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Phytoremediation of liquid waste electroplating using *Salvinia* sp.

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Abstract. Liquid waste of chromium electroplating can cause water pollution if not treated. The negative impact of chromium can be minimized with water weeds such as *Salvinia molesta* and *Salvinia natans*. The objective of this research was to compare the effectiveness between *S. molesta* and *S. natans* as a phytoremediator and the best time exposure. The research design was Randomized Completely Block Design. The main plot was the biomass of *S. molesta* and *S. natans* 50 g (B1), 100 g (B2), and 150 g (B3). The subplot was the time of exposure, which consists of 1 day (T1), 6 days (T2), and 12 days (T3). There were 24 treatment combinations, and each treatment was repeated three times. Observed parameters include Cr in water, pH, DO, and TSS. Data were analyzed by Anova and followed by Tukey's test. This research showed that both *S. molesta* and *S. natans* were effective in decreasing Cr in water and TSS in the opposite increase of pH and DO. The most effective treatment was biomass of *Salvinia* 150 g and 12 days of time exposure. Both of *S. molesta* and *S. natans* can be used as phytoremediators to improve water quality, while *S. molesta* is more effective than *S. natans*. Biomass of *S. molesta* 150 g and 12 days were effective treatments to improve the water quality of chromium electroplating.

1. Introduction

The chrome plating industry produces chromium-containing liquid waste with characteristics of high Cr content (> 2ppm), acidic pH (<3), low dissolved oxygen (DO), otherwise high Total Suspended Solid (TSS) levels. If the waste is not treated first, it will cause a decrease in water quality and the life of aquatic organisms [1,2]. Pollution of chrome liquid waste reduction is necessary to try a simple, inexpensive, but effective waste treatment using phytoremediation techniques [3,4]. Phytoremediation is the use of plants to extract, remove, or detoxify pollutants from their environment [5,6]. Some waterweed plants such as *Salvinia*, *Pistia*, and water hyacinth can be used as phytoremediators to absorb toxic elements, especially heavy metals [7,8,9]. One of the heavy metals is chromium, which found in chrome plating waste. *Salvinia* is a type of aquatic plant that floats freely in water and includes water weeds. This plant habitat is rice fields, gutters, and ponds. *Salvinia* sp as a phytoremediator plant is selected based on the consideration that *Salvinia* sp can grow in waters with low nutrient content. The morphology of *Salvinia molesta* has long, thick roots, thus absorbing more heavy metals [10,11].

Salvinia found in Indonesia are *S. molesta* with hair and *S. natans* without hair [12,13]. This plant leaves unite to form a composition composed of three tight leaves. Two leaves of each bouquet float with short stems and hair on *S. molesta*. Each leaf does not share a flat edge, and all three leaves hang in water and function to absorb water [14]. The broad root of *Salvinia* contains phytochelatin substances to absorb Cr in liquid chrome plating [10,11]. The process of absorption heavy metal, including Cr through the roots of aquatic plants, is called rhizofiltration. In this case, it is assumed that the area of the



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rhizosphere is directly proportional to the biomass amount. Thus there is a relationship between an increase in plant biomass and an increase in chromium absorption. Besides the exposure time factor and leaf surface area, the presence of hair or waxy coatings in the aquatic plants used is vital to influenced chromium absorption [10].

The purpose of this study was to determine the ability of *S. molesta* and *S. natans* as phytoremediators in absorbing Cr from Cr plating waste. To determine biomass and the best exposure time of *Salvinia* as a phytoremediator to improve water quality due to the pollution of chrome plating.

2. Methods

2.1. Material

Salvinia molesta and *S. natans* are taken from the rice fields of the Pamijen district of the Baturaden sub-district. Waste was taken from the chrome plating industry in Tegal. The instrument used include analytical scales, BOD incubators, sample bottles, and Atomic Absorption Spectrophotometry (AAS) brands of Perkin Elmer. The research design was Randomized Completely Block Design. The main plot was the biomass of *S. molesta* and *S. natans* 50 g (B1), 100 g (B2), and 150 g (B3). The subplot was the time of exposure 1 days (T1), 6 days (T2), and 12 days (T3). There was 24 treatment combination, and each treatment was repeated three times. Independent variables were biomass and time of exposure. The dependent variable was Cr in water. Other parameters were DO, pH dan TSS.

