Global Veterinaria 16 (5): 425-430, 2016
ISSN 1992-6197

DOI: 10.5829/idosi.gv.2016.16.05.10321

Estimation of Some Heavy Metals Concentration in Layer Farms at El- Fayoum Governorate

[1]K.H. Abdou, [1]Walaa A.R. Moselhy, [2]M.M. Manal and [3]O.H. Ehdaa

[1]Department of Toxicology and Forensic Medicine,
Faculty of Veterinary Medicine, Beni Suef University, Egypt
[2]Department of Biochemistry, Animal Health Institute, Cairo, Egypt
[3]Department of Biochemistry, Animal Health Institute, El-Fayoum, Egypt

Abstract: The objective of this work was to estimate the lead (Pb), Cadmium (Cd), Copper (Cu), Zinc (Zn), Iron (Fe) and Manganese (Mn) contents in drinking water, layer feed and in addition Hen's Eggs collected from two layer farms which present at two different areas, non industrial area (Integrated poultry project in El-Azab) and industrial area (Kom Oshim) in Tamia district in El-Fayoum province, Egypt, during winter season. All samples will be analyzed to determine the translocations of heavy metals from water and feed to the bird's eggs. The results explained that the mean metal contents in the different samples of selected poultry farms are Pb (0.436±0.26, 0.529±0.089), (2.891±0.194, 3.182±0.28) and (0.071± 0.03, 0.099±0.0396 ppm). Cd (0.2912±0.029, 0.3936±0.013), (0.508±0.017, 0.5854±0.003) and (0.005±0.0013, 0.0125±0.003 ppm). Cu (4.651±0.044, 4.1352±0.288), (9.15±1.202, 14.75±0.417) and (0.0442±0.0075, 0.03032±0.004 ppm). Zn (55.238±0.386, 57.739±0.466), (57.605±3.06, 58.319±0.73) and (0.0668±0.018, 0.016±0.00498 ppm). Fe (309.49±44.015, 291.553±0.466), (153.58±15.3, 124.12±3.26) and (0.013±0.008 ppm , ND). And Mn (2.63±0.3049, 2.178±0.191), (84.98±5.676, 85.884±1.07) and (0.0056±0.0037 ppm , ND) for eggs, layer feeds and drinking water which were collected from non industrial area and industrial area in El-Fayoum province, Egypt, respectively. These data interpreted that Pb and Cd in eggs, layer feeds and drinking water collected from industrial area were higher than that which were collected from non industrial area. Also these metals residual concentrations particularly in layer eggs and drinking water were more than the permissible limits.

Key words: Environmental Pollution · Poultry · Heavy Metals · Chicken Egg · Layer Feeds

INTRODUCTION

Environmental pollution with heavy metals is considered to be one of the most important problems concerning human and animal health. Lead, cadmium, copper, zinc, iron and manganese are among the most important of these metals. Industrial and agricultural processes have resulted in an increased concentration of heavy metals in air, water and soil and subsequently, these metals are taken by plants and animals and take their way into food chain [1]. Poultry could take up heavy metal compounds from different sources; metal residues may concentrate in their eggs [2- 5]. The contamination with heavy metals is a severe health hazard since they are toxic, bio accumulates and biomagnifications in the food chain, which is the principal route of heavy metals intake into eggs, is through the feeds. Eggs used as evidence for environmental pollution since they can accumulate the heavy metals from diet and surrounding environment, iron and manganese, beside zinc belong to the most important, basic micro elements that are standardized in poultry feeding. They are accumulated in the content and shells of egg in quite different concentrations, dependent on a dose and form of these elements as well as on many other factors, including physiological ones [6]. It is evident from the results of calculation of the ADI from consumption of 100g egg/day that Cd, Pb and Fe were the most predominant metals constituting hazardous effect in

Corresponding Author: Khaled Abbas Helmy Abdou, Department of Toxicology and Forensic Medicine, Faculty of Veterinary Medicine, Beni Suef University, Egypt.
Tel: +20101906577.

human through consumption of layer eggs, so, the consumption of eggs from industrial area should be avoided. The aim of the present study was to evaluate the concentrations of Pb, Cd, Cu, Zn, Fe and Mn contents in drinking water, layer feed and in addition Hen's Eggs collected from two layer farms which present at two different areas, non industrial area (Integrated poultry project in Al-Azab) and industrial area (Kom Oshim) in Tamiyyah district in El-Fayoum province, Egypt, during winter season.

