

HEAVY METAL RESIDUES IN HEN'S MEAT AND EGGS AS INFLUENCED BY ENVIRONMENTAL POLLUTION

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ABSTRACT □ Forty samples of each hen's meat and eggs were collected from four Egyptian localities. Each ten samples were randomly collected from various farms distributed in each locality. At the same time other forty samples of each of water and feeds were obtained from the same localities from which hen's meat and eggs were collected. After preparation of water, feed, hen's meat and egg samples, heavy metals (mercury, lead, cadmium, copper and zinc) were estimated in these samples using Atomic Absorption Spectrophotometer. The obtained data indicated a correlation between metal residues in hen's meat and eggs and its concentration in water and

feeds, hence hen's eggs may be used as an indicator of environmental pollution. The results are evaluated according to International Standards of W.H.O./F.A.O. and Egyptian standards. The results indicated that presence of heavy metal residues above the permissible limits in examined hen's meat and egg samples, may act as hazards for human health.

Importance and public health significance of heavy metals under test as well as adapted control measures regarding the water and ration supplied to hens to avoid such serious problem, saving human food and health were discussed.

INTRODUCTION

Chemical pollution of food, water, soil and air represent a major problem in the world and may ultimately threaten the survival of human. Heavy metals are among the most dangerous forms of pollutants that have a tendency to accumulate in tissues and organs of birds and animals as well as humans (Antoniou et al., 1989).

Heavy metals are naturally present in the environment, but industrial and agricultural uses were resulted in an increased concentration in air, water and soil and subsequently make their way into the food chain (Higham and Tomkins, 1993). Poultry receive heavy metal contaminants from feed of plant or animal origin. The contamination of poultry feed has been considered as the main source of metal residues in poultry meat and eggs (Leonzio and Massi, 1989).

The continuous exposure to low concentration of metals may result in bioaccumulation and resulting health consequence in man, so the heavy metals have recently come to the forefront dangerous substances causing serious health hazards in humans as other organisms (Maessen et al., 1985; Friberg et al., 1986; Subramanian, 1988 and Manahan, 1989).

Accordingly the present study was undertaken in some Egyptian localities to throw headlights over the problem of water and feed pollution with heavy metals and to what extent this pollution influences the residue levels of these chemicals in hen's meat and eggs.

MATERIAL AND METHODS

SAMPLING:

a. Water and feed samples:

Forty samples of each of water and feed were collected in triplicate from four localities (El-Nobaria, Damanhour, Rasheid and Desouk). Ten samples of each feed and water were randomly collected from various farms distributed in each locality.

b. Hen's meat and egg samples:

Forty samples of each hen's meat and eggs were also collected in triplicate from the same localities from which water and feed samples were obtained.

Preparation of samples for heavy metal analysis:

Water samples were kept by addition of 1 ml conc. nitric acid per litre until the time of analysis. Feed samples were ground through feed miller. 5 gm subsample of each ground feed samples were dried at 105 °C for 12 hours. Dried samples were placed in crucible and dry

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ashed in Muffle furnace at 550 °C for 4 hours. Ashed materials were cooled to room temperature and put in Kjeldahl flash. 10 ml conc. HNO₃ and 5 ml conc. H₂SO₄ were added to the sample and digestion was completed. The digest was diluted to 100 ml with deionized water.

Tissues from breast and thigh were excised 10 gm of each sample were placed into crucible dish then dried at 135 °C for 2 hours. Dried samples were placed into Muffle furnace and ashed at 500 °C for one hour. Ashed materials were cooled to room temperature, wetted with conc. HNO₃ and placed again into the Muffle furnace at 500 °C for one hour. After cooling, the wetting procedure was repeated to obtain white ash. The sample was quantitatively transferred to a 10 ml volumetric flask, by carefully washing the crucible with 1 ml conc. HNO₃, then two ml portion of diluted HNO₃. All washings were transferred to the volumetric flask. The washing was repeated twice and the solution was diluted to volume with deionized water.

The white and yolk of three eggs were blended for 5 minutes. 5 gm subsample from blended eggs were taken for analysis. Each sample was placed into crucible then dried at 135 °C for 4 hours. The procedures

were conducted as previously mentioned in feed samples.

