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Detection of heavy metals and evaluation of beef procured from the different market of Dhaka in Bangladesh

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ABSTRACT: *The study was conducted to appraise the quality of beef via detection of heavy metal contents. Twenty markets were selected randomly from the Dhaka city corporation (DCC) of Bangladesh. Beef samples were collected from the selected market of DCC by two phases during study period. In first phase, fifty beef samples were collected from ten markets by purchasing to detect the heavy metal contents i.e chromium (Cr), cadmium (Cd), lead(Pub) and arsenic (As) in this study. In second phase, another fifty samples were collected from different ten markets of DCC to detect similar metal content as did in first phase. A total of 100 meat samples was collected from the selected market and analyzed to determine the concentration of toxic metals (Cr, Cd, Pb, As) in meat samples. In first stage, except for As (P>0.05) , all other metals (Cd, Cr and Pb) collected from different markets affected significantly (P<0.01) between treatments . In second phases of experimental study, all the detected metals (Cd, Cr, Ob, As) measured in this study differed significantly (P<0.01) between treatment. It can be concluded that the quality of beef of different markets appears to be good based on the chemical evaluation, even though variation was found in the toxic metal contents of meat samples in this study. The analyzed values of toxic metals in beef samples are within the range or limits of the acceptable level, so no health hazard will create over the consumer world through after consumption of beef.*

KEY WORDS: Beef, quality, heavy metal (Cd, Cr, Pb, As), meat evaluation, market

INTRODUCTION

Livestock farming is a very common phenomenon in the rural area of Bangladesh. The expansion of this sector in the urban areas is also noticeable now-a-days. We do know that two important and delicious food products are mainly meat and milk, a good sources of animal protein received from livestock. It is needless to say that livestock is a part and parcel and has been a very important sub-sectors of agriculture which provides premier quality of protein to the consumer world, and helps to enhance the national and rural economy of Bangladesh (Kamal et al., 2019).

The delicious food item or products are beef or cattle meat available in the market to nourish the consumer world. People are purchasing this meat from both super market and open market to meet their daily protein need or food requirement. It is needless to say that the beef is very dear to the people as a palatable dish, particularly for those who are muslim. As we see that numerous cattle farming is rising in the country as a beef fattening or other program to supply this meat for meeting increasing daily demand of marketing, and to serve special purposes of the consumer. In this regard, many cattle are slaughtering each and every day across the country. A great number of animals are also slaughtered every year for serving particular purpose say Eid festival, in a developing country like Bangladesh. The main product of the slaughtered animal is the beef or meat, which is consumed by the people as palatable dish, and the products remain as by-products are mainly hides and skin, and as a raw materials this products help to grow many industries (eg. leather, textile, tannery) in the country.

It is reported that industrial wastes such as effluents, sludge, particle etc., releasing in the environment are a great sources of heavy metals. The metals say Cr, Ni, Pb, and As etc., arise from tanneries and other industries. Some of these metals are very toxic and present in the environment, posing a great threat for food chain, man, animal and ecosystem health. So it is inevitable or give more emphasis to monitor the quality of beef available in the market for the food security, consumer safety, and public health risk assessment (Haque et al., 2021). As it is reported that the main emerging issues in Bangladesh are consumer health, feed and food safety (Hashem *et al*., 2020).

Feed or food is the fuel of life. No animal or living being thrives without having food. And the safety of food products (beef) is assumed that it has direct connection with the feed materials consumed by the animals (Kamal et al., 2016 and 2020). In beef fattening or farming program, we note that cattle are allowed to feed on varieties of feedstuffs such as complete feed, forage, fodder, green grasses, cereal by-products, gruel, bran, and so on for their sustenance or maintenance of the body. It is reported that these feedstuffs are considered a good sources of heavy metal contaminants and toxins that mainly come from anthropogenic and natural sources (Sarkar et al., 2008, Rahman et al., 2008, Hossain et al., 2016). In addition, the feedlots and water used for raising the animals help to enter toxic metals into the food products or meat (Kasozi et al., 2018).. The contaminating agents of food safety related to these feedstuffs might be biological, chemical or physical in nature (Rahman et al., 2020). Each of these hazards is associated with special sources and pathway of contamination and exposure. Many human activities relating to multiple industrial, domestic, agricultural, medical, and technological applications etc., have stimulated to disseminate the toxic metals widely in the environment, raising concerns over their potential effects on human health and the environment (Kamal et al. 2022).

In this study, we surveyed twenty markets of Dhaka City Corporation (DCC) and collected beef samples for conducting this study. Some important arising issues such as public health, food safety and food quality have stimulated us to explore the detection of toxic metals (Pb, Cd, Cr and As) in beef samples of different markets of DCC, Bangladesh, regarding the risk associated with

consuming food contaminated by these hazardous elements. The metals at low concentration are liable to cause severe health problems (Ali et al., 2013).

