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Original Article

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Abstract

The concentrations of some heavy metals, (Fe, Zn, Cu, Pb ,Cd and Co) in Cows meat, and some chicken organs collected from five regions of Damietta governorate (El-Zarka, Faraskour, Kafr El-Batiekh, Damietta City and New Damietta city) in Egypt country were assessed using Flame Atomic Absorption Spectrophotometry (A.A.S). Also the study aimed to evaluate the effect of heat on the heavy metals concentrations. The obtained results declared that the concentrations of heavy metals in cows meat samples from different regions showed a variation followed the order Zn> Fe> Cu> Pb> Cd> Co. The same observation was found in concentrations of heavy metals in chicken gizzard samples, Zn> Fe> Cu> Pb> Cd> Co. While, in the chicken livers the concentrations of heavy metals followed the sequence of Fe > Zn> Cu > Pb> Cd > Co. According to maximum allowable levels the concentrations of Zn, Cu and Cd in chicken gizzard and livers below the allowable levels, while the concentrations of Fe and Pb above the safe limits. Also according to allowable levels of **(FAO, 1983)**, Cd concentration in cows meat within safe limit of 0.1 µg/g, while Pb concentration above allowable level of 0.1 µg/g. Cu concentration in cows meat above maximum allowable level of 5 µg/g according to **(EC, 2005)** also the mean concentrations of Cu and Fe in all the meat samples were higher than the regulatory limit for **(FAO/WHO, 2000)**, 0.1 and 0.3 µg/g, respectively. Through the results, boiling method had a highly efficiency in reduction of some heavy metals concentrations more than grilling method.

1. Introduction

As a development of industrialization during the last centuries, the heavy metals level of soils has increased worldwide (**Adriano, 2001**). Hot spots of soil contamination are located in areas of large industrial activities as Damietta Governorate as it is famous by intensive industry, where surrounding agricultural areas are affected by atmospheric deposition of heavy metals. Also, agricultural practice, e.g., application of sewage sludge or phosphate fertilizers, has to lead to increased metals concentration in soils. In addition, domestic and industrial – polluted – sewage water is usually used for irrigating agricultural lands, in the absence of any treatment, which negatively affects lands fertility and the quality of the plants. Besides, the increase of heavy metals concentration up to highly toxic levels may also affect animals and the human body through the food chain to which they have thus access **(Karatas *et al.*, 2006)**. The toxicity of these metals is in part due to the fact that they accumulate in biological tissues, a process known as bioaccumulation and biomagnifications **(Sathyamoorthy *et al.* 2016).** The process of bioaccumulation of metals occurs in all living organisms as a result of exposure to metals in food and the environment, including food animals such as poultry, poultry and fish as well as humans **(Alturiqi and Albedair, 2012** and **Elsharawy, 2015**). These pollutants often have direct physiological toxic effects because they are stored or incorporated in tissues **(Shahat *et al.*, 2017)**. In recent years, many studies have been focused on the concentrations of heavy metals in meat and other foods to check for those hazardous to human health (**Hassouba *et al.*, 2007;**

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(Alturiqi and Albedair, 2012, Hassanin *et al.*, *2014*; Elsharawy, 2015, Walaa and Amal A, 2018)

Iron, copper, zinc, and manganese are essential metals and play important roles in biological systems. On the other hand, mercury, lead, and cadmium, etc. are non-essential elements. In contrast to the non-essential metals, which are toxic even in trace amounts, the essential metals tend to only produce toxic effects when the metal intake is in extreme excess. Heavy metals have the same pathway of exposure, emissions from industry and traffic exhaust contain considerable air contaminants, which reach the food chain and then animals to finally deposit in the human body (**ATSDR, 1988**). Industrial air pollution releases some heavy metals into the atmosphere which becomes potential sources of water pollution after dry or wet deposition. Agriculture soils are rich in heavy metals as a result of the use of various phosphatic fertilizers, organic matters, and pesticides as well as the presence of decaying plant and animal residue. The use of wastewater in irrigation and sewage sludge has further increased the number of heavy metals in agriculture soils. The agricultural run-off together with soil erosion is considered as the potential source of water pollution **(Salem *et al.,* 2000).** Chickens either free-range or under intensive rearing systems, are exposed to vast array of heavy metals and trace elements via inhalation of polluted air or ingestion of contaminated feed. The chicken meat has a good advantage in comparison with beef meat, but sometime poultry may carry heavy metals and other elements which may be naturally present in air, water, soil and poultry food or can reach it as a result of human activities such as industrial and agricultural processes **(Elsharawy, 2015)**. Poultry feed contains high concentrations of minerals which is directly added to the ration to fulfill the bird body requirements and in many cases, exceed the bird needs. Additionally, poultry ration in many cases contain bone or fish meals that fishes may be collected from contaminated waters, which are considered major sources of feed contamination with metals **(Sadeghi *et al*. 2015** and **Walaa and Amal, 2018).**

Concentrations of lead in different food products vary greatly. Lead in food originates mainly from atmospheric deposition and adherence of lead-rich soil particles to plants. It is estimated that approximately half of the human lead intake is through the food, with around half originating from plants **(Nasreddine and Massin, 2002).** Studies confirm that heavy metals can directly influence behavior by impairing mental and neurological function; dysfunction in the blood, circulating system, detoxification pathway clon, liver, kidney, skin, endocrine system and immune system). In addition they can increase allergic reaction and cause genetic mutation **(Capark and katalenic, 2001).** This study aimed to assess the concentrations of some heavy metals (Fe, Zn, Cu, Pb, and Cd) in cow's meat and some organs of chicken consumed in Damietta governorate and study the effect of boiling and grilling as cooking methods on its levels.

