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Different Stocking Density on Water Quality of Red Tilapia (*Oreochormis sp*) in Budikdamber System

Vina Nur Nadiro*, Sri Andayani[2], Maheno Sri Widodo[2], Nurhalisa[1]

[1] Master's Degree Program in Faculty of Fisheries and Marine Science, University of Brawijaya, Malang, East Java, Indonesia.
[2] Department of Aquculture, Faculty of Fisheries and Marine Science, University of Brawijaya, Malang, East Java, Indonesia.

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Corresponding Author:
Vina Nur Nadiro
vinanurnadiro@student.ub.ac.id

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Abstract: The problems of fish and plant cultivation are limited land, decreasing quality and quantity of water for human needs, food sources, and increasing population on earth. Optimization of fish farming with high stocking densities accompanied by high feeding will cause accumulation of organic matter in the culture containers which will worsen the quality of the rearing water which will ultimately have an impact on the physiological conditions, survival and growth of fish. One of the technologies for growing vegetables, fruit and fish farming that has been developed to overcome these obstacles is the Budikdamber system with red tilapia organisms and water spinach plants. The purpose of this study was to determine the quality of water with different stocking densities in the Budikdamber system with water spinach and without water spinach. The experimental design used a factorial complete randomized design with density treatment (A (2 fish/10L), B (4 fish/10L), C (6 fish/10L), D(8 fish/10L) and system (budikdamber with water spinach) (a) and without water spinach (b)). The results showed that temperature parameters ranged from 22.4 - 30.6°C, pH ranged from 6.4 - 8.9, and DO ranged from 1.07 - 16.4 mg/l. Parameters of temperature, pH, and DO are in a range that is not in accordance with optimum conditions (temperature = 25-32°C, pH = 6.5 – 8, and DO ≥3), but can still be tolerated by tilapia so that fish tilapia still survive. Water spinach plants can reduce ammonia so that the ammonia value in the treatment using kale decreased from week 1 to 4 and conversely, for budikdamber without water spinach, it increased from week 1 to week 4. The highest SR value was found in the Ba treatment (4 fish/10 liters) with water spinach is 91.67%.

Keywords: Budikdamber; Stocking Density; Water Quality.

Introduction

The development of growing plants, fruit and fish farming is increasingly faced with various problems such as limited land, decreasing quality and quantity of water resources (Susetya & Zulham, 2018). In line with Nursandi, (2018), which states that the world's issues regarding the increasingly limited quality and quantity of water for human needs, the increasingly limited food sources, and the increasing population on earth.

Optimization of fish farming with high stocking densities accompanied by high feeding will cause accumulation of organic matter in containers. According to Alfia et al., (2013); Adineh et al., (2019); Ofori-Mensah et al., (2018) stated that the accumulation of organic matter (leftover feed and faeces) will worsen the quality of the rearing water which will ultimately have an impact on physiological conditions, survival, and growth of fish (Wedemeyer & Yasutake, 1997).

One of the technologies for growing vegetables, fruit and fish farming that has been developed to overcome these obstacles is the budikdamber system. Budikdamber stands for cultivating fish in a bucket accompanied by vegetables or fruits. Budikdamber became known in 2018-2019 by a lecturer named Juli Nursandi from the Polytechnic Lampung State. Budikdamber adapted the YuminaBumina technique which is a cultivation technique that combines fish and vegetables or fruits (Purnaningsih et al., 2020).

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Budikdamber can be used to cultivate a variety of freshwater fish such as catfish, tilapia, carp, catfish and sepat fish. The plant that is usually used is water spinach. This vegetable was chosen because it has the advantage of being easy to cultivate, cheap, quick to harvest also can improve water quality (Suroso & Antoni, 2017). Red tilapia (*Oreochromis sp*) is one of the fisheries commodities that has developed over time and has high economic value. Tilapia has the characteristics of fast growing, easy to reproduce, has a high ability to adapt, and tastes good meat so that the global market demand is increasing (Ramadayanti et al., 2021).

Based on the explanation above, it is necessary to conduct further research regarding water quality with differences in stocking density of red tilapia (*Oreochromis sp*) in the budikdamber system.

Method

Location and Time of Research

This research was conducted in January 2023 in the fish reproduction laboratory (Faculty of Fisheries and Marine Sciences Brawijaya University) for 28 days.

