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Effects of yttrium and phosphorus on growth and physiological characteristics of *Microcystis aeruginosa*

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Abstract: Yttrium is a main kind of rare earth elements (REEs) with wide applications in modern industry and farming. Phosphorus, an essential element of algae, is used as the nutrients and also one of the main factors of eutrophication. To investigate the effects of yttrium and phosphorus on *Microcystis aeruginosa (M.aeruginosa)*, the growth and physiological changes were studied by lab cultured experiments. In the experiment, exogenous yttrium was tested by a concentration gradient (0.0, 0.1, 0.3, 0.5, 1.0 mg/L), meanwhile, phosphorus was tested by three concentrations (0.0, 0.02, 0.2 mg/L). The results show that the contents of chlorophyll *a* (chl-*a*) and soluble protein increase compared with the control and they have certain correlation with algal cells density. The growth status of algae is stimulated by initial yttrium concentration ≤0.3 and 0.2 mg/L phosphorus, while it is inhabited by 0.5 and 1.0 mg/L yttrium. Besides, the activity of superoxide dismutase (SOD) of algae increases with addition of yttrium dose (0–0.3 mg/L) when phosphorus dose is 0.2 mg/L. Furthermore, when yttrium dose is 0.5 and 1.0 mg/L, the vitality of SOD presents a sharp decline. The malondialdehyde (MDA) contents increase with time and addition of yttrium dose, 0.2 mg/L phosphorus weakens the accumulation of MDA.

Keywords: *Microcystisaeruginosa*; Yttrium; Phosphorus; Growth; Rare earths

1. Introduction

With the rapid development of economy and the influence of human activities increased, algal bloom phenomenon occurs frequently all over the world. The algae types, causing algal boom, are bacillariophyta, pyrrhophyta, chlorophyta, cyanophyta, etc. Cyanobacteria, distributed widely in waters, can memorably proliferate and lead to worrisome algal bloom because of an excess input of nutrient[0]. Algal bloom can exhaust the dissolved oxygen in the water, which would directly result in degradation of water environment and may lead to certain issues, such as anaerobic status in water, releasing unpleasant odors and blocking of water treatment facilities. It has been one of main water pollution issues humans are facing currently**Error! Reference source not found.**. What's more, we use the water resource which is rich in algae in our living and entertainment unconsciously. Algae toxins, one kind of metabolites of certain algae, are potential risks to public health[0]. In China, algal bloom has been paid enough attention due to eutrophication in some fresh water lakes, such as Dianchi Lake, Taihu Lake, Chaohu Lake seasonally**Error! Reference source not found.**. The *M.aeruginosa* is a typical blue-green algae, possesses the characteristics of cyanobacteria**Error! Reference source not found.**. Notably, the management and restoration of affected water-body have been challenge due to frequent occurrence of algal bloom. So in order to minimize the disadvantage of algal bloom, scientists have done considerable researches about it in the past decades. They studied the effects of external

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