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EFFECTS OF DIFFERENT PROCESSING METHODS ON NUTRIENT CONTENTS AND ACCEPTABILITY OF HOG PLUM (*Spondias mombin* Linn.) LEAF BY WEST AFRICAN DWARF SHEEP

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ABSTRACT: Three experiments were conducted to evaluate the effect of processing method on leaves from *Spondias mombin* tree as fodder for ruminants in the tropics. The leaves were subjected to three different physical processing methods; T1 control (fresh but air drying), T2 (fresh but soaked in ordinary water for 24 h then air drying), and T3 (fresh but soaked in water at 50°C for 20 min then air drying). Nutrient and secondary metabolites content were determined in experiment 1. In experiment II, the Coefficient of preference (CoP) was determined. In vitro gas production was used to predict metabolizable energy (ME), organic matter digestibility (OMD), short-chain fatty acid (SCFA) and methane (CH4) of *S. mombin* leave with different processing methods in experiment 111. Results revealed significant differences in the chemical composition of *S. mombin* leaf subjected to different processing methods. The dry matter value was highest in *S. mombin* leaves soaked in hot water (90.22%), and lowest in *S. mombin* leaves soaked in water at room temperature (85.05%). Crude protein was highest in leaf processed with hot water (11.25 %) and lowest in control (9.59 %). No significant variations were observed for minerals and anti-nutrients investigated. The Vitamin content of leaves of *S. mombin* tree with various processing methods differed significantly except for vitamin E. The preference coefficient value was greater in leaves soaked at 50°C for 20 mins than leaves from the other processing method and control. All leaves of *S. mombin* tree from all processing methods considered in this study were acceptable to the animals, but leaves soaked in 50°C for 20 mins were most preferred. The in vitro gas production parameters and characteristics were not significantly different. In conclusion, *S. mombin* leaf subjected to 50 °C for 20 mins is more advantageous as forage in animal nutrition than unprocessed.

Keywords: *In vitro* gas production, Nutritional value, Processing method; Ruminant, *Spondias mombin* leaf.

INTRODUCTION

The potential of browsing plants as an alternative fodder resource in ruminant nutrition has attracted the attention of researchers worldwide (Mbatha and Bakare, 2018; Medjekal et al., 2020). Several indigenous and exotic browse species have been investigated and evaluated for inclusion in ruminant feeding systems. Unfortunately, farmers' adoption of most of these species faced several challenges, such as pests and disease attacks and the presence of anti-nutritional factors. Therefore, there is the need for continuous screening of browse plants to identify those with good potential as supplements for livestock fodder and which could serve as alternatives to those species that have already been evaluated (Fadiyim et al., 2011). *Spondias mombin*, popularly known as the Caja plant, belongs to the family Anacardiaceae, native to the tropical Americas and have naturalized in many parts of Africa and Southeast Asia (Duarte and Paull, 2015). It is predominant in all Brazilian regions and West Africa (Sofowora, 2013). *Spondias mombin*, a rainforest plant, is commonly found in Nigeria's southwest and coastal region (Fadimu et al., 2018). The leaves are used for animal feed during the drought. Various parts of the plant are being used in traditional medicine (Tabuti et al., 2010).

Similarly, Cordeiro et al. (2021) reported that the leaves of *S. mombin* have antimicrobial and antioxidant substances such as tannins, saponins, resins, sterols, triterpenes, flavonoids, and alkaloids. Njoku and Akumefula (2007) report that the leaves of *S. mombin* are potential feedstuff for ruminants because of their richness in crude protein, vitamins, and minerals. Igwe et al. (2010) reported that the crude protein and fibre content from three different species of Spondias mombin ranged from 11.04 to 14.23% and 8.93 to 10.51%, respectively. This crude protein (CP) content compares well with many other browsing plants. Though, biologically active constituent in plants with potential as animal feeding stuff has been a concern. The treatments to which these plants are subjected could have a significant effect on the availability or unavailability of these constituents to animals (Schmitt et al., 2020; Ntalo et al., 2022).

