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Public health implication of consuming canned fish

Manal M. El-Sadaawy[1,*], Fadia A. Morsy[1], Hoda H.H. Ahdy[1], Laila M. Fattah[2], Amany El-Sikaily[1] and Azza Khaled[1]

[1]Marine Pollution Lab, [2]Marine Chemistry Lab, Division of Marine Environment, National Institute of Oceanography and Fisheries Alexandria, Egypt
**Corresponding author:Manal Mohamed El-Sadaawy*
E-mail:manal_dn@yahoo.com

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Abstract

Due to their nutritional value, fish and canned fish products are highly quality foods that are beneficial to human health. Fish is a vital, healthy source of animal protein and vitamins. Eight brands of canned sardines and tuna fishes, originating from six countries commercialized in Egypt were analyzed in composite samples to investigate the impact of consuming fishes on public health. The contents of the nutritive substances of canned fish (protein, macro-elements and lipids) and some metals (Cu, Fe, Mn, Zn, Cr and Ni) were determined. The accuracy of the method was corrected by standard reference material (DORM-2). Among tested metals, Fe attains the highest concentrations for both canned sardine and tuna fishes (28.192-30.235 and 17.767-33.552 µg/g wet weight respectively) followed by Zn (18.795-20.157 and 11.845-22.368 µg/g wet weight respectively) and recorded comparable ranges for Cu, Mn and Ni (1.719-2.047 and 0.760-1.396; 0.920-2.439 and 0.581-0.833; 0.407-0.792 and 0.271-2.600 µg/g wet weight respectively) while Cr attains the lowest values for both sardine and tuna canned fish (0.157-0.423 and 0.186-0.322 µg/g wet weight respectively). The levels of metals in the studied fish were far below the permissible levels for various governmental agencies. From a nutritional point of view, canned fish products are rich in major and trace elements. Where, canned sardines recorded highest calcium, magnesium and sulphate content, while canned tuna contained the higher phosphate. In this context, the average protein concentration in sardine was higher than that in the tuna fish samples. On the other hand; the lipid concentration in sardine samples gave an average lesser than their concentrations in tuna fish. These results indicated that there is no risk in canned fish with respect to the concentrations of all the studied metals. The estimated weekly intakes by human consuming for both canned sardines and tuna were also evaluated for possible consumer health risks. The weekly intakes through consumption either of canned sardines and tuna did not exceed the toxicological reference values established by WHO, and consequently there was no human health risk.

Keywords: Canned fish, nutrition, heavy metals, PTWI.

1. Introduction

There is an increase concern about the quality of foods in several parts of the world. "Food safety" implies absence or acceptable and safe levels of contaminants, adulterants, naturally occurring toxins or any other substance that may make food harmful to health on an acute or chronic basis. Food quality can be considered as a complex characteristic of food that determines its value or acceptability to consumers. Besides safety, quality attributes include: nutritional value; organoleptic properties such as appearance, color, texture, taste and functional properties (WHO, 1998). Fish and Canned fish, like (tuna, mackerel and sardine) are largely eaten in many countries as they are sources of protein rich in essential amino acids, trace and major and elements (calcium, phosphorus, fluorine, iodine), fats that are valuable sources of energy, fat-soluble vitamins, and unsaturated fatty acids that, among other benefits, have a hypocholesterolic effect (anti-arteriosclerosis) (Ismail, 2005). However, humans may be exposed to harmful trace elements such as arsenic, silver, lead, mercury, cadmium, and nickel mainly through contaminated drinking water, consumption of fresh and processed foods and through occupational exposures. Amongst those species recognized as potentially accumulating highest metal levels, tuna is one of the most frequently consumed and commercially available groups of fish worldwide (Burger *et al.*, 2005). These pelagic organisms are high performance fish with very high metabolism rates and, thus, high food intake rates, a property that accentuates the exposure to trace elements (Kojadinovic *et al.*, 2007). Consequently, adverse human health effects may occur if this fish is consumed too much or in large enough quantities. In this context it is also of interest to consider canned tuna, which amongst canned fishery products is doubtless the most largely and frequently consumed. Canned tuna is, in fact, well eaten in the developed world, especially for most working families. It is not surprising, that an interest in sardine-type fishes consider as prospective replacements for, or supplements to, big fish in the consumer diet has emerged (Dewailly and Rouja, 2009; Tibbetts, 2004). They are not only cheaper, but they are also higher in Omega-3 fatty acids and their small size and shorter life span apparently precludes their ability to concentrate the elevated metal levels that larger fish do. They are already among the most abundant fishes to be listed by the US Environmental Protection Agency (USEPA) as healthy and safe for human consumption (Natural Resources Defense Council/NRDC, 2007). Concentration of metals in canned fish varies, depending on the type and origin of the food, pH of the canned product, oxygen concentration in the headspace, quality of the inside lacquer coating of cans, storage place, etc. (Tahàn *et al.*, 1995, Tarley *et al* , .2001). Nevertheless, publications on the concentrations of toxic elements in canned tuna and dietary intakes of these elements via these fishery products in Egypt and in Arabian countries are lacking as well as a few literature data confirms the ability of these large pelagic predators to accumulate substantial levels of toxic metals (Storelli *et al*., 2002; Licata *et al*., 2005). Accordingly, the objectives of the present work are to determine the concentration levels of some metals (Cu, Zn, Cr, Fe, Mn and Ni) in canned fish samples purchased from supermarkets located in different Egypt cities and to compared it with the permissible limits of the European Legislation (Official Journal of the European Union, 2006; European Food Safety Authority (EFSA), 2009), as well as to estimate the weekly intake and compared it with the Provisional Tolerable Weekly Intake (PTWI) recommended by the Joint FAO/WHO Expert Committee on Food Additives (WHO, 2006; EFSA, 2009) to investigate the impact of consuming canned fishes on public health.

