American Journal of Engineering Research (AJER) ***2016***
American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-5, Issue-7, pp-243-247
www.ajer.org
Research Paper Open Access

Detection of Chromium (Cr) using X-ray Fluorescence Technique and Investigation of Cr Propagation from Poultry Feeds to Egg and Chicken Flesh

Arifuzzaman Rajib[1], A.T.M. Saiful Islam[2], Md. Razu Ahmed[3], Md. Tariqur Rahman[4], Md. Atowar Rahman[5], Abu Bakar Md. Ismail[6]

[1,2]*(Applied Physics, Electronics and Communication Engineering, Bangabandhu Sheikh Mujibur Rahman Science and Technology University, Bangladesh)*
[3]*(Applied Chemistry and Chemical Engineering, Bangabandhu Sheikh Mujibur Rahman Science and Technology University, Bangladesh)*
[4,5,6]*(Applied Physics and Electronic Engineering, Rajshahi University, Bangladesh)*

ABSTRACT: *This paper presents possibility of detecting the presence of Chromium (Cr) in poultry in Rajshahi area using X-ray fluorescence (XRF) technique. It also investigates the propagation of Cr from poultry feeds to chicken flesh. Poultry feeds were collected from different vendors at Rajshahi. It was found that some of the locally produced poultry feeds contained a considerable amount of Cr that propagates to the chicken meat and egg. This Cr might be hazardous for human health. Among the four most widely used feeds in Rajshahi region maximum Cr concentration of 17.3 ppm was detected in "Adorsho feed (Pabna)". Transmission of Cr from feed to egg and various parts of chicken were investigated with chicken samples of different ages grown by feeding "Adorsho feed". An average of 4.3 ppm of Cr was found in Yolk and 2.7 ppm was found in the egg-white. Highest concentration of Cr was found to be 5.9 ppm in the brain of 29-days old chicken. The concentration of Cr was different in various parts of chicken depending on its age. The experimental results indicate that the XRF technique can be used efficiently to detect the presence and transmission of heavy metals like Cr from feed to egg and poultry.*

Keywords: *XRF, Heavy metal contamination, Chrome shaving in tannery, Chromium toxicity for human health.*

I. INTRODUCTION

Poultry is one of the major protein sources, cheap & available for people in Bangladesh. It is a promising sector. It requires large scale feed production activities. There are various sources of raw materials for poultry feed production. In many ways these sources can be associated with anthropogenic heavy metals, in particular Cr, pollution. It is better to monitor any probable propagation of heavy metals like Cr into the food chain through the final feeds rather than the various raw materials for feeds. There was news in the Daily Star on July 24, 2010, titled "**Toxic poultry feed poses health risk**" that expressed concern over the possible presence of heavy metals, particularly Cr in the poultry in Bangladesh. Human exposure to chromium occurs from both natural and anthropogenic sources. The oxidation state of Cr determines chemical and toxicological behaviors of Cr. Cr is considered as one of the most noxious heavy metals, which is listed as one of 129 priority pollutants by the USEPA. Cr can exist in many oxidation states but its most stable forms are Cr (III) and Cr (VI). Cr (VI) is highly toxic and responsible for health hazards like mutation, cancer and cell damage [1]. Therefore it is important to quantify Cr in the poultry feed and its percentage transporting into chicken and eggs [2]. This article the focus of investigation is therefore the determination of Cr in poultry feed, chicken and eggs. In Bangladesh, the tannery, ceramic, textile dying and sulfuric acid producing industrial sites are especially associated with heavy metal pollution [3]. Almost all of the tanning industries in Bangladesh tan hides using chrome tanning method which is associated with vigorous chromium contamination both in liquid and solid waste form disposal. Over the last several years poultry has become a very popular and promising sector in Bangladesh. A large section of Bangladesh people consume poultry meat and egg to fulfill their protein demand. Conventionally, heavy metals, particularly Cr is quantified by atomic absorption spectroscopy (AAS), Inductively-coupled plasma spectroscopy (ICPS) etc, which are costly,

time consuming and require sample preparation [4,5, 6]. In contrast, XRF is fast, low-cost and require no sample preparation [7, 8, 9, 10].

In our study, it was found that among various brands of poultry feeds in the Rajshahi market "Adorsho feed" brand that is produced in Pabna district, contained highest concentration of Cr. Accordingly, the poultry samples for this study were collected from a farm at Amgchi Bazar in Horian union of Rajshahi that use "Adorsho feed" for their chicken raising. Collected poultry were analyzed for heavy metals, particularly Cr, in the six major parts of poultry. These parts are brain, liver, kidney, stomach, flesh (fillet), heart. Poultry chicken of various ages, 22, 29 and 36 days, but of same batch (same firm and feeding the same feeds) were investigated.

