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# Spectrophometric Estimation Studies of Mineral Nutrient in Three Cocoyam Cultivars

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**Abstract:** The mineral nutrient of two cultivars of *xanthosoma sagittifolium* (white flesh and red flesh) and one cultivars of colocasia (colocasia asculenta) were investigated using the S series atomic absorption spectrometer (Model 711735 v1.26), Perkin-Elmer UV visible spectrophotometer (Model 295E). *Xanthosoma sagittifolium* (white flesh) was composed of Na (1365.05), K (3057.16), Mg (313.70), Ca (190.93), Fe (8.28), P (44.39), Zn (2.49) and Cu (0.52) (mg/100g); *xanthosoma sagittifolium* (red flesh) was found to contain Na (1297.89), K (1737.48), Mg (314.30), Ca (107.38), Fe (9.11), P (44.94), Zn (3.10) and Cu (0.78) (mg/100g) while *colocasia esculenta* contained Na (1521.34), K (4276.04), Mg (415.07), Ca (132.43), Fe (8.66), P (72.21), Zn (2.63), Mn (0.13) and Cu (0.78) (mg/100g). Manganese was not detected in the *Xanthosoma Sagittifolium* cultivars investigated. ANOVA results showed variations (P = 0.05) in the amounts of the nutrients within the species. The mineral composition portray the cultivars as good sources of Na, K, Mg and Ca whose salts regulate the acid-base balance of the body system. However, values obtained for Ca, Fe and Na are less than the daily requirement but could be augmented by either increasing the quantity consumed or complimenting it with other food sources.

**Key words:** Cocoyam species, mineral nutrient, AAS, UV visible spectrophotometer

## Introduction

Cocoyam, a member of the araceae family is an ancient crop grown throughout the humid tropics for its edible corms, cormels and leaves, as well as for other traditional uses (Ekanem and Osuji, 2006). It has many varieties. Like many plants of the araceae family, the cocoyam grows from the fleshy corm (tuber) that can be boiled, baked or mashed into a meal. Cocoyams are rich in carbohydrates and very low in protein (Nail, 1984). The cormels are used for human consumption while the corms serve as planting material. The corms supply easily digestible starch and are known to contain substantial amounts of protein, vitamin C, thiamine, riboflavin and niacin. (Niba, 2003). The leaves are important source of proteins and vitamins (Purseglove, 1972). The main nutrient supplied by cocoyam, as with other roots and tubers, is dietary energy provided by the carbohydrates. The protein is low (one to two percent) and in almost all root crop protein, sulphur-containing amino-acids are the limiting amino-acid (FAO, 1990).

Taro (colocasia) is a good source of potassium. Cocyam, like other roots and tubers are deficient in most other vitamins and minerals but contain significant amounts of dietary fiber (Niba, 2003). Leaves of taro are cooked and eaten as vegetable. They contain beta-carotene, iron and folic acid which protects against anemia (FAO, 1990). There are about 1530 calories in one pound of malanga (*xanthosoma*) flour (Jirarat *et al*., 2006). The composition of malanaga flour is approximately: 75.5% carbohydrates, 5.1% protein, 1.6% flat, 9.8% fiber, 1.2% water and 6.8% minerals (Jirarat *et al*., 2006).

Potassium is the major mineral in cocoyam while sodium tends to be low. The high potassium to sodium ratio may be an additional benefit in the diet of patients with high blood pressure; however, high potassium foods should be omitted in diet of people with renal failure (FAO, 1990).

Sefa-Dedeh and Kofi-Agyir (2002), observed no distinct variation in the starch granule size of the two *xanthosoma* species (red and white flesh). Enomfon and Umoh (2004) observed that raw *xanthosoma sagittifolium* corm contained Na (66.15±0.42), K (524.95±0.51), Mg (46.60±0.21) Ca (18.64±0.03), Fe (0.42±0.41), P (70.41±0.26), Zn (0.46±0.18), Mn (0.63±0.02) (mg/100g), while in a different study by Bradbury and Holloway (1998) on taro (*colocasia esculanta*) on fresh wet basis, it contained Ca (160.0), P (330.0), Mg (320.0); Na (34.0), K (3280.0), S (54.0), Zn (47), Mn (1.4) (mg/kg). Iwuoha and Kalu (1995) compared the calcium oxalate and some physico-chemical properties of flours from three cultivars of colocasia spp. Results showed that boiling effected the highest oxalate reduction.

The aim of this study is to establish the mineral contents in cocoyam species and compare the information among the different cultivars. The knowledge obtained from this study will be useful in elucidating the nutritive values and possible use of cocoyam at industrial level in order to optimize the physiological benefits.

