

Mineral Content, Proximate Composition and the Antioxidant Properties of the Ethanol Extract of the Fruit Pulp of Doum Palm (*Hyphaene thebaica* L.)

ABSTRACT

The fruits of the doum palm tree, *Hyphaene thebaica* are one of the oldest relish fruit. This study analyzed the chemical composition (both proximate and the mineral contents) of this plant, as well as its antioxidant property. The mineral content was determined by atomic absorption spectrophotometry, while the proximate and phytochemical analyses were carried out using standard procedures at Bayero University, Kano. The fruit were found to contain some minerals including K (3366.21 mg/100g), Ca (292.04 mg/100g), Na (212.27 mg/100g), Mg (177.14 mg/100g), Fe (4.86 mg/100g), Mn (0.83 mg/100g), Zn (0.68 mg/100g), Cu (0.40 mg/100g), Ni (0.32 mg/100g) and Co (0.12 mg/100g). The proximate composition of the doum palm fruit pulp reveals protein (2.86%), lipid (0.92%), ash content (6.24%), crude fiber (12.87%), moisture content (8.64%) and carbohydrate 68.47%. The DPPH radical scavenging efficacy of the ethanol extract of the fruit of the doum palm tree was analyzed in order of increasing concentration of the extract. At concentration 0.0625 mg/mL, 0.125 mg/mL, 0.250 mg/mL and 0.500 mg/mL the extract showed inhibitory activity of 31%, 61%, 72% and 81% respectively. Thus the doum palm fruit pulp extract possess potential antioxidant properties.

Keywords: *Hyphaene thebaica*, Antioxidant, DPPH, Proximate analysis, Mineral content

1. INTRODUCTION

The therapeutic properties of various medicinal plants have been used for centuries to treat many human diseases. As estimated, between 60-90% of the population of developing countries use traditional herbal medicines considering them to be a normal part of primary healthcare. The demand of herbal medicine has been increasing day by day by consumers as they perceive these forms of healing as safe and effective than the synthetic drugs. This trend of using alternative and complimentary healthcare has prompted scientists to investigate the various biological activities of medicinal plants. [1] These plant-derived products contain a great diversity of phytochemicals such as phenols, flavonoids, tannins and other phytoconstituents that possess numerous health related effects such as antibacterial, antidiabetic and anticarcinogenic properties. One important plant that possesses such properties is the doum palm tree (*Hyphaene thebaica* L.). [2]

Originally native of the Nile valley but grows well in the Northern part of Nigeria, doum palm (*Hyphaene thebaica*) is a desert palm tree with edible oval fruit. It is a member of the palm family, Arecaceae, and it is dichotomous and arborescent in nature. Doum palm is listed as one of the useful plants of the world. [3] Its fiber and leaflets are used by people along the Nile to weave baskets. The doum palm fruit has a brown outer fibrous flesh which is normally chewed and spewed out. Doum palm kernel is edible when it is unripe but hard when it is ripe. Moreover, doum palm is also used for local craft, for construction and the root is also medicinal. The foliage is used to make mats, ropes, baskets, and hats while the stem with the leaves are used for construction purpose. [4] Roots of doum palm are used for treatment of bilharzias while the fruit is often chewed to control hypertension. [5]

The powder of the fruit pulp of doum palm was used in making some alcoholic drinks, as well as in the treatment of bilharzias, bleeding especially after child birth and also as haematinic agent. [6,7] The anti-cancer, antioxidant and antimicrobial activities of the fruit pulp of the doum palm have also been well documented. [8,9,10] The fruit pulp is also used locally to control hypertension when chewed, while the

roots are used in the treatment of bilhaziasis. [11] The fruit pulp of *H. thebaica* has been shown to contain nutritional trace minerals, proteins and fatty acids, in particular the nutritionally essential linoleic acid [11] and many other beneficial nutrients. [12] In a study by Shehu *et al.*, [13] it is reported that the extract of the fruit of *H. thebaica* (L) Mart reduces fasting hyperglycaemia. In this study, we investigated the mineral content, proximate composition and the antioxidant properties of the ethanol extract of the fruit pulp of doum palm (*Hyphaene thebaica*).

