Tigernut and Its Food Application: A Review

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Abstract: Tigernut is a tuber crop with an exquisite taste and many properties for a healthy diet. It is a tuber that has been used for centuries in major parts of Africa. Tigernut has high-energy content (starch, fats, sugars and proteins), it is rich in minerals such as phosphorus and potassium and in vitamins E and C, soluble glucose and oleic acid. The purpose of this study is to review literature findings on tigernut and its food applications. Tigernut has attracted very little scientific findings and it is an underutilized crop that is yet to be fully exploited. Development of new food products from tigernut could enhance more interest in this crop and contribute to food security of many developing nation.

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1. Introduction

Tigernut (*Cyperus esculentus var. sativus),* an emergent grass- like plant belonging to the sedge family, is also found to be a cosmopolitan perennial crop of the same genus as the papyrus plant that is common in seasonally flooded wetlands. It is widely distributed in the temperate zones within South Europe as its probable origin, and has become naturalized in Ghana, Nigeria and Sierra Leone (Anon *et al.,* 1992). Tiger nut is one of the earliest domesticated crops and in fact, was found in vases and was used to embalm bodies of the Egyptian Pharaohs (Watt and Breyer-Brandwyk, 1962). In Nigeria, tiger nut is available in fresh, semi-dried and dried form in the markets where it is sold locally and consumed even uncooked. Tiger nuts are under-utilized due to lack of information on their nutritional potential (Rita, 2009). A lot of people eat the tiger nut without knowing the nutritional benefits and products that can be obtained from it like tiger nut oil and milk.

2. Origin of Tigernut

Tigernut has been considered a foodstuff since ancient times (Pascual *et al.,* 2000). In those times in Egypt, *Cyperus esculentus* tubers were roasted and used as sweetmeat. It was discovered that there are almost no contemporary records of this plant in other parts of the Old World (Zohary and Hopf, 1993). Nowadays, tigernuts are cultivated in Northern Nigeria, Niger, Mali, Senegal, Ghana, and Togo where they are used primarily uncooked as a side dish (Omode *et al.,* 1995). Tigernut is an important representative crop of the Spanish Mediterranean region, with nearly 2450 ha and an annual production of 9000 metric tons (CRDO, 2012). This plant was originally native to the Mediterranean region but its cultivation has now spread to many warm countries (Mohamed *et al.,* 2005). It is usually sown in April and picked in November (Osagie *et al.,* 1986). Tigernut is also cultivated in American countries like Chile (Ormeno-Nunez, 2008), Brazil (De Abreu matos *et al.,* 2008), and the USA, in such states as Lousiana (Moore *et al.,* 1998), Missouri (Kelley and Fredickson, 1991), New Mexico (Taylor and Smith, 2005), and Florida (Mosquera *et al.,* 1996) where it is mainly used as animal feed. However, in many countries, *Cyperus esculentus* is considered a weed (De Vries, 1991) and it is underutilized (Adejuyitan, 2011; Ukwuru and Ogdobo, 2011).

3. Morphology and Cultivation of Tigernut

Tigernut is a tough erect fibrous-rooted perennial plant, 1 to 3 ft high, reproducing by seeds and by many deep, slender rhizomes, which form weak runners above the ground, and small tubers or nutlets at the tips of underground stems (Consejo, 2006). Young tubers are white, while older tubers are covered by a yellow outer membrane; they are usually found within 6 inches of the ground surface. High temperatures and low nitrogen levels increase tuber production and an increased day length (by lighting) will reduce tuber formation. The tuber epidermis (skin) contains substances, which inhibit sprouting of tubers; the plant grows best in moist sandy-loam soils but will grow in the hardest clay, tolerates high soil moisture and is intolerant to shade (Oderinde and Tairu, 1998; James *et al.,* 1991). The plant produces small, oblong tubers in abundance, which is sweet and rich in fat (Aliyu and Sanni, 2009). Like other sedges, the plant is most frequently found inhabiting wet

