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Characterization of Heavy Metals in Broiler and Fish Feeds from Some Selected Markets of Mymensingh and Tangail Districts

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ABSTRACT

Contamination of feedstuffs and ingredients with heavy metals has become a global issue due to the transmission of toxic substances within the human food chain. Therefore, this study was conducted to investigate the concentration of heavy metals in broiler and fish feed from some selected markets of Mymensingh and Tangail districts. Nine broiler feeds (Swadhin, Paragon, BP feed, Adnan Agro grower, Adnan Agro Sonali, Nourish, United, Sonali Grower and New hope) and six fish feeds (Stella S-3 small size, Stella S-3 big size, Mega 102, Ruposhi Bangla Shift-A 2/P/F, Ruposhi Bangla Shift-A T/G and Mega 301) were selected for this study. Cadmium, lead and chromium concentration of all samples were determined by Atomic Absorption Spectrophotometer (Shimadzu AA-7000). The detected maximum and minimum concentrations of these elements ranged from 0.012-0.027 ppm for cadmium, 0.09-0.17 ppm for lead and >0.05-334.8207 ppm for chromium. The concentrations of heavy metals in feeds were the highest for Cr and the lowest for Pb. It was observed that lower concentrations of Cd and Pb were found in broiler and fish feeds, all of which were below detection limit according to the World Health Organization and European Commission for food safety. Concentrations of Cr in two samples (one fish feed, Stella S-3 small size and one broiler feed, Swadhin feeds) exceeded the standard limits, which indicate that not all the feed samples are safe for human health and Cr may be bio-accumulated to human body through consumption of broiler or fish contaminated with Cr.

Introduction

Feedstuffs contamination by heavy metals has become a burning issue in recent years due to their possible increase in bio-systems (Islam et al., 2014). Fertilizers, industrial discharge, fossil fuels municipality wastes are the main sources of heavy metal contamination in soils and subsequent uptake by crops (Pendias and Pendias, 1992; Rai et al., 2019). Contaminated crops and crop residues are being used for feed production in broiler and fish farms. It is an alarming matter that the protein concentrate derived from tannery solid wastes is also used as poultry feed, fish feed, and organic fertilizers in Bangladesh, which can lead to heavy metal contamination (Islam et al., 2014). Uptake of these heavy metals through contaminated crops and animal products may ultimately lead to long term health hazards. Heavy metals are specially regarded with the toxicological as well as the carcinogenic effects. In Bangladesh, the tannery, ceramic, textile dying and sulfuric acid producing industrial sites are especially associated with heavy metal pollution. The disposal points of these sorts of industrial sites are reported to discharge Cd, Pb, Mn, Ni, Cu, and Zn in excessive concentrations which are further concerned with the contamination of soils, vegetation, and water bodies (Kashem and Singh, 1999). Heavy metal toxicity can result in the damage or reduced mental and central nervous function, lower energy levels, and damage to blood composition, lungs, kidneys, liver and other vital organs (Tchounwou *et al.,* 2002). Long-term exposure may affect the physical, muscular and neurological degenerative processes (Thomas and Mohaideen, 2014).

Aquatic systems are very sensitive to heavy metal pollutants and the gradual increase in the levels of such metals in aquatic environments has become a problem of primary concern. Fishes are the aquatic inhabitants which can be highly affected by heavy metals (Ayas, 2007; Hadeel and Ahmed, 2019). Therefore, we must ensure that fish feeds are not contaminated with heavy metals or should not cross their acceptance limit. Heavy metal contamination of the food items is one of the most

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important assessment parameters of food quality assurance (khan *et al.*, 2008).

Absorption of heavy metals through broiler and fish feed causes serious consequences on health status and thereby economic development. During the last ten years there are significant increases in poultry farms in Bangladesh as well as the availability of broiler meat also increased to a great extent. The risk associated with the exposure to heavy metals present in foodstuffs represents a concern to human health (Wang and Du, 2013; IARC, 1990; Flora *et al.*, 2012). In Bangladesh, there is very little reliable works have been conducted to analyze the potential health risks from heavy metal contaminated fertilizer and feeds.

