

Domestication of Spawning and Nursery of Seluang Fish (*Rasbora argyrotaenia*)

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ABSTRACT

Seluang fish (*Rasbora argyrotaenia*) is a freshwater fish with promising aquaculture potential, but successful domestication requires reliable captive breeding and larval rearing techniques. This study evaluated two domestication-related experiments conducted under controlled laboratory conditions. The first experiment assessed the effects of broodstock sex ratio on spawning performance using three male-to-female ratios (1:1, 2:1, and 3:1), each with three replicates. A total of 12 female and 24 male broodstock were used. Reproductive performance was evaluated based on fecundity, fertilization rate (FR), and hatching rate (HR). The second experiment examined the effects of three larval feeds (MeM Prime 500 µm, dried silkworm meal, and PF-0 feed) on nursery performance. A total of 2,400 larvae were stocked at 200 larvae per aquarium and reared for 30 days. Growth in length and weight, survival rate (SR), and feed conversion ratio (FCR) were measured. Data were analyzed using one-way ANOVA at a 95% confidence level. In the spawning experiment, broodstock sex ratio had no significant effect on fecundity (469–605 eggs; $p = 0.0503$) or fertilization rate (79.75–84.75%; $p = 0.8603$). Hatching rate ranged from 82.50% to 85.43%; however, the reported ANOVA result ($p = 0.4719$) indicated no significant difference among treatments. In the nursery experiment, feed type did not significantly affect length growth (15.82–17.85 mm; $p = 0.9029$), weight gain (1.95–2.01 g; $p = 0.9985$), survival rate (82.75–85.65%; $p = 0.5913$), or FCR (1.40–1.44; $p = 0.5913$). Water quality remained within acceptable ranges for spawning and larval rearing throughout the study. These findings indicate that the tested broodstock sex ratios and larval feed types produced comparable reproductive and nursery performance under the conditions evaluated.

INTRODUCTION

The genus *Rasbora* comprises freshwater fishes widely distributed throughout Southeast Asia, including Indonesia (Syarif *et al.*, 2023). Several species have substantial economic value: *Rasbora argyrotaenia* and *Rasbora sumatrana* are consumed locally, whereas *Rasbora trilineata* is widely traded as an ornamental species because of its attractive appearance, peaceful behavior, and adaptability to aquarium conditions

(Kasamawut *et al.*, 2025). Seluang fish (*R. argyrotaenia*) is therefore an important freshwater commodity in Indonesia, both as a food fish and as a potential ornamental species (Ningrum *et al.*, 2019). Increasing domestic and international demand has stimulated interest in its aquaculture development. However, the sustainability of wild populations is threatened by intensive harvesting and habitat degradation associated with human activities (Yanti, 2019; Inda *et al.*, 2025). These pressures emphasize the need to shift from dependence on wild capture toward controlled and sustainable production. Developing reliable culture techniques for *R. argyrotaenia* would support species conservation, diversify aquaculture production, and create additional economic opportunities for local communities (Syarif *et al.*, 2025).

Fish domestication is the progressive adaptation of a species from its natural habitat to controlled culture conditions, including artificial environments, formulated feeds, and managed reproduction. It is a fundamental prerequisite for large-scale production and *ex situ* conservation (Augusta, 2018). Domestication generally involves three sequential stages: successful survival under culture conditions, sustained growth, and reliable reproduction in captivity (Effendi, 2004). The process includes the selection of suitable wild stocks, preparation of appropriate rearing facilities, provision of nutritionally adequate feeds, maintenance of suitable water quality, and selective breeding to improve production traits (Zonneveld, 2017; Sulistiyanto, 2019; Widyastuti, 2020). Complete domestication requires closure of the life cycle in captivity without continued dependence on wild-caught eggs, larvae, juveniles, or broodstock (Liao & Huang, 2000; Bilio, 2007). Accordingly, effective broodstock management and successful larval and juvenile rearing are central to the domestication process (Bilio, 2007; Teletchea & Fontaine, 2011).

Broodstock management includes the selection and conditioning of mature fish, induction or control of spawning, gamete collection, fertilization, and egg incubation (Liao *et al.*, 2001). Equally important is the development of appropriate nursery systems and feeding strategies for larvae and juveniles. Stocking density can strongly influence growth performance and water quality during the nursery phase of silver rasbora (Azhar *et al.*, 2022). Once the full life cycle is completed consistently in captivity, domestication can progress toward reliable seed production and commercial culture. For species with ecological and economic value, such as *R. argyrotaenia*, this process can contribute simultaneously to conservation and rural livelihoods (Ferawati *et al.*, 2025).

