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HEAVY METALS IN SOME READY -TO- EAT CHICKEN MEAT PRODUCTS

Hassan, M. A[1], Reham, A. Amin[1] and Amira, M. Abd El Aziz[1]
[1]*Food Control Dept., Fac. Vet. Med., Benha University*

A B S T R A C T

A total of 90 random samples of ready - to – eat chicken meat products represented by sheish tawook, chicken burger and chicken pane (30 of each) were collected from different restaurants of high and low standard levels of hygiene (15 of each) at El-Kalyoubia governorate and directly transferred to the laboratory for determination of their contents of lead, cadmium and copper. The obtained results indicated that the mean values of lead concentration in the examined samples of shiesh tawook, chicken burger and chicken panee were 0.76 ± 0.07, 0.55 ± 0.06 0.32 ± 0.04 mg/kg wet weight, respectively, at low hygienic level, whereas, they were 0.52 ± 0.05, 0.39 ± 0.05 and 0.23 ± 0.03 mg/kg wet weight, respectively, at high hygienic level. The differences between the examined samples of ready – to – eat chicken meat products were highly significant ($p < 0.01$) according to their lead content. Also the obtained results indicated that the mean values of cadmium concentration in the examined samples of shiesh tawook, chicken burger and chicken panee were 0.58 ± 0.05 , 0.38 ± 0.04 and 0.24 ± 0.02 mg/kg wet weight, respectively, at low hygienic level, however, they were 0.40 ± 0.04, 0.26 ± 0.03 and 0.17 ± 0.03 mg/kg wet weight, respectively, at high hygienic level. The differences between the examined samples of ready – to – eat chicken meat products were significant ($p < 0.05$) according to their cadmium content.. Furthermore, the obtained results indicated that the mean values of copper content in the examined samples of shiesh tawook, chicken burger and chicken panee were 2.46 ± 0.25 , 2.15 ± 0.019 and 1.79 ± 0.21 mg/kg wet weight, respectively, at low hygienic level, while, they were 1.7 ± 0.16 , 1.55 ± 0.13 and 1.4 ± 0.09 mg/kg wet weight, respectively, at high hygienic level. The differences between the examined samples of ready – to – eat chicken meat products were highly significant ($p < 0.01$) according to their copper content.

Key words: Heavy Metal, Ready to eat chicken products

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1. INTRODUCTION

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 **[17]**. During the last decade, the demand of ready to eat (RTE) chicken products increased in Egyptian food markets and received real consumer preferability because they represent quick easily prepared meat meals and solve the problem of shortage of fresh meat of high price, which is not within the reach of large numbers of families with limited income. Therefore, the production of RTE chicken products has grown rapidly **[16].** Today, the environmental pollution by heavy metals 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 **[11]** .Environmental exposure through food is recognize as an important source of heavy metal exposure in developed countries **[12].** Owing to their toxicity persistence and tendency to accumulate, heavy metals when

occurring in higher concentrations, become severe toxins for human being and all living organisms **[9]** through alteration of physiological activities and biochemical parameters in blood and tissues and through defects in cellular uptake mechanisms in the mammalian liver and kidney, inhibiting hepatic and renal sulfate / bicarbonate transporter causing sulfaturia. With respect to human health impacts, lead, cadmium and copper are of primary concern because of their known toxicity to human being **[13]**. They may arise from natural geological sources or from human activities, industrial, mining or agricultural activities. Lead is recognized as a toxic substance, which accumulates in the body due to its low rate of elimination. The classic symptoms of lead poisoning are colic, abdominal pain, anemia and encephalopathy. As well as, lead is considered as one of immunosuppressive agents in human **[1].** Moreover, cadmium poisoning may result in a case called Itai - Itai or Ouch - Ouch disease, which is characterized by severe pain, soft bones and death, may occur as result of renal failure **[18].** 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 **[2].** Chronic copper poisoning may lead to Wilson,s disease which is manifested by destruction of nerve cells, liver cirrhosis, aschitis, edema and hepatic failure. In addition, copper poisoning is characterized by Kayser Fleischer ring, which is a golden brown ring of accumulated copper in the cornea of the eye. The present work was carried out to determine the residual concentrations of lead, cadmium and copper in some products of RTE chicken meat products (sheish tawook, chicken burger and chicken pane).

