

Measuring the Genotoxic Potential in Two Drinking Water Resources of Budapest in Salmonella/Microsome System

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The origin of dissolved materials in drinking water may be natural or artificial /so as contamination, production of water treatment or originate from the distribution system (Brauch et al. 1988, Öllös 1987, Cotruvo 1985, Meyers 1988)/. The organic materials of water reacts with chlorine, chlorine dioxide and ozone during water treatment (Schalecamp 1977, Fawell et al. 1987, Glaza et al. 1989, Mc. Guire 1988, Liimatainen and Grummt 1988, Öllös 1987, Öllös and Kollár 1983, Reckhow and Singer 1990, Singer 1990). Examination of the effect of reaction products to health needs modern and practical methods (Daignault et el. 1988, Lykins et al. 1986, Maron and Ames 1983, van Rossum 1985, Sujbert 1991, Vartainen et al. 1987, Wigilius et al. 1985).

MATERIALS AND METHODS

The water samples were taken daily from pre- and after chlorinated water of Budapest City Water Treatment Plant (BCWT Plant), and from the ozoned and chlorinated water of Ráckeve Water Treatment Plant No. 2. (RWT-2 Plant).

The macroreticular resin and the glasswool was extracted with di-chlor-methane and methanol in Soxhlet extractor for 24 -24 hours.

20 cm high XAD-2, XAD-4 cleared macroreticular resin was put in to a 25 cm high, 2 cm diameter glass pipe. On the top of resin and in the bottom 1/2 cm cleared glasswool was put. The two resin beds were connected. The chlorinated water samples were filtered through the resin (total quantity of 120,23 L) for 23 days long (daily 6 hours).

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The ozonized and chlorinated water was filtered through the resin for 29 days long (daily 12 hours) (total quantity 339,8 L). After the sampling the cells were transported to laboratory (under water level).

The water was let down from the column. Nitrogen gas was led to the top of the column. The adsorbed organic materials were eluted with 4 x 50 ml methanol and 4 x 50 ml dichlor-methane. The solvent solution was removed with Rotadest vacuum distillator at 45 - 50 °C. The traces of solvent were eliminated by nitrogen gas. The air-dry remaining was measured and dissolved in dimethylsulphoxyd, and was filled up to 5 mL. The stock-solution was kept till usage at 4 - 10 °C in a dark place.

The oxygen demand of water samples was measured after the Hungarian Standard (MSZ 448/20) with permanganometry in acid milieu. The concentration of active chlorine was measured with iodo-metry method. The resin adsorbent was measuring weigh. The linear regression, correlation, "t" -test were counted (Horváth, 1974).

The mutagen activity of water samples were measured after Maron and Ames in Salmonella/livermicrosome system.

Negative mutagen activity: The revertant colony number of measured sample was not deviated ($p < 5 \%$) from the revertant colony number of control sample significantly (double distilled water). Moderated mutagen activity: The revertant colony number of measured sample was greater significantly ($p < 5 \%$) than the revertant colony number of control sample (double distilled water). Clear revertant colony number: Difference of revertant colony number of measured sample and control sample (double distilled water). Mutagen activity: The revertant colony number increased after the dilutioning the measured sample after following each other three times. The revertant colony number of the less diluted sample exceeded twice at least the colony number of control sample (double distilled water). There was linear regression and correlation between the dry residue and the revertant colony number.

RESULTS AND DISCUSSION

It can be seen in table 1. that the macroreticular resin adsorbent of the water samples from BCW Plant was 94 times higher at XAD-2 and 115 times higher at XAD-4 than in the ground water samples of RWT-2 Plant. The averages of oxygen demand of clear surface water are 1,63-2,31 times higher than in the

clear ground water. The average of free chlorine is 3,72-5,5 times higher in clear surface water than in clear ground water.

Table 1. Some characteristic parameters of examined water samples

	BCWT Plant	RWT-2 Plant
XAD-2 total adsorbate (mg/l)	12,23	0,13
XAD-4 total adsorbate (mg/l)	14,99	0,13
COD (mg/l)	1,44 ± 0,17 (18)	0,77 ± 0,22 (36)
Free chlorine (mg/l)	1,63 ± 0,53 (19)	0,39 ± 0,19 (36)

The mutagen activity of XAD-2 resin and TA 98 strain without livermicrosome activation can be characterised: regression co-efficient, a: 0,795; axial-crossing regression b=19,0; correlation co-efficient r=0,926. The adsorbate of the water sample of BCWT Plant without livermicrosome activation contained mutagen, potential human mutagen contamination to TA 98 test strain (2. table).

The induced revertant colony number (233,0) after the effect of XAD-2 resin (29,408 mg/100 µL) aberates from the revertant colony number of control sample (131,0) significantly (p < 0,01) (3. table). The adsorbate of the water sample of BCWT Plant without livermicrosome activation contains moderated potential human mutagen contamination to TA 100 test strain.

