Journal

J. Biol. Chem. Environ. Sci., 2019, Vol. 14(1): 301-318
http://biochemv.sci.eg

NUTRITIONAL VALUE OF TIGER NUT (*CYPERUS ESCULENTUS L.*) TUBERS AND ITS PRODUCTS

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ABSTRACT

The purpose of this study is to identify the nutritional value of tiger nut tubers and their products. Tiger nut tubers *(Cyperus esculentus L.,)* cultivar were collected from Tanta city, Egypt. The chemical composition and mineral analysis of tiger nut tubers were determined. Extraction of oil and determined of some physico-chemical properties of oil and identification of fatty acids composition (%) by gas liquid chromatography (GC). Also, identify of amino acids in tiger nut flour by amino acid analyzer. Preparation of tiger nut milk was processed in lap and compared with soymilk as a control. Also, microbial content of tiger nut milk were determined. In addition to, sensory evaluation of milk made from tiger nut was determined. The obtained data for the composition of tiger nut tubers indicated that the moisture content of tiger tubers was 8.50%. The carbohydrate content of tiger nut tubers 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 results provide additional information about the nutritional value and confirm that of tiger nut tubers are an interesting healthy food such as imitation milk.

Key words : Chemical analysis, milk, minerals, sugars content, tiger tubers.

INTRODUCTION

Tiger nut (*Cyperus esculentus* L.) is an edible perennial grass-like plant native to the Old World, and is a lesser-known vegetable that produces sweet nut-like tubers known as "earth Almonds" **(Cos kuner, *et al.*, 2002).** Tiger nut is also known by various other names as chufa (in Spanish), earth nut, yellow nut sedge, groundnut, rush nut, and edible galingale **(Oderinde and Tairu 1988**).

Tiger nut has been considered a foodstuff since ancient times **(Pascual, *et al.*, 2000).** It was an important food in ancient Egypt **(Negbi 1992).** Tiger nut is a crop of early domestication and was added to other crop of the Nile Valley; its dry tubers have been found in tombs from predynastic times about 6000 year ago **(Zohary 1986).** In those times in Egypt, C. esculentus tubers were roasted and used as sweetmeat. According to **Zohary and Hopf (1993),** there are almost no contemporary records of this plant in other parts of the Old World.

C. esculentus had been reported to be a "health" food, since its consumption can help prevent heart disease and thrombosis and is said to activate blood circulation **(Chukwuma, *et al.*, 2010)**. It was also found to assist in reducing the risk of colon cancer **(Adejuyitan, *et al.*, 2009).** This tuber is rich in energy content (starch, fat, sugar, and protein), minerals (mainly phosphorus and potassium), and vitamins E and C **(Belewu and Belewu 2007)** thus making this tuber also suitable for diabetics and for those intent on losing weight **(Borges *et al.*, 2008)**.The tubers contain about 25 % oil, which are resistant to peroxidation, 50 % digestible carbohydrates, 4 % protein and 9 % crude fiber **(Shilenkoo *et al.*, 1979**; **Emmanuel and Edward, 1984).** The oil extracted from tiger nut can be used as food oil as well as industrial purposes **(Zhang *et al.*, 1996; Barninas *et al.*, 2001).**

Foods based on tiger nut are prepared by a wide range of recipes and preparation methods. The best-know application of tiger nut in food technology is the production of "horchata de chufa" (tiger nut milk) **(Mosquera, *et al.*,1996).** It is also used successfully as a flavoring agent in ice cream. Flour of roasted tiger nut is sometimes added to biscuits and other bakery products **(Cos kuner, *et al.*,2002),** as well as in making oil, soap, and starch extracts **(Adejuyitan 2011). Belewu and Abodunrin (2008)** found tiger nut useful in the preparation of kunnu (a local beverage in Nigeria). 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. In Ghana is also prepared a similar beverage from roasted and another from non-roasted tiger nut **(Sanful 2009).**

Experts are therefore looking into other possible unconventional sources of plant milk, which will be nutritionally uncompromising. One such source could be from tiger nut tubers. It has 5.8% moisture, rich in protein (7%) **(Temple *et al.*, 1990)** and carbohydrates such as reducing sugar (5.6%), soluble polysaccharides (7.4%) and starch (86.4%) **(Temple 1989)**. It also has essential amino acids like lysine, threonine and cysteine in appreciable proportion **(Temple *et al.*, 1990).**

Tiger nut milk (TNM) is an imitation milk product produced by extracting the juice from tiger nut tubers. **Okafor *et al.*,(2003)** reported that yellow variety of tiger nut is bigger in size, has attractive color, fleshy body, yields more milk upon extraction, contains low fat, more protein and less anti-nutritional factors especially polyphenols.

