RESEARCH ARTICLE

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Determination of Heavy Metals (Pb, Cd) and Evaluation of Commercially Produced Broiler Feed Available in Bangladesh

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ABSTRACT

The study was conducted to evaluate the quality of ready-made broiler feed (starter and grower) procured from seven different feed mills of five divisions of Bangladesh. Seven feed mills were selected randomly from the different region of Bangladesh. Broiler starter and grower feed were collected from each of the feed mills by purchasing method for assessing the heavy metal contents i.e., Pb and Cd in this study. A total of 210 feed samples (105 starter and 105 grower) was collected from the selected feed mills and analyzed to determine the concentration of toxic metals (Pb, Cd) in feed materials. The quality of incoming feed samples was appraised on the basis of sensorial and visual characteristics and laboratory analyses. The data revealed that broiler starter (BSF) and grower feed (BGF) of seven feed mills appeared to be good based on organoleptic test by assessing sensorial and visual characters (e.g., colour, texture, size, smell, flavor, odour, dust particle, foreign matter, stone, sand etc.) of the observed feed samples. The heavy metal data (Pb, Cd) of broiler starter and grower feed samples from laboratory analyses of five divisions of seven feed mills showed no variation (P>0.05) between treatment. Though the Pb and Cd contents of broiler feed samples of five divisions of seven feed mills together had no difference (P>0.05), but significant variation (P<0.01) was observed in the various feed samples of individual division (Dhaka, Chittagomg). It can be concluded that the quality of broiler feed of different feed mills appears to be good based on the chemical evaluation, even though variation was found in the toxic metal contents of individual division's feed samples only. The analyzed concentration of toxic metals of feed samples wre within the range or limits of the acceptable level, so here had no possibility of causing public hazard for the consumer world through after consumption of feed by the broiler chicken.

Keywords: Feed quality, Feed mill, Ready-made broiler feeds (starter and grower), Toxic metals (Pb, Cd).

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I. Introduction

Bangladesh is mainly an agricultural country in the world, and poultry farming is considered as an integral part of agriculture, which is creating enormous job opportunity for the people of Bangladesh [1]. As a result, small and large scale poultry farms are expanding rapidly, and providing meat, eggs and employment to the people of Bangladesh. People are also facing manifold problems with the increase of farming activities and productivity. We can trace one salient problem in both developed and developing countries is the environmental pollution with heavy metals and metalloids [2]. The toxicity and necessity of heavy metals have been studied lot for their toxic effects and bioaccumulation in food chains [3]. In addition to their essentiality for human nutrition, some micronutrients say copper, chromium and nickel could cause toxicity at the higher concentration [4[. Apart from these metals, some other toxic elements namely arsenic (As), cadmium (Cd) and lead (Pb) could easily enter into the food chain and cause health risk for the man and animals [4]. Arsenic, cadmium chromium, nickel and lead are deemed to be the most poisonous metals in the environment as per the declaration of US-EPA [5]. Consumption of these toxic elements for longer period of time by living beings could have a detrimental effect even at low concentration. For example, metal Pb is involved in the reduction of mental health of children causing pathological changes in the vital organs and CNS. Moreover, Cd could expose toxic effect on the vital organs of the body, particularly cardiovascular system, kidneys, and bones [6].

Some heavy metals are essential for living beings, but many home and abroad organizations reported that when the toxic metal contents go beyond the acceptable level could

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show physical problems. The access of heavy metals in feed or food materials takes place by means of natural and anthropogenic ways including various range of process and avenues. The non-biodegradable nature of heavy metals and gradual deposition of their contents in the animal body might be toxic and carcinogenic. The study is aimed to evaluate the possible presence of heavy metals in poultry feed and consequently the effects of heavy metals from poultry meat to the people of Bangladesh.

The major animal protein source is the poultry meat amongst others for the people in Bangladesh. It is a promising and flourishing sector. It requires large scale feed production activities. We usually formulate poultry feed by the different sources of resources or available raw materials found in the nature. The feed resources can be polluted by different ways. In a developing country like Bangladesh, we see the major sources of environmental pollution by heavy metals are the wastages retrieved from the tannery and textile industries. The availability of these wastes in poultry feed could warrant further exploration or systematic research to determine the extent of contamination of heavy metal pollutants.

The residual effect of broiler feed and meat might aggravate the situation. As we know that toxic elements are non-biodegradable and do not spoil easily, as a result the metals start to deposit in soil or animal bodies continually. Toxic metals such as Pb and Cd in particular, have a great potential to cause disorders in living organisms. It is important to explore the actual sources or existence of heavy metals into the food chain through the finished products rather than the individual feed materials used for the formulation of broiler ration. For this reason, local market available feeds of different district of Bangladesh are taken into consideration for conducting this study to measure the content of heavy metals (Pb, Cd) using Atomic Absorption Spectrophotometer (AAS).

