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Chemical Composition and *In Vitro* Gas Production of Silage from Guinea Grass, Cassava Peel and Cashew Apple Waste at Different Periods of Ensilage

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Abstract: A study was carried out to determine the quality of silage produced from guinea grass, cassava peel and cashew apple waste at different ensiling periods. The materials were mixed into nine different proportions and ensiled for 30, 60 and 90 days making twenty-seven (27) treatments with each replicated three times. At the expiration of ensiling duration, the jars were opened, the contents were mixed, oven-dried and the proximate composition and fibre fractions were determined. The results showed that there were significant ($p<0.05$) reduction in the Dry Matter (DM), Crude Protein (CP) and Neutral Detergent Fibre (NDF) with increase in ensiling duration while the Non Fibre Carbohydrate (NFC) increased with increased ensiling duration. The highest CP content (14.44%) was obtained in 25% Guinea Grass (GG)+25% cassava peel (CAP)+50% Cashew Apple Waste (CAW) which was not significantly ($p>0.05$) different from 100% CAW. The NDF varied ($p<0.05$) from 44.21 in 75% CAP+25% CAW silage to 60.31 in 100% GG. The reduction in the CP and NDF of the silage is still within the range required for growth and maintenance in ruminant animals.

Key words: Cassava, cashew, *in vitro*, ensilage, guinea grass

INTRODUCTION

Nigeria needs to develop its ruminant livestock industry with its growing population in the last few decades but feed shortage is one of the main constraints. Traditional feeds are expensive and agro-industrial by-products such as brewery grains have been exploited. Cashew apple (*Anacardium occidentale* L.) is a promising feed source, which could be used in the livestock industry. FAO (2003) reported Nigeria as the third major producer of cashew after India and Veitnam. In 2000, the country had 291,000 ha of cashew trees with over 184, 000MT of cashew nut were produced per year. There is commercial increasing interest in processing the cashew apple as a source of sugar-rich juice for human consumption. The waste product from this processing is known as cashew pulp/apple waste, which is of little or no use for human consumption after extraction. Kinh *et al.* (1997) noted that is uneconomical to dry the cashew apple or the waste product after juice extraction and it is more appropriate to develop methods to use it in wet form. This is the rationale for this study. Owing to its high moisture content and low crude protein content as reported by Kinh *et al.* (1997) initiates the idea to ensile it with Guinea grass (*Panicum maximum* Jacq) which is a grass in its abundance in southwest Nigeria in the wild as well as cassava peel which is another agro-industrial by product that can serve as source of energy. Hence, the need for this experiment to determine the quality of the silage from mixtures of cashew apple waste, cassava peel and Guinea grass as affected by ensiling duration.

MATERIALS AND METHODS

The experiment was carried out in the laboratory of the Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta. Cashew Apple Waste (CAW) and cassava peel (CAP) were collected from the cashew processing unit and from the cassava flakes (Gari) processing unit of the Federal University of Agriculture, Abeokuta, respectively. The local variety of Guinea grass was harvested from within the University. The CAW and CAP were wilted for 36 h to reduce the moisture content and they were chopped to less than 3 cm to make compaction easy. A total of eighty-one laboratory silo in form of glass jars of 960 mL were used for ensiling. The ensiled materials were cashew apple waste (this is a by-product of cashew processing

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industry after that the juice has been extracted and the apple waste); cassava peel (it is the peel of cassava, a by-product of the cassava flaking industry) and Guinea grass (it was cutback and later harvested at 8 weeks after cutback) which were filled into the silos in the percentage are presented in Table 1. Each of the nine forage-agro by products mixtures was ensiled for three different number of days (30, 60 and 90 days) with 3 replicates. At the expiration of each ensiling duration, the silage was opened, thoroughly mixed and sub-samples taken for analyses.

Chemical analyses and *in vitro* gas production techniques: The DM content of silage samples was determined by drying in a forced-air oven at 60°C until constant weight was achieved. After drying, samples were ground to pass a 2 mm sieve. The Crude Protein (CP), Ether Extract (EE), ash and Non Fibre Carbohydrate (NFC) were determined according to AOAC (1995). Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), acid detergent lignin (ADL) (Van Soest *et al.*, 1991), cellulose was taken as the difference between ADF and ADL while hemicellulose was calculated as the difference between NDF and ADF.

