IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 13, Issue 6 Ser. II (June. 2019), PP 55-61
www.iosrjournals.org

Influence of Different Pre-treatments on the Nutritional and Organoleptic Properties of Vegetable Milk produced locally from Tiger- Nut (*Cyperus esculentus*) Tubers

*Ntukidem, V. E., Ukwo, P. S., Udoh, I. E. and Umoinyang, E. U.
Department of Food Science and Technology, Faculty of Agriculture University of Uyo, Uyo. Nigeria.
Corresponding author: Ntukidem, V. E

Abstract : *This study focused on the effect of pre-treatments on the nutritional and sensory quality of vegetable milk produced locaally from tiger-nut tubers. Milk extracts were obtained from fresh tubers (Sample A), sprouted tubers (Sample B) roasted tubers (sample C) while Sample D was made from tubers that sprouted before roasting. Samples were analyzed for proximate, macronutrients (mineral), vitamin C composition and sensory properties. Result of proximate composition indicated that there was a significant (P<0.05) difference in moisture, lipid, carbohydrate, protein and ash content. There was no significant (P<0.05) difference among samples B and C in terms of ash content. Also, there was no significant (P<0.05) difference in samples A, B, and D except for sample C in fibre content. Lipid content of sample D was relatively higher (P<0.05) than the other milk samples. However, in terms of caloric value, sample D was significantly (P<0.05) higher than the rest of the samples. Results also revealed that, there was a significant (P<0.05) difference among all the milk samples in terms of vitamin C content. Results of macronutrient (minerals) showed the presence of sodium, potassium, calcium, zinc and iron. The mineral compositions were in comparable amount. Sensory properties of the tiger-nut milk samples evaluated indicated that sample D (roasted sample) was most preferred by the panelists in terms of taste, consistency, aroma, mouthfeel, aftertaste and general acceptibility.*
Keywords: *Tiger-nut, milk, sprouting, fermentation, tuber and roasting*

Date of Submission: 08-06-2019 Date of acceptance: 25-06-2019

I. Introduction

Milk is a white liquid produced from the mammary gland of mammals [1]. All mammals including humans produce milk to feed their offspring until they can digest solid food [2]. It contains valuable nutrients and can also offer a range of health benefits. Some plants also contain milk like substances, which has been consumed for centuries in different cultures both as a regular drink (such as Spanish horchata) and as substitute for dairy milk [3]. The most popular vegetable milks are soymilk, almond milk, rice milk and coconut milk etc. these milk varies in their nutritional content. They contain neither lactose nor cholesterol and are sometimes sold with added calcium and vitamins especially B_1 and B_2 [4].

The search for lesser known and underutilized indigenous food crops, many of which are potentially valuable as human and animal foods have been intensified to maintain a balance between population growth and agricultural productivities particularly in the tropical and sub-tropics areas of the world. *Cyperus esculentus* (tiger-nut) is sedge of the family Cyperaceae that produces rhizomes from the base and tubers that are spherical. It is commonly known as “earth almond”, chutaand zulu nut [5].

In Nigeria, three varieties (black, brown and yellow) with different names are planted but only two varieties of yellow and brown are readily available in the market. The yellow is preferred to all the other varieties because of its inherent properties like its bigger size, attractive colour and fleshy body. Tiger-nut can be eaten raw, roasted, dried, baked or made into refreshing beverage (Tiger-nut milk). The nuts are usually eaten unprepared, pounded into cake and served at the end of a meal [6].

Tiger-nut has been described as an important food of high nutritional and economic values [7] and a source of starch for human consumption and industrial use [8]. It yields more miles upon extraction and contains lower fat and more protein [9]. The origin of the use of this tuber for making milk is exclusive to the Spaniards to which it could have been introduced by the Arabs. Tiger-nut milk/beverage/drink commonly called *kunnuaya*” in Northern Nigeria is a healthy drink with many nutrients [10]. It is nourishing and energetic product recommended by experts to be taken during any season of the year, especially in dry season when the sun is hot. In Spain, it is called chufa de horchata. It is rich source of nutrients such as Vitamin C and E, and minerals such as Phosphorus, Magnesium, Potassium, Calcium, Iron and also Carbohydrates, unsaturated fats, proteins and some enzymes, which help in digestion. In fact this drink contains more Iron, Magnesium and Carbohydrates than the cow’s milk [11]. It has also the advantage of 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 [12].

