

EFFECT OF PROCESSING METHODS ON THE CHEMICAL COMPOSITION OF CASSAVA PEEL AS LIVESTOCK FEED RESOURCE

Okah , U., Adedokun, O. O. and Ebere, C. N.*

ABSTRACT

*College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, P.M.B. 7267, Umuahia, Abia State, Nigeria. *Corresponding author: email: okahuc@yahoo.co.uk , Mobile: 08051515840*

This study was conducted to evaluate the effects of processing on the chemical composition of cassava peel meal as livestock feed resource. Cassava peels of bitter variety TMS 30555 (Tropical Manihot species) from 9 to 12 months plant were collected fresh. The samples included, T1 (Fresh peels), T2 (sun-dried), T3 (Ensiled), T4 (Soaked) and T5 (boiled). The different processing methods showed significant differences ($p < 0.05$) in the proximate composition of the cassava peel meal. T1 gave the highest (macro-minerals followed by T2 suggesting that sun drying is an effective processing method for cassava peel. Vitamins B₁ and B₂ differed significantly ($p < 0.05$) in all the treatments with highest values (0.48 and 1.04 ppm) in soaked and the least values (0.23 and 0.62 ppm) in boiled cassava peel meal, respectively. There were significant differences ($p < 0.05$) in the niacin content of the processed cassava peel meal samples with T4 recording the highest value. Hydrogen cyanide (HCN) was generally low and quite lower than the recommended different safe levels 100ppm and 124 mg g⁻¹ of diet for poultry. The study showed that processing resulted in improvement in the cassava peel meal in terms of proximate composition, minerals and vitamins. The cyanide content was almost completely eliminated. Sun drying of cassava peel being a simple and straight forward process which reduced HCN and maintained adequate nutrient profile of the peel is hereby recommended for the processing of cassava peel as livestock feed resource.

Keywords: *Cassava peel, processing methods, proximate composition, cyanide*

INTRODUCTION

Cassava is one of the major root crops produced in sub-Saharan Africa. As at 2002, Africa exported only one tonne of cassava annually (FAO, 2001) but by 2007, out of more than 228 million tonnes of cassava produced worldwide, Nigeria produced 50 million tonnes of cassava with 5 million tonnes of cassava peels. According to FAO (2001), about 250 to 300 kg of cassava peels is produced per tonne of fresh cassava. It has been projected that total world cassava utilization would reach 275 million tonnes by 2020 (IFPRI, 2008). Currently, there is increase in campaign for enlarging the cassava production scale in Nigeria. The implication of this is increase in the quantity of waste produced from cassava processing.

Substantial quantities of cassava (*Manihot esculenta* Crantz) peels that could provide carbohydrate for livestock are generated annually from the processing of cassava into starch, chips and gari (Ezekiel *et al.*, 2010). Maximum utilization of this bio-resource in an integrated agricultural system would alleviate the major challenge of inadequate dry season feed for livestock in the tropics especially, and generate additional income for cassava processors and farmers. One of the toxins produced by cassava plant is hydrogen cyanide (HCN) which is present in different tissues of the cassava plant. This is released when the tissue is disrupted. Hydrogen cyanide (HCN) has been reported as a major limiting factor in the use of cassava and its products in animal feeding (Egena *et al.*, 2007). There are at least two forms of chronic cyanide poisoning in domestic animals: they include hypothyroidism due to disruption of iodide uptake by the follicular thyroid cell sodium-iodide symporter by thiocyanate, a metabolite in the detoxification of cyanide, and chronic cyanide and plant cyanide metabolite (e.g., various glutamyl β-cyanoalanines) -associated neuropathy toxidromes (e.g., equine sorghum cystitis ataxia syndrome, cystitis ataxia syndromes in cattle, sheep, and goats) (Rhian, 2014).

Tewe (1984) recommended HCN tolerable level of not more than 100ppm in the diet of poultry. Hydrogen cyanide level of more than 124mgg⁻¹ of diet was reported to depress growth, reduce feed intake and feed conversion ratio in broilers (Egena *et al.*, 2007). Most researchers have been investigating methods of processing that can reduce the HCN content to a safe level for the consumption of cassava and its products by animals. Tewe and Kasali (1986) reported that sun drying which is the commonest method of treatment can partially reduce the cyanogenic glycoside content. Heat produced by drying reduces the cyanide content of cassava and its products. Linamarin, the major cyanogenic glucoside found in cassava peel and bitter varieties can be eliminated by heat from drying or boiling (Mc Donald *et al.*, 1981). However, it is necessary to identify other methods that are highly effective, that require no sophisticated equipment and can readily be adopted by subsistent farmers. This study was therefore aimed at evaluating the effect of processing methods of cassava peel on its nutritive value.

