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Heavy Metals in Poultry Products in Bangladesh: A Possible Death Threat to Future Generations

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Abstract

The study evaluated the possible presence of heavy metals in poultry product and consequently the effects of heavy metals from poultry product to the people of Bangladesh. The findings indicate that the level chromium contamination along with other heavy metals were above the standard limits recommended by the World Health Organization and were the major cause for food-borne illness. Tannery and textile industries were the main sources of environmental pollution of heavy metals in Bangladesh. Further exploration through systematic research is warranted to determine the extent of contamination of heavy metal pollutants discharged from textile and tannery wastes that are found in poultry feed. As regards to environmental protection and food safety, animal feed additives in Dhaka City and elsewhere should be controlled based on appropriate legal limits approved by the regulatory agencies of Bangladesh.

Keywords: Food Safety Education, Heavy Metals, Poultry Product, Ecosystem, Tannery Industry, Textile Industry

INTRODUCTION

Heavy metals are defined as metallic elements present in human body (Fergusson, 1990). Heavy metals are vital for proper functioning of biological systems and constitute essential nutrients for humans, and their deficiency or excess could lead to a number of disorders (Ward, 1995; Anderson, 1997). For example, iron is an important component of hemoglobin and cytochrome c; zinc is essential for certain DNA-binding proteins; and copper, manganese, selenium and zinc in trace amount are vital for proper performance of enzymes. In addition, boosting of the immune system and escalating its functionality depends on zinc and selenium (Henry and Miles, 2001). Arsenic is essential to promote growth and acts as a coccidiostats (AAFCO, 1999).

However, excess amounts of these essential metals can be detrimental to human wellbeing as well as to the environment. A study conducted in India revealed that industrial effluents discharged from textile and tannery factories exceed the permissible limits for cadmium, chromium and copper (Deepali, 2010). These effluents

released onto the land and discharged into the environmental water ultimately leach into ground water. Strong evidence suggested contamination due to accumulation of these undegradable toxic metallic components results in a series of hazards to the ecosystems (Malarkodi *et al*, 2007).

Leather industry is one of the main income earning segments in Bangladesh- the highest priority sectors for its growth prospective, employment generation and contribution towards export diversification (Paul, 2012; Technical Report, 2013). Statistics from the Export Promotion Bureau of Bangladesh for the financial year 2011-12 reported the leather industry sector expanded by 17.5% and earned US\$765 million in revenue, approximately 57% of the total revenue (Technical Report, 2013). It is evident that the industry is one of the major sources to the nation's economy, however, this has also brought major public health hazards and serious threat to the environment. Most of the tanneries follow chrome tanning process where chromium sulfate is used (Hossain *et al*, 2007; Mazumder *et al*, 2013). Therefore, industrial effluents that cause a wide range of environmental harm and health risks are of major concerns not only in developing countries such as Bangladesh but also in developed countries.

The main objective of this study was to review studies that evaluated the presence of heavy metals in effluents of textile and tannery industries and also the additives used in animal feed in Bangladesh. The review also looked into the health of people in Bangladesh affected by ingestion of products from poultry fed with heavy metal contaminated feeds and examined the current recommend strategies to control heavy metals effluents to levels safe to humans.

METHODOLOGY

The reviewed data was retrieved from documents available mainly in scientific electronic databases (PubMed, Scopus and Web of Science). Google and Google Scholar were used to search key words, e.g. "heavy metal", "poultry industry in Bangladesh", and "industrial pollutions". Ongoing and unpublished research works, including reports from three leading Bangladesh daily newspapers (The Daily Star, New Age and Dhaka Tribune) were analyzed. Thirty nine documents were retrieved from the databases of national and international peer reviewed journals from 1995-2018. Online sources of environmental hazards and safety related journals were searched for relevant publications. Quantitative and qualitative studies reporting on heavy metal pollutions from textile and tannery industries were included in this review.

