# TIGERNUTS: BENEFITS AND NEGATIVE HEALTH IMPLICATIONS

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## ABSTRACT

Tigernut *(Cyperus esculentum)* is a perennial grass-like plant with spheroid tubers, pale yellow cream kernel surrounded by a fibrous sheath. It is a weed plant of tropical and Mediterranean regions. It has many names which include yellow nutsedge, chufa and nut grass. Its sweet almond-like tubers are highly appreciated for their health benefits and nutritive value: high content of fiber, proteins, and sugars. They are rich in oleic acid and glucose, as well as in phosphorus, potassium, and vitamins C and E. They are not part of the nut family and are completely safe for people with any sort of nut allergies. These tuberous "nuts" are mainly used to manufacture a milky beverage called "horchata de chufa". Tiger nut has attracted very little scientific and technological interest, except for the production of "horchata de chufa" and some studies on its oil. Development of new products from the tubers could enhance more interest in this crop. In this respect, various opportunities are offered: source of dietary fiber, use of its oil in cooking or salad preparation, production of caramel to be used as a food additive. This review presents an overview of the tiger nut, its products, benefits and negative health implications.

## Introduction

Tigernut *(Cyperus esculentum)* is a perennial grass-like plant with spheroid tubers, pale yellow cream kernel surrounded by a fibrous sheath (Temple, 2014). It is also known as yellow nut sedge, earth or ground almonds, "*souchet"* in French, "*ermandeln"* in German and "*chufa"* in Spanish (Temple, Ojobe & Kapu, 2013). Grossman and Thomas (2012) reported that c*hufa* came to Spain from Africa. It is found wild and cultivated in Africa, South America, Europe and Asia. 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 (Grossman & Thomas, 2012).

Furthermore, tigernuts are edible, sweet, nutty, flavoured tubers which contain protein, carbohydrate, sugars, and lots of oil and fiber (Food and Agriculture Organization (FAO), 2013). Tigernuts have been cultivated for food and drink for men and planted for hogs for many years in Spain and that the lovely milky elixir is served in health Spas, Pubs, and Restaurants as a refreshing beverage (competing successfully with other soft drinks) (Grossman & Thomas, 2012). Unfortunately, despite these potentials in tigernuts, it has been a neglected crop in Nigeria. This probably may be due to inadequate knowledge on its production, utilization and nutritional value (Grossman & Thomas, 2012). Tigernut could provide a basis for rural industries in Africa. It is an important food crop for certain tribes in Africa, often collected and eaten raw, baked as a vegetable, roasted or dried and grind to flour (Moore, 2014). The grinded flour is mixed with sorghum to make porridge, ice-cream, sherbet or milky drink. It is mostly consumed raw as snack without knowledge of the food and nutritional quality (FAO, 2012). It has also been found to possess good therapeutic quality (Farre, 2013). The expansion of tigernut milky drinks will significantly help the research linking tigernut milk to healthier cholesterol levels and other

non-dairy manufacturers. This could also gain a boost from an increased consumer interest in health foods" (Zimmerman, 2013).

Variety of food products can be derived from tigernut tubers though there is little documentation at large (Moore, 2014). Various food processing techniques can be applied to tiger nut processing to modify its appearance, develop its natural flavour, stimulate the digestive juices, add variety to the menu, make it easily digestible and bio-available, destroy harmful microorganisms, improve its nutritional quality and prevent decomposition. One ounce of tigernuts contain numerous nutrients in varying proportions of which some are; 120 calories, 19g of carbohydrate, 2g of protein, 7g of fat, 10g of fiber, 1.8mg of iron, 28mg of magnesium, 1.1mg of zinc, 215mg of potassium and 0.1mg of vitamin B6 (Moore, 2014). Tigernut is widely used for animal (feed) and human consumption. In Spain, these tubers are mainly used to make a milk-like beverage called "horchata de chufa". This beverage (tiger nut milk or orgeat in English-speaking countries) is a nonalcoholic refreshing drink of dairy appearance and is usually consumed in summertime (Mountney & Gould, 2015). This beverage was originally made by Muslims and now is widespread in Spain and several other European and Latin-American countries (Nnam, 2012). In Spain, the "horchata" industry is of considerable economic importance (Obizoba, 2014).