2. MATERIAL AND METHODS

2.1 Sample Collection and Preparation

Mature fruits of doum palm were obtained from Gezawa Local Government of Kano State, Nigeria, brought to the department of Biological Sciences, Yusuf Maitama Sule University, Kano, and was identified by a plant taxonomist. The plant was identified and authenticated and issued a voucher specimen number YUHAN 0047.

The fruits were crushed using mortar and pestle to separate the pulp from the kernel. The pulp sample (the doum palm pulp) was then ground into fine particles using pestle and mortar [14] and then packed in an air tight container and stored in a desiccator (containing silica gel) ready for further analysis.

All the chemicals used were of analytical grade.

2.2 Extraction of the Sample

Here fifty grams (50 g) of the powdered sample was soaked in 300 ml of absolute ethanol for forty eight hours (48 hrs) and stored away from direct light. The supernatant was decanted and filtered using filter paper. The filtrate was evaporated to dryness, and stored in sample bottles at room temperature to avoid any biological degradation. [15]

2.3 Determination of Mineral Content

Mineral analysis was carried out using 10 g of the ground doum palm fruit pulp, where the pulp was subjected to dry ashing for 5 hr in well cleaned porcelain crucibles at 550°C. The residue ash was dissolved in 5 ml of HNO₃/HCl (1:2) and heated gently on a hot plate until brown fumes disappeared and white coloration was formed. The solution on each crucible was filtered into 100 ml volumetric flask and the volume made up to 100 ml with deionized water. [16]

The cations (K, Ca, Na, Mg, Fe, Mn, Zn, Cu, Ni and Co) were determined using flame atomic absorption spectrophotometer (model VGP 210, Buck Scientific, USA). [16]

2.4 Determination of Proximate Composition

The proximate compositions of the ground doum palm pulp were determined using standard analytical methods. [17,18,19]

All measurements were done in triplicates and values presented in percentage.

2.4.1 Moisture Content

Two grams of the ground doum palm pulp was oven-dried in a crucible at 105 °C for 5 hrs. The dried sample was then cooled in desiccator for 1 hr and weighed to a constant weight and the percentage loss in weight was expressed as percentage moisture content. [17]

2.4.2 Ash Content

The residue remaining was weighed after the ashing of 2 g ground doum palm pulp in a crucible. The ashing was done in a muffle furnace of temperature 550 °C for 6 hr. The ashed sample was cooled in a desiccator and weighed. The percentage residual weighed was expressed as ash content. [17]

2.4.3 Crude Lipid Content

Continuous extraction of lipid was done for 5 hr with petroleum ether in a soxhlet extractor with 2.00 g of the ground doum palm pulp used to determine the crude lipid content. [20]

2.4.4 Crude Protein Content

Kjeldahl method was used to determine total protein. Here 1 g of the ground doum palm pulp was transferred into a filter paper and put into a Kjeldahl flask, 10 cm³ of concentrated H₂SO₄ were added and digested in a fume cupboard until the solution becomes colorless. The distillation was carried out with 15 mL of 50% of NaOH. The tip of the condenser was dipped into a conical flask containing 6 cm³ of 4% boric acid in a mixed indicator until a green coloration was observed. Titration was done in the receiver flask with 0.01 M HCl until the solution turned red. [21]

2.4.5 Crude Fiber Content

Estimation of the crude fiber was done by acid and alkaline digestion methods 2.00 g of the ground doum palm pulp were used with 20% H₂SO₄ and NaOH solution. [21]

2.4.6 Carbohydrate Content

The carbohydrate content of the test sample was determined by estimation using the arithmetic difference method. [22,23]