Many studies have been carried out on Tiger-nut but there is paucity of information on the effects of pretreatments on the proximate, macro-minerals and organoleptic properties of milk produced from Tiger-nut varieties. Despite the potentials of Tiger-nut as food, it has been an underutilized crop in Nigeria probably due to inadequate knowledge on its production, utilization, and nutritional benefits and value. More so, there is no scientific documentation of a successful product made from Tiger-nut in the Nigerian market. The study therefore was conducted to investigate the effects of pretreatment on the nutritional quality and sensory properties of vegetable milk produced from Tiger-nut tubers.

II. Materials and Methods

2.1 Sample Collection

Fresh tiger-nuts were purchased from Akpan Andem Market in Uyo and were taken to the Department of Food Science and Technology laboratory. The variety used was the yellow variety of tiger-nut tubers.

2.2 Sample Treatments

Fresh tiger-nuts were visually selected. Defective tubers were manually removed and discarded. Hence only matured healthy tiger-nut tubers were selected. Tiger-nut were weighed out in portions, washed thoroughly in water and drained prior to use for all the studies. And the following treatments were carried out.

2.3.1 Fresh

Fresh tiger-nuts (1000 g) were soaked in clean water for 24 hours. The soaked tiger-nut tubers was washed, drained and blended into paste in electric blender and slurred. 1000 ml of water was used during the blending and slurring process. The slurry was filtered with the aid of a muslin cloth and the filtrate obtained was transferred into a plastic bottle and carried to the analytical laboratory for analysis. Modified method [13].

2.3.2 Sprouting

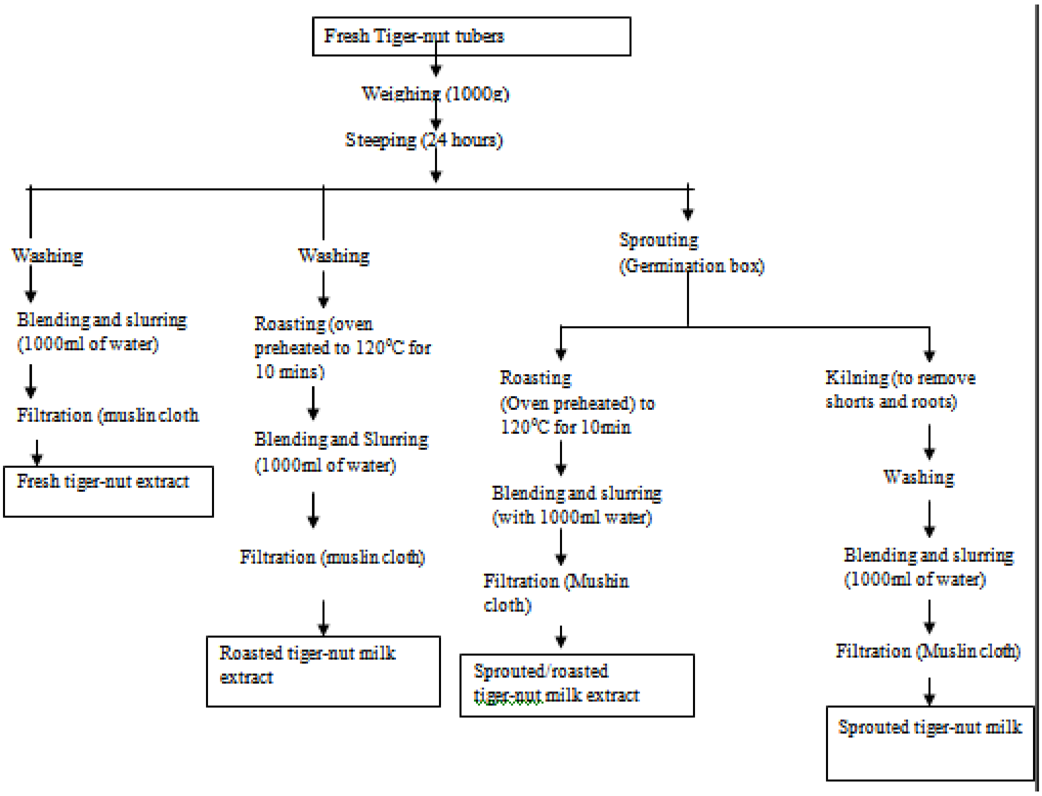
Fresh Tiger-nut was visually selected. A portion of Tiger-nut (1000g) was soaked in a vessel for 24 hours and was drained out. The soaked Tiger-nuts were washed, drained and put in a germination box. Water was sprinkled at 6 hours interval to soften the tubers. After 5 days, it germinated giving out shoots and roots. After the sprouting period, the Tiger-nut tubers were cleaned, washed, drained and blended into paste in an electric blender and slurred. 1000mls of water was used during the blending and slurring process. The slurry was filtered with the aid of a clean muslin cloth and the filtrate obtained was transferred into a plastic bottle and carried to the analytical laboratory for analysis, Modified method [13].

