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Influence of Wet Brewers Grains on Rumen Fermentation, Digestion and Performance in Growing Lambs

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Abstract: In 2 consecutive trails, 5 isoenergetic and isonitrogenous diets containing incremental levels (0, 150, 300, 450, 600 g kg^{-1} DM) of Wet Brewers Grains (WBG) were fed to growing Rambouillet×Pelibuey male lambs (16±1.9 kg). Fifty (intact) lambs were used in a feedlot trial and 10 (rumen cannulated) in a digestion trial. The pH, Volatile Fatty Acids (VFA) and ammonia-N in lambs were also estimated. Dry matter intake (1022, 1040, 1026, 1021 and 1011 g day^{-1}) average daily gain (180, 192, 195, 185, 178 g) and feed efficiency (5.7, 5.4, 5.3, 5.5, 5.7) were not significantly different between lambs fed the diets containing 0, 150, 300, 450, 600 g WBG kg^{-1} DM, respectively. Moreover, lambs digested similar ($p>0.01$) proportions of organic matter (70, 69, 67, 70 and 67%, respectively), crude protein (71, 71, 70, 72 and 69%, respectively) and neutral detergent fiber (66, 69, 66, 67 and 62%, respectively). Furthermore, ruminal pH and molar proportions of VFA did not varied ($p>0.01$); however, ruminal ammonia-N (10, 11, 13, 14, 14 mg 100 mL^{-1}, respectively) increased ($p<0.05$) as WBG increased. In despite of differences in WBG content in the diets, grow increments and digestion characteristics of lambs were similar.

Key words: Rambouillet×Pelibuey lambs, wet brewers grains, animal performance, nutrient digestion

INTRODUCTION

Brewers' grains are the most important byproduct of brewery industry. Every 100 l of beer accounts for an average of 20 kg of brewers grains (Reinold, 1997). Brewers grains are often used as a livestock feed. Because they provide protein, fiber and energy, are used in a variety of diets. Protein in brewers' grains can meet a significant portion of supplemental protein requirements; in addition, they provide fiber and needed bulk in the diets of ruminants (Westendorf and Wohlt, 2002). On DM basis it contains a range of 220 to 280 g kg^{-1} CP and 2.5 Mcal ME kg^{-1} DM (NRC, 2001). Brew residues can be Dried Brewers Grains (DBG) or Wet Brewers Grains (WBG) which can be marketed directly. Moisture content in WBG ranges between 650-800 g kg^{-1} (Grasser *et al*., 1995). The DBG is easy to store because of its low moisture content; however, use of WBG has been recently increased, considering that drying implies additional expenses due to fuel cost. Moreover, WBG transportation and provision in farms has improved considerably (Crawshaw, 2001).

Brewers grains are suitable as forage source (Younker *et al*., 1998) especially at the farms located near breweries. Knowledge of their practical use of WBG for animal feeding has been the aim of several trials especially for dairy cattle. However, the dietary use of WBG in feedlot lambs has not been precisely addressed by nutritional studies. Thus, the aim of the study was to determine and compare nutrient digestion and performance characteristics of lambs consuming diets with WBG at 0, 150, 300, 450 or 600 g kg^{-1} DM.

MATERIALS AND METHODS

Fifty Rambouillet×Pelibuey male lambs recently weaned (19±1.5 kg BW) were included in a feeding trial. Dewormed and vaccinated animals were randomly allotted to one of five treatment diets (10 per treatment). The proportions of ingredients included in diets are given in Table 1. Experimental diets (Table 2) contained 0 (control diet), 150 (diet 2), 300 (diet 3), 450 (diet 4) and 600 g kg^{-1} DM of WBG (diet 5). Lambs were adapted to diets for a

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Table 1: Ingredients in experimental diets fed to lambs

