Journal of Tropical Pharmacy and Chemistry

Journal homepage: https://jtpc.jurnalfamul.com

Assessment of Bisphenol A and Heavy Metals in Some Commercial Brands of Canned Fish

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Abstract

Bisphenol A are commonly referred to as endocrine disruptive chemicals that migrates into food through canning. Even at low levels, they can result in a variety of health issues, Heavy metal toxicity has become a severe threat and is linked to a number of health risks. When fish are exposed to chemical pollutants, especially when being canned for preservation, bioaccumulation usually occurs. Acid digestion methods were used to measure the specified heavy metals in canned fish, and an atomic adsorption spectrophotometer was used to conduct the analysis. The results of Heavy metals show that Iron, copper and Zinc have the highest concentration indicating that the canned fish are rich in Iron, copper and Zinc, while Lead has the lowest concentration. For Bisphenol A, the concentration ranges from 0.019 to 0.403 µg/g and satisfied this stipulated standard. Based on the results, the four selected heavy metals, Cu, Fe, Zn, and Pb, as well as Bisphenol A, have concentrations that are within WHO-acceptable levels in canned fish.

Keywords: Bisphenol A, Heavy metals, canned fish

Received: 13 February 2023 **Accepted**: 30 June 2025

DOI: https://doi.org/10.25026/jtpc.v9i1.552

How to Cite:

Opatola, S. F, Akpambamg, V.O. E, Lere-Aliu, M. O., 2025. Assessment of Bisphenol A and Heavy Metals in Some Commercial Brands of Canned Fish. *J. Trop. Pharm. Chem.* **9**(1). 1-6. **DOI**: https://doi.org/10.25026/jtpc.v9i1.552

1 Introduction

Processing aids in preserving the food's sensory qualities and nutritional worth End users gain greatly from the handling and storage benefits of food processing and packaging. However, this is occasionally linked to the possibility of chemical migration from the package to the meal itself. Tin, glass, ceramics, and plastic packaging materials may emit trace amounts of toxins when they come into touch with food. This possible threat to human health stems from the transfer of chemicals from packaging and other food contact materials to the food. The most common method of fish preservation is canning. Fish that has been cooked, processed, and sealed in an airtight container, such as a tin can, is referred to as canned fish [1]. Fish is an aquatic organism with significant economic value that adapts to environmental changes. Fish typically experience bioaccumulation when exposed to chemical contaminants, particularly Bisphenol A and heavy metals. When chemical pollutants enter a fish's body, they have the potential to harm and impair the underlying mechanisms [2], [3], [4]. Bisphenol A exposure in humans has been related to changes in immunological, cardiovascular, metabolic, and developmental systems. system [5], [6], [7]. According to studies, bisphenol A is an endocrine disruptor that modifies biological functions. The build up of Bisphenol A in the body has many physiological, neurological, and developmental effects [8].

In this study, Bisphenol A and four trace elements, Zinc, Copper, Lead and Iron were assessed. All four heavy metals can have detrimental health effects at high concentrations. A significant coating or component used to stop iron and steel from corroding and migrating into food is zinc. Zn is significant and necessary, particularly throughout puberty, pregnancy, and menopause. It is involved in most human metabolic pathways and is crucial for several enzymes that are necessary for immune function, wound healing, and reproduction. Loss of appetite, slowed growth, altered skin, and aberrant immune function can all result from a zinc shortage [9].

Since many varieties of fish have been reported to be contaminated with lead and because the solder used to make cans is a source of lead contamination of food during canning, it is crucial to monitor the lead concentration in canned fish. Lead may cause several illnesses, including kidney impairment [10].

Iron does not result in any nutritional loss in the product and is a necessary element for humans and other creatures. Fish is a major source of iron for adults and children [11].

The main objective of this study was to assess the level of Bisphenol A, zinc, iron, copper and lead ingested via the consumption of canned fish. For this purpose, BPA and four elements levels were evaluated and compared to other studies.

