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Original article

Levels of selected trace metals in canned tuna fish produced in Turkey

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ABSTRACT

Trace metals (iron, zinc, copper, cadmium, tin, mercury and lead) in canned tuna, obtained from 4 different brands in Turkey, were determined using Inductively Coupled Plasma–Mass Spectrometer (ICP–MS). The trace metals were found to be in the range of 20.2–38.7 mg/kg for iron, 8.20–12.4 mg/kg for zinc, 0.48–0.58 mg/kg for copper, 0.01–0.02 mg/kg for cadmium, 0.02–0.13 mg/kg for tin, 0.06–0.30 mg/kg for mercury, and 0.09–0.45 mg/kg for lead. These results showed that there is no risk in canned tuna with respect to the concentrations of zinc, copper, cadmium and tin. However, it was determined that some of the samples may contain iron, lead and mercury above the legal limits set by health authorities. It was concluded that trace metals in canned tuna must be monitored comprehensively and periodically with respect to the consumer health.

1. Introduction

The most important forms of aquatic pollution are heavy metals since they accumulate in aquatic organisms and may transfer to humans in the food chain (Ashraf et al., 2006). Fish are very important human foods, but they exposed to chemicals in polluted and contaminated waters (Ikem and Egeibor, 2005). Therefore, they may accumulate potentially toxic minerals and represent one of the major sources of heavy metals for humans. Predator fish, in particular, may accumulate these substances more than the others (Plessi et al., 2001) Tuna, as a predator, is able to concentrate large amounts of heavy metals, and this species is commonly consumed as canned (Voegborlo et al., 1999). It is known that fish may also be contaminated by heavy metals during commercial processing like canning. So, information on the metal content in canned fish is important to ensure that it is safe for human consumption (Ikem and Egeibor, 2005). Therefore most countries monitor the levels of heavy metals that may occur due to the commercial handling and processing (Ashraf, 2006).

Canned tuna fish are largely eaten in many countries, such as Libya, USA, Portugal, the Kingdom of Saudi Arabia, and Iran (Voegborlo et al., 1999; Ikem and Egeibor, 2005; Lourenço et al., 2004; Ashraf et al., 2006; Khansari et al., 2005). However, with respect to the trace metal content of canned tuna from Turkey, very little comparative data are available (Çelik and Oehlenschlager, 2007; Tuzen and Soylak, 2007).

The present study was carried out in view of the scarcity of information about heavy metals in canned tuna fish, produced in Turkey, which is frequently exported, and also consumed by Turkish people. It is hoped that our results will help in generating data needed for the assessment of toxic metal intake from this source.

2. Materials and methods

During the year 2008, four different Turkish brands (A, B, C, and D) of canned tuna (160 g each) were analyzed regarding trace metals (iron, zinc, copper, cadmium, tin, mercury and lead). Brand A and B have 70% and 26% of Turkey's canned tuna market, respectively (Proceeding report, 2008, 2009). Brands C and D are smaller companies having the rest of market. Samples obtained from the retail markets in Istanbul, which is a megacity expanded onto the grounds of Asia and Europe, having a surface area of 5512 km^2, population is 12 573 836, and population intensity is 2400 person/km^2 (Istanbul Metropolis Municipality, 2010). In terms of the Turkey's export and import performance, Istanbul is ahead of other cities, with 44% of all exports, and 42% of all import (Enterprise Europe Network, 2010). The intensity of population and the importance of this city's trade performance are the reasons of choosing it as the sampling area. From each brand (A, B, C and D)

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15 samples were randomly purchased from various retail markets in different localizations of Istanbul. Each of 15 canned tuna of a brand was separately homogenized and analyzed. The material of the liquid sauce of the canned tuna, vegetable oil, was expunged before homogenization. Any metals or glass equipment were not used against metal contamination and adhesion, respectively. To analyze mercury, Au was added to make an amalgam, HCl was not used. Standards were prepared just before analysis.

