

ISBN : 978-602-18940-0-2

The 2nd International Seminar on New Paradigm and Innovation on Natural Sciences and its Application



“Science for Environmental Sustainability and Public Health”

**DIPONEGORO UNIVERSITY
OCTOBER 4, 2012
SEMARANG, INDONESIA**

organized by :



**FAKULTAS
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The Potential Used of Microalgae for Heavy Metals Remediation

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ABSTRACT

Bioremediation is a biologically environmental cleaning process from pollutant. Phytoremediation is the use of plant (lower to higher plants) to clean up polluted terrestrial or aquatic ecosystem, due to their ability to absorb pollutant and an efficiently mechanism on the accumulation of water, nutrients, and mineral. Microalgae require heavy metals for enzymatic process, however, at a high concentration may toxic. Microalgae are primary producer in aquatic ecosystem, therefore have an important role in the food web. Most of microalgae are live in the water as a plankton and contribute 50% of water oxygen, the rest are in the humic places.

This reserach was conducted in order to find out the potential use of microalgae, particularly *Chlorella*, *Spirulina*, *Chaetoceros*, and *Porphyridium* to remediate heavy metals of lead (Pb), cadmium (Cd) and copper (Cu). On the experimental research, 0.5 mg heavy metals were added to the 1 L microalgae culture. The microalgae population was counted every day for 14 days. The concentration of initial and 14 days heavy metals concentration in the microalgae culture were measured.

Chlorella has the highest population on the Pb, Cd and Cu treatments, with the reduction of heavy metal cocentration on the culture media were 90%, 62%, and 83%, respectively. *Porphyridium* culture had shown the highest reduction of Cu and Cd concentrations of 96% and 70% respectively, although its population was a half of *Chlorella* population. *Spirulina* had the lowest population on the Cd treatment with the reduction of Cd concentration on the media was 73%. *Chaetoceros* had the lowest population on the Pb treatment with its reduction of 81%. Seems that the microalgae species showed different respond to heavy metals. Further research has to be developed to determine the percentage of heavy metal that accumulated on the microalgae.

Keywords: bioremediation, heavy metals, microalgae, *Chlorella*, *Spirulina*, *Chaetoceros*, *Porphyridium*

1. INTRODUCTION

One of the major water pollution is heavy metals, particularly from industrail waste. Traditionally, heavy metals can be removed physically or chemically which is often ineffective and/or very expensive, specific to each metal ion ^[1]. New technology had to be develop to reduce heavy metal concentrations to environmentally acceptable level at low cost. This new technology of bioremediation is the process of cleaning the environment from pollution using organism in-situ or ex-situ ^[2]. In the earlier development, bioremediation only used microorganism, however recently plant even lower plant such as microalgae had been develop for phytoremediation. This green technology offer alternative environmental friendly of restoration caused by surface area that able to absorb substantial efficiently on the water, mineral, nutrient as well as absorb selective ion and adapt on a high concentration of heavy metal ^[3]. Microalgae is a good biodegradator since it able to bound heavy metal ion on the cell wall; the stock of microalgae is easily founded, low cost, minimum sludge, and no need additional nutrient. However, its small size, and easily degraded by microorganism was its disadvantages.

Resea

rch on the microalgae had started on the use of diatom for reconstruction past environmental change ^[4,5,7] and as bioindicator of water quality ^[5]; research on phytoplankton in relation to the trophic state^[6]. Based on those research, there was a significant correlation on the microalgae and heavy metal reduction.

Research on the use of microalgae as a bioremediation agent was partially done per genus/species, such as on *Spirulina*, *Nostoc* (Cyanobacteria); *Chlorella vulgaris*, *Eklonia radiata*, *Scenedesmus acutus* (Chlorophyte).

