Heavy Metal Residues in chicken cuts up and processed chicken meat products

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A B S T R A C T

The present study was conducted on 90 random samples of raw chicken meat (breast; thigh and drum stick, 15 of each) and processed chicken meat (hot wings; nuggets and shawerma, 15 of each) collected from different poultry slaughter shops and supermarkets in Kaliobia Governorate, for determination ofthe heavy metals residues (lead, cadmium, arsenic and copper) in them and their acceptability for human consumption. The results revealed that, for raw chicken meat samples; the mean values of lead, cadmium, arsenic and copper, concentrations "mg/Kg" in the examined samples of breast were 0.19 ± 0.01; 0.09 ± 0.01; 0.03 ± 0.01 and1.94 ± 0.05,respectively; for thigh samples ,they were 0.26 ± 0.01;0.11 ± 0.01;0.04 ± 0.01 and 2.08 ± 0.06, respectively and for drum stick samples , they were0.35 ± 0.02;0.14 ± 0.02;0.06 ± 0.01 and 2.25 ± 0.06, respectively. Meanwhile, for processed chicken meat samples; these mean values in hot wings samples, they were 0.39 ± 0.01; 0.19 ± 0.01; 0.07 ± 0.01 and 2.18 ± 0.09, respectively; for nuggets samples were 0.47 ± 0.02; 0.25 ± 0.01; 0.10 ± 0.01 and 2.41 ± 0.11, respectively and for shawerma samples ,they were0.61 ± 0.02;0.32 ± 0.01;0.12 ± 0.01and 2.63 ± 0.12, respectively. Moreover, the study concluded that, raw chicken meat and processed chicken meat products have public health hazard as the residues in them, might be exceeded the recommended safe permissible limits.

Key words: Chicken meat, Lead, Cadmium, Arsenic, Copper.

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1. INTRODUCTION

Chicken meat and its products are important for human diet over the entire world because they contribute to solve the global food problems and provide the well-known protein, fat, essential amino acids, minerals, vitamins and other nutrients (Alturiqi and Albedair, 2012).

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, threatening the animal and human health and quality of the environment (Järup, 2003 and DekoFehinti et al., 2012).

Heavy metal toxicity could be present in different ways depending on its route of ingestion, its chemical form, dose, tissue affinity, age and sex, as well as whether exposure is acute or chronic (Johri et al., 2010).

The main heavy metals of concern are lead, cadmium, copper, mercury and arsenic which at even low concentrations pose serious health hazard to primary and secondary consumers due to bio magnifications (Demirezen, and Uruc, 2006).

The main source of heavy metals in chicken meat arises from contamination of poultry feed and drinking water. Other sources of contamination can by vehicle emission and dirty slaughter places (Ghimpeteanu et al., 2012).

The effects of metals and metalloids are partly due to the direct inhibition of enzymatic systems and also to the indirect alteration of the essential metal ion equilibrium. Majority of the known metals and metalloids are very toxic to living organisms and even those

considered as essential can be toxic if present in excess (Celik and Oehlenschlager, 2007).

Lead is an accumulative poison; it has hematological effect due to the inhibition of hemoglobin synthesis and shortening life span of circulating erythrocytes resulting in anemia (Alberti and Fidainz, 2002).

It has a toxic and damage effects leading to reduction of the congental development and intellectual performance in children; increase blood pressure; damage of the brain and kidneys; cardiovascular and reproductive diseases in adults (Uluozluet al., 2009 and Kaplan et al., 2011).

Cadmium is used extensively in the mining and electroplating industries and found in fertilizes and fungicides. It is a very toxic heavy metal, which accumulates inside the body particularly kidneys and chronic exposure may induce heart diseases, anemia, skeletal weakness, depressed immune system response, kidney and liver diseases ; cancer and death (Fallah et al., 2011).

Copper is an essential element for man and animals. It is required for normal biological activity of several enzymes and it added to poultry diets with manganese and zinc (premix) to enhance their weight gain and disease prevention (Jackson et al., 2003).

Meanwhile, ingestion of excessive doses of copper may lead to adverse health problems, such as severe nausea, bloody diarrhea, hypotension, liver and kidney damage (Ikem and Egiebor, 2005).

