International Food Research Journal 22(5): 1931-1938 (2015)
Journal homepage: *http://www.ifrj.upm.edu.my*

Chemical composition, physicochemical properties and fatty acid profile of Tiger Nut (*Cyperus esculentus* L) seed oil as affected by different preparation methods

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Article history

Received: 4 October 2014
Received in revised form: 20 January 2015
Accepted: 26 January 2015

Keywords

Tiger nut oil
Fatty acid composition
Proximate composition
Soaking
Blanching
Roasting

Abstract

A comprehensive lipid profiling has been carried out on the seed oils from different preparation methods (soaking, blanching and roasting) of tiger nut (*Cyperus esculentus* L), in order to evaluate their potential uses. The paper reports the proximate evaluation of tiger nut tubers. The proximate composition was 7.30, 2.64, 22.14, 4.33, 15.47, and 48.12 % for, moisture, ash, crude fat, crude protein, crude fiber, and carbohydrate, respectively. The quality of the extracted oils was assessed in terms of acid value, iodine value, saponification value, peroxide value, refractive index, and unsaponifiable matter. The major fatty acids (FAs) of the tiger nut tuber oil were oleic (69.25%), palmitic (15.19%), linoleic (8.37%), and Stearic (5.07%) acids. These values did not vary significant (P<0.05) after soaking, blanching, and roasting. This information may indicate that certain soaking, blanching, and roasting conditions applied to tiger nut (*Cyperus esculentus* L) prior to oil extraction may not enhance the fatty acids composition of the obtained oil. In addition, tiger nut oil can replace some common vegetable oils in food products.

Introduction

The *Cyperaceae* are monocotyledonous plants which include up to 4000 species worldwide (Ekeanyanwu and Ononogbu, 2010). Most of the *Cyperaceae* family is of very little economic value with the exception of *Cyperus papyrus* which is used in the manufacture of paper and *Cyperus esculentus* L (tiger nut) which is edible (Simpson and Inglis, 2001). Tiger nut is a weed plant of tropical and Mediterranean regions. It is a root crop which grows widely in wet places as a grass and is sometimes cultivated for its small and sweet tubers (Eteshola and Oraedu, 1996). It is very famous in Egypt and locally named (Hab Alaziz), where it is mainly consumed after soaked in water for tenderization or blanched as a traditional snack food or roasted and grinded in powder form as a drink. The oil from the nut is extracted by traditional methods on a small scale for food uses. Tiger nut is known in other parts of the world, especially in the Valencia region of Spain where it is commonly known as "chufa" and the oil from the nut is now produced on a commercial scale for the European market (Yeboah *et al*., 2012).

Edible oils and fats are essential nutrients in the human diet and play a vital role in the supply of essential fatty acids and energy. In addition to their nutritional qualities, the oils and fats contribute consistency and specific binding characteristics to the products that contain them. The lipids also affect the structure, stability, taste, aroma, storage quality and sensory and visual characteristics of the foods. Chemically, oils and fats are predominantly composed of triacylglycerols (Ribeiro *et al*., 2007). There is increasing awareness of the importance of vegetable oils as sources of food, biofuel, health enhancing compounds, i.e., nutraceuticals, as feedstock for industrial polymers and for many other industrial products. Thus the world demand for vegetable oils is set to rise even more rapidly from year to year, and this trend will impact on the price levels of oils. It is therefore important that poor countries and communities which have non-conventional seed oils carry out research that can lead to commercial production of their seed oils to at least satisfy local demand. An important component of this search is to collect detailed scientific data that will inform on the potential uses of all such seed oils.

There are a few scientific reports and technological interests about the FA composition of the seed oil from tiger nut (Glew *et al*., 2006). However, literature reports about the detailed composition of

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the FA components, in the seed oils of tiger nut a plants grown in Egypt are rather lacking. Knowing that oily seeds play a role in disease prevention and considering their nutritional importance, as well as the difference in the composition of nutrients in seeds due to environmental conditions and type of treatments (raw, soaked, blanched or roasted seeds).

The aim of this study was to collect comprehensive data on the physicochemical, compositional and structural properties of non-conventional seed oils of different preparation methods from the seeds of tiger nut grown in Egypt. Such data will inform on the nutritional value of the seeds and will also be useful in evaluating the seed oils for other potential uses, such as biodiesel, biolubricants, and sources of oleochemicals that will add extra value to these oils in the region.

