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Degradation Characteristics of Urea and Lime Treated Groundnut Shells Based Diets.

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Target audience: Ruminant Nutritionist and Livestock farmers.

Abstract

This research was conducted to investigate the chemical composition and rumen degradation characteristics of treated groundnut shells (GNS) based diets in the rumen. It was carried out in the Teaching and Research farm of the Department of Animal Science A.B.U. Zaria. Three fistulated Yankasa rams with average weight of 26kg was used for the degradation studies, housed in a pen, and tethered to the ground. They were fed with a diet formulated to contain 14% crude protein throughout the study period; water was given ad lib. Measurements on the chemical composition and the degradation characteristics were investigated. Feed samples were placed in nylon bags and were suspended in the rumen for 3, 6, 12, 24, 36, and 48 hours. Chemical analysis of the degraded residue and the feed samples was carried out so also the statistical analysis. DM degradability of the feed samples was analysed with the NEWAY program developed by the Rowett Research Institute. The overall results indicate that alkali treatment affected the compositions of the diets and appeared to be better than the untreated. Based on the present findings, urea-lime GNS based diets increased the DM and decreased lignin and ADF; it also appears to degrade faster.

Keywords: groundnut shells, lime, urea, treatment, in-sacco, degradation characteristics.

Description of Problem

Small ruminants play a key role in bridging the wide gap between requirement and supply of animal protein for human consumption (1) because of their special features such as relatively short generation interval (compared to cattle), high reproductive rate and low production cost. Given the estimated population of 34.5 million goats and 22.1 million sheep in Nigeria (2), the importance and advantages of small ruminants cannot be over looked.

Feed scarcity is one of the major constraints to livestock production in the West African Sub-region (3). There is shortage of the conventional animal feed because food grains are required almost exclusively for human consumption. Poor quality roughages comprise a huge part of the feed available to ruminants for a considerable part of the year (4).

And these feed resources are characterised of being inlow plane nutrition (5) with attendant low productivity of ruminant animals (6).

The main feed resources for ruminant animals are pastures, crop residues and other agro-industrial by-products. In the dry season and post-harvest periods, these crop residues become the main sources of energy for ruminants when poor quality forages prevail (7). The quantity and quality of available crop residues are major factors influencing productivity of ruminants in Nigeria, especially regions with high population of livestock. Ruminants in such areas depend largely on crop residues during the long dry periods of the year for maintenance as well as for the production of meat, milk, skin and fibre (8).

The potential of groundnut shells treated with urea and lime, used as a feed source in ruminant diets after a period of storage along with supplementation may improve its degradability in the rumen. Even though, highly developed reliable laboratory techniques/procedures such as acid detergent fibre and Menke *in vitro* gas production technique [$Y = b(1 - e^{-1})$] have been used to predict the nutritive values of groundnut shell to the animal; the techniques have often simply attempted to mimic the *in vivo* processes. The *in sacco* procedure has the advantage of giving a very rapid estimate of the rate and extent of step-by-step degradation in the functioning rumen (9).Therefore, the study reported here, which is a follow up of a previous study by (10), examined the *in sacco* degradation of treated GNS mixed with other ingredients fed to Yankasa rams.

Materials and Methods

Study location

The study was carried out in the Teaching and Research Farm of the Department of Animal Science, Ahmadu Bello University (ABU), Zaria, located between latitude 11°04'N and longitude 7°42'E on an altitude of 706m above sea level (11). The area falls within the Northern-Guinea Savannah zone of Nigeria, characterized by 6 to 7 months of rainfall varying from 0.0 to 816.0 (mm/month). The temperature ranges from 15.3°C in December and January to 36.25°C in March and April (12).

