UNIVERSITY OF BELGRADE, FACULTY OF AGRICULTURE - SERBIA
AND INTERNATIONAL AQUATIC VETERINARY BIOSECURITY CONSORTIUM, LUDWIG-MAXIMILIANS-UNIVERSITY MUNICH, GERMANY

SUPPORTED BY
EUROPEAN AQUACULTURE SOCIETY, EAS
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PAN-HELLENIC SOCIETY OF TECHNOLOGISTS ICHTHYOLOGISTS, (PASTI)

8th INTERNATIONAL CONFERENCE "WATER & FISH"

CONFERENCE PROCEEDINGS

Faculty of Agriculture, Belgrade-Zemun, Serbia
June, 13 – 15. 2018.

PUBLISHER
University of Belgrade - Faculty of Agriculture

FOR THE PUBLISHER:
Prof. Dr. Milica Petrović

COMPUTER DESIGN
GRAPHIC, Novi Sad

TECHNICAL PREPARATION OF A COVER
Dr. Božidar Rašković

TECHNICAL TEXT PREPARATION
Dr. Ivana Živić

PRINTED BY
GRAPHIC, Novi Sad

NUMBER OF COPIES PRINTED
400 COPIES

ORGANIZATION OF THE CONFERENCE SUPPORTED BY:
Ministry of Education, Science and Technological Development Republic of Serbia

GENERAL DONOR
DTD RIBARSTVO, Bački Jarak

PRELIMINARY ASSESSMENT OF THE DEGREE OF VULNERABILITY AND HEALTH RISK IN SOME FISHING WATERS BASED ON CYANOBACTERIA IN 2017

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PRELIMINARNA PROCENA STEPENA RANJIVOSTI I ZDRAVSTVENI RIZIK NEKOLIKO RIBOLOVNIH VODA NA OSNOVU ANALIZE CIJANOBAKTERIJA U TOKU 2017. GODINE

Apstrakt

U uslovima klimatskih promena, sve učestalije opterećenosti nutrijentima u vodama je sve prisutnija pojava cvetanja cijanobakterija koja može da bude praćena produkcijom toksina opasnih po sve vodene organizme. U takvim uslovima širom sveta zabeležena su akcidentna masovna uginuća riba. Toksini, takođe, mogu da se akumuliraju u različitim organima riba i da predstavljaju zdravsteni rizik po ljude koji ih konzumiraju.

Analizom zajednice fitoplanktona u 15 akumulacija u Srbiji u periodu od aprila do septembra 2017. godine, zabeleženo je prisustvo 27 taksona Cyanobacteria. iz rodova Aphanizomenon, Aphanocapsa, Aphanothece, Chroococcus, Chrysosporum, Cuspidothrix, Cylindrospermopsis, Dolichospermum, Gloeocapsa, Leptolyngbya, Microcystis, Oscillatoria, Phormidium, Planktolyngbya, Planktothrix, Pseudanabaena, Snowella i Woronichinia.

Prema preporukama WHO, u odnosu na brojnost cijanobakterija, praćene ribolovne vode u periodu istraživanja su kategorisane kao vode niskog (Barje, Divljana, Kamenica, Marića bara, Potpeć, Prvonek, Savsko i Zvorničko jezero), srednjeg (Bojnik, Garaši i Zaova) i visokog stepena (Vučkovica, Smoljinac, Srebrno jezero) opasnosti i zdravstvene ugroženosti. U Srebrnom jezeru zabeležena je invazivna vrsta Cylindrospermopsis raciborskii, čije širenje areala u Srbiji i često masovno umnožavanje nosi visok rizik po zajednice vodenih organizama, a pre svega riba.

Prilikom pripreme Programa upravljanja ribolovnim vodama i predviđanja daljih aktivnosti na njima, neophodno je uzeti u obzir rezultate dobijene monitoringom koji se odnose na prisustvo i brojnost cijanobakterija, obzirom da direktni negativni efekti i akumulacija cijanotoksina predstavljaju rizik za ribe, njihovo zdravlje, kvalitet, ali i direktno i indirek-

tno za zdravlje čoveka. Ukoliko je moguće, uz različite metode prevencije i sanacije, predvideti i biomanipulaciju adekvatnim ribljim vrstama.

Takođe, neophodna je edukacija upravljača ribolovnih voda, kao i korisnika (pre svega ribolovaca) u cilju prepoznavanja potencijalnih rizika i preduzimanja mera kontinuiranog monitoringa, i privremene ili trajne zabrane korišćenja voda, ukoliko rezultati pokažu visok stepen rizika i opasnost po zdravlje.

Ključne reči: *Cyanobacteria, ribolovne vode, zdravstveni rizik*
Keywords: *Cyanobacteria, fishing waters, health risk*

INTRODUCTION

Due to increasingly present eutrofication of the aquatic ecosystems comes to frequent occurrence of Cyanobacterial blooms, often followed by the production of cyanotoxins in their cells. Cyanotoxins are very poisonous substances, which when released into the water represent a threat to both aquatic and terrestrial organisms (Sedmak & Svirčev, 2011). The massive accidentally fish kill caused by blooming of cyanobacteria, in Serbia are already known (Đorđević & Simić, 2014; Đorđević et al., 2015).

