# Studies on Comparative Utilization of Urea and Groundnut Cake Rations by West African Dwarf Goats

## I. N-BALANCE AND GROWTH

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SUMMARY

**Twelve West African dwarf castrated goats, 6-8 months old and 7 to 15 kg liveweight, were used. Two sources of N, urea and groudnut cake, were used at three levels of crude protein (N x 6.25), viz., 10, 17 and 24%, in cassava flour-based rations. These rations were then used as supplements to dry, poor quality *Cynodon nlemfuensis* forage. Six animals, two on each level of protein were maintained on the urea-based rations in 3 x 3 Latin Square Design while the other six animals were similarly maintained on the groundnut cake-based rations. Each experiment consisted of three trials and each trial lasted three weeks. During these periods, liveweight changes, daily intake of the forage and of the concentrates were recorded. N-balance studies were also carried out at the end of the series of these experiments.**

**The results indicated that the urea-fed goats tended to grow faster than those goats fed on the groundnut cake-based rations with the overall mean live weight gains of 35.7 and 31.4 g per day respectively although the differences were not significant ($P > 0.05$) respectively. The former required daily 0.17g DCP per $W_{kg}^{0.734}$ for maintenance; similarly the latter required 0.26g DCP per $W_{kg}^{0.734}$ per g live weight gain and 1.43 g DCP per $W_{kg}^{0.734}$ for maintenance. The N-balance studies also showed better utilization of the N content of urea than that of the groundnut cake, with the overall mean N-balance values of 6.15 and 5.54 g/day.**

## INTRODUCTION

RUMINANT animals are noted for their efficiency in the utilization of coarse forages to meet their body needs. However, under certain circumstances, they may compete with the monogastric animals for protein and carbohydrate concentrate mixtures to meet their protein and energy requirements for growth and production.

The ability of a large number of non-protein nitrogenous (NPN) substances to support growth of ruminal bacteria *in vitro* has extensively been studied (Belasco, 1954; Henderickx and Martin, 1963). Reid (1953) indicated that ruminants can utilize urea as a source of protein for growth. The end-products of the breakdown of NPN substances and proteins in the rumen is $NH_3$ (Mangold and Schmitt-Kramer, 1927; Sym, 1938; Harris, Work and Henke, 1943; Wegner, Booth, Bohstedt and Hart, 1941; McDonald, 1948 and 1952; Belasco, 1954; Chalmers, Cuthbertson and Synge, 1954; Annison, Chalmers, Marshall and Synge 1954; Annion, 1956; Lewis and McDonald, 1958; El-Shazley, 1958; Moor and King, 1958; Williams, Gutierrez and Doetsch, 1960; Preston, Whitelaw and MacLeod, 1963; Pilgrim, Gray, Weller and Belling, 1970; Mba, Adegbola and Oyenuga, 1971; Mba, Faoye and Oyenuga, 1974). The ruminal $NH_3$ is then utilized by the micro-organisms for the microbial cell constituents (Portugal and Sutherland, 1966; Schwartz, 1967; Pilgrim *et al.*, 1970). Thus, Loosli, Williams, Thomas, Ferris and Maynard (1949) had shown that the urea-N was utilized in the rumen for the synthesis of microbial proteins of very

high biological value to the host ruminant animal. Urea, a synthetic product from the petroleum industry, is of little or no feed value to the monogastric animals (Foster, Schoenheimer and Rittenberg, 1939). It is therefore possible for the urea-N, in the presence of readily fermentable carbohydrate, to replace the conventional type of proteins in the rations of the ruminant livestock.

The present studies were undertaken to compare the extent to which the groundnut cake and urea could be utilized by young growing West African Dwarf goats with respect to growth performance and N retention.

## MATERIALS AND METHODS

### Animals and their management

Twelve West African dwarf castrated goats, 6-8 months old, ranging in liveweights from 7 to 15kg, were used in these trials. Clean, fresh water and salt licks were provided *ad. lib.*

### Diets and Plan of the experiments

Two sources of N from urea and groundnut cake were used at 10, 17 and 24 % protein. These protein concentrates were compounded from cassava flour, molasses, mineral salts and goundnut cake or urea (Table 1) and used to supplement *Cynodon nlemfuensis.*