MATERIALS AND METHODS

Experimental location

The experiment was conducted in the Animal Science and Production Laboratory of Michael Okpara University of Agriculture, Umudike, Umuahia. Umudike is located in Abia State on latitude 05° 29' north, longitude 07° 33' east and at an altitude of 122 meters (400 feet) above sea level. It falls within the humid rain forest zone which is characterized by long duration of (7 to 9 months) rainfall and short period of dry season. Average rainfall is 2169.8mm in 148 – 155 rainy days, average ambient temperature is 26 °C with maximum of 32 °C and minimum of 22 °C. Relative humidity ranges from 50 – 95 % (NRCRI, 2014).

Experimental material

Cassava peels of bitter variety TMS 30555 (*Tropical Manihot species*) from 9 to 12 months plant were collected fresh from the commercial “gari” processing unit of the National Root Crops Research Institute (NRCRI), Umudike.

Processing of experimental cassava peel meal

The different processing methods used were aimed at improving the nutritive quality and reducing the cyanide content of the cassava peel for better utilization by animals. Treatment 1 constituted fresh cassava peel meal (FCPM). The cassava peel was washed, chopped into tiny particle sizes of about 1 x 1cm for easy milling before it was used to conduct chemical analysis. Treatment 2 was sun-dried cassava peel meal (SCPM). The cassava peel was washed, and then air-dried on a concrete platform for five days during dry season (March) with occasional turning during the period. It was later milled using a 2-mm screen and bagged and stored in a cool dry condition for analysis. Treatment 3 was ensiled cassava peel meal (ECPM). The cassava peel was washed and chopped into tiny particle sizes of about 1 x 1cm for easy compaction. Moisture content of the peel was reduced to about 40% by pre-wilting for 2 days on a cemented corridor. The chopped cassava peels were then compacted into an air tight plastic container and allowed to stay for 21 days. The resultant product was then air-dried for five days, milled, bagged and stored for analysis. Treatment 4 was soaked cassava peel meal (SCPM). The cassava peel was washed chopped and packed into a plastic container, water twice its weight was added, and then it was left uncovered for three days. The water was drained while the peels were compressed in a jute bag to drain properly. The drained peels were then air-dried on a cemented platform for five days. The dried peels were then milled, bagged and stored for analysis. Treatment 5 was boiled cassava peel meal (BCPM). The washed and chopped cassava peels were put into boiling water of about 100 °C and allowed to stand for 15 minutes. The boiling will destroy the enzyme linamarase at about 72 °C thus leaving a considerable portion of the glucosides intact. The water was drained and peels were air-dried on cemented platform for five days. The peels were then milled, bagged and stored for analysis.

Chemical analyses

The processed cassava peel meals were analyzed for proximate composition using the procedure of AOAC (1990). The various cassava peel meals were subjected to wet digestion with hydrochloride and nitric acids according to the Johnson and Ulrich (1951) methods. Following the digestion, the mineral elements, sodium (Na), potassium (K) and calcium (Ca) were determined by flame photometry, using Jen way digital flame photometer. Magnesium (Mg) was determined by Atomic Absorption Spectrophotometry using buck 600 AAS. Phosphorus (P) was determined by using spectric 21D digital spectrometer. The B-vitamins were determined by the high-performance liquid chromatographic (HPLC) methods, a procedure described by Tee and Khor (1996). The total cyanide content was determined by the acid hydrolysis and picrate kit methods as described by Rezaul and Howard (2002).

Experimental design and statistical analysis

The experimental design was a Completely Randomized Design (CRD). There were five processing methods, and the analysis of each parameter of interest was done in triplicate. All data collected were subjected to one-way analysis of variance (ANOVA) (Steel and Torrie, 1980), significantly different means were separated according to Duncan Multiple Range Test (DMRT) (Duncan, 1955) using SAS (1999).

