ISSN: 2224-0616
Int. J. Agril. Res. Innov. & Tech. 6 (2): 57-60, December, 2016 Available online at http://www.ijarit.webs.com

CHROMIUM AND LEAD CONTAMINATION IN COMMERCIAL POULTRY FEEDS OF BANGLADESH

J.S. Jothi[1,5*], N. Yeasmin[2], I.Z. Anka[3] and S. Hashem[4,6]

Received 21 September 2016, Revised 9 December 2016, Accepted 27 December 2016, Published online 31 December 2016

Abstract

Heavy metals contamination into food chain is considered as an emerging crisis throughout the world especially in developing countries like Bangladesh. The concentration of heavy metals including Cr and Pb in commercial poultry feed samples (protein meal feed, meat and bone meal and fish meal feed) were detected by using Air/ Acetylene Flame Atomic Absorption Spectrophotometer. The mean concentration of heavy metals were found in protein meal feed in a range where Cr 10.63 to 218.10 mg kg^{-1} and Pb 7.37 to 52.25 mg kg^{-1}. In meat and bone meal feed samples, Cr was recorded from 9.15 to 40.59 mg kg^{-1} and Pb 5.0 to 61.42 mg kg^{-1}. Cr was found 17.68 to 78.39 mg kg^{-1} and Pb 3.54to 16.44 mg kg^{-1} in fish meal feed samples. However, results showed that all feed samples contained chromium and lead where both metals were present at alarming levels in most of the samples. It is therefore suggested that regular detection of heavy metals especially Cr and Pb should be done to evaluate the health risks and to protect the end user from food that might harmful for their health.

Keywords: Heavy Metal, Protein Meal Feed, Meat and Bone Meal, Fish Meal Feed, Bangladesh

[1]Department of Food Processing and Engineering, Chittagong Veterinary and Animal Sciences University, Bangladesh
[2]Department of Applied Food Science & Nutrition, Chittagong Veterinary and Animal Sciences University, Bangladesh
[3]Department of Aquaculture, Chittagong Veterinary and Animal Sciences University, Bangladesh
[4]Department of Aquaculture, Bangladesh Agricultural University, Bangladesh
[5]Department of Biofunctional Science and Technology, Graduate School of Biosphere Science, Hiroshima University, Japan
[6]Department of Bioresource Science, Graduate School of Biosphere Science, Hiroshima University, Japan

*Corresponding author's email: juthi.engg.bau@gmail.com (J.S. Jothi)

Introduction

The tanning industries of Hazaribagh, Bangladesh are manufacturing hide about 220 metric ton day^{-1} with the discharge of 600-1000 kg of solid waste/ton processed hide. The tannery solid wastes are used as poultry feed, fish feed, and in production of organic fertilizers by converting to protein-concentrate with some treatment. Recently numerous large and small mills are established to renovate protein-concentrate (about 200-250 tons day^{-1}) from tannery solid wastes. Heavy metal, particularly chromium (Cr), is one of the significant threats, utilized as a part of the tanning processes. In perspective of the actualities, chromium may immigrate to poultry items and besides biomagnifies into food chain (Hossain *et al.,* 2009).

Through bioaccumulation heavy metals are responsible for producing some toxicity in human such as neurotoxicity, nephrotoxicity, fetotoxicity and teratogenicity which may led disturbance in blood, gastrointestinal, nervous systems and cardiovascular system, changes in the detoxification pathways (colon, kidney, liver, skin), release and functioning of various hormone. Because of heavy metal contamination, mental behaviour, neurological functions and utilization of neurotransmitter may be deviated in human body (Iftikhar *et al.,* 2014).

