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-Short Communication

ASSESSMENT OF SELECTED HEAVY METALS CONCENTRATION IN DIFFERENT BRANDS OF FISH FEED AVAILABLE IN BANGLADESH

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ABSTRACT

The paper reports the findings on the concentrations of heavy metals in ten different fish feed by using Atomic Absorption Spectrometer. The level of heavy metal concentrations (dry weight) in the fish feed ranged from 1.17 to 2.0, 2.33 to 4.67, 5.17 to 21.67, 106.67 to 363.3, 3.5 to 7.16, 3.83 to 21.2, 56.7 to 141.6 and 2.1 to 16.49 mg/kg of Cd, Co, Cu, Fe, Ni, Pb, Zn and Cr respectively. The concentrations of Fe, Pb, Co, Cr in different brands of fish feed exceeded the maximum permissible limits recommended by FAO/WHO and EU whereas the concentrations of Cd, Cu, Ni, Zn were within acceptable limits.

Keywords: Toxic metal, Carcinogenic, Lead, Chromium, Cadmium, Cobalt.

Bangladesh is well known for cultivation of fish to fulfill protein demand of the country and in 2014, the country was ranked 6th in global farmed fish production (FAO, 2016). The common sources of fish feed ingredients are maize, rice, rice polish, wheat, soybean grits, mustard oil cake, coconut oil cake, lentil bran, molasses etc. The exposure of these sources onto various anthropogenic pollutants, especially the heavy metals may affect our food chain through the feeds. In Bangladesh, tannery, ceramic, textile dyeing and sulfuric acid producing industrial sites are especially associated with heavy metal pollution and disposal of these industrial wastes are responsible to contaminate soils, vegetation, and water bodies (Kashem *et al.* 1999). Contaminated tannery solid wastes are also used in feed production as protein source (Mottalib *et al.* 2016).

Heavy metals' contamination of fish is a dangerous risk because it causes bio-magnifications and bio-concentration in various levels of food chain and thus enters the human body and causes various adverse and toxic affect. Among all heavy metals, arsenic, cadmium, mercury and lead are the most dangerous metals and having harmful impacts on the human body. Cadmium is toxic and it may cause kidney dysfunction, skeletal damage, prostate cancer, mutations (Uluozlu *et al*. 2009). Lead is a metabolic poison and nickel increases risk of lung cancer, cardiovascular disease, neurological deficits, and high blood pressure (Macomber *et al*. 2011). Chromium (III) plays an important role in nutrition of animal and human being but long term exposure can cause damage to liver, kidney circulatory and nerve tissues, as well as skin irritation (Sabbir *et al.* 2018). The hexavalent form of chromium is considered as carcinogenic (Basaran *et al.* 2000). Essential metals such as copper, zinc, iron, manganese and cobalt play important role in biological system. Excess deposition of these metals may also cause harm to human. The paper presents the results of current study in

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assessing the concentration of Cd, Pb, Ni, Fe, Cr, Co, Cu and Zn in different brand of fish feed.

Ten fish feed samples of different commercial brands; Rupshi Quality Fish Feed Ltd (FF1), Lily Fish Feed Ltd (FF2), Aman Fish Feed Ltd (FF3), S.M. Fish Feed Ltd (FF4), Pragan Fish Feed Ltd (FF5), Lion Feeds Ltd (FF6), Saudi Bangla Fish Feed Ltd (FF7), Mesh Fish Feed Ltd (FF8) Quality Fish Feed Ltd (FF9), Teer Feeds Ltd (FF10) were collected from fish cultivating firms. Samples were dried in a hot air oven at 105^{o}C until a constant weight was achieved and finally powdered. 3g of the homogenate of each sample (dry weight) was digested with 25 mL mixture of concentrated HNO_3, H_2SO_4 and $HClO_4$ in (4:1:1; v/v) at 80°C for 3 hours ensuring complete digestion when the solution became colorless (Allen *et al.*1986). After cooling, the mixture was filtered over Whatman no. 42 filter paper along with washing with double distilled water. The containts were then transferred into a 50 mL volumetric flask and diluted to the volume of the flask.

All samples were analyzed using Atomic Absorption Spectrometer (Perkin Elmer A Analyst 200). Detection limits were 0.01, 0.05, 0.03, 0.04, 0.06, 0.20, 0.01 and 0.04 mg/kg and corresponding wavelength used were 229, 241, 325, 248, 232, 283, 214 and 285.0 nm for Cd, Co, Cu, Fe, Ni, Pb, Zn and Cr respectively. Chemicals used were Merck Germany, analytical grade including standard stock solutions of known concentrations of different metals. All analyses were replicated three times and blank samples were analyzed after each seven samples. The precision and analytical accuracy of the analyses were checked by the analysis of standard reference material C.P.A Chem., Bulgaria. To assess the concentration level of trace elements, mean, median, minimum, maximum and standard deviation of feed samples were performed using Microsoft Excel (version 2007).

