LEAD AND MERCURY AS HEAVY METAL RESIDUES IN IMPORTED CANNED FISH PRODUCTS

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A B S T R A C T

Ninety random samples of imported canned fish products represented by canned tuna, sardine and mackerel (30 of each) were purchased within their validity dates from different supermarkets located in Menoufia Governorate. Each sample was kept in a separate sterile plastic bag and transferred to the laboratory in an insulated ice box as quickly as possible. All collected samples were examined for detection of their contents of heavy metal residues to evaluate their quality according to standard legislations. The obtained results revealed that the average concentration of lead (mg\kg) in the examined samples of canned tuna, sardine and mackerel were 0.13± 0.01, 0.25± 0.01 & 0.42± 0.02 for origin (A) and 0.19± 0.01, 0.33± 0.02 and 0.51± 0.03 for origin (B). On the other hand, the mean values of the concentration of mercury (mg\kg) in the examined samples of canned tuna, sardine and mackerel were 0.49± 0.02 , 0.63± 0.03 &1.06 ±0.04 for origin (A) and 49.25± 4.39 , 66.53± 7.04 and 85.76± 8.12 for origin (B), respectively. The public health significance of such serious pollutants and some recommendations to avoid contamination of imported canned fish products were discussed.

Key words: - lead, mercury, tuna, sardine, mackerel, fish, heavy metals.

(BVMJ-26(2):119-125, 2014)

1. INTRODUCTION

Nowadays, fish canning industry became well established in A.R.E. and the locally produced canned fish products are widely distributed in the Egyptian Market under different market names. The procedures applied in fish canning industry vary with the type of product being canned and the size and shape of the container, but generally there are principle steps in common practice and the most important one is the selection and preparation of raw materials for processing to obtain a product, which agreed with the quality control standards. Canned foods offer a shortcut in meal preparation. Canned food is subjected to heavy metal contamination during the canning process (Fong et al., 2006). Nutritionally, fish contain protein of a high biological value, highly digestible and at least as good as red meat with respect to content of essential amino acids, appreciable amounts of cobalt, magnesium, phosphorous, iron and copper (Eldaly, 2000). On the other hand, Fish have the ability to accumulate heavy metals in their tissues by the absorption along the gill surface and gut tract wall to higher levels several hundred times more than the concentration of metals in their surrounding water medium(Nammalwar, 1983). Toxic elements are very harmful even at low concentration when ingested over a long time. (Celik and Oehlenschager, 2007). Pollution and industrial practices result in concentrations of metals and other environmental agents that are related to environmental toxicity (Novelli et al., 1998). Therefore, the current study was planned out to determine the level of contamination of some canned fish products with lead and mercury.

2. MATERIAL AND METHOD.

A grand total of 90 random samples of imported canned fish products represented by canned tuna, sardine and mackerel (30 of each) were purchased within their validity dates from different supermarkets located in Monofia Governorate. .All collected samples were examined for detection of their contents of lead and mercury residues to evaluate their quality according to standard legislations.

2.1. Digestion procedure

2-1-1-Preparation of samples for estimation of lead (Finery et al., 1990):

After washing, digestion of one gram from each sample was carried out by 10ml of digestion mixture (60ml Nitric acid "HNO_3" 65% 40ml Perchloric acid "$3HCLO_4$" 70-72%) in screw capped tube after maceration by sharp scalpel. The tubes were tightly closed and the contents were vigorously shacked and allowed to stand overnight at room temperature. The tubes were heated for 4 hours in water bath adjusted at 70 C to ensure complete digestion of samples. The tubes were then left to cool at room temperature and diluted with 10ml deionized water, capped with plastic film and thoroughly mixed. The digest was then filtered with Whattman filter paper No. 42 and the filtrate was completed to 100 ml with deionized water. Moreover, the filtrate was collected in test tube and kept at room temperature until analyzed for its heavy metal contents.

2-1-2- Preparation of samples for estimation of mercury (Diaz et al., 1994)

Accurately, 0.5 g of the macerated sample was digested in 10 ml of concentrated mixture of sulphoric acid and nitric acid solutions (1:1) at 45 C for 15 hours. After digestion, the mixture was filtered by Whitman filter paper No. 42 and the filtrate was completed to 100 ml with deionized water.

2.2. Preparation of blanks and standard solutions:

Preparation of blanks and standard solutions was applied in the same manner of wet digestion technique and by using the same chemical.

2.3. Analysis

The digest, blanks and standard solutions were aspirated by using flame Atomic Absorption Spectrophotometer (Perkin Elmer Atomic Absorption Spectrophotometer "AAS" model 2380 equipped with Mercury Hydride System "MHS", USA) and analyzed for lead at wavelength 217nm and mercury at wave length 253.7nm.Estimation of heavy metals in each examined sample was expressed by (mg\kg) of wet weight samples according to the following equation:

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

Where,
C=Concentration of lead or mercury (mg/kg) wet weight.
R=Reading of digital scale of AAS.
D=Dilution of prepared sample.

