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Research Article

Determination of Macronutrients and Micronutrients in Tigernuts

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Abstract

Tiger nut is one of the widely distributed and underutilized plants in tropical and subtropical regions and it is laden with minerals and vitamins that are beneficial to the body. This study is aim to produce and carry out the quality assessment of baobab pulp enriched tiger nut milk drink. Tiger nut was Dried, Sorted, Washed, Soaked, Drained, Blended, Filtered, Homogenized, Bottled, and Cooled, macronutrients and micronutrients contents were determined using proximate analysis. The study shows vitamin composition, such as thiamin (Vitamin B1), Riboflavin (vitamin B2) and Niacin (vitamin B3). The moisture content range between 42.71 to 33.86%. The protein and ash content enriched value ranges between 16.15 to 10.03%. The fibre content ranged from 1.27 to 0.26% with sample A, having the list value of 0.26%. The carbohydrate was 33.22 to 26.28%. Magnesium (Mg), Potassium (K), Phosphorous (P), and Calcium (Ca) were the major in organic constituents of the ash in all studied samples. Among the trace elements (Mg, K, P and Ca) are a bit high and are within the limits advised for nutrition. The current studies revealed that tiger nut tuber have high Magnesium, Potassium, Phosphorous and calcium and low Iron, mineral contents. Therefore, tiger nut flour could be used as supplementation for cereal flour to improve the important nutrients needed in the body.

Keywords: Tigernut; Vitamins; Minerals; Protein; Carbohydrate; Ash; Fibre; Fat

Introduction

Tiger nut (*Cyperus esculentus*) is one of the widely distributed and underutilized plants in tropical and subtropical regions [1,2]. The extract from the nut called "*horchata de chufa*", and its other byproducts have generated over 3 million euro in the industry [3]. The tubers can be processed into flour or milky extracts, or can be consumed raw as snacks. Tiger nut is laden with minerals and vitamins that are beneficial to the body. In recent years, the quest for an alternative to dairy milk, which will reduce the prevalence of hypercholesterolemia, cow milk allergy and lactose intolerance, has intensified, thus leading to development of new products and specialty beverages [4]. Plant-based milk such as flax milk, oat milk, hazelnut milk, quinoa milk, and soymilk, are now marketed, and are gaining consumer confidence since they are lactose- and cholesterol-free, and are low in calories.

Baobab (*Adansonia digitata*) is a deciduous tree belonging to the family Bombacacceae. The trees are found in the savanna of Africa and India and known to be rich in phytochemicals and nutrients [5]. Various parts of the tree are used as febrifuge, immune stimulants and for treating diarrhea, inflammation and infections. The seeds can be fermented and used as flavoring agents or roasted and eaten as snacks; they can equally be used as thickening agents

in soup [6]. The pulp is a rich source of polyphenolic compounds that could play a protective role against oxidative stress [7]. It can be dissolved in milk and water, and the extract is used as a drink and a sauce for food, or as a fermentation agent in local brewing. The fruit pulp is laden with high amounts of vitamin C, minerals, and lipids, which make it suitable as a seasoning and appetizer, and in the production of juice. Micronutrient Deficiency or dietary deficiency is not enough of one or more of the micronutrients required for optimal plant or animal health. In humans and other animals they include both vitamins deficiencies and mineral deficiencies, whereas in plant the term refers to deficiencies of essential trace minerals [8].

