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# Physico-Chemical and Sensory Quality of Tigernut (*Cyperus Esculentus*) –Coconut (*Cocos Nucifera*) Milk Drink

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## Abstract

Physico-chemical and sensory qualities of blends of milk drink from tigernut *(Cyperus esculentus)* and coconut *(Cocos nucifera)* were evaluated. Twelve blends (Sample A – K) were formulated using different ratios of tigernut to coconut milk as follows: 100:0, 90:10, 80:20, 70:30, 60:40, 50:50, 40:60, 30:70, 20:80, 10:90 and 0:100. The pH, total titratable acidity, specific gravity and viscosity ranged between 5.86-6.37, 0.10-0.15%, 0.99-1.08, and 0.25-0.69 centipoise (cP) respectively. Viscosity decreased with increase in coconut milk. The solid non-fat, protein, crude fibre and carbohydrate content decreased with increase in Coconut milk substitution and the values ranged from 8.45 - 13.70%, 2.39 - 3.93%, 0.46 – 0.87% and 4.10 - 8.65% respectively. The moisture content ranged between 83.80% for Sample A and 89.50% for Sample I. The fat (2.09 – 3.64%) and ash content (0.13 – 3.00%) varied significantly among blends. The colour, flavor, mouth feel, taste and overall acceptability had increase in likeness with increase in coconut milk. The result indicated that the tigernut-coconut drink is of good quality and the 10% Tignernut substitution based on the sensory properties was more acceptable. This forms a baseline data for further studies.

**Keywords:** Tigernut-coconut milk drink, Physico-chemical, Proximate, Sensory qualities.

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## Contents

## 1. Introduction

Milk, a lacteal secretion from mammary gland is a rich source of protein and essential component such as vitamins and minerals which promote growth, bone and teeth development [1]. It serves as an excellent source of all nutrients except ascorbate and has been recognized as an important food for infant and growing children [2]. In developing countries, the cost of dairy milk and their product are expensive for the commoners to purchase. The dramatic decrease in the consumption of milk and milk products stimulated in part the processing of milk from different seeds and nuts [3]. In view of the scarce milk supply in various countries and the ever increasing gap between the requirement and population, efforts have been made over the years to develop alterative milk- like products from vegetable sources [4]. Among the sources of vegetable milk, Soybean has received very high research attention and more research is still being designed to improve the quality of soymilk [5]. However, hardly any attention has been given to the use of locally available underutilized tubers like tigernut in milk production or in combination with other milk to produce a palatable ready–to–serve bottled beverage, like "Horchata de chufas" as done in south Europe especially in Spain [6].

Tigernut (*Cyperus esculentus*) is an under- utilized tuber of the family *Cyperaceae*, which produces rhizomes from the base of the tuber that is somewhat spherical [7]. It is a tuber that grow freely and is consumed widely in Nigeria and other parts of west Africa, East Africa, parts of Europe particularly Spain as well as in the Arabian peninsula [8]. In Nigeria, tigernut is known as "*Aya*" in Huasa, "*Ofio*" in Yoruba and "*Akiausa*" in Igbo. Three varieties (Black, brown and yellow) are cultivated in the country and among these, only two varieties (yellow and brown) are readily available in the market. The yellow variety is preferred to all other varieties because of its inherent properties like its bigger size and attractive colour. The yellow variety also yields more protein and possess less anti-nutritional factors especially polyphenols [9]. Tigernut produces high quality oil of up to about 25.5% content and 8% of protein [10]. The protein in tigernut is of high biological value considering the many essential amino acids it contained [11]. These amino acids are higher than those proposed in the standard by the FAO/WHO [12] and satisfy amino acid need of adults [13]. Tigernut has been reported to be an excellent source of some useful minerals (iron, calcium phosphorus, potassium, sodium, magnesium, zinc and traces of copper) and vitamin E that are essential for body growth and develpment [14]. It is said to be aphrodisiac, carminative, diuretic, emmanogogue stimulant and tonic and also plays a role in the treatment of flatulence, indigestion, diarrhea, dysentery and excessive thirst [10]. Tigernut is used in the production of refreshing purely natural vegetable milk. The milk originated from Spain where it is known as *Chufa de horchata* while it is commonly called *kunnu aya* in Northern Nigeria. It is a very nutritive energy drink both for the young and the old. The qualities of tigernut in this context stimulate its inclusion in the preparation of beverage so as to provide protein energy-rich drink at affordable price in place of animal protein/fat which is scarce and expensive [15].

