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Tigernut Milk: A Nutritious Under-Utilized Food Ingredient

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ABSTRACT

One of the under-utilized food ingredients in Africa and other developing economies is the Tigernut milk. In this study, the nutritional, physico-chemical and sensory properties of tigernut milk were evaluated by comparing them with those of peak milk, a popular animal milk product in Nigeria, using standard methods. The results showed that all the nutrient factors were significantly (P≤ 0.05) different. There was a higher amount of moisture (10.95%) and crude protein (3.65%) in PM than TM. Conversely, there were higher amounts of crude fibre (93.33%) crude fat (61.96%), total ash (16.67%), and carbohydrates (77.59%) in TM than PM. With the exception of pH and total titratable acidity, the other physico-chemical properties varied significantly (P≤0.05). PM contained 11.76% and 13.58% more total titrable acidity and total solids, respectively than TM while TM had 65.39% more energy value than PM. Both milk samples showed mild acidic pH values of 6.63±0.03 and 6.64±0.13 for PM and TM, respectively. This suggests high susceptibility of both milk samples to microbial spoilage at ambient temperatures, hence, the need to stabilize them. Sensory evaluation showed that PM was 8.40%, 17.81%, 16.76%, and 6.06% more preferred to TM while the aroma of TM was 38.79% adjudged better than that of PM. Ultimately, all the sensory properties were significantly (P≤0.05) different except colour and general acceptability.

Keywords: Animal, milk, nutrients, plant, properties.

INTRODUCTION

Milk is the lacteal secretion of the mammary glands of healthy mammals like cow, sheep, goat, etc [1-3]. It is slightly acidic having a pH of around 6.5 - 6.7 [4]. Milk is highly valued because it is a source of many nutrients essential for the proper development and maintenance of the human body [1]. It is a complex nutritious product containing more nutrients than any other single food [1, 5]. Its exceptional nutrient profile includes water, protein, fat, carbohydrates, cholesterol, minerals, vitamins and energy [5, 6]. Hence, it is regarded as a complete diet [6]. Consumption of at least three servings of milk or milk products daily can have a positive impact on health and prevention of such diseases as osteoporosis, colon cancer, diabetes and help with weight management [5]. It is therefore recommended that every human being should consume a certain amount of milk to augment his or her nutritional deficit [6]. To underscore the importance of milk, it is one of the most carefully tested and regulated foods [2]. This is because it is easily contaminated by microbes leading to spoilage as a result of its mild acidic nature. It is easily affected by extremes of temperatures [1]. Different varieties of milk include whole milk, skimmed milk, flavoured milk, evaporated milk, sweetened condensed milk, whole dry milk and many more [2, 5].
However, milk may have, somewhat, been redefined technically. Today, the meaning of milk gives more consideration to its constituent substances than its source or origin owing to the discovery of soy and other milks of plant origin at the turn of the 20th century. These plant milks have been shown to be highly nutritious, beneficial to health and cheap [7-11]. Considering the present dietary trend which is geared towards low cholesterol and low saturated fatty diets [12], plant milks have been proposed as substitutes for animal milks in diets to combat coronary heart and cardiovascular diseases as well as malnutrition in poor regions of the world where animal milks are scarce and not affordable [13-16]. One of such underutilized plant milks in Africa and other developing economies is the Tigernut milk.

Tigernut milk is obtained from the tigernut plant (*Cyperus esculentus L.*) which is of the family Cyperaceae [17, 18]. This plant is cultivated for its small tuberous rhizome which is eaten raw or roasted, pressed for its juice to make beverage or milk, extracted of non-drying oil or used as hog feed [18]. It is variously known in Nigeria as *ofio* or *aki-hausa* in Igbo, *imumu* in Yoruba and *aya* in Hausa [17, 19]. Its health benefits were enumerated by [17]. Tigernut milk originated from Spain where it is known as *chufa de horchata while* it is commonly called *kunnu aya* in Northern Nigeria [20]. It is a healthy and rich source of nutrients such as carbohydrates, vegetable fat, protein, fibre, vitamins, minerals, energy and some digestive enzymes such as catalase, lipase and amylase [17-21]. Tigernut milk has been reported to contain more iron, magnesium and carbohydrate than cow milk [22]. In addition, it has the advantage of not containing sodium, lactose sugar, casein protein, gluten, cholesterol and therefore ideal for people who are hypertensive or do not tolerate gluten or lactose and its derivatives present in cow milk [23, 24]. Unlike soymilk or other soy products, tigernut milk does not produce any allergy [24].

