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Physical and Proximate Compositions of Selected Milk Products in Abuja and Keffi Metropolis, Nigeria

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ABSTRACT

Milk and its products have been an important component of nutritional diet. Soymilk, *nunu* and processed cheese consumed within Abuja and Keffi metropolises were analyzed for their physical and proximate compositions. The pH, specific gravity and total titratable acidity of the samples were within the acceptable limits.The result of the proximate compositions indicated that fat, total solids, total solids non- fat, ash and protein were higher in cheese samples from Abuja and Keffi. The above compositions of soya milk samples from Abuja and Keffi did not vary. But the protein and total solids content of *nunu* from both metropolises were different. Fibre was found in soya milk samples and its protein and iron contents were higher than that in *nunu* sample thus a good substitute for alleviating protein malnutrition. At the end of this study, it was concluded that all the milk samples analyzed from Abuja and Keffi have good nutritional values.

Keywords: Specific gravity, titratable acidity, milk, proximate, nutritional value.

1. Introduction

Milk is a food of outstanding interest and has been taken by humans for a long period of time. It is a nutrient rich food produced from the mammary gland of mammals, which promotes healthy growth in babies before they are able to digest other types of food. Equally good for the overall wellbeing of every individual, milk contains many nutrients that are needed by the body to function and build new cells.

It is the best diet for human health because it contains a good source of essential minerals such as calcium and phosphorous [1]; [2]; [3]. Due to its nutritional importance, milk is consumed at large scale in recent time. Many people are moving towards dairy alternatives for variety of reasons including better health. The continuous increase in population and inadequate supply of protein has inadvertently increased malnutrition in developing countries; however, in order to meet the protein demands in developing country like Nigeria where animal protein is inadequate and expensive, effort is geared

towards finding alternative sources of protein from soya beans and other plants. Since plants are important source of relatively inexpensive protein, introduction of plant milk may contribute to alleviation of protein malnutrition.

Milk is extremely perishable and various methods are employed to preserve it but the most is fermentation. Milk may undergo fermentation spontaneously by natural microflora or by the addition of lactic acid bacteria (cultures). Fermented milk products were known to be more stable and advantageous than fresh milk. They preserve the high quality nutrients present in milks in a relatively stable form [4].

2. Materials and Methods

The following materials and apparatus were employed for this project; they include: *nunu,* Soya beans ,cheese, Oven, crucible, desiccator, copper sulphate, sodium sulphate, Potassium sulphate, Concentrated sulphuric acid, ammonia, digestion flask, distillation apparatus, sodium hydroxide, petroleum ether, hydrochloric acid, flat bottom flask, thermometer, weighing scale, beakers, acetone, pH meter, phenolphthalein and bromocresol blue.

2.1 Methods

Sample Collection

The '*nunu*' (1 L) each was obtained from Fulani women in Apo Abuja and Akwanlabu in Keffi Local Government Area of Nasarawa State respectively and kept in a clean container. The cheese (250 g) were purchased from well-known supermarkets in both metropolises while the soybeans (500g) were purchased from village market(Garki) in Abuja and from (Sowokasuwa) market in Keffi, these were kept properly for preparation.

Sample Preparation

The obtained *nunu* and cheese samples from the two different areas were labeled correctly and kept in a refrigerator at 4^{o}C under aseptic condition until they were used for analysis.

Production of Soya milk.

Soya milk was produced by modified method described by [5]. Soybeans (500 g) were soaked for 12 hours in a one and half litres of clean warm water. It was later blanched with 3 liters of water (65^{0}C) for about 5 minutes so as to inactive lipoxygenase and other anti-nutritional factors. The blanched beans were drained, dehulled and ground with 325 ml of portable water in a Q- link auto clean blender

(model-365 XG). The resulting slurry was filtered through a small diameter white cloth and the extract (milk) obtained was pasteurized at 80^0C for 25 minutes to destroy pathogenic microorganisms and then stored in a sterile container with cap in refrigerator after labeling. This method of preparation was used for both samples from Abuja and Keffi.

