STUDIES ON PROTEIN REQUIREMENTS OF STEERS

II* — NITROGEN BALANCE STUDIES WITH THREE BREEDS OF CATTLE MAINTAINED ON ALL-ROUGHAGE SUPPLEMENTED DIETS

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SUMMARY

COMPARATIVE studies lasting between 59—63 days were carried out using the N-balance method to investigate the effects of groundnut cake supplementation on N-mentabolism and digestible crude protein (DCP) requirements of three breeds of steers maintained on all—roughage rations of hay and fresh grass of *Cynodon nlemfuensis* **var** *robustus.*

The results indicated that N—intake (g/day) increased appreciably with supplementation. The percentage increases in the intake were 36.4, 40.0 and 48.0 for the White Fulani, cross—bred and German Brown Steers respectively. Apparent disgestibility coefficients for N also increased by 10%,6.8% and 7.1% for these steers respectively. Faecal nitrogen output (g/day) increased slightly with supplementation with all breeds of steers, while urinary nitrogen loss decreased with the White Fulani, increased with the German Brown and showed no difference with the crossbreed, Absorbed nitrogen (g/day), N—balance (g/day) and N—retention (%) all increased with supplementtations Mean values for both metabolic faecal nitrogen (MFN) (gN/kgDM consumed and endogenous urinary nitrogen (EUN) (g/day/wkg 0.75) decreased with supplementation while the mean Biological value (BV) (%) increased. The values were 2.4 6gN/kg DM consumed, 0.11/day/wg 0.75 and 75.87% respectively.

Digestible crude protein requirements (DCP) decreased with supplementation in all the three breeds of steers. The values were 1.06, 0.38 and 0.81 (0.75 ± 0.20) g/day/wkg 0.75) by the N—balance methods and 1.08, 0.51 and 1.20 (0.93 ± 0.21) gDCP/day/wkg 0.75 by the factorial methods.

The DCP requirements therefore range from 0.75 — 0.93 g/day/wkg 0.75 for these breeds of steers.

While there were decreases of approximately 13.14%, 1.9% and 6.4% in the mean DM intake from the basal rations, there were increases in the total DM intake (basal ± GNC supplements) of approximately 0.42%, 11.56% and 11.4% of the indigenous, crosses and German Brown steers respectively. Supplementation resulted in non significant (P 0.05) increases in the apparent digestibilities of the nutrients.

INTRODUCTION

RESULTS from earlier studies (Ikhatua and Olubajo 1978) and those reported elsewhere on other breeds of zebu cattle (Elliot and Topps, 1963b) and Karue (1971) have indicated low nitrogen requirements of African breeds of cattle or other breeds of cattle managed under tropical conditions.

The observations of Elliot and Topps (1963 b,c; 1964) that the maintenance requirements of digestible crude protein of cattle can be reduced by partly replacing roughages with concentrates in the diet are well supported by derivations from data of Winchester and Harvey (1966).

This paper reports the effects of groundnut cake supplementation on the digestible crude protein requirements of three breeds of steers maintained on all-roughage diets.

MATERIALS AND METHODS

The series of hays and fresh grass of giant star grass (*Cynodon nlemfuensis* var *robustus)* fed in these studies were obtained from pastures previously described (Ikhatua and Olubajo 1978).

Both rations were fed at rates to supply 7.1% digestible crude protein as recommended by NRC (1970) for steers of similar liveweights.

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12 animals consisting of four steers each from three breeds of cattle namely:- White Fulani (Zebu) cattle, weighing between 190 — 205kg (197.6 ± 8.1kg) crossbreed of German Brown x N'Dama weighing between 161 — 207.5kg (184.3 ± 23.20kg) and German Brown weighing between 196 — 220 (208 ± 9.10kg) were used in two feeding and digestibility trials, using each breed once with either ration.

In the trials which lasted between fifty-nine and sixty-three days, each steer was housed in an individual metabolism cage. Feeding of the animals was twice daily at 0800 and 1600 hours. The groundnut cake supplement was offered only in the mornings. The amount so offered was determined by finding the ratios of the supplement to the basal diet consumed by each steer from the previous day intake. The last 12 days of each trial were used for metabolism studies in which total collections of faeces and urine were made and weekly samples of the feeds-hay, fresh grass and the groundnut cake and their residues were taken as previously described (Ikhatua and Olubajo, 1978).

