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Mineral Composition of Ten Elites Sweet Potato (*Ipomoea Batatas* [L.] Lam.) Landraces of Benin

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A B S T R A C T

Sweet potato is one of staple food crop in Africa, often relegate to second-rate/place, which can play a vital role in combating food shortage and malnutrition including hidden hunger, overweight and obesity among the population. To establish scientific basis for efficient valorization and sustainable utilization of the crops in Benin, the assessment of mineral composition of ten selected cultivars (01 cream, 02 white, 03 yellow and 04 orange flesh-colored) was carried out using standard spectrophotometry procedures. The mineral composition of the tubers on dry weight basis ranged from: 0.53 to 0.73 mg/100 g for the iron, 0.23 to 0.27 mg/100 g for zinc, 23.04 to 29.97 mg/100g for calcium, 21.30 to 25.40mg/100 g for magnesium, 42.00 to 46.33 mg/100 g for phosphorus, 308.67 to 328.67 mg/100 g for potassium and 29.00 to 34.00 mg/100g for sodium. Potassium represented the mineral salt recorded in highest amount in all the sample and can contribute in average to 19.78% and 15.83% to recommended dietary allowance of children and adults respectively. Pearson correlation analysis show that iron content of the cultivars is significantly correlated positively with magnesium and calcium content while negatively correlated with zinc content. The projection of the cultivars on the factorial axis 1 and 2 of the PCA allow to classify them into three (3) major group. Groupe1 assembles 03 cultivars (E3, E7 and E9, all orange fleshed), characterized by high iron, magnesium and calcium content while Group 2 and 3 clustered 04 cultivars each with E10 presenting characteristic of the two groups. Group 1 cultivars can be a good raw material for sweet potato-based infant and childbearing women formula. Ca/P; Na/K and Ca/Mg ratio showed that the ten cultivars analyzed are suitable to be a good food for impoverishment diseases such as hypertension and diabetes management.

Introduction

One of the world's greatest challenges is to secure adequate food that is healthy, safe and of high quality for all (Hunter and Fanzo, 2013). Among the different type of malnutrition, 'Hidden hunger', a deficiency of micronutrients – vitamins and minerals – is particularly severe, and affects as many as 3 billion people globally (FAO, 2013). This type of malnutrition and obesity frequently exist side by side, causing a 'double burden' (FAO, 2013). Minerals are naturally occurring chemical elements the body uses to help perform certain chemical reactions (Ikwechi and Ikwechi, 2009), and they are essential for the normal functioning of muscles, heart, nerves, and in the maintenance of body fluid composition as well as for building strong bones (Chaney, 2006).

Traditionally, the diets of early population were based on traditional food with wide range of crops including Neglected and Underutilized Species-NUS which led to healthier population, holistic life, free from most of the modern day diseases. With recent wave of economic depression and its attendant effect on the purchasing power of the population of less developed nations, it has become obvious that the local food stuffs will play increasing role in the food, nutrition and health security of the rural people and the increasing urban poor (Aja et *al*., 2010). In addition, recent international fora have emphasized the importance of biodiversity for food security and health and its central role in household food security and income generation (Bisselua and Niang, 2013). Among the local food, sweet potato (*Ipomoea batatas* (L.) Lam.) is estimated to play a vital role in combating the food shortages and malnutrition (Naskar *et al*., 2008) due to its contents of various kinds of physiologically functional components in both roots and leaves, which have the potential to maintain human health and mitigate the diseases (Yoshimoto, 2010). As a staple food in most poor region of the continent, it is becoming increasingly recognized as an important crop in Africa because of its relatively cheap price compared to cereals and others roots and tubers crops in the continent (Tomlins et *al*., 2010). Sweet potatoes are a nutritious food, low in fat and protein, but rich in carbohydrate. Both tubers and leaves are good sources of antioxidants (Teow et *al*., 2007), fiber, zinc, potassium, sodium, manganese, calcium, magnesium, iron, and vitamin C (Antia et *al*., 2006).

