Poll Res. 39 (4) : 1256-1261 (2020)

ISSN 0257–8050

DECREASING ORGANIC MATTER IN WASTE WATER FROM *SANGKURIANG* CATFISH AQUACULTURE (*CLARIAS GARIEPINUS*) USING ATTACHMENT MEDIA AND BACTERIAL CONSORTIUM

DIANA ARFIATI[1], SHOFIYATUL LAILIYAH[2], KARINA FARKHA DINA[2], ERLANGGA ADIALAM[3], ALYA RAHMA MAGHFIRA[3] AND NOVIA ANANDA SARI[3]

[1] Lecturer in Aquatic Resource Management Study Program, Faculty of Fisheries and Marine Science, Universitas Brawijaya, Malang, Indonesia

[2] Postgraduate Student of Aquaculture Study Program, Faculty of Fisheries and Marine Science, Universitas Brawijaya, Malang, Indonesia

[3]Undergraduate Student of Aquatic Resource Management Study Program, Faculty of Fisheries and Marine Science, Universitas Brawijaya, Malang, Indonesia

(Received 8 April, 2020; accepted 14 May, 2020)

ABSTRACT

The High level of organic matter in waste water from *Sangkuriang* catfish aquaculture is composed from feces and remaining feed. If the wastewater is directly flowed into public waters, it will increase the level of organic matter and cause eutrophication. This study was carried out as an attempt to decrease the level of total organic matter in the waste water from *Sangkuriang* catfish aquaculture. This study employed an experimental method with completely randomized factorial design and the data were analyzed by using Factorial ANOVA to reveal the differences in organic matter decrease for 120 hours (5 days). The main treatment was the addition of 50% and 75% attachment media of the experiment tank surface area. The additional treatments were 2 types of bacterial consortia from market products (bacterial consortium E and B). The organic matter was measured by using a KMnO4 oxidizer. The result indicated that the best decrease in organic matter was obtained in treatment with 75% attachment media and bacterial consortium E. In bacterial consortium E, the organic matter in the initial level was 64.464 mg/L and it decreased into 5.48 mg/L after 120 hours or there was 92% decrease. During the study, the water quality condition could support the lives of bacteria and other aquatic organisms. However, the carbon dioxide level from the reform of organic matter was high (39.6-159.72 mg/L). Thus, it is necessary to utilize carbon dioxide by involving autotrophic organisms such as plants in the management of organic matter.

KEY WORDS : Organic matter, Waste management, Bacterial Consortium B, Bacterial Consortium E, *Sangkuriang* Catfish, Aquaculture

INTRODUCTION

Aquaculture is the activity of farming or rearing aquatic organisms such as fish and shrimp. Waste water from aquaculture that is directly flowed into public waters will cause an increase in the total organic matter level (TOM) in the waters. High level of organic matter in aquaculture waste water is due to feeding activity in which the fish feed is not entirely consumed. The remaining feed forms organic matter which will be flowed into the public waters, so that the total organic matter level will increase along with the longer cultivation time (Triyatmo, 2002). One of the problems in aquaculture is waste water disposal which results in a decrease in the water quality in the environment around the aquaculture site due to the accumulation of organic matter from the remaining feed or feces (Septiani *et al.,* 2014). It is estimated that 10% from 100 units of feed given to fish is not consumed (wasted). The remaining 10% feed is solid waste and 30% is liquid waste produced by fish.

An increase in total organic matter (TOM) can be caused by the biological activities of fish such as the release of metabolic products (feces and urine). High level of organic matter can also trigger eutrophication (increased fertility) and it usually has some negative impacts on fish (Manengkey, 2010). Bacteria will attach to the media and reproduce on it in the form of green fiber, which can be used to wash the dishes (Fitri *et al.,* 2016). The purpose of this study was to decrease total organic matter (TOM) in in the waste water from *Sangkuriang* catfish (*Clarias gariepinus*) aquaculture.

Research Material and Method

The study was conducted in November 2019 at the Hydrobiology Laboratory of Fish Resources Division and the Fisheries Product Sustainability Laboratory, Faculty of Fisheries and Marine Science, Universitas Brawijaya. The method employed in this research was an experimental method with completely randomized factorial design. The main factor was the addition of attachment media with different surface area and the addition of bacterial consortium E and B, while the second factor was the length of experiment period (24 hours, 48 hours, 72 hours, 96 hours, and 120 hours).