The present study therefore evaluated controlled spawning and nursery performance of seluang fish (*R. argyrotaenia*). Specifically, it examined whether broodstock sex ratio affected reproductive performance and whether different feed types influenced larval growth, feed utilization, and survival. The results are intended to support the development of practical and sustainable culture protocols for this species.

MATERIALS AND METHODS

1. Place and Time of Research

The research was conducted in June–September 2025 at the Wet Laboratory of the Faculty of Fisheries and Marine Sciences, Lambung Mangkurat University, Banjarmasin in Banjarbaru, Indonesia. Broodstock of seluang fish (*Rasbora argyrotaenia*) were collected from the inland waters of South Kalimantan Province, Indonesia, using local fishing gear operated by experienced fishermen. The fish were transported to the Aquaculture Laboratory of the Faculty of Fisheries and Marine Sciences, Lambung Mangkurat University in aerated containers to minimize handling stress and maintain water quality during transportation. Upon arrival, the broodstock were acclimated to laboratory conditions for 14 days before the experiment commenced. During the acclimation period, fish were maintained in holding tanks under controlled environmental conditions and fed a commercial diet twice daily. All experimental procedures involving fish handling, maintenance, and spawning were conducted in accordance with institutional guidelines for animal welfare. The study was reviewed and approved by the relevant institutional authority. Broodstock collection was conducted with the permission of local authorities and complied with applicable regulations governing the collection and use of aquatic organisms for research purposes.

2. Tools and Materials

The tools and materials used in the first and second stages of research are summarized below in Table (1).

Table 1. Tools and materials used in the first and second experiments.

No	Tool name	Amount	Utility
	Tool		
1.	Aquarium 40×30×30 cm	9 pieces	Test container
2.	Aerator stone	9 pieces	Oxygen supply
3.	Petri dish	4 pieces	Sample counting container
4.	Stationery	4 pieces	Recording data
5.	Digital Ruler	4 pieces	Measuring length
6.	0.1 g Digital scale	2 pieces	Measuring weight
7.	scoop	24 pieces	Fishing tools
8.	Thermometer	1 piece	Temperature measuring device
9.	pH Meter	1 piece	pH Meter
10.	DO meter	1 piece	DO measuring instrument
11.	Blower	1 piece	Produce oxygen/aeration
12.	Spectrophotometer	1 piece	Ammonia measuring instrument
	Material		

1.	Male Seluang fish broodstock	24 tails	First stage research
2.	Female Seluang Broodstock	12 tails	First stage research
3.	PF 800 Feed		First stage research
4.	Larvae 3 Days Old Opportunity	2400 heads	Second stage research object
5.	MeM Prime 500 µm Feed	-	Feed for larvae second research
6.	Silkworm Feed	-	Feed for larvae second research
7.	PF 0 Feed	-	Feed for larvae second research



Fig. 1. Seluang fish.



Fig. 2. Spawning aquarium for seluang fish.

3. First Research Work Procedure

This study comprised two experiments: the first evaluated spawning under different broodstock sex ratios, whereas the second evaluated feed types during larval rearing to 30 days of age.

a. Selection and Management of Broodstock

Broodstock were selected only when they exhibited clear signs of gonadal maturity. Mature females had enlarged abdomens and released yellow eggs after gentle abdominal pressure, whereas mature males had slimmer bodies and released milky-white milt during stripping. Female broodstock weighed 7.5–10.5 g and measured 5.5–7.6 cm

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in total length. Before spawning, all broodstock were conditioned with PF-800 pellets containing 39% crude protein. Feed was supplied daily at 3% of total biomass in four equal meals at 07:00, 11:00, 15:00, and 19:00 h to provide adequate nutrients for gonadal development.

b. Seluang Fish Spawning

Natural spawning was conducted in nine aquaria measuring $40 \times 30 \times 30$ cm, each filled to a water depth of 30 cm. Before use, the aquaria and spawning substrates were cleaned and disinfected. Kakaban prepared from coconut fiber was placed inside each aquarium as an egg-attachment substrate and secured with weighted netting. Spawning generally occurred at night. During courtship, males actively pursued females and stimulated them through body contact, after which females released eggs onto the substrate and males released sperm for external fertilization. Broodstock were removed immediately after eggs were detected to minimize egg predation and cannibalism.

Eggs were counted immediately after the completion of the spawning event, approximately 12 hours after broodstock introduction into the spawning aquarium. Following spawning, all broodstock were carefully removed from the aquarium before egg counting was conducted to prevent egg predation and disturbance. The eggs attached to the spawning substrate and those deposited on the tank bottom were collected and counted manually. Observations were performed promptly after broodstock removal to minimize the possibility of egg loss, fungal infection, or mechanical damage. These procedures were implemented to ensure accurate estimation of fecundity, fertilization rate, and hatching success.