Coconut (*Cocos nucifera*) is a large palm, growing up to 30 m (98 ft) tall, with pinnate leave 4-6 m (13-20 ft) long and pinnate 60-90 cm long; old leaves break away cleanly, leaving the trunk smooth, they are generally classified into two types: tall and dwarf [16]. Coconut is one of the most important palm extensively grown and used nut in the world. It is an important commercial crop in many tropical countries, contributing significantly to their economies [17]. Coconuts grows extensively in Nigeria and are eaten as snack usually for the pleasure of it, they may be excellent sources of raw materials for the development of dairy- like products [18]. Coconut milk is being used by confectionaries, bakeries, biscuit and ice cream industries worldwide to enhance flavour and taste of various products [19].

This study is therefore aimed at the preparation of a refreshing and affordable milk drink from tigernut and coconut, and to evaluate the physico-chemical and sensory properties of the milk drink.

## 2. Materials and Methods

### 2.1. Tigernut Tubers and Coconut

Dried tigernut tubers and matured coconut used in this study were procured from Rumuwoji market, Mile 1, Port Harcourt, Rivers State, Nigeria.

### 2.2. Extraction of Tigernut Milk

Tigernut milk was prepared by the method described by Adedokun, et al. [3]. Briefly, 1 kg of dried tigernuts was manually sorted to remove foreign matters. The sorted nuts were washed with tap water and soaked in 6 L of warm distilled water at room temperature for 48 h to hydrate. Thereafter the nuts were washed and wet milled into slurry using (QBL-18L40, Taipei city, Taiwan). The milk was extracted by sieving using a cheese cloth. The chaff was discarded and the milk was packaged in sterile plastic bottles and refridgerated till required for use.

### 2.3. Extraction of Coconut Milk

Coconut milk was also prepared as described by Belewu and Belewu [20]. The coconuts were shelled and the meat separated from the shell with a kitchen knife. The brown layer was also removed using a kitchen knife. The meat was thoroughly washed and grated using (QBL-18L40, Taipei city, Taiwan). Warm water was added to the grated coconut meat and allowed to stand at room temperature for 1 h. Thereafter, the milk was extract using a cheese cloth. The milky-white opaque emulsion was packaged in sterile plastic bottles and refrigerated till when needed for use.

### 2.4. Tigernut/Coconut Milk Blends

The extracted tigernut milk (TM) and coconut milk (CM) were mixed at different proportions as shown in Table 1. A homogeneous mixture was achieved with the use of a food Q-Link blender and grinder (QBL-18L40, Taipei city, Taiwan) operated at full speed for 5 minute. The resultant blend was pasteurized at 70$^0$C for 15 minute in a water-bath and cooled immediately to room temperature (28±2$^0$C) for further analysis.

**Table-1.** Ratios for the blend of Tigernut-Coconut milk

| Sample ID | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Blend (TM:CM) | 100:0 | 90:10 | 80:20 | 70:30 | 60:40 | 50:50 | 40:60 | 30:70 | 20:80 | 10:90 | 0:100 |

### 2.5. Physical Analyses

The physical properties of the products determined were pH, total titrable acidity, total solids, specific gravity and viscosity. The pH of 10 mL of the milk blends was determined with a pH meter (TS 652, Germany). Thereafter, the 10 mL of the sample was titrated against 0.1 mol L-1 NaOH with phenolpthaline as indicator to determine the amount of acid in the sample as total titratable acidty (TTA). The result was expressed as % lactic acid. Total solid Total solid was determined by difference after analyzing for moisture using an automatic moisture analyser (AND ML-50, Japan). Specific gravity of the samples was determined using the AOAC [21] method. The density of the milk was measured against the density of water. Viscosity of the samples was determined with the aid of a Rotary Digital Viscometer (NDJ-85, China) at 20°C. The rate of flow of 250 mL of the milk blend was compared with the rate of flow of the same amount of water.

