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PHYTOREMEDIATION OF EFFLUENT TEXTILE WWTP FOR NH_3-N AND CU REDUCTION USING *PISTIA STRATIOTES*

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Abstract

Quality of typical conventional treated textile wastewater treatment plant (WWTP) become environmental problem because of high levels of nutrients and metals. Nutrients and metals regulated in the quality standard are NH3-N and Cu. This study aims to determine the phytoremediation process of *Pistia stratiotes* to NH_3-N and Cu removal. The steps of the research were conducting range finding and running test. The range finding test, effluent textile WWTP concentration was 20%; 40%; 60%; and 80%. In the range finding test process for 21 days the number of dead *Pistia straiotes* was 0%; 4%; 12%; and 16% of the total test biota were 25. In the running test with 100% effluent textile WWTP, NH_3-N and Cu removal are 71.25%±5.8 and 76.7%±9, respectively.

Key words : *Pistia stratiotes*, NH_3-N removal, Cu removal, textile wastewater, WWTP.

Introduction

The growth of the industry are controlled by the textile industry and textile products sector. The growth of this industry, on the other hand as help economical growt. On the other hand textile industry degraded the quality of the local environment. However, environmental can be directly felt from indicators of pollution such as strong odors and the color of wastewater discharged through rivers. Some conventional wastewater treatment results still cannot guarantee a better quality standard (Suryawan, *et al.,* 2019a; Suryawan, *et al.,* 2019b).

The content of heavy metals and nutrients in wastewater are issued above the quality standards stipulated by the Regulation of the Minister of Environment. Cu metal is a dominant hazardous metal contained in textile wastewater (Zille, 2005; Suharty, 1999). While the nutrient in the form of ammonia-N (NH_3-N) is one of the parameters set in the quality standard that has the potential in eutrophication in water bodies. Eutrophication often occurs in the management of textile wastewater that is not good in performance (Suryawan, *et al.,* 2018). For this reason, phytoremediation can be used as an effort to improve the effluent quality of textile wastewater with low cost and easy operation. Phytoremediation is an effort to use plant parts for decontamination of waste and environmental pollution problems both ex-situ using artificial ponds and in-situ (directly in the field) in areas contaminated. So far research on the use of phytoremediation agents for textile wastewater treatment has been widely reported such as decreasing levels of textile waste color, Cu, organic, and nutrient removal. Study of Dewi *et al.,* 2014 with *Salvinia natans* can treatment of methylene blue and congo red dye. Ong *et al.,* also reported azo dye Acid Orange 7 (AO7) containing wastewater can degraded by constructed wetland (Ong *et al.,* 2009).

In addition to dye parameters, metal parameters such as copper (Cu) can be absorbed by plants (Handayani *et al.,* 2012; Turan and Esringu, 2007; Aboughalma *et al.,* 2008). Organic matter is also one of the elements needed by plants to photosynthesize. Other studies report that *Scirpus grossus* and *Iris pseudacorus* are effective in removing BOD (Biochemical Oxygen Demand) and COD (Chemical Oxygen Demand) (Tangahu *et al.,* 2019). Phytoremediation with *Eichornia crassipes* and *Lolium perenne L* can remove NH_3-N and TP higher than remove of COD (Wang *et al.,* 2011). Another study also report that TP removal high. (Souza *et al.,* 2013).

One of the aquatic plants is *Pistia stratiotes L.* that can used as phytoremediation media. Pistia is a type of waterweed that grows very fast and has the ability to adapt to new environments. *Pistia stratiotes* has an ability that can help improve the polluted water environment. The possibility of the use of water plants in wastewater treatment has been conducted a lot in both laboratory and industrial scale (Tjitrosoepomo, 2000). The purpose of this study was to determine the ability, *Pistia stratiotes* as phytoremediation media for Cu and NH_3-N in Textile WWTP as post-treatment.

Materials and Method

Effluent Textile WWTP and reactor

Initial characterization of the effluent textile WWTP was conducted after stabilization pond treatment (Fig. 1). The effluent textile WWTP characteristics are shown in table 1. Table 1 indicates that the values of pH, TSS, BOD, COD, phenol grease and fat were meet the standard quaility. The BOD value was measured up to 48.7 mg/L and COD value up to 178 mg/L.

Plants have a wet weight of about 5-15 grams. The *Pistia stratiotes* plants used are certainly healthy plants by looking at morphology. The condition of the leaves must look fresh and green. Certainly, pests or diseases do not attack the leaves. The *Pistia stratiotes* plants used are new shoots from the parent.