Heavy metals and metalloids could play an important role in human body. In this study, concentrations of two toxic metals (Pb, Cd) in broiler feed collected from the five divisions of Bangladesh were assessed. However, the study might be helpful for the farmers, or could play an important role to improve the broiler productivity through the reduction of poultry feed cost [7]. Further, the findings could assure broiler feed, meat quality and safety, and the data will act as a guideline for supplying quality feed to the consumer world or health-conscious people across the globe. Many stakeholders, poultry enterprises, feed mill companies, farm integrators and other personnel involved in the poultry farming might be benefitted from this sort of study. After all, the study could play a pivotal role in detecting poisonous metals of broiler feed sample assuring feed quality, consumer health and food safety of Bangladesh. Considering the above points, the aim of the current study was to explore the concentration of selected metals (Pb and Cd) contaminating poultry feed available in the different feed mills of Bangladesh.

II. Materials and Methods

A. Study Area and Experimental Period

The study area was incorporated five divisions or districts (e.g., Dhaka, Chittagong, Razshahi, Khulna and Rangpur) of Bangladesh. Research materials say broiler feed (starter and grower) samples were collected from these areas for conducting the experiment. All the laboratory works were performed at the QC Lab, DLS, Dhaka, Bangladesh. The study period was from November 2020 to December 2021.

B. Ethical Study

The study was dealt with only inert materials (feed), so no ethical approval was needed for undergoing this sort of study/

C. Selection of Feed Mills and Sample Collection

Seven feed mills were selected from the five divisions of Bangladesh. Feed mills were selected randomly by surveying based on the number of criteria such as production per day, price, availability, reputation, selling rates, farmer's acceptability and appreciation, Starter and grower diet samples were collected by purchasing from those selected feed mills during the study period. Later three or fifteen sub-samples were made from each treatment or bulk sample and stored in an air sealable plastic bag before undergoing lab analyses. Prior to lab analyses the physical and or sensorial characteristics of the incoming feeds were also observed minutely just after arrival of the purchased feeds (Table I).

TABLE I: Physical and or Sensorial Characteristics of the Incoming Feed Materials of Different Feed Mills

Type of feed	Characters of feed	Observation	Comments
Broiler starter feed (BSF)	Colour	Grey to brownish	Satisfactory
	Odour/smell/flavour	Acceptable flavor, no offensive smell or bad odour	
	Dust particle	No dust particle	
	Stone /sand	No stone or sand	
	Foreign body	No external foreign matter found	
	Texture/size	Apparently good, crumble, permissible size/texture	
Broiler grower feed (BGF)	Colour	Brownish	Satisfactory
	Odour/smell/flavour	No offensive smell or bad odour	
	Dust/stone/sand/dirt particles present	Not applicable	
	Foreign body	No external foreign matter found	
	Texture/size	Pelleted form and suitable for growing broiler	

D. Sample Preparation and Analysis Procedure

A total number. of 210 broiler feed samples (105 starter and 105 grower) was collected during 2021. Collected samples were dried and ground by pestle and mortar, and then taken for the lab analysis. For the digestion of samples, approximately 0.5 gm of feed sample was digested with 8ml of HNO_3 (65%) and 2 ml of H_2O_2 (30%) in acid pre-washed Teflon vessels. The digestion procedure was done by Microwave acid digestion system (Ethos Easy Milestone) After digestion, it was diluted 50 ml final volume with deionized water. Each batch of digestion set was used to make the reference material analytical blanks. All samples were done three times. Diluted samples and the standard solution were separately put into a set of fresh tubes for analyses. The analysis was done by Atomic Absorption Spectrophotometer (Shimadzu Model FAAS & GFAAS-7000). The method of analysis was followed standard validated and internal developed validated method for each metal. The content of heavy metals (Pb, Cd) of feed samples were measured at 283.30 and 228.8 nm wavelength, respectively.

E. Statistical Analysis

Statistical software Minitab [8] was used to analyze all the collected data of this study. One-way ANOVA with diet as a factor was used to complete the data analyses. The significance of differences between means was determined by Fisher's least significant difference at $P \leq 0.05$.

