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Mercury Level Evaluation of *Sardinella aurita* From the Western Coast (Zawia, Libya)

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ABSTRACT

Sardinella aurita is a small marine fish that is widely consumed. This fish is significant due to its omega-3 fatty acid content. It inhabits relatively shallow coastal waters and can be subject to contamination from land sources. The aim of this study was to identify the mercury content in S. aurita fish brought from Zawia, west of Tripoli. Fish samples were brought in July 2010 and mercury content was analyzed using a device DMA-80 evo. The results indicated that the mercury concentration in S. aurita was 0.0361 ± 0.0064 µg/g. The mercury concentrations identified are lower than the international standards (WHO and FAO = 0.5 µg/g). The fish under study are fit for human consumption. The results showed that there is a correlation between the concentration of mercury and the size of the fish, as the larger the fish, the higher the concentration of mercury.

تقييم مستوى الزئبق في سمك السردين *(Sardinella aurita)*
من الساحل الغربي (الزاوية، ليبيا)

محمود عبدالمطلب باره ،صبرى عبدالمجيد فكيرين

سردينيلا أوريتا سمكة بحرية صغيرة تُستهلك على نطاق واسع. تُعد هذه السمكة مهمةً لاحتوائها على أحماض أوميغا 3 الدهنية. تعيش هذه السمكة في المياه الساحلية الضحلة نسبيًا، وقد تكون عرضة للتلوث من مصادر برية. هدفت هذه الدراسة إلى تحديد محتوى الزئبق في أسماك سردينيلا أوريتا المُستوردة من مدينة الزاوية، غرب طرابلس. جُلبت عينات من الأسماك في يوليو 2010، وحُلِّل محتوى الزئبق باستخدام جهاز .DMA-80 evo أشارت النتائج إلى أن تركيز الزئبق في سردينيلا أوريتا بلغ 0.0361 ± 0.0064 ميكروغرام/غرام. وتركيزات الزئبق المُحددة أقل من المعايير الدولية (منظمة الصحة العالمية ومنظمة الأغذية والزراعة = 0.5 ميكروغرام/غرام). الأسماك قيد الدراسة صالحة للاستهلاك البشري. أظهرت النتائج وجود علاقة بين تركيز الزئبق وحجم السمكة، فكلما كبرت السمكة، ارتفع تركيز الزئبق فيها.

INTRODUCTION

Fish plays an essential role in a balanced diet because it contains high-value protein and essential nutrients (Obeid *et al*, 2011). Seafood provides energy and high-quality protein. It plays a vital role in providing essential nutrients such as iodine, selenium, calcium, and vitamins A and D, all of which have well-known health benefits. Additionally, seafood is rich in long-chain n-3 polyunsaturated fatty acids (or omega-3s) (LC-PUFAs), making it an essential part of dietary patterns associated with good health (Mehouel *et al*., 2019 and Al-Mughairi *et al*., 2013). Many aquatic systems are negatively impacted by a variety of pollutants, such as organic and inorganic materials and heavy metals. These pollutants can cause significant harm to human health and the organisms living in the surrounding ecosystems (Genc and Yilmaz, 2018). Heavy metals are discharged into the aquatic environment from various natural and anthropogenic sources, including domestic and industrial wastewater, inorganic fertilizers, pesticides, pollution from shipping and port activities, geological weathering of the Earth's crust, and seepage from landfills (Mehouel *et al*.,2019). Fish are a potential major source of human exposure to environmental pollutants, such as heavy metals and metalloids, according to scientific data. These compounds are found naturally in the environment and reach aquatic environments via various geochemical processes. Industrial waters, agriculture, urban sewage and other sources are all anthropogenic. In the aquatic environment, heavy metals are bioaccumulated through the food chain (Chahid *et al*., 2014). Among the various toxic substances that contaminate fish and seafood, three heavy metals: lead, cadmium, and mercury are the only ones recognized in European Union regulations concerning hazardous metals (Canli *et al*., 2001). Mercury is a toxic element that is nonessential for life and is frequently found in aquatic ecosystems. It is released into the environment through various natural and human-made processes, such as geologic weathering, gold mining, and coal combustion. Previous studies have demonstrated harmful effects of mercury on fish health at concentrations greater than 0.3 mg/ kg wet weight. In certain cases, they exceed the safety levels set by the World Health Organization (WHO), which stipulates a limit of 0.5 mg/ kg wet weight for human consumption (Condini *et al*., 2017). Determining the chemical quality of aquatic organisms, especially their heavy metal contents, is important for human health (Tuzen, 2009). The local population consumes fresh sardines primarily due to their accessibility and relatively affordable prices. The mercury found in sardines originates from the environment, as it is released into the water through agricultural runoff from farms and industrial pollution. Mercury can be absorbed by plankton, which is consumed by small fish, which are then preyed upon by larger fish, such as sardines (Lad *et al*., 2023). In Libya, sardine (*S. aurita*) is a commercially important species because it is the most consumed fish. In this study, the level of mercury contamination in sardines (S. aurita) caught off the Libyan coast (western Libya) was evaluated and contributed to the development of a database of mercury concentration in the region

