process. PME removes methyl groups from galacturonic acid residues of pectin, thereby encouraging the separation of the pectin chains, and allows access of other enzymes to the substrates. It is considered that the polygalacturonase, which is directly responsible for the degradation of pectin, acts if the methoxyl groups have removed previously by PME. This paper studies the relationship between PME activity and softening of the fruits during postharvest. Fruits harvested at the turning stage were stored at room temperature for 4 days until they reached the red-ripe stage. Quality parameters assessed were determined quality like CSS, colour, firmness and PME activity. The data show that the fruits turned red in about 24 hours, as the tristimulus parameter (a) increased from -3 to +8. The firmness of the fruit declined progressively during the 4 days of storage, and PME activity also declined gradually, showing a high correlation between shelf-life and activity of PME enzyme. However, this correlation is not so marked between PME activity and fruit softening, suggesting that PME is not the only enzyme involved in this process.

S02.392

Do Quercetin Glucosides Govern Skin Colour Changes in Brown Onion Bulbs during Curing?

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Due to the maritime climate of the UK, onions are artificially cured in closed environments. Curing removes excess water from the outer skin and seals the neck to reduce infection and minimise weight loss from the flesh. Current curing practise involves holding onions at 28 °C for three-six weeks which creates a golden brown colour that is appreciated by consumers. Cepaic acid, a possible oxidation product of quercetin, was recently identified as a novel brown pigment in dry onion skin. The aim of this work was to investigate further which compounds contribute to the colour change of brown onion skin during curing. Onion cv. Sherpa bulbs were cured at 20 or 28 °C for 6 weeks (relative humidity 65 – 75%). Replicated samples of onion skin were taken throughout the curing process. Objective colour, non-structural carbohydrates and flavonols were measured in the skin samples. Onions cured at 28 °C were on average significantly more brown (according to hue angle (H°)) and darker (according to lightness (L*)) than those cured at 20 °C. Quercetin glucoside concentrations were lower in the skins of onions cured at 28 °C compared with those cured at 20 °C. The relationship be-

tween colour and quercetin glucoside concentrations was confirmed using Partial Least Squares Discriminant Analysis (PLSDA) when nine physiological and biochemical variables (chroma (C*), dry weight, fructose, glucose, H°, L*, quercetin, quercetin 3,4-diglucoside and quercetin 4-glucoside) were considered. PLSDA clearly differentiated between onions cured at 20 and 28 °C, with the variance mainly explained by differences in quercetin 3,4-diglucoside and quercetin 4-glucoside concentrations and H° and L* values. In summary and for the first time, the increase in brown pigmentation during curing at higher temperatures has been shown to be linked to the conversion of quercetin glucosides possibly into brown oxidative products.

S02.393

Role of Plant Growth Regulators in Onion Storage

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Long-term storability of onions is a result of first, dormancy induction and then sprout suppression. Most research to extend onion storage life has concentrated on plant breeding, husbandry and the storage environment, with relatively little attention being paid to understanding the underlying physiological mechanisms involved in governing onion bulb dormancy. Technologically advanced refrigerated and controlled atmosphere storage systems have been designed to maintain availability of onions for prolonged periods, but this is energy intensive, and often depends upon the use of the sprout suppressant, maleic hydrazide (MH). There are also increasing pressures from both consumers and retailers to eliminate residues in food, which makes the future use of MH as a sprout suppressant uncertain. During storage many biochemical changes occur in an onion bulb, including fluctuations in dry weight, non-structural carbohydrates, flavour compounds and plant growth regulators. The interactions of ethylene, abscisic acid (ABA) and cytokinins with carbon metabolism and sprouting in onions are discussed in the context of better understanding postharvest physiological changes in onion. Recent work by the authors has monitored the temporal and spatial changes in concentrations of the cytokinins zeatin (Z) and isopentenyladenine (2iP) and their conjugates zeatin riboside (ZR) and isopentenyladenosine (IPA), using a newly developed LC-MS method. Bulb ABA concentration declined during storage, with a subsequent increase after onset of sprouting, while Z, 2iP, ZR and IPA generally increased during cold-storage, with spatial differences measured in their distribution within the bulb. In addition, sprout growth was reduced in cold-stored onions treated with 10 µL×L⁻¹ ethylene for 24 h at 20 °C before curing, despite continuous exposure to ethylene in store already being introduced as a method of increasing onion storage life.

S02.394

Effects of Postharvest Treatment on the Chemical Properties of Cell Walls and their Influence on the Texture of White *Asparagus* Spears

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The fleshy spears of white *Asparagus* (*Asparagus officinalis* L.) are “developmental immature, rapidly growing” subterranean shoots. After harvest they retain their physiological activity leading to a rapid decline of respiratory substrates. The unaltered continuation of shoot differentiation also includes thickening and lignification of cell walls of both sclerenchyma sheath cells and vascular bundles. The spears become fibrous and tough which is highly undesired in horticulture. Low temperatures and high CO₂ may reduce the spears’ physiological activity. Storage at low temperature and/or controlled atmosphere (CA) is therefore used for maintaining textural properties of spears. However, the effects of these parameters on the dynamic interactions of short-term changes in texture and chemical cell wall

properties, and soluble carbohydrates of white asparagus have not yet been comprehensively investigated. Temperature- and high CO₂-mediated effects on solved (glucose, fructose, sucrose) and structural carbohydrates (cellulose, hemicellulose and pectins), lignin content, variations in stiffness and toughness as well as water status and respiration of white asparagus spears were investigated to characterise the physiological and biochemical bases of the potential modifications in white asparagus spears stored under water vapour saturated conditions for up to seven days. Respiration slightly declined during the entire storage period irrespective of the CO₂ and temperature regime. In contrast, high CO₂ concentrations and low temperatures inhibited both the degradation of soluble carbohydrates and the synthesis of cellulose and lignin, thus partially maintaining initial tissue toughness. The dynamics of cellulose and lignin content was always identical. The relative ratio of cell wall and soluble carbohydrates was more or less constant indicating that soluble sugars were mainly used for growth and not for respiration. The interaction of soluble and structural carbohydrates with biochemical and mechanical cell wall properties will also be discussed in terms of optimizing postharvest technologies to product physiological concerns.

S02.395

D-Mannoheptulose: Special Carbohydrate in Avocado: Presence Postharvest and Importance to the Industry

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D-mannoheptulose is a rare carbohydrates produced by avocado trees. Although it has been reported to be a potential 'inhibitor' of fruit ripening, little research has been carried out to examine its 'inhibitory' effect on fruit ripening. Therefore, an experiment was designed to investigate whether the infiltration of D-mannoheptulose has an effect on the postharvest fruit ripening pattern. D-mannoheptulose (2.5 mg·L⁻¹) was infused into the fruit through peduncle either once or continuously over 17 days experimental period. The continuous infusion of D-mannoheptulose increased the shelf life of avocado fruit compared with the other treatments and improved other fruit quality attributes, such as fruit weight and fruit firmness. Overall, as D-mannoheptulose has multifunctional roles, proper preharvest cultural practices increasing the concentration of this sugar play a major role in fruit quality, therefore allowing the industry to ship quality fruit to longer distances, such as North America.

S02.396

Effect of Hot Water and Molybdenum Dips on Bioactive Compounds in Lemon Flavedo and Their Antioxidant Capacity during Cold Storage

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South African citrus fruit require cold sterilization against fruit flies during or before shipping to certain lucrative markets as phytosanitary standard. However, cold storage may result in chilling injury, which appears as pitting and sunken lesion on the surface of the fruit and, therefore, reduces the marketability of fruit. Previous research found a combination of hot water dips (HWD) and molybdenum (Mo) a possible means to alleviate chilling injury. The purpose of this investigation was, therefore, to alter bioactive compounds in the flavedo and to quantify their effect on membrane lipid peroxidation as a measure of cold storage damage to lemon fruit. Fruits were obtained from two sources and treated with 2 min HWD at 47 °C or 53 °C in combination with a subsequent 1 or 10 μM Na₂MoO₄·2H₂O soak for 30 min. Fruits were subsequently stored at -0.5 °C for either 7, 14, 21 or 28 days, transferred to room temperature and thereafter evaluated weekly for chilling injury. Total antioxidants (FRAP), phenolics, flavonoids, ascorbic acid, lipid peroxidation, specific flavonones, α-tocopherol and β-carotene were quantified in the flavedo. Lemon fruit sourced from Sun Valley (Capetown) during the 2007 harvest season

were the only consignment susceptible to chilling injury. Chilling susceptibility was related to low levels of bioactive compounds and higher lipid peroxidation as compared with to non-chilled fruit. Hot water dips at 53 °C, and 1 μM Mo in combination with HWD at 53 °C, seem to enhance bioactive compounds. In general, HWD and Mo enhanced rind phenolics, flavonoids and flavonones at specific storage times, however, the intensity of the alteration in such compounds depended on fruit origin.

S02.397

Performance of Coconut Fiber as Cushioning Packaging Systems for Tropical Fruits

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Tropical fruits are usually subject to significant percentage of post-harvest losses mainly because of mechanical injuries during transportation and distribution. Among the tropical fruits mango and papaya are the most affected ones and, therefore, this work investigated the use of a new biodegradable cushioning material, the green coconut (*Cocos nucifera* L.) fiber. An adequate cushioning material must be efficient to prevent fruit damage such as bruising and the consequent loss of market quality. The objective of this work was to compare the performance coconut fiber against straw wood and polyethylene foam net for protection of mango and papaya. The performance of these three cushioning materials and of a control test was evaluated based on a vibration test (ASTM D 999-08) at frequency of 15 Hz during 2 hours on the effect on fruit quality. After the vibration exposure the fruits were stored at room temperature and analyzed for weight loss, color change, respiration rate and mechanical injuries during three days. It was observed that the protection offered by the materials minimized mechanical bruising and decreased the quality loss as compared to the control, as far as weight loss, color change and respiration rate. Comparatively, the protection rate was foam net > coconut fiber > straw wood. It seems that the lower protection of the straw wood was due to a higher bruising damage to both fruits. Despite of the better performance of foam net, the coconut fiber has a great potential as a new cushioning material, because of its biodegradable and renewable nature and its low cost since it is originated from industrial coconut water.

S02.398

The Mechanism and Control of Postharvest Quality Loss of *Agaricus bisporus*

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Agaricus bisporus known as "White button mushroom" is the most economical mushroom in the world in which kinds of necessary nutrients, such as excellent essential amino acids, vitamins, minerals and polysaccharide are existed. Mushroom quality is defined by a combination of factors, but most characteristics are based on consumer preference. The desired mushroom is white, evenly round closed "cups" with a short stipe. However, harvested mushrooms stay at the ageing progress along with the cap opening and stipe elongation gradually, browning of mushrooms also takes place at the same time. To enhance the quality and commercial values of this edible fungus, the mechanisms of postharvest quality loss of *Agaricus bisporus* were necessarily understood. *Agaricus bisporus* is a microbe and the loss of product quality is caused not only by inappropriate environment conditions, but also by continued senescence. The skin layer covering the cap may be damaged easily, leading to an enzymic response and subsequent brown discoloration, which is catalysed by polyphenol oxidase (PPO). Cap opening occurs rapidly after harvest, predominantly due to continued mushroom development and nutritional isolation. Also, stress genes are switched on as a response to the wound damage of harvest and the increase in respiration under water stress and nutritional limitation. In addition, control of quality loss is also very important. Physical and chemical methods can reduce respiration, development and browning, but do not prevent it. Research in improvements by agronomy and breeding with the help of molecular biology and enzymology to select resistant strains may be a potential area.

S02.399

Effect of Modified Atmosphere Packaging (MAP) with Increased Levels of O₂ on Postharvest Quality of Iranian Table Grape cv. Shahroodi

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Table grape as a non-climacteric fruit with low physiological activity is sensitive to water loss and fungal infection mainly caused by *Botrytis cinerea* during postharvest handling, storage and marketing. In the present study a factorial experiment was conducted on the basis of completely randomized design with three replications using two gas combinations including 10%CO₂+15%O₂ and 10%CO₂ + 60%O₂ to evaluate the efficacy of modified atmosphere packaging to control decay and keeping postharvest quality in Iranian table grapes compared to controls. Fruits were stored at 1 °C and 80-90% RH for 60 days. Samplings were carried out every 15 days and measurements were made following the placing of fruit for 1 day at room temperature. Our results showed that decay incidence for control bunches and those kept in MAP of 10%CO₂+15%O₂ was in day 30. We observed that increasing O₂ level from 15% to 60% could delay decay incidence until day 60. In addition both fruit browning and pedicle desiccation decreased for mentioned treatment.

S02.400

Postharvest Decay Development on Guava Stored under Several Controlled Atmosphere Conditions

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The control of postharvest fungal decay on guava (*Psidium guajava* L. cv. Pedro Sato) stored under controlled atmosphere with low oxygen level (5 kPa) were compared with its association with increasing carbon dioxide atmospheres. The combination of high concentrations of carbon dioxide (1 kPa, 5 kPa, 10 kPa, 15 kPa and 20 kPa) with low oxygen level did not result in additional decay control. The oxygen level (5 kPa) was the main factor for controlling postharvest fungal development which resulted in very low percentages of fruits with symptoms of anthracnose and styler end rot throughout cold storage, regardless the CO₂ concentration. After transference to ambient conditions only the atmospheres with 5 kPa O₂ (control), 5 kPa O₂ + 1 kPa CO₂ and 5 kPa O₂ + 5 kPa CO₂ reduced the incidence of styler end rot (P < 0.05). There was not a significant interaction among CA combination and storage duration on the percentage and number of typical anthracnose lesions, although.

S02.401

Preservation of Fresh Peppers (*Capsicum annuum* L. cv. Fyuco.) under Organic and Conventional System and Stored in Modified Atmosphere

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The objectives of this investigation consisted in a comparison of peppers (*Capsicum annuum* L. cv. Fyuco) belonging to organic sowings and conventional modified atmosphere packaging with different gas concentrations (CO₂ and O₂), where the gas concentration, sensorial parameters, the contents of: soluble solids, dry matter, protein and calcium were evaluated; besides, the color by color measurement.

The modified atmosphere packaging of this vegetable was studied in plastic bags, where four fresh fruits were introduced, stored to 6 °C and HR: 90%, by a period

of 27 days. Two tests were made (B1 and B2), cultivated peppers in an organic and conventional system. Each test had three treatments: T0 corresponding to the observer, with 21% of O₂ and without vaccination of CO₂, T1 with a content of O₂: 2.5% and CO₂: 14% and T2: with a content of O₂: 2.0% and CO₂: 18%. In each of them the sensorial aspect was evaluated the next day by 14 expert people after being harvested and then the day 15 after being packaged and stored. The evaluations of gas concentration were made the days 6, 10, 14, 20 and 27 after being packaged. The color evaluation by color measurement, and soluble solid content, dry matter, protein and calcium, were evaluated the day after being harvested, and the days 6, 10, 14, 20 and 27 after being packaged and stored. According to the objectives, the gas concentration showed a reduction oscillation of O₂ and an increased tendency of CO₂, having these oscillations no importance. According with the sensorial evaluations, the greater estimation was obtained by treatment T1 B1 belonging to the organic sowing. The color by color measurement, the content of dry matter and soluble solid did not demonstrate any significant difference in the evaluations.

S02.402

Role of Soluble Carbohydrate Content on Longevity of Cut Rose (*Rosa hybrida* L. cvs. Eldorado and Black Magic) Flowers

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Postharvest characteristics of *Rosa hybrida* between 2 cultivars (Eldorado & Black Magic) were investigated. The vase life markedly varied between cultivars, it was 5.6 days for 'Black Magic' and 13.3 days for 'Eldorado' in distilled water. Treatment with sucrose plus 8-hydroxyquinoline citrate (HQC) markedly increased vase life. Concentrations of fructose, glucose and sucrose in petals of 'Eldorado' were much higher than those of 'Black Magic'. There was no difference between these cultivars in sugar concentrations in stems. In petals of both cultivars, concentrations of fructose were higher than glucose and sucrose but in stems sucrose were the main carbohydrate. There was little difference in ethylene production trends between 'Eldorado' and 'Black Magic' flowers but Black Magic produced higher ethylene concentrations at sixth day.

S02.403

The Effect of Small Oxygen Concentration in Controlled Atmosphere on the Ethylene and CO₂ Emission Rates in Passion Fruit.

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The performance of an experimental set-up for ethylene and carbon dioxide detections was tested, analyzing in real time the effect of low concentration of oxygen on the respiration and ethylene emission rates in passion fruit. A photoacoustic spectrometer was used for ethylene analysis and a commercial infrared gas analyzer (URAS 14) was applied for CO₂ detection. Three modified atmospheres of nitrogen and oxygen mixtures (100% v/v N₂ - 0% v/v O₂; 97% v/v N₂ - 3% v/v O₂ and 94% v/v N₂ - 6% v/v O₂) were produced by electronic flow controllers and used to push in continuo flow the emitted CO₂ and C₂H₄ molecules from fruit stored in sealed chambers into to the analyzers. The emission of ethylene was drastically effected by the low concentration of oxygen. The effects of 0 and 3% of oxygen on the response of C₂H₄ and CO₂ emissions were greater than the effect of 6% of oxygen. During the analyzing time of 220 min, the climacteric peak which is typically present for normal atmosphere store condition (O₂ - 21 % v/v) was not observed for 0 and 3% of oxygen. The levels of CO₂ concentration due to fruit respiration under modified atmospheres of 0 and 3% of oxygen were smaller than for 6%, which had a behavior similar for 21 % of oxygen. Color behavior was

monitored by the use of a Minolta Colorimeter. The change of the hue angle for fruit under atmosphere condition of O₂ - 6 % was quicker than for O₂ - 0 and 3 % v/v. The results encourage to the use of the photoacoustic spectroscopy for studies of controlled and modified atmosphere.