Water Sampling and Treatment

The sample of wastewater from *Sangkuriang* Catfish aquaculture in adult fish ponds was taken at the Technical Implementation Unit of PTPBP2KP Kepanjen, Malang, East Java. Sampling was carried out at the end of the aquaculture period at the outlet (part of the pond having the highest organic matter level). The sample was then brought to the Hydrobiology Laboratory of the Fish Resources Division, Faculty of Fisheries and Marine Science. It took around 1.5 hour from the research site to the laboratory and there was no preservative given to the sample during the process. Furthermore, the water sample was put into 19 observation tanks with a volume of 10 liters; each tank was filled with 4 liters of water. The 19 observation tanks consisted of: 3 treatment tanks with 75% attachment media, 3 treatment tanks with 50% attachment media, 3 treatment tanks with 75% attachment media added with bacterial consortium E, 3 treatment tanks with 50% attachment media added with bacterial consortium E, 3 treatment tanks with 75% attachment media added with bacterial consortium B, 3 treatment tanks with 50% attachment media added with bacterial consortium B, and 1 control tank. The control tank was a treatment without the addition of attachment media and bacterial consortium.

The bacterial consortium E consisted of *Lactobacillus casei* and *Saccharomyces cerevisiae* while bacterial consortium B consisted of bacteria having lignolitic, cellulotic, proteolitic, lipolitic, and fixation characteristics that were not named after the bacteria. The bacterial consortium was obtained in the form of liquid products which were found in the market to decompose the septic tank waste. The number of bacteria added to each treatment tank was 12 ml, referring to Khairul (2017) stating that the dosage of bacterial consortium in liquid form that is appropriate for waters is 3 mL per 1 liter of water. Thus, the researchers used 12 mL bacterial consortium in 4 liters of water. In this study, the treatment bank was not given aeration during the process of decreasing organic matter for 5 days or 120 hours.

Water Quality and Total Bacteria Calculation

Water quality parameters measured in this study were pH, temperature, dissolved oxygen, and carbon dioxide. The pH parameter was measured by using pH paper. Then, the temperature and dissolved oxygen parameters were measured by using DO meters. The carbon dioxide parameter was measured by using Na_2CO_3 titration and The organic matter was measured by using a KMnO4 oxidizer The number of total plate count (TPC) bacteria was used to find out the number of bacteria existed in the water sample.

RESULTS

Total Organic Matter

The level of total organic matter (TOM) in the treatment with 75% attachment media added with bacterial consortium E decreased from 47.61 mg/L to 5.48 mg/L or there was 92% decrease after 5 days (Figure 1). The bacteria in suspension decreased after 120 hours or 5 days. The highest number of bacteria in water at 120 hours was found in the control treatment (44.6 x 1010^2 CFU/mL). Meanwhile, the lowest number was in the treatment of 50% attachment media added with bacterial consortium (4.8 x 10^2 CFU/mL). The total bacteria in the water column in all treatments ranged from 4.8 x 10^2 CFU/mL to 59.5 x 10^2 CFU/mL. The bacteria in the water column during the 5^{th}-day observation

