Dept. of Food Hygiene.
Animal Health Research Institute, Assiut, Egypt.

DETERMINATION OF SOME HEAVY METALS IN SOME READY-TO-EAT MEALS IN ASSIUT CITY

(With 2 Tables)

By

H.H. ESSA; A.M. ABD EL-MALEK and EMAN EZ-ALDAWLA SHARKAWY*

*Dept. of Forensic Med. and Toxicology. Fac. Vet. Med., Assiut Univ., Assiut, Egypt.

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تعيين بعض المعادن الثقيلة فى بعض الوجبات المجهزة للأكل فى مدينة أسيوط

حمدى حسين عيسى ، أشرف محمد عبد المالك ، ايمان عز الدولة شرقاوى

تم تجميع عدد ٤٥ عينة من ساندوتشات اللحوم الجاهزة للأكل (١٥ عينة لكل من ساندوتشات الشاورمة، الكفتة والكبدة) من المطاعم المختلفة فى مدينة اسيوط تم تحليلها بإستخدام مقياس الإمتصاص الذرى الطيفى لتعيين مستويات الرصاص، الكادميوم والنحاس بهـا. أظهـرت النتائج أن القيم المتوسطة لعناصر الرصاص، الكادميوم والنحاس فى عينات الشاورمة كانت ٠,٦٠١ ±٠,٠٧٤، ٠,٠١٠ ±٠,٠٠٥ و ٠,١٧٠ ±٠,٩٥٤ جزء فى المليون على التـوالى وفى عينات الكفتة كانت ٠,٣١٦ ±٠,٠٦٤، ٠,٠٠٣ ±٠,٠٠١ و ١,٢٨٠ ±٠,١٥٨ جزء فى المليون على التوالى بينما كانت القيم المتوسطة لهذه العناصر فـى عينـات الكبـدة ٠,٣١٠ ± ٠,٠٥٧، ٠,٠٢٠ ±٠,٠٠٧ و٠,٠ ٣٦,٦٦٥ ±٥,٦٣٨ جزء فى المليون على التوالى. وقد وجد أن عينات الشاورمة التى تم تحليلها قد تجاوزت الحد المسموح به لعنصر الرصـاص فـى المواصفات القياسية المصرية من جهه أخرى لم تتعدى مستويات الكادميوم فى العينات التى تم تحليلها النسبة المسموح بها فى مصر أما النحاس فقد تجاوز تركيـزه الحـد المصـرى المسموح به فى عينات الكبدة وقد تم مناقشة الأهمية الصحية والتأثيرات السامة لهذه المعادن الثقيلة وكيفية الحد من أو التحكم فى مصادر وصول هذه العناصر الى الوجبـات المجهـزة للأكل.

SUMMARY

A total of 45 random samples of ready-to-eat shawerma, kofta and fried liver (kibda) sandwiches (15 of each) were collected from different restaurants in Assiut city, Egypt. They were analyzed by Atomic Absorption Spectrophotometer (AAS) for determination of lead (Pb), cadmium (Cd) and copper (Cu) levels. The obtained results showed that

the average values of Pb, Cd and Cu in the samples of shawerma were 0.601 ± 0.074, 0.01 ± 0.005 and 0.954 ± 0.170 ppm, respectively, whereas, in samples of Kofta were 0.361 ± 0.064, 0.003 ± 0.001 and 1.280 ± 0.158 ppm, respectively. While the average values for these elements in samples of liver were 0.310 ± 0.057, 0.020 ± 0.007 and 36.665 ± 5.638 ppm, respectively. The results of this study indicate that ready-to-eat shawerma sandwiches have Pb values above the maximum permissible levels established by Egyptian Organization of Standardization and Quality Control (EOSQC, 1993). The Cd concentrations in all examined samples are lower than the EOSQC (1993) recommended limit of 0.1 ppm. Whereas, the Cu concentration exceeded the level permitted by the EOSQC (1993) in liver samples. Public health importance and the hazardous toxic effects of the examined heavy metals as well as the suggestive recommendations to reduce or control the sources of pollution of RTE meat sandwiches with these metals were discussed.