Preliminary studies in different parts of the world indicate that poultry feeds are exposed to contamination by heavy metals and trace elements. Hossain *et al.* (2007) analyzed various types of solid tannery waste (used for protein-concentrate production) for chromium, cadmium, lead, arsenic, and mercury contents in Bangladesh. The maximum chromium content of the solid waste was found to be 3.2%. Zhang *et al.* (2012) found that poultry feed had high concentrations of heavy metals in China. Similarly, high levels of heavy metals were found in poultry feed in Pakistan (Iftikhar *et al.,* 2014).

However, there is invariably insignificant data in literature performed on heavy metal contamination in poultry feed available in the different markets of Bangladesh. Hence, the study is important to meet a void in research. The aim of this study was to assess the levels of chromium (Cr) and lead (Pb) concentration in selected poultry feed (Protein meal, meat and bone meal and fish meal) samples available in the different markets of Bangladesh.

Materials and Methods

Collection of poultry feed samples

Commercial poultry feed samples as protein feed, meat and bone meal and fish meal were collected from markets of different locations (each districts) in Bangladesh. For analyzing the parameters, protein feed samples were coded as Brand PM_1 to Brand $PM_{10,}$ meat and bone meal samples were coded as Brand MBM_1 to Brand MBM_{12} and fish meal samples were coded as Brand FM_1 to Brand FM_7.

Preparation and analysis of feed specimens

A total of 290 commercial poultry feed samples including 10 brand of protein feed, 12 brand of meat and bone meal and 7 brand of fish meal along with 10 replicates each were purchased from different markets in Bangladesh. Samples were prepared by wet digestion method as described by AOAC (2005). 2g of feed was digested by 10ml M HNO_3 for 24 hrs, then heated at 200ºC for 15-20 minutes and cooled 5 to 10 minutes, after that added 10 ml of Aqua regia (HNO_3: HCl, 3:1), reheated to ensure dryness and cooled for 5 to 10 minutes. Then diluted with 100 ml of distilled water, filtered through Whatman filter paper No. 42 and finally stored in volumetric flask. The required volume (100 ml) of the filtrate was used to measure heavy metal levels in feed samples by using Air/ Acetylene Flame Atomic Absorption Spectrophotometer (Analytikjena, ZEEnit Model: 300P, Germany). At each step of digestion processes, acid blanks (laboratory blank) were prepared in order to ensure that the samples and chemicals used were not contaminated. They were analyzed by atomic absorption spectrophotometer before the samples and their values were subtracted to ensure that the equipment read only the exact values of heavy metals. Each set of digestion has its own acid blank and was corrected by using its blank. Each standard solution was measured 3 times and the mean were plotted. A blank solution of distilled water was used to check accuracy of the standard solutions and it was run after every 10 samples. The absorption wave lengths for the heavy metals were 357.87 nm for Cr and 217.0 nm for Pb.

Statistical analysis

The data that were obtained from the experiments were statistically analyzed to find the mean and standard deviation among the various samples in triplicate. Data were analyzed using the software, IBM SPSS Statistics, version 20 at the 0.05 level.

Results and Discussion

Cr and Pb content in Protein meal feed samples

The mean concentration and associated standard deviation of Cr and Pb in commercial protein feed meal samples are presented in Table 1. The mean concentrations were found in commercial protein feed meal samples in the range as Cr 10.63±1.52 to 218.1±2.54 mg kg^{-1} and Pb 7.37±0.48 to 52.25±0.97 mg kg^{-1}.

In case of protein feed meal samples highest chromium concentration was found in brand PM_5 (218.10 mg kg^{-1}) and lowest chromium concentration was found in brand PM_7 (10.63 mg kg^{-1})**.** In the regulations of EU (2003), there are no maximum allowed concentrations of chromium for feed ingredients and compound feed. However, chromium was detected in all commercial protein feed meal samples at high level. The maximum allowed limits for chromium concentrations in food lies between 0.1 and 0.5 mg kg^{-1} for human (Alkhalaf *et al.,* 2010). The source of chromium in poultry feed samples could be from tannery solid waste and 3956 mg L^{-1} Cr might be presented in its effluent (Tariq, 2009).

