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The Effect of Processing on the Sodium, Potassium and Phosphorus Content of Six Locally Consumed Varieties of *Manihot esculenta* Grown in Bayelsa State

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Abstract: The minerals, sodium (Na), potassium (K) and phosphorus (P), content in the peels, raw unfermented pulp and fermented pulp of six local varieties of *Manihot esculenta* (cassava) grown and consumed in Bayelsa state were determined. The six varieties where identified as old cassava cultivars traditionally named Janet, Rowaina, Yomugha, Accra, Agric and Oguru in Bayelsa state. Flame photometer was used for the analysis of Na and K; while the colourimetric determination of P was done using vanado-molybdate method described in AOAC. The average mineral content determined (ppm) in the raw and fermented pulp from all the varieties were 6.33 and 3.33 for Na; 45.43 and 9.83 for K; 1.42 and 0.73 for P, respectively. The inner peels had more Na, K and P than the rest segments. Hence it appeared to be the mineral storehouse (probably due to pH values between 6.55 and 7.21) from where they are translocated to the pulp during growth. The outcome of processing by use of fermentation was a drastic reduction in the mineral content of fermented product. The effect of processing on the P content was deemed to be species-dependent. There was no detectable P in the fermented pulp of Accra variety.

Key words: Cassava, processing, minerals, fermentation, pH value

INTRODUCTION

Cassava (*Manihot spp.*) is a dicotyledonous plant belonging to the family of *Euphoriaceae* and the genus *Manihot esculenta* represents a host of cassava cultivars often indistinguishable from one species to another (Janick *et al*., 1974).

At full maturity cassava can grow up to 1-3 meters in height depending on the variety, soil type and fertility (Osagie and Eka, 1998). It can also adopt itself to varieties of climate conditions, thriving best in a warm and humid atmosphere. Although it tolerates poor soil conditions, sandy loams with pH 6.0-7.5, is considered the best for optimum cultivation.

Cassava is believed to have originated from Brazil, South America, but it is grown in large quantities in several tropical countries especially in Nigeria and Congo, where it serves as an important staple food (Olatunji, 1986). It is a cheap source of carbohydrate food, both for human and livestock in the tropics. The average contribution to the daily dietary energy intake is 15%, supplying about 70% of the total calories intake of more than half of 120 million people in Nigeria.

Nigeria was recorded as the highest producer of cassava in the world, with 34 million metric tons in the year 2001 (Ezulike *et al*., 2006). This achievement was attributed in part to the development (by International Institute of Tropical Agriculture, IITA, Ibadan and National Root Crops Research Institute, NRCRI, Umudike) of improved high-yielding, pest and disease-tolerant varieties (Ezulike *et al*., 2006).

Investigation into the mineral distribution in segments of cassava tubers is receiving attention (Osagie and Eka, 1998; Njoku and Iwuoha, 2006). Also the effect of various processing techniques in the nutrient status of the final product is documented (FIIRO, 2006). However there is little or no information on the mineral content of the six local cassava varieties grown and consumed in Bayelsa state.

Popular cassava varieties grown and consumed in Bayelsa state include Oguri, Rowaina, Accra, Yomugha, Janet and Agric. Attempt by taxonomist to distinguish them into their distinct species was met with little success. Accra was suspected to be a local variety from Ghana. Agric could be a tropical manure species (TMS-IITA). Bitter Agric could have been obtained from middle belt, a CV from Federal Ministry of Agriculture released in, 1967. Janet (CV Aburu-Asun) might be a local variety of about 20 years old. Oguru was thought to be more recent than the above mentioned varieties. On the other hand, Rowaina with a long history of usage was thought to be the best developed tuber. The longer it stays in the soil the better in terms of starch content. Finally, Yomugha could be an old Agric, CV 60506.

Hence, there seems to exist no information on the mineral distribution in the segments of these varieties. Furthermore, the effect of processing on the mineral components is yet to be established. These varieties are processed into three major products, namely starch, roasted fermented cassava grits (garri) and fermented cassava mash (fufu).The present study intends to determine the mineral distribution in the segments of

the cassava tubers and the effect of processing by fermentation, on the mineral content of the cassava mash produced from these six varieties.