Material and Methods

Raw material and preparation of samples

Brown variety tiger nut *(Cyperus esculentus)* tubers were purchased from local market in Fayoum province (Egypt). Tubers were separately sorted, thoroughly cleaned from other impurities and divided into four parts. One part was analyzed raw, a second part was blanched in distilled water; another part was roasted into a laboratory oven, while the last was soaked in tap water. The boiling water blanching was done with tap water for 45 min at 100°C until the tubers were well tender. The roasting was done on an aluminum tray as single layer of tubers and placed into an oven set at 130 ± 5°C. Sample roasted for 30 min., were immediately cooled to room temperature. The soaking was conducted in 1000 mL beaker containing 500 mL tap water for a period of 48 h at room temperature (25 ± 2°C). Treated tiger nut tubers were oven-dried for 6 h at 45 ± 5°C. The cooled samples were then kept in plastic bags and kept refrigerated until use.

Thousand-grain weight

To determine the one thousand (1000) grain weight seed selected randomly and weighted to an accuracy of 0.001 g, the determination repeated five times and the average of 1000- grain was recorded.

Hectoliter weight

Hectoliter weight was recorded as the weight of 100 liters of seeds in kilogram, the determination repeated five times and the average of 100 liters was recorded.

Proximate analyses of tubers

The major chemical constituent, moisture, ash, crude fat, crude fiber, and crude protein were determined in triplicate according to AOAC standard methods (1990). Carbohydrate content was calculated by difference as the sum of the moisture, fat, protein, fiber, and ash contents were subtracted from 100 as outlined in AOAC (1990). The food energy value of the tubers was obtained by multiplying the mean value of the protein, fat, and carbohydrate by Atwater factors of 4, 9, and 4, respectively, and expressing the sum of the products in kilocalories (Osborne and Voogt, 1978).

Oil extraction

About 250 grams of each treatment of tiger nut tubers was ground in a blender and the oil extracted by four successive extractions with purified n-hexane (1:3 w/v) at room temperature. The miscella was separated from the cake by filtration using Whatman No. 1 filter paper. The filtrated miscella, were combined and n-hexane was removed under vacuum, at 50°C. The obtained oil was dried over anhydrous sodium sulphate then, directly analyzed.

Physicochemical properties

Physical constants

The refractive index of extracted oils was measured according to AOAC (1990) using Abbe refractometer at 25°C. The method described by Lee *et al*., (2004) was applied for determination of color; the absorbance of 5 % (w/v) solutions of oils in chloroform was measured at 420 nm using a "spectronic 20" spectrophotometer (Bauch & Lamb).

Chemical constants

The iodine value, saponification value, unsaponifiable matter, acid value, and peroxide values were determined according to standard IUPAC methods for the analysis of oils and fats (Dieffenbacher and Pocklington, 1987). The ester value was obtained by subtracting the acid value from the saponification value. All experiments were conducted in triplicate.

Analysis of fatty acid composition

Methyl esters of fatty acids were prepared in accordance to the method of Morrison and Smith (1964) with some modification. For sample 100 mg adding 1mL BF_3/methanol (14%) and 1 mL hexane. The tube is vortexed and placed under nitrogen for 60 min at 100°C. Esters of fatty acids were extracted by adding 1 mL of hexane and washing with 2 ml of distilled water. After the centrifugation step (4500

Table 1. Chemical composition of tiger nut tubers

Parameter (%)	Moisture	Ash	Crude fat	Crude protein	Crude fiber	Carbohydrate*	Food Energy Value (kcal/100 g)
Wet weight	7.30±0.18	2.64±0.33	22.14±0.81	4.33±0.08	15.47±0.22	48.12	409.01
Dry weight	0.0	2.85	23.88	4.67	16.69	51.91	441.23

Data are mean ± SD of three replicates.
*by difference

rpm, 10 min, 20°C.), the supernatant is recovered in vials and then injected into the GC column.

Methyl esters were analyzed by GC-type CG-2010 Plus, Shimadzu, equipped with a flame ionization detector and a capillary column of 60m length, 0.25 mm internal diameter, the thickness of the film is 0.20 microns. The oven temperature was 200°C. The detector and the injector are at a temperature of 250°C. The samples were separated on the column using helium as the carrier gas with a flow rate of 0.8 mL / min. The sample is injected in split mode. The temperature program used in the analysis is to keep the unit at 120°C for 2 min and then climb to180°C for 2 min and keep the sample at 220°C for 25min. The peak integration is done on the software GC solution (Shimadzu). Peak identification of fatty acids on the chromatogram is made using standard fatty acids (Restek, Food industry FAME Mix - methylene chloride 30 mg/mL).