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

2.5 Determination of Antioxidant Properties of Doum Palm Fruits Pulp Extract

Evaluation of DPPH radical scavenging method was adopted as reported by Chandra and Goyal [24]. Free radical scavenging activity of the extract was measured by 1,1-diphenyl-2-picryl hydrazyl (DPPH). Here 0.1 mM solution of DPPH in ethanol was prepared and added to 3 ml of the extracts at different concentration of 50, 25, 12.5 and 6.25 mg/mL respectively. The mixture was then shaken vigorously and allowed to stand at room temperature for 30 min. The absorbance was then measured at 517 nm using spectrophotometer. Reference standard compound being used was ascorbic acid and the procedure was done in triplicate. Lower absorbance of the reaction mixture indicated higher free radical activity. The percentage DPPH scavenging effect was calculated by using following equation:

$$\text{Percentage Inhibition (\%)} = \frac{A_0 - A_1}{A_0} \times 100$$

Where:

A₀ was the Absorbance of control reaction

A₁ was the Absorbance in presence of test or standard sample

3. RESULTS AND DISCUSSION

The mineral contents of the doum fruit pulp is presented in Table 1, while the proximate composition of the fruit pulp is presented in Table 2, and the and DPPH radical scavenging activity of the fruit is presented in Table 3.

Table 1: Mineral contents of the Doum Fruit Pulp (mg/100g)

S/No	Mineral	Mean Value (mg/100g)
1	Potassium (K)	3366.21
2	Calcium (Ca)	292.04
3	Sodium (Na)	212.27
4	Magnesium (Mg)	177.14
5	Iron (Fe)	4.86
6	Manganese (Mn)	0.83
7	Zinc (Zn)	0.68
8	Copper (Cu)	0.40
9	Nickel (Ni)	0.32
10	Cobalt (Co)	0.12

Table 2: Proximate Composition of the Doum Palm Fruit Pulp

S/NO	Parameters	Fruits (%)
1	Protein	2.86
2	Lipid	0.92
3	Ash Content	6.24
4	Crude Fiber	12.87
5	Moisture Content	8.64
6	Carbohydrate	68.47

Table 3: DPPH Radical Scavenging Activity in Doum Palm Fruit

S/No	Sample	Conc. (0.0625 mg/mL)	Conc. (0.125 mg/mL)	Conc. (0.250 mg/mL)	Conc. (0.500 mg/mL)
1	Fruit Pulp	31%	61%	72%	81%
2	Ascorbic Acid	57%	73%	82%	91%

The major minerals, potassium, calcium, sodium and magnesium were found in high amounts, while iron, manganese, zinc, copper, nickel and cobalt were found in lower amounts. All these elements, potassium (3366.21 mg/100g), calcium (292.04 mg/100g) and sodium (212.27 mg/100g), magnesium (177.14 mg/100g), iron (4.86 mg/100g), manganese (0.83 mg/100g), zinc (0.68 mg/100g), copper (0.40 mg/100g), nickel (0.32 mg/100g) and cobalt (0.12 mg/100g) were found to be in agreement with similar findings reported by Babiker and Makki [25]; Aboshora *et al.*, [12] and Reda [26]. However, the result is higher than some the values reported by Bonde *et al.*, [27]. It is evident from the results that these essential mineral elements are present in large amount in the fruit of doum palm plant, and this means that the fruit can be used as an excellent source of these elements especially during deficiency condition where they may be used to keep the balances and ratios between those in need. [12]

The results for the proximate composition of the doum palm fruit pulp studied revealed the presence of some amounts of protein (2.86%), lipid (0.92%), ash (6.24%), crude fiber (12.87%), moisture content (8.64%) and carbohydrate (68.47%). These results were found to be very close to that reported by Hussein *et al.*, [28]; Babiker and Makki [25]; Aboshora *et al.*, [12] and Reda [26]. However, some researchers have reported much higher parameters in some instances. For example, Bonde *et al.*, [27] has reported a much higher protein content of 9.26%, while Hussein *et al.*, [28] reported 6.41%. Similarly, the value of the crude fiber (12.87) is found to be higher than that reported by Nwosu *et al.*, [29] who reported 8.1%, Aboshora *et al.*, [12] who reported (6.64%) and Abdel-Rahman *et al.*, [30] who reported (7.17%). Foods rich in dietary fiber have other numerous health benefits including reduction in the risk of coronary heart disease, obesity, diabetes, reduction of hypertension and hyperlipidemia. They also contribute to gastrointestinal health, decrease cholesterol and fat contents, as well as some forms of cancer. [31,32,33] The moisture content reported in this research work (8.64%) is also found to be higher than that reported by FAO [34] (4.00%), Abdel-Rahman *et al.*, [30] (5.47%) and Aboshora *et al.*, [12] (5.50%). The carbohydrate content of this research work was found to be as high as 68.47%, and this result is in agreement with those obtained by Tunland and Meyer [35]; Venn and Mann [36]; Hussein *et al.*, [28]; Babiker and Makki [25]; Aboshora *et al.*, [12]; Reda [26].