Materials

The tools used in the research were thermometers, pH meters, DO meters, rulers, scissors, ropes, scales, basins, mini nets, scoopnets, glass plastic, bucket, and wire rope. The materials used in this research were red tilapia use 1000 pf pellet feed, and also water spinach

Experiment Design

The experimental design used a completely randomized factorial design with treatments density (A (2 fish/10L), B (4 fish/10L), C (6 fish/10L), D(8 fish/10L)) and system (with water spinach) (a) and without water spinach (b)). Completely Randomized Factorial Design (RALF) is applied to homogeneous environments that have more than one independent variable (Sudarwati et al., 2019). The experimental layout used in this study can be seen in Tabel 1.

Reasearch Parameters

Parameters measured were water quality which included temperature, pH, and dissolved oxygen (DO), ammonia, and SR (survival rate).

Data Analysis

The data obtained from the observations are presented in the form of tables and graphs. The design used was Factorial Completely Randomized Design. Furthermore, the data obtained were analyzed using Microsoft Exel, Factorial Analysis ANOVA at 95% confidence interval.

Tabel 1. Experimental layout

Density	System	Repetitions		
		1	2	3
A (2 fish/10L)	With water spinach (a)	1Aa	2Aa	3Aa
	Without water spinach (b)	1Ab	2Ab	3Ab
B (4 fish/10L)	With water spinach (a)	1Ba	2Ba	3Ba
	Without water spinach (b)	1Bb	2Bb	3Bb
C (6 fish/10L)	With water spinach (a)	1Ca	2Ca	3Ca
	Without water spinach (b)	1Cb	2Cb	3Cb
D (8 fish/10L)	With water spinach (a))	1Da	2Da	3Da
	Without water spinach (b)	1Db	2Db	3Db

Result and Discussion

Temperature

Measurement of water quality data of temperature is carried out every day in the morning at 04.00 and afternoon at 14.00. Measurement of this parameter is used to determine whether the condition of the rearing optimal for the life of tilapia.

The temperature during the study ranged from 22.4 - 30.6°C. The temperature values obtained during the study were not in accordance with the optimum conditions for tilapia cultivation, but were still within the tolerable range in rearing tilapia in the budikdamber system with water spinach and without water spinach. The optimal temperature for cultivating tilapia is 25-32°C (SNI 7750: 2009).

At the lowest point in the morning, the temperature measurement shows a low number, this is due to the absence of sunlight. Conversely, during the day at the maximum point there is already sunlight, so that the temperature value is higher than the condition in the morning. The temperature value is affected by the state of the sunlight. If there is sunlight, there will be heat transfer activity from the atmosphere, currents meeting and turbidity which causes the temperature value to high (Boyd, 1982). Ridwantara et al., (2019) states that low temperature values will cause fish growth to slow down because the metabolism of enzyme activity and fish growth hormone does not work optimally. At high temperatures, it will cause an increase in metabolic rate, respiration and the level of oxygen consumption in fish. Agree with Putra (2015) which states that increasing temperature will cause an increase in the respiration process. In this case, energy for respiration is energy that is included in the value of basal metabolism (the minimum energy needed by fish to live). Thus the increase in temperature will cause an increase in basal metabolism. To determine the effect of temperature differences between treatments, a test of variance was carried out which is presented in Table 2.

Table 2. Temperature Variety Test

Source of diversity	DF	SS	MS	F Count	F Table 0.05
Treatment	7	0.043	0.006	1.602ns	2.657
A (Density)	3	0.007	0.002	0.582ns	3.239
B (System)	1	0.025	0.025	6.413*	4.494
AB (Density x System)	3	0.012	0.004	1.018ns	3.239
Galat	16	0.062	0.004		
Total	23	0.105			

Note: (ns) non-Significant; (*) Significant

pH

pH data measurements were carried out every day in the morning at 04.00 and afternoon at 14.00. Measurement of this parameter is used to determine the condition of the rearing optimal conditions or no for the life of tilapia. The pH during the study ranged from 6.4 to 8.9. The pH values obtained during the study were not in accordance with the optimum conditions for tilapia cultivation, but were still within the range that could be tolerated in rearing tilapia in the budikdamber system with water spinach and without water spinach. The optimal pH for tilapia cultivation is 6,5 – 8,5 (SNI 7750: 2009).

Low pH values will affect the growth of tilapia in aquaculture buckets, including causing the solubility of metals in water to increase and are toxic to organisms and affect the physiological damage of organisms (Nur et al., 2020). Conversely, a high pH can also increase the concentration of ammonia in water which is toxic to fish. Thus, pH that is too low and too high will result in a significant reduction in growth rate and feed efficiency (Tatangidatu et al., 2013).

To determine the effect of temperature differences between treatments, a test of variance was carried out which is presented in Table 3.

