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3rd iSNPiNSA

International Seminar on New Paradigm and Innovation on Natural Sciences and its Application

Developing Innovation and Application of Applied Sciences for Sustainable Development

PROCEEDINGS

Diponegoro University
2013

The 3rd International Seminar on New Paradigm and Innovation on Natural Sciences and its Application 2013

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PREFACE

Good Morning Ladies and Gentlement

On behalf of the Organizing Committee, i would like to warmly welcome you to the 3rd Internasional Seminar on New paradigm and Innovation on Natural Sciences and Its Application (ISNPINSA). This seminar has been successfully conducted since 2011 and therefore becoming an annual event since then. The theme of ISNPINSA this year is Developing Innovation and Its Application of Applied Sciences for Sustainable Development.

The aims of this seminar are to facilitate brain storming and state of the art information in field of sciences and mathematic; to increase innovation of technology that can be applied in industries; to contribute in formulating strategy to increase the role of science for the community; and to stimulate collaboration between industries, researchers and government to increase community welfare.

We divided the parallel session in this seminar into specific topic that can accommodate the field range from chemistry, physics, biology, mathematics and the science related to them. By inviting the speakers from academics and industries, we hope that this event can be a bridge between researchers, scientists and industries in order to foster developing innovation and its application to support sustainable development.

In closing, I wish to express my gratitude to all speakers, presenters and participants in this seminar. I hope that we can have a fruitful and productive discussion, brain storming and presentation that can increase and develop our understanding in sciences. I take this opportunity to thank the organizing committee for this seminar and the Faculty of Science and Mathematics for the necessary funding. The various sponsors are also thanked for their kind hospitality.

Thank you

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Utilization of Immobilized Algae for COD, N, P Removal in Textile Wastewater

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ABSTRACT

Development of the textile industry in Indonesia is quite promising, which reached 1.48% per year. Textile wastewater has characteristics of concentrated color and containing of COD, BOD, N, P, and heavy metals are high. Immobilized microalgae bioremediation is an alternative that can be done to reduce the disadvantages of bioremediation using free microalgae without reducing its ability to reduce waste contaminants. The objective of the research is to observe reduction of color, COD, N, and P of textile wastewater by using microalgae immobilization. In the acclimation process in textile wastewater, Chlorella vulgaris and Spirulina platensis was cultured in 1.5%, 2%, 2.5%, and 3% textile wastewater by the addition 50% of syntetic nutrients. the optimal concentration for the cultivation of microalgae Chlorella vulgaris highest OD_{680} occurred on day 7 of 0.43 obtained in 2.5% of textile wastewater. Spirulina platensis reached highest OD_{680} on day 12 of 0.4 obtained in 2.5% of textile wastewater. The best ratio removal COD, N, P textile effluent obtained at a ratio of 1:3 v/v (bead:wastewater). Chlorella vulgaris and Spirulina platensis immobilized decrease highest COD by 44% and 43% with a final concentration of 235 ppm and 240 ppm. Nitrogen and total phosphorus absorbed 100% on day 5. Factor affecting removal COD, N, P of textile wastewater by immobilized microalgae is ratio bead:wastewater and heavy metal concentration

Keyword: *Immobilized microalgae, Textile Wastewater, COD, Nutrient*

1. INTRODUCTION

The textile industry is one of the fast growing industries and plays a fairly important in Indonesia. Development is quite promising, which reached 1.48% per year[1]. It also marks an increase in the risk of environmental damage caused by waste disposal, especially if the waste is not handled properly[2]. Textile wastewater color intensity ranges from 50-100 mg/L and BOD and COD values in a row 80-6000 mg/L and 150-12000 mg/L[3]. COD and BOD parameter value is very far above the water quality standard threshold of textile industry wastewater required by Ministerial Decision No. LH. 51/MENLH/10/1995 respectively of 300 and 150 mg/L[4].

Textile wastewater containing COD, N, P, and heavy metals that can degrade water quality in the environment. A high content of heavy metals in textile waste originating from the dye at one stage in the production process. To reduce the content of pollutants in wastewater can be used bioremediation process using microalgae as its microorganisms.