Table 1. Concentration of Cr and Pb in Protein feed meal samples.

Brand name	Chromium (Cr)		Lead (Pb)	
	Concentration (mg kg^{-1})	RSD[%]	Concentration (mg kg^{-1})	RSD[%]
PM_1	130 ± 11.85	9.1	52.25±0.97	1.9
PM_2	83.52 ± 2.69	3.2	16.94±1.56	9.2
PM_3	19.24± 1.72	9.0	16.52±0.84	5.1
PM_4	15.04± 0.86	5.7	10.39±0.59	5.7
PM_5	218.1±2.54	1.2	9.18±1.01	11
PM_6	19.76±0.88	4.5	10.91±1.30	11.9
PM_7	10.63±1.52	14.3	49.77±0.88	1.8
PM_8	143.1±5.37	3.8	8.71±0.74	8.5
PM_9	45.26±1.11	2.5	7.73±0.13	1.6
PM_{10}	60.61±3.3	5.4	7.37±0.48	6.5
Reference Standards				
EU 2003 (ppm)	0		5	

Pb content in Brand PM_1 (52.25 mg kg^{-1}) was higher followed by Brand PM_7 (49.77±0.88 mg kg^{-1}), Brand PM_2 (16.94±1.56 mg kg^{-1}), Brand PM_3 (16.94±1.56 mg kg^{-1}), Brand PM_6 (10.91±1.30 mg kg^{-1}), Brand PM_4 (10.39±0.59 mg kg^{-1}), Brand PM_5 (9.18±1.01 mg kg^{-1}), Brand PM_8 (8.71±0.74 mg kg^{-1}), Brand PM_9 (7.73±0.13 mg kg^{-1}) and Brand PM_{10} (7.37±0.48 mg kg^{-1}). Contamination levels of heavy metal in feed were compared to the permissible limits recommended by European Union (EU). In this research, all protein feed samples had excess amount of Pb whereas acceptable limit is 5.0 mg kg^{-1} for feed according to EU (2003).

Cr and Pb content in meat and bone meal feed samples

The mean concentrations and associated standard deviations of Cr and Pb in meat and bone meal feed samples are presented in Table 2. The mean concentrations of heavy metals were found in all meat and bone feed meal samples in the range as Cr 9.15±1.29 to 40.59±1.54 mg kg^{-1} and Pb 5.0±1.4 to 61.42±0.38 mg kg^{-1}.

The maximum concentration of Cr was observed in Brand MBM_6 whereas minimum concentration was observed in Brand MBM_1. Chromium was detected in all meat and bone feed meal samples. According to EU (2003), chromium is not allowed at any concentration in poultry feed ingredients. From this experiment, all commercial samples contain Cr that might be very hazardous by entering into food chain.

Table 2. Cr and Pb concentration in Meat and bone feed meal samples

Brand name	Cr		Pb	
	Concentration (mg kg^{-1})	RSD[%]	Concentration (mg kg^{-1})	RSD[%]
MBM_1	9.15±1.29	14.1	61.42±0.38	0.6
MBM_2	20.37±1.87	9.2	20.13±0.55	2.7
MBM_3	25.64± 5.67	0.2	21.20±0.87	4.1
MBM_4	24 ± 2.48	10.3	5.0±1.4	27.9
MBM_5	21.92±1.04	4.8	9.88±1.22	12.4
MBM_6	40.59±1.54	3.8	8.36±1.26	15.1
MBM_7	13.09±.47	3.6	6.11±0.98	16.1
MBM_8	15.82±2.13	13.4	10.96±0.80	7.3
MBM_9	23.83±2.51	10.5	11.02±1.13	10.2
MBM_{10}	30.14±2.11	7.0	17.49±0.48	2.7
MBM_{11}	28.88±2.55	8.8	6.4±0.80	12.4
MBM_{12}	32.02±.31	1.0	10.42±0.29	2.8
Reference Standards				
EU 2003 (ppm)	0		5	

