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Assessing metal bioaccumulation levels in muscles, feathers, litter and feed of poultry chicken (*Gallus domesticus*) and its environment

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Abstract

The study reported here was conducted to detect the accumulation level of heavy metals in poultry chicken *Gallus domesticus* at two districts Mirpur and Bhimber of Azad Jammu and Kashmir. The concentration level of selected heavy metals (Pb, Zn, Cd, Ni, Co, Mn, Cu) was examined in muscle tissues of chest and thigh, feed, feathers, litter, water had been given to the broiler chicken. Thirty to forty days old broiler chicken had been selected for the exposure of heavy metals. The filtrate of digested samples were analyzed through Flame Atomic Absorption Spectrophotometer (FAAS). The results obtained from this study show that the concentration level of selected heavy metals in muscle tissues were below permissible limit set by WHO. WHO permissible limits of various metals (mg/kg) are determined as muscles- Pb 0.2, Cd 0.1-0.5, Ni 0.5, Zn 10-50, Cu 1mg, Mn 1mg. Water- mg/l Pb 0.01-0.05, Cd 0.01, Ni 0.2, Zn 5, Cu 2, Mn 0.1-0.4 Feed- mg/Kg Pb less than 1, Cd 1, Mn 30-40, Cu 1-10, Ni 10, In feathers all selected metals were below permissible limit except Ni exceeded. In water samples concentration level of Pb, Ni, Mn, Cd and Co exceeded the permissible limit while Zn and Cu were below permissible limit. In poultry litter concentration of Mn, Zn and Ni were higher. The accumulation of heavy metals in body tissues poultry chicken was insignificant, so the chicken can be deliberated safe for human ingestion.

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Introduction

The anthropogenic effects on the atmosphere have been detected on large scale and very multifarious with most of them incapable to be inverted (Akbar *et al.,* 2009). When heavy metals found within living tissues, they are potentially unsafe because of their harmfulness, bioaccumulation and biomagnification capabilities (Aycicek *et al.,* 2008).

Now a day's poultry meat is an important constituent of food and source of protein. Usually protein is produced by two types of resources that are animals and plants. Broiler meat provides huge extent of protein as compared to plant resources. But unfortunately in Pakistan poultry industry is an ignored and minor sideline of our agricultural industry and it is much costly and many health hazards are reported (Anonymous, 2003). It is need of the time that general public should have the capability to purchase their regular intake nutrition by harmless resources (Maqbool *et al.,* 2005; Khalid *et al.,* 2001). Currently, the tendency in poultry is to produce reap by improving the growth rate. For this determination numerous metals added in poultry feed to make promising the enhancement in mass and avoidance of sicknesses. These heavy metals are used as supplemental to overwhelm the problem of insufficiency. In poultry industry commonly these are used to encounter the protein prerequisite and typically they are used as inorganic supplement (Anonymous, 1998).

These contaminants often have physical and biological disruption in cellular levels for this reason they are deposited or assimilated in body soft tissues (Mariam *et al.,* 2004). Contaminated poultry feed and water are leading sources of metals in broiler meat. The presence of heavy metals in broiler meat exposed thoughtful consideration (Iwegbue *et al.,* 2008).

In vision of the circumstance that poultry has been testified to be pretentious because of the consumption of heavy metals confined feed additives in poultry feed manufacturing system (Islam *et al.,* 2007). Several studies are directed to evaluate the heavy metals from poultry feed and consequences indicated the involvement of high concentration of heavy metals (Abdullah *et al.,* (2010).

Once these metals are mixed in feed beyond the mandatory level, these can accumulate in fleshy tissue of broiler, when human being consume this soft tissues of broiler also accumulate in human body tissues and can also be released in excreta to cause environmental influences (Mcbride and Dpiers, 2001). On ingestion of broiler heavy metals can come into food chain. There are several studies approved to identify the heavy metals accumulation in chicken meat. Due to bioaccumulation actions the presence of these lethal elements in feed pose severe health threats in consumers and secondary consumers.

