رقم البحث (12)

RESIDUES OF LEAD, CADMIUM AND TIN IN SOME CANNED MEAT PRODUCTS SOLD IN MARKETS OF DAMIETTA GOVERNORATE

BY

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ABSTRACT

Residues of lead, cadmium and tin in a total of ٨٠ random samples of local canned beef, imported canned beef luncheon, imported canned chicken luncheon and imported canned turkey luncheon meats which collected from different brands that sold in different markets at Damietta Governorate, Egypt, were determined by using Perkin Elmer Atomic Absorption Spectrophotometry. Results revealed that mean lead concentrations (ppm) were ٠.٤٨٤ , ٠.٤٧٨ , ٠ .٣٥٢ and ٠. ٤٢٣; mean cadmium concentrations (ppm) were ٠,٠٤٦ , ٠,٠٤٩ , ٠.٠٤٥ and ٠. ٠٤٧; while mean tin concentrations (ppm) were ١.٦٩٦ , ١.٤٥٦ , ٠,٧٣٢ and ٠. ٦٥٢ in the examined canned beef, canned beef luncheon meat, canned chicken luncheon meat and canned turkey luncheon meat, respectively. All the obtained concentrations of these residues in different examined samples of canned meat products were compared with its permissible limit. Also, the calculated daily intake of such elements for adult person from consumption of these canned meat products were compared with Acceptable Daily Intake (ADI) recommended by FAO/WHO (٢٠٠٤). Public health significance of the obtained results and recommendations were discussed.

INTRODUCTION

Meat and its products are widely consumed in many parts of the world by human because it has high protein content, fatty acids, vitamins and trace elements. Canned meat products in particular are well eaten in many countries including A.R.E. because they are convenient and affordable for most working families. All types of both canned beef and

canned luncheon meats either locally or imported are very popular in supermarket chain, public markets and small grocery retail outlets. Owing to the great consumption of these canned meat products, the safety issues related to the possibility of heavy metals contamination are of concern. Several agencies and organizations such as Egyptian Organization for Standardization, Food and Agriculture Organization (FAO), World Health Organization (WHO) and Commission of European Communities provide quidelines on the intake of heavy metals in different food items by human. Therefore, this work was planned to throw light on the content of contamination of canned beef and canned luncheon meats by lead, cadmium and tin as well as their public health significance.

MATERIALS AND METHODS

- **Collection of samples :**

A total of ٨٠ random samples of local canned beef, imported canned beef luncheon meat, imported canned chicken luncheon meat and imported canned turkey luncheon meat (٢٠ each) were collected as original packaged from different brands sold in markets of Damietta Governorate. All collected samples were labelled and taken to the laboratory for analysis.

- **Perparation and ashing of collected samples :**

A measured weight subsample (٥ grams wet weight) was taken from each thoroughly mashed meat product and transferred into clean and acid-washed crucible and dried at ٧٠ – ٨٠ oC for ٢٤ hours. All dried subsamples were ashed in muffle furnace at ٤٥٠ – ٥٠٠ oC for ٦-٨ hours. ٢ ml of pure analar Conc. nitric acid was added to each ashed sample and then evaporated carefully just to dryness on warm hot plate. The samples were placed again into muffle furnace at ٤٥٠ – ٥٠٠ oC for ١ hour and the ashing procedure was completed according to official methods of analysis recommended by A.O.A.C. (١٩٨٤). Each ashed sample was dissolved in ١N HCl and filtered through Whatman filter paper No. ٤٢ and the volume completed to ٢٠ ml with ١ N HCl.

- **Analysis by using Atomic Absorption Spectrophotometry :**

All filterated samples were analyzed for their lead, cadmium and tin contents according to **Medina et al. (١٩٨٦)** and **Abdallah et al. (١٩٩٣)** by using " Perkin– Elmer Atomic Absorption Spectrophotmetry model ٢٣٨٠, USA, ١٩٨٨ ".

