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COMPARATIVE ELEMENTAL CONTENTS (Cu, Ca, Zn, K, Mg, Ni, Fe AND Cd) OF SEVEN VARIOUS EDIBLE TUBERS IN NIGERIA

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Seven different types of popular tubers consumed in Nigeria have been analysed for their elemental composition. Metals that were investigated include Ca, Cu, Zn, K, Mg, Na, Ni, Fe, and Cd. Results obtained showed that samples contain high amount of potassium and sodium; moderately low amount of magnesium and calcium, while zinc, iron, nickel and cadmium were present at trace levels. Amount of zinc in most samples was found to be about 34 times higher than the amount of cadmium. This was found to be an advantage in masking Cd-induced hypertension in some mammals.

Key words: Edible tubers, Nigeria, Elemental contents, Atomic absorption spectrophotometer.

Introduction

Mineral elements, though usually form a small portion of total composition of most plant materials and of total body weight, they are nonetheless of great physiological importance particularly in the body metabolism [1-3]. Their effects are related to concentration and recorded observations range from a deficiency state, to role as biological essential component, to inbalance created when excess of one interferes with the functions of another, to pharmacological activities [4-6]. It is observed in the national food balance sheet in Nigeria that the consumption of roots and tubers per person per day is about 37% of the total food consumption thus revealing the strategic importance of roots and tubers in dietary needs [7].

Various reports are available on some edible tubers found in Nigeria [9-11] among others, but little or non information in Nigerian studies on the comparative elemental composition of seven edible tubers commonly consumed and also used as industrial feedstocks. These tubers include white yam (*Dioscorea rotunda*), yellow yam (*Dioscorea cayenesis*), water yam, (*Dioscorea qlata*), bitter yam (*Dioscorea dumentorum*), Cassava (*Manihot esculenta*), sweet potato (*Ipomoea batatas*) and Cocoyam (*Colocasia esculenta*). The results will provide baseline information on the elemental composition on Nigeria tubers as well as serving as a guide for sourcing essential elements in starchy tuber materials.

Materials and Methods

Sample preparation and pretreatment. Tuber samples were procured locally from three different major markets in and around the State Capital of Ogun State, viz., Kuto, Iberekodo and Lafenwa markets. Three sets of seven tubers per sample per market were purchased. This gave nine samples per each tuber collected for analysis. The tubes were peeled with clean pen-knife to remove the bark. The peeled tuber was washed several times with distilled water. Portion of each tuber was cut into small pieces, washed several times with distilled water and air-dried. The dried samples were used for all the analyses. The tissue samples were dried at 105 ± 0.5°C for 12hr and each separately ground to powder in a porcelain mortar. The nine dry powdered samples for each tuber were pooled together in each case. The pooled powder was stored in a plastic bottle. Solutions of the tuber samples (tissue) were prepared by weighing 2g of each pooled sample and redried at 105°C in an oven followed by dry ashing in a muffle furnace at 450°C for 16hr. The residual ash was dissolved in about 2-5cm^3 concentrated nitric acid. This was transferred quantitatively into a 250cm^3 volumetric flask and 10cm^3 5% lanthanum added to act as ionisation suppresant, and the solution was made up to the mark with distilled water. The resulting solution was used directly for all the analyses. Absorptions were taken on the Philips PV 9100X atomic absorption spectrophotometer using appropriate hollow cathode lamp and the conditions for the instrument are shown in Table 1.

Results and Discussion

The concentration of K is the highest in all the elements analysed for various tubers as shown in Table 2. Bitter yam gave the highest concentration of 37,850 ± 260 mg kg^{-1} dry matter. This is followed by sweet potato, 34,175 ± 210 mg kg^{-1}, Water yam, 22,560 ± 200 mg kg^{-1}; yellow yam, 20,300 ± 185 mg Kg^{-1}; white yam, 11,700 ±101 mg kg^{-1} and least in

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cassava tuber, 3850 ± 45 mg Kg^{-1} DM. There is wide range of K concentration (3,850 - 37, 850 mg Kg^{-1}) obtained in this work as shown in Table 3. The results are in agreement with the levels obtained by Olaofe *et al.* [8] and Bonire *et al.* [11] for agricultural products and whiteyam respectively. The recommended daily dietary allowances (RDA) (USA), (1980) for K is 350 - 925 , 550 - 1650 mg and 1875 - 5625 mg for infants, children and adults respectively. From the survey results the tubers (tissue) will be a very good source of K to balance the high Na intake through food additive e.g. table salt (NaCl) for improvement of taste. Authorities have recommended that K intake should equal Na intake to counteract the effect of Na in raising blood pressure and the National Research Council has suggested a daily intake from 1.8 to 5.6g (UK recommended values) as safe and adequate [12].

