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Copper, Lead, Cadmium and Mercury Concentrations in the Mussel Elliptio

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As the marine pollution increases world wide, control strategies and routine monitoring of contaminants in the marine environment are more required. Although their impact has no visible influence comparing to other pollutants heavy metal pollution can cause long-term effects on ecosystems. The bioaccumulation of contaminants in the tissues and the organs of marine organisms has been extensively studied throughout the world and led to the adoption of the bioindicator concept for the environmental quality assessment. Mussels are recognized as pollution bioindicator organisms as they accumulate pollutants in their tissues at elevated levels in relation to pollutant biological availability in the marine environment (Bat et al. 1999; Machado et al. 1999; Vos and Hovens 1986).

Trace metals including chromium, cobalt, copper, iron, manganese, molybdenum, vanadium, strontium and zinc exist naturally in the environment and they are essential elements for living organisms. However, some trace metals such as mercury, lead and cadmium are not required for metabolic activity and can be toxic even at quite low concentrations (Cetinkaya 1996; Topcuoglu 2002).

Yenikapı and Anadolu Kavagı are two different regions in Marmara Sea; it is connected through the Bosporus on the northeast with the Black sea and through the Dardanelles on the southwest with the Aegean Sea. It is 280 km long from northeast to southwest and nearly 80 km wide at its greatest with marine life in the Marmara Sea heavily threatened by habitat degredation mostly due to human activities (Taramelli 2005), such as fisheries, ship traffic, water pollution and coastal anthropization.

The present study deals with the use of *Elliptio buckleyi* Lea, 1843 as a bioindicator of heavy metals (copper, lead, cadmium and mercury) contamination in marine ecosystem (Yenikapı and Anadolu Kavagı, Marmara Sea, Turkey; Fig. 1).

Materials and Methods

In this study, mussel samples (*Elliptio buckleyi* Lea, 1843) were collected from the two different locations, shown in Fig. 1, Anadolu Kavagı, and Yenikapı in the Marmara Sea, in 2004–2005.

The samples were brought to the laboratory on the same day. A microwave digestion system (Berghof MWS3+) was used to prepare the samples for analysis. In recent years, microwave digestion processes have been used in numereous studies (Kucuksezgin et al. 2001; Machado et al. 1999; Usero et al. 2003) owing to the advantages of this technique, which include speed of digestion and less possibility of contamination during the process. One gram of mussel sample was mixed with 5 mL HNO_3 65% and 5 mL H_2SO_4 in polipropile crucible. After 10 min mixing 1 mL H_2O_2 added and placed in Microwave (1 h at 105°C). After digestion, the residues diluted to 25 mL with 0.3% of HNO_3 (Canli and Atli 2003; Glumni et al. 1994; Stahr 1977; Sures et al. 1995). Instrument calibrated standart solutions were prepared from commercial materials. Following acid digestion, all the samples were analysed for

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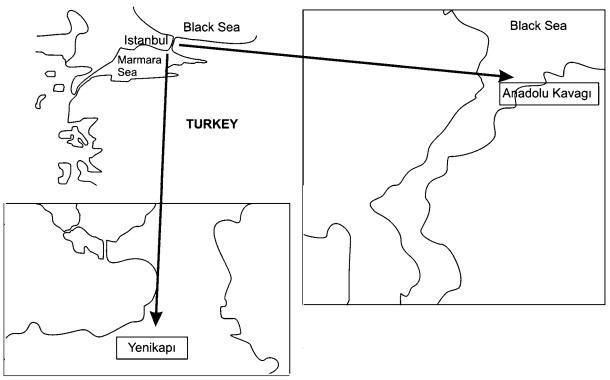

Fig. 1 Marmara Sea, Turkey, showing locations of study area, Anadolu Kavagı and Yenikapı

four elements (Cu, Pb, Cd, and Hg) by atomic absorption spectrophotometer (AAS). Cu, Cd and Pb were analysed in a graphite furnace (Perkin Elmer A Analyst 800 with Zeeman Background Corrector) with an autosampler. Detection limits for Cu, Cd and Pb were 0.014, 0.002 and 0.05 µg/L, respectively. Wavelengths for Cu, Cd and Pb were 324.8, 228.8 and 283.3 nm, respectively. Also hydride-generation technique (detection limit 0.009 µg/L) was used for analysis of Hg. Wavelength was 253.7 nm for Hg. All reagents used for this analyze were of analytical grade. Statitical analysis of data was carried out using SPSS statistical package programs. Differences between two different groups were compared by independent student *t* test.