- **Quantitative determination of heavy metals :**

The concentrations of Pb, Cd and Sn (µg/g wet weight) in each sample were calculated according to the following equation :

$$C_1 = (A_1 / A_2) C (D/W)$$

Where :

C_1 = Heavy metal concentration in a sample (µg/g wet weight).

A_1= Absorbance reading of sample solution.

A_2= Absorbance reading of standard solution.

C = Concentration of heavy metal (µg/ml) of standard solution.

D = Dilution factor of a sample.

W = Weight of a sample.

- **Calculation of daily metal intake :**

For estimation of daily metal intake for adult person (٧٠ Kg) from consumption of canned meat products, mean data analyzed in the present work was combined with consumption data of meat product (١٠٠/ day/ adult person) obtained from Nutrition Institute, Cairo, A.R.E. (٢٠٠٦). Comparison of Acceptable Daily Intake (ADI) value of heavy metal recommended by FAO/WHO (٢٠٠٤) with daily metal intake for adult person (٧٠ Kg) from consumption of canned beef (١٠٠g / day), canned beef luncheon meat (١٠٠g / day), canned chicken luncheon meat (١٠٠g/ day) and canned turkey luncheon meat (١٠٠g / day) was calculated and recorded.

RESULTS

Table (١) : Lead concentration (ppm) in canned meat products. (n = ٢٠ each)

Type of samples	Min.	Max.	Mean ± S.M.E.	Unaccepted samples		Permissible limit *
				No.	%	
Canned beef	٠,٢٤٠	١,٢٠٠	٠,٤٨٤±٠,٠٦١	5	25	٠,٥ ppm
Beef luncheon	٠,١٦٠	١,٢٨٠	٠,٤٧٨±٠,٠٧٠	5	25	
Chicken luncheon	٠,١٢٤	١,٨٤٤	٠,٣٥٢±٠,٠٤١	3	15	
Turkey luncheon	٠,١٦٨	١,٠٨٤	٠,٤٢٣±٠,٠٥٥	4	20	

* Permissible limit according to Egyptian Standard (١٩٩٣).

Table (٢) : Cadmium concentration (ppm) in canned meat products. (n = ٢٠ each)

Type of samples	Min.	Max.	Mean ± S.M.E.	Unaccepted samples		Permissible limit *
				No.	%	
Canned beef	٠,٠١٢	٠,٢٣٢	٠,٠٤٦±٠,٠١٢	3	15	٠,1 ppm
Beef luncheon	٠,٠١٦	٠,٣٠٠	٠,٠٤٩±٠,٠١٥	2	10	
Chicken luncheon	٠,٠٢٠	٠,١٦٨	٠,٠٤٥±٠,٠٠٩	3	15	
Turkey luncheon	٠,٠١٦	٠,٢٠٠	٠,٠٤٧±٠,٠١١	3	15	

* Permissible limit according to WHO (٢٠٠0).

Table (٣) : Tin concentration (ppm) in canned meat products. (n = ٢٠ each)

Type of samples	Min.	Max.	Mean ± S.M.E.	Unaccepted samples	Permissible limit *
Canned beef	١,٢٨	٢,٢٤	١,٦٩٦±٠,٠٧٨	0.0	١٠٠ ppm
Beef luncheon	١,٠٤	١,٩٢	١,٤٥٦±٠,٠٦٨	0.0	
Chicken luncheon	٠,٤٨	٠,٩٦	٠,٧٣٢±٠,٠٣٦	0.0	
Turkey luncheon	٠,٤٨	٠,٨٠	٠,٦٥٢±٠,٠٢٦	0.0	

* Permissible limit according to Egyptian Standard (١٩٩٣).

Table (٤) : ADI of heavy metal calculated according to data of Nutrition Institute, Cairo.