According to Chaney (2006), in the class of micro nutrients, minerals can be divided into two groups including major minerals (calcium, chloride, phosphorus, potassium, sodium, sulphur, and magnesium) and trace minerals (iodine, iron, zinc, selenium, fluoride, chromium, copper, molybdenum, and manganese). Therefore, the body needs larger amounts of major minerals than trace minerals; although trace minerals play significant role in good health maintenance. Minerals salts play a major role in the maintenance of individual's health. According to Adjatin et *al*. (2013), distorted enzymatic activity and poor electrolyte balance of the blood fluid are related to inadequate calcium, potassium and magnesium as they are the most required elements of living cells. Also deficits in iron, zinc, and calcium can have far-reaching adverse consequences on growth, health, and cognitive development during childhood (Gibson et al. 2010).

There is more recent evidence that proves that a varied diet is beneficial (Tucker, 2001; Bisselua and Niang, 2013) for improved nutritional status of people particularly micronutrient density of diet. In this context, a highly nutritious neglected and underutilized specie like sweet potato (often considered as poor man's food and relegate to the second-rate food), when usually part of a diverse diet may help to combat malnutrition, hidden hunger, overweight and obesity. Hence, for diversification of the utilization of the crops, there is need to evaluate it nutritional composition, it physico-chemical properties as well as it technological aptitude as it has been done for cassava (Sanoussi et *al*., 2015 a). Preliminary study on ten (10) sweet potato cultivars was focused on proximate composition, starch, total and reducing sugars content for better orientation of the existing local varieties in terms of utilization towards the appropriate industrial process (Sanoussi et *al*., 2015 b). This study also clarified the correlation between the parameters that have been analyzed and the link between the ten cultivars. However, there is lack of information on micro nutrients composition of Benin sweet potato cultivars especially its minerals and vitamins content for establishment of a complete database of the sweet potato food composition table in Benin. To pursue this, the present study aims to:

- provide reliable data on some (major and minor) minerals content of the ten selected sweet potato cultivars (preliminary analyzed for proximate composition) and their contribution to recommended dietary allowance;
- Appreciate the health benefits of these cultivars through Ca/P, Na/K, Ca/Mg ratio;
- Examine the correlation between the variables for breeding and nutritional purpose.

Materials and Methods

Ten (10) landraces cultivars (table 1) were analyzed. These were selected from the 108 accessions collected in the southern and central regions of Benin and maintained at the experimental farm of the Faculty of Sciences and Technology of Dassa. Selection of cultivars was based on their productivity and/or their predominant and secondary flesh color and peel color. Flesh color was considered as it is known to be related to Vitamin A content. For the analysis, five (5) medium size sweet potato roots, freshly harvested from the farm, were thoroughly washed with potable tap water and cleaned using paper towels. Cleaned roots were peeled manually with a stainless steel knife and cut into small pieces, wrapped into aluminum paper and kept into refrigerator for future analysis. The mineral content analyses were carried out at the laboratory of Regional Institute for Industrial and Biological Engineering (IRGIB-Africa). Figure 1 presented some of the samples of sweet potato that have been selected for the analysis.

Mineral composition analysis

The mineral composition of the samples was evaluated using spectrophotometric methods. Zinc, iron, and calcium were determined through Atomic Absorption Spectrophotometric while Phosphorus, sodium, potassium, magnesium were evaluated through UV spectrophotometry inductively coupled plasma (ICP) according to (AOAC, 2000). The wavelengths used were 2483A for the iron, 2133A for zinc and 4227A for calcium.

