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Characteristics of ensiled cassava leaves and maize stover as dry season feed for ruminants

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Abstract

Insufficient quantity and quality of feed for ruminants during the dry season is a major limiting factor for effective production and management. Smallholder farmers generate large crop residues in the wet season, which are rich in nutrients in which ruminants can feed on in the dry season by proper ensiling. Cassava Leaves (CL) and Maize Stover (MS) residues were thus ensiled to evaluate their nutritional qualities as feed for ruminants. Fresh cassava leaves and maize stover were collected, chopped and wilted. Silages were prepared as: T1 (100%CL), T2 (100%MS), T3 (50%CL+50%MS), T4 (25%CL+ 75%MS) and T5 (75%CL+25%MS). Ensiling lasted for 21 days after which they were opened to determine the quality using physical assessment of colour, smell, texture, pH and temperature. Chemical composition of the silages comprising Crude Protein-CP, Crude Fibre-CF, Ether Extract-EE, ash content, Acid Detergent Fibre-ADF, Neutral Detergent Fibre-NDF and Acid Detergent Lignin-ADL were assessed. Nutritive values of the diets were evaluated using in vitro fermentation technique to determine Total Gas Production (TGP), methane, Metabolizable Energy (ME), Short Chain Fatty Acids (SCFA) and Organic Matter Digestibility (OMD). Coefficient of Preference (COP) was determined using a cafeteria feeding technique. Olive-green colour, alcoholic smell and firm texture were observed in the silages. The pH ranged from 4.13 to 4.73 while higher pH was observed in 100%CL. The temperature was between 31°C and 32ºC. The values obtained for the DM ranged from 64.37 to 67.9%. The CP values varied between 8.64 and 19.68%. The lowest CP of 8.64% was observed in T2 (100%MS) while 19.68% was obtained in T1 (100%CL). The ash content ranged from 8.65 to 13.00% and the CF value varied from 33.70 to 40.39%. It was observed that 100%MS had significantly (P<0.05) higher CF (40.39%) compared to other treatments. The EE values varied between 4.45 and 5.22%. The EE value in 100%CL (5.22%) was significantly (P<0.05) higher compared to other silage treatments. The NDF, ADF and ADL values varied from 62.70-69.80%, 43.95-47.90% and 22.95-25.80%, respectively and significant differences were observed. The total gas volume ranged from 8.33 to 13.8mL, methane 5.3 to 7.6, OMD (32.72-42.5%), ME (4.06-5.28kCal) and SCFA (0.15-0.27). The CoP of the silages was $\geq$ to the unity of one with the exception of T2. It can be concluded that, combinations of 50% cassava leaves and 50% maize stover could be used as feed for ruminants.

Keywords: silage quality, *in vitro*, nutritive value, chemical composition, acceptability

Introduction

Inadequate diet is a major factor limiting ruminant production and management in Nigeria. This is because ruminant production is in the hands of conservative and traditional livestock farmers who rely mainly on native and unimproved pasture for their animals. The available natural pasture in the dry season are not sufficient, fibrous and deficient of essential nutrients most especially proteins which are required for increased rumen microbial fermentation and also enhanced animal performance. The implication of inadequate nutrition in ruminants result in economic losses to the farmers due to loss in weight, prolonged time to reach market weight and reduced production capacity of animals. Although, the utilization of agricultural by-products such as cassava peel, brewer's dry grain, wheat offal, common crop residue such as cowpea haulm as alternative feed to ruminants have been adopted by commercial ruminant farmers. The availability of these feed resources to smallholder ruminant farmers is still a challenge due to their high demand. Incorporation of the underutilize crop residues commonly generated by crop farmers may be a panacea to the reoccurring dry season problems encountered by smallholder ruminant farmers. Cassava is a root crop and grown in large expanse in Nigeria with seldom use of the cassava top after the roots have been harvested. The leaves have been reported as potential feed for ruminant (Ajayi *et al*., 2019). The high crude protein of cassava leaf was reported by Ravindran (1993) to be 21%, serving as protein bank for cattle, sheep and goats. Although, the high concentration of cyanogenic glucosides in cassava leaves is a short coming to its utilisation, studies have shown the detoxification effect by fermentation. When cassava leaf was fed to goats, it reduced the level of nematodes worm burdens in the faeces thus, having an anthelmintic property due to the presence of tannin and also enhanced growth rate when compared with other foliages and grass (Seng Sokerya and Rodrigeuz 2001; Nguyen Kim Lin *et al*., 2003; Seng Sokerya *et al*., 2003). Ho Quang Do *et al*. (2002) also reported an increase in feed intake and Nitrogen retention in goats when fresh cassava leaves replaced grass as a supplement to untreated rice straw. Maize is abundantly cultivated in Nigeria and it is second to none but cassava. Because of its short maturity period, maize is grown twice in a year in the rainforest areas of Nigeria, leaving huge residues on the field (Perlack and Stokes, 2011). Maize is rich in hydrolisable crude fibre and therefore, may be used as energy source for ruminants. Thus, cassava top and maize stover when strategically combined in feeding systems can sustain production and management of ruminants.

