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Treatment with salicylic acid extends the vase life of important commercial cut flowers

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ABSTRACT

A completely randomized design related study was conducted to evaluate the efficacy of salicylic acid (0 as control, 100, 200 and 300 ppm) to extend flower display life with 5 most important cut flowers across the world *Alstroemeria peruviana, Gerbera jamesonii, Lilium asiaticum, Rosa hybrida* and *Polianthes tuberose* with 3 replications and 3 samples for each replication. Applying salicylic acid extended the vase life of cut flowers significantly except in Rosa Hybrida. The highest vase life was observed for the treatments of 300 ppm. The addition of 300 ppm salicylic acid to clean distilled water extended the vase life of *Alstroemeria peruviana, Gerbera jamesonii, Lilium asiaticum, Polianthes tuberose* and *Rosa hybrida* by 30 -55 (%) relative to control. Salicylic acid treatments increased relative water content, petal water content and initial fresh weight in cut flowers, over control. The beneficial effects of salicylic acid are associated with the plant regulating and anti-stress properties of salicylic acid. Results of this experiment provide support for wider testing and use of this natural, cheap, safe and biodegradable compound, as a vase solution additive for extending the postharvest longevity of cut flower species susceptible to vascular blockage of bacteria and ethylene which are used widely in the world.

1- Introduction

Cut flowers are precious products of horticulture. Maintaining good quality of cut flowers and extending the vase life, is considered important and practical for having acceptable products for the markets. In general, many studies have been under taken for this purpose. (Redman, et al, 2002; Macnish et al, 2008 and Solgi et al, 2009, Zencirkiran, 2005; Zencirkiran, 2010). Vase life of cut flowers is mainly affected by two main factors, namely ethylene which accelerates the senescence of many flowers and by microorganisms which cause vascular blockage and thus reduces the vase life of cut flowers (Van Doorn, 1994; Zencirkiran, 2005; Zencirkiran, 2010). A floral preservative usually is a complex mixture of sucrose (sugar), acidifier, an inhibitor of micro-organisms and also an ethylene action or synthesis inhibitor like STS and SA (Marry, 2000).

Salicylic acid (SA) is considered to be a potent plant hormone because of its diverse regulatory roles in plant metabolism (Popova et al., 1997). It was first extracted from willow trees, and named after the Latin word "Salix" by Rafacle Piria in 1938. SA has been found to play a key role in the regulation of plant growth, development and in responses to environmental stresses (Hayat et., al, 2009). Further, its role is evident in ion uptake and transport (Harper and Balke, 1981), photosynthetic rate, stomatal conductance and transpiration (Khan et al., 2003). SA is considered to be an important signaling molecule which is involved in local and endemic disease resistance in plants in response to various pathogenic attacks (Enyedi et al., 1992; Alverez, 2000). Besides providing disease resistance to the plants, SA can modulate plant responses to a wide range of oxidative stresses (Shirasu et al., 1997). SA also suppressed ACC synthase and ACC oxidase activities and biosynthesis of ethylene, and hence retarded the climacteric rise in ethylene production, in kiwi fruit (Zheng, 2002). SA has been shown to interfere with the biosynthesis and/ or action of ethylene, abscisic acid and cytokinins in plants (Hayat et., al, 2009). SA and its derivative, acetyl salicylic acid (ASA) have been reported to inhibit ethylene production in pear (Leslie and Romani, 1988), banana (Srivastava, 2000) and carrot cell suspension cultures, suggesting the role of SA as an antagonist to ethylene action. In another experiment, the effects of SA and sucrose on cut roses were investigated and results showed a significant decrease in respiration rate, alleviation of the moisture stress and improved decorative quality of cut flowers, improving the vase life (Li et al., 2004). Also, the upward gravitropic bending of snapdragon was inhibited using SA (Friedman et al, 2003). SA reduced the pH of water and the proliferation of bacteria was reduced (Guy et al., 2003) consequently.

