The Ability of Water Hyacinth (*Eichhornia crasipes* Mart.) and Water Lettuce (*Pistia stratiotes* Linn.) for Reducing Pollutants in *Batik* Wastewater

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Abstract. *Batik* produced by craftsmen is categorized as a small and medium industry. The problem of *Batik* production is less attention to the environment because the craftsmen lived in the middle of a residential area that has inexperience. One of less attention to the environment is no treatment of wastewater that reaches up to 95 % (61.9 L each cloth). Thus it polluted the river. This research aimed to treat the wastewater of *Batik* production by using phytoremediation. In this study, phytoremediation was carried out in three tanks in series using *Eichhornia crassipes* and *Pistia stratiotes* which are abundant in Indonesia. The treated wastewater was evaluated for its ammonia and chromium (Cr). The results showed that ammonia reduced 78.36 % by *E. crassipes*, and 73.13 % *P. stratiotes*. While *E. crassipes* reduced Cr by 63.76 % and *P. stratiotes* by 83.39 %. This research concluded that *E. crassipes* and *P. stratiotes* are potential plants to reduce the pollutants in *Batik* wastewater.

Keywords: Ammonia, chromium, phytoremediation, treatment.

1 Introduction

The role of small and medium-sized enterprises (SMEs) in economic development and growth is crucial in both developing and developed countries [1]. In Sokaraja, Indonesia there are some *Batik* SMEs that grow rapidly that collaborate as a society called 'Sawunggaling'. Those societies and other industries are located in the middle of residential

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areas. Inexperience is a main reason for less attention to the environment. None of these industries has wastewater treatment thus polluting the river.

Environmental pollution is living things, matter, energy, and other components that interfere into the environment by human activities, thus it converts environmental quality standards [2]. Environmental pollution from the batik industry can be identified from the solid color of wastewater disposal. The water usage in the *Batik* production (61.9 L each cloth) is abundant and 95 % as wastewater disposal generated from soaking, heating, and rinsing. The problem from *Batik* production involves high volumes of water and chemicals such as waxes and dyes.

These pollutants interfere with quality standards following the Indonesian Minister of Environment Regulation No. 5 of 2014, shown in Table 1.

Table 1. Comparison of wastewater batik quality and standards in Sokaraja, Indonesia

Parameters	Quality of sample (mg L^{-1})	Quality standards (mg L^{-1})
Biological Optical Density $(BOD)_5$	2.5	60
Chemical Optical Density (COD)	5.8	150
Total Suspended Solid (TSS)	10.135	50
Total phenol		0.5
Total chrome (Cr)	1.057	1.0
Total ammonia (NH_3-N)	278.681	8.0
Sulfide	381.96	0.3
Oil and fat	280	3.0
pH	9.63	6.0 to 9.0

From Table 1, it shows that some parameters have exceeded the quality standard threshold value. Even though there are regulations, the *Batik* industries ignore wastewater treatment because the punishment is too weak.

The phytoremediation model is simple, inexpensive, and easily operated [3]. Phytoremediation is considered to be a method for removing the pollutants in wastewater and recognized as a better green remediation technology using plants [4, 5] such as Water Hyacinth (*Eichhornia crassipes* Mart.) and Water Lettuce (*Pistia stratiotes* Linn.).

Water hyacinth is one of waterweed that uncontrollable growth but its nutrient absorption has provided a way for its usage in phytoremediation [4]. Moreover, Water Lettuce is a tropical plant that resists severe weather variability, fast reproduction, and simple manipulation. In addition, Water Lettuce is capable of remediating heavy metals [6]. The purpose of this study was to examine the *E. crassipes* and *P. stratiotes* plants in reducing pollutants in *Batik* industry wastewater. The pollutants indicated by ammonia and Chromium.

2 Methods

2.1 Plant material

The *E. crassipes* and *P. stratiotes* seedlings were conducted from the fish pond, in the region of Sokaraja, Banyumas, Central of Java, Indonesia. The seedlings were removed approximately 30 d growth because those plants are a perennial weed. The selection plants for this study based on their morphological character i.e green leaves and a stem length was 10 cm. The greenhouse was used to expose plants getting natural light and ambient temperature. Those situations were close to their natural environment. Plants were separated and cultivated for 14 d before the experiment was carried out with sterile water to prevent contamination with other agents and to support the growth of roots, without fertilizer or additives.

2.2 Experimental procedure

This study used a phytoremediation model with three tanks made of multilevel arranged glass with a continuous drainage system, with a flow rate of 5 L h^{-1}. The parameters observed in the treatment were ammonia and chromium.

The phytoremediation model was conducted on a laboratory scale in a greenhouse. Environmental factors were controlled by insect threats. The phytoremediation model is shown in Figure 1.

(A) (B)

Fig.1. (A) Treatment with *Eichhornia crassipes*, (B) treatment with *Pistia stratiotes*.

