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Trace Elements in Some Imported Commercial Infant Cereal Formulas on the Ghanaian Market by INAA

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ABSTRACT

A total of sixteen (16) imported baby cereals samples were collected from various markets in the Greater Accra. Selected elemental contents were determined by Instrumental Neutron Activation Analysis (INAA). Al, Br, Ca, Cl, K, Mg and Na were determined. The elements present in the samples were in the range of levels reported in literature. The element that presented minor concentrations is Al. Its highest concentration was 11.04 ±0.59 ppm in BFBN_3. Br was present in four (4) of the sixteen (16) samples analysed. The average concentration of Br in all the samples was 9.89 ±0.69 ppm. Cl, Ca, Mg and Na were present in minor concentrations in most of the samples analyzed. The concentration of Cl ranged from 0.06± 0.003% to 0.36 ± 0.02 % where as Ca had concentrations ranging from 0.27± 0.02 % to 1.37 ± 0.07 % . Na and Ka ranged from 0.10 ±0.01% to 1.03 ±0.03 %. The resu lts of the present investigation showed that the imported baby cereals on the Ghanaian market contain some important nutrients that appear to have a very positive effect on human health.

Keywords: INAA, Baby Cereals, Infant nutrition, breast milk, micronutrients, multielementals.

INTRODUCTION

Breast milk is recommended as the sole source of infant nutrition for the first 6 months of life. However, less than 35% of the world's infants are exclusively breast fed at this age[1]. Breastfeeding should continue along with complementary feeding until 2 years of age. However, this is not always possible due to the fact that not all mothers are able to produce sufficient amounts of milk for their infants [2]. Usually after six months exclusive breastfeeding, complimentary feeding becomes necessary [3]. Many brands of infant formulae are designed to provide required nutrients as recommended diet intake (RDI) of minerals for infants and toddlers [4]. Some of these elements may constitute potential health risk if consumed above the RDI values. The composition of commercial baby foods can be very different from the foods that make up the diet of the general population and therefore information is needed on the levels of many metals and elements in these food groups.

Trace elements can be divided from a dietary point of view into three groups; the essential trace elements (micronutrients) which are constituents of hormones, vitamins and catalysts for the enzyme systems for the metabolic processes in the cells and they function at low concentrations in living tissues; the possibly essential trace elements; and the non-essential trace elements; which are made up of the toxic and non-toxic elements which have no metabolic functions in the living organism [5].

It has been documented that diet is the main source of trace element [6] and the nutritional importance of many trace elements has been established [7,8]. However, many elements can be present in foods naturally, or through human activities, such as processing, storage, farming activities and industrial emission [9]. To maintain the physiological and metabolic processes of the body, the appropriate intakes of these elements are required. Since, deprivation can lead to diseases; whereas, excessive intake of some of these essential elements may adversely affect the human metabolic function [10, 11]. At high concentrations these essential elements can lead to poisoning [12]. Literature has also revealed that some toxic elements are also present [13]; which enters into the food chain through processing and their presence has been a source of concern to health practitioners due to their health implications. Though, these toxic elements are added sometimes' intentionally with additives on formula resulting in excess of toxicity [14, 15].

There is therefore the need to obtain better information of trace element levels in imported commercial infant cereals in Ghana. It is obvious that baby food products on the Ghanaian market have not be fully investigated to determine the trace and minor element contents in these infant cereals which is being widely used by the populace. Notwithstanding, the need for the routine monitoring of these infant food products cannot be overemphasized. We have therefore carried out this work in order to have an up to date knowledge on the imported infant baby food products on the Ghanaian market. To ensure dependable work, we have adopted the Instrumental Neutron Activation Analysis (INAA) due to it advantages of low detection limit, multi elemental capability, a non-destructive method and no sample preparation is required for analysis of this work.

Previously neutron activation analysis for the comparative study of minor and trace elements in human, animal and commercial milk [16]. It was again used to determine the concentration of 24 elements in four honey brands commercially available in Austin, Texas (USA) [17]. In Nigeria, INAA was used in the analysis of trace element of some shaving powders commonly marketed in Nigeria [18] and in Ghana, INAA method was developed and applied for the simultaneous determination of 19 elements in 10 individual food items [19]. Most recently, INAA was successfully applied to multielemental determination of eleven medicinal plants used to cure the urinary track diseases observed in Algeria in conjunction with Compton suppression [20], and in Portugal, it was applied INAA with Compton suppression to determine .trace- and minor-element contents in foodstuff [21].

MATERIALS AND METHODS

_ Sampling

Different branded imported commercial baby food that are sold in Ghana were purchased from normal retail outlets in the Greater Accra Region. These brands comprised of the various types of each brand of infant cereal formula. These brands show a fair representation of the infant food products on the Ghanaian Market.

