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RESEARCH ARTICLE

ASSESSMENT OF HEAVY METAL CONCENTRATION IN POULTRY MEAT SAMPLES COLLECTED FROM CHITTAGONG CITY

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ABSTRACT

The present study was carried out to determine the heavy metal concentration in poultry meat samples. The meat samples were collected from five broiler farms in Chittagong city area. A total number of 25 meat samples were collected. Heavy metal generally found in environment through fossil fuels combustion and indiscriminate waste management. The selected heavy metal such as lead and chromium concentration was determined by atomic absorption spectrophotometer. The mean concentration of lead and chromium in meat were 0.228-0.290 mg/kg and 0.048-0.112 mg/kg respectively. The comparison indicates that for meat samples lead was not significantly different ($p>0.05$) in all farms except farm B ($p<0.05$) but chromium was significantly different ($p<0.05$) in case of all farms. In present study all the meat samples showed lower concentration than permissible limit which is safe to human health

INTRODUCTION

Heavy metal contamination is a major international concern due to food safety issues and human health risk through the food chain. They are transferred into the environment through anthropogenic activities such as mining, industrial processing, waste water irrigation, agricultural activities, transport and fuel combustion, iron and steel production, coal and oil combustion, waste incineration, non-ferrous manufacturing and cement kilns (Dietz *et al.*, 1998).

Heavy metals find their way into living organisms from dietary and non dietary exposure where they accumulate and persist for long time. They enter into the food material and from there they ultimately make their passage into the tissue (Baykov *et al.*, 1996). Lead, chromium, cadmium, mercury, arsenic are among the main toxic metals which accumulate in food chains and have a cumulative effect (Cunningham and Saigo, 1997).
Accumulation of heavy metal depends on the organ of interest and on the metal characteristics. Heavy metals often have physiologically toxic effects and are stored in living tissues. The uptake of heavy metals by living organisms is related to the bioavailability of such elements, represented by the characteristics of the metal, the nutritional facts and the age of the organisms. Industrializations Progress throughout the world has been accompanied by the extraction and distribution of mineral substances from their natural deposits. Many minerals, especially trace elements, have undergone chemical changes through technical processes as finally pass, dispersed and in solutions into water and air and consequently into food chain.

Some trace elements are common in the diet and necessary for good human health. Iron (Fe) and copper (Cu) are essential trace elements which required by humans nevertheless, all metals are toxic at higher concentrations (Chronopoulos *et al.*, 1997; Lane and Morel, 2009). Other heavy metals as arsenic (As), Cadmium (Cd), lead (Pb), chromium (Cr) are toxic and their accumulation over time inside chicken can cause serious illness. Certain elements that normally toxic are beneficial for certain organisms or under certain conditions (Lane *et al.*, 2005). Heavy metals may cause acute or chronic toxicity of human. Intake of heavy metals through the food chain has been widely reported through the world (Muchuweti *et al.*, 2006).

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Poultry meat is important source of protein and fat which used as major component of diet. Chemical composition of meat depends on both the kind and degree of the feeding animal. The need for mineral compounds depends on the age, physiological state and feed intake as well as on living conditions (Baykov *et al.*, 1996). Poultry could take up heavy metal compounds from different sources; metal residues may concentrate in their meat, and eggs (Nisianakis *et al.*, 2009).

Contamination with heavy metals is a serious threat because of their toxicity, bioaccumulation and biomagnifications in the food chain (Demirezen and Uruc, 2006). Although contamination of animal feed by toxic metals cannot be entirely avoided given the prevalence of these pollutants in the environment, there is a clear need for such contamination to be minimized, with the aim of reducing both direct effects on animal health and indirect effects on human health (SCAN, 2003). The risk associated with the exposure to heavy metals present in food product had aroused widespread concern in human health. Improvements in the food production and processing technology had increased the chances of contamination of food with various environmental pollutants, especially heavy metals. Ingestion of these contaminants by animals causes deposition of residues in meat. The risk of heavy metal contamination in meat is of great concern for both food safety and human health because of the toxic nature of these metals at relatively minute concentrations (Santhi *et al.*, 2008; Mahaffey, 1977). Chromium is an essential element for human beings, further it acts in the organism as maintaining normal glucose tolerance (Upreti RK *et al.*, 2004).

