EFFECTS OF UREA - AMMONIATION AND COTTON SEED CAKE SUPPLEMENTATION ON THE UTILIZATION OF SORGHUM STOVER BY SHEEP

A.M., ADAMU, I.F. ADU[1], S.A.S., OLORUNJU, C.B.I. ALAWA AND O.S. LAMIDI,

National Animal Production Research Institute, Shika, P.M.B 1096, Zaria, Nigeria.

[1]*University of Agriculture, Abeokuta, Ogun State, Nigeria.*

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ABSTRACT

The effects of cotton seed cake (CSC) supplementation and urea- ammoniation on the utilization of sorghum stover by Yankasa sheep was studied. Chopped sorghum stover was ensiled with ferlitizer grade urea at 4% urea (w/w), the urea being dissolved in water to reconstitute the silage to 50% DM. The experiment was a 2x3 factorial design of unammoniated and ammoniated sorghum stover and three levels of CSC supplementation (0.5, 1.0 and 1.5% of the sheep body weight). The growth trial was conducted with 24 yearling sheep, averaging 18.2 kg liveweight and lasted for 60 days. Intake of sorghum stover by sheep was improved ($P < 0.05$) by urea - ammoniation, but not significant ($P > 0.05$). Increasing the level of supplementation with CSC improved ($P > 0.05$) stover intake by sheep fed the unammoniated stover, but resulted in decreased ($P > 0.05$) intake of ammoniated stover by sheep. Sheep liveweight gains were improved by ammoniation and supplementation ($P < 0.01$). The interaction between urea-ammoniation of the stover and CSC supplementation resulted in better ($P < 0.05$) liveweight going in sheep. Twelve Yankasa rams averaging 16.9 kg liveweight were seperately used for the metabolism trial. Ammoniation and supplementation did not affect DM, NDF and ADF digestibilities ($P > .05$), but resulted in increase ($P < 0.05$) in cellulose and hemicellulose digestion. Ammoniation and supplementation resulted in higher N-balance of the sheep. Ammoniation resulted in marked increases ($P < 0.01$) in rumen ammonia concentrations, but increasing the level of supplementation did not appreciably ($P < 0.05$) affect rumen ammonia concentrations.

Keywords: Sorghum stover, Urea-ammoniation, supplementation, sheep.

INTRODUCTION

Cereal crop residues form the bulk of the roughage consumed by ruminants in the dry season, especially in the Sudan and Guinea savanna zones of Nigeria. A major limiting factor in the utilization of cereal crop residues is their low digestibility and relatively poor nutrient composition Kiangi, 1981, Alhassan, *et al.*, 1990 and Alhassan and Aliyu, 1991). Direct nutrient supplementation, alkali and ammonia treatments are known to increase the digestibility and intake of crop residues and low quality forages (Jackson, 1977; Horton and Steacy, 1979; Lufadeju, 1988; Alhassan and Aliyu, 1991). However, there is a dearth of information on the combined effects of nutrient supplementation and ammoniation of crop residues and sorghum stover in particular on the performance of ruminant animals in Nigeria. Therefore, the purpose of the study reported here is to evaluate the effects of urea-ammoniation of sorghum stover and supplementation with CSC on the feed intake, feed utilization and nutrient digestibility by sheep.

MATERIALS AND METHODS

Sorghum stover and ensilage:- Stover from short Kaura variety of sorghum was harvested in late November and chopped with a forage chopper. One portion of the chopped stover was ammoniated for four weeks with fertilizer grade urea at 4% (W/W), the urea being dissovived in water to reconstitute the silage to 50% DM. The material was ensiled above ground level on a concrete slab and covered with a thick polythene sheet held in place with stones around the edge. After ensilage the

stover was spread to dry in the sun for 14 days before feeding. The second portion of the stover was stored on a concrete slab in the same area as the ensiled material and covered with polythene sheet until fed.