For other minerals, the solutions obtained after mineralization of the samples were diluted with the appropriate reagents. For the determination of magnesium, the solution of EGTA - Acid Ethylene Glycol bis (β-aminoethyeteher) - N, N, N ', N' tetraacetic acid, sodium hydroxide and potassium hydroxide was added to the sample and then kept in the dark for 1 hour before reading on a spectrophotometer at

550 nanometers. For the phosphorus content determination, the reagent used is nitro-vanadomolybdic and the measurement of the optical density was done at 430 nanometers. Potassium is determined by subjecting the suitably diluted sample solution (with pure potassium chloride dried one hour in 2% hydrochloric acid) in a spectrophotometer set at 760 nanometers while the sodium determination is made by direct submission of the mineralized solution at the spectrophotometer at 590 nanometers.

Statistical analysis

The results obtained were analyzed using descriptive statistics (means and standard deviation) and the coefficient of correlation of Pearson. All analyses were carried out in three replicates and the data were evaluated for significant differences in their means with Analysis of Variance (ANOVA) ($p<0.05$). For the analysis of variance (ANOVA) and test of Newman Keul was performed to assess significance of differences between means of mineral analysis variable of the ten sweet potato cultivars at probability $p=0.05$. Coefficient of correlation of Pearson was calculated and Pearson correlation matrices generated to assess the correlation between variables. Principal Component analysis PCA was also performed to examine the relationship between the 10 cultivars by considering them as individuals and mineral composition parameters as variables. All the statistical analyses were performed using MINITAB® software version 14.

Results and Discussion

Mineral composition of the cultivars

In order to understand the potential contribution of sweet potato cultivars available locally to health via dietary balance, the ten selected cultivars were analyzed for their iron, zinc, calcium, magnesium, potassium, phosphorus and sodium content (Table 2).

The iron content of the sweet potato samples analyzed varied from 0.53 to 0.73 mg/100 g on dry weight basis. These values are lower than those (0.73 to 1.26 mg/ 100 g) reported for 12 varieties of sweet potato (for fresh tubers) in South Africa by Laurie et *al*. (2012). The orange flesh cultivars E3, E7, E8 and E9 recorded the highest iron content (table 2) while the lowest iron content (0.53mg/100g) was found with E2, a yellow flesh cultivar. Apart from the variety E8, no statistically significant difference was observed between the iron content of the orange flesh cultivars. However, the variation in the iron content observed between all the other cultivars are statistically significant and could be the results of genotypes variation since all the sample analyzed were harvested from the same experimental farm where the edaphic and climatic conditions are likely the same. Lack of iron is known to be responsible for the anemia which is among the most redoubtable micronutrient deficiencies among children as well as vitamin A deficiency (Sanoussi et *al*., 2013).

Zinc is one of the most common targeted micronutrient in food fortification program due to the high prevalence of it deficiency among children under the age of 5 years and women of childbearing age in developing areas of Africa, Asia, and Latin America (La Frano et *al*., 2014). The analysis of zinc content of the samples showed that cultivars E5 (cream flesh), E6 (white flesh), E4, E10 (Yellow fleshed) and E8 (orange flesh) presented the same zinc content (0.27 mg/100g) which is the highest value among all the ten cultivars (table 2). The values obtained here is far lower than recommended dietary allowance per day for zinc for both children and adults hence indicating that cultivars analyzed are very poor in zinc. Just as for iron, the establishment of breeding programme aimed at improving not only the zinc content of local varieties, but also its bioavailability is recommended.

Calcium content of the ten selected sweet potato cultivars ranged from 23.04 to 29.97 mg/100g on dry weight basis. Similar to iron and zinc content, the calcium content of the ten cultivars evaluated were not significantly different at p = 0.05 for six cultivars (E1, E4, E5, E6, E8, E10) (table 2). The average calcium content of the ten samples studied is approximately 25.60% and contribute only 3.2% of the daily requirement of calcium in children and adults. Calcium is very important to humans for its role in blood clotting, muscle contraction, neurological function, bone and teeth formation/repairs and also as an important factor in enzymatic metabolic processes (Senga Kitumbe et *al*., 2013) and in the preservation of the integrity of the intracellular cement substances (Karau et *al*., 2012; Adjatin et *al*., 2013).

