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# Evaluation of Heavy Metals Content in Fresh and Canned Sardines Produced in Some Mediterranean Countries

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## ABSTRACT

Most heavy metals which bio-accumulate in fishes do not have any biological significance or beneficial use, but due to the presence of heavy metal, fish can pose a health risk to consumers. The present investigation was carried out to evaluate the Concentrations level of mercury (Hg), cadmium (Cd), and lead (Pb) in Sardines available in the Libyan market and produced in different countries of the Mediterranean region. All collected samples were analyzed by graphite furnace atomic absorption spectrometry after microwave assisted digestion, for detection of their contents of heavy metal residues to evaluate their quality according to standard legislations. The obtained results indicated concentrations for lead and mercury ranges from (0.0070 - 0.0125) and (0.0 - 0.0095) mg/kg respectively. It was observed that the levels of Lead and Hg in all different samples were within the permissible limits according to the standards of the World Health Organization and the European Union. Cadmium was not found in all samples.

**تقييم المعادن الثقيلة في السردين المنتج في بلدان مختلفة من منطقة البحر الأبيض المتوسط**

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معظم المعادن الثقيلة التي تتراكم بيولوجيًا في الأسماك ليس لها أي أهمية بيولوجية أو استخدام مفيد، ولكن نظرًا لوجود المعادن الثقيلة، يمكن أن تشكل الأسماك خطرًا صحيًا على المستهلكين. تم إجراء هذا البحث لتقييم مستوى تركيزات الزئبق، الكادميوم والرصاص في السردين المتوفر في السوق الليبي والمنتَج في بلدان مختلفة من منطقة البحر الأبيض المتوسط. تم تحليل جميع العينات التي تم جمعها بواسطة مطياف الامتصاص الذري لفرن الجرافيت بعد الهضم بمساعدة الميكروويف، للكشف عن محتوياتها من بقايا المعادن الثقيلة لتقييم جودتها وفقًا للتشريعات القياسية. أشارت النتائج المتحصل عليها إلى أن تركيزات الرصاص والزئبق تتراوح بين (0.0125–0.007) و (0.0 – 0.0095) مجم / كجم على التوالي. نلاحظ أن مستويات الرصاص والزئبق في جميع العينات المختلفة كانت ضمن الحدود المسموح بها وفقًا لمعايير منظمة الصحة العالمية والاتحاد الأوروبي. لم يتم العثور على الكادميوم في جميع العينات.

## INTRODUCTION

The pollution of marine ecosystems is a worldwide problem, and the situation is aggravated by the ability of these ecosystems to concentrate and accumulate some metals within the food chains (Jinadasa *et al*., 2010). The molluscs, crustaceans, cephalopods, fish and others seafood are an important part of the human diet that can be naturally rich or contaminated with some heavy metals (García, *et al*., 2016; Yi et al., 2017). Fish can concentrate very high levels of these contaminants, sometimes exceeding authorized limits. This bioaccumulation is closely related to the place of some

fish species at the top of the aquatic food chain (Chahid *et al*., 2014). Fish are a significant source of proteins, vitamins, minerals, and omega-3-polyunsaturated fatty acids whose benefits an important role in the prevention of most cardiovascular pathologies. But the polluted water from industrial and domestic waste water leads to fish contaminated by toxic metals (Olmedo *et al*., 2013). Heavy metals like cadmium (Cd), mercury (Hg) and lead (Pb) can interfere with biological systems and have inappropriate interactions with different intracellular structures. They are highly toxic to marine organisms and human, even at very low concentrations due to bioaccumulation (Ungureanu and Mustatea, 2022). Absorbed mercury in humans becomes more toxic due to its prolonged half-life. Its interaction is not limited with various enzymes and proteins, it has a great affinity with thiol group in proteins and can cause damage and dysfunction of the central nervous system (CNS) (Jyothi and Farook, 2020). Cd and Pb are extremely harmful to humans, and excessive amounts may harm the kidneys and induce chronic toxicity signs such as decreased organ function, infertility, hypertension, tumors, and hepatic malfunction (Khansari *et al*., 2005). Lead exposure is associated with neurodevelopmental effects which can impact brain function, and lower intelligence quotient, delayed growth, hearing loss, impaired fertility, and adverse pregnancy outcomes. Because of neurodevelopmental effects, fetuses, infants, and children are the most sensitive to lead exposures (Dahiya *et al*. 2005). Levels of heavy metals in fish and canned fish samples have been widely reported in the literature (Tarley *et al*., 2001; Mol, 2010; Kumar *et al*., 2013; Halabi 2015; Popovic *et al*., 2018; Mehouel *et al*., 2019; Kowalska *et al*., 2020; Alcala-Orozco *et al*., 2021; Rakib *et al*., 2021; Islam and Mustafa, 2022; Bufarwa *et al*., 2022 Aljabryn, 2022, Kasmi *et al*., 2023).

