Effect of the Inclusion of Dried Bovine Ruminal Contents in the Diet of Growing Sheep on Productive Performance and Meat Quality

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ABSTRACT: The aim of this study was to evaluate the productive performance, some rumen variables, carcass yield and physicochemical characteristics of meat, when growing sheep were fed dried bovine ruminal contents (DBRC). Thirty two weaned lambs (16 males, 16 females) of Pelibuey, Dorper and Katahdin breeds with an initial mean body weight of 19.5 ± 1.5 kg, were randomly assigned in a completely randomized design with factorial treatment arrangement, to four treatments with the inclusion of T1: 0, T2: 15, T3: 30, and T4: 45% of DBRC in their ration. The productive behavior trial lasted 60 days, rumen liquor was obtained by esophageal probe at the 60th day of the experiment, animals were slaughtered at the 60th day of the trial, carcass yield and meat quality were evaluated. Data were analyzed by analysis of variance and mean differences were calculated using the Tukey test. The results showed no differences ($P>0.05$) for DMI and DWG due to treatment, but there were differences ($P<0.05$) for DMI (1.88 kg males, 1.50 kg females) and DWG (0.33 kg males, 0.26 kg females) due to gender. Ruminal pH, rumen ammonia nitrogen, acetic, propionic and butyric acid were not affected ($P>0.05$) by treatment or gender. Carcass yield and meat quality indicators for color L*, a * and b *, were similar ($P>0.05$) among treatments. However there were differences ($P<0.05$) for a* (11.37 males, 13.69 females) and b* (11.27 males, 13.06 females) due to gender. No differences ($P>0.05$) were found for pH and water holding capacity (WHC) among treatments or between genders. It is concluded that the addition of DBRC up to 45% in the diet of growing sheep does not affect growth performance, ruminal pH, ammonia nitrogen, VFA concentration, carcass yield and physico-chemical characteristics of meat.

Keywords: Dried bovine ruminal contents, Growing sheep, Productive performance, Meat quality.

INTRODUCTION

Ruminal contents are abattoir waste material which in many countries causes environmental pollution, however they contain a considerable amount of crude protein, digested feed, as well as rumen microbes and the products of their metabolism (Olafadehan *et al.,* 2014), which might been used for ruminant feeding. The aim of this study was to evaluate the productive response, as well as meat and carcass quality when dried bovine ruminal contents (DBRC) were included in the diet of growing sheep.

MATERIALS AND METHODS

Thirty two weaned lambs (16 males, 16 females) of Pelibuey, Dorper and Katahdin breeds with an initial mean body weight of 19.5±1.5 kg, were randomly assigned to four groups of eight animals (4 males, 4 females), with the same number of animals of each breed in each group, to four treatments, with the inclusion of T1: 0, T2: 15, T3: 30, and T4: 45% of DBRC in their ration. The productive behavior trial lasted 60 days, with a previous adaptation period of 20 days.

Lambs were housed in individual pens, and fed twice a day at 9:00 h and 14:00 h, with ad libitum access to feed and water. DM, ash, ether extract and crude protein were determined in the diets and refusals according to AOAC (2000), as well as FDN and FDA (Van Soest *et al.,* 1991). Diets were isoproteic and isoenergetic. Initial body weight (IBW), DMI, DWG, feed conversion (FC), and final weight (FW) were recorded for each animal. At day 60 of the experiment, ruminal fluid samples were taken via esophageal probe, 3 h after the morning feeding. The samples were tested for pH, VFA (Erwin *et al.,* 1961), and N-NH_3 concentration (McCullough, 1967). Animals were slaughtered after the productive behavior trial. They had a 12 h fasting period before slaughtering. The characteristics of the carcass and meat were evaluated on five animals of each treatment. The pH was assessed 24 h post mortem in the Longissimus dorsi muscle, as well as color and water holding capacity (WHC). The experimental design used was a completely randomized with factorial arrangement 4 X 2, where the model included treatment, sex and the interaction effects. Data were analyzed by PROC GLM (SAS, 2002), and means were compared with Tukey test.

