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Evaluation of the mineral and antinutritional composition of bottled and sterilized Tigernut (*Cyperus esculentus*) milk

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Abstract

Nowadays, beverages are not just considered as thirst quenchers; specific functionality is the major ingredient expected in beverages, which has becomes a lifestyle. In recent years, these initiations have led to newly developed products in the beverages sector. Companies are learning the consumption styles of various individuals and making novel beverages through blends of milk and energy drinks. Tigernut milk is among the most valued plant-based beverages, obtained from the aqueous extract of tigernuts tubers. This study investigated the mineral and antinutritional components of bottled and sterilized tigernut milk. Two varieties of tigernut tuber (Yellow and brown) were processed using three methods (Boiling, soaking and malting), and the milk was bottled and further sterilized. The results obtained showed that Iron recorded the least value at (1.73mg and 2.24mg) for yellow and brown tigernut tubers; alsotigernut tubers were low in some antinutrients except flavonoids. The result for the tigernut milk elucidated that processing and sterilization had little effect on the mineral content of tigernut milk. The study also showed that the pre-processing treatment applied (Soaking, boiling and malting) to the tigernut either increased or caused a decline in the mineral content of the tigernut milk, whereas, processing and sterilization affected the antinutrient content of tigernut milk. All processing methods showed a significant difference ($p<0.05$.) as there was a decrease in the phytate and oxalate content. The study highlighted the possibility of processing tigernut tubers into milk extract that can be bottled and sterilized for a period of time.

Keywords: Tigernut, Minerals, Antinutrients, Plant-based beverages, Processing.

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Contents

Contribution of this paper to the literature

This research study provides information on the heat penetration study used to determine the sterilization temperature suitable for thermal processing of tigernut milk, which is unique, compared with existing studies. It also gives data on the effect of different processing methods on the nutrient composition of bottled and sterilized tigernut milk.

1. Introduction

1.1. Background of Study

Recently in research studies, there has been emphasis on new food product development that is required to meet the present demands of consumers. The upsurge in urban development has increased these demands; which makes studies in functional beverages the recent trend. Beverages are no longer used to quench thirst; it is required that the functionality in these drinks are considered before consumption, and various beverage producing companies are using the perceptions of various persons as a vital tool in promoting innovative beverage combinations. Therefore, the growing interest on the need to promote healthy living by people has created a prospect for plant-based beverages to thrive. An example of such functional requirement is milk alternatives, which is used to mitigate issues of lactose intolerance, calorie concern, cow milk allergy and prevalence of hypercholesterolemia [1]. Ethnic origin is responsible for lactose intolerance. For instance, adult white north Europeans, Australasians and North Americans record the lowest rates, ranging from 5 % in the British population to 17% in northern France and Finland. In, Africa, South America and Asia, over 50 % of the population experience lactase non-persistence, and almost 100 % in some Asian countries [2]. Hence, there is a great need to explore the potentials of plant based milk alternatives.

Additionally, plant sources are good functional food and nutraceuticals due to healthy components such as vitamins minerals and antioxidants present in them Das, et al. [3]. Non-dairy products that are commonly used are Soy milk, peanut milk, rice milk, safflower milk, and tigernut milk[4-9]. Tigernut milk is one of the most consumed plant-based beverages, obtained during aqueous extraction from tigernuts tubers (Cyperus esculentus) [10]. They are rich in minerals[11, 12] yet they are vastly underutilized. Tigernut is widely cultivated in Nigeria, so exploring both its economic and nutritional potential is crucial. The findings of this research will provide reference data on tigernut production at a commercial scale, thereby diversifying its use and increasing production. Thus, food professionals, prospective researchers, and food industries will find the data obtained in this study highly valuable.

2. Materials and Methods

2.1. Sources of Raw Materials

Brown and yellow varieties of tigernut tubers were purchased from farmers in Jalingo, Taraba State, Nigeria. A 26mm crown corks manufactured by Pellconi Company in Italy was successfully delivered through a courier serviceDalsey Hillblom Lynn (DHL) and used for capping. The automated machine used for capping was purchased from Canada and shipped to Nigeria, the manufacturing company is Officine Pesce bottling system Italy with the model number PG 93/C. Vitamilk bottles were washed, sterilized and reused for bottling.