The world health organization (WHO) estimate that more than two billion people suffer from micronutrient deficiency globally [8]. Micronutrient Defieciency and Malnutrition is estimated globally to cause the deaths of between 3 and 5 million people per year [9]. Micronutrient Deficiency is the result of disturbance in the equilibrium between dietary intake such as vitamins and minerals. Micronutrient Deficiency form an important health issue, with Malnutrition affecting key development outcomes including poor physical and mental development in children. Also the sufferings and increase of Chronic Diseases such as cardiovascular diseases and thyroid Deficiency Colorectal Cancer. The factors that contribute to malnutrition, chronic diseases and poor nutrition outcomes are complex and vary across production and consumption settings. In Nigeria the underlying causes of malnutrition and ill health are poverty, inadequate food production, inadequate food intake and improper combination available indigenous foods [10]. Man has the right to get the best possible start in life. Yet it has been found that the majority of human consume a diet which is deficient in most micronutrients, with specific reference to the required amount of nutritional balance [11]. Human are greatly affected by micronutrient deficiency and food insecurity that heads to ill-health. It was therefore considered important to conduct this research work which may enhance and help reduce or combat micronutrient deficiency problems specifically Oteomalacia, Osteoporosis, Anemia etc. Ingredients (tiger nut milk and baobab pulp) used in this work are known to contain lots of minerals and vitamins that helps a great deal in boosting the immune system, support normal growth and development especially for growing children as well as adults [12].

Chronic diseases are currently one of the leading health problems in the world and one of its etiology have been linked to consumption `of foods and drinks high in synthetic food additives. With the formulation and quality assessment (proximate, microbiological, nutritional and sensory) of this natural drink, it could be said that this natural plant based and enriched drink can successfully replace or compete with the popular chemically laddened drinks and help in reducing the rate and management of chronic diseases [13]. In recent years ,increased awareness of the health and well-being of people globally have necessitated the partial switch from animal- based food product to natural and healthy food with nutrient balanced profile required for various metabolic, physiological, and other functional demands [12].

Micronutrient deficiencies are a matter of major public health concern. Micronutrients are vitamins and minerals needed by the body in very small amounts. However, their impact on a body's health is critical, and deficiency in any of them can cause chronic and even life-threatening conditions. Many of these deficiencies are preventable through nutrition education and consumption of a healthy diet containing diverse foods, as well as baobab pulp enriched tiger nut milk drink, where needed. This research study seeks to provide assistance in combating micronutrient deficiency particularly, and chronic diseases through production and consumption of baobab pulp enriched tiger nut milk drink. In addition, this study will further increase the use and knowledge of underutilized food locally and readily available in our communities (Nigeria) to solve public health problems such as micronutrient deficiency e.g Oteomalacia, Osteoporosis, Anemia, e.t.c.

Materials and Methods

Source of raw materials

The raw materials that were used for this study was obtained from Kasuwan Bacci Market Kaduna State Nigeria. Other equipment that were used for this study was obtained from the Nutrition and Dietetics Departmental workshop.

List of materials/equipment that was used

Tiger nut, Sugar, and Baobab Powder.

Equipment used

Measuring Tray, Measuring Scale, Bowl, Spatula, Sieve, Muslin Cloth, Blender, Cups, and Spoons.

Preparation of tiger nut milk

Tiger nut milk was prepared by modifying the method of Obinna-echem and Robinson [14]. 1200g of dried tiger nut was obtained from the market, it was manually sorted to remove foreign materials and unwanted particles, the tiger nut was then cleaned, and the nut was soaked in portable water for about 12 hours. The soak water was drained the following morning, and the soak nut was wet milled into slurry using fabricated attrition for several times, with the addition of 1800 ml of water. The slurry was pressed using muslin cloth to extract the milk, it was then packaged into clean bottles and refrigerate. Below is the flow chart for the tiger nut milk production.

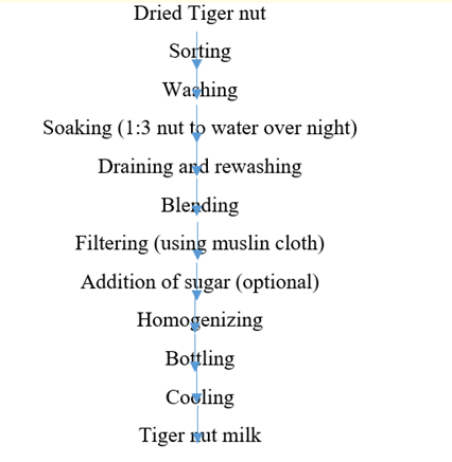

Figure 1: Flow Chart for the preparation of Tiger Nut Milk. Source: FAO 2016.

