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Microbubble Technology to Improve Growth of Catfish (*Clarias* sp.)

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Abstract: Catfish (*Clarias* sp.) is one of the economically important freshwater fish that has been widely cultivated both traditionally and intensively. Catfish has many advantages such as fast growth, resistance to disease, and can live in water conditions that are low in oxygen content. The use of microbubble technology is expected to support the performance of catfish farming with a biofloc system. With the application of this technology, it is hoped that the oxygen supply from micro-sized air bubbles will increase. Because the diameter of the air bubble is less than 50 µm, it is expected to last a long time in the water and can spread horizontally so that it can be utilized optimally by catfish and biofloc. The purpose of this study was to evaluate the effectiveness of microbubble technology on the growth performance of catfish. The research method used a completely randomized design, with 4 treatments and 3 replications. The variables measured during the study included survival rate, length and weight growth, specific growth rate, feed conversion ratio (FCR), and water quality including temperature, dissolved oxygen (DO), pH, ammonia (NH_3), nitrite (NO^{2-}), nitrate (NO^{3-}), oxygen consumption rate (OCR), and total organic matter (TOM).

Keywords: Catfish; Growth; Microbubble

Introduction

Catfish (Clarias sp.) is one of the economically important fresh water fish that has been cultivated both traditionally and intensively. Catfish have many advantages such as faster growth, disease resistance and can live in low oxygen water conditions. As high market demand increases, various efforts to increase the production of catfish farming are increasingly being carried out to support fish growth (Tasyah et al., 2020). One of them is cultivating catfish using the biofloc system. When compared to conventional catfish farming, biofloc technology is able to show better feed conversion performance (Rusherlistyani et al., 2017). The feed conversion ratio for catfish farming using the biofloc system is 0.8 compared to conventional systems which reach 1.1 (Rizal et al., 2018). According to Wulandari et al. (2020), the catfish survival rate of the biofloc system also showed better results than the conventional system.

Biofloc technology must be supported by the performance of heterotrophic bacteria in converting ammonia into microbial biomass which forms aggregates called biofloc to be consumed by cultivated biota (De Schryver et al., 2008). The biofloc system has a very high oxygen demand because the biofloc and biofloc are in the same water. So that when biofloc aggregates are high, the amount of oxygen used by biofloc can exceed that used by cultivated biota (Kuhn & Lawrence, 2012). In the application of biofloc system catfish farming, dissolved oxygen is produced from the aeration unit. The aeration unit creates movement and circulation of water in the container which indirectly affects the formation of biofloc (Crab et al., 2012).

The air bubbles produced by the aeration unit are 200 µm in size so they don't last long in the water which

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results in dissolved oxygen concentrations tending to stagnate. Microbubble technology is a technology that can produce micro air bubbles with a diameter of less than 100 µm. According to Agarwal et al. (2011), the working principle of a microbubble generator is to break up large diameter particles into small diameter micro-sized particles (10-50 µm) which are influenced by air pressure and water discharge. Endo et al. (2008) in their research stated that the application of a microbubble generator can efficiently supply oxygen for aquaculture activities and can increase dissolved oxygen levels. Micro bubbles with a diameter of less than 50 µm will have low buoyancy so they can last a long time in aquaculture waters and also have high surface tension so that they can spread horizontally in the water (Tsuge, 2015).

Microbubble is a newly developed technology that has a positive effect on the growth and survival of aquatic biota. The use of microbubble technology is expected to support the performance of biofloc catfish farming. With the application of this technology, it is hoped that the supply of oxygen from micro-sized air bubbles will increase so that catfish and biofloc can be utilized optimally. The purpose of this study was to evaluate the effectiveness of microbubble technology on the growth performance of catfish. This research is expected to be useful for farmers in applying microbubble technology to obtain optimal catfish growth.

Method

Time and Location

This research was conducted for 45 days from August 2021 to September 2021. The research was carried out at the Ponds and Aquaculture Laboratory, Department of Fisheries and Marine Sciences, University of Mataram. Analysis of water quality parameters was carried out at the Bioecology Laboratory and Aquaculture Laboratory, Department of Fisheries and Marine Sciences, University of Mataram.

