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Comparative Study Between The Levels of Some Heavy Metals in Balady Eggs and foreign breed Eggs

Neveen H Abo El-Enaen, Salah-El-Dein W M and Enas M Sami

ABSTRACT

A total of 300 egg samples of balady and the foreign breed eggs (150 for each) were collected from Zagazig city markets during summer 2009 for detection and determination of lead cadmium, manganese, zinc and copper residues and comparing between the residues of these metals in the mentioned examined two egg types. The obtained results revealed that the mean residues of the estimated heavy metals were 0.233, 0.0266, 2.10, 31.84 and 4.58 ppm for lead, cadmium, manganese zinc and copper respectively in the examined balady egg samples; while, in the foreign breed eggs the mean residues of the mentioned heavy metals were 0.156, 0.015, 0.86, 18.04 and 2.636 ppm respectively.

All the estimated heavy metals recorded higher concentrations in eggs produced from the balady flocks than those from the foreign breed flocks. The difference between the two examined egg types in the essential metals (manganese, zinc and copper) was statistically significant. Meanwhile, the non essential heavy metals (lead and cadmium) recorded insignificant higher levels in balady eggs rather than the other examined egg type. The relatively high levels of the examined heavy metals in the balady eggs than those in the foreign breed eggs may be explained by the higher production of the foreign breed flocks than those in balady flocks, and consequently the conversion rate of feed in the foreign breed flocks is higher than those in the balady flocks, it means that the allowance of each balady egg from the feed and feed pollutants in higher than those in the foreign breed egg.

The estimated heavy metals in the examined egg samples recorded low safety levels in most samples of both balady and foreign breed eggs, only few samples exceeded the permissible limits. Also, the calculated daily intake of the estimated metals from the examined egg samples contributed safety and very low rate.

INTRODUCTIN

The effect of environmental pollution on the contamination of foods and on their safety for human consumption is a serious global public concern *(1)*. Heavy metals are unique among pollutants that cause adverse health effect, in that they occur naturally and in many instances ubiquitous in the environment, regardless of how metals are used in the consumer products or industrial processes. Small level of human exposure is in most instances, inevitable. Many heavy metals are biologically essential as manganese, zinc and copper; but, become toxic by exposure to high doses. Moreover, they have the tendency of bioaccumulation in tissues of birds and animals. The common sources of these metals are effluents discharged from metal processing factories, mining products, chemical and sewage sludge effluents *(2)*. Organic manure and decaying plant and animal residues are considerable sources of these pollutants *(3)*. Furthermore, 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)*.

Eggs are important source of the animal protein in the human diet. An egg is composed of about 11% proteins. Further it contains all the amino acids necessary for body metabolism. This makes eggs an essential part of the diet of those who wish to increase weight and build muscles *(6)*. Most of the proteins are concentrated in the white part of the egg, known as albumin or egg white. Furthermore, Eggs are rich in vitamin B, especially vitamin B12, vitamin A, vitamin D, vitamin E and vitamin K. It should be noted that very few food items that contain vitamin D. Furthermore, eggs are rich in essential minerals as calcium, phosphorus, iodine, zinc and iron *(6)*.

In the Egyptian markets, there are two sources of the table eggs; the first one comes from the native breed flocks which called balady breeds. Although many consumers preferred this type of eggs, the egg productions of the balady flocks are relatively few in number and the egg is small in size. Meanwhile the second source of the eggs is the foreign breeds flocks of the foreign breeds which carry the names of the famous international poultry companies, these flocks give a profuse egg production and relatively large egg size, thus; it represented the most displayed eggs in the Egyptian markets.

Because there are many differences between the circumstances of the production of the two mentioned egg types, the difference between their environmental pollutions with the heavy metals is expected. Therefore, the aim in the current study was to compare between the balady and foreign breed eggs in the levels of some diffused important heavy metals (lead, cadmium, manganese, zinc and copper).

MATERIAL AND METHODS

Collection of samples

A total of 300 egg samples of balady and layer eggs (150 for each) were collected from Zagazig city markets during summer 2009. Each 5 eggs from the same source and collected at the same time were represented as one sample. Egg samples were packed, identified and transferred carefully to the laboratory and stored in the refrigerator at 4- 8 °C till the analysis was conducted *(7)*.

