Proximate Analysis, Mineral Content and Phytochemical Constituents of *Hyphaene thebaica* Fruit

[*1]Hussaini, I., [2]Gadaka, Y.M., [3]Ishaku, A.H., [4]Lewami, A.K., [5]Kachalla, M.A., and [6]Garba, A.K

[1]Department of Biology, Ahmadu Bello University Zaria, Kaduna State, Nigeria.
[2&3]Department of Fisheries Technology, Yobe State College of Agriculture, Science and Technology, Gujba P.M.B. 1104 Nigeria.
[4]Department of Statistics, Yobe State College of Agriculture, Science and Technology, Gujba P.M.B. 1104 Nigeria.
[5]Department of Agricultural Technology, Yobe State College of Agriculture, Science and Technology, Gujba P.M.B. 1104 Nigeria.
[6]Department of Veterinary Services, Ministry of Agriculture and Natural resources, Yobe state, Nigeria

[*]Corresponding author: hussainiisa25@gmail.com 08032818354

Abstract

In order to maximize the use of natural resources, this study examined the phytochemical components, mineral content, and proximate composition of pulp from Doum palm *Hyphaene thebaica* fruits. It is necessary to prepare cheaper feed through the use of alternative plant energy sources. Fruits of *Hyphaene thebaica* revealed the presence of an appreciable amount of nutrients such as: %CP (5.25±0.02), %Ash (11.35±0.13), %Fiber 10.15±0.13, %Moisture 4.05±0.01, %Lipid 7.80±0.23 and Nitrogen free extract (71.56±0.46). The Macro minerals determined include; sodium Na (4225±0.34mg), magnesium Mg (22.40±0.22mg), calcium Ca (1494±0.14mg), potassium K (3275±0.21mg), phosphorus P (119.5±0.12mg), while the Micro minerals determined are manganese Mn (16.50±0.08mg), iron Fe (1294.25±0.52mg), zinc Zn (94.75±0.43mg) and copper (u (56±0.04mg) respectively. Phytochemicals constituents: alkaloid, flavonoid, saponin, phenol and tannin (0.116mg/ml, 0.265mg/ml, 0.054mg/ml, 0.340mg/ml and 0.061mg/ml) respectively. Because *Hyphaene thebaica* fruit pulp contains significant amounts of phytoconstituents and key nutrients, it can be employed in a food industry application, including the production of feed.

Keywords: *Hyphaene thebaica, proximate, phytochemical, minerals*

Introduction

Doum palm (*Hyphaene thebaica*) is a desert palm tree native to Egypt, sub-Saharan Africa, and West India. According to Aboshora *et al*. (2014), it is abundant in antioxidants, the B-complex, vital minerals, and a good supply of monosaccharides like fructose and glucose. Although originally from the Nile Valley, this plant thrives in northern Nigeria. It belongs to the Arecaceae family of palms and is dichotomous and arborescent by nature. One of the world's useful plants is *H. thebaica* (Fletcher, 1997; Datti et al., 2020). The food industry uses *H. thebaica* fruit for a variety of purposes, including the production of cakes, sweetmeats, and nutrient-dense beverages (Aboshora et al., 2014). When it's not ripe, it can be eaten, but when it is, it becomes hard. Researchers have discovered flavonoids, polyphenols, saponins, hydroxycinnamates, glycosides, essential oils, and terpenoids among the fruits of *H. thebaica* that are active components. As a result, fruits have strong immune-stimulatory, antioxidant, and antibacterial properties (El-Beltagi et al., 2018). An increase in the growth rate, immune parameters, and antioxidant enzyme activity of common carp, Cyprinus carpio, has been shown to be achieved by dietary Date palm fruit extracts, Phoenix dactylifera, a plant related to *H. thebaica* (Hoseinifar *et al.*, 2017).