MATERIALS AND METHODS

The fresh tubers were washed with water and separated into outer peels, inner peels and pulp with a stainless steel knife. The fermented pulp or cassava mash was produced by soaking the peeled tubers in water for three days, after which they were washed, shredded/sieved and dewatered in that order (Fig. 1). The outcome of fermentation was a soft pulp with a strong sour odour. A lot of water was used to wash the scum and eliminate the odour. The rest of the water is pressed out of the mash until a sticky mash (a starchy cake) is obtained (Fig. 1).

Moisture content determination: Each component was dried to constant weight in the oven at 80°C so as to obtain the moisture content (AOAC, 1980). The dried sample was milled into a fine powder with an electric blender and stored in a clean labeled container inside a desiccator till required for analysis.

ph determination: The pH determination was carried out using glass electrode pH meter model pHS-25 by B. Brain scientific and instrument company England. The pH values of the diluted samples were measured after calibration of the instrument with pH 7.0 and 4.0 buffer solutions. The result was recorded as pH measured in water.

Ashing: Dry ashing was carried out by incinerating 0.5g sample in a muffle furnace at 550°C (AOAC, 1980). Five milliliters of diluted ashed samples was pipetted into 100ml volumetric flask, followed by the addition of 45 ml distilled water. Within 5 minutes 20 ml of vanadomolybdate reagent was also added and diluted to volume. The solution was mixed, allowed to stand for 10 minutes and the absorbance measured at 415 nm against a reagent blank. For the blank distilled water was used in place of the sample. Phosphate concentration was read off a standard by the same procedure using graded concentration of dry anhydrous potassium dihydrogen phosphate.

RESULTS

pH values: The average pH values measured from the aqueous solutions of the six cassava samples were between 6.59 and 7.24. No significant difference was obtained between the mean values ($p > 0.05$) (Table 1 and Fig. 2).

The mineral components: The mean values (ppm) of sodium determined form the outer peel, inner peel, raw pulp and fermented pulp of the six cassava species

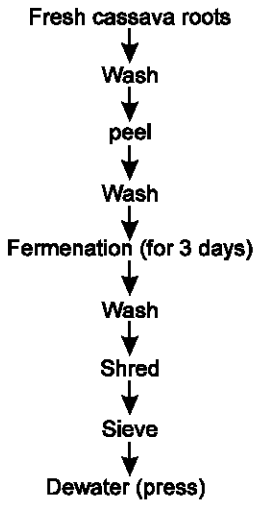

Fig. 1: Flow chart of cassava processing into fermented pulp

were 2.0, 5.3, 6.0 and 2.0 for Janet; 6.0, 5.3, 6.0 and 4.0 for Rowaina; 6.0, 10.0, 6.0 and 4.0 for Yomugha; 6.0, 4.0, 6.0 and 2.0 for Accra; 6.0, 12.0, 6.0 and 4.0 for Agric; 2.0, 14.0, 8.0 and 4.0 for Oguru, respectively (Table 2 and Fig. 3).

The values (ppm) for potassium were 31.8, 39.5, 52.3 and 11.5 for Janet; 41.0, 46.8, 35.8 and 9.0 for Rowaina; 28.8, 57.8, 66.8 and 12.5 for Yomugha; 25.0, 38.3, 36.44 and 6.5 for Accra; 32.0, 57.2, 37.3 and 9.5 for Agric; 21.5, 63.3, 39.8 and 10.0 for Oguru in that order (Table 3 and Fig. 4).

The phosphorus content (ppm) in the outer peel, inner peel, row pulp and fermented pulp of the various species were 1.5, 2.2, 1.2 and 1.5 for Janet; 1.2, 1.9, 1.5 and 1.5 for Rowaina; 1.2, 1.9, 1.2, an 0.8 for Yomugha; 0.8, 2.2, 1.2 and 0.0 for Accra; 1.9, 1.7, 1.7 and 0.3 for Agric; 1.2, 1.7, 1.7 and 0.3 for Oguru, respectively (Table 4 and Fig. 5).

