The ability of *Pistia stratiotes* in Wastewater Contaminated with Methyl Orange

Anshah Silmi Afifah[1,] , *Darwin* Darwint[1,] Muhammad Rizki Apritama[1,] and *I Wayan* Koko Suryawan[2*]

[1]Facullty of Engineering, Department of Environmental Engineering, Universitas Universal, Kompleks Maha Vihara Duta Maitreya, Batam, Kepulauan Riau, Indonesia.

[2]Faculty of Infrastructure Planning, Department of Environmental Engineering, Universitas Pertamina, Komplek Universitas Pertamina, Jalan Sinabung II, Terusan Simprug, Jakarta 12220, Indonesia

Abstract. Methyl orange dyes are often used in industrial activities and produce wastewater that can pollute the environment. One of the plants that usually live in water and usually used phytoremediation is pistia plan. This study aimed to determine the acute toxicity (LC-50) of pistia plants in methyl orange wastewater. This study consisted of two stages, acclimatization and range-finding tests. The reactor used in the study has volume 5 L. The detention time in determining acute toxicity for pistia plants is 30 days. The acclimatization stage for seven days showed a profitable growth in the pistia plant. The LC-50 value in pistia plants showed a value of 58.73 mg/L. Knowing the LC-50 value in pistia plants is used as a standard reference for wastewater treatment containing methyl orange into the waters. The lethal concentration (LC-50), which can kill 50% of the pistia plant, is 58.73 mg/L.

1 Introduction

The dyeing process in the textile industry produces wastewater that contains color. The amount of wastewater effluent generated varies depending on the daily average water consumption and product. Wastewater, which contains a thick color, contains suspended solids, highly fluctuating pH, high temperature, COD, BOD. One of the dyes that are often used is methyl orange. Methyl orange is an azo-salt organic dye widely used as an analytical reagent in the paper, food, textile, and leather industries [1].

The methyl orange dye has a value of λmax 465 nm due to the azo group [2]. The lethal concentration (LC) is a substance outside the organ of either plant, animal or human organism, which can affect the death of the test organism. By knowing the lethal concentration, the dye that is safe for the environment can be determined. Some azo dyes for water hyacinth have LC-50 values for rhodamine B 99.5 mg/L, methyl violet 83.2 mg/L, and methylene blue 74.5 mg/L [3]. Dyes usually contain recalcitrant molecules that

* Corresponding author: i.suryawan@universitaspertamina.ac.id

are potentially carcinogenic, toxic and resistant and inhibit oxidizing reactions [4]. Dyes can be harmful to the land and aquatic animals, and even human life [5]. These dyes must be treated with various technologies to reduce environmental pollution [6,7].

Pistia stratiotes plants are floating, aquatic, stoloniferous plants with short stems and floating in ponds. The rootstalk touches the water column and produces long hairy roots with light yellow-green leaves in the form of a rosette [8]. This plant is widely used as decoration and even used as an advanced treatment plant in wastewater treatment. *Pistia stratiotes* plants managed to remove Cd metal from batik industrial waste by 64.09% within eight days of processing [9]. Another crop commonly used in wastewater treatment is water hyacinth [10]. Wastewater treatment with plants must know the limit of pollutant concentrations that plants can accept so that shock does not occur due to fluctuations in the concentration of dyes in the wastewater effluent.

This study aimed to determine the lethal concentration (LC-50) of the methyl orange dye, which is safe for the life of the *Pistia stratiotes* plant. With the presence of the lethal concentration value, processing can be carried out using a constructed wetland or phytoremediation with *Pistia stratiotes* at the limit of the lethal concentration of methyl orange.

2 Method

This research was conducted in a laboratory-scale reactor with a water volume of 5 L. The wastewater used was artificial wastewater with a methyl orange concentration of 1; 10; 25; 50 and 100 mg / L. The initial characteristics of artificial wastewater were measured turbidity, pH, and TDS at the beginning and end of the process for 30 days of testing.

There are two stages in this research, namely the acclimatization stage and the range finding test stage. The acclimatization stage is carried out within seven days to see the condition of the *Pistia stratiotes* plant. The selected should not be withered and yellowish. The number of *Pistia stratiotes* plants in the testing reactor is 12 plants. The *Pistia stratiotes* initial characteristics are seen based on the weight and width of the *Pistia stratiotes* plant's leaves. The range-finding test stage was carried out for 30 days and observed the number of dead trees.

3 Result and discussion

3.1 Acclimatization

Acclimatization is carried out with tap water within seven days (Fig. 1). Within seven days, the *Pistia stratiotes* plants in the reactor have grown well. The growth of *Pistia stratiotes* is measured qualitatively by measuring the width of the leaves. The average leaf width growth on the 7th day reached ± 2.1 cm, and the increase in wet weight reached ± 5.8 g. The increase in leaf width and mass of *Pistia stratiotes* plants indicates that range-finding tests can be carried out.

