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NUTRITIVE VALUE AND ACCEPTABILITY OF DRY BANANA LEAVES ENSILED WITH CASSAVA PEELS AND UREA BY WEST AFRICAN DWARF SHEEP

*Abegunde, T. O., Odedire, J. A., Akande, C. O., Omoleke, R. T. and Adebayo, M. A.

Department of Animal Sciences, Obafemi Awolowo University
Ile-Ife, Osun State, 220282, Nigeria

*Corresponding author

ABSTRACT

Scarcity of feed resources for ruminant animals during the dry season is a serious challenge in developing countries. However huge quantities of unwanted farm wastes such as dried banana leaves are either burnt, disposed or left to rot on the farm on a yearly basis. The potential of dried banana leaves ensiled with cassava peels and urea as feed for ruminant animals was thus investigated.

Dried banana leaves ensiled with varying levels of cassava peels (0, 10, 20 and 30 %) to make dietary treatments (T1, T2, T3 and T4 respectively), were assessed for its chemical, anti-nutrients and organic acids contents. Feeds were offered to twelve West African Dwarf (WAD) sheep to assess the acceptability of the silage in a cafeteria experiment. Proximate analysis of the four (silage) diets showed that it contained 95.90 – 97.20 % dry matter (DM), 8.05 – 11.3 % crude protein (CP), 31.95 – 36.55 % crude fibre (CF), 6.95 – 11.10 % ether extract (EE), 7.25 – 11.05 % ash content, 35.43 -38.80 % Nitrogen Free Extract (NFE). There was no significant difference ($P>0.05$) in the NFE fractions across the dietary treatments. Crude fibre reduced ($P<0.05$) with increasing levels of the cassava peels. The dietary treatment significantly ($P<0.05$) affected the tannin content and other antinutrient components, except for saponin, as they reduce with increasing level of cassava peels in the diet. Acetic acid and propionic acid contents were not significantly ($P<0.05$) affected by silage composition. Lactic acid contents of T2 and T3 were higher ($P>0.05$) than T1 and T4. Physical attributes of silage diets were adjudged to be adequate, based on the colour, temperature, pH and smell. The order of preference of silage diets by WAD sheep is: T4 > T2 > T3 > T1. Dried banana leaves ensiled with cassava peels and urea holds potential as silage feed for ruminants showing better quality and acceptability by WAD sheep as cassava peel increased in the diets.

Keywords: Acceptability, Banana leaves, Feed Intake, WAD sheep and Silage.

INTRODUCTION

The uncertainty over the consistency of production and quality of pasture forage or green fodder particularly in the dry season necessitates the utilization of abundant non-conventional feedstuffs by goats (Okwori *et al*., 2016). Other means of bridging this gap is to conserve available fodder by ensiling (Wong, 2000). The conservation of forage as silage should be of particular interest and value to Nigerian livestock farmers since it provides ample opportunity for harnessing wet season`s excess forage growth for later use during the period of scarcity in the dry seasons (Adeyinka *et al*., 2008).

