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EVALUATING CONCENTRATION OF MERCURY RESIDUES IN CANNED TUNA

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Abstract: **Tuna fish has been consumed widely all around the world. Mercury poisoning threat is so high that some countries measure the mercury residues of the environment and foods continuously or intermittently. The aim of the present study was to search and review the findings from the scientific published literature studies focusing on concentration of mercury residues in commercial canned tuna. The results of the data search, remaining 12 articles were suitable in this review. Concentration of mercury residues in canned tuna were determined in this study using Atomic Absorption Spectroscopy (AAS), Inductively Coupled Plasma Emission Spectrometer, or Direct Mercury Analyzer (DMA-80). A large proportion of commercial canned tuna samples from different countries were analysed and found to have mercury residues that were within the acceptable range. Measuring the concentration of mercury residues is essential based on public health aspect. According to EU announcement, the safe level of mercury in fish is 1 mg/kg. The US Environmental Protection Agency has set 0.5 mg/kg for mercury. Based on Provisional Tolerance Weekly Intake set by JECFA (Joint FAO/WHO), PTWI is 0.5 mg/ kg for mercury.**

Keywords: **Concentration, heavy metals, mercury residues, canned tuna.**

I. INTRODUCTION

Canned products are characterized by a long shelf life, do not need to be kept at low temperature, and do not require special treatment during transport or distribution.[1] The name "canned food" means the food product enclosed in metal cans, glass jars, or plastic containers, the long shelf life of which is ensured through the process of pasteurization and airtightness of the packaging, providing protection against the access of air and contaminants.[2] Water chemistry, duration of exposure of fish to contaminants in water, concentrations of contaminants in water, feeding habit of fish, contamination of fish during handling and processing, quality of canned fish and shelf life of canned fish can affect in the level of contaminants in fish. Canned food products, in spite of their taste and nutritive values, can also contain contaminant influenced by the pH of the canned product, oxygen concentration in the headspace, the quality of the lacquer coatings of canned products, quality of coating and also storage place.[3,4] Among the numerous contaminants, heavy metals pose a serious threat to human health [41GS_6 Many elements (heavy metals) that are present in seafood are essential for human life at low concentrations, other elements such as Arsen (As), Cadmium (Cd), Chromium (Cr), Mercuy (Hg), and Lead (Pb) have no known essential function in biological systems and are toxic even at low concentrations.[5,6]

Mercury (Hg) is one of natural heavy metals that could cause food-borne toxicities by contaminating different nutritional levels. This element is also an environmental pollutant due to the stability and the ability to accumulate in biologic tissues. Mercury is found in natural sources such as soil erosion and volcano eruption and human activities such as electricity generation, steelmaking, fossil fuels and residue discard play roles in releasing this element to the environment. Mercury usually released into the environment in the form of inorganic and some aquatic microorganisms cause mercury methylation and change its form to the organic one, methyl mercury. Mercury attaches to thiol group of the cysteine available in proteins of various fish body parts and this causes not getting destroyed even after preparation and cook. Eating contaminated fish is the most important cause of mercury poisoning according to the US Environmental Protection Agency report.[7,8]

The aim of the present study was to search and review the findings from the scientific published literature studies focusing on concentration of mercury residues in commercial canned tuna.

II. MATERIALS AND METHODS

Search strategy. The data used in this research is secondary data obtained not from direct observation, but obtained from the results of research that has been conducted by researchers earlier. A comprehensive literature search conducted during June 2023 to December 2023 in the form of national and international articles using the database such as PubMed, (https://www.ncbi.nlm.nih.gov/pubmed/advanced), Web Science, and Google Scholar. Search words/ MESH terms used in PubMed, Web science and Google Scholar can be listed as Search (concentration) OR (heavy metals) OR (mercury residues) OR (canned tuna).

Articles identified were exported and duplicate articles were subsequently removed. The titles and abstracts of all articles identified independently were reviewed, and studies that did not meet our inclusion criteria were excluded. The information was taken from each study using a collection form that consisted of author, the publication year, title, method, and results.The full texts of the remaining articles were then reviewed to determine whether these articles still met the inclusion criteria.

