

Production of Peanut Milk and its Functional, Physiochemical, Nutritional and Sensory Characteristics

Abstract

This study was aimed to investigate the functional properties of peanut seeds, and physicochemical, nutritional and sensory analysis of processed peanut milk. Standard methods were used in this research to determine the functional properties and proximate composition, while minerals were determined by a flame photometer and colourimeter. Firstly, the functional properties of whole and defatted kernel of peanut seeds were studied, and the best results were found in the defatted sample. Peanut milk samples were divided into four samples depends on the percentage of powder milk addition (3, 6, 9 and 12%) as well as the control sample without addition. The pH, total soluble solids, viscosity, and density of samples were (6.2-6.5, 6-16%, 3-8 mPa/s and 1.01-1.05 g/cm³, respectively), increased with the increasing of milk powder. About the proximate analysis, the highest values of ash, protein, fat, total carbohydrates (0.8, 6.3, 6.3 and 7.5%, respectively) were found in the sample of 12% powder milk. Sodium, potassium, and calcium in the samples (3, 6, 9 and 12%) were found in the range 38-58, 55-89 and 10-18 mg/100 g, respectively. Sensory evaluation results revealed great acceptance for peanut milk made with 3% powder milk addition, while we're not found a significant difference in the colour and taste of all samples and control. This study proved the possibility of using Sudanese peanut as a milk substitute which was found to be a good source of nutrients. This study suggested to use peanut milk as a milk substitute, and in yoghurt manufacture, future work should aim at studying optimum storage condition and stable packaging requirements.

Keywords: Peanut milk, functional properties, physiochemical analysis, nutritional value, sensory evaluation, minerals content.

1. Introduction

Peanut (*Arachishypogaea*) is an annual herb whose chief, and the remarkable characteristic is the production of fruits underground. The many cultivars fall naturally into two distinct botanical groups depending upon differences between them in their branching habit [1]. Peanuts are rich in essential nutrients, In a 100 g serving, peanuts provide 570 calories and are an excellent source (defined as more than 20% of the Daily Value, DV) of several B vitamins, vitamin E, several dietary minerals, such as manganese (95% DV), magnesium (52% DV) and phosphorus (48% DV), and dietary fiber (right table). They also contain about 25 g protein per 100 g serving, a higher proportion than in many tree nuts[2]. Peanut seeds (kernels) grow into a green oval-leafed plant about 18 inches tall, which develop delicate yellow flowers around the lower portion of the plant. The flowers pollinate themselves and then lose their petals as the fertilised ovary begins to enlarge [3].Some studies show that regular consumption of peanuts is associated with a lower risk of mortality specifically from certain diseases. However, the study designs do not allow Cause Peanuts are rich in monounsaturated fats, the type of fat that is emphasized in the heart-healthy Mediterranean diet. Studies of diets with a special emphasis on peanuts have shown that this little legume is a big ally for a healthy heart. In one such randomized, double-blind, cross-over study involving 22 subjects, a high monounsaturated diet that emphasized peanuts and peanut butter decreased cardiovascular disease risk by an estimated 21% compared to the average American diet [4].Protein ingredients must possess appropriate functional properties for food applications and consumer acceptability. These are the intrinsic physicochemical characteristics which affect the behavior of protein in food systems during processing, manufacturing, storage and preparation, e.g., sorption, solubility, gelation, bureaucracy, ligand-binding, and film formation. These properties reflect the composition and conformation of the proteins, their interactions with other food components, and they are affected by processing treatments and the environment. Because functional properties are influenced by the composition, structure and conformation of ingredient proteins, systematic elucidation of the physical properties of component protein is expedient for understanding the mechanism of particular functional trains[5].Since peanut is an important legume as it uses for many reasons in the world particularly Sudan which it uses daily as a food edible oil in our cooked food and as a butter in the meal. Cultivation of peanuts in the Sudan in many environment and production of edible oil has been accompanied with loose of crops contents, find alternatives to milk from nutrient source. Therefore, the main objective of this study was to

produce peanut milk and its physiochemical characteristics, functional as well as its sensory analysis.

2. Materials and Methods

Materials, tools and equipment's

Peanut was collected from a local market in Wad Medani City (put collection period, month, year ...), Gezira State, Sudan, and was transported to the laboratory of food analysis department of Food Engineering and Technology, Faculty of Engineering and Technology, University of Gezira, Sudan. All other chemicals and reagents were of the highest grade commercially available. Oven, spectrophotometer, pH-meter, refractometer, centrifugation machine and Soxhlet. to explain, we don't understand this part: putting the equipment's brand.

