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THE EFFECT OF THYROXINE HORMONE AND RECOMBINANT GROWTH HORMONE (RGH) SOAKING ON THE RATE OF EGG YOLK ABSORPTION AND GROWTH OF TAWES FISH (*Barbonymus gonionotus*)

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ABSTRACT

Tawes fish (Barbonymus gonionotus), also known as lampan, is an indigenous freshwater species with significant economic value and cultivation potential. However, suboptimal growth remains a common challenge in aquaculture. Hormonal treatments such as thyroxine and rGH are known to enhance metabolic processes, potentially improving egg yolk absorption and larval growth. This study aimed to evaluate the effects of thyroxine and rGH hormone immersion on the rate of egg yolk absorption and development of newly hatched tawes fish larvae. The experimental design employed a CRD with four treatments and three replications: A (thyroxine 0 mg/L + rGH 2.5 mg/L), B (thyroxine 0.1 mg/L + rGH 0 mg/L), C (thyroxine 0 mg/L + rGH 2.5 mg/L), and D (thyroxine 0.1 mg/L + rGH 2.5 mg/L), with hormone immersion conducted for 60 minutes. The results demonstrated that the combined immersion of thyroxine and rGH significantly (P <0.05) improved the absolute weight gain, absolute length increment, and survival rate of tawes fish larvae. The highest values for absolute weight (0.043±0.002 g) and length (12.77±0.15 mm) were observed in treatment D (thyroxine 0.1 mg/L + rGH 2.5 mg/L), while the best survival rate (70.00±2.00%) was recorded in treatment A (thyroxine 0 mg/L + rGH 2.5 mg/L). These findings suggest that the combined use of thyroxine and rGH can effectively enhance the early growth and development of tawes fish larvae.

KEYWORDS: Tawes fish; larvae growth; Recombinant Growth Hormone (rGH); Yolk absorption rate

INTRODUCTION

Tawes fish (*Barbonymus gonionotus*), also known as lampan, is a native freshwater species that plays a vital role in Indonesia's aquaculture industry (Tamsil & Hasnidar, 2024). As a herbivorous fish, tawes can thrive on plant-based diets, making their cultivation cost-effective and highly accessible for small-scale and traditional farmers (Hanief *et al*., 2014; Ayyub *et al*., 2019). Its ability to utilize low-cost feed not only reduces production expenses but also supports food security initiatives by providing an affordable source of protein. In light of the growing demand for fish due to population growth and shifting dietary preferences, the strategic cultivation of tawes has the potential to significantly contribute to meeting national fish consumption targets (Samad *et al*., 2025).

Despite its economic potential, the cultivation of tawes fish in Indonesia still faces several constraints, particularly related to suboptimal growth rates during the early stages of development. These early developmental phases are critical as they influence survival, future growth, and harvest yields. Slow initial growth often results in extended production cycles, increased operational costs, and reduced profitability (Nuswantoro *et al*., 2019; Pasaribu *et al*., 2019). Furthermore, traditional farming techniques that rely heavily on natural growth cycles may not be sufficient to meet the increasing market demand. As a result, there is a pressing need for innovative interventions that can improve early growth performance in tawes larvae.

One of the most promising approaches to address these challenges is hormonal engineering (Moniruzzaman *et al*., 2015; Mulyani *et al*., 2015). Among the hormones explored, thyroxine—a metabolic hormone produced by the thyroid gland has demonstrated significant benefits in fish larviculture

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(Andriawan *et al*., 2020). Thyroxine plays a key role in regulating metabolic rate, enhancing nutrient uptake, and stimulating growth processes. When administered at appropriate dosages and developmental stages, thyroxine can effectively accelerate yolk sac absorption and promote faster transition to exogenous feeding (Muslim *et al*., 2019; Setiawan *et al*., 2022). The improved metabolic activity also leads to better energy utilization, contributing to higher survival and growth rates in fish larvae.