Preparation of samples

The whole albumen and yolk of the each 5 eggs (which represented one sample) were blended with a high speed blender for 5 minutes. Five gm of sub-sample from the blended eggs were taken for analysis. Ten ml conc. nitric acid and 5 ml conc. sulphuric acid were added to the sample and digestion was completed. The digest was diluted to 100 ml deionized water and filtered. The clear filtrate was kept in refrigerator to avoid evaporation *(7)*.

Preparation of blank solution

Blank solution consists of 10 ml. of nitric acid and 5 ml. sulphuric acid was subjected to digestion, dilution and filtration as previously mentioned in the preparation of the examined egg samples to detect any trace of the studied metals in acids or deionized water used.

Quantitative determination of the examined metal residues

Quantitative determination of lead, cadmium, manganese, zinc and copper residues was conducted by using UNICAM 969 Atomic Absorption Spectrophotometer in toxicology unit, Animal Health Research Institute. The concentrations of metals (ppm) in the examined samples were calculated according the following equation *(7)*:

Concentration of metal in samples = $\frac{AxB}{W}$, where A= metal concentration (ppm) in the prepared sample from the digital scale reading of Atomic Absorption Spectrophotometer, B= the final volume of the prepared sample, W= weight of sample in gram.

Statistical analysis

Statistical analysis of data was conducted using "Statistic for animal and veterinary science" *(8)*.

RESULTS AND DISCUSSION

Results achieved in Table 1 showed the comparison between the heavy metal residues (ppm) in balady eggs and foreign breed eggs. It is clear that all the estimated heavy metals recorded higher concentrations in eggs produced from the balady flocks than those from the foreign breed flocks. The differences between the two egg types were significance in manganese, zinc and copper levels. Meanwhile, the differences were insignificance about both lead and cadmium residues. The comparison between our estimations and the previous results was declared in Table 2. This comparison exhibited that, although our estimations recorded lower metal levels than those previously Egyptian record *(9)* and recent Indian *(14)* studies, the metal concentrations in the present study were higher than those in the most foreigner investigations. These differences attributed to the environmental circumstances which varied from country to other.

Table 1. Comparison between the heavy metal residues (ppm) in balady eggs and foreign breed eggs .

Egg type / Metal*	Balady eggs			Foreign breed eggs		
	Range	Mean	±S.E.	Range	Mean	±S.E.
Lead	N.D.- 1.2	0.233	0.061	N.D.- 1.4	0.156	0.0533
Cadmium	N.D.- 0.23	0.0266	0.009	N.D.- 0.08	0.015	0.0044
Manganese	0.1- 5.5	2.10[a]	0.228	0.1- 3.1	0.86[b]	0.108
Zinc	4.8- 49.6	31.84[a]	2.3184	2.3- 40.8	18.04[b]	1.737
Copper	2.0- 6.9	4.58[a]	0.2993	N.D.- 5.5	2.636[b]	0.3117

N.B.: Different letters within the same raw mean highly significant variations between the values of the metal concentrations ($P \leq 0.01$).
*Sixty eggs were used for analysis of each metals , 30 from each egg species

Table 2. Mean concentrations (ppm) of the heavy metal residues in the present study compared with previous results of the published studies.

Result / Metal	Present study		Coincided with our estimations	Exceeded our estimations	Below our estimations
	Balady eggs	Foreign breed			
Lead	0.233	0.156	-	1.9 in Egypt *(9)*	0.081 in Kuwait *(1)* 0.06 in Slovenia *(10)*
Cadmium	0.0266	0.015	0.03 in Slovenia *(10)*	0.99 in Egypt *(9)*	0.007 in Kuwait *(1)* 0.0005 in Belgium *(11)* 0.0014 in Greece*(12)*
Manganes e	2.10	0.86	1.1 in USA *(13)* 0.96 in India *(14)*	-	1.1 in USA*(13)* 0.96 in India*(14)*
Zinc	31.84	18.04	24.2 in USA *(13)* (19.2- 20.3) Belgium *(11)*	102.8 ppm in India*(14)*	24.2 in USA *(13)* (19.2- 20.3)Belgium *(11)* (10- 12 ppm) Spain *(15)*
Copper	4.58	2.636	-	-	0.9 in USA *(13)* (0.56- 0.7) Spain *(15)* (0.43- 0.52) Belgium *(11)* 1.2 in India *(14)*

Frequency distribution of the estimated heavy metals showed in Table 3, which indicates that the lead residues were not detected in 11 (36.6%) and 15 (50%) out of the examined balady and foreign breed egg samples respectively, these residues exceeded the permissible limit in 6 (20%) and 3 (10%) in the mentioned two examined types of eggs respectively. On the other hand, cadmium residues were not detected in 16 (53.3%) in both balady and foreign breed egg samples, also; 7 (23.3%) and 6 (20%) out of the two mentioned examined egg samples respectively were higher than the cadmium permissible limit. Manganese, zinc and copper residues were detected in all the examined egg samples except 3 (10%) out of the foreign breed egg samples were not contained copper residues. On the other aspect, zinc and copper residues were below the permissible limits in all the examined egg samples. Meanwhile, manganese permissible limit was not judged in the available standards.

