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Nutritional and Phytochemical Screening of Raw and Boiled Hypocotyls of African Fan Palm (*Borassus aethiopum*)

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ABSTRACT

The proximate analysis, phytochemical screening and mineral properties of palmyra palm (*Borassus aethiopum*) were evaluated on the dried powder of the raw and boiled hypocotyl. The results obtained showed that the moisture, ash, fat/lipid content, crude fibre, protein and carbohydrates of the hypocotyl had values at (7.17, 3.00, 3.35, 2.63, 11.25, 72.60 and 9.33, 2.67, 2.80, 4.03, 10.00 and 72.57) %. The Phytochemical analysis performed were Alkaloids (76.00 and 43.47) %, cyanogenic derivative (78.84% and 48.60%), tannins (19.97 and 19.96)%, and Phytate (1.19 and 0.07). The mineral composition; potassium, calcium, zinc and iron was determined using Atomic Absorption Spectrometry with values 633.70 and 452.27 mg/100 g, 148.65 and 120.78 mg/100g, 1.36 and 2.13 mg/100 g, 2.05 and 3.24 mg/100 g respectively. Furthermore, the result of the t-test analysis carried out showed that there is a significant difference between the raw and boiled sample of Palmyra palm. The quantitative phytochemical analysis of the *Borassus aethiopum* hypocotyls revealed a good percentage of phytochemicals such as alkaloids, Saponin, flavonoids, steroids, cyanogenic derivatives, tannins and phytate and hence can be used in pharmaceutical and medical science to produce drugs and supplements that can prevent diseases.

INTRODUCTION

The significance of plants cannot be overemphasized in our day-to-day lives as they are the major source of oxygen needed by humans and other animals for breath and existence, they serve as a means of livelihood to many house hoods, provide raw materials for many industrial products such as pulp which is used to produce paper and other raw materials. Other organic extracts such as dyes, pesticides and drugs are gotten from plants (Benjamin et al, 2022).

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 (Benjamin et al, 2022). 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 (Anhwange et al, 2020). Most of the food consumed by humans are sourced from plants and animals, the former has been grouped into; leafy vegetables, seeds, tubers and fruit (Karou et al, 2006). There are over 30,000 known edible plants, from which only 300 were domesticated accounting for more than 95% of the required human plant food (Kamanzy et al, 2002). 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 (Edeoga et al, 2005). The

food which humans depend on wholly for survival is derived from primary metabolites.

These foods when eaten raw may however contain secondary metabolites such as tannins, terpenes, alkaloids, flavonoids just to mention but a few which may be deleterious to health. African fan palm shoots are beneficial to man as they contain carbohydrates for energy, proteins for buildup of body tissues, vitamin A which improves night vision, vitamin B1[thiamine] which converts sugars and starches into energy, vitamin B2[riboflavin] which enables utilization of fats, proteins and sugars, vitamin B6 which aid the metabolism of protein, carbohydrates and fats and as well controls the body cholesterol level, vitamin E which protects the body store of vitamin A, tissues and fats from destructive oxidation, they also contain folate and pantothenic acids. Minerals found in African Fan palm shoots include calcium, magnesium, phosphorus, potassium, sodium, zinc, copper, manganese, selenium and iron. However, the amount of carbohydrate present in these shoots do not amount to more than 3-4 grams per 100grams serving which if exceeded would have led to a high calorie content detrimental to health. Apart from primitively consuming the shoots as food, they help boost the immune system, they are anti-cancer fighting, have anti-inflammatory properties, they are heart friendly and help in developing a healthy weight loss and contain a negligible amount of fat. Shoots also contain a significant amount of dietary fiber (Amos, S et al, 2001 & Adamu, B. et al, 2012)

LITERATURE REVIEW

Palmyra palm (*Borassus aethiopum*) is a non timber forest product (NTFP). It belongs to the family Arecaceae. It is

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a multipurpose species native to the semiarid zones and sub humid tropical regions of Africa, in the South of Asia, Islands of the Pacific and the Indian Ocean. Palmyra-palm (*Borassus aethiopum*) is a tropical plant with multiple uses and the hypocotyl is appreciated by the population in food and in traditional medicine. In addition all parts of this plant such as the stem, roots, fruits, leaves, hypocotyl, petioles, seeds and sap are a source of richness for rural populations (Dewole, et al, 2013). Ethno botanical survey revealed the aphrodisiac properties of *Borassus aethiopum* as well as anti-oxidant, analgesic and anti-inflammatory properties of this plant which contribute immensely to the treatment of various ailments (Dewole, et al, 2013).

Borassus aethiopum is an evergreen tree growing to 20 m (65 ft) by 5 m (16 ft) at a slow rate. It is hardy to zone. The flowers are pollinated by insects. The plant is not self-fertile and it is noted for attracting wildlife. It is also suitable for: light (sandy), medium (loamy) and heavy (clay) soils, it prefers well-drained soil and can grow in nutritionally poor soil. It requires a suitable pH of acid, neutral and basic soils growing in very acidic and alkaline soils. *Borassus aethiopum* does not grow in shade hence it prefers moist soil and can tolerate drought.