Banana by-products which consist of the banana crop residues (stem and leaves) are often used fresh as feeds for ruminants. Parts of the banana plant, such as leaves, young plant, rejected fruits and stems, can be used as fodder for ruminants, particularly cattle, sheep, goats and buffalo. By-products of the banana plant can produce 11.20 t ha^{-1} of dry matter (Rochana *et al*., 2017). Dried banana leaves are common in many parts of West Africa and it is available all year round. The dried leaves are well preserved and are seen hanging on the plant. Katongole *et al*., (2008) reported dry matter contents of the leaves as 21.6 %, while Hembade and Patel (2004) reported the protein content of the leaves as 11.3%. The leaves can be fed to sheep as a fresh forage, hay or silage (Eniolorunda and Oduyemi, 2003). Dried banana stalks have been fed to goats at 20 % DM of diet and up to 50 % DM without any adverse effects, except for low daily weight gains (Poyyamozhi and Kadirvel, 1986). Their value was comparable to that of other crop residues such as cereal and rice straws and sugarcane tops (Viswanathan *et al*., 1989). Banana plant waste silage is low in energy and protein. So, strategic supplementation (smart feeding) of locally available concentrate supplements such as maize, wheat bran and soybean meal with or without addition of non-protein nitrogen (NPN) sources will compensate for the low weight gain or milk yield (Anjaneya, 2015). Dried banana leaves contain very low fermentable carbohydrates which may not support adequate fermentation process in silage production. Good quality silage requires the production of lactic acid to rapidly reduce pH and this is predicated on the condition that the plant material contains sufficient fermentable carbohydrates (McDonald *et al.*, 1995). Cassava peels which represents about 5 – 15% of the root contains easily fermentable carbohydrates in forms of sugar (Aro *et al*., 2010; Nwokoro *et al.*, 2005) and is a suitable source of fermentable carbohydrates. The use of cassava peels as additive in silage production is well documented (Olorunnisomo and Fayomi, 2012; Falola *et al*., 2013). In this way, sufficient fermentable carbohydrate for lactic acid bacteria is provided and simultaneously the protein content of the

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silage is increased (Asefa and Ledin, 2001). One other way of resolving this challenge is through the inclusion of non protein nitrogen sources such as urea in low quantity. Shoukry *et al*., (1999) reported that ensiling with urea was preferable to drying when feeding banana foliage to sheep. This practice is a common and cheap method of increasing nitrogen (N) supply to ruminants fed silage. The present study was therefore designed to assess the nutritive value (Antinutrients, chemical composition, Lactic and volatile fatty acid contents) and acceptability of dried banana leaves ensiled with cassava peels and urea as feed for WAD sheep.

MATERIALS AND METHODS

Experimental Location

The research was carried out at the laboratory of the Department of Animal Sciences, Obafemi Awolowo University, Ile-Ife, Osun State while acceptability trials were carried out at the Sheep and Goat Unit of the Teaching and Research Farm of the same university, with latitude 7°31 8.4"N and longitude 4° 31 15.96"E in the tropical rainforest ecological zone of Nigeria (Amujoyegbe *et al*., 2008).

Silage Production

Dried banana leaves were collected from a banana plantation within the campus of the Obafemi Awolowo University, Ile-Ife and cassava peels were collected from Tonkere, a village very near to the University Teaching and Research farm. Fertilizer grade urea was used as the Non protein Nitrogen source. Dried banana leaves were chopped into lengths of about 2-3cm using a forage chopper to aid compaction. The chopped leaves were mixed with the cassava peels (fermentable carbohydrate source) at varying inclusion levels of 0%, 10%, 20%, 30% of the total silage diet. Urea solution (30g/l H_2O) was sprinkled on the silage mixture before they were packed, compacted and sealed in thick industrial polythene bags to create an anaerobic condition for proper fermentation. The silage was ensiled for twenty eight (28) days before being fed to the WAD sheep.

Proximate components

Separate and smaller packs of the prepared silage, for the purpose of laboratory analysis, were opened and samples taken and oven dried at 65 ^{0}C until constant weight was obtained for dry matter determination after which they were milled and ether extract, crude fibre, Crude protein, ash and Nitrogen Free Extract of the diets were determined according to the standard procedures of AOAC (2000)

Determination of volatile fatty acid and lactic acid contents of the silages

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The volatile fatty acid composition of the sample extraction and analysis were carried out using the modified standard test methods of Anthony *et al*. (1986) The lactic acid content was determined using the calorimetric method of Baker and Summerson (1941).

Antinutrients determination

Saponin, oxalate, Tannin, phytate, alkaloid and flavonoids were determined following the procedure of Obadoni and Ochuko, (2001), Day and Underwood (1986), Makkar and Goodchild, (1996), Day and Underwood, (1986), Boham and Kocipai-Abyazan, (1974), Harborne, (1976) respectively.

