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Effect of Soaking in Water and Rumen Digeta Solutions on Metabolizable Energy Content and Chemical Composition of Barley Seeds for Use in Poultry Diet

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Abstract: An experiment was carried out to evaluate the effect of soaking in water and different rumen digesta solutions on nutritional value of dry barley seeds. Treatments were included distilled water as control and rumen digesta that diluted with distilled water to obtain 20, 40 and 60% digesta solutions. Solutions have added to 10 kg of barley seed samples to achieve final 30% moisture content. After 21 days the chemical composition and energy content of barley seed were determined. Gross energy of barley seeds did not affected by different experimental treatments. Use of 20% rumen digesta solution resulted to a significant ($p<0.01$) increase in AME and AMEn content of barley seeds. Barley seed that treated with 40% of rumen digesta solution had highest TME and TMEn content and its different from seeds that treated with 60 and 100% rumen digesta solutions was significant ($p<0.05$). The chemical composition such as dry matter, crud protein, crude fat, crud fiber, ash and NFE were found to be similar and there was no significant difference. However, soaking in rumen digesta solutions increased crud protein, ether extract, crude fiber and ash content of barley seeds numerically.

Key words: Barley, soaking, rumen digesta, chemical composition, energy

INTRODUCTION

Barley is a good source of nutrient and it contains 94% of the digestible or metabolizable energy content of some cereals, such as corn or wheat. Barley has higher content of digestible nutrients relative to alternative energy feedstuffs. The levels of bioavailable essential amino acids, particularly lysine is higher in barley relative to other grains. Also, barley contains more phosphorus than common cereal grains and that phosphorus has a relative high bioavailability. Low cost and higher levels of available nutrients resulted to economic advantage of barley than other cereal grains for use in poultry diets. However, these grain contain relatively high proportions of Non-starch Polysaccharides (NSP's), especially beta-glucans (about 4-7%), which are known for their anti-nutritive properties. In poultry, endogenous enzymes have a limited ability to digest non-starch polysaccharides. Thus their content and composition in the diet negatively affect the digestibility and absorption of nutrients and reduce poultry performance (Alam *et al*., 2003). The content of NSP in the diet is positively correlated with gut viscosity (Bedford and Classen, 1992; Alam *et al*., 2003). Choct and Annison (1992) demonstrated that the concentration of soluble arabinoxylan in broiler diets is positively correlated with the relative depression in AME, nitrogen retention, feed conversion efficiency and weight gain.

Different approaches have been used for improve barley nutritional value for poultry including development of hull-less barley varieties, betaglucan extraction, use of exogenous enzymes, radiation and soaking in water. Soaking has been documented to be an effective treatment to remove antinutrional factors, which can be eliminated with the discarded soaking solution. Use of exogenous enzymes is now a commonplace practice (Sayyazadeh *et al*., 2006). In developing countries use of enzyme is not economic, because enzymes are imported and have high costs. Microorganisms in rumen can producer celloulase and betaglucanase enzymes. An alternative way in these countries could be use of rumen fluid that is a combination of soaking and microbial enzymes, produce in slaughters in high quantities and have no cost. This study carried out to evaluate the effect of soaking in water and different rumen digeta solutions on nutritional value of barley seeds.

MATERIALS AND METHODS

Samples and processing: The dry raw seeds collected from the barley fields on July 2005 in Isfahan, Iran. The seeds were cleaned first and then kept in room temperature until processing. Rumen digesta collected from slaughtered finishing cows at slaughter house and diluted with distilled water to obtain 20, 40 and 60% digeta solutions. Distilled water (as control), pure and diluted

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rumen digeta have added to 10 kg of barley seed samples to achieve final 30% moisture content. Four sub samples have taken from each samples as replications and kept at room temperature for 21 days. Samples have mixed 2 times at the day to prevent mold growth. After 21 days, samples dried at room temperature and samples have taken for further analysis and Sibbald experiment.

Proximate analysis: Moisture content of all raw and treated barley seeds were determined by oven drying to a constant weight at 105°C. The samples were analyzed in 5 replications. Crude protein (Kjeldahl, N×6.25), crude fiber, ether extract and ash content were determined in accordance with the standard procedures of the Association of Official Analytical Chemists (1990). Nitrogen Free Extracts (NFE) were obtained by difference.

