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Effect of Different Stocking Density on the Growth of Catfish *(Clarias gariepinus)* in Aquaponics Budikdamber System

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Abstract. Budikdamber (fish farming in buckets) is an innovation from the aquaponics system that is carried out to keep catfish *(C. gariepinus)* and plants in the same container. In the Budikdamber system, it is important to pay attention to the high and low density of fish stocking because the rearing container used is a bucket. The purpose of this research was to determine the growth rate and survival rate of catfish at different stocking densities. This research was conducted with 3 treatments and each treatment had 3 repetitions, treatment A (40 fish/m3), treatment B (80 fish/m3), and treatment C (120 fish/m3). The observations showed that the highest specific growth rate of catfish was found in treatment A with a value of 12.74%, followed by treatment B 12.55% and treatment C 12.20%. The highest survival rate of catfish was found in treatment A, which was 90.8%, followed by treatment B at 87.9%, and treatment C at 86.7%. The highest feed conversion ratio (FCR) of catfish was found in treatment B, which was 0.475, followed by treatment A at 0.445, and the lowest FCR value was found in treatment C, which was 0.368. Water quality parameters measured during observations included dissolved oxygen (DO), temperature, acidity (pH), nitrite and nitrate, where all water quality parameters were still considered optimal for growth and survival of catfish.

Keywords Catfish; Growth; Different Stocking Density

I. INTRODUCTION

Catfish Cultivation is one type of aquaculture business that is growing. Catfish farming is growing rapidly due to the relatively easy cultivation and marketing technology to be mastered by the community, and relatively small business capital required. In the breeding of catfish, it produces pond water waste that comes from the metabolism of fish and dissolved feed residues, where this waste contains pollutants that are toxic to fish. However, the water that comes from catfish waste can still be used for the process of cultivating vegetables using an aquaponic system [1].

Aquaponics is a plant cultivation technique that is integrated with the cultivation of aquatic animals [2]. Aquaponics basically consists of fish farming and plant raising. In the aquaponics system, plants absorb nitrate in the water. The nitrate produced from the nitrification process is used as a source of nutrients by plants, resulting in an improvement in water quality in the cultivation media [3]. The interaction between fish and plants results in a mutually beneficial relationship, where fish manure provides nutrients to plants while plants act as filters for ammonia and other nitrogen compounds from the water [4].

Currently, there are many aquaponics systems that can be applied on a small scale, one of which is a floating raft system that uses bucket cultivation containers. The fish farming system using bucket containers is also better known as Fish Cultivation in Buckets (Budikdamber). In this system, plant roots directly absorb nutrients without using flannel so that the amount of nutrients follows the length of the plant roots. The Budikdamber system is fairly simple, because this system does not use electricity and its setup is also easy [5].

Budikdamber is an innovation from an aquaponics system that is carried out to keep fish and plants in the same container, where the container used is a bucket. The advantages of this system are that it does not require electricity, is inexpensive and does not require a large area [6]. In the Budikdamber system, it is important to pay attention to the high and low density of fish stocking because the rearing container used is a bucket. High stocking density will interfere with the growth rate even though food needs are fulfilled. This is due to competition in fighting over fish space [7]. Therefore, it is necessary to conduct research on the effect of stocking density on the growth rate and survival of fish in aquaponics with budikdamber system.

II. RESEARCH METHODS

A. Research Time and Location

This research was conducted for 4 weeks, from January 25, 2022 to February 16, 2022 at Pondok ABS, Jalan Goagong, Bukit Jimbaran, South Kuta, Badung, Bali.

B. Research Methods

The method used in this research is an experimental method using a group system. Total of buckets used are 9 buckets measuring 80 liters with a volume of water used as much as ± 60 liters. The test material used in this research was catfish seed (*C. gariepinus*). This research used three treatments, namely A (stocking density of 40 fish/m^3), B (stocking density of 80 fish/m^3), and C (stocking density of 120 fish/m^3). Each treatment consisted of three repetitions. Fish sampling was carried out once every 7 days as many as 10 fish for each treatment and repetition.

