

NUTRITIONAL AND INVITRO ANTIOXIDANT ACTIVITIES OF *CYPERUS ESCULENTUS* (TIGER NUT).Iboyi Nathaniel O.*¹, Enemor Victor A. H.² and Mbachu N. A.²¹Department of Chemistry, Faculty of Sciences, Admiralty University of Nigeria, Ibusa, Delta State. Nigeria.²Department of Biochemistry, Faculty of Bioscience, Nnamdi Azikwe University, Awka, Anambra State. Nigeria.

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ABSTRACT

Nutritional and invitro antioxidant actions of *Cyperus esculentus* (tiger nut) locally known as “isipaccara” in Effik, “aki awusa” in Igbo, ”aya” in Hausa and “ofio” in Yoruba and its other names are Zulu nut, yellow nut grass, ground almond, Chufa was carried out. Increasing awareness among consumers about its associated allergies, concerns about its saturated fatty acids, scarcity and cost however have necessitated the development of plant materials as alternative food ingredients. The proximate composition of the raw tuber showed that moisture content of tigernuts ranged from 29.84+0.47 %, crude protein 4.37+0.24 %, ash 15.25+0.09 %, crude fibre 6.79+0.11 %, crude fat 3.02+1.13 %, and carbohydrate 40.71+1.64 %. Tigernuts contain significant amounts of Mg (15.28+0.01mg), K (2.06+0.004 mg), Ca (4.97+0.02 mg), Se (4.98+0.09mg), Cu (0.08 – 0.99 mg), Zn (1.04+0.045 mg) and Na (1.59+0.01 mg), Antioxidant activity of the tiger was measured, the results shows that catalase is 2.18 ± 0.01, SOD unit enzymes is 1.67 ± 0.10, Nitric oxide (mg/kg) is 8.52 ± 1.51.

KEYWORDS: Proximate, Tigernut, Antioxidant, Mineral and *Cyperus esculentus*.**INTRODUCTION**

Tiger nut is a grass-like plant of the Family *Cyperaceae* (sedge family), Order Cyperales or Graminales.^[1] Like other sedges, the plant is most frequently found inhabiting wet marshes and edges of streams and ponds where it grows in coarse turfs.^[2]

Tigernuts grow in the wild, along rivers and are cultivated on a small scale by rural farmers mostly in the northern states of Nigeria. It is locally called “aya” in Hausa; “aki awusa” in Igbo; “ofio” in Yoruba and “isipaccara” in Effik. Tigernuts are edible, sweet, nutty, which contain protein, carbohydrate, sugars, and lots of oil and fiber.^[3] Tiger nut has many other common names which include, Zulu nut, yellow nut grass, ground almond, Chufa, edible rush, rush nut, duck potato etc.^[4] In Nigeria, tiger nut is well grown in the middle belt and northern region,^[4] where it is sold locally and consumed uncooked. In Spain, the tubers are consumed mainly as a drink called “horchata de chufa” (Chufa Milk). It has been cultivated as a livestock food and for human consumption.^[5]

According to,^[6] three varieties are cultivated i.e. yellow, brown and black. Among these only two varieties; yellow and brown are readily available in Nigeria market.^[7]

Literature values revealed that tigernut helps to prevent heart problems, thrombosis and activate blood circulation; it is also responsible for preventing and treating urinary tract and bacterial infection and assist in reducing the risk of colon cancer when eaten,^[8] The following characteristics make it a perfect milk substitute:

- It is ideal milk for persons that don't tolerate gluten (celiacs) or that are allergic to cow milk and its derivatives and It helps in reduction of LDL (“bad”) cholesterol and increases HDL (“good”) cholesterol because of its high contents of oleic acid and Vitamin E, which has an antioxidant effect on fats.
- The high content of oleic acid and the amino acid arginine prevents arteriosclerosis and it is suitable for diabetic persons.
- It is recommended for persons with digestion disorders, flatulence and diarrhoeas because of the content of digestive enzymes (lipase, catalase and amylase). It is high phosphorus, potassium, calcium, magnesium and iron.

