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Full length research paper

Comparative Evaluation of the Nutritive Value of *Terminalia catappa* Fruit, Husk and Kernel as Feed Supplement for Ruminants in Nigeria

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Abstract

Nutrient and anti-nutrient content, mineral composition and coefficient of preference of fruit, husk and kernel of Terminalia catappa by West African Dwarf Sheep were determined in Ijebu-Ode, South West of Nigeria. In vitro gas production of fruit, husk and kernel were carried out for a period of 24 hr incubation to predict metabolizable energy, organic matter digestibility and short chain fatty acids. Methane was measured by introducing 10 M NaOH into the inoculums after incubation. The soluble degradable fraction (a), insoluble degradable fraction (b), potential degradability (a+b) and rate of degradation (c), were also estimated. Results revealed significant ($p<0.05$) differences for nutrient content among the parts. The dry matter (DM) and neutral detergent fibre ranged from 87.23-94.19 and 26.21-46.90 % in the kernel and husk, respectively. The crude protein ranged from 4.33-14.83 % in the husk and kernel, respectively. The micro-minerals differed significantly ($p<0.05$) among the different parts, while the macro-minerals showed no significant ($p>0.05$) variation. It was observed that the husk and kernel have the lowest and highest concentration of micro-minerals, respectively. The values are: Fe (192.5 and 208.4 $mg.kg^{-1}$), Cu (3.2 and. 5.1 $mg.kg^{-1}$) and Mn (28.6 and 46.6 $mg.kg^{-1}$) respectively. The parts were implicated for anti-nutritients, though not significant. The in-vitro gas production, metabolizable energy, organic matter digestibility, short chain fatty acid and methane production varied significantly ($p<0.05$) with the kernel recording the highest value, while the lowest values were recorded for the husk. They ranged from 5.50-7.75 ml/200mg DM; 3.37-5.05 MJ/Kg DM; 26.72-40.24%; 0.14-0.25 µmol; 2-6 ml/200mg DM in the husk and kernel respectively. Same trend was observed for a, b, a+b and c ranging from 3.00- 3.50ml/200mg DM; 5.25-9.29ml/200mg DM; 8.25-12.79ml/200mg DM and 0.16-0.25ml/h in husk and kernel respectively. The coefficient of preference revealed that kernel and fruit were acceptable to the animals, while the husk was rejected, ranging between 0.82 and 1.01 in the husk and kernel respectively. The kernel was mostly preferred, it can be concluded that the fruit can be sourced for possible feed supplement for ruminants.

Key words: Coefficient of preference, *in-vitro* gas production, nutritive value, *Terminalia catappa* fruit

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Introduction

For quite some decades, browse plants have been recognized by researchers as important feed resources in ruminant feeding, serving as fairly major sources of protein. This quality is most useful in the dry season in Nigeria when most of pasture plants become dry and low in protein, minerals and vitamins (Bamikole *et al*.,2004; Babayemi, 2009). With browse plants, there is always a choice of feeding the leaves alone, the leaves with fruits or the fruits alone (Elahi *et al.,* 2017). However, there are other browse plants which are underutilized or unutilized at all. Such may include *Cida acuta* and Siam weed (*Chromolaena odorata*) among others (Anurudu *et al*., 2004). This may probably be due to paucity of information on their nutritive value.

Indian almond (*Terminalia catappa*) is one of them. It is a widely growing shade plant in Nigeria and other high rainfall areas of West Africa (Ezeokonkwo and Dodson, 2004). Fruiting twice a year, the tree is more of an ornamental plant than a feed or food source but provides seasonal fruits that may be more useful for human consumption (Adejumo, 2005). From personal observation, the fruits are copiously produced and litter the surroundings of every tree, most especially in the dry season. It is on this basis, therefore, that this study was initiated to assess the fruit, husk and kernel of Indian almond as a possible feed supplement. To arrive at this, an evaluation of nutrient and anti-nutrient content, nutritive value, mineral profile and acceptability of the different parts of the fruits were undertaken. In addition, an *in-vitro* gas production evaluation was assessed to predict the metabolizable energy (ME), organic matter digestibility (OMD), short chain fatty acid (SCFA) and methane (CH_4) of the different parts.

