Tropical Animal Production 1984 9:157-162

PLASMA AND RUMINAL CONSTITUENTS AND PERFORMANCE OF SHEEP FED VARIOUS NITROGEN SUPPLEMENTS

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Forty male Desert sheep 21 kg mean body weight were used to study the effects of nitrogen source on growth rate, feed efficiency, plasma urea nitrogen concentration and ruminal ammonia and total volatile fatty acid concentrations. The sheep were offered ad libitum sorghum grain - wheat bran - alfalfa hay based diets supplemented by cottonseed meal (CSM), groundnut meal (GNM), or sesame seed meal + urea (17% of total dietary nitrogen as urea) for 94-day trials on isonitrogenous and isocaloric basis. Daily gains of CSM and GNM supplemented sheep averaged 0.152 kg and 0.184 kg respectively compared with 0.127 and 0.112 kg for SSM and SSM + urea supplemented diets ($P < 0.01$). The daily feed intake was significantly higher ($P < 0.01$) for the CSM and GNM supplemented diets. The free daily water intake followed the same pattern as that of daily feed intake; however, free water intake per kg dry-matter intake was similar. The feed conversion ratio (Feed/gain) was significantly higher ($P < 0.01$) for SSM + urea supplemented diet. The source of nitrogen in the diet had no significant effect on nitrogen balance and on the apparent digestibilities of the diet components except for the crude fibre ($P < 0.05$) in CSM supplemented sheep. Plasma urea nitrogen, 3 h post feeding, was significantly ($P < 0.05$) elevated in SSM and SSM + urea supplemented sheep. VFA concentration was high ($P < 0.05$) in the rumen liquor of sheep supplemented with CSM. There was no treatment effect on ruminal pH.

Key Words: Sheep, protein supplements, liveweight gain, digestibility

The rate of protein breakdown in the rumen varies greatly with the nature of the food (McDonald 1962). Ammonia is the chief end-product of protein hydrolisis in the rumen (El Shazly 1958), part of which is absorbed via the portal system and is converted to urea in the liver (Lewis 1957). Stern et al (1978) and Wohlt et al (1973) have shown ruminal protein degradation to be proportional to protein solubility, thus the rapid degradation of soluble protein will result in an increased rate of ammonia release, with a subsequent loss of ammonia across the rumen wall. One of the major factors affecting protein solubility of oil cakes is the heat generated during oil extraction (Little et al 1963). However, the high temperature involved in screw-pressing as compared with solvent extraction had no effect on the quality of groundnut meals (Duckworth et al 1961). Pendlum et al (1976) reported a depression in the rate of gain and feed conversion ratio when urea replaced natural protein supplements. This depression may be attributed to the poorer utilization of urea or protein solubility on microbial growth when expressed as g crude protein synthesized per 100 g DM digested (Stern et al 1978), although the total amount of microbial nitrogen synthesized daily was significantly lower for urea diets (Stern et al 1978).

In the Sudan cotton seed meal (CSM), sesame seed meal (SSM) and ground-nut meal (GNM) are sold at similar prices despite the differences in their chemical composition, particularly the crude protein level. CSM is most commonly used protein supplement, while SSM is the least common. This experiment was conducted to study: (1) growth of sheep fed sorghum grain -wheat bran- alfalfa hay based diets supplemented with CSM, SSM, GNM or SSM + urea; (2) ruminal ammonia, total volatile fatty acids and plasma urea nitrogen as affected by solubility of protein supplement.

Materials and Methods

Forty yearling male desert sheep initially averaging 21 kg in body weight were utilized in a completely randomized experimental design to study the effect of nitrogen source on growth rate, plasma urea nitrogen (PUN), ruminal ammonia nitrogen (RA-N) and total volatile fatty acid (VFA) concentrations. The sheep were fed sorghum grain -wheat bran- alfalfa hay diets supplemented with cotton seed meal (CSM), sesame seed meal (SSM), ground-nut (peanut) meal (GNM) or sesame seed meal (SSM) + urea. The diets were calculated to be isonitrogenous and isocaloric. Diets in which urea was utilized as a nitrogen supplement had 50% of the SSM nitrogen as urea (17% of total dietary nitrogen). The diets were fed ad libitum to sheep in groups of ten for a 94 d period. Water was offered free choice. Records for the amount of water consumed daily by each group, the amount of water evaporated and the daily temperature and relative humidity were kept. Free water intake (water drunk from the barrels) was calculated as described by Harbin et al (1959). Feed consumption and body weight were recorded weekly.

At the end of the fattening trials, nitrogen balance studies were conducted. The nitrogen content of all samples (food, faeces and urine) was determined by a macro-kjeldhal method. Ether extract, ash and crude fibre in food and dried faeces were determined by the method of the Association of Official Agricultural Chemists (1965).