Mg and Ca are the next elements reasonably present in the tubers. Mg and Ca having similar functions may antagonise each other. An excess amount of Mg will inhibit bone calcification [13]. From the results shown in Table 2, sweet potato gave the highest concentration of Mg (2,900 ± 105 mg kg-1 DM) followed by bitter yam (1,590 ± 21mg kg^{-1}) and least by Cocoyam (450 ± 6 mg Kg^{-1}). The concentration range and the mean for all the tuber samples is 450-2,900 mg kg^{-1} and 1169 ±897 mg kg^{-1} respectively as shown in Table 3. There is wide concentration of Mg in the tubers. The RDA for Mg is estimated to be 300 - 350 mg per day. The concentration of Mg in these tubers is not adequate for human diet, but can compliment other sources of foods, particularly nuts, legumes, cereal grains and mostly green vegetables that are abundantly rich in Mg. Sweetpotato gave the highest concentration of Ca (870 ± 6.1 mg kg^{-1} DM) as shown in Table 2. There is a wide range of Ca concentration among the tubers (115-870 mg kg^{-1}) as shown in Table 3, with white yam giving the least (115 ± 4.2 mg kg^{-1}).The RDA (USA, 1980) for Ca was 360-540, 800 and 800-1200mg per day for infants, children and adults respectively.

The richest dietary sources of minerals (milk, cheese and other dairy products) are often out of the reach of majority of developing countries of the world. Hence the concentration range of calcium in tubers in this study cannot satisfy the daily requirements but can augment other sources of food. Since bone serves as a homecastric mechanism to maintain Ca level in blood, long term dietary deficiency is probably one of the factors responsible for bone-thinning, especially where these tubers are taken as the main (80%) food without proper dietary balancing.

Na, Zn, Cu, Fe and Ni were present in trace amounts with Cd being extremely low as shown in Table 2 for all the tubers studied. White yam gave the highest concentration of Na (165 ± 3.8 mg kg^{-1} DM) and a concentration range of 12.5-165mg kg-1 for all the tubers as shown in Table 3. The low concentration of Na could be an advantage to hypertensive patients. The RDA intake for Na is 1100-3300 mg per day which is often met through food additives. Zn concentration ranges from 7.40 - 21.9 mg kg^{-1} for all the tubers. Bitteryam gave the highest concentration of Zn (21.90 ± 0.47 mg kg^{-1}). The RDA (USA,1980) for Zn was set at 15 mg perday for adults, plus 5 mg addition during pregnancy and 10 mg dur-

TABLE 1. INSTRUMENT PARAMETERS.

	Ca	Cu	Zn	K	Mg	Na	Ni	Fe	Cd
Wavelength (nm)	422.7	324.8	213.9	766.5	285.2	589.0	232.0	248.3	228.8
Burner height	8	8	7.5	8	7.5	8	8	8	7.5
Acetylene flow rate/dm^3 min^{-1}	1.0	1.10	1.0	1.1	1.0	1.1	1.0	0.9	1.0
Impact bead	on	on	on	on	on	on	on	on	on

TABLE 2. ELEMENTAL CONTENTS OF SEVEN VARIOUS EDIBLE TUBERS IN NIGERIA (FIVE REPLICATES, *MG KG^{-1} DM)

Sample	Ca	Cu	Zn	K	Mg	Na	Ni	Fe	Cd
White yam (*Dioscorea rotunda*)	115±4.2	14.2±0.62	20.2±0.40	11,700±101	475±8.0	165±3.8	11.40±0.2	42.5±0.64	0.51±0.02
Yellow yam (*Dioscrea cayenesis*)	460±2.4	18.4±0.78	19.7±0.34	20,300±185	487±9.0	89±2	9.8±0.1	33.2±0.40	0.53±0.03
Water yam (*Dioscorea olata*)	225±2.1	18.2±0.80	7.4±0.09	22,560±200	1,450±16	84±2.2	10.2±0.12	48.6±0.50	0.46±0.02
Bitter yam (*Dioscorea dumentorum*)	850±5.6	19.4±0.85	21.9±0.47	37,850±260	1,590±21	125±1.8	10.9±0.10	29.7±0.32	0.48±0.01
Cassava tuber (*Manihot esculenta*)	150±1.6	18.3±0.74	7.80±0.08	3,850±45	830±15	12.5±0.3	7.20±0.10	24.8±0.30	0.42±0.01
Sweet potato (*Ipomoea batatas*)	870±6.1	14.3±0.54	20.5±0.39	34,175±210	2,900±05	52±1.3	8.4±0.2	38.3±0.42	0.53±0.03
Coco yam (*Colocasia esculenta*)	615±5.3	18.9±0.78	15.1±0.31	16,200±110	450±6	97.0±1.6	9.6±0.18	35.6±0.37	0.38±0.02

* = Mean ± SD. DM = Dry Matter. SD = Standard deviation.