Concentration of heavy metals are also greater in litter be contingent on ingestion of poultry feed. Poultry litter contain nitrogen, potassium and phosphorus, because of this poultry litter is very important and can be used as a manures for crops but this litter also contains a good concentration of heavy metals (Davis, 1998), which eventually enter in food chain and threaten the human health.

Heavy metals are pervasive and uninterruptedly being released from synthetic sources into the water and terrestrial ecosystems, threatening the health of man and animals (Aschner, 2002; Abulude *et al.,* 2006a; Abulude *et al.,* 2006b). When heavy metals found within living tissues, they are potentially unsafe because of their harmfulness, bioaccumulation and biomagnification capabilities (Aycicek *et al.,* 2008).

In most of countries of the world, food contamination with heavy metals is a thoughtful issue. Contamination by heavy metals can be transmitted in the animals through direct exposure, contaminated water, crops grown on irrigated wastewater, industrial wastewater, vehicle emissions, filthy slaughterhouses etc. The toxic nature of certain metals and the major contributor to the global burden of these metals through food consumption are well documented (Hellou, *et al.*, 1992; Joseph and Srivastha, 1993, DHSS, 1980). Hence, the levels of these heavy metals in food products are under numerous examination. Since these metal bioaccumulation, must, therefore, is to study the concentration of toxic heavy metals in chickens in order to maintain the exposure of consumers.

Exposure of general population to these toxic metals is of highest apprehension because of their non-biodegradeable nature. This study was accompanied to examine the environmental or natural accumulation of these selected heavy metals (Cd, Pb, Ni, Zn, Cu, Mn and Co) in Chicken's body tissues, feed, feathers, litter, dust and water samples were collected from different poultry farms situated in two major districts (Mirpur and Bhimber) of Azad Jammu and Kashmir.

Materials and methods

Sampling Sites

Six Poultry farms in district Mirpur and five poultry farms in district Bhimber of Azad Jammu and Kashmir were selected for sampling purpose.

Sample Collection

Six samples (chest, thigh, feed, poultry litter, water, feather,) were collected from each poultry farm. 36 samples from district Mirpur, 30 samples from district Bhimber Number of samples 6 sample from each poultry farm and 5 poultry farm. The muscles samples were collected from 30-40 days old age chick.

All samples were collected in reseal able plastic bags except water samples, water samples were collected in small plastic bottles. Collected samples except water, feed and dust were transported in an ice box till reach to the laboratory then kept in refrigerator until analysis.

Sample Digestion

Take small portion of collected sample and cut into small pieces then weighed it about 1g and transferred into sterilized glass flask then cover the mouth of glass flask with aluminum foil. Add 5ml of HNO_3 and 1 ml $HCIO_4$ glass flask, cover the mouth of flask with aluminum foil and left over this apparatus for overnight. Process of digestion was carried out on a hot plate and temperature of hot plate was 200˚C which was gradually raised from 50˚C-200˚C until the sample was digested and converts into colorless liquid.

Filtration

After the digestion of collected samples, these digests was allowed to cool and then filtered through Whatman filter paper No. 45, then transferred to 25ml volumetric flask and made up to mark with deionized water, then pour into sterilized collecting bottle and sealed to avoid contamination.

Preparation & Filtration Of Blank Samples

In sterilized glass flask add 5ml of HNO_3 and 1 ml $HCIO_4$ in glass flask, the process of digestion and filtration was carried out by following the same procedure as described above.

Preparation Of Spike Samples

I prepared the six spike samples, three with 0.2ppm concentration and three with 0.5ppm concentration of heavy metals (Pb, Zn, Ni, Mn, Cu, Co and Cd). For the preparation of these samples of required concentration (0.2ppm and 0.5ppm Conc.)

Preparation Of Standard Solutions

For making 10ml of working standard solutions I took 10ppm of metal solution from 1000ppm metal stock solution to these standard solutions of different concentrations were used from metal stock solutions.