This experiment was designed to investigate effects of SA as components of the vase solution on the vase life of 5 major economic cut flowers.

2- Materials and methods

- Plant material

Flowering stems of 5 economically important cut flower species were supplied from a local grower. The Plants were grown under standard greenhouse conditions with 22 and 16 0C day and night temperatures, respectively.

- General processing

Upon arrival in the laboratory, the flower stems free of visible damage were trimmed to 45–50 cm-length using cutters. Leaves on 25cm of stems bottom were removed by hand that would otherwise be submerged in vase water. Stems were then immediately assigned at random to treatments, depending upon the particular experiment. Glass vases of 800mL capacity were prepared and filled with 300mL of deionized water and 0, 100, 200 and 300 ppm SA. Sucrose at 4% was added in all treatments as a base solution.

The opening of each vase was covered to limit vase solution evaporative loss and to allow determination of the uptake by stems of the different preservatives and contamination from falling flowers and leaves. Stems were maintained in a controlled environment room at 21 ± 0.5 ◦C and 40–60% relative humidity. Weight reduction or in other words water uptake of vases and relative fresh weight of cut flowers were measured every day through the experiment from day 1 to 10 (Karimi et., al. 2008).

- Vase life determination

Vase life of 5 cut flowers used in this experiment was determined according to the table below (Macnish et., al. 2008).

- Petal water content

Petal water content from each sample was determined at the end of control treatment vase life for each cut flower studied. 1g of petals from all replications and each sample were taken as FW and then dried at 70 0C for 24 h and their DW was recorded for this purpose. Petal water content (WP %) was then determined using the following equation (Kalate jari et., al, 2008):

$$\%WP= FW-DW/DW \times 100$$

- Water content

Dry weights of the examined cut flowers were determined after the end of vase life period. For this purpose, cut flowers were put in an oven at 72 0C for 24 hours.

- Weight of initial (%)

Fresh weights of cut flowers were measured every day. For determining the initial weight (%), the fresh weight (flowers+ leafy stems) determinations were made just before the immersion in the test solutions and repeated to day 9 (Petridou et., al, 2001). By this time, the vase life of some of the cut flower treatments like control was ended.

- Experiment design and data analysis

This experiment was conducted as a completely randomized design with SA at (0, 100, 200, 300 ppm) with 3 replications and 3 samples (individual flowers) for each replication. Data were analyzed as completely randomized design of ANOVAs using JMP4. Where significant ($P\leq0.05$) treatment effects were determined by ANOVA, data means were separated by the LSD test

3- Results

3-1- Vase life

According to the results shown in Table 2, using SA as a preservative significantly increased the vase life of all 5 cut flowers (P≤5%). The highest values observed in *Alstroemeria peruviana, Gerbera jamesonii, Lilium asiaticum, Rosa hybrida*, and *Polianthes tuberosa* are 26, 17.11, 18.22, 8.51 and 15.33, respectively and on the other hand, the lowest values are 18.44, 10.22, 15.55, 3.96 and 9.77 for the same cut flowers (Table 2). *Alstroemeria peruviana, Gerbera jamesonii* and *Polianthes tuberosa* showed a greater effect among other ones. *Lilium asiaticum* nearly showed the least increasing effect and it seems that senescence goes on with anther release and SA is not able to control this event properly. Increasing SA concentrations enhance the vase life to noticeable values and the highest of all was observed in 300 ppm SA treatment (Table 2).

3-2- Petal water content

Results from petal water content (%) measurement shows a significant difference in SA treatments over control (P≤5%). SA treatments with 34% increase by average compared to control, showed the highest petal water content (%) in applied treatments (Fig. 2). SA levels were also different significantly for some cut flowers like Rosa hybrida. The lowest amounts measured are in control treatment while the highest are differently spread in higher concentrations of (200 or 300 ppm) within cut flower samples.