2. Materials and methods

Various species of canned fish of different geographical regions available were collected randomly from supermarkets. Canned fish samples (two brands of sardines, and six brands of tuna) were purchased which representing four countries (Morocco, Republic of Yemen, Indonesia and Thailand) were collected between 2009 and 2010 (Table 1). The content of fish in tins was first separated from the oil and then the fish content from three tins with the same lot code was homogenised with a food mixer. Homogenised samples were stored in a freezer until the analysis.

The health benefits and risks stemming from canned fish consumption were determined according to the provisional tolerable weekly intake (PTWI) for contaminants and the quantities of ingredients that render a canned fish diet healthy. The accuracy of the analytical procedure was carried out by duplication of the samples and analytical validation was conducted through the analysis of certified reference samples (DORM-2). The blanks and calibration standard solutions were also analyzed in the same way as the sample solutions (Table 2)

Table 1. Countries of origin of cans analyzed, and the production and 'Best By' dates of cans samples purchased during 2009 and 2010.

Sample No.	Brand	Type of fish	Country origin	Production Date	Best by Date
1	--	Sardine	Morocco	06/2006	06/2011
2	--	Sardine	Thailand	05/2008	05/2011
3	--	Tuna	Thailand	11/2007	11/2010
4	Goody	Tuna	Indonesia	04/2008	04/2011
5	Tenderina	Tuna	Indonesia	07/2008	07/2011
6	Botan	Tuna	Thailand	02/2007	02/2010
7	Hiba	Tuna	Republic of Yemen	01/2008	01/2011
8	Harvest	Tuna	Thailand	12/2008	12/2011

Table 2. Results and analysis of heavy metals of DORM-2 reference material (µg/g dry weight)

Metals	Heavy metals (µg/g dry weight)					
	Cr	Cu	Fe	Mn	Zn	Ni
Certificated values	35.07	2.98	142	3.33	21.8	19.85
Observed values	33.98	2.8	146	3.14	22.44	18.09
Recovery%	96.89	93.96	102.82	94.29	102.94	91.13

2.1. Metal Analysis

Samples of canned fish (4-5 g wet weight) were weighed directly into acid-washed Teflon digestion vessels. Fifteen milliliters of ultra pure nitric acid were added to each vessel. After swirling gently, Teflon vessels were covered and left at room temperature overnight. The samples were then heated at 100°C for 2-3 hours or until complete digestion, and then cooled to room temperature. After cooling digests were finally made up with deionized water to 25ml in acid washed standard flasks after filtration and then placed in acid washed polyethylene bottles until analysis. For each run, a duplicate sample, spiked samples, and two blanks were carried through the whole procedure (Ikem and Egiebor, 2005). Metal concentrations in all solutions were determined and measured as (µg/g wet weight), using Flame Atomic Absorption Spectrophotometer (A.A.S. Shimadzu, Japan) for determination of Cr, Cu, Fe, Mn, Ni and Zn .Canned fish (homogenized) samples were spiked with various concentrations of heavy metals for the recovery repeatability tests and for verifying the analytical methodology. For each run, triplicate samples, spiked samples and blanks were carried through the digestion reaction.

2.2. Determination of calcium and Magnesium Concentrations

Ca and Mg concentrations of digested canned tissue samples were determined by EDTA titration in presence of murexide and Eriochrome black T indicator, respectively (APHA-AWWA-WPCF 1992).

2.3. Determination of Sulphate

The sulphate (SO_4) content of digested canned tissue samples was estimated by turbidimetric method (APHA-AWWA-WPCF 1992).

2.4. Determination of Phosphorus

Phosphorus (P) content of the digested samples was evaluated based on the reaction with an acidified molybdate reagent to yield phosphomolybdate complex, which then reduced to a colored blue compound (Strickland and Parson 1965).

2.5. Determination of Total Lipids and Protein

Total lipids and protein content were determined in five replicated individual canned samples for each brand. The canned tissue was homogenized by an electric homogenizer with 1 volume of saline. The resulting homogenates were divided into aliquots for total lipids and total protein. Total lipids aliquots were extracted immediately, while protein aliquots were frozen for later assay. All procedures were carried out without exposing the samples to heat by keeping them in ice. Lipids were extracted from homogenate (1 ml) using 20 volume of (1:1) chloroform-methanol (Folch *et al.*, 1957). Extracted lipids were spectrophotometrically determined colorimetrically with sulfophospho vanillic mixture according to Folch and colleagues (1957).Protein was quantified using the method of Lowry *et al.* (1951). All used reagents were of analytical grade.

3. Results and discussion

3.1. Nutritional ingredients (Magnesium, Calcium and Phosphorus)

From a nutritional point of view, canned fish products are rich in major and trace elements. The basic major essential to proper body function are calcium and phosphorus, and the possibility of utilizing these elements depends on their mutual ratios in the foods consumed. Canned fish is a good source of calcium and phosphorus.

As shown in Figure (1), canned sardines recorded highest calcium, magnesium and sulphate concentrations, while canned tuna contained the higher phosphate level as shown in Figure (1). Ca content ranged between 31.615 ± 0.94 and 22.437 ± 3.24 mg/g for sardine and tuna respectively. On the other hand, the highest value of phosphorus recorded in tuna (3.774± 1.691 mg/g) and lowest value was recorded in sardine (1.994± 0.05 mg/g). The recommended daily allowance of calcium is contained in an average of about 420 g of canned fish while that of phosphorus is found in about 365 g. (Usydus *et al.*, 2008)