MATERIALS AND METHODS

Materials

Selected Farms: Two poultry farms were selected from El-Fayoum governorate, one of them is located 5 km away from Kom Oshim, Tamiyyah which is an industrial area (farm A), which contain industrial activities such as chemicals, ceramics and bricks. While the other farm is integrated poultry project in El-Azab which is away from the industrial area about 34 km (farm B). All the samples were collected during the period of 2014 & 2015.

Samples: Eighty egg samples were collected randomly from each farm, samples were transferred in plastic bags to the laboratory were kept cold until the contents were removed. Samples of layer feeds and drinking water twenty each were taken from both farms A and B.

Sample Analysis: Water samples were analyzed according to APHA [7]. Layer feed samples were analysed according to AOAC [8]. Egg samples were analyzed according to method applied by Abdel Kader and Zaki [9, 10]. The detection & estimation of these metals in previously digested samples will be determined by Atomic Absorption Spectrophotometry.

Statistical Analysis: Data were expressed as mean ± standard error (SE) and analyzed using T test followed by Duncans test as a post-hoc test using IBM SPSS Statistics 22.0 soft ware package according to SAS [11].

RESULTS

As seen in Table 1 Pb, Cd, Cu and Fe levels in egg samples collected from non industrial and industrial areas showed a highly increase Significance difference at levels $P<0.05$ however for Zn the difference was not statistically significant ($p >0.05$). The levels of iron, manganese and copper in the examined hen's egg samples which were collected from non industrial region were higher than that levels of these heavy metals which were collected from industrial region while the levels of lead and cadmium in the examined samples were higher in industrial region than that levels of these heavy metals in non industrial region. Also the iron levels in egg samples were above limit recorded by USDA [14] (17.6 ppm).

Our results explain that the levels of Pb and Cd in examined water samples which were collected from industrial area were higher than those levels of these two metals in water samples which were collected from non industrial area. While the levels of Zn, Cu, Fe and Mn in examined water samples which were collected from non-industrial area were higher than those levels of these metals in water samples which were collected from industrial area, those high concentrations of copper, iron and manganese may be as a result of domestic waste and the metallic pipes that are used to transport water [19]. Lead and cadmium levels detected in the water samples exceed permissible limits recorded by WHO [19] (0.01& 3μg/l ppm) for lead and cadmium respectively. The obtained results indicated that the metal found mostly abundant in water samples was (Pb) as compared to other metals. The concentrations of (Pb) and Cd in examined layer feed samples which were collected from industrial area farms were higher than that levels of these two metals of layer feed samples which were collected from non industrial area farms. The obtained results indicated that the metal found mostly abundant in layer feed samples was iron in comparable with other metals with mean values of (153.58±15.3 and 124.12±3.26 ppm) at non industrial and industrial regions respectively. Fe, Mn, Zn and Cu levels detected in layer feeds were above limits recorded by WHO [15, 16] (80, 60, 40 and 8 mg/kg) respectively. But (Pb) and (Cd) levels detected in layer feeds were within limits recorded by Baars *et al*. [18]. As seen in Table 2, Pb, Cd, Zn and Mn, levels in water samples collected from non industrial and industrial areas showed a highly increase Significance difference at levels $P<0.05$. But, Fe and Cu levels in water samples collected from non industrial and industrial areas showed non Significance difference at levels $P<0.05$. Generally, in the following studied heavy metals Cd, Fe, Mn, Zn and Cu in feed samples which were collected from industrial and non-industrial farms, we found a highly statistically significant difference at level ($p<0.05$).