3-3 Weight loss

Effect of SA was highly significant in this trait (P≤1%) and the SA 300 ppm which had the highest effect among other treatments, even increased the fresh weight in the 14th day of experiment for *Alstroemeria peruviana*, while a noticeable reduction was observed in control for all cut flowers especially *Lilium asiaticum* and *Polianthes tuberosa* (Fig. 3). The rate of weight reduction between days 0 to 16 was significantly different in treatments used compared to control (Fig 3). Weight reduction is observed all in cut flowers of this experiment and within higher concentrations as the time to this event goes further on and it happens later. Rosa hybrida lost its weight earlier than others and was only measured to day 8 when the vase life ended.

3-4- Water content

According to results, placement of cut flowers in vase water containing SA, significantly increased water content at the end of the experiment (P≤1%). The highest amount of this trait was observed in higher concentrations of SA (200 or 300 ppm) (Fig. 4). The *Alstroemeria peruviana* and *Lilium asiaticum* showed better response to the treatments, whereas, *Gerbera jamesonii* and *Rosa hybrid* do not show a regular scheme.

4- Discussion

A large number of factors such as pre-harvest conditions, packaging and post harvest handling as well as storage interfere in the vase life. Salicylic acid has been found to play a key role in regulating the plant growth and in the responses to environmental stresses (Raskin, 1992; Yalpani et al., 1994; Senaratna et al., 2000). SA treatments extended vase life in association with inhibition of ethylene production (Srivastava, 2000).

Pathogens also affect vase life due to vascular blockage (Van Dome, 1998). In Free State, SA has a pH of 2.4 and acidic solution inhibits bacteria growth and proliferation (Raskin, 1992). The addition of SA to vase water has previously been shown to extend the longevity of cut Rosa flowers (Lee et al., 2004 and Guy et al., 2003).

Water constitutes a large proportion of horticultural products weight. In addition to water, carbohydrates are the other major constituent of these products. These products are commonly take water and other materials from the mother plant, but when cut off, they rapidly move into senescence and death which take place in water loss and weight reduction. This reduction is much higher in stress conditions. SA can modulate plant responses to a wide range of oxidative stresses and prevents cell wall degradation (Shirasu et al., 1997). As an apparent result in this experiment, no fresh weight reduction is observed and a small increase is even, observed in SA treatments after 10 days.

Petals of a cut flower are the main ornamental parts and turgidity of this part is important for a good looking product. Petal turgidity depends largely on water uptake and maintenance in treatments used. Results of this experiment show a significantly higher water uptake and maintain the water in cut flowers which increases the cut flower fresh weight, subsequently. The increases in water uptake and subsequently cut flower fresh weight, is apparently due to the acidifying and stress alleviating properties of SA (Lee et al, 2004). According to our results, we can generally discuss that, the major part of the water uptake is gathered in the petals which in fact helps to have a better visual quality in SA treated cut flower samples.

Relative water content (RWC) is an index representing the amount of water in the plant organs and shows the ability of a plant in maintaining water under stress conditions (Abbaszadeh et al., 2008). So in a controlled environment for an experiment, the measured RWC shows the response of a plant and the higher the measured amount, the greater the ability of a treatment for keeping water (Abbaszadeh et al, 2008). Therefore according to our results, it seems that at day 10 of the experiment (end of control vase life), the samples placed in control treatments were under severe stress and could not take up and keep water properly, whereas the SA treatments in comparison, at the same time were under normal non stress conditions. Mean measured RWC in leaves of SA treatments was 50% higher compared to control. CA had no significant effect on this measured trait. In case of solution uptake our results did not agree with Karimi et., al. 2008.

5- Conclusion

In conclusion, the present study demonstrates that the inclusion of 100-300 ppm SA in clean vase water can significantly extend the display life of five commercial cut flower species (i.e. *Alstroemeria peruviana, Lilium asiaticum, Rosa hybrida, Gerbera jamesonii* and *Polianthes tuberosa*). Higher concentrations showed better effects, although sometimes stem browning was observed at higher concentrations. Our findings provide support for wider testing and use of the natural, cheap, safe and biodegradable compound, SA as a vase solution additive for extending the postharvest longevity of flower species that are susceptible to vascular blockage of bacteria and ethylene which are used widely in the world.