Methods

Extraction oil by Soxhlet

Hexane was heated to reflux, hexane vapour travels up a distillation arm, and floods into the chamber housing the thimble of solid. The condenser ensures that any solvent vapour cools, and drips back down into the chamber housing the peanuts. The chamber containing the peanut slowly fills with warm solvent. Some of the desired compounds dissolve in the warm solvent. When the Soxhlet chamber is almost full, the chamber is emptied by the syphon. The solvent is returned to the distillation flask. The thimble ensures that the rapid motion of the solvent does not transport any solid material to the still pot. This cycle takes 4 hours. During a cycle, a portion of the non-volatile compound dissolves in the solvent. At the end of the cycle, the desired compound was concentrated in the distillation flask. After extraction the solvent was removed, typically using a rotary evaporator, yielding the extracted oil. Place the method reference

Functional properties

Water absorption capacity

The water absorption capacity (WAC) was estimated by the method of [5] with the modification described by [6]. 0.5 gm of peanut flour added to 5 gm distilled water was stirred in a centrifuge tube using a glass rod for 2 minutes at room temperature (26°C). After 20 minutes equilibration, the suspension was centrifuged for 20 minutes at 440 rpm at room temperature (26°C). The freed water was decanted into a 10 ml graduated cylinder, and the volume was recorded.

Fat absorption capacity (FAC)

FAC of the samples was measured by a modified method of [5] 2 grams of the sample was treated with 20 ml of refined peanut oil in a 15 ml centrifuge tube. The suspension was stirred in a centrifuge tube using a glass rod for 2 minutes at room temperature (26°C). The suspension was centrifuged for 20 minutes at 440 rpm at room temperature (26°C). The freed fat was decanted into a 10 ml graduated cylinder, and the volume was recorded.

Bulk density (BD)

BD was determined by the method of [7]. About 10 grams of material were placed in a 10 mL graduated cylinder and gently packed by tapping the cylinder on the bench (10) times to a reasonable height (approximately 5-8). The volume of the sample was recorded.

Gelation

Least gelation concentration of the sample was measured by the method of [8] with a slight modification. Appropriate sample suspensions of (4, 8, 12 and 16%) were prepared in 100 ml of distilled water. The test tubes containing these suspensions were then heated for one hour in a boiling water bath followed by rapid cooling under running cold tap water. The test tubes were further cooled for 3 hours at (4°C). The least gelling concentration was determined as that concentration did not fall or slip when the test tube was inverted.

Foam capacity (FC)

FC was determined according to the method of [9]. Flour (2 g) was dispersed in 100 ml of distilled water and the contents transferred to a mixer blender whipped for 5 min. At high speed for 5 min. The contents, along with the foam, were poured into a 250 ml measuring cylinder; the foam volume was recorded after 30 s. FC was expressed as percentage increase in volume. After 30 min, the volume of foam was measured and expressed as follows:

$$FC = \frac{\text{Volume after whipping} - \text{Volume before whipping}}{\text{Volume before whipping}} \times 100$$

Emulsification capacity

Emulsification Capacity was determined by the method of [1]. 1 g flour, added to 30 ml peanut oil, these contents added to 60 ml sodium hydroxide and the whole mixture in a blender at 9500 rpm for 30 minutes after that added another 30 ml of oil to the mix and put the mix in centrifuge at speed 3000 rpm for 30 minutes.

Processing of peanut milk

Peanut milk was prepared by following the method of [10], with slight modifications. Sorted peanut seeds were cleaned and roasted at 100°C for 20 min in an oven. Roasting found to improve nutrient composition (protein, fibre and fat) and decrease the flavour of peanut. The seeds were then de-skinned and weighed before extracted oil. The kernels were then mixed with water in a ratio of 1:4 and transferred to a blender where they were blended for 5 min at medium speed. The slurry formed was filtered using a double-layered cheesecloth to prepare the peanut milk. After that Placed the peanut milk on the heater over medium heat until boil, after that added a pinch of salt, sugar and different concentration of powder milk along with additional vanilla for flavour and let it cool, after it has come to room temperature poured it in a pitcher.

Proximate analysis

There is no need for equations; the method is very basic, perhaps joining the centesimal composition in a single paragraph or topic!

Moisture content

Moisture determination was conducted using the [11]. Disposable aluminium weighing dishes, (<50 mm diameter and <40 mm deep) which had been numbered, dried in the oven for 30 minutes, cooled in a desiccator and weighed again were used. A two g sample was weighed out and repeated in triplicate. Using tongs, aluminium weighing dishes containing the samples were placed in an air-drying oven at 130° C for about one hour. The samples were removed and placed in a desiccator to cool for 30 minutes and reweighed. The moisture content was calculated according to the following equation:

$$\text{Moisture content (\%)} = \frac{W_1 - W_2}{\text{Moist samples weight}}$$

Where:

W_1 = weight of dish and dry sample.

W_2 = weight of the dish.

