Mineral composition of five improved varieties of cassava

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ABSTRACT

Five new cassava mosaic disease resistant (CMD) varieties released to farmers in Nigeria were evaluated for mineral composition. Results show that TME 419 differed significantly (p<0.05) from other varieties in calcium (900ìg/g) and manganese (32.3ìg/g) content. The hybrid check (TMS 30572) and TMS 98/0505 were significantly different (p<0.05) from other varieties in magnesium (1300ìg/g) and potassium (3900ìg/g), respectively. TMS 97/2205 differed significantly (p<0.05) from other varieties in phosphorus (1200ìg/g) and sodium (63.7ìg/g). Data also revealed that TMS 98/0581 was significantly different (p<0.05) from other varieties in iron (184.2ìg/g) while TMS 98/0510 differed significantly (p<0.05) from other varieties both in copper (10.9ìg/g) and zinc (8.5ìg/g). Chipping and grating had no significant effect (p>0.05) on calcium, sodium, copper, and zinc content of cassava flour. However, treatment effect was obvious in other minerals, chipped having a significant difference (p<0.05) in magnesium, potassium and manganese contents compared to grated samples. Conversely, grated samples differed significantly (p<0.05) in phosphorus and iron compared to chipped samples. Estimated daily recommended dietary allowances (RDA) from major minerals found in CMD varieties show that calcium, potassium, phosphorus and copper contributions to RDA ranged from 17.5-22.5%, 13.8-20.7%, 32.1-42.9%, and 127.8-302.8% in both adult males and females, respectively if 250g flour is eaten daily. The highest level of magnesium contribution (81.3% and 104.8%) to RDA was found in TMS 30572 for adult males and females, respectively, from 250 g flour. TMS 98/0581 was highest in iron contribution to RDA with 575.6% and 255.8% for adult males and females, respectively, provided 250 g flour is eaten. TMS 98/0510 had the highest level of contribution to RDA, 19.3% for adult males, while 26.6% is accruable to adult female, provided 250 g flour is consumed. New cassava varieties may constitute important raw materials in the food industries based on their nutritional composition.

Key words: Minerals, nutrition, recommended daily allowance, raw materials, food industry.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is a major food crop in the humid and sub-humid parts of Africa and a major source of energy for millions of people in these regions (Asiedu, *et. al*. 1992). It is the most important root crop in Nigeria in terms of food security, employment creation, and income generation for crop producing households (Ugwu and Ukpabi, 2002). World production of cassava was 160 million tons of fresh roots, with 80 million tons produced in Africa, out of which 34 million tons is produced in Nigeria (FAO, 1994) and by this figure, Nigeria is the largest producer of cassava in the world. The daily per capital consumption of cassava in Nigeria contributed about one megajoule (mJ) to the diet. Estimated household consumption is about 30 million metric tons, with a marketable surplus for industrial demand of about 10% of total production (Nwachukwu, 2005). The adaptation of cassava to the food and farming systems and multiplicity of uses makes it indispensable to food security. Cassava is a cheap source of carbohydrate from nutritional point of view. The roots of currently available varieties are relatively low in protein, although in Central Africa, substantial amounts of protein are derived from cassava leave, which are a popular vegetable (Berry, 1993).

The major uses of cassava in Nigeria (Philip, *et al*., 2005) include flour, which involves several unit operations, resulting in flour of different properties, which are used for various purposes. Other products include *gari*, creamy-white, granular flour with a slightly fermented flavour and slightly sour taste. Fresh roots may also be boiled and pounded to obtain pounded *fufu*, which is popular in Ghana, and to some extent in Nigeria and Cameroon (Hahn, 1997). Fresh cassava roots also finds considerable use as a feed for livestock such as goat, sheep, cattle, and particularly pigs (Ihekoronye and Ngoddy, 1985). Nwosu (2005) identified some of the industrial uses of cassava including ethanol production, livestock feeds, confectioneries, monosodium glutamate processing, sweeteners, glues, textiles and pharmaceuticals.

The International Institute of Tropical Agriculture (IITA) had developed several varieties of cassava mosaic disease resistant cultivars. New varieties are being currently disseminated in Nigeria and many parts of West and Central Africa (WCA) and East and Southern Africa (ESA) to improve agricultural productivity, rural income and generate raw materials for local industries. The mineral composition of five top varieties of CMD released cultivars was therefore investigated to enhance delivery, utilization and industrial potential.