RESULTS AND DISCUSSION

No significant differences (P>0.05) were found on the IBW of the animals. Gender affected DMI, males consumed more feed (1.88 kg) than females (1.50 kg). Treatments had no effect on DWG, but the gender did (0.33 kg males, 0.26 kg females). FC was not different for any treatment, and no differences were found due to gender (P>0.05). FW was lower (P<0.05) in females (33.82 kg) than in males (40.49 kg) (Table 1). The results obtained in this study for DWG were higher (270, 300, 310 and 320 g for T1, T2, T3 and T4, respectively), than those reported by Lerma and Salinas (1990) in Pelibuey sheep, when sorghum straw was substituted for 0, 13, 26 and 39% of DBRC (193, 188, 201 and 201 g, respectively). The highest consumption of dry matter observed in T4 might explain that DWG was the highest for this treatment. Gender also affected DMI, being higher in males than in females. FC showed differences due to gender and treatment x gender interaction, mainly because dry matter intake was lower in the females.

There were differences for FW due to gender. Notter *et al.* (1991) mention that the higher weight gain in males compared to females can be attributed to their capability of utilizing nutrients in a more efficient manner, and that sexual hormones influence the growing pattern in lambs.

Table 1. Productive behavior of sheep fed DBRC

	TREATMENT				SEX			P>F			
Kg	T1	T2	T3	T4	SE	F	M	SE	T	S	T*S
IW	19.25	19.50	19.05	19.16	1.44	18.15	20.12	0.81	0.992	0.098	0.996
DWG	0.27	0.30	0.31	0.32	0.01	0.26a	0.33b	0.01	0.308	0.0005	0.269
FC	5.57	5.55	5.77	5.78	0.22	5.76	5.59	1.59	0.877	0.470	0.600
DMI	1.52	1.70	1.80	1.85	10.87	1.50a	1.88b	76.20	0.122	0.001	0.622
FW	35.78	37.96	37.84	38.51	1.86	33.82a	40.49b	1.33	0.707	0.001	0.690

a,b,c Different letters in the same row indicate significant differences (P<0.05).

SE: Standard error of the mean., T: Treatment, S: Sex.

Ruminal pH, ammonia nitrogen, as well as the percentages of acetic, propionic and butyric acids were not different (P>0.05), due to the addition of DBRC in the diet, or animal gender. No differences were observed on treatment x gender interaction (Table 2). Ruminal pH was similar among treatments and gender. The values observed in this study are between those considered as physiological normal, in the range of 5.5 to 7.0 (Krause and Oetzel, 2006), No differences were found for VFA concentration among treatments or gender. These values coincide with those reported by Corona *et al*. (1999), when working with forages of similar fiber content to the diets offered to sheep in this research.

Table 2. Ruminal pH, ammonia N and VFA concentration in sheep fed DBRC

	TREATMENTS					P>F		
	T1	T2	T3	T4	SE	TREAT	SEX	T*S
pH	6.06	6.27	6.29	6.14	0.14	0.640	0.716	0.841
NH3 (mg dl-1)	19.74	20.03	18.87	19.05	0.53	0.347	0.218	0.813
ACE (%)	65.32	64.04	67.17	64.98	1.91	0.734	0.879	0.826
PRO (%)	35.78	37.96	37.84	38.51	1.86	0.461	0.460	0.329
BUT (%)	13.78	13.88	13.15	12.53	0.90	0.663	0.136	0.222

a,b,c Different letters in the same row indicate significant differences (P<0.05).
SE: Standard error of the mean.

NH_3: Ammonia N, ACE: Acetic Acid, PRO: Propionic Acid, BUT: Butyric acid.

The hot (T1 57.90; T2 58.12; T3 57.92; T3 56.88%) and cold (T1 57.45; T2 57.55; T3 57.39; T4 56.45%) carcass yield was similar for all treatments (P>0.05), but different due to gender (P<0.05) (females 58.72, 58.18; males 56.98, 56.52%) for hot and cold carcass, respectively. Hot and cold carcass yield percentages were higher for females than males. These results can be related with the higher gastrointestinal content observed in males, which are similar to the results observed in other studies, in which carcass yield has been affected by the amount of gastrointestinal content (Dominguez-Vara *et al.,* 2009; Ribeiro *et al.,* 2011). Meat pH is related to the degree of stress the animal suffers during slaughter. Nevertheless mean 24 h post-mortem pH was 5.8, which is considered to be adequate (Oliete *et al.,* 2006) to produce meat with appropriate color, texture and juiciness characteristics (Schiffner *et al.,* 2005).The inclusion of DBRC to sheep diets did not affect meat quality, observing normal values for meat pH, color L*, a*, b* or WHC. However a* and b* color indicators were higher (P<0.05) in females (a*13.69, b*13.06) than males (a*11.37, b*11.27), females showed darker meat color as a consequence of a higher concentration of hemes pigments, due to a higher precocity (Sañudo, 1992).

