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Metal Contamination of a Fish Species (*Mugil curema*) of the Beach of Soumbedioune (Dakar/Senegal)

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Authors' contributions

This work was carried out in collaboration between all authors. Authors MN and ID designed the study, performed the statistical analysis, wrote the protocol and first draft of the manuscript. Authors ID, CTD, BN and CD managed the analyses of the study. Authors CD, AD, DC and MH managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This present work consists in studying the metal contamination of the beach of Soumbédioune, located at the western frontage of the Dakar area. This site, unloading place of fishery products, includes the channel IV which drains urban rejected waters. We determined the concentrations of the metal elements (Fe, Zn, Cr), in *Mugil curema* with spectrophotometry UV-visible. Metal elements can be very dangerous for human health when they are present in the environment at high concentrations. Thus the study of the metal contamination in the marine organism, in particular fish, makes it possible to envisage a possible contamination of the man. The results obtained show that the concentrations of the metal elements vary according to the weight and the size of the mullets. T

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he maximum content in chromium of 133 µg/g was obtained with *Mugil curema*1, that out of iron was of 85.5 µg/g with *Mugil curema*8 and that out of zinc obtained with *Mugil curema*1 was of 150 µg/g. However the found values are definitely higher than the standards established by FAO and the EEC.

Keywords: Mullets; metal parameters; spectrophotometry; contamination.

1. INTRODUCTION

The physicochemical and metal quality of the marine environment plays a very significant role in the determination of biological quality and the degree of the pollution of this medium.

In this medium, all pollutants particularly heavy metals as well as the natural substances are subject to the biogeochemical phenomena [1].

Heavy metal can be found in water, in form of complexes mineral or organic, in colloidal or particulate form and are thus distributed in the aquatic environment [2,3].

Urban used water is one of the principal sources of metal contamination in aquatic ecosystems [4].

The transformation of the metal elements is due to physicochemical or biological factors, which can neutralize these metals and, facilitate their dispersion in the marine environment and increase their degree of toxicity [1].

To this end, several studies have been undertaken in order to evaluate the levels of metal contamination of organism [5,6] and particularly on pollution by metals of various edible fish species [7-11].

Fish is used as bio-indicator to determine the contamination of aquatic ecosystems [12].

It is very significant to note that the muscles usually have a low content of metals because of their weak metabolic activity but they can be used as circumstantial biological indicator because of its mass compared to the other organs like the liver. The concentration of heavy metals sin the muscles of fish, exposes man to metal contamination by the fish [13].

The goal of this study is to determine the concentrations of metals (Fe, Zn, Cr) in the flesh of a fish species (*Mugil curema)* in order to evaluate the level of contamination of our coasts.

2. MATERIALS AND METHODS

2.1 Study Site

Dakar area constitutes a significant economic region in Senegal because of its strong concentration of light and heavy industries located near the seaside. This area comprises several wet depressions that are coasts. Hence we were interested in the evaluation of metal bio-accumulation in fish in the bay of Soumbédioune. The beach of Soumbédioune is located in the district of Medina in Dakar, on the western cornice. It is a place of unloading fishery products which receives used water coming from the western channel which crosses part of the Dakar area.

2.2 Sampling

The set aim was to obtain a range of representative samples which reflects all the physical and chemical characteristics of studied site. The principal stages which characterize a step of sampling are the development of a strategy of samplings on the sites and their conservations.

The fish samples (n=9) were collected on the level of bay of Soumbédioune. They were transported to the laboratory and measured the weight and the size and preserved in the refrigerator at a temperature of -20°C before preparation.

The results of measurements were gathered in Table 1.

Table 1. Weight and size of the mullets

Mugil curema	**Weight**	**Size**
Mca 1	199.26 g	27.4 cm
Mca 2	121.84 g	22.2 cm
Mca 3	98.65 g	21 cm
Mca 4	94.80 g	20.5 cm
Mca 5	72.70 g	19.5 cm
Mca 6	85.71 g	19.5 cm
Mca 7	62.78 g	17.5 cm
Mca 8	48.14 g	15 cm
Mca 9	43.63 g	14.5 cm

