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## Effects of Steaming and Soaking on Chemical Composition of Cashew Nutshell: Implications for Ruminant Animal Nutrition

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**Abstract:** Samples of cashew nut shell were screened to determine the effect of steaming and soaking treatments on chemical composition, pH and phyto chemical content Four samples of cashew nut shell. T<sub>1</sub> (Raw), T<sub>2</sub> (Steamed), T<sub>3</sub> (Soaked in water for 1 day) and T<sub>4</sub> (soaked in wood ash solution for 1 day). Samples of T<sub>3</sub> and T<sub>4</sub> were soaked for additional 2 days in water and wood ash solution for the determination of phyto chemical content. The tests were carried out in triplicate for each treatment. Data obtained were subjected to a one way analysis of variance. Treatment means where significant ( $p < 0.05$ ) difference existed were separated using Least Significant Difference (LSD) at 5% level of probability. Treatment method had no significant ( $P > 0.05$ ) effect on crude protein, crude fibre, nitrogen free extracts and Dry matter contents. However, there were significant ( $P < 0.05$ ) differences in the values for pH and Ether Extracts. There were significant ( $P < 0.05$ ) differences in values for all the phytochemicals from T<sub>1</sub> to T<sub>4</sub>. Phenolic compounds in cashew nut shell ranged from (8.22 to 16.83%). None of the treatment methods completely removed the phytochemicals. It was concluded that cashew nut shell may be safe for inclusion in ruminant rations after much of the oil has been extracted and feeding may require supplementation with energy, protein and mineral sources to balance for nutrient requirements of farm animal that can tolerate higher fibre diets.

**Key words:** Cashew nut shell, phyto-chemicals, pH, proximate composition

### INTRODUCTION

Nutrition has been identified as a key factor to the survival and profitability of livestock production. In Nigeria and other parts of the tropics feeds and feeding of ruminants during the long dry season has become a major source of concern (Ocheja, 2008). The competition for conventional feed materials for ruminant and non-ruminants has led to scarcity and escalating cost of conventional ingredients such that feed cost accounts for about 70% of the recurrent cost of production (Akinmutimi, 2004). As a way of mitigating scarcity of feedstuffs especially during the dry season, the pre-occupation of many farmers has been to search for alternative feed ingredients that can easily substitute for the usually expensive and scarce conventional ingredients (Ojebiyi *et al.*, 2008).

The search has led to the treatment and optimization of some agro by-products that are cheap, readily available, safe, nutritionally adequate and preferably not in direct use by humans. One of such alternative feed ingredients is the cashew nut shell which is a by-product of the cashew nut processing factory (Ocheja *et al.*, 2011a) It is the left over after cashew kernel have been removed from the shell.

Cashew nut shell or pericarp only holds promises as a feedstuff for the ruminant considering its appreciable

proportional weight of 74% that is incomparable with the kernel (24%) and the testa (2%) of a whole cashew nut (Arogba, 2008). However, cashew nut shell exudates liquid that appears to present unattractive flavor. This may constrain voluntary intake by farm animals. Studies have shown that cashew nut shell liquid contains phenolic lipids that are essentially composed of anarcadic acid and its derivatives with high potency for antioxidant and biological activity. In another study (Ocheja *et al.*, 2011a) listed some constraints to the use of cashew nut shell in livestock rations to include its high content of oil (38-41%) high level of acidity ( $pH = 3.5$ ) and lack of awareness of processing techniques to enhance the nutritional potentials. Work on the use of cashew nut shell in ruminant feeding seems to be scanty which make this investigation expedient.

The aim of this trial was to screen cashew nut shell for its chemical composition and to test the effects of steaming, soaking in water or in wood-ash solution on nutritional contents.

### MATERIALS AND METHODS

Samples of raw cashew nut shells were obtained from Kogi State University campus, Anyigba and crushed (T<sub>1</sub>) samples of steam treated for (20 minutes) cashew nut shells were also obtained from the cashew nut

processing factory Kogi State University, Anyigba and crushed (T<sub>2</sub>), 10g of the crushed raw cashew nut shells were soaked in water (100ml) for 1 day (T<sub>3</sub>). Another 10g crushed raw cashew nut shell were soaked in wood ash solution (10g in 100ml water) for 1 day (T<sub>4</sub>). However, part of the samples in T<sub>3</sub> and T<sub>4</sub> (10g each) were soaked in water and wood ash solutions respectively for 3 days each, retrieved and dried for the determination of their phyto chemical contents.

