

MONITORING OF CYANOBACTERIAL TOXINS IN EUTROPHIC FRESHWATER BODIES IN SLOVENIA: A TWO-YEAR SURVEY

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Introduction

Cyanobacterial blooms are a common issue in eutrophic waters worldwide. High nutrient concentrations resulting from agricultural practices and poor wastewater management promote the growth of autotrophic organisms, including cyanobacteria. Climate change, particularly increased water temperature and thermal stratification, influences both cyanobacterial growth and surface bloom formation (Burford et al., 2019). Cyanotoxins produced by certain cyanobacteria can pose a threat to human and animal health, either through long-term exposure (genotoxicity, tumour promotion) or acute poisoning (livestock, pets) (Chorus & Welker, 2021). Despite the potential threats, cyanotoxins are not regularly monitored in Slovenia or in most other European countries. To assess the current situation, we performed a two-year survey of the occurrence of cyanobacterial toxins in selected eutrophic Slovenian freshwater bodies.

Methods

We conducted a two-stage sampling campaign. In August and September 2021, we sampled phytoplankton and phytobenthos at ten sites with historical observations of cyanobacterial blooms, and analysed selected cyanotoxins (microcystins (MCs), anatoxins (ATXs), saxitoxins, and cylindrospermopsins) by LC-MS/MS. In 2022, we selected four lakes where MCs and ATXs had been detected in 2021 and sampled them monthly from April to September, and the remaining six lakes once in August. In total, we collected 80 samples over the two-year period. Sampling and cyanotoxin analyses are described in Zupančič et al. (2021).

Results and discussion

Of the 40 phytoplankton samples analysed, 26 (65%) contained detectable concentrations of MCs, with MC-RR being the most common variant (all 26 samples), followed by MC-LR (22 samples), MC-YR (seven samples), and MC-RRdm and MC-HtyRdm (four samples each). Two or more (up to four) variants co-occurred in 22 of the 26 samples. Total MC concentrations ranged from 47.6 ng/L to 23,960.0 ng/L (median 2,350.5 ng/L). In phytobenthos samples, MCs were detected in 22 (55%) of 40 samples, with the most common variant being MC-RR (19 samples), followed by MC-LR (17 samples), MC-YR (five samples), and MC-HtyRdm (four samples). MC-RRdm was not detected in any phytobenthos sample. While eight samples contained only one MC variant, two or three variants co-occurred in the remaining 14 samples. Total MC concentrations ranged from 21.3 ng/g dry weight (d.w.) to 113,460.0 ng/g d.w. (median 5,875.0 ng/g d.w.). Anatoxins were detected in eight (20%) of 40 phytoplankton samples; all of them contained ATX-a, and two of them also contained homoATX-a. Total ATX concentrations ranged from 31.2 ng/L to 1,206.0 ng/L (median 136.3 ng/L). In phytobenthos samples, ATXs (variant ATX-a) were detected in three (8%) of 40 samples. ATX-a concentrations ranged from 140.0 ng/g d.w. to 200.0 ng/g d.w. (median 200 ng/g d.w.). Saxitoxins or cylindrospermopsins were not detected in any sample. Temporal variation in cyanotoxin concentrations was also analysed in selected lakes (Fig. 1). In phytoplankton, MCs were generally present throughout the warm season (May to August). In phytobenthos, the trend in Hotinja vas and Podgrad roughly followed the phytoplankton

trend, while no trend was observed in Ledava and Radehova. Presence of ATXs was more sporadic in both sample types (not shown).

All lakes that contained cyanotoxins in 2021 also had them in 2022, and our historical data confirmed the presence of MCs in eight of ten lakes in 1994/1995 as well. Therefore, toxic cyanobacterial blooms at these sites are not one-time events, but rather a recurring phenomenon that could negatively impact the health of the local population. Three phytoplankton samples exceeded the WHO guidelines (Chorus & Welker, 2021) for MC concentration in drinking water (short-term exposure, 12 µg/L), while one sample nearly reached the recreational water limit (24 µg/L). The sampled lakes are popular recreational and fishing areas, and some of them were used as bathing waters in the past. In addition, two of them are located in regional parks and two others are in close proximity (< 700 m) to Natura 2000 protected areas.

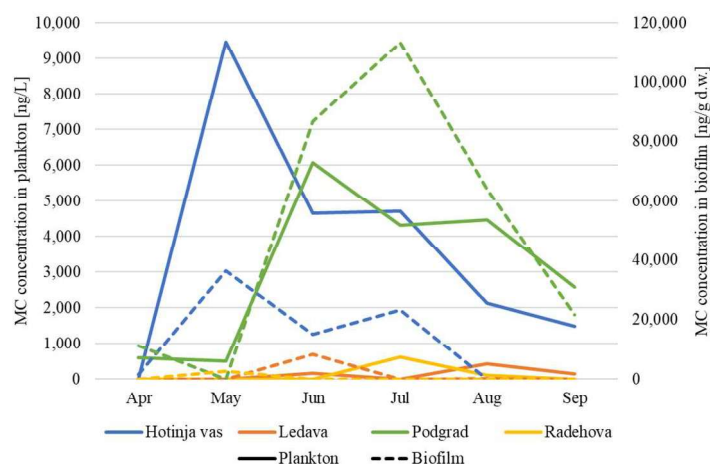


Figure 1. Temporal variation of microcystins in selected lakes in 2022.

Conclusions

MCs and ATXs were repeatedly detected in phytoplankton and phytobenthos of various eutrophic lakes and reservoirs in Slovenia. Moreover, it was shown that not only planktic cyanobacteria are a source of cyanotoxins, but also benthic species in the biofilm. Considering the importance of these waters for the local population (recreation, fishing) and the potential health threat of cyanotoxins, including these toxins in the national water monitoring program is strongly recommended.

Keywords: cyanotoxins, microcystin, anatoxin-a, LC-MS/MS, phytoplankton, phytobenthos

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