2.3.3 Roasting

A portion of Tiger-nut (1000g) was soaked in clean water for 24 hours. The soaked Tiger-nut was washed in water, drained and roasted in the oven preheated to $120^{0}C$ for 10 minutes. The roasted Tiger-nuts were then cooled and blended into paste in electric blender and slurred. 1000ml of distilled water was used during the blending and slurring process. The slurry was filtered with the aid of a clean muslin cloth and the filtrate obtained was transferred into a plastic bottle and carried to the analytical laboratory for analysis, modified method [13].

2.3.4 Sprouting and Roasting

A portion of Tiger-nut (1000g) was soaked in a vessel for 24 hours and drained out. The soaked tubers were washed, drained and sprouted on a germination box. Water was sprayed at 6 hours interval to soften the tubers and facilitate sprouting. After 5 days, it germinated giving out shoots and roots. The tubers were then washed and roasted ion the oven preheated to $120^{0}C$ for 10 minutes, the roasted Tiger-nut was then cleaned and blended into paste in electric blender and slurred. 1000ml of distilled water was used during the blending and slurring process. The slurry was filtered with the aid of a clean muslin clot and the filtrate obtained was transferred into a plastic bottle and carried to the analytical laboratory for analysis.



2.7 Method of analysis

2.7.1 Determination of Proximate composition of the samples

Proximate analysis including: moisture content, ash, crude fiber, crude protein, crude fat, carbohydrate and caloric value were carried out on the samples using standard methods described by the Association of Official Analytical Chemists [14]. The determinations were done in triplicates and all reagents used for the analysis were of analytical grade.

2.7.2 Mineral composition analysis

Mineral (Na, K, Ca, Mn, Zn, and Fe.) contents of the Tiger-nut milk samples were determined by Atomic Absorption Spectrophotometry (AAS) and flame photometry according to the methods of [15].

2.7.3 Determination of Ascorbic Acid (Vitamin C)

Principles: Ascorbic acid reacts with 2,4 dinitrophanyly-hydrazine after oxidation of vitamin C to dehydroascobic acid. Ascorbic acid in oxidized to dehydroascorbic acid by curpricsulphate. The dehydroascorbic acid is a strong acid solution reacts with 2, 4dinitrophanyl-hydrazine to form dinitrophenyl-hydrazone. The hydrazine in the presence of strong sulphuric acid solution develops a red colour, which can be measured spectrophotometrically. Thiourea is added to dinotrophenyl-hydrazine reagent to prevent oxidation of the dinitrophenyl-hydrazone reagent by interfering substances.

Procedures: 1g of the sample was extracted with 10ml of TCA 6g/100ml, filter and pipette 1ml of the clear solution into a test-tube. The standards were pipette into a test tube (1ml). 1ml of the 6g/100ml TCA was pipette into a test tube as a blank. 1 ml of DTCS reagent was added to all the tubes, which were caped, mixed and incubated in a water bath and chilled for 10min in an ice water bath while mixing slowly 2mls of cold 12m H_2SO_4 was added to the tubes. The spectrophotometer was adjusted with the blank to read zero absorbance at 520nm and then the absorbance of standard and test read [15].

