TOXICITY-CHEMISTRY RELATIONSHIPS IN SEDIMENTS COLLECTED FROM BLACK SEA

R. Oral [1]*, B. Buyukisik [1], F. Kucuksezgin [2], E. Y. Ozkan [1] and E. Darilmaz [2]
[1] Ege University, Faculty of Fisheries - rahime.oral@ege.edu.tr
[2] Dokuz Eylul University, Institute of Marine Sciences and Technology, 35340 Izmir, Turkey

Abstract

This research investigated the spatial distribution of chemical contamination and toxicity of marine surfacial sediments collected from six sites along the Turkish coast in Black Sea. Sediment toxicity to sea urchin (*Paracentrotus lividus*) embryonic development was evaluated with whole sediment specimens. Concurrently, sediment samples were analyzed for their chemical characterisation to evaluate toxicity data.

Keywords: Ecotoxicology, Sediments, Black Sea, Petroleum, Metals

Introduction

It is dificult task to make a desicion about toxicity of sedimentary contaminats to aquatic organisms. Bioassays are routenely used for sediment quality evaluation. Among these sea urchin embryotoxicity bioassays are recognized as reliable, sensitive and ecologically important tools for evaluating marine and estuarine environmental quality [1- 2]. The goals of this sudy were to determine concentration of metals and petroleum hydrocarbons in Black Sea sediments and relationships between contamination and biological effects.

Material and Methods

Sediment samples collected from six sites along the Turkish coast in Black Sea (Istanbul, Eregli, Inebolu, Sinop, Ordu, Trabzon) by using core sampler. Surface sediment samples were taken from upper 2cm. depth for chemical and toxicological analyses.

Determination of petroleum hydrocarbons were made by GC-FID according to UNEP [3]. 0.2g dry sediment samples were digested with $HCl,HNO_3,HClO_4,HF$ acid mixture. Differantial Pulse Anodic Stripping Voltametry (DP-ASV) was used for Cu ,Pb and Zn by using Metrohm Voltammeter model 797VA Computrace according to Metrohm VAApplication Work AWUK4-0134-042002. C^{14} dating was made in Beta Analitic Inc.

The embryotoxicity test with sea urchin (Paracentrotus lividus) embryos was performed using the procedure reported in detail in before [1]. Bioassays were carried out in by evaluating the following endpoints: a) normal (N) pluteus larvae; b) retarded (R) plutei, with size <1/2 N, yet no evident abnormalities; c) malformed plutei (P1) exhibiting a number of skeletal or other abnormalities; d) developmentally arrested embryos (P2), i.e. unable to undergo larval differentiation (blastulae or gastrulae), and e) dead (D) plutei (D1) or early embryonic death (D2).

Results and Discussion

Bioassay with sea urchin showed that the highest embryotoxicity was exerted by the sediment from Istanbul (P1+P2 = 100 %) compared to controls (P1+P2 @ 3,5%). Sediments from Zonguldak and Inebolu displayed significantly higher developmental toxicity while the other sediment samples failed to show any significant difference compared to blank controls (Table1).

Tab. 1. Developmental toxicity of sediment samples collected from Turkish coast in Black Sea. % Developmental defects in *P. lividus* larvae, means ± SEM.

Sampling Site	N	P1	P2	P1+P2	value
Blank Control	96,5±0,9	2,7±0,7	0,3±0,2	3,0±0,8	
Positive Control ($CdSO_4$ 2.5X10^{-4}M)	0,0±0,0	0,0±0,0	100,0±0,0	100,0±0,0	,000
Istanbul	0,0±0,0	94,5±3,5	5,5±2,2	100±0,0	,000
Zonguldak	77,3±3,4	21,8±3,5	0,8±0,5	22,5±3,6	,000
Inebolu	78,3±3,1	20,8±3,2	0,3±0,3	21,2±3,1	,000
Sinop	89,5±0,4	10,2±0,5	0,5±0,5	10,5±0,4	,000
Ordu	92,7±1,3	7,3±1,3	0,0±0,0	7,3±1,3	,010
Trabzon	93,8±1,2	5,8±1,2	0,0±0,0	5,8±1,6	,076