III. Results

A. Heavy Metal Contents of Broiler Starter Feed (BSF) of Different Feed Mills

The analytical values of heavy metal contents (Cd, Pb) of the BSF samples were shown below in Tables II–IV. The data showed that analyzed values of Pb and Cd of BSF procured from five different divisions were identical (P>0.05) between treatment (Table II), but variation (P<0.01) was observed between treatment only in division-wise feed samples retrieved from Chittagong and Dhaka division, respectively (Tables III, IV). The statistically similar but highest contents of Cd were found in the feed samples of BSF-A (8.16 µg/kg) and BSF-D (8.28 µg/kg) group whereas lowest amount of Cd was found in BSF-B (3.20 µg/kg) and BSF-F (3.16 µg/kg) group, respectively, in Dhaka. Actually, no significant (P>0.05) variation was found in the feed samples of Chittagong division for Cd, even though marginal (P<0.096) difference was observed between treatment in Cd content for the feed samples of Chittagong division (Table IV). The amount of Pb content in the BSF samples of Dhaka and Chittagong divisions differed significantly (P<0.01) between treatment (Tables III, IV). In Dhaka, the highest content of Pb (P<0.01) found in BSF-E (218.93 µg/kg) and BSF-D (211.07 µg/kg) and lowest amount being in BSF-A (158.30 µg/kg) and BSF-G (162.62 µg/kg) dietary group, respectively. In Chittagong, the highest content of Pb (P<0.01) found in BSF-A (600.38 µg/kg), BSF-G (595.0 µg/kg) and lowest amount being in BSF-D (279.24 µg/kg) dietary group, respectively.

B. Heavy Metal Contents of Broiler Grower Feed (BGF) of Different Feed Mills

The results of Cd and Pb contents in BGF demonstrated in Tables V-VII. Similar trend was observed as those found in the BSF stated above. The data revealed that the analyzed values of Pb and Cd contents of BGF of five different divisions were found similar (P>0.05) (Table V), but toxic metal content variation (P<0.01) was observed in the individual division feed materials (Tables VI, VII). The highest content of Cd (P<0.01) was found in the feed samples of BGF-C (8.29 µg/kg) and the lowest amount of Cd was found in BGF-B (3.0 µg/kg) and BGF-G (3.20 µg/kg) dietary group, respectively, in Dhaka, as evinced from Table VI. In Chittagong, similar but the highest content of Cd (P<0.01) was found in BGF-E (16.75 µg/kg) and BGF-C (15.63 µg/kg) and the lowest level was found in the dietary group of BGF-G (5.10 µg/kg), BGF-F (5.19 µg/kg) and BGF-A(5.30µg/kg), respectively (Table VII). The amount of Pb content in the BGF samples of Dhaka and Chittagong divisions were also differed significantly (P<0.01) between treatment (Tables VI, VII). In Dhaka, the highest content of Pb (P<0.01) was found in BSF-F (759.42 µg/kg) and lowest amount being in BSF-E (355.46 µg/kg), BSF-C (356.40 µg/kg), BGF-B (377.90 µg/kg) and BGF-D (379.08 µg/kg) dietary group, respectively (Table 6). In Chittagong, the highest content of Pb(P<0.01) found in BSF-A (934.60 µg/kg), BSF-B (886.10µg/kg), BSF-E (876.60 µg/kg), and lowest amount being in BSF-C (445.23 µg/kg) dietary group, respectively.

TABLE II: Heavy Metal Contents of Broiler Starter Feed of Different Feed Mills of Five Divisions

Metal (µg/kg)	Feed mill/company							SEM	P-values
	BSF-A	BSF-B	BSF-C	BSF-D	BSF-E	BSF-F	BSF-G		
Cd	5.33	6.79	7.34	7.42	5.74	8.13	7.30	0.374	0.421
Pb	489.1	673.9	514.7	537.60	405.2	527.0	529.30	37.796	0.702

Data refer to mean value of fifteen replicates consisting of seven treatments. SEM, standard error means. BSF-broiler starter feed of a particular feed mills five divisions.

TABLE III: Heavy Metal Content of Broiler Starter Feed of Different Feed Mills of Dhaka

Metal (µg/kg)	Feed mill/company							SEM	P-value
	BSF-A	BSF-B	BSF-C	BSF-D	BSF-E	BSF-F	BSF-G		
Cd	5.38	6.64	7.93	6.93	5.22	7.00	8.88	0.374	0.096
Pb	600.38^{a}	570.55^{b}	343.53^{c}	279.24^{d}	348.28^{c}	554.60^{b}	595.00^{a}	4.941	0.01

Table Iv: Heavy Metal Content Of Broiler Starter Feed of Different Feed Mills of Chittagong

Metal (µg/kg)	Feed mill/company							SEM	P-value
	BGF-A	BGF-B	BGF-C	BGF-D	BGF-E	BGF-F	BGF-G		
Cd	7.70	8.10	8.85	8.24	10.49	6.34	9.68	0.467	0.314
Pb	888.70	685.70	834.20	733.80	854.90	580.40	660.90	39.856	0.326