4. Second Research Work Procedure

The work procedures carried out during the research were:

1. Preparation of aquarium container

Twelve aquaria ($40 \times 30 \times 30$ cm) were cleaned thoroughly, rinsed with clean water, and filled to approximately half of their capacity with well water. Salt was added as part of the routine water-preparation procedure before larval stocking.

2. Aeration preparation

Each aquarium was supplied with continuous aeration from a central blower to maintain adequate dissolved oxygen throughout the nursery period.

3. Preparation of larvae of seluang fish

Larvae used in the nursery experiment were obtained from captive spawning of wild-origin broodstock. Before spawning, broodstock were acclimated to laboratory conditions to reduce handling stress. Three-day-old larvae that were actively swimming and had absorbed their yolk reserves were stocked at 200

larvae per aquarium. Survival was monitored from the second day after transfer to the nursery aquaria.

4. Feed Preparation, Maintenance and Feeding

Three feeds were evaluated: MeM Prime (500 µm), dried silkworm meal, and PF-0. Each feed was selected to match the mouth size and digestive capacity of the larvae. Fish were fed four times daily at 07:00, 11:00, 15:00, and 19:00 h for 30 days. The daily ration was maintained at approximately 3–5% of biomass and adjusted according to fish growth.

5. Hypothesis and research design

The study followed a completely randomized design and consisted of two independent experiments. In the spawning experiment, broodstock were assigned to male-to-female ratios of 1:1, 2:1, and 3:1, with three replicates per treatment. Reproductive responses included fecundity, fertilization rate, and hatching rate. In the nursery experiment, larvae received one of three feeds: MeM Prime 500 µm (Treatment A), silkworm meal (Treatment B), or PF-0 (Treatment C), also with three replicates per treatment. Growth in length and weight, survival rate, and feed conversion ratio were evaluated.

First stage research hypothesis:

Ho = sex ratio of seluang fish (*Rasbora argyrotaenia*) has no effect on the number of eggs, fertilized eggs and their hatchability

H1 = Sex ratio of seluang fish (*Rasbora argyrotaenia*) significantly affects the number of eggs, fertilized eggs and their hatchability.

Meanwhile, the second research hypothesis:

Ho = different types of food do not affect the growth and survival of seluang larvae and juveniles of seluang fish (*Rasbora argyrotaenia*)

H1 = different types of food affect the growth and survival of seluang larvae and juveniles of seluang fish (*Rasbora argyrotaenia*)

6. First research parameter

a. Fecundity

Fecundity was defined as the total number of eggs released by a female during a spawning event, irrespective of whether the eggs were fertilized.

b. Egg Fruit Power (Fertilization Rate- FR)

Fertilization rate (FR) was determined as the percentage of eggs that showed

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normal early embryonic development after fertilization. Egg samples were examined microscopically, and eggs showing normal cleavage were classified as fertilized.

$$FR = \frac{\text{Number of fertilized eggs}}{\text{Total number of eggs laid}} \times 100\%$$

c. Egg Hatchability (Hatching Rate)

Hatching rate (HR) was calculated as the percentage of fertilized eggs that successfully hatched into live larvae.

7. Second Research Parameter

- a. Absolute growth in length and weight was calculated as the difference between the final and initial measurements of each variable.
- b. Feed conversion ratio (FCR) was calculated as the total amount of feed consumed divided by the corresponding increase in fish biomass.
- c. Survival rate (SR) was calculated as the number of fish remaining at the end of the experiment divided by the initial number stocked, multiplied by 100.

8. Physical-Chemical Parameters of Water

During the spawning experiment, water quality was measured before and after spawning. During the nursery experiment, water temperature, pH, dissolved oxygen, and ammonia were measured every five days using a thermometer, pH meter, dissolved-oxygen meter, and spectrophotometer, respectively. These measurements were used to verify that culture conditions remained suitable throughout both experiments.

9. Research Data Analysis

Data from the two experiments were analyzed separately using SPSS version 25.0 for Windows. Normality and homogeneity of variance were assessed before analysis. Treatment effects were evaluated by one-way analysis of variance (ANOVA) at a 95% confidence level. When significant differences were detected, means were compared using the Honestly Significant Difference (HSD) test. Water-quality data were summarized descriptively.

- If $F_{\text{count}} < f_{\text{table}} (5\%, 1\%)$ accept H_0 , reject H_1
 - If $F_{\text{calculated}} > f_{\text{table}} (5\%, 1\%)$, accept H_1 and, reject H_0 .
- If the calculation results were significantly different, further test calculations were carried

out using the Honestly Significant Difference (BNJ) test.