2.7.4 Evaluation of Sensory properties

In this study, 20 semi-trained panelists were selected from students and staffs of the Department of Food Science and Technology were used to evaluate the product. Attributes considered were taste, colour, flavour, mouth-feel, consistency, aroma and general acceptability. It was a 9-point Hedonic scale that was used to score the product with 9 representing “like extremely” and 1 representing “dislike extremely”.

2.7.5 Statistical Analysis

All treatments were replicated trice for accuracy and analysis done in triplicate except for sensory evaluation. The scores or data obtained expressed as mean $\pm$ standard deviation were subjected to statistical analysis of variance (ANOVA) to determine whether there were any significant ($P>0.05$) difference among the mean of samples using the statistical package for Social Statistical (SPSS Version 20). Mean were separated using the Duncan's New Multiple Range Test (DMRT).

III. Results and Discussion

Effect of Pretreatment on the proximate composition of the Tiger-nut Milk Samples

Moisture content of a food affects its stability and overall quality [17]. Moisture content of sample D (roasted and sprouted tiger-nut-milk) had highest moisture content of 89.97% followed by sample B (sprouted tiger-nut milk) had moisture content of 85.39%. There was a significant ($P<0.05$) difference among all the analyzed samples, but sample C and A had moderately low moisture contents. This could affect the stability and safety of food with respect to microbial growth and proliferation hence the products require cold storage.

Milk is a liquid therefore it is expected that the moisture content to be a bit higher, this work has revealed that the moisture content of all the samples were within the range of 68.41-89.97% which agrees with the work of Udeozor, [16].

Ash content gives an overall estimate of the total mineral elements present in the food material. There was a significant difference between sample A, and B, but there was significant difference between sample C and D. Sample A had the highest ash content of 0.35% followed by Sample D with 0.27%, Samples C and D (0.22 and 0.12% respectively). A similar observation was made by Okorie and Nwankezi [17] during the boiling of tiger-nut which showed that the raw tiger-nut sample had a higher (1.8%) ash content compared to the boiled sample which had an ash value of 0.142%, the boiled sample had a significant reduction in its ash content as a result of the leaching of mineral element into the cooking water [18].

The fibre content in the samples showed that samples C was significantly ($P<0.05$) different from Samples A, B and D. Fibre content reduction in samples B and D may be attributed to prolonged days of sprouting which might have led to the fermentation of the tiger-nut tuber. This was not in line with the work of Ndubuisi [13], which ranged from 7.48 – 13.97% and showed that malting increases fibre value of tiger-nuts (4.6%). Increased in fibre value due to soaking may be attributed to polymerization (multiple additions involving many identical molecules). In contrast, fibre values reduced due to drying and roasting. This may be attributed to loss of soluble fibre by hydrolysis, enzymatic degradation and decomposition. In addition, roasting may have increased the pectin level in tiger-nuts and the degree of esterification (formation of organic products from organic acids and alcohols) leading to decreased crude fibre content.

Protein content in this study showed significant ($P<0.05$) difference in sample A and B while samples C and D had no significant ($P<0.05$) difference. Soaking was the only treatment administered to samples A decreased its protein value by (0.05 %). This may be attributed to leach out of soluble proteins. Also, roasting reduced the protein value of sample D (0.09%). This may also be due to enzymatic degradation of free nitrogen protein released during soaking and roasting. Sprouting increased the protein value of sample B, this might be due to some specific amino acids, which decrease and or increase due to soaking and germination.

All the samples showed significant ($P<0.05$) difference in terms of lipid content. Lipid value of the tiger-nut milk samples increased as a result of drying (sample C). This may be attributed to concentration of fat due to moisture loss. Decreased in fat is due to sprouting (sample D) which may be due to the activities of the lypolytic enzymes such as lipase during sprouting. This can be further used to synthesis carbohydrate for roots and development [20], [21].

The results of the carbohydrate content in all samples were significantly ($P<0.05$) different. Sample C had the highest value (27 ± 0.01 %) and this may be attributed to starch hydrolysis due to heat. Crease observed in sample D may be due to Alpha-amylase activity, which breaks down complex carbohydrate to simple sugar, which are utilized as stored in the plant tissues during the sprouting and roasting process. Increases in carbohydrate due to soaking (sample A) may be attributed to starch conversion to simple sugar (glucose and fructose) by degrading enzymes such as diastatics, alpha and beta amylase [22].

