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Metal Concentrations in tissues of *Mullus barbatus* L. Catched from the West Algerian coast

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Abstract

Heavy metal concentrations were investigated in body tissue of a demersal *Mullus barbatus* from commercial cached in west Algerian coast (Oran and Beni Saf). Fish samples were collected seasonally from November 2013 to April 2014, a total of n= 149 fish were measured. Muscle, liver and gonads were analyzed for zinc, cadmium and nickel by Atomic Absorption Spectrophotometer.The aim of this study was to determine relationship between trace metals concentrations with size, organs bioaccumulation and seasons, and compare between the levels of contamination of the mullet fished from the two ports. Finally, to assess the risk of its consumption on human health. Statistical analysis pinpointed no substantial differences in metal concentration levels between size classes concerning mature fish Significant differences were observed between tissues concentrations of Zn; gonads accumulate it more than liver and muscle. The concentrations of Cd in body of red mullet vary significantly according to season, spring records the highest concentrations. Although, the two sites were exposed to different sources of pollution but no significant difference was observed between their levels of contamination. In this study, the mean values of Cd in muscle tissues are slightly higher than the limits fixed by the FAO.

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Introduction

Among the pollutants that incoming sea, heavy metals are pollutants whose harmfulness is related to their persistence and toxicity. They can be transferred into the food chain, affecting both aquatic organisms and humans (Amiard, 2011). Western Algerian coast, like other regions of Mediterranean sea, is concerning by metallic pollution. Caused by urbanization of coastal areas, industrial growth and wastewater discharged directly into the sea, Added to this the high number of tourists during summer. This led to classify some of these areas, as areas at risk of marine pollution like Beni saf's coasts, and other such hotspots of pollution like Oran's coasts (EEA, 2006).

For these reasons, several studies for determination of metals concentrations in aquatic organisms are conducted, in Algeria (Taleb and Boutiba, 2007; Belhoucine, 2012; Rouane-Hacen, 2013; Benali *et al*., 2015) and through Mediterranean coasts using *Mullus barbatus* as bioindicator species in Italy (Conti *et al*., 2012; Copat *et al*., 2013), Spain (Benedicto *et al.* 2007; Martínez-Gómez *et al*., 2012), Greece (Giannakopoulou and Neofitou, 2014), and Turkey (Tepe *et al*., 2008; Çağrı Taş *et al*., 2011)
Through this study, concentrations of three heavy metals (Cd, Ni, Zn) were examined in organs of the red mullet *Mullus barbatus* , muscle that is the edible part of fish and the source of protein, liver as detoxification organ and gonads that are the reproductive organ, for understanding distribution of metals in fish tissues according size and seasons and evaluating the risk of its consumption on human health.

Materials and methods

Studies area

Both areas of Oran and Beni Saf have an important fishery. Bay of Oran is located in North West of Algeria, and south west of the Mediterranean sea (Fig. 1). The port of Oran (latitude 35 ° 56 'north and longitude 00 ° 04' 30 "), is a combined port (commercial, traveller and fishing). This area is concerning by pollution incoming sea by direct discharge of wastewater, an estimated 50% of the Oran population lives near the sea (Boutiba *et al*., 2003), this is compounded by the deficit in water treatment prior to discharge into the sea in most cases (Grimes, 2010).

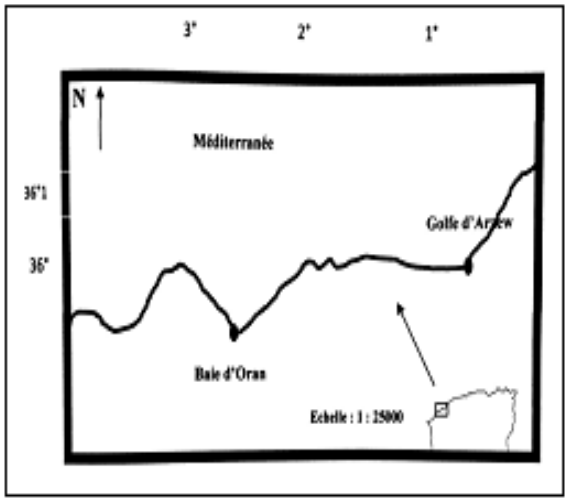

Fig. 1. Map of Oran Bay.

Beni Saf Bay is provided of the largest continental shelf in the Algerian coast. It's located western than Oran between latitude 35 °20'N et 35°40'N and longitude 2° 00' west à 2°30' east(Fig. 2). Several rivers come out onto this area (Grimes, 2010).

