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Ability of local species plant in surface flow constructed wetland to reduce biochemical oxygen demand (BOD) and chemical oxygen demand (COD) in sasirangan wastewater

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Abstract

Sasirangan wastewater has characteristics of high pH as well as high level of biochemical oxygen demand(BOD)and chemical oxygen demand(COD). Sasirangan industries produce large amount of wastewater, which then is directly discarded around the environment without treatment processes. The effect afterward is the oxygen supply in the water diminishes and eventually triggers the activity of anoxic-anaerobic microorganisms that produces odors. Constructed wetlands are able to become the alternative to waste treatment technology at the economical household scale industries. This study was conducted to determine the ability of the removal of BOD and COD in the sasirangan effluent with constructed wetlands (CW) surface flow system using the batch method. Plants used in CW is *Hydrilla verticillata*, purun tikus (*Eleocharis dulcis*) and lotus (*Nelumbo nucifera*). CW was running for 0, 3, 6, 9 and 12 days. This study shows that the best removal of BOD dan COD in CW occurred on 12th days. BOD and COD removal for 12 days at the CW reactor that planted with *H. verticillata, E. dulcis, N. nucifera*, and the combination of all plant, respectively is 98.19% and 98.41%; 98.74% and 98.73%; 98.48% and 98.61%; 98.89% and 98.83%. It can be concluded that CW planted with *H. verticillata, E. dulcis, N. nucifera*can remove BOD and COD on liquid waste sasirangan with the greatest efficiency at CW with combination of plants with retention time of 12 days

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Introduction

The sasirangan fabric is one out of ten leading commodities in South Kalimantan. Until now, the sasirangan fabric has been produced in home industry scale. In 2007, based on the data from the Trade and Industry Office of South Kalimantan, there were 103 units of home industry. In Banjarmasin itself, there is a center of sasiranganhome industry namely Kampung Sasirangan, located in across to Masjid Village, Central Banjarmasin, South Kalimantan Indonesia. In the coloring process, Sasirangan fabric used the synthetic dyes (Mizwar, 2013).

Sasirangan wastewater has the characteristics of high pH as well as high levels of BOD and COD (Christie, 2015). BOD and COD in waste caused by the presence of organic compounds which originate from the dyes used in the dyeing process. Sasirangan industries produce large amount of wastewater, which then is directly discarded around the environment without treatment processes. The effect afterward is the oxygen supply in the water diminishes and eventually triggers the activity of anoxic-anaerobic microorganisms that produces odors.

Constructed wetlands are able to become the alternative to waste treatment technology at the economical household scale industries. The construction is simple in which it can be built by using local materials. The easy operation and maintenance system makes it possible to be done by local workers. South Kalimantan has abundant aquatic plant such as *Hydrilla verticillata, Eleocharis dulcis* and *Nelumbo nucifera*, hence this research allows being applied in South Kalimantan.

In the research conducted by Rondonuwu (2014), phytoremediation method has been done by using *Eichhornia crassipes, Typha* sp, *Nelumbium nelumbo*, *Ipomoea aquatic,* and *Hydrilla verticillata* to absorb the waste containing mercury. In Sofia's research (2015), phytoremediation method has been done by using media of *Pistiastra tiotes* and *Hydrilla verticillata* to absorb the BOD and COD in liquid waste of sasirangan industry.

The objective of this research is to find out the effectiveness of BOD and COD removal in liquid waste of sasirangan industry. This research was conducted by applying Surface Flow Constructed Wetland using media plant *Hydrilla verticillata, Eleocharis dulcis* and *Nelumbo nucifera.*

Materials and method

Materials

This research was used surface flow constructed wetland reaktor made from wood and coated by plastic with dimension 65 cm x 35 cm x 35 cm. Plants used were*E. dulcis* with stem height 20-30 cm, *N.nucifera* with stem height 40-50 cm, and young *H. verticillata.* This research was conducted in a pilot scale using 15 reactors with wastewater as much as 60 liters/reactor.

Method

According to Supra data (2005), by using the bulk flow pattern (batch), the concentration of reactant or pollutant will decrease not against the distance function but will be replaced by the time function. The time variations used in this research were 0, 3, 6, 9 and 12 days. In each reactor, sasirangan wastewater used was diluted with mineral water with ratio 1: 5. This research was carried out with 5 triple treatments. Before the operation, plant medium reactor must have been acclimatized for 30 days. It should have been done to ensure that the entire plants had already undergone the shape changes namely generative and vegetative growth of the tested plants as well as to give the adaptation time to the new environment. Sample of effluent water was taken and BOD and COD measured using Indonesian National Standard (SNI : 6989.72:2009) methode. The data obtained were presented in tables and graphs,andthen analyzed statistically and discussed descriptively.