Policy analysis was carried out in terms of the existing poultry situation in Bangladesh in regulating the presence of heavy metals in poultry feeds, and the policies of other countries were also examined. Relevant conference presentations related to heavy metals and poultry in Bangladesh together with findings of historical observations and a cross-sectional prevalence study of heavy metal and poultry in Bangladesh were included. The review attempted to contribute to the existing literature in the form of new findings and also critically evaluated existing findings.

CONTAMINATION OF FOOD CHAIN

Food chain contamination is a common route of human exposure to heavy metals (Nwude *et al*, 2010). The heavy metals have several toxic effects on the body, viz. association of elevated blood pressure and hypertension with lead exposure; kidney malfunction due to long-term contact with cadmium in air, food, and/or water and damage of lungs and fragile from excess exposure (Martin *et al*, 2006); allergic reactions in skin, damage to lungs and triggering of asthma attacks (ATSDR, 2005), and cellular damage, mutation of cells and even cancer (Mazumder *et al*, 2013) from chromium exposure; and irritation of eyes, mouth and nose from long-term exposure to copper dust (Gerberding, 2004). Heavy metals can enter dairy manufacture through the burning of fossil fuels (atmospheric deposition), agrochemicals (pesticides), biosolids, land application of inorganic fertilizers, and animal manure (Nicholson *et al*, 2003). Hence, there is an urgent need to strengthen and securing the entire food chain from heavy metals contamination (Okoye *et al*, 2011).

FINDINGS IN ASIA (WITH THE EXCEPTION OF BANGLADESH)

In China, a wide range of heavy metals in animal manure are associated with the presence of heavy metals in feed additives in animal production industry (Zhang *et al*, 2012). These feed additives are used in both small and large farms, and, thus, animal feed additives should be controlled so that they do not contain heavy metals exceeding China legal limits.

In India, high levels of heavy metals contamination are present in soil and ground water samples that receive effluents from tannery and textile industries (Deepali, 2010). The effluents were found to surpass the legal (prescribed) limits for discharge into the environment. Prior treatments of the effluent should have been performed before disposal as the levels of a number of the heavy metal components present were higher than the legal limits and thus not safe to be discharged (Deepali, 2010). Experts from the World Health Organization estimated that the heavy metals levels in water and soil exceed the safe limits in the study site (Deepali, 2010).

In Pakistan, heavy metals were detected in all examined samples of poultry feed and tanneries, which are the main sources of environmental pollution (Imran *et al*, 2014). Effluents from tanneries are discharged into drains without any prior treatment. Another study in Pakistan it was established that in all the three districts the daily intake values of heavy metals through egg were found above the permissible values (Zafar Khan, et, al., 2016).

SITUATION IN BANGLADESH

The main problem in Bangladesh is caused mostly by the poultry feed producers, who neither use scientific approach to maintain proper standards nor follow health and hygiene standards (SOS, 2003). A study showed tannery solid wastes converted to protein concentrates for use in fish and poultry feed and in production of organic fertilizers without proper treatment (Hossain *et al.*, 2007), and this alarming practice has become a common scenario in small and large tanneries. About 90% of tannery industries are located in 25 hectares of land in Hazaribagh, south-west of Dhaka city (Fig 1) (Hossain *et al*, 2009). Each large tannery produces 200-250 tons of protein concentrate per day and 600 to 1000 kg of tanned processed cut skin and/or rawhide (Zahid *et al*, 2004; Hossain *et al*, 2007; *ibid*, 2009; Mazumder *et al*, 2013). In most (80%) tannery industries the stages of processing involve chrome tanning, which uses chromium salts in large amounts (Mazumder *et al*, 2013).

