Journal of the Nigerian Association of Mathematical Physics
Volume27, (July, 2014), pp 295 – 300
© J. of NAMP

Determination of Bromine in Food Additives by Instrumental Neutron Activation Analysis

Hankouraou Seydou

Physics Department, Gombe State University, Gombe

Abstract

The concentrationof bromine was determined in food additive samples. The Instrumental Neutron Activation analysiswas used to determine the element bromine in seven food additive samples. The mean bromine concentrations of 10.17±0.18 ppm for Curry powder, 30.29±0.36 for Onga, 19.56±0.33ppm for Dowin cube, 32.26±0.42 ppm for Salt, 18.02±0.31 ppm for Royco, 20.41±0.39ppm for Maggi cube were determined. The mean value for Ajino moto was below the detection limit. The daily intake values are in the range of 0.12 to 0.38mg with highest value of 0.38mg for salt. All the intake values obtained are below the recommended daily allowance (RDA) of 1 mg per day per person as given by WHO. The low values are indication of minimal fluctuations of concentration of bromine in the analyzed samples.

Keywords: Instrumental Neutron Activation Analysis, Nigeria Research Reactor-1, food additive, Bromine, intake and agreement

1.0 Introduction

Bromine is a naturally occurring element that can be found in many inorganic substances. Humans however, have many years ago started the introduction of organic bromines in the environment. These are all compounds that are not natural and can cause serious harm to human health and the environment. Bromine is corrosive to human tissue in a liquid state and its vapors irritate eyes and throat. Bromine vapors are very toxic with inhalation. Humans can absorb organic bromines through the skin, with food and during breathing. Organic bromines are widely used as sprays to kill insects and other unwanted pests. But they are not only poisonous to the animals that they are used against, but also to larger animals. In many cases they are poisonous to humans, too. The most important health effects that can be caused by bromine-containing organic contaminants are malfunctioning of the nervous system and disturbances in genetic materials. But organic bromines can also cause damage to organs such as liver, kidneys, lungs and milt and they can cause stomach and gastrointestinal malfunctioning. Some forms of organic bromines, such as ethylene bromine, can even cause cancer.

Organic bromines are often applied as disinfecting and protecting agents, due to their damaging effects on microorganisms. When they are applied in greenhouses and on farmland they can easily rinse off to surface water, which has very negative health effects on daphnia, fishes, lobsters and algae. Organic bromines are also damaging to mammals, especially when they accumulate in the bodies of their preys. The most important effects on animals are nerve damage and next to that DNA damage, which can also enhance the chances of development of cancer. The uptake of organic bromine takes place through food, through breathing and through the skin. Organic bromines are not very biodegradable; when they are decomposed inorganic bromines will consist. These can damage the nerve system when high doses are absorbed. It has occurred in the past that organic bromines ended up in the food of cattle. Thousands of cows and pigs had to be killed in order to prevent contagion of humans. The cattle suffered from symptoms such as liver damage, loss of sight and depletion of growth, decrease of immunity, decreasing milk production and sterility and malformed children [1].

Corresponding author: Hankouraou Seydou E-mail:seydou5k@yahoo.com Tel.: +2348065631501

Inorganic bromines are found in nature, but whereas they occur naturally humans have added too much through the years. Through food and drinking water humans absorb high doses of inorganic bromines. These bromines can damage the nervous system and the thyroid gland [2].

Bromine widely occurs in the natural environment. It is one of the trace elements unessential to humans. Bromine taken up at higher level is toxic. It's quite slowly excretion from the body tissue causes bromism with symptoms of mental disturbance. Recent investigations indicate that bromine may also be related to dilated cardiomyopathy and uremic heart failure. The maximum permissible limit given by the world health organization (WHO) is 1.0mg/day/person [2].

Its determination in human diets such as food additives is therefore essential.

2.0 Experimental

The samples were Nigerian food additives, procured from shops in Zaria. The samples were homogenized. Homogenized samples were prepared for irradiation according to the samples preparation procedure developed for NIRR-1[3].The sample codes and description are given in Table 1.Samples were irradiated using NIRR-1 at the Centre of Energy Research and Training(CERT) ABU, Zaria.