Materials and Methods

Study area

The study was carried out in the Teaching and Research Farm of the Tai-Solarin University of Education, Ijagun, Ijebu-Ode. Ijagun is located on the outskirt of Ijebu-Ode which is on latitude 6˚47' N and longitude 3˚58' E and about 5.4 km south of Ijebu-Ode. Climatically, Ijebu-Ode has the tropical wet and dry climate characterized by heavy annual rainfall, high temperature and high relative humidity. The mean annual rainfall is between 1200 mm and 1500 mm with peak of rainfall in the months of June and July. The mean minimum temperature is about 23˚ C in February and mean maximum temperature being 32˚ C in March. The wet season is March to October or early November (Ijebu-Ode in Maps, 1990).

Sample collection

Samples of the ripe and neat Indian almond fruits were collected from the environment of Tai Solarin University of Education, Ijebu-Ode. Some whole fruits were oven dried (in the dry season period) at 80˚ C till attaining constant weight in about 48 hours. For others picked, the pulp (mesocarp) was separated from the nuts. The nuts were cracked open to obtain the kernels while the cracked endocarp surrounding the kernel constituted the husk. Later, the pulp and the kernels were oven dried and milled in hammer mill having a 3 mm sceen mesh. All dried samples were later taken to the laboratory for analysis.

Chemical analysis

Crude protein (CP), crude fibre (CF), ether extract (EE) and total ash of samples of fruit, husk and kernel were analyzed in triplicates using standard procedure of AOAC (2012). The CP was determined with the micro Kjeldahl distillation apparatus while the neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined by Van Soest method, (1994).

Mineral analysis

Ten mineral elements were analyzed from plant parts digested with nitric acid/perchloric acid mixture in ratio 4 : 1. Each digest was made up to 100 ml in a standard volumetric flask with deionised water. The Ca, Na, K, Fe, Cu, Mn, Zn, Mg and Pb in the digest were determined with atomic absorption spectrophotometer model 420 (Gallenkamp and Co. Ltd).

Phosphorous in the digest was determined colometrically by the phosphovanadomolybdate method of AOAC (2012). The colour so developed was read in an atomic absorption spectrophotometer at 420 m/u.

Quantitative determination of tannin, saponins, oxalate and phytate

Tannin contents were determined as described by Swain (1979). The spectrophotometric method of Brunner (1984) was used for saponin analysis while oxalate and phytate contents were determined as described by Maga (1983).

Acceptability of fruit parts

Study of relative acceptability of the Indian almond fruit parts was carried out at the sheep and goat house of the Tai Solarin University of Education, Ijebu-Ode. Following the procedure of Mako *et al* (2012), eight adult West African Dwarf sheep were used in a cafeteria feed preference study that lasted two weeks. Animals were housed in a group pen in the sheep and goat house with adequate ventilation and suitable concrete floor. About 8 kg of each of fruit, husk and kernel of Indian almond was introduced on a cafeteria basis to the animals in three different wooden feeders, each measuring 100 x 40 cm, so that all animals had free access to each of the samples in the troughs. Positioning of a feed sample was changed daily to prevent bias, that is, each animal getting accustomed to a particular feeding trough. Consumption was measured for 6 h per day and quantity consumed recorded. Sample preference was determined from the coefficient of preference (CoP) value. This was calculated as the ratio of intake of each individual animal and the average intake of the three feed samples (Karbo *et al*., 1993, cited by Bamikole *et al*., 2004). Feed was taken to be relatively preferred if the CoP value was greater than unity.

***In vitro* gas production**

Rumen fluid was obtained from three West African Dwarf female goats through sunction tube before the morning feed. The animals were fed concentrate consisting of 40% corn bran, 35% wheat offal, 20% palm kernel cake, 4% oyster shell, 0.5% salt and 0.5% growers premix for three days prior to the collection of rumen liquor. Incubation was as reported (Menke and Steingass 1988) using 120 ml calibrated syringes in three batch incubation at 39 ^{0}C. Into 200 mg samples in the syringes was introduced 30 ml inoculums containing cheese-cloth-strained rumen liquor and buffer ($NaHCO_3$ + Na_2HPO_4 + KCl + NaCl + $MgSO_4.7H_2O$ + $CaCl_2.2H_2O$) (1:2, v/v) under continuous flushing with CO_2. The gas production was measured at 3, 6, 9, 12, 15, 18, 21 and 24, after 24 h of incubation; 4 ml of NaOH (10 M) was introduced to estimate the amount of methane produced. The average of the volume of gas produced from the blanks was deducted from the volume of gas produced per sample. The volume of gas produced at intervals was plotted against the incubation time, and from the graph, the gas production characteristics were estimated using the equation $Y= a+b(1-e^{-ct})$ described by Orskov and McDonald (1979), where Y= volume of gas produced at time 't', a = intercept (gas produced from insoluble fraction), c = gas production rate constant for the insoluble fraction (b), t = incubation time, metabolizable energy (ME, MJ /Kg DM) and organic matter digestibility (OMD, %) were estimated as established (Menke and Steingass 1988) and short chain fatty acids (SCFA, *u*mol) was calculated as reported (Getachew *et al,* 1999)

