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Research Article

Evaluation of Broiler Meat through Detection of Poisonous Metals (Cr, Cd) Available in Bangladesh

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Abstract

The study was undertaken to assess the quality of broiler meat via detection of heavy metal contents. Seven farms were selected randomly from the five divisions of Bangladesh. Broiler meat samples were collected during starting and growing phases of production stage from each of the farms by purchasing to detect the heavy metal contents *i.e* chromium (Cr) and cadmium (Cd) in this study. A total of 210 meat samples (105 starter and 105 grower) was collected from the selected farms and analyzed to determine the concentration of toxic metals (Cr, Cd) in meat samples. The heavy metal data (Cr, Cd) of broiler starter meat samples from laboratory analyses of five divisions of seven feed mills were unaffected ($P>0.05$) between treatment. The Cd contents of broiler grower meat samples of five divisions of seven farms together differed significantly ($P<0.05$) between treatment except for Cr. Significant variation ($P<0.01$) was observed in the various meat samples of broiler chicken by individual division (Dhaka, Chittagomg). It can be concluded that the quality of broiler meat of different farms appears to be good based on the chemical evaluation, even though variation was found in the toxic metal contents of meat samples. The analyzed concentration of toxic metals in meat samples were within the range or limits of the acceptable level, so no possibility of causing health hazard will create over the consumer world through after consumption of broiler meat.

Keywords: Broiler Meat; Quality; Toxic Metal (Cd, Cr); Meat Evaluation; farm

Introduction

Poultry farming is an emerging industry in Bangladesh. This farming is considered as an important sub-sector of the livestock sector in Bangladesh. Amongst different poultry farming, commercial broiler raising is expanding steadily and has become very popular to the people of Bangladesh. The reasons for the increased broiler farming are numerous such as rapid growth rate, supplying premier quality of meat, quick return, low cost involvement, little space needed etc., which could play a vital role in the country's GDP, rural economy and female's empowerment. The premier quality of broiler meat is one of the major and cheaper protein sources and more available for the people of Bangladesh. Why not, meat from other livestock say beef, lamb, and fish are not cheaper or available at this price in the market with few exception. As a result, broiler farms are increasing and consumption of poultry meat by the people is also being increased across the country day by day. So it is very essential as a priority basis to monitor the quality of broiler meat for the food security, consumer safety, and public health risk assessment [1].

We see that chicken meat is more advantageous for the consumer than that of other livestock say beef. Toxic metals that are normally found in air, water, soil, poultry feeds, pesticides, insecticides etc., can get an easy access into poultry meat by means of numerous human activities such as industrial feed processing, agricultural activities, irrigation, harvesting, drug administration and so on [2]. Besides, the effluent discharges from rapid urbanization, faster industrialization,, usage of inorganic fertilizers in crop field, emissions of transport and dumping wastages from civic areas and contamination of water reservoir etc., are most likely to contaminate the food chain as well as chicken meat production [3].

It is reported by strong evidences that poultry meat can be contaminated by heavy metals say cadmium (Cd) and chromium (Cr) for the residual effects that might come from multiple sources. It can include discharge from textile and leather industries, and chemicals, Deepali [4] reported that industrial wastes released from the textile and tannery factories exceed the normal limits of toxic metals (e.g. Cd,, Cr, Cu). The excess amounts of these metallic elements in the food chain can be harmful both for human and the environment. The gradual deposition of these undegradable toxic metals in biological tissues can result in a series of hazards to the ecosystems [5]. The main focus of our study is to make the people aware of health hazard from the food contamination with heavy metals rather than holding poultry meat producers or farmers or food producers accountable for this.

In a developing country like Bangladesh, we see the major sources for earning foreign currency include leather industry and garments factories. The main reasons for raising this industries in the country might be the cheap labour force, available raw materials, and production of quality hides and skins by the livestock of Bangladesh. Every year a lot of animals are sacrificed during Eid-ul Azha as a part of celebration of their religious festival by the muslim community. The by-products say hides and skin retrieved from the slaughtered animals are used by the leather industry of Bangladesh for earning

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foreign currency. A lot of meat scraps including other by-products are produced by the leather industry after processing and tanning the hides and skin for exporting this product to the overseas countries. It can be assumed that poultry industry can use these by-products for the diet formulation of poultry as a cheap source of raw materials for the reduction of feed cost. Few report stated that the wastages retrieved from these industries., particularly tannery are liable to cause a great havoc for the human being and environmental pollution by heavy metal contamination in food chain [6]. The availability of these wastes in poultry feed and meat could warrant further research to determine the extent of contamination of heavy metal pollutants.

