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Improvement of Batik Wastewater Quality Using Biosorption Process

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Abstract. Sokaraja Batik Center directly releases wastewater from their plant into the Wangan River and because of the presence of some organic matters and heavy metals in the wastewater, this river may become polluted. However, the pollutant compounds in the batik wastewater can be separated through the use of the biosorption process. For the purpose of this research, the experimental method was implemented to assess the effectiveness of treating wastewater using the biosorption process. The result of the research revealed that biosorption using *S. cinerea* and *P. ostreotus* baglog waste in a tea bag as the biosorbent is effective. It also revealed that this process can decrease the pollutant matters in batik wastewater by 70%, although the BOD, COD, and TSS may not meet up with the threshold according to Regional Regulation of Central Java Province No. 5 of the year 2012. However, this treatment method has not yet been accepted by craftsmen because of the financial implication and the difficulties in its preparation.

1. Introduction

Sentra Batik Sokaraja is one of the indigenous industrial batik centers in Banyumas Regency with 29 units of home batik industry. This business organization disposes their batik wastewater directly to the Wangan River and this increases the pollutant concentration of the reception segment [1]. This wastewater contains rhodamin B dyestuff up to 0.344 mgL⁻¹, metilin blue at 0.179 mgL⁻¹ and methyl orange at 0.779 mgL⁻¹ [2]. It also contains BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand) and TSS (Total Suspended Solid) of 1238.76 mgL⁻¹, 3040 mgL⁻¹ and 2563 mgL⁻¹ respectively [3]. High concentration of pollutant compound has the possibility of contaminating Wangan River which is originally used for bathing, washing, fish farming and irrigation. The quality of this river is below standard based on Government Regulation Number 82 (2001) for Cr, Cu, and Pb. It has been discovered that the Cr concentration in this river is 0.231 mgL⁻¹ [4] which are also below the required standard.

The process of biosorption, which involves binding metal through adsorption of an inactive or dead organism, can be used in separating pollutant compounds in batik wastewater [5]. This process is very useful for the adsorption of heavy materials in waste water because it is selective, highly rated and fast [6]. Its adsorption capacity is determined by the surface area of the biosorbent used [7]. However, the surface area can be expanded through the reduction of particle sizes. Some forms of biosorbent have been applied in adsorbing heavy metals in wastewater, such as biosorbent immobilized silica gel [8], biomass size 1 cm [9], ash [10], powder [11], pellet [12] and tea bag package [13]. The tea bag package



is advantageous because it can be easily separated from the waste during application. Therefore, the aim of this research is to study the effectiveness of the biosorption process using tea bag package on the quality of batik wastewater.

2. Research Methods

2.1. Batik Wastewater Preparation

The batik wastewater used in this research was made up of residual coloring and dyeing waste and it was taken from Sokaraja Batik Center in SokarajaKulon Village, Sokaraja District, Banyumas Regency, Central Java Province. It was specifically collected from four different home industries considering the different types of dyes used (Fig.1). The selected wastewaters were mixed for the experiment because there is no separation in channeling all the batik wastewaters from the Centre into the Wastewater Treatment Plant (WWTP) that has been built for that purpose. The initial pH of the mixture was set at 8 through the addition of 1M of NaOH. The research was conducted from January to November 2015.

