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KALIDAMI RETENTION PONDS PHYTOREMEDIATION WITH NUTRIENT ADDITION FROM *SCENEDESMUS* SP: A MICROLAGAE

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ABSTRACT

Retention pond is an estuary water body. Water travels through many point sources that are dominated with domestic wastewater. In a big city such as Surabaya that has quite a big number of population, there are more wastewater discarded into water bodies. Generally, various algae and microalgae species are found in the water of retention ponds. Due to those reasons, this study analyzed the utilization of microalgae *Scenedesmus* sp in the treatment of water with high levels of nutrient and organic matter. Kalidami retention pond was used as the research area. The purpose of this study is to discover the effect of Potassium (K) and Carbon (C) on dissolved oxygen (DO) and chlorophyll-a. The study was conducted on a laboratory scale with a batch system and continuous aeration. Microalgae were cultured until 3.5 mg/L of chlorophyll-a was obtained. Phycoremediation was carried out by adding elements K and C. The results of this study show that the reactors added with 3% of K and 29.41 mg/L of C acquired the highest concentrations of DO at 7.70±0.14 mg/L and chlorophyll at 8.88±0.12 mg/L.

KEYWORDS: Chlorophyll-a, Dissolved oxygen, Domestic waste, Retention pond, *Scenedesmus sp.*

INTRODUCTION

Municipal waste generally contains high levels of nitrogen, phosphate (PO_4^{3-}), and organic matter. In Surabaya City, domestic waste carries 0.44 mg/L to 1.08 mg/L of orthophosphate, 15,000 mg/L of COD, and 9,000 mg/L of BOD (Wijaya and Soedjono, 2018). High concentrations of PO_4^{3-} can lead to eutrophication (Piranti, *et al.*, 2018), causing a decline in dissolved oxygen (DO) in the water.

In general, a retention pond has a quite high concentration of organic matters, so various algal species can be found in it. Based on a study conducted by Restuhadi *et al.* (2017), algae-bacteria can be bioremediation agents in wastewater. In this case, waste is used by microalgae as a source of nutrients and these microalgae symbiosis with other microbes to remove pollutant (Oktavitri *et al.*, 2019). Microalgae can remove metal concentration in media through biosorption, adsorption, and bioaccumulation (Purnamawati *et al.*, 2015). Microalgae such as *Chorella, Chlamydomonas, Spirulina, Scenedesmus, Nostoc, Synechoccytits* (Purnamawati, *et al.*, 2015), and *Oscillatoria* can be utilized to treat wastewater (Bwapwa, *et al.*, 2017).

Some species of algae, particularly *Chlorella vulgaris* and *Scenedesmus obliqus* are able to degrade shrimp farming wastewater. They can reduce organic and inorganic matters in the waste, especially phosphate, up to 0 mg/L (Kabir *et al.*, 2017). *Scenedesmus sp* can remove BOD by 74%, COD by 72%, NH_4^- by 95% from tapioca wastewater (Romaidi *et al.*, 2018). *Scenedesmus* sp can decrease phosphorus and nitrogen in domestic waste by 65±12% and 80±9% respectively (Acevedo *et al.*, 2017). This biological process is more effective than biological process in biofiltration. Purwatiningrum (2018) explained that biofiltration have low efficiency to remove COD and BOD (not more than 15%), however different results showed by Ningrum (2018), biological process using sand filtration combined with aeration system successfully remove organic matter more than 65%.

The provision of nutrients, pH, light intensity, dissolved oxygen, and temperature influence the growth of algae and bacteria (Selvika *et al*., 2016), (Simatupang *et al.*, 2017), (Mohamed *et al*, 2019). Algal growth requires organic matters such as chemical oxygen demand (COD), biological oxygen demand (BOD), and nutrients including Nitrogen (N), Potassium (K), Phosphorus (P) dan Carbon (C) (Subagiyo *et al.,* 2016).

The addition of elements K and C to dissolved oxygen (DO) and chlorophyll concentrations has not been widely carried out. Therefore, this study is expected to be able to complement other studies regarding wastewater phycoremediation using microalgae.

MATERIALS AND METHODS

Algae taken from a pond in Bulusidokare Village, Sidoarjo, East Java were cultured. The algal culture was conducted with a 25 L plastic tube reactor in a greenhouse by being aerated with an RC 410 aerator. It was put under sunlight and added with NPK fertilizer (Ratnawati *et al.,* 2017).

Prior to the phytoremediation process, the characteristics of retention pond water, namely COD, BOD, PO_4-P, DO, and pH were revealed through a preliminary analysis of the water. APHA 5220 C was utilized for analyzing COD; SNI 06-6989 72-2009 for BOD; APHA 4500 P-E, Ed 22, 2012 for PO_4-P; SNI 06-6989,14-2004 for DO, and SNI 06-6989,11-2004 for pH.

