PRINT ISSN 1119-8362
Electronic ISSN 2659-1499

Full-text Available Online at
https://www.ajol.info/index.php/jasem
https://www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 30 (5) 1697-1701 May 2026

Proximate Composition, Mineral Element Profile and Phytochemical Constituents of Tiger Nuts (*Cyperus Esculentus*) Tubers Sourced from Benin City, Nigeria

***IMAFIDON, MI; EMUMEJAKPO, OF**

**Department of Chemistry, Faculty of Physical Science, University of Benin, Benin City, Nigeria*

**Corresponding Author Email: imafidon.idiaghe@uniben.edu*
**ORCID: https://orchid.org/0009-0005-9704-6795*
**Tel: +2348057002455*

Co-author Email: faithoghenero02@gmail.com

ABSTRACT: Due depleting foreign exchange reserves and the search for potential local and natural alternative to synthetic pharmaceutical agents, the objective of this paper is to investigate the proximate composition, mineral element profile and phytochemical constituents of tiger nuts (*Cyperus esculentus*) tubers sourced from Benin City, Nigeria, using appropriate standard procedure. Data obtained reveals that the proximate analysis revealed that tiger nut (*Cyprus esculentus*) is a rich source of carbohydrate (50.89±0.25), crude fat (26.53±0.18), crude fibre (7.50±0.29), crude protein (4.57±0.08), ash (3.00±0.29) and moisture (7.50±0.29). The relatively low moisture content implies favourable shell-life characteristics. Mineral profiling identified exceptionally high concentrations of phosphorus (4914 mg/kg) and potassium (2565 mg/kg) as well as nutritionally significant quantities of iron (190 mg/kg) and magnesium (52 mg/kg). Phytochemical screening confirmed the presence of glycosides, alkaloids, saponins, phenols, flavonoids, terpenoids, and eugenols, while tannins and steroids were absent-suggesting minimal anti-nutritional burden. Collectively, these findings substantiate the growing recognition of *Cyperus esculentus*, as a functional food and a promising source of health- promoting bioactive compounds.

DOI : https://dx.doi.org/10.4314/jasem.v30i5.36

License: CC-BY-4.0

Open Access Policy: All articles published by **JASEM** are open-access and free for anyone to download, copy, redistribute, repost, translate and read.

Copyright Policy: © 2026. Authors retain the copyright and grant **JASEM** the right of first publication. Any part of the article may be reused without permission, provided that the original article is cited.

Cite this Article as: IMAFIDON, M. I; EMUMEJAKPO, O. F (2026). Proximate Composition, Mineral Element Profile and Phytochemical Constituents of Tiger Nuts (*Cyperus Esculentus*) Tubers Sourced from Benin City, Nigeria. *J. Appl. Sci. Environ. Manage*. 30 (5) 1697-1701

Dates: Received: 30 April 2026; Revised: 10 May 2026; Accepted: 14 May 2026; Published: 30 May 2026

Keywords: *Cyperus esculentu*, Chemical Composition, Proximate Analysis, Mineral Analysis. Phytochemical Constituents.

Throughout history, plants have served as the cornerstone of human nutrition and traditional medicine. A growing body of scientific evidence confirm that diets rich in plant-derive nutrients and bioactive compounds are inversely associated with the incidence of non- communicable diseases-including type 2 diabetes, cardiovascular disease, certain cancers and inflammatory arthritis. These protective effects are attributed not only to macronutrients and essential micronutrients, but also to a diverse array of secondary metabolites collectively termed phytochemicals. Among the underutilised crops attracting increasing scientific and commercial interest is the "tiger nuts" (*Cyperus esculentus*), a perennial sedge belonging to the family Cyperaceae. Known by several vernaculars' names-including chufas, yellow nutsedge, earth almond and ground almond-the plant produce small, starchy tubers that have been consumed as a food source for approximately 4,000 years. Archaeobotanical records indicate its use in ancient Egypt, and today it is cultivated extensively across Sub-Sahara Africa, Asia, the Arabian Peninsula, and parts of Europe, most notable Spain (Abdelkader *et al.*, 2017).

**Corresponding Author Email: imafidon.idiaghe@uniben.edu*
**ORCID: https://orchid.org/0009-0005-9704-6795*
**Tel: +2348057002455*

Cyberus esculentus occurs in three morphological varieties –brown, black, a yellow—each exhibiting distinct physiochemical a functional property (Nina *et al*, 2019). The tubers rheological behaviour is substantially modulated by its moisture content (Gassparre and Rosell, 2019). Compositionally, tiger nuts are characterised by high dietary fibre, significant quantities of lipids (Predominately oleic and linoleic acids). Simple and complex carbohydrates (sucrose and starch) and notable concentrations of the amino acid arginine – a precursor of insulin-stimulating hormones (Bamishaiye and Bamishaiye, 2011).