2.2. Research procedure

Salvinia was taken from the rice fields of Pamijen village, the Baturaden sub-district, then maintained in a greenhouse with a plastic bucket that was given 10 ml of distilled water. The pH is set 6-7 for 14 days. Then Chrome plating diluted 1:10 with aquadest. *Salvinia* was selected based on the same size and washed thoroughly. Then the biomass was weighed at 50 g, 100 g, and 150 g. Then put into chrome liquid waste that has been diluted with distilled water 1:10. After 14 days, *Salvinia* plants are taken from electroplating waste then roasted for 12 hours at 80°C so that the weight is constant. Then it is transferred to the porcelain cup and put into the furnace for 8 hours until the color turns white ash weight was weighed and ready to be analyzed by Atomic Absorption Spectrophotometry. Measurement of Cr levels with AAS at a wavelength of 357.9 nm and strong current 3,5 A° [15]. Measurement of supporting parameters DO with DO meter and TTS with APHA method [16]. Value of pH measured by pH meter. Both primary and supporting parameters were measured at 1, 6, and 12 days.

3. Results

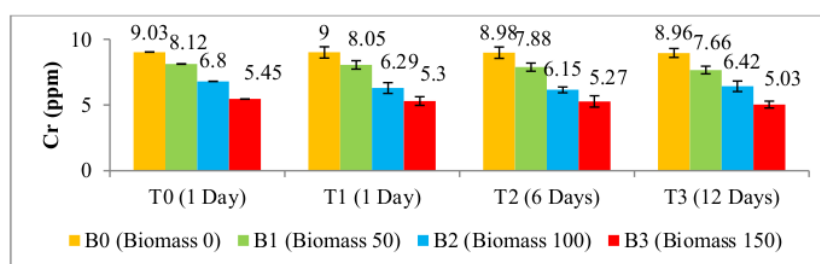


Figure1. Chromium (Cr) Levels in waste after treated with *S. molesta*

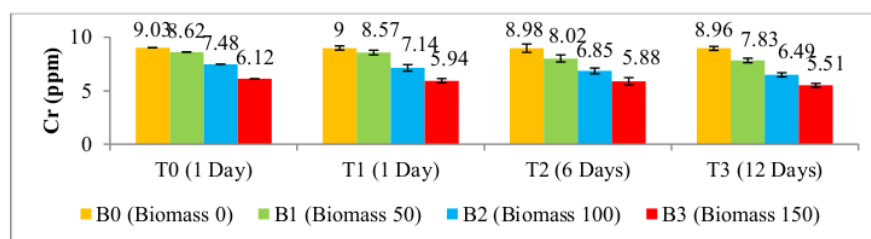


Figure 2. Chromium levels in waste after treated with *S. natans*

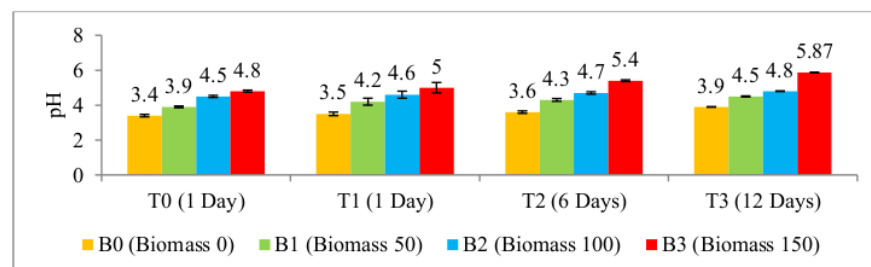


Figure 3. pH Value in waste after treated with *S. molesta*

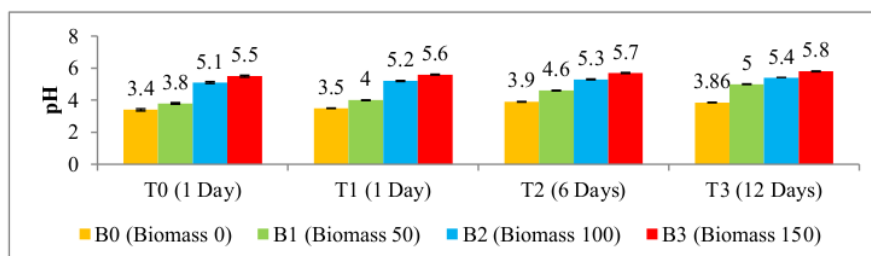