Calcium content of the samples analyzed seems to be higher in the orange flesh cultivars than the others. The calcium content of the samples are much lower than the average content of calcium (50mg / 100g) reported by Laurie et *al*. (2012) for fresh tubers of 12 sweet potato cultivars in South Africa. These same authors reported that there is a strong correlation between the calcium content of the soil for the cultivation and the sweet potato tubers. Thus, the observed difference between our results and those of these authors may be likely due to the difference in calcium content of the soils on which the samples were cultivated. However, regardind the low contribution (3.2%) of the average calcium content of the samples to the recommended dietary requirements per day, it can be suggests that sweet potato is not a good source of calcium.

Magnesium is also present in small quantities (21.30 to 25.40mg/100 g) in the ten sweet potato cultivars studied. The highest magnesium content (23.30 to 25.40 mg/100g) is recorded in the range of the orange flesh sweet potato cultivars (E3, E7, E8 and E9) and the cultivars with the pale orange (E3 and E7) presented the highest values of magnesium content (25.40 mg/100 g) among all the cultivars. This last observation suggested that the orange flesh sweet potato cultivars has high amount of minerals than the white and cream flesh cultivars. According to Alinnor and Oze (2011), magnesium plays essential role in calcium metabolism in bones and is also involved in prevention of circulatory diseases. This mineral is known to help in regulating blood pressure and insulin releases. In addition it has been reported that magnesium intervene in prevention of cardiomyopathy, muscle degeneration, growth retardation, alopecia, dermatitis, immunologic dysfunction, gonadal atrophy, impaired spermato-genesis, congenital malformations and bleeding disorders (Andzouana and Mombouli, 2012; Adjatin et *al*., 2013). All those last functions of the mineral highlighted here could also be more assured by the orange flesh cultivars than cultivars with others flesh colors if their magnesium is well assimilate in the body. Moreover all the samples analyzed are a significant source of calcium for children because they contribute to over 10% (13.88%) of their recommended dietary requirements in calcium.

Phosphorus is very important mineral salt for human health. According to Andzouana and Mombouli, (2012), phosphorus in conjunction with calcium, contribute to strengthening the bones and teeth especially in children and lactating mothers. Phosphorus content of the samples analyzed varied from 42.00 to 46.33 mg/100 g. These values are low when compared to the recommended dietary allowance (800 mg per day for both children and adults) and to those from 115.00 to 203 mg / 100g reported by Ukom et *al*. (2009) for four varieties of sweet potato varieties in Nigeria. According to Laurie et *al*. (2012), low phosphorus content in sweet potato samples could be explained by the low phosphorus content of the soil where they are cultivated on one hand, and the low availability of phosphorus for plants due to the low pH of the soil on the second hand.

Potassium represented the mineral salt recorded in highest amount in all the sample. However the values recorded for the sample analyzed (308.67 to 328.67mg/100g) is lower than the one (338.00 to 407.04 mg/100g) reported by Ellong et *al*. (2014) but higher than certain values of the range from 191.00 to 334.00 mg/ 100g reported by Laurie et *al*. (2012). This difference may be due to the fact that Laurie et *al*. (2012) results are reported on fresh weight basis.

Although potassium was found in highest amount, the consumption of 100 g of sample (dried) will allow to cover about only 20 % and 15% of potassium requirement per day for children and adult respectively. This will highly contribute to the regulation of heart beat, neurotransmission and water balance of the body as reported by Alinnor and Oze, (2011), before an additional potassium amount will be taking, through another food intake, to make the dietary balance. In addition, high amount of potassium in the body was reported to increase iron utilization (Nair et *al*., 2013) and beneficial to people taking diuretics to control hypertension (Nair et *al*., 2013; Adjatin et *al*., 2013).