In some parts of Africa, Europe and Asia, tigernut is grown for its edible tubers. Tigernuts may be regarded as an obnoxious weed that has been used historically as food and medicine by the Egyptians and Native Americans. Even today the Egyptians cultivate tigernuts in moist soils or sandy shores for their edible tubers.^[9]

Tigernut tubers may be consumed raw, roasted, or ground into flour as well as being used to produce vegetable oil, and cellulose.^[3] Tigernut is a representative crop of the Spanish Mediterranean region, where tubers are used to make horchata. The milky-looking aqueous extract of tiger nuts has a pleasant and characteristic flavor of vanilla and almonds and could be sold in Pubs. Unfortunately, popularity of tigernut milk extract or “horchata” has not extended to Nigeria. In Maradi state, Eastern Niger, tigernut is cultivated for export to Nigeria.

The research for lesser known and underutilized crops, which include tiger nuts, many of which are potentially valuable as human and animal food has been intensified to maintain a balance between population growth and agricultural productivity particularly in tropical and sub-tropical areas of the world.^[10]

MATERIALS AND METHOD

Collection and Identification of Sample

The *Cyperus esculentus* (tigernut) was collected from daily market in Ngaski Local government Area, Warra in Kebbi State of Nigeria. The Sample was identified according to the identification protocols of Dutta.^[11]

Preparation of the Sample

The tubers was thoroughly screened to remove the defective/bad ones and stones. The tubers was washed, rinsed and air- dried. The sample was ground using wooden mortar and pestle or using electric blender until a fine powder was obtained to ensure homogeneity. The powdered sample was passed through a fine (2mm mesh) sieve to remove any remaining residue. The fine powdered sample was stored in labeled plastic container.

Preparation of Plant Extract

Aqueous extract of the sample was prepared by soaking 100g of dried powdered sample in 200ml of distilled water for 24 hours. The extracts was filtered using whatman filter paper No.42 (125mm).^[12]

Determination of Ash content

After drying and grinding, 1g of the powdered sample was spread in porcelain dish and placed in muffle furnace. The ash sample was digested using 3mL of 6N HCl and made up to the mark of 100mL standard flask.

Proximate Composition Analysis of *Cyperus esculentus* (tigernuts)

The sample was subjected to proximate analysis to determine the moisture, ash, crude fiber, crude protein and nitrogen using the standard method of the Association of Official Analytical Chemists, AOAC (1990)^[13] The sample was prepared in triplicate and the nitrogen was determined by the micro kjedahl method described by Pearson (1976)^[14] and the nitrogen content was converted to protein by multiplying by a factor of 6.25. Carbohydrate was determined by the difference.

The proximate components of fresh tigernuts were determined by the methods described in.^[13,14,15]

Analysis of Mineral elements

Analysis of mineral elements was carried out using atomic absorption spectrophotometer (AAS) Varian AA240 (Atomic Absorption Spectrophotometer) according to the method of APHA (American Public Health Association) 1995.^[16]

Invitro Antioxidant activities

The invitro antioxidant activity of the samples was analyzed using different antioxidant parameters such as SOD, Catalase, GSH-peroxidase, Nitric oxide, e.t.c. are done using spectrophotometry methods.

RESULTS

Table 1: Mineral Composition *C. esculentus*.