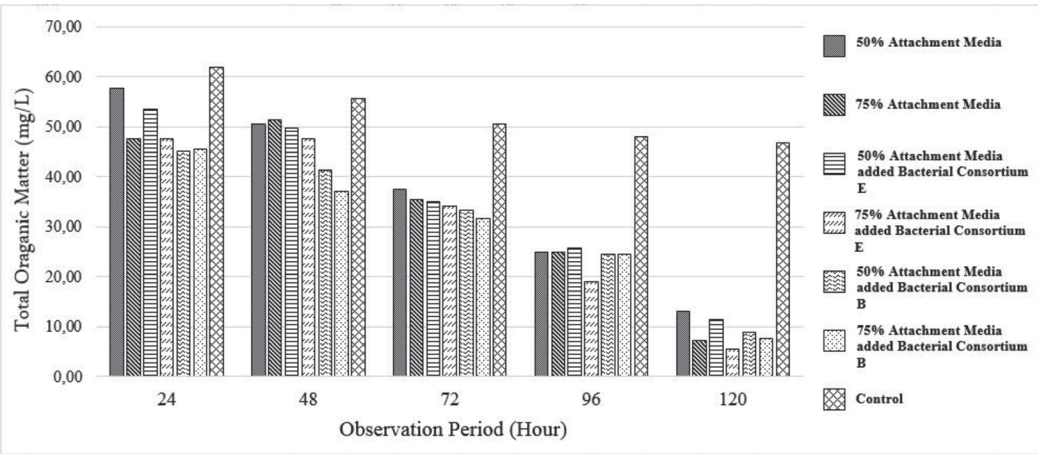

Fig. 1. Measurement Graph of Total Organic Matter

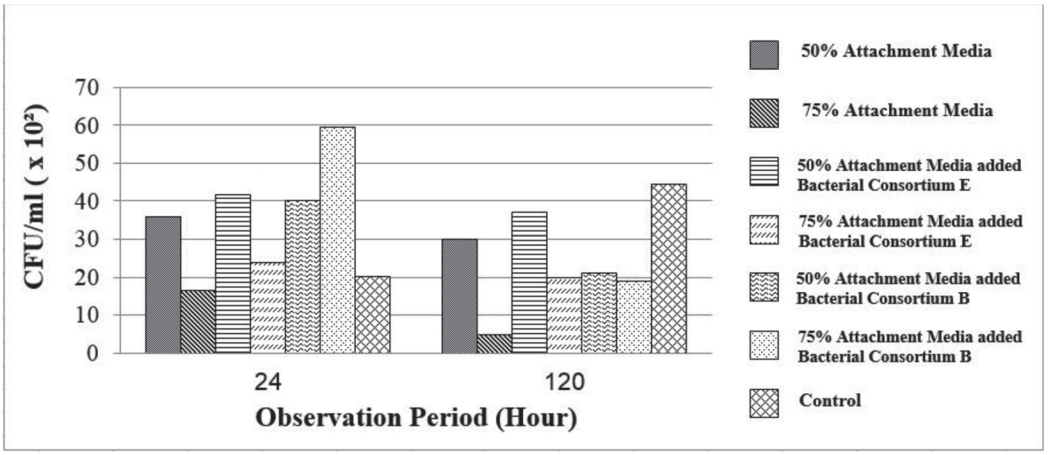

Fig. 2. Graph of Total Bacteria during the 24th and 120th hour

period decreased in all treatments. The total number of bacteria at 24 hours and after 120 hours can be seen in Figure 2.

Water Quality

During the study, the temperature of the media ranged from 24.7 °C - 25.9 °C as seen in Table 1. The pH value in aquaculture wastewater without treatment (control) was 7.8. The pH value in each treatment can be seen in Table 1. The relative pH value does not fluctuate in each treatment group. The highest pH value of 8 was in each treatment, while the lowest pH value was 7 in the 48th-hour control treatment. In each treatment of bacterial addition, the pH value obtained was always below 8, ranging from 7 - 7.9; in which the range became an indicator that the bacteria began to work effectively in degrading organic matter.

Besides appropriate pH value, oxygen is needed for the life of the organism. In this study, the dissolved oxygen ranged from 0.7 to 1.7 mg/L while the value in the control treatment tank was 3.52 mg/L as seen in Table 1. In this research, CO_2 level in the treatment media added by bacteria ranged from 39.6 mg/L - 159.72 mg/L as seen in Table 1. The highest CO_2 level was found in the treatment of 50% attachment media addition at 120th-hour which was 159.72 mg/L. Meanwhile, the lowest CO_2 level was found in the control treatment at the 24th-hour which was 39.6 mg/L.