2.2. Sample Preparation

Tigernut extract used for the study was extracted from tigernut tubers (Plates 1-3). The tigernut tubers were sorted to remove defective tubers. Matured tigernut tubers selected were weighed and portioned, the tubers were also washed to remove sands and debris prior to use. Different processing methods (boiling, malting and soaking) were used before the extraction process was carried out.

2.2.1. Boiling Method

The method described by Asante, et al. [13] with slight modification was used. About 200g of tigernut tubers was weighed out and boiled at the temperature of 1000C for 5 minutes before extraction. Omniblend V model TM800 was used to reduce the particle size of the boiled tubers, then milled into paste. After the blending process, the slurry was filtered with a clean, damp muslin cloth. Distilled water (500 ml) was used together for the blending and slurring process. Before bottling and capping process, the filtrate from the extract was boiled at 70 0 C for 15 minutes to avoid curdling (Figure 1).

2.2.2. Malting Method

The method of Ndubuisi [14] with modification was used. About 200g of tigernut tubers was weighed out then submerged in water (600ml) for a period of 24 hours before draining. During soaking, the tigernut tubers were washed and drained at the interval of 6 hours before placing them in a jute bag and kept at room temperature. Water was sprinkled on the tubers twice a day. At the fifth day, germination occurred, and the tubers gave out shoots and roots. The germinated tubers were washed/devegetated. Omniblend V model TM 800 was used to reduce the particle size of the malted tubers, and then milled into paste. After the blending process, the slurry was filtered with a clean, damp muslin cloth. Distilled water (500 ml) was used together for the blending and slurring process. Before bottling and capping process, the filtrate from the extract was boiled at 70 0 C for 15 minutes to avoid curdling (Figure 1).

2.2.3. Soaking Method

The method according to Ndubuisi [14] with modification was used A weighed portion of tigernut tubers (200g) was cleaned with water, drained, and immersed in a 600ml of water for a period of12 hours. Then the tubers were drained. Omniblend V model TM 800 was used to reduce the particle size of the soaked tubers, then milled into paste. After the blending process, the slurry was filtered with a clean, damp muslin cloth. Distilled water (500 ml) was used together for the blending and slurring process. Before bottling and capping process, the filtrate from the extract was boiled at 70 0 C for 15 minutes to avoid curdling (Figure 1).

2.3. Heat Penetration Studies

Heat penetration study was done on the bottled tigernut milk to determine the appropriate sterilization condition to ensure that the indicator organism (Clostridium botilinum) was eliminated and nutrients retained. The goal was to achieve an F0 (F zero) in the range of 12-15 minutes which is recommended for low acid canned foods. In carrying out this process, the sterile bottles were hot filled with the tigernut milk then capped before inserting a thermocouple at the center of the can to evaluate the temperature of the milk as sterilization is being carried out (Plates 4-6). It should be noted that the inserted thermocouple must be well sealed with thermostable gum to avoid leakage during sterilization. The instrumented bottle was placed in a retort autoclave along with other capped bottled tigernut milk. The thermocouple captured the temperature of the tigernut in the bottle every two minutes. The appropriate sterilization for the tigernut milk was achieved after 12.82 minutes. The temperature profile for the calculation of F0 using modified trapezium approach is illustrated in Table 1.

