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EVALUATION OF UREA AND LIME TREATED GROUNDNUT SHELLS IN MIXED RATIONS ON INTAKE AND DIGESTIBILITY OF *YANKASA* RAMS

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ABSTRACT

The study was carried out to evaluate the effect of feeding groundnut shell (GNS) treated with urea, lime and urea-lime in total mixed ration on intake and digestibility using yearling *Yankasa* rams. The experimental diets were composed of untreated groundnut shell (UTGNS), urea treated groundnut shell (UGNS), lime treated groundnut shell (LGNS) and urea-lime treated groundnut shell (ULGNS) denoted as T_1, T_2, T_3, and T_4, respectively which were mixed with maize offal, cotton seedcake, bone meal and salt. The GNS were treated with 5% urea, 5% lime and 5% (2.5% urea and 2.5% lime mixed together) ensiled in Perdue Improved Cowpea Storage bags for a period of 3 weeks. The diets were formulated to contain 14% crude protein and were fed to 4 yearling *Yankasa* rams in a 4×4 Latin square arrangement with four periods of 15 days each. The animals were kept in individual metabolism cages. Feed was offered without restriction and water was supplied *ad libitum*. The results revealed significant improvements in all the parameters measured. There was a considerable improvement in the chemical composition of the treated GNS after treatment with urea and lime. Voluntary intake increased significantly ($P<0.05$) in rams fed UTGNS and ULGNS based diets but was lower in the UGNS group. There was a significant ($P<0.05$) increase in dry matter digestibility, crude protein digestibility, and acid detergent fibre with 1024.20g/d, 191.10g/d and 327.30g/d respectively in animals fed the ULGNS based diet. The results suggests that treatment with 2.5% urea and 2.5% lime on GNS in total mixed ration increased the DM intake by 5.7g/day, DMD by 7.4% and CP digestibility by 4.0% in *Yankasa* rams. It was therefore concluded that ULGNS in mixed ration could improve voluntary intake and digestibility in *Yankasa* rams.

Key words: Groundnut shells, urea, lime, Intake, digestibility, *Yankasa*.

INRODUCTION

Shortage of feed resources often impose major constraints on the development of animal production in tropical and sub-tropical countries (Aregheore, 2000). Considerable quantities of crop residues are generated every year in most developing countries and their utilization in animal feeding is not a common practice in tropical countries due to low nutritive content (Akinfemi *et al.*, 2012). The problem of dry season feeding of livestock in particular, has directed research efforts towards harnessing and enhancing the utilization of abundant arable by-products and crop residues as described by Malau-Aduli *et al.* (2003). Hence, many studies are undertaken to evaluate the potentials of groundnut shells in feeding ruminants (Squidoo, 2014). Therefore, the concept of matching ruminant livestock production with available feed resources (Aregheore, 2000) has intensified research into the evaluation of more crop residues for use as livestock feeds in Nigeria. Treating GNS before feeding to livestock may provide low-cost and readily available feed resource among rural communities where groundnut production is pre-dominant,

consequently reducing environmantal impact of such crop residue.

Alkali treatment of crop residues is not enough to support ruminants beyond maintenance level (Orden *et al.*, 2000); thus, the need for supplementation. Supplementation (with agro-industrial by-products) modifies inequalities in nutrients present for metabolism (Russell, 2002), uplifts ruminal ammonia nitrogen concentration and aids to achieve maximum rates of fermentation (Abdel Hameed *et al.*, 2013). It is established that ruminant animals fed low nitrogen (N) roughages also respond well to nitrogen sources of plant or animal origin through supplementation (Preston and Leng, 1987).

Since animal performance on such feedstuffs is poor due to low voluntary intake and digestibility, resulting from low protein concentrations and high levels of indigestible or slowly degradable fibre (Abdel Hameed *et al.*, 2013), supplementation is paramount. Therefore, this study, which was a follow up to the work conducted by Millam and Abdu (2017), examined the effect of feeding groundnut shells treated with urea and lime in mixed rations on nutrient intake and digestibility in *Yankasa* rams.