_ Sample Preparation

The samples were prepared for irradiation without further treatment total of 16 samples with weight range between 200.0mg and 210.0mg as well as the certified reference materials ***Whole Milk Powder*** supplied by National Institute of Standards and Technology (NIST), for verification and quality control purpose were prepared for analysis by INAA. The samples were weighed directly onto polyethelene films heat sealed and packed into Polyethelene capsules and heat sealed.

_ Irradiation and Counting

The irradiation facility is the Ghana Research Reactor -1 (GHARR-1) at the Ghana Atomic Energy Commission. Like all Miniature Neutron Source Reactor (MNSR) facilities, GHARR-1, is specifically designed for neutron activation analysis, (NAA) therefore it has the capabilities for the analysis of trace, minor and major elements in different sample matrices [22]. For analysis of short-lived nuclides requiring shorter irradiation times, the samples were placed in rabbit capsules and sent to the reactor through a pneumatic transport system into the r irradiation channel. The irradiation took 2 minutes and after the cooling time of 2-15 minutes, the counting was performed for 600 seconds. For medium lived element the samples were irradiated for 1 hour and after 24 hours cooling, the samples were counted for 600 seconds.

RESULTS AND DISCUSSION

The concentrations of the infant cereal food studied are in table 1. The results obtained varied between the different types of sixteen (16) baby food products which were based on rice, maize, fruits, lactea and oats. The study demonstrated a variation in the concentrations of most of the essential elements in infant food which may be due to the ingredients.

As far as trace minerals are concerned, there were no indications of abnormal levels of Mg, Ca, Na, K, and Cl. The concentration of Mg was moderate in the samples where it was measured the concentrations ranged from 0.06% to 0.19% with the highest concentration found in BFP_1 which is a mixed fruit based baby food and the lowest concentration seen in oats based BFBN_2. Calcium, Ca which about 99% is found in the skeleton and other parts such as the plasma, extravascular fluid, amongst other parts [23] had concentrations between 0.27% and 1.37%. Chlorine was also between 0.06% and 0.34%. On the other hand Sodium and Potassium had concentrations ranging from 0.1 % - 1.03 %. The range obtained for aluminium in this study was (2.89 - 11.07ppm). These values are higher than those reported in other research papers [24]. There is concern because of the possibility of increased amounts of aluminium being deposited in the brain and the resulting risk of brain dysfunction [25] and aluminium is now being implicated as interfering with a variety of cellular and metabolic processes [26]. The results shown in these samples is therefore of great concern though within tolerable limit, and effort should therefore be made to reduce the aluminum content in these infant baby foods products [14]. The level of concentrations in these samples could be due to manufacturing processes or packaging. Bromine was also present in four of the sixteen samples analysed at concentration of a low of 4.87 ppm – 13.78 ppm. Graphical comparison in the concentration of the various elements and samples is seen in figures 1- 7. Results from this work shows that the concentrations essential elements in the infant food products was found to be adequate for the daily supply of the elements determined and also similar with previous report by [27].In addition, these elements in these infant foods meets the infants' need of nutrient as specified by WHO/UNICEF [4].

For method validation, standard reference material NIST 8345 (whole milk powder) was analysed under the same condition as the samples and concentrations calculated. The results for the analysis of the whole milk powder are presented in table 2. The results obtained in the lab work compared favorably with the reported values of the standard reference materials.