Despite these benefits, tiger nut is currently an underutilized crop in Ghana. It is locally consumed in its fresh state and there is no significant commercial product from the nut although it is highly exploited as cherished milk-like beverage called "Atadwe milk" **(Tetteh & Ofori, 1997).**

The objective of this study is to utilization from tiger nut tubers for the production of imitation milk, determination of chemical composition (%) of tiger nut tubers. Also, measurements of physico chemical properties and fatty acids of extracted oil from tiger nut tubers. The imitation milk was processed in lab and compared with soya milk from Soya Factories in Food Technology Research Institute. Also, sensory evaluation of samples was determined and microbial quality of all samples was measured.

MATERIALS AND METHODS

Experiments were conducted in the departments of the Food Technology Research Institute (FTRI) of the Agricultural Research Center, Giza, Egypt. During the three years 2016-2018

Materials:

Source of tubers: Tiger nut (chufa) tubers (*Cyperus esculentus*) and olive oil were obtained from the local markets at Tanta City, Egypt.

Reagents:

All chemical and reagents of the analytical methods used in present study were analytical grade purchased from sigma-Aldrich Company for chemicals, USA and El-Gamhouria Trading Chemicals and Drugs Company, Egypt. Pure standards of fatty acids methyl esters used in this study were obtained from Koch light Laboratories, Ltd, England.

Methods:

Proximate analysis: A.O.A.C. (2005) methods were used to determine moisture, protein, fat, crude fiber and ash contents while carbohydrate was calculated by difference. Starch content was determined according to **(Abdel-Akher and Michalinos, 1963).** Sugar content was extracted by the method described by **Pearson *et al.*, (1999).**

Minerals analysis: The method described by **A.O. A.C. (2005)** was used for mineral analysis. The ash was digested with 3 cm^3 of 3 Ml HCl and made up to the mark in a 100 Cm^3 standard flask with 0.36 Ml HCl before the mineral elements were determined by atomic absorption spectrophotometer.

Oil extraction: Chufa tubers and olive fruits were crushed and pressed by hydraulics laboratory press. The extracted oils were dried over anhydrous sodium sulphate, filtered through Whitman No.1 filter paper, and kept in brown bottles at 5˚C until analysis.

Physico-chemical properties of oils: Refractive index, color, acid value, peroxide value, iodine number and saponification number were determined according to **A.O. A. C. (2005).**

Stability test (Rancimat induction period):

The induction period measurements were carried out on the tested samples in order to provide a quick indication of the trends in resistance to the oxidative rancidity as well as of the shelf-life of samples. The induction periods, as the oxidative stability index, of the tested samples were measured by an automated Rancimat (MetrohmUd. CH-9100 Herisau, Switzeland, model 679), comprises

of the control unit and the wet section containing 6 reaction vessels, according to the method described by **Berrin and Feral (2008).**

Fatty acid composition determination: Fatty acid composition was analyzed on the gas liquid chromatography (GLC). The oil was etherified before GLC analysis using the method described by Stahle (1967). The methyl esters of fatty acids were prepared using (benzene: methanol: concentrated sulfuric acid 86: 10: 4) and the methylation process was carried out for one hour at 80 – 90°C.

A pye Unicom PU 4550 equipped with dual flame ionization detector was used. The fractionation of fatty acid methyl esters was conducted using a coiled glass column (1.5 mm X 4 mm) packed with diatomic (100 – 120 mesh) and coated with 10 % polyethylene glycol adipate. The oven temperature was programmed at 8˚C / min. from 70˚C to 190˚C then isothermally at 190˚C for 10mn. With nitrogen at 30ml / min. as a carrier gas, the flow rates for hydrogen and air were 30 ml/ min. and 320 ml / min. respectively. Detector and injector temperature were 300˚C and 250˚C respectively. The chromatogram of the authentic fatty acids used to characterize the unknown fatty acids according to their retention times. Present normalization of each fatty acid was calculated by the normalization with response factor method using the PU 4810 competing integration. The fatty acid composition was expressed as percentage of total fatty acid by **Farag *et al.*, (1984).**