2.Materials and Methods

2.1.Collection of Samples

Thirty samples of cows meat and some chicken organs, liver and gizzard (ten of each) were collected from five sites of Damietta governorate (El-Zarka, Faraskour, Kafr El-Batikh, Damietta City and New Damietta City) in Egypt country. All of the samples were randomly purchased from chicken and meat butchers and were put in sealed polyethylene bags and transported to the laboratory where they were stored at 4 c until analysis. Accordingly, sampling locations were selected; **Figure (1)**.

Samples of cows meat and chicken organs (gizzards and livers) were washed with distilled water to remove any contaminated particles. Then samples were cut to small pieces using clean ceramic knife and homogenized by macerating in a stainless steel blender and then mixed, and the resultant was kept for analysis. The analysis is subsequently made by flame atomic absorption spectrophotometer (A.A.S): Samples and standards are aspirated into the appropriate A.A.S flame. Perkin-Elmer double beam 2380 atomic absorption spectrometer was used with adapted Perkin-Elmer hollow-cathode lamps and conventional 10 cm slot burner head for an air-acetylene flame. A hollow cathode lamp, for the metal being measured, provides a source of characteristic radiation energy for that particular metal. The absorption of this characteristic energy by the atoms of interest in the flame is related to the concentration of the metal in the aspirated sample.

Figure (1) : Location Map of the Study Area (Damietta Governorate) Showing the Sites of Investigations

2.2. Determination of Heavy Metals Residues

Two grams of well-homogenized sample was dried in an oven around 130 ºC. Heat the contents of the dish with a soft flame (such as that of a Bunsen burner) until all volatile or readily combustible matter has been removed. Transfer the dish to a furnace set at 250 ºC. Slowly raise the temperature to 550 ºC. Ash at this temperature for about 6 to 8 hours remove the dish and cool. Ash should now be white or brownish red and essential only be carbon free. Remove the dish from the furnace. Cool and add gently 1 to 2ml of nitric acid and water to dissolve the salts. Filter into a 25 ml volumetric flask using Whatman No. 44 filter paper. Wash the residue and basin twice using water. Makeup to volume with water, **(AOAC, 2000).**

2.3. Effect of Heat on Heavy metals Content

Contaminated cows meat, chicken gizzards and chicken livers samples which represented Faraskour 1, Damietta City 1 and Damietta City 1, respectively, as they recorded the highest concentration of heavy metals (14.3, 23.4 and 27.2 µg/g), respectively, were as a control samples. The samples were distributed to two different cooking conditions of boiling and grilling. The samples were washed and boiled in a cooking pan with enough water to cover meat using gas stove; the processed meat was prepared as described by **(Omojola *et al.*, 2014)**. All meat, gizzard and liver samples were partially boiled for 20 minutes with water. No spices or food additives were added. Grilling of samples was carried out in a stainless grill for 20 minutes depending on the size of the samples. Boiled and grilled samples were chopped into smaller parts and air-dried to remove moisture. Air-dried samples were milled into powdery form using a blender then prepared to analyze for its heavy metals content as a previous method.

2.4. Statistical Analysis

One and Two-way ANOVA compared the data of the different study sites. The one-way ANOVA and correlation analyses were conducted using SPSS 22 for Windows. The presence or absence of a significant difference was specified at 95% confidence interval and significance level of p=0.05.

3. Results and Discussion

3.1. Heavy Metals Residues

Through the obtained results as shown in **Tables (1, 2, 3 and 4)** and **Figure (2)**, The mean concentrations of heavy metals analyzed in fresh cows meat were detected at varying concentrations in the order of Zn > Fe > Cu > Pb > Cd > Co. This is the same order of the mean concentration of heavy metals in chicken gizzards. This indicates that Zinc (Zn) was the most abundant heavy metal in the cows meat and Chicken gizzard samples with concentrations ranged between (14.6 to 41.7) and (20.7 to 42) µg/g, respectively, with mean concentrations of 30.7±2.7 and 32.2±2.4 µg/g, respectively. The results also showed that Zn had a weak negative correlation with Fe (r = -0.012) and positive correlation with Cd and Cu (r = 0.403 and r = 0.195 respectively, p < 0.05) **Table (6).**

While, chicken livers recorded the lowest mean concentration of Zn (24.3±2.3 µg/g). These results were lower than **(Abduljaleel *et al.,* 2012)** as he reported that, Zn levels in chicken gizzard (118.93 µg/g) and liver (78.8 µg/g) and had a significant positive correlation with Fe in both gizzard and liver (r = 0.78 and r = 0.61 respectively, p < 0.05) and weak positive correlation with Cu in both gizzard and chicken liver (r = 0.20 and r = 0.22 respectively, p < 0.05) **Table (6).**