Statistical analysis

Statistical analyses were conducted using SPSS (Statistical Programme for Social Sciences, SPSS Corporation, Chicago, IL, USA) version 16.0 for Windows. All analyses were performed in triplicate and data reported as means ± standard deviation (SD). Data were subjected to analysis of variance (ANOVA). The confidence limits used in this study were based on 95% ($P < 0.05$).

Results and Discussion

Physical properties of seeds

The search for lesser known and underutilized crops, many of which are potentially valuable as human and animal foods has been intensified to maintain a balance between population growth and agricultural productivity, particularly in the tropical and sub-tropical areas of the world. Tiger nut *(Cyperus esculentus)* is underutilized sedge of the family *Cyperaceae* which produces rhizomes from the base and tubers that are somewhat spherical. The density characteristics of the tiger nut tubers are quite useful in computing product yield and throughput in processing machinery; the thousand-grain weight (g) and hectoliter weight (kg) of tiger nut have measured. It could be noticed that the thousand-grain and hectoliter weights of tiger nut tubers were 257.78 ± 0.52 g and 64.45 ± 0.09 kg respectively.

Proximate composition of tubers

The results in Table 1 show the proximate analysis of tubers before treatments. For all samples, the parameters of protein, ash, crude fiber, carbohydrates, and total lipids contents were calculated excluding the percentage of moisture and volatile components at 105°C, that is, in relation to the percentage of dry mass (dry residue). Tiger nut was observed to be high in dietary fiber content (15.47%), which could be effective in the treatment and prevention of many diseases including colon cancer, coronary hearth diseases, obesity, diabetics and gastro intestinal disorders (Anderson *et al.*, 1994), and would also rank well with other whole grains or starchy roots, such as potatoes, mature leguminous seeds, nuts and fruits (Davidson *et al*., 1975) as a source of fiber in foods. Tiger nut tubers were also found to be a rich source of carbohydrates (48.12%) and contains moderate amount of protein (4.33), thus being an excellent source of energy (409 kcal/100 g). The protein compares favorably with the value of 9.8% reported for wheat flour (Akubor and Badifu, 2004), 6.34% reported for jackfruit seed flour (Mukprasirt and Sajjaanantakul, 2004).

The oil yield from tiger nut obtained in this study, as shown in Table 1, was 22.14 %, which is lower than that of safflower oil (32%) and linseed oil (34%), both produced on commercial scale but much higher than soybean oil (20%) and corn oil (about 6%) (Bockisch, 1998). The defatted residues consequently became more replete with carbohydrates which could be processed further into livestock feeds, syrups, and other forms for diverse purposes, thus suggesting solvent extraction as the most acceptable and economical method of oil extraction relative to those enumerated .

The low moisture content (7.30) of *C. esculentus* tubers remains an asset in storage and preservation of the nutrients. The tubers could therefore serve as a cheap source of raw material for the food and

Table 2. Effect of different preparation methods on physicochemical properties of tiger nut oils.[a]

Parameter	Untreated	Soaking	Blanching	Roasting
Refractive Index	1.4646±0.16	1.4642±0.08	1.465±0.12	1.4651±0.24
Color (as absorbance at 420nm)	0.20±0.06	0.28±0.27	0.21±0.33	0.22±0.22
Acid Value (mg / g oil)	7.23±0.35	10.78±0.28	8.48±0.11	8.97±0.42
Acidity (as % oleic acid)	3.64±0.33	5.42±0.25	4.26±0.17	4.51±0.21
Saponification Value (mg / g oil)	200.71±0.44	198.98±0.58	199.14±0.38	201.24±0.30
Ester Value (mg / g oil)	193.48±0.18	188.20±0.12	190.66±0.09	192.27±0.28
Iodine value (g I2 / 100 g of oil)	72.35±0.33	71.82±0.38	71.89±0.40	72.94±0.52
Peroxide Value (meq O2 / kg oil)	0.79±0.18	1.52±0.12	1.12±0.24	0.80±0.20
Unsaponifable Matter (%)	1.71±0.18	1.26±0.28	1.52±0.24	0.46±0.36

[a]Data are mean ± SD of three replicates.

oleochemical industries, and would also yield stable commercializable oil for diverse purposes and applications including shampoos, soaps, margarine and cooking oils. Its tubers are said to be aphrodisiac, carminative, diuretic, emmenogogue, stimulant and tonic (Chopra *et al.*, 1986; Chevallier, 1996). Tiger nut has also been reported to be used in the treatment of flatulence, indigestion, diarrhea, dysentery, and excessive thirst (Chevallier, 1996). Therefore, tiger nut, with its inherent nutritional and therapeutic advantage, could serve as good alternative to imported vegetable oils in food products.