Physical Properties

Determination of pH

The pH was carried out using seven excellence pH meter (Mettler Toledo) with model 4.0.1 serial No B719086801.The pH meter was calibrated with reference standards buffers of pH 4.01, 7.00 and 10.01. The pH meter was powered and the electrode dipped into the solution of the standards followed by sample reading at ambient temperature and the values obtained were recorded for all the samples.

Determination of Total Titratable Acidity (TTA)

The titratable acidity was determined by the method described by [6]. The cheese (10g) sample was dissolved in 10ml of distilled water and mixed thoroughly, while 10ml of the milk samples were measured each and added 1ml of phenolphthalein indicator and mixed thoroughly. The solution was titrated against 0.1N standard sodium hydroxide solution until pink end-point color which lasted for about 10-15 seconds as an indication of complete neutralization. The titer values were recorded and the data were calculated for the total titratable acidity using equation 1.

$$TTA(\%) \frac{=N/10\ NaOH(ml)\times 0.009}{weight\ of\ milk\ sample} x\ \frac{100}{1} \quad (1)$$

Determination of Total Solids

The method described by [6] was used to determine the total solids. Total solid is the weight of dried sample residue. The samples (3 g) were weighed into a dry Petri dish of a known weight. The total portion was pre-dried for 25minutes on steam bath and then dried for 3hours at 105^0C in air oven. Recorded values were used to calculate percentage solid using equation 2.

$$\%\ Total\ Solid = \frac{W2-W}{W1-W} \times 100 \quad (2)$$

where: W = Weight of the dish

W_1= Weight of dish and sample portion

W_2 = Weight of dish and dried sample

Determination of Total Solids-Non-Fat

The total solids-non-fat was determined as described by [6]. This was obtained by taking the difference between percentage total Solids and percentage fat content of each of the samples. Calculation was done using equation 3.

% Solids-Not-Fat = % Total Solids - % Fat content (3)

Determination of Specific Gravity

Milk sample was sufficiently filled into a glass cylinder, then lactometer was held by the tip and inserted into the milk. The lactometer was allowed to float freely until it reached equilibrium. Then the lactometer reading at the lower meniscus was recorded. At the same time thermometer was inserted into the milk sample and the temperature of the milk recorded. This was repeated for all the samples. The specific gravity of the samples was calculated using the equation 4.

Specific gravity = L/1000) + 1 (4)

Where: L is the corrected lactometer reading at a given temperature, that is for every degree above 15.56^{0}C, 0.2 was added to the lactometer reading but for every degree below 15.56^{0}C, 0.2 was subtracted from the lactometer reading.

Proximate Analysis

Determination of Moisture Content**.**

The moisture content of the sample was determined using the method as outlined in [6]. It is the measure of percentage moisture lost due to drying at a temperature of 105^{0}C. The samples (2g) each was weighed (W1) into a pre-weighed crucible (W0) which was dried in hot drying oven at105^{0}C for 3 hours, then the crucible was removed, cooled in a desiccator and weighed. The process of drying, cooling and weighing was repeated until a constant weight (W2) is obtained. The weight loss was calculated using the equation 1 and all values were recorded for each sample.

$$\% \text{ moisture} = \frac{w1-w2}{w1-wo} \text{x } \frac{100}{1} \quad (5)$$

Where: W1 = Initial weight of the sample W2 = Weight of the dried sample W0= Weight of empty crucible.

Determination of Ash Content

The direct heating method as contain in [6] was used to determine the ash content. Each milk samples (10 g) was measured into a crucible of known weigh separately; the samples were burnt to ash in a muffle furnace for 5hours at 550^0C until all the organic matters are burnt leaving a white residue. They were cooled in a desiccator and the weights of the ashes were determined. All values were recorded. The % Ash content was calculated using equation 6.