Research Design

The study was designed using a randomized design with three treatments and four replications, namely: Treatment A: Maintenance of catfish without aeration, Treatment B: Maintenance of catfish using a conventional aerator, Treatment C: Maintenance of catfish using MBG (microbubble generator).

This research refers to Ratulangi et al. (2022). The preparations made in the initial research were making a recirculation system, and installing a microbubble generator (MBG) in 3 tanks, installing aerators in 3 tanks, and the other 3 tanks were not given aeration. The cleaned vessel is filled with water from the drilled well and the water quality is measured at the water source. The recirculation system and pump for MBG were run, with each tank filled with approximately 100 L of water. The volume and discharge of water were maintained in the same condition from the beginning of the study to the end of the study.

The fish used came from Batu Kumbung Fish Fry Center, West Lombok. As many as 50 fry were spread in each vessel with a size of 10-12 g/fish. Before being stocked, the fish were reared in ponds for one week, then the fish were randomly spread in maintenance tanks and acclimatized for one week. During the first stage of the maintenance process, the feed given is in the form of commercial feed. Feeding was carried out ad libitum 3 times a day.

Variables measured during the study included survival rate, weight growth, length growth, specific growth rate, feed conversion ratio (FCR), and water quality. Measurements of fish length and weight were carried out by sampling every two weeks as many as 25 fish (50%), except at the end of the study all fish were measured for length and weight.

Survival Rate

The formula used to determine the survival rate according to Ronald et al. (2014) are as follows:

$$SR = \frac{Nt}{No} \times 100\% \quad (1)$$

Note:
SR = Survival rate (%)
Nt = Number of fish at the end of experiment
No = Number of fish at the start of experiment

Weight Growth

Weight growth according to Asma et al. (2016), calculated by the formula:

$$W = Wt - Wo \quad (2)$$

Note:
W = Weight growth (g)
Wt = Final fish weight (g)
Wo = Initial fish weight (g)

Length Growth

Length growth according to Asma et al. (2016), calculated by the formula:

$$L = Lt - Lo \quad (3)$$

Note:
L = Growth in length (cm)

Lt = Final fish length (cm)
Lo = Initial fish length (cm)

Specific Growth Rate

The formula used to measure specific growth according to Ronald et al. (2014), are as follows:

$$SGR = \frac{\ln Wt - \ln Wo}{t} \times 100\% \quad (4)$$

Note:
SGR = Specific growth rate (% per day)
Wt = Final fish weight (g)
Wo = Initial fish weight (g)
t = Maintenance time (days)

Feed Conversion Ratio

Feed Conversion Ratio (FCR) according to Ronald et al. (2014) can be calculated by the formula:

$$FCR = \frac{F}{((Wt + D) - Wo)} \quad (5)$$

Note:
FCR = Feed conversion ratio
Wt = total fish weight at the end of experiment (g)
Wo = total fish weight at initial experiment (g)
D = Total weight of fish that died during experiment (g)
F = Total amount of feed given (g)

Water Quality

Water quality parameters measured during the study period included temperature, dissolved oxygen (DO), pH, ammonia (NH_3), nitrite (NO^{2-}), nitrate (NO^{3-}), oxygen consumption rate (OCR), and total organic matter (TOM).

Statistic Analysis

The data obtained were processed using one way Anova SPSS version 25, followed by the Duncan test with a 95% confidence interval. Furthermore, the results obtained are presented in the form of graphs and tables.

Result and Discussion

Survival Rate

The results of the analysis of variance (ANOVA), the application of microbubble on the survival rate performance of catfish ($p<0.05$) H_0 was rejected. The results of the Survival Rate (SR) in catfish can be seen in Figure 1.

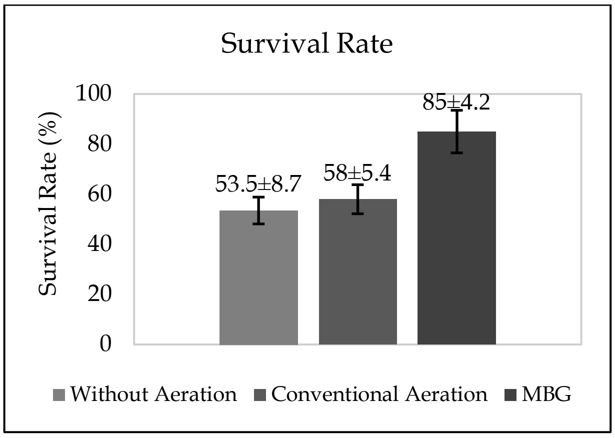

Figure 1. Survival Rate

Figure 1 shows that the treatment without aeration was not significantly different from the conventional aeration treatment, but significantly different from the aeration treatment using microbubbles. The highest survival rate was achieved in the aeration treatment using microbubble with a value of 85 ± 4.2%, while the lowest survival rate was in the treatment without aeration with a value of 53.5 ± 8.7%.