Dilutions

Dilutions with different concentrations of standard solutions were made:

0.2ppm, 0.4ppm, 0.6ppm, 0.8ppm, 1ppm

Sample Analysis

Atomic Absorption Spectrophotometer (AAS) was used for the analysis of collected samples. For the determination of heavy metals (Cd, Pb, Ni, Zn, Cu, Mn and Co) in different collected was made by the use of Atomic Absorption Spectrophotometer (AAS). Air acetylene gas was applied in the analysis of prepared and filtered samples by Flame Atomic Absorption Spectrophotometer (FAAS). Atomic absorption spectrophotometer was adjusted manually by standard solution of particular heavy metals. The flame condition has been optimized for maximum absorption and linear response during aspiration of known standards.

Results and discussion

Environmental pollution has come to be a global threat and it distresses the biological systems and human healthiness. The undiscriminating discharge of harmful chemicals and highly toxic metals in an environment may badly disturb the worth of different nutrition properties. In Pakistan poultry meat is mainly used as a food material. Because of environmental pollution broiler chicken is exposed to various heavy metals by poultry feed as well as polluted breeding localities (Sattar and Chaudhary, 1978; Khurshid and Qureshi, 1984). Due to bioaccumulation nature of heavy metals, they alarmingly contaminate the food chain that's why these metals are becoming increasingly important in the light of their role in nutrition as well as human health. Vulnerability of contagious diseases are greater than before because these heavy metals modify the number of factors of host's immune response. They have capability to change the structure of DNA (Bruins *et al.*, 2000; Blasliak *et al.*, 1999). The present study was conducted to examine the levels of heavy metals pollution in broiler chicken (*Gallus domesticus*) at two major districts Mirpur and Bhimber of Azad Jammu & Kashmir.

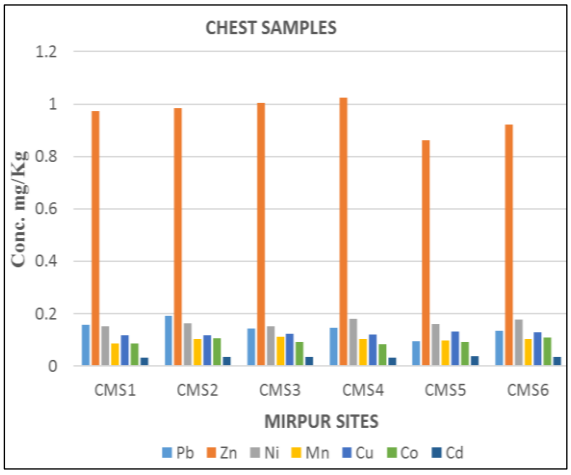


Fig. 1. Concentration of heavy metals in chest samples from district Mirpur.

The mean values for lead, zinc, nickel, manganese, copper, cobalt and cadmium were determined as 0.1453, 0.9610, 0.1644, 0.1017, 0.1233, 0.0950 and 0.0346nm/kg respectively.

The mean values indicate that the concentration of these metals in chest muscles were below the permissible limits set by WHO/FAO (Fig. 1).

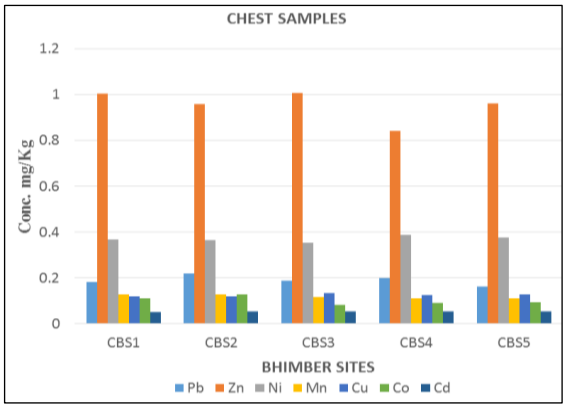


Fig. 2. Concentration of heavy metals in chest samples from district Bhimber.

