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Determination of Iodine and Bromine Along With Their Interfering Elements in Zaria Soils by Epithermal Neutron Activation Analysis

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Abstract

The concentrations of iodine and bromine along with the interfering elements were determined in soils samples. The complementary analytical technique of ENAA was used to determine 5 elements in the soil samples. The mean concentrations of I (4.76±2.38 ppm), Br(3.84±2.03 ppm), K(2.78±1.34 %), Mn(336.18±188 ppm) and Na(2266.7±1476 ppm) were determined establishing a base line data of these elements The obtained median values for elements I and Br of 3.91and 3.74 ppm in Zaria soil respectively were below the median values of world soils. The concentration ranges of major elements (major nutrients) such as K, Mn and Na in soil compared well with the reported world soil ranges.

Keywords: Epithermal Neutron Activation, Nigeria Research Reactor-1, Zaria Soils, Iodine and Bromine.

1.0 Introduction

Iodine being one of trace elements essential to human health, its deficiency disorder (IDD) has been found in almost all countries, including Nigeria. IDD can seriously threaten human health. The main reason for this disease is that the intake of iodine does not meet physiological need. However the excess of iodine can also induce many diseases such as hypothyroidism and cretinism. The main routes through which people take iodine are air and diet, for which diet accounts for more than 98% [1].

IDD was reported to contribute serious health problems in Nigeria especially in areas where the soil is deficient in iodine. A wide spread of IDD was observed especially goitre, cretinism, reproductive failures and hypothyroidism in four most endemic states of Ebonyi, Taraba, Nassarawa and Benue [2].

The most frightening aspect of iodine deficiency in babies and children is ability of the brain to be fully developed for maximum intelligent quotient (IQ). A recent survey revealed that children born in iodine deficient areas have tendency to have low IQ. Another recent survey conducted in Nigeria in 1993 affirmed this and also indicated a 20 percent prevalence rate for IDD, with an estimated 25 to 35 million Nigerians at risk. At the time of survey, less than 40 percent of table salt sold in Nigerian markets was iodized [2].

IDD constitutes the single greatest cause of preventable brain damage in infant and of retarded development in young children. It is a threat to both health and development worldwide. IDD result in goitre, stillbirth, miscarriage, mental retardation and impaired capability, among other consequences [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 . Its determination in human diets is therefore essential. The maximum permissible limit given by the world health organization (WHO) is 1.0mg/day/person [1].

Therefore it is necessary to determine the iodine and bromine contents in soils were the major crops serving as basic foods stuff are grown up.

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2.0 Experimental

The samples were soils, procured from areas in Zaria Town.Samples were collected from six different locations namely: Palladan, Kufena Kudingi, Basawa, Tsibiri and Kamphaghi. At each location two sampling sites were selected. In each of the sampling sites, samples were collected at depths of 0-15 cm and 15-30 cm from the surface soil using auger and plastic trowel. The samples were stored in clean polyethylene bags. Samples collected at identical depth interval from the same sampling unit were then combined together to obtain sub-composite samples. Sub-composite samples from identical depth interval from the various sampling sites at each sampling location were subsequently mixed together to obtain composite sample and systematically labeled to reflect the sampling location and sampling depth. Table 1 shows the details of soil sampling for the study.

Soil samples were homogenized. Homogenized samples were prepared for irradiation according to the samples preparation procedure developed for NIRR-1 [3].Samples were irradiated using NIRR-1 at the Centre of Energy Research and Training(CERT) ABU, Zaria.

Care was taken during the sample preparation in order to minimise the contamination of the standards samples by avoiding 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. This is necessary in order to reduce matrix effect, as well as ensuring uniform neutron attenuation and absorption.

An assembly of polyethylene sample containers, a cadmium (Cd) shield and 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 time is 5 min at a neutron flux setting of $5x10^{11}$ n cm^{-2} s^{-1}. Every sample was irradiated separately.

The irradiated samples were removed from the Cd-Shield after irradiation. 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* –2004 [4], was used for peak identification and evaluation.

Table 1: Code of soil samples collected at various locations in Zaria.

