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Mineral elements and toxicants in segments of *Manihot esculenta* grown in Bayelsa State.

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ABSTRACT
The mineral elements, magnesium (Mg), calcium (Ca), iron (Fe), and the toxicants lead (Pb), cadmium (Cd), and hydrogen cyanide (HCN) content in the peels, raw pulp unfermented pulp of six varieties of Manihot esculenta (cassava) grown and consumed in Bayelsa State were determined. The six varieties were identified as old cultivars traditionally named Accra, Agric (sweet and bitter varieties), Janet, Oguru, Rowaina and Yomugha. Atomic absorption spectroscopic technique was used for the determination of cations; while alkaline picrate method was used for the spectrophotometric determination of hydrocyanide content. The highest mineral contents determined were Mg 0.86±0.10, Ca 32.48±2.2 and Fe 3.51±0.007 (ppm) in the fermented pulp of Janet, inner peels of agric (sweet variety) and outer peels of Rowaina respectively. The compositions of toxicants in the outer peels were 1.47±0.09 ppm for Pb (inYomugha) and 0.87±0.24 and 3.51±0.1 (ppm) for Cd and CN, in that order (in agric bitter variety). Processing by fermentation achieved between 6.98% and 45% reduction in the cyanide content; however it appeared to drastically reduce some mineral content of the fermented product.

Key words: *Cassava varieties, minerals, toxicants, fermentation, Bayelsa state.*

INTRODUCTION

Cassava (*Manihot spp*) a dicotyledonous plant, belongs to the family Euphorbiaceae. Its drought tolerance and ability to adapt to various soil and weather conditions make it a choice staple root crop for farmers. The present work is a continuation of the first phase of the cassava project (Amos-Tautua and Madukosiri, 2009); and borders on the elemental determination in segments of cassava, (*Manihot esculenta)* varieties which include Accra, Agric (sweet and bitter varieties) Janet, Oguru, Rowaina and Yomugha. According to the taxonomist, the Accra variety arrived Nigeria from Ghana, whereas agric (bitter variety) was from the middle belt as "CV" released in 1967 from Federal Ministry of Agriculture. Janet's use was dated back to about 20 years ago, while Oguru was believed to be more recent. The variety Rowaina has the longest record of use and was thought to be the best developed tuber with a history of a good starch yield when allowed to fully mature. Yomugha was suspected to be an old agric CV 60506.These varieties are common among farmers and many households in Bayelsa. However, information on the chemical composition including mineral and toxicant distribution in the segments of these varieties are non available to us and if they exist, should be obsolete. Furthermore, the effect of processing by fermentation on the mineral components and toxicant levels is yet to be established. Processing by fermentation is a commonly adopted traditional method of processing of cassava tubers in many ethnic groups in Nigeria.
The present work investigates these for recommendation to farmers/producers and consumers of cassava.

MATERIALS AND METHODS

The tubers were washed with water and separated into outer peels, inner peels and raw pulp with stainless knife. The tubers were processed using the traditional fermentation method involving the steps represented below (Fig 1).Each segment was dried to constant weight in the oven at 80^{o}C. The dried samples were milled into fine powder with an electric blender and stored in clean labeled sample containers in a desiccator till required for analysis.Ashing was

carried out by incinerating 0.5g sample in a muffle furnace at 550^0C (AOAC 1980). The ashed sample solution was obtained by dissolving the dry ash with concentrated IM HNO_3 acid and made up to 100 ml with distilled water. Atomic absorption spectrophotometric method as described by Burtis and Ashwood (2001) was used for metal analysis.

Extraction and determination of Hydrocyanide:
Extraction of hydrocyanide of the samples was achieved by dissolving 5g of milled sample in 50ml distilled water in corked conical flask and kept overnight. The solution was filtered and the filtrate used for the cyanide determination using the alkaline picrate method as explained by Onwuka (2005).