Two experiments, a growth and a metabolism trial, were performed. Both experiments were a 2x3 factorial combination of unammoniated (USS) and ammoniated (ASS) sorghum stover and three levels of CSC supplementation (0.5, 1.0 and 1.5% of the animal's body weight). A non-supplemented group was not included because earlier preliminary studies in NAPRI have shown that sheep fed cereal crop residues without supplementation lost weight (Adu and Alhassan - personal communications).

Growth Trial:

A total of twenty four yearling ewes averaging 18.2kg, were used, four sheep being allocated to each treatment. The growth trial lasted for 60 days.

Digestion Trial:

For the digestion trial, 18 rams averaging 16.9kg were fed in metabolism crates to evaluate the digestibility of the diets used in the growth trial. A 14 day preliminary feeding period, during which the rams were fed ad libitum sorghum stover based treatments preceeded the 7-days total collection of faeces and urine. During the faecal and urine collection period the feed offered was reduced to 90% of the voluntary intake recorded during the adjustment period. This is to ensure total intake of feed offered. Urine of the sheep was collected in plastic bowls containing 10ml of 50% sulphuric acid added as a preservative. 10% each of daily faecal output and orts as well as twenty five percent (25%) of daily urinary output were composited for chemical analyses.

Chemical and Statistical Analyses:

The dry matter concentrations of experimental diets and faecal samples were determined by drying in an oven at 100 C for 24 hr. The total nitrogen in feeds and faeces was determined by the Kjeldahl procedure (A.O.A.C., 1980). The detergent fibre fractions of the feed (Neutral detergent fibre, acid detergent fibre, cellulose and hemicellulose) were determined according to Goering and Van Soest (1970) while Rumen ammonia concentrations were estimated using A.O.A.C. 1980 method. All data were subjected to analysis of variance of a factorially designed experiment according to Steele and Torrie (1968) using a general linear mode (SAS, 1988).

RESULTS AND DISCUSSION

Table 1 shows the chemical composition of the test ingredients. Ammoniation of the stover led to 88.5%, 13.01% and 19.7% increase in CP, cellulose and hemicellulose contents respectively and 6.67%, 2.72% and 15.09% decrease in NDF, ADF and lignin contents respectively. Similar increases in N level have been recorded when barly straw was treated with anhydrous ammonia (Dryden and Kempton, 1983). Decreases in NDF contents of forages as a result of urea treatment has also been reported (Hadjipanatjiotou, 1984).

TABLE 1: CHEMICAL COMPOSITION OF THE TEST INGREDIENTS

Item	Unammoniated sorghum Stover (USS)	Ammoniated Sorghum Stover (ASS)	Cotton Seed Cake
Dry matter	92.57	92.77	94.10
Crude Protein	7.06	13.31	25.31
NDF	76.09	71.02	53.60
ADF	44.05	42.85	24.35
Cellulose	33.96	38.38	23.97
Hemicellulose	32.04	38.15	29.35
Lignin	6.96	5.91	10.42
Ash	5.05	5.11	4.20

Growth Trial:

The results of the growth trial are shown in Table 2. Urea-ammoniation caused a 4% increase ($P > 0.05$) in total feed consumed.

TABLE 2: EFFECT OF UREA-AMMONIATION AND COTTON SEED CAKE SUPPLEMENTATION ON DM INTAKE AND PERFORMANCE OF SHEEP

Levels of supplementation of CSC (% body Wt.)	USS			ASS level of supplementation of CSC (% body Wt.)			S.E.
	0.5%	1.0%	1.5%	0.5%	1.0%	1.5%	
DM intake (g/kg 0.75 BW): Total (stover + suppl.)	56.23	65.72	75.35	63.76	70.39	70.97	3.01
Sorghum stover	45.7	52.14	46 20	53.20	49.77	51.35	2.73
A.D.G. (g/d)	-50.00	-33.30	50.00	16.70	0.00	33.30	4.79