Environmental quality data (water) obtained from sample measurements were then analyzed descriptively to determine their effect on the main parameters of the study. Data from specific areas were analyzed descriptively and compared with the latest updated research.

RESULTS

The reproductive and nursery responses are summarized in Table (1). Reproductive variables included fecundity, fertilization rate, and hatching rate, whereas nursery variables included growth in length and weight, survival rate, and feed conversion ratio. Water-quality measurements are presented separately in Table (2).

Table 1. Research results on domestication of spawning and nursery of seluang fish.

Treatment	Parameters						
	Fecundity (egg)	Fertilization Rate (%)	Hatching Rate (%)	Length Growth (mm)	Weight Growth (g)	Survival Rate (%)	FCR
Treatment A	469±98.86 ^a	79.75±3.49 ^a	82.50±1.29 ^a	15.82±1.676 ^a	1.95±0.129 ^a	82.75±3.403 ^a	1.40±0.051 ^a
Treatment B	605±62.14 ^a	84.25±2.63 ^a	85.43±1.90 ^a	17.85±1.415 ^a	2.01±0.122 ^a	85.65±2.385 ^a	1.44±0.065 ^a
Treatment C	579±90.55 ^a	84.75±1.89 ^a	83.50±0.58 ^a	17.43±1.049 ^a	1.97±0.095 ^a	84.10±3.792 ^a	1.44±0.059 ^a

1. Fecundity of Seluang Fish (Egg)

Broodstock sex ratio did not significantly affect fecundity ($p = 0.0503$). Mean fecundity ranged from 469 ± 98.86 eggs in Treatment A to 605 ± 62.14 eggs in Treatment B. Although Treatment B produced the highest numerical mean, the difference among treatments was not statistically significant (Fig. 3).

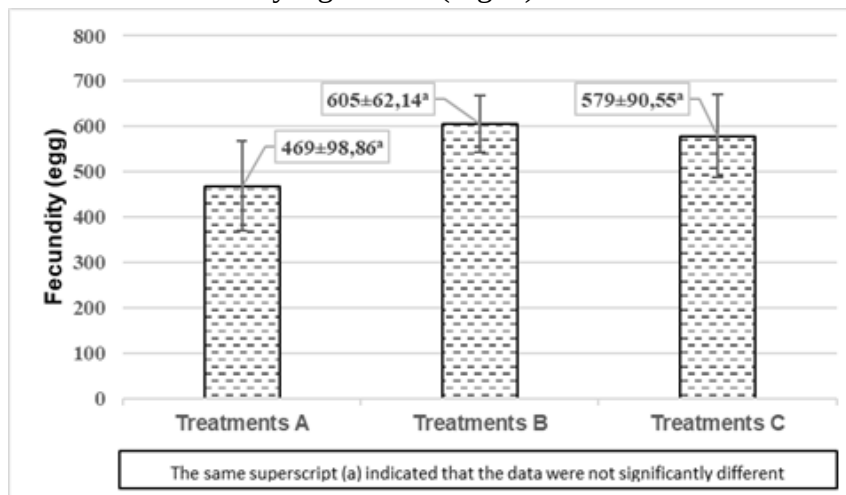


Fig. 3. Mean fecundity of seluang fish.

2. Fertilized Seluang Fish Eggs (%)

Fertilization rate did not differ significantly among broodstock sex-ratio treatments ($p = 0.8603$). Mean values ranged from $79.75 \pm 3.49\%$ in Treatment A to $84.75 \pm 1.89\%$ in Treatment C. The slightly higher value in Treatment C was numerical only and was not supported by a significant treatment effect (Fig. 4).

