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Mob: +92 300 3008585, Fax: +92 41 8815544

E-mail: editorpjn@gmail.com

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Effects of Two Levels of Protein Supplementation on Intake, Apparent Digestibility and Ammonia Nitrogen in Growing Goats Fed Ammoniated Crop By-Products

J. Santos Serrato-Corona[1], Tania I. Minor-Hinojosa[2],
Hector D. Garcia-Sanchez[1] and Andrea Minor-Hinojosa[1]
[1]Facultad de Agricultura y Zootecnia-Universidad Juarez del Estado de Durango,
Domicilio Conocido, Ej. Venecia, Dgo, Apdo. Postal 1-142, Gomez Palacio, Dgo
[2]Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias (INIFAP). Blvd.
José Santos Valdez 1200. Col. Centro. 27440, Cd. Matamoros, Coahuila, Mexico

Abstract: Agroindustrial by-products have a tremendous potential as nutrient sources for ruminants in arid and semiarid areas. An experiment was conducted to evaluate the effects of two ammoniated crop by-products and two levels of protein supplementation on intake, ammonia nitrogen and apparent digestibility of DM in growing goats. Eight goats crossed with Alpine (16.8±0.85 kg BW) were randomly assigned to four groups in a replicated Latin Square design with a 2 x 2 factorial arrangement of treatments. Goats were individually fed and received forage at 2% body weight dry matter base plus 150 g of supplement daily. Body weight gain was higher in goats fed sorghum stubble ($p = 0.01$). Dry matter retention was higher in goats fed sorghum stubble ($p = 0.04$). Organic matter retention was affected by forage ($p = 0.001$). FND was similar between supplements, but goats fed sorghum stubble retained more FND ($P = 0.01$). No significant effect of CBP*SUP interaction was detected ($p = 0.87$). Ammonia nitrogen concentration ($N\text{-}NH_3$) was higher in goats fed sorghum stubble ($p = 0.006$). Goats supplemented with WMS showed higher ammonia nitrogen concentration ($p = 0.005$). Interaction did not affect blood urea nitrogen concentration ($p = 0.79$). Blood urea nitrogen was higher in goats fed sorghum stubble ($p = 0.01$). Supplementation did not affect blood urea nitrogen concentration ($p = 0.18$). In conclusion, feeding ammoniated sorghum stubble plus supplementation based on poultry litter-sugarcane molasses, wheat middling's and soybean meal is a suitable alternative during drought season for growing goats.

Key words: Goats, supplementation, crop by-products, ammoniation

INTRODUCTION

Crop by-products can be used as a potential source of nutrients for ruminants, since ruminants have the capacity to degrade and use the fibrous part of such by-products. However, because of their low nutritional value only a small proportion of this roughages is fed to ruminants (Horton and Steacy, 1979). Crop by-products are characterized by low crude protein (6%), high NDF (>60%) and low available energy content (Horton and Steacy, 1979; Males, 1987), limiting the use of these materials to growing animals. Ammoniation has been used to increase the intake and digestibility of low quality roughages by Garrett *et al.* (1974). Ammoniation improves the nutritional value of crop by-products doubling the crude protein content (Horton and Steacy, 1979) and increasing feed intake by around 20% (Streeter *et al.*, 1982).

Supplementation of low quality roughages with agroindustrial by-products may decreases body weight loss (Huston *et al.*, 1999). Animal and agro industrial by-products can be used to decrease nutrient deficiencies in ruminants taking into account their cost, availability, nutritional characteristics and health aspects for animal and humans. In supplements with 40% of poultry litter body weight lost is decreased in growing goats fed low quality forages. A level lowers than 20% of sugarcane molasses in the diet cause a complementary effect in fermentation of the basal diet (Encarnacion and Hughes-Jones, 1981). Serrato *et al.* (2015) reported an increased $N\text{-}NH_3$ concentration in growing goats supplemented with sugarcane molasses-poultry litter. Therefore, an experiment was conducted to evaluate the effects of supplementation on intake and digestibility of two crop by-products by goats.