The residual effect of broiler feed and meat might intensify the situation. It is necessary to investigate the actual sources of heavy metals into the food chain through periodic examination of feed and meat regularly. For this reason, broiler meat of different farms from five districts of Bangladesh are taken into consideration for conducting this study to measure the content of heavy metals (Cr,Cd) using Atomic Absorption Spectrophotometer (AAS). After all, the study could play a pivotal role in detecting poisonous metals of broiler meat sample assuring meat quality, consumer health and food safety of Bangladesh. Considering the above points, the present study was undertaken to investigate the concentration of metals (Cr and Cd) contaminating poultry meat available in the different farms of Bangladesh.

Materials and Methods

Study Area and Experimental Period

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

Selection of Farms and Sample Collection

Seven poultry farms were selected from the five divisions of the Bangladesh. Farms were selected randomly by surveying based on the number of criteria such as production, durability of farms, number of birds, farm size, farm reputation, farmer's profession, and farms income per year etc., Broiler meat samples were collected during tarter and grower period of time by purchasing the birds from those selected farms. 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.

Data Collection and Sample Analyses

A total number of 210 broiler meat samples (105 starters and 105 growers) were collected during 2021 from the selected farms available in the five divisions of Bangladesh. Collected samples were dried and ground by pestle and mortar, and then be taken for the lab analysis. For the digestion of samples, approximately 0.5 gm of meat samples was digested with 8ml of HNO3 (65%) and 2ml 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. The reference material analytical blanks were prepared with each batch of digestion set. All samples were prepared in triplicate. 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 contents of heavy metals (Cr, Cd) of meat samples were measured at 357.9 & 228.8 nm wavelength, respectively.

Statistical Analysis

All collected data were subjected to analysis by one way ANOVA using Minitab software [11]. The data were analyzed using one-way ANOVA with meat as factor. The significance of differences between means was determined by Fisher's least significant difference at $P \leq .0.05$.

Results

Heavy Metal Contents of Broiler Meat Fed Starter Diet of Different Farms of Bangladesh

The analytical values of metallic element contents (Cd, Cr) of the broiler starter meat (BSM) samples were shown below in Tables (2, 3, 4). The data showed that analyzed values of Cr and Cd of BSM procured from five different divisions were not affected (P>0.05) by treatment, but marginal variation was found in the Cr (P<0.079) contents for the meat samples obtained from the different farms of five divisions (Table 2). Apart from this, variation (P<0.01) was observed only in division-wise meat samples procured from Chittagong and Dhaka division, respectively (Tables 3,4). In Dhaka, the statistically similar but highest contents of Cd were found in the meat samples of BSM-A (52.14µg/kg) and BSM-F (54.69 µg/kg) group whereas lowest amount of Cd was found in BSM-C (40.48µg/kg) group, respectively (Table 3). The BSM-D (51.69 µg/kg) and BSM-G(48.09 µg/kg) group had the highest amount of Cd(P<0.01) and BSM-C(27.86 µg/kg) being the lowest in Chittagong (Table 4). Table 3 showed that the Cr (P<0.01) content in the BSM-G (897.87 µg/kg) was the highest and the lowest amount found in BSM-F(451.88 µg/kg), BSM-E(451.02 µg/kg) and BSM-A(469.72 µg/kg)group, respectively, in Dhaka. The BSM-D (596.73 µg/kg) group contained the highest amount of Cr() whereas lowest Cr contents contained in the BSM-G (192.04 µg/kg) and BSM-F (200.27 µg/kg) group, respectively, in Chittagong (Table 4).

Heavy Metal Contents of Broiler Meat Fed Grower Diet of Different Farms of Bangladesh

The results of Cd and Cr contents in broiler grower meat (BGM) demonstrated in Tables (5, 6, 7). The data revealed that the analyzed

Table 1: Global permissible limits/standards of heavy metals [7-10].

Name of samples	Standards	Metals	
		Cd (mg/kg)	Cr (mg/kg)
Chicken meat	*WHO/FAO	0.05	1.0
Liver	*WHO/FAO	0.5	-
Chicken meat	*EC	0.05	-
Liver	*EC	0.5	-
Chicken meat	CN	0.1	-
Liver	CN	0.5	-
Chicken meat	Arabian	0.01 to 1.0	--

Table 2: Heavy metal contents of broiler meat sample fed starter diet of different farms of five divisions.