***Key words**: Ready-to-eat shawerma, kofta, liver (kibda) sandwiches, lead, cadmium, copper.*

INTRODUCTION

In recent years, there is an increasing trend for ready-to-eat meals to be consumed both in the home and in restaurants. They are offered quickly, delicious meals. Ready-to-eat (RTE) meat sandwiches such as shawerma, hawawshy, kofta, fried liver (kibda), hamburger and sausage have become more popular meat sandwiches in Middle East countries. They are considered the most common RTE sandwiches sold by street vendors and fast food restaurants (Williamson *et al.*, 2005 and Ayaz *et al.*, 1985).

Because of the changing life style in Egypt, people are consuming a variety of fast foods on a daily basis. Traditional meat-containing fast foods, such as Shawerma, kofta and fried liver (kibda) sandwiches are becoming popular. Ingredients for RTE meat sandwiches may include raw produce such as lettuce, alfalfa sprouts, onions, parsley, green pepper, Egyptian spices, sliced tomatoes and tahina (sesame) sauce.

Environmental pollution is the main cause of heavy metal contamination in food chain. The trace metal contents of individual foods depend upon the trace metals introduced in the growing, transport,

processing and fortification of food (Anderson *et al.*, 1992). The other technological processes used to bring the food to the consumer can significantly increase the total trace metal contents of the food (Cabrera *et al.*, 2003).

Heavy metals are potential environmental contaminants with the capability of causing human health problems if present to excess in the food we eat. They are given special attention throughout the world due to their toxic effects even at very low concentrations (Das, 1990).

Lead (Pb) is neurotoxic with varying symptoms. It is particularly toxic to the brain, kidneys, reproductive system, and cardiovascular system. Exposures can cause impairments in intellectual functioning, kidney damage, infertility, miscarriage, and hypertension (Silbergeld 1996). Pb is a special hazard for young children. Exposure of children to high levels may cause encephalopathy and/or irreversible mental retardation (Goyer 1996).

According to the Agency for Toxic Substances and Disease Registry (ATSDR 1999), foods account for more than 90 percent of human exposure to cadmium (Cd) through eating foods containing it; low levels in all foods but highest in liver and kidney meats.

Cd poisoning may result in a case called Itai-Itai or Ouch-Ouch disease which characterized by sever pain, soft bones and the death may occur as a result of renal failure (Peter, 1993).

Copper (Cu) is an essential trace element for animals and man. It is released into the environment primarily through mining, sewage treatment plants, solid waste disposal, welding and electroplating processes, electrical wiring materials, plumbing supplies (pipes, faucets, braces, and various forms of tubing) and agricultural processes. It is a common component of fungicides and algaecides. Agricultural use of Cu for these purposes can result in its presence in soil, ground water, farm animals (grazing animals like cows, etc.) and many forms of produce (ATSDR 1990).

Acute toxicity of ingested Cu is characterized by abdominal pain, diarrhea, vomiting, tachycardia and a metallic taste in the mouth. Continued ingestion of Cu compounds can cause cirrhosis and other debilitating liver conditions (Mueller-Hoecker *et al.*, 1988).

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

Owing to serious health risks, the levels of heavy metals (Cd and Pb) and trace element (Cu) were determined in some Egyptian ready-to-eat meat sandwiches such as shawerma, kofta and fried liver (kibda) to evaluate their safety for human consumption.

MATERIALS and METHODS

Collection of samples:

A total of 45 random samples of ready-to-eat shawerma, kofta and fried liver (kibda) sandwiches (15 of each) were collected from different restaurants in Assiut city for determination of their Pb, Cd and Cu levels.

Digestion of samples:

Five grams from each sample (content of the sandwich) were digested by using a mixture of nitric and perchloric acids (Khan *et al.*, 1995).

