Use of microbubble generator on the growth vannamei shrimp culture

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Abstract. The advanced challenges from the vannamei shrimp cultivation nowadays keep on pushing the fisheries industry on improving its productivity, however, with minimum use of water resource and an efficient land. This research aims to discover the growth and survival rate of vannamei shrimp that is cultivated in a circular tarpaulin pond with a microbubble aeration system. This research shows that microbubble can increase the amount of dissolved oxygen (DO) within the tarpaulin pond, in which the value of DO in the system blower is 3.69 Mg/L and 5.05 Mg/L in the microbubble system. The DO value within the tarpaulin pond with the microbubble system also affects the growth and viability of the shrimp, in which the growth of shrimp cultivated in the microbubble tarpaulin pond is greater (10.16 gr) than those cultivated in the blower pond (8.77 gr). Moreover, microbubble is more efficient on the use of shrimp’s feed provided with the smaller FCR value than the blower group. The application of microbubble in the circular tarpaulin pond with a high density of population can increase the amount of dissolved oxygen and therefore support the growth of aerobic bacteria to prevent air quality degradation in consequence to increase the viability of the shrimp.

1. Introduction

The fishery industry continues to innovate in developing shrimp farming technology as an effort to increase export demand and meet the protein needs of the community, moreover with more efficient use of land and water sources [1]. One of the efforts made to maintain the sustainability of shrimp farming activities is to initiate shrimp farming on narrow land such as utilizing home yards using tarpaulin pond media to maintain the continuity of shrimp farming activities without reducing the target amount of production obtained [2].

The high stocking density can cause water quality problems, especially the availability of oxygen in the water and the accumulation of ammonium from the remaining feed [3]. Some of the advantages of tarp pond shrimp farming include high stocking density, easy installation, maximum shrimp growth, minimal shrimp mortality, easier shrimp harvesting, and more even and maximum oxygen diffusion.
when aeration is added [4]. Under the statement of [5], aeration is a very important factor in shrimp cultivation, especially in ponds with high stocking densities.

A microbubble is a tool that functions to produce small-size air bubbles in the water in consequence of wider oxygen transfer and the rate at which bubbles rise to the surface of the water is much lower than that of macro bubbles [6].

Moreover, the microbubbles produced by the microbubble generator have physicochemical properties that have been widely applied as a tool for wastewater treatment [7]. This study aims to determine the growth and viability of Vannamei shrimp (L. vannamei) in a round tarpaulin pond with a microbubble generator aeration system.

2. Materials and Methods

2.1. Vannamei Shrimp (Litopenaeus vannamei)
The shrimp used was Vannamei shrimp (L. vannamei) PL 12 with an average weight of 0.02 gr. Shrimp larvae were reared in a round tarpaulin pond with a diameter of 3 m, a volume of water of 7.065 m³, a density of shrimp’s population of 500 individuals/ m³ with a water salinity of 20 ppt. The study was designed with 2 (two) treatments or applied studies, namely two maintenance basins where one tarp pool is equipped with a Microbubble Generator with a power capacity of 370 Watt, while the other tub is equipped with a blower generator. Water quality measured in this study were temperature, salinity, TOM, Nitrite, TAN, Alkali, DO, and the water flow. Shrimp are kept for 70 days and fed 3 times a day at 07.00 A.M., 11.00 A.M., and 16.00 P.M with a dose of 5% body weight/day.

2.2. Construction of Circular tarpaulin pond and microbubble installation
The pond construction is made of 6 mm diameter of an iron frame covered with waterproof vinyl plastic with a thickness of 0.03 mm in the shape of a round pond diameter of 3 mm. The tarpaulin pond is installed in an iron frame until it exits the surface of the pond so that when it rains the tarpaulin pond can be protected from the outer landslide. The volume of water used is 7.065 m³; furthermore, the microbubble generator is activated before the plankton growth is carried out. The shape and construction of the pond can be seen in Figure 1 below.

![Figure 1. Design of the Tarpaulin pond and the installation of microbubble](image-url)
2.3. Plankton growth
Plankton growth was carried out using Ceraclean with a composition of 40% silicate and 25% Ca. The dosage used is 20 ppm/week, besides that, it is also used Probiotics (Super Marine) innovative products from Polytech KP Sidoarjo with a usage dose of 5 ppm/day.

2.4 Measurement Parameters
2.4.1 Mean Body Weight (MBW)
*Means Body Weight* (MBW) is defined as the average weight of shrimp during the sampling process. MBW can be calculated by following formula:

\[
MBW = \frac{\text{Shrimp weight (g)}}{\text{Total number of shrimp (a tail)}}
\]

2.4.2 Biomass
Biomass = the average of shrimp’s weight × population

2.4.3 Feed Conversion Rate (FCR)
*Feed Conversion Rate* is the ration between the weights of feed that has been given in the cycle period with the total weight (biomass) produced during the sampling. FCR can be calculated based on the following formula:

\[
FCR = \frac{F}{(BT + BD) - BO}
\]