Physicochemical properties of seed oils

Preliminary characterization of the seed oils from tiger nut recovered from three different preparation methods (soaking, blanching, and roasting) was carried out (Table 2). Refractive index generally shed light on structural properties such as average molecular mass and degree of unsaturation of the fatty acids in oils and fats. Thus the similar refractive index values for untreated tiger nut (1.4646), soaking (1.4642), blanching (1.4650), and roasting (1.4651), given in Table 2, would tend to suggest that all seed oil samples had similar average FA chain lengths and degrees of unsaturation. Also the comparable saponification values (SV) of 200.71, 198.98, 199.14, and 201.24 mg KOH/g for untreated, soaked, blanched, and roasted tiger nut seed oils, respectively, pointed in the direction of similar average chain lengths for the FAs in all oil samples. The FA compositions of untreated and treatments oil samples, as estimated by GC of the fatty acid classes, given in Table 3, clearly show that there were no marked differences of the degree of unsaturation in the tiger nut oil samples. Indeed the iodine value (IV) for untreated tiger nut oil (72.35 g I_2/100g oil), and that for soaked, blanched, and roasted tiger nut seed oils with values 71.82, 71.89, and 72.94 (g I_2/100g oil), respectively, agreed with the GC estimation of the degrees of unsaturation in seed oils.

The tiger nuts seeds used in this investigation were several weeks old before the extraction of the oils. The parameters for oxidative and hydrolytic rancidity/ stability, given in Table 2, i.e. acid value (AV), acidity, and peroxide value (PV): 7.23 mg KOH/g, 3.64 (as % oleic acid), and 0.79 meq O_2/kg, respectively, for untreated tiger nut, 10.78 mg KOH/g, 5.43 (as % oleic acid), and 1.52 meq O_2/kg, respectively, for soaked tiger nut, 8.48 mg KOH/g, 4.26 (as % oleic acid), and 1.12 meq O_2/kg, respectively, for blanched tiger nut, 8.97 mg KOH/g, 4.51 (as % oleic acid), and 0.80 meq O_2/kg, respectively, for roasted tiger nut, are quite reasonable as they compare very favorably with Codex recommended values for virgin olive oil (Kirk and Sawyer, 1991). These parameters indicate that the untreated tiger nut and the different treatments of tiger nut seed oils should have good keeping-capacity. The relatively low acid values given in Table 2, as they indicated limited lipase hydrolysis of the oils, would give some expectation of low values for diacylglycerols and monoacylglycerols.

The highest unsaponifiable matter content was observed in untreated sample (1.71%), while the lowest levels were found in roasted tiger nut sample (0.46%). The results confirmed a previous report that roasting was found to cause an increase in the passage of phenolic compounds to the oil whereas the level of tocopherols, phospholipids, lutein and β-carotene was decreased (Durmaz and Gökmen,

Table 3. Changes in fatty acids composition of tiger nut oils as affected by different preparation methods[a]

Compounds	Untreated	Soaking	Blanching	Roasting
C14 :0 Myristic	0.12±0.12	0.11±0.28	0.11±0.45	0.11±0.42
C16:0 Palmitic	15.19±0.28	15.14±0.33	15.21±0.38	15.05±0.12
C16:1 Palmitoleic	0.29±0.08	0.30±0.25	0.33±0.34	0.28±0.18
C18:0 Stearic	5.07±0.18	5.31±0.22	5.16±0.20	5.20±0.26
C18:1n9c cis Oleic	69.25±0.08	68.97±0.02	69.09±0.12	69.33±0.06
C18:2n6c cis Linoleic	8.37±0.06	8.37±0.18	8.42±0.12	8.28±0.04
C20:1n7 Paullinic	0.80±0.08	0.84±0.18	0.80±0.20	0.82±0.01
C18:3n3 Linolenic	0.19±0.18	0.20±0.33	0.19±0.28	0.20±0.30
C21:0 Heneicosylic	0.22±0.32	0.21±0.40	0.20±0.36	0.21±0.18
C20:3n3 Mead	0.19±0.08	0.20±0.14	0.19±0.16	0.19±0.22
C24:1n9c Nenvonic	0.31±0.10	0.35±0.15	0.32±0.03	0.32±0.03
Total saturated	20.59	20.78	20.68	20.58
Total unsaturated	79.41	79.22	79.32	79.42
Σ MUFA	70.66	70.46	70.53	70.75
Σ PUFA	8.75	8.76	8.79	8.67
n6/n3	43.54	42.44	44.95	41.12
PUFA/SFA	0.42	0.42	0.43	0.42

[a] Mean values ± standard deviation of triplicate determinations are reported. Results are expressed as percentage of the total fatty acids. No significant was observed in fatty acid composition of oils with different preparation methods ($P < 0.05$).