Metal	ADI [a] µg/٧٠ kg person	Canned beef ١٠٠ g/day [b]		Canned beef luncheon ١٠٠g/day [b]		Canned chicken luncheon ١٠٠g/day [b]		Canned turkey luncheon ١٠٠g/day [b]	
		µg/day/ person	%	µg/day/ person	%	µg/day/ person	%	µg/day/ person	%
Lead	٢٥٠	٤٨,٤	١٩,٣٦	٤٧,٨	١٩,١٢	٣٥,٢	١٤,٠٨	٤٢,٣	١٦,٩٢
Cadmium	٧٠	٤,٦	٦,٥٧	٤,٩	٧,٠	٤,٥	٦,٤٢	٤,٧	٦,٧١
Tin	١٤٠٠٠٠	١٦٩,٦	٠,١٢	١٤٥,٦	٠,١٠	٧٣,٢	٠,٠٥	٦٥,٢	٠,٠٤

a. FAO/WHO, Joint Expert Committee on Food Additives (٢٠٠٤).

b. Daily consumption of meat (١٠٠g daily) for adult person according to Nutrition Institute, Cairo, A.R.E. (٢٠٠٦).

DISCUSSION

- **Lead concentration in canned meat products :**

Results recorded in Table (١) revealed that all the examined samples of canned meat products contained lead at different concentrations. In the examined samples of canned beef, lead concentration was ranged from ٠,٢٤ ppm to ١,٢٠ ppm with a mean level of ٠,٤٨٤ ppm and lead concentration exceed the permissible limit (٠,٥ ppm) recommended by **Egyption Standard (١٩٩٣)** in ٥ samples which representing ٢٥% of total samples of canned beef, Table (1). In the examined samples of canned beef luncheon meat, lead concentration was varied from ٠,١٦ ppm to ١,٢٨ ppm with a mean level of ٠,٤٧٨ ppm and lead permissible limit (٠,٥ ppm) was exceeded in ٥ samples which representing ٢٥% of total samples of canned beef luncheon meat, Table (1). In canned chicken luncheon meat, lead concentration was ranged from ٠,١٢٤ ppm to ٠,٨٤٤ ppm with a mean level of ٠,٣٥٢ ppm and lead permissible limit (٠,٥ ppm) was exceeded in ٣ samples which representing ١٥% of total samples of canned chicken luncheon meat, Table (1). In the examined samples of canned turkey luncheon meat, lead concentration was ranged from ٠,١٦٨ ppm to ١,٠٨٤ ppm with a mean level of ٠,٤٢٣ ppm and lead concentration exceed the permissible limit (٠,٥ ppm) recommended by **Egyptian Standard (١٩٩٣)** in ٤ samples which representing ٢٠% of total samples of canned turkey luncheon meat, Table (1). Higher lead concentration in canned meat products were recorded by **Parisi et al**. **(١٩٨٥)** and **El-Zeini et al. (١٩٩٧)**. While, lower lead concentration in canned meat products were recorded by **Oddi** and **Maggi (١٩٨٦), Osman** and **Al-Rehiayani (٢٠٠٦)** and **Premavalli et al. (٢٠٠٧)**.

Presence of lead residues in canned meat products may be attributed to contamination of raw beef and poultry meat which used for manufacturing of canned meat products **(Gartrell et al., ١٩٨٦ a; Gartrell et al., ١٩٨٦ b; Cocchieri** and **Fiore, ١٩٨٧; Ukhun et al., ١٩٩٠** and **Tsoumbaris** and **Papadopoulou, ١٩٩٤)** or may be attributed to lead contamination during processing and canning from metallic containers **(Sanchez et al., ١٩٨١** and **Reilly, ١٩٩١)**. Moreover, canned meat products having lead concentration above its permissible limit represent an additional route of lead exposures and act as a serious health hazard for human especially children.