In a developing country like Bangladesh, the information, data, and other findings relating to the extent of heavy metal contamination in beef of different markets are not sufficient. National policy makers in the food industry are therefore not well informed to take the necessary steps or action to protect consumers. So the results of the current study can be helpful for the stakeholders, policy makers industrialists, consumers etc., to address priority and for conveying critical message or information for safeguarding public safety. Considering this view, the present study was conducted to detect the contents of heavy metals in beef of different market in Bangladesh.

MATERIALS AND METHODS

Study area and experimental period

The study areas include twenty markets of Dhaka City Corporation (DCC) of Bangladesh. Research materials say beef 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 market and sample collection

Twenty markets were selected randomly from the different places of DCC of the Bangladesh. Data collection was rendered in two phases of study from the selected markets. Ten different markets in one phase and another ten markets in second phases of study was done. In first phase, beef samples were collected from ten different markets located in the different places of DCC, Bangladesh. The markets are BKB (Banani Kacha Bazar), GM (Gabtoli Kacha Bazar), KBM (Kawran Bazar market), KSM (Kalabagan Staff quarter Math Bazar), MB-(Meradia Bazar), MKB (Mohakhali Kacha Bazar), MKM (Mohammadpur Krishi market), MLM-(Malibug Bazar), MTM (Mohammadpur Town Market), ZKB (Zinjira kacha Bazar). In second phase, around two months later, the beef samples were also collected from another ten markets by purchasing from DCC. These are AKB (Azimpur kacha bazar), AP (Abdullahpur Paikari Bazar),; BB (Bakshi Bazar) -, FB (Farmgate Bazaar), GKB(Gulistan Kacha Bazar), -, MQB (Mirpu rKrishi Market), ODB (Old Dhaka babu bazaar), ODM (Old Dhaka Moulivi Bazaar), TKB (Tejgaon Kacha bazaar), , and UKB (Uttara Kacha Bazaar). Markets were selected randomly by surveying based on the number of criteria such as availability, durability of markets, selling volume, number of animal slaughters each day, location, communication, number of sale proceeds, , size of the market, modern facility , customer security, and income and investment of the sellers in the biz, source of animals, type of animals etc., Bulk beef samples were collected during study period from each those selected markets. Later five 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 100 beef samples was collected during 2021.Sampling was done by taking five (5) individual samples from each market and bulking these together to provide one sample amount of 500 g in an air tied zipper bag for analysis located at different places of DCC of Bangladesh from 20 different markets engaged in beef selling process. Collected samples were dried and ground by pestle and mortar, and then be taken for the lab analysis. For the digestion of samples, approximately 1.0 gm of meat samples was digested with 6 ml of HNO_3 (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 10 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 (As, Pb, Cr, Cd,) of meat samples were measured at 193.7, 283.0, 357.9 and 228.8 nm wavelength, respectively.

Table 1: Global permissible limits/standards of heavy metals (FAO/WHO-2011)

Name of Metals (mg/kg)	Limit	Standards/references	**Type of samples**
Cd	0.50	FAO-1983	Meat
Cr	0.05	FAO-1983	
Pb	0.10	Codex –Alimentarius Commission-1994	
As	<0.50	Monie, 1999, Bahri & Romdane, 1991	

Statistical analysis:

All collected data were subjected to analysis by one way ANOVA using Minitab software (Minitab version 16, 2000). 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 $P \leq 0.05$

RESULT

The results of heavy metal contents (As, Cr, Pb, Cd) of beef samples procured from the ten different markets of Dhaka city corporation (DCC) were shown in Table 1 and Table 2, respectively. Table 1 data belong to phase 1 and the data represented in Table 2 that are collected from the phase-2 experimental period. The results showed that the contents of chromium (Cr), lead (Pb) and cadmium (Cd) differed significantly ($P<0.01$) between treatment except for arsenic (As) ($P>0.05$).during phase 1(Table 1). The highest amount of Cr was found in MKB (10.81 µg/kg) and lowest value was found in the market of KSM (0.73 µg/kg). The amount of Pb was highest in the market of MLM (69.63 µg/kg) and MB market had the lowest content of Pb (11.08µg/kg). The

KBM market had the highest value of Cd (13.18 µg/kg) content while GM market received the lowest level (4.49µg/kg), as shown in Table 1.

