Estimation of Some Heavy Metal Residues in Tissues of Chickens in Sharkia Governorate With Relation to Public Health

Maha, M. Sameer and Mai, S. Gomaa*
Food Hygiene Dept., Animal Health Research Institute, Zagazig, Egypt
*Toxicology Dept., Fac. of Medicine, Zagazig Univ.

ABSTRACT

One hundred of broiler tissue samples (25 of each muscles, gizzard, liver and skin) were collected from markets of Zagazig Province, Sharkia Governorate, during winter 2008- 2009 for detection and determination of cadmium, lead and copper residues. The obtained results revealed that the average cadmium residues in the muscle, gizzard, liver and skin samples were 3.636, 3.688, 4.088 and 4.164 ppm respectively; while, the mean lead levels were 5.376, 2.904, 6.676 and 4.416 ppm, in the same mentioned tissues respectively. The average levels of copper residues were 5.184, 5.196, 6.952 and 4.152 ppm for the examined muscles, gizzard, liver and skin samples respectively. Both cadmium and lead residues exceeded the permissible limits in all the examined samples, except 2 (8%) of the gizzard samples had lead residues within the permissible limit. On contrary, copper residues were detected in levels below the permissible limits in all the examined samples. The present study recorded high levels daily intake of cadmium and lead from the consumption of 250 gm broiler muscles.

INTRODUCTION

Environmental pollution with heavy metals is considered to be one of the most important problem confronting the public health. Because the food is the main source of these hazardous elements; thus, the effect of the environmental pollution on contamination of foods and their safety for human consumption is a serious global public concern and data of this subject have been reported by several investigators *(1,2)*.

The sources of the heavy metal pollutions in the environment may be agricultural sources as fungicides, herbicides, phosphate fertilizers, organic manure and the presence of decaying plant and animal residues *(3)*, or industrial sources as rubber and paint manufacture. Moreover, high concentrations of lead may be found in roadside soil due to previous using of leaded gasoline *(4)*. Also, rocks and soil may be a natural source of these elements *(5)*.

Poultry meat constitutes an excellent source of high quality, easily prepared, cooked and digested animal protein, which contains all essential amino acids beside many vitamins and minerals which are necessary for maintaining life and promoting growth *(6)*. Many studies recorded high levels of different environmental pollutants in domestic birds in Egypt *(7)*.

The aim of this study was to investigate the levels of cadmium, lead and copper, in chicken muscle (breast and thigh), skin, liver and gizzard and comparing with the recommended permissible limits and discussing the public health importance of the detected metals.

MATERIALS AND METHODS

A total of twenty five broiler chickens were collected from markets of Zagazig Province Sharkia Governorate, during winter 2008-2009 for detection and determination of cadmium, lead and copper residues.

Collection and preparation of samples

The examined broiler chickens were slaughtered, picked up and eviscerated. From each broiler carcass, muscle (breast and thigh), skin, liver and gizzard were taken and placed in polyethylene bags. The samples were identified and kept frozen till the analysis was carried out. Chicken tissue samples were prepared according to the extraction method with modifications *(8)*. One gram of each tissue samples was macerated in screw capped bottle

by sharp scalp. Five ml. of digesting solution (3 ml. of nitric acid + 2 ml. perchloric acid) were added to the tissue samples. The bottles were tightly closed and the contents were vigorously shacked and allow to stand overnight at room temperature. The tubes were heated for three hours in water bath adjusted at 70°C to ensure complete digestion. The digestion bottles were vigorously shacked for 30 minutes during heating in water bath. The bottles were cooled at room temperature and then diluted to 30 ml with deionized water and thoroughly mixed. The digest was filtered through 0.45µm Whatman filter paper. The clean filtrate of each sample was kept at room temperature until analyzed for determination of heavy metal contents.

Preparation of blank solution

Blank solution consists of 3 ml. of nitric acid and 2ml. perchloric acid that were subjected to digestion, dilution and filtration as previously mentioned in the preparation of chicken tissue samples to detect any trace of the studied metals in acids or deionized water used.