Preparation of baobab pulp powder

Whole baobab fruits was weighed, carefully crushed to separate the pulp from the seed using pestle and motar, the mixture was sieved using 0.09micro sieve to obtain fine powder. The seed was discarded, the powder was weighed and packaged into polyethylene bags, it was then sealed and stored in a cold dry place of (15-30°c).

Preparation of tiger nut milk drink enriched with baobab pulp.

Milk of tiger nut was mixed with the baobab pulp.

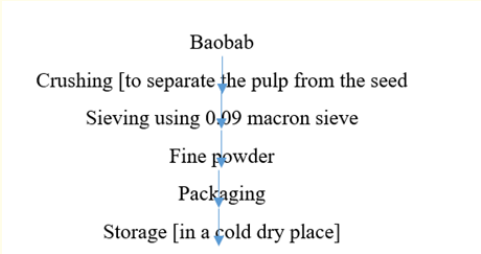

Figure 2: Flow Chart for baobab pulp. (Source: FAO 2016).

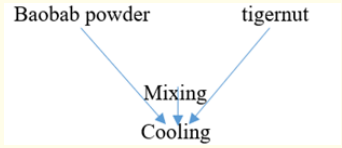

Figure 3: Flow Chart for baobab pulp enriched with Tiger nut milk. (Source: FAO 2016).

Sample	Ratio
A	100:0
B	100:5
C	100:10
D	100:15

Table 1: Ratio of tiger nut milk in ml to the baobab powder in Grams.

Sample A: 100 ml of tiger nut mik were measured. Sample B: 100 ml of tiger nut milk were measured and 5g of baobab were measured and was uniformly mixed with the milk. Sample C: 100 ml of tiger nut milk were measured and 10g of baobab were measured uniformly mixed with the milk. Sample D: 100 ml of tiger nut milk were measured and 15g of baobab pulp powder were measured and uniformly mixed with the milk.

Proximate analysis

The samples of baobab pulp enriched tiger nut milk drink was analyzed for moisture by oven drying method, protein by formal titration method, fat by Rose Gottleib method, ash by use of mufle furnace, crude fiber and carbohydrate by difference method. This

methods was adopted from Association of Official Analytical chemist (AOAC) 2003 and practical manual on food technology, nutrition and dietetics for schools and industries second edition and conducted in KEPA.

Moisture (oven drying method)

Tiger nut milk was dried in the oven under standard condition and the residue weighed.

Procedure

Dry clean petri dish and lid was heated in the oven and cooled in the desiccators and weighed. 0.5mls of the sample (tiger nut) was pipette in the dish and the lid was replaced and it was weighed. The dish was placed without the lid on a boiling water bath until the water is evaporated from the sample, the under surface of the dish was wiped and then placed in the oven at 102"c for 2/2 hours. The lid was put on the dish and, then cooled in the desiccators and weighed. The heating and weighing was done at hourly intervals until successive weighing was achieved.

Calculation:

$$\% \text{ m0isture} = \frac{\text{WI}-\text{W2}}{w_1} \text{ x } 100$$

Where

WI = weight of sample before drying

W2 = weight of sample after drying.

Protein determination by formal method (AOAC, 2003)

Proteinare organic nitrogenous compound of very high molecular weight and are complex in nature. Not all plant proteins contain all the essential amino acids, therefore, a diet based on such foods should be selected carefully to avoid certain deficiency disease, and four elements are found all proteins: nitrogen (16%), carbon (50%), hydrogen (7%) and oxygen (220). In addition to these, some protein contain Sulfur (3%) and other contain phosphorus, some contain metals such as, iron, copper and zinc.

Procedure

Ten milliliter of milk was pipette into a conical flask and 1.0 ml of phenolphthalein and 0.4 ml saturated potassium solution were added and was left for 2 minutes. The potassium oxalate removes the disturbing effect of soluble calcium salts. The milk was then neutralizing with 0.Im sodium hydroxide solution from a burette until it is faint in color. 2 mls of 40% formaldehyde solution was added to the neutralized milk. The second titration was continued to the same pink color as previously and then the amount of 0.1m sodium hydroxide require for the Second titration was recorded only.

