

Cyanobacterium *Microcystis aeruginosa* Bloom in Aras Dam Reservoir

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ABSTRACT: Occurrences of cyanobacterial bloom typically appear in eutrophic lakes which either have been affected by anthropogenic nutrient loading or are naturally rich in nutrients. *Microcystis* blooms have been reported all over the world in freshwater ecosystems mainly due to increased population which results in increased the waste water production. The aim of this study was to recognize the basic reasons of *Microcystis aeruginosa* bloom in Aras reservoir. Water temperature, pH, DO, EC, TN, N-NO₂, N-NO₃, P-Po₄, chl a and the number of *Microcystis* colonies were determined. The effects of these parameters on the microcystis increased growth was examined. Though we could not strictly relate a few other factors to this phenomenon, higher water temperature, pH and DO in the sampling site i.e. 27° C, 9.16 and 17.2 mg/L respectively, surely favored the *M.aeruginosa* bloom. In brief, preventing or reducing the nutrients flow into the reservoir should be considered as a priority in order to reduce *Microcystis* scum forming colonies.

Key words: Eutrophic lakes, Nutrients, Cyanobacteria, Dominance, Freshwater

INTRODUCTION

Cyanobacterial blooms in freshwater ecosystems have created serious water quality problems. These problems and their ecological consequences have been intensively studied in freshwater (Chorus and Bartram, 1999; Chorus, 2001; Adeyemi, 2009; Sahmoune *et al.*, 2009; Khanna *et al.*, 2009; Mishra *et al.*, 2009; Banerjee and Srivastava, 2010; Adekunle *et al.*, 2010). Harmful effects of cyanobacteria in fisheries, domestic and recreational areas have well been documented (Znachor *et al.*, 2006; Santhanam and Amalraj, 2010; Rajesh Kannan *et al.*, 2010; Jeong *et al.*, 2010). Occurrences of cyanobacterial bloom typically appear in eutrophic lakes which either have been affected by anthropogenic nutrient loading or are naturally rich in nutrients. *Microcystis* blooms have been reported all over the world (Sömek *et al.*, 2008; Velmurugan *et al.*, 2009). *Microcystis* produces bad-smelling and unsightly scum, hampering the treatment of water for drinking, clogging irrigation pipe and preventing recreational use of water bodies (Yoshinaga *et al.*, 2006). Some *Microcystis* species produce toxins that cause fetal poisoning of livestock and humans (Carmichael, 1992). To predict and prevent nuisance *Microcystis* blooms in freshwater systems, it is necessary to understand the conditions that lead to *Microcystis* dominance. Aras

dam-reservoir plays important roles in the region such as fisheries, agricultural, industrial, and domestic and drinking water supply. In spite of these crucial roles, few studies have been performed on the reservoir water quality. Therefore, the present study attempts to focus on the occurrence of *Microcystis auroginosa* bloom in Aras dam reservoir.

MATERIALS & METHODS

Aras river is one of the largest rivers in northwest Iran and Caspian sea basin. Aras dam (max capacity = 1350 × 10⁶ m³, max area = 153 km², mean depth = 20 m and height = 36 m) was constructed on this river in 1972. Sampling was conducted seasonally from three stations along the water body (stations 1, 2 and 3) in 2008-2009 (Fig.1). Phytoplankton counting and identification were made using 5-ml settling chambers with a Nikon TS100 inverted microscope at 400× magnification by Utermöhl (1958) method. At least 50 fields or 100 individuals of the most abundant species were counted in each sample (Venrick, 1978). *Microcystis* colonies were counted according to Venrick (1978) and Semina (1978). Water temperature, dissolved oxygen, electron conductivity (EC) and pH were measured in situ at every sampling site in the superficial water layer (50 cm depth) with a WTW 320

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Oxymeter, a WTW LF 320 ECmeter and a Testo 320 PHmeter respectively. Analysis of nutrients and Chlorophyll a measurement were carried out by spectrophotometer in laboratories. Dissolved nutrients (ammonia, nitrites, nitrates and phosphates) were measured as described in Greenberg et al. (1992). Samples for chlorophyll a determination were filtered through a glass fiber filter (GF/C) buffered with magnesium carbonate. Phytoplankton chlorophyll a concentrations were estimated according to the method of Parsons and Strickland (1965) after 24h extraction in 90% acetone. The phytoplankton taxa were identified according to the following references: Smith (1950), Prescott (1962), Tiffany and Britton (1971), Bellinger (1992) and Desikachary (1959).

