CHEMICAL COMPOSITION AND KINETICS OF RUMINAL FERMENTATION OF COMPOSITE CASHEW NUT SHELL

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ABSTRACT
In Nigeria, the major constraint to livestock production is the scarcity of quality and insufficient supply of feed throughout the year. A non-conventional feedstuff could ameliorate the limitation. Therefore, this study was carried out to evaluate the chemical composition and in vitro fermentation characteristics of differently treated composite cashew nut shell (CNS). The different treatment comprised raw CNS, urea, lye, microbial, boiled, roasted and poultry litter. The samples were incubated for 24 hours. The chemical composition showed that there was significant difference ($p < 0.05$) and the dry matter (DM) ranged from 82.24% (urea treated) to 89.35% (poultry litter treated) while the crude protein (CP) varied from 6.62% (raw) to 11.98% (lye treated). The in vitro potential gas production and degradability showed that lye treated CNS produced the highest (3.00mL) gas volume at 6 hour and also recorded the highest gas volume throughout the incubation period while the highest volume of methane gas (3.88mL) was obtained in raw CNS, the least value was observed in boiled treatment. The organic matter digestibility (OMD) (34.63%), short chain fatty acid (SCFA) (0.16 um), and metabolizable energy (ME) (4.13 Kcal/g) obtained in this study were all highest in lye treated CNS and were least (27.46%), (0.08 um) (3.38 Kcal/g) in raw CNS respectively. It can be concluded from the results of this study that cashew nut shell, if lye treated can be included in the ration of ruminants.
Keywords: Cashew nut shell, gas production, ruminant, lye treatment, short chain fatty acid

INTRODUCTION

Nutrition plays a major role in the overall productivity and wellbeing of the goat flock (Alokan, 2008; Ogunjemite and Ibhaze, 2020) as goats are important livestock for food security where they are most kept by smallholders (Adu *et al.,* 2004). But the scarcity and seasonality of pasture coupled with higher demand for animal protein in the world market has therefore made it important to utilize most of the agro industrial by-product which are often regarded as waste (Ogunjemite *et al.* 2021). One of such agro industrial by-product in Nigeria is cashew nut shell (CNS). It is a by-product of the cashew nut processing factory which is cheap, readily available and not in direct use by humans. It is the left over after cashew kernel have been removed from the shell (Ocheja *et al.* 2011; Ogunjemite *et al.* 2021). *In vitro* gas production is a technique used in evaluating feed quality (Ibhaze *et al.* 2020). It involves volumetric measurement of gas production in phosphate and bicarbonate, which is used to predict fermentation end-product, microbial protein synthesis and digestibility substrate by the rumen microbes in the *in vitro* system (Babayemi and Bamikole, 2006). It is a quick method for predicting short chain fatty acids, organic matter digestibility and metabolizable energy content of ruminant feeds (Menke and Steingass, 1988). The advantage of *in vitro* method is that it is less expensive and less time-consuming and accurate to predict feed intake, digestibility, microbial nitrogen supply, animal performance, short chain fatty acids, carbon dioxide and metabolizable energy of feed (Babayemi and Bamikole, 2006; Ibhaze *et al.,* 2020). Gas production reflect all fermented nutrients, soluble, as well as insoluble and fractions that are not fermentable which do not contribute to gas production and from the total gas production, methane, individual volatile fatty acids can be predicted (Fievez *et al.,* 2005). This study was carried out to determine the chemical constituents and dry matter degradability of ensiled cashew nut shell for ruminant feeding using *in vitro* gas production technique.

MATERIALS AND METHODS

Parameters (%)	Raw	Lye	Poultry litter	Urea	Boiled	Roasted	Microbial
Cashew nut shell	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Cassava peel	55.0	55.0	55.0	55.0	55.0	55.0	55.0
Palm kernel cake	17.0	17.0	17.0	17.0	17.0	17.0	17.0
Common Salt	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Bone meal	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Premix	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Fermentation kinetics

The *in vitro* procedure were carried out according to the method of Menke and Steingass, (1988). Incubation was done at 39±1ºC and the volume of gas production was measured at 3, 6, 9, 12, 15, 18, 21, and 24 hours. At the end of the termination hour, 4 mL of NaOH (10M) was introduced to estimate the methane production according to the method of Fievez *et al.* (2005); metabolizable energy (ME), organic matter digestibility (OMD) and short chain fatty acids (SCFA) were estimated according to the methods of Menke and Steingass, (1988). The average of the volume of gas produced was estimated according to the method of Getachew *et al.* (1999).