6- Acknowledgment

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7- References

- Abreu, M. E and Munne-Bosch, S. 2008. Salicylic Acid may be Involved In The Regulation Of Drought-Induced Leaf Senescence In Perennials: A Case Study In Field-Grown Salvia officinalis L. Plants. Enviro. and Exp. Botany. 64: 105-112.

- Alverez, A.L., 2000. Salicylic acid in machinery of hypersensitive cell death and disease resistance. Plant Mol. Biol. 44: 429–442.

- Babalar, M., Asghari, M., Talaei and A., Khosroshahi, A. 2007. Effect of Pre- and Postharvest Salicylic Acid Treatment on Ethylene Production, Fungal Decay and Overall Quality Of Selva Strawberry Fruit. Food Chem. 105: 449-453.

- Bhattacharjee, S. K., Singh, V., and Saxena, N. K. 1993. Studies on Vegetative Growth, Flowering, Flower Quality and Vase Life Of Roses. Singapore, J. Of Primary Industries. 21 (2): 67-71.

- Capdeville, G., Maffia, L. A., Finger, F. L and Batista, U. G. 2003. Gray Mold Severity And Vase Life Of Rose Buds After Pulsing With Citric Acid, Salicylic Acid, Calcium Sulfate, Sucrose And Silver Thiosulfate. Fitopatol.bras. 28: Braslia.

- Christopher, T.D., Lee, I. R and Gustafson, J. E. 2000. The Effects Of Salicylate on Bacteria: A Review. The Inter. J. of Biochem. & Cell Biology. 32: 1029-1043.

- Dole, J. M., F. Harold and P. Wilkins. 1999. Floriculture Principles and Species. Prentice Hall Inc, Upper Saddle River, New Jersey.

- Enyedi, A.J., Yalpani, N., Sliverman, P., Raskin, I., 1992. Signal molecule in systemic plant resistance to pathogens and pests. Cell 70: 879–886.

- Harper, J.R., Balke, N.E., 1981. Characterization of the inhibition of K+ absorption in oats roots by salicylic acid. Plant Physiol. 68: 1349–1353.

- Hayat, Q., Hayat S., Irfan, M and Ahmad, A. 2009. Effect Of Exogenous Salicylic Acid Under Changing Environment: A review. Enviro. and Exp. Botany, article in press.

- Kafi, M and Ghahsareh, M. 2009. Floriculture. 4th edition, Jahad press, Tehran, volume 1, pages 108-118.

- Kalate jari S., Khalighi A., Moradi F. and Fatahi moghadam M. R. 2008. The effect of calcium chloride and calcium nitrate on quality and vase life of rose flowers cv. Red Giant. Olum fonun Iran. 9: no. 3: 163-179.

- Kang, G. Z., Wang, C. H., Sun, G and Wang, Z. X. 2003. Salicylic Acid Changes Activities Of H2O2-Metabolizing Enzymes and Increases The Chilling Tolerance Of Banana Seedlings. Enviro. and Exp. Botany. 50: 9-15.

- Karimi., M. Asil., M., H. Lahiji., H. S. and Sasani., S., T. 2008. Effects of temperature and different chemical treatments for extending Lilium cut flower shelf life. Olum fonun Iran. No. 43: 1-9.

- Khan, W., Prithviraj, B., Smith, D.L., 2003. Photosynthetic responses of corn and soybean to foliar application of salicylates. J. Plant Physiol. 160: 485–492.

- Macnish, A. J., Leonard, R. T and Nell T. A. 2008. Treatment With Chlorine Dioxide Extends The Vase Life Of Selected Cut Flowers. Postharvest Biol. Technolo. 50: 197-207.