$$\% \text{ Ash} = \frac{W2\_W0}{W1\_W0}. \times 100 \quad (6)$$

Where: W0 = weight of empty crucible

W_1 = Weight of milk sample + crucible W_2 = weight of ash + crucible

Determination of Protein Content

The macro Kjeldahl method as described by [6] was used to determine the crude protein content. The method is based on the principle of digestion, distillation and titration to calculate percent Nitrogen content of milk sample. 1ml of milk sample was introduced into the digestion flask. Potassiumsulphate (10 g), one tablet of sodium sulphate (catalyst) and 20ml of concentrated sulphuric acid were added to the digestion flask. The flask was placed on the digestion block in fume cupboard and subjected to heat until frothing ceases giving a clear solution. The mixture was allowed to cool and was diluted with 90ml of distilled water and 80ml of 40% sodium hydroxide was added plus few anti-bumping granules. The solution was allowed to boil. Then, 50ml of saturated boric acid was prepared and poured inside a 100ml beaker with the addition of 1ml of Bromocresol indicator and the boiling solution was distilled into the beaker until it reaches 100ml. Then, 50ml of the stirred solution was titrated with 0.1N HCl until a wine color appeared. The nitrogen in the sample was then determined. The percentage nitrogen of each sample was calculated using equation 7.

$$N\ (\%) = MHCl \times T \times 0.01401 \times 100 \quad (7)$$

Where: M= molar concentration of acid and T = titre value

% Crude protein = % Nitrogen × 6.25

Determination Fat Content

The Soxhlet solvent extraction method as described by [6] was used to determine the fat content. Each of the milksample (2 g) was weighed (W_0) into a porous thimble and covered with a clean white cotton wool. Petroleum ether (300 ml) was poured into an extraction flask, which was previously dried in the oven at 105^0C, cooled and weighed (W_2). The porous thimble was placed inside the Soxhlet and all apparatus assembled together. The extraction was done for 3hours. The thimble was removed carefully and the extraction flask placed in a hot water bath so as to evaporate the petroleum ether and then dried in an oven at a temperature of 105^0C to completely free the solvent and the moisture. It was cooled in a desiccator and reweighed (W_1). The percentage fat was calculated using equation 8. The same experimental procedure was repeated for all samples. All values were recorded.

$$\% \text{ Fat} = \frac{W_1 - W_2}{W_0} \times 100 \quad (8)$$

Where: W_0 = weight of Sample in gram W_1 = weight of flask + oil

W_2 = weight of the flask.

Determination of Crude Fibre Content

The crude fibre was determined using the procedure in [6] It was determined as the fraction remaining after digestion with standard sulphuric acid and sodium hydroxide under careful controlled condition. Five grams (5 g) each of the measured milk samples were used. The fibre sample was weighed into 500 ml prepared sulphuric acid solution. The mixture was boiled for 30 minutes, refluxed 3 times by boiling water and was followed by the addition of 100 ml prepared sodium hydroxide. The beaker was heated and the boiling was allowed to continue for another 30 minutes. Finally, the fibre was extracted and was dried by moistening with small portion of acetone which was allowed to drain. The sample in the crucible was incinerated at 550^0C for 3hours until all carbonaceous matter was burnt. The crucible containing the ash was cooled in the desiccator and the weight was taken. All values were recorded and the percentage crude fibre was calculated using equation 9 for all the samples.

$$\% \text{ Crude fibre} = \frac{W_1 - W_2}{W} \times \frac{100}{1} \quad (9)$$

Where: W = weight of sample used

W_1 = Weight of sample and crucible before ashing

W_2 = Weight of crucible and ash.

Determination of Carbohydrate Content

The carbohydrate content was determined by method of difference as described by [7]. This method was used for all the different samples. The values were calculated using equation 10.

CHO = 100 - % (ash + protein + fat +crude fibre + moisture) (10)

Results

The results of the physical properties and proximate contents of the milk samples are presented in Table 1 and 2 as seen below

Table 1: Physical Parameters of Milk Samples.

Samples	pH	SG (g/ml)	TTA (%)
X_I	6.70±0.00	1.018±0.00	0.02±0.01
Y_I	6.65± 0.01	1.016±0.00	0.05±0.04
Z_I	4.19±0.00	1.053±0.03	0.96±0.02
X_2	6.70±0.01	1.028±0.00	0.02±0.01
Y_2	6.60±0.01	1.017±0.02	0.06±0.02
Z_2	4.08±0.00	1.052±0.01	0.98±0.03

SG = specific gravity, TTA = Total titratable acidity
X_I Y_I Z_I represents soymilk, *nunu* and cheese from Abuja metropolis while X_2 Y_2 and Z_2 represent samples from Keffi metropolis.