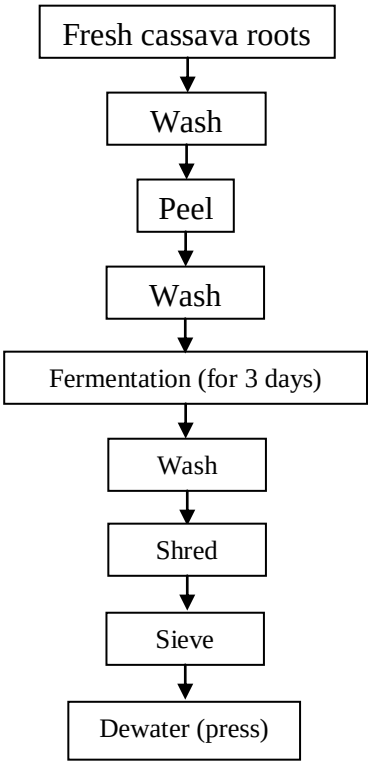

Figure 1: Flow Chart for Cassava Processing into Fermented Pulp

RESULTS
The mean (±SD, ppm) values of magnesium determined from the outer peel, inner peel, pulp and fermented pulp of the cassava varieties were highest in Janet 0.51±0,03, 0.51±0.003, 0.48±0.001 and 0.86±0.10 and least in Accra 0.23±0.003, 0.24±0.001, 0.06±0.001 and 0.06±0.00 respectively (Table 1). The values of calcium were highest in Yomugha 14.95±2.1, 30.32±2.63, 14.87±0.98 and 0.49±0.03, and least in Accra varieties 7.56±1.3, 6.98±0.12, ND (non-detectable) and 0.06±0.01 (Table 1). On the other hand iron levels were highest in the various segments of Rowaina 3.51±0.007, 1.32±0.04, 0.11±0.001 and 0.05±0.01; but undetected in all the segments of Oguru, in that order (Table 2). For lead, cadmium and hydrocyanide, the highest values were recorded in the outer peel of Yomugha (1.47±0.09), outer peel of Agric bitter (0.87±0.24) and the inner peel of Agric bitter (3.51±0.1) respectively (Tables 2 and 3).

DISCUSSION
With the exception of cereals, root and tuber crops are important group of staple foods in tropical African regions. Among the common roots and tubers, cassava seems to be widely used tuber crop. The reason for this preference may be connected with its potentials and suitability to diverse farming techniques, cheap production and vulnerability to replete processing forms and uses. Many cassava varieties exist but the adoption by farmers and consumers is governed by genetic and organopletic characteristics. Such characteristics include time of maturity, dry matter content, starch content and quality, crude fiber content, root spread, shape, cyanide content.The present work assessed some minerals Mg, Ca, Fe and some toxic metals Pb, Cd and HCN levels in segments of varieties of *Manihot esculenta,* grown and consumed in Bayelsa state Nigeria, with a view to making recommendation concerning their use, by both producers and consumers. The varieties Janet,
Rowaina, Yomugha, Accra, Agric and Oguru shall be discussed vis a vis their nutritional (mineral) and toxicological data.
The Mineral Components
The results of the mineral analysis showed that Mg was fairly distributed in all the varieties with the exception of Accra, which contained significantly low levels ($P<0.05$). Iron levels in both the outer and inner peels of Rowaina were higher than those determined from other varieties. The Mg and Ca were lower than those reported by other workers (Njoku and Iwuoha 2006). Contrarily, the iron values in the outer and inner peels of Rowaina compared favourably to other varieties from National Roots (8082) and Tropical Manihot (30522) species respectively (Njoku and Iwuoha 2006).
The Mg, Ca and Fe values in the raw tubers were much higher than those determined by Ebuehi et al (2005) from a local variety in Lagos termed “Ofege”.

This is an indication that the local varieties determined in the present work could be useful as rich mineral sources among the tuber crops.

Toxicants

The Pb in Yomugha was higher than those from other varieties. Cadmium (Cd) levels were minimally distributed in the segments of the cassava varieties. Again, segments of Agric (sweet) and Accra showed non- detectable levels. The differences in the values of the elements determined from the varieties were attributed to genetic factors governing bioaccumulation in plants, and in part to environmental pollution of water and soil (Madukosiri and Dressman, 2009). Hydrocyanide was higher in the peels than in the raw pulp while Agric (bitter) contained more hydrocyanide than other varieties.

Effect of Fermentation Processing Technique

Fermentation appear to have differing effects on the mineral and toxicant levels of processed cassava varieties. For example the Mg levels (in Yomugha), Ca levels (in Rowaina and Oguru) and iron levels (in Rowaina) appeared lower after fermentation; whereas the levels of Mg (in Janet), Ca (in Accra and Agric bitter), and iron (in Rowaina and Accra) increased. This increase in iron levels could be attributed to the use of iron-made utensils in food preparation.

There was increase in Pb and Cd values after fermentation. Contrarily, the hydrocyanide levels in all varieties were reduced by fermentation process. The reduction was between 6.98 and 58.57%.

However, the percentage reduction was low when compared to values reported by other workers (Ihkekeronye and Ngoddy, 1985).