Retention pond water was phytoremediated in the greenhouse using a batch method using a glass tube reactor with a volume of 8 L and aerated with an RC 410 aerator. Test reactors used the water of the retention pond that has been added with algal culture. The ratio of retention pond water to algal culture was 1:3. The variables in this study include the addition of KH_2PO_4+K_2HPO_4 as element K with 0%, 1%, and 3% concentrations of the total K in Bold's Basal Medium (BBM), and the addition of sucrose as element C with 0 mg/L and 29.4 mg/L concentrations. The control reactor contained water from the retention pond without the addition of algae or elements K and C. Every reactor was labeled with a code as presented in Table 1. DO, and chlorophyll-a analyses were analyzed on days 0, 3, 6, 9, 11, 13, 16, 18. Thermo Scientific Genesys 20 spectrophotometer was utilized to analyze chlorophyll.

Table 1. Research reactor codes

Reactor Code	Element K (KH_2PO_4 + K_2HPO_4)(%)	Element C (Sucrose) (mg/L)
Control	0	0
0K	0	0
1K	1	0
3K	3	0
0KC	0	29.41
1KC	1	29.41
3KC	3	29.41

RESULTS AND DISCUSSION

The preliminary analysis of retention pond water revealed that none of the tested parameters meet the quality standards for class III water according to Surabaya Regional Government Regulation No. 2 of 2004. The same as PO_4-P, COD and BOD concentrations also exceeded the stipulated quality standards, which were 132.48±0.04 mg/L and 60.85±0.92 mg/L. The ratio of BOD/COD, which was 0.45, suggest that Kalidami retention pond water is easy to degrade by microorganisms (Tamyiz, 2015), pointing out that the right method to treat this water is using biological treatment, such as phytoremediation. Similar occurrence was also found with DO. The concentration of BOD that is above the quality standard will lead to low DO value. The value of pH tended to be neutral, which was 7.24±0.00.

The concentrations of DO in each reactor throughout the research are presented in Figures 1 and 2. The addition of element K (KH_2PO_4 + K_2HPO_4) and element C (sucrose) also affected the DO concentrations. K functions as an enzyme activator during photosynthesis, respiration, as well as carbohydrate and protein synthesis (Nurhayati *et al.*, 2019). The increase in DO concentration from day 3 to day 11 was due to the availability of nutrients needed for algal growth, so the algae had an exponential phase with a rapid growth rate(Ramírez *et al.,* 2018). *Scenedemus sp* are algae that adapt easily with a life cycle of 3 to 7 days, so they could grow well at the beginning of the study(Fadilla, 2010). In the photosynthesis process, algae also convert CO_2 into O_2(Panggabean and Prastowo, 2017). On the other hand, the DO concentration in the control reactor is lower than that in the test reactors becauseDO concentration only came from the aeration system and oxygen diffusion from the air, not from photosynthesis.

The addition of C also affects DO concentrations. Figure 1 and Figure 2 show that during the research, the reactors with the addition of elements K and C (0KC, 1KC, 3KC) had a higher DO level than that in reactors that were only added with K without C (0K, 1K, 3K). It is because element C is a source of energy and a co-substrate for microalgae and bacterial growth (Nurhayati *et al.*, 2019).

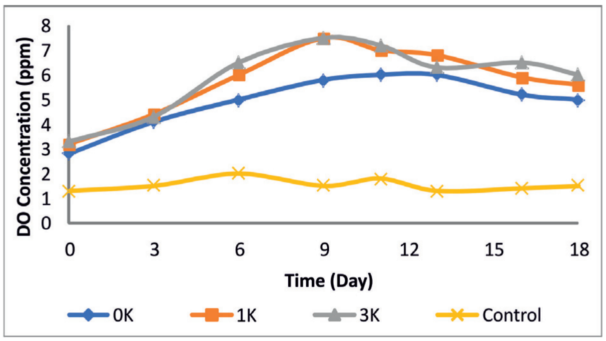

Fig. 1. DO concentration throughtout the research after the addition of Element K

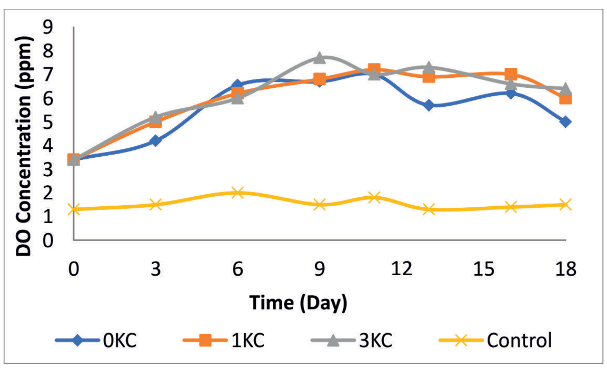

Fig. 2. DO concentration throughout the research after the addition of elements K and C

The results of the study point out that the highest DO concentration was obtained in 3KC reactor, which was the reactor added with 3% of K and 29.4 mg/L of sucrose, on day 9 at 7.70±0.14 mg/L. It increased by 106%.