The survival rate (SR) of fish is the percentage of the number of live fish at the end of the study compared to the number of fish at the start of experiment (Fahrizal & Nasir, 2017). Data on the survival rate (SR) of catfish obtained during the study showed that the aeration treatment using microbubble was the best treatment with the highest SR of 85 ± 4.2%, while the lowest SR was obtained in the treatment without aeration of 53. 5±8.7%. The microbubble application had a significant effect on the survival rate of catfish reared for 45 days. This study showed that the survival rate of catfish with microbubble application was the best survival rate when compared to other treatments.

The low survival rate in the treatment without aeration, namely 53.5 ± 8.7%, was caused by several factors. Pratama et al. (2019), stated that fish survival was influenced by good aquaculture management including stocking density, feed quality, water quality, and parasites. One of the important water qualities is the dissolved oxygen content in the water. Microbubbles can supply oxygen in water with small sizes and prevalent. Microbubble aeration treatment is thought to be able to maintain resilience and prevent stress so that the survival rate of catfish is high. Scabra et al. (2021), states that increasing the dissolved oxygen content in water can be done by applying the Micro Bubble Generator (MBG) technology device. The MBG device is a device that functions to produce small diameter air bubbles in water and to optimize the rate and amount of oxygen transfer. Rosariawari et al. (2018), stated that the MBG device using the spherical ball method at a pressure of

13 Psi can increase the dissolved oxygen content in fish culture media up to 12 mg/L.

Another study was also conducted by Firman et al. (2019) about the application of microbubble on tilapia which resulted in a survival rate of above 80%. Microbubble research on tilapia was also carried out by Thongdon-a et al. (2019) which produces an SR of 83% - 96%. Hidayat et al. (2016) also conducted research on the use of microbubble aerators on catfish which resulted in catfish survival rates ranging from 91.67% - 97.22%.

Weight Growth

The results of the analysis of variance (ANOVA), the application of microbubble on the growth performance of catfish weight ($p<0.05$) H_0 was rejected. The results of catfish weight growth can be seen in Figure 2.

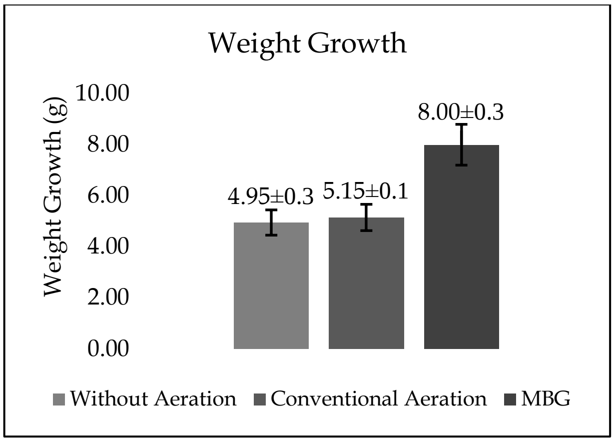

Figure 2. Weight Growth

Figure 2 shows that the treatment without aeration was not significantly different from the conventional aeration treatment, but significantly different from the aeration treatment using microbubbles. The highest weight growth was achieved in the aeration treatment using microbubbles with a value of 8.00 ± 0.3 grams, while the lowest weight growth was in the treatment without aeration with a value of 4.95 ± 0.3 grams.

Growth is a biological process that will take place in the fish's body, growth will occur if the amount of food consumed by fish exceeds the body's maintenance needs. The growth rate is affected by water temperature, feed supply, food composition, space for movement, oxygen supply and metabolic waste products (Pratama et al., 2020). The microbubble application had a significant effect on the absolute weight growth which was maintained for 45 days. The lowest absolute weight growth rate was in the treatment without aeration, which was 4.95 ± 0.3 grams, and the highest growth rate was in the aerated microbubble treatment, which was 8.00 ± 0.3 grams.