$$ME = 2.20 + 0.136^{*}GV + 0.057^{*}CP + 0.0029^{*}CF$$
$$OMD = 14.88 + 0.889GV + 0.45CP + 0.651XA$$
$$SCFA = 0.0239^{*}GV – 0.0601$$

Where GV, CP, CF and XA are net gas productions (ml /200 mg DM), crude protein, crude fibre and ash of the incubated samples respectively.

Statistical analysis
Data obtained were analyzed and subjected to analysis of variance procedure (ANOVA) of SAS (2012). Significant treatment means were separated by Duncan's multiple range test of the same package.

Results and discussion
Chemical composition
The chemical composition of the fruit, husk and kernel of Indian almond are presented in Table 1. Significant differences ($p < 0.05$) were observed among the different fruit parts for dry matter (DM), organic matter (OM), crude protein (CP) , ether extract (EE), ash, neutral detergent fibre (NDF) and acid detergent lignin (ADL). The OM was highest in all the materials with a mean value of 94.47 %. Dry matter content was highest in the husk (94.19 %) and least in the kernel (87.23%). These values agreed with those of Odure *et al*. (2009), Akpabio (2012) and Abegunde (2014) who reported 97.24 %; 95.00 % and 92.50 % respectively for the OM of Indian almond seed (nut). Also, these values were within the range of those reported for by-products sometimes used for animal feeds such as cowpea husk (93.05%), groundnut shell (94.10 %), etc. (Malau Aduli *et al*., 2003, cited by Bamikole and Babayemi, 2008).

The CP was highest in the kernel (14.83 %), followed by the whole fruit (6.52 %) and least in the husk (4.33 %). Crude protein component in this study (4.33 % - 14.83 %) is consistent with 7.22 % - 18.40 % reported elsewhere (Ajayi and Oyewole 2017) but lower than values (24.00 %) obtained by Mbah *et al*. (2013) and (24.00 %) by Deng *et al.* (2017). However, these values are higher than 5.94 % reported elsewhere (Bolaji *et al*., 2013). The variations in all these studies could have resulted from wide variation in the sampling method, analytical procedure and stage of ripening of the fruits among other factors. In the opinion of Bamikole and Babayemi (2008), the recommended critical CP level is 7 %, below which feed intake in ruminants is depressed. Judging by this opinion, only the kernel of Indian almond is considered adequate in CP constituent. The fruit and the husk would need some level of protein fortification to meet up to standard.

The EE component followed the same trend with DM, while the ash followed that of OM. Both were moderate in the samples suggestive of possible long shelf life if utilized as a feed resource and reasonable amount of mineral contents. Obviously this level of EE would not be able to inhibit microbial activities during fermentation in the rumen thereby leading to a depressed digestibility as observed by Orskov and Ryle (1990). The NDF contents of the fruit (40.32 %), husk (46.90 %) and kernel (36.21 %) were fairly low and below 55-60 % level that can limit feed intake (Wanapat *et al.,* 2013). The higher proportion of cell walls (NDF) in the husk could be explained by the fact that it is the hardy and stony part of the almond fruit (the endocarp).