Ash content

The ash content was determined according to the [11] using a muffle furnace. Four grams of the sample was weighed and repeated in triplicate into porcelain crucibles, which have been ignited,

cooled in a desiccator and weighed and placed in a cool electric muffle furnace. The temperature was 540°C overnight for complete ashing. The ash crucibles were transferred directly into a desiccator, then cooled for 30 minutes and weighed immediately. The ash was determined by calculation and expressed as a percentage using the following equation:

$$\text{Total ash (\%)} = \frac{\text{Ash weight}}{\text{Sample weight}} \times 100$$

Protein content

Protein content was determined according to the Kjeldahl method described by [12]. Two grams of each sample were placed in digestion flask (500 ml), K₂SO₄ was added to it. Then 25 ml of concentrated sulfuric acid was added, and the content was heated at 35°C in a fume cupboard until a clear solution was obtained (2-3 hours) and left to cool before that antidumping granule was added. The digested samples were poured in a volumetric flask (100 mL) and diluted to 100 mL with distilled water. Five mL were distilled using 10 ml of 40% NaOH; 25 ml of boric acid with drops of methyl red were placed in a conical flask. Distillation of the reaction mixture liberated ammonia and reacted with boric acid, changing the colour from red to light greenish blue. Excess alkali was then titrated using 0.1 N, hydrochloric acid until the colour changed to light purple. The titration reading was reported. The protein content was determined by multiplying the percentage nitrogen by empirical factor 6.36; as follows:

$$\text{N\%} = \text{Volume of HCl} \times \text{N} \times 14 \times \frac{\text{dilution factors}}{1000 \times \text{weight of sample}} \times 100$$

$$\text{Protein \%} = \text{N\%} \times 6.63.$$

Where: 14 = the molecular weight of nitrogen.

N = Normality of acid, HCl.

Fat content

A rapid volumetric method (Gerber method), as described by [13], was used for the determination of fat content of different samples. Ten ml of concentrated sulfuric acid was poured in a butyrometer tube. Then 10.94 ml of mixed milk was added slowly at the sides, followed by 1.0 ml of fat – free amyl alcohol, which was also added slowly at the sides, the tube was closed with special metal, and rubber stoppers and the content thoroughly and immediately centrifuged at 1100 rpm for 10 min. The tube was then transferred to a water bath at 65°C for 3 min for complete fat suspension. The percentage of fat was determined directly from butyrometer neck.

Total carbohydrates

The number of carbohydrates was calculated by difference. The values refer to “total carbohydrate by difference” that is, the sum of the figures for moisture (MC %), protein (PC %), fat (FC %), and ash (Ash %) are subtracted from 100, as follows:

$$\text{Total Carbohydrate \%} = 100 - [\text{MC\%} + \text{PC\%} + \text{FC\%} + \text{Ash C\%}].$$

Minerals

According to AOAC Official Method, (2000), samples were dried and ashed at 525°C for 4 hours. The ash was dissolved in (1 ml hydrochloric acid +3 ml distilled water) and a few drops of nitric acid, brought to a final volume of 250 ml with distilled water and filtered. Sodium, calcium and potassium, iron and phosphor were determined by flame atomic absorption spectroscopy according to [11].

Reducing sugar content determination

The reducing sugar content of samples and were estimated according to the Nelson- Somogyi, (2000) method. One ml of the sample was mixed with one part of solution B and four parts of solution A. The mixture was boiled in water bath for 25-30 minutes, and then it was cooled under running tap water, and after that one ml of Nelson reagent was added. The optical density (O.D) of the samples has been read using spectrophotometer at wavelength 520 nm¹⁰.

Physiochemical properties

There is no need for equations; the method is very basic, perhaps joining the Physiochemical properties in a single paragraph or topic!

pH determination

The pH of the peanut milk samples was estimated according to [11]. The pH of the samples was measured using a pH meter; the pH was determined by inserting the electrode of the pH meter in the sample then taking the result displayed on the pH meter.

Total soluble solid content determination (TSS)

The TSS content of peanut milk samples was estimated according to the [11]. The point from milk samples was taken and put in abbe refractometer and adjusted the point breaker and then read the focus.

Viscosity

The viscosity of the samples was determined by the method of [14]. The spindle of the viscometer was inserted into the sample at the speed of 20rpm, and the reading on the viscometer was taken after 3 minutes for each sample.

Density

The density of the samples was determined by the method of [15]. A 50ml bottle of density was washed and dried in the oven and weighted empty then filled by milk then dried and weighed again the difference between empty bottle weight and the weight of the bottle is full of milk equal the mass of milk, as follows:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{x}{50}$$

Sensory evaluation

How many individuals participated in the sensory evaluation?

