International Food Research Journal 22(6): 2634-2636 (2015)
Journal homepage: *http://www.ifrj.upm.edu.my*

Assessment of some mineral elements in different brands of powdered milk sold in Samaru Zaria, Nigeria

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Article history

Received: 19 December 2014
Received in revised form: 15 April 2015
Accepted: 3 May 2015

Keywords

Milk powder
Mineral elements
A.A.S
RDA
Samaru-Zaria

Abstract

Powdered milk products contain important nutrient elements and are mostly consumed in developing countries. Good quality control is very essential in the production and processing of powdered milk products, also transportation and storage conditions might have effects on the composition of these products. The deficiency or excess of any of the mineral elements in powdered milk may create significant health problems for the consumer. In this study, the concentration levels of some mineral elements in different brands of powdered milk sold in Samaru market Zaria Nigeria were determined using Atomic Absorption Spectroscopy (A.A.S). The average concentrations of Ca, Mg, Fe, Cu, Zn and Mn in the five brands of powdered milk studied were 12183.16, 986.70, 108.88, 5.92, 42.97, and 8.44 mg/kg respectively. These concentrations of Ca, Mg, Fe, Cu, Zn and Mn contribute about 38, 9, 20, 13, 9 and 10% respectively to the recommended dietary allowance (RDA) per serving (25 g of powdered milk).

Introduction

Commercial production of dried milk dates back to 1832 and was pioneered by Russian chemist M. Dirchoff (Hunziker, 1920). Since then, powdered milk has been produced using different techniques. The production method and stages employed makes the whole milk susceptible to contamination and/or having the required essential element. Most of the powdered milk available in the market is produced from cow's milk. However, the breed of cow and its environment, method of manufacture and storage, all combined, affect the quality and quantity of essential and trace elements present (Salah *et al.*, 2013).

Whole milk powder contains on average 25-27% protein, 37-38% carbohydrates, 25-28% fat, and 6-7% (ash) minerals (Tamime, 2009). Essential elements in powdered milk are sodium, potassium, calcium, phosphorus and magnesium. Metals present in milk powder which are well below 50 mg/kg can be referred to as trace metals. These metals have some nutritional and/or toxicological significance. For instance, iron, copper and zinc are found to be necessary in certain quantities in food. These elements can cause ill effect when consumed at higher levels. Moreover, metals such as lead, cadmium, mercury and arsenic are found to be toxic even at low levels of 10-50 mg/kg (WHO, 1996). A recent review on the sources and deficiency diseases of mineral nutrients in human health and nutrition can be found in Gupta and Gupta (2014).

Powdered milk is widely consumed in many developing countries such as Nigeria. In fact, most of the tea served during breakfast in Nigeria consists of two to three table spoon of powdered milk. Moreover, milk is frequently used in the manufacture of infant formula, recipes for baked products, beverages and confectionary. However, storage conditions and high temperature can degrade the nutritive value of milk powder. Hence, there is the need to periodically asses the levels of both essential and trace mineral elements in powdered milk for both food safety and nutritional considerations. As such, in this study, we determined the levels of some essential and trace elements in five different brands of powdered milk sold in Samaru Zaria, Nigeria.

Materials and Methods

Reagents and solutions

All reagents used were of analytical grade. Deionised water was used for the preparation of all solutions. All glasswares were initially washed with detergent and water, and then rinsed several times with deionized water and dried.

Sampling

Three samples each of the five brands of whole milk powder were purchased from the local market in Samaru Zaria. The samples were labeled as brands 1-5 and taken to the laboratory for analysis.

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Table 1. Mineral elements composition of the powdered milk samples (mg/ kg)

MINERAL ELEMENTS (mg/ kg)*						
Sample	Ca	Mg	Fe	Cu	Zn	Mn
Brand 1	9,575	953	161	5.60	38.86	2.30
Brand 2	11,719	1040	71	5.30	41.63	9.30
Brand 3	12,157	923	88	5.40	33.84	8.30
Brand 4	15,308	1078	143	6.20	34.72	10.70
Brand 5	12,157	939	82	7.10	65.79	11.60
Mean ± SD	12,183 ± 2,048	987 ± 68	109 ± 40	5.92 ± 0.75	42.97 ±13	8.44 ± 3.66

*Values are mean of triplicate analysis
SD = standard deviation

Atomic absorption spectroscopy

Hydrogen peroxide, Percholoric acid and Nitric acid were used for digestion. 0.5 g of powdered sample was weighed into Pyrex glass beakers and 20 ml analytical grade HNO_3, 5 ml $HClO_4$ and 1 ml H_2O_2 added. The digestion was achieved as described by Jolanta *et al*. (1996). The completely digested samples were allowed to cool to room temperature and the volume made up to 50 ml with de-ionized water. The digested samples were analyzed in triplicate, using a flame atomic absorption spectrophotometer (VARIAN 240FS, Sweden). Stock solutions, 1000 mg/l each of Ca, Mg, Fe, Cu, Zn and Mn purchased from Sigma-Aldrich were used for AAS analysis. Calibration standard for each element was prepared using these stock solutions by employing serial dilution technique. The mineral element composition in each sample was deduced from the calibration curves. For each sample three determinations were performed and average results were reported.

