IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 6 Ver. XI (June 2016), PP 118-125
www.iosrjournals.org

Mineral Compositions of Three Musa Species at Three Stages of Development

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Abstract: *This study was aimed at evaluating the mineral compositions of three Musa species at three stages of development. The mineral elements compositions were analyzed by atomic absorption spectrophotometeric method. Results of the mineral composition of three Musa species at three stages of development revealed that iron content was higher in plantain than as in banana and Saba banana. Cobalt was not detected in all stages of the three samples. Also, sodium was the most available mineral with very high quantity, followed by magnesium and iron. Zinc content of the samples revealed no significant difference amongst the three Musa species but increases as the species ripens or develops. These indicate that Musa species is a good species of plant with high mineral composition especially in a ripped stage and should be recommended for our daily diet.*

Keywords: *Mineral, Musa species, significant increase and Spectrophotometric*

I. Introduction

Since the dawn of human civilization plants have made large contributions to facilitate human health and well being [1]. The stage of maturity of plants greatly affects the concentrations of nutrients in plants [2], thus it is very important to choose suitable stage of harvesting [3]. Medicinal potentials of most common plants have been extensively studied and compiled but the lack of information regarding the potential of these plants at varying stages of development makes these plants to be highly underutilized.

During the process of growth and development of fruit, series of developmental transitions are undergone. These processes involve coordinated changes in a number of catabolic and anabolic reactions [4], which leads to the synthesis or degradation of wide range of bioactive compounds. Hence, fruits at varying maturity levels may possess vivid bioactive compounds, which need to be studied so as to provide maturity indices for its usage as a source of food or medicine. It has also been proven that ethno-botanically derived compounds have potential bioactive compounds and they therefore provide greater potential for product development [5].

In Nigeria, fruits can be harvested at all stages of development (from immature to overripe) and can be used as a source of food in one form or the other. Some fruits are picked when they are mature but not yet ripe [6]. According to [7], plantain fruits may be consumed unripe (green), yellow-green, or ripe.

The stage of maturation at which any fruit is harvested also influences the fruit's green-life or its ability to be stored for long periods [7]. Fruits harvested at an early stage of maturity are of poor quality upon ripening, despite having a long storage life [8]. Similarly, harvesting at an advanced stage of maturity is unsuitable for fruits intended for long distance shipment due to their shorter storage life. However according to [9], the appropriate time to harvest unripe plantain for maximum benefit is between the 12th and 14th week. This two week period provides enough time for harvest, distribution, marketing and utilization of the produce before ripening.

Increased vegetable utilization and consumption are critical to alleviate world-wide incidence of nutritional deficiencies. Investigations have shown that some plants contribute to increased intake of some essential nutrients and health-promoting phytochemicals. Phytochemicals are present in virtually all of the fruits, vegetables, legumes (beans and peas), and grains we eat, so it is quite easy for most people to include them in their diet.

Musa paradisiaca L is an herbaceous plant (up to 9 m long) with a robust treelike pseudostem, a crown of large elongated oval deep-green leaves (up to 365 cm in length and 61 cm in width) with a prominent midrib. Each plant produces a single inflorescence like drooping spike, and large bracts opening in succession, ovate, 15-20 cm long, concave, dark red in color and somewhat fleshy. Fruits are oblong, fleshy, 5-7cm long in wild form and longer in the cultivated varieties. The ripe fruits are sweet and full of seeds and the peel is thicker than other banana. *Musa paradisiaca* is a type of plantain, which is normally cooked before it is eaten. It belongs to the AAB genomic group.

Musa sapientum L is a treelike perennial herb that grows 5 - 9 m in height, with tuberous rhizome, hard, long pseudostem. The inflorescence is big with a reddish brown bract and is eaten as vegetables. The banana plant grows up to 10 to 26 feet. Musa *sapientum* known as true banana or dessert banana is usually eaten raw at maturity. It belongs to the AAA genomic group.

Musa saba L is primarily a cooking banana although it can also be eaten raw. It is one of the most important banana varieties in Philippine cuisine. It is also known as the Cardaba banana or simply Saba banana. Saba bananas are part of the saba subgroup (ABB). Saba banana is a triploid (ABB) hybrid of the seeded banana *Musa balbisiana* and *Musa acuminata* [10]. It has predominant *Musa balbisiana* gene. It's also designated as *Musa acuminata* × *balbisiana* Colla (ABB Group) 'Saba'.