- Macnish, A. J., Jiang, Cai-Z. and Reid, M., S. 2010. Treatment with thidiazuron improves opening and vase life of iris flowers. Postharvest Biol. Technolo. 56: 77–84.

- Ping L. X., Qun, P. X., Qi, Z. Z and Liang L. Z. 2004. Preservation Effects Of Salicylic Acid on Cut Roses. Department of Horticulture, South China Agricultural University, Guangzhou 510642, Guangdong, China.

- Popova, L., Pancheva, T., Uzunova, A., 1997. Salicylic acid: properties, biosynthesis and physiological role. Bulg. J. Plant Physiol. 23: 85–93.

- Redman P. B., Dole, J. M., Maness, N. O and Anderson J. A. 2002. Postharvest Handling Of Nine Specialty Cut Flower Species. Sci. Hort. 92: 293-303.

- Shirasu, K., Nakajima, A., Rajshekar, K., Dixon, R.A., Lamb, C., 1997. Salicylic acid potentiates an agonist-dependent gain control that amplifies pathogen signal in the activation of defense mechanism. Plant Cell 9: 261–270.

- Solgi M., Kafi, M., Taghavi T. S and Naderi, R. 2009. Essential Oils And Silver Nanoparticles (SNP) As Novel Agents To Extend Vase-Life Of Gerbera (Gerbera jamesonii cv. 'Dune') flowers. Postharvest Biol. Technol. 53: 155-158.

- Srivastava, M. K., Dwivedi, U. N. 2000. Delayed Ripening Of Banana Fruit By Salicylic Acid. Plant Sci. 158: 87-96.

- Van Doorn W.G., Zagory D., Witte Y.D., and Harkema H. 1994. Effect of vase-water bacteria on the senescence of cut carnation flowers. Postharvest Biol. Technol., 1:161-168.

- Xu, X. B and Tian, S. 2008. Salicylic acid alleviated pathogen-induced oxidative stress in harvested sweet cherry fruit. Postharvest Biol. Technol. 49: 379-385.

- Yu, T., Chen, J. S., Chen, R., Huang, B., Liu, D. H and Zheng, X. D. 2007. Biocontrol Of Blue And Gray Mold Diseases Of Pear Fruit By Integration Of Antagonistic Yeast With Salicylic Acid. Inter. J. of Food Microbiol. 116: 339-345.

- Zhang, Y., Chen, K. S., Zhang, S. L and Ferguson, I. 2003. The Role Of Salicylic Acid In Postharvest Ripening Of Kiwifruit. Postharvest Biol. Technol. 28: 67-74.

- Zencirkiran, M. and Mengus, A. 2003. Cold storage of Alestromeria pelegrina 'Ostara'. New Zealand, J. crop, Hort. Sci. 31: 255-259.

- Zencirkiran, M. 2002. Cold storage of Freesia refracta 'Corduta'. New Zealand, J. crop, Hort. Sci. 30: 171-174.

- Zencirkiran, M. 2005. Effect of sucrose and silver thiosulphate pulsing on stem- base cracking and vase life in Leucojum aestivum L. flowers. J. of Hort. Sci. and Biotech. 80 (3): 332-334.

Zencirkiran, M. 2010. Effect of 1-MCP (1-Methyl Cyclopropene) and STS (Silver thiosulphate) on the vase life of cut Freesia flowers. Scientific research and Essays. 5 (17): 2409-2412.

Table 1- Criteria used to determine end of flower vase life.

Species	End of vase life characteristics
Alstroemeria peruviana	Wilting and/or drop of >50% of petals
Gerbera jamesonii	Drooping of flower and/or moderate wilting of petals
Lilium asiaticum	Senescence of all buds on a stem
Rosa hybrida	Wilting, blueing, disease of petals and/or drooping of flower
Polianthes tuberosa	Wilting and/or petal burning

Table 2- Vase life (day) of tested cut flower species in control and SA treatments.