Sodium content varies from 29.00 to 34.00 mg/100g with the average sodium content of 31.80 mg/100g. The recommended dietary allowance was 400 mg/day and 500 mg/day for children and adult respectively. This amount of sodium will contribute to approximately cover 10% sodium requirement per day for both children and adults. No variation in sodium content of the sweet potato cultivar depending upon the flesh color was observed. There is growing concern regarding dietary sodium and its consequences for public health. According to Alinnor and Oze (2011), sodium is an important mineral that assists in the regulation of body fluid and in the maintenance of electrical potential in the body tissue. However there is consensus that increased sodium intake can cause increased blood pressure, which in turn can increase the risk for cardiovascular and renal disease (DeSimone et *al*., 2006).

The iron content, calcium content and magnesium content of the analyzed samples appear to be higher in the orange flesh cultivars than the others while phosphorus, potassium and sodium are found highest amount in the yellow-fleshed cultivars. This latter observation suggests that, in addition to their potential abundance in β-carotene, colored flesh (orange, yellow) sweet potato cultivars also have the highest quantity of minerals compared with white and cream flesh cultivars. This finding corroborates the results of Laurie et *al*. (2012), in which they indicated that for minerals (calcium, magnesium, zinc, phosphorus, potassium), orange-fleshed sweet potatoes varieties contribute more to cover the mineral requirement than cream flesh sweet potato varieties.

Ca/P, Na/K and Ca/Mg ratios are used by several authors (Alinnor and Oze, 2011; Adjatin et al. 2013) to appreciate health benefit of food. Ca/P ratio is used to evaluate food with regard to its potential aptitude to provide calcium and to increase or not its absorption in small intestine. Food is considered good if the ratio Ca/P is above 1 and as poor when less than 0.5 (Alinnor and Oze, 2011; Adjatin et *al*., 2013); Ca/P ratio above 2 help to increase the absorption of calcium in the small intestine. Regarding this standard, the sweet potato cultivars analyzed can be all considered as relatively good food since their Ca/P ratio falls in the range from 0.56 to 0.70. In addition orange flesh cultivars which scored highest Ca/P ratio could be considered as the best.

Na/K ratio of the sweet potato cultivar studied varies from 0.09 to 0.11. According to Alinnor and Oze (2011), a food source having Na/K ratio of less than 1 has impact on lowering blood pressure since Na/K ratio is known for help in controlling high blood pressure. Thus, it can be concluded that all the ten sweet potato cultivars are good food that have impact on lowering blood pressure. Sweet potato consumption could be recommended as useful nutraceutical therapy for hypertensive individuals. This observation is in agreement with the results of survey conducted in Benin and which indicated that sweet potato has some blood pressure lowering properties (Sanoussi et *al*., 2015 c). Ca/Mg values ranged from 1.04 to 1.20 which are therefore in accordance with the recommended value of 1.00 (NRC, 1989).

Correlation of the variables and Principal Component Analysis of the mineral profile data

The Pearson correlation analyses of the variable (Table 3) show that iron content of the ten cultivars is significantly correlated positively with magnesium and calcium content while negatively correlated with zinc content on one hand. On the other hand, the magnesium content of the cultivars is significantly correlated positively to calcium while significantly correlated negatively with zinc content. Calcium content of the ten cultivars is significantly correlated negatively to their phosphorus content (table 3). These observations suggested that the more a cultivar is rich in iron, the higher are its magnesium and calcium contents and the lower are its zinc and phosphorus contents. Therefore, these results are relevant for breeding programme focusing on improved the sweet potato cultivars in a particular mineral content. Hence, it can be inferred that in a breeding programme focus on improving iron content of the cultivars will lead to an increase of their magnesium and calcium content and therefore in a lowering of their zinc and phosphorus contents.