The concentrations of toxic and essential metals (dry sample) of the present study ranged from 1.17 to 2.0, 2.33 to 4.67, 5.17 to 21.67, 106.67 to 363.3, 3.5 to 7.16, 3.83 to 21.2, 56.7 to 141.6 and 2.1 to 16.49 mg/kg of Cd, Co, Cu, Fe, Ni, Pb, Zn and Cr respectively in (Table 1).

Table 1. Concentration of heavy metals in commercial fish feed (mg/kg dry sample), n =10

Metal	Concentrated values (Present Study)					Safe Limit		
	Max.	Min.	Median	SD	% SD	FAO/WHO	EU	USEPA
Cd	2.0	1.17	1.67	± 00.28	28	2.2	2.0	-
Co	4.67	2.33	2.67	± 00.74	74	1.0	1-1.5	-
Cu	21.67	5.17	11.92	± 04.64	464	30.0	100.0	-
Fe	363.3	106.67	163.35	± 80.04	8040	100	-	90-100
Ni	7.16	3.5	4.67	± 01.06	106	-	0.1-8.0	-
Pb	21.2	3.83	5.92	± 05.14	514	2.0	5.0	-
Zn	141.6	56.7	100.8	± 23.82	2382	150.0	-	80.0-160.0
Cr	16.49	2.1	3.97	±04.40	440	1.0-2.0	1.0	-

n=No. of samples; SD, standard deviation; FAO (1984), Food and Agriculture Organization; EU (2003), European union; USPEA (2011) United States Protection Environmental Agency

The concentrations of Cd ranged from 2.0 to 1.17 mg/kg and the level is lower than the maximum permissible limits of FAO/WHO, 1984 (2.2 mg/kg) and EU, 2003 (2.0 mg/kg). Cobalt and Cu concentrations ranged from 2.33 to 4.67 mg/kg and 5.17 to 21.67 mg/kg respectively. Cobalt content in all samples exceeded the maximum permissible limits FAO/WHO, 1984 (1 mg/kg) and EC, 2003 (1.2 mg/kg) whereas the mean concentration of Cu (11.97 mg/kg) found in the analyzed samples was below the FAO/WHO (1984) guideline (30.0 mg/kg) and EU (2003) standard of 100 mg/kg. Lead content in the samples were in the range of 3.83 to 21.2 mg/kg. The highest concentration of Pb was found in Lion Feeds while lowest was in SM Fish Feed. Lead concentration in all samples exceeded the FAO/WHO (1984) and EU (2003) limit for of 2 mg/kg and 5 mg/kg respectively except SM Fish Feed. The maximum concentration of Pb in the present study was higher than the result reported by Kundu *et al.* 2017 (16.39 mg/kg). Iron was detected in the range of 106.67 to 363.30 mg/kg which exceeded the maximum permissible limit (100 mg/kg) proposed by WHO (1984) and EU (2003). The highest concentration of Fe was detected in Rupshi Quality Fish Feed whereas that was lowest in Aman Feed. The maximum concentration of Ni was 7.16 mg/kg in Lion Feed and the lowest concentration was 3.15 mg/kg in Mesh Fish Feed. The limits for the allowed nickel content in different human foods range between 0.1 and 8.0 mg/kg by EU (2003). The concentration of Cr was found to range from 2.1 to 16.49 mg/kg. Chromium concentration in all samples exceeded the FAO/WHO (1984) and EU (2011) standard limit for Cr of 1- 2 mg/kg and 1 mg/kg respectively. The results of the study are alarming and show that some of the feed samples contain chromium three to four times higher than the maximum chromium consumption level. Chromium content in fish feed found 3.0 mg/kg by Daia *et al*. (2016) which was lower than the present study. The highest concentration of Zn was found (141.67 mg/kg) in Aman Feed while SM Fish Feed had the lowest value (56.67 mg/kg). Zinc content of all feed samples were within the maximum permissible limits of WHO, 1984 (150 mg/kg) and USEPA, 2011 (80-160 mg/kg) standards.