	Vase life			
	Control	SA		
	0 ppm SA	100 ppm SA	200 ppm SA	300 ppm SA
Alstroemeria peruviana	18.44c	22bc	24.11ab	26a
Gerbera jamesonii	10.22c	11.67bc	14b	17.11a
Lilium asiaticum	15.55b	18a	18.67a	18.22a
Rosa hybrida	4.96b	6.11b	7.14a	8.51a
Polianthes tuberosa	9.77c	13b	14.89a	15.33a

(a) (b) (c)

Fig. 1- Vase life determination of different cut flowers in this experiment. a) *Gerbera jamesonii*, b) *Polianthes tuberose* and c) *Lilium asiaticum*

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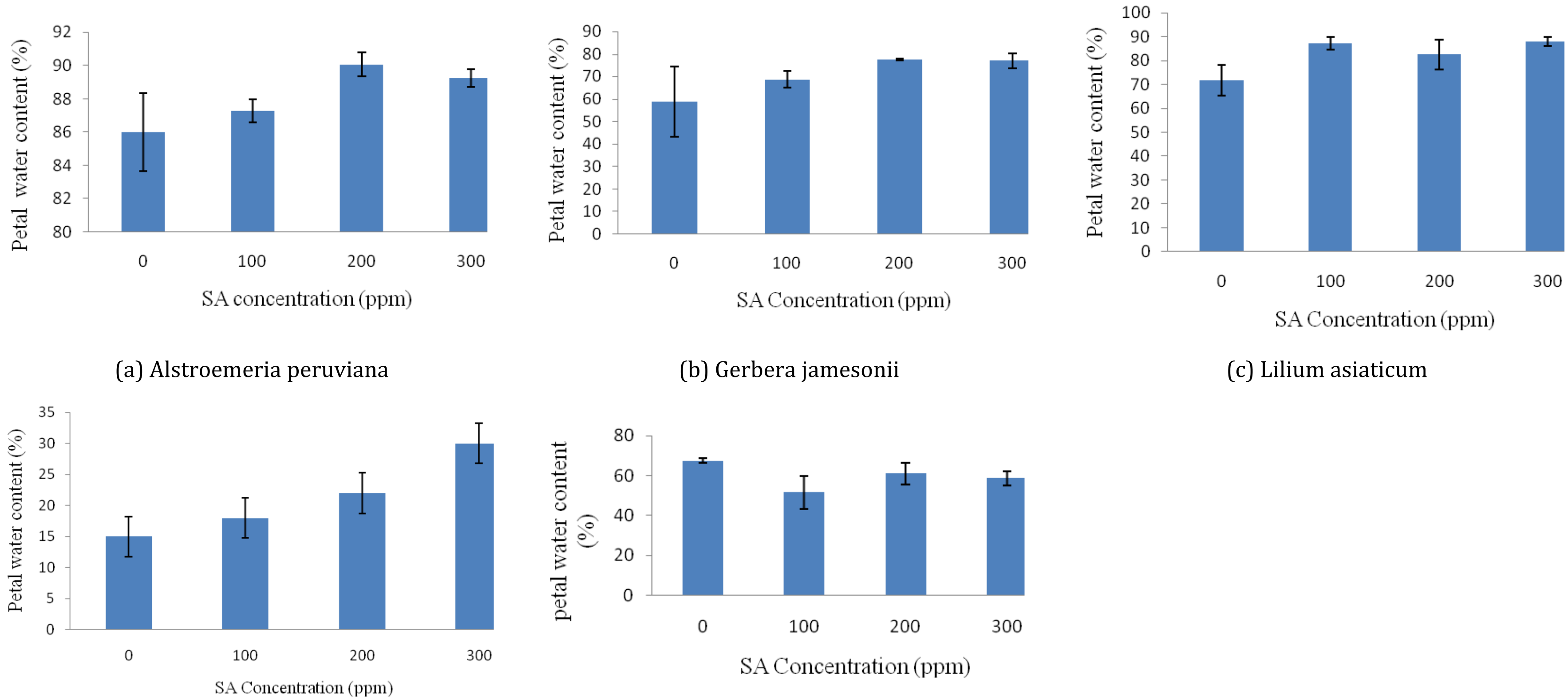

(a) Alstroemeria peruviana

(b) Gerbera jamesonii

(c) Lilium asiaticum

(d) Rosa hybrid

(e) Polianthes tuberosa

Fig. 2. Petal water content of different cut flowers studied, (Bars show ± standard error).