The fruits otherwise known as fingers are 8 to 13 cm long and 2.5 to 5.5 cm in diameter. Saba Bunches are big with 8 to 16 hands having 12 to 20 fingers per hand. The fruits are short and stubby and highly angular (plate 1b). Saba banana is a beautiful plant with an unusual bluish-green colored fruit. The pulp is white and starchy, making it ideal for cooking. The bright white interior contrasts with the outer peel. They are usually harvested while still green after about 150 to 180 days after planting [11]. The skin is thick and yellow when ripe (Plate 1c).

Saba banana has the largest and tallest stem attaining a height of four meters. It can grow to 25 feet and is very tolerant of cold and resistant to wind. The trunk can be as thick as 24 inches. Its leaves are dark green, and the banana is green skinned or green verging toward yellow. This plant is often grown for shade. The Saba plant's pseudo stem is robust and grows taller than the dessert cultivars, producing about 8 suckers per mat at harvest. Its fruit, however, has a longer gestation period at 150 to 180 days after flowering. The plant's potential yield is 26 to 28 kg per bunch with one bunch containing up to 16 hands, each hand having 12 to 20 fingers.

In Nigeria, *Musa saba* is available year round in Southern part of the country but highly underutilized. It is highly restricted in utilization to production of flour and fried chips, thereby predisposing it to rapid post harvest spoilage contributed by its physiological metabolic activities and high moisture content. It is relatively cheaper as compared to dessert bananas and plantains and has been reported to be rich in minerals, ash and ascorbic acid [12].

Banana and plantain fruits can be used industrially in the production of baby food and pastries [13 and 14]. The peels of plantain can be dried and made into meal which can be used to substitute up to 70 – 80% of the grain in pig and dairy diets with little change in performance [15]. The meals are also used in poultry diets but when in high level tends to depress growth and reduces feed efficiency. The leaves, sheaths and petioles are used in tying, roofing, wrapping, and packaging of food. Plantain and banana are also used in beer production. In Central and East Africa, the juice from the ripe fruits is fermented to make beer with low alcohol content [15 and 16].

Akpabio *et al*, (2012), [17], also observed that green plantain and banana pseudo stems can be used in alcohol production, paper making and in the preparation of cellulose derivatives. Unripe plantain because of its starch content indicates wider utility in alcohol production, fuel and sugar industries, and as drug binder in pharmaceuticals.

Plantain and banana play important role in income generation for both large scale and small holders' farmers in the country, especially for those who produce them within their homestead or gardens [18].

Plantains and bananas are known to contain bioactive compounds (phytochemicals) such as alkaloids, flavonoids, tannins and phenolic compounds [19 and 20]. According to [21], knowledge of the chemical composition of a plant together with its antioxidants activity will give a fair estimate of its therapeutic potential furthermore.

From the ongoing it is clear that knowledge of the constituents of any plant at each usable stage of development is necessary for better understanding of when it will be used to achieve desired result. Information about the stages of development of banana and plantain used to realize certain objectives in literature are scanty. Since these plantation crops can be utilized at different stages of development there is therefore an increased need to reveal the constituents at possible usable stages.

Minerals are naturally occurring substances that are solid and inorganic which are represented by a chemical formula, usually abiogenic, and has an ordered atomic structure [22]. Like vitamins, minerals are also necessary to maintain proper body functions. But dates are not only a rich source of energy; they also provide important minerals to our diets. There are 22 minerals that are needed in varying amounts; 250mg and higher are the major minerals (e.g. calcium, potassium, phosphorous, magnesium, sodium, chloride etc), while the trace minerals are 20mg or less (e.g. zinc, iodine, boron, molybdenum, manganese, fluorine, iron, chromium) [23]. Minerals are involved in several metabolic functions that occur within the human body. Several minerals are components of enzymes (protein based molecules that speed up a chemical reaction in a living organism) which act as catalysts for many of the chemical reactions that occur within the body. Minerals also regulate and manage the normal function of human and animal organs, muscles, and tissues [23]. For example, sodium and potassium are crucial for maintaining proper fluid balance, calcium is the primary structural component in bones and teeth, and iron is responsible for transporting oxygen, in the blood, throughout the body. Skin, hair, nails, teeth, bones, and all other tissues require minerals to be able to form. In addition, minerals are also involved in several bodily functions, including controlling several systems within the body and in the production of energy. In the event that an individual is deficient in any one of the major or trace minerals, the human body will digress to a level of structural weakness, internal system dysfunction, and over time, contract some form of debilitating disease [23].