DISCUSSION

The result of decomposition of organic matter with the addition of bacteria became higher when compared to decomposition of organic matter without the addition of bacteria. Microorganisms can consume organic matter and turn it into carbon dioxide, water and energy for their growth and reproduction activity (Fidiastuti and Suarsini, 2017). When the bacteria grow, carbon will be used to form microbial cell composition material by releasing

Table 1. The water quality Measurement (Secondary Data, 2019)

No	Parameters	Treatment	Observation Period (Hour)				
			24	48	72	96	120
1	Temperature	50% Attachment Media	25.4	25.0	25.4	25.2	25.7
		75% Attachment Media	25.5	25.0	25.0	25.3	25.8
		50% Attachment Media added Bacterial Consortium E	25.5	25.2	24.8	25.1	24.8
		75% Attachment Media added Bacterial Consortium E	25.5	25.6	25.6	25.3	25.8
		50% Attachment Media added Bacterial Consortium B	25.5	24.9	25.1	25.1	25.8
		75% Attachment Media added Bacterial Consortium B	25.5	24.9	25.1	25.2	25.9
		Control	25.2	24.7	25.1	25.4	26
2	pH	50% Attachment Media	8.0	7.7	8.0	8.0	7.7
		75% Attachment Media	8.0	7.7	8.0	8.0	8.0
		50% Attachment Media added Bacterial Consortium E	8.0	8.0	7.3	8.0	8.0
		75% Attachment Media added Bacterial Consortium E	8.0	8.0	7.7	8.0	8.0
		50% Attachment Media added Bacterial Consortium B	8.0	8.0	7.7	8.0	8.0
		75% Attachment Media added Bacterial Consortium B	8.0	7.7	8.0	7.7	8.0
		Control	8	7	8	8	8
3	Dissolved Oxygen	50% Attachment Media	0.7	0.7	1.0	1.2	1.5
		75% Attachment Media	1.1	0.8	1.1	1.2	1.7
		50% Attachment Media added Bacterial Consortium E	0.7	0.8	0.8	1.1	1.7
		75% Attachment Media added Bacterial Consortium E	0.7	1.0	1.0	1.2	1.2
		50% Attachment Media added Bacterial Consortium B	1.1	0.7	0.9	1.1	1.4
		75% Attachment Media added Bacterial Consortium B	1.3	0.9	0.9	1.0	1.6
		Control	1.2	0.7	0.8	1	1

carbon dioxide and other volatile materials. In the biodegradation process, the microbes will also assimilate nitrogen, phosphorus, potassium and sulfur bound in the protoplasm of the cell so that organic matter will decrease with the addition of bacteria (Ken *et al.*, 2019).

The 92% decrease in organic matter indicated that the waste water from *Sangkuriang* Catfish aquaculture could be directly flowed into the waters without causing further problem. The optimum level of organic matter in the water, in the form of dissolved, colloidal and suspended organic matter, is 5-10 mg/L (Sari *et al.*, 2014). In this study, the addition of bacterial consortia E and B relatively showed similar results in decreasing organic matter; likewise, the addition of 50% and 75% attachment media. During the observation, it took 5 days for the bacteria to reduce organic matter. Based on the analysis of Factorial ANOVA, the addition of attachment media and a bacterial consortium within 5 days could significantly decrease the level of organic matter in which F-count was greater than the F-table (5.970> 1.748).

The aquaculture waste water management or organic waste decrease using bacteria can be performed with aerobic, anaerobic, and both aerobic and anaerobic conditions. When there is an attachment medium, the bacteria that degrade the organic matter will grow on it (Dewi and Masithoh, 2013). Microorganisms can grow on a medium that is partially or completely immersed or that is only flowed by water. Bacteria that attach themselves to the media will form mucus on the surface of the media, and form a layer where bacteria live in a colony; often referred to as biofilms (Hadiwidodo *et al.*, 2012).

Temperature is a water quality factor affecting biodegradation, particularly metabolic processes and bacterial growth rate. In general, the increase in temperature affects the activity of enzymes used in degrading organic matter. If the temperature is not optimum, the bacterial growth becomes slow or there is no growth. According to Sholihati *et al.* (2015), if the temperature is getting higher, the enzyme activity will increase to reach the optimum point and will decrease if the enzyme is denatured. The value of the relative temperature did not fluctuate and it was still relatively stable since the difference in value between treatments was not too wide. The range of temperature values in both control and treatment was still in the optimal limit to support the activity of bacteria in degrading organic matter. The optimum temperature range for bacterial activity in the degradation process is generally 24 °C – 30 °C (Isnawati and Trimulyono, 2018).

