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USE OF STANDARD BIOTESTS FOR THE EVALUATION OF THE TOXICITY OF LEACHATE FROM RAINWATER AND FILTRATES FROM LANDFILLS

1. Introduction

Šiauliai is a district centre in the north of Lithuania. Previously, many industrial enterprises operated in this city. Now, for environmental reasons, great importance is attached to municipal waste regulation and to filtrate cleaning of landfills as well as the ecological state of Lake Talsa, which is situated in the centre of the city of Šiauliai.

Exploitation of the landfill started in 1960. During the initial period from 1960 to 1980 municipal waste was deposited together with industrial waste including toxic materials of the entire city. At that time large bicycle, TV-set, machine and military aircraft repair plants, three leather processing companies, meat, dairy and beer producers, bakeries, building construction, mechanical, leather haberdashery, furniture and footwear plants, an oil product realization company and some building-repair and motor transport organizations were operating in Šiauliai. Thus, there were many types of waste during this period. A major proportion of heavy metals came to the leachate from the lowest and thickest layer of waste.

The second period is considered to be from 1980 to 1993. During this period only non-segregated municipal waste was officially deposited, but unofficially a large amount of industrial waste was transported to the landfill for about two years. Municipal waste from the second period differed in composition from waste of the third, current period. The prevalent waste of the third period are various packing materials. Waste segregation in the city is just starting.

Lake Talša (area – 52.5 ha) and its surroundings are a popular zone for recreation and a meeting place for inhabitants of the city. During Soviet times lechate from factories producing leather goods flowed out to the lake. Now these industrial enterprises have closed down, so the main source of pollutants is now rainwater, flowing from the streets of central part of the city. The municipality's task is monitoring these objects. The main indexes of pollutants, levels of substances polluting the lake and physical parameters are determined here. These indexes show the negative influence of complex pollutants on biological organisms. Bacteria, plankton, benthos and fish live in the water and they are an indicator of changes in the trophical environment. Usually, these organisms, for different reasons, cannot escape from their unfavourable environment or make it favourable, so they themselves should change. Physiological and biochemical responses to changes can be used as indicators of environmental pollution.

We present here the results of investigations, which were carried out in order to assess the level of complex pollutants in the municipal waste dump and leachate of rainwater. The toxicity from the four drains (marked I, II, III, IV) of the leachate of the rainwater was determined. The water flows to the lake through these drains. The toxicity of filtrates from the landfill protective ditch and leachate from the land-reclamation canal, which is near the landfill, were determined too.

2. Methods and materials

TOXKITS sample complexes, which include specially prepared (immobilized or in an abiotic condition) organisms were used for our investigations. The experiments were carried out with protozoa (*Tetrahymena thermophila*), crustacean (*Daphnia magna*, *Daphnia pulex* and *Thamnocephalus platyurus*) and micro algae (*Selenastrum capricornutum*) cultures. The aim of the research was to evaluate the vitality of organisms and the suppression of growth. The preparation of the samples and analysis of results were done using standard methods.

The toxicity of chemical solutions for biocenosis is evaluated by various standard methodologies using LC₅₀ (the lethal concentration when 50% of tested organisms die) and toxicity indexes (Perssone G., 1993).

The toxicity index of water (TI):

Non-toxic	0
Slightly toxic	<1
Toxic	1–10
Very toxic	11–100
Extremely toxic	>100

3. Results

The reaction of living organisms to toxins depends on the species of organisms used for research. The reaction of the tested organisms to a toxic solution is specific to their species and the chemical element or solution. When carrying out the quantitative evaluation, we paid attention to species from each trophic group of the water ecosystem.

The dumpsite of Siauliai is surrounded by a protective ditch. The filtrate from this dump accumulates in it. The toxic influence of the filtrate on living organisms was evaluated using a series of tests, whose results are presented in Table 1.