Data extraction and synthesis of the results. Inclusion criteria in the present study were (i) full text available; (ii) report of concentration of mercury residues in commercial canned tuna; (iii) published full article or abstract; (iv) original (experimental new data) research; and (v) published between 2019 and 2023. To avoid any mistake in the translation process and for the clarity of the reports, only those articles published in the ''English language'' were included. Some of the unpublished citations such as reports from federal agencies, foundations, and research institutes and proceedings of relevant conferences were not included because of the lack of peer review.

Data from each study included the year of study and publication; total sample size; number of positive samples (samples in which mercury residues was detected); mean, standard deviation, and range of the mercury residues concentration; and method of mercury concentration detection.

This literature review is synthesized using the narrative method, did not use any other additional analysis techniques. The author only summarized the results in the literature then analyzed descriptively with a description in the form of a narrative explanation.

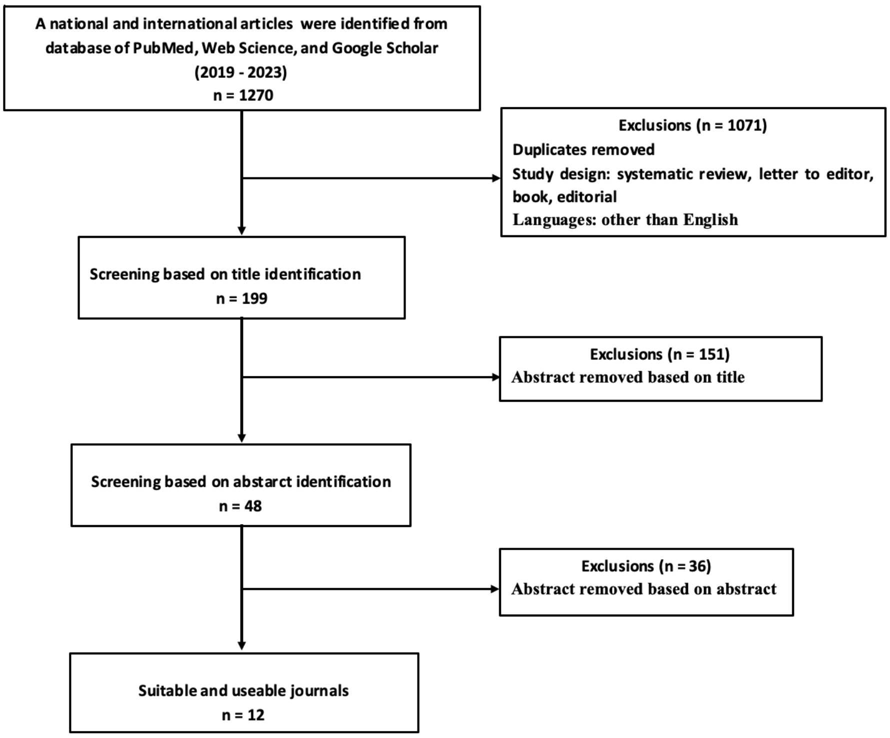

Figure 1. Flow diagram of the search and selection articles process

III. RESULTS

The results of the data search, identified 1270 relevant studies through the database that was previously mentioned using keywords and filters. A 1071 full text articles excluded after the duplicated study, study design and language analysis. A 151 articles excluded after the screening title, therefore 48 articles assess for eligility. In the final stage of the eligibility assessment, 36 articles were excluded and the remaining 12 studies were suitable in this review.

