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REVIEW

Metal Concentrations in Canned Fish in Developing Countries and Its Relation with Human Health Risk

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Abstract

Fish protein consumption by humans, including that of canned tuna fish, is rising steadily all over the world. There are some concerns, though, regarding the potential for exposure to high metal concentrations in canned fish products. Numerous studies on the concentration of metals in seafood, including, lead (Pb), tin (Sn), chromium (Cr), mercury (Hg), arsenic (As), nickel (Ni), and cadmium (Cd) in canned fish, have been carried out worldwide. Majority of the reports indicated that the heavy metals in the canned fish were low, in the permissible limit and safe for human consumption. Some factors such as fish habitat water quality, exposure time of fish to heavy metals in water, levels of concentrations of the heavy metals in water, trophic pattern of fish, heavy metals contaminations of fish during processing, especially soldering of packaging cans, quality and shelf life of canned fish can bring about elevated rise in the heavy metals of the canned fish. It is recommended that before a fish is used for canning, prior assessment of its heavy metal concentrations should be done. Also, regular monitoring of the levels of heavy metals that may occur in the canned fish due to processing and canning should be carried out. All these will help in determining the safety of the canned fish, guide against any adverse health risk associated with consumption of canned fish and allay consumers' fear of cancer from the consumption of canned fish.

Introduction

In the human diet, seafood offers a good source of protein, omega-3 fatty acids, unsaturated fatty acids, vitamins, micronutrients, and macronutrients, and consumption of seafood is increasing enormously (Pieniak et al., 2010). Fish consumption helps children's normal neuronal development and lowers the risk of chronic diseases like depression, heart disease, rheumatoid arthritis, and some cancers (Di Giuseppe et al., 2014).

The modernization of living practices among people in developing nations has made a lot of canned fish consumption necessary. This is due to the fact that it is easily accessible, inexpensive, and quick to prepare and eat with a variety of staple foods. According to the National Toxicology Program (NTP) and the International Agency for Research on Cancer (IARC), some heavy metals, including cadmium, nickel, arsenic, beryllium, and chromium, are known to cause cancer in humans and animals.

The wider populace is worried that eating canned fish could expose them to high levels of heavy metals because the fish used, the cans used to package the fish, and the canning process itself are all contaminated with heavy metals. According to them, all of these could be a factor in the rise in cancer cases in developing nations.

The cancer from heavy metals could be described as environment which is due to lifestyle, economic, and behavioural factors and pollution. Between 70% and 90% of common cancers are due to environmental factors and therefore potentially preventable. Deaths from cancer have been increasing primarily due to lifestyle changes in the developing world. Only two decades ago, the percentage of new cancer cases was similar for developed and developing regions. Today, 55 percent of new cases arise in developing nations—a figure that could reach 60 percent by 2020 and 70 percent by 2050. The number of new cancer cases worldwide will grow from around 12 million todays to 15 million in 2020, with much of that growth occurring in developing nations.

Heavy Metals in Canned Fish and Cancer

Fish can be preserved in a variety of ways, including smoking, freezing, drying, salting, and canning (Jedrychowski et al., 2007). The marine environment, which is contaminated by heavy metals and industrial wastes, is the main source of metals in the fish tissue (Fakhri et al., 2018).