MATERIALS AND METHODS

Experimental Site

The study was carried out at the Teaching and Research Farm of the Department of Animal Science, Ahmadu Bello University (ABU), Zaria, Nigeria. Zaria (with a latitude 11°04′N and longitude 7°42′E on an altitude of 706m above sea level) is located in the Northern-Guinea Savannah zone of Nigeria (Wikipedia, 2017). The area is characterized by 6 to 7 months of rainfall varying from 0.0 to 816.0 (mm/month). The mean ambient temperature is 15.3°C in December and January but gets as high as 36.25°C in March and April; mean humidity is 47% (World66, 2016).

Source and Processing of Groundnut Shells

The groundnut shells (SAMNUT 10 variety) were obtained from the Legume Research Programme of the Institute for Agricultural Research (IAR), ABU, Samaru, Zaria. The shells were dried under a shade for 5 days and later pulverized using a hammer mill fitted with 1cm screen. The processed GNS were treated with urea at 5%, lime at 5% and urea plus 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 plus 25g lime dissolved in 1 litre of water to treat 1kg of GNS, respectively]. The solution (urea, lime, urea+lime) were uniformly sprayed on the pulverized GNS and mixed thoroughly using a hand shovel on concrete floor according to the procudure of Can *et al.* (2004). The treated GNS were ensiled for a period of 21 days in Perdue Improved Cowpea Storage (PICS) double layer polyethylene bags which was properly sealed as described by Al-Masri and Guenther (1999). After the 21 days ensiling process, the treated materials were spread on polyethylene sheet to air-dry for 5 days pending the commencement of the experiment.

Table 1: Formulation of the groundnut shells based diet

Ingredients (kg)	UTGNS	UGNS	LGNS	ULGNS
Maize offal	35.65	46.30	44.90	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
Crude Protein (%)	14.00	14.00	14.00	14.00
Crude Fibre (%)	36.03	19.22	18.98	12.44
Cost/kg diet (₦)	23.57	19.85	20.34	18.36

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

Treatments and Experimental Design

Four total mixed rations (TMR) containing 14% crude protein were formulated (Table 1). The diets were offered to 4 rams in a 4×4 Latin Square Design (Table 2) for the determination of intake and nutrient digestibility.

Table 2: Experimental layout for each GNS based complete diets

Periods	Ram 1	Ram 2	Ram 3	Ram 4
1	T1	T2	T3	T4
2	T2	T3	T4	T1
3	T3	T4	T1	T2
4	T4	T1	T2	T3

Experimental Animals and Housing

The animals were purchased from the livestock market in Giwa local government area of Kaduna State. They were quarantined for 2 weeks and routine management practices were observed (deworming with albendazol, and hoof trimming with hoof trimmer for 2 of the rams) before the commencement of the trial. The animals were placed in a sack, stabilized and weighed using spring balance to get their initial live weight, and were housed in metabolism cages (1.0×0.8m), elevated 0.8m above ground, with provision for separate collection of faeces and urine as described by Osuji *et al.* (1993). The metabolism cages were kept in a well-ventilated room with concrete cement floor.

Metabolism Trial

Four yearlings *Yankasa* rams weighing 21kg on the average were used for the digestibility studies. The experiment lasted for 15 days for each period. The animals were offered feed based on voluntary intake of the TMR throughout the experimental period. The first 10 days of the experiment was the adjustment period, while day 11 to 15 was the collection period.

The animals were weighed a day before the commencement of the experiment and were placed in individual metabolic cages. Daily feed refused by each animal was collected and measured starting from day 11 through to day 15 (i.e. 5 days), the total faeces voided by each animal was collected in a bucket, weighed, mixed and a sample was taken for dry matter analysis. The dried sample (10% aliquot) was stored in a polyethylene bag pending chemical analysis. The urine was sampled using diluted sulphuric acid (0.1N H_2SO_4); added to the urine container to ensure that the pH is less than 4 to avoid loss of nitrogen. Twenty mills of the urine aliquot was collected daily and taken to the laboratory for analysis. The animals were reweighed after faecal and urine collection, and before feeding on day 15. (Osuji *et al.,* 1993).

