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Nutritional and Antinutritional Profile of *Borassus aethiopum* Mart (African Palmyra Palm) Shoots

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Abstract

Borassus aethiopum (African palmyrah palm) shoots was analysed for its nutritional and antinutritional compositions. The proximate composition showed 56.33%w/w moisture, 11.2%DW crude fibre, 6.9%DW crude protein and 81%DW available carbohydrate. Mineral content (per 100g dried sample) indicates the presence Mg (640mg), Ca (433.3mg), K (236.7mg), Mn (12.85mg), Zn (12.74) and Fe (11.5mg/100gDW) as the most abundant. The level of toxic Pb and Cd in the shoot is of great concern considering their health effect. Amino acids analyses showed that the shoot is not a good protein source when compared to WHO/FAO/UNU reference standard for school children. Nevertheless, the shoot contains an appreciable amount of essential amino acids (lysine, threonine, phenylalanine and tyrosine) above the reference standard for adult. The concentrations of hydrocyanic acid, nitrate, oxalate and phytate were lower than the reference toxic standard level.

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The results indicate that the *B. aethiopum* shoot is a food stuff with appreciable levels of both macro and micro nutrients as well as safe levels of antinutritional factors.

Keywords: Palmyrah Palm; *Borassus aethiopum*; Shoots; Nutritional; Anti–nutritional.

1. Introduction

Food is no doubt the most basic necessity for one to effectively function in his ecosystem. It is a substance that often composed of carbohydrates, lipids, proteins, vitamins and water which are eaten or drunk by animals or humans for nutrition [1]. The constituent in food contains important chemical substances known as nutrients. These are ingested, digested, absorbed and circulated in the blood streams to feed the cells which constitute the body building blocks and consequently, the increase in body resistance to diseases and faster recovery of illnesses is witnessed [2].

Most of the food consumed by humans are sourced from plants and animals, the former has been grouped into; leafy vegetables, seeds, tubers and fruits [3]. There are over 30,000 known edible plants, from which only 300 were domisticated accounting for more than 95% of the required human plant food [4]. The part of plant responsible for bearing of seeds is known as fruit and is considered a healthy food supplement because it composed of an appreciable amount of water, carbohydrates, lipids, proteins, vitamins and minerals such as calcium, magnesium, potassium, sodium, zinc, copper and iron [5].

The plant *B. aethiopum* (Plate 1) has been described as a palm tree with huge fan shaped leaves [6]. In Nigeria, the hausa call it *Giginya*, the yoruba call it *Agbonolodu*, the igbo call it *Ubiri*. The plant is a dioecious plant and can reach up to 20m high on average and 1m in diameter [7].

The shoot of *B. aethiopum* (plate 2) is obtained by burying the matured seeds of the plant in pit and allowed to germinate. The young germinating shoot or hypocotyls known as *Muruchi* or *Gazari*, is usually harvested after 7 to 8 weeks of planting [6]. *Muruchi* is an important source of food for the rural people in Northern Nigeria. The people consume it either raw or boiled and claimed that it enhances libido in women and aphrodiasiac in men [8]. The shoots are potential source of starch in Cote d'Ivoire which is an important raw material in industry [9]. Akinnnyi and Waziri [10] reported high concentration of carbydrate (83.00%) and crude fibre (3.96%) and low fat (1.49%) in the shoot of *B. aethiopum* plant on dry weight basis. Similarly, the shoots contained an appreciable amount of both macro and micro mineral elements.

Despite the nutritional benefits of the plant shoots "Muruchi", antinutritional factors such as phytate, tannins, oxalate, hydrocyanic acid and nitrate which blocked the bioavailability of some mineral elements are also present in the shoot [6].

The present study investigated the proximate, minerals, amino acids and antinutritional composition of the shoots of *B. aethiopum* plant "Muruchi" obtained from Argungu Local Government, Kebbi State, Nigeria, as the literature on its nutritional and antinutritional compositions from this part of the country is very scanty so as to establish its potential as a source of nutrients supplement.

Plate 1: *Borassus aethiopum* tree

Plate 2: *Borassus aethiopum* shoots (Muruchi)

Source of Plate 1 *:http://en.m.wikipedia.org/wiki/Borassus#/media/File:Borassus_flabellifer.jpg*

Source of Plate 2*: www.hort.purdue.edu/newcrop/faminefoods/ff_families/palmae.html*

2. Materials and Methods

2.1. Sample Collection and Treatment

The shoots of B. aethiopum plant were purchased from Kara Market, Sokoto North Local Government Area, Sokoto State, Nigeria. The seedlings were dehulled, washed with distilled water, chopped in pieces and milled then air dried. The dried sample was pulverized into powder using pistle and motar and sieved. The powdered sample was the stored in a clean polythene bag untill when required for analysis except for moisture content determination in which fresh sample was used.