RESULTS AND DISCUSSION

The dry matter (DM) which ranged from 82.24 – 89.35% was lower than (92.21%, 91.50%) that Ocheja *et al.* (2013) reported and the crude protein (CP) values obtained were above the critical 8% CP requirement by ruminants for optimum microbial activities in the rumen (Ibhaze *et al.,* 2020b) except in raw CNS. The improved CP content observed in the treated samples might be due to the various treatments. The low crude fibre (CF) content of the treated samples indicated that the various treatments were able to degrade the CF content appreciably, suggesting that when fed in vivo, it can be degraded easily by rumen microbes. The values were within the requirement of 8 – 33% crude fibre suggested by Castrillo, (2001). Gas production reflects the degradation of dietary organic matter and more gas production, more degradation of organic matter (Groot *et al.,* 1996). It was observed that lye treated cashew nut shell produced the highest gas volume at 24 hour incubation. This implied that digestion would take place within the normal rumen retention time and would not result in bloat in the animal fed (Babayemi and Bamikole, 2006). The methane gas volume obtained were lower than 3.00 – 5.00 ml reported by Omotoso *et al.,* (2018) in composite cocoa pod husk and also lower to 3.00 – 4.00 reported by Okoruwa and Agbonlahor, (2016). This implied that the low methane produced showed that the feed substrate cannot cause nutritional disorder resulting in bloat. The level of SCFA indicates that the samples have potentials to make energy available to animals (Babayemi and Bamikole, 2006).

Table 1: Chemical composition (%) of raw and treated cashew nut shell

Parameters	Raw	Urea	Microbial	Boiled	Roasted	Lye	Poultry	P-value
Dry matter	86.15±0.17^{b}	82.24±0.11^{c}	84.42±0.21^{c}	82.41±0.03^{c}	88.61±0.27^{a}	88.11±0.18^{a}	89.35 ± 0.04^{a}	0.01
Crude protein	6.62±0.47^{c}	11.53±0.03^{a}	10.30±0.48^{ab}	8.94±0.50^{b}	8.87±0.45^{b}	11.98±0.49^{a}	11.72 ±0.00^{a}	0.02
Crude fibre	22.95±0.15^{a}	14.78±0.13^{bc}	13.54±0.19^{c}	16.43±0.14^{b}	16.75±0.05^{b}	12.16±0.04^{d}	15.36 ±0.22^{b}	0.01
Ether extract	13.10±0.21^{b}	15.94±0.04^{ab}	12.05 ±0.01^{c}	13.67±0.07^{b}	6.67 ±0.11^{d}	24.61±0.19^{a}	16.43 ±0.14^{ab}	0.01
Ash	7.01 ±0.14^{d}	9.55 ±0.26^{b}	12.74±0.02^{a}	7.41±0.08^{d}	8.86±0.23^{bc}	9.17±0.05^{b}	8.95 ±0.28^{bc}	0.01
Gross energy (KJ/100gDM)	12.07±0.17^{b}	13.07±0.24^{ab}	10.54±0.05^{d}	11.67±0.10^{c}	7.91±0.14^{e}	15.39±0.02^{a}	13.46±0.04^{ab}	0.04
NDF	83.84±0.13^{b}	71.85±0.35^{e}	80.74±0.18^{c}	85.80±0.33^{a}	66.32±0.33^{f}	63.70±0.22^{g}	74.75±0.14^{d}	0.01
ADF	58.66±0.10^{c}	55.70±1.52^{d}	58.66±0.10^{c}	60.58±0.11^{b}	56.18±0.10^{d}	56.73±0.08^{d}	63.14±0.30^{a}	0.01
ADL	42.60±0.12^{e}	48.94±0.15^{b}	45.97±0.13^{c}	56.12±0.16^{a}	49.72±0.16^{b}	44.41±0.01^{d}	46.67±0.11^{c}	0.01

a,b,c,d,e,f = means within the same row with different superscripts are significantly different ($P < 0.05$).

