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Short Communication

Features of weighty metals in canned tuna fish

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Concentrations of metals (aluminium, cadmium, lead and mercury) were determined from canned tuna commercialized in Canada and India, by inductively coupled plasma - optical emission spectrometer (ICP-OES) and direct mercury analyzer (DMA 80). Higher concentration of Al (1.806 to 3.161 µg/g) and Hg (0.60 to 0.62 µg/g) were found in tuna processed from India. Cd and Pb ranged from 0.020 to 0.025 and 0.011 to 0.089 µg/g respectively in Canadian canned tuna. Among metals, Cd showed lower values in both samples. In conclusion, highest levels of metals were accumulated in Indian made product. This can be attributed to differences in the canning process and quality of food. It was concluded that heavy metals in canned tuna must be monitored comprehensively and periodically with respect to the consumer health.

Key words: Canned tuna, heavy metals, inductively coupled plasma - optical emission spectrometer (ICP-OES), seafood.

INTRODUCTION

Toxicological and environmental studies have prompted interest in the determination of toxic elements in food. Mercury, cadmium and lead can be tolerated only at extremely low levels and at certain concentrations they are exceptionally toxic to humans (Voegborlo, 1999). Fish is widely consumed in many parts of the world because it has high protein content, low saturated fat and also contains omega fatty acids known to support good health (Ikem and Egiebor, 2005). Fish are constantly exposed to chemicals in polluted and contaminated waters. So the heavy metals content in fishery products need to be well established. Since fish is the last link in the aquatic food chain, the heavy metal concentrations in many fish species have been determined in relation to the metal content of the aquatic environment. The metals can be classified as potentially toxic (aluminium, arsenic,cadmium, lead, mercury, etc.), probably essential (nickel,vanadium, cobalt) and essential (copper, zinc, selenium) (Munoz-Olivas and Camara, 2001). Elements present in seafood, are essential at low concentration; however, they can be toxic at high concentrations (Ray, 1994; Oehlenschlager, 2002). Tuna is a migratory fish and able to concentrate large amounts of heavy metals (EU, 2005).

The distribution of metals varies between fish species development status and other physiological factors (Kagi and Schaffer, 1998). The effects of these elements on human health have also been widely reported (Lall, 1995; Linder and Hazegh-Azam, 1996; Munoz-Olivas and Camara, 2001). With respect to the trace metal content in canned fish products, very little data are available. The present study was carried out in view of the scarcity of information about heavy metals in canned tuna fish, produced and exported from Canada and India.

MATERIALS AND METHODS

Sample preparation and digestion

During 2010, canned tuna (Anchor, India and Grace, Canada) processed from Canada and India were selected to analyze Aluminum, Cadmium, Lead and Mercury. Canned tuna samples

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Table 1. Concentrations (µg/g) of heavy metals in canned tuna fish produced in Canada and India, number of package investigated (*n*), arithmetic mean (Mean), Standard deviation (SD).

Products	No. of package investigated (*n*)	Mean ± SD			
		Al	Cd	Pb	Hg
Canada	3	1.806 ± 0.002	0.020 ± 0.002	0.011 ± 0.002	0.60 ± 0.009
Indian	3	3.161 ± 0.001	0.025 ± 0.002	0.089 ± 0.003	0.62 ± 0.012

Table 2. Comparison of measured values with certified values standard reference material canned tuna (µg/g dry weight).

Metals	Atomic Number	Atomic weight	Certified value	Measured value	
				Canada	Indian
Al	13	26.98	1.901	1.806 ± 0.002	3.161 ± 0.001
Cd	48	112.40	0.348	0.020 ± 0.002	0.025 ± 0.002
Pb	82	207.19	2.00	0.011 ± 0.002	0.089 ± 0.003
Hg	80	200.59	0.196	0.60 ± 0.009	0.62 ± 0.012

Table 3. Minimum and maximum content of heavy metals in Turkish canned tuna compared to that in other major markets (µg/g).

Region	Al	Cd	Pb	Hg
Canada	1.806 (mean: 0.002)	0.020 (mean: 0.002)	0.011 (mean: 0.002)	0.60 (mean: 0.009)
India	3.161 (mean: 0.001)	0.025 (mean: 0.002)	0.089 (mean: 0.003)	0.62 (mean: 0.012)
Turkey		0.00 –0.09 (mean: 0.01)		0.00 –1.14 (mean: 0.14)
Turkey		182.0-246.5		
Kingdom of Saudi Arabia		0.07-0.64 (mean: 0.22)		
Iran		0.09-0.32 (mean: 0.18)		0.20-0.66 (mean: 0.29)
Libya		0.09-0.32 (mean: 0.18)		0.20-0.66 (mean: 0.29)
U.S.		0.00- 53.9 (mean: 1.9)		53.0-739.6 (mean: 284.8)