Voluntary dry-matter intake and digestibility coefficient (McDonald *et al.,* 2010) of the feed were calculated using the formula below:

$$\text{Dry matter intake} = \text{dry matter offered daily} - \text{dry matter refused daily}$$

$$\text{DM Digestibility (\%)} = \frac{\text{nutreint consumed} - \text{nutrient in feaces}}{\text{nutrient consumed}} \times 100$$

Chemical Analysis

The samples of TMR and faeces were collected and oven-dried for chemical composition (dry matter, crude protein, acid detergent fibre, neutral detergent fibre, ether extract, ash, nitrogen free extract and lignin) determination as described by AOAC (2005). For the urine, nitrogen was determined using the Kjeldahl method.

Statistical Analysis

The data on nutrient intake and digestibility studies were analysed using the General Linear Model Procedure (PROC GLM) of Satistical Analysis System (2002) in a one-way analysis of variance. The effect of treatments was tested and significant differences between treatment means were determined using Duncan's Multiple Range Test (DMRT) in the SAS package.

RESULTS

Chemical Composition of the Experimental Diets

The results of the chemical composition of the formulated groundnut shells based diets are presented in Table 3. The neutral detergent fibre levels across the treatment groups were highest in UTGNS (54.28%) and lowest in LGNS (49.87%). The crude protein was highest in LGNS (18.25%) and lowest in UTGNS (16.69%). The nitrogen free extract values across the treatment groups were highest in ULGNS (67.90%) and lowest in UGNS (65.24%).

Table 3: Chemical composition of the groundnut shells based diets

Parameters (%)	UTGNS	UGNS	LGNS	ULGNS
DM	92.17	94.04	91.88	94.13
CP	16.69	17.94	18.25	17.56
ADF	27.19	29.82	29.44	30.08
NDF	54.28	50.88	49.87	52.22
EE	4.18	4.56	4.19	4.78
Ash	4.52	4.87	6.19	5.10
NFE	66.20	65.24	66.45	67.90
Lignin	8.78	8.88	10.08	9.32

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

Feed and Nutrient Intake in *Yankasa* Rams fed GNS mixed ration

The effect of urea and lime treated groundnut shells (GNS) based diets on nutrient intake of *Yankasa* rams are shown in Table 4. The results revealed that the daily feed intake for treated and untreated GNS were significantly different (P<0.05) and it was highest in UTGNS (1110.90g), followed by ULGNS (1088.10g) and lowest in UGNS (914.30g). Animal on UTGNS had significantly (P<0.05) higher water intake (3019.50ml) compared with other treatments. Animals on ULGNS and UTGNS had significantly (P<0.05) higher dry matter intake (1024.20g) and (1023.90g), respectively as compared with other treatment groups. The CP intake was significantly (P<0.05) similar for all treatment except for UGNS (16.03g) which was significantly lower. The ADF intake ranged from 272.60g/d, 287.20g/d, 302.00g/d and 327.30g/d in UGNS, LGNS, UTGNS, and ULGNS respectively; with the highest in ULGNS compared to other treatments while NDF intake was highest for UTGNS (603.00 g) and lowest in UGNS (465.20g).

Table 4: Nutrient intake in *Yankasa* rams fed groundnut shell based diets

Parameters (g/d)	UTGNS	UGNS	LGNS	ULGNS	SEM
Daily feed intake	1,110.90^{a}	914.30^{b}	975.50^{b}	1,088.10^{a}	63.91
Water intake[1]	3,019.50^{a}	2,562.00^{b}	2,693.80^{b}	2,816.00^{b}	176.75
Dry matter intake	1,023.90^{a}	859.80^{b}	896.30^{b}	1,024.20^{a}	59.22
Organic matter intake	973.70^{a}	815.20^{b}	835.90^{b}	968.80^{a}	55.79
Crude protein intake	185.40^{a}	164.03^{b}	178.03^{a}	191.10^{a}	11.22
Acid detergent fibre	302.00^{b}	272.60^{b}	287.20^{b}	327.30^{a}	18.56
Neutral detergent fibre	603.00^{a}	465.20^{c}	486.50^{c}	568.20^{b}	33.32