Table 3. pH Variety Test

Source of diversity	DF	SS	MS	F Count	F Table 0.05
Treatment	7	0.402	0.057	117.494*	2.657
A (Density)	3	0.002	0.001	1.650ns	3.239
B (System)	1	0.389	0.389	794.792*	4.494
AB (Density x System)	3	0.011	0.004	7.573*	3.239
Galat	16	0.008	0.000		
Total	23	0.410			

Note: (ns) non-Significant; (*) Significant

DO (Dissolved Oxygen)

Dissolved oxygen measurements are carried out every day in the morning at 04.00 and afternoon at 14.00. Measurement of this parameter is used to determine the condition of the rearing optimal conditions for the life of tilapia.

Along with the increasing number of densities, the lower the amount of DO. This is due to competition for oxygen between fish with limited media. DO during the study ranged from 1.07 – 16.4 mg/l. The DO values obtained during the study were not in accordance with the optimum conditions for tilapia cultivation, but were still within the tolerable range in rearing tilapia in the budikdamber system with water spinch and without water spinach. The optimal DO for tilapia cultivation is ≥3 (SNI 7750: 2009).

At the lowest point in the morning, the DO measurement shows a low number, this is due to the absence of sunlight. Conversely, during the day at the maximum point there is already sunlight, so the DO value is higher than in the morning. DO value is influenced by the state of sunlight. If there is sunlight, there will be photosynthetic activity which produces oxygen which causes DO values to high (Pramleonita et al., 2018).

The dissolved oxygen value is less in accordance with the optimum conditions which should cause stress to the fish (Barton et al., 1991; Barton, 2002). This is because the brain does not get an adequate supply of oxygen, and fish die due to lack of oxygen (anoxia) because fish cannot bind oxygen dissolved in the blood (Tatangindatu et al., 2013; Delince et al., 1987). Increasing dissolved oxygen levels can be done by adding aeration to make it easier for oxygen to diffuse into the water so that dissolved oxygen levels can increase (Androva & Harjanto, 2017). To determine the effect of temperature differences between treatments, a test of variance was carried out which is presented in Table 4.

Table 4. Dissolved Oxygen Variety Test

Source of diversity	DF	SS	MS	F Count	F Table 5%
Treatment	7	7.94	1.13	10.20*	2.66
A (Density)	3	6.08	2.03	18.21*	3.24
B (System)	1	0.28	0.28	2.52ns	4.49
AB (Density x System)	3	1.59	0.53	4.76*	3.24
Galat	16	1.78	0.11		
Total	23	9.72			

Note: (ns) non-Significant; (*) Significant

Ammonia

Ammonia measurements were carried out once a week for 4 weeks. Measurement of this parameter is used to determine the condition of the rearing optimal conditions for the life of tilapia. The weekly graph of the ammonia value in each treatment can be seen in Figure 1.

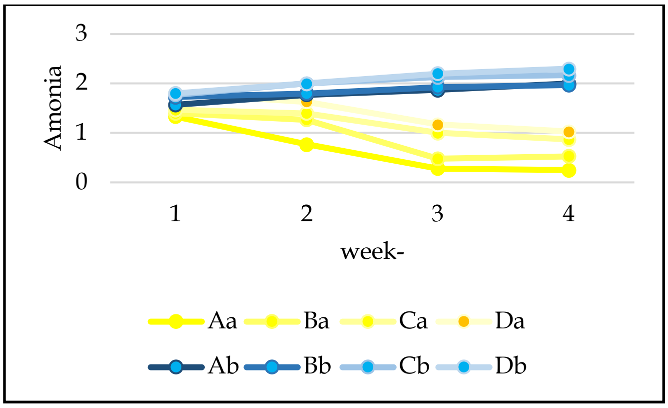

Figure 1. Measurement of red tilapia ammonia for 4 weeks, Aa (2 fish/10 L with water spinach), Ba (4 fish/10 L with water spinach), Ca (fish/10 L with water spinach), Da (8 fish/10 L with water spinach), Ab (2 fish/10 L without water spinach), Bb (4 without water spinach), Cb (6 without water spinach), and Db (8 without water spinach).

Based on the Figure 1 in each treatment using water spinach along with the large number of fish stocking densities, ammonia decreased from the first week (1,33 mg/L) to the 4th week (0,23 mg/L). Whereas in the treatment that did not use water spinach, in each treatment the density increased from the first week (1,53 mg/L) to the 4th week, which was 2,25 mg/L.