Semi-trained panellists were given a hedonic scale questionnaire to evaluate the peanut milk was evaluated through colour, texture, flavour and overall acceptability. They were scored on a scale of 9 points, in which (1: extremely bad, 2: very bad, 3: bad, 4: fairly bad, 5: satisfactory, 6: fairly good, 7: good, 8: very good, 9: excellent). During the sensory evaluation, panellists were instructed to drink water or wash mouth after each evaluation. Sensory evaluation was done on the day in which bread was prepared.

Statistical analysis

The analysis of variance (ANOVA) was performed to examine the significant level in all parameters measured. (SPSS) The test was used to separate between the means. All analyses were performed in triplicate (n = 3). The level of significance was 0.005 [16].

Results and Discussion

Functional properties of peanut kernel

Water absorption capacity

As shown in Table 1, water absorption capacity of defatted peanut kernel and whole seed were 2.0 and 1.0 mL/g, respectively, these results were found similar to that reported by [17], which was found water absorption capacity of peanut kernel (2.0 mL/g) and lower than that reported by [18], which was found (4.0 mL/g). Water and oil binding with proteins are very important in the food system because of their effects on the flavour and texture of foods. Generally, the protein subunit structure dissociates on heating or under extreme alkali conditions, and any possible factors that may affect these groups may cause changes in the water and oil absorption capacities. The WAC is an important functional property of flours due to swelling, and it affects the characteristics of body thickness and viscosity [17].

Oil absorption capacity

As also shown in Table 1, the oil absorption capacity of defatted peanut kernel and whole seed were found to be 1.0 and 1.75 mL/g, respectively. Oil absorption capacity was observed to be lower than that reported by [19], which was found (2.93 mL/g) and in close agreement (1.75 mL/g), which reported by [20].

Bulk density

As can be seen in Table 1, the bulk density of defatted peanut kernel and whole seed were 0.54 and 0.63 g/mL, respectively, these results were higher than that reported by Kaur and Singh (2006), which was found (0.33 g/mL) and in agreement with that result reported by Kaur and Singh, (2005) which was found it (0.63 g/mL) higher bulk density is desirable since it helps to reduce the paste thickness which is an important factor in convalescent and child feeding [21]. Bulk density is a property of powders defined as the mass of the many particles of the material divided by the total volume occupied.

Gelation

Gels may be defined by their ability to immobilise a liquid, their macromolecular structure, or their textural or rheological properties. The least gelation concentration for defatted peanut kernel and whole seed are shown in Table 1. Gelation values were 7.6 and 3.2%; respectively, these results were similar to that reported by [22], which was recorded as 3.0 and 7.0% respectively for other varieties. It formed a weak gel at whole seed and strong gel at the defatted kernel. Variations in gelling properties may be ascribed to the ratios of different constituents, such as proteins, carbohydrates and lipids [20].

Foaming properties

As illustrated in Table 1, foaming capacity of the defatted kernel and whole seed, were 1.0 and 4.0%, respectively, the result of whole seed was similar to that reported by [17], which was found it as 4.0%. Defatted peanut flours may not be suitable in the food system that requires foaming such as cake and ice cream. Foaming is an important characteristic feature of most proteins. Some food proteins can foam and maintain stable foams, depending on the type of protein, the degree of denaturation, pH, temperature, and processing methods. The rheological and optical properties of thermally irreversible gels are the outcome of two events. First, a change in protein structure is needed that permits protein-protein interaction

Emulsifying properties

As can also be seen in Table 1 the emulsifying properties of defatted kernel and hole seed were 18 and 10%; respectively, these results were lower than that reported by [17], which was found (20%) for defatted kernel and (11.0%) for hole seed. The formation and stability of the emulsion are very important in food systems such as salad dressing. The presence and physiochemical properties of surfactants control the formation of stable emulsions. Proteins are preferred over low molecular weight surfactants for emulsification purposes in foods [22]. Emulsions form the basis of a huge range of food products, where those stabilised by proteins are of great interest. The interfacial properties of proteins have been extensively studied in the field of food colloid research. Emulsifying properties of proteins basically depend on two effects: a substantial decrease in the interfacial tension and the electrostatic, structural and mechanical energy barrier caused by the interfacial layer that opposes the destabilisation processes [17].

Table 1. Functional properties of defatted and whole seed of peanut

Samples	WAC (mL/g)	OAC (mL/g)	BD (g/mL)	GC (%)	FC (%)	EC (%)
Defatted	2.0±1.4	1.0±0.5	0.54±0.4	7.6±0.5	0.01±0.02	18±2.1
Whole seed	1.0±0.7	1.75±0.3	0.63±0.2	3.2±0.6	4.0±0.2	10±2.1

WHC: water absorption capacity; OHC: oil absorption capacity; BD: bulk density; GC: gelation capacity; FC: foaming capacity; EC: emulsifying capacity.

The chemical composition of peanut milk

The results of moisture, ash, protein, fat, carbohydrates and reducing sugar of processed peanut milk are illustrated in Table 2.

