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Effects of heat treating of barley grain on ruminal DM degradation using nylon bags technique

Valiollah Palangi[1]*, Akbar Taghizadeh[2], Yousef Mehmannavaz[3] and Hamid Paya[2]

[1] *Member of Young Researchers Club, Maragheh Branch, Islamic Azad University, Maragheh, Iran*

[2] *Department of Animal Science, Faculty of Agriculture, University of Tabriz, Iran*

[3] *Department of Agriculture , Maragheh Branch, Islamic Azad University, Maragheh, Iran*

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Abstract

This study was carried out to the determination of nutritive value of barley grain (un treateated and treated with 120° C heat) using nylon bag technique in Gizel sheep . Tow fistulae Gizel sheep with average BW 50.5±2.5 kg used in a complete randomized design. The ruminal DM disappearance were measured 0, 4, 8, 16, 24, 36 and 48 h. Dry matter degradability of barley un treateated and treated grain at 48 h were 73.62 and 66.37%, there were higher and lower respectively, that showed significant differences ($p<0.05$). Results of DM degradability characteristics showed that modelIII was the best fit to barley grain DM disappearance.

***Corresponding Author:** Valiollah Palangi ✉ dizajparvane@yahoo.com

Introduction

Ruminants obtain most of their energy from cereal grains with starch as the principal nutrient. The amount of starch in feeds for ruminants may vary from zero in green fodder to almost 100% in potatoes and maize (Sommer, 2000). The most important site of cereal grain starch digestion is the rumen (Theurer, 1986).

Barley grain is a principal source of energy in small ruminant diets in many parts of world. The introduction of new barley cultivars has resulted in raw materials with a wide range of nutritional characteristics. The rapid rate of fermentation of barley starch contributes to some nutritional and health problems such as reduced feed intake, laminitis, bloat, acidosis, ruminitis and liver abscesses (Ørskov, 1986; Givens *et al.,* 1993).

In the rumen, barley starch is more readily degradable than corn starch once the pericarp is cracked by processing, because the protein matrix in barley is readily solubilized and penetrated by proteolytic bacteria. However, rapid and extensive ruminal carbohydrate fermentation increases the incidence of bloat, acidosis, laminitis, liver abscesses, and feed intake problems related to digestive upsets (Yang *et al.,* 2000).

During the last two decades, a number of studies have examined ways to modulate rumen degradability of barley grain. These have included physical processing techniques such as pelleting, steam rolling, steam flaking, and toasting which use either moisture, heat, and pressure to gelatinize starch granules (Svihus *et al.,* 2005).

Heat, steam and pressure interaction in different heat treatments of cereal grains causes destruction of endosperm structure and protein matrix by which starch granules are surrounded in the grain endosperm and gelatinization of usual semi-crystal structure of starch granules is caused (Stojanović *et al.,* 2005., Kotarski *et al.* 1992).

The in situ technique has been widely used to study ruminal digestion kinetics of feeds for cattle. Although in this technique the incubated feed is not subject to mastication and passage, it is no better way to simulate the rumen environment to study ruminal digestion kinetics (Nocek, 1988). This technique has been reported to be well correlated with animal performance (Orskov, 1989; Khazaal *et al.,* 1993), with voluntary feed intake and in vivo dry matter digestibility (Khazaal *et al.,* 1995). In Brazil, researchers have used the in situ method to evaluate tropical forages, agricultural residues and industrial by-products for feeding cattle (Vilela *et al.,* 1994; Gomes *et al.,* 1994; Aroeira *et al.,* 1995).

The objective of this study was to determine DM disappearances of heat treated barley in the rumen by in situ technique.

Materials and methods

Animals and feeding

Two yearling (Gizil) wethers (50.5±2.5 kg) were used. At least 30 day before initiation of the experiment, each wether was surgically fitted with a ruminal cannula. The wethers were housed in tie stalls under controlled environmental conditions with continuous lighting and constant temperature (24 to 26°C). The sheep fed diet content 40% alfalfa: 60% concentrate containing 2.9 Mcal kg−1 DM and 14% CP. The feed was fed in equal portions every 8 h to maintain a relatively stable rumen environment. Barley grain was collected from at least 10 different areas within a bin. All samples were dried in an oven at 100°C until a constant weight was achieved. Heat treatment was applied in an oven in which barley grain were spread on trays in 2 cm layers. After cooling, barley grain was ground to pass through a 2-mm screen sieve.