2.2. Proximate Analysis

Standards methods of AOAC [11] were used for the proximate analysis. The moisture content was determine by weighing two grammes (2g) of fresh seed kernel in a crucible and dried in an oven (Gallenkamp, UK) at 105^oC for 24 hrs. The dried sample was then cooled in a desiccator for 30 minutes and weighed. The ash content was determined by the incineration of 2g dried sample in a muffle furnace at 55^oC for 2hrs. Crude lipid (CL) was Soxhlet extracted from 2g dried sample with n-hexane for 8hrs.The nitrogen (N) content was estimated by micro-Kjeldahl method and crude protein (CP) content calculated as N% x 6.25. Crude fibre (CF) content was determined by treating 2g dried sample with 1.25% (w/v) H_2SO_4 and 1.25% (w/v) NaOH. The available carbohydrate (CHO) was calculated by difference. Calorific value (CV) was determined using the following equation: *CV (kcal/100g) = (CHO x 4) + (CL x 9) + (CP x 4)*

2.3. Mineral Analysis

Mineral analysis was carried out after sample digestion of 2g of the dried sample with $24cm^3$ mixture of nitric acid/perchloric/sulphuric acids in the ratio 9:2:1 respectively. Ca, Mg, Fe, Co, Mn, Cr, Ni, Cu and Zn were determined by atomic absorption spectrophotometry, Na and K by atomic emission spectrometry [11] and P by the molybdenum blue colorimetric method [12].

2.4. Amino acids Analysis

Amino acids composition of the seed kernel was determined using the method reported by Usman [13]. Duplicate samples were hydrolyzed by transferring 50mg of the sample into a 15ml ampoule, adding 5ml of 6M HCl, sealing the vial under vacuum, flushed with nitrogen, and digesting at 110^{o}C for 24hrs. The sulphur-containing amino acids were determined using perfomic acid. Amino acids analyses were performed by high performance liquid chromatography (Shimadzu, G-C-14A, Kyoto, Japan).

2.5. Antinutritional Analysis

The method of Ola and Oboh [14] was adopted for determination of phytate. Hydrocyanic acid was determined by the AOAC [11] method. Oxalate and nitrate were determined by the methods of Krishna and Ranjhan [15]. For tannins the method of van-Burden and Robinson [16] was employed.

2.6. Statistical Analysis

Data generated in triplicates were expressed as mean ± standard deviation using SPSS version 10 statistical packages.Please make sure that you use as much as possible normal fonts in your documents. Special fonts, such as fonts used in the Far East (Japanese, Chinese, Korean, etc.) may cause problems during processing. To avoid unnecessary errors you are strongly advised to use the ‘spellchecker’ function of MS Word.

3. Results and Discussions

3.1. Proximate composition:

The result of proximate composition is presented in Table 1. The moisture content (56.33%W/W) was higher than the value reported in *B. aethiopum* shoots (5.40%W/W) [10] which could be due to genetic variation as well as the climatic conditions in which the plants were grown. Higher moisture content is associated with a rise in microbial activities during storage [17], therefore, the *B. aethiopum* shoots should be properly dried before storing.

The ash content of the shoot was 1.17% dry weight (DW), which is an indication that it contains nutritionally important mineral elements. The value obtained is comparable to the value 1.18%DW reported in the shoots of *B. aethiopum* obtained from Yobe State [10].

The *B. aethiopum* shoots contain low level of crude lipid (0.01%DW) which is lower than 1.49%DW [10] also lower than 0.16%DW reported in the pulp of *B. aethiopum* fruit obtained from Kousseri Area, Cameroon [6]. Low lipid content make the *B. aethiopum* shoots good source for weight control.

The shoots contain 11.20%DW crude fibre which is higher than 3.96%DW reported in the shoots of *B. aethiopum* obtained from Yobe State, Nigeria [10]. The value obtained is also higher compared to the

5.72%DW reported in the pulp of *B. aethiopum* fruits obtained from Kousseri Area, Cameroon [6]. The higher fibre obtained support bowel regularity, help maintain normal cholesterol levels and blood sugar levels, reduce constipation and also prevention of heart diseases [18].