Table 1: Chemical composition (%) of fruit, husk and kernel of Indian almond plant

Parameters	Fruit	Husk	kernel	SEM
Dry matter	90.17^b	94.19^a	87.23^c	0.39
Organic matter	95.71c	94.09^b	93.60^a	0.30
Crude protein	6.52^b	4.33^c	14.83^a	0.24
Ether extract	5.94^b	8.69^a	4.16^c	0.29
Ash	4.29^c	5.91^b	6.40^a	0.30
Neutral detergent fibre	40.32^b	46.90^a	36.21^c	0.28
Acid detergent fibre	19.77^c	32.11^a	36.21^b	0.22

^{a,b,c}= means on the same row with different super script differed significantly ($p<0.05$)

Macro- and micro-mineral elements

Table 2 presents the macro- and micro-mineral concentrations in the fruit, husk and kernel of Indian almond plant. Result indicated that the fruit, husk and kernel contained all the minerals analyzed in appreciable quantities. There were no significant differences ($p > 0.05$) among the different parts for the macro-minerals. However, for the micro-minerals, there were significant differences ($p < 0.05$). The Ca and P concentrations in the three samples were similar.

The K concentration in the kernel (0.816 g/100g DM) was highest while K values in fruit (0.374 g/100g DM) and husk (0.422 g/100 g DM) were low and similar. Sodium concentrations were similar in the three. Also, Mg contents were similar. With regard to recommended small ruminant requirement levels of 0.18 – 1.04 g/100g DM of Ca; 0.16-0.37 g/100g DM of P; 0.18 – 0.25 g/100g DM of K; (Underwood, 1981); 0.04-0.10 g/100g DM of Na; and 0.08 - 0.25 g/100g DM of Mg (NRC 2002), the fruit, husk and kernel of Indian almond can adequately take care of the required levels of these minerals in sheep and goats. The samples also have sufficient concentrations of Fe, Zn and Mn to meet the recommended 30 - 40 mg/kg Fe; 20 – 50 mg/kg Zn and 20 – 40 mg/kg Mn (NRC 2002) for the small ruminants. As for goat and sheep requirement for Cu, put at 8 -10 mg/kg (NRC 2002) the samples cannot meet this requirement adequately. The extremely high concentration of Fe (192.5 – 208.4 mg/ kg DM) in the studied samples could be of concern for fear of Fe toxicity. However, McDowell (1992) has opined that Fe toxicity is a rear problem in domestic animals. This is because the absorption of Fe is independent of the dietary source. The efficiency of absorption may drastically increase during periods of iron need and decrease drastically during periods of Fe overload in a sort of feed-back mechanism.

Table 2: Macro- and micro-mineral content of fruit, husk and kernel of Indian almond plant

	Macro minerals (g/100g DM)					Micro minerals (mg/kg)				
Form	Ca	P	K	Na	Mg	Fe	Zn	Cu	Mn	Pb
Fruit	0.232	0.364	0.422	0.196	0.316	196.4^{b}	52.7^{a}	4.3^{b}	31.2^{b}	11.4^{a}
Husk	0.226	0.343	0.374	0.185	0.287	192.5^{c}	47.4^{b}	3.2^{c}	28.6^{c}	9.5^{b}
Kernel	0.251	0.285	0.816	0.213	0.300	208.4^{a}	31.7^{c}	5.1^{a}	46.6^{a}	2.7^{c}
SEM	0.42	0.42	0.42	0.42	0.41	0.35	0.35	0.48	0.47	0.36

^{a,b,c} = means on the same row with different super script differed significantly ($p<0.05$)

Anti-nutrients

Presented in Table 3 are the anti-nutritional factor contents (ANFs) of Indian almond fruit, husk and kernel. The different samples were all implicated for all the ANFs investigated. However, no significant variation ($p > 0.05$) occurred among the different parts. For tannin, the husk had the highest (0.036 %) while the kernel had the lowest (0.017 %). The level of tannin in this study is lower than the range of 6 – 10% considered to depress feed intake and growth (Min *et al.,* 2003), also lower than the range of 142.5 and 390 g/kg reported for Ficus thonnigi and Ficus exasparate respectively (Yusuf and Muritala, 2013). Diets containing 2 – 4% tannin of the DM in ruminants have been shown to have beneficial effects because they reduce the protein degradation in the rumen by forming a protein-tannin complex thereby increasing the amount of by-pass protein that will be available in the small intestine for the animals (Barry and McNabb, 1999; Yacout, 2016). If the tannin concentration in a diet is high, >7%, microbial enzyme activities including cellulose and intestinal digestion may be depressed (Tadele, 2015; Yacout, 2016). Tannins are capable of binding to protein to form both reversible and irreversible complexes leading to decreased protein digestibility. However, on the positive side, tannin in animal feeds can increase efficiency of protein utilization, reduce parasite burden, reduce proteolysis during ensilage, prevent bloat, increase quality of animal products, reduce nitrogen emission into the environment and defaunate the rumen (Adesogan, 2004, cited by