MATERIALS AND METHODS

An experiment was conducted at the Faculty of Agriculture and Zootechny in Durango, México, parallel 25°46' 56" north and meridians 103°21' 02" west. With an average temperature of 22° and extreme dryness,

Corresponding Author: J. Santos Serrato-Corona, Facultad de Agricultura y Zootecnia-Universidad Juarez del Estado de Durango, Domicilio Conocido, Ej. Venecia, Dgo. Apdo. Postal 1-142, Gomez Palacio, Dgo

with an average rainfall of 240 mm and 1110 m altitude. Eight growing goats crossed with French-Alpine five months old and averaging 16.8±0.85 kg initial body weight were used. Goats were randomly allotted to one of the four treatments in a replicated Latin Square Design with a 2 x 2 factorial arrangement. Before treatments were applied each goat was administered subcutaneously with 0.5 ml of IVERMECTINA™. Animals were individually supplemented once daily at 07:00 h with 150 g of one of three supplement treatments (Table 1). Goats were fed ammoniated sorghum stubble (11% PC, 66% NDF) or ammoniated corn stover (10% PC, 66% NDF) at 2.2% body weight dry matter basis at 07:00 h daily.

The two crop by-products, sorghum stubble or corn stover bales were grounded in a hammer mill thru a 4 cm screen. Ammoniation of crop by-products was performed by using 3 kg of urea and 50 l of water per 100 kg air dry basis. After the urea was dissolved in the water, the solution was uniformly sprayed on layers 20 cm depth of roughages. To achieve the airtight condition the roughages were covered with a plastic film and the edges were sealed with sand. The ammoniation process lasted 20 days at a temperature of 30-35°C. Before the ammoniated roughages were offered, it was allowed to aerate for one day to allow for the escape of volatile ammonia.

Supplements were processed before fed as follows; ingredients were well mixed and placed into a 40 l container on layers 10 cm depth, compressing the material to create an anaerobic environment and covered with a black plastic film. The ensiling period lasted 30 days. Roughage and supplements sub-samples were collected every week and composited for chemical analysis. Clean water and mineral mix were available at all times.

Goats were weighed in the morning of two consecutive days at the beginning and at the end of the experimental period, to determine body weight change. 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. Besides, goats were individually supplemented at a rate of 150 g daily. Periods lasted 18 days each.

From day 14 to day 18 of each period fecal collection bags were fitted to the animals to assess total fecal and urine output. Fecal collection bags were removed and replaced every 12 h 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 determinations. Samples were analyzed for DM, ash and Kjeldahl nitrogen (AOAC, 2000). Neutral detergent fiber and ADF were analyzed by nonsequential methods of Goering and Van Soest (1970).

Daily subsamples were composited by weight (10% wet weight) within goat and treatment. On the last day of each period one blood sample was drawn via jugular vein puncture two hours after giving the supplement in each goat. Blood samples were centrifuged at 3000 x g for 20 min at room temperature within 1 h after collection. Serum was harvested and frozen at -20°C until latter analysis. Serum samples were analyzed for blood urea nitrogen (BUN) by spectrophotometry using a commercial kit colorimetric procedure (BioSystems, Barcelona, Spain™).

On day 18 of each period goats were deprived of forage 12 h and 8 mL of rumen fluid were collected in all goats of each treatment by stomach tube connected to a vacuum pump. Rumen fluid was collected two hours after giving the supplement in each goat. Rumen fluid was strained through 4 cheese cloth layers and a 10 mL aliquot was acidified with 0.2 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, nitrogen retention, BUN and ammonia nitrogen were analyzed by analysis of variance for a completely randomized design. All statistical analyses were performed by using the GLM procedure of SAS (SAS Inst., Inc., Cary, NC).

RESULTS AND DISCUSSION

No crop by-product x supplementation interactions ($p>0.79$) were observed in this trial therefore the main effects are presented. Crop by-product and dry matter intake by goats were grater ($p<0.02$) when fed the ammoniated sorghum stubble than when ammoniated corn stover was offered (Table 2). Intake of NDF ($p = 0.03$) and ADF ($p>0.01$) were higher in goats fed ammoniated sorghum stubble as compared with goats fed ammoniated corn stover. Goats fed ammoniated sorghum stubble showed a higher protein intake than those consuming ammoniated corn stover. Since protein content in the supplements was different and all goats received the same amount of supplement daily,

