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Full Length Research Paper

Determination of Heavy Metals in Gonads of Pelagic Species of the Mediterranean Sea (Algerian coastline) using Atomic Absorption Spectrometry

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ABSTRACT

The presence of heavy metals in our environment has been of great concern because of their toxicity when their concentration is more than the permissible level.
This work aims to measure the contamination of a pelagic fish of the Bay of Oran; Sardinelle *Sardinella aurita*. It was collected during six months from May to October 2005. 400 concentrations of heavy metals (lead and zinc) were determined after wet digestion by atomic absorption spectrophotometry with flame in the gonads of which are the organs of reproduction. Les results show that metal concentrations are below the maximum permissible doses. This observation does not diminish the potential risk to human in the long term.

Key words: trace metals, *Sardinella aurita*, Bay of Oran

INTRODUCTION

According to the UN-Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP), marine pollution is the introduction by men, directly or indirectly, of substances or energy to the marine environment resulting in deleterious effects such as: hazards to human health; hindrance of marine activities, including fishing; impairment of the quality for the use of seawater, and reduction of amenities.
Due to industrialization, the number of factories and population has increased rapidly. Massive amounts of domestic wastewater and industrial effluents are transported by rivers and discharged into the sea, contaminating rivers and coastal waters [cf. Gibbs 1995]. Such anthropogenic pollutants are the main sources of heavy metal contaminants in the ocean [cf. Eromosele *et al.;* 1995**;** Chernoff et al. 1979].
Toxic metals may normally be present in the body in very low levels, but continuous exposure or metabolic abnormalities can cause accumulation of heavy metals in body tissues, and subsequently, in the brain.
Many of these elements are essential to the body in very low concentrations such as zinc which is an essential component of many enzymes but in high concentrations these can be toxic. Some heavy metals have no essential function in the body (e.g., mercury and lead) where any concentrations can be harmful.
The aim of the present study is to determine the concentrations of lead (no essential metal) and zinc (essential metal) in gonad of fish species of the Mediterranean Sea (coastline of Oran, Algeria) using flame atomic absorption

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spectrometry. The fish species used in this study were *Sardinella aurita.* Several techniques have been used for determination of metal concentrations in fish species such as flame atomic absorption spectrometry [Bermejo-Barrera *et al.* 2001], graphite furnace atomic absorption spectrometry [Botson *et al.* 2004], electro-thermal atomic absorption spectrometry [Mendez *et al*. 2002], inductive coupled plasma [Petisleam *et al*. 2005], and mass spectrometry [Sanchez *et al*. 2003].

MATERIALS AND METHODS

The Bay of Oran is located on the west coast of Algeria. It is between the Bay of Andalusia and the Gulf of Arzew (Figure 1):

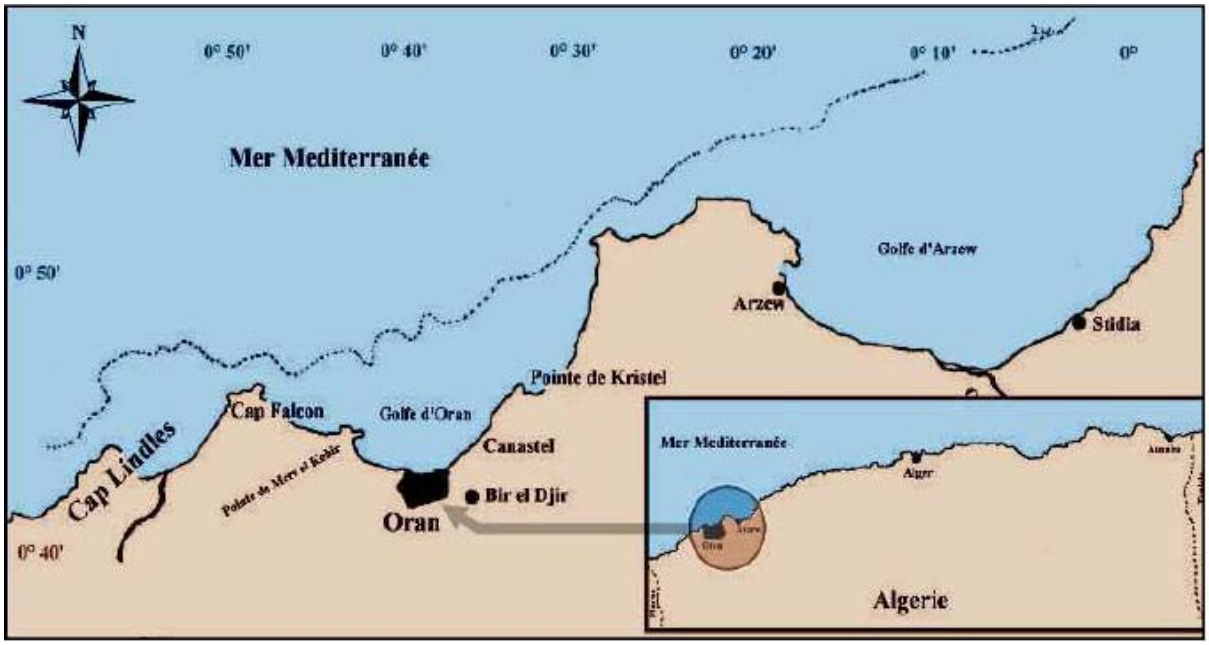

Figure 1: Geographical position Bay of Oran

According to Benmessaoud [2010], more than 90 million cubic meters of wastewater is discharged annually on the shores of the coast of Oran.