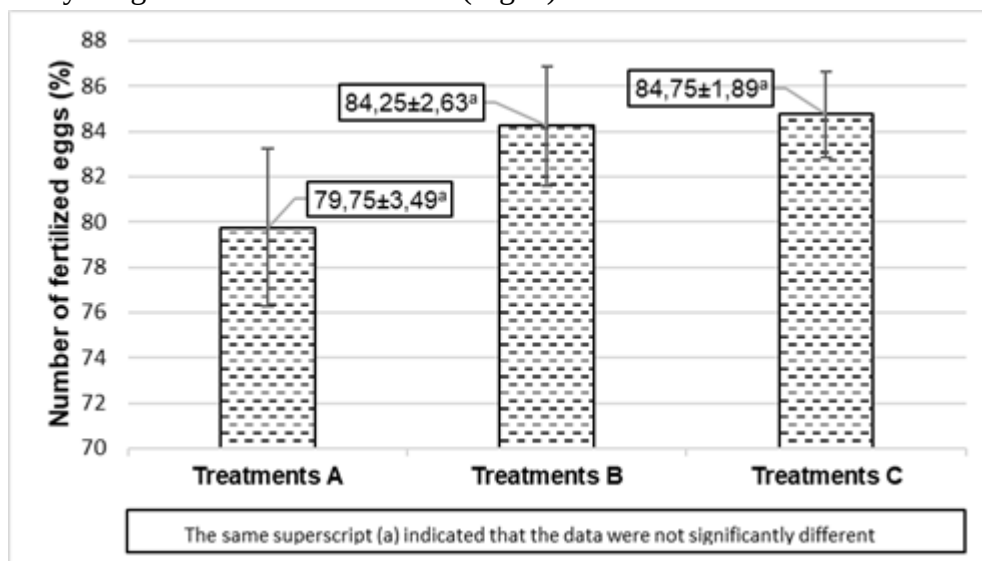


Fig. 4. Mean fertilized seluang fish (eggs).

3. Hatching Rate of Seluang Fish (%)

Hatching rate ranged from $82.50 \pm 1.29\%$ to $85.43 \pm 1.90\%$ and did not differ significantly among treatments ($p = 0.471866$). Treatment B produced the highest numerical mean, but this value was statistically comparable with those of treatments A and C (Fig. 5).

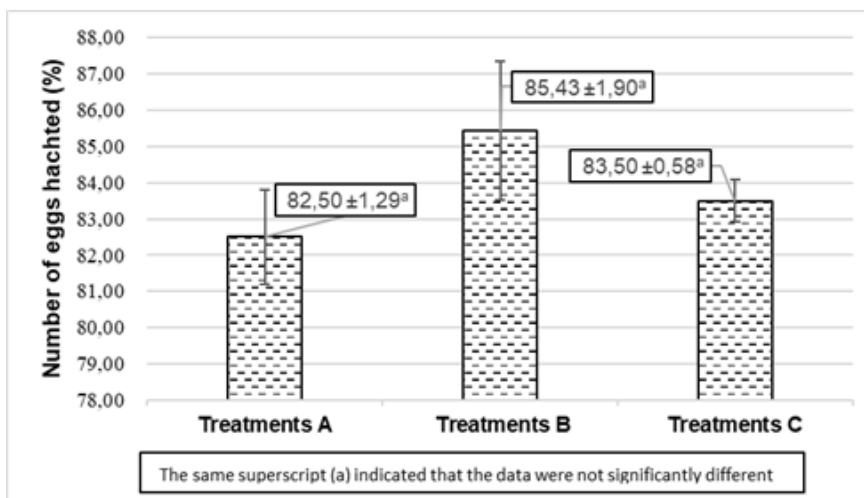


Fig. 5. Mean number of hatched seluang fish eggs (%).

4. Increase in Length of Seluang Fish Seeds (mm)

Feed type did not significantly affect larval length gain ($p = 0.9029$). Mean length gain ranged from 15.82 ± 1.676 mm in Treatment A to 17.85 ± 1.415 mm in Treatment B (Fig. 6).

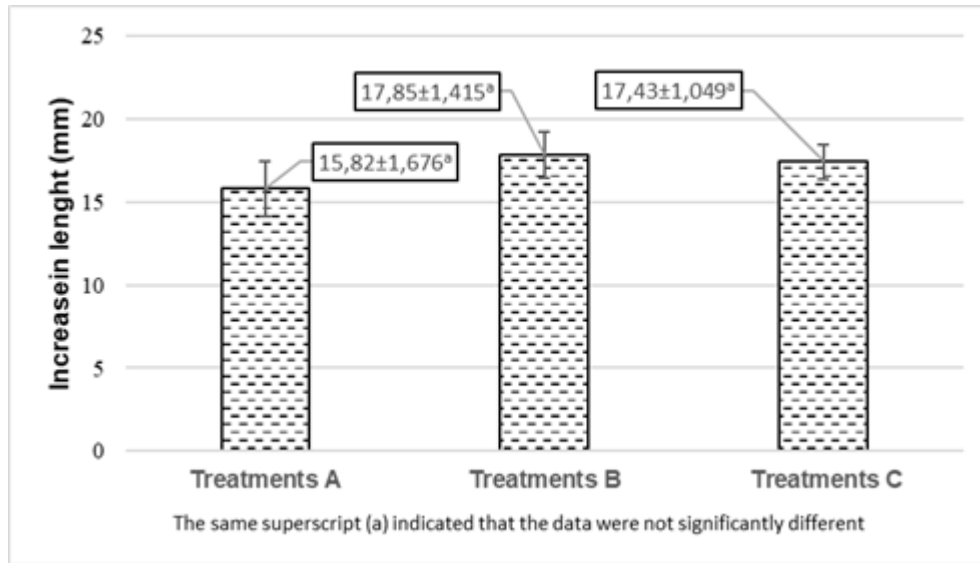


Fig. 6. Mean of increase in length of seluang fish seeds (mm).

