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Determination of Cr Content in Canned Fish Marketed in Iran

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***Abstract*—**The presence of heavy metals in the environment could constitute a hazard to food security and public health. These can be accumulated in aquatic animals such as fish. Samples of four popular brands of canned fish in the Iranian market (yellowfin tuna, common Kilka, Kawakawa and longtail tuna) were analyzed for level of Cr after wet digestion with acids using graphite furnace atomic absorption spectrophotometry. The mean concentrations for Cr in the different brands were: 2.57, 3.24, 3.16 and 1.65 µg/g for brands A, B, C and D respectively. Significant differences were observed in the Cr levels between all of the different brands of canned fish evaluated in this study. The Cr concentrations for the varieties of canned fishes were generally within the FAO/WHO, U.S. FDA and U.S. EPA recommended limits for fish.

***Keywords*—**Heavy metals, essential metals, canned fish, food security.

I. Introduction

TODAY one of the most serious problems facing the world is contamination of the environment by inorganic, organic, and organometallic materials. There has been growing interest in the monitoring of heavy metals in the bio-organs [18], [33]. Fish tissues may contain heavy metals from their presence in the water or fish foods [25]. The accumulation of metals varies greatly between both fish species and/or fish tissues. Generally, fish could translocate the larger quantities of heavy metals in the gill, liver, and muscle tissues [17].

Heavy metals make up one of the most important group of pollutants [7]. The major source of exposure of humans to heavy metals is through food ingestion. Many chemical elements that are present in the human diet are essential for human life at low concentrations but can be toxic at high concentrations. Other elements such as Hg, Cd, Pb, Cr and Sn have no known essential function in living organisms and are toxic even at low concentrations when ingested over a long period. Therefore, many consumers regard any presence of these elements in foodstuffs such as fish and fishery products as a hazard to health [11], [15].

Heavy metals are generally released into aquatic environments in different ways such as urban discharge, agriculture, mining, combustion, geochemical structure and industrial discharges and accumulation of these metals is dependent on the concentration of the metal and the exposure period [10], [12], [26], [36], [37], [43], [51].

Metal pollution in the marine environment is not very visible but its impacts on delicate marine ecosystems and humans are drastic. In other words, heavy metals discharged into the marine environment can damage both marine species diversity and ecosystem due to their toxicity [53]. Heavy metal burdens in fish follow a multivariate dependence pattern. Fish are often at the top of the aquatic food chain and may concentrate large amounts of some metals from the water [24]. Fish can accumulate substantial amounts of metals in their tissues especially muscles and this, can represent a major dietary source of these metals for humans [18], [44].

Trace metals are significant either from the viewpoint of their essentiality or their toxicity [9], [38]. Low or high trace element unbalances can be considered as risk factors for several diseases. Metals, such as Fe, Cu, Zn and Mn, are essential metals since they play important roles in biological systems [53].

Chromium is widely distributed in human tissues in extremely low and variable concentrations. Chronic exposure to high Cr levels has been correlated with lung cancer in humans and kidney damage in animals [27]. The main concern about the absorption of Cr depends on its speciation. Chromium (VI) penetrates cell membranes, whereas Cr(III) does not; thus, Cr(VI) may cause genotoxic effects and cancer, whereas Cr(III) does not. The adequate dietary intake in adults can range from 0.50 to 2.00 µg for Cr(III) [16], [45], [55].

For most nonoccupationally exposed individuals, diet is the main route of exposure to environmental pollutants [8]. Fish and other aquatic life forms are constantly exposed to chemicals in polluted and contaminated waters. Fish have been found to be good indicators of heavy metal contamination in aquatic systems because they occupy different trophic levels and are of different sizes and ages [5], [13].

The question of risk from eating fish is complicated, however, by the positive health and social benefits of consuming fish [5], [49]. For some people fish may be their main source of protein, while for others, it may be the healthiest source. Fishes and fishery products are widely consumed because of their high protein content, low saturated fat, the presence of omega fatty acids and liposoluble vitamins all of which are known to support good health [6], [50]. Several studies have documented the long-term cardioprotective benefits for adults as well as the reproductive benefits of eating fish [6].

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The toxic effects of heavy metals particularly Hg, Cd, Cr and Pb have been broadly studied [4], [14], [21], [30]. However, fish, fish products, and seafood are also often the subject of investigations for heavy metal accumulations and many jurisdictions have monitoring programs in place to protect consumers [3], [11]-[13], [16], [19], [23], [26], [28], [29], [31], [32], [34], [40], [41], [46], [53], [56], [57].

Fish can accumulate substantial amounts of heavy metals in their tissues especially the muscles and, thus represent a major dietary source of these metals for humans [1], [18], [33], [44].

Contamination may occur during the commercial processing of seafoods [13], [29]. Tuna, as a predator, is able to concentrate large amount of heavy metals. Some of them are used for biomonitoring of environmental contamination [19], [35]. Canned fish is the most popular processed seafood in the developed world since it is convenient and affordable and eaten regularly in many countries, including Libya, USA, Portugal, the Kingdom of Saudi Arabia, Turkey and Iran [1], [11], [22], [54]. Because the metal pollution in aquatic environments can be harmful to human health [53], it is necessary to understand and control the hazard levels of pollution in seafood. Therefore in this study, the level of Cr was evaluated in commercial canned fish products that are commonly consumed in Iran (Longtail tuna, Kawakawa, Kilka and Yellowfin tuna).