RESULTS & DISCUSSION

In a relatively recent review (Hyenstrand *et al.*, 1998) nine factors have been listed that promote *Microcystis* dominance: resource competition, light conditions, PH/CO₂ conditions, buoyancy, high-temperature tolerance, avoidance by herbivores, superior nutrient storage, ammonium-N exploitation and competition for trace elements. In the present study, water temperature was measured 27 ° C and PH was 9.16 (Table 1). These conditions (high temperature and higher PH values) favored cyanobacterial bloom in Aras reservoir. On the other hand, dissolved oxygen concentration was obtained 17.2 mg/L which indicated the higher photosynthetic process of phytoplankton in the surface layer of water during day time. Also,

M.aeruginosa density was 21,615 colonies/L and chlorophyll a concentration was determined as 132 µg/L which well demonstrated the hypereutrophic state of the water in the sampling sites. Furthermore, relatively low phytoplankton density (2.98×10^5 cells/L) other than *Microcystis* indicated the higher competing power of this alga. In this study, orthophosphate-P and total N concentrations were determined as 0.6 and 1.1 mg/L (Table 1). During the growth season, orthophosphate-P and total N concentrations may be low or depleted. In general, while some parameters such as water temperature, DO, PH, P-PO₄ and chlorophyll a determined in the present study well corresponded with results of studies performed on the cyanobacterial blooms in freshwater ecosystems (e.g. Johnston and Jacoby, 2003; Dokulil and Teubner, 2000), other factors are difficult to contribute to the pronounced development of *Microcystis* in Aras-dam reservoir and may not be necessarily the same in all reservoirs. Masoudi *et al.*, (2004) concluded that Geosmin an organic compound was the agent of bad smelling and unpleasant taste in Bukan-dam reservoir (northwest of Iran) water which was produced by *Microcystis*. Though we did not determine Microcystins or other toxic chemicals of the water in this study but it should be considered as an important factor for the future investigations. On the other hand, Yoshinaga *et al.* (2006) suggested that low hydraulic turnover rates favored *Microcystis* dominance in a eutrophicated reservoir in Japan. Aras dam-reservoir is a relatively large (mean depth = 20 m)

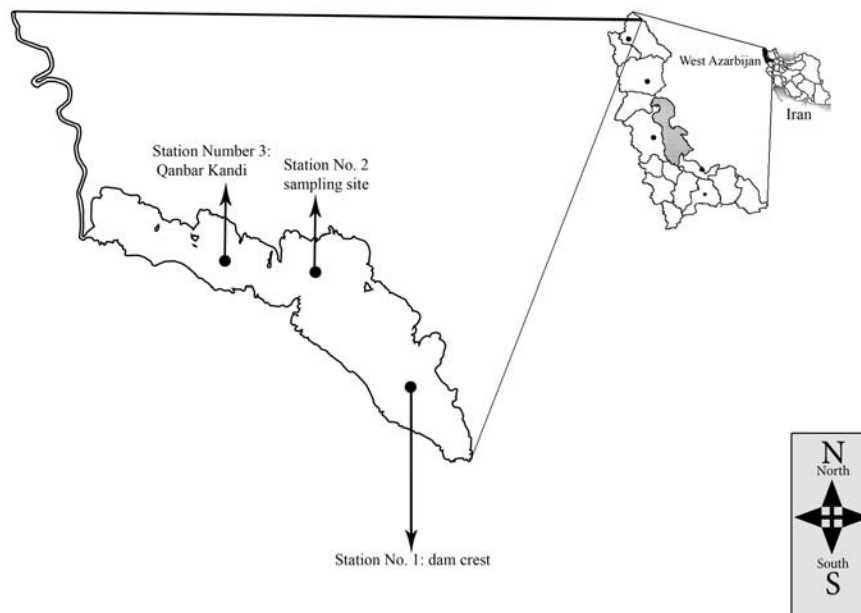


Fig. 1. The location of Aras-dam reservoir and sampling sites

reservoir in which water turnover rate has not been studied in details. Therefore, this parameter should be considered as an important factor in *Microcystis* bloom in the reservoir and should be investigated as a separate research program in the future studies.

Table 1. The physicochemical and biological parameters of sampling site

Parameter	
Water temperature (°C)	27.0
Dissolved oxygen (mg/L)	17.2
PH	9.16
EC (µmose.cm ⁻¹)	253
N-NO ₂ (mg/L)	0.01
N-NO ₃ (mg/L)	1.0
N_NH ₃ (mg/L)	0.06
TN (mg/L)	1.1
P_PO ₄ (mg/L)	0.6
HCO ₃ (mg/L)	138
Chl a (µg/l)	112
Microcystis (Colony/L)	21,615

CONCLUSION

In conclusion, further investigations of the mechanisms of *Microcystis* bloom formation is needed to prevent it. However, cyanobacterial cell abundances in the Aras-dam reservoir should be monitored to prevent human and animal diseases, because the lake is used by human for drinking water, fisheries and tourism activities.

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