Source and processing of groundnut shells

The groundnut shells (SAMNUT 10 variety) used in this study was obtained from the Legume Research Programme of the Institute for Agricultural Research, ABU Samaru, Zaria. The shells were dried under a shade for 5 days and later pulverized using a hammer mill fitted with 1cm screen then stored in bags until when required for the study. The processed GNS were treated with urea at 5%, lime at 5% and urea–lime at 2.5% each, [i.e. 50g urea dissolved in 1 litre of water to treat 1kg of GNS; 50g lime dissolved in 1 litre of water to treat 1kg of GNS; and combination of 25g urea and 25g lime dissolved in 1 litre of water to treat 1kg of GNS, respectively]. The solution (urea, lime, urea-lime) was uniformly sprayed on the pulverized GNS and mixed thoroughly using a shovel on concrete floor (13). The treated GNS were stored in a sealed Perdue Improved Cowpea Storage (PICS) double polyethylene bags for a period of 21 days as described by (14). Thereafter, they were spread on polyethylene sheet to air dry awaiting the commencement of experiment.

Experimental animals

Four Yankasa rams with an average weight of 26kg were fistulated and used for the degradability studies. They were housed in a well-ventilated pen, pegged separately with a considerable distance, on the floor. This is to avoid clash and rubbing their sides on the wall to prevent rupture of the stitched area. The cannula area was disinfected daily with Dettol and cotton wool to prevent infection, and sprayed with Charmil® (multi-action skin spray) to repel housefly and heal the wound. The material used as cannula was improvised, made from PVC plastic.The fistulated rams were fed twice a day with a formulated diet having 14% CP (Table 1) so as to have a similar rumen condition and to avoid bias.

Experimental diets

Four diets having 14% crude protein was compounded to contain the untreated and the treated groundnut shells along with other ingredients (Table 2). Some quantity of the compounded feed was sampled and placed in the nylon bag for the degradation studies.

Table 1 : Diet fed to cannulated rams during degradation study

Ingredients (%)	**Amount (kg)**
Cowpea husk	50.00
Maize bran	34.00
Cotton seed meal (undelinted)	7.00
Poultry manure(deep litter)	7.00
Bone meal	1.50
Salt	0.50
Total	100.00
Calculated analysis	
Energy (ME, Kcal)	1088
Protein (%)	14.01
Crude fibre (%)	23.39

Table 2: Gross composition of untreated and treated groundnut shells based diet

Ingredients (kg)	**UTGNS**	**UGNS**	**LGNS**	**ULGNS**
Maize offal	35.65	46.3	44.9	50.55
Cotton seed cake	22.35	11.70	13.10	7.45
GNS	40.00	40.00	40.00	40.00
Bone meal	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50
Total	100	100	100	100
Calculated analysis				
Energy ME, kcal/kg	1829	2332	2337	2442
Protein (%)	14.00	14.00	14.00	14.00

UGNS: untreated groundnut shell, UTGNS: urea treated groundnut shell, LTGNS: lime treated groundnut shell, ULTGNS: urea-lime treated groundnut shell.

In situ degradation

The ruminally fistulated rams were allowed 14 days period to adjust to the feeding and housing conditions prior to suspension of bags. They were fed twice daily. Housing and management condition were equal for all sheep.DM disappearances in the rumen were estimated using the nylon bag technique. The incubation procedure is as follows:

-The feed samples were ground through a 3 mm screen (mesh) using a Laboratory hammer mill.

-The samples were oven dried at 105°C overnight to determine the dry matter (DM).

-The nylon bagswith size 5cm×10cm with pore size 41µm (ANKOM Technology) were oven dried at 65°Cfor 30 minutes, allowed to cool and weighed.

-Three grams of the feed sample was placed in the nylon bag, tied tightly using a nylon string which was resistant to the rumen microbes, at about 25cm to the cannula top. The nylon bag containing the sample was suspended in the rumen of the cannulated rams immediately after feeding.

Samples were incubated at 3h, 6h, 12h, 24h, 36h and 48h are for the treated diets. Sequential removal approach (15) was used to withdraw the sample from the rumen.