Boiled hypocotyl of *Borassus aethiopum* (Palmyra palm) are widely used in most areas in Benue state; this is carried around by vendors who use it as a source of income in their daily lives. As a result of its high rate of consumption mostly by the old and little by the young in the Benue valley, due to its medicinal value and health implications it is of utmost importance scientifically to investigate and identify the bioactive constituents present in this plant (Kolawole, S.E. & Obueh, H.O. (2013)). The *Borassus aethiopum* plant in the Benue communities is recognized and kept within the ecosystem for not only its social importance but also for its economic value. The *Borassus aethiopum* plant is commonly known as the African Fan Palm, Palmyra palm, Toddy palm in English, Akuu (kuugh) in Tiv, Odoo in Idoma, Muruchi in Hausa and kolabula by the Benin people. The different part of this plant such as the roots, petioles, sap, fruits, seeds, final buds, shoots, wood and the resin are important sources of income for the rural communities especially for the women (Gbesso F et al, 2013). Numerous ways of the fruit consumption are known. The fruit can be directly boiled for eating or germinated before cooking. However, the hypocotyls obtained after fruit germination is the best-selling derivative product consumed in various cities in Benue state and Nigeria as a whole, and also in many countries like Benin, Senegal, and Burkina Faso etc. In Benin the hypocotyl is mostly appreciated by the rural and urban populations especially by the department of Zou-colliness and still remains the centre of production and distribution (Kolawole, Gbesso F et al, 2013 & Waziri et al, 2010).

Research has revealed that about 90% of the households in Central Benin consume the products of *Borassus aethiopum* with the hypocotyl inclusive. The high level of

consumption explains the interest of the hypocotyl in the diet of the local population. Besides its use in the diet, the hypocotyl is also renowned for its medicinal properties. An ethno botanic investigation revealed the aphrodisiac properties of the hypocotyls which is use in the treatment of erectile dysfunction in men (Waziri et al, 2010). Hypocotyls are most often consumed boiled or sometimes smoked. The hypocotyls are mostly vended in streets of Benue state, Benin and also certain streets in various states in Nigeria.

Ornamentally, the leaves of the palm have served the basketry and mat industries. The trunk has been used in constructing bridges, and telegraphic poles due to its tough and termite resistant nature. The roots, leaves, flowers and fruits are used for multiple purposes such as nutrition agents, treatment for sexually transmitted diseases (e.g., beign herpes), cutaneous fungal infections, and viral infections particularly measles (Waziri et al, 2010, Gbesso et al, 2016). The flowers are used to treat impetigo, whereas the roots are used for asthma treatment. The sap of *Borassus aethiopum* is usually boiled immediately after extraction to make sugar or fermented to produce an alcoholic beverage. Also, the mature hard nuts are grounded and used in porridge. Other studies have revealed that the young shoot of the germinating fruit of *Borassus aethiopum* extract contain an anabolic effect of androgens; therefore, supporting its local use as an aphrodisiac. Furthermore, the methanolic seed coat of *Borassus aethiopum* has been shown to possess free radical scavenging action and its leaves have an effective anthelmintic activity against Indian adult earth worms. The young shoots of this plant are rich in starch and fibre, which aids in the control of various ailments especially diabetes. It is believed that the regular consumption of the flour of this plant increase body strength, reduce hunger and the incorporation of it in other foods would positively reduce malnutrition. However, due to the presence of bitter compounds (steroid and Saponin) has limited its consumption rate. Owing to the presence of bitterness and inadequate supplies of starch and fibre, research to the food properties and the possible use of starch and fibre from economic, under-utilized fibre rich food plants based has become of expected attention (Sakande. J et al, 2012).

MATERIALS AND METHODS

Study Area

The research was conducted in Makurdi, town the Benue State capital. The town is located at latitude 7° 38'N - 7° 50'N and longitude 8° 24'E - 8° 38'N. It is situated in the Benue valley in the North Central Nigeria

Sample Collection and Identification

Fresh samples of raw and boiled Palmyra palm hypocotyls were obtained from Ugba market in Logo Local Government Area of Benue state and were taken to Department of Biology Science of the Benue State University Makurdi for Identification and authentication.

Sample Preparation

Dirt's and other extraneous materials were removed from the hypocotyls with a stainless steel knife. The hypocotyls were washed, chopped into pieces and dried under shade and thereafter reduced to powdered form using mortar and pestle and blended with an electronic blender.

Sample Digestion

5 g of the hypocotyl powder was weighed into a 250 mL beaker. The sample was then digested with 200 ml of distilled water with 1 mL of HNO₃ and 2 mL of HCl added. This was then heated to boil after which it was filtered. The digested sample was then stored in a 100 mL volumetric flask prior to analysis with AAS.