Tadele, 2015). Same trend was observed for saponin, oxalate and phytate. These ANFs also called plant secondary metabolites are compounds which reduce the nutrient utilization or feed intake of plants used in animal feeds. Many of them can cause toxicity in livestock. The oxalate levels in the studied samples ranged from 0.36 – 1.40 % which were comparable to 0.52-0.82 % in some herb legumes fed to goats (Ologhobo, 1989) or to 0.49 % in some five *Ficus* species (Bamikole *et al*., 2004) and quite below the 2 % level that can lead to acute toxicosis in ruminants (Tadele, 2015). Oxalate binds minerals like Ca, Mg, K and Na forming their complexes which are highly insoluble and therefore interfere with their metabolism. Saponin levels in Indian almond fruit (0.68 %) and husk (0.73 %) may be considered to be on the high side while level in the kernel (0.10 %) was low and safe. Forages containing saponin have been shown to be defaunating agents (Teferegene, 2000) and capable of reducing methane production which is energy loss to the animals and also contribute to the destruction of ozone layer (Johnson and Johnson, 1995). The level of saponin obtained in this study may not pose any problem to the animals. On a general note saponins can affect animal performance and metabolism through erythrocyte haemolysis, blood and liver cholesterol reduction, decreased growth rate, bloat in ruminants, inhibition of smooth muscle activity, enzyme inhibition and reduction in nutrient absorption (Tadele, 2015). Phytate levels in the samples, though not significant was least in the kernel (0.62 %) and highest in the fruit (1.25 %) and husk (1.26 %). All three levels could be considered safe as they were far below the 5 % level suggested to be toxic by Onwuka (1983). The biochemical significance of phytate in feedstuffs is the formation of protein and mineral-phytic acid complexes thereby reducing protein and mineral bioavailability. It is also inhibitory to the actions of gastrointestinal tyrosinase, trypsin, pepsin, lipase and amylase (Tadele, 2015).

Table **3**: Anti-nutritional factors and contents (%) in fruit, husk and kernel of Indian almond plant

Parameters	Fruit	Husk	Kernel	SEM
Tannin	0.028	0.036	0.017	0.41
Oxalate	1.400	1.142	0.356	0.42
Saponin	0.680	0.730	0.104	0.42
Phytate	1.251	1.260	0.623	0.42

Animal preference

The preference level of animals fed the fruit, husk and kernel of Indian almond are on display in Table 4. A coefficient of preference (CoP) value higher than unity was taken to be preferred or accepted while the converse was true for a CoP value less than unity. For this reason, the fruit (CoP, 1.01) and the kernel (CoP, 1.32) were accepted by the animals while the husk (CoP, 0.86) was not. Of note, the kernel in which the levels of the ANFs and NDF (26.21 %) were lowest was the most preferred while the husk with the highest levels of tannin, saponins, phytate and NDF (46.90 %) was the least preferred. The tannin level of a sample is capable of reducing feed intake and lowering palatability, while high saponins level can cause astringent sensation (Tadele, 2015). Furthermore, the NDF of a forage or sample is a good indicator of how much forage/sample an animal will consume. It is the best indicator of net energy lactation, net energy maintenance or net energy gain since intake has a major effect on a net energy content. As the NDF content of forages increases, forage intake and net energy decrease.

Table 4: Preference of experimental animals introduced to fruit, husk and kernel of Indian almond plant

Form	Mean daily (kg DM) Consumption of all animals	Coefficient Of preference	Ranking
Fruit	4.23	1.01	2
Husk	3.35	0.86	3
Kernel	5.23	1.32	1

In-vitro gas production:

Figure 1, shows the gas production pattern from fruit, husk and kernel of TC at 24 hr incubation period. Ruminal fermentation of structural and non-structural carbohydrates produces gases, acetate, propionate and butyrate (Rodriguez *et al.,* 2015). The rate and extent of gas production can be considered a good indicator of the digestibility and fermentability of feeds and microbial protein synthesis (Elghandour et al. 2015a). The different kinetics of gas production depends on the chemical composition of the fermented substrates that illuminates their nutritional value as feeds (Elghandour *et al.,* 2015b). Significant differences ($p<0.05$) were observed for all the parts from 3 to 24 hr incubation period. The net volume of gas produced increased progressively with hour of incubation. Total gas produced ranged from 3.0 to 7.75 ml/ 200 mg DM in the husk and kernel respectively. Gas production is an indication of degradability of samples (Arifuddin *et al.,* 2017). The degradation observed in the samples is an indication that TC fruit can be used as feed supplement for ruminants Fig 1**.**