After removal, the bags were washed thoroughly, under running water until the effluent was clear. The washed bags and samples residues were dried in an oven at 65°C for 48 hours. They were allowed to cool in a desiccator and reweighed. The dry matter of the residue was determined and the DM disappearance (15) was calculated using the formula:

$$\text{DM disappearance (\%)} = \frac{a-b}{a} \times 100$$

where:

a = weight of sample before incubation

b = weight of sample after incubation

The rate of degradation (DM) was calculated with the formula as proposed by (16).

$$Y = a + b\,(1 - e^{-ct})$$

where:

Y = degradability at time, t

a = intercept (washing losses)

b = potentially degradable fractions

c = rate of degradation of b

t = time

Chemical analysis

DM, CP and NFE were measured according to (17) while lignin, ADF and NDF were measured according to (18).

Statistical analysis

The data on degradability characteristics were analysed using the Generalised Linear Models Procedure (PROC GLM) of (19) in a one-way analysis of variance. The effect of treatment was tested and significant differences between treatment means established by Duncan's Multiple Range Test.The rate of dry matter disappearance was analysed using the NEWAY programme developed by the Rowett Research Institute (16).

Results and Discussion

Chemical composition

The results of the chemical composition of the formulated diets are shown in Table 3. There was a general increase in the CP level of all the diets. The level of inclusion of the CSC in the diets may have boost the level of protein in all the diets (with a mean value of 17.61%)

giving them a level higher than the recommended CO level of 15% by (20), for optimum maintenance or production for sheep.There was a considerable increase in NFE (67.90%), CP (17.56%) and decrease in lignin (8.78%), ADF (27.19%) for ULGNS based diets.

Table 3: Chemical composition of the groundnut shells based diets

Parameters (%)	UTGNS	UGNS	LGNS	ULGNS
DM	92.17	94.04	91.88	94.13
Lignin	9.32	8.88	10.08	8.78
ADF	30.08	29.82	29.44	27.19
NDF	54.28	50.88	49.87	52.22
CP	16.69	17.94	18.25	17.56
NFE	66.20	65.24	66.45	67.90
TDN	240.25	237.36	239.13	242.89

UTGNS: untreated groundnut shell, UGNS: urea treated groundnut shell, LGNS: lime treated groundnut shell, ULGNS: urea -lime treated groundnut shell, DM: dry matter, CP: crude protein, EE: ether extract, NDF: neutral detergent fiber, ADF: acid detergent fiber, NFE: nitrogen free extract; TDN: total digestible nutrient

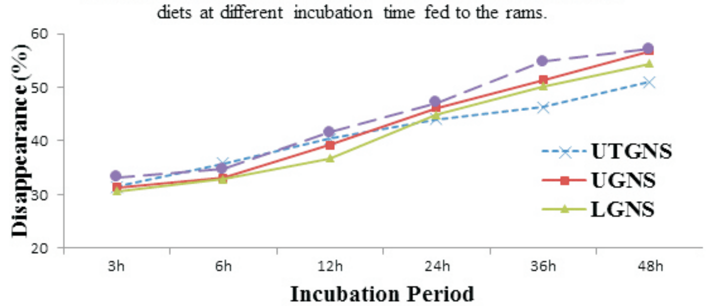
These increases could be as a result of the effect of urea-lime treatment on the GNS or supplementation to the treated GNS in the diet for its efficient ingestion (21).

Increased ADF (30.08%) and NDF (54.28%) were observed in UTGNS; these could be as a result of the lignified nature of GNS in the diet because it has not undergone alkali treatment. Hence, there were lower CP and NFE levels.

DM Disappearance

Ruminal DM disappearance of the GNS based diets are presented in Figure 1. There was significant difference within the treatment diets measured for all incubation times. The disappearance of the DM in the GNS based diets by the end of 48 hours of incubation is generally considered to be equivalent to digestibility and being the mean retention time of fibrous feeds in ruminants (22). The significant differences observed in the GNS based diets could be due to variations in the chemical composition of the diets; their cell wall change in alkali used for treating the GNS and incubation times. While alkali treatments modified cell wall composition and increased *in sacco* degradation of GNS based diets compared to the untreated GNS, the extent and increase depend on the type of alkali used.

Figure 1: *In situ* DM disappearance of the groundnut shells based diets at different incubation time fed to the rams.