2. Material and Methods

2.1. Collection of Samples:

A grand total of ninety random samples of ready- to -eat chicken meat products represented by shiesh tawook, chicken burger and chicken panee (30 of each) were collected from different restaurants of high and low standard levels of hygiene (15 of each) at Kalyobia governorate. The collected samples were directly transferred to the laboratory for determination of their contents of lead, cadmium and copper.

2.2. Determination of Heavy Metal Residues (Wet Digestion Technique) [20]

2.2.1. Washing procedure:

Washing of the glass wares and plastic film was an important process to avoid any sort of contamination. The test tubes, polyethylene tubes and glasswares were soaked in water and soap for 2 hours then rinsed several times with tap water. After that glassware have been rinsed once with distilled water, once with mixture (consisted of 520 ml de-ionized water, 200 ml concentrated HCI and 80 ml (H2O2), and once with washing acid (10% Nitric acid). Finally, they were washed with de-ionized water, and then air-dried in incubator away from contamination or dust.

2.2.2. Digestion Procedure:

One gram of each sample was macerated by sharp scalpel in a screw-capped tube. Five milliliters of the digestion mixture (60 ml nitric acid 65% and 40 ml perchloric acid 70-72%) were added to the tissue sample. The tubes were tightly closed and the contents were vigorously shaked and allowed to stand overnight. Then the tubes were heated for 3 hours in water bath adjusted at 70°C to ensure complete digestion of the samples. The digestion tubes were vigorously shaked at 30 minutes intervals during the heating period. Finally the tubes were cooled at room temperature and then diluted with 5 ml de-ionized water, and filtered by using filter paper (Wattman No. 42). The filtrate was collected in polyethylene tubes. These tubes were capped with polyethylene film and kept at

room temperature until analyzed for heavy metal contents.

2.2.3. Preparation of blank and standard solution:

Blank solution consists of 5 ml of digestion mixture. This blank tube was put in a screw caped tube, and was treated similar to wet digestion tubes. Finally, it was diluted with 5ml deionized water similar to digestion tubes. The blank tube was used to determine the heavy metal contamination that may be present in the chemicals used for wet digestion. However, standard solutions using pure certified metal standards were prepared for each metal. Serial standard solutions for lead, cadmium and copper were prepared at ideal adequate strength.

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 Spectrrophotometer (AAS) (UNICAM 969 AA Spectrophotometer) which was adjusted at 217.0 nm for lead, 228.8 nm for cadmium and 324.8 nm for copper. Absorbance and concentration were recorded on the digital scale of AAS.

2.2.5. Calculation and Quantitative determination of heavy metals:

The concentrations of heavy metals were calculated as ppm (mg/kg) on wet weight of the examined samples according to the following equation:
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).

2.3. Statistical Analysis:

All the obtained results were evaluated statistically according to analysis of variance "ANOVA" test

