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# Nutritional potential of post extraction residues and silage from leaves of five cassava varieties as feed for ruminants

Fasae O.A., Obasa O.A. and Akinade, O.P.
Department of Animal Production and Health, Federal University of Agriculture, P.M.B.2240, Abeokuta, Nigeria.

**Corresponding Author:** animalexp@yahoo.co.uk

**Target Audience:** Ruminant farmers, Scientists and Extension agent

## Abstract

*The nutritional potential of post extraction residues and silage from leaves of five local cassava varieties cultivated in south west Nigeria namely Ilaro, Oko-iyawo, Mafamipa, Odongbo, Idileru as feed for ruminants, was evaluated using chemical composition and in - vitro dry matter digestibility as indices. Chemical composition of the fresh leaves, residues and silage differed (P < 0.05) somewhat across varieties. Results indicated that processing reduced (P < 0.05) the inherent nutrients of cassava leaf residues produced after the extraction of protein concentrate from cassava leaves with crude protein (CP) content ranging from 8.08% in Ilaro to 10.32% in Odongbo, respectively, while the hydrocyanic content (mg/100g) reduced (P < 0.05) and ranged from 12.88 in Mafamipa to 21.13 in Ilaro. The DM, CP and HCN contents of the cassava leaf silage decreased (P < 0.05) slightly compared to the fresh leaves across varieties. The in - vitro dry matter digestibility of the leaf residues and silage also differed (P < 0.05) among varieties ranging from 25.00% to 53.33% in Idileru and Odongbo, respectively. It was therefore concluded that leaf residues from the extraction of protein concentrate as well as leaf silage of the studied cassava varieties has a potential as maintenance ration or as supplements to high quality forage and can help in alleviating dry season feed shortage experienced in ruminant production.*

**Keywords:** Cassava leaf, post extraction residue, silage, ruminant, chemical composition, *in-vitro* digestibility

## Description of Problem

Cassava *(Manihot esculenta crantz)* is a perennial woody shrub extensively cultivated as an annual crop in Nigeria for the purposes of tuberous roots as a source of energy for humans and animals. Peasant farmers mostly grow cassava as a primary staple food and it's also being used as a cash crop to produce industrial ethanol, starches and livestock feeds. Cassava is extremely reliable to grow without excessive use of costly inputs, survives drought periods and grows well with limited supplies of water and these qualities have endeared cassava to resource-poor farmers (1).

The use of cassava and its products in livestock feeding has been on the increase and evidence of its suitability in livestock feeding has been documented (1, 2). Ruminants being complex stomach structured animals can be fed not only on cassava tuber, but also the stem, leaves, peel and various by-products of tuber harvesting and processing such as residues from starch and leaves. The leaves if adequately managed and utilized could serve as a cheap source of nutrients and fundamental link in the food chain, thereby assisting farmers in solving the challenges of feed shortage encountered as a result of seasonal reduction in feed supply and reduced pasture quality (3, 4).

Cassava forage has been found to efficiently serve as a protein and roughage supplement in ruminant feeding systems, used as a supplement for animals in either fresh or wilted form or as hay and silage. The production of cassava forage into silage has been found to be an appropriate method to conserve cassava leaf as feed for use during dry season feeding (5).

Moreover, the fibrous residues after extraction of protein concentrate from leaves, which usually serve as waste products have been found to contain unextracted protein as well as non-protein nitrogen that can serve as a potential source of ruminant feed (6, 7). This study therefore examines the nutritional potential of post-extraction residues and silage from five local varieties of cassava leaves cultivated in Nigeria as feedstuff for ruminants.

## Materials and Method

### *Sourcing and processing of cassava leaves*

Leaves from five local varieties of cassava cultivated in south west Nigeria with local names Odongbo, Oko – iyawo, Ilaro, Idileru and Mafamipa were sourced from the cassava farms in local communities around the Federal University of Agriculture, Abeokuta, Nigeria. The cassava leaves were identified according to varieties and processed into residues and silage. For the production of post extraction residues from cassava leaves, leaves were plucked, weighed and washed before pulping using the hammer mill as described (8). The pulping ruptured the plant cell walls and the juice which contains most of the protein was squeezed out from the leaves, by means of a press and the post extraction leaf residues were collected and air - dried for a week before it was grinded as described (7). Samples of leaf residues were packed into tightly sealed nylon bags, properly labelled and analysed for proximate composition.