Lead found everywhere in the environment and at low levels in almost all living organisms (Doganoc, 1996). The general population is exposed to Pb from air and food. Lead ingested by chicken is deposited in bones, soft tissues and eggs, so contaminated egg yolk represents a potential public health hazard especially to children repeatedly consuming eggs (Trampel *et al.*, 2003). Lead is a neurotoxicant and of major public health concern which causes both acute and chronic intoxication (Gossel and Bricker, 1990), moreover it causes encephalopathy in children (Carl, 1991). The rate of urbanization and industrialization is increasing day by day in several cities of Bangladesh. Besides many problems associated such developments, major one is the contamination and is principally associated with lead and chromium contamination. The accurate determination of trace metals in poultry meat is still an analytical challenge, due to their low concentration level and difficulties that arise from matrix characteristics. So, assessment of heavy metal in poultry meat has great importance for human health.

MATERIALS AND METHODS

Study area and Study design

Different broiler farms are belonging to Chittagong city area were selected for the current study. A cross-sectional study was carried out on different meat samples from selected broiler farms in the study area in order to determine the heavy metals.

Sample collection

25 Poultry meat samples were collected from different broiler farms of Chittagong city area. The meat samples were collected in polyethylene bags and stored at freezing temperature for analysis.

Detection and estimation of heavy metal

The amount of (Pb, and Cr) heavy metal was measured by Atomic Absorption Spectrophotometer (AAS) Model: ZEE nit 700P, Germany. All laboratory works were performed at Chittagong Veterinary and Animal Sciences University and Bangladesh Council of Scientific and Industrial Research (BCSIR). Samples were prepared by wet digestion method as described by AOAC (2005). A 5 gm of meat samples was taken into crucibles and placed into oven at 105^0C for 2 hours to remove moisture content. Then 5ml nitric acid was added with each samples and kept for 24 hours. Thereafter samples were heated in digestion chamber at 200^0C for 15-20 minutes and cool for 5-10 minutes. After digestion 5 milliliters aqua regia solution were added and again heated the samples until dried. Finally the samples were kept for cooling and added 100 milliliter deionized water in volumetric flask for dilution. The digested samples were filtered through Whatsman No.1 filter paper. 12 ml filtrate sample was taken into felcon tube from standard volumetric flask and processed sample analyzed through Atomic Absorption spectrophotometer. Heavy metal concentration estimated in fresh dry weight basis. The absorption wavelengths for the heavy metals were 357.87 nm for Cr and 217.0 nm for Pb. The metal content calculated by using formula:

Statistical analysis

All laboratory data were stored in Microsoft Excel 2007 and then exported into STATA^{IC} 13.0 (Stata Corporation, College Station, TX, USA) for statistical analysis. Descriptive analysis was performed by using mean and standard deviation for different variables. Finally oneway ANOVA was used to compare the level of heavy metal residues in meat of different farms of Chittagong. The level of significance was set ≤ 0.05.

RESULTS

Concentration of Lead (Pb) in poultry meat

Lead content in poultry meat samples collected from different farms are shown in table-1. It appears that in case of poultry meat the highest mean concentration of lead was found 0.372 at farm D and lowest mean concentration was found 0.228 at farm B. It can be illustrated that lead content of meat was higher in farm A than farm B. It also indicates that lead content in farm E was lower than farm D and farm E. Variation of lead concentration in poultry meat among different farms are shown in table-2. It can be illustrated that the comparison between reference value with mean value of different samples in different farms for meat was not significantly different (p>0.05) in all farms except farm B (p<0.05). Mean plot of lead (Pb) in poultry meat, concentration of lead (Pb) in poultry meat at different farms and comparison of lead concentration of poultry meat from different farms with reference value are shown in fig.-1, 2, 3 respectively. The comparison of lead concentration in poultry meat from different farms between reference values indicates that lead content was lower than tolerable limit.