Mineral (ppm)	Mean + SD
Tin	0.00+0.00
Arsenic	0.134+0.01
Aluminum	0.00+0.00
Calcium	4.97+0.02
Selenium	4.98+0.09
Copper	0.04+0.009
Manganese	0.21+0.003
Nickel	0.44+0.05
Chromium	0.69+0.009
Iron	1.73+0.05
Cobalt	0.07+0.008
Zinc	1.04+0.045
Lead	0.00+0.00
Cadmium	0.059+0.007
Magnesium	15.28+0.01
Sodium	1.59+0.01
Potassium	2.06+0.004
Vanadium	0.00+0.00
Mercury	0.55+0.01
Silver	0.49+0.32

The current study show that the Macro-element nutrient present in *C. esculentus* nut has the highest value in Magnesium, calcium and selenium value of 4.97 mg/kg and 4.98 mg/kg respectively while potassium, sodium and Iron contents with values 2.06mg/kg, 1.59 mg/kg and 1.73mg/kg respectively, but with lower Cadmium, Copper and Cobalt content value as 0.059mg/kg, 0.04 mg/kg and 0.07mg/kg respectively, (Table 1). The presence of potassium and calcium in tiger nut are adequate for bone and teeth development in infants.^[17]

Table 2: Proximate Analysis of *C. esculentus*.

Parameters	Mean + SD
Moisture content	29.84+0.47
Ash content	15.25+0.09
Fiber content	6.79+0.11
Fat content	3.02+1.13
Protein content	4.37+0.24
Carbohydrate	40.71+1.64

The results in the Table 2 of this study has established that tubers of *C. esculentus* which is the only edible member of the sedge (*Cyperaceae*) family and widely consumed in Nigeria as very nutritious. The proximate composition of food is a major index of nutritious potentials of crops. The raw tubers gave proximate values (%) of 29.84, 15.25, 6.79, 3.02, 4.37 and 40.71 for moisture, ash, fiber, fat, protein, and carbohydrate, respectively. These were compared with the proximate values of some

widely consumed nuts already reported in literature (Table 3). The protein level of *C. esculentus* is quite low and within range for other nuts like the hickory nut (3.60%), chest nut (4.53%), coconut (2.06%) and pine nut (6.81%). *Cyperus esculentus* has a fat content of 3.02 which is comparable to values for some widely consumed nuts already reported in literature (Table 3). Fat is important in diets because it promotes fat soluble vitamin absorption.^[18]

Table 3: Nutritional composition (g/100g) of some widely consumed nuts.

Nuts/qty	Carbon. (g)	Protein (g)	Fat (g)	Fiber (g)	Water (g)	Calcium (g)	Zinc (g)	Iron (g)	Copper (g)	Calories (Kcal)
Walnut	15.10	30.40	70.70	10.60	5.45	72.50	4.28	3.84	1.28	759
Brazil nut	17.00	20.10	92.70	12.50	4.68	24.60	6.42	4.76	2.48	919
Hazelnut	20.70	17.60	84.50	9.20	7.32	25.30	3.24	4.41	2.04	852
Hickory nut	5.17	3.60	18.30	0.92	0.76	17.00	1.22	0.60	0.21	187
Chestnut (roasted)	75.70	4.53	3.15	18.50	51.90	42.00	0.82	1.30	0.73	350
Coconut (grated/fresh)	12.20	2.60	26.80	11.20	37.60	12.00	0.88	1.94	0.35	283
Peanut (dried)	23.60	37.50	37.50	12.70	9.71	85.00	4.78	4.72	1.46	827
Pine nut	4.03	6.81	6.81	0.50	1.90	7.39	1.21	2.61	0.29	146

Table 4: Antioxidant Analysis of *C. esculentus*.

Parameters	Mean+SD
Catalase (μmol/ml)	2.18+0.01
Peroxidase (μmol/ml)	27.33+0.13
SOD unit enzymes	1.67+0.10
Glutathione reductase (mol/ml)	13.65+0.49
Glutathione peroxidase (μmol/ml)	9.07+0.70
Nitric oxide (mg/kg)	8.52+1.51
Hydroxyl radical (mg/100g)	6.81+0.21
Polyphenol oxidase unit enzymes	0.81+0.21

The findings of the invitro antioxidant Analysis of *C. esculentus* presented in Table 4 of this study have established that tubers of *C. esculentus* which is the only edible member of the sedge (*Cyperaceae*) family and widely consumed in Nigeria is very nutritious with antioxidant that helps the body to fight against the free radicals of the body. The body free-flowing oxygen molecules can create free radicals, otherwise known as oxidative damage. This damage can eventually lead to diseases, such as heart disease and cancer. It's important to have a diet rich in antioxidants to protect yourself from oxidative damage over time, and tiger nuts are a great source of antioxidants. With

high vitamin E content and oleic acid, these "nuts" help you protect your body from disease.