Determination of Mineral Contents

Potassium, Calcium, Magnesium, Zinc, Iron, Copper and Manganese were analyzed after digestion with HNO₃ and HCl. This was done by transferring the digested samples into a 60 ml sample bottle after which the Atomic Absorption Spectrophotometer (model PG 990) with appropriate hollow cathode lamps was used for the elemental analysis.

Determination of Proximate Composition

Moisture Content

Empty clean crucible dishes were dried in the oven at a temperature of 105°C for 30 minutes and cooled for 10 minutes in a desiccator. 2 g of the samples (raw and boiled hypocotyl) were weighed and put in the dishes and heated for 3 hours at a temperature of 105°C (Sakande. J et al, 2012). The dishes were then removed from the oven, cooled in a desiccator and weighed. The moisture content was calculated using the formula below:

$$\text{Moisture (\%)} = \frac{\text{weight loss}}{\text{sample weight}} \times 100 \dots\dots\dots 3.0$$

Ash Content

The ash content was estimated by complete incineration. 5 g of both raw and boiled hypocotyl samples were weighed in to a pre-heated and cooled crucible and was incinerated in a muffle furnace at 600°C for 3 hours (Sakande. J et al, 2012). The ash was then cooled in a desiccator and weighed. The ash content was determined using;

$$\text{Ash (\%)} = \frac{w_3 - w_1}{w_2 - w_1} \times 100 \dots\dots\dots 3.1$$

Crude Fibre

Exactly 5 g of the powdered sample were weighed and placed in 500mL conical flask containing 200 cm³ of 1.25% H₂SO₄ which was boiled gently for 30 minutes. The content was filtered and the residue was scrapped back into the flask with a spatula. 200 cm³ of 1.25% NaOH was added and allowed to boil gently for 30 minutes. The content was then filtered and washed thoroughly with hot distilled water. The precipitate was rinsed once with 10% HCl and twice with ethanol. The content was then allowed to dry and the residue scraped

into a weighed crucible and dried overnight at 105°C in hot oven. It was then cooled in a desiccator. The sample was heated again at 500°C for 2 hours in a furnace. It was finally cooled in a desiccator and weighed (Sakande. J et al, 2012).

The percentage of crude fibre was calculated using the equation below:

$$\text{Crude fibre (\%)} = \frac{\text{weight loss on ignition}}{\text{weight of sample}} \times 100 \dots\dots\dots 3.2$$

Crude Fat

Round bottom flask for each sample was washed and oven dried and their respective weights taken with that of the boiling chips.

The lipid content was then determined according to the Soxhlet method using hexane as a solvent (Ahmed. A, el al, 2010)..10g of flour from each sample was weighed and inserted into a Soxhlet extraction cartridge (thimble). The assembly was then placed in the extractor, where 150 ml of hexane was added. It was then allowed to heat for 3 hrs after which the hexane was collected. The fat extracted was then put in a water bath at 68°C to enable complete escape of hexane. This was then followed with oven drying for 30 minutes and the weight of the round bottom flask with the fats extracted measured. The amount of lipid extracted was obtained from the difference between the weights of the flask with the anti-bumping agents before extraction and the weight after extraction.

The crude fat content was calculated using the equation below;

$$\text{Crude fat (\%)} = \frac{\text{weight of oil extracted}}{\text{weight of sample}} \times 100 \dots\dots\dots 3.3$$

Crude Proteins

About 1 g of the sample was weighed and 7.5 g of Kjeldahl catalyst was weighed into a Kjeldahl digestion flask and 20 mL of Sulphuric acid was added. The content in the flask was then heated in the Kjeldahl digestion flask until a clear blue coloration was formed, which showed that digestion was complete. The flask was then cooled and the content diluted with 250mL of distilled water and 70 mL of 50% NaOH was then added. The content was then distilled using Kjeldahl distilled apparatus. The distillate was then received into a flask containing 50 mL of 4% boric acid solution and Bromocresol Green solution indicators after distillation, 150 mL of the distillate collected was titrated against 0.1 MHCl to the end point (Ahmed. A, el al, 2010). This is calculated with the equation given below;

$$\% N = \frac{(S-B) \times M \times 14.007}{1000 \times \text{weight of sample}} \times 100 \dots\dots\dots 3.4$$

% N = percentage of nitrogen

S = titre value of sample

B = titre value of blank

M = molarity of HCl

crude protein = % N × 6.25

Carbohydrate

The carbohydrate content was determined using the differential method (Ahmed. A, el al, 2010). According to

the principle of this method, the sample consists essentially of water, minerals, proteins, fats, and carbohydrates. The content of carbohydrates is determined by reduction according to the following formula:

$$\text{Carbohydrate (\%)} = 100 - (\text{Protein} + \text{Fat} + \text{Fibre} + \text{Ash} + \text{Moisture}) \dots \dots \dots 3.5$$

Quantification of Phytochemicals

These hypocotyls were pulverized and used for the

preparation of the other extracts, methanol and aqueous were obtained by successive extractions with solvents, according to the polarity level.

