Global Veterinaria 8 (6): 660-664, 2012
ISSN 1992-6197

Translocation of Zinc and Nickel from Poultry Feed to Broilers and Their Excretion Through Litters

Khalil ur Rehman, Shahla Andleeb, Ansar Mahmood,
Syed Mohsin Bukhar, Mian Muhammad Naeem and Kamran Yousaf

Department of Environmental Sciences, Government College University, Faisalabad, Pakistan

Abstract: An experiment was designed to evaluate the the heavy metals viz. nickel and zinc in feed stuffs mixed with pre-mixers and body tissues in broilers and domestic layers reared at five farms in Faisalabad, Pakistan. In broilers the highest levels of nickel (125±1.00 mg kg^{-1}) in muscles were determined at farm-C. In liver (101±0.90 mg kg^{-1}) and skin (66±0.48) its maximum quantity was observed at farm-D whereas maximum excreted also through litters at farm-D as compared to other farms. The maximum contents of zinc (142±2.20 mg kg^{-1}) were observed in muscles at farm D whereas its higher amount (146±2.38 mg kg^{-1}) was also excreted via litters at farm-D because of introducing more quantities of zinc in pre-mixers. Zinc concentrations did not detected in liver and skin tissues at all farms under study. Similarly even minute quantities of both metals did not detected in domestic layers. It could be deduced from the current results that higher levels of both metals introduced through broiler feed accumulated in all body tissues. All levels were higher than permissible levels prescribed in relevant literatures.

Key words: Broilers · Pre-Mixers · Micronutrients · Skin · Liver · Litter

INTRODUCTION

A complete and balanced diet is necessary for human health and vitality. Protein is an essential element to form a perfect diet and is usually produced by two kinds of resources that are plants and animals. Pakistan is deficient in production of proteins from animal sources. Currently 66% Pakistanis are lacked in protein in their daily food. Use of protein in human diet is in-sufficient and its presence in animal resources as compared to growth rate of human beings is very low. For avoiding this threat poultry industry is consider the best option for protein production as compared to any other resources available at current time. Broiler meat gives large amount of protein in contrast to plant resources. But unfortunately in Pakistan poultry is an ignored and minor sideline of our agricultural industry and it is much costly and many health hazards are reported (Anonumous, [1]. It is essential to make possible that people buy the basic required things at a low cost. It might be possible only when producer manage to sell their product at an economical price. Many researchers have been researched to find out the comparison between the profit and deficit related to the poultry industry and then values in the market. It is the need of the time that people should have the capacity to buy there daily intake diet by safe resources [2, 3].

Recent trend in poultry industry is to produce crop by enhancing the growth rate. For this purpose various metals are added in poultry feed to make possible the boost in weight and prevention of diseases. These heavy metals are much higher in poultry feed than the required value. Deficiency of heavy metals is another reason for their addition in feed. Deficiency can cause different problems in broiler as they perform many functions as trace elements. To overcome the problem of deficiency these heavy metals are being used as supplementary diet. Mostly these are being used in poultry industry to meet the protein requirement and they are normally being used as mineral supplements [4]. Many studies are conducted to assess the heavy metals from poultry feed and results showed the mixing of high concentration of heavy metals [5]. The use of heavy metals in excess are accumulated in body tissues of broiler. That study showed that the

Corresponding Author: Khalil ur Rehman, Department of Environmental Sciences, Government College University, Faisalabad, Pakistan.

amount of Copper and other some metals were within the Anonumous, limits [33] but the amount of Nickel and some other metals were more than the permissible limits [6]. The toxic elements present in feed pose serious health hazards to consumers and secondary consumers due to biomagnifications. These substances are also normally found in natural environment. Due to many reasons these elements can easily entered in feed ingredients of different animals and complexes of nature these elements or substances are not completely digested at all. These have the potential to cause serious effect not only the tissues but also the bone and other body parts [7].