Ingredients	Control	Diets[1] 1	2	3	4
Wet brewers grains, $g\ kg^{-1}$ DM		150	300	450	600
Corn ground, $g\ kg^{-1}$ DM	520	490	438	370	160
Molasses cane, $g\ kg^{-1}$ DM	30	38	29	30	40
Alfalfa hay, $g\ kg^{-1}$ DM	420	320	230	145	25
Soybean meal	30				
Oat hay, $g\ kg^{-1}$ DM					160
Megalac, $g\ kg^{-1}$ DM					10
Calcium carbonate, $g\ kg^{-1}$ DM		2	3	5	5

[1]In diet 1, lambs consumed 150 g wet brewers grains kg^{-1} DM; in diet 2, 300; in diet 3, 450 and in diet 4. 600

Table 2: Chemical composition of treatment diets

Item	Control	Diets[1] 1	2	3	4
Dry matter, $g\ kg^{-1}$ DM	894	600	443	362	319
Organic matter, $g\ kg^{-1}$ DM	945	947	952	935	947
Ash, $g\ kg^{-1}$ DM	55	54	48	65	53
Crude protein, $g\ kg^{-1}$ DM	176	176	175	176	175
Neutral detergent fiber, $g\ kg^{-1}$ DM	244	257	281	304	381
Acid detergent fiber, $g\ kg^{-1}$ DM	155	155	159	164	191
Ether Extract, $g\ kg^{-1}$ DM	32	33	36	38	45
TND[2], %	75	76	76	76	77
ME[2], Mcal	2.7	2.7	2.7	2.7	2.7

1In diet 1, lambs consumed 150 g wet brewers grains kg^{-1} DM; in diet 2, 300; in diet 3, 450 and in diet 4. 600, [2]Calculated according to published values of feed ingredients

period of 10 days (d) thereafter, for a period of 126 d. Diets were offered to lambs twice a day (08:30 and 16:00 h) considering a 5% increase according to the previous day. Feed intake of lambs was recorded daily by numerical difference within feed offered and refused by the animals. Individual weight of lambs was recorded at the beginning of adaptational period and every 14 days thereafter. Weight of lambs at the beginning of adaptational period was used as a covariable to correct ADG.

Ten (24±2.3 kg BW) ruminal cannulated Rambouillet×Pelibuey male lambs were used in a replicated 5×5 Latin Square design that lasted 21 d in each period (14 d of adaptation and 7 d for collections). Lambs were fed, *ad libitum*, the same experimental diets used in the feeding trial. Animals were housed in metabolic crates and had free access to water during the experimental period. Diets were offered twice daily (08:00 and 16:00 h). Feed consumption was recorded daily by weighting feeds offered and refused by the lambs. Diet samples and orts were collected daily and dried at 55°C for 48 h and then were ground (1-mm screen) in a Wiley mill. Samples were grouped by period and composites were stored for further analyses.

On d 15 of each period, after morning feeding, rumen fluid samples were obtained at 0, 1.5, 3, 6, 9, 12, 15, 18 h. Samples were strained through two layers of cheesecloth. Ruminal fluid pH was measured (Courning pH meter) immediately after sampling and then samples of 30 mL were acidified with 8 drops of sulphuric acid 97% and stored in a freezer (-4°C). Afterwards, samples were analyzed for Volatile Fatty Acids (VFA) and ammonia-N following the procedures described by FAO (1986).

Total fecal collections of individual animals were carried out from d 16-21. Feces were weighted and mixed daily and a representative sample (5%) was taken, stored at -4°C and subsequently thawed. Feces were partially dried at 55°C during 48 h, after that feces were ground through a 1-mm screen for chemical analysis. Concentrations of DM, ash, CP (AOAC, 1997) NDF and ADF (Van Soest *et al*., 1991) in diets, orts and feces were determined. *In vivo* digestibility coefficients of DM, OM, CP, NDF and ADF were calculated using procedures by Van Soest (1994).