The four samples (T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub>) were taken to the laboratory to determine their proximate composition according to standard procedure (AOAC, 1995). pH was determined according to the method of AOAC (1995) using pH meter model HM 305, Tokyo, Japan the mineral profile were determined with an atomic absorption spectro-photometer. And the phytochemicals content was determined using the methods of Fasset (1996) and Bradbury (1999) after T<sub>3</sub> and T<sub>4</sub> were retrieved and properly dried. Each sample had three replicates.

**Data analysis:** Data were subjected to a one way analysis of variance treatment means where they existed were separated using Least Significant Difference (LSD) according to SAS Institute (2000).

## RESULTS AND DISCUSSION

**Effects of treatment on proximate composition and pH of cashew nut shell:** The effects of treatment on the proximate composition and pH of cashew nut shell is presented in Table 1 below.

Treatment had no significant ( $P>0.05$ ) effect on crude protein. Crude fibre, nitrogen free extracts and dry matter. There were significant ( $P<0.05$ ) increase in ash value for T<sub>4</sub> (1.51%) compared to T<sub>1</sub> (1.12%) T<sub>2</sub> (1.10%) and T<sub>3</sub> (1.01%) which were statistically the same this could be due to up take of some mineral elements such as calcium, magnesium, sodium, phosphorus etc by cashew nut shell from the wood ash solution.

The crude protein levels for all the treatments T<sub>1</sub> (6.22%) -T<sub>4</sub> (5.98%) were lower than the critical level of 8% for ruminants as reported by NRC (1996) necessary to provide minimum ammonia levels required by rumen

micro organisms to support optimum activities. This implies that when including cashew nut shell in rations for ruminants a fairly high protein source is required to raise the overall protein content of the ration to about 12-16% to facilitate maximum dietary crude fibre digestion in the rumen. The crude fibre levels of 23.05 to 24.57 can be tolerated by ruminants (NRC, 1996). The dry matter range of 90.30-92.21 were very high. The ash content range of 1.01 to 1.51 suggested that cashew nut shell may be low in minerals. The low mineral content could be balanced up by other ingredients or by using vitamins-minerals premix. The ether extract levels of 38.22 to 41.00% were high, this may also translate to correspondingly high carotene content (Ambarasu *et al.*, 2004). This high level of ether extracts (fats) may depress fibre digestion since Maithison (1997) reported a depression in fibre digestion when fat levels exceed 5-6% in ruminant rations. This generally implies that other ingredients to be used in compounding rations for ruminants along side cashew nut shell should be low in ether extracts so as to reduce the fat content of the rations to recommended levels. However the high ether extract content may also reduce methane emission since it was reported that there was a 33% reduction in methane emission when 4% canola oil was added to a diet containing 85% concentrate in a feed lot (Maithison, 1997).

The nitrogen free extracts of 28.51 to 30.10% are low, this would mean that other ingredients to be used in the ration especially the carbohydrate source should be high in nitrogen free extracts. There were significant ( $p<0.05$ ) reduction in pH values as a result of soaking in water (T<sub>3</sub>, 4.83) and soaking in wood Ash solution (T<sub>4</sub>, 6.60). however, pH values for T<sub>1</sub> and T<sub>2</sub> were similar.

**Effects of Treatment on mineral profile of cashew Nut shell:** The effects of Treatment on the mineral profile of cashew nut shell is summarized in Table 2.

The composition of all the minerals considered were quite low. This may be due to the low ash content of cashew nut shell (Ocheja *et al.*, 2011a). The calcium, potassium, sodium and phosphorous levels for all the treatment were lower than 0.50, 0.6, 0.50 and 0.35%

Table 1: Effects of Treatment on proximate composition and pH of Cashew Nut Shell (%)