- **Cadmium concentration in canned meat products :**

Results recorded in Table (٢) declared all the examined samples of canned meat products contained cadmium at various concentrations. In the examined samples of canned beef, cadmium concentration was ranged from ٠,٠١٢ ppm to ٠,٢٣٢ ppm with a mean level of ٠,٠٤٦ ppm and cadmium concentration exceed the permissible limit (٠,1ppm) recommended by **WHO(٢٠٠0)** in 3 samples which representing ١٥% of total samples of canned beef, Table (2). In the examined samples of canned beef luncheon meat, cadmium concentration varied from ٠,٠١٦ ppm to ٠,٣٠ ppm with a mean level of ٠,٠٤٩ ppm and cadmium permissible limit (٠,1ppm) recommended by **WHO (2000)** was exceeded in 2 samples which representing 1٠% of total samples of canned beef luncheon meat, Table (2).

In canned chicken luncheon meat, cadmium concentration ranged from ٠,٠٢ ppm to ٠,١٦٨ ppm with a mean level of ٠,٠٤٥ppm and cadmium permissible limit (٠,١ppm) was exceeded in 3 samples which representing ١٥% of total samples of canned chicken luncheon meat, Table (2). In the examined samples of canned turkey luncheon meat, cadmium concentration was ranged from ٠,٠١٦ ppm to ٠,٢٠ ppm with a mean level of ٠,٠٤٧ppm and cadmium concentration was exceed the permissible limit (٠,١ppm) recommended by **WHO (٢٠٠0)** in 3 samples which representing 1٥% of total samples of canned turkey luncheon meat, Table (2). On the other hand, comparison of the obtained results with other standard revealed that 4 samples of canned beef, 6 samples of canned beef luncheon, 4 samples of canned chicken luncheon and 5 samples of canned turkey luncheon were contained cadmium concentrations over the permissible limit (0.05ppm) recommended by **Commission of European Communities (2001)** and representing 20,30,20 and 25% of the examined canned meat samples, respectively. Lower cadmium contents in canned meat products were recorded by **Oddi** and **Maggi (١٩٨٦)** and **Osman** and **Al-Rehiayani (٢٠٠٦)**. While, higher cadmium concentration in canned meat products was recorded by **El-Zeini et al. (١٩٩٧)**.

Presence of cadmium residues in canned meat products may be attributed to contamination of raw beef and poultry meat which used for manufacturing of canned meat products **(Gartrell et al., ١٩٨٦ a ; Gartrell et al., ١٩٨٦ b ; Cocchieri** and **Fiore, ١٩٨٧ ; Ukhun et al., ١٩٩٠ ; Tsoumbaris** and **Papadopoulou, ١٩٩٤** and **Muller et al., ١٩٩٨)** . Cadmium is found in most foodstuffs at a very low concentration, unless contamination has occurred during production, handling and canning process. Cadmium levels in animal tissues, especially liver and kidney, are strongly related to levels in animal feeds **(Fox,١٩٨٧** and **Reilly, ١٩٩١)**. Moreover, canned meat products containing cadmium concentration above its permissible limit may have a critical impact on public health.

- **Tin concentration in canned meat products :**

Results recorded in Table (٣) declared tin concentration was ranged from ١,٢٨ppm to ٢,٢٤ ppm with a mean level of ١,٦٩٦ ppm in canned beef samples. In canned beef luncheon samples, tin concentration was ranged from ١,٠٤ ppm to ١,٩٢ ppm with a mean level of ١,٤٥٦ ppm. While, the concentration of tin in the examined samples of canned chicken luncheon meat was ranged from ٠,٤٨ ppm to ٠,٩٦ppm with a mean level of ٠,٧٣٢ ppm and tin concentration in canned turkey luncheon meat was ranged from ٠,٤٨ ppm to ٠,٨٠ppm with a mean concentration of ٠,٦٥٢ ppm, Table (٣). The obtained results revealed that all the examined samples of canned beef, canned beef luncheon, canned chicken luncheon and canned turkey luncheon meats were contained tin concentration within the permissible limit (١٠٠ppm) recommended by **Egyptian Standard (١٩٩٣)**. Higher tin concentrations in canned meat products were recoded by **Jiraskova** and **Srna (١٩٨٣)** and **Parisi et al. (١٩٨٥)**. There are many factors which play significant roles in the contamination of canned foods with tin. Uptake of tin by food depends mainly on the nature of the foods as well as on whether cans are lacquered or not. Other factors include PH of the food in the cans, the storage time and temperature of the canned foods. Meat and meat products are often contained in lacquered cans and are not aggressive to tin **(Reilly,١٩٩١).**