TABLE 1

**Composition of rations fed to goats**
*Diets-a/*

| *Constituents* | *Urea-based concentrate* | | | *Groundnut-based concentrate* | | |
|---|---|---|---|---|---|---|
| | *A*,(10%) | *B*,(17%) | *C*,(24%) | *A*,(10%) | *B*1,(17%) | *C*1,(24%) |
| Urea (42%N) | 3.3 | 5.7 | 7.7 | — | — | — |
| Groundnut cake etc. | | | | 23.3 | 34.5 | 55.8 |
| Urea (42%N) | 3.3 | 5.7 | 7.7 | — | — | — |
| Groundnut cake | — | — | — | 23.3 | 39.5 | 55.8 |
| Cassava flour | 91.4 | 89.0 | 87.0 | 71.4 | 55.2 | 38.9 |
| Molasses | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Min. Mixture | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

a/ Crude Protein levels of diets in brackets

The twelve castrated goats were randomised into two groups of 6 animals for the two sources of N. Each group was further randomised into three sub-groups of two animals; each sub-group was then fed each level of protein supplementary ration in a 3 x 3 Latin Square design for each N source. Each experiment consisted of three trials and ech trial lasted three weeks before the animals in a sub-group werechanged to another level of protein supp lement. The animals were weighed before and after each trial. During the last 7 days of each trial the animals were transferred to individual metabolism cages for the N-balance studies in order to collect urine and faeces (Oyenuga, 1961).

Two parts of chopped fresh grass to one part of the protein concentrates were offered at 08.00 hr. The grass and the concentrates were each sampled daily during the last 7 days and stored for subsequent chemical analysis. All the concentrates were usually consumed each day but the grass residues were collected, weighed and stored for chemical analysis.

**Collection of faeces**

Each animal was harnessed during the last 7 days of each trial with a collection bag, lined inside with a polythene bag. The total wet faeces excreted daily were removed from the polythene bag, weighed and dried in a forced-draught oven at 80°C for 24 hours. These daily stored samples were then bulked at the end of each collection period, milled with a Christy and Norris mill and stored in air-tight bottles until required for chemical analysis.

**Collection of urine**

Some small polythene buckets wetted with 2-3 ml of 10 percent mercuric chloride were placed beneath the metabolism cages during the last 7 days of each trial (Oyenuga, 1961). Volume of urine for each animal was measured daily and 10 % of daily samples were stored at —5°C in a deep freezer till the end of the collection period when these were bulked mixed and used for chemical analysis.

**Analytical procedure**

The AOAC (1970) method was used for the determination of the dry matter (DM) and N contents of the grass samples, concentrates, faeces and urine. The Markham's semi-micro- Kjeldahl apparatus was used for the N determination

From these determinations, N-balance and digestibility values were calculated.

## RESULTS

**Chemical composition of the diets**

The proximate chemical compositions of the concentrates and the grass (*C. nlemfuensis*) are shown in Table 2. The determined crude protein (CP) values of the concentrates agree very well with the calculated values.

TABLE 2

**Chemical Composition of Concentrates and Grass (g/100g Dry Matter) Fed to Goats**

| | *Crude protein* | *Crude fibre* | *Ether extract* | *Ash* | *N-free extract* | *Dry matter* |
|---|---|---|---|---|---|---|
| *Urea-based concentrate* | | | | | | |
| A (10%) | 10.6 | 2.3 | 2.4 | 13.5 | 56.8 | 85.6 |
| B (17%) | 17.3 | 3.3 | 3.9 | 13.0 | 47.4 | 84.9 |
| C (24%) | 24.1 | 3.5 | 3.5 | 12.5 | 40.3 | 83.9 |
| *Groundnut cake-based Concentrate* | | | | | | |
| $A_1$ (10%) | 10.8 | 4.3 | 3.0 | 14.7 | 54.3 | 87.1 |
| $B_1$ (17%) | 17.5 | 4.9 | 3.2 | 15.0 | 47.8 | 88.4 |
| $C_1$ (24%) | 24.5 | 6.5 | 3.2 | 13.9 | 40.3 | 88.4 |
| *Grass (C.nlemfuensis)* | 10.0 | 27.4 | 1.1 | 8.6 | 37.9 | (29.5) |

**Dietary N intake and Digestibility**

The mean N metabolism data including the daily dry matter (DM) consumption are shown in Table 3 for the urea-based and the groundnut cake-based concentrate mixtures. The DM consumption varied very little from 0.4 to 0.6 kg per goat per day. The daily N intakes for each animal for the groundnut cake and urea rations were $7.88 \pm 1.73$ and $7.89 \pm 1.18$g at 10 % protein level, $11.48 \pm 0.89$ and $13.88 \pm 1.09$g at 17 % protein level, $14.69 \pm 3.69$ and $16.10 \pm 3.90$g at 24 % protein level respectively. These increases in the daily N intakes as the protein levels were increased were highly significant for the groundnut cake and urea rations ($P < 0.01$). Expressing these

intakes on metabolic size basis, the daily consumptions of each animal for the groundnut cake and urea rations were 1.14 and 1.01g at 10% protein level, 1.66 and 1.74g at 17% protein level, 2.11 and 2.01g per $W_{kg}^{0.734}$ at 24% protein level (Table 3).