Metals	Broiler farms							SEM	P-values
	BSM-A	BSM-B	BSM-C	BSM-D	BSM-E	BSM-F	BSM-G		
Cd(µg/kg)	29.16	28.27	30.29	29.40	31.64	33.73	30.55	1.663	0.984
Cr((µg/kg)	515.8 0	683.6 0	697.30	760.7 0	655.5 0	589.5 0	603.0 0	21.788	0.079

[Data refer to mean value of fifteen replicates consisting of seven treatments; SEM, standard error means. BSM-broiler starter meat of a particular farm offive division]

Table 3: Heavy metal contents of broiler meat sample fed starter diet of different farms of Dhaka division.

Metals	Broiler farms							SEM	P-values
	BSM-A	BSM-B	BSM-C	BSM-D	BSM-E	BSM-F	BSM-G		
Cd(µg/kg)	52.12^{a}	46.143^{b}	40.48^{d}	49.10^{b}	43.33^{c}	54.69^{a}	47.77^{b}	0.399	0.01
Cr((µg/kg)	469.72^{d}	714.35^{b}	560.97^{c}	621.13^{c}	451.02^{d}	451.88^{d}	897.87^{a}	5..007	0.01

[Data refer to mean value of three replicates consisting of seven treatments; SEM, standard error means. ^{a,b,c,d}Means bearing different superscripts within a column are significantly different at **P<0.01, SEM, standard error means BSM-broiler starter meat of a particular farm of Dhaka division]

Table 4: Heavy metal contents of broiler meat sample fed starter diet of different farms of Chittagong division.

Metals	Broiler farms							SEM	P-values
	BSM-A	BSM-B	BSM-C	BSM-D	BSM-E	BSM-F	BSM-G		
Cd(µg/kg)	35.68^{c}	44.62^{b}	27.86^{d}	51.69^{a}	41.89^{b}	35.62^{c}	48.09^{a}	0.34	0.01
Cr((µg/kg)	414.84^{b}	414.60^{b}	382.84^{c}	596.73^{a}	414.91^{b}	200.37^{d}	192.04^{d}	4.28	0.01

[Data refer to mean value of three replicates consisting of seven treatments; SEM, standard error means. BSM-broiler starter meat of a particular farm of Chittagong division]

Table 5: Heavy metal contents of broiler meat sample fed grower diet of different farms of five divisions.

Metals	Farms							SEM	P-values
	BGM-A	BGM-B	BGM-C	BGM -D	BGM-E	BGM-F	BGM -G		
Cd(µg/kg)	25.54^{b}	40.48^{a}	25.20^{b}	36.04^{a}	37.88^{a}	36.80^{a}	39.87^{a}	1.53	0.026
Cr((µg/kg)	86.15	56.14	44.89	42.62	56.7	75.64	88.88	5.89	0.191

[Data refer to mean value of fifteen replicates consisting of seven treatments; SEM, standard error means. BGM-broiler grower meat of a particular farm of five division]

Table 6: Heavy metal contents of broiler meat sample fed grower diet of different farms of Dhaka division.

Metals	Farms							SEM	P-values
	BGM-A	BGM-B	BGM-C	BGM -D	BGM-E	BGM-F	BGM -G		
Cd(µg/kg)	26.25^{d}	43.89^{c}	45.69^{c}	48.00^{b}	52.22^{a}	53.10^{a}	43.22^{c}	0.34	0.01
Cr((µg/kg)	166.05^{a}	118.29^{c}	55.90^{d}	53.26^{d}	145.67^{b}	60.03^{d}	115.89^{c}	4.77	0.01

[Data refer to mean value of three replicates consisting of seven treatments; SEM, standard error means. BGM-broiler grower meat of a particular farm of Dhaka division]

Table 7: Heavy metal contents of broiler meat sample fed grower diet of different farms of Chittagong division.

Metals	Farms							SEM	P-values
	BGM-A	BGM-B	BGM-C	BGM -D	BGM -E	BGM -F	BGM -G		
Cd(µg/kg)	17.57^{c}	38.40^{b}	19.62^{c}	49.40^{a}	36.95^{b}	35.69^{b}	34.52^{b}	0.32	0.01
Cr((µg/kg)	29.65^{d}	38.92^{c}	50.26^{b}	41.52^{c}	59.84^{b}	78.85^{a}	38.17^{c}	3.27	0.01