S02.404

Cold Storage of Jaboticaba (*Myrciaria jaboticaba* (Vell) Berg. cv. Sabará) under Controlled Atmosphere with Different Levels of Oxygen

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Jaboticaba (*M. jaboticaba*) is a very perishable Brazilian berry with a shelf-life of only 2 days under ambient conditions. For such perishable berries low temperatures and controlled atmosphere (CA) have been used to extended shelf-life, then, the objective of this study was to determine the effect of CA with different levels of oxygen (1, 5, 10, 15 and 20% O₂) during cold storage (12.5 °C) of jaboticaba 'Sabará'. Ripe fruits were harvested and placed into plastic containers (3.2 L) and stored at 12.5±0.5 °C in a humidified gas flow system using a flowboard at a flow rate of 100 mL min⁻¹. At these conditions fruit were kept for up to 8 days and, initially, and each 2 days a group of fruit was analysed in order to verify the effect of CA on fruit quality. Atmospheres with the lowest oxygen concentrations (1% and 5%) significantly reduced the respiratory rates and delayed the ripening process, which was confirmed by the maintenance of higher titratable acidity (TA) content and lower ratio. However, at the lowest oxygen level (1% O₂) firmness decreased more notably than all other fruits stored at higher levels. Untrained panelists sensory evaluated the fruit and the result indicates that CA effectively maintained fruits quality throughout cold storage. After only 2 days at ambient conditions jaboticabas received score of 1.63 (dislike strongly) compared to those under CA which have got score 7.40 (like slightly). After 8 days of storage fruits of all treatments did not reach the limit of acceptability (score 5) and were rated as 6.20 without showing any difference between treatments. Atmospheres the lowest oxygen levels (1% and 5% O₂) slightly reduced rot development which was the main cause of deterioration.

S02.405

Acoustic Impulse Method Cannot Determine Nectarine Fruit Quality

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Potential of acoustic impulse method for determining the quality of two nectarine cultivars (Diamond Ray and Venus) fruit was studied. Among acoustic properties (resonant frequency, stiffness, peak width), only peak widths was significantly different (P≤0.001) between cultivars. Standard quality measurements (fruit weight, firmness, stone share, soluble solids concentration (SSC), titratable acidity (TA), SSC/TA ratio), only stone share (P≤0.001), TA (P≤0.01) and SSC/TA (P≤0.05) was significantly different between cultivars. No clear acoustic signal could be observed in measured fruits. There was no significant correlation between the stiffness and firmness and any other quality characteristics. Major reason is probably a stone resonance which distorts acoustic signal. Based on the above study, acoustic impulse method cannot be used for nectarine fruit.

S02.406

Evaluation of the Impact of Hot Water Treatment on the Sensory Quality of Fresh Tomatoes

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Minimizing the effects of chilling injury during shelf-life is important for maintaining the sensory quality of fresh tomato fruit. Postharvest hot water treatments within certain limits of exposure time and water temperature have been shown to increase the resistance of tomatoes to chilling injury. Mature-green 'Tasti-Lee' and 'Florida 47' tomatoes were submerged in water at 25 (control), 52, or 54 °C for 2.5, 5.0, and 2.5 minutes, respectively. The fruit were then exposed to 100 µl/l ethylene for 2 days at 20 °C to uniformly initiate ripening, and any fruit not exhibiting external red color after the ethylene treatment were discarded. The remaining fruit were stored at 18 ± 1 °C and 80% relative humidity until fully ripe. Ripeness was evaluated by subjective firmness determination and colorimetry (CIE L*a*b* system), with the tomatoes judged to be ripe when the fruit were slightly soft and the a* value measured at the fruit equator exceeded 20. When selected as fully ripe, the color, firmness, concentration of sugars, organic acids, and volatile compounds were measured and a trained panel evaluated sensory quality using 18 descriptors measured on a 16-point scale. Sensory data were analyzed by several methods of multivariate analysis including principal component analysis (PCA), generalized Procrustes analysis, and agglomerative hierarchical clustering. PCA showed that Tasti Lee treated at 52 or 54 °C was associated with the most flavor descriptors, including tomato, fruity, vine/sharp aroma and flavor, but also musty and mealy. In contrast, Florida 47 treated at 25 or 54 °C were high on firmness and sourness descriptors. Florida 47 treated at 52 °C and Tasti Lee treated at 25 °C were in the middle of the first factor on the PCA plot, with Florida 47 having a high score for salty, and Tasti Lee a high score for green aroma.

S02.407

Biochemical Changes on Stored Apple Fruits

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In the present work monitored in terms of biochemical composition 6 apple varieties namely: Delicios de Voinești, Starkrimson, Starkprim, Jonathan, Idared and Generos. Biochemical changes followed in fruits were: total carbohydrates, acidity titrated, ascorbic acid and polyphenols. Monitoring was carried out over a period of 5 months of storage in optimum conditions (1 to 4 degrees C and humidity 90-95%), sampling was done monthly frequency. It was a decline in the total carbohydrate content in average of 20.1%, acidity titrated with 18.2%, ascorbic acid with 27.3% and polyphenols content fell by an average of 23.8%. Thus, it has been observed that, although the fruits have been stored in optimal conditions, their content in bioactive products decreased on average by about 20%, which translates to a relatively large decrease their quality.

S02.408

Storage Quality of Disease Resistant Table Grape Cultivars Lidi, Lilla, Palatina and Sarolta

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Quality of four disease resistant table grape cultivars bred in Hungary (Lidi, Lilla, Palatina, Sarolta) was studied after storage in air at 0 °C for 4 weeks and one week at 21 °C (simulated marketing period). Cultivar significantly affected all studied parameters (soluble solids concentration (SSC), titratable acidity (TA), SSC/TA ratio, electroconductivity (EC) and pH). However, storage affected only SSC and pH. Significant interaction between cultivar and storage was determined on SSC, EC and pH. Among studied cultivars, the most significant changes after storage were detected in Palatina (only TA remained unchanged) and Lidi remained practically unchanged (except in pH which decreased). Sensory analysis showed that significant differences among cultivars occurred in sugar/acid ratio, aroma, taste and general appearance. In spite of significant changes of quality parameters after

storage, Palatina received the best marks from panelists. Future studies should be focused on optimizing postharvest technology for these resistant cultivars to preserve quality during storage.

S02.409

Commercial CA Storage Case Studies Show Potential Energy Savings with 1-MCP (Smartfreshsm) and 'Gala' Apples

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An earlier study in 2008/09 showed 1-Methycyclopropene (1-MCP; Smart-FreshSM) treated 'Gala' apples ripened slower when stored under higher than normal controlled atmosphere (CA) storage temperatures to provide a ~35% energy and some cost savings. To confirm these results, a further commercial case study in 2009/10 was carried out to track the energy usage and quality changes in 'Gala' apples from two identical CA storage rooms (each 210 t) filled on the same day with fruit from the same origin and stored for ~6 months at 1.0 kPa O₂ + 2.0 kPa CO₂. One CA room was treated with 1-MCP and maintained at 4.0 °C while the untreated room was kept at 1.5 °C. Four grower lots, each with slightly different fruit quality characteristics were followed over the storage period with regular monitoring of fruit respiration and ethylene production. Energy balances were calculated from the cooling equipment and CO₂ absorber run time records to show differences in energy usage. Untreated and treated apples in both years show comparable energy usage, ripening behaviour and quality relationships. Grade out results from all the remaining fruit lines in both rooms is compared, especially for defects such as rots. After storage removal fruit samples were held in a simulated marketing chain followed by a short shelf-life period at room temperature after which fruit quality parameters from both rooms are compared and a sensory test carried out.

S02.410

Study on Hypobaric Storage of 'Hujing' Juicy Peach

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'Hujing' is one of the most important juicy peach cultivar grown in Zhejiang province of China. Because of its unique eating quality such as softness, juicy taste and nutritional value, 'Hujing' juicy peach is highly welcomed by consumers. However, it is harvested at hot raining season and is susceptible to deterioration and nutritional losses after harvest. The fruit have a short postharvest life and will rapidly lose their market value at ambient temperature. Low temperature is effective in inhibiting fruit decay and reducing nutritional losses. However, 'Hujing' juicy peach stored at low temperature developed some physiological disorders including can't afterripening. Hypobaric storage has been shown to significantly inhibit postharvest ripening and senescence, thus extending shelf life in various fruits and vegetables. In order to overcome the defects of common cold storage, the authors came up with the idea of applying hypobaric storage technique in maintaining postharvest quality of 'Hujing' juicy peach. The effects of programmed hypobaric storage on the physiological and biological characteristics of 'Hujing' juicy peach were compared to cold storage in air. The results indicated that hypobaric storage not only significantly slowed down respiratory, ethylene production rates, but also inhibited the decrease of soluble sugar, titratable acids and Vitamin C contents. Moreover, hypobaric storage inhibited the increase of PE activities, delayed the increases of protopectin content, thereby maintaining good eating quality and extending the storage life of cold-stored fruit. Hypobaric storage under 5±2kPa pressure could extend the storage life up to 30 days.

S02.411

Chilling Injury in Avocados and its Prevention with Thermal Treatment

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The influence of chilling injury on fruit quality and the use of hydrothermal treatments to minimize those effects were tested in avocados. These symptoms, the black spots, appeared in 'Geadá' and 'Quintal' avocados after being stored at 4 °C for more than 14 days and in 'Fortuna' after 21 days. 'Geadá' had a shelf-life of 4 days at 22 °C, at 4 °C it was up to 14 days, and at 11 °C reached 18 days. 'Quintal' lasted up to 7 days at 4 °C and had shelf-life of 6 days after being transferred to ambient. At the same temperature, 'Fortuna' were stored for 21 days and had a shelf-life of 6 - 8 days, after transference to ambient. These fruits had a shelf-life of 21-22 days when kept at 11 °C. In the second part of this study, when stored at 4 °C for 28 days, fruit browning compromised the appearance which was associated to peroxidase and polyphenoloxidase activity. Cold stored fruit, after transferred to ambient, showed premature climacteric peak, with low intensity. The ripeness was associated to pectinmethylesterase and polygalacturonase activity. The use of hydrothermic treatment was tested to prevent chilling injury. 'Geadá' avocados were treated at 38 °C for 0 - 90 minutes, before storage at 4 °C for 28 days. 'Quintal', 'Fortuna' and 'Hass' were treated at 38 °C for 60 - 90 minutes at 38 °C + 1 minute at 50 °C. 'Quintal' and 'Fortuna' were stored at 4 °C for 28 days. 'Geadá' treated with 38 °C for 60 and 90 minutes, reduced the chilling injury development. For 'Quintal', the most efficient was 38 °C for 60 minutes. These were not efficient to control cold damage in 'Fortuna'. 'Geadá' and 'Quintal' had a shelf-life of 4 days, after being stored at 4 °C for 28 days. 'Fortuna' was only adequate for consumption immediately after taken from cold storage.

S02.412

Shelf-Life of Anthurium Cut Flowers: Evaluation Criteria

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Along the anthurium (*Anthurium andraeanum*) shelf-life period several degradation processes occur, which lead to the final senescence slower or faster. The intensity and speed of these processes directly depend on the cultural practices applied before and during the postharvest management. The efficiency of the technology applied for decreasing the senescence process is frequently evaluated by subjective methods, and based on few observations. The goal of this research was to develop criteria for evaluation of the senescence of anthurium cut flowers 'Eidibel' that might be applied as a common language among the researchers in scientific publications to judge this product. With this objective 120 anthurium cut flowers were kept in a room at 21 to 29 °C for 23 days and were daily analyzed. The scale for the evaluation of senescence development includes grades, from ten (excellent) to one (bad). Grading was related to descriptive and visual aspects of the spathe, and of the spadix, concerning with color, shine, turgescence, and necrosis occurrence.

S02.413

Sensorial Profile of Stored Sweet Corn

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Brazil has a big market for sweet corn (*Zea mays* L.) due to the local tradition of consuming it fresh or as pamonha and curau, dishes prepared with fresh grated sweet corn mixed with milk or coconut milk, and sugar. However, due to its short shelf-life the most sweet corn produced in Brazil is destined to the canned industry. The goal of this research was to evaluate the sweet corn quality stored in different packages under room temperature and under refrigeration by using Quantitative Descriptive Analysis (QDA). Data were analyzed by multivariate analysis. Best results were observed when the fresh sweet corn spike was stored during five days under room temperature (25 °C ± 1 and air humidity of 65% - 75%) without straw and placed over polystyrene tray wrapped with plastic film. Under refrigeration (5 °C ± 1 °C) the best results were observed when 50% of the straws were maintained covering the fresh spike, which was stored during five days over polystyrene tray wrapped with plastic film.

S02.414

Apple Ripening Determined by Conventional Methods and a Genetic Assay ('Nsure' Methodology)

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Molecular biology techniques are developing rapidly and can now be used as assays to help determine the optimum harvest date for fruit crops. While such assays are currently more expensive and time consuming than the conventional maturity tests currently used for apples they offer a number of potential advantages, in particular the possibility to detect changes in fruit ripening processes at a very early stage and perhaps in the near future more novel applications to help predict storage quality outcomes. To adapt a new methodology for practical use requires trialling and comparison with existing methods. When the results from practical ripening testing in different seasons and with a range of apple cultivars are available, the suitability and reliability of molecular methodology can be better understood and assessed. This work compares conventional methods for optimum harvest date determination with a proprietary genetic testing service, supplied by the Dutch based Company 'Nsure'. The 'Nsure' test measures the expression of genes with relevance to some of the key ripening processes in a maturing apple. In 2008 and 2009 three apple cultivars: 'Gala', 'Fuji' and 'Braeburn' from the Lake Constance growing region, Germany were sampled three times in the period leading up to harvest and two times from unharvested trees after the expected optimum harvest date. The conventional ripening parameters: fruit firmness, total soluble solids and starch degradation patterns were used to calculate a ripening index ('Streif index') and the optimum harvest date for long term storage was determined. In addition, samples for the respiration rate, ethylene production and internal ethylene were taken. Gene expression at each sampling date was evaluated by Nsure company. The results from both methods are compared.

S02.415

Assurance of Quality Litchi at Post-Harvest Stage with Pre-Harvest Chemical Treatments

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Consumers all over the world consider good quality fruits and vegetables to be those that have fresh market quality. The quality of horticultural produce at harvest has a decisive influence on its post harvest quality. The litchi (*Litchi chinensis* Sonn) is an important fruit crop having great potential in the international market due to its characteristic flavour and exotic taste. Quality and safety are the two most important factors in the international scenario of liberalized world trade. Litchi is a crop which has a short harvest period coupled with a short shelf life. In recent years the use of chemicals as pre-harvest sprays for improving crop productivity including quality and storage behaviour of fruits have been greatly realized. The present paper is on the influence of pre-harvest sprays of calcium chloride (0.5% and 0.6%), calcium nitrate (1%, 1.5% and 2%) and boric acid (0.2%, 0.4% and 0.6%) and control (distilled water with few drops of Teepol). First application of these chemicals was done when fruits were at bean seed size and second application two weeks prior to harvest. Pre-harvest application of 4% boric acid resulted in higher TSS (16.76°Brix) and lower acidity content (0.55-1%) in fruits during storage. The total sugar (15.92%) and reducing sugar (11.94%) content were also enhanced with 4% boric acid application as pre-harvest treatment. The physical parameters of fruits (weight and diameter of fruit and pulp weight) were found to be positively influenced with the application of calcium nitrate @ 1.5% as pre-harvest spray. The harvested fruits were stored under refrigerated condition (5-7 °C) during the course of study.

S02.416

Effect of Temperature and Exogenous Ethylene on Ripening of 'Jingbai' Pear

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'Jingbai' pear (*Pyrus ussuriensis* Maxim.) is a native pear variety of Beijing, China. It is one of the best varieties with tender juicy and fragrant flesh texture. It needs to go through ripening in order to achieve the best eating quality. At present, the main way of ripening at room temperature is a natural way in practice, the main disadvantage is long-time needing, inconformity of softening and high rotting rate. To search the better condition for improving its ripening quality, the influence of different temperature (14 °C, 17 °C, 20 °C, 23 °C, 26 °C and 28 °C) and exogenous ethylene (50 µL×L⁻¹, 100 µL×L⁻¹ and banana for assistant ripening) were investigated, and ethylene production, respiration rate, firmness, SSC (Soluble solid content) pH, ΔE value, H value, weight loss and disease rate were detected respectively. The results indicated that temperature and ethylene influenced ripening process and quality directly. Fruit firmness exhibited a significant linear negative relation with the ripening time (p<0.01), the high or low temperature caused the inconformity of skin color and softening rate, low-temperature (14 °C) delayed the start time of ethylene peak, high temperature (28 °C) restrained synthesis of ethylene and softening of flesh, following the temperature rise, the respiration rate, weight loss and rot fruit increase, but the ethylene production decrease. Exogenous ethylene treatments improved fruit respiration and ethylene production, application of proper ethylene promoted the fruit ripening and uniform skin color. According to the study, suitable temperature of 'Jingbai' pear ripening was 17 °C-23 °C, the optimum temperature was 20 °C, the optimum concentration of ethylene was 100 µL×L⁻¹.

S02.417

The Use of Modified Atmosphere Storage for Kenyan Grown Cut Roses

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Kenya is a leading exporter of air freighted horticultural fresh produce and cut roses form one of their major exports to the UK. Cut stems of 'Golden Gate' and 'Duett' roses grown in Kenya were packaged in a modified atmosphere (MA) of 5% CO₂, 10% CO₂, 15% CO₂ and normal air. The stems were then stored at 2 °C for three, 11 and 20 days, with control stems (unstored) put in a vase life room on day zero. Respiration rate was measured during the storage period and quality attributes evaluated after transfer to the vase life room at the end of each storage period. The stems stored at 5% CO₂ for three days had improved vase life compared with those stored for 20 days in the same atmosphere; storage for 20 days had a negative impact on vase life. In addition to improved vase life with MA storage, there was a delay in the onset of *Botrytis cinerea* infection on 'Duett' roses. The study demonstrates that modified atmospheres can be beneficial for the short term storage of roses.