Materials and methods

The experiment was carried out at the small ruminant research centre of the Department of Animal Science, University of Ibadan, Nigeria. The University falls between 345 East of the Greenwich meridian and latitudes 727 of the equator in the savannah zone of Nigeria.

Collection of materials

Freshly harvested Cassava leaves (CL) and Maize stover (MS) were collected from Apologun village in Oyo, Oyo state, Nigeria. The cassava leaves were obtained from the commonly adopted variety of 'Arubielu'. The cassava leaves and maize stovers were chopped to a length of 3-5cm and wilted for 12hours. The cassava leaves and maize stover were prepared into five treatments with four replicates.

Treatment 1: 100% CL
Treatment 2: 100% MS
Treatment 3: 50% CL + 50% MS
Treatment 4: 25% CL + 75% MS
Treatment 5: 75% CL + 25% MS

Each treatment was thoroughly mixed and quickly filled in polyethylene bag silo. Compression was made to eliminate pockets of air and rapidly sealed to prevent re-entry of air. Bags filled with sand were placed on each of the silos and kept in a cool, dry and rat proof room for 21 days.

Silage quality evaluation

Physico-chemical characteristics of silages were done as described by Babayemi and Igbekoyi (2008). Dry matter content of the silages was determined by oven drying at 65 ^{o}C and constant weight was obtained. Samples were milled to pass through a

1mm screen and stored at a room temperature for subsequent laboratory analysis. Proximate analysis of the silages was determined according to AOAC (1990) procedures while the Acid Detergent Fibre (ADF) and Neutral Detergent Fibre (NDF) were determined using the method of Van soest *et al*, (1991). Rumen fluid was obtained from three West African dwarf female goats using the method of collection previously described by Babayemi and Bamikole (2006) for the determination of *in vitro* fermentation of the silages. The liquor was collected into a thermo flask that had been pre-warmed to a temperature of 39 ºC before feeding the animals in the morning. Incubation was done as described by Menke and Steingass (1988) using 120mL calibrated syringes in three batch incubation at 39 ºC into 200mg sample, 30mL inoculums containing strained rumen liquor and buffer (1:2, v/v) under continuous flushing with CO_2 was introduced into the syringe. Gas production was measured at 3, 6, 9, 12, 15, 18 and 24 h. At post incubation period, 4 mL of NaOH (10 M) was introduced to estimate methane production as reported by Fievez *et al*, (2005). Metabolisable energy, organic matter digestibility and short chain fatty acids were calculated as reported by Getachew *et al*. (1997). Data were subjected to analysis of variance (SAS, 1988). About 1kg of each diet was fed to the animals on cafeteria basis using five feeding troughs. Thus, the animals have free access to all the feeds. The feed positioning was changed to avoid biasness by the animals. The amount of feed consumed was monitored for 6 hours each day and the quantity consumed was recorded. Consumption was measured by the deduction of the remnants from the amount offered and the co-efficient of preference (CoP) value calculated as the ratio of the intakes for the individual silage to the average intake of all the silages.

Coefficient of preference (CoP) =
<u>Intake of individual silage offered</u>
Mean intake of the silage types

If CoP is < 1, the material is poorly accepted and when > 1, the material is well accepted. (Karbo *et al*., 1993; Bamikole *et al*., 2004).