3. Results

4. Discussion

In respect to human health impacts, three heavy metals are of primary concern, lead, cadmium and copper because of their known toxicity to human being and other living organisms through progressive irreversible accumulation in their bodies **[21].** The results recorded in Tables (1) revealed that 86.67%, 66.67% and 60%, at low hygienic level, and 73.33%, 53.33% and 40%, at high hygienic level, of the examined samples of ready – to – eat sheish tawook, chicken burger and chicken pane, respectively, were contaminated with lead.
It is evident from results recorded in table (1) and Fig. (1) that the concentrations of lead in the examined samples of ready – to – eat sheish tawook, chicken burger and chicken panee ranged from 0.08 to 1.56 with a mean value of 0.76 ± 0.07, 0.05 to 1.12 with a mean value of 0.55 ± 0.06 and 0.03 to 0.87 with a mean value of 0.32 ± 0.04 mg/kg at low hygienic level, respectively, and from 0.06 to 1.027 with a mean value of 0.52 ± 0.05, 0.04 to 0.96 with a mean value of 0.39 ± 0.05 and 0.01 to 0.63 with a mean value of 0.23 ± 0.03 mg/kg at high hygienic level, respectively. These differences between the examined samples of ready – to – eat chicken meat products and between low and high hygienic levels, were highly significant ($p < 0.01$), while the difference due to interaction between the kinds of products and the hygienic levels were significant ($p < 0.05$) (table 3). The obtained results were nearly similar to those reported by **[19]** on the other hand lower results were reported by **[5].** According to the safe permissible limit stipulated by **EOS (2005)** for lead in ready – to – eat chicken meat products (0.1 ppm), it was indicated that 73.33%, 46.67% and 40%, at low hygienic level, and 53.33%, 40% and 20%, at high hygienic level, of the examined samples of ready – to – eat sheish tawook, chicken burger and chicken panee, respectively, were not in accordance with this limit (table 4). Lead exposure has also been associated with reduced bone growth in fetuses and children, resulting in reduced

Table 1. Incidence of lead in the examined samples of ready-to-eat chicken meat products at two levels of hygiene

Hygienic status / Chicken meat products	Low hygienic level		High hygienic level	
	No.	%	No.	%
Shiesh tawook	13	86.67	11	73.33
Chicken burger	10	66.67	8	53.33
Chicken panee	9	60.00	6	40.00

Table 2. Statistical analytical results of lead levels (mg/kg) in the examined samples of ready-to-eat chicken meat products

Hygienic status / Chicken meat products	Low hygienic level			High hygienic level		
	Min.	Max.	Mean ±S.E	Min.	Max.	Mean ±S.E
Shiesh tawook	0.08	1.56	0.76±0.07	0.06	1.027	0.52±0.05
Chicken burger	0.05	1.12	0.55±0.06	0.04	0.96	0.39±0.05
Chicken panee	0.03	0.87	0.32±0.04	0.01	0.63	0.23±0.03

S.E = Standard error of mean

Fig 1. Mean values of lead levels in the examined samples (mg/kg) of ready –to- eat chicken meat products

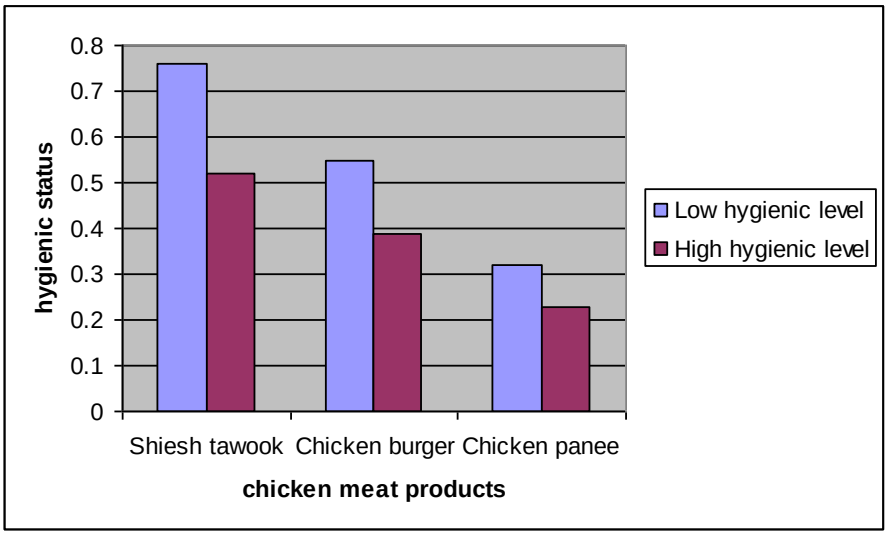

Table 3. Analysis of variance (ANOVA) of lead levels (mg/kg) in the examined samples of ready – to- chicken meat products