Mca: Mugil curema

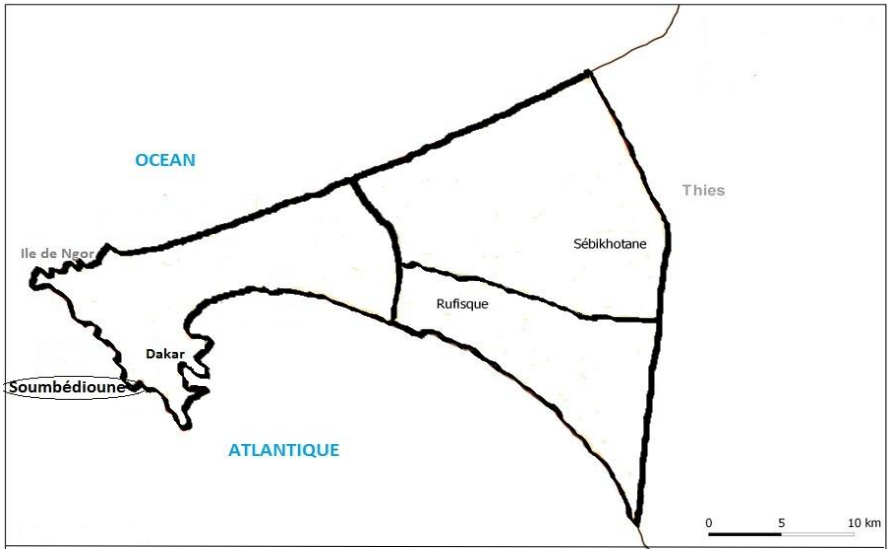

Fig. 1. Mullet's extraction points

2.3 Preparation of the Samples

At the laboratory, Fish was dissected and the flesh was removed and dried in a drying oven for 2h at 60°C until the weight became constant and finally the samples were crushed and preserved in plastic sachets.

2.4 Experimental Methods

The analysis of the metal elements (Fe, Zn and Cr) in the flesh of *Mugil curema* was carried out at the Organic Physical Environmental Analysis Laboratory of the Faculty of Science (Dakar).

The analyses were made in four stages.

2.4.1 Preparation of the white and the sample

The white can consist of demineralized water or the sample to be analyzed without addition of reagents.

The preparation of the sample to be analyzed consists in adding reagents in 5 or 10 ml of the prepared solution. It is a method of analysis per proportioned addition. It is very significant to respect the reading time prescribes in the protocol of analyses to ensure a homogeneity of the solution to be proportioned.

2.4.2 Preparation of the photometer

The apparatus comprises several methods of reading of the content of the element to be proportioned: Visocolor, Visocolor Eco or nanocolor with wave-lengths of 520 and 605 nm. Themethod, to choose, depends on each element and its measurement is posted directly on the screen of the apparatus.

2.4.3 Adjustment of the zero of the concentration

The zero of the concentration must be adjusted before each measurement.

2.4.4 Measurement of prepared sample

The sample was placed in the measuring cell and the concentration of the sample was read directly on the screen of the apparatus in mg/L.

3. RESULTS AND DISCUSSION

3.1 Metal Parameters in Fish

The mean concentrations of heavy metals in the flesh of *Mugil curema* are shown in Table 2.

The results show that chromium had the highest average concentration of 133 µg/g in *Mugil curema* 1 (Mca1) and the lowest concentration of 8.7 µg/g in Mca5.

The iron records concentrations that vary between 6 to 85.5 µg/g of dry weight.

Zinc is not detected for the Mca3 mullets to Mca9 however we see a variation of 70 µg/g with Mca2 to 150 µg/g with Mca 1.

Table 2. Average concentrations of metals (Cr, Fe and Zn) of µg/g of dry weight in the flesh of the mullets

Metals / Mullets	[Cr]±σ (µg/g)	[Fe] ±σ (µg/g)	[Zn]±σ (µg/g)
Mca1	133.0±8.5	26.3±5,7	150.0±14.0
Mca2	21.3±6.8	40.5±12.0	70.0± 10.0
Mca3	18.7±1.5	6.7±0.5	<LD
Mca4	13.7±1.1	6.0±2.6	<LD
Mca5	8.7±2.1	23.5±2.1	<LD
Mca6	15.3±3.7	6.3±1.0	<LD
Mca7	17.3±3.2	46.7±1.5	<LD
Mca8	15.3±3.2	85.5±6.0	<LD
Mca9	15.3±1.5	60.3±6.0	<LD