DISCUSSION

The results of the proximate composition of tigernuts in Table 2 showed that raw tigernuts, as widely consumed in Nigeria are healthy snacks. Tigernuts are high in carbohydrate, fat and fibre content. They are also rich in magnesium, potassium, iron, copper, zinc, vitamin C, vitamin E and are low in calcium and sodium (Table 1).

They are fairly good sources of protein, fresh tigernuts are high in moisture content which point out that it could perish easily due to microbial attack. However, dried

tigernuts are low in moisture with higher concentration of nutrients. Tigernuts could be eaten fresh or dried as snacks by young and old (children, adolescents, adults, pregnant, aged and lactating mothers) for its high energy and preventive or protective nutrients. These nutrients could significantly contribute to the body's metabolic processes, refreshing the body as well. Tigernuts in comparison to other starchy roots and tubers have interestingly, significantly higher fat content and could contribute more than 73 % of fat to a child's daily fat need and more than 49 % of fat to an adults daily fat requirement.^[19] Fat content of tigernuts are relatively similar to that of nuts and seeds but are higher than that of cereals and compares well with that of soya beans.^[20] High fat content of tigernuts may indicate high values of oil soluble vitamins such as vitamins A, D, E and K.

Higher results were observed in moisture content; ash; and crude fibre when compared with the literature.^[21,22] The higher significance observed in this present result occurred because the samples were oven dry at 20⁰C when compared with those samples in the literature. In addition, the values observed in crude protein, fat, and metabolisable energy were found to be lower when compared with those reported on tigernut by,^[23] which would probably be due to difference in variety.

Fibre content of tigernuts (7.48 – 11.51 %) rank well with that of whole grains, nuts, fruits and matured leguminous seeds.^[24] Tigernut fibre values from the findings are in line with the reports of,^[25,26,38] reported a lower fibre value (5.50%). Tigernuts if consumed on daily bases, the fibre content could pay its important role in the reduction of pressure and transit time of food through the body aiding to digestion. Fibre aids in alleviation of flatulence problem, thus, tigernut fibre could be explored in formulating diets for treating indigestion, constipation and non communicable diseases such as colon cancer, diverticulosis, coronary heart disease and obesity, Tigernut tuber contains digestive enzymes such as catalase, lipase and amylase. These enzymes help to alleviate indigestion, flatulence and diarrhoea.^[27,28]

Protein content of tigernuts (4.37%) fell within the range of values reported by other researchers.^[29,38,26,30]

Tiger nut has high fibre content, the consumption of significant quantities of *C. esculentus* would therefore not constitute a risk factor to some pathologic stages i.e diabetic mellitus, obesity and coronary heart disease. Past researches have linked low fibre content in the diet with health problems such as heart disorders, bowel cancer and appendicitis.^[31]

The mineral ash value of 100 g tigernut (0.70 – 1.53 %) fell within the range reported for other starchy roots and tubers such as yam, cassava and potatoes.^[32] Tigernuts ash value was in line with the reports of.^[38] However,

values reported by.^[29] and Addy and.^[26] on tigernuts had significantly higher values (2.48 % and 6.70 % DW, respectively).

Essential minerals such as Na, Ca, and K are found to be comparable with the results in the literature.^[22] Na-K ratio was found to be less than 1 in all the samples suggesting that tigernut tubers will probably be suitable for food formulation of diets for hypertensive patients.^[33]

Magnesium provides bone strength, aids enzyme, nerve and heart functions. Tigernuts could contribute adequate Mg and Zn (100 %) to the daily need of children. Phosphorus enhances quick release of energy in the body and may combine with calcium for bone and teeth development. Tigernuts are relatively low in calcium and sodium. Recent studies on blood pressure showed that a diet rich in potassium and magnesium but low in sodium can lead to a decrease in blood pressure within days of beginning a specific diet.^[28] Potassium aids nerve impulse transmission and it is a major cation of intracellular fluid. High potassium to low sodium ration of tigernuts therefore, may be imperative in diet formulations for patients with high blood pressure and oedema as well.