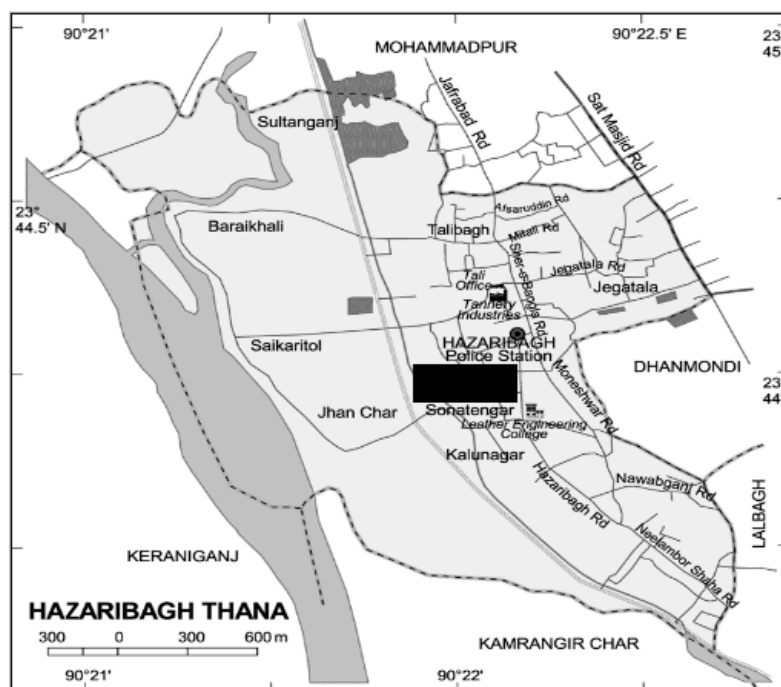


Fig 1 : Map of Hazaribagh Thana (administrative unit), Dhaka

Source: Hossain *et al.*, 2007 (Hazaribagh Thana)

Poultry feed contamination by tannery toxic waste

In 2007 the Bangladesh Council for Scientific and Industrial Research (BCSIR) reported the presence of chromium in eggs and poultry meat above permissible limits (Hossain *et al*, 2007). There is no significant change in chromium level after boiling and drying. Poultry feed based on tannery solid waste is mostly produced in Dhaka, but is distributed throughout the country (Hossain *et al*, 2007). The presence of chromium in samples from two different areas of the country is 1.94 and 2.49% respectively (Hossain *et al*, 2007). Bangladesh Livestock Research Institute found that there was a higher chance of developing antibiotic resistance from long term consumption of chicken and eggs that contained antibiotics (Daily Star, 2015). According to Dr. Abul Hossain, University of Dhaka, the normal level of chromium in chickens 0.5-2 mg/.0005-.002g but those that consumed toxic feed laid eggs containing chromium 100-1,000 times higher than normal level (Dhaka Tribune, 2014). One study revealed, based on dry weight, the mean chromium concentration is 1.9016 ppm (range = 0-19.8051 ppm) from 96 eggs collected from Dhaka and seven other districts of the country (Hossain *et al*, 2009). A chromium content of 23.3809 µg was found in a single poultry egg, which exceeded the recommended daily dietary intake of children (1-8 years of age) (Hossain *et al*, 2009). From chickens collected from different parts of the country, all liver and gizzard samples contain chromium (range = 0.24-15.0 and 0.15-4.7 ppm respectively), with detectable amounts in the meat but none in the brain (Parvin and Rahman, 2014).

It is worth noting that all samples examined by Hossain *et al* (2007), in addition to chromium, contain arsenic, cadmium, lead, and mercury, with concentration at one site of 2.212, 3.888, 30.114, and 13.916 ppm, and at another site of 0.099, 0.991, 7.577, and 0.166 ppm, respectively.

In addition, tests conducted by the Nutrition Cell of Agriculture Research Council, Bangladesh revealed fish feed contains 4,971 ppm chromium and poultry feed con 4,205.70 ppm, although the permissible level is 30 ppm, the nutrient requirement level for both types of feed set by the Nutrition Cell (Daily Star, 2014a).