Jugular blood samples for plasma urea nitrogen determination and ruminal liquor samples were taken 3h post feeding following overnight fast on day 94 of the trial. After the blood samples were taken they were immediately placed in chilled preheparinized tubes and subsequently centrifuged at 3000 RPM. The plasma was stored at -20C until assayed for plasma urea nitrogen by the method described by Conway (1957). Rumen liquor samples were taken by stomachtumes. Each rumen liquor sample was strained through four layers of cheese cloth and kept for immediate measurements of ruminal ammonia nitrogen (Conway 1957) and VFA (Kroman et al 1967).

Rumen liquor pH was measured by a pH meter - Electronic Instruments Ltd - model 7030.

The data were analyzed as a completely randomized design by analysis of variance (Steel and Torrie 1960).

Results and Discussion

Growth, feed intake and feed efficiency as affected by nitrogen source are presented in Table 2. The average initial weights of sheep in each nitrogen source treatment were very similar. However the final weights were significantly different ($P<0.01$). GNM and CSM supplemented sheep were heavier than SSM

or SSM + urea supplemented sheep. Daily weight gains, based on weekly period gains, of the GNM and CSM supplemented sheep averaged 0.184 and 0.152 kg respectively compared with 0.127 and 0.112 kg for sheep supplemented with SSM and SSM + urea respectively. The difference between GNM and CSM was not statistically significant but weights were significantly higher ($P < 0.01$) than SSM or SSM + urea supplemented sheep. The feed intake followed the same pattern as that of daily gains (Table 2). However, the feed conversion ratio was significantly lower ($P < 0.01$) in SSM + urea supplemented sheep compared to the other nitrogen supplements. The results of the present study suggest an advantage in feeding GNM or CSM rather than SSM or SSM + urea as supplemental source of nitrogen. The striking observation made here is the low palatability of SSM despite its richness in protein and minerals compared to CSM.

The daily free water intake (water drunk from barrels) followed the same pattern as that of daily feed intake. However, the free water intake per kg dry matter consumed was not affected by nitrogen supplement. The values of water intake reported here are lower than the values (3.2 kg/kg DM) reported by Khalifa (1974) in sheep fed legume and grass hay.

Within the range of temperature (31.55 ± 1.75) and relative humidity (43.1 ± 8.2) recorded during the study, water intake per kg dry matter was not correlated to ambient temperature ($R^2 = 0.02$).

The apparent digestibility coefficients for the ration components together with the nitrogen balance data as affected by protein supplement are shown in Table 3. Source of nitrogen supplement in the diet had no significant effect on the digestibility of the ration components studied except for crude fibre which was higher ($P < 0.05$) in CSM supplemented sheep compared to the other supplements. This may be ascribed to the type of crude fibre fraction provided by CSM and groundnut hulls which was added to SSM, GNM and SSM + urea diets to bring the crude fibre to the same percentage (Table 1). The results suggested that the crude fibre fraction in CSM was utilized at higher efficiency than the crude fibre fraction provided by groundnut hulls. Raleigh and Wallace (1963) studied the effect of urea, cottonseed meal and a combination of urea and cottonseed meal as nitrogen sources on the digestibility and performance of growing steers fed low quality roughage. They reported that the source of nitrogen had no significant effect on the digestibility of dry matter, organic matter, crude protein and cellulose.

Source of nitrogen in the diet also had no effect on nitrogen retention (Table 3).

The concentration of ammonia in ruminal fluid collected on day 94 of the study is presented in Table 4. Nitrogen source in the diet had no significant effect on ruminal ammonia nitrogen concentrations. Based on the results of investigation by Roffler and Satter (1973) using in vitro techniques, maximal microbial growth occurs at about 5 mg of ammonia nitrogen per 100 ml of ruminal fluid; the ammonia nitrogen values obtained here suggested there was more than adequate ammonia nitrogen in all four treatments.

Total ruminal VFA concentrations are also shown in Table 4. VFA concentration was highest ($P < 0.05$) in CSM supplemented sheep compared to both SSM and SSM + urea supplemented sheep. There was no significant difference in the concentration of VFA in CSM and GNM supplemented sheep; however, the concentration was slightly lower in GNM supplemented sheep. The differences in the concentrations of VFA may be ascribed to the faster microbial growth when CSM supplemented ration was fed.

Source of nitrogen in the diet had no significant effect on the pH of the rumen liquor (Table 4).