Table 1. The main characteristics of included studies

No.	Author	Year of Publication	Journal, Volume	Title
1	Rodriguez-Mendivil, D.D; Enrique Garcia-Flores, E.; Juan Temores-Pena, J.; and Wakida, F.T.	2019	Health Scope. 2019 May; 8(2):e78956. doi: 10.5812/jhealthscope.78956	Health Risk Assessment of Some Heavy Metals from Canned Tuna and Fish in Tijuana, Mexico
2	Pacoma, A.U and Yap-Dejeto, L.G.	2019	Science Diliman (July-December 2019) 31:2, 82-88	Health Risk Assessment: Total Mercury in Canned Tuna and in Yellowfin and Frigate Tuna Caught from Leyte Gulf and Philippine Sea
3	Dalia Mohamed Shawky El-Dahman, Mohamed Ahmed Hassan, and Nesreen Zakrya Eleiwa	2019	Benha Veterinary Medical Journal, Vol. 36, No. 2:49-56, June, 2019	Assessment of Heavy Metal Residues in Some Fishery Products
4	Pawlaczyk, A.; Przerywacz, A.; Gajek, M; Szynkowska-Jozwik, M.I.	2020	Molecules 2020, 25, 5884; doi:10.3390/molecules25245884	Risk of Mercury Ingestion from Canned Fish in Poland
5	Kowalska, G.; Pankiewicz, U.; and Kowalski, R.	2020	Journal of Analytical Methods in Chemistry Volume 2020, Article ID 2148794, 13 pages https://doi.org/10.1155/2020/2148794	Determination of the Level of Selected Elements in Canned Tuna and Fish and Risk Assessment for Consumer Health
6	Sharkawy, A.A; El-Sayed, A.M; and ALI, M.A.M	2020	Assiut Vet. Med. J. Vol. 66 No. 165 April 2020, 1-20	Heavy Metals Content in Canned Tuna Fish Marketed in Assiut City, Egypt and Its Related Human Health Risk Assessment
7	Djedjibegovic, J.; Marjanovic, A.; Tahirovic, D.; Caklovica, K.; Turalic, A.; Lugusic, A.; Omeragic, E.; Sober, M. and Caklovica, F.	2020	Scientific Reports | (2020) 10:13238 https://doi.org/10.1038/s41598-020-70205-9	Heavy metals in commercial fish and seafood products and risk assessment in adult population in Bosnia and Herzegovina
8	Morshdy, A.E.M.A; Hussein, M.A.M; Darwish, W.S; Yousef; R.E, Tharwat, A.E	2021	Slov Vet Res 2021; 58 (Suppl 24): 101–7 DOI 10.26873/SVR-1431-2021	Residual Content of Selected Heavy Metals In Commercial Canned Fish In Egypt: Dietary Intakes and Human Health Risk Assessment
9	Saad, S.M; Nada, S.M; Nada, M.F	2021	Benha Veterinary Medical Journal 40 (2021) 33-37	Control of some heavy metals contaminating fish products
10	Aboglida, E.E; Samhoud, F.M; Elbeskri, A.M; Ahmed, M.A	2022	International Science and Technology Journal, Volume 29, April 2022	Determination of mercury concentration in canned tuna fish at Libyan market
11	Nava, V.; Di Bella, G.; Fazio, F.; Potortì, A.G; Lo Turco, V.; and Licata, P	2023	Applied Science 2023, 13, 793. https://doi.org/10.3390/app13020793	Hg Content in EU and Non-EU Processed Meat and Fish Foods
12	Nagy, N.; Kirrella, G.A.K; Moustafa, N.Y; Abdallah, R.	2023	Journal of Advanced Veterinary Research (2023) Volume 13, Issue 3, 377-383	Quality Assessment of Some Imported and Local Canned Tuna Sold in Kafrelsheikh, Egypt

Rodriguez-Mendivil, et al., (2019) carried out a study analyzing canned tuna to assess the health risk related to consumption of canned tuna by evaluating chromium (Cr), cadmium (Cd), mercury (Hg), and lead (Pb) concentrations. Fortyeight samples (six samples from eight different brands of canned tuna) were collected during 2016 in different commercial establishments in Tijuana, Mexico, using simple random sampling. Mercury was measured using the cold vapor atomic absorption spectrometry (CVAAS) method (United States Environmental Protection Agency (USEPA) method 7419b. The wet weight heavy metal concentrations in the canned tuna for Hg were 0.005 to 1.17 mg/ kg. The results suggest that the consumption of canned tuna and fish in Tijuana does not represent a health risk for the general population in terms of exposure.[9]

Mercury residues in two brands of canned tuna that are commercially and widely available in Tacloban City contamination was evaluated by Pacoma and Yap-Dejeto (2019) using modified set of criteria by Maqbool et al. (2016). In this study, all canned tuna were found to contain traces of mercury. Canned tuna samples of both brands had an average concentration of 0.07 mg/ kg. The presence of elevated mercury in food increases probable health risks and may have profound impacts on the body.[10, 11]