Concentration of Chromium (Cr) in poultry meat

Chromium content in poultry meat samples collected from different farms are shown in table-3. The result showed that highest chromium concentration was found 0.112 at farm C and lowest chromium concentration was found 0.048 at farm B. The Chromium content in poultry meat sample was higher in poultry meat of farm B than that of farm A and it also indicates that the chromium content in poultry meat of farm E was lower than that of farm C and farm D. Variation of chromium concentration in poultry meat among different farms are shown in table-4. The comparison between reference value with mean value of different samples in different farm for meat showed that chromium was significantly different ($p<0.05$) in case of all farms. In present study in case of farm A, farm B, farm C and farm D correlation coefficient was strongly negative except farm E that was shown in table-5. Mean plot of chromium (Cr) in poultry meat, concentration of chromium (Cr) in poultry meat at different farm and comparison of chromium concentration of poultry meat from different farms with reference value are shown in fig.-4, 5, 6 respectively.

Table 1 Concentration of Lead (Pb) in poultry meat from different farms

Name of Farms	Mean ± SD	Minimum	Maximum
A	0.242± 0.33	0	0.72
B	0.228±0.257	0	0.66
C	0.370±0.363	0	0.85
D	0.372±0.312	0.04	0.78
E	0.290±0.309	0.02	0.7

Table 2 Variation of lead concentration in poultry meat among different farms

Name of Farms	Mean value of lead(Pb) in poultry meat	Reference value of Pb in meat (mg/kg)	t-test P value
A	0.242	0.5[a]	0.156
B	0.228	0.5[a]	0.046
C	0.370	0.5[a]	0.447
D	0.372	0.5[a]	0.387
E	0.290	0.5[a]	0.167

