



ASSESSMENT OF TOXIC ELEMENTS IN SELECTED NIGERIA BROILER FEEDS USING NEUTRON ACTIVATION ANALYSIS (NAA)

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ABSTRACT

In this study, Neutron Activation Analysis (NAA) was used to determine the concentrations of some toxic elements Mn, Cr, Zn, Fe, Co, Sr, La, Sm, Th and Se in some selected Nigeria broiler feed samples. Each sample (A, B, C, and D) represents certain brand of the feeds. The work was carried using the Nigeria Research Reactor – 1 (NIRR -1) at the Center for Energy Research and Training Ahmadu Bello University, Zaria by short and long irradiation protocols, using thermal flux of $5.0 \times 10^{12} \text{ n cm}^{-2} \text{ s}^{-1}$. Quality Control and Quality Assurance of the method was tested by analyzing Standard Reference Materials (NIST 1515 apple leaves,). However, the results shows the Fe concentration in sample B and Zn concentration in sample C and D were found to exceed the maximum acceptable limit with the exception of sample A. This makes the feeds contaminated with Fe and Zn not safe for broilers consumption since toxic elements are bio-accumulative and have the tendency to be transferred to human after consumption.

Key words: Broiler feed, NAA, MNSR, NIRR-1

INTRODUCTION

Certain mineral elements such as Iron, Manganese, Copper and Zinc are essential dietary nutrients for poultry and livestock. However, all mineral elements, whether considered to be essential or potentially toxic, can have an adverse effect upon humans and animals if included in their diet at excessively high concentrations (Reem *et al.*, 2012 and Surtipanti *et al.*, 1990).

Heavy metals such as zinc, Iron, Manganese, Copper, Lead, Cadmium, Nickel, Selenium and Cobalt normally get into the environment through fossil fuels combustion and indiscriminate waste management. Various Organisms within a given ecosystem are actually contaminated along their cycles of food chain with heavy metals. Humans are also in turn exposed to them by consuming the contaminated plants and animals (Reem *et al.*, 2012 and Surtipanti *et al.*, 1990). Neutron Activation Analysis (NAA) is a quantitative and qualitative method being extensively used as an analytical tool in the environmental, biological, geological and cosmological fields. It provides precise and accurate results with high sensitivity and selectivity for a large number of elements. NAA is more effective for trace element analysis in the presence of other elements in varying matrices. The advent of high-resolution gamma ray spectrometry using HPGe detectors has increased the potential of this technique. (Kapsimalis *et al.*, 2009 and Oladipo, 2003)

The method of Neutron Activation Analysis (NAA), has been successfully used on a regularly basis in several areas of nutrition and broilers feed (4). NAA has

become an important and useful research tool due to its advantages. These include high accuracy, small quantities of samples and no chemical treatment. This technique allows the determination of important elements directly related to human health. NAA also provides data concerning essential and toxic concentrations in foodstuffs and specific diets. (Avegliano *et al.*, 2008 ; Kogo *et al.*, 2009; and Oladipo, 2003)

This research is to be carried out to determine the concentration of toxic elements in selected broiler feed using aforementioned method.

Materials

The materials used for the experiment are: Reactor for irradiation, Water, HPGe detector, spectrometer, feed samples for analysis, analytical balance, glove, cylinder, laboratory agate and mortar, cotton wool, acetone sieve, white papers, forceps spatula.

Methods

Feed products were collected from the Kaduna state Nigerian from retail. These products and types were selected on popularity among the Nigerian people. The four samples collected are represented as Sample A, Sample B, Sample C and Sample D. Samples were properly dried and crushed into fine powdered form using a quartz model no. 3 and mutter model no. 80320 all made by Coors Company, USA, then samples were then homogenized and sieved with sieve no. 6 which has an opening of 250 μm (0.0098 in) and Taylor equivalent mesh of 60 produced by the W.S. Tyler Company, USA (Ahmed *et al.*, 2010 and Ahmed, 2008).

Powdered feed samples were prepared in 0.125g polyethylene vials. Each vial contained roughly 0.125 gram of the feeds sample.