- **Calculated daily intake of heavy metals :**

Results recorded in Table (٤) revealed that the calculated daily intake of lead (µg/day) was ٤٨,٤, ٤٧,٨, ٣٥,٢ and ٤٢,٣ for adult person (٧٠ kg) from consumption of canned beef, canned beef luncheon, canned chicken luncheon and canned turkey luncheon meats (١٠٠ g/day of each) , respectively, and these quantities representing ١٩,٣٦, ١٩,١٢, ١٤,٠٨ and ١٦,٩٢% of Acceptable Daily Intake (ADI) stipulated by **FAO/WHO (٢٠٠٤)**.

The principal route of lead exposure for people in the general population is food. Adults absorb ٥-١٥% of ingested lead and usually retain less than ٥ % of what is absorbed, while children absorb ٤١,٥% of ingested lead. From public health point of view, lead has a large affinity to thiol and phosphate containing ligands, inhibits the biosynthesis of heme and thereby affects the membrane permeability of kidney, liver and brain cells which reduce the function or completely breakdown of these tissues **(WHO,١٩٨٠** and **Goyer, ١٩٩٦)**.

Results recorded in Table (٤) revealed the calculated daily intake of cadmium (µg/ day) was ٤,٦, ٤,٩, ٤,٥ and ٤,٧ for adult person from consumption of canned beef, canned beef luncheon, canned chicken luncheon and canned turkey luncheon meats (١٠٠g/day of each), respectively, and these values representing ٦,٥٧, ٧,٠, ٦,٤٢ and ٦,٧١ % of Acceptable Daily Intake (ADI) stipulated by **FAO/WHO (٢٠٠٤)**.

Food is the major source of cadmium to the nonsmoking population **(Elinder,١٩٨٥)**. ٢-٦% of ingested cadmium is absorbed from the gastrointestinal tract and the absorption may reach ٢٠% of a given dose in an individual with low body stores of iron **(Nadig, ١٩٩٠)**. Cadmium is a cumulative toxic metal with biological half life ranging from ٢٠-٤٠ years **(Shibamoto** and **Bjeldanes,١٩٩٣)** and body burden increases with age **(WHO, ١٩٨٠)**. Cadmium acts on sulfhydryl groups of essential enzymes, it binds to phospholipids and interferes with oxidative phosphorylation as well as it can replace zinc in metalloenzmes which change its activity. Cadmium accumulates mainly in liver and kidney **(Goyer,١٩٨٩)**.

The calculated daily intake of tin (µg/ day) was ١٦٩,٦, ١٤٥,٦, ٧٣,٢ and ٦٥,٢ for adult person from consumption of canned beef, canned beef luncheon, canned chicken luncheon and canned turkey luncheon meats (١٠٠g/day of each), respectively, and these quantities representing ٠,١٢, ٠,١٠, ٠,٠٥ and ٠,٠٤% of Acceptable Daily Intake (ADI) stipulated by **FAO/WHO (٢٠٠٤)**, Table (٤).

The normal level of tin in foods is low, except where they have been in contact with metal in cans or other tin-plated containers. Tin in foods appears to be poorly absorbed and is excreted mainly in feces and small amount of absorbed tin may be retained in kidney, liver and bone **(WHO,١٩٧٣)**. High levels of tin in foods can cause acute poisoning and the toxic dose in human being ٥-٧mg/kg body weight. However, nausea and vomiting have been occur when levels of ٢٥٠ mg/kg of tin in food have been consumed. While, prolonged intake of tin at subacute levels have been associated with growth retardation, anemia and histological changes in the liver. Tin interfere with iron absorption and hemoglobin formation **(Reilly, ١٩٩١)**.