Results

Presented in Table 1 are the physical characteristic of ensiled cassava leaves and maize stover. The pH values ranged between 4.13 in T4 and 4.73 in T1 with significant differences among treatments. Temperature ranged between 31°C and 32°C and no significance was observed. All the treatments had alcoholic smell. Texture was dry and firm while, olive-green colour was recorded across the treatments.

Table 1: Physical characteristics of cassava leaves and maize stover silage

	Treatments				
Parameters	**T1**	**T2**	**T3**	**T4**	**T5**
pH	4.73^{a}	4.33^{bc}	4.53^{ab}	4.13^{c}	4.53^{ab}
Temp (ºC)	32ºC	32ºC	32ºC	32ºC	31ºC
Smell	Alcoholic	Alcoholic	Alcoholic	Alcoholic	Alcoholic
Texture	Dry&Firm	Dry&Firm	Dry&Firm	Dry&Firm	Dry&Firm
Colour	Olive-green	Olive-green	Olive-green	Olive-green	Olive-green

^{abc} Means with different superscript differed significantly (P<0.05). T1=100%CL, T2=100%MS, T3=50%CL + 50%MS, T4=25%CL + 75%MS, T5=75%CL + 25%MS, CL= Cassava Leaves, MS= Maize Stover

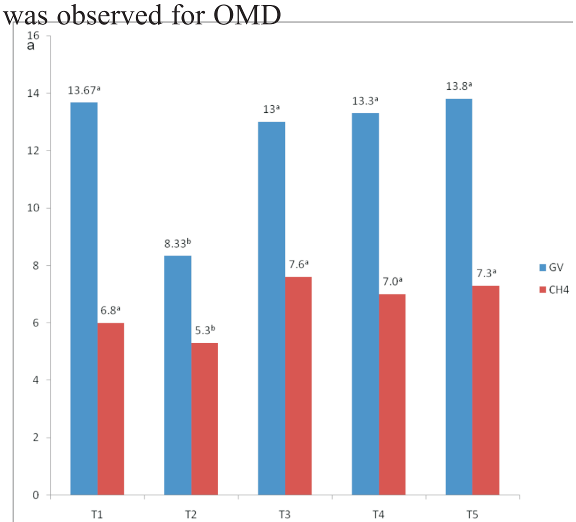
Table 2 shows the Dry Matter (DM) and chemical composition of ensiled cassava leaves and maize stover. The values obtained for the DM ranged from 31.10 to 35.63%. The crude protein values obtained for all the silages varied between 8.64 and 19.68% in T2 and T1, respectively. Significant (P<0.05) differences were observed across the treatments. Ash content ranged from 8.65 to 13.00% while the values of CF obtained varied from 33.70 to 40.39%. The EE values for all the treatments varied between 4.45 and 5.22%. Neutral Detergent Fibre values varied from 62.70 to 69.80% in T2 and T1. The ADF values were between 43.95% and 47.95%. Higher ($P<0.05$) ADF values were observed in T1 (47.95%) and T3 (47.90%) compared to T2 (43.95%) and T4 (44.15%). Acid Detergent Lignin (ADL) values varied from 22.95 to 25.80%.

Table 2: Dry matter and chemical composition of ensiled cassava leaves and maize stover

	Treatments					
Parameters (%)	**T1**	**T2**	**T3**	**T4**	**T5**	**SEM**
Dry matter	32.30^{a}	32.66^{b}	33.32^{b}	35.63^{a}	31.10^{c}	0.69
Crude protein	19.68^{a}	8.64^{e}	14.24^{c}	11.24^{d}	16.30^{b}	0.25
Ash	10.60^{c}	8.65^{e}	13.00^{a}	9.60^{d}	11.65^{b}	0.35
Crude fibre	34.75^{c}	40.39^{a}	35.90^{b}	35.68^{b}	33.70^{d}	0.31
Ether extract	5.22^{a}	4.45^{d}	4.53^{b}	4.61^{c}	4.57^{b}	0.08
NDF	69.80^{a}	62.70^{c}	68.55^{a}	65.45^{b}	64.70^{bc}	0.82
ADF	47.95^{a}	43.95^{b}	47.90^{a}	44.15^{b}	45.80^{ab}	1.10
ADL	24.80^{ab}	23.20^{c}	25.80^{a}	22.95^{d}	24.05^{b}	1.01