### 2.6. Proximate Analysis

The moisture, protein and ash content of the tigernut-coconut milk blends were determined using standard analytical methods [21]. Moisture was determined by using an automatic moisture analyser (AND ML-50, Japan). Ash was determined gravimetrically in a murffle furnace (Sanyo Gallenkamp, Weiss Technik, West Midlands, UK) at 500°C for 24 h. Determination of protein was by Kjeldahl method. After distillation and titration, the nitrogen was corrected using a factor of 5.7. Fat was determined by Rose-Gottlieb method [22]. Carbohydrate was obtained by difference. Total solid was obtained by difference (%TS = 100 - Moisture content). The Total solid non-fat was obtained as follows: (%) TSN= TS – Fat [23]. Where, TS =Total solid, TSN=Total solid non-fat

### 2.7. Sensory Analysis

A panel of 20 panelists consisting of staff and students chosen from the university community were used for evaluation of the sensory attributes of the Tigernut-Coconut milk. They were asked to assess the samples based on the following attributes: colour, mouth feel, taste, flavour and overall acceptability. Panelists rating were based on a 9-point hedonic scale with the degree of likeness of the product attribute express as: 1 - dislike extremely, 2 - dislike very much, 3 - dislike moderately, 4 - dislike slightly, 5 - neither like nor dislike, 6 - like slightly, 7 - like moderately, 8 - like very much and 9 - like extremely.

### 2.8. Statistical Analysis

Results were analyzed statistically by the analysis of variance and difference between means separated by least significant difference (LSD) procedure.

## 3. Results and Discussion

### 3.1. Physical Properties

The pH, titratable acidity (% Lactic acid), specific gravity and viscosity of different blends of tigernut-cocount milk drink were shown in Table 2.

**Table-2.** The pH, titratable acidity (% Lactic acid), specific gravity and viscosity of different blends of tigernut-cocount milk drink

| Sample Identity | Blend TM:CM | pH | Total Titratable (%Lactic acid) | Specific Gravity | Viscosity (cP) |
|---|---|---|---|---|---|
| A | 100:0 | 5.99±0.02 | 0.15±0.07 | 1.10±0.1 | 0.69±0.06$^{a}$ |
| B | 90:10 | 6.05±0.05 | 0.13±0.07 | 1.02±0.01 | 0.61±0.01$^{a}$ |
| C | 80:20 | 6.18±1.18 | 0.12±0.01 | 0.99±0.04 | 0.40±0.01$^{b}$ |
| D | 70:30 | 5.95±0.04 | 0.12±0.01 | 1.03±0.01 | 0.33±0.03$^{bc}$ |
| E | 60:40 | 5.95±0.06 | 0.13±0.01 | 1.02±0.01 | 0.35±0.01$^{bc}$ |
| F | 50:50 | 5.95±0.07 | 0.11±0.01 | 1.02±0.01 | 0.33±0.03$^{bc}$ |
| G | 40:60 | 5.86±0.2 | 0.17±0.01 | 1.03±0.02 | 0.38±0.04$^{b}$ |
| H | 30:70 | 6.12±0.07 | 0.10±0.01 | 1.00±0.01 | 0.35±0.01$^{bc}$ |
| I | 20:80 | 6.20±0.01 | 0.11±0.01 | 0.99±0.01 | 0.49±0.02$^{ab}$ |
| J | 10:90 | 6.10±0.06 | 0.10±0.01 | 1.00±0.01 | 0.25±0.01$^{c}$ |
| K | 0:100 | 6.37±0.04 | 0.10±0.02 | 1.08±0.01 | 0.25±0.01$^{c}$ |