Determination of amino acid: Amino acid of chufa nut was carried out in National Research Center, Giza, Egypt, as follows: samples were subjected to acid hydrolysis using 6N Hcl. The hydrolyzate was recovered by removing the acid by evaporation in a rotary evaporator. Amino acids were performed in hydrolyzate using amino acid analyzer. LC 3000 amino acid analyzer, High performance system, a product of LC biochrom EPPDROP. Germany). Amino acids were analyzed according to **A.O. A.C. (2005).**

Preparation of tiger nut milk: The big yellow tiger nut (the most used for Preparation of tiger nut milk). It was sorted out to remove broken, rotlen, stones pebbles, and other dirt soils. It was later rinsed in distilled water and soaked for 6hrs at 60˚C to soften the fiber **(Ejoh *et al.*, 2006).** 500ml of warm distilled water was added to 2.00 of tiger nut and blended several times with sterile Kenwood blender **(Ukwur, *et al.*, 2011).** The mash was through a clean sterile muslin cloth to separate the milk and it was further strained to obtain affine

consistency. The filtered tiger nut milk was transferred into a clean container, pasteurized in a water bath at 100℃ for 15 min, cooled to temperature of 43℃.

Preparation of soy bean milk: one kg of soy bean was soaked overnight for 18hr in 3Lof warm portable water to give a bean: water ratios of 1:3 the beans were then drained rinsed with treated water. The blanched beans were drained, de hulled and ground with 750ml of treated water in Q-link auto- clean blender. The resulting slurry was boiled for 15 min. The samples were duplicated, one portion stored at 4℃ **(Udeozor and Awonorin, 2014).**

Microbial Analysis:

Preparation of Diluents and Media: Diluents (peptone water) and media (nutrient Agar and potato Dextrose Agar) were prepared according to manufacturer`s pacification

Microbial Analysis of samples: One milliliter (1ml) of each sample was serially transferred into nine milliliter (gml) of the sterile diluents (peptone water) with a sterile pipelle and shaken vigorously serial dilution was continued until $10^4$was obtained. Aliquot portion (0.1ml) of the 10^4 and 10^2 dilutions were inoculated onto freshly prepared, surface dried nutrient agar (NA) and potato dextrose agar (PDA), respectively. Nutrient agar plates were incubated for 24-48 h at37℃ while potato dextrose agar plates were incubated at ambient temperature (28±2℃) for 3-5 days.

Determination of microbial population: Total plate counts for the nutrient were done by counting colonies at the plates. Reverse side of the culture plates. Total colony count was expressed in colony forming units per milliliter (cfu/ml). Plate counts for the PDA plates was done using colony counter for the yeasts and hand lens molds **(Harrigan and McCanee, 1976).**

Sensory evaluation: The organoleptic test of imitation milk was determined according to the method described by **Carpenter *et al.*, (2000).**

Statistical analysis: Analysis of variance and the least significant difference (LSD) test at 5% was calculates to allow comparison between the mean values of the studies parameters (Cochran and Cox 1992).

RESULTS AND DISCUSSION

1- Chemical composition of tiger nut tuber:

Table (1) shows the chemical composition of tiger nut tubers flour. It was show that tiger nut tubers flour has high contents of carbohydrate, fat and fiber with low contents of ash and protein. The obtained data for the composition of tiger nut tubers indicated that the moisture content of tiger tubers was 8.50%. The carbohydrate content of tiger nut tubers 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). It was reported that tiger nut tubers contain almost twice the quantity of the starch as potato or sweet potato tubers. (**Kuner *et al.*, 2002)** regarding, total sugar content, reducing sugar and sucrose, in general tubers have high contents of sugar when the sugar contents of chufa tubers were compared with those of other tubers and nuts the sugar level of chufa was relatively low. However, the taste of chufa depends on the sugar content to give a very characteristic flavor. Because of its pleasant nutty flavor; chufa is consumed as akin of snack food and could be useful in food technology.