II. Aims And Objectives

This study was aimed at evaluating the mineral compositions of three *Musa* species at three stages of development

Plate 1a: Fruits of Saba Banana {*Musa acuminata x balbisiana* Colla (ABB Group) cv saba}at the Immature Stage.

Plate 1b: Fruits of Saba Banana {*Musa acuminata x balbisiana* (ABB Group) cv saba} at green Mature Stage

Plate 1c: Fruits of Saba Banana {*Musa acuminata x balbisiana* (ABB Group) cv saba} at the Ripe Stage of Development.

Plate 2 a Fruits of Plantain (*Musa paradisiaca* L) at the Immature Stag

Plate 2 b Fruits of Plantain (*Musa paradisiaca* L) at the green Mature Stage

Plate 2 b Fruits of Plantain (*Musa paradisiaca* L) at the Ripe Stage

Plate 3a Fruits of Banana (*Musa sapientum* L) at the Immature Stage of Development

Plate 3b Fruits of Banana (*Musa sapientum* L) at the green Mature Stage

Plate 3c Fruits of Banana (*Musa sapientum* L) at the Ripe Stage of Development

III. Materials And Methods

Sources of Materials

Fresh plantain, banana and saba banana fruits used in this work were supplied through special arrangements with plantation farmers at Nike town in Enugu StateNigeria. The three *Musa* species used were *Musa paradisiaca* L, *Musa sapientum* L *and Musa saba* L. The species were identified and authenticated accordingly by Professor C. U. Okeke, a plant taxonomist of the Department of Botany Nnamdi Azikiwe University, Awka.

The fruits were collected fresh and used immediately in the analyses. The collection of the samples in these analyses was based on the rate of their development as recommended by [23]. Immature, green mature and ripe fruits were collected for the analyses (Plate $1a^{-c}$, 2^{a-c} and 3^{a-c}). Fruits at each these stages of development were aged 30–45 days following fruit set for immature; 70 – 90 days of fruit set for green mature: while the ripe stage were those whose peels were showing 50% or more visible xanthophylls exposures or yellowing.

Sample Preparation

The samples were thoroughly washed under running water and the back removed exposing the pulp which was homogenized using a Kenwood warring blender and kept in the refrigerator until required for analysis.

Mineral Content Determination

The mineral elements compositions were analyzed by atomic absorption spectrophotometer the method of [24]. The samples were digested and stock solution of the elements prepared. Aliquot of the ash solution was aspirated to the instrument for the determination of metals/minerals namely, Ca, Mg, Na, K, Fe, Zn, Mn, Cu, and Co. The concentrations of all the minerals were expressed as mg/100 g dry weight of the sample. Each value was the mean of triplicate determination ± standard error.

Determination of Calcium

Exactly 10ml of the sample filtrate was pipetted into 250ml conical flask and 25ml of 10% potassium hydroxide was added into the same flask and a pinch of calcein indicator was also added. 0.1N EDTA was used to titrate the solution till colour changed from pinkish-green to full pinkish colour.

Determination of Phosphorus

Exactly 5ml of the sample was pipetted into a test tube,1ml of ascorbic acid solution and 1ml of 2.5% ammonium molybdate reagent was added to the sample and mixed well. The well mixed sample was boiled in a water bath for about 5minute for the blue colour to develop. The absorbance was read at 620nm.

Determination of Magnesium

Exactly 10ml of the sample filtrate was pipetted into 250ml conical flask after which 25ml of ammonia buffer solution was added into the conical flask and was properly mixed. Then a pinch of Erichrome black T indicator was added and titrated with 0.02N of EDTA until the colour of the solution changed from wine-red to blue colour.

Determination of Iron

Exactly 5ml of the sample was pipette into a test tube and 1ml of 2.5% hydroquinol and 1.5ml of acetate buffer was added to the sample, after which 1ml of 0.1% pyridine was also added and shaked properly to mix. The volume of solution was made up with dilute water and was properly mixed. The colour was allowed a maximum of 24hoursfor it to develop and the absorbance was read at 530nm using spectrophotometer.

Determination of Zinc

Exactly 10ml of the sample filtrate was pipetted into a 250ml conical flask and 2ml of 12% hydroxylamine hydrochloride was added and 10ml of ammonia buffer was also added into the conical flask. Then a pinch of Erichrome black T indicator was added into the solution and titrated with EDTA till colour changed from wine-red to blue.

IV. Results

Results of Mineral Compositions of Three *Musa* Species at Three Stages of Development

Results of the mineral composition of three *Musa* species at three stages of development showed that the iron content was higher in plantain than as in banana and Saba banana. Cobalt was not detected in all stages of the three samples. Also, sodium was the most available mineral with very high quantity, followed by magnesium and iron (Table 1).

