Vol. 20 · March 2015
Print ISSN 2012-3981 • Online ISSN 2244-0445
doi: http://dx.doi.org/10.7719/jpair.v20i1.316
Journal Impact: H Index = 2 from Publish or Perish

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Cadmium and Chromium in Selected Canned Goods Commercially Available in the Philippines

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ABSTRACT

Heavy metals are both naturally occurring and anthropogenic such that even processed food canned for easy marketing and handling may be contaminated with it. This study aimed to determine the presence or absence of cadmium and chromium in canned fish and meat commercially available in the Philippines. Acid digestion was employed to the solid fish and meat samples prior to quantitative instrumental analysis using Flame Atomic Absorption Spectroscopy (FAAS). The results showed that the canned meat and fish samples tested all contained cadmium and chromium. None of the canned fish and meat samples went beyond the limit for cadmium in food. Canned fish all went beyond the limit for chromium on both California and United States Environmental Protection Agency (EPA) limits. Only CF2 and CF8 went beyond the Center for Food Safety limit in Hong Kong. For canned meat samples, all went beyond the limit set for chromium relative to California EPA standards but not on US EPA and Center for food Safety in Hong Kong limits. All of the levels of cadmium as projected mathematically did not go beyond the acceptable blood levels for both the samples of canned meat and fish. Concentration of chromium from meat when projected in blood did not exceed the safe levels while chromium in CF2 and CF8 exceeded the acceptable blood amounts as mathematically projected.

Keywords– Environmental Toxicology, cadmium, chromium, canned goods, FAAS, Philippines

INTRODUCTION

The common cause of cadmium poisoning is by ingestion of cadmium-contaminated compounds. In the digestive tract, it reacts with the gastric acid forming soluble and absorbable cadmium chloride. Cadmium arrests respiration, causes nausea, vomiting, abdominal cramps, diarrhea, weakness and prostration (Soine, Roger & Wilson, 1967). The symptoms of cadmium poisoning upon ingestion did not vary much from decades back. It causes acute gastrointestinal effects, such as vomiting and diarrhea. Cadmium is widely used in industrial processes as anticorrosive agent, as a stabilizer in PVC products, as a color pigment, a neutron absorber in nuclear power plants, and in the fabrication of nickel-cadmium batteries (Godt et al., 2006). Cadmium may cause severe arthralgia, osteomalacia, dysfunctions in the kidneys, lungs and gastrointestinal tract (Dart, 2004; Elinder, 1985).

Chromium is an essential trace (up to 10 mcg/L) element required for maintaining normal glucose tolerance. The recommended dietary intake is 50 to 200 mcg/day of Cr^{3+}, the most common ionic form of the metal. Upon ingestion, it causes nephritis and glycosuria. Chromium salts, chromates and dichromates are destructive to tissue when applied topically or administered orally. Individuals exposed to ''chromate dust" develop deep ulcers of the skin and nasal mucosa which heal very slowly (Soine, Roger & Wilson, 1967). Chromium VI results to untoward gastrointestinal, respiratory, hepatic, endocrine, immunological, and neurologic system effects. Accumulation of chromium can lead to cancer (Agency for Toxic Substances and Disease Registry, 2007).

Contamination of cadmium and chromium in commercially available commodities may pause health threats to the Filipino community. For the last decades, concern on food quality was raised not only in the Philippines but all over the globe. Food safety implies the absence and acceptable or safe levels of contaminants, adulterants, naturally occurring toxins or any other substances that may make food injurious to health on an acute or chronic basis (Lizada, 2007).

By eating commercial food products like canned sardines, contaminants may be ingested as well. Heavy metals may be acquired from food as these are natural food components. Environmental and food processing contamination may

increase its amount in canned goods (Iwegbue, Nwajei, Arimoro, & Eguavoen, 2009).

Cadmium is absorbed through oral (5%), inhalational (25%) and dermal (0.5%) route (Dart, 2004; Guy, 1999; Kjellstrom, Borg & Lind, 1978). Chromium is absorbed from 0.4 to 2.5% when ingested (National Institutes of Health, 2013). While for cadmium, the acceptable oral limit in food which is 0.05ppm (Environmental Protection Agency,nd; 2009; Sireli Göncüoğlu, Yıldırım, Gücükoğlu, & Çakmak, 2006). For health protective level it was mentioned that California goal for total chromium in drinking water is 0.02ppb or 0.00002 ppm (Environmental Protection Agency, Office of Environmental Health Hazard Assessment, California, 2011), 0.1ppm in drinking water (Environmental Protection Agency USA, 2010) and 1ppm for vegetables (Yau, 2011).