Table 1: Lead, Cadmium, Copper, Zinc, Iron and Manganese levels (ppm) in layer egg samples of selected poultry farms at El-Fayoum province, Egypt. During winter season in comparison with the permissible limits

During winter season	Non industrial area	Industrial area		
Elements	Mean±SE Egg	Mean±SE Egg	P-value Egg	Permissible limits Egg
Pb	0.436±0.26	0.529±0.089	0.001*	0.05 ppm
Cd	0.2912±0.029	0.3936±0.013	<0.001*	0.05 ppm
Cu	4.651±0.044	4.1352±0.288	<0.001*	10 ppm
Zn	55.238±0.386	57.739±0.466	0.397	20 ppm
Fe	309.49±44.015	291.553±0.466	<0.001*	17.6 ppm
Mn	2.63±0.3049	2.178±0.191	0.054	0.10–3.99 mg/kg

Data Expressed as (Mean± S.E and T test n=10 of each samples).

* Significant difference at levels P<0.05.

° Vanovermeire *et al.* [12]

□ ATSDR [13]

□ USDA[14]

Table 2: Lead, Cadmium, Copper, Zinc, Iron and Manganese levels (ppm) in layer feeds and drinking water samples of selected poultry farms at El-Fayoum province, Egypt. During winter season in comparison with the permissible limits

During winter season	Non industrial area		Industrial area					
	Mean ±SE		Mean ±SE		P-value		Permissible limits.	
Elements	Layer feeds	Drinking water	Layer feeds	Drinking water	Layer feeds	Drinking water	Layer feeds	Drinking water
Pb	2.891±0.194	0.071± 0.03	3.182±0.283	0.099±0.0396	0.295	0.002*	5 mg.kg^{-1}	0.01 mg/l
Cd	0.508±0.017	0.005±0.0013	0.5854±0.003	0.0125±0.003	<0.001*	<0.001*	1mg/kg	3µg/l
Cu	9.15±1.202	0.0442±0.0075	14.75±0.417	0.03032±0.004**	<0.001*	0.105	8 mg/kg	2000 µg/l
Zn	57.605±3.06	0.0668±0.018	58.319±0.73	0.016±0.00498**	0.002*	<0.001*	40 mg/kg	5 mg/l
Fe	153.58±15.3	0.013±0.008	124.12±3.26	ND	<0.001*	0.518	80 mg/kg	300 µg/l
Mn	84.98±5.676	0.0056±0.0037	85.884±1.07	ND	<0.001*	<0.001*	60 mg/kg	400 µg/l

Data Expressed as (Mean± S.E and T test n=10 of each samples).

* Significant difference at levels P<0.05.

WHO [15&16].

WHO [17].

Baars *et al.* [18].

WHO [19].

Table 3: Comparison of acceptable daily intake (ADI) value of heavy metals with the Mean concentrations of metals (mg/kg) in examined egg samples collected during winter season

		Mean concentrations of metals (mg/kg) in examined egg samples collected from		Calculated acceptable daily intake (ADI) of metals from consumption of 100 g egg/day (b)			
				Mg/day/person		% (c)	
Heavy metals	Acceptable daily intake (ADI mg/70kg person) (a)	Non industrial area	Industrial area	Non industrial area	Industrial area	Non industrial area	Industrial area
Lead	0.5	0.436	0.529	0.0436	0.0529	8.72	10.58
Cadmium	0.07	0.2912	0.3936	0.02912	0.03936	41.6	56.2
Copper	35.0	4.651	4.1352	0.4651	0.41352	1.33	1.18
Zinc	70.0	55.238	57.739	5.5238	5.7739	7.89	8.25
Iron	56.0	309.49	291.553	30.949	29.1553	55.27	52.1
Manganese (d)	10	2.63	2.178	0.263	0.2178	2.63	2.178

(a) According to FAO/WHO Codex [20].

Daily consumption for adult person according to Nutritional Institute, Egypt [21&22].