Environmental pollution has come to be a global threat and it distresses the biological systems and human healthiness. The undiscriminating discharge of harmful chemicals and highly toxic metals in an environment may badly disturb the worth of different nutrition properties. These contaminants often have physical and biological disruption in cellular levels for this reason they are deposited or assimilated in body soft tissues (Mariam *et al.*, 2004). Contaminated poultry feed and water are leading sources of metals in broiler meat. The presence of heavy metals in broiler meat exposed thoughtful consideration (Iwegbue *et al.*, 2008). It is important to make promising that the individuals buy the basic vital stuffs at low rate. It might be promising merely to find out the evaluation between earnings and inadequacy associated to poultry industry and then ethics it in the market place. It is need of the time that general public should have the capability to purchase their regular intake nutrition by harmless resources (Maqbool *et al.*, 2005. And khalid *et al.*, 2001).

The mean values for lead, zinc, nickel, manganese, copper, cobalt and cadmium were 0.1904, 0.9547, 0.3697, 0.1189, 0.1248, 0.1017 and 0.0527mg/kg respectively. The mean values indicate that the concentration of these metals in chest muscles were below the permissible limits set by WHO/FAO but conc. of lead touch the P value (Fig. 2).

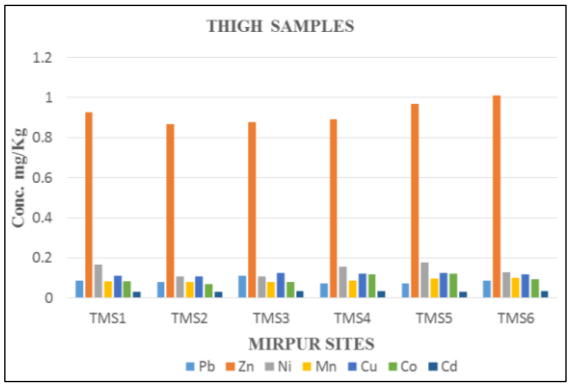


Fig. 3. Concentration of heavy metals in thigh samples from district Mirpur.

The mean values for lead, zinc, nickel, manganese, copper, cobalt and cadmium were 0.0845, 0.9238, 0.1403, 0.0877, 0.1181, 0.0938 and 0.0325mg/kg respectively. The mean values indicate that the concentration of these metals in thigh muscles were below the permissible limits set by WHO/FAO (Fig. 3).

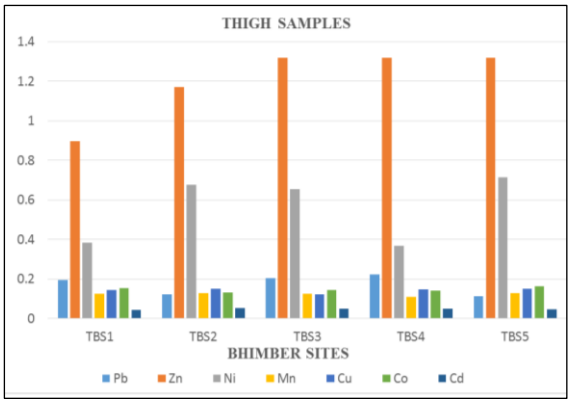


Fig. 4. Concentration of heavy metals in thigh samples from district Bhimber.

The mean values for lead, zinc, nickel, manganese, copper, cobalt and cadmium were 0.1708, 1.2046, 0.5591, 0.1231, 0.1424, 0.1464 and 0.0481mg/kg respectively. The mean values indicate that the concentration of these metals in thigh muscles were below the permissible limits set by WHO/FAO except the level of nickel touch the permissible limit (Fig. 4).

The mean values given in Fig. 5 demonstrate the concentrations of heavy metals in feathers of poultry chicken samples collected from six different poultry farms at district Mirpur. The mean values for lead, zinc, nickel, manganese, copper, cobalt and cadmium were 0.1364, 1.3994, 0.2472, 0.2494, 0.1551, 0.0701 and 0.0444mg/kg respectively.

The mean values indicate that the concentration of these metals in feathers were below the permissible limits set by WHO/FAO.