Moisture content

As recorded in Table 2, the moisture content of peanut milk which has been added powder milk 3%, 6%, 9%, 12%, were 88.9, 87.2, 85.4 and 83.1, respectively, decreased with the increase of powder milk addition. These results are similar with that results were reported by [23], which was found the moisture content of soy milk at the range of 87.8–80% and were found to be lower than that reported by Nail, (1978), who reported 89.2%. Also, this result was in agreement with the moisture content of raw milk was reported by [24], which was found to be 85%. Control of moisture in products can be a vital part of the process of the product. There is a substantial amount of moisture in what seems to be dry matter. Ranging in products from cornflake cereals to washing powders, moisture can play an important role in the final quality of the product [25].

Ash content

Data in Table 2, showed that the ash content of peanut milk (3%, 6%, 9% and 12%) were 0.4%, 0.5%, 0.6% and 0.8%, respectively. The results were similar with results reported by [26] which was found the ash content of almond milk 0.6%. Also, this result was similar (0.5) which reported by Liu and Chang, (2004) [29]. However, was higher than the result [27] 2% and also higher than that result .3% which reported by [29]. On the other hand, [28] reported that the ash content of soy milk was 0.9%. Ashes are the solid remains of fires. Specifically, it refers to all non-aqueous, non-gaseous residues that remain after something is burned. In analytical chemistry, to analyse the mineral and metal content of chemical samples, ash is the non-gaseous, non-liquid residue after complete combustion. Ashes as the end product of incomplete combustion will be mostly mineral, but usually still contain an amount of combustible organic or other oxidizable residues [30].

Protein content

As shown in Table 2, The protein content of peanut milk (3%, 6%, 9% and 12%) was 1.7%, 3.1%, 5% and 6.3%, respectively, this result indicates when added powder milk the rated of protein was increased. The ash result of peanut milk at 3 % and 6% are lower than results obtained by [31] who found that the protein content of raw milk was 4.94 %, but near to the result

of peanut milk when we added powder milk 9%. However, it is higher than that obtained by [32].3.38%, and similar with results reported by

., which was found protein content of soy milk in the range 3.8 - 6%. Food texture can be improved by enzyme-mediated covalent cross-linking of different food components, such as proteins and carbohydrates. Cross-linking changes the biological and immunological properties of proteins and may change the sensitising potential of food allergens [32].

Fat content

The fat content of peanut milk (3%, 6%, 9% and 12%) were shown in Table 2, were 1%, 3.6%, 6.9% and 7.5, respectively. These results were higher than that reported by [34] which was found fat content of raw milk 2.7, but in close agreement with that reported by [35] who found fat content 3.7.

Total carbohydrates

The total carbohydrate of processed peanut milk in Table 2, and showed total carbohydrates content at powder milk addition 3%, 6%, 9% and 12% were 3.3%, 5.6%, 6.9% and 7.5%, respectively. These results are lower than results reported by [36] which was found the total carbohydrate of soy milk 8.9 %, and agreement with that reported by [37] who found the total carbohydrate of almond milk 7.5

Reducing sugars content

As shown in Table 2, there were significant differences between peanut milk samples; the reducing sugar content was (7.95, 10, 77, 15, 85 and 21.50), respectively. This result was similar to that reported by [38] which was found the reducing sugar of soy milk in the range 7-20. A reducing sugar is any sugar that is capable of acting as a reducing agent because it has a free aldehyde group or a free ketone group. The monosaccharides can be divided into two groups: the aldoses, which have an aldehyde group, and the ketoses, which have a ketone group. Ketoses must first tautomerize to aldoses before they can act as reducing sugars.

Table 2. Proximate analysis of processed peanut milk

PMA (%)	Moisture	Ash	Protein	Fat	CHO	Reducing sugar
3%	88.9±1.2	0.4±0.3	1.7±0.2	1.0±0.4	3.3 ±0.5	7.95±0.6
6%	87.2±0.7	0.5±0.2	3.1±0.6	3.6±0.5	5.6 ±0.8	10.77±1.3
9%	85.4±1.4	0.6±0.3	5.0±0.4	4.9±0.5	6.9 ±0.8	15.85±0.6
12%	83.1±1.3	0.8±0.3	6.3±0.4	6.3±0.7	7.5 ±1.3	21.50±0.9

PMA: Powder milk addition.

CHO: Total carbohydrates.

Physicochemical properties of processed peanut milk

pH

The pH value of peanut milk (3 %, 6%, 9% and 12%) were shown in Table 3, and were 6.6, 6.5, 6.3 and 6.2, respectively, there is no significantly different effect on the pH value. These results were in close agreement with results reported by [39] which was found the pH value of soymilk in the range 6 – 6, 6. On the other hand, [34] reported that the pH of raw milk 6.7%.

