

Mercury in four common fishes sold in Algeria and associated humans risk

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Introduction

Fish consumption is a substantial part of human nutrition, providing essential nutrients such as proteins, polyunsaturated fatty acids, vitamins and minerals like selenium and iodine. However, the benefits of fish consumption are mitigated by inherent risks, as they can serve as reservoirs for harmful chemical contaminants, including toxic trace elements. Cadmium (Cd), mercury (Hg) and lead (Pb) are among the pervasive contaminants found in aquatic ecosystems, primarily originating from industrial waste discharge. These non-biodegradable and accumulative elements pose health risks along the entire food chain.

Previous investigations in Algeria have revealed varying levels of mercury in different fish species. For example, Mehoul et al. (2019) identified predominant mercury levels at 0.62 ± 0.16 mg/kg (range: 0.15–0.89 mg/kg) in sardines, whereas in another study (2019), they reported levels of 0.04 ± 0.03 mg/kg (range: 0.01–0.12 mg/kg) for the same species. Moreover, Benguendouz et al. (2017) documented levels ranging from 0.080 mg/kg to 0.130 mg/kg, while Khellaf et al. (2023) observed concentrations ranging from 0.02 mg/kg to 0.08 mg/kg wet weight (ww) in fish samples. In line with previous studies in Algeria, we conducted this survey to measure the concentration of total mercury in four commonly consumed fish species (*Sardina pilchardus*, *Merluccius merluccius*, *Sparus aurata*, *Auxis rochei*), with the aim to assess potential risks for human consumption and filling this gap in the understanding of seafood safety in the region.

Study design and sampling

Our study focused on **135 fresh fish samples** [one fish per sample for *Merluccius merluccius*, *Sparus aurata*, *Auxis rochei* and three fishes per sample for *Sardina pilchardus*] collected during 2021, from 82 traders from Ouargla city and 53 traders from Constantine city. Fishes were identified, measured and weighed. It consists of 105 samples of sardine (*Sardina pilchardus*), 10 samples of sea bream (*Sparus aurata*), 14 samples of hake (*Merluccius merluccius*) and 6 samples of bonito (*Auxis rochei*).

Sample analysis

Sample mineralisation followed the procedure outlined in European Standard EN 13,805 (2002). 2 g of each sample was placed in Teflon digestion vessels, followed by 3 mL of HNO₃ along with 0.5 mL of H₂O₂. The mineralisation process was facilitated using a “Topwave®” microwave oven (Analytik-Jena®, Jena, Germany). The digestion vessel, situated in a pressure container, underwent a 3-h treatment at 170°C in the oven. The resulting solution was transferred into 10 mL test tubes and supplemented with distilled water. Analysis Mercury was analysed using a thermal decomposition amalgamation Atomic Absorption Spectrophotometer (Mercur, Analytik-Jena®, Jena, Germany), equipped with a hollow cathode mercury lamp operating at a wavelength of 253.7 nm. Each sample was analysed in triplicate. Mercury concentrations were expressed as mg/kg wet weight..

Results and discussions

Table 1. QA/QC data for the applied analysis.

Linearity (mg/Kg ww)	0.05–0.5
LOD (mg/Kg ww)	0.001
LOQ (mg/Kg ww)	0.01
R ²	0.997
CRM 463	
Certified value	2.85 ± 0.16
Measured value	2.83 ± 0.10
Recovery	99.2%
SRM 1570a	
Certified value	0.030 ± 0.003
Measured value	0.028 ± 0.002
Recovery	93.3%

Table 2. Mercury (mg/kg wet weight) in fish samples.

Statistics	<i>Sardina pilchardus</i>	<i>Merluccius merluccius</i>	<i>Sparus aurata</i>	<i>Auxis rochei</i>	Total
Min	0.09	0.14	0.03	0.12	0.03
Max	0.38	0.79	0.68	0.47	0.79
1st Quartile	0.12	0.14	0.16	0.14	0.12
Median	0.15	0.17	0.25	0.19	0.15
3rd Quartile	0.23	0.36	0.31	0.27	0.23
Mean	0.17	0.26	0.27	0.23	0.19
SD	0.08	0.19	0.18	0.13	0.11
Regulatory standard	0.5	0.5	0.5	0.5	0.5
n > standard/N	0/105	1/13	1/11	0/6	2/135

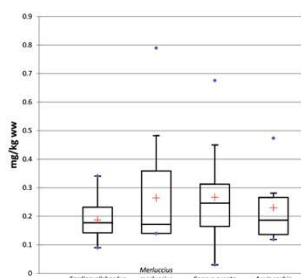


Figure 1. Concentration ranges of mercury for the different species.