Many studies were about the dispersion of toxic metals among various soil samples, especially 25-year poultry waste-amended soil. Copper and Zinc, normally, accumulate close to the soil surface where the total amounts of Cu and Zn in waste-amended soils were significantly higher than in no amended soils [8]. Toxic metals are possible environmental pollutants with the capacity to cause health problems in human beings [9, 10]. Toxic metals are not easily convertible by the microorganism that play their role for balancing the natural environment and these heavy metals are considered the most imperative problem to our environment [11]. These can cause many unwanted health problems by entering in human body. Mostly the entry of these toxic metals in the body of human being is caused by food items [12, 13]. Some cancer diseases are also related with diet enriched by toxic substances. Some time it leads towards death [14]. Many of the researchers demonstrated that elements used in feed deposit in body and cause harmful impacts on animal life. In case of poultry industry deposition of heavy metals in body of broiler were result of their excessive use in poultry feed. Levels of these toxic metals were also higher in litter depending on composition of poultry feed. In poultry litter samples amount of aluminum and arsenic were detected to high. Their impacts on soil and crops were further analyzed on using the litter as fertilizer [15]. Due to the binding nature of arsenic this can be concentrated in to the soil very easily as compared to other metals. This can cause many potential effects on the health of the persons that work in such field contained contaminated soil [16]. It is also noticed that litter using as a fertilizer does not meet the required standard values. Litter used in crop fields cause high concentration of Arsenic, which has the ability to damage crops as well soil quality.

For marketing of poultry industry, poultry litter is very important and can be used for crops as fertilizer, because this contains high nitrogen, Phosphorus and Potassium concentrations but it also contains concentration of heavy metals [17]. The main objectives of the research were to provoke people about the poultry industry, to analyze the feed of broiler and to determine the bioaccumulation of metals in different body tissues and excretion through litters. Further to compare the variations of heavy metals in body tissues and litters of broiler and domestic layers.

MATERIALS AND METHODS

Five poultry farms were selected from District Faisalabad, Pakistan for collection of feed, body tissues and litter samples of broiler and domestic fowls. Two poultry farms were selected, 20km away from city, located at Jaranwala Road, designated as Farm-A and Farm-B. whereas two were 15km away from main city at Samundari road designated Farm-C and Farm-D and remaining one was at Jhang road named Farm-E. Sample of domestic layer from nearest village of each selected poultry farm were also selected. Different ingredients were used for making poultry feed such as small grains (wheat, rice, maize, millet, sorghum barley and dried sea food, blood of animals, broken pulses and different vitamins) and heavy metals. Poultry feed is the combination of foodstuff and Pre-mixers. Farm-A, B, C and D used locally manufactured foodstuff available in market while Foodstuff used by Farm-E was fully equipped with high technologies. Pre-mixers were combination of different heavy metals manufactured locally on demand and their concentrations were not known to the poultry owners. Similarly litter samples were collected from each poultry farm.

The samples were grinded with pestle mortar and sieved to attain the size of 0.3-0.5mm. Evaluated concentrations were compared with the permissible limits (nickel, 2 mg kg^{-1} zinc, 3 mg kg^{-1}) established by World Health Organization (FAO) and Food and Agriculture Organizations (FAO) [33]. For analysis of these samples slides were prepared by using the method described by Nisar *et al.* [19]. Samples were analyzed at proton induced X-ray emission (PIXE) established at Center of Advance Studies of Physics (CASP) at Government College University, Lahore (GCUL), Pakistan. Collected data was subjected to Analysis of Variance (ANOVA) to determine the variance of heavy metals in the body tissues of broiler

Table 1: Heavy metals (nickel and zinc) concentrations (mean±S.E.) in food stuff and pre-mixers (feed) used as feed for broilers at selected poultry farms for current experimentations

	Farm-A		Farm-B		Farm-C		Farm-D		Farm-E			
Elements	Foodstuff (mg kg^{-1})	Pr-emixer (g kg^{-1})	Foodstuff (mg kg^{-1})	Pr-emixer (g kg^{-1})	Foodstuff (mg kg^{-1})	Pr-emixer (g kg^{-1})	Foodstuff (mg kg^{-1})	Pr-emixer (g kg^{-1})	Foodstuff (mg kg^{-1})	Pr-emixer (g kg^{-1})	(Mean ±S.E)	P.L.
Nickel	0	28.00	0	27.00	0	33.00	0	33.60	0	26.00	29.52±157	0
Total (g kg^{-1})	28.00		27.00		33.00		33.60		26.00			
Zinc	89	1.500	132	1.299	165	1.557	178	16.00	49	1.367	1.587±74.0	40
Total (g kg^{-1})	1.58		1.43		172		1.77		1.41			

Table 2: Heavy metals (nickel and zinc) concentrations (mean±S.E.) in muscles, liver, skin and litters of broilers reared at five farms under study

		Farms				
Tissues types	Elements	Farm-A	Farm-B	Farm-C	Farm-D	Farm-E
Muscles	Nickel	120±2.10A	100±2.40B	125±1.00A	111±4.78B	98±1.01B
	Zinc	104±3.08B	82±1.20C	107±1.09B	142±2.20A	63±2.10D
Liver	Nickel	73±1.09B	50±2.8C	100±2.48A	101±0.90A	24±0.39D
	Zinc	-	-	-	-	-
Skin	Nickel	55±0.05B	50±0.01B	20±0.02C	66±0.48A	20±0.47C
	Zinc	-	-	-	-	-
Litter	Nickel	85±1.70C	55±1.08D	104±0.09B	146±2.38A	24±0.30E
	Zinc	140±2.30B	80±1.00C	148±1.70B	192±2.30A	48±1.11D

Rows sharing similar alphabets followed by letters do not differ significantly (P>0.01)

and domestic layers. Least Significant Difference (LSD) was introduced to make the multiple comparisons of heavy metal concentrations in broiler muscles, liver, skin and litter samples [18].