Zinc is abundant in living organisms because of its important role in the biological systems. It is known to participate in various biochemical pathways in human beings. Immunological abnormalities, growth retardation, loss of appetite and skin abnormalities are some of the complications of zinc deficiency in the body **(Al -Bratty *et al.* 2018).**

The levels of iron (Fe) in cows meat, chicken gizzard and chicken livers ranged between (nd to 25.8), (nd to 76.5) and (nd to 119.11) µg/g, respectively, with mean concentrations of 13.5±3.1, 28.6±7.6 and 34.0±13.6 µg/g, respectively. The results also showed that Zn had a positive correlation with Pb in cows meat, chicken gizzard and chicken livers (r = 0.55, r = 0.09 and r = 0.09 respectively, p < 0.05) **Table (6).**Chicken found to be containing higher Fe contents than cows meat samples. These results are in agreement with that obtained by **Alturiqi and Albedair, (2012**) and the mean concentration of iron higher than **Al Bratty *et al.* (2018)** observed that Fe concentration in the chicken samples were in the range from 9.6 - 119 µg/kg.

Copper (Cu) can be used in agriculture (fertilizers, algaecides, feed supplements) and animal and human excreta (animal manure and human sewage sludge). Copper is also intentionally released into some water bodies to control the growth of algae and human activities **(ATSDR, 1990)**. Much of the copper discharged to water is in particulate form and tends to settle out, precipitate out. Also, rivers are depositing sludge on their banks that is contaminated with copper, due to the disposal of copper-containing wastewater. All of these lead to soil contamination with copper. Copper concentration of samples ranged between (1.2 to 22.0), (0.93 to 27.7) and (2.4 to 15.4) µg/g for cows meat, chicken gizzard and chicken liver, respectively. With mean concentration of 10.3±2.04, 9.8±2.6 and 7.7±1.4 µg/g for cows meat, chicken gizzard and chicken liver, respectively. It recorded significance negative correlation with Pb in all samples (r = -0.62, r = -0.48 and r = -0.34 at p < 0.05) for cows meat, chicken gizzard and chicken liver, respectively, **Table (6).** The highest mean concentration for Cu were recorded in cows meat samples and these results on the contrary of the results of **Elsharawy, 2015** who found that the Cu concentration levels were; liver> gizzard > thigh meat > breast meat. While the obtained results found higher copper concentration in gizzard than liver samples and that are in agreement with (**El-Sakkary, 2007; Ghimpeteanu *et al.,* 2012 and Faten *et al.,* 2014).** Cu is essential metal but it may cause chronic toxicity for animal and human with excess concentrations. Cu deposition in most organs as liver, gizzard, brain and eyes, so consumption of such meat from polluted environment may pose human health hazards **(Faten *et al.,* 2014** and **Elsharawy, 2015**).

The levels of lead (Pb) in all analyzed samples ranged from (nd to 12.4), (nd to 34.6) and (nd to 9.8) µg/g for cows meat, chicken gizzard and chicken liver, respectively. With mean concentrations of 3.3±1.42, 6.6±3.3 and 1.9±0.94 µg/g for cows meat, chicken gizzard and chicken liver, respectively, in order of gizzard > cows meat > liver. The results also showed that Pb had an intermediate significance positive correlation with Fe r = 0.54 at p < 0.05) which appeared only in cows meat. The obtained results in contrast with **Elsharawy, (2015)** and **Okeke *et al.,* (2015)** as the Pb concentration levels were; liver> gizzard >thigh meat > breast meat. Pb has attendance to bioaccumulate in human tissues and organs mainly in the liver, gizzards and bones leading to several diseases. The obtained results are in agreement with **Reem *et al.* (2012)** reported that in chicken samples in the local markets of Basrah city, Iraq, Pb contents were in the range of 0.171-3.269 mg/kg.

Cadmium (Cd) concentration of cows meat samples ranged between (nd to 1.3) while, in chicken gizzard from (nd to 0.73) and from (nd to 0.99) µg/g for chicken livers with mean concentrations of 0.13±0.13, 0.073±0.073 and 0.1±0.1 µg/g, respectively. The results in agreement with **Sadeghi *et al .* (2015)** who found that higher levels of Pb and Cd in chicken liver samples 3.79 ± 3.64 and 0.37 ± 0.09 mg/kg, respectively. In contrast, the obtained results were higher than **Al Bratty *et al.* (2018)** who found that Cd (nd - 0.01) and Pb (0.13 - 1.10) mg/kg in chicken samples. Also study results in cow's meat regarded lower concentrations of Pb and Cd than **Sathyamoorthy *et al.* (2016)** who found that Cd (5.1 – 6.6) and Pb (2.4 – 4.6) mg/kg. The concentration of Fe, Zn, Pb and Cd in cow's meat were lower than those recorded by **(Alturiqi and Albedair, 2012).**

It is worth mentioning that, all study samples regarded absence of Co metal except in chicken gizzards. Co is a major constituent of vitamin B12 and an essential element in the synthesis of this vitamin by bacterial fermentation in ruminant animals. Thus, deficiency of Co causes deficiency of vitamin B12 and hence macrocytic anaemia **(Hassan *et al.* 2013**). The concentrations of Co ranged between (nd- 0.18) µg/g with mean concentration of 0.018±0.018 µg/g. In contrast, **Hassan *et al.* (2013**) dominated that liver displayed the highest Co concentrations (13.2µg/100g).

