Heavy metals residue in some chicken meat products

Faten S. Hassanin[1], Hassan M. A[1], Amira M. Mahmoud [2], Enas A. Mohamed[2]

[1] Department of Food Control, Fac. of Vet. Med., Benha Univ., Egypt. [2]Animal Health Research Institute (Benha branch), Egypt.

A B S T R A C T

A grand total of 120 random samples of chicken meat products represented by chicken pane, chicken nuggets, chicken sheish tawook and chicken kofta (30 of each) were collected from different super markets at El-Kalyoubia governorate. The collected samples were produced by two different poultry processing plants namely A and B. In other words, each chicken meat product was represented by 15 samples related to the processing plant A and 15 ones related to the processing plant B. The samples were directly transferred to the laboratory for determination of their contents of cadmium, copper and mercury. The obtained results indicated that the mean values of cadmium concentration in the examined samples of chicken pane, chicken nuggets, chicken sheish tawook and chicken kofta were 0.06 ± 0.01, 0.13 ± 0.01, 0.17 ± 0.01 and 0.25 ± 0.02 mg/kg, respectively for plant A. While mean values for plant B were 0.11 ± 0.01, 0.19 ± 0.01, 0.26 ± 0.02 and 0.38 ± 0.02 mg/kg, respectively. Also the obtained results indicated that the mean values of copper concentration in the examined samples of chicken pane, chicken nuggets, chicken sheish tawook and chicken kofta were 1.12 ± 0.08, 1.48 ± 0.13, 0.99 ± 0.07 and 2.03 ± 0.16 at plant A, respectively, and 1.31 ± 0.12, 1.68 ± 0.15,1.24 ± 0.10 and 2.17 ± 0.18 at plant B, respectively. Furthermore, the obtained results indicated that the mean values of mercury content in the examined samples of chicken pane, chicken nuggets, chicken sheish tawook and chicken kofta were 0.015 ± 0.01, 0.17 ± 0.01, 0.22 ± 0.02 and 0.31 ± 0.02 mg/kg at plant A, respectively, and 0.18 ± 0.01, 0 .26 ± 0.01, 0.29 ± 0.02 and 0 .35 ± 0.02 mg/kg at plant B, respectively.

Keywords: Heavy metals, Chicken products.

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1. INTRODUCTION

Chicken meat constitutes an excellent source of high quality animal protein for feeding infants, young children, adults and convalescents. Because of its high meat yield, low shrinkage during cooking, ease of cooking and serving, and low cost, it fits well into the menu of food service (Zhang et al., 2001). With the progress of meat technology, the utilization of chicken meat in the form of chicken products makes it possible for the consumer to eat chicken meat in different forms and renders the processor to convert the various types of meat into unified products in different shapes, easily handled, stored and rapidly used (Pearson and Gillette, 1996). Today, the environmental pollution by heavy metals is considered as one of the most serious problems in the world over the last few decades. Emissions of heavy metals to the environment occur via a wide range of pathways, including air, water and soil (Järup, 2003). With respect to human health impacts, cadmium, copper and mercury are of primary concern because of their known toxicity to human being (Levensen and Barnard, 1988). Cadmium is classified as a probable human carcinogen. Chronic

exposure to cadmium is also associated with a wide range of other diseases, including heart disease, anemia, skeletal weakness, depressed immune system response, kidney and liver disease (Codex Alimentarius Commission Procedural Manual, 2001). Copper is known to be essential at low concentrations, but toxic at high levels. However, ingestion of excessive doses of copper may lead to severe nausea, bloody diarrhea, hypotension and jaundice (Gossel and Bricker, 1990). Mercury was used as fungicides seed dressing. Toxic compounds of mercury accumulate in animal tissues (Underwood, 1977). The present work was carried out to determine the residual concentrations of cadmium, copper and mercury in some chicken meat products (chicken pane, chicken nuggets, chicken shiesh tawook and chicken kofta), produced by two different poultry processing plants.

2. MATERIAL AND METHODS

2.1. Collection of Samples:

A grand total of 120 random samples of chicken meat products represented by chicken pane, chicken nuggets, chicken shiesh tawook and chicken kofta (30 of each) were collected from different super markets at El-Kalyoubia governorate. The collected samples were produced by two different poultry processing plants namely A and B. In other words, each chicken meat product was represented by 15 samples related to the processing plant A and 15 samples related to the processing plant B. The samples were directly transferred to the laboratory for determination of their contents of cadmium, copper and mercury.

