

MONITORING OF CONCENTRATION OF TRIHALOMETHANES AS ONE OF THE INDICATORS OF HEALTH SAFETY MANAGEMENT OF POOL WATERS IN THE AREA OF OSIJEK-BARANJA AND VUKOVAR-SRIJEM COUNTY

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Introduction

Disinfection plays an important role in maintaining the quality of pool water. Water disinfection is the process of destroying pathogenic bacteria and reducing the total number of all live bacteria to prevent the transmission of disease through water. The most commonly used disinfectant is chlorine. During the chlorination process, chlorine can react with the organic substances present in the water (sweat, urine, oils) creating a series of by-products known as trihalomethanes. Based on numerous studies of the effect of trihalomethanes on human health, they are classified as carcinogenic and mutagenic compounds, and their excessive intake can lead to a number of health problems (damage to the liver, kidneys and central nervous system). This study investigates trihalomethane concentrations in pool waters at bathing areas in the area of Osijek-Baranja and Vukovar-Srijem county, in 2020 (182 analyzed samples) and 2021 (233 analyzed samples).

Materials and methods

- Sampling of pool water
- Sample preparation (liquid-liquid extraction) → extract
- GC analysis (GC-ECD)
- Data analysis

Chromatographic conditions:

Column: Rtx®-502.2 (60mx0,25mm(ID)x1,4 µm)
Injection volume: 4 µl
Inlet temperature: 220°C
Mode: Split (10:1)
Gas: nitrogen (flow=2,6 ml/min)
Temperature programming
Detector temperature: 325°C



Table 1. Concentrations of trihalomethanes in swimming pools in 2020

2020.																
Concentration of trihalomethanes (µg/l)																
POOL AREA A				POOL AREA C			POOL AREA E				POOL AREA H					
Months	Children	Olympic size	Recreation	Whirlpool	Children	Attractions	Recreation	Whirlpool	Children	Olympic size	Recreation	Family	Small	Big		
1	-	15	15	18	-	-	-	14	-	-	13	-	-	-	-	-
2	-	13	15	20	-	-	-	13	-	-	12	-	-	-	-	-
3	-	-	-	-	-	-	-	15	-	-	11	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	14	25	17	-	-	-	10	-	-	<10	-	-	15	16	-
6	-	14	30	16	-	-	-	21	11	10	<10	15	<10	<10	11	<10
7	24	17	30	18	-	-	-	21	16	22	25	33	28	15	14	20
8	37	20	41	20	<10	15	<10	35	15	44	39	108	37	13	32	13
9	14	13	19	13	-	-	-	51	17	16	29	28	-	-	-	-
10	<10	11	12	16	-	-	-	20	<10	<10	10	-	-	-	-	-
11	<10	12	11	25	-	-	-	-	-	-	-	-	-	-	-	-
12	11	11	11	24	-	-	-	-	-	-	-	-	-	-	-	-
POOL AREA B				POOL AREA D			POOL AREA F		POOL AREA G		POOL AREA I					
Months	Children	Olympic size	Recreation	Whirlpool	Olympic size	Recreation	Non-swimmers	Children	Olympic size	Small	Big	Small	Big			
1	15	16	13	18	14	-	-	-	-	-	-	-	-	18		
2	<10	16	11	12	11	-	-	-	-	-	-	11	-	19		
3	19	30	20	22	27	-	-	-	-	-	-	18	-	24		
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
5	22	21	21	<10	<10	-	-	-	-	-	-	<10	-	17		
6	25	24	25	24	19	-	-	<10	<10	-	-	12	-	17		
7	24	24	23	15	18	40	34	21	15	17	17	21	33	73	42	18
8	24	25	23	21	23	80	56	85	52	44	68	55	78	48	39	38
9	21	23	22	20	<10	-	-	-	-	-	-	17	-	19		
10	<10	<10	<10	<10	<10	-	-	-	-	-	-	12	-	15		
11	<10	11	<10	<10	12	-	-	-	-	-	-	14	-	14		
12	-	-	-	-	-	-	-	-	-	-	-	10	-	14		