Literature Review

Botanical Description of Doum Palm

The doum palm is a dioecious palm and grows up to 17 m (56ft) high. The trunk, which can have a girth of up to 90 cm (35 in), the trunk divided into two branches, each branch divided again into two branches, and the ends of the branches contain tufts of large leaves. The bark is smooth, dark gray and contains the scars of fallen leaves. The petioles are about 1 m long, sheathing the branch at the base and contain curved claws. The leaves are fan-shaped and measure about 120 by 180 cm (47 by 71 in). Male and female flowers are produced on separate trees. The inflorescences are similar in general appearance, up to about 1.2 m (3 ft. 11 in) long, irregular in the branching and have two or three spikes in each branch. Male flowers have a short-stalk, solitary in pits of the spadix, spathe-bracts encircling the spadix, pointed. Branches of female spadices become thicker in the fruiting stage. Woody fruits are produced in the female palm that continues on the tree for a long time. They are 6–10 × 6–8 cm, smooth, rectangular to cubical with rounded edges, shiny brown when ripe. Its fresh weight is about 120 g and dry weight is about 60 g and each one containing a single seed. The size of seeds about 2–3.5 × 3 cm, the color is ivory, truncate at the base and the apex is obtuse (WAC, 2014).

Biological activities of Doumfruit extracts

Antioxidant activity of doum fruit extracts

Doum is one of the commonly consumed traditional beverages in Egypt and is rich in polyphenolic compounds. Several studies have recorded that doum fruit extracts contain high number of flavonoids, phenols and used as antioxidant and antibacterial activities, which can alleviate the adverse effects of oxidative stress and prevent diseases caused by pathogenic bacteria (Aboshora *et al*., 2014). It is well-known that plant phenolic compounds are highly effective free radical scavengers. Phenolic compounds antioxidant activity is associated with the presence of functional groups in the ring and the annular structure of the molecule, conjugated double bonds (Dzialo *et al*., 2016). The antioxidant activity increased with the increase in concentration and the consumption of doum plant which would exert several beneficial effects by the valueof its antioxidant and antimicrobial activities (Mohamed *et al*., 2010).

Traditional uses of Doum Palm

*H. thebaica*tree is one of the most useful plants in the world (Fletcher, 1997). Along the Nile, people usedits fiber and leaflets to spin baskets. The fruits of doum palm are contained antioxidants (Hsu *et al*., 2006). Palms are used for firewood and charcoal. Leaves are probably the most important part ofthe palm, providing the raw material used in basketry, making mats, brooms, coarse textiles, ropes, thatching and string (Moussa *et al*., 1998). Leaves may also be used as fuel. The fibers of roots obtained after soaking in water for 2–3 days, and flogging of the roots

are used for making fishingnets. Due to the high amounts of fibers in wood, it is difficult to cut them using an ax. Wood produced from the male palm is considered better than that of the female. It is often used for building, providing for support and rafters for houses, railway sleepers, planks, water ducts and wheels fence posts and raft construction. Dried bark is used to produce a black dye for leather wear (WACATD, 2009). Roots are used in the treatment of bilharzia, while fruit pulp is helped in the reduction control hypertension (Kamis *et al*., 2003). The hard seed inside the fruit, known as (vegetable ivory) is used to treat sore eyes in livestock using charcoal from the seed kernel as well as making buttons and small carvings, and artificial pearls (Orwa *et al*., 2009). In Turkey and Kenya, the powder made from the outer covering of the fruit is added to water and milk and left to stand to make a mild alcoholic drink; in other countries, the terminal meristem is tapped for making palm wine. The thin dried brown rind is used in the manufacture of sweetmeats, cakes, and molasses. In Egypt, the fruit is sold in herbalist shops and is popular among children. Apart from the use of the fruit as food, juice is extracted from the young fruit and palm wine is prepared from the sap (Fassiola, 1998). Doum palm fruit in its powder form was applied in some food products as a source of fiber, stabilizer and minerals as well as for its potential healthy effect (Abd El-Rashid and Hassan, 2005). Research on the fruit pulp of *H. thebaica*showed that it contains nutritional trace minerals, proteins and fatty acids, in particular the nutritionally essential linoleic acid (Cook *et al*., 2000). Also, aqueous doum palm extracts increased the viability and activity of some certain dairy starter cultures which used in the manufacture of some dairy products especially probiotics (Hassan and Aumara 2005).