Data or Information on the heavy metal content in canned fish is important to ensure safe consumed fish for human consumption. The Aim of the present study was the determination of heavy metals levels cadmium (Cd), mercury (Hg) and lead (Pb) in fresh and canned Sardines produced in different countries of the Mediterranean region.

## MATERIALS AND METHODS

- Sample collection

Six (6) different Sardines Samples were random collected from the Libyan Market to determine the levels of heavy metals cadmium (Cd), mercury (Hg) and lead (Pb). The Sardines samples include one fresh and five canned Sardines produced in Libya, Malta, Morocco, Tunisia and Spain. The commercial name and Country are summarized in Table (1).

**Table (1): Fresh and canned Sardines.**

| | | |
|---|---|---|
| SS-1 | Alkhoms | Libya |
| SS-2 | Delamaris | Malta |
| SS-3 | Flash | Morocco |
| SS-4 | Nour | Tunisia |
| SS-5 | Calvo | Spain |
| SF-1 | Fresh | Sabratha |

- **Procedure used**

The sardine samples were dried at 110 $^{o}$C until they attained constant weight. 5.0 mL of nitric acid and 5.0 mL of sulfuric acid was added to 5g of Fish samples in 50.0 mL beaker. After the reaction is complete, the samples were heated up in heat block at 60 $^{o}$C for 30 minutes, cooled down and then added 10 mL of nitric acid. After drying, the temperature was then raised 150 $^{o}$C. After cooling, hydrogen peroxide was added until it become clear, and then transferred to the 50.0 mL volumetric flask and completed with di-ionized water. The determination of heavy metals concentration was performed using the PerkinElmer® AAnalyst 800 atomic absorption spectrophotometer (DSL, 2023).

## RESULTS AND DISCUSSION

Samples of fresh and canned Sardines were analyzed for lead (Pb), Cadmium (Cd) and mercury (Hg) contents, and summarized in Table (2).

**Table (2): Heavy metals concentrations in Sardines.**

| | **Concentrations in [mg/kg]** | | | | | |
|---|---|---|---|---|---|---|
| | Cd | | Pb | | Hg | |
| | WHO 0.1 | EU 0.05 | WHO 0.2 | EU 0.3 | WHO 0.5 | EU 0.5 |
| | Experimental | | Experimental | | Experimental | |
| SS-1 | 0.0 | | 0.0093 | | 0.0002 | |
| SS-2 | 0.0 | | 0.0110 | | 0.0002 | |
| SS-3 | 0.0 | | 0.0125 | | 0.0001 | |
| SS-4 | 0.0 | | 0.0070 | | 0.0001 | |
| SS-5 | 0.0 | | 0.0081 | | 0.0 | |
| SF-1 | 0.0 | | 0.0088 | | 0.0095 | |

The World Health Organization has established as the safety permissible limits for heavy metal quantity from eating fishes a weekly, maximum dosage, commonly known as Provisional Table Weekly Intake (PTWI), per kg of body weight. Taking an average human body weight for an adult of approximately 75 kg, we can calculate the quantity per person/per week (Report of experts, 2004). Therefore, these limits are given in µg/person/week and are the following:

Hg: 5 µg/(kg.p.w.) = 375 µg/person/week

=0.375 mg/person/week
Cd: 7 µg/kg.p.w. =525 µg/person/week
= 0.525 mg/person/week
Pb: 25 µg/kg.p.w.=1,875 µg/person/week
= 1.875 mg/person/week.