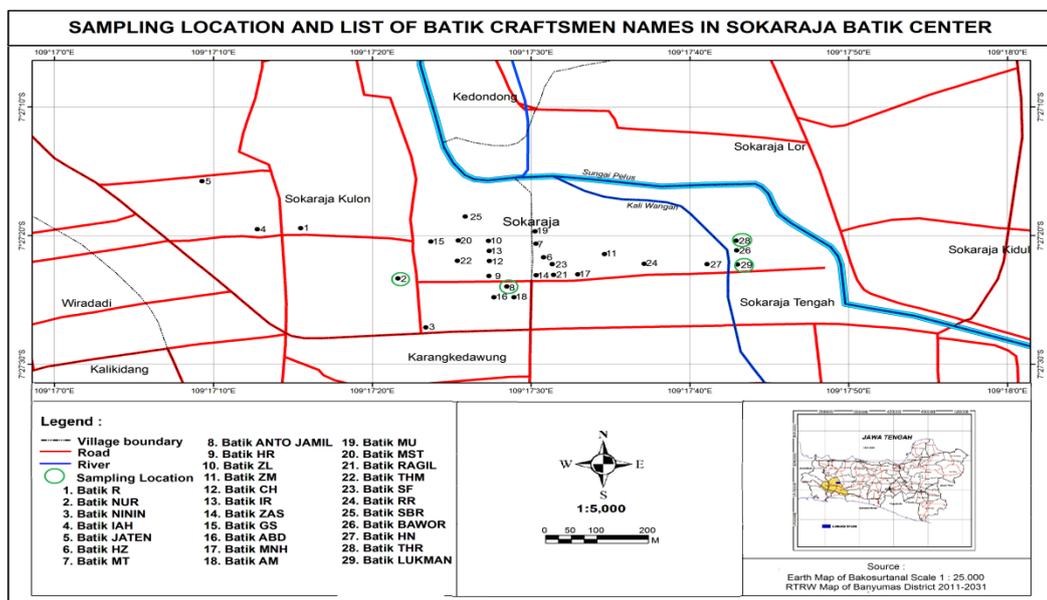


Figure 1. Sampling location and the list of batik craftsmen in Sokaraja Batik Center

2.2. Biosorption Experiment

The batik wastewater prepared was placed in a 2L bucket as a stock solution. 10 biosorbents in a tea bag were added to the solution. The mixture ratios. *cinereum* and *P. ostreatus* bag log wastes were 3:1 and biosorbent particle size was 250-425[13]. The bucket was homogenized with a stirrer at 175 rpm for 1 hour and the treatment was repeated 3 times

2.3. The effectiveness of Batik Wastewater Treatment

The effectiveness of the treatment was measured through a comparison of the concentration parameters before and after biosorption. The comparison was also drawn between the data obtained and the environmental quality standards in accordance with the Central Java Provincial Regulation Number 5 of 2012.

2.4. Data Analysis

A pre-test and post-test analysis method were used in analyzing the data from the experiment.

3. Result and Discussion

The results of the study show that the quality of batik wastewater from biosorption for the parameters of BOD, COD, and TSS is still above the required environmental quality standards (Figure 2). It also shows that phenol, chromium, ammonia as well as oil and fat parameters are below the quality standard (Table 1).