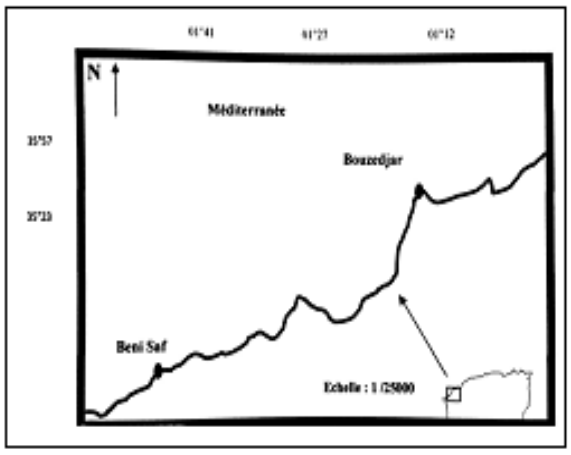

Fig. 2. Map of Beni saf Bay.

Sample collection and metal determination

Mullus barbatus is a demersal fish recommended by FAO/UNEP, 1993 as bioindicator species for monitoring metallic pollution. In this study, red mullet was sampled from commercial catches from tow fisheries, Oran and Beni Saf, seasonally during November 2013 to April 2014.

A total of 71 and 78 fishes were sampled respectively from Oran and Beni Saf. All samples were in commercial size; they were measured for total lengths and weight, to the nearest mm and g, and sexed. Only females were kept and subdivised in two sub group for minimized the natural variability (OSPAR, 1999), the measurements are given in Table 1. For each sub group, whole liver, gonads and 1-2 g of right dorso-lateral muscle were dissected from each fish and homogenised. The mineralization was performed with Velp device for wet digestion; the homogenized samples (1 g) were digested with 1ml of nitric acid for 1 hour in 95°c, then digested samples were diluted to a final volume of 4ml with deionised water. Finally, these solutions were analyzed by atomic absorption spectrometer.

Statistical analysis

the satatistical analysis was performed using STATISTICA. To compare trace metals concentrations between groups, non-parametric variance ANOVA Kruskal-Wallis was used.

Results

The mean values and standard deviations of metals concentrations in red mullet tissues are given in Table 2. All results are expressed in wet weight.

Concerning Cd, in remaining sample (mean of the concentrations in the three organs), its concentration is ranged between 0.024 - 0.092 µg/g wet weight in Oran and between 0037 - 0096 µg/g wet weight in Beni Saf. For muscle, average concentration of Cd is ranged between 0.025 - 0.09 µg/g for samples from the bay of Oran and 0.043 - 0.098 µg/g for samples from Beni Saf.

Table 1. Mean lengths and weights of the samples analyzed in this study.

sites	size classes	*n*	L±Sd (cm)	W±Sd (g)
Oran	<19	44	17.32±0.98	55.9±10.12
	≥19	27	20.5±1.14	99.21±20.78
Béni Saf	<19	38	17.64±093	60.09±10.66
	≥19	40	20.57±1.21	94.3±20.18

L: mean length, W: mean weight, Sd: standard deviation.

Liver contains an average concentrations of Cd ranged between 0.029 - 0.097 µg/g and 0.023 - 0.089 µg/g. And gonads between 0.0085 - 0.09 µg/g and 0.045 - 0.1 µg/g, respectively in Oran and Beni Saf.

The averages concentrations of Ni are between 0.041 - 0.085 µg/g and between 0.033 - 0.077 µg/g in remaining sample, between 0.033 and 0.11 µg/g and 0.009 and 0.103 µg/g in muscle and ranged between 0.04 - 0.08 µg/g and 0.091- 0.024 µg/g in liver and between 0.051 - 0.084 µg/g and 0.048 -0.068 µg/g for gonad, respectively in Oran and Beni Saf.

The averages concentrations of zinc are ranged between 16.85 - 9.75 µg/g and 20.36 - 23.3 µg/g in remaining sample, In muscle between 4.12 - 1.7 µg/g and 2.36 - 2.66 µg/g, in liver between 2.78 -10.32 µg/g and 12.98 - 31.8 µg/g, finally between 16.04 - 37.76 µg/g and 35.74 - 51.46 µg/g ; respectively in Oran and Beni Saf.

Monitoring of changes in average concentrations of trace metals by season between the two sites reveals that for the average concentration of Cd in remaining sample of mullet, there is a significant difference between fish caught from Oran and Beni Saf only in autumn (ANOVA, Kruskal-Wallis, P <0.05).

The average concentrations in remaining sample of Ni is significantly different between the two sites in autumn and winter (ANOVA, Kruskal-Wallis, P <0.05). For Zn, there is a significant difference in average concentration of liver and gonads between the two ports in autumn, winter and spring (ANOVA, Kruskal-Wallis, P<0.05).