Feed is a complex biological matrix having many organic compounds as well as minor, trace and major elements. In general thermal neutrons are better suited for the detection of toxic and elemental composition at low quantities in all types of matrices. Elemental composition can be analyzed by either of one of two reactions: the short-lived where the samples were irradiated for two minute and long lived where the samples were irradiated for five hours. To further increase the analytical sensitivity of the sample a high purity germanium (HPGe) gamma-ray detector was used. At low energy levels less than 100keV, detectors with beryllium windows function at a significantly higher efficiency than detectors with the more common aluminum window. All samples were irradiated using the Nigeria Research Reactor-1 (NIRR-1) at the Centre for Energy Research and Training Ahmadu Bello University Zaria Kaduna State Nigeria (Ahmed, *et al.*, 2010 and Ahmed, 2008). Samples were

irradiated with thermal neutron flux of 5.0×10^{11} neutrons/cm²s using a pneumatic facility (Rabbit systems) with electronic timers monitoring the exact irradiation and decay times. Calibration was done using a prepared NIST 1515 (apple leaves) standard irradiated under the same experimental conditions (Ahmed *et al.*, 2010 and Ahmed, 2008). Each feed sample was irradiated for 2min short lived irradiation and 5hrs for the long lived irradiation, and finally, were counted on HPGe gamma-ray detector. The techniques of Compton suppression NAA are now well established (Biegalski and Landsberger,1995; Landsberger and Wu,1995) and will not be discussed further suffice to state that because of the coincidences of the major decay gammas of ³⁸Cl and ²⁴Na the intensity of these photons are further reduced. Quality control was done by determining the certified elemental concentration in NIST1515 apple leaves. Identify the isotopes in the spectra using gamma library was carried out to determine the elemental concentrations and their uncertainties using standard method (Funtua *et al.*, 2012; Kapsimalis et al., 2009 and Kogo *et al.*, 1990).

RESULTS AND DISCUSSIONS

Table 1: The concentrations of toxic elements in the samples A, B, C, and D.

ELEMENT	CONCENTRATION IN (PPM)			
	SAMPLE A	SAMPLE B	SAMPLE C	SAMPLE D
Mn	45.2 ± 0.6	8.3 ± 0.3	125.2 ± 0.9	143.4 ± 0.9
Se	0.068 ± 0.009	0.12 ± 0.01	0.08 ± 0.01	0.037 ± 0.008
Cr	0.8 ± 0.3	BDL	BDL	BDL
Fe	334 ± 38	718 ± 47	333 ± 31	113 ± 24
Co	0.061 ± 0.012	0.07 ± 0.02	0.09 ± 0.01	0.082 ± 0.020
Zn	42.4 ± 3.6	41.2 ± 4.4	117 ± 5	95 ± 5
Sr	212 ± 25	BDL	BDL	BDL
La	0.31 ± 0.03	0.79 ± 0.08	0.17 ± 0.03	BDL
Sm	0.044 ± 0.005	0.123 ± 0.006	0.018 ± 0.005	BDL
Th	BDL	0.08 ± 0.02	BDL	BDL