[Data refer to mean value of three replicates consisting of seven treatments; SEM, standard error means; ^{a,b,c,d} Means bearing different superscripts within a column are significantly different at **P<0.01, BGM-broiler grower meat of a particular farm of Chittagong division]

values of Cr contents of BGM of five different divisions were found similar (P>0.05) (Table 5), but the Cd content variation (P<0.05) was observed (Tables 5). The BGM-B(40.49µg/kg) farm sample received the highest content of Cd and BGM-A(25.54µg/kg) got lowest amount of Cd element. The amount of Cd and Cr contents in the different farm BGF samples of Dhaka and Chittagong divisions were also differed significantly (P<0.01) between treatment (Tables 6,7). The data from Dhaka division showed that similar but highest Cd (P<0.01) contents were found in BGM-F(53.10µg/kg) and BGM-E(52.22µg/kg) and lowest in BGM-A(26.25µg/kg) group, respectively. In Chittagong, the highest Cd(P<0.01) content was found in BGM-D(49.40µg/kg) and BGM-A(17.57µg/kg) being the lowest (Table 7). The Cr content in BGM-A (166.05µg/kg) group was the highest and the lowest being BGM-D(53.26µg/kg) group in Dhaka. The BGM-F(78.85µg/kg) was the highest in Cr content while BGM-A(29.65 µg/kg) group received lowest amount of Cr metal in Chittagong division (Table 7).

Discussion

Broiler meat and meat products contaminated with toxic metals are risky and a great concern for the consumer world from the standpoint of both food safety and public health [3]. Poisonous metals chromium and cadmium in broiler meat 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 meat are necessary for ensuring meat quality, food security and consumer safety. Though many works have been done regarding the analyses of these metals in various feedstuffs [12-16], but the data are inadequate in the meat of poultry. So it is needless to say that the study warrant further analyses to explore more data relating heavy metal detection in poultry meat and meat products.

However, it is obvious from the current data that there was no significant variation of the toxic metal contents (Cr, Cd) in the different meat samples procured from the five divisions in Bangladesh. But significant difference was found in the Cr and Cd contents of different meat samples of individual division say Dhaka and Chittagong. The variation of micro-nutrient contents (Cr, Cd) found in the broiler meat fed by starter and grower feed in individual division might be due to number of factors involved such as feed composition, ingredient quality, harvesting time, crude fibre contents, anti-nutritive factors, feed digestibility and so on. These factors might influence the nutritive values of meat and feed reported by previous investigators [17,18].

It is clear that all the analytical values of Cr and Cd of broiler grower and starter meat of different farms of Bangladesh found in this study are lower than the maximum permissible limits (MPL) of contaminants in poultry meat, as per the suggestions given by WHO/FAO and European Commission (Table 1). It reported that the MPL for Cr and Cd are 1.0 mg/kg, and 0.05 mg/kg in poultry meat, which are considered as harmless. The values beyond this limit are liable to cause toxicity or public hazard. The reported values indicate that our analytical values of heavy metal (Cr and Cd) contents found in broiler meat samples are safe and sound from the standpoint of toxicity level. So the meat can be used safely and undoubtedly by the consumer world across theglobe.

Broiler farming has now been flourishing business across the globe. It has a great demand in the world's food industry to supply good quality and cheaper sources of animal protein to the consumer world. Its quality maintaining is very much important to feed the consumer world safely. The growth of broiler is faster than that of any other livestock. So it goes without saying that the rapidly growing broiler meat can meet the huge protein gap of the country [19]. It is obvious that a lot of husbandry practices including special care, management, feeding, lighting brooding, breeding, housing, vaccination, medication etc., are needed for the commercial broiler production. As a part of this activities, farmers, poultry integrators, feed miller companies etc., very often use many antibiotics, hormonal drugs, enzymes, feed additives, medicines etc,, in poultry diets, which are most likely to increase the load of heavy metals in human body. In this regard, holistic approaches including different strategies are very much important to reduce the toxic metal load in food chain, which could result in maintaining meat quality, food safety, food security and consumer health across the globe. It could include adopting good animal husbandry practices, control of drug administration in poultry efficiently, prudent use of diet, careful attention for feed formulation, develop culture for the organic food production, enacting stern rules and legislative laws, statutory control over the poultry feed uses, identification of standard limits, periodic detection, quantification, investigation, and routine examination of heavy content in poultry meat and meat products including other foodstuffs are noteworthy [20].

Conclusion

It could be concluded that the heavy metal contents of different meat samples analyzed in this study were found similar during starter period of growth phase, but significant differences were found in later stages. However, it is observed that the analyzed heavy metal (Cr, Cd) contents obtained in this study were found below the limit of the reference values as per the instruction given by the EC or WHO/FAO. So it could be decided that analytical values of heavy metal contents in broiler meat found in this study are safe and sound, or not detrimental for the consumer world. Therefore, the broiler meat can be used safely by the consumer without any hesitation. However, further study can be done to assure the meat quality and food safety, as all the farms existing in Bangladesh were not taken into consideration to detect all heavy metal contents found in the nature.

Competing Interests

No clash or dash or conflicting issues herein declared by the authors.

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