The oil fraction contains approximately 18% saturate fatty acids (palmitic and stearic acid) and 82% unsaturated fatty acids (oleic and linoleic acid), making the tuber a viable feedstock for biodiesel production in addition to its food applications (Zhang *et al*., 1996). Beyond their nutritional value, tiger nuts have been reported to support gastro intestestinal health by alleviating constipation and diarrhoea and their rich mineral profile – encompassing potassium, phosphorus, calcium, magnesium and iron – contributes to blood circulation, skeletal integrity, muscle function, and tissue regeneration (Mohdaly, 2019).

Industrial applications are equally divers: tiger nut flour is used in the formulation of plant-based milks, yoghurts, jams, beers, chocolates, and edible oils (Achoribo and Ong, 2017). Despite this impressive repertoire of applications, comprehensive characterisation of the chemical composition of locally sourced Cyperus esculentus in Nigeria remains limited. The objective of this paper is to investigate the proximate composition, mineral element profile and phytochemical constituents of tiger nuts (*Cyperus esculentus*) tubers sourced from Benin City, Nigeria.

MATERIALS AND METHODS

Chemicals and Reagents: All reagents employ in this investigation were of analytical grade. The phytochemical screening utilised Dragendroff's reagent, Wagner's reagent, Fehling's reagent, ferric chloride ($FeCLl_3$), ammonia solution, sodium hypochlorite, sodium potassium titrates, potassium dichromate, alkaline sodium phenate solution, Kjehdhal catalyst, hydrochloric acid, sulphuric acid (H_2SO_4), chloroform, sodium hydroxide (NaOH), hexane, petroleum ether and distilled water.

Instruments and Apparatus: Instruments include a UV/Vis spectrophotometer**,** muffle furnace**,** soxhlet extraction apparatus**,** hot- air oven**,** desiccators**.** Atomic Absorption Spectrophotometer (AAS), flame photometer**,** analytical weighing balance**,** conical flask**,** volumetric flask**,** crucibles**,** beakers and test tubes

Sample Collection and Preparation: Fresh *Cyberus esculentus* tubers were procured from New Benin Market, Benin City, Edo State, Nigeria. Botanical authentication was carried out by Dr. H.A. Akinnibosun of the department of Plant Biology and Biotechnology, Faculty of Life Science, University of Benin, and a voucher specimen was deposited under herbarium number of UBH-C419.

Prior to analysis, the tubers were sorted, washed thoroughly to remove soil and extraneous matter, and sun-dried for five days. The dried material was milled in a laboratory milling machine and sieved to obtain a uniform fine powder. The resultant powder was transferred to airtight plastic containers and stored at ambient temperature until required for analyses.

Proximate Composition Analysis: Proximate analysis of tiger nut powder was conducted in triplicate following standard procedures of Association of Official Analytical Chemists (AOAC, 2005). Parameters determined included moisture, ash, protein, crude fat, crude fibre, and nitrogen-free extract (carbohydrate by difference).

*Moisture Content***:** A pre-weighed crucible (W_1) was charged with 2g of sample (W2) and dried in a hot-air oven at 105^{o}C to constant weight (W_3).

$$\%moisture = \frac{W_2 - W_3}{W_1} * 100 \quad (1)$$

Where w_1=initial weight of empty crucible; w_2=Weight of crucible + sample before drying; W_3 = Weight of crucible + sample after drying.

Ash Content: Two grams of sample were incinerated in a muffle furnace at 550^{0}C for 3 h. crucibles were cooled in a desiccator and the residual ash weighed (W_3).

$$\%ash = \frac{W_3 - W_1}{W_2 - W_1} * 100 \quad (2)$$

Where w_1=Weight of crucible; w_2=Weight of crucible + sample; W_3 = Weight of crucible + ash

Crude Fibre: Two grams of the sample were subjected to sequential acid digestion (1.25g H_2SO_4) and alkaline digestion (1.25% NaOH) under reflux. The final residue was washed with hot water and

ethanol, oven dried, weighed, incinerated and reweighed.

$$\%crude\ fibre = \frac{W_2 - W_3}{W_1} * 100 \quad (3)$$

Where w_1=Weight of sample used; w_2 = Weight of crucible + dried residue; W_3 = Weight of crucible + ash