Aquatic environments are contaminated by human activities such as industrial discharge, municipal and agricultural wastewater, and solid wastes as well as by natural sources such as metals that leak from the Crust of the earth (Domingo et al., 2007). In addition to those sources, the canning process for fish can also introduce contaminants (Mol, 2011), (Figure-1). There are many studies linking consumption of canned fish high in heavy metals above the FAO/WHO permissible limits to various health problems including cancer (Ikem & Egiebor, 2005; Khansari et al. 2005; Turkmen et al. 2005; Rahimi et al. 2010; Carver & Gallicchio 2017). But, most of these reports attributing heavy metals in canned fish to health problems such as cancer appear to be contradictory. For instance, Rahimi et al. (2010) who analysed and determined levels of mercury, cadmium and lead in canned tuna fish marketed in Iran reported that the levels of these toxic elements were found to be above permissible limits, with only mercury having a concentration below the permissible limit. Sobhanardakani et al. (2018) assessed contamination of canned tuna with Cr, Cu, Fe, Mn and Ni and noted that the concentrations of Cr, Cu, Fe, Mn and Ni in the canned fish are within permissible limits. They concluded that population consuming the canned fish might have no potential significant health risk including cancer. Five brands of canned Tuna fish in Tehran were evaluated by Fathabad et al. (2015) for copper, zinc, manganese, iron, selenium, aluminium, chromium, nickel, lead and cadmium. They reported that the consumption of the five (5) brands of the canned tuna does not pose any risk to the health of consumers particularly with respect to zinc, copper, cadmium and tin concentrations; though some of the brands contained iron, lead and mercury above the legal limits set up by some health authorities which could potentially lead to cancer. Celik & Oehlenschlager (2007) analyzed three samples of canned tuna from two different Turkish brands and reported higher amounts of Zn than the permissible limits. The concentrations of Pb, Zn, Fe, Cd, Mn and Hg in 46 canned fish samples of nine different brands consumed in Ghana were analysed by Boadi et al. (2011). They observed significant differences in the element concentrations across nine different canned fish brands, but the metal concentrations for the canned fishes were generally within the WHO/FAO, FDA and US, EPA recommended limits for fish. They opined that there is no serious health risk associated with the consumption of canned fishes analyzed. However, they reported that low-risk groups (adolescents and adults) and high-risk groups (pregnant mothers and children) must reduce the consumption of canned fish, as frequent consumption may result in bioaccumulation of the metals and increased health