The Ethos D (Type Ethos plus 1) microwave lab station purchased from Milestone Inc., (Monroe, Ct, USA) was used to digest fish samples prior to metal analysis. Thermo electron X7 Inductively Coupled Plasma–Mass Spectrometry (ICP–MS), (model X series, UK) was used to analyze digested samples for total metals. The fallowing elements were measured using the ICP–MS: Iron (Fe), Zinc (Zn), Cooper (Cu), Cadmium (Cd), Tin (Sn), Mercury (Hg), and Lead (Pb). For each sample, between 0.3 and 0.5 g of fish muscle (wet weight) was weighed and placed in a Teflon digestion vessel with 7 ml of concentrated (65%) nitric acid (HNO_3) and 1 ml 30% hydrogen peroxide (H_2O_2). The sample in the vessel containing concentrated nitric acid was then subjected to a microwave program as follows: Step 1: 25–200 °C for 10 min at 1000 W; Step 2: 200 °C for 10 min at 1000 W. Digests were finally made up with deionised water to 25 ml in acid washed standard flasks. Calibration stock standards were purchased from High-Purity Standards, Charleston, USA. The standards were appropriately diluted and used to calibrate the ICP–MS before metal determinations in samples (EPA, 1995). ICP–MS operating conditions: Nebulizer gas flow 0.91 L/min, Radio frequency (RF) 1200 W, Lens voltage 1.6 V, Cool Gas 13.0 L/min, Auxiliary Gas 0.70 L/min. The results obtained were analyzed by means of ANOVA, and statistical package SPSS 11.0 was used. The analyses were carried out in triplicate, and the significance level was chosen as 0.05. In order to validate the method for accuracy, certified reference material (catalogue no. BCR-278R, LGC Promochem, Middlesex, UK) was analyzed (Table 1). The reference material was mussel tissue, parameters were As, Cd, Cr, Cu, Hg, Mn, Pb, Se, and Zn.

3. Results and discussion

Good recoveries of samples (the average recovery was 102.9%) demonstrate the accuracy of the methods. The concentrations of Fe, Zn, Cu, Cd, Sn, Hg and Pb in canned tuna, obtained from different brands, are presented in Table 2.

Iron deficiency causes anemia and fish is the major source of this 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. Therefore, Republic of Turkey Ministry of Agriculture (2002) proposed 15 mg/kg Fe as limit for canned foods. In this study, the average Fe concentrations were 34.4 mg/kg for

Table 1
Observed and certified values of trace metal concentrations in standard reference material, mussel tissue, originally certified as BCR-278R[a] ($n = 3$).

	Elemental concentrations (mg/kg)		
	Certified value	Uncertainty	Observed value
Hg	0.196	0.009	0.198
Cd	0.348	0.007	0.376
Cu	9.45	0.13	9.66
Zn	83.11	1.70	84.68
Pb	2.00	0.04	2.03

[a] ERM (2004). Mussel tissue. European Commission Directorate-General Joint Research Centre. Institute for Reference Materials and Measurements, Reference Materials Unit, Geel, Belgium.

Table 2
Concentrations (mg/kg) of trace metals in different brands of Turkish canned tuna.

Brands	Fe		Zn		Cu		Cd		Sn		Hg		Pb	
	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
A ($n = 15$)	10.8–76.2	34.4 ± 18.8AB	6.09–23.5	10.5 ± 4.76AB	0.28–1.77	0.58 ± 0.35A	ND–0.09	0.02 ± 0.02A	ND–0.53	0.13 ± 0.15A	0.01-0.20	0.06 ± 0.05A	ND–3.54	0.31 ± 0.90A
B ($n = 15$)	13.7–74.6	38.7 ± 19.3A	4.76–14.3	8.20 ± 2.70A	0.27–1.06	0.57 ± 0.23A	ND–0.03	0.01 ± 0.01B	ND–0.17	0.06 ± 0.06A	0.02-0.24	0.10 ± 0.07A	ND–0.56	0.09 ± 0.16A
C ($n = 15$)	ND–75.8	26.7 ± 28.2AB	4.52–21.2	9.50 ± 5.03AB	0.19–1.06	0.55 ± 0.20A	ND–0.04	0.01 ± 0.01B	ND–0.10	0.04 ± 0.04B	ND–0.25	0.09 ± 0.10A	ND–4.13	0.45 ± 1.06A
D ($n = 15$)	ND–80.7	20.2 ± 27.9B	3.68–30.1	12.4 ± 6.41B	0.08–1.76	0.48 ± 0.41A	ND–0.01	0.01 ± 0.01B	ND–0.06	0.02 ± 0.02B	ND–1.14	0.30 ± 0.43B	ND–3.25	0.26 ± 0.83A
Average of all brands	ND–80.7	30.00 ± 5.18	3.68–30.1	10.15 ± 1.53	0.08–1.77	0.55 ± 0.10	ND–0.09	0.01 ± 0.01	ND–0.53	0.06 ± 0.06	ND–1.14	0.14 ± 0.18	ND–4.13	0.28 ± 0.15
Detection limits	100 ppb		0.15 ppb		0.10 ppb		0.10 ppb		0.5 ppb		0.15 ppb		0.10 ppb	
Limit values	15[a]		50[b,c,d]		20[b] 30[c,e,f]		0.5[e] 0.1[b,g]		250[a,d,f]		1[b,g,h]		0.2[g] 0.4[b]	

A, B: Different letters in the same column show significant differences among samples ($p < 0.05$).
ND: Not detected.
[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).
[g] EU (2005).
[h] FDA (2001).