Source of variance	D.F	S.S	M.S	F. value
Total	89	0.1880		
Between products (p)	2	0.0292	0.0146	9.74++
Between Hygiene (H)	1	0.0213	0.0213	14.21++
(P) x (H) interaction	2	0.0213	0.0058	3.86+
Error	84	0.0116	0.0015	

D.F = Degrees of freedom += significant differences (P < 0.05)
S.S = Sum Squares ++= High significant differences (P < 0.01)
M.S = Mean squares

Table 4. Acceptability of the examined samples of ready- to- eat chicken meat products based on theirs contents of lead

Chicken meat / products	Maximum permissible limit* (mg/kg)	Unaccepted samples at low hygienic level		Unaccepted samples at high hygienic level	
		No.	%	No.	%
Shiesh tawook	0.1	11	73.33	8	53.33
Chicken burger	0.1	7	46.67	6	40.00
Chicken panee	0.1	6	40.00	3	20.00

* According to EOS (2005)

Table 5. Incidence of cadmium in the examined samples of ready – to- eat chicken meat products at two levels of hygiene

Hygienic status / Chicken meat products	Low hygienic level		High hygienic level	
	No.	%	No.	%
Shiesh tawook	10	66.67	9	60.00
Chicken burger	9	60.00	6	40.00
Chicken panee	7	46.67	4	26.67

Table 6. Statistical analytical results of cadmium levels (mg/kg) in the examined samples of ready – to- eat chicken meat products

Hygienic status / Chicken meat products	Low hygienic level			High hygienic level		
	Min.	Max.	Mean ±S.E	Min.	Max.	Mean ±S.E
Shiesh tawook	**0.06**	**1.14**	**0.58±0.05**	**0.05**	**0.92**	**0.40±0.04**
Chicken burger	**0.04**	**0.81**	**0.38±0.04**	**0.02**	**0.65**	**0.26±0.03**
Chicken panee	**0.03**	**0.59**	**0.24±0.02**	**0.01**	**0.41**	**0.17±0.03**

S.E= standard error of mean

Fig 2. Mean values of cadmium levels (mg/kg) in the examined samples of ready –to- eat chicken meat products

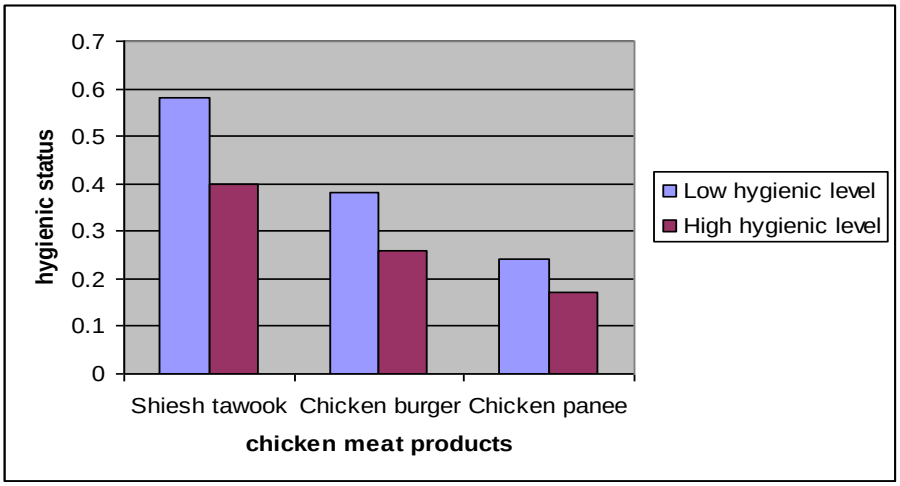

Table 7. Analysis of variance (ANOVA) of cadmium levels (mg/kg) in the examined samples of ready – to- eat chicken meat products