Waste Water Treatment Plant (WWTP) textile industry mostly uses activated sludge system in reducing waste contaminants. The advantage of this system can be used on a home scale wastewater treatment to industrial scale. Activated sludge system deficiency that does not remove color from industrial waste and can enhance the color through oxidation, does not eliminate the nutrients that require tertiary treatment, recycling of biomass causes high biomass concentration in the aeration tank so the required residence time is right. Bioremediation is the use of microbes to clean up contaminants in soil and groundwater. Microbes are very small microorganisms, such as microalgae, which lives naturally in the environment. N and P elements that are nutrients for microorganisms are nutrient for human waste. With the basic use of microalgae as a microbe that can absorb elements of N and P in the wastewater. In addition to reducing levels of COD and BOD waste, microalgae can absorb heavy metal content. Textile wastewater treatment using bioremediation systems using microalgae can be used as an alternative to textile wastewater treatment because of its ability to absorb contaminants such as sewage BOD, COD, N, P, heavy metals and color.

In some previous studies on the use of microalgae *Chlorella vulgaris* bioremediation processes because of its ability to reduce heavy metals. But many levels of N, P, COD, and heavy metals that have absorbed maximally only about 60-70%[5]. El-Sayed et al have experimented with using Scenedesmus sp that has been immobilized to reduce salinity of about 50% and have the ability to live in 100% sea water[6]. By using microalgae immobilization ability to live at high concentrations of waste that can be done.
This research will be conducted bioremediation of textile wastewater contains high concentrations of heavy metals by using immobilizing microalgae *Chlorella vulgaris* and *Spirulina platensis* with entrapment techniques in alginate polymer. This research will be observed decrease COD, N, P of textile wastewater by using microalgae immobilization.

2. EXPERIMENTAL METHOD

2.1. Cultivation of *Chlorella vulgaris* and *Spirulina platensis* on Textile Wastewater

10% *Chlorella vulgaris* and *Spirulina platensis* OD_{680} 0.6 cultivated in 1000 mL Erlenmeyer containing the textile wastewater with concentration of 1.5%, 2%, 2.5%, and 3% and added 50% synthetic nutrients. Measure OD by using a spectrophotometer and measure pH on days 1 to 13.

2.2. Immobilization of Microalgae *Chlorella vulgaris* and *Spirulina platensis* in Alginate

Chlorella vulgaris and *Spirulina platensis* with the amount of 0.6 OD_{680} centrifuged at 3500 rpm for 15 minutes. Residue was washed with distilled water using demineralization. Microalgae residue was dissolved in 50 ml of distilled water demineralization. 4% sodium alginate solution with the same volume to obtain a solution of 2% algal-alginate[7]. Mixture was mixed using a magnetic stirrer in order to have a perfect solution. Inserted into the injection solution and put into a solution of 0.1 M $CaCl_2$ and allowed to stand for 1 hour to stabilize the bead. Having obtained the bead *Chlorella vulgaris* and *Spirulina platensis*, beads were washed in demineralization water to stop the process of coagulation.

2.3. Integrating Immobilizing Microalgae *Chlorella vulgaris* and *Spirulina platensis* on Textile Wastewater.

In a 1000 ml Erlenmeyer included immobilization of microalgae with ratio bead:wastewater (v/v) 1:1, 1:2, 1:3 with 24-hour lighting, 18 watt, aeration, and room themperature. On day 1, 3, 5, and 7 were measured COD, N, and P

Removal COD, N, and P(%)

$$\frac{C_i - C_f \ x100}{C_i} \qquad (1)$$

Where,
C_i = Initial concentration of COD, N, P (mg/l)
C_f = Final concentration (equilibrium) COD, N, P (mg/l)

3. RESULT AND DISCUSSION

3.1. Results Analysis of Chemical Content of Textile Wastewater

Analysis of chemical constituents of textile wastewater can be seen in Table 1.

Tabel 1. Analysis of chemical constituents of textile wastewater

Parameter	*Value*
pH	*9,69*
COD (mg/L)	*1755*
N_{total} (mg/L)	*75,87*

P_{total} (mg/L)	25,39
Cr (mg/L)	600
Cu (mg/L)	80
As (mg/L)	-
Hg (mg/L)	-
Fe (mg/L)	0,46
Co (mg/L)	-
Pb (mg/L)	-