CONCLUSION AND RECOMMENDATION

Analytical data obtained from this work shows presence of lead, cadmium and tin residues at various concentrations in the different types of canned meat products (canned beef, beef luncheon, chicken luncheon and turkey luncheon meats) which collected from different localities at Damietta Governorate. Some samples of these canned meat products were contained lead and cadmium above the recommended permissible limit and this may pose a health risk to individuals consuming large quantity of these canned meat products. On the other hand, tin residues in these canned meat products was lower than the recommended permissible limit and there is no health risk when the obtained data compared with the respective established Acceptable Daily Intake of tin.

In order to protect human health from the hazardous effects of heavy metals in canned meat products, a regular and representative monitoring of toxic metals during growth of both farm animals and poultry were recommended especially for its feeding stuffs and drinking water. Also, heavy metal contamination of both animal and poultry tissues during slaughtering, transportation, handling, storage, manufacturing and canning processes must be avoided.

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الملخص العربى

متبقيات الرصاص والكادميوم والقصدير في بعض منتجات اللحوم المعلبة المباعة بأسواق محافظة دمياط

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أجريت هذه الدراسة لتقدير عناصر الرصاص والكادميوم والقصدير في عدد ٨٠ عينة عشوائية من منتجات اللحوم المعلبة والمجمعة من الأسواق المختلفة والمتواجدة بمراكز محافظة دمياط وذلك بواسطة استخدام جهاز الامتصاص الذرى الطيفي. وقد أوضحت النتائج وجود عناصر الرصاص والكادميوم والقصدير بتركيزات مختلفة في جميع عينات اللحم البقري المعلب محليا ولانشون اللحم البقري المعلب المستورد ولانشون لحم الدجاج المعلب المستورد ولانشون لحم الرومى المعلب المستورد بمتوسط تركيز عنصر الرصاص ٠,٤٨٤ ، ٠,٤٧٨ ، ٠,٣٥٢ ، ٠,٤٢٣ جزء في المليون من هذه المنتجات على التوالي وأن متوسط تركيز الكادميوم ٠,٠٤٦، ٠,٠٤٩، ٠,٠٤٥، ٠,٠٤٧ جزء في المليون من هذه المنتجات على التوالى وأن متوسط تركيز القصدير ١,٦٩٦، ١,٤٥٦، ٠,٧٣٢، ٠,٦٥٢ جزء في المليون من هذه المنتجات على التوالى وقد تم مقارنة جميع نتائج تركيزات الرصاص والكادميوم والقصدير بالحدود المسموح بها في منتجات اللحوم المعلبة. كما تم مقارنة الكم اليومي الذي يتناوله الإنسان البالغ من عناصر الرصاص والكادميوم والقصدير عند استهلاك مثل هذه المنتجات بالمأخوذ اليومي المسموح به عالمياً وقد أسفرت النتائج أن المأخوذ اليومي من عنصر الرصاص يمثل ١٩,٣٦% ، ١٩,١٢% ، ١٤,٠٨% ، ١٦,٩٢% وأن المأخوذ اليومي من عنصر الكادميوم يمثل ٦,٥٧% ، ٧%، ٦,٤٢% ، ٦,٧١% وأن المأخوذ اليومي من عنصر القصدير يمثل٠,١٢%،٠,١% ، ٠,٠٥% ، ٠,٠٤% من المأخوذ اليومي المسموح به عالمياً للإنسان البالغ عند استهلاك مثل هذه المنتجات على التوالى. هذا وقد ناقشت الدراسة أخطار هذه الملوثات على الصحة العامة وكذلك ط٩رق الوقاية منها.