Assessment of Heavy Metals in Cooked Meat and Chicken Meat

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A B S T R A C T

This study was conducted to evaluate the levels of heavy metals (lead , cadmium and copper)in cooked beef and chicken meat . The obtained results indicated that the mean values of lead concentration in the examined samples of boiled chicken thigh, boiled chicken breast, roasted chicken thigh, roasted chicken breast, boiled fore quarter beef and boiled hind quarter beef were 0.15± 0.01 , 0.12± 0.01 ,0.21± 0.02 ,0.16± 0.01 ,0.09± 0.01 and 0.13±0.01 mg/kg wet weight, respectively. While the mean values of cadmium concentration in the examined samples of boiled chicken thigh, boiled chicken breast, roasted chicken thigh, roasted chicken breast, boiled fore quarter beef and boiled hind quarter beef were 0.09± 0.01 , 0.06± 0.01 ,0.14± 0.01 ,0.10± 0.01 ,0.05± 0.01 and 0.08± 0.01 , respectively Furthermore, and that the mean values of copper concentration in the examined samples of boiled chicken thigh, boiled chicken breast, roasted chicken thigh, roasted chicken breast, boiled fore quarter beef and boiled hind quarter beef were 2.28± 0.35 , 1.47± 0.22 ,2.59± 0.46 ,2.06± 0.31 ,1.47± 0.19 and 1.60±0.23 mg/kg wet weight, respectively, The public health importance of the heavy metals and the recommended points were discussed.

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1.INTRODUCTION

The nutritional value of meat is generally derived from its high protein content. The fats in meats can also be a valuable source of energy for the body. Meat typically contains important minerals including iron, phosphorous, zinc, and the complete range of B vitamins, some of which like vitamin B12 can usually only be found in foods derived from animals.

Chicken meat is one of the most popular food products worldwide. It constitutes an excellent source of high quality animal proteins, vitamins, as riboflavin, thiamine and ascorbic acid ,Poultry meat also has a milder flavor which is more readily complemented with flavoring and sauces , Poultry fat is almost associated with the skin where it is easily removed resulting reducing dietary fat contrasted with mammalian meats as beef(Zhang *et al.*, 2001). In recent years, much attention has been paid to the possible dangers of metal poisoning in human. It has been reported that lead and cadmium are concentrated mostly in kidney, liver leading to kidney damage and liver cirrhosis. They constitute severe threat to human health due to their cumulative nature resulting in cancer, renal failure, human hypertension, neuropathy of central & peripheral nervous system, gastroenteritis, diarrhea, diabetes mellitus and osteomalacia (Klopov, 1998 and Eife*et al*., 1999).

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 (Chisaolm, 1973).

Cadmium is a very toxic heavy metal, which accumulates inside the body particularly kidneys leading to kidney stones(Fergusson, 1990). Generally, the ingestion of cadmium may result in acute gastroenteritis which is characterized by sudden onset of vomition, diarrhea and abdominal pain(Buculer*et al.,* 1986). , Chronic copper poisoning may lead to Wilson,s disease which is manifested by destruction of nerve cells, liver cirrhosis, aschitis, edema and hepatic failure. Also, copper poisoning is characterized by Kayser Fleischer ring which is a golden brown ring of accumulated copper in the cornea of the eye. There fore, this study was conducted to evaluate heavy metals contamination in cooked meats.

2.MATERIALS AND METHODS

2.1.*Collection of Samples*:

Ninety random samples of cooked meat and chicken meat from different restaurants in El-Kalyobia Governorate. The cooked chicken meat samples were represented by boiled thigh ,boiled breast ,roasted thigh and roasted breast (15 of each). Further, the cooked beef samples were represented by fore quarter and hind beef*(*15 of each) . All collected samples were kept in a separated sterile plastic bag and preserved in an ice box then transferred as quickly as possible to the laboratory with a minimum limit of delay. then subjected to following examination.

2.2.*Methods*:

2.2 .1. Washing procedures (AOAC, 2006):

2.2.2. Digestion technique (Deng et al., 2007):

Accurately, 2 g of each sample were macerated by sharp scalpel and digested by 10ml of digestion mixture (60ml of 65% Nitric acid and 40ml of 70% perchloric acid) in screw capped tube after maceration The tubes were tightly closed and the contents were vigorously shaken and allowed to stand over night at room temperature. Moreover, the tubes were heated for 4 hours in water bath starting from 60^{o}C till reach 110^{o}C ensure complete digestion of the samples. The digestion tubes were vigorously shaken at 30 minutes intervals during the heating period. The tubes were then left to cool at room temperature and diluted with 1ml deionized water (30%) as well as reheated in water bath at 70^{o}C to ensure complete digestion of the samples. At this point, all organic matrixes have been destroyed. Each tube was diluted with deionized water till reach 25 ml and the digest was filtered with Whattman filter paper No. 42. The filtrates were collected in Pyrex glass test tubes capped with polyethylene film and kept at room temperature until analyzed for their lead, cadmium and copper concentrations.