Table 1: Mineral Compositions of Three *Musa* Species at Three Stages of Development

Mineral	**Plant Type**	**Mineral Compositions mg/100g**		
		Immature	**Green Mature**	**Ripe**
Fe	Banana	0.60± 0.025	2.18 ±0.010	0.10 ±0.029
	Plantain	2.55 ± 0.012	2.51 ± 0.006	1.33 ± 0.006
	Saba banana	1.59 ± 0.015	0.63 ± 0.040	3.38 ± 0.023
Zn	Banana	0.01 ± 0.029	0.01 ± 0.023	0.01 ± 0.000
	Plantain	ND	ND	0.01 ± 0.000
	Saba banana	0.01 ± 0.000	ND	ND
Co	Banana	ND	ND	ND
	Plantain	ND	ND	ND
	Saba banana	ND	ND	ND
Na	Banana	43.50 ±0.764	50.00 ± 2.000	62.5 ± 0.764.
	Plantain	102.5 ± 2.000	112.00 ± 1.000	100.50 ± 3.041
	Saba banana	122.50 ±1.041	130.00 ± 1.528	132.50 ± 1.893
Ca	Banana	1.90 ± 0.100	1.43 ± 0.006	1.43 ± 0.010
	Plantain	1.38 ± 0.020	0.97 ± 0.068	1.09 ± 0.118
	Saba banana	1.53 ± 0.010	1.07 ± 0.130	1.41 ± 0.010
K	Banana	0.03 ± 0.006	0.01 ± 0.003	0.03 ± 0.010
	Plantain	0.07 ± 0.006	0.04 ± 0.006	0.03 ± 0.003
	Saba banana	0.05 ± 0.000	0.05 ± 0.006	0.01 ± 0.006
Mg	Banana	63.00 ± 1.000	113.00 ±0.577	142.00 ±1.000
	Plantain	151 .00± 1.528	145.00 ± 2.887	153.00 ± 1.528
	Saba banana	137.00 ± 1.155	141.00 ± 1.528	142.00 ± 1.000
Cu	Banana	0.26 ± 0.044	0.26 ± 0.010	0.28 ± 0.020
	Plantain	0.29 ± 0.010	0.2 ± 0.050	0.18 ± 0.020
	Saba banana	0.34 ± 0.032	0.49 ± 0.030	0.47 ± 0.017
Mn	Banana	0.05 ±0.006	0.09 ± 0.006	0.04 ± 0.005
	Plantain	0.09± 0.015	0.07 ±0.006	0.08 ± 0.010
	Saba banana	0.07 ±0.015	0.08 ± 0.012	0.10 ±0.026

Results are in Means ± Standard Error.

V. Discussion

The mineral composition of the *Musa* species at different stages of development revealed that Cobalt is not present in the three *Musa* species at any level of development. Cobalt is a mineral essential for the inhibition of ethylene production [25]. A significant difference in the sodium, Magnesium, Copper and Calcium contents of the three *Musa* species were also revealed. The Sodium content was higher in plantain than in banana. Amongst the three *Musa* species, Saba banana had the highest quantity of sodium content. The potassium content was seen to have dropped as ripening/development progresses. Magnesium is higher in plantain than in Saba banana and banana respectively. Copper was seen to be higher in Saba banana than in banana and plantain. Calcium was higher in banana than in plantain and Saba banana. Calcium is an important mineral in preventing body from bone demineralization and osteoporosis. The Iron content revealed no significant difference between the three species. Iron is essential for haemoglobin formation, normal function of the central nervous system and the oxidation of carbohydrates, protein and fats [26]. Decrease in mineral element composition is a crucial physical event of softening of banana fruits [23 and 27]. The variation in mineral contents at the growth stages is mainly attributed to preferential absorbance and this might be due to cultivar and/or soil, climate, agricultural practice and the quality of water for irrigation [28]. Most of the minerals are very crucial in many enzymes activities, protecting cells from free radicals attack, regulation of glucose homeostasis [29].

Zinc is an important component of carotenoids [22, 30, 31 and 32]; it forms a non enzymatic covalent bonding with chlorophyll thus its conversion to carotenoids. This explains why the level of zinc increases with ripening. Zinc content of the samples revealed no significant difference amongst the three *Musa* species but differs as the species ripens or develops. This shows that *Musa* species is a good species of fruit with a good mineral composition and should be recommended for our daily intake.

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