Human contamination of heavy metals through consumption of contaminated poultry

Ingestion of heavy metals through food chain by humans has been broadly testified all over globally (Muchuweti M, *et al*, 2006; Duruibe, JO, *et al*, 2006; Khan S, *et al*, 2008). There is a growing concern that ingestion of chromium in water, poultry and eggs is associated with an increase in the incidence of cancer. In a statement, the Head of the Cancer Epidemiology Department, National Institute of Cancer Research and Hospital (NICRH) in Dhaka pointed out the number of cancer patients is rising daily, which might be due to ingestion of meat from poultries fed with feeds contaminated with heavy metals (Daily Star 2010). According to NICRH (2005), the recorded number of cancer patients treated is 5,411, rising to 6,492 in 2006, 6,926 in 2007 and 7,518 in 2008. The Principal Scientific Officer of Bangladesh Council for Scientific and Industrial Research (BCSIR) stated the poultry meat in local markets of Bangladesh contains 2.5% (w/w) chromium compared to 0.4% (w/w) in imported chicken meat. Moreover, in addition to chromium, there are some 30 types of harmful chemicals, such as acids and sodium chloride, which are used for tanning (Daily Star 2010). Thus, there is a possible human health risk through consumption of contaminated poultry meat as it exceeded the daily adequate intakes level (Ahmed, S, *et al*, 2017; Bari *et al*, 2015).

The health effects of heavy metals poisoning include reduced IQ, anemia, neurological damage, nerve disorders, and other health problems. The effects of heavy metals in children are most severe and at high concentrations of heavy metals exposure can lead to death (Bari *et al*, 2015).

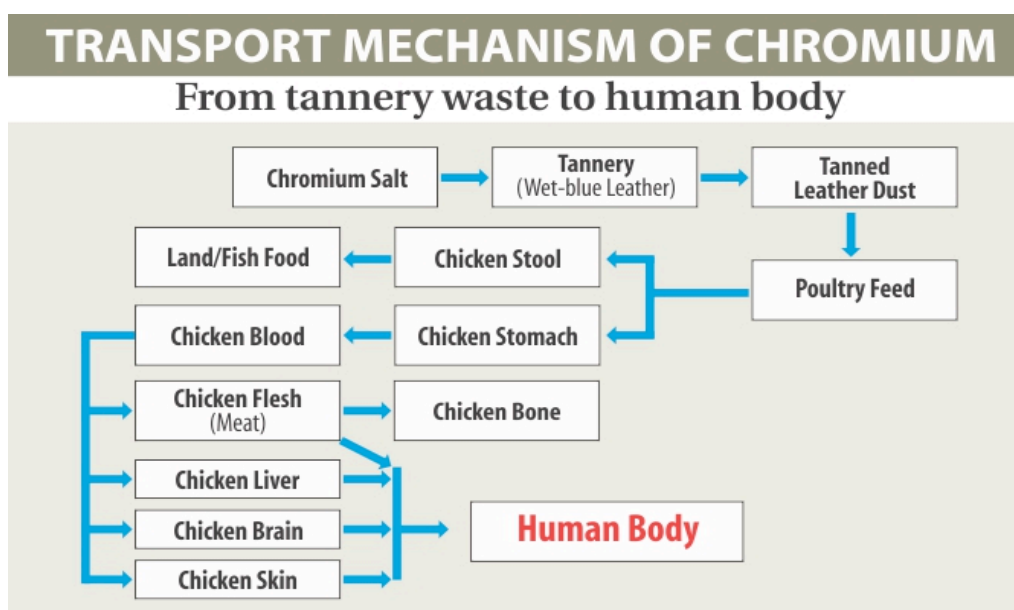


Fig 2: Transport Mechanism of Chromium

(Source: Hossain, 2014; Daily Star, 2014)