Calculation = % protein = Aldehyde value x 0.17

Where aldehyde value is equivalent to ml of 0.Im sodium hydroxide solution required per 100 ml milk for the reduction of acidity produced by formaldehyde.

Crude fiber determination (AOAC, 2003)

Crude fibre is the insoluble and combustible organic residue, which remains after sample has been treated prescribed condition. The most common condition are consecutive treatment which light petroleum boiling With dilute H2So4, boiling dilute NaOH, dilute Hel alcohol and others, This empirical treatment provides a crude fibre consisting largely of the cellulose content and hemicelluloses content of the sample. The amounts of these substances in the crud fibre vary with the condition employed tor constant results a standardized procedure most be rigidly adhered to the fat has to be extracted from sample and residue used for the determination.

Procedure

After using soxhlet apparatus to extract fat from 2g of sample 100 ml of boiling conc. H_2SO_4 was poured into the extracted sample and then it was continue boiling for 30 minutes. It was then remove from the boiling and filtered and warm water was used to wash down excess acid from the sample. The residue was then scraped away washed and clean and put into another beaker and 100 ml of boiling NaoH was added and boiled continuously for 30mins. It was removed and wash down with warm water to remove excess bade. Fold filer paper plus residue was dried in a crucible before aching in furnace at 550-600^{o}c and the result was recorded.

Determination of ash content

Ash is the incombustible (1.e inorganic) materials left from complete combustion of sample. It is largely made up of mineral element e.g., calcium, magnesium and sodium. The ash value is obtained by careful cognition of material to remove all organic materials. The ash differs in composition from the inorganic matter in the original food sample or material. Natural materials Contain varying amount of inorganic matter of complex and different composition.

Procedure

The silica dish was heated over a Bunsen flame and then transfer into a furnace at a temperature of 55°c -600°c for 15mins with a forceps. It was then allowed to cool in a desiccated and weigh. 5mls of the sample was pipette into a petri evaporated to dryness in an oven. The dish was heated over a Bunsen flame cupboard until no fume is observed. The dish was then transferred into furnace at 550°c for 2 hours until complete aching and constant weight is achieved. The dish was cooled in the desiccators and the weight was recorded.

Calculation

$$\% \text{ Ash} = \frac{\text{weigh of ash residue alter ignition}}{\textit{the dry weight of sample}} \text{ x } 100$$

pH measurement (AOAC, 2003)

The term pH is used to measure the amount of hydrogen ion concentration (H^+) of a solution. It is therefore decreased as a measure of the acidity of alkalinity of the solution.

Procedure

Twenty milliliter of the sample was weighed into a conical flask (tiger nut) and the pi was determined using pH meter.

Total acidity determination (AOAC, 2003)

Principle

Milk is acid to phenolphthalein, alkaline to methy'1 orange, but amphoteric to Litmus due to the presence of phosphate. The pH is usually about 0.14% (as Lactic acid) on storage, the acidity increase due to the action of microorganisms, and a sour taste is perceptible when this reaches about 0.3%. Milk is decidedly sour at 0.4% and when the acidity reached 0.6% it curdles at ordinary temperature. The sample was titrated with sodium hydroxide to a phenolphthakein end point using milk containing rosaniline as a comparism standard.

Procedure

Ten milliliter of the sample (tiger nut was pipette into beakers. 1 ml of the dilute rosaniline solution was added to one dish and stirred with a glass rod to other 1 ml of phenolphthalein solution was added and would titrate with 0.IM NaOH, stirring the sample until the colour is the same as the rosaniline comparison standard.

Determination of milk fat (Practical Manual, 2004)

The fat content of milk is determined either volumetrically as in the Gerber's and Babcock method or rapid gravimetrically as in the Rose -Gttlieb and majonnier method. The rapid volumetric methods are often used for routine purposes for determining fat content of dairy products including whole milk, skim milk, butter milk, cram, powdered milks and ice cream. The Rose-Gottlieb method is a gravimetric method of milk fat determination. The sample was treated with ammonia and ethanol, the latter to precipitate protein and the former to dissolve the precipitate and fat wa extracted with diethyl ether and petroleum ether. This method is considered suitable for reference purposes.

