Journal of Chemical Health Risks

www.jchr.org

ORIGINAL ARTICLE

Determination of the amount of Heavy Metals in the Most Widely Used Brands of Canned Fish in Kashan During 2018, Iran

Rouhullah Dehghani[1], Gholamreza Mostafaeii[1], Hossein Akbari[2], Mohammad Sadegh Pour Abbasi[3], Fatemeh Asadi[1], Maryam Rezaei[1], Zakieh Kashani[1], Maryam Hoseini[1], Seyed Mahdi Takhtfiroozeh[*1]

[1]*Social Determinants of Health (SDH) Research Center and Department of Environment Health, Kashan University of Medical Sciences, Kashan, Iran*

[2]*Department of Biostatistics and Public Health, Faculty of Health Kashan University of Medical Sciences, Kashan, Iran*

[3]*Assistant professor of Cardiovascular Surgery Kashan University of Medical sciences, Kashan, Iran*

(Received: 25 February 2020 Accepted: 28 September 2021)

KEYWORDS

Food contamination;
Food preservation;
Analysis;
Sea food;
Tuna

ABSTRACT: Due to the impacts of heavy metals on human health and the top rank of these elements on marine products such as canned fish, this study aimed to determine the heavy metals of the most widely used brands of canned fish on the market of Iran. In this study, referring to the 25 major distribution centers of canned goods such as canned fishing, 10 brands of the most widely consumed brands of available canned tunas that produced in 2018, were sampled in two series of production. 10 g of homogenized samples was dried by the hot plate and 10 ml of concentrated nitric acid was added. Then, it was injected into the ICP - AES. For data analysis, ANOVA and Kruskal-Wallis tests were used to compare brands, also, one sample T-test was used to compare heavy metals of each brand. Our study showed that the average lead concentrations obtained was above the standard limit is 86.7 percent of samples. According to World Health Organization standard limits, the tin content was less than standard level in all brand sin the study. Cadmium concentration was in the standard limit in 96.7 percent of samples. The results showed that canned fish of Kashan market production have the most lead among brands. Measured values are higher than standard lead level, also with enhanced monitoring and the use of appropriate coverage in conserve cans or using non-soldered cans, decreased levels of metals such as lead and tin.

INTRODUCTION

Food contamination may be due to various substances, including residues of pesticides [1, 2], pathogenic organisms [3-5], insect larvae and other arthropods [6-10]. If the primary sources of production, chemical materials such as pesticides and fertilizers were used, there was a risk of these contaminants in canned food [11-15].One of the main resources of heavy metals are volcanic rocks and dust deposits. Human himself can be involved in the release of heavy metals in the environment in various forms such as applications in the textile industry, metal plating and battery [7, 16].If the rate of heavy metals entry into the body is more than required, it will cause poisoning [17], generally, heavy metals in the environment are considered a potential risk for living organisms [18-25]. Most important components of the body including enzymes and protein shave such groups, as a result, heavy metals cause interruption and of enzyme activity and disrupt the synthesis of essential components of the body [26, 27].

[*]Corresponding author: smtfwho@yahoo.com (S. M. Takhtfiroozeh)
DOI: 10.22034/jchr.2021.1894292.1105

Entry and presence of these agents in the environment, particularly aquatic environment in the long term, lead to reduced reproduction capacity of fisheries, respiratory and neurological problems, etc., in addition, due to its accumulation in fish body (bioaccumulation) and transfer them to consumers in next ring of the food chain, including humans, can cause irreversible complications [28].

Lead, cadmium and tin are of the most important heavy metals; lead is a metal that the absorption of which more than the threshold, cause metabolic and toxicity complications; its first symptoms include fatigue, disturbing the situation of sleeping and constipation [29]. According to FAO recommendation, the maximum permissible level of lead in fish muscle is 0.5 mg per kg [30]; exceeding the stated limit results in the peripheral and central nervous system disorders, kidney tumor, increased risk of blood pressure and cardiovascular disease for adults. [31, 32]. Cd is of the few elements that has no constructive role in the human body and causes toxicity even in very low levels, and iron deficiency [33-39].The most important adverse effects of cadmium exposure is Itai-itai disease, destruction of kidney and some other tissues of the body, rickets, and reproductive disorders [40, 41]. In foods kept inside cans, some tin may exist, the high levels of which cause corrosion and the loss of conserved container. The important source of tin metal contamination in canned foods, is painting canned containers [42-48].

