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Original Research Article

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

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ABSTRACT

The objective of this work was to estimate the lead (Pb), Cadmium (Cd), Copper (Cu), Zinc (Zn), Iron (Fe) and Manganese (Mn) levels in drinking water, layer feed and muscle samples were collected during winter season 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. All samples will be analyzed to determine the translocations of heavy metals from water and feed to the bird's muscle. The results explained that the mean metal concentrations in the different samples of selected poultry farms are Pb (1.1034±0.097, 1.173±0.129), (2.891±0.194, 3.182±0.28) and (0.071±0.03, 0.099±0.0396 ppm). Cd (0.419±0.004, 0.389±0.017), (0.508±0.017, 0.5854±0.003) and (0.005±0.0013, 0.0125±0.003 ppm). Cu (5.9±2.1, 0.8596±0.054), (9.15±1.202, 14.75±0.417) and (0.0442±0.0075, 0.03032±0.004 ppm). Zn (14.50±1.285, 13.628±1.053), (57.605±3.06, 58.319±0.73) and (0.0668±0.018, 0.016±0.00498 ppm). Fe (171.011±79.6, 186.74±72.65), (153.58±15.3, 124.12±3.26) and (0.013±0.008 ppm, ND). And Mn (3.187±1.539, 1.398±0.768), (84.98±5.676, 85.884±1.07) and (0.0056±0.0037ppm, ND) for muscle, layer feeds and drinking water which were collected from non industrial area and industrial area in El-Fayoum province, Egypt, respectively. These data indicated that Pb and Cd in muscle, layer feeds and drinking water collected from industrial area were higher than that collected from non industrial area. Also these metals residual concentrations particularly in layer muscle and drinking water were more than the permissible limits.

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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 [1]. Industrial and agricultural processes have resulted in an increase 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; and its residues may concentrate in meat [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 deposition into the tissues of poultry. On the other hand, the accumulation of heavy metals varies significantly from one tissue to another within an animal, and varies also between one animal and another [6]. The determination of heavy metals in tissue and organs of poultry has therefore received serious attention [7-9]. The high levels of Pb may result in toxic effects in humans which in turn cause problems in the synthesis of haemoglobin (Hb), effects on kidneys, gastrointestinal tract (GIT), joints and reproductive system, and acute or chronic damage to nervous system. It can enter the body through ingestion and inhalation. Its maximum allowable levels may be 5 μg/L (in bottled water) to set elemental impurities limit. It can cause disruption of biosynthesis of Hb, anaemia, high B.P., kidney damage, reproductive/fertility problems and brain or nervous system damage. Also, The Cd if exposed for long time may cause kidney dysfunction. Its high exposure may cause obstructive pulmonary disease and lung cancer. Bone defects (osteomalacia, osteoporosis) have also been reported in humans and animals. Besides, it can also cause increased blood pressure and myocardial disease in animals. Cd is more readily absorbed through the lungs than the digestive system. It can damage kidneys, CNS and immune system. It can also cause bone fractures and reproductive problems. It can cause stomachaches, diarrhea and vomiting. The LD50 (oral) of Cd in animals ranges from 63-1125 mg/kg. [10].

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 muscle 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 Tammiyah district in El-Fayoum province, Egypt, during winter season.

Materials and methods:

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 winter of 2014 and 2015.

Samples:

Forty samples of drinking water and layer feed samples were collected from two layer farms (in each layer farm a 10 water and 10 feed samples were collected during period of 2014 & 2015.) and in addition to 20 layers (at the age ranged from 270-275 days) were collected from each of two layer farms (10 form each layer farm). Layer were slaughtered, picked up and eviscerated and from each layer carcasses muscle (breast and thigh) were taken. The samples were collected from both farms A and B.

Sample analysis

Statistical Analysis:

Data were expressed as mean (ppm)±standard error (SE) and analyzed using T- test and the statistical significance of correlation coefficients among different traits were carried by Duncan's test according to Statistical Analysis System (SAS, 1988).[14]**.** As a post-hoc test using IBM SPSS Statistics 22.0 soft ware package and the chart was created by Microsoft Excel 2010 software. The 0.05 level of probability was used as the criterion for significance

Results:

Table 1. Lead, Cadmium, Copper, Zinc, Iron and Manganese levels (ppm) in layer muscle 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	p-value	Permissible limits.
	Mean±SE	Mean±SE		
elements	**muscle**	**muscle**		**muscle**
Pb	1.10±0.097	1.17±0.129	0.119	[a] 0.1 mg/kg
Cd	0.41±0.004	0.38±0.017	<0.001 *	[a] 0.1 mg/kg
Cu	5.9±2.1	0.85±0.054	<0.001 *	[e] 20 ppm
Zn	14.50±1.285	13.62±1.053	0.554	[c] 50 ppm
Fe	171.01±79.6	186.74±72.65	0.693	[h] 30-150 mg/kg
Mn	3.18±1.539	1.39±0.768	0.013*	[d] 0.5 mg/kg

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

* Significant difference at levels P<0.05.