Procedure

Direct solvent extraction will be used

One hundred and ten milliliter of sample (tiger nut) was weighed into stoppered bottle (500ml) for all the four samples. 250mls of petroleum ether to each flask containing the samples and then was mixed thoroughly. The bottle was allowed to stand for 72 hours with interval shaking for between 5-10 minutes. The solvent was distilled in an air oven to constant weight and the amount of fat was measured.

Microbiological analysis

Enumeration of Mesophilic Acrobic Bacteria (Total Plate Count) (AOAC 2003)

This is by far the most widely used method for determining the numbers of viable cells or colony forming until (cfu) per ml or gram in a food-product.

Principle

It is based on the principle that the microbial cells present in a sample mixed with an agar medium each from visible separated colonies after incubation at 30'c-35 c for 48-72 hours. The number of mesophillic aerobic bacteria per ml or gram of sample was calculated from the number of colonics obtained in selected petri dishes count is designed to provide an estimate of the total number of aerobic organisms in a particular food. A series of dilution of the food homogenate was mixed with sugar medium incubated at 30c 35 c for 48 -72 hours. It| was assumed that each visible colony is the result of multiplication of a single cell on the surface of the agar. 1he total aerobic plate count is useful for indicating potential spoil-

age in perishable products. The aerobic plate count is also useful indicating the sanitary condition under which food was produced and processed.

Procedure

Plate count agar of 17.5 PCA was dissolved into 1000 ml of distilled water in a 1000 ml conical flask; one ringer tablet was also dissolved into 500 ml of distilled water in a conical flask. The two flasks' was covered with cotton wool and wrapped with foil paper. 9 ml of ringer solution will pipette using l0 ml pipette and transferred to a clean test tube. The same amount of ringer solution will pipette into 24 different test tube together with 40 petri dishes and the PCA were taken to the autoclave and was sterilized at 121°c for 15mins.

Preparation of food homogenate

Ten milliliter of each sample was pipette into 90mls of the ringer solation and was thoroughly mixed to make the food homogenate.

Serial dilution and pipetting

The food homogenate was mixed very well by shaking and one ml was pipette into a tube containing 9 ml of ringer solution and was mixed carefully with a pipette by aspiration. From the first dilution, the same pipette was used to transfer 1.0 ml to 2 dilution tube containing 9 ml of ringer solution and it was mixed with a fresh pipette and so was done up to the last tube, all the dilution was shaken carefully.

Pour plating

Ten milliliter of the food homogenates and of each dilution of the homogenate will pipette into appropriately marked petri dishes, 10, 10, 10', 10 etc. 15mls of the PCA would poured into each Petri dish it will be mixed thoroughly by shaking clock wise and anticlock Wise to mix the sample and agar medium thoroughly and uniformly and it will then allowed to solidify.

Incubation

The prepared dishes are inverted and was taken to the incubator and was incubated at 30 ± 1°c for 72 ± 3hr.

Counting the colonies

All dishes containing 30-300 colonies was counted using colony counter and the results was recorded.

Calculation

When the dishes examine contain no colonies, the result was expressed as less than lx10^1bacteria per g or ml. When the dishes (dilution lin 10) contain less than 30 colonies the result wa expressed as less than 3x10 (30x10). When the colonies are more than 30, count the colonies in both plates of a dilution and calculate the average, retaining only two significant digits and multiply by the inverse of the corresponding dilution to obtain the number of bacteria per g or ml.

Determination of coliform bacteria

Principle

The coliform group of bacteria includes all the aerobic and facultative anaerobic, gram negative, non sporulating bacilli that produce acid and gas from the fermentation of lactose, the classical species of this group are escherichia and aerobatic aerogoies. The relationship of these organisms to others of the enterie group. Salmonella, shigella, Proteuos, pseudomonas and alkagenes all of which are gram negative non speculating bacilli, coliform organisms particularly Escherichia coli are constantly present in the human intestine in large number. It is estimated that billions of these organisms are execrated by an average person in one day. These live longer in water than intestinal pathogens do.