Overall, the results of the current study indicated that the concentrations of heavy metals in cows meat samples from different regions showed a variation followed the sequence as Zn >Fe > Cu > Pb> Cd > Co. The same observation was found in concentrations of heavy metals in chicken gizzard samples, Zn >Fe > Mn > Pb> Cu > Cd. While in chicken livers the concentrations of heavy metals followed the sequence Fe > Zn> Cu > Pb> Cd > Co.

Zn, Fe and Cu are essential elements and relatively higher levels may be related to their physiological roles in various chicken tissues. Fe tends to accumulate at higher levels in human beings to invertebrates because it plays important roles in the body system as an essential element **(Al Bratty *et al.* 2018).** According to maximum allowable levels in **Table (4)** the concentrations of Zn, Cu and Cd in chicken gizzard and livers below the allowable levels, while the concentrations of Fe and Pb above the safe limits. Also according to allowable levels of **(FAO, 1983)**, Cd concentration in cow's meat within safe limit of 0.1 µg/g, while Pb concentration in cows meat above allowable level of 0.1 µg/g. While, Cu concentration in cows meat above maximum allawable level of 5 µg/g according to **(EC, 2005).** The mean concentrations of Cu and Fe in all the meat samples were higher than the regulatory limit for **(FAO/WHO, 2000)**, (0.1 and 0.3 µg/g, respectively), while Zn levels were below the regulatory limit (250 µg/g). So applying of some good agricultural practices can lead to the elimination of important fluctuations of concentration of heavy metals, which were found in identical reports in the raw material and in the final product.

Cu and Fe concentrations in cows meat samples **Table (1)** showed intermediate significant variation among regions (P ≤ 0.01), but Pb concentrations showed highly significant variation among regions (P ≤ 0.001). Zn and Cd concentrations showed a non-significant variation (P > 0.05). Data in **Table (2)** declared that Fe concentrations in chicken gizzard samples showed highly significant variation among regions (P ≤ 0.001). While Zn concentrations showed intermediate significant variation among regions (P ≤ 0.01). Pb, Co, Cu and Cd showed a non-significant variation (P >

0.05). Fe concentrations in chicken livers samples **Table (3)** showed highly significant variation among regions (P ≤ 0.001). But Pb, Zn, Cu and Cd showed a non-significant variation (P > 0.05).

3.2. Effect of Heat on Heavy metals Content

Cooking methods of cows meat and chicken as; grilling, marinating, simmering which uses to increase palatability, increase flavor, tenderness and aroma of food and decrease microbial load and break down some hazardous residues in food. Grilling is a method of cooking which involves the application of dry heat to the food. The food is usually place on a grill, a wire grid with a heat source on the top or below the grid **(Elsharawy, 2019).** Through the results in **Table (5)** and **Figure (3)**, boiling of cows meat reduced Pb, Cu and Fe concentrations by percent of (44, 93 and 5%), respectively, while increased Zn concentration. On the other hand, grilling of cows meat reduced Pb and Cu concentrations by percent of (8 and 88%), respectively, while increased the concentrations of Zn and Fe. The obtained results were in agreement with **(Joyce *et al.* 2016)** who found that grilling increased the iron levels to 26.06 ppm. This may be attributed to the interactions between the meat and the metal grid which is often made of iron. Therefore, during grilling, some of the Fe particles can get into the meat **(Joyce *et al.* 2016)**. Cd not detected in boiled and grilled cows meat. Boiling of Chicken gizzards reduced Pb, Zn, Cu and Fe concentrations by percent of (80, 17, 88 and 61%), respectively. While, grilling of chicken gizzards reduced Pb, Zn, Cu and Fe concentrations by percent of (39, 8, 75 and 58%), respectively. Respect to chicken livers boiling reduced Cu and Fe concentrations by percent of (44 and 92%), respectively while increasing Pb, Zn concentrations. Also Cd not detected in boiled and grilled chicken gizzards.

Grilling of chicken livers reduced only Fe concentration by percent of (88%) while increased concentrations of Pb, Zn and Cu. Cd not detected in boiled and grilled chicken livers. The results were in agreement with **(Elsharawy, 2019)** who summarized that grilling method reduced Pb, Fe and Cu concentrations. Concentration of Pb in chicken livers after boiling and grilling was above maximum allowable level, while the concentrations of Zn and Cu still within allowable levels as shown in **Table (4).** The concentration of Fe after grilling of cows meat samples was above the regulatory limit for **(FAO/WHO, 2000)** (0.3) µg/g, while increasing of Zn levels after boiling and grilling were below the regulatory limit (250 µg/g).