Table 2. Concentrations of trihalomethanes in swimming pools in 2021

2021.																
Concentration of trihalomethanes (µg/l)																
POOL AREA A				POOL AREA C			POOL AREA E				POOL AREA H					
Months	Children	Olympic size	Recreation	Whirlpool	Children	Attractions	Recreation	Whirlpool	Children	Olympic size	Recreation	Family	Small	Big		
1	17	13	14	16	-	-	-	-	-	-	-	-	-	-	-	-
2	19	17	21	35	-	-	-	-	-	-	-	-	-	-	-	-
3	14	14	17	21	-	-	-	-	-	-	-	-	-	-	-	-
4	20	16	23	12	-	-	-	-	-	-	-	-	-	-	-	-
5	26	18	30	16	-	-	-	-	25	<10	<10	18	10	-	-	-
6	47	29	47	26	28	33	13	71	7,4	182	11	6,3	11	8,7	6,7	19
7	35	26	41	30	43	17	75	34	102	45	35	24	23	33	48	101
8	29	20	29	28	25	42	63	57	92	86	29	22	29	42	77	67
9	-	-	-	-	-	-	-	-	30	17	13	19	15	1,7	2,1	-
10	19	16	20	20	-	-	-	-	20	5,6	10	12	-	-	-	-
11	13	14	13	21	-	-	-	-	21	7,2	9,9	7,2	-	-	-	-
12	11	16	12	16	-	-	-	-	13	7,5	8,6	7,2	-	-	-	-
POOL AREA B				POOL AREA D			POOL AREA F		POOL AREA G		POOL AREA I					
Months	Children	Olympic size	Recreation	Whirlpool	Olympic size	Recreation	Non-swimmers	Children	Olympic size	Small	Big	Small	Big			
1	20	27	19	21	<10	-	-	-	-	-	-	-	-	<10	-	-
2	17	23	15	18	13	-	-	-	-	-	-	-	-	19	-	20
3	12	13	13	14	19	-	-	-	-	-	-	-	-	16	-	16
4	11	16	11	10	11	-	-	-	-	-	-	-	-	13	-	14
5	12	22	13	15	15	-	-	-	-	-	-	-	-	12	-	15
6	20	29	21	8,8	14	12	12	122	121	158	141	31	171	87	14	18
7	22	34	25	15	26	93	67	93	79	78	79	39	61	87	38	83
8	27	43	29	23	23	140	12	148	11	79	74	87	71	29	19	64
9	5,6	14	5,6	5,5	7,6	-	-	-	-	-	-	-	-	14	8,7	16
10	11	12	10	15	10	-	-	-	-	-	-	-	-	14	-	15
11	9,9	17	9,9	11	11	-	-	-	-	-	-	-	-	8,8	-	12
12	6,8	17	7,8	8,6	10	-	-	-	-	-	-	-	-	17	-	10

■ - outdoor swimming pool
□ - indoor swimming pool

According to NN 59/2020:

„Article 4.



(1) In order to ensure the health of users, the physical, chemical and microbiological indicators of pool water must correspond to the conditions for pool water prescribed in Annex I of this Ordinance and form an integral part thereof

(2) The pool water sample is correct if the values of the tested indicators meet the prescribed values from paragraph 1 of this article”

From Annex I:

Total trihalomethanes – sum of specified parameters:

- Chloroform
- Bromodichloromethane
- Dibromochloromethanes
- Bromoform

MDK (maximum allowable concentration) of total THM:
100 µg/l

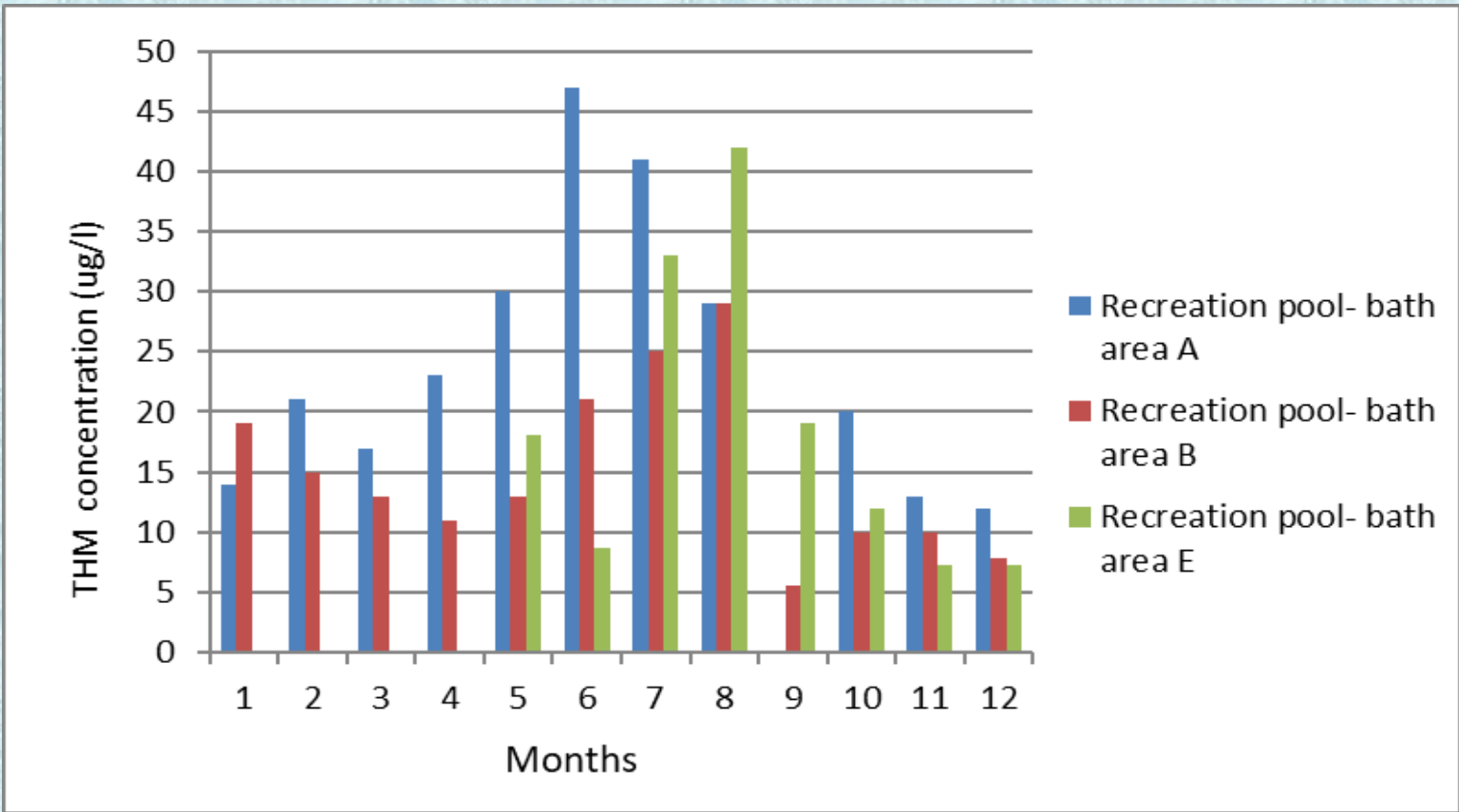


Figure 1. THM concentrations in recreation indoor pools at different bath area in 2021

Results:

- The amount and impact of the THMs exposure may be influenced by many factors as well as dose and type of disinfectant, the number of swimmers, water and air temperature, the ventilation system in the building but the swimmers themselves have the greatest influence on the THMs concentration in the pool. They introduce various contaminants to the water, such as epithelial particles, sweat, urine which increase the concentration of THM's.
- The most common trihalomethane is chloroform.
- Outdoor swimming pools usually have higher THM concentrations than indoor pools.
- In 2020 and 2021, concentrations of trihalomethanes were mostly in accordance with legislation, but during the summer period, the concentration of THM's exceeded the permitted value of 100 ug/l in some samples of outdoor pool water. Successful actions were taken to reduce the concentration of THM's in pool water – through repeated sampling and analysis we determined that the sample is in accordance with legislation.
- It is important to regularly and systematically monitor the concentration of trihalomethanes in order to be able to react in cases of elevated concentration to prevent the harmful impact on human health.