The concentration of chlorophyll-a throughout the research is presented in Figures 3 and 4. Chlorophyll concentration on day 0 in the test reactors was between 4.4 mg/L and 4.5 mg/L, while the concentration in the control reaction was 2.2 mg/L. The difference in chlorophyll-a concentration on day 0 was due to the addition of algal culture to the test reactors, so they had higher concentrations of chlorophyll-a. From day 3 to day 6, retention pond water contained quite high levels of nutrients such as C, P, and K. These nutrients were absorbed by algae for rapid growth and photosynthesis.

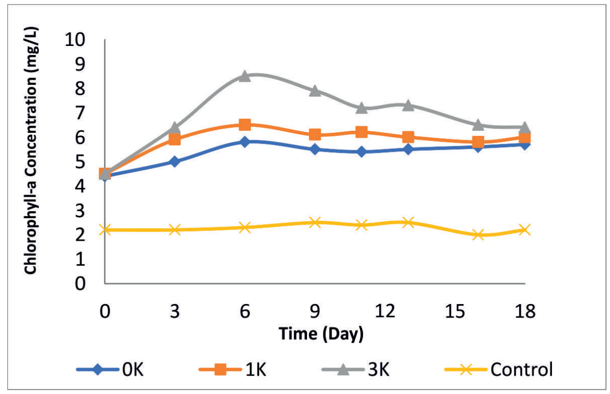

Fig. 3. Chlorophyll-a concentration throughout the research after the addition of element K

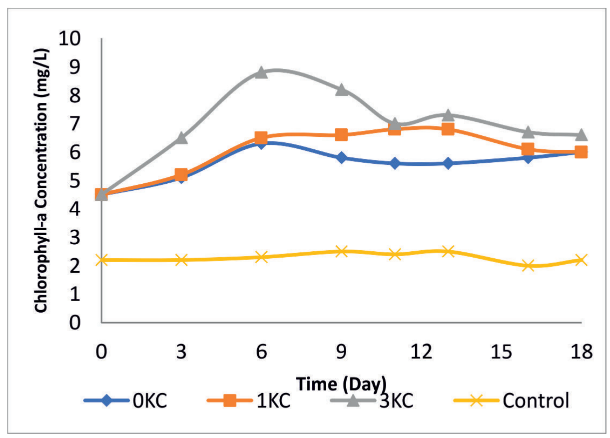

Fig. 4. Chlorophyll-a concentration throughout the research after the addition of elements K and C

From day 13 to day 18 has stable growth because the media had a stationary phase in which the growth of microorganisms was offset with the death of microorganisms. The stationary phase occurs due to the decrease of nutrients and energy in the media (Selvika *et al.*, 2016); (Mardalena, 2016). The results of this study were almost similar to the results of another study (Oktavia *et al.*, 2014).

The addition of element K has an impact on the concentration of chlorophyll-a. It occurred because the addition of KH_2PO_4 + K_2HPO_4 salts fulfilled the nutrients of K and P that are needed for the growth of algae. K is a macronutrient that functions as a co-enzyme during photosynthesis and respiration (Soeprobowati *et al.*, 2013). One of the characteristics of algal growth is the incline of chlorophyll-a concentration.

The highest concentration of chlorophyll-a at 8.88±0.12 mg/L was achieved on day 6 in the 3KC reactor, which was added by 3% of K and C. The concentration increased by 95.6%. It occurred because the addition of elements K and C fulfilled the needs of K, C, and P nutrients in the reactor, so algae grew optimally and the algae-bacteria symbiosis was also optimal.

CONCLUSION

From this study, it can be concluded that the addition of elements K and C affects the concentration of DO and chlorophyll. The highest DO concentration was obtained in the reacted added with 3% of K and 29.4 mg/L of C (3KC) on day 9 at 7.70±0.14 mg/L with 106% increase. The highest chlorophyll-a concentration occurred in the reactor added with 3% of K and 29.4 mg/L of C (3KC) on day 6 at 8.88 ±0.12 mg/L, increased by 95.6%.

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