2.4. Statistical analysis

The obtained results were statistically analyzed by application of analysis of variance (ANOVA) according to Feldman et al. (2003).

3. RESULTS

The study revealed that the average concentration of lead (mg\kg) in the examined samples of canned tuna, sardine and mackerel were 0.13± 0.01, 0.25± 0.01 and 0.42± 0.02 for origin (A) and 0.19± 0.01, 0.33± 0.02 and 0.51± 0.03 for origin (B), respectively (table 1). Concerning the lead levels, the differences between the examined sample of canned fishes products show high significant differences $p<0.01$ as result of types of products and origin.. In contrast, non-significant differences appeared because of interaction between types of products and their origin.

Table (1): Statistical analytical results of lead levels (mg/kg) in the examined samples of imported canned fishes (n=15).

Origin / Product	A			B		
	Min.	Max.	Mean ± S.E	Min.	Max.	Mean ± S.E*
Canned Tuna	0.01	0.27	0.13 ± 0.01	0.02	0.44	0.19±0.01++
Canned Sardine	0.02	0.49	0.25 ± 0.01	0.02	0.52	0.33 ± 0.02
Canned Mackerel	0.04	0.93	0.42 ± 0.02	0.05	1.28	0.51 ± 0.03

S.E*= Standard error of mean. ++ = High significant differences *(p<0.01)*

Table (2): Acceptability of the examined samples of imported canned fish based on their levels of lead (n=15).

Canned fish	Maximum Permissible Limit (mg/kg)*	Positive samples		Unaccepted Samples	
		No.	%	No.	%
Origin A:					
Canned Tuna	0.1	4	26.67	1	6.67
Canned Sardine	0.1	6	40.00	3	20.00
Canned Mackerel	0.1	7	46.67	4	26.67
Origin B:					
Canned Tuna	0.1	5	33.33	2	13.33
Canned Sardine	0.1	7	46.67	4	26.67
Canned Mackerel	0.1	10	66.67	7	46.67

*Egyptian Organization of Standardization "EOS" (2005)

Table (3): Statistical analytical results of mercury levels (mg/kg) in the examined samples of imported canned fish (n=15).

Origin / Product	A			B		
	Min.	Max.	Mean ± S.E	Min.	Max.	Mean ± S.E*
Canned Tuna	0.09	1.02	0.49 ± 0.02	0.13	1.25	0.57 ± 0.02
Canned Sardine	0.16	1.68	0.63 ± 0.03	0.21	2.07	0.82 ± 0.04
Canned Mackerel	0.19	2.17	1.06 ± 0.04	0.26	2.43	1.18 ± 0.05

S.E*= Standard error of mean.

Table (4): Acceptability of the examined samples of imported canned fish based on their levels of mercury (n=15).

	Maximum Permissible Limit (mg/kg)*	Positive samples		Unaccepted Samples	
		No.	%	No.	%
Origin A:					
Canned Tuna	0.5	4	26.67	2	6.67
Canned Sardine	0.5	8	53.33	5	33.33
Canned Mackerel	0.5	9	60.00	5	33.33
Origin B:					
Canned Tuna	0.5	6	40.00	3	20.00
Canned Sardine	0.5	9	60.00	6	40.00
Canned Mackerel	0.5	12	80.00	8	53.33

*Egyptian Organization of Standardization "EOS" 2005

Furthermore, the permissible limit of lead in canned fish should not exceed 0.1 mg\kg (EOS 2005). Accordingly 6.67%, 20% and 26.67% of the examined samples of canned tuna, sardine and mackerel were unaccepted respectively. Concerning origin (B), 13.33%, 26.67% and 46.67% of the examined canned tuna, canned sardine and canned mackerel were unaccepted, respectively, as shown in table (2). Results achieved in table (3) revealed that the concentrations of mercury (mg\kg) in the examined samples of canned tuna, sardine and mackerel were 0.49± 0.02, 0.63± 0.03 and1.06± 0.04 for origin A and 0.57± 0.02, 0.82± 0.04 and 1.18± 0.05 for origin B, respectively. Concerning mercury level the differences between the examined samples of canned fish show high significant differences $p<0.01$ as result of types of products and origin. In contrast, non-significant differences appeared because of interaction between types of products and their origin. The permissible limit of mercury in canned fish should not exceed 0.5mg\kg(EOS, 2005). Accordingly 6.67% , 33.33% and 33.33% of the examined samples of canned tuna , sardine and mackerel were un accepted .In regard to origin (B), 20% ,40% and 53.33% of canned tuna , canned sardine and canned mackerel were unaccepted respectively (table 4).