Sardinella aurita was selected for the present study and collected during six months from May to October 2005. After measurements, gonads were weighed and frozen until their chemical analysis. We opted for the wet mineralization as opposed to the dry mineralization because it can eliminate errors due to loss of volatiles organometallic during drying [cf. FAO 1977].

Wet mineralization of samples was performed by the method of Amiard *et al.* [1987] using a mineralizator type VELP (Figure 2 and 3):

Figure 2: Mineralizator (VELP) (Laboratoire Réseau de surveillance environnementale, University Oran)

Sample 1g

1 ml of nitric acid
Temperature: 95°C

mineralization

adjusted to 4 ml of bidistilled H_2O

Analysis with the Atomic Absorption Spectrophotometer with Flames.

Figure 3: Protocol of mineralization according to Amiard *et al.* [1987]

1 ml of nitric acid is added to 1 g of sample and then adjusted to 4 ml of bidistilled water after one hour at 95°C. A biological sample of Mediterranean fish, provided by the International Agency for Atomic Energy (IAEA) and coded 350 was used as standard. It is used to validate the tests. Analyses were performed with the Atomic Absorption Spectrophotometer with Flames 'Perkin Elmer, Analyst 100' (Figure 4):

Figure 4: The Atomic Absorption Spectrophotometer with Flames

A total of 400 analyses were performed.

RESULTS AND DISCUSSION

The results of analysis indicated that the concentrations of lead in all examined tissues varied from 0.22 mg/kg to 0.45 mg/kg and the zinc between 4 mg/kg from 6.5 mg/kg as shown in Figure 5:

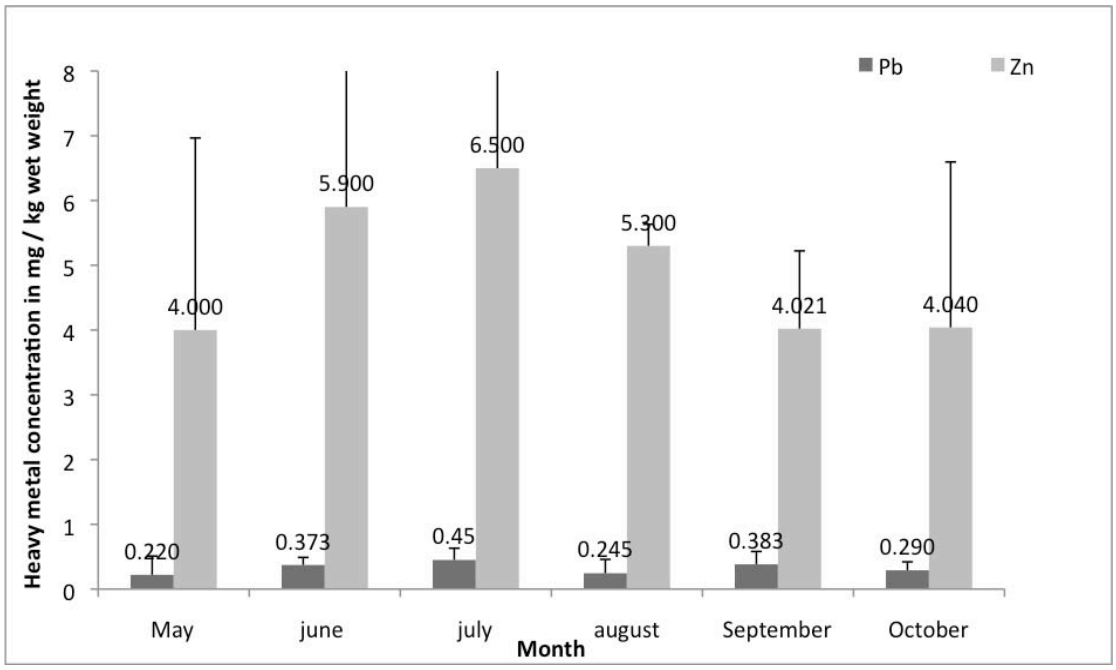

Figure 5: The monthly average concentration of lead and zinc in gonads of *Sardinella aurita*

The values of zinc were higher than that of lead. Indeed, zinc is an essential metal [cf. Lafabrie 2007] which is involved in many physiological processes and is essential to the life of a large number of organisms [cf. Rengel 1999].
The month of July recorded the maximum concentration for lead and zinc.
Similar results were found in other aquatic organisms in bay of Oran like the Boops boops, Mullus barbatus , Sepia officinalis and the Merlucius Merlucius.