2011). Although a clear decrease was observed in unsaponifable matter content of roasted tiger nut oil, the oxidative deteriorations parameters was similar to the untreated tiger nut oil. This may be attributed to the formation some components had antioxidant capacity especially in case of roasting as a result of thermal treatment. Often, the antioxidant capacity is even enhanced due to the increased availability of phenolic compounds or by the formation of new compounds with antioxidant properties formed during the heating process, such as themelanoidins formed by the Maillard reaction (Lemos *et al*., 2012). It is claimed in model studies that Maillard reaction products (MRPs) could retard oil oxidation to some extend (Wagner *et al.*, 2002). On the other hand, it has been observed in many studies that oils extracted from roasted seeds have a greater oxidative stability than the oil from unroasted seeds (Veldsink *et al*., 1999; Wijesundera *et al.*, 2008; Durmaz and Gökmen, 2010). Thus, accounting for the antioxidant potential of MRPs and phenolic compounds that passed to the oil, roasting derived increase in oxidative stability and antioxidant capacity of tiger nut oil could be attributed to the increase of these compounds. Meanwhile heat pretreatment was reported to decrease the lipolytic enzyme activities in extracted oil that also provide better oxidative stability to the oils extracted from roasted seeds and nuts (Veldsink *et al*., 1999).

Fatty acid composition

The chemical, physical and biological characteristics of lipids are largely dependent upon the composition and positional distribution of fatty acids on the glycerol backbone, thus the stereospecific analysis of fatty acids in the triacylglycerol was considered important for use of the lipid for both dietary and industrial purposes (Hunter, 2001; Yoon and Kim, 2003). Effect of boiling water blanching for 45 min, roasting at 130 °C for 30 min and soaking in water for 48 h at room temperature as three different preparation methods on fatty acid composition of *Cyperus esculentus* tubers were studied and the results are shown in Table 3. The FA profile of the seed oil from untreated tiger nut, closely resembles the FA profile for olive oil; with FA composition of oleic acid, 18:1, (69.25%), palmitic acid, 16:0, (15.19%),

linoleic acid, 18:2, (8.37%), and stearic acid, 18:0 (5.07%), the tiger nut oil sample was virtually like some variety of olive oil, wherein major FAs were oleic acid (55–83), palmitic acid (7.5–20), linoleic acid (3.5–21), and stearic acid (0.5–5.0) (Firestone, 2006). This favourable FA content of tiger nut oil, combined with its nutty flavour, should make tiger nut oil a very attractive vegetable oil which can be used in a number of food products. Even though the oil yield obtained in this work was 22.14 %, tiger nut can be grown on commercial scale in the region for exploitation of its oil as it is currently being done in Spain.

With regard to the issue of fatty acids, our data are in accord with those of Kim *et al.* (2007) and Yeboah *et al.* (2012) which show that four fatty acids (oleic, palmitic, linoleic, and stearic acid) account for >97% of the total fatty acid in tiger nut tuber, and this plant food is a good source of essential fatty acid linoleic acid. In contrast to the observations of Eteshola and Oraedu (1996), who found myristic acid to be present in tiger nut tuber at a level of 28.1%. The variability in the fatty acid composition of the oils, as reported by the different investigators, may be due to the age of the tissue analyzed, genetic history, climate, nutrition, temperature, and oxygen tensions, any of which can profoundly alter the composition of the endogenous lipid of a plant (Stump, 1980). The oleic acid content of tiger nut tuber oil is much greater than that of most other vegetable oils, such as sunflower oil (23.6%), soybean oil (24.9%), or corn oil (23.8%), but comparable to that of olive oil (Warner and Knowlton, 1997; Romero *et al*., 1998; Chung and Choe, 2001). Tiger nut oil with its high percentage of oleic acid, should be relatively stable and resistant to oxidation (Oderinde and Tairu, 1988).

