

# Composition of Two Local Cassava Varieties and the Effect of Processing on their Hydrocyanic Acid content and Nutrient Digestibility by the Rat

By

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## SUMMARY

Two common Nigerian cassava varieties were subjected to proximate analysis with a view to assessing the relative potential nutrient composition of the roots, stems, leaves and seeds. The results obtained showed that the leaves, seeds and stems in that order are much richer than the roots in protein but higher in crude fibre. There was a relationship between the crude protein contents of the roots and stems and the hydrocyanic acid (HCN) content of the plant while that of the leaves and seeds did not appear to follow the same trend.

HCN of the bitter cassava variety was considerably higher in the whole tuber, pulp and peel than in the sweet strain. Sundrying and ensiling resulted in appreciable losses of HCN. Grated root lost about half its HCN content within six hours while stored whole roots showed a rapid decline in HCN from the fifth day after harvest. Apparent digestibility coefficients (A.D.C.) of the major nutrients of cassava roots were not significantly ( $P < 0.05$ ) affected by the processes of boiling or sundrying.

## INTRODUCTION

The incorporation of cassava roots into practical livestock rations has increased tremendously within the last decade (Nestle, 1973). This has been attributed to the comparative cheapness of this tropical staple as compared to the conventional energy sources like maize and guinea corn (Phillips, 1974). Moreover, potentials still exist for more efficient utilization of this root crop. These include:

- (i) attempts at preserving the roots, as losses due to post-harvest deterioration are remarkable.
- (ii) Utilization of the other parts of this plant which are hitherto being discarded after harvesting. Indeed, a number of reports indicate that the food value of cassava leaves are uncommonly high (Van Veen, 1939; Rogers and Milner, 1963; Oyenuga, 1968; and Eggum, 1970).
- (iii) Removal of the toxic factor-hydrocyanic acid (HCN) from cassava and cassava products meant for human consumption. This area has aroused considerable interest within the last decade, mainly because clinical evidence has indicated that residual HCN in cassava products can be major aetiological factors in the pathogenesis of a number of neurological and endocrinological anomalies observed in humans (Ekpechi, 1967; Osuntokun, 1968).

The studies here reported were carried out to compare the proximate composition of the roots, stems, leaves and seeds of two Nigerian cassava varieties. It was also aimed at quantifying the HCN of these two widely grown varieties and to evaluate the effect of some processing methods on the HCN content, proximate composition and digestibility of the roots by rats.

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## EXPERIMENTAL PROCEDURES

The cassava used for this study was obtained from the International Institute of Tropical Agriculture (IITA), Ibadan. Whole plants of the two cassava varieties (Isunikankiyan and Oyanrugbapupa) were uprooted at about 12 months of age. The roots, stems and leaves were separated, cut into pieces and oven-dried at 60°C for 48 hours. The different parts were then passed through a Thomas Wiley laboratory type 4 mill with a 1mm screen<sup>1</sup>. Samples were taken and bottled until analysed.

Sundried cassava roots was prepared by chopping whole roots into bits of 1-3cm, with a machet and spread out on tarpaulin in the sun. The chips were constantly turned over whenever there was rain. Drying was accomplished in about 2 weeks because of bad weather. The dried pieces were then milled into a powdery form for sampling.

Cassava silage was made by passing unpeeled fresh roots through a large mill and tightly packing in empty coal-tar drums perforated at the bottom and lined with banana leaves. The sides of the drums had cellophane lining. The drums were covered with banana leaves and a plastic sheet and weighted down with heavy stones. They were then allowed to stand for about eight weeks.

Grated roots were obtained by using a grater made from a flat sheet of iron, punched with nails on one side to create a sharp roughened edge at the other and securely fastened to a wooden board. The grater was held between the legs and the root was rubbed against the grater.

Proximate analysis of samples was done by the A.O.A.C. (1970) methods. HCN was analysed iodometrically by the method of Knowles and Watkins (1950).

Digestibility trial was carried out with 3 groups of 4 adult male rats (Wistar Strain) given fresh, boiled and sundried cassava of the high HCN (Oyanrugbapupa) variety as 100% of their diets. The feeds were given to appetite and after 4 days of adaptation, there was a 6-day collection period.