Sample Code	Sampling Depth (cm)	Sampling Location
PDN-1	0 – 15	Palladan
PDN-2	15 – 30	Palladan
KFA-1	0 – 15	Kufena
KFA-2	15 – 30	Kufena
TSI-1	0 – 15	Tsibiri
TSI-2	15 – 30	Tsibiri
BSA-1	0 – 15	Bassawa
BSA-2	15 – 30	Bassawa
KDG-1 KDG-2	0 - 15 15 – 30	Kudingi Kudingi
KPG-1	0 – 15	Kamphaghi
KPG-2	15 – 30	Kamphaghi

3.0 Results and Discussion

Epithermal Neutron Activation Analysis using cadmium filter has successfully been used in determining the elements I, Br, K, Mn and Na in the soil samples obtained from Zaria environment. The measured concentrations of I, Br, K, Mn, and Na, in the soil samples with the absolute standard deviations are presented in Table 2.

Fig. 1 shows comparison of I, Br, K, Mn and Na concentration in soils from the five locations. In the soils samples the highest concentrations for I (8.25 ppm), Br (7.38 ppm), and Na (4126 ppm) were obtained at Palladan (PDN) an area situated in the vicinity of Zaria, Sabon Gari Local Government were some industrial activities are taken place capable of polluting the environment. Mn gave highest concentration (673 ppm) in the sample obtained from Kapanghi a rocky area. The highest concentrations of potassium 4.3 and 3.81 % were found at Kudungui (KDN) and Palladan respectively.

The concentrations of I and Br are relatively low in the study area. The obtained medians for these elements are below the medians of World soils (Table 3). The Iodine concentrations obtained were found to be in the range of 2.97– 8.5 ppm. The Iodine median value in Zaria soils is 3.91 ppm while the world median value is 5.0 ppm. The Bromine concentrations obtained were in the range of 1.40-7.38 ppm which is below the world range of 5-40 ppm. Its mean, is determined to be 3.84 ppm against the world mean value of 5 ppm.

It is well known that Manganese is a very important metallic redox catalyst that governs the behavior of most trace metals in soils [5].

Table 2: Mean concentration in soils at various sampling Areas (values are in ppm except where stated in %)

Element	I	Br	Mn	Na	K (%)
PDN	8.25 ± 0.35	7.38± 1.85	316.00 ± 44.12	4126 ±1278	3.81± 0.61
KFA	3.6± 1.98	1.40±0.8	418.9 ± 90.79	1961 ± 214	2.91± 0.35
KDG	4.21±0.1.48	3.64±0.73	230.05±15.78	3560±374	4.30 ± 0.40
KPG	BDL	3.85±0.36	673.60± 49.35	523 ±26.00	0.82 ±0.05
BSA	2.97 ± 1.14	4.38±1.1	162.45.0±20.57	703.5±135	1.54 ± 0.06
TSI	BDL	2.44±0.57	216.05±3.74	2726±948	3.34 ± 0.78

Table 3: Range, mean and median value for Zaria soils and world soils [6]. All values are in (ppm) unless otherwise specified in %.

Element	Mean	Median	Range		World	
				Mean	Median	Range
I	4.76±2.38	3.91	2.97-8.25	NA	5	NA
Br	3.84±2.03	3.74	1.40-7.38	5	10	5-40
K(%)	2.78±1.34	3.12	0.82-4.30	1.4	1.4	0.08-3.7
Mn	336.18±188	273.03	216.05-673.6	850	1000	100-4000
Na	2266.7±1476	2343.5	703.5-4126	6300	500	700-7400

