Journal of Advanced Zoology

ISSN: 0253-7214

*Volume **44** Issue **02 Year 2023** Page **271:279***

Domestication of *Belontia Hasselti* with Different Densities Using Zeolite Filter Media in Recirculation System

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Article History

Received: 06 June 2023
Revised: 05 Sept 2023
Accepted: 11 Aug 2023

Abstract

Belontia hasselti have not been widely cultivated and still depend on catching from nature. Community needs require the cultivation of B. hasselti that are still wild to satisfy their needs. Things that need to be considered in the acclimatization process for the domestication process are stocking density and the right cultivation technology system to support the survival rate of the B. hasselti. This study aimed to determine the best stocking density during the domestication process of B. hasselti using zeolite filter media in a recirculation system. This study used a completely randomized design with five treatments and three replications. The treatments given differences in stocking density were 1 (P1), 2 (P2), 3 (P3), 4 (P4), and 5 (P5) fish L^{-1}. The results of this study showed that the best stocking density was in P1 (1 fish L^{-1}) tail resulted in 91% survival rate, absolute weight growth at 3.17 g, absolute length growth at 0.18 cm, and feed efficiency at 16.91%. The water quality during the study was still within the tolerance limits for B. hasselti, i.e. temperature 27.4-27.6°C, pH 6.1-7.8, dissolved oxygen 5.4-5.5 mg L^{-1}, and ammonia 0.06-0.1 mg L^{-1}.

Keywords: *Belontia Hasselti, Domestication, Recirculation, Zeolite*

1. Introduction

Belontia hasselti is a type of fish in swamp waters which has the advantage of being developed as a cultivation commodity. The challenge in cultivating *B. hasselti* is the low survival rate of fish when these fish are reared in a cultivation environment. This is presumably due to the high stress levels of the *B. hasselti* when they are in a new environment which causes a decrease in the health of the fish so that it easily causes death (Hasanah et al., 2019). According to Augusta (2016), the extinction of living populations can be prevented by domestication. The results of a study by Tanbiyaskur et al. (2022) showed that *B. hasselti* were raised for 30 days with a stocking density of 1 fish in 3 L of water, with an absolute length growth at 3.83 cm, an absolute weight growth at 3.98 g, a feed efficiency value at 75.99%, and 100% survival rate. Solutions to increase survival rate and reduce stress levels of *B. hasselti* when they are in a new environment which can cause a decrease in fish health, one of which was by implementing a recirculation system with the addition of zeolite.

Belontia hasselti can be protected by maintaining the water quality and increasing their survival rate. Efforts to increase the density of *B. hasselti* more than 1 fish in 3 L of water need to be done to increase the productivity of *B. hasselti* cultivication. The aquaculture recirculation system was one of the applications of sustainable aquaculture that can control the disposal of waste into the environment (Ramli et al., 2017; Amin et al., 2022). A solution to increase survival rate and reduce stress levels of *B. hasselti* when in a new environment which can cause a decrease in fish health, one of which was by implementing a recirculation system through the addition of zeolite (Purnayudha et al., 2014). According to research results from Febriyanti (2021) on rearing *B. hasselti* size 10-11 cm with a density of 1 fish L^{-1} using an aquarium with a volume of 5 L of water with a total stocking of 5 individuals and maintenance for 45 days resulted in a survival rate at 66 .67%, the absolute weight and length growth values were at 6.52 g and 0.85 cm. Therefore, research on the domestication of *B. hasselti* with different densities using zeolite filter media in a recirculation system needs to be carried out to produce a higher stocking density and maximum survival.

2. Methods

Place and Time

This research was conducted from September to October 2022 at the Laboratory of Aquaculture and Experimental Ponds, Aquaculture Study Program and Laboratory of Microbiology and Fishery Products Biotechnology, Fisheries Product Technology Study Program, Department of Fisheries, Faculty of Agriculture, Sriwijaya University.

