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Assessment of Heavy Metals Concentration and Nutritional Composition of African Fan Palm (*Borassus aethiopum*) from Hong, Adamawa State, Nigeria

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Abstract

African fan palm (*Borassus aethiopum*) shoots is widely consumed as snack in Nigeria and other West African countries. The shoot of *B. aethiopum* was analyzed for its nutritional composition and determination of some heavy metals concentration, using Atomic Absorption Spectrophotometry (ASS). The results of the proximate analysis and nutritional composition showed 56.33%w/w and 53.22%w/w of moisture content, 11.56%DW and 9.20%DW of crude fibre, 6.90%DW and 4.25%DW of crude protein, 1.72%DW and 1.43%DW of fats, 77.32%DW and 70.00%DW of carbohydrate in Fada rake and Hyema respectively. The result of the mean concentration of some heavy metals in the seedling shoots of the *B. aethiopum*, indicates that Cr (0.034.94mg/g and 0.025 mg/g), Mn (0.830mg/g and 1.001 mg/g), Pb (0.036mg/g and 0.028 mg/g) Zn (6.770mg/g and 6.520 mg/g) and Cu (0.020mg/g and 0.021 mg/g) in Fada rake and Hyema respectively. The shoot of *B. aethiopum* is a good source of carbohydrate, protein, and fibre. The mean concentrations of all the studied heavy metals are within the permissible limit for consumption. From the outcome of this study, the following recommendation could be made. The heavy metal concentrations in the study *B. aethiopum* were within the permissible limit; therefore, it is safe for consumption.

Keywords: African fan palm (*B. aethiopum*), Nutrient composition, Heavy metals, Determination, Hong

Introduction

The plant *Borassus aethiopum* is an Arecaceae and is also known in Africa as the mother of trees or as Savannah's guard (Ali *et al*. 2010). The plant is dioecious and can reach up to twenty meters high on average and one meter in diameter. The young germinating shoot (hypocotyl) known as "Muruchi" or Gazari, is usually harvested after seven to eight weeks of planting. *B. aethiopum* have other common names such as Ron palm, Borassus palm, African fan palm, Palmyra palm and Deleb palm (Orwa *et al*. 2009). In Nigeria, the Hausa call it Giginya, Kilba call it kusha·a, In Igala land it is called "Odo" and the Igbo call it Ubiri.

The shoot "Muruchi" is an important source of food for the rural people in Northern Nigeria (Ahmed *et al*. 2010). Consumed either raw or boiled and reported to enhances libido in women and aphrodisiac in men. The shoots are a potential source of starch which is an important raw material in the industry (Akinnnyi and Waziri 2012).

The African fan palm is an attractive palm and every part of the tree can serve as the socio-cultural and economic needs of humankind (Siaw *et al.* 2014). The leaves are useful in making baskets and mats, whereas the trunk is useful in the construction of bridges telegraphic poles due to the toughness and termite resistant nature of the wood (Sarkodie *et al*., 2015). According to Sambou et al. (2012), upon ripening, the mesocarp is fleshy and can be consumed by grilling, boiling, or mixing with sugar or honey. The roots are used in traditional medicine to cure various ailments including asthma. The seed shoot of germinating *B. aethiopum* is one of the local foods that don't seem to fit into the exotic life of the modern populace. More than 88% of the palm is used for the welfare of the people, serving as food (Michel *et al*. 2013).

B. aethiopum not only provide raw materials for industries but also serve as indispensable constituents of the human diet, supplying the body with minerals, vitamins, and certain hormone precursors; in addition to protein and energy germinated shoot of *B. aethiopum* is widely consumed as a snack in Nigeria and other West African countries (Waziri *et al*. 2011, Michel et al., 2013). Currently, consumption is more popular among the elderly than the younger generation. Waziri *et al*. (2011) analyzed the evaporated ash of the fruit which is commonly used in the Northern part of Nigeria as a condiment. They elucidated the nutritional value of the dried fruit in supplying Sodium (Na) and Potassium (K) as food supplements and its consumption as condiments in general.