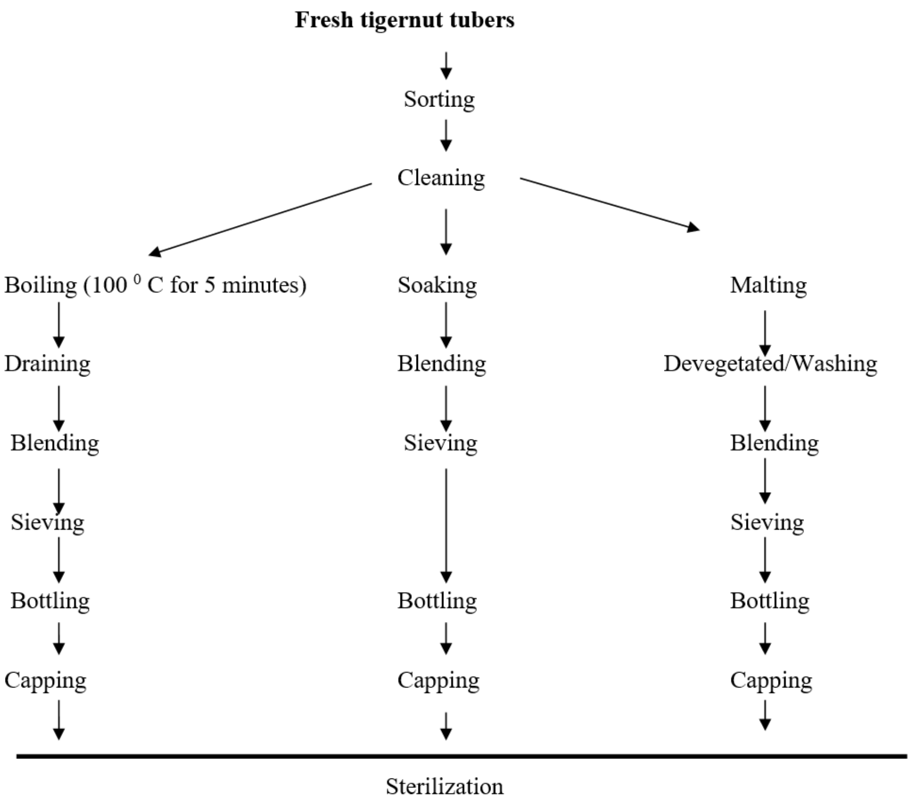

Figure 1. A flow chart illustrating the processing, production and sterilization of Tigernut milk.

Varieties of tigernut tubers

Plate 1: Yellow Tigernut

Plate 2: Brown Tigernut

Plate 3: Malted Tigernut

Heat penetration/ Bottling process

Plate 4: Penetration studies

Plate 5: Bottling process

Plate 6: Bottled tigernut milk

Table 1. Temperature and time profile for the sterilization of the Tigernut milk.

Time 2 (Min)	Temperature (oC)	L	Area under the curve
0	108.4	0.054954	0.409767
2	116.5	0.354813	0.743859
4	116.9	0.389045	0.825561
6	117.4	0.436516	0.915146
8	117.8	0.47863	0.979817
10	118	0.501187	1.025995
12	118.2	0.524807	1.155765
14	119	0.630957	1.261915
16	119	0.630957	1.291651
18	119.2	0.660693	1.352524
20	119.4	0.691831	1.399777
	119.5	0.707946	1.466523 **F_o for tigernut** 12.8283

2.4. Analysis

2.4.1.Determination of Mineral Content

Sodium (Na), magnesium (Mg), iron (Fe), calcium (Ca), potassium (K), and copper (Cu) were analyzed using the method as described by AOAC [15].

2.5. Determination of Phytochemical Properties

The method as described by Harborne [16] was used to determine Alkaloids while the method of Amadi, et al. [17] was used to determine Tannins and phytate. Also the method described by Vichapong, et al. [18] was used to determine Flavonoid, and Oxalate was determined using the method described by Savage, et al. [19].

2.6. Statistical Analysis

The mean and standard deviation of the data obtained from the study was calculated and analyzed with single factor Analysis of variance (ANOVA) SPSS version 22.0. The significant difference between mean values was determined using the Duncan New Multiple Range Test. MINITAB version 19.0 was used to show interaction.

3. Results and Discussion

3.1. Mineral Composition

The mineral composition of the tigernut tubers are shown on Table 2. The mineral content of the tigernut tubers ranged from 1.7mg/100g to 526.25mg/100g. Iron recorded the least value at 1.73mg and 2.24mg for yellow and brown variety respectively. While potassium recorded the highest value 460mg-526.25mg for yellow and brown variety. There was no significant difference $p<0.05$ in the copper content in both varieties. Also no significance difference $p<0.05$ was recorded for the sodium content in both variety. The calcium content is lower than values obtained by Arafat, et al. [20] whose study revealed that tigernut tubers have high calcium (152mg) but low values of iron (2mg), and copper (1.30mg) mineral contents. The values of calcium found in the tigernut, are adequate for teeth and bone development in infants. Magnesium aids enzyme activities, provides bone strength, support nerve and heart functions. According to Ahmed and Hussein [21]tigernut tubers contain small quantities of iron, phosphorus, manganese, zinc and copper but have a high content of sodium and calcium. Tigernuts could contribute sufficient magnesium to the daily requirements of growing children. Oladele and Aina [22] reported the mineral element of tigernut, their result showed that potassium had a value of (216 mg/l00g), sodium had a value of (245 mg/l00g) and calcium had a value of (155 mg / l0g) these values are lower than values obtained in this study except for calcium which is slightly higher. Although it has been known that tigernut is an underutilized tuber, this study has shown that tigernuts contain essential minerals. From the result of the study, it can be concluded without doubts that tigernut is a good source of some minerals, and having these minerals present; it could serve as an important dietary supplement.