Estimation of metals:

Lead, cadmium and copper were determined by using Atomic Absorption Spectrophotometer (GBC 906 AA) according to Agemain *et al.* (1980).

RESULTS

The obtained results of the study are summarized in Tables 1, 2.

Table 1: lead, Cadmium and Copper levels (ppm) in examined ready-to-eat meals.

Element	Examined samples	Number of samples	Minimum	Maximum	Mean±S.E.
Lead	Shawerma	15	0.050	0.769	0.601 ± 0.074
	Kofta	15	0.038	0.719	0.316 ± 0.064
	Liver	15	0.063	0.613	0.310 ± 0.057
Cadmium	Shawerma	15	0.000	0.050	0.010 ± 0.005
	Kofta	15	0.000	0.013	0.003 ± 0.001
	Liver	15	0.000	0.063	0.020 ± 0.007
Copper	Shawerma	15	0.375	2.000	0.954 ± 0.170
	Kofta	15	0.525	1.963	1.280 ± 0.158
	Liver	15	3.913	70.000	36.665 ± 5.638

Table 2: Recommended levels of lead, cadmium and copper in food.

The mean heavy metals esidues (ppm) in all examined samles			EOSQC (1993) Maximum Permissible Limits in meat and meat products	EOSQC (1993) human daily and weekly intake	Commission Regulation (EC) No 853/2004	WHO (1984)
Metal	Examined samples	Mean value (ppm)				
Lead	Shawerma Kofta liver	0.601±0.074 0.316±0.064 0.310±0.057	0.5ppm	Weekly intake 0.05 mg/kg body weight for adults and 0.025 mg/kg body weight for children	Maximum Leves of pb in meat of bovine Animals 0.10 (mg/kg wet weight)	Pb level should not more than 0.05 ppm
Cadmium	Shawerma Kofta liver	0.010±0.005 0.003±0.001 0.020±0.007	0.1 ppm	Weekly intake 0.0067-0.0083 Mg/kg body weight	Maximum Leves of Cd in meat of bovine Animals 0.050 (mg/kg wet weight)	Cd should not exceed 0.05ppm
Copper	Shawerma Kofta liver	0.954±0.170 1.280±0.158 36.665±5.638	15 ppm	Daily intake 0.05-0.5 mg/kg body weight	.....	.....

EOSQC :Egyptian Organization for Standardization and Quality control
Commission Regulation (EC) : Regulations of the European communities
WHO : World Health Organization
N.B : ppm=mg/kg.

DISCUSSION

The environmental pollution is a matter of great concern worldwide, and consequently contamination of food chain is getting increasingly important in view of its role in human health and nutrition (Khan *et al.*, 1996). Heavy metals have recently come to the forefront dangerous substances. They are considered as serious chemical health hazards for men and animals (Jarup, 2003).

Lead (Pb):

In the present study, the obtained results in Table (1) revealed that the mean values of Pb in RTE sandwiches of shawerma, kofta and liver were 0.601± 0.074, 0.316 ± 0.064 and 0.310 ± 0.057 ppm, respectively. These obtained results showed that shawerma samples are higher than to that obtained by Sharkawy and Amal (2003) who revealed that Pb levels was 0.072 ± 0.006 ppm in RTE shawerma in Assiut City and Morshdy *et al.* (2000) who found that mean value of Pb concentration in shawerma at Zagazig city was 0.221± 0.037 ug/g wet weight and Fatin (1998) who found that mean values of Pb in shawerma sample was 0.078 ± 0.006 ppm. On the other hand, the obtained levels of Pb in kofta and liver samples are lower than that reported by Fatin (1998) who found that mean value of Pb in kofta sample was 0.459 ± 0.032 ppm and the result recorded by El-Shorbagy (2004) who found Pb level of 4.806 ± 0.519 ppm in liver samples.