were purchased from retail outlets located in Pondicherry, Tamil Nadu, India. A minimum of three samples (160 g each) from each brand of canned fish were used for this study. After opening each can, oil was drained off at 60°C for 48 h and the meat was powdered using mortar and pestle. About 0.1 to 0.5 g of sample was taken in a 150 ml beaker and 10 ml of freshly prepared HNO_3 (Conc.): H_2O_2 (30%) (4:1 v/v) was added and incubated at room temperature for 24 h. After incubation they were heated upto 120°C by hot plate method. Heating was continued until the volume was reduced to about 5 ml. The solution was allowed to cool, transferred into a 20 ml volumetric flask and diluted to the mark with deionised distilled water. This solution is then filtered through No. 1 Whatman filter paper and concentrations of metals except mercury were determined by using Inductively Coupled Plasma - Optical Emission Spectrometer (ICP-OES) (Perkin Elmer, Optima 2100DV) and Direct Mercury Analyzer (DMA 80) was used for mercury (Hg) determination. The principle of the DMA 80 analyzer is based on thermal decomposition, amalgamation and atomic spectrometry detection.

Statistical analysis

One-way ANOVA was employed in the assessment of variation in metal concentrations among canned tuna fish brands.

RESULTS AND DISCUSSION

Good recoveries of samples (the average recovery was 102.9%) demonstrate the accuracy of the methods. The concentrations of Al, Cd, Pb and Hg in canned tuna are depicted in Table 1. Among the samples, the highest aluminum content (3.161 µg/g) was found in the Indian made canned tuna, while in the Canadian made canned tuna, the aluminum content was 1.806 µg/g (Table 2). Aluminum is not considered to be an essential element in humans. The permissible aluminum for an adult is 60 mg/day (WHO, 1989). According to Turkmen et al. (2005), aluminum content has been reported in the range 0.02 to 5.41 µg/g dry weight in fish species from Iskenderum Bey, northern east Mediterranean sea, Turkey (Table 3).

The maximum level of Cd permitted by FAO/WHO (1972) is 0.5 mg/kg. Indian made canned tuna showed the highest Cadmium content (0.025 µg/g), while in Canadian made, it was 0.020 µg/g. It was reported that, in anchovy Cadmium content was found as 5.77 µg/kg (wet weight) (Celik et al., 2004) and 200 µg/kg (dry weight) (Tuzen, 2003). Cadmium may accumulate in the human body and may induce kidney dysfunction, skeletal damage and reproductive deficiencies (Commission of the European Communities, 2001).

Soldering is a source of lead contamination in the canning process. Therefore, the monitoring of lead concentration in canned fish is important for human health (Voegborlo et al., 1999). The lowest lead levels (0.011 µg/g) were found in Canadian made and higher (0.089 µg/g) in Indian made canned tuna. Lead contents have been reported in the range 0.0 to 0.03 µg/g in canned tuna fish from USA (Ikem and Egiebor, 2005), 0.18 to 0.40 µg/g in canned tuna fish from Libya (Voegborlo et al., 1999), 0.076 to 0.314 µg/g in canned fish from Turkey (Celik and Oehlenschlager, 2006) and 0.0162 to 0.0726 µg/g in canned tuna fish from Iran (Khansari et al., 2005). Lead is known to induce reduced cognitive development and intellectual performance in children and increased blood pressure and cardiovascular disease in adults (Commission of the European Communities, 2001). The maximum lead level permitted for canned fishes is 0.2 mg/kg according to the Turkish Food Codex (Anonymous, 2002) and European Communities (Commission of the European Communities, 2001).

The concentration of mercury in the present study was 0.60 µg/g in Canadian canned tuna and 0.62 µg/g in Indian made canned tuna. The FDA reports that methyl mercury levels in canned tuna fish are in the range of 0.1 to 0.2 ppm (Carrington et al., 1997). Mercury may induce alteration in the normal development of the brain of infants and at higher levels may induce neurological changes in adults (Commission of the European Communities, 2001). Mercury also has toxicity effects on kidney, the developing fetus and it is a possible human carcinogen (Occupational Safety and Health Administration, 2004). Mercury may induce neurological changes and some diseases, and tuna is well known to accumulate large amount of this metal than many other fish species (Ikem and Egiebor, 2005). The average Hg content was 0.01 mg/kg in Iranian canned tuna (Khansari et al., 2005), and it was 0.29 mg/kg in Libyan canned tuna (Voegborlo et al., 1999).

Conclusion

In this study, the levels of Aluminum, Cadmium, lead and Mercury from canned tuna fish samples were studied. The levels of some toxic elements in analyzed canned fish samples were found to be above legal limits. The level may be reduced by more careful handling practices and processing of raw materials. Canned fish samples should be analyzed more often in Pondicherry super markets with respect of toxic elements. This study improves the baseline data and information on Aluminum, Cadmium, Lead and Mercury concentration in canned tuna fish commonly marketed in Pondicherry. Such data provide valuable information a safety of fishes commonly consumed by the public.

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