Comparative Study of Growth Performance of Three Tilapia Strain in Intensive Culture System

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Abstract. High stocking density is an important factor in cultivation to increase the eficency if fish farming for nutrition requirements. High stocking density generally impact on fish physiology and growth performance. However, many studies on individual fish have different growth perfromance from different strain. Some technology had been developed to optimize tilapia production in high stocking density. This study aimed to determine the growth performance of three different strain of tilapia (red tilapia, nirwana tilapia, and jatimbulan tilapia) reared in 20 m^3 of round tarpaulin with additional of microbubble generator. This study used an intensive system with 100 fish/m^3 of stocking density. The results showed that the microbubble generator was able to increase the carrying capacity of water quality such as increasing dissolved oxygen in the waters, temperature and pH. The high content of dissolved oxygen in the water significantly increasing the growth of tilapia. The highest weight was found in red tilapia with a final weight of 199.56 ± 0.05 gr, followed by Nirwana tilapia with 176.59 ± 0.10 gr, and Jatimbulan tilapia with 153.91 ± 0.06 gr. In addition, the high content of dissolved oxygen in the waters also affect the rearing period of tilapia.

1. Introduction

The world's population will increase to 8 billion in 2023 and Indonesia will become the 4th country in the world with the highest population [1]. The increaments is in line with the increasing of feed nutritional, especially derived from fishery products. Tilapia is a candidate species to complete food requirements with high protein and folic acid content. In 100 grams of tilapia there are around 128 calories, 0 grams of carbohydrates, 26 grams of protein, 3 grams of fat, as well as a number of vitamins B3, B12, potassium and phosphorus [2].

Indonesia has developed an intensive tilapia farming system. However, the high stocking density in intensive cultivation affected new problems such as reduced water quality and unsuitable cultivation media [3]. This can affect the growth and productivity of farmed fish [4]. The high stocking density in a cultivation medium must be accompanied by the addition of oxygen. One of the fisheries technologies that has been developed to increase the oxygen content of the waters is the microbubble generator [5]. Microbubbles are capable to produce air bubbles with a diameter of <200 µm, so that is more stable in the waters [6]. In addition, the microbubble generator is believed to be able to stimulate of aerobic bacteria and able to degrade waste products in the rearing medium water [7].

Tilapia (*Oreochromis niloticus*) is the most widely cultivated species and has the potential to improve the quality of its cultivated stock [8]. Several species of tilapia such as red tilapia, jatimbulan tilapia, and nirwana tilapia have been successfully developed in Indonesia through cross-breeding. Some of these tilapia species also have their own uniqueness - each starting from the growth rate, adaptation level, spawning time, and maintenance or enlargement period. This study aims to determine the growth rate, level of adaptation, and survival rate of red tilapia; jatimbulan tilapia; and nirwana tilapia through intensive stocking density with the addition of a microbubble aeration system.

2. Methods

2.1. Pond Construction

The pond used in this study is a round tarpaulin with a diameter of 5 m and a capacity of 20 m^3. The tub construction is made conical in the middle of the base as a central drain which is connected directly to the sewer. Each tub is equipped with two microbubble generators (0.5 Hp) on each side. Water changes are carried out every two weeks by removing 15 percent the water from the drain and replacing it with new water.

2.2 Test Samples

There are three types of tilapia (*O. niloticus*) (red tilapia, jatimbulan tilapia, and nirwana tilapia) taken from hatchery in Pasuruan, East Java. A total of 6000 red tilapia, nirwana tilapia and jatimbulan tilapia with a length of ±5cm were stocked into 3 ponds with a stocking density of 100 individuals/m^3 or 2000 individuals per pond. The average weight of tilapia in this study was red tilapia 5.54 ± 0.02 gr, nirwana tilapia 5.23 ± 0.01 gr, and jatimbulan tilapia 5.49 ± 0.01 gr. During the maintenance period, 0.5 ppm of probiotic was added once every 2 weeks. In addition, siphoning conducted every day from the central drain. The addition of new water is carried out in 2 weeks by 15% of the total volume.

2.3 Feed Management

Each pond was given the same feed of pellets produced by PT. CP Prima with protein content (18%), fat (8%), fiber (8), ash content (10%), and water content (12%). The size of the feed is adjusted to the fish's mouth opening. During the rearing period, the fish were given pellet feed of 5% of the total biomass/day twice, in the morning (08.00 WIB) and afternoon (16.00 WIB).