Table 1 Concentrations in different brands of Baby foods

Sample ID	Product	Al (ppm)	Ca (%)	Cl (%)	K (%)	Na (%)	Mg (%)	Br (ppm)
BFN_1	Fiber	3.46 ± 0.21	0.59 ± 0.03	0.36 ± 0.02	0.25 ± 0.02	0.52 ± 0.02	0.14 ± 0.01	BDL
BFF_1	Lactea	3.68 ± 0.01	0.67 ± 0.04	0.31 ± 0.01	0.46 ± 0.02	0.33 ± 0.02	0.10 ± 0.01	13.78 ± 1.04
BFN_2	Maize	4.28 ± 0.21	0.60 ± 0.03	0.23 ± 0.01	0.12 ± 0.01	0.55 ± 0.03	BDL	BDL
BFN_3	Rice	2.89 ± 0.14	0.50 ± 0.02	0.06 ± 0.003	BDL	0.33 ± 0.02	0.10 ± 0.01	BDL
BFN_4	Oat	4.77 ± 0.19	0.54 ± 0.03	0.23 ± 0.01	0.27 ± 0.02	1.03 ± 0.03	0.10 ± 0.01	BDL
BFBN_1	Rice	6.33 ± 0.22	0.68 ± 0.04	0.21 ± 0.01	BDL	0.14 ± 0.01	BDL	BDL
BFBN_2	Oat	6.14 ± 0.21	0.61 ± 0.04	0.21 ± 0.01	0.39 ± 0.02	0.10 ± 0.01	0.06 ± 0.002	7.93 ± 0.16
BFBN_3	MA	11.07 ± 0.59	0.96 ± 0.03	0.10 ± 0.01	0.10 ± 0.01	0.11 ± 0.01	0.12 ± 0.01	BDL
BFB_1	Fruits	7.50 ± 0.31	0.45 ± 0.02	0.11 ± 0.01	0.18 ± 0.01	0.11 ± 0.01	BDL	BDL
BFB_2	MH	6.89 ± 0.23	0.60 ± 0.04	0.27 ± 0.02	0.13 ± 0.01	0.31 ± 0.02	0.08 ± 0.002	BDL
BFB_3	CN	7.05 ± 0.22	0.63 ± 0.04	0.31 ± 0.02	0.47 ± 0.03	0.11 ± 0.01	BDL	4.87 ± 0.46
BFB_4	Multi-cereal	6.62 ± 0.15	0.27 ± 0.02	BDL	0.10 ± 0.01	0.13 ± 0.01	BDL	BDL
BFC_1	Maize	6.98 ± 0.28	0.70 ± 0.04	0.34 ± 0.02	0.40 ± 0.02	0.10 ± 0.01	BDL	BDL
BFC_2	Wheat	8.13 ± 0.17	1.37 ± 0.07	0.10 ± 0.01	BDL	0.26 ± 0.01	BDL	BDL
BFC_3	FW	7.33 ± 0.17	1.12 ± 0.09	BDL	0.30 ± 0.02	0.29 ± 0.02	0.07 ± 0.003	BDL
BFP_1	MF	8.67 ± 0.44	0.88 ± 0.06	BDL	0.36 ± 0.02	0.13 ± 0.01	0.19 ± 0.019	12.99 ± 1.08

CN-capital nutrition; MH-milk & honey; MF-mixed fruits; FW-fruits & wheat; MA-muesli with apple

Table 2 Concentrations of elements in SRM 8435 Whole Milk Powder

Element	This work	Reported
Br (mg/kg)	18.5 ± 0.59	20 ± 10
Ca (%)	0.90 ± 0.03	0.922 ± 0.049
Cl (%)	0.80 ± 0.06	0.842 ± 0.044
K (%)	1.21 ± 0.10	1.363 ± 0.047
Mg (mg/kg)	813 ± 80	814 ± 76
Na (%)	0.36 ± 0.03	0.356 ± 0.040

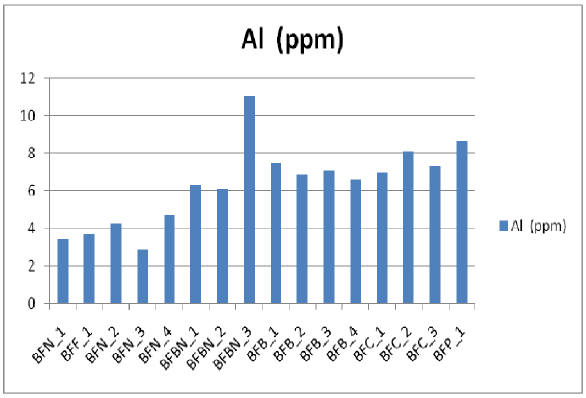


Figure1 Concentration of Al in samples (ppm)

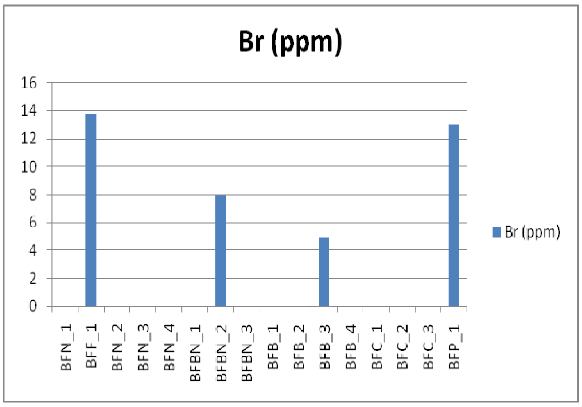


Figure 2 Concentration of Br in samples (%)