Performance data of lambs were statistically analyzed as a completely block design and rumen fermentation and digestion data with a replicated 5×5 Latin Square design using the General Linear Model (GLM) procedure of SAS (2000) . The Tukey´s test was used to adjust for multiple comparations.

RESULTS AND DISCUSSION

Chemical composition of experimental diets offered to lambs is shown in Table 2. Concentrations of crude protein and ME were about the same in all diets. However, fiber fractions (NDF and ADF) and EE tended to increase as WBG increased from 0-600 g WBG kg^{-1} DM. Despite of differences in fiber and lipid content of diets, lambs had similar ($p>0.05$) dry matter intake, growth rate, ADG and feed efficiency (Table 3). Similar findings were reported by Yang *et al*. (2000) who found that goats fed different levels of WBG-silage had similar trends of DMI, ADG or feed efficiency. Moreover, (Hoffman and Armentano, 1988) observed no changes in DMI, milk yield or milk composition of lactating cows feeding diets containing 21.5% (70% DM) DBG and 23.5% WBG (43% DM). Conversely, McCarthy *et al*. (1990) reported a reduced DMI (1.9 and 1.6 kg d^{-1}, respectively) in lambs fed diets with 0-35% WBG-silage, but ADG was higher (270 and 240 g d^{-1}, respectively). Furthermore, Boloventa *et al*. (1988)

Table 3: Initial weight, average daily gain, dry matter intake and feed efficiency of lambs fed incrementally levels of wet brewers grains

		Diets[1]					
Item	Control	1	2	3	4	SEM	p<
Initial weight, kg	16	16	16	16	16	2	1.0
Final weight, kg	40	41	41	40	39	3	0.2
Total gain, kg	26	25	25	26	23	1	0.1
Average daily gain, g	180	192	195	185	178	37	0.4
Dry matter intake, g day^{-1}	1022	1040	1026	1021	1011	88	1.0
Feed efficiency[2]	5.7	5.4	5.3	5.5	5.7	1	0.2

[1]In diet 1, lambs consumed 150 g wet brewers grains kg^{-1} DM; in diet 2, 300; in diet 3, 450 and in diet 4. 600, [2]Calculated as dry matter intake/ADG

Table 4: Nutrient Intake and digestion of lambs fed diets with graded levels of wet brewers grains

		Diets[1]					
Item	Control	1	2	3	4	SEM	p<
Dry matter intake							
$g\ d^{-1}$	1158	1226	1186	1190	1173	103	1.0
$g\ kg^{-1}\ d^{-1}$	33	35	33	34	33	4	1.0
$g\ kg^{0.75}\ d^{-1}$	80	83	82	82	81	10	1.0
Crude protein intake							
$g\ d^{-1}$	204	215	207	209	206	19	0.2
$g\ kg^{-1}\ d^{-1}$	6	6	6	6	6	1	1.0
$g\ kg^{0.75}\ d^{-1}$	14	15	14	14	14	0.2	1.0
Digestibility (%)							
Dry matter	68	70	68	72	68	3	1.0
Organic matter	70	69	67	70	68	4	1.0
Crude protein	71	71	70	72	69	3	0.4
Neutral detergent fiber	66	69	66	67	62	5	0.2
Acid detergent fiber	67	66	68	66	65	3	0.4

[1]In diet 1, lambs consumed 150 g wet brewers grains kg^{-1} DM; in diet 2, 300; in diet 3, 450 and in diet 4, 600

