Journal of Animal and Veterinary Advances 9 (12): 1761-1764, 2010
ISSN: 1680-5593

Effects of Undegradable Intake Protein on Milk Yield, Bun and Dry Matter Digestibility in Lactating Goats Fed Ammoniated Corn Stover

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Abstract: Protein supplementation can improve productivity of goats consuming low quality forages by either increased feed intake or by increased efficiency on nutrient usage. An experiment was conducted to evaluate the effects of different levels of UIP on milk yield, dry matter digestibility and blood urea nitrogen in lactating goats fed ammoniated corn stover. About 18 young goats 32.3±2.1 kg initial body weight and 8-10 weeks postpartum were used in the experiment. Goats were randomly assigned to one of the three treatments. All goats received a basal diet of 90% ammoniated corn stover (92% DM, 11% CP, 75% NDF) plus 10% alfalfa hay (90% DM, 18% CP, 60% NDF) once a day at 2% BW at 0800 h throughout the trial. Water and salt mineral mix were available at all times. Animals were individually supplemented once daily at 0800 h, receiving 100 g of one of the three supplement treatments; low UIP (LUIP; 51% CP, 70% RDP:30% UIP), medium UIP (MUIP; 50.8% CP, 60% RDP:40% UIP) or high UIP (HUIP; 50.7% CP, 50% RDP:50% UIP). On day 19 and day 42 of the treatment period milk production was assessed milking by hand. From 40-42 day fecal collection bags were fitted to the animals to assess total fecal and urine output. On day 43 of the experimental period one blood sample was collected before supplementation and every hour for 6 h after supplementation via jugular venipuncture. Nutrient digestibility and body weight change were analyzed by analysis of variance for a completely randomized design while milk yield and blood urea nitrogen where analyzed by repeated measurement. Feed intake was similar ($p = 0.43$) between treatments while goats in the BP group showed the highest average daily gain ($p = 0.5$). Milk yield ($p = 0.53$) and BUN concentration ($p= 0.51$) were no influenced by supplements. Protein supplementation did not influence nutrients digestibility between treatments. These results suggest that protein supplementation can diminish body weight loss and support low milk yield in goats consuming ammoniated corn residues.

Key words: Goats, protein supplementation, ammoniated straw, milk production, ammoniated corn, postpartum

INTRODUCTION

Goat population in the Comarca Lagunera (Durango and Coahuila) is around 458 271 heads. The main sources of nutrients for most of the herd are native grasses, shrubs and crop by-products such as corn stover.

Cereal straws are produced in considerable quantities in Mexico; however, due to their low quality represent the most widely underutilized source of energy. Low quality roughages are inefficiently utilized by ruminants because of high content and poor digestibility of the fibrous fractions.

Because of their relatively low availability of metabolizable energy crop residues are most efficiently utilized in maintenance rations for non-productive animals (Ward, 1978). However, physical and chemical treatments can improve feed intake and nutrient utilization by ruminants. Use of ammonia gas and urea has attracted considerable attention (Sundstol and Coxworth, 1984) as a mean of adding nitrogen and increasing feed intake and digestibility simultaneously. Hadjipanayiotou *et al.* (1993) reported an increased nutritive value, voluntary intake and digestibility in cattle and sheep fed ammoniated crop residues.

Because of corn residues might be deficient in protein and energy for lactating ruminants it will be necessary to supplement these nutrients to prevent deficiencies. An experiment was conducted to evaluate the effects of different quantities of UIP on milk yield, nutrient digestibility and blood urea nitrogen in lactating goats fed ammoniated corn residues.

MATERIALS AND METHODS

Eighteen lactating young goats with an average initial body weight of 32.3±2.1 kg and 8-10 weeks postpartum were used in a completely randomized design to investigate the effect of different quantities of UIP on

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dry matter digestibility, milk yield, body weight change and blood urea nitrogen concentration. Corn residue was harvested and grounded in a hammer mill thru a 4 cm screen. Urea (3% measured on air-dry matter) was dissolved in water (0.5 l per kg air-dry straw) and applied on layers (20 cm depth) of known straw weight. The straw was covered with a plastic film and the edges were sealed with sand. The ensiling period was 15 days at a temperature of 30-35 (C. Before the roughage was offered, it was allowed to aerate for one day to allow for the escape of volatile ammonia.

