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Effect of air temperature of a tower heat-dryer on in vitro digestibility of organic matter and metabolozable energy content of brewer's grain

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Abstract

The aim of the present study was to evaluate the effect of the air temperature on in vitro digestibility of organic matter (DOM), metabolizable energy (ME) and net energy for lactation (NEL) values, and drying efficiency of brewer's grains (BG) using a new technology of a tower heat-dryer system. The technology was developed to dry BG when it was flew constantly through a tower (10 m length) against a current of pressure of heated air at 180 ºC (LAT) or 240 ºC (HAT) with a pressure suction cooling. Dried samples were obtained from the lowest and the highest applied temperature, then ground to pass through a 2-mm screen and subjected to a gas production technique. Rumen content was collected from three ruminally fistulated sheep (42±2.5 kg, body weight) and strained through 4 layers of cheesecloth. The laboratory handling of rumen fluid was carried out under a continuous flow of CO2. In vitro incubation of the samples was done using a manual pressure transducer technique. Approximately 200 mg of each sample was weighed into a 120 ml serum bottle (n=8). The bottles were pre-warmed at 38.6 °C before the injection of 30 ml rumen fluid-buffer mixture (10 ml rumen fluid and 20 ml buffer solution) into each bottle followed by incubation in a water bath at 38.6 °C. Gas pressure was recorded after 2, 4, 8, 12 and 24 h of incubation and converted to gas volume using experimentally determined calibrated curve. Metabolizable energy, NEL and DOM values of the samples were calculated using following equations: ME (MJ/kg DM)= 1.56 +0.1390 GP +0.0074 XP +0.0178 XL; NEL (MJ/kg DM)= 0.1010 GP +0.0051 XP +0.011 XL; DOM (g/kg DM)= 14.88 +0.8893 GP +0.0448 XP +0.0651XA. Where GP is net gas produced after 24 h of incubation (ml/0.2 g DM), and XP, XL and XA are crude protein, crud fat and ash content of the feed (g/kg DM), respectively. Data were analysed using the GLM procedure of SAS. Results indicated that air temperature of the new drying technique had a significant (P< 0.05) effect on ME (MJ/kg DM), NEL (MJ/kg DM) and DOM (LAT= 9.71, 5.64 and 620, HAT= 9.98, 5.79 and 640, respectively) of the BG samples evaluated. Results indicated that the drying process of the samples dried at the air temperature of 180 ºC was less efficient than the highest applied temperature, as observed in 9% of more consumed drying time with similar moisture output compared with the HAT samples. Therefore, the highest air temperature used in the present study was more efficient and safe for drying and enhancing the nutritive values of the BG samples evaluated.

Keywords: digestibiliy, metabolizable energy, net energy, brewer's grains

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Introduction

Brewer's grains (BG) have high moisture which caused to give problems associated with their mould contamination and conservation. Two methods exist to remove these problems, are ensiling and drying. The effect of heat drying on organic matter digestion in the rumen and small intestinal and energy availability depends on the feed moisture, applied temperature and time consumed to drying (Broderick et al., 1991). The *in vitro* gas production technique has proved to be a potentially useful technique for feed evaluation. Menke and Steingass (1988) suggested that the gas volume after 24 h of incubation has a relationship with metabolizable energy in feedstuffs. Sommart et al. (2000) reported that gas volume is a good parameter to predict digestibility, fermentation end-product and microbial protein synthesis of the substrate by rumen microbes in the in vitro system. Additionally, in vitro dry matter and organic matter digestibility were shown to have high correlation with gas volume (Sommart et al., 2000).
The aim of the present study was to evaluate the effect of the air temperature on the digestibility of organic matter (DOM), metabolizable energy (ME) and net energy for lactation (NE_L) values, and processing drying efficiency of brewer's grains dried using a new tower heat-dryer system.

Materials and methods

A new technology of a tower heat-dryer was developed to dry BG when it was flew constantly through a tower (10 m length) against a current of pressure heated air from 180 ºC (LAT) to 240 ºC (HAT) with a pressure suction cooling. Dried samples were obtained from the lowest and the highest applied temperature, then ground to pass through a 2-mm screen and subjected to a gas production technique (Menke and Steingass, 1988).