2.2.3. preparation of blank and standard solutions :

2.2.4 Analysis:

The digest, blanks and standard solutions were aspirated by Atomic Absorption Spectrophotometer and analyzed for their concentrations of such elements.

Absorbency of lead, cadmium and copper 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.

N. B. The concentration of each element in the blank solution was also calculated and subtracted from each analyzed sample.

2.3. Statistical analysis: the obtained results were statistically evaluated by application of Analysis of Variance (ANOVA) test according to Feldman et al. (2003).

3. RESULTS

It is evident from results recorded in table (1) and Fig. (1) that the concentrations of lead in the examined samples of boiled chicken thigh, breast, roasted chicken thigh, breast and boiled beef fore quarter and hind quarter were ranged from 0.04to 0.26 with a mean value of 0.15 ± 0.01 , 0.03 to 0.19 with a mean value of 0.12 ± 0.01 and 0.06 to 0.34 with a mean value of 0.21 ± 0.02 and from 0.04 to 0.29 with a mean value of 0.16 ± 0.01 , 0.01 to 0.16 with a mean value of 0.09 ± 0.01 and 0.02 to 0.25 with a mean value of 0.13 ± 0.01mg/kg, respectively. was significant at level ($p<0.05$) According to EOS (2005) which recommented that the maximum permissible limit for lead is 0.1 mg/kg , the percentages of unaccepted boiled chicken thigh, breast, roasted chicken thigh, breast and boiled beef fore quarter, hind quarter were 33.3% , 20% , 53.3% ,33.3% , 13.3% and 20% , respectively.

Results achieved in table (2) and fig. (2) revealed that the concentrations of cadmium in the examined samples of boiled chicken thigh, breast, roasted chicken thigh, breast and boiled beef fore quarter, hind quarter were 0.01 to 0.19 with a mean value of 0.09 ± 0.01 , 0.01 to 0.12 with a mean value of 0.06 ± 0.01 , 0.03 to 0.22 with a mean value of 0.14 ± 0.01, 0.04 to 0.29 with a mean value of 0.10 ± 0.01, 0.01 to 0.11 with a mean value of 0.05 ± 0.01 and 0.01 to 0.13 with a mean value of 0.08 ± 0.01 mg/kg, respectively. Such variations between the examined samples of cooked meat and chicken meat products were significant ($p < 0.05$),. According to EOS (2005) which recommended that the maximum permissible limit for cadmium is 0.1 mg/kg , the percentages of unaccepted boiled chicken thigh, breast, roasted chicken thigh, breast and boiled beef fore quarter, hind quarter were 26.7% , 13.3% , 40% ,20% , 6.7% and 13.3% , respectively. Furthermore, table (3) and fig. (3) indicated that the concentrations of copper in the examined samples of boiled chicken thigh, breast, roasted chicken thigh, breast and boiled beef fore quarter, hind quarter meat ranged from 1.16to 3.27 with a mean value of 2.28 ± 0.35, 1.01 to 2.93 with a mean value of 1.74 ± 0.22 , 1.42 to 3.65 with a mean value of 2.59 ± 0.46 , 1.18 to 3.10 with a mean value of 2.06 ± 0.31 , 0.87 to 2.55 with a mean value of 1.47 ± 0.19 and 0.96 to 2.71 with a mean value of 1.60 ± 0.23 mg/kg, respectively. The significant differences ($p < 0.05$) as indicated by t- test . According to Food Stuff Cosmetics and Disinfectant Act (2002) which recommented that the maximum permissible limit for copper is 20 mg/kg , all the examined samples of Boiled chicken thigh , Boiled chicken breast , Roasted chicken thigh , Roasted chicken breast , Boiled fore quarter meat and Boiled hind quarter meat were accepted

Table1(1): Statistical analytical results of lead levels "mg/Kg" in the examined samples of cooked chicken meat served at restaurant level (n=15).

Cuts	Thigh			Breast		
Cooking	Min	Max	Mean ± S.E*	Min	Max	Mean ± S.E*
Boiled chicken	0.04	0.26	0.15± 0.01	0.03	0.19	0.12 ± 0.01+
Roasted chicken	0.06	0.34	0.21 ± 0.02	0.04	0.29	0.16 ± 0.01

Table (2): Statistical analytical results of lead in the examined samples of boiled meat served at restaurant level (n=15).