The high rate of absolute weight gain in the treatment with microbubbles is thought to be due to dissolved oxygen with micro-sized molecules being able to trigger an increase in appetite. The increase in fish weight is also caused by the quantity of feed given. Increased growth in fish indicates that the amount of feed given is in accordance with the needs of the fish. However, if the feed given exceeds the needs of the fish, the feed is not utilized and is wasted in the waters, causing environmental pollution. Conversely, the decrease in growth in fish indicates that the fish lacks nutrition or even the amount of feed given is very small. Pratama et al. (2020) stated that the recirculation of water in fish rearing serves to help biological balance in water, maintain temperature stability, and help distribute oxygen. Arifin (2016) added that fish need dissolved oxygen for breathing and burning of food which produces energy for swimming, growth, reproduction, etc.

Scabra et al. (2022) reported that the application of microbubble was able to increase the growth and survival of tilapia. Microbubble research on tilapia was also carried out by Thongdon-a et al. (2019) which increased the weight growth of tilapia. Hidayat et al. (2016) also conducted research on the use of microbubble aerators on catfish which resulted in an increase in catfish weight.

Length Growth

The results of the analysis of variance (ANOVA), the application of microbubble on the long growth performance of catfish ($p<0.05$) H_0 was rejected. The results of the long growth of catfish can be seen in Figure 3.

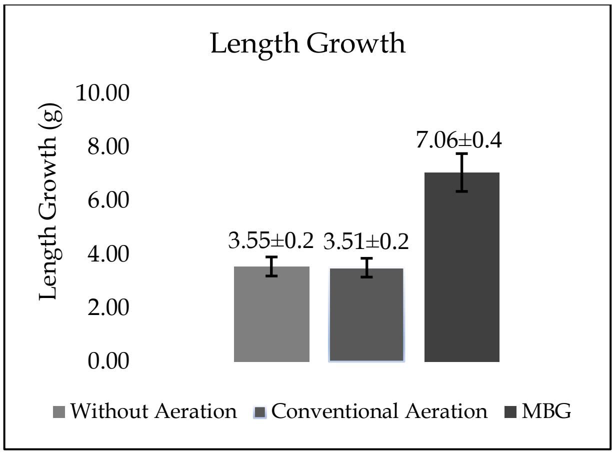

Figure 3. Length Growth

Figure 3 shows that the treatment without aeration was not significantly different from the conventional aeration treatment, but significantly different from the aeration treatment using microbubbles. The highest growth in length was achieved in the aeration treatment using microbubble with a value of 7.06 ± 0.4 cm, while the lowest growth in length was in the conventional aeration treatment with a value of 3.51 ± 0.2 cm.

Growth is a biological process that will take place in the fish's body, growth will occur if the amount of food consumed by fish exceeds the body's maintenance needs. The growth rate is affected by water temperature, feed supply, food composition, space for movement, oxygen supply and metabolic waste products (Pratama et al., 2020). Microbubble application had a significant effect on absolute length growth which was maintained for 45 days. The growth in length of catfish reared using microbubble was higher than the other treatments. The lowest absolute length growth rate was in the conventional aeration treatment of 3.51 ± 0.2 cm and the highest growth rate was in the microbubble aeration treatment of 7.06 ± 0.4 cm.

The high rate of absolute elongation in the treatment with microbubbles was thought to be due to dissolved oxygen with micro-sized molecules being able to trigger an increase in appetite. The increase in fish length is also caused by the quantity of feed given. Increased growth in fish indicates that the amount of feed given is in accordance with the needs of the fish. However, if the feed given exceeds the needs of the fish, the feed is not utilized and is wasted in the waters, causing environmental pollution. Conversely, the decrease in growth in fish indicates that the fish lacks nutrition or even the amount of feed given is very small. Pratama et al. (2020) stated that the recirculation of water in fish rearing serves to help biological balance in water, maintain temperature stability, and help distribute oxygen. Arifin (2016) added that fish need dissolved oxygen to breathe and burn food which produces energy for swimming, growth, reproduction, and others.