S02.418

Effects of Pre and Post-Cold Acclimation on Needle Retention Duration (NRD) of Balsam Fir (*Abies balsamea* L.) Clones

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Balsam fir (*Abies balsamea*, L) is the principle Christmas tree species grown in Atlantic Canada with approximately 10, 000 ha (25, 000 ac) grown, and generating approximately \$72 million annually. Needle loss is the most significant challenge facing the Christmas tree industry of Atlantic Canada, and has been anecdotally attributed to warmer fall and less days for natural cold acclimation. The objective of this experiment is to screen various genotypes at pre and post-cold acclimation to determine if needle retention is improved. Two year old branches were collected from the Tree Breeding Centre, Department of Natural Resources, Debert, NS (45° 25' N, 63° 28' W). Branches were collected in October (pre-cold acclimation) and January/February (post-cold acclimation) then were laid out in the lab and monitored for their needle loss. Branches collected in October (prior to cold

acclimation) had an average NRD of 34 days compared to the 39 days for post cold acclimated branches, a significant ($p=0.001$) increase of 5 days. The initial NRD (before cold acclimation) did show a correlation with the net change in NRD suggesting that the clones that are resistant for needle drop benefitted less due to cold acclimation while the clones that are sensitive to needle drop benefitted. Regression analysis confirmed that the relationship was significant ($p=0.001$) with $R^2 = 46.8\%$. Overall, clones 206 and 398 showed the best NRD before and after cold acclimation, as they were still green and somewhat soft after 50 days. Clones 346, 503, 504, 513, 566 and 643 did retain their needles after 50 days but they were not soft and they did not retain a green color. It is recommended from this study that clones 206 and 398 are tolerant for needle drop can be used for future breeding purposes to develop better needle retaining trees.

S02.419

Effects of Carbon Dioxide Enriched Atmospheres on the Postharvest Control of *Botrytis* Rot of 'Duett' Cut Roses

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The effectiveness of using carbon dioxide for postharvest control of *botrytis* rot on short and long term storage of roses, cultivar 'Duett' roses was investigated. The flowers were stored at 5 °C in atmospheric air, 10% CO₂ or 20% CO₂ for 11 and 30 days. The use of carbon dioxide reduced the *botrytis* rot on inoculated and non inoculated flower petals with the highest reduction achieved by the 20% CO₂. Inoculated flowers stored in air for 30 days developed *botrytis* rot during storage while those stored in carbon dioxide did not show any signs of rotting. Storing flowers in carbon dioxide enriched atmospheres also improved the flower quality and vase life.

S02.420

Effects of Different Temperature and Carbon Dioxide Concentration on Postharvest Physiology and Fresh-Keeping of 'Housui' Pear

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In order to gain the optimum storage condition for 'Housui' (*Pyrus pyrifolia* (Burm.f.) Nakai) pear, cold storage and CA storage were both studied. Five different temperatures (-1.5 °C, -1.0 °C, 0 °C, 1.5 °C, 5 °C) were referred in the cold storage, and five different CO₂ concentrations (1%, 2%, 3%, 4%, 5%) were included in the CA storage in which the O₂ concentration maintain 3% and the temperature kept 0 °C. After storage period for 2, 4, 5, 6 months in above mentioned condition and then 7 days at 20 °C respectively the storage effects were evaluated by detecting the fruits firmness, membrane permeability, content of ethanol and total phenolic material, PG activity, PPO activity and index of core browning etc.. The result indicated that -1.5 °C cold storage kept higher fruits firmness and much lower fruit rot rate, but different degree chilling (or maybe freezing) injury was found in fruits, ethanol content was much higher than other cold storage treatments, at 5 °C, the fruits can be stored for only less than 60 days, and storage time could reach 120 and 150 days at 0-1.5 °C and -1 °C respectively. In case of CA storage, compared with control, the optimum condition was 3% O₂ plus 1% CO₂, which could keep fruit good firmness and flavor, inhibit PPO activity, ethanol content and core browning remarkably, delay polyphenol material degrade and remain better integrality of cell membrane, as the CO₂ content increase, ethanol concentration and core browning index of fruits increased also, when the CO₂ content $\geq 3\%$, the fruits taste a little bitter, however, even 5%CO₂ content, no flesh browning was found. Based on two years experiment, we can conclude that the optimum temperature is -1-0 °C, and the optimum CO₂ concentration of CA storage is 1%, when O₂ concentration is 3%.

S02.421

Study the Effect of Humic Acid and Benzyl Adenine on Postharvest Life of Cut Gerbera

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Gerbera is an important cut flowers and its postharvest life may vary according to the cultivar and postharvest treatments. Humic acid (HA) might beneficial to plant growth by improving nutrient uptake and hormonal effect especially cytokinin activity when it use in plant nutritional programs. But there are very rare records on its effects on postharvest life of flowers. A factorial experiment was conducted to compare the effect of two concentrations of HA (25 and 50 mg/L) and Benzyl Adenine (BA) (10 μM) on vase life of 2 common gerbera cultivars (Cavana and Carmen Blue). The harvested flowers were pre-treated initially with the mentioned solutions for 24 hours. Then after they were moved to vase containing 8-Hydroxy quinoline citrate solution (200 mg/L). The preservative solution was changed every 3 days and the results were recorded everyday for the flowers. It was shown that all the treatments could improve postharvest life of cut gerbera for 2 days in comparison to the control (distilled water pre-treatment). Although HA couldn't decrease the ethylene production of flowers as much as BA treated flowers, but its effect on improvement of the postharvest life was not significantly different with BA. It seems HA can be a potential compound in improving the postharvest life of gerbera. The HA mode of action seems to be a hormonal effect along with some nutritional improvement.

S02.422

Effects of Two Types of Packaging Films as Passive Modified Atmosphere on Some Important Quality Traits of Peach Fruit cv. Alberta

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This research was carried out to determine the effects of polypropylene and low density polyethylene (LDPE) films for increasing the postharvest life of peach fruit cv. Alberta. Fruits were harvested at commercial maturity stage and packed into a modified atmosphere bags. Fruits were stored at 1 °C and 90% relative humidity for 9 weeks. Sampling was carried out each week and fruit were then stored at room temperature for 24 hr and their attributes were investigated. Results showed that both LDPE and PP films suppressed weight loss of fruits in contrast with control. The color index increased during storage period and no significant differences were observed between treatments and control according to color index. The fruit firmness decreased over time but it was lower in passive MAP treatments compared to controls. During storage the titratable acidity of fruits were decreased. Furthermore, the LDPE films showed higher TA than controls and PP films. Total soluble solids (TSS) decreased during storage but no significant difference was observed between treatments and control. In the case of vitamin C, there were no significant differences among treatments and control.

S02.423

Storage Temperature and Period for Suppression of Pupation in *Freesia* "Yvonee" and "Shinygold" Corms According to Harvesting Times

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Freesia hybrida, a member of the Iridaceae is important greenhouse cut flower crop in Korea. The cut flower production of freesia requires first the release of

dormancy of harvested corms and then initiation of floral buds. Dormancy of freesia corms are breaking by storage at 30 °±2 °C for 10-13 weeks and insure rapid uniform shoot emergence when planted. If corms are not breaking dormancy, it will be pupation after planting. Pupation, known as a morphological process of formation of small corms on the old one where shoot emergence does not occur after planting. The depth of dormancy of freesia corms depends on harvesting time. Freesia corms were harvested with two different time, 30days late and immediately after cut flower. The harvested freesia corms were stored for 100days at 5°, 10°, 15°, 20°, 30 °C. Corms harvested immediately after cut flower those of pupation were inhibited by stored at 30 °C for more than 80days in “Yvonee” and stored at 20 °C for more than 100days or 30 °C for more than 60days in “Shiny Gold”. Corms harvested 30days late after cut flower those of pupation are inhibited by stored at 20 °C for more than 100days or 30 °C for more than 40days in “Yvonee” and “Shiny Gold”.

502.424

Effects of Modified Atmosphere Packaging and Cold Storage on Browning and Quality of *Flammulina velutipes*

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Browning is one of the most important problems in *Flammulina velutipes* which directly resulted in quality deterioration and limited the processing and marketing. However, there is little study on the storage of *Flammulina velutipes* presently. Effects of modified atmosphere packaging and cold storage on the browning and quality of *Flammulina velutipes* were investigated with a view to provide a scientific basis for flammulina preservation technology. Research studied the changing principle of browning degree, PPO activity, POD activity, weight loss, total sugar content and decay rate were measured in flammulina with MA packaging at (0±1) °C for 15d. The results indicated that activities of PPO and POD increased, weight loss and total sugar degraded, browning and decay rates are relatively high, and quality declined in the postharvested flammulina after 15 days of storage. MA packaging and cold storage could inhibit the increases in activities of PPO and POD and weight loss and total sugar degradation, and reduce significantly browning and decay rates, which indicated that MA packaging and cold storage could maintain the quality of flammulina.

502.425

Short-Term Pulsing Treatments with Salicylic Acid Improved Postharvest Life of ‘Yellow Island’ Cut Rose

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Several pulse treatments with salicylic acid was tested for effectiveness to delay flower senescence in cut rose cv. Yellow Island. Flower stems were pulsed for 14 hours before transferred to distilled water. Vase life, water uptake, fresh weight, flower diameter, protein content, lipid peroxidation and proline concentration were determined in different intervals. The result exhibited that salicylic acid pulse treatment significantly improved the vase life as compared the distilled water. The pulse solution containing 150 mg/L salicylic acid together with 3 % Sucrose and 200mg/l 8-Hydroxyquinoline sulfate the maximum vase life (9.62 days) as control (5.87 days). Protein content was highest at harvest time, thereafter decreased gradually during senescing of rose petal. In contrast, increasing in lipid peroxidation and proline amino acid accumulation may be due to senescence-associated oxidative damage to petals. Salicylic acid treatment prevented declining protein content and suppressing lipid peroxidation and proline amino acid accumulation in rose flower.

502.426

Physical and Chemical Characterization of Blood Orange Produced in the Organic System

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In Brazil, the orange characterized by intense red color of the pulp and juice, is called the blood orange (*Citrus sinensis*). The color and intensity are dependent on many factors, mainly the climate of the region where they are grown. The objective was to evaluate the physical and chemical characteristics of blood oranges grown under organic crop management. The fruits were harvested in July 2009 from São José do Vale do Rio Preto-RJ (22°13'39.0" S, 42°54'48,1" O), 733m above sea level, with 19 °C average annual temperature. After that, the fruits were taken to the postharvest physiology laboratory at Embrapa Food Technology. There were performed the following analyses: average weight, volume of juice, juice yield, pH, total titratable acidity, total soluble solids, vitamin C, fructose, glucose, sucrose, total sugars, skin color and pulp color. The results obtained for the average fruit weight was 99.94 ± 6.25g. The volume of juice was 34.58 ± 5.28 mL with 0.34 ± 0.03% of juice yield. The pH average of fruits was 3.87 and the total titratable acidity was 0.75 ± 0.02 % of citric acid. The average of total soluble solids contents was 10.95°Brix. The average contents of vitamin C, fructose, glucose, sucrose and total sugars were respectively 757.33 ± 91.47mg×L⁻¹, 416.17 ± 77.37mg×L⁻¹, 7.17 ± 2.71mg×L⁻¹, 2.37 ± 0.20g×L⁻¹ and 423.33 ± 77.36mg×L⁻¹. The results for the skin color were: L* 69.06 ± 0.99, a* 15.73 ± 1.62, b* and 72.60 ± 1.45 and E 101.53 ± 1.53 while the color of the pulp presented L* 59,98 ± 1,30, a* 4,63 ± 1,55, b* 31,51 ± 2,24 e E 20,26 ± 7,95.

502.427

Physical and Chemical Characterization of Persian Lime Fruit Produced under Organic Crop Management

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People always say about the superior quality of organic fruit, but there are no search results that confirm this statement. In order to answer this question, it was proposed this work to evaluate physical and chemical characteristics of the Persian Lime (*Citrus aurantifolia*), in the laboratory of Postharvest Physiology at Embrapa Food Technology Center, Rio de Janeiro. Fruits were harvested in two maturation stages (green and yellow) at the end of June 2009. It was evaluated the total soluble solids content, total titratable acidity, pH, instrumental color, firmness, vitamin C, total sugars content, fructose, glucose and sucrose. The average weight of fruits at the yellow maturation stage was 146.29 ± 13.94g and 150.22 ± 11.61g in the fruits with a green shell. The results of the skin color were: L*=74.99±1.59, a*=-3.00±1.29, b*=66.18±2.32, E=95.98±2.19 and L*=71.90±1.71, a*=-4.56±0.44, b*=61.87±1.49, E=95.98±3.09, for fruits at the maturation stage yellow and green, respectively. The average of total soluble solids content, total titratable acidity and pH were: 7.38±0.30°Brix, 0.07±0.005 mg×100g⁻¹ of citric acid and 5.97±0.07 for yellow fruits, and 7.50±0.14°Brix, 0.067±0.010mg×g⁻¹ of citric acid and 5.80±0.010 for green fruits. The total sugars content in the yellow limes were 557.00±283.42mg×100g⁻¹. The contents of fructose, glucose and sucrose were 530.0±278.60 mg×100g⁻¹, 27.0±7.44 mg×100g⁻¹ and 0.36±0.07 mg×100g⁻¹, respectively. The vitamin C contents were 345.75±82.02mg×100g⁻¹ and 386.25±38.03, mg×100g⁻¹ for yellow and green limes.

S02.428

Effect of Preharvest Ethylene Spray on Fruit Quality and Chemical Attributes of Sour Cherry

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Influence of pre harvest ethylene spray on fruit quality attributes and certain nutritional compounds of 'Cigany Meggy' sour cherry (*Prunus cerasus*) were studied. Trees were sprayed with ethephon at 250ppm one week before anticipated commercial harvest. The quality attributes and nutritional compounds measured were: antioxidant activity, total phenolic and anthocyanin content, soluble solids concentration (SSC), titratable acidity, juice pH, and flesh firmness. Fruits from trees receiving ethephon spray had significantly lower SSC, anthocyanin content and lower firmness than those from non-sprayed control. Ethephon treatment did not affect antioxidant activity and total phenolic content, although both of them tended to be higher in fruits from non-treated control. There was a significantly positive correlation coefficient between anthocyanin content and SSC ($r=0.98$).

S02.429

Effect of Ethanol on Postharvest Quality of Two Carnation Cultivars

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Ethanol can increase the vase life of some cut flowers by inhibition of ethylene biosynthesis or ethylene action or both. The effect of different concentrations of ethanol (2, 4 and 6 %) on carnations cultivar 'Pilar' and 'Mundo' was studied. Data were recorded to determinate ethylene production, vase life, fresh weight and solution uptake over time. Distilled water and silver thiosulphate (0.5 and 1 mM) were used for the control treatments. Continuous treatment with 2 % and 4 % of ethanol for cultivar 'Mundo' and 2 % for cultivar 'Pilar' increased vase life compared with the water treatment. In the senescence phase of ethanol-treated carnation flowers, the typical petals inrolling, characteristic of this process, was not observed, but stems were more dry and fragile, and stem diameter was reduced. The three concentrations of ethanol reduced the peak of ethylene production. The treatments with 2 % and 4 % of ethanol for cultivars 'Mundo' and 2 % for cultivar 'Pilar' delayed the ethylene production compared with the water treatment. All ethanol-treated flowers reduced the increase of the fresh weight during the first days and increased the relative fresh weight loss in comparison with the silver thiosulphate treatments, which could be related to a reduction of the solution uptake.

S02.430

Effect of Modified Atmosphere Packaging on Chemical Composition, Antioxidant Activity, Anthocyanin and Total Phenolic Content of Sweet and Sour Cherry Fruits

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The impact of packaging in a regular air storage at 0 °C and modified atmosphere storage (MAP) packaging on composition of several nutritional compounds in 'Siah-e Mashhad' sweet cherry and 'Albaloo' (a local Iranian sour cherry) and 'Érdi bôtermô' sour cherries was studied. Antioxidant activity, anthocyanin content, and total phenolic content were highest in 'Albaloo', followed by 'Bôtermô' and 'Siah-e Mashhad' both at harvest and after storage. Total antioxidant activity was lowest after 15 day of packaging. Antioxidant activity in the storage remained unchanged in 'Siah-e Mashhad' and 'Bôtermô', while it increased in 'Albaloo' sour cherry.

Total anthocyanin content expressed as cyanidin-3-glucoside, was highest in 'Albaloo', intermediate in 'Siah-e mashhad', and low in 'Bôtermô'. During storage, anthocyanin content was decreased significantly specially in 'Albaloo' and 'Siah-e Mashhad'. MAP treatment maintained storage quality of cherries and gave better chemical attributes.

S02.431

Effect of Modified Atmosphere Packaging on Postharvest Quality of Carambola (*Averrhoa carambola* L.)

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The effects of modified atmosphere packaging (MAP) with polyvinyl chloride (PVC) plastic film and polyethylene (PE) plastic bag on the storage life under 10 °C of carambola fruits (*Averrhoa carambola* L.) were investigated. Measurements of firmness, percentage of weight loss, flesh colour, electrolyte leakage, malondialdehyde (MDA) content were performed during the experiment. The results showed that carambola which kept in PE packaging was extent storage life for 27 days, following by PVC packaging and control for 24 and 19 days, respectively. Moreover, PE treatment could maintain firmness of carambola during storage life than PVC and control. Fruit in MAP had minimal water loss (1.25 -2.55%) that PE bag was more effective in reduction of weight loss than PVC wrapped. The PE bag was extremely effectively in delaying of turning yellow of carambola and also decreasing of hue value. To decrease in hue represent a change in peel colour from green to yellow in control fruit. Using PE packaging delayed turning yellow following by PVC and control respectively. During storage, electrolyte leakage significantly increased in control set, but not in the MAP treatments, in correlation with the development of turning yellow of carambola. Malondialdehyde (MDA), an indicator of lipid peroxidation caused by ROS, increased during storage and the contents were higher in control fruit than PVC and PE treatment, respectively. This study showed using PE packaging under 10 °C as the optimal treatment to maintain the quality and prolong storage life of carambola.