Table 3. Estimated weekly intake and health risk of mercury in fish ($p < 0.001$).

Fish species	EWI (mg/kg bw/week)		THQ	
	Adults	Children	Adults	Children
<i>Sardina pilchardus</i>	$0.47 \times 10^{-3} \pm 0.15 \times 10^{-3}$ [0.22 $\times 10^{-3}$ – 0.85 $\times 10^{-3}$]	$1.09 \times 10^{-3} \pm 0.36 \times 10^{-3}$ [0.52 $\times 10^{-3}$ – 1.99 $\times 10^{-3}$]	0.06 ± 0.02 [0.03–0.12]	0.15 ± 0.05 [0.07–0.28]
<i>Merluccius merluccius</i>	$0.66 \times 10^{-3} \pm 0.48 \times 10^{-3}$ [0.35 $\times 10^{-3}$ – 1.97 $\times 10^{-3}$]	$1.54 \times 10^{-3} \pm 1.13 \times 10^{-3}$ [0.82 $\times 10^{-3}$ – 4.61 $\times 10^{-3}$]	0.09 ± 0.07 [0.049–0.275]	0.21 ± 0.16 [0.11–0.64]
<i>Sparus aurata</i>	$0.67 \times 10^{-3} \pm 0.44 \times 10^{-3}$ [0.07 $\times 10^{-3}$ – 1.69 $\times 10^{-3}$]	$1.55 \times 10^{-3} \pm 1.03 \times 10^{-3}$ [0.17 $\times 10^{-3}$ – 3.94 $\times 10^{-3}$]	0.09 ± 0.06 [0.01–0.23]	0.22 ± 0.14 [0.02–0.55]
<i>Auxis rochei</i>	$0.57 \times 10^{-3} \pm 0.34 \times 10^{-3}$ [0.30 $\times 10^{-3}$ – 1.18 $\times 10^{-3}$]	$1.34 \times 10^{-3} \pm 0.78 \times 10^{-3}$ [0.69 $\times 10^{-3}$ – 2.76 $\times 10^{-3}$]	0.080 ± 0.047 [0.04–0.16]	0.19 ± 0.11 [0.10–0.38]

Considering the average fish consumption of 175 g per week and assuming an average body weight of 70 kg for adults and 30 kg for children, the results presented in Table 3 provide insights into the potential health implications of Hg exposure through fish consumption. The EWI for adults ranged from 0.07×10 mg/kg bw/week, while for children, it varied from 0.17×10^{-3} to 1.97×10 to 4.61×10^{-3} μ g/kg bw/week. Mean EWI values consistently fell below the PTWI of 1.60×10 mg/kg bw/week, reassuring that the investigated fish species pose no discernible health risks for adult consumers. However, a nuanced perspective is essential when –3 considering the health implications for children. Although the EWI values for children generally remain within acceptable limits, the proximity to the upper threshold necessitates caution. Children, being a vulnerable age group, might warrant specific attention in future risk assessments or dietary guidelines.

Moreover, the THQ values, ranging from 0.01 to 0.64, all below 1, reinforce the conclusion of low risk to the local population's health associated with fish consumption. Despite some samples exceeded the EWI for children, it is crucial to underscore that the absence of a risk of carcinogenic adverse effects is evident for the Algerian population based on our study.

Conclusion

Our study focused on assessing Hg contamination in four fish species available in the Algerian market. Within the fish samples, consistently low levels of mercury were identified, all falling below the limits in force in Algeria. Importantly, the evaluation of health risks associated with mercury presence indicated that the consumption of these fish species is unlikely to result in harmful non-carcinogenic effects on humans. Nevertheless, considering the inherent characteristics of mercury and other contaminants that could potentially pose risks to human health and the environment, further comprehensive studies are recommended. These investigations should aim to monitor the dynamic changes in mercury concentration and other contaminants within both fishing zones and aquaculture farms.