Table—1: Heavy metal contents of beef procured from different market of Dhaka

Metals (µg/kg)	Market										SEM	P-values
	BKB	**GM**	**KBM**	**KSM**	**MB**	**MKB**	**MKM**	**MLM**	**MTM**	**ZKB**		
As	3.51	3.53	4.49	3.81	4.98	4.64	4.22	4.82	5.56	3.48	0.276	0.742
Cr	9.61^{a}	6.56^{b}	1.88^{d}	0.73^{d}	8.54^{a}	10.81^{a}	3.75^{c}	4.63^{c}	4.93^{c}	4.68^{c}	0.222	0.01
Pb	25.94^{d}	52.44^{b}	53.74^{b}	34.62^{d}	11.08^{f}	29.87^{d}	45.85^{c}	69.63^{a}	40.12^{c}	25.25^{e}	0.834	0.01
Cd	8.42^{b}	4.49^{d}	13.18^{a}	6.42^{c}	6.53^{c}	6.48^{c}	7.20^{c}	6.17^{c}	9.99^{b}	5.09^{d}	0.130	0.01

[Data refer mean values of five replicates consisting of ten treatments; ^{a,b,c,d}Means bearing different superscripts within a column are significantly different at **P<0.01, ; SEM, standard error means; BKB—Banani Kacha bazar, GM-GabtoliKacha bazar, KBM-Kawran bazar market, KSM- Kalabagan Staff quarter Math Bazar, MB-Meradia bazar, MKB—Mohakhalikacha bazar, MKM—Mohammadpur Krishi market, MLM-Malibug Bazar, MTM—Mohammadpur town market, ZKB—Zinjira kacha bazar]

Table 2 demonstrated that all the metal contents (Cr, Pb, Cd, As) measured in this study differed significantly (P<0.05), (P<0.01) between treatment during phase 2. The highest amount of As (P<0.05) was found in ODB (5.61µg/kg) and lowest value was found in the market of FB (2.18µg/kg). The highest amount of Cr was found in FB (12.15 µg/kg) and lowest value was found in the market of ODM (5.16 µg/kg). The amount of Pb was highest in the market of AKB (46.74 µg/kg) and BB market had the lowest content of Pb (14.85 µg/kg). The AKB market had the highest value of Cd (18.78µg/kg) content while FB market had the lowest level (4.07 µg/kg), as shown in Table 2.

Table—2: Heavy metal contents of beef procured from different market of Dhaka

Metals (µg/kg)	Market										SEM	P-values
	AKB	**AP**	**BB**	**FB**	**GKB**	**MQM**	**ODB**	**ODM**	**TKB**	**UKB**		
As	4.93^{b}	5.58^{a}	3.34^{c}	2.18^{d}	4.11^{b}	4.37^{b}	5.61^{a}	4.22^{b}	4.60^{b}	4.20^{b}	0.216	0.042
Cr	11.43^{a}	9.01^{b}	11.50^{a}	12.15^{a}	5.95^{c}	7.24^{b}	7.87^{b}	5.16^{c}	11.69^{a}	8.96^{b}	0.457	0.01
Pb	46.74^{a}	22.64^{d}	26.27^{d}	46.68^{a}	31.55^{c}	39.13^{b}	41.65^{b}	39.05^{b}	44.14^{a}	41.70^{b}	1.003	0.01
Cd	18.78^{a}	15.77^{b}	14.85^{b}	4.07^{d}	9.16^{c}	19.32^{a}	7.27^{c}	11.50^{c}	8.83^{c}	6.78^{d}	0.064	0.01

[Data refer mean values of five replicates consisting of ten treatments; ^{a,b,c,d}Means bearing different superscripts within a column are significantly different at *P<0.05 and **P<0.01; AKB-Azimpurkacha bazar, AP—AbdullahpurPaikari Bazar,; BB—Bakshibazar-, FB—Farmgate bazar, GKB-Gulistankacha bazar, -, MQB—Mirpurkrishimarket ODB—Old Dhaka babu bazar, ODM, Old Dhaka moulivi bazar TKB- Tejgaonkacha bazar, ,UKB—UttaraKacha bazar]

DISCUSSION

The delicious foodstuffs basically meat, milk and eggs are considered as non-piscine protein sources retrieved from the macro and micro-livestock are very important food items used by the

people all over the world (Saiful, 2018). The foodstuffs play a pivotal role to solve the global food crisis or malnutrition by providing essential nutrients (e.g proteins, minerals, vitamins, essential and non-essential amino acids) to the consumer world (Alturiqi and Albedair, 2012).

Beef or cattle meat contaminated with poisonous/toxic elements are problematic and posing a great threat for the consumer world. These toxic elements found in beef or other foodstuffs are reported to expose toxicity and carcinogenic effect at low level accumulation in the body tissues. So periodic test or gradual analyses of toxic metal contents in beef or other meat or foodstuff are very 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 (Ullah et al., 2017, Saiful, 2018, Rashid et al, 2018, Korish and Attia, 2020, Hosain et al., 2021, Kasozi et al., 2021, Kamal et al., 2022, Hossain et al., 2022), but the data are not suffice and sufficient in the country that can help to create national health policy or security plan to safeguard the people . So it goes without saying that the study warrant further analyses to explore more data relating heavy metal detection in beef or other meat and meat products.