The analyzed *B. aethiopum* shoots contain low amount of crude protein (6.90%DW) which is higher than 4.90%DW in the shoots of *B. aethiopum* [10]. According to Watt and Merrill [19], plant foods that provide more than 12% of its calorific value from protein are considered good source of protein and this indicates that the shoots under investigation is a potential source of protein.

The main function of carbohydrate is for energy supply. *B. aethiopum* shoots had 81% DW carbohydrates which is relatively lower than 83%DW [10], which shows that carbohydrate is the major macro nutrient in the shoots of *B. aethiopum*. The calorific value of the *B. aethiopum* shoots is 350kcal/100g which is lower than 365.71kcal/100g reported in the shoot from Yobe State [10]. The energy value is within the range of recommended daily intake of 300kcal of energy per 65kg body weight adult human [7]. The shoots therefore if consumed in good quantity could be a good source of energy.

Table 1: Proximate Composition of *Borassus aethiopum* Shoots (g/100g dry weight)

Parameters	Composition
Moisture (W/W)	56.33 ± 0.58
Ash	1.17 ± 0.29
Crude lipid	0.01 ± 0.00
Crude fibre	11.20 ± 0.58
Crude protein	6.90 ± 0.14
Available Carbohydrate	81.00 ± 0.23
Calorific value (kcal/100g)	351.69 ± 0.34

Data are mean ± standard deviation of triplicate result W/W = Wet weight

3.2. Mineral Composition:

The result is presented in Table 2. The shoots of *B. aethiopum* contain an appreciable quantity of both macro and micro elements. Among the macro elements magnesium is the most abundant followed by calcium, potassium and then phosphorus which recorded 640mg, 433.30mg, 236.7mg and 27.45mg/100g DW respectively. Similarly, micro elements manganese, zinc, chromium and iron recorded 12.85mg, 12.74mg, 12.45mg and 11.51mg/100g DW respectively. The results indicate that the shoot if properly utilize could help as supplement in proper development of bones and teeth, maintenance of acid-base balance in the body and normal functioning of nervous system. However, the high lead content (11.11mg/100g DW) In the shoots of *B. aethiopum* indicates its possible effect on damaging nervous system, kidney and brain disorder [20].

Table 2: Mineral Composition of *B. aethiopum* Shoots (mg/100g dry weight)

Element	Concentration
Na	5.08 ± 0.14
K	236.70 ± 15.28
Mg	640 ± 34.60
Ca	433.30 ± 57.70
P	27.45 ± 0.14
Fe	11.51 ± 0.40
Mn	12.85 ± 1.00
Zn	12.74 ± 1.50
Cu	0.09 ± 0.04
Cr	12.45 ± 0.72
Ni	ND
Pb	11.11 ± 0.28
Cd	0.66 ± 0.01

Data are mean ± standard deviation of triplicate result ND = Not detected

3.3. Amino acids Profile:

Twenty amino acids are commonly found as component of proteins [21]. From the result obtained seventeen aminoacids were detected as presented in Table 3. The result indicated that non-essential amino acids (alanine, arginine, aspartic acid, glutamic acid, glycine, histidine, proline and serine) are high in concentration (80%) compared to the essential amino acids (isoleusine, leusine, lysine, methionine, cystine, phenylalanine, tyrosine, threonine and vaine) which constitutes 20% of the total amino acids analyzed. Among the essential amino acids lysine, tyrosine,threonine, valine and leusine are the predominance acids, while aspartic acid and arginine were the major non-essential amino acids in the *B. aethiopum* shoots under investigation.

To evaluate the nutritional quality of *B. aethiopum* Shoots, the percentage of the essential amino acids in the shoots were compared with those of reference standard amino acid profile established for both adults and preschool children [22] and the result is presented in Table 4. All the essential amino acids are below the standard requirement for preschool children and therefore limited, while for adults requirement, lysine, threonine and sulphur containing amino acids (methionine and cystine) are above the reference standard value which indicates that the shoots of *B. aethiopum* if properly utilized could supply the teaming population with the required dietary protein for adults.