The calories value showed significant ($P<0.05$) difference in all sample. Sample D had the least amount of energy while sample C had the highest with values (49.55 ± 0.03kcal/100g) to (139.90 ± 0.05kcal/100g) respectively. High-energy value of tiger-nut milk samples can be explained by the high content of carbohydrate and lipid. This is desired by the growing and energetic young adults and because low-energy foods tend to limits the optimal utilization of other nutrients through the protective effect of carbohydrate on protein and polyphenols.

From the result of vitamin C composition, all samples (A, B, C and D) were significantly ($P<0.05$) different. Sample B had the highest score (45.72 ± 0.02mg/100g) while sample C had the lowest score (0.01 ± 0.00mg/100g). This is an indication that vitamin C content of tiger-nut increases with in the length of fermentation time. This may be attributed to increase or multiplication of microbial cells. The decrease in the score of sample D may be attributed to heat during roasting because increased temperature will lead to a decrease in the vitamin C composition of tiger-nut milk.

Table 1: Physiochemical Composition

Parameters	A	B	C	D
Moisture (%)	$74.90^{c}\pm0.05$	$85.39^{b}\pm0.01$	$68.41^{d}\pm0.01$	$89.97^{a}\pm0.03$
Ash (%)	$0.35^{a}\pm0.02$	$0.22^{c}\pm0.00$	$0.12^{c}\pm0.01$	$0.27^{b}\pm0.03$
Fibre (%)	$0.12^{b}\pm0.02$	$0.10^{b}\pm0.01$	$0.22^{a}\pm0.02$	$0.11^{b}\pm0.00$
Protein (%)	$0.05^{c}\pm0.00$	$0.26^{a}\pm0.03$	$0.12^{b}\pm0.01$	$2.19^{d}\pm0.01$
Lipid (%)	$2.25^{c}\pm0.02$	$2.45^{b}\pm0.05$	$3.22^{a}\pm0.01$	$2.19^{d}\pm0.01$
Carbohydrate (%)	$2.33^{b}\pm0.02$	$11.58^{c}\pm0.02$	$27.61^{a}\pm0.01$	$7.37^{d}\pm0.03$
Caloric value (Kcal)	$109.77^{b}\pm0.03$	$69.41^{c}\pm0.01$	$139.9^{a}\pm0.05$	$49.55^{d}\pm0.03$
Vitamin C (mg)	$0.44^{b}\pm0.02$	$45.72^{a}\pm0.02$	$0.1^{d}\pm0.00$	$0.13^{c}\pm0.02$

Values are means $\pm$ standard deviation of triplicate determinations. Means in the same row with different superscript are significantly (P<0.05) different

Key

A - Fresh Tiger-nut with extract
B - Sprouted tiger-nut milk extract
C - Roasted tiger-nut milk extract
D - Roasted and sprouted tiger-nut milk extract

Effect of Pretreatment on the Macro Mineral Composition of the Tiger-nut Milk Samples

The macro mineral composition of the tiger-nut samples as presented in table 2 indicated that significant (P<0.05) differences were observed among some samples while some showed no significant difference (P<0.05). All samples were significantly (P<0.05) different in terms of Sodium content. Sample D recorded the highest score followed by B, A, and C increases may be due to fermentation and heat while the decrease may be attributed to roasting. Some samples for potassium were significantly (P<0.05) different, while some were not. Sample D had the highest score followed by A, C and D. Also, decrease may be attributed to utilization of potassium during germination and growth and an increase may be due to roasting which leads to concentration of minerals due to moisture loss.

For Calcium content, all samples were significantly (P<0.05) different. Increase in calcium may be attributed to freeing of Calcium from calcium phosphate to phytase [22]. On the contrary, decrease in Calcium was due to roasting. Manganese showed no significant (P<0.05) difference. This may be attributed to the fact that the various treatments had little or no impact on the Manganese content of the samples.

