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Assessment of Elemental Concentration of Milk Powder Collected From Local Market Using PIXE Technique

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Abstract: *Foodstuff pollution is a major concern now-a-days, especially in Bangladesh. Toxicity assessment of baby food is essential before providingto the children. The quantitative estimation of trace and major elements, their concentrationof ten different milkpowdersamples collected from local markethas been done. The total experimental works from sample preparation to spectrum data analysis have been done at the Accelerator Laboratory of Atomic Energy Center, Dhaka.The IBA technique PIXE and spectrum analysis shows that the major elements found in all the ten samples are S, Cl, K, Ca, Fe, Cu, Zn, Se etc. The concentration of Potassium (1123.15±395.65 ppm) and Calcium (866.05±305.95 ppm) are seen relatively high in analyzed samples. The projection of Iron is 45.9±32.9 ppm. The elements and their concentration study of imported milk powder may provide a clear view whether any type of elemental or heavy metal toxicity is present or not. Further study will provide sufficient knowledge to evaluate the significance of the importance especially related to human health.*

Keywords: *PIXE, toxicity, IBA,GUPIX, MAESTRO-32*

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I. Introduction

Feeding the babies especially the imported powder milk is a sensitive issue for every parent.Dieting is a vital determinant of growing health and nutritional status of babies. Breastfeeding is the best among all other options. The dietary habits depend on so many factors like socio-economic status, regional customs, traditions etc.The assessment of essential and heavy metal toxicity will provide sufficient knowledge to understand the nutritional status of milk powder and their effects on baby health. In the developed countries, food quality analysis is a routine work and is done tobe ensured the health and quality of their citizenlife [1].Elemental analysis of the powder milk is important for many reasons. Trace elements play the important roles in the functioning of many proteins, hormones, enzymes, and other large molecules.Excess mineral intakes may lead to toxicity also [2].

Precise information on food consumption patterns of babies may be helpful for their growth and protect them from different kind of diseases. The imbalance food intake may be the cause of many diseases. Present research has been undertaken to achieve the knowledge and skill of experiment and analysis procedures, assessment of heavymetal contamination, and elemental analysis of powder milk in order to obtain accurate information of both the essential and toxic element composition.

II. Methodology

Accelerator laboratory of Atomic Energy Center inDhaka is equipped with 3MV VDG Accelerator and associated sub-systems. Proton Induced X-Ray Emission is an IBA method that relies on the spectrometry of characteristic X-rays emitted from the target elements due to the irradiation of high energy ion beam (3MeV) of Hydrogen or Helium gas. PIXE technique may be applied for the identification of various constituents in a compound target[3]. Quantitative analysis is also possible with the appropriate corrections to absorption and X-ray yields. PIXE has been successfully applied to solving problems in many fields, including corrosion and oxidation, semiconductors, metallurgy, thin films, geosciences, air pollution and atmospheric science, biology, medicine, art, archaeology, water analysis, and forensic science.PIXE is well adapted to measure major, minor, and trace element in different sample matrices [4-5]. The present research works has been utilized PIXE for irradiation and analysis of a number of powdermilk samples.

