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The Determination of Fermentation Characteristics of Treated and Untreated Barley Grain Using Gas Production Technique

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Abstract: In order to determine of fermentation characteristics of treated and untreated barley grain the experiment was carried out. The treatment contain Untreated Barley Grain (UBG), Teated Barley Grain at 120°C, 5′ (TBG 1) and 20′ (TBG2) and 100°C, 5′ (TBG 3) and 100°C, 20′ (TBG 4). The gas production was measured at 2, 4, 8, 16, 24, 36 and 48 h. The gas production data were fitted by the equation of $P = A(1-e^{-ct})$. The gas production of treated barley grain at 48 h was lower than the other treatments ($p<0.05$). Also the gas production of soluble and insoluble fractions (A) and rate of gas production in most of treated barley grain were lower than the other treatments ($p<0.05$). Treatment of barley grain by heat had low gas production resulting and improved efficiencies of barley grain and increased by pass protein.

Key words: Barley grain, heat treated, gas production, fermentation, TBG

INTRODUCTION

In ruminant due to ruminal microorganisms and their activities in catabolism and anabolism of protein, the protein requirements must be calculated according to Ruminal Degradable Protein (RDP) and Undegradable Dietary Protein (UDP) (McDonald, 1995). Some studies (Abdoli, 2003; Wallace, 1988) have been shown that high UDP in diet can be improved feed efficiency and wool production in sheep. The barley grain is as a major source of energy in ruminants and since barley grain constitute major part of diet and can be supplied part of protein requirement, but due to high RDP can not be supplied sufficient UDP (Sadegi *et al*., 2003). Using some processing as steam flack, heat treatment and rousting increase amount of UDP in barley grain (Waldo, 1973). Fiems *et al.* (1990) reported treating barley grain using steam flak increased UDP.

Engstrom *et al.* (1992) showed that the treating of barley grain using steam flak decrease RDP due to starch retrogradation. Treating of barley grain using toasting can be decreased ruminal starch degradability as well as RDP, while Mc Niven *et al.* (1994) reported rousting increased UDP, but had not effect on rate and site of carbohydrate digestion. The *in vitro* gas production system has been used as a predictor of ruminal degradation of feed and indicator of digestible dry matter intake. This technique also has potential to replace in situ dry matter and disappearance (Taghizadeh *et al*., 2006). The objective of this study was to determine of gas production characteristics of untreated and heat treated barley grain.

MATERIALS AND METHODS

***In vitro* gas production:** The treatment contain untreated Barley Grain (UBG), autoclaved Treated Barley Grain at 120°C, 5′ (TBG1), and 20′ (TBG2), treated barley grain at 100°C, 5′ (TBG3) and 20′ (TBG4). Two Ghizel sheep (38±2 kg) used as donors of rumen liquor. The sheep were fed a diet consisting 40% alfalfa hay: 60% concentrate. Equal volumes of ruminal fluid from each sheep collected 2 h after the morning feeding were combined and strained through four layers cheesecloth and mix with buffer prewarmed at 39°C (2 buffer: 1 ruminal fluid).

The inoculums were dispensed (20 mL) per vial in to substrate 35 mL serum vial containing of 300 mg per vial, which had been warmed to 39 °C and flashed with oxygen free CO_2. The vials were sealed immediately after loading and were affixed to a rotary shaker platform, set at (120 rpm) housed in incubator. Vials for each time point, as well as blanks (containing no substrate) were prepared in triplicate. Gas production was measured in each vial after 2, 4, 6, 8, 16, 24, 36 and 48 h of incubation using a water displacement apparatus (Fedorak and Hrudey, 1983).

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Chemical analysis: Determination of nitrogen were conducted using kjeldahl method in an automated kjelfoss apparatus (Foss Electeric,Copenhageh, Denmark) natural detergent fiber and ADF were measured according to the method of Vansoest *et al.* (1991).

Calculation and statistical analysis: Gas production was calculated as mL g^{-1} sample DM and gas production values over time for each sample were fitted to a one component Mc Donald model: $y = A\ (1\text{-}e^{-ct})$ that y is the volume of gas production at time t, A the soluble and insoluble gas production (ml g-1 DM) and c rate of gas production of insoluble fraction (%/h) and this time. Parameters A and c were estimated by an iterative least square method using a none linear regression procedure of the Statistical Analysis System (SAS, 2001). Difference between treatments in gas production data was analyzed using the General Linear Model (GLM) procedure of SAS institute Inc (SAS, 2001) and Dunkans multiple range test used for the comparison of means.

