5th International Seminar of Research Month 2020
Volume 2021
http://dx.doi.org/10.11594/nstp.2021.0907

NST PROCEEDINGS

OPEN ACCESS

Conference Paper

Comparison Between *Chlorella vulgaris* And *Spirulina platensis* in Oxidation Ditch Algae Reactor for Treating Tofu Wastewater

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ABSTRACT

Wastewater has been giving a high contribution to the quality of water bodies. Tofu wastewater is one of the contributors since it might contain high organic loading. Microalgae is one of the promising solutions to improve wastewater treatment, especially organic wastewater. However, every microalga has its specific properties and it will affect the quality of treated wastewater. This study aims to compare *Chlorella vulgaris* and *Spirulina platensis* in an oxidation ditch algae reactor (ODAR) for treating tofu wastewater. The ODAR system was set up under ratio wastewater and microalgae 1:1, the sample was taken every day for 7 days of observation. The sample was analyzed for BOD, DO, and Chlorophyll-a. The results showed that *Spirulina platensis* has a higher performance in removing organic pollutants than *Chlorella vulgaris,* which is shown 60% BOD removal, higher DO concentration (5-8 mg/L), and 2,67 mg/L of Chlorophyll-a. Performance of *Spirulina plantesis* in treating organic wastewater was indicated as a fast-growing microalga than *Chlorella vulgaris.*

Keywords: Oxidation ditch, tofu wastewater, microalgae, organic.

Introduction

The tofu industry is one of the industries that produce high levels of organic matter. These organic materials are in the form of proteins, carbohydrates, fats, oils, and amino acids. The presence of these organic compounds causes a high concentration of BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), TSS (Total Suspended Solid), nitrogen, and phosphorus in water bodies due to wastewater has been discharging into the river without being treated (Hidayah et al., 2020a). Discharged wastewater might become toxic and will damage the quality of waters and the surrounding environment, and become the most dangerous threat to living things. Especially if the water is used as raw water in clean water treatment (Husin, 2003). Treatment of wastewater containing organic materials generally uses biological treatment methods (Pratiwi et al., 2019). Oxidation ditch is a biological wastewater treatment that has a high removal ability with a relatively small concentration of microorganisms, oxygen supply, and natural mixing (Dirjen IKM, 2007). The oxidation ditch process with the addition of microalgae or known as oxidation ditch algae reactor has a high removal ability and potential to be an effective process. The algae contained therein and the added algae have a very influential role, which is utilized is the symbiotic interaction between heterotrophic bacteria and algal cells therein (Nurrohman, 2016). Microalgae has many advantages for treating wastewater due to their large availability in the water, their fast reproduction, a wide range of microalgae toxicity, a lot of remediable waste, and is non-patho-

How to cite:
Safrilia, S., et al. (2021). Comparison between chlorella vulgaris and *spirulina platensis* in oxidation ditch algae reactor for treating tofu wastewater . *5th International Seminar of Research Month 2020*. NST Proceedings. pages 1-9. doi: 10.11594/ nstp.2021.0907

genic. Microalgae utilize waste as a source of nutrients and enzymatically degrade pollutants. Nitrogen and phosphorus contained in waste are used as carbon sources (Farahdiba et al., 2020). The microalgae used in this study were *Chlorella vulgaris* and *Spirulina platensis* microalgae. According to Lim et al. (2010) microalgae such as Chlorella and Spirulina are grown in high rate algae pond have proven useful in treating industrial wastewater. *Chlorella vulgaris* is a microalga that is included in the Chlorophyceae class, according to Nurhayati et al. (2014). *Chlorella vulgaris* is a unicellular microalga with a spiral shape of 3-6 μm size, glass-shaped chloroplasts, types of chlorophyll a and b and can live with a pH> 4, a salinity of 2.5% and a room temperature of < 38˚C. In *chlorella vulgaris* textile waste, it can reduce the organic load by NH_4–N (44.4–45.1%), PO_4–P (33.1–33.3%), and organic matter (38.3–62.3%). According to research by Simamora et al. (2017) Spirulina is quite efficient in improving the quality of contaminated industrial wastewater. The results showed that *Spirulina platensis* was able to reduce levels of organic matter by 93.59% and ammonium by 71.42%. This study aim is to compare *Chlorella vulgaris* and *Spirulina platensis* in an oxidation ditch algae reactor for treating tofu wastewater

Material and Methods

This research was conducted on a pilot scale, tofu wastewater was taken from tofu industry in Waru, Sidoarjo. Oxidation ditch algae reactor with a batch system was used to treat wastewater as a biological process, this study applied 3 reactors. Each reactor capacity was 250 liters, with a ratio of waste to microalgae 1: 1. The types of microalgae used are Chorella vulgaris and *Spirulina platensis*. The parameters BOD, DO, chlorophyll-a was measured by using BOD Winkler, DO meter, and extraction, respectively. The Experimental was run for 7 days. The initial stage in this research was the microalgae seeding stage which is useful for increasing the number of microalgae, then it was followed by the acclimatization stage, therefore the microalgae can adapt to wastewater. In the acclimatization stage, the waste will be added gradually until the maximum microalgae can survive.

