CHEMICAL COMPOSITION AND RUMINAL DEGRADATION OF UREA- AND LIME-TREATED GROUNDNUT SHELLS IN YANKASA RAMS

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ABSTRACT

The evaluation of alkali chemical treatment on groundnut shells (GNS) using urea, lime and urea-lime on its nutritive value was examined based on *in sacco* rumen degradation. Untreated (UTGNS), urea treated (UGNS), lime treated (LGNS) and urea-lime treated (ULGNS) groundnut shells were incubated at different incubation intervals in the rumen of 3 fistulated Yankasa rams.The GNS were treated with 5% urea, 5% lime and 5% urea-lime, ensiled for a period of 3 weeks. The results revealed significant differences in the parameters measured. There was improvement in the hydrolysis of the cell wall components (lignin, ADF and NDF); CP was increased by 8.53%, when urea-lime was used to treat the GNS. The DM disappearance in ULGNS appeared to be faster within the treatment groups.

Keywords: Groundnut shells, urea-lime, *in sacco*, Yankasa rams.

INTRODUCTION

In Nigeria, there are plenty of groundnut shells (GNS): with an average of 1018 kg/ha produced annually (Larbi *et al.*, 1999). With the exception of a little quantity used as fuel or mulching material, most of them are thrown away as waste. It is a normal practice in Nigeria either to burn or leave them on the farm to decompose. Burning has time-honoured global condemnation in the recent past and therefore, the need for its transformation to a feed resource (Akinfemi, 2010). GNS contains more than 60% fibre, and therefore, its nourishing value can be improved through chemical treatment; among which alkali proved to be better (Khan *et al.*, 2006). Treatment has the benefit of increasing the protein content and making available other nutrients trapped within the cell wall of GNS. Upgrading fibre utilization following treatment with alkali (Sarnklong *et al.*, 2010) suggests that scope exists to obtain more nutrients from fibre by microbial fermentation in the rumen. Thus, the possibility can be tested through the *in vivo* processes. Therefore, the present study intends to use the *in sacco* technique which has the advantage of giving a very quick estimate of the rate and magnitude of degradation in the functioning rumen; to evaluate the use of GNS to be used as a feed source for feeding Yankasa rams.

MATERIALS AND METHODS

The study was carried out in the Teaching and Research Farm of the Department of Animal Science, Ahmadu Bello University (ABU), Zaria, Kaduna state.The groundnut shell (SAMNUT 10 variety) was obtained from the Legume Research Programme of the Institute for Agricultural Research, ABU Samaru, Zaria. The shells were pulverized using a hammer mill fitted with 1cm screen after drying. 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. 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 Al-Masri and Guenther (1999). Thereafter, they were air dried awaiting the commencement of experiment.Threeruminally fistulated rams with an average age of 15 months with an initial weight of ±26kg wereused as replicates to determine *in sacco*. The animals were allowed 14 days period to adjust to the feeding and housing conditions prior to suspension of bags. They were housed in experimental pens and fed twice daily. Housing and management condition were equal for all sheep.DM disappearances in the rumen were estimated for the GNS using the nylon bag technique. The bags (ANKOM Technology) used with size 5cm×10cm and with pore size 41µm, were tiedusing a nylon string and suspended in the rumen approximately 1 hour after feeding. Bags for each sample were removed after 0, 12, 24, 48, 72 and 96h of incubation. The bags were weighed and tested according to the procedure described by Ørskov and McDonald (1979). Subsequently, DM, lignin, ADF, NDF, CP and NFE were measured according to Van Soest *et al.* (1991)and AOAC (2005).

Data analysis:data for ruminal disappearance characteristics were fixed to the equation proposed by Ørskov and McDonald (1979).

$$P = a + b(1 - e^{-ct})$$

$$ED = a + [bc/(c+k)](1 - e^{-(c+k)t})$$

The data obtained were analysed for ANOVA (one-way) using Generalised Linear Models Procedure (PROC GLM) of (SAS, 2002).