Cadmium, lead and chromium contents of three mostly used commercial fish feed and poultry feeds were determined to study the risk of heavy metal contamination of food chain through this sector (Islam *et al.,* 2007). Kundu *et al*. (2017) examined concentration of heavy metals (Cu, Fe, Pb, Cd and Na) in fish feed and cultured fish in Muktagacha Upazilla of Mymensingh District. In recent years the increasing demand of food safety has accelerated research initiatives regarding the risk associated with consumption of food contaminated by heavy metals (Mansour *et al.*, 2009). So, it has become an urgent issue to analyze the heavy metals in primary produce and raw materials. The present study was conducted to determine the concentration of heavy metals in broiler feed and fish feed from some selected markets of Mymensingh and Tangail districts.

Materials and Methods

Study area and collection of samples

For this study, fish and broiler feed samples were collected from Mymensingh and Tangail districts. A details description of fish and poultry feed collection markets has been given in Table 1. Most of the collected fish feeds were locally produced. Total fifteen samples of poultry feed and fish feed having at least 500g weight were collected from both retailer and wholesaler of the selected markets. The bags were properly labeled with unique codes. The samples were collected from Mymensingh District in January, 2019 whereas the samples from Tangail district were collected in April, 2019.

Sample processing

Collected samples were air dried and kept in individual paper bag with proper labeling and oven dried (Model no: KD 400 NUVE, Turkey) at 60°C for 48 hours until a constant weight was obtained. The dried samples were finely grinded by an electric grinder (Model no: IKA A11B). Then the ground samples were kept in polythene zipper bags labeled with specific code number until subsequent analysis.

Sample digestion

The samples were digested according to the guideline proposed by FAO (1983). The samples were digested with di-acid mixture (HNO_3: $HClO_4$ = 10 ml : 5 ml). Exactly 1 g of each feed sample was taken into a conical flask and added 10 ml of HNO_3 and kept overnight for pre-digestion. After pre-digestion, the samples were placed in a fume hood chamber and allowed to homogenize at first 2 hrs (60 ^{0}C-80 ^{0}C). After cooling, 5 ml $HClO_4$ was added and place under fume hood again. After cooling, the samples were filtered through Whatman No. 42 filter paper to remove unwanted suspended materials. After filtering both broiler and fish feed samples, the digests were made up to 50 mL volume by deionized water and kept in labeled air tight polyvinyl bottles. Then the samples were stored in the refrigerator until analysis.

Table 1. Name of the broiler and fish feed, districts and markets from where the samples were collected

District Name	Upazilla	Market name	Feed types	Feed names
Mymensingh	Sadar	Churkhai Bazar	Fish	Stella S-3 (Small size)
	Sadar	Dapunia Bazar	Broiler	New Hope (713)
	Sadar	Churkhai Bazar	Fish	Stella S-3 (Big size)
	Sadar	Churkhai Bazar	Fish	Mega Feed (102)
	Bhaluka	Bhaluka Bazar	Broiler	Adnan Agro Ltd. (Grower Feed)
	Bhaluka	Bhaluka Bazar	Broiler	Adnan Agro Ltd. (Sonali Feed)
	Trishal	Porabari Bazar	Broiler	Sonali Grower (S . M . S)
	Trishal	Boilor Bazar	Fish	Ruposhi Bangla (Shift-A) 2/P/F
	Trishal	Boilor Bazar	Fish	Ruposhi Bangla (Shift-A) T/G
	Trishal	Ukil bari	Fish	Mega Feed (301)
	Fulbaria	Radhakanai Bazar	Broiler	Nourish Poultry Feed
Tangail	Sadar	Sontosh Bazar	Broiler	Paragon (starter)
	Sadar	Porabari bazar	Broiler	United Feeds Limited
	Gopalpur	Gopalpur bazar	Broiler	Swadhin Feed
	Gopalpur	Mannan road	Broiler	BP Feed

Analysis of heavy metals

Determination of Cr, Pb and Cd in broiler and fish feed samples were done by using Atomic Absorption Spectrophotometer (Model no: SHIMADZU, AA-7000, Japan). Mono element hollow cathode lamp was employed for the determination of each metal of interest. At first, the AAS was calibrated following the manufacturer's recommendation. The filtered samples were run directly for the determination of heavy metals in the samples. Then, the concentration of the metals in broiler and fish feed samples was recorded directly by AAS. Cr in broiler and fish feed were determined from Analytical and Microbiology Labs, Interdisciplinary Institute for Food Security (IIFS), Bangladesh Agricultural University, Mymensingh and Pb and Cd in broiler and fish feed were tested in Soil science lab, BARI, Gazipur.