Variation of Pb concentrations among several studies from different locations may be attributed to the differences of age of animals from which the meat obtained for preparing these meat meals (Hafez, 1995) as well as the differences of degree of environmental contamination at which slaughtered cattle were fed and grown up. Leita *et al.* (1991) pointed out that Pb residues in animal tissues was related to both soil and pasture content of Pb, traffic density, as well as area of mining, smelting and sewage drainage. Generally contamination of meat with heavy metals including Pb depends on nature and age of animal, place of animal, dietary habits, slaughtering, transportation condition and exposure time to dust etc. (Sabir *et al.* 2003).

From the obtained results in Table (2), the examined shawerma sandwiches exceeded the permissible limits (0.5 ppm) that was recommended by EOSQC, 1993 for Pb and above the permissible limits that was established by WHO (1984) which reported that Pb level should not be more than 0.05 ppm. Also, The mean Pb levels of shawerma samples were higher than that recorded in the commission regulation

(EC) No 853/2004 which defined the maximum level of Pb in meat of bovine as, 0.10 mg/kg (wet weight). On contrast, examined kofta and liver sandwiches were below the permissible levels recorded by EOSQC (1993).

Shawerma is among the most popular of all snacks in the Arab world. Most often made from beef meat. It is cut into thin slices and arranged on a vertical skewer from which individual servings are shaved. A popular way to serve shawerma is in sandwich form, rolled into a flat round of bread and garnished with finely chopped tomatoes, parsley, lettuce, onions, and tahini (sesame) sauce.

The data showed higher level of Pb in shawerma sandwiches. This may be attributed to shawerma is usually manufactured and sold outside the restaurants, that make these sandwiches liable for Pb pollution by motor vehicle exhaust especially at areas of high traffic density like squares and near stations where such product was frequently sold. (Morshdy *et al.* 2000 and Hu, 2002)

Moreover, sandwich fixings such as onions, pickles, tomatoes, and lettuce may be the source of Pb in shawerma sandwiches because Pb may contaminate the soil and concentrate in root vegetables (e.g., onion) and leafy green vegetables (Ward and Savage 1994).

Also, added spices such as pepper, mustard and other common spices have been reported to contain significant quantities of some heavy and trace metals (Gupta *et al.*, 2003).

In addition, equipments and utensils used for cooking may be the source of Pb in this meal. Benneth (1981) mentioned that Pb intake occurs from the consumption of food stored in lead lined containers. Also, Pb can pathway to the food supply through leach from older plumbing into drinking water or water used for food manufacturing or processing (Health Canada, 1998).

Lead is recognized as toxic substance which accumulated inside the body due to its low rate of elimination. Thus the damage of the central nervous system is a marked and common feature particularly in children due to low lead tolerance (Lidsky and Schneider, 2003; Johansen *et al.*, 2004).

Cadmium (Cd):

The results in Table (1) showed that the mean Cd levels were 0.100 ± 0.005, 0.003 ± 0.001 and 0.020 ± 0.007 ppm in RTE sandwiches of shawerma, kofta and liver, respectively. These results were nearly similar to that obtained by Fatin (1998) who revealed the mean value of Cd in shawerma in Kalyobia governorate was 0.092 ± 0.008 ppm and

Sharkawy and Amal (2003) who found Cd level of 0.067 ± 0.006 ppm in shawerma sold in Assiut city. While higher results reported by Fatin (1998) who recorded the the average Cd level in kofta was 0.083 ± 0.006 ppm. On contrary, higher levels were recorded by Fatin (2005) El-Shorbagy (2004) who found that the mean level of Cd in liver samples were 2.34 ± 0.18 and 0.736 ± 0.173 ppm, respectively.

The observed variability in the levels of Cd among different studies may reflect the presence of Cd contamination in the raw materials used during production or secondary contamination from different technological processes or even in the product distribution network (Nnorom *et al.*, 2007).