To estimate the levels of mercury in fishery products, twenty five random samples of canned tuna were collected randomly from different fish markets in Kafr El-Sheikh and Gharbia governorates, Egypt. All collected samples were analyzed by Atomic Absorption Spectrophotometer for estimation of their heavy metals concentrations (mercury). The obtained results revealed that the mean values of mercury 1.03 ± 0.02 in canned tuna. The majority of the examined canned tuna exceeded the safe permissible limits recommended by EOS (2010) for mercury. El Dahman et. al (2019) concluded that the examined samples of canned tuna were significantly polluted with high levels of toxic metals (mercury) which seriously distress human health.[12]

Pawlaczyk, A et.al (2020) carried out a study to determined total mercury in 57 canned tuna which were purchased from local markets in Poland in the years 2019–2020. The analyses were carried out using the cold vapor AAS technique. The obtained results were compared against domestic and international standards as well as with the literature data in order to evaluate the safety of the canned fish consumption. The study revealed that none of canned fish exceeded the acceptable levels set by the FAO/WHO. The highest amount of Hg was recorded for canned tuna (maximum 0.351 mg/kg, mean 0.797 mg/kg.[13]

Kowalska et.al (2020) conducted a study to determine the content of cobalt, silver, tin, antimony, lead, mercury, cadmium, arsenic, vanadium, chromium, manganese, nickel, and uranium in canned meat and canned fish by means of ICP-MS apparatus and mercury analyzer. The research material consisted of 9 assortments from 3 kinds canned tuna fish purchased from the hypermarket in Lublin. It was found the mean and deviasi for 3 kind of canned tuna (Tuna *Katsuwonus pelamis* in sauce, Tuna in oil and Tuna *Thunnus albacares* in sauce) 0.061 ± 0.009, 0.036 ± 0.001, and 0.078 ± 0.011, respectively.[14]

Forty canned tuna samples from five brands were examined to determine their metal concentration. The samples were collected from supermarkets found in Assiut city (Egypt) from June 2017 to November 2017. The metals were determined using Inductively Coupled Plasma Emission Spectrometer (iCAP 6200) . From these studied, Sharkawy et.al (2020) was found the mean and standard deviasi for mercury concentration in canned tuna 1.301 ± 7.035 mg/kg. The results indicate that the examined canned tuna were polluted with mercury. Hazard indices for the estimated metals in these canned tuna imply that excessive and continuous intake of these tuna could result in chronic adverse health effects on the consumers. However, consumption of large quantities of these canned tuna increases human exposure to the risk especially of Hg toxicity. It recommended that more studies for assessment for quality control should be done to help safeguard the health consumers.[15]

Djedjibegovic et.al (2020) investigates the level of exposure to cadmium (Cd), mercury (Hg), and lead (Pb) via fish and seafood products in adult population in Bosnia and Herzegovina. Metals content was determined in seven commercial species of fish and seafood products widely available and consumed in BiH. Analysis of mercury was performed by flow injection cold vapour atomic absorption spectrometry (FIAS AAS). It was found the mean and standard deviasi for mercury concentration from seven samples bluefin canned tuna 0.062 ± 0.028 mg/ kg. There is no canned tuna samples was found above the maximum residue level (MRL) set in the European Union (1mg/ kg).[16]

The study was conducted by Morshdy et.al (2021) to estimate the residual contents of heavy metals, namely mercury (Hg) in four kinds of commercially purchased canned tuna from Zag-azig city, Egypt. Twenty imported samples were analyzed by Atomic Absorption Spectrophotometer. The obtained results revealed residual mercury mean and standar deviation of canned tuna 0.030 ± 0.010 mg/ kg. There is no canned tuna samples was found higher than the established maximum permissible limits (MPL) by European Union (1mg/ kg).[17]

Twenty five random samples of canned tuna obtained from different localities in Menoufia governorate, Egypt and estimated for their harmful residues such as mercury. Saad et.al (2021) determined the mercury residues concentration using Flame Atomic Absorption Spectrophotometer. They were found that the average values of mercury in the investigated samples of canned tuna were 0.65 ± 0.01mg/kg. According to EOS (2010) which stated that the maximal limits permitted for mercury is 0.5 mg/kg in fish. The obtained results allow to conclude that most of fish products exposed for consumption were contaminated with chemical residues such as mercury.[18]