2 Materials and Methods

2.1 Chemical reagents for Bisphenol A

All reagents were analytical reagent grade. In a 100 mL volumetric flask, 5.0 mg of 4,4'-isopropylidenediphenol, also known as Bisphenol A (CAS number 80-05-7, Aldrich), was dissolved in 96% (v/v) ethanol to create a stock solution with 50 mg/L of the chemical (Panreac). After sufficient dilution with n-hexane to a final concentration of 3 mg/L, a standard solution of 100 mg/L of 2H10-anthracene in n-hexane provided by Cromlab (Barcelona, Spain) was used as the internal standard. The silylation reagent was Sigma SIL-A, a combination of trimethylchlorosilane (TMCS), hexamethyldisilazane (HMDS), and pyridine (1:3:9). The microextraction process included sodium chloride, sodium sulfate, and dichloromethane (panreac)

2.2 Chemical reagent for heavy metals

All chemicals used were of the highest purity and all solutions were prepared using distilled water.

2.3 2.2.1 Instruments

For the wet digestion methods magnetic stirrer/hot plates were used. To determine the metal ion absorbencies, Atomic Absorption Spectrophotometer (GBC 932 plus, GBC Scientific Equipment Ltd.) was used.

2.4 2.2.2 Methods of Digestion

The digestion methods employed in this study was acid digestion. The method performed was aqua regia solution (HCl: HNO_3).

2.5 2.2.3 Acid digestion

Acid digestion methods differ due to the chemical composition used in method. The acid digestion methods used in this study are described below;

A mixture of concentrated HCl and HNO_3, in the ratio of 3:1 and 1 ml $HClO_4$ acid is used as the aqua regia mixture. 1.0 g of fish sample was digested in 10 ml of aqua regia mixture in digestion tubes for 3h at 60°C

Atomic absorption spectrophotometer was used for analysis of samples for both methods

3 Results and Discussion

Table 1: Concentration of Heavy Metals in Canned Fish

Sample code	Concentration (ug/ml)
A (Gheisha)	0.40±0.070[a]
B (Sardine)	0.07± 0.007[b]
C (Sardine)	0.03±0.028[c]
D (Sardine)	0.02±0.169[c]

Table 2: Concentration of Heavy Metals in Canned Fish

Samples	Fe (mg/kg)	Cu(mg/kg)	Pb(mg/kg)	Zn(mg/kg)
A (Gheisha)	0.119±0.011	0.110± 0.014	0.008±0.002	0.082±0.014
B(Sardine)	0.105±0.010	0.104±0.012	0.008±0.002	0.091±0.016
C(Sardine)	0.098±0.010	0.129± 0.017	0.006±0.001	0.073±0.012
D(Sardine)	0.100±0.008	0.100± 0.011	0.007±0.003	0.047±0.008

3.1 Bisphenol A

Bisphenol A is regarded as a potential endocrine disruptor that mimics the action of the hormone estrogen [12]. Table 1 presents a summary of the BPA results present in the 4 samples of canned fish. It shows that BPA is detected in all the samples. The average mean concentration of BPA in the canned fish samples collected in this study are; 0.403, 0.071, 0.030, 0.019, 0.197 µg/g, which are lower than the 0.6 μg/g permissible limit [13]. The values of BPA concentrations obtained in the canned foods evaluated in this study satisfy this stipulated standard, showing that the consumption of these canned foods is safe.

The presence of Bisphenol A in canned fish (sardine) or gheisah may be due to leaching of BPA the can as a result of the can coatings with epoxy resin as discussed in the literature or sterilization conditions used by different product companies; temperature appears to be a more important factor in leaching than the age of the container. It could also be as a result of accidental exposure of the canned fish products to heat or acidity (e.g., sunlight) during storage and transportation [14]. Heat and contact with either acidic or basic compounds accelerate hydrolysis of the ester bond linking BPA molecules in polycarbonate and resins [15], [16]. Can coating type and sterilization conditions appear to be the main determinants, storage time has no effect on BPA migration [17], [18].

Sample B, C, D (Sardine) give low concentration than sample A (Gheisha). The reason may be as a result of the high concentration of oil which thus prevent the leaching of the BPA. The oil in the canned sardines appears to have reduced the leaching of the BPA from the can's coating. This perhaps explains one of the antioxidant roles of omega-3 oils in human diets.

