USING MARINE MACROALGAE AS BIOMONITORS: HEAVY METAL POLLUTION ALONG THE TURKISH WEST COASTS OF THE BLACK SEA

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Abstract
Heavy metals (Fe, Zn, Ni, Cu, Mn, Co, Pb and Cd) were determined in *Ulva lactuca*, *Enteromorpha linza* and *Cystoseira barbata*. Samples were collected during summer 2013 from 4 different sites of the Turkish Black Sea coastal zone. All metals except Zn and Pb in macroalgae were high in Inebolu. Metal levels except Cd in *U. lactuca* from Inebolu region were lower than the maximum permissible values of French regulation (>0.5 mg/kg dry wt.).

Keywords: Algae, Black Sea, Metals, Bio-accumulation, Bio-indicators

Introduction
Aquatic ecosystems are contaminated by heavy metals and they cause serious ecological changes, due to their toxicity, persistence and accumulative behaviour in the organisms, resulting in accumulation in biota [1]. Marine macroalgae are used as biomonitors for environmental assessment in coastal areas due to their accumulation capacity. They are primary producers and have an important role for transferring of pollution to upper levels in food webs. Seaweeds have been used in many Asian countries as habitual diet, however in Europe they are considered as novel food [2]. France was the first European country to establish a specific regulation concerning the use of seaweeds for human consumption as non-traditional food substances. There is a tendency to monitoring macroalgae due to their ecological significance and also nutritional value. Therefore, it is important to determine heavy metal concentrations in seaweeds. The Black Sea has been exposed to pollution pressure that derives both from human activities and natural sources. Many studies are available on heavy metal concentrations in macroalgae species in the Black Sea [1]. Nevertheless, there is no a regulation about the usage of seaweeds for human consumption in the Black Sea countries. The aim of this study is to determine essential (Fe, Zn, Ni, Cu, Mn, and Co) and non-essential (Pb and Cd) metals in macroalgae of the southern Black Sea coasts for the monitoring of the metal pollution in 2013.

Materials and Methods
U. lactuca, *E. linza* and *C. barbata*) were collected in 2013 from Igneada, Inebolu, Sinop and Samsun (Fig. 1) and were washed, dried and homogenized. Then algae were digested with concentrated HNO_3 (Merck) and evaporated. Metals were determined using a UNICAM 929 Flame Atomic Absorption Spectrophotometer. The digested samples were analysed with 3 replicates and were expressed as mg/kg dry wt.

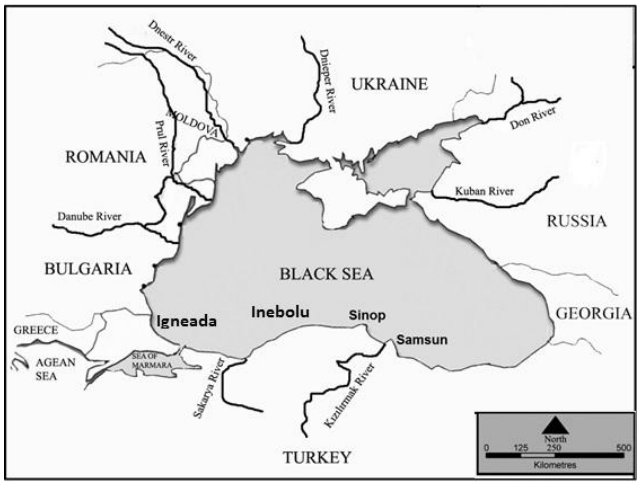

Fig. 1. Study area.

Results and Discussion
The relative abundance of metals in macroalgae followed the order of Fe>Zn>Mn>Cu>Ni>Pb>Co>Cd>Hg. Bat [1] pointed out the high uptake of Fe and Zn in green algae and Ni, Cu, Mn and Pb in brown algae, suggested that these algae may be used as potential biomonitors for heavy metal pollution. Results showed that metal concentrations were high in Inebolu whereas the highest Zn and Pb levels were determined in *C. barbata* and *U. lactuca* from Samsun coasts, respectively. All metal levels were the lowest in Sinop coasts (Table 1).

Tab. 1. Minimum and maximum concentrations (Mean± SD) of heavy metals in macroalgae collected during summer 2013 along the southern coastal zone of the Black Sea.

Metals		(mg/kg dry wt.)	Species	Stations
Fe	Min	327±18	*C. barbata*	Sinop
	Max	1754±65	*U. lactuca*	Inebolu
Zn	Min	7±0.6	*E. linza*	Sinop
	Max	65±16	*C. barbata*	Samsun
Ni	Min	0.8±0.01	*C. barbata*	Sinop
	Max	2.4±0.3	*U. lactuca*	Inebolu
Cu	Min	5±0.7	*C. barbata*	Sinop
	Max	37±7	*C. barbata*	Inebolu
Mn	Min	2±0.2	*E. linza*	Sinop
	Max	64±11	*U. lactuca*	Inebolu
Pb	Min	0.08±0.01	*U. lactuca*	Sinop
	Max	1.9±0.4	*U. lactuca*	Samsun
Cd	Min	0.09±0.01	*U. lactuca*	Sinop
	Max	0.66±0.07	*U. lactuca*	Inebolu
Co	Min	0.2±0.01	*C. barbata*	Sinop
	Max	1.5±0.4	*C. barbata*	Inebolu

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Ulva spp. and *Enteromorpha* spp. are authorized as vegetables and condiments according to French regulation. Although mean Cd level (0.66±0.07 mg/kg dry wt.) in *U. lactuca* from Inebolu was slightly higher than those in French Regulation (0.5 mg/kg dry wt.) according to the regulation (EC) No 629/2008 setting maximum level for cadmium (3 mg/kg dry seaweed) is needed for food supplements consisting exclusively or mainly of seaweed [2]. *U. lactuca*, *E. linza* and *C. barbata* are widespread species in the Black Sea and thus can be used as a very good biomonitor for heavy metal pollution. Monitoring of coastal waters is also a requirement for Marine Strategy Framework Directive, so it is assumed that the regular monitoring of macroalgae of the Black Sea coastal areas is essentially required for assessment of environmental health of the future.

References
1 - Bat L. 2014. Heavy Metal Pollution in the Black Sea. In: Turkish Fisheries in the Black Sea published by TUDAV, Publication No: 40, Istanbul/Turkey.
2 - CEVA 2014. Edible seaweed and French regulation - Synthesis made by CEVA, 3 pp. Available from: www.ceva.fr/