The *in vitro* gas production was determined following the procedure of Menke and Steingass (1988). In each, 200±0.05 mg of the milled samples were weighed into 100 mL syringe as the only substrate (n = 3). In addition, triplicate bottles of incubation solution without substrate were included as blanks to assist in estimating the net gas production. Rumen contents were obtained from four adult ruminally cannulated West African dwarf goats just before their morning feeding, pooled and used as inoculum and sieved with 4 layers cheese cloth. The goats were fed 50% maize hay basal and 50% concentrate. Macro and micro elements, reduction and resazurin dye solutions were mixed together with distilled water, refluxed with CO_2 continuously until the pH was adjusted to 6.9 with buffer solution. This solution was mixed together in ratio 2:1 with the rumen fluid. The syringes were placed in a water bath with temperature regulated at 39°C. The gas volumes were recorded at 3, 6, 9, 24, 36 and 48 h of incubation. Gas volume at each incubation time was expressed per unit of incubated Dry Matter (DM).

Statistical analysis: The experimental design was a 9×3 factorial design and data collected were analyzed using the General Linear Model Procedure of Sas (1999) computer package with significant means separated using Duncan Multiple Range Test while the *in vitro* gas production result was further presented graphically.

RESULTS AND DISCUSSION

The proximate composition of the silages as affected by the ensiling duration and treatment combination are given in Table 2. The ensiling duration had significant ($p<0.05$) effect on all the parameters determined with silage ensiled for 30 days having the highest DM (22.03%), CP (15.48%), EE (6.70%) which was statistically similar to the 60 days silage while the reverse was the case with NFC and ash has no particular pattern. The decreasing trend in the DM content of the silages with the increase in the ensiling duration is in line with the findings of Kinh *et al.* (1997), the recorded DM content of the silages at 30 Days After Ensiling (DAE) was similar to that reported by same author for same duration of ensiling for 100% Cashew Apple Waste (CAW). The DM content as affected by the treatment combination significantly ranged ($p<0.05$) from 16.82 in 100% CAP to 26.17 in 25% GG+75% CAW silage with the DM of 25 GG+75% CAW silage being significantly ($p<0.05$) higher. The DM content of all the silages in this study fell below the range suggested as ideal by McCullough (1977). The decreasing trend in CP content with increasing in ensiling duration is in line with the findings of Kinh *et al.* (1997) and Suksombat and Lounglawan, 2004). 25% GG+25% CAP+50% CAW and 100% CAW were noted to be statistically similar and significantly ($p<0.05$) higher than other treatment combinations with 25% GG+25% CAP+50% CAW silage CP (14.44%) being highest. The CP contents of the silages in this study were higher than the 7% considered as minimal requirement for ruminant animals according to Van Soest (1994). The Non Fibre Carbohydrate (NFC) of the silage as influenced by ensiling durations increased with increase in ensiling duration while the NFC ranged significantly ($p<0.05$) from 15.58% in 100% GG to 28.08% in 25%GG+25% CAP+50% CAW. The NFC recorded in this study were slightly higher than that reported by Dele (2012) for *Panicum maximum* silage and are within the range that can be easily degraded or fermented as NFC is a crude estimate of the carbohydrate pool that differ in digestibility from NDF. It has also been reported to have positive relationship with ammonia nitrogen utilization in the rumen (Tylutki *et al.*, 2008). The concentration of fibre fractions are as presented in Table 3. As for the NDF, it was observed that it decreased as the ensiling duration increase, with the NDF (62.09%) content of silage ensiled for 30 days being significantly ($p<0.05$) the highest. This trend was also observed in other fibre fractions except for the hemicellulose with its trend being the reverse. This is in contrast with the findings of Lounglawan *et al.* (2011) that reported increase in NDF with increase ensiling

Table 1: Percentage composition of the ensiled materials

	Forage-agro by product mixtures (%)								
	1	2	3	4	5	6	7	8	9
Guinea Grass (GG)	100	75	25	50	0	25	0	25	0
Cassava peel (CAP)	0	25	25	25	0	50	100	0	75
Cashew Apple Waste (CAW)	0	0	50	25	100	25	0	75	25
Total	100	100	100	100	100	100	100	100	100