Table 2: Proximate Composition of the Milk Samples (%)

Samples	Moisture	Ash	Protein	Fat	TS	TSN	Fibre	CHO
X_I	94.0±0.00	0.27±0.03	2.36±0.01	1.20±0.00	6.02±0.01	4.82±0.00	0.32±0.02	1.85
Y_I	91.0±0.00	0.58±0.04	1.95±0.01	4.25±0.02	8.85±0.02	4.60±0.00	0.02±0.00	2.20
Z_I	71.30±0.01	0.85±0.02	4.76±0.01	11.30±0.03	28.70±0.00	17.40±0.00	0.00±00	11.79
X_2	93.85±0.00	0.32±0.01	2.45±0.00	1.04±0.02	6.76±0.01	5.72±0.00	0.35±0.00	1.99
Y_2	89.50±0.00	0.65±0.02	2.53±0.03	3.79±0.03	10.35±0.04	6.56±0.00	0.03±0.14	3.50
Z_2	75.41±0.02	0.32±0.01	3.95±0.02	9.98±0.01	24.59±0.02	14.61±0.00	0.00±00	9.98

TS = Total Solid, TSN = Total solid non – fat, CHO = Carbohydrate

Discussion

The pH of the milk samples are presented in Table 1. The pH of samples X_1, Y_1 and Z_1 were found to be 6.70±0.00, 6.65 ±0.01 and 4.19±0.00 respectively while samples X_2, Y_2 and Z_2 gave 6.70, 6.60 and 4.08 respectively. Milk pH gives an indication of milk hygiene and determines sample acidity and alkalinity. Sample X_1 and X_2 have the highest pH value 6.7±0.00 showing that it is less acidic and this will be good for people that have stomach ulcers. The value obtained for soya milk (X_1 and X_2) in this study was higher than the reported value of 6.40 ± 0.02 by [8] seen in the analysis of fermented milk from different milk samples. This could be due to variety of soya beans used in the study. There was no much difference in the pH of Y_1 and Y_2. The average pH value for Y samples (6.63± 0.01) was within the range of 6.60 to 6.80 as reported by [9];[10].The pH value for samples Z_1 and Z_2 (4.19 ±0.00, 4.08±0.00) was lower, which could be due to longer storage and the action of lactic acid bacteria (bacteria growth) which causes acidity increase. The pH value for Z samples in this study however correlates with the value 4.30 obtained by [11] for cheese.

Specific gravity is done basically to determine the volume equivalent to lg of each milk sample so as to establish the volume corresponding to mass required when subjected to proximate analysis [12]. There was no much differences among the specific gravity of samples X_1 and X_2 , Y_1 and Y_2 and Z_1 and Z_2 (Table 1). The specific gravity obtained in this study for X and Y samples were within the range of 1.027 g/ml to 1.035g/ml as reported by [13] except for samples Z with value (1.051 ± 0.03g/ml). This value however agrees with that reported by [14]; [9] on who stated that addition of

solids such as sugar and flour into milk increases the specific gravity of milk beyond the value of 1.035g/ml.

Total titratable acidity of the samples are 0.02±0.02%, 0.05±0.04% and 0.96±0.01% for X, Y and Z respectively (Table 1). The total titratable acidity for Y_1 *and* Y_2(0.05±0.04%) was in agreement with the result obtained by [15], who reported range value of 0.06% to 0.08% for their work from the sample consumed within Kaduna in Nigeria. The low acidity of the X samples could be due to inhibition of microbial organisms through heating after their preparation. There was high acidity on sample Z_2(0.98±0.03) compared to X_2 (0.02±0.01) and this could be that the microorganism utilized the lactose in cow milk to release more lactic acid which probably results to higher acidity [16].