Figure 4. pH Value in waste after treated with *S. natans*

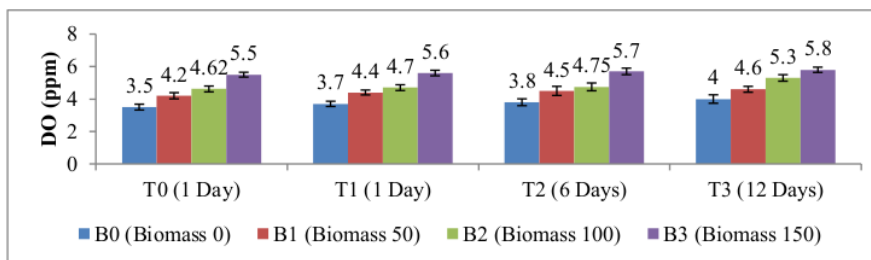


Figure 5. Dissolved Oxygen (DO) Levels after waste treated with *S. molesta*

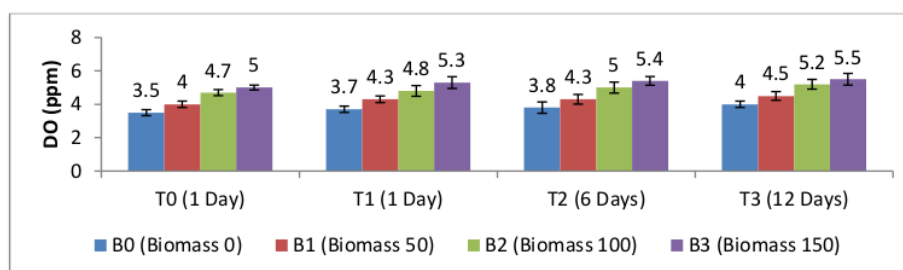


Figure 6. Dissolved Oxygen (DO) Levels after waste treated with *S. natans*

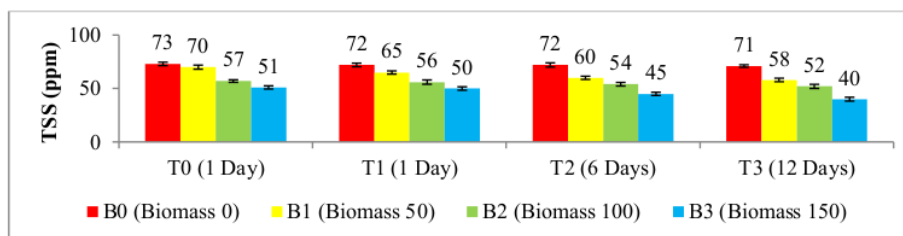


Figure 7. Total Suspended Solids (TSS) Levels after waste treated with *S. molesta*

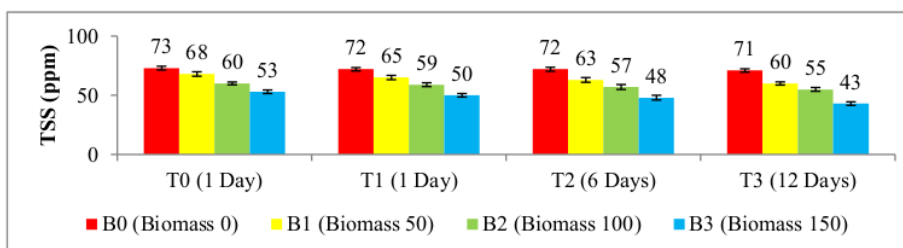


Figure 8. Total Suspended Solids (TSS) Levels after waste treated with *S. natans*

4. Discussion

Based on these data indicated that both *S. molesta* (Figure1) and *S. natans* (Figure 2) could absorb Cr. The absorption of toxic elements, including Cr by plants, can be done in two ways, first through the root system and the leaf surface. Include passive absorption and active absorption involving energy derived from the photosynthesis process in the form of ATP [6,17]. Ion Cr will be absorbed through the process of rhizofiltration by phytochelatin that are in the roots. Phytochelatin is a peptide compound composed of glutamate, cysteine, and glycine will increase when the plant undergoes stress metal. The peptide in phytochelatin binds metal ions, and so on, Cr will be stored in tissue and vacuole [3,5,7]. In the next process, the metal moves across the root membrane to the leaf. The Water's Cr levels were decreased because of the Caspary band on the endodermis. The transport is passed through the symplast to and accumulated in the leaves [13,14,18].