C. Research Parameters

a. Absolute Length Growth

The absolute length growth is calculated using the following formula [8]:

$$LM = Lt - Lo$$

Noted: LM is growth in absolute length (cm); Lt is final length of seed (cm); Lo is initial length of seed (cm)

b. Specific Growth Rate (SGR)

The specific growth rate of Catfish is calculated using the following formula [9]:

$$SGR = \frac{\text{LnWt} - \text{LnWo}}{\text{t}} \times 100\%$$

Noted: SGR is specific growth rate (%); LnW_t is weight of test animals at the end of the experiment (g); LnW_0 is weight of test animals at the beginning of the experiment (g); t is trial time interval (days)

c. Survival Rate (SR)

The survival rate of catfish was calculated at the beginning of stocking and at the end of the research. Calculating survival rate is done using the following formula [9]:

$$SR = \frac{\text{Nt}}{\text{No}} \times 100\%$$

Noted: SR is life pass of test fish (%); Nt is total of fish that live at the end; N_0 is total of fish that live at the beginning.

d. Feed Conversion Ratio (FCR)

Calculating the feed conversion ratio (FCR) is used to determine the use of feed, by comparing the amount of feed given to the total weight of the fish produced. The FCR formula used is the following formula [10]:

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

Noted: FCR is feed conversion rate; F is amount of feed given during the study (g); Wt is total weight of fish at the end of the research (g); D is total weight of fish that died during the research (g); W_0 is total weight of fish at the beginning of the research (g).

D. Data analysis

The research data were analyzed using One Way Analysis of Variance (One Way ANOVA) at a 95% confidence interval, and Duncan's test was performed to compare all pairs of mean test treatments.

III. RESULT AND DISCUSION

A. Growth and Specific Growth Rate of Catfish (*C. gariepinus*)

The results of this research showed that treatment A had better growth values and fish-specific growth rates than the other two treatments. The growth of catfish in treatment A had an average weight of 19,78 g (Figure. 1), an average length of 14,34 cm (Figure. 2) with an absolute length growth of 3,63 cm (Figure. 3), while the specific growth rate of fish in treatment A had a value of 12,74 % (Figure. 4). The higher growth and specific growth rate of fish in treatment A was thought to be due to having the lowest stocking density compared to treatments B and C.

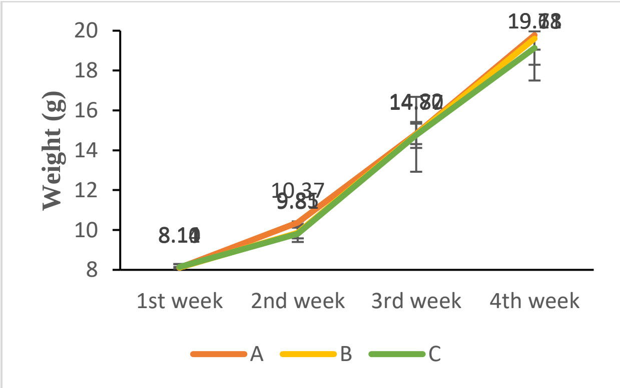

Figure. 1. Catfish Weight Growth Chart

The low stocking density causes the fish to have sufficient and adequate space to support growth in any given treatment. This is in line with the statement by Setyaningsih et al [11] that stocking density can affect growth and specific growth rates. Yunus et al [12] added that if fish are kept at low stocking densities, their growth is better than those at high stocking densities. Puspita and Sari [13] also state that the lower fish density, the wider space for movement and the greater opportunity to obtain food, so that the growth and specific growth rate of fish increases.