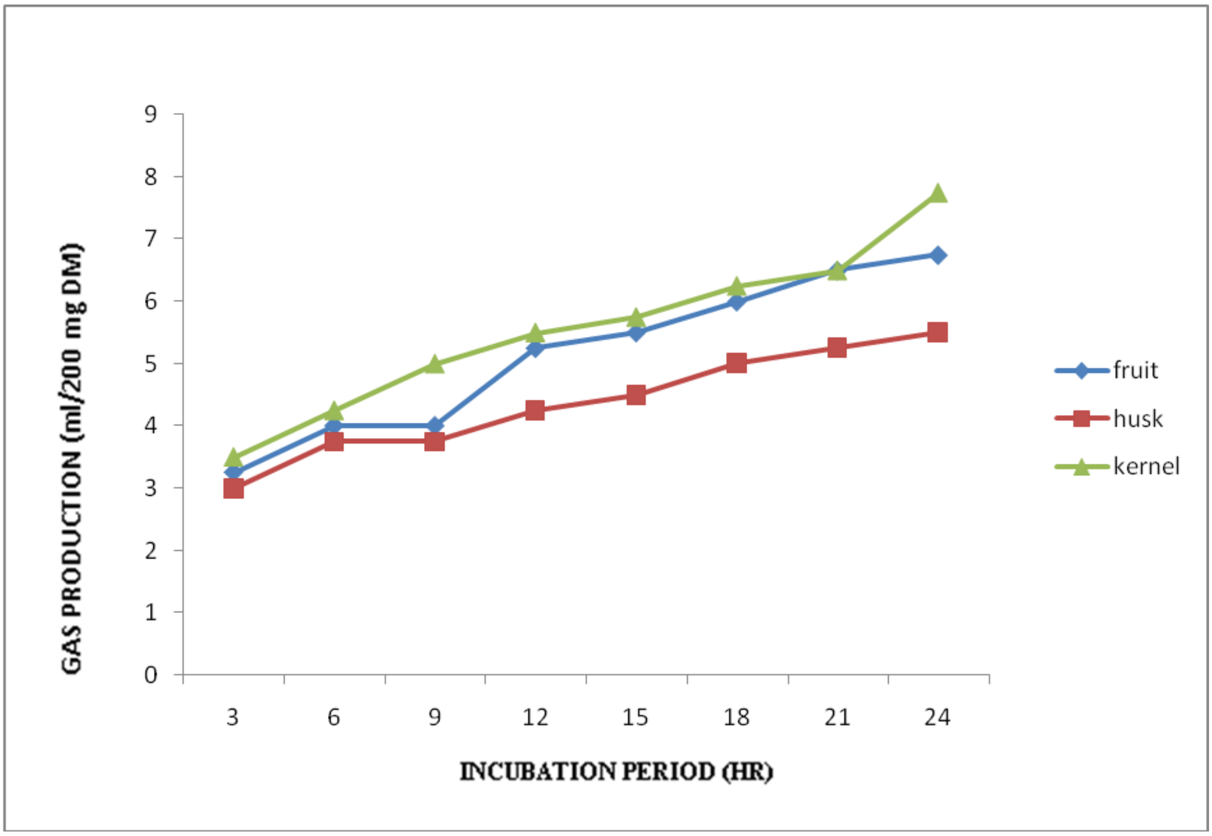

Figure 1: *In vitro* gas production (ml/200 mg DM) of Fruit, husk and kernel of *Terminalia catappa*

