



Review

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TIGER NUT (*CYPERUS ESCULENTUS*); MORPHOLOGY, PRODUCTS, USES AND HEALTH BENEFITS

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Abstract


Tiger nut or *Cyperus esculentus* originated from Africa and tropical Asia considered some authors, while other authors consider that it is native to tropical and subtropical regions throughout the world. It belongs to the *Cyperaceae* family, which produces rhizomes and spherical tubers. This plant is fast growing up with 20 to 70 cm tall. It lives in a moderate climate with a temperature between 20 °C and 30 °C in all soil types except saline soil. It can be eaten; dry, raw, roasted, or grated, also it can be transformed into milk called "Horchata". With the use of Tiger nut for food purposes mainly in raw consumption (gluten-free flour, ice-cream milk type extract) due to its unique sweetness, as well as, a valuable source for vegetable oils, add to that it has a lot of medicinal benefits (reduces the risk of colon cancer, used as a heart stimulant, effective remedy for diarrhea and anti-inflammatory) and used as high added value compound such as starch, glucose, protein, and minerals. Despite all these previously mentioned benefits and advantages, a low focus had been putting into Tiger nut's researches. Therefore, this work has an aim to review the work done before and mention the great importance of valorizing Tiger nuts. This study gives a brief introduction about *Cyperus esculentus* and describes its morphology and its world distribution.

Keywords: Tiger nut, *Cyperus esculentus*, Nutrition, Oil, Health

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1. Introduction

Tiger nut "*Cyperus esculentus* Lativum" belongs to *Cyperaceae* and it is known by other names like chufa, yellow nutsedge, earth almond and ground almond. It is a perennial crop cultivated extensively in Asia, East Africa, parts of Europe particularly Spain as well as in the Arabian Peninsula (Abdelkader et al., 2017). Tiger nut is a crop of early domestication, its dry tubers have been found in tombs from predynastic times about 6000 years

ago and it was an important food in Egypt where they used their tubers as sweetmeat (Zohary, 1986).

Tiger nut is erect, with yellowish-green leaves, triangular stem about 20 to 60 cm tall, superficial rhizomes that store proteins, starches and other nutrients to lead to the production of many tubers and golden-brown flower head. The plant forms a complex, shallow underground system composed of fine fibrous roots, thin scaly rhizomes, and spherical tubers appear somewhat long or round with a dimension of 8 mm to 16 mm (Abdelkader

et al., 2017). Because of its fast growing is often confused with weeds in some areas. It is ideally developed in well-drained soils, sandy or loamy, with a pH range of 5.0-7.5 and grows best when temperatures over 20 °C (Dyer, 2009).

Tiger nuts are appeared to have more prospective usage as nourishment and industrial materials; it can be used to produce beverage, milk or yogurt, flour, nougat, jam, beer, chocolate, a feed source, edible oil and as soaps (Achoribo and Ong, 2017). Tiger nuts are rich in minerals such as phosphorus, potassium, calcium, magnesium, and iron. It's also rich in vitamins E and C, and a good quantity of vitamin B1 (Maduka and Ire, 2018). Tiger nut assists in stabilizing the central nervous system and helps the body to adapt to stress (David, 2005). Moreover, it defends the internal mechanisms and prevents constipation and diarrhea (Maduka and Ire, 2018).

2. World Distribution

C. esculentus grows almost in all temperate, tropical and subtropical regions of the world like a weed. It's located in the Mediterranean region, Africa, India, North America, Mexico, Peru, and others (CABI, 2020). Most growers of the tiger nut are the West African countries such as Nigeria, Senegal and Ghana. Also Spain is a good producer and exporter of Chufa which is popular there (Ezeh et al., 2014). In Turkey, Tiger nut, which called 'Yer bademi', can be founded as a weed in Northwest of Turkey and Northeast of Anatolia (Tubives, 2020). Two varieties are registered 'SARI ŞEKER' (Figure 1) and 'BALYUMRU' (Figure 2) by Eastern Mediterranean Agricultural Research Institute in Turkey (TTSM, 2020).



Figure 1. Tiger nut tubers: 'Sari Şeker' variety.