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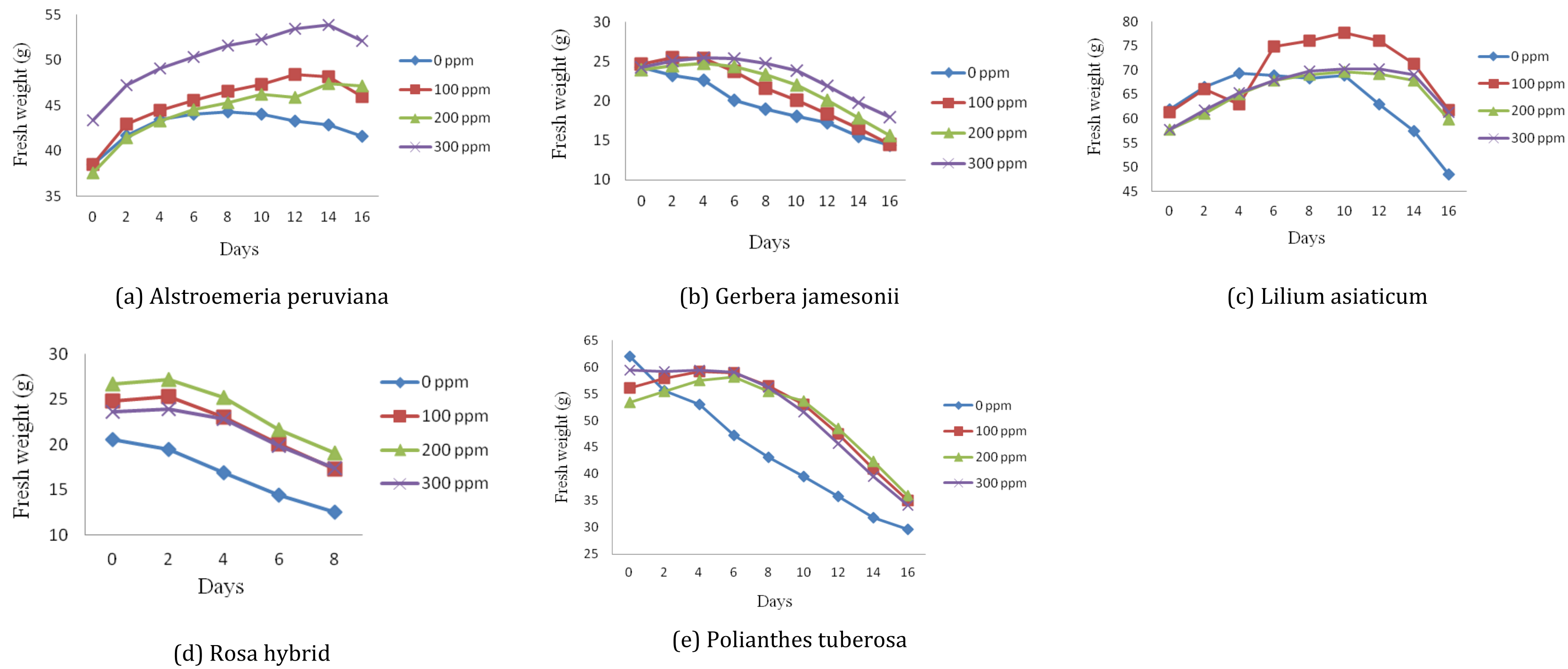
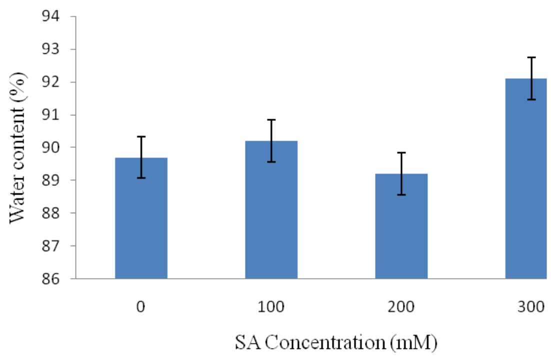
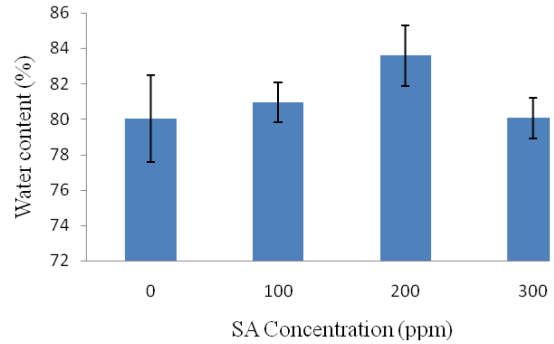