Table 5 present the *in vitro* gas fermentation characteristics of fruit, husk and kernel of TC. Fraction 'a' indicates the amount of gas produced from soluble degradable fraction of the samples. This is the fraction that rumen microbes first ferment for them to obtain energy for immediate requirement. Result of this study indicated no significant variation for this fraction, with the kernel recording the highest value (3.25 ml/200 mg DM) and husk recording the lowest value (3.00 ml/200 mg DM). This result is comparable to a range of 4.92 – 5.87 reported for *Zea mays* leaves elsewhere (Arifuddin *et al.,* 2017). This is an indication that the kernel consist of more rapidly degradable carbohydrate. The 'b' indicates the fraction that is insoluble but degradable, this fraction varied significantly ($p<0.05$) among the fruit parts with the kernel recording the highest value (9.29 ml), while the lowest value (5.25 ml) was obtained in the husk. These values are lower and at variance with the value range (49.041 and 52.487 ml) reported for *Leucaena leucocephala* leaves collected during wet and dry seasons respectively (Arifuddin *et al.,* 2017). This is the fraction that is fermentable at a slower rate compared to the 'a' fraction. It is the fraction that rumen microbes ferment after the rapidly fermented fraction has been depleted; the 'b' fraction then becomes the major source of gas generated during the course of fermentation. The lower 'b' values obtained in this study are indications of the fibrous nature of the incubated samples (Mako, 2009). The 'a+b' fraction indicates the potential degradability of the fruit parts. It follows the same trend with the 'b' fraction. It ranged significantly from 8.25 to 12.79 ml in husk and kernel respectively. These values are lower than values of 98.1 ml reported for *Leucaena leucocephala* (Babayemi 2007). The rate of degradation 'c' among the fruit parts was not significant. The highest (0.25 ml/h) rate of degradation was obtained in the kernel, while the lowest (0.16ml/h) was recorded for the husk. These values are higher than values (0.0007ml/h) reported elsewhere (Babayemi, 2007).

Table 5: *In vitro* gas characteristics of fruit, husk and kernel of *Terminalia catappa* (Indian almond)

Parameters	*In vitro* Characteristics			
	a (ml/200 mg dm)	b (ml/200 mg dm)	c (ml/h)	a+b (ml/200mg DM)
Fruit	3.25	7.13^{b}	0.20	10.38^{b}
Husk	3.00	5.25^{c}	0.16	8.25^{c}
Kernel	3.25	9.29^{a}	0.25	12.79^{a}
SEM	0.74	1.51	0.07	1.58

a= soluble degradable fraction; b= insoluble degradable fraction;
a+b = Potential degradability; c= rate of degradation,
SEM = standard error of mean

The results of calculated parameters: metabolizable energy (ME, MJ /Kg DM), short chain fatty acids (SCFA, µmol) and organic matter digestibility (OMD, %) for fruit, husk and kernel of TC are presented in Table 6. The ME, SCFA and OMD values for fruit, husk and kernel differed significantly ($p<0.05$). The ME, SCFA and OMD ranged from 3.37 to 5.05 MJ/Kg DM; 0.14 to 0.25µmol and 26.72 to 40.24% in the husk and kernel respectively. This result is lower and at variance with the values (7.5 to 10.4 MJ / Kg DM; 0.751 to 1.185 µmol and 40.7 to 70.4%) reported for *Albizia lebbeck* and *Tephrosia bracteolate* seeds (Babayemi *et al.,*2009). The ME is a source of energy to animals consuming the feed samples. Feedstuffs that are inherent in certain anti-nutritive factors have been reported to be low in metabolizable energy and organic matter digestibility (Aregheore and Abdulrazak 2005);

this might be the reason for the fairly low ME and OMD obtained in this study. However, the kernel with ME (5.05 MJ / Kg DM), SCFA (0.25 µmol) and OMD (40.24 %) came superior to the fruit and husk. Also, these values were within the range of values reported elsewhere (Ogunbosoye and Babayemi, 2010) for some non leguminous browse plants as dry season feed for ruminants in Nigeria. For the plants, they reported: ME (4.90 – 6.46, MJ / Kg DM), SCFA (0.32 – 0.57, µmol) and OMD (38.43 – 48.67, %).