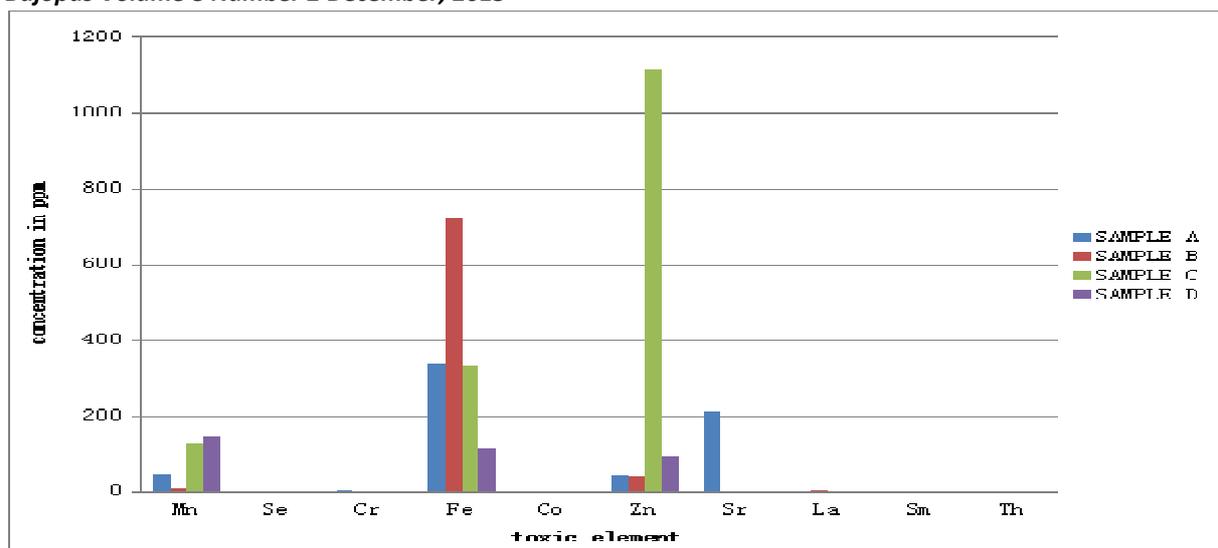


Fig. 1 shows the concentration of toxic element in samples A, B, C and D.

Results obtained on elemental concentrations of sample A, sample B, sample C and sample D are given in Table 1 and Figure 1. It can be observed from Table 1 and Figure 1 that the order of the concentration values of the elements for Sample A is Fe > Sr > Mn > Zn > Cr > La > Se > Co > Sm with Th found to be below detection limit, Fe > Zn > Mn > La > Sm > Se > Th > Co with Cr and Sr found to be below detection limit for Sample B, Fe > Mn > Zn > La > Co > Se > Sm with Cr, Sr and Th found to be below detection limit for Sample C, Mn > Fe > Zn > Co > Se with Cr, Sr, La, Sn and Th found to be below the detection limit for Sample D.

The toxicity of iron (Fe) is governed by absorption (Parekhan *et al.*, 2014). The more you take in the more you are at risk. Ferritin is a unique iron storage protein containing 24 storage proteins. When excess dietary containing iron is absorbed, the body produces more ferritin. Ferritin is greatly abundant in the heart and liver, therefore there is a large amount in these organs, and iron rushes to these organs for storage (Parekhan *et al.*, 2014; Okoye *et al.*, 2011; Ahmed, Y.A., 2008; Kogo *et al.*, 2009; and Oladipo, 2003;).

Zinc (Zn) concentration was found to be highest in the sample C followed by sample D, A and B respectively. Zinc is non toxic and essential element in human diet, too little Zinc is harmful to human health (Okoye *et al.*, 2011; Parekhan *et al.*, 2014; Reem *et al.*, 2012 and Surtipanti *et al.*, 1990). It was observed that the concentration of zinc in a samples A and B, were within the permissible limit of 10-50 ppm ($\mu\text{g/g}$), while the concentration in samples C and D is above the permissible limit set by (ATSDR 2004; Reem *et al.*, 2012 and Surtipanti *et al.*, 1990).

Fig 1 shows the concentration of Chromium (Cr) with value of $(0.8 \pm 0.3 \text{ ppm})$ in sample A is above the permissible limit (0.1 ppm), mean while the concentration of Chromium in samples B, C, and D, is below detection limit (BDL). Chromium is an essential element helping the body to use sugar, protein and fat

at the same time it is carcinogenic for organisms, excessive amounts of Cr may cause adverse health effects (ATSDR 2004; Parekhan *et al.*, 2014. Avegliano *et al.*, 2008 ; Kogo *et al.*, 2009; Oladipo, 2003; and Ahmed, 2008). The concentrations of Copper Cu, Selenium Se, Chromium Cr, Cobalt Co, Argon Ar, lanthanum La, Samarium Sm and Thorium Th in the entire sample were found to be Below Detection Limit (BDL), even though some of them have little importance in the feed and animal body. The result for elemental composition in the standard NIST 1515 (apple leaves) was found to be in excellent agreement with the certified value after the irradiation.

CONCLUSION

In this work, four (4) different samples of broiler feed were collected from different area to determine the concentration of toxic elements using neutron activation analysis (NAA). Result shows that the distribution of the toxic elements in sample C and sample D Nigeria broiler feed contain higher concentration of Zn compared to sample A and B, which shows that the concentration of Zn in the sample C and D is above the permissible limit. Sample B contained highest concentration of Fe compared to the other three samples A, C and D this shows that sample B contained some level of toxicity of iron compare to the other samples. The levels of the entire studied element were within the tolerance limit except Fe in sample B and Zn in sample C and D. We have demonstrated in this study that neutron activation analysis NAA method is ideal for determination of nutrients and heavy metals in broiler feed. Since the technique is a non-destructive one and requires no sample dissolution.

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