The principal component analysis PCA grouped the variables into 7 components among which the first two are significant (eigen value>1) and explained 74.20 % of the total variability (Table 5). PC1 is correlated with iron, zinc, calcium, magnesium and phosphorus and explains 55.70 % of total variability while PC2 (18.50 % of total variability) is associated with zinc, potassium and sodium contents of the cultivars (Table 3).

Projection of the cultivars on the factorial axis 1 and 2 allowed classifying the sweet potato cultivars into three (3) major group (figure 2). Groupe1 assembles three (03) cultivars (E3, E7 and E9) all with orange flesh and is characterized by high iron, magnesium and calcium content. These cultivars can be a good raw material for sweet potato infant and childbearing women formula since the importance of these three minerals for those target group are well known.

Table.1 List and Characteristics of the Selected Cultivars

Accession number	Vernacular name	Collecting sites	Skin color	Predominant flesh color	Secondary flesh color	Estimated mean yield (t/ha)
E5	Welli F	Sissèkpa	White	Cream	None	76.38
E1	Avoungokan vôvô	Sagon	Pink	White	None	40.80
E6	Gbagolo	Dasso	Purple	White	None	33.90
E10	Bombo wéwé	Sokan	Cream	Yellow	Pink	12.65
E4	Atanboué	Dasso	White	Yellow	None	18.53
E9	Carrotti	Bozoun	Orange	Dark orange	None	21.32
E3	Loki kpikpa	Pira	Pale Orange	Pale orange	None	36.96
E8	Dokouin C	Kétou	Pink	Pale orange	Orange	36.35
E7	Mansawin	Sokan	Yellow	Pale orange	Yellow	18.51
E2	Bombo vôvô	Sokan	Dark purple	Yellow	Purple	38.88

Figure.1 Some Samples from the Ten Selected Sweet Potato Cultivars Analyzed

Table.2 Minerals Salts Profile of Roots of the Ten Selected Sweet Potato Cultivars