Bacteria are able to degrade waste significantly in the pH condition of 6.1 to 8 (Al-Gheethi and Ismail, 2014). In addition to inhibiting the activity of bacteria, pH value, which is above 8, prevents the growth of bacteria so that the degradation process runs slowly (Lay, 1994). The change in pH indicates the process of biodegradation of organic matter performed by bacteria. The pH value at the beginning of the degradation process will be high compared to other treatments. The high pH value at the beginning indicates that the bacteria is starting to degrade aquaculture wastewater. Dissolved oxygen levels in treatment tanks tend to be low because organic matter processed by bacteria in aerobic way produces CO_2 and methane, and the output is in the form of sulfides and hydrogen. All of these gases require oxygen as so it does not damage the environment (Doraja *at al*., 2012). According to Prayogo *et al*. (2017), DO values from the treatment of adding various bacteria concentrations tend to be lower than the initial DO values before the addition of bacteria. The existence of metabolic process by bacteria that requires oxygen decreases the DO value in wastewater. According to Salimin and Rachmadetin (2011), if bacteria take a longer time to reproduce, the biomass and the need of oxygen will increase. This process decreases the dissolved oxygen level. So that the dissolved oxygen level in the tank decreases along with the longer incubation time. However, for facultative anaerobic bacteria, the bacteria are still possible to grow and develop even the oxygen concentration is low. Facultative anaerobic bacteria can live with or without oxygen (Fathoni *et al.,* 2015). Bacteria require a minimum of 2 mg/L of dissolved oxygen in the respiration process; oxygen is needed by microorganisms to oxidize organic pollutants into carbon dioxide (CO_2) and water (H_2O) (Adrianto, 2018).

Carbon dioxide is the result of organic matter reform by bacteria. Organic matter is used by bacteria as a source of nutrient for growth and replacing new cells. Organic matter will be reformed by certain bacteria that have cellulolytic, proteolytic, lipolytic, and amylolytic characteristics, this will form acetyl-CoA and be in the Kreb cycle. The result of the Kreb cycle is adenosine (ATP) and the waste product is carbon dioxide (Lay *et al.,* 2003). Carbon dioxide in the public waters is then absorbed by aquatic organisms such as phytoplankton and aquatic plants in the process of photosynthesis (Panggabean and Prastowo, 2017). An increase in CO_2 level in each of these treatments is likely due to the process of organic matter reform by bacteria. If the organic matter decreases continuously, the CO_2 level will increase because the final result of organic matter degradation is in the form of CO_2 and H_2O (Supriyantini *et al.,* 2017).

CONCLUSION

Pertaining to the results of this study, it can be concluded that the addition of attachment media and bacterial consortium could decrease the organic matter in waste water form *Sangkuriang* catfish aquaculture up to 96% after 120 hours. The addition of 50% and 75% attachment media area decreased the amount of organic matter significantly.

Then, it is suggested that there is a need to utilized carbon dioxide which involves autotrophic organisms such as plants in the management of organic matter.

REFERENCES

Adrianto, R. 2018. Pemantauan Jumlah Bakteri *Coliform* Di Perairan Sungai Provinsi Lampung**.** *Majalah Teknologi Agro Industri (Tegi)*. 10 (1): 1-6.

Al-Gheethi, A.A.S. and Ismail, N. 2014. Biodegradation of Pharmaceutical Wastes in Treated Sewage Effluents by *Bacillus subtilis* 1556WTNC. *Environmental Processes*. 1 (4) : 459-481.

Dewi, Y.S. and Masithoh, M. 2013. Efektivitas teknik biofilter dengan media bio-ball terhadap penurunan kadar nitrogen total. *Jurnal Ilmiah Fakultas Teknik LIMIT'S*. 9 (1) : 45-53.

Doraja, P.H., Shovitri, M. and Kuwytasari, N.W. 2012. Biodegradasi limbah domestik dengan menggunakan inokulum alami dari tangki septik. *Jurnal Sains dan Seni ITS*. 1 (1) : 44-47.

Fathoni, A., Khotimah, S. and Linda, R. 2015. Kepadatan bakteri *Coliform* di Sungai Segedong Kabupaten Pontianak. *Protobiont*. 5 (1) : 20-23.

Fidiastuti, H.R. and Suarsini, E. 2017. Potensi bakteri indigen dalam mendegradasi limbah cair pabrik kulit secara *in vitro*. *Bioeksperimen*. 3 (1) : 1-10.