Procedures for metal analysis:

Metal concentration in the solution were determined by Atomic Absorption Spectrophotometry (Perkin Elmer, model 2380 U.S.A.) with alteration of standard burner head of A.A.S. in relation to the light beam of the examined metal. Metals examined in this study were mercury, lead, cadmium, copper and zinc. Sample preparations and analysis were carried out according to Analytical Methods for Atomic Absorption Spectrophotometer (1982).

RESULTS AND DISCUSSION

Pollution of food with heavy metals has become a serious health concern during the recent years. Food borne heavy metal intoxications are mostly limited to long-term consumption of food from environments that contain high levels of toxic metal pollutants. Mercury is an extremely toxic metal in all its forms, it is a cumulative poison because of high affinity of tissue to it. It inhibits enzyme activities and causes kidney damage in both man and animals (Timbrell, 1982).

The analytical results listed in table (1) revealed that the mean concentration of mercury in hen's meat and

eggs of examined localities exceeded the permissible limit (Kluge Berge et al., 1992) 0.5 ppm where these concentrations were 1.12 ± 0.30 , 1.21 ± 0.60 , 1.31 ± 0.58 and 1.99 ± 0.29 for meat and 4.91 ± 1.72 , 6.11 ± 1.17 , 5.11 ± 0.48 and 6.88 ± 1.44 for eggs in El-Nobaria, Damanhour, Rasheid and Desouk respectively. Similarly the mean mercury levels in feed and water exceeded the permissible limit indicated by W.H.O. (1984) [0.001 ppm for water] and Egyptian standard (1993) [0.05 ppm for feed]. A correlation between mercury level in hen's meat and eggs and its concentration in water and feed was observed, where the highest concentration of mercury in hen's meat and eggs like in water and feed were existed in Desouk followed by Damanhour, Rasheid and El-Nobaria.

Residues of mercury in hen's meat and eggs had been reported by many investigators (Becker and Sperveslage, 1989; Kambamanoli-Dimou et al., 1989; Leonzio and Massi, 1989; Abd El-Kader, 1994 and Abd El-Kader and El-Atabany, 1994). Such residues may be arise from rations which contain fish and meat meal or treated cereal grains beside mercury may be dissolved out of the plastic troughs or pipes (F.A.O. and W.H.O., 1972).

Lead is unknown to be essential for the functioning of biological systems and the general view is that where possible the exposure to lead showed be kept as low as possible like mercury, lead is retained in the organs for a long time, that is to say it is accumulative poison. Chronic lead poisoning is characterized by neurological defects, renal tubular dysfunction and anaemia also it has potential carcinogenic effect (Underwood, 1977 and Zawurska and Medras, 1988).

Pearson (1976) set a guide line value of 2 ppm to be the permissible limit of lead in food, accordingly the level of lead in the eggs obtained from all examined localities exceeded this limit, while the level of lead in hen's meat collected from the same localities was high but still within the permissible limit. On the other hand, German guide line of lead in animal tissues is 0.5 ppm (Kluge-Berge et al., 1992). Accordingly, the level in examined hen's tisexceeded this limit. These figures parallel to the level of lead in examined feed and water samples where the highest concentration of lead was recorded in water and feed samples collected from the same localities, table (1).

Cadmium is virtually absent from the human body at birth and it is a cumulative poison like mercury and

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lead (Commission of the European Communities, 1978 and Gracey and Collins, 1992). It is one of the most toxic metals. Moreover, the use of cadmium by industry has resulted in the contamination of the environment and food chain (Engberg and Bro-Rasmussen, 1974; Underwood, 1977; Mortvedt and Osborn, 1982 and Tsalev and Zaprianov, 1983).

The results presented in table (1) revealed that highest concentrations of cadmium was found in meat and egg samples obtained from Desouk followed by Damanhour, El-Nobarria and Rasheid. Hen's meat and eggs obtained from all localities showed cadmium concentration over the permissible limit indicated by Kluge-Berge et al. (1992) [0.5 ppm]. Also there was a linear relationship between cadmium level in water and feed and its residue in hen's meat and eggs. The high level of cadmium in feed and water resulted from absorption of cadmium from contaminated soil through important food crops especially wheat, corn and rice (Schroeder and Balassa, 1961). It is a waste by-product of many industrial processes, and is also a contaminant in superphosphate fertilizers and urban sewage sludges used to fertilize pastures or crops (Kostial, 1986).

