HEAVY METALS AND SENSORY EVALUATION OF CANNED TUNA FISH

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ABSTRACT

In this study, two heavy metals in canned tuna fish were determined after digestion by the AOAC methods. Mercury and Cadmium levels in canned tuna fish were determined by flame atomic absorption photometry. The results of this study indicate that canned tuna fish imported into the country have concentrations well below the permissible FAO/WHO levels for these toxic metals. Their contribution to the body burden can therefore be considered negligible and the fish seem to be safe for human consumption. For the sensory evaluation, tuna flakes in vegetable oil (Starkist) from Ghana and light meat tuna chunks in sunflower oil (John West) from Thailand were the most preferred while tuna flakes in brine (John West) from Thailand is the least preferred.

INTRODUCTION

There is increasing concern about the quality of foods in several parts of the world. The determination of toxic elements in food has prompted studies on toxicological effects of them in food. Heavy metals are considered the most important form of pollution of the aquatic environment because of their toxicity and accumulation by marine organisms. While mercury and cadmium can be tolerated at extremely low levels, at certain concentrations, they are exceptionally toxic to humans. Methyl mercury may induce alterations in the normal development of the brain of infants and at higher levels may induce neurological changes in adults. Mercury contaminates mostly fish and fishery products. Cadmium accumulates in the human body and may induce kidney dysfunction, skeletal damage and reproductive deficiencies. Also, it cannot be excluded that it acts as a human carcinogen [2]. This work is aimed at determination of mercury and cadmium concentrations in canned tuna fish.

Metal pollution of the sea is less visible and direct than other types of marine pollution but its effects on marine ecosystems and humans are intense and very extensive. The toxic effects of heavy metals, particularly arsenic, mercury, cadmium and lead, have been broadly studied [4,6,8,9]. The distribution of metals varies between fish species, depending on age, development status and other physiological factors [5]. Fish accumulate substantial concentrations of mercury in their tissues and thus can represent a major source of this element for humans. Fish are the single largest sources of mercury and cadmium for man. Mercury is a known human toxicant and the primary sources of mercury contamination in man are through eating fish. Biotransformation of mercury and methyl mercury formation constitutes a dangerous problem for human health [4]. Metal contaminations in food, especially in marine products, have been broadly investigated [3,11,7]. Tuna as a predator is able to concentrate large amount of heavy metals. Some of them are used for biomonitoring of environmental contamination [3,10]. In the present study, we evaluated the total concentrations of mercury and cadmium in imported canned tuna fish which are frequently consumed by the populace and also carried out sensory analysis on them. Therefore we wish to determine mercury and cadmium levels in canned tuna fish. It is expected that the results of this research will assist in acquiring information about the level of some toxic metals in imported canned tuna fish.

MATERIALS AND METHODS

Ten canned tuna fish samples imported from four different countries was obtained from the retail market. They include:

1. Tuna Flakes in Vegetable Oil (Starkist) from Ghana.
2. Light Tuna Chunks in Oil (Bumble Bee) from USA.
3. Skipjack Tuna Salad (John West) from Thailand.
4. Tuna in Mayonnaise (John West) from Thailand.
5. Tuna Steak in Sunflower Oil (John West) from UK.
6. Tuna Steak in Brine (John West) from UK.
7. Tuna Flakes in Sunflower Oil (John West) from Thailand.
8. Tuna Flakes in Brine (John West) from Thailand.
9. Tuna Chunks in Sunflower Oil (John West) from Thailand
10. Tuna Chunks in Brine (John West) from Thailand.

All glassware was soaked over night in 10% (v/v) nitric acid followed by washing with 10% (v/v) hydrochloric acid and rinsed with double distilled water and dried before using. A Perkin Elmer AAnalyst 100 atomic absorption spectrophotometer equipped with a deuterium background corrector was used for the determination of heavy metals. All reagents used were of analytical reagent grade. After opening each can, oil was drained off and the meat was homogenized thoroughly in a food blender with stainless steel cutters. Samples were then taken and digested promptly as follows: 2g of homogenized sample was weighed and placed into a 150ml conical flask. To this was added 5 ml concentrated sulphuric acid, and then heated at 70^0C for 2 hr. (or until the sample was completely digested). The mixture was cooled and 25 ml of 6% potassium permanganate solution was added to the cooled solution. The mixture was heated at 70^0C for 2 hr, and then cooled. 10 ml hydroxyl ammonium chloride was added to the solution, to reduce excess permanganate. The mixture was then diluted to 50 ml in a volumetric flask, with distilled water. A blank (distilled water) solution was carried out through the same process. 5ml of 1000mg/l stock standard was diluted to 200ml to give 25mg/l intermediate stock standard. From this, three working standards were prepared in the range 0.001-0.005mg/l. Mercury and cadmium was determined by direct aspiration of the sample solution into the NO_2/acetylene flame. The blanks and calibration standard solutions were also analysed in the same way as the sample solutions.

A ten-member taste panel was used for sensory evaluation of ten different canned tuna fish. The samples were scored for appearance, flavour, taste and texture using a 4-point scale in which a score of 4 was given to the excellent product and 1 to the sample that was fair. The samples were presented to the panellists on white plates with the samples coded alphabetically. Each of the panellists was provided with score sheet, a plate, spoon and a sachet of pure water for mouth rinsing after tasting each sample. Statistical analysis was carried out to determine the difference between the samples that was preferred.

Table 1: Mercury and Cadmium contents in some imported canned tuna fish.