II. RESULTS AND DISCUSSIONS

XRF technique was used to detect the Cr in poultry feeds and then in chicken flesh. There are many commercial producers of poultry feed in Bangladesh. The feed samples were selected from the four widely used feeds in Rajshahi city, namely, Adorsho feed (Pabna), City feed (Narayngong), Mono feed (Gazipur), Index feed (Mymensing). Samples were collected in pre-cleaned plastic bag. Without further processing, the feed samples were made as pellet using pellet making machine as the XRF machine could only analyze samples in the shape of pellet. Boric Acid was used as a grinding and briquetting agent for feed samples. This is particularly suitable for processing samples with strong re-welding tendencies, and results in XRF sample pellets that are fair to moderately bond together. For the detection of Cr in chicken flesh various parts of the chicken were investigated. The chicken parts were analyzed as it is without any sample preparation.

EDX-3600B from Skyray® Instruments Ltd, USA was used for XRF analysis. The Restriction of Hazardous Substance (RoHS) directive was used in this project. RoHS directive was issued in 2003 by the European Commissiona that restricts the use of six substances, Lead, Mercury, Cadmium, Hexavalent Chromium, Polybrominated biphenyls (PBB) and Polybrominated diphenyl ethers (PBDE) to improve environmental quality. A typical energy spectrum that shows the Cr content is given in Fig 1. Fig 2 shows the Cr concentration in ppm in poultry feed samples. Figure 13: G-V hysteresis curves of Al/Si-NCs/ITO structure at different frequencies.

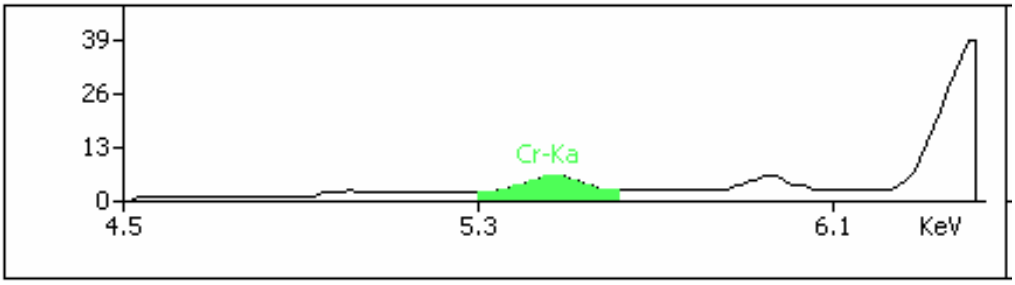

Figure 1. Typical spectrograph of XRF machine.

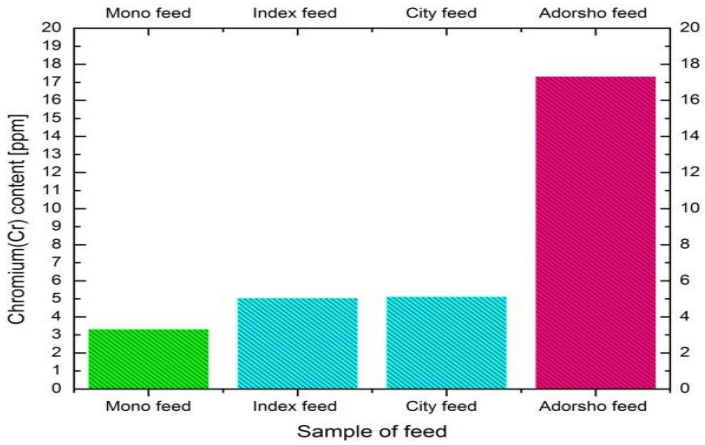

Figure 2. Cr levels in the analyzed feed samples.

The detected Cr-concentrations were found to be: 3.56 ppm in Mono feed (Gazipur), 5.03 ppm in Index feed (Mymensing) , 5.665 ppm in City feed (Narayngong) & 17.3 ppm in Adorsho feed (Pabna). In the

commercial feed types, Mono feed (Gazipur) contained the minimum levels of these heavy metals. In contrast, Adorsho feed (Pabna) contained the maximum levels of heavy metals. So, Adorsho feed was investigated in details.

The poultry samples were collected from a poultry farm at "Amgchi Bazar" in Horian union of Rajshahi that use "Adorsho feed" for their chicken raising. Each whole chicken sample was separated in 6 different body parts. These parts were Liver, Heart, Brain, Kidney, Flesh and Stomach. Next these parts were frozen in house-hold freezer. From these frozen parts few samples were randomly dissected for XRF analysis. Accumulation of Cr with aging of poultry was also investigated by repeating the Cr analysis in 22, 29 and 36 day-old chickens. Eggs were collected from "Amgachi Bazar" poultry farm. The egg samples were boiled desecrated in two parts, albumin and yolk, for XRF analysis.