Determination of Alkaloids

Exactly 2 g of the was weighed and added into a 250 mL beaker and 100 mL of 10% acetic acid in methanol was added and covered with aluminum foil and allowed to stand for 4 hours. After which the solution was filtered using a Whatman filter paper (No: 125). 12 mL of ammonium hydroxide solution was then added to the filtrate and allowed to cool. The precipitate was dried in the oven at 60°C and reweighed to determine the weight of the alkaloid (Ahmed. A, et al, 2010).

$$\text{Alkaloid(\%)} = \frac{(\text{Weight of filter paper} + \text{alkaloid}) - (\text{weight of filter paper})}{\text{Weight of sample used}} \times 100 \dots 3.6$$

Determination of Steroids

This was determined according to (Akinniyi. J.A et al, 2010) without modification. 2 g of the methanol extract of the samples were macerated with 50 ml of chloroform for 24 hours. It was then filtered and evaporated. The dried masses were then combined to give the chloroform extract.

Determination of Saponin

About 1.40 g of the powdered sample was added into a conical flask and 150 mL of 20% aqueous ethanol added. The samples were heated over a hot water bath for 5 hours with continuous stirring at 50°C. The solution was filtered and the residue re-extracted with 200 mL of 20% ethanol. The combined extract was reduced to 40 mL over water bath at 90°C. The concentrate was transferred into a 250 mL separatory funnel and 20 mL of diethyl ether added and shaken vigorously. The aqueous layer was recovered while the ether layer discarded. The purification process was repeated. Furthermore, 60 mL of n-butanol was added and washed thrice with 10 mL of 5% aqueous sodium chloride. The remaining solution was then heated in a water bath. After evaporation the sample was dried in the oven to a constant weight in a measured crucible. The Saponin content was calculated using standard formulae.

$$\text{Saponins (\%)} = \frac{(\text{Weight of crucible} + \text{saponin}) - (\text{Weight of empty crucible})}{\text{weight of sample used}} \times 100$$

Determination of Tannins

About 2 g of the sample was weighed and added into test tubes. 15 mL of distilled water was added and stirred at 10 minute interval for 1 hour and then filtered. A total

volume of 3 mL of the filtrate, (sample) standard tannic acid solution and distilled water was added into the test tubes, labeled sample standard and blank respectively. 1.0 of Folin-Denis reagent was added to all the test tubes followed by 2.5 mL of saturated sodium bicarbonate solution which was then added and allowed to incubate at room temperature for 120 minutes. The absorbance of the sample and the standard was read against the blank at 490 nm.

The percentage of tannin is calculated thus:

$$\text{Tannin (\%)} = \frac{\text{AT} \times 100 \times \text{Vf}}{\text{AS} \times \text{W} \times \text{Va}} \times \text{C} \dots \dots \dots 3.9$$

Where:

AT = Absorbance of the test sample

AS = Absorbance of the standard solution

C = Concentration of standard solution

W = Weight of the sample used

Vf = Total volume of the extract

Va = Volume of the extract analyzed

Determination of Flavonoids

Exactly 2.5 g of the samples were weighed into a 250 mL beaker and 50 mL of 80 % aqueous methanol was added, covered with a filter paper and allowed to stand for 24 h, at ambient conditions. The supernatant was discarded so that the residue at the bottom remains. 50 mL of ethanol was added to the residue; it was covered with a filter paper and allowed to stand for 24 h, at ambient condition. The mixture was filtered into a conical flask using a Whatman filter paper (No 12, 125 mm). The procedure was repeated two times with the same sample and the filtrate combined. Empty crucibles were weighed and their weight recorded. The filtrates were transferred into the crucible and evaporated to dryness over a water bath. The crucible was cooled in a desiccator to a constant weight. The percentage of flavonoids was estimated as:

$$\% \text{ Flavonoids} = \frac{\text{weight of flavonoids}}{\text{weight of sample}} \times 100 \dots \dots \dots 3.10$$

Determination of Cyanogenic Derivatives

Exactly 1.0 g of the sample was weighed into a 250 mL round bottom flask and 200 mL of distilled water was added and the mixture allowed to stand for 2 h. 1 mL of tannic acid was added into the mixture and distilled into a 250 mL conical flask containing 20 mL of 2.5 % NaOH. 100 mL of the distillate was measured into a 250 mL conical flask and 8 mL of 6 M NH₄OH and 2 mL of 5 % KI was added. The mixture was titrated with 0.02 M AgNO₃ from a micro-burette against a black background to the end-point marked by permanent turbidity. The amount of cyanogenic glycoside was estimated as:

$$\text{Cyanogenic glycoside (mg/100 g)} = \frac{\text{Titre value (mL)} \times 1.08 \times \text{extract volume (mL)}}{\text{aliquot volume (mL)} \times \text{weight of sample (g)}} \times 100 \dots \dots \dots 3.11$$

Where titre value = volume of AgNO₃ used, extract volume = 100 mL, aliquot volume = 110 mL, weight of sample = 1 g and conversion factor = 1.08.