TABLE 3. RANGE OF VARIOUS ELEMENTS PRESENT IN SEVEN VARIOUS EDIBLE TUBERS IN NIGERIA (mg kg^{-1} DM).

Eelement	Range	*Mean ± SD
Ca	115 - 870	469.3 ± 319
Cu	14.20 - 19.40	17.3 ± 2.18
Zn	7.40 - 21.90	16.10 ± 6.2
K	3,850 - 37, 850	20948 ± 12,000
Mg	450 - 2,900	1169 ± 897
Na	12.5 - 165	89.2 ± 49
Ni	7.20 - 11.40	9.6 ± 1.44
Fe	24.8 - 42.50	36.10 ± 7.9
Cd	0.38 - 0.53	0.473 ± .05

* Mean ± SD of the means of all the seven tubers. DM = Dry matter.

ing lactation. In view o the low concentration of Zn observed in the tubers in this work, the tubers are not good source of dietary Zn.

The results in Table 2 showed low concentration of Cu (white yam 14.2 ± 0.62 mg kg^{-1} yellow yam 18-4 ± 0.78 mg kg^{-1}. water yam, 18.20 ± 0.80 mg kg^{-1}. bitter yam 19.4 ± 0.83 mg kg^{-1}. sweet potato 14.3 ± 0.54 mg kg^{-1}, cassava tuber 18.3 ± 0.74 mg kg^{-1} and cocoyam 18.9 ± 0.78mg kg^{-1}). The RDA (USA) for copper was 2-3 mg for adults and 1-1.5 mg for children. Since copper deficiency has not been reported in humans consuming a varied diet, these tubers are good source of dietary copper since they are stable food in developing countries. Low concentration of Fe was observed in the results as shown in Table 2. Water yam gave the highest concentration of 48.6 ± 0.50 mg kg^{-1} while Cassava tuber gave the lowest value (24.8 ± 0.3 mg kg^{-1}). It was reported that tubers with high Fe concentration ratio in the bark/tissue usually have thick bark [9]. Cassava tuber has the thickest bark among the tubers studied but low concentration of Fe on the tissue. It may be suggested that there is high concentration of Fe in cassava bark than the tissue. The RDA (USA) for Fe was set at 15 and 18 mg per day for children and adults respectively. The tubers are not good source of Fe, especially when some of the elements are lost during food processing. Ni concentration was very low for all the tubers. The concentration ranges from 7.2 to 11.40 mg kg^{-1}. No RDA (USA, 1980) was established for Ni to determine the extent of its requirement for humans. Cd gave extremely low concentration in all the tubers as shown in Table 2. Sweet potato and yellow yam gave the highest concentration of 0.53 ± 0.3 mg kg^{-1} each. The concentration range of 0.38-0.53 mg kg^{-1} for Cd was shown in Table 3. The mean of all the tuber samples shown in Table 3 indicates that the tubers contain about 34 times as much Zn as Cd. Zn has been shown to be capable of masking Cd-induced hypertension in some mammals [5]. Therefore, these tubers could be considered appropriate when recommending suitable diets for hypertensive patients.

Conclusion

This study has shown that Nigerian consumed tubers contain high amount of K that could be adequate to balance Na intake to counteract the effect of Na in raising blood pressure. Mg and Ca were found to be at moderately low level that augmentation of tubers with other foods will be necessary to meet dietary level for Mg and Ca. The tubers gave low level of Cu (concentration range of 14.20 - 19.40 mg kg^{-1}), but the values were found adequate to meet the RDA. It has equally been found that Zn, Fe and Ni are deficient and present in traceable level in the tubers (tissue) studied and the tubers are not good sources of such elements. Cd was found to be extremely low (average concentration 0.473 ± 0.05 mg kg^{-1}) and the poorest in all the elements studied. From the results a comparison of Zn to Cd concentration (34 :1) was found to be an advantage in masking Cd-induced hypertension in some mammals.

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