Furthermore the EU Regulation1881/2006/EU has established the following maximum concentration limits in fish tissues for Hg, Cd, Pb and these are 0.5 mg/kg, 0.05 mg/kg and 0.30 mg/kg, respectively.
The study revealed that the average concentrations of lead and mercury in the examined samples of canned and fresh sardines were 0.0093 ± 0.00188 mg/kg and mercury 0.0017± 0.00383 respectively. It was observed that the levels of Lead and Hg in all different samples were within the permissible limit according to the WHO and EU Standards.

## CONCLUSION

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Aim of the present study was the determination of heavy metals levels in fresh and canned Sardines produced in different countries of the Mediterranean region. Six (6) different Sardines Samples were random collected from the Libyan Market to determine the levels of heavy metals cadmium (Cd), mercury (Hg) and lead (Pb). The Sardines samples include one fresh and five canned Sardines produced in Libya, Malta, Morocco, Tunisia and Spain. The determination of heavy metals concentration was performed using the PerkinElmer® AAnalyst 800 atomic absorption spectrophotometer in Delta Technical Services (DSL) company Tripoli Libya. The study revealed that the average concentrations of lead and mercury in the examined samples of fresh and canned sardines were 0.0093 ± 0.00188 mg/kg and mercury 0.0017± 0.0038 respectively.

## REFERENCES

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Alcala-Orozco Maria, Balcom Prentiss H., Sunderland Elsie M., Olivero-Verbel Jesus & Caballero-Gallardo Karina, (2021): Essential and toxic elements in sardines and tuna on the Colombian market, Food Additives & Contaminants: Part B, DOI: 10.1080/19393210.2021.1926547

Aljabryn (2022), Heavy metals in some commercially fishery products marketed in Saudi Arabia, Food Sci. Technol, Campinas, 42, e34222, DOI: Dhttps://doi.org/10.1590/fst.34222.

Bufarwa S. M., Khatab A. A., Mahmoud R., Salim M. O. and Benarous N. M. , (2022), Evaluation of Some Heavy Metals (Co, Zn, Pb, and Cd) in Sardines Cans Samples Taken from Some Markets in El-Beida City-Libya, Libyan Journal of Basic Sciences (LJBS), Special Issue for 5th International Conference for Basic Sciences and Their Applications (5th ICBSTA), Vol: 19, Issue: 5, P:38-43, 3-4/12/2022-https://ljbs.omu.edu.ly/eISSN 2707-6261

Chahid, A., Hilali, M., Benlhachimi, A. and Bouzid, T. (2014) Contents of cadmium, mercury and lead in fish from the Atlantic sea (Morocco) determined by atomic absorption spectrometry. *Food Chem.*, 147: 357-360.

Codex Alimentarius. Codex general standard for contaminants and toxins in food and feed - CODEX STAN 193-1995. Joint FAO/WHO; 2015 p. 59. Available: 10.13140/RG.2.1.4910.2560.

Commission Regulation (EC) No. 1881/2006, Setting Maximum Levels for Certain Contaminants in Foodstuffs. [(accessed on 19 December 2006)].

DAHIYA, Sudhir, Rupali KARPE, AG HEGDE and RM SHARMA. 2005. 'Lead, Cadmium and Nickel in Chocolates and Candies from Suburban Areas of Mumbai, India'. *Journal of Food Composition and Analysis* 18(6), 517–22.

García, et al., 2016; Yi et al., 2017 García, M.Á., Núñez, R., Alonso, J., Melgar, M.J., 2016. Total mercury in fresh and processed tuna marketed in Galicia (NW Spain) in relation to dietary exposure. Environ. Sci. Pollut. Res. Int. 23, 24960-24969.

DSL (2023), Delta Technical Services company Tripoli Libya, DTS Ref. No. DS23-174 .

Halabi, Camillia (2015), Detection and Determination of Heavy Mineral Elements in Some Types of Canned Meat Sold in the Domestic Market, Tishreen University Journal for Research and Scientific Studies - Biological Sciences Series Vol. (37) No. (6).

Islam MS, Mustafa RA (2022), Assessment of trace elements in canned fish and health risk appraisal. Foods and Raw Materials;11(1): 43–56. https://doi.org/10.21603/2308-4057-2023-1-554.

Jinadasa, B.K.K., Rameesha, L.R.S., Edirisinghe, E.M.R. and Rathnayake, R.M.U. (2010) Mercury, cadmium and lead levels in three commercially important marine fish species of in SriLanka. *Sri Lanka J. Aquat. Sci.*, 15: 39-43.