Table 2. Mineral composition content of tigernut tubers.

Micronutrient	Yellow variety	Brown variety
Calcium (mg/100 g)	79.92**±0.01	119.70**±0.00
Magnesium (mg/100 g)	121.21**±0.06	169.41**±0.00
Iron (mg/100 g)	1.73*±0.09	2.24*±0.09
Sodium (mg/100 g)	395.00^{NS}±17.68	392.50^{NS}±0.00
Potassium (mg/100 g)	460.00**±0.00	526.25**±8.84
Copper (mg/100 g)	17.84^{NS}±0.81	15.57^{NS}±0.81

Note: Values are mean ± standard deviation of duplicate determinations.
**: Means placed in the same row are significantly different at ($p<0.05$).
*: Means placed in the same row are significantly different at ($p<0.01$).
NS: Means placed in the same row are not significantly different at ($p<0.05$).

3.2. Antinutrient Composition of Tigernut Tubers

Table 3 shows the antinutrient composition of tigernut tubers. The values recorded ranged from 0.12mg to 19.70mg.the yellow variety recorded the least value of 0.12mg for oxalate and phytic acid content and there was no significant difference $p<0.05$ between with phytic acid content of the yellow and brown varieties. The result obtained showed that tigernut tubers are low in some antinutrients except flavonoids. Even though alkaloids are known for their toxicity, not all are toxic. They are also responsible for the inhibition of some mammalian enzyme activities such as phophodiesterase, and prolonging the action of cyclic adenosine monophosphate (cAMP). They also affect stimulating hormones such as thyroid and glucagons. Some forms of alkaloids have also been shown by scientist to be carcinogenic [23]. However, antinutrients content obtained from this study were relatively low when compared to the antinutrients content reported for nuts such as peanuts [24]. When phytates are present in a biological systems it may chelate divalent metals such as magnesium and calcium, or inhibit the absorption of essential minerals in the intestinal tract[25] thus reducing its bioavailability [26]. Phytates chelate with mineral elements therefore having an effects on the utilization of those minerals. They also react with residues of proteins. Tannins and sometimes oxalates, also bind to proteins thereby causing difficulty in protein digestion. Oxalates can expunge calcium in the form of calcium oxalate in the blood which may result to the damage of the organ [27].

Table 3. Antinutrient composition of tigernut tubers.

Antinutrient	Yellow variety	Brown variety
Alkaloid (mg/100 g)	1.37**±0.04	2.27**±0.07
Phytic acid (mg/100 g)	0.12^{NS}±0.00	0.14^{NS}±0.01
Oxalate (mg/100 g)	0.12**±0.01	0.22**±0.01
Tannin (mg/100 g)	0.99^{NS}±0.08	1.24^{NS}±0.08
Flavonoid (mg/100 g)	19.70*±0.00	18.45*±0.35

Note: Values are mean ± standard deviation of duplicate determinations.
**: Means placed in the same row are significantly different at ($p<0.05$).
*: Means placed in the same row are significantly different at ($p<0.01$).
NS: Means placed in the same row are not significantly different at ($p<0.05$).

Table 4. Mineral composition of tigernut milk.