MATERIAL AND METHODS

Commercial sardine fish were collected from the fish market in Zawia (n=55), located on the western coast of Libya, approximately 48 km west of Tripoli city, as shown in Figure 1. The samples were refrigerated until they arrived at the Marine Biology Research Center laboratory in Tajoura. The samples were weighed, and the total length of each sample was determined, as shown in **Table 1**. Fish flesh samples were collected and placed in plastic bottles labeled with the sample number and data. A Milestone DMA-80 evo was used to determine the mercury concentration in the wet weights of the samples.

Statistical analysis

Microsoft Excel® (2010) was used to calculate means, standard deviations, minimum and maximum values, coefficient of variation, and correlation coefficients.

Fig. 1. Sampling location

Table 1. The mean length and weight of fish.

Fish species	n	Length (cm)		Weight (g)	
		Range	Mean ± SD	Range	Mean ± SD
Sardinella aurita	55	15.10-17.50	16.41 ±0.623	27.30-42.50	33.50 ±3.469

n=Number of samples, SE=Standard deviation,

RESULTS AND DISCUSSION

Table 2 shows the mercury concentration obtained in samples of Sardinella aurita in the Zawia area, where the mercury concentration ranged from 0.0234 to 0.0475 µg/g, with an average of 0.0361±0.0064 µg/g ww. The results of the study showed that the concentration of mercury in the fish under study was lower than the internationally permissible limits set by the WHO (1993), FAO (2009), (EC) No 629/2008, BPOM (Indonesia's Food and Drug Monitoring Agency), and SNI (Indonesian National Standard), which have established a maximum mercury concentration of 0.5 µg/g for fish and other seafood products, which indicates that these fish are suitable for human consumption. The findings of the present study were in agreement with those of (Al-Kazaghly *et al*., 2025) and (Aldeeb *et al*., 2023) reported that the concentration of mercury in sardine was below the acceptable level for human consumption. The results of this study were also consistent with a study conducted by (Mehouel *et al*., 2019) on another species of sardines, where the results were within the normal range. The results of this study were lower than those of a similar study conducted by (Joiris *et al*., 1999), on Tunisian sardines, where the maximum mercury content was 0.17 µg/g ww (1.7 times the average), or 0.15 µg/g ww.

Table. 2. Average mercury concentrations in the fish ug/g wet.w.

Fish species	n	Mercury concentrations (µg/g wet weight)			CV%
		Mean±SD	Lower	Upper	
Sardinella aurita	55	**0.0361**±0.0064	0.0234	0.0475	17.8