The pH, Total titratble acidiy and specific gravity did not vary significantly ($P \geq 0.05$)
Values of viscosity with the same superscript do not vary significantly ($P \geq 0.05$). N=3±SD

There was no significant difference ($P \geq 0.05$) in the pH, Titratable acidity and specific gravity of the blends. The pH of the milk blends from 5.86 - 6.37 for Sample G and Sample K (the blend with 60% Coconut milk and 100% coconut milk) respectively. This range of pH is an indication of low acidity. pH indicates the level of acidity ($H^{+}$) and alkalinity ($OH^{-}$) in the milk and is used to determine the wholesomeness of the milk. The level of titratable acidity in all the treatment ranged between 0.1 - 0.17% lactic acid. This compared favorably with soymilk 0.10 - 0.30% and tigernut milk 0.13 - 0.20% [24] and cow milk 0.17 - 0.19% as reported by Bowen and Lawrence [25]. The level of acidity of the milk drink is also an indication of a good quality, as lactic acid is usually produced from the activities of microorganism where the milk sugar is converted to lactic acid. Levels of lactic acid more than what has been obtained in this study is not required since the product is not a fermented product. The viscosity varied from 0.25 - 0.69 centipoise (cP) for sample K and A respectively. The viscosity seemed to decrease with increase in coconut milk. This may be attributed to the carbohydrate content of Tigernut. The specific gravity ranged between 0.99 - 1.08 for sample C and K respectively. This level of specific gravity is an indication of good quality. Higher specific gravity would mean that there is more water than milk solid. The

amount of water would depend on the quantity used for extraction and result indicated that the quantity used was acceptable for a good quality milk drink.

### 3.2. Proximate Composition of Tigernut-Coconut Milk Drink

Table 3 shows the proximate composition of milk drink produced from different blends of tigernut and coconut milk. The Total solid content varied between 16.20±0.04 to10.50±0.07% for sample A and I respectively. The total solid non-fat ranged from 8.45±0.10 - 13.70±0.04% for Sample K and Sample A respectively. The variation could be attributed to the solid content of the coconut milk as the trend was that of decrease with increase in the substitution of coconut milk. It also indicated consistency in the milk extraction method. The solid non-fat content followed a similar trend ranging from 13.70±0.04 - 6.86±0.07%. Except for sample I, the solid non-fat content of the tigernut and coconut milk drink were either greater than or comparable with cow's milk

The crude protein obtain ranged between 3.93 - 2.93% for sample A and K respectively. This observation indicated that tigernut milk had more protein than the coconut milk as the decrease in protein was with increase in coconut milk. The result obtain was lower than 6.64% as reported by Ogbonna, et al. [26]. However, the crude protein found in the milk blend compared favourably with 3.20% and 3.4% for coconut natural milk blend and cow milk respectively [27] as reported by Adedokun, et al. [3].

The Fat content of the milk blend varied from 2.09 to 3.75% for sample C and sample I respectively. This result compared favourably with 2.36 and 3.12 % for coconut-natural milk and tigernut-natural milk blend [3]. Crude fibre varied from 0.46 for sample K to 0.87 for Sample A. Tigernut contributed significantly to the crude fibre content of the milk blend. The high crude fibre content of blends with more tigernut milk makes for its recommendation for result people with problems of digestion, flatulence, and diarrhea. Ash content is a measure of mineral elements in a food. The ash content of the samples varied significantly and the unsubstituted coconut milk (sample K). The result obtained compare unfavorably with the findings of Adedokun, et al. [3] in which 1.08% was reported from natural tigernut blend.