Feed sub-samples were collected every week and composited for chemical analysis. All goats received a basal diet of ammoniated corn stover (90 and 92% DM, 11% CP, 75% NDF) plus alfalfa hay (10%; 90% DM, 18% CP, 60% FND) once a day at 2% BW at 0800 h throughout the trial. Water and salt mineral mix were available at all times. Animals were individually supplemented once daily at 0800 h, receiving 100 g of one of the three supplement treatments (Table 1); low UIP (LUIP; 51% CP, 70% RDP: 30% UIP), medium UIP (MUIP; 50.8% CP, 60% RDP: 40% UIP) or high UIP (HUIP; 50.7% CP, 50% RDP: 50% UIP). 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. Forage intake and refusals were recorded daily and refusals were discarded each morning prior to feeding. Forages were fed following supplemental feeding each morning.

On day 25 and 41 of the treatment period milk production was assessed milking by hand. From day 36-39 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 DM, NDF and nitrogen determinations. Daily sub-samples were composited by weight (10% wet weight) within goat and treatment. On day 43 of the experimental period one blood sample was collected before supplementation and every hour for 6 h after supplementation via jugular venipuncture. 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 by using an enzymatic procedure (Diagnostic Chemicals Limited, Oxford, Connecticut).

Feed intake, body weight change, dry matter digestibility and nitrogen retention were analyzed by analysis of variance for a completely randomized design while milk yield and blood urea nitrogen were analyzed in a split plot analysis of variance. All statistical analyses were performed by using the GLM procedure of SAS (SAS Inst., Inc., Cary, NC).

Table 1: Ingredients and supplement chemical composition

	Treatments[1]		
Ingredient	LUIP	MUIP	HUIP
Soybean meal	69.00	30.00	11.50
Wheat meddlings	10.00	9.00	-
Corn Gluten	9.80	49.50	79.50
Sorghum milo rolled	7.00	7.00	4.50
Urea	3.20	3.50	2.50
Mineral premix	1.00	1.00	1.00
Chemical Composition			
Crude protein (%)	51.00	50.80	50.70
Rumen degradable protein (%)	15.43	20.27	25.28
Undegradable intake protein (%)	35.56	30.40	25.40
Metabolizable energy, Mcal kg^{-1}	2.80	2.90	3.10

[1]LUIP = basal diet+100 g of supplement low in undegradable protein (51% CP, 70% RDP:30% UIP) ; MUIP = basal diet+100 g of supplement medium in undegradable protein (50.8% CP, 60%, RDP:40% UIP); HUIP = basal diet+100 g of supplement high in undegradable protein (50.7% CP, 50% RDP, 50% UIP)

RESULTS AND DISCUSSION

Feed intake was similar ($p = 0.43$) for all goats as shown in Table 2, however, a trend to decrease ammoniated roughage intake was observed as the amount of UIP in the supplement increased. Weixian (1995) reported a similar trend in cattle fed ammoniated wheat straw and supplemented with three levels of cottonseed cake. The different quantities of UIP supplemented influenced ($p = 0.05$) body weight change in an inconsistent fashion. Goats supplemented with the highest amount of RDP showed the greatest body weight gain with values of 75, 15 and 44 g for treatments LUIP, MUIP and HUIP, respectively. Even though no difference ($p = 0.53$) was appreciated on milk yield goats supplemented with the highest amount of UIP produced more milk (433 mL day^{-1}) compared with those goats supplemented the lowest quantity of UIP (325 mL day^{-1}). These results may indicate animal's priority for milk synthesis and secretion at the expense of body fat reserves. Sparrow *et al.* (1973) observed the greatest milk yield and also the greatest weight loss in cows receiving a high-protein diet. Serrato-Corona (1998) reported the greatest body weight loss and the highest milk production in postpartum beef cows supplemented with the highest quantity of undegradable intake protein (602 g day^{-1}) compared with those animals receiving less amount of UIP and fed sub-maintenance diets.