The concentrations of petroleum hydrocarbons, metal and % organic carbon of sediment samples are given in Table2. Readman et al., [4] was reported 6,4 ng/g naphtalane concentration in Bosphorus (Istanbul) sediment samples. This result consistent with present data measured in Istanbul (7,0 ng/g). ΣPAH levels of all stations were much smaller than ERL value of 4122 ng/g. It has not been expected toxicity from ΣPAH value. The aliphatic hydrocarbon, n-C_{17} concentrations was significantly related to % developmental defects of sea urchin (R^2=0,84). Bioaccumulation dynamics of aliphatic hydrocarbons in detritivoros fishes and codding feed crude oil controlled by an efficient molecular discrimination during intestinal absorbtion. Higher bioaccumulation factors has been found in the range of betwee n-C_{15} and n-C_{17} [5]. It was suggested that the correlations were probably related to hydrophobocity and bioaccumulation factors of n- alkanes like fishes. Trace metal concentrations was not correlated with toxicity data. The only station Zonguldak was not exceeded the ERL values according to metals. Suddenly drops of Cu and Pb in Zonguldak was due to the fact that surface sediment layer dated to 1780±40BP (calculated AD 130-350)

Tab. 2. Petroleum hydrocarbons and some metals concentrations in six sediment specimens from Black Sea and ERL guideline values (Effects-Range-Low). All HC values are as ng/g.

lifatique	Istanbul	Zonguldak	Inebolu	Sinop	Ordu	Trabzon	ERL
-C_{10}	377	120	232	73	148	550	
-C_{12}	1669	511	614	435	742	2387	
-C_{14}	1457	484	598	337	697	2012	
-C_{16}	813	181	218	121	219	956	
-C_{17}	309	107	135	129	nd	Nd	
'rystane	177	37	151	87	nd	Nd	
-Octadecene	14	11	Nd	23	33	71	
-C_{18}	406	140	89	76	85	483	
'hytane	14	nd	61	nd	nd	Nd	
-C_{20}	92	1	124	85	6	218	
-C_{21}	1261	128	1017	173	234	198	
-C_{22}	93	37	68	27	33	133	
-C_{24}	111	40	nd	257	75	nd	
-C_{26}	170	nd	25	29	39	7	
qualane	179	nd	nd	nd	75	10	
-C_{27}	515	106	218	236	363	233	
-C_{30}	390	9	7	33	nd	6	
-C_{32}	218	nd	51	94	110	90	
-C_{34}	194	nd	40	208	130	nd	
-C_{17}/Pry	2	3	1	1	-	-	
-C_{18}/Phy	30	-	1	-	-	-	
Odd Numbered -HC	2262	377	1520	625	597	437	
C_{17}+ ΣC_{21}-C_{34}	3441	427	1561	1186	1059	677	
ven Numbered -HC	6196	1534	2127	1799	2393	6922	
otal Aliphatique	8459	1911	3647	2424	2990	7353	
'ry/Phy	13	-	2,5	-	-	-	
romatique	KD01	KD02A	KD03	KD04	KD05A	KD06	
laphthalene	7	78	28	nd	nd	25	160
-MethylNaphthalene	nd	7	29	46	17	nd	
-Ethyl Naphtalene	nd	nd	nd	nd	nd	nd	
cenaphthylene	nd	nd	nd	nd	nd	nd	44
cenaphtene	nd	nd	nd	nd	nd	nd	16
luorene	nd	nd	nd	nd	nd	nd	19
'henanthrene	nd	nd	nd	nd	nd	nd	240
nthracene	nd	nd	nd	nd	nd	nd	85.3
-methylphenanthrene	nd	nd	212	151	227	nd	
-methylphenanthrene	nd	nd		nd	nd	nd	
-6dimethylphenantren	nd	nd	227	nd	nd	nd	
luoranthene	nd	247	nd	nd	nd	nd	600
'yrene	nd	33	nd	nd	nd	nd	665
-methylpyrene	nd	nd	nd	nd	nd	nd	
hrysene	nd	nd	nd	nd	nd	nd	384
'erylene	nd	139	4		11	nd	
enzo(a) anthracene	nd	nd	nd	nd	nd	nd	261
enzo(b)fluorantene	nd	nd	nd	nd	nd	nd	
enzo(k)fluorantene	nd	nd	nd	nd	nd	nd	
enzo(e)pyrene	nd	nd	177	112	142	153	
enzo(a)pyrene	nd	nd	348	129	158	221	430
deno)1,2,3-cd) pyrene	nd	nd	nd	nd	nd	nd	
iBenzo(a,h)anthracene	nd	nd	nd	nd	nd	nd	63.4
enzo(g,h,i)perylene	nd	nd	nd	nd	nd	nd	
eP/BaP	-	-	1	1	1	1	
PAH	7	505	1024	437	555	399	4022
otalOrg.C mg/g	22.1	4.3	11.3	18.6	15.4	18.4	
n µg/g	210.5*	137.0	116.0	141.8	137.4	203.8*	150
'b µg/g	79.6*	17.8	52.1*	204.0*	69.4*	58.3*	46.7
u µg/g	82.1*	9.4	36.6*	68.8*	78.0*	51.1*	34

: Concentrations exceeded ERL values

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