Rumen content was collected from three ruminally fistulated sheep (42±2.5 kg, body weight) and strained through 4 layers of cheesecloth. The laboratory handling of rumen fluid was carried out under a continuous flow of CO_2. In vitro incubation of the samples was done using a manual pressure transducer technique (Theodorou et al., 1994). Approximately 200 mg of each sample was weighed into a 120 ml serum bottle (n= 4). The bottles were pre-warmed at 38.6 °C before the injection of 30 ml rumen fluid-buffer mixture (10 ml rumen fluid and 20 ml buffer solution) into each bottle followed by incubation in a water bath at 38.6 °C. Gas pressure was recorded after 2, 4, 8, 12 and 24 of incubation and converted to gas volume using experimentally determined calibration curve. Metabolizable energy, NE_L and DOM values of the samples were calculated using the equations of Menke and Steingass (1988):

$$ME\ (MJ/kg\ DM) = 1.56 + 0.1390\ GP + 0.0074\ XP + 0.0178\ XL$$
$$NE_L\ (MJ/kg\ DM) = 0.1010\ GP + 0.0051\ XP + 0.011\ XL$$
$$DOM\ (\%) = 14.88 + 0.8893\ GP + 0.0448\ XP + 0.0651XA$$

Where GP is net gas produced after 24 h of incubation (ml/0.2 g DM), and XP, XL and XA are crude protein, crude fat and ash content of the feed (g/kg DM), respectively. Data were analyzed using the GLM procedure of SAS (SAS Institute, 1990). Tukey's test was used to compare the means at $P< 0.05$.

Results and discussion

Effect of air temperature on gas produced after 24 h incubation, ME, NE_L and DOM of the samples are presented in Table 1. Results indicated that air temperature of the new drying technique had a non significant ($P< 0.05$) effect on ME, NE_L and DOM of the BG samples evaluated in the present study.

The highest air temperature of the drying system used in this experiment did not result in energy value reduction, as measured by in vitro gas production technique. In the present drying system, a combination of high air temperature and high air flow was applied to dry the feed at the lowest consumed time while taking the moisture out and keeping safe the nutritional quality of the output. The established rule to be followed in any drying system is the highest water removal rate at the lowest consumed time. Results of the present study indicated that the drying process of the samples dried at the air temperature of 180 ºC was less efficient than the highest applied temperature, as observed in 9% of more consumed drying time with similar moisture output compared with the HAT samples. Therefore, the highest air temperature used in the present study was more efficient and safe for drying and preserving the nutritive values of BG samples evaluated.

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Table 1 Effect of air temperature applied in a new tower heat-dryer on gas production after 24 h incubation, ME, NEL and DOM of dried brewer's grains.

	air temperature			
Items	LAT	HAT	SEM	*P-value*
Gas produced after 24 h (ml/0.2 g DM)	34.1	36.7	0.83	<0.05
ME (MJ/kg DM)	9.71	9.98	0.14	<0.05
NEL (MJ/kg DM)	5.64	5.79	0.09	<0.05
DOM (g/kg DM)	620	640	7.00	<0.05

-PP3136-

Chemical components, minerals and digestibility of legume straws(*Lens calinorismedik Lentil, Lathyrus sativus* L.*)* in South West of Iran

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Abstract

These by-products mostly have a low nutritive value and some of them high nutrient inhibitor, bur plentiful available and cheap in this regions, which need to identify and measuring of nutrient value and digestibility of them. Although, farmer obligated to use new feed to replacing of the expensive feed in the feed decline from November to May. To determine the chemical compositions, minerals and in-vitro digestibility of *Lens calinorismedik Lentil* (LCL)and *Lathyrus sativus L.* (LSL) straws in shahrekord, kohrang and lordegan climates in Chaharmahal & Bakhtiari province of Iran. They were most dominant Legume straws that they used in ruminant winter diets. These legume straws gathered from different climates for three years during 2002 to 2004 years. They were analyzed for chemically composition Dry Matter, Crud Protein, Crud Fiber, ASH, Ether Extract, Neutral Detergent Fiber, Acid Detergent Fiber, Acid Detergent Lignin, Calcium, Phosphorous, Manganese, Ferro, Magnesium, Cupper, Zinc, and in-vitro digestibility comprising dry matter digestibility (DMD), organic matter digestibility (OMD) and dry organic matter digestibility (DOMD) were determined in-vitro and energy was determined using of calorie meter bomb. All of the data classification with Excel software and used of *SAS* for statistical analyzed. Total mean of crud protein for the LCL and LSLstraws were 7.52 and 10.32 percent respectively. Crud protein of LSL was significantly ($P<0.05$) higher than LCL. The results showed that the amount of gross energy for LSL was 4007 kcal/ Kg DM and significantly was higher than LCL. The mean of DMD for LCL and LSL straws were 59.98 and 59.8 percent respectively. The OMD were 56.29 and 56.79 percent respectively. The minerals status of LCL and LSshowed that these Legume straws can provide *Calcium* for ruminant requirements for maintenance and growth in sheep and goats at the winter. The mean of elements were lower in LCL straw (0.14 percent) and higher in LSL (0.20 percent) and amount of *phosphorous* was lower than critical value required for ruminant. In addition the effects of climates and sampling years were significant ($P<0.05$) on nutrient matter, minerals, dry and organic matter digestibility.