The tubers of tigernuts are edible, with a slightly sweet, nutty flavour, compared to the more bitter-tasting tuber of the related Cyperus rotundus (purple nutsedge). They are quite hard and are generally soaked in water before they can be eaten, thus making them much softer and giving them a better texture. Flour of roasted tiger nut is sometimes added to biscuits and other bakery products as well as in making oil, soap, and starch extracts. It is also used for the production of nougat, jam, beer, and as a flavoring agent in ice cream and in the preparation of kunnu (a local

beverage in Nigeria) (Belewu & Abodunrin, 2013). Kunnu is a nonalcoholic beverage prepared mainly from cereals (such as millet or sorghum) by heating and mixing with spices (dandelion, alligator pepper, ginger, licorice) and sugar. To make up for the poor nutritional value of kunnu prepared from cereals, tiger nut was found to be a good substitute for cereal grains (Moore, 2014). Tiger nut oil can be used naturally with salads or for deep frying. It is considered to be a high quality oil. Tiger nut "milk" has been tried as an alternative source of milk in fermented products, such as yogurt production, and other fermented products common in some African countries and can thus be useful replacing milk in the diet of people intolerant to lactose to a certain extent (Lapham & Drenian, 2013).

Tiger nut milk has been found to be good for preventing arteriosclerosis, since its consumption can help prevent heart problems and thrombosis and activate blood circulation, mainly because its unsaturated fatty acid content is similar to that of olive oil and its arginine is a precursor of nitric oxide which helps the veins to expand (Marsili & Ray, 2012). Tiger nut milk or "horchata" can be drunk by diabetics for its content in low-glycemic carbohydrates (mainly starch) and due to its arginine which liberates hormones that produce insulin (Aletor & Ojo, 2014). Tigernut milk is also a suitable drink for celiac patients, who are not able to tolerate gluten and also for the lactose-intolerant who stay away from cow milk and many dairy foods. It could also be recommended for those who have problems with digestion, flatulence, and diarrhea because it provides some digestive enzymes like catalase, lipase, and amylase (Bixquert, 2013 ; Adejuyitan 2011 ). It was also found to assist in reducing the risk of colon cancer (Adebowale, Adeyemi & Oshodi, 2014). This tuber is rich in energy content (starch, fat, sugar, and protein), minerals (mainly phosphorus and potassium), and vitamins E and C thus making this tuber also suitable for diabetics and for those intent on losing weight (Bankole & Eseigbe, 2014).

This article will help to educate nurses about the concept of tigernut, its nutritional composition, properties, health benefits and negative health implications of tigernut consumption.

**Objectives**

The objectives of this paper are to:

1. Explain the concept of tigernut
2. Discuss the health benefits of tigernut
3. Discuss the negative health implications of tigernut consumption

**Concept of Tigernut**

Tigernuts are not actually nuts but tubers found on the root of a sedge plant. It was first discovered 4000 years ago and comes in several varieties (Deatra, 2013). The tubers were originally cultivated by ancient Egypt's populations at the Nile valley. Their cultivation was subsequently extended throughout other areas with temperate climate and fertile soil. Reports have shown that tigernuts came to Spain from Africa (Deatra, 2013). Tigernuts are edible tubers with a sweet nutty flavour. Other common names for these tubers are "earth almond" and "yellow nut sedge". They are quite hard and are generally soaked in water before consumption. In Egypt and the Mediterranean nut sedges were used as sources of food, medicine and perfumes (Linseen, 2013). Tigernut tubers were routinely roasted and consumed by nursing mothers. The dried ground tubers were used in coffee and chocolate drinks (Moore, 2014). Oil extracted from the tubers was an ingredient in soap maikng as well as a lubricant for fine machinery. The leafy plant parts of the nut sedge were fed to livestock. Egyptians made very efficient use of the nut sedge. They used them in cultivation as early as 2400 BC. One such example of tigernut is

depicted in a wall painting of an Egyptain tomb in 15th century BC (Deatra, 2013). In the painting, workers are shown to be weighing the nuts while a scribe records their work (Ball, 2014). In another part of the same tomb, instructions were written for eating the tubers as sweets after grinding and adding honey. Tigernut tubers have been found in the tombs and are considered to be locally domesticated in Egypt. This gives the impression that the tubers were greatly valued by the Egyptian people as a food source (Deatra, 2013)