## Materials and Methods

**Collection and preparation of test samples:** The cocoyam cormels used in this study were purchased

from Oshodi market, Lagos, Nigeria. They were thoroughly washed with water and the outer skins peeled off using a knife. The fleshy part of the cormels were grated into tiny pieces using the manual kitchen grater, air-dried and ground manually with the laboratory metallic mortar into a fine powder. The powder of each sample was stored in air-tight cellphone bags as stock samples until required for analyses.

**Chemical analyses:** The reagents used were of analytical grade. The ash content was determined using the ignition method (Horsefall and Ayebaemi, 2004). The crucibles used were thoroughly washed and dried in an air-circulating oven at 100°C for 15 minutes. They were removed into a dessicator to cool. The crucibles were later preheated in the carbolite furnace at 550°C for 10 minutes.

Exactly 1.0475g, 1.0347g and 1.0068g of *Xanthosoma Sagittifolium* (white flesh), *Xanthosoma Sagittifolium* (red flesh) and *colocasia esculenta* were respectively placed in each of the pre-heated, cooled and weighed crucible and then reweighed. The temperature was allows to rise to 550°C and the ashing carried on for one hour at this temperature. The crucibles was removed from the furnace, allowed to cool in a dessicator and reweighed. The percentage ash content was calculated

$$\text{Ash (\%)} = \frac{\text{mass of ash (g) x 100}}{\text{mass of sample (g)}} \quad \ldots\ldots\ldots (1)$$

**Preparation of sample solutions:** Upon ashing, 3 drops of 1M $HNO_3$ acid was added to the sample in each of the crucibles to digest then. About 50mls of distilled water was used to rinse the digests into 100 mL flasks respectively, the flasks were filled up to the marks with distilled water. The digests were filtered into sample bottles each using the Whatman filter paper (125mm) prior to analyses. The Na, K, Fe, Zn, Mg, Mn and Cu content in the samples were determined using Atomic Absorption Spectrometer (AAS) at 589.0nm, 766.5nm, 248.3nm, 214.0nm, 285.2nm, 279.6nm and 324.8nm wavelengths respectively; using the air-acetylene flame. The concentrations of the elements in the samples were calculated using the formular:

$$\text{Concentration (mg/100g)} = \frac{\text{Concentration} \times 10}{\text{Sample weight}} \quad \ldots\ldots (2)$$

Determination of the phosphorus content of the samples was done by colorimetry, as phosphate, using the Perkin-Elmer UV-visible Spectrophometer (Model 295E) at a wavelength of 470nm. 10 mL of each sample was pipetted into three 50 mL flasks each and another 50ml flask each and another 50mls flask was left as blank. 3 drop 1M $HNO_3$ solution was added to each of the flasks and also to the standard solution of phosphate. (1.0 mL standard phosphate = 0.2mg $P_2 0_5$). 5 drops of 1M $HNO_3$ and 12.5 mL of vanadate molybdate were also added to all the flasks and the solutions left to stand for 25 minutes. The blank solution was used to set the instrument at zero absorbance prior to the determination. The absorbance of the standard phosphate solution was determined followed by the samples absorbance. The concentration of phosphate in the samples was thereafter obtained.

$$\text{Concentration of X} = \frac{\text{Absorbance of X} \times \text{Concentration of } S_2}{\text{Absorbance of } S_2} \quad \ldots\ldots\ldots (4)$$

Where X = Phosphate in the volume of sample use (aliquot)

$S_2$ = Standard whose concentration was already stipulated

The number of milligrams of phosphate in 100g sample was calculated thus:

$$P_2O_5 \text{ (mg/100g)} = \frac{Cx \times 1000}{Sm} \quad \ldots\ldots\ldots (5)$$

Where Cx = Concentration of the phosphate in the aliquot

Sm = Sample mass

The phosphorus content was determined from the phosphate content thus:

$$P \text{ (mg/100g)} = \frac{P_2O_5 \text{ (mg/100g)} \times \text{atomic weight of P}}{\text{Molecular weight of } P_2O_5} \quad \ldots\ldots (6)$$

**Statistical analyses:** Analysis of variance, was used to ascertain if variation existed amongst the mineral studied.

## Results and Discussion

The mineral nutrients level (on dry wet basis) and the ash content of the cocoyam species studied are given in the Table below:

Table 1: The mineral nutrients level and the ash content of the cocoyam species

| Mineral (Mg/100g) | Xanthosoma Sagittifolium (White Flesh) | Sagittifolium Xanthosoma (Red Flesh) | Colocasia Esculenta (Taro) |
|---|---|---|---|
| Na | 1365.05 | 1297.89 | 1521.34 |
| K | 3057.16 | 1737.48 | 4276.04 |
| Mg | 313.70 | 314.30 | 415.07 |
| Ca | 190.93 | 107.38 | 132.43 |
| Fe | 8.28 | 9.11 | 8.66 |
| P | 44.39 | 44.94 | 72.21 |
| Zn | 2.49 | 3.10 | 2.63 |
| Mn | Not detected | Not detected | 0.13 |
| Cu | 0.52 | 0.78 | 1.04 |
| Ash content % | 4.6014 | 3.6242 | 7.7771 |