Table 1: Chemical composition of Chufa tubers

Components %	Chufa tubers
Moisture	8.5±0.065
Protein	5.08±0.039
Oil	30.01±0.229
Carbohydrates	45.73±0.035
Ash	2.23±0.052
Fiber	14.8±0.113
Starch (g / kg)	293.50±2.241
Sucrose (g / kg)	99.35±0.759
Reducing sugar (g / kg)	27.61±0.211

Data are expressed as mean ±SE values given represent means of three determinations

2- Mineral content of tiger nut tuber:

Mineral compositions of tiger nut are shown in **Table (2)** K, Na and Ca were the major in organic constituents of the ash in all studied samples. Among the trace elements (expect zinc, copper and iron) the valves found in chufa nut are low and within the limits advised for nutrition. The current studies revealed that tiger nut tuber have high calcium, sodium and copper and low magnesium, manganese, phosphorus, iron, zinc and Copper mineral contents. The high values of calcium found in the tiger nut are adequate for bone and teeth development in infants. The presence of other minerals such as iron is highly important because of its requirement for blood formation. Therefore, tiger nut flour could be used as supplementation for cereal flour to improve its content from Ca (**Oladele and Aina, 2007**).

Table 2: Mineral content of chufa tuber (ppm).

Minerals	Contents (ppm)
Calcium	152.0±1.16
Sodium	150.50±1.150
Phosphour	141.00±1.077
Magnesium	122.00±.932
Mangnese	56.00±0.428
Iron	39.50±0.302
Copper	1.29±0.010
Zine	0.97±0.008

Data are expressed as mean ±SE values given represent means of three determinations

3- Physico-chemical properties of tiger nut oil

Table (3) shows the physico-chemical properties of tiger nut oil. The obtained data indicated that the refractive index, the colour and oxidative stability of tiger nut and olive oils were similar. The results indicated that the acid value, iodine number and saponification value of tiger nut oil were higher than those of olive oil. Regarding, the physico-chemical properties of tiger nut tubers and olive oils. The obtained data indicated that the refractive index of both oils were 1.4660 and 1.4656 respectively. The color index of tiger nut and olive are clear bright yellow. The results indicated that the acid as (% oleic acid) of tiger nut oil was lower (0.98%) than those of olive oil (0.20%). The peroxide value of tiger nut oil is lower (4.65meq/kg oil)

than that of olive oil (2.50meq/kg oil). The iodine value of tiger nut oils higher (79.67) as compared with olive oil (91.00) .saponification number of tiger nut oil is higher than that olive oil. Oxidative stability of tiger nut and olive oils on 100˚C using Rancimat method was 30.00 and 39.60 hours, respectively. These characters as whole indicate the increase of shelf life of tiger nut oil compared with olive oil **(Mendez *et al.*, 1996 and Linssen *et al.*, 1988).**

Table 3: Some physico-chemical properties of tiger nut and olive oils.

Properties	Tiger nut oil	Olive oil
Refractive index at 25°C	1.466 ±0.110	1.4656±0.110
Coluor at 35 yellow Red	7.030 ±0.054	2.30 ± 0.017
Acid value (% as oleic acid)	0.980 ±0.005	0.20 ±0.002
Peroxide value (Meq.O2/ kg oil)	4.650 ±0.036	2.50 ±0.019
Iodine number (Hanus)	79.670 ±.609	91.00 ±.695
Saponification number	190.770 ±1.46	189.67±1.45
Unsaponifiable matter (%)	0.570 ±0.005	1.3 ±0.010
Oxidative stability (hr)	30.000 ±0.229	39.60 ±0.303

Data are expressed as mean ±SE values given represent means of three determinations

4- Fatty acid composition of tiger nut oil

Fatty acid composition of tiger nut as compared to olive oils is shown in **Table (4).** Tiger nut oils had high amounts of unsaturated fatty acids. The major unsaturated fatty acids were oleic (69.88) followed by palmitic (14.44%) and at the last was linolenic (9.35%) acids. Tiger nut oil analysis indicated that the most abundant saturated fatty acid is palmitic acid, where as the main saturated fatty acids present are oleic and linoleic acids. Olive oil had the highest percentage of palmitic and oleic acid. There was no significant difference between levels of most the fatty acids in the tiger nut and olive oils. The stearic and oleic acids content was virtually the same in both oils. The present study has shown that oleic acid is the major fatty acid in tiger nut oil, just as reported by other investigators **(Linssen *et al.*, (1988).** These compositions indicated that the tiger nut oil is similar with olive oil in fatty acids composition **(Mendez *et al.*, 1996**).

Table 4: Fatty acid composition (%) of tiger nut tubers and olive oil.