Fish comes into contact with cyanobacteria and their toxins in various ways, which can affect their growth, development, reproduction, survival (Palikova et al., 2007; Drobac et al., 2016). Fish exposure to cyanotoxins can occur in two ways: by active introduction through drinking and consuming of cyanobacterial cells and other organisms that have accumulated cyanotoxins in their tissues, or by direct contact of the epithelial cells with the surrounding water containing toxins (Palikova et al., 2007). Cyanotoxins can accumulate in fish and other hydrobionts organs, and their consuming represent a potential risk to human health.

Accumulation of cyanotoxins in fish may leads to desorders of the antioxidant defense system, as well as histopathological changes in various fish organs, including the liver, intestines, kidneys and muscles (Drobac et al., 2016).

The health effects that cyanobacteria and their toxins have, both on fish and potentially on human which in their diet use cyanotoxin-infected fish, have led to an increase in interest in cyanobacteria research, especially in waters used for fishing purposes.

By the Decision on the Determination of Fishing Areas (Official Gazette of the Republic of Serbia, 90/2015) it has been established 17 fishing areas on the territory of the Republic of Serbia. The research of fishing waters carries out with the goal to get an Fishing Water Management Program, according to the Law on the Protection and Sustainable Use of Fish Stock (Official Gazette of the Republic of Serbia, 128/2014). Within this research, the nekton community (qualitative analysis, biomass, real and potential production of fish) is primarily enquired, while a lot less attention is dedicate to the benthos and plankton communities.

The aim of this paper is to provide a preliminary assessment of the degree of vulnerability and health risk in some fishing waters in Serbia, based on the presence of potentially toxic Cyanobacteria and the total number of this group of organisms during the research period.

MATERIAL AND METHODS

Field research of 15 reservoirs of different purposes in the territory of the Republic of Serbia was conducted in the period from April to September 2017 (Table 1).

The samples for the phytoplankton qualitative analysis were collected by sweeping a plankton net (netframe 25 cm ø, mesh net e.g. 22 μm), while the samples for the quantitative analysis were collected from a depth of one meter by Rutner's bottle (2 l).

The qualitative analysis was done by the light microscope Motic BA310 with digital camera Bresser (9MP) and MicroCamLab software. Taxonomic identification of Cyanobacteria was made using appropriate identification keys. The quantitative analysis of phytoplankton was conducted using the Sedgewick-Rafter counting chamber, with a Motic BA310 microscope.

Assessment of the degree of hazard and health risk (for the research period) was done according to the number of Cyanobacteria and on the basis to the recommendation of the World Health Organization (WHO) (Chorus & Bartram, 1999).

RESULTS AND DISCUSSION

Qualitative analysis of phytoplankton community during the 2017 years in 15 Serbian reservoirs resulted with a total of 27 identified taxa, recorded in 14 reservoirs (Table 1).

Some of the potentially toxic cyanobacteria (Chorus & Bartran, 1999), such as *Aphanizomenon flos-aquae, Dolichospermum flos-aquae* (as *Anabaena flos-aquae*) *Microcystis aeruginosa, M. viridis*, *Cuspidothrix issatschenkoi, Cylindrospermopsis raciborskii* and *Snowella lacustris* were recorded (Table 1).

Table 1. Qualitative and quantitative analysis of Cyanobacteria in the investigated fishing waters

Reservoir/ month 2017	Taxa	Abundance of Cyanobacteria (cell/ml)
Fishing area „Južna Morava 1"		
Barje June	*Planktolyngbya* sp. Anagn. & Komárek *Snowella lacustris* (Chodat) Komárek & Hindák *Woronichinia compacta* (Lemmerm.) Komárek & Hindák	2 118
Divljana July	-	0
Prvonek June	*Aphanocapsa inserta* (Lemmerm.) Cronberg & Komárek *Dolichospermum planctonicum* (Brunnth.) Wacklin et al. *Pseudanabaena* sp. Lauterborn	2 307
Fishing area "Južna Morava 2"		
Bojnik June	*Chroococcus* sp. Nägeli *Cuspidothrix issatschenkoi* (Usachev) Rajan., Komárek, Willame, Hrouzek, Kastovská, Hoffm. & Sivonen *Dolichospermum planctonicum* (Brunnth.) Wacklin et al. *Dolichospermum* sp. (Ralfs ex Bornet & Flahault) Wacklin, Hoffman & Komárek *Planktolyngbya limnetica* (Lemmerm.) Legn. & Cronberg *Snowella lacustris* (Chodat) Komárek & Hindák	23 898

