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Estimation of some heavy metals residues in chicken and meat shawerma from fast food restaurants and its relation to public health

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Abstract

A total of 40 random meat and Chicken Shawerma samples (20of each) were collected from different fast food restaurants in Beheria Governorates for the determination of Lead, Cadmium, Aluminium, Copper, and Zinc using Microwave Plasma Atomic Emission Spectroscopy (MP-AES) Spectrophotometer. The obtained results showed that the average value of lead, cadmium, copper, and zinc in examined meat Shawerma were 0.55± 0.14, 1.66± 0.33, 75.32 ± 7.84, and 110.54± 8.64 ppm respectively. While, in examined chicken shawerma were 0.09± 0.02, 0.99± 0.17, 47.19 ± 6.13 and 92.65± 9.62 ppm, respectively. Regarding, aluminum detected in one sample of meat Shawerma with value 0.001 ppm and one only in chicken Shawerma with value 0.001 ppm. The results were compared to the Egyptian national standards and some of the international ones. High levels of lead and cadmium in meat shawerma may be due to contamination from industrial sources or preparation methods of Shawerma, which played an important role in the presence of high levels of heavy metals, which considered being a risky health hazard. Controlling sources of pollutants was the main suggestion to control the high levels of heavy metals pollutions.

Key words: *Heavy metals, Meat Shawerma, chicken Shawerma, fast food, public health.*

Introduction

In recent years, in Egypt there is an increasing trend for ready to eat meals (including chicken and meat Shawerma) to be consumed both at home and restaurants. They are offered quickly, delicious meals. Shawarma is made by placing strips of meat or marinated chicken on a skewer as a large rotating cone. Animal fat and onion or tomatoes are that is located behind the actual cone. The meat is thinly sliced by a chef with a large knife to a circular tray below to be retrieved. Shawarma is made up include onion, tomato, lettuce, parsley, with dressing include Tahina, vinegar, spicy. **(Essa *et al.,* 2007 and William *et al.,* 2008).**

Today, the environmental pollution by heavy metals is considered as one of the most serious problems in most countries all over the world (**Abou-arab, 2001)**. Trace metals have been introduced to the environmental both through natural processes and because of human activities such as industrialization or fuel combustion (**Kosonovic *et al.,* 2007)**.

Emissions of heavy metals to the environment occur via a wide range of pathways, including air, water, soil, rapid industrialization, increase in road traffic, consumer habits and life style **(Voutsaand and Samara, 2011).** Heavy metal pollutants can contaminate the products during

processing through raw materials, cooking utensils, food packaging and spices used during processing (**Raikwar *et al.,* 2008).**

Contamination of meat and chicken tissues with heavy metals is a matter of great concern for food safety and human health due to progressive irreversible bioaccumulation in human body organs, especially kidney, liver and spleen. Furthermore, heat treatment of food for long period of time cannot destroy heavy metals. Thus, there is a great risk associated with the consumption of ready to eat meat if they are manufactured from already contaminated raw meat (**Chitmanat and Traichaiyaporn, 2010).** 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 through alteration of physiological activities and biochemical parameters in blood and tissues, through affecting nervous, cardiovascular, renal and reproductive systems and through defects in cellular uptake mechanisms in the mammalian liver and kidney, inhibiting hepatic and renal sulfate / bicarbonate transporter causing sulfaturia **(Javed *et al.,* 2009).**

Lead is recognized as a toxic substance, which accumulates in the body due to its low rate of elimination. Lead is toxic to the blood and the nervous, urinary, gastric and genital system. Furthermore, it is also implicated in causing carcinogenesis mutagenesis and teratogenesis in experimental animals (**Pitot and Dragan, 1996).**

Cadmium is a very toxic heavy metal,it may accumulate in the human body and may induce kidney dysfunction, skeletal damage, reproduction deficiencies, prostate cancer, mutations, and foetal (embryonic) death (**Uluozlu *et al.,* 2009)**. Generally, the ingestion of cadmium may result in acute gastroenteritis which is characterized by sudden onset of vomition, diarrhea and abdominal pain **(Kazantzis, 2004).**