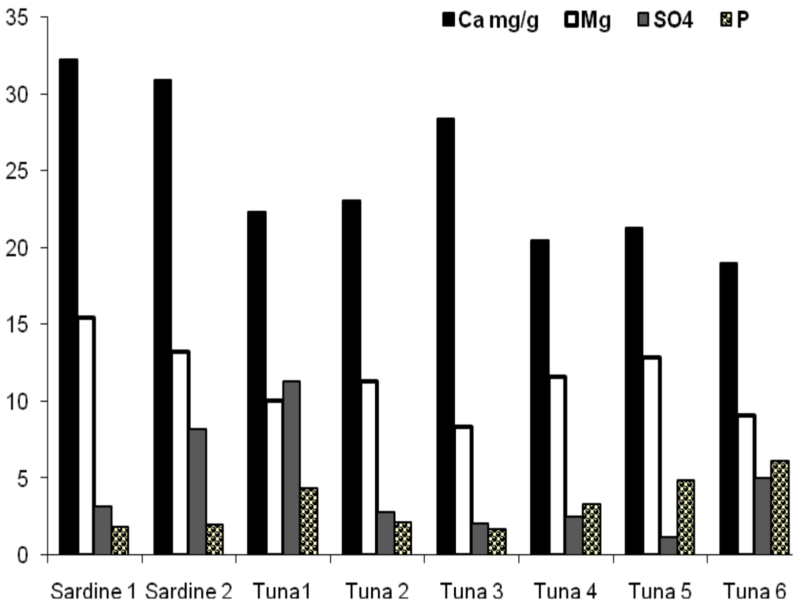

Figure 1. Average concentrations of nutritive components (units/g wet weight).

3.2. Metal Contamination

The mean values of copper, zinc, chromium, nickel, manganese and iron concentrations in canned sardines and tuna studied are given in Table (3). Iron is the most abundant of the examined metals. Iron deficiency causes anemia and fish is the major source of this examined metal (Ikem and Egeibor, 2005). However, it is also known that, when their intake is excessively elevated the essential metals can produce toxic effects (Ashraf *et al*., 2006). Ponka *et al*. (2007) underlined that mammals are not able to excrete excess iron, and chronic iron overload is associated with slowly progressing failure of various organs.

The highest mean level of iron attains in sardine (29.214 µg/g), while the mean concentrations of iron in the canned tuna is 25.46 µg/g. Similarly, Tarley *et al.* (2001) reported the average concentration of iron in canned sardines of Brazil as 20.96 to 88.83 µg/g, while Ikem and Egiebor (2005) reported Fe levels in the range of 0.01–88.4 mg/kg in canned fish samples purchased in the states of Georgia and Alabama (USA). Abou- Arab *et al*. (1996) reported a mean concentration of 4.21 (0.82–12.6 µg/g Fe) for imported sardine samples collected from the great Cairo governorate. Also iron exhibited an average concentration range in canned sardines from 30.022 to 48.112 µg/g, vary in canned tuna from 15.758 to 23.957 µg/g, and fluctuate between 26.311 and 31.755 µg/g in mackerel (Ahdy *et al.*, 2009). However, the mean concentrations of iron in the canned sardines from Nigerian market ranged from 8.04 to 48.18 µg/g Fe was recorded by (Iwegbue *et al.*,2009), while MoI (2011) reported iron content of tuna product from Turkey was 80.7 mg/kg. Republic of Turkey Ministry of Agriculture (2002) proposed 15 mg/kg Fe as limit for canned foods. The upper tolerable intake level (UL) of iron in children (0 months–8 years) and males/females (14–70 years) is 40 and 45 mg/day, respectively (Institute of Medicine, 2003),while the recommended dietary allowance (RDA) of iron for 7–12 months infants and males/females 51–70 years is 11 and 8 mg/day, respectively.

Zinc is involved in most metabolic pathways in humans and it`s deficiency can lead to loss of appetite, growth retardation, skin changes and immunological abnormalities. Too little zinc can cause problems, but too much zinc is also harmful to human health (Agency for Toxic Substances and Disease Registry (ATSDR), 2004). The marine organisms rich in proteins contain high concentrations of zinc 10-50 µg/g (WHO, 1996).but the excess of Zn may be harmful.

In this study, the levels of zinc range from 19.476 µg/g in canned sardine and 16.973 µg/g in canned tuna, and none of the samples exceeded the permissible limit (50 mg/kg) (Turkish Food Codex, 2002; MAFF, 1995; Associacao Brasileira das Indústrias da Alimentacao (Abia), 1998). There are no health risks with respect to Zn concentrations in canned sardine and tuna. In Kingdom of Saudi Arabia, and in US, the mean concentrations of Zn in canned tuna were found to be 10.4 mg/kg, and 4.78mg/ kg, respectively (Ashraf *et al*., 2006; Ikem and Egeibor, 2005). Likewise, Tuzen and Soylak (2007) reported the mean Zn value as 17.8mg/kg for canned tuna, commercialized in Turkey. However, Çelik and Oehlenschlager (2007) analyzed three samples of canned tuna from two different Turkish brands and reported higher amount of Zn than the limits. Meanwhile, the average zinc concentrations from the Egyptian supermarkets was ranged from

9.773-21.98 μg/g. (Ahdy *et al*., 2009), also 3.68-30.1 mg/kg for zinc was recorded for canned tuna fish produced in Turkey (Mol, 2011)

Determination of the Cu concentration in fish is also an important subject with respect to human consumption (Amundsen *et al*., 1997). Copper is required for iron utilization, and as a cofactor for enzymes involved in glucose metabolism and the synthesis of hemoglobin, connective tissue and phospholipids. Numerous studies have been directed on copper metabolism in fish and there is a lot of concern about the toxic effects related to heavy-metal pollution in the aquatic environment (Lall, 1995); however, copper is not toxic for humans in low concentrations (Linder, 1996), but it was also regarded as a potential hazard that can be harmful for human health when excessively exposed (Yilmaz *et al*., 2007). Very high intake can cause liver and kidney damage (ADTSR, 2004; Ikem and Egiebor, 2005). Whereas FAO (1983), WHO (1996) and MaFF (1995) report levels up to 30 mg/kg, the recommended limit for Cu in fish is 20mg/ kg according to Turkish Food Codex (2002). In this study, all samples contained lower concentration of Cu than these limits (Table 3); this result shows that all samples were safe for human consumption regarding Cu concentrations. Average Cu contents in canned tuna from Kingdom of Saudi Arabia, US, and Turkey were reported as 1.02mg/kg (Ashraf *et al*., 2006), 0.25 mg/kg (Ikem and Egeibor, 2005), 2.50mg/kg (Tuzen and Soylak, 2007), Tarley *et al.,* 2001(1.31 to 2.25 μg/g), 7.1–45.7 μg/g (Celik and Oehlenschlager, 2007),0.533 to 3.308 μg/g from the Egyptian market (Ahdy *et al*.,2009) and 0.08 –1.77 for tuna fish produced in Turkey (MoI , 2011) respectively . It is clear that there is no risk with respect to the concentrations of Cu in canned fish.

