PROXIMATE ANALYSIS AND THE DETERMINATION OF SOME PHYSICO-CHEMICAL CHARACTERISTICS OF COMMON EVAPORATED MILKS

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Abstract

Proximate compositions and physico-chemical characteristics of different brands of evaporated milks in Nigeria were determined using standard methods. The moisture content ranged between 68.85 % and 71.86 %, the ash content 1.32 %-1.96 %, the fat content 7.52 %-8.83 %, the percentage protein 7.65 %-11.42 % and the percentage carbohydrate 7.67 %-11.34 %. Acidity levels (0.50-0.72 %) of all the samples were above the 0.45 % lactic acid minimum literature value, while the energy value ranged between 602.80 KJ/100 g and 676.45 KJ/100 g. The milk samples were also analyzed for some important minerals, viz:- Zn, Fe, Mg, and Ca using Graphite Furnace Atomic Absorption Spectroscopy (FAAS). The levels of these elements were; Zn (4.15-17.85 μg/g); Fe (0.14-1.42 μg/g); Mg (296.00-371.50 μg/g) and Ca (1165.00-1335.50 μg/g). With few exceptions, the results obtained show good agreement with literature values and provide information on the nutritional value of some of the common evaporated milks sold on Nigerian markets.

Keywords: Milk, proximate analysis, physico-chemical, AAS

1. Introduction

Mammals secrete milk from mammary glands to supply nutrition to their young ones. Milk is unique, nutritious and is a source of water, proteins, lipids, carbohydrates and minerals which are natural sources of energy and many essential and beneficial nutrients needed for various morphological processes. Besides these nutrients, milk also contains compounds such as conjugated linoleic acid (CLA) and butyric acid that have been established to be anti-carcinogenic (Back, 1999; Alais and Linden, 1991). About 22 minerals considered to be essential to the human diet are present in milk (FAO/WHO, 1973) and calcium accounts for the highest level of these minerals (Back, 1999). In many western countries milk and dairy products contribute between 50 and 60 % of average calcium intake in a form that is readily utilized (Harding, 1995). Not only is milk a readily usable source of calcium, it is believed that it may also enhance the bioavailabity of calcium from other food sources (Harding, 1995).

Similar to honey, milk is an article of diet whose major function in nature is food (Goff, 1995). The consumption statistics show that about 94 % of the world milk supply is utilized as processed milk or milk products (Harding, 1995).

Considerable attention is paid to obtaining the best possible quality of milk by improving the yield, composition and hygienic quality, and minimizing the level of contaminants at all stages of milk or milk products production. With the rise in level of nutritional awareness among the population, milk consumption, particularly at breakfast, is increasing at a fast rate among the Nigerian population.

As in other countries, milks that are sold on Nigerian markets are of different brands and from different sources. It is important to be sure of the nutritional quality of these products which are relied on for providing energy as well as essential mineral nutrients for the human population. This informs our decision to determine the compositional quality of common evaporated milks sold in Nigerian markets.

2. Materials and Methods

(a) Sample collection and preparation

Samples of five different brands of evaporated milk were bought at a major market located at Ile-Ife, Southwestern Nigeria in April 2005. The samples were stored in a cool dry place before analysis. They were prepared for analysis using the Association of Official Analytical Chemists method, AOAC, (1990). Prior to the analysis, the unopened can was tempered in water bath at approximately 60 ^{0}C for 2 hours, for homogenization. The can was removed from the water bath and shaken vigorously every 15 minutes. It was then allowed to cool to room temperature. The entire lid was removed and the content was stirred with a glass rod.

(b) Analysis of Samples

(i) Proximate Analysis

The typical composition of each sample was analyzed using AOAC recommended methods. Percentage Moisture, % Fat, % Ash, % Protein and % Carbohydrate were determined in each sample following the Association of Official Analytical Chemists methods (AOAC, 1990).

(ii) Physico-Chemical Parameters

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The physico-chemical parameters determined in the milk samples include elemental composition, acidity and the energy value.

(iii) Acidity

20 ml of the sample was put into a conical flask and diluted with twice its volume of CO_2 – free H_2O. 2 ml of phenolphthalein indicator was added and the mixture titrated with standard 0.1 M NaOH to first persistent pink colour end point (James, 1995). The acidity was calculated using the following formula.

Titratable acidity (% lactic acid) = volume of NaOH used/ volume of milk sample taken for titration.