The use of physical treatment of leaves and seeds in livestock feeds to reduce secondary metabolites has been explored by many researchers. Osum et al. (2013) reported a significant ($P < 0.05$) decrease of micronutrients in the extracts, while it caused a significant ($P<0.05$) increase in the protein, fat, and ash content of the oven-dried leaves of *Vitex doniana* subjected to different processing methods. Sallau et al. (2012) also observed an 88.10%,80.95% and

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61.90% reduction of cyanide in the leaf of *Moringa oleifera* after subjection to boiling, simmering, and blanching, respectively. Similarly, following boiling, the trypsin inhibitor in *Arachis hypogaea* L. (groundnut) lowered to 0.09TUI/g from 0.12TUI/g, while the oxalate content also reduced from 3.04 mg/g to 2.62 mg/g. When Asparagus beans (*Vigna Sesquipedis*) were soaked in water, the alkaloids reduced from 0.34 to 0.28%, phytate from 0.18 to 0.09, tannin from 0.23 to 0.09%, trypsin inhibitor from 13.82 to 9.41 TUI/100g: HCN from 8.63 to 5.68% and Saponin from 0.42 to 0.24% (Nwosu, 2010). Most previous studies explored the medicinal benefits of this plant; however, to the best of our knowledge, there are no studies that consider the effect of processing method on the nutritional value and preferences of *S. mombin* leaf for ruminant nutrition.

Therefore, considering this plant's potential to be a browsing plant, this study is designed to evaluate the effect of processing methods on the nutritional value and acceptability of *Spondias mombin* leaves by West Africa Dwarf sheep.

MATERIAL AND METHODS

Ethical approval: Institutional Animal Care and Use Committee Statement (I.A.C.U.C.)

Routine care and experimental protocols used in this study were approved by the Animal Science Unit in Department of Agricultural Science, of Tai Solarin University of Education, Ijagun. Ijebu-Ode, Nigeria, and conformed to published guidelines for ethical conduct and reporting of research in animal science (Jarvis et al., 2005; Kilkenny et al., 2010).

Harvesting of leaves and identification

Spondias mombin leaves were harvested from *Spondias mombin* trees located at the botanical garden of Tai Solarin University. Ijebu Ode, Nigeria and authenticated at the Herbarium unit of the Department of Agriculture at the same University.

Processing techniques

About 15 kg of the leaves were harvested, washed, and processed using different methods for nutrient content evaluation, acceptability, and in vitro gas production. The following processing techniques were used. Fresh and air drying for 48 h (control, T1), Fresh but soaking in water for 24 hours, then air-drying for 48 h (T2), and Fresh but soaking in a water bath of 50 ^{o}C for 20 mins, then air drying for 2-days (T3) as described in the review of Samtiya et al. (2020). Each processing method processed about 5kg of *Spondias mombin* leaves for the nutritional content, acceptability, and in vitro gas production experiments. After this, the leaf samples from all treatments were packed into sealed nylon, labelled accordingly, and kept for experimental use.

Chemical analysis

Dry matter, crude protein, crude fibre, ether extract and total ash of samples were analyzed in triplicates using the standard procedure described in AOAC (2012). The neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined by the Van Soest (1995) method.

Analysis of minerals

A total of ten minerals were analyzed. All samples were digested with HNO3 / HClO3 mixtures (nitric acid and perchloric acid) (20:5 v/v). The digest was 100 ml in a standard volumetric flask with deionized water. Ca, Na, K, Fe, Cu, Mn, Zn, Mg and Pb in the digest were determined with the atomic absorption spectrophotometer model 420 (Gallenkemp and Co. Ltd). Phosphorus in the digest was estimated with vanadomolybdate solution. The colour that developed was read with a spectrophotometer at 420 nm.

Quantitative determination of Tannin, Saponin, Oxalate and Phytate

Tannin contents were determined as described by Bohm and Kocipai-Abyazan (1994). Peng and Kobayasli (1995) method was used for saponin analysis. While Oxalate and Phytate contents were determined as described by Oke (1969) and Maga (1983).

Determination of Vitamin content

Vitamins A and E were determined as described by AOAC (2000). The water-soluble Vitamin B was determined as follows: B1 as described by Poornima and Ravishankar (2009), B2 as described by Uraku et al. (2014) and B3 as described by Scalar (2000). Vitamin C was determined as described by Hussain et al. (2006).