Physico-chemical parameters

Physico-chemical parameters were assessed following the methods described by Kilic (1986). The colour of the silage was assessed using a colour chart while smell and texture of the silage mixtures were adjudged by six (6) individuals. The temperature and pH of the silage was determined using a pH meter installed with a thermometer.

Acceptability trials

Twelve (12) WAD Sheep were used in a Cafeteria experiment to evaluate the acceptability of ensiled mixtures of dried banana leaves and cassava peels with urea. The cafeteria experiment lasted seven days after initial seven day – adaptation period. About 1.5kg (3% body weight) of each diet was introduced for a duration of six (6) hours per day in eight (8) different plastic feeding troughs. The position of the feeding troughs was changed daily to prevent bias and conditioning of the animals in recognizing part of the pen for a particular diet (Ogunbosoye and Otukoya, 2014). The amount consumed was monitored for six hours per day after which they were fed with dried cassava peels. Feed preference was determined from the coefficient of preference (CoP) value (Falola *et al.*, 2013, Ososanya and Olorunnisomo, 2015). A diet was adjudged to be relatively preferred when the CoP value is greater than unity (Karbo et al, 1993, Babayemi, 2007).

$$\text{CoP} = \frac{\text{Intake of individual feed offered}}{\text{Mean intake of all the feed offered}}$$

Statistical analysis

All data collected were subjected to analysis of variance (ANOVA) using the procedure of SAS (1999). Significant treatment mean values were compared using the Duncan Multiple Range Test of the same package. The mean obtained for Dry matter intake was ranked using SPSS 2.0.

RESULTS AND DISCUSSION

Table 1 shows the gross composition of the silage diets with varying levels of cassava peels and constant urea inclusion. T1 had no cassava peels while T2, T3 and T4 had 10, 20 and 30% cassava peels included in the diets with all treatments sprinkled with 30g urea/lH_2O. Urea is a compound highly soluble in the rumen, which produces ammonia, used by microorganisms for the synthesis of microbial protein (Barbosa *et al*., 2012). The utilization of urea either in drinking water, or sprinkled on stover has been suggested as a possible means of improving the nutritive value of crop residues (Jayasuriya, 1982). Its use in silage production had also been reported (Deville *et al*., 1979; Elkholy *et al*., 2009).

Table 1: Gross composition of experimental silage diets of dried banana leaves, cassava peels and urea.

Treatments	Dried Banana Leaves (%)	Cassava Peels (%)
T1	100	-
T2	90	10
T3	80	20
T4	70	30

Table 2 presents the chemical composition (g/100g DM) of dried banana leaves silage ensiled with varying levels of cassava peels and urea. Ensiling with cassava peels significantly ($P<0.05$) reduced CP level of diets which ranged from 8.05 to 11.30 g/100g DM. These values were however higher than values reported by Anjaneya (2015) for fresh banana plant waste silage. This is probably due to the inclusion of urea in the fermented diets. Crude fibre (CF) values reduced ($P<0.05$) with increasing levels of cassava peels in diets with CF values ranging from 31.95 - 36.55 g/100g DM. These values are similar to those reported (29.00 - 35.00 g/100gDM) by Olorunnisomo (2011), for Elephant grass ensiled with increasing levels of cassava peels. The crude fiber values obtained in this study are higher than 18.70% obtained by Mako *et al*., (2011). Reduction in CF content may have resulted from increased cell wall degradation due to increased silage fermentation caused by the addition of cassava peels. This statement agrees with the report of Bolsen *et al*. (1996). Ether extract was significantly affected by the inclusion levels of cassava peels, with lowest values observed in diets with 10% Cassava peels (7.40%) while diet ensiled with 20% cassava peels had the highest value of 11.10%. Ash contents (8.55-13.10g/100g) of

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dried banana leaves ensiled with cassava peels are higher (P<0.05) than that without cassava peels. This may be as a result of higher ash content of cassava peels as compared to dried banana leaves. The ash values reported in this study are similar to the value (12%) reported by Omole *et al.*, (2011) but higher than 5.1% reported by Valarini and Possenti, (2006). The ash content is an indication that the silage diets ensiled with cassava peels will be a good source of minerals. There were no significant differences in the Nitrogen Free Extracts (NFE) across the dietary treatments.