For the ensiling process, each variety of cassava leaves was chopped into pieces to less than 3 cm to make compaction easy. The leaves were transferred into 24 laboratory silo in form of glass jars of 960 ml, used for ensiling, with 8 jars replicated 3 times for each of the varieties. The jars were later sealed air-tight for a period of 49 days. At the expiration of each ensiling duration, the silage was opened, thoroughly mixed and sub-samples taken, weighed and oven-dried at $100^0$C for 24 hours and analysed for its chemical constituents.

### *Proximate analysis and in vitro dry matter digestibility*

The proximate composition of the defoliated and stored leaves was determined (9). The DM was determined by oven drying at $65^0$C to constant weight, crude protein by Kjeldhal method and fat by Soxhlet fat extraction method. The hydrocyanic acid (HCN) in feed was assessed as described (10).

The *in vitro dry matter* digestibility of residues, silage and the cassava leaves from which they were produced were determined according to the procedures of (11).

***Statistical analysis***

Data generated were subjected to one way analysis of variance using the statistical package of (12) and significant means were separated using Duncan multiple range test (13).

**Results and Discussion**

The chemical composition of the leaves from five cassava varieties is shown in Table 1. Dry matter (DM) differed (P < 0.05) across varieties with highest (P < 0.05) values of 90.86, 90.87 and 90.71% observed in Idileru, Odongbo and Mafamipa varieties, respectively, while Oko iyawo and Ilaro recorded the lowest (P < 0.05) values of 89.65 and 89.60% for DM, respectively. Crude protein content also varied across varieties with Ilaro and Odongbo varieties having the highest (P < 0.05) content. The variation in composition across varieties was similar to the reports of (14, 15) that demonstrated a considerable variation in the chemical composition among leaves of different cassava varieties. The differences in the chemical composition among varieties could be attributed to the variation due to differences in genetic make-up as well as plant development such as the age of plant at harvest, plant density, ratio of leaf/stem, soil quality, fertilisation, harvesting frequency and climate (16).

**Table 1 : Proximate composition (%) of the various varieties of cassava leaves.**

| Parameters | Cassava varieties | | | | | |
|---|---|---|---|---|---|---|
| | Idileru | Ilaro | Mafamipa | Odongbo | Okoiyawo | SEM |
| Dry matter | $90.86^{a}$ | $89.65^{b}$ | $90.87^{a}$ | $90.71^{a}$ | $89.60^{b}$ | 0.13 |
| Crude protein | $21.07^{c}$ | $24.22^{a}$ | $22.84^{bc}$ | $23.40^{a}$ | $21.77^{c}$ | 1.02 |
| Crude fibre | $11.57^{a}$ | $11.72^{a}$ | $8.32^{b}$ | $8.18^{b}$ | $8.20^{b}$ | 0.45 |
| Ash | $11.02^{a}$ | $11.31^{a}$ | $9.01^{b}$ | $9.75^{b}$ | $9.79^{b}$ | 0.23 |
| Ether extract | $4.98^{a}$ | $4.30^{a}$ | $3.40^{b}$ | $3.57^{b}$ | $3.29^{b}$ | 0.17 |

$^{a,b,c,}$ Mean within the same row with different superscript differ significantly (P < 0.05)

The chemical composition of post extraction cassava leaf residues from cassava (Table 2) shows a variation (P<0.05) in the chemical constituents. Dry matter (DM) was highest (P<0.05) in Idileru and Mafamipa varieties, respectively with Odongbo varieties having highest crude protein (CP) content, following the same trend observed in DM of leaves before extraction.