Zinc content showed significant (P<0.05) differences in all samples. Increases in the score for Zinc may be attributed to soaking and sprouting. On the contrary, the decrease was due to roasting. Iron showed significant (P<0.05) difference in some samples. As a result of the pretreatment, Sample B recorded the highest score followed by D, A and C. Increase in Fe score was due to germination while a decrease may be attributed to roasting.

The findings from this work differs from Belewu and Abodunrin [12] who reported mineral content of tiger-nut milk beverage in mg/100g of Ca, Mg, K and P as 0.40, 0.20, 1.90 and 0.30 respectively. The variation among the findings from the different work in non-dairy milk beverage may be as a result of differences in the mineral composition of soil, the type of soil and location where the crop is planted [23]. In addition, variation should be attributed to differences arising from the methods of production adopted by different researcher. Onyeka [24] reported that mineral elements are inorganic that are found in traces and play important roles in human nutrition and their inadequacy may result to nutritional disorder in human body.

Table 2: Macro mineral Composition of the Tiger-nut Milk Samples (mg/100g)

Parameters	A	B	C	D
Sodium	$16.11^{b}\pm0.01$	$14.86^{c}\pm0.04$	$13.74^{d}\pm0.02$	$17.07^{a}\pm0.03$
Potassium	$1.71^{b}\pm0.01$	1.64c$\pm$0.04	$1.64^{c}\pm0.01$	$1.81^{a}\pm0.02$
Calcium	$25.73^{c}\pm0.02$	$25.56^{b}\pm0.08$	$23.09^{d}\pm0.01$	$26.15^{a}\pm0.05$
Manganese	$0.05^{a}\pm0.02$	$0.04^{a}\pm0.01$	$0.04^{a}\pm0.01$	$0.06^{a}\pm0.03$
Zinc	$0.56^{c}\pm0.03$	$0.79^{a}\pm0.01$	$0.05^{d}\pm0.00$	$0.06^{b}\pm0.00$
Iron	$0.06^{ab}\pm0.03$	$0.09^{a}\pm0.01$	$0.05^{b}\pm0.00$	$0.06^{ab}\pm0.00$

* Values are means $\pm$ SD (Standard Deviation) of triplicate determination. Means in the same row with different superscript are significantly (P<0.05) different

Key

A - Fresh Tiger-nut with extract

B - Sprouted tiger-nut milk extract
C - Roasted tiger-nut milk extract
D - Roasted and sprouted tiger-nut milk extract

Effect of Pretreatment on the Sensory Properties of the Tiger-nut Milk Samples

From the result of the sensory evaluation as presented in table 4, the score for appearance indicated that the panelist preferred sample A the most followed by B, C and D as the least. The appearance mainly depends on the type of treatment that was carried out. This was because sample A had the milky colour that could be likened to the regular cow milk. Decreases in the appearance score of sample C and D may be attributed to the brown obtained from roasting. This is because caramelization of tiger-nut occurs at a temperature above 100^0C [25].

Panelist preferred the taste of C followed by A, D and B, the taste was greatly impacted by the treatments. Sample C tasted like a mild chocolate drink, which may be attributed to the effect of roasting of the tiger-nut tubers at temperature of 120^0C, which brought about browning reaction (Maillard reaction). This browning reaction impacted a unique characteristics flavour similar to that of roasted coffee bean [22]; [20].

Sample A had the taste of plain tiger-nut milk this may be due to the fact that no special treatment was applied to it. Sample D tasted like a strong caffeinated drink, which may be attributed to the fact that it was sprouted and roasted. Sample B tasted like palm-wine this may be attributed to the sprouting time, which lead to fermentation of the tubers.

The panelist preferred the consistency of sample C followed by A, D and B as the least. This may be attributed to their difference in moisture content and temperature, increase in moisture content leads to a decrease in consistency.

The panelist preferred the aroma of Sample C followed by A, D and B as the least. The score for the aroma of Sample C may be attributed to the flavour impacted by roasting. This is because roasting impacts characteristics flavour in food due to the reaction of particular amino acids in the presence of reducing sugar [22]. Sample B had the lowest score because of it undesirable odour, which may be due to increase in the type of organic acid produced overtime during fermentation [26].

The panelist preferred the mouth-feel of Sample C followed by A, B and D as the least. Sample C was best preferred and this could be attributed to it consistency which gave it a creamy mouth-feel. Sample D had the lowest score and this could be attributed to it strong coffee taste and low consistency which left a grainy particle in the mouth and throat on digestion.