marshes and edges of streams and ponds where it grows in coarse tufts (Temple *et al.,* 1990). Tiger-nut (*Cyperus esculentus L.)* belongs to the Division–*Magnoliophyta*, Class–*Liliopsida,* Order– *cyperales* and Family–*Cyperaceae* and was found to be a cosmopolitan, perennial crop of the same genus as the papyrus plant (Watt and Breyer-Brandwyk, 1962). The tubers are about the size of peanuts and are abundantly produced in Nigeria. It has many other names like Zulu nut, yellow nutgrass, ground almond, chufa, edible rush and rush nut**.** It is known in Nigeria as Aya in Hausa, Ofio in Yoruba and Akiausa in Igbo where three varieties (black, brown and yellow) are cultivated. Among these, only two varieties, yellow and brown are readily available in the market. The yellow variety is preferred to all other varieties because of its inherent properties like its bigger size, attractive colour and fleshier body. The yellow variety also yields more milk upon extraction contains lower fat and more protein and possess less anti-nutritional factors especially polyphenols (Okafor *et al.,* 2003). Tiger-nut has been cultivated since early times (chiefly in south Europe and West Africa) for its small tuberous rhizomes which are eaten raw or roasted, used as hog feed or pressed for its juice to make a beverage.

4. Product Derived from Tigernut

Tigernut Milk ("Horchata")

The Horchata is vegetable milk extracted directly from the tigernut. It is a refreshing drink, superb as substitute of traditional cow milk with a natural sweet taste. It is a nourishing and energetic product recommended by experts to be taken during any season of the year, especially in dry season when the sun is hot. It is ideal milk for persons that do not tolerate gluten (celiacs) or that are allergic to cow milk and its derivates (Belewu and Abodunrin, 2006). 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 enzyme arginine prevents arteriosclerosis. The high content of fibre has a good effect on digestion, as it stimulates digestive juices, contributes to a longer feeling of fullness and speeds up transit in the intestinal tract and so prevents constipation. It has a high content of minerals, phosphorus, calcium, magnesium, iron and vitamins, where the content of vitamin C and E is especially considerable Recommended for persons with digestion disorders, flatulence and diarrheas, because of the content of digestive enzymes (lipase, catalase, amilase) (Tigernut Traders, 2009).

Tigernut Flour

Tiger nut flour has a unique sweet taste, which is ideal for different uses. It is a good alternative to many other flours like wheat flour, as it is gluten free and good for people who cannot take gluten in their diets. It is considered good flour or additive for the bakery industry, as its natural sugar content is high, avoiding the necessity of adding extra sugar (Anderson *et al.,* 2009). The flour is used to make cakes and biscuits and the oil is used for cooking (Wise, 2009).

Tigernut Oil

This is high quality oil extracted by a cold, virgin process in order to ensure that it retains all the unique nutritious qualities of the Tigernut itself. Tigernut oil was first used by Egyptians 4000 years ago in preference to olive oil. Indeed, it is generally considered a healthier alternative. The oil is golden brown in colour and has a rich, nutty taste (Osagie *et al.,* 1986). The oil remains in a uniform liquid form at refrigeration temperature. This makes the oil suitable for salad making. It has a high oleic acid and low polyunsaturated fatty acid (linoleic acid and linolenic acid) (Okladnikov *et al.,* 1977; Ezebor *et al.,* 2005), enough to cover daily minimum needs for an adult (around 10 g) and low acidity, and so is excellent for the skin. They are high in Vitamin E (alpha and gamma-tocopherol) which prevents ageing. The oil compares well with corn; soybean, olive and cotton seed oil and can thus serve as a substitute for these oils especially in times of scarcity (Jozef *et al.,* 1998). The oil is a potential source of biodiesel and much research has been conducted (He *et al.,* 1996).

5. Nutritional and Medicinal Importance of Tigernut

According to Mason (2009), tiger nuts have long been recognized for their health benefits as they have a high content of soluble glucose and oleic acid, along with high energy content, they are rich in minerals such as phosphorous and potassium, calcium, magnesium and iron necessary for bones, tissue repair, muscles, the blood stream and for body growth and development and rich in vitamins E and C. Milk from tigernut is suitable for diabetic people and also helps in weight control (Martinez, 2003), due to its content of carbohydrates with a base of sucrose and starch (without glucose), and its high content of Arginine, which liberates the hormone that produces insulin (Chevallier, 1996). It is recommended for those who suffer from indigestion, flatulence and diarrhoea because it provides digestive enzymes like the catalase, lipase and amylase. The high content of oleic acid has positive effect on cholesterol, thereby preventing heart attacks, thrombosis and activates blood content of soluble glucose. Tiger nut reduces the risk of colon cancer. It prevents constipation. Tiger nut contains a good quantity of vitamin B_1, which assists

in balancing the central nervous system and helps to encourage the body to adapt to stress (David, 2010). The milk supplies the body with enough quantity of Vitamin E, essential for fertility in both men and women. Vitamin E also delays cell aging, improves elasticity of skin and helps to clear the appearance of wrinkles, acne and other skin alterations.