**Table 2: Proximate composition (%) of post extraction leaf residues of five varieties.**

| Parameters | Varieties | | | | | SEM |
|---|---|---|---|---|---|---|
| | | | Cassava | | | |
| | Idileru | Ilaro | Mafamipa | Odongbo | Okoiyawo | |
| Dry matter | 90.86[a] | 89.65[b] | 90.87[a] | 90.71[b] | 89.60[b] | 0.13 |
| Crude protein | 8.25[c] | 9.71[b] | 8.31[c] | 10.32[a] | 8.08[c] | 0.25 |
| Crude fibre | 11.57[a] | 11.72[a] | 8.32[b] | 8.18[b] | 8.20[b] | 0.45 |
| Ash | 11.02[a] | 11.31[a] | 9.01[b] | 9.75[b] | 9.79[b] | 0.23 |
| Ether extract | 4.98[a] | 4.30[a] | 3.40[b] | 3.57[b] | 3.29[b] | 0.17 |

[a,b,c,] Mean within the same row with different superscript differ significantly ($P < 0.05$)

The reduced ($P < 0.05$) CP content observed in cassava leaf residues, compared to that of cassava leaves, might be attributable to the extraction process of protein concentrate. This corroborates earlier reports of reduction in CP contents of leaf residues obtained from the extraction of protein concentrate from the leaves of different forage plants (7, 17). Moreover, other various processing methods have earlier been reported to either increase or decrease some proximate components in cassava leaves. The processing effect of sun or oven drying as well as chopping and wilting have been found to reduce the crude protein content of cassava leaves (18, 19). (20) reported that blanching for 5 min increased protein content of cassava leaves but reduced ash content while drying cassava leaves, followed by grinding in a hammer mill and passing through a 60-mesh sieve has been reported to reduce fibre but increased the protein (21).

However, the CP content of 8.08 to 10.32% obtained in post extracted cassava leaf residues across varieties in this present study will be suitable as maintenance ration, suggesting its potential as feedstuff for ruminants. Previous reports confirm that ruminant animals require a minimum of 7% CP for proper ammonia production required by the rumen microorganism to support optimum microbial activity (22).

Table 3 shows the proximate composition (%) of ensiled cassava leaf varieties. The nutrient contents of the cassava leaf silage varied across varieties and DM and CP contents decreased slightly in values compared to the fresh leaves across varieties as shown in Table 1, supporting the reports of (23) that observed a reduction in CP content of cassava leaf silage fed as a supplement in ruminants' diets. Moreover, it has been reported that under good fermentation conditions, only minor effects on the silage protein content should be expected in relation to the products it is made from (24).

**Table 3: Proximate composition (%) of ensiled cassava leaf varieties.**

| Parameters | Varieties | | | | | SEM |
|---|---|---|---|---|---|---|
| | | | Cassava | | | |
| | Idileru | Ilaro | Mafamipa | Odongbo | Okoiyawo | |
| Dry matter | 55.83[a] | 54.00[b] | 55.05[a] | 54.18[b] | 54.92[b] | 0.53 |
| Crude protein | 17.71[bc] | 21.93[a] | 16.56[c] | 19.81[a] | 18.81[b] | 1.12 |
| Crude fibre | 10.01[a] | 8.00[a] | 8.01[b] | 10.02[b] | 5.97[b] | 0.45 |
| Ash | 8.01[a] | 7.02[a] | 6.01[b] | 7.01[a] | 6.06[b] | 0.23 |
| Ether extract | 7.40[a] | 8.69[a] | 5.69[b] | 5.12[b] | 5.49[b] | 0.17 |

[a,b,c,] Mean within the same row with different superscript differ significantly ($P < 0.05$)

The HCN content in varieties of cassava leaves, residues and silage are shown in Figure 1. The content of HCN in fresh cassava leaves ranged from 71.13 to 88.80mgHCN/kg in Ilaro and Idileru, respectively with considerable reduction ($P < 0.05$) observed in leaf residues and silage, which could be attributed to the effect of processing on these leaves. The existence of cyanogenic glucosides has made some form of processing a pre-requisitive for the use of cassava leaves in animal feeding. Many researches have demonstrated different effective processing methods of reducing the content of HCN in cassava leaves which is a poisonous agent for livestock (25, 26, 27). This reduction is due to the action of endogenous linamarase on glucosides following loss of cell integrity (wilting) or tissue damage (chopping).