[a] FAO/WHO, (2001) and E.O.S.Q.C., (2007) .[15&16]

[e] Pearson, (1976).[17]

[h] Demirezen and Uruc, (2006). [3]

[d] WHO, (1996).[18]

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		p-value		Permissible limits.	
	Mean ±SE		Mean ±SE					
elements	**Layer feeds**	**Drinking water**	**Layer feeds**	**Drinking water**	**Layer feeds**	**Drinking water**	**Layer feeds**	**Drinking water**
Pb	2.89±0.194	0.07± 0.03	3.18±0.283	0.099±0.0396	0.295	0.002*	[e] 5 mg.kg^{-1}	0.01 mg/l [h]
Cd	0.50±0.01	0.005±0.0013	0.58±0.003	0.012±0.003	<0.001*	<0.001*	[c] 1mg/kg	3µg/l [h]
Cu	9.15±1.202	0.04±0.0075	14.75±0.417	0.03±0.004	<0.001*	0.105	[c] 8 mg/kg	[h] 2000 µg/l
Zn	57.60±3.06	0.06±0.018	58.31±0.73	0.016±0.00498	0.002*	<0.001*	[c] 40 mg/kg	5 mg/l [d]
Fe	153.58±15.3	0.013±0.008	124.12±3.26	ND	<0.001*	0.518	[c] 80 mg/kg	[h] 300 µg/l
Mn	84.98±5.676	0.005±0.0037	85.88±1.07	ND	<0.001*	<0.001*	60 mg/kg	400 µg/l[h]

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

* Significance difference from permissible limits at levels P<0.05

[c] WHO, (1992&1995).[19&20]

[d] WHO, (2004).[21]

[e] Baars et al., (1992).[22]

[h] WHO, (2011).[23]

It is worth mentioning that examined layer muscles were contaminated by lead and cadmium. lLead levels in poultry tissue samples which were collected from industrial area were above the permissible limits for lead and cadmium levels in muscle [16 and 15].

Also iron and manganese levels in poultry tissue samples which were collected from non industrial and industrial area were above the permissible limits [3 and 18] for Fe & Mn respectively. And our results showed that iron concentration in water and feed was found to be statistically correlated to layer muscles.

Copper and zinc levels in poultry tissue samples which were collected from non industrial and industrial area were within the permissible limits [15] for Cu & Zn respectively.

The obtained results indicated that the metal found mostly abundant in the layer tissues was iron in comparable with other metals. 171.011±79.6 ppm and 186.74±72.65 ppm in layer muscles from non industrial region and industrial region respectively.

The given results revealed that there is a significant difference between layer muscle samples collected from non industrial region and industrial region at levels ($p<0.05$).in Cd, Cu and Mn levels. But, Pb, Zn and Fe levels in muscle samples collected from non industrial and industrial areas showed non Significance difference at levels $P<0.05$.

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 Cu, Zn 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.

Also, iron level was determined in water samples which were collected from non 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 [23]. Lead and cadmium levels detected in the water samples exceed permissible limits [23].

The difference in Pb, Cd, Zn and Mn in water samples between industrial and non-industrial regions was statistically significant at level ($p<0.05$). And 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. Pb and Cd levels detected in layer feeds were within limits recorded by Baars et al., (1992). [22].

Table (3) comparison of acceptable daily intake (ADI) value of heavy metals with the calculated daily intake from layer meat during winter season.

Heavy metals	acceptable daily intake (ADI mg/70kg person) (a)	Mean concentrations of metals (mg/kg) in examined layer meat samples collected from		Calculated acceptable daily intake (ADI) of metals from consumption of 250 g layer meat /day (b)			
		Non industrial area	industrial area	Mg/day/person		% (c)	
				Non industrial area	industrial area	Non industrial area	industrial area
Lead	0.5	1.1034	1.173	0.27	0.29	55.17	58.65
Cadmium	0.07	0.419	0.389	0.10	0.09	149.6	138.93
Copper	35.0	5.9	0.8596	1.47	0.21	4.214	0.614
Zinc	70.0	14.50	13.628	3.62	3.40	5.18	4.87
Iron	56.0	171.011	186.74	42.75	46.68	76.34	83.37
Manganese (d)	10	3.187	1.398	0.79	0.34	7.97	3.495

a)According to FAO/WHO (Codex, 2011) [24].