Direct counting method

Procedure

Macconkey agars of 17.5g was dissolved into 1000 ml of distilled water in a thousand mls conical flask, 1 ringer tablet was dissolved into 500 ml of dístill water. The two flasks was covered with cotton wool and wrapped with a foil paper. 9mls of ringer solution was pipette using 10 ml pipette and transferred to clean test tube. The same amount of ringer solution was pipette 24 different test tube and the medium and the test tube and petri dishes was sterilized at 121°c for 15mins. 10 mls of each sample was pipette into 90mls of ringer solution and was mixed thoroughly to make the food homogenate.

One milliliter of food homogenate was pipette into a tube containing 9 ml of ringer solution and mixed carefully with pipette by aspiration from the first dilution the same pipette was used to transfer 1.0 ml to2 dilution tube containing 9 ml of ringer and it was mixed with a fresh pipette and so was done up to the last tube and every dilution was shaked carefully.

Pour plating

One milliliter of the food homogenate and of each dilution of homogenate was pipette into an appropriately marked petri dishes 10^2, 10^3, 10^4, 10^5, e.t.c. 15mls of the macconkey agar was poured into each petri wish to mixed thoroughly by shaking clock wise and antilock wise to mixed the sample and the agar medium thoroughly and uniformly and it was allowed to solidify.

Incubation

The prepared dishes are inverted and taken to the incubator and incubated at 30 ± 1°c for 72 ± 3hr. After the incubation it was then confirm of these are coliform.

Mineral analysis

A spectrophotometric method was used to determine some selected content of minerals of the sample as applicable in (AOAC, 2010). Flame photometry was used to determine the iron, magnesium, potassium, phosphorous and calcium content of the sample, while the vitamin B complex concentration was assessed using the technique.

Sensory evaluation

The four sample of baobab pulp enriched tiger nut milk drink was presented and sensory evaluation was conducted in the department of nutrition and dietetics in which twenty ledges comprising with lecturers and students were present, using 9-point hedonic scale questionnaire they were asked to access the preference of the product in terms of texture, taste, aroma, colour, and overall acceptability. The result was obtained and analyzed statistically using analysis of variance (ANOVA) at 5% level of significant ($P \leq 0.05$).

Data analysis

All physicochemical tests was conducted in triplicates, while the microbial experiment was done in quadruplicate and the mean values and ± standard deviation was reported, Statistical analysis was performed by applying analysis of variance (ANOVA) to determine the acceptability of the product.

Result and Discussion

Table 2 shows the results of vitamin composition, thiamin (Vitamin B1), Riboflavin (vitamin B2) and Niacin (vitamin B3). Vitamin B1, B2, and B3 are measured in milligram.

S/N	Thiamin	Riboflavin	Niacin
1	0.03 ± 0.00a	0.05 ± 0.00a	0.05 ± 0.00a
2	0.04 ± 0.00b	0.07 ± 0.00b	0.07 ± 0.00b
3	0.05 ± 0.00c	0.05 ± 0.00a	0.10 ± 0.00c
4	0.08 ± 0.00d	0.05 ± 0.00a	0.11 ± 0.00d
5	0.35 ± 0.00e	0.05 ± 0.00a	0.23 ± 0.00e

Table 2: Vitamin composition of tigernut milk enriched with baobab powder.

Sample	MC	Protein	Fat	Fibre	Ash	CHO
1	38.29 ± 10.15b	10.20 ± 0.01b	16.15 ± 0.02e	0.26 ± 0.01a	1.88 ± 0.01a	33.22 ± 10.14a
2	42.71 ± 0.01b	14.09 ± 0.02c	14.46 ± 0.01d	0.41 ± 0.01b	2.05 ± 0.01b	26.28 ± 0.03a
3	40.65 ± 3.33b	17.01 ± 0.01de	11.57 ± 0.01c	1.00 ± 0.00c	2.95 ± 0.01c	26.81 ± 3.34a
4	33.86 ± 0.01b	19.46 ± 0.02	10.03 ± 0.03b	1.27 ± 0.01d	3.24 ± 0.02d	32.15 ± 0.03a

Table 3: Proximate composition of the tigernut milk enriched with baobab powder.