In China, tiger nut milk is used as a liver tonic, heart stimulant, drank to heal serious stomach pain, to promote normal menstruation, to heal mouth and gum ulcers, used in Ayurvedic medicines and is a powerful aphrodisiac (sexual stimulant). The black species of the tiger nut is an excellent medicine for breast lumps and cancer. The tubers have a relatively high total antioxidant capacity, because they contain considerable amounts of water-soluble flavonoid glycosides. Consumption of antioxidants could protect the immune system of malnourished populations. The intake of antioxidant-containing foods may delay the progression of HIV infection to AIDS.

For many years, the tiger nut tubers have been considered to have adequate properties to fight respiratory infections, and some stomach illnesses. *Horchata de chufa* is considered to this date an effective remedy for diarrhea, according to popular tradition in Valencia, Spain. It promotes the production of urine and this is why it is a preventive measure for cyst, prostrate, hernia, rectum deformation and prolapsed (anal feature-small painful flesh at the tip of the anus) and to prevent endometriosis or fibrosis as well as blockage of the tip of the fallopian tube. The oil reduces low density lipoprotein-cholesterol (LDL-C) and increases high density lipoprotein-cholesterol (HDL-C) (Belewu and Abodunrin, 2006), reduces levels of triglycerides in blood and the risk of forming bloody clots, thereby preventing arteriosclerosis. It also stimulates the absorption of calcium in bones and the production of new bony material, due to short and medium chain fatty acids, oleic acid and essential fatty acids (Temple *et al.,* 1990). It is also recommended for infants and the elderly because of its high content of Vitamin E and its antioxidant benefits in the cell membrane (Davido, 2010).

Utilization of Tigernut

Tigernut has been used extensively mainly for human consumption in Spain [Mason,2009; Tigernut Traders, 2009). The milk can be extracted, treated and bottled. In United Kingdom, tigernut is superb bait for carp fishing (Wise, 2009). In Nigeria, the utilization of tigernut is highly limited in spite of the fact that tigernut is cultivated widely in the Northern part of the country. Tigernuts are eaten raw mainly as snacks or fried and eaten mixed with roasted groundnuts (Abaejoh *et al.,* 2006). It was reported that sweetened tigernut extract are bottled and sold in Ghana (Kofi, 1993). It also finds uses as a flavouring agent for ice cream and biscuits (Cantatejo, 1997) as well as in making oil, soap, starch and flour. Although many researchers have worked on tigernut (Addy and Eteshola, 1994; De Vries, 1991; Eteshola and Oraedu, 1996; Cortes *et al.,* 2005) to mention but a few, yet there is a need for increased utilization and awareness about its applications in food formulation.

6. Previous Research Work on Tigernut and Its Food Application

Belewu and Abodunrin (2006) have also found its usefulness in the preparation of kunnu (a local beverage in Nigeria). The report further shows that kunnu prepared from tigernut were rich in fat, crude protein and mineral content. He therefore concluded that preparation of kunnu from tigernut was cheaper and a more nutritious beverages with high level of acceptability. The chemical composition and functional properties of flour produced from two varieties (Yellow and brown) of tigernut have been studied (Oladele and Aina, 2007). The report shows that tigernut flour from the two varieties is rich source of oil, mineral elements and contain moderate amount of protein. Therefore, tigernut can be find useful application in food formulation. Ade-omowaye *et al.* (2008) reported the use of brown variety of tigernut in breadmaking using 10-50% dilution of wheat flour with tigernut flour. The report further shows that only bread baked from 10% dilution of wheat with tigernut (brown variety) flour was acceptable. Ade-omowaye *et al.* (2009) study the effect of different pretreatment (germinated, fermented, roasted and pregelatinized) on some properties of tigernut as underutilized crop in Nigeria. The report further shows slight variation in the crude fat, fibre and ash contents of the resultant meals after pretreatment. Therefore, pretreated tigernut meal could find useful application in various food formulation and development such as weaning foods, baked foods and beverage products. Adejuyitan *et al.* (2009) also studied some of the physicochemical properties of flour obtained from fermentation of tigernut, in which fermentation process can also be applied to improve the nutrient of the tigernut flour. Chukwuma *et al.* (2010) studied the phytochemical composition and some biochemical effects of Nigerian tigernut tuber. The findings shows that phytochemical (alkaloids, cyanogenic glycosides, resins, tannins, sterols and saponins) were observed in the raw tuber while only alkaloids, sterols and resins were observed in the roasted tuber. Udeozor (2012) studied the proximate composition and sensory qualities of tigernut-soy milk drink. The report further shows that tigernut-soy milk blend had higher protein and fat but low in pH and milk produced from tigernut-soymilk were generally accepted. He therefore concluded that