Chromium (III) is an essential nutrient element that potentiates insulin action and thus influences carbohydrate, lipid and protein metabolism. However, Cr (VI) is carcinogenic (Ikem and Egiebor, 2005; Tuzen and Soylak, 2006). Excessive amount of chromium (III) may cause adverse health effects (ATSDR, 2004).The chromium levels are 0.29 μg/g in canned sardine and 0.251 μg/g in canned tuna fish samples. Chromium concentrations recorded in this study are compared with literature obtained for canned fish in the USA (0.0–0.30 μg/g) (Ikem and Egiebor, 2005), 0.07–6.46 μg/g dry weight in fish species from Iskenderun Bay, northern east Mediterranean Sea, Turkey (Turkmen *et al*., 2005)., canned sardines in Brazil (0.46-1.18 μg/g) Tarley *et al*., 2001, imported fish in Egypt [sardines,0.5–18.9 μg/g; mackerel, 3–20.4 μg/g (Abou-Arab *et al*., 1996); tuna fish (0.10–0.57 μg/g)(Ashraf ,2006)]. On the other hand, chromium in canned fish ranged from 8.688 μg/g in sardine to 10.022 μg/g in tuna in canned fish from Egyptian markets (Ahdy *et al*., 2009).

Although manganese is an element of low toxicity, it has a considerable biological significance. Daily intake of small amount of manganese is needed for growth and good health in children. Children, as well as adults, who lose the ability to remove excess manganese from their bodies, have nervous system problems. According to the Environmental protection Agency (EPA) and (ATSDR, 2004), FAO (1983) and Turkish standards (Anon, 2002), there is no information on the carcinogenicity of manganese.

The NRDC has recommended safe and adequate daily intake levels for manganese that range from 0.3 to 1 mg/day for children up to 1 year, 1–2 mg/day for children up to age 10, and 2–5 mg/day for children 10 and older. The UL of manganese for children (1–3 years old) and males/females (19–70 years old) is 2 and 11 mg/day, respectively (Institute of Medicine, 2003). Daily intake of small amounts of manganese is needed for growth and good health in children.

The recorded manganese levels are given to be 1.68 μg/g in canned sardine fish and 0.666 μg/g in canned tuna fish samples. Manganese levels may also be affected by food processing. Manganese contents in the literature have been reported in the range 0.01–2.55 μg/g in canned fish samples (Ikem and Egiebor, 2005), 1.56–3.76 μg/g dry weight in fish samples of the middle Black Sea (Turkey) (Tuzen, 2003), and 0.05–4.64 μg/g dry weight in fish species from Iskenderun Bay, northern east Mediterranean Sea, Turkey (Türkmen *et al*., 2005). Iwegbue *et al*. (2009) recorded the mean concentrations of manganese ranged from 0.64 to 1.71 μg/g.

Nickel can cause respiratory problems and it is carcinogenic (ATSDR, 2004). The upper tolerable intake level (UL) of nickel for children (1–3 years old) and males/females (19–70 years old) is 7 and 40 mg/day, respectively (Institute of Medicine, 2003). Nickel concentrations of the studied samples ranged from 0.599 to 0.954 μg/g wet weight for sardine and tuna samples respectively. Ashraf (2006) has reported a mean nickel concentration of 0.16 μg/g in canned tuna fish from Saudi Arabia compared to the 0.04–3.26 μg/g we observed by Iwegbue *et al*.(2009)

3.3. Estimated weekly intakes

Previous studies reports that the fish consumed was dependent on culture and availability of fish species (Shatenstein *et al*., 1999); Fitzgerald *et al*., 1999; Oken *et al.*, 2003). The daily intake of an element from food consumption is dependent on the element concentration in food and amount of food consumed. In Egypt, General authority of fish resources and development (2008) has recommended weekly consumption of (approximately 260 g) of fish. The Estimated weekly intake (EWI) values shown in Table (4) were calculated by assuming that a 70 kg individual will consume 37.5 g of fish/day. Thus, the EWI values (Table 4) of trace elements by an adult (µg/kg body weight) consuming 260 g of canned fish/week were calculated using the averages posted by each brand in Table (4), [EWI (µg/70 kg body weight/week) = Mean metal levels (µg/g) × fish consumption (Kg/70 Kg body weight/week)]. The weekly intakes estimated in this study are agreement with values reported by many researchers for fish (Ikem and Egiebor 2005; Türkmen and Ciminli, 2007; Türkmen *et al*., 2009; Ikem and Egilla, 2008, Türkmen *et al*., 2010, Türkmen *et al*., 2011). The result from Table (4) indicates that the EWI of Cu, Fe, Mn, Ni, and Zn by a 70 kg adult consuming 260 g of fish/week were all below the respective PTWIs recommended by the expert committee on food additives (Joint FAO/WHO Expert Committee on Food Additives, 2004; WHO, 1993; EPA, 2008) as shown in Table (4), revealing that there was no any bad impact on human health risk from the consumption of investigated canned sardine and tuna.

3.4. Total lipids and protein:

As with many animal products, fish and fishery products contain water, proteins and other nitrogenous compounds, lipids, carbohydrates, minerals, and vitamins. The chemical composition of fish varies greatly from one species and in one individual fish to another depending on age, sex, environment, and season (FAO, 2008; Mahmoud and Allam 2002).