Table 1:
Ingredient and chemical composition of the experimental diets fed to sheep

Ingredients %	Nitrogen source			
	CSM	SSM	GNM	SSM+Urea
Meal	20	10	10	5
Wheat bran	20	20	20	20
Sorghum grain	40	40	40	40
Alfalfa hay	15	15	15	15
Salt	1	1	1	1
Molasses	4	4	4	8.3
Ground nut hulls	0	10	10	10
Urea	-	-	-	-
Dry matter	94.7	94.9	95.2	94.4
Analysis, %[a]				
Crude protein	15.4	15.9	16.1	15.9
Ether extract	4.4	2.9	3.2	3.1
Nitrogen-free extract	58.0	59.9	58.6	61.9
Crude fibre	14.1	13.0	13.0	10.4
Ash	8.1	8.4	9.2	8.7
Calcium	0.71	0.79	0.81	0.53
Phosphorus	0.62	0.49	0.51	0.49

[a] Analysis on a dry matter basis.

Plasma urea nitrogen (PUN) on day 94 of the study is also given in Table 4. PUN was higher ($P < 0.05$) in SSM and SSM + urea supplemented sheep compared to CSM and GNM supplemented sheep. This observation suggested that there was insufficient microbial activity to utilize the ammonia nitrogen produced within the rumen. As a result, ammonia diffused through the rumen wall. However, it is also possible that the various nitrogen supplements

Table 2:
Growth and efficiency of sheep fed different nitrogen sources

Item	Nitrogen source			
	CSM	SSM	GNM	SSM+Urea
Number	10	10	10	10
Initial Wt, kg	21.6	20.0	20.7	20.8
Final Wt, kg	35.8[a]	31.9[b]	38.0[a]	31.3[b]
Total gain, kg	14.3	11.9	17.3	10.5
Average daily gain, kg	0.152[a]	0.127[b]	0.184[a]	0.112[b]
Daily intake, kg DM	1.16[a]	0.96[b]	1.20[a]	1.03[b]
Feed/gain	7.77[a]	7.73[a]	6.66[a]	9.32[b]
Free water intake, kg	3.4[a]	2.6[b]	3.3[a]	2.7[b]
Free water intake, kg/kg DM	2.9	2.7	2.8	2.6

a, b

Values in the same line bearing different superscripts differ significantly ($P < 0.01$).

resulted in different patterns of plasma amino-acids concentrations (Pendlum et al 1976). Blood urea nitrogen values reported here are higher than those reported by Pendlum et al(1976). This is likely to be due to the increased nitrogen intake associated with increased feed intake as the sheep became heavier and/or the decline in protein requirement and tissue protein synthesis as the animals progress towards maturity.

Table 3:
Apparent digestibility coefficients (%) and nitrogen balance of sheep fed on different nitrogen sources[1]

	Nitrogen source			
	CSM	SSM	GNM	SSM+Urea
Apparent digestibility :				
Dry matter	64.7	66.7	64.8	68.4
Organic matter	67.1	72.1	67.9	71.1
Crude protein	61.9	72.1	67.7	68.7
Crude fibre	40.2[a]	32.9[b]	30.8[b]	30.3[b]
Ether extract	71.8	63.2	65.3	63.4
Nitrogen balance				
Nitrogen intake (g/day)	27.1	20.7	30.3	30.6
Faecal nitrogen (g/day)	10.3	5.8	9.9	9.6
Urinary nitrogen (g/day)	9.6	9.4	12.9	13.2
Nitrogen balance (g/day)	7.1	5.5	7.5	7.8
% of intake	26.0	27.0	25.0	26.0
% of digestible intake	42.3	36.9	36.8	37.1

[1] Results are mean of 5 animals

[a,b] Values on the same line bearing different superscripts differ significantly ($P < 0.05$)

Table 4:
Plasma urea-nitrogen (PUN), ruminal ammonia nitrogen (RA-N), total volatile fatty acids (VFA) and pH of sheep fed different nitrogen sources[1]

Nitrogen Source	CSM	SSM	GNM	SSM+Urea
PUN (mg/100 ml)	7.5 ±1.4[a]	10.9 ±1.2[b]	8.4 ±1.5[a]	10.8 ±1.9[b]
RA-N (mg/100 ml)	24.6 ±4.8	23.0 ±5.6	21.2 ±4.4	20.8 ±3.6
VFA (mEq/100 ml)	7.7 ±0.6[a]	6.1 ±0.6[b]	6.8 ±0.7[a,b]	6.2 ±0.5[b]
pH	6.0 ±0.2	6.3 ±0.2	6.3 ±0.3	6.4 ±0.2

1 Values are means ± SD of ten animals.

a,b Means on the same line with different superscripts differ significantly ($P < 0.05$).

Acknowledgement

The authors wish to thank the graduate college, University of Khartoum for the provision of funds, the University farm for the provision of facilities and Mr Salah A Hussien for technical assistance

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Received July 28, 1983