Total solid content

The total solid content of peanut milk which has been added powder milk (3%, 6%, 9%, 12%) were shown in Table 3 were 6, 11, 12 and 16%, respectively, these results were higher than that reported by [28], which was found total solid content of soy milk at the range of 6-13%, and similar with result reported by [33], who found total solid content of cow milk (11.0%).

Viscosity

The viscosity value of peanut milk (3%, 6%, 9%, 12%) were shown in Table 3 were 3, 4, 6 and 8 mPa/s, respectively, these results were lower than that reported by [40], which was found the viscosity of coconut milk in the range of 6 – 12 mPa/s, but these results are in full agreement with those reported by [41]. Viscosity is a property of the fluid which opposes the relative motion between the two surfaces of the fluid that are moving at different velocities. In simple terms, viscosity means friction between the molecules of the fluid. When the fluid is forced through a tube, the particles which compose the fluid generally move more quickly near the

tube's axis and more slowly near its walls; therefore some stress is needed to overcome the friction between particle layers to keep the fluid moving [40] .

Place two decimal places

Table 3. Physicochemical properties of processed peanut milk

PMA (%)	pH	TSS	Viscosity	Density
3%	6.6±0.2	6±0.7	3±1.4	1.01±0.1
6%	6.5±0.2	11±0.7	4±2.1	1.02±0.3
9%	6.3±0.3	14±0.7	6±2.2	1.03±0.2
12%	6.2±0.3	16±0.7	8±1.4	1.05±0.2

PMA: Powder milk addition.

TSS: Total soluble solid.

Density

Data in Table 3 showed that the density value of peanut milk (3 %, 6 %, 9 %, 12%) were 1.01, 1.02, 1.03 and 1.05 g/cm³ respectively, the result was similar with result reported by [41] which was found the density of soy milk 1.05 and lower than that reported by [38] which was found the density of soy milk 1.09 g/cm³. Similarly, hydrostatic weighing uses the displacement of water due to a submerged object to determine the density of the object.

Minerals contents of processed peanut milk

As shown in Table 4, the minerals content was determined. Sodium content of 3%, 6%, 9% and 12% samples, were 38, 44, 54 and 58 mg/100g, respectively, while the potassium content were 55, 72, 82 and 89 mg/100g, respectively, while the calcium content were 10, 12, 14, 18 mg/100g. Minerals content is associated with the ash content [19]. The result of sodium is lower than that results reported by [42], which was found sodium content of soy milk 59 mg/100g. While potassium content was higher than that reported by Rutgers, (2006), which was found 92.0mg/100g, and calcium content was lower than that reported by [29], which was found calcium content of almond milk 33.0 mg/100g (Table 4).

Table 4. Minerals content (mg/100 g) of processed peanut milk

PMA (%)	Na	K	Ca
3%	38±0.05	55±0.02	10±0.12
6%	44±0.09	72±0.03	12±0.09
9%	54±0.03	82±0.09	14±0.22
12%	58±0.01	89±0.11	18±0.31

PMA: Powder milk addition.

Sensory evaluation of peanut milk

Sensory scores of peanut milk with different concentrations of powder milk addition and powder milk (control) were presented in Table 5. The analysis of variance (ANOVA) of the data showed that the effect of peanut milk on sensory properties was statistically significant ($p < 0.05$) for samples evaluated in this study. Sensory evaluation of peanut milk samples was undertaken with consideration of the most acceptable parameters colour, taste, texture, flavour, appearance and the overall acceptability was taken and used as a control. The sensory properties of powder milk (control) are presented in Table 5. All sensory scores colour, texture, flavour, taste, appearance and overall acceptability were significant. All sensory scores were rated as acceptable by the panel. According to the results in Table 5, powder milk (control) showed excellent attributes in comparison with other types of peanut milk. The sensory properties of peanut milk with powder milk 3%, 9% were presented in Table 4.5 all sensory scores, colour, texture, flavour, and overall acceptability were significantly different among blend samples, except flavor, and for the sample 12% all sensory scores were rated as acceptable by the panel except texture and appearance. According to the results in Table 5 the sample of peanut milk 6% showed excellent attributes in comparison with other types of milk.

Table 5. Sensory analysis of processed peanut milk

PMA	Colour	Taste	Texture	Appearance	Flavour	Overall acceptability
3%	8.8 ^a	7.7 ^a	8.0 ^a	8.6 ^a	8.4 ^b	8.4 ^a

6%	6.8 ^a	6.1 ^a	6.0 ^a	7.1 ^a	6.2 ^a	6.6 ^a
9%	7.4 ^a	7.2 ^a	7.3 ^a	8.0 ^{ab}	7.3 ^b	7.6 ^a
12%	6.8 ^a	7.2 ^a	6.6 ^b	7.4 ^{ab}	8.3 ^a	7.7 ^{ab}
control	7.4 ^a	6.3 ^a	7.0 ^a	7.9 ^a	6.2 ^a	7.1 ^a

PMA: powder milk addition

Conclusion

The present study confirms the possibility of producing milk from peanut. The manufactured milk was analysed chemically, physically and subjected to sensory analysis. Peanut milk sample with 3% powder milk received the highest consumer acceptability scores compared with others. A significant increase in physicochemical properties with addition powder milk compared to raw milk.