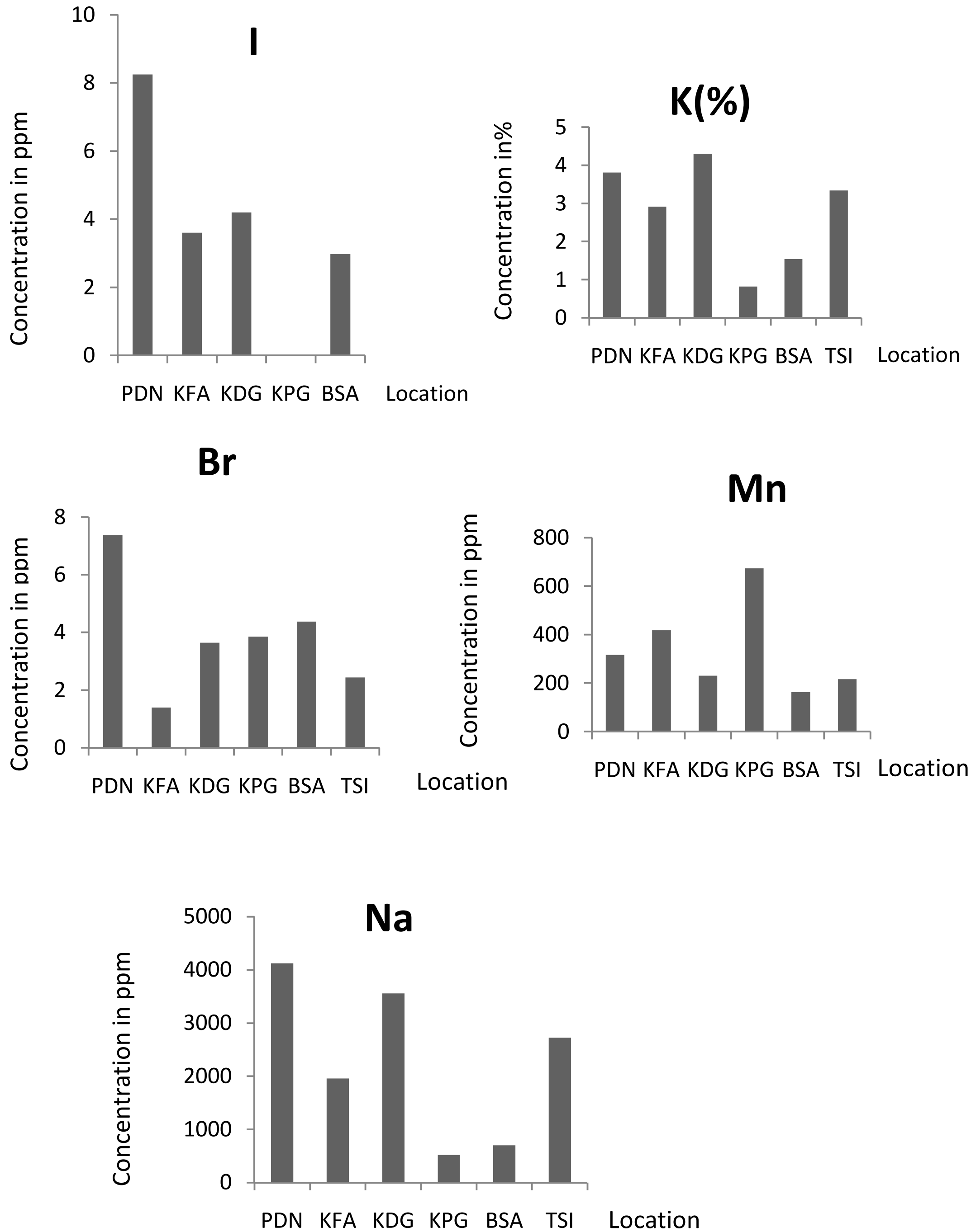

Fig.1 : Comparison of I, Br, K, Mn and Na concentration in soils.

In order to simplify classification, the index *AT* defined as Agreement which is 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 as defined by [7] is calculated with the help of the following equation

$$AT = (s / \overline{x})100\%$$

and the results are shown in Table 4. A large *AT* value indicates a large fluctuation of the specific trace element within the sample or vice versa [7].

Fig.2 gives the representation of the *ATs* of the elements. The *ATs* can roughly be categorized according to [7] into three groups: Group 1: *AT*<60; Group2: 60<*AT*<90; and Group3: *AT*>90.Thus, the trace element I, Br, K, and Mn are in group1, while Na is in Group2. The fluctuations of various trace elemental concentrations in Group1: *AT*<60 are less than the concentration of Na in Group2.