Table 2: Chemical composition (g/100g DM) of dried banana leaves ensiled with varying levels of cassava peels and urea

Parameters	T1	T2	T3	T4	SEM	PROB
CP	11.30^{a}	8.05^{c}	9.98^{b}	9.98^{b}	0.32	0.0006
DM	96.35^{bc}	95.90^{c}	97.20^{a}	96.70^{ab}	0.18	0.0052
CF	36.55^{a}	35.15^{a}	33.80^{b}	31.95^{c}	0.09	<0.0001
EE	9.40^{b}	6.95^{c}	11.10^{a}	7.40^{c}	0.48	0.0011
ASH	7.25^{b}	11.05^{ab}	8.55^{ab}	13.10^{a}	1.41	0.0723
NFE	35.43	38.80	36.88	37.58	5.40	0.3873

$^{a, b, c, d}$: Means within each row with different superscript are significantly different (p<0.05); T1 = 100%DBL + US; T2 = 90%DBL +10%CP + US; T3 = 80%DBL + 20%CP + US; T4 = 70%DBL + 30%CP + US;

Table 3 shows the anti-nutrient contents of the dried banana leaves ensiled with cassava peels. Saponin content of diets was unaffected by treatments. Saponins are high-molecular-weight glycosides, consisting of a sugar moiety linked to a triterpene or steroid aglycone (Hostettmann and Martson, 1995). The results obtained here does not agree with the reports of Pinos-Rodriguez *et al.* 2008 who found that ensiling *Agave salmina* led to reductions in saponin levels. The same trend of reduction in saponin levels was also reported by Lima *et al.* (2015) in *Brachiaria* species ensiled and made into hay. Materials used for silage production will determine to a large extent the content of the anti-nutrients and how they are affected by the process. In this study, dry banana leaves which contained low levels of anti-nutrients were used while cassava peels contain low saponin. This situation might have brought about the similarity in the saponin values in all the silage diets. Oxalate was higher (P<0.05) in T3 than in others. The Oxalate content (0.13-0.45 g/100g) reported in this study is low when compared to 1.26 % earlier reported for yam peel and 1.04% reported for Sweet potato peel (Akinmutimi and

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Anakebe, 2008) and 0.024% reported for orange peel (Oluremi *et al.*, 2010). The oxalate values obtained are lower than the critical values of 0.8 - 1.2% DM to cause problems of calcium imbalance (Bolenz *et al.*, 1990). Oxalates from plant sources have been known to cause irreversible oxalate nephrosis when ingested in large doses. Phytate (g/100g) was similar and higher ($P<0.05$) in T2 (0.36) and T3 (0.37) than T1 (0.30) and T4 (0.27). The significant reduction of phytate in the diet with 30% inclusion implies adequate fermentation which facilitated the anti-nutrient reduction despite the increased quantity of cassava peel in this diet. Phytic acid acts as a strong chelator to form insoluble complexes that are not readily absorbed from the gastro intestinal tract (Leiner, 1980). The values reported in this study are similar to the values of 10.12 – 12.45 mg/g reported elsewhere for cassava peels ensiled with moringa, gliricidia and leucaena (Aye, 2016). However, these values are lower than the critical levels in ruminant diet. Silage dietary treatment significantly ($P<0.05$) affected the tannin content of diets with highest ($P<0.05$) value observed in T2 (93.2 mg/100g) and lowest value observed in T4 (65.2mg/100g). This result shows a reduction in tannin content with increasing inclusion level of cassava peels and this can be attributed to the fermentation process involved across the diets. Losses of sugars during wilting and the first step of ensiling, by plant respiration and microbial growth could explain the reduction of the anti-nutrients in the present study. Alkaloids and flavonoids were significantly higher in T2 than in other treatment diets. Alkaloids are the most efficient therapeutically significant plant substance (Njoku and Akumefula, 2007). Although the alkaloid contents of the silage diets is lower compared to those of some medicinal plants, its presence in the silage diets presents them as adequate for animals as alkaloids possess significant pharmacological properties (Bribi, 2018)