In addition to thyroxine, recombinant growth hormone (rGH) has gained considerable attention in aquaculture due to its potent effects on promoting somatic growth (Ihsanudin *et al*., 2014; Karimah *et al*., 2018). rGH functions by stimulating protein synthesis and cellular development, thereby enhancing tissue growth and improving feed conversion efficiency (Alimuddin *et al*., 2010). It can be delivered through various methods such as injection, oral administration, or immersion, with immersion being particularly suitable for larval stages due to its uniform exposure and minimal handling stress (Aprilliani *et al*., 2018; Kurniawan *et al*., 2021). The application of rGH in aquaculture has been demonstrated to enhance growth rates, reduce production cycles, and improve harvest yields in various freshwater species.

Recent studies have reported encouraging results regarding the use of hormonal treatments in larval fish. Setiawan *et al*. (2022) found that thyroxine administration significantly improved nutrient absorption and growth in fish larvae, while Aprilliani *et al*. (2018) demonstrated enhanced growth performance with rGH immersion. Kurniawan *et al*. (2021) further validated the effectiveness of immersion techniques for rGH delivery, optimizing protocols for larval application. However, limited studies have evaluated the synergistic effects of combining thyroxine and rGH, particularly in tawes fish. Therefore, this study aims to investigate the combined impact of thyroxine and recombinant growth hormone immersion on the growth performance of tawes fish larvae. By exploring this approach, the research aims to provide evidence-based strategies for enhancing larval development and overall aquaculture productivity in Indonesia.

MATERIALS AND METHODS

This study employed a structured experimental design to evaluate the effects of thyroxine and recombinant growth hormone (rGH) immersion on the growth performance of *Barbonymus gonionotus* larvae. Newly hatched larvae, with egg yolk averaging 0.001 grams and body lengths of approximately 0.01 cm, were sourced from the Muntilan Fish Health and Environmental Testing Laboratory (LPKIL), Magelang. The experimental setup utilized 10-liter maintenance jars equipped with aerators to maintain dissolved oxygen levels, digital scales for precise measurement of fish and feed weights, and a Water Quality Checker (WQC) to monitor key water parameters, including dissolved oxygen (DO), pH, and temperature.

Hormonal treatments included commercially available thyroxine (Thyrax) at a concentration of 0.1 mg/L and recombinant growth hormone (MINA GROW) at 2.5 mg/L. A completely randomized design (CRD) was applied, consisting of four treatments with three replicates each: Treatment A (control without hormones), Treatment B (0.1 mg/L thyroxine only), Treatment C (2.5 mg/L rGH only), and Treatment D (combination of 0.1 mg/L thyroxine and 2.5 mg/L rGH). These hormone concentrations and combinations were selected based on previous studies demonstrating improved growth and metabolic performance in fish larvae (Setiawan *et al*., 2022; Aprilliani *et al*., 2018).

Before hormone immersion, larvae underwent a salinity shock treatment at 7 ppt for 2 minutes, a method validated by previous research to enhance hormone absorption efficiency in fish larvae (Atmojo *et al*., 2017). Afterward, larvae were immersed in hormone solutions according to their respective treatments for 60 minutes. Following immersion, larvae were maintained for 28 days, with feeding initiated after the egg yolk had fully absorbed. Initial feeding involved boiled egg yolk diluted in water during the first week, transitioning to Moina sp. provided at a density of 150 individuals per feeding twice daily in the second and third weeks. In the fourth week, commercial feed was supplied ad libitum, adhering to feeding practices recommended in aquaculture research for optimal larval growth and health (Kurniawan *et al*., 2021).

Water management involves 50% water replacement every three days, accompanied by routine monitoring of water quality parameters using the WQC in accordance with best practices for maintaining optimal environmental conditions (Rahmawati & Handayani, 2021). Data collection included microscopic observation of the egg yolk absorption rate from initial hatching until depletion, measurement of absolute weight growth and absolute length growth using digital scales and millimeter rulers, calculation of the specific growth rate (SGR), and assessment of the survival rate (SR).