The widespread use of aluminum foils to wraps meat and chicken for cooking them in the oven in order to prevent water uptake and avoid direct heat makes them a significant potential source of dietary aluminum **(Ranau *et al.,* 2001**). Aluminum toxicity is well known in patients with long standing chronic renal failures, in recent years associated with various bone (Osteomalacia) and neurological failure (Alzheimer's diseases**) (Gupta *et al.,* 2005).**

Copper and zinc are essential elements and when given in excess are toxic to man and animal **(Pond, 1975).** Copper is known to be essential at low concentrations, but toxic at high levels. However, ingestion of excessive doses of copper may lead to severe nausea, bloody diarrhea, and hypotension and jaundice. Chronic copper poisoning may lead to Wilson's disease which is manifested by destruction of nerve cells, liver cirrhosis, ascites, edema and hepatic failure. **(Gossel and Bricker, 1990).**

Zinc is an essential element for human as being involved in protein synthesis and as a constituent of many enzymes. It is a relatively non-toxic to human. High levels of zinc in foods may be toxic to the human, where it causes deficiencies in metals like copper **(Falandys, 1991).**

The continuous consumption of sandwiches contaminated with these heavy metals exceeding the safe permissible limits may result in a public health hazards through progressive irreversible accumulation in human body **(Shibomoto and Bjeldans, 2000).**

Therefore, this study planned to determine heavy metal residues lead, cadmium, copper,Zinc and Aluminumin meat and chicken Shawerma and their effect on public health.

Material and methods

Collection of samples

A total of 40 random meat and chicken Shawerma samples including (20 of each) were collected from different fast food restaurants in

Beheria governorates, Egypt. The collected samples were directly transferred to the laboratory for determination of their content of heavy metal and trace elements residues.

Chemical and standards:
All chemicals and standards are of Analytical grade. Metals stock standards of Pb, Cd, Al, Cu, and Zn were obtained from Merck, Darmstadt, Germany (1000 µg/ml).

Sample preparation (Hassan, 2015):
Microwave digestion was used to prepare 0.5 gm of the meat samples. Ten mL of HNO_3 was added to accurately weighed ≈ 50 ml of the sample. A preloaded method for the MARS6 (CEM, Corporation, USA) microwave was used to digest the samples. Once cooled, the solution was diluted quantitatively to 10 ml using ultrapure water. The microwave digestion parameters were according to the following table. Sample preparation and analysis were done in Central Agriculture Pesticides laboratory, Dokki, Egypt.

Table (A). Microwave digestion system parameters

Options	Internal fiber optic temperature controlInternal pressure controlDuo Temp Control
Temperature	210 °C
Pressure	800
Time	Ramp: 21 minutes Hold: 15 minutes
Power	400-1800
Vessels	Easy Prep full starter set, P/T control

Table (B). Microwave plasma Atomic Emission parameters.

Parameter	Value
Replicates	3
Pump rate	15 rpm
Samples uptake delay	15 seconds
Rinse time	30 seconds
Stabilization time	15 seconds
Fast pump during uptake and rinse	On (80 ppm)
Nebulizer	OneNeb
Spray Chamber	Double pass cyclonic
Auto sampler	Agilent SPS3
Sample pump tubing	Orange/green
Waste pump tubing	Blue/blue

Table (C). Metals Determined in meat, their wavelength and calibration range, limit of detection (LOD) and limit of Quantification (LOQ) of metals determined in meat.

Elements	Wavelength (nm)	Calibration range (µg/ml)	Correlation Coefficient	Limit of detection LOD	Limit of Quantification LOQ
Pb	405.9	0 – 2.500	0.99996	$3.300 X10^{-3}$	0.011
Cd	228.8	0 – 2.500	0.9992	$2.100 X10^{-3}$	$7.000X10^{-3}$
Al	396.2	0-2.000	0.9981	$0.400 X10^{-3}$	$1.333X10^{-3}$
Cu	324.8	0 – 2.500	0.9992	$0.700 X10^{-3}$	$2.333 X10^{-3}$
Zn	213.9	0 – 1.500	0.9904	$4.500 X10^{-3}$	0.015

Statistical Analysis according to Tarla *et al.*, (2015).