Sample A and K had significantly the highest (8.65%) and lowest (4.10%) carbohydrate content. The trend was a decrease in carbohydrate content with the increase in coconut milk substitution, confirming the high carbohydrate content of tigernut. This could be of health importance as it can be used by diabetic patient due to its high content of arginine, which liberates the hormone insulin [28].

**Table-3.** Proximate composition of different blends of tigernut-cocount milk drink

| Sample Identity | Blend TM:CM | PARAMETER (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Moisture** | **Total solid** | **Solid Non-Fat** | **Ash** | **Crude fiber** | **Fat** | **Protein** | **Carbohydrate** |
| A | 100:0 | 83.80±0.04$^{a}$ | 16.20±0.04 | 13.70±0.04 | 0.26±0.02$^{ab}$ | 0.87±0.03$^{a}$ | 2.50±0.01$^{c}$ | 3.93±0.01$^{a}$ | 8.65± 0.07$^{a}$ |
| B | 90:10 | 84.25±0.04$^{ab}$ | 15.75±0.04 | 13.22±0.04 | 0.23±0.01$^{b}$ | 0.85±0.03$^{a}$ | 2.53±0.03$^{c}$ | 3.38±0.01$^{b}$ | 8.28±0.02$^{a}$ |
| C | 80:20 | 86.65±0.02$^{b}$ | 13.35±0.02 | 11.26±0.02 | 0.13±0.03$^{c}$ | 0.67±0.03$^{b}$ | 2.09±0.01$^{d}$ | 3.79±0.01$^{a}$ | 6.45±0.08$^{b}$ |
| D | 70:30 | 85.75±0.30$^{b}$ | 14.25±0.03 | 11.56±0.03 | 0.30± 0.01$^{a}$ | 0.67±0.02$^{b}$ | 2.69±0.03$^{c}$ | 3.61±0.07$^{ab}$ | 6.85±0.07$^{b}$ |
| E | 60:40 | 86.10±0.60$^{b}$ | 13.90±0.60 | 10.91±0.05 | 0.15±0.02$^{c}$ | 0.62±0.02$^{b}$ | 2.99±0.01$^{c}$ | 3.72±0.02$^{ab}$ | 5.62±0.02$^{b}$ |
| F | 50:50 | 86.90±0.07$^{bc}$ | 13.10±0.07 | 9.94±0.06 | 0.16±0.01$^{c}$ | 0.81±0.02$^{a}$ | 3.16±0.08$^{bc}$ | 3.61±0.02$^{ab}$ | 4.99±0.07$^{bc}$ |
| G | 40:60 | 88.30±0.90$^{cd}$ | 11.70±0.09 | 8.68±0.09 | 0.25±0.01$^{b}$ | 0.52±0.02$^{c}$ | 3.02±0.01$^{bc}$ | 3.46±0.05$^{b}$ | 4.76±0.04$^{c}$ |
| H | 30:70 | 88.30±0.40$^{cd}$ | 11.70±0.40 | 8.43±0.30 | 0.16±0.01$^{c}$ | 0.51±0.05$^{c}$ | 3.27±0.05$^{bc}$ | 3.08±0.01$^{bc}$ | 4.61±0.03$^{c}$ |
| I | 20:80 | 89.50±0.70$^{d}$ | 10.50±0.07 | 6.86±0.07 | 0.18±0.01$^{c}$ | 0.51±0.02$^{c}$ | 3.64±0.05$^{a}$ | 2.87±0.02$^{c}$ | 4.88±0.16$^{cd}$ |
| J | 10:90 | 88.20±0.04$^{cd}$ | 11.80±0.04 | 9.06±0.04 | 0.29±0.01$^{a}$ | 0.49±0.07$^{c}$ | 2.74±0.03$^{c}$ | 2.63±0.04$^{cd}$ | 4.49± 0.07$^{b}$ |
| K | 0:100 | 88.70±0.10$^{cd}$ | 11.30±0.10 | 8.45±0.10 | 0.17±0.01$^{c}$ | 0.46±0.02$^{c}$ | 2.85±0.07$^{c}$ | 2.39± 0.07$^{d}$ | 4.10±0.07$^{bc}$ |

