MARINE MACROALGAE FOR ASSESSMENT OF RADIONUCLIDE AND HEAVY METAL POLLUTION IN THE BLACK SEA

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Abstract
Radionuclide and heavy metal content have been monitored systematically since 1996 in eleven of the widespread Black Sea macroalgae species from the Bulgarian Black Sea coast by low level gamma spectroscopy and atomic absorption spectrometry. Tendencies in the concentration variations during the studied period are examined and all obtained data give information about different macrophytic species ability to accumulate certain nuclides and trace elements from one and the same sampling location. The obtained data are compared with the results from the regions of the Black Sea, Mediterranean, Tyrrhenian and Atlantic Ocean
Keywords : Algae, Black Sea, Bio-accumulation, Radionuclides, Trace Elements.

Aquatic organisms, especially macroalgae are widely used as bioindicators for the study of marine contamination by radionuclides and heavy metals. Some species tolerate high levels of pollutants and can successfully be used to obtain reliable information of marine ecological status.
In order to evaluate the ecological status of coastal habitat and provide valuable data for estimation of contaminants, an environmental monitoring program was started and performed along the Bulgarian Black Sea coast. Radionuclide and heavy metal content was monitored in eleven macroalgae species collected from about 20 reference locations during the period 1996-2005. Data are obtained for the most widespread species from the phylum Chlorophyta (six), Rhodophyta (three) and Phaeophyta (two), accumulation capacities are compared within and between Phylum and species to assess the levels of bio-accumulation and potential application as bio-indicators.

Tab. 1. Radionuclide activity concentrations in macroalgae collected in the Mediterranean and Black Sea. * present study.

Algae	^{137}Cs Bq/kg	^{40}K Bq/kg	^{210}Pb Bq/kg	^{226}Ra Bq/kg
Ceramium rubrum[1]	0.8	-	-	-
Cystoseira sp. [2]	1.5	900	-	-
Cladophora sp. [2]	n.d.	2170	-	-
Enteromorpha sp. [2]	5	1076	-	-
Chaetomorpha sp. [2]	11	2525	-	-
Ulva sp. [2]	6	930	-	-
Corallina sp. [2	5	250	-	-
Ceramium rubrum[2]	12	880	-	-
Ulva sp.*	3.4	596	6	9.3
Ceramium sp*	9.4	1343	13	17
Cladophora sp. *	12	1300	8	12
Enteromorpha sp. *	4.5	690	7	10
Cystoseira sp.*	5.4	1400	12	11
Chaetomorpha sp.*	2.3	1860	10	7
Corallina sp. *	2.1	140	12	10
Callithamnion sp *	4.4	1580	10	7
Ulva sp [3]	< 1.2	900	3.49	< 1.7
Cystoseira sp [3]	< 1.1	1800	8	1.2

The data for macroalgae, obtained by us are compared also with authors from the Black Sea region - (Romanian, Turkish) and Mediterranean Sea (Syrian) for radionuclides (Table 1) as well as Tyrrhenian (Italian) and Atlantic for trace elements (Table 2).
This work establishes a data base for radioecological status of Bulgarian Black Sea marine ecosystems concerning the radionuclide and trace metal content along the Bulgarian coast. Data were obtained at the chosen 20 locations for the eleven macroalgae species in the period 1996 - 2005 indicating no serious antropogenic pollution along the shore.
The studied macroalgae species are suitable for assessment of nuclide and trace metal behavior in the Black Sea ecosystems and some species can be used as bio-indicators for the status of the marine habitat.

Tab. 2. Trace element concentrations in macroalgae collected in the Tyrrhenian Sea, Atlantic Ocean, and Black Sea. *present study.

Algae	Cd mg/kg	Cr mg/kg	Cu mg/kg	Mn mg/kg	Zn mg/kg	Pb mg/kg
Ulva lactuca [4]	1.35	< 1	7.5	-	34.2	6.5
Cystoseira sp. [4]	1.3	< 1	4.2	-	33	5.3
Ulva lactuca [5]	0.5	0.5	24	50	24.1	23.5
Cystoseira sp. [5]	0.75	0.95	6.85	25	97	14
Ceramium rubrum[5]	0.8	1.5	16	59	62	11
Ulva sp.*	0.8	1.8	5.6	40	24	1.7
Ceramium sp*	0.9	6	7.6	120	22	2.2
Cladophora sp. *	1	7	6	170	19	3.5
Enteromorpha sp. *	0.8	5.3	7	47	14	2.4
Cystoseira sp.*	0.3	2.3	4	42	1.6	18
Chaetomorpha sp.*	1.3	7	5	180	12	2.7
Corallina sp. *	0.7	4.8	1.5	55	13	1.4
Callithamnion sp *	0.5	3.7	5.4	87	18	2.3
Enteromorpha sp. [6]	0.07	0.54	11.4	21	14	1.06
Ulva sp [7]	0.18	1.63	5.8	-	45	1.94
Padina pavonica [8]	1.56	3,6	13.3	-	84	11.4
Ulva sp [9]	0.24	4.78	4.7	194	26.1	-
Ulva sp [10]	0.6	1.56	5.5	-	5.2	3.68

References

1 - Bologa A., Apa M., Cociasu A., Cuingoglu E. Patrascu V., Pecheanu I., Piescu V. Popa L., 1996. Present level of contaminants in the Romanian Black Sea sector, *IAEA TecDoc 1094*, 469- 475.
2 - Guven K.C., Topcuoglu S., Gungor N., 1993. Chernobyl radioactivity in Algae Collected from the Marmara and Black Sea. *Turkish J. Nucl. Sciences* 20: 21-30.
3 - Al-Masri M S, Mamish S., Budier Y., 2003. Radionuclides and trace metals in eastern Mediterranean Sea algae *J. Env. Radioact.* 67: 157-168.
4 - Guven K.C., Okuş E., Topcuoğlu S., Esen N., Kücükcezzar R., Seddingh E., Kut D., 1998. Heavy Metal Accumulation in Algae and Sediments of Black Sea coast of Turkey *Tox. Env. Chem.*, 67: 435-440.
5 - Topcuoglu S., Guven K.C., Kirbasoglu C., Gungor N., Unlu S., Yilmaz Z., 2001. Heavy Metals in marine algae from Sile in the Black Sea *Bull. Env. Contam. Toxicol.*, 67: 288-294.
6 - Favero N., Frigo M.G., 2002. Biomonitoring of metal availability in the southern basin of the lagoon of Venica (Italy) by means of macroalgae, *Wat. Air Soil Poll.* 140: 231-246.
7 - Campanella, L., Conti, M., Cubadda, F., Sucapane, C., 2001. Trace metals in seagrass, algae and molluscs from an uncontaminated area in the Mediterranean C. *Env. Poll*. 111: 117-126.
8 - Malea P, Haritonidis S. 2000. Use of green alga Ulva rigida C. Agardh as an indicator species to reassess metal pollution in Thermaikos Gulf, Greece, after 13 years *J. Appl. Phicology*, 12, 169-176.
9 - Muse, J., Stripeikis, J., Fernandez, F., Huicqui L., Tudino M., Carducci C., Troccoli O., 1999. Seaweeds in the assessment of heavy metal pollution in the Gulf San Jorge, Argentina *Env. Poll.*,104: 315-322.