Based on the chemical analysis of textile wastewater levels were performed in the Laboratory of Healthcare Central Java Province obtained the results that have properties of textile wastewater is alkaline with a pH of 9.69. this is caused by the process of mercerization, the cloth dipped in a solution of soda (NaOH 20% -25%) in the pressure. This process aims to develop fibers that improve appearance, ability to absorb color and strength. In Table 1 shows that the COD concentration of 1755 mg/L, this concentration exceeds the threshold set by Kep. Men. Neg. L.H. No: KEP-51/MENLH/10/1995 about the Wastewater Quality Standard for Industrial Activity for 150 mg/L. Central Java Provincial Government Regulation No. 5 of 2012 also require waste COD threshold of 150 mg/l. For threshold levels of nitrogen and phosphorus is not listed on KEP-51/MENLH/10/1995 and Central Java Provincial Government Regulation No.05 of 2012 but will be compared with the results of Research and Development of Water Resources Ministry of Public Works in 2011 which states that the threshold level of Nitrogen and phosphorus is 0.116 to 1.310 mg/l and 0.0 to 0.080 mg/l, it is when compared with the results of the analysis Table 1 Nitrogen and phosphorus content of textile waste is very much above the specified threshold. In Table 1 shows that the levels of heavy metals Cr and Cu are very high around 600 ppm and 80 ppm Cu this is clearly very far with the required threshold Minister Decree LH 1995. If analyzed in simple terms is very reasonable because of the color of textile waste being analyzed has solid black on the state and on dilution to 30% (v/v) textile waste shows a greenish blue color that is characteristic look of metal complexes of Cr and Cu.

3.2. Growth Acclimation *Chlorella vulgaris* and *Spirulina platensis* on Textile Wastewater

In the study acclimation of *Chlorella vulgaris* and *Spirulina platensis* growth in textile wastewater, 10% microalgae cultivated with 0.6 OD_{680} in textile wastewater with concentration of 1.5%, 2%, 2.5%, and 3% with a 50% addition of synthetic nutrients. Concentration determination was based on the concentration of waste that causes difficult entry of light that would interfere with the process photosyntesis microalgae. In addition, levels of heavy metals Cr and Cu were high at 600 mg/L and 80 mg/L so as to give toxic effect for microalgae[8][9][10][11].

Figure 1 shows the OD *Chlorella vulgaris* and *Spirulina platensis* in textile wastewater. Cultivation of the results obtained that the cultivation of *Chlorella vulgaris* in sample C-1,5% had the highest OD on day 5 with a value of 0.36, C-2% had the highest OD on day 7 with a value of 0.38, C-2,5% had the highest OD on day 7 with a value of 0.4, and C-3% had the highest OD on day 10 with a value of 0.30. of the graph can be seen that the highest OD *Chlorella vulgaris* at a concentration of 2.5% with a value of 0.43 on day 7.

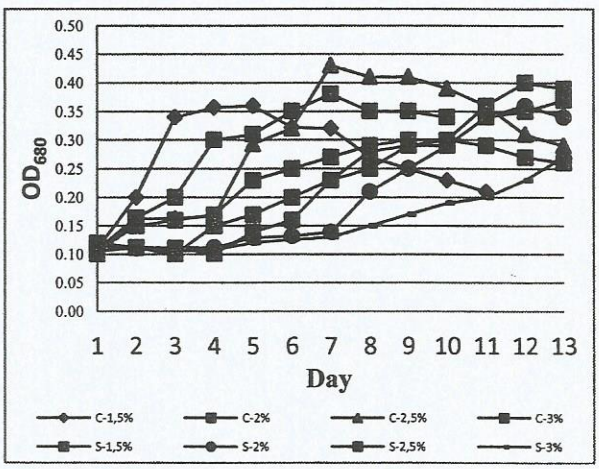

Figure 1. Cultivation of *Chlorella vulgaris* and *Spirulina platensis* in textile wastewater

On the cultivation of *Spirulina platensis* in textile waste by dilution of 1.5%, 2%, 2.5%, and 3% the result that the sample S-1,5%, S-2%, and S-2,5% showed the highest OD value on day 12 with a value of 0.35, 0.36, and 0.40. At concentrations of S-3% *Spirulina platensis* had the highest OD price on day 13 with a value of 0.27. Table 2 showed the growth rate of *Chlorella vulgaris* and *Spirulina platensis* in textile wastewater

Table 2. Growth rate microalgae in textile wastewater

Mikroalga	Wastewater dilution	OD_{max}	μ
Chlorella vulgaris	1,5%	0.36	0.057
	2%	0.38	0.082
	2,5%	0.43	0.295
	3%	0.30	0.034
Spirulina platensis	1,5%	0.35	0.029
	2%	0.36	0.057
	2,5%	0.40	0.105
	3%	0.27	0.160

