SCREENING TEN VARIETIES OF CASSAVA LEAVES AND PEELS FOR FEED QUALITY USING *IN VITRO* GAS PRODUCTION

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Abstract
The research was carried out to determine the feed quality of leaves and peels from ten cassava varieties using *in vitro* gas production technique. Ten varieties of cassava leaves and peels were obtained from the International Institute of Tropical Agriculture (IITA) located at Onne, Rivers State, Nigeria in 2018. There were significant difference ($P< 0.05$) in methane (CH_4) and short chain fatty acids (SCFAs) produced, dry matter digestibility (DMD), organic matter digestibility (OMD) and fermentation efficiency (FE). The DMD was least in TMS 96/1632 leaves and TMS 98/0505 peels and highest in TMS 92/0326 leaves and TMS 01/1638 peels, respectively. Although no clear trend was recorded for OMD and FE, the mean OMD was above 50.0% while, FE was above 1.00 for both leaves and peels except for TMS 98/0505, which was below 1.00, Mean crude protein (CP) and neutral detergent fibre (NDF) were 30.0% and 67.1% for leaves and 6.8% and 55.7% for peels, respectively. Varieties TMS 98/0510, TMS 98/0505 and TMS 92/0326, appear to be potential feed resources for sustainable livestock production being high in CP, NDF, and DMD but, low in CH_4 emission. These three varieties with good feed quality can be used as feed for animals and thus, will reduce the cost of livestock production with potential for reducing greenhouse, like methane gas, emission.

Introduction
Cassava plays an important role in food security and also serves as a cash crop in Africa. Nigeria is reported to be the world's largest producer of cassava and the production comes from about two-thirds of the 36 states with majority coming from the southern parts of the country (Bassey and Harry, 2013). About 90% of the total cassava produced is consumed by man while, the processing of cassava yields an estimated 14 million tonnes of by-products, which comprises peels, leaves, stumps, woody and undersized tubers mostly disposed of as waste (Okike *et al*.,2015). Despite this, the inability of ruminant animals to get adequate feed throughout the year, especially in the drier parts of the country, still remains a major technical constraint in meeting increasing future demands for milk and meat. Studies at the International Livestock Research Institute (ILRI) have demonstrated the importance of cassava as livestock feed under its flagship Cassava Value Addition Project (Samireddypalle *et al*., 2015; Niayale *et al*., 2020).

To mitigate this challenge, the need to continuously search for alternative feed resources that are less competitive for their use by man and other livestock perhaps still remains a better intervention needed to enhance the proliferation of small ruminants (Adewumi and Ajayi, 2010). In addition to this, recent studies have demonstrated that, cassava could be used as a feed resource with potential for reducing greenhouse gas emissions attributable to livestock production (Preston *et al*., 2021). There are different varieties of cassava crop residues fed to livestock, and these consist of components that are slightly different from each other. To identify most suitable varieties as feed resources, the use of *in vitro* techniques for feed evaluation in ruminants is now, widely, used and has been accepted due to its ease of adoption, repeatability, minimized use of animals and the decrease in funding for *in vivo* evaluation of feeds (Getacheow *et al*., 2005). Therefore, the study was conducted to identify and determine the nutritive values of leaves and peels from ten elite varieties of cassava leaves and peels required to meet the nutrient requirements of small ruminants.

Materials and Methods

Samples Collection

The cassava leaves and peels used for the experiment were obtained from the International Institute of Tropical Agriculture (IITA), at Onne, Rivers State, Nigeria. The peels and leaves from a total of 10 varieties of cassava were used for the study. The varieties of cassava used for the experiment were: TME 419, TMS 98/0510, TMS 30572, TMS 95/0289, TMS 92/0326, TMS 01/1368, TMS 98/0581, TMS 96/1632, TMS 98/0505, TMS 91/2324. The leaves and peels were collected from cassava plants harvested from research plots at IITA-Onne.

Chemical Analysis

The samples were oven-dried for 48 hours (2 days) at 70℃ to a constant weight. The milled samples were analyzed to determine the acid detergent lignin (ADL), acid detergent fibre (ADF), neutral detergent fibre (NDF), crude protein (CP) and ash contents.