5. Seluang Fish Seed Weight Increase (g)

Larval weight gain was also unaffected by feed type ($p = 0.9985$). Treatment B produced the highest numerical mean (2.01 ± 0.122 g), whereas treatments A and C produced mean gains of 1.95 ± 0.129 and 1.97 ± 0.095 g, respectively (Fig. 7).

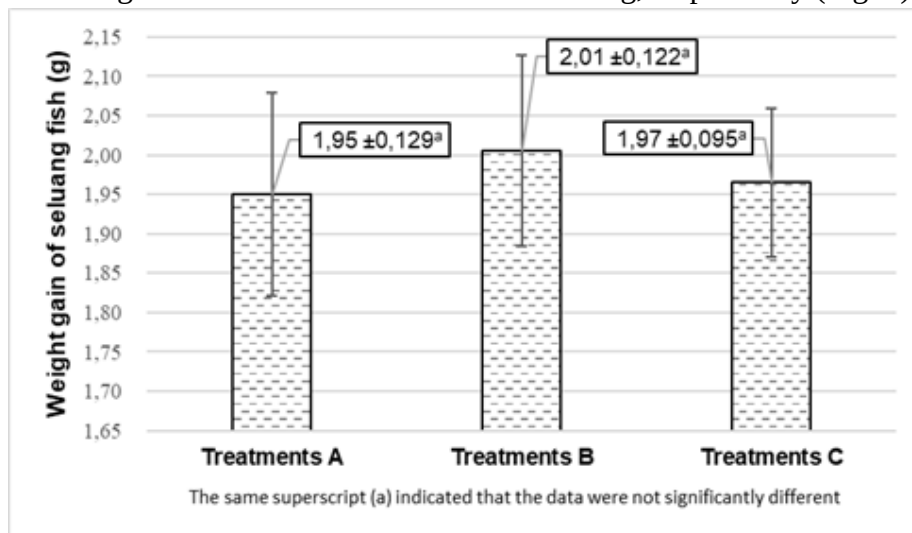


Fig. 7. Mean of seluang fish seed weight increase (g).

6. Survival Rate of Larvae to Seed (%)

Survival rate did not differ significantly among feed treatments ($p = 0.591332$). Mean survival ranged from $82.75 \pm 3.403\%$ in Treatment A to $85.65 \pm 2.385\%$ in Treatment B (Fig. 8).

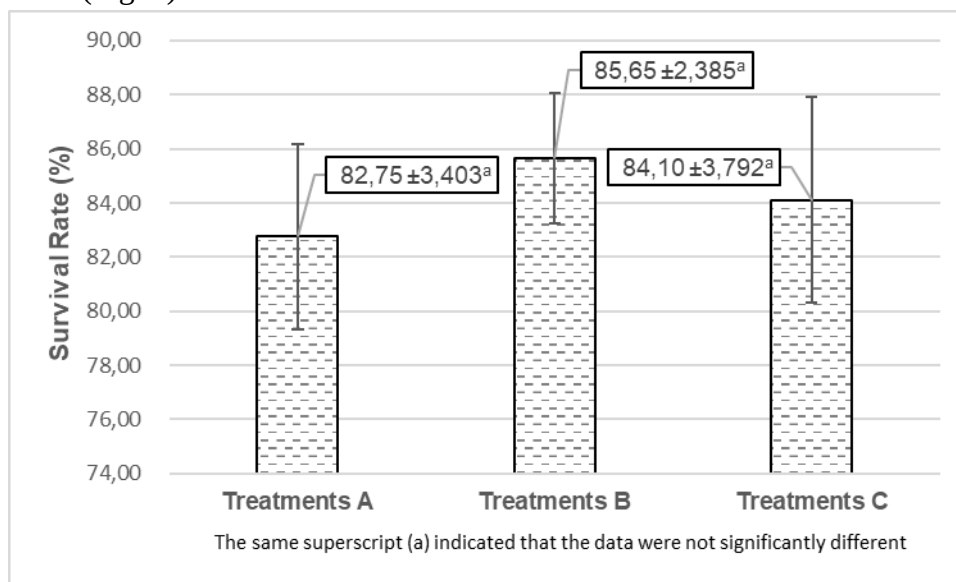


Fig. 8. Survival rate of larvae to juvenile (%).