RESULTS AND DISCUSSION

The chemical compositions of the untreated and treated GNS are shown in Table 2. UTGNS had higher lignin, ADF and NDF values of 23.50%, 59.90% and 69.20 respectively compared to other treatments. ULGNS had the higher CP value (15.43%) while LGNS had the highest NFE level of 53.62%. Lignin decreased from 23.50–11.11%; ADF from 59.90–29.36%; and NDF from 69.20–60.60%. Crude protein content increased from 6.90–15.43%. NFE also increased from 21.80–53.62%.There was improvement in the hydrolysis of GNS samples to release available nutrients encapsuled within the lignified cell wall. As reported byTrach *et al.* (2001),thecombination of urea and lime was found to be highly effective in improving the nutritive value of rice straw.

There was significant difference in the disappearance rates (Figure 1) of the untreated and the treated GNS at different incubation times. The DM disappearance of ULGNS was consistently higher (P<0.05) compared to the treated groups. UTGNS was suggested to degrade slower than treated GNS (Sarnklong *et al.*, 2010), it is consistent with the result of this study.Fast disappearance of ULGNS in this study may be attributed to improved degradability of GNS as suggested by Sarnklong *et al.* (2010) that the combination of urea and lime improved the degradability of rice straw especially varieties with low degradability than urea or lime alone. Slow disappearance of UGNS in this study is in contrast to Gunun *et al.*(2013) who showed that urea treatment of crop residues improved degradability compared to the untreated.

The degradable constants for the different incubation times are presented in Table 3. The immediately soluble fraction 'a' ranged from 19.97% in UTGNS to 24.04% in ULGNS. This might be as a result of the variation in the chemical compositions in the content of the soluble fractions of the GNS materials. Higher values obtained in ULGNS is in consistence with the reports of Fadel Elseed *et al.* (2003)that treatment with urea and lime increases the solubility of crop residues.

The insoluble but rumen degradable fraction 'b' was highest in ULGNS (5.81%). This suggest that adequate cellulose was available for microbial digestion (Karimi *et al.*, 2014). This result was in consistence with the report ofAbdu *et al.*(2011), that crop residues with low cell wall constituents have high degradability.

ULGNS was observed to contain the highest amount of potentially degradable DM 'a+b' with 29.85%, this indicates the potential to degrade more in the rumen. This result is in consistence with the work of Abdu *et al.*, (2011), they reported that low lignin content may result in high degradability.

The rate of rumen degradable fraction (b) per hour 'c' was fast in ULGNS (0.085). This might be attributed to favourable rumen pH (Chaudhry, 2000) provided by the urea-lime for the GNS used in the study. This was in consistence with the findings ofOrden *et al.*(2000) that reported higher rates of degradation of (b) per hour for treated crop residues when fed to sheep.

CONCLUSION

The results of this study indicated that the treatment of GNS with 2.5% urea and 2.5% lime decreased the lignin content by 12.39%, ADF by 30.03% and NDF by 8.60%. The CP content was increased by 8.53%, so also the NFE by 31.82%. The improvement in the ruminal degradability of groundnut shells expected from combining urea and lime treatment was achieved; ULGNS had the fastest disappearance in the rumen. However, further research is warranted to verify the latter roles of urea and lime in treating GNS, concerning its possible use in the diets of ruminants.

REFERENCE

Abdu, S. B., Hassan, M. R., Adamu, H. Y., & Yashim, M. (2011). Effect of Level of Zizyphus mauritiana Leaf Meal Inclusion in Concentrate Diet on Rumen Degradation Characteristics. *World Journal of Life Science and Medical Research*, *1*(6), 117–121.

Akinfemi, A. (2010). Bioconversion of peanut husk with white rot fungi: Pleurotus ostreatus and Pleurotus pulmonarius. *Livestock Research for Rural Development*, *22*(3), 1–11. Retrieved from http://www.lrrd.org/lrrd22/3/akin22049.htm

Al-masri, M. R., & Guenther, K. D. (1999). Changes in digestibility and cell-wall constituents of some agricultural by-products due to gamma irradiation and urea treatments. *Radiation Physics and Chemistry*, *55*, 323–329.

AOAC, (Association Of Analytical Chemist). (2005). *Official Method of Analysis* (17th ed.). Maryland, USA: AOAC International.

Chaudhry, A. S. (2000). Rumen degradation in sacco in sheep of wheat straw treated with calcium oxide , sodium hydroxide and sodium hydroxide plus hydrogen peroxide. *Animal Feed Science and Technology*, *83*(1), 313–323. Retrieved from www.elsevier.com/locate/anifeedscii

Fadel Elseed, A. M. A., Sekine, J., Hishinuma, M., & Hamana, K. (2003). Effects of ammonia, urea plus calcium hydroxide and animal urine treatment on chemical composition and in sacco degradability of rice straw. *Asian-Australasian Journal of Animal Sciences*, *16*, 368–373.

