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Oat Hay Apparent Digestibility, Rumen Ammonia Nitrogen and Bun in Goats Supplemented with Fermented Molasses-Poultry Litter

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Abstract: The study was conducted to determine oat hay apparent digestibility, blood urea nitrogen and ammonia nitrogen in goats supplemented with fermented molasses-poultry litter. About 20 young Alpine Frances goats with 16.6±1.8 kg initial body weight were used. Goats were randomly assigned to 1 of 4 treatments in a complete randomize design. The evaluated treatments were oat hay (C); oat hay plus 150 g of Molasses-Poultry litter-Soybean Meal mix (MPSM); oat hay plus 150 g of Molasses-Poultry litter-Wheat Meddling mix (MPWM) and oat hay plus 150 g of Molasses-Poultry litter-Sorghum Grain mix (MPSG). Supplements and basal diet (oat hay) were individually fed. Apparent digestibility of DM, OM, NDF, ADF and N were determined. Blood urea nitrogen and ammonia nitrogen were also determined. Feed intake was higher ($p = 0.0001$) in supplemented goats compared to goats in the control group. Supplemented goats consumed more DM than those in the control group ($p = 0.0003$). Dry matter retention was not affected by supplementation ($p = 0.11$). Organic dry matter tended to increase ($p = 0.08$) in supplemented goats. Supplemented goats retained more nitrogen ($p = 0.0001$) than those in the control group with values of 6.37, 10.43, 8.59 and 8.00 g day^{-1} for treatments C, MPSM, MPWM and MPSG, respectively. The concentration of N-NH_3 in rumen fluid tended to increase ($p = 0.08$) as the quantity of nitrogen in the supplement increase. The results shows that supplementation with molasses-poultry litter plus soybean meal, wheat middlings or sorghum grain can increase feed intake and nitrogen retention in growing goats fed oat hay.

Key words: Goats, by-products, rumen fermentation, supplementation, quantity, supplementation

INTRODUCTION

Goat population in the Comarca Lagunera (Durango and Coahuila) Mexico is around 458 271 heads. Forage quality and availability is low especially during the winter and early spring as a consequence goats nutritional status is poor. Supplementation with medium quality hay and by-products can alleviate the problem in grazing goats.

Feed intake and digestibility of low to medium quality forages can be increased by an adequate supplementation program. By-products such as poultry litter and molasses increases intake of low quality forages by ruminants. Sweetness of molasses may stimulate the intake of roughages and non desirable feeds. Processing of poultry litter such as anaerobic fermentation can improve feed intake, facilitate management and reduce pathogen organisms for ruminants, especially when mixed with carbon sources. Madrid *et al.* (1997) and Maity *et al.* (1999) reported increases on feed intake and digestibility of low quality roughages in goats supplemented with different sources of nitrogen.

An experiment was conducted to evaluate the effect of supplementation with a mix of molasses-poultry litter plus soybean meal, wheat meddling or sorghum grain on feed intake, apparent digestibility of oat hay, blood urea nitrogen and ammonia nitrogen in rumen fluid in growing goats.

MATERIALS AND METHODS

The experiment was carried out in Lucero, Durango, Mexico (25° 56'N, 103° 26'W; 1110 m above sea level). Mean yearly precipitation is around 240 mm. About

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Table 1: Oat hay and supplements chemical composition used in the experiment

	Supplement[1]			
Component (%)	Oat hay	MPSM	MPWM	MPSG
DM	92.00	69.37	77.33	74.71
OM	91.80	86.76	89.50	89.40
N	1.28	4.08	2.68	2.03
CP	8.00	25.55	17.09	12.69
NDF	66.05	16.22	24.91	17.12
ADF	41.66	9.86	11.66	9.86
Ash	8.20	13.24	10.50	10.60

[1]MPSM = Molasses-Poultry litter-Soybean Meal mix (30:40:30); MPWM = Molasses-Poultry litter-Wheat Meddling mix (30:40:30); MPSG = Molasses-Poultry litter-Sorghum Grain mix (30:40:30)

20 young Alpine Frances breed goats with 16.6±1.8 kg initial body weight were used. Goats were randomly allotted to 1 of 4 treatments in a complete random design with 5 goats per treatment. All goats received a basal diet of oat hay (8.2% CP) at 2.2% body weight dry matter basis. Oat hay was fed following supplemental feeding each morning. Animals were individually supplemented once daily at 0600 h, receiving 150 g of 1 of the 3 supplement treatments (Table 1).