^{abcde} Means of treatments along a row with different superscript differed significantly ($P<0.05$). T1=100%CL, T2=100%MS, T3=50%CL+50%MS, T4=25%CL+75%MS, T5=75%CL+25%MS, CL= Cassava leaves, MS= Maize Stover, NDF=Neutral Detergent Fibre, ADF= Acid Detergent Fibre, ADL= Acid Detergent Lignin

Gas volume and methane production of ensiled cassava leaves and maize stover are presented in Figure 1. The total gas volume was highest in T5 (13.80) and T2 (8.33) had the lowest, methane production varied between 5.3 in T2 and 7.6 in T3. The ME, OMD and SCFA of the silages from varied proportion of cassava leaves and maize stover are shown in Table 3. The values range between 4.06 in T2 and 5.28 in T1 for ME. Similar trend was observed for OMD (range 32.72 – 42.25) and SCFA (0.15 – 0.27). Significant difference was not observed among treatment except in T2 in all the estimated parameters. Presented in Table 4 is the free choice intake of ensiled maize stover and cassava leaves. The study showed that the coefficient of preference was equal and some were greater than the unity of one with exception of T2 with the CoP value of 0.8.



T1=100%CL, T2=100%MS, T3=50%CL+50%MS, T4=25%CL+75%MS, T5=75%CL+25%MS, CL= Cassava leaves, MS= Maize Stover

Figure 1: Gas volume and methane production of ensiled cassava leaves and maize stover

Table 3: Metabolisable Energy (ME; MJ/Kg DM), Organic Matter Digestibility (OMD %), Short Chain Fatty Acids (SCFA; Umol/200mg DM) of ensiled cassava leaves and maize stover

	In vitro parameters		
Treatments	ME	OMD	SCFA
T1	5.28[a]	42.5[a]	0.27[a]
T2	4.06[b]	32.72[b]	0.15[b]
T3	4.85[a]	40.59[a]	0.25[a]
T4	4.94[a]	39.11[a]	0.91[a]
T5	5.14[a]	42.22[a]	0.27[a]
SEM			

T1=100%CL, T2=100%MS, T3=50%CL+50%MS, T4=25%CL+75%MS, T5=75%CL+25%MS, CL= Cassava leaves, MS= Maize Stover

Table 4: Free choice intake of ensiled cassava leaves and maize stover by West African dwarf goats

TREATMENT	Mean daily intake	Coefficient of preference (CoP)
T1	0.79	1.1
T2	0.55	0.8
T3	0.66	1.0
T4	0.68	1.0
T5	0.77	1.1

T1=100%CL, T2=100%MS, T3=50%CL+50%MS, T4=25%CL+75%MS, T5=75%CL+25%MS, CL= Cassava leaves, MS= Maize Stover

Discussion

Silage physical characteristics and pH.

The mean value of 31.5ºC obtained for the silages was within the range of 28 ºC to 35ºC obtained by 'tMannetje (1999) for good quality silage. The aroma of the ensiled materials being alcoholic in aroma corroborate the report of Lyimo *et al*. (2016) that well fermented silage should exhibit a pleasant, vinegar, alcoholic or fruity smell which could indicate a well prepared silage. Silage with rancid butter or putrid smell often depicts poor fermentation dominated by clostridia bacteria that produces high level of butyric acid (Marsha, 1999). It was also observed that the texture of the silages were all dry and firm, agreeing with Saun and Heinrichs (2008) who reported that a good quality silage should have a dry and firm texture due to the production of lactic acid and acetic acid. The silages were all olive-green in colour due to the initial colour of the ensiled materials, authenticated by Oduguwa *et al*. (2007) that there should be little or no difference in the colour of original material after ensiling. The pH of 4.1-4.8 obtained in the present study indicated good quality silage as reported by Yang *et al.* (2004). Menesses *et al.* (2007) also affirmed that the pH of good silage is within the range of 3.5 to 5.0. The variations in the pH values of the silages depend on the moisture contents and the buffering capacity of the materials used for ensiling.