Increasing the level of supplementation with CSC resulted in increase ($P<.05$) in total feed consumed by sheep fed the USS but not by sheep fed the ASS. Intake of sorghum stover by sheep was improved ($P<0.05$) by urea ammoniation. Increasing the level of supplementation resulted in improved ($P<0.05$) intake of USS but resulted in decreased ($P>0.05$) intake of ASS by sheep. The combined effects of urea-ammoniation and CSC supplementation resulted in increased ($P<0.05$) intake of the sorghum stover. Average daily gains of sheep fed ASS were better ($P<0.05$) than those fed USS. Increasing the level of supplementation resulted in improved ($P<0.05$) liveweight gains in both the sheep fed USS and ASS but the effect was more marked with ASS than with USS. The interaction of urea-ammoniation and CSC supplementation resulted in improved ($P<0.05$) liveweight gains by sheep. At the highest level of supplementation, sheep fed USS had better liveweight gains than those fed ASS, possibly because sheep fed USS consumed more total feed than sheep fed ASS.

The effects of ammoniation of cereal crop residues on feed intake and performance of ruminants have been variously reported in literature. In a study of the value of urea-treated straw in the diets of lactating goats, Hadjipanatjiotou (1984) found that there were no significant effect of urea treatment on milk yield and liveweight changes. In contrast, Orskov, *et. al.* (1983) fed Friesian heifers with ammonia-treated or untreated barley straw as the only feed and found that ammoniation greatly improved the nutritive value of the barley straw. Similarly, Faulkner, *et. al.* (1985) reported that cows fed ammonia-treated wheat straw increased liveweight gain ($P<0.05$) by 0.1kg when compared with cows fed untreated wheat straw. They also found that intake by lambs of ammoniated wheat straw was higher ($P<0.05$) than that of unammoniated straw. The above data agree with the results of the present study. Most studies reported in literature show that nutrient supplementation of ruminants fed low quality forages resulted in better intake of the forage and improved performance by the animals. There are few studies in which the combined effects of ammoniation of low quality forage and nutrient supplementation have been investigated. Faulkner *et al.* (1985) showed that cows fed ammoniated wheat straw and supplemented with alfalfa hay consumed 13.8% ($P<0.01$) more feed than those fed the untreated straw. The cows receiving alfalfa hay supplement had better liveweight gains ($P<0.05$). These results are in agreement with the work reported here.

Digestion Trial:

Table 3 shows the DM intake and digestibility of feed constitutents. Total feed consumption was improved by 28.8% as a result of urea-ammoniation. This result is similar to that obtained by Orskov *et. al.* (1983) when they fed ammoniated barley straw to heifers as the sole feed.

Increasing the level of supplementation resulted in increased total feed intake ($P<01$) at the lower levels of supplementation. Total feed intake declined at the highest level of supplementation in sheep fed both USS and ASS. The combined effect of ammoniation and supplementation resulted in higher ($P<.05$) total DM intake. Ammoniation improved

TABLE 3: EFFECT OF UREA - AMMONIATION AND COTTON SEED CAKE SUPPLEMENTATION ON DRY MATTER INTAKE AND DIGESTIBILITY BY SHEEP.

	USS Level of supplementation of CSC (% body Wt.)			ASS Level of supplementation of CSC (% body Wt.)			
	0.5%	1.0%	1.5%	0.5%	1.0%	1.5%	S.E.
DM intake (g/kg $^{0.75}$ BW):							
Total (stover + suppl)	65.45	79.29	74.84	90.59	101.46	85.06	3.63
Sorghum stover	57.91	60.53	42.16	57.14	76.64	53.78	4.03
Digestibility:							
DM	59.42	64.95	65.60	61.80	63.89	64.00	3.44
NDF	61.98	66.64	65.74	66.82	72.55	65.22	3.23
ADF	42.97	49.02	44.09	46.81	53.27	42.32	5.03
Cellulose	64.49	69.15	74.07	71.02	79.78	71.00	2.50
Hemicellulose	88.57	88.12	90.30	91.79	96.33	93.59	2.61
Nitrogen	37.47	58.92	58.75	55.66	58.59	60.70	4.36
N-balance (g/d)	2.51	5.15	5.33	3.96	5.28	6.10	0.34

stover intake ($P<.05$) by 16.8%. Increasing the level of supplementation resulted in increased ($P<0.05$) intake of the stover at the lower levels of supplementation but caused a decline in stover intake at the highest level in sheep fed both USS and ASS. This decline in stover intake at the high level of supplementation could be due to substitution of the supplement for the stover by sheep. The highest stover intake was by animals fed ammoniated stover and receiving the 1% level of supplementation.