Data were statistically evaluated by one-way analysis of variance. Determination of the differences among means was carried out by using the least significant differences test. All statistical analyses were done using the Statistical Package for Social Sciences (SPSS 16.2) program

Results

Table (1). Statistical analytical results of heavy metals and trace elements residues (ppm) in examined meat Shawerma (n=20).

Metals	No. of examined samples	Minimum µg/ml	Maximum µg/ml	Mean ±S.E. µg/ml
Lead	20	0.01	2.60	0.55± 0.14
Cadmium	20	0.01	4.60	1.66± 0.33
Copper	20	20.12	140.52	75.32 ± 7.84
Zinc	20	52.14	182.01	110.54± 8.64
Aluminum	20	0.001	0.001	0.001

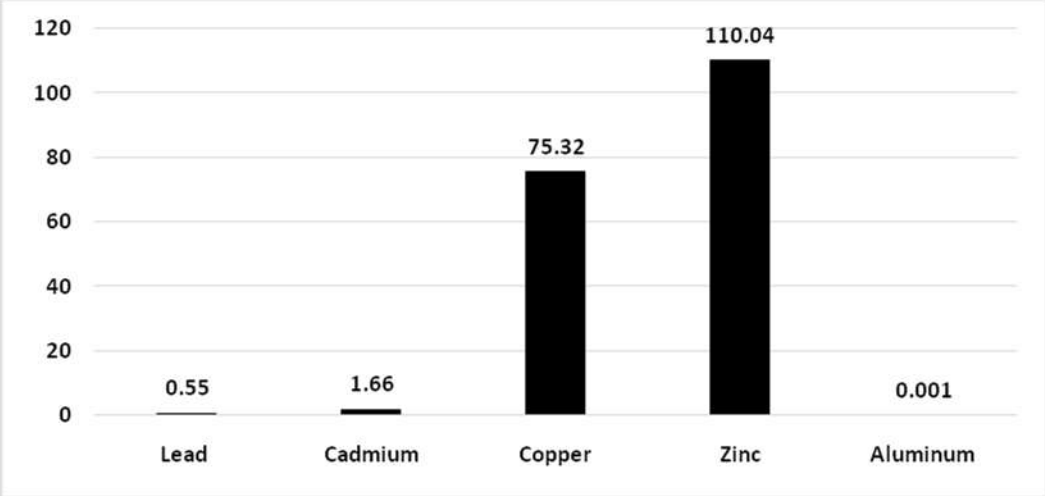

Fig (1). Mean values of heavy metals and trace elements residues in examined meat Shawerma samples

Table (2). Statistical analytical results of heavy metals and trace elements residues (ppm) in examined chicken Shawerma (n=20).

Metals	No. of examined samples	Minimum µg/ml	Maximum µg/ml	Mean ±S.E. µg/ml
Lead	20	0.01	0.32	0.09± 0.02
Cadmium	20	0.20	2.30	0.99± 0.17
Copper	20	15.95	95.45	47.19 ± 6.13
Zinc	20	30.98	170.17	92.65± 9.62
Aluminum	20	0.001	0.001	0.001

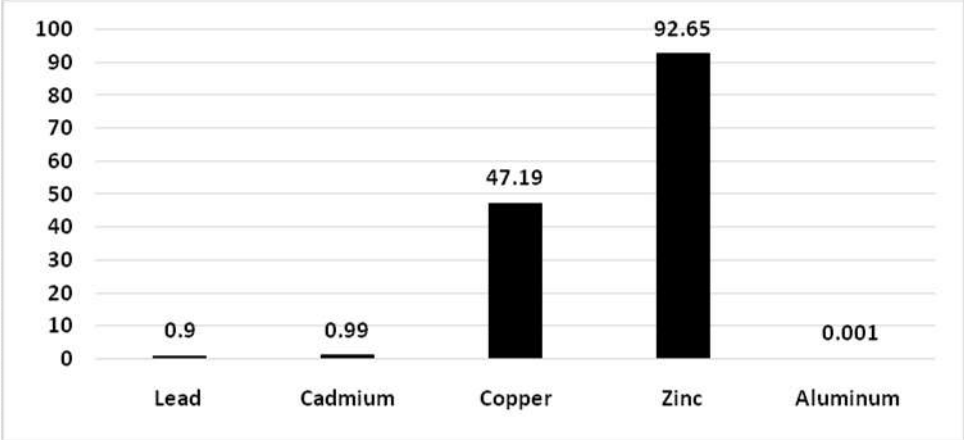

Fig (2). Mean values of heavy metals and traces elements residues in examined chicken Shawerma samples.