Arsenic is a metalloid that occurs in inorganic and organic forms and is found in the environment, both naturally occurring and as a result of human activity. The inorganic forms of arsenic are more toxic than organic ones. However, so far, most of the data regarding arsenic occurrence in food, gathered under the official control of foodstuff, is still reported as total arsenic, without differentiating the various types of arsenic in the diet (Carey et al., 2010).

It has toxic effects includes decrease in hemoglobin, packed cell volume, erythrocytic count and total leukocytic counts, heterophils and lymphocytes (Halder et al., 2009).

Considering the fact that chicken meat and its products can contain some toxic heavy metals and therefore exposure to the toxic trace metals will be gained through consumption of these products, the accurate determination of them has been focused by researchers in last decades, worldwide (Fallah et al., 2011).

Therefore, the present study is to evaluate the contamination of some raw chicken meat and processed ones with heavy metals and their availability for human consumption.

2. MATERIALS AND METHODS

2.1. Collection of samples

A grand total of 90 random samples of raw chicken meat (breast; thigh and drum stick, 15 of each) and processed chicken meat (hot wings; nuggets and shawerma, 15 of each) were collected from different poultry slaughter shops and supermarkets in Kaliobia Governorate, Egypt. All collected samples were examined for determination of lead, cadmium, arsenic and copper levels on the basis of wet weight (mg/Kg).

2.2. Determination of heavy metals

Washing procedures following AOAC, (2006)

Digestion technique following Tsoumboris and Papadopoulou, (1994)

Preparation of blank and standard solutions following Shibamoto and Bjeldanes,(2000)

Analysis: The digest, blanks and standard solutions were aspirated by Atomic Absorption Spectrophotometer and analyzed for their concentrations of such elements following conditions recommended by the instrument instruction

Quantitative determination of heavy metals:

Absorbency of mercury, lead and cadmium was directly recorded from the digital scale

and their concentrations were calculated according to the following equation:

$$C=R \times (D/W)$$

Where, C= Concentration of the element (wet weight); R= Reading of digital scale of AAS; D= Dilution of the prepared sample; W= Weight of the sample

2.3. Statistical Analysis

Analysis of Variance (ANOVA) test was applied for statistical evaluation of the obtained results of each heavy metal detected in the examined samples of chicken meat and its products according to Feldman et al. (2003).

3. RESULTS

The results of heavy metals levels (lead, cadmium, arsenic and copper) were tabulated in tables (1-4)

The obtained results in Table (1), revealed that 40%, 46.7% and 60% of raw chicken meat (breast; thigh and drum stick), respectively and 60%, 66.7% and 80%, of processed chicken meat (hot wings; nuggets and shawerma) respectively, were contaminated with lead. Moreover, appeared that, the minimum and the maximum lead concentrations "mg/Kg" in the examined samples of raw chicken meat (breast; thigh and drum stick) ranged from 0.02 to 0.38; 0.04 to 0.51 and 0.04 to 0.64, respectively, with a mean values of 0.19 ± 0.01; 0.26 ± 0.01 and 0.35 ± 0.02, respectively. In addition, the minimum and the maximum lead concentrations "mg/Kg" in the examined samples of processed chicken meat (hot wings; nuggets and shawerma) ranged from 0.05 to 0.69; 0.06 to 0.82 and 0.06 to 1.17, respectively ,with a mean values of 0.39 ± 0.01; 0.47 ± 0.02 and 0.61 ± 0.02, respectively.

The results in Table (2) declared that; 33.3%, 46.7% and 53.3% of raw chicken meat (breast; thigh and drum stick), respectively and 46.7%, 60% and 73.3%, of processed chicken meat (hot wings; nuggets and shawerma) respectively, were contaminated with cadmium. Moreover, appeared that, the minimum and the maximum cadmium concentrations "mg/Kg" in the examined samples of raw chicken meat (breast; thigh and drum stick) ranged from 0.01 to 0.16; 0.01 to 0.22 and 0.02 to 0.29, respectively, with a mean values of 0.09 ± 0.01; 0.11 ± 0.01 and 0.14 ± 0.02, respectively. In addition, the minimum and the maximum cadmium concentrations "mg/Kg" in the examined samples of processed chicken meat (hot wings; nuggets and shawerma) ranged from 0.01 to 0.37; 0.03 to 0.40 and 0.04 to 0.51, respectively ,with a mean values of 0.19 ± 0.01; 0.25 ± 0.01 and 0.32 ± 0.01, respectively.