Phytate Determination

The method used was that of (Ahmed. A, el al, 2010, & Akinniyi. J.A et al, 2010) with slight modification. 0.2 g of the samples was weighed into 250 mL conical flask. This was then soaked in 100 mL of 20% HCl for 3 hours, the samples were then filtered and 50 mL of the filtrates was placed in a 250 mL beaker and 100 mL distilled added to the samples. 10 mL of 0.3% ammonium thiocyanate solution was added as indicator and titrated with standard iron (III) chloride solution which contained 0.00195 g iron per 1 mL.

It was then calculated as;

$$\text{phytic acid} = \frac{\text{titre value} \times 0.001 \times 1.19 \times 1}{2} \dots\dots\dots 3.12$$

Statistical Analysis

Data were analyzed using t-test analysis which was carried out on 95% confidence level and the probability of $t = 0.05$ obtained values at 0.509, 0.007 and 2.64 showed that there is a significant difference between the raw and boiled sample of the Palmyra palm hypocotyl.

RESULTS AND DISCUSSION

The results of the mineral, proximate and phytochemical screening of Palmyra palm hypocotyls (*Borassus aethiopicum*) is presented Table 1, 2 and 3 respectively.

Table 1: Mineral composition of raw and boiled hypocotyl of *Borassus aethiopicum*

Mineral	Raw (mg/100 g)	Boiled (mg/100 g)
Potassium	633.70 $\pm$ 0.021	452.27 $\pm$ 0.021
Sodium	43.54 $\pm$ 0.021	40.16 $\pm$ 0.000
Zinc	1.36 $\pm$ 0.007	2.13 $\pm$ 0.028
Magnesium	71.54 $\pm$ 0.021	63.25 $\pm$ 0.007
Manganese	63.31 $\pm$ 0.078	61.49 $\pm$ 0.014
Calcium	148.65 $\pm$ 0.000	120.78 $\pm$ 0.007
Iron	2.05 $\pm$ 0.000	3.24 $\pm$ 0.021

Values are mean duplicate $\pm$ S.D determination.

Table 2: Quantitative Phytochemical contents of raw and boiled hypocotyl of *Borassus aethiopicum*

Parameter	Raw (%)	Boiled (%)
Flavonoid	14.40 $\pm$ 0.000	9.00 $\pm$ 0.848
Alkaloids	76.00 $\pm$ 1.131	43.47 $\pm$ 0.000
Tannins	19.97 $\pm$ 0.000	19.96 $\pm$ 0.000
Saponins	17.85 $\pm$ 3.040	6.00 $\pm$ 0.000
Steroids	6.00 $\pm$ 0.353	5.25 $\pm$ 0.707
Cyanogenic derivatives	78.84 $\pm$ 0.901	48.60 $\pm$ 0.708
Phytates	1.19 $\pm$ 0.077	0.07 $\pm$ 0.021

Values are mean duplicate of $\pm$ S.D determination

Table 3: Proximate composition of raw and boiled hypocotyl of *Borassus aethiopicum*

Component	Raw (%)	Boiled (%)
Moisture	7.17 $\pm$ 0.763	9.33 $\pm$ 2.254
Ash	3.00 $\pm$ 0.800	2.67 $\pm$ 2.193
Crude Fat	3.35 $\pm$ 1.62	2.80 $\pm$ 2.828
Protein	4.03 $\pm$ 0.247	2.63 $\pm$ 0.247
Crude Fibre	11.25 $\pm$ 1.060	10.00 $\pm$ 1.414
Carbohydrate	71.20 $\pm$ 0.000	72.57 $\pm$ 0.000

Values are average duplicate of S.D determination.

DISCUSSION

Mineral Content

Potassium

The values of potassium obtained in this study ranges from 633.70 $\pm$ 0.021 mg/ 100g and 452.27 $\pm$ 0.021 mg/ 100 g this is greater than (Akinniyi. J.A et al, 2010) which show no concentration of potassium at all. The values reported were greater than that of (Sastry. N.Y et al, 2012). at 236.7 mg. it could be seen from table 1 that, all the minerals analyzed potassium have the highest concentration than all the other minerals. Potassium is both a mineral and an electrolyte. It aids the muscle to work including the muscles that control breathing and heart beat. Potassium is mostly gotten from the food we eat and the excess potassium that is not required by the body is removed from the blood by the kidney. Potassium has a daily dietary intake of 3500-4700 mg (Sastry. N.Y et al, 2012).

