

^{210}Po in shellfish *Mytella falcata* from a tropical estuary

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Abstract. Edible parts of the shellfish *Mytella falcata* collected in Mundaú Lagoon, a tropical estuary in the northeast coast of Brazil, were analyzed for ^{210}Po contents. This lagoon serves as an estuary to the Mundaú River and a phosphate fertilizers factory is installed in its right margin. The bivalves were manually collected during the first two weeks of March 2007 and February 2008. The method for ^{210}Po determination consisted of spontaneous deposition on copper disks followed by alpha counting. A decrease of the activity concentration of ^{210}Po with soft tissue weights was achieved, presenting a significant linear relationship ($p < 0.05$). The average value found for the activity concentration of ^{210}Po in *Mytella falcata* was $88.4 \text{ Bq} \cdot \text{kg}^{-1}$ wet weight.

1. INTRODUCTION

^{210}Po ($t_{1/2} = 138.4$ days) is a naturally occurring radionuclide within the ^{238}U decay chain. It is a high energy alpha emitter and is considered to be the most important contributor of radiation dose received by the human beings via seafood, because of its high accumulation rates in the edible parts of marine organisms [1–3].

^{210}Po is concentrated in most marine organisms by factors of 10^3 – 10^5 relative to seawater concentration and its accumulation varies from one tissue to another, according to the capacity to concentrate polonium [2]. This radionuclide gives rise to almost 7% of the dose equivalent, through natural radiation intake [4] and about 77% of daily intake comes from solid food, mainly seafood [5].

The ^{210}Po activities in estuaries and other coastal areas can vary largely, depending on the geology of the watershed and the chemical weathering conditions [6]. Moreover, these activities can be increased by industrial and agricultural impact, resulting from the manufacture and use of phosphate fertilizers, since phosphate rocks contain relatively high concentrations of occurring radioactive materials from the uranium and thorium decay series [7–10].

The increasing demand of land owing to the expansion of the agricultural activities and the installations of new industrial plants leads to serious impacts upon estuaries and coastal waters, with implications on the water quality, fisheries yields, tourism and a socio-economic scenario as a whole.

The transport, modification and degradation of the carrier-pollutant associations have to be related to the gradients of the estuarine mixing zone and dispersion in the coastal waters. River borne materials introduced to the estuary react and undergo particle-solution transformations due to sudden changes in salinity, pH, turbidity, respiration and primary production. Some are retained by sedimentation and others are by-passed without reaction to the sea. The degree to which materials are retained or exported to the sea also depends upon the systems flushing time. Coastal lagoons are more apt to retain and recycle materials, than estuarine-deltas [11].

Bivalves have continuous contact with the sediments because of the sedentary mode of life and feed from the particulate materials which are sources of ^{210}Po .

In this paper, edible parts of the shellfish *Mytella falcata* of Mundaú Lagoon were analyzed for ^{210}Po contents. This bivalve represents a good source of proteins and has an economic relevance, since its production is about 5 tons a year.

2. MATERIALS AND METHODS

2.1 Study area

The estuarine-lagoon system of Mundaú-Manguaba is situated on the northeast coast of Brazil, state of Alagoas, close to the city of Maceió ($9^{\circ}35' \text{ S}$ and $35^{\circ}50' \text{ W}$) and corresponds to a choked system characterized by a large potential for material recycling and retention. It has an area of 79 km^2 with two main water bodies, which converge at their lower portions with a single access to the sea. Due to the strong dependence on salinity, the shellfish *Mytella falcata* occurs only in some parts of Mundaú Lagoon, which has an area of 27 km^2 and serves as an estuary for Mundaú River.

This region is affected by the sugar-cane monoculture (Alagoas is the third state of Brazil in the production of sugar-cane) and the estuary receives discharges of chemical contaminants, together with domestic, industrial and agricultural wastewaters. A phosphate fertilizers factory is installed on the right margin of Mundaú River, close to its mouth.

Due to the impoverishment of soil quality in the monocultures, as a consequence of the long-term exploitation of the same mineral resources, fertilization is a permanent requirement and the major part of the phosphate fertilizers produced in the region are used in the sugar-cane monoculture.

2.2 Sampling

Mytella falcata is a filter-feeding bivalve that lives fixed on the bottom, covering the sediments in some places of the Mundaú Lagoon. The organisms were obtained from the fishermen who dove to collect them during the first two weeks of March 2007 and February 2008. After this the bivalves were washed thoroughly with distilled water to free them from attached particulate matter owing to high radionuclide association with silt/detritus materials.

During the first two weeks of March 2007 and February 2008, bivalves were found only in one place in the sediments of Mundaú Lagoon. The organisms collected in 2007 were divided randomly in 5 different lots. From each lot five organisms were separated randomly and analyzed individually.

The organisms collected in February 2008 were separated by size (3.0 cm, 3.5 cm and 4.0). Organisms with 4.0 cm size were the largest observed. Five organisms of each size were separated and analyzed individually.