The results in Table (3) showed that, 13.3%, 13.3% and 20% of raw chicken meat (breast; thigh and drum stick), respectively and 20%, 26.7% and 33.3%, of processed chicken meat (hot wings; nuggets and shawerma) respectively, were contaminated with arsenic. Moreover, it cleared that, the minimum and the maximum arsenic concentrations "mg/Kg" in the examined samples of raw chicken meat (breast; thigh and drum stick) ranged from 0.01 to 0.05; 0.01 to 0.07 and 0.01 to 0.11, respectively, with a mean values of 0.03 ± 0.01; 0.04 ± 0.01 and 0.06 ± 0.01, respectively. In addition, the minimum and the maximum arsenic concentrations "mg/Kg" in the examined samples of processed chicken meat (hot wings; nuggets and shawerma) ranged from 0.01 to 0.12; 0.01 to 0.16 and 0.02 to 0.18, respectively ,with a mean values of 0.07 ± 0.01; 0.10 ± 0.01 and 0.12 ± 0.01, respectively.

The results in Table (4) showed that, all examined samples of raw chicken meat and processed ones (100%) were contaminated with copper. Moreover, appeared that, the minimum and the maximum copper concentrations "mg/Kg" in the examined

samples of raw chicken meat (breast; thigh and drum stick) ranged from 0.69 to 2.81; 0.86 to 3.15 and 0.92 to 3.44, respectively, with a mean values of 1.94 ± 0.05; 2.08 ± 0.06 and 2.25 ± 0.06, respectively. In addition, the minimum and the maximum copper concentrations "mg/Kg" in the examined samples of processed chicken meat (hot wings; nuggets and shawerma) ranged from 0.89 to 3 .27; 1.03 to 3.62 and 1.21 to 3.81, respectively ,with a mean values of 2.18 ± 0.09; 2.41 ± 0.11 and 2.63 ± 0.12, respectively.

Table 1: Incidence and concentrations of lead (mg/Kg) in the examined samples of raw chicken cuts and processed chicken meat products (n=15)

samples	+ve samples		Min	Max	Mean ± S.E*	Unaccepted Samples Maximum Residual Limit (mg/Kg)**	
	No.	%				No.	%
Raw chicken cutst:Breast	6	40	0.02	0.38	0.19 ± 0.01	4	26.7
Thigh	7	46.7	0.04	0.51	0.26 ± 0.01	6	40
Drum stick	9	60	0.04	0.64	0.35 ± 0.02	7	46.7
Processed chicken meat:							
Hot wings	9	60	0.05	0.69	0.39 ± 0.01	7	46.7
Nuggets	10	66.7	0.06	0.82	0.47 ± 0.02	8	53.3
Shawerma	12	80	0.06	1.17	0.61 ± 0.02	10	66.7

S.E* = standard error of mean,** Maximum Residual Limit of lead (0.10mg/Kg) stipulated by Egyptian Organization of Standardization "EOS" (2010).

Table 2: Incidence and concentrations of cadmium "mg/Kg" in the examined samples of raw and processed chicken meat products (n=15)

samples	+ve samples		Min	Max	Mean ± S.E*	Unaccepted Samples Maximum Residual Limit (mg/Kg)**	
	No.	%				No.	%
Raw chicken cuts:Breast	5	33.3	0.01	0.16	0.09 ± 0.01	3	20
Thigh	7	46.7	0.01	0.22	0.11 ± 0.01	5	33.3
Drum stick	8	53.3	0.02	0.29	0.14 ± 0.02	7	46.7
Processed chicken meat:							
Hot wings	7	46.7	0.01	0.37	0.19 ± 0.01	6	40
Nuggets	9	60	0.03	0.40	0.25 ± 0.01	8	53.3
Shawerma	11	73.3	0.04	0.51	0.32 ± 0.01	9	60

S.E* = standard error of mean,** Maximum Residual Limit of cadmium (0.10mg/Kg) stipulated by Egyptian Organization of Standardization "EOS" (2010)