3.4. Antinutritional Composition

The result of antinutritional composition of *B. aethiopum* Shoots is presented in Table 5. From the result, phytate is the most abundant antinutritional factor in the shoots (6.34mg/100g DW) and is lower than 14.42mg/100g DW reported in the seedling of *B. aethiopum* [23]. Phytate is a strong chelating agent that binds dietary essential minerals such as zinc, calcium and iron to form complexes thereby decreasing the bioavailability of these minerals [24]. The oxalate contents is relatively lower than 2.3mg/100g DW in the seedling of *B. Aethiopum* [23]. Presence of oxalate in food causes irritation in the mouth and interfere with absorption of divalent minerals particularly calcium by forming insoluble salt with them [17]. Consumption of oxalate may results in kidney disease [25]. Tannins content in the shoots is relatively low (0.002mg/100g DW), Tannins in the biological system have the ability to chelate protein making it impossible or difficult to digest [26]. Hydrocyanic acid content (0.2mg/100g DW) is lower compared to 0.35mg/100g DW recorded in *B. aethiopum* seedling [23]. Consumption of high quantities of HCN can result to death or chronic neurological disorder, the value obtained is quite safe for consumption given that the lethal dose for the adult human is 50 – 60mg per 60kg body weight [27]. The nitrate content of the shoots (0.045mg/100g DW) is lower than the acceptable daily intake level of 3 – 7mg/kg body weight equivalent of 220mg for 60kg person [28].

Table 3: Amino acid Profile of *Borassus aethiopum* Shoots (g/100g protein)

Amino acid	Concentration
Lysine*	2.67 ± 0.67
Histidine	1.18 ± 0.12
Arginine	7.40 ± 1.13
Aspartic acid	30.52 ± 0.61
Threonine*	1.56 ± 0.76
Serine	4.33 ± 1.31
Glutamic acid	3.13 ± 0.96
Proline	1.39 ± 0.11
Glycine	0.79 ± 0.15
Alanine	2.12 ± 0.97
Cystine*	0.41 ± 0.14
Valine*	1.37 ± 0.57
Methionine*	0.38 ± 0.11
Isoleucine*	0.69 ± 0.35
Leucine*	1.26 ± 0.42
Tyrosine*	1.32 ± 0.85
Phenylalanine*	0.70 ± 0.11

Data are mean ± standard deviation of dublicate result * Essential Aminoacids

To predict the bioavailability of some divalent elements specifically calcium, magnesium, zinc and iron, antinutrient to nutrients molar ratio were calculated and the results presented in Table 6. From the results, it was observed that, [oxalate] / [Ca], [oxalate] / [Ca + Mg] ratio are below the critical level known to impair calcium bioavailability [29]. Similarly, the [phytate] / [Ca] is low compared to the critical value known to cause calcium deficiency by the phytate. The [phytate] / [Zinc] is lower than the critical value known to impair zinc bioavailability. Mitchikpe *et al*. [30] reported that, for iron bioavailability, [phytate] / [Fe] should not exceed 0.4; the result obtained is lower than the critical value which indicates the bioavailability of iron.

Table 4: Results for Amino acids score of *Borassus aethiopum* Shoots

Essential Amino acids	Amino acids Content (g/100g protein)	WHO Ideal value		(% Amino acids/Ideal) x 100	
		A	**B**	Children	Adult
Isoleucine	0.69	2.8	1.3	25	53
Leucine	1.26	6.6	1.9	19	66
Lysine	2.67	5.8	1.6	46	167
Threonine	1.56	3.4	0.9	46	173
Valine	1.37	3.5	1.3	39	105
Cystine + Methionine	0.79	2.5	1.7	32	59
Phenylalanine + Tyrosine	2.02	6.3	1.9	32	106

Table 5: Antinutritional Composition of *Borassus aethiopum* Shoots (mg/100g dry weight)

Antinutritional factor	Concentration
Phytate	6.34 ± 2.44
Oxalate	0.002 ± 0.00
Tannins	0.002 ± 0.001
Nitrate	0.045 ± 0.00
Hydrocyanic acid	0.21 ± 0.006

Data are mean ± standard deviation of dublicate result

Table 6: Antinutrient to Nutrients Molar Ratio

Antinutrient to Nutrients	Molar Ratio	Critical level
[Oxalate]/[Ca]	2.0×10^{-6}	2.5
[Oxalate]/[Ca + Mg]	5.80×10^{-7}	2.5
[Phytate]/[Ca]	8.70×10^{-4}	0.2
[Phytate]/[Fe]	4.57×10^{-2}	0.4
[Phytate]/[Zn]	4.89×10^{-2}	10

4. Conclusion

The analytical results have revealed that *Borassus aethiopum* Shoots is potentially a good source of carbohydrate, protein and some essential mineral elements especially calcium, potassium, magnesium, iron, manganese and zinc which are found in high concentration. The antinutrient to nutrients molar ratio indicates that *B. aethiopum* Shoots are relatively safe for consumption.

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