Acceptability study

Sixteen West African Dwarf sheep of 18±0.5 kg average body weight was individually housed in pen, 1.5×1.5 m in size, using a complete randomized design with four animals per treatment. Each pen has 3 different feeding troughs (150 × 60 cm each) with one water trough. Leaves (about 1 kg) from each processing method were placed in a separate feeding trough and were strategically placed in the pen in the form of cafeteria feeding, with animal having free access to each of the three feeding troughs (Mako, 2009). The feed preference study lasted for 10 days, excluding a week for the

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animals' adaptation to the leaves from different processing methods. The location of feeders was changed every day to prevent the adaptation of the animal to a particular feeding trough. The feeding was allowed from 08:00 to 16:00 hr daily.

The feed consumed was determined by deducting the feed refusal from the quantity offered. Dried samples (about 200 g) of each processing method taken during the 10-day acceptability trial were used to determine the dry matter content. The leaves of processing method preferred were assessed from the Coefficient of preference (CoP) value calculated from the ratio between the intakes of each processing method divided by the average intake of all processing methods (Mako and Babayemi, 2008). Thus, the plant was acceptable, provided the CoP was greater than 1.

In vitro gas production

This was carried out using the method described by Menke and Steingass (1988). A 200 mg milled leaf sample of each processing method was incubated in triplicate with buffered rumen fluid in 120 ml calibrated glass syringes. A total of 12 ewes of West Africa Dwarf sheep 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 seven days prior to the collection of rumen liquor. Before morning feeding, rumen fluid was collected from the 12 ewes using a suction tube into a pre-heated (39 °C) thermos flask. This was mixed with the buffered mineral solution in the ratio of 1:2 under continuous stirring and flushing with carbon dioxide. Then 30 ml inoculums containing cheesecloth strained rumen liquor and buffer (NaHC03 + Na2HP04 + KCl + NaCl + MgS04. 7H20 + CaCl2. 2H20) were dispensed into a pre-heated sample containing blank syringes and incubated in a water bath maintained at 39 °C. The reading of gas volume was recorded after 3, 6, 9,12,15,18 and 24 h of incubation. The average volume of gas produced from the blanks was deducted from the gas produced per sample. The volume of gas produced at intervals was plotted against the incubation time. From the Graph 1, the gas production characteristics were calculated using the equation, Y= a+b (1-e-ct) described by Orskov and McDonald (1979), where Y= volume of gas produced at the time (t), a = intercept (gas produced from insoluble fraction), c = gas production rate constant for the insoluble fraction (b), and t = incubation time.