Table 6: Metabolizable energy (ME, MJ / Kg DM), short chain fatty acids (SCFA, µmol) and the organic matter digestibility (OMD, %) of *Terminalia catappa* (Indian almond)

	In vitro Parameters		
Parameters	ME (MJ/Kg DM)	SCFA (µmol)	OMD (%)
Fruit	3.67[b]	0.19[b]	29.91[b]
Husk	3.37[c]	0.14[c]	26.72[c]
Kernel	5.05[a]	0.25[a]	40.24[a]
SEM	0.21	0.04	1.40

ME = Metabolizable energy; SCFA = Short chain fatty acid;
OMD = Organic matter digestibility; SEM = standard error of mean

Figure 2, presents the methane production of the fruit, husk and kernel of TC. The fruit and the husk recorded the same value (2 ml) for methane production. Therefore no significant variation occurred between the husk and fruit for methane production, but significant difference was observed between the husk, fruit and the kernel. It ranged significantly from 2- 6 ml in the husk, fruit and kernel respectively. This result is lower than the range of 18 to 24 ml reported for some dry season forages (Babayemi, 2007). In most cases feedstuffs that show high capacity for gas production are also observed to be synonymous with high methane production. Methane production during ruminal fermentation indicates an energy loss of 10 – 11 % of gross energy intake (McCrabb and Hunter, 1999; cited by Ogunbosoye and Babayemi, 2010). When saponin-rich ingredient is added to such a diet, methanogenesis is reduced (Ogunbosoye and Babayemi, 2010).

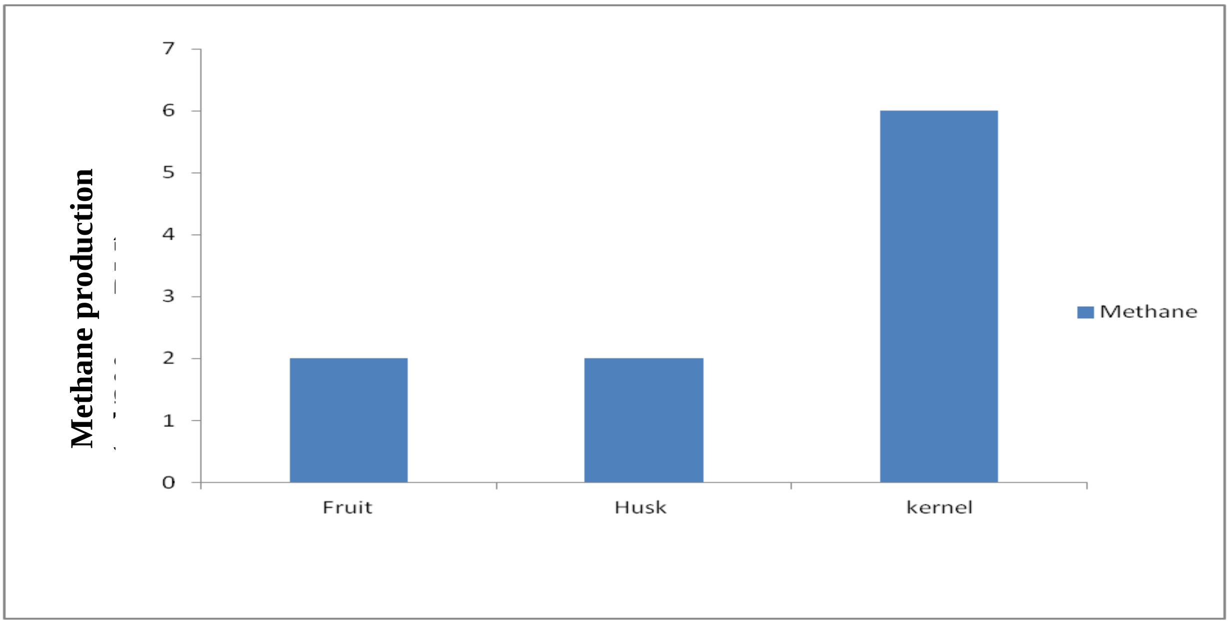

Figure 2: Methane Production (ml/200mg DM) of Fruit, husk and kernel of *Terminalia catappa*

Conclusions

From this study, *T. catappa* is a good fruit for livestock consumption. The minerals and chemical compositions as characterized, are comparable to many other fruits and seeds. This is suggestive of a good supplement to other feed ingredients. The anti-nutritional factors reported are not much that could be of concern to nutrition. Of the three samples investigated, the kernel is most superior in feed value and is therefore recommended. However, because the seed of *T. catappa* is hard to crack which often breaks into pieces during extraction there is a hinderance to full utilization of the kernel. To surmount this problem calls for further research efforts.

Conflict of Interst

Author didn't declare any conflict of interst regarding this article.

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