Pre-processing method	**Variety**	**Post-packaging**	**Calcium (mg/100 g)**	**Magnesium (mg/100 g)**	**Iron (mg/100 g)**	**Sodium (mg/100 g)**	**Potassium (mg/100 g)**	**Copper (mg/100 g)**
Malted	Yellow	Fresh	$78.90^{d}\pm0.08$	$71.86^{b}\pm0.04$	$0.76^{f}\pm0.00$	$212.50^{c}\pm7.07$	$136.25^{c}\pm1.77$	$14.43^{bcd}\pm0.81$
Malted	Yellow	Sterilized	$79.07^{d}\pm0.07$	$47.82^{e}\pm0.25$	$0.70^{f}\pm0.09$	$136.25^{g}\pm5.30$	$103.75^{h}\pm1.77$	$17.28^{a}\pm1.61$
Malted	Brown	Fresh	$78.61^{e}\pm0.12$	$71.59^{b}\pm0.00$	$1.26^{cd}\pm0.00$	$192.50^{e}\pm3.54$	$83.75^{i}\pm1.77$	$12.73^{d}\pm1.61$
Malted	Brown	Sterilized	$39.84^{f}\pm0.11$	$48.50^{c}\pm0.56$	$1.21^{d}\pm0.08$	$190.00^{e}\pm3.54$	$118.75^{de}\pm1.77$	$13.29^{cd}\pm0.81$
Soaked	Yellow	Fresh	$38.70^{g}\pm0.06$	$46.87^{f}\pm0.03$	$0.94^{e}\pm0.07$	$215.00^{c}\pm3.53$	$111.25^{fg}\pm1.77$	$15.57^{abc}\pm0.81$
Soaked	Yellow	Sterilized	$39.76^{f}\pm0.00$	$48.23^{cde}\pm0.00$	$0.83^{ef}\pm0.09$	$107.50^{h}\pm3.53$	$116.25^{ef}\pm1.77$	$16.14^{ab}\pm1.60$
Soaked	Brown	Fresh	$39.66^{f}\pm0.17$	$72.32^{a}\pm0.09$	$1.27^{cd}\pm0.00$	$201.25^{d}\pm5.30$	$110.00^{g}\pm0.00$	$14.43^{bcd}\pm0.81$
Soaked	Brown	Sterilized	$39.77^{f}\pm0.00$	$48.27^{cd}\pm0.04$	$1.27^{cd}\pm0.00$	$133.75^{g}\pm1.77$	$77.50^{j}\pm3.53$	$15.57^{abc}\pm0.81$
Boiled	Yellow	Fresh	$80.04^{a}\pm0.01$	$48.56^{c}\pm0.02$	$1.61^{a}\pm0.09$	$257.50^{b}\pm3.54$	$131.25^{c}\pm1.77$	$17.84^{a}\pm0.80$
Boiled	Yellow	Sterilized	$79.45^{c}\pm0.04$	$48.17^{cde}\pm0.00$	$1.52^{b}\pm0.00$	$208.75^{cd}\pm1.77$	$123.75^{d}\pm1.77$	$16.14^{ab}\pm1.60$
Boiled	Brown	Fresh	$78.98^{d}\pm0.00$	$47.94^{de}\pm0.05$	$1.39^{bc}\pm0.00$	$160.00^{f}\pm3.53$	$220.00^{a}\pm3.54$	$6.48^{e}\pm0.80$
Boiled	Brown	Sterilized	$79.64^{b}\pm0.06$	$24.19^{g}\pm0.07$	$1.21^{d}\pm0.09$	$268.75^{a}\pm1.77$	$191.25^{b}\pm5.30$	$8.75^{e}\pm0.81$

Note: Values are mean ± standard deviation of duplicate determinations. Means placed in the same column with different superscripts are significantly different at ($p<0.05$).
a represents: highest significant mean among the treatments
b represents: second highest significant mean among treatments
c represents third highest significant mean among treatments
d –I represents: significant mean after a b, c
j represents: least significant mean among treatments