Bulked feeds and faeces samples were milled and analysed for their proximate compositions and pooled urine samples were analysed for nitrogen using the procedures of A.O.A.C. (1975). Nitrogen of metabolic origin in the dried milled faeces was determined according to the methods of Van Soest and Wine (1967) as modified by Mason (1969).

Digestible crude protein (DCP) requirements were estimated first by the N-balance method from the regression equations relating N-balance (Y) and Absorbed — N (X) both expressed as g/day/wkg 0.75 and secondly by the factorial equation of ARC (1965). The truly absorbed nitrogen was obtained by adding the metabolic faecal nitrogen (MFN, g/day) to the nitrogen intake (g/day) and then deducting the total faecal nitrogen output (g/day). The absorbed N at zero N-balance multiplied by 6.25 gave the DCP requirements for maintenance.

RESULTS

Results of the proximate composition of the hay, fresh grass and the groundnut cake supplement are shown in Table 1.

TABLE 1

Chemical composition of hay, fresh grass and groundnut cake supplement

	Dry Matter	*Organic Matter*	*Crude Protein*	*Crude Fibre*	*Nitrogein Free-Extractives*	*Ether Extract*	*Ash*	*Gross Energy* ***KCAL g/DM***
HAY I	86.35	91.80	8.80	32.20	49.60	1.20	8.20	5.32
HAY II	85.75	90.35	9.05	31.25	48.70	1.3	9.65	4.68
HAY III	85.60	89.43	10.05	31.30	48.13	0.95	9.57	4.65
Groundnut Cake	89.40	93.70	49.15	5.46	29.40	9.75	6.30	4.42
FRESH GRASS I	26.75	89.60	9.30	32.35	49.63	1.02	10.40	4.84
FRESH GRASS II	25.72	89.65	11.43	29.41	47.63	1.18	10.35	4.64
FRESH GRASS III	24.51	89.96	11.10	75	46.82	1.29	10.01	4.52
Groundnut Cake	89.35	93.58	4. 2	5.41	29.25	9.70	6.42	4.48

I — OCTOBER — NOVEMBER 1975
II — SEPTEMBER — NOVEMBER, 1976
III — SEPTEMBER — OCTOBER, 1977.

The crude protein content of the fresh grass is approximately 8% higher than the corresponding content in the hay. Similarly, the total ash is higher in the fresh grass than in the hay by a mean value of about 8.5% whereas the hay ration is generally higher in its percentage contents of crude fibre and nitrogen — free — extractives than the fresh grass by mean values of approximately 3.3% and 4.0% respectively.

Tables 2 and 3 show comparisons of nitrogen balance and nitrogen metabolism data with the all-roughage and with the roughage plus the supplement respectively.

From Table, it can be observed that N-intake (g/day) by the three breeds of steers increased appreciably with supplementation. The increases were 36.43%; 40.03% and 48.02% for the White Fulani; crossbred and German Brown steers respectively. The faecal nitrogen output increased slightly with supplementation as a result of increased nitrogen intake. There was a decrease in urinary nitrogen loss with the White Fulani. While there was virtually no difference with the crossbred, there was an increase of approximately 40.3% with the German Brown steers.

There were virtually no marked differences among breeds with nitrogen absorption. On treatment basis however, more N was absorbed from the supplemented rations than the basal rations. Similarly the nitrogen retention percentage values indicated that more N was retained by the steers when fed roughage plus supplement than on all-roughage rations. N-percentage retention trends were the same on treatment basis.

Apparent digestibility coefficients for N indicate 10.8%, 6.8% and 7.1% higher values than those recorded for all roughage rations with the White Fulani; crossbred and German Brown steers respectively.