^{abc} means with different superscripts within the same row are significantly different (P<0.05), [1] = litre; UTGNS: untreated groundnut shells, UGNS: urea treated groundnut shells, LGNS: lime treated groundnut shells, ULGNS: urea-lime treated groundnut shells, SEM: standard error of means

Nutrient Digestibility in *Yankasa* Rams

The apparent nutrient digestibility coefficients of the compounded rations are presented in Table 5. There were significant (P<0.05) differences in all the parameters analysed across treatments. Rams fed ULGNS diet had highest values (P<0.05) for all parameters while lowest values was observed with UGNS (36.27%) for DM; UTGNS (36.99%) for lignin, ADF (55.31%) and EE (84.60%); UGNS (39.74%) for NDF; UTGNS (65.90%) for CP; and LGNS (16.87%) for NFE. There was no difference significantly in CP digestibility between UTGNS, UGNS and LGNS. However, UGNS had the least results in all parameter except for NDF (39.74%) and EE (86.20%).

Table 5: Nutrient digestibility in *Yankasa* rams fed GNS based diets

Parameters (%)	UTGNS	UGNS	LGNS	ULGNS	SEM
DM	39.17^{b}	36.27^{c}	36.72^{c}	46.55^{a}	2.06
CP	65.90^{b}	65.98^{b}	65.98^{b}	69.90^{a}	0.76
ADF	55.31^{c}	54.41^{c}	58.60^{b}	62.31^{a}	1.79
NDF	47.18^{b}	39.74^{c}	39.69^{c}	51.50^{a}	2.38
EE	84.60^{c}	86.20^{b}	85.66^{b}	87.25^{a}	0.75
NFE	25.57^{ab}	16.87^{b}	21.46^{ab}	34.65^{a}	2.59
Lignin	36.99^{c}	33.40^{d}	44.36^{b}	49.79^{a}	3.05

^{abc} means with different superscripts within the same row are significantly different (P<0.05), UGNS: untreated groundnut shells, UTGNS: urea treated groundnut shells, LTGNS: lime treated groundnut shells, ULTGNS: urea-lime treated groundnut shells, DMD: dry matter, CP: crude protein, CF: crude fiber, EE: ether extract, NDF: neutral detergent fiber, ADF: acid detergent fiber, NFE: nitrogen free extract, SEM: Standard error of means

DISCUSSIONS

Chemical Composition of the Total Mixed Ration

The high value of NDF in UTGNS could be as a result of the lignified nature of GNS in the TMR because it was not treated with alkali as pointed out by Sarnklong *et al.* (2010). Hence, UTGNS had lower levels of CP, EE, Ash, and NFE compared to other treatments. The level of inclusion of cotton seed cake or alkali treatment of the GNS boosted the level of protein in all the diets, with a mean value of 17.61% giving them a level higher than the recommended CP level of 15% by NRC (2007), for optimum maintenance or production of sheep. The increased levels of crude protein and high levels of soluble carbohydrates for LGNS and ULGNS, respectively could be as a result of effective supplementation of the groundnut shell for efficient ingestion of crop residues (Smith, 1989) or as a result of the efficient breakdown of the structural carbohydrates of the GNS (Yulistiani *et al.,* 2015).

Feed and Nutrient Intake

The findings of this study revealed that there was an improvement in daily feed intake in rams fed ULGNS and UTGNS based rations. These results were consistent with the those reported by Wanapat *et al.* (2013) who found that treatment with urea plus lime increased DM intake of lactating cows compared to untreated rice straw. Meanwhile, it was in contrast with same author who reported that if rice straw was treated with urea-lime chemical, it could have the highest result among all treatments. This means the combination between urea and lime could improve intake of GNS by ruminants. The increase in intake of ULGNS based diets under the present study may thus be explained by virtue of increased degradability in the

rumen (Millam and Abdu, 2017) and increase in outflow of shell cell wall into the abomasum as a result of alkali treatment as reported by Trach *et al.* (2001b) and Wanapat *et al.* (2013). This combination (urea and lime) will give a better result than urea or lime alone and has the benefit of improving ruminal digestion, with an increased content of both calcium and nitrogen (Pradhan *et al.,* 1997; Sarnklong *et al.,* 2010).