DISCUSSION

Food processing entails the subjection of food stuff to a combination of physical and chemical treatment in order to achieve a desired food property and quality. Processing in traditional African setting often involves dehulling/peeling, sun drying, milling, sieving and fermentation. Methods often chosen depend on the nature of the food material and the objective of the processor. For example cassava as a staple food, can be processed to achieve a variety of products having improved keeping quality. Most methods employed in the processing of cassava incorporate fermentation. Fermentation itself is an enzyme degradative process leading to the breakdown of naturally structured complex food molecules into more relaxed easily digestible intermediates such as dextrins, oligopeptides and low

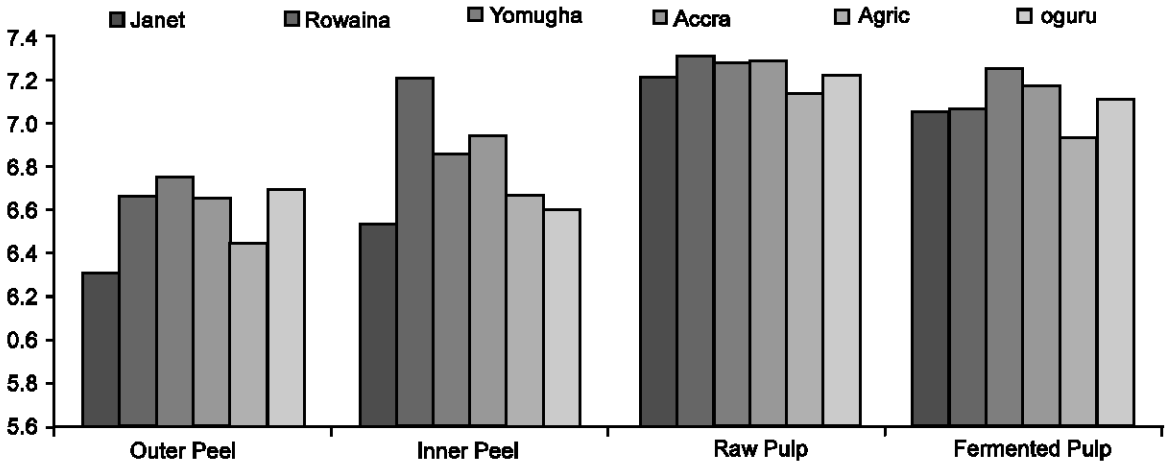

Fig. 2: Comparison of pH in Different Cassava Species

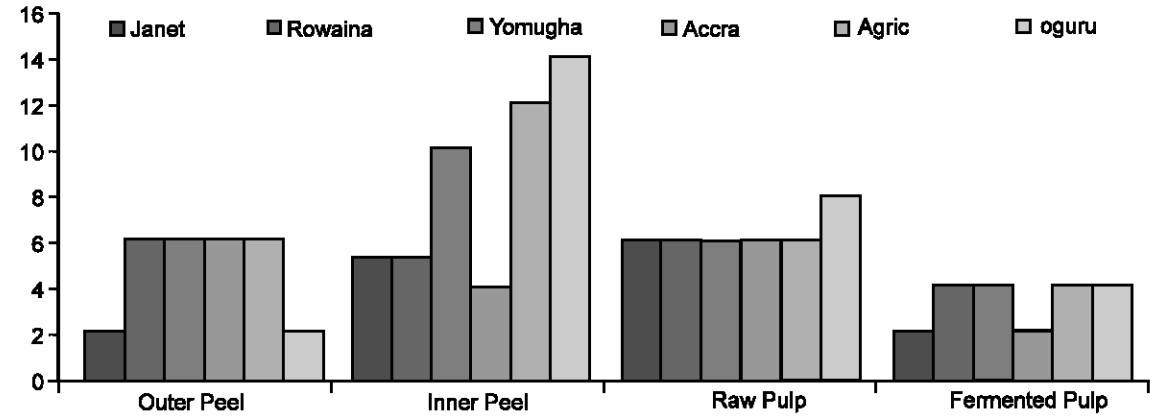

Fig. 3: Comparison of Sodium Concentration (ppm) in Different Cassava Species

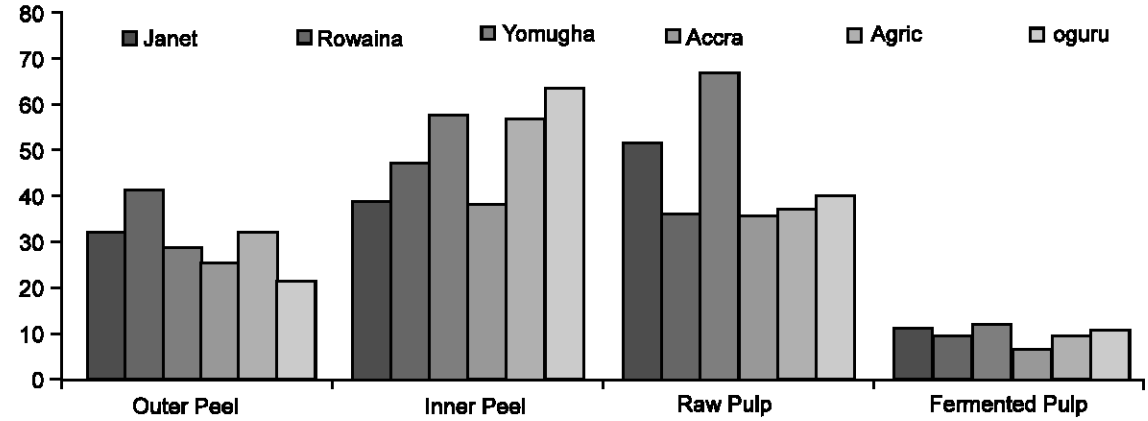

Fig. 4: Comparison of Potassium Concentration (ppm) in Different Cassava Species