Samples	Flesh color	Vernacular name	Mineral salts composition (mg/100g on dry weight basis)									
			Iron	**Zinc**	**Calcium**	**Magnesium**	**Potassium**	**Phosphorus**	**Sodium**	**Ca/P**	**Na/K**	**Ca/mg**
E1	White	Avoungokan vôvô	0.60 ± 0.00^{ab}	0.23 ± 0.00^{a}	24.67 ± 0.44^{b}	23.37 ± 0.04^{cd}	310.67 ± 0.44^{b}	44.00 ± 0.00^{bcd}	31.83 ± 0.22^{d}	0.56	0.10	1.06
E6	White	Gbagolo	0.57 ± 0.04^{a}	0.27 ± 0.00^{d}	24.00 ± 0.00^{b}	21.30 ± 0.13^{a}	308.67 ± 0.44^{a}	45.33 ± 0.44^{de}	34.00 ± 0.00^{f}	0.53	0.11	1.13
E5	Cream	Wêlli F	0.60 ± 0.00^{ab}	0.27 ± 0.00^{d}	24.93 ± 0.18^{b}	22.47 ± 0.37^{b}	323.67 ± 0.44^{d}	42.00 ± 0.66^{a}	32.33 ± 0.22^{d}	0.59	0.10	1.11
E2	Yellow	Bombo vôvô	0.53 ± 0.04^{a}	0.25 ± 0.00^{c}	23.07 ± 0.38^{a}	22.50 ± 0.00^{b}	315.33 ± 0.44^{c}	44.67 ± 0.44^{cd}	32.00 ± 0.00^{d}	0.52	0.10	1.03
E4	Yellow	Atanboué	0.60 ± 0.00^{ab}	0.27 ± 0.00^{d}	25.00 ± 0.00^{b}	23.00 ± 0.00^{c}	326.67 ± 0.88^{f}	44.67 ± 0.44^{cd}	29.00 ± 0.00^{a}	0.56	0.09	1.09
E10	Yellow	Bombo wéwé	0.63 ± 0.04^{ab}	0.27 ± 0.01^{d}	24.00 ± 0.27^{b}	23.10 ± 0.06^{cd}	325.00 ± 0.00^{e}	46.33 ± 0.44^{e}	34.33 ± 0.04^{f}	0.52	0.11	1.04
E3	Orange clair	Loki kpikpa	0.73 ± 0.04^{b}	0.23 ± 0.00^{a}	28.90 ± 0.20^{d}	25.40 ± 0.06^{e}	314.00 ± 0.00^{c}	42.00 ± 0.00^{a}	30.50 ± 0.33^{bc}	0.69	0.10	1.14
E7	Orange clair	Mansawin	0.70 ± 0.00^{b}	0.24 ± 0.00^{ab}	27.10 ± 0.53^{c}	25.40 ± 0.13^{e}	315.00 ± 0.00^{c}	42.33 ± 0.44^{a}	33.10 ± 0.06^{e}	0.64	0.11	1.07
E8	Orange clair	Dokoui C	0.63 ± 0.04^{ab}	0.27 ± 0.00^{d}	24.40 ± 0.13^{b}	23.50 ± 0.00^{d}	315.33 ± 0.88^{c}	43.67 ± 0.44^{bc}	30.33 ± 0.44^{b}	0.56	0.10	1.04
E9	Dark orange	Carroti	0.73 ± 0.04^{b}	0.25 ± 0.00^{bc}	29.97 ± 0.24^{e}	25.07 ± 0.11^{e}	310.67 ± 0.44^{b}	43.00 ± 0.00^{ab}	31.00 ± 0.00^{c}	0.70	0.10	1.20
RDA for children OMS (mg/day)			10.00	10.00	800.00	170.00	1600.00	800.00	400.00	> 0.5	< 1	1.00
RDA for adult OMS (mg/day)			15.00	15.00	800.00	350.00	2000.00	800.00	500.00			
Contribution to RDA for children (%)			6.33	2.55	3.20	13.83	19.78	5.48	7.96			
Contribution RDA to for adult (%)			4.22	1.70	3.20	6.72	15.83	5.48	6.37			

RDA : Recommended Dietary Allowance
Value with different superscript in the same column are statistically different at probability p=0.05 %

Table.3 Pearson Correlation Matrice Between the Variables of Mineral Profile of Ten Selected Sweet Potato Cultivars in Benin

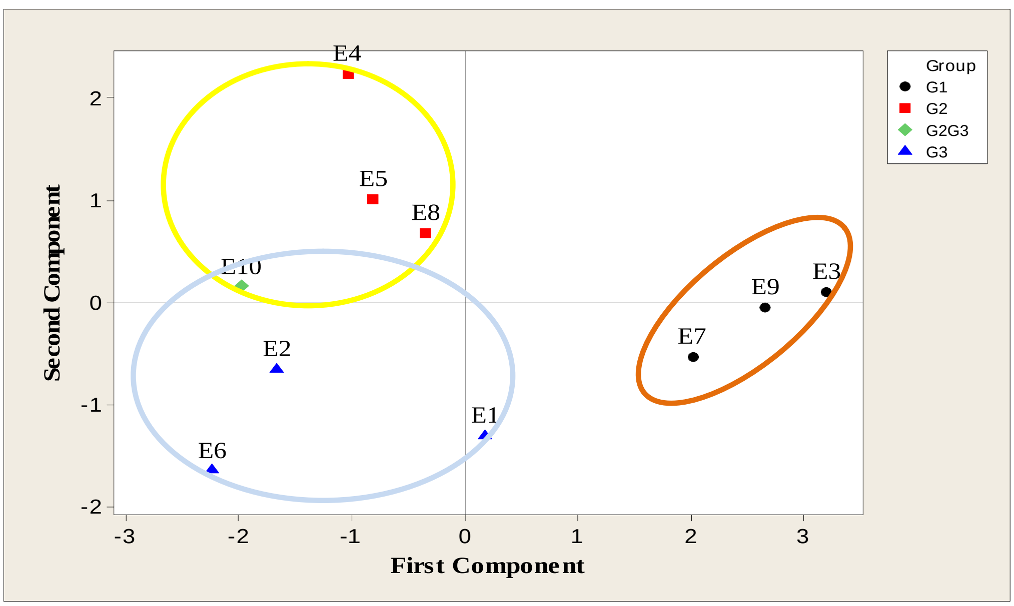
Parameters	Iron	Zinc	Calcium	Magnesium	Potassium	Phosphorus
Zinc	-0.440					
Calcium	0.927*	-0.499				
Magnesium	0.910*	-0.648*	0.842*			
Potassium	-0.179	0.525	-0.291	-0.170		
Phosphorus	-0.579	0.468	-0.650*	-0.620	0.174	
Sodium	-0.199	0.116	-0.313	-0.310	-0.135	0.349