Table 1: Crop by-products and supplements composition fed to growing goats

	-- Crop by-product[1] --		---- Supplement[2] ----	
Item (%)	Corn	Sorghum	PMWS	PMC
Dry matter	92.03	92.59	92.25	92.25
Crude protein	10.00	11.00	18.26	11.80
NDF	66.00	65.00	19.39	14.78
ADF	40.00	41.00	8.0	6.1
Ash	7.3	10.3	16.32	15.06

[1]Ammoniated corn stover or ammoniated sorghum stubble
[2]PMWS = 40% poultry litter, 30% sugarcane molasses, 15% wheat middlings and 15% soybean meal; PMC = 40% poultry litter, 30% sugarcane molasses, 30% cracked corn grain

Table 2: Feed intake, excretion and nutrients retention in growing goats fed with ammoniated corn stover or sorghum stubble and supplemented with two levels of protein

	Treatment[1]							
	Corn stover		Sorghum stubble		Probability[2]			
Item	PMWS	PMC	PMWS	PMC	By prod	SUPP	By-Prod *SUPP	SE[3]
Intake, g								
DM	619.1	617	704.2	683.6	0.02	0.72	0.77	31.66
OM	474.4	482.7	561.2	554.5	0.003	0.97	0.76	25.07
NDF	353.1	330	408.4	374.3	0.02	0.17	0.79	20.75
ADF	224.3	1985	257.9	225.4	0.02	0.02	0.79	12.6
CP	108.7	75.5	112.4	77.1	0.47	<.001	0.76	3.59
Excretion, g								
DM	272.9	259.5	290.7	266.4	0.5	0.31	0.76	18.34
OM	211.4	201.2	206.8	190.4	0.59	0.35	0.83	14.27
NDF	146.4	136.7	136.2	133.1	0.44	0.47	0.47	8.85
ADF	113.1	104.3	110.2	98	0.52	0.15	0.80	7.12
CP	18.3	14.2	20.6	21.9	0.01	0.49	0. 81	1.89
Retention, g								
DM	346.2	357.5	413.5	417.2	0.04	0.81	0.9	30.89
OM	262.9	281.5	354.4	364.1	0.001	0.56	0.85	24.44
NDF	206.6	193.2	272.2	241.1	0.01	0.31	0.68	21.63
ADF	111.2	94.2	147.6	127.4	0.01	0.15	0.89	12.62
CP	90.4	61.1	91.7	55.1	0.43	<.001	0.06	2.92

[1]Treatment = Ammoniated corn stover or ammoniated sorghum stubble. PMWS = 40% poultry litter, 30% sugarcane molasses, 15% wheat middlings and 15% soybean meal; PMC = 40% poultry litter, 30% sugarcane molasses, 30% cracked corn grain

[2]By-prod = crop by-product, SUPP = Supplement, By-prod*SUPP = interaction crop by-product*supplement

[3]SE = Standard Error

goats receiving PMWS had higher protein intake (78.4 g/d) than those supplemented with PMC (67.7 g/d). Body weight change was not affected by crop by-product (p = 0.22) or kind of supplement (p = 0.25).

Nutrients retention is shown in Table 2. The interaction was not significant (p = 0.91), as well as the type of supplement (p = 0.78) but the type of crop by-product modified retention of dry matter (p = 0.05), goats receiving sorghum stubble retained 380.9 g dry matter while goats which received corn stover retained 321.3 g. Organic matter retention was influenced by crop by-product (p<0.01) goats fed with sorghum stubble retained 359.2 g while goats fed corn stover retained 272.2 g. Type of supplement did not affect organic matter retention (p = 0.85). With regard to NDF retention no difference was detected due to supplementation (p = 0.48), however goats fed with ammoniated sorghum stubble retained more amount of NDF (p = 0.02) compared to those fed corn stover. Same trend as NDF retention was found for ADF retention. No crop by-product x supplementation interaction (p = 0.66) was observed for protein retention. Supplementation affected protein retention (p<0.01), goats supplemented with PMWS retained 76.6 g of crude protein daily while those supplemented with PMM retained 65.9 g. Protein retention was higher (p = 0.001) in goats fed sorghum stubble (77.2 g) than in those fed corn stover (65.4 g). Similar results were reported by Ibarra (2011) who found an increased nitrogen retention in growing goats fed ammoniated corn stover and supplemented with a mix based on sugarcane molasses, poultry litter and wheat middlings than in the control group.