Contamination of the samples was avoided by minimizing excessive direct contact. As these could give rise to errors in the measured concentrations of trace elements in the samples and standards. All standards samples were prepared in identical manners with the samples to be analyzed in order to reduce matrix effect, as well as ensuring uniform attenuation and absorption of neutron.

An assembly of polyethylene sample containers associated polyethylene cushions were transferred in the reactor "NIRR-1" in a rabbit capsule transport done by pneumatic transfer systems A and B. The irradiation of the sampleis done separately at a neutron flux setting of $5x10^{11}$n cm^{-2} s^{-1}. The irradiated samples were allowed to decay. Induced activities in detector foil was measured on a *GEM – 30195 HPGe* axial, vertical dipstick detector (*ORTEC*), which has a relative efficiency of 10% and resolution of 1.95 keV, at 1.33 MeV, ^{60}Co. The gamma ray acquisition system consist of *MAESTRO* multi-channel Analyzer (*MCA*) emulation software card, coupled to the detector via electronic modules, all manufactured by *ORTEC*. The multi-purpose Gamma ray analysis software *Win SPAN* –2004was used for peak identification and evaluation [4].

The peak area under the characteristics gamma ray peaks of the elements of interest were determined by peak fit software MAESTRO for Windows developed at ORTEC. The concentration calculation was done by the relative method of INAA. Using concentration of element in standard ($C_{x,std}$) and specific activity of standard ($A_{sp,std}$) and sample ($A_{sx,sa}$), the concentration of element present in the sample ($C_{x,sa}$) was calculated for the same counting period by the following equation:

$$C_{x_{sa}} = C_{x_{std}} \frac{A_{sp_{sa}}}{A_{sp_{std}}} \tag{1}$$

After determination the concentrations of elements from different diet samples, the data so obtained were subjected to various statistical analysis in order to study the trend and distribution of the elements.

The corresponding average daily dietary intake for the elements of interest as defined by [5] was calculated by the following formula:

$$I_i = \Sigma_j C_{ij} \bullet D_j \tag{2}$$

where, I_i is the daily intake of the element i; C_{ij} is the concentration of the food category j ; D_j is the daily consumption of the food category j .

Agreement *(AT)* defined as the ratio of the standard deviation (σ) of the concentration of a given element in the sample with respect to the average concentration(x) of the element in the sample, expressed as percentage was determined. *(AT)* as defined by [6] is given by

$$AT = (s / \bar{x})100\% \tag{3}$$

A large *AT* is an indication of a large fluctuation of the specific trace element within the sample or vice versa.

Table 1: Sample code and Description

S/NO	SAMPLE CODE	SAMPLE DESCRIPTION	BATCH NUMBER
1	121B2	Curry powder	f_1
2	121B4	Ajino moto	17
3	121B6	Onga	1034
4	121B8	Dowin Cube	27110
5	121B10	Salt	MC2/08/10
6	121B12	Royco	284
7	121B14	Maggi Cube	906411785

3.0 Results and Discussion

Instrumental Neutron Activation Analysis using cadmium filter has successfully been used in determining the element Br in the food additive samples obtained from Zaria market. The measured concentrations of Br in the food additive samples with the absolute standard deviations are presented in Table 2. The concentration ranges from 10.17 to 32.26 ppm. The highest bromine concentrations were obtained in samples 121B6 (Onga) and 121B10 (Salt) with respective values of 30.26 and 32.26 ppm. The determined values of Bromine in the samples were compared in Figure 1. The lowest value was obtained in sample 121B2 (curry powder).The daily intakes of Bromine obtained in the samples range from 0.12 to 0.38mg which are lower than the WHO maximum toxic value of 1.0 mg per day per person [7]. The results show that the consumption of these food additives is safe to some extent if the daily intake value is not exceeded.

