Environmentally non-aggressive reduction of cyanobacterial populations in lakes by electro-oxidation with boron-doped diamond electrode

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LIFE Stop CyanoBloom

6th Croatian Congress of Microbiology with International Participation

CYANOBACTERIAL BLOOM FORMATION ISSUES

Cyanobacterial blooms are regularly formed in fresh-water bodies. Increased cyanobacterial concentrations and the resulting toxin formation have negative ecological, biogeochemical, health-related and economic impacts[1]. A toxic cyanobacterial species *Planktothrix rubescens* and *Microcystis aureginosa* inhabit deep lakes and shallow ponds and can bloom throughout the entire year[2,3]. Several chemico-physical methods have been developed for bloom reduction, but they are often non-selective, ineffective or relatively expensive. Recently, a novel method using advanced oxidation processes and boron-doped diamond (BDD) electrodes has been a popular research topic.

In our study, different intensities of electro-oxidation stress have been tested on two natural water samples with predominant concentrations of two different cyanobacteria species (*P. rubescens* and *M. aureginosa)*.

MATERIALS AND METHODS

P. rubescens was collected with plankton net in Lake Bled (Slovenia), while *M. aureginosa* in pond Hotinja vas (Slovenia). The complete water samples (500 ml) were pumped through the electrolytic cell, equipped with two 60 cm^2 large BDD electrodes (Condias, Germany). Two sets of experimental conditions were tested: applying current intensity of 0.6 A at a slow flow rate of 0.075 L/min (electro-oxidation time (ET) = 9.6 s) and applying 3 A at 1 L/min (ET = 0.72 s). The effect of treatment was detected by following the change in chlorophyll (CHL) and phycocyanin (PC) *in vivo* fluorescence with Submersible Sensors (Cyclops 7, Turner Designs, USA) until the signals stabilized, by extraction of photosynthetic pigments[4] and determination of cyanobacterial biovolume[5].

RESULTS AND DISCUSSION

- Treating *P. rubescens* with 0.6 A at flow rate of 0.075 L/min resulted in average 70 % of PC and CHL signal reduction 5 days after treatment (Fig. 1). The total cell biovolume reduced for 80 % (Fig. 2).
- The cell biovolume at treating *M. aeruginosa* at same conditions reduced for 50 % after 3 days, while PC in CHL signals reduced for up to 65 %.

Intensifying the current to 3 A and shortening the ET for 13-times by elevating a flow rate to 1 L/min produced similar effect of stress (Fig. 2). Quantification of pigments by extraction showed drastic reductions in PC and CHL concentration after the electro-oxidation treatment at all tested experimental conditions (Fig. 3).