Results and discussion

Biochemical Oxygen Demand (BOD)

The average measurement result of BOD is presented in the Fig.1 while the percentage of BOD removal in Fig. 2. Based on Fig. 1 and Fig. 2, it notices the decrease of BOD content occurs from the first level that is before and after treatments.

BOD value before treatment was 2700 mg/L. In treatment 1, in which control reactor contained only sasirangan wastewater, the lowest BOD value was indicated by the sample of the 9th day as much as 252.30 mg/L with removal percentage of 90.66%.

In treatment 2, in which reactor containedsasirangan wastewater and *H. verticillata*, the lowest BOD level was indicated by the sample of the 12th day as much as 48.85 mg / L with removal percentage of 98.17%.

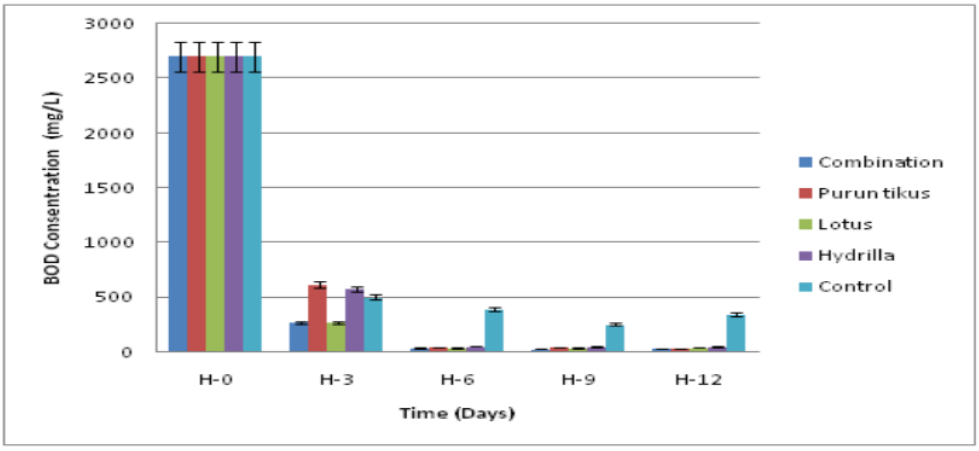

Fig. 1. Concentration changes of BOD towards the contact time.

In treatment 3, in which reactor contained sasirangan wastewater and *E. dulcis*,the lowest BOD level was indicated by the sample of the 12th day as much as 34 mg/L with removal percentage of 98.74%. In treatment 4, in which reactor contained sasirangan wastewater and *N. nucifera*, the lowest BOD level was indicated by the sample of the 9thday as much as 35, 14 mg/L with removal percentage of 90.12%. In treatment 5, in which reactor containing sasirangan wastewater,*H. verticillata*, *E. dulcis* and *N. nucifera* was 98.89%., the lowest BOD level was indicated by the sample of the 12th day as much as 26.13 mg/L with removal percentage of 98.89%. The treatment using plants combination showed bigger BOD decrease than the treatment using only one kind plant.

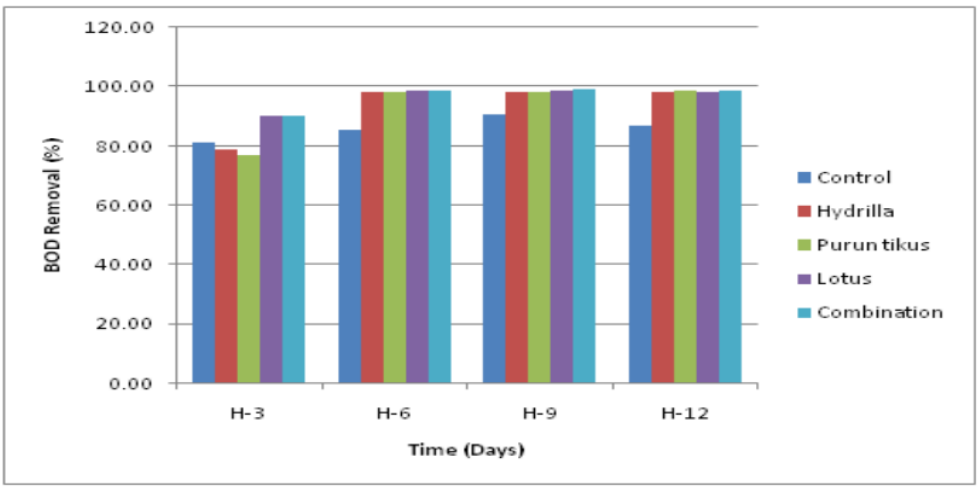

Fig. 2. The percentage of BOD removal.