Contaminations of lead and tin used in packaging and conserve cans, in case of consumption and continuity, accumulate in the body and cause acute and chronic poisoning, meanwhile children are crucial importance, since 10% of lead entered into the body will be absorbed; this amount reaches 50% in children. [49, 50].Several studies have been conducted around the world on the amount of heavy metals found in fish; the study of authors on marine fish of the Bay of Bengal can be mentioned. They showed that among various species of fish, heavy metals concentrations are also significantly different [51].The levels of some metals like cadmium in fish and its products were studied in Japan, the results of which have shown this contamination levels higher than the allowable limits in some species[52]. In the study by authors, the metals lead and cadmium levels were lower than the standard MAFF (Ministry for Agriculture, Fisheries and Food), and tin level is lower than the standard of Brazil [53]. In Iran, authors found that concentrations of heavy metals such as lead, tin, mercury and nickel in Tabriz market canned tuna were lower than the average standard level or at the level of standards [54].Also, based on study, tin level in 24% of samples, lead level in 5% and cadmium content in 2% of samples, were measured higher than the defined standard limit, which can jeopardize consumers' health [48].

With the growing pollution of marine ecosystems with heavy metals, the problems of quality issues with these valuable source of food has intensified [25, 28, 33, 55, 56].Thus, according to the possible harmful impacts of heavy metals in fish and willingness of people to use it, our research group intended to assess the heavy metals contents in common brands of canned fish in the market of Kashan city.

MATERIALS AND METHODS

In this cross-sectional descriptive study, referring to the 25 major distribution centers of canned goods such as canned fish in Kashan, in 2018 year, 10 most widely used brands of canned fish available which have been manufactured in 2018, were produced in two series with three replications, all canned samples were selected at least 6 months before the expiry date, after opening the cans, homogenization operation was carried out by stirring. Then, 10 grams of homogeneous samples was weighed by the digital scale and was placed on a hot plate for 24 hours at 120 degrees for drying. The dried samples became powder by a mortar and 0.6 grams of powdered samples [57] were transferred into 25 mL beaker.10 ml concentrated nitric acid was added to the beakers containing the samples , then the beakers were placed on the hot heater at 120°C for 2 hours and were heated until reaching a transparent solution. The transparent sample were transferred into the flask after passing through a filter paper, using double distilled water was reached to the required volume and was injected into the ICP – AES (Inductively Coupled Plasma-Atomic Emission

Spectrometers) device. To analyze the data, first the amount of heavy metals were specified in the form of mean and standard deviation for each brand, then Analysis of Variance (ANOVA) and Kruskal-Wallis tests were used to compare brands, as well as the single sample T test was used for comparison of heavy metals of each brand with the standard, and then was compared with standard values for cadmium, tin, and lead metals, which are respectively, 0.1, 250and 0.5 mg per kg.

RESULTS

Our study showed that the average level of lead in samples of tuna was between 0.98 ± 0.41 mg per kg. The lead level of the total first batch was 1.2 ± 0.28, 0.76 ± 0.415 in the second total batch, 0.98 ± 0.267in all samples. The least amount of lead in the second series of production of No.3 tuna concentration was 0.21 ± 0.23.The highest concentration of lead in the first production series of No.5 tuna was 1.53 ± 0.157. Table 1 shows that in tuna samples of No.10 and No.6, there was a significant difference in terms of lead ($P < 0.05$).

Table 1. Mean concentration of lead in canned fish in terms of brand and series of production (milligrams per kilogram).

Brand No.	First production series	Second production series	Total	P_{value}
	X±SD	X± SD	X± SD	
1	1.14±0.072	1.19±0.24	1.16±0.0879	0.804
2	0.94±0.172	0.55±0.07	0.748±0.097	0.062
3	1.28±0.361	0.21±0.23	0.748±0.183	0.062
4	1.42±0.35	1±0.37	1.21±0.118	0.4
5	1.53±0.157	0.796±0.754	1.163±0.437	0.19
6	0.946±0.24	0.7±0.253	0.826±0.244	0.027
7	1±0.112	0.5±0.458	0.75±0.285	0.128
8	0.99±0.093	0.83±0.208	0.91±0.058	0.454
9	1.32±0.23	0.63±0.288	0.98±0.049	0.144
10	1.44±0.11	1.18±0.04	1.31±0.075	0.023
Total	1.2±0.28	0.76±0.415	0.98±0.267	

The average tin content in samples of tuna was between 1.98 ± 8.66 mg per kg. The average tin in total samples of the first series of production was 3.82 ± 12.06, 0.147 ± 0.5 in the second series of production, and 1.98 ± 6.02 in all samples, which the amount of tin in the first and second batches of fishtunasNo.2, No.6, No.7, No.8, No.9 and No.10 with the concentration of zero. The highest tin content in the first production series of No.5tuna was 1.01 ± 1.75. There was no significant difference in samples of tuna in terms of tin level.