Materials and Methods

Sample Collection and Preparation

Mature doum palm fruits were sourced from Yobe State, Nigeria's Geidam Local Government Area. For authentication, the fruits were sent to the Department of Botany at the Faculty of Life Sciences at Amadu Bello University in Zaria. The pulp and kernel of the fruits were separated by crushing them with a mortar and pestle. The pulp sample, or doum palm pulp, was then finely pulverized using a pestle and mortar in accordance with Abdulsalam et al.'s (2018) method. The pulp was then sieved through a 0.2 mm sieve, placed in an airtight container, and kept in a desiccator that contained silica gel in preparation for additional analysis.

Determination of Proximate Composition

The Association of Official Analytical Chemists (AOAC 1998) method was used at the Institute of Agricultural Research (IAR), Ahmadu Bello University in Zaria, Nigeria, to test the proximate composition of doum palm fruit pulp.

Determination of moisture content

Method:

- ✓ Dry the empty dish and lid in the oven at 105^0C for 3hrs and transfer to desiccators to cool. Weight the empty dish and lid.
- ✓ Weight about 3g of the sample to the dish. Spread the sample to the uniformity.
- ✓ Place the dish with the sample in the oven. Dry for 3hrs at 105^0C
- ✓ After drying, transfer the dish with partially covered lid to the desiccators to cool. Reweight the dish and its dried sample.

Calculations

$$Moisture\ content\ (\%) = \frac{W1-W2}{W2} \times 100 \ldots(1)$$

Where:

W1= Weight (g) of sample before drying

W2= Weight (g) of sample after drying

%DM = 100 - %Moisture

Determination of crude protein

Measuring the nitrogen content of the feed and multiplying the result by 6.25 yields the crude protein content. This component is based on the observation that 16% of protein is nitrogen. The Kjeldahl method was used to calculate crude protein. Digestion, distillation, and titration are steps in the process.

Reagents:

For Kjeldahl catalysts, combine one-part copper sulphate and nine parts potassium sulphate (K2SO4). H2SO4 is sulfuric acid. 40% NaOH, 0.2 HCL, and 4% H3BO3 solutions Mix 200ml of 0.2% bromocresol green (in 95% ethanol) with 100ml of 0.1% methyl red (in 95% ethanol) to create the indicator solution.

Method:

- ✓ Place sample (0.5-1g) in digestion flask.
- ✓ Add 5kjeldhal catalysts and 200ml conc. H_2SO_4
- ✓ Prepare a tube containing the above chemical except samples are blank. Place flask in incline position and heat gently unite frothing ceases. Boil briskly until solution clear.
- ✓ Cool and add 60ml of distilled water cautiously.
- ✓ Immediately connect the flask to digestion bulb on condenser and with tip of condensed standard acid and 5-7 drops of mix indicator in receiver. Rotate flask to mix content thoroughly; then heat until all NH3 is distilled.
- ✓ Remove receiver, wash tip of condenser and titrate excess standard acid distill with standard NaOH solution.

Calculation:

$$\%\ Protein = \frac{(A-B)\times N \times 14.007 \times 6.25)}{W} \quad \ldots\ldots (2)$$

Where:

A= Volume (ml) of 0.2 N HCL used sample titration

B= Volume (ml) of 0.2 N HCL used in blank titration

N= Normality of HCL

W= Weight (g) of sample

14.007= Atomic weight of nitrogen

6.25= the protein-nitrogen conversation factor for fish and its by-product.