2.4. Growth Performance, Survival Rate, and Feed Efficiency

Growth Performance (absolute weight gain, survival rate, daily growth rate, and feed conversion rate (FCR) are taken every 2 weeks. Absolute weight gain (g/fish) is the total growth of fish during the rearing period, which is calculated by the formula:

$$\text{Absolute weight gain (g/fish)} = \text{final body weight} - \text{initial body weight}$$

Specific growth rate (gr) is used to determine the estimated average growth of fish every day, which is calculated by the formula:

$$\text{SGR (gr)} = ((\text{In(final average weight)} - \text{In(initial average weight)})/\text{duration of experience})*100$$

Weight gain (%) is the addition of fish weight during the rearing period which is calculated by the formula:

$$\text{WG (gr)} = ((\text{final mean weight} - \text{initial mean weight})/\text{initial mean weight})*100$$

Food conversion rate (FCR) is used to determine the efficiency of the feed used during the rearing period, calculated by the formula [9] :

$$FCR = F / [(Wt + d) – W0]$$

Where:
F: the amount of feed consumed
Wt: fish biomass at the end of the study (g)
W0: fish biomass at the beginning of the study (g)
d: Biomass of fish which died during the study (g)

Survival rate (%) is defined as the ratio between the number of fish harvested and the fish stocked during the rearing period and is calculated by the formula [10]:

$$SR (\%) = (\text{Number of fish harvested} / \text{Number of Fish Stocked}) \times 100$$

2.5. Water Quality Measurement
Water quality data such as temperature, pH and dissolved oxygen are measured every day at 09.00 am using the Sera Test kit.

2.6. Data Analysis
Water quality data were analyzed descriptively. Meanwhile, data on growth, survival rate, and absolute weight gain were analyzed using one way analysis of variance (ANOVA). If there is a significant difference in each pond, the analysis is continued using Duncan's test with a significant level of 95%.

2.7. Research Ethics Using Animal Experiments
This study was in accordance with the National Ethical Guidelines for the Use of Experimental Animals which fulfils the basics of research ethics (11):
- Respect: respecting experimental animals as living beings, not as inanimate objects.
During rearing, fish are conditioned in an appropriate environment to meet their physical and psychological needs, including temperature, water pH, water quality, and sufficient space to move. Feeding is balanced and appropriate to the nutritional needs of the fish to ensure optimal health and growth. Good handling to avoid stress and regular health checks.
- Benefeciary: beneficial to humans & other creatures.
When keeping fish, make sure we pay attention to their welfare by using good husbandry methods. Raise public awareness about the importance of fish conservation and habitat protection through education programmes.
- Justice : be fair in the use of experimental animals
Ensure that the use of fish as experimental animals is strictly necessary to achieve research objectives that are important for the advancement of science and human welfare. Conduct testing procedures that minimise suffering and stress to the fish as much as possible. Use testing methods that do not result in excessive suffering or unnecessarily invasive procedures.

The research did not require approval from the ethics committee/review board because the research was in accordance with national guidelines for using animal experiments. The research has taken into account animal welfare, research ethics and protection of research subjects.

3. Results and Discussion

3.1. Growth Performance
During the rearing period, several growth parameters were measured to evaluate the growth rate of each tilapia species (red tilapia, nirwana tilapia and jatimbulan tilapia). The results of the analysis of

absolute growth in length and weight as well as survival and feed efficiency values after 12 weeks of rearing are presented in table 1.

Table 1. Growth Rate, Survival Rate dan Feed Efficiency

Parameters	Strain		
	Red Tilapia	Jatimbulan Tilapia	Nirwana Tilapia
Initial length (cm)	8,54 ± 0,44	8,64 ± 0,33	8,67 ± 0,52
Initial Body Weight (g/fish)	5,54 ± 0,02	5,23 ± 0,01	5,49 ± 0,01
Final of length (cm)	24,66 ± 1,86	21,85 ± 0,57	19,77 ± 1,85
Absolute Weight Gain (g/fish)	199,56 ± 0,05	176,59 ± 0,10	153,91 ± 0,06
SGR (gr)	1,43	1,26	1,10
Weight gain (%)	360 ± 20	337,6 ± 48	280 ± 12
SR (%)	95	97	96
FCR	0,90	1,07	1,1

Tilapia (*O. niloticus*) is a tropical fish species with high growth rates, survival rates, and productivity compared to other tropical fish species. Tilapia is also a fish species that easily adapts to its environment and is a fish that consumes natural food in the aquatic environment [12]. In addition, tilapia is also the most widely used consumption fish species for breeding programs [13].

The results of the analysis of the length and weight growth as well as the feed coefficient of the three tilapia strains at the end of the rearing period are presented in Table 1. In general, the length growth values of all strains were relatively similar. The difference in length and weight can be influenced by several factors during rearing including the response of feed and the environment, in this case the availability of dissolved oxygen in the waters. In addition, the high oxygen in the waters also shorten the maintenance time for tilapia until it reaches consumption size.