Source of variance	D.F	S.S	M.S	F. value
Total	**89**	**0.1247**		
Between products (p)	**2**	**0.0106**	**0. 0053**	**4.38+**
Between Hygiene (H)	**1**	**0.0095**	**0.0095**	**7.92++**
(P) x (H) interaction	**2**	**0.0038**	**0.0019**	**1.55 NS**
Error	**84**	**0.1008**	**0.0012**	

D.F = Degrees of freedom += significant differences ($P < 0.05$)
S.S = Sum Squares ++= High significant differences ($P < 0.01$)
M.S = Mean squares NS= Non significant differences

Table 8. Acceptability of the examined samples of ready- to- eat chicken meat products based on their contents of cadmium

Chicken meat products	Maximum permissible limit* (mg/kg)	Unaccepted samples at low hygienic level		Unaccepted samples at high hygienic level	
		No.	%	No.	%
Shiesh tawook	0.1	8	53.33	7	46.67
Chicken burger	0.1	7	46.67	4	26.67
Chicken panee	0.1	5	33.33	3	20.00

* According to EOS (2005)

Table 9. Incidence of copper in the examined samples of ready- to – eat chicken meat products at two levels of hygiene

Hygienic status / Chicken meat products	Low hygienic level		High hygienic level	
	No.	%	No.	%
Shiesh tawook	15	100	15	100
Chicken burger	15	100	15	100
Chicken panee	15	100	15	100

Table 10. Statistical analytical results of copper levels (mg/kg) in the examined samples of ready- to- eat chicken meat products

Hygienic status / Chicken meat products	Low hygienic level			High hygienic level		
	Min.	Max.	Mean ±S.E	Min.	Max.	Mean ±S.E
Shiesh tawook	1.18	3.88	2.46±0.25	0.91	2.67	1.71±0.16
Chicken burger	0.99	3.07	2.15±0.19	0.75	2.14	1.55±0.13
Chicken panee	0.86	2.72	1.79±0.21	0.53	1.68	1.14±0.09

S.E = Standard error of mean

Fig 3. Mean values of copper levels in the examined samples of ready –to- eat chicken meat products

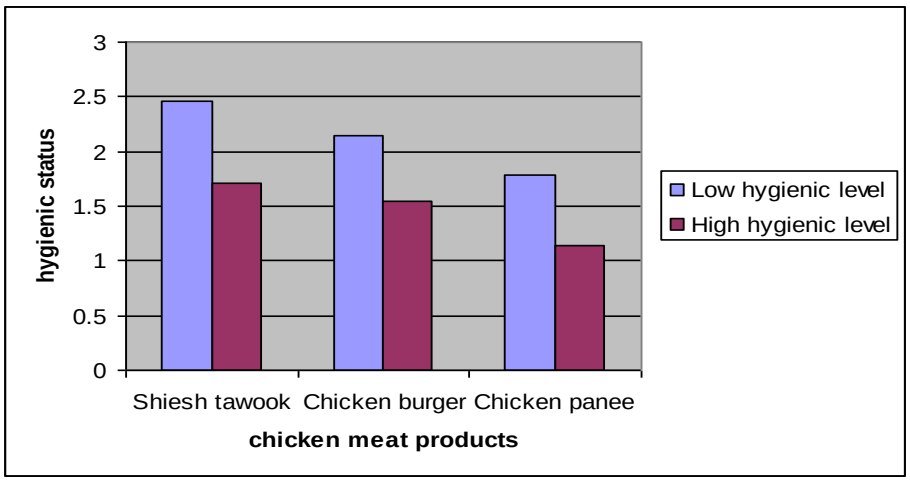

Table 11. Analysis of variance (ANOVA) of copper levels (mg/kg) in the examined samples of ready – to- eat chicken meat products

Source of variance	D.F	S.S	M.S	F. value
Total	89	95.7761		
Between products (p)	2	10.8453	5.4227	6.63++
Between Hygiene (H)	1	9.6512	9.6512	11.80++
(P) x (H) interaction	2	6.5760	3.2880	4.02+
Error	84	68.7036	0.8179	