The summarized data on lipids and protein content are presented in Table (5). The average protein concentration in sardine was 7.105±0.52 (g/100 g wet wt.); while its average content in the tuna fish samples was 6.715±0.249 (g/100 g wet wt.). On the other hand, the lipid concentration in sardine samples gave an average of 1.71±0.58 (g/100 g wet wt.). In contrast, its concentrations in tuna fish were 2.007±0.34 (g/100 g wet wt.). These finding are in agreement with Tucker (1997); Rahimi *et al*. (2010). Fish is widely consumed in many parts of the world by humans because it has high protein content, low saturated fat and also contains omega-3, calcium, phosphorus, iron, trace elements like copper and a fair proportion of the B -vitamins known to support good health. also, with Kris-Etherton *et al*. 2002. It is estimated that the consumption of one portion of fatty fish, daily, delivers about 900 mg/day of n-3 acids, with consequent reduction of mortality in patients with coronary diseases (Kris-Etherton *et al*.(2002). Moreover Fish and canned fish, like (tuna, mackerel and sardine) are sources of protein rich in essential amino acids, micro and macro elements (calcium, phosphorus, fluorine, and iodine (ATSDR, 2003; Lutter and Dewey 2003; Erkan and Özden 2007).

Table 3. Mean concentrations of heavy metals under investigation in canned sardines and tunas (µg/g wet weight) collected during 2009-2010.

Concentration (µg/g wet weight)						Fish Type
Zn	Ni	Mn	Fe	Cr	Cu	
20.157	0.407	2.439	30.235	0.423	1.719	Sardine 1
18.795	0.792	0.920	28.192	0.157	2.047	Sardine 2
19.476	0.600	1.680	29.214	0.290	1.883	Mean
14.971	0.613	0.592	22.457	0.300	0.863	Tuna 1
18.868	0.798	0.643	28.302	0.204	0.904	Tuna 2
11.845	0.271	0.581	17.767	0.227	0.760	Tuna 3
18.732	0.393	0.581	28.097	0.186	0.990	Tuna 4
15.054	2.600	0.833	22.582	0.322	1.024	Tuna 5
22.368	1.047	0.764	33.552	0.269	1.396	Tuna 6
16.973	0.954	0.666	25.46	0.251	0.990	Mean
50[b,c,d]			15[a]		20[b]	Limit values
15*					30[c,e,f]	
12**						
40[e]						

a: Republic of Turkey Ministry of Agriculture (2002).
b: Turkish Food Codex, 2002.
c: Maff, 1995.
d: Abia, 1998.
e:FAO,1983.
f:WHO,1996.
*: The recommended daily intakes of zinc 15 mg Zn for adult males (Anon, 2002).
**: The recommended daily intakes of zinc 12 mg Zn for adult females (Anon, 2002).

Table 4. The estimated daily and weekly intakes for the canned sardine and tuna fishes collected from Egyptian Markets during 2009-2010.

Canned Fish Type								Metal	
T6	T5	T4	T3	T2	T1	S2	S1		
51.860	38.018	36.778	28.217	33.574	32.056	76.034	63.848	EDI	Cu
363.019	266.123	257.447	197.519	235.016	224.394	532.240	446.933	EWI	
0.148	0.109	0.105	0.081	0.096	0.092	0.217	0.182	PTWI%	
35000								PTDI[a]	
245,000								PTWI[b]	
1246.213	838.742	1043.617	659.934	1051.221	834.125	1047.127	1123.028	EDI	Fe
8723.491	5871.196	7305.319	4619.535	7358.550	5838.873	7329.886	7861.198	EWI	
2.225	1.498	1.864	1.178	1.877	1.490	1.870	2.005	PTWI%	
56000								PTDI[a]	
392,000								PTWI[b]	
28.383	30.952	21.581	21.595	23.895	21.989	34.176	90.605	EDI	Mn
198.679	216.667	151.064	151.163	167.264	153.923	239.230	634.237	EWI	
0.290	0.316	0.220	0.220	0.244	0.224	0.349	0.925	PTWI%	
9800[d]								PTDI[c]	
68,600								PTWI[b]	
38.895	96.558	14.590	10.078	29.642	22.784	29.407	15.101	EDI	Ni
272.264	675.906	102.128	70.543	207.492	159.486	205.849	105.706	EWI	
11.113	27.588	4.168	2.879	8.469	6.510	8.402	4.315	PTWI%	
350[c]								PTDI[a]	
2,450								PTWI[b]	
830.809	559.161	695.745	439.956	700.814	556.083	698.084	748.686	EDI	Zn
5815.660	3914.130	4870.213	3079.690	4905.700	3892.582	4886.591	5240.799	EWI	
1.187	0.799	0.994	0.629	1.001	0.794	0.997	1.070	PTWI%	
70000								PTDI[a]	
490,000								PTWI[b]	

Note:
a: PTDI, Permissible Tolerable Daily Intake (µg/day/70 kg body weight)
b: PTWI for 70 kg adult person (µg/week/70 kg body weight)
c: WHO recommends a TDI (Tolerable Daily Intake) of 5 µg/day/kg body weight, i.e. 350 µg/day for a 70-kg person (WHO 1993)
d: EPA recommends a RfD (Reference Dose) of 0.14 mg/day/kg body weight, i.e. 9,800018 µg/day for a 70-kg person (EPA 2008)

Table 5. Mean concentrations of Protein and Lipids under investigation in canned sardines and tunas collected during 2009-2010.

Lipids (g/100gmuscle)	Protein(g/100g muscle	Type of Can
1.3	7.47	Sardine 1
2.12	6.74	Sardine 2
1.71±0.58	7.105±0.52	Mean±S.D
1.74	6.54	Tuna 1
1.61	6.34	Tuna 2
2.02	6.94	Tuna 3
2.59	7.00	Tuna 4
2.13	6.68	Tuna 5
1.96	6.79	Tuna 6
2.007±0.34	6.715±0.25	Mean±S.D

4. Conclusions

Contamination of canned fish by trace metals may occur during commercial handling and processing, and depending on the conditions of the raw material. Therefore, monitoring of these products is important with respect to toxic elements affecting human health. According to the data presented in this study, it can be concluded that all concentrations of metals under investigation in either canned sardines or tuna recorded levels under the permissible limits. The result from this study indicated that there was no difference existed in the element concentrations across brands for each canned fish type. Meanwhile sardine (brand 1) from Morocco recorded a highly elevated level of protein and low concentration of lipids, so it may be considered as food quality for the human health. The current study revealed that there was no any bad impact on human health risk from the consumption of investigated canned sardine and tuna.