molecular weight products. Despite the age-long existence of the practice of fermentation in most traditional African society, investigation into its nutritional implication is scanty in the literature (Onigbinde, 2001). The present work has assessed the effect of processing (by fermentation) on the minerals, Na, K and P components of the six varieties of locally produced cassava crop tubers consumed in Bayelsa state. The pH values (at room temperature) of the outer peel, inner peel, raw pulp and fermented pulp were also determined.

The result obtained from the mineral analysis showed

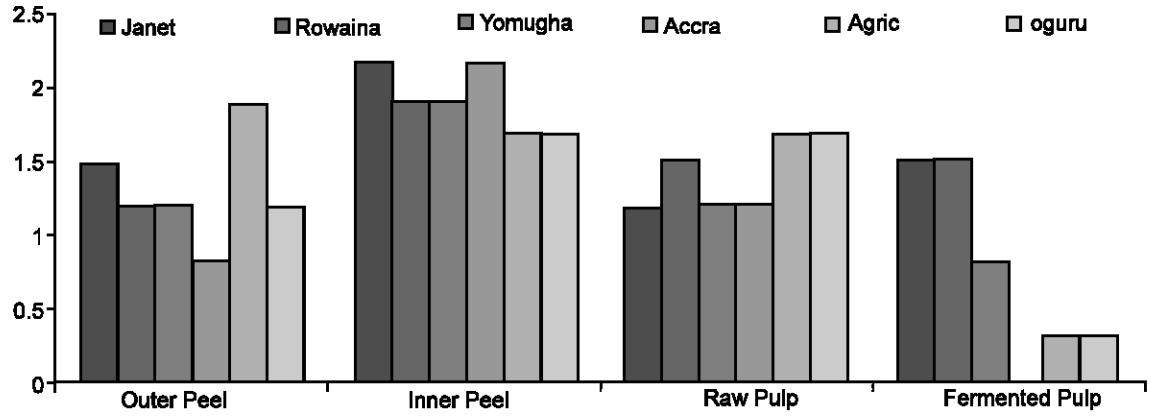

Fig. 5: Comparison of Phosphorus Concentration (ppm) in Different Cassava Species

Table 1: Comparison of pH in Different Cassava Species

Cassava Species	Outer Peel	Inner Peel	Raw Pulp	Fermented Pulp
Janet	6.3	6.55	7.23	7.06
Rowaina	6.66	7.21	7.31	7.07
Yomugha	6.75	6.86	7.28	7.24
Accra	6.65	6.95	7.28	7.18
Agric	6.45	6.68	7.13	6.93
Oguru	6.7	6.62	7.23	7.11
Average	6.59	6.81	7.24	7.1

Table 2: Comparison of Sodium Concentration (ppm) in Different Cassava Species

Cassava Species	Outer Peel	Inner Peel	Raw Pulp	Fermented Pulp
Janet	31.8	39.5	52.3	11.5
Rowaina	41	46.8	35.8	9
Yomugha	28.8	57.8	66.8	12.5
Accra	25	38.3	36.44	6.5
Agric	32	57.2	37.3	9.5
Oguru	21.5	63.3	39.8	10
Average	30.02	50.48	45.43	9.83