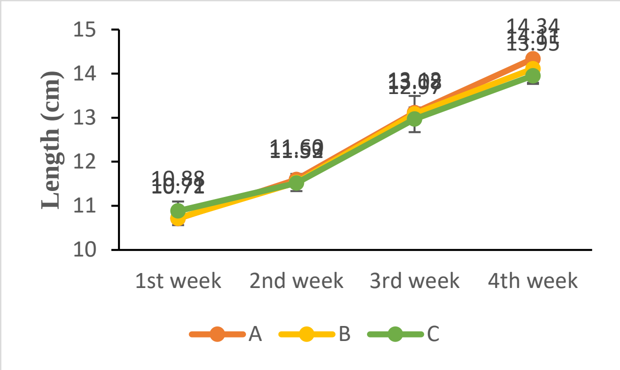

Figure. 2. Catfish Length Growth Chart

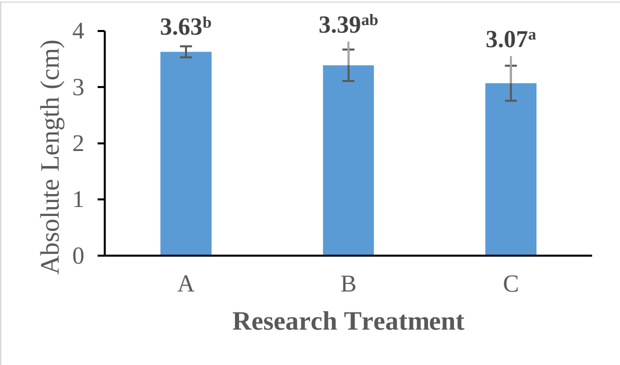

Figure. 3. Catfish Absolute Length Growth Chart

Based on the results of the analysis, treatment C had the lowest growth value and fish specific growth rate. The weight growth value of treatment C was 19,13 g, the average length was 13,95 cm and the absolute length growth was 3,07 cm, while the value of the specific growth rate of fish in treatment C was 12,20%.

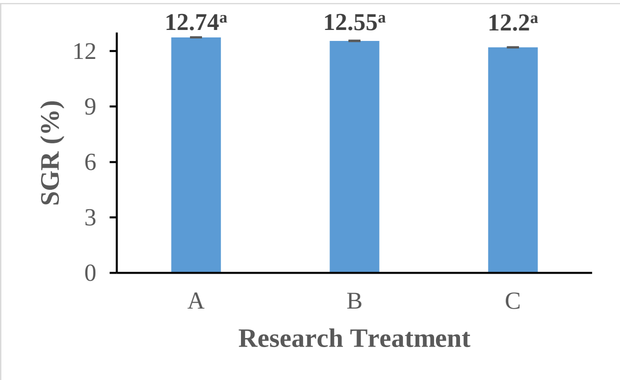

Figure. 4. Catfish Specific Growth Rate Chart

The low growth value and specific growth rate of fish owned by treatment C is suspected to be a higher competition than the other two treatments for the struggle for space and dissolved oxygen in fish. This can cause fish to experience stress which results in inhibited metabolism and decreased fish appetite, thus slowing fish growth [14]. According to Liswahyuni et al [15] to produce optimal growth in fish, they must get sufficient and nutritious food and an environment that is in accordance with the required growth. Nurlaela et al [16] added that a decrease in the specific growth rate of fish was due to competition for space, dissolved oxygen and makasifeed. So that there is a higher competition in treatment C in getting the fish needs to grow. Therefore, the growth rate of fish in treatment C became the lowest.

B. Water Spinach Length Growth

The results of this research showed that treatment A had a better growth value of kale than the other two treatments. The growth of water spinach length in treatment A was 48,21 cm, followed by treatment C, which was 46,37 cm. The lowest growth of water spinach was found in treatment B, which was 43,86 cm. The water spinach during the observations looked good, indicated by the absence of wilted water spinach stems and greenish healthy leaves. This indicates that the absorption of metabolic waste from catfish is carried out very optimally by water spinach. Dauhan [17] stated that the optimal absorption of water spinach for ammonia is indicated by the good condition of water spinach, so that water spinach can use it for growth.

C. Survival Rate

Based on the results of this research, it was known that the survival rate of catfish reared in the Budikdamber aquaponic system with different densities did not show any difference between treatments. This indicates that catfish can be kept in the Budikdamber aquaponic system up to a stocking of 120 fish/m^3. This was because the growth and survival results obtained at a stocking density of 120 fish/m^3 were not significantly different from those obtained at a lower stocking density. The results of fish survival rates in this research were the same as those conducted by Hermawan et al [18] where the values obtained showed no significant effect of differences in stocking density on fish survival.