In situ degradation

In situ methods procedures was determined using Nocek *et al* (1988) and reviewed by Taghizadeh *et al* (2005), the ground samples (5g) were placed in Dacron bags (5.5×10 cm;47-µm pore size) and were closed using glue. Each feed sample was incubated in

6 replicates (2 replicates for each wethers) in the rumen. The incubation times for barley grain samples were 0, 4, 8, 16, 24, 36 and 48 h. Nylon bags were suspended in the rumen in a polyester mesh bag (25×40 cm;3mm pore size) and were removed from the rumen at the same time so that all bags could be washed simultaneously. The nylon bags were then removed from the mesh bag and washing until the rinse water remained clear. Samples were then dried in an oven at 55˚C until a constant weight was achieved before determination of DM disappearance. The DM degradation data was fitted to the exponential equation P = a+b(1 – e-ct) (Ørskov and McDonald, 1979), where P: is the disappearance of nutrients during time t, a: the soluble nutrients fraction which is rapidly washed out of the bags and assumed to be completely degradable, b: the proportion of insoluble nutrients which is potentially degradable by microorganisms, c: is the degradation rate of fraction b per hour and t is time of incubation.

Calculations and statistical analysis

Data were analyzed as a completely randomized design using a general linear model (GLM) procedure of SAS (1999), with Duncan's multiple range test used for the comparison of means. Feeds were the only sources of variation considered.

Results and discussion

In Situ Ruminal Degradability

The degradability of DM is shown in Table 1. Untreateated barley showed high ruminal DM disappearance in all of the incubation times there were significant differences (P < 0.05). During the incubation period the growing trend of ruminal dry matter disappearance can be observed.

Table 1. In situ DM disappearance (% of DM).

barley	Incubation time (h)						
	0	4	8	16	24	36	48
untreated	23.79[a]	38.39[a]	42.65[a]	55.24[a]	63.43[a]	65.77[a]	73.62[a]
treated	22.09[b]	34.15[b]	40.19[b]	51.27[b]	57.42[b]	64.19[b]	66.37[b]
SEM	0.1369	0.2111	0.3001	0.4368	0.2874	0.2400	0.2723
P-Value	0.0009	0.0001	0.0044	0.0030	0.0001	0.0096	<0.0001

[a,b,c]: Means within a column with different subscripts differ (p<0.05).

The comparison of various fitted models for dry matter degradability of untreated and treated barley grain based on the coefficient of determination (R^2) showed that model 3 was the best fit to DM degradability (Table 2).

Table 2. Measurement of DM degradation characteristics of untreated and treated barley grain.

model	a	b	c	L	d	k	SSE	R^2
Untreated								
1	25.1826	49.2993	0.0593	-	-	-	75.0840	98.66
2	21.2733	53.2086	0.0593	-1.2862	-	-	75.0840	98.66
3	24.3624	52.2862	0.0298	-	-	5.7615	72.1523	98.71
4	23.7903	57.4820	0.0281	1.66×10^{-25}	0.0797	-	52.0108	99.07
5	23.8599	56.5535	0.0302	-	0.0757	-	51.8918	99.07
Treated								
1	22.8248	46.0445	0.0606	-	-	-	14.1825	99.71
2	20.7394	48.1300	0.0606	-0.7305	-	-	14.1825	99.71
3	22.5063	49.0824	0.0364	-	-	3.2921	11.7301	99.76
4	22.0997	49.0475	0.0438	1.3×10^{-25}	0.0473	-	8.4207	99.82
5	22.1594	48.6649	0.0456	2.3054	0.0428	-	8.3424	99.83

1- Ørskov and Mc Donald (1979) without leg phase, 2- Ørskov and Mc Donald (1979) with leg phase 3- France *et al* (1999) and 4- Danoa *et al* (2004) 5- Danoa *et al* (2004) without leg phase.

Probably it is due to changes in rumen bacteria during feeding and increase the growth rate of bacteria. Angstrom *et al.,* (1992) are known to reduce digestibility of barley grain processing with heat-

induced increase in acid detergent insoluble nitrogen through the Maillard reaction. The achieved differences can be depended on the differences in barley variety, drying processing, climate conditions, maturity and sample size: square area in used nylon bag and microbial contamination.

Conclusion

Barley grain has high fermentable ability in the rumen that allows fewer starch escape on digestion in the rumen. Therefore, barley treating with heat reduced rumen degradation of this meal and preventing metabolic problems. And also, help the increased intestinal absorption and the usability of it.

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