TABLE V: HEAVY METAL OF BGF OF DIFFERENT FEED MILLS OF FIVE DIVISIONS

Metal (µg/kg)	Feed mill/company							SEM	P-value
	BSF-A	BSF-B	BSF-C	BSF-D	BSF-E	BSF-F	BSF-G		
Cd	8.16[a]	3.20 [d]	8.28[a]	4.63[c]	7.17[b]	3.16[d]	4.21[c]	0.189	0.01
Pb	158.30[d]	175.63[c]	193.68[b]	211.07[a]	218.93[a]	166.21[d]	162.62[d]	3.989	0.01

Data refer to mean value of fifteen replicates consisting of seven treatments. BGF-broiler grower feed of a particular feed mill of five divisions.

TABLE VI: HEAVY METAL CONTENT OF BGF OF DIFFERENT FEEDMILLS OF DHAKA

Metal (µg/kg)	Feed mill/company							SEM	P-values
	BGF-A	BGF-B	BGF-C	BGF-D	BGF-E	BGF-F	BGF-G		
Cd	6.14[b]	3.00[d]	8.29[a]	4.62[c]	6.25[b]	4.54[c]	3.20[d]	0.238	0.01
Pb/	663.36[b]	377.90[d]	356.40[d]	379.08[d]	355.41[d]	759.42[a]	423.98[c]	13.033	0.01

TABLE VII: HEAVY METAL CONTENT OF BGF OF DIFFERENT FEED MILLS OF CHITTAGONG

Metal (µg/kg)	Feed mill/company							SEM	P-value
	BGF-A	BGF-B	BGF-C	BGF-D	BGF-E	BGF-F	BGF-G		
Cd	5.30[d]	10.84[b]	15.63[a]	6.41[c]	16.75[a]	5.19[d]	5.10[d]	0.593	0.01
Pb	934.60[a]	886.10[a]	445.23[d]	827.40[b]	876.60[a]	640.40	831.20[b]	18.801	0.01

IV. DISCUSSION

Poisonous metals lead and cadmium in broiler feed might exhibit toxicity and carcinogenic effect at low concentration on public health by consumption of poultry products day by day. So periodic detection or gradual analyses of toxic metal contents in broiler feed are necessary for ensuring feed quality, food security and consumer safety. Though many works have been done regarding the analyses of these metals in various feedstuffs [9]–[13], but the data are too low in the complete or ready-made feed of poultry. So, it is needless to say that the study warrants further analyses to explore more data relating heavy metal detection in poultry feed.

However, it is obvious from the current data that there was no significant variation of the toxic metal contents (Pb, Cd) in the different feed samples procured from the five divisions in Bangladesh. But significant difference was found in the Pb and Cd contents of different feed samples of individual division say Dhaka and Chittagong. The variation of micro-nutrient contents (Pb, Cd) found in the broiler starter and grower feed in individual divisions might be due to number of factors involved such as feed composition, ingredient quality, harvesting time, crude fibre contents, anti-nutritive factors and so on. These factors might influence the nutritive values of each compound feed reported by previous investigators [7], [14.]. It is clear that all the analytical values of Pb and Cd of broiler grower and starter feeds of different feed mills of Bangladesh found in this study are lower than the maximum permissible limits (MPL) of contaminants in poultry feed, as per the suggestions given by BSTI and European Commission [15]. It reported that the MPL for Pb and Cd is 5.0 mg/kg and 0.5 mg/kg, respectively, in poultry feed samples, which are considered as harmless. The values beyond this limit are liable to cause toxicity. The reported values indicate that our analytical values of Pb and Cd contents found in broiler feed samples of different feed mills are safe and sound from the standpoint of toxicity level. Soc, the feed can be used safely and undoubtedly by the poultry industry across the country.

V. CONCLUSION

The obtained data of this study revealed that similar metal contents were found in the broiler feed received from five divisions, but variable content of toxic metals were observed in the feed samples of individual division. The findings indicate that the heavy metal contents contained in the broiler feed found lower than the toxic level as reported by the Council Directive 2002/32/EC. It can be concluded from this study that ready-made broiler feed manufactured by different companies or feed mills in Bangladesh appeared to be good in quality and safe for the consumption by the poultry industry. It could warrant further, gradual, and periodic study to check the feed quality and food safety, as all heavy metals or all sorts of feed manufactured by all feed industry in the country are not considered in this study.

COMPETING INTERESTS

The authors declare that the study has no conflicting matter or interests.

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