References

1. Beuchat, L.R., Cherry, J.P and Quinn, M.R. (1975). Physicochemical properties of peanut flour as affected by proteolysis. *J. Agricultural and Food Chemistry*, 23, 616–620.
2. Bryant, L.A., Montecalvo, J.J.R., Morey, K.S. and Loy (1988). Processing, functional and nutritional properties of okra seed products. *J. Food Sci.*, 53, 810-816.
3. Halward, Tracy; Stalker, Tom; LaRue, Elizabeth; Kochert, Gary (1992). Use of single-primer DNA amplifications in genetic studies of peanut (*Arachishypogaea* L.). *Plant Molecular Biology*. 18 (2): 315–325.
4. Oshodi, A. A., and Ekperigin, M. M. (1989). Functional properties of peanut.
5. Lin, A.S., and Dorisi, E. (1974). Certain Functional properties of some milk substitute. *J. Food Sci.*, 39, 368-390.
6. Quinn, M.R. and Beuchat, L.R. (1975). Functional property changes are resulting from fungal fermentation of peanut flour. *J. Food Sci.*, 40, 475.
7. Wang, J.C. and Kinsella, J.E. (1976) Functional properties of alfalfa leaf protein: foaming. *J. Food Sci.*, 41,498 – 501.
8. Coffman, C. and Garcia, V.V. (1977). Functional properties and amino acid content of protein isolate from mug bean flour. *J. Food Tech.*, 12, 473-478.
9. Lawhon, J.T., Cater, C.M. and Mattil, K.F. (1972). A Comparative study of the whipping potential of an extract from several oilseedflours. *J. Cereal Sci. Today*, 17, 240-244.

10. Salunkhe, D.K. and S.S. Kadam (1989). Handbook of World Food Legumes: Nutritional Chemistry, Processing Technology and Utilization. 1st Ed., CRC Press. Inc., Boca Raton.
11. AOCC, (2000). International Approved Methods of Analysis, 11th Ed. Methods 08-01.01, 44-15.02A, and 46-13.01. Available online only. AACCI: St. Paul, MN, Association of Official Analytical Chemists. Arlington, VA, USA.
12. AOAC (1999). Official methods of Analysis of the Association of Official Analytical Chemists, 15thed. (Helrich, K., Ed) Arlington, VA. Basha, S.M. and Pancholy, S.K. (1982).
13. Onimawo, I. A., and Asugo, S. (2004). Effects of germination on the nutrient content and functional properties of pigeon pea flour. J. Food Science and Technology-Mysore, 41(2), 170–174.
14. Jianmei Yu, M. A. and Ipek, G. (2007). Extrusion parameters and consumer acceptability of a peanut-based meat analogue
15. AOAC (2005). Official Methods of Analysis of the AOAC, 15thed. Methods 932.06, 925.09, 985.29, 923.03.
16. Gleick, P.H., ed. (1993). Water in Crisis: A Guide to the World's Freshwater Resources. Oxford University Press. p. 13, Table 2.1 Water reserves on the earth.
17. Rutgers R. (2006). The Consistency of Starch-milk Puddings. II.—Influence of Cooking and Cooling Conditions etc. and Type of Starch. J. Sci. Food Agric. 9(2): 69-77.
18. Kaur, M., Sandhu, K.S. and Singh, N. (2006). Comparative study of the functional, thermal and pasting properties of peanut flours from different field pea (*Pisum sativum* L.) and pigeon pea (*Cajanus cajan* L.) cultivars. Food Chemistry, 104, 259–267.
19. Mizubuti, I. Y., Junior, O. B., Souza, L. W. D., DaSilva, R. S. D. F. and Ida, E. I. (2000). Functional properties of pigeon pea (*Cajanus cajan* (L.) Mill sp) flour and protein concentrate. Archives Latinoamericanos De Nutrition, 50(3), 274–280.
20. Kaur, M. and Singh, N. (2005). Studies on functional, thermal and pasting properties of flours from different Chickpea (*Cicer arietinum* L.) cultivars. J. Food Chemistry, 91, 3, 403–411.
21. Padmashree, T.S., Vijayalakshmi, L. and Puttaraj, S. (1987). Effect of traditional processing on the functional properties of cowpea (*Vigna catjang*) flour. J. Food Science and Tech., 24, 221-224.
22. Akintayo, E.T., Oshodi, A.A. and Esuoso, K.O. (1999). Effect of NaCl, ionic strength and pH on the foaming and gelation of pigeon pea (*Cajanus Cajan*) protein concentrates. J. Food Chemistry, 66, 51–56.
23. Ikyia, 1D.I. Gernah, H.E. Ojobo and O.K (2013). Effect of Cooking Temperature on Some Quality Characteristics of Soy Milk. Oni1Department of Food Science and Technology, University of Agriculture, Makurdi, Nigeria 2Department of Food Science and Technology, University of Mkar, Nigeria
24. Sohail, M. (1983). The microbiological quality of milk produced in the Balearic Islands. International Dairy Journal, 5:69- 74.
25. Nail (1978). Nutritional and Quality Assessment of soy Milk Blend Institute of Food Science and Technology, University of Agriculture, Faisalabad –Pakistan.
26. Gallier S, Gordon K, Singh H. (2012). Chemical and Structural Characterization of Almond Oil Bodies and Bovine Milk Fat Globules. Food Chemistry 132(4): 1996-2006.
27. DiarraNor, Aisha hbint I., and Hasa, (2009). Almond milk production and study of quality characteristics Faculty of Applied Science, University of Technology MARA.