Cuts	Min	Max	Mean ± S.E*
Fore quarter	0.01	0.16	0.09 ± 0.01+
Hind quarter	0.02	0.25	0.13 ± 0.01

+ = Significant differences (P<0.05) as indicated by student t-test

Table (3): Statistical analytical results of cadmium levels "mg/Kg" in the examined samples of cooked chicken meat served at restaurant level (n=15).

Cuts	Thigh			Breast		
Cooking	Min	Max	Mean ± S.E*	Min	Max	Mean ± S.E*
Boiled chicken	0.01	0.19	0.09± 0.01	0.01	0.12	0.06 ± 0.01+
Roasted chicken	0.03	0.22	0.14 ± 0.01	0.04	0.29	0.10 ± 0.01

+ = Significant differences (P<0.05) as indicated by student t-test

Table (4): Statistical analytical results of cadmium in the examined samples of boiled beef served at restaurant level (n=15).

Cuts	Min	Max	Mean ± S.E*
Fore quarter	0.01	0.11	0.05 ± 0.01+
Hind quarter	0.01	0.13	0.08 ± 0.01

+ = Significant differences (P<0.05) as indicated by student t-test

Table (5): Statistical analytical results of copper levels "mg/Kg" in the examined samples of cooked chicken meat served at restaurant level (n=15).

Cuts	Thigh			Breast		
Cooking	Min	Max	Mean ± S.E*	Min	Max	Mean ± S.E*
Boiled chicken	1.16	3.27	2.28± 0.35	1.01	2.93	1.74 ± 0.22+
Roasted chicken	1.42	3.65	2.59 ± 0.46	1.18	3.10	2.06 ± 0.31

+ = Significant differences (P<0.05) as indicated by student t-test

Table (6): Statistical analytical results of copper in the examined samples of boiled beef served at restaurant level (n=15).

Cuts	Min	Max	Mean ± S.E*
Fore quarter	0.87	2.55	1.47 ± 0.19+
Hind quarter	0.96	2.71	1.60 ± 0.23

+ = Significant differences (P<0.05) as indicated by student t-test

Table (7): Acceptability of the examined samples of cooked meat and chicken meat based on their levels of lead (n=15).

Food meals	Maximum Permissible Limit (mg %)*	Accepted Samples		Unaccepted Samples	
		No.	%	No.	%
Boiled chicken thigh	0.10	10	66.7	5	33.3
Boiled chicken breast		12	80	3	20
Roasted chicken thigh		7	46.7	8	53.3
Roasted chicken breast		10	66.7	5	33.3
Boiled fore quarter meat		13	86.7	2	13.3
Boiled hind quarter meat		12	80	3	20

* Maximum Residual Limit stipulated by Egyptian Organization for Standardization "EOS" (2005).

Table (8): Acceptability of the examined samples of cooked meat and chicken meat based on their levels of cadmium (n=15).

Food meals	Maximum Permissible Limit (mg %)*	Accepted Samples		Unaccepted Samples	
		No.	%	No.	%
Boiled chicken thigh	0.05	11	73.3	4	26.7
Boiled chicken breast		13	86.7	2	13.3
Roasted chicken thigh		9	60	6	40
Roasted chicken breast		12	80	3	20
Boiled fore quarter meat		14	73.3	1	6.7
Boiled hindquarter meat		13	86.7	2	13.3

* Maximum Residual Limit stipulated by Egyptian Organization for Standardization "EOS" (2005).

4. DISSCUSION

The concentrations of lead in the examined samples of boiled chicken thigh , boiled chicken breast , roasted chicken thigh , roasted chicken breast , boiled fore quarter beef and boiled hind quarter beef ranged from 0.04to 0.26 with a mean value of 0.15 ± 0.01 , 0.03 to 0.19 with a mean value of 0.12 ± 0.01 and 0.06 to 0.34 with a mean value of 0.21 ± 0.02 and from 0.04 to 0.29 with a mean value of 0.16 ± 0.01 , 0.01 to 0.16 with a mean value of 0.09 ± 0.01 and 0.02 to 0.25 with a mean value of 0.13 ± 0.01mg/kg, respectively.The significant differences ($p<0.05$) as indicated by student t- test .

According to the safe permissible limit stipulated by EOS (2005) for lead in cooked meat and chicken meat products (0.1 ppm), it was indicated that 33.3%, 20% ,53.3% , 33.3%, 13.3% and 20%, of the examined samples of boiled chicken thigh, boiled chicken breast , roasted chicken thigh, roasted chicken breast, boiled fore quarter beef and boiled hind quarter beef, respectively.

Lead is one of the most ubiquitous metals known to humans. Children, pregnant women, and the malnourished can absorb 40-70% of ingested lead. Dietary deficiencies of iron, calcium, zinc and ascorbic acid can result in increased gastrointestinal absorption of lead(Sargent, 1994)..