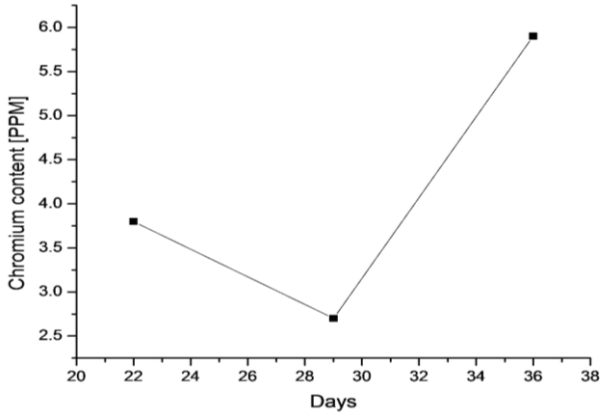

Figure 3. Accumulation of Cr with age in kidney of chicken.

Fig 3 shows the accumulation of Cr in the kidney of chicken. The distribution of Cr in various parts of chicken with aging is compiled in Table 1. The value of Cr in the table is an average value of three samples, i.e, Cr concentration of 36-day old chicken kidney, 5.9 is an average value of 3 parts of kidney of the of 36-day old chicken. The average value of Cr in six parts of chicken remains almost same, which is 3.74 ppm, irrespective of age. But the distribution of Cr varies with the age and parts of chicken. The exact cause of this distribution is not known. Fig 4 shows the Cr content in eggs. These eggs are from the same poultry farm, where the Layer chickens are fed "Adorsho feed".

Sample parts	Cr in ppm		
	22-day old chicken	**29**-day old chicken	**36**-day old chicken
Kidney	**3.8**	**2.8**	**5.9**
Brain	**3.5**	**5.8**	**2.8**
Heart	**4.7**	**2.7**	**3.5**
Liver	**4.1**	**2.6**	**2.5**
Stomach	**4.0**	**3.5**	**3.4**
Flesh	**2.8**	**5.8**	**3.0**

Table 1: Accumulation of Cr in various parts of chicken sample with aging of chicken.

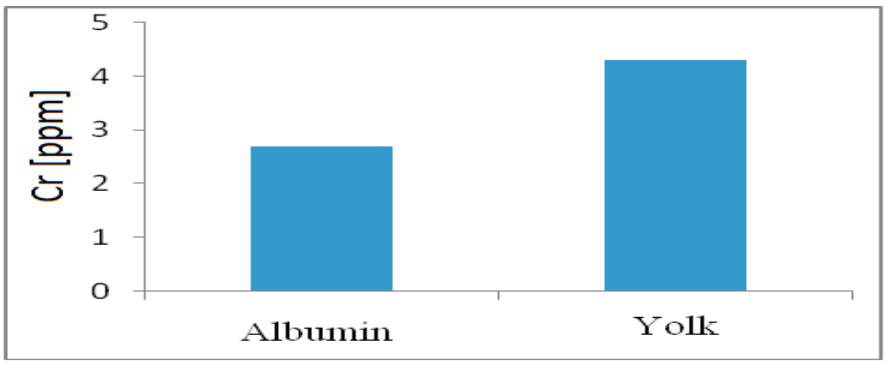

Figure 4. Cr content in Albumin and Yolk of boiled egg.

The effect of cooking of the chicken parts was not investigated. It has been pointed out in the published reports [11, 12] that the cooked fishes contained increased the metal content, particularly Cr, from its raw form. The percentage of transmission of Cr from the poultry feed to chicken flesh has been derived from the following relation.

$$Transmitted\ Cr\ in\ chicken\ from\ feed = \frac{\text{Average value of Cr in chicken}}{\text{Average value of Cr in feed}} \times 100 = \frac{3.74}{17.3} \times 100 = 21.62\%$$

From the above equation it appears that nearly 21.5% of Cr in poultry feed is being transmitted from the poultry feed to chicken flesh.