Through the results, the best method of cooking depending was boiling more than grilling. The heat may be converting some heavy metals to other compounds. Cooking methods (boiling, steaming, and frying among others) can change the levels of toxic metals through various means, including the evaporation of water and volatile components, solubilization of the element and also by metal binding to other macronutrients present in the food item such as carbohydrates, lipids and proteins **(Morgan *et al.* 1999).** As shown in **Table (5),** Fe, Zn, Cu and Pb concentrations in cows meat, chicken gizzards and livers samples after boiling and grilling showed highly significant variation among regions (P ≤ 0.001).

Table (1): Heavy Metal Concentrations in Cows meat (µg/g).

Regions of Samples	Concentration of Heavy Metals in cows meat (µg/g)						
	Pb	Zn	Co	Cu	Fe	Cd	*Mean
EL Zarka 1	ND	33	Nd	14.1	ND	ND	7.9
EL Zarka 2	ND	30.8	ND	12.9	6.9	ND	8.4
Faraskour 1	3.16	37.1	ND	22.0	23.8	Nd	14.3
Faraskour 2	2.3	41.7	ND	14.0	17.5	Nd	12.6
Kafr El-Batikh 1	10.2	40.5	ND	1.8	17.5	1.3	11.9
Kafr El-Batikh 2	12.4	26.2	ND	1.2	23.3	Nd	10.5
Damietta City 1	0.8	14.6	ND	6.2	25.8	Nd	7.9
Damietta City 2	3.91	31.9	ND	8.5	16.3	Nd	10.1
New Damietta 1	ND	30.9	ND	7.4	0.59	Nd	6.5
New Damietta 2	ND	19.8	ND	14.7	3.0	ND	6.3
***Mean±SE**	3.3±1.42	30.7±2.7	ND	10.3±2.04	13.5±3.1	0.13±0.13	9.6
F-Value	28.52	1.29	-	6.28	9.07	1.0	-
P-value	0.001***	0.386ºº	-	0.035**	0.016**	0.486ºº	-

ººNon-significant (P > 0.05), * = low significant (P ≤ 0.05), ** = intermediate significant (P ≤ 0.01)
*** = highly significant (P ≤ 0.001).

Table (2): Heavy Metal Concentrations in Chicken gizzard (µg/g).

Regions of Samples	Concentration of Heavy Metals in Chicken gizzard (µg/g)						
	Pb	**Zn**	**Co**	**Cu**	**Fe**	Cd	***Mean**
EL Zarka 1	ND	20.7	ND	13.1	ND	Nd	5.6
EL Zarka 2	ND	23.8	ND	10.8	11.7	ND	7.7
Faraskour 1	8.18	32.7	ND	4.1	26.2	ND	11.9
Faraskour 2	1.08	35.4	ND	14.7	27.1	ND	13.0
Kafr El-batikh 1	10.23	41.7	ND	1.2	20.7	ND	12.3
Kafr El-batikh 2	34.6	31.4	ND	0.93	25.6	0.73	15.5
Damietta City 1	7.87	42.0	0.18	14.1	76.5	ND	23.4
Damietta City 2	1.9	40.1	ND	27.7	66.5	ND	22.7
New Damietta 1	0.87	27.1	ND	6.6	15.9	ND	8.4
New Damietta 2	0.81	27.1	ND	5.1	15.9	ND	8.2
***Mean±SE**	6.6±3.3	32.2±2.4	0.018±0.018	9.8±2.6	28.6±7.6	0.073±0.073	5.6
F-Value	2.45	8.91	1.00	3.61	48.77	1.00	-
P-value	0.176^{oo}	0.017**	0.486^{oo}	0.096^{oo}	0.000***	0.486^{oo}	-

^{oo}Non-significant (P > 0.05), * = low significant (P ≤ 0.05), ** = intermediate significant (P ≤ 0.01)
*** = highly significant (P ≤ 0.001).

Table (3): Heavy Metal Concentrations in Chicken livers (µg/g).

Regions of Samples	Concentration of Heavy Metals in chicken Liver (µg/g)						
	Pb	**Zn**	**Co**	**Cu**	**Fe**	**Cd**	***Mean**
EL Zarka 1	0.61	21.5	ND	12.0	0.93	ND	7.0
EL Zarka 2	ND	29.7	Nd	15.4	3.5	ND	9.7
Faraskour 1	ND	26.9	ND	3.6	35.8	ND	13.3
Faraskour 2	3.43	31.5	ND	12.0	51.5	ND	16.4
Kafr El-Batikh 1	1.43	22.6	ND	2.4	15.7	ND	7.0
Kafr El-Batikh 2	9.8	26.0	ND	2.6	15.0	0.99	8.9
Damietta City 1	1.8	24.2	ND	8.4	98.0	Nd	22.2
Damietta City 2	2.0	35.0	ND	6.8	119.1	ND	27.2
New Damietta 1	ND	12.9	Nd	6.7	ND	ND	4.9
New Damietta 2	ND	12.9	Nd	6.7	Nd	ND	4.9
***Mean±SE**	1.9±0.94	24.3±2.3	0.0±0.0	7.7±1.4	34.4±13.6	0.1±0.1	12.9
F-Value	1.20	4.24	-	3.78	58.39	1.00	-
P-value	0.412^{oo}	0.072^{oo}	-	0.089^{oo}	0.000***	0.486^{oo}	-

^{oo}Non-significant (P > 0.05), * = low significant (P ≤ 0.05), ** = intermediate significant (P ≤ 0.01)
*** = highly significant (P ≤ 0.001).