## RESULTS AND DISCUSSION

### Chemical Composition

The results of proximate analysis of the two Nigerian cassava varieties compared are shown in Table 1. The results indicated that for both varieties, the leaves, seeds and stems are richer in crude protein than the roots. It was also noted that the high HCN variety had a higher protein content in the root and stem than the low HCN variety. The reverse was however the case with leaf and seed protein content. It is

TABLE 1  
Proximate Composition of two Nigerian Cassava Varieties\* (Dry Basis)

Part of plant	Crude Protein	Ether Extract	Crude fibre	N.F.E.	Ash
	%	%	%	%	%
<i>Oyanrugbapupa variety (High HCN):</i>					
Root	5.8	1.2	5.4	83.5	4.1
Stem	10.3	0.8	37.8	43.1	8.0
Leaves	29.8	5.4	16.9	39.1	8.8
Seeds	25.0	25.1	30.2	8.9	10.8
<i>Isunikankiyan variety (Low HCN):</i>					
Root	4.7	1.0	3.9	86.9	3.5
Stem	9.0	1.1	39.0	45.5	5.4
Leaves	33.7	11.2	13.9	33.7	7.5
Seeds	27.4	27.5	26.6	10.8	7.7

\*Mean of 4 determinations.

also noteworthy that the seeds of the high and low HCN varieties contained 25 and 28% ether extractable material respectively. The observation that cassava leaves contain a relatively higher percentage of protein than other parts is therefore consistent with published results (Oyenuga, 1968; Eggum, 1970). Van Veen (1939) also indicated that 75% of the crude protein of cassava is true protein.

The point of relevance, especially in the Nigerian context is that cassava leaves have not assumed any considerable importance in human and animal nutrition despite their potential as protein source. While cassava leaves are not generally regarded by outside observers as components of diets for the people of West Africa, it should be noted that they are usually consumed in the form of vegetable stew, perhaps of more under conditions of stress and in rural areas. It is however not widely practised and in some African communities, it may be regarded as indicating adverse economic condition (Dalziel, 1948). Nevertheless, cassava leaves are of great nutritional value since the high protein content of the leaves would to some extent compensate for and complement the low and poorer protein content of the roots when consumed together. Campbell (1922) pointed out that cassava was regarded as the "all sufficient" food in south-western Congo because the people obtain "bread from the root and meat from the leaves". Cooked cassava leaves were called "old man's meat" because they require no chewing.

The high proportion of ether extractable material in the seeds of both varieties is of great practical interest. The fatty acid composition of the storage lipids of cassava seeds was analysed by GLC (Nartey and Moller, 1973). Major components were linoleate (61.6%), oleate (22.4%) and palmitate (10.3%), with myristate, palmitoleate, stearate and linolenate as minor components. A trace of arachidate occurred during early germination. Nartey, Moller and Anderson (1974) reported the occurrence of storage lipids in the seed kernels to the extent of 47%. The practical implication of this is that it places the

cassava plant in the category of oleaginous plants with exceptionally high seed storage lipids and the seeds may therefore represent a potentially useful source of dietary and industrial proteins and fats, comparable with other protein-lipid rich seeds.

It thus appears that cassava leaves could be used as protein supplement fed with the roots and the young stems could be consumed as forage. In Colombia, South America, attempts are being made at evaluating the potentials of closely planted young stems as forage for cattle (Alvarez-Luna, 1973).

### HCN content

Values of the HCN content of different parts of the fresh roots of the two cassava varieties are presented in Table 2a.

Calculation of the HCN content of the pulp and peel as proportions of that in the whole tuber on a dry matter basis indicate that there is a difference in the distribution of the glucoside in the two varieties. The HCN in the pulp of the I sunikankiyan (sweet) and Oyanrughapupa (bitter) strains were 33.9% and 46.0% of their respective whole root HCN content. The HCN content of the peel were 5.5 and 2.5 times of that in the whole root of sweet and bitter strains respectively. Peel to pulp ratio revealed that the HCN in the peel of the two strains were 16.5 and 4.26 times of that in the pulp in the sweet and bitter varieties respectively. Comparison of HCN content between varieties revealed that the HCN values of the whole tuber, pulp and peel of the sweet variety were 20.3, 15.0 and 57.7% of that in the bitter variety. This suggests that HCN content of bitter varieties are higher in all parts of the cassava root than in sweet strains.