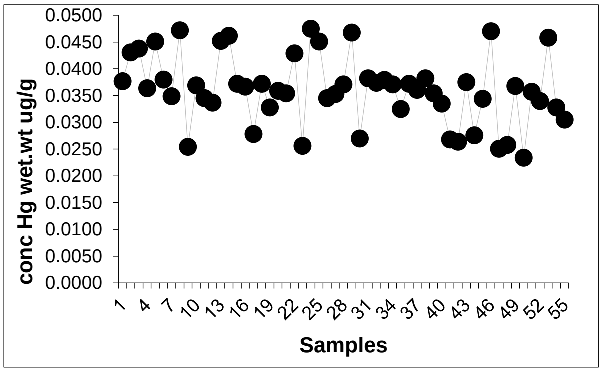

Fig .2. Mercury concentration in the fish under study

The results of this study, when compared to mercury concentrations in fish from other locations around the world (see Table 3), indicate that the mercury levels found here are relatively low. According to (Liu *et al.*, 2015), the concentration of heavy metals in fish is affected by various factors such as habitat, location, and feeding behavior. Coefficient of variation in current study was 17.8 and according to (Santos *et al.*, 2021), maximum coefficient of variation (CV) accepted between analytical replicates of each sample is below 20%.

Table 3. Mercury concentration (µg/g ww) in sardines in different regions of the world.

Regions	Hg (µg /g w w). MV±SD	Reference
Sicilian coast	0.132±0.108	(Naccari *et al.*,2015)
Algeria (Dellys)	0.130±0.05	(Aissioui *et al.*,2022)
Algeria (Boumerdes)	0.07±0.02	(Aissioul *et al.*,2021)
Atlantic ocean, southeast Brazil	0.128±0.045	(Silva *et al.*,2011)
Prigi (Andonesia)	0.58±0.65	(Sartimbul *et al.*,2021)
Ghana	0.007-0.020 (0.016)	(Voegborlo and Adimado ,2010)

***MV* medium value**

In this study, a positive correlation was observed between mercury concentrations in Sardinella aurita and the size of the fish (length and weight) (Figure 3). The correlation coefficients, which range from 0.773 to 0.946, suggest that these variables are highly correlated. Mercury concentration increases with fish size, which is consistent with what was reported by (Storelli *et al.*, 2006).

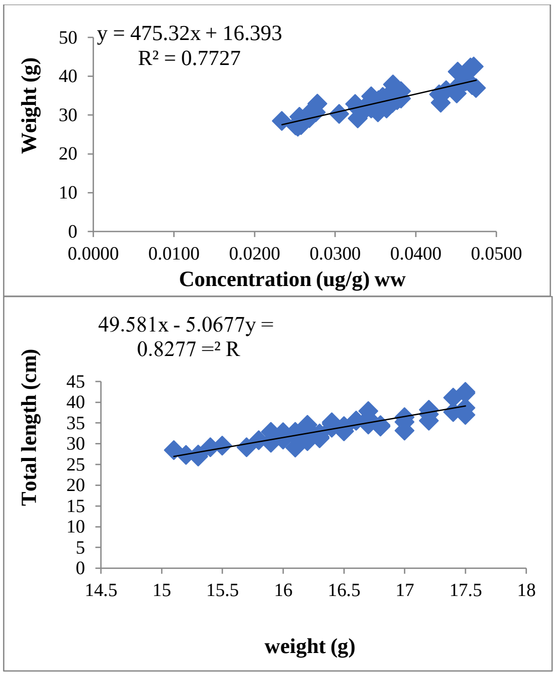

Fig 3. Strong correlation between mercury concentration and fish size.

According to (Sompongchaiyakul *et al.*, 2008), the positive correlation between mercury levels and fish length and weight indicates that these fish have the potential to accumulate higher levels of mercury as their size increases. According to (Sartimbul *et al.*, 2021), the negative correlation between fish size and mercury concentration is influenced by fish habitat, location, feeding behavior, and life stage.

CONCLUSION

Mercury concentrations in S. aurita are below the maximum limits set by WHO (1993), FAO (2009), EC No. 629/2008, and others. Therefore, it is suitable for human consumption. Mercury concentrations in fish have also been found to be lower than the average mercury levels in other countries. There is a strong correlation between mercury concentration and fish size, the larger the fish, the higher the mercury concentration. The positive correlation showed that these fish have the same habitat and similar feeding behavior. The current study provides valuable information to the community to help increase awareness and understanding of the safe limits of S. aurita consumption.

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