MERCURY CONTAMINATION OF RAJA SPECIES FROM COASTAL SEA OF BAR REGION

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Abstract

The Adriaic Sea, as other seas and ocenas, have natural mechanisms to store, and in many cases, decompose natural or man made polutants and contaminants. Mercury is a metal which is released into the environment from the natural and anthropogenic sources. Once released, mercury undergoes a series of complex transformations and cycles between atmosphere, hydrosphere and pedosphere. Methyl mercury is a chemical form of mercury which is by far, the most common form in the food chain. Fish and fish products are the dominant source of methyl mercury in food. Methyl mercury is rapidly accumulated by most aquatic biota and attains its highest concentrations in fish who are at the top of the aquatic food chain. The aim of this research was to obtain data on mercury contamination in Raja fish, that are often used as a food in coastal region. The fish were sampled from three localities in Bar region: Volujica, Bar harbour and Sutomore. The mercury contamination was tested in muscle tissue, applying Atomic Absorption Spectroscopy by the Thermo Electron S2 AA System. Two species of Raja genus were present: *Raja montagui* and *R. miraletus*. All collected fish had mercury contamination in musscle tissue near or above the proposed levels by Commission Regulation (EC) No 1881/2006.

Introduction

Considering the numerous harmful effects on the marine ecosystems and the vigorous antagonism between ecology and economy, awareness of the necessity for continuous monitoring sediment - water - organism interactions has been increased, with the aim to protect and preserve marine environment quality.

The oceans and seas are ecosystems with natural mechanisms to store, and in many cases, decompose polutants and contaminants which have been released by the industry in restricted extent. However, this ability varies depending on numerous factors, such as: size of the sea or ocean, its currents, circulation speed, tides, temperatures, depth, freshwater flow, and even because of marine wildlife density and diversity.

The Adriatic Sea is a spacious bay of the central part of the Mediterranean Sea, of which is divided by the Apennine Peninsula. The harbor Bar is the most important Montenegrin port, located in a natural bay between the old city of Bar and Ulcinj, protected from the south by the hill Volujica, with a wide opening to the west. The total length of the operational shore is 3 km, which could host 20 ships at the same time. The closed storage area has more than 100.000 m^2. The harbour Bar is capable for all types of goods transshipment, especially, ores, concentrates, metallurgy products, oil and its derivatives, grain and its products, fertilizers, pesticides, cement and wood.

Mercury is a metal which is released into the environment from both natural and anthropogenic sources. Once released, mercury undergoes a series of complex transformations and cycles between atmosphere, hydrosphere and pedosphere. Methyl mercury is a chemical form of mercury which is by far, the most common form in the food chain. Fish meat is the dominating contributor to methyl mercury dietary exposure for all age classes, followed by the fish products. According to WHO (World Health Organization), the mercury content in these commodities varies widely among different fish species, and is in general higher in predatory fish. Methyl mercury contamination negatively impacts human and animal health. The response of fish methyl mercury concentrations to changes in mercury deposition has been difficult to establish, according to Harris et al. (2007), as sediment contain large pools of historical contamination. Methyl mercury is rapidly accumulated by most aquatic biota and attains its highest concentrations in fish who are at the top of the aquatic food chain (Salonen et al., 1995).

Fish with their specific diet, feeding on phyto- and zooplankton, represent a suitable and accurate bioindicator for the marine water pollution analyses. They are the natural bioindicators that could in appropriatte time warn of the presence of the harmful substances in the water. As they are usually used in human nutrition, especially in the coastal regions, the harmful and dangerous substances are accumulated in thir bodies in the larger quantities than those found in the water column, which directly affects human health. Recently, special attention has been paid to the presence of mercury, as the new studies have shown an increase of mercury concentrations in the tissue of marine species. Summerizing all the researhes, a Global Ocean Observing System (GOOS) database was created, with all the known results so far detected throughout the world.

Raja are fish who belong to a genus of skates in the family Rajidae, which include 16 species. They have specific flat body with a rombic shape. These bottom-dwellers are active during both day and night, and typically feed on molluscs, crustaceans and fish, which make them a secondary consumers in the food chains. Fish accumulate methyl mercury in their tissues, where it becomes strongly bound. Methyl mercury is not removed from fish tissue by any practical cooking method (Hightower & Moore, 2003).

The aim of this research was to obtain data on mercury contamination in Raja fish, that are often used as a food in coastal region.

Experimental

The fish were sampled from three localities in Bar region: Volujica, Bar harbour and Sutomore (Figure 1.). The fish were collected from the daily catch of the local fisherman by the random principal choice. The mercury contamination was tested in muscle tissue, applying Atomic Absorption Spectroscopy (AAS) by the Thermo electron S2 AA System

The standard metal solution (stock solution, 1000 mg/L) was made by dissolving 1 g of metal or its salt (calculated on 1,000 g of metal) in hydrochloric acid (1:1). Deluting the stock solution (with water), a series of lower concentration of methal were prepared.