Source: [a]FAO/WHO, 1987

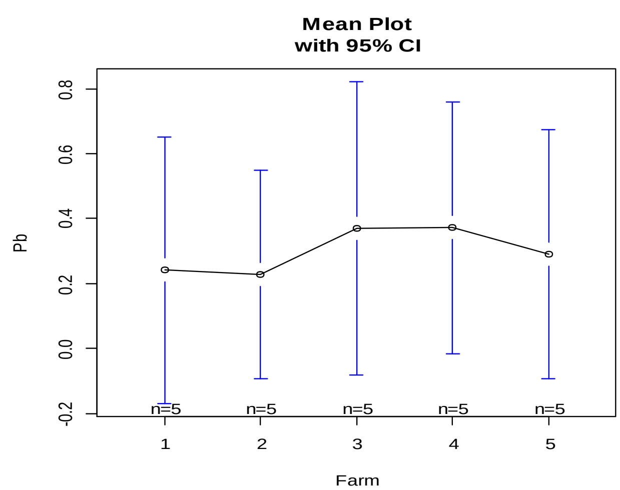

Figure1 Mean plot of lead (Pb) in poultry meat

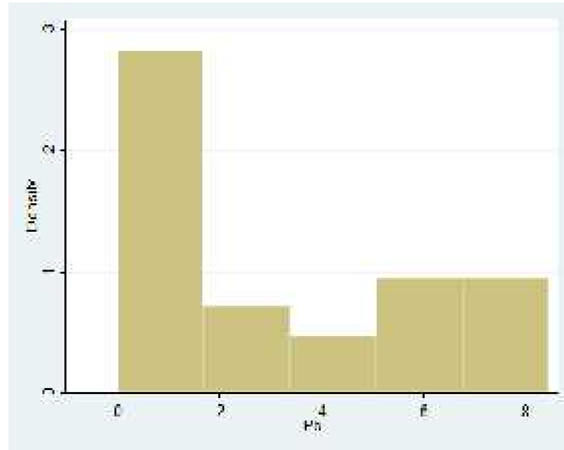

Figure 2 Concentration lead (Pb) in poultry meat at different farm

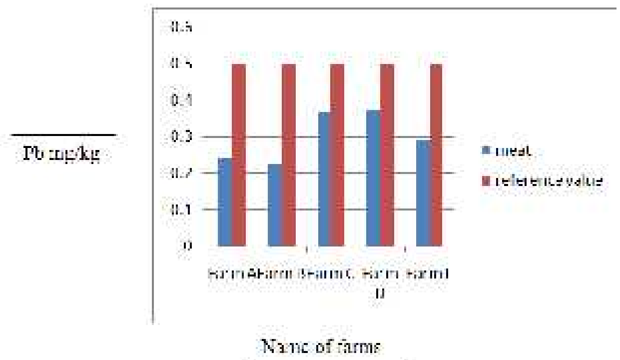

Figure 3 Comparison of lead concentration of poultry meat with reference value

Table 3 Concentration of Chromium (Cr) in poultry meat from different farms

Name of farms	Mean ± SD	Minimum	Maximum
A	0.06±0.079	0	0.17
B	0.048±0.067	0	0.16
C	0.112±0.165	0	0.39
D	0.06±0.058	0.01	0.16
E	0.054±0.061	0	0.15

Table 4 Variation of chromium concentration in poultry meat among different farms

Name of Farms	Cr mean value in Meat	Reference Value of Cr in Meat	t-test P value
A	0.06	1[b]	0.001
B	0.048	1[b]	0.001
C	0.112	1[b]	0.003
D	0.06	1[b]	0.001
E	0.054	1[b]	0.001

Source: [b]EU, 2002

Table 5 Correlation coefficient of Pb and Cr in poultry meat among different farms

Metal name	Farm A	Farm B	Farm C	Farm D	Farm E
Pb					
Cr	-0.6	-0.2	-0.2	-0.4	0.01

DISCUSSION

Assessment of heavy metal in poultry meat can become an important tool for food nutritionists. The recommended daily allowance for lead is 0.3 mg per day and maximum permissible limit of lead in food stuff is 1-5 mg/ kg (IAEA, 1980). Excess lead is known to reduce the cognitive development and intellectual performance in children and to increase blood pressure and cardiovascular disease incidence in adults (Anonymous, 2005).

The result of this study indicates that lead concentration of poultry meat 0.228-0.290 mg/kg. The high concentration of lead in the muscle indicates long term bioaccumulation. In this study the concentration of Pb exceeded the FAO/WHO standard of 0.5mg kg-1 for Pb. The high levels of Pb in poultry products emanate mainly from contamination of feeds and water sources. Mariam *et al*, (2004) reported mean levels of 3.15mg.kg-1 for lead in poultry meat. The levels found in this study were much lower than these values. Chromium plays an important role in body function (metabolic function, co-factor of insulin) in trace amount but it turn to be toxic when it exceeds the tolerance limit .The daily requirement of chromium for adult is estimated between 0.02 to 0.5 mg/day. The permissible limit of chromium in poultry meat is 1mg/kg. The comparison of chromium concentration in poultry meat from different farms between reference values indicates that chromium content was lower than tolerable limit. Iwegbue *et al* (2006) found the concentration of Cr in chicken meat ranged between 0.01- 3.43mgkg-1 which is above the permissible limit.

CONCLUSION

Poultry meat is a good source of protein. Heavy metal contamination in food is important topic. Heavy metals are considered particularly dangerous to human health because, in the preparation of food, they do not decompose; on the contrary, their concentration tends to bioaccumulate. A long term consumption of heavy metal containing food above tolerance limit has a hazardous impact on human health. Even if there were in small amounts, the presence of these heavy metals can generate worries due to their cumulative effect in the consumers' organism. It is concluded that the present study showed that meat sample contain lower amount of lead and chromium below permissible limit which is safe to human health.

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