Tigernuts contain protective nutrients because it could supply adequate zinc, copper, iron, vitamin C and E. Zinc is an integral part of hormones and more than nearly 100 different enzymes. Zinc is important in many metabolic reactions and may play an important role in immunity, alcohol metabolism, sexual development and reproduction. Copper aids in iron metabolism. It works with many antioxidants, enzymes especially those involved in protein metabolism and hormone synthesis. High iron content of tigernuts could contribute in preventing anaemia. Fe is the functional component of haemoglobin and other key compounds used in respiration, immune function and cognitive development. The Fe content in tigernuts (100 g) could be enough to cover the daily minimum needs (providing about 67 – 68 %) for children. Tigernuts could provide about 27 – 64 % of adolescents or adults daily iron need and 18 – 49 % of pregnant mother's daily iron needs.^[34]

Antioxidants are free radical scavengers which neutralize reactive oxygen species (ROS) produced during aerobic cellular metabolism: superoxide (O₂⁻), hydrogen peroxide (H₂O₂) and peroxyinitrite (OONO⁻). Also, antioxidants exert protective effects on cells against the deleterious effects of ROS on cell membranes, mitochondria, DNA, lipids or proteins. Natural antioxidants are important elements in health maintenance and prevention of atherosclerosis, aging, neurodegenerative diseases, carcinogenesis, hematological disorders or chronic inflammation. These are a collection of antioxidants that act to suppress or prevent the formation of free radicals or reactive species in cells. They are very fast in neutralizing any molecule with the potential of developing into a free radical or any

free radical with the ability to induce the production of other radicals. Three key enzymes: superoxide dismutase, catalase and glutathione peroxidase are top on the list. Endogenous antioxidants (catalase, superoxide dismutase, peroxidase and glutathione) exert their activity by scavenging oxygen free radicals and thereby are important in preventing oxidative stress. Fruits, vegetables and grains contain numerous free radicals scavenging molecules including polyphenols, flavonoids, vitamins, that have a significant antioxidant activity as reported by Amelia, M. G., *et al.*, 2020.^[36]

The metal ions which are normally bound by SOD are iron (Fe), zinc (Zn) copper (Cu) and manganese (Mn). In this regards, SODs are classified into three forms and these include (i) Fe-SOD which is commonly found in prokaryotes and chloroplasts of some plants (ii) Mn-SOD which is present in prokaryotes and mitochondria of eukaryotes and (iii) Cu/Zn-SOD is predominant in eukaryotes and more distributed, localized basically in cytosol but also found in chloroplasts and peroxisomes,^[38,39]

CONCLUSION

The utilization of tiger nut (*Cyperus esculentus*) is steadily increasing. This might be as a result of knowledge on the composition of tiger nut especially the protein and fibre, the protein content has a lot to play and the tigernut contain protein in appreciable amount depending on the variety which helps in body development and repair of tissues, the fibre also helps in reducing cholesterol and body weight. Tiger nut tubers are a rich source of fiber, carbohydrates and moderate amount of protein. Tiger nut tubers grown at different sites do not have the same potential or composition of proximate analysis due to the geographical location.

Considering the nutritive and health benefits of the tigernuts; there is need for increased utilization and awareness of its health benefits as it is rich in vitamin, amino acids, and medicinal factors. Moreover, it is suggested that products from tigernuts should be encouraged so as to solve the problem of protein-calorie malnutrition in Africa. Different kinds of products are obtained from tigernut such as milk as it is popularly called in the northern Nigeria as “kunu aya” or tigernut milk.

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