A Case Report: Algal Bloom of *Microcystis aeruginosa* in a Drinking-Water Body, Eğirdir Lake, Turkey

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Abstract

Eğirdir Lake is one of the largest lakes of Turkey. It has provided some of drinking-water for Isparta since 1994 due to the problem of water shortage. A few successive blooms were firstly observed in the western shores of Eğirdir Lake during the summer and autumn of 2006. The blooms were seen as a bluegreen jelly or band in shores of the lake. *M. aeruginosa* and *M. flos-aqua* were identified in our investigation but *M. aeruginosa* was determined as the bloom-forming species. *M. aeruginosa* was counted as 16,530 colony/L and Chlorophyll-*a* concentration was measured as 117 µg L^{-1} in our investigation. In this respect, we can say that Eğirdir Lake is under the potential risk of cyanobacterial toxicity. Surface water temperature was recorded as 24.2°C. Orthophosphate-P (PO_4-P) and inorganic nitrogen (NO_2-N, NO_3-N and NH_4-N) concentrations were not detected from the sampling station. Details of the other environmental parameters are given in the text.

Key words: Eğirdir Lake, drinking-water, cyanobacterial bloom, *Microcystis aeruginosa*.

Introduction

Massive growth (bloom) of cyanobacteria (blue-green algae) in ponds, lakes, reservoirs or other freshwater systems have become serious water quality problems which also threaten human and animal health (WHO, 2003; Chorus and Bartram, 1999; Carmichael *et al.*, 2001). Occurrences of cyanobacterial bloom typically appear in eutrophic lakes, which either have encountered anthropogenic nutrient loading or are naturally nutrient rich (Vaitomaa, 2006). Blooms of *Microcystis* species are known as one of the most common worldwide (Silva, 2003; Kann and Gilroy, 1997). The growth of *Microcystis* produces bad-smelling and unsightly scum, preventing recreational use of water bodies, hampering the treatment of water for drinking, and clogging irrigation pipe (Yoshinaga *et al*., 2006).

Microcystis aeruginosa (Kütz) Kütz. is formed as spherical or elongated colonies with cells more or less spherical, colony sheath is indistinct and cells are with gas-vacuoles, bringing about floating (Desikachary, 1959). *M. aeruginosa* occur fresh to moderately brackish water, often forming dense blooms in mid-to late summer and fall to the bottom sediments in autumn (John *et al*., 2002). This organism produces a vast number of peptides (microcystins), some of which are highly toxic (Grobbelaar *et al*., 2004). Microcystins cause fatal poisoning of livestock and human (Sivonen, 1996).

Eğirdir Lake is one of the largest lakes of Turkey. The lake has a rich fishery potential and several endemic fish species such as *Capoeta pestai, Phoxinellus egridiri, P. handlirschi, P. zeregii, Tylognathus klatti* (Geldiay and Balık, 1996). It has provided some of drinking-water for Isparta since 1994 due to the problem of water shortage. Moreover, Eğirdir Lake has an importance with respect to irrigation and electrical production. The lake connects to Kovada Lake via a regulator and channel system and supports Kovada I and II hydroelectric power plant. Tourism activities also occur in southern beaches of the Lake.

There are a few studies on cyanobacterial bloom and toxicological effects of them in Turkish freshwater systems (Albay *et al*., 2003; 2005). Present study has an aim to attract attention to the first occurrence of *Microcystis aeruginosa* bloom in the Eğirdir Lake providing drinking-water.

Materials and Methods

Eğirdir Lake has a tectonic origin and is 929 m above sea level. It is located at latitude 38°15′ N and longitude 30°52′ E in The Lake District, southwest Turkey (Figure 1). It has of surface area of approximately 482 km^2 and maximum depth of the lake ranges from 9 m to15 m. Northern part of the lake is also called as Hoyran Lake. Main water sources of the lake are underground springs, small streams and rain waters. Especially, most of the streams transport domestic, agricultural and industrial wastes to the lake.

On 5th October 2006, only one water sample and a quantitative plankton sample with 5 L volumes were taken from a station where cyanobacterial bloom appears frequently. The plankton sample was fixed in 4% formaldehyde solution in field. Enumeration

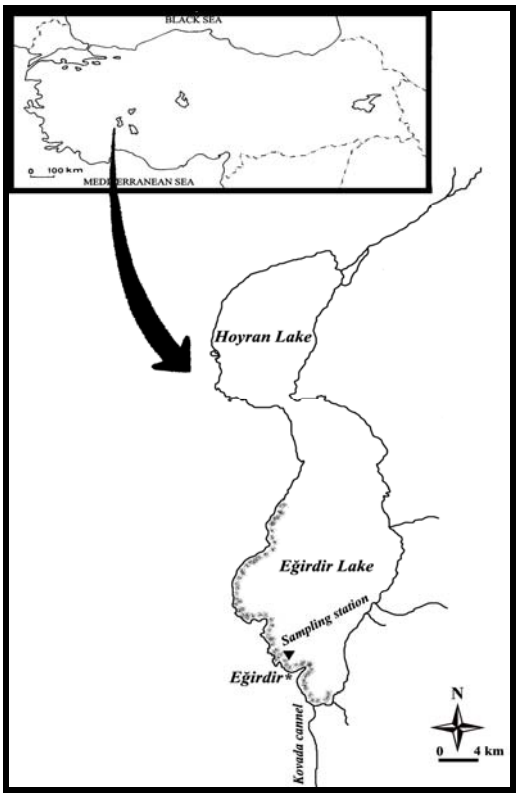

Figure 1. The map of study area.