Scabra et al. (2022) reported that the application of microbubble was able to increase the growth and survival of tilapia. The microbubble study on tilapia was also carried out by Firman et al. (2019) which increases the length growth of tilapia. Pratama et al. (2020) also conducted research on the use of microbubble aerators on catfish which resulted in an increase in catfish length.

Specific Growth Rate

The results of the analysis of variance (ANOVA), the application of microbubble on the performance of the specific growth rate of catfish ($p<0.05$) H_0 was rejected. The results of the specific growth rate of catfish can be seen in Figure 4.

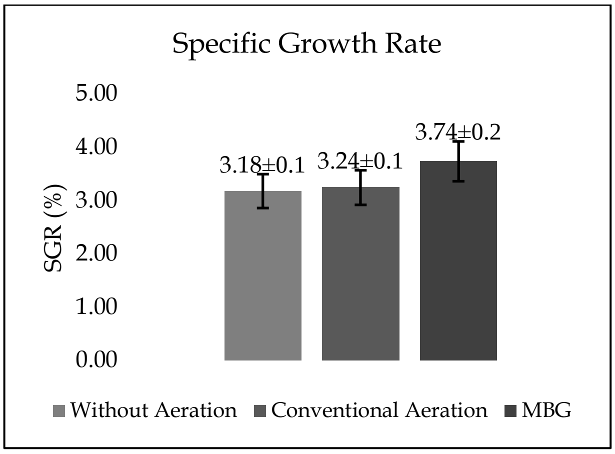

Figure 4. Specific Growth Rate

Figure 4 shows that the treatment without aeration was not significantly different from the conventional aeration treatment, but significantly different from the aeration treatment using microbubbles. The highest specific growth rate was achieved in the aeration treatment using microbubbles with a value of 3.74 ± 0.2%, while the lowest specific growth rate was in the treatment without aeration with a value of 3.18 ± 0.1%.

Growth is a biological process that will take place in the fish's body, growth will occur if the amount of food consumed by fish exceeds the body's maintenance needs. Growth rate is influenced by water temperature, feed supply, food composition, space for movement, oxygen supply and metabolic waste products (Pratama et al., 2020). The microbubble application had a significant effect on the specific growth rate which was maintained for 45 days. The lowest specific growth rate was in the treatment without aeration, namely 3.18 ± 0.1%, and the highest specific growth rate was in the microbubble aeration treatment, which was 3.74 ± 0.2%.

The high specific growth rate in the treatment with microbubble administration is thought to be due to dissolved oxygen with micro-sized molecules being able to trigger an increase in appetite. The increase in fish weight is also caused by the quantity of feed given. Increased growth in fish indicates that the amount of feed given is in accordance with the needs of the fish. However, if the feed given exceeds the needs of the fish, the feed is not utilized and is wasted in the waters, causing environmental pollution. Conversely, the decrease in growth in fish indicates that the fish lacks nutrition or even the amount of feed given is very small. Pratama et al. (2020) stated that the recirculation of water in fish rearing serves to help bioslogical balance in water, maintain temperature stability, and help distribute oxygen. In addition to sufficient feed, water quality in the rearing medium also supports fish growth. Arifin (2016) added that fish need dissolved oxygen to breathe and burn food which produces energy for swimming, growth, reproduction, and others.

Firman et al. (2019) reported that the application of microbubble was able to increase the specific growth rate of tilapia by 1.08% - 3.12%. Microbubble research on koi fish was also carried out by Saputra et al. (2018) which increased the specific growth rate by 1.17% - 2.35%. Hidayat et al. (2016) also conducted research on the use of microbubble aerators on catfish which produced an SGR value of 1.42% - 1.58%.

Feed Conversion Ratio

The results of the analysis of variance (ANOVA), the application of microbubble on the performance of the feed conversion ratio in catfish ($p>0.05$) H_0 is accepted. The results of the catfish feed conversion ratio can be seen in Figure 5.