Intake of ammoniated stover was significantly higher ($P<0.01$) than the unammoniated stover during the metabolism trial, while the growth trial the differences were not significant ($P>0.05$). This could be explained by the fact that during the growth trial, the animals were fed *ad. lib* stover and they could therefore select the most nutritious portion of the stover unlike in the digestion trial where selection was minimised because the animals were given restricted amount of feed, ie 90% of the voluntary intake. Ammoniation and supplementation did not affect DM digestibility ($P>0.05$) but resulted in increase in digestibility of NDF and ADF by sheep but these increases were not significant ($P>.05$). Other workers have shown that digestibility of the fibre fractions of low quality forages have been improved by ammoniation and supplementation (Dias-Da-Silva, 1986, Williams, 1983; Butterworth and Mosi, 1986). Although the digestion of cellulose and hemicellulose fractions of the stover by sheep was increased by ammoniation, the increase was only significant ($P<0.05$) for hemicellulose digestion. The digestion of nitrogen was improved ($P<0.05$) by both ammoniation and CSC supplementation. N-balance of sheep was not improved ($P>0.05$) by ammoniation of the stover but CSC supplementation resulted in more ($P<0.05$) N being retained by sheep fed both USS and ASS. The interaction between ammoniation of the stover and level of supplementation with CSC did not produce better N-retention.

Table 4 shows the ruminal ammonia concentration of sheep fed the different diets. Ammoniation markedly increased ($P<0.01$) ruminal ammonia concentrations. Increasing the level of supplementation caused increases in the pre-feeding ruminal ammonia concentrations only in sheep fed the unammoniated stover. In all cases ruminal ammonia concentrations of sheep fed the treated stover remained very high even 4 hours after feeding. This suggests that such rumen will support greater fibre digestion and is evidenced by the greater NDF and ADF

TABLE 4 EFFECT OF UREA-AMMONIATION AND COTTON SEED CAKE SUPPLEMENTATION ON RUMEN AMMONIA CONCENTRATION OF SHEEP

	USS Levels of supplementation of CSC (%body WL)			ASS Level of supplementation of CSC (%body WL)			
	0.5%	1.0%	1.5%	0.5%	1.0%	1.5%	S.E.
Before feeding	6.44	8.05	9.66	12.56	13.20	8.37	1.29
2.5h after feeding	8.70	18.35	11.60	28.66	27.69	23.83	1.05
4h after feeding	7.27	14.53	9.91	24.42	24.58	19.38	2.23

digestions by sheep fed treated straw. Ruminal ammonia concentrations of sheep in this experiment are above the recommended value of 5mg/100ml for efficient microbial activity in the rumen (Satter and Slyter, 1974).

It is concluded from these results that ammoniation of sorghum stover and CSC supplementation improved the nutritional quality of sorghum stover fed to sheep. The effect of supplementation on intake and digestibility was more marked at the lower levels of supplementation than at the higher levels. At the higher levels of supplementation, ammoniation had no advantage, probably because the ruminal ammonia concentrations required for maximum microbial biomass production has been met by the degradation of the supplement. It may be that at this high level of ammonia concentrations required for maximum microbial biomass production has been met by the degradation of the supplement. It may be that at this high level of ammonia concentration energy will be a limiting factor. It is also concluded that supplementation with CSC at the 1% of the sheep body weight with ammoniated but not with unammoniated sorghum stover will maintain sheep liveweight. Higher levels with either stover can result in marginal gains while lower levels will lead to liveweight losses.

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