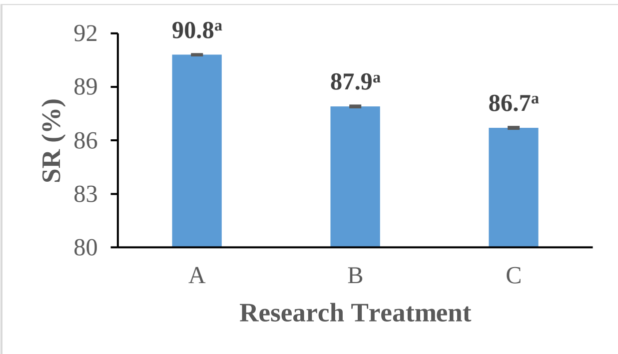

Figure. 5. Catfish Survival Rate Chart

The survival value obtained in this research can be said to be good, ranging from 86.7%-90.8% (Figure. 5). Lestari [19] states that the survival value of a good cultured fish is greater than 50%. Treatment A had the highest survival rate because the competition between fish in this treatment was not as high as in treatments B and C. This made the catfish found in treatment A easier to get space, dissolved oxygen and the feed needed to survive. Otherwise, catfish in treatment C had a narrower range of motion than the other two treatments. According to Faisyal et al [20] the survival of fish is influenced by internal and external factors, internal factors such as resistance to disease, feed, and age while external factors such as stocking density, disease, water quality.

Most catfish deaths during the research occurred in the early weeks of rearing. This is presumably because the dead catfish have not been able to adapt quickly to environmental changes, so that the fish experience stress and lead to death. In addition to this there is a catfish found during the research allegedly due to a disease that attacks fish. This is based on the presence of white spots that appear on the skin of the fish, therefore efforts are being made to replace the rearing media. Zainun [21] mentions that catfish infected with *Ichtyophirius multifiliis* are characterized by white spots on the body surface with excessive mucus production which will be difficult to treat, because this parasite attacks the outside of the fish. The results of the survival rate of fish in this study are in accordance with research conducted by Hermawan et al [18] where the values obtained indicate that there is no significant effect of differences in stocking density on fish survival.

D. Feed Conversion Ratio

The FCR value obtained in this research was in the range of 0,368-0,475 (Figure. 6). This indicates that the feed provided has good feed quality and can be utilized properly by fish. Conditions of good feed quality will be used more for growth. The feed used during the study was crumble HI-PRO-VITE 781-2 with a protein content of 33% and the frequency of feeding 2 times a day. According to Arief et al [22] the factors that affect feed efficiency are the type of nutrient source and the amount of each component of the nutrient source in the feed used.

The results of the feed conversion value in this research were considered lower than the FCR value which was quite good according to the DKPD [23], which ranged from 0,8 to 1,6. Karimah et al [24] added that high feed efficiency indicates efficient use of feed, so that only a few nutrients are broken down to meet energy needs and the rest is for growth. The low value of the feed conversion ratio during the research showed that the feed provided had good nutrition. This is in accordance with the statement of Shofura et al [25], the lower the feed ratio value, the better the quality of the feed provided. If the feed conversion value is high, the quality of the feed given is not good, on the contrary if the feed conversion value is low, it means that the quality of the feed given is good.