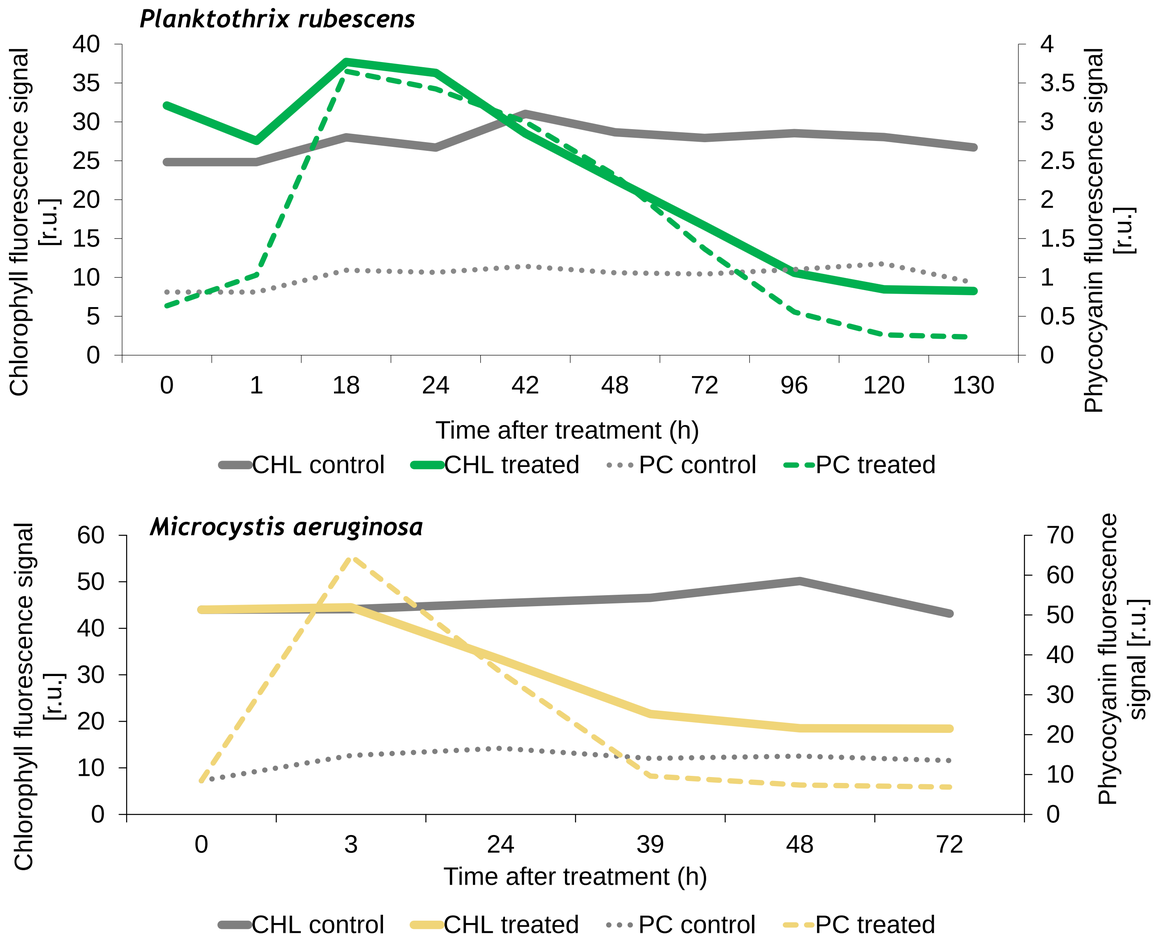

Figure 1: Changes in CHL and PC fluorescence after electro-oxidation treatment with 0.6 A at 0.075 L/min.