This study found that urea treatment alone had a negative effect on intake . This is in contrast to the report of some researchers (Sarnklong *et al.,* 2010; Abdel Hameed *et al.,* 2013; Wanapat *et al.,* 2013) who found that urea treatment improved intake. However, Yulistiani *et al.* (2015) reported that urea treated rice straw did not increase intake when fed to sheep. This finding was similar to the results obtained in this study. This could be attributed to the type of animal used and the difference in feed acceptability by these animals (Huyen *et al.,* 2012). Furthermore, the low feed intake might also be as a result of slow digestion rate (Distel *et al.,* 1994) or distension of the rumen wall (Grovum, 1988).

The increase in DM intake in animals fed ULGNS were similar to the works of Gunun *et al.* (2013a, 2013b) who found that there was an increase in DM intake in dairy cows fed urea treated rice straw compared with untreated rice straw. The increase in intake could be as a result of increase palatability of the diet due to supplementation with high fermentable carbohydrates and protein which improved the nutritive value of the feed (Smith, 1989; Melaku *et al.,* 2004).

Nutrient Digestibility

The increase in dry matter digestibility in rams fed ULGNS based diets was in consistent with the earlier findings of others researchers (Trach *et al.,* 2001b; Fadel Elseed *et al.,* 2003; Wanapat *et al.,* 2013). Wanapat *et al.* (2013) reported an increase in the digestibility of rice straw fed to lactating dairy cows due to hemicellulose and lignin degradation which exposed the surface area for microbial attack; this may be the reason. Improvement in GNS apparent digestibility as a result of treatment with lime and urea combination have also been reported by Zaman and Owen (1990) and Sahoo *et al.* (2000). Since the rumen is the primary site for fibre digestion, the increase in apparent digestibility of the ULGNS based diet may also be presumed to be due to amplified rumen degradability which resulted from improved susceptibility of structural carbohydrates of GNS cell wall to rumen fermentation as well as additional energy being made accessible for better growth of rumen microbes for fermentation (Wanapat *et al.,* 2013; Yulistiani *et al.,* 2015). The combination of urea and lime greatly increased the digestibility of straw as reported by Pradhan *et al.* (1997) and Sarnklong *et al.* (2010).

The decrease in digestibility of UGNS based diets in this study did not agree withsome researchers (Hossain *et al.,* 2010; Sarnklong *et al.,* 2010; Huyen *et al.,* 2012; Gunun *et al.,* 2013a, 2013b) who indicated that urea treated rice straw increased digestibility of fibrous roughages. On the other hand, the findings of this study agrees with the work of Trach *et al.* (2001a) who found that there was no improvement in rice straw digestibility or microbial protein production in the rumen of beef cattle when the CP content of rice straw increased from 8 to 10% DM. This might be attributed to the digestibility of the GNS, it's not only influenced by its own composition but also by the composition of other feed ingredients consumed with it. When roughage and concentrate are given in equal parts in a ration, the digestibility of the concentrate mixture might differ from what is expected (Gao *et al.,* 2015). The associative effect is usually negative for digestibility of mixed rations, as a result of rapid fermentation of starch to volatile fatty acids which depressed the rumen pH to 6 or less. The low pH inhibits cellulytic microorganisms and fibre digestion. This indicates that starch have a direct effect on cellulolysis (Yulistiani *et al.,* 2015).

CONCLUSIONS

The results of this study revealed that treatment of groundnut shells with 2.5% urea and 2.5% lime in total mixed ration increased crude protein intake by 5.7g/day, dry matter digestibility by 7.4% and CP digestibility by 4.0% in *Yankasa* rams. This results offer additional information and practical data on the use of low quality roughage such as groundnut shells with effective chemical treatment. Therefore, it was concluded that groundnut shell treated with urea plus lime at 2.5% level each could improve the nutritive value of groundnut shells in TMR, voluntary intake and digestibility in *Yankasa* rams. However, further studies is required to evaluate the effect of feeding treated GNS in TMR on growth performance and blood parameters of *Yankasa* rams.

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