References

Abou-Arab, A.A.K.; Ayesh, A.M.; Amra, H.A. and Naguib, K.: 1996, Characteristic levels of some pesticides and heavy metals in imported fish. *Food Chemistry*, 57(4):487-492.

Agency for Toxic Substances and Disease Registry (ATSDR): 2003, Toxicological Profile for Fluoride. Atlanta, GA, USA.

Agency for Toxic Substances and Disease Registry (ATSDR): 2004, Agency for Toxic Substances and Disease Registry, Division of Toxicology, Clifton

Road, NE, Atlanta, GA, available at: http://www.atsdr.cdc.gov/toxprofiles.

Ahdy, H.H.H., Mohamed L. Abd EL-Fattah, Khaled A. and EL-Sikaily, A.: 2009, Canned fish between benefits and risks on the Egyptian markets. *Egyptian journal of aquatic research*, 35(2): 511-520.

Amundsen, P.A.; Staldvik, F.J.; Lukin, A.; Kashulin, N.; Popova, O. and Reshetnikov, Y.: 1997, Heavy metals contamination in freshwater fish from the border region between Norway and Russia. *Science of the Total Environment*, 201: 211–214.

Anon: 2002, Gıda Maddelerinde Belirli Bulasanlarin Maksimum Seviyelerinin Belirlenmesi Hakkinda Teblig˘. T.C. Tarim ve Koyisleri Bakanligi Koruma ve Kontrol Genel Mudurlugu Teblig No. 2002/63, Official paper No.: 23.09.2002- 24885.

APHA-AWWA-WPCF: 1992, Standard Methods for the Examination of Water and Waste Water, 14th edit, American Public Health Association, Washington, DC, USA.

Ashraf, W.: 2006, Levels of selected heavy metals in tuna fish. *The Arabian Journal for Science and Engineering*, 31(1A): 89-92.

Ashraf, W.; Seddigi, A.; Abulkıbash, A. and Khalide, M.: 2006, Levels of selected metals in canned fish consumed in Kingdom Of Saudi Arabia. *Environmental Monitoring and Assessment*, 117: 271-279.

Associaiaçâo Brasileira das Indústrias da Alimentaçâo (ABIA): 1998, Portaria No. 685-Serviço de Vigilância Sanitâria/Ministério da Saúde.

Burger, J.; Stern, A.H.; Gochfeld, M.: 2005, Mercury in commercial fish. Optimizing individual choices to reduce risk. *Environmental Health Perspectives*, 113: 266-271.

Çelik, U. and Oehlenschlager, J.: 2007, High contents of cadmium, lead, zinc and copper in popular fishery products sold in Turkish supermarkets. *Food Control*, 18(3): 258-261.

Dewailly, E. and Rouja, P.: 2009, Think big, eat small. Science 325, 578-85. DOI:10.1126/science.326_44a

European Food Safety Authority (EFSA): 2009, Scientific panel on contaminants in the food chain. Cadmium in food 30/01/2009. Belgium: EFSA; 2009/03/20.<http://www.efsa.europa.eu/EFSA/efsa_locale1178620753820_1211902396126.htm>.

Erkan N and Özden Ö.: 2007, Proximate composition and mineral contents in aqua cultured sea bass (*Dicentrarchus labrax*), sea bream (*Sparus aurata). Food Chemistry*, 102: 721-725

FAO/WHO Expert Committee on Food Additives: 2004, Summary of Evaluations Performed by the Joint FAO/WHO Expert Committee on Food Additives (JECFA 1956–2003), (First through sixty-first meetings). Food and Agriculture Organization of the United Nations and the World Health Organization, ILSI Press International Life Sciences Institute, Washington, DC.

Fitzgerald, E.F.; Deres, D.A.; Hwang, S.; Bush, B.; Yang, B.; Tarbell, A. and Jacobs, A.: 1999, Local fish consumption and serum PCB concentrations among Mohawk men at Akwesasne. *Environmental Research*, 80, S97-S103.

Folch, J.; Lees, M. and Stanley, G.H.S.: 1957, A simple method for the isolation and purification of total lipids by sulphophospho-vanillin reaction. *Clinical Chemistry*, 18:673-4

Ikem, A. and Egilla, J.: 2008, Trace element content of fish feed and bluegill sunfish (*Lepomis macrochirus*) from aquaculture and wild source in Missouri. *Food Chemistry*, 110:301-309

Ikem, A. and Egiebor, N.O.: 2005, Assessment of trace elements in canned fishes (Mackerel, Tuna, Salmon, Sardines and Herrings) marketed in Georgia and Alabama (United state of America). *Journal of Food Composition and Analysis*., 18: 771-787.

Institute of Medicine: 2003, Dietary Reference Intakes: Applications in Dietary Planning. Subcommittee on Interpretation and Uses of Dietary Reference Intakes and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. Institute of Medicine of the National Academies, The National Academies Press, Washington, DC, p. 248.

Ismail, H.M.: 2005, The role of omega-3 fatty acids in cardiac protection: An overview. *Frontiers of Bioscience*, 10: 1079-1088.

Iwegbue, C.; Nwajei, G.; Arimoro, F. and Osa, E.: 2009, Characteristic levels of heavy metals in canned sardines consumed in Nigeria. *Environmentalist*, 29:431-435

Kojadinovic, J.; Potier, M.; Le Corre, M.; Cosson, R.P. and Bustamante, P.: 2007, Bioaccumulation of trace elements in pelagic fish from the Western Indian Ocean. *Environmental Pollution*, 146: 548-566.