The digestibility values for the groundnut cake and urea rations were 73.26+ 8.47 and 69.65 ± 7.51 at 10 %, 80·04± 3.73 and 77.44 ± 12.65 at 17%, 74.51 ± 6.76 and 76.25 ± 6.25 at 24 % protein level respectively (Table 3). The corresponding faecal N losses from each goat per day were 2.07 ± 0.57 and 2.40±0.66 at 10 %, 2.31 ± 0.53 and 3.03 ± 0·69 at 17%, 3.87 ± 0.82 and 3.90 ± 0.80g at 24% protein level respectively. These small increases at different protein levels were not significant (P>0.05).

**Nitrogen balance**

The N-balance values are shown in Table 3. There were significant increases as to the levels of proteins in the groundnut cake ration (P<0.05) and the urea ration (P<0.01). However, the optimal N-balance occurred at the 17% protein level for the two sources of nitrogen.

A curvilinear relationship existed between the daily N intake and the N-balance data for the groundnut cake ration (Fig. I) and the urea ration (Fig. 2) and multiple correlation coefficients with regression equations of $Y = 0.33 + 1.27x - 0.31x^2$ ($R = 0.55$) and $Y = 0{\cdot}89 + 2.14x - 0.63x^2$ ($R = 0.63$) respectively were significant (P<0.01). The mean daily N intakes for the goats fed on the groundnut cake-based ration were 2.05g N per $W_{kg}^{0.734}$ (12.81g CP per $W_{kg}^{0.734}$ Similar intake values for the goats on the intake urea-based ration were 1.70g N per $W_{kg}^{0.734}$ and 10.63g CP per $W_{kg}^{0.734}$ These animals therefore required daily, on the average, 12.81 g CP and 10.63g CP per $W_{kg}^{0.734}$. from the groundnut cake and the urea rations respectively for maintenance and growth. Similar calculations from Figs. 1 and 2 using the

TABLE 3

**Summary of N Metabolism and Utilization Values for the West African Dwarf Goats Maintained on Different Levels of Urea or Groundnut cake-based Concentrate Mixtures**

| | *Urea-based concentrate mixture and grass* | | | *Groundnut cake-based concentrate mixture and grass* | | |
|---|---|---|---|---|---|---|
| | *A* (10%) | *B* (17%) | *C* (24%) | $A_1$ (10%) | $B_1$ (17%) | $C_1$ (24%) |
| | *grass* | | | | | |
| Initial live weight (kg) | 16.53±3.51 | 16.88±2.49 | 16.58±3.41 | 13.78±3.19 | 13.82±2.17 | 13.97±1.98 |
| Final „ „ (kg) | 17.15±3.29 | 17.43±2.34 | 17.23±1.08 | 14.30±3.10 | 14.20±2.07 | 14.40±2.00 |
| Mean „ „ („) | 16.84±3.40 | 17.14±2.40 | 16.91±3.38 | 14.04±3.15 | 14.02±2.16 | 14.20±2.00 |
| „ live weight ($W_{kg}^{0.734}$) | 7.92±1.18 | 8.04±0.83 | 7.95±1.14 | 6.93±1.13 | 6.93±0.79 | 7.00±0.72 |
| Dry Matter Consumed (kg/day | 0.48±0.04 | 0.54±0.05 | 0.50±0.02 | 0.44±0.01 | 0.45±0.01 | 0.45±0.02 |
| N metabolism (g/day) | | | | | | |
| Intake | 7.89±1.18 | 13.88±1.09 | 16.10±3.90 | 7.88±1.73 | 11.48±0.89 | 14.69±3.69 |
| Faeces | 2.40±0.66 | 3.03±0.69 | 3.90±0.80 | 2.07±0.57 | 2.31±0.53 | 3.87±0.82 |
| Urine | 0.92±0.30 | 2.90±0.49 | 6.26±1.94 | 1.59±0.31 | 2.49±0.44 | 3.72±0.97 |
| Balance | 4.57±0.77 | 7.94±0.47 | 5.95±0.95 | 4.22±0.73 | 6.73±0.33 | 5.67±2.00 |
| N intake (g/day/$W_{kg}^{0.734}$) | 1.01±0.01 | 1.74±0.04 | 2.01±0.04 | 1.14±0.01 | 1.66±0.03 | 2.11±0.04 |
| N balance („ „ „) | 0.59±0.01 | 1.00±0.01 | 0.76±0.02 | 0.61±0.02 | 0.98±0.01 | 0.80±0.01 |
| N digestibility | 69.65±7.51 | 77.44±12.65 | 76.25±6.25 | 73.26±8.47 | 80.04±3.73 | 74.51±6.76 |
| Live weight gain (g/day) | 28.57 | 50.00 | 28.57 | 27.14 | 27.14 | 40.00 |