The result from the table 3 shows significant difference between samples. The moisture content range between 42.71 to 33.86% and sample B had the highest moisture value (42.71%) compared to the other enriched tigernut (Sample C and D). There are changes in some constituents of the Flour, There was an increase in protein and ash content and reduction in fat, while the enriched value ranges 16.15 to 10.03% the fat content decreased as are baobab pulp was added. The fibre content ranged from 1.27 to 0.26% with sample a having the list value 0.26%. The ash content increase with the addition of baobab to the tigernut. The carbohydrate was 33.22 to 26.28%, there was significant difference among samples as A (33.22%) had the highest value when compared to the enriched samples as shown on the table 3.

The result of the table 4 shows Mineral compositions of tiger nut formulated with baobab flour. Mg, K, P, and Ca were the major in organic constituents of the ash in all studied samples. Among the trace elements (Mg, K, P and Ca) are a bit high and are within the limits advised for nutrition. The current studies revealed that tiger nut tuber have high Magnesium, Potassium, Phosphorous and calcium and low Iron, mineral contents. The high values of calcium found in the tigernut are adequate for bone and teeth development

S/N	MG	K	P	Ca	Fe
1	118.31 ± 0.01a	268.67 ± 0.67d	153.58 ± 0.29d	243.22 ± 0.01a	2.82 ± 0.01a
2	122.02 ± 0.01b	291.56 ± 0.02c	150.51 ± 0.09c	266.11 ± 0.01b	3.03 ± 0.03b
3	127.58 ± 0.01c	345.23 ± 0.02c	145.43 ± 0.02b	278.59 ± 0.01c	3.27 ± 0.02c
4	134.10 ± 0.01d	393.88 ± 0.01d	142.25 ± 0.13a	292.18 ± 0.01d	3.81 ± 0.01d

Table 4: Mineral composition of tigernut milk enriched with baobab powder.

in infants. The presence of other minerals such as iron is highly important because of its requirement for blood formation. Therefore, tiger nut flour could be used as supplementation for cereal flour to improve its content from Ca [15].

Table 5 shows the mean sensory scores for tigernut and its formulation (Sample A, B, C and D). All the samples were highly rated in their sensory attributes including their overall acceptability. Significant differences ($P < 0.05$) however existed among sample attributes. Sample A was rated highest in terms of taste, mouth feel and overall acceptability. Sample A and B was rated highest in terms of color, Appearance, Flavour, Sweetness and Viscosity. Although the reference samples had higher ratings than the test samples in terms of colour and aroma. The difference was only marginal. The sample 20:80 (Sample D) received the lowest score in taste, colour and mouth feel. Sample 40:60 (Sample C) was significantly different ($p < 0.05$) from the other samples in its overall acceptability.

Samples	Colour	Appearance	Taste	Mouth	Flavour	Sweetness	Viscosity	Overall
A	7.70 ± 0.02b	7.70 ± 0.18b	8.10 ± 0.20bc	7.85 ± 0.27c	7.70 ± 0.18b	8.20 ± 0.20bc	8.10 ± 0.20b	8.10 ± 0.19ab
B	7.70 ± 0.23b	7.70 ± 0.23b	8.55 ± 0.15c	8.05 ± 0.18c	7.50 ± 0.33b	8.55 ± 0.15c	8.10 ± 0.35b	8.80 ± 0.12c
C	7.35 ± 0.18ab	7.35 ± 0.18ab	7.35 ± 0.25b	7.40 ± 0.33bc	7.30 ± 0.19b	7.35 ± 0.25b	7.00 ± 0.36b	7.85 ± 0.22b
D	6.55 ± 0.37a	6.55 ± 0.37a	6.10 ± 0.49a	6.35 ± 0.47a	6.10 ± 0.40a	6.05 ± 0.48a	5.70 ± 0.42a	6.75 ± 0.39a

Table 5: Sensory evaluation of the tigernut milk enriched with baobab powder.