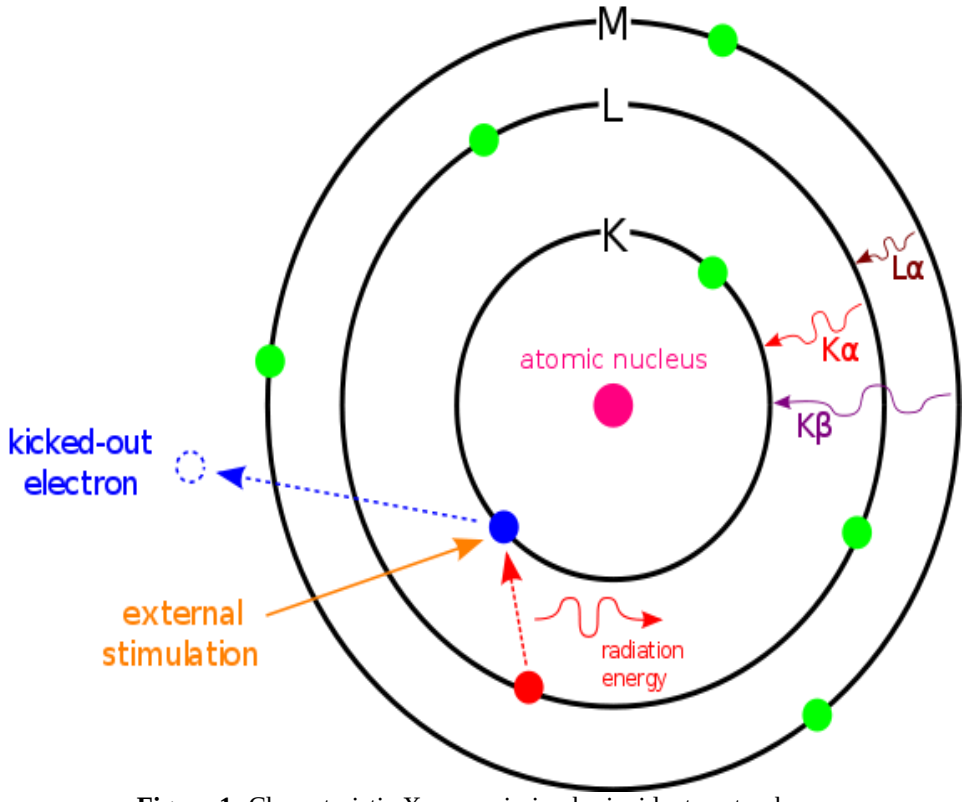

Figure 1: Characteristic X-ray emission by incident proton beam

When charged particles with sufficient energy hit a sample, a vacancy in the inner shells of an atom may be created. The probability of creating a vacancy is higher when velocity of the incoming ions matches the velocity of the inner shell electrons. This probability (cross-section) for ejecting inner shell electrons is quite high (of the order of barns) for MeV ions. Such a vacancy can be filled in a number of ways and one of the processes may emit X-rays with energy characteristic of that particular atomic number.This characteristic X-rays are detected using solid state semiconductor detector [6].

III. Sampling And Preparation

Ten different powder milk samples were collected from local market for this research works. According to the labeling of the packet, three of them were for the babies aged born up to 6 months, three were for aged 6^{+}months to 2 years which were collected from departmental store and rest of the four powder milksamples were collected from local shops.All the powder milk samples were dried using electric oven at the temperature of 45^{0}C continuously during 7 days to make completely moisture free.The samples were ground in an Agate Mortal Pester forfine powder [7-8]. To avoidcross contamination, the Pester was cleaned by acetone (CH_3-CO-CH_3) for every sample. 0.25gm ofpowder milk was taken and pelletized to make pellet (7mm dia. and 1mm thick). Finally, the pellets were preserved in vacuum desiccator to protect them from any type of contamination. Next the pellets were set in the ion beam scattering chamber on sample-wheeler for irradiation by proton beam of 2.4 MeV [9].

IV. Irradiation And Data Acquisition

PIXE techniquewas applied for sample irradiation. The data acquisition has been done through the setup using software MAESTRO-32. The spectrum has beenanalyzed using GUPIX/DAN-32 software to find the elements and their concentration [10].

Data spectrum of one of the powder milk samples has been shown below:

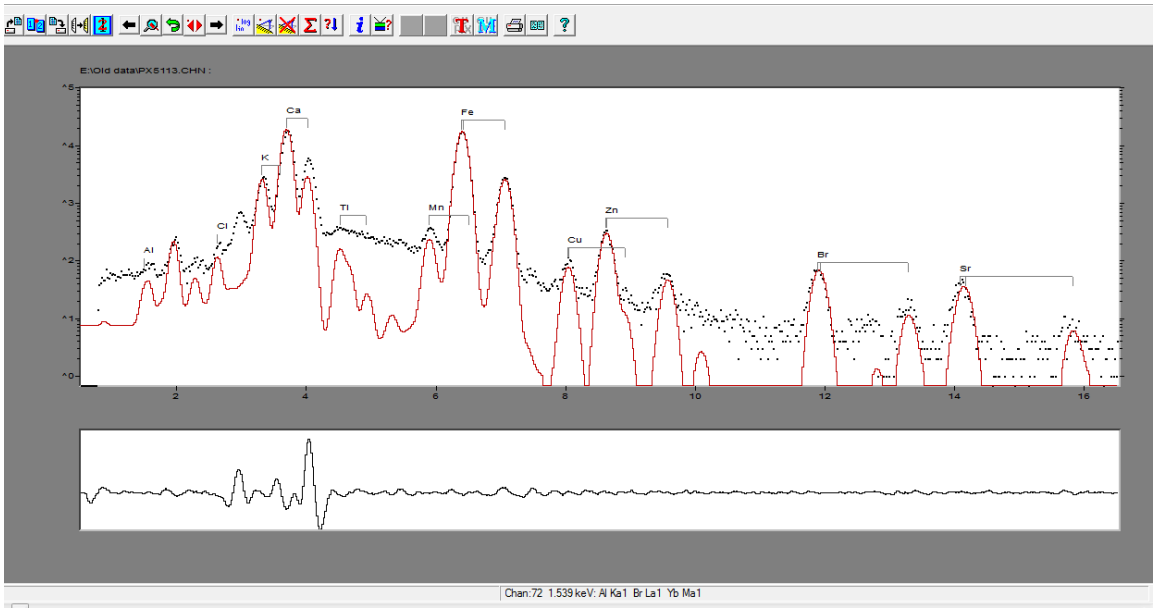

Figure 2: Analyzed data spectrum of a powder milk sample

The data acquisition setup was calibrated using IAEA standard sample. The concentration calculations were done by using the following formula:

$$C_s = C_{st}\frac{S_s Y_s}{S_{st} Y_{st}}$$

Where

C_s = elemental concentration of the sample
C_{st} = elemental concentration of the standard sample
S_s = elementalstopping power of the sample
S_{st} = stopping power of the standard
Y_s = elementalyield of the sample
Y_{st}= yield of the standard
All the data information and results have been projected in this manuscript.