RESULT AND DISCUSSION

The proximate composition of the fresh and processed cassava peel is presented in Table 1. There were significant ($p < 0.05$) differences in all the parameters considered. The dry matter, crude protein and ether extract content which ranged from 27.7 to 89.7%, 8.7 to 11.3% and 3.0 to 3.5%, respectively were higher than the values reported by Devendra (1977), which were 4.8% crude protein, 1.2% ether extract, and the values by Adegbola (1980) which were 13.5% dry matter, 6.5% crude protein and 1.0% ether extract. The present crude fibre content range (4.7 to 6.9%) and ash (2.0 to 4.9%) were lower than the 10.0% crude fibre and 6.5% of ash reported by Adegbola (1980). However, the nitrogen free extract (NFE) content reported in this study was within the range reported by Adegbola (1980). Hydrolysis resulting from processing could have led to reduction in nitrogen content of processed peels, hence, lowering the crude protein content in the processed peels. The level of reduction in nitrogen content might depend on the method of processing employed. The observed improved fibre content of processed cassava peels was more in soaked, followed by the ensiled. It is suspected that the carbohydrate

degradation of the peels resulted in higher fibre content, depending also on the level of degradation achieved by the processing method. Ether extract and ash content of cassava peels appear to be improved by soaking above every other method, probably due to release of these nutrients from their bound form in the cells of cassava peel. The variations in proximate composition as compared with the reports by other authors might probably be due to differences in variety, the mineral composition of the soils where the plant was grown, the amount of flesh in the peel, and even the analytical techniques and the skill of the laboratory technologist.

Table 1 Proximate composition of fresh and processed cassava peel meal (%DM)

Parameters (%)	T1	T2	T3	T4	T5	SEM
Dry matter	27.7c	89.7a	89.2a	88.2b	88.6b	0.21
Crude protein	11.3a	10.2c	8.7e	10.3b	9.4d	0.03
Crude fibre	4.7e	5.2d	5.7b	6.9a	5.3c	0.00
Ether extract	3.3b	3.2c	3.0e	3.5a	3.2d	0.00
Ash	4.2c	2.6d	4.4b	4.9a	2.0e	0.02
NFE	4.2e	68.5b	67.4c	62.70d	68.80a	0.16

*Mean within the same column with different letters differ significantly ($p < 0.05$). NFE = Nitrogen Free Extract

Table 2 shows the effect of treatment on the Macro-mineral composition of the cassava peel meal. All the minerals evaluated were affected by the processing methods. The lower values obtained in processed cassava peels compared with fresh cassava peels (T1) tend to suggest that processing leads to loss of macro-minerals. However, sun-dried cassava peels (T2) was found to be better than all the other processing methods in macro minerals retention. The values for minerals reported by Ganiya (2006) for unfermented, naturally fermented or inoculated fermented cassava peel were generally lower than the values obtained in this study. The Ca, Na and K reported by Ganiyu (2006) were 0.03, 0.04 and 0.05ppm, respectively. The present values reported herein for Ca, Na and K ranged from 0.06 to 0.12, 0.06 to 0.18 and 0.04 to 0.21 ppm, respectively. Variations in the values of the minerals as reported by different workers might be due to differences in cultivars, soil minerals and processing methods. The importance of these mineral nutrients in nutrition cannot be overemphasized. The phosphorus content of the cassava peel meals did not differ significantly, while the magnesium content was significantly ($p < 0.05$) reduced by the various processing methods, especially the ensiling. Phosphorus is involved in the intermediary metabolism of carbohydrates as phosphorylation is a pre-requisite for bone and teeth structures (Wong, 1990). Potassium can activate enzymes such as alkaline phosphatase, lactate dehydrogenase and aspartate aminotransferase (serum glutamic oxaloacetic transaminase) necessary for energy production (Wong, 1990). Potassium and sodium have interrelated functions in the body, being distributed in the body fluids and tissues are involved in maintenance of water balance, osmotic pressure, acid-base balance and neuromuscular function (Wong, 1990). Apart from the fact that low dietary intake of the salts could give rise to mineral deficiencies, excessive sweating (in the tropics) has also been associated with low salt levels (Wong, 1990). The low mineral content of the boiled cassava peel suggests that high level of heat adversely affects the processes of release of the minerals from the plant cells.