In Vitro Gas Production and Methane Measurement

Rumen liquor obtained from goats was filtered and strained through a cheese cloth to remove foreign materials and particles. The rumen liquor was mixed with the buffer solution and placed in a beaker and put into a water bath at 39°C. The rumen and buffer mixtures were gassed continually with carbon (iv) oxide to keep the microbes alive. The mixtures were put into each syringe containing the crop samples and placed inside the incubator, set at 39°C, while readings were taken at 3 hours interval for 24 hours. After 24 hours, the syringes were removed from the incubator and 40% of sodium hydroxide placed inside each syringe to displace CO_2 leaving only methane, which is then recorded as methane (CH_4) gas production. The Ankom bags were removed from the syringes, washed and placed inside an envelope. The samples were dried to constant weights and values obtained were used for calculating dry matter contents, short chain fatty acids (SCFAs) and organic matter digestibility (OMD).

Statistical Analysis

The results obtained from *in vitro* gas production and chemical analysis were analyzed using analysis of variance (ANOVA) as Completely Randomized Design (CRD) with three replications and correlation analysis.

Results and Discussion

Table 1 shows the chemical composition of leaves from ten varieties of cassava. The table shows that, TMS 92/0326 recorded the highest ($P<0.05$) crude protein of (31.3%) across the treatments, while TMS 95/0289 gave the least (29.3%) crude protein across varieties. TMS 92/0326 has the least (66.0%) NDF. Also, TMS95/0289 and TMS 98/0510 has the highest (9.9%) ash content, while TMS 92/0326 has the least (8.9%) ash content. One of the limiting factors of cassava leaves as feed is the presence of high content of hydrogen cyanide (HCN) as shown in Table 1, and this is in agreement with Anaeto *et al.* (2013) that, HCN limits cassava leaves for feeding monogastric animals though, it can be fed to ruminant animals. The ash content recorded from the findings ranged from 8.9% - 9.9%, which is higher than the value 4.6 - 6.4% recorded by Awoyinka *et al* (1995).

Table 1: Chemical composition (%) and hydrogen cyanide content of leaves from 10 cassava varieties

Leave varieties	CP	NDF	ADF	ADL	ASH	CELL	HEMI CELL	HCN
TMS 30572	29.8	67.4	51.3	15.4	9.5	35.9	16.1	46.2
TMS 98/0510	29.5	67.6	51.7	15.5	9.8	36.2	15.9	46
TMS 98/0505	30.1	66.9	49.8	15.1	9.3	34.6	17.1	46.8
TMS 91/2324	29.7	67.5	51.3	15.4	9.7	35.9	16.1	46.1
TMS 01/1638	30.7	66.8	49.7	14.9	9.1	34.8	17.1	47.1
TME 419	29.9	67.2	51.1	15.3	9.1	35.8	16.2	47
TMS 95/0289	29.3	66.7	51.9	15.7	9.9	36.2	15.2	45.9
TMS 96/1632	30.2	66.8	49.8	14.9	9.2	34.8	17.1	46.9
TMS 98/0581	29.9	67.3	51.1	15.3	9.5	35.8	16.1	46.2
TMS 92/0326	31.3	66	49.6	14.6	8.9	34.9	16.5	47.2
Mean	30	67.1	50.7	15.2	9.39	35.5	16.4	46.6
SEM (df=10)	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01

Table 2 shows the chemicals composition of cassava peels. The table shows that (TMS 92/0326) has the highest crude protein of (7.5%) across the treatments while (TMS 98/0510) has the least crude protein (6.1%) across the treatments. Furthermore, TMS 950289 has highest neutral detergent fibre (56.7%) across the treatments while TMS 92/0326 has the least NDF (54.0%). Also, TMS 95/0289 had the highest ash content (5.8%), while (TMS 92/0326) has the least ash content (4.9%). The results shows that livestock farmers can make use of cassava peels more than cassava leaves despite its high crude protein content and this agrees with (Etela and Okoro, 2011) that, the preference for cassava leaves as feed is low (about 1.7%) because, of the extent of ignorance about its nutritional value in spite of its relatively higher crude protein content. Udebible (2004) reported that, the use of cassava peels like other agro-industrial by-products is limited by anti-nutritional factors and high fibre content. The high cyanide content can be reduced by sun drying, fermentation, ensiling and this is in agreement with (Etela and Okoro, 2011) that, different methods are used by most livestock farmers to reduce HCN content, which includes sun drying and parboiling. Raissa *et al.*

(2015) reported that, the presence of anti-nutritional compounds in feedstuff interfere with the degradation process.