Table 3: Incidence and concentrations of arsenic "mg/Kg" in the examined samples of raw and processed chicken meat products (n=15)

samples	+ve samples		Min	Max	Mean ± S.E*	Unaccepted Samples Maximum Residual Limit (mg/Kg)**	
	No.	%				No.	%
Raw chicken cuts:Breast	2	13.3	0.01	0.05	0.03 ± 0.01	1	6.7
Thigh	2	13.3	0.01	0.07	0.04 ± 0.01	1	6.7
Drum stick	3	20	0.01	0.11	0.06 ± 0.01	2	13.3
Processed chicken meat:							
Hot wings	3	20	0.01	0.12	0.07 ± 0.01	2	13.3
Nuggets	4	26.7	0.01	0.16	0.10 ± 0.01	3	20
Shawerma	5	33.3	0.02	0.18	0.12 ± 0.01	5	33.3

S.E* = standard error of mean,** ** Maximum Residual Limitof arsenic (0.01mg/Kg) stipulated by Food Stuffs Cosmetics and Disinfectant Act (2007)

Table 4: Incidence and concentrations of copper "mg/Kg" in the examined samples of raw and processed chicken meat products (n=15)

samples	+ve samples		Min	Max	Mean ± S.E*	Unaccepted Samples Maximum Residual Limit (mg/Kg)**	
	No.	%				No.	%
Raw chicken cuts:Breast							
	15	100	0.69	2.81	1.94 ± 0.05	0	0
Thigh	15	100	0.86	3.15	2.08 ± 0.06	0	0
Drum stick	15	100	0.92	3.44	2.25 ± 0.06	0	0
Processed chicken meat:							
Hot wings	15	100	0.89	3.27	2.18 ± 0.09	0	0
Nuggets	15	100	1.03	3.62	2.41 ± 0.11	0	0
Shawerma	15	100	1.21	3.81	2.63 ± 0.12	0	0

S.E* = standard error of mean,** Maximum Residual Limitof copper (20mg/Kg) stipulated by Food Stuffs Cosmetics and Disinfectant Act (2007)

4. DISCUSSION

Heavy metals residues in foods of animal origin such as poultry meat and other protein sources is a serious issue and need a great concern because these metals are highly toxic in nature and had adverse effects on human health (Umer et al.,2017).

4.1. Lead

The recorded results in Table (1), revealed that, the mean values of lead concentrations in the examined samples of raw chicken meat (breast; thigh and drum stick) were 0.19 ± 0.01; 0.26 ± 0.01 and 0.35 ± 0.02, respectively. In addition, the mean values in processed chicken meat (hot wings; nuggets and shawerma) were 0.39 ± 0.01; 0.47 ± 0.02 and 0.61 ± 0.02, respectively. Moreover, 42 samples, 4 breast (26.7%); 6 thigh (40%); 7drum stick (46.7%); 7 hot wings (46.7%); 8 nuggets (53.3%) and 10 shawerma (66.7%) were unaccepted for human consumption, as they were exceeded the maximum permissible limit of lead in raw chicken meat and its products that should not exceed 0.10 mg/kg (EOS, 2010). Nearly similar results were obtained by Abd El-Mageed-Walaa (2013), who found that the mean values of lead were 0.16 ±0.01 and 0.27 ± 0.02 mg/kg, in examined samples of chicken breast and thigh, respectively and El-Sharawy- Nagwa (2015)), who found that the mean values of lead were 0.26 ± 0.016 mg/kg, in examined samples of chicken thigh. Meanwhile, lower results obtained by EI-Tawwab (2004) who found that the mean value of lead were 0.318 ± 0.008 mg/kg wet weight, in the examined samples of shawarma and Mohamed- Enas (2014) who found that the mean value of lead were 0.30 ± 0.01 mg/kg wet weight, in the examined samples of nuggets and higher results obtained by Shaltout et al. (2003); who found that the mean value of lead were 0.79 mg/kg wet weight in examined samples of shawarma, Mohamed- Hala and Nosier-Shireen (2009) who detected that, the mean values of lead in chicken shawerma was 1.484 ±1.771, Abd El-Aziz-Amira (2013) who detected that, the mean values of lead in chicken processed products were0.76 ±.07 mg/kg and Iwegbue et al. (2008) who detected that, the mean values of lead in chicken meat was 4.60 ±.92 mg/kg.

Lead encephalopathy in children due to lead toxicity characterized by irritability, ataxia, convulsion and altered state of consciousness, whereas lead toxicity in adults lead to neuropathy result in wrist and food drop (Jarup, 2003 and Lidsky and Schneider, 2003 and Kaplan et al., 2011).