The physico-chemical, nutritional and sensory comparison of animal milk with other plant milks such as soymilk have been copiously reported [3, 25] but there is a paucity of such information with tigernut milk.

Therefore, the objective of this study is to evaluate the physico-chemical, nutritional and sensory properties of tigernut milk by comparing them with those of peak milk, a popular animal milk product in Nigeria.

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MATERIALS AND METHODS

Source of Materials

Peak milk (a full cream, unsweetened evaporated cow milk, commercially processed and produced in Nigeria by Friesland Campina WAMCO PLC, packaged in 157ml tin, still within its wholesome and shelf-life period of one year), dried tigernut tubers and granulated sugar were purchased from an open market in Uyo, Akwa Ibom State of Nigeria. The dried tigernut tubers were processed into tigernut milk (Figure 1) using a modified method [24] and stored in a refrigerator at about 8^{o}C. The peak milk was also kept in the refrigerator at the same temperature until needed for the analysis.

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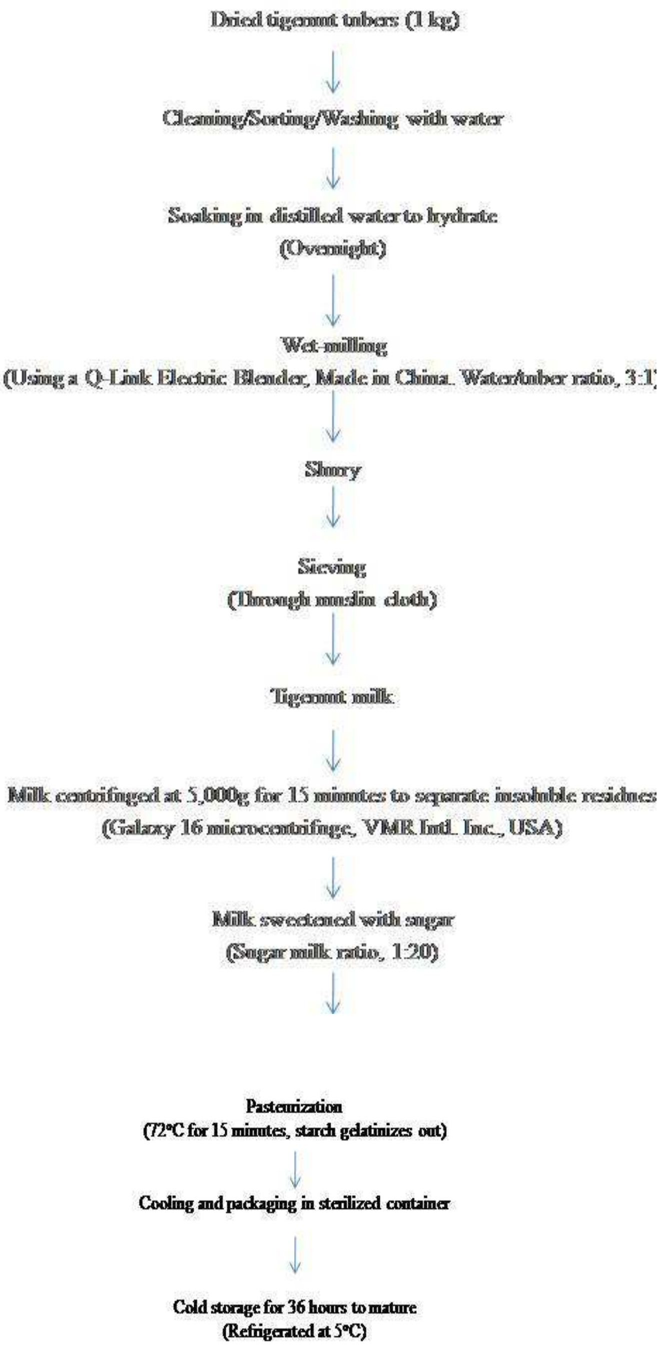

Figure 1: Production process of tigernut milk.
Source: Modified method (24).