Table 3: Anti-nutrients in dried banana leaves ensiled with cassava peels and urea

Parameters/Treatments	T1	T2	T3	T4	SEM	Prob
Saponin (g/100g)	0.18	0.15	0.11	0.13	0.03	0.4006
Oxalate (g/100g)	0.13^{b}	0.23^{b}	0.45^{a}	0.13^{b}	0.03	0.0003
Phytates (g/100g)	0.30^{b}	0.36^{a}	0.37^{a}	0.27^{b}	0.01	0.0020
Tannin (mg/100g)	63.0^{d}	93.2^{a}	87.9^{b}	65.2^{c}	0.59	<0.0001
Alkaloids (g/100g)	0.45^{b}	0.61^{a}	0.49^{b}	0.42^{b}	0.01	<0.0001
Flavonoids (g/100g)	0.31^{c}	0.44^{a}	0.37^{b}	0.33^{c}	0.01	0.0002

$^{a, b, c, d}$: Means within each row with different superscript are significantly different ($p< 0.05$)

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T1 = 0%CP + 100%DBL+ US;T 2 = 10%CP + 90%DBL+ US; T3 = 20%CP + 80%DBL+ US; T4 = 30%CP + 70%DBL+ US; CP = Cassava Peels; DBL = Dried Banana Leaves; US = Urea Solution; SEM = Standard error of mean; Prob = Probability level.

Table 4 shows the volatile fatty acids and lactic acid content of silage diets. Acetic acid and propionic acid contents were not affected (P<0.05) by varying levels of cassava peels. Similarity in the acetic and propionic acid values across silage diets obtained from this study agrees with the report of Alvarez *et al.* (2012) that the percentage of propionic acid in green banana and bunch ensiled with additive did not vary with the conservation period. Butyric acid and lactic acid are higher in T2 and T3 than T1 and T4. Lactic acid values ranged from 3.50 (T4) to 4.44 % (T3). Lactic acid bacteria produce lactic acid which plays an important role in the preservation of green crops. The diet with highest value of lactic acid (T3) may have been better preserved due to the preponderance of lactic acid produced. McIlroy *et al*. (1977) reported that the lactic acid content in aerobic fermentation products, such as silage, ranged from 1.55-2.5%. Under this condition, the stability of the nutrients was achieved in the fermented feed material. Lactic acid content (3.50 – 4.44) was within the range (4-7%) reported by Ward (2011). The acetic acid obtained across the diet was within the acceptable range (< 3%) (Ward, 2011). Propionic acid content of the silage diet was slightly above the recommended values for grass silage (0.1 % of 25-35% DM) while the butyric acid values observed in this study are within the recommended values of <0.5% of 25-35% DM.

Table 4: Volatile fatty acids, lactic acid and Ammonia nitrogen profile of dried banana leaves ensiled with Cassava peels and urea

Parameter g/100g	T1	T2	T3	T4	SEM	PROB.
Acetic acid	1.89	1.70	1.66	1.97	0.09	0.1194
Propionic acid	0.12	0.20	0.26	0.15	0.04	0.2128
Butyric acid	0.10^{b}	0.18^{a}	0.14^{ab}	0.11^{b}	0.01	0.0236
Lactic acid	3.66^{b}	4.20^{a}	4.44^{a}	3.50^{b}	0.15	0.0069

$^{a,b,c:}$ means within the same rows with different subscript are significantly different (p<0.05). T1 = 0%CP + 100%DBL+ US;T 2 = 10%CP + 90%DBL+ US; T3 = 20%CP + 80%DBL+ SD; T4 = 30%CP + 70%DBL+ US; CP = Cassava Peels; DBL = Dried Banana Leaves; US = Urea Solution; SEM = Standard error of mean; Prob = Probability level.