Parameters	Treatments				S.E.M
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	
Crude protein	6.23	6.15	6.1	5.98	0.12
Crude fibre	23.05	23.55	24.57	23.91	0.35
Nitrogen free extracts	28.51	28.87	30.1	29.17	0.45
Ether Extracts	41.00 <sup>a</sup>	40.40 <sup>a</sup>	38.22 <sup>b</sup>	39.43 <sup>a</sup>	0.6
Ash	1.20 <sup>b</sup>	1.10 <sup>b</sup>	1.01 <sup>b</sup>	1.51 <sup>a</sup>	0.11
Moisture	8.50 <sup>ab</sup>	7.79 <sup>b</sup>	9.70 <sup>a</sup>	8.40 <sup>ab</sup>	0.63
Total	100	100	100	100	-
Dry matter	91.5	92.21	90.3	91.6	0.61
pH	3.51 <sup>c</sup>	3.47 <sup>c</sup>	4.83 <sup>b</sup>	6.60 <sup>a</sup>	0.62

a,b,c,: Treatment means on the same row with different super scripts differ significantly ( $P<0.05$ ). SEM: Standard error of mean.

Table 2: Effects of Treatment on the mineral profile of cashew nut shell (%)

Minerals	Treatments				S.E.M
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	
Phosphorous	0.016 <sup>b</sup>	0.016 <sup>b</sup>	0.015 <sup>b</sup>	0.020 <sup>a</sup>	0.035
Potassium	0.089	0.088	0.087	0.097	0.002
Calcium	0.007 <sup>b</sup>	0.007 <sup>b</sup>	0.007 <sup>b</sup>	0.011 <sup>a</sup>	0.007
Sodium	0.006 <sup>b</sup>	0.006 <sup>b</sup>	0.005 <sup>b</sup>	0.009 <sup>a</sup>	0.001
Copper	0.013	0.012	0.013	0.013	0.001
Iron	0.01	0.011	0.01	0.011	0.001
Zinc	0.003	0.003	0.003	0.003	0
Nickel	0.003	0.003	0.003	0.003	0
Magnesium	0.003 <sup>b</sup>	0.003 <sup>b</sup>	0.003 <sup>b</sup>	0.004 <sup>a</sup>	0.001

a,b: Treatment means on the same row with different super scripts differ significantly (P<0.05). SEM: Standard Error of Mean.

Table 3: Effects of the Treatment on the phytochemicals content of cashew nut shell (%)

Phyto-chemicals	Treatments				S.E.M
	T1 (untreated)	T2 (steaming)	T3 (water soaking)	T4 (wood ash soaking)	
Cyanide	0.009 <sup>a</sup>	0.005 <sup>b</sup>	0.002 <sup>c</sup>	0.002 <sup>c</sup>	0.002
Flavonoid	1.104 <sup>a</sup>	1.057 <sup>b</sup>	0.872 <sup>c</sup>	0.655 <sup>d</sup>	0.102
Saponin	0.060 <sup>a</sup>	0.060 <sup>a</sup>	0.054 <sup>b</sup>	0.032 <sup>c</sup>	0.056
Tannin	0.17 <sup>a</sup>	0.158 <sup>b</sup>	0.047 <sup>c</sup>	0.016 <sup>d</sup>	0.028
Alkaloids	0.16 <sup>b</sup>	0.20 <sup>a</sup>	0.12 <sup>c</sup>	0.11 <sup>c</sup>	0.09
Phytate	0.042 <sup>a</sup>	0.031 <sup>b</sup>	0.029 <sup>c</sup>	0.015 <sup>d</sup>	0.01
Oxalate	0.157 <sup>a</sup>	0.096 <sup>b</sup>	0.024 <sup>c</sup>	0.016 <sup>d</sup>	0.319
Phenolic compounds	16.83 <sup>a</sup>	15.43 <sup>b</sup>	10.43 <sup>c</sup>	8.22 <sup>d</sup>	2.035

a,b,c,d: Means on the same row with different super script differ significantly (P<0.05). SEM: Standard error of means.

levels respectively recommended for non lactating goats (NRC, 1981). The levels of the trace minerals reported i.e., copper, iron, nickel and zinc were adequate to sustain ruminants (McDonald, 2002). The significant (P<0.05) increase in values of phosphorous, calcium, sodium and magnesium for T<sub>4</sub>, could be due to up take of these minerals by cashew nut shell from the wood ash solution. The slightly lower (P>0.05) values reported for most of the minerals in T<sub>3</sub> could be due to losses of these minerals in water due to soaking.

**Effects of treatment on phytochemicals content of cashew nut shell:** The effects of treatment on the phytochemical/anti-nutritional factors in cashew nut shell are presented in Table 3.