Gunun, P., Wanapat, M., & Anantasook, N. (2013). Effects of Physical Form and Urea Treatment of Rice Straw on Rumen Fermentation , Microbial Protein Synthesis and Nutrient Digestibility in Dairy Steers. *Asian-Australasian Journal of Animal Sciences*, *26*(12), 1689–1697. Retrieved from http://dx.doi.org/10.5713/ajas.2013.13190

Khan, M. A., Sarwar, M., Nisa, M., Khan, M. S., Bhatti, S. A., Iqbal, Z., … Ki, K. S. (2006). Feeding Value of Urea Treated Wheat Straw Ensiled with or without Acidified Molasses in Nili-Ravi Buffaloes. *Asian-Australasian Journal of Animal Sciences*, *19*(5), 645–650.

Larbi, A., Dung, D. D., Olorunju, P. E., Smith, J. W., Tanko, R. J., Muhammad, I. R., & Adekunle, I. O. (1999). Groundnut (Arachis hypogaea) for food and fodder in crop-livestock systems: forage and seed yields, chemical composition and rumen degradation of leaf and stem fractions of 38 cultivars. *Animal Feed Science and Technology*, *77*(8), 33–47.

Orden, E. A., Yamaki, K., Ichinohe, T., & Fujihara, T. (2000). Feeding Value of Ammoniated Rice Straw Suplimented with Rice Bran in Sheep: II. In Situ Rumen Degradation of Untreated and Ammonia Treated Rice Straw. *Asian-Australasian Journal of Animal Sciences*, *13*(7), 906–912.

Ørskov, E. R., & McDonald, I. (1979). The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. *Journal of Agriculture Science (Cambridge)*, *92*(2), 499–503. doi:http://dx.doi.org/10.1017/S0021859600063048

Sarnklong, C., Cone, J. W., Pellikaan, W., & Hendriks, W. H. (2010). Utilization of Rice Straw and Different Treatments to Improve Its Feed Value for Ruminants : A Review. *Asian-Australasian Journal of Animal Sciences*, *23*(5), 680–692. Retrieved from www.ajas.info

SAS, (Statistical Analysis Systems). (2002). Procedures Guide. North Carolina, USA: Statistical Analysis Systems Institute, Cary.

Trach, N. X., Mo, M., & Cu Xuan Dan. (2001). Effects of treatment of rice straw with lime and/or urea on its chemical composition, in-vitro gas production and in-sacco degradation characteristics. *Livestock Research for Rural Development*, *13*(4).

Van Soest, P. J., Robertson, J. B., & Lewis, B. A. (1991). Methods of dietary fibre, neutral detergent fibre and non-starchy polysaccharide in relation to animal nutrition. *Journal of Dairy Science*, *74*, 3583–3597.

Table 1: Chemical composition of urea and lime treated groundnut shells

Parameters (%)	UTGNS	UGNS	LGNS	ULGNS
DM	91.00	91.97	91.15	92.44
Lignin	23.50	14.12	12.08	11.11
ADF	59.90	29.36	31.88	29.87
NDF	69.20	61.32	62.15	60.60
CP	6.90	12.06	11.38	15.43
NFE	21.80	51.45	53.62	50.27

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, NDF: neutral detergent fiber, ADF: acid detergent fiber, NFE: nitrogen free extract

Table 2: Degradation constants and effective degradability of the differently treated groundnut shell

Parameters	Different treatments				SEM
	UTGNS	UGNS	LGNS	ULGNS	
a (%)	19.97[c]	21.84[b]	21.83[b]	24.04[a]	0.20
b (%)	4.07[b]	1.24[c]	3.70[b]	5.81[a]	0.49
a+b (%)	24.04[c]	23.08[d]	25.54[b]	29.85[a]	0.62
c (h^{-1})	0.026[c]	0.038[b]	0.036[b]	0.085[a]	0.01

[abc]:Means with different superscripts within a row are significantly different ($P<0.05$), 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

Figure 1: *In situ* **dry matter disappearance (%) of the untreated and treated groundnut shells at different incubation time.**