Table 1 shows that the growth performance of red tilapia was higher than the other two fish strains, while the lowest growth was found in the Nirwana strain. The average weight of red tilapia at the end of the rearing period was 199.56 ± 0.05 g with an average daily growth value of 1.43 grams, weight gain of 360 ± 20%, 95% SR, and 0.9 FCR. This growth value is still higher than red tilapia which is cultivated using the biofloc system, which has an average daily growth value of 0.34 and an SR value of 61% [14]. In addition, red tilapia cultivated in brackish waters has a weight gain value of 391 ± 31%, with an FCR value of 1.07. Research by [15] also shows that the use of microbubble can significantly increase the growth of cultivated fish.

3.2. Weight Gain

The weight gain of tilapia in this study increased significantly ($P < 0.05$) until the twelve week of rearing. Based on the results of the study, it appears that the growth pattern of the three tilapia strains has increased with increasing rearing period (Figure 1). From the beginning of the rearing period to the second week, the pattern of weight gain was relatively same, but differences were seen during the fourth week of rearing period and became more evident at the end of the rearing period.

The highest weight gain was found in red tilapia with a final weight of 199.56 ± 0.05 gr, followed by nirwana tilapia with 176.59 ± 0.10 gr, and jatimbulan tilapia with 153.91 ± 0.06 gr. Red tilapia showed the highest growth rate compared to Nirwana tilapia and Jatimbulan tilapia. The growth of tilapia nirwana in the first week was still low when compared to jatimbulan tilapia. However, the growth of Nirwana tilapia began to grow one level higher than Jatimbulan tilapia in the sixth week onwards. The fastest growth of tilapia in this study occurred at the start of the sixth week.

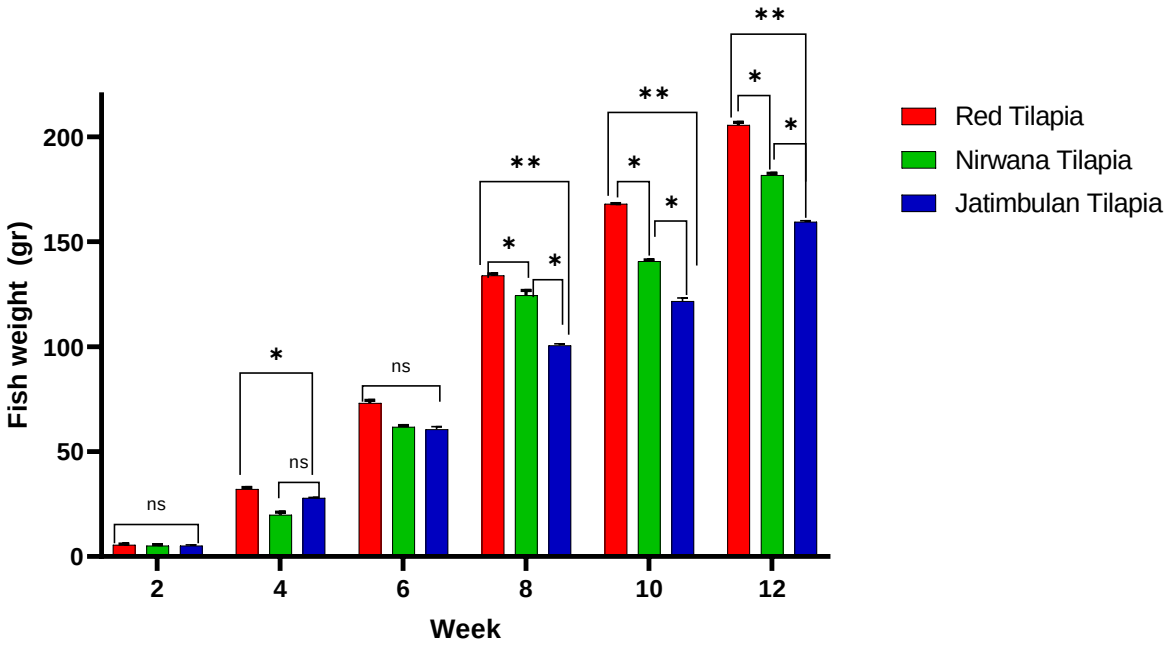

Figure 1. Weight Gain of Different Strain Tilapia in 12 Week

3.3. Specific Growth Rate

The daily average growth of red tilapia showed a higher rate (1.43 gr) compared to Nirwana tilapia (1.26 gr) and Jatimbulan tilapia (1.1 gr). This also shows that the FCR value of red tilapia is lower than the FCR of Nirvana tilapia and Jatimbulan tilapia. Red tilapia is strain developed by Balai Benih Ikan (BBI) Janti in Klaten. Red tilapia is known have a fast growth rate, resistant to disease, and more adaptive, so it can be cultivated in various cultivation media [16]. Red tilapia is a potential candidate for cultivation. Red tilapia showed the better diversity than their parents. Based on the results of statistical analysis on the growth performance between the three strains, the results were not significantly different ($P>0.05$), while the differences in the weight gain characters between tilapia populations. Significant differences were shown between the weight gain of red tilapia compared to jatimbulan tilapia and nirwana tilapia ($P<0.05$).