2.3 Analytical procedure

To determine ^{210}Po in these bivalves, the soft tissues were separated from the valves and each sample was weighed and spiked with a known activity of ^{208}Po as an internal isotopic tracer for radiochemical yield, then digested by concentrated HNO_3 and after that by H_2O_2 30%. The solution was boiled for 2 hours, cooled and then filtered. The filtrate was evaporated at 80°C until dryness. The residue was dissolved in 0.5 M HCl and 1 g of hydroxylamine hydrochloride was added, heated at 90°C and polonium was spontaneously deposited on copper disks during 4 hours.

For determination of ^{210}Po activity, an alpha spectrometry system was applied with a silicon surface barrier detector, ORTEC, model 576, coupled to a computer for spectrum analysis [12].

Analytical quality was made by analysis of blank and reference standard (spiked sample) for every 20 analyzed samples, according to EPA recommendation [13].

3. RESULTS AND DISCUSSION

The Kruskal-Wallis ANOVA test analysis has shown no significant differences ($p > 0.05$) for the analyzed ^{210}Po activities between the three size classes of organisms collected in February 2008 (Fig. 1).

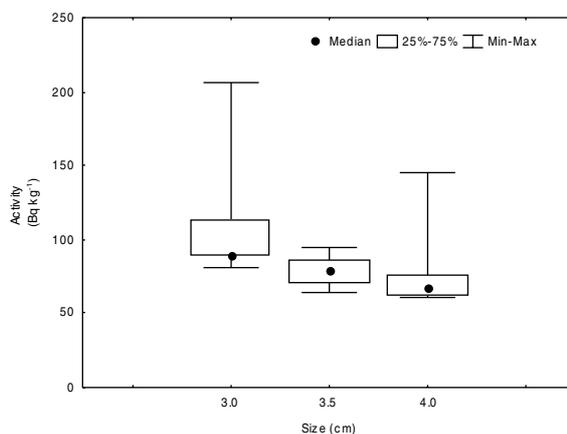


Figure 1. Median and range (min – max) of the activity concentration of ^{210}Po in the soft tissues of *Mytella falcata* according to their total shell length.

The activity concentration of ^{210}Po in *Mytella falcata* decreased with soft tissue weights (W), presenting a significant linear relationship ($p < 0.05$) (Fig. 2). It is important to note that the younger organisms bioaccumulate faster the pollutants than the older ones and/or the corporal mass dilution could be occurring.

Table 1 shows the results obtained for ^{210}Po average activity concentrations for the organisms collected in March 2007.

The ^{210}Po activity concentrations in *Mytella falcata* found in 2007 (Table 1) and 2008 (fig. 1) are close to the smallest activity concentrations found for molluscs in the United Kingdom near a phosphate industry [7] and about 3.5 to 4 times higher than those found in mussels from the Turkish coast of Black

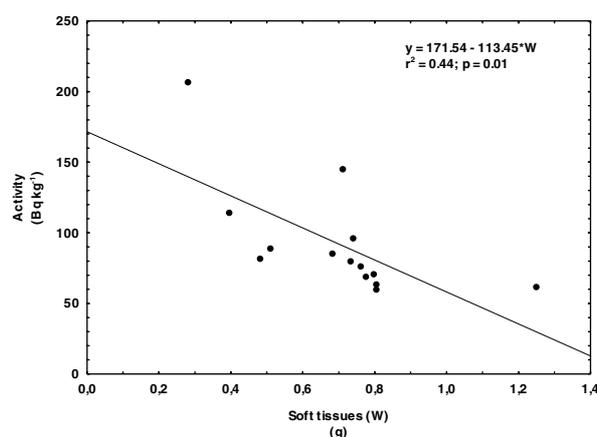


Figure 2. Relationship between ^{210}Po activity concentrations and the weight of the soft tissues of *Mytella falcata* from Mundaú Lagoon.

Sea [14], and in Cienfuegos Bay (Cuba) [15], respectively. When compared with the mussel *Perna perna* from Guanabara Bay, in the south eastern coast of Brazil [12], *Mytella falcata* presents an activity concentration for ^{210}Po 2 to 4 times higher. However this activity is about one half when compared with the mussels collected at Cabo Frio Island, approximately 100 km northeast of Rio de Janeiro city [16].

Table 1. ^{210}Po average activity concentrations in *Mytella falcata* from Mundaú Lagoon (March 2007).

Lot	^{210}Po (Bq kg ⁻¹ , wet weight)
1	85.1 ± 5.0
2	73.2 ± 4.9
3	89.6 ± 6.8
4	61.4 ± 4.2
5	71.6 ± 5.0

Further studies including sediments, water, fish and crustacean are necessary to verify the influence of the phosphate fertilizers factory in the ^{210}Po activity concentrations, and the contribution of these organisms to the radiation dose received by the population, because the levels of consumption of seafood are high in this region.

As the collections were made only in the summer, it could not be verified if there is seasonal variation in ^{210}Po activities in *Mytella falcata* from Mundaú Lagoon.

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