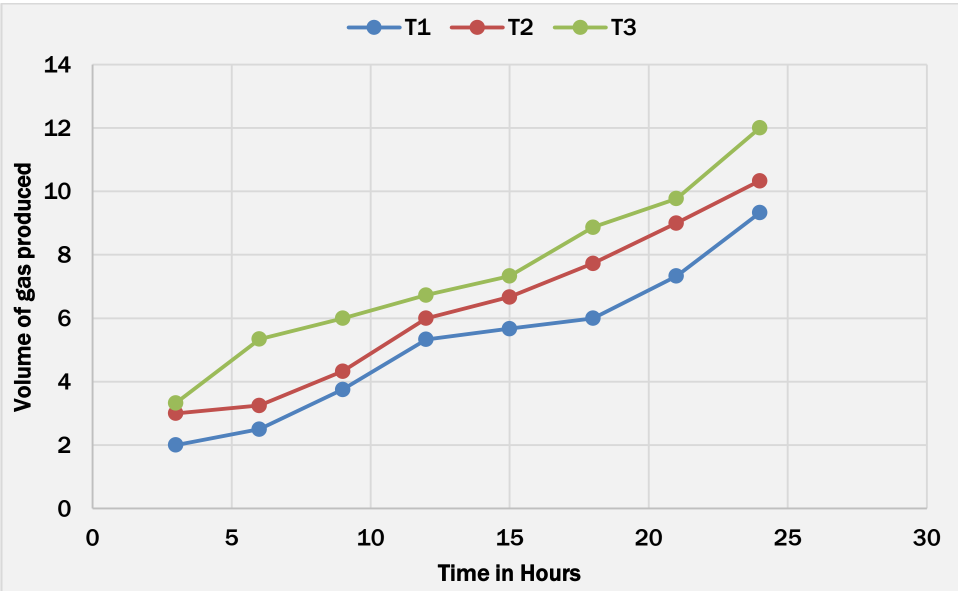

Figure 1 - Gas Production (ml/200mg D.M.) of *Spondias mombin* leaves subjected to different physical processing methods.

The methane gas component was measured at the end of the fermentation period by injecting 4.0 ml of NaOH (10 M) into each syringe containing the incubated samples, following the technique described by Fievez et al. (2005). The measured methane gas volume was related to its respective total gas volume to estimate the methanogenic potential of the digestible OM (Moss et al., 2000). The volume of gas produced after 15 h of incubation was used as an index of energy content and organic matter digestibility (O.M.D.) as described by Menke and Steingass (1988) and short-chain fatty acid (S.C.F.A.) production according to Negesse et al. (2009).

The metabolizable energy (M.E., M.J./Kg D.M.) and organic matter digestibility (O.M.D., %) were estimated as established by Menke and Steingass (1988), and short-chain fatty acids (SCFA, mmol) 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, C.F. and X.A. are net gas productions (ml /200 mg D.M.), crude protein, crude fibre, and ash of the incubated samples.

Statistical analysis

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Data obtained were analyzed using SAS's general linear model (GLM) procedure- 2012. Single-factor analysis of variance (ANOVA) was used to assess the effects of the processing method of *Spondias mombin* leaf on nutrient composition, coefficient of preference, in vitro gas production, O.M.D., ME and S.C.F.A. with the following model: Yij = μ + Bi + Eij. Where: Yij is an observation, μ is the overall mean, Bi is the effect of leaf growth stages, and Eij is the experimental error. Significant means were separated by Duncan's (1955) Multiple Range Test. Differences between means were considered statistically significant, P<0.05.

RESULTS

The result of the chemical composition is presented in Table 1. It was observed that all parameters examined varied significantly (P<0.05). The dry matter ranged from 85.05 – 90.22 %, with leaves soaked in water at room temperature for 24 hours having the lowest while leaves soaked in 50 °C for 20 mins the highest value. The crude protein content ranged from 9.59-to 11.25%. The macro and micro mineral content of *S. mombin* leaves subjected to different physical processing methods are presented in Table 2. The result revealed that all leaves from different processing methods contained all minerals investigated. There were no significant variations among the leaves from different processing methods for all the minerals investigated.

Presented in Table 3 is the anti-nutritional content of *Spondias mombin* leaves subjected to different physical processing methods. All the physical processing methods were implicated for all the antinutrients investigated. No significant variation occurred among the different processing methods. The tannin, oxalate, saponin and phytate levels ranged from 0.27-0.88; 0.392-0.432; 0.281-0.397 and 0.6-0.623 %, respectively.

Table 4 presents the vitamin content of leaves subjected to different physical processing methods. All vitamins investigated differed significantly (P<0.05) except vitamin E. In all the vitamins analyzed, the *S. mombin* leaves subjected to hot water (50 °C) for 20 mins had the lowest values while the control had the highest values. Table 5 presents the Coefficient of preference (CoP) of *Spondias mombin* leaves exposed to different physical processing methods by sheep. Table 6 shows the *in vitro* gas production parameters of *Spondias mombin* leaves exposed to different physical processing methods. No significant differences were observed for metabolizable energy (ME), organic matter digestibility (OMD), short-chain fatty acid (SCFA) and methane (CH_4). They ranged from 3.89-4.52 MJ/Kg D.M., 37.13-39.01%, 0.15-0.22 µmol, and 3.50-6.00 ml soaked in hot water for 20 mins, soaked in water at room temperature and the control, respectively.

Figure 1 presents the gas production pattern of the different processing methods *of Spondias mombin* leaves incubated for 24 hr.