This observation may be explained by the increase of temperature of seawater, which is highest during the month of July in Algerian waters [cf. Boutiba 1992]. Indeed, when the water temperature increases, fish are more active and absorb more water (and contaminants) that passes through their gills, skin and their digestive tract [cf. Cossa *et al.* 1989].
The females showed higher concentrations of heavy metals than males (Figure 6):

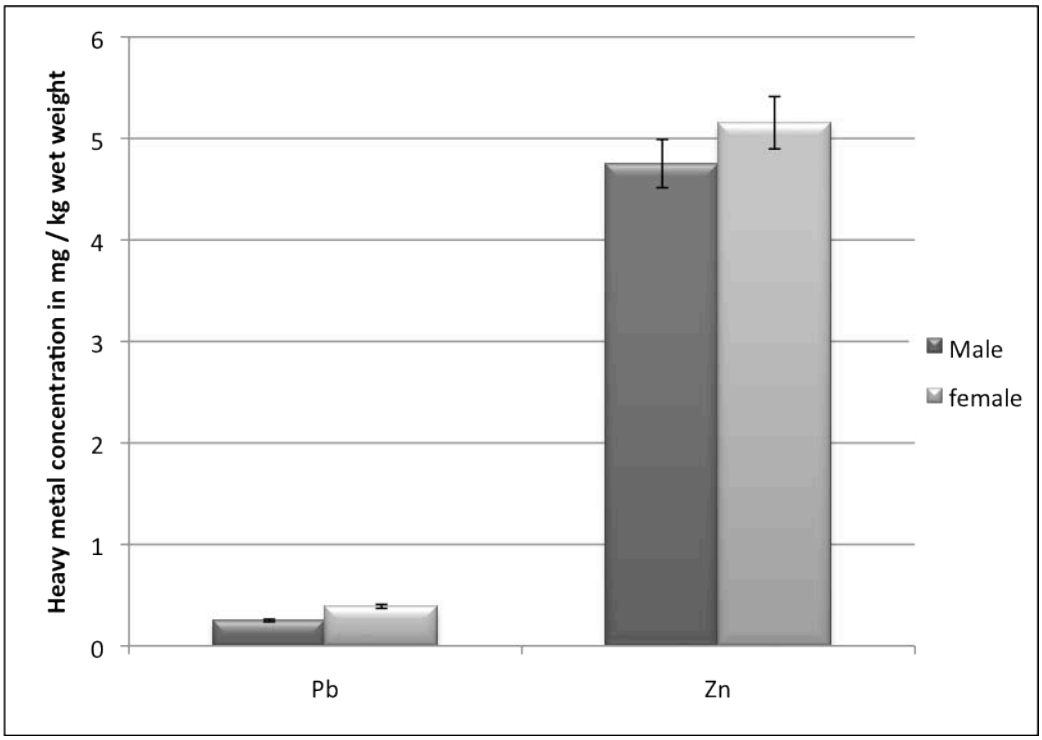

Figure 6: The average concentration of lead and zinc in gonads of *Sardinella aurita*

This increase may be attributed to the higher tendency of accumulation by ovaries rather than testes. The concentration increased with the increase in the gonado-somatic index, whereas the higher values of the gonado-somatic index (GSI) showed higher concentrations of heavy metals. Other research in many aquatic organisms such as crustacean Nephrops norvegicus showed that the sex is an important factor for heavy metal levels where females accumulated higher values than males. According to Mortet [1988], an ovarian sequence for *Sardinella aurita* begins in the Bay of Oran to the beginning of July. It is characterized by an intense vitellogenic activity. Vitellogenesis is accompanied by an accumulation of reserves for the growth of eggs, but at the same time, by the metallic pollutants found in the biota [cf. Mortet 1988].

The average rates for lead and Zinc in our samples of *Sardinella aurita* are very low compared to the maximum permissible dose recommended by the IOPR 1996:

Table 1: Permissible dose recommended by the IOPR 1996

	Pb	Zn
S. aurita	0.32	4.95
DMA (fish)	0.5	<100

CONCLUSION

The concentrations of metals detected in the gonads of sardinella suggest contamination of the food chain and especially phytoplankton and zooplankton which is the favorite food of the sardinelle.

In effect, the work of Ennouri *et al.* [2008] on metal contamination of the sardinella in Tunisian coast, affirm that the concentrations of zinc in the organs of sardinella are 8 x higher than concentrations in zooplankton.

This may be due to the higher position occupied by sardinella in the food chain.

Accordingly, planktivorous fish accumulates metals following their bioavailability in the environment.

The origin of metal pollutants detected in the organs of *Sardinella aurita* in the Bay of Oran is due to multiple reasons: absence of a sufficient number efficient purification systems [cf. Boutiba *et al.,* 2003] and the use the anti-fouling paints on the hulls of boats for limiting the fixing of marine organisms.

To manage and control water pollution, it is suggested to study more about the distribution and the treatment of contaminants. Moreover, treatment of wastewater is a determining factor to ensure that wastewater containing pollutants are not rejected directly into the sea.

Despite metal pollution in the Bay of Oran, the levels of micropollutants detected in the organs of sardinelle are relatively low.

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