Materials and Tools

The materials used in this study were *B. hasselti* (8.0-9.0 cm), commercial fish pellets with 31-33% protein content, and 2-3 mm zeolite with 6-8 mesh. The tools used in this study were pH meters, thermometers, analytical balances, rulers, aquariums, DO meters, spectrophotometers, glucose test kits, water pumps, blowers, filter boxes, filter sponges, hoses, and aeration stones.

Experimental Design

This study used a completely randomized design (CRD) consisting of 5 treatments and 3 replications. *Belontia hasselti* maintenance was carried out for 30 days with different fish densities, namely:

P1 : Stocking density of 1 fish L^{-1}

P2 : Stocking density of 2 fish L^{-1}

P3 : Stocking density of 3 fish L^{-1}

P4 : Stocking density of 4 fish L^{-1}

P5 : Stocking density of 5 fish L^{-1}

Research Preparation

Research preparation began with preparing the rearing containers, media water, and fish. The maintenance containers used were 15 aquariums measuring 30x30x30 cm^3 with a water level of 20 cm so that the water volume became 18 L. Before stocking the fish, the aquarium was filled with 18 L of water which had been given a solution of potassium permanganate at a dose at 15 mg L^{-1} and left for 3 days so that the aquarium used was sterile (Saputra & Ibrahim, 2021). After 3 days the potassium permanganate solution was discarded and the aquarium was washed again with clean water. The water used for rearing media was taken from well water at the Aquaculture Laboratory and Experimental Ponds, Aquaculture Study Program, Department of Fisheries, Faculty of Agriculture, Sriwijaya University. The design of the maintenance container with a recirculation system using zeolite filter media can be seen in Figure 1 as follows:

Figure 1: Design of a recirculation system using zeolite filter media

The top of the aquarium was a filter box measuring 28x15x11 cm^3 which has been filled with filter media in the form of 255.6 g of zeolite from the conversion of the zeolite dose used in Firdaus *et al.* (2014) research as much as 1.8 kg in 126 L of water which results in 100% survival rate in maintenance of pearl trout (*Trichogaster leeri*) seeds. The size of the zeolite used was 2-3 mm and the filter sponge measured 28x12.5x2.5 cm^3 and a water pump has been installed at the bottom of the aquarium. The aeration hose that has been fitted with an aeration stone was inserted into the fish-rearing water as deep as 10 cm.

Fish Stocking

The *B. hasselti* used were obtained from fisherman in Tanjung Baru Village and sized between 8.0-9.0 cm, and stocking density was adapted to each treatment. The *B. hasselti* were acclimatized for three days for adjustment, and then length, weight, and water quality were measured.

Maintenance

The *B. hasselti* were reared for 30 days, and the feed for the *B. hasselti* was given in the form of commercial pellets. The frequency of feeding was three times a day, i.e at 8 a.m, 12 a.m, and 4 p.m with the feeding method at satiation.

Parameter

Parameters observed in this study included survival rate, growth in absolute weight and length of fish, feed efficiency, fish blood glucose, and water quality for rearing *B. hasselti* including temperature, pH, dissolved oxygen and ammonia.

Data Analysis

Data on water quality, survival rate, absolute growth in weight and length of fish obtained were tested using analysis of variance at 95% confidence intervals. If there was a significant difference, then the Least Significant Difference (LSD) was further tested.

3. Results and Discussion

Water Quality of Rearing *B. hasselti*

The range of several water quality parameters for all treatments during the study such as temperature ranged from 26.0-29.4°C, dissolved oxygen 5.4-5.7 mg L^{-1}, ammonia 0.02-0.16 mg L^{-1} and pH 6.1-7.8 (Table 1).