(iv) Energy Value

The energy value of each sample was estimated by calculation following the proximate analysis and making use of energy values which take into account losses of energy resulting from incomplete digestion (James, 1995).

$$Energy\ value(KJ/100g) = \left[\begin{matrix}(\%\ available\ carbohydrates\ x17)\\ +(\%\ protein\ x17)+(\%\ fat\ x37)\end{matrix}\right]$$

(v) Elemental Composition

1 ml of milk sample was digested with 20 ml of conc. HNO_3 until brown fumes of Nitrogen dioxide disappeared. After cooling, 10 ml of 70 % perchloric acid was added and the solution was heated to give a clear light green solution. The clear solution was transferred into a 50 ml standard flask and was made up to mark with double distilled water (IAEA, 1997). Levels of Zn, Mg, Fe, and Ca were determined in the digested milk samples using Graphite Furnace Atomic Absorption Spectroscopy (FAAS) technique at the Center for Energy Research and Development (CERD), Obafemi Awolowo University, Ile-Ife, Nigeria. The instrument was operated as contained in the instrument's hand book while calibration was done using mixed calibration standard solution prepared from the pure BDH Analar grade salt of each metal. The analytical quality control includes pre-treatment of the glassware used such as measuring cylinders, crucibles, volumetric flasks, sample bottles, pyrex beakers and pipettes etc. These were thoroughly washed with warm detergent solution and rinsed well with distilled water followed by drying in an oven at 100 °C. In all the analyses blank determinations were also made where required following the same procedures for original samples. All the organic solvents used were double distilled and all the reagents used were BDH Analar grade.

3. Results and Discussion

(a) Proximate Analysis

The results of the proximate analysis are as shown in Table 1. The moisture content of the samples ranged from 68.85 to 71.86 %. Milk brand 5 has the least water content while milk brand 3 contains the highest moisture content. The implication of low moisture content milk is that there is reduction of water activity which affects microbial growth and the predominant microbial culture, therefore shelf life is increased due to reduced availability of water for microbial growth (Christian, 1981). The results obtained to a large extent are consistent with the production and expiry dates on the milk cans, with brand 5 having one and half years shelf life as compared to brand 3 which has only one year shelf life.

Brand 1 is richer in mineral ash (1.96 %) than all the other evaporated milks followed by brand 2 (1.87 %) while brand 5 has the least mineral content (1.32 %). The ash level shows the level of enrichment of various samples with minerals.

Brand 1 is the richest in fat (8.83 %) followed by brand 2 (8.67 %) and brand 3 has the lowest fat content (7.52 %). Low fat content of brand 3 compared to other samples is worthy of note and this is probably due to the fact that it is made from skimmed milk (0.1 %-0.5 % fat) and the milk fat is upgraded with vegetable oil. It is interesting to note that while brand 1 has the highest fat and carbohydrate contents, it has the least protein content. Brand 3 is the richest in protein (11.42 %) even though it has the least carbohydrate content (7.67 %).

The results obtained for the proximate analysis are to a large extent in agreement with literature values which is an indication of the quality of the Nigerian milk brands. It is however noted that while previous studies in the literature placed emphasis on the minimum value for fat (7.50 %) and maximum value (75.00 %) for the moisture content in whole evaporated milk, they are silent on the minimum and maximum values for protein and carbohydrate contents (Vanste Inc, 2003; Wong, 1998; Fox, 1997; Harding, 1995, Goff, 1995). This could be responsible for the variation in the protein and carbohydrate contents of the various brands of evaporated milks. Consistency with 25.00 % minimum literature value for total solids is also noted for all the samples.

(b) Physico-chemical parameters

The results of the acidity and energy values for the various milk brands are as shown below in Table 2 while Table 3 shows their elemental composition. Acidity of the milk samples varies from 0.50 to 0.72

Table 1: Proximate composition of common brands of evaporated milks sold on Nigerian markets

Parameter (% ± Sd)	Brand 1	Brand 2	Brand 3	Brand 4	Brand 5	Literature values
Moisture	70.22 (0.18)	71.50 (0.14)	71.86 (0.08)	69.56 (0.01)	68.85 (0.04)	69.30 – 75.00
Ash	1.96 (0.04)	1.87 (0.06)	1.53 (0.05)	1.69 (0.13)	1.32 (0.11)	1.50
Fat	8.83 (0.52)	8.67 (1.08)	7.52 (0.21)	8.52 (0.08)	8.47 (0.48)	7.50 – 9.00
Protein	7.65 (0.04)	8.84 (0.04)	11.42 (0.08)	9.35 (0.04)	11.07 (0.06)	6.50 – 8.20
Carbohydrate	11.34 (0.66)	9.12 (0.95)	7.67 (0.12)	10.90 (0.06)	10.29 (0.33)	9.50 – 12.00
Production Date	04/05	02/05	03/05	08/04	09/04	
Expiry Date	04/06	08/06	03/06	02/06	03/06	

Sources of literature values: (Fox, 1997; Harding, 1995; Wong, 1998; Vanste Inc, 2003; Goff, 1995)

Table 2: Acidity levels and energy values of common brands of evaporated milks sold on Nigerian markets