D.F = Degrees of freedom += significant differences (P < 0.05)
S.S = Sum Squares ++= High significant differences (P < 0.01)
M.S = Mean squares

Table 12. Acceptability of the examined samples of ready –to- eat chicken meat products based on their contents of copper

Chicken meat products	Maximum permissible limit* (mg/kg)	Unaccepted samples at low hygienic level		Unaccepted samples at high hygienic level	
		No.	%	No.	%
Shiesh tawook	20	-	-	-	-
Chicken burger	20	-	-	-	-
Chicken panee	20	-	-	-	-

* According to Food Stuff Cosmetics and Disinfectant Act (1997)

head circumference and stature**.** Lead interferes with bone formation, maturation and resorption and may also be a potential risk factor for osteoporosis. Lead may exert both indirect and direct actions on bone turnover. Signs and symptoms of acute lead poisoning in adults may include abdominal pain, anorexia, nausea, severe vomition, intestinal cramps, epigastric, colic, constipation**,** headache, joint and muscle pain, convulsions, hemolytic anemia. Concerning the cadmium level, table (5) declared that 66.67%, 60% and 46.67%, at low hygienic level, and 30%, 40% and 26.67%, at high hygienic level, of the examined samples of ready – to – eat sheish tawook, chicken burger and chicken panee, respectively, were contaminated with cadmium. Results achieved in table (6) and fig. (2) revealed that the concentrations of cadmium in the examined samples of ready – to – eat sheish tawook, chicken burger and chicken panee ranged from 0.06 to 1.14 with a mean value of 0.58 ± 0.05, 0.04 to 0.81 with a mean value of 0.38 ± 0.04 and 0.03 to 0.59 with a mean value of 0.24 ± 0.02 mg/kg at low hygienic level, respectively, and from 0.05 to 0.92 with a mean value of 0.40 ± 0.04, 0.02 to 0.65 with a mean value of 0.26 ± 0.03 and 0.01 to 0.41 with a mean value of 0.17 ± 0.03 mg/kg at high hygienic level, respectively. Such variations between the examined samples of ready – to – eat chicken meat products were significant ($p < 0.05$), while high significant difference ($p < 0.01$) between these examined samples appeared due to the difference in hygienic level. Nearly similar results were obtained by **[6]** and lower results were reported by **[5].** Table (8) showed that 53.33%, 46.67% and 33.33%, respectively, at low hygienic level, and 46.67%, 26.67% and 20%, respectively, at high hygienic level, of the examined samples of ready – to – eat sheish tawook, chicken burger and chicken panee, respectively, exceeded the safe permissible limit recommended by **EOS (2005)** for cadmium in ready – to – eat chicken meat products (0.1 ppm). Cadmium is nephrotoxic pollutant**,** causing kidney damage**,** end stage renal disease (ESRD)**,** irreversible renal failure**,** nephritis, kidney stones and overall mortality **[12].** Moreover, cadmium is classified as a probable human carcinogen (group I) **[10].**Interestingly cadmium is not directly genotoxic, but only weakly mutagenic in mammalian cells **[3].** Regarding to copper level, table (9) showed that all (100%) the examined samples of ready – to – eat sheish tawook, chicken burger and chicken pane, at both low and high hygienic levels, were contaminated with copper. Furthermore, table (10) and fig. (3) indicated that the concentrations of copper in the examined samples of ready – to – eat sheish tawook, chicken burger and chicken panee ranged from 1.18 to 3.88 with a mean value of 2.46 ± 0.25, 0.99 to 3.07 with a mean value of 2.15 ± 0.19 and 0.86 to 2.72 with a mean value of 1.79 ± 0.21 mg/kg at low hygienic level, respectively, and from 0.91 to 2.67 with a mean value of 1.71 ± 0.16, 0.75 to 2.14 with a mean value of 1.55 ± 0.13 and 0.53 to 1.68 with a mean value of 1.14 ± 0.09 mg/kg at high hygienic level, respectively. Such variations between the examined samples of ready – to – eat chicken meat products and between low and high hygienic levels were highly significant ($p < 0.01$). On the other hand, the interaction between the kinds of products and the hygienic levels was significant ($p < 0.05$) as shown in table (11). Higher results were obtained by **El-Sakkary (2007) and Hassan (2007).** Respectively, table (12) showed that all the examined samples of ready – to – eat sheish tawook, chicken burger and chicken panee, produced at both low and high hygienic levels were accepted based on their copper content according to **Food Stuff Cosmetics and Disinfectant Act (1997)** which stated that the maximum permissible limit for copper should not exceed 20 mg/kg in ready – to – eat chicken meat products. Copper is an important constituent in a number of different