The panelist preferred the aftertaste of Sample C followed by A, B and D, this may be attributed to it chocolaty aftertaste which was impacted by roasting. The lowest score, which was attributed to D, could be attributed to the biting sensation after ingestion, which was due to combine effect of fermentation and heat.

For general acceptability, sample C was the most preferred, followed by A, B and D recorded the least score. This was attributed to score of their sensory characteristics. Sample C was the most preferred because of its high score in taste, consistency, aroma, mouth-feel and aftertaste compared to others while sample D had the least score considering the sensory parameters.

Table 3 Sensory Evaluation of the Tiger-nut Milk

Parameters	A	B	C	D
Appearance	$8.35^a \pm 0.81$	$7.75^a \pm 1.06$	$7.10^b \pm 1.02$	$5.50^c \pm 1.00$
Taste	$7.15^a \pm 1.13$	$5.15^b \pm 1.46$	$7.55^a \pm 0.74$	$5.60^b \pm 1.69$
Consistency	$7.15^a \pm 1.03$	$5.50+\pm 1.39$	$7.20^a \pm 0.89$	$5.70^b \pm 1.34$
Aroma	$6.90^a \pm 0.97$	$5.60^b \pm 1.69$	$7.35^a \pm 1.08$	$6.20^{ab} \pm 1.59$
Mouth-feel	$7.00^a \pm 0.98$	$6.20^b \pm 1.19$	$7.35^a \pm 1.08$	$5.70^b \pm 1.59$
Aftertaste	$7.20^a \pm 1.10$	$6.00^b \pm 1.52$	$7.35^a \pm 0.75$	$5.70^b \pm 1.52$
General Acceptability	$7.55^a \pm 1.19$	$6.30^b \pm 1.21$	$7.85^a \pm 0.51$	$5.85^b \pm 1.42$

* Value are means $\pm$ SD (Standard Deviation) of triplicate determination. Means in the same row with different superscript are significantly ($P<0.05$) different

Key

A - Fresh Tiger-nut with extract
B - Sprouted tiger-nut milk extract
C - Roasted tiger-nut milk extract
D - Roasted and sprouted tiger-nut milk extract

IV. Conclusion

The study showed that the pre-treatment applied (fresh, soaked, sprouted/roasted and sprouted) to the tiger-nut either increased or decreased the proximate composition and sensory attributes of the milk. Sprouting of the tiger-nut gave good yield in Vitamin C content. Roasting reduced the macro mineral level but gave a reasonable score in the proximate composition and sensory properties of the tiger-nut milk. However, sprouting and roasting gave the highest score in the macro mineral composition of the tiger-nut milk. Pre-treatment on the tiger-nut tubers before milk extraction will bring multi-choices and encourage flexibility depending on the deficiency or taste of the consumers thereby increasing the utilization of these tubers.

It is therefore recommended that public enlightenment on the methods of preparations using these pre-treatments should be conducted both at the local communities and the cities of developing countries. There is need for further experimental investigation to be geared towards ascertaining the nutritional quality of tiger-nut products. There is also need for further development of products based on tiger-nut milk for households and commercial purposes to ensure food security. This in turn will increase its production and utilization, thereby making it more popular

References

[1]. Anon (2005). What is Milk? Dairy Farmers of Washington: http://www.havemilk.com/article.asp?id=5805 (Accessed 16th March, 2019).

[2]. B. Hajirostamloo Comparison of Nutritional and Chemical Parameters of Soymilk and Cow Milk. World Academy of Science, Engineering and Technology.57, 2009,436-439.

[3]. J. W. Anderson,B.M Johnstone, and M.E. Cock-Newell. Metal Analysis of the Effects of Soy Protein Intake on Serum Lipid.New England Journal of Medicine333(5), 1995, 276-282.

[4]. WHO/FAO (2002) Joint WHO/FAO Expert report on Diet, Nutrition and Prevention of Chronic Diseases: Executive Summary, as cited in Food and Nutrition Bulletin24:2002, 285-286.