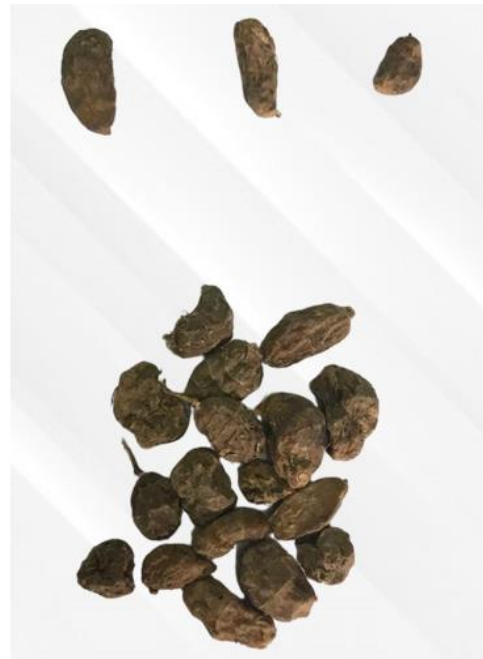


Figure 2. Tiger nut tubers: 'Balyumru' variety.

3. Morphology

Cyperus esculentus is classified in order "Graminales" in class "Angiospermae", subclass, "Monocotyledonae", and a family of *Cyperaceae* which consists of about 75 genera and over 4000 species. Tiger nut can be produced annually by seeds or perennially by corm like solid bulbs at the base of a leaf fascicle or by rhizomes. It is a perennial which reproduces annually by seeds and perennially either by corm like solid bulbs at the base of a leaf fascicle. Yellow nutsedge is a grass perennial fast-growing plant; it is erect, robust and smooth (Figure 3) (Gene, 1987).

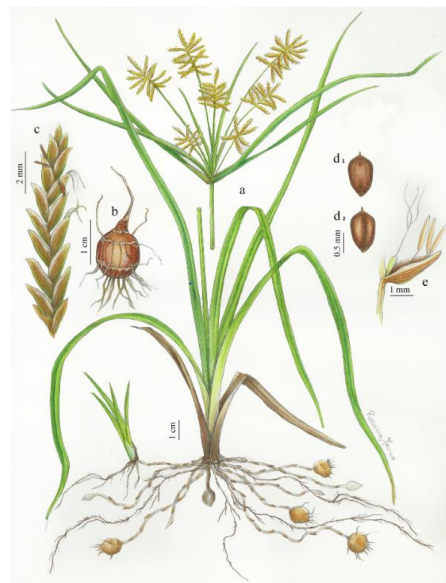


Figure 3. *Cyperus esculentus* (original drawing by Rosaria Manco): (a) habit of the flowering plant; (b) mature tuber; (c) spikelet; (d1) achene: dorsal view; (d2) achene: ventral view; (e) details of flower and rachilla (Follak et al., 2016).

The rachis, 2 to 9 cm long, is terminated by an umbel which is an inflorescence with golden-brown flower-bearing rays in a cluster springing from the same level. The umbel consists of several erect short rays and two to nine strongly ascending longer rays. The umbel is surrounded at the same level with three to nine leaves (Gene, 1987). The inflorescence consists of 5 to 10 unequal stalks bearing terminal spikes with pinnate spikelets and golden-brown flower heads. The small seeds are yellowish, 3 sided achenes that are often not viable (Wilma and Chester O., 1986). Flowers are bisexual and borne in spikelets along a rachilla at the axils of distichous scales, rachilla is persistent, with hyaline wings, 0.3–0.5 mm wide (Figure 4) (Follak et al., 2016). Bright green basal leaves, with a distinctive mid-vein, a waxy surface, gradually pointed tip, arranged in 3, form a sheath around the stem, 4 to 9 mm wide and 20 to 90 cm long (Figure 5).



Figure 4. Tiger nut in the flowering period (Follak et al., 2016).



Figure 5. Tiger nut leaf.