Fatty acids	Tiger nut oil	Olive oil
Myristic (C14:0)	1.210 ±0.0092	0.00±0.000
Palmitic (C16:0)	14.440 ±0.110	15.85±0.121
Palmitoleic (C16:1)	0.360±0.009	1.90±0.014
Stearic (C18:0)	0.040 ±0.001	3.63±0.028
Oleic (C18:1)	69.880 ±0.533	71.50±0.546
Linoleic (C18:2)	9.350±0.072	5.39±0.041
Linolenic (C18:3)	0.160 ±0.001	0.83±0.006
Arachidic (C20:0)	3.560 ±0.027	0.53±0.004
Total saturated	19.250 ±0.147	20.38±0.155
Total unsaturated	80.750±0.617	79.62±.608
Mono unsaturated	70.240 ±0.536	73.40±0.561
Poly unsaturated	10.510 ±0.241	6.22±0.047

Data are expressed as mean ±SE values given represent means of three determinations

5-Amino acid composition:

The amino acid composition (%) of tiger nut flour is presented in **Table (5).** Aspartic acid was the most predominant amino acid followed by glutamic, alanin, leucine, lysine and glycine. Cystine and methionine were in the lowest levels in tiger nut flour. On the other side, essential amino acids represented 28.68%, while non-essential amino acids represented 71.32% and E/N was 0.65% for tiger nut flour. A total of seventeen amino acids was identified in the tiger nut tubers, namelyeystein, proline, L-alanine, L-aspartic acid, glycine, L-glutamic acid, araginine and the essential amino acids : isoleucine ,leucine,lysine,L-histidine,L-methionine,L-theronine,L-phenylalanine, L-tyrosine, L-serine and L-valine.the amino acids profile was determinate by aspartic acid ,which resulted from the conversion of asparagine **(Borges *et al.*, 2008).** Tiger nut tubers are good source of these compounds, however, amino acids profiles are not will balanced ,with contain essential amino acids occurring in limiting concentration when compared to **FAO (2005)** recommended levels.

Table 5: Amino acids composition (%) of chufa tubers protein.

Amino acids	Levels (%)
Aspartic	11.56±0.088
Therionine	2.35±0.018
Serine	3.00±0.023
Gultamic	12.42±0.095
Glycine	4.50±0.035
Alanine	5.78±0.044
Valine	4.07±0.031
Isoleucine	3.00±0.013
Leucine	5.57±0.043
Tyrosine	3.85±0.029
PhanyleAlnine	4.50±0.035
Histidine	4.50±0.035
Lysine	5.57±0.043
Arginine	21.84±0.167
Proline	3.00±0.020
Cyctine	2.57±0.020
Methionie	1.92±0.014
Essential amino acids	28.68
Non-essential amino acids	71.32

Data are expressed as mean ±SE values given represent means of three determinations

6-Processing of some products from tiger nut tubers

6-1-Tiger nut milk

From data in **Table (6)** show that the proximate analysis of all samples. The protein, fat and crude fiber were higher for chufa milk than types soy milk. In the other hand the carbohydrate, moisture content was tower for chufa milk than for types soy milk and it was similar carbohydrates, moisture increase in type's soy milk. All samples had high moisture contents between. This could affect the stability and safety of food with respect to microbial growth and proliferation hence the produce require cold storage. The pH value for milk samples ranged from 5.96 to 6.81 the result of PH value for tiger nut milk had the highest PH value. These PH values fell within the value reported by **(Belewu *et al.*, 2007)** who used tigernut for the

preparation of yoghurt. It used tigernut for the preparation of kunnu. Total ash in the samples was lower than ash content of 1.5% as reported by (**Uhwuru *et al.*, 2008)** and there was no significant deference (P> 0.05).

Table6: Proximate composition, pH and total energy of three different milk source:

Samples	Protein %	Carbohydrate %	Fat %	Crude fiber %	Ash%	Moisture%	pH
Soy bean milk commercial	4.02±0.017	9.10±0.074	4.20±0.050	0.18±0.008	0.52±0.008	82.20±0.176	6.57±0.032
Soy bean milk lab	3.90± 0.003	49.50±0.044	4.07±0.021	0.18±0.006	.61±0.010	82.04±0.008	5.96±0.257
Chufa milk	6.90±0.002	3.17 ±0.022	25.40±0.153	0.36±0.008	0.54±0.00	63.58±0.112	6.81±0.099

Data are expressed as mean ±SE values given represent means of three determinations.