Table 1: Water quality of rearing B. hasselti

Treatment	Ranges			
	Temperature (°C)	Dissolved Oxygen (mg L^{-1})	Ammonia (mg L^{-1})	pH
P1	26,0-29,1	5,4-5,6	0,02-0,09	6,1-7,3
P2	26,0-29,1	5,4-5,7	0,03-0,09	6,1-7,8
P3	26,1-29,4	5,4-5,7	0,02-0,12	6,2-7,5
P4	26,1-29,1	5,4-5,5	0,02-0,13	6,5-7,6
P5	26,2-29,1	5,4-5,6	0,04-0,16	6,5-7,5

Survival Rate, Absolute Growth and Feed Efficiency of *B. hasselti*

B. hasselti reared at different densities using a zeolite filter in the recirculation system resulted in different survival rate and growth, the higher the stocking density, the lower the growth in absolute weight and absolute length, feed efficiency, and survival rate as seen in Table 2.

Table 2. Average survival rate, absolute growth (weight and length) and feed efficiency of *B. hasselti*.

Treatment	Survival Rate (%) ($LSD_{\alpha 0,05}$ = 10,49)	Absolute Growth Rate		Feed Efficiency (%) ($LSD_{\alpha 0,05}$ = 2,45)
		Weight (g) ($LSD_{\alpha 0,05}$ = 0,36)	Length (cm)	
P1	90,7±8,50^{c}	3,17±0,29^{c}	0,18±0,02	16,91±2,00^{c}
P2	85,2±3,23^{bc}	2,84±0,20^{c}	0,16±0,02	14,66±2,13^{bc}
P3	81,6±6,70^{abc}	2,41±0,10^{ab}	0,15±0,03	13,55±0,39^{ab}
P4	78,2±4,86^{ab}	2,38±0,11^{ab}	0,14±0,01	12,80±0,33^{ab}
P5	74,4±3,87^{a}	2,20±0,13^{a}	0,13±0,02	11,38±0,63^{a}

Note: Numbers in the same column followed by the same superscript letter show no significant different effect on the 5% LSD test

Blood glucose Level of *B. hasselti*

The blood glucose level of *B. hasselti* reared for 30 days found that the higher the stocking density of the fish, the higher the blood glucose level. The blood glucose of the *B. hasselti* during the study was presented in Table 3.

Table 3. Blood glucose of *B. hasselti* during the study

Treatment	Blood glucose level (mg dL^{-1}) at day -		
	1 ($LSD_{0.05}$=2.50)	15 ($LSD_{0,05}$=2.94)	30 ($LSD_{0.05}$=4.94)
P1	72.3±2.08^{a}	71.7±1.53^{a}	71.0±3.61^{a}
P2	75.3±0.58^{b}	76.3±1.53^{b}	76.3±3.51^{b}
P3	77.0±1.73^{bc}	81.0±2.65^{c}	78.3±2.52^{b}
P4	78.7±1.15^{cd}	87.0±1.00^{d}	87.0±2.00^{c}
P5	79.7±0.58^{d}	88.7±0.58^{d}	89.7±1.15^{c}

Note: Numbers in the same column followed by the same superscript letter show no significant different effect on the 5% LSD test

Based on the results of monitoring water quality during the study in Table 1, it was known that the water quality values measured during the research process are still within the tolerance limits for the rearing of *B. hasselti* according to Hasanah et al. (2019) including temperatures between 25°C and ammonia was still within tolerance limits according to Arianto et al. (2019) i.e. in the range of 0.012-0.104 mg L^{-1}. The range of values of several water quality parameters in this research such as temperature was 27.4-27.6°C, dissolved oxygen was 5.4-5.5 mg L^{-1}, ammonia was 0.06 ± 0.1 mg L^{-1} and pH 6,1-7,8. Based on the research results of Thornton et al. (2018), *B. hasselti* in the natural habitat of the Sebangau River, Central Kalimantan, can live in a temperature ranged at 25.5-31.0°C, pH ranged from 3.2-4.8, dissolved oxygen 0.8-3.8 mg L^{-1} and ammonia 0.05-0.60 mg L^{-1}. Based on Kulla et al. (2020), the water temperature at 28°C was the optimal value for the survival rate of freshwater fish. In the Black River, Pekanbaru, the *B. hasselti* lived in the water temperature ranged 27-28°C (Firdaus & Efawani, 2015). *B. hasselti* in the natural habitat of the Sebangau River, Central Kalimantan, can live in suboptimal pH environmental conditions ranging from 3.2 to 4.8 (Agustinus & Gusliany, 2020). Siswanto et al. (2021), stated that a good oxygen concentration in aquaculture was 5-7 mg L^{-1}.