< LD: lower than the limit of detection

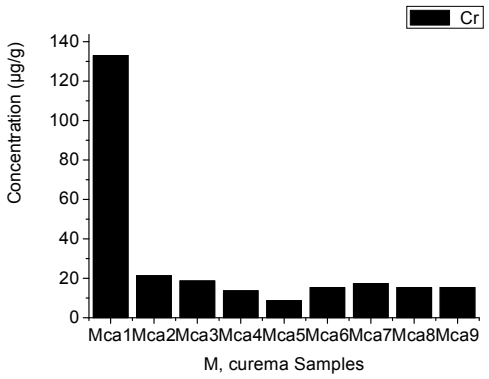

Fig. 2. Average chromium concentration

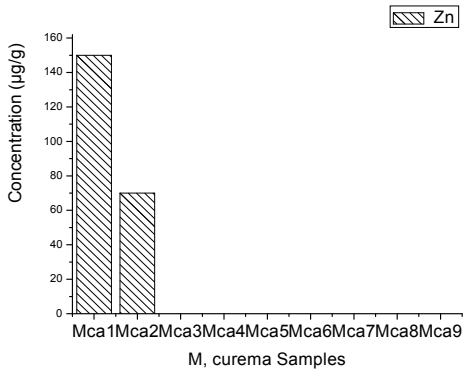

Fig. 3. Average zinc concentration

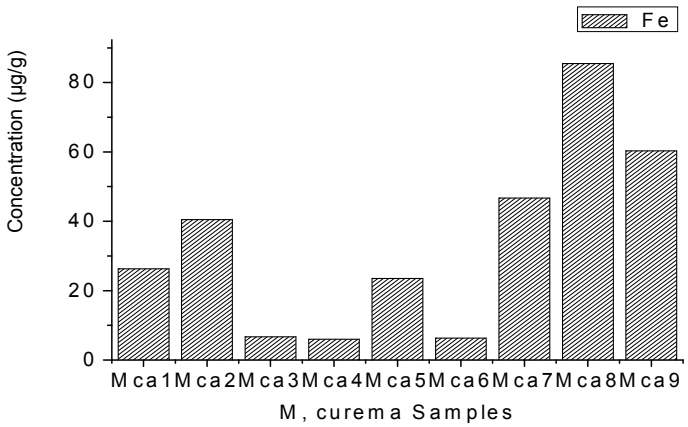

Fig. 4. Average iron concentration

The contents obtained for certain mullets are however higher than the standards established by the OMS/FAO for the zinc which is of 70 µg/g and for the chromium which is of 5.5 µg/g according to the CEE/R n466/2001 [14].

For iron the value reference is of 20 µg/g, which corresponds to the maximum value in which the toxic effects related to the food iron quantity eaten can show [15].

3.2 Study of the Variation of the Content of Each Metal in the mullets

The correlation between the concentrations of heavy metals and the size of the species depends on several factors, such as the metabolism of specific metal in fish, the type of fabric considered, competition between the effects of ageing, the tissue growth and the availability of metal in the environment [16,17].

Concentrations of metals higher present at the young species generally reflect time court of accumulation in fish, combined with the higher rate of metabolism compared to the adult organism [18,19].

The differences in concentrations metal between the species can be related to the habitat, the mobility of fish, the food, or with other characteristics of the behavior.

According to our study, the maximum content chromium plates some is obtained with Mca1 whose size is larger (Fig. 2).This could be explained to the fact why the oldest fish are contaminated because they have a more significant residence time compared to the least old. They thus accumulate of chromium which is a very toxic element and not essence [20].

Similarly for the zinc, the detected concentrations are higher for the oldest mullets whose weights and size are more significant (Fig. 3).The least old need the essential elements for the growth. It is for that, that they consume all accumulated zinc.

The accumulation of iron is more significant for the mullets whose weights and size are less significant (Fig. 4). This could be explained owing to the fact that the least old fish need more iron than oldest because this one is a trace element essential to their growth.

4. CONCLUSION

The pollution of the environment by heavy metals (iron, chromium, zinc, copper, nickel, mercury, arsenic and cadmium) is due to emissions coming from the human activities.

Within the context of this work, we established the profile of contamination of the coasts of Dakar Area, by the proportioning of heavy metals in the flesh of *Mugil curema*. The analyses were carried out by spectrophotometry UV-VISIBLE using photometer PF-11.

The results obtained, starting from biological biological indicator, allow an evaluation of the state of contamination by iron, the zinc and the chromium of Dakar Area. A quantification of the impact of the contributions anthropic of these metals in the aquatic environment was also carried out.

The strong contents of metals found in the flesh of *Mugil curema*, revealed the real danger which this part of the littoral dakarois presents, which is used for the fishing and the unloading of the products halieutics. Moreover, the fish consumption of this zone can cause a problem of public health.

It is urgent to carry out a regular control based on an effective policy whose actors will be the State, the industrialists and the scientific community.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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