Salvinia molesta can decrease Cr in waste of 44.41%, but *S. natans* only for 40.88%. *S. molesta* has a longer root than *S. natans*, which is 17-20 cm, while *S. natans* is only 14-15 cm so that Cr is absorbed by *S. molesta* more. In addition to root shape, leaf surface area and leaf shape also influence the absorption of Chrome. The surface of *S. natans* leaves narrower than *S. molesta*, and the surface shape of leaves is smooth with no hair, whereas *S. molesta* leaves the surface is wider than *S. natans*, and the

surface of leaves is hairy [10]. As a result, *S. molesta* can make the transpiration process faster than *S. natans* so that it can absorb more Cr.

The pH value of chrome plating at the fist is acidic at range 3.4- 3.5 [2]. After treated with *S. molesta* and *S. natans*, the pH value is increased. An increase in pH value was started at 50g, 100 g, and 150 g biomass treatment for days 1, 6, and 12. The highest pH value was on the 12 days after treatment with 150 biomass of *S. molesta* and *S. natans*. It is occurred due to much CO₂ was utilized by photosynthesis of both *S.molesta* and *S. natans*. That process will shift the balance to the right, and a reduction in H⁺ ions will occur so that the liquid waste increases to near neutral pH [3,19]. Tuckey's test results showed the exposure time of 12 days with 150 g of *Salvinia* spp biomass 150 g was the most effective treatment in increasing pH value. The increasing percentage pH value on day 12 with biomass *S. molesta* treatment at range 52.3% and *S. natans* at range 44.74%.

DO levels increased after waste treated with both *S. molesta* and *S. natans*, as shown in Figure 5 and Figure 6. An increase in DO levels on waste is caused by the addition of oxygen produced by the photosynthesis process of *Salvinia* spp [11]. Tuckey's test showed the exposure time of 12 days with 150 g of *Salvinia* biomass was the most effective treatment in increasing DO levels. DO levels increased by *S. molesta* remediation was at range 29% and *S. natans* at range 22%.

At first, Chrome plating waste high TSS levels at range 71-73 ppm. The high TSS levels cause inhibition of the penetration light into the water, interfering with photosynthesis, and causing a decrease in the amount of oxygen [4]. Nevertheless, TSS levels were decreased after treated with both *S. molesta* (Figure 7) and *S. natans* (Figure 8). *Salvinia* spp is an aquatic plant that very strong in absorbing nutrients, thus can absorb Cr heavy metals in large quantities. The more biomass of *Salvinia* in the treatment is equal to the lower of the TSS level in chrome plating waste. *Salvinia* spp can actively absorb pollutants but does not inhibit the penetration of light into water [10,20]. Tuckey's test showed the exposure time of 12 days with 150 g of *Salvinia* spp biomass was the most effective treatment in reducing TSS levels. The highest percentage reduction in TSS level on day 12 with 150 g biomass of *S. molesta* at range 42.86% and *S. natans* 38.76%.

5. Conclusion

Salvinia molesta and *S. natans* have the ability as phytoremediators of chrome plating waste, which is characterized by a decrease in Cr and TSS levels in the waste accompanied by an increase in DO levels and pH values. *S. molesta* and *S. natans* 150 g biomass and 12 days exposure time are the best treatments in improving the quality of chrome plating wastewater. *Salvinia molesta* has a higher ability as a phytoremediator for chrome plating waste compared to *S. natans*

