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ORIGINAL ARTICLE

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Seasonal variations of arsenic in mussels *Mytilus galloprovincialis*

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Abstract Total arsenic concentration in the edible part of mussels *Mytilus galloprovincialis* was evaluated seasonally in the coastal area of Rijeka Bay (North Adriatic Sea, Croatia). Sampling stations were located close to the City of Bakar with no industrial facilities (site 1), in the vicinity of the oil refinery and oil thermoelectric power plant (Urinj, site 2), and 4 miles away from the Plomin coal thermoelectric power plant (Brseč village, site 3). Additionally, the concentration of arsenic in the tail muscle of the lobster *Nephrops norvegicus*, collected in Rijeka Bay, was studied. During winter at sites 2 and 3, the total arsenic in the edible part of the mussels was 16.4 mg As/kg FW (FW=fresh weight) and 4.38 mg As/kg FW, respectively, and increased during springtime at site 2 (6.5 mg As/kg FW) compared to the rest of the year, when individual total arsenic concentration at all sites ranged from 1.7 to 3.7 mg As/kg FW. In the winter (sites 2 and 3) and springtime (site 2) there was no correlation between the length of the mussel shell and the arsenic concentration in the edible part of the mussels. In the other seasons, at sites 1, 2 and 3, there was a correlation between arsenic in the edible part of mussels and shell length in most cases (correlation coefficients r varied from 0.64 to 0.85; P <0.05 to P <0.01). Correlation between shell length (in the narrow range of shell lengths from 3.4 to 5.0 cm) and arsenic in the edible part of the mussels shows linearity with a high regression coefficient (r =0.914; P <0.001). The increase of arsenic in the mussels during winter and spring was suggested at least partially as a result of a low nutritional status, i.e. reduced weight of the mussels' edible part during winter. In addition, a linear relationship was found between body length and arsenic concentration in the tail muscle (mean 17.11±4.48 mg As/kg FW) of the Norway lobster.

Keywords Arsenic · *Mytilus galloprovincialis* · Rijeka Bay

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Introduction

The aquatic environment is important in the global cycling of arsenic. The background level of arsenic in marine environments is slightly higher (2–3 μg/l) than in freshwater and terrestrial environments (Moore and Ramamoorthy 1985; Phillips 1990). Atmospheric deposits, output from rivers, and up-welling from marine sediments lead to enrichment of arsenic in marine organisms. The arsenic content in the body results from the balance between the processes of metal accumulation and depuration. The dominant form of arsenic in marine and brackish waters is arsenate. Tissues of marine invertebrates accumulate arsenic in the range of 1–100 mg/kg DW (DW= dry weight), mostly in the form of organoarsenic (arsenobetaine) compounds. Up to 22% of the total arsenic is occasionally present as inorganic As (Neff 1997).

Arsenobetaine and arsenocholine are more efficiently accumulated from seawater by the mussel *Mytilus edulis* than other chemical forms such as arsenite and arsenate and other organometallic complexes (Gaisler et al. 1995). Arsenobetaine has been found to be the major organoarsenic compound in the muscle of freshwater fish (Shiomi et al. 1995). Excretion of dimethylarsinic acid in urine was significantly higher in volunteers following consumption of mussels containing high arsenic concentrations than would be expected on the basis of the present methylated derivatives in shellfish (Buchet et al. 1994).

Human consumers bioaccumulate mostly arsenobetaine, which is neither toxic nor carcinogenic to mammals, and therefore represents a low risk to the consumers