Borassus aethiopum seedling shoot is been cultivated, sold, and consumed in high quantity in Hong Local Government Area of Adamawa State, Nigeria. There are some findings on *B. aethiopum* seedling shoot on nutritional composition; however, there is nothing about concentration levels of heavy metals in *B. aethiopum* conducted in Hong Local Government Area of Adamawa State, Nigeria. That may have adverse health effects from consumption of the *B. aethiopum* seedling shoots. Interest in the ecosystem levels of heavy metals is a global one because of the potential hazards of these metals to the health of animals, humans, and plants when they exist at elevated levels. Heavy metals are dangerous because they bioaccumulate (Chang *et al.* 2014). Heavy metals, such as cadmium, chromium, lead and others have been classified as carcinogenic to humans and wildlife by the International Agency for Research on Cancer (IARC) (Beyersmann and Hagger *et al*. 2006). As such it is imperative to have a clear identification of the heavy metals and their concentration levels in *B. aethiopum* seedling shoots; hence this research will be a step in that direction. This study was carried out mainly to evaluate the nutrient composition and to determine some heavy metals concentration levels in *B. aethiopum* seedling shoot in Hong Local Government Area of Adamawa State, Nigeria.

Materials and Methods

A total of forty (40) raw young shoot samples of *B. aethiopum* were collected from Fadama Rake and Hyema Hong Local Government Area, Adamawa State, Nigeria. The samples were taken to Animal Production and Soil Science Laboratory Adamawa State, University Mubi. The samples were decalyxed, washed with distilled water, peeled and pieces manually using a kitchen knife into small pieces milled to obtain moisture content, then dried using hot air oven, the dried sample was pulverized into powder using pestle and motor. The samples were digested at six hundred degrees centigrade (600°C) for twenty-four hours (24hrs) and cooled at room temperature (AOAC 2010).

Determination of Heavy Metals

The samples were digested with a tri-acid mixture (HNO_3: HCO_4: H_2SO_4) in the ratio of 10:4:1, respectively at a rate of 5ml per 5.0g of sample. The samples were placed on a hot plate at 200ºC temperature and digested until the liquor became clear. All the digested liquor was filtered through Whatman 541 filter paper and diluted with 25mls of distilled water (AOAC 2010). The determination of the heavy metals was done directly on each final solution using a Buck Scientific 200A Model, Atomic Absorption Spectrophotometer (AAS). The heavy metals (Mn, Cr, Pb, Cu, and Zn) concentrations were quantified from the calibration curve of the standard. Values obtained were expressed in milligrams per gram (mg/g) (AOAC, 2000; AOAC, 2010; APHA, 2017).

Determination of Moisture

To the empty weighed moisture container (W0), about 2 grams of the samples were added and weigh again (W1). The samples are oven-dried at a temperature ranges from 105-110°C for 24 hours. The desiccator was allowed to cool and the can with the dry sample was weighed (W2). Finally, the dried sample was returned to the oven for another 24 hours to completely remove residual moisture contents (AOAC, 2010).

Determination of Ash

The empty crucible (W0) and the crucible containing 2g of the samples (W1) were weighed. The samples were allowed to ash in a muffle furnace at 500-600°C for 3 hours. Then the sample was allowed to cool in the desiccator and weighed the dry sample plus the crucible (W2) following the method of AOAC (2010).

Determination of Crude Fats

A 250ml of empty extraction flask was dried in a hot air oven at 105-110°C and allowed to cold in a desiccator and weighed. Two grams of the ground samples was put into the labeled porous thimble and then covered with clean white cotton wool. About 200ml of petroleum ether was added to the dried 250ml extraction flask and placed the covered porous thimble to the condenser for 5-6 hours. The porous thimble was removed carefully and collects petroleum ether in the top container for use and then the extraction flask was removed from the water bath free from petroleum ether. Finally, the extraction flask was oven-dried containing oil and fats at 105-110°C for an hour as in AOAC (2010).