S02.432

Effect of 1-Methylcyclopropene (1-MCP) on Postharvest Quality of Peaches After Exposure to Exogenous Ethylene

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Peaches 'Mibaekdo' were harvested from commercial orchards in S/Korea. Fruit (4-5 Kg) per each box were treated for 6 hours within 15 L chambers held in air, 5ppm, and 10ppm ethylene to keep good external appearance and market quality, respectively. After treatment the fruit were held at 20 °C for 12 h with 1-MCP (5 µL L⁻¹) and then stored at 8 °C (90-95% RH) for 14 days. Increase of respiration and ripening were not affected by exogenous ethylene application (5 and 10ppm) during the short exposure for 24 hours. However after exposure to exogenous ethylene, respiration and internal ethylene evolution were greatly affected by 1-MCP treatments. Fruit softening, SSC and titratable acids were most inhibited by 5ppm ethylene and subsequent 1-MCP (1 µL L⁻¹) treatments during storage for 14 days.

S02.433

Quality Management of Cut Carnation Flowers with Long-Term Sucrose Treatment

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Shipping time management of cut flowers is inevitable as a natural product. Storage of cut flowers in dry conditions brings lowered quality even though kept in low

temperature. The aim of this work is to show the possibility of quality management of cut carnation flowers with long-term sucrose treatment. Cut carnation flowers (cv. Excerea) were kept in solution containing 0 to 15% sucrose and germicide at 4 µl x for 3 weeks. Flowers treated higher sucrose showed higher increase of fresh weight during both sucrose treatment and longevity test. Considerable glucose and fructose accumulation was observed in petals and calyx after 3 weeks of 5% sucrose treatment. In the cut flowers without STS treatment, the flowers treated with 5% sucrose for 3 weeks showed delayed in-rolling and ethylene production compared with flowers treated with 0% sucrose. No significant difference in flower longevity was observed among the flowers treated with 5% sucrose for 4 to 8 weeks. Cut flowers harvested in April and treated with 5% sucrose for 6 weeks displayed larger size of flowers with slightly higher L*, lower a*, b* and C* values in comparison with flowers harvested in May. Content of two major anthocyanins in petals of flowers harvested in April was slightly lower than those in May. Tested other 5 genotypes of carnation could adopt long-term sucrose treatment. Present study demonstrates that the long-term sucrose treatment is effective way to keep cut carnation flower quality.

S02.434

Regulation of Rose Petal Growth by Cell-Elongation Inhibitors

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Long vase life is an important element of cut flower quality. Especially in roses, we enjoy their flower opening which is the petal growth from bud to full bloom. If the speed of petal growth could be controlled and petal made to open fully, roses might be enjoyed for longer. Flower opening is generally caused by expansion growth of petal cells. It has been suggested water influx into petal cells is a key mechanism for cell enlargement and flower opening. However, it has been proposed that when the cell wall remains rigid, water influx and cell expansion do not occur. Plant cell wall was restrained its loosening by xyloglucan, which is a structural polysaccharide of primary cell wall. Xyloglucan endotransglycosylase/hydrolase (XTH) is known as one of the enzymes to rearrange the xyloglucan and loose the wall enabling cell growth. Furthermore, XG9, one of the xyloglucan-derived oligosaccharides, was reported to inhibit auxin-induced elongation of pea hypocotyls. This inhibition was suggested to be caused by suppression of XTH activity. The aims of our study are to clarify how XTH involves in rose flower opening and to regulate its activity for control of petal growth and improvement of vase life. In previous reports, we have isolated four XTH cDNAs from rose petal and analyzed their mRNA expression independently during petal development and some paralogs have shown their mRNA transcript levels exclusively correlated to rose flower opening. In this study, we analyzed XTH activity to examine their functions in detail. Then we got XG9 from rose and mung bean. Now we are investigating their effects to control the speed of rose petal expansion and analyzing their influence on XTH mRNA transcription and activity.

S02.435

Preliminary Data for Non-Invasive Estimation of Firmness in Apple Fruits Using Novel Optical Sensing Techniques

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The project is focused on the development of non destructive methods for fruit quality evaluation such as spectroscopy and multispectral imaging, in commercially Danish grown apples for juice making. Non-invasive sensors that allow rapid measurements of fruit composition are desirable to replace traditional destructive methods in terms of optimization of resources and sampling. The outcome will be the development of practical fruit quality evaluation methods for growers that can

be applied at the orchards, in order to give an additional added value to a traditional low cost product. In preliminary experiments we have tested the ability of visible/NIR spectroscopic technique for its ability to predict firmness, which is a relevant fruit quality trait connected to juice making [1]. Measurements of firmness on the shade and exposed side of the apples were carried out using invasive (penetrometer Wagner type Basic 7/16[™]) and non invasive (spectrometer system Tec 5, MOE-1 System, Serie 0036-equip #101091) methods. Collected data was analyzed using multivariate data analysis (PLS: Partial least squares and PCA: Principal component analysis) in order to establish correlations between electromagnetic radiation (400-730nm.) and firmness. The intention is to build a model using PLS and PCS techniques to identify wavelengths that are predictive for firmness of apple cultivars for commercial harvesting.

S02.436

Fruit Quality, Colour Development and Absorbance Difference Index (IAD) of Different Nectarine Cultivars at Different Harvest Dates

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The influence of cultivar and harvest date on colour development, fruit size, fruit quality parameters and absorbance difference index were assessed. Fruit was collected from commercial orchards located in the area of Lleida (Spain) in 2009. The cultivars were grouped in five couples in which each one had a similar commercial harvest date, except 'Big Top[®]' which was considered as a reference. Each couple of cultivars included a sweet and a non sweet cultivar, and different percentage of fruit coloured surface. The cultivars covered a range of maturity from June to September. Each cultivar was harvested at 7 days intervals at five harvest dates, two before commercial harvest date, one at commercial harvest date and another two after commercial harvest date. Over the different harvest dates, fruit firmness and titratable acidity were the only fruit quality parameters showing differences between both types of cultivars (sweet-non sweet). Fruit firmness, decreased along different harvest dates for all the cultivars, but in different rates depending on the cultivar, while soluble solids content increased. Titratable acidity was dependent on cultivar but, in general, sweet cultivars showed a decrease during harvest dates, whereas non-sweet cultivars maintained it more constant. On all harvest dates, sweet cultivars presented greater percentage of red skin colour than the non-sweet cultivars, and they developed red colour earlier. Most of the sweet cultivars showed more than 60% of red skin colour even before commercial harvest, and the non-sweet cultivars achieved this percentage after commercial harvest. Fruit size through different harvest dates was dependent also on cultivar. Related to the decrease of fruit chlorophyll-a content at different dates during fruit ripening, IAD also decreased for each cultivar and this decrease was not dependent on the cultivar type.

S02.437

Preliminary Results of Flame Grapefruit in "Campo de Cartagena"

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Flame grapefruit is a new variety of coloured grapefruit, widely grow in Florida. This new variety has been introduced in Spain through the IVIA and to clean up by the apex technique *in vitro*. The interest of this variety consist in knowing if the quality of the fruit and its coloration is higher or not than the other two widely grow variety in Spain, Star Ruby and Rio Red. Flame trees were planted in "Campo de Cartagena" in 2008 and in 2009/2010 harvest they gave the first fruits, which are comparing with the two varieties mentioned above. Fruits were harvested before the natural change of colour (green to orange) in November and January. Prelimi-

nary results show that the quantity of the fruit is similar in the three varieties but Flame external and internal colour is similar to Rio Red and lower than Star Ruby.

S02.438

Preliminary Study About Barberina Orange in "Campo de Cartagena"

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Barberina orange is a spontaneous mutation of Valencia Late orange tree detected in Rafelcofer (Valencia) in 1982. The study of mother tree began in 1992, some plants were taken to germoplasm bank IVIA (Valencia) to closely follow them up. Some of the difference characteristics of this orange are late maturity, good size, good coloration and excellent organoleptics quality. Which less acidity Valencia late orange can be recollected during May and June. We can distinguish Valencia Late from Barberina because has bigger and more intensive green leaf. Barberina can be used as orange juice and as fresh fruit. Fruits can stay long time in trees without sings of less production for the next year. We will exposure the quality characteristics of this new variety in comparation with Valencia Late and other rootstock as Cleopatra mandarin and Carrizo citrange than grow in "Campo de Cartagena" (Murcia, Spain). Data show a bigger size of the fruit, more intensive coloration, more quality of juice and seedless. The production is high.

S02.439

Cold Storage of Strawberry 'Oso Grande' in Different Concentrations of O₂

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The marketing of strawberries is hampered by its perishability, mainly because to the post-harvest diseases. Studies have shown that atmospheres with high levels of O₂ can maintain the quality of vegetables and slow the growth of microorganisms. The aim of this study it was to evaluate the quality of strawberry 'Oso Grande' under controlled atmosphere with different concentrations of O₂. The strawberries were selected, cooled and stored at 10 °C in the hermetic mini-chambers. It was applied different concentrations of O₂ by the continuous flow of 150mL.min⁻¹ with a "flowboard". Treatments consisted of five concentrations of O₂ (1%, 3%, 20%, 60% and 90%) and strawberries were evaluated for 10 days. Treatment with 90% O₂ provided the lowest incidence of rot (2.85%), followed by 60% O₂ (6.41%) at the end of storage. These treatments also received the highest scores in the appearance. The other treatments showed 16.22 to 20.83% of the fruit with rot. The respiratory activity of the fruit with 1 and 3% O₂ was 11.3 and 15.3 mL CO₂×Kg⁻¹×h⁻¹. In other treatments the results were similar, with values of 21.8 mL CO₂×Kg⁻¹×h⁻¹. The loss of fresh strawberries was less than 1%, demonstrating the effectiveness of the technique in the control of relative humidity in storage. The treatments did not affect the firmness, with a reduction of 8.8 N at the beginning to 7.3 N at the end of storage. Despite presenting statistical difference in the variables related with skin color (brightness, chromaticity and hue), the difference was subtle, not being visually perceptible. Strawberries 'Oso Grande' stored at 10 °C under controlled atmosphere with 60% and 90% of O₂, keep commercial characteristics for 10 days.

S02.440

Apples in the Southern Brazil - Effect of Cultivars and Clones on Fruit Quality

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The apple Brazilian production has the challenge of finding cultivars more adapted to the particular geographic condition of the Southern part of Brazil. With the prediction of global warming it becomes very important to evaluate the performance of new genetic material – including plant/rootstock combination – under different climates and soil condition. This study aim to compare the fruit color, firmness and chemical composition of 2 cultivars and 10 clones of apple, grafted on M9 and Maruba rootstocks, the latter with M9 as interstem. Fruit of cultivars Pink Lady and Daiane and clones of Gala (MaxiGala, Gala Real, Galaxy, Royal Gala, Imperial Gala and Baigent) and Fuji (Fuji Suprema, Fuji Select, Fuji Precoce and Mishima), were harvested in orchards of the Experimental Station of Embrapa Grape and Wine, located in Vacaria/State of Rio Grande do Sul (latitude 28°30'48"; longitude 50°52'56", altitude 968m). Fruits were harvested from plants of 2 and 3 years old (in 2007/08 and 2008/09) and evaluated for starch (scale from 1 to 5), titratable acidity (Cmol/L), Soluble Solids (°Brix), firmness of mesocarp (N), skin color (L*, a*, b*, C*, h*) and fruit size. The results showed a significant effect (P < 0.01) of year on the analyzed variables. There was only one significant effect caused by rootstock: M9 caused an increase on fruit diameter (P < 0.05). It was also observed an increase in fruit firmness of plants grafted on Maruba rootstock with M9 interstem this result, however, needs to be confirmed in further studies. Other quality variables were not influenced either by rootstocks, cultivar/clone, or interaction of these factors.

S02.441

Estimation of Soluble Solids Content and Firmness in Apple (Golden cv.) by NIR Absorbance Indices

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The objective of this study was to evaluate in Smoothee Golden Delicious apples, the use of NIR spectroscopy as a non-destructive method to estimate some quality parameters during the ripening process of fruits. In this experiment, 225 apples were collected from an experimental orchard of the Estación Experimental de Aula Dei (CSIC) in Zaragoza (Northeastern, Spain). Absorbance NIR (305-1145nm) were recorded from samples picked up every 15 days during 7 months until harvest. In the same fruits, soluble solids contents (SSC) and firmness were measured by traditional destructive methods. MLR and PLS calibration methods were used to create the statistical model to predict SSC and firmness. Good results were obtained when PLS calibration was applied to the whole spectrum. However, as a novelty, when the same procedure was applied using solely three absorbance indices A670/A785, A670/A980 and A785/A980 instead the whole spectrum In this case, the correlation coefficient improved significantly. The R² values were 0.97 for firmness and 0.84 for SSC, which are higher than other reported in the literature for the same commodity. On the other hand, when MLR calibration models were applied, the estimations of these parameters were less accurate than when the PLS method was used.

S02.442

Determination of SO₂ Residue Levels of Some Table Grape Varieties during Storage

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This research was carried out at laboratory of post harvest physiology and cold rooms of the Department of Horticulture, faculty of Agriculture, university of Ankara. The aim of the research was to determine of SO₂ residue Revels of some table grape varieties during storage. Sultani Çekirdeksiz cvs. was harvested from Manisa region and Müşküle cvs. was harvested from İznik region and transported to Ankara. Grapes were precooled and grape guard pad placed on the grapes then packed. They were stored at 0 °C and 85-90%R.H. conditions. The experiments are conducted in "Randomize plot design" and parameters like the appearance, flavour, total soluble solid content, titratable acidity, SO₂ value, decay rate and weight

losses were measured fifteen days intervals during storage period. As a result, of two years experiments, residue level of SO₂ has not been higher than maximum level 10 mg/L during storage in Sultani Çekirdeksiz cvs. and it has been stored successfully for 90 days. However Müşküle cv. has been stored successfully for 90 days.

S02.443

Image Based Apple Quality Estimation at Harvest Time

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This paper presents a new method for automatic estimation of the quality of fruits at harvest-time: Pixfel©. The early knowledge of apple quality level is a mandatory tool for marketing and sale management allowing to anticipate the trade planning and to increase the farmer income. The affordable price of digital cameras enabled us to propose an automated system of quality prevision management for the professionals which works without disturbing the current infrastructure. Pixfel© allows an automatic early estimation of apple quality including grade, coloration and major surface defects such as russeting, bitter pit, soft scald, decay... At the entrance of the cold storage facility, each bulk shipping bin is photographed, and then the fruits visible on the top are segmented to determine the diameter and surface coloration for each individual fruit. The results are then introduced in a centralized database for statistical analysis. Finally, using Pixfel® allows to replace the early estimation of the quality of fruits usually manually operated by sampling. The proposed tool has been tested since the 2004 harvest, and the results provided by the image analysis algorithm has been validated using exhaustive measurements operated on the batches of fruits. The commercial testing begun in 2007 at SCICA Castang, the most important apple grower in France, and the final product was released in 2009.

S02.444

The Chemical, Physical and Mechanical Properties in Storage Period Organic and Conventional of Kiwifruits

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This study was carried out to determine the chemical, physical and mechanical in storage period of organic and conventional kiwifruits. Kiwifruits were stored during four months. Measurements were made three periods (postharvest, second and fourth months of stored fruits). The chemical properties such as the total soluble solid content, titratable acidity, pH, total phenolic, total antioxidant activity, total sugar and organic acid, physical properties such as length, width, thickness, geometric mean diameter, sphericity, surface area, mass, fruit density, bulk density, porosity, static coefficient of friction, colour characteristics (L, a, b) and mechanical characteristics namely skin and flesh firmness were determined for kiwifruit cv. Hayward. The changes of chemical, physical and mechanical properties were obtained according to the measurement periods.

S02.445

Changes in Water Status in 'Camarosa' Strawberries Associated with Storage at Low Temperature and High CO₂

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Despite the essential role of water in fruits there is still little information about changes in water status during their postharvest storage. Moreover, the water status (the distribution of free and bound water) also differs between fruits of equal water content. This work puts forward the possibility that the storage of strawberries under different storage conditions could be associated with changes in the amount of some

specific water fractions. Due to the suitability of differential scanning calorimetry (DSC) for monitoring water status in fruits, we applied this technique to determine the water status of strawberries exposed to low temperature and high CO₂ levels. We examined the changes in the amount of unfreezable water fraction (UFW) at 0 °C for 10 days in strawberries stored in air or pretreated with 20% CO₂ for 3 days and then transferred to air for a further 7 days. As part of our integrated approach to water state analysis we determined the evolution of compatible solutes. Quality parameters such as colour, taste and polyphenol content have also been analyzed. Our results indicate that storage at 0 °C was associated with a significant decrease in UFW content in untreated strawberries by the third day of storage at 0 °C. In contrast, the UFW content in strawberries at the end of the 3-day CO₂ treatment did not change. This effect of short-term high CO₂ treatment on water status could be especially useful in strawberries that exhibit a high susceptibility to water loss during postharvest storage. The ability of CO₂-treated strawberries to prevent the decrease in UFW content is discussed.

S02.446

Defining the Suitable Cold Storage Temperature for Persimmon cv. Karaj

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Each fruit cultivar needs specific storage temperature for suitable postharvest life without chilling injury. No sufficient information about suitable storage temperature for Iranian persimmon (cv. Karaj) is available and the aim of this study was to determine the best storage temperature for this persimmon cultivar. The fruits were harvested at mature stage and maintained at different storage temperatures of 0, 2 and 5 °C at > 80% RH. In persimmon fruit, browning, gel formation and softening are chilling injury symptoms. Fruit traits as well as quality factors were determined during storage period by collecting data at monthly intervals for 4 months. Results showed that fruits at 0 °C had highest firmness with no gel formation and external or internal browning. Also fungal incidence at 0 °C was less than that at 2 ° and 5 °C. There was no significant difference among fruits for TSS, TA and color index at different temperatures. Therefore considering the high fruit quality with low fungal incidence and without chilling injury symptoms, 0 °C is the best cold storage temperature for 'Karaj' persimmon fruit.