(a) Percentage calculated to ADI

(b) Acceptable daily intake (ADI mg/70kg person) according to USEPA [23]

Regarding heavy metal residues in the examined hen's egg collected from layer farms, table (1). Show that the average lead and cadmium concentrations in the examined samples were (0.436±0.26and 0.2912±0.029 ppm) and (0.529±0.089 and 0.3936±0.013ppm) for Pb and Cd at the two different areas respectively. These results are relatively higher than those obtained by Azza and Hanaa [24] from commercially, home produced and organic egg samples which were collected from Egypt and Samia *et al*. [25] who examined lead (Pb) and cadmium (Cd) levels in egg samples which were collected from four sectors (North Delta, Middle Delta, South Delta and Upper Egypt) representing different geographic areas in Egypt. The presence of heavy metals residues in hen's egg samples may be attributed to high levels of such compound in feeds and water [1]. Lead, cadmium and zinc levels detected in the egg samples were above permissible limit recorded by Vanovermeire *et al*. [12] (0.05, 0.05 and 20 ppm), who examined pb, cd and zn in Free -range eggs obtained from hens of private owners and of commercial farms in different regions at Belgium But copper and manganese levels detected in the egg samples were within permissible limit recorded by Vanovermeire et al. and ATSDR [12&13] (10 ppm and 0.10–3.99 mg/kg). Our results revealed that Zn, Cu and Fe levels detected in hen's egg samples which were collected from the non industrial and industrial areas were in average of (55.238±0.386, 4.651±0.044 and 309.49±44.05 ppm) and (57.739±0.466, 4.1352±0.288 and 291.553±22.4 ppm) for Zn, Cu and Fe levels in hen's egg samples which were collected from the non industrial and industrial areas respectively. These results are relatively higher than those obtained by Azza and Hanaa [23] for Cu and Zn levels. Also our results were much higher than those obtained by Al-Ashmawy [26] and Shahid Ul Islam et al. [27] for Cu and Fe levels in egg samples which were collected from Commercially and home-produced eggs of hen rolled in Mansoura city marketes, Egypt and five farms located at Peshawar Khyber Pakhtunkhwa district at Pakistan respectively. In the same way our results were nearly similar to those reported by Samia *et al.* [25] for Zn, Cu and Mn levels.

Table (3) declares that average concentrations of lead (pb), cadmium (cd), copper (cu), zinc (zn), iron (fe) and manganese (mn) in examined egg samples collected from non industrial and industrial area give daily intake of about (0.0436, 0.02912, 0.4651, 5.5238, 30.949 and 0.263) and (0.0529, 0.03936, 0.41352, 5.7739, 29.1553 and 0.2178) mg/day/person for pb, cd, cu, zn, fe and mn respectively from consumption of 100g egg samples that contributed about (8.72, 41.6, 1.33, 7.89, 55.27 and 2.63) and (10.58, 56.2, 1.18, 8.25, 52.1 and 2.178) of ADI recommended by FAO/WHO Codex [20] respectively. The inorganic lead compounds are classified by the International Agency for Research Cancer (IARC) as a probably carcinogenic to humans Codex [20]. It is evident from these results that Cd was the most predominant toxic metals constituting a hazardous effect in human through consumption of eggs especially for eggs collected from industrial area. The results showed that the water of layer farms were elevated in its concentrations of lead and this may cause bioaccumulation of this metal in layer eggs [1].

Concerning heavy metal residues in drinking water samples collected from layer farms at non industrial and industrial areas, table (2). And Show that the mean values of lead and cadmium in water samples were (0.071±0.03 and 0.005±0.0013) and (0.099±0.0396 and 0.0125±0.003 ppm) for Pb &Cd at non industrial and industrial areas respectively. Our results were similar to those reported by Hussein *et al.* [28] and Ahmed [1] for lead levels in water samples which were collected from some areas in province of, Mecca Almokaramah, Saudi Arabia and broiler and layer farms at Zagazig district respectively.