TABLE 2

Nitrogen — balance data of three breeds of steers maintained on roughage & concentrate supplement

Characteristics	*White–Fulani*		*G. Brown X N'Dama*		*German Brown*	
	All-roughage	*Roughage + GNC*	*All-roughage*	*Roughage + GNC*	*All-roughage*	*Roughage +GNC*
Nitrogen-Intake (g/Day)	69.62 ± 5.93	109.51 ± 5.02	62.15 ± 2.43	103.64 ± 3.16	65.05 ± 2.02	125.14 ± 2.51
Faecal Nitrogen (g/day)	23.67 ± 1.84	25.48 ± 1.44	16.44 ± 0.58	21.66 ± 0.89	18.09 ± 1.03	26.93 ± 0.98
Urinary nitrogen (g/day)	22.16 ± 1.97	19.90 ± 1.60	17.51 ± 1.01	17.61 ± 1.16	17.4 ± 1.03	29.14 ± 1.12
Nitrogen-balance (g/day)	23.79 ± 3.19	64.13 ± 3.64	28.61 ± 1.85	64.37 ± 1.94	31.47 ± 0.94	69.07 ± 1.89
Absorbed Nitrogen (g/day)	45.95 ± 4.61	84.03 ± 3.75	45.71 ± 2.09	81.98 ± 2.58	48.96 ± 4.96	98.21 ± 1.87
N — retenion (%)	66.0	77.49	73.55	79.11	73.02	78.48
Apparent N— digestibility (%)	68.12 ± 1.38	76.40 ± 0.96	73.14 ± 0.86	78.47 ± 0.66	72.98 ± 0.21	78.53 ± 0.32
Apparent DM digestibility (%)	69.40 ± 1.03	71.97 ± 0.90	60.76 ± 0.86	62.94 ± 0.09	63.67 ± 0.96	69.11 ± 0.55

TABLE 3

Nitrogen metabolism data of three breeds of steers maintained on all-roughage supplemented diets

	White-Fulani	German Brown X N'Dama	German Brown	Mean
Metabolic faecal nitrogen (gN/kgDM intake)	3.37	2.12	1.90	2.46±0.46
Endogenous urinary nitrogen (g/day/wkg 0.75)	0.14	0.05	0.14	0.11±0.03
*DCP requirements for maintenance (g/day/wkg 0.75)	1.06	0.38	0.81	0.75±0.20
**DCP requirements for maintenance (g/day/wkg, 0.75)	1.08	0.51	1.20	0.93±0.21

* = Values estimated by the N-balance method.
** = Values estimated from factorial equation of ARC (1965)

$$\text{DCP (g/day/wkg 0.75) for maintenance} - 6.25\left(\text{EUN X}\frac{100}{\text{BV}}\right) \pm \text{MFN}\left(\frac{100}{\text{BV}} - 1\right)$$

where EUN = Endogenous urinary nitrogen (g/day/wkg 0.75)
MFN = Metabolic faecal nitrogen (g/day/wkg 0.75)
BV = Biological value (%).

High and significant ($P < 0.01$) correlation coefficients (r) of 0.78, 0.87 and 0.76 were recorded for these steers in the regression equations relating faecal nitrogen (Y) (g/kgDM intake) and N-intake (g/day). The intercepts on the Y-axis in the graph describing these relationships are the estimates of metabolic faecal nitrogen, MFN (Bell and Loosli, 1951); and the values so obtained were 3.37; 2.12 and 1.90 with an overall mean value of 2.46 ± 0.46gN/kgDM consumed for all the three breeds of steers.

The endogenous urinary nitrogen (EUN) was similarly estimated from the regression equations relating urinary nitrogen (Y) and absorbed nitrogen (X). The intercept of the regression line on the Y-axis of the graph relating urinary nitrogen on truly absorbed nitrogen both variables being expressed on Wkg 0.75 basis to allow pooling of the data for body weight variations is an estimate of the minimum endogenous urinary nitrogen g/day/wkg 07.5 (Brody and Procter, 1932). Values of 0.14, 0.05 and 0.14 were obtained with these steers respectively, giving a mean of 0.11 ± 0.03g/day /Kg 0.75 for the three breeds of steers.