Sodium

The values of Sodium obtained for the raw and boiled sample of Palmyra palm as shown in table 1 ranges from 43.54 $\pm$ 0.021 and 40.16 $\pm$ 0.00 mg/100 g. This result shows that there is no much variation in the sodium content of the raw hypocotyls from the boiled hypocotyls with a difference of 3.38 mg/ 100 g. This shows a higher yield of the sodium mineral as compared to (Jamkhande et al, 2014) which shows an average value of 1.45 $\pm$ 0.80 mg/ 100 g. These differences could be as a result of the composition of the soil whereby the hypocotyls are produced (Sastry. N.Y et al, 2012 & Jamkhande et al, 2014). The World Health Organization recommended intake of calcium in adults is 1000 mg in male and female, which shows that both the raw and boiled hypocotyls contain lesser amount of the World Health Organization recommended daily standard.

Zinc and Iron

The value for zinc and iron obtained from this study were 1.36 $\pm$ 0.007 mg/ 100 g for raw , 2.13 $\pm$ 0.028 mg/ 100 g for boiled, and 2.05 $\pm$ 0.00 mg/ 100 g , 3.24 $\pm$ 0.021 mg/ 100 g of iron. These values are different to those obtained by [18] at 2.08 mg/100 g for boiled and 0.06 mg/100 g for the raw which shows a significant difference from the result of this study. The values of iron obtained by [19] were 1.41 mg/100 g for boiled and 0.05 mg/100 g. The values of the zinc and iron content obtain from the study is less than that of [20, 21, 22] which were 12.74 mg/100 g for zinc and 11.51 mg/100 g for iron. The daily recommended nutritional intake of zinc for adults is 12 mg/day and 18 mg/day for iron. Cell growth regulations, gene expression, are important roles played by zinc in the body. Iron is use for the formation of melanin and transport of oxygen to the body tissues. This is a vital part of dieting in infants, pregnant women, breast feeding mothers, and it is also use to prevent anemia in the elderly. The significant difference between the zinc and iron content could be due to the mineral composition

of the soil and climatic conditions. This could also be attributed to the anti-nutritional factor such as phytate that can bind to essential dietary minerals such as zinc and iron (Oumarou. Z. Nadège W.N et al, 2019)

Magnesium

The values of magnesium in this study indicate that magnesium has a concentration of 71.54 ± 0.021 mg/100 g for raw hypocotyls and 63.25 ± 0.007 mg/100 g for boiled hypocotyls which shows a good deal of magnesium in the samples. The results obtained from this study are higher than those of and (Sobert S.J. & Struwig, M., 2019) which were 8.42 mg/100 g for boiled and 9.11 mg/100 g for the raw hypocotyls. Magnesium is the second most intracellular cation right after potassium and has a dietary daily intake of between 50-400 mg. The results of this study show that the raw and boiled hypocotyls of Palmyra palm falls within the range of the daily dietary intake of magnesium. Magnesium plays a vital role in the physiological functions of the body such as maintaining normal nerve and muscle function, it also supports a healthy immune system, maintains heart beat and also helps to regulate glucose level in the blood.

Manganese

The values of manganese gotten from this study showed its concentration at 63.31 ± 0.077 mg/100 g and 61.49 ± 0.014 mg/ 100 g for raw and boiled sample. The values obtained in this study are greater than those reported on the previous work on the evaluation of the nutritional and anti-nutritional composition of the African Palmyra Palm by (Onwuka, G. I. al, 2005, & Oduwaye. O. F) at 12.85 mg/ 100 g and 11.89 mg/100 g. Manganese is one of the micro elements analyzed and from the results of the research work carried out it had more concentration than the other micro elements such as iron and zinc analyzed. The dietary intake of manganese is 2.3 mg for men older than 19 years of age, this shows that the amount of manganese in the Palmyra palm hypocotyls is very high and above recommended dietary daily intake.

Calcium

Calcium is one of the essential macro elements it plays an important role in bones building and also blood clotting. About 99% of calcium in our body is in our teeth and bones. Table 1 shows the concentration of calcium for the raw and boiled samples at 148.65 ± 0.00 mg/100 g and 120.78 ± 0.007 mg/100 g this values were higher than those reported by [28,29] which were 14.16 mg/100 g for boiled and 19.32 mg/100 g for raw. This difference could be attributed to the mineral composition of the soil and climatic condition.

Phytochemical Screening

Flavonoids

The ranges of values obtained for this research work are 14.40 ± 1.13 and 9.00 ± 0.85 for raw and boiled samples as shown in table 4.2. This shows that there is more

Flavonoid content in the raw sample than the boiled. The results obtained is higher than that of (Morton J.F. 1992., & Akinpelu. D. A et al, 2008) on the preliminary Phytochemical screening of *Borassus flabellifer* which were 9.80 ± 0.03 and 8.80 ± 0.02 . Comparatively, the study of (Temitope. O. O et al, 2016) on proximate analysis, Phytochemical and mineral composition of boiled *Borassus aethiopum* hypocotyl reported Flavonoid value at 1.42 ± 0.07 . Flavonoids have been reported to exhibit antibacterial, antifungal and antiviral effects. They also perform antioxidant, protective effects and inhibit the initiation, promotion and progression of tumors (Temitope. O. O et al, 2016, Ajai, A.I, 2012)