Table 2: Effect of ensiling duration and Forage-agro by product mixture on proximate composition (%) on silage produced from mixture of cashew apple waste, cassava peel waste and guinea grass

Ensiling duration (days after ensiling DAE)	DM	CP	EE	ASH	NFC
30	22.03^{a}	15.48^{a}	6.70^{a}	7.99^{ab}	7.74^{c}
60	20.89^{aab}	13.69^{ab}	6.78^{a}	8.69^{a}	14.02^{ab}
90	19.93^{ab}	12.36^{ab}	5.59^{ab}	6.66^{ab}	23.40^{a}
SEM	1.06	1.27	1.18	2.25	1.75
Forage-agro by product mixture					
GG (100)	21.03^{abc}	9.48^{cd}	6.50^{abc}	8.13^{cd}	15.58^{f}
GG+CAP (75+25)	21.78^{ab}	12.11^{ab}	6.36^{abc}	7.59^{d}	24.22^{c}
GG+CAP+CAW (25+25+50)	22.00^{ab}	14.44^{a}	6.27^{abc}	4.81^{e}	28.08^{a}
GG+CAP+CAW (50+25+25)	19.59^{c}	12.38^{aab}	4.56^{d}	9.56^{ab}	16.38^{f}
CAW (100)	25.80^{a}	14.36^{a}	4.72^{d}	10.38^{a}	19.34^{e}
GG+CAP+CAW (25+50+25)	18.80^{c}	12.80^{aab}	4.10^{d}	4.98^{e}	21.99^{d}
CAP (100)	16.82^{d}	7.65^{d}	7.43^{ab}	8.42^{c}	25.48^{abc}
GG+CAW (25+75)	26.17^{a}	12.66^{aab}	9.41^{a}	6.53^{de}	25.82^{abc}
CAP+CAW (75+25)	22.53^{ab}	11.74^{c}	8.88^{aab}	8.63^{c}	26.54^{ab}
SEM	1.84	2.45	1.91	2.21	1.34

Mean with same letter along same column are not significantly different (p>0.05), Mean±SD error mean, DM: Dry matter, CP: Crude protein, EE: Ether extract, NFC: Non fibre carbohydrate, GG: Guinea grass, CAP Cassava peel, CAW: Cashew apple waste

Table 3: Effect of ensiling duration and Forage-agro by product mixture on fibre fractions (%) on silage produced from mixture of cashew apple waste, cassava peel waste and guinea grass

Ensiling duration (days after ensiling DAE)	NDF	ADF	ADL	HEM	CEL
30	62.09^{a}	45.02^{a}	19.74^{a}	17.07^{ab}	25.28^{a}
60	56.82^{ab}	37.13^{ab}	16.24^{ab}	19.69^{aab}	20.89^{ab}
90	51.99^{c}	30.05^{c}	15.23^{abab}	21.94^{a}	14.82^{c}
SEM	2.76	2.73	2.58	1.65	2.11
Forage-agro by product mixture					
GG (100)	60.31^{a}	40.98^{a}	20.17^{a}	19.33^{aab}	20.81^{ab}
GG+CAP (75+25)	49.72^{c}	31.43^{c}	13.25^{e}	18.29^{ab}	18.18^{d}
GG+CAP+CAW (25+25+50)	46.40^{c}	31.24^{c}	19.18^{a}	15.16^{d}	12.06^{ef}
GG+CAP+ CAW (50+25+25)	57.12^{ab}	38.00^{aab}	18.70^{aab}	19.12^{aab}	19.30^{c}
CAW (100)	51.20^{c}	34.28^{ab}	16.20^{ab}	16.92^{c}	18.08^{d}
GG+CAP+CAW (25+50+25)	56.13^{ab}	39.80^{a}	17.47^{ab}	16.33^{c}	22.33^{aab}
CAP (100)	51.02^{c}	38.75^{aab}	15.75^{c}	12.27^{e}	23.00^{a}
GG+CAW (25+75)	45.58^{cd}	28.82^{cd}	14.52^{d}	16.76^{c}	14.30^{e}
CAP+CAW (75+25)	44.21^{d}	23.26^{d}	13.02^{e}	20.95^{a}	10.24^{f}
SEM	3.11	3.26	2.13	1.57	1.09