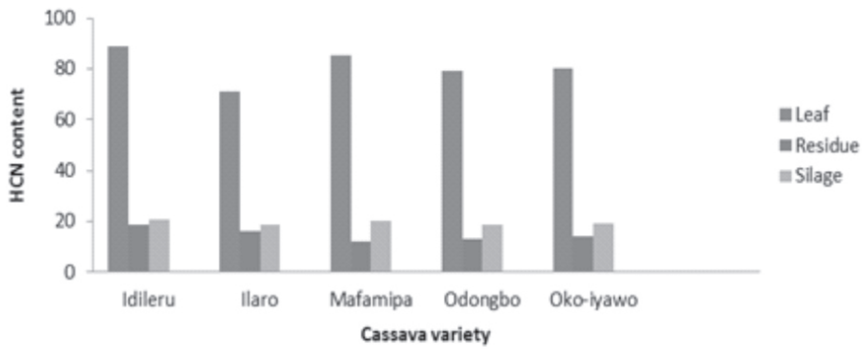


**Figure 1: Hydrocyanic acid content (Mg/kg) of cassava leaves, residues and silage**

Moreover, using fresh cassava foliage as a feed for ruminants can be a problem due to its fairly high HCN content (2). Chronic sub-lethal dietary cyanide has reportedly caused some reproductive effects including lower birth rates and an increased number of neonatal deaths, impaired thyroid function (28). Generally, only plants that produce more than 20mg HCN/100g fresh weight are considered deleterious (29).

However, one of the more important differences between different varieties of cassava is in the content of HCN as observed in the results of this study. In many cases the varieties with high HCN content are referred to as very bitter or bitter varieties while those low in HCN are classified as sweet varieties (30).

The *in – vitro* dry matter digestibility (%) of varieties of cassava leaves, residues and silage are shown in Figure 2, with variation observed across varieties. The variation observed in the digestibility could be as a result of the differences in the morphology and stage of maturity of the leaves (31). In addition, the presence of different concentration of anti-nutritional factors such as hydrocyanic acid and tannin (32) could be a predisposing factor. Nevertheless, the DM digestibility of leaf silage was higher ($P < 0.05$) compared to the fresh leaves and residues, suggesting its better utilization by ruminants.

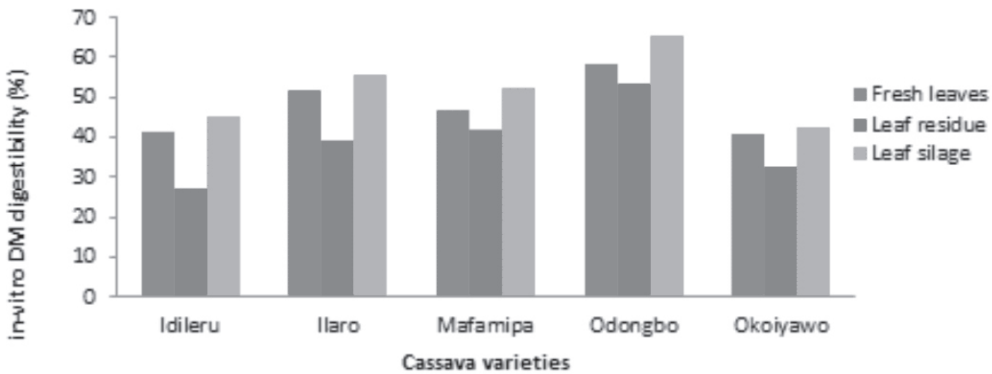


**Figure 2: *in-vitro* Dry matter digestibility (%) of leaves, residues and silage from five varieties of cassava.**

From the result of this present study the leaves, residues and silage of Odongbo and Ilaro cassava varieties recorded a high percentage digestibility which could be as a result of the high CP content. This indicates that the inherent nutrients in Odongbo and Ilaro varieties will be more available when compared with the other varieties. In addition, the low HCN content in these varieties could also have prompted better digestibility. Findings have shown that varieties with the highest anti-nutritional contents tend to exhibit the lowest nutritional contents indicating an inversely proportional relationship between anti-nutritional factors and nutritional contents in plants (33).

**Conclusion and Applications**

1. The post extraction residues and silage from cassava leaves have potential in serving as feed resources in ruminant production systems with residues and silage from Odongbo and Ilaro varieties having the best nutrient content and high digestibility values.
2. The crude protein content of post extraction residues and silage from cassava leaves could best be exploited and used as a maintenance ration for the sustainability of ruminant animals during difficult months of the dry season, when there is lack of good nutritive feed, thereby improving the productivity of these animals.

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