3.3. Mineral Composition of Tigernut Milk

The mineral composition of tigernut milk is presented in Table 4. The result recorded ranged from 39.70mg to 80.04mg for the calcium content, magnesium content ranged from 24.19mg to 72.32mg while the iron content recorded 0.70mg to 1.61mg. The result of the sodium content was 133.75mg to 268.75mg, while potassium ranged from 77.50mg to 220mg and copper ranged from 6.48mg to 17.84mg. The boiled brown variety had the least value for copper. Sodium, calcium, and potassium are still the major constituents of tigernuts, the result recorded showed all samples were significantly different $p<0.05$. Processing and sterilization had little effect on the mineral content of tigernut milk. Although there was a decline on the calcium content of the malted brown which recorded 78.61mg for freshly produced tigernut milk and 39.84mg for the sterilized tigernut milk. However, there was a significant increase on the potassium content. Also there was a significant difference $p<0.05$ on the sodium composition for the boiled samples. The disparity within the findings may be as a result of the type of soil used for planting, variations in the mineral composition of soil, and location where the crop was planted [28]. A number of studies have proven that mineral and acceptability of tigernut milk is usually affected by the planting period and location of the tigernut tubers [29].

In addition, variation in the mineral content of the samples could be attributed to the different processing methods (soaking, boiling and malting) used in this study. Onyeka [30] reported that mineral elements are inorganic that are found in minute quantity and play vital roles in human nutrition and their deficiency may affect the body functions. This study showed that the pre-treatment applied (soaking, boiling and malting) to the tigernut either improved or caused a decline on the mineral content of the tigernut milk.

3.4 Antinutrient Composition of Tigernut Milk

The result for the antinutrient composition of the tigernut milk is shown in Table 5.

Results obtained showed that processing and sterilization affected the antinutrient content of tigernut milk. This could be attributed to the fact that processing generally reduces the antinutrient content of tigernut milk [31]. Soaking serves as a medium for the removal or reduction of possible antinutrient present, such as tannins and oxalates, phytic acids, polyphenols which could be released in to the water and discarded during draining process [32]. Similarly Onwuka [33] reported a decrease in tannin content of vegetable cowpea (Vigna unguiculata) and pigeon pea (Cajanus cajan) with a rise in soaking time. Values obtained for tannins in this study was lower than 2.02% obtained by Adekanmi, et al. [34] for soaked tigernut at room temperature but higher than 0.07% and 0.15% reported for brown millet and soybean reported by Liu [35]. The effect of soaking on the antinutrient composition could be as a result of leaching during soaking period due to the solubility of tannin in water. Soaking is a crucial step during malting in the production of vegetable milk because it tenderizes plant materials to help facilitate milling and extraction, makes milk easily digestible and palatable, and removes anti nutritional factors [34-36].Tannins inhibit the activities of enzymes such as amylase, trypsin and lipase by forming insoluble complexes with protein [37] and divalent ions such as zinc and iron thereby inhibiting their absorption 2+ 2+ in the body [38]. Also the malting process decreased the tannin contents as a result of the activity of enzyme phenyl oxidase [39] microbial activities could also result to the decrease especially the phytic acid due to increased microbial activities during the malting process. All the processing methods used in this study significantly affected the phytate content. According to Khan, et al. [40] the higher the moisture content, the higher the phytate loss.

It has been reported the malting as a pre-processing method is known to be the most effective method of reducing phytates [41]. A broad range of microflora has been known to possess phytate activity that may be responsible for the reduction of phytate content [42]. The oxalate content was significantly reduced. Similarly, Obasi and Wogu [43] recorded a significant decline in the oxalate content of yellow maize soaked in water for a period of 12 hours. The alkaloid content also reduced, although the different processing methods had effect on the alkaloid, sterilization had more effect in reducing the alkaloid content. The low alkaloid content obtained in this study agrees with studies reported by Yadesa and Biadge [44] on the effect of some traditional processing methods on nutritional composition and alkaloid content of lupin bean. The concentration of alkaloids, phytate, tannin, hydrogen cyanide, oxalate and saponin reduces after fermentation [45]. Tannin, saponin and oxalate can be reduced by soaking [46].

Table 5. Antinutrient composition of tigernut milk.