Statistical analysis

At the end of the analysis of heavy metals, found data were compiled, tabulated and analyzed. The qualitative data were transferred into quantitative data and Microsoft Office Excel 2013 software was used for data analysis and preservation. Various descriptive statistical measure such as range, mean etc. were used for categorization and describing the variables. Figures (1 to 6) are used for the presentation of findings.

Results and Discussion

Lead (Pb) concentration in fish and broiler feed

The mean concentrations of lead in all brands of fish feed samples were in the range of 0.09 to 0.17 ppm. Mean value of 0.17 ppm was obtained in Ruposhi Bangla brand (Shift-A) 2/P/F feeds which were higher than the other feed types while the Stella S-3 (small size) fish feeds had the lowest concentration which was 0.09 ppm. Lead concentration in broiler feed samples ranged from 0.11-0.16 ppm and the average concentration was 0.13 ppm. The highest value of Pb concentration (0.16 ppm) was obtained in the BP feed brand. The Nourish brand had lowest concentration which was 0.11 ppm. Comparing the obtained values with the maximum acceptable limit for lead (5 mg/kg) in feed as recommended by European Commission (2003), all of the feed samples had lower concentrations than the permissible limit (appendix I). However, the values obtained in this study were lower than 23.2–32.6 mg/kg obtained by Mahesar *et al.* (2010) in fish feed. On the contrary, the average concentration of lead content in different animal feed samples (59 samples) was 4.77 mg/kg, ranging between 1 to 9.5 mg/kg (Alexieva *et al.,* 2007) which was higher than this study.

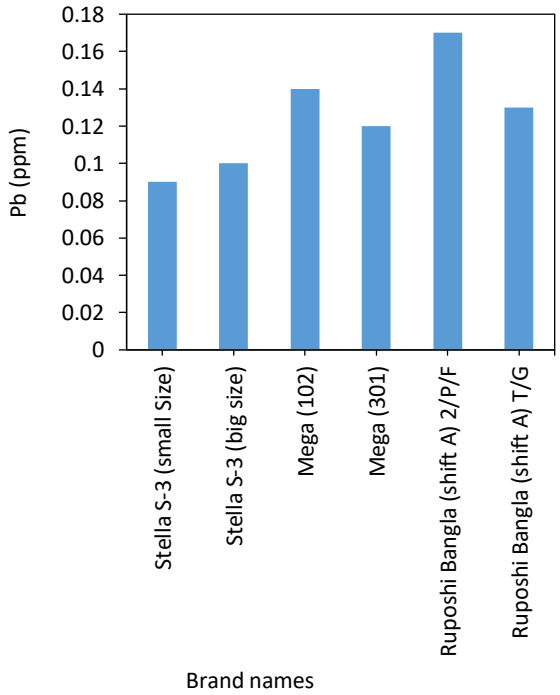

Figure 1. Concentrations (ppm) of lead (Pb) in six commercial fish feeds of Mymensingh and Tangail Districts

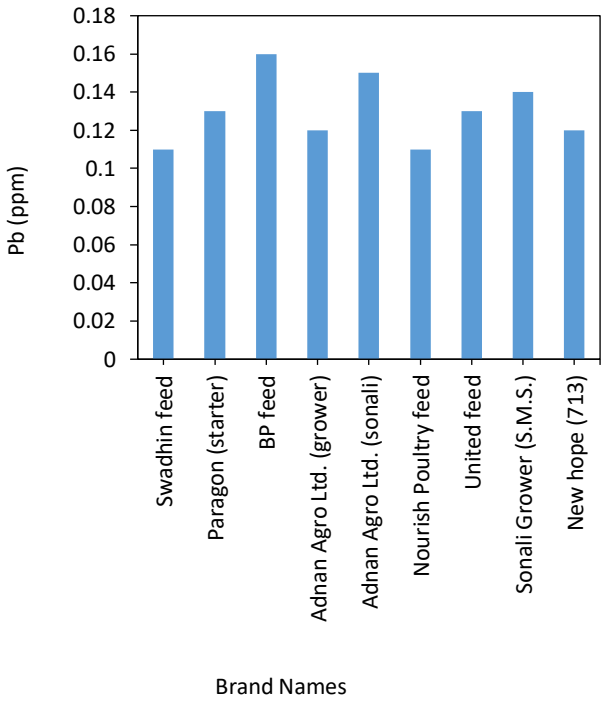

Figure 2. Concentrations (ppm) of lead (Pb) in nine commercial broiler feeds of Mymensingh and Tangail districts