Based on the data presented in the graph of BOD test results, it can be seen that the decline of BOD value occurs along with the time increase. The decline of BOD value after treatment occurred because the longer the time, the smaller a number of organic compounds contained in sasirangan wastewater due to absorption done by *H. verticillata*, *E. dulcis* and *N. nucifera* for metabolic processes.

Organic substances contained in wastewater will be decomposed by microorganisms into simpler compounds and will be used by plants as a nutrient. Organic compounds in waste water is a nutrient for plants. Plant root tissues will decompose organic matter into carbon, nitrogen, and energy for microbial life (Handayanto and Hairiah, 2007).

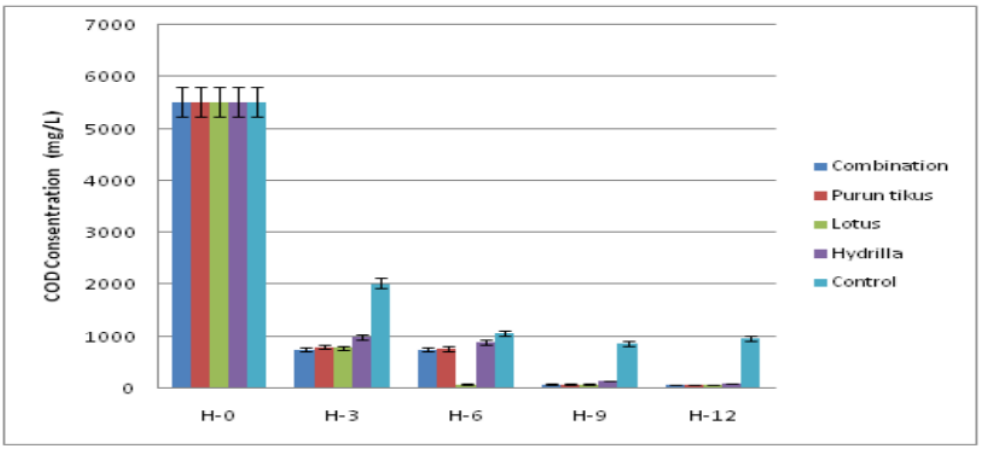

Fig. 3. Changes in concentrations of COD towards contact time.

Plants supply oxygen to the water and soil so that the environment has a higher dissolved oxygen than water and soil are not overgrown with aquatic plants, thus allowing the aerobic microorganisms can live in an environment of artificial wetlands (Khiatuddin, 2003).

Aerobic microorganism's role in lowering the BOD through the process of oxidation. Aerobic microorganisms decompose the organic matter faster than anaerobic microorganisms (Vymazal in Tangahu & Warmadewanthi, 2001).

Chemical Oxygen Demand(COD)

In this research, the COD content from sasirangan wastewater was tested. COD is the amount of oxygen needed by an oxidizing agent to decompose (oxidize) all organic and inorganic materials contained in water. The test results of COD which had been conducted used contact period on the 0, 3rd, 6th, 9th and 12th days for an average sample value of COD test results that can be seen in Figure 3 and Figure 4.

Based on Fig. 3 and 4, COD content declines from its first level before and after treatment. COD value before treatment was 5518.68 mg/L. Samples were tested per 3 days in accordance with the contact time. In treatment 1, in which control reactor contained only sasirangan wastewater, the lowest COD value was indicated by the sample on the 9th day as much as 866.13 mg/L with removal percentage of 82.43%.

In treatment 2, the reactor contained sasirangan wastewater and *H. verticillata*, the lowest COD value was indicated bythe sample on the 12th day as much as 87.75 mg/L, with removal percentage is 94.41%.