Centers for disease control and prevention, CDC (2012) stated that, lead can be ingested from various sources, including lead paint and

house dust contaminated by lead paint, as well as soil, drinking water and food.
Abd EI-Salam et al. (2013) reported that, Pb may enter the atmosphere during mining, smelting, refining, manufacturing processes and by the use of lead containing products.

4.2. Cadmium

The obtained results in Table (2) appeared that, the mean values of cadmium concentrations in the examined samples of raw chicken cuts up(breast; thigh and drum stick)were 0.09 ± 0.01; 0.11 ± 0.01 and 0.14 ± 0.02, respectively; while in processed chicken meat (hot wings; nuggets and shawerma) were 0.19 ± 0.01; 0.25 ± 0.01 and 0.32 ± 0.01, respectively. Moreover, 38 samples, 3 breast (20%); 5 thigh (33.3%); 7drum stick (46.7%); 6 hot wings (40%); 8 nuggets (53.3%) and 9 shawerma (60%) were unaccepted for human consumption, as they were exceeded the maximum permissible limit of cadmium in raw chicken meat and its products that should not exceed 0.05 mg/kg (EOS, 2010). Nearly similar results were obtained by Abd El-Mageed- Walaa (2013)), who found that the mean values of cadmium were 0.09 ±0.01 and 0.10 ± 0.01 mg/kg, in examined samples of chicken breast and thigh, respectively .Meanwhile, lower results obtained by EI-Tawwab (2004) who surveyed that the mean value of cadmium were 0.241 ± 0.004 mg/kg wet weight, in examined samples of shawarma, Aiad et al. (2007) who recorded that the mean values of cadmium in examined sample of nuggets were 0.047 ± 0.013 ,Hamasalim and Mohammed (2013) who recorded that the mean values of cadmium in examined sample of chicken processed products were 0.06 ± 0.003;Mohamed- Enas (2014) who recorded that the mean values of cadmium in examined sample of nuggets were 0.19 ± 0.01 and El-Sharawy- Nagwa (2015) , who found that the mean values of cadmium were 0.04 ± 0.02 mg/kg, in examined samples of chicken thigh and higher results obtained by Shaltout et al. (2003) who recorded that,the mean value of cadmium were 2.185 mg/kg wet weight, in the examined samples of shawarma , Abd El-Aziz-Amira (2013) who detected that, the mean values of cadmium in chicken processed products were 0.58 ±.05 mg/kg and Mohamed- Hala and Nosier-Shireen (2009) who found that the mean value of cadmium in chicken shawarma sample were 0.338 ± 0.435mg/kg .In humans and animals, cadmium contamination is usually caused by the food chain (Zhuang et al., 2009). Cadmium may accumulate in the human body and plays a role in hypertension, diabetes mellitus, 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 and also, may induce kidney dysfunction, skeletal damage and reproductive deficiencies (Johri et al., 2010 and Hamasalim and Mohammed, 2013).

Codex Alimentarius (2001) stated that, cadmium is released into the atmosphere from the burning of coal, other fossil fuels, sewage sludge, medical and municipal wastes. Cadmium contamination of the soil water and sediments can occur through municipal wastewater treatment, electroplating, metal processing, plastic and dye manufacturing, and the application of phosphate fertilizers. Cadmium enters plants and animals (poultry) life cycle from the soil and water, thus entering the food supply. Currently, food contributes 80-90% of the cadmium doses received by most people. Lead as a metallic contaminant has been found to occur in processed foods and particularly canned foods, whereas, when the food handling equipment and utensils are made of inappropriate materials or through corrosion,

the metal is released onto or in the food as a contaminant.