Table 2: Effects of supplementing increasing quantities of UIP on animal performance and blood urea nitrogen in goats fed ammoniated corn stover

	Treatment[1]				
Item	LUIP	MUIP	HUIP	p-value	SE[2]
Feed intake (g day^{-1})	1132.7	1062.4	942.1	0.43	108.0
Body weight change (g day^{-1})	75.0^{a}	15.0^{b}	44.0^{ab}	0.05	14.0
Milk yield (mL day^{-1})	325.0	325.0	433.0	0.53	78.0
BUN (mg dL^{-1})	28.3	23.9	25.5	0.51	2.7

[1]LUIP = basal diet+100 g of supplement low in undegradable protein (51% CP, 70% RDP:30% UIP); MUIP = basal diet+100 g of supplement medium in undegradable protein (50.8% CP, 60% RDP:40% UIP); HUIP = basal diet+100 g of supplement high in undegradable protein (50.7% CP, 50% RDP:50% UIP). [2]Standard Error

Table 3: Effects of supplementing increasing quantities of UIP on nutrient intake and retention by lactating goats fed ammoniated corn stover

	Treatment[1]				
Item	LUIP	MUIP	HUIP	P-value	SE[2]
Intake (g day^{-1})					
DM	1040.50	957.90	865.50	0.43	99.23
NDF	747.40	695.60	606.80	0.42	76.90
N	23.60	24.00	23.70	0.98	1.70
Excretion (g day^{-1})					
DM	277.00	346.40	265.60	0.55	54.60
NDF	140.70	178.30	122.70	0.50	32.50
N	4.30	5.30	4.20	0.65	0.88
Retained (g day^{-1})					
DM	763.50	629.50	618.30	0.29	65.90
NDF	606.70	517.20	501.80	0.43	57.40
N	19.30	18.70	19.70	0.85	1.20
Retention (percentage of intake)					
DM	67.90	59.30	64.00	0.20	2.90
NDF	53.50	48.90	51.90	0.17	1.50
N	1.71	1.78	2.05	0.07	0.09

[1]LUIP = basal diet+100 g of supplement low in undegradable protein (51% CP, 70% RDP:30% UIP); MUIP= basal diet+100 g of supplement medium in undegradable protein (50.8% CP, 60% RDP: 40% UIP); HUIP = basal diet+100 g of supplement high in undegradable protein (50.7% CP, 50% RDP:50% UIP).[2] Standard Error

Dry matter digestibility was not affected (p = 0.29) by UIP supplementation. Level of UIP in the supplement did not influence NDF digestibility (p = 0.43) as shown in Table 3. 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 ruminal microbes requirements. Petersen *et al.* (1985) reported that microbial protein production is low regardless of nitrogen source supplied when low quality roughage contributes over 90% of the diet. Protein supplementation may increase forage intake and digestibility when forage protein is less than 7% (Bowman *et al.*, 1995). The failure to improve DM and NDF digestibilities was probably due to the fact that the basal diet contained >6% crude protein.

Protein retained in goats receiving different quantities of UIP was similar (p = 0.83) between groups as shown in Table 2. Similar nitrogen retention was reported by Serrato *et al.* (2002) in lactating goats supplemented with different sources of protein. Blood urea nitrogen concentrations were similar (p = 0.51) among treatments as shown in Table 1. A positive relationship between increased dietary protein intake and BUN has been reported by several researchers. Blood urea nitrogen is positively correlated with dietary nitrogen in sheep (Preston *et al.*, 1965) and cattle (Preston *et al.*, 1978). Eggum (1970) indicated that at least three factors can influence BUN, namely the quantity and content of protein in the diet and the time after feeding. Values of BUN found in this trial were in the upper usual normal physiological range which can be partially explained by the amount of soluble nitrogen applied to the roughage and that in the supplement.

CONCLUSION

These results suggest that lactating goats can be fed with a basal diet of ammoniated corn residues and supplemented with protein sources when good or medium quality forages are not available. Although, BUN only responded numerically it can be used as an indicator of nitrogen solubility. Therefore, further research is warranted to better understand the rumen dynamic in goats fed low quality forages and supplemented with protein or energy sources.

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