Determination of fat content

Reagent: Petroleum ether

Method:

- ✓ Place the bottle and lid in the incubator at 105^0C (Overnight to ensure the weight of the sample is stable).
- ✓ Weight about 3-5g of the sample to paper filter and wrap.
- ✓ Take the sample in to extraction thimble transfer into soxhlet.
- ✓ Fill petroleum ether about 250ml in to the bottle and take it on the heating mantle.
- ✓ Connect the soxhlet apparatus and turn on the water to cool them and then switch on the heating mantle.
- ✓ Heat the sample about 14hrs (heat rate 150 drop/minutes).
- ✓ Evaporate the solvent by using the vacuum condenser.
- ✓ Incubate the bottle at 80-90^0C until solvent is completely evaporate and bottle is completely dry.
- ✓ After drying, transfer bottle with partially covered lid to the desiccators to cool. Reweight the bottle its dried content.

Calculation

$$\%\ \text{Fat} = \frac{weight\ of\ fat}{weight\ of\ sample} \times 100 \quad \ldots\ldots (3)$$

Determination of ash content

Method:

- ✓ Place crucible and lid in furnace for about 550^0C (overnight to ensure the impurities on the surface of crucibles are burned off.
- ✓ Cool the crucible in desiccators for about 30minutes

- ✓ Weight the crucible and lid to 3 decimal places.
- ✓ Weight about 5g of the sample in to the crucible. Heat over low Bunsen flame with lid half covered. When fumes are no longer produced, place the crucibles and lid in furnace.
- ✓ Heat at 550^0C overnight. During heating, do not cover the lid. Place the after complete heating to prevent loss of fluffy ash. Cool down the desiccators.
- ✓ Weight the ash with crucible and lid when the sample turns to grey. If not, return the crucible and lid to the furnace for further Ashing.

Calculation:

$$\% \text{ Ash} = \frac{weight\ of\ ash}{weight\ of\ sample} \times 100 \quad \ldots\ldots (4)$$

Determination of crude fiber

This fraction was design to include those materials in the sample which are of low digestibility. Examples: cellulose, certain hemicelluloses and lignin if present.

Procedure:

- ✓ Weight out a small quantity of the prepared fish sample about 5g.
- ✓ Remove moisture from the sample by placing the sample in oven.
- ✓ Extract the sample with petroleum ether to remove the crude fat. (The sample used for crude fat determination may be used for crude fiber.
- ✓ Boil the remainder of the sample in diluted H_2SO_4 (1.25%) for about 30 minutes and filter, then boil in diluted sodium hydroxide (1.25%) for 30 minutes and filter.
- ✓ These fractions remove the protein, sugar or starch and more soluble hemicelluloses and minerals and also possibly some of the lignin if present.
- ✓ Dry the residue and weight. The residues consist of the fiber and the more soluble mineral matter of the sample.
- ✓ Ash the residue to oxidize the crude fiber and weight ash.
- ✓ Calculation the amount of crude fiber in the sample by subtracting the weight of the ashes from the weight of the residue.

Calculation:

$$\% \text{ Fiber} = \frac{weight\ of\ crude\ fiber}{weight\ of\ original\ sample} \times 100 \ldots (6)$$

Nitrogen Free Extract (NFE)

NFE was calculated using the formula below. It is obtained by subtracting the of percentages of all nutrients already determined from 100.

$$\%NFE = 100 - (\%MC + \%ASH + \%CP + \%EE) \ \ldots\ldots\ldots (7)$$

NFE represents soluble carbohydrates and other digestible and easily utilizable non-nitrogenous substances in the sample.

Determination of Iron (Fe), Zinc (Zn), Calcium (Ca), Copper (Cu), Manganese (Mn) and Magnesium (Mg) by Atomic Absorption Spectrometry

Determination of Sodium (Na) and Potassium (K) by flame photometer

Principle: When an element's atoms return to their ground state after being excited by the flame's high temperature, the flame photometer detects the release of radiant energy. The element's concentration in the solution was correlated with the emission degree.