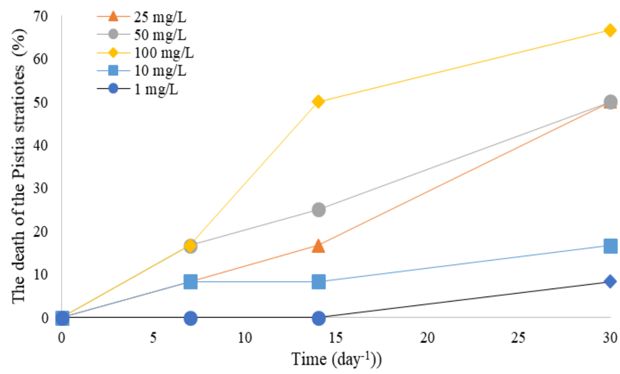

Fig. 1. Development of *Pistia stratiotes* Mortality Rate

Giving toxicity to *Pistia stratiotes* showed an increase in the test biota's mortality for 30 days of detention (Fig. 2). The higher the methyl orange concentration, the greater the test biota number that died in the experiment. In addition to the toxicity concentration, the level of toxicity can be influenced by environmental characteristics such as humidity, room, and temperature. Besides, differences in age, genetics, and health of the test biota can also affect [11]. The physical and chemical conditions, when tested for toxicity, are shown in Table 1. Dissolved oxygen (DO) values indicate the optimum conditions for aerobic bacteria growth.

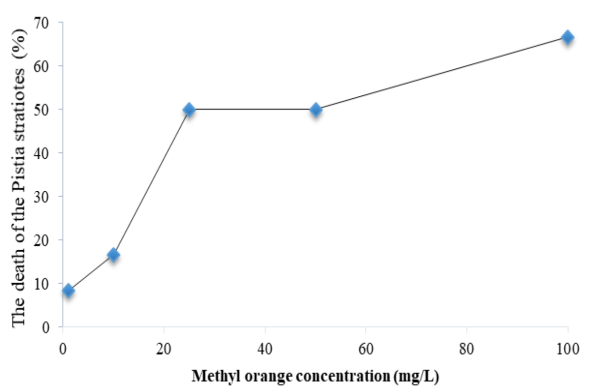

Fig. 2. The Death of *Pistia stratiotes* with a Detention Time of 30 Days in Methyl Orange Wastewater

The results of the LC-50 value calculation are calculated based on the regression equation in Fig. 3. The LC-50 value shows a value of 58.73 mg/L. The provision of methyl orange wastewater at a 58.73 mg/L concentration will cause 50% of *Pistia stratiotes* plants' deaths. The experimental results showed lower yields than water hyacinth for rodhamin b, methyl violet, and methyl blue dye [3]. Several studies have shown that textile waste in Indonesia is toxic. Research using the *Daphnia Magna* test biota shows textile waste in the Bandung area is not safe if disposed of into the environment [12]. The toxicity of batik textile industrial wastewater for goldfish test biota showed a value of 3.34 mg/L [13]. Before being discharged to water bodies, textile waste must be treated first to reduce its widespread environmental impact [14].

Table 1. Physical and chemical conditions of the environment during the process of giving toxicants

PARAMETERS	CONCENTRATION	UNIT
TDS	98±4,76	mg/L
pH	6,4±3,81	-
DO	5,61±0,87	mg/L
Temperature	28,8±4,52	ºC
Turbidity	12	NTU

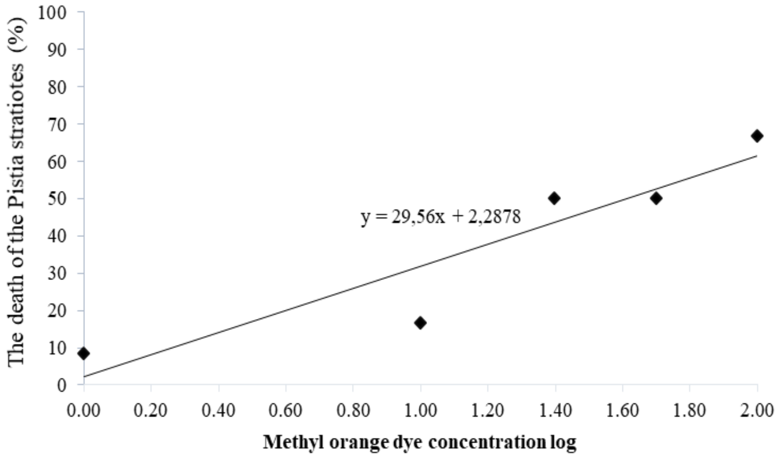

Fig. 3. Log of Methyl Orange Concentration on the Percentage of Death of *Pistia stratiotes*

4 Conclusion

The study results from the determination of lethal concentration (LC-50) were 58.73 mg/L, which can kill 50% of *Pistia stratiotes* trees. It is advisable to conduct research with several other coloring agents commonly used in the dyeing process on textiles and then carry out trials on the original wastewater in the wastewater treatment plant's effluent. Several types of aquatic plants that often live in waters also need to know the lethal concentration level. In selecting plants in the phytoremediation process, it is better to see the maximum limit of dye concentrations that plants can accept in treating textile wastewater.

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