S/N	Canned Tuna Samples	Hg (mg/kg)	Cd (mg/kg)
1.	Tuna Flakes in Vegetable Oil (Starkist) from Ghana	<0.01	<0.005
2.	Light Tuna Chunks in Oil (Bumble Bee) from USA	<0.01	<0.005
3.	Skipjack Tuna Salad (John West) from Thailand	<0.01	<0.005
4.	Tuna in Mayonnaise (John West) from Thailand	<0.01	<0.005
5.	Tuna Steak in Sunflower Oil (John West) from UK	<0.01	<0.005
6.	Tuna Steak in Brine (John West) from UK	<0.01	<0.005
7.	Tuna Flakes in Sunflower Oil (John West) from Thailand	<0.01	<0.005
8.	Tuna Flakes in Brine (John West) from Thailand	<0.01	<0.005
9.	Tuna Chunks in Sunflower Oil (John West) from Thailand	<0.01	<0.005
10.	Tuna Chunks in Brine (John West) from Thailand	<0.01	<0.005

EU Permitted levels for Mercury in canned tuna fish = 0.5 mg/kg
EU Permitted levels for Cadmium in canned tuna fish = 0.3 mg/kg

Table 2: Sensory evaluation of some imported canned tuna fish.

S/N	Canned Tuna Samples	Appearance	Flavour	Taste	Texture
1.	Tuna Flakes in Vegetable Oil (Starkist) from Ghana	4	3	3	3
2.	Light Tuna Chunks in Oil (Bumble Bee) from USA	1	2	1	3
3.	Skipjack Tuna Salad (John West) from Thailand	3	3	1	3
4.	Tuna in Mayonnaise (John West) from Thailand	3	3	2	2
5.	Tuna Steak in Sunflower Oil (John West) from UK	3	3	3	3
6.	Tuna Steak in Brine (John West) from UK	2	2	1	2
7.	Tuna Flakes in Sunflower Oil (John West) from Thailand	3	2	2	2
8.	Tuna Flakes in Brine (John West) from Thailand	1	1	1	1
9.	Tuna Chunks in Sunflower Oil (John West) from Thailand	3	4	4	4
10.	Tuna Chunks in Brine (John West) from Thailand	2	3	2	2

Note: 4 = Excellent, 3 = Good, 2 = Satisfactory, 1 = Fair

RESULTS AND DISCUSSION

Ten samples of canned tuna fish were analyzed for mercury and cadmium (Table 1). The result shows that canned tuna fish imported into the country from Ghana, Thailand, USA and UK have concentrations well below the FAO/WHO permissible levels for these toxic metals. Their contribution to the body burden can therefore be considered negligible and the fish seem to be safe for human consumption. From Table 2, light meat tuna chunks in sunflower oil (John West) from Thailand and tuna flakes in vegetable oil (Starkist) from Ghana were the most preferred. The least preferred was tuna flakes in brine (John West) from Thailand. This is probably due to the packing material in which the tuna was canned. The levels of toxic elements in shellfish are related to age, sex, season and place [5]. It is also reported that cooking reduces the amount of some metals [1]. Moreover, the advances of new packaging technology, especially the use of cans with lacquered walls and mechanical seam, reduce or, in most cases, eliminate the leaching of heavy metals into the food. Results of this study shows that the consumption of these imported canned tuna fish is adequately protective and this result will also serve as a baseline for the choice of packing material for the Institute's tuna and tilapia canning.

REFERENCES

1. Atta, M.B., El-Sebaie, L.A., Noaman, M.A., & Kassab, H.E. (1997). The effect of cooking on the content of heavy metals in fish. Food Chemistry, 58, 1-4.
2. Council Regulation [EC] No 466/2001 of 8 March 2001 setting maximum levels for certain contaminants in foodstuffs (Official Journal L 313, 30/11/2001 P. 0060-0060).
3. Enomoto, N., & Uchida, Y. (1973). Cadmium and other heavy metals contents in marine products from Ariak Sea in canned goods in the market. Saga daigaku Nogaku Inho, 69-75, [cited in Chem. Abstr. 18 (1974) 2506].
4. Inskip, M.J., & Piotrowsiki, J.K. (1985). Review of the health effects of methyl mercury. *Journal of Applied Toxicology,* 5, 113-133.
5. Kagi, J.H., & Schaffer, A. (1998). Biochemistry of metallothionein. Biochemistry, 27, 8509-8515.
6. Kurieshy, T.W., & D'siliva, C. (1993). Uptake and loss of mercury, cadmium and lead in marine organisms. Indian Journal of Experimental Biology, 31, 373-379.
7. Liang, Y., Cheung, R.Y.H., & Wong, M.H. (1999). Reclamation of wastewater for polyculture of freshwater of freshwater fish, bioaccumulation of trace metals in fish. Water Research, 33, 2690-2700.
8. Narvaez, D.M. (2002). Human exposure to mercury in fish mining areas in the Philippines. FAO/WHO Global forum of food safety regulation. Morocco: Marrakech.
9. Nishihara, T., Shimamato, T., Wen, K.C., & Kondo, M. (1985). Accumulation of lead, cadmium and chromium in several organs and tissues of carp. *Journal Hygienic Chemistry,* 31, 119-123.
10. Schmitt, C.J., & Brumbaugh, W.G. (1990). National contamination biomonotoring program: Concentrations of arsenic, cadmium, copper, lead, mercury, selenium and zinc in US freshwater fish, 1976-1984. Archives of Environmental Contamination and Toxicology, 19, 731-747.
11. Uysal, H. (1980). Levels of trace elements in some food chain organisms from the Aegean Coasts. Journess Etudes Pollution, 503-512.