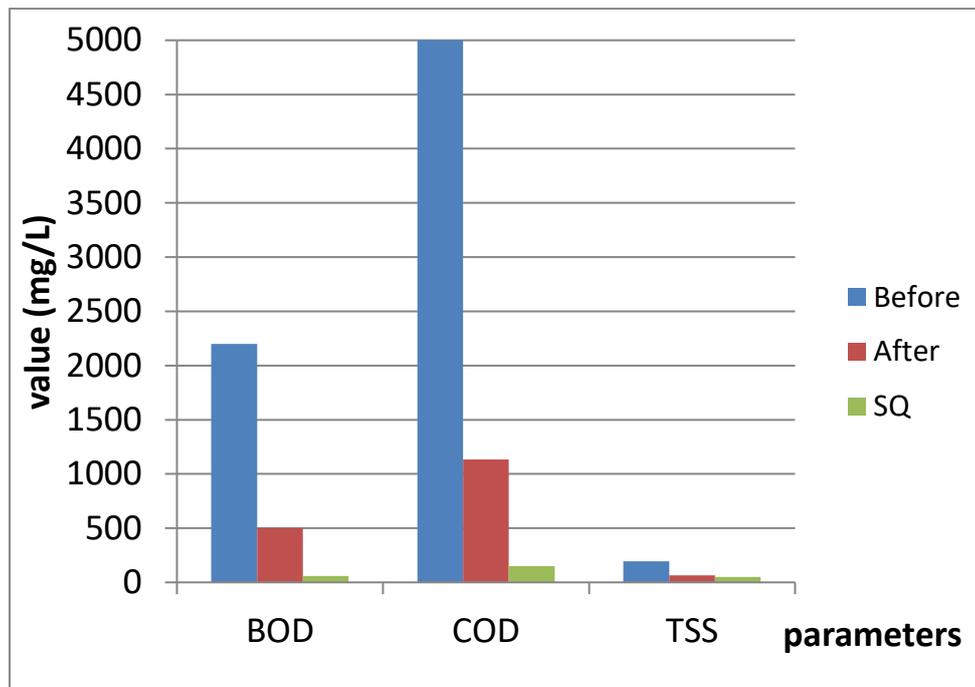


Figure 2. BOD, COD, and TSS of Batik Wastewater Before and After Biosorption

The figure shows that the BOD, COD and TSS levels before biosorption were 2200 ± 4.08 , 5000 ± 4.322 and 194 ± 1.93 mg L⁻¹ respectively. It also shows that the biosorption process can only reduce BOD levels by 77% to have 500 ± 9.09 mg L⁻¹, COD by 77% to have 1133.8 ± 0.98 mg L⁻¹ and TSS by 65% to reach 66 ± 2.16 mg L⁻¹. Therefore, it can be deduced that the process was effective in reducing the levels of organic pollutants even though the figures are still above the accepted standard of quality.

Biosorption with single biosorbent *P. Ostreatus* bag log waste was able to reduce BOD and COD of batik liquid waste by 93.95% and 79.66% respectively [14]. These high levels of BOD, COD, and TSS can be associated with a large number of organic pollutants in the wastewater which are major as a result of starching process. It is important to point out that the presence of high organic matter in an aquatic environment can increase turbidity which results in blockage of light penetration and oxygen diffusion. These conditions further lead to the death of aquatic biota and this decreases primary water productivity.

Table 1. Quality of batik waste water before and after biosorption

No	Parameters	Unit	Before biosorption	After biosorption	Maximum Value
1	Temperature	°C	19.2±0.3	25.2±0.02	38
2	BOD	mgL ⁻¹	2200±4.08	500±9.09	60
3	COD	mg L ⁻¹	5000±4.322	1133.8±0.98	150
4	TSS	mg L ⁻¹	194±1.93	66±2.16	50
5	Phenol	mg L ⁻¹	0.3812±0.0003	0.063±0.0008	0.5
6	Chromium	mg L ⁻¹	0.024±0.0012	0.003±0.0008	1
7	Amoniac	mg L ⁻¹	0.3026±0.0007	0.0285±0.0005	8
8	Sulfide	mg L ⁻¹	undetected	undetected	0.3
9	Oil and grease	mg L ⁻¹	8.75±0.014	1.45±0.029	3
10	pH	-	8.9±0.163	7.1±0.245	6 - 9

Note: Standard quality based on Regional Regulation of Central Java Number 5 of 2012

Table 1. shows that the temperature was lower before than after biosorption with a figure of 19.2±0.3 and 25.2±0.02 respectively. This is associated with stirring at high speed which produces heat energy that consequently increases the temperature of the mixture. Oil and fat levels were also found to have decreased after biosorption. The oil and fat content was measured to be 8.75mg L⁻¹ before, and 1.45mg L⁻¹ after the process. This figure is far below the required quality standard as stated by the regulatory body (Table 1). The presence of oil and fat in the wastewater is as a result of the night or wax in the pelorodan process. The resultant effect of this is that it alters the diffusion of oxygen into the aquatic environment which disturbs the physiology of water organisms and eventually kills them.

The phenol content in the wastewater did not meet up with environmental quality standards before and after the biosorption process. Phenol in batik wastewater comes from synthetic dyes. It is a toxic compound that can inhibit the regeneration of organisms by causing damage to their reproductive organs. Chrome is a metal element found in synthetic dyes used in strengthening the colors of a fabric. Like phenol, it is also found in the batik wastewater. Chrome content meets environmental quality standards before and after biosorption but the process can reduce total chromium content by 62.69% from initial concentrations of 0.744 mgL⁻¹ to 0.156 mgL⁻¹ [13]. Despite the fact the content is small, there is a need to pay attention to it because of its ability to accumulate in living things. A decrease in the pH value of the waste was also observed after the biosorption process. This variation can be associated with the protons released during the process.

From the experiment, it can be concluded that after the biosorption process, phenol, chromium, ammonia, pH and oil and fat parameters met the quality standards as stated by regulatory bodies.

4. Conclusion and Recommendation

Conclusively, the experiment shows that the quality of batik wastewater is better after the biosorption than before the process. It also shows that the process did not have an effect on the levels of BOD, COD, and TSS as they are still above the quality standard. It is recommended that further research is carried out to improve the efficiency of treatment on batik wastewater.

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