Table 2: Chemical composition (%) and hydrogen cyanide content of cassava peels from 10 cassava varieties

Peel varieties	CP	NDF	ADF	ADL	ASH	CELL	HEMI CELL	HCN
TMS 30572	6.7	56.4	41.3	11.5	5.5	29.9	15.1	25.1
TMS 98/0510	6.1	56.6	41.7	11.5	5.7	30.2	14.9	25
TMS 98/0505	6.8	54.9	39.8	11.1	5.2	28.8	15.1	25.8
TMS 91/2324	6.5	56.5	41.4	11.3	5.6	30	15.1	25.1
TMS 91/1638	7.2	54.8	39.7	10.9	5.1	28.8	15.1	26
TME 419	6.5	56.2	41.1	11.2	5	29.9	15.2	25.9
TMS 95/0289	6.2	56.7	41.9	11.7	5.8	30.2	14.8	24.9
TMS 96/1632	7.3	54.8	39.8	10.9	5.2	28.8	15.1	25.9
TMS 98/0581	6.9	56.3	41.1	11.3	5.4	29.9	15.2	25.2
TMS 92/0326	7.5	54	39.6	10.5	4.9	29	14.5	26.2
Mean	6.8	55.7	40.7	11.2	5.4	29.6	14.9	25.5
sem (df=10)	0.02	0.01	0.01	0.01	0.01	0.02	0	0.01

Table 3 shows that TMS 92/0326 gave the highest ($P< 0.05$) dry matter digestibility (DMD) value, while TMS 96/1632 gave the lowest DMD value among leaves from the ten varieties of cassava. Organic matter digestibility (OMD) ranged from highest ($P< 0.05$) for TMS 96/1632 to the lowest OMD value recorded in TMS 98/0510. TMS 98/0510 gave the highest fermentation efficiency (FE), while TMS 98/0581 recorded the lowest FE. This shows that, over 60% of the nutrients contained in the feed consumed were properly utilized by the animals.

Table 3: Variation in dry matter digestibility (%), organic matter digestibility (%) and fermentation efficiency of cassava leaves incubated using rumen liquor from West African Dwarf goat

Cassava Varieties	Dry Matter digestibility (DMD)	Organic Matter digestibility (OMD)	Fermentation efficiency (FE)
TMS 30572	68.67	54.87	2.11
TMS 98/0510	77.1	51.35	2.74
TMS 98/0505	56.67	53.11	1.85
TMS 91/2324	63.8	53.69	2.06
TMS 01/1638	70.9	56.04	2.1
TME 419	55.9	54.28	1.75
TMS 95/0289	55.53	57.8	1.54
TMS 96/1632	54.8	58.97	1.48
TMS 98/0581	55.5	52.52	1.87
TMS 92/0326	79.53	55.45	2.39
Mean	63.84	58.81	1.98
SEM (df=10)	2.594	0.744	0.088

Table 4 shows that TMS 98/0510 and TMS 01/1638 recorded high digestibility, while TMS 98/0505 and TMS 96/1632 gave low digestibility among the ten varieties of cassava peels. TMS01/1368 gave the highest ODM value, while TMS 96/1632 gave the lowest OMD among peels from the ten cassava varieties. Varieties TMS 98/0510, TME 419 and TMS 96/1632 recorded high FE while, TMS 98/0505 gave the lowest FE. The fermentation efficiency of cassava peels is low and has an effect on the chemical composition of the varieties; this is in agreement with Adeleke *et al.* (2017).