Table 3: Comparison of Potassium Concentration (ppm) in Different Cassava Species

Cassava Species	Outer Peel	Inner Peel	Raw Pulp	Fermented Pulp
Janet	2	5.3	6	2
Rowaina	6	5.3	6	4
Yomugha	6	10	6	4
Accra	6	4	6	2
Agric	6	12	6	4
Oguru	2	14	8	4
Average	4.67	8.43	6.33	3.33

that the inner peel contained higher concentration of Na, K and P than in the outer peel and the raw pulp; while the fermented pulp had the lowest amount of the minerals. The inner peel appeared to be the mineral storehouse (probably due to favourable pH values between 6.55 and 7.21) from where they are translocated to the pulp during growth.

A marked difference was observed between the levels of Na in the raw and fermented pulp. The six cassava varieties yielded an average of 6.33 ppm sodium from their raw pulp; while the fermented mash contained 3.33 ppm of the element. The difference was significant ($p < 0.05$) and was attributed to the loss of the element through the processing water which was discarded.

The same trend was observed in the K content. The average K values in the raw and fermented pulp were 45.43 and 9.83 (ppm) respectively. Potassium loss during processing seemed to be more pronounced than that of Na.

Contrarily the effect of processing on the phosphate (determined as phosphorus) content appeared to be species-dependent. The P values in the species, Janet and Rowaina appeared unchanged after processing. This could be attributed to increased phosphorus/pulp mass ratio through concentration effect during processing. On the other hand, Yomugha, Agric and Oguru showed decreased phosphorus level from 1.2-1.7 to 0.3-0.8 in the raw and fermented pulp respectively. The fermented Accra pulp had undetectable phosphorus value.

When compared to the values reported by other workers the measured Na and P content in the raw pulp appeared much lower (Njoku and Iwuoha, 2006). On the other hand, the potassium levels compared favourably to those of the varieties of National Roots 8082 species published in the cited reference.

The importance of these mineral nutrients in nutrition cannot be overemphasized. Phosphorus is involved in the intermediary metabolism of carbohydrates as phosphorylation is a pre-requisite for bone and teeth structures. Potassium can activate enzymes such as alkaline phosphatese, lactate dehydrogenase and aspartate aminotransferase, (serum glutamic oxaloacetic transaminase) necessary for energy production. Potassium and sodium have interrelated

Table 4: Comparison of Phosphorus Concentration (ppm) in Different Cassava Species

Cassava Species	Outer Peel	Inner Peel	Raw Pulp	Fermented Pulp
Janet	1.5	2.2	1.2	1.5
Rowaina	1.2	1.9	1.5	1.5
Yomugha	1.2	1.9	1.2	0.8
Accra	0.8	2.2	1.2	0
Agric	1.9	1.7	1.7	0.3
Oguru	1.2	1.7	1.7	0.3
Average	1.42	1.93	1.42	0.73

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. Potassium and sodium deficiencies could be rare but consumption of highly processed foods which had not been fortified with the minerals, might give rise to suboptimal intake. 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. Common symptoms of sodium deficiency include muscular cramps, drowsiness, mental confusion and circulatory changes leading to shock (Devlin, 1992). However, since sodium deficiency is rare the importance of sodium in nutrition is not often viewed in terms of its requirement, but its metabolism/homeostasis in relation with certain diseases such as cardiovascular diseases. Therefore, the low Na content of the processed tubers should not be viewed as a short coming, since dieticians may find them useful and handy during the dietary management of conditions (such as hypertension and certain oedema) requiring low salt intake.

Conclusion: The present work has determined the level of the elements sodium, potassium and phosphorus in the outer peels, inner peels and raw pulp of six local cassava varieties. The peels contained higher values of the minerals than were determined in the raw pulp. The sodium and phosphorus content were lower than those obtained by other workers in improved cassava varieties. On the other hand, the potassium content was comparable to those from the literature.

Processing by fermentation did greatly reduce the Na and K content in all the varieties, whereas for the phosphorus values the reduction seemed to be species dependent.

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