Energy assay: Metabolisable energy determined by Sibbald (1986) method. Gross energy was determined using an adiabatic bomb calorimeter (Parr Instrument, Moline. Il, USA) using a benzoic acid standard. In order to determine AMEn and TMEn excreta samples were analyzed for nitrogen (Kjeldahl) contents.

Statistical analysis: The results obtained from the experiment were analyzed by an analysis of variance using the General Linear Model (GLM) procedure of SAS and means were compared by LSD Test (SAS Institute, 2001).

RESULTS AND DISCUSSION

Energy content: Gross energy of barley seeds did not affected by different experimental treatments (Table 1). Use of 20% rumen digesta solution resulted to a significant ($p<0.0$) increase in AME and AMEn content of barley seeds. Barley seed that treated with 40% of rumen digesta solution had highest TME and TMEn content and its different from seeds that treated with 60 and 100% rumen digesta solutions was significant ($p<0.05$). Barley seed contain a noticeable amount of NSP's. Annison (1991) showed that the content of NSP in the diet increase digestive tract viscosity and inversely related to the Apparent Metabolizable Energy (AME) of wheat. Concentration of soluble betaglucan and arabinoxylan in broiler diets is positively correlated with the relative depression in AME and nitrogen retention. It has been reported that digestibility can improved by enzyme supplementation. Also, it has been reported that main part of cereal starch ferment in lower part of gastrointestinal tract (Douglas *et al*., 2000). Rumen digesta contains NSP degrading enzymes or microbes that produce these enzymes and ferment sugars in barley. NSP degrading enzyme can reduce the negative effects of antinutritive factors and therefore improve barley seed energy content. Then, the improvement in barely energy content after soaking in rumen digesta may be attributed to microbial fermentation in rumen digesta.

Table 1: GE, AME, AMEn, TME and TMEn (Kcal kg^{-1}) of water and rumen digesta treated barley seeds

		Rumen digeta solution (%)			
Seed contents	Control (distilled water)	20	40	60	100
GE	4071	4034	4037	3993	4060
AME	2142^{bc}	2715^{a}	2387^{ab}	1938^{c}	2291^{bc}
AMEn	2071^{bc}	2587^{a}	2302^{ab}	1833^{c}	2193^{bc}
TME	3293^{ab}	3581^{ab}	3802^{a}	3063^{ab}	2918^{b}
TMEn	3149^{ab}	3420^{ab}	3677^{a}	2939^{b}	2792^{b}

Mean value in the column with same letter(s) are not significantly different

Table 2: Chemical composition of water and rumen digeta treated barley seeds (g 100 g^{-1} DM)

		Rumen digeta solution (%)			
Extracts	Control (water)	20	40	60	100
Dry matter (%)	91.90	92.30	92.80	92.10	92.80
Nitrogen	1.68	1.69	1.71	1.74	1.85
Crud protein	10.50	10.60	10.70	10.90	11.60
Ether extract	1.50	1.50	1.80	1.90	2.20
Crud fiber	4.20	4.60	4.80	5.20	5.40
Ash	2.30	2.60	2.70	2.70	2.90
Nitrogen free extract	81.50	80.70	80.00	79.30	77.90

Chemical composition: The gross composition such as dry matter, crud protein, crude fat, crud fiber, ash and NFE were found to be similar and there was no significant difference. How ever, soaking in rumen digesta solutions increased crud protein (0.1 to 1.1%), ether extract (0.3 to 0.7%), crude fiber (0.4 to 1.2%) and ash content (0.3 to 0.6%) of barley seeds numerically (Table 2). Rumen digesta have 10^{10} to 10^{11} bacteria and 10^{4} to 10^{6} protozoa per gram of sample and microbial biomass is produce protein, carbohydrate and lipid source for animal. The protein content of microbial cells generally accounts for 40 to 60% of the cell dry weight and protozoa may contain 10 to 40% of total N in ruminal pool. The increase in curd protein may be a result of microbial protein in rumen digesta. Also, ruminal bacteria synthesize fatty acids for incorporation into cell membrane phospholipids and sphingolipids have been isolated from ruminal species. Therefore, the increase in ether extract could be attributed to fatty acids in cell membrane of ruminal bacteria.

These results showed that rumen digesta solutions could be used for improve the nutritional value of barley seeds and more studies are required to evaluate the use of rumen digesta treated seeds in poultry diets.

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