enzymes in man and animals; it accumulates mostly in muscle liver acting as essential elements, but it may be toxic for both animals and humans when its concentration crosses the safe limits **[14].** Copper compounds causes cirrhosis and liver debilitating condition in continuous ingestion **[19].** The obtained results in the present study concluded that the examined samples of shiesh tawook were the most contaminated samples with lead, cadmium and copper followed by those of chicken burger and chicken pane, respectively. Furthermore, the examined samples of ready – to – eat chicken meat products at high hygienic level are safer for human consumption as compared with those sold at low hygienic level of hygiene based on heir contents of heavy metals.

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مجلة بنها للعلوم الطبية البيطرية
BENHA UNIVERSITY
FACULTY OF VETERINARY MEDICINE

تقييم بعض المعادن الثقيلة في منتجات لحوم الدواجن الجاهزة للأكل

محمد أحمد حسن، ريهام عبد العزيز أمين، أميرة محمد عبد العزيز
قسم مراقبة الأغذية – كلية الطب البيطري – جامعة بنها

الملخص العربي

أجريت هذه الدراسة على عدد تسعين عينة (90) من منتجات الدواجن الجاهزة للأكل "شيش طاووق، برجر فراخ، بانيه" بواقع ثلاثين عينة (30) من كل نوع مأخوذة من محلات ذات مستوى صحي منخفض ومرتفع بواقع خمسة عشر عينة (15) من كل مستوى وذلك لمعرفة مدى تلوثها بتلك المعادن الثقيلة. وقد دلت نتائج الدراسة على أن متوسطات تركيز الرصاص فى عينات الشيش طاووق، برجر فراخ والبانيه التى تم فحصها كانت (0.76±0.07)، (0.55±0.06) و (0.32±0.04) مجم / كجم على التوالى فى المستوى الصحي المنخفض، بينما كانت، (0.52±0.05)، (0.39±0.05) و (0.23±0.03) مجم / كجم على التوالى فى المستوى الصحى المرتفع. أما بالنسبة للكادميوم فى عينات الشيش طاووق، برجر فراخ والبانيه فإن متوسطات تركيزه هى (0.58±0.05)، (0.38±0.04) و (0.24±0.02) مجم / كجم على التوالى فى المستوى الصحى المنخفض، بينما كانت (0.40±0.04)، (0.26±0.03) و (0.17±0.03) مجم / كجم على التوالى فى المستوى الصحى المرتفع. وبالنسبة للنحاس فى عينات الشيش طاووق، برجر فراخ والبانيه فإن متوسطات تركيزه هى (2.46±0.25)، (2.15±0.19) و (1.79±0.21) مجم / كجم على التوالى فى المستوى الصحى المنخفض، بينما كانت (1.71±0.16)، (1.55±0.13) و (0.14±0.09) مجم / كجم على التوالى فى المستوى الصحى المرتفع. هذا وقد تمت مناقشة الخطورة الصحية لهذه المعادن الثقيلة مع بيان المصادر المختلفة لتلوث منتجات الدواجن الجاهزة للأكل بتلك الملوثات الخطيرة.

(مجلة بنها للعلوم الطبية البيطرية: عدد 24 (1)، يونيو 2013: 128-139)