Alkaloids

Alkaloids are the most efficient therapeutically significant plant substances. Pure isolated alkaloids and their synthetic derivatives are used as basic medicinal agents because of their analgesic, antispasmodic and anti-bacterial properties. The value obtained from this study shows the mean value of the raw and boiled Palmyra palm hypocotyls at 76.00 ± 0.00 and $12.80 \pm 0.00\%$ respectively. These values are above those reported by (Ajai, A.I, et al, 2012) in his study on the Phytochemical constituents and nutrient evaluation of black rhun palm with values of alkaloid ranging from 24.16 ± 0.034 to 22.80 ± 0.769 . Similarly some authors had reported a value of $0.76 \pm 0.01\%$ for alkaloid in their previous study on the minerals and nutritional profile of *Borassus heineanus* which is lower to the value obtained by the present study. These differences in values could be attributed to the difference in chemical composition of the soil and the hypocotyl used (Rignero. R. al, 1997).

Tannins

The range of values for tannins obtained from the present study for raw and boiled samples are 19.97 ± 0.00 and 19.96 ± 0.00 . The values obtained show a minor difference between the raw and boiled sample of the Palmyra palm hypocotyls. The value obtained from this research are lower than those reported from the previous research on the proximate, mineral and anti nutritional composition of *Borassus akeassii* with values ranging from 22.80 ± 0.02 and 22.78 ± 0.02 [35] and also lower than that of [36] which was 279.36 ± 30.79 g/100 g. Another researcher reported tannin value at 31.77 ± 1.67 mg/100 g on his study on the nutritional and antioxidant properties of some African edible plants (AOAC, al, 1990). The presence of tannin in the plant indicates the astringent properties of Palmyra palm hypocotyls and in addition, aid in the healing of wounds and burns (AOAC, al, 1990)

Saponin

The value of Saponin obtained from this study is as shown in table 2 for the raw and boiled hypocotyls. The values show that there is more Saponin value in the raw sample than the boiled sample 17.85 ± 3.040 and 6.00

± 0.000 respectively. Previous studies reported the anti-nutritional values of Saponin at 643.03 ± 33.20 mg/100g and 2.18 ± 0.28 mg/100 g in their work on the nutritional and anti-nutritional composition of the African Palmyra palm. The values obtained in the present study are lower than those reported by but higher that reported by (AOAC (2002) on the physicochemical characterization of date palm. Some authors also reported the Saponin value of *Borassus aethiopum* mart at 0.25 ± 0.01 , these value is also lesser as compared to that obtained from this study. The variation could be partly attributed to the method of analysis used and as well as the climatic condition of the hypocotyls harvested region. The difference could also be attributed to the storage time before the analysis was carried out.

Steroids

Table 2 shows the result of steroids obtained from this study with values at 6.00 ± 0.00 and 5.25 ± 0.35 which is not consistent with those obtained by previous works which are 11.00 ± 0.87 and 9.80 ± 0.65 . These values are similar to those reported by (AOAC al, 2002) with 5.85 ± 0.001 and 5.92 ± 0.003 . The difference in the values could be due to the composition of the hypocotyl and mineral composition of the soil from which there are harvested as well as the climatic conditions.

Cyanogenic Derivatives

Hydrogen cyanide is of high detriment for human consumption. Small amount of it in the human body can cause harm to one's health. Table 2 of this study showed the values of the cyanogenic derivative at 78.84 ± 0.901 % and 48.60 ± 0.708 %. Previous research work on the Phytochemical screening of *Borassus akeassii* reported the cyanide concentration to be 0.35 g. The value varies and is lower with that obtained from the present study. It can be deduced from the study that the cyanide concentration reduces on boiling, this is because during boiling, disruption of tissue and parenchyma occur and this facilitates the release of the free cyanide into the boiling water and also the enzyme, beta glycosidase is destroyed. Also, evaporation of free cyanide is volatile to heat. It is also worthy of note that the disruption of tissue and parenchyma during boiling leads to softening of the shoots which makes it palatable for consumption (AOAC 2002 & Alhooti, J.S. al, 1998).

Phytate

The ranges of values obtained from this research work on phytate are shown in Table 2. The value obtained shows a little significant difference between the two samples. Phytate are responsible for the inhibition of absorption of minerals such as iron, zinc and calcium to the body. Some authors in their work on the Physico chemical properties of *Borassus aethiopum* reported phytate concentration in the hypocotyls at 87.88 ± 19.59 mg/ 100 g. Another study on the Aphrodisiac properties of Hypocotyls Extracts of *Borassus aethiopum* Mart collected in Central of Benin

Republic reported its value at 275.75 ± 53.54 mg/100 g. The result obtained from this study are lesser than those reported by previous works. The present study revealed phytate value to be 27.61 ± 0.59 mg/100 g. This variation may be as a result of the hypocotyl composition and also due to the method of analysis employed.