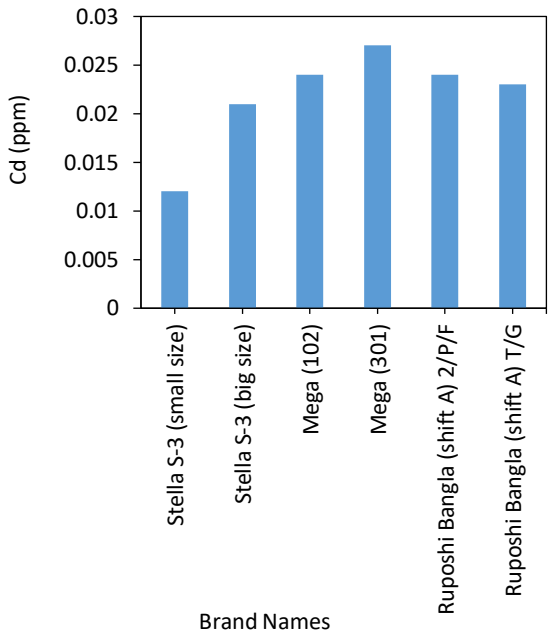

Figure 3. Concentrations (ppm) of cadmium (Cd) in six commercial fish feeds of Mymensingh and Tangail Districts

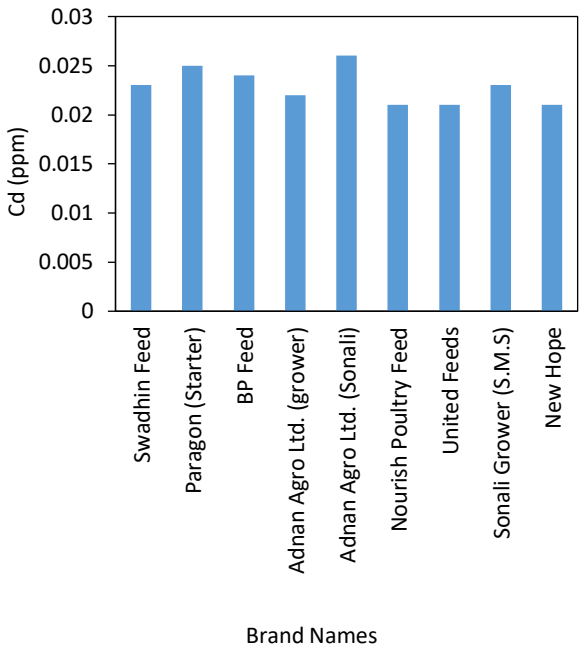

Figure 4. Concentrations (ppm) of cadmium (Cd) in nine commercial broiler feeds of Mymensingh and Tangail districts

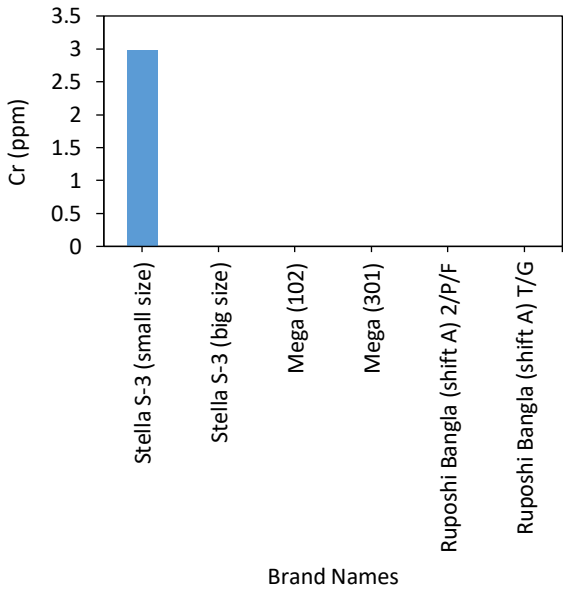

Figure 5. Concentrations (ppm) of chromium (Cr) in six commercial fish feeds of Mymensingh and Tangail Districts