The level of Pb was detected highest in Brand MBM_1 (61.42±0.38 mg kg^{-1}) and lowest in Brand MBM_4 (5.0±1.4 mg kg^{-1}). According to the EU (2003) maximum permissible concentration for Pb is 5 mg kg^{-1} in feed. In this study, about 92% meat and bone meal feed samples had excess amount of Pb whereas acceptable limit is 5.0 mg kg^{-1} for feed according to EU standard. Usually 4.362 mg L^{-1} lead could be existed in the effluent from tanneries (Tariq, 2009) which might be a source of Pb contamination in meat and bone feed meal samples.

Cr and Pb content in Fish feed meal samples

The mean concentrations of Cr and Pb in commercial fish feed meal samples are presented in Table 3. In fish feed meal samples, the mean concentration of Cr was recorded as 17.68 to 78.39 mg kg^{-1} and Pb 3.54 to 16.44 mg kg^{-1}.

Cr content in Brand FM_7 (78.39 mg kg^{-1}) were higher and in Brand FM_3 and Brand FM_5 (17.68 mg kg^{-1}) were lower in fish feed meal samples. Chromium was detected from all fish feed meal samples. There is no maximum allowed concentrations of chromium for feed ingredients and compound feed in EU (2003) regulations.

The highest Pb content was found 16.44 mg kg^{-1} in Brand FM_6 while the lowest value was found 3.54 mg kg^{-1} in Brand FM_4. It was found that mean concentrations of Pb from all commercial fish feed meal samples were 14% below, 29% optimum and 57% higher than the maximum permitted concentrations (5.0 mg kg^{-1}) recommended by EU (2003). Lead toxicity is known to cause musculo-skeletal, renal, ocular, neurological, immunological, reproductive and developmental effects (Ambedkar and Muniyan, 2012).

Table 3. Concentration of Cr and Pb in fish feed meal samples.

Brand name	Cr		Pb	
	Concentration (mg kg^{-1})	RSD[%]	Concentration (mg kg^{-1})	RSD[%]
FM_1	18.90±3.28	1.7	11.13±1.08	9.7
FM_2	49.11±3.10	6.3	6.4±0.31	4.9
FM_3	17.68±2.65	1.5	8.91±1.55	17.4
FM_4	20.69±0.25	1.2	3.54±0.37	9.4
FM_5	20.99±2.0	9.5	4.40±0.49	11.1
FM_6	17.68±1.95	1.1	16.44±0.68	4.1
FM_7	78.39±0.69	0.9	4.94±1.66	33.7
Reference Standards				
EU 2003 (ppm)	0		5	

Conclusion

Now-a-days, heavy metal contamination is predominant throughout the Bangladesh and hence presented as an alarming level in poultry feed. Cr and Pb concentrations in poultry feeds are important to know in order to regulate the consumption of poultry products. The present study showed that all feed samples contained chromium and lead. However, Chromium concentration is higher in protein meal feed and lead concentration is higher in meat and bone meal samples than other feed samples. The current regulations do not permit chromium in poultry feed. The average chromium content in all feed samples was several times higher than allowed chromium concentrations for human foods. More detailed research is needed for investigation of six-valent chromium and it's potential hazards in animal and human. Lead was higher for maximum studied commercial poultry feed samples than those specified EU (2003) in 5.0 mg kg^{-1}. It is therefore suggested that regular survey of heavy metals especially Cr and Pb should be done to evaluate health risks and to find possible protective measures to avoid the health injuries.

Acknowledgements

The authors gratefully acknowledge to the Faculty of Food Science and Technology, Chittagong Veterinary and Animal Sciences University, Bangladesh for providing the facilities to carry out this research work. Authors also like to express their sincere gratitude to the authority of Bangladesh University Grants Commission, Bangladesh for providing funds for this project.

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