process of *Microcystis* colonies was carried out according to relevant literatures (Venrick, 1978; Semina, 1978). Result of the enumeration was presented as colony/L. The taxonomic identification was made using the monographs on Cyanobacteria (Desikachary, 1959; Compere, 1986).

Some physicochemical parameters, such as temperature, pH, dissolved oxygen (D.O.), D.O. saturation and conductivity, were measured *in situ* using YSI 30 model SCT meter, WTW 330 model pH meter and WTW 330 model oxygen meter. Analyses of nutrients and Chlorophyll-*a* measurement were carried out spectrophotometrically in the laboratories (APHA - AWWA - WPCF, 1995).

Results and Discussion

Some physicochemical and biological variables measured from surface water during the bloom occurrence are presented in Table 1. Surface water temperature was recorded as 24.2°C. *Microcystis* blooms often appear in eutrophic waters at high temperature (Yoshinaga *et al*., 2006). Orthophosphate-P (PO_4-P) and inorganic nitrogen (NO_2-N, NO_3-N and NH_4-N) concentrations were not detected from the sampling station. Cyanobacteria can utilise ammonium, nitrite, and nitrate as sole N sources (Tandeau de Marsac and Houmard, 1993). During the growth season, orthophosphate-P and combined inorganic N concentrations may be low or depleted in pelagic waters simultaneously with variable concentrations of dissolved organic P and N compounds (Münster and Chróst, 1990).

A few successive blooms were firstly observed in the western shores of Eğirdir Lake during the summer and autumn of 2006. The blooms were seen as a bluegreen jelly or band in shores of the lake (personal observations). Chorus and Bartram (1999) reported that light winds drive colonies of cyanobacteria to leeward shores and bays, where they form scum changing the cyanotoxin risk from moderate to high. *M. aeruginosa* and *M. flos-aqua* was identified in our investigation but *M. aeruginosa* was determined as the bloom-forming species. There were no other bloom-forming algae or toxic cyanobacteria. *M. aeruginosa* were counted as 16,530 colony/L and Chlorophyll-*a* concentration was measured as 117 µg L^{-1} in our investigation. Albay *et al*. (2005) reported that chlorophyll-*a* concentrations varied between 13.3–216 µg L^{-1} (mean 79.3 µg L^{-1}) and microcystin (MC) concentrations also varied between 0.1 – 24.2 µg L^{-1} MC-LR equivalents (mean 4.14 µg L^{-1} MC-LR equiv.) in the Kucukcekmece Lagoon where occurrence of *M. aeruginosa* bloom was observed. In this respect, we can say that Eğirdir Lake is under the potential risk of cyanobacterial toxicity although MC concentrations were not measured in the lake. On the other hand, all cyanobacterial blooms may not be always toxic. Cyanobacterial toxin concentration is apparently

Table 1. The measured physicocemical and biological parameters of sampling station

Parameters	Unit	Sampling station
Temperature	°C	24.2
Dissolved oxygen	mg L^{-1}	5.2
Oxygen saturation	%	66.5
pH		7.8
Conductivity	µS	383.0
NO_2-N	µg L^{-1}	Nd
NO_3-N	µg L^{-1}	Nd
NH_4-N	µg L^{-1}	Nd
PO_4-P	µg L^{-1}	Nd
Ca^{++}	mg L^{-1}	16.1
Mg^{++}	mg L^{-1}	53.5
Chlorophyll-a	µg L^{-1}	117.0
M. aeruginosa	colony/ L	16,530

Nd: No detect.

influenced by many factors such as the composition of the phytoplankton community, stage of growth of the cyanobacterial population, and domination of toxic species of cyanobacteria (Tarczynska *et al*., 2001). Furthermore, it is well known that *M. aeruginosa* contains also non-toxic strains and microcystin production is affected by various environmental factors such as water temperature, pH, intensity of solar radiation, dissolved oxygen and CO_2 availability (Grobbelaar *et al*., 2004). Consequently, analytical methods should be made on water samples to be sure the on toxicity of cyanobacterial blooms.

In conclusion, cyanobacterial cell abundances and toxin concentrations in the Eğirdir Lake must be monitored for human and animal health in the future summer periods because the lake is used by human for drinking-water, fisheries and tourism activities. Moreover, pollution sources which accelerate to eutrophication process of the lake must be obstructed.

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