Table (3). Acceptability of examined meat and chicken Shawerma for toxic heavy metals

Heavy metals	Maximum permissible limits (ppm)	Unaccepted meat shawerma		Unaccepted chicken shawerma	
		No.	%	No.	%
Lead (Pb)	0.1*	12	60	3	15
Cadmium (cd)	1.0**	13	65	8	40
Aluminum	2***	0	0	0	0

***EOS, (2010) **Eu, (2001) *** WHO, (2011)**

Table (4). Acceptability of examined meat and chicken shawerma for trace elements residues

Heavy metals	Maximum permissible limits (ppm)*	Unaccepted meat shawerma		Unaccepted chicken shawerma	
		No.	%	No.	%
Copper (Cu)	200	٠	٠	٠	٠
Zinc (Zn)	150	4	20	3	15

***ANZFA, 2001**

Discussion

Heavy metals can be classified as potentially toxic (cadmium, lead, aluminum, etc.) and essential (iron, copper, zinc and selenium) (**Jalbani *et al.*, 2007**). Toxic elements can be very harmful even at low concentration when ingested over a long time period. The essential metals can also produce toxic effects when the metal intake is excessively elevated (**Celik and Oehlenschlager, 2007**). Contamination of food with heavy metals may be due to environmental contamination and also contamination during processing. Thus, it is of great importance to determine the concentrations of heavy metals in meat and chicken shawerma, which became an essential part of human fast food.

The obtained results in table (1) revealed that the concentrations of lead in the examined meat Shawerma samples ranged from 0.01 to 2.60 with a mean value of 0.55± 0.14 mg/kg; cadmium concentration ranged from 0.01 to 4.60 with a mean value of 1.66± 0.33 mg/kg, while the concentration of trace elements residues copper and zinc ranged from (20.12 to 140.52), (52.14 to 182.01) with a mean value of 75.32 ± 7.84 and 110.54± 8.64mg/kg, respectively. Regarding to aluminum, only one

samples positive with value of 0.001.

Furthermore, table (2) indicated that the concentrations of lead, cadmium, copper and zinc in the examined chicken shawerma samples ranged from (0.01 to 0.32), (0.20 to 2.30), (15.95 to 95.45) and (30.98 to 170.17) with a mean value of 0.09± 0.02,0.99± 0.17,47.19 ± 6.13 and 92.65± 9.62 mg/kg, respectively. While, aluminum was detected in only one samples with value 0.001.

Higher result of lead content 1.48 ± 1.771 ppm in chicken meat shawerma was reported by **Mohamed and Nosier (2009).** While lower result of lead content 0.0601 ± 0.074 ppm in shawerma sandwiches in Assiut city was reported by **Essa *et al.,* (2007).**

The present results of cadmium value in meat shawerma were similar to those of **Gonzalez-Weller *et al.* (2006)** who reported that cadmium mean was 1.68 ± 1.76 in chicken meat from Spain markets. Lower mean values of cadmium 0.338 ± 0.435 ppm were reported in Cairo and Giza governorates by **Mohamed and Nosier (2009)** and 0.067 ± 0.006 ppm in Assiut city was reported by **Sharkawy and Mohamed (2003)** in shawerm as and wiches. The source of cadmium mainly from sewage sludge, atmosphere deposition **(European commission, 1996).**

Mohamed and Nosier (2009) reported that the mean values of copper in chicken shawerma sandwiches was 2.854 ± 2.642 ppm in Cairo governorate, while **Essa *et al.* (2007)** from Assiut city reported that mean value of copper in shawerma sandwiches was 0.954 ± 0.170.
Lower results of zinc content in chicken shawerma sandwiches 24.422 ± 11.032 ppm were reported by **Mohamed and Nosier (2009)** in Cairo governorates. While in Turkey znic mean value in chicken meat was 11.5 ± 0.9 µg/gm (**Demirel *et al.,* 2008).**