The total phenolic compounds content of 16.83% for T<sub>1</sub> was high but lower than 20% reported by (Arogba, 2008). This is of significance since phenols possess antioxidant activity (Zinkliski, 2000). Anti oxidants reduce the rate of oxidation reactions that involve chemicals transfer of electrons from a compound or substance to an oxidizing agent. Anti oxidants play an important role in lipid and emulsion systems by preventing undesirable changes in flavours and nutritional qualities of food (Arogba, 2008). This may be useful in livestock feed preparation by way of preventing or delaying rancidity and preventing oxidative damage to the living cells and tissues of plant, animals and man. This quality is health promoting. The levels of cyanide saponin, tannins and

phytate for T<sub>1</sub> are quite low and therefore safe and so may not need treatment to remove them. Tannins have been reported to have antihelmintic properties and anti carcinogenic effects. Saponins are reported to inhibit the growth of benign and malignant tumours and are also reported to have anti microbial and antiviral properties. According to (Nityanand, 1997) ruminants can break down saponins but monogastrics can not. Saponins have been reported to have a bitter taste and hence reduce palatability as well as cause depression in feed intake (Nityanand, 1997).

The flavonoid level of 1.104% for T<sub>1</sub> was high however values for T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> were all significantly (P<0.05) reduced by all the treatment methods used in this work, this is important since flavonoids are said to have antifungal and antimicrobial activities (Arogba, 2008). The levels of Tannins for T<sub>1</sub> (0.17%) was below the levels that could reduce the ability of the rumen microbes to digest fibre (Chestrworth, 1992). The tannin level range of 0.016% (T<sub>4</sub>)-0.17% (T<sub>1</sub>) may not also be able to impact beneficial effects in terms of reducing the wasteful protein degradation in the rumen by the formation of the protein-tannin complex as reported by (Barry, 1987). The oxalate levels of 0.1160% (T<sub>4</sub>)-0.1570% (T<sub>1</sub>) were very low and therefore below the 2% level of soluble oxalate that could cause toxicity in ruminants (McKenzie *et al.*, 2005) high oxalate levels induces deficiency of calcium in grazing animals (Allison *et al.*, 2001). Soaking in wood ash solution (T<sub>4</sub>)

significantly ( $P < 0.05$ ) reduced the levels of all the phytochemicals considered while soaking in water for three days also reduced the levels of all the phytochemicals significantly ( $P < 0.05$ ) except that of saponin that was only marginally ( $P > 0.05$ ) reduced. Both results were in line with the report of (Ahmed *et al.*, 2005).  $T_2$ , heat treatment (steam) significantly ( $P < 0.05$ ) reduced the levels of all the phytochemicals tested except that of saponin which was marginally ( $P < 0.05$ ) reduced and alkaloid that recorded a significant ( $P < 0.05$ ) increase from 0.160% ( $T_2$ ) to 0.20% ( $T_2$ ), this trend however could not be explained. Soaking in wood ash solution ( $T_4$ ) appears to be the most effective of all the methods tested in this work in reducing the levels of phytochemicals even though none of the methods completely removed the phytochemicals.

**Conclusion:** Treatment methods used in this work had no significant ( $P < 0.05$ ) effects on crude protein, crude fibre, nitrogen free extracts and dry matter. Values for ether extract, pH and moisture contents were significant ( $P < 0.05$ ). Soaking in wood ash, raised the ash phosphorus, calcium, sodium and magnesium levels of cashew nut shell significantly ( $P < 0.05$ ). Soaking in water reduced the levels of phosphorus, potassium, calcium, sodium, iron slightly but values were not significant ( $P < 0.05$ ). All the phytochemicals reported were at tolerable levels, all the treatment methods used reduced the levels of phytochemicals factors significantly ( $P < 0.05$ ). Heat treatment was least effective while soaking in wood ash was most effective in reducing the levels of the phytochemicals.

**Recommendations:** The high oil content of cashew nut shell may necessitate the extraction of excess oil. Installing oil press in cashew kernel processing factory so that cashew nutshell can be managed as a feed ingredient for compounding rations for livestock that can tolerate high fibre level such as fatterer pigs and feed lot ruminants.

It is also recommended that rations containing cashew nutshell should be fortified or supplemented with ingredients high and balanced for energy, protein and essential mineral nutrients.

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