Determination of levels of heavy metals (arsenic, lead, cadmium and mercury) in tin milk produced in Ghana.

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ABSTRACT

Analysis of milk samples indicated their contamination by some heavy metals residues, exhibiting a wide array of hazardous impacts on human health. It can be observed that levels of mercury in milk is higher, followed by levels of lead, Arsenic, and cadmium. The statistical analysis of obtained data revealed that all examined milk samples having Pb, Cd, As and Hg levels above the recommended permissible limit.

Keywords : Milk, Lead, Mercury, Arsenic, Cadmium, Health hazards, Metals.

1 Introduction

This metal provides a role in the development and maintenance of the cardiovascular system (including the heart, arteries and other blood vessels), the skeletal system and structure and formation of the nervous system (including the brain). Copper is a critical functional component of a number of essential enzymes (cuproenzyme).

These play a critical role in cellular energy production and formation of strong and flexible connective tissues. Copper is also involved in respiration and the synthesis of hemoglobin.

The metals present in milk are as a result of exposure of the cow to certain factors like eating grass contaminated with the metals, drinking water from contaminated sources and even dust that settles on the grass that he cows consume. Levels of the metal in the milk depend on the level of exposure of the cow to the contaminated site. Lead may also affect brain function by some metals found in milk include copper, zinc, lead, and iron interfering with neurotransmitter release and synapse formation.1 Lead is known to damage the kidney, liver and reproductive system, basic cellular processes and brain function4. Known as one of the ubiquitous harmful metals, lead is found usually in very low levels in milk and dairy products, except when animals have consumed contaminated feed.2 Milk contains both essential and nonessential trace elements. Lead is nonessential, potentially toxic heavy metal even at very low concentrations.3 Concentration of lead in milk is a matter of special concern because in Turkey cow milk is one of the major dietary constituents for infants from the fourth-sixth month of life onwards.

For public health, the concentrations of Pb in milk need to be monitored. In Turkey, milk is consumed both raw and in pasteurized products in large quantities, and it is important that contaminant levels remain low to minimize exposure. The most commonly used methods for Pb determination in milk and in milk products, among which at least 100 of them are produced by the International Dairy Federation, IDF. Falomir et al., determine lead in human milk by electro thermal atomic absorption spectrometry directly. 4. Eleven minor and trace elements including lead were determined in thirty two breast milk samples by ICP-MS.7 Karadjova et al. 5 used combined analytical procedures consisting of wet digestion step. Measurements of minor and trace metal contents, comprising Al, Pb, Cd, Cr, Cu, Fe, Mg, Mo,Mn, Ni, P, Sb, Si, Sn, Zn, Ti is also very helpful in assessment of quality of milk during its manufacturing treatment and production. For carrying out these determinations were used different techniques: flame atomic absorption spectrometry6 capillary zone electrophoresis7 ,

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inductively coupled argon plasma emission spectroscopy8 , differential pulse anodic stripping voltammetric technique9, inductively coupled plasma optical emission spectrometry,10 flow injection spectrometric methods11, atomic fluorescence, spectrometry12 and stripping potentiometry13 .Many reports indicate the presence of heavy metals in milk, and often it is needed to assess the levels of heavy metals in food. Lead, cadmium and mercury residues in milk are of particular concern because milk is largely consumed by infants and children 14, and the determination of these heavy metals levels in milk.

The objective of this work is to find the levels of heavy metals (arsenic, lead, cadmium and mercury) in tin milk produced in Ghana and aims at finding out whether the levels are below or above the optimum level needed for human consumption especially babies and also to find the degree of contamination.

1.1 Significance of Study

Supporters of milk argue that the concentration of chemical contamination is so low that it does not pose a serious threat to health. Scientific evidence repudiates this logic. Though not widely recognized, alteration of the body's immune system is a damaging effect of milk chemicals and trace elements. Many diseases such as cancer are caused by the single molecules of toxins in the body. Through this study I wish to highlight the dangers of drinking milk whose levels of contamination are too high and the long and short effects of they have on the human body especially on infant children since they are the main consumers of milk. This will enable us to establish the level of the metals in the milk and whether they are contaminated to a degree which is harmful to the body.

2.0 METHOD AND MATERIALS

2.1 Sampling

Sample was obtained from the Kaneshie market. Sam-pling method used was random sampling. The samples were taken based on their expiry dates so as to obtain different manufacture dates for the samples. Tin milk used for the project was Ideal Milk. Ideal Milk was picked because it is one of the most popular brands of tinned milk being consumed on the Ghanaian market.

2.2 Sample Treatment

5mls of sample was measured into a beaker and topped to 10ml with distilled water (this was done to dilute the milk since it was too thick for analysis in its undiluted form). A few drops of 0.1M Trichloroacetic acid were added to the sample to precipitate the proteins in the milk.12 different samples were prepared with three prepare from one tin. The samples were then put in the Centrifuge at a speed of X2000 for 20 minutes. After that, the aqueous fraction was then separated by decanting. 12 porcelain crucibles were washed thoroughly and treated with distilled water to prevent contamination that might affect the results. The aqueous part of the sample were then poured into the porcelain crucibles and marked for easy identification. Crucible content was ashed in a muffle furnace for one hour. The ash was then dissolved in 15ml 0.5M Nitric acid. The dissolved sample was then filtered with filter paper. It was then poured into previously treated sample bottled for storage. Each sample from the same tin was marked similarly for easy identification.