Aboglida et.al (2022) was conducted a study to determine a mercury concentration in canned tuna fish at Libyan market. During the year of 2017, about twenty five types of canned tuna from imported and local brands were used for this study (with 3 replicates for each type), collected from different supermarkets found. Concentration of mercury was analyzed by cold vapor atomic absorption spectrophotometer using the Direct Mercury Analyzer (DMA). Mercury (Hg) concentration in canned fish brands (n=25) ranged between 0.087 - 7.542 mg/kg. Some of the samples had Mercury content higher than the acceptable limits. Therefore, comprehensive and intermittent monitoring of heavy metals in canned fish is needed to assess the safety of these products with respect to human health.[19]

Nava et.al (2023) was conducted a study to determine the mercury concentration using a direct mercury analyzer (DMA-80), a rapid technique that permitted a direct analysis of processed foods investigated in processed food products. Seventeen samples of canned tuna of EU and non-EU origin purchased in supermarkets and ethnic food shops in Messina (Italy). The results obtained were ranged between 0.009 - 0.290 mg/kg. DMA-80 analysis was shown as a convenient, fast, and reliable method for measuring mercury. The results showed all samples were within European legislative limits.[20]

Mercury concentration was evaluated and compared between some local and imported canned tuna products by Nagy et.al (2023). A total of 36 samples of imported and local canned tuna (18 for each divided into chunk and shredded tuna) were randomly collected from different shops and markets in Kafr El Sheikh Governorate, Egypt. Mercury concentration was measured using the atomic absorption spectrophotometer. All examined imported tuna samples (mean ± SD was 0.3 ± 0.26 and 0.4 ± 0.26 mg/100 g for imported chunk and shredded samples, respectively)within the permissible limit according to CIFA, (1992); EC, (2005); ES, (2010) which stated that Mercury level should not be more than 0.5 mg/kg. In contrast the examined local tuna samples exceeded the permissible limit. The results showed that the mean ± SD was 0.5 ± 0.3 and 0.62 ± 0.3 mg/100 g for local chunk and shredded samples, respectively. No significant difference between all examined samples. The higher mercury values in local canned tuna may be attributed to the geographical area from which tuna fish is obtained.[21, 22]