In most cases, this plant is wind pollinated. Individual seeds, often not viable, are borne as achenes with a thin outer covering that remains intact after maturity. The achenes are yellowish-brown, three angled, and 1.2 to 1.5 mm long (Wilma and Chester, 1986). *C. esculentus* is characterized by white and superficial rhizomes with a segmented aspect which are connected to small tubers. At the end of the growing season and near maturity stage the color of tubers changed from white to yellow and the dimension is increased. Vegetative colonies of plants are often produced from the tubers and their rhizomes. Tubers are 6 to 10 mm long and located at the end of slender rhizomes which when mature become wiry and hard to break (Figures 6 and 7). Chufa is usually highly productive, and one plant may produce hundreds of tubers (Bamishaiye and Bamishaiye, 2011).



Figure 6. Fresh tiger nut tubers (Maduka and Ire, 2018).



Figure 7. Dried tiger nut tubers (Maduka and Ire, 2018).

4. Climate and Soil Requirements

Tiger nuts can take only 90 to 110 days to mature if it is properly managed according to the plant's requests mentioning by researchers, it is planted in April-July and harvested in September-November (Maduka and Ire, 2018). Chufa can't grow up well on sites that are intensely wet or flooded; also it can't endure drought or salinity. It develops best in slightly acid to neutral soils (pH 5.0 to 7.5) of fine texture and high moisture content

(Merrell, 1975., Wilma and Chester, 1986). The ideal germination is initiated at temperatures at or above 20°C but optimal germination accumulates when temperatures alternate between day and night are 30 °C and 20 °C respectively (Wilma and Chester, 1986). Pascual-Seva et al (2016) reported that planting *C. esculentus* in raised beds with drip irrigation increases yield compared to the traditional crest planting system without reducing the average size of the tubers. Also, they find that sowing rhizomes in beds with three plant rows using two drip lines lead to the highest irrigation water-use productivity.

5. Usage and Products

Tiger nut tubers can be eaten snacked, roasted, fried or baked, also it can be used in food product to make flour, starch, cakes, and biscuits. It can also be an aroma of ice cream and cookies for its particular sweetness (Gambo and Da'u, 2014). About 4000 years ago, Tiger Nut Oil (TNO) has been used by Egyptians in medicine. Besides, it has thought been identified to be suitable as frying oil and cosmetic products (Mohdaly, 2019). Tubers must be sorted, cleaned and dried after harvesting in order to be used. The drying method is different according to the producer's wishes (milk, oil, flour etc.) it can be a natural or an artificial drying (Asante et al., 2014; Kareem et al., 2015). In Spain especially in Valencia where chufa is frequently used there, tubers can be made into a refreshing beverage to make a kind of milk called "Horchata" (Mohdaly, 2019). The caramel extracted from malted tubers of tiger nut can be used to make, flavor, or color to some baked products. Moreover, it may be added for non-alcoholic malt beverages and dark beers, and in condiment products (Bamishaiye and Bamishaiye, 2011).

6. Health and Benefits

For 4000 years, tiger nut has been used as a healthy plant because of its content of several minerals, energy, and oleic acid. It has a high content of arginine which liberates the hormone that produces insulin, besides its content of carbohydrates with a base of sucrose and starch (Bamishaiye and Bamishaiye, 2011). Tiger nut tubers are benefit for bones, tissue repair, muscles, the bloodstream and body development due to its richness in phosphorus, potassium, calcium, magnesium and iron necessary (Mohdaly, 2019). Phosphorus and calcium, as basic elements in tiger nut tubers, constitute the bulk of the mineral substance of the bones and teeth. It has an impact in the formation of ATP, a vitality compound imperative for "activating" glucose, unsaturated fats, etc. (Achoribo and Ong, 2017). Potassium plays a role in many enzymatic responses and significant physiological processes such as nerve conduction, heart rhythm, and muscle contraction (Mohdaly, 2019). Also, tiger nut is thought to have a preventive effect against cardiovascular diseases and cancer because of its content on vitamin E which plays a role on the formation and functioning of the red blood cells. (Gambo and Da'u, 2014).