Determination of Carbohydrate

The nitrogen-free extractive (NFE) referred to as soluble carbohydrate is not determined directly but obtained as a difference between crude protein and the sum of ash, protein, fat, and crude fibre as in AOAC (2010).

Crude Fibre

Two grams of ground sample was weighed into a liter conical flask. About 200ml of boiling 1.25% H_2SO_4 was added and boiled gently for 30 minutes using a cooling finger to maintain a constant volume. Then filtered through muslin cloth stretched over 9cm Buchner funnel and rinsed well with distilled water and was scraped back into the flask with a spatula. 200ml of boiling 1.25% NaOH was also added and allowed to boil for 30 minutes using a cooling finger to maintain a constant volume. Then filtered through Whatman 541 filter paper and the residues were washed thoroughly with hot distilled water, rinsed once with 10% HCL and twice with methylated spirit/ acetone and finally rinsed three times with petroleum ether (BP 40-60°C). The samples were allowed to drain and dry, scraped back into the crucible and oven-dried at 105°C. The desiccator was allowed to cold and weighed (W1), where it undergoes ashing at 550°C for 90 minutes in a muffle furnace. Further cold in a desiccator and weighed again (W2) (AOAC, 2010).

Statistical Analysis

Data obtained was analyzed by the student T. test to compare the differences between the concentration level of heavy metals in *B. aethiopum* seedling shoot obtained in Hyema and Fadama rake. Using a statistical software package (SPSS for Windows 21.0). The results were presented as mean±standard error and $P > 0.05$ was regarded as not statistically different

Results

The result obtained in this study shows that Crude protein in Fadama Rake is 6.90% and Hyema 4.25%; and Fats 1.72% in Fadama Rake while 1.43% in Hyema. The value of Crude fibre in Fadama Rake is 09.20% and in Hyema is 11.56%. The result of Ash is 1.14% in Fadama rake while 1.17% is recorded in Hyema and the result of Moisture content is 56.33% and 53.22% obtained in Fadama Rake and Hyema respectively. Carbohydrate was observed to be 77.32% and 70.00% in Fadama Rake and Hyema respectively. And statistically, there is a significant difference at 95% degree of freedom between the shoot of *Borassus aethiopum* obtained from Fadama Rake and Hyema.

Table 1: Proximate analysis of *B. aethiopum* seedling Shoots mg/g dry weight

Parameters	Fadama Rake (%)	Hyema (%)
Crude protein	06.90	04.25
Fats	01.72	01.43
Crude fibre	09.20	11.56
Ash	01.14	01.17
Moisture	56.33	53.22
Carbohydrate	77.32	70.00

All the heavy metals studied were detected at different levels in the two locations. The level of Manganese was 0.830mg/g and 1.001mg/g in Fadama Rake and Hyema respectively. Zinc was 6.770mg/g in Fadama Rake and 6.520mg/g in Hyema while Chromium was 0.034mg/g in Fadama Rake and 0.025mg/g in Hyema. Lead was recorded 0.036mg/g in Fadama Rake and 0.028mg/g in Hyema; whereas the level of Copper was observed to be 0.020mg/g in Fadama Rake and 0.021mg/g in Hyema respectively.

Table 2: Mean Concentration of Heavy Metals in *B. aethiopum* seedling shoot mg/g

Element composition	Fadama Rake mg/g	Hyema mg/g
Manganese	0.830	1.001
Zinc	6.770	6.520
Chromium	0.034	0.025
Lead	0.036	0.028
Cupper	0.020	0.021

$p > 0.05$

Discussion

Nutritional Composition

The results of the proximate analysis are presented in Table 1. In the table, the moisture content (56.33%W/W) obtained from Fadama Rake was relatively higher than the value obtained from Hyema (53.22%D/W), which could be due to the climatic conditions in which the plants were grown. Higher moisture content is associated with a rise in microbial activities during storage; therefore, B. aethiopum shoots should be properly dried before storing Chandra and Samsher, (2013).