At low concentrations of between 1.5%, 2%, and 2.5% growth of *Chlorella vulgaris* and Spirulina plarensis slightly delayed but did not show an effect that is too large this is because the concentration of heavy metals that can still be tolerated by the microalgae *Chlorella vulgaris* and *Spirulina platensis*. At 3% concentration of heavy metal concentrations reached a maximum level that can be tolerated by microalgae. In this experiment the concentration obtained optimum cultivation of *Chlorella vulgaris* and *Spirulina platensis* in textile waste 2.5% with the highest OD *Chlorella vulgaris* obtained on day 7 with OD 0.43 and the highest OD *Spirulina platensis* obtained at day 12 with OD 0.40. Table 2. show that there is an increase growth rate of *Chlorella vulgaris* and *Spirulina platensis* with increasing concentrations of textile wastewater. At a concentration of 3% textile wastewater *Chlorella vulgaris* occurs due to large concentrations of heavy metals that cause toxic effects to the growth of chlorella. On *Spirulina platensis* decrease not shown due to the concentration of the growth rate of 3% has not earned Od_{max} on day 13. Lukavsky et al explains that the level of toxicity of some heavy metals Cd>Co>Cr> Cu>Pb>Ni>Zn>Al>Fe, Cr metal has more toxicity than Cu, although both are heavy metal with high toxicity after Cd and Co[8]. Banerjee et al explains that the LC_{50} of kromuim on algae is 20 ppm on algae Aulosima fertilissima[9]. Eisler showed that chromium has on algae LC_{50} ranged from 0.032 to 6.4 ppm[10]. Heavy metals Cu concentration has destructive properties 0.03-1,1 ppm.[11]

3.3. Integrating Waste Immobilization of Microalgae In Textiles In The decrease of COD, N, P

Chlorella vulgaris immobilized with a ratio of 1:3 v/v (beads:wastewater) decrease highest levels of COD with a final concentration of COD in the effluent of textile is 235 ppm or the ability to reduce levels of COD by 44%. Similar results were also shown by *Spirulina platensis* immobilized with a ratio of 1:3 v/v (beads:wastewater) has the ability to reduce levels of COD by 43% by the end of COD in the effluent concentration of 240 ppm. COD end result is still above the threshold required by the Decree of the Minister of Environment in 1995 amounted to 150 ppm. this is due to heavy metal contaminants that reduce the performance of microalgae in the removal COD. Concentration of heavy metals in textile waste approach LC_{50} concentration which decreases the ability to absorb 50%. 1:3 ratio shows the ability to absorb COD levels better than the ratio of 1:1 and 1:2 which can only reduce levels of COD by 42% and 43% for the type of microalgae *Chlorella vulgaris*. Hadiyanto and Azim explains that the immobilization stability will increase compared with the free microalgae[12].
Ability to reduce levels of N and P textile wastewater microalgae *Chlorella vulgaris* and *Spirulina platensis* very large. *Chlorella vulgaris* and

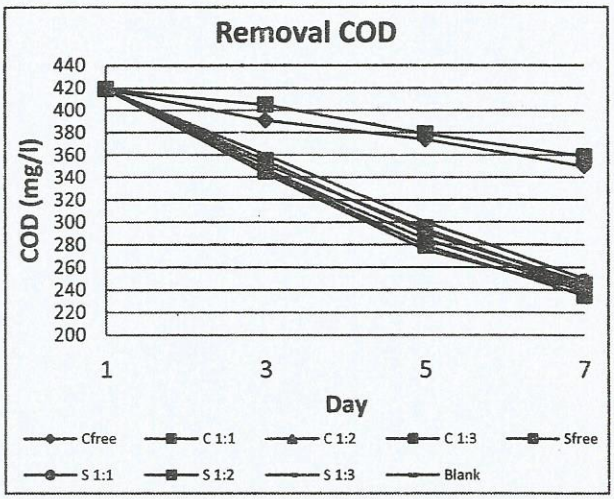

Figure 2. Removal COD by using free microalgae, immobilized icroalgae, and blank bead

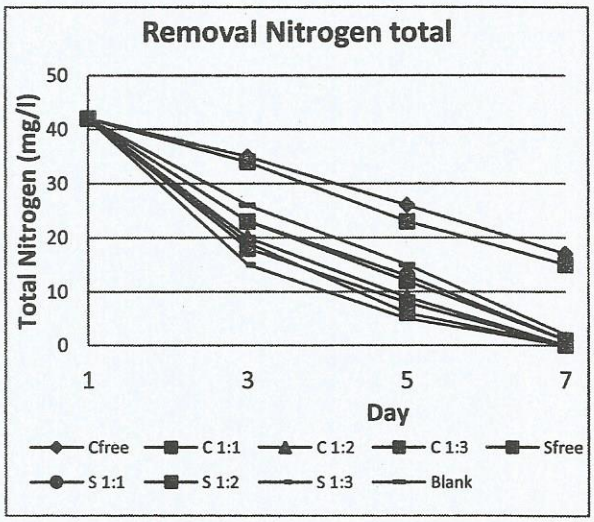

Figure 3. Removal nitrogen total by using free microalgae, immobilized icroalgae, and blank bead