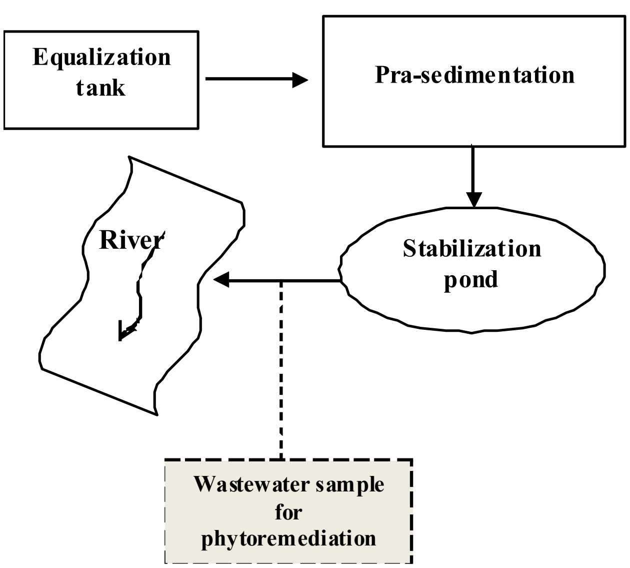

Fig. 1: Schematic diagram textile WWTP effluent with phytoremediation sampling area.

The reactor used in batch conditions. The reactor volume is 20 L with water depth of 16 cm. In running phytoremediation process, reactor without any treatment.

Table 1: Textile WWTP effluent water quality analysis results.

No.	Parameter	Unit	Wastewater quality	Standard
1	pH	-	8,1	6-9
2	COD	mg/L	178	150
3	BOD	mg/L	48,7	60
4	TSS	mg/L	5,61	50
5	Ammonia N (NH_3-N)	mg/L	12,14	8
6	Total chromium(Cu)	mg/L	3,741	1
7	Grease and fat	mg/L	nd	3
8	Phenol	mg/L	nd	0,5

Experimental Set-up for Range Finding Test (RFT) and Phytoremediation

Range Finding Test (RFT) is carried out before acclimatization process. The acclimatization process is carried out by tap water for 7 days to accustom *Pistia stratiotes* plants to the environmental conditions at laboratory site (temperature, humidity, and lighting). RFT are used d WWTP effluent samples with concentrations dilution of 20%, 40%, 60%, and 80%, respectively. The RFT process was carried out for 14 days with a total of each *Pistia stratiotes* of 25.

The phytoremediation reactor volume used is 20 L which is used in phytoremediation process. Then the *Pistia stratiotes* plants that survive in RFT conditions are used in the phytoremediation process. The phytoremediation process is carried out for 14 days by taking water samples once every two days. The study was conducted with three repetitions under the same conditions. Analysis for NH_3-N and Cu parameters is based on the standard method (APHA, 1989).

Results and Discussion

Range Finding Test (RFT)

The mortality rate of *Pistia stratiotes* plants increases with the detention time in WWTP effluent wastewater (Fig. 1). The mortality rate of *Pistia stratiotes* plants on 14 days of detention had shown a significant difference; especially concentrations of 80% and 60%, which reached Pistia stratiotes plant mortality by 16% and 12%

with total of plant, are 25.

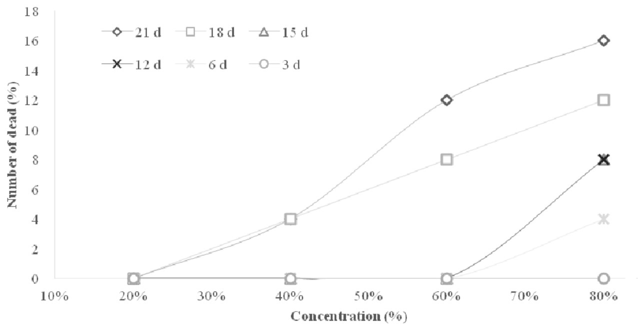

Fig. 1: Monitoring number of *Pistia stratiotes* that die during the acclimation process.

Phytoremediation

The results of NH_3-N and Cu removal for *Pistia stratiotes* were shown in Figures 1 and Figure 2. The results of NH_3-N removal on day 14 showed an average of 71.25% ± 5.8. The results showed the NH_3-N concentration value of 3.49 mg/L, which was able to meet the quality standard. The results of other studies to treat domestic wastewater using *Phragmites sp.* reed bed and water-floating macrophyte water hyacinth (*Eichhornia crassipes*) can remove NH_3-N by 73% and 69% (Valipour *et al.,* 2014). Other studies, the use of aquatic plants *Stachys japonica*, *Lycopus lucidus*, *Rumex japonicus*, and *Rumex acetosa* removal of NH_3-N were 96.3%, 94.5%, 95.7%, and 93.6%, respectively. (Guifang, 2010).