S02.448

Effects of Silver Nanoparticles and Sucrose on *Gerbera jamesonii* cv. 'Deep Purple' Cut Flowers

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Gerbera (Gerbera jamesonii) vase life is most often terminated by stem bending or breaking and petal wilting. Maintenance of a positive water balance is important for this cut flower. Effects of vase solutions containing 1 mg×L⁻¹ silver nanoparticles (SNP) with or without 6 % sucrose on gerbera cv. 'Deep Purple' vase life, relative fresh weight, relative solution uptake, stem bending or breaking, stem end discoloration and ethylene production by petals, stem ends and stem necks were evaluated. The combination of SNP plus 6 % sucrose increased vase life by 8 days compared with the deionised water control. This treatment maintained relative fresh weight above 1.0 g g⁻¹ initial fresh weight for 18 days compared to only 4 days for the control. Petal wilting and stem break were decreased by SNP plus 6 % sucrose compared to the control. Stem breakage was most frequently recorded for control and SNP treatments. SNP plus 6 % sucrose treatment enhanced ethylene production by petals, stem ends and stem necks during vase life. However, there were no obvious adverse effects of this increased ethylene on vase life parameters. Ethylene production in control and SNP treatments increased sharply upon stem breakage. Overall, results suggest that 1 mg×L⁻¹ SNP plus 6 % sucrose has commercial potential as a vase solution for cut gerbera flowers.

S02.449

Magnetic Resonance Imaging for Kiwifruit Quality Evaluation: Shelf-Life and PGR Detection

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Magnetic Resonance Imaging (MRI) is a technique known predominantly for its medical and diagnostic applications, and is capable of producing non invasively high quality images of any internal volume or section of the considered sample. MRI has been widely applied in food science in the last decade, mostly for studying fruits and vegetables. Several papers are present in literature, mainly concerning the determination of the internal morphology, the evolution of tissues during post-harvest ripening/storage, and the evaluation of the overall quality by measuring quality related parameters. Kiwifruit has been extensively studied; we have recently considered the variation of the internal structure, and thus the quality, as a function of the post-harvest storage conditions, i.e. temperature and atmosphere, for cv. Hayward and for new varieties, which might be appealing for the market in the next future. We have also considered the effects of plant growth regulators (PGR) on the shelf-life, and we have observed that MRI is capable of distinguishing kiwifruits treated with PGR from those not treated, as well as of discriminating the specific PGR used. Comparison of T2-weighted MRI images of untreated and treated (with two different PGRs, i.e. auxin and cytoquinine) samples showed that the use of PGR can be determined, both at harvesting and commercialization step, with a precision of 100%. MRI images revealed large differences in terms of tissues' organization of the external part, with water arrangement and cellular wateriness playing a fundamental role. We observed that T2-weighted MRI images of untreated kiwifruits are characterised by four regular concentric spherical crowns. Auxin-treated samples showed several 2-3 mm thick channels dark in colour, while T2-weighted MRI images of cytoquinine-treated kiwifruits have darker stains in the outer zones.

S02.450

Leaf Treatments to Improve Postharvest Quality in Cut Flower Species

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The quality characteristics of cut flower species are influenced by environmental factors such as temperature and solar radiation, which depend on the growing season. During the winter or the summer it is often difficult to obtain a high quality product. In cut flower species like chrysanthemum, gerbera and lilies, the main problems are: reduction of the stem diameter and height, flower size, low intensity of flower color, high flower abortion, low flower longevity. These problems can be attributable to a reduced photosynthetic activity and to the consequent reduced availability of energy resources necessary to complete the development of the plant and of the flowers. The use of easily available products, such as sugars (sucrose, glucose, fructose), salts (K_2SO_4 , H_2PO_4), antioxidant compounds (malonic acid, vitamin C, citric acid), carried out 20 to 10 days before harvesting, was evaluated with the aim to improve flower quality. In lilies, the leaf treatments determined a significant increase of stem height and diameter, bud and leaves length, flower color and longevity, and a reduction of flower abortion. In gerbera and chrysanthemum, the results showed a significant increase of the stem height and diameter and of flower size following leaf treatments. The trials also showed that the use of these compounds can increase the longevity of the flowers and retard the bending of the stems, that is the main problem in the vase life of gerbera. These results demonstrated that the use of simple and easily available compounds can guarantee the production of high-quality flowers, even in unfavourable environmental conditions for ornamental species production.

S02.451

Investigation of Sugar and Acid Contents in Bamboo Shoots during Storage under Modified Atmosphere Packaging (MAP) Condition

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Sugar and total oxalic acid contents in bamboo shoots, with or without application of the modified atmosphere packaging (MAP), were investigated during storage at 5 °C and 25 °C. The accumulations of sugar content were different among sections along the length of bamboo shoot (apical, middle, and basal). In all treatments of three different harvest crops, the content of sucrose was highly observed at the apical section. Meanwhile, glucose and fructose contents among the sections changed slightly. The results also indicated that the predominant sugar accumulation was observed in contents of sucrose and total sugar of MAP treatment stored at 25 °C. Additionally, during storage, there was no significant change of total oxalic acid content in all tissues of MAP treatment. The results clearly suggested that the characteristics of sugar accumulation along the length of bamboo shoot, depending on their specific tissue sections. Moreover, the application of MAP influenced the changes of postharvest cellular metabolism of bamboo shoot, since it significantly induced the accumulation of sugars and maintained content of oxalic acid during storage.

S02.452

Functional and Physico-Chemical Characteristics in Brazilian and Chinese Cultivars of Fresh and Freeze-Dried Garlics

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Garlic is considered a medicinal plant and its health benefits are attributed to organosulfur compounds, particularly the thiosulfonates. The objective of this study was to evaluate the physico-chemical (moisture content, soluble solids, acidity and pH) and functional (allicin content, antioxidant activity by the β -carotene/linoleic acid and total phenolic compounds) characteristics of fresh and processed (freeze-dried) garlics. The experimental used Brazilian (Peruano and Caçador) and Chinese (Jinxiang) cultivars in a completely randomized design with three replications. The results showed no significant differences in moisture, soluble solids and pH for all fresh garlic cultivars studied. There were significant differences in the acidity content, with Peruano cultivar showing the highest acidity. No significant was observed in allicin content, but differences were noted in antioxidant activity and phenolic compounds. Peruano cultivar showed smaller antioxidant potential in relation to Caçador and Jinxiang cultivars. Freeze-dried garlic showed significant differences in functional compounds evaluated. Jinxiang cultivar had less allicin content and antioxidant activity. Freeze-drying caused significant losses in the level of allicin content in the Jinxiang cultivar (91%), in antioxidant activity in the Jinxiang (66%), Caçador (53%) and Peruano (30%) cultivars, and in the content of total phenolic compounds in Caçador (46%) and Jinxiang (40%) cultivars. Overall the Brazilian cultivars showed higher levels of functional properties than the Chinese cultivars.

S02.453

Varietal Responses of Zucchini Squash Fruit to Storage Temperature

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Postharvest loss of commercial value is a negative trait affecting zucchini fruit quality.

After harvesting and during fruit storage, zucchini fruits are susceptible to chilling injuries and fruit deterioration by softening. Since the real commercial value for this crop in Almería depends on its export to Europe, it becomes very important the use of techniques to improve fruit shelf-life. A total of 5 different commercial varieties of zucchini squash fruits growing in greenhouses in Almería (Spain) have been analyzed for commercial life, including tolerance to chilling storage. Ten fruits of each variety were used for each treatment. They were stored in climate chambers with controlled relative humidity, at three different temperatures: 4, 12 and 20 °C. One analysis was performed after 7 days of storage and other after 14 days. In order to compare varieties and to select the best adapted to postharvest storage and temperature, several parameters related to quality have been analysed: water loss, chilling damage (appearance of pits in the fruit peel), and firmness. Symptoms of chilling injury can be the consequence of oxidative stress resulted from excess reactive oxygen species that induce peroxidation and breakdown of fatty acids in membrane lipids. Malonyldihydroaldehyde (MDA) content was measured in order to detect differences in peroxidation levels among fruits from the 5 zucchini varieties used in this work. The oxygen radical scavenging activities catalase (CAT) and guaiacol peroxidase (GPX) have been also measured in the different varieties, as indicative of stress resistance. We have been able to detect one variety that retains better fruit quality after storage time and low temperatures, and which shows a good correlation between storage resistance, low MDA levels and CAT and GPX activities. The results will be discussed in this presentation.

S02.454

Acoustic Resonance Analysis for Quality Characterization of Fruits and Vegetables

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Acoustic resonance analysis is a method which has been successfully implemented in various industries for non-destructive on-line quality assessment of different materials such as roof tiles or gear blocks. The current investigation aims to adapt this method for non-destructive quality assessment of fresh fruits defects such as meakiness in apples and peaches, and woody and especially hollow asparagus spears. Preliminary studies indicated the problem that the wide span of geometric variation of fruit and vegetables impair measurements, resulting in a lack of the typical impulse response characteristic known for metal or ceramic devices under test. Hence, it is advantageous to look into time domain variations and to use specific models. Therefore the asparagus spears as well as the fruit have been impacted repeatable with a specific clapper. The mechanic vibration in the structure or in the ambient air are measured touching or contactless, converted into electric signals, filtered, amplified and fitted to the following data processing line. In a second step the data were extracted and classified with the software SR20 AT (RTE, Pfnitzal, Germany) to generate produce state specific "finger prints". Data obtained on the specific produce have all been calibrated by established organoleptic methods, by rating, and by instron-type machine application.

S02.455

Fruit Peduncles as an Indicator for Postharvest Freshness of Sweet Cherries

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Sweet cherries shelf life is always very limited even if fruit are stored under optimal conditions. Especially peduncle browning and their dehydration may indicate initial quality changes. Hence, subjectively graded changes in peduncle appearance are often used to evaluate the decline in fruit freshness. The presented investigation denotes means to objectively determine the properties of fruit peduncles and evaluates their applicability as indicators of fruit freshness. Changes in colour and structure (shrinkage, bending, ...) of fruit peduncles, initially green and turgescant at harvest, mainly result from variations in water status and degradation of pigments (chlorophylls). Selected components of water status and chlorophyll fluorescence parameters were determined to objectively characterize cherry fruit peduncle properties.

The results show that peduncle discoloration is a helpful indicator of losses of freshness in sweet cherries. Colour changes were initially mainly due to water losses. Temperature dependent metabolic processes affect colour only after prolonged storage.

S02.456

Skin Colour Changes in Fruits of Two Sweet Cherry Cultivars, its Heterogeneity and Relationship with Quality Indices

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Sweet cherries (*Prunus avium* L.) are non-climacteric fruit, so must be harvested once they complete colour, soluble solids content and firmness changes associated with maturity. Colour of the fruit skin is a maturity index used to decide the harvest time, optimum colour depends on cultivar. The aim of this work was study the amount of fruits colours (heterogeneity) in a plant, the relationship between quality and colour and validates the colour as a harvest index in two cultivars. Fruits of Lapins cultivar were harvested from 9th to 12th weeks after blooming (WAB), and from 10th to 13th WAB, for the Sweetheart cultivar. At each sampling time, all fruits of a tree were collected. Proportion of fruit in each colour class (from 1 to 8, from green to mahogany) in relation to total fruit per tree was calculated. For each colour, b* (CIELAB* colour space), firmness (Durofel® units), total soluble solids content (%TSS) and titratable acidity (%TA) were measured. Heterogeneity of fruits maturity of each plant was calculated using b*. Cultivars differed on heterogeneity only in the first sampling time, being higher for Lapins. The b* correlated with firmness (r=0.84 and r=0.28, for Lapins and Sweetheart, respectively) and %TSS (r=-0.92 and r=-0.90, for Lapins and Sweetheart, respectively). Regardless sampling time, Lapins reached similar %TSS when fruit developed a similar colour, while harvest date showed influence in the %TSS reached in advanced maturity stages of Sweetheart (colours 7 y 8). Also, the firmness of each class of colour differed with the harvest date, mainly in Lapins. The %TSS increased from 8.4 to 20 (colour 1 to 8) in Lapins and from 12% to 22%, in Sweetheart (colour 3 to 8). TA did not show a clear behaviour during maturity. Colour could predict %TSS in both cultivars and firmness, in Lapins.

S02.457

Evaluation of Floral Longevity in Rose cv. Charlotte Grown on Substrates with Drainage Recycling

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Rose productivity and quality progress have led to an increase in the area of this crop's cultivated land planted in substrates. However, one of the problems derived from these systems has to do with the production of leaching that cause a negative impact on the environment. The objective of the present study was to evaluate the impact of water drainage recycling systems on longevity of cut rose as cultivated on different substrates. The plants, grafted on Natal Brier rootstocks were cultivated at a 6.5 plant/m² density, under unheated plastic greenhouse conditions at SENA (Centro de Biotecnología Agropecuaria). The substrates used were 100% burned rice husk, 65% burned rice husk – 35% coconut fiber, and 35% burned rice husk – 65% coconut fiber; and the recirculation percentages were 0%, 50% and 100%. A completely randomized split-plot design with three replications was applied. The main plots corresponded to the recirculation percentages, the subplots to the substrates, and the experimental unit to the 12m² bed (15m x 0.8m). Additionally, treatments consisting in only soil and 100% coconut fiber were also included. In the postharvest laboratory of the Faculty of Agronomy of National University of Colombia, Bogotá campus, the following parameters were measured: dry mass of the flowering stems organs at the moment of harvest, flower opening grade point average, "bent-neck", petal blueing, incidence of diseases and vase life (days). Ranging between 7 and 9 days, floral longevity of variety Charlotte did

not show significant differences between the evaluated treatments, and neither did flower opening Grade Point Average. During the evaluation, the factors causing flower stem discarding were: flower bluing, followed by "bent-neck", *botrytis*, mildew and no flower opening.

502.458

Detection of Mealininess in Tomato by Textural Analysis

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Mealininess is a frequent texture defect in tomato. Currently, this sensory descriptor is not measured by instruments, and it is often described as the result of a defect in the adhesion and rigidity of the cell walls. Consumer detects lack of juiciness and flavor and sandy consistency. In this work, two different tomato cultivars (Optima and Jack) were tested in order to determine the influence of the variety in the development of the mealiness. As the stage of maturity is another main factor of influence, tomatoes of those varieties were collected over several weeks during the production period. The Texture Analyser TA-XT2 of Stable Micro System was used to perform mechanical test. A confined compression test was performed on tomato flesh cylinders that were confined in a special device on drying paper. The texture analyzer pushed the load cylinder until a maximum deformation of the tomato flesh cylinder of 5 mm was reached. As the cylinder was compressed, an amount of juice came off and was gathered in drying paper. The area stained (cm²) by the juice was calculated by an image analyzer as a measure of the tomato juiciness. We also measured and recorded another variables such as maximum confined compression force (N) or distance to maximum load force (mm). In addition, solid soluble content (°Brix), colour (CieLab) and sensory analyses were carried out to detect mealiness. As a conclusion, differences between the two varieties were observed. Obtained data didn't show any correlation between juiciness measured as area stained and sensory mealiness, but was possible to classify the fruits in order to identify the best tomatoes for the market.

502.459

Effect of Different Treatments of Pulsing on Vase Life of Inflorescences of *Oncidium varicosum* 'Samurai'

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Oncidium varicosum is a species with large occurrence in South America. It produces yellow flowers, commonly named golden shower, ballet dancer and Anita's flower. The objectives of postharvest physiology of flowers are to study the factors related to quality loss of cut flowers and it is related to several physiological processes and with the interactions between the floral components and with qualitative factors. In this context this research had as finality to study physiological aspects of postharvest physiology of cut inflorescences of *Oncidium varicosum* 'Samurai' after treatment with pulsing solutions containing silver salts, 8-HQC and sucrose. It was observed reduction of the relative water content of *Oncidium* flowers treated with pulsing of STS (2mM). The contents of soluble carbohydrates and reducing sugars decreased, being the higher contents measured in flowers treated with STS (2mM). All parameters related with flower coloration reduced in all treatments. Similar results was obtained for carotenoids contents except with STS (2mM) which differed significantly from the order treatments at the 8th and 12th of vase life. The inflorescences longevity varied from 12 days (distilled water) to 15 days (STS 2Mm).

502.460

Natural Products Utilization to Preserve Postharvest of 'Vega' Cut Roses

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Use of natural products like floral preservative has contributed to reduce indiscriminate use of chemical products. Therefore, this research tested solutions to keep quality and to increase commercial durability of 'Vega' cut roses. It was used a casual design in a factorial schema composed by six post harvest treatments and four evaluation dates. The following treatments were conducted: 1) Distilled water; 2) Metil jasmonate (350 µM) application in pulsing form for four hours; 3) Methyl jasmonate (500 µM) spraying; 4) Mint oil (100 ppm); 5) Ginger oil (100 ppm); and 6) Propolis (0.05%) used as a maintenance solution. Flowers stayed in an environment at 20±2 °C and 67±3% RH. Physiological and qualitative evaluations were conducted. Natural products presented a beneficial action over the shelf life of flowers. However, methyl jasmonate spraying was, in all evaluated parameters, the most efficient product to maintain floral quality, providing a lower fresh mass loss and a lower respiratory rate of flowers. It also permitted improvement in coloration maintenance, water relative content and reducing sugars, what led to a shelf life extension of roses.

502.461

Effects of Natural and Induced Parthenocarp on Ethylene Production and Postharvest Quality of Zucchini Fruits

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The current production of zucchini squash in Almería (Spain) greenhouses requires of the induction of parthenocarp by using treatments with synthetic auxins. Therefore there is great interest in developing varieties of zucchini with natural parthenocarp. We have identified a number of commercial and local varieties in which non-pollinated fruits develop and reach a marketable size without hormone treatments. In this communication we present data concerning the effect of parthenocarp in different fruit postharvest quality parameters, including ethylene production, weight loss, firmness, and chilling injury, in the commercial hybrids Cora, Argo, Natura and Elena. Pollinated and non-pollinated fruits from control and auxin treated plants were stored at 4 and 20 °C for 7 and 14 days in climate chambers with controlled relative humidity. Ethylene production is induced in all the fruits after storage at 4 °C for 7 days, but decreased significantly after 14 days of storage at the same temperature. Nevertheless, when fruits were conserved at 20 °C, the evolution of ethylene remained constant throughout storage. The quality and commercial life of the fruit, as well as the chilling injury were very dependent on the genotype, but also affected by pollination and the storage temperature regime.

502.462

Sensory Evaluation of New ACW Apricot Hybrids and Different Clones of 'Luizet' Compared with International Cultivars

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'Luizet' was until 1995 the main apricot cultivar produced in Valais, Switzerland.