Generally, the water quality values for all treatments were within the range that supports *B. hasselti* survival rate. This showed the role of the recirculation system with zeolite filter media in supporting the rearing procces of *B. hasselti* to a density 5 fish L^{-1}. This statement was reinforced by the results of research from Affandi et al. (2014) on rearing eels at different salinities using a recirculation system with synthetic cotton filter media, activated carbon, zeolite, and bioballs producing water quality values such as temperature at 31°C, pH 7.7, and ammonia at a value of 0.001 mg L^{-1} and resulted in a survival rate at 100%. Based on the research of the recirculation system from Firmansyah et al. (2021) on rearing tilapia for 45 days using zeolite filter media can maintain water quality in the ranged at 26.6-28.3°C for temperature, pH in the ranged at 7.1-8.5, dissolved oxygen 5.6-7.8 mg L^{-1}, total ammonia value below 1 mg L^{-1}, so it could resulting in 85% survival rate. The results of research by Sugito et al. (2017), that used in the filter media recirculation system could maintain water quality during *Pangasius polyuranodon* rearing, such as temperatures ranged from 27-30°C, dissolved oxygen 5.01-6.14 mg L^{-1}, pH 6.4-7.4, and ammonia in the range of 0.001-0.056 mg L^{-1}. During the study, the dissolved oxygen content obtained still supported the survival rate of *B. hasselti* during 30 days of maintenance. According to Fekri et al. (2018), the relationship between temperature and dissolved oxygen levels was that the higher the temperature, the less oxygen solubility. Besides temperature, dissolved oxygen was also an important water quality factor for aquatic biota. Ammonia levels could be toxic to farmed fish at concentrations above 1.5 mg L^{-1} (Wahyuningsih & Gitarama, 2020). Based on the ammonia levels obtained during the study, the higher the stocking density of *B. hasselti*, the higher the water ammonia levels in the cultivation media (Azhar et al., 2022). However, the ammonia value was still within the limits that could be tolerated by *B. hasselti*. Ammonia (NH3) was toxic to aquatic organisms (Lin et al., 2022). The effect of high ammonia level was could damage to the gill tissue so that its function as a respiratory tool will be disrupted (Xu et al., 2021).

The mineral zeolite was very good at absorbing ammonia. Zeolite could remove ammonia from water because in the porous structure of the zeolite, there were sodium ions as a substitute for absorbed ammonia ions (Royan et al., 2019). The irregular crystal structure of zeolite on the surface and the high surface area makes it a very effective trap for fine particulate matter and ammonia ions. Moreover, the microporous zeolite media was large enough to allow particles of colloid size to be entrapped. As a result, zeolite could be used as a water filter to reduce ammonia levels (Diansari et al., 2013; Mujahidah et al., 2023).

Fish survival rates was one of the success factors in fish cultivation activities (Wijayanto., 2023). Based on the results of the study, it was found that the higher the stocking density of the *B. hasselti*, the lower the survival. This was in accordance with the statement of Utami et al. (2018) that higher densities will lead to high oxygen competition and reduce survival due to less stable oxygen supply at higher stocking densities. Good environmental conditions, especially low ammonia levels could make fish comfortable and have a good appetite. According to Rahayu et al. (2022), the using of several filter compositions such as zeolite, coconut coir, charcoal and gravel can maintain water quality well, especially in suppressing ammonia content so that fish were not stressed and did not cause death to fish. This was confirmed by Mramba et al. (2023) that good water quality will affect fish survival rate and fish growth.