Quantitative determination of metals in the examined samples

Quantitative determination of the examined metal residues was conducted using Perkin- Elmer mod. 2830, USA, Atomic absortion (AAS) Spectrophotometer, (Faculty of science, Mansoura University). The concentrations of metals were calculated according to the following equation: ppm metal in samples = A×B÷W where, A= ppm metal in prepared samples from the digital scale reading of AAS., B= final volume of prepared samples in ml. and w = weight of samples in gm.

Statistical analysis

Statistical analysis of data was conducted, using *"Statistical Analysis System" (9)*

RESULTS AND DISCUSSION

Table 1. Heavy metal concentrations (ppm, wet weight) in the examined tissues of broiler chickens (n= 25 for each).

Tissues / Metal	Muscle			Gizzard			Liver			Skin		
	Min	Max	Mean ±S.E	Min	Max	Mean ±S.E	Min	Max	Mean ±S.E	Min	Max	Mean ±S.E
Cadmium	1.8	6.2	3.636 ±0.292^{a}	1.4	5.2	3.688 ±0.146^{a}	1.6	6.5	4.088 ±0.325^{a}	1.8	6.3	4.164 ±0.259^{a}
Lead	4.0	6.6	5.376 ±0.184^{b}	0.1	5.5	2.904 ±0.345^{d}	4.0	9.8	6.676 ±0.384^{a}	2.0	6.6	4.416 ±0.305^{c}
Copper	1.2	8.9	5.184 ±0.516^{b}	2.2	7.6	5.196 ±0.474^{b}	2.3	11.0	6.952 ±0.524^{a}	1.2	6.7	4.152 ±0.393^{b}

N.B.: The difference between letters within the same category (muscle, gizzard , liver and skin) means variation between the values of tissue residues is significant ($p \leq 0.05$).

Table 2. Frequency distribution of heavy metals in the examined tissues of broiler chickens (n= 25 for each).

Metal	P.L.* (ppm)	Muscle				Gizzard				Liver				Skin			
		Within P.L		Over P.L		Within P.L		Over P.L		Within P.L		Over P.L		Within P.L		Over P.L	
		No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
Cadmium	0.05 *(10)*	0.0	0.0	25	100	0.0	0.0	25	100	0.0	0.0	25	100	0.0	0.0	25	100
Lead	0. 5 *(10,11)*	0.0	0.0	25	100	2	8	23	92	0.0	0.0	25	100	0.0	0.0	25	100
Copper	15 *(11)*	25	100	0.0	0.0	25	100	0.0	0.0	25	100	0.0	0.0	25	100	0.0	0.0

*: P.L= Permissible limit

Table 3. Comparison of acceptable daily intake (ADI) values of the detected metals with calculated daily intake from the examined broiler chicken muscles.

Metal	ADI mg/70kg person*(12)*	Mean conc. of the metals in the present study (mg/kg)	Calculated daily intake from consumption of 250 gm chicken meat daily*(13)*	
			mg/day/person	%
Cadmium	0.07	3.636 ±0.292	0.909	1298.5
Lead	0.50	5.376 ±0.184	1.344	268.8
Copper	35.00	5.184 ±0.516	1.296	3.7

The obtained results of the heavy metal residues in the examined poultry tissue samples (Table 1) revealed that the average of cadmium residues in the muscle, gizzard, liver and skin samples were 3.636 ±0.292, 3.688 ±0.146, 4.088 ±0.325 and 4.164 ±0.259 ppm respectively. These findings are nearly similar to those detected in poultry meat products in Egypt ***(14)*** and chicken meat in Turkey ***(15)***, while; other Egyptian studies ***(16-19)*** detected lower cadmium levels than those in the current investigation. Moreover, another study in Nigeria ***(20)***, estimated lower cadmium residues than our figures in poultry muscle (0.01- 1.27 ppm) and gizzard (0.01-1.02 ppm).

