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GROWTH AND SURVIVAL RATE OF DOMESTICATED *JIELABU* FISH (*Betta dennisyongi* Tan, 2013) REARED WITH DIFFERENT STOCKING DENSITIES

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ABSTRACT

Betta dennisyongi, locally known as *Jielabu* fish, is an endemic ornamental species originating from southwest Nanggroe Aceh Darussalam, Indonesia. The fish currently faces increasing exploitation and habitat degradation which raise conservation concerns and emphasize the need for domestication efforts. This study aimed to determine an appropriate stocking density for the early culture of *B. dennisyongi*. The research was conducted from October to December 2023 using a completely randomized design with four stocking densities (1, 2, 3, and 4 fish L^{-1}) with three replications. Juvenile fish collected from the wild were acclimated and reared for 60 days in 10-L aquaria. Biological parameters measured included survival, specific growth rate, length gain, weight gain, feed conversion ratio, and feed efficiency, while water quality was monitored periodically. Stocking density significantly affected survival rate and growth ($p < 0.05$) of *B. dennisyongi*, with the lowest density (1 fish L^{-1}) producing the most favorable performance, while densities of 3–4 fish L^{-1} resulted in reduced outcomes. Feed conversion ratio and feed efficiency did not differ significantly among treatments ($p > 0.05$). All measured water quality parameters remained within acceptable ranges for Betta fish culture. Overall, the study indicates that lower stocking densities support better biological responses, and that 1 fish L^{-1} is the most suitable for cultivation, while 2 fish L^{-1} may serve as an acceptable alternative for practical application. These findings provide a foundation for developing effective domestication protocols and support conservation-oriented aquaculture of this vulnerable endemic species.

KEYWORDS: economic value; endemic ornamental fish; *jielabu* fish; natural catch; stocking density

ABSTRAK: Pertumbuhan dan Kelangsungan Hidup Ikan Jielabu (*Betta dennisyongi *Tan, 2013) yang Dipelihara dengan Padat Tebar yang Berbeda

Betta dennisyongi*, yang dikenal secara lokal sebagai ikan Jielabu, merupakan spesies ikan hias endemik dari wilayah barat daya Nanggroe Aceh Darussalam, Indonesia. Peningkatan* *pemanfaatan dan degradasi habitatnya telah menimbulkan kekhawatiran dalam kegiatan konservasi dan menekankan perlunya upaya domestikasi. Penelitian ini bertujuan untuk menentukan padat tebar yang sesuai untuk pemeliharaan awal* ***B. dennisyongi****. Penelitian dilakukan pada bulan Oktober hingga Desember 2023 menggunakan rancangan acak lengkap dengan empat padat tebar (1, 2, 3, dan 4 ekor* L^{-1}*) masing-masing dengan tiga ulangan. Benih ikan yang dikumpulkan dari alam diaklimatisasi dan dipelihara selama 60 hari dalam akuarium berkapasitas 10 L. Parameter biologis yang diukur meliputi kelangsungan hidup, laju pertumbuhan spesifik, pertambahan panjang, pertambahan bobot, rasio konversi pakan, dan efisiensi pakan, sedangkan kualitas air dipantau secara berkala. Padat tebar berpengaruh nyata terhadap kelangsungan hidup dan pertumbuhan (*$p < 0.05$*)* ***B. dennisyongi****, di mana padat tebar terendah (1 ekor* L^{-1}*) memberikan performa terbaik, sedangkan padat tebar 3–4 ekor* L^{-1} *menghasilkan performa yang lebih rendah. Rasio konversi pakan dan efisiensi pakan tidak berbeda nyata antarperlakuan (*$p > 0.05$*). Seluruh parameter kualitas air berada dalam kisaran yang sesuai untuk budidaya Betta fish. Secara keseluruhan, penelitian ini menunjukkan bahwa padat tebar rendah mendukung respons biologis yang lebih baik, dan 1 ekor* L^{-1} *merupakan padat tebar yang paling sesuai, sementara 2 ekor* L^{-1} *masih dapat diaplikasikan. Temuan ini menjadi dasar bagi pengembangan protokol domestikasi yang efektif dan mendukung budidaya yang berorientasi pada konservasi bagi spesies endemik rentan ini.*