Table2: Concentration of bromine and daily intake in the samples

S/NO	SAMPLE CODE	CONCENTRATION OF BROMINE IN THE SAMPLE (ppm)	STANDARD DEVISION (SD)
1	121B2	10.17	0.18
2	121B4	BDL	BDL
3	121B6	30.26	0.36
4	121B8	19.56	0.33
5	121B10	32.26	0.42
6	121B12	18.02	0.31
7	121B14	20.41	0.39

Another factor that was determined is the agreement. A large *AT* is an indication of a large fluctuation of the specific trace element within the sample or vice versa. Bromine in 121B2 (curry powder) and 121B14 (maggi cube) showed highest values *AT* of 1.8 and 2 % respectively, while all the other elements showed low *AT*. The lower values of *AT*sdeterminedin this work indicate that the fluctuations of the concentration Bromine in the various samples of food additives are not large.

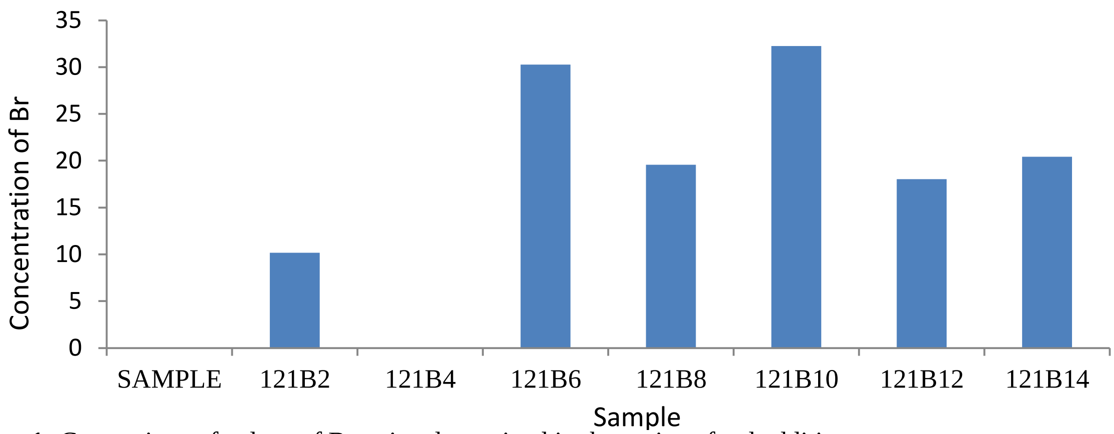

Figure 1: Comparison of values of Bromine determined in the various food additives

Table 3: Daily intake and Agreement for Bromine

SAMPLE	Daily intake of Br in ppm	Agreement (%)
121B2	0.12	1.8
121B4	NA	NA
121B6	0.36	1.2
121B8	0.23	1.7
121B10	0.38	1.3
121B12	0.22	1.7
121B14	0.24	2