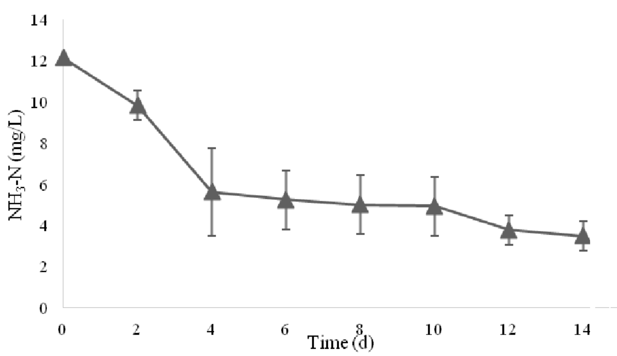

Fig. 2: Results of NH_3-N concentrations in phytoremediation process by *Pistia stratiotes.*

Final Cu concentration by phytoremediation process with *Pistia stratiotes* of 0.87 mg/L, which can meet quality standards. The results of Cu removal in WWTP effluent in this study only showed a value of 76.7% ± 9 (Figure 2). This value has a tendency lower than previous research. The use of *Pistia stratiotes* for treating batik wastewater is able to remove Cu of 91.95% (Hernayanti and Proklamasiningsih, 2005). Cu removal in phytoremediation of textile wastewater using *Pistia stratiotes* for 6, 12, 24 and 48 hours respectively was 80.10 ± 0.64%; 88.47 ± 1.80%; 97.3 ± 0.99%; and 100% (Dwijayanti *et al.,* 2016).

Medicago plant can absorb Cu accumulation at a rate of 0.21 mg/kg in the root of the soil (Taha *et al.,* 2018). Resuld of water and solid media Cu absorption by plant its different. Another study stated that another heavy metal such as Cd, Pb, Ni, Zn and Cr also can treated with phytoremidiation process (Syed *et al.,* 2018; Al-Zurfi *et al.,* 2018; Tilwankan *et al.,* 2018) .

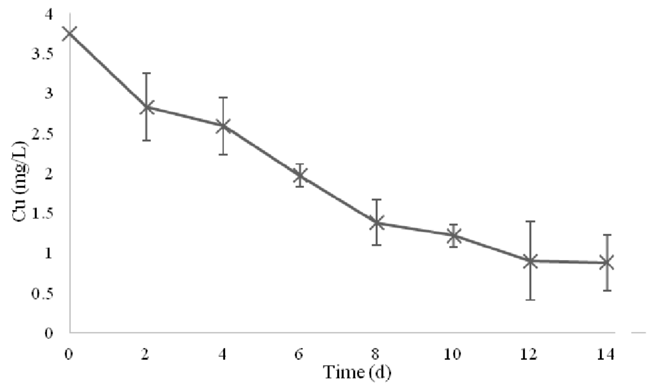

Fig. 3: Results of Cu concentrations in phytoremediation process by *Pistia stratiotes.*

High levels of metal concentration can be described in total dissolved solid (TDS). TDS concentrations in this study tended to decrease however were no better than NH_3-N and Cu removal. The TDS decrese is only 22.6%±4 within 14 days of detention (Figure 4). Alireza *et al.,* (2010) water hyacinth phytoremediation treatment result a removal of about 16% of TDS from domestic wastewater. Phytoremediation with water hyacinth, water lettuce, and vetiver high TDS removal was 55.6%, 48.7 %, and 39.6% (Abinaya *et al.,* 2018). While the pH does not seem to change significantly and tends to steady (Fig. 5).

Conclusion

The results of the phytoremediation process by *Pistia stratiotes* for NH_3-N and Cu removal are 71.25% ± 5.8

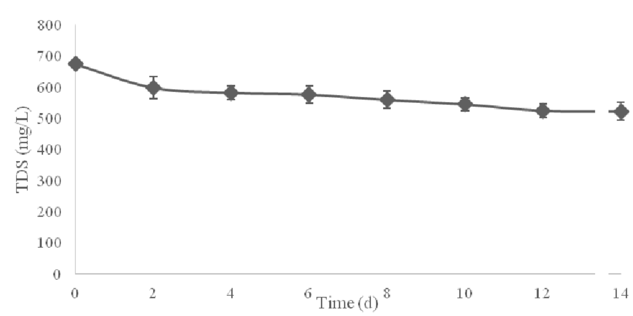

Fig. 4: Results of Cu concentrations in phytoremediation process by *Pistia stratiotes.*

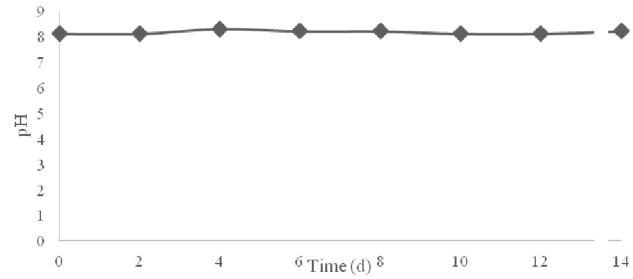

Fig. 5: pH change during phytoremediation process by *Pistia stratiotes*.

and 76.7% ± 9, respectively. The results of the comparison of the processed results indicate that it meets the effluent quality standards of textile wastewater. The application of phytoremediation is suitable as a post-treatment for textiles WWTP.

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