III. CONCLUSIONS

Chicken is an important source of protein in Bangladesh and widely consumed in all over Bangladesh. The risk associated with the exposure to Chromium (Cr) present in food product had aroused widespread concern in human health. Investigated all the poultry feeds contained considerable amount of Cr. The highest concentration of Cr was found in "Adorsho Feed" of Pabna, Bangladesh. The chickens that are raised by feeding "Adorsho Feed" also contained Cr above normal level. Based on poultry feed samples testing during the present study, metals could have been transferred via poultry feeds to poultry chickens and eggs. The white portion (Albumin) of egg is more appropriate for eating than yolk. The high average value (3.74) of Cr in chicken certainly points its root to the production of poultry feed from the tannery waste, that results from the chrome shaving of lather. X-Ray Fluorescence (XRF) has been used in this study to do fast screening of Cr in poultry feed and various parts of chicken. It can be concluded that instead of costly heavy metal analysis by AAS, ICPS etc, very simple and low-cost XRF technique can efficiently detect Cr in feeds, eggs and poultry chickens.

ACKNOWLEDGEMENTS

This work was funded by the Department of Applied Physics and Electronic Engineering, University of Rajshahi, Rajshahi 6205, Bangladesh. The authors acknowledge the help of central science laboratory of University of Rajshahi for XRF characterization support.

REFERENCES

[1] Agency for Toxic Substances and Disease Registry (ASTDR), Toxicological profile for chromium, U.S. Department of Health and Human Services (Atlanta, GA, 2000).

[2] L. T. Mazumder, S. Hasan, and M. L. Rahman, Hexavalent Chromium in Tannery Solid Waste Based Poultry Feed in Bangladesh and Its Transfer to Food Chain, *IOSR Journal Of Environmental Science, Toxicology And Food Technology (IOSR-JESTFT), Volume 3*, pp. 2319, 2013.

[3] M. A. Kashem, B.R. Singh,Heavy metal contamination of soil and vegetation in the vicinity of industries in Bangladesh, *Water, Air and Soil Pollution, Volume 115*, pp. 347, 1998.

[4] M Shahidul Islam, M Azizul Islam Kazi, M Moazzem Hossain, M Aminul Ahsan, AMM Maruf Hossain, Propagation of Heavy Metals in Poultry Feed Production in Bangladesh, *Bangladesh Journal of Scientific and Industrial Research,Volume 42*, pp. 4, 2007.

[5] C. O. Bokoye, C. N. Ibeto and J. N. Ihedioha, Assessment of heavy metals in chicken feeds sold in south eastern, Nigeria, *Advances in Applied Science Research,Volume 2*,pp. 63, 2011.

[6] I.V. Popescu, C. Stihi, Gh.V. Cimpoca, G. Dima, Gh. Vlaicu, A. Gheboianu, I. Bancuta, V. Ghisa,G. State, Environmental Samples Analysis by Atomic Absorption Spectrometry (AAS) and Inductively

Coupled Plasma-Optical Emission Spectroscopy (ICP-AES), Rom. *Journ. Phys. Volume 54*, pp. 741, 2009.

[7] B. Constantinescu, R. Bugoi, E. Oberländer-Târnoveanu, K. Pârvan, Medieval silver coins analyses by PIXE and ED-XRF techniques, Rom. *Journ. Phys. Volume 54*, pp. 481, 2009.

[8] Gh. Vlaicu, N. Pavel, F. Parsan, C. Stihi, G. Dima, Comparative study concerning the X-ray fluorescence analysis of the pressed and molten slag samples, *Revista de Chimie Volume 58*, pp. 1154, 2007.

[9] V. Ghisa, I.V. Popescu., M. Belc, A. Ene, Study of Some Roman Brooches Discovered at Tomis–Constanta, by X-Ray Fluorescence Technique, Rom. *Journ. Phys. Volume 53*, pp. 557, 2008.

[10] Laura A. Hutton, Glen D. O'Neil, Tania L. Read, Zoë J. Ayres, Mark E. Newton, and Julie V. Macpherson, Electrochemical X-ray Fluorescence Spectroscopy for Trace Heavy Metal Analysis: Enhancing X-ray Fluorescence Detection Capabilities by Four Orders of Magnitude, *Anal. Chem., Volume 86*, pp. 4566, 2014.

[11] José L. Domingo, Influence of Cooking Processes on the Concentrations of Toxic Metals and Various Organic Environmental Pollutants in Food: A Review of the Published Literature, *Critical Reviews in Food Science and Nutrition, Volume 51*, pp. 29, 2010.

[12] N. Kalogeropoulos, S. Karavoltsos, A. Sakellari, S. Avramidou, M. Dassenakis, M. Scoullos, Heavy metals in raw, fried and grilled Mediterranean finfish and shellfish, *Food and Chemical Toxicology, Volume 50*, pp. 3702–3708, 2012.

[13] F. I. Bassey, F. C. Oguntunde, C. M. A. Iwegbue, V. N. Osabor, C. A. Edem, Effects of processing on the proximate and metal contents in three fish species from Nigerian coastal waters, *Food Science & Nutrition, Volume 2*, pp. 272, 2014.