Oat hay (C); oat hay plus 150 g of a mix 30% Molasses, 40% Poultry litter and 30% Soybean Meal (MPSM); oat hay plus 150 g of a mix 30% Molasses, 40% Poultry litter and 30% Wheat Meddling (MPWM) and oat hay plus 150 g of a mix 30% Molasses, 40% Poultry litter and 30% Sorghum Grain (MPSG).

Supplements were processed before fed, ingredients on the supplements were mixed and placed into a container on layers 20 cm depth, compressing the material to create an anaerobic environment and covered with a black plastic film. The ensiling period lasted 30 days. Forage and supplements sub-samples were collected every week and composited for chemical analysis. Water and salt mineral mix were available at all times.

To determine feed intake a 10% over the intake on the previous day was offered. Forage intake and refusals were recorded daily and refusals were discarded each morning prior to feeding. To estimate body weight change goats were weighed in the morning of 2 consecutive days at the beginning and at the end of the experimental period. From day 29-32 fecal collection bags were fitted to the animals to assess total fecal and urine output. Every 12 h fecal collection bags were removed and replaced on each animal, fecal and urine output was recorded and thoroughly mixed.

Representative sub-samples (10% of total wet weight) were collected and frozen within 1 h after collection at -20°C for later analysis. Daily sub-samples were composited by weight (10% wet weight) within goat and treatment an analyzed for DM, OM, NDF, ADF and N content. On day 35 of the experimental period goats were deprived of forage 12 h and 1 blood sample was collected before supplementation and every hour for 6 h after supplementation via jugular vein puncture. Blood samples were centrifuged at 3000×g for 20 min at room temperature within 30 min after collection. Serum was harvested and frozen at -20°C until latter analysis. Serum samples were analyzed for BUN spectrophotometrically using a commercial kit (Diagnostic Chemicals Limited, Oxford, Connecticut).

On day 37 of the experimental period goats were deprived of forage 12 h and 8 mL of rumen fluid were collected in 3 goats of each treatment by stomach tube connected to a vacuum pump. Rumen fluid was collected before supplement was fed (0 h) and every 2 h for 6 h after supplementation. Liquor was strained through 4 cheese cloth layers and a 10 mL aliquot was acidified with 2 mL of 50% (v/v) hydrochloric acid. Samples were frozen at -20°C until analysis could be conducted. Ammonia concentration was determined by the phenol-hypochlorite method of Broderick and Kang (1980). Feed intake, body weight change, dry matter digestibility and nitrogen retention were analyzed by analysis of variance for a completely randomized design (Steel and Torrie, 1980) while milk yield and blood urea nitrogen were analyzed by repeated measurements. All statistical analyses were performed by using the GLM procedure of SAS (SAS Inst., Inc., Cary, NC).

RESULTS AND DISCUSSION

Feed intake was higher ($p = 0.0001$) in supplemented goats compared to goats in the control group (Table 2). Forage dry matter, CP and fiber contents affect voluntary intake however when CP is <7% intake is diminished due to the important role of N on rumen bacteria growth (Fox *et al*., 1992). Madrid *et al*. (1997) and Maity *et al*. (1999) reported increases on feed intake and digestibility in supplemented goats fed low quality forages.

Protein supplementation often stimulate feed intake in cattle consuming low quality fiber (Lusby *et al*., 1982; Lusby and Horn, 1983; Krysl *et al*., 1989). By contrast, feed intake is not affected by protein supplementation when forage CP content is 11% (Minson, 1982). Energy supplements based on cereal grains have shown to decrease the intake and digestibility of low quality forages (Moore *et al*., 1995). Supplemented goats gained more weight ($p = 0.02$) than those fed only with oat hay as shown in Table 2.