Research on the use of zeolite filters has been carried out such as research by Diansari et al. (2013) which showed that a tilapia with density of 1 fish L^{-1} could support survival rate of up to 86.67%. Fani et al. (2015) using zeolite filter media resulted in the highest survival rate in the stocking density of 1 fish L^{-1} goldfish seed, which was 68%. The results of Pratama et al. (2022) for the maintenance of *Tor soro* fry using 75% zeolite filter, sand, and palm fiber produced water quality values such as temperature in the range of 26-29°C, pH 6-7, dissolved oxygen 5.18-5.90 mg L^{-1}, and ammonia in the range of 0.06-0.10 mg L^{-1} so resulting in an absolute length growth value at 12.28 cm, absolute weight growth at 8.87 g and 100% survival rate. This was indicated a higher fish survival rate value supported by good water quality management.

The growth of cultivated organisms could be influenced by several factors, i.e. stocking density, feed and water quality during maintenance which affect the success of cultivation (Mumpuni., 2022). According to Kampai (2012), the growth of *B. hasselti* has a positive allometric picture (weight growth was faster than length growth). The results of this study showed that P1 (stocking density of 1 fish L^{-1}) produced the highest absolute growth which also resulted in the highest feed efficiency. High stocking densities will disrupt the growth rate even though the feed requirement was sufficient (Sihite *et al.*, 2020).

Having high stocking densities can lead to fish dying because they do not have enough space to move around in research containers. According to Gauy et al., (2023), competition for space could affect fish growth, because with different stocking densities in containers that have the same area it was suspected that there was competition in terms of opportunities to get feed. Based on the research results, the highest absolute weight growth was also accompanied by the highest feed efficiency value at 16.91%. The efficiency of feed utilization was related to the addition of body weight that comes from the utilization of protein in the feed (Cahyoko et al., 2011; Fitriadi et al., 2022). A comparison of the body weight growth of a fish and the amount of feed consumed during its rearing period yields the value of feed efficiency (Dangeubun et al., 2019). Feed efficiency in this study was still low because *B. hasselti* utilizes feed as energy for survival not for growth, this was in accordance with the statement of Agustinus & Minggawati (2021), the slow growth of *B. hasselti* was expected because the energy that should be used for growth was more directed survive. According to Mukti et al. (2021), generally good feed efficiency was greater than 50%. A high density value of feed efficiency will result in high absolute weight and absolute length growth because fish utilize nutrients from the feed given during rearing (Pietoyo et al., 2021; Gazali et al., 2023). The increase in stocking density will cause stress which induces high blood glucose *B. hasselti*. A high density of fish is a critical factor because it has the potential to be a source of stress, one of the indicators to know the stress response was the value of blood glucose levels (Djauhari et al., 2019; Mahasri et al., 2022). The results of this study showed that the higher the stocking density, the higher the blood glucose level. The blood glucose levels of the *B. hasselti* in this study ranged from 71.0-89.7 mg dL^{-1}. This value was still within normal limits according to Renitasari et al. (2021), which was the normal fish glucose level was around 40-90 mg dL^{-1}. The results demonstrated that *B. hasselti* can still maintain normal blood glucose level until density of 5 fish L^{-1} using zeolite filter media.

4. Conclusion

Domestication of *B. hasselti* using zeolite filter media in the recirculation system by a stocking density of 1 fish L^{-1} (P1) produce the best survival rate at 90.70%, absolute weight and lenght growth at 3.17 g and 0.18 cm and feed efficiency at 16.91%. The higher of fish density applied, the higher the fish blood glucose level. In general, water quality value remains within acceptable ranges that supports survival rate of *B. hasselti*. Future research in the form of cultivation engineering is needed to increase fish stocking density to more than 1 fish L^{-1} which can significantly increase the production of *B. hasselti* cultivation.

Acknowledgements

The author would like to thank the Laboratory of Aquaculture and Experimental Ponds, Aquaculture Study Program, Department of Fisheries, Sriwijaya University.

Conflict of interest:

The authors declareno conflict of interest

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