*means that the correlation is statiscally significant

Table.4 Eigen Value and Proportion of Contribution of the Mineral Salt Parameters to the Variability on the Principal Components Axes of PCA

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Iron	0.455	0.095	-0.422	-0.230	0.081	-0.158	0.722
Zinc	-0.359	0.391	-0.305	-0.201	0.669	-0.306	-0.210
Calcium	0.470	0.067	-0.196	-0.239	0.251	0.691	-0.373
Magnesium	0.473	0.084	-0.189	-0.076	-0.334	-0.576	-0.532
Potassium	-0.183	0.706	-0.331	0.312	-0.445	0.249	0.032
Phosphore	-0.389	-0.133	-0.182	-0.784	-0.416	0.091	-0.027
Sodium	-0.185	-0.557	-0.715	0.362	-0.001	0.048	-0.102
Eigenvalue	3.899	1.292	0.790	0.461	0.441	0.094	0.020
Proportion	0.557	0.185	0.113	0.066	0.063	0.013	0.003
Cumulative	0.557	0.742	0.855	0.921	0.984	0.997	1.000

Figure.2 Projection of the Sweet Potato Cultivars on the First and Second Component Axes



The group 2 combines four (04) sweet potato cultivars (E4-yellow flesh, E5-cream flesh, E8-pale orange flesh and E10 yellow flesh) which recorded high potassium and zinc contents while the group 3 individuals (04 cultivars) are characterized by high phosphorus and sodium contents. However it can be remarked that, the group 2 and 3 include both the cultivar E10 which represented the only one sweet potato cultivars which combines the characters of the two groups.

In conclusion, this study allowed to establish data on mineral composition of ten local sweet potato varieties in order to complete existing nutritional data base for efficient valorization and sustainable utilization of the crop in Benin. Although all minerals are found in low amount in all sweet potato cultivars analyzed, orange flesh cultivars exhibit the highest iron, calcium and magnesium content while the yellow flesh cultivars have the highest amount of phosphorus, potassium and sodium. These colored flesh cultivars are therefore promising cultivars that could be promoted through food intended for particular target group such as children and childbearing women for improved nutritional and health status and combating malnutrition. Among the major minerals salts, potassium was found in highest quantities in all cultivars and could contribute to about one fifth of recommended dietary allowance for children while among the minor minerals salts it is iron which is found in highest quantities. The Ca/P; Na/K and Ca/Mg ratio showed that the ten cultivars analyzed are suitable as good food in the management of impoverishment diseases such as hypertension and diabetes. The Pearson correlation analysis of the mineral composition variable allow to gather important knowledge for future breeding programme of the crops in Benin. However, since the mineral composition varies depending upon the soil edaphic conditions and others factors, future studies need to be conducted on the ten cultivars planted in different regions of the country in order to generate reliable data on mean value of each mineral salt for establishment of a proper food composition table for nutrition programme.

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