KATA KUNCI: ikan hias endemik; ikan jielabu; nilai ekonomis; padat tebar; tangkapan alam

INTRODUCTION

Indonesia harbors remarkable Betta diversity, with approximately 53 species recorded—representing 71.6% of the 74 Betta species known worldwide (Froese & Pauly, 2025). Among these, four species have been documented in Aceh waters (Nur *et al.*, 2022b), including two native species: *Betta dennisyongi* Tan, 2013 and *Betta rubra* Perugia, 1893. The locally named *Jielabu* fish refers to *B. dennisyongi*, an endemic freshwater ornamental species found in the southwestern region of Nanggroe Aceh Darussalam Province, Indonesia. This Betta fish is highly valued in the ornamental trade due to its distinctive blackish base coloration and vivid red markings, which greatly enhance its aesthetic appeal (Nur *et al.*, 2022b). Color expression is one of the primary factors influencing the market value of ornamental fish (Haq *et al.*, 2022). Interest in *B. dennisyongi* increased substantially during the COVID-19 pandemic in Aceh, contributing to a rise in regional ornamental fish trading activity (Saputra *et al.*, 2024). Consequently, this Betta fish has become favored among freshwater ornamental fish enthusiasts. Its economic value is relatively high, with domestic prices ranging from IDR

50,000 to 250,000 per pair and international prices reaching approximately IDR 895,200 per pair (based on an exchange rate of USD 1 = IDR 16,000) (Nur *et al.*, 2022a).

The species' increasing commercial appeal has driven many fishermen to harvest *B. dennisyongi* intensively from the wild (Saputra *et al.*, 2024). Such continuous extraction imposes substantial pressure on natural populations, heightening their vulnerability (Low, 2019). Habitat degradation—particularly deforestation linked to oil palm plantation expansion—further exacerbates threats to the species' survival in its native environment (Nur *et al.*, 2022a). Reflecting these combined pressures, the IUCN Red List categorizes *B. dennisyongi* as a vulnerable species, indicating a high risk of extinction in the wild due to population decline, restricted distribution, and ongoing habitat loss (IUCN, 2020). These conditions underscore the urgent need for aquaculture-based culture and breeding programs to reduce dependence on wild captures and support long-term conservation (Saputra & Efianda, 2018).

One promising strategy to address these conservation challenges is domestication. Domestication involves adapting wild fish to controlled environments through managed rearing, acclimation, and reproduction (Pasquet, 2018; Teletchea, 2019). This approach is essential not only for reducing exploitation of wild populations but also for supporting potential restocking efforts for *B. dennisyongi*. Fish may be considered domesticated once they can survive, grow, and reproduce under human-managed conditions. A critical requirement for successful domestication is determining optimal husbandry practices, particularly stocking density. Since Betta fish often experience stress when transitioning from natural habitats to aquaculture systems, establishing an appropriate stocking density becomes fundamental. Therefore, this study was conducted to determine the optimal stocking density for domesticated *B. dennisyongi*.

MATERIALS AND METHODS

Time and Place

This research was conducted from October to December 2023 at the Aquaculture Systems and Technology Laboratory, Aquaculture Study Program, Teuku Umar University, West Aceh Regency, Nanggroe Aceh Darussalam Province, Indonesia. The study spanned three months, with the first month devoted to aquarium preparation and acclimation of *B. dennisyongi* (*jielabu* fish). The second and third months were allocated to experiments evaluating different stocking densities of the respected species.

Experimental Design

This study was conducted using an experimental approach. A completely randomized design (CRD) was applied, consisting of four treatments with three replications. The stocking density treatments were 1 fish L^{-1} (P1), 2 fish L^{-1} (P2), 3 fish L^{-1} (P3), and 4 fish L^{-1} (P4). The experimental design was adapted from a methodology previously applied to *B. rubra*, another native Betta species from Aceh that shares similar ecological characteristics with *B. dennisyongi* (Saputra *et al.*, 2024).