Results recorded in table (2). Show that average lead and cadmium concentrations in layer feed samples were (2.891±0.194 and 0.508±0.017ppm) and (3.182±0.283and 0.5854±0.003 ppm) for Pb and Cd in layer feed samples which were collected from layer farms of non industrial and industrial areas respectively. The concentrations of (Pb)and Cd in examined layer feed samples which were collected from industrial area farms were higher than that levels of these two metals of layer feed samples which were collected from non industrial area farms. So that the high levels of lead and cadmium in layer feed from industrial area farms resulted from pollution of feed stuffs from plant origin and as a results of expanding industrial and agricultural activities at the area. Therefore, contamination of poultry feed appears to represent a serious risk of persistent heavy metals in layer meats and eggs [1]. While Zn, Cu and Mn levels in layer feed samples collected from non industrial and industrial areas were (57.605±3.06, 9.15±1.202 and 84.98±5.676 ppm) and (58.319±0.73, 14.75±0.417 and 85.884±1.07 ppm) respectively. Our results were similar to that which obtained by Okoye *et al*. [29] in layer feed samples collected from different markets in the South Eastern, Nigeria and examined for the presence of Mn and Zn, While the results recorded by Rehman *et al.* [30] were much higher than that of our results for Fe, Mn and Zn levels in samples which were collected from five poultry farms (A, B, C, D and E) located at Faisalabad district, Pakistan.

CONCLUSION

From this work, it can be concluded that toxic metals obtained in the eggs, drinking water and layer feeds show a certain level of pollution of the environment which have resulted in an increased concentrations of heavy metals in air, water and soil and subsequently, these metals are taken by plants, birds and animals and take their way in to eggs. Presence of high levels of heavy metal residues in hen's egg may be attributed to high levels of such compounds in feeds and water and the contamination of such layer feeds appear to represent a serious risk of persistent heavy metals in poultry eggs there fore feed supplement added to hen's diet should be measured and calculated it's residues in eggs to avoid un desirable increase in their amounts. (Pb) and (Cd) in eggs collected from industrial area were higher than that which was collected from non industrial area. Also these metals residual concentrations particularly in layer eggs were more than the permissible limits, so, the consumption of eggs from industrial area should be avoided.

REFERENCES

1. Ahmed, W.M.S.E.D., 2002. Studies on heavy metals pollution in poultry farms in relation to production performance, Department of Hygiene and Animal Husbandry, Faculty of Veterinary Medicine. Zagazig University, Egypt.
2. Nisianakis, P., I. Giannenas, A. Gavriil, G. Kontopidis and I. Kyriazakis, 2009. Variation in trace element contents among chicken, turkey, duck, goose and pigeon eggs analyzed by inductively coupled plasma mass spectrometry (ICP-MS). Biological Trace Element Research, 128(1): 62-71.
3. Demirezen, O. and K. Uruc, 2006. Comparative studies of trace elements incertain fish, meat and meat products. Food Chemistry, 32: 215-222.
4. Baykov, B.D., M.P. Stoyanov and M.L. Gugova, 1996. Cadmium and lead bioaccumulation in male chickens for high food concentrations. Toxicol. Environ. Chem., 54: 155-9.
5. Mohammed, A.I., B. Koloand Y.A. Geidam, 2013. Heavy Metals in Selected Tissues of Adult Chicken Layers (Gallus spp) ARPN Journal of Science and Technology, 3(5), May 2013, ISSN 2225-7217.
6. Recommended allowances and nutritive value of feedstuffs. Poultry feeding standards (in polish), 4th Edition. The Kielanowski Institute of animal Physiology and Nutrition. PAS, Jabonna (Poland) and polish Branch of WPSA.
7. APHA, (American Public Health Association), 1995. Standard Methods for Examination of water and waste water. American Public Health Association 16th Edition Washington, D.C.20005, 1995.
8. AOAC. International Official method, 2006. Committee on Residues and Related Topics "AOAC". 2006. General referee Reports, Metals and other elements. Journal of AOAC International, 89(1): 290-303.
9. Abdel Kader, M.A., 1994. Heavy metal in poultry feed, water, dropping and hen's eggs. Zag. Vet J., 22(4): 12-18.
10. Zaki, M.S.A., 1998. Heavy metals in fresh and salted marine fish. 4 th Vet. Med. Zag. Congress, 26-28 August 1998 in Hurghada, pp: 331-33.
11. SAS., 1988. SAS/STAT User´s Guide Release 6.03 Edition.SAS Institue, Cary, NC.
12. Vanovermeire, I., L. Pussemier, V. Hanoti, L. De Temmerman, M. Hoenig and L. Goeyens, 2006. Chemical contamination of free-range eggs from Belgium. Food Additives and Contaminants, 23(11): 1109-1122.
13. ATSDR, 2000. Toxicological profile for manganese. Atlanta, GA, United States Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.
14. USDA, U.S. Department of Agriculture, Agricultural Research Service "USDA, 2011.USDA National Nutrient Database for Standard Reference, Release 24. Nutrient Data Laboratory Home Page. Downloaded from http://www.ars.usda.gov/ba/bhnrc/ndl.
15. WHO, 1992. Cadmium. Environmental Health Criteria, Geneva, pp: 134.
16. WHO, 1995. Lead Environmental Health Criteria, Geneva, pp: 165.
17. WHO, 2004. World Health Organization, Guidelines for drinking-water quality Recommendations. International Standards of Drinking Water. Geneva.
18. Baars, A.J., H. Van Beek, I.J.R. Visser, G. Voss, W. Van Delft, G. Fennema, G.W. Lieben, K. Lautenbag, J.H.M. Nieuwenhuijs, P.A. Coulander, F.H. Pluimers, Van G. De Harr, T.J. Jorna, G.M.TH. Tuinstra, P. Zandstra and B.Bruinsjzn, 1992. Lead intoxication in cattle: Acase Report. Food Additives and Contaminants, 9(4): 357-364.
19. WHO, 2011. Lead in Drinking-water. Background document for development of WHO Guidelines for Drinking-water Quality. WHO/SDE/WSH/03.04/09/Rev/1.