Despite its excellent internal quality, this cultivar is characterized by a rapid post-harvest evolution that correspond no more to the actual commercial quality requirements. Consequently, 60% of the Swiss orchard was renewed, mainly with international cultivars and in a near future with hybrids originated from the ACW breeding program. Therefore, in the last two decades, the apricots consumption in Switzerland changed from a monovarietal to a multivarietal situation with a large range of taste and visual quality. The aim of this project was to evaluate the sensory characteristics of new ACW apricot hybrids and of different clones of 'Luizet' and to compare them with the sensory quality of international cultivars. A panel was trained and a list of 11 descriptors was chosen. These descriptors were well-adapted to discriminate the different cultivars. A sensory profile was established for each tested cultivars and correlated with physicochemical traits of the fruits, like colour, firmness, titratable acidity and solid soluble content. A Principal Component Analysis (PCA) revealed high relations between the descriptors and the first PCA-axe, describing a ripening-axe. Based on this sensory analysis, the commercial potentiality of new ACW hybrids and the choice of the best qualitative 'Luizet' clone are discussed.

502.463

Postharvest Storage Systems Affect Phytochemical Content and Quality of Traditional Portuguese Onion Cultivars

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Onion (*Allium cepa*) cultivars are generally classified based on color, pungency and use and differ widely in their keeping quality. In addition to sensory characteristics, consumers value the nutritional and health effects, particularly the antioxidants potential of this vegetable. In the traditional onion growing region of Póvoa de Varzim, Northwestern Portugal, landrace cultivars are harvest in July and stored in traditional non-refrigerated clamps in the field for up to 5 (white onion) or 7 months (red onion). The aim of this work was to assess the effect of two post-harvest systems, refrigerated storage at 2 °C and traditional non-refrigerated clamps, on phytochemicals and physico-chemical quality of two Portuguese landrace cultivars of onions ('Branca da Póvoa' and 'Vermelha da Póvoa'). Flavonoid composition, dry weight, pH, soluble solids content (SSC), pungency and firmness were measured at harvest and following 3 and 6 months in storage. The red onion was more pungent and had higher dry matter, SSC, and about twice total flavonol levels than the white cultivar. Results from two consecutive years in 2004 and 2005 showed that pH and pungency increased during storage, at a higher rate in the refrigerated system. Flavonols also increased significantly during storage in both cultivars. In contrast, SSC, and firmness tended to decrease. Red onion stored in field clamps reached higher levels of flavonols (64% maximum, at 6-months of storage in 2004) than refrigerated onions (40% maximum). In white onions the flavonol increase was also higher in field storage (60% increase, at 5-months of storage in 2005). These results suggest that storage at fluctuating ambient temperatures can positively affect flavonol metabolism, while maintaining the flavonols profile. Onion storage improved the content on flavonoids and pungent compounds, potentially improving the health benefits of onion consumption.

502.464

A Research on the Shelf Life of Two Different Clemantine Mandarin Types

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During this research, the shelf life of two different clemantine mandarin types was investigated. The study was carried out in pomology laboratory and storage

rooms of Batu Akdeniz Agricultural Research Institute in 2008. KLE 69 and KLE 82 clemantine mandarin types present in the "Citrus variety selection and variety development project" have been used. Clemantine mandarin types have been kept for 21 days under 20 °C. During the shelf life trial, % weight loss, fruit juice amount (g citric acid/100 ml fruit juice), total soluble solid amount (%), titratable acid amount (%), total soluble solids/titratable acidity ratio and change in rind thickness (mm) have been examined analysis conducted with 7 day intervals and three repetitions.

502.465

Maturation of Peaches by Near Infrared Spectroscopy (NIR)

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The development of non-destructive techniques to evaluate the ripeness stage and fruit quality by near infrared (NIR) is allowing to assist the evolution of fruit maturation without destruction. The instrument is calibrated based on measurements of reference methods on the same sample of several fruits. However, the present work aimed to establish calibration curves by the method of non-destructive testing of fruits using NIR-Case Sacmi® for future evaluations of fruit ripeness and quality characteristics of peaches cultivars Chimarrita, Maciel, Eldorado and Jubileu. The trial was carried out in the laboratory of the horticulture at Universidade Federal de Pelotas (UFPEL), Pelotas/RS – Brazil, in December 2009. It was analyzed the specters generated by NIR-Case at wavelengths from 600 to 1000nm and the values of the reference methods with data from destructive measurements of fruits samples to obtain the calibrations values. Then, they were calculated using the calibration software of the NIR SACMI (SMC 085.10.415). The mathematical analyses of calibration are part of the software that came with the equipment. For the calibration curves of the peaches cultivars it was read the following linear correlation coefficients for total soluble solids (°Brix); flesh firmness (kg cm²)-1; titratable acidity (meq NaOH 100 mL)-1 and dry matter (%). It is concluded that the calibrations found by NIR- for total soluble solids and firmness of peaches 'Chimarrita', 'Maciel', 'Eldorado' and 'Jubileu' were highly significative, which become very reliable for using in the determination of ripeness and quality of these peach cultivars. Nevertheless, the results were not satisfactory for the calibrations of titratable acidity and dry matter of peaches of the particular cultivars, requiring further studies.

502.466

Studies on Cut-Flower Selection of *Spiraea* and Application in Landscape

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The *Spiraea* is a sort of beautiful ornamental plants with colorful flowers and strong ecological adaptability. The objective of this study is to provide scientific bases for cut flower selection and application in landscape of *Spiraea*. The cut-flower selection was studied on the *S. trilobata*, *S. dasyantha*, *S. salicifolia* etc and the cut-flower selection standard was preliminary made. This paper also analyzed their application forms in landscape, which hoped to provide the theoretical basis for choosing and application of *Spiraea*. The main results were as follows: 1. The cut-flower selection was studied on 6 *Spiraea* species with 3 different vase solutions. The results indicated that the vase-life was prolonged against to the water by the solution A (1% sugar+50ppm8-HQ) and solution B (1% sugar+1% ethanol+50ppm8-HQ). The cut-flower selection standard was preliminary made and the *S. dasyantha*, *S. salicifolia*, *S. japonica*, *S. fritschiana* had big potential of cut-flowers which the vase-life was about 10d. 2. The application of *Spiraea* in landscape was very limited through the investigation. The *S. × bumalda* 'Goldmound', *S. japonica*, and *S. thunbergii* were common and the application form was unitary.

S02.467

Change of Total Polyphenols Content and Antioxidant Activity in Kernel of *Carya cathayensis* Sarg Pre and Post Processing and Storage

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Total Polyphenols concentrations of the extracts from raw, processed and rancid Kernel of *Carya cathayensis* Sarg were determined by Folin-Ciocalteu Colorimetry. Capability of total antioxidation, reductive ability and elimination ratio of hydroxyl radicals of the Total Polyphenols from Kernel of *Carya cathayensis* Sarg were also examined. Total Polyphenols concentrations were 1065.4mg/L, 319.78mg/L and 204.4 mg/L in 60 mL solution extracted by 70% methanol with 2g raw, processed and rancid Kernel of *Carya cathayensis* Sarg separately. With 2.14g/L VE as reference standard, the order of total antioxidative capability, reductive ability were raw *Carya cathayensis* Sarg >VE>processed *Carya cathayensis* Sarg>rancid *Carya cathayensis* Sarg, while elimination ratio of hydroxyl radicals was VE >raw *Carya cathayensis* Sarg>processed *Carya cathayensis* Sarg>rancid *Carya cathayensis* Sarg. These results indicated Capability of total antioxidation, reductive ability and elimination ratio of hydroxyl radicals has close correlation with contents of Total Polyphenols, which was important antioxidative substance in the Kernel of *Carya cathayensis* Sarg.

S02.468

Textural Characteristics and Spatial Sugar Profile of a Super Sweetcorn Stored with or without Husks

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The increase in sweetcorn cob consumption has led to more research into several quality parameters during storage. Sweetness and firmness are the major quality attributes in sweetcorn cobs such that maintaining these is critical. In the fresh sweetcorn market, there is an ongoing dispute over whether sweetcorn cobs sold as naked (husks having been fully removed) are closer to consumer requirements as compared to window stripped (cobs with a narrow area free of leaves) retail formats. The relationship between sugar content of edible parts (kernels) and non-edible tissues (shank and core) of cobs has also not been investigated and may help explain the biochemical changes and possible relationship between format and handling conditions. Accordingly, the effect of cob format on postharvest temporal changes in texture and sugars content of edible and non-edible tissues of twin-packed UK-grown super sweetcorn (sh2) cobs of cv. 6800 were evaluated. Results suggest that naked cobs maintained significantly higher mean values of maximum compressive load than window strip cobs when stored at 5 °C for 10 days. The total sugar content (glucose + fructose + sucrose) of kernels was ca. 1.21-fold lower than in the core and 1.16-fold lower than of shank. However and importantly, sucrose content in kernels was ca. 1.4-fold greater than in the core and ca. 2.2-fold greater than in the shank. Furthermore, glucose and fructose content in shanks was significantly higher than in core and kernels. In summary, temporal changes in textural profile were strongly dependent on retail format of the cobs, and sugar profile on the spatial distribution in kernels, core or shank tissue during storage.

S02.469

Diagnose of Fruit Quality and Mineral Contents of 'Fuyu' Persimmon Produced in Southern Brazil

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This study was carried out to characterize fruit quality and mineral contents of 'Fuyu' persimmon fruit (*Diospyros kaki* L.) produced in Southern Brazil, in 2007 and 2008.

Additionally, leaves harvested in the summer were assessed for mineral content. Fruits were harvested at commercial maturity from 65 commercial orchards, and assessed in terms of quality after 45 days of storage under modified atmosphere (at 0±0.8 °C), followed by seven days of shelf life (at 23 °C). Fruits were treated with 1-MCP before storage to prevent chilling injury. At harvest, fruits had fresh mass of 223±42 g, soluble solids content (SSC) of 14.8±0.9 %, flesh firmness of 60.9±5.8 N and skin color index of 4.2±0.8 (on a 3.5 to 8.0 scale). The contents of N, P, K, Ca, and Mg in the fruit (mg×kg⁻¹ of fresh mass) were of 685±86, 291±86, 1611±195, 109±18, and 68±8, respectively. The contents of P, K, Ca, Mg, Mn and B in the leaves were similar to the values previously reported for different production areas, while the contents of Zn were lower, and N, Fe and Cu were higher. There was a negative correlation between fruit size and flesh firmness and Ca content, as well as between fruit SSC and N content in the leaves. The incidence of fruits with black groove disorder (lined black dots along the skin) varied from 15% to 59% in 68.3% of the orchards. There was not significant correlation between incidence of black groove disorder and fruit size, flesh firmness, skin color or SSC. However, the incidence of this disorder had a positive correlation with leaves N content. Fruit also exhibit a moderate incidence of black spot disorder on the skin (an average incidence of 11.5%), which had a positive correlation with fruit skin color index and flesh K content.

S02.470

Study on the Effect of Some Chemical Treatments on Vase Life and Qualitative Factors of Two Cultivars of *Alstroemeria*: 'Odessa' and 'Sacramento'

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Early leaf yellowing before petal abscission is a major problem in vase life of *Alstroemeria*. Besides, the vase life of many cultivars is terminated when the petals abscise. In this study, the effect of plant growth regulators and Silver nanoparticles on increase of flower and leaf longevity of *Alstroemeria* cultivars 'Odessa' and 'Sacramento' were investigated. Cut flowers were treated with 24h pulse treatments which include GA3 (50 µM, 150 µM and 300 µM) and TDZ (1 µM, 5 µM and 10 µM). Afterwards, cut flowers were held in preservative solution (Sucrose 2% +Nanosid 2ppm). Treatments were evaluated for their effects on vase life, relative fresh weight, solution uptake, total soluble solids in stem, membrane stability, total chlorophyll, the ratio of fresh weight to dry weight, relative water content and absorbance. The result indicated that GA3 300 µM treatment in 'Odessa' increased flower and leaf longevity. Moreover, GA3 300 µM treatment in 'Sacramento' has a deep effect to prevent leaf senescence whereas the preservative solution was more effective on increase of flower longevity. In addition, 2ppm Nanosid in preservative solution declined the growth of microorganisms and Sucrose 2% overcome the lack of carbohydrates in respiration process. Relative fresh weight, solution uptake and total soluble solids in stem increased in all treatments except control. In early days, the process of the flower opening in all treatments delayed in comparison with the control. Also, GA3 (50, 150 µM) in 'Odessa' and GA3 300 µM in 'Sacramento' had the maximum rate of the total chlorophyll on 12th day. Consequently, pulse treatment with 150µM GA3 for 24h in 'Odessa' and 300 µM GA3 for 24h in 'Sacramento' were the best treatments.

S02.471

Non-Destructive Measurement (NIR CASE) of Internal Quality Characteristics in Plum Varieties

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Firmness and soluble solids content (SSC) were tested in 1920 fruits from 'Black Amber', 'Black Ruby', 'Fortune', 'Golden Globe', 'Songold' and 'Angeleno'. Japa-

nese plum varieties using destructive methods to validate NIR CASE predicted values and calibrate the model. Shelf-life and dry matter were also evaluated for some varieties during 2009. Predicted values for firmness demonstrate models based on NIRS spectrometry weren't suitable: $r^2=0.05$ to 0.47 and $ME=-11.48$ to 0.86 . The highest values for fruit firmness were determinate in 'Golden Globe' (from 3.6 to 4.8 kg/ 0.5 cm 2) and the lower in 'Songold' (from 0.9 to 1.3 kg/ 0.5 cm 2). The distinct models for plum varieties gave good prediction for SSC presenting correlation coefficients superior to 0.77 and modeling efficiency generally more adequate with 'Black Amber' for exception ($r^2=0.29$, $ME=0.20$). SSC values varied from 15.6 °Bx in 'Angeleno' to 10 °Bx in 'Black Amber'. 'Golden Globe' presented the best predicted values both for firmness and SSC, $r^2 = 0.82$ and 0.78 and $ME=0.86$ and 0.89 , respectively. Dry matter ranges from 11 to 25% more frequent from 14 to 19% . During shelf-life evaluation, after storage at 4 °C during 29 days for 'Black Amber', 21 days for 'Black Ruby' and 7 days for 'Fortune', firmness decreased and SSC increased from the first till the fourteenth day. 'Black Amber' presented the best values for firmness in post-harvest conditions.

S02.472

The Effect of CA Storage on Quality Parameters of Shallot (*Allium ascalonicum* L.) Bulbs

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Shallot (*Allium ascalonicum* L.), despite lower popularity compared to common onion, receive recognition in some countries i.e. in France and conquer new markets. Shallot used to be propagated vegetatively, however recently new cultivars, grown from seeds, have appeared in production practice. Vegetative propagation is less effective than generative, and therefore new cultivars arouse interest of growers and researchers. Few publications concerning shallot have been published until now, especially about storage influence on quality of this vegetable. In this study the effect of CA storage on quality of shallot bulbs was examined. Quality parameters of the bulbs were examined directly after harvest and after seven months of storage. Shallot cultivars ('Conservor F1', 'Prisma F1', 'Bonilla F1', 'Olympus F1') were stored under different atmosphere compositions ($5\%CO_2+5\%O_2$, $5\%CO_2+2\%O_2$, $2\%CO_2+5\%O_2$, $2\%CO_2+2\%O_2$, $0\%CO_2+21\%O_2$, $15\%CO_2+2\%O_2$). During storage period weight losses were determined, as well as firmness, soluble solids content, dry matter content and colour. The highest weight losses were observed in normal atmosphere conditions. Also firmness and soluble solids content after seven months was lower, however interaction of gas composition and cultivar was observed. Dry matter content was higher in CA stored bulbs than in freshly harvested ones, but the increase depended on gas composition. The colour of dry and fleshy scales became brighter in all bulbs except bulbs of 'Bonilla F1'. The study showed that CA storage positively affected shallot bulbs during storage compared with normal atmosphere storage.

S02.473

Preharvest Citric Acid Application Extended Post-Harvest Vase Life of *Lilium* cv. Brunello

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Preharvest application of citric acid is a novel method in vase life extension of Cut flowers which is reported on tuberose earlier and confirmed here on *lilium*. In this research three levels of Citric acid (0 , 0.075 , 0.15 percent v/v) and malic acid (0 , 0.075 , 0.15 percent v/v) were used together two times during growth period of *lilium* plants in a randomized factorial design with three replications. The results indicate that 0.15% citric acid had increased vaselife from 13.1 to 14 days ($\alpha=0.05$). The interesting finding was the effect of citric acid on bulbil weight which had increased from 3.5 gr to 8.5 g in 0.15% citric acid ($\alpha=0.05$). Malic acid while having no effect on pre-mentioned traits, surprisingly increased the

chlorophyll content significantly. The interaction effect between citric acid and malic acid on vase life and chlorophyll content proved significant and was evident in results both as antagonistic and synergistic in various traits. In ANOVA analysis the effect of citric acid on vase-life extension was more prominent increasing it from 11.8 to 14.3 days in treatment with 0.15% citric acid and without malic acid comparing to control. Some assumptions about the possible physiological background are made.

S02.474

Effects of Different Storage Temperatures on Quality of Unshelled and Shelled Almonds

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Almond (*Prunus dulcis* Mill.) kernels are relatively metabolically inert because of their low water content, but uncontrolled environmental conditions during storage can cause drastic quality loss. The aim of this work was to evaluate how the removal of the shell and the storage at different temperatures may affect almonds quality. For 2 years, almonds (cv. Marta) were harvested, dried and stored with and without shell at 0 and 20 °C. Initially and after 2, 5 and 9 months of storage, quality attributes were assessed. Rupture force, color, and sensorial evaluation were carried out on the kernels; acidity and tocopherols content on the oil, while sugar content, antioxidant activity and total phenols were measured on the defatted powder. For both years, the presence of shell reduced the variation in some color parameters, while the effect of the temperature was less evident. No differences were observed in rupture force and sensorial attributes related to storage temperature and modality (shelled/unshelled). Antioxidant activity remained almost constant during storage in 2007, while in 2008 a decrease after 2 months was observed, without differences due to the storage conditions in both studied years. Phenols content was affected by storage modality; in 2007, a lower decrease in unshelled almonds than in shelled ones was observed, while in 2008 almonds stored in shell at 0 °C showed a delay in phenols loss during storage, without any effect of storage temperature. In all the samples, sucrose content did not change during storage in 2007, while a transient increase was observed after 2 months of storage in 2008. Tocopherols content did not show evident variation, while oil acidity increased during storage, regardless of the storage temperature and modality.