Materials and Tools

The materials used in this study included a commercial feed, PF 500 (Prima Feed), which contained 3.89% moisture, 13.03% ash, 4.63% lipid, 31.27% protein, 2.56% crude fiber, and 44.63% nitrogen-free extract. Juvenile *B. dennisyongi* (*jielabu* fish) used for the experiment were collected from a water canal in the Beutong Hills, Nagan Raya Regency, Nanggroe Aceh Darussalam Province, Indonesia. Prior to stocking, the fish were measured to determine their initial size distribution. Figure 1 shows a representative juvenile *B. dennisyongi* used in the study. The fish displayed the typical reddish-brown base coloration with prominent vertical barring.

The experimental system utilized aquarium tanks measuring 40 × 26 × 28 cm^3, with a glass thickness of 2 mm and a weight of 2.3 kg. Each tank was supplied with aeration from a Resun LP-40 air pump. Fish length measurements were taken using a ruler with a measuring range of 0–15 cm, while fish weight was recorded using a Joil digital scale with an accuracy of 0.01 g. Water quality parameters were continuously monitored: dissolved oxygen (DO) was measured using a Lutron DO-5510 (Taiwan), temperature with a standard laboratory thermometer, and pH using a Smart Sensor AS218 digital pH meter (China). Ammonia, nitrite, and nitrate concentrations were analyzed using a spectrophotometer.

Figure 1. Representative juvenile of *jielabu* fish (*B. dennisyongi* Tan, 2013)

Fish Maintenance Procedures

The experimental fish were collected from a water canal in the Beutong Hills, Nagan Raya Regency, Nanggroe Aceh Darussalam Province, Indonesia. Local fishermen gathered the fish during a one-month sampling period due its limited population in the wild, and the individuals obtained were subsequently used in this study. This sampling phase also functioned as an initial acclimation and early domestication stage for *B. dennisyongi*. The initial mean length and weight of the sampled fish were 2.92 ± 0.54 cm and 0.24 ± 0.11 g, respectively. The fish were maintained in 10-L aquaria, with stocking densities adjusted according to the experimental treatments. Water used in the study was sourced from a well, allowed to settle for 24 hours to reduce potentially harmful dissolved substances such as heavy metals or organic compounds, and then transferred into the experimental aquaria. Each aquarium was filled with a working volume of 10 L.

During the collection and preliminary acclimation phase, the fish were fed *Tubifex* sp. *ad libitum*. To transition the fish to a commercial diet, *Tubifex* sp. was gradually alternated with PF 500 commercial feed until the fish readily consumed the pellets. Pellet acceptance was assessed through behavioral observation, with *B. dennisyongi* displaying a strong feeding response to PF 500. Following acclimation, the fish were cultured for 60 days, with continuous aeration provided 24 hours per day. To maintain water quality, waste removal and partial water changes were conducted every three days, carried out in the morning before feeding. Feeding occurred twice daily, at 08:00 and 17:00 Western Indonesian Time, until the fish reached satiation. Fish mass was recorded at both the beginning and end of the culture period.

Test Parameters

This study evaluated several biological performance parameters, including survival rate, specific growth rate, length gain, weight gain, feed conversion ratio, and feed efficiency. Fish length was measured as total length, defined as the distance from the tip of the snout to the posterior end of the caudal fin. Both total length and body weight were recorded at the beginning and end of the experiment. Water quality parameters—including temperature, dissolved oxygen, pH, ammonia, nitrite, and nitrate—were monitored to assess the rearing environment. Water quality measurements were conducted every 10 days. Survival rate, specific growth rate, length gain, weight gain, feed conversion ratio, and feed efficiency were calculated using formula (1) to (6).