RESULTS

Nickel concentration in muscles did not differ significantly (p>0.01) at farm-A and C and at farm-B and E. similarly non-significant variations (p>0.01) were detected in muscles tissues at farm-B and D. the highest (125±1.00 mg kg^{-1}) nickel levels were recorded in tissues in fowls reared at farm-C while lowest (98±1.01 mg kg^{-1}) at farm-E. Significant differences (p<0.01) were observed in zinc levels except at farm-A and C. In liver tissues nickel concentrations did not differ significantly (p>0.01) at farm-C (100±2.48 mg kg^{-1}) and D (101±0.90 mg kg^{-1}). Its highest (101±0.90 mg kg^{-1}) levels were detected at farm-D whereas lowest (24±0.39 mg kg^{-1}) at farm-E. Not even the minute quantities of zinc were detected in liver tissues of broilers collected from five farms selected for studies (Table 2).

Nickel concentrations in skin samples did not show any significant (p>0.01) differences at farms-A and B and between tissues collected from farms-C and E. the maximum (66±0.48 mg kg^{-1}) contents were detected at farm-D while lowest (20±0.48 mg kg^{-1}) at farm-C and E. Zinc content were entirely absent in skin samples collected from five farms under study. Significant variations (p<0.01) were found in nickel levels excreted through litters reared at all five farms. Maximum (192±2.30 mg kg^{-1}) contents of nickel were recorded in broilers samples collected from farm-D and lowest (48±1.11 mg kg^{-1}) at farm-E (Table 2). Zinc levels in litter samples varied significantly (p<0.01) at farms-B, D and E while non-significant variations (p>0.01) were recorded at farm-A and C (Table 2). Foodstuffs did not added in poultry feed while pre-mixtures having nickel levels were 28.0, 27.0, 33.0, 36.0 and 26.0 g kg^{-1} at farms A, B, C, D and E. the zinc c oncentrations in foodstuff ranged from 0.049-0.178 mg kg^{-1}whereas its contents varied from 1.299-16.0 g kg^{-1} in pre-mixers were introduced in poultry feed at five poultry farms (Table 1).

Significantly strong positive correlation (r=0.948) was observed between nickel and zinc levels in muscles while significant negative (r=-0.984) between nickel of liver and skin. As the skin and muscles tissues were concerned strong positive (r=0.987) correlation was observed for nickel concentrations. Similarly highly strong positive correlation (r=0.976) was observed for nickel in muscles and litters. Strong negative correlation (r=-0.978) was also found between skin tissues and litters.

DISCUSSION

Many studies were carried out to assess the heavy metals in broiler feed and their accumulation in muscles, liver and skin [5, 15, 19, 20]. Broiler litter was also analyzed to assess the residues of these metals. Heavy metals in broiler feed of selected poultry farms were only Nickel varied from 26.0-33.0 g kg^{-1} and Zinc 1.416-1.778 g kg^{-1}.

Concentrations were already high than WHO and FAO permissible limits [33] for broiler feed in foodstuff and pre-mixers were added to enhance the growth rate, which make concentrations of these heavy metals 100 times greater than permissible limits. Highest concentrations of Nickel and Zinc were detected in broiler feed of farm-D (33.0 g kg^{-1}) and lowest concentrations of these metals were detected in broiler feed of farm E (26.0 g kg^{-1}). Normally domestic layers gain weight of 1.5 kg in about 70-80 weeks because these are omnivorous and take seeds, vegetables and insects as feed. Higher contents of heavy metals are introduced for getting maximum weight within six to seven weeks. It may cause the health hazardous effects on humans taking broilers as meat [5].