FIG.1 RELATIONSHIP BETWEEN DAILY N-INTAKE AND N-BALANCE OF GOATS MAINTAINED ON GRASS AND GROUNDNUT CAKE PROTEIN CONCENTRATE

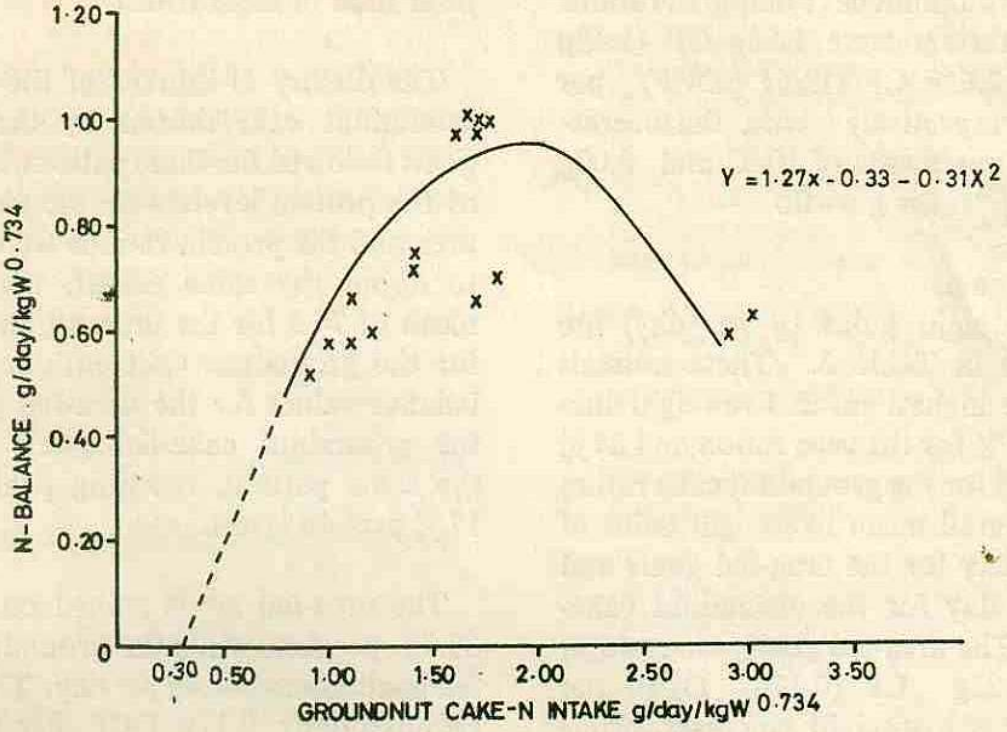
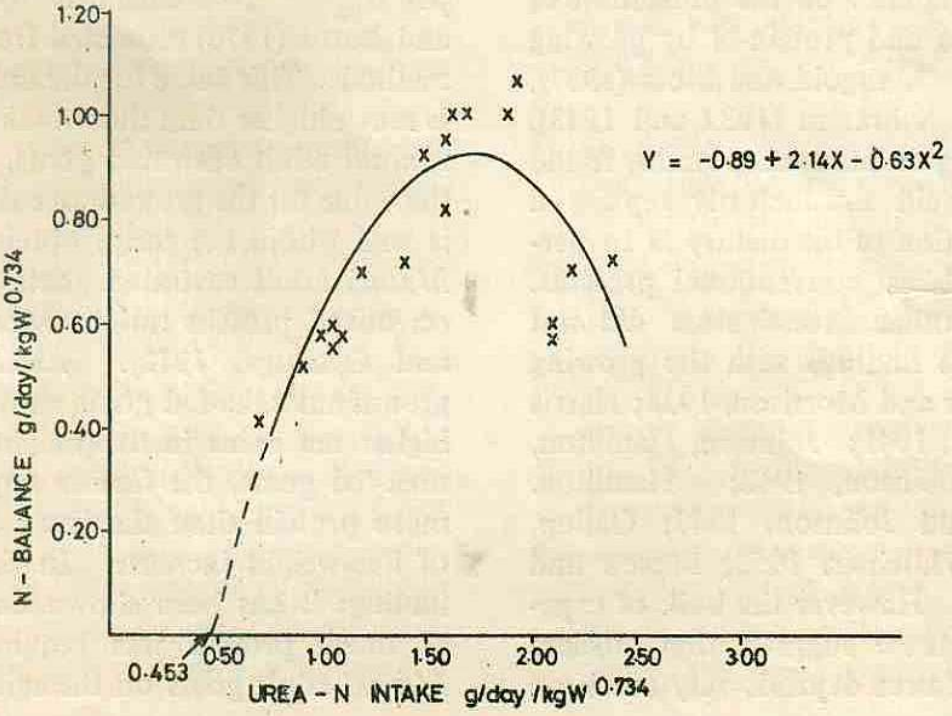