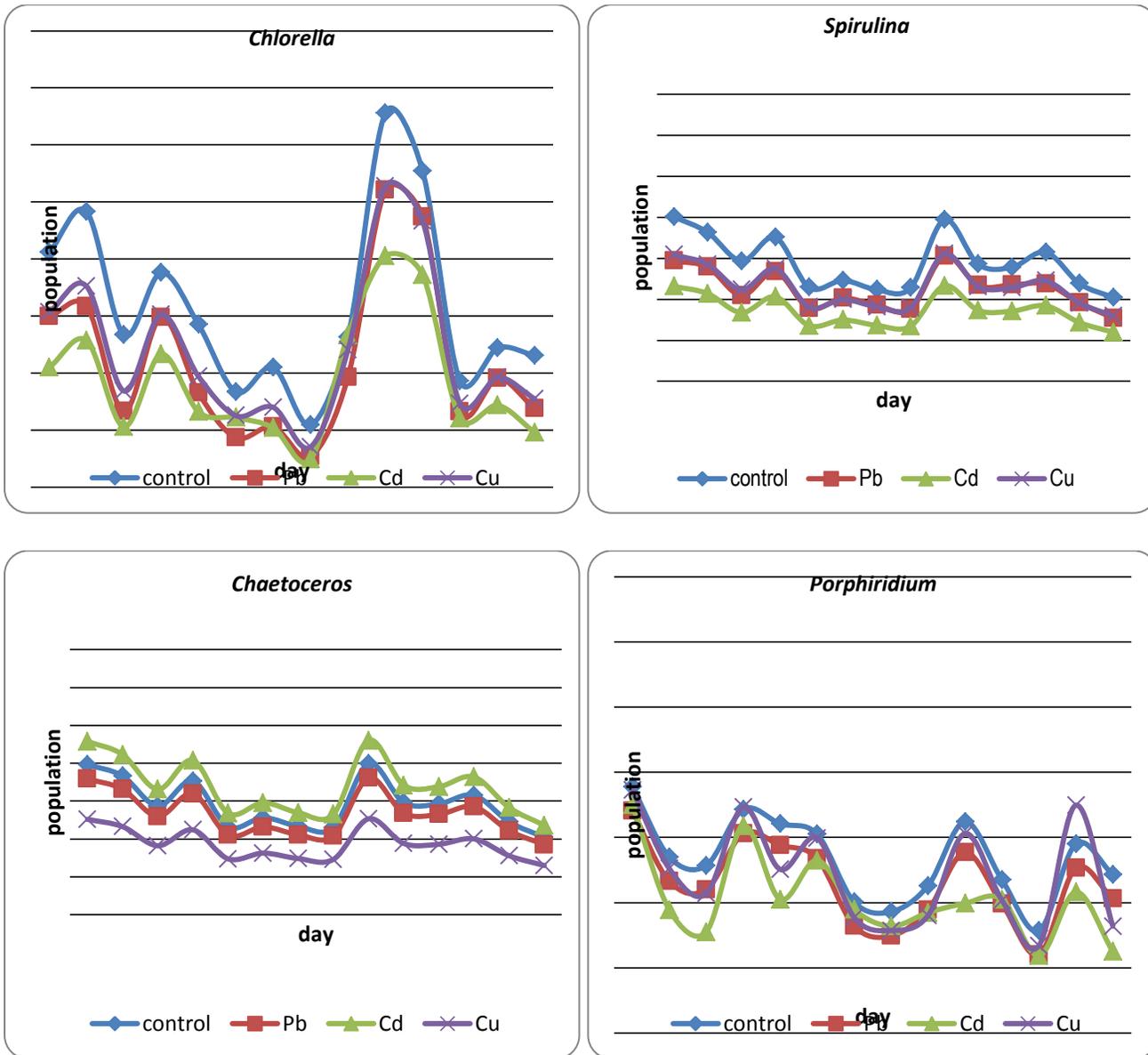


Figure 1. The population growth ($\times 10^2$ individu/mL) of *Chlorella*, *Spirulina*, *Chaetoceros*, and *Porphyridium* on the 0.5 mg Pb, Cd, and Cu exposure