The uses of such high levels of heavy metals were also used for better productions by many researchers [5,7,11,15,20-23]. The maximum concentrations of nickel were found accumulated in body tissues like muscles (125±1.00 mg kg^{-1}) followed by liver (101±0.90 mg kg^{-1}) and skin (66±0.48 mg kg^{-1}). Similarly studies were also conducted by various researchers who found higher contents in muscles of chicken meat [7,8,24,25]. These contaminants often have direct physiological toxic impacts because they can be accumulated in body tissues and released in litter [15, 20, 26, 27]. In recent study more accumulation of metal was detected in muscles and liver tissues. Such aggregations of metals affect the necessary activities of chicks like scratching, walking, feeding and drinking [21]. Current results showed the trend of heavy metals accumulation, mostly, in metabolic organs. These heavy metals perform many functions in body but their presence in excess amount may cause many toxic impacts. Maximum quantity of nickel 146±2.38 mg kg^{-1} and 24±0.30 mg kg^{-1} of zinc excreted through their litters. Results of present studies were greater than permissible values (2 mg kg^{-1}) mentioned in the literature [33]. Their excretion through litters may cause bad effects on human beings when using poultry manure as organic fertilizers [6, 28, 29]. High levels of heavy metals in poultry manure introduced as organic fertilizer in fields Copper and Zinc accumulated in close to soil surface and could be useful for plant growth but use in excess amount of heavy metals can increase toxicity of soil.

Heavy metal contents in chicken meat mainly accumulated in metabolic organs as muscles, liver and kidney. [22, 30]. In present study maximum contents were found in muscles (125±1.0 mg kg^{-1}) because higher quantity of nickel was used in pre-mixers. Liver (101±0.90 mg kg^{-1}) accumulated higher concentrations of nickel than skin (66±0.48 mg kg^{-1}) because of its slower metabolic rate for a longer period of time. In present study maximum 24±0.30 mg kg^{-1} of zinc was detected in poultry litters but Nicholsona *et al*. [31] recorded 0.40, 0.50 and 0.18 g kg^{-1} of its quantity in poultry, pig and cattle manures respectively. Recorded values were higher than permissible limits as 3.0 mg kg^{-1} [34]. Translocation of such heavy metals from feed to high performing metabolic tissues may cause severe impacts on bones structure, neurological, cardiovascular and kidney functions. These are also involved in carcinogenesis, teratogenesis and mutagenesis [5, 11, 13]. It was concluded from the study that broiler feed containing high concentration of heavy metals may translocation to broiler and accumulate in their metabolic tissues and retards their normal body functions. Similarly these are transferred to human beings through the use of broiler meat and ultimately cause the sever impacts on human normal body functions. Further studies can be conducted for risk assessment of consumers and life cycle analysis of poultry litter and its impacts on soil and water quality. There should be public awareness about health hazards associated with consumption of broiler meat.

REFERENCES

1. Anonymous, 2003. Economic Survey of Pakistan, 2002-03. Ministry of Finance, Planning and Development, Islamabad, Government of Pakistan.
2. Maqbool, A., M.N. Sarwar and K. Bakhsh, 2005. Moderanization of poultry farming. Economic and Business Review. Pakistan Vet. J., 27(1): 25-28.
3. Khalid, N., H. Rehman, M.O. Omer and N. Ahmad, 2001. National Poultry Congress (NPC)-2001, under the auspices of Pakistan Poultry Association September 29 Lahore-Pakistan. J. Agric. Food Chem., 50: 4146-4150.
4. Anonymous, 1980. Mineral Tolerance of Domestic Animals. Washington, DC. National Research Council, (NRC), National Academy Press.
5. Abdullah, N., A. K. Osman and K.A. Salaman, 2010. Monitoring of aflatoxins and heavy metals in some poultry feeds. AJFS. 4(4): 192-199.
6. Iwegbue, C.M., A.G.E. Nwajei and E. Iyoha, 2008. Heavy metal residues of chicken meat and gizzard and turkey meat consumed in southern Nigeria. Bulg. J. Vet. Med., 11(4): 275-280.
7. Khan, C.A. and G.A.L. Meijer, 2005. The risk of contamination of food with toxic substances present in animal feed. Anim Feed Sci. Tech., 133: 84-108.