7. Feed Conversion of Seluang Fish

Feed conversion ratio was statistically similar among treatments ($p = 0.233413$). Mean FCR values ranged from 1.40 ± 0.051 in Treatment A to 1.44 ± 0.065 in Treatment B and 1.44 ± 0.059 in Treatment C (Fig. 9).

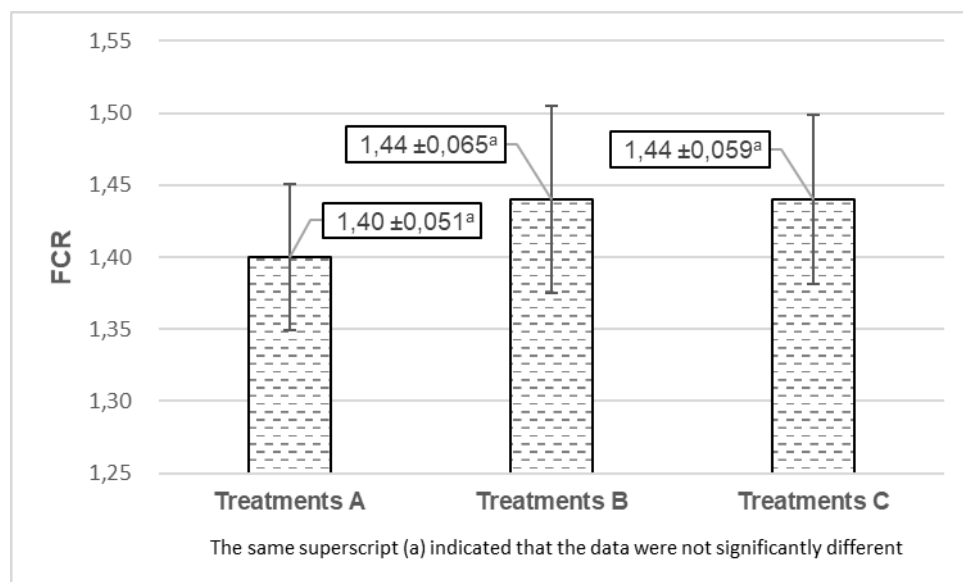


Fig. 9. Feed conversion of seluang fish.

8. Seluang Fish Water Quality

During spawning, water temperature ranged from 27.0 to 29.0 °C, dissolved oxygen from 3.68 to 4.50 mg L⁻¹, pH from 6.98 to 7.21, and ammonia from 0.03 to 0.09 mg L⁻¹. During nursery rearing, temperature ranged from 27.0 to 29.5 °C, dissolved oxygen from 3.65 to 4.80 mg L⁻¹, pH from 6.88 to 7.20, and ammonia from 0.03 to 0.09 mg L⁻¹. These values indicate that culture conditions remained relatively stable throughout the study.

Table 2. Water quality analysis results.

Treatment	Parameters			
	Temperature	DO	pH	Ammonia
Treatment A	27.25±0.29	4.00±0.39	7.20±0.05	0.05±0.00
Treatment B	27.75±0.65	4.04±0.45	6.99±0.08	0.05±0.00
Treatment C	28.25±0.87	3.79±0.08	7.11±0.11	0.05±0.00

DISCUSSION

Relative fecundity, expressed as the number of eggs per unit broodstock weight, is generally more informative than absolute fecundity when comparing reproductive performance among fish of different sizes (Akhdiana *et al.*, 2021a). In the present study, absolute fecundity ranged from 469 to 605 eggs and was not significantly affected by broodstock sex ratio. The numerical maximum observed at a 2:1 male-to-female ratio may reflect variation in female maturity or spawning readiness rather than a consistent treatment effect. Reported fecundity values for *R. argyroteenia* vary widely among populations and experimental conditions, ranging from approximately 1,143 to more than 4,800 eggs per female (Lisna, 2011; Zubaidah *et al.*, 2021; Harijono *et al.*, 2025). Such variation is expected because fecundity is influenced by broodstock size, nutritional

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status, gonadal maturity, and environmental conditions. The present values should therefore be interpreted in relation to the relatively small body size of the broodstock and the conditions of captive spawning.

Fertilization rate reflects the combined quality of the oocytes and sperm as well as the effectiveness of gamete interaction. In this study, fertilization rates were high (79.75–84.75%) and statistically comparable among sex-ratio treatments. This indicates that a 1:1 ratio was sufficient to achieve effective fertilization under the experimental conditions and that increasing the number of males did not provide a measurable advantage. Previous studies have reported fertilization rates of 90.8–97.65% for *R. argyrotaenia*, although differences in broodstock conditioning, spawning induction, and egg-handling procedures limit direct comparison (**Zamroni et al., 2011**).