Similar body weight gain have been reported in Boer goats fed grass hay and supplemented with soybean meal and wheat meddling (Moore *et al*., 2002). Brito found higher body weight gain in lambs fed silage of molasses-poultry litter than in those fed only forage. In cattle consuming low quality forage higher weight gain has been reported with supplements based on soybean

Table 2: Effect of supplementation with silage of molasses-poultry litter plus soybean meal, wheat meddling or sorghum grain on feed intake, body weight change and nutrient retention in growing goats fed oat hay

	Treatment[1]					
Items	C	MPSM	MPWM	MPSG	p-value	EE[2]
Feed intake (g day^{-1})	598.30^{a}	786.70^{b}	784.00^{b}	751.70^{b}	0.0001	16.60
Intake (g day^{-1})						
DM	550.40^{a}	689.60^{b}	665.50^{b}	664.60^{b}	0.0003	18.56
OM	505.30^{a}	627.80^{b}	608.20^{b}	607.40^{b}	0.0003	17.04
NDF	363.50	403.70	391.20	384.60	0.2100	12.26
ADF	229.30	254.20	242.50	241.50	0.2300	7.73
N	7.04^{a}	11.73^{d}	10.13^{c}	9.33^{b}	0.0400	0.23
Excretion (g day^{-1})						
DM	145.00^{a}	209.50^{b}	242.70^{bc}	169.10^{ac}	0.0200	18.01
OM	109.80^{a}	154.30^{b}	182.10^{b}	124.20^{ba}	0.0200	14.20
NDF	68.70^{a}	117.90^{b}	129.60^{b}	82.30^{a}	0.0090	10.30
ADF	65.10^{a}	90.60^{ab}	105.90^{bc}	70.50^{ab}	0.0400	9.00
N	0.66^{a}	1.29^{b}	1.54^{b}	1.33^{b}	0.0040	0.10
Retained (g day^{-1})						
DM	405.40	480.00	422.70	495.40	0.1100	26.70
OM	395.50	473.40	426.10	483.20	0.0800	23.10
NDF	294.80	285.70	261.60	302.30	0.3900	16.70
ADF	164.10	163.60	136.60	171.00	0.2500	11.80
N	6.37^{a}	10.43^{c}	8.59^{b}	8.00^{b}	0.0001	0.27
Retention (%) feed intake						
DM	67.80	60.90	54.00	65.80	0.0900	3.50
OM	66.10	60.10	54.40	64.20	0.2400	3.00
NDF	49.30^{a}	36.20^{b}	33.40^{bc}	40.20^{b}	0.0500	2.10
ADF	27.40^{a}	20.70^{b}	17.40^{b}	22.70^{abc}	0.0100	1.60
N	1.06^{a}	1.32^{b}	1.09^{a}	1.06^{a}	0.0004	0.10
Body weight change (g day^{-1})	6.40^{a}	75.00^{b}	65.00^{b}	39.00^{ab}	0.0004	0.02

[1]C = Oat hay; MPSM = Oat hay plus 150 g of Molasses-Poultry litter-Soybean Meal silage (30:40:30); MPWM = Oat hay plus 150 g of Molasses-Poultry litter-Wheat Meddling silage (30:40:30); MPSG = Oat hay plus 150 g of Molasses-Poultry litter-Sorghum Grain silage (30:40:30); [2]Standard Error; [abc]Means within column with different superscript differ at probability indicated

meal than with supplements based on wheat meddling or corn grain (Grigsby *et al*., 1992; Sr Galloway *et al*., 1993). Probably due to the higher protein quality, essential amino acids and 35% bypass protein of soybean meal (NRC, 1996). Dry matter disappearance was similar between treatments (p = 0.11).

Effectiveness of protein supplementation in ruminants consuming low digestibility, low protein roughages may be achieved when nitrogen readily degradable to ammonia is fed to satisfy nitrogen rumen microbes requirements. Digestibility of NDF and ADF were similar (p = 0.39 and p = 0.25, respectively) between treatments. Nitrogen retention was higher in supplemented goat (p = 0.0001) compared to no supplemented goats. Goats supplemented with MPSM retained 10.43 g day^{-1} while those receiving MPWM and MPSG retained 8.59 and 8.0 g day^{-1}, respectively.

Nitrogen retention increased as the N concentration augmented in the supplement. Avitia and Serrato found a similar trend in goats supplemented with protein and fed ammoniated corn stover. Richards *et al*. (2006) reported an increase in nitrogen retention in cattle supplemented with soybean meal, wheat meddling and molasses (16 g day^{-1}) compared to those cows consuming only brome hay (7.3 g day^{-1}). The results implied that soybean meal