MATERIALS AND METHODS

Five new released varieties of cassava (98/0505, TME 419, 97/2205, 98/0581, and 98/0510, including the reference, TMS 30572) were investigated. Tuberous cassava roots were harvested one year after planting from the experimental station of the International Institute of Tropical Agriculture, High Rainfall Station, Onne agro ecology, located on Latitude 04^{o} 43' N, Longitude 07^{o} 01' E and 10m Altitude, near Port Harcourt, Nigeria. Root samples were peeled manually with the aid of stainless steel kitchen knife. Some aliquots were chipped into small pieces, while some were grated prior to dehydration. Samples were placed in petri dish and covered with filter paper to avoid contamination, and transferred carefully into Forced-Air Sanyo Gallenkamp Moisture Extraction Oven and dried at 65^{o}C for about 48 hours and milled with the aid of stainless Kenwood Chef Warring Blender, Model KM001 series. Mineral analysis was performed using the procedure described by Allen *et al*., (1984). Daily recommended dietary allowances (RDA) from major minerals found in CMD varieties were estimated with reference to Institute of Medicine, National Academy of Sciences (2002) tables of RDA. All mineral elements investigated were determined spectrophotometrically on the Buck Scientific Atomic Absorption/Emission Spectrophotometer 205 in the Plant Anatomy and Physiology Research Laboratory, Faculty of Science, University of Port Harcourt, Herbarium, Port Harcourt, Nigeria.

Data Analysis

The data generated were analysed using Statistical Analysis Systems version 9.1 SAS (2003) software package. Significance of treatment means was tested at 5% probability level using Duncan's New Multiple Range Test (DNMRT).

RESULTS AND DISCUSSION

Mineral profile of CMD varieties is presented in Table 1, which shows a significant difference ($p<0.05$) between TME 419 and other varieties in calcium (900ìg/g) and manganese (32.3ìg/g) content. The range of calcium (700-900µg/g) levels found in new CMD varieties is higher than 330µg/g earlier reported in cassava root (Ihekoronye and Ngoddy, 1985). The physiological roles of minerals in human diet have been widely reported (Ihekoronye and Ngoddy, 1985; Okaka *et al*., 1992; Onigbinde, 2001). The hybrid check, TMS 30572 and TMS 98/0505 were significantly different ($p<0.05$) from other varieties in magnesium (1300ìg/g) and potassium (3900ìg/g), respectively. TMS 97/2205 differed significantly ($p<0.05$) from all other varieties in phosphorus (1200ìg/g) and sodium (63.7ìg/g) content. TMS 98/0581 was significantly different ($p<0.05$) from other varieties in iron (184.2ìg/g) while TMS 98/0510 differed significantly ($p<0.05$) from other varieties both in copper (10.9ìg/g) and zinc (8.5ìg/g). The levels of iron found in new CMD varieties were much higher than 7µg/g reported in fresh cassava roots (FAO, 1998) and 64µg/g reported in sweet potato (Ihekoronye and Ngoddy, 1985). Moreover, this new data surpassed 1.06mg/100g of iron obtained in raw green plantain (Ahenkora, *et. al*., 1996) and 0.2-0.3mg/100g values obtained in flours of two sweet potato varieties (Onuh, *et al*., 2004). The same trend was observed for zinc, when compared to a meager level of 0.26mg/100g obtained by Ahenkora *et al*. (1996) in *Apantu pa* plantain in Ghana. Chipping and grating had no significant effect ($p>0.05$) on calcium, sodium, copper, and zinc content of cassava flour (Table 3). Chipped samples had a significant difference ($p<0.05$) in magnesium, potassium and manganese contents compared to grated samples. Conversely, grated samples differed significantly ($p<0.05$) in phosphorus and iron compared to chipped samples. Ebuehi (2005) reported significant losses in various minerals including calcium, magnesium, phosphorus, iron, sodium and chloride ions identified in the roots and raw leaves of cassava as a result of boiling. Boiling and frying has also been implicated in losses of certain micronutrient in plantain including iron, copper and zinc (Ahenkora, *et al*., 1996). Daily recommended dietary allowances from major minerals found in CMD varieties were estimated (Table 3). Results show that calcium, potassium, phosphorus and copper contribution to RDA ranged from 17.5-22.5%, 13.8-20.7%, 32.1-42.9%, and 127.8-302.8% in both adult males and females, respectively if 250g flour is eaten daily. The highest level of magnesium contribution (81.3% and 104.8%) to RDA was found in TMS 30572 for adult males and females, respectively, from 250 g flour. TMS 98/0581 was highest in iron contribution to RDA with 575.6% and 255.8% for adult males and females, respectively. The trend with zinc follows a different pattern, with TMS 98/0510 having the highest level of contribution to RDA, 19.3% for adult males, while 26.6% is accruable to adult female, provided that 250 g flour is consumed. Increased production and utilization of new cassava varieties may contribute to offset micronutrient deficiencies prevailing in Africa.