The present work has established the levels of magnesium, calcium, iron, lead, cadmium and hydrocyanide in the outer peels, inner peels and raw pulp of six local varieties of cassava commonly consumed in Bayelsa State. The peels contained higher levels of minerals than the raw pulp. This information should be useful to producers of cassava.

The effect of fermentation appears to lower the amount of minerals in the cassava samples. Hence processors of cassava should be encouraged to reduce, to the barest minimum, the level of hydrocyanide and other water-soluble toxicants.

Table 1: Mean (±SD) of Magnesium and Calcium levels (ppm) in segments of different cassava varieties.

Cassava Variety	Outer peel		Inner Peel		Raw Pulp		Fermented Pulp	
	Mg	Ca	Mg	Ca	Mg	Ca	Mg	Ca
Janet	0.51±0.03	9.85±0.09	0.50±0.003	7.15±0.22	0.48±0.001	10.63±1.3	0.86±0.10	ND
Rowaina	0.49±0.001	10.11±0.1	0.49±0.006	24.76±2.16	0.39±0.11	9.98±0.90	0.48±0.002	0.48±0.06
Yomugha	0.32±0.01	14.95±2.1	0.51±0.005	30.32±2.63	0.51±0.03	14.69±0.98	0.48±0.002	0.49±0.03
Accra	0.23±0.003	7.56±1.3	0.24±0.001	6.98±0.12	0.06±0.001	ND	0.06±0.00	0.06±0.01
Agric sweet	0.32±0.002	2.72±0.01	0.49±0.002	32.48±2.2	0.44±0.03	10.59±0.74	0.45±0.008	0.45±0.05
Agric bitter	0.50±0.001	7.75±0.92	0.65±0.001	30.40±2.81	0.5±0.004	8.93±0.82	0.51±0.03	0.51±0.07
Oguru	0.51±0.10	9.52±1.01	0.51±0.004	26.99±3.00	0.48±0.12	0.48±0.008	0.32±0.001	0.32±0.04

ND – Not Detected

Table 2: Mean (±SD) of Iron and Lead levels (ppm) in segments of different cassava varieties.

Cassava Variety	Outer peel		Inner Peel		Raw Pulp		Fermented Pulp	
	Fe	Pb	Fe	Pb	Fe	Pb	Fe	Pb
Janet	0.40±0.002	0.10±0.009	0.15±0.02	ND	0.32±0.006	0.60±0.12	0.32±0.002	0.95±0.22
Rowaina	3.51±0.007	0.58±0.02	1.32±0.04	0.01±0.001	0.11±0.001	0.37±0.02	0.05±0.01	0.41±0.009
Yomugha	0.08±0.010	1.47±0.09	0.002±0.00	0.004±0.001	0.08±0.001	0.83±0.07	0.19±0.003	1.26±0.023
Accra	0.12±0.009	0.48±0.08	0.09±0.001	ND	ND	ND	0.03±0.001	ND
Agric	ND	ND	0.39±0.005	ND	0.39±0.002	ND	0.04±0.001	ND
sweet	ND	0.87±0.11	ND	0.55±0.04	0.59±0.003	ND	0.59±0.004	0.002±0.001
Agric	ND	0.005±0.001	ND	ND	ND	ND	ND	ND
bitter								
Oguru								

ND – Not Detected

Table 3: Mean (±SD) of Cadmium and Hydrocyanide levels (ppm) in segments of different cassava varieties.

Cassava Variety	Outer peel		Inner Peel		Raw Pulp		Fermented Pulp	
	Cd	HCN	Cd	HCN	Cd	HCN	Cd	HCN
Janet	0.003±0.00	0.31±0.05	ND	0.54±0.04	ND	0.43±0.10	0.002±0.00	0.31±0.12
Rowaina	0.0042±0.001	2.02±0.20	0.0055±0.002	1.55±0.51	0.0007±0.00	0.58±0.03	0.0055±0.001	1.40±0.31
Yomugha	0.0014±0.00	0.93±0.16	0.0035±0.001	1.65±0.36	0.001±0.00	1.02±0.07	0.0059±0.002	0.55±0.05
Accra	ND	1.25±0.33	ND	1.88±0.60	ND	1.50±0.03	ND	1.13±0.12
Agric sweet	ND	2.22±0.09	ND	1.94±0.45	ND	1.70±0.05	ND	1.22±0.13
Agric	0.87±0.24	3.01±0.08	0.21±0.01	3.51±0.17	ND	2.12±0.08	0.002±0.00	1.83±0.03
bitter	0.005±0.001	0.62±0.04	0.005±0.002	0.67±0.12	ND	0.43±0.07	0.003±0.001	0.41±0.02
Oguru								

ND – Not Detected

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