The high cadmium level in hen's

meat and eggs should be considered with great care because many studies revealed that cadmium had a significant role in the incidence of some diseases e.g. diabetes mellitus (Merali and Singhal, 1977); chronic renal failure (Friberge, 1984); human hypertension (Nishiyama et al., 1986) and anaemia (Watanabe and Murayama, 1974).

Copper is an essential element having roles in formation of erythrocyte, release of tissue iron, development of bone, C.N.S. and connective tissue. It is also required for normal biological activity of many enzymes (Evans, 1973). On the other hand, an excess of copper can be extremely toxic because of its affinity to sulfhydryl groups (Evans, 1971). Also excessive intake of copper results in accumulation in liver and hence become a threat to man (Polprasert, 1982 and Forstner and Wittmann, 1983). Also abnormally high liver copper levels are characteristic of a number of diseases in man, these include Mediterranean anaemia, hemochromatosis, cirrhosis and yellow atrophy of the liver, severe chronic diseases accompanied by anaemia and Wilson's disease (hepatolenticular degeneration) (Underwood, 1977). Moreover, copper interacts with cadmium, iron, lead, mercury, silver and sulfide

Table (1): Association between heavy metals content of water and feed and their residues in hen's meat and eggs.

Source of samples	Mercury (ppm)					Lead (ppm)					Cadmium (ppm)					Copper (ppm)					Zinc (ppm)				
	Feed	Water	Tissues	Eggs		Feed	Water	Tissues	Eggs		Feed	Water	Tissues	Eggs		Feed	Water	Tissues	Eggs		Feed	Water	Tissues	Eggs	
El-Nobaria	2.19±	0.180±	1.12±	4.91±	2.33±	0.11±	0.52±	3.56±	1.20±	0.04±	0.61±	1.81±	0.82±	0.33±	0.43±	0.99±	ND	ND	0.13±	0.18±					
	0.83	0.77	0.30	1.72	0.52	0.02	0.01	0.89	0.66	0.006	0.02	0.88	0.07	0.02	0.22	0.25			0.09	0.05					
Dammanhour	3.20±	0.211±	1.21±	6.11±	2.82±	0.18±	0.56±	3.11±	1.40±	0.09±	0.73±	1.90±	0.61±	0.39±	0.68±	0.89±	ND	3.21±	0.26±	2.10±					
	1.22	0.097	0.60	1.17	0.61	0.04	0.11	0.97	0.78	0.037	0.13	0.36	0.33	0.03	0.15	0.18		1.03	0.07	0.91					
Rasheid	4.98±	0.272±	1.31±	5.11±	2.12±	0.37±	0.66±	3.88±	1.25±	0.03±	0.53±	1.52±	2.98±	1.30±	0.81±	1.40±	1.00±	2.36±	0.15±	2.10±					
	1.16	0.038	0.58	0.48	0.32	0.03	0.03	1.02	0.20	0.001	0.22	0.35	0.97	0.57	0.46	0.96	0.67	0.87	0.03	0.97					
Desouk	4.55±	0.281±	1.99±	6.88±	2.33±	0.26±	0.58±	3.20±	1.60±	0.06±	0.76±	1.96±	0.31±	ND	0.46±	0.58±	3.16±	0.18±	0.18±	5.88±					
	1.93	0.14	0.29	1.44	0.11	0.09	0.02	0.99	0.65	0.020	0.31	0.27	0.01		0.14	0.02	0.88	0.01	0.01	1.36					

ND = Not detectable.