Table 2. Average level of tin in canned fish in terms of brand and series of production (milligrams per kilogram).

Brand No.	First production series	Second production series	Total	P_{value}
	X± SD	X± SD	X± SD	
1	0±0	0.58±0.33	0.29±0.165	0.093
3	0.026±0.046	0.033±0.057	0.03±0.026	0.91
4	37.19±15.83	0±0	18.59±7.91	0.055
5	1.01±1.75	0.86±1.49	0.935±1.62	0.423
Total	3.82±12.06	0.147±0.5	1.98±6.02	

The average cadmium rate in samples of tuna was between 0.007 ± 0.03 mg per kg. The average cadmium in total samples of the first batch was zero, 0.0147 ± 0.0429 in the second batch of samples, and 0.0073 ± 0.0214 in the total samples. The lowest cadmium in the first and second production series of tunas, No.4, No.6, No.7, No.9 and No.10 was zero. The highest amount of cadmium in the first batch of No.5 tuna concentration was 0.3 ± 0.052.There was no significant difference in samples of tuna in terms of the amount of cadmium (Table 3).

Table 3. Average amount of cadmium in canned fish in terms of brand and series of production.

Brand No.	First production series	Second production series	Total	P_{value}
	X± SD	X± SD	X± SD	
1	0±0	0.3±0.052	0.015±0.026	0.423
2	0±0	0.02±0.034	0.01±0.017	0.423
5	0±0	0.066±0.115	0.033±0.057	0.423
8	0±0	0.03±0.052	0.015±0.026	0.423
Total	0±0	0.0147±0.0429	0.0073±0.0214	

As can be seen in Table 4, the amount of lead in a total 30 samples, exceeded the standard limit in the first batch of fish samples, but only 13.3% of the samples in the second production series are within the standard range, and the rest are higher than standard level. Also it was within the standard range in two samples of No.3 (66.7 percent) one example of No.5 (33.3%) and one sample of No.9 (33.3%) is.

Table 4. Number and percentage of, standard and non-standard lead samples in terms of brand in two production series (milligrams per kilogram).

Brand No.	First production series		Second production series	
	Non-standard	standard	Non-standard	Standard
1	3(100)	-	3(100)	-
2	3(100)	-	3(100)	-
3	3(100)	-	1(33.3)	2(66.7)
4	3(100)	-	3(100)	-
5	3(100)	-	2(66.7)	1(33.3)
6	3(100)	-	3(100)	-
7	3(100)	-	3(100)	-
8	3(100)	-	3(100)	-
9	3(100)	-	2(66.7)	1(33.3)
10	3(100)	-	3(100)	-
Total	30(100)	-	26(86.7)	**4(13.3)**

Table 5 shows that the amount of tin in all 30 cases of canned fish production in both the first and second series in 100% of the samples were in standard limit.

Table 5. Number and percentage of standard and non-standard tin samples by brand in two production series.

Brand No.	First production series		Second production series	
	Non-standard	standard	Non-standard	standard
1	-	3(100)	-	3(100)
2	-	3(100)	-	3(100)
3	-	3(100)	-	3(100)
4	-	3(100)	-	3(100)
5	-	3(100)	-	3(100)
6	-	3(100)	-	3(100)
7	-	3(100)	-	3(100)
8	-	3(100)	-	3(100)
9	-	3(100)	-	3(100)
10	-	3(100)	-	3(100)
Total	-	**30(100)**	-	**30(100)**

The results of the show that the amount of cadmium in all samples of the first production series has been at the standard level, but in the second series, in one sample of No.5 tuna (33.3%), it has been beyond the standard (Table 6).

Table 6. Number and percentage of standard and non-standard cadmium samples by brand in two production series.