Parameters	Brand 1	Brand 2	Brand 3	Brand 4	Brand 5	Literature values
Acidity (% lactic acid)	0.50	0.53	0.66	0.68	0.72	0.45 minimum
Energy KJ/100 g	649.54	626.18	602.80	659.41	676.54	549.5-676.4

Sources of literature values :(Fox, 1997; Harding 1995; Wong, 1998, Vanste Inc, 2003)

Table 3: Elemental composition of common brands of evaporated milks sold on Nigerian markets (µg/g ± S.D)

Element	Brand 1	Brand 2	Brand 3	Brand 4	Brand 5	Literature values
Zn	4.15 (0.06)	17.85 (0.01)	16.65 (0.001)	6.10 (0.002)	7.55 (0.005)	7.70-10.00
Fe	1.03 (0.11)	0.97 (0.27)	0.45 (0.02)	1.42 (0.01)	0.14 (0.00)	1.90-2.00
Mg	313.50 (0.001)	336.50 (0.013)	297.00 (0.01)	371.50 (0.003)	297.00 (0.003)	240-300
Ca	1335.50 (0.21)	1183.50 (0.14)	1300.00 (0.02)	1165.00 (0.02)	1210.00 (0.01)	2610-3100

Sources of literature values: (Harding, 1995; Wong, 1998).

% which are all above the minimum value (0.45 %) specified in the literature (Goff, 1995). The high acidity values for brands 3, 4 and 5 could be due to their high protein content since caseins and whey proteins are the major contributors of acidity in milk (Goff, 1995).

It is interesting to note that although brand 5 does not have the highest proportion of any of the food constituents; it supplies the highest energy value (674.54 KJ/100 g). The high energy level of this milk is due to even distribution of fat, carbohydrate and protein contents in it. Brand 3 supplies the least energy and this is justifiable since it has the least fat and carbohydrate contents which are the major sources of energy.

The results show that the concentrations of the elements ranged as follows; Zn (4.15-17.85 μg/g); Fe (0.14-1.42 μg/g); Mg (297.00-371.50 μg/g) and Ca (1165.00-1335.00 μg/g). Calcium and Mg exist as major elements in all the milk samples while Zn and Fe are found as trace elements as expected. The calcium content is lower than what is recommended in the literature (2610-3100 μg/g). Mg content in all the samples fairly agrees with the literature values (240-300 μg/g). The values of Fe in all the samples are lower than the literature values (1.90-2.00 μg/g). This implies that the samples need to be more fortified with Fe. Zinc values (17.85 μg/g) and (16.65 μg/g) are highest for milk brands 2 and 3 respectively which are higher than literature values (7.70 – 10.00 μg/g), while brands 1 and 5 gave 4.15 μg/g and 7.55 μg/g concentrations respectively.

The results show that brand 1 has the highest concentration of Ca, which function in the formation of bones and teeth (Back, 1999). Milk brand 4 has the highest Mg content (371.50 μg/g) that is responsible for protein synthesis and mineral balance in human beings. It also has the highest Fe content (1.42 μg/g), which is responsible for heamoglobin formation (Cook, 1983). Milk brands 2 and 3 are good sources of Zn (17.85 and 16.65 μg/g) respectively. Zn has been discovered to be part of insulin and enzymes. It aids protein digestion and contributes to immunity in man (Wordstron, 1982).

This work shows that brand 3 evaporated milk has the lowest fat composition and could be the milk of choice for consumers watching their weight. It could serve as a good choice in the absence of skimmed milk. Evaporated milks richer in fat like brands 1 and 2 evaporated milks are recommended for children since it has been recorded that infants fed on low fat milks develop eczema and skin lesions (Sharp, 1981). Brand 1 which has the highest ash, fat and carbohydrate contents is good for consumers desiring optimal level of these while brand 4 seems to have even distribution of all the food constituents and would be good for all consumers. Milk brand 5 however supplies the highest energy value and can be depended on for maximum energy intake even though there has to be mineral supplements from other sources. All the samples are good sources of Ca and could be recommended for people suffering from osteoporosis and children suffering from rickets (Back, 1999). Also, all the evaporated milk samples can be depended upon for Mg and if taken regularly can prevent severe diarrhea, chronic renal failure, and protein-calorie malnutrition which are all symptoms arising from deficiency of Magnesium (WHO, 1973). Milk brands 2 and 3 are better sources of Zinc and may be recommended for pregnant women since Zn is known to be essential for normal embryogenesis and for growth in infants (Apgar, 1972), while brands 1 and 4 are better sources of Fe, which is an essential part of heamoglobin, which carries oxygen in blood (Cook, 1983).

4. Conclusion

This preliminary study has demonstrated that evaporated milks in Nigeria are of good quality with proximate and physico-chemical composition agreeing with literature values. However, it would be interesting to carry out a detailed trace element characterization of the different brands for information on their essential/toxic trace element composition.

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