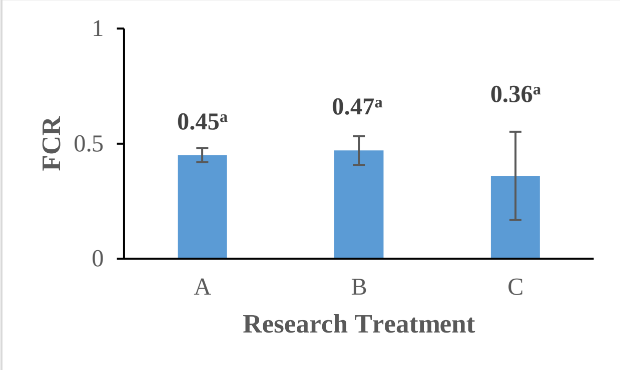

Figure. 6. Catfish Feed Conversion Ratio Chart

E. Water Quality

Dissolved oxygen (DO) content during the study ranged from 3,3 to 4,1 mg/L, where the range is almost the same as all treatments performed, you can refer TABLE 1. The DO content during the research was classified as good for optimal growth of catfish, referring to Setyani et al [26] for optimal growth of catfish, a good DO value content was above 3 mg/L. One of the environmental factors that influence the success of catfish farming in buckets is the quality of the water used. Water quality parameters such as dissolved oxygen (DO), temperature, acidity (pH), nitrite and nitrate. Dissolved oxygen (DO) is a water quality parameter that plays an important role in the survival and growth of catfish. Because if DO level in the water is low, it can cause a decrease in appetite in fish [27] so it affects growth.

During the research, the average value of the water temperature in each treatment ranged from 28,5-28,7°C. The temperature value obtained during the study was classified as good, referring to Wicaksana et al [28] which stated that a good temperature for catfish farming activities was at a temperature of 20-30°C. Dissolved oxygen (DO) is often a limiting factor for the success of catfish farming activities, where the temperature value can affect the level of DO content in the waters [29]. The pH value during the research ranged from 6,75-6,87 was considered optimal, referring to Imaduddin and Saprizal [30] which stated that the growth of catfish would be optimal if the pH value was in the range of 6-9. The value of the degree of acidity (pH) is no less important in catfish farming activities. A less than optimal pH value can cause fish to be susceptible to disease, stress fish, low productivity and growth [31].

The average content of nitrite and nitrate during the research ranged from 0,023-0,033 mg/L and 7,18-7,78 mg/L. This value is still below the threshold value of the quality standard based on Bali Governor Regulation No. 16 of 2016 of 1 mg/L and 10 mg/L. During the observation, the highest nitrite content was found in treatment C of 0,033 mg/L, while the highest nitrate content was in treatment B of 7,78 mg/L. Nitrite (NO2) and nitrate (NO3) are inorganic nitrogen that can be utilized by aquatic plants for nitrite growth. Based on Damanik et al [32], nitrite is the result of the first stage of the nitrification process that is not utilized by plants and is decomposed by *nitrosomonas* bacteria into nitrate with the help of oxygen.

The results of the nitrate value in treatment B had the highest nitrate content among other treatments, this is suspected to be a lack of absorption of nitrate content by water spinach for growth. It is proven by the average length growth of water spinach in treatment B, which was the lowest at 43,86 cm, while in treatments A and C it was 48,21 cm and 46,37 cm. This is directly proportional to the results of research by Gerung et al [33] which states that the nitrate content in one of the treatments decreased due to the absorption of nitrate carried out by water spinach. Setijaningsih and Suryaningrum [34] state that the nitrate content in the waters is influenced by the DO content, because oxygen will oxidize nitrite in water to nitrate. Therefore, the highest nitrite content in treatment C was suspected to be nitrite deposition caused by the lack of DO in the waters.

TABLE 1
WATER QUALITY VALUE RANGE

Parameter	Treatment		
	A	B	C
DO (mg/L)	4,1	3,6	3,3
Temperature (°C)	28,7	28,5	28,7
pH	6,87	6,82	6,75
Nitrite (mg/L)	0,023	0,024	0,033
Nitrate (mg/L)	7,18	7,78	7,55

IV. CONCLUSION

The best growth rate of catfish *(C. gariepinus)* was found at a stocking density of 40 fish/m^3 which was 12,74%/day, followed by a stocking density of 80 fish/m^3 of 12,55%/day. While the stocking density of 120 fish/m^3 became the lowest growth rate of 12,20%/day. The survival rate of catfish *(C. gariepinus)* in each treatment was classified as good with a stocking density of 40 fish/m^3 being the best fish survival rate among other treatments, which was 90,6% followed by a stocking density of 80 fish/m^3 of 87,9% and a density of 87,9%. the stocking of 120 fish/m^3 was 86,7%.

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