*Colocasia esculenta* had the highest percentage of ash (7.78%) when compared to the *X. sagittifolium* (white) with percent ash content of 4.60% and the *X. sagittifolium* (Red) with the lowest percent ash of 3.62%. *Colocasia esculenta* had the highest values in Na (1521.34), K (4276.04), Mg (415.07); P (72.21), Mn (0.13), Cu (1.04) (mg/100g); this probably, was as a result of its highest ash percentage. Na and K were least in *X. Sagittifolium* (Red); Mg, Cu and P were least in *X. Sagittifolium* (White). Manganese was detected in only colocasia *esculenta*. The Zn and Fe contents in *X Sagittifolium* (red) were the highest while the reverse is case of its Ca content.

Potassium had the highest value in all these samples, this finding agrees with the report (Enomfon and Umoh, 2004; FAO, 1990). The Ca, P, Fe and K values for *colocasia esculenta* were intermediate between those reported (Bradbury and Holloway, 1998). The Mg, Cu, Zn and Fe values for the *X. sagittifolium* species were higher than that reported by (Enomfon and Umoh, 2004), while the reverse was the case for the P content. Manganese was completely undetected in the X. Sagittifolium species against the value of 0.63±0.02mg/100g reported (Enomfon and Umoh, 2004; FAO, 1990). There is dearth of information on the minerals contents of cocoyam, this confirms the assertion by Ekanem and Osuji (2006) that cocoyam research is still at the primary stage. The variations in the values obtained in this study from others obtained in previous literatures could be attributed to many factors. As with all crops, the nutritional composition of roots and tubers varies from place to place depending on the climate, the soil, the crop variety and other factors (FAO, 1990).

Njoku (2004) also noted that samples can be contaminated by materials from which ashing was carried out as well as the linings of the furnace. Dissolved metals ions present in the distilled water used for sample preparation can also influence the results obtained. Agricultural activities, waste disposal, method of analysis and error in calculation may also play significant roles in varying the results.

The colour intensities of the samples may be attributed to the quantities of Cu and Fe in them. Though the samples were in shades of brown, the *colocasia esculenta* flour was the darkest, probably because of its highest Cu and intermediated Fe contents; this was followed by *X. Sagittifolium* (red flesh) which also contained highest Fe and intermediate Cu contents.

Analysis of variance result showed that there was appreciable variations ($p = 0.05$) in the amounts of the nutrient within the species. The values of P, Ca, Mg and K obtained for *Colocasia osculenta* in this work were greatly higher than those reported in (Aregheorel and Perera, 2003) probably, because the samples used in their work were previously cooked in the traditional way of taro preparation in *samon*, which had a likelihood of altering the mineral values of the sample studied (Blanco *et al*., 2004). Studied are needed to identify, characterize and evaluate these several sources of variation to permit data compilers to provide users with food composition data that are less variable, perhaps through submissions of existing food categories, regional tables, dated values and so forth.

**Conclusion:** The results presented in this study reveal that cocoyam is enriched with mineral nutrients especially, K, Na and Mg. Consuming micronutrient rich foods such as cocoyam is important for building a strong immune system and help the body absorb and utilize protein and carbohydrates and to digest and absorb other nutrients.

The adult daily requirements for source of these nutrient, are Ca, 700mg, Fe; 13-16mg Mg, 13mg, K, 1-2Mg and Na, 6g (Longman, 2006). Considering the mineral nutrient levels in the cocoyam species studied, one can conclusively recommend daily diet of cocoyam as the food has been found to be of high nutritive value. 100g cocoyam flour contained greater quantities of Mg and K than the daily requirements, but safety resides in the fact that the different processing methods of cocoyam markedly reduces the level of antinutritional factors contents and to a large extent, the mineral contents thus, rendering them safe for human consumption (Ndimantang *et al*., 2006; Iwuoha and Kalu, 1995). The value obtained for Ca, Fe and Na in this work are less than the daily requirement but could be augmented by either increasing the quantity of cocoyam consumption or complementing it with other food sources. The present study has therefore provided some information on the nutritive values of cocoyam (*Xanthosoma Sagittifolium* and *colacasia esculenta*). Their mineral compositions portray them as good sources of Na, K, Mg and Ca, whose salts regulate the acid-base balance of the body.

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