Crude Fat: Two grams of sample were Soxhlet-extracted with petroleum ether for 8 h. The solvent was evaporated, and the oil residue dried at 60^0 C for 30 min and weighed.

$$\%Fat = \frac{Weight\ of\ fat}{Weight\ of\ sample} * 100 \quad (4)$$

Crude protein: Nitrogen was determined by the Kjeldahl method using micro- digestion with concentrated $H_2SO_{4\ and}$ catalyst mixture, followed by colorimetric measurement at 630nm using a UV/Vis spectrophotometer.

$$\%N = \frac{IR\ *SR\ *\ Color\ Vol.*\ Digest\ Vol}{Ws\ x\ Aliquot\ Taken\ x\ 10000} \quad (5)$$

Where IR = instrument reading, SR = slope reciprocal, WS = weight of sample, %Crude Protein = %Nitrogen * 6.25. *Carbohydrate (N.F.E):*

Calculated by difference. %carbohydrate = 100 - % (protein + fat + ash + fibre + moisture content)

Mineral Elements Analysis: Mineral analysis was performed in accordance with AOAC method. 2g sample was ashed at 5500C, and the resulting ash dissolved in 10ml of 0.1MHCl, filtered, and made up to 100ml with distilled water. Concentrations of magnesium (Mg), copper (Cu), Zinc (Zn), Lead (Pb), Iron (Fe), calcium (Ca), and manganese (Mn) by the use of atomic absorption spectrophotometer (AAS). Potassium (K) and sodium (Na) were quantified by flame photometry and phosphorus (P) was determined spectrophotometrically. Phytochemical Screening:

Ten grams of the powdered *Cyberus esculentus* were macerated in 50mL of distilled water.

The aqueous extract was filtered through Whatman No. 1 filter paper and subjected to qualitative phytochemical screening using standard procedures described by Shaikh and Patil (2020); Vishnu *et al.* (2019) and Tiwari *et al*., (2011).

Alkaloid (Drangendorff's Test): 2 mL of Drangendorff's reagent was added to 3 mL of extract. Formation of a reddish- brow precipitates indicated a positive result.

*Glycoside (General Test)***:** 3mL of chloroform was added to 2 Ml of filtrate and shaken. The chloroform layer was separated and 10% ammonia solution was added, a brown ring confirmed the presence of glycosides.

Phenolic compound (FeCl3 Test): A few drops of 10% ferric chloride were added to 2mL of extract, a pale yellow-blue colouration indicated phenolics.

Tannins (Gelatin Test): Extract dissolved in 5mL distilled water was boiled with 1% gelatin and 10% NaCl for 3 min., addition of 2 drop ($FeCl_3$) to the filtrate a bluish precipitate signified tannin.

*Saponins (Frothing Test)***:** 0.5g of extract and was shaken vigorously 2 mL distilled water, persistent stable foam indicated the presence of saponins.

Flavonoids (Lead Acetate Test): To 1mL of extract, a few drops of 10% of lead acetate solution were added, reddish precipitation confirmed flavonoids.

Eugenols (KOH/HCL): 2 mL of the extract was mixed with 5 mL of 5% KOH solution. The aqueous layer was separated and filtered, acidified with HCl—a pale yellow colour indicated eugenols.

Steroids (Salkowski Test): 2 mL of extract was treated with 2 mL chloroform and 2 mL concentrated $H_2SO_{4;}$ a colour shift from violet t0 blue or green indicated steroids.

Terpenoids (Salkowski Test): 3ml of the extract was treated with 1mL of chloroform and 1.5 mL concentrated H_2SO_4 added along the tube wall; a. reddish- brown colouration indicated steroids

RESULT AND DISCUSSION

The results obtained from this study are represented in the table below and the discussion for each result follows subsequently.