Table 2. Comparison of mercury residues concentration in commercial canned tuna

Study Yr	Published Yr	Samples			Method	Mercury (Hg) mg/ kg			Standard	Ref.
		Samples origin	Kind of Tuna	Number of Samples		Mean	SD	Range		
2018	2019	Canned tuna in water collected in different commercial establishments in Tijuana, Mexico	-	48	Atomic Absorption Spectroscopy (AAS)	0.344	0.456	0.005 – 1.17	1.0 mg/kg (Mexican Standard)	9
2018	2019	Canned tuna that are commercially in Tacloban City	-	2	Inductively Coupled Plasma Optical Emission Spectrometer	0.07	-	-	-	10
2019	2019	Canned tuna from different fish markets in Kafr El-Sheikh and Gharbia governorates, Egypt	-	25	Atomic Absorption Spectroscopy (AAS)	1.03	0.02	0.37 - 1.78	0.5 mg/ kg (EOS, 2010)	12
2019	2020	Canned tuna purchased from local markets in Poland	-	57	Atomic Absorption Spectroscopy (AAS)	0.797	0.719	0.113 – 0.351	0.5 – 1 mg/ kg	13
2020	2020	Canned tuna purchased from the hypermarket in Lublin (year of production 2017)	– Tuna (*Katsuwonus pelamis*) in sauce – Tuna in oil Tuna (*Thunnus albacares*) in sauce	3 3 3	Non-flame Atomic Spectrometry Absorption Technique	0.06180 0.03690 0.07840	0.00910 0.0014 0.0117			14
2020	2020	Canned tuna samples from five brands collected from supermarkets found in Assiut city (Egypt)	– *Katsuwonus Pelamis* – *S. palmitus* – *S. ponticus* – *S.mediterraneus and* – *Thynnus brachypterus Coryphaena hippurus*	40	Inductively Coupled Plasma Emission Spectrometer, iCAP 6200	4.652	0,413	1.301 – 7.035	0.5 mg/ kg (CIFA, 1992)	15
2020	2020	Atlantic canned bluefin tuna from Thailand	Bluefin tuna	7	Flow Injection Cold Vapour Atomic Absorption Spectrometry (FIAS AAS)	0.062	0.028	0.037 – 0.116	1 mg/ kg (EU)	16
2020	2021	Canned tuna collected randomly and equally from grocery stores and hyper-markets in Zagazig city, Sharkia Governorate, Egypt	-	20	Atomic Absorption Spectroscopy (AAS)	0.03	0.01	-		17
2021	2021	Random samples of canned tuna from different localities in Menoufia governorate, Egypt	-	25	Flame Atomic Absorption Spectrophoto meter	0.65	0.01	0.11 – 1.25	0.5 mg/ kg (EOS, 2010)	18
2017	2022	Canned tuna from imported and local brands sold of markets in Libya	-	25	Atomic Absorption Spectroscopy (AAS)	1.002	1.514	0.052 - 7.543	0.5 mg/ kg (FAO/ WHO)	19
2022	2023	Canned tuna purchased in supermarkets and ethnic food shops in Messina	– Canned tuna in olive oil (*Katsuwonus pelamis*) – Canned tuna in olive oil (*Thynnus albacares)* – Canned natural tuna (*Thynnus albacares)* – Canned tuna in olive oil (*Katsuwonus pelamis*) – Canned natural tuna (*Thynnus albacares)* Canned tuna pate (*Katsuwonus pelamis*)	17	Direct Mercury Analyzer (DMA-80)	0.25092 0.29021 0.00925 0.07011 0.05082 0.02065	0.00368 0.00464 0.00085 0.00422 0.00358 0.00352	0.009 –0.290		20
2021-2022	2023	Imported and local canned tuna (18 for each divided into chunk and shredded tuna) were randomly collected from different shops and markets in Kafr El Sheikh Governorate, Egypt	– Imported chunk canned tuna – Imported shredded canned tuna – Local chunk canned tuna – Local shredded canned tuna	36	Atomic Absorption Spectroscopy (AAS)	0.030 0.040 0.050 0.062	0.026 0.026 0.030 0.030		0.5 mg/ kg (CIFA, 1992; EC, 2005; ES, 2010)	21

IV. DISCUSSION

Heavy metals are considered as serious pollutants to aquatic ecosystems due to their long-term persistence, toxicity, bioaccumulation, and biomagnification along the water, sediments and aquatic food chain.[12, 23] The high levels of heavy metals in the environment can be accumulated in the animal and human tissues because these metals are poorly degraded either in the environment or inside the tissues. Fish are good bioindicator for detection of contamination by heavy metals in the aquatic system. Fish can easily absorb the pollutants especially metals from the polluted water, feed and bioaccumulate them in their tissues. Fish have the ability to accumulate heavy metals in their tissues by the absorption along the gill surface and gut tract wall and also the intake of contaminated food or drinking water as the main resources can cause enter the heavy metals into the fish body. Accumulation of heavy metals varies greatly between fish species and fish tissues.[3, 4, 15, 24]

Fish and fish products compsumption is recommended among the food products of animal origin in their nutritive value (as source of high value protein, lipid, vitamins and essential fatty acids as well as Omega-3 fatty acids), which have many health benefits, lowering obesity, weight gain, body mass index, insuline resistance and type 2 diabetes mellitus, inflammatory bowel diseases, and maintain harmony gut microbiota balance.[12, 25] Contamination of fish during handling and processing, quality of canned fish and shelf life of canned fish can affect in the level of contaminants in fish. The heavy metal levels in canned fishes is influenced by the pH of the canned product, oxygen concentration in the headspace, the quality of the lacquer coatings of canned products, quality of coating and also storage place. Generally, fish could translocate the large quantities of toxic heavy metals in the liver, gill, and also muscle tissues. In liver, toxic heavy metals leads to defects in cellular uptake mechanism in the mammalian liver and kidney and inhibit hepatic and renal sulfate/ bicarbonate transporter through various mechanisms, leading to sulfaturia following heavy metal intoxication. Contaminants in fish can pose a health risk to the fish themselves, to their predators, and to humans who consume them. Furthermore freezing or heat treatment of fish for long period of time cannot destroy the heavy metals. Thus, there is great risk associated with consumption of the frozen fish.[3, 4, 12, 26]