Results and discussion

Two species of skates were present: *Raja montagui* Fowler, 1910 and *R. miraletus* Linnaeus, 1758.

All collected skate specimens had mercury contamination in musscle tissue near or above the proposed levels by Commission Regulation (EC) No 1881/2006 (Table 1.).

Table 1. Mercury concentrations in skate musle tissues

The sample locality	Species	Average concentration of detected Hg (mg/kg)
Volujica	*Raja montagui*	1,15*
Volujica	*Raja miraletus*	0,70
Harbour Bar	*Raja miraletus*	0,85
Sutomore	*Raja miraletus*	0,50

*results above the maximum permissible concentrations (MPC) according to Commission Regulation (EC) No 1881/2006

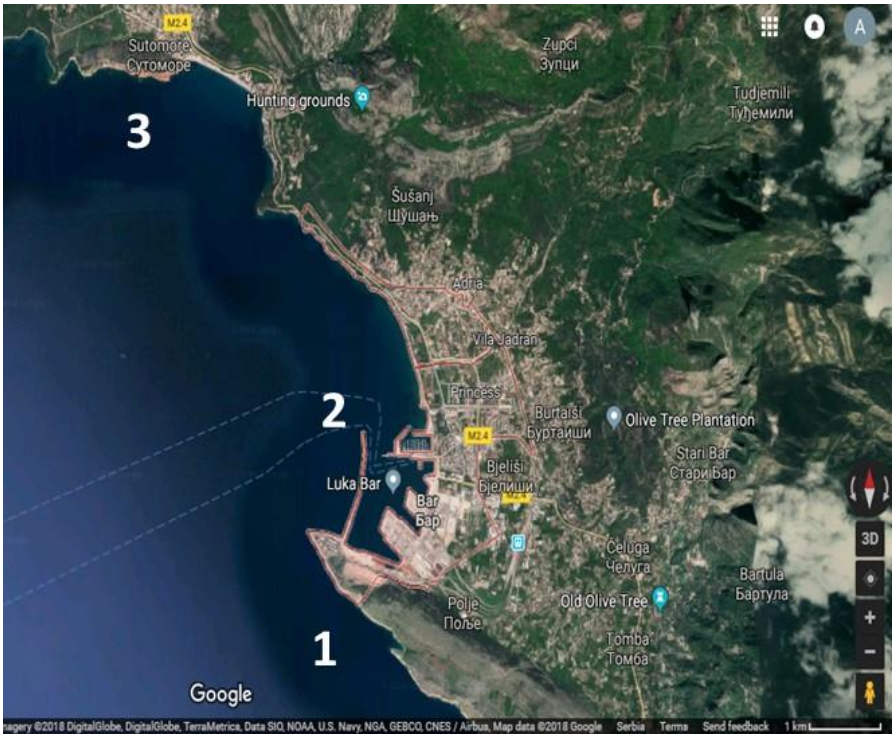

Figure 1. The sample localities: 1 – Volujica, 2 – Harbour Bar, 3 - Sutomore

The prospected fish species, have had relatively high concentrations of mercury contamination, but according to Quian et al. (2001), variance among fish genera and species indicate the need for an indicator genus or species for future studies.

R. montagui is a small skate, widespreaded in the inshore waters and shallow shelf seas of the Northeast Atlantic and is common throughout the Mediterranean Sea. Juveniles tend to occur closer inshore on sandy sediments, with adults also common further offshore on sand and coarse sand-gravel substrates. Juveniles feed on small crustaceans, with larger individuals predating on larger crustaceans, and fishes (Ellis et al., 2007). *R. miraletus* is found predominantly on the shelf and appears to be one of the most abundant skates in the Mediterranean. The small maximum size of this species suggest it is likely to have a relatively short generation time and a relatively high capacity to replace numbers lost to exploitation (Smale et al., 2009). The high mercury concentration in these fish could be explained by their place in the marine food chain, as well as their preference to live at sea bottom, closely to sediment which is also contaminated.

Conclusion

Of all the heavy metals, mercury is one of the most dangerous environmental unorganic poisons, as it has no known physiological role in human metabolism. Haevy exposure to mercury, usually by food intake, causes a number of effects in the human body. Methyl mercury is absorbed on average 95% when consumed (Hightower & Moore, 2003). Methyl mercury could be accumulated, if consumed, at a greater rate than it is excreted by feces, urine and sweat. Usually, it has been accumulated in brain, muscle and kidney, not only in humans, but in all vertebrata species. Moreover, methyl mercury can cross from the maternal to fetal blood compartmnets, as well as it can cross the blood brain barrier, where biotransformation to inorganic mercury takes place.

At prospected localities, two Raja species were identified and in all collected specimens mercury concentrations were near or above the maximum permissible concentrations (MPC) according to Commission Regulation (EC) No 1881/2006. Fish and fish products are the dominant source of methyl mercury in food. Since raja species are frequenty found on culinary menus in the coastal region of Montenegro, the continuous monitoring of heavy metal contamination shoud be conducted, not only in fish body, but in sediment and water also.

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