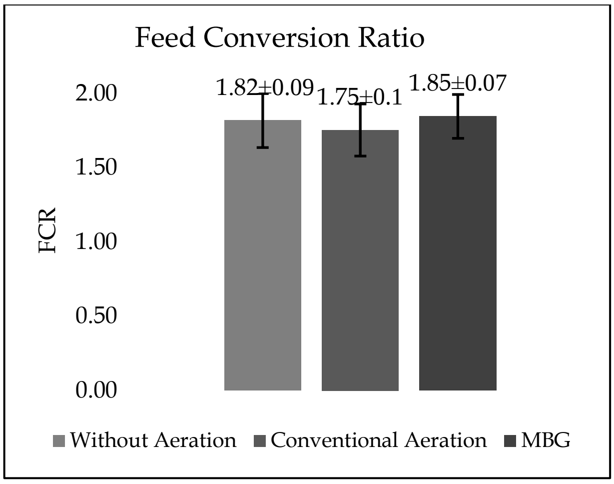

Figure 5. Feed Conversion Ratio

Figure 5 shows the results of all treatments were not significantly different. The FCR value of all treatments was 1.82 ± 0.09 without aeration, conventional aeration was 1.75 ± 0.1, and 1.85 ± 0.07 with microbubble aeration.

The feed conversion ratio is the ratio between the amount of feed given and the weight of the fish fry produced. Feeding in a minimum amount but being able to provide a maximum response to the growth of fish fry is an indication that the feed is of good quality (Anis & Hariani, 2019). Microbubble application had no significant effect with other treatments on the FCR of catfish reared for 45 days. Feed conversion ratio respectively were the treatment without aeration 1.82 ± 0.09, the conventional aeration treatment 1.75 ± 0.1, and the aeration treatment using microbubble 1.85 ± 0.07.

The feed conversion ratio (FCR) is used to determine the efficiency level of the feed used in each treatment. The treatment with the lowest FCR value is the best treatment showing the highest feed efficiency (Anis & Hariani, 2019). A low value of the feed conversion ratio (FCR) indicates that fish are able to efficiently consume feed for their weight growth. A high feed conversion ratio (FCR) value is the opposite of a low FCR. A high FCR value indicates that fish are unable to utilize the food they consume efficiently so their growth is less than optimal.

Even though the FCR values for all treatments were different, the FCR values for all treatments were good for catfish farming activities. This is in line with the opinion of Mardhiana et al. (2017) who argue that the value of the catfish feed conversion ratio ranges from 1.7-2.8. Scabra et al. (2022), stated that the FCR which was relatively good in all of these treatments was also supported by a stable oxygen value from start to finish of maintenance produced by the microbubble device. The optimal oxygen value will support metabolic activity in fish, so that a lot of energy is produced and this energy can be used for growth. When oxygen is low, the energy extracted from feed in the respiration process will not be optimal. The rate of metabolism is closely related to the process of respiration in which this process will extract energy from food molecules which depends on the presence of oxygen.

Water Quality

Water quality has a very important role in supporting the life and growth of catfish. Water quality parameters observed during maintenance can be seen in Table 1.

Tabel 1. Water Quality During Research

Parameter	Treatment A	Treatment B	Treatment C	References
Temperature (°C)	26.2-30.5	26.5-29.3	26.2-30.9	25-30 (Kelana *et al.*, 2021)
Dissolved Oxygen (DO) (mg/L)	6.2-7.3	6.2-7.4	6.3-7.7	>4 (Kelana *et al.*, 2021)
pH	7.5-8.4	7.5-8.4	7.5-8.3	6,5-8,5 (Kelana *et al.*, 2021)
Ammonia (NH_3) (mg/L)	0.06-0.18	0.06-0.18	0.06-0.18	<0,01 (Kelana *et al.*, 2021)
Nitrite (NO^{2-}) (mg/L)	0.02-0.05	0.02-0.05	0.05-0.07	<1 (Kusumawati *et al.*, 2018)
Nitrate (NO^{3-}) (mg/L)	8-9	8-9	7-8	<20 (Adharani *et al.*, 2016)
Oxygen Consumption Rate (mg/L)	7.3-9.2	7.2-9.3	7.1-9.3	1,28-9,55 (Mohamed *et al.*, 2013)
Total Organic Matter (mg/L)	6.4-7.3	6.2-7.1	5.5-6.2	≤30 (Anggraini *et al.*, 2019)

Based on Table 1, it can be seen that the temperature during the study ranged from 26.2°C-30.9°C. Dissolved oxygen (DO) content during the study ranged from 6.2 mg/L-7.7 mg/L. The pH during the study ranged from 7.5-8.4. Ammonia (NH_3) during the study ranged from 0.06 mg/L-0.18 mg/L. Nitrite (NO^{2-}) during the study ranged from 0.02 mg/L-0.07 mg/L. Nitrate (NO^{3-}) during the study ranged from 7 mg/L-9 mg/L. The Oxygen Consumption Rate (OCR) during the study ranged from 7.1 mg/L-9.3 mg/L. Total Organic Matter (TOM) during the study ranged from 5.5 mg/L-7.3 mg/L.