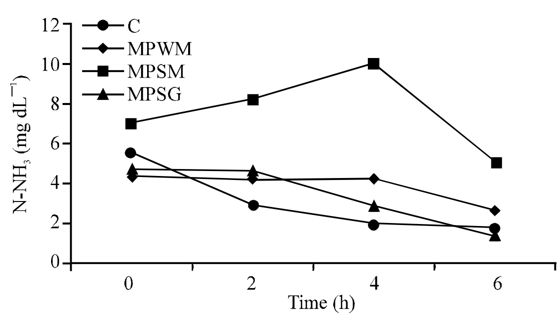

Fig. 1: Nitrogen ammonia concentration (N-NH$_3$) in rumen fluid of growing goats fed oat hay and supplemented with molasses-poultry litter silage added with soybean meal, wheat meddling or sorghum grain (p = 0.08; EE = 7.89)

protein supplied amino acids, peptides or carbon chains for ruminal microbial population. Stern *et al*. (1994) pointed out that supplementation with soybean meal increase the uptake of amino acids, peptides or both by ruminal microbes. Supplemented goats showed a tendency to increase (p = 0.08) ammonia nitrogen in rumen fluid as nitrogen augmented in the supplement (Fig. 1). Goats receiving the MPSM showed higher N-NH$_3$ concentration (7.4 mg dL^{-1}) than the goats in the control group (2.9 mg dL^{-1}) with intermediate values

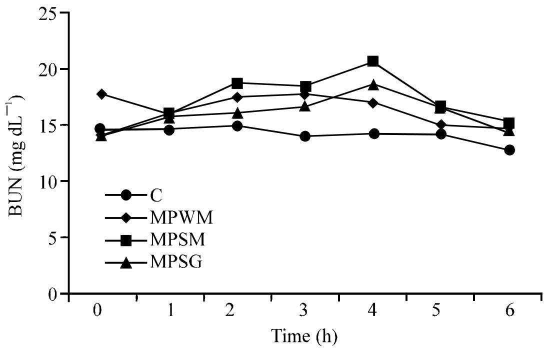

Fig. 2: Blood urea nitrogen (mg dL^{-1}) in growing goats fed oat hay and supplemented with molasses-poultry litter silage added with soybean meal, wheat meddling or sorghum grain (p = 0.30; EE = 1.11)

for the treatments MPWM (3.7 mg dL^{-1}) and MPSG (3.3 mg dL^{-1}). Similar N-NH_3 concentration (6.52 mg dL^{-1}) was reported by Moore *et al.* (2002) in goats supplemented with soybean meal. Satter and Slyter (1974) and Soto-Navarro *et al.* (2004) indicate that N-NH_3 concentration is related to protein content in the supplement consumed. In steers supplemented with soybean meal the N-NH_3 plateau between 3 and 4 h after feeding (Richards *et al.*, 2006).

Hennessey (1996) suggested a readily fermentable source of nitrogen for ammonia production to ensure adequate ruminal microbial fermentation. Nitrogen supplementation based on nonprotein nitrogen to cattle grazing dormant forages was suggested to be effective by Petersen (1987) only when ruminal ammonia concentration in ruminal fluid is <2.0 mg dL^{-1}.

Results suggest that adding a true protein source favoured nitrogen availability for rumen microbes. Blood urea nitrogen concentration was not different (p = 0.3) between treatments with values of 17.6, 16.0, 14.2 and 16.1 mg dL^{-1} for treatments C, MPWM, MPSB and MPSG, respectively (Fig. 2).

The higher blood urea nitrogen concentration was observed between 2 and 4 h after supplementation. Lapierre and Lobely pointed out that protein sources resistant to rumen microbes fermentation provide the largest amount of nitrogen absorbed as amino acids, rendering a low synthesis and elimination of urea. By contrast soluble protein sources may favor N-NH_3 escape throughout the rumen epithelium, increasing blood urea nitrogen concentration. Serrato and Avitia reported similar concentration of blood urea nitrogen (17.6 mg dL^{-1}) in goats fed ammoniated corn stover and supplemented with a supplement based on soybean meal, corn gluten and wheat meddling.

Dietary protein content may affect blood urea nitrogen in goats. Blood urea nitrogen concentration in this trial are in the normal physiological range reported by Morros and Dukes whom report a normal physiological range in goats from 6-28 mg dL^{-1}.

CONCLUSION

The results of the current indicate that supplementation with silage of molasses-poultry litter plus soybean meal, wheat middling or sorghum grain can increase nitrogen retention in growing goats fed oat hay. Supplementation with fermented poultry litter-molasses plus soybean meal supply the ammonia nitrogen required for rumen microbesfermentation.

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