ULGNS had the highest values at most incubation times; UTGNS was highest at 0 and 6h. The higher value of UTGNS based diet at 0h might be attributed to the high solubility of other constituent ingredients included in the diet (23).Fast disappearance observed in ULGNS based diets may suggest that there was low cell wall content and the presence of more soluble materials (24); or it had the tendency to undergo a greater degree of particle disintegration which provides better adhesion sites for microbial attachment and activity (25).

LGNS had the lowest values for 0h, 3h, 6h, and 12h while UTGNS had the lowest values for 24h, 36h and 48h.Slow disappearance rates for LGNS based diets may suggest that the solubility of lime in the diet was low, especially at 0h (26) and the ruminal microbes could not readily degrade the diet in the first 12 hours of intake. The slow disappearance of UTGNS based diets indicates that the level of NDF in the diets might have brought about this result or the microbes were not able to degrade the diet to a higher extent in 48 hours compared to other diets (27).

Degradation characteristics

The significant difference within the treatment diets for degradation constants is presented in Table 3.

Table 4 : Degradation constants of the differently treated groundnut shell based diets at different incubation periods for the groundnut shells based rations

Parameters	Different treatments				SEM
	UTGNS	UGNS	LGNS	ULGNS	
a (%)	40.40'	38.47'	36.11'	37.17'	0.27
b (%)	19.49'	33.05'	34.15'	30.97'	1.33
a + b (%)	59.89'	71.52'	70.26'	68.14'	1.57
c (h^{-1})	0.035'	0.023'	0.021^{d}	0.028'	0.01

''':Means with different superscripts within a row are significantly different (P<0.05) , UTGNS: untreated groundnut shell, UGNS: urea treated groundnut shell, LGNS: lime treated groundnut shell, ULGNS: urea-lime treated groundnut shell, a: readily soluble fractions, b: insoluble fraction but degradable in rumen, c: rate of degradation of fraction b per hour, a+b: potentially degradable fraction, SEM: standard error of means

The difference in the degradable fraction observed with deferent chemical treatment might be as a result of their variable chemical compositions, especially the proportion of cell wall and its composition (28).

UTGNS had the highest value (40.40%) for the readily soluble fraction, also called the washing losses (a) and lowest (19.49%) for the insoluble but rumen degradable fraction (b). The increase in soluble fractions for UTGNS based diets may have resulted from the more soluble carbohydrates in the diets which vary between treatment diets fed to the animals. According to (29), the soluble carbohydrates dissolve faster than structural carbohydrates. The decreased value of 'b' for UTGNS might be attributed to high NDF and ADF in the diet suggesting a high lignin content which may have resulted in the low rate of degradation and may limit the rate of degradation in the rumen (28).

LGNS and UGNS had the highest value for 'b'. This was consistent with the work of (30)that used urea to treat sorghum stover, maize stover and sugar cane bagasse. On the other hand, the increase was in contrast with the findings of (31) who reported the degradation of lime treated wheat straw to be low.This increasemay possibly be influenced by the carbohydrate fraction readily available for the rumen microbial population (32), or as a result of the breakdown of the glucosidic linkages in the GNS as a result of treatment.

The potentially degradable fraction (a+b) was recorded to be highest for UGNS (71.52%) and LGNS (70.26%). The increase was in consistence with the works of (25) and (31) that reported greater values for potentially degradable fraction when ammonia was used to treat rice straw and lime to treat wheat straw respectively.

The rate of degradable fraction b per hour (c) was highest for UTGNS (0.035) and lowest for LGNS (0.021). The value obtained for 'c' in UTGNS falls within the range of values reported for crop residues: millet = 0.023–0.035; sorghum = 0.028–0.038 (16). High c values of UTGNS based diets was in contrast with the results obtained by (4). It may be attributed to the rumen condition or the diet composition of the animal (31). High ADF and lignin content (28) suggests the low rate of degradation per hour of the LGNS based diets.

Conclusions and Applications

From the results of the study, it was concluded that:

1. Treatment with urea and or lime improves the quality of groundnut shells
2. The DM disappearance was faster in ULGNS.
3. Better results were obtained for degradation constants with UGNS and LGNS hence this shows the importance of treatment in improving ground nut shell.

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