In aquaculture business, water quality is one of the important factors that influence the survival of cultivated fish. Water conditions as a living medium for aquatic biota must be adapted to optimal conditions for the biota being reared (Kusumawati et al., 2018). Parameters measured during the study were temperature, DO, pH, ammonia, nitrite, nitrate, OCR, and TOM.

The temperature during the study was 26.2°C-30.9°C. The range of water quality parameters for grow-out culture is 25°C-30°C. If the maintenance temperature is less than the range (low temperature), it results in low catfish activity and reduced appetite, which will result in slow catfish growth (Kesuma et al., 2019). The dissolved oxygen value obtained in the study was 6.2 mg/L-7.7 mg/L, this DO content was optimal and good for the growth of aquatic biota which is supported by the statement of Kesuma et al. (2019) that the requirement for DO content for growing catfish cultivation is a minimum of 3 mg/L. Kusumawati et al. (2018) added that aquatic organisms need oxygen to burn food for activities, such as swimming, growth, reproduction, and etc. The range of pH during the study was 7.5-8.4. Kesuma et al. (2019) stated that the optimal pH conditions for fish are in the range of 6.5-8.5. (Ayuniar & Hidayat, 2018) added that a pH value of 7-8.5 is an ideal range of values for biological productivity, while a pH value below 4 will be detrimental to aquatic life. Ammonia measurements during the study ranged from 0.06 mg/L-0.18 mg/L. The maximum ammonia content in aquaculture waters for catfish rearing is 0.1 mg/L. Ammonia will have an acute effect at a concentration of 1.0-1.5 mg/L (Kesuma et al., 2019).

Nitrite during the study was 0.02 mg/L-0.07 mg/L. The recommended nitrite level for catfish farming is <1 mg/L (Kusumawati et al., 2018). Excess nitrite compounds in waters will reduce the ability of fish blood to bind oxygen (O_2), because nitrite will react more strongly with hemoglobin which causes a high mortality rate (Pratama et al., 2017). The nitrate value obtained in the study was 7 mg/L-9 mg/L, this nitrate content was in an optimal state and good for the growth of aquatic biota which is supported by the statement of Adharani et al. (2016) that the concentration of nitrate for growing catfish cultivation is a maximum of 20 mg/L. The range of oxygen consumption rate (OCR) during the study was 7.1 mg/L-9.3mg/L. Mohamed et al. (2013) stated that OCR for catfish was in the range of 1.28 mg/L-9.55 mg/L. The catfish showed considerable variation in oxygen consumption rate over the course of the study but no deaths occurred. The level of oxygen consumption can be hypothesized to influence the survival of catfish which may have an effect on growth and hunger resistance. Measurements of total organic matter (TOM) during the study ranged from 5.5 mg/L-7.3 mg/L. The quality standard for safe TOM concentration values is ≤30 mg/L (Anggraini et al., 2019). TOM is all precipitated organic matter (detritus, phytoplankton or other biota excretion) that can be broken down by microorganisms in the waters. But some organic components such as lignin, cellulose and coal which have a high carbon content cannot or are difficult to decompose. These difficult-to-decompose components will cover water areas, shallow waters and can also result in decreased DO concentrations in water (Rustam et al., 2018).

Conclusion

The application of microbubble in catfish farming shows significant growth results compared to without aeration and the use of conventional aeration. In addition, the survival rate of catfish farming using microbubble also showed significant results. However, the feed conversion ratio parameter does not show a significant difference. The water quality during the study using microbubble aeration was also included in the good range for the life and growth of catfish.

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Author Contribution

BDHS, LWAB, and MM collects data and provide research facilities, LMA and SF processes and analyzes data, RIA compiles and prepares articles.

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Conflicts of Interest

The authors declare no conflict of interest.

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