Proximate Analysis

Moisture Content

The mean value of the moisture content obtained from this study were 7.17% for raw and 9.33% for boiled as presented in Table 3. These values are higher than those obtained by (Camara, F. & Amaro, C.A. 2003 & Fergusin, E.L et al, 1993) which were 0.98% for raw and 2.16% for boiled. These show a significant difference between the samples under study with respect to moisture. From literature it has been reported that high moisture content leads to difficulty in storage and hence spoilage. The significant difference between these two flours could be partly attributed to the drying time of the samples before usage for analysis.

Ash Content

The mean values of ash content for this research work ranges from 3.00% and 2.67% for raw and boiled samples, the results of this study are similar to those obtained by on the Physicochemical properties of Palmyra palm (*Borassus aethiopum*) fruits from Northern Cameroon which were 2.88% for raw and 2.53% for boiled samples. These results are slightly above from those obtained by which are 1.17% and 1.18% respectively. The difference could be attributed to the effects of climate and the composition of the sample.

Fat

The ranges of values obtained for fat in this study are 3.35% and 2.80% for raw and boiled samples. This trend shows a variation in the results obtained by (Ahmed. A, et al, 2010] in his study of the Proximate Analysis, Phytochemical and Mineral Composition of Boiled *Borassus aethiopum* which shows the results at 0.23% for raw and 0.17% for boiled. The result obtained from this study shows that the lipid is higher than those obtained by (Al-Samarai et al, 2016 & Aina D.O, al, 2018) which are 0.01%, 1.49% and 1.11%. This result is lower than that obtained by (Alli. G al, 2017) with 10.73%. The low fat content of *Borassus aethiopum* allows it better storage stability while avoiding rancidity and it is also an ideal food for weight control

Protein

The values of protein obtained from this study are 4.03% and 2.63% as shown in Table 3 for the raw and boiled samples. This shows a high protein content in the raw sample. The protein content obtained from this study was higher than those reported by (Jatau, D.F al, 2008).) 3.06% for the raw and 2.71 for the boiled. The result obtained was similar to (Ojha,V, 2013) with a value

of 4.90%. Studies have shown that boiling denatures proteins. From literature it has been reviewed that plants with a protein content of greater than 12% are considered a good protein source (Sharma, L al, 2004). Hence, the hypocotyls of Palmyra palm shoots studied are a good source of protein if consumed in the right proportions

Crude Fibre

The value of crude fibre obtained from this study ranges from 11.25% for the raw and 10.00% for the boiled. The results obtained from this study work were lower than those obtained by (Sharma, L al, 2004 & Bhatt,P, al, 2005). Previous work on optimization of Phenolics and Dietary Fibre Extraction from Date palm seeds reported higher values at 23.92% and 28.20% respectively (Kumbhare.V al, 1996). The presence of crude fibre in food or plant is an indication of the level of non-digestible carbohydrate and lignin.

Carbohydrate

The carbohydrate values of the raw and boiled sample of *Borassus aethiopum* obtained from this study were 72.57% and 71.20% as reported in Table 3. This results show that hypocotyls of *Borassus aethiopum* are rich in carbohydrate. The results obtained from this study are lower than those of (Kumbhare.V al, 1996 & Giri, S al, 2000) which reported values of 86.75% for raw and 87.19% for boiled. From the Present study it can be drawn that carbohydrates are the major macronutrients of Palmyra palm hypocotyls (shoots). The results obtained are also lower than those obtained in Ivory Coast by (Zhang,J, 2008) which averaged 83.79 ± 1.0 and higher than those reported in Benin by (Wan-You al, 2005) in his work on the Valorization of the Palmyra palm hypocotyl with value at 43.50%. The major function of carbohydrates is to produce energy to the body. Palmyra palm shoots are comparable to most starchy foods such as yam, cassava, with little protein and fat.

CONCLUSION

Borassus aethiopum hypocotyl is a nonconventional food resource with potentially exploitable attributes. The flour of these hypocotyls contains an appreciable amount of physico-chemical properties. This study evaluated the physico-chemical composition of *Borassus aethiopum* and revealed that it is rich in carbohydrates, with low lipid (fat) content, also with an appreciable amount of crude fibre. The hypocotyls also contain certain amount of protein; moisture and low ash content

The hypocotyls also contains appreciable amount of Minerals that are vital for metabolic activities in the body. The mineral composition revealed all the minerals analyzed with appreciable amounts in potassium, calcium, magnesium, manganese, and sodium. The study also reports a low amount of minerals with respect to zinc and iron which is due to the presence of phytate that inhibits its adsorption.

The quantitative phytochemical analysis of the *Borassus*

aethiopum hypocotyls revealed a good percentage of phytochemicals such as alkaloids, Saponin, flavonoids, steroids, cyanogenic derivatives, tannins and phytate and hence can be used in pharmaceutical and medical science to produce drugs and supplements that can prevent diseases.

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