Table (4): Mean Concentration of Heavy Metals through all Sites (Mean µg/g ±SE), Maximum allawable levels of heavy metals in chicken.

Samples	Mean Concentration of Heavy Metals through all Sites Mean±SE (µg/g)					
	Pb	**Zn**	**Co**	**Cu**	**Fe**	**Cd**
Fresh cows meat	3.3±1.42	30.7±2.7	0.0±0.0	10.3±2.0	13.5±3.1	0.13±0.13
Fresh chicken gizzards	6.6±3.3	32.2±2.4	0.018±0.018	9.8±2.6	28.6±7.6	0.073±0.073
Fresh chicken livers	1.9±0.94	24.3±2.3	0.0±0.0	7.7±1.4	34.0±13.6	0.1±0.1
(EOS, 2010) (poultry offal µg/kg)	0.5	-	-	15.0	20.0	1.0
WHO, 1998 in chicken (µg/g)	2.0	100.0	-	30.0	-	1.0

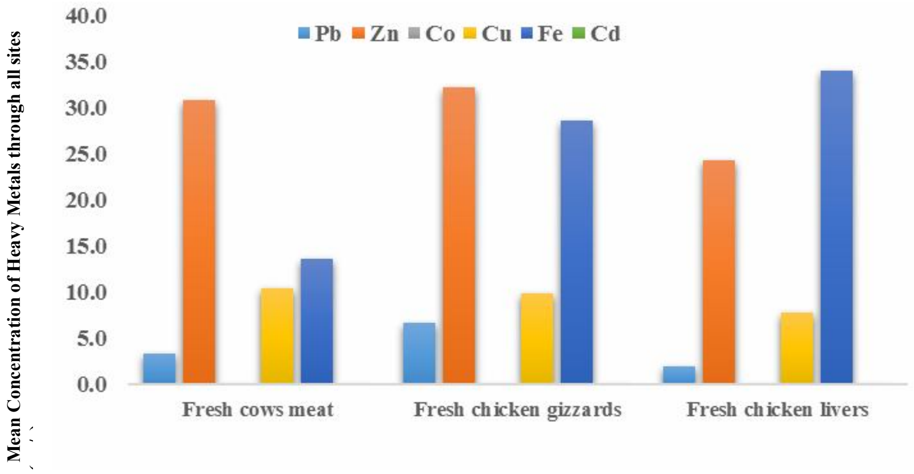

Figure (2): Mean Concentrations of Heavy Metals through all Sites (µg/g) under the Investigation at Damietta Governorate.

Table (5): Removal of heavy metals from contaminated cows meat, chicken gizzards and livers during boilling and grilling for 20 minutes.

Heating Method	**Concentration of Heavy Metals (µg/g)**									
	Pb		Zn		Cu		Fe		Cd	
	Conc.	Red.%	Conc.	Red.%	Conc.	Red.%	Conc.	Red.%	Conc.	Red.%
Control Meat	**3.16**		**37.1**		**22.0**		**23.8**		**ND**	
Boiled Meat	1.78	44	45.72	0	1.55	93	22.66	5	ND	ND
Grilled Meat	2.91	8	42.93	0	2.6	88	29.12	0	ND	ND
Control Gizzard	**7.87**		**42.0**		**14.1**		**76.5**		**ND**	
Boiled Gizzard	1.6	80	34.66	17	1.71	88	30.13	61	ND	ND
Grilled Gizzard	4.82	39	38.83	8	3.58	75	32.01	58	ND	ND
Control Liver	**1.8**		**24.2**		**8.4**		**98.0**		**ND**	
Boiled Liver	7.4	0	36.82	0	4.73	44	8.22	92	ND	ND
Grilled Liver	3.81	0	41.37	0	10.7	0	11.45	88	ND	ND
***P-value* in all samples**	0.000***		0.000***		0.000***		0.000***			