Table 4: Agreement

Element	AT (%)
I	50
Br	52.86
K	48.2
Mn	55.92
Na	65.12

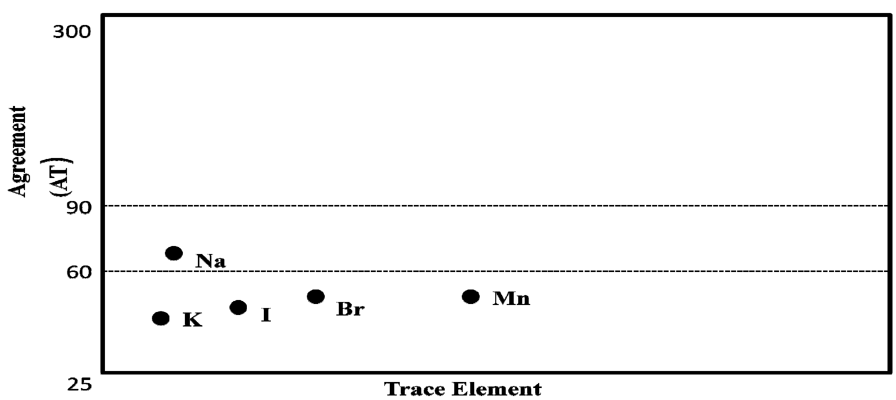

Fig. 2: Agreement (*AT*) of the determined trace elements.

The correlation matrix represents the whole set of soils. Table 5 shows significant correlation for the following pairs of elements determined from Zaria soil Na-K (0.80), Br-Mn (0.81), Br-K (0.60) and I-Br (0.88).The implication of these results shows that the complexes of other elements within the soil strata could influence the presence of any given element.

In Table 6 the concentrations of the elements in Zaria soil were compared with the results obtained by [8]. The concentration of iodine was not determined by [8] because the NAA method is not good for its determination. The determination of iodine in this work is an indication of the reliability of ENAA compared to NAA for its determination. For the elements Br, K, Mn and Na the obtained concentration compared well with those obtained by [8] using the conventional NAA techniques.

Table 5: Correlation coefficient of the elements determined from Zaria soils

Element	**Na**	**K**	**Mn**	**Br**	**I**
Na	1				
K	0.8	1			
Mn	0.25	0.49	1		
Br	0.44	0.6	0.81	1	
I	0.24	-0.03	0.09	0.88	1

Table 6: Values obtained in this work for soil in ppm or as stated compared with those obtained by Idris [8].

Element	**This work**	**Idris [8]**	**% relative Error**
I	4.76	NA	NA
Br	3.84	3.9	1.53846
K	2.78	2.83	1.76678
Mn	336.18	335.18	0.298347
Na	2266.7	2761.27	17.911

4.0 Conclusion

The concentrations of iodine and bromine along with the interfering elements were determined in soils. The obtained median values for elements I and Br in soil are below the median values of world soils. The concentration ranges of major elements (major nutrients) such as K, Mn and Na in soil were found to be in agreement with the world soil ranges as reported by [6].

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References

[1]. 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.*

[2]. Akunyili D. (2004): Natural Health, Guardian Newspaper, Thursday, September 16, 2004, P 38.

[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 Elsevier. Akadémiai Kiadó, Budapest.

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

[5]. Bartlett, R. J. [1998]: Characterizing Soil Redox Behavior. In: Soil Physical Chemistry, Sparks, D. L. (Eds.). CRC Press, Boca Raton, FL, pp: 371– 391.

[6]. Shahabuddin M., Dilder Hossain M., Hossain S. M., Monzurul Hoque M.,Mamun Mollah M., and Halim M. A. (2010):Soil Contamination in Nuclear Reactor Surrounding Areas in Savar,Bangladesh using Instrumental .Neutron Activation Analysis Method. *International journal of Environmental Sciences* Volume 1, No 3, 2010: 0976 – 4402 pp282-295

[7]. 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.

[8]. Idris M.C. (2011); Determination of Multi-element Profiles of Soils in Zaria using Instrumental Neutron Activation Analysis (INAA), unpublished M.Sc. Thesis, Ahmadu Bello University, Zaria, Nigeria.