a. Survival rate (SR) (Saputra & Mahendra, 2019):

$$SR = \frac{Ni}{Nf} x\ 100 \ldots\ldots\ldots\ldots (1)$$

Where:

SR : Survival rate (%)

Ni : Final number of fish (ind)

Nf : Initial number of fish (ind)

b. Specific growth rate (SGR) (Gabriel *et al.*, 2019):

$$SGR = \frac{(\ln(Wf) - l\ \ (Wi))}{t} x\ 100 \ldots\ldots\ldots\ldots (2)$$

Where:

SGR : Specific growth rate (% $days^{-1}$)

Ln wf : Average weight of fish at the final of the study (g)

Ln wi : Average weight of fish at the initial of the study (g)

t : Maintenance duration (days)

c. Length gain (IL) (Saputra *et al.*, 2016):

$$IL = Lf - Li \ldots\ldots\ldots\ldots (3)$$

Where:

IL : Length gain (cm)

Lf : Average total length of fish at the final of the study (cm)

Li : Average total length of fish at the initial of the study (cm)

d. Weight gain (WG) (Saputra *et al.*, 2016):

$$WG\ (g) = Wf - Wi \ldots\ldots\ldots\ldots (4)$$

Where :

WG : Weight gain (g)

Wf : Average weight of fish at the final of the study (g)

Wi : Average weight of fish at the initial of the study (g)

e. Feed conversion ratio (FCR) (Rodde *et al*., 2021):

$$FCR = \frac{FC}{Wf + Wd - Wi} \quad \text{..........(5)}$$

Where :

FCR : Feed conversion ratio

FC : Total feed consumed by fish (g)

Wf : Average weight of fish at the final of the study (g)

Wd : Average weight of dead fish (g)

Wi : Average weight of fish at the initial of the study (g)

f. Feed efficiency (FE) (Gabriel *et al*., 2019):

$$FE = \frac{Wf + Wd - Wi}{FC} \; x \; 100 \quad \text{..........(6)}$$

Where :

FE : Feed efficiency (%)

Wf : Average weight of fish at the final of the study (g)

Wd : Average weight of dead fish (g)

Wi : Average weight of fish at the initial of the study (g)

FC : Total feed consumed by fish (g)

Data Analysis

The collected research data were organized and tabulated using Microsoft Excel. Statistical analyses were conducted using SPSS version 25.0. Analysis of variance (ANOVA) was employed to determine whether the experimental treatments produced statistically significant differences in the measured parameters. When ANOVA indicated significant variation among treatments, Duncan's multiple range test was subsequently applied to compare treatment means and identify specific groups that differed statistically ($p < 0.05$).

RESULTS AND DISCUSSION

Statistical analysis showed that variations in stocking density significantly affected ($p < 0.05$) the survival rate and growth performance of *jielabu* fish (*B. dennisyongi*). The results for survival rate and growth parameters are presented in Table 1, while the ranges of water quality parameters during the 60-day culture period are summarized in Table 2.

Table 1. Mean and standard deviation of survival rate and growth of *jielabu* fish (*B. dennisyongi*, Tan 2013) reared with different stocking densities for 60 days

Treatments	SR [%]	SGR [% days^{-1}]	IL [cm]	WG [g]	FCR	FE [%]
P1	100 ± 0.00^{a}	1.391 ± 0.15^{a}	0.920 ± 0.34^{a}	0.314 ± 0.31^{a}	1.414 ± 0.20^{a}	71.74 ± 10.70^{a}
P2	93.3 ± 5.77^{ab}	1.329 ± 0.15^{a}	0.722 ± 0.26^{a}	0.294 ± 0.29^{a}	1.298 ± 0.34^{a}	80.44 ± 19.86^{a}
P3	91.11 ± 3.85^{b}	0.966 ± 0.11^{b}	0.695 ± 0.08^{a}	0.189 ± 0.18^{b}	1.284 ± 0.27^{a}	80.05 ± 15.37^{a}
P4	91.66 ± 2.89^{b}	0.893 ± 0.12^{b}	0.508 ± 0.03^{a}	0.170 ± 0.17^{b}	1.353 ± 0.17^{a}	74.78 ± 10.34^{a}

Note: Values with different superscript letters in the same column indicate significantly different results ($p < 0.05$). P1= 1 fish L^{-1}, P2= 2 fish L^{-1}, P3= 3 fish L^{-1}, P4: 4 fish L^{-1}. SR = survival rate; SGR = specific growth rate; IL = length gain; WG = weight gain, FCR = feed conversion ratio; FE = feed efficiency.