**Ecology of Tigernut**

Tigernut is common in seasonally wet grassland, irrigated crops, damp grassland, and along banks, but at the same time is considered fairly drought resistant (Bera & Mukherjee, 2014). It does not tolerate shade. Best yield are obtained with moderately high temperature throughout the growing season, and well distributed rainfall. High temperature of 27 - 30 ºC, with low nitrogen levels favors tuber formation. Light sandy loamy soils of PH 5.5 - 6.5 are preferred, but can grow in any soil provided it is well drained. Alluvial soils containing relatively high quantities of Manganese (Mn), sulfur (S), calcium (Ca), Magnesium (Mg), and boron (Bo) are particularly suitable (Ball, 2014). It is tolerant of salty soils. Short photo periods of 8-12 hours favor tuber formation and long photo periods of more than 16hrs favor vegetative growth (Food and Agriculture Organization (FAO), 2012).

Tigernut cultivation requires sandy soil and a mild climate. Tubers are soaked in water for 24 – 36 hours before being planted out, either by hand or using a drill. In United States of America, tubers which had been chilled were found to germinate better and to produce more sprouts per tuber (Ball, 2014). Tubers may be planted at 10-15cm intervals along rows 60-90cm apart, about 2.5-4cm deep. At closing spacing, 1 tuber per hole is used, with 2 per hole at wider spacing seed

rates (FAO, 2012). Tigernuts are planted during March, April and May and must be irrigated every week until they are harvested in November and December. Harvest time may take 90-120 days only and at the end of dry season. Immediately after harvest, tigernuts are washed with water in order to remove any sand and small stones. Once the Tigernuts have been cleaned, they are dried out in order to preserve them (Bender, 2013). This is a natural process that requires 1-3 months. Temperature and humidity levels are carefully monitored during this period. The Tigernuts are turned over every day to ensure uniform drying. Small and damaged tigernuts are removed before packaging and utilization (FAO, 2012).

**Nutritional composition of tigernuts and its products**

Food and Agriculture Organization (2012) showed that tigernut tubers are rich in starch (20-30%) and fat (20-28%) with small quantities of protein which is about twice of that of cassava (Addy & Eteshola, 2014). Tigernuts have relatively higher fat content and gross energy, and in this regard compared better with nuts than that of cereals which also belong to the same other Cyperales. Research has been done on the oil extracted from the seeds of yellow nut sedge (*Cyperus esculentus* var. *esculentus*) as a non-conventional oilseed (Moore, 2014). This study was used to determine oil substitutes for more conventionally used oil types such as soybean, palm and olive oils. Non-conventional oils would be less expensive and therefore more available to poorer (developing) countries.

Tigernut oil is 80% unsaturated fatty acid, mainly oleic (64.2 – 68.8 %) and this shows that tigernut oil has a good potential as a substitute for imported olive oil (Deatra, 2013). Fat in diets provide twice much energy as carbohydrate or protein, thus low fat diets are recommended to aid weight control. Different types of fat (fatty acids) have different effects on health and the risk of

diseases states such as coronary heart disease (CHD). Saturated fatty acids (SFA) increase levels of blood cholesterol and should be avoided whenever possible. There is evidence that the replacement of SFA with monounsaturated fatty acid (MUFA) may have a favorable effect on the risk of CHD. Valls (2013) investigated types of fat intake in relation to CHD risk in women and reported that for every increase of 5% in energy from MUFA there is a decrease in CHD relative risk of 0.81%.

Tigernut is a good source of phosphorous, potassium and iron. It also contains magnesium, calcium, zinc, copper, sodium and manganese (FAO, 2013). Phosphorus found in plant is usually bound to a compound called phytate meaning that it is poorly absorbed from the gut into the body. Phosphorous (P)**,** together with calcium, constitutes the bulk of the mineral substance of the bones and teeth. It plays a part in the formation of ATP (an energy compound indispensable for "activating" glucose, fatty acids, etc) and in improvement of intellectual performance. Phosphate is important in the body. It helps regulate acidity/ alkalinity by acting as a buffer (Moore, 2014). Potassium (K) is important in maintaining electrolyte and chemical balance between the tissue cells and the blood. K is the most important neural element in intracellular behaviour. It plays a part in numerous enzymatic reactions and in important physiological processes, such as cardiac rhythm, nervous conduction, and muscular contraction.