NA=NOT AVALABLE

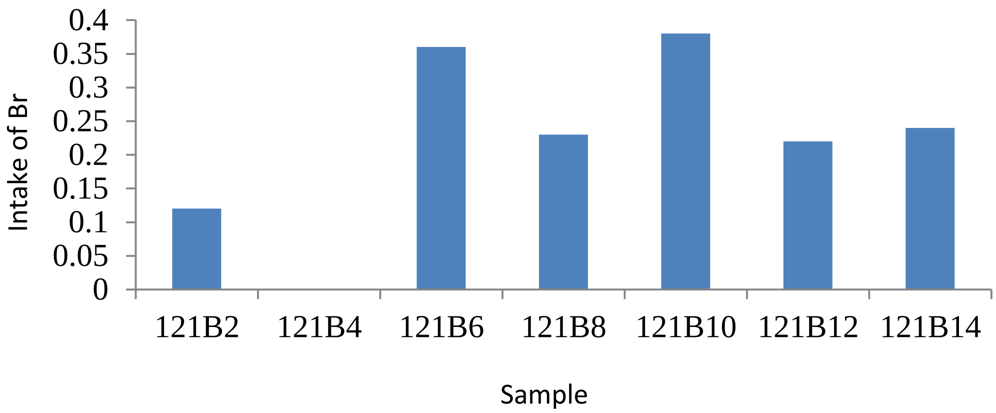

Figure 2: Comparison of Daily intake of Bromine in food additives

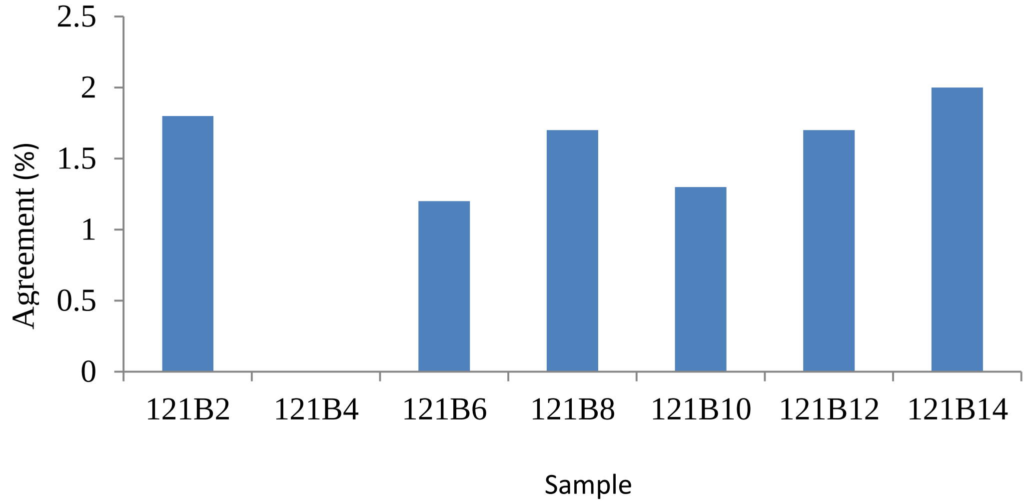

Figure 3: Comparison of Agreement Values of food additive Samples

4.0 Conclusion

The concentrations of bromine were determined in food additive samples.The concentration ranges from 10.17 to 32.26 ppm. The highest bromine concentrations were obtained in Onga and Salt with respective values of 30.26 and 32.26 ppm. The obtained intake values for element Br are below the WHO recommended values of 1mg per day per person. The results show that the consumption of these food additives is safe to some extent if the daily intake value is not exceeded.

5.0 Acknowledgements

Center of Energy Research and Training (CERT) and IAEA are hereby acknowledged for making all the facilities available. The author also extends his special thanksto the staff of the centre that through one way or the other have assisted towards the success of this work.

6.0 References

[1] Lenntech,V. B.,(2011):Chemical properties, Health and Environmental effects of elements from http:// www.lenntech.com/periodic/elements/br.htm

[2] Xiaolin H., Chifang C., Qfang Q., Guodong L., Yongbao Z. and Ke W.**,** (1997): The Study of Iodine in Chinese Total Diets. *The Science of Total Environment 193 (1997) 161-167, Elsevier*

[3] Jonah S.A, Umar I.M .Oladipo M.O.A, Balogun G.I., and Adeyemo D.J (2006):Standardization of NIRR-1 Irradiation and Counting for Instrumental Neutron Activation Analysis, *Applied Radiation and Isotopes*, 64(2006) 818-822 ElsevierAkadémiaiKiadó, Budapest.

[4] Wang L.(2004):Multi-Purpose Gamma-Ray Spectrum Analysis Software, CIAE/ *Win SPAN.*

[5] Jixian W., Rusong C., and Hongda Z.(2002) : Study in China on ingestion and organ content of trace elements of importance in radiological protection *Food and Nutrition Bulletin,* vol. 23, no. 3 (supplement) © 2002, the United NationsUniversity.

[6] Chien-Yi, C. and Sheng-Pin C. L. (2001): Determination of Several Trace Elements in Chinese Herbs with Epithermal Neutron Activation Analysis Analytical Sciences 2001, Vol.17 Supplement 2001 © the Japan Society for Analytical Chemistry.

[7] WHO (1996). Trace Elements in Human Nutrition and Health. WHO Technical Report Series Geneva. P119- 205.