The different milk types formed samples PM (for Peak Milk) and TM (for Tigernut Milk). All reagents used for this study were of analytical grades. This research work was carried out in the Food Processing/ Preservation Laboratory of the Department of Food Science and Technology, University of Uyo, Nigeria

Proximate Composition

Samples PM and TM were analyzed for moisture, crude protein, crude fibre, crude fat, total ash and carbohydrates using standard methods [26].

Physico-chemical Properties

The pH of the two samples (PM and TM) was determined using a pH meter (Orion star A211, Thermo Fisher Inc., IL, USA). Total titratable acidity (TTA) and total solids (TS) were analysed according to [26] while their total energy value was estimated using the Modified Atwater Factors as described [27].

Sensory Analysis

The sensory analysis of both milk samples was carried out by a ten-man untrained panellists familiar with milk and milk products. The cold milk samples were served in opaque cups (labelled in alphabets) for the assessment of aroma, taste, consistency and general acceptability. The opaque cups were used in order to conceal the identity of the samples since the off-milk colour of TM could have easily sold it out thereby influencing unduly the decision of the panellists. Thereafter, the samples for colour assessment were served in white transparent glasses. All the scores were based on a nine-point hedonic scale as earlier reported [28].

Experimental Design

Forty replicate samples (of two blocks each) of PM and TM were analysed for six proximate properties, four physico-chemical and five sensory properties, each in triplicate in a randomized complete block design (RCBD).

Statistical Analysis

Means and standard deviation of data generated were calculated. Data obtained for proximate composition and physico-chemical properties were subjected to Analysis of Variance (ANOVA) while those for sensory properties were analysed using the student's t-test. Significance was accepted at $P \leq 0.05$ [28, 29, 30].

RESULTS AND DISCUSSION

Proximate Composition

Results of the proximate composition (Table 1) showed that the quantities of nutrients were significantly ($P \leq 0.05$) different in both PM and TM samples.

As shown in Figure 2, there was a higher amount of moisture (10.95%) and crude protein (3.65%) in PM than TM. Conversely, there were higher amounts of crude fibre (93.33%), crude fat (61.96%), total ash (16.67%) and carbohydrates (77.59%) in TM than PM. A major difference between PM and TM is that the former is of animal origin while the later is of plant origin.

Both animal and plant proteins have been reported to contain essential amino acids necessary to synthesize complete protein profiles that satisfy adult needs [17, 31, 32]. However, TM does not contain casein protein [24]. The higher fibre content of TM would be beneficial in the prevention and treatment of many diseases including colon cancer, coronary heart diseases, obesity, diabetes and gastrointestinal disorders [33]. Similarly, the high vegetable fat content of TM would boost not only its nutrient value as alternative food supplement in human diets but also as a source of energy [18]. The principal fatty acids of TM are reported as myristic, oleic, linoleic and palmitic acids [18]. These unsaturated fatty acids prevent chemical decomposition; improve digestive secretion and nutritional therapy [18]. The high total ash content of TM is suggestive of a useful source of minerals for body growth and development. As earlier reported (24, 34), TM is a significant source of calcium and phosphorus, and contains even more iron and magnesium than PM [22]. The carbohydrate profile of TM which includes sucrose and starch (excluding glucose) are due to its content of *arginina* (essential amino acid, L-arginine) which stimulates the release of the hormone insulin making it ideal for diabetic patients [21]. The higher carbohydrate content of TM also contributed significantly to its high energy value. Unlike animal milk, plant milk does not contain lactose sugar which causes lactose-intolerance in individuals lacking the enzyme lactase, to break down the sugar leading to flatulence, bloating of the stomach and diarrhoea when animal milk is consumed [3].

Table 1: Proximate composition of peak milk and tigernut milk*

Samples	Moisture (%)	Crude protein (%)	Crude fibre (%)	Crude fat (%)	Total ash (%)	Carbohydrate (%)
PM	95.0±0.14^b	8.50±0.19^a	0.50±0.19^c	9.70±0.20^a	1.50±0.01^b	13.0±0.58^e
TM	84.6±0.41^a	8.19±0.11^b	7.50±0.19^d	25.5±0.60^b	1.80±0.02^a	58.01±1.24^f

* Values are means of triplicate determinations ± S.D.
^{abc}Means with different superscripts on the same column are significantly different at P<0.05.