Table 3. Frequency distribution of the heavy metal concentrations in balady eggs and foreign breed eggs

Egg type / Metal#	P.L.** (ppm)	Balady eggs						Foreign breed eggs					
		Not Detected		Within P.L.		Over P.L.		Not Detected		Within P.L		Over P.L.	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Lead	0.3(16)	11	36.6	13	43.3	6	20	15	50	12	40	3	10
Cadmium	0.02(16)	16	53.3	7	23.3	7	23.3	16	53.3	8	26.6	6	20
Manganes*	-	0.0	0.0	-	-	-	-	0.0	0.0	-	-	-	-
Zinc	50(17)	0.0	0.0	30	100	0.0	0.0	0.0	0.0	30	100	0.0	0.0
Copper	20(17)	0.0	0.0	30	100	0.0	0.0	3	10	27	90	0.0	0.0

*: Permissible limit of manganese in table eggs is not judged in any available standard.
**: P.L.= Permissible Limit.
#Sixty eggs were used for analysis of each metals , 30 from each egg species

Table 4. Comparison of acceptable daily intake (ADI) values of the detected metals with calculated daily intake from the examined balady eggs and foreign breed eggs.

Metal	ADI mg/ 70 kg / person *(18)*	Mean conc. Of the metals in the present study (mg/kg)		Calculated daily intake from consumption of 100 gm. egg daily *(19)*			
				Balady eggs		Foreign breed eggs	
		Balady eggs	Foreign breed eggs	mg/day /person	%	mg/day /person	%
Lead	0.50	0.233	0.156	0.0233	4.66	0.0156	3.12
Cadmium	0.07	0.0266	0.015	0.00266	3.8	0.0015	2.14
Manganese	5.0	2.10	0.86	0.21	4.2	0.086	1.72
Zinc	70.00	31.84	18.04	3.18	4.5	1.0804	1.5
Copper	35.00	4.58	2.636	0.458	1.3	0.2636	0.75

Table 4 indicates that the previously mentioned average concentrations of lead, cadmium, manganese, zinc and copper in the examined balady egg samples gave a daily intake of about 0.0233, 0.00266, 0.21, 3.18 and 0.458 mg/ person of the mentioned metals respectively for egg consumers (100 gm/ person) *(19)* and this contribute of about 4.66%, 3.8%, 4.2%, 4.5% and 1.3 % of the acceptable daily intake (ADI) recommended by FAO/ WHO *(18)* respectively. Meanwhile; the mean values of lead, cadmium, manganese, zinc and copper residues in the examined egg samples from the foreign breed flocks gave a daily intake of about 0.0156, 0.0015, 0.086, 1.0804 and 0.2636 mg/ person respectively, and this contributed to about 3.12%, 2.14,% 1.72%, 1.5% and 0.75% of the acceptable daily intake (ADI) recommended by FAO/ WHO respectively. The obtained results revealed that, all the estimated heavy metals in this study recorded higher calculated daily intake from the consumption of balady eggs than those from the foreign breed eggs. On the other hand, although these results indicated low levels of the calculated daily intake of the tested heavy metal which reach to the consumer body via the egg consumption, another study in Taiwan *(20)* recorded lower levels than our figures in duck eggs, they estimated 0.0017, 0.0001 and 0.040 mg/person/day of lead, cadmium and copper respectively .

From the obtained results of the present investigation, it is evident that all the estimated heavy metals recorded higher concentrations in eggs produced from the balady flocks than those from the foreign breed flocks. This result may be explained by the higher production of the foreign breed flocks than those in balady flocks, and consequently the conversion rate of feed in the foreign breed flocks is higher than those in the balady flocks, it means that the allowance of each balady egg from the feed and feed pollutants is higher than those the allowance of the foreign breed egg. On the other hand, the differences between the two examined egg types in the essential metal levels (manganese, zinc and copper) were statistically significant because these metals were added to the poultry feed; and subsequently accumulated continuously in eggs; thus, the difference between these metals in the two examined egg types become clear and significant. On contrarily, the non essential heavy metals (lead and cadmium) absolutely were not added to the poultry feed; consequently, these metals were not detected in many examined egg samples as exhibited in Table 3. Therefore, the repetition of not detected lead and cadmium residues leads to – statistically - non significant variations between the two examined egg types *(21)*.