Fishing area "Zapadna Morava"		
Vučkovica September	*Microcystis viridis* (A. Braun in Rabenhorst) Lemmenrm. *Phormidium* sp. Kütz. ex Gomont *Planktolyngbya* sp. Anagn. & Komárek	967 259
Marića swamp July	*Chroococcus* sp. Nägeli *Leptolyngbya notocorum* (Bornet ex Gomont) Anagn. & Komárek *Pseudanabaena* sp. Lauterborn *Phormidium* sp. Kütz.ex Gomont	1 998
Potpeć May	*Phormidium irriguum* (Kütz. ex Gomont) Anagn. & Komárek *Planktolyngbya* sp. Anagn. & Komárek *Pseudanabaena* sp. Lauterborn	2 627
Fishing area "Kolubara"		
Garaši July	*Chroococcus dispersus* (Keiss.) Lemmerm. *Dolichospermum* sp. (Ralfs ex Bornet & Flahault) Wacklin, Hoffman & Komárek *Gloeocapsa* sp. Kütz. *Planktolyngbya* sp. Anagn. & Komárek *Planktothrix agardhii (Gomont)* Anagn. & Komárek *Snowella lacustris* (Chodat) Komárek & Hindák	21 615
Kamenica July	*Aphanocapsa inserta* (Lemmerm.) Cronberg & Komárek *Gloeocapsa* sp. Kütz. *Leptolyngbya* sp. Anagn. & Komárek	6 965
Savsko August	*Leptolyngbya* sp. Anagn. & Komárek *Phormidium* sp. Kütz. ex Gomont	5 087
Zvorničko July	*Leptolyngbya* sp. Anagn. & Komárek *Planktolyngbya limnetica* (Lemmerm.) Legn. & Cronberg	7 214
Fishing area "Velika Morava 1"		
Šumarice April	*Aphanizomenon flos-aquae* Ralfs ex Bornet & Flahault *Chroococcus limneticus* Lemmerm. *Chroococcus minutus* (Kütz.) Nägeli Chrysosporum minor (Kiselev) Komárek *Cuspidothrix issatschenkoi* (Usachev) Rajan., Komárek, Willame, Hrouzek, Kastovská, Hoffm. & Sivonen *Microcystis aeruginosa* (Kütz.) Kütz. *Oscillatoria tenuis* Agardh ex Gomont *Snowella lacustris* (Chodat) Komárek & Hindák	2 349

Fishing area "Mlava"		
Smoljinac July	*Aphanocapsa inserta* (Lemmerm.) Cronberg & Komárek *Cuspidothrix issatschenkoi* (Usachev) Rajan., Komárek, Willame, Hrouzek, Kastovská, Hoffm. & Sivonen *Dolichospermum flos-aquae* (Bréb. ex Bornet & Flahault) Wacklin et al. *Microcystis aeruginosa* (Kütz.) Kütz. *Microcystis viridis* (A. Braun in Rabenhorst) Lemmenrm. *Pseudanabaena catenata* Lauterborn	377 672
Srebrno July	*Aphanizomenon flos-aquae* Ralfs ex Bornet & Flahault *Cylindrospermopsis raciborskii* (Woloszyńska) Seenayya & Subba Raju *Leptolyngbya* sp. Anagn. & Komárek *Planktolyngbya limnetica* (Lemmerm.) Legn. & Cronberg *Pseudanabaena* sp. Lauterborn	277 057
Zaova July	*Aphanizomenon flos-aquae* Ralfs ex Bornet & Flahault *Aphanothece* sp. Nägeli *Cuspidothrix issatschenkoi* (Usachev) Rajan., Komárek, Willame, Hrouzek, Kastovská, Hoffm. & Sivonen *Microcystis aeruginosa* (Kütz.) Kütz. *Pseudoanabaena catenata* Lauterborn *Planktolyngbya* sp. Anagn. & Komárek	39 776

According to the WHO recommendations (Chorus & Bartran, 1999), in relation to the abundance of cyanobacteria, fishing waters are classified as low probabilities of adverse health effects (Barje, Divljana, Kamenica, Marića swamp, Potpeć, Prvonek, Savsko and Zvorničko), as waters of moderate probability of adverse health effects (Bojnik, Garaši and Zaova), and as water of high risk of adverse health effects (Vučkovica, Smoljinac and Srebrno), based on preliminary results in the research period.

The occurrence of the invasive tropical species *Cylindrospermopsis raciborskii* in Srebrno Lake is especially significant. Increasingly frequent finding of this species in Serbia (Cvijan & Fužinato, 2011; Karadžić et al., 2013; Đorđević & Simić, 2014; Đorđević et al., 2015) indicates the expansion of its area. *C. raciborskii* can produce very strong toxin cylindrospermopsin and in case of massive occurrence, could lead to fish kills (Đorđević et al., 2015).

CONCLUSIONS

During the preparation the Fishing Water Management Program and anticipating further activities on them, it is necessary to take into account the monitoring results that are related to the presence and the number of cyanobacteria, because of the cyanotoxins and its direct negative effects and the risk for fish, their health, quality, and therefore directly and indirectly for human health. It is also necessary to anticipate biomanipulation with adequate fish species, with different methods of prevention and rehabilitation, if it is possible.

The training of fishery water managers and users (primarily fishermen) is needed with the goal of identify potential risks, to take measures of continuous monitoring and temporary or permanent water use prohibition, if the results show a high risk of adverse health effects.

ACKNOWLEDGEMENTS

This work was supported by the Ministry of Education and Science and Technological Development of the Republic of Serbia (Project No. TR 31011).

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