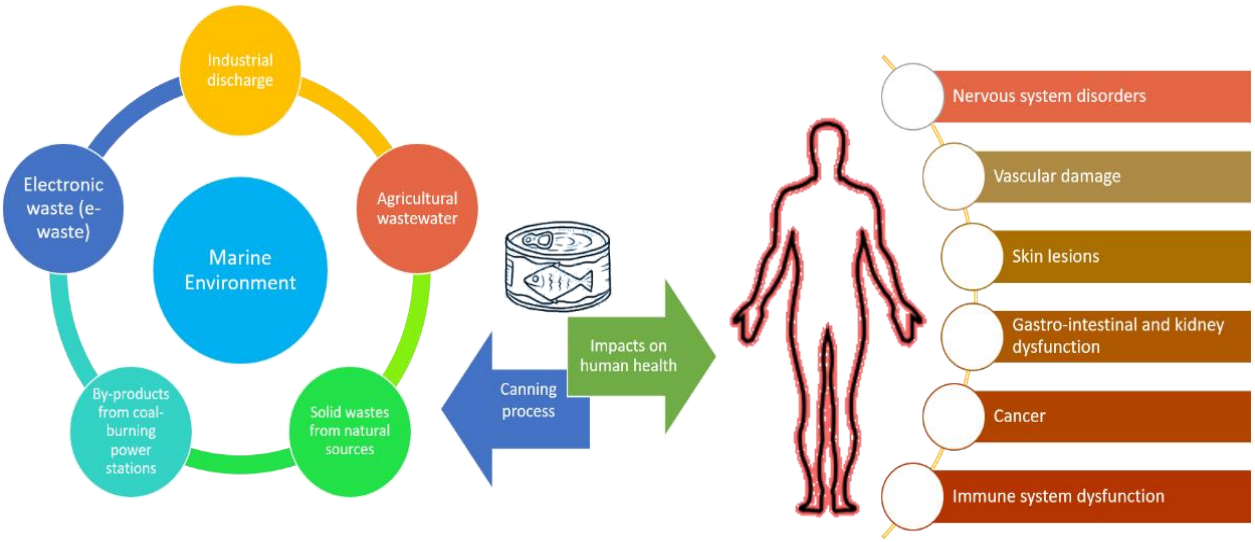

Figure 1. Heavy metal contamination sources of fish and impacts on human health

risks such as cancer. Khansari et al. (2005) determined the levels of mercury, arsenic, cadmium, lead and tin in commercial canned fish which are frequently consumed by the Iranian population and also exported. They observed that fish from the Persian Gulf area of Iran have concentrations well below the permissible FAO/WHO levels for these toxic metals. Their contribution to cancer can therefore be considered negligible and the fish are safe for human consumption. The concentrations of Cd, Pb, Ni, Cr, Cu, Co, Fe, Mn, and Zn were determined in selected brands of canned mackerel, sardine, and tuna in Nigeria by Iwegbue (2015) with a view to providing information on the dietary intakes of metals and lifelong health hazards associated with the consumption of these products. He found that Cd and Pb occurred at concentrations above the maximum permissible limits in most of the samples, while the other metals occurred at levels below their respective permissible limits. He noted that excessive intake of these products could cause health hazards such as cancer in the long-term. In a similar research in Nigeria, Iwoha et al. (2013), recorded levels of Cu, Cr, Zn, Fe, Pb, Ni and Mn, to be below the levels set by WHO and other standard bodies in two varieties of canned mackerel fish. Also, in Nigeria, Odiko (2017) assessed Fe, Zn, Mn, Ni, and V in brands of canned fishes stored in vegetable oil marketed in Benin City, Nigeria. He reported that heavy metal concentrations increased with increasing storage time especially Fe and Zn. However, all the metal concentrations were in the permissible set limits by Food and Agriculture Organization (FAO), World Health Organization (WHO) and European Union (EU) legislation for fish except for nickel. Samples of canned tuna fish from Iran were analysed for lead, cadmium, copper, zinc, tin, and iron by Zarei et al. (2010), who reported that all the heavy metals were within the permissible limits for fish in the sampled canned tuna. Similarly, Malakootian et al. (2011), determined Pb, Cd, Ni, and Zn Concentrations in canned fish in Southern Iran. They reported that the contents of toxic metals in the Persian Gulf canned tuna fish were below the permissible levels and that the consumption of Iranian canned tuna fish of the Persian Gulf is safe for human health. Ashraf (2006) reported on the levels of Hg, Pb, Cd, Cu, Ni, and Cr in the samples of canned tuna fish in Saudi Arabia. His account of the heavy metals on the canned fish was that the all the heavy metals analysed in the canned fish were low and were in the permissible limit for human consumption. In contrast to Ashraf (2006) study, Thaqafi et al. (2014) showed that heavy and toxic metals were relatively high in canned fish in Saudi Arabia and that these metals levels were above the maximum tolerance levels reported by the food international regulatory standards. Lima de paiva et al. (2017), determined levels of inorganic contaminants in 30 samples of five commercial brands of canned Tuna in Brazil; they found out that 20% of the tuna sampled surpassed the limit of heavy metal concentrations as recommended by Brazilian and European legislation for Cadmium. They noted that four cans of the fish per week could surpass the provisionally tolerable monthly intake for methyl mercury by 100% thereby leading to health issues such as cancer. Similarly, Novakov et al. (2017) determined heavy metals in 57 samples of canned tuna, 25 samples of canned sardines and 16 samples of canned smoked sprouts from Serbia. They reported that some of the samples contained cadmium, arsenic and copper above the limits set by European and Serbian legislations. Al-Mutarri (2015), estimated some heavy metals (Fe, Cu, Zn, Ni, Cd, Cr and Pb) in canned tuna found in the local market of Hilla city in Iraq and reported that only Fe was above the limits. In another study of heavy metals in canned tuna in India by Balakrishnan et al. (2012), they found that the levels of aluminium, cadmium, lead and mercury from the canned tuna fish samples were above legal limits which could potentially lead to health issues such as cancer.

Conclusion

There is no conclusive research or report from the literature that demonstrates canned fish consumption is the reason for the increase in cancer cases in developing nations. The majority of reports stated that the canned fish was safe for human consumption, contained low levels of heavy metals, and fell within allowable limits. The trophic pattern of fish, heavy metal contamination of fish during handling and processing, particularly during soldering of packaging cans, quality and shelf life of canned fish, and water quality of fish habitat (especially with high levels of heavy metals) are some of the factors that can cause an elevated rise in the heavy metals concentrations of the canned fish.

The high levels of heavy metals found in some canned fish may also be related to factors like the pH of the canned fish, the amount of oxygen in the headspace, the coating's quality, the storage location, and the storage period. Prior analysis of a fish's heavy metal concentrations is advised before the fish is used for canning. The levels of heavy metals that might be present in canned fish as a result of commercial handling, processing, and canning of the fish should also be routinely monitored.

All of these will help determine the safety of the canned fish, provide guidance regarding any negative health risks related to its consumption, and allay consumer concerns about cancer from canned fish consumption.

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Author Contribution

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