Kris-Etherton, P.M.; Harris, W.S. and Apple, l.J.: 2002, For the nutrition committee. AHA scientific statement. Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. *Circulation*, 106: 2747-2757.

Licata, P.; Trombetta, D.; Cristani, M.; Naccari, C.; Martino, D.; Cal, M. and Naccari, F.; 2005. Heavy metals in liver and muscle of bluefin tuna (*Thunnus thynnus*) caught in the Straits of Messina (Sicily Italy). *Environmental Monitoring and Assessesment*, 107: 239-248.

Lall, S.P.: 1995, Macro and trace elements in fish and shellfish. In: Ruiter A (ed) Fish and fishery products. CAB International, pp 187-213.

Linder, M.C. and Hazegh-Azam, M.: 1996, Copper biochemistry and molecular biology. *American Journal of Clinical Nutrition*, 63:797S- 811S

Lowry, O.H.; Rosenbrough, N.J.; Farr A.L. and Randall, R.J.: 1951, Protein measurement with folin phenol reagent. Journal of *Biological Chemistry* 193: 265-75.

Lutter, C.K. and Dewey, K.G.: 2003, Proposed nutrient composition for fortified complementary foods. *Journal of Nutr*ition 133: 3011S-3020S

MAFF: 1995, Monitoring and surveillance of non-radioactive contaminants in the aquatic environment and activities regulating the disposal of wastes at sea, 1993. Aquatic Environment Monitoring Report No. 44. Directorate of Fisheries Research, Lowestoft.

Mahmoud, Th.H. and Allam, S.M.: 2002, Heavy metals, protein and lipid concentrations in the muscles, liver and gonads of Boops boops. *Journal of Egyptian and Germany Society of Zoology,* 37A: 225-242

Mol, S.: 2011, Levels of selected trace metals in canned tuna fish produced in Turkey. *Journal of Food Composition and Analysis*, 24: 66-69

Natural Resources Defense Council (NRDC): 2007, Mercury contamination in fish. A guide. NRDC, New York (USA). Available online: ww.nrdc.org/health/effects/ mercury/guide.asp.

Official Journal of the European Union: 2006, Commission regulation (EC) No 1881/ 2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs. L 364/5.

Oken, E.; Kleinman, K.P.; Berland, W.E.; Simon, S.R.; Rich-Edwards, J.W. and Gillman, M.W.: 2003, Decline in fish consumption among pregnant women after a national mercury advisory. *Obstetrics and Gynecology*, 102: 346-351

Ponka, P.; Tenenbein, M. and Eaton, J.W. 2007: Iron. In: Nordberg, G.F., Fowler, B.A., Nordberg, M., Friberg, L.T. (Eds.), Handbook on the Toxicology of Metals, 3rd ed., 30. Academic Press, pp. 577–598

Rahimi, E.; Hajisalehi, M.; Kazemeini, H. R.; Chakeri, A.; Khodabakhsh, A. and Derakhshesh, M.: 2010, Analysis and determination of mercury, cadmium and lead in canned tuna fish marketed in Iran. *African Journal of Biotechnology*, 9(31): 4938-4941.

Republic of Turkey, Ministry of Agriculture: 2002, Gıda Maddelerinde Belirli Bulas¸ anların Maksimum Seviyelerinin Belirlenmesi Hakkında Teblig. T.C. Tarım ve Köyişleri Bakanlığı Koruma ve Kontrol Genel Mudurlugu. Teblig No 2002/63, Official gazette: 23.09.2002-24885.

Shatenstein, B.; Kosatsky, T.; Tapia, M.; Nadon, S. and Leclerc, B.S.; 1999, Exploratory assessment of fish consumption among Asian-origin sportfishers on the St. Lawrence River in the Montreal Region. *Environmental Research*, 80, S57-S70.

Storelli, M.M.; Giacominelli-Stuffler, R.; Marrcotrigiano, G.O.: 2002, Total and methylmercury residues in cartilaginous fish from Mediterranean Sea. *Marine Pollution Bulletin*, 44(12): 1354-1358

Strickland JDH, Parson TR.: 1965, "A Manual of Seawater Analysis", 2nd edit. Issued by Fisheries Research Board of Canada, Ottawa, ON, Canada.

Tahàn, J.E.; Sànchez J.M.; Granadillo, V.A.; Cubillàn, H.S., and Romero, R.A.: 1995, Concentration of total Al, Cr, Cu, Fe, Hg, Na, Pb and Zn in commercial canned seafood determined by atomic spectrometric means after mineralization by microwave heating. *Journal of agricultural and food chemistry*, 43: 910-915.

Tarley, C.R.T.; Coltro, W.K.T.; Matsushita, M. and de Souza, N.E.: 2001, Characteristic levels of some heavy metals from Brazilian canned sardines (*Sardinella brasiliensis*). *Journal of Food Composition and Analysis*, 14:611-617

Tibbetts, J.: 2004, The state of the oceans, part 1: eating away at a global food source. *Environmental Health Perspectives*, 112(5), A282-A291.

Tucker, B.W.: 1997, "Overview of current seafood nutritional issues: Formation of potentially toxic products", in: Shahidi F, Jones Y, Kitts DD (Eds.), Seafood safety, processing and biotechnology. Technomic Publishing Co. Inc., Lancaster, PA (USA).

Turkish Food Codex: 2002, Su Urunleri Yonetmeligi, Official paper No. 24936, Ankara, Turkey.

Türkmen, A.; Türkmen, M.; Tepe, Y. and Çekiç, M.: 2010, Metals in tissues of fish from Yelkoma Lagoon, northeastern Mediterranean. *Environmental Monitoring and Assessment*, 168: 223-230

Türkmen, A.; Türkmen, M.; Tepe, Y. and Akyurt, I.: 2005, Heavy metals in three commercially valuable fish species from Iskenderun Bay, Northern East Mediterranean Sea, Turkey. *Food Chemistry*, 91(1): 167–172.