The results in our study for Cd levels in RTE shawerma, kofta and fried liver (kibda) sandwiches were within the permissible limits of EOSQC (1993) which recommended that the concentration of Cd should not exceed 0.1 ppm. Also, the mean Cd levels of examined RTE shawerma, kofta and fried liver (kibda) sandwiches appeared to be within the permissible limits of WHO (1984) which reported the mean content of Cd should not exceed 0.05 ppm and that defined in Commission Regulation (EC) No 853/2004 of the commission of the European communities, that maximum levels of Cd in meat of bovine animals were 0.050 mg/kg (wet weight) (Table 2).

Cadmium in food comes to a large extent from atmospheric cadmium as a result of foliar absorption or root uptake of cadmium deposited on soils. In rural areas, 20–60% of the total plant cadmium may originate from foliar absorption (Jensen & Bro-Rasmussen, 1991).

Lower levels of exposure to Cd are mainly of concern with respect to toxicity to the kidney. Cd accumulates in the kidney where it can remain for many years and exposure to Cd over a long time can cause irreversible damage to the kidneys (Goyer, 1996).

Copper (Cu):

The obtained results in Table (1) revealed that the mean values of Cu concentrations in examined RTE sandwiches of shawerma, kofta and liver (kibda) were 0.954 ± 0.170, 1.280 ± 0.158 and 36.665 ± 5.638 ppm, respectively.

From the above mentioned results, it is obvious that the liver samples had high levels of Cu exceeding the guideline standard limit. The current results are in agreement with those reported by El-Seady (2001) that the mean values of Cu concentrations in liver sample of sheep were 29.20 mg/kg. On the other hand, the Cu content in liver was higher than that obtained by Fatin (2005) who found that the mean level

of Cu in sheep liver was 12.82 ± 1.06 ppm and in goat liver was 15.22 ± 1.43 ppm and Ibrahim *et al.* (2001) who record 18.526 ± 3.71 ppm as mean value of Cu in liver of young cow.

According to the EOSQC (1993) the permissible limit for Cu is 15 mg/kg, the mean Cu levels of examined kofta and shawerma samples were found to be below the permissible limits; while in examined liver samples, the incidence of Cu was higher than the safe permissible limits (Table 2).

This result may be attributed to widely use of Cu in cooking utensils and water distribution systems, as well as fertilizers, bactericides, fungicides, algicides and antifouling paints. It is also used as animal feed additives and growth promoters, as well as for disease control in livestock and poultry (WHO, 1998).

The actual concentration of copper in food from various countries varies widely depending upon the food product, the growing conditions (soil, use of fertilizers high in copper, water, use of copper fungicides) and the type of processing used; in particular, pH levels and the use of copper vessels (Muller *et al.*, 1996).

Copper is known to be essential at low concentrations but it is toxic at high levels. Accordingly, ingestion of an excessive dose of Cu may lead to sever nausea, bloody diarrhea, hypertension and jaundice. Moreover, chronic Cu poisoning may result in what is known "Wilson's disease" which manifested by destruction of nerve cells, liver cirrhosis, ascitis, oedema and hepatic failure (Gosel and Bricker, 1990).

In conclusion, fast food sandwiches especially shawerma, kofta and liver (kibda) are consumed in Egypt in large quantities. For obtaining these RTE meat meals with a minimal Pb pollution, the manufacturing of such products should be done inside the restaurants and shops away from the motor vehicle exhaust especially at the areas of high traffic density. Also, Pb should be eliminated from gasoline in motors of different transport means, besides, prevention of rearing animals near high traffic density roads.

The accumulation of heavy metals can have middle-term and long term health risks, and strict periodic surveillance of these contaminants is therefore advisable.

It is essential, in order to protect public health, to keep contaminants at levels which are toxicologically acceptable. The presence of contaminants must be reduced more thoroughly wherever possible by means of good manufacturing or agricultural practices, in

order to achieve a higher level of health protection, especially for sensitive groups of the population.

Any maximum level adopted at Egyptian Standard level will have to be reviewed regularly to take account of the advance of scientific and technical knowledge and improvements in manufacturing or agricultural practices with the objective of achieving steadily decreasing levels.

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