6-2- Microbial analysis of tiger nut milk

The presence of these organisms in the samples at ambient temperature indicated storage condition of food. The total heterotrophic bacterial count in **Table**s **(7,8)** showed that no growths were detected incommercial soy bean milk, lab soy bean and tiger nut milk at zero days, at 7 days and 14 days under storage at 4c◦ the counts in ambient –stored samples ranged from 1.5×10^2 to 4.7×10^5cfu/ml. This indicated that contamination existed in the product samples with decreasing it in the product samples of tigernut milk .soy bean milk is imitation milk similar in composition with animal milk. Its rich nutrient and moderate PH makes it an excellent culture medium for the growth of microorganisms especially bacteria. Hence, the soy bean milk was available, the higher the bacterial contamination. Milk products are, however, easily perishable because contaminating bacteria my multiply rapidly and render it unfit for human consumption. Bacterial growth was retarded to some level by refrigeration, although refrigeration was not feasible throughout due to economic /technical reasons. After zero days, the level of contamination was critical to the microbiological status of the ambient- stored milk samples, this could be attributed to the absence of a chemical preservative to keep the product shelf-stable and the PH

temperature of the medium which was favorable to microbial proliferation.

Table 7:Total hetrotrophic bacterial count in cfu/ml of commercial soy milk, lab soy milk and tigernut milk Extract under storage at 4℃.

Samples	Storage period day		
	0	7	14
Commercial soy bean milk	NG	NG	NG
Lab soy bean	NG	NG	NG
Tigernut milk	NG	NG	NG

Data are expressed as mean ±SE values given represent means of three determinations

Table 8:Total hetrotrophic bacterial count in cfu/ml of commercial soy milk, lab soy milk and tiger nut milk Extract under storage at 28±2℃.

Samples	Storage period day		
	0	7	14
Commercial soy bean milk	2.2×10^3	9.5×10^4	4.7×10^5
Lab soy bean	1.3×10^2	7.5×10^3	2×10^5
Tigernut milk	1.5×10^2	$8.0X10^2$	$1.0 X 10^5$

Data are expressed as mean ±SE values given represent means of three determinations

7- Sensory evaluation of tiger nut milk.

The sensory scores revealed various significant differences in all the parameters evaluated **(Table 9).** Although the highest colour, aroma, taste, Mouth feel and overall acceptability were recorded for chufa milk . All samples were generally acceptable to panelist. Thus there was no significant deference ($p>0.05$) in aroma, overall acceptability. It was noted from this study that the mouth feel values for chufa milk was the highest attributed to high fat contents in tigernut milk. It was agreed with the **(Sa'id, *et al.*, 2017)** they reported that fat is known to promote good mouth feel.

Table 9: Sensory evaluation of three different milk sources:

Samples	Colour	Aroma	Taste	Mouth feel	Overall acceptable
Soy milk commercial	(8.43 ± 1.0166)	(7.38 ± 1.0114)	(7.00 ±1.2773)	(6.95 ± 1.0501)	(29.75±0.9312)
Soy milk lab	(7.33 ± 1.0794)	(7.85 ± 1.3870)	(7.78 ± 1.3521)	(7.48 ± 1.3715)	(30.43 ± 3.8671)
Chufa milk	(7.98 ± 0.7518)	(7.93 ± 1.1951)	(8.03 ± 1.3226)	(8.00 ± 1.1002)	(31.93 ± 3.7215)

Data are expressed as mean ±SE values given represent means of three determinations.

REFERENCES

Abdel-Akher, M. and A.N. Michalinos, (1963): Separation and Purification of starch from Chufa nut tubers (*Cyperus esculentus*). Starch 9: 329-334.

Adejuyitan, J. A, E. T. Otunola, E. A. Akande, I. F. Bolarinwa, and F. M. Oladokun (2009): Some physicochemical properties of flour obtained from fermentation of tigernut(*Cyperusesculentus*) sourced from a market in Ogbomoso, Nigeria. Afr. J. Food Sci., 3:51–5.

Adejuyitan, J. A. (2011): Tigernut processing: its food uses and health benefits. Am J Food Technol 6(3):197–201.

A.O.A.C. (2005): 20TH Edition published by association of Official Analytical Chemists Anligton, Virginia, USA.

Barninas, J.T., H.M. Maina, S. Tahir, D. Kubmarwa, and K. Tsware (2001): A preliminary investigation into the biofeul characteristics of Tigernut (*Cyperus esculentus*) oil. Bioresource Technology, 79: 87- 89.

Berrin, B., and T. Feral (2008): Chemical composition and oxidative stability of flax, safflower and poppy seed and seed oils. Bioresource Technology 99(14):6354-9.