S02.475

Respiration and Ethylene Emission of Rose Buds during Development in Plant and Vase Life

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The emission of CO_2 and ethylene production of rose (*Rose* sp.) buds belonging to the 'Charlotte' variety were measured during their development in plant and in vase. Floral stems were obtained from a crop at Bogotá plateau (Colombia). Floral stems were periodically harvested in different development stages (S1, S2, S3, S4 and S5). In the laboratory, in vase, floral buds in development stages (S4, S5 and S6) were periodically taken. S3 represents the point of commercial cut, S4 floral opening, S5 symptoms visible of shriveling and S6 senescence. For the same time period, buds in vase reached full senescence while buds in plant got stage S4. Highest CO_2 emission rates took place during S1 stage. During the bud's development two climatic peaks took place. The first one at S3 stage coincides with the beginning of the floral opening and an active dry mass accumulation in petals. The second one occurs at S4 stage in attached buds on plant and at S6 stage in buds in vase. This is the first report of the occurrence of a second climatic peak in attached buds on plant as well as in vase. Apparently, the second climatic peak would be related to processes associated to the inversion of source-sink relation in buds. It wasn't detected any emission of C_2H_4 neither in attached buds on plant nor in vase buds.

S02.476

Changes in Chemical Composition during Cold-Storage of Several Peach Cultivars (*Prunus persica*)

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Peaches are a perishable food as their metabolic activity persists after harvest. Long-term storage is only possible at low-temperature storage. This low temperature during storage is one of the main tools to reduce the postharvest deterioration, maintaining the overall quality and the nutritional value of fruits, since diminish metabolic activity of produce, reduce the respiration rate and in consequence slow down ripening. However, the storage potential is depending on the cultivar. Fruit of 'Early Rich', 'Sweet Dream', 'Elegant Lady', 'August Red', and 'Royal Glory' cultivars were picked in Alcarras (Segrià, NE Spain) and stored under air atmosphere at -0.5 °C for 10, 20 and 40 days and analysed after remaining 3 days at 20 °C (shelf-life). Effects of cold-storage and shelf-life period on physicochemical parameters and aroma volatile compounds have been studied. The physicochemical parameters studied were: weight, calibre, titratable acidity, soluble solids content, flesh firmness and skin and flesh colour. A partial least square regression model (PLS1) was run, in an attempt to correlate volatile compound emission and standard quality parameters as X-variables to consumer's acceptance studied as Y-variable, and thus to find the variables having most weight on the discrimination between cultivars and storage period. This regression model was able to explain up to 86% of total variability in the consumer's acceptance 2-ethyl-1-hexenal, propyl hexanoate, titratable acidity and soluble solids content were the variables found more consistently with a positive correlation with consumer's acceptance.

S02.477

Carotenoids and Aromatic Profiles of Watermelons with Different Colors in Flesh

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Watermelons (*Citrullus vulgaris* Schrad) are of different colors in their flesh, such as white, red or pink, yellow, orange etc. In our research, mature fruits of 12 watermelon cultivars with different colors in flesh were subjected to HPLC, GC and GC-MS analysis to determine and quantify their compositions and contents of carotenoids, soluble sugars, organic acids and aromas. In the investigated watermelons, eight cultivars of red flesh, three of yellow flesh and one of orange flesh were selected. Results showed that violaxanthin, zeaxanthin and their esters were main carotenoids in yellow flesh watermelons. Red flesh watermelons were rich in all trans-lycopene, cis-isomers of lycopene, phytoene and β-carotene. However, phytoene, β-carotene and its cis-isomers took up large percentage in total carotenoids in orange flesh watermelons. In addition to above carotenoids, lutein and α-carotene were also found in flesh of watermelons. Though the contents varied largely among cultivars, sucrose was the most abundant soluble sugar in flesh of most watermelons with the highest found in a red flesh cultivar of Nongkang Xiangfeng as 635.69 mg/g in average, fructose second to it. However, contents of fructose kept stable among cultivars, which changed within a range of 118.04-175.40 mg/g DW. Other soluble sugars such as glucose and raffinose were also determined. Citric acid and malic acid were main organic acids found in flesh of watermelons, other than that, quinic acid, tartaric acid and oxilic acid was detected. In their aromatic profiles, alcohols and aldehydes served as main components, special aromas such as limonene was detected in yellow flesh cultivars. The relationships between aromatic and carotenoids profile, between carotenoids and soluble sugar profile were undergoing analysis to illustrate their interactions at the biochemical view.

S02.478

Storage of Half-Finished Fruit and Berry Products

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The great significance of fruits and berries in human's diet is determined by the physiologically active matters in them. Practically it is not possible to preserve berries fresh for a long time therefore it is necessary to consider their processing. Fresh fruits and berries grown in Latvia, were investigated and analysed after harvesting. Food quality and safety issues depend on the quality of raw stuffs and half-finished products. Desserts prepared from fruit and berries are products, quality of which depends on storage conditions of half-finished products. Content of vitamin C was used as an index of quality during storage. The nutritive value of biologically active substance is retained while the organoleptic indices worsen only a bit. The objective characterization of physical properties of products allowed evaluating quality, to incorporate it into technological regimes of the treatment. The temperature of storage was constant during the whole experiment. Decrease of the amount of ascorbic acid is considered to be the indicator of the oxidation process of the product. Researches proved that in a low temperature the decrease of the amount of vitamin C in fruit takes place slowly. The decrease of losses is mainly insured by quick cooling. Fruits and berries are the main providers of biologically active substances for human's organism. Cooling allows to eliminate the seasonal nature of their consumption. The seasonal climatic conditions of Latvia hinder proper nutritional balance. Widening the assortment of frozen fruit and berries is one of the ways to improve the diet. At present in Latvia several aspects of qualitative changes during the cooling process have not been elaborated and sufficiently developed in practice. Processing of food products prolongs their storage time. Both physical and chemical treatment methods were applied in the research.

S02.479

Maturation Characterization of Black Sigatoka Resistant Bananas

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This work aimed to characterize the physical, chemical, and physicochemical aspects of the bananas maturation ('Thap Maeo', 'Caipira', 'Pakovan Ken' and 'Preciosa') resistant to Black Sigatoka (*Mycosphaerella fijiensis* Morelet), seeking to develop technology for the postharvest conservation. Bananas were picked (Stage 1) at an experimental orchard (Ceará, Brazil), and transported to Embrapa Tropical Agro-industry (± 240km), where they were stored at 21±2 °C and 85±5% UR, until they were completely ripe (Stage 7). During that period, the color of the peel was evaluated daily and when changes happened, indicative of a stage change, the physical aspects (fruit weight, peel weight, and finger drop) were analyzed. After these evaluations, the peels were separated for chlorophyll and carotenoids analysis. The pulps were homogenized and stored in a freezer for later quantitation of total sugars, starch, pH, titratable acidity and soluble solids. The experimental design was completely randomized, with three repetitions and four fruits per repetition, being the data submitted to analysis of variance and the averages compared by Tukey test (p<0,05). The ripening of these bananas followed the characteristic pattern observed in bananas not resistant to Black Sigatoka. This pattern is characterized by the maintenance of the total weight; but with reduction on peel weight and thickness, and the increase of pulp weight, suggesting a transfer of mass from peel to pulp. The chlorophyll decreased strongly as the ripening progressed making already existent carotenoids evident, once significant increase was not observed (p<0,05). In general, the soluble solids, total sugars, starch, and titratable acidity presented significant differences (p<0,05), indicating the change of stages of maturation of those bananas. A difference in finger drop resistance could be verified in the analyzed hybrids.

502.480

Effect of 1-MCP on Leaf Abscission and Vase Life of Sword Fern (*Nephrolepis cordifolia*) under Water Stress

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Leaf abscission limits the length of vase life of sword fern (*Nephrolepis cordifolia*), especially when the leaves have undergone a period of postharvest water stress. Leaves (fronds) of sword fern were placed on the laboratory table for 3, 6, 9 and 12 hours after cutting. The rate of ethylene production and that of leaf abscission increased dramatically after the dehydration treatment, more so after a longer period of dehydration. The vase life of the control leaves was 13.2 days, whereas the vase life of the water-stressed leaves was 7.0 days after 3 h of dehydration and 4.7 days after 12 h of dehydration. A 3 h period of treatment with 1-MCP at concentrations of 200, 300 or 400 ppb prior to the period of dehydration reduced the rate of ethylene production and leaf abscission. As 1-MCP was able to alleviate the effect of dehydration, the data indicate that the effect of dehydration on leaf abscission is mediated by ethylene.

502.481

Effect of Physical Characteristics Over the Respiration Rate of Carrots during Storage

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Transpiration is the main cause of weight loss in agricultural products during storage, including carrots. It is an important physiological process that affects the main quality characteristics of agricultural products, such as saleable weight, appearance and texture. The transpiration rate of horticultural products is proportional to superficial area, influenced by the water vapor pressure and air velocity. Being that stated, the transpiration coefficient is a parameter that reflects the water loss of a specific surface. Thus, the objective of this work was to evaluate the influence of physical characteristics on the respiration rate of carrots (*Daucus carota* L.) cv. Brasília during storage. Carrots with conic shape type were classified by means of surface-volume ratio values, in three different classes: short, average and long (0.1214, 0.0847 and 0.0710 mm²×mm³, respectively). The roots were stored in climatic chambers at temperatures of 10, 20 and 30 °C, and air relative humidity of 45, 65 and 95 %, during 120 h. Transpiration coefficient was obtained at constant temperature, calculated by water mass flow, vapor pressure and relative humidity, being related to surface-volume ratio. This last parameter was calculated by means of the dimension characteristics of the roots, with the aid of a digital caliper. The work was carried out in a completely randomized design with three repetitions, in split-split plots. The main plots contained the three RH, the split plots the classes and the split-split plots storage time. Surface-volume ratio presented significant influence on the transpiration coefficient. Short carrots obtained the highest transpiration coefficient, and at relative humidities of 45 and 65 % led to an increase of transpiration coefficient values. All carrot classes stored at temperatures of 10, 20 and 30 °C, and 95 % of relative humidity presented lowest values of transpiration coefficient, being acceptable to commercialization of these products.

502.482

Harvest Maturity Modulates the Incidence of Albedo Breakdown and Fruit Quality of 'Washington Navel' Orange

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Consumer acceptability of sweet oranges depends on sugar: acid ratio, which is influenced by harvest maturity. This study was aimed at determining the effects of

harvest maturity on the incidence of albedo breakdown (AB) and fruit quality of 'Washington Navel' orange. Fruit were harvested in the first week of July, August, September, and October, 2009. AB was observed the major physiological disorder in the fruit and its incidence increased from 65% at the first harvest to 89.33% in the last harvest. The delayed harvesting increased rind-softening significantly as revealed by puncture resistance, rind tensile strength and compression tests. An increase in soluble solids concentration (SSC) was observed from 11.5% in July to 15.26% in September and then it decreased during the October harvest to 14.5%. Sucrose, glucose and fructose were the major soluble sugars present in juice. The changes in concentrations of individual sugars, sucrose, glucose, and fructose also showed a trend similar to SSC. However, titratable acidity (TA) decreased from 1.25% in July to 0.76% in October. The changes in SSC and TA resulted in a significant increase in their ratio with the delay in harvesting. Our results suggest that excessive delay in harvesting increased the incidence of AB and rind-softening. Fruit quality in terms of SSC and acidity improved till September harvest and deteriorated in later harvest.

502.483

Post-Harvest Blueing of Spatha in *Anthurium andreaeanum* 'Tropical' as Affected by Pre-Harvest Conditions

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Post-harvest blueing of *Anthurium spatha* has recently become a serious quality problem in red *Anthurium* varieties in The Netherlands. Although the first signs of blueing can show already at harvest, allowing timely flower rejection, blueing mostly becomes visible during and after the trading channel, leading to quality claims. By means of a nursery comparison between 10 growers and a parallel greenhouse experiment, it was investigated how different circumstances during greenhouse cultivation (including climate, nutrition factors and crop management) contribute to blueing within the first 12 days after harvest. Blueing was observed in all nurseries in varying degrees depending on the harvest date. A good correlation was found with the time that the RH is over 80% during the six weeks previous to harvest. The effect of high RV on blueing was increased by high CO₂ concentrations, both suggesting reduced transpiration as the main cause. The greenhouse experiment confirmed these findings and also showed that the recently introduced crop management method of breaking young leaves increased the chances for blueing. A higher calcium supply in the nutrient solution contributed to a slight increase of the calcium content in the spatha tissue, but could not prevent blueing. The increase of the nutrition EC as a method to prevent blue coloration, widely used by growers, was found to make the problem more severe and to reduce strongly the concentration of Calcium, Magnesium, Manganese and Boron in the spatha tissue.

502.484

Application of Humic and Fulvic Acids in Nutrient Solution Affect Postharvest Characteristics of *Gerbera jamesonii* L.

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The effect of humic substances (humic (HA) and fulvic acid (FA)) on growth and postharvest life of gerbera (*Gerbera jamesonii* L.) cv. "Lourdes" were examined. HA and FA applied to solutions in six combinations including control, 80% HA+20% FA (100 mg/l), 60% HA + 40% FA (100 mg/l), 40% HA + 60%FA (100mg/l), 100% FA (100 mg/l) and 100% FA (50mg/l). Although HA and FA application did not significantly improve yield (number of harvested flower per plant), flower diameter, flower weight, shoot length and diameter of scapes but they enhance postharvest life of harvested flowers. The results showed that 50 mg/l FA was the most effective treatment and extended the vase life by 5.5 days and prevented and delayed bent neck incidence. On the other hand all HA and FA treatments could decrease water loss after 6 days at least 105% in comparison to control. It seems

hormonal effects along with nutritional improvement by humic substances had been efficient in improving the postharvest quality of harvested flowers.

S02.485

Respond of New Apple Cultivars for Storing their Fruits in Different Variants of ULO Conditions

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Impact different concentrations of O₂ and CO₂ on prolonged keeping quality and general quality of fruits was during 3 storage seasons assessed using 23 new apple cultivars and their advanced selections. Values of O₂ and CO₂ magnitudes fluctuated within the range of 0,5–2 % O₂ and 0,5–3 % CO₂, whereas the temperature was always 1 °C. Generally the best results were achieved if the both O₂ and CO₂ were on the level of 1%. On the other way round the atmosphere with content of 1% O₂ and 3% CO₂ showed to be the least favourable. The worst reaction to this composition had 'Angold' that is otherwise very well stored cultivar. Upon the total results 'Meteor' and 'Rucla' were the most remarkable cultivars for prolonged storing even in higher concentrations of the both gases. Fruits of the both cultivars had always remarkable top quality at the termination of their storing.

S02.486

"Effect of Dry and Wet Storage at Cool Temperatures on Post Harvest Performance of *Narcissus tazetta* cv. Kashmir Local"

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An experiment was conducted to determine the optimal harvest maturity stage for short term cool dry or wet storage in *Narcissus tazetta* cv. Kashmir Local. The scapes were harvested at 0800 h when the scapes were between pencil and goose neck stage. The harvested scapes were cut to a uniform size of 20 cm and processed for dry and wet storage at 5 & 10 °C. A separate set of scapes each for dry and wet storage was kept at room temperature (14 ± 2 °C). After 72 h of storage the scapes were kept at room temperature in test solutions viz. distilled water, Sucrose (0.15M) and Sucrose (0.15M) + 8-HQS (50 mg / L). The average vase life of scapes was assessed to be terminated when 50% open flowers senesced, which was characterized by loss of turgor followed by wilting of tepals. The scapes dry or wet stored at 5 and 10 °C for 72 h had maintained their premature status, whereas flowers on most of the scapes had generally bloomed during storage at room temperature. The results of our experiments showed that the scapes previously wet stored in distilled water for 72 h at 5 °C before transfer to Sucrose (0.15M) + 8-HQS (50 mg / L) exhibited marked improvement in blooming, solution uptake, maintenance of membrane integrity, fresh or dry mass of flower, sugar fractions and soluble proteins with a corresponding decrease in α- amino acid pool. The present results suggest that cool wet storage of premature scapes of *Narcissus tazetta* for 72 h at 5 °C in distilled water improved subsequent postharvest performance in the holding solution (Sucrose +8- HQS) and can be used as an effective postharvest strategy for this beautiful cut flower.

S02.487

Physico-Chemical Characteristics of Eight Genotypes of Cambuí (*Myrciaria floribunda* O. Berg) in Alagoas-Brazil

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Physical-chemical characterization of fruits is important to establish phenotypic variations and genetic and environmental associations in species that have eco-

nomical importance. This work had the objective to characterize physical-chemically fruits of eight genotypes of cambuí (*Myrciaria floribunda*) from wild populations in South Coastal zone in Alagoas, Brazil. The biometric variables evaluated were: mass of fresh fruit (MFF), fresh pulp (MFP) and seeds (MFS), long (LD) and width (WD) diameter and LD/WD. The chemical analyses made were: pH, total soluble solids, reducing total sugar, vitamin c, sucrose and acidity. The results showed basically two groups of colored fruits: yellow-orange and red-wine. Both groups showed, respectively, low variation of MFF (1.37g and 1.33g), MFP (1.27g and 1.22g) and MFS (1.1g and 1.1g). The LD values were higher in relation to the WD in both genotypes, respectively, (11,15mm and 9.25mm) and (10.23mm and 9.41mm). Statistical data showed that the genotypes MF01PA, MF02PA, MF04PA and MF07PA had highest MFF. The genotypes MF01PA, MF02PA and MF07PA had highest MFP, while MF07PA had the highest value to MFS. The chemical analysis characterized cambuí fruit as juicy, presenting in average °Brix 11.8/100 g, pH 3.15, acidity of 1g/100g, reducing sugars of 8.7g/100g, sucrose 0.6g/100g and vitamin c of 11.5mg/100g. The genotypes presented high potential for fruit selection since pulp contributes, on average, with 77.86% of MFF, considered as an essential attribute in the process of industrialization.