The result of the proximate analysis is presented in Table 2. The moisture content of sample X_1 (94.0±0.00 %) was the highest followed by X_2 (91.0±0.00 %). Samples Y moisture content were also high. The high moisture content of sample X and Y could be as a result of addition of water during their blending and preparation methods respectively. This could affect their stability and safety with respect to microbial growth hence, they will require cold storage. The moisture content of sample X from different areas for this study was in conformity with the report of [17] who stated that about 92.75% of soya milk is water and will require short storage stability. The percentage moisture of Z_1 (71.30±0.05%) was lower than sample Z_2 (75.41±0.02) but it agreed with the work reported by [18] who reported moisture content 67% and 79% for soft cheese. The lower percentage moisture could be due to moisture lost during draining of whey. Also the lactic acid bacteria causes the protein in the curd to contract and squeeze out moisture in the process called syneresis [19].

The fat content in this study showed that cheese was the highest in fat (11.30± 0.3%) and (9.98±0.01 %) for Z_1 and Z_2 respectively. Samples Y_1 and Y_2 gave (4.25 ± 0.02%) and (3.79±0.03 %) in Table 2.The fat content of Y samples was within the range for fat (2.5% to 6.0%) as reported by [9]. The sample Y_2 value for this work was the same with the findings (3.79%) of [20] but lower than the reported value (6.54%) of [15]. This difference between the Y samples from Abuja and Keffi could be as a result of difference in the milking condition of the cows. Sample X_1 fat content of this study (1.20 ± 0.00%) was lower than the findings of [21] at a value of 2.82±0.22% fat for soya milk. The difference could be from processing condition during heating because heat helps in extraction of oil hence the amount of heat applied and the duration time could affect fat composition [22]. The fat content of cheese as reported by [23] showed the range of 16-30% and this value however is higher than the present study of both Z_1 and Z_2 samples (11.30 ± 0.03,9.98±0.01)% but in agreement with

the findings of [24] who reported 11.02% fat content for cheese. Total fat intake may influence some of the major risk factors for coronary heart disease, particularly through its impact on obesity and type II diabetes. Recent studies have shown that a high fat meal increases vaso-activity and endothelial function [25]. People can reduce the intake of animal fat by consuming soymilk.

The protein content of the samples X_1 and X_2 were 2.36±0.01,2.45±0.00%, Y_1 and $Y_2$1.95± 0.01, 2.53±0.03% and Z_1 and $Z_2$4.76± 0.01, 3.95±0.02% respectively. The protein content of X samples from both Abuja and Keffi were higher than that of samples Y. The value for this work was in agreement with the findings of [21] who reported a value of 2.58± 0.00% for protein in soymilk blends. The high protein content in sample X_2 could be due to higher protein in soybean variety used in soya milk production purchased from Keffi. [26] reported high protein content (4.9% to 5.55 %) in sample X. Sample Y_2 has lower protein than sample Y_1. The low protein content in sample Y_1 could be due to the type of breed of cow, feed and lactation stage. The result of this study for (1.95± 0.01%) was lower than the findings of [15] who reported (2.73%) of protein in the sample. Samples Z had a higher protein contents (4.76± 0.01, 3.95±0.02)% but sample Z_1 protein content was higher. This could be due to the type of milk used in cheese making and other added contents. But caution should be exercised in taking this product because its fat content was high (11.30 ±0.03%). From this study, it showed that samples X contains appreciable amount of protein sufficient for body growth and development. Its consumption will help eliminate protein deficiency in the developing nations and can serve as a good substitute for cow's milk consumption.

The ash content which is a reflection of the mineral compositions was found to be present in all the samples analyzed. The percentage ash content of the products were$X_1$0.27±0.31%,X_2 0.32±0.01, $Y_1$0.58±0.04%,Y_2 0.65±0.02 and $Z_1$0.85±0.14%, $Z_2$0.68±0.05 for soya milk, *nunu* and cheese from Abuja and Keffi respectively as presented in Table 2. The highest percentage ash (0.85±0.14%) was found in Z when compared with the other samples, and this value agrees with that reported by [24] for cottage cheese. This high ash content could be due to added nutrients and minerals in the cheese. The ash content of sample Y_1 for this study (0.58%) was higher than (0.37% and 0.436%) as reported by Ibrahim *et al.*, (2014), and [15] respectively. However,Y_2 value was the same as the value of 0.7% to 0.8% as reported by [9]. This difference in the samples could be influenced by breed, feed and stage of lactation, even experimental error. Samples X percentage ash for this study (0.27 and 0.32)% was lower than the findings of [21] who reported the value of 0.72 %. This difference could be due to poor soil nutrient and growing conditions of the soya beans.