The ash content of the shoot of *B. aethiopum* was (1.17%) dry weight (DW) obtained in Fadama Rake which is higher than (1.14%), the result obtained from Hyema. However, the results of the present studies are lower than the result reported by some authors Umar *et al*. (2015), who reported 1.18%, in samples from Kware Local Government Area, Sokoto State, Nigeria. And similarly lower than the 1.49%DW reported by Ali *et al.* 2010 in samples from Yobe State Nigeria. Siaw *et al.* 2014; and Adzinyo *et al*. 2015 in their respective studies shows the plant *B. aethiopum* containing important nutritionally contents.

The result of Crude fibre in *B. aethiopum* shoot in Fadama Rake was observed to be 11.20%DW, which is higher than (9.56%D/W), the value from Hyema. Similarly observed to be higher than the value (3.96%DW) reported by Akinniyi and Waziri, (2011) in samples from Argungu Local Government, Kebbi State Nigeria. The higher fibre obtained support bowel regularity, helps maintain normal cholesterol levels and blood sugar levels, reduces constipation, and also prevention of heart diseases. Crude fibre plays an important role in facilitating effective digestion in the human body by stimulating the digestion of riboflavin and niacin efficiently. Fibre directly clears up indigestion and constipation Siaw *et al*. (2014)

The result of this study indicates that the shoot of *B. aethiopum* in Fadama Rake contains 1.72% of fats which are relatively higher than the value obtained in the shoot from Hyema (1.43%). These differences may be due to the geographical locations where the plants were collected. These results were ultimately lower than the result (2.5%) reported by Bello and Bolade 2006, in Umaru Musa Yar'adua University Katsina, Nigeria. These results indicate that *B. aethiopum* can be an important source of Low fats content, which makes *B. aethiopum* shoots a good source for weight control Ali *et al.* (2010).

The analyzed *B. aethiopum* shoots contain a high amount of crude protein content (6.90%DW) in Fadama Rake which is higher than the result obtained in Hyema (4.90%DW). This is in line with the result of Akinnnyi and Waziri (2011), who reported (6.9%) in Argungu Local Government, Kebbi State Nigeria. Moreover, the result obtained in Fadama rake is relatively higher than (4.3%DW) the value reported by Umar (2016) in Kware Local Government Area, Sokoto State, Nigeria; and the value (6.40%) reported by (Ali *et al*. 2010) in samples obtained from Ghana. According to Watt and Merrill (2013), plant foods that provide more than 12% of its calorific value from protein are considered a good source of protein and this indicates that the shoots of *B. aethiopum* are a potential source of protein. Protein in the diet contributes to the growth and repair of worn-out tissues (Akinnnyi and Waziri 2011).

The main function of carbohydrates is for energy supply. *B. aethiopum* shoots in Fadama Rake had 77.32% DW carbohydrates which are relatively higher than the value obtained from Hyema 70.00%DW, however, these two results were lower than (83.00%), which was the highest composition of carbohydrate reported by (Akinnnyi and Waziri 2011), which shows that carbohydrate is the major macronutrient in the shoots of *B. aethiopum*. The energy value is within the range of recommended daily intake of 300kcal of energy per 65kg bodyweight adult human Umar *et al*. (2015). The shoots therefore if consumed in good quantity could be a good source of energy.

Heavy Metals Concentrations:

The result presented in Table 2, shows the shoots of *B. aethiopum* contain an appreciable quantity of heavy metals (Mn, Zn, Cr, Cu and Pb) in both Fadama Rake and Hyema. This results of the present study show that the concentration of Manganese (1.001mg) obtained in Hyema is higher than the value obtained from the shoot of *B. aethiopum* in Fadama Rake (0.830mg), which may be as the result of their soil type or plants species. The result of this study is lower than the value of 12.85mg as reported by Umar *et al*. (2015) in Usman Danfodiyo University, Sokoto State, Nigeria.