However, it is obvious from the current data that about all the elements (Cr, Cd, Pb, As) measured in this study showed significant variation in the different beef samples procured from the twenty different markets of DCC in Bangladesh. The variation of these toxic elements in the different market of beef samples might occur due to numerous factors available in the nature. The first and foremost factors we can consider for the variation of these elements in beef are feed, water, soil, animal husbandry practices, agricultural, medical and industrial activities (Rahman et al., 2008, Hossain et al., 2016, Kamal et al., 2022). This is supported by the previous researchers who reported that the feedlots and water used for raising the animals help to enter toxic metals into the meat (Kasozi *et al.,* 2018). Apart from these, the physical, chemical , biological nature of feed and its compositional differences , ingredient quality, crude fibre content, anti-nutritive factors, feed digestibility etc, can also influence the nutritive values of meat and feed reported by previous investigators (Hossainet al,, 2014, Ghosh et al., 2019, Rahman et al., 2020).

It is clear that all the analytical values of Cr, Cd, Pb, and As of beef of different markets of Bangladesh found in this study are lower than the maximum permissible limits (MPL) of contaminants in beef, as per the suggestions given by WHO/FAO [7, 9] in Table 1. It reported that the MPL for Cr (0.05 mg/kg), Cd (0.5 mg/kg), and Pb (0.10 mg/kg) in beef meat, respectively. We see the analytical values obtained in this current study are lower than the values of MPL as stated in (Table 1). The overall arsenic (As) level found in the beef samples of different market in DCC is also lower than the limit (<0.5) reported by previous researchers (Bahri and Romdane, 1991, Monies, 1999), also stated in Table 1.. It is deemed that if any estimated or analytical values go higher beyond the MPL have possibility to cause detrimental effect on public health. However, the reported values indicate that our analytical values of Cr, Cd, Pb and As contents found in beef samples of different market are safe and sound from the view point of toxicity level. So the meat can be used safely and undoubtedly by the consumer world across the country.

Beef cattle farming or beef fattening program has now been a very profitable business in the developing country like Bangladesh. It is noticeable that the onset of these farming is mostly started or begun just a couple of month before the eid festival. A great number of cattle is raised by the farmers on this occasion to sell in the eid market. Huge number of cattle are sacrificed during this occasion. The slaughtering of these animals in eid festival result in the availability of delicious food item (meat) that is consumed by the people and the by-products, particularly hides and skin, are used by the tannery or leather industries. The huge protein gap of the country can be met by raising beef cattle in this way, and it can help people to earn foreign currency by exporting leather in abroad. However, it is reported that the effluent or wastages, sludge, particle released from the leather or tannery industries or textile mills or other factories are liable to cause food contamination with heavy metals (Kasozi et al., 2018, Kasozi et al., 2021).

It is obvious that a lot of animal husbandry practices or activities including special care, management, feeding, grazing, breeding, housing, vaccination, medication etc., are needed for the beef cattle production commercially. As a part of this of human activities, farmers, cattle integrators, feed miller companies, household owners, and other personnel involved in this business etc., very often use many antibiotics, hormonal drug. enzymes, feed additives, medicines etc,, in the preparation of cattle diets, which are most likely to increase the accumulation of heavy metals in the biological tissue of animal body (Hossain et al., 2016, Kasozi et al., 2018, Kamal et al., 2022). Accumulation of heavy metals in food as one of the environmental pollutants due to the development of urban industries and human activities, is one of the threats to public health (Raeeszadeh et al., 2021).

In view of above, we can suggest 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 and food security, and above all, consumer health across the globe. It may include adopting good animal husbandry practices., control of drug administration in animal efficiently, prudent use of diet, careful attention for feed formulation, develop culture of organic food production, enacting stern rules and legislative laws, statutory control over the livestock feed uses, identification of standard limits, periodic detection, quantification, investigation, and routine examination of heavy contents in meat and meat products including other foodstuffs are remarkable.

CONCLUSION

It could be concluded that the heavy metal contents of different meat samples of verities market in DCC showed significant differences in the treatment. However, it is observed that the analyzed heavy metal (Cr , Cd, Pb, As) contents obtained in this study were found below the limit of the reference or standard value or concentration as per the instruction given by the WHO/FAO. So it could be decided that analytical values of metals of the beef meat samples of different market found in the current study are safe and sound, or not detrimental for the consumer world. Therefore, the beef meat can be used safely by the consumer world without any hesitation. Further study can

be done to assure the meat quality and food safety, as all farms' beef meat existing in Bangladesh are not taken into consideration to detect all heavy metals found in the nature.

Competing Interests

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

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