Results and Discussion

It is well known that mussels are able to concentrate heavy metals such as Hg, Cd, Zn, Cu, Pb and many others in their tissues; therefore they can be used for monitoring heavy metal pollution of the environment. In the present study four metals were analysed in mussel, *Elliptio buckleyi* Lea, 1843 collected from two different regions of Marmara Sea; Yenikapı and Anadolu Kavagı. Metal contents (Cu, Pb, Cd, and Hg) for these two regions are shown in Table 1.

Table 1 Copper, lead, cadmium, and mercury concentrations in mussels samples for Anadolu Kavagı and Yenikapi

Metal (as ppm)	Anadolu Kavagı (n:30)	Yenikapı (n:30)	*p*
Copper	1.74 ± 0.63 (0.51–2.99)	1.18 ± 0.32 (0.64–2.11)	*
Lead	0.13 ± 0.05 (0.08–0.32)	0.68 ± 0.2 (0.20–0.96)	***
Cadmium	0.18 ± 0.06 (0.04–0.32)	1.08 ± 0.14 (0.56–1.40)	*
Mercury	0.23 ± 0.1 (0.07–0,42)	0.75 ± 0.09 (0.56–0.90)	–

* $p < 0{,}05$; *** $p < 0{,}001$

Copper, Pb, Cd and Hg contents in Yenikapı region were 0.64–2.11, 0.20–0.96, 0.56–1.40 and 0.56–0.90, respectively. Copper, Pb, Cd and Hg contents in Anadolu Kavağı were 0.51–2.99, 0.08–0.32, 0.04–0.32 and 0.07–0.42, respectively. Differences for Cu, Pb and Cd were statistically significant ($p < 0.05$). Especially Pb, Cd and Hg contents in Yenikapı region were found higher than Anadolu Kavagı region.

Metal content in mussels was evaluated in some studies (Bat et al. 1999; Cetinkaya 1996; Karadede and Unlu 2000; Kucuksezgin et al. 2001; Sunlu 2002; Senturk 1993; Topcuoglu 2002) in Turkey. *Mytilus galloprovincialis* Lamarck, 1819 was used in those studies. Also there is no study for *Elliptio buckleyi* Lea, 1843. In a study; Bat et al. (1999) determined Cu, Zn, Pb and Cd concentrations in the Mediterranean Mussel *Myltilus galloprovicialis* Lamarck, 1819 from the Sinop Coast of the Black Sea. Seasonal differences were also evaluated in the same study and the levels of metals found were generally lower than the permitted levels. Senturk (1993) studied Hg, Cd and Pb concentrations in the mussel in the Marmara Sea with AAS. In that study mussels were collected form different areas of Marmara Sea. Mercury, Cd and Pb contents for Anadolu Kavagı were 0.34, 0.15 and 0.85 ppm, respectively; for Yenikapı 0.63, 0.70 and 0.81 ppm, respectively. Confirming our results, Yenikapı region was found to be more polluted than Anadolu Kavagı. However, comparing to Senturk's (1993) study Pb contents were found lower and Cd contents were found higher in our study. Vos and Hovens (1986) studied Cr, Ni, Cu, Zn, As, Se, Cd, Mg and Pb contents in Dutch fishery products 1977–1984. Lead, Cd, Hg and Cu contents were 0.29–1.1, 0.08–0.46, 0.02–0.07 and 1.1–4.9 ppm, respectively in mussels. Mercury, Pb and Hg contents lower and Cu levels higher than our study results. Sunlu (2002) determined heavy metal levels in *M. galloprovincialis* Lamarck, 1819 for the Bay of Izmir. Lead, Cd and Cu contents for five different parts of bays were determined as follows; 0.58–1.82, 0.04–1.12 and 0.32–3.25 ppm, respectively. Comparing to our study; the contents of the lead was found to be higher; and the contents of Cd were found higher than Anadolu Kavagı results and lower than Yenikapı results. Therefore, Cu contents were similar to our findigs.

Cu and Cd contents in our study were found lower than Machado et al.'s (1999) study. Also Cu and Pb contents were lower than Catsiki et al. (2004) study where they found Cu and Pb contents as follows; 4.10–6.94, 0.59–3.26 ppm, respectively. Glynn et al. (2003) investigated trace metal concentrations in shellfish from Irish waters. Cadmium, Cu, Pb and Hg contents in mussel tissue were found 0.263, 8.33, 1.95 and 0.182 ppm, respectively. When these findings were compared with our study results, it was shown that Pb and Cu contents were higher, and Hg con-

tents were lower. Cadmium contents were higher than Anadolu Kavagı (0.16 ppm), but lower than Yenikapi (1.08 ppm) contents.