Results and Discussion

The following is Table 1 which shows the characteristics of tofu wastewater used as raw water in processing.

Table 1. Initial analysis of tofu wastewater

No.	Parameter	Unit	Score	Quality Standards *)
1.	BOD	mg / L	4102	150
2.	COD	mg / L	10251	3 00
3.	pH		4.46	6.0 - 9.0
4.	Temperature	° C	34.7	-

The ability of various types of microalgae in BOD removal is shown in Figure 1. Biochemical Oxygen Demand (BOD) is defined as the amount of dissolved oxygen required by microorganisms at the time of breaking down organic matter, under aerobic conditions. The breakdown of organic matter in question is that this organic material is used by organisms as food and its energy is obtained from the oxidation process (Salmin, 2005, Hidayah et al., 2020b). After the experiment was carried out for 7 days, tofu wastewater treatment with various types of microalgae resulted in varying BOD reduction results for each variable. it can be seen that after the interaction of the waste with the addition of microalgae, there was a decrease in different BOD concentrations. In the treatment with the addition of microalgae *Spirulina platensis*, there was a decrease of 60%. Meanwhile, the addition of *Chlorella vulgaris* decreased the BOD concentration by 51.4%. A previous study has mentioned that *Spirulina platensis* in tofu waste can reduce the concentration of

organic COD by 93.59% (Simamora et al., 2017). The decrease in BOD value is probably due to the addition of microalgae, which makes use of organic compounds contained in wastewater. These organic compounds are nutrients needed by algae for their growth. Also, microalgae need oxygen to absorb organic compounds. This oxygen is obtained from the brush aerator and when the algae photosynthesize. Microalgae that are added to wastewater will experience photosynthesis because microalgae have chlorophyll pigments which can increase oxygen supply and degradation of organic matter can take place quickly, finally BOD drops (Budiardi et al, 2018).

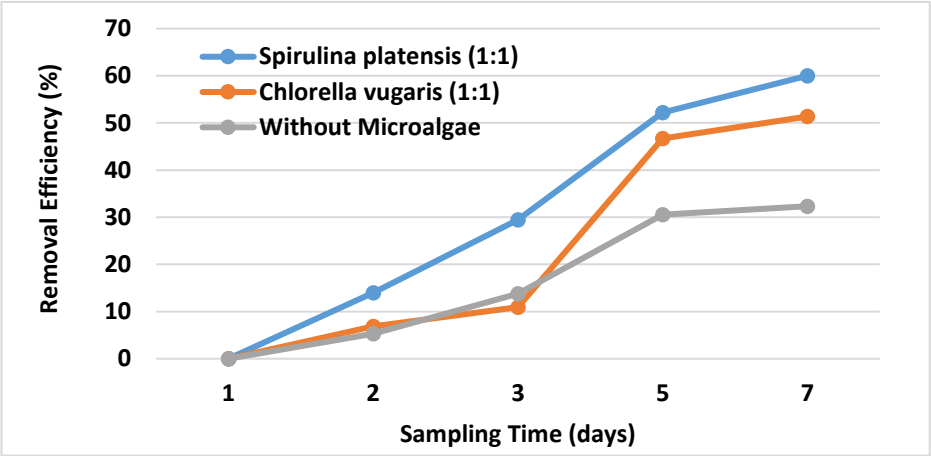

Figure 1. Graph of BOD removal efficiency in ODAR for various types of microalgae

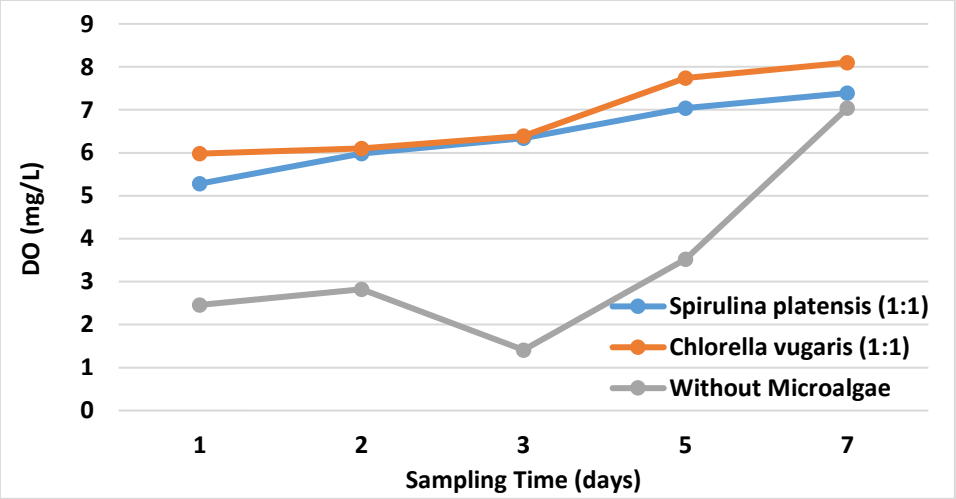

Figure 2. The relationship between sampling time and DO concentration in various types of microalgae