Ammonia nitrogen (NH_3-N) concentration in rumen fluid is shown in Fig. 1. No crop by-product x type of supplement interaction was detected (p = 0.87). Crop by-product significantly affected NH_3-N concentration (p<0.01). Goats fed ammoniated sorghum stubble showed concentrations of 10.19 mg/dL while those receiving corn stover recorded 7.81 mg/dL. Type of supplement also influenced N-NH_3 concentration (p<0.01) goats supplemented PMWS recorded 10.22 mg/dL while those receiving PMM showed concentrations of 7.78 mg/dL. Flores (2011) found higher N-NH_3 concentration (p<0.01) in rumen fluid of goats supplemented with poultry litter-sugarcane molasses and receiving sorghum stubble as a basal diet than in unsupplemented goats. Ruminal ammonia nitrogen concentration was increased when goats were fed ammoniated crop by-products. This result was consistent with previous studies which indicated that ammoniation of low quality roughages had affected ruminal N-NH_3 concentration (Wanapat *et al.*, 2009; Mapato *et al.*, 2010). Ammoniation of rice straw increased ruminal NH_3-N concentration in steers suggesting an increased level of soluble nitrogen, particularly immediately after feeding (Gunun *et al.*, 2013).

Blood urea nitrogen concentration is shown in Fig. 2. Crop by-product x supplementation interaction was no observed. Higher BUN concentration (p = 0.01) was

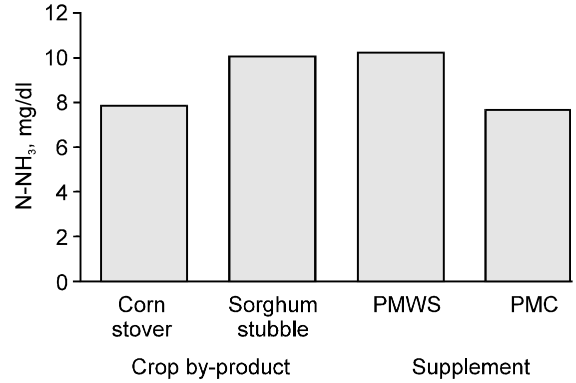

Fig. 1: Main effects of crop by-product and supplement on ammonia nitrogen in growing goats (interaction p = 0.87)

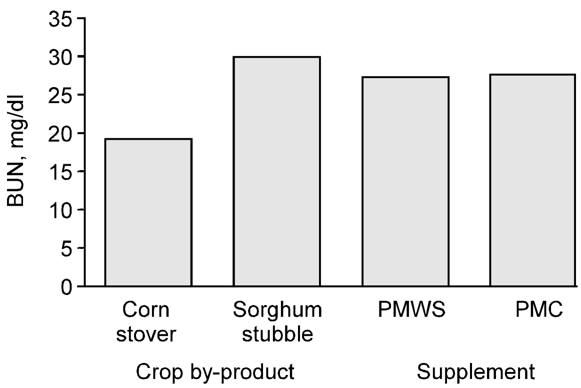

Fig. 2: Main effects of crop by-product and supplement on blood urea nitrogen in growing goats (interaction p = 0.79)

observed in goats fed ammoniated sorghum stubble (32.42 mg/dl) than in goats fed ammoniated corn stover (27.75 mg/dl), which are in the higher normal physiological ranges reported by Dukes (1955) and Morros (1967) which are from 13 to 28 mg/dl. Type of supplement did not influence the concentration of BUN (p = 0.18). Serrato and Avitia (2005) showed mean values of 16.5, 19.3 and 17.2 mg/dl in growing goats fed with ammoniated corn stover and supplemented 25, 50 and 75 g daily with soybean meal, corn gluten and wheat middlings, respectively. Olther and Wektorsson (1983) postulated that an excess in the consumption of nitrogen increases the synthesis and removal of urea and it is reflected in an increase in the concentration of urea nitrogen in blood serum. The high concentration of BUN may suggest an increased availability of soluble nitrogen into the rumen environment. Gunun *et al*. (2013) reported higher BUN concentration in steers fed ammoniated rice straw than in those fed untreated rice straw.

Conclusions: According to the results obtained it can be concluded that feeding growing goats with ammoniated sorghum stubble or corn stover and supplemented with a mix based on sugarcane molasses-poultry litter is an economical and feasible alternative during the dry season in semiarid regions.

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