Maximum levels for Hg, Pb and Cd in foodstuffs, including bivalve mussels were evaluated in EU Commusion Regulation 466/2001/EEC (as amended by Regulation 221/2002/EC). Standart valves for Cd, Pb and Hg as follows; 1.0, 1.5 and 0.5 mg/kg; in our study Cd (1.08 ± 0.14 ppm) and Hg (0.75 ± 0.09 ppm) contents for Yenikapı region were higher than standard valves of EU regulation (Glynn et al. 2003).

Study results indicate that Yenikapı region is more polluted than Anadolu Kavagı region; especially for the Pb, Cd and Hg contents (0.68, 1.08 and 0.75 ppm, respectively). The concentrations of those heavy metals in Anadolu Kavagı region were 0.13, 0.16 and 0.23 ppm, respectively. These heavy metals are introduced to Marmara Sea by rivers, direct discharge of industrial wastes and agricultural and municipal usage. In addition to these the metal levels in the marine environment have increased due to oil pollution and airborne contaminants.

References

Bat L, Gundogdu A, Ozturk M, Ozturk M (1999) Copper, zinc, lead and cadmium concentrations in the Mediterranean mussel *Mytilus galloprovincialis* Lamarck, 1819 from the Sinop Coast of the Black Sea. Turk J Zool 23:321–326

Canli M, Atli G (2003) The relationships between heavy metal (Cd, Cr, Cu, Fe, Pb, Zn) levels and the size of six Mediterranean fish species. Environ Pollut 121:129–136

Catsiki V, Hatzianestis I, Rigas F (2004) Distribution of metals and organic contaminants in mussels from Thermaikos Gulf. Glob Nest Int J 5:117–124

Cetinkaya O (1996) A freshwater mussel species *Unio stevenianus* Krynicki 1837 (Mollusca: Bivalvia: Unionidae) from the river Karasu flowing into Lake Van, Turkey. Turk J Zool 20:169–173

Glumni M, Ostacoli G, Zelano V (1994) Comparison between microwave and conventional heating procedures in Tessier's extractions of calcium, copper, iron and manganese in a lagoon sediment. Analyst 119:2075–2080

Glynn D, Tyrrell L, McHugh B, Rowe A, Monaghan E, Costello J, McGovern E (2003) Trace metal and chlorinated hydrocarbon concentrations in shellfish from Irish Waters, 2001. Marine Institute, Marine Environment and Food Safety Services, Abbotstown, Dublin 15

Karadede H, Unlu E (2000) Concentrations of some heavy metals in water, sediment and fish species from the Atatürk Dam Lake (Euphrates), Turkey. Chemosphere 41:1371–1376

Kucuksezgin F, Altay O, Uluturhan E, Kontas A (2001) Trace metal and organochlorine residue levels in Red Mullet (*Mullus barbatus*) from the Eastern Agean, Turkey. Water Res 35:2327–2332

Machado LM, Bebianno MJ, Boski T, Moura DM (1999) Trace metals on the Algarve Coast, II: bioaccumulation in mussels *Mytilus galloprovincialis* (Lamarck, 1819). Boletin Inst Esp Oceanogr 15:465–471

Senturk F (1993) Cesitli yörelerden avlanmış mollusklarda civa, kadmiyum, kurşun düzeylerinin saptanması. T. C. Istanbul Universitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi

Stahr MM (1977) Analytical toxicology methods manual. University Press, Iowa

Sures B, Taraschewski H, Haug C (1995) Determination of trace metals (Cd, Pb) in fish by electrothermal atomic absorption spectrometry after microwave digestion. Anal Chem Acta 311:135–139

Sunlu U (2002) Comparison of heavy metal levels in native and cultured mussel Mytilus galloprovincialis(L, 1758) from the Bay of İzmir (Aegean Sea/Turkey). Mediterranean mussel watch-designing a regional program for detecting radionuclides and trace-contaminants, Marseilles, 18–20 April 2002

Taramelli V (2005) The Mediterranean Sea. Available from http://www.cibra.unipv.it/CIBRA_EDU_Mediterraneo_uk.html

Topcuoglu S (2002) Monitoring of radionuclides and heavy metals in Turkish Black Sea Coast, Bosphorus and Marmara Sea using mussels (*Mytilus galloprovincialis*) as a bioindicator. Mediterranean bussel watch-designing a regional program for detecting radionuclides and trace-contaminants, Marseilles, 18–20 April 2002

Usero J, Izquierdo C, Morillo J, Gracia I (2003) Heavy metals in fish (*Solea vulgaris*, *Anguilla anguilla* and *Liza aurata*) from salt marshes on the Southern Atlantic coast of Spain. Environ Int 29:949–956

Vos G, Hovens JPC (1986) Chromium, nickel, copper, zinc, arsenic, selenium, cadmium, mercury and lead in Dutch Fishery Products 1977–1984. Sci Tot Environ 52:25–40