2.2. Determination of Heavy Metal Residues:

2.2.1. Washing procedure:

The trials recommended by Shibamoto and Bjeldanes (1993).

2.2.2. Digestion Procedure:

2.2.2.1. Preparation of samples for the estimation of cadmium and copper (according to Finerty et al., 1990)

2.2.2.2. *Preparation of samples for the estimation of mercury* (according to Diaz et al., 1994)

2.2.3. Preparation of blank and standard solution.

2.2.4. Determination and Analysis.

The concentration of heavy metals in the digested samples, blank and standard solutions were determined by using Atomic Absorption Spectrophotometer (AAS) (UNICAM 969 AA Spectrophotometer) which was adjusted at 228.8 nm for cadmium, 324.8 nm for copper and 253.7 nm for mercury. Absorbance and concentration were recorded on the digital scale of AAS.

2.2.5. Calculation and Quantitative determination of heavy metals:

Metal concentration (mg/kg) wet weight = C x V/W

Where C is the concentration of the metal in the sample extract as determined by AAS (mg/L), V is the volume of the extract (ml) and W is the weight of the sample (g).

3. RESULTS

Results achieved in table (1) revealed that the concentrations of cadmium in the examined samples of chicken pane, chicken nuggets, chicken sheish tawook and chicken kofta with a mean value were 0.06 ± 0.01, 0.13 ± 0.01, 0.17 ± 0.01 and 0.25 ± 0.02, respectively for plant A. While mean values for plant B were 0.11 ± 0.01, 0.19 ± 0.01, 0.26 ± 0.02 and 0.38 ± 0.02, respectively. The differences between the examined samples of chicken meat products were highly significant ($p < 0.01$) according to their cadmium content. Concerning the cadmium level, table (2) declared that 6.67%, 13.33% ,13.33 % and 33.33% at

plant A , and 13.33%,13.33%, 20.00 % and 33.33 at plant B, of the examined samples of chicken pane, chicken nuggets, chicken sheish tawook and chicken kofta, respectively, exceeded the safe permissible limit recommended by EOS (2005) for cadmium in chicken meat products (0.5 ppm), Regarding to copper level, table (3) indicated that the mean levels of copper in the examined samples of chicken pane, chicken nuggets, chicken sheish tawook and chicken kofta were 1.12 ± 0.08, 1.48 ± 0.13, 0.99 ± 0.07 mg/kg and 2.03 ± 0.16 at plant A, respectively, and 1.31 ± 0.12, 1.68 ± 0.15,1.24 ± 0.10 and 2.17 ± 0.18 at plant B, respectively. The differences between the examined samples of chicken meat products were high significant ($p < 0.01$) according to their copper content. Table (4) showed that all the examined samples of chicken pane, chicken nuggets, chicken sheish tawook and chicken kofta , produced at both plant A and plant B were accepted based on their copper content according to Food stuffs Cosmetics and Disinfectant (2002).

The results presented in table (5) revealed that the mean values of mercury in the examined samples of chicken pane, chicken nuggets, chicken sheish tawook and chicken kofta were 0.015 ± 0.01, 0.17 ± 0.01, 0.22 ± 0.02 mg/kg and 0.31 ± 0.02 at plant A, respectively, and 0.18 ± 0.01, 0.26 ± 0.01, 0.29 ± 0.02 and 0.35 ± 0.02 at plant B, respectively. The differences between the examined samples of chicken meat products were highly significant ($p < 0.01$) according to their mercury content. According to the safe permissible limit stipulated by EOS (2005) for mercury in chicken meat products (0.5 mg/kg), it was indicated that all the examined samples of chicken pane, chicken nuggets and chicken sheish tawook were accepted, on the other hand, 6.67% of the examined chicken kofta samples were unacceptable at plant A. It was reported that in plant B all the examined samples of chicken pane and chicken nuggets were accepted, while 6.67% and 13.33% of the examined chicken shiesh tawook and chicken kofta samples, respectively as shown in table (6).

