PAH CONTENT AND TOXICITY OF SEDIMENT, SEAWATER AND MUSSEL TISSUE IN GULF OF RIJEKA

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Abstract
The total concentrations of PAHs at 6 sampling sites of the Gulf of Rijeka vary from bellow detection limit to 305 ng/l in seawater, from 213 to 695 μg/kg dry weight in sediment and from 49.2 to 134 ng/g wet weight in mussel tissue. Toxicity of seawater and sediment organic extract is correlated with PAHs content indicating that PAHs are predominant toxic compounds. There is a positive correlation between potential toxicity of mussel biological fluids and reduction of anoxic survival time.
Keywords : Adriatic Sea, Pah, Bivalves, Ecotoxicology.

The Gulf of Rijeka is a landlocked bay of the Northern Adriatic Sea with an area of 450 km^2, average depth 60 m and volume of 27 km^3 with a number of industrial enterprises (petrochemical, electricity generating facilities fuelled by charcoal, shipyard and harbor) situated along its coastline in suburban areas of Rijeka. Therefore, an increase in anthropogenic influence on marine environment in Gulf of Rijeka especially with PAHs is expected. The concept of integrative chemical and biological monitoring for ecotoxicological evaluation of risk in environmental management was applied. The relationship between presence of specific contaminants (PAHs) in different matrices, their potential toxicity and ability to affect marine mussel was investigated. Collection of seawater, sediment and mussel specimens was performed at six sampling sites comprising site under the direct influence of refinery waste waters (1), oil refinery dock areas (2, 3), recreational areas (4, 6) and marina (5). The quantification of the PAH content in the samples was performed with HPLC and the potential toxicity of organic extracts of seawater and sediment as well as mussel biological extract was measured by Microtox bioassay. Physiological condition of mussels was measured as anoxic survival time [1].
The total concentration of the PAHs detected in the seawater, sediment and mussel varies indicating differences in recent input of PAHs in marine environment are in the range similar to those reported for the Thermaikos Gulf, Greece [2] (Table 1.).

Tab. 1. Total PAH content and toxicity of sediment, seawater and mussel tissue in Gulf of Rijeka.

	SEDIMENT		SEAWATER		MUSSEL	
SITE	PAH µg kg-1 DW	TOX 1/EC50*100	PAH ng l-1	TOX 1/EC50*100	PAH ng g-1 WW	TOX 1/EC50*100
1	213	0.65	237	6.3	103	1.4
2	241	0.80	294	5.4	134	1.7
3	624	0.89	291	8.5	57	1.4
4	511	0.92	d.l.	2.0	99	1.8
5	695	1.30	305	7.6	101	2.9
6	577	0.90	195	5.3	49	3.9
	R = 0.819		R = 0.894		No correlation	

The total PAH levels in sediment samples were similar to those reported for the Gulf of Trieste [3]. Two sediment samples (1, 2) could be classified as slightly contaminated and 4 sediment samples (3, 4, 5, 6) as highly contaminated. The levels of PAHs in mussels *Mytilus galloprovincialis* are within the same range reported for the same species from Thermaikos Gulf, Greece [2], in *M. edulis* from Northern Irish Sea Loughs [4] and in Baltic Sea bivalves *Macoma balthica* and *Astarte borealis* [5]. A good functional linear regression between toxicity data sets over seawater and sediments PAHs was noted (R = 0.894 for seawater, R = 0.819 for sediment) while no correlation between mussel toxicity and PAHs was observed. This result suggests that the PAHs represent the majority of toxic compounds present in organic extracts of seawater and sediment from the Gulf of Rijeka, while the level of toxic content in mussels depends not only on PAHs concentration in the environment but on their bioavailability, bioaccumulation and metabolisation in mussels, as well as on the presence of other toxic environmental contaminants accumulated by mussels. In search of correlation between PAH accumulation and physiological response determined as reduced capacity of mussels to adapt to additional stress, anoxic survival has been measured and the result are presented in Table 2.

The lowest anoxic survival time was detected for mussels with the lowest tissue PAH content suggesting that other environmental factors have influenced this response. Additional stressors might have affected viability of mussels as is the case with any field study. Positive correlation (R = 0.935) between potential toxicity of mussels and reduction of anoxic survival time confirms the presence of other unknown toxic contaminants, besides PAHs, that were accumulated in mussels and impacted the physiological parameter measured.

Tab. 2. Toxicity and anoxic survival of mussel *Mytilus galoprovincialis* collected in the Gulf of Rijeka.

SITE	1	2	3	4	5	6	
TOX 1/EC50*100	1.4	1.7	1.4	1.8	2.9	3.9	R = 0.935
Anoxic survival / days	8.4	7.4	7.8	7.2	6.4	6.0	

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