28. DiarraNor, Aisha hbint I., and Hasa, (2009). Almond milk production and study of quality characteristics Faculty of Applied Science, University of Technology MARA.
29. Agurbiade, S.O., M.H. Sharwie, and J.O. Olanlokun, (2011). Evaluation of Some Nutritional Characteristics of Indian Almond (*Prunusamygdalus*) Nut., J. of Nutrition, 4,316-318.
30. Liu A M and Chang C U (2004) Effect of Soy Milk Characteristics and Cooking Conditions Coagulant Requirements for Making Filled Tofu Department of Cereal and Food Sciences, North Dakota State University, Fargo, North Dakota 5810.
31. Soha, R.H. (2012). The composition of milk in Fundamentals of Dairy Chemistry. Second edition, edited by Webb, B, H.; Johnson, R.H. Griffiths, M. W. p 104 – 108.
32. Nelson and Somogi, L. R. (2000). Chemical, physical and sensory characteristics of soy milk as affected by processing conditions. J. Food Science, 57, 401–405.
33. Donkor, O., A. Henriksson, T.V asiljevic and N.P. Shah, (2007). Galactosidase and proteolytic activities of selected probiotic and dairy cultures in fermented soymilk, Food Chemistry, 104, 10–20.
34. Salma, H. D. (2016). Major advances in fresh milk and milk products. Fluid milk products and frozen desserts. American Dairy Science. 69:1163 - 1173. And Alford, J. A. The AVI publishing Co. Inc. Westport connection, USA.
35. Abdullah, A., Malundo, T.M.M., Resurrection, A.V.A., and Beuchat, L.R. (1993). Descriptive sensory profiling for optimising the formula of a peanut milk-based-liquid coffee whitener. J. Food Sci., 58(1):120–123. American Peanut Research and Education, Inc. 1973. Peanuts Culture and Uses. p. 601.
36. Laswai, H.S., N. Thonya, D. Yesaya, V.C.K. Silayo, K. Kalwa, J.J. Mpagalile and W.R.N. Ballegu, (2009). Use of locally available flavouring materials in suppressing the beany taste in soy milk. Afri. J. Food Agric. Nutr. Dev., 9(7): 1548-1560.
37. Hayes, M.G., P.F Fox and, A.L. Kelly, (2005). Potential applications of high-pressure homogenization in processing of liquid milk. J. of Dairy Research, 72, 25–33.
38. Yau-Chun, L.V., S. Huan-Lu, L. Xin, W. Liang and G. Shun-Tang, (2011). Influence of blanching and grinding with hot water on beany and not -beany flavour in soy milk. J. Food Sci., 76(1): 20-25.
39. Yuan, S., S.K. Chang, Z. Liu and B. Xu, (2008). Elimination of trypsin inhibitor activity and beany flavour in soy milk by consecutive blanching and Ultra-High Temperature (UHT) processing. J. Agric. Food Chem., 56(17): 7957-7963.
40. Chiewchan N, Simuang J, Tansakul A. (2004). Effects of Fat Content and Temperature on the Apparent Viscosity of Coconut Milk. Journal of Food Engineering 64(2): 193-197.
41. Rehman, S., H. Nawaz, M.M. Ahmad, S. Hussain, A. Murtaza and S.H. Shahid, (2007). Physicochemical and sensory evaluation of ready to drink soy-cow milk blend. Pak. J. Nutr., 6(3): 283-285.
42. Onuorah, C.E., A.O. Adejare and N.S. Uhiara, (2007). Comparative physicochemical evaluation of soymilk and soya cake produced by three different methods. Nig. Food J., 25: 28-38.

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