(b) Daily consumption for adult person according to Nutritional Institute, Egypt.(1996 and 2006) [25&26]. (c) Percentage calculated to ADI

(d) Acceptable daily intake (ADI mg/70kg person) according to USEPA (2001) [27].

Discussion:

Concerning heavy metals in layer muscles:

Regarding heavy metal concentrations in layer muscles collected from layer farms, table (1) Show that the average lead and cadmium concentrations in muscle collected from the two different regions were (1.1034±0.097 & 0.419±0.004 ppm) and 1.173±0.129&0.389±0.017 ppm) in muscle in non industrial and industrial regions respectively. The pollution of tissues with lead may be due to air pollution from leaded gasoline consumption by different vehicles [1]. Results of Akan et al., (2010) [26] and Mohammed et al., (2013) [5] indicated that lead levels were lower than that of our results. On the other hand results of Okoye et al., (2011), [27]. Reported much higher lead and cadmium values of exotic layer (muscle) collected from different markets in Enugu State. Also our results reported much higher Pb and Cd levels in muscles than that reported by Manal and Hosnia, (2015) [28] and reported much higher Zn, Cu, Cd, Fe and Pb levels in muscles than that reported by Thirulogachandar et al., (2014), [29]. In the same way Iwegbue et al., (2008) [9] recorded higher lead and cadmium values in chicken meat which were collected from 7 different localities. Similar findings of lead were determined by Soad and Abolghait, (2013), [30]. The mean values of copper, zinc and manganese in muscle of the examined layer samples collected from non industrial and industrial regions were (5.9±2.1, 14.50±1.285 and 3.187±1.539 ppm) and (0.8596±0.054, 13.628±1.0529 and 1.398±0.768 ppm) in muscle samples for copper, zinc and manganese in muscle of the examined layer samples collected from non industrial and industrial regions respectively. The results of Iwegbue et al., (2008) [9] reported relatively similar Cu, Zn and Mn levels in chicken meat which were collected from 7 different localities. Also Okoye et al., (2011) [27] recorded higher copper values in muscle of exotic layer collected from different markets in Enugu state. On the other hand results of Akan et al.,(2010) [26] for zinc analysis were much lower than our results. Deposition of heavy metals in layer meat were results of their excessive use in poultry feed [31].The presence of heavy metals in chicken meat may result from natural occurrence in the soil, from where they are taken up by the plants that feed the chicken, or due to the use of contaminated fish powder as a source of animal protein feed, or from the remnants of vehicle ex- hausts, which are hit by air to the source of fodder and water to drink used in poultry [32].

Table (3) declares that average concentrations of pb, cd, cu, zn, fe and mn in examined layer muscle samples collected from non industrial and industrial area give daily intake of about (0.2759, 0.1048, 1.475, 3.625, 42.753 and 0.797) and (0.2933, 0.0973, 0.215, 3.407, 46.685 and 0.3495) mg/day/person for pb, cd, cu, zn, fe and mn respectively from consumption of 250g meat samples that contributed about (55.17, 149.6, 4.214, 5.18, 76.34 and 7.97) and (58.65, 138.93, 0.614, 4.87, 83.37 and 3.495) of ADI recommended by FAO/WHO codex, (2011), [22] respectively. It is evident from these results that Pb and cd were the most predominant toxic metals constituting hazardous effect in human through consumption of layer meat especially for tissues collected from industrial area.

Also heavy metals in drinking water of layer farms:

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., (2013) [33] and Ahmed, (2002) [1] for lead levels.

In addition heavy metals in layer feeds:

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. There fore, contamination of poultry feed appears to represent a serious risk of persistent heavy metals in layer meats [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) for Zn, Cu and Mn levels in layer feed samples collected from non industrial and industrial areas respectively. Our results were similar to that which obtained by Okoye et al., (2011) [27]. While the results recorded by Rehman et al., (2012) [31] were much higher than that of our results for Fe, Mn and Zn levels.

Conclusion:

From this work, it can be concluded that toxic metals obtained in the layer parts, 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 layer tissues. Presence of high levels of heavy metal residues in poultry tissues 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 meat there fore feed supplement added to hen's diet should be measured and calculated it's residues in poultry tissues to avoid un desirable increase in their amounts. Pb and Cd in layer muscles collected from industrial area were higher than that which was collected from non industrial area. Also these metals residual concentrations particularly in layer muscles were more than the permissible limits, so, the consumption of layer muscles from industrial area should be avoided

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