Values with the same superscript in the same column do not vary significantly ($P \geq 0.05$). N=3±SD

### *3.3.* Sensory Properties

The sensory properties (colour, flavor, mouth feel, taste and overall acceptability) of the various blends of Tigernut and Coconut drink are shown in Figure 1. The general trend was that of increase in likeness with increase in coconut milk substitution. This may be related to the viscosity of the drink which followed a similar trend. The flavor and overall acceptability of the 100% Coconut milk (Sample K) was liked very much, while the colour, taste and mouth were liked moderately. The attributes for Sample A, B, C and D (the 100, 90, 80 and 70% Tigernut substitution) were slightly disliked. Sample G, I and J with 30, 20 and 10% Tignernut substitution had values of slight and moderate likeness for all the sensory properties. The addition of 10% Tigernut would be recommended based on the sensory properties.

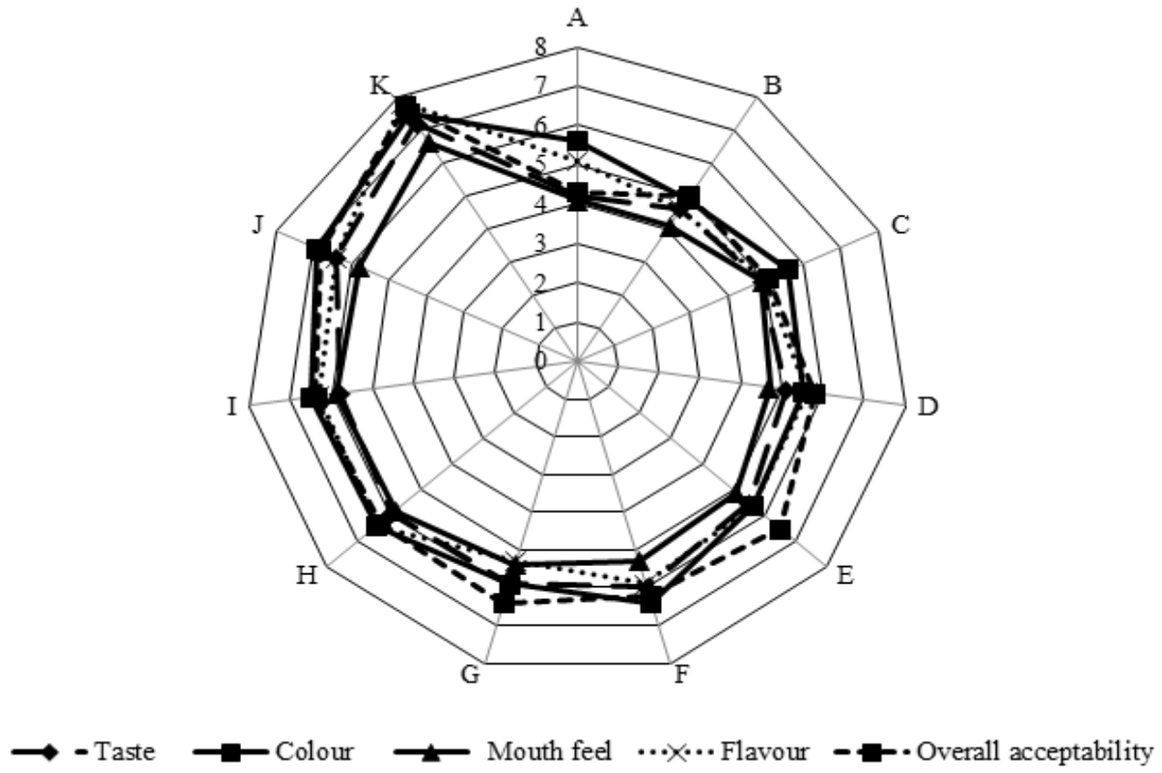


**Figure-1.** Sensory properties of different blends of tigernut-cocount milk drink
Blends (TM:CM): A(100:0), B(90:10), C(80:20), D(70:30), E(60:40), F(50:50), G(40:60), H(30:70), I(20:80), J(10:90), K(0:100)