2.2 INSTRUMENTAL MEASUREMENT

Instrument used for analysis of sample was the ICP-ES (IRIS Intrepid ICP). The samples from similar tin were combined into one main sample due to it's the sample size and availability of dissolved ash to be analyzed in the sample.

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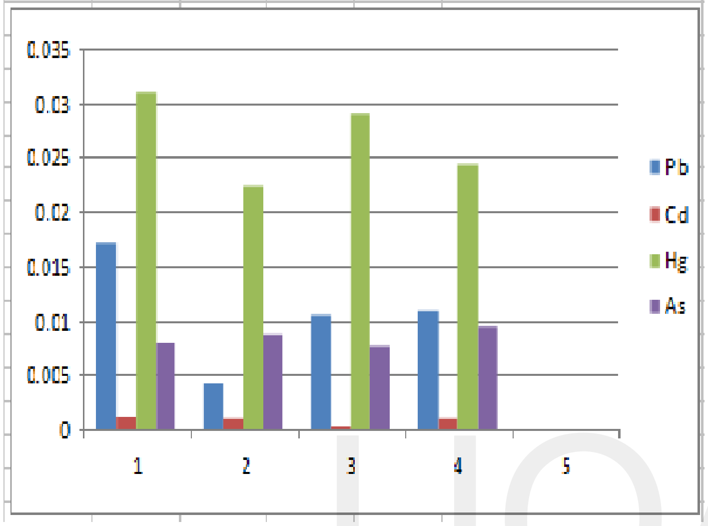
4.0 RESULTS

A graph show indicating the amount of Lead, Cadmium, Mercury and arsenic in milk sample at different concentrations.

Pb	Cd	Hg	As
0.0171	0.001	0.0311	0.008
0.0042	0.0009	0.0224	0.0087
0.0104	0.0001	0.029	0.0075
0.0108	0.0009	0.0244	0.0094

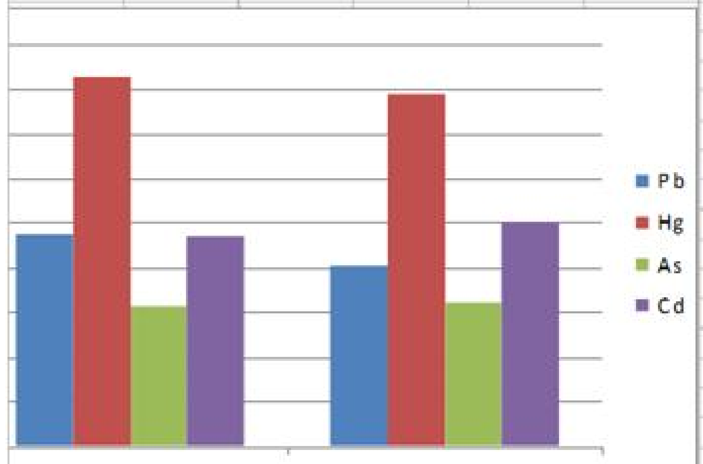


4.1 Reproducibility Studies

Double distilled containing 5ppm each of Pb, Cd, Hg, and As were analyzed using the ICP-ES. The following wave-lengths were used Pb-220.353nm, Cd-226.502nm, Hg-184.950nm, and As-197.262nm. Results were as shown in the table below.

A graph show indicating the reproducibility of Lead, Cadmium, Mercury and arsenic in milk sample at different concentra-tions

Pb	Hg	As	Cd
5.172	5.525	5.013	5.169
5.102	5.487	5.022	5.202
5.137	5.506	5.017	5.185
0.05	0.026	0.006	0.224
0.9645	0.479	0.1301	0.456
102.74	110.5	100.34	103.7



4.2 DISSCUSION

From the table of result, it can be observed that levels of mercury in milk is higher, followed by levels of lead, Arsenic, and cadmium. Analysis of whole milk samples indicated their contamination by some heavy metals residues, exhibiting a wide array of hazardous impacts on human health. Beyond certain limits, all metals turned to be toxic to human body. This could be applied to essential minerals like as well as non-essential metals and metalloids like Pb and Cd com-pounds. In relation to many previously reported surveys worldwide, Tables 1 and 2 summarized results obtained in this study and correlated our findings with results of these surveys.

The statistical analysis of obtained data revealed that all ex-amined milk samples having Pb, Cd, As and Hg levels above the recommended permissible limit.

5.0 CONCLUSION

This study highlighted the dangers of drinking milk whose levels of contamination are too high and the long and short effects of they have on the human body especially on infant

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children since they are the main consumers of milk. This will enable us to establish the level of the metals in the milk.

6.0 RECOMMENDATION

Levels of metals recommended by regulating bodies must strictly be followed to avoid health risk to consumers.

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