CONCLUSIONS

The addition of DBRC in the diet of sheep did not affect the productive performance or rumen parameters. The hot and cold carcass yield percentage was not affected by the addition of DBRC to the diet of the sheep. However, gender did show differences, favoring females with higher yield percentage. The physiochemical variables of the carcass were within the normal ranges, the addition of up to 45% of DBRC did not affect carcass quality, meat pH, WHC, L*, a* and b* color indicators.

REFERENCES

AOAC. Association of Official Analytical Chemists. 2000. Official methods of analysis of the Association of Official Analytical Chemists. 15th. Ed. Washington, D.C.

Corona, L., G.D. Mendoza, F.A. Castrejon, M.M. Crosby, and M.A. Cobos. 1999. Evaluation of two yeast cultures (Saccharomyces cereviseae) on ruminal fermentation and digestion in sheep fed a corn stover diet. Small Rum. Res. 31: 209-214.

Domínguez-Vara, I.A., S.S. González-Muñoz, J.M. Pinos-Rodríguez, J.L. Bórquez-Gastelum, R. Bárcena-Gama, G. Mendoza-Martínez, L.E. Zapata, and L.L. Landois-Palencia. 2009. Effects of feeding selenium-yeast and chromium-yeast to finishing lambs on growth, carcass characteristics, and blood hormones and metabolites. Anim. Feed Sci. Technol. 152: 42-49.

Erwin, E. S., G. J. Marco, and E. Emery. 1961. Volatile fatty acid analysis of blood and rumen fluid by gas chromatography. J. Dairy Sci., 44:1768-1771.

Krause, K. M., and G. R. Oetzel. 2006. Understanding and preventing subacute ruminal acidosis in dairy herds. A review. Anim. Feed Sci. Technol. 126: 215–236.

Lerma, D.E., and J. Salinas. 1990. Substitution of sorghum bicolor by bovine ruminal content in sheep diets. III Animal Nutrition Meeting. GNMNA-UAAAN. Buenavista, Saltillo, Coahuila., Mexico. pp. 35-38.

McCullough, H., 1967. The determination of ammonia in whole blood by direct colorimetric method. Clin. Chim. Acta. 17: 297–304.

Notter, D.R., R.F. Kelly, and F.S. McClaugherty. 1991. Effects of ewe breed and management system on efficiency of lamb growth production: II. Lamb growth, survival and carcass characteristics. J. Anim. Sci. 69: 22-33.

Olafadehan, O.A., S.A. Okunade, and A.A. Njidda. 2014. Evaluation of bovine rumen contents as a feed for lambs. Trop. Anim. Health Prod. 46: 939-945.

Oliete, B., T. Moreno, J.A. Carballo, L. Monserrat, and L. Sánchez. 2006. Study of rubia gallega breed veal quality during the ageing time under vacuum. Arch. Zootec. 55: 3-14.

Ribeiro, E.L.A., I.Y. Mizubuti, L. Ferreira da Silva, F.H. Pereira de Paiva, C.L. De Sousa, and F.A. Boscaro de Castro. 2011. Performance, ingestive behaviour and carcass characteristics of feedlot lambs submitted to different feeding frequencies. Rev. Bras. Zootec. 40:892-898.

SAS. 2002. User´s Guide: Statistics. SAS Institute. Cary, North Carolina. USA.

Schiffner, E., K. Oppel, and D. Lörtzing. 2005. Homemade meats and sausages. Ed. Acriba, S. A. Zaragoza, Spain.

Sañudo, C., M.P. Santolaria, I. Sierra, M.J. Alcalde, and C. Touraille. 1992. Sensory meat characteristics for light lamb carcasses. Proc 38th International Congress Meat Science Technology. Clermont-Ferrand, France. pp. 277.

Van Soest, P. J., J. B. Robertson, and B. A. Lewis. 1991. Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition. J. Dairy Sci. 74: 3583–3597.