Data Analysis

The rate of yolk absorption is done by observing the decrease in the volume of the yolk. Observations are made from the eggs hatching until the yolk attached to the body of the larvae runs out. Yolk volume formula Hemming and Buddington (1988); Ariska *et al.* (2017)

$$V = 0.1667\ \pi\ LH2$$

Note:

V = Volume of egg yolk (μm^3)

L = Longitudinal diameter of the egg yolk (µm)

H = Egg yolk diameter shortens (µm)

Ardimas (2012) egg yolk absorption rate formula:

$$LPKT = \frac{Vo - Vt}{T}$$

Information:

LPKT = Egg yolk absorption rate (μm^3/hour)

Vt = Final egg yolk volume (μm^3)

V0 = Initial egg yolk volume (μm^3)

t = Length of time

The formulas used for these parameters were as follows: Absolute weight gain (AWG) was determined by subtracting the initial average weight from the final average weight of the fish. Absolute length growth (ALG) was calculated by subtracting the initial average length from the final average length. The specific growth rate (SGR) was estimated as the percentage increase in weight per day, using the natural logarithm of initial and final weights divided by the culture duration. Survival rate (SR) was calculated as the proportion of fish that survived until the end of the study period, expressed as a percentage. Statistical analyses were performed to compare differences between treatment groups, with significance determined at the 5% level.

Absolute Weight Gain (AWG) (National Research Council, 2012)

$$AWG = W_{final} - W_{initial}$$

Absolute Length Growth (ALG) Bagenal, T. B. (1978)

$$ALG = L_{final} - L_{initial}$$

Specific Growth Rate (SGR) (Brett & Groves, 1979)

$$SGR\ (\%/day) = \frac{\ln(W_{final}) - \ln(W_{initial})}{T} \times 100$$

Survival Rate (SR) (Abdel-Tawwab *et al.*, 2010)

$$SR\ (\%/day) = \frac{N_{final}}{N_{initial}} \times 100$$

RESULTS AND DISCUSSION

Egg Yolk Absorption Rate

In this study, the rate of egg yolk absorption was used as one of the key indicators to assess the physiological response of tawes fish larvae to hormonal treatments. The volume of egg yolk was measured at specific intervals post-hatching, and the percentage reduction over time was used to calculate the absorption rate. The data presented below compares yolk absorption across different hormone treatment groups to determine the influence of thyroxine and recombinant growth hormone (rGH), both individually and in combination.

Soaking in thyroxine, rGH and a combination of both hormones affects the rate of egg yolk absorption in tawes fish, with the highest rate of egg yolk absorption in treatment D of 3%/hour, treatment A of 2%/hour, treatment B of 2%/hour, and treatment C of 2%/hour. Treatment A takes 60 hours, treatment B for 57 hours, treatment C for 57 hours, treatment D for 51 hours until the egg yolk runs out. Based on the results obtained, the highest rate of egg yolk absorption was observed in Treatment D, which is a combination of thyroxine hormone at 0.1 mg/l and rGH at 2.5 mg/l. Several factors influence the rate of absorption, including metabolic activity in the body of fish larvae. The addition of a combination of thyroxine and rGH hormones can accelerate the rate of egg yolk absorption because the addition of both hormones can accelerate fish metabolism. The highest rate of egg yolk absorption is due to the optimal thyroxine content in the body, resulting in increased metabolism (Pebriyanti *et al.*, 2015). According to Khalil *et al.* (2011), the thyroxine hormone can stimulate the rate of food oxidation, increase the rate of oxygen consumption, increase growth, and accelerate the metamorphosis process.