Türkmen, M. and Ciminli, C.: 2007, Determination of metals in fish and mussel species by inductively coupled plasma-atomic emission spectrometry. *Food Chemistry*, 103: 670-675

Türkmen, M.; Türkmen, A. and Tepe, Y.: 2011, Comparison of Metals in Tissues of Fish from Paradeniz Lagoon in the Coastal Area of Northern East Mediterranean. *Bulletin of Environmental Contamination Toxicol*ogy, 87: 381-385

Türkmen, M.; Türkmen, A.; Tepe, Y.; Ateş, A., and Töre, Y.: 2009, Determination of metals in fish species from Aegean and Mediterranean seas. *Food Chemistry*, 113: 233-237.

Tuzen, M.: 2003, Determination of heavy metals in fish samples of the middle Black Sea (Turkey) by graphite furnace atomic absorption spectrometry. *Food Chem*istry, 80: 119-123.

Tuzen, M. and Soylak, M.: 2006, Chromium speciation in environmental samples by solid phase extraction on Chromosorb 108. *Journal of Hazardous Materials*, 129: 266-273

Tuzen, M. and Soylak, M.: 2007, Determination of trace metals in canned fish marketed in Turkey. *Food Chemistry*, 101: 1378-1382.

US Environmental Protection Agency (USEPA): 2008, Manganese compounds. US environmental protection agency. http://www.epa.gov/ttn/atw/hlthef/manganes.html. Accessed 18 June 2008

Usydus, Z.; Richert, J.S.; Polak-Juszak, L.; Kanderska, J.; Adamczyk, M.; Ciecwierz, M. and Ruczynska, W.: 2008, Food of marine origin: Between benefits and potential risks, Part I: Canned fish on the polish market. *Food Chemistry*, 111: 556-563.

WHO (World Health Organization): 1996, Health criteria other supporting information. In: Guidelines for Drinking Water Quality, vol. 2, 2nd ed. WHO, Geneva, pp. 318-388.

WHO: 1998, Drafit Guidelines for safe Recreational water Environment: Coastal and fresh water. World Health Organization, Geneva. Switzerland.

WHO (World Health Organization): 2006, Summary and conclusions of the sixty-seventh meeting of the joint FAO/WHO Export Committee on Food Additives, Rome, 20–29 June 2006. Geneva: World Health Organization.

Ylmaz, F.; Özdemir, N.; Demirak, A. and Tuna, A.L.: 2007, Heavy metal levels in two fish species Leuciscus cephalus and Lepomis gibbosus. *Food Chemistry*, 100, 830-835.

الآثار الصحية العامة الناتجه عن استهلاك الاسماك المعلبه

منال محمد السعداوى ـ فادية ابو المجد مرسى ـ هدى حافظ عهدى ـ ليلى محمد عبد الفتاح ـ
أمانى محمد السقيلى ـ عزة محمد خالد

نظرا للقيمه الغذائية للأسماك، ومنتجات الأسماك المعلبة ذات الجودة العالية التي تعود بالفائدة على صحة الإنسان. فالأسماك مصدر حيوي و صحي للبروتين الحيواني والفيتامينات .وقد تم تحليل المواد المركبة في نوعين من أسماك السردين المعلب ،وستة من التونة ، والتي تنشأ من ست دول تجاريا في مصر. تم تحديد محتويات المواد الغذائية فى الأسماك المعلبة (البروتين ، الدهون) وبعض المعادن (النحاس ، الحديد ، المنغنيز ، والزنك ، والكروم والنيكل .عنصرالحديد سجل أعلى التركيزات لكل من أسماك السردين المعلب وسمك التونة (17.767-33.552,28.192-30.235 ميكروغرام / غرام من الوزن الرطب على التوالي) ثم الزنك (١٨.٧٩٥-٢٠.١٥٧و١١.٨٤٥-٢٢.٣٦٨ ميكروغرام /غرام من الوزن الرطب على التوالي) ، وسجلت مقارنة نطاقات النحاس ، المنغنيز والنيكل (١.٧١٩-٢.٠٤٧ و ٠.٧٦٠ -١.٣٩٦ ;٠.٩٢٠-٢.٤٣٩ و ٠.٥٨١-٠.٨٣٣;٠.٤٠٧-٠.٧٩٢ و ٠.٢٧١ -٢.٦٠٠ ميكروغرام / غرام من الوزن الرطب على التوالي) ، في حين سجل الكروم أدنى القيم لكل من أسماك السردين والتونة المعلبة (٠.١٥٧-٠.٤٣٢ و ٠.١٨٦-٠.٣٢٢ ميكروغرام / غرام من الوزن الرطب على التوالي). كانت مستويات المعادن التى تم تعيينها أقل بكثير من المستويات المسموح بها للوكالات الحكومية المختلفة . من وجهة النظر الغذائية ، منتجات الأسماك المعلبة غنية في العناصر الكبرى والصغرى .حيث سجلت أعلى تركيزات الكالسيوم والمغنيسيوم والكبريتات فى السردين المعلب ، بينما التونة المعلبة تحتوي على أعلى تركيزللفوسفات. و في هذا السياق ، كان متوسط تركيز البروتين في عينات السردين أعلى من أسماك التونة ومن ناحية أخرى كان متوسط تركيز الشحوم في عينات السردين أقل من متوسط التركيزات في سمك التونة .وأظهرت هذه النتائج أنه لا يوجد خطر في تناول الأسماك المعلبة فيما يتعلق بتركيزات المعادن التي درست .كما تم تقييم الإستهلاك البشري الأسبوعى لكل من السردين والتونة المعلبة كانت أقل من المخاطر المحتملة على صحة المستهلك .الإستهلاك الإسبوعى لكل من سمك السردين والتونة المعلبة لا تتجاوز قيم السمية المرجعية التي وضعتها منظمة الصحة العالمية ، وبالتالي لم يكن هناك أي خطر على صحة الإنسان.