Discussion

From the result of vitamin composition, all samples (A, B, C and D) were significantly ($P < 0.05$) different. Sample A had the highest score (0.03.72 ± 0.00mg/100g) while sample B had the lowest score (0.05 ± 0.07mg/100g). This is an indication that vitamin B complex content of tiger-nut increases with in the length of fermentation time. This may be attributed to increase or multiplication of microbial cells. This is in agreement with the work of [16]. Vitamins is micronutrients that have protective functions in the body and must be acquired via food. Vitamin analysis revealed that *Cyperus esculentus* is high in vitamins B1, and B3, all of which play important roles. However, the inclusion of baobab in the milk increased the Vitamins content by >25% in sample B, C and D compared with sample fresh tigernut extract. Vitamin act as co-enzymes in macronutrient metabolism, when eaten in sufficient amounts, the tested plant samples are good sources of Vitamin B and can be used to maintain good health in humans and animals.

The proximate composition of product of the samples is shown in table 3. Carbohydrate, in addition to moisture, was quantitatively a major component of the beverage. The beverage samples were fairly rich in fat, protein and ash. Crude fibre was sparsely present. An observable trend was that carbohydrate content increased with increase in tigernut substitution (Baobab). Several workers have confirmed the presence of high carbohydrate content in tigernut [17]. Processing however affected the crude fibre content of the samples as they were very low as against the high crude fibre content of the tigernut milk. The test samples A and D had the highest carbohydrate content while the sample B and A recorded the highest fat, protein and ash contents. Moisture however increased under this same condition. Carbohydrate and fats were major components of this product, Crude fibre was more evidently present in this product as against the quantity in product. Significant differences were observed in carbohydrate, fats and moisture values. Reconstituting the drink by 25% (w/v) recorded the highest levels of nutrients. Earlier researchers have confirmed high levels of various nutrients in tigernut [18]. These nutrients were not significantly affected during processing. The mineral composition shows Potassium are the most abundant in all the tigernut milk, with values ranging from 268.67 to 393.88. The second most abundant minerals was Calcium, with values ranging from 243.22 to 292.11. The

high values of calcium found in the tigernut are adequate for bone and teeth development in infants. High Ca: P ratios have been reported to contribute to a low prevalence of obesity [19]. The K: Ca ratio of the tigernut milk were greater than minimum recommended 5:1 ratio for healthy living [19]. The presence of other minerals such as iron is highly important because of its requirement for blood formation. Therefore, tigernut milk could be used as supplementation for cereal flour to improve its content from Ca [20].

The sensory attributes reveals that all the samples were highly rated in their sensory attributes including their overall acceptability. Significant differences ($P < 0.05$) however existed among sample attributes. The sensory properties can be influenced by processing formulation, preparation and modification [9]. The same method employed [9] was also used in the production of tiger nut milk. Milk fortified with baobab pulp powder used in this work. The palatability properties of the samples were studied. This includes, tatse, mouth feel, Appearance, flavour, colour and overall acceptability accessories. All the sensory properties were however significantly ($P \leq 0.05$) different.

Conclusion

It was concluded that the tiger nut milk can be enriched with baobab pulp powder to influence the taste, mouth feel, flavor, appearance, colour and overall acceptability of the final product. The product can also be used to combat macro and micronutrients deficiency particularly calcium in the society, and also used as a healthy substituted for people that are lactose intolerant. This milk can also be used as milk substitute for infants that drink more of artificial flavoured and non-nutritive sugar ladened drinks (e.g viju milk). This study shows that tiger nut baobab milk is a rich source of minerals, especially calcium, phosphorous and potassium and is high in vitamin B complex. The milk have good radicals scavenging abilities. This study concluded that tiger nut milk could be produced for consumption and will be acceptable by the consumers. The higher the amount of baobab pulp powder added to the imitation milk the better the health benefit it offers.

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