Different researchers have reported antioxidant activity in both the leaves and the fruit pulp of the doum palm plant. [37,9,38,10,39,40,41]. In this study, the doum palm fruit pulp extract exhibited a comparable antioxidant activity with that of the standard (ascorbic acid) at varying concentrations analyzed (0.0625, 0.125, 0.250 and 0.500 mg/mL). There was a concentration-dependent increase in the percentage antioxidant activity for all concentrations tested. Ascorbic acid was used as the standard for the DPPH antioxidant activity testing. At varying concentration of the ascorbic acid there was also increasing percentage inhibition ranging from 57% to 91%. While at the same varied concentrations the extract recorded percentage inhibition ranges of 31% to 81%.

4. CONCLUSION

Traditionally many plants have been widely used for the treatment many health problems, ranging from ailments to diseases. *Hyphaene thebaica*, the doum palm tree is a desert tree that is widely used in medicine for the treatment of several disease conditions. It is a well-known plant for its anti-inflammatory, antibacterial, anticancer and antioxidant activities. In this research work, the antioxidant activity of this all-important plant was explored, alongside its minerals and proximate contents. The findings from this study prove beyond any doubt that this plant is a potential source of antioxidants and may be effectively as preventive agent against many health problems, as well as an excellent source of some nutrients and minerals required for healthy living of man and other animals.