Concerning lead residues, the mean residues of this metal in the examined muscle, gizzard, liver and skin samples were 5.376 ±0.184, 2.904 ±0.345, 6.676 ±0.384 and 4.416 ±0.305 ppm, respectively, the obtained levels coincided with those recorded in poultry meat products ***(14)*** and pigeon tissues ***(18)*** in Egypt. Meanwhile, our estimations were higher than those detected in poultry muscles and gizzard in the recent Turkish and Nigerian studies ***(15,20)*** and in both broiler tissues and ostrich muscles (0.36 ppm) in two previous Egyptian studies ***(16,17)***. On contrary, another local study estimated higher lead levels in quail muscles and liver (32.4 and 36.0 ppm respectively) than those in the current investigation ***(19)***.

Copper residues were detected in the poultry tissues in the levels of 5.184 ±0.516, 5.196 ±0.474, 6.952 ±0.524 and 4.152 ±0.393 ppm for the examined muscles, gizzard, liver and skin samples respectively. Nearly similar findings of copper residues were estimated in poultry meat products in Egypt ***(14)*** and poultry muscles and gizzard in Nigeria ***(20)***. On the other hand our findings were lower than those obtained in different broiler ***(16)***, pigeon ***(18)*** and quail tissues ***(19)*** in three Egyptian studies.

The statistical analysis (Table1) revealed insignificance variance in cadmium residues between the all examined organs. On contrary, the significant variance of lead residues were detected within the four examined tissues, liver had the significant higher lead levels followed by muscle, skin and gizzard respectively. Moreover, liver contained the significant higher copper concentrations than the other three examined tissues, while; no significant differences could be detected between copper levels within these tissues. The tendency of the heavy metals to accumulate in liver rather than other examined tissues was attributed to the nature of liver function as an organ of detoxification, these results agreed with those previously reported in the other studies ***(16, 18, 19)***

Regarding the Frequency distribution of heavy metals in the examined samples, Table 2 showed that the both cadmium and lead residues exceeded the permissible limits in all of the examined samples except 2 (8%) gizzard samples which had lead residues within the permissible limit. On contrary, copper residues were detected in levels below the permissible limits in all the examined samples.

The results showed in Table 3 Indicated that the average concentrations of cadmium, lead and copper in the examined broiler muscles were 3.636 ±0.292, 5.376 ±0.184, 5.184 ±0.516 mg/kg (ppm) respectively as previously mentioned, which gave a daily intake of about 0.909, 1.344, 1.296 mg/ person respectively for chicken meat consumer (250 gm/ person/ day) ***(13)*** and this contributed to about 1298.5, 268.8 and 3.7% of acceptable daily intake respectively. The calculated daily intake in the current study were nearly coincided with those reported in broiler breast muscle in a recent Egyptian study ***(14).*** On the other hand, our estimations were clearly higher than those recorded in another Egyptian study in poultry meat ***(16)*** which calculated 0.229, 0.639, and 0.284 mg/ person / day of cadmium, lead and copper respectively. The results of the present investigation indicate heavy contamination of the examined broiler muscles by the heavy metals which constitute a serious health hazardous for the consumers.

From the public health point of view, cadmium and lead were non essential heavy metals and have no known beneficial biological function; they cause many harmful to health. Cadmium toxicity may be manifested by renal dysfunction ***(21)***, growth retardation and testicular damage ***(22).*** Moreover, cadmium was classified as class one human carcinogen ***(23).*** On the other aspect, chronic lead poisoning leads to neuropathy and kidney damage ***(24).*** Also, lead exposure can produce chromosomal abrasion and cancer ***(25).*** Copper is essential metal for the biological processes in human and animals, but when it exceeds the permissible limit in food, it exhibits its toxic symptoms. Chronic copper exposure leads to hepatorenal or hepatocerebral degeneration or Wilson's disease ***(26).***

The obtained results showed that the examined broiler chicken tissues suffered from relatively high levels of cadmium and lead residues. Because the broiler farms often located in rural areas far from the industrial pollutants; thus, the most probable source of metal contamination is feeding rather than atmosphere.