Table (1): Statistical analytical results of cadmium levels (mg/kg) in the examined samples of chicken meat products (n=15).

Processing plant / Product	A			B		
	Min.	Max.	Mean ± S.E	Min.	Max.	Mean ± S.E*
Chicken pane	0.01	0.15	0.06 ± 0.01	0.01	0.23	0.11 ± 0.01^{++}
Chicken nuggets	0.01	0.24	0.13 ± 0.01	0.02	0.37	0.19 ± 0.01
Chicken shiesh tawook	0.02	0.33	0.17 ± 0.01	0.02	0.51	0.26 ± 0.02
Chicken kofta	0.03	0.41	0.25 ± 0.02	0.04	0.69	0.38 ± 0.02

S.E*= Standard error of mean.
++ = High significant differences ($P<0.01$).

Table (2): Acceptability of the examined samples of chicken meat products based on their levels of cadmium (n=15).

Chicken meat products	Maximum Permissible Limit (mg/kg)*	Positive samples		Unaccepted Samples	
		No.	%	No.	%
Plant A:					
Chicken pane	0.05	3	20.00	1	6.67
Chicken nuggets	0.05	4	26.67	2	13.33
Chicken shiesh tawook	0.05	6	40.00	2	13.33
Chicken kofta	0.05	6	40.00	4	33.33
Plant B:					
Chicken pane	0.05	4	26.67	2	13.33
Chicken nuggets	0.05	5	33.33	2	13.33
Chicken shiesh tawook	0.05	7	46.67	3	20.00
Chicken kofta	0.05	8	53.33	5	33.33

* Egyptian Organization of Standardization "EOS" (2005)
++ = High significant differences ($P<0.01$)

Table (3): Statistical analytical results of copper levels (mg/kg) in the examined samples of chicken meat products (n=15).

Processing plant	A			B		
Product	Min.	Max.	Mean ± S.E	Min.	Max.	Mean ± S.E*
Chicken pane	0.59	1.84	1.12 ± 0.08	0.65	2.06	$1.31 \pm 0.12^{++}$
Chicken nuggets	0.76	2.35	1.48 ± 0.13	0.91	2.53	1.68 ± 0.15
Chicken shiesh tawook	0.53	1.61	0.99 ± 0.07	0.72	1.87	1.24 ± 0.10
Chicken kofta	0.94	2.88	2.03 ± 0.16	1.01	2.95	2.17 ± 0.18

S.E*= Standard error of mean.
++ = High significant differences (P<0.01)

Table (4): Acceptability of the examined samples of chicken meat products based on their levels of copper (n=15).

Chicken meat products	Maximum Permissible Limit (mg/kg)*	Positive samples		Unaccepted Samples	
		No.	%	No.	%
Plant A:					
Chicken pane	20	15	100	-	-
Chicken nuggets	20	15	100	-	-
Chicken shiesh tawook	20	15	100	-	-
Chicken kofta	20	15	100	-	-
Plant B:					
Chicken pane	20	15	100	-	-
Chicken nuggets	20	15	100	-	-
Chicken shiesh tawook	20	15	100	-	-
Chicken kofta	20	15	100	-	-

* Food Stuffs Cosmetics and Disinfectant Act (2002)

Table (5): Statistical analytical results of mercury levels (mg/kg) in the examined samples of chicken meat products (n=15).

Processing plant / Product	A			B		
	Min.	Max.	Mean ± S.E	Min.	Max.	Mean ± S.E*
Chicken pane	0.08	0.21	0.15 ± 0.01	0.09	0.30	0.18 ± 0.01
Chicken nuggets	0.09	0.28	0.17 ± 0.01	0.09	0.37	0.26 ± 0.01
Chicken shiesh tawook	0.11	0.34	0.22 ± 0.02	0.13	0.55	0.29 ± 0.02
Chicken kofta	0.14	0.52	0.31 ± 0.02	0.17	0.61	0.35 ± 0.02

S.E*= Standard error of mean.
++ = High significant differences (P<0.01)

Table (6): Acceptability of the examined samples of chicken meat products based on their levels of mercury (n=15).