Table 4: Variation in dry matter digestibility (%), organic matter digestibility (%), and fermentation efficiency of cassava peels incubated using rumen liquor from West African Dwarf goat

Cassava Varieties	Dry Matter digestibility (DMD)	Organic Matter digestibility (OMD)	Fermentation efficiency (FE)
TMS 30572	49.7	60.73	1.25
TMS 98/0510	68.4	63.08	1.61
TMS 98/0505	34.53	60.73	0.91
TMS 91/2324	57.57	56.63	1.67
TMS 01/1638	68.65	65.72	1.54
TME 419	62.33	60.15	1.64
TMS 95/0289	51.9	64.25	1.19
TMS 96/1632	40.77	51.93	1.61
TMS 98/0581	50.1	63.8	1.19
TMS 92/0326	43.26	57.21	1.23
Mean	52.72	60.35	1.385
sem (df=10)	2.658	0.763	0.9

Table 5 shows significant difference ($P< 0.05$) in methane (CH_4) and short chain fatty acids (SCFAs) production from the leaves. TMS 30572 and TMS 95/0289 produced the highest CH_4 gas while, TMS 96/1632 produced the least methane gas among the cassava varieties. TMS30572 and TME 419 produced the highest CH_4gas volume, while TMS 96/1632 and TMS 92/0326 recorded the lowest CH_4 gas volume. Reduction in methane (CH_4red) was high in all the varieties with its highest value in TMS 96/1632 and lowest value in TMS30572 and TMS 95/0289. The production of SCFAs in TMS 96/1632 is highest, while TMS 98/0581 recorded the lowest producer. The high volume of short chain fatty acid observed indicates the availability of high energy to the animal as reported by Tona (2014) that, short chain fatty acids are volatile fatty acids (VFAs) and their presence in feedstuff is indicative of energy. Yusuf *et al.* (2013) reported that, high methane production implies energy loss and excessive accumulation of the gas in the rumen results in bloat.

Table 5: Variation in methane and short chain fatty acid contents of cassava leaves incubated using rumen liquor from West African Dwarf goat

Cassava Varieties	Methane (CH_4)	Methane Gas Volume (CH_4GV)	Methane Reduction (CH_4Red)	Short Chain Fatty Acid (SCFA)
TMS 30752	23.33	0.73	86.74	0.72
TMS 98/0510	18.67	0.66	89.39	0.63
TMS 98/0505	19.67	0.64	88.83	0.67
TMS 91/2324	19.33	0.61	89.02	0.69
TMS 01/1638	21.33	0.62	87.88	0.75
TME 419	21.33	0.71	87.88	0.71
TMS 95/0289	23.33	0.65	86.74	0.8
TMS 96/1632	17.33	0.47	90.15	0.83
TMS 98/0581	19.33	0.64	89.02	0.66
TMS 92/0326	18.00	0.54	89.77	0.74
Mean	20.17	0.62	88.54	0.72
SEM (df=10)	0.732	0.017	0.416	0.02

Table 6 shows that, TMS 98/0505 and TME 419 were the highest producers of methane gas, while TMS 96/1632 was the lowest producer of methane gas in the peels. Also, among all the varieties of cassava peels, TMS 96/1632 gave the highest CH_4GV. TMS 01/1638 gave the highest SCFA, while TMS 96/1632 recorded the lowest SCFA among the varieties of cassava peels. High production of methane by TMS 98/0505 and TME 419 will increase the amount of greenhouse gas emission and this will lead to global warming, climate change and make the environment unfriendly for habitation. However, all samples of cassava peels from the test varieties are good sources of short chain fatty acids (SCFA).

Table 6: Variation in methane and short chain fatty acid contents of cassava peels incubated using rumen liquor from West African Dwarf goat

Cassava Varieties	Methane (CH_4)	Methane Gas Volume (CH_4Gv)	Methane Reduction (CH_4Red)	Short Chain Fatty Acid (SCFA)
TMS 30752	23.33	0.73	86.74	0.72
TMS 98/0510	18.67	0.66	89.39	0.63
TMS 98/0505	19.67	0.64	88.83	0.67
TMS 91/2324	19.33	0.61	89.02	0.69
TMS 01/1638	21.33	0.62	87.88	0.75
TME 419	21.33	0.71	87.88	0.71
TMS 95/0289	23.33	0.65	86.74	0.8
TMS 96/1632	17.33	0.47	90.15	0.83
TMS 98/0581	19.33	0.64	89.02	0.66
TMS 92/0326	18.00	0.54	89.77	0.74
Mean	20.17	0.62	88.54	0.72
SEM (df=10)	0.732	0.017	0.416	0.02

Conclusion

The results from the research indicated that TMS 98/0505, TMS 98/0510, TME 419, TMS 96/1632, TMS 01/1638 are highly recommended to farmers as non-conventional feed resources for ruminants.

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