The Pearson Correlation Coefficient in the present study, r is used to describe the interrelationships between the elements analysed at a significant level of 0.05 and 0.01. Table 2 shows a high positive correlation between Ni-Co (0.917) and Cr-Pb

Table 2. Correlation matrix of trace metals in fish feed

	Cu	Ni	Co	Fe	Zn	Cr	Pb	Cd
Cu	1							
Ni	0.659*	1						
Co	0.672*	0.917**	1					
Fe	0.516	0.122	0.228	1				
Zn	0.097	-0.051	-0.275	-0.139	1			
Cr	0.413	0.795**	0.767**	-0.332	0.025	1		
Pb	0.318	0.684*	0.706*	-0.278	-0.002	0.914**	1	
Cd	0.519	-0.008	-0.051	0.774**	0.325	-0.258	-0.218	1

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed), N=10

(0.914) at the 0.01 level which indicates the similar source of these trace metals in fish feed.

Contaminated raw materials of feed might be the source of these metals. The correlation between Cu and Ni, Cu and Co, Cu and Fe, Cu and Cd, Ni and Cr, Ni and Pb, Co and Cr, Co and Pb, Fe and Cd were above 0.5.

CONCLUSION

This study revealed the concentrations of Cd, Cu, Ni, Zn in different brands of fish feed were within the acceptable limits whereas the concentrations of Co, Fe, Pb, Cr exceeded the limit recommended by FAO/WHO, EU. Use of contaminated raw materials during fish feed production might be the possible source of these metals. To maintain the safety of food chain and to minimize the heavy metals' contamination, it is mandatory for the feed producers to observe and maintain standards for heavy metals in fish feeds.

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REFERENCES

Allen, S. E., H. M. Grimshaw and A. P. Rowland. 1986. Chemical analysis. In: Moore PD, Chapman SB (eds) Methods in plant ecology. *Blackwell Scientific Publication, Oxford*, pp. 285–344.

Basaran, B. M., Ulas and O. B. Behzat. 2000. Toxicological profile for chromium. US Department of Health and Human Service, Atlato, GA, 158.

Bukar, H. and M. D. Saeed. 2015. Proximate and heavy metals analysis of selected poultry feed from Kano Metropolis. *Journal of Chemical and Pharmaceutical Research* **7**(1): 16-24.

Daia, Y. S., B. Jonesb, K. M. Leeb, W. Lib, L. Postc and T. J. Herrmana. 2016. Heavy metal contamination of animal feed in texas. *Journal of Regulatory Science* **4:** 21-32.

Environmental and Technology Brief for Cityzens. 2009. Human health effects of heavy metals.

European Commission. 2003. Opinion of the scientific committee on animal nutrition on undesirablesubstances in feed.

FAO. 2016. Fisheries and Aquaculture topics. The State of World Fisheries and Aquaculture (SOFIA). Topics Fact Sheets. Text by Jean-Francois Pulvenis. In: FAO Fisheries and Aquaculture Department.

FAO/WHO. 1984. List of maximum levels recommended for contaminants by the Joint FAO/WHO. Codex Alimentarius Commission.

Kashem, M. A. and B. R. Singh. 1999. Heavy Metal Contamination of Soil and Vegetation in the Vicinity of Industries in Bangladesh. *Water, Air, and Soil Pollution* **115**(1-4): 347-361.

Kundu, G. K., M. Alauddin, M. S. Akter, M. S. Khan, M. M. Islam, G. Mondal, D. Islam, L. C. Mohanta and A. Huque. 2017. Metal contamination of commercial fish feed and quality aspects of farmed tilapia (Oreochromis niloticus) in Bangladesh; *Bioresearch communiucation* **1**(3): 345-353.

Macomber, L. and R. P. Hausinge. 2011. Mechanism of nickel toxicity in microorganisms. *Metallomics Integrated Biometal Science* **3**: 1153-1162.

Mottalib, M. A., A. Sultana1, S. H. Somoal1, M. N. Abser. 2016. Assessment of Heavy Metals in Tannery Waste-Contaminated Poultry Feed and Their Accumulation in Different Edible Parts of Chicken. *IOSR Journal of Environmental Science, Toxicology and Food Technology* **10**(11): 72-78.

Sabbir, W., M. Z. Rahman, T. Haldar, M. N. Khan and S. Ray. 2018. Assessment of heavy metal contamination in fish feed available in three districts of south western region in Bangladesh. *International journal of Fisheries and Aquatic Studies* **6**(2): 100-104.

Uluozlu, O. D., M. Tuzen, D. Mendil and M. Soylak. 2009. Assessment of trace element contents of chicken products from Turkey. *Journal of Hazardous Materials* **163**(2-3): 982-987.

USEPA. 2011. Regional Screening Levels (RSLs) - Generic Tables.

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