Rapid metabolic activity requires large amounts of energy to accelerate the absorption of egg yolk. The best treatment is treatment D, which combines thyroxine and rGH hormones, as both hormones function to increase metabolic activity. This finding is reinforced by Pebriyanti *et al.* (2015), who state that the increase in egg yolk absorption rate in catfish larvae is due to the physiological effects of immersion in thyroxine hormone, which can increase metabolic rate. Physiological effects can increase protein breakdown, stimulate growth, and enhance active oxygen production in metabolically active tissues, thereby increasing the metabolic rate. The addition of thyroxine and rGH hormones can be applied to fish using several methods, including oral, injection, and immersion. The method used in this study for adding hormones is the immersion method. This method was chosen because it is easier to apply to the size of the larvae. Administering hormones to larvae via the injection method is less effective compared to oral and immersion methods. Oral and immersion methods are relatively more straightforward

Table 1. Comparison of Treatment A, B, C, and D for Egg Yolk Absorption Rate

Time to	Treatment A (0 Tr +0 rGH hours)		Treatment B (0.1 Tr + 0 rGH)		Treatment C (0 Tr + 2.5 rGH)		Treatment D (0.1 Tr + 2.5 rGH)	
	Volume (µm3)	Egg Yolk Absorption (%)	Volume (µm3)	Egg Yolk Absorption (%)	Volume (µm3)	Egg Yolk Absorption (%)	Volume (µm3)	Egg Yolk Absorption (%)
0 hours	1.49	0	1.25	0	1.19	0	1.78	0
24 hours	0.51	-66	0.30	-76	0.28	-77	0.28	-86
48 hours	0.04	-97	0.02	-98	0.03	-98	0.00	-100
60 hours	0.00	-100	0.00	-100	0.00	-100		
Egg Yolk Absorption Rate	2%/hour		2%/hour		2%/hour		3%/hour	

Figure 1. Comparison of 100% egg yolk and 0% egg yolk.

methods to apply in fish farming (Erlangga *et al*., 2017).

Considering the findings of Hastuti *et al*. (2024) on the closely related Java barb (*Barbonymus gonionotus*) fry, which identified an optimal temperature range of 31.12 to 32.9°C for growth and survival, the importance of environmental factors in larval development becomes apparent. While our study focused on hormonal influences, the temperature range established by Hastuti *et al*. (2024) suggests a critical environmental parameter that could interact with the physiological effects of thyroxine and rGH. It is plausible that maintaining water temperatures within this optimal range could further enhance the metabolic responses induced by the hormonal treatments in tawes larvae, potentially leading to even more efficient yolk absorption and improved overall larval performance. Conversely, suboptimal temperatures might impede the larvae's ability to respond fully to the metabolic stimuli provided by the hormones.

Absolute Weight

Absolute weight gain is a key indicator of larval growth performance in aquaculture studies. It reflects the net increase in body mass over a specified maintenance period and serves as a fundamental measure to assess the effectiveness of dietary or hormonal treatments in fish larvae. In this study, absolute weight was measured at the end of a 28-day rearing period to determine the impact of different hormone immersion treatments—thyroxine, recombinant growth hormone (rGH), and their combination—on the growth of tawes fish larvae. The results, as illustrated in Figure 2, provide insight into how each treatment influenced larval biomass development compared to the control.

The results of the study showed that immersion of larvae in thyroxine and rGH hormones affected the absolute weight of tawes fish (F count > F table) with the best study being treatment D with a combination of thyroxine hormones 0.1 mg/L + rGH 2.5 mg/L which gave an absolute weight result of (0.025 ± 0.003) grams. These results suggest that thyroxine and rGH hormones can act synergistically to influence metabolism in fish. Treatment A, without the addition of a combination of hormones, showed the lowest absolute weight of 9.7 ± 0.003 grams. Treatment B, involving immersion in 0.1 mg/L thyroxine hormone (0.033 ± 0.002), yielded the same results as treatment C, which used a dose of rGH at 2.5 mg/L (0.035 ± 0.003). These results indicate that immersion with a combination of thyroxine and rGH hormones gives better results when compared to using a single hormone (thyroxine or rGH).