REFERENCES

1. Wendakoon, C., Calderon, P., & Gagnon, D. (2011). Evaluation of Selected Medicinal Plants Extracted in Different Ethanol Concentrations for Antibacterial Activity against Human Pathogens. *Journal of Medicinally Active Plants*, 1(2):60-68.
2. Bidlack, WR., Omaye, ST., Meskin, MS. and Topham, DW. (2000): Phytochemicals as Bioactive Agents. Boca Raton: CRC Press.
3. Fletcher R. (1997). Listing of Useful Plants of the World. Australian New Crops <http://www.newcrops.uq.edu.au/listing/hyphaenethebaica>.
4. Moussa H., Hank A., Margolis HA., Dube P and Odongo J. (1998): Factors Affecting the Germination of Doum Palm (*Hyphaene thebaica* Mart.) Seeds from the Semi-Arid Zone of Niger, West Africa. *For. Ecol. Elsevier Science Direct, Int. J. Life. Sci. Scienti. Res.*,104:27-41.
5. Orwa C., Mutua A., Kindt R., Jamnadass R. and Anthony S. (2009): Agro-Forest Tree Data Base: A Tree Reference and Selection version 4.0 (<http://www.worldagroforestry.org/sites/treedbs/treedatabases-asp>).
6. Adaya, Al., Bdliya, H., Bitrus, H., Fanjayi, M., Ealon, D., Gambo, MB., Goggebe, M. Makinta A., Okoli, D., Onoluabi, AD., Polet G., Salisu, M., Sanusi, SS., Sach, MT. and Shuaibu M. (1977). *Hidden Harvest Project Research Series* 3(3):14-27.
7. Von-Maydell, H. (1986). Trees and Shrubs of Sahel: their Characteristics and Uses. Eschborn, Germany, Pp 173–175.
8. Carter P (1971). Spectrophotometric Determination of Serum Iron at the Submicrogram Level with a New Reagent (Ferrozine). *Anal. Biochem.*, 40:450–455.
9. Hsu B, Coupar IM, Ng K. (2006). Antioxidant Activity of Hot Water Extract from the Fruit of the Doum Palm, *Hyphaene thebaica*. *Food Chem., Elsevier Science Direct*. 98:317–328.
10. Faten MA. (2009): Antioxidant and Anticancer Activities of Doum Fruit Extract (*Hyphaene thebaica*) *African Journal of Pure and Applied Chemistry* 3(10):197-201.
11. 11. Kamis AB., Modu S., Zanna H. and Oniyangi TA (2003): Preliminary Biochemical and Haematological effects of Aqueous Suspension of Pulp of *Hyphaene thebaica* L. Mart in Rats. *Biokemistri*. 13:1-7.
12. Aboshora, W., Lianfu, Z., Dahir, M., Gasmalla, MA., Musa, A., Omer, E. and Thapa, M. (2014). Physicochemical, Nutritional and Functional Properties of the Epicarp, Flesh and Pitted Sample of Doum Fruit (*Hyphaene thebaica*). *Journal of Food and Nutrition Research*, 2(4):180-186.
13. Shehu BB., Gidado A., Buratai LB. and Benisheikh AAG. (2015): Sub-Acute Toxicity Studies of Methanol Extract of *Hyphaene thebaica* (L) Mart Fruit Pulp on Normal Wister Albino Rats. *Intl. J of Res (IJR)* 2(6):460-467.
14. Abdulsalam I., Magaji MY. and Bah SU. (2018): Effects of Dietary Levels of Doum Palm Pulp Meal (*Hyphaene thebaica*) Supplementation on the Performance of Broiler Chickens. *Asian Journal of Research in Animal and Veterinary Sciences* 2(2):1-8.
15. Bayero, AS., Datti Y., Shuaibu, MM., Nafisatu, AM., Asma'u, AA., Dikko, MA., Zakari, AH. and Yusuf, M. (2019): Phytochemical Screening and Antibacterial activity of the Root Bark Extracts of *Neocarya macrophylla*. *ChemSearch Journal* 10(2):41-45.
16. Shahid I, Chaudhry AV. and Anjum MA. (1999). Effect of Root Stock on Leaf Mineral Composition and Productivity of Kinnow Mandarin. *Int. J. Agric. Biol.* 1:91-93.
17. Association of Official Analytical Chemists (AOAC) (2003). Official method of analysis. (15th Edition), Washington D.C. *Journal of Medicinal Plants Research* Vol. 4(4), Pp 212.
18. Shumaila G. and Mahpara S. (2009): Proximate Composition and Mineral Analysis of Cinnamon. *Pakistan Journal of Nutrition* 8:1456-1460.
19. Oluduro A.O. (2012). Evaluation of Antimicrobial Properties and Nutritional Potentials of *Moringa oleifera* Lam. Leaf in South Western Nigeria, *Malaysian Journal of Microbiology*, 8(2):59-67.
20. Udo EJ. and Oguwele JA. (1986): Laboratory Manual for the Analysis of Soil, Plants and Water Samples. 3rd Edition, Department of Crop Production, University of Ilorin, Kwara State Nigeria, Pp.131-152.
21. Gabriel AF., Igwemmar NC., Sadam AA. and Babalola SA. (2018) Characterization of Seed Oil from *Citrullus lanatus* (Watermelon) *Direct Res. J. Public Health and Environ. Technol.* 3(2):34-40.