Tiger nut oil has a high oleic acid and low polyunsaturated fatty acid (linoleic acid and linolenic acid), enough to cover daily minimum needs for an adult (around 10 g) and low acidity, and so is excellent for the skin. It is regarded as high quality oil due to its extraction without adding any external heat (cold pressed oil), and is highly recommended for cooking over other oils because it is more resistant to chemical decomposition at high temperatures. 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.

It was observed that the processes of soaking, blanching, and roasting generally have very close fatty acids composition compared with the untreated sample. These results are in accordance with those reported earlier (Jung *et al*., 1999; Kim *et al*., 2002). Roasting caused no significant variation in fatty acid composition of extracted oils. Ozcan (2004) reported that roasting caused slight variations in fatty acid composition of *P. terebinthus* oil.

The variation in the percentage of fatty acids in tiger nut was not significant. 18:1n−9 predominated in the roasted sample was a little higher, while the value for 18:2n−6 was lower. These results are in agreement with those obtained by Yoshida *et al*., (2006), who reported that longer microwave processing caused higher roasting temperatures that resulted in a lower percentage of linoleic acid and higher percentages of oleic, palmitic and stearic acids.

From the analysis of the summation of FAs (Table 3), it can be seen that the MUFAs (16:1, 18:1n−9, 20:1, and 24:1) totaled 70.66, 70.46, 70.53, and 70.75% of the total fatty acids present in the samples of untreated, soaked, blanched and soaked tiger nut oils, respectively. These results are considered very advantageous for health as this class of fatty acids is responsible for reducing LDL and total cholesterol, thereby preventing heart attacks, thrombosis and activates blood content of soluble glucose; thus its digestion is recommended.

The linoleic fatty acids (belonging to the omega-6 family of fatty acids) and α-linolenic fatty acids (belonging to the omega-3 family of fatty acids) are considered essential, as they cannot be synthesized by mammals and must be obtained from food (Moreira and Mancini, 2004). According to Ribarova *et al.* (2003), polyunsaturated fatty acids must make up 7–10% of the total energy ingested for an adequate diet as far the correct ingestion of lipids is concerned. Furthermore, omega-3 family of fatty acids may have a positive effect in the treatment of depression and schizophrenia (Schram *et al.*, 2007). The PUFAs found in the samples were 18:2n−6, 18:3n−3, and 20:3n3, in very small amounts. Hence, the source of practically all of the PUFA in the tiger nut is 18:2n−6. The consumption of 18:2n−6 (linoleic acid) is commonly thought to be capable of reducing LDL and total cholesterol, but its excess ingestion (greater than 10% of total calories ingested) may cause a reduction in good cholesterol (HDL).

In this regard, it is important to note the great difference between the amounts of 18:2n−6 and 18:3n−3, and the ratio n6/n3. For food to be considered healthy, according to the England Department of Health (1994), the n6/n3 ratio should be between 5 and 10:1, but it was very high, ranging between 41 to 44:1. This ratio suggests that to rebalance the ingestion of n−6 and n−3, individuals who ingest a portion of tiger nut oils should also ingest other foodstuffs containing significant quantities of n−3 family fatty acids and low amounts of n−6 family

fatty acids. The saturated FAs (SFA) found in the samples were 14:0, 16:0, 18:0, and 21:0, and their summation was 20% for all of the samples studied. The PUFA/SFA ratio remained 0.42 for all of the samples, without a significant ($P < 0.05$) difference between the treatments.

Conclusion

Tiger nut tubers are a rich source of oil and contains moderate amount of protein. It is also a rich source of fiber and carbohydrates. Eleven different individual fatty acids were identified, with 18:1n−9 oleic predominating in the studied samples. The edible and stable oil obtained from the tuber is said to be superior oil that compares favorably with olive oil. The results of this study have provided much justification for the use of tiger nut oil in food products. The high content of oleic acid makes tiger nut oil a very nutritious and health enhancing oil. Thus tiger nut oil should be developed into a commercial product for use in food products. With a few exceptions, the results of the experiments presented here show that the exposure of tiger nut seeds prior to oil extraction to different preparation methods (soaking, blanching, and roasting) caused no significant loss or change in the content of fatty acids in the oils. Further studies are required to reveal whether the waste residue after oil extraction could be further modified to produce syrups, flours, or livestock feeds. We undertake to expand these results to factory circumstances, because the laboratory-scale experimental design methodology is easily extendable to factory scale as well.

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