Conclusion and Recommendations

1-Cadmium and lead residues were found in high levels; thus, application of some fungicides, herbicides, phosphate fertilizers and sewage sludge should be kept under control.

2-Zinc supplementation for broiler farms which suffered from lead and cadmium pollutions is advisable to reduce cadmium and lead accumulations in tissues.

3-Continuous monitoring of broiler farms to detect the levels heavy metal pollutions was recommended.

4-Further studies should be enhanced to investigate the probable indistinctive sources of lead and cadmium pollutions in our feed and environment.

REFERENCES

1. ***Ellan G, Van Loon JW and Tolsma, K (1989):*** Heavy metals in vegetables grown in the Netherlands and in domestic and imported fruits. National Institute of Public Health and Environmental Protection. 190: 34-39.

2. ***Alegria A, Barbera R, Ferre R (1990):*** Influence of environmental contamination on Cd, Co, Cr, Cu. Ni, Pb and Zn content of edible vegetables: Safety and nutritional aspects. J.Micronutr Anal 8:91-104.

3. ***Goel PK (1997):*** Water pollution (cause, effects and control) Published by H.S. Poplai for new age international (p) limited, New Delhi, India.

4. ***Underwood E J (1977):*** Trace elements in human and animal nutrition. Academic Press. New York, San. Francisco, London, A Subsidiary of harcout brace Jovanovich, Publisher.

5. ***Moalla SN and Pulford I D (1995):*** Mobility of metals in Egyptian desert soils subject to inundation by Lake Nasser. Soil use and management Volume 11 Issue 2 Page 94-98, June.

6. ***Pearson A M and Dutson T R (1997):*** production and processing of healthy meat, poultry and fish products,1st Ed. Blackie Academic and Professional, London.

7. ***Abdel Kader MA and El Atabany A (1994):*** Heavy metal residues in chicken tissues and its public health importance. Zag. Vet. J. 22 (2): 188-194.

8. ***Graig D S and Wayne C (1984):*** Simple automated wet digestion of animal tissues for determination of seven elements by atomic absorption spectroscopy. Technical communication,107: 115.

9. ***Statistical Analysis System "SAS" (1987) :*** SAS User's guide : Statistical Methods "SAS" Institute Inc., Cary, North Carolina.

10. ***FAO/WHO (1992):*** Codex Alimentarius Commission. Standard program codex committee on food additives and contaminants 24th Session, Hague, 23-28 March.

11. ***EOSQC "Egyptian Organization for standardization and Quality control" (1993):*** Maximum limits for heavy metals in food, Ministry of Industry No. 2360/1993 pps, Cairo, Egypt.

12. ***FAO/WHO, Joint Expert committee on food additives, WHO Technical Report Series No. 505 (1972), No. 555 (1972c), No. 647 (1980), No. 683(1982), No. 751(1987) and No. 776 (1989):*** Evaluation of certain food additives and contaminants.

13. ***Nutritional Institute, Cairo, Egypt, (1996):*** The guide of healthy food (diet) for Egyptian family.

14. ***Neveen H Abo El-Enaen and Aida M Amin (2008):*** A study on some hazardous element residues in chicken meat products in relation to public health. Zag. Vet. J. Vol. 36(3):49-55.

15. ***Uluozlu OD, Tuzen M, Mendil D, Soylak M (2009):*** Assessment of trace element contents of chicken products from Turkey. J Hazard Mater. Apr 30;163(2-3):982-987.

16. ***Salah El –Dien, WM (2002):*** Studies on heavy metal pollution in poultry farms in relation to production performance. Ph.D. Thesis, Animal, Poultry and Environ. Hygiene, Fac. of Vet. Med. Zag. Univ.

17. ***Salah El –Dien, WM and Nabela, IE (2003):*** Determination of some heavy metal levels in meat products of Black Neck Ostrich *(Struthio Camelus Domesticus)*. Zag. Vet. J. Vol. 31(2): 158-165.

18. ***Salah El-Dien, WM and Omima, I A (2004):*** Estimation of some heavy metal residues in tissues of pigeons at Sharkia Governorate markets. J. Egypt. Vet. Med. Assoc. 64 (3): 389-398.