The concentration of Zinc in *B. aethiopum* obtained in Hyema (6.520mg/g), is relatively higher than the value obtained in Fadama Rake (6.770mg/g), based on these two parameters, the concentration of Zinc seems to be more abundant in Fadama Rake than Hyema, which may be as a result of environmental location where the plants grow. However, these two results were lower than the value (12.74mg/g) reported by Hassan *et al.* (2011).

Comparing the two values obtained from Fadama Rake and Hyema, Chromium concentration tends to be higher in Fadama Rake (0.034mg/g) than in Hyema (0.025mg/g). However, despite the high concentration of Chromium obtained in Fadama Rake, these results were ultimately lower than the value (02.45mg/g) reported by Akinniyi and Waziri (2011). These high concentrations can either be due to their soil type or even the species of plants.

Copper recorded (0.020mg/g) in *B. aethiopum* shoot obtained in Fadama Rake which is higher than the concentration of Copper obtained in Hyema (0.021mg/g), the value obtained in Fadama Rake is higher than the value (0.09mg/g) reported by Gemah (2011), and Hyema respectively. Chromium in trace amounts is known to play an important role in the metabolism and physiological activities in the human body.

This present research shows that the concentration of Lead obtained in Fadama Rake (0.036mg/g) is higher than the concentration obtained in the shoot of *B. aethiopum* in Hyema (0.028mg/g), these two values are lower than the value (01.11mg/g) reported by Hassan *et al*. (2011). These changes in concentration may be associated with the species of *B. aethiopum* as well as their environmental soil where *B. aethiopum* was grown. The results indicate that the shoot of *B. aethiopum* if properly utilized could help as a supplement in the proper development of bones and teeth, maintenance of acid-base balance in the body, and normal functioning of the nervous system. However, the high lead content (0.7mg/g DW), in the shoots of *B. aethiopum* indicates its possible effect on damaging the nervous system, kidney, and brain disorder by (Soetan *et al*. 2010).

In conclusion, the study on the proximate analysis and determination of heavy metals concentration in *B. aethiopum* seedling shoots revealed that *B. aethiopum* shoots are potentially a good source of carbohydrate, protein, and fibre. The mean concentrations of all the heavy metals studied were within the permissible limit as stated by WHO/FAO (2002). Based on this analytical research carried on *B. aethiopum* the researchers, therefore, recommend that *B. aethiopum* is good for consumption since it is a source of carbohydrate, protein, fibre and low fats. The heavy metals detected in *B. aethiopum* are Lead, Copper, Chromium, Manganese, and Zinc. However the mean concentration levels of these heavy metals were within the permissible limit, therefore it is safe for consumption.

References

Adzinyo, O.A., Kpodo. F.M; Asimah, V.K. and Asante-Dornyinah, D (2015). Sensory and physio-chemical characteristics of naturally flavoured. *Borassus eathiopum* syrups. *Food science and quality Management*, 45, 109-113’

Ali, A., Tchiegang, C., Alhadji, D., Saidou, C. and Adji, M.B. (2010). Drying the African palm tree (*Borassus aethiopum* mart). Fruits in view of production Edible flour. *Journal of Food Technology*, 8 (5): 211-216.

Akinniyi J A, Waziri M (2011). Proximate value and mineral content of the shoot of *Borassus* *aethiopum* mart (Giginya). *Journal of chemical Society of Nigeria* 10 (4): 100-103.

AOAC. (2000). Association of Official Analytical Chemists. *Official methods of analytical Chemists.* 18th ed. Washington D.C

AOAC. (2010). Association of Official Analytical Chemists. *Official methods of analytical Chemists.* Washington D.C

APHA, (2017). *Standard methods for the examination of water and waste-water* 21st Edition, Washington, D, C

Bello, S. B. and Bolade, M.K. (2006). Selected Physiochemical Properties of flour from root of *Borassus aethiopum*. *Journal of Food analysis* **9**(4), 701-716

Beyersmann, D. and Hartwig, A. (2008). Carcinogenic metal compounds: Recent insight into molecular and cellular mechanisms. *Archives of Toxicology*, **82**(8): 493–512.