Table 1 - Chemical composition (%) *Spondias mombin* leaves subjected to different

Parameters \ Physical processing methods	T1	T2	T3	S.E.M.
Dry matter (DM)	85.05^c	89.34^b	90.22^a	0.42
Crude protein (CP)	9.59^c	10.28^b	11.25^a	0.33
Crude fibre	17.18^a	16.64^b	15.23^c	0.20
Ether extract	8.24^a	7.95^b	7.50^c	0.30
Ash	10.00^a	9.79^b	8.25^c	0.20
Neutral detergent fibre	46.48^c	57.94^b	55.01^a	0.32
Acid detergent fibre	33.63^c	35.52^b	45.67^a	0.40
Acid detergent lignin	10.98^a	10.24^b	9.56^c	0.30

^{abc}= means on the same row with different superscripts differ significantly (*P<0.05); SEM= Standard Error of mean

Table 2 - Macro and micro mineral content of *Spondias mombin* leaves subjected to different physical processing methods

Processing methods	Macrominerals (%)					Micro minerals (mg/kg)				
	Ca	P	K	Na	Mg	Fe	Zn	Cu	Mn	Pb
T1	1.230	0.22	2.156	1.21	0.41	569.0	58.5	13.3	22.4	11.2
T2	1.330	0.17	1.70	1.17	0.38	551.5	54.3	11.0	20.4	9.1
T3	1.341	0. 13	1.65	1.06	0.26	546.1	53.3	10.8	17.6	8.4
SEM	0.29	0.15	0.13	0.30	0.29	10.9	2.5	0.8	7.3	0.9

SEM= Standard Error of the mean (*P<0.05)

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Table 3 - Secondary Metabolites (%) content of *Spondias mombin* leaf subjected to different physical processing methods

Parameters \ Physical processing methods	T1	T2	T3	S.E.M.
Tannin	0.88	0.44	0.27	0.41
Oxalate	0.432	0.408	0.392	0.42
Saponin	0.397	0.368	0.281	0.42
Phytate	0.623	0.617	0.600	0.42

SEM= Standard Error of the mean (*P<0.05)

Table 4 - Vitamin content (mg/100 g) of *Spondias mombin* subjected to different physical processing methods

Vitamins \ Physical processing methods	T1	T2	T3	S.E.M.
A	5.72[a]	5.10[b]	4.38[c]	0.01
B1	0.060[a]	0.040[b]	0.021[c]	0.001
B2	0.31[a]	0.281[b]	0.223[c]	0.001
B3	3.87[a]	3.54[b]	3.21[c]	0.02
C	19.01[a]	17.21[b]	14.43[c]	0.21
E	1.12[a]	1.01[a]	1.10[a]	0.001

[abc]= means on the same row with different superscripts differ significantly (*P<0.05); SEM= Standard Error of mean.

Table 5 - Mean of daily intake of leaves from different parts of *Spondias mombin* and the Coefficient of preference by WAD sheep.

Processing methods	Mean daily (kg/D.M.) consumption by all animals	Coefficient of preference	Ranking
T1	3.26	1.85	3
T2	3.40	1.89	2
T3	4.23	2.05	1

Table 6 - *In vitro* Parameters of leaves of *Spondias mombin* subjected to different physical processing methods

Methods \ *In vitro* parameters	ME (MJ/Kg DM)	SCFA (µmol)	OMD (%)	CH_4 (ml/200mg DM)
T1	3.89	0.15	37.13	6.00
T2	4.12	0.18	38.78	4.15
T3	4.52	0.22	39.01	3.50
SEM	0.24	0.04	1.75	2.00

ME= Metabolizable energy; SCFA= Short chain fatty acid; OMD= Organic matter digestibility; CH_4 = Methane; SEM = standard error of mean. (*P<0.05)

Table 7 - *In vitro* characteristics of *Spondias mombin* leaves subjected to different physical processing methods.

