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IMPACT OF NUTRIENT ENRICHMENT ON UNICELLULAR CYANOBACTERIUM *MICROCYSTIS*

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A B S T R A C T

Among nutrients, nitrogen and phosphorus are mainly responsible for emergence of blooms of cyanobacteria in lakes and reservoirs. The present study indicates that in the synthetic medium umber of cells increases when P applied alone while the numbers are always less when N and P applied together. However, growth is less pronounced in the natural lake water which indicates the presence of chelating material (s).

INTRODUCTION

Microscopic phytoplankton has been a focus of study in the past to characterize lake trophic states. Bioassays which are conducted with cyanobacterial species (particularly unicellular or filamentous forms) as test organisms can be used for the monitoring of the nutrient enrichment in polluted water.

Numerous factors may be involved in the ecological success of cyanobacteria. Enumeration of these factors, which lead to the emergence and dominance of cyanobacteria in lakes, might be helpful in minimizing their occurrence.

Nitrogen and phosphorus are two main nutrients responsible for emergence of planktonic forms such as *Microcystis*. This unicellular cyanobacterium produces toxic substances which cause harm to animals and even cause death. Cyanobacterial toxins have even been associated with human illness (Gentile, 1971 ; Watanabe and Oishi, 1982). Interaction involving essential trace elements availability, such as copper and its impact on various physiological processes of cyanobacteria (Kashyap and Gupta, 1982 ; Gupta, 1983, 1986, 1988) have generated increasing evniornmental concerns. Recently, interactive effects of nitrogen and copper has been studied in *Microcystis* (Gupta, 1987, 1989). The Present study was undertaken to test the different N : P concentrations in *Microcystis* sp. in natural lake water and synthetic medium.

MATERIAL AND METHODS

The unicelluar cyanobacterium *Microcystis* sp., was collected with the help of a plankton net (100 μm mesh from one of the ponds of the Indian Botanic Garden, Botanical Survey of India, Howrah. An axenic culture of the alga was grown and maintained in nutrient rich ASM-1 (Gorham *et al.* 1964) medium modifed by Reynolds and Jaworski (1978) employing standard microbiological techniques. Experiments were conducted in 25 ml culture tubes containing 10 ml culture medium with addition of phosphorus (1.5 mg $p.l^{-1}$ as KH_2PO_4) or nitrogen (20-22 mg $N.l^{-1}$ as $NaNO_3$) or a combination of both. Cultures without addition of N and P served as control. Assays were conducted in triplicates and in two sets : one in natural water and other containing modified ASM-1 medium. The initial cell density of inoculum was 1×10^6 cells per ml. Prior to bioassays the cyanobacterium was cultured in nutrient deficient medium for atleast 4-6 days to avoid carry-over of luxury uptake of N and P during

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experimental period. Cultures were maintained in an incubator at 24±1° C continuously illuminated with cool fluorescent tubes (irradiance 3.87 Wm^{-2}) for 16 hrs. : 8 hrs. light and dark period, respectively. Growth was monitored by counting cell numbers and by measuring optical density at 650 nm using UV spectrophotometer (EC, India). To test the involvement of other factors application of EDTA was made wherever considered necessary. The specific growth rate was calculated using the following equation given by Myres and Kratz (1955) :

$$k = \frac{2.32 (\log N_2 \quad \log N_1)}{T_2 \quad T_1}$$

where,

N_1 = Initial cell density at time T_1, and

N_2 = Final cell density at time T_2

RESULTS AND DISCUSSION

No morphological variations were detected in *Microcystis* under varied nutrient supply conditions although such changes have been reported in many cases in response to changes in culture conditions. The nutrient enrichment (N : P) has been used successfully to control the dominance of cyanobacteria in polluted enviornments of lakes and ponds (Gupta, 1994).

An increase in cell density was observed when P was supplied as a single nutrient, but the total number of cells was always less than the yield with N and P together although cell density was always less in lake medium indicating that in the presence of P, N became the limiting nutrients. Further in presence of N and P both maximum cell density of 1×10^9 cells. ml^{-1} was observed in the control of ASM-1 medium (Table-1). In the lake water, growth was less pronounced in the synthetic medium but positive growth response was noticed after the addition of nutrients.

Table 1 : *Effect of nutrient enrichment on cell density of Microcystis (after 3 weeks of incubation)*

Medium nutrients	Lake water -EDTA	Lake water +EDTA	ASM-1 medium
Control	1×10^8	2×10^8	1.5×10^8
+N	8×10^6	1×10^7	9.5×10^6
+P	2.5×10^7	5×10^7	5×10^7
+NP	4×10^8	6×10^8	1×10^9

Since N : P ratio hypothesis alone was insufficient to explain the low growth rate and thus dominance of the blue green algae in lakes, the involvement of other factors which inhibited the growth, were tested. To test the presence of metals, EDTA was added in lake water medium which enhanced the yield in all tubes including control suggesting presence of metals. It is likely that metal toxicity was more pronounced in lake water than in ASM-1 medium as observed earlier for *Microcystis aeruginosa* (Gupta, 1990a,b) and for *Ankistrodesmus falcatus* (Wong *et al.* 1983). It has been observed that high concentrations of ammonium nitrogen are also toxic in the absence and presence of heavy metal.

The present study indicates probable limiting/ inhibiting factors might be P and NH_4-N and /or metal but criteria based on bioassays with single metal are not advisable since a single metal is rarely dominant in natural water system where many enviornmental variables are interacting. Therefore, nutrient enrichment ratio alone will be insufficient to predict such results. As such to study biological responses to water quality with the help of algal bioassays will be more effective if the toxicity of the trace organic mixtures is assayed simultaneously.

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