*** = highly significant (P ≤ 0.001).

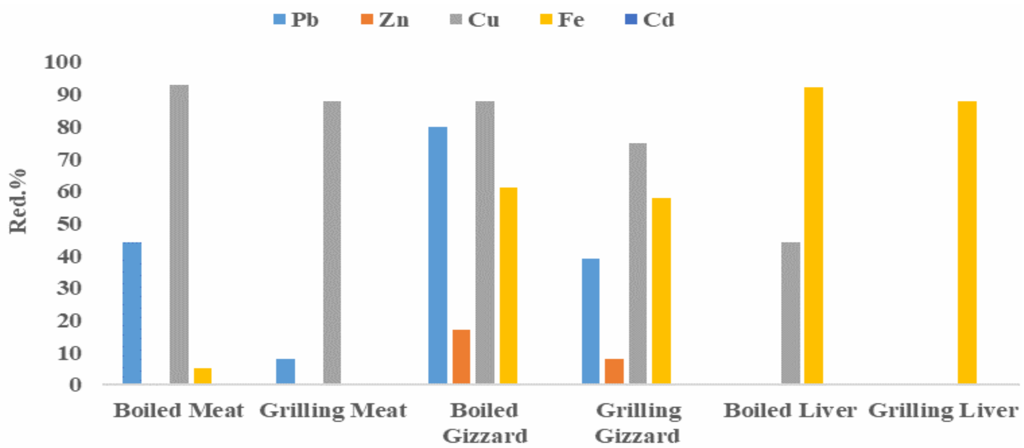

Figure (3): Removal of heavy metals from contaminated cows meat, chicken gizzards and livers during boilling and grilling for 20 minutes.

Table (6): Correlation Coefficient of Heavy Metals.

	Cows Meat						Chicken Gizzard					Chicken Liver			
	Fe	**Cu**	**Cd**	**Zn**	**Pb**		**Fe**	**Cu**	**Zn**	**Pb**		**Fe**	**Cu**	**Zn**	**Pb**
Fe	1	*-0.208*	**0.142**	*-0.012*	**0.560**	**Fe**	1	**0.553**	**0.786**	0.096	**Fe**	1	*-0.047*	**0.617**	0.098
Cu		1	*-0.462*	**0.196**	*-0.628*	**Cu**		1	**0.210**	*-0.488*	**Cu**		1	**0.222**	*-0.340*
Cd			1	**0.403**	**0.541**	**Zn**			1	**0.223**	**Zn**			1	**0.295**
Zn				1	**0.240**	**Pb**				1	**Pb**				1
Pb					1										

Value = high positive significance ؛*Value* = high negative significance

4. Conclustion

Through the study it was concluded that the concentrations of some heavy metals were above the safe limits as Fe and Pb in chicken gizzard and livers. Also concentrations of Cu, Pb and Fe in cows meat were above maximum allawable levels. Cooking (boiling and grilling) had a highly effect in metal concentrations reduction, the most effective one was boilling. In addition to after boiling and grilling of the samples the concentrations of Pb and Fe still above safe limits. So applying of some good agricultural practices can lead to the elimination of important fluctuations of concentration of heavy metals, which were found in identical reports in the raw material and in the final product.

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References

Abduljaleel, S.; Shuhaimi-othman, M. and Abdulsalam, B. (2012). Assessment of Trace Metals Contents in Chicken (Gallus gallus domesticus) and Quail (Coturnix coturnix japonica) Tissues from Selangor (Malaysia). Journal of Environmental Science and Technology, 5 (6): 441-451.

Adriano, D.C. (2001). Trace Elements in Terrestrial Environments. Biogeochemistry, Bioavailability, and Risks of Metals, second ed. Springer, New York, p. 867.

Al Bratty, M.; Alhazmi, H. A.; Ogd,i S. J.; Otaif, J. A.; Al-Rajab, A.; Alam, M. F. and Javed, S. A. (2018). Determination of Heavy Metals in Various Tissues of Locally Reared (Baladi) Chicken in Jazan Region of Saudi Arabia: Assessment of Potential Health Risks. Pakistan J. Zool., 50(4): 1509-1517.

Alturiqi, A. S. and Albedair, L. A. (2012). Evaluation of some heavy metals in certain fish, meat and meat products in Saudi Arabian markets.Egyptian Journal of Aquatic Research. 38: 45-49.

AOAC. (2000). Association of Official Analytical Chemists. Official methods 999.11. Determination of Lead , Cadmium , Copper , Iron and Zinc in Foods Atomic Absorption Spectrophotometry after dry ashing)/ Manual Methods of Analysis for Adulterants and Contaminants in Foods.17th ed. I.C.M.R 1990, pp: 138.

ATSDR. (1988). ATSDR, Agency for Toxic Substances and Disease Registry, "The Nature and Extent of Lead Poisoning in Children in the United States": Areport to Congress. Atlanta, pp:19.

ATSDR. (1990). ATSDR, Agency for Toxic Substances and Disease Registry, "Toxicological Profile for Polycyclic Aromatic Hydrocarbons, U. S". Department of Health and Human Services, Public Health Service, pp:1-18.

Capark, K. and Katalenic, M. (2001). Food contamination monitoring in Crootia. ARH. High Rada, 52(2):169-75.

EC. (2005). European Commission Regulation (EC) No. 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC. Text with EEA relevance. O.J.EU L70, 1-16.

El-Sakkary, H. (2007). Fast food as a chemical residue hazard. M. thesis of Vet. Sci., Meat hygiene, Banha Univ. Fac. of Vet.Med., Egypt.

Elsharawy Th. N. (2019). Control of Cadmium, Copper, Iron and Lead Residues in Chicken Meat and Their Offal. J. Food Nutr. Sci., 6(1): 62-67.