Methods \ *In vitro* characteristics	a (ml/200 mg DM)	b (ml/200 mg DM)	c (ml/h)	a+b (ml/200 mg DM)
T1	1.10	14.45	0.10	16.01
T2	1.30	15.13	0.10	17.23
T3	1.43	18.06	0.11	19.13
SEM	0.1	1.05	0.02	1.52

a= soluble degradable fraction; b= insoluble degradable fraction; a+b= Potential degradability; c= rate of degradation; SEM= standard error of mean (*P<0.05)

DISCUSSION

The proximate analysis results quickly estimate the nutrient content of leaves or feedstuff and show the potential and clues for further research. Though, the proximate analysis of the feed may not be the true reflection of the nutritional value of such feedstuff. It provides the primary guideline in screening feedstuff with the potential of being a browse plant for ruminant animals.

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The dry matter (DM) and the crude protein values obtained in the study are more in the processed leaves than in control. This result agrees with Adebayo et al. (2014) but is lower than the 15.44% CP reported by Omoniyi et al. (2013). The same trend as the dry matter and crude protein was observed for ADF and NDF. These values are lower and at variance with the values reported by Igwe et al. (2010) but in agreement with the values reported by Adebayo et al. (2014). The CP content is more than that proposed as the minimum requirement for growth (113g C.P./Kg D.M.) and lactation (120 CP/Kg D.M.) in ruminants (NRC, 2001). This makes Spondias mombin leaves a good source of protein supplement for low-quality roughage. The values of NDF for physically processed leaves are within the recommended limit of 60.00% guaranteed for forage intake by ruminants (Wanapat et al., 2013). The ash content of the processed leaves was lower than the control but was still high despite the treatment effect. This suggests that many inorganic elements are contained in the leaves (Akinmoladun, 2018; Mishra et al., 2022). The macro and micro mineral content of *S.mombin* leaves subjected to different physical processing methods revealed that all leaves from different processing methods contained all minerals investigated. There were no significant variations among the leaf from different processing methods for all the minerals investigated. However, all the minerals investigated have higher values in control than the processed except for Calcium. This implies that most of the minerals analyzed in this study are vulnerable to water treatment, reducing them when subjected to water treatment. Yet, the values obtained in the processed leaves are within the recommended limit for the proper functioning of the body system and agree with the values reported for Spondias mombin by Ayoola et al. (2010).

Tannins are plant polyphenols that can form complexes with metal ions and macromolecules such as proteins and polysaccharides, thereby protecting them from ruminal degradation (Akubugwo and Ugbogu, 2007; Siemińska-Kuczer et al., 2022). Mlambo et al. (2015) report that 2- 3% of tannin in ruminants' diets is beneficial because it helps in reducing rumen protein degradation by the protein-tannin complex formed. They can reduce feed intake, feed efficiency and weight gain when the value is above 60 to 100g/kg (Ogbe and George, 2012). Saponin suppresses methanogenesis, a significant energy loss to animals (Wang et al., 2009). Agbaire (2012) observed that Saponin higher than 10% in ruminant diets could result in gastroenteritis, diarrhoea, and dysentery. Oxalate can form complexes with most essential trace elements, making them unavailable for enzymatic activities and other metabolic processes. High doses of oxalic acid cause corrosive gastroenteritis, shock, convulsive symptoms, and renal damage (Eneobong, 2001). Phytic acid inhibits the absorption and utilization of some mineral elements (Eneobong, 2001). In this study, the values of all phytochemicals investigated are lower in the processed treatments than in the control. This implies that subjecting S. mombin leaves to water for 24 at room temperature or to hot water (50 ^{o}C) for 20 mins would significantly reduce the secondary metabolites considered in this study. Therefore, S. mombin leaves treated by physical methods in this study lower the antinutrients appreciably without adversely affecting the proximate composition. All phytochemicals investigated were within the safe limit for ruminant consumption, as reported by Teferedgne (2000). This makes the values of these phytochemicals in all the different processing methods in this present study beneficial. Vitamins are organic molecules that are essential micronutrients which an organism needs in small quantities for an efficient functioning of its metabolism system. Vitamins quantity produced via the body is insufficient. Therefore, sources through diet are essential. The values of all the investigated vitamins are lower in the processed leaves compared with the control. This could be because most of these vitamins, except vitamin E, are water-soluble vitamins. However, the values fall within the recommended levels for ruminant animals, as Maduka et al. (2014) reported. The high values of vitamins observed showed that the plant has a high nutritive value which could attenuate physiological oxidative stress due to its high concentration of vitamin C and E (Maduka et al., 2014). Also, feeding this plant to ruminants will boost such animals' immune and reproductive systems because of the high-level vitamin C and E content.