The biological values were estimated from the regression of N-balance (Y,g/day/wkg 0.75) and Absorbed nitrogen (X,g/day/wkg 0.75). The gradients of the lines relating these parameters are the indices of biological values. These values were 74.3; 77.1 and 76.2 for the crossbred, German Brown and White Fulani steers with a mean of 75.87%. Correlation coefficients (r) were significant ($P < 0.01$) with values of 0.88, 0.86 and 0.90 for the German Brown, crossbred and White Fulani steers respectively.

The digestible crude protein (DCP) required for maintenance, that is, the amount of DCP intake required to keep the animal in zero N-balance or nitrogen equilibrium, were 1.06; 0.38 and 0.81 (0.75 ± 0.20) g/day/wkg 0.75 by the N-balance method and 1.08, 0.51 and 1.20 (0.93 ± 0.21) g/day/wkg 0.75 by the factorial equation of ARC (1965).

The estimated DCP required for maintenance by all the breeds of steers therefore ranged from 0.75 — 0.93g/day/wkg 0.75 with a mean value of 0.84g/day/wkg 0.75.

The results showed a decrease in the mean DM intake of the basal rations by approximately 13.14%; 1.9% and 6.4% and an increase in the total DM intake (basal ± GNC supplements) of approximately 0.42%, 11.56% and 11.04% for the indigenous, crosses and exotic animals respectively. Non-significant ($P < 0.05$) increases in the apparent digestibilities of the nutrients were also observed.

DISCUSSION

The recorded increase in the total DM and N intake from the all-roughage supplemented rations agrees with similar findings by Egan (1965) who attributed such increase that occurred when protein supplements were given to sheep offered low-protein roughage to an improvement on the protein status of the animals.

The increased but non-significant digestibility of most nutrients with supplementation is also in accordance with the observations of Elliot and Loosli (1959) that the digestibilities of feed components were not significantly affected by the proportion of concentrate supplementation to the roughage in the rations. The improved digestibility of crude protein with supplementation agrees with Broster *et al's* (1969 report that additional protein in the diet of cattle increases the digestibility of protein and energy.

The slight increases in the faecal — N output with supplementation as a result of increased nitrogen intake is supported by Roy (1969) who found that faecal — N excretion increased with increasing proportion of N-intake.

The increased N — absorbed with increasing intake of dietary nitrogen on groundnut cake supplementation is expected since the digestibility of the crude protein increased with increasing intake of nitrogen. The observed increased in nitrogen absorbed with increasing N-intake agrees with the reports of Adegbola (1974), Stobo and Roy (1973).

The mean metabolic faecal nitrogen obtained in these studies is lower than the value of 3.6gN/kg/DM consumed reported in an earlier study (Ikhatua and Olubajo, 1978) but is comparable with values of 2.04 and 2.70gN/kgDM consumed and reported by Black, Pearce and Tribe (1973) and Lofgreen and Kleiber, (1953) respectively. The endogenous urinary nitrogen excretions were not much different from those earlier reported except that the crossbred steers had a sharp reduction in the EUN value with supplementation.

Generally, the biological values of the supplemented rations were much higher than those for all-roughage rations. The higher values were indicative of better and higher utilization of the additional nitrogen from GNC supplement. The mean value for all the steers is however lower than the value of 85.1% reported by Stobo and Roy (1973) using groundnut cake based rations.

The reduced DCP requirements for maintenance with supplementation is in conformity with the findings of Elliot and Topps (1963 b, c; 1964). They reported a reduction in the DCP requirements of cattle and sheep when roughages were partly replaced by concentrate. This reduction in DCP requirements for maintenance with supplementation might be due to the fact that these animals had derived their maximum requirements for maintenance from the all-roughage diets, while the greater proportion of the protein intake with supplementation was used for productive purposes. In addition, it is very likely that the bacteria and other micro-organisms in the rumen found the protein of the supplement much more easily available while that of the roughage is less so and possible the amino acid make-up of the groundnut cake is more complete for rapid synthesis of their own body protein.

The mean DCP requirements for these steers is slightly lower than the value of 0.89gDCP/day/wkg 0.75 obtained by Singh and Mahadevan (1970) using groundnut based rations.

The reductions in the requirements is between 20.2% and 48.6% of their requirements using all-roughage rations (Ikhatua and Olubajo, 1978).

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