Discussion

The comparison between the mean concentrations of metals at both size classes shows that the size of the red mullet do not seem to affect the bioaccumulation of metal trace elements for mature invidious in the

two sampling areas. Effectively Giannakopoulou, 2014 and Çağrı Tas *et al.* 2011, note that size is not a statistically significant parameter that determines the metal accumulation in mature *Mullus barbatus*.in these studies, the difference in the metal accumulation was observed with the juveniles that depend on higher metabolic rates (Giannakopoulou and Neofitou, 2014). And live at shallow depths (Carlucci *et al.,* 2009) where metals are more accumulate in sediment and in water.

Table 2. Concentrations of metals (mean ± standard deviation) in tissues of *Mullus barbatus* (µg /g wet weight).

Organes		*Cd*		*Ni*		*Zn*	
	sites	*Oran*	*Beni Saf*	*Oran*	*Beni Saf*	*Oran*	*Beni Saf*
Remaining sample	Automn	0.024±0.013*	0.037±0.015	0.04±0.013*	0.073±0.018	9.75±6.34	20.36±22.14
	winter	0.05±0.013	0.052±0.038	0.081±0.01*	0.033±0.025	16.85±18.20	22.31±24.12
	spring	0.092±0.003	0.096±0.006	0.085±0.015	0.077±0.038	12.84±10.8	23.3±20.43
Muscle	Automn	0.034±0.002	0.043±0.007	0.033±0.003	0.061±0.019	4.12±0.22	2.66±2.34
	winter	0.025±0.002	0.045±0.05	0.083±0.011	0.009±0.0007	2.48±0.39	2.5±0.14
	spring	0.09±0.002	0.098±0.004	0.11±0.018	0.103±0.021	1.7±0.25	2.36±0.45
liver	Automn	0.029±0.007	0.023±0.021	0.04±0.004	0.091±0.007	8±0.9*	13.04±1.41
	winter	0.061±0.013	0.026±0.034	0.077±0.014	0.024±0.025	10.32±0.16*	12.98±4.72
	spring	0.097±0.001	0.089±0.002	0.08±0.007	0.081±0.03	2.78±13.09*	31.8±10.35
Gonades	Automn	0.0085±0.006	0.045±0.002	0.051±0.02	0.068±0.015	17.14±4.66*	45.38±21.41
	winter	0.061±0.009	0.084±0.0007	0.084±0.012	0.067±0.002	37.76±16.85*	51.46±15.13
	spring	0.09±0.0007	0.1±0.002	0.075±0.002	0.048±0.05	16.04±4.18*	35.74±25.48

*significant difference between sampling area.

Zinc concentrations is significantly higher ($p<0.05$) in gonads than in liver and finally in muscle, however, there is no significant difference between the concentrations of Cd and Ni in the three organs.

The comparison between the levels of contamination of mullet from the two sites is very difficult because the results are heterogeneous through the season. The contaminant concentrations of mullet tissue may partly reflect the sediment countenance of the same contaminant in the same area, and the degree of their bioavailability and the ability of fish to biotransform it (Martínez-Gómez *et al*., 2012). Knowing that the transfer of the contaminants (Cd, Zn, Ni) through the food chain is low (IPCS/INCHEM, 2014a; IPCS/INCHEM, 2014b; IPCS/INCHEM, 2014c), so, most of these items comes from water (Martínez-Gómez *et al*., 2012). It signify that the concentrations of trace elements depend on endogenous variation like the increase of the metabolic activity of fish related to temperature through seasons (Kargin, 1996), and also on exogenous variations like the abiotic factors (temperature, salinity) that govern the bioavailability of contaminants in water. .

The concentrations of Cd and Ni found in muscle of *M. barbatus,* are in the concentration ranges observed in Turkey on the same species (Tepe *et al*., 2008) but far exceed the concentrations found in mullet muscle in Italian Studies (Conti *et al*., 2012; Copat *et al*., 2013).

Finally, the mean concentration of Cd in muscle of red mullet that is the edible part is 0.059 ± 0.025 µg/Kg wet weight and 0.062 ± 0.036 µg/Kg wet weight respectively for fish from Oran and Beni Saf. These concentrations are within the maximum permissible doses fixed by FAO 1983 for Cd, that is 0.5 µg/g muscle fish, in Oran and slightly higher in Beni Saf. These concentrations are not harmful for human health but must be monitored.

Conclusion

This study provides informations on the metal contamination at the Algerian coast. This paper note that all metals measured are present in the different organs of red mullet on both sampling sites, this fish has a great commercial value and is very appreciate locally. The relationship between fish size and contamination among mature individues could not be proved, it is noted that all metals are accumulated at variable rates by the fish tissues depending on the organ and the metal. The variations of metal concentration in *M. barbatus* can be influenced by seasonal variation.

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