The study will help give a good picture of cadmium and chromium contamination in canned meat and fish, if any. The information will hopefully result to cleaner food processing and environmental clean-up. Academicians and researchers may use the results of this study to initiate related, relevant researchers to improve on commercially available canned goods released in the market.

OBJECTIVES OF THE STUDY

The study aimed to determine the presence or absence of cadmium and chromium in canned meat and fish available in the Philippine Market. Specifically, it aimed to determine the amounts of cadmium and chromium in the analyzed samples using Flame Atomic Absorption Spectroscopy. Further, the amounts were compared with acceptable limits of the metals. The study aimed to calculate the projected blood levels of cadmium and chromium upon ingestion and compared with limits acceptable in blood.

MATERIALS AND METHODS

Research Design

This study employed the descriptive-exploratory design of research. The concentrations of heavy metals from canned fish and meat samples were analyzed after acid digestion and Flame Atomic Absorption Spectroscopy.

Sample Collection

Ten canned meat and ten canned fish products were collected from five supermarkets in Metro Manila, Philippines in the early parts of 2013. These were the more popular canned goods. The products are available all over the country.

Sample Acid Digestion and Preparation

Five (5) grams of each solid meat and fish samples were digested in 10 mL concentrated nitric acid in an open glass container for 24 hours, at room temperature. The following day the pre-digested samples were heated at 80°C for 5 hours.

Samples were then cooled to room temperature, and the volume was adjusted to 50 mL with distilled water and filtered. Diluted samples were stored in polyethylene (PET) bottles and were analysed using Flame Atomic Absorption Spectroscopy (Prester, Juresa & Blanusa, 1998).

Flame Atomic Absorption Spectroscopy (FAAS)

Cadmium and chromium contents of the fish and meat samples collected were analyzed using Flame Atomic Absorption Spectrophotometer (Shimadzu AA-6300) at the Department of Chemistry Instrumentation, De La Salle University, Vito Cruz, Manila, Philippines. Prepared standard solutions with different concentrations of lead, cadmium and chromium were used to calibrate the spectrophotometer prior to analysis using distilled water as the control.

Data Analysis

The data were analyzed by comparing values to standards set for cadmium and chromium in food. The projected blood levels were also compared with acceptable limits in blood.

RESULTS AND DISCUSSION

Canning which is a kind of processing food may contribute to the presence of heavy metals in food. This procedure preserves food as these are sealed in an airtight container. Canned food offers fast food.

Fish have good health benefits but there have been many reports on contamination of fish by chemicals in the environment. Marine and fresh water organisms have been studied in different areas for heavy metal contaminants.

Heavy metal contamination in varied food is hazardous to health and hazard is dependent on the level of the toxicant incorporated (Chukwujindu, 2009).

Recently, few toxicological studies are made in determining the levels of heavy metals found in canned meat although the presence of heavy metals was confirmed in previous studies. In a study conducted back in the 1990's, seven heavy metals were found in samples of canned shoulder pork, preserved lunch pork, ham and liver paste (Brito, 1990). This was a study conducted in Spain, more than 20 years ago, so it could be said that these values may have changed throughout the years since industrialization and new canning technologies have been adopted. However, fewer studies have been conducted on canned meat samples marketed in Asia in spite of the high consumption rate of such products in the region. One study, conducted on pork products in Chennai, India, revealed that the samples had cadmium from 0.038 to 0.545 mg/kg', chromium up to 2.244 mg/kg, copper up to 2.847 mg/kg, lead up to 6.290 mg/kg and zinc from 6.927 to 144.575 mg/kg. Generally, heavily spiced products had higher levels of heavy metals. It was also found out that levels of Cadmium exceeded the Maximum Permissible Level (MPL) imposed by the Food and Agriculture Organization (FAO) (Santhi, 2008).

Table 1. Cadmium and Chromium levels in canned fish samples and blood as projected mathematically

Canned Fish Samples	Cd mean Concentration (ppm)	Projected Cd in blood at 5% absorption (mcg/L)	Cr mean Concentration (ppm)	Projected Cr in Blood at 2.5% absorption (mcg/dL)
CF1	0.0179+/-0.0002	0.895	0.2802+/-0.0003	0.7005
CF2	0.0085+/-0.0001	0.425	2.2837+/-0.0015	5.7092
CF3	0.0101+/-0.0034	0.505	0.2099+/-0.0006	0.5247
CF4	0.0094+/-0.0005	0.47	0.2632+/-0.0004	0.658
CF5	0.0113+/-0.0021	0.565	0.1972+/-0.0027	0.493
CF6	0.0103+/-0.0008	0.515	0.2566+/-0.0005	0.6415
CF7	0.0107+/-0.0007	0.535	0.1996+/-0.0004	0.499
CF8	0.0123+/-0.0003	0.615	6.2721+/-0.0009	15.680
CF9	0.0104+/-0.0054	0.52	0.2432+/-0.0011	0.608
CF10	0.0116+/-0.0006	0.58	0.3581+/-0.0001	0.8952