The dissolved oxygen value is described in Figure 2, it is useful to see the level of pollution in waters. If the water has a low level of pollution, the DO value is high and vice versa (Salmin, 2005), while increasing DO value is due to the activity of microalgae during photosynthesis (Istiyanie, 2011), it is because, during photosynthesis, microalgae will produce oxygen. Part of the dissolved oxygen produced from the photosynthesis process is used by aerobic bacteria to oxidize organic matter in wastewater. This can be proven by the decrease in the concentration of organic matter accompanied by an increase in the value of chlorophyll-a.

Chlorophyll-a is a green coloring pigment in plants, algae, and photosynthetic bacteria (Nio Song & Banyo, 2011). So that in this study the chlorophyll-a concentration was used as an

illustration of the amount of algae density in the reactor. The ability of chlorophyll-a is considered to be closely related to the decrease in organic matter contained in wastewater. Based on the figure in Figure 3, it can be seen that there is an increase in the growth of microalgae cells every day. This is due to the interaction that occurs between microalgae and waste. According to (Arifin, 2012) the compounds contained in waste are nutrients needed by microalgae for their growth. As mentioned (Istiyanie., 2011) the increase in DO value is due to the activity of microalgae during photosynthesis because during photosynthesis the microalgae will produce oxygen. Dissolved oxygen generated from the photosynthesis process is partly used for aerobic bacteria to oxidize organic matter in wastewater. This can be proven by increasing the value of chlorophyll-a in water accompanied by a decrease in BOD concentration.

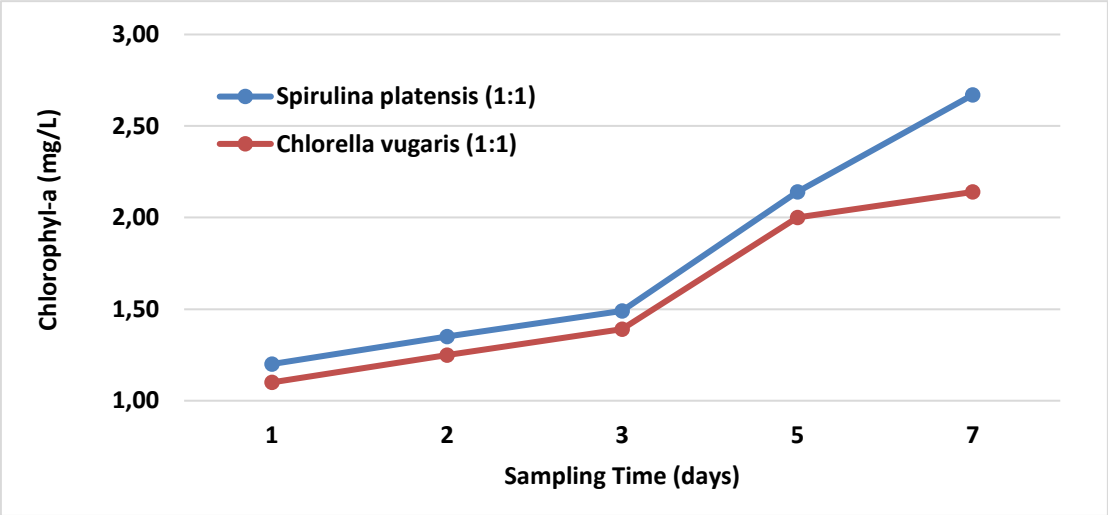

Figure 3. The relationship between sampling time and chlorophyll-a concentration in various types of microalgae

Conclusion

The results of the study can be concluded that microalgae *Spirulina platensis* has a better performance in removing organic pollutants than the *Chlorella vulgaris* microalgae, with a decrease of 60%. Research on the comparison between *Chlorella vulgaris* and *Spirulina platensis* in oxidation ditch algae reactor for treating tofu wastewater still needs to be studied further by using other types of microalgae

Acknowledgment

The author would like to thank Direktorat Jenderal Pendidikan Tinggi Indonesia through Penelitian Dasar Scheme for multi-year, with Contract No. 12/UN63.8/LT - Kontrak/III/2020 is greatly appreciated

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