The most sensitive targets for lead toxicity are the developing nervous system, the haemotological, gastrointestinal, renal, reproductive and cardiovascular systems. Excretion of lead is primarily via the kidneys and can also be excreted with bile through the gastrointestinal tract, and the half life of lead in blood is about 30 days 20-30 years in bone which contains up to 94% of the body burden of lead (Patocka and Cerný, 2003).

Lead exposure has also been associated with reduced bone growth in fetuses and children, resulting in reduced head circumference and stature. Lead interferes with bone formation, maturation and resorptionand 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(CDC, 2006).

The concentrations of cadmium in the examined samples of boiled chicken thigh , boiled chicken breast , roasted chicken thigh , roasted chicken breast , boiled fore quarter beef and boiled hind quarter beef ranged from 0.01 to 0.19 with a mean value of 0.09 ± 0.01 , 0.01 to 0.12 with a mean value of 0.06 ± 0.01 , 0.03 to 0.22 with a mean value of 0.14 ± 0.01, 0.04 to 0.29 with a mean value of 0.10 ± 0.01, 0.01 to 0.11 with a mean value of 0.05 ± 0.01 and 0.01 to 0.13 with a mean value of 0.08 ± 0.01 mg/kg, respectively.Such variations between the examined samples of cooked meat and chicken meat products were significant ($p < 0.05$),.

Table (8) showed that 26.7%, 13.3% , 40%, 20%, 6.7% and 13.3%, of the examined samples of boiled chicken thigh , boiled chicken breast , roasted chicken thigh , roasted chicken breast , boiled fore quarter beef and boiled hind quarter beef , respectively, exceeded the safe permissible limit recommended by EOS (2005) for cadmium in ready – to – eat chicken meat products (0.1 ppm),

Cadmium is a cumulative toxic agent with a biological half – life of 10-30 years. Accurately, cadmium acts on sulphhydryl groups of essential enzymes and also binds to albumin, phospholipids and nucleic acids, interferes with oxidative phosphorylation and replaces zinc in enzymes so changing their activities (Bernard, 2004).

Cadmium is a severe pulmonary and gastrointestinal irritant, which can be fatal if inhaled or ingested. Furthermore,cadmium plays a role in hypertension, diabetes mellitusin human, through injury of adrenal gland, adipose, hepatic, and pancreatic tissue, especiallycells 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).

Cadmium is nephrotoxic pollutant, causing kidney damage, end stage renal disease (ESRD), irreversible renal failure, nephritis, kidney stones and overall mortality (Johri*et al.,* 2010). Moreover, cadmium is classified as a probable human carcinogen (group I) (IARC, 1993). Interestingly cadmium is not directly genotoxic, but only weakly mutagenic in mammalian cells (Dally and Hartwig, 1997).

The concentrations of copper in the examined samples of boiled chicken thigh , boiled chicken breast , roasted chicken thigh , roasted chicken breast , boiled fore quarter beef and boiled hind quarter beef ranged from 1.16to 3.27 with a mean value of 2.28 ± 0.35, 1.01 to 2.93 with a mean value of 1.74 ± 0.22 , 1.42 to 3.65 with a mean value of 2.59 ± 0.46 , 1.18 to 3.10 with a mean value of 2.06 ± 0.31 , 0.87 to 2.55 with a mean value of 1.47 ± 0.19 and 0.96 to 2.71 with a mean value of 1.60 ± 0.23 mg/kg, respectively. The significant differences ($p < 0.05$) as indicated by student t- test .

All the examined samples of boiled chicken thigh , boiled chicken breast , roasted chicken thigh , roasted chicken breast , boiled fore quarter beef and boiled hind quarter beef were accepted based on their copper content according to * Food Stuffs Cosmetics and Disinfectant Act (2002)towhich stated that the maximum permissible limit for copper should not exceed 20 mg/kg in cooked meat and chicken meat

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 (Marian *et al.,* 1991). Copper compounds causes cirrhosis and liver debilitating condition in continuous ingestion (Muller-Hoccker *et al.*, 1988).

Chronic exposure to copper fumes leads to a syndrome termed "metal fume fever" which is characterized by nasal congestion, fever up to 39°C, chills, malaise and shortness of breath. The symptoms generally developed after repeated exposure (Zenz, 1988).

5. CONCLUSION

The obtained results in the present study concluded that the examined samples of Rosted chicken Thigh were the most contaminated samples with lead, cadmium followed by boiled chicken Thigh and rosted chicken breast Furthermore, the examined samples of boiled beef fore quarter were less contaminated with heavy metals residues . To control these serious pollutants to gain access to meat and chicken meat products.

Application and implementation of hazard analysis and critical control point (HACCP) system may be the appropriate solution to ensure quality and safety of such ready – to – eat food particularly during preparation and serving.

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