Procedure: The sample's Na and K content were examined using flame photometry. For the determination of Na and K, the same wet digested food sample solutions utilized in AAS were employed. For both Na and K, standard solutions containing 20, 40, 60, 80, and 100 milli equivalent/L will be employed. The process outlined in the AAS is applied for calculating the total mineral intake.

Determination of Phosphorus (P) by spectrophotometry: Phosphorus in the sample

was determined by the method of spectrophotometry as given below:

Principle: The basis for calorimetric determination was the idea that specific substances or components will react with the right reagent to produce color. A colorimeter or spectrophotometer was used to measure the color's intensity. The spectrophotometer reacts with inorganic phosphorus. Phosphomolybdate is created when inorganic phosphorus interacts, and this reaction results in molybdenum blue. The amount of phosphorus in the solution was calculated by measuring its blue color.

Phosphorus analysis: Sample from final blue solution was taken in a cuvett and introduced to spectrophotometer. The readings of the phosphorus were recorded in ppm.

Calculation of phosphorus: The calculations for the total mineral intake involve the same procedure as given in AAS.

Determination of Phytochemical Constituents of *Hyphaene thebaica* pulp

The phytochemical contents were determined in the Department of Pharmacognosy and Drugs Development at Ahmadu Bello University in Zaria, using the methodology outlined by Sofowora (1993).

Results and Discussion

Proximate composition of *H. thebaica* fruits

A portion of protein (5.25±0.02%), fat (7.80±0.23%), ash (11.35±0.13%), crude fiber (10.15±0.13%), moisture content (4.05±0.01%), and NFE (71.56±0.46%) were found in the pulp of Doum palm fruits that were investigated. It was discovered that these outcomes closely matched those published by Hussein *et al.* (2010), Datti *et al.* (2020), and Aboshora *et al.* (2014). Nonetheless, in certain cases, some researchers reported higher parameters. The protein content was 9.26% higher, according to Bonde *et al.* (1990). Comparably, the value of crude fiber (10.15%) is more than the figures published by Abdel-rahman *et al.* (2014) and Nwosu *et al.* (2008), who reported (8.1%) and (7.17%), respectively.

In addition to these and many other health advantages, foods high in dietary fiber also lower the risk of obesity, diabetes, heart disease, hypertension, and hyperlipidemia. Additionally, they lower fat and cholesterol levels, support healthy gastrointestinal function, and protect against several types of cancer (Datti *et al.*, 2020). The moisture content (4.05±0.01%) was very close with that reported by FAO (2006) (4%), Abdel-rahman *et al*., (2014) (5.50%). Differences in this study's proximate compositions such as the moisture, fiber, and protein contents and some reported literatures may result from differences in the species and the time of year the plant was harvested, according to Siddique *et al*. (2003) and Datti *et al*. (2020). It might also be caused by the environmental, climatic, and storage conditions. The size of the seed, its volume to surface area ratio, and the relative attractions of fat, protein, and starch to water in the seed are a few more variables that might also affect the moisture content of the seeds (Datti *et al.*, 2020).

Table 1: The proximate composition of *H. thebaica* fruit (mg/100g)

Proximate content	**Mean values**
% Moisture	4.05±0.01
% Ash	11.35±0.13
% Crude lipid	7.80±0.23
% Crude protein	5.25±0.02
% Crude fiber	10.15±0.13
% NFE	71.56±0.46

Key: mean ± Standard error NFE= Nitrogen free extract

Mineral content of *Hyphaene thebaica* fruit

Iron, manganese, zinc, and copper were found in less proportions than the main minerals potassium, calcium, sodium, phosphorous, and magnesium. Several elements were found to be in agreement with similar findings reported by Datti *et al*. (2020). These elements included potassium (3275±0.21 mg/100 g), calcium (1494±0.14 mg/100 g), sodium (4225±0.34 mg/100 g), magnesium (22.4±0.22 mg/100 g), iron (1294.25±0.52 mg/100 g), manganese (16.50±0.08 mg/100 g), zinc (94.75±0.43 mg/100 g), and copper (56±0.04 mg/100 g).