II. Materials and Methods

A. Sample Collection

During the year 2012, 120 samples of four different Iranian brands (30 samples for each brand were obtained: yellowfin tuna (*Thunnus albacares*) [Brand A]; common kilka (*Clupeonella cultriventris* caspia) [Brand B]; kawakawa (*Euthynnus affinis*) [Brand C], and longtail tuna (*Thunnus tonggol*) [Brand D]) of canned fish (185 g cans) were analyzed for their content of Cr.

B. Chemical Analysis

All glassware was cleaned by soaking overnight in 10% nitric acid, followed by rinsing with distilled water. The acids used for wet digestion were of high purity Ultrex (Merck, Germany) grade, while the distilled water was further deionized (SKU: D4521). The blank values were below the detection limits of the instrument. Working standards were made from the stock by dilution of the measured aliquots with 1.0M nitric acid. Spectrophotometric analysis was done at the most sensitive setting for each metal. Each sample was analyzed in triplicate and the results, which mostly agreed within ±1.0%, were averaged. A reagent blank determination was carried out with every batch of 10 samples.

After opening each can oil/broth was drained off and the meat was homogenized thoroughly in a food blender (Hongdun HWT). Samples were then digested without delay in quartz Erlenmeyer flask with 15 ml of a Suprapure nitric: perchloric: sulphuric acid (25 + 25 + 1 v:v:v) mixture. About 5 g of sample were digested, using a hot plate at 150°C. Further aliquots of nitric acid were added until a completely colorless solution was obtained. After evaporation using Perkin Elmer Multiwave 3000, the residue was dissolved in 10 ml of water with 1ml of conc. Suprapure HCl at 100°C. Finally, the volume was made up to 25 ml with deionized water. Determination of Cr was done by direct aspiration of the sample solution into the air-acetylene flame of the atomic absorption spectroscopy (4110 ZL, Perkin Elmer) [1], [11].

C. Statistical Analysis

One-way analyses of variance (ANOVA) and Tukey test were used to determine whether Cr concentrations varied significantly between species, with values less than 0.05 ($p<0.05$) considered statistically significant. The statistical calculations were done using SPSS 15.0 version (SPSS Inc., Chicago, IL, USA) statistical package.

III. Results and Discussion

The concentrations of Cr in Yellowfin tuna, Kilka, Kawakawa and Longtail tuna is presented in Table I along with relevant statistical parameters. For comparing the mean concentrations of Cr in the different brands of canned fish by ANOVA and the Tukey test indicated that there were significant differences within and between all of the evaluated brands ($p<0.05$).

TABLE I
Mean Cr Level in Different Brands of Canned Fish Examined in this Study (in Micrograms per Gram Wet WT)

Sample (fish and brand)	No.	Average concentration±SD
Yellowfin tuna	30	2.57±1.87
Kilka	30	3.24±2.35
Kawakawa	30	3.16±2.97
longtail tuna	30	1.65±1.49

The levels of heavy metals in fish depend upon many factors like the duration of exposure of fish to contaminants in the water, the feeding habits of each fish species, the, concentrations of contaminants in the water column, water chemistry, any contamination of fish during handling and processing, and fish sex, weight, season [4]. According to Taha´n et al. (1995), the pH of the canned product, the quality of the lacquer coatings of canned products, oxygen concentration in the headspace, quality of coating and place of storage place may control the metal levels in canned fishes for those metals found in the canning material [42].

Cr (III) is an essential nutrient that helps the body use sugar, protein, and fat but Cr(VI) is carcinogenic [28]. Excessive amount of Cr(III) may cause adverse health effects [49]. In the literature, Cr levels in fish have been reported to be in the range of 0.06-0.84 µg/g for muscles of fish from the Black Sea coasts [48], 0.10-1.60 µg/g for muscles of fish from the Turkish seas [47], 0.04-1.75 µg/g for muscles of fish from the Marmara, Aegean and Mediterranean Sea [52], 0.310-0.73 µg/g for muscles of fish from the western coast of the United Arab Emirates [20] and 0.2-1.87 µg/g for muscles of fish from Indian fish markets [39].

The results from this study indicated that significant differences existed in the Cr concentrations across four different canned fish species. Also, analytical data shows that the Cr concentrations for the varieties of canned fishes were generally within the FAO/WHO, U.S. FDA and U.S. EPA recommended limits for fish, Cr (8.0 μg/g) [2]. There is therefore no serious health risk associated with the consumption of the Cr in the canned fishes analyzed. Therefore more research and assessments of seafood quality is needed in many countries to provide more data and help safeguard the health of humans.

This study may help in generating data needed for surveillance programs aimed at ensuring the safety of the food supply and minimizing human exposure. It is hoped that monitoring of these metals regularly will increase the consumer confidence in canned fish products from Iran.

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