A comparison of the values obtained in these studies with those of previous workers confirms that there is a wide variation in the HCN content of cassava varieties. Investigations on five Nigerian cassava varieties by Oyenuga and Amazigô (1957) showed that the HCN content of the whole root from these strains range between 354mg to 1,121mg per kg of fresh root

TABLE 2

Hydrocyanic Acid Content\* of Different Parts of the Fresh Tuber and Flour of two Varieties of Cassava

Part of tuber	Isonikankiyon Variety		Oyanrugbapupa Variety	
	Fresh Basis mg/kg	Dry Matter Basis mg/kg	Fresh Basis mg/kg	Dry Matter Basis mg/kg
Fresh whole tuber	81.8	233.7	402.3	1149.4
Fresh pulp	31.6	79.1	236.6	528.6
Fresh peel	380.3	1302.0	780.6	2256.0

Mean of six determination.

material. A dose of 2.042mg KCN/kg body weight for cattle and 2.4mg KCN/kg body weight for sheep have been reported to be fatal to these livestock species (Coop and Blakley, 1950). These values correspond to 0.817mg HCN and 0.926mg HCN for cattle and sheep respectively. The values reported by Oyenuga and Amazigo (1957) therefore indicate that ingestion of some Nigerian cassava varieties may result in manifestations of acute cyanide toxicity symptoms in these livestock species. Indeed, Obioha (1972) reported that sheep and goat have died within minutes of ingesting some Nigerian cassava varieties.

#### Effect of sundrying, grating and ensiling on HCN content

Analysis of the HCN content of sundried cassava showed that on air dry basis the sweet and bitter strains contained 12.6 mg/kg and 57.6 mg/kg HCN respectively. When these are converted to 100% dry matter basis, the values are 14.2 and 64.9 mg/kg HCN respectively.

A comparison of this result with those shown in table 2 indicate that on a dry weight basis, there was a loss of 119.5 mg/kg from the sweet variety and 1084.5 mg/kg in the bitter strain of cassava. This on calculation gave 89.4% and 94.4% HCN losses in the sweet and bitter varieties respectively.

Concentrations of HCN in cassava reported in the literature may not be of direct

applicability in livestock feeding trials due to the volatility of the HCN. Considerable losses might therefore occur during feed preparation especially when the fresh forms are used. The loss of HCN from the grated whole tuber of the Oyanrugbapupa variety is shown in Table 3. It can be observed that there was a loss of about half the total HCN content within the first six hours of grating. Subsequent losses were remarkably slower largely due to lower concentration gradient between the grated mass and the immediate environment.

The change in HCN content of the Oyanrugbapupa variety of cassava on storage of whole roots for one week is also shown in Table 4. This indicates that loss of HCN from the cassava roots was gradual until the fifth day when a sharp fall in HCN content was observed. The advantage of a decrease in HCN content may however not outweigh the decline in nutritional value which may accompany it due to post-harvest deterioration.

Ensiling of the Oyanrugbapupa variety of cassava reduced the hydrocyanic acid content from 1149.4 mg/kg to 17 mg/kg when expressed on a dry basis. This gives a calculated loss of 98% HCN from the fresh cassava root. Ensiling therefore appears a more efficient method than sundrying as a means of HCN removal from the root.

TABLE 3

Change in Hydrocyanic Acid Content of Grated Oyanrugbapupa Variety of Cassava over 24 hours

Hours	HCN content*, mg/kg		HCN content, as % of that in freshly grated tuber
	Fresh basis	Dry matter basis	
0	398.0	1137.1	100
6	201.0	574.3	50.5
12	147.3	420.9	37.0
18	135.7	387.7	34.1
24	113.4	324.0	28.5

\* Mean of three determinations per period.

TABLE 4

Change in Hydrocyanic Acid Content of the Oyanrugbapupa Variety of Cassava over a one-week period of Storage-whole Roots.

Days of storage	HCN content*, mg/kg		HCN content, as % of that in fresh tuber
	Fresh basis	Dry matter basis	
0	402.3	1149.4	100
1	336.4	961.1	83.5
2	315.7	902.0	78.5
3	323.7	924.0	80.5
4	176.2	503.4	43.8
5	139.1	377.4	34.6
6	51.3	146.6	12.8

\* Each value represents the mean of 4 determinations except the 0-day of storage which is the mean of 6 determinations.