Brand No.	First production series		Second production series	
	Non-standard	standard	Non-standard	standard
1	-	3(100)	-	3(100)
2	-	3(100)	-	3(100)
3	-	3(100)	-	3(100)
4	-	3(100)	-	3(100)
5	-	3(100)	**1(33.3)**	2(66.7)
6	-	3(100)	-	3(100)
7	-	3(100)	-	3(100)
8	-	3(100)	-	3(100)
9	-	3(100)	-	3(100)
10	-	3(100)	-	3(100)
Total	-	**30(100)**	**1(3.3)**	**29(96.7)**

Table 7 indicates the comparison of the concentration of heavy metals in canned tuna with the under study heavy metals international standards, as can be seen in the table, the obtained average lead concentration is above the standard. According to World Health Organization standards, the tin level in this study is less than standard and also cadmium concentrations lower than standard.

Table 7. Comparison of the heavy metals concentration in canned tuna with international standards of heavy metals.

Heavy metal international standard (for food)	Pb (mg kg^{-1})	Sn (mg kg^{-1})	Cd(mg kg^{-1})
World Health Organization	0.5	250	0.2
Food and Agriculture Organization	0.3	-	0.5
U.S. Food and Drug Administration	0.3	-	1
Ministry of Agriculture, Fisheries & Food (UK)	0.3	-	0.02
National Health & Medical Research Council (Australia)	-	-	0.05
Institute of Standards and Industrial Research of Iran (129681st. Edition)	0.3	-	0.5
Our study (Min)	0.21	0	0
Our study (Max)	**1.53**	37.19	0.3
Our study (Average)	**0.98**	1.98	0.007

DISCUSSION

In this study, the average amount of lead allowed in the canned fish was measured greater than the threshold, the amount of tin less than standard and cadmium concentrations were also lower than the standard. Increased levels of lead in the body causes lead poisoning (Saturanism), the most important impact of this poisoning is the appearance of blue lines on the gums [58].In this study, based on the results, the mean lead concentration was 0.98 in mg. European Commission Directive 2001 and FAO guidelines declared the allowable level of lead in fish as 0.4 and 0.5mg, respectively. In the study in canned fish in Tanzania they showed that the received dose of heavy metals such as aluminum, cadmium, copper, iron, lead and zinc was lower than permitted by WHO (World Health Organization) and FAO (Food and Agriculture Organization), which is not in agreement with our study [59]. According to studies, proved the high dose levels of lead and chromium in these marine products which is consistent with our study [60]. In the study, the amount of tin metal measured was lower than the standard of Brazil country[53]. Similar studies was conducted in Turkey and in Libya, in 1999 on canned tuna, which the results indicated that these products are free from contamination with heavy metals [61, 62],which these results are inconsistent with the lead measurement by our study; the results difference in the accumulation of heavy metals in canned tuna, may have various causes such as curing process. Authors, showed in their study that although the studied average heavy metals in used fish is lower than the standard, but lead levels were above the maximum allowable standard in 37% of samples which is consistent with our study [63].In this study, the average amount of lead allowed in tuna fish was more than the threshold of international standards, which might be argued that the existence of environmental pollution, which is imported by oil tankers and plants wastewater to the marine environment, and lack of self-purification assessment regulations of area due to the situation and the future development of the industry, have not been taken by the authorities and in cumbents. As mentioned above, based on this study, is the fact that the amounts of heavy metals such as lead, is higher than the standards set for human consumption, in some of these products, and the presence of this metal will follow irreparable risks, especially for children.

CONCLUSIONS

In general, one can conclude that in heavy metal levels difference in canned tuna fish used in Kashan with other provinces of Iran and other countries, there may be several factors such as geographical and environmental conditions, quality of water resources, allowed industries on beach margins, waste disposal regulations, fish species and tissues tested, different laboratory activities and so on. Also with enhanced monitoring and the use of appropriate coverage in conserve cans or using non-soldered cans, decreased levels of metals such as lead and tin [64, 65].

Suggestions

It is recommended that evaluation of these metals in the water and fish breeding farms in comparative terms, can give us proper start working on how to use these water resources or even fish farming in these waters. In addition to carbohydrates, lipids, amino acids and vitamins, some heavy metals are essential for biological activity of cells at the allowed limit. Some metals such as iron, is vital for life and others such as copper and zinc, and lead to a partial amount and in the standard limit, are essential for enzyme activity. With public participation and the promotion of environmental culture, we can take a big step in the process of self-purification process of aquatic environments.

ACKNOWLEDGEMENTS

This article is the result of moral and material support of Vice Chancellor for Research and Technology Department of Kashan University of Medical Sciences. Hereby, the authors appreciate the Vice Chancellor as well as health care and laboratory workers.

Conflict of interests

No conflict.

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