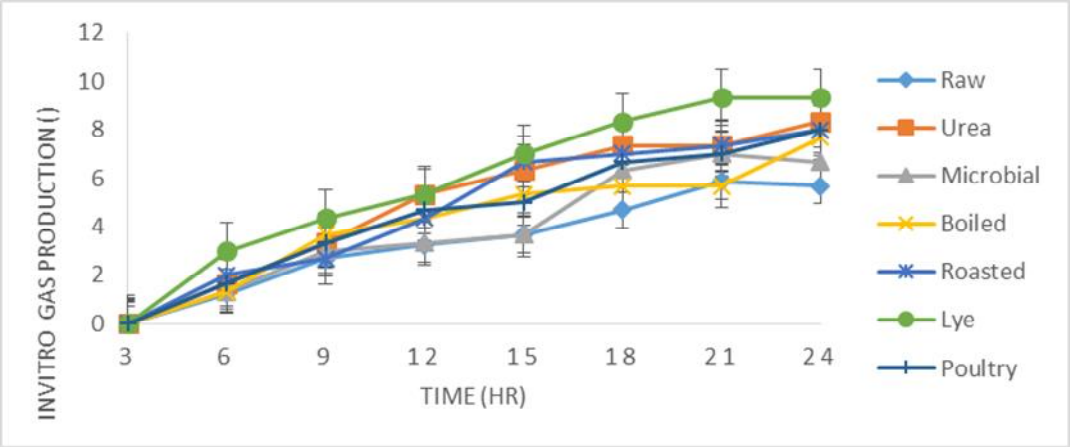

Figure 1: *In vitro* gas production (mL) of raw and differently treated cashew nut shell

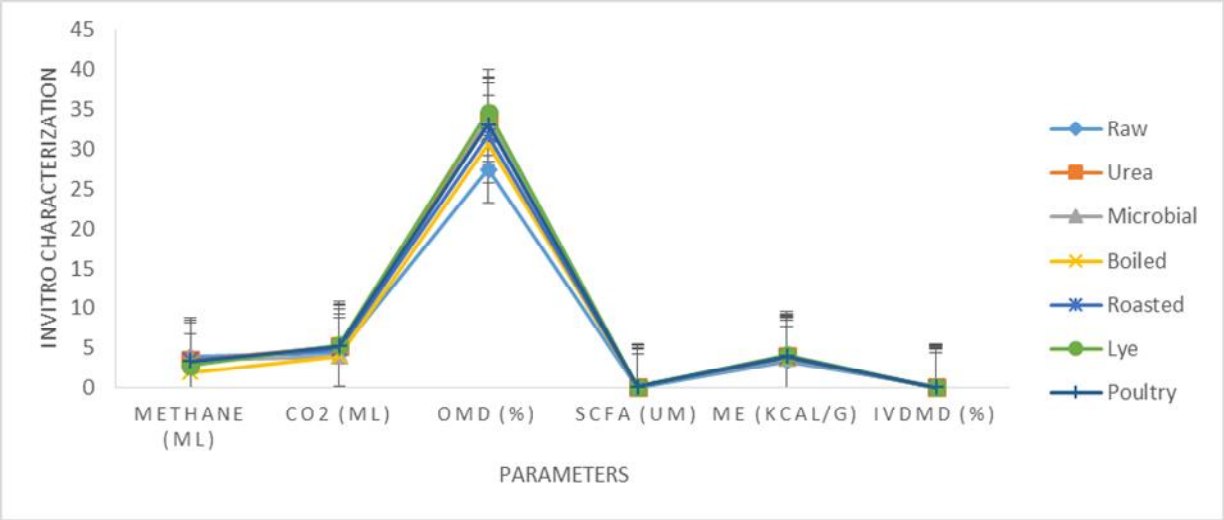

Figure 2: *In vitro* characteristics of raw and differently treated cashew nut shell
OMD- Organic Matter Digestibility; CO_2- Carbon (IV) oxide; SCFA- Short chain fatty acid; ME- Metabolizable energy; IVDMD- In vitro dry matter disappearance.

CONCLUSION

The study provided information on nutritive value of cashew nut shell as a potential feed for ruminant production.

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