Total solids values for samples X_1 and X_2(6.02±0.01, 6.76±0.01)%, samples Y_1 and Y_2 (8.85 ± 0.02,10.35±0.04)% and samples Z_1 and Z_2 (28.70± 0.00, 24.59±0.02)% are presented in Table 2. [27] analysis showed that sample X contained about 6%total solids and this value corresponds to the work of this present study. The percentage total solid content for Y samples was higher than that reported by [15] at the value of 7.68 %. Sample Y_1 was lower than Y_2 and this could be as a result poor grazing condition of cows in that area. The high percentage total solid in samples Z (28.70 ± 0.02 %) as found in this work could be due to less water content and increased milk cheese components. The total solid content was due to high fat contents. The value for this work is higher than the reported value of 21.24% to 25.35 % by [28]. These variations could be due to difference in breed, vegetation, soil nutrient, feeding and management practices which effects milk composition and quality [9].

The total solids non- fat for the milk samples were X_1 and X_2(4.82±0.00 and 5.72±0.00)%, Y_1 and Y_2(4.60±0.00 and 6.56)% Z_1 and Z_2(28.70 and 24.59)% for soya milk, *nunu* and cheese respectively (Table 2). The high total solid non-fat in sample Z could be due to high fat content of this sample. The sample Z_1 from Abuja is 3b% higher than sample $Z_2$from Keffi in total solid non- fat content. There is also difference in the total solid non-fat content of sample X and Y. The solid non-fat for Y samples (4.60 and 6.56) was less than the findings of [29] and [30] who reported higher value of 8.7% and 9.10% respectively. This difference could be from the feeding practices, season, milking method and lactation period of cows used [31].

Crude fibre was not found in Z samples (0.00%) while the crude fibre found in Y samples was a trace (Table 2). This result was in agreement with the report of [32] who reported (0.00%) fibre in cow milk cheese. Samples X gave a crude fibre value of (0.32& 0.35%) and this was in agreement with the findings of [21]. The percentage fibre content found in samples X is a big plus for plant proteins.

Carbohydrate was calculated by percentage difference. All the sample products have carbohydrate values as presented in Table 4.2. SamplesX_1 and X_2 gave 1.85 and 1.99, Y_1 and Y_2 gave 2.20 and 3.50 while Z_1 and Z_2 gave 11.79 and 9.98. The high carbohydrate content of samples Z could be due to its low moisture value and zero fiber. The low lactose value in samples X and Y could be due to their high moisture value. This difference could also be due to differences arising from milk compositions, animal species and plant origin.

Conclusion

For a man to live a healthy and active life, a wide range of nutrients are required. The required body nutrient can only be obtained from a balanced diet. The physical and chemical composition of milk products in Abuja and Keffi metropolises were studied. The result obtained showed that soya milk, *nunu* and cheese have protein content of 2.36%, 1.95% and 4.76% respectively from Abuja metropolis (X_1, Y_1 and Z_1) while the same parameters from Keffi gave values 2.45%, 2.53% and 3.95%(X_2, Y_2 and Z_2). It was concluded that the samples from Abuja and Keffi will provide good nutrients to the body. Soya milk (sample X) is one of the good sources of high quality protein that can help in solving malnutrition problem in Nigeria. It is also commercially available and cheaper than the expensive animal milk product. Cheese (Y) has a high fat content which might not be good for people with heart disease. Fiber was found in sample X and this gave it a big plus.

The percentage moisture difference in Sample Y could be attributed to the difference in environmental temperature and atmospheric humidity in Keffi, Nasarawa State.

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