4. DISCUSSION

Water pollution leads to fish contamination with toxic metals, from many sources, e.g. industrial and domestic waste water, natural runoff and contributory rivers (Arain et al., 2008). The current results of lead levels were nearly similar to those recorded by Morshady et al. 2013, "0.127± 0.02 ppm", higher results were obtained by Abdelgwad 2003 "1.985± 0.22 ppm", however, lower results were reported by Khansari et al. 2005 "0.036 ppm" for tuna. In sardine, lower results were reported by Ikem and Egiebar 2005 "5.1 ppm", while, higher results were obtained by Abdelgwad 2003 "2.419± 0.28 ppm". The results of mackerel agree with those obtained by Tuzen 2009 "0.45±0.03 ppm", higher results were reported by Abdelgwad 2003 "2.532± 0.308 ppm", while, lower findings were recorded by Morshady et al. 2013 "0.023 ±0.01 ppm". Children are particularly susceptible to lead exposure due to high gastrointestinal uptake and the permeable blood brain barrier **(**Jarup, 2003). Biological interest in lead has cantered principally on its properties as a highly toxic accumulative poison in man and animals moreover, lead levels in edible tissue of fish over permissible limits are implicated in chronic lead toxicity (plumbism) results in anemia, Abdominal pain (lead colic), lead encephalopathy, renal damage, lead palsy and recently lead is considered as one of immune suppressive agents in animal and human (Commission of the European Communities, 2001). Concerning mercury level nearly similar results were recorded by Huggett et al. 2001 "1.0 ppm", while higher results were obtained by Tariq et al. 1994 "2.301 ppm", however, lower results were obtained by Herming et al. 1980 "0.04-0.55 ppm", and Oivera et al. 1997 "0.21 ppm". Fish is the main source of methyl mercury for human, Mercury pollution arises mainly from both natural sources and by anthropogenic source as the mercury had been used for numerous industrial applications all of these sources lead to disposition of mercury in the form of both wet and dry precipitation into lakes and streams (Sheffy, 1987).The consumption of fish and shellfish contaminated with mercury lead to Minimata disease in human and other vertebrates including fish. The symptoms of this disease were muscular weakness. Loss of vision impaired cerebral function, paralysis, coma and finally death (Matida et al., 1972). Finally, the consumption of such imported canned fish products contaminated with these serious heavy metals may constitute, at times, public health hazard.

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مجلة بنها للعلوم الطبية البيطرية عدد 26 (2): 119-125، يونيو 2014

الرصاص والزئبق كمتبقيات للمعادن الثقيلة في الأسماك المعلبة المستوردة

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الملخص العربي

تم جمع 90 عينة عشوائية من معلبات التونة، السردين والماكريل المتداولة بأسواق محافظة المنوفية وذلك لتحليلها باستخدام جهاز الامتصاص الذرى الطيفي للتعرف على مدى تلوثها الرصاص والزئبق. وقد كان متوسط تركيز الرصاص في مجموعة (ا) 0.13 ±0.01 في التونة المعلبة و0.25 ±0.01 في السردين المعلب 0.42 ±0.02 في الماكريل المعلب. ومتوسط تركيز الرصاص في مجموعة (ب). 0.19 ±0.01 في التونة المعلبة و0.33 ±0.02 في السردين المعلب 0.51 ±0.03 في الماكريل المعلب. واكدت النتائج ان متوسط تركيز الزئبق في مجموعة (ا) 0.49 ±0.02 فى التونة المعلبة و0.63 ±0.03 في السردين المعلب1.06±0.04 في الماكريل المعلب و متوسط تركيزالزئبق فى مجموعة (ب) 0.57 ±0.02 فى التونة المعلبة و0.82 ±0.04 في السردين المعلب1.18 ±0.05 في الماكريل المعلب، و6.67% من عينات التونة و20% من عينات السردين و26.67 من عينات الماكريل للمجموعة (ا) و13.33 من عينات التونة و26.67 من عينات السردين و46.67 من عينات الماكريل للمجموعة (ب) غير مقبولة بالنسبة لعنصر الرصاص. ووجد ان 6.67 %من عينات التونة و33.33% من عينات السردين و33.33% من عينات الماكريل للمجموعة (ا) و20% من عينات التونة و40 % من عينات السردين و53.33% من عينات الماكريل للمجموعة (ب) غير مقبولة بالنسبة لعنصر الزئبق. وخلاصة القول فقد وجد ان بعض العينات التي تم فحصها غير صالحة للاستهلاك. وقد تم مناقشة الاهمية الصحية لمتبقيات المعادن الثقيلة لكل عنصر على حدة ومدى تأثيرها على صحة الانسان ومصادر التلوث المختلفة بها بالإضافة الى بعض التوصيات لتحسين جودة معلبات الاسماك.

(مجلة بنها للعلوم الطبية البيطرية: عدد 26(2):119- 125, يونيو 2014)