Nonetheless, the outcome surpasses certain values stated by Bonde *et al*. (1990). The results clearly show that these vital mineral elements are abundant in the fruit of the Doum palm plant, which implies that the fruit can be used as a great source of mineral elements, particularly in times of deficiency when they can be used to maintain ratios and balances Aboshora *et al*., (2014).

Table 2**:** The macro and micro mineral content of *H. thebaica* fruit (mg/100g)

Macro minerals	**Mean value**
Sodium (Na)	4225±0.34
potassium (K)	3275±0.21
Calcium (Ca)	1494±0.14
Phosphorous (P)	119.5±0.12
Magnesium (Mg)	22.4±0.22
Microminerals	
iron (Fe)	1294.25±0.52
Zinc (Zn)	94.75±0.43
Copper (Cu)	56±0.04
Manganese (Mn)	16.50±0.08

Key: mean ± Standard error

Phytochemical Constituents of *Hyphaene thebaica*

Anti-nutritional factors are chemical compounds that are produced in natural food and/or

feedstuffs by a species' normal metabolism. These compounds can act against optimal nutrition through a variety of mechanisms, such as the inactivation of certain nutrients, a reduction in the digestive process, or the metabolic utilization of food or feed. The following bioactive metabolites were found in the fruit pulp of the Doum palm according to the study's phytochemical screening results. Antraquinones (negative) were not found during the screening, but alkaloids (0.12 mg/ml), flavonoids (0.24 mg/ml), saponins (0.01 mg/ml), phenol (0.34 mg/ml), tannins (0.06 mg/ml), carbohydrates (1.89 mg/ml), steroids (0.15 mg/ml), triterpenes (0.17 mg/ml), and C/glycosides (0.18 mg/ml) were. The findings of Umaru *et al*. (2007), who found greater values of oxalate, phytate, saponin, and tannins (13.50%, 1.18%, 8.25%, and 6.39%), did not support the conclusions of this investigation. The variations in cultivar, soil type, climate, and geographic location could all be contributing factors to the relative disparities. Muhammad *et al.* (2011), on the other hand, showed comparable outcomes but with reduced phytochemical components derived from date palm fruit. The findings demonstrate that the antinutritional compounds found in doum palm fruit are safe to eat and within safe bounds. The interactions between different antinutritional factors in a given drug are also a significant element to take into account, as these interactions can sometimes reduce the harmful effect of the interacting antinutrients (Francis *et al*., 2001).

Table: 3: Qualitative and Quantitative Phytochemical Constituents of *H. thebaica* fruit

Phytoconstituents	Inferences	Quantitative (mg/ml)
Alkaloids	+	0.116667
Flavonoids	+	0.265000
Saponins	+	0.054000
Phenols	+	0.340667
Tannins	+	0.061667
Carbohydrates	+	1.898667
Steroids	+	0.151000
Triterpenes	+	0.171000
C/glycosides	+	0.184667
Antraquinones	-	0

Key: (+)= present, (-) Absent

Conclusions

The chemical composition of the fruits of *Hyphaene thebaica* was found to include significant levels of CP (5.25±0.02), Ash (11.35±0.13), and NFE (71.56±0.46). Micro minerals are manganese Mn (16.50±0.08mg), iron Fe (1294.25±0.52mg), zinc Zn (94.75±0.43mg), copper (u) (56±0.04mg), and sodium Na (4225±0.34mg), magnesium Mg (22.40±0.22mg), calcium Ca (1494±0.14mg), potassium K (3275±0.21mg), and phosphorus P (119.5±0.12mg), which are the macro minerals. Alkaloid, flavonoid, saponin, phenol, and tannin (0.116 mg/ml, 0.265 mg/ml, 0.054 mg/ml, 0.340 mg/ml, and 0.061 mg/ml) are the constituents of phytochemicals. they are beneficial for both medical and nutritional purposes.

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