V. Figures And Tables

Table 1: Elemental compositions of powder milk samples

Element	Concentration in ppm									
	Babycare-1	Lactogen-1	Biomil-1	Babycare-2	Prima-2	Lactogen-2	Fresh	Dano	Diploma	Marks
S	9.5	23.2	15.2	39.7	36.4	46	31.1	52.8	26.2	35
Cl	360.0	337	299.6	472.7	460.5	469.3	508.3	266.3	277.6	505.7
K	830.3	970.2	936.2	727.5	1232.3	1518.8	1145.6	1196.6	821.2	1352.1
Ca	728.6	706.2	652.3	560.1	780.2	882.8	870.3	646.4	1172	882.7
Si	117.8	153.6	93.4	58.3	149.2	216.1	147.1	92.9	66.6	237.8
Cr	2.3	0.42	0.649	0	0.198	0	0	0.187	0	0
Fe	55.7	13.2	51.8	13.3	13	43.1	52.5	28.6	78.8	50.2
Co	1.1	0	1.3	0.730	0	0	0	0	0	0
Ni	1.2	0.205	0	0.161	0.101	0	0	0	0	0.739
Cu	2.0	3.9	3	6	5.9	7.2	5.3	7.3	5.9	5.8
Zn	36.1	35	12.7	19.9	41.1	55.7	45.8	79.1	19.6	52.5
As	1.9	0	0	0.467	0	0	0	0	0	0
Se	0	0.154	0.321	0	0.439	0	0	0.31901	0	0

Table 2: The average concentrations, range and standard deviationof powder milk samples

Element	Average Concentration (ppm)	Range (ppm)	Standard Deviation
S	31.51	9.5 - 52.8	13.39266
Cl	395.7	266.3 - 508.3	97.16602
K	1073.08	727.5 - 1518.8	256.8003
Ca	788.16	560.1 – 1172	174.1226
Si	133.28	36.4 - 237.8	59.78641
Cr	0.3754	0.649 - 2.3	0.711221
Fe	40.02	13.0 - 78.8	22.23899
Co	0.313	0.73 - 1.3	0.522091
Ni	0.2406	0.739 - 1.2	0.406254
Cu	5.23	2.0 - 7.3	1.737207
Zn	39.75	2.7 - 79.1	19.92052
As	0.2367	0.467 - 1.9	0.60257
Se	0.123301	0.154 - 439	0.172953

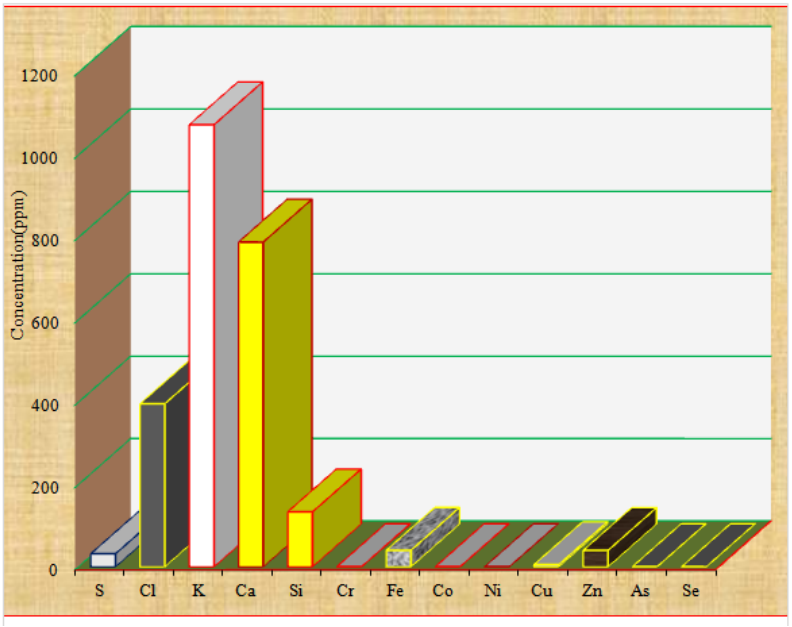

Figure 3: Graphical projection of elemental concentration (average)

VI. Conclusion

PIXE technique is employed to the study of elemental constituents of some milk powders generally people used those every day in Bangladesh. Sufficiently high concentrations of Si, Cl, K, and Ca were found in the samples. Further, good correlations between the concentrations of K and Cl in the milk samples are also observed. But Fe content in the samples analyzed was not up to the expectation level. So far, no toxic elements such as Cd, Pb, and Hg etc. are not detected. The maximum concentration was found for Ca and the minimum was found for Se. The product was found to be wholesome with regard to the content of major and trace elements.

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