argued that feedlot lambs fed diets with incremental levels (0, 40, 60 and 80%) of DBG reduced their DMI from 127 (0%) to 83 g $kg^{0.75}$ d^{-1} (80%); however, ADG was significantly higher when lambs consumed 40 or 60% of DBG. In addition, Anigbogu (2003) fed lambs with a basal diet of cassava leaves and grass hay (*Andropogen gayanus*) at 1:1 ratio and maize offal concentrate, the later was substituted with DBG at levels of 0, 15, 30, 45 and 60%. He found that ADG was significantly higher at 30 (152 g d^{-1}) and 45% (168 g d^{-1}) compared with other treatments. In the two previous studies, diets fed to lambs were not isonitrogenous this fact might have explained the differences between treatments in DMI and ADG. Moreover, Olorunnisomo *et al*. (2006) found significantly differences in DMI and ADG of lambs fed a basal diet of concentrate and guinea grass hay (*Panicum maximum*) with 0, 32 or 64% of dry sorghum brewers' grain; however, after urea addition, there were not differences in lamb performance. In addition, West *et al*. (1994) found that lactating Jersey cows fed diets containing 0, 15, or 30% wet brewers grains or 30% wet brewers grains plus liquid brewers' yeast during hot, humid weather, DMI was not different; even though diets with 30% wet brewers grains contained only 35.5% DM and approximately 50 versus 36.8% NDF for the control diet. Moreover, Dhiman *et al*. (2003) argued that DMI, milk yield and milk composition did not differ in lactating dairy cows fed diets containing 15% of dietary DM as DBG or WBG with similar DM.

In this study, lambs digested similar ($p>0.05$) amounts of DM, OM, CP, NDF and ADF (Table 4). Conversely, McCarthy *et al*. (1990) established higher lamb digestion coefficients for DM, NDF and ADF in a diet containing 35% WBG compared to control diet (0% WBG). Moreover, Boloventa *et al*. (1998) reported apparent digestibilities of DM, OM, CP and NFD increased as DBG levels decreased by lamb diets containing increasing levels of dried brewer´s grain. Ozduyen and Ogun (2006) evaluated coefficient digestibility of WBG-silage with sunflower whole plant getting higher coefficient values for WBG than sunflower and WBG-sunflower mixes.

In this study, ruminal NH_3-N concentration increased ($p<0.05$) as WBG increased. However, pH and total and individual VFA concentrations did not varied ($p>0.05$) between treatment diets (Table 5). Similar findings were reported by Dhiman *et al*. (2003) who found no differences in ruminal pH and molar proportions of VFA in dairy cow diets with DBG or WBG. Conversely, Davis *et al*. (1983) observed an increase in ruminal pH and a decreased in ruminal VFA concentrations when 20, 30 and 40%

Table 5: Rumen parameters of lambs fed diets containing incrementally levels of wet brewers grains

	Diets1						
Item	Control	1	2	3	4	SEM	p<
pH	6.2	5.9	6.0	6.1	5.9	0.1	0.6
Ammonia N (mg dl^{-1})	10[b]	11[b]	13[ab]	14[a]	14[a]	0.4	0.05
Volatile fatty acids							
Total VFA, mM	154	156	160	161	161	5.0	1.0
Acetic acid, mM	93	98	92	97	97	1.0	1.0
Propionic acid, mM	39	38	43	43	42	1.0	1.0
Butyric acid, mM	18	17	22	18	18	0.4	0.4
Molar proportions							
Acetic acid	61	63	57	61	61	1.0	1.0
Propionic acid	26	25	27	27	26	0.3	1.0
Butyric acid	12	11	14	11	12	0.2	0.3
Acetic:propionic ratio	2.4	2.6	2.1	2.3	2.3	0.2	0.4

[1]In diet 1, lambs consumed 150 g wet brewers grains kg^{-1} DM; in diet 2, 300; in diet 3, 450 and in diet 4. 600, abDifferent superscripts letters in row are different ($p<0.05$)

WBG was added to the diet for dairy cows by replacing soybean meal Changes in ruminal fermentation characteristics could be attributed to differences on degradation rates of WBG and soybean meal.

IMPLICATIONS

Diets with incremental levels of WBG did not affected performance, ruminal fermentation or digestion parameters of lambs; even though dry matter, NDF, ADF and EE content in diets varied in response to incrementally levels of WBG. Thus, the use of diets with high content of WBG may be a cost-effective profitable way for feedlot lambs.

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