The main threats to human health from heavy metals are associated with exposure to mercury, cadmium and lead, due to their known toxicity to human being, even at low concentrations when ingested over a long period.[12, 27] Mercury occurs in the environment in various forms: elemental, inorganic, and organic. They are all toxic but differ in their level of toxicity. The degree of toxicity depends mainly on how the form is absorbed and how it is biotransformed to other mercury forms. The routes of exposure include: inhalation, ingestion (e.g., by food or water), or absorption through skin. In addition to the type of mercury being absorbed, the route and duration of exposure, the dose and the age or the developmental stage of the person exposed play a crucial role in the observed health effects.[13, 28, 29] Mercury can accumulate in human body through eating of fish and other marine organisms. Mercury is one of the most toxic elements has neurotoxic effect. Minamata disease is sometimes referred to as Chisso - Minamata disease. It is a neurological syndrome caused by severe mercury poisoning. The cause of this disease was the release of methyl mercury in industrial wastewater, this highly toxic chemical bioaccumulated in shellfish and fish in MinamataBay in japan which when eaten by the local population resulted in mercury poisoning. Mercury could easily pass through the placenta causing lesions in the nervous system, behavioral disorders, growth retardation of the embryo and so forth. Methyl mercury poisoning in adults could impose toxic effects by effecting on cardiovascular system. The signs of this poisoning in adults may include ataxia, confusion, unconsciousness and death.[12, 30, 31]

Tuna is characterized with high metabolic rate, high food intake and high accumulation capacity for metallic pollutants. Tuna is one of the most consumed fish all over the world. Canned tuna have been found to contain increasingly high amounts of mercury, lead and cadmium as well as some other heavy metals. The accumulation in large fish species is so high that several studies indicated the relationship between the increasing level of tuna fish consumption and high concentration of methyl mercury in the blood.[7, 32]

Many instrumental analytical methods may be employed to measure the concentration level of heavy metals in various samples. The most predominant techniques are atomic absorption spectrometry (AAS), atomic emission/fluorescence spectrometry (AES/AFS), inductively coupled plasma mass spectrometry (ICP-MS), inductively coupled plasma optical emission spectrometry (ICP-OES), X-ray fluorescence (XRF) and anodic striping voltammetry (AVS).[33,34]

Measuring the mercury concentration is essential based on public health aspect. According to EU announcement, the safe level of mercury in fish is 1 ppm. The US Environmental Protection Agency has set 0.5 ppm and 0.7 μg/kg as traces for mercury and methyl mercury, respectively. Based on Provisional Tolerance Weekly Intake set by JECFA (Joint FAO/WHO), PTWI is 5 for mercury and 1.6 μg/kg b.w. for methyl mercury. Mercury poisoning threat is so high that some countries measure the mercury content of the environment and foods continuously or intermittently. The USA analyzed the mercury content of canned tuna in 1998-2003 period and announced that its content has been increased a little since 1991 but it is still less than the trace announced by the FDA (1 ppm).[7]

V. CONCLUSION AND SUGGESTIONS

A. Conclusion

The results of the data search, remaining 12 articles were suitable in this review. The mercury residues concentration in canned tuna were analyzed using Atomic Absorption Spectroscopy (AAS) method, Inductively Coupled Plasma Emission Spectrometer method, or Direct Mercury Analyzer (DMA-80) method. A large propotion of commercial canned tuna samples from different countries were found to have mercury residues that were within the acceptable range. According to EU announcement, the safe level of mercury in fish is 1 ppm. The US Environmental Protection Agency has set 0.5 ppm and 0.7 µg/kg as traces for mercury and methyl mercury, respectively. Based on Provisional Tolerance Weekly Intake set by JECFA (Joint FAO/WHO), PTWI is 5 µg/kg b.w for mercury.

B. Suggestion

For future researchers, it is hoped that the results of this review will be data resources and research references related to evaluating concentration of mercury residues in canned tuna.

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