S02.488

Essential Descriptors for Sugar Apple (*Annona squamosa* L.) Cultivars

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Sugar apple is a deciduous tropical fruit tree that originates in lowland Central America, where it is indigenous. It is believed that it was first introduced into Brazil in the early XVII century by a few seeds and since then has been cultivated where it became one of the most popular fruits. Because of its narrow genetic base introduced sugar apple has an apparently homogeneous population in Brazil. However, due its alogamic pattern of sexual propagation their populations have intercrossed for centuries giving the opportunity to appear some interesting genotypic variations. Several cultivars have been selected all over the world but sugar apple diversity has not been consistently characterized nor there is an IPGRI Descriptor List for sugar apple. Genotypes were sampled in three cultivated areas in Alagoas-Brazil. Several descriptors were utilized considering exclusively the morphologic characteristics of fifty sampled plants. The descriptors were focused only in characters simple to be observed on stem, branches, leaves and fruits using just a ruler and a hand lens (10x). Characters that presented a very wide variation like width and length of leaves were used only when it was very evident. This is the first key based on morphologic descriptors presented for this species and is supposed to be used to identify sugar apple genotypes of interest to breeding programs during its vegetative and reproductive phases.

S02.489

Mass Estimation of Mangoes by Processing of White Background Grayscale Images

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The postharvest grading of mangoes normally includes mass measurement using expensive dynamic weighing systems to group similar fruits in the same package. Third world's small producers cannot buy systems like those, which are normally complex to install and operate/maintain. This work describes a study for grading of mangoes (*Mangifera indica* L., cv. Tommy Atkins) based on image processing. It aims to apply image processing, afterwards, on a low-cost postharvest fruit selection and grading system. A hundred mangoes were acquired at the local market of Joao Pessoa, Brazil, and divided into two 50 units groups, randomly. A Sony™P7 digital

camera was fixed at the center top of a closed polystyrene box (50x50x50cm), internal walls covered with white paper. Two 20WPL lamps illuminate the mango at the center bottom of the box. Top view picture of the fruit, at rest, was taken. An off-line Matlab™ software calculated the top area of the fruits using a new threshold value $y=x+x(m/k)$, where x : Otsu's threshold; m : mean intensity of the image previously segmented using Otsu's algorithm; k : empirical constant ($=1500$), ambient light dependent. All the fruits were weighted using a digital scale (5kg max., 1g acc.) and the first group was used to find (area x actual mass) relation: $m(g)=-108.7+0.002649A(\text{pixels}^2)$. The other 50 fruits images were used to validate the equation found. Result showed a highly linear correlation between the top area and the measured masses ($R^2 = 0.96$; $SD = 15.7g$) for the first group. It was possible to estimate, by using the area of the top images, the masses of the mangoes belonging to the second group. The (predicted x actual) mass values shown $R^2 = 0.94$, $SD = 19.8g$. Research is being carried out in order to improve the grading system on a conveyor belt, indicating also the possible use with other fruits or horticultural products.

502.490

The Research on Determination of Suitable Table Grape Cultivars for Handling and Storage

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The berry detachment force and resistance to crushing of important forty-five table grape cultivars determined in consecutive three years trials. The tests were made on fifty berries from each cultivar with specially modified weighing scale. The berry crushing and berry removal forces of Palieri were highest. The other cultivars having strong berry and pedicel attachment were Royal, Danam, Ribol, Cardinal, Ata Sarısı cultivars. Ribol, Kozak Siyahı, Kadın Parmağı, Ata Sarısı, Amasya Siyahı cultivars showed high resistance to crushing. According to the detachment force and crushing test results, thirteen cultivars were selected for cold storage trials. Palieri was found the most suitable cultivar for long term storage. The other suitable cultivars for cold storage were Royal, Ribol, Kozak Siyahı, Amasya Siyahı, Müşküle and Gros Vert cultivars.

502.491

Dynamics of Trace Gas Emissions from Avocado under Changing O₂ Levels

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To slow down ripening and senescence very often 1-10 % O₂ levels and up to 10% CO₂ are applied during the storage period. By lowering the O₂ level, aerobic respiration turns gradually into alcoholic fermentation. As result, acetaldehyde and ethanol - the fermentation metabolites are produced and can serve as markers for sub-optimal storage conditions. Ethylene also plays an important role in storage conditions. Since avocado fruit are sensitive to ethylene even at relatively low temperature storage conditions, their storage should benefit by control of ethylene concentrations. This means that a timely monitoring of these compounds is essential to successful marketing. However, their concentrations in storage rooms are normally below the detection limit of the conventional analyzers. On-line measurements of trace gases (acetaldehyde, ethanol and ethylene) released by avocado (cv. Fuerte and Hass) using PTR-MS and laser-based ethylene detection are presented. Returning to aerobic conditions after a period of low O₂ leads to a high upsurge in acetaldehyde release, probably due to the elevated ADH activity which is higher in avocado than in other fruits. This might partially explain the success of short anaerobic treatments in reducing ethylene release. When the O₂ level is stepwise increased the acetaldehyde emission is also showing a stepwise behavior although less pronounced at higher O₂ levels, while the levels of CO₂ and ethanol are virtually not influenced. This indicates that, although O₂ was externally applied at a low level, part of the fruit tissue experiences anaerobic conditions. Ethylene concentrations may need to be reduced to 0.01 µL/L or lower in order to obtain significant

benefit, especially for 'Fuerte' in the storage. The commercial potential of reliable instrumentation other than conventional GC or electrochemical sensors for on-line monitoring the dynamic of acetaldehyde, ethanol and ethylene under different storage conditions is shown.

502.492

Storability of 'Algeria' and 'Golden Nugget' Loquats in Modified Atmosphere Packaging

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Loquat, classified as a non climacteric fruit, has a short postharvest life if not properly handled. Loss of firmness, browning of the skin, bruises and reduction of sugars, together with shriveling and decay are the main causes of spoilage. Modified atmosphere packaging (MAP) reduces weight loss and shriveling in loquats, but can also induce adverse effects, such as browning and hastened reductions of sugars and organic acids. The aim of this work was to assess the impact of a modified atmosphere packaging (MAP) generated by an easy-to-open polylactic acid (a biodegradable polymer) tray on fruit of 'Golden Nugget' and 'Algeria' loquat. About 300 g of fruit of each cultivar was packaged and stored for 5, 10 or 15 days at 5 or 10 °C. At the end of each storage period fruit were transferred for a week to simulated retail conditions (SL) at 20 °C and 60-65% RH. Chemical analyses and visual assessments were carried out at the end of each storage period and the respective week of SL, while in-package gas composition was determined at day interval during the first 6 days of storage and every three days thereafter. The rate of degradation of total soluble solids and titratable acidity was higher in packaged fruit than in un-packaged one and at 10 °C than at 5 °C. Although the lid of the trays was not hermetically sealed, the overall gas transmission rate was drastically reduced, generating an in-package CO₂ partial pressure of 7.25 kPa and 10.33 kPa in fruit stored at 5 and 10 °C, respectively. In contrast, weight loss, browning and overall visual quality in packaged fruit changed negligibly, especially in those stored at 5 °C. Although at the taste analysis packaged fruit showed a lower intensity of sweetness and sourness than un-packaged one, they were better considered than un-packaged one for overall preference.

502.493

Harvesting Stage of 'Green Dwarf' Coconut Fruits for Water Fresh Consume

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This work aimed to evaluate physical alterations of fruits of 'Green Dwarf' coconut variety during its development, as well as the alterations on water quality, occurring between the sixth and eighth months of fruit development, objecting to characterize the proper harvesting stage of fruits destined for the coconut water market. The orchards were located in Paracuru County, Ceará State, Brazil. In March, 2001, newly formed fruit bunches were marked, and evaluated three at a time. The duration were zero, 35, 70, 105, 120, 133, 147, 161, 182, 189, 196, 203, 210, 217, and 224 days. Fruits were evaluated for mass, polar and equatorial diameter, water content, total soluble solids (TSS), soluble sugar (SS) and reducing sugars (RS), titratable acidity (TA), pH, TSS/TA ratio, turbidity, and sensorial analysis. A random sampling design was applied to the experiments with 15 treatments (time) for fruit physical characteristics, 13 for fruit water content and water content/fruit mass ratio, 12 for water quality, and 7 for sensorial analysis. In the two first cases three replicates composed of five fruits, each coming from an experimental unit was analyzed. For the sensorial analysis samples were composed of water from the 15 fruits, and analyzed by 30 panelists (replicates). Fruits from 'Green Dwarf' variety reached full development at six months age, with matura-

tion commencing right after that, and characterized by a decrease in fruit mass, water content, water soluble solids and sugars content, and an increase in turbidity. Harvest of 'Green Dwarf' coconut fruit for consume of water may be initiated at the sixth month of fruit development and proceed until the beginning of the seventh month, given that during this period fruits presented the best quality, as proved, also, by sensorial analysis.

S02.494

Quality Evaluation of Cherries 'Sunburts' Harvested at Different Ripeness Stages

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The sweet cherry 'Sunburst' is highly appreciated by consumers due to its organoleptic traits. Regional producers tend to harvest cherries sooner in order to increase their profits. With the aim of understanding the consequences of this we have tested the effect of different ripeness stages at the moment of harvesting in what concerns quality. Quality parameters tested included external colour (L^* , a^* , b^*), fruit texture, soluble solids content (TSS), titratable acidity (TA). A sensorial analysis allowed us to study some important attributes. To evaluate nutritional quality total antioxidant activity were measured too. Once more, and according to results obtained in previous studies, we conclude that there is no advantage in picking up less ripe cherries considering external and biochemical results.

S02.495

Use of 1-MCP for Keeping Postharvest Quality of Ekmek Quince Fruit

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This study was carried out in Ankara University, Faculty of Agriculture, Department of Horticulture during 2006-2008 years in order to determine effect of 1-methylcyclopropan (1-MCP) treatments on postharvest fruit quality of quince cv. Ekmek. 1-MCP was applied at different concentrations such as 300 ppb and 1000 ppb as soon as possible after harvest at 12 °C temperature for 20 hours. After application period, fruit were ventilated for an hour and then were stored under 0 ± 1 °C temperature and 85-90% relative humidity conditions for six months. Control fruit were also kept at 12 °C temperature for 20 hours and then stored at the same conditions without 1-MCP treatments. During storage period of six months, changes in fruit skin color (CIE L, a, b), soluble solid content, titratable acidity, weight loss, sensory evaluation, flesh browning were investigated at monthly intervals. As a result of this study, it was observed that 1-MCP treatment at 1000 ppb concentration higher effectively prevented flesh browning and weight loss, loss of titratable acidity and green color than 300 ppb 1-MCP treatment and controls ($P < 0.05$).

S02.496

NAA and STs Effects on Bract Abscission and Carbohydrate Levels of Potted *Bougainvillea spectabilis* Willd.

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The aims of this work were to study bract and flower abscission in *Bougainvillea spectabilis* 'Killie Campbell' plants, under postproduction conditions. The effect of spraying with Silver Thiosulphate (STS) and with Naphtalene Acetic Acid (NAA, at high concentration: $500 \text{ mg} \times \text{l}^{-1}$), separately or together, was tested. Quantification of non-structural carbohydrates in the bracts, leaves and stems were assessed. Treatments that include NAA are the ones that reduce significantly bract abscission. Unexpectedly, the higher the levels of bract soluble and total carbohydrates, measured at day 10 postproduction (PP), the higher the abscission of

total bracts. However, the lower the percentage of starch in the bracts, measured at day 17 PP, the higher the bract abscission. No correlations were found between the levels of leaf non structural carbohydrates and bract or leaf abscission. Levels of all stem non structural carbohydrates decreased between days 10 and 17 PP. Percent of starch in the stems, as quantified at day 10 PP, or the average between day 10 and day 17 PP, was positively correlated with bract abscission. These results show, for the first time, that abscission can positively correlate with non-structural carbohydrates levels in the organ that abscise. Probably, a more active metabolism in bracts that abscise earlier, with an higher rate of consumption and an higher rate of import/production, i.e. an higher flow of carbohydrates through the organ, is the explanation for the higher content of carbohydrates measured in these bracts.

S02.497

Optimizing the Vase Life of Cut Lisianthus (*Eustoma grandiflorum*)

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A study was conducted to determine the effects of sucrose (at 0, 20, 40 and 60 g/L), citric acid (at 0 and 160 mg/L), aluminum sulphate, (at 0 and 160 mg/L) and silver nitrate (at 0 and 120 g/L) on vase life and quality attributes of lisianthus cut flowers (cv. Mariachi blue fonce). Cut flowers were treated with the above mentioned compounds during 34 days storage at 20 ± 2 °C and at the end of shelf life the amount of electrolyte leakage, relative water content and opened flowers' buds were determined. 60 g/L sucrose in combination with citric acid was the most effective treatment in increasing the vase life. Flowers treated with 60 g/L sucrose and aluminum sulphate had the highest relative water content. The lowest electrolyte leakage (29.84%) was recorded in flowers treated with 60 g/L sucrose and 120 mg/L silver nitrate. The highest percentage of opened flower buds was obtained in flowers treated with 60 g/L sucrose and 160 mg/L aluminum sulphate.

S02.498

Chilling Injury of 'Miraflores' and 'Rojo de Piñana', Two Traditional Peach Cultivars Grown in the Ebro Valley (Spain)

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The Ebro Valley is one of the most productive areas for the peach industry in Europe. The aim of this study was to characterize physico-chemically as well as organoleptically two peach cultivars native to the Ebro Valley, 'Miraflores' and 'Rojo de Piñana', during cold storage at 0 °C and 5 °C for 45 days. We have examined the correlations between changes in quality parameters and the onset of symptoms of chilling injury (CI). The main CI symptoms observed were flesh browning and red pigmentation (bleeding). However, no significant differences in leatheriness were found, maybe because of the low susceptibility of these cultivars to that symptom. CI in 'Rojo Piñana' was already detected on day 15 at both temperatures which led to a significant decrease in flesh colour (b^* and C^*) and firmness, whereas phenolic content and oxidation enzymatic activity increased significantly. In the case of 'Miraflores', CI symptoms were first detected on day 19 when stored at 5 °C, but in this case only the flesh colour (L^*) and texture were significantly different between injured and not injured fruit. When stored at 0 °C, the first symptoms of CI in this cultivar appeared on day 34 and significant differences in the skin colour (a^* , h^* and L^*), phenolic content, texture and peroxidase activity were detected between affected and non-affected samples. In conclusion, the 'Miraflores' cultivar appears less sensitive to chilling injury than 'Rojo de Piñana', since the last one showed earlier and more severe disorders, at both storage temperatures. Based on this evaluation, the shelf life of 'Miraflores' could be prolonged up to 30 days at 0 °C.

S02.499

Chlorophyll Absorbance: a Harvest Index for Sorting Melting And Non-Melting Fleshed Peaches According to Ripeness Levels

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In recent years various methods have been developed for nondestructive evaluation of ripeness parameters for peaches, however many of these have been difficult to implement and handle, as well as being based on physiological principles that not suffer substantial changes during ripening. In order to assess the absorbance of chlorophyll 'a' of the fruit's skin and its correlation with other parameters, peaches cvs. 'Ryan Sun', 'Sweet September' (melting flesh) and 'Kakamas' (non melting flesh) were harvested in four ripeness classes. The ripeness classes were defined by the color of the epidermis, and determined visually in the field. Further, it was measured the fruit weight, the soluble solids concentration (SSC), the flesh firmness, and the Chroma and Hue of the skin's background color. The rate of absorbance of chlorophyll (IAD), measured as the difference in absorbance between two wavelengths near the peak of chlorophyll 'a', was obtained through a portable Da-meter device (Sinteleia, Bologna, Italy). The data was submitted to ANOVA, and the means of each ripeness class were separated with Duncan's test (<0.05). Furthermore, a correlation analysis (Pearson) between the parameters was performed. The observed Hue and IAD values, on each ripeness class determined on the field and on the three varieties were different, confirming the effectiveness of the commonly used criteria for deciding the time of harvesting. In contrast, the weight, the CSS, the flesh firmness and Chroma, were not in all cases, different on the four classes of ripeness. High correlations were observed between IAD and Hue, $r = 0.82$ in 'Ryan Sun' and 'Sweet September', and 0.87 in 'Kakamas'. According to the results obtained, the IAD is a valuable index for deciding the harvest time, either for melting, as for non melting peaches.

S02.500

The Effect of Hot Water Treatment on Quality of Green Bean during Short Term Storage

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Green bean is a perishable vegetable with limited marketability. During four years of investigation, the influence of postharvest hot water treatment on storage ability of green bean cv. Paulista was conducted. The pods were subjected to hot water dipping of temperatures: 55 °C – 15 sec, 50 °C – 30 sec, 45 °C – 2 min, 40 °C – 10 min, 38 °C – 20 min. Treated pods were cooled in ambient temperature and next packed to PE plastic bags, each 400 g of pods. Green bean was stored for 14 days at temperatures 2 °C, 5 °C and 8 °C. Results showed that during 8 days of storage, the green bean kept good quality. The small brown spots were visible only on not treated pods while the treated looked almost like freshly harvested. During the following days the discoloration increased, especially at 5 and 8 °C. Hot water treatment improved the storage ability of green bean. The browning at all temperatures were the biggest for control object (non treated beans). The treated bean maintained very good quality at 2 °C, good at 5 °C and slight good at 8 °C. The untreated pods only stored at 2 °C after 14 days looked good but at 5 °C and at 8 °C were not acceptable for market. The storage temperatures influenced significantly on the discoloration as well as the quality of green beans. During 14 days at 2 °C the pods maintained very good quality, at 5 °C - good but at 8 °C only mediocre. The chilling injury appeared on the pods placing after storage at temperature 18 – 20 °C but only on the bean kept before at 2 °C. The intensity of chilling injury development was bigger on untreated pods in comparison to dipped in hot water after harvest.