(a) Alstroemeria peruviana (b) Gerbera jamesonii (c) Lilium asiaticum (d) Rosa hybrid (e) Polianthes tuberosa

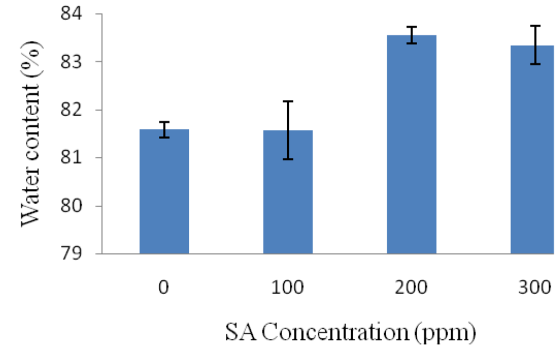
Fig. 3. Weight reduction of treated cut flowers in different SA levels.



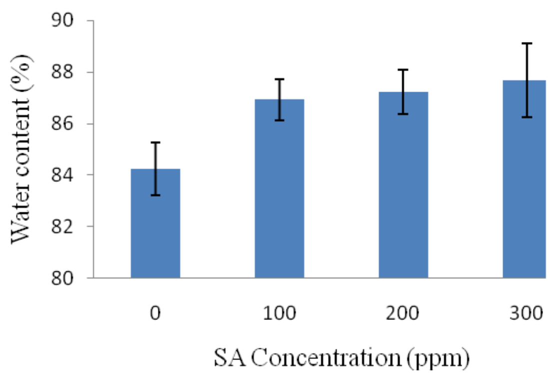
(a) Alstroemeria peruviana



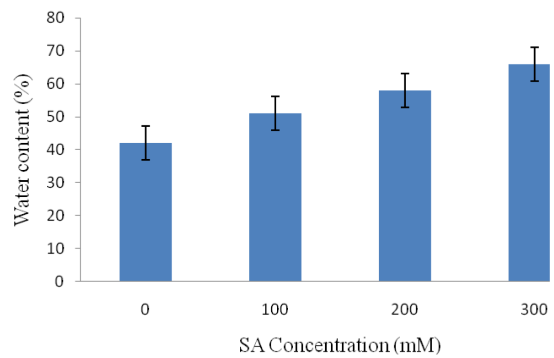
(b) Gerbera jamesonii



(c) Lilium asiaticum



(d) Rosa hybrid



(e) Polianthes tuberosa

Fig. 4. Water content of of different cut flowers studied. (Bars show ± standard error).