### Digestibility Studies

Proximate composition of the fresh, boiled and sundried cassava used in the digestibility studies are presented in Table 5.

Boiling fresh cassava roots resulted in a loss of crude protein and ether extractable material. This loss might have been largely due to the dissolution of soluble nitrogen and ether extractable material from the root into the water in which they were immersed during this process.

An appreciable increase in crude protein was observed after sundrying whole cassava roots. This increased protein content may be largely due to fungal growth on the moist chips during the drying process. Cassava has been reported to be an excellent growth medium for *Aspergillus flavus* (Boshell, 1968). Clerk

and Claurie (1968) also found that over 26 fungi species can be identified on sun-dried cassava chips. Indeed, personal observations on sun-dried peeled cassava chips prepared for consumption mainly in the Oyo State of Nigeria in form of 'lafun' shows that a majority of them have green colouration which may not be unrelated to proliferous fungal growth.

The observed rise in ash content of cassava roots on sundrying may be partly due to contamination of the chips by dust during the drying period.

Mean values and their standard errors of the apparent digestibility coefficients (ADC) of nutrients in fresh, boiled and sun-dried cassava are presented in Table 6. Boiling or sundrying did not cause an appreciable change in the ADC of the gross energy, organic matter and nitrogen free extractives of Cassava.

TABLE 5  
 PROXIMATE COMPOSITION OF FRESH, BOILED AND SUN-DRIED CASSAVA  
 (OYANRUGBAPUPA VARIETY) OFFERED IN DIGESTIBILITY STUDIES WITH RATS

	Dry matter basis							
	Dry matter (as fed) %	Gross energy kcal/g	Organic matter %	Crude protein %	Ether extract %	Crude fibre %	Nitrogen free extract %	Ash %
Fresh cassava	35.6	4.4	97.2	2.3	0.5	4.9	89.5	2.8
Boiled cassava	31.3	4.0	97.2	2.7	0.2	5.7	89.6	2.8
Dried cassava	87.7	4.2	96.0	4.2	0.9	5.1	85.8	4.0

TABLE 6  
 APPARENT DIGESTIBILITY COEFFICIENT (A.D.C.) OF NUTRIENTS IN FRESH,  
 BOILED AND SUN-DRIED CASSAVA FED TO RATS

Treatment	APPARENT DIGESTIBILITY COEFFICIENT							
	Gross Energy %	Dry Matter %	Organic Matter %	Crude Protein %	Ether Extract %	Crude Fibre %	Nitrogen free extracts %	
Fresh	87.5 ± 0.7	87.2 ± 0.9	89.5 ± 0.7	27.2 ± 10.4	37.1 ± 8.4	51.0 ± 1.4	95.0 ± 0.4	
Boiled	89.3 ± 0.5	89.7 ± 0.5	91.2 ± 0.5	47.0 ± 7.5	19.6 ± 4.3	61.4 ± 2.2	95.9 ± 0.3	
Sun-dried	89.8 ± 1.1 (NS)	89.0 ± 1.3 (NS)	90.8 ± 1.1 (NS)	32.7 ± 10.6	65.0 ± 9.2	56.6 ± 3.1	95.8 ± 0.5 (NS)	

NS : Not statistically significant ( $P > 0.05$ )

Appreciable differences however occurred in the ADC of crude protein and ether extract. Digestibility of both nutrients were negative in the boiled cassava samples while the fresh root gave negative value for the crude protein digestibility. The best ADC of nitrogen and ether extract was observed in the sun-dried cassava samples.

It is recognized that fecal nitrogen consists in part of compounds other than those originating from the undigested or unabsorbed food (Maynard and Loosli, 1969). This latter fraction called the metabolic fecal nitrogen (MFN), will therefore affect the absolute values obtained in this study.

It will therefore appear from this study that boiling does not confer any measurable beneficial effect on the ADC of any of the nutrients in cassava. Moreover, this process results in a depletion of the crude protein and ether extract of cassava. The results also demonstrate that sundrying cassava improves the apparent digestible coefficient of all the nutrients. Variance analysis however revealed that the content and apparent digestibility of major nutrients in the whole cassava root are not significantly affected by the processes of boiling and sundrying.

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