Belewu, M. A, and A. O. Abodunrin (2008): Preparation of kunnu from an unexploited rich food source: tiger nut (Cyperus esculentus). Pak J. Nutr 7:109–11.

Belewu, M. A, and K. Y. Belewu (2007): Comparative physicochemical evaluation of tigernut, soybean and coconut milk sources. Intl J. Agric. Biol., 5:785–7.

Bozan, B. and F. Temelli (2008): Chemical composition and oxidative stability of flax, safflower and poppy seed and seed oils. Bioresource Technology 99(14):6354-9.

Borges, O, B. Goncalves, L. Sgeoeiro, P. Correia, and A. Silva (2008): Nutritional quality of chestnut cultivars from Portugal. Food Chem 106:976–84.

Carpenter, R.P. D.H. Lyon and T.A. Hasdell (2000): Guidelines for sensory analysis in food product development and quality control. pp. 71 – 91. Gaithersburg.

Chukwuma, E. R., N. Obioma, and O. I. Cristopher (2010): The phytochemical composition and some biochemical effects of Nigerian tigernut (*Cyperus esculentus* L.) tuber. Pak J Nutr., 9(7):709–15.

Cochran , W.G. and G.M. Cox (1992) : Experimental designs , 2nd edition , Wiley , New York.

Cos kuner, Y., R. Ercan, E. Karababa, and A. N. Nazlican (2002): Physical and chemical properties of chufa (*Cyperus esculentus L*) tubers grown in the Çukurova region of Turkey. J. Sci. Food Agri., 82:625–31.

Emmanuel, O.A. and E. Edward (1984): Nutritive value of a mixture of tigernut tubers (*Cyperus esculentus L*.) and baobab seeds (*Adansonia digitata* L.). J. of the Science of Food and Agriculture, 35: 437-440.

Ejoh, A. R., R. Ndjouenkeu, and D. Dijomdi (2006): Characteristics of Tiger nut (Cyperus esculentus) tubers and their performance in the production of a milky drink. Journal of Food Processing and Preservation, 30: 145–163.

Farag, R.S., E.A. Abfel Rahim, A.M. Elsharabasy, F.M. Hewedy, and A.A. Ragab (1984). Biochemical studies on lipids of hens egg during incubation .Seifen de-fette , Wachse, 100:63.

Harrigan, W.F. And M.E. McCance, (1976): Laboratory methods in food and dairy microbiology. Academic Press, London, pp: 20-42.

Linssen, J., G. Kielman, L. Codijnsen, and W. Pilmik (1988): Comparison of Chufa and Olive Oils. Food Chemistry, 28: 279-285.

Kuner, Y.C., R. Ercan, E. Karababa, A.N. Nazlican (2002): Physical and Chemical properties of chufa (*Cyperus esculentus* L.) tubers frown in the Cukurova region of Turkey. Journal Science of Food and Agriculture, 82: 625-631.

Mendez, E., J. Sanhueza, H. Speisky, and A. Valenzuela, (1996): Validation of the Rancimat test for the assessment of the relative stability of fish oils. J.A.O.C.S., 73: 1033 -1037.

Mosquera, L.A., C.A. Sims, R.P. Bates, and S. F. O'Keefe (1996): Flavor and stability of 'horchata de chufas'. J Food Sci., 61(4):856–61

Negbi, M. (1992): A sweetmeat plant, a perfume plant and their weedy relatives: a chapter in the history of *Cyperus esculentus* L. and C. rotundus L. Econ Bot., 46:64–71.

Oderinde, R.A. and O.A. Tairu, (1988): Evaluation of the properties of yellow nut sedge (*Cyperusesculentus*) tuber oil. Food Chem., 28:233–7.

Okafor, J. N.C., J. I. Mordi, A.U. Ozumba, H.M. Solomon, and O. Olatunji (2003): Preliminary studies on the characterization of contaminants in tiger nut (yellow varieties). Proc 27th Annual Nigerian Institute of Food Science and Technology Conference, Kano, Nigeria, 13-17 October p 210-211.

Oladele, A.K. and J.O. Aina, (2007): Chemical composition and functional properties of flour produced from two varieties of tiger nut (Cyperus esculentus). Afr. J. Biotechnol., 6: 2473-2476.