3.4. Survival Rate

There was no significant difference in the survival rate in this study. The highest survival rate is found in Nirwana Tilapia around 97%. The survival rate of Nirwana tilapia in this study was higher than other tilapia commodities (97%). Nirwana tilapia is one of the superior tilapia species which is the result of a cross between GIFT tilapia and GET tilapia from the Philippines, with a high level of tolerance to environmental changes (Islama et al. 2021). The average weight gain of nirwana tilapia at the end of the rearing period in this study was 176.59 ± 0.10 g, with an average daily growth value of 1.26 grams, a weight gain of 337.6 ± 48%, and an FCR of 1.07. Nirwana tilapia fed gamal leaf meal (Gliricidia sepium) produced an average growth of 0.11 per day [17].

Tilapia with a stocking density of 25 individuals/m^3 has reached the weight gain was 215.63 ± 6.17 grams, while tilapia with a stocking density of 50 individuals/m^3 was 216.46 ± 50.01 grams, and the stocking density of 100 individuals/m^3 was 165.40 grams [18]. This value indicates that the higher the stocking density, the lower the growth of tilapia. The high stocking density for tilapia cultivation can increase the metabolic rate of fish. This is very closely related to the oxygen levels in the waters. Decreasing water oxygen levels will lead to decreased fish appetite, fish health and development [19]. The three strains of tilapia in the study showed higher average weight with a stocking density of 100 individuals/m^3. Microbubble aeration in this study are more stable compared

with blower system. This supports the aquatic environment, higher in oxygen concentration and affected the increament of survival rate more than 40%.

3.5. Water Quality

The water quality parameter values in this study are in accordance with tilapia aquaculture standards. There is no significant difference in the value of water quality parameters in each pond (red tilapia, nirwana tilapia and jatimbulan tilapia) (Table 2). The average temperature in red tilapia ponds was 26.2 ± 0.2°C, jatimbulan tilapia was 26.0 ± 0.1°C and nirvana tilapia was 26.3 ± 0.2°C during the rearing period. The pH value in each pond is 7 – 7.5. Dissolved oxygen content in each pond in this study was 8 ppm in the morning and 7.3 ppm at night.

Table 2. Water Quality in Ponds

Parameters	Comodity		
	Red Tilapia	Jatimbulan Tilapia	Nirwana Tilapia
Temperature (°C)	26,7 – 27,5	26,5 – 27	26,5 – 27,3
pH	7 – 7,5	7 – 7,5	7 – 7,5
DO (mg/l)	7,6 – 8,3	7,5 – 8,2	7,4 - 8

Tilapia is a tropical fish species that is resistant to high temperature changes up to 40 – 42°C. The optimum temperature for the growth and reproduction of tilapia is 26 - 30°C [20]. The temperature of the waters in this study t§ended to be stable and in accordance with the standard temperature for rearing tilapia (26 – 27.5°C). The results of pH measurements in this study were also classified as optimal according to rearing of tilapia. According to [21], the pH value is influenced by the presence of activity and respiration in the cultivation pond. The process of photosynthesis requires carbon dioxide to be converted into monosaccharides by the autotroph group. Respiration that occurs where the increasing concentration of carbon dioxide and affected the decreament of pH value.

Microbubble is a technology that is able to spread oxygen evenly into the waters through the microsized air bubbles it produces. The mechanism of action of microbubbles is by increasing dissolved oxygen levels. Microbubble also has a simpler construction and has better water purification capabilities compared to other technologies [22]. The application of microbubble technology in this study is known to be able to stabilize water conditions in each pond with optimal temperature, pH and dissolved oxygen values for the growth of tilapia.

4. Conclusion

Red tilapia showed a significantly increasing in body weight compared to nirwana and jatimbulan tilapia. The application of microbubble in the intensive system culture of tilapia significantly increasing the growth of tilapia. Microbubble generator is able to increase the carrying capacity of water quality such as increasing dissolved oxygen in the waters, temperature and pH. This study concluded that microbubbles appropriate form water quality management for intensive system culture of red tilapia.

5. Acknowledgments

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