The nutritional content of a feed is crucial; however, an animal's acceptance of such feed is more vital. Hence, this aspect of the study was looked into. The animals' co-efficient of preference (CoP) showed that all leaves subjected to different physical processing methods were acceptable to the animals because the CoP was greater than unity (Mako and Babayemi, 2008). Many factors may influence the acceptability of feed by ruminants. Provenza and Cinocotta (1994) reported that physical plant structure and chemical composition are the most vital factors influencing animals' preference for feed. The crude protein of the leaf subjected to soaking in hot water for 20 mins was the highest. This might be the reason why it is most preferred. Also, this could be because this treatment contains the lowest values of phytochemicals like tannins that can affect the palatability of browse plants compared to others. Similarly, the action of a short time soaking in hot water could make the leaves succulent and soft; hence the most preferred compared with others.

In combination with in vitro digestibility and ME content, chemical composition can be considered valuable indicators for preliminary evaluation of the potential nutritive value of forages (Kafilzadeh and Heidary, 2013). The values of ME, OMD, and SCFA obtained here indicate that animals will obtain energy from the S. mombin leaves subjected to different physical processing methods. Methane production is an energy loss to ruminants. Also, it has environmental implications as a significant contributor to greenhouse gas emissions (USEPA, 2014). Feedstuff that shows a high capacity for gas production is also synonymous with high methane production (Njidda, 2010), hence the reason for high methane production in control compared with others. The result obtained in this present study aligned with the 4.74 MJ/Kg D.M.; 38.03 % and 0.22 μmol reported for Spondias mombin leaf by Omoniyi et al. (2013), but lower and at variance with the report for Spondias mombin leaf by Ogunbosoye and Babayemi (2010). This variance could be due to different processing methods used.

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The same trend as in vitro gas production parameters was observed for a, b, a+b and c. These results are lower and at variance than Ogunbosoye and Babayemi (2010) report for Spondias mombin leaf.

The gas production pattern reflects the effectiveness and extent of forages' degradability because forages with high ruminal degradability of dry matter tend to have high gas production (Njidda and Nasiru, 2010). A high lignin level negatively influences the degradation of fibre and non-fibre (Mizubiti et al., 2011). The lignin content obtained in the control treatment in this study is high, hence the low volume of gas produced. There was a steady increase in the gas production for 24 hours; no significant variations were observed in the gas volume produced at every interval. Many factors may determine the amount of gas produced during fermentation, depending on the nature and level of fibre, the presence of secondary metabolites and the potency of rumen liquor (Babayemi et al., 2004). The values observed in this present study agree with the report for Spondias mombin leaf by Omoniyi et al. (2013) but are lower and at variance than the 43 – 175 ml reported by Ogunbosoye and Babayemi (2010). This could be attributed to the processing methods implored in the research. The processed treatments have lower lignin content compared with unprocessed. The low volume of gas production of the Spondias mombin leaf in control connotes the low digestibility of the leaf, which may be due to the higher values of anti-nutritional factors and fibre compared with the processed.

CONCLUSION

The nutrient, antinutrient, mineral, vitamin content, and *in vitro* gas production fermentation revealed that Hog plum (*Spondias mombin*) leaf has potential forage for ruminants when subjected to physical processing methods such as soaking in hot water (50 ^{o}C) for 20 mins. In addition, animals prefer Hog plum leaves soaked in hot water (50 ^{o}C) for 20 min. compared with ordinary air-dried leaves before feeding.

DECLARATIONS

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Authors' contribution

Conceptualization, investigation, writing, data collection and methodology were carried out by Ikusika Olusegun and Adejoke Mako. While Thando Mpendulo and Ikusika did the statistical analysis, supervision, and validation of the research work.

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Data availability statement

Data Will be available on request.

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