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Table (2):

	Recommended guideline values (ppm)		
	Water (WHO, 1989) Feed	Egyptian standard (1993)	Food
Mercury	0.001	0.05	0.50
Lead	0.050	0.50	0.50
Cadmium	0.005	0.10	0.50
Copper	1.000	--	--
Zinc	5.000	--	--
	Daily intake (mg/kg b.wt.)	Weekly intake (mg/kg b.wt.)	
Mercury	--	0.005	The provisional tolerable daily and weekly intake of heavy metals in food established by Egyptian standard (1993) and by the joint FAO/WHO Expert Committee on Food (1989)
Lead	--	0.050 for adult 0.250 for children	
Cadmium	--	0.0067-0.0083	
Copper	0.05-0.50	--	
Zinc	0.30-1.00	--	

(Evans, 1971).

Our results recorded in Table (1) revealed that copper level accumulation in hen's meat and eggs was not so remarkable, also the copper level in feed and water is also under permissible limit as indicated in Table (2). However, copper level in hen's meat and eggs was high in Rasheid where feed and water pollution with copper was more pronounced (Table, 1). Such findings may be explained on the basis that copper does not accumulate in food chain, also copper occurs in food in many chemical forms and combinations which affects its availability to man and animals. Several inorganic dietary factors markedly affect copper absorption, retention and distribution within the body.

Zinc is biologically essential trace element for man and animal and transported and utilized in living animals as metal proteins or metal complexes (Underwood, 1977). In similarity to copper, zinc also interacts calcium, cadmium, iron, copper and manganese (Pories et al., 1973).

Table (1) showed that non of the examined hen's meat and egg samples in the localities under investigation exceeded the permissible limit of zinc in food, also the same table indicated that zinc level in water is also under the permissible limit as

indicated in Table (2). However, there was an association between zinc concentration in water and feed and its residue in hen's meat and eggs. In similarity to copper, zinc does not accumulate in tissues (Heth, 1966). Therefore chronic zinc toxicity from dietary sources are not hazard to man.

It was concluded that an association between heavy metal residues in hen's meat and eggs and their content in feed and water, hence hen's eggs may be used as an indicator of environmental pollution which agrees with the conclusion of Fimreite (1979), Leonzio and Massi (1989) and Kambamanoli-Dimou et al. (1989 & 1991).

Also in the light of the results obtained from the present study, it could be concluded that pollution of egg samples with various heavy metals residues in different concentration above the permissible limit may act as a kind of health hazard. Since eggs provide a unique well balanced source of nutrients for human of all ages due to their high quality of protein, unsaturated fatty acids, iron, phosphorus, vitamins and trace elements in addition to their availability at modest cost, ease of preparation and popular taste (Stadelman and Cotterill, 1973). Subsequently we suggested recommended points that

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must be taken into consideration which include avoidance of pollution of feed and water supplies with heavy metals, in addition, periodical examination of feed and water supplies should be done and assessed according to the International Standards. Also periodical examination should be done for eggs and other food and their load of heavy metals should be evaluated according to the international guidelines as a prophylactic means to conserve the human health.

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الملخص العربي

"بقايا المعادن الثقيلة في لحم و بيض الدجاج و تأثيرها بالتلوث البيئي"

**

*

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**كلية الطب البيطرى بمشتهر

جمعت ٤٠ عينة من كل لحم و بيض الدجاج من ٤ مناطق من جمهورية مصر العربية و فى نفس الوقت جمعت ٤٠ عينة من كل من المياه و العليقة من نفس المناطق بواقع ١٠ عينات عشوائية من المزارع المختلفة من كل منطقة . و قد تم تجهيز العينات لقياس بقايا الزئبق و الرصاص و الكاديوم و النحاس و الزنك و ذلك بواسطة جهاز الامتصاص الذرى الطيفى . و قد أسفر تحليل العينات عن وجود علاقة طردية بين مستويات المعادن الثقيلة فى لحم و بيض الدجاج و تركيزاتها فى المياه و العليقة و بالتالى يمكن استخدام بيض الدجاج كمؤشر للتلوث البيئى بالمعادن الثقيلة.

و قد قيمت النتائج طبقا للمعايير الدولية و دلت النتائج على تواجد بعض العناصر الثقيلة فى بيض و لحم الدجاج بتركيزات أعلى من المسموح به مما يشكل خطورة على صحة الإنسان و قد نوقشت طرق التحكم المختلفة لمنع تلوث المياه و العليقة لعدم حدوث مثل هذه المشاكل الخطيرة حفاظا على صحة الإنسان.