## 4. Conclusion

The physico-chemical properties of tigernut-coconut drink gave an indication of a good quality milk drink. Although the solid non-fat, protein, crude fibre and carbohydrate content decreased with increase in Coconut milk substitution, the 10% substitution of Tignernut had moderate likeness for all the sensory attributes. The 10% Tignernut substitution based on the sensory properties would be recommended. This forms a baseline data for further studies.

## References

[1] B. J. Akinyele, M. O. Fawole, and F. A. Akinyosoye, "Microorganisms associated with fresh cow milk, wara, and nono; two local milk products hawked by Fulani women in Ilorin, Kwara state, Nigeria," *Nigerian Food Journal*, vol. 17, pp. 11-17, 1999.

[2] M. U. Ukwuru and A. C. Ogbodo, "Effect of processing treatment on the quality of tigernut milk," *Pakistan Journal of Nutrition*, vol. 10, pp. 95-100, 2011. *View at Google Scholar | View at Publisher*

[3] I. I. Adedokun, S. U. Okorie, and B. Batu, "Evaluation of proximate, fibre qualities and consumer acceptability of bambaranut-tigernut – coconut milk beverage blends," *International Journal of Nutrition and Food Sciences*, vol. 3, pp. 430-437, 2014. *View at Publisher*

[4] T. Singh and G. S. Bains, "Extract-milk beverage, processing and physic-chemical characteristics," *Journal of Food Science*, vol. 53, pp. 1387-1390, 1988. *View at Google Scholar | View at Publisher*

[5] P. Sun-Young, K. S. Marsh, Y. S. Jenny, and S. E. Yun, "A study on a proceedings method to improve soymilk quality," in *Proceeding of Pre-Congree Internet Conference*, 2000, pp. 31-32.

[6] J. I. Mordi, A. U. Ozumba, G. N. Elemo, and O. Olatunji, "Physicochemical and sensory evaluation of Nigerian tiger-nut extract beverage," *Bioscience Biotechnology Research Communications*, vol. 22, pp. 203-207, 2010. *View at Google Scholar*

[7] F. Devries and T. Feuke, "Chufa (Cyperus Esculentus) a weedy cultivar or cultivated weed?," *Economic Botany Journals*, vol. 45, pp. 27- 37, 1999. *View at Google Scholar | View at Publisher*

[8] R. Abaejoh, I. Djomdi, and R. Ndojouenkeu, "Characteristics of tigernut (Cyperus Esculentus) tubers and their performance in the production of a milky drink," *Journal of Food Processing and Preservation*, vol. 30, pp. 145-163, 2006. *View at Google Scholar | View at Publisher*

[9] J. N. C. Okafor, J. I. Mordi, A. U. Ozumba, H. M. Solomon, and O. Olatunji, "Preliminary studies on the characterisation of contaminants in tigernut (Yellow Variety)," in *Proceedings of 27th Annual Nigerian Institute of Food Science and Technology (NIFST) Conference, 13-17, Nigeria*, 2003.