Table 2. Range value of water quality measured from the rearing medium of *jielabu* fish (*B. dennisyongi*, Tan 2013) reared with different stocking densities for 60 days

Water Quality	Unit	P1	P2	P3	P4
Temperature	°C	29.0 - 30.1	28.7 - 30.9	29.8 - 30.6	28.6 - 30.7
pH		6.3 - 7.7	6.6 - 7.4	6.2 - 7.8	6.5 - 7.9
DO	mg L^{-1}	5.23 - 5.60	5.76 - 5.89	5.28 - 5.67	5.16 - 5.89
NH_3	mg L^{-1}	0.21 - 0.60	0.37 - 0.58	0.27 - 0.60	0.38 - 0.60
NO_2	mg L^{-1}	0.393 - 1.113	0.626 - 0.996	0.390 - 0.926	0.305 - 0.720
NO_3	mg L^{-1}	1.6 - 5.7	1.8 - 3.3	0.5 - 3.7	1.4 - 2.3
Alkalinity	mg L^{-1}	80 - 140	80 - 120	80 - 120	100 – 120

Note: P1= 1 fish L^{-1}, P2= 2 fish L^{-1}, P3= 3 fish L^{-1}, P4: 4 fish L^{-1}.

The highest survival rate (SR) was observed in P1 treatment (1 fish L^{-1}), reaching 100 ± 0.00% (Table 1). Stocking density is known to influence fish stress levels throughout the culture period (Sofian *et al.*, 2016), and lower densities generally reduce stress, thereby increasing survival. The findings of this study are consistent with James and Sampath (2006), who reported that higher stocking densities in *B. splendens* result in lower growth and survival.

Lower stocking densities alleviate stress by minimizing disruption of homeostasis, which can be triggered by excessive population density, handling, suboptimal water quality, or the presence of predators (Schreck & Tort, 2016). Reduced density also decreases competition for space and feed (Latifah *et al.*, 2022). Ample swimming space helps reduce stress, allowing fish to maintain better physiological stability and consequently higher survival (Arianto *et al.*, 2019).

Treatments P3 and P4 exhibited the lowest survival rates, at 91.11 ± 3.85% and 91.66 ± 2.89%, respectively. These results indicate that stocking densities of 3–4 fish L^{-1} are excessive for *B. dennisyongi*. High stocking densities increase stress levels in cultured fish (Jia *et al.*, 2022), and prolonged stress negatively affects fish health and survival (Aura *et al.*, 2025).

The highest growth performance was also recorded in the P1 treatment, with a specific growth rate (SGR) of 1.391 ± 0.15% day^{-1}, length gain (IL) of 0.920 ± 0.34 cm, and weight gain (WG) of 0.314 ± 0.31 g (Table 1). Enhanced growth at lower stocking densities is attributed to reduced competition for feed, oxygen, and space, allowing fish to move more freely and efficiently utilize available resources. Mutia *et al.* (2020) similarly reported that lower stocking densities support better growth due to decreased competition and improved access to feed and oxygen.

Conversely, the lowest growth performance occurred in the P4 treatment (4 fish L^{-1}), with an SGR of 0.893 ± 0.12% day^{-1}, IL of 0.508 ± 0.03 cm, and WG of 0.170 ± 0.17 g. Growth reduction at high densities is likely due to increased competition for movement space, oxygen, and feed, leading to suboptimal physiological conditions. Permana *et al.* (2024) emphasize that high stocking densities intensify competition and metabolic waste accumulation (CO_2 and feces), which can further compromise water quality and growth.