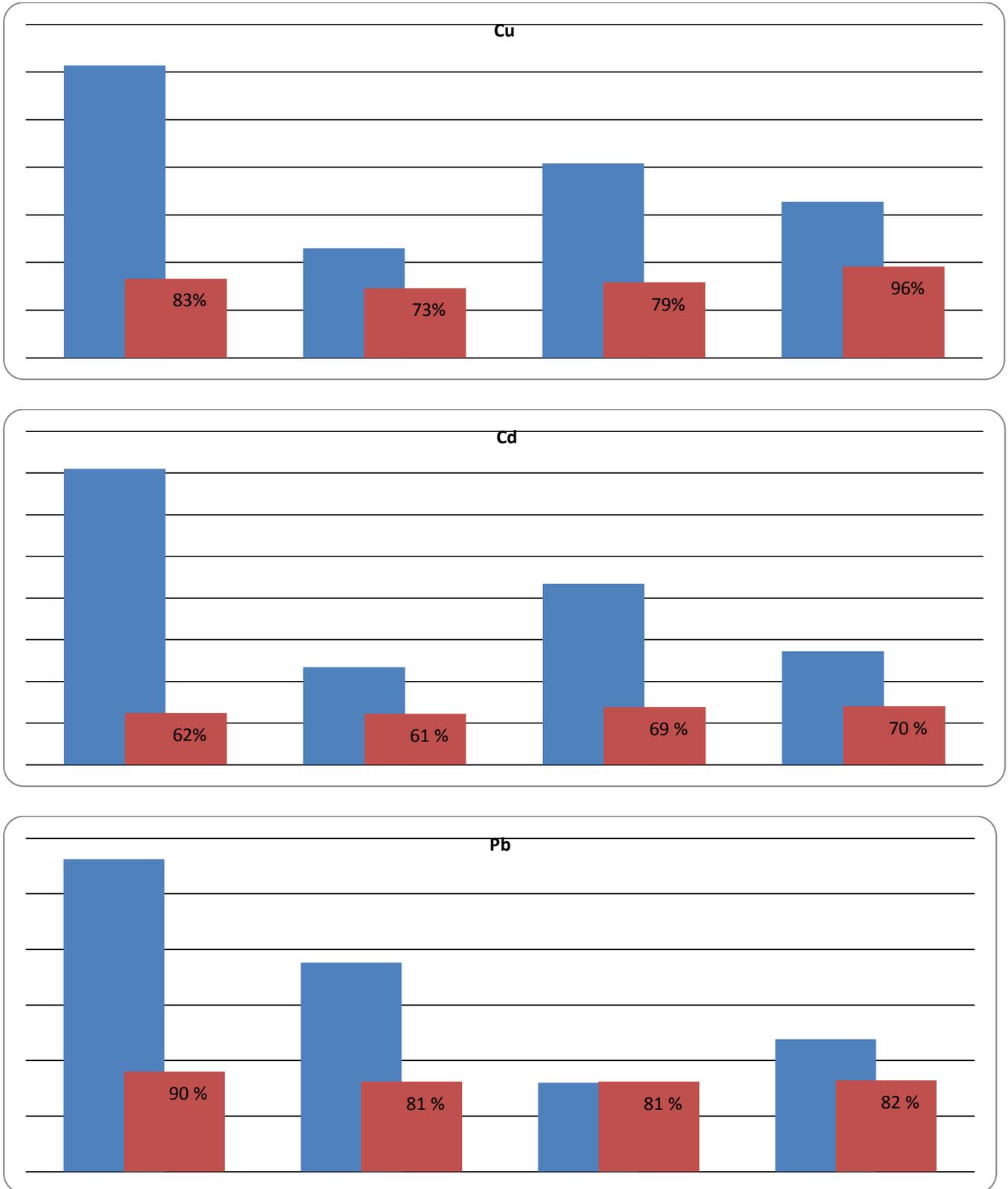


Figure 2. The population of *Chlorella*, *Spirulina*, *Chaetoceros*, and *Porphyridium* and the percentage of reduction heavy metal concentration

Pb and Cd has reduce the growth of *Cladophora fracta* when metal concentration were increased. This might be due to the fact that Pb induces the activity of the enzyme peroxidase that is involved in the degradation of indoleacetic acid (IAA), the hormone which stimulates plant growth and multiplication ^[1]. Several studies have reported on the effects of heavy metal on microalgal growth. *Chlamydomonas reinhardtii*, *Chlorella salina*,

Chlorella sorokiniana, *Chlorella vulgaris*, *Chlorella miniata*, *Chlorococcum* sp, *Cyclotella cryptica*, *Lyngbya taylorii*, *Phaeodactylum tricornutum*, *Porphyridium purpureum*, *Scenedesmus abundans*, *Scenedesmus quadricauda*, *Scenedesmus subspicatus*, *Spirogyra* sp., *Spirulina platensis*, *Stichococcus bacillaris* and *Stigeoclonium tenue* have found as biosorbents for heavy metal ions ^[15]. *Spirulina* sp had perform bioabsortion of Cr³⁺, Cd²⁺ and Cu²⁺ ions ^[13]. The limitation of this research was mono treatment of heavy metals concentration, furthure research require to be develop on different concentration.

5. CONCLUSION

Different microalge perform different population growth under heavy metal exposure. The concentration of 0.5 Pb, Cd, and Cu had reduce the population of *Chlorella*, *Spirulina*, *Chaetoceros*, and *Porphyridium*. *Chlorella*, and *Chaetoceros* was good for reducing Pb, whereas *Porphyridium* was good for decreasing Cu.

ACKNOWLEDGMENT

Thanks to Biological students of 2010 for their practical work on Protist. Thanks to Haikal, Her Nur Yoga, Devi, Purwati, Syarif Prasetyo for compiling data.

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