Information:
- \(F\) = Amount of feed (gr)
- \(BT\) = Final weight of the shrimp (gr)
- \(BD\) = Dead shrimp weight (gr)
- \(BO\) = Initial Weight of the Shrimp (gr)

2.4.4 Survival Rate (SR)
*Survival Rate* (SR) / viability is the survival rate of shrimp compared to the total density of shrimp expressed in percent. The SR calculation formula is as follows:

\[
SR = \frac{NT}{NO} \times 100\%
\]

Information:
- \(SR\) = Survival Rate of shrimp (%)
- \(NT\) = Final number of shrimp during the experiment (a tail)
- \(NO\) = Initial number of shrimp during the experiment (a tail)

2.5 Data Analysis
The obtained data from the research results are presented in tabular form. The data of the shrimp growth and water quality were statistically analyzed to find out the difference between blower
treatment and microbubble, one-way variance analysis (ANOVA) T-test with a significance level of 95% (P<0.05).

3. Result and Discussion

3.1 The Growth of Vannamei Shrimp

Means Body Weight of vannamei shrimp was carried out every seven days by taking 10% shrimp samples from each tarpaulin pond. The results of the growth sampling obtained are MBW 4.145 gr; Biomass 13.18 Kg, SR 93%, FCR 1.4 for the blower system pond and MBW 4.67 gr, biomass 15.4 Kg, SR 95.2%, and FCR 1.25 for the microbubble system pond (Table 1).

| AGE weeks | Blower | Microbubble |
|-----------|--------|-------------|
|           | MBW (gram) | SR (%) | Biomass (Kg) | FCR | MBW (gram) | SR (%) | Biomass (Kg) | FCR |
| 1         | 0.65 | 100 | 2.275 | 1.4 | 0.65 | 100 | 2.275 | 1.4 |
| 2         | 1.2  | 99  | 4.19  | 1.4 | 1.3  | 99  | 4.504 | 1.4 |
| 3         | 1.7  | 96  | 5.86  | 1.5 | 2.1  | 96  | 7.06  | 1.4 |
| 4         | 2.7  | 96.57 | 9.12  | 1.47 | 3.03 | 94  | 9.99  | 1.47 |
| 5         | 3.5  | 93  | 11.46 | 1.5 | 3.8  | 94  | 12.53 | 1.56 |
| 6         | 4.2  | 93  | 13.69 | 1.54 | 4.6  | 94  | 15.13 | 1.53 |
| 7         | 5.1  | 93  | 16.61 | 1.49 | 5.4  | 94  | 17.77 | 1.52 |
| 8         | 6.2  | 93  | 20.18 | 1.44 | 7.09 | 94  | 23.29 | 1.37 |
| 9         | 7.4  | 88  | 22.94 | 1.44 | 8.6  | 94  | 28.2  | 1.31 |
| 10        | 8.8  | 83  | 25.57 | 1.44 | 10.2 | 93  | 33.27 | 1.25 |

Based on the table above and the statistical analysis, shrimp growth showed that there was a difference between the shrimp in the blower system tarpaulin pond (8.77 gr) and the shrimp in the microbubble system tarpaulin pond (10.169 gr). Besides, the FCR in microbubble system tarpaulin ponds with an FCR value of 1: 1.25 where it takes 1.25 Kg of feed to produce 1 Kg of shrimp meat. While in the tarp pool with the blower system, the FCR value is 1: 1.4.

The growth of vannamei shrimp is greatly influenced by the availability of appropriate feed, both in terms of quality and quantity. Giving excessive amounts of feed can increase production costs and cause excess feed residue which will have an impact on decreasing water quality, thereby affecting growth [8]. The calculation results also showed that the growth rate of vannamei shrimp in tarpaulin ponds with microbubble application was higher when compared to the blower system of vannamei shrimp cultivation.

Giving the right balanced amount of feed will provide optimum growth and controlled waste [9]. The application of microbubble can be concluded to be more efficient in utilizing feed so that it can press down waste product released into the aquatic environment. Excess amount of feed spread will worsen water quality and cause ammonia and nitrite which are not good for shrimp; Oxygen levels will also be reduced because they are used to decompose organic matter [10].

3.2 Water Quality

Water quality monitoring is conducted every seven days according to the measured parameters. Temperature observations were carried out in the afternoon at 16.00 P.M and at night at 20.00 P.M.
The average value of water quality observations (Tables 2 and 3) in the tarp pond with the blower system is 28.9 °C, salinity 20 ppm, Nitrite 0.024 ppm, TAN 0.029 ppm, total alkalinity 180.9 ppm, DO 3.69 Mg/L, and water flow 0 m/sec. Meanwhile, opposed to the previous pond, the average value of water quality parameters for tarpaulin ponds with microbubble systems is 28 °C, salinity level 20 ppm, TOM level 72.2 ppm, TAN level 0.031 ppm; Nitrite level 0.027 ppm; Total Alkalinity 185 ppm; DO (Dissolved Oxygen) level 5.05 Mg/L, and the water flow of 0.29 m/sec.