Jyothi, Narjala Rama and Farook, Nainar Abdulkhader Mohamed; Mercury Toxicity in

Public Health, Environmental Health, DOI: 10.5772/intechopen.90333.

Kasmi K., Belhaj K., Nasri H., Slimani D. , Allai L., Mansouri F., Aissioui S., Abdellaoui S., Addi M. and Chafi A. (2023), Heavy Metals Concentration in Sardina pilchardus (Walbaum, 1792) from the Moroccan Mediterranean Coast and Potential Human Health Risk Assessment, Hindawi, Journal of Food Quality, Article ID 1455410, 13 pages, https://doi.org/10.1155/2023/1455410.

Khansari, F Emami, Ghazi-Khansari M and Abdollahi M. (2005). 'Heavy Metals Content of Canned Tuna Fish'. *Food chemistry* 93(2), 293–6.

Kowalska G, Pankiewicz U, and Kowalski R (2020); Determination of the Level of Selected Elements in Canned Meat and Fish and Risk Assessment for Consumer Health, Journal of Analytical Methods in Chemistry, Article ID 2148794, 13 pages, doi.org/10.1155/2020/2148794.

Kumar Manindar, Lakshya Tanmay and Viraj Raaz (2013); Features of weighty metals in canned tuna fish, Advances in Aquaculture and Fisheries Management Vol. 1 (6), pp. 058-059.

Mehouel F, Bouayad L, Hammoudi AH, Ayadi O, Regad F (2019); Evaluation of the heavy metals (mercury, lead, and cadmium) contamination of sardine (*Sardina pilchardus*) and swordfish (*Xiphias gladius*) fished in three Algerian coasts, *Veterinary World*, 12(1): 7-11.

Mol, Suhendan (2010); Levels of Heavy Metals in Canned Bonito, Sardines, and Mackerel Produced in Turkey, Biol Trace Elem Res (2011) 143:974–982 DOI 10.1007/s12011-010-8909-5.

Olmedo, P., Pla, A., Hernández, A.F., Barbier, F., Ayouni, L. and Gil, F. (2013) Determination of toxic elements (mercury, cadmium, lead, tin and arsenic) in fish and shellfish samples. Risk assessment for the consumers. *Environ. Int.*, 59: 63-72.

Popovic, Aleksandar R., Djinovic-Stojanovic, Jasna M., Djordjevic, Dragana S., Relic, Dubravka J., Vranic, Danijela V., Milijasevic, Milan P., & Pezo, Lato L., (2018); Levels of toxic elements in canned fish from the Serbian markets and their health risks assessment, *Journal of Food Composition and Analysis* 18(6), 517–22, doi.org/10.1016/j.jfca.2018.01.003.

Rakib Md. Refat Jahan, Jolly Y. N., Enyoh Christian Ebere, Khandaker Mayeen Uddin, Hossain M. Belal, Akther Shirin, Alsubaie Abdullah, Almalki Abdulraheem Bradley S. A. & D. A. (2021); Levels and health risk assessment of heavy metals in dried fish consumed in Bangladesh, Scientific Reports, volume 11, Article number: 14642.

Report of experts participating in Task 3.2.11 (2004), Assessment of the dietary exposure to arsenic, cadmium, lead and mercury of the population of the EU Member States, Directorate-General Health and Consumer Protection, SCOOP 3.2.11 – Intake of As, Cd, Pb and Hg.

Tarley CeHsar R. T., Coltro Wendell K. T., Matsushita Makoto, and de Souza Nilson E. (2001); Characteristic Levels of Some Heavy Metals from Brazilian Canned Sardines (Sardinella brasiliensis); Journal of Food Composition and Analysis 14, 611-617 doi:10.1006/jfca.2001.1028.

Ungureanu, Elena Loredana and Mustatea, Gabriel, (2022); Toxicity of Heavy Metals, Environmental Impact and Remediation of Heavy Metals, DOI: 10.5772/intechopen.102441.

Yi, Y., Tang, C., Yi, T., Yang, Z., Zhang, S., 2017. Health risk assessment of heavy metals in fish and accumulation patterns in food web in the upper Yangtze River, China. Ecotoxicol. Environ. Saf. 145, 295-302.