Mean with same letter along same column are not significantly different (p>0.05), Mean±SD error mean, NDF: Neutral detergent fibre, ADF: Acid detergent fibre, ADL: Acid detergent lignin, HEMI: Hemicellulose, CELL: Cellulose, GG: Guinea grass, CAP: Cassava peel, CAW: Cashew apple waste

duration. The reason for this decrease in NDF value might be as a result of the microbes in the silage utilizing the NDF with increase in ensiling duration as reported by Ely *et al.* (1981) and Chauhan and Kakkar (1981). The 100% GG silage was observed to have the highest ($p<0.05$) NDF (60.31%), ADF (40.98%) and ADL (20.17%) contents which was statistically similar with that of 25% GG+25% CAP+50% CAW silage while the least values were recorded for 75% CAP+25% CAW silage. The NDF values recorded were lower than the critical level of NDF (75%) reported by Buxton (1996) above which the NDF inhibits feed intake.

The cumulative gas production of the silage as affected by the ensiling duration is as shown in Fig. 1. The gas produced (46.32 mL/200 mg DM) from silage ensiled for 30 days was significantly ($p<0.05$) the least while the silage that was ensiled for 90 days had the highest gas volume (62.66 mL/200 mg DM). The gas volume produced as affected by the forage-agro by product mixture was ($p<0.05$) significant as presented in Fig. 2. The least gas production (33.32 mL/200 mg DM) was recorded for 100% GG silage while the 75%CAP+25% CAW silage had the highest gas volume (69.12 mL/200 mg DM). This might be as a result low NFC and NFE content

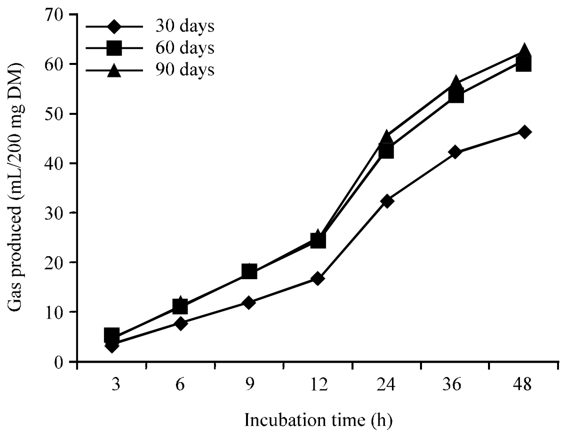

Fig. 1: Gas production of silage produced from guinea grass, cassava peel and cashew apple waste as affected by ensiling duration

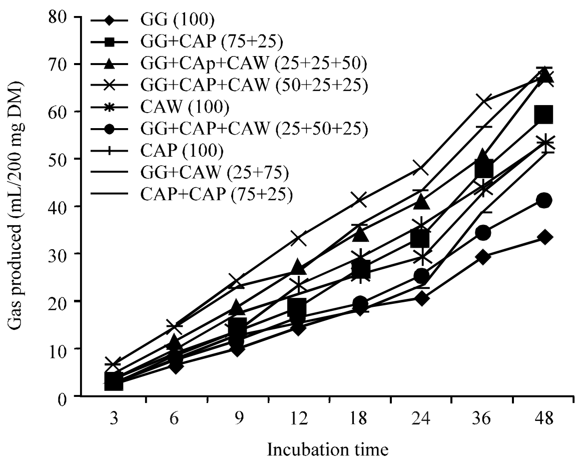

Fig. 2: Gas production of silage produced from guinea grass, cassava peel and cashew apple waste as affected by forage-agro by product mixture

of the silage which has a positive correlation with gas production and the high NDF and ADF which is known to have a negative relationship with gas production. This may tend to reduce the microbial activity through increasing the adverse environmental conditions as incubation time progress. This is consistent with De Boever *et al.* (2005) and Sallam *et al.* (2007) who reported that gas production was negatively related with NDF content and positively with starch.

CONCLUSION

The DM, CP, NFC and fibre fractions were maintained for 30 and 60 days gave a good indication that these silage can be kept for the peak of the dry season. In addition, the forage-agro by product mixture of 25% GG+25% CAP+50% CAW was selected from this study for high CP content and low fibre fraction as valuable feed for ruminant animals.

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