Iron (Fe) in food is often in a complex form. Vitamin C aids in the absorption of iron. Vitamin C is a reducing agent and changes Fe into a more easily absorbed form. An acid medium also helps Fe absorption. Consequently, Fe helps prevent anaemia. Zinc has a wide variety of functions in the body and is found in all body tissues. It is involved in many enzyme reactions including those involved in energy generation from carbohydrate, fat and protein. It also has a role in cell division, the transport of carbon dioxide and oxygen in the blood and also in immunity. Since it

has a wide range of role in the body, symptoms of zinc deficiency are also wide-ranging and include a delay in wound healing, poor appetite, a suppressed immune system and poor growth (Wardlaw & Kessel, 2012). Magnesium is also involved in many enzyme systems and in particular those involving the currency of energy in the body, ATP. Magnesium is also required for the synthesis of proteins, the production of energy and muscle contraction (Moore, 2014).

Bosch, Alegria & Farre (2015) observed that the essential amino acid contents of tigernuts were greater than those proposed in the protein standard for adults by the FAO/WHO, with the exception of histidine. The arginine content (1414.0 ± 4.75 mg) is found to be very high compared to the other essential amino acids while the Tyrosine (50.0 ± 0.13 mg / g N ) and methionine content as total sulphur (58.1 ± 0.62 mg) is found to be low. Lysine content of tigernuts (307.5 ± 0.30) may supplement foods deficient in lysine such as maize. This can be useful in the development of multi-mixes in infant nutrition. A 200 ml glass of "horchata" contains about 1.12% starch, 1.30% fat, 12.60%, protein; 0.35% carbohydrate, 0.38% fibre and 132 Cal energy value (FAO, 2012). Tigerwhite, a brand of vegetable milk by Bottlegreen contains vitamins E, thiamin, niacin, vitamin B6 and folate (Moore, 2014).

**Properties of Tigernuts**

There is little documentation on the physico-chemical, functional and organoleptic properties of tigernuts (Satin, 2015). Physico-chemical and functional properties influence the food quality. The term "functionality" as applied to food ingredient's usefulness in food (Satin, 2015). Most functional properties play a major role in food ingredients during preparation, processing or storage. The functional properties of tigernuts can predict how tigernuts should be used in food formulations. Tigernuts are rich in starch. Starch has two major components: amylose and

amylopectin. These polymers are very different structurally with amylose being linear and amylopectin highly branched - each structure playing a critical role in the ultimate functionality of the native starch and its derivatives. Viscosity, gelatinization, texture, solubility, tackiness, gel stability, cold swelling and retrogradation are all functions of their amylase/amylopectin ratio (Satin, 2015). Functionality is the key to marketing starches in the wide range of food applications. No other ingredient provides texture to as many foods as starch does. Whether it is a soup, stew, gravy, pie filling, sauce or custard, starch provides a consistent shelf-stable product that consumers rely upon. Viscosity is a useful criterion of desegregation (such as is produced in the initial states of hydrolysis of proteins, starch and pectin). It is important in influencing the processing, preparation and quality attributes of foods. The extent of specific functional properties of starches required by the food industry is almost unlimited and includes the following: specific viscosity (hot and cold) freeze-thaw stability (natural/modified) clarity, opacity, processing conditions tolerance, gel formation, flow properties, emulsion stabilizing capacity, mouth feel, lubricity, palate-coating, suspension characteristics, bland taste, long shelf-life stability, colour, anti-caking, cold-water swelling or dispersibility swelling and resistance to swelling film-forming properties (Marsili, 2013). Satin (2015) reported that starches obtained from starchy tubers and rice showed similar properties; the solutions of the starches exhibit good paste stability, clarity, and adhesive strength. Starch can be used in many starch-based foods as well as in the cosmetic industry, and for laundry, glazing and stiffening. Starch from tigernuts gelatinizes efficiently and it has low levels of tannin that could exert some inhibitory effects on the activities of the amylases (Umerie & Uka, 2014).

The oil in tigernuts can be classified as stable, non-drying (lauric) oil, as implicated by its very low iodine value (<100), sharp melting point, and low un-saturation. Tigernut oil shares with coconut oil,