Table 1: Proximate composition of Tiger Nut (*Cyperus esculentus*)

NUTRIENT	COMPOSITION (%)
Moisture	7.50 ± 0.50
Crude Protein	4.57 ± 0.14
Crude Fat	26.53 ± 0.32
Crude Fibre	7.50 ± 0.50
Ash	3.00 ± 0.50
Carbohydrate	50.89 ± 0.44

Data are mean value ± standard deviation for triplicate determination

The proximate composition of tiger nut *Cyperus esculentus* powder is presented in Table1. Carbohydrates constituted the dominant fraction (50.89 ± 0.25%), affirming the tuber's role as a high-energy food source. Crude fat tanked second (26.53 ± 0.32%), reflecting the well-documented lipid-richness of *Cyperus esculentus* and their potential as an oil crop. The relatively low moisture content (7.50 ± 0.29%) is noteworthy from a food technology perspective, as reduced moisture inhibits microbial proliferation and enzymatic spoilage, thereby conferring extended shelf life on processed tiger nut products. Crude protein was (4.57 ± 0.14%), which, modest in compares with conventional legumes, is consistent with previously published values for tiger nuts and reflects the tuber's characteristically lower protein content relative to other nut varieties. Dietary fibre (7.50 ± 0.50%) was at a level physiologically significant for promoting colonic motility, modulating postprandial glycaemic, and supporting the gut micro biome. Ash content (3.00±0.50%) provides an index of total mineral matter and suggests a meaningful inorganic nutrient contribution.

Table 2: Mineral analysis of Tiger Nut (*Cyperus esculentus*)

PARAMETERS	CONCENTRATION (mg/kg)
Magnesium	52
Potassium	2,565
Sodium	3
Phosphorus	4,914
Calcium	23
Iron	190
Manganese	7
Copper	10
Zinc	55

The mineral composition of tiger nut, expressed in mg/kg is summarised in Table2. Phosphorus emerged as the most abundant mineral (4,914 mg/kg), a finding of considerable nutritional significance given phosphorus's indispensable roles in energy metabolism (ATP), nucleic acid structure, and skeletal mineralisation. Potassium ranked second (2,565 mg/kg) and is well known for its widespread distribution in plant foods and its critical function in maintaining intracellular osmotic balance and membrane potential. A particularly important observation concerns the sodium to potassium ratio (Na+/k+) which was calculate as 0.15. This value falls well within the threshold of ≤ 1.0 recommended by the World Health (2012) for the prevention of hypertension and cardiovascular diseases. Epidemiological evidence consistently demonstrates that a low Na+/k+ ratio is a stronger predictor of blood pressure regulation than either cation or alone, further underscoring the cardio protective potential of regular tiger nut consumption (Geleijnse *et al.*, 2004). Sodium (375 mg/kg) was the third most abundant element. Magnesium (52 mg/kg), essential for over 300 enzymatic reactions and capable of partially substituting for calcium in cellular metabolism, ranked next. Iron (190 mg/kg) was present at level sufficient to contribute meaningful to daily requirements, supporting haemoglobin synthesis and electron transport. Zinc (55 mg/kg) plays a pivotal role I hormonal regulation and immunological function, while calcium (23 mg/kg), though present in moderate quantities, contributes to bone density and neuromuscular signalling. Magnesium (7 mg/kg) and copper (10 mg/kg), though classified as trace elements, fulfil established catalytic and structural roles in metal-enzymes.

Table 1: Phytochemical screening of Tiger Nut (*Cyperus esculentus*)

PHYTOCHEMICALS	TEST METHOD	Result
Glycosides	General Test	+
Saponins	Frothing	+
Phenols	Ferric Choride	+
Eugenols	KOH/HCl	+
Terpenoids	Salkowski	+
Steroids	Salkowski	-
Alkaloids	Dragendoff's	+
Flavonoids	Lead acetate	+
Tannins	Ferric chloride	-

Key: - Absent, + Present, ++ Largely Present

The quantitative phytochemical profile of aqueous extract of *Cyperus esculentus* is presented in Table 3. Seven classes of bioactive compounds were detected: alkaloids, glycosides, saponins, phenolics, flavonoids, terpenoids, eugenols. The absence of tannins and steroids is noteworthy, as tannins are known anti-nutrition factors that can impair protein igestibility and mineral absorption, while steroids, when present in high concentration in food, may pose endocrine concerns. Their absence thereby enhances the overall nutritional quality of the tuber. The identified phytochemicals collectively confer a broad spectrum of pharmacological activities. Alkaloids, phenolics, and flavonoids are well-established free radical scavengers with antioxidant capacity, providing cellular protection against oxidative stress implicated in chronic degenerative diseases. Saponins exhibit cholesterol-binding properties and anti-inflammatory activity, while terpenoids have reported to possess antmicrobial, anti-inflammatory, and antitumour properties. Eugenol, phenypropanoid, is recognised for its analgesic, anti-inflammatory, and antioxidant effects. The co-occurrence of glycosides further enriches the bioactive profile with potential cardio tonic and immunomodulatory properties.