Table 1. The results of toxicity tests for the filtrate from the dumpsites and for the water from the land reclamation canal. Nt. – non-toxic

Organism tested	Sample			
	From the canal		Filtrate	
	LC ₅₀	TI	LC ₅₀	TI
<i>Tetrahymena thermophila</i>	56.50	1.77	40.30	2.48
<i>Daphnia magna</i>	Nt.	0	8.83	11.32
<i>Thamnocephalus platyurus</i>	Nt.	0	3.22	31.05
<i>Selenastrum capricornutum</i>	Nt.	0	9.71	10.30
Total toxicity		1.77		55.15
Average toxicity of sample		0.44		13.79

Thamnocephalus platyurus gave the most sensitive response to toxins – the filtrate of the dump was extremely toxic to them (TI=31), because LC₅₀ was observed at a concentration of 3.22 ml/l. According to the test with daphnia and micro algae the filtrate was toxic (TI = 10–11). Concentrations of 8–9% gave a 50% mortality rate. Protozoa gave the lowest response to the toxin (LC₅₀ = 40 mg/l, toxicity index ≈2.5). The average toxicity of the sample reached 13.79, while total toxicity reached 55.15. This indicates the high toxicity of the filtrate from the dump.

There is a land – reclamation canal by the side of the dump, the toxicity was determined here in order to measure the level of pollutants filtrating into ground waters. The results of the testing showed that the water was slightly toxic. These results allow us to hypothesise that the filtrate of the protective ditches of the dump influences the stability of the ecosystem, because an influence of toxins on the biotic elements was also found in the water, which flows by the dump.

The rainwater effluents from the territory of the city of Šiauliai flow into lake Talša (daily flow – 643.4 m³). The largest territory is the one from which water is collected into the 2nd drain – 164.6 ha (daily flow – 462 m³). Our evaluation showed that the water which flowed into lake Talša from the 2nd rainwater effluent drain was very toxic – TI – 53.65. The water was toxic to all the biotic elements researched. All the tested organisms showed that the TI toxicity index was more than 1. This drain was distinguished, because its water was also toxic to micro algae (TI = 20), which was not a characteristic of other drains. Crustacean *Daphnia pulex* gave a strong response to toxin: the lethal concentration was 4 mg/l. *Daphnia magna* are the least sensitive LC₅₀ = 70 ml/l.

The sample from the 1st drain was also toxic, the lethal concentration for daphnia – 20–30 mg/l, protozoa and algae did not react to the toxin. The water from the 3rd and 4th rain effluent drains was not toxic.

The results obtained allow let us to conclude that the rain effluents, flowing into lake Talša have different levels of pollution: the water from the 2nd drain is highly toxic, the water of the 1st drain is toxic, no harmful influence on the biota could be found in the 3rd and the 4th drains.

Our investigations were compared with the results of chemical analysis. The comparison gave us our main results. The conclusions from bio-tests and chemical analyses were the same, so we suppose there are no unknown inorganic nor organic toxins in the leachate.

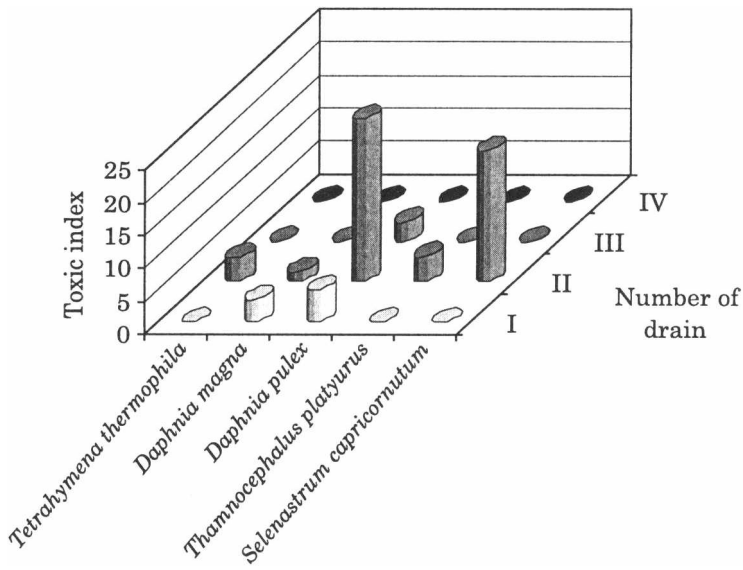


Fig. 1. The toxicity of the rain effluents drains flowing into lake Talša

Literature

- Persoone G. et al., *Cost-effective acute hazard monitoring of polluted waters and waste dumps with the aid of toxkits*, Final report. Gent, 1993.
- Tričys, V., Mociūtė, N., Klimas, R., Motiekaitytė, V., "Research of Šiauliai landfill leachate treatment", *1st International Symposium on Environmental Problems in the Baltic region States*. Šiauliai, 2001.