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Research Article

PHYTATE-ZINC DYNAMICS OF RETTED CASSAVA PRODUCT 'PUPURU' PROCESSED WITH WATER FROM DIFFERENT SOURCES

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Abstract

'Pupuru', an indigenous retted cassava product processed with water from different sources was analyzed for nutritive elements including; potassium, sodium, calcium, phosphorus and zinc and some anti nutrients: cyanide, tannin and phytate. The concentration of the minerals increased while the anti nutrient concentration decreased in the processed 'pupuru' as compared to the unprocessed cassava. To predict the effect of phytate on zinc bioavailability, molar ratios of [phytate] / [Zn], [Ca] / [phytate] and [Ca] [phytate] / [Zn] were calculated. The calculated [Ca] [phytate] / [Zn] molar ratio for all the products (0.1 - 0.26 mol/kg) were all below the 0.5 mol/kg critical value while the [phytate] / [Zn] molar ratios (5.8 - 10.8) were all below the 15:1 value considered to be critical. The foregoing shows that processing cassava into 'pupuru' will reduce anti nutrient concentrations and enhance zinc bioavailability.

Keywords: Cassava, Retted, Pupuru, Phytate / Zinc, Dynamics

INTRODUCTION

Cassava (*Manihot esculenta,* Cranzt) is an important food crop which forms part of diet for both animals and humans in Africa. It is a source of high energy (about 607 KJ/100 g), carbohydrates, but contains less than 1 % protein[1] hence, the increasing records of malnutrition in populations where cassava products are consumed in high amounts. In Nigeria, about 90 % of the 14 million tonnes produced annually is consumed[2]. Alongside the high carbohydrates, cassava contains certain anti nutrients: cyanogenic glucosides, tannins and phytate[3]. These substances at high concentrations have potentially serious dietary implications. Cyanogenic glucosides are hyrolysed to HCN, a potent respiratory chain inhibitor[4]. Tannins elicit their anti nutritional properties by precipitating dietary proteins and digestive enzymes and decreasing the digestibility of carbohydrates[5] while high phytate intake may affect starch digestibility[6], it is also capable of forming insoluble complexes with divalent nutritive elements such as calcium and zinc rendering them unavailable for intestinal uptake[7]. The anti nutritional effects of phytate primarily relate to the strong chelating ability associated with its six reactive phosphate groups[8]. There also exists a kinetic synergism between Ca and Zn ions resulting in a Ca : Zn : phytate complex less soluble than phytate complex formed with either ion alone[9]. 'Pupuru,' a local meal made from processed cassava tubers is consumed by not less than 4-6 million people in Nigeria[10]. It is processed by local women as depicted in the flow chart below. The steeping stage is carried out in a flowing stream and fermentation is carried out by natural flora. Oyetayo[11] have assessed the microbial distribution of cassava fermented into 'pupuru.' The foregoing seeks to evaluate the effect of steeping cassava in different types of water on some anti nutrients in 'pupuru,' to estimate the mineral composition and determine the bioavailability of zinc as affected by phytate.

MATERIALS AND METHODS

Processing of Cassava tubers

Fresh cassava tubers obtained from a local farm around Akure, Nigeria and purchased in the market were sorted, peeled, washed and processed into 'pupuru'as depicted below.

Sample analyses

Mineral analyses

The Mg, Zn, Ca, Fe, Cu, Mn contents were determined on aliquots of the solutions of the ash of the samples by established atomic absorption spectrophotometry procedures with a Model 372 Perkin-Elmer atomic absorption spectrophotometer[12] while the Na, K and P concentrations were determined using flame photometer.

Anti nutrient analyses

Cyanide concentration was determined by the methods of AOAC[13], phytate estimated by the methods of Wheeler and Ferrel[14] and tannin by the methods of Makkar *et al.* [15]

Calculation of molar ratio

Molar ratio for the prediction of zinc bioavailability were calculated from the results of the analyses as calculated by the methods Ferguson *et al*. [16]

Statistical Analysis

Data gathered from the various analyses were processed using one-way analysis of variance (ANOVA) and the means were compared using Duncan Multiple range test.