Results and Discussion

The results of the mineral element composition of the different brands of powdered milk studied are summarized in Table 1. The calculated mineral elements in each brand of powdered milk sample per serving (25 g of powdered milk) and the recommended daily allowance (RDA) for adult of each mineral element is summarized in Table 2. The calcium content in all the samples is within the range of 9,000-15,000 mg/kg. Calcium plays a huge role in maintaining bone and preventing osteoporosis. It is also crucial in nerve function, muscle contraction and blood clotting (Passmore and Eastwood, 1986). Akpanyung (2006) reported an average concentration of 11,108 mg/kg in powdered milk samples purchased from local markets in Nigeria. Compared with our study, this falls within the same range of calcium content in the samples but less than the average by 1000 mg/kg. Thus, powdered milk is a rich source of calcium.

The concentration levels of magnesium in the different brands were within the range 920-1000 mg/ kg. This is in agreement with the values of 919.80 ppm and 1000 mg/kg reported by Semaghiul *et al.* (2008) and Akpanyung (2006) respectively. The Fe concentration of brand 1 (161 mg/kg) is twice the concentration of brand 2 (71.10 mg/kg), brand 3 (87.70 mg/kg) and brand 5 (81.50 mg/kg). The mean Fe content in this study is significantly higher than that reported by Semaghiul *et al.* (2008) (21.73 ppm), Salah *et al*. (2013) (20.41 ppm) and Perween *et al.* (2011) (4.33 mg/l). This is probably due to the fortification of the powdered milk.

Copper content in this study was within the range of 5.3-7.1 mg/kg. This is slightly higher than that reported by Akpanyung (2006) (3.9 mg/kg). Zinc concentration ranged between 33.84 and 65.79 mg/ kg which are significantly lower than the mean Zn content reported by Akpanyung (2006) (126.1mg/ kg). But it is significantly higher than that reported by Semaghiul *et al*. (2008) (3.24 ppm). However, the manganese content (2.30-11.60 mg/kg) in this study was similar to those reported by Akpanyung (2006) (7.8 mg/kg) but higher than that reported by Salah *et al*. (2013) (0.50 ppm).

Comparing the mineral elements analyzed with those written on the packages we observed that not all the brands have all the mineral elements under investigation written on their package. However, the calcium content is well indicated and the values we obtain in all the samples are above those written on the package except brand 1 (9,300 mg/kg) which have almost the same value of 9,575 mg/kg as reported.

An average Nigerian does not consume 100g of powdered milk at any particular instant in a day (Akpanyung, 2006). Rather about three (3) teaspoons of milk (approx. 25 g) are added to a cup of beverage before drinking (Akpanyung, 2006). Thus, the mineral element composition per 25 g of the powdered milk samples was calculated and is shown in Table 2. These result indicated that the average concentration of calcium and magnesium in

Table 2. Calculated mineral elements in each powdered milk sample per serving (25 g of powdered milk) compared with recommended daily allowance (RDA) for adult

Element	Powdered Milk Samples (mg/25g)					RDA[a] (mg)
	Brand 1	Brand 2	Brand 3	Brand 4	Brand 5	
Ca	304.58	292.97	311.79	382.69	303.94	800 - 1,200
Mg	23.84	26.00	23.07	26.94	23.49	270 - 400
Fe	4.03	1.78	2.19	3.58	2.04	15
Cu	0.14	0.13	0.14	0.16	0.18	1.5 - 3.0
Zn	0.97	1.04	0.85	0.87	1.64	12 - 15
Mn	0.06	0.23	0.21	0.27	0.29	2 - 5

[a] FNB, 1989

the different brands were 11,183 and 986.70 mg/kg respectively. These concentrations gave a daily intake of about 304.58 and 24.67 mg/serving respectively and these quantities representing 38.07 and 9.14 % of the acceptable daily intake recommended by Food and Nutrition Board America.

Likewise, the average concentration of Fe, Cu, Zn and Mn were 109, 6, 43, and 8 mg/kg respectively. These concentrations supplied a daily intake of about 3, 0.2, 1.1 and 0.2 mg/serving respectively and these quantities representing 20, 13, 9 and 10 % of acceptable daily intake recommended by Food and Nutrition Board America.

From these results it could be concluded that if a person considers powdered milk as his/her only source of calcium in a day, it means the person needs to take 3 to 4 glass of milk per day. Mg, Fe, Cu, Zn and Mn were in very insufficient amount in the milk samples studied so one should consider other sources of these elements to achieve the recommended daily intake per day. However, fresh cow milk contains 13 mg of magnesium per 100 g of milk (Kataoka *et al*., 1991). This corresponds to about 94 mg per 100 g in the powdered milk samples under investigation representing about 35% (per 100 g) of RDA. Thus, it is a remarkable contribution to the RDA for magnesium which is 270 – 400 mg for adults (FNB, 1989). This increase in Mg can be attributed to the fortification of powdered milk with trace elements that is mostly practiced by the manufacturers.

Conclusion

The concentrations of mineral elements; Ca, Mg, Fe, Cu, Zn and Mn in different brands of powdered milk sold in Samaru Zaria Nigeria were successfully determined by Atomic Absorption Spectroscopy. The products were found to be rich in calcium. On the other hand, magnesium, copper, zinc and manganese were in trace amount. Extensive benefit will be derived from these products if one consumes 100g of powdered milk per day (which is equivalent to 4 glass of milk per day).

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