Hatching rate was similarly unaffected by sex ratio and remained above 82% in all treatments. These values fall within the broad range previously reported for *R. argyrotaenia* and related rasbora species (**Zamroni et al., 2011; Zubaidah et al., 2021; Harijono et al., 2025**). Because all treatments were exposed to comparable incubation conditions, the absence of significant differences suggests that egg quality and environmental stability were more influential than the number of males assigned per female. The numerically higher hatching rate in Treatment B should therefore not be interpreted as evidence of a superior sex ratio.

Early growth of *R. argyrotaenia* larvae is rapid during the first days after hatching, followed by a slower phase as endogenous reserves are depleted and exogenous feeding becomes established (**Zamroni et al., 2011**). Reported larval sizes increase from approximately 3–4 mm shortly after hatching to about 6 mm by nine days of age. In the present study, larvae reached length gains of 15.82–17.85 mm over 30 days, with no significant differences among feed treatments. This suggests that all three feeds were sufficiently acceptable and nutritionally adequate to support early growth under the tested conditions.

Initial larval size is an important determinant of subsequent nursery performance. **Budi et al. (2020)** reported a total length of 3.14 ± 0.17 mm and a weight of 1.08 ± 0.06 mg for two-day-old larvae. By approximately one month of age, *R. argyrotaenia* juveniles commonly reach 15–20 mm total length. The growth achieved in the present study therefore falls within the expected range for the species.

Stocking density can affect both individual growth and total biomass production. **Azhar et al. (2022)** found that lower densities favored individual growth, whereas higher densities increased total biomass but reduced feed-use efficiency. In the present study, stocking density was held constant across treatments; consequently, the absence of significant growth differences is more reasonably attributed to similar utilization of the tested feeds than to density-related effects.

Survival during larval rearing is strongly influenced by feed quality, stocking density, handling, and water quality. Previous studies have reported survival rates ranging

from approximately 73% during early domestication to more than 90% under optimized feeding conditions (**Augusta, 2018; Vira *et al.*, 2023**). The survival rates recorded in the present study (82.75–85.65%) indicate generally favorable nursery conditions. Because survival did not differ significantly among feeds, none of the tested diets appeared to impose a marked disadvantage during the 30-day rearing period.

The survival values obtained here were higher than the 47% reported by **Ritonga *et al.* (2022)** but lower than the 96.52–98.09% reported for wader cakul by **Zubaidah *et al.* (2021)**. Differences among studies may reflect variation in species, stocking density, feed quality, handling practices, and environmental conditions. Such comparisons should therefore be interpreted cautiously.

Feed conversion ratio ranged from 1.40 to 1.44 and did not differ significantly among treatments. These values indicate efficient feed utilization and are substantially lower than the FCR of 2.8 reported during early domestication trials (**Augusta, 2018**). **Azhar *et al.* (2022)** similarly showed that FCR in silver rasbora is sensitive to stocking density and culture conditions. Because all treatments in the present study were maintained under comparable conditions, the similar FCR values indicate that the three feeds supported broadly equivalent feed-use efficiency.

The similarity in FCR among treatments is consistent with the comparable growth and survival responses. Although the feeds differed in composition and form, each apparently supplied adequate nutrients for maintenance and somatic growth. The absence of a significant treatment effect also suggests that environmental variation among aquaria was limited.

Stable water quality is essential for successful domestication and nursery rearing of Rasbora species. Recommended conditions for tropical rasboras generally include temperatures of 25–30 °C, pH values of 6–8, and dissolved oxygen concentrations above 3 mg L⁻¹ (**Zulfadhli & Radhi, 2019; Ritonga *et al.*, 2022**). The temperature, pH, dissolved oxygen, and ammonia values recorded in the present study remained within acceptable ranges for both spawning and nursery rearing.

The measured ammonia concentration remained low (approximately 0.05 mg L⁻¹), indicating that aeration and routine management were sufficient to limit the accumulation of nitrogenous waste. Maintaining near-neutral pH can also support nitrification and reduce the risk of ammonia toxicity in intensive systems. Because water-quality values were similar among treatments, they were unlikely to have confounded the observed reproductive or nursery responses.

CONCLUSION

1. Broodstock sex ratio did not significantly affect fecundity, fertilization rate, or hatching rate under the conditions of this study.
2. Feed type did not significantly affect larval growth in length or weight, survival rate, or feed conversion ratio during the 30-day nursery period.
3. Water temperature, pH, dissolved oxygen, and ammonia remained within acceptable ranges throughout the spawning and nursery experiments, indicating that culture conditions were suitable for *R. argyrotaenia*.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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