| Age (Weeks) | Temperature | Salinity | TOM | Nitrite | TAN | Alkalinity | DO | Current |
|-------------|-------------|----------|-----|---------|-----|------------|----|---------|
| 1           | 29          | 20       | 85  | 0.01    | 0.02| 190        | 3.1| 0       |
| 2           | 29          | 20       | 80  | 0.01    | 0.02| 197        | 3.3| 0       |
| 3           | 29          | 20       | 82  | 0.01    | 0.01| 165        | 3.0| 0       |
| 4           | 29.2        | 20       | 75  | 0.02    | 0.04| 197        | 3.3| 0       |
| 5           | 28.5        | 20       | 70  | 0.03    | 0.03| 200        | 4.2| 0       |
| 6           | 28          | 20       | 82  | 0.03    | 0.04| 200        | 4.0| 0       |
| 7           | 29.5        | 20       | 65  | 0.03    | 0.03| 170        | 4.0| 0       |
| 8           | 29          | 20       | 60  | 0.02    | 0.02| 165        | 4.0| 0       |
| 9           | 29          | 20       | 45  | 0.04    | 0.04| 160        | 4.0| 0       |
| 10          | 29          | 20       | 45  | 0.04    | 0.04| 165        | 4.0| 0       |

Table 2. Observation of Tarp Pond Water Quality Blower System

| Age (Weeks) | Temp. | Salinity | TOM | Nitrite | TAN | Alkalic | DO | Current |
|-------------|-------|----------|-----|---------|-----|---------|----|---------|
| 1           | 29    | 20       | 85  | 0.01    | 0.02| 190     | 4.5| 0.35    |
| 2           | 29    | 20       | 80  | 0.01    | 0.02| 197     | 4.6| 0.29    |
| 3           | 28.5  | 20       | 86  | 0.02    | 0.03| 198     | 5.2| 0.35    |
| 4           | 29    | 20       | 80  | 0.02    | 0.03| 200     | 5.3| 0.34    |
| 5           | 29    | 20       | 70  | 0.02    | 0.02| 200     | 5.2| 0.35    |
| 6           | 28.5  | 20       | 70  | 0.03    | 0.03| 200     | 4.9| 0.29    |
| 7           | 29    | 20       | 65  | 0.04    | 0.04| 160     | 4.8| 0.22    |
| 8           | 29    | 20       | 65  | 0.04    | 0.04| 160     | 5.4| 0.29    |
| 9           | 29    | 20       | 45  | 0.04    | 0.04| 160     | 5.4| 0.28    |
| 10          | 20    | 20       | 45  | 0.04    | 0.04| 165     | 5.2| 0.35    |

Table 3. Observation of tarp Pond Water Quality Microbubble System

The table above, generally shows that the average value of the water quality between the tarp pond with the blower system and the tarpaulin pond with the microbubble system did not experience differences in the values for parameters of temperature, salinity, TOM, nitrite, TAN level, total alkalinity, TBC, and TVC. Statistical analysis using T-test showed that the average DO content in the tarpaulin pond with the blower system and the tarpaulin pond with the microbubble system was significantly different or p<0.05.

The difference in water quality parameters between the two can be seen from the DO and the water flow (current) values. The DO value and current in the tarp pool with the blower system is 3.69 Mg/L with a current speed of 0 m/sec. However, in the microbubble system tarpaulin pond the DO value and current speed was higher, respectively 5.05 Mg/L and the current speed was 0.299 m/s.
Oxygen is a water quality parameter that plays a direct role in the metabolic process of aquatic biota, especially shrimp. The availability of dissolved oxygen in water bodies is a supporting factor for the growth, development, and life of shrimp [11]. Research by [12] shows that microbubbles are able to supply oxygen to cultivation activities efficiently (6.4 Mg/L DO). The macrobubbles produced by the blower have high buoyancy so they tend to rise up faster to the surface. Meanwhile, the microbubbles produced by the microbubble generator have small buoyancy so that oxygen will slowly rise to the surface and remain in each layer of water for a long period of time [13]. In addition, the tarpaulin pond with a microbubble system is able to create a water currency of 0.299 m/sec, so this shows that microbubbles are able to spread across the surface of the water.

Oxygen is a water quality parameter that plays a direct role in the metabolic process of aquatic biota, especially shrimp. The availability of dissolved oxygen in water bodies is a supporting factor for the growth, development, and life of shrimp [14]. The high DO content in microbubble tarpaulin ponds supports the presence of aerobic bacteria which can accelerate the breakdown of organic matter deposited in the bottom of the pond [15].

4. Conclusion
The microbubbles generated by the microbubble generator have low buoyancy, so they can last a long time in the tarpaulin pond of shrimp rearing. This causes the DO content in the tarpaulin pond with a microbubble system (5.05 Mg/L) and causes the creation of airflow so that oxygen in the tarpaulin pond waters with a microbubble system is greater. Dissolved oxygen plays a role in water treatment in shrimp tarpaulin ponds directly and can accelerate shrimp growth. The use of microbubble can be said to be more effective in utilizing feed and preventing cannibalism in shrimp, which in turn can increase the shrimp survival rate.

5. References
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