19. ***Nasr IN, Salah El-Dien WM and Hend AM (2007):*** Evaluation of some chemical pollutant levels in quail tissues. Zag. Vet. J. Vol. 35(1): 20-31.

20.Iweghue CMM, Nwazei GE and Iyoha EA (2008): Heavy metal residues of chicken meat and gizzard and turkey meat consumed in southern Nigeria. Bulgarian Journal of Veterinary Medicine. Vol 11(4): 275-280.

21.Elinder CG and Jarup L (1996): Cadmium exposure and health risks: recent finding Ambio. 25, 370-373.

22.Gossel TA and Bricker JD (1990): Principles of clinical Toxicology 2nd ed. Raven press Ltd. New York.

23.International Agency for Research on Cancer"IARC" (1993): Beryllium, Cadmium, Mercury and Exposure in the Glass Manufacturing Industry. IARC Monography on the evaluation of carcinogenic risk to humans. Vol. 58 (Lyon: World Health Organization).

24.Maga J and Tu AT (1995): Food Additive Toxicology, Marcil Dekker, Inc. New York, Basel, Hong Kong.

25.Johnson FM (1998): The genetic effects of environmental lead. Mutat, Res. Apr: 410 (2): 123-140.

26.Jones,TC and Hunt,RD (1983): Veterinary Pathology, 5th ed Lea and Febiger. Philadelphia (USA).

الملخص العربي

تقدير بقايا بعض المعادن الثقيلة في أنسجة الدجاج بمحافظة الشرقية و علاقتها بالصحة العامة

مها محمد سمير ، مي سمير جمعة*

قسم صحة الأغذية - معهد بحوث صحة الحيوان (معمل الزقازيق الفرعي)

*قسم السموم – كلية الطب – جامعة الزقازيق

تم تجميع ١٠٠ عينة من أنسجة دجاج التسمين من محافظة الشرقية (٢٥ من كل من العضلات و القانصة و الأكباد و الجلد) خلال شتاء ٢٠٠٨ - ٢٠٠٩ و ذلك لاستبيان متبقيات الكادميوم و الرصاص و النحاس و قد أسفرت الدراسة عن النتائج التالية.

وجد أن متوسط متبقيات الكادميوم كانت ٣,٦٣٦ ، ٣,٦٨٨، ٤,٠٨٨ و ٤,١٦٤ جزء في المليون في العضلات، القانصة، الأكباد، و الجلد علي التوالي، في حين كانت متبقيات الرصاص ٥,٣٧٦، ٢,٩٠٤، ٦,٦٧٦ و ٤,٤١٦ جزء في المليون في نفس الأنسجة علي التوالي، أما متوسط متبقيات النحاس كانت ٥,١٨٤، ٥,١٩٦، ٦,٩٥٢ و ٤,١٥٢ جزء في المليون علي التوالي في نفس العينات المذكورة سابقا.

أسفرت النتائج عن وجود متبقيات الكادميوم و الرصاص بمستويات أعلي من الحدود القصوى المسموح بها في كل العينات عدا عينتان من القانصة (٨%) احتوتا علي رصاص بمستويات أقل من الحد الأقصى المسموح به، في حين كانت متبقيات النحاس أقل من الحدود القصوى المسموح بها في كل العينات.

وجد أن المأخوذ اليومي من الكادميوم و الرصاص من لحوم الدجاج بناء علي نتائج الدراسة الجارية يعطي مستويات أعلي من المسموح بها من هذين العنصرين من كل أنواع الغذاء.

من نتائج الدراسة الحالية نستخلص أن أنسجة الدجاج محل الدراسة كانت تعاني من التلوث بالكادميوم والرصاص مما يستلزم تكثيف البحث و الدراسة لمعرفة مصادر التلوث بهذين العنصرين و طرق مقاومة ذلك التلوث، و قد تمت مناقشة الأهمية الصحية للمعادن الثقيلة محل الدراسة.