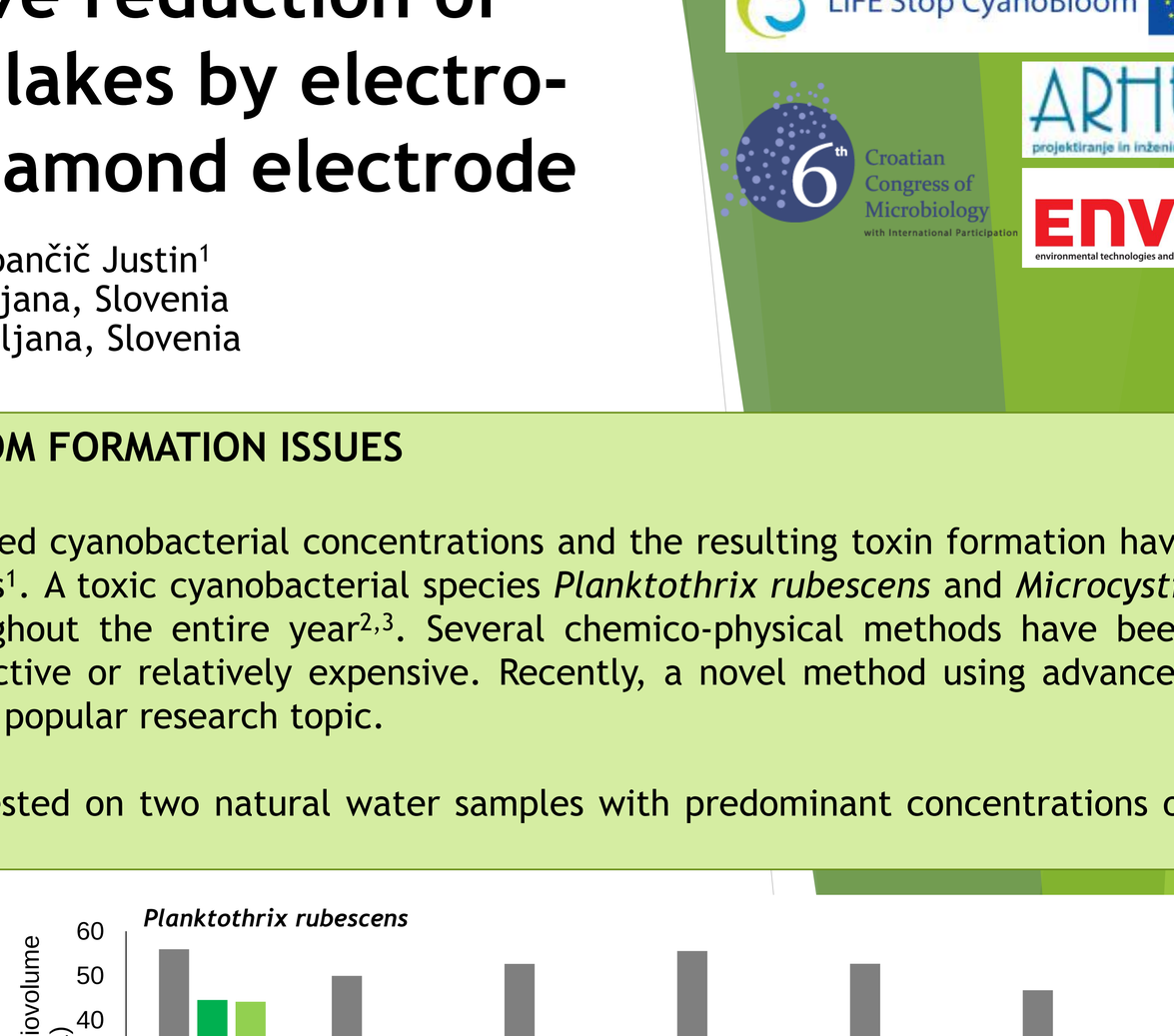

Figure 2: Cyanobacterial biovolume reduction after electro-oxidation treatments at different conditions.

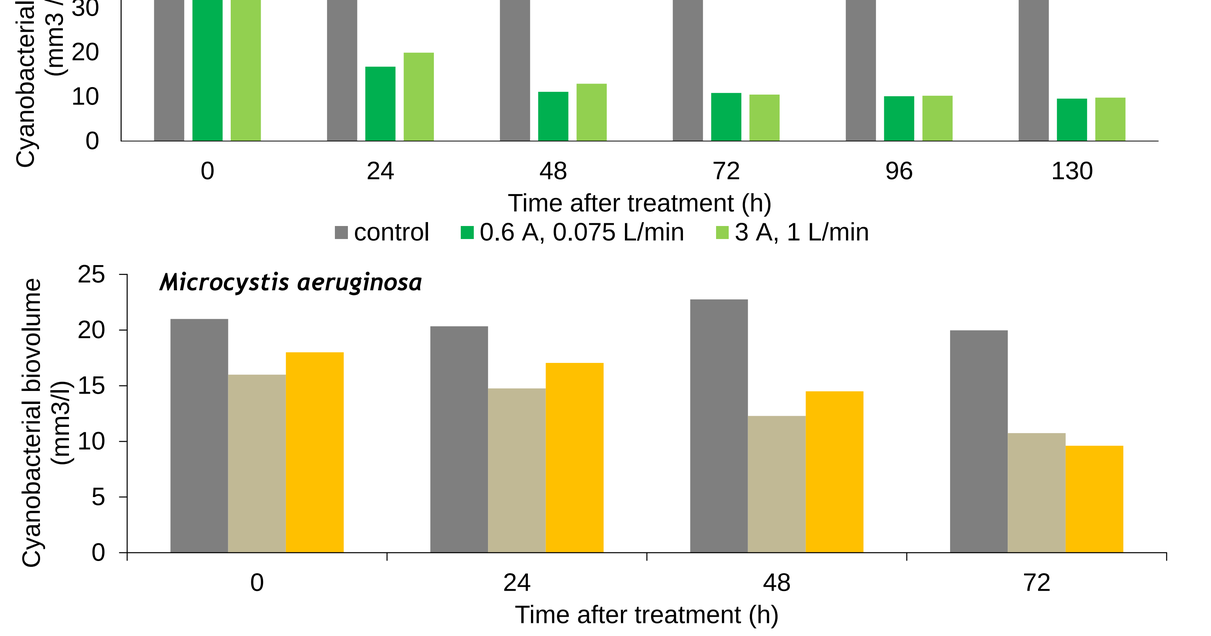

Figure 3: Effect of different electro-oxidation treatments on PC and CHL concentrations.

CONCLUSIONS

- Reductions in measured pigment fluorescence and extracted pigment concentration both show that hydroxyl radicals, produced at electro-oxidation, can cause damage on cyanobacterial photosynthetic pigments.
- Both tested set-ups confirmed to be successful at reducing cyanobacterial population.
- Further optimisation of the method for its *in vivo* implementation to be regularly used in fresh water bodies is needed.

LITERATURE:
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