Table 1: Composition of mineral elements (mg/100g) in unprocessed cassava and retted cassava product 'Pupuru'

Mineral	Unprocessed	Warm*	Well*	Stream*	Sterile*
K	120.47	192.0	180.2	180.0	122.1
Na	70.42	78.5	76.1	83.3	77.9
Ca	19.85	65.2	96.0	88.0	72.0
Mg	6.8	24.0	28.4	23.6	29.2
P	7.38	6.5	7.3	6.8	6.8
Zn	3.66	3.04	1.21	2.06	1.57
Fe	0.38	0.47	0.11	0.28	0.13
Cu	0.25	0.22	0.09	0.10	0.09
Mn	0.15	0.12	0.05	0.16	0.05

Values are means of three replicates. *Type of water used for processing cassava tuber

Table 2: Anti nutrient composition of unprocessed cassava and retted cassava product 'Pupuru'

	Cyanide (mg/kg)	Phytate (mg/100g)	Tannin (%)
Unprocessed	5.38 ± 0.37	225.64 ± 0.00	0.52 ± 0.00
Warm*	2.39 ± 0.20	206.44 ± 9.60	0.15 ± 0.01
Well*	3.06 ± 0.20	150.03 ± 24.49	0.17 ± 0.02
Sterile*	2.03 ± 0.00	1.69 ± 0.00	0.10 ± 0.00
Stream*	1.35 ± 0.00	0.10 ± 0.00	0.05 ± 0.00

* Type of water used for processing cassava tuber * Values are means of three replicates

Table 3: Calculated [Phytate] / [Zn], [Ca] / [Phytate] and [Ca][Phytate] / [Zn] molar ratios of unprocessed cassava and retted cassava product 'Pupuru'

	[phytate] / [Zn]	[Ca] / [phytate]	[Ca][phytate] / [Zn]
Unprocessed Cassava	5.8	1.43	0.03
Warm	5.2	5.45	0.10
Well	10.8	11.6	0.26
Sterile	8.7	8.46	0.19
Steam	8.5	10.3	0.15

Values are means of three replicates * Type of water used for processing cassava tuber. Up: unprocessed

RESULTS AND DISCUSSION

Mineral analyses

The mineral distribution of 'pupuru' processed using various water types is shown on Table 1. There was an increase in the K, Na, Ca and Mg content of the 'pupuru' as compared with the unprocessed cassava. However, the P, Zn, Fe, Cu and Mn concentrations decreased when compared with the unprocessed cassava except for Fe concentration in the warm water processed 'pupuru' which was higher than in the unprocessed cassava.

Anti nutrient analyses

The anti nutrients (cyanide, tannin, phytate) composition of all the 'pupuru' samples were significantly lower ($P \geq 0.05$) in the processed than the unprocessed cassava with the stream water fermented 'pupuru' having the lowest level of anti nutrients. The decrease in the anti nutrient levels is as a result of the various processing methods through which the raw cassava was passed. For instance, phytate concentrations (mg / 100 g) of the 'pupuru' ranged between 112.82 ± 0.00 (stream water fermented) to 206.44 ± 9.60 (warm water fermented) as compared to 225.64 ± 0.00 of the unprocessed cassava tuber. Phytate concentrations have been found to reduce with fermentation, soaking and heating methods. Fermentation makes use of microbes some of which secrete phytases which hydrolyze a significant portion of phytate[17] reducing its affinity for various cations[18]. Our previous investigation on African Breadfruit seeds showed decrease in phytate content after processing[19]. Also, 'pupuru' could be considered safe for consumption due to the low levels of tannin and cyanide. Aletor[20] stated concentration ranges of 0.76 - 0.90 % for tannin while Akinrele *et al.*[21] had predicted 30 mg/Kg as critical values for these anti nutrients.

Calculated Ratio

The calculated [Phytate] : [Zn] molar ratios of the raw and cassava product processed with water from different sources were all below 15:1, a value considered critical[22] indicating that 'pupuru' processed using water from these sources will not reduce zinc bioavailability and predispose to zinc deficiency. Calculated [Ca]: [Phytate] molar ratios were lower than the critical value of 6:1[16] and for the raw cassava and warm water processed 'pupuru'. While the well, sterile and stream water processed 'pupuru' were above the value. Calcium is an important constituent of bones and teeth and it is also involved in signal transduction in physiology. Phytate can influence the functional and nutritional properties of food depending on its concentration[23]. The mineral bioavailability trend was clearer on the calculation of the [Ca][Phytate] / [Zn] as Wise[22] suggested that phytate solubility and the proportion of Zn bound to the complex in the intestine depends on the Ca levels and also, the Ca : Zn : Phytate complex is less soluble than the Phytate complex formed by either ion alone[10]. The calculated [Ca][Phytate] / [Zn] molar ratio for the raw cassava and 'pupuru' processed from different water were all below 0.5 mol/kg[24]. This result shows that processing cassava into pupuru using water from different sources did not reduce zinc bioavailability in the product.

CONCLUSION

From the foregoing, processing of raw cassava tubers into 'pupuru' a local staple, led to reduction in phytate concentration and enhanced zinc bio availability *in vitro*. Investigations to confirm these results are subject of further toxicological studies.

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