Fitri, H.M., Hadiwidodo, M. and Kholiq, M.A. 2016. Penurunan kadar COD, BOD dan TSS pada limbah cair industri MSG (monosdium glutamat) dengan biofilter anaerob media bio-ball. *Jurnal Teknik Lingkungan*. 5 (1) : 1-10.

Hadiwidodo, M., Oktiawan, W., Primadani, A.R., Parasmita, B.N. and Gunawan, I. 2012. Pengolahan air lidi dengan proses kombinasi biofilter anaerob-aerob and wetland. *Jurnal Presipitasi*. 8 (2) : 84-95.

Isnawati and Trimulyono, G. 2018. Temperature range and degree of acidity growth of isolate of

indigenous bacteria on fermented feed “fermege” . *Journal of Physics Conference Series*. 953 (1): 1-5.

Ken, R.A., Suprihadi, A. and Raharjo, B. 2019. Biodegradasi Senyawa Hidrokarbon Oleh Strain *Bacillus cereus* (VIC) Pada Kondisi Salinitas Yang Berbeda. *Jurnal Biologi*. 4 (3) : 62-71.

Khairul, 2017. Pemberian dosis probiotik berbeda terhadap kelulushidupan benur udang windu (*Penaeus monodon* Fabricius). *Jurnal Nukleus*. 3 (1) : 25-29.

Lay, B. W. 1994. *Analisis Mikroba di Laboratorium*. Raja Grafindo Persada: Jakarta. 168 hlm.

Lay, Jiunn-Jyi, Kuo-Shuh, Fan, J. Chang and Chia-hung Ku, 2003. Influence of chemical nature of organic wastes on their conversion to hydrogen by heat-shock digested sludge. *Internasional Journal of Hydrogen Energy*. 28 : 1361-1367.

Manengkey, H.W.K. 2010. Kandungan bahan organik pada sedimen di perairan Teluk Buyat dan sekitarnya.*Jurnal Perikanan dan Kelautan Tropis*. 6 (3) : 114-119.

Prayogo, F.A., Suprihadi, A. and Raharjo, B. 2017. Microbial Fuel Cell (Mfc) Menggunakan Bakteri *Bacillus Subtilis* Dengan Substrat Limbah Septic Tank Serta Pengaruhnya Terhadap Kualitas Limbah. *Jurnal Biologi*. 6 (2) :17-25.

Salimin, Z. and Rachmadetin, J. 2011. Denitrifikasi Limbah Radioaktif Cair Yang Mengandung Asam Nitrat Dengan Proses Biooksidasi. Prosiding Seminar Nasional Teknologi Pengelolaan Limbah IX. Pusat Teknologi Limbah Radioaktif-BATAN Fakultas Teknik Universitas Sultan Ageng Tirtayasa. 149-158.

Sari, T. A., Atmodjo, W. and Zuraida, R. 2014. Studi bahan organik total (BOT) sedimen dasar laut di perairan Nabire, Teluk Cendrawasih, Papua. *Jurnal Oseanografi*. 3 (1): 81-86.

Septiani, N., Maharani, H.W. and Supono, 2014. Pemanfaatan bioflok dari limbah budidaya Lele Dumbo (*Clarias gariepinus*) sebagai pakan Nila (*Oreochromis niloticus*). *E-Jurnal Rekayasa dan Teknologi Budidaya Perairan.* 2 (2) : 267-272.

Sholihati, A.M., Baharuddin, M. and Santi, 2015. Produksi dan uji aktivitas enzim selulosa dari bakteri *Bacillus subtilis*. *Al-Kimia***.** 3 (2) : 78-90.

Supriyantini, E., Soenardjo, N. and Nurtania, S.A. 2017. Konsentrasi Bahan Organik Pada Perairan Mangrove Di Pusat Informasi Mangrove (PIM), Kecamatan Pekalongan Utara, Kota Pekalongan. *Buletin Oseanografi Marina*. 6 (1) : 1-8.

Triyatmo, B. 2002. Kualitas and kesuburan air budiday Lele Dumbo (*Clarias gariepinus*) dengan bolume pergantian air berbeda. *Jurnal Perikanan UGM*. 4 (2) : 15-21.