The value of ammonia during the study ranged from 0,23 to 2,5. The ammonia value obtained during the study was not in accordance with the optimum conditions for tilapia cultivation, but it was still within the tolerable range in rearing tilapia in the budikdamber system with water spinach and without water spinach. Optimal ammonia for tilapia cultivation is not more than 1 mg/L (Asmawi, 1983). If the ammonia value exceeds 1 it can inhibit the absorption of blood hemoglobin for oxygen and the fish will die (Siegers, 2016).

The decrease in the value of ammonia in budikdamber is influenced by the presence or absence of water spinach. In the Budikdamber treatment with water spinach there was a very optimal absorption of ammonia which was utilized by water spinach plants for growth. The low level of ammonia by using water spinach is thought to be because the roots are more fibrous (Dauhan et al., 2014; Anderson et al., 2019). Agree with Damanik *et al.*, (2018) which states that plants in the cultivation of the Yumina-Bumina system can function to improve water quality by reducing the concentration of inorganic nitrogen such as ammonia (NH_3), nitrite (NO_2) and nitrate (NO_3). Water spinach in fish and vegetable cultivation are able to reduce ammonia levels produced by manure and fish feed residue (Rokhmah *et al.*, 2020). To determine the effect of differences in ammonia between treatments, a test of variance was carried out which is presented in Table 5.

Tabel 5. Ammonia Variety Test

Source of diversity	DF	SS	MS	F Count	F Table 5%
Treatment	7	5.63	0.80	93.60*	2.66
A (Density)	3	0.94	0.31	36.54*	3.24
B (System)	1	4.51	4.51	525.22*	4.49
AB (Density x System)	3	0.17	0.06	6.78*	3.24
Galat	16	0.14	0.01		
Total	23	5.76			

Note: (*) Significant

SR (Survival Rate)

SR data collection was carried out at the beginning and end of the study. SR data collection was conducted to determine the percentage of fish survival. Based on the results of the 4-week study, the average SR value was obtained for tilapia which can be seen in Table 6.

Based on the table above, the Ba treatment (4 fish/10L) with water spinach had the highest SR value of 91.67%, while the Ab (2 fish/10L) without water spinach had the lowest SR value of 50%. The existence of death in cultivated fish during the study could be caused by stress triggered by water quality that was not suitable for the life of the fish being cultivated. According to Zalukhu et al., (2016) states that fish mortality is caused by water quality that is less than optimal for cultivated fish. Water quality that is less than optimal will cause fish stress and end in death. In addition, competition for space for movement can also affect the survival of fish because in ponds of the same area with different stocking densities for each treatment it is possible that there is competition in terms of opportunities to get feed (Niazie et al., 2013). Treatment of high stocking density causes low feed consumption in fish which can stress fish and eventually die (Strange & Schreck, 1978).. This is in accordance with the opinion of Islami et al., (2013) which states that the increasing stocking density of fish reared, the competition for space for movement so that the losing individuals will be disrupted by their survival, including slow fish growth, and can result in low production.

Table 6. SR (Survival Rate) of Tilapia (%)

Treatment	Repetition 1	2	3	Total	Average	STD
Aa	50	100	50	200	66.67	28.87
Ba	100	75	100	275	91.67	14.43
Ca	83	84	83	250	83.33	0.58
Da	75	88	75	238	79.33	7.51
Ab	50	50	50	150	50.00	0.00
Bb	75	75	75	225	75.00	0.00
Cb	67	67	50	184	61.33	9.81
Db	64	75	75	214	71.33	6.35

To determine the effect of different treatment stocking densities and systems on the percentage of survival of tilapia, an analysis of variance was carried out as shown in Table 7.

Table 7. Survival Rate Variety Test

Source of diversity	DF	SS	MS	F Count	F Table 5%
Treatment	7	3611.3	515.90	3.34	2.66
A (Density)	3	1956.0	652.00	4.22*	3.24
B (System)	1	1504.1	1504.17	9.74*	4.49
AB (Density x System)	3	151.1	50.39	0.33^{ns}	3.24
Galat	16	2470.0	154.38		
Total	23	6081.3			

Note: (ns) non-Significant; (*) Significant

Conclusion

Based on research with the treatment of differences in stocking densities with the budikdamber system on tilapia on water quality, it can be concluded that the parameters of temperature, pH, and DO are in a range that is not in accordance with optimum conditions, but can still be tolerated by tilapia so that tilapia remain still survive. Water spinach can reduce ammonia so that the value of ammonia in the treatment using water spinach decreased from the first to the fourth week and budikdamber without water spinach, it increased from the first week to the fourth week. The highest SR value was found in the Ba treatment (4 fish/10 liters) with water spinach, 91.67%.

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