Table 2. Cadmium and Chromium levels in canned meat samples and blood as projected mathematically

Canned meat samples	Cadmium (Mean Concentration)	Projected Cd in blood at 5% absorption (mcg/L)	Chromium (Mean Concentration)	Projected Cr in Blood at 2.5% absorption (mcg/ dL)
CM1	0.0102+/-0.0001	0.51	0.0086+/-0.0062	0.0215
CM2	0.0112+/-0.0004	0.56	0.0042+/-0.0005	0.0105
CM3	0.0103+/-0.0013	0.515	0.0064+/-0.0001	0.016
CM4	0.0114+/-0.0025	0.57	0.0032+/-0.0056	0.008
CM5	0.0106+/-0.0018	0.53	0.0132+/-0.0005	0.033
CM6	0.0111+/-0.0004	0.555	0.0052+/-0.0007	0.013
CM7	0.0103+/-0.0007	0.515	0.0097+/-0.0062	0.024
CM8	0.0198+/-0.0009	0.99	0.0147+/-0.0008	0.037
CM9	0.0075+/-0.0043	0.375	0.0068+/-0.0005	0.017
CM10	0.0063	0.315	0.0092	0.023

Given the acceptable limit for cadmium in food (0.05ppm), limit for drinking water from California and USA EPA (orally taken similar to food) for chromium (0.02ppb and 0.1ppm respectively), and 1ppm limit for chromium in vegetables according to the Center for Food Safety in Hong Kong, none of the canned fish samples went beyond the limit for cadmium but all went beyond the limit for chromium on both California and US EPA limits. Only CF2 andCF8 went beyond the Center for Food Safety limit in Hong Kong. For the canned meat, none of the analyzed samples of canned meat went beyond the limit set for cadmium while all samples went beyond the limit set for chromium relative to California EPA standards but not on US EPA and Center for food Safety in Hong Kong limits. Given the acceptable blood levels for cadmium at 5mcg/L (ATSDR, 2013) and 3mcg/dL for chromium (ATSDR, 2008) all of the levels of cadmium as projected mathematically did not go beyond the acceptable blood levels for both the samples of canned meat and fish. Concentration of chromium from meat when projected in blood did not exceed the safe levels while chromium

in CF2 and CF8 exceeded the acceptable blood amounts as projected. The oral absorption of cadmium at 5% and chromium at 2.5% are quite small. This results to generally safe amounts of projected cadmium and chromium in blood.

A study of canned products from Turkey showed trace levels for copper, zinc, manganese, iron, selenium, aluminum, chromium, nickel, and cobalt. The values obtained for chromium are close to those of the canned fish tested in this study with a value range of 0.19-0.52 ppm (Tuzen & Soylak, 2007). In another study on vegetables, legumes and fish in cans from Lebanon, cadmium levels were shown to exceed permissible levels of EU (Korfali & Hamdan, 2013). Contamination of canned products, not only of meat and fish with cadmium and chromium have been observed not only in the Philippines but also in other countries. Continued monitoring and processing improvement must be put in place.

CONCLUSIONS

Thus, from the results of the study, the canned meat and fish samples tested all contained cadmium and chromium. None of the canned fish samples went beyond the limit for cadmium but all went beyond the limit for chromium on both California and US EPA limits. Only CF2 andCF8 went beyond the Center for Food Safety limit in Hong Kong. For the canned meat, none of the analyzed samples of canned meat went beyond the limit set for cadmium while all samples went beyond the limit set for chromium relative to California EPA standards but not on US EPA and Center for food Safety in Hong Kong limits. All of the levels of cadmium as projected mathematically did not go beyond the acceptable blood levels for both the samples of canned meat and fish. Concentration of chromium from meat when projected in blood did not exceed the safe levels while chromium in CF2 and CF8 exceeded the acceptable blood amounts as projected.

TRANSLATIONAL RESEARCH

The outcome of this study entitled, “Cadmium and Chromium in Selected Canned Goods Commercially Available in the Philippines” may be translated into use in the community by sending the information to the Philippine Association of Food Technologists Incorporated. Further analyses of other canned good products and the full method of processing will help identify areas in the procedure that can be improved to lessen the contaminants. PAFTI may create guidelines for better canned good processing.

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