Chicken meat products	Maximum Permissible Limit (mg/kg)*	Positive samples		Unaccepted Samples	
		No.	%	No.	%
Plant A:					
Chicken pane	0.5	2	26.67	-	-
Chicken nuggets	0.5	3	40.00	-	-
Chicken shiesh tawook	0.5	3	46,67	-	-
Chicken kofta	0.5	4	60.00	1	6.67
Plant B:					
Chicken pane	0.5	2	33.33	-	-
Chicken nuggets	0.5	4	53.33	-	-
Chicken shiesh tawook	0.5	5	53.33	1	6.67
Chicken kofta	0.5	5	66.67	2	13.33

* Egyptian Organization of Standardization "EOS" (2005)

4. DISCUSSION

Heavy metals are persistent type of pollutants and cannot be destroyed by heat treatment, so that, their persistence enhances their potential to reach and affect the human being (Levensen and Barnard, 1988).

The obtained results in the present study concluded that the examined samples of chicken kofta were the most contaminated samples with cadmium, copper and mercury followed by those of chicken shiesh tawook, chicken nuggets and chicken pane, respectively.

Chicken kofta samples were more contaminated due to its raw material or the spices which are considered as a source of contamination with heavy metals.

Furthermore, the examined samples of chicken meat products of plant A were safer for human consumption as compared with those of plant B based on their contents of heavy metals.

The recorded results of cadmium levels in table (1) were nearly similar to results which obtained by El-Sakkary (2007), who found that mean values of cadmium were 0.15 ± 0.02 and 0.06 ± 0.01 mg/kg, in examined chicken pane and sheish tawook samples respectively, while lower results were reported by Aiad et al (2007), who found that the mean cadmium levels were 0.047 ±

0.013 and 0.050 ± 0.006 mg/kg, in examined nuggets and chicken fillet samples respectively.

Cadmium is a severe pulmonary and gastrointestinal irritant, which can be fatal if inhaled or ingested. Furthermore, cadmium plays a role in hypertension, diabetes mellitus in human, through injury of adrenal gland, adipose, hepatic, and pancreatic tissue, especially cells within islets of Langerhans, reducing insulin levels, altering glucose metabolism and / or glucose uptake that ultimately results in increased blood glucose (Edwards and Prozialeck, 2009).

Regarding to copper level, table (3) indicated that our results were nearly similler to that obtained by El-Sakkary (2007), who found that the mean values of copper were 2.068 ± 0.32 and 2.05 ±0.19 mg/ kg in examined chicken pane and sheish tawook samples respectively, and lower results were recorded by Aiad et al (2007), who found that the mean values of copper were 0.108±0.004 and 0.058±0.002 mg/ kg in examined nuggets and chicken fillet samples.

Copper is an important constituent in a number of different enzymes in man and animals; it accumulates mostly in muscle and liver acting as essential element, but it may be toxic for both animals and humans when its concentrations crosses the safe limits (Mariam, 1991). Copper compounds causes cirrhosis and liver debilitating condition in continuous ingestion (Muller-Hoccker et al., 1988).

The obtained results of mercury levels were higher than results reported by Aiad et al. (2007), who found that the mean values of mercury were 0.059±0.035 and 0.053±0.006 mg/kg in examind nuggets and chicken fillet samples.

Mercury occurs naturally in the environment in low levels. The main source of mercury comes from industrial sources (Clarkson, 2002).

During recent years, the importance of Hg in the food chain has become better understood. Inorganic, organic mercury derivatives are arising as effluent from industrial processes and converted in the lakes and rivers into soluble methyl mercury. This is carried down to the sea, where it is taken by man and animal through drinking water (Sharkawy and Mohamed, 2003).

In order to control these pollutants to gain access to chicken meat products, and to improve the sanitary status of chicken meat processing, a good quality raw meat should be used in preparations of chicken meat products. Purchase chicken from reputable sources, markets and grocers with a history of providing safe food to customers. High quality spices and additives free from any contaminants should be used. Education and training of food handlers and consumers about harmful effects of chemical residues in foods is the key stone of effective quality control. Application and implementation of hazard analysis and critical control point (HACCP) system may be the appropriate solution to ensure quality and safety of such products particularly during preparation and serving.