8. Han, F.X., W.L. Kingery, H.M. Selim and P.D. Gerard, 2005. Accumulation of Heavy Metals in A Long-Term Poultry Waste-Amended Soil. Soil. Sci. 165(3): 260-268.
9. Das, A.K., 1990. A Text Book on Medical Aspects of Bio-inorganic Chemistry, 1st Ed, Delhi. CBS.
10. Das, A.K., 1990. A Text Book on Medical Aspects of Bio-inorganic Chemistry, 1st Ed, Delhi. CBS.
11. Bennett, J.W. and M. Klich, 2003. Mycotoxins. Clin. Microbiol. Rev., 16: 497- 516.
12. Zaidi, M.I., A. Asrar, A. Mansoor and M.A. Farooqui, 2005. The heavy metal concentrations along roadside trees of Quetta and its effects on public health. J. Appl. Sci., 5: 708-711.
13. Jarup, L., 2003. Hazards of heavy metal contamination. Br. Med. Bull., 68: 167-182.
14. Sathawara, N.G., D.J. Parikh and Y.K. Agarwal, 2004. Essential heavy metals in environmental samples from western India. Bull. Environ. Contam. Toxicol., 73: 756-761.
15. Steenland, K. and P. Boffetta, 2000. Lead and cancer in humans: Where are we now? Am. J. Ind. Med. 38: 295-299.
16. Cang, L., Y.J. Wang, D. Zhou and Y. Dong, 2008. Heavy metals pollution in poultry and livestock feeds and manures under intensive farming in Jiangsu Province. J. Environ Sci., 16(3): 371-374.
17. Brookes, P.C., 2008. The use of microbial parameters in monitoring soil pollution by heavy metals. Biol Fertil Soils. 19 4): 269-279.
18. Davis, K., 1998. Federal Codes of Regulations: Animals and Animal Products. Consumer Report. pp: 17.
19. Nisar, A., A.N. Akhtar, M. Shahnawaz, S. Saadat and J.H. Zaidi, 2010. Aerosol Studies of Urban Areas of Lahore Using Pixe. Int. J. PIXE. 20(3-4): 101-107.
20. Ghita, M., V. Stanescu, L. Tudor, L.I. Ilie and A.M. Gallis, 2009. Determination of heavy metals content of meat and meat by-products by using neutron activation analysis and atomic absorption spectrometry. Scientific Works - University of Agronomical Sciences and Veterinary Medicine, Bucharest Series C, Veterinary Medicine. 55(3): 140-146.
21. Shah, T.G., J.A.K. Baig, H.I. Afridi, G.A. Kandhro, M.B. Arain, N.F. Kolachi and S.K. Wadhwa, 2010. Determination of total mercury in chicken feed, its translocation to different tissues of chicken and their manure using cold vapor atomic absorption spectrometer. FCT. 48(8-9): 2357-2360.
22. Weeks, C.A., T.D. Danbury, H.C. Davies, P. Hunt and S.C. Kestin, 2000. The behaviour of broiler chickens and its modification by lameness. Appl. Anim. Behav. Sci., 67: 111-25.
23. Julian, R.J., 2000. Physiological, management and environmental triggers of the ascites syndrome: a review. Avian Pathol., 29: 519-27.
24. Dermirezen, O. and K. Uruc, 2006. Comperative study of trace elements in certain fish, meat and meat products. Food Chemistry. 32: 215-222.
25. Mahesar, S.A., S.T.H. Sherazi, A. Niaz, M.I. Bhanger, Siraj-ud-din and A. Rauf, 2010. Simultaneous assessment of zinc, cadmium, lead and copper in poultry feeds by differential pulse anodic stripping voltammetry. Food Chem Toxicol., 48(8-9): 2357-2360.
26. Shahid, I.M., M.A.I. Kazi, M.H. Moazzem, M.A. Ahsan and A.M.M. Hossain, 2007. Propagation of Heavy Metals in Poultry Feed Production in Bangladesh J. Sci. Ind. Res., 42(4): 465-474.
27. Bath, E., 1989. Effect of heavy metals in soil on microbial processes and populations. Water, Air and Soil Pollution. 47(3-4): 335-379.
28. Mariam, I., S. Iqbal and S.A. Nagra, 2004. Distribution of some trace and macro minerals in beef, mutton and poultry. IJAB. 6: 816-820.
29. Duncan, D.B., 1980. Multiple range and multiple F-tests. Biometrics, 11: 1-42.
30. Sanotra, G.S., C. Berg and J.D. Lund, 2003. A comparison between leg problems in Danish and Swedish Broiler Production. Anim. Welfare. 12: 677-83.
31. Nicholsona, F.A., B.J. Chambersa, J.R. Williamsb and R.J. Unwinc, 1999. Heavy metal contents of livestock feeds and animal manures in England and Wales. Bioresour Technol., 70: 23-31.
32. Mcbride, M. and G. Dpiers, 2001. Trace element contents of selected fertilizers and dairy manures as determined by ICP-MS. Soil Sci. Plant Anal., 32: 139-156.
33. Anonymous, 1992. World Health Organization (WHO), Environmental Health Criteria, Geneva. pp: 134.
34. Anonymous, 1995. World Health Organization (WHO), Environmental Health Criteria, Geneva. pp: 165.