20. Codex Alimentarius Commission, 2011.FAO/WHO, Joint Food Standards Programme, Codex Committee on Contaminants in Foods, Working document for information and use in discussions related to contaminants and toxins in the GSCTFF, List of Maximum Levels for Contaminants and Toxins in Foods, Part 1, March, CF/5 INF/1.
21. Nutrition Institute, Cairo, Egypt, 1996.The guide of healthy food (diet) for Egyptian family.
22. Nutrition Institute, Cairo, Egypt, (2006): The guide of healthy food (diet) for Egyptian family.
23. USEPA, United States Environmental Protection Agency (USEPA), 2001.Integrated risk information system (IRIS). Health risk assessment for Manganese. Office of Health and Environmental assessment, Cincinnati, Ohio.
24. Azza, M.K.S. and M.R.H. Hanaa, 2011. Determination of Some Heavy Metals in Table Hen's EggsJournal of American Science, 7(9).
25. Samia, M.H., D.A. Laila and M.A. Abdel-Wahhab, 2012. Mineral and Heavy Metals Content in Eggs of Local Hens at Different Geographic Areas in Egypt Global Veterinaria, 8(3): 298-304.
26. AL-Ashmawy, M.A.M., 2013. Trace elements residues in the table eggs rolling in the Mansoura City markets Egypt. International Food Research Journal, 20(4): 1783-1787.
27. Shahid ul Islam, M., M. Zafarand M. Ahmed, 2014. Determinationof heavy metals from table poultry eggs in Peshawar Pakistan. Journal of Pharmacognosy and Phyto Chemistry, 3(3): 64-67.
28. Hussein, K.H., O.A. Abu-Zinadah, H.A. EL-Rabey and M.F. Meerasahib, 2013. Estimation of some heavy metals in polluted well water and mercury accumulation in broiler organs. Braz. Arch. Biol. Technol., 56(5) Curitiba Sept./Oct. 2013.
29. Okoye, C.O.B., A.U. Aneke, C.N. Ibeto and J.N. Ihedioha, 2011. Heavy . Metals analysis of local and exotic poultry meat International Journal of Applied Environmental Sciences Feb. 1.2011.
30. Rehman, U.K., S. Andleeb, A. Mahmood, S.M. Bukhari, M.M. Naeem and K. Yousaf, 2012. Assessment of Heavy Metals in Different Tissues of Broilers and Domestic Layers. Department of Environmental Sciences, Government College University, Faisalabad, Pakistan Global Veterinaria, 9(1): 32-37.