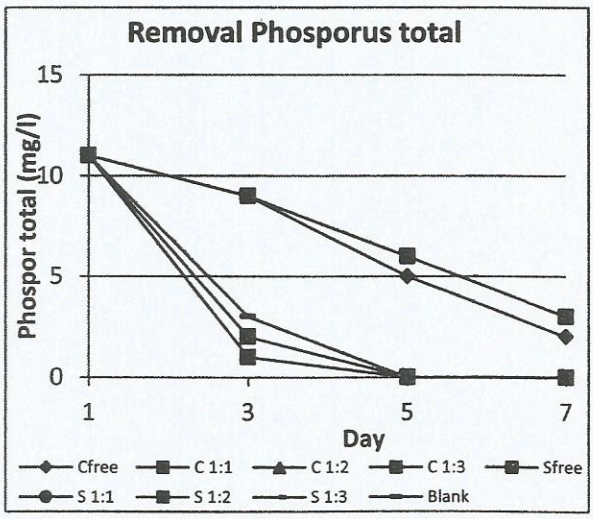

Figure 4. Removal phosporus total by using free microalgae, immobilized icroalgae, and blank bead

Spirulina platensis cultivated freely in textile wastewater can reduce N content up to 60% on *Chlorella vulgaris* and 64% in *Spirulina platensis*. Free *Chlorella vulgaris* and *Spirulina platensis* cultivated in textile wastewater can reduce N content up to 60% on *Chlorella vulgaris* and 64% in *Spirulina platensis*. Ability *Spirulina platensis* to absorb more N than *Chlorella vulgaris* because body size is larger than Spirulina *Chlorella vulgaris*. Besides the need for cultivation of *Spirulina platensis* N is higher than *Chlorella vulgaris*. Ability to absorb P in textile wastewater showed the same thing where *Chlorella vulgaris* and *Spirulina platensis* phosphorus levels by 82% and 73%. This is because the needs of P on *Chlorella vulgaris* higher than in *Spirulina platensis*.
On immobilized microalgae N and P uptake capacity increased to 100% at a ratio of 1:2 and 1:3. At a ratio of 1:1 absorption capability N *Chlorella vulgaris* and *Spirulina platensis* immobilized only by 98% and 98%. N and P content of textile wastewater after bioremediation by microalgae immobilized does not pollute the environment because it absorbed 100%.

Table 3. Final concentration and removal presentation at day 7

type	Concentration at day 7					
	COD (ppm)	% COD Removal	N (ppm)	% N Removal	P (ppm)	% P Removal
C free	350	16	17	60	2	82
C 1:1	243	42	1	98	0	100
C 1:2	240	43	0	100	0	100
C 1:3	235	44	0	100	0	100
S free	359	14	15	64	3	73
S 1:1	247	41	1	98	0	100
S 1:2	243	42	0	100	0	100
S 1:3	240	43	0	100	0	100
Blank	250	40	2	95	0	100

4. CONCLUSION

In the process of acclimation of *Chlorella vulgaris* and *Spirulina platensis* in textile effluent with nutrient addition of 50% is obtained that the optimal concentration for the cultivation of microalgae *Chlorella vulgaris* highest OD680 occurred on day 7 with a value of 0.43 obtained in sewage dilution 2.5 %. *Spirulina platensis* OD_{680} reached highest on day 12 of 0.4 obtained in 2.5% dilution of textile wastewater. The best ratio decreased color, COD, N, P, and heavy metals textile effluent obtained at a ratio of 1:3. *Chlorella vulgaris* and *Spirulina platensis* immobilized highest COD decrease by 44% and 43% with a final concentration of 235 ppm and 240 ppm. *Chlorella vulgaris* and *Spirulina platensis* immobilized reduce total nitrogen and phosphorus by 100%. Factor affecting removal COD, N, P of textile wastewater by immobilized microalgae is ratio bead:wastewater and heavy metal concentration.

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