[5]. J.A. Adejuyitan. Tigernut Processing: Its Food Uses and Health Benefits. American Journal of Food Technology 6(3), 2011, 197-201.

[6]. J. Lowe, Nigeria Sedge. 2nd Ed. Ibadan, Nigeria 1973, pp. 83-84.

[7]. E.B. Oguntona, and E.B. Akinyele. Nutrient Composition of Commonly Eaten Food in Nigeria.Food Basket Foundation Publication Series.Obt Printing Ventures, Ibadan, Oyo State.1995.

[8]. J. W. Barkoand R. M. Smart. The nutritional ecology of Cyperusesculentus, an Emergent plant, Aquatic Botany.6, (1979). 13-28.

[9]. J.C. Okafor, and H.C. Okolo.Nutritive Value of a Mixture of Tigernut Tubers and Baobab Seeds.J. Sc. Food Agric.35, 2003, 437-440.

[10]. E. I. Bamishaiye and O. M. Bamishaiye . Tiger-nut: as a plant, its derivatives and benefits. African journal, Agriculture, Nutrition and Development11(5), 2011, 5157-5170.

[11]. G.E. Chevallier. The Encyclopedia of Medicinal Plants. Dorling Kindersley Press, London, 1996, 48-51.

[12]. M.A. Belewu, and O.A. Abodunrin.Preparation of Kunnu from Unexploited Rich Food Source.Tigernut (Cyperusesculentus) World Journal of Dairy and Food Science. 1:2006, 19-21.

[13]. L.C. Ndubuisi. Evaluation of Food Potentials of Tigernut Tubers (Cyperusesculentus) and Its Products (Milk, Coffee and Wine). Home Science, Nutrition and Dietetics. 2009, 34-36.

[14]. AOAC Official Methods of Analysis (24th Edition).Association of Official Analytical Chemist, Washington DC, USA 2010.

[15]. AOAC Official Methods of Analysis of the Association of Official's Analytical Chemists.17th ed. Association of Official Analytical Chemists, Arlington, Virginia 2003.

[16]. L.O. Udeozor. Tiger-nut-soy milk drink: preparation, proximate composition and sensory qualities. International Journal of Food and Nutrition Science.1(4), , 2012, 18-26.

[17]. S.U. Okorie and E.C. Nwanekezi. Evaluation of Proximate Composition and Anti-Nutritional Factors of Cyperusesculentus (Tigernut) as Influenced by Boiling.Journal of Environmental Science, Toxicology and Food Technology.8: 2004,70-72.

[18]. C. Hunt, P. Burn, and Z.CAdamezuk. Proximate Composition and Fat Type of Popular Take Away Meal. Int. J. Food Sci.And Technology22: 1987, 669-675.

[19]. A. Morris, A. Barnett, A. and O. Burrows. Effect of processing on Nutrient Contents of Food.Research gate 37: 2004, 160-165

[20]. Lake and Waterworth. Munn Rankin and Hildreth's Foods and Nutrition. 13th ed. Bell and Hyman Ltd London, 1983, pp 58-367.

[21]. G. M. Wardlaw and W. M. Kessel. Perspective in Nutrition: 5th edition. Mc-Graw Hill.2002.

[22]. A.E. Bender. Nutrition and Dietetic Foods. 2nd ed. Chemical Publishing co. Inc. New York.1973.

[23]. E.A. Adjidzi, E.K Ingbian, and O. Abu. Effect of Hot Water and Steam Blanching on the Quality of Aqueous Extract from Tiger-nuts (Cyprus esculentus) PAT 7(1): 2011, 90-102.

[24]. E.U. Onyeka. Mineral Elements and their Importance in: Food and Nutrition. 2nd Edition. Charismatic Publishers, Owerri. 2008

[25]. S.C Umerie, and J.N. Enebeli. Malt Caramel From Tubers of Cyperusesculentus. Biores, Tech57: 1996, 215-216.

[26]. FAO Traditional Food Plants: Food and Nutrition Paper 42, Rome 1998, 239-242.

Ntukidem, V. E" Influence of Different Pre-treatments on the Nutritional and Organoleptic Properties of Vegetable Milk Produced Locally From Tiger- Nut (*Cyperus esculentus*) Tubers" IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) 13.6 (2019): 55-61.