In treatment 3, the reactor contained sasirangan wastewater and *E. dulcis*, the lowest COD value was indicated by the sample on the12th day as much as 69, 86 mg/L, and with removal, the percentage is 98.73%. In treatment 4, the reactor contained sasirangan wastewater and *N. Nucifera*, The lowest COD value was indicated by the sample on the 12th day in the amount of 76, 71 mg/L. Which percentage of COD removal is 98.61%.

In treatment 5, in which reactor contained sasirangan wastewater, *H. verticillata, E. dulcis and N. nucifera*, the lowest COD value was indicated by the sample on the 12th day as much as 64.39 mg/L with removal percentage is 98.83%.

In the combination treatment showed a decrease COD plants greater than the treatment using only one species.

Based on the data presented in the graph COD test results can be seen that a decline in the value of COD. COD concentration reduction in line with the decrease in the concentration of BOD. Hariyadi *et al.* (1992) stated that the COD is the amount of oxygen required in special conditions to oxidize the organic substances are chemical, producing CO_2 and H_2O.

In the waste water, there are several components that cannot be biologically oxidized by microorganisms. This is why the COD value is always greater than the value of BOD (Hindarko, 2003).

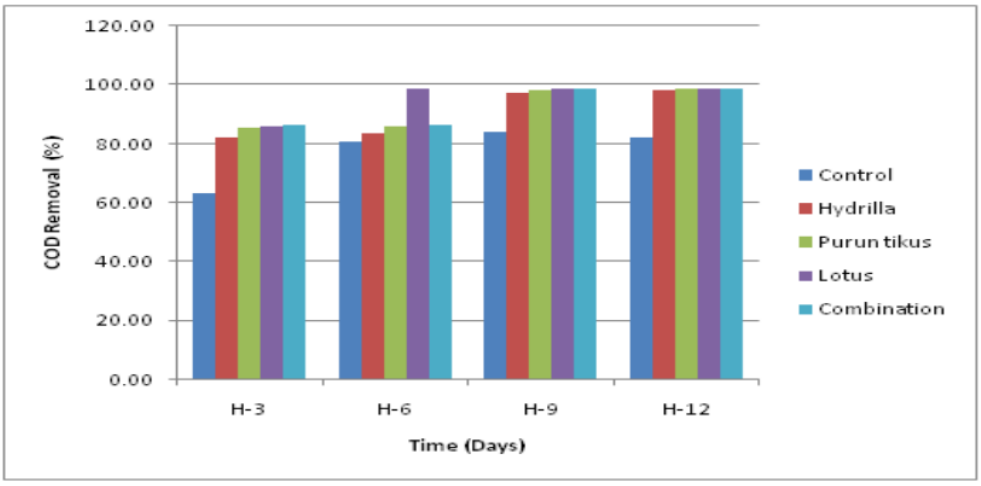

Fig. 4. The percentage of COD removal.

The results of this study can remove BOD 98.89% better than research by Gamage and Yapa (2001) using *E. Crassipes* which can only set aside 75% BOD from textile waste water, while COD can be set aside 81.4% (Priya and Selvan 2017), a similar study using a combination of *Nostoc, E. Crassipes* and *Pistia stratiotes* can set aside 60% COD (Roy *et al.*, 2010) in this study the combination of plants *H. verticillata, E. dulcis*, and *N. nucifera* can set aside COD 98.83%.

The decline of COD value is due to the solid materials which have been settled so that the waste material in the waste water is also reduced.

In addition, some of the waste material has been oxidized and partly absorbed by plants thereby reducing the value of COD.

The declining value also occurs because the amount of dissolved oxygen is quite a lot especially from the plant's photosynthesis that makes the organic material decomposition more effective.

Conclusions

This study show that the ability to removeBOD in constructed wetland reactor for 12 days of H. verticillata was 98.19%, *E. dulcis* amounted was 98.74%, *N. nucifera* was 98.48%; and a combination of *H. verticillata, E. dulcis,* and *N. Nucifera* was 98.89%. The ability to remove COD in constructed wetland reactor for 12days of the plant *H. Verticillata* was 98.41%; *E. dulcis* was 98.73%; *N. Nucifera* was 98.61%; and a combination of *H. verticillata, E. dulcis*, and *N. nucifera* was 98.83%.

Constructed Wetlands with a combination of plants have the greatest ability in reducing BOD and COD from sasirangan wastewater but the stability of the efficiency of these systems is not yet known, so further research with longer time spans is needed.

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