Conclusion: The findings of this investigation established research *Cyperus esculentus* as a

nutritionally dense and biochemically complex food crop. It dominates carbohydrate and crude fat fractions render it a concentrated source of dietary energy, while its fibre content supports gastrointestinal health. The phytochemicals richness of the tuber – encompassing alkaloids, saponins, glycosides, phenolics, flavonoids, terpenoids, and eugenols, while remaining free of anti-nutritional tannins and steroids—further substantiates the therapeutic potential of Cyperus *esculentus*, as a plant-based source of health- promoting compounds. These results provide a robust chemical basis for the continued exploration of tiger nut in nutraceutical formulation, functional food development, and evidence-based dietary recommendations for both human and animal health.

DECLARATIONS:

Ethical Approval: This study did not involve human participants or animal experimentation and therefore did not require formal ethical approval. All procedures involving data handling and analysis were conducted responsibly and in accordance with standard academic and institutional guidelines.

Disclaimer on Artificial Intelligence usage: Author(s) hereby declare that no generative Artificial Intelligence (AI) technologies such as Large Language Models (ChatGPT, COPILOT, XLNet, Ernie 3.0 Titan etc) and textto-image generators have been used during writing or editing of this manuscript.

Declaration of Conflict of Interest: In compliance with our ethical standards, there were no known conflict of interest or personal relationships that have influence the work reported in this paper.

Data Availability Statement: In compliance with our ethical standards, I solely declared that the availability of this research data is kept in custody of the corresponding author upon request.

REFERENCE

AbdelKader, H; Ibrahim, F; Ahmed, M; El-Ghadban, E (2017). Effect of Some Soil Additives and Mineral Nitrogen Fertilizer at Different Rates on Vegetative Growth, Tuber Yield and Fixed Oil of Tiger Nut (Cyperus esculentus L.) Plants. *J Plant* Prod, 8(1): 39–48.

Achoribo, ES; Ong, MT (2017). Tiger nut (Cyperus esculentus): Source of natural anticancer drug? Brief review of existing literature. *Euro.Mediterr. Biomed. J.*, 12(19), 91–94. https://doi.org/10.3269/1970-5492.2017.12.19

AOAC (2005). Official Methods of Analysis – 17th edition. Association of Official Analytical hemists. Maryland

Bamishaiye, EI; Bamishaiye, OM (2011). Tiger nut: as a plant, its derivatives and benefits. *Afri. J of Food, Agri, Nutr. Develop.* 11(5).

Bazine, T Arslanoğlu, ŞF (2020). Tiger Nut (*Cyperus Esculentus*); Morphology, Products, Uses and Health Benefits. Black Sea *J of Agri*, 3(4), 324–328. ttps://dergipark.org.tr/tr/pub/bsagriculture/issue/56447/703497

Gasparre, N; Rosell, CM (2019). Role of hydrocolloids in gluten free noodles made with tiger nut flour as non-conventional powder. Food Hydrocolloids, 97, 105194. https://doi.org/10.1016/j.foodhyd.2019.105194

Geleijnse, JM; Kok, F; Grobbee, DE (2004). Impact of dietary and lifestyle factors on the prevalence of hypertension in Western populations. *Euro J. of Pub. Hh.* 14(3), 235–239. https://doi.org/10.1093/eurpub/14.3.235.

Mohdaly, AA. (2019). Tiger Nut (Cyperus esculentus L.) Fruit Oils: Chemistry and Functionality (pp. 243–269). Springer Nature Switzerland.

Nina, GC; Ogori, AF; Ukeyima, M; Hleba, L; Císarová, M; Okuskhanova, E; Vlasov, S;Batishcheva, N; Goncharov, A; Shariati, MA (2019). Proximate, mineral and functional properties of tiger nut flour extracted from different tiger nuts cultivars. *J of Micro.,Bioteh. and Food Sci, 9(3),653–656.*

Shaikh, JR; Patil, M. (2020). Qualitative tests for preliminary phytochemical screening: An overview. *Inter. J of Chem. Stud.*, 8(2), 603–608.

Tiwari, P; Kumar, B; Kaur, M; Kaur, G; Kaur, H. (2011). Phytochemical screening and Extraction: A Review. *Inter. Pharma. Sci*, 1(1), 98-106.

Vishnu, B; Velurajan, S; Palanisamy, A. (2019). Phytochemical analysis of Alpinia officinarum and to test its anti-oxidant, anti-microbial, anti-inflammatory and anti-arthritic activity. *J.of App Pharma. Sci*, 9(01), 001-007.