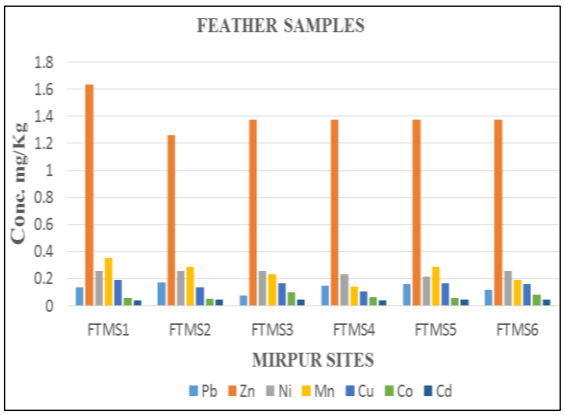


Fig. 5. Concentration of heavy metals in feather samples from district Mirpur.

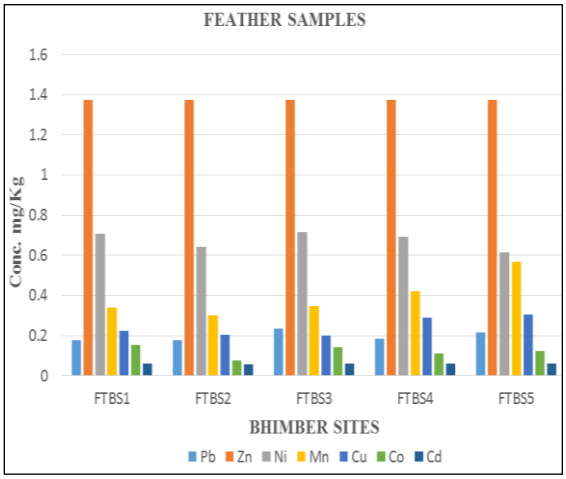
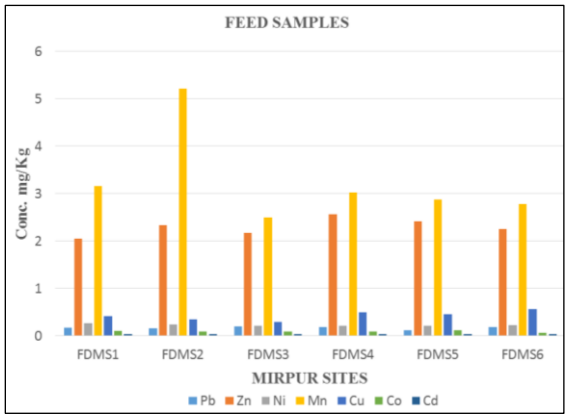


Fig. 6. Concentration of heavy metals in feather samples from district Bhimber.

Fig.. 6 exhibit the concentrations of heavy metals in feathers of poultry chicken samples collected from five different poultry farms at district Bhimber. The mean values for lead, zinc, nickel, manganese, copper, cobalt and cadmium were 0.1988, 1.3749, 0.6745, 0.3950, 0.2447, 0.1207 and 0.0598mg/kg respectively.

The mean values indicate that the concentration of nickel in feathers is slightly higher than the permissible limit but the level of other metals were below the permissible limits set by WHO/FAO.



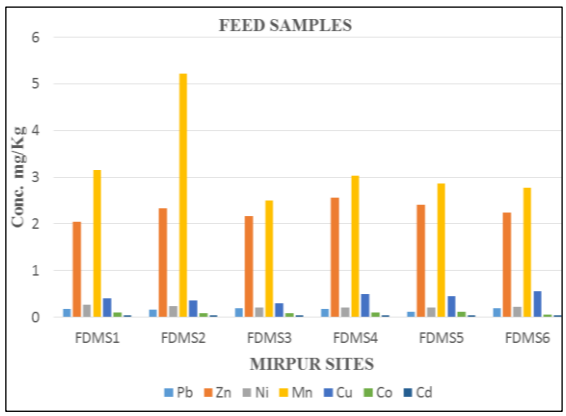


Fig. 7. Concentration of heavy metals in feed samples from district Mirpur.