Thyroxine hormone helps regulate the metabolic process in fish, stimulates growth rate, increases appetite, promotes body weight gain, and enhances the speed of food absorption. These physiological effects are supported by the findings of Pebriyanti *et al*. (2015), which state that the administration of thyroxine hormone to fish larvae functions as intended, increasing the metamorphosis process and influencing body cell growth by enhancing protein utilization or retention. rGH has been shown to enhance the metabolic rate in fish, thereby facilitating accelerated cellular development. Growth hormone (GH), a key regulator of somatic growth, stimulates cellular proliferation and differentiation, ultimately contributing to increased body weight. Elvarianna *et al*. (2017) reported that GH administration effectively promotes weight gain in fish by enhancing cellular growth processes.

Considering the study by Tamsil & Hasnidar (2024) on the reproductive biology of silver barb (*Barbonymus gonionotus*) in Lake Tempe, South Sulawesi, Indonesia, while seemingly distinct, it provides valuable context regarding the general biology and life history of a related *Barbonymus* species within Indonesia. Their findings on the length-weight relationship and condition factor in silver barb highlight the importance of understanding the growth patterns and overall well-being of these cyprinid fishes in their natural environment. While Tamsil & Hasnidar (2024) focused on mature individuals and reproductive aspects relevant to conservation and domestication, our study focuses on the early larval stages and the influence of exogenous hormones on growth.

Although the specific environmental conditions and life stages differ between the two studies, both contribute to a broader understanding of factors influencing the growth and development of *Barbonymus* species in Indonesia. Our findings on the efficacy of combined thyroxine and rGH in promoting weight gain in tawes larvae could have implications for aquaculture practices aiming to enhance early growth and potentially reduce the time to market. Furthermore, understanding the fundamental growth responses to

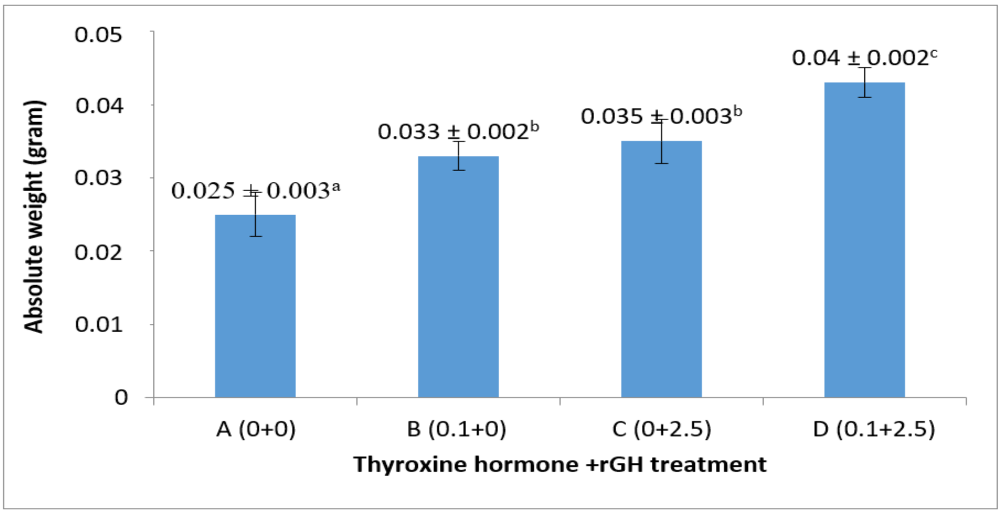

Figure 2. Histogram of Absolute Weight Values of Tawes Fish.

hormonal manipulation in controlled environments can complement ecological studies, such as that of Tamsil & Hasnidar (2024), providing a more comprehensive picture of the biological plasticity and growth potential within the *Barbonymus* genus.