References

- [1] Zayed A and Terry N 2003 Chromium in the Environment: Factor Affecting Biological Remediation *Journal of Plant & Soil* **249** 139-156
- [2] Dube D, Champaklal T, Parekh and Nyoni B 2016 Removal of Chromium and Nickel from Electroplating Wastewater using Magnetite Particulate Adsorbent: (1) Effect of pH, Contact Time and Dosage, (2) Adsorption Isotherms and Kinetics *Modern Applied Science* **10** 222-232
- [3] Oktavia Z, Budiyo and Dewanti N A Y 2016. Pengaruh Variasi Lama Kontak Fitoremediasi Tanaman Kiambang (*Salvinia Molesta*) Terhadap Kadar Kadmium (Cd) Pada Limbah Cair Home Industry Batik "X" Magelang *Jurnal Kesehatan Masyarakat* **4** 238-245
- [4] Safarrida A, Ngadiman and Widada J 2015 Phytoremediation of Chromium in Aqueous Waste using Aquatic Plants *Jurnal Bioteknologi & Biosains Indonesia* **2** 55-59
- [5] Prajapati S K, Meravi N and Singh S 2012 Phytoremediation of Chromium and Cobalt using *Pistia stratiotes*: A Sustainable Approach *Proceedings of The International Academy of Ecology and Environmental Sciences* **2** 136-138
- [6] Setiyo A and Gustaman R A 2017 Pengendalian Kromium (Cr) yang Terdapat di Limbah Batik dengan Metode Fitoremediasi *Unnes Journal of Public Health* **6** 155-160

- [7] Hidayati N 2005 Fitoremediasi dan Potensi Tumbuhan Hiperakumulator *Jurnal Hayati* **12** 35-40
- [8] Puspita U R, Siregar A S and Hidayati N V 2011 Kemampuan Tumbuhan Air Sebagai Agen Fitoremediator Logam Berat Kromium (Cr) yang Terdapat pada Limbah Cair Industri Batik *Berkala Perikanan Terubuk* **39** 58-64
- [9] Suharto B, Wirosoedarmo R and Sulanda R H 2016 Processing of Waste Batik with Phytoremediation using Water Hyacinth Plants (*Eichornia crassipes*) *Journal Natural Resources and Environmental* **3** 14-18
- [10] Fuad M T, Aunurohim and Nurhidayati T 2013 Efektivitas Kombinasi *Salvinia molesta* dengan *Hydrilla verticillata* dalam Remediasi Logam Cu pada Limbah Elektroplating *Jurnal Sains dan Seni POMITS* **2** E240-245
- [11] Dhir B 2009 *Salvinia*: an Aquatic Fern with Potential Use in Phytoremediation *Environ. We Int. J. Sci. Tech.* **4** 23-27
- [12] Nguyen V V 1973 Some of the Biology of *Salvinia molesta* D.S Mitchell *Proceeding of the second Indonesian Weed Science Conference April 2-5th Yogyakarta*
- [13] Salisbury F B and Ross C W 1995 *Plant Physiology Fourth edition* (Belmont, California: Wadsworth Publishing Company)
- [14] Thilakar R J, Rathi J and Pillai P M 2012 Phytoaccumulation of Chromium and Copper by *Pistia stratiotes* L. and *Salvinia natans* (L.) *All J. Nat. Prod. Plant Resour.* **2** 725-730
- [15] ACGIH 2000 *Threshold Limit Value and Detection Method for Chemical Substances and Biological Exposure indices* (Cincinnati: Signature publication)
- [16] American Public Health Association (APHA) 2002 *Standard method for the Examination of Water and Wastewater 18th edition* (Washington DC: American Water Works Association, Water Pollution Control Federation)
- [17] Begum A, Krishna and Hari S 2010 Bioaccumulation of Trace Metals by Aquatic Plant *Conference Proceeding Department of Chemistry School of Engineering Bangalore*
- [18] Hemayanti and Proklamasiningsih E 2004 Fitoremediasi Limbah Cair Batik Menggunakan Kayu Apu (*Pistia stratiotes* L) untuk Memperbaiki Kualitas Air *Jurnal Pembangunan Pedesaan* **4** 164-172
- [19] Widowati H 2000 *Peranan Tumbuhan Air sebagai Bioremediator Pencemaran Akibat Kegiatan Industri Batik* (Universitas Gadjah Mada Yogyakarta)
- [20] Imron I, Dermiyati D, Sriyani N, Yuwono S and Suroso E 2019 Perbaikan Kualitas Air Limbah Domestik dengan Fitoremediasi Menggunakan Kombinasi Beberapa Gulma Air: Studi Kasus Kolam Retensi Talang Aman Kota Palembang *Jurnal Ilmu Lingkungan* **17** 51-60

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