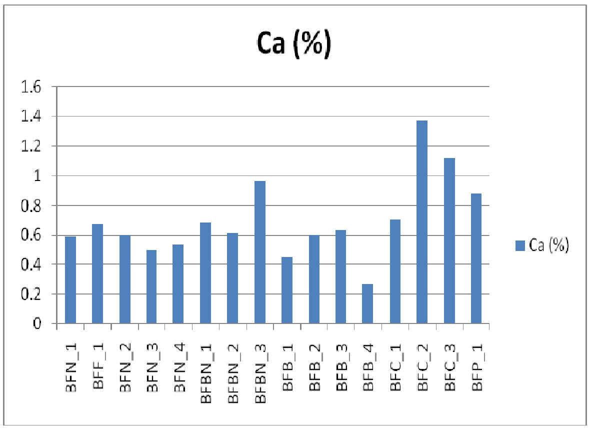
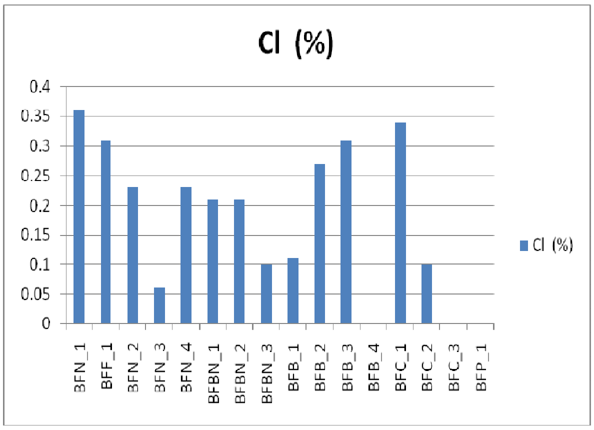


Figure 3 Concentration of Ca in samples (%)



Firgure 4 Concentration of Cl in samples (%)

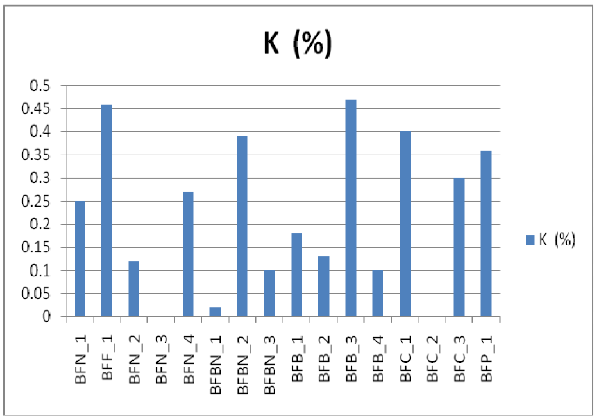


Figure 5 Concentration of K in Samples (%)

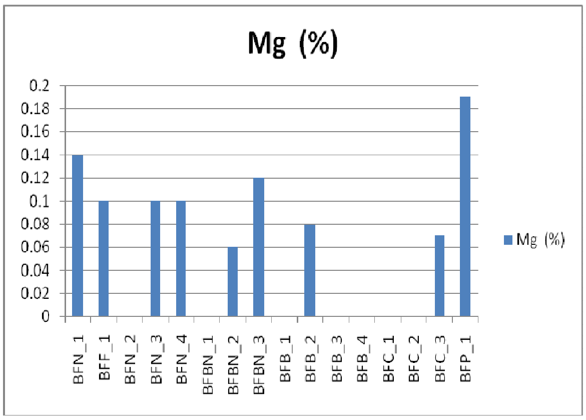


Figure 6 Concentration of Mg in samples

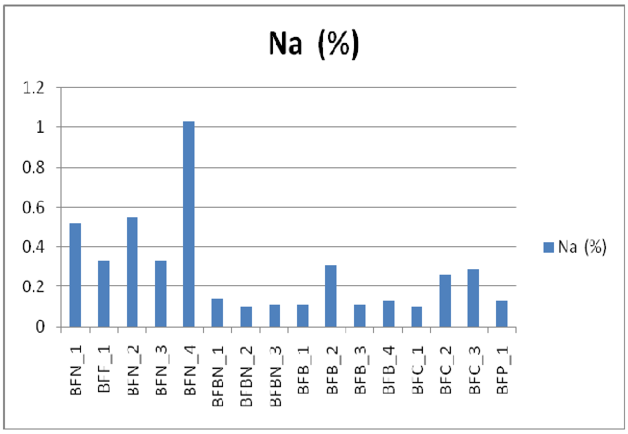


Figure 7 Concentration of Na in sample (%)

CONCLUSION

The study of these samples shows that samples do no contain abnormal concentration of essential elements. Though within intake limits, some of the non essential elements are of great concern. These elements are significant in infant feeding because these foods are used to supplement regular breast feeding. For the elements considered in this study, the essential elements compared well with that of other researchers and are within specified limits in international guidelines. For the non essential elements, there is the need for the infant food manufacturers to continue to make every effort to reduce their concentrations in the cereals. Due to the influx of imported infant cereals into Ghana, it is recommended that constant work is done on these baby food brands that are on the Ghanaian market to monitor the elemental contents of these infant foods.

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