an exceptional saturated oil, olive oil and groundnut oil the common feature of remaining liquid at room temperature for the same possible reason of having a preponderance of relatively short-chain saturate fatty acids. The heat of combustion of tiger nut oil (9500 g cal / g) qualifies it edible oil. Since the oil is low in solidification point (-2 to -4) it makes it a requisite for salad and cooking oil. The oil can be used as an accompaniment or for cooking food. Less fat is absorbed into food during cooking as a crust is formed on the surface, preventing the oil itself from being absorbed (FAO, 2012). Tigernut oil has a very low viscosity making it a suitable substitute for industrial applications in petroleum and natural gas (Deatra, 2013). Tigernut oil is stable and could be used for diverse purposes and applications including polish, shampoos, soaps, and by-products, margarine, salad and cooking oils (Umerie & Uka, 2014). Tigernuts are rich in carbohydrate reserves and they have a natural sweet vanilla. Almond flavoured taste. Sugar acids and reducing sugars (polyhydroxy-carbonyl compounds) show a browning reaction (or caramelization) when heated a relatively high temperatures. Browning reaction is accelerated by the presence of carboxylic acids and their salts, phosphates, metallic ions and nitrogenous substances present in foods (FAO, 2013).

**Nutritional and Health Benefits of Tigernut**

Tigernuts and its products are rich in carbohydrates, monosaccharides, disaccharides and polysaccharides (Moore, 2014). They contain relatively high levels of protein, oleic acid (monounsaturated fatty acid which has a bigger resistance to chemical decomposition) and fat (Moore, 2014). Tigernuts have excellent nutritional quality with a fat composition similar to olive oil and rich mineral content, especially phosphorus and potassium (FAO, 2012). Tigernut oil has a mild, pleasant flavour and is considered as food oil similar but superior in quality to olive oil. The polyunsaturated fatty acid content (linoleic acid & linolenic acid) is enough to cover daily minimum needs of about 10g (Moore (2004). Tigernut oil has high content of

Vitamin E (alpha-tocopherol), and thus higher oxidative stability than other oils**,** due to its content of polyunsaturated fatty acids and gamma-tocopherol.

Tigernuts may need to rely significantly on its health benefits, promoting a rich monounsaturated fatty acid content, high vitamin E levels and prebiotic qualities (Moore, 2004). Vitamin E, an antioxidant which protects the body form free radical attack, is vital for the maintenance of cell membranes. It may also play an important role in delaying cells from aging thereby improving the elasticity of skin. Vitamin E is good for treatment of acne and other skin "alterations". It is particularly important in areas of the body exposed to oxidative stress such as the lungs and the red blood cells. Vitamin E may reduce the risk of cancer and heart disease due to its role as anti-oxidant, however research in this area is currently inconclusive (Wardlaw & Kessel, 2012). In supra-nutritional doses, Vitamin E has been claimed to benefit diseases associated with oxidative stress including cardiovascular disease, cancer, Alzheimer's and Parkinson's disease (Bunden, 2014). Tigernut oil has therapeutic properties as it reduces "bad" cholesterol (LDL-cholesterol) and increases the "good" one (HDL-cholesterol). It can also reduce levels of triglycerides in blood, reduce risk of formation of bloody clots, produce dilatation in veins and prevent arteriosclerosis.

Tigernut oil exhibits positive effects on digestive secretions (gastric, pancreatic and bile), due to high content of oleic acid, the most powerful stimulator of production of Cholecistokinine (Bender, 2013). Tigernuts may prevent heart attacks, thrombosis and activate blood circulation. The high contents of soluble glucose in tigernuts prevent cancer. Recently, some investigators discovered that they reduce the risk of suffering colon cancer. Tigernuts have relative antioxidant capacity, because they contain considerable amount of water-soluble flavonoid glycoside (a phytochemical). Consumption of antioxidant could protect the immune system of malnourished

populations. The intake of antioxidant containing foods may delay the progression of HIV infection to AIDS (Obizoba, 2014). The high fibre content of tigernuts combined with its delicious taste makes them ideal for healthy eating. The high content of fiber content of tigernut has a good effect on digestion (Obizoba, 2015). This is because fibre stimulates digestive juices, contributes to a longer feeling of fullness and speeds up transit in the intestinal tract and so prevents constipation. Tigernut may have prebiotic qualities, a result of the short chain carbohydrates called oligosaccharides, which feed probiotic bacteria helping to promote intestinal health (Nnam, 2012). Moore (2014) reported that levels of oligosaccharides have not been measured in tigernut, however they were found in the milky drink "horchata". The oligosaccharides, which are short chain carbohydrates and have shown the most promise as potential prebiotics. Recent research has also suggested that oligosaccharides may increase the absorption of the minerals calcium and magnesium. These effects were observed with doses in the range of 5-10 g per day (Delzenne, 2013).