Physico-chemical parameters of dried banana leaves ensiled with cassava peels are presented in Table 5. These parameters include temperature of the silage diets which ranged between 28.50 - 29.27°C and pH value of 3.55 – 4.82, while colour ranged from brown to dark brown. Temperature is one of the essential factors affecting silage colour (Falola *et al*., 2013). Excessive heat production is indicative of poorly preserved silage which could result in mallard reaction which further affects the digestibility of protein and fibre components (Bolsen et al., 1999). The lower the temperature during ensilage, (probably) the less will be the colour change (Babayemi, 2009). Temperature of silage diets in this study are higher than that reported by Falola *et al*. (2013) for Vetiver grass ensiled with cassava peels, but similar to those reported for guinea grass harvested at 4 and 6 weeks regrowth (Babayemi, 2009). There was a progressive reduction in pH as cassava peels increased in the silage mixture. This implies that cassava peels served as adequate additive for proper fermentation characteristics of the plant material. Lower pH values have been indicated to preserve silages better and elicit longer stability during feeding out process. The pH values obtained in this study were lower than the recommended values of 4.5-5.5 classified to be pH for good silages (Menenses *et al*., 2007). However, similar lower pH (3.0-3.9) had been reported for silages in the tropics (Bilal, 2009, Nhan *et al*., 2009 and Ososanya and Olorunnisomo, 2015). Good silage is described as that which retains the original colour of the standing plant (Oduguwa *et al*., 2007). This is in line with the observed colour of silages in this study as the brown colour of the dry leaves was retained in the final silage product. Texture of the silage diets was firm, not wet but fairly moist. The firm texture indicating a well preserved silage.

Table 5: Physico-chemical parameters of dried banana leaves ensiled with Cassava peels and urea

Parameters	T1	T2	T3	T4
Temperature	28.83°C	28.88°C	28.50°C	29.27°C
Texture	Dry	Moist firm	Moist firm	Moist firm
Smell	Choking	Slightly pleasant	Pleasant alcoholic	Pleasant alcoholic
pH	4.82	3.73	3.66	3.55
Colour	Brown	Dark brown	Dark brown	Dark brown

T1 = 100%DBL + US; T2 = 90%DBL +10%CP + US; T3 = 80%DBL + 20%CP + US; T4 = 70%DBL + 30%CP + US;

The result of the Acceptability trial of dried banana leaves ensiled with cassava peels is shown in Table 6. Silage preference on cafeteria basis showed that T4 was most preferred while T1 was least preferred. When the CoP is equal to or greater than 1, the diet is considered to be acceptable

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and when CoP is less than 1, the diet is assumed to be unacceptable to livestock (Ososanya and Olorunnisomo, 2015). Accordingly, silage diets T1 (comprising of dry banana leaves ensiled without cassava peels) and T3 were rejected by sheep, while T2 and T4 were preferred. The order of preference was: T4 > T2 > T3 > T1. The result on the preference of silage diets is supported by the observations from the physico-chemical parameters where the accepted silages had the most desirable smell and pH for well preserved silage.

Table 6: Acceptability of dried banana leaves ensiled with cassava peels and urea by WAD sheep.

DIET	Mean Dry matter intake (KgDM)	CoP	RANK
T1	0.055^{d}	0.678^{a}	4th
T2	0.098^{b}	1.128^{bc}	2nd
T3	0.075^{c}	0.98^{b}	3rd
T4	0.112^{a}	1.27^{c}	1st

^{a,b,c}: Means within same column with different superscripts differ significantly ($p<0.05$)

CoP = Coefficient of Preference; T1 = 100%DBL + US; T2 = 90%DBL +10%CP + US; T3 = 80%DBL + 20%CP + US; T4 = 70%DBL + 30%CP + US

CONCLUSION

Dried banana leaves ensiled with cassava peels and urea has potential as silage feed for ruminants with leaves ensiled with 30% cassava peels showing better quality and acceptability by WAD sheep.

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