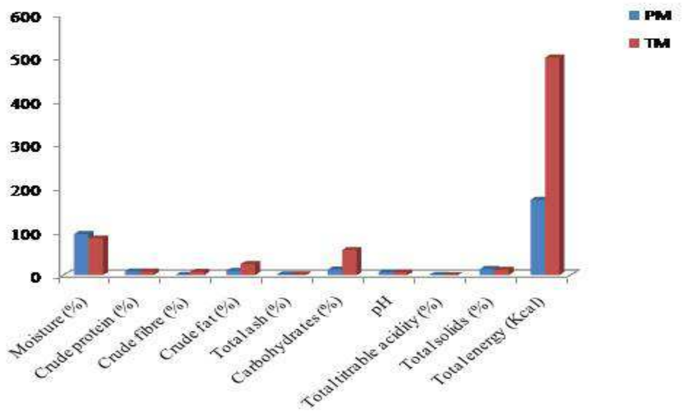

Figure 2: Comparing the nutritional and physico—chemical properties between peak milk and tigernut milk.

Pysico-chemical Properties

Table 2 shows the results of the physico-chemical properties of PM and TM. With the exception of pH and total titratable acidity, the other properties varied significantly (P≤ 0.05). PM contained 11.76% and 13.58% more total titratable acidity and total solids than TM while 65.39% more total energy was contained in TM than PM. Both milk samples showed mild acidic values of 6.63±0.03 and 6.64±0.13 for PM and TM, respectively.

Table 2: Physico-chemical properties of peak milk and tigernut milk*

Sample	pH	Total titratable acidity (%)	Total solids (%)	Total energy (Kcal)
PM	6.63±0.03^a	0.17±0.02^b	14.21±0.10^a	173.58±0.01^c
TM	6.64±0.13^a	0.15±0.05^b	12.28±0.25^b	501.55±0.25^d

* Values are means of triplicate determinations ± S.D.
^{abc}Means with different superscripts on the same column are significantly different at P<0.05.

This suggests high susceptibility of both milk samples to microbial spoilage at ambient temperatures. Hence the need to stabilize them through either pasteurization or sterilization and storage at appropriate cold temperatures.

Sensory Analysis

The results of the sensory evaluation showed that PM was 8.40%, 17.81%, 16.76%, and 6.06% more preferred to TM while the aroma of TM was 38.79% adjudged better than that of PM (Figure 3).

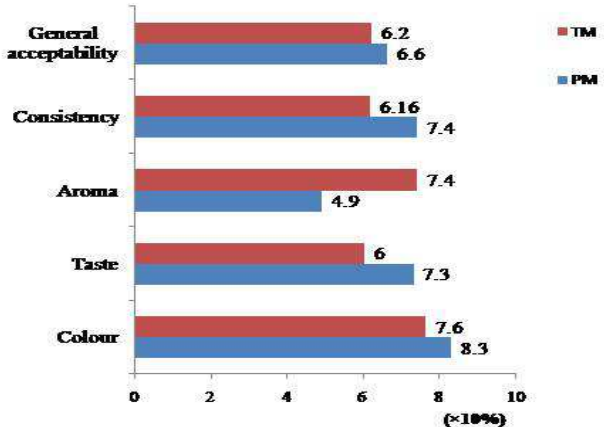

Figure 3: Sensory evaluation of peak and tigernut milk samples.

All the sensory properties were however significantly (P≤ 0.05) different with the exception of colour and general acceptability which showed no significant differences. The superiority of the taste, consistency and general acceptability of PM over TM may have resulted from a proper homogenization of its constituent substances using sophisticated machines during its industrial processing unlike TM which was produced and manually blended on a laboratory scale.

CONCLUSION

Presently, dietary trends emphasize healthy nutrition for healthy living. Thus, low fat and low cholesterol diets, functional foods, food supplements and nutraceuticals are popularized with claims of being nutritionally beneficial to health. Empirical data from the comparative analyses of the proximate composition (ash, carbohydrates, fat, fibre, moisture and protein) and the physico-chemical properties (pH, total titratable acidity, total solids and energy) of the two milk samples investigated: tigernut milk (TM) and peak milk (PM), established the superiority of the former while their sensory evaluation (aroma, taste, consistency and general acceptability) favour the later.

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