The amino acid profile of tigernuts is dominated by arginine (Coffman & Garcia, 2014). Although arginine is not an essential amino acid, it has been termed „conditionally essential". It is essential in the fetus and the neonate. In adults it may have a role in disease states especially where tissue is being broken down such as in sepsis or trauma (Wu, Meininger & Knabe, 2013). The area of arginine remains an exciting area of nutrition research, however it must be noted that some of the effects may require pharmacological doses, at a much higher level than that supplied by our regular diet (Moore, 2014). Many of the postulated beneficial roles of arginine are related to the fact that it is a precursor for nitric oxide (NO). NO is a vasodilator produced by the endothelial cells of the vascular system and has an important role in the regulation of the cardiovascular system. This "endothelium-derived relaxation" is impaired in conditions such as

diabetes, high blood pressure and high plasma cholesterol (Pieper, Jordan, Adams & Roza, 2016) demonstrated in animal studies that oral administration of L-arginine could normalize endothelial relaxation in diabetic rats. Guigliano, Marfella and Verrazzo (2013), however, showed that intravenous infusion of L-arginine (3-5g) to humans could reduce blood pressure in diabetic men. In men with high blood cholesterol levels, 21g per day of intravenously administered arginine improved endothelium derived relaxation. This intravenous dose is much higher than the level of arginine consumed in a usual diet (Moore, 2014). Tigernuts are free from gluten cholesterol. They have very low sodium content (Satin, 2015). Scientific analysis on the "nutritional and dietetic aspects of tigernuts", "digestive aspects of tigernuts" and "effects of tigernuts on heart diseases and related aspects" concluded that tigernuts have high content of oleic acid, have positive effects on cholesterol levels due to high content of vitamin E (Farre, 2013). Tigernuts are suitable for diabetic persons, ideal for children, older persons and sportsmen and are very healthy. For many years, tigernuts have been considered to have adequate properties to fight respiratory infections, and some stomach illnesses (Coffman & Garcia, 2014). Zimmermann (2013) concluded that tigernuts reduce the risk of colon cancer and are suitable for diabetic and obese persons. To this date, "horchata" is considered an effective remedy for diarrhea, according to popular tradition in Valencia, Spain. "Horchata", a natural sweet tasting vegetable milk can be extracted directly from tigernuts and used as a refreshing drink which can also serve as substitute for cow milk. The following characteristics make "horchata" a perfect substitute of vegetable milk (Moore, 2014):

1. It is ideal milk for persons that do not tolerate gluten (celiacs) or that are allergic to cow milk and its derivates.

2. 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.
3. The high content of oleic acid and the amino acid arginine prevents arteriosclerosis.
4. It is suitable for diabetic persons.
5. It is recommended for persons with digestion disorders, flatulence and diarrheas, because of the content of digestive enzymes (lipase, catalase and amylase).
6. It is high phosphorus, potassium, calcium, magnesium and iron.
7. It has considerable amounts of vitamins C and E.

**Negative Health Implications of Tigernut Consumption**

Generally, there are no gross health implications of tigernut consumption as the benefit of its consumption outweighs its negative health implicaions (Bunden, 2014). Despite this, it has been found that tigernut contains antinutrient factors (Bender, 2013). Antinutrient factors are natural or synthetic compounds that interfere with the absorption of nutrients (Bender, 2013). Nutritional quality of a food may be dictated mainly by its chemical composition and the presence of anti-nutritional factors, such as phytic acid, tannin and trypsin inhibitor. Phytic acid, a principal storage ubiquitously distributed in plants was reported to be about 724 mg per 100 g (Linssen, 2013). However, reports have been made by researchers that fermentation, hydrothermal treatment and some other processing methods are able to nullify or reduce this antinutrient effect (Obizoba & Atti, 2012). Therefore the level of antinutrient in raw tigernuts could be reduced by processing.

There are no reported cases of tigernut toxicity (Adebajo, 2013). However, Ochratoxin A (OTA) has been found as a contaminant in tigernut. Ochratoxin A (OTA) is a mycotoxin produced by different species of *Aspergillus* and *Penicillium* (Adebajo, 2013). It is found as natural contaminants in many foodstuffs including cereals, dried fruits, cocoa, wine, poultry eggs and milk. OTA is immunosuppressive, teratogenic, genotoxic and mutagenic. The problem with mycotoxin contamination in herbal plants is that they are consumed directly, unlike other products such as maize and groundnuts, which may undergo some processing before eating (Adebajo, 1993). Besides, the presence of aflatoxins in tigernut at toxicologically unsafe levels (Addy & Eteshola, 2014). Bankole and Eseigbe (2016) detected aflatoxins in 35% of tigernut with concentrations ranging from 10-120 g / kg collected from different parts of Nigeria, and the incidence of *Aspergillus flavus* and aflatoxin contamination was found to be correlated.