In general, the estimated heavy metals in the examined egg samples recorded low safety levels in the most of samples of both balady and foreign breed eggs, only few samples exceeded the permissible limits. Also, the calculated daily intake of the estimated metals from the egg production contributed very low and safety rate.

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الملخص العربي

دراسة مقارنة بين مستويات المعادن الثقيلة في البيض البلدي و بيض قطعان دجاج البياض التجارية

نيفين حسن إسماعيل أبو العينين – وائل محمد صلاح الدين – إيناس محمود سامي
معهد بحوث صحة الحيوان – معمل الزقازيق الفرعى (وحدة صحة الأغذية)

تم إجراء هذه الدراسة للمقارنة بين متبقيات بعض أهم المعادن الثقيلة في البيض البلدي و بيض قطعان البياض التجارية، تم تجميع عدد ٣٠٠ بيضة (١٥٠ من كل نوع من النوعين المذكورين) و تم أخذ كل ٥ بيضات من نفس المصدر و اعتبارهم كعينة واحدة. تم هضم العينات و إعدادها للقياس و قياسها بجهاز الامتصاص الذري و قد أسفرت الدراسة عن النتائج التالية.

كان متوسط متبقيات المعادن الثقيلة في عينات البيض البلدي٠,٢٣٣ ، ٠,٠٢٦٦ ، ٢,١ ، ٣١,٨٤ ، ٤,٥٨ جزء في المليون للرصاص ، الكادميوم، المنجنيز، الزنك و النحاس على التوالي، في حين كان متوسط متبقيات نفس العناصر سابقة الذكر في بيض قطعان دجاج البياض التجارية ٠,١٥٦ ، ٠,٠١٥ ، ٠,٨٦ ، ١٨,٠٤، ٢,٦٣٦ جزء في المليون على التوالي. من النتائج السابقة يتضح أن كل المعادن الثقيلة محل الاختبار كانت أعلي في بيض الدجاج البلدي عنها في بيض قطعان البياض التجارية، و قد كانت الزيادة معنوية فيم يخص المنجنيز، الزنك و النحاس، في حين لم تكن تلك الزيادة معنوية في فيما يخص الرصاص و الكادميوم، و تعزي زيادة تركيز المعادن الثقيلة في بيض البلدي عنه في بيض قطعان البياض التجارية لارتفاع معدل التحويل الغذائي في نوع البيض المذكور مؤخرا عن النوع الأول (البلدي) مما يجعل نصيب كل بيضة من الأعلاف و بالتالي من الملوثات الموجودة في تلك الأعلاف في بيض البلدي أعلي منه في بيض قطعان البياض. أما سبب وضوح و معنوية الفوارق فيم يخص العناصر الضرورية (المنجنيز، الزنك و النحاس) و عدم معنوية الفارق في العناصر الغير ضرورية (الرصاص و الكادميوم) فذلك يرجع لوضع العناصر الضرورية في الأعلاف الخاصة بالبياض و هذا لا يحدث بالطبع مع العناصر الغير ضرورية، مما يجعل الصورة أكثر وضوحا في الحالة الأولي.

فيم يتعلق بمقارنة النتائج بالحدود القصوى المسموح بها كانت بقايا الزنك و النحاس في الحدود المسموح بها في كل العينات، في حين تعدي عدد قليل جدا من العينات الحدود القصوى للرصاص و الكادميوم، و لم تتوافر الحدود القصوى الموصي بها للمنجنيز في المواصفات القياسية المتاحة. من ناحية أخرى سجل المأخوذ اليومي للمعادن الثقيلة من استهلاك البيض في ضوء نتائج الدراسة معدلات آمنة و منخفضة جدا مقارنة بالمأخوذ اليومي المسموح به من المعادن الثقيلة – بالرغم من وجود عدد قليل من العينات تعدي الحدود القصوى– كما ذكرنا سالفا، مما يشير لوجود العينات في الحدود الآمنة للاستهلاك الآدمي في ضوء نتائج الدراسة.