FIG.2 RELATIONSHIP BETWEEN DAILY N-INTAKE AND N-BALANCE OF GOATS MAINTAINED ON GRASS AND UREA-BASED CONCENTRATE



mean digestibility revealed that the daily maintenance requirements for the goats fed on the groundnut cake and urea rations at N equilibrium were 1.88g CP (1.43g DCP) and 2.63g CP (1.96g DCP) per $W_{kg}^{0.734}$ respectively with the corresponding requirements of 10.93 and 8.00g CP per $W_{kg}^{0.734}$ for growth.

**Liveweight gains**

The liveweight gains (g per day) are also shown in Table 3. These animals showed the highest mean liveweight increases at 17% for the urea ration and 24% protein level for the groundnut cake ration with the overall mean liveweight gains of 35.7 g per day for the urea-fed goats and 31.4 g per day for the groundnut cake-fed goats. The urea-fed goats, on average, required 0.22g CP (0.17g DCP) per $W_{kg}^{0.734}$ per g liveweight increase, while the groundnut cake-fed goats required daily 0.35g CP (0.26g CP) per $W_{kg}^{0.734}$ per g liveweight gains.

## DISCUSSION

There is paucity of information on the comparative studies on the utilization of urea-N values and protein-N by growing young goats. Mangold and Stotz (1937), Nehring and Schramm (1939 and 1943), using growing and fattening lambs, found that urea could satisfactorily replace a large proportion of the dietary N to perform as well as conventional proteins. Studies by other investigators did not confirm these findings with the growing lambs (Miller and Morrison, 1938; Harris and Mitchell, 1941; Johnson, Hamilton, Mitchell, Robinson, 1942; Hamilton. Robinson and Johnson, 1948; Gallup, Pope and Whitehair, 1952; Beeson and Perry, 1952). However the bulk of experimental evidence suggests that efficient utilization of urea depends very much on the availability of a readily fermentable carbohydrate, as obtained in the cassava flour used in these trials.

The dietary N intakes of the urea and groundnut cake rations by the growing goats followed the same pattern, increasing as the protein levels were increased. The urea and the protein rations were digested to about the same extent, with overall mean of 74.5 for the urea ration and 75.9 for the groundnut cake ration. The N-balance values for the urea-fed goats and the groundnut cake-fed goats followed the same pattern, reaching peaks at the 17% protein levels.

The urea-fed goats gained on average, 35.7g per day, while the groundnut cake-fed goats gained 31.4g per day. The former required daily 0.17g DCP per $W_{kg}^{0.734}$ per g liveweight increase and 1.96g DCP per $W_{kg}^{0.734}$ for maintenance; similarly, the latter required 0.26g DCP per $W_{kg}^{0.734}$ per g of liveweight gain and 1.43g DCP per $W_{kg}^{0.734}$ for maintenance. The values for maintenance requirement are close to the values of 1.53—2.18 g DCP per $W_{kg}^{0.734}$ recommended by Devendra and Burns (1970) estimated from factorial methods. This value for the urea-fed goats is much higher than that obtained with the *Maradi* adult castrated goats. However, the value for the groundnut cake-fed goats is well within the range obtained for the *Maradi* adult castrated goats maintained on mixed protein ration (Mba, Egbuiwe and Oyenuga, 1972). Although the groundnut cake-fed goats showed slightly higher net gains in live-weights than the urea-fed goats, the former required 53% more protein than the latter for each g of live-weight increase. In the previous findings it has been shown that over 2.5 as much protein was required by the *Maradi* adult goats on the mixed protein

concentrate as those fed on the urea rations for their maintenance requirements (Mba *et al.*, 1972).

The carcass and nutritive qualities of these liveweight gains need to be estimated. These will go a long way to confirming further that urea can be a useful substitute to conventional protein sources in the nutrition of ruminant livestock.

## ACKNOWLEDGEMENTS

The authors are very grateful to the University of Ibadan Senate Research Grant Committee for the financial support.

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