Futhermore, tigernuts should be eaten in only moderate amounts at any one time. Ingestion of 300 g of the fibrous dehydrated nuts, chewed without being rehydrated has been known to cause fecal impaction (Ball, 2014). Tigernut is a good source of nutritional fibre . Fibre aids digestion. However, excessive intake can lead to stomach problems like bloating, diarrhoea and flatulence. This is why the Unites States' National Institute of Health (2014) suggests that adults should eat between 20 and 35 grams of fibre per day. Also, the University of Chicago (2014) also states that for children less than two years, about 75 per cent of them develop nut allergies on their first exposure. A serious allergic reaction is known as anaphylaxis which can cause stomach collapse, low blood pressure and loss of consciousness. Despite these few possible side effects, tigernuts have more positives than negatives.

**Summary**

Tigernut *(Cyperus esculentum)* is an edible perennial grass-like plant with spheroid tubers, pale yellow cream kernel surrounded by a fibrous sheath (Temple, 2014). Tigernuts are not actually nuts but tubers found on the root of a sedge plant. It was first discovered 4000 years ago and comes in several varieties (Deatra, 2013). 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 (Grossman & Thomas, 2012). Unfortunately, despite these potentials in tigernuts, it has been a neglected crop in Nigeria. This probably may be due to inadequate knowledge on its production, utilization and nutritional value (Grossman & Thomas, 2012). Variety of food products can be derived from tigernut tubers though there is little documentation at large (Moore, 2014). One ounce of tigernuts contain numerous nutrients in varying proportions of which some are; 120 calories, 19g carbohydrate, 2g protein, 7g fat, 10g fiber, 1.8mg iron, 28mg magnesium, 1.1mg zinc, 215mg potassium and 0.1mg vitamin B6 (Moore, 2014).

Tigernut contains a high load of antioxidant that protects the body from coronary heart disease and cancer. It serves as a great source of fiber for the body, it holds antibacterial properties, works as a prebiotic, helps control diabetes mellitus, improves sex lives of both man and woman and it helps lower bad cholesterol and reduces the risk of developing arteriosclerosis. Generally, there are no gross health implications of tigernut consumption as the benefit of its consumption outweighs its negative health implicaions (Bunden, 2014). ). Despite this, it has been found that tigernut contains antinutrient factors which impair the absorption of nutrients from the gastrointestinal tracts. Other negative health implication is the risk of fecal impaction and

stomach problems if it is eaten more than 300g in a day. Also, there is risk of allergy to tigernut if eaten for children less than 2 years.

## Conclusion

In conclusion, despite the diverse benefits in tigernut, it has been a neglected crop in Nigeria especially in the southeastern part of Nigeria. This probably may be due to inadequate knowledge on its production, utilization and nutritional value. Therefore, nurses play a key role in the education of the public about the nutritional benefits of tigernut.

## Recommendations

The recommendations were made based on the information gotten from the reviewed literatures. They include:

1. Nurses should help increase the awareness of tigernut and its benefit to the members of public by first organizing seminars among themselves to know all that is needed to be known about tigernut.
2. Tigernuts and its product could be used in diets by young and old, pregnant and lactating mothers, for its high energy, iron and vitamins C and E content.
3. Tigernut milk extract could be used as an excellent substrate or medium in food fermentation processes and also as food additives (colouring agents, flavouring agents, sweetening agents, rising agents) in foods, confectionaries and bakery.
4. High fiber content of tigernuts could be explored in formulating diets for relieving constipation problem, diabetics, weight watchers and the obese.
5. In addition, high potassium to low sodium ratio of tigernuts may be imperative in diet formulations for patients with high blood pressure and oedema as well.

6. There is need for further development of products based on tigernuts for households and commercial purposes to ensure food security. These in turn will increase its production and utilization, thereby making it more popular.
7. There is also need for further experimental investigation geared towards ascertaining the nutritional quality of tigernut products, identifying microbial species and enzymes found in tigernuts and its products using standard cultural, morphological and biochemical characteristics.

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