Chemical composition of the silages

The chemical composition of the silage gives a more reliable and accurate assessment of silage quality. The values obtained for the Crude Protein (CP) are shown in Table 2 and were ranged from 8.64 - 19.68g/100gDM with significant differences among treatments. The apparent variations could be due to the inclusion levels of cassava leaves and maize stover. It was also observed that the CP levels increased with an increasing level of cassava leaves and a decreasing level of maize stover. This is due to the high percentage of crude protein in the cassava leaves (16.7 - 39.9% CP) as reported by Ravidran (1993). Thus, cassava leaves and maize stover mixtures at the two levels of inclusion seemed beneficial and therefore can be used for supplementing the low protein forages such as maize stover and other crop residues. The crude protein obtained in the study was above the value of 10 - 12% recommended by ARC (1985) as the inclusion level of cassava leaves increased. The ash content obtained in the present study was within the range 5.7 - 12.5% reported by Ravidran (1993) and 4.3 - 10.2% according to Feedipedia (2012), except for the higher value in 13.0% in T3. The crude fibre is the indigestible portion of forages. The values of CF obtained in the current study varied from 33.70 - 40.39%, it increased as the inclusion level of maize stover increased which may be due to the high percentage of crude fibre in maize stover as reported by Owen (1994). Cell wall carbohydrates can be quantified by determination of NDF fraction, which include cellulose, hemicellulose and lignin as the major components according to Van Soest *et al*. (1991). The NDF, ADF and ADL levels in the diet affects the dry matter intake and digestibility as reported by Meissner *et al*. (1991). The NDF values increased as the maize stover inclusion in the diet increased, thus in agreement with the findings of Owen (1994). This may be as a result of high NDF content in maize stover as compared to cassava leaves. The values obtained were above the level of 55-60g/100gDM as obtained by Meissner *et al*. (1991). The higher the NDF, the lower the feed intake and the digestibility. The ADF measures the amount of cellulose, lignin and insoluble ash. As the ADF increases, the digestibility and the energy levels decreases (Coombe, 1981). The values of ADF obtained in the study (43.95-47.95g/DM) were above the recommended values of 25% for ruminants (NRC, 2001) and the values of 23-26.3% obtained by Daodu and Babayemi (2009).

In vitro gas production characteristics of silages at 24 hour incubation period

Presence of secondary metabolites, nature of fiber and potency of rumen liquor for incubation are factors that affect the amount of gas produced during fermentation (Babayemi *et al.*, 2004). The highest gas production was observed in T5 while the lowest was observed in T2. T5>T1>T4>T3>T2. The gas production is an indication of microbial degradation of the samples (Babayemi *et al*., 2004, Fievez *et al*., 2005). The low gas volume in T2 may be as a result of the stage of harvest of the plant (dry straw with high fiber) while the high gas volume in T1 and T5 could be as result of high crude protein which results into more microbial activities in the rumen. Methane production in ruminants is a wasteful process and accounts for energy loss of about 10-11% of the total energy meant for the animal from the feed. It is one of the gases contributing to global warming (Ajayi and Babayemi, 2008). The SCFA, OMD and ME of T1 were the highest while that of T2 was the lowest. There was progressive decline as the reports agreed with Amuda *et al*. (2017) and Binuomote *et al*. (2010). The higher fiber content in T2 could have resulted in low OMD, ME and SCFA since high NDF and ADL contents leads to low fiber degradation. The results from the metabolizable energy of silages were within the reported range of 4.5-15 by Menke and Steingas (1988) except T2. The study also revealed that animals selected their feed based on their instinctive characteristics. Coefficient of preference (CoP) of the silages varied from 0.8 to 1.1 in the order of preference T1>T5>T4>T3>T2. Among the silages, T1 and T5 were most preferred probably because of its tenderness and physical structure of cassava leaves and the high crude protein content. This observation supports the findings of Olanite *et al*. (2011) who stated that the structure of the plants affects its acceptability. Babayemi (2009) and Van Soest (1994) also stated that the physical and the chemical composition are the most important factors that affect preference. Forbes (1995) reported that ruminants eat the amounts of feed which leave them with the most comfortable feelings; this could be the reason for the non acceptability of T2. Diet T2 has a coarse nature, high in lignin and low in crude protein. Low digestibility and high lignin may limit its intake (Aregheore, 2005).

Conclusion

The study revealed that cassava leaves and maize stover were potential feed resources to circumvent the low quality and quantity of forages available in the dry season. For optimal and economic utilization of cassava leaves a protein bank, the combination of 50% cassava leaves and 50% maize stover could be used as feed for ruminants.

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