[10] J. A. Adejuyitan, "Tigernut processing: Its food uses and health benefits," *American Journal of Food Technology*, vol. 6, pp. 197-201, 2011. *View at Google Scholar | View at Publisher*

[11] T. O. Ojobe and V. J. Tempo, "Amino acid composition of tigernut tubers (Cyperus Esculentus)," *Nigerian Journal of Science and Biotechnology*, vol. 2, pp. 35-38, 1983. *View at Google Scholar*

[12] P. I. Akubor, "Physico chemical and sensory characteristics of melon and milk," *Journal of Food Science and Technology*, vol. 35, pp. 93-97, 1998. *View at Google Scholar*

[13] L. Bosch, A. Alegria, and R. Farré, "RP-HPLC determination of Tiger nut and orgeat Amino acid contents," *Food Science and Technology International*, vol. 11, pp. 33-40, 2005. *View at Google Scholar | View at Publisher*

[14] A. K. Oladele and J. O. Aina, "Chemical composition and functional properties of flour produced from two varieties of tigernut (Cyperus Esculentus)," *African Journal of Biotechnology*, vol. 6, pp. 2473-2476, 2007. *View at Google Scholar | View at Publisher*

[15] L. O. Udeozor, "Tigernut-soy milk drink: Preparation. Proximate composition and sensory qualities," *International Journal of Food and Nutrition Science*, vol. 1, pp. 18-26, 2012. *View at Google Scholar*

[16] T. Pradeepkumar, B. Sumajyothibhaskar, and K. N. Satheesan, *Management of horticultural crops (Horticulture Science Series Vol.11, 2nd of 2 Parts)*: New India Publishing, 2008.

[17] L. P. Richard, *The coconut: Florida cooperative extension service*: University of Florida: Fact Sheet HS 40, 1994.

[18] O. Akoma, U. O. Elekwa, A. T. Afodunrinbi, and G. C. Onyeukwu, "Yoghurt from coconut and tigernuts," *Journal of Food Technology in Africa*, vol. 5, pp. 132-134, 2000. *View at Google Scholar | View at Publisher*

[19] J. G. Persley, "Replanting the tree of life," presented at the CAB. International Wallingford Oxon, 1992.

[20] M. A. Belewu and K. Y. Belewu, "Comparative physic-chemical evaluation of tigernut, soybean and coconut milk sources," *International Journal or Agriculture and Biology*, vol. 9, pp. 785-787, 2007. *View at Google Scholar*

[21] AOAC, *Official methods of analysis*, 20th ed. Arlington, VA: Association of Official Analytical Chemist, 2006.

[22] AOAC, *Official methods of aanalysis*, 15th ed. Washington D-C, USA: Association of Official Analytical Chemist, 1990.

[23] S. B. Javaid, J. A. Gadahi, M. Khaskeli, M. B. Bhutto, S. Kumbher, and A. H. Panhwar, "Physical and chemical quality of market milk sold at Tandojam, Pakistan," *Pakistan Veterinary Journal*, vol. 29, pp. 27-31, 2009. *View at Google Scholar*

[24] C. Cortes, M. J. Esteve, A. Frigola, and F. Torregrosa, "Quality characteristics of horechata (A Spanish Vegetable Beverage) treated with pulsed electric fields during shelf-life," *Food Chemistry*, vol. 91, pp. 319-325, 2005. *View at Google Scholar | View at Publisher*

[25] W. H. Bowen and R. A. Lawrence, "Comparison of the carcinogenicity of Honey, cattle milk human milk and sucrose," *Pediatrics*, vol. 116, pp. 921-926, 2005. *View at Google Scholar | View at Publisher*

[26] A. C. Ogbonna, C. I. Abuajah, and R. A. Utuk, "Tigernut milk: A nutritious but underutilized food ingredient," *Food Biology*, vol. 2, pp. 14-17, 2013. *View at Google Scholar*

[27] S. Rehman, A. M. Mushtaq, A. Yameen, K. Almas, and S. Mnutaha, "Sensory and nutritional evaluation of coconut-natural milk blend," *Pakistan Journal of Life and Social Sciences*, vol. 2, pp. 104-108, 2004. *View at Google Scholar*

[28] A. Gambo and A. Da'U, "Tigernut (Cypernus Esculentntus): Composition, products, uses and health benefits – review," *Bayero Journal of Pure and Applied Sciences*, vol. 7, pp. 56-61, 2014. *View at Google Scholar | View at Publisher*