Keywords:*Lens calinorismedik Lentil, Lathyrus sativus L.*,chemical compositions, minerals, digestibility, Iran

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Introduction

Small-scale farmers, who are raising the most productive sheep and goats in south west of Iran, utilized legumes straw as a feed resource with various supplemental materials at the winter. These by-products mostly have a low nutritive value and some of them high nutrient inhibitor or antinutrinional factor, but plentiful available and cheap in this regions, which need to identify and measuring of nutrient value and digestibility of them. Although, farmer obligated to use new feed to replacing of the expensive feed in the feed decline from November to May. Legumes straws and food legumes are a valuable source of feed for livestock. The whole seed of most legumes is a rich source of energy and amino acids. For the Lathyrus legumes, the meal are used as a protein concentrate. There is also considerable potential to use the residues left after harvesting the seeds as sources of fodder for livestock. *Lens calinorismedik Lentil*, *Lathyrus sativus* L. are the most prominent species of the forage plants, due to seed requirements and the amount of straw per harvest and the leaf ratio in the yield. There are several opinions about the quality of harvest remains. Other opinion is that this feed has poor nutritive value but it can be significant as bulk feed for livestock with lower nutrient requirements, such as calves. Legume seeds are sources of carbohydrate, crude fiber, amino acids, vitamins, minerals and essential fatty acids. However, it is their contribution of energy and amino acids that have the greatest economical potential in the feeding of livestock. As sources of energy, leguminous seeds are rich, generally containing as much, or slightly more, energy than that found in cereals. Their value as sources of amino acids depends on a number of factors, including the concentration and pattern of essential amino acids relative to the animal's needs and the digestibility of the amino acids. The harvest index for food legumes varies greatly, both between species and between cultivars within a species. The different plant morphologies result in a range of leaf: stem ratios. The stage of maturity at which harvest is made results in variations in the nature of the residues which may, as for cowpeas picked as immature pods, still be green; be harvested at maturity when the plant stem is drying. The method of harvest, likewise, leaves some food legume straws and stubbles in the field, while for others the whole plant is harvested and the legume seed recovered by whole vine threshing. The latter procedure can result in stem, leaf and pod/hull residues being separated as different components for subsequent use as animal feeds. Consequently the feeding value of the crop residue needs to be described quite specifically not in terms of analysis of samples of bulk material other than edible seed, but in terms of the classes of standing or harvested fractions, and the postharvest treatments in grain recovery. As with most crop plants, there is considerable dry matter loss, decreased protein and soluble carbohydrate content and increasing fiber content with approaching maturity of the plant. However, for most of the common food legumes, the stem material is of better digestibility and nitrogen content than cereal straws. Leaf digestibility is high, but for some legume crop residues at maturity may contribute little to the material recoverable by animals grazing stubbles, or hand fed vine-threshed materials. Cowpeas are regarded as a dual purpose crop raised for grains for human consumption and fodder for animal production. Green or dry pods may be hand harvested, leaving green stem and leaf material which can constitute 50-70% of the harvestable biomass. This material has 14-16% crude protein and a digestibility of 55-65%. This residue will support growth in goats. However, if the crop is allowed to mature, protein content falls to 10-11 %, and digestibility to 45-55%.Intake of these hand harvested residues is reduced to about 1.8% of liveweight and maintenance of live weight of animals become questionable. If there is substantial dry matter loss of residues of vines cut at harvest time, fiber content is increased per unit organic matter, and this together with leaf loss will further reduce digestibility and protein content. Use of the residues as supplements to other feedstuffs is often reported but the specific composition of the residues fed and the basal diet so supplemented leave real questions of the complementarily for ruminant nutrition. The major limitation of the feeding of leguminous proteins is the concern about levels of ant-