Vitamin C in tiger nut is a good antioxidant, promotes iron absorption and helps in maintaining vitamin E levels essential for the immunological system and tissue preservation (Roselló-Soto et al., 2019). Because it contains a high amount of vitamin B1, tiger nut assists in adjusting the central nervous system and encourage the body to adapt to stress (David, 2005). Tiger nut was reported to be high in dietary fiber content, which is effective in the treatment and prevention of many diseases such as colon cancer, coronary health diseases, gastro intestinal disorders, obesity and diabetics (Achoribo and Ong, 2017). Besides, it is aphrodisiac, carminative, diuretic, emmenagogue, stimulant and tonic. It is used also in the treatment of flatulence, indigestion, diarrhea, dysentery and excessive thirst (Adejuyitan, 2011). Tiger nut oil has a golden brown color and a rich nutty taste, is one of the highest oleic acid contents that it has a lipid and fatty acid profiles very similar to the olive oil. It has a high oleic acid and low polyunsaturated fatty acid and low acidity, which make it excellent for the skin. It has higher oxidation stability than other oils, due to the presence of polyunsaturated fatty acids and gamma-tocopherol (Mohdaly, 2019). Also, it is recommended for cooking over other oils since it is more resistant to chemical decomposition at high temperatures. Furthermore, in the textile industry, oil is used to waterproof textile fibers. It is additionally a potential source of biodiesel (Bamishaiye and Bamishaiye, 2011). *C. esculentus* oil is rich mineral content, especially phosphorus and potassium and a high quantity of vitamin E (alpha-tocopherol) (Mohdaly, 2019; Roselló-Soto et al., 2019). Tiger nut oil is reported to be an; antioxidant, anti-arthritic, anti-inflammatory, analgesic, antibacterial, atherosclerotic and anticonvulsant (Krichène et al., 2016). The milk extracted from tubers "Horchata", as they call in Spain, is extracted by cleaning and soaking the batches of fresh tiger nut samples in cold water for 24 hours, wet milled with about two liters per kilogram of water, using a clean sterilized blender. This was followed by filtration using a muslin cloth to remove the chaff from the milk. The tiger nut milk is very nutritive and serves as a good source of energy (Oyetoro et al., 2019). It is a rich source of minerals such as iron, magnesium, and carbohydrates more than the cow's milk, in addition to phosphorus, potassium, calcium, unsaturated fats, proteins and some enzymes which help in digestion. On the other side, it's not containing lactose, casein, sugar or proteins of the milk, or cholesterol and is, therefore, an ideal drink for people who do not tolerate gluten or cow's milk (Bamishaiye and Bamishaiye, 2011). Tiger nut milk contains vitamin E which delays cell aging, increases skin elasticity and helps relieve the appearance of wrinkles. Besides, it is essential for fertility in both men and women, besides it is considered as a heart stimulant, liver tonic, drank to heal serious stomach pain, to promote normal menstruation and is a powerful aphrodisiac (Mohdaly, 2019). The Milk is recommended for those who suffer from indigestion, flatulence, and diarrhea because

it provides digestive enzymes like the catalase, lipase, and amylase (Adejuyitan, 2011).

7. Chemical Composition of Tiger Nut Tuber

The researches done to identify the chemical composition of tiger nut tubers indicated that the moisture content of tiger tubers was (8.50%). The carbohydrate was found to be the first component in these tubers (45.73%) followed by oil content (30.01%). Moreover; protein, ash and crude fiber of tiger nut tubers were (5.08%), (2.23%) and (14.80%) respectively. The starch content of tiger nut tubers was (293.50 g/kg) followed by sucrose content (99.35g/kg) and reducing sugar (27.61g/kg) (Arafat, 2019; Roselló-Soto et al., 2019).

The high quantity of minerals in tiger nut tubers was potassium, phosphor, magnesium calcium, sodium which were 267.18 mg/100g, 158.86 mg/100g, 118.14 mg/100g, 43.36 mg/100g and 17.02 mg/100g respectively (Suleiman et al., 2018).

8. Conclusion

Due to the attempts to change many sources of alimentary products such as ash, gluten, protein, sugar, etc., by other healthy sources, tiger nut is one of the best solutions. Its high content of nutrients and minerals, also the high oil quality makes it an important alimentary and medicinal plant. Therefore, Tiger nut should have broader research and more use regarding its important benefits for human health. For this reason, it will be beneficial to carry out studies, especially in marginal areas where agricultural production is limited and to increase research on production and medicinal uses.

Conflict of interest

The authors declared that there is no conflict of interest.

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