Higher results of aluminum in chicken meat shawerma sandwiches (155.11±68.777 ppm) was reported in Cairo governorates by **Mohamed and Nosier (2009).**

Diab (2005) detected the aluminum mean level in cooked meat with onion in aluminum pan and stored for 72 hours was 92.18 ± 2.17 (mg/kg wet weight) and that with onion and tomato stored for the same time was 237.73 ± 8.65 mg/kg.

Cooking in aluminum utensils increase aluminum concentration in foods **(Scancar *et al.,* 2004**) and not suitable for acidic foods as they cause greater migration of Al to food, in addition poultry breast meat store more Al than leg meats besides the holding time of meat in aluminum pans and presence of tomatoes and citric acid which are used in chicken shawerma preparation helps increasing migration and concentration levels from pans to meat **(Gaballa, 2000).**

According to Egyptian Organization for Standardization and Quality Control **(EOS, 2010)** which stipulated that permissible limit for lead residues in meat, which must be, not exceed than 0.1 ppm, it was indicated that 12 samples (60%) and 3 samples (15%) of examined meat and chicken Shawerma, were not in accordance with this limit (table 6).The higher lead concentrations in the examined meat and chicken shawerma samples may be attributed to the heat treatment during cooking processing, leaching from utensils, corrosion of packing materials, using raw materials, water and food additives as spices, pepper which contain higher levels of lead (> 2.2 ppm) as recorded by **Santhi *et al.,* (2008).**

Table (3) showed that 13 samples (65%) and 8 samples (40%) of the examined meat and chicken Shawerma, exceeded the safe permissible limit recommended by **EU (2001)** for cadmium in meat (1.0 ppm). Higher cadmium concentrations in the examined meat and chicken Shawerma samples may be due to adding spices and herbs (garlic, onion and pepper) which contain cadmium and pesticides may be

a source of cadmium as recorded by **Krejpcio *et al.*, (2007).** While, for aluminum, all examined meat shawerma samples (100%) were within the permissible limits which stipulated by **WHO (2011)** (2 ppm) and considered safe for human consumption.

According to the safe permissible limit stipulated by **ANZFA (2001)** for copper and zinc residues must not exceed (200 and 150 ppm), it was indicated that 0 and 20% of examined meat shawerma and (0 and 15 %)of examined chicken shawerma, respectively, were not in accordance with this limit. (Table4).

Copper is an essential component of various enzymes and it plays a key role in bone formation, skeletal mineralization and in maintaining the integrity of the connective tissues. Copper is essential for good health, but very high intake can cause health problems such as liver and kidney damage **(ATSDR, 2004).** Copper can also cause public health hazards in high concentrations **(Brito *et al.*, 2005).** In humans, 10-30 mg of orally ingested copper from foods stored in copper vessels might cause intestinal discomfort, dizziness and headaches, while excess accumulation of copper in liver may result in hepatitis or cirrhosis and in a hemolytic crisis similar to that seen in acute copper poisoning **(Johnson, 1993).**

Zinc is an essential element in human diet. Too little Zn can cause problems; however, too much Zn is harmful to human health **(ATSDR, 2004).**

Conclusion and recommendation

Based on the previous results, meat shawerma more contaminated than chicken shawerma with heavy metal residues. Meat and chicken Shawerma are consumed in Egypt on large scale and quantities. Chicken and meat preparation which takes several hours prior cooking and treatment must be done in suitable pans and containers other than the aluminum or corrosive substances causes migration of dangerous heavy metals and traces to the chicken meat affects dangerously the general health. Also, the display of meat and chicken Shawerma must be inside the selling shops not to be exposed to different pollutants from gasoline motors, dust, and other several air pollutants in addition to a great concern to the quality of dressings and added materials like tomato, spices, mastered, vegetables to prevent them from acting as dangerous source of several contaminants, especially heavy metals which act as severe hazard for general health specially in case of continuous consumption.

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