Pre-processing method	Variety	Post-packaging	Alkaloid (%)	Phytic acid (%)	Oxalate (mg/100 g)	Tannin (%)	Flavonoid (%)
Malted	Yellow	Fresh	$1.05^{f}\pm0.03$	$0.040^{b}\pm0.000$	$0.025^{ab}\pm0.007$	$0.650^{de}\pm0.00$	$18.70^{a}\pm0.00$
Malted	Yellow	Sterilized	$0.94^{g}\pm0.01$	$0.055^{a}\pm0.007$	$0.010^{c}\pm0.000$	$0.595^{de}\pm0.08$	$14.70^{ef}\pm0.71$
Malted	Brown	Fresh	$1.81^{c}\pm0.02$	$0.050^{ab}\pm0.000$	$0.020^{b}\pm0.000$	$0.815^{bc}\pm0.08$	$15.45^{de}\pm0.35$
Malted	Brown	Sterilized	$1.29^{d}\pm0.04$	$0.040^{b}\pm0.001$	$0.020^{b}\pm0.000$	$0.705^{cd}\pm0.08$	$10.70^{h}\pm0.71$
Soaked	Yellow	Fresh	$1.20^{e}\pm0.02$	$0.055^{a}\pm0.007$	$0.010^{c}\pm0.000$	$0.880^{b}\pm0.00$	$17.70^{ab}\pm0.00$
Soaked	Yellow	Sterilized	$1.01^{f}\pm0.03$	$0.060^{a}\pm0.000$	$0.010^{c}\pm0.000$	$0.805^{bc}\pm0.08$	$16.70^{bc}\pm0.71$
Soaked	Brown	Fresh	$2.08^{a}\pm0.03$	$0.055^{a}\pm0.007$	$0.030^{a}\pm0.000$	$0.990^{a}\pm0.00$	$16.45^{cd}\pm0.35$
Soaked	Brown	Sterilized	$1.93^{b}\pm0.04$	$0.060^{a}\pm0.000$	$0.010^{c}\pm0.000$	$0.825^{b}\pm0.08$	$11.95^{g}\pm0.35$
Boiled	Yellow	Fresh	$0.16^{i}\pm0.00$	$0.050^{ab}\pm0.000$	$0.010^{c}\pm0.000$	$0.220^{g}\pm0.00$	$17.70^{ab}\pm0.00$
Boiled	Yellow	Sterilized	$0.09^{j}\pm0.01$	$0.050^{ab}\pm0.000$	$0.010^{c}\pm0.000$	$0.220^{g}\pm0.00$	$17.70^{ab}\pm0.00$
Boiled	Brown	Fresh	$1.03^{f}\pm0.03$	$0.060^{a}\pm0.000$	$0.025^{ab}\pm0.007$	$0.540^{ef}\pm0.00$	$17.45^{bc}\pm0.35$
Boiled	Brown	Sterilized	$0.65^{h}\pm0.01$	$0.050^{ab}\pm0.000$	$0.020^{b}\pm0.000$	$0.440^{f}\pm0.00$	$13.95^{f}\pm1.06$

Note: Values are mean ± standard deviation of duplicate determinations. Means placed in the same column with different superscripts are significantly different at ($p<0.05$).
a represents: highest significant mean among the treatments
b represents: second highest significant mean among treatments
c represents third highest significant mean among treatments
d –I represents: significant mean after a b, c
j represents: least significant mean among treatments

Also, it has been reported by researchers that hydrothermal treatment, fermentation and some processing methods have the ability to reduce this antinutrients [47].The flavonoid contents recorded shows that tigernut can be used as a functional food as it is rich in flavonoid. Administration of tigernut extract on Wistar rats resulted in delayed manifestation of diarrhoea symptoms which suggests that anti-diarrhea property of tigernut milk is linked to the presence of flavonoids and tannins [21]. The availability of numerous phytochemicals with antioxidant activity agrees that tigernut milk are beneficial to health [48-50]. Due to the chemical composition of tigernut it is suggested that Tigernut milk can be used as functional Oluwadunsin, et al. [50]. Olagunju and Oyewumi [51] recommended that tigernut beverages can be useful in the prevention of cardiovascular diseases. Consumption of tigernut can also lower the risk of diabetes and obesity due to its lipase and α-amylase inhibition capacity [49].

4. Conclusion

Results obtained from this study shows that Tigernut tubers can be processed into different products using various pre-processing methods. Generally, the processing treatment (malting, soaking and boiling) significantly affected the antinutrient composition of the tigernut milk except for the flavonoid content. Variations in mineral values obtained for each samples were as a function of processing treatment and sterilization. The study highlighted the possibility of processing tigernut tubers into shelf-stable milk extract which can be stored for an extended period.

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