Absolute Length

Absolute length is another essential growth parameter that reflects linear body development in fish larvae. Monitoring changes in length provides insight into skeletal and muscular development, which is crucial for evaluating the effectiveness of nutritional and hormonal interventions during early life stages. In this study, the absolute length of tawes fish larvae was measured at the end of a 28-day maintenance period to evaluate the effects of thyroxine and rGH treatments. The findings, summarized in Figure 3, demonstrate the varying degrees of linear growth among the different treatment groups, highlighting the influence of each hormone application on larval development.

The results of the analysis of variance showed that the treatment with thyroxine and rGH hormones affected the absolute length of tawes fish with F count

> F table. The results of the Duncan test showed that treatment A was significantly different from treatments B, C, and D. Treatment B was significantly different from treatments A and D but not significantly different from treatment C. Treatment C was significantly different from treatments A and D, but not significantly different from treatment B. Treatment D was significantly different from treatments A, B, and C.

The effect of soaking thyroxine, rGH, and a combination of both hormones on tawes fish larvae gave a significant effect on the growth of the absolute weight of tawes fish larvae ($P < 0.05$) with the best absolute weight value of tawes fish in the study being treatment D with an average value of (12.77 ± 0.15), treatment C with an average value of (11.66 ± 011), treatment B with an average value of (11.53 ± 0.11) and treatment A with an average value of (9.27 ± 0.15). Based on the study's results, soaking a combination of thyroxine and rGH hormones had a significant effect on the growth of the absolute length of tawes fish larvae. Thyroxine hormone can stimulate development and growth in fish, especially in the larval phase. Administration of thyroxine hormone can increase the growth and survival of fish. The systematic work of thyroxine hormone is to stimulate growth and as a catalyst for faster growth reactions (Dedi, 2018). rGH is a hormone that can increase the growth and reproduction of farmed fish. The rGH hormone can stimulate growth by enhancing fish appetite and improving feed conversion efficiency. Triwinarso *et al*. (2010) stated that recombinant growth hormone can increase appetite, improve feed conversion, enhance protein synthesis, reduce nitrogen excretion, stimulate metabolism and fat oxidation, and promote protein synthesis and insulin release.

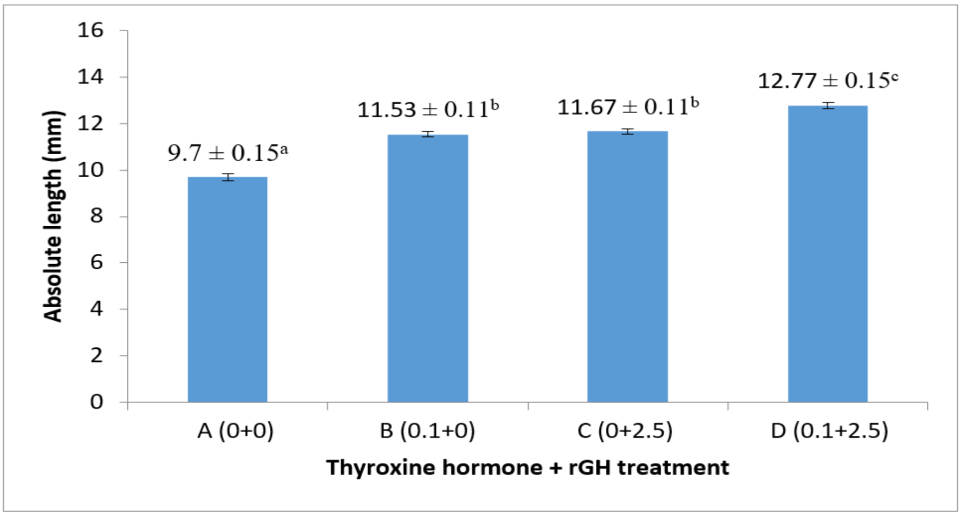

Figure 3. Histogram of Absolute Length Values of Tawes Fish.