4.3. Arsenic

Concerning the arsenic results, Table, 3 showed that, mean values of arsenic concentrations in the examined samples of raw chicken cuts up (breast; thigh and drum stick)were 0.03 ± 0.01; 0.04 ± 0.01 and 0.06 ± 0.01, respectively and in processed chicken meat (hot wings; nuggets and shawerma) were 0.07 ± 0.01; 0.10 ± 0.01 and 0.12 ± 0.01, respectively. In addition, 14 samples, 1 breast (6.7%); 1 thigh (6.7%); 2drum stick (13.3%); 2 hot wings (13.3%); 3 nuggets (20%) and 5 shawerma (33.3%)were unaccepted for human consumption, as they were exceeded the maximum permissible limit of arsenic in raw chicken meat and its products that should not exceed 0.01mg/kg (Food Stuff Cosmetics and Disinfectant Act, 2007) .Nearly similar variable concentrations of arsenic in raw chicken meat and its products were obtained by Ghosh et al.(2012) who found that the mean values of arsenic were 0. 0556± 0.0113 mg/kg, in examined samples of chicken thigh and Islam et al. (2013) who found that the mean values of arsenic were 0. 053± 0.01 mg/kg, in examined samples of chicken thigh. Meanwhile, higher results obtained by El-Sharawy- Nagwa (2015) who found that the mean values of arsenic were 0. 46 ± 0.01 mg/kg, in examined samples of chicken thigh and Imran et al. (2015) who found that the mean values of arsenic were0. 77± 0.68 mg/kg, in examined samples of chicken meat samples

Chronic ingestion of arsenic has deleterious effects for human even at low exposure levels, resulting in various clinical symptoms such as hyperpigmentation and keratosis; cardiovascular disease; neuropathy; suppress hormone regulation and hormone mediated gene transcription; increases in fetal loss, premature delivery, and decreased birth weights of infants and urinary tract and lung cancers (Lasky et al., 2004 and Kapaj et al., 2006).

Smedley and Kinniburgh (2002) recorded that, human activities, such as the burning of fossil fuels, metal smelting and the production of semiconductors and glasses, have stimulated the accumulation of arsenic in the environment. Arsenic is also a component of many commonly used materials, including wood, pigments, insecticides, herbicides, rodenticides and fungicides.

4.4. Copper

Regarding to copper results Table, 4 showed that, the mean values of copper concentrations in the examined samples of raw chicken cuts up(breast; thigh and drum stick)were 1.94 ± 0.05; 2.08 ± 0.06 and 2.25 ± 0.06, respectively. Meanwhile, in processed chicken meat (hot wings; nuggets and shawerma), they were 2.18 ± 0.09; 2.41 ± 0.11 and 2.63 ± 0.12, respectively. Moreover, all examined samples of raw chicken cuts up and processed ones (100%) were accepted for human consumption based on their contents of copper and come in accordance with those recorded by Food Stuff Cosmetics and Disinfectant Act (2007) which stipulated that, the maximum permissible limit of copper in raw chicken meat and its products should not exceed 20 mg/kg. Nearly similar results were obtained by Mohamed- Hala and Nosier-Shireen (2009) who recorded that the mean value of copper in chicken shawerma samples was 2.854 ± 2.642 mg/kg, Abd El-Mageed-Walaa (2013) who found that the mean values of copper were 1.46 ±0.10 and 2.91 ± 0.13 mg/kg, in examined samples of chicken breast and thigh, respectively. Meanwhile, lower results obtained by El-Sharawy- Nagwa (2015) who found that the mean values of copper were 0. 26± 0.016 mg/kg, in examined samples of chicken thigh, Aiadet al.(2007; Hamasalim and Mohammed (2013) who

recorded that the mean value of copper in chicken processed samples was .15 ± .005 mg/kg and Mohamed- Enas (2014) who recorded that the mean values of copper in examined sample of nuggets were1.68 ± 0.15 and higher results obtained by Iwegbue et al. (2008) who found that the mean values of copper were 5.15± 0.50 mg/kg, in examined samples of chicken meat samples and Imran et al. (2015) who found that the mean values of copper were 3.01 ± 0.59 mg/kg, in examined samples of chicken meat samples.

Copper toxicity including, jaundice, nausea, severe colic, diarrhea, while chronic disease was epitomized by wilson's disease which characterized by excessive copper deposition in most organs as liver, gizzard, brain and eyes, so consumption of such meat from polluted environment may pose human health hazards resulting in cancer, renal failure, hypertension, neuropathy of both central and peripheral nervous system (Brito et al., 2005 and Nnaji et al., 2007).

Finally, the present study proved that, raw chicken cuts up and processed chicken meat products have public health hazard as the residues in them, might be exceeded the recommended safe permissible limits stipulated by Food Stuffs Cosmetics and Disinfectant Act (2007) and Egyptian Organization for Standardization (EOS, 2010) and must be controlled to prevent or minimize the toxic residues and improve the sanitary status of chicken meat and processed chicken meat products.

Kaur and Rani (2006) recorded that, the using of sewage sludge were pointed to Cu contaminations.

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