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مجلة بنها للعلوم الطبية البيطرية عدد 27 (2): 256-263 ديسمبر 2014

بقايا المعادن الثقيلة في بعض منتجات لحوم الدواجن

فاتن سيد حسانين[1] ، محمد أحمد محمد حسن[1]، أميرة محمد محمود[2]، إيناس عبد الله محمد على[2]
[1]قسم الرقابة الصحية على اللحوم والدواجن والأسماك ومنتجاتها- كلية الطب البيطرى- جامعة بنها.
[2] معهد بحوث صحة الحيوان- بنها.

الملخص العربي

أجريت هذه الدراسة علي 120 عينة عشوائية من منتجات لحوم الدواجن ممثلة فى 30 عينة من كل من منتجات البانية و الناجتس و الشيش طاووق والكفتة من منتجات مصنعين مختلفين (أ،ب) من الأسواق فى محافظة القليوبية. وقد تم تمثيل كل مصنع بعدد 15 عينة من كل نوع من المنتجات السابقة و قد تم فحص متبقيات العناصر الثقيلة (الكادميوم – النحاس – الزئبق) فى هذه المنتجات . وقد دلت نتائج الفحص على ان تركيز عنصر الكادميوم (مجم/كجم) فى البانية، الناجتس، الشيش طاووق والكفتة كالتالى،0,06 ± 0,01، 0,13 ± 0,01 ، 0,17 ± 0,01 ، 0,25 ± 0,02 على التوالى بالنسبة لمصنع (أ) بينما كان فى مصنع (ب) 0,11 ±0,01 ، 0,19 ± ,01 ، 0,26 ± 0,02 ، 0,38 ± 0,02 على التوالى .وكانت نسبة العينات التى تعدت المستوى المسموح به (0,01 مجم/كجم) وفقا للمواصفة القياسية المصرية (2005) 6,67 % ، 13,33 % ،13,33 % ، 33,33 % في مصنع (أ)، بينما كانت النسب فى مصنع (ب) كالاتى 13,33 % ، 13,33 % ، 20% ، 33,33 % فى عينات البانية ، الناجتس ، الشيش طاووق و الكفتة على الترتيب. وكان متوسط مستوى عنصر النحاس مجم/كجم فى عينات البانية ، الناجتس ، الشيش طاووق و الكفتة كالتالى 1,12 ± 0,08 ، 1,48 ± 0,13 ، 0,99 ± 0,07 ، 2,03 ± 0,16 فى مصنع (أ) . بينما كانت 1,31 ± 0,12 ، 1,68 ± 0,15 ، 1,24 ± 0,1 ، 2,17 ± 0,18 فى مصنع (ب) على التوالى . وطبقاً لتلك النتائج فان جميع العينات التى تم فحصها فى مصنع (أ) ، (ب) لم تتعدى المستوى المسموح به فى عنصر النحاس. وقد وجد أن متوسط قيم عنصر الزئبق (مجم/كجم) لمنتجات البانية ، الناجتس ، الشيش طاووق و الكفتة كالاتى 0,15 ± 0,01 ، 0,17 ± 0,01، 0,22 ± 0,02 ، 0,31 ± 0,02 على التوالى فى مصنع (أ) بينما كانت فى مصنع (ب) كالتالى 0,18 ± ,01 0 ، 0,26 ± 0,01 ، 0,29 ± 0,02 ، 0,35 ± 0,02 على التوالى. وفقا للمواصفة القياسية المصرية (2005) وقد وجد أن جميع عينات البانية ، الناجتس و الشيش طاووق الخاصة بمصنع (أ) لم تتعد المستوى المسموح به. بينما كانت 6,67 % من عينات الكفتة قد تعدت المستوى المسموح به. أما بالنسبه لمصنع (ب) جميع عينات البانية و الناجتس لم تتعد المستوى المسموح به بينما عينات الشيش طاووق و الكفتة قد تعدت المستوى المسموح به بنسبة 6,67 % ، 13,33% على التوالى.هذا وقد تم مناقشة مدى تأثير هذه العناصر على صحة وسلامة المستهلك كذلك المصادر المختلفة لسبب وجودها فى منتجات لحوم الدواجن بالإضافة إلى بعض التوصيات التى تم وضعها لتحسين جودة منتجات لحوم الدواجن وعدم تأثيرها على صحة المستهلك.

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