3 Results and discussions

E. *crassipes* and *P*. *stratiotes* reduced pollutants in *Batik* wastewater 4 % dilution. That high concentrations for *E*. *crassipes* and *P*. *stratiotes* were resistant. In the *E*. *crassipes* and *P*. *stratiotes* was used for the phytoremediation of the heavy metal, which affected leaf abnormalities, such as chlorosis and necrosis. This indicated that *E*. *crassipes* and *P*. *stratiotes* are more resistant to pollution agents proved by healthy plant and leaf quality was maintained even in the presence of high concentrations [7].

Before treatment of 4 % *Batik* wastewater, it observed ammonia of 5.73 mg L^{-1} and Cr of 596 mg L^{-1}. The *E*. *crassipes* and *P*. *stratiotes* grew in Wastewater for 15 d, with a recirculation rate of 20 L h^{-1} decreased of ammonia, as shown in Figure 2.

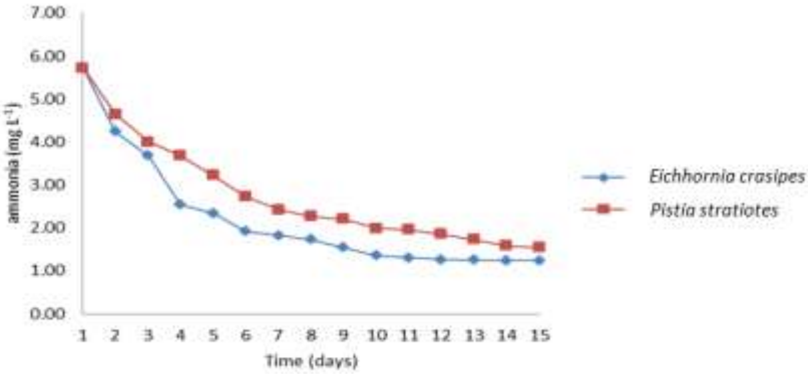

Fig.2. The decrease in ammonia parameters in *Eichhornia crassipes* and *Pistia stratiotes*.

Figure 2 showed that *E. crassipes* reduced ammonia reached up to 1.54 mg L^{-1} for 15 d, equal to 78.36 % and 1.24 mg L^{-1} or 73.13 % by *P. stratiotes*. The decrease of ammonia is an indication of absorption by plants [8].
The results of the chromium in *Batik* wastewater treatment shown in Figure 3.

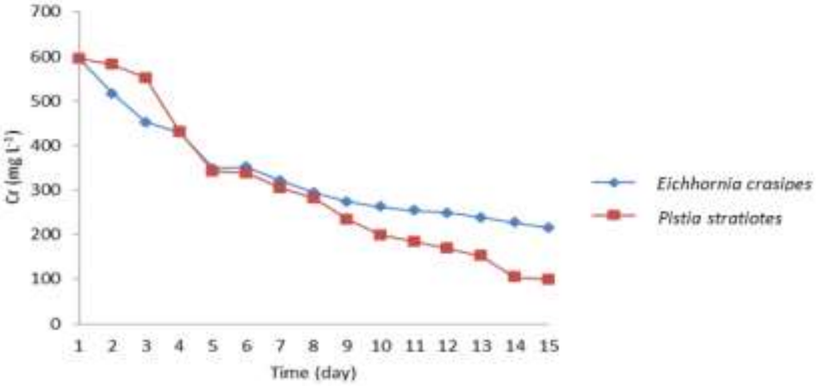

Fig.3. Decrease in Cr parameters in *Eichhornia crasipes* and *Pistia stratiotes*.

The decrease in chromium was 63.76 % in *E. crassipes* and 83.39 % in *P. stratiotes*. Both plants have hair-like roots that are used as a filter, tolerant, accumulate and eliminate environmental pollutants [6].

E. crassipes and *P. stratiotes* have shown their effectiveness in treating wastewater [9]. These plant species can sterilize higher heavy metals and help decontaminate soil, water, and others [5]. This also shows that the two plants have potential as bioindication and phytoremediation of contaminated aquatic environments [10]. In addition, Phytoremediation is related to the toxicity of heavy metals in contaminated ecosystems and bioremediation technology that is feasible, sustainable, and environmentally friendly [11]. This is in line with the results in the wastewater of his research Tewari et al. [12]. The impact of Cr contamination contained in *Batik* wastewater in physiology plants depends on metal speciation, which is responsible for mobilization, subsequent absorption and toxicity produced in plant systems [13].

4 Conclusion

This research concluded that *E. crasipes* and *P. stratiotes* plants reduced pollutants in *Batik* wastewater. The research indicated that the reduction of ammonia and Chromium were effective. Thus the two plants are potential adsorbent Ammonia and Chromium removal technology for wastewater treatment

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