Table 2: Effect of processing methods on the macro-mineral compositions of cassava peel meal (ppm)

Minerals	T1	T2	T3	T4	T5	SEM
Ca	0.12a	0.11ab	0.06c	0.10b	0.07c	0.02
K	0.21a	0.17b	0.04d	0.17b	0.09c	0.03
P	0.13	0.15	0.15	0.15	0.12	0.04
Mg	0.09a	0.08b	0.03e	0.06c	0.05d	0.00
Na	0.18a	0.14b	0.06e	0.12c	0.08d	0.02

*Mean within the same column with different letters differ significantly ($p < 0.05$).

Table 3 summarizes the effect of processing on the B- vitamins and hydro-cyanide content of cassava peel meal. There were significant ($p < 0.05$) differences in all the parameters considered. The study showed an appreciable retention of the vitamins when different processing methods were employed. The values of vitamins recorded agree with the values reported by Purselove (1991) which showed that cassava root contains small amounts of niacin, vitamin B₁ and B₂. However, soaking significantly ($p < 0.05$) improved the vitamins content of the cassava peels. Significant loss in thiamine and B₂ (Riboflavin) by boiling confirm the report of Onimawo and Akubor (2005) that thiamine and riboflavin are water soluble vitamins and are lost in cooking water, destroyed during cooking and roasting. The niacin content of the differently processed cassava peels (0.27, 0.35, 0.31, 0.72, and 0.53 ppm), shows that niacin was not destroyed by the processing methods. Niacin is not easily destroyed by cooking (Onimawo and Akubor (2005). It is stable to heat, light, oxidation and pH. Niacin is a major component of two enzymes nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate

(NADP) which are vital for the release of energy from foods (Onimawo and Akubor (2005). The study showed that boiling and soaking gave appreciable retention of niacin in the cassava peels.

Table 3 Effect of processing methods on the B- vitamins and hydrogen cyanide contents of cassava peel meal

Constituents (ppm)	T1	T2	T3	T4	T5	SEM
B ₁	0.35b	0.25c	0.28c	0.48a	0.23c	0.02
B ₂	0.86b	0.80bc	0.75c	1.04a	0.62d	0.03
Niacin	0.27d	0.35c	0.31cd	0.72a	0.53b	0.02
HCN (mgKg ⁻¹)	27.30a	5.88c	6.25b	3.45d	1.78e	0.03
% RD	-----	78.5	77.1	87.4	93.5	-----

*Mean within the same column with different superscript differ significantly (p< 0.05); % RD – Percentage Reduction of HCN

Hydrogen cyanide was highly reduced by boiling cassava peel (1.78mgkg⁻¹) (93.5%) reduction. Cooke and Maduagwu (1978) reported that soaking of cassava normally precedes cooking or fermentation. It provides suitable larger medium for fermentation and allows for greater extraction of the soluble cyanide into the soaking water. A very significant reduction in total cyanide is achieved if the soaking water is routinely changed over a period of 3 to 5 days (Cooke and Maduagwu, 1978). The significant reduction of cyanide during sun drying confirms the report of Tewe *et al.* (1976) that sun drying for 2 to 5 days reduces cyanide. Onua and Okeke (1999) reported 53% reduction of cyanides in fresh cassava by sun drying. Reduction in cyanide by ensiling confirmed the report of Onua and Okeke (1999) that ensiling reduced cyanide content in fresh cassava from 1120mgkg⁻¹ to 569mgkg⁻¹, caused the disintegration of the intact glucoside via marked cell disruption, drop in pH of ensiled medium and intense heat generation. Processing of cassava peels by boiling, soaking, sun drying and ensiling were all effective in reducing the HCN level of cassava peel meal to a high percentage for use as animal feed resource.

CONCLUSION AND RECOMMENDATION

Although the other processing methods employed were equally effective in HCN reduction, the sun drying being a simple and straight forward method and more cost effective, with adequate nutrient retention especially crude protein (10.3%) and about 78.5% HCN reduction, is therefore recommended as the best processing method of cassava peel as animal feed resource. However, ensiling appears to be most unacceptable method of processing cassava peel as it had the lowest value in nutrient retention and HCN reduction tendency. It is necessary however, that these products be subsequently utilized in animal feeding trials to assess their performance.

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