RESULTS AND DISCUSSION

The chemical composition of the treatments in this experiment is presented in the Table 1. The CP and NDF in UBG were more than reported the NRC (1985) but ADF in UBG was lower than the NRC reports. This difference can be expected due to differences in environmental factors, type and variety of barley grain.

The gas production data are shown in Table 2 and 3. The gas yielded in TBG and TBG3 at 48 h was lower than the other treatments ($p<0.05$).

The gas production of soluble and insoluble fractions (A) showed significant differences between treatments ($p<0.05$). The gas production of TBG2 was lower than the other treatments ($p<0.05$). Also the rate of gas production (c) in TBG2 was lower than the other treatments ($p<0.05$). Treating of barley grain using autoclave processing can be changed structure of soluble and insoluble carbohydrate fractions (Gelatinization of starch, formation of dextrans,…) resulting low gas production in treated barley grain using autoclaving process. The rate of gas production of UGP was lower than that Sadegi *et al.* (2003) reported this difference can be expected regarding to variety and gas production recording assay. The gas production parameters (A and c) of untreated and treated barley grain obtained in this study were difference from that reported by Menk *et al.* (1979). These differences probably are resulted from variation in type, gas production recording assay, processing of barley grain.

Treated barley grain decreased gas yielded at incubation times as the maximums gas production at major incubation times obtained from UBG. This finding can be resulted from autoclaving of barley grain that influence barley membrane resulting decreased ruminal fermentation and increased escaped carbohydrate and protein from ruminal fermentation and can improve milk yield in high performance dairy cows (Broderick *et al.*, 1991). Scwab (1995) showed that the effect of heat treating on escaped nutrient from ruminal fermentation is resulted to type of processing, time of processing and moisture containing.

Table 1: Chemical composition of barley grain (%)

Feed	DM	CP	ADF	NDF
Barley grain used in this experiment	92	11.56	6.0	26.8
Barley grain in NRC (1985)	90	10.80	6.6	20.1

Table 2: The gas production of treatments at incubation times (mL g^{-1}DM)[1]

	Incubation time						
Feedstuff	2	4	8	16	24	36	48
UBG	23.11^{a}	39.77^{abc}	62.45^{bc}	100.89^{ab}	179.34^{ab}	254.67^{ab}	276.89^{a}
TBG 1	17.78^{c}	27.56^{c}	41.78^{efd}	65.78^{c}	13.45^{ed}	224.0^{abcd}	265.3^{a}
TBG 2	18.89^{b}	27.77^{c}	39.56^{f}	66.44^{c}	111.12^{e}	185.34^{d}	231.78^{b}
TBG3	23.11^{b}	40.00^{abc}	58.67^{cde}	91.55^{b}	143.1^{cde}	174.4^{d}	194.4^{b}
TBG4	17.77^{b}	43.89^{abc}	59.55^{cd}	100.6^{ab}	172.8^{abc}	239.3^{ab}	270.4^{a}
SEM*	1.99	5.03	4.27	5.37	7.96	10.7	11.6

[1]Different letters within columns indicates statistical differences ($p<0.05$). *SEM: Standard Error Mean

Table 3: The gas production parameters estimated by equation at $P = A\ (1\text{-}e^{-ct})$

	Treatments					
Parameters	UBG	TBG1	TBG2	TBG3	TBG4	SEM
A	290.48^{a}	283.25^{b}	247.35^{e}	276.27^{d}	282.17^{c}	0.22
C	0.057^{b}	0.048^{d}	0.04^{e}	0.05^{c}	0.059^{a}	0.001

[a]Different letters within rows indicates statistical differences ($p<0.05$). [c]SEM: Standard Error Mean

CONCLUSION

The low gas production in treated barley grains show high protection of these treatments from ruminal fermentation resulting high escaped nutrient to lower digestive tract offer users flexibility in formulation rations according to the productive performance of target animals.

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