Fig. 7 demonstrate the concentrations of heavy metals in feed samples of poultry chicken collected from six different poultry farms at district Mirpur. The mean values for lead, zinc, nickel, manganese, copper, cobalt and cadmium were 0.1704, 2.2940, 0.2271, 3.2563, 0.4270, 0.0918 and 0.0393mg/kg respectively. The mean value indicate that the concentration of manganese in poultry feed is higher than the permissible limit but the concentration of other metals in feed samples were below the permissible limits set by WHO/FAO.

Fig. 8 exhibit the concentrations of heavy metals in feed samples of poultry chicken collected from five different poultry farms at district Bhimber. The mean values for lead, zinc, nickel, manganese, copper, cobalt and cadmium were 0.1869, 1.7706, 0.3990, 1.8344, 0.3081, 0.09162 and 0.05692mg/kg respectively. The mean value indicate that the concentration of manganese in poultry feed is higher than the permissible limit but the concentration of other metals in feed samples were below the permissible limits set by WHO/FAO.

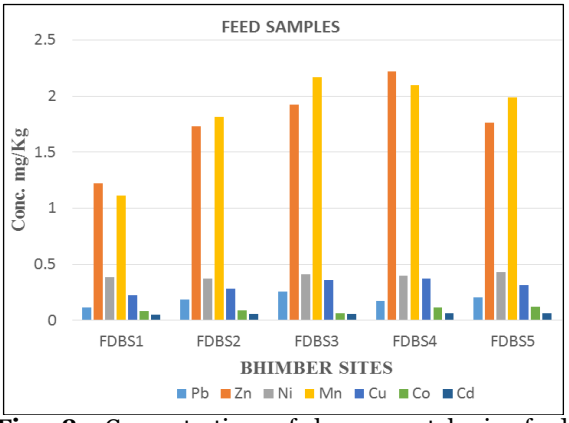


Fig. 8. Concentration of heavy metals in feed samples from district Bhimber.

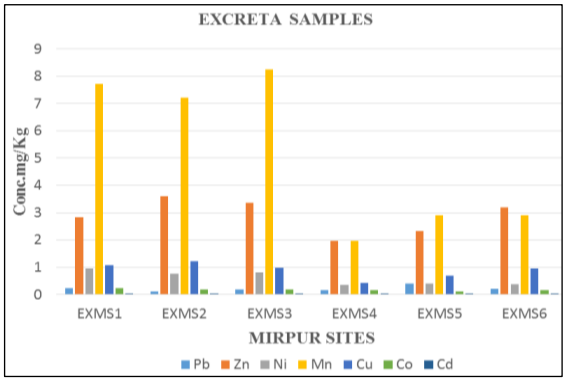


Fig. 9. Concentration of heavy metals in excreta samples from district Mirpur.

Fig. 9 show the concentrations of heavy metals in poultry litter collected from six different poultry farms at district Mirpur. The mean values for lead, zinc, nickel, manganese, copper, cobalt and cadmium were 0.2159, 2.8808, 0.6154, 5.1613, 0.8909, 0.1768 and 0.0496mg/kg respectively.

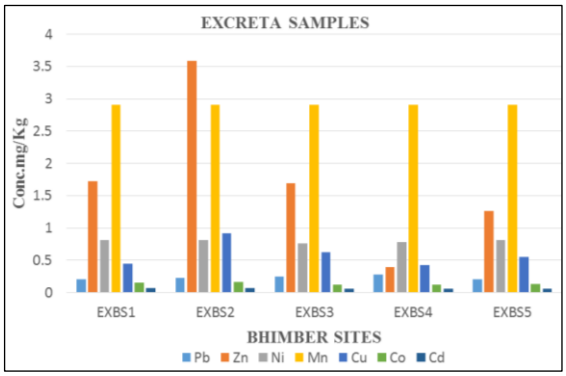


Fig. 10. Concentration of heavy metals in excreta samples from district Bhimber.