Pascual, B., J.V. Maroto, S. Lopez-Galarza, A. Sanbautista, and J. Alagarda (2000): Chufa (*Cyperus esculentus L.* var. sativus Boeck.): unconventional crop. Studies related to applications and cultivation. Econ Bot., 54(4): 439–48.

Pearson, D. A., C.H. Tan, J.B. German , P.A. Davis, and M.E. Gershwin (1999): Apple Juice inhisits human low lipoprptein oxidation .Life Science , 64: 1913-1920.

Sa'id, A.M., H. Abubakar and B. Bello (2017): Sensory and Microbiological Analysis of Tiger Nut (Cyperus esculentus) Beverage. Pak. J. Nutr., 16:731-737.

Sanful, R. E. (2009): Production and sensory evaluation of tigernut beverages. Pak J Nutr., 8(5):688–90.

Shilenkoo, M., G. Kalacheva, G. Lisovskii, and I. Trubachev (1979): Chufa (*Cyperus esculentus*) as a source of vegetable fat in shelf life – support system. Kosm Biological Aviaksom Med, 13: 70 – 74.

Stahle, E. (1967): Thin Layer chromatography. A laboratory Handbook. Ed, Springer Verloag Berline pp. 35, Heidel Berg, New York.

Temple, V. J. (1989): Lesser known plant foods. In: Nutritional quality of plant foods. Osagie AU, Eka OU (eds). Post-harvest Research Unit, University of Benin, Nigeria.p 245-274.

Temple, V.J., T.O. Ojobe, and N.M. Kapu (1990): Chemical analysis of tiger nut (*Cyperus esculentus*). J Sci. Food Agric., 50:262-263.

Tetteh, J. P. and E. Ofori, (1997): A baseline survey of tiger nut (*Cyperus esculentus*) production in the Kwahu South District of Ghana. Ghana Journal of Agricultural Science, 31, 211-216.

Udeozor, L.O. and S.O. Awonorin, (2014): Comparative microbial analysis and storage of tiger nut soy milk extract. Austin Journal of Nutrition and Food Sciences, 2: 1-6.

Uhwuru, M., J.O. Loveth, and N. Onokah (2008): Production and quality assessment of tiger nut (*Cyperus esculentus*) imitation milk during storage. Journal of Food Science and Technology -Mysore- 45(2):180-182.

Zhang, H., M.A. Hanna, Y. Ali and L. Nan, (1996) : Yellow nut – sedge *(Cyperus esculentus* L.) tuber oil as fuel. Industrial crops and products, 5: 177- 181.

Zohary, D. (1986): The origin and early spread of agriculture in the Old World. In: Barigozzi C, editor. The origin and domestication of cultivated plants. Amsterdam: Elsevier. p. 3–20.

Zohary, D. and M. Hopf, (1993): Domestication of plants in the Old World. 2nd ed. Oxford: Clarendon Press. 279 p.

القيمة الغذائية لدرنات حب العزيز (Cyperus esculentus L.) ومنتجاته

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تهدف هذه الدراسة الى التعرف على القيمة الغذائية لدرنات حب العزيز ومنتجاتها. وفى هذه الدراسة تم الحصول على درنات حب العزيز من مدينة طنطا – محافظة الغربية – مصر، حيث تم تقدير التركيب الكيماوى للدرنات وكذلك الاملاح المعدنية. كما تم استخلاص الزيت من الدرنات وتقدير بعض الخواص الطبيعية والكيمائية للزيت المستخلص. ايضا تم التعرف على الاحماض الدهنية المكونة للزيت باستخدام جهاز التحليل الكروماتوجرافى الغازى. على الجانب الاخر تم تقدير الاحماض الدهنية فى دقيق درنات حب العزيز بعد استخلاص الزيت منها.

ومن الناحية التكنولوجية تم تحضير لبن مخلق من درنات حب العزيز فى المعمل ومقارنتها بلبن صويا مخلق ومحضر فى المعمل ايضا كعينة كنترول (فى المعمل). اللبن المخلق (سواء من درنات حب العزيز او الصويا) تم تقدير المحتوى الميكروبى له. بالاضافة الى ماسبق تم اجراء التقييم الحسى للبن المحضر من درنات حب العزيز ولبن الصويا.

اشارت النتائج المتحصل عليها الى االقيمة الغذائية المرتفعة لدرنات حب العزيز واكدت النتائج على اهمية استخدام درنات حب العزيز فى اعداد اغذية صحية على سبيل المثال لبن حب العزيز المخلق.