The thyroxine hormone can enhance protein retention, allowing the utilization of absorbed protein to exceed the amount that is excreted. The combination of thyroxine hormone and rGH has been shown to influence increases in both weight and length in fish larvae. Heraedi *et al*. (2018) reported that thyroxine can elevate the metabolic rate. Metabolism involves the conversion of nutrients into energy in the form of ATP, which serves as the primary source of cellular energy required for tissue repair and growth. Therefore, a higher metabolic rate leads to faster ATP production, which in turn supports cell growth. Erlangga *et al*. (2017) further demonstrated that the administration of recombinant thyroxine and rGH significantly improved the weight, length, and survival rate of fish larvae.

Ayyub *et al*. (2019) investigated the morphological characteristics of silver barb (*Barbonymus gonionotus*) populations across various river systems and a reservoir in Central Java, emphasizing the role of environmental factors, particularly current velocity, in driving morphological differentiation within this species. Their study identified dorsal depth, snout length, and caudal peduncle depth as key diagnostic traits. While the present study examines the effects of hormonal manipulation on the absolute length of *Barbonymus* larvae under controlled laboratory conditions, the findings of Ayyub et al. highlight the morphological plasticity of *Barbonymus* in response to environmental variability in natural habitats.

Pratama *et al*. (2018) investigated the effects of temperature variation (32°C, 30°C, and 28°C) on key reproductive and growth parameters in *Osphronemus gouramy* (gourami), including egg hatching time, hatching rate, larval survival, and SGR. This research is particularly relevant for aquaculture practices, where environmental manipulation is often employed to enhance seed production. Their results indicate that

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temperature has a significant impact on hatching success and larval growth. Among the tested conditions, incubation at 30°C provided the most favorable outcomes, yielding a shortened hatching time, a high hatching rate (98.17%), excellent survival (97.11%), and an optimal SGR (6.87 ± 0.29%).

Although differing in focus and methodology, both studies contribute to the broader understanding of factors influencing the development and morphology of *Barbonymus* species in Indonesia. Ayyub *et al.* (2019) demonstrated that morphological traits in *Barbonymus* can be highly responsive to local environmental conditions, highlighting the species' phenotypic plasticity. In contrast, the present study demonstrates that under controlled aquaculture conditions, exogenous hormonal treatment can effectively modulate growth parameters, including absolute length.

Specific Growth Rate (SGR)

Expressed as a percentage, the SGR enables standardized comparisons of growth performance across different treatment groups. In the present study, SGR was employed to assess the relative impact of thyroxine and rGH immersion on the daily growth efficiency of *Barbonymus gonionotus* larvae during a 28-day rearing period. As shown in Figure 4, the SGR values for each treatment group provide a comprehensive overview of the effects of individual and combined hormonal applications on larval growth dynamics.

The results of the analysis of variance showed that the treatment of thyroxine and rGH hormones affected the SGR of tawes fish with an F count > F table. The results of the Duncan test showed that Treatment A was significantly different from Treatments B, C, and D. Treatment B was significantly different from Treatments A and D but not significantly different from Treatment C. Treatment C was significantly different from Treatments A and D, but not significantly different from Treatment B. Treatment D was significantly different from Treatments A, B, and C.

The effect of immersion in thyroxine, rGH and a combination of both hormones on tawes fish larvae gave a significant effect on the specific growth rate of tawes fish larvae ($P>0.05$) with the best specific growth rate value in treatment D with an average value of (13.46±0.13), treatment C with an average value of (12.66±0.26), treatment B with an average value of (12.48±0.22), and treatment A with an average value of (11.53±0.35). The results of this study indicate the immersion of thyroxine and rGH hormones on the SGR of tawes fish larvae. The thyroxine hormone produced by the thyroid gland contains iodine elements essential for all body tissues, particularly for growing cells, such as those found in larvae. Hormonal engineering can help in the growth of tawes fish larvae because the addition of hormones can increase metabolism. According to Khalil *et al.* (2011), the thyroxine hormone can also stimulate the rate of oxidation of food materials, increase the rate of oxygen consumption, increase growth