milk from tigernut and soybean should be encouraged due to high nutrient content so as to solve the problem of protein-calorie malnutrition. Ogbonna *et al.* (2013) also studied the physico-chemical, nutritional and sensory properties of tigernut milk by comparing them with those of peak milk (a popular animal milk product in Nigeria). The report further shows that higher amount of crude fibre, crude fat, total ash and carbohydrates were noticed in tigernut milk than peak milk and the physico-chemical properties of the two milk (tigernut milk & peak milk) varied significantly except pH and total titratable acidity. Awonorin and Udeozor (2014) also worked on chemical properties of Tigernut-soymilk extract. The report further shows that combination of tigernut milk and soymilk extract resulted in milk (beverage) with improved nutrient composition and organoleptic properties. Thus, tigernut and soybean could be used as beverage for both the young and old persons due to the nutrient potentials present in it. He therefore concluded that milk extract from tigernut and soybean should be encouraged because such beverage will be helpful in reducing nutritional related problems such as protein-calorie malnutrition in Africa in particular and in the world generally. Zahra and Ahmed (2014) reported on exploring the suitability of incorporating tigernut flour as novel ingredient in gluten-free biscuit. Corn flour was diluted with tigernut flour in biscuit formulation at three levels of 10, 20 and 30% of tigernut flour. The report further shows that mixture of corn and tigernut flour can be successfully incorporated into gluten-free cereal based products resulting in biscuits of acceptable quality. Otubuah *et al.* (2015) also conducted a research study on development of a tigernut based ready to use therapeutic spread. He therefore concluded that spread produced from tigernut flour were accepted and had an excellent colour, flavour, smoothness, after taste, spreadability and sweetness. Kareem *et al.* (2015) also reported on some quality attributes of high quality cassava-tigernut composite flour and its extruded snacks. The report further shows that inclusion of tigernut flour to high quality cassava flour at varying proportions in production of extruded snacks considerably enhanced the protein contents of the composite flour and also improved some physical and sensory properties of the extruded snacks. Oke *et al.* (2016) also reported the proximate, functional, pasting and rheological properties of dilution of wheat flour with tigernut flour. The study showed that addition of tigernut flour has the advantage of improving the mineral and fibre content of flour. Oke *et al.* (2017) also reported the use of yellow variety of tigernut in breadmaking using 2-10% dilution of wheat flour with tigernut flour. The report further shows that incorporation of tigernut flour into wheat flour bread production has dramatically improved the parameter investigated as well as bread quality. However, bread baked from 8% dilution of wheat with tigernut flour was acceptable. Kayode *et al.* (2017) studied the effect of addition of different spices on the quality attributes of tigernut milk (Kunun-aya) during storage. He therefore concluded that addition of spices had varying effects on the quality attributes of Kunun-aya and could extend its shelf life for 5days under refrigerated conditions. Oke *et al.* (2017) also investigated the potentials of tigernut pomace with dilution of wheat using 2-10% in the production of chinchin. The report further shows that blending of wheat flour with tigernut pomace had significant effect on the functional properties of wheat-tigernut pomace flour blend. However, wheat flour can be incorporated into tigernut pomace up to 10% for the production of chinchin without affecting its overall acceptability.

Conclusion

Tigernut seeds are cheap and readily available but grossly underutilized and needs more attention because of their nutritional qualities. In addition food formulations and food products from tigernut can increase their use in food applications and aid in developing food products with higher consumer acceptance.

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