The relation of XAD-2 resin adsorbate and the mutagen activity of TA 98 test strain without livermicrosome activation can be characterised: regression co-efficient a: 24,321; axial-crossing regression b=14,14; correlation co-efficient r=0,890. The XAD-2 resin adsorbent of water sample of RWT-2 Plant without livermicrosome activation to TA 98 test strain contained potential human mutagen contamination (4. table). The XAD-2- and XAD-4 resin adsorbent of water sample of RWT-2 Plant with and/or without livermicrosome activation to TA 100 test strain showed a negative result.

The XAD-2 resin adsorbate of chlorinated clear surface water without livermicrosome activation indicates at TA 98 test strain mutagen activity, at TA 100 test strain moderated mutagen activity. It was necessary 2,4 L organic material in water sample to the effect. The organic adsorbate of XAD-2 resin adsorbate of the ground water indicated genotoxicity without

Table 2. Adsorbate of Water Sample from BCWT Plant and Bacterium Number of TA-98 test strain

Quantity of adsorbate led to media (mg/100 µl)		Revertant bacterium number			
		XAD-2 resin		XAD-4 resin	
XAD-2 resin	XAD-4 resin	-S-9 mix	+S-9 mix	-S-9 mix	+S-9 mix
29.408	96.004	41.3	224.0	22.0	-
5.881	19.208	28.5	-	-	-
2.940	9.604	23.0	190.0	16.0	-
0.930	3.039	-	-	-	33.0
0.294	0.960	20.0	168.0	12.0	27.0
0.093	0.303	-	-	-	25.0
0.029	0.096	13.0	200.0	4.5	14.0
Control					
Double dist. water/disc		18.5	243.0	23.0	37.0
Dimethyl-sulphoxyde/disc		15.7	245.0	20.0	35.0
4 µg-1,2-diamino -4 nitrobenzol /disc		1806.0	-	1924.0	-
10 µg 2-aminofluoren/disc		-	1411.0	-	2107.0
Total adsorbate of water samples		1.4704 g		1.8021 g	

livermicrosome activation at TA 98 test strain. It was necessary 6,7 L XAD-2 organic material adsorbate in original water sample to the effect. The examined ground water contained less organic precursor then surface water. It was necessary 2,8 times more ground water to indicate genotoxicity. It can be supposed that in the gained water will be produced less byproducts.

Table 3. Adsorbate of Water Sample from BCWT Plant and Bacterium Number of TA-100 test strain

Quantity of adsorbate led to media (mg/100 µl)		Revertant bacterium number			
		XAD-2 resin		XAD-4 resin	
XAD-2 resin	XAD-4 resin	-S-9 mix	+S-9 mix	-S-9 mix	+S-9 mix
29.408	96.004	233.0	168.5	135.0	110.0
5.881	19.208	188.0	169.0	-	-
2.940	9.604	133.8	126.0	112.0	107.0
0.930	3.039	-	-	-	118.0
0.294	0.960	116.0	131.0	98.0	104.5
0.093	0.303	-	-	-	98.5
0.029	0.096	106.0	133.0	113.0	97.5
Control					
Double dist. water/disc		131.0	126.0	107.5	126.0
Dimethyl-sulphoxyde/disc		110.7	139.5	104.0	139.5
4 µg-1,2-diamino -4 nitrobenzol /disc		1051.5	-	703.5	-
10 µg 2-aminofluoren/disc		-	360.5	-	360.5
Total adsorbate of water samples		1.4704 g		1.8021 g	

The revised Salmonella/livermicrosome system after Maron-Ames method can be considered to be suitable to screen the mutagen potential of drinking water. The bio-assay signs the potential mutagen and/or carcinogen pollution and the possibility for human exposition.

Table 4. Adsorbate of Water Sample from RWT-2 Plant and Bacterium Number of TA-98 test strain

Quantity of adsorbate led to media (mg/100 µl)		Revertant bacterium number			
		XAD-2 resin		XAD-4 resin	
XAD-2 resin	XAD-4 resin	-S-9 mix	+S-9 mix	-S-9 mix	+S-9 mix
0.8800	0.8800	35.5	49.5	19.0	37.5
0.3520	0.1720	24.0	38.5	-	-
0.1760	0.1760	23.0	40.0	-	-
0.1173	0.1173	19.5	32.5	-	-
0.0880	0.0880	17.8	26.5	15.0	22.0
0.0088	0.0088	10.5	30.3	11.5	20.5
0.0009	0.0009	10.5	30.3	15.0	26.5
Control					
Double dist. water/disc		15.3	29.6	15.5	32.0
Dimethyl-sulphoxyde/disc		15.8	25.8	20.0	27.0
4 µg-1,2-diamino -4 nitrobenzol /disc		1902.0	-	1902.0	-
10 µg 2-aminofluoren/disc		-	1535.5	-	1535.5
Total adsorbate of water samples		0.0440 g		0.0440 g	

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