Based on this results human may be exposed to Bisphenol through the hydrolysis of epoxy resins and polycarbonate plastics.

3.2 Heavy metals

Copper is an essential trace element vital to the health of all living organisms. Copper enhances bone strength, red and white blood cell maturation, iron transport, cholesterol and glucose metabolism, heart muscle contraction, and brain development. Moreover, Cu has a major role in oxygen transport, bone development, and protein synthesis and is an essential component of countless enzymes [19]. On the other hand, acute Cu toxicity is associated with nausea, vomiting, and epigastric pain. For that reason, a maximum limit intake of Cu was set at 30 mg/day by WHO. Therefore, a high intake of Cu has been recognized to cause adverse health problems such as kidney and liver damage for human [20], [21].

According to the results Cu in canned fish samples ranged from 0.100 to 0.129 and were lower than the Maximum Permissible Level. The results of other study of [22] reported that the mean concentrations of Cu (µg/kg w.wt) in canned fish from Georgia and Alabama were 0.32 for pink salmon, 0.47 for red salmon, 0.25 for tuna, 0.81 for mackerel, 0.83 for sardines and 0.60 for herring.

Lead is known to increase blood pressure and cardiovascular disease in adults, and to induce reduced cognitive development and intellectual performance in children [9], [23]. The concentrations of Lead in the sample ranged from 0.006 to 0.008 mg/kg. Lead has the lowest levels in all the samples analysed for the two digestion methods used. The reason for the presence of Lead in the study samples may be linked to metallic deposits in fishes, especially the gills, the maximum lead level permitted for fish set by the European Commission [13] guideline and FAO is 0.4 and 0.5 µg/g, respectively [9], [24]. The Pb concentration in canned fish samples in this study were also low compared to previous study from Iran which reported lead in the range of 0.016-0.073 µg/g [25].

Previous studies have also reported lead contents in the range of 0.0-0.03 µg/g in canned fish samples [26], 0.18-0.40 µg/g in canned tuna fish [27] and 0.076-0.314 µg/g in Turkish canned fish samples [26], [28].

Iron was the metal that had the highest concentrations in all samples out of the heavy metals that were analysed for except in sample C. The iron concentrations obtained ranged from 0.098 to 0.119mg/kg. Iron is an essential mineral and is the most abundant transition element, and probably the most well-known metal in biologic systems especially plays an important role in the human physiology. Iron deficiency causes anemia, reducing cognitive function and also physical work capacity. Whereas, high intake of this element may be the cause of organ failure [11], [20], [21]. It is known that chronic iron overload may be the cause of organ failure [29]. The concentration of Iron is still within the permissible level. The concentration of iron can increase respectively with increase of storage period due to internal erosion [30].

Zn obtained from diet plays a number of roles such as activation of enzymes involved in wound healing, nervous system function, cell growth and immune health. Optimal nucleic acid and protein metabolism, as well as cell growth, division and function all require availability of zinc. However, high-zinc diet can cause nausea, digestive upset, including diarrhea, abdominal pain, vomiting, lethargy, anemia and dizziness. Ingested Zn usually affects the GIT before it is distributed through the body. High dose Zn supplementation interferes with the uptake of copper. Hence, many of its toxic effects are in fact due to copper deficiency. Zinc ranging between 0.047 mg/kg and 0.091 mg/kg (Digestion). The value reported in this study is lower than the maximum zinc level permitted (MPL) for fish which is 40–50 µg/g according to the FAO.

4 Conclusions

Based on the results, the concentrations of four selected canned fish were within permissible limits of Cu, Fe, Zn Pb and Bisphenol A. Routine monitoring of different fish commonly consumed in Nigeria is recommended to prevent human exposure to these toxic metals and endocrine disrupting chemical.

5 Declarations

5.1 Author Contributions

The names of the authors listed in this journal contributed to this research.

5.2 Funding Statement

This research was not supported by any funding sources.

5.3 Conflicts of Interest

The authors declare no conflict of interest.

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