22. De Conto LC., Gragnani MAL., Maus D., Ambiel HCI., Chiu MC., Grimaldi R. and Goncalves LAG. (2011): Characterization of Crude 62 Watermelon Seed Oil by Two Different Extraction Methods. *Journal of American Oil Chemists' Society* 88:1709 -1714.
23. James CS. (1995). Analytical Chemistry of Food. Champman and Hall, London Pp.64-65.
24. Chandra S. and Goyal AT. (2014): Antioxidant Activity by DPPH Radical Scavenging Method of *Ageratum conyzoides* Linn. Leaves. *American Journal of Ethnomedicine*, 1(4):244-249.
25. Babiker, HAM. and Makki, HMM. (2013): Nutritional Value of Doum Fruits (*Hyphaene thebaica*) and Their Suitability for Production of Ready-to- Use Concentrated Drink. M.Sc. Thesis. College of Agriculture Studies Sudan University of Science and Technology.
26. Reda AA. (2015): Physicochemical Properties of Doum (*Hyphaene thebaica*) Fruits and Utilization of its Flour in Formulating Some Functional Foods *Alexandria Journal of Food Science and Technology* 12(2):29-39.
27. Bonde, SD., Agate, VV. and Kulkarni, DK. (1990): Nutritional Composition of the Fruits of Doum Palms (*Hyphaene*) from the West Coast of India. *Principles* 34(1):21-23.
28. Hussein, AM., Salah, ZA. and Hegazy, NA. (2010): Physicochemical, Sensory and Functional Properties of Wheat-Doum Fruit Flour Composite Cakes. *Polish Journal of Food and Nutrition Sciences* 60(3):239- 244.
29. Nwosu, FO., Dosumu, OO. and Okocha, JOC. (2008). The Potential of *Terminalia catappa* (Almond) and *Hyphaene thebaica* (Dum Palm) Fruits as Raw Materials for Livestock Feed. *African Journal of Biotechnology* 7:4576-4580.
30. Abdel-Rahman, N., Awad, I. and Elshafe'a, B. (2014): Characterization of some Sudanese Edible Forest Fruits. *Journal of Agri-Food and Applied Sciences*, 2:39-44.
31. Anderson JW., Baird P., Davis RH., Ferreri S., Knudtson M., Koraym A., and Williams CL. (2009): Health Benefits of Dietary Fiber. *Nutr Rev.* 67(4):188–205.
32. Viuda-Martos, M., Lopez-Marcos, MC., Fernandez-Lopez, J., Sendra, E., López-Vargas, JH. and Perez-Alvarez, JA. (2010): Role of Fibre in Cardiovascular Diseases: A Review. *Comprehensive Reviews in Food Science and Food Safety* 9(2):240–258.
33. Brownlee, IA. (2011): The Physiological Roles of Dietary Fibre. *Food Hydrocolloids* 25(2):238-250.
34. FAO. (2006): Composition and Characteristics of Selected Palm Products. FAO Corporate Document Repository. Forestry Department. Tropical Palm. FAO. Rome. Italy.
35. Tunland, BC. and Meyer, D. (2002): Non Digestible Oligo and Polysaccharides (Dietary Fibre): Their Physiology and Role in Human Health and Food. *Comprehensive Reviews in Food Science and Food Safety*, 1:73-92.
36. Venn BJ. and Mann JI. (2004): Cereal Grains, Legumes and Diabetes. *Eur J Clin Nutr* 58:1443-1461.
37. Lopez M., Martinez F., Del-Valle C., Ferrit M. and Luque R. (2003): Study of Phenolic Compounds as Natural Antioxidants by a Fluorescence Method. *Talanta Academic Journals* 60:609-616.
38. Eldahshan O., Ayoub N., Singab A. and Al-Azizi M. (2008): Potential Superoxide anion radical scavenging activity of doum palm (*Hyphaen thebaica* L.) Leaves Extract. *Rec. Nat. Prod.* 2:83–93
39. Mohamed AA., Khalil AA. and El-Beltagi HES. (2010): Antioxidant and Antimicrobial Properties of Kaff Maryam (*Anastatica hierochuntica*) and Doum Palm (*Hyphaene thebaica*) *Grasas y Aceites* 61:67-75.
40. Lamiaa AG. and Laith ZF. (2018): Antioxidant Activity of Two Different Extracts From Doum (*Hyphaene thebaica*) Fruits *Journal of Pharmacy and Biological Sciences* 13(4):30-33.
41. Ghada, AT., Ibrahim BA., Hassan AE., Usama AM., Mohamed GS., May B. and Ayman MM. (2020) Metabolomic Profiling and Antioxidant, Anticancer and Antimicrobial Activities of *Hyphaene thebaica* *Processes* 8(266):1-13.