Elsharawy, N. Th. M. (2015). Some Heavy Metals Residues in Chicken Meat and their Edible Offal in New Valley. 2 nd Conference of Food Safety, Suez Canal University, Faculty of Veterinary Medicine, I: 53 - 60 .

EOS. (2010). Egyptian Organization for Standardization and Quality Control. Maximum level for certain contaminants in food stuffs. ES No. 7136/2010.

FAO. (1983). Food and Agricultural Organization. Compilation of Legal Limits for Hazardous Substance in Fish and Fishery Products. FAO Fishery circular464: 5–100.

FAO/WHO (2000). Report of the 32nd Session of the Codex Committee of the Food Additives Contaminants. Beijing People's Republic of China, 20-24 March.

Faten, S.; Hassan, M.; Amira, M. and Enas, A. (2014). Heavy metals residues in some chicken meat products. Benha veterinary medical journal, 27 (2): 256-263.

Ghimpeteanu, O.; Das, K.; Miltaru, M. and Scippo, M. (2012). Assessment of heavy metals and mineral nutrients in poultry liver using inductively coupled plasma -mass spectrometer (ICP-MS) and direct mercury analyzer (DMA). Bulletin UASMV, veterinary medicine, 69 (1-2): 258-266.

Hassan A. A. ; Rylande, Ch.; Sandange, T. M . and Brustad, M. (2013). Copper, Cobalt and Chromium in Meat, Liver, Tallow and Bone Marrow from Semi-domesticated Reindeer (Rangifer tarandus tarandus L.) in Northern Norwa. Food and Public Health, 3(3): 154-160.

Hassanin, F.S.; Hassan, M. A.; Mohmoud, A. M. *et. al*. (2014). Heavy metal residue in some chicken meat products. Benha Vet. Medical journal, 27(2): 256-263.

Hassouba, M. M.; Hashim, M. F. and Omaima, M. E. L. (2007). Hygienicstatus and prevelance of heavy metals and pesticides residues in frozen meat, chichen and their products in Luxor city. Assiut Vet. Med. J. Vol., 53 (114):1-15.

Joyce, K.; Emikpe, B. O.; Asare, D. A.; Asenso, T. N. and Richmond Y, et al. (2016). Effects of Different Cooking Methods on Heavy Metals Level in Fresh and Smoked Game Meat. J. Food Process. Technol., 7: 617.

Karatas, M.; Dursun, S.; Guler, E.; Ozdemir, C. and Emin Argun, M. (2006). Heavy metal accumulation in wheat plants irrigated by waste water. Cellulose Chem. Technol., 40 (7): 575-579.

Morgan, J. N. (1999). Effects of processing on heavy metal content of foods. Adv. Exp. Med. Biol., 459: 195–211.

Nasreddine, L. and Massin, D. P. (2002). Food contamination by metals and pesticides in the European Union. Should we worry?. J. Toxicol. Letters. 127: 29-41.

Okeke, O.; Ujah, I.; Okoye, P.; Ajiwe, V. and Eze, C. (2015). Assessment of the heavy metal levels in feeds and litters of chickensrose with in Awka Metropolis and itsenvirons. IOSR journal of applied chemistry (IOSR-JAC), 8 (1): 60-63.

Omojola, A.; Hammed, S.; Attoh-Kotoku, V.; Wogar-Gogar, G. and yanda, O.; *et al.* (2014). Physicochemical and organoleptic characteristics of Muscovy drake meat as influenced by cooking methods. Africa. J. Food Sci., 8: 184-189.

Reem, H.: Manal, E. and Hanady, M. (2012). Assessment of heavy metals (Cd , Pb and Zn) contents in livers of chicken available in the local markets of Basrah city, Iraq. Basra Journal of Veterinary Research, 11: 43-51.

Sadeghi, A.; Hashemi, M.; Jamali – Behnam, F.; Zohani, A.; Esmaily, H. and Dehghan, A. A. (2015). Determination of Chromium, Lead and Cadmium Levels in Edible Organs of Marketed Chickens in Mashhad, Iran. Journal of Food Quality and Hazards Control, 2: 134–138.

Salem, H. M.; Eweida, A. E. and Farag, A. (2000). Heavy metals in drinking water and their environmental impact on human health. ICEHM2000. pp: 542-556.

Sathyamoorthy, K.; Sivaruban, T. and Barathy, S. (2016). Assessment of heavy metal pollution and contaminants in the cattle meat. J. of Industrial Pollution Control, 32(1): 350-355.

Shahat, M.; Ammar, M. S.; Ramzy, S. M. and Baz, A. M. (2017). Health Risk Assessment of Toxic Heavy Metals and Pesticides Residues of some Raw Animal Foods Collected from Egyptian Market. Current Science International, 6(2): 421-430. veterinary medicine, 69 (1-2): 258-266.

Walaa, F. S. and Amal, A. R. (2018). Residues of some Toxic Heavy Metals and Trace Elements in Chicken Eggs. Zagazig Veterinary Journal, 46 (1): 8-16.

WHO. (1998). Wold health organization. Environmental health criteria IPCS. International Program of Chemical Safety.