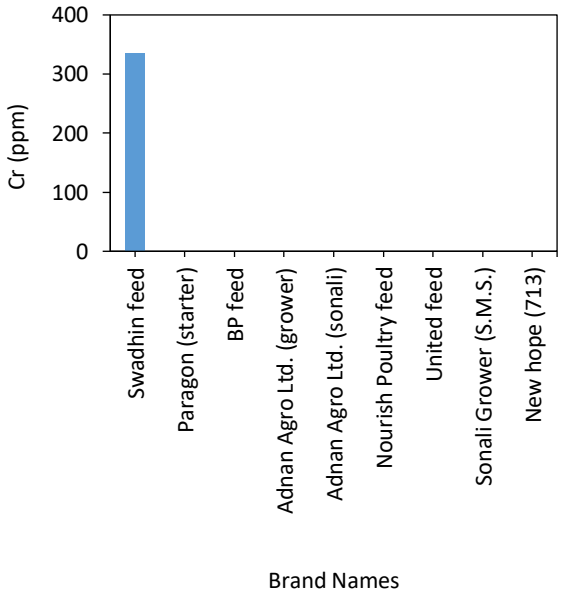

Figure 6. Concentrations (ppm) of chromium (Cm) in nine commercial broiler feeds of Mymensingh and Tangail districts

Cadmium (Cd) concentration in fish and broiler feed

The values of cadmium in fish feed obtained were in a range of 0.012 to 0.027 ppm. The Mega (102) feed had a comparatively higher mean (0.027 ppm) concentration compared to the other feed types while the Stella S-3 (small size) brand had the lowest concentration which was 0.012 ppm. The mean concentrations of cadmium (Cd) in the different brands of broiler feeds were in the range of 0.021 to 0.026 ppm. The highest mean concentration (0.026 ppm) was obtained in the Adnan Agro brand (Sonali feed). The Nourish feed, United feeds and New Hope brand had a lowest concentration which was 0.021 ppm. All feed samples had lower mean concentration of cadmium compared to the maximum acceptable limit (2 mg/kg cadmium) in feed samples as stipulated by European Commission (2003). However, the values obtained in this study were lower than the values (3.8–33.6 mg/kg) obtained by Mahesar *et al.* (2010) but comparable to 0.463 mg/kg reported by Okoye *et al. (*2011).

Chromium (Cr) concentration in fish and broiler feed

Among six fish feed samples, only one feed sample contained chromium that exceeded the maximum detection level. The concentration of Chromium was 2.9787 ppm (Stella S-3, small size) which was collected from Sadar Upazilla, Mymensingh. Among nine broiler feed samples, Chromium was detected in only one sample (Swadhin feeds) and concentration was 334.8207 ppm which was collected from Gopalpur Upazilla in Tangail district. The highest concentration of chromium was found in the Swadhin feeds at 334.8207 ppm while the Paragon, BP feed, Adnan Agro (both Grower and Sonali), Nourish, United, Sonali Grower and New hope feeds had the lowest mean level of chromium, which was below the detection limit. Chromium in two samples (Stella S-3 Small size fish feed and swadhin broiler feed) showed higher concentration compared to the maximum recommended limit (5 mg/kg) set by EC (2003), it indicates that not all the feed samples are safe for human health and Cr may be bio-accumulated to human body through consumption of Cr contaminated broiler or fish.

Conclusion

It is an important issue to the worldwide which needs preventive measures throughout the food chain from farm to table. The main objectives of this research were to determine the concentration of heavy metals in fish and broiler feed from some selected markets of Mymensingh and Tangail districts. In case of broiler feed, the highest concentrations of heavy metals were recorded for Cr in Swadhin feeds (334.8207 ppm) in Gopalpur Bazar in Gopalpur Upazilla of Tangail district and lowest concentrations of heavy metals was recorded for Cr which was below detection limit. In case of fish feed, the highest concentrations of heavy metals were also recorded for Cr in Stella S-3 (small size) is 2.9787 ppm which was found in Churkhai Bazar in Mymensingh Sadar Upazilla of Mymensingh district and lowest concentrations of heavy metals was also recorded for Cr which was below detection limit. The study revealed the presence of Pb and Cd in fish feed and broiler feed are at non-toxic levels. Cr in thirteen samples was found in below detection limit, in one sample (Stella S-3, small size) Cr was below standard level and in one sample (Swadhin feeds) it exceeds the standard level. It indicates that not all the food samples are safe for human health. To maintain the safety of food chain and to further minimize the heavy metals contamination, the government should monitor feed and food samples regularly.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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