Fig. 10 illustrates the concentrations of heavy metals in poultry litter collected from five different poultry farms at district Bhimber.

The mean values for lead, zinc, nickel, manganese, copper, cobalt and cadmium were 0.2361, 1.7323, 0.7969, 2.9070, 0.5947, 0.1376 and 0.0641mg/kg respectively.

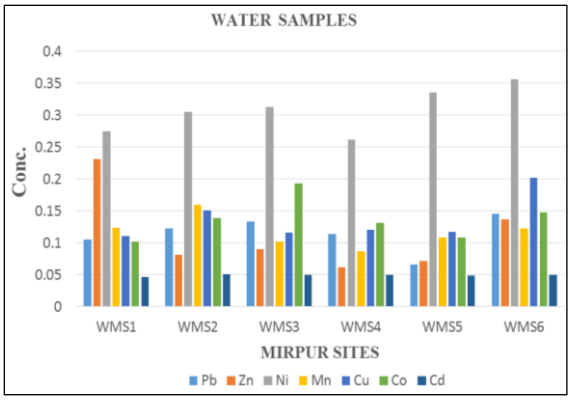


Fig. 11. Concentration of heavy metals in water samples from district Mirpur.

Fig. 11 illustrate the concentrations of heavy metals in water samples collected from six different poultry farms at district Mirpur. The mean values for lead, zinc, nickel, manganese, copper, cobalt and cadmium were 0.1144, 0.111933, 0.307567, 0.11715, 0.136167, 0.136733 and 0.049033mg/kg respectively.

The concentration level of lead, nickel, manganese, cadmium and cobalt exceeded the permissible limits set by WHO while the concentration of zinc and copper were much below the range of permitted limits.

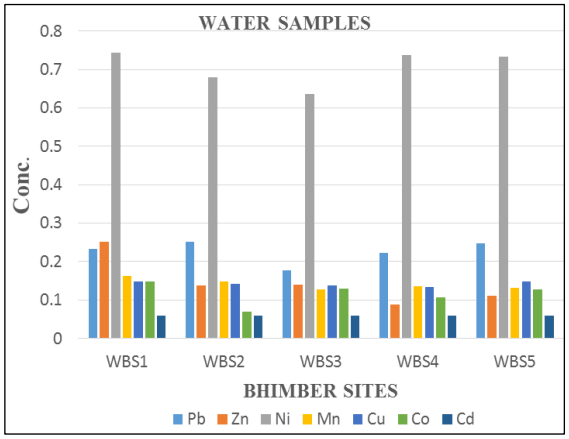


Fig. 12. Concentration of heavy metals in water samples from district Bhimber.

Fig. 12 demonstrate the concentrations of heavy metals in water samples collected from five different poultry farms at district Bhimber. The mean values for lead, zinc, nickel, manganese, copper, cobalt and cadmium were 0.22626, 0.14568, 0.70588, 0.14156, 0.14172, 0.1166 and 0.05952mg/kg respectively. The concentration level of lead, nickel, manganese, cadmium and cobalt exceeded the permissible limits set by WHO while the concentration of zinc and copper were much below the range of permitted limits.

Conclusion

Environmental heavy metal contamination is a matter of great anxiety around the world and thus adulteration of the food chain is becoming increasingly important in the light of its role in human health and nourishment. The results obtained from this study show that the concentration level of heavy metals Pb, Zn, Ni, Mn, Cu, Co and Cd in muscle tissues (chest and thigh) of broiler were below permissible limit set by WHO. In feathers of broiler collected from poultry farms located at District Mirpur, all selected metals were below permissible limits while, feathers collected from poultry farms located at District Bhimber, concentration of nickel exceeded the permissible limit. In water samples collected from both districts concentration level of Pb, Ni, Mn, Cd and Co exceeded the permissible limit while Zn and Cu were below permissible limit. The accumulation of heavy metals in body tissues poultry chicken was insignificant, so the chicken can be deliberated safe for human ingestion.

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