Table 1. Mineral composition of cassava mosaic disease resistant (CMD) varieties

Cultivar	Ca	Mg	K	P	Na	Mn	Fe	Cu	Zn_
				µg/g					
TMS 97/2205	800[b]	800[c]	2900[e]	1200[a]	63.7[a]	28.1[d]	163.5[d]	6.3[c]	8.0[c]
TMS 98/0505	700[c]	700[d]	3900[a]	1000[b]	50.3[e]	28.2[c]	184.0[b]	4.6[d]	6.0[e]
TMS 98/0510	700[c]	900[b]	3500[b]	1000[b]	46.9[f]	24.5[e]	117.3[f]	10.9[a]	8.5[a]
TMS 98/0581	800[b]	700[d]	3100[c]	1200[a]	50.4[d]	28.2[c]	184.2[a]	6.3[c]	5.6[f]
TME 419	900[a]	700[d]	2600[f]	1000[b]	58.5[b]	32.3[a]	168.5[c]	8.1[b]	7.6[d]
TMS 30572	800[b]	1300[a]	3000[d]	900[c]	55.1[c]	31.9[b]	123.1[e]	6.3[c]	8.3[b]

Values in the same column with different letters are significantly different at p<0.05.

T**able 2.** Effect of processing on mineral composition of cassava mosaic disease resistant varieties

	Ca	Mg	K	P	Na	Mn	Cu	Fe	Zn
Treatment					*u*g/g				
Chipped	800[a]	1040[a]	3920[a]	720[b]	53.53[a]	30.80[a]	7.28[a]	105.64[b]	6.44[a]
Grated	783[a]	850[b]	3170[b]	1050[a]	54.15[a]	28.87[b]	7.08[a]	156.77[a]	7.33[a]

Chipped=Fresh cassava roots were chipped after peeling prior to dehydration, Grated=Fresh cassava roots were grated after peeling prior to dehydration.
Values in the same column with different letters are significantly different at p<0.05.

Table 3. Mineral composition of cassava mosaic disease resistant varieties to daily recommended dietary allowance

		% Minerals from daily consumption of 250g flour					
		Adult Male/Female					
Cultivar	**Ca**	**Mg**	**K**	**P**	**Cu**	**Fe**	**Zn**
TMS 97/2205	20/20	50/64.5	15.4/15.4	42.9/42.9	175/175	510.9/227.1	18.2/25
TMS 98/0505	17.5/17.5	43.8/56.5	20.7/20.7	35.7/35.7	127.8/127.8	575/255.6	13.6/18.8
TMS 98/0510	17.5/17.5	56.3/72.6	18.6/18.6	35.7/35.7	302.8/302.8	366.6/162.9	19.3/26.6
TMS 98/0581	20/20	43.8/56.5	16.5/16.5	42.9/42.9	175/175	575.6/255.8	12.7/17.5
TME 419	22.5/22.5	43.8/56.5	13.8/13.8	35.7/35.7	225/225	526.6/234.0	17.3/23.8
TMS 30572	20/20	81.3/104.8	15.9/15.9	32.1/32.1	175/175	384.7/170.9	18.9/25.9

RDA for adult males and females are 1000mg Ca each, 400mg and 310mg Mg, respectively, 4.7g K each, 700mg P each, 900ìg/g Cu each, 8mg and 18mg Fe, respectively and 11mg and 8mg Zn (Institute of Medicine, National Academy of Sciences, 2002).
Estimated values were obtained from data on mineral composition of CMD varieties in Table 1.

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