Chang, Z. Na, S., Guang-Ming, Z., Min, J., Jia-Chao, Z., Xin-Jiang, H. An-Wei, C. and Jia-Mei, Z. (2014). Bioaccumulation of zinc, lead, copper, and cadmium from contaminated sediments by native plant species and Acrida cinerea in South China. *Journal of Environmental and Monitory Assessment,***186**:1735–1745.

Gemah, D. (2012). Nutritional and Antinutritional composition of the African palmyrah palm *Borassus aethiopum* seedling. *Nigerian Journal Nutritional Science,* **33**(2), pp 67-78

Hagger, J.A., Jones, M.B., Leonard, D.L.P., Owen, R. and Galloway, T.S. (2006). Biomarkers and Integrated Environmental Risk Assessment: Are There More Questions Than Answers. *Integrated Environmental Assessment and Management Journal,* **2**(4): 312–329.

Hassan, K.J., Umar, S.M. Dangoggo and A.S Maigandi (2011). "Antinutrients composition and Bioavailability prediction as Examplified by calcium, iron and zinc Pakistan. *Journal of Nutrition,* **10**(1), pp. 23-28,

Michel, N.A, Justin, S.S., Baernard, S. T., Ezoua, p., Chatigre, O.K N'zi Agbo, G. and Djaman, J.A. (2013). Physiochemical characterization, Enzymatic and Rheology of the flour of young shoot of palmyrah (*Borassus eathiopum mart*). *Asian Journal of Science and Technology* 4(10):036-047.

Orwa, C., Mutua, A., Kindt, R, Anthony, S. (2009). Agroforestry Database; a tree reference and Selection guide version 40. *International Journal of Agricultural and Veterinary Sciences* **4**(1): 18-23,

Sambou, B., Lawesson, J.E., Barford, A. S. (2002). *Borassus eathiopum,* a threatened multipurpose palm in Senegal. Principes, **36**(3):148-155.

Sarkodie, J.A., Squire, S.A., Kretchy, I.A., Bekoe, E.O., Domozoro,C.Y.F., Ahiagbe, K.M.J., Adjei, E., D. A., Amponsah, Nyako, A.K. (2015). *Borassus eathiopum* a potential medical sources of Antioxidant, Anti inflamatory and antimicrobial Agent. *Medpub Journal* (1):1-7.

Siaw, D.E., Asamoah, E.F. and Baidoe , G.A. Abe-Inge. (2014). The stock and socio-economic uses of *Borassus eathiopum* in Abrimasu forest reserve of Mompong forest district Journal of Energy and Natural Resources Management **21**(5):

Soetan, K.O., Olaiya, C.O. and Oyewole, O.E. (2010).The importance of mineral element for humans and demostic animals and plants: A review, *African Journal of Food Science,* **4**(3):200-222.

Umar, K.J., Abdullahi, B.M, Mohammed, S., Hassan, L.G and Sani, N.A. (2015). Nutrition and Antinutriention al profile of *Borassus eathiopum* mart (African palmyra palm) shoot. *International Journal of sciences: Basic and applied Research,* **24**(3), 39-49.

Watt B.K, and A.L. Merril. "*Composition of foods. Agricultural Handbook No. 8*." Washington D C; U.S Department of Agriculture, 2051-2054.

Waziri, M., Akinniyi, J.A and Chidi, M. A. (2011). Elemental composition of Dalang. A food con -diment from evaporated extract of *Borassus eathiopum* fruits ash. *American Journal of food and nutrition* **1**(3): 13-125.

World Health Organisation (WHO)."Evaluation of certain food additives. Technical report series 913" Geneva, WHO, pp.20 32, (2002). Publication Services Unit, 219 Huntington Road, Cambridge CB3 ODL, United Kingdom.