Government role and actions

In 2014, a mobile court of the Rapid Action Battalion seized 3,000 bags of poultry feed made from toxic tanner wastes produced at Hazaribagh and sealed its factory (New Age, 2014). An employee and colleague of a fish and poultry feed factory in Hazaribagh were each fined BDT 200,000 (US\$ 2366.71) for using toxic tannery waste and were jailed for two years. An enquiry by the Daily Star in July 2010 found around 100 small traders around Hazaribagh who used raw tannery waste as ingredients and supplied them to some 20 feed factories across the country. Since 2010, the practice of using tannery wastes for fish and poultry feed is still ongoing due to the annual increase in price of imported protein for feed (Daily Star, 2014a). Furthermore, it is important to note that the ground water of Hazaribagh is already highly polluted with carcinogenic heavy metals (SOS, 2003). The Director of the Department of Environment (Monitoring and Enforcement) in Dhaka was assigned to take action against perpetrators who used tannery wastes in poultry and fish feeds (Daily Star, 2010). Recently, Bangladesh has started producing Antibiotic Growth Promoter free poultry food. The poultry industry urged the government to allow local companies to produce poultry vaccines, take the backyard poultry under vaccination coverage and arrange training for the farmers as well as the concerned officials on safe food (Dhaka Tribune, 2018). Strong political will is essential to implement and enforce existing policies and laws, which have to be revised to be more effective.

CONCLUSION

The textile and tannery industries in Bangladesh are undoubtedly the major sources of heavy metals pollution of the environment. The production of poultry feed from tannery wastes should be closely monitored by the relevant government agencies to ensure that poultry feeds are prepared from heavy metals-free raw materials. In order to understand the extent of pollution of the environment and contamination of the livestock and poultry in the country, a systematic survey should be conducted. "Till date, studies on human were conducted for arsenic intoxication only in Bangladesh. Other heavy metal related illness incidence should be documented by large scale studies" (Hezbollah, et. al, 2016). The "Poultry Feed Reference Standards, February 2002", formulated by the Ministry of Fisheries and Livestock, Government of Bangladesh encompasses no criteria for the heavy metals as pollutants into poultry feeds, which stresses immediate attention (Islam, et. Al. 2007). In order to save the environment and means, biological remediation procedures for heavy metals need to be adopted (Bari et al., 2015).

Poultry is a rising industry and has become an essential source of protein for the people of Bangladesh and awareness on the health consequences of using tannery wastes for the production of poultry feeds is essential through initiation of educational programs on food safety in the large and small scale poultry industries. In addition, proper waste treatment and reducing heavy metals effluents to safe levels should be considered to address this issue. Moreover, the disposal problem of tannery wastes must be addressed through recycling the waste products into other useful by-products, such as glue and sodium dichromate. Prohibiting the production of poultry feed from solid tannery wastes may not be economically attractive, therefore, the manufacturing process of poultry/fish feed should be engineered in such a way that heavy metals remain at acceptable minimum level. 'To minimize the heavy metals contamination, tannery and other industries that produce wastes containing heavy metal should have treatment facilities to ensure toxic wastes are not released into the environment and should be planned in such a way that minimum adaptation of heavy metals takes place' (Parvin and Rahman, 2014).

The chamber of commerce, the consumer rights protection council, activists and donor agencies should come forward to assist the government to deal with this issue. The government needs to be more proactive and vigilant so that the future generations of Bangladesh will be free from life-threatening diseases associated with unsafe food supply and food-borne illnesses. In the light of environmental protection and to maintain the safety of food chain- public health departments, professional bodies and law enforcement agencies should monitor and ensure rigorous quality control of cattle and poultry feeds generated from tannery and textile wastes.

AUTHORS' CONTRIBUTIONS

SM designed and conducted the literature review and contributed to the manuscript structure as well as drafting and overall editing of the manuscript. SM and AA contributed in designing the Methodology. AA, JD contributed to the reviewing and editing of the manuscript. All authors read and approved the final manuscript.

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CONFLICTS OF INTERESTS

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