Differences in stocking density did not significantly influence ($p > 0.05$) feed conversion ratio (FCR) or feed efficiency (FE). Across treatments, FCR values were below 1.5, and FE values exceeded 70% (Table 1), indicating that the feed provided was nutritionally adequate and efficiently utilized by *B. dennisyongi*. In aquaculture, an ideal FCR approaches 1.0, while acceptable ranges vary from 1.0 to 2.4 depending on species, feed type, and culture practices (Fatima *et al.*, 2020; Fry *et al.*, 2018). Lower FCR values indicate more efficient feed utilization. Feed efficiency values above 50% are considered good, meaning a large proportion of feed is converted into biomass. The results suggest that both the feed quality and digestive efficiency of *B. dennisyongi* were satisfactory.

Water quality plays a crucial role in determining fish survival and growth (Saputra *et al.*, 2024). Poor water quality results in reduced performance, while good water quality supports optimal fish health and productivity (Hridoy *et al.*, 2025). The pH values during the study ranged between 6.2 and 7.9 (Table 2). Rachmawati *et al.* (2016) reported that pH 6–7 is optimal for ornamental Betta fish. Temperature ranged from 28.6 to 30.9°C, which falls within the recommended range of 27–32°C for Betta fish culture. The optimal temperature for Betta fish is approximately 28°C (Lichak *et al.*, 2022; Nisa *et al.*, 2023). Dissolved oxygen (DO) values ranged from 5.16 to 5.89 mg L^{-1}. Matielo *et al.* (2019) noted that DO ≥ 5 mg L^{-1} is suitable for Betta culture, and Linayati *et al.* (2022) suggested an optimal range of 5.8–8.2 mg L^{-1}. Ammonia concentrations ranged from 0.21 to 0.60 mg L^{-1}, which falls within the acceptable range for ornamental fish (0.0–0.9 mg L^{-1}) (Oliveira *et al.*, 2008). Concentrations exceeding 1.5 mg L^{-1} may become toxic (Wahyuningsih & Gitarama, 2020). Nitrite concentrations (0.305–1.113 mg L^{-1}) were within safe limits. Xu *et al.* (2022) reported that nitrite becomes toxic at ≥ 29.36 mg L^{-1}. Betta fish are relatively tolerant due to their labyrinth organ, which allows aerial respiration and reduces nitrite and ammonia uptake through the gills (Kajimura *et al.*, 2023). Nitrate concentrations (0.5–5.7 mg L^{-1}) were also within acceptable levels for freshwater culture (0.62–9.79 mg L^{-1}) (Deswati *et al.*, 2023). Concentrations exceeding 10 mg L^{-1} may be harmful.

CONCLUSIONS

This study underscores the critical role of stocking density in shaping the culture performance of *jielabu* fish (*B. dennisyongi*). Among the densities evaluated, 1 fish L^{-1} provides the most favorable biological response, while 2 fish L^{-1} remains a viable option, as its performance does not differ meaningfully from the lower density. These findings offer practical guidance for establishing stocking practices that support the domestication and aquaculture development of this endemic species.

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AUTHOR CONTRIBUTION

3 FS: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Resources, Project administration, Supervision, Writing – original draft, Writing – review and editing; ZZ: Data curation, Investigation, Methodology, Resources, Writing – review and editing; MAN: Data curation, Formal Analysis, Investigation, Resources, Software; AFS: Methodology, Validation, Writing – original draft; MM: Methodology, Validation, Writing – 12 original draft; MA: Investigation, Resources, Writing – review and editing; DASU: Validation,

Visualization, Writing – review and editing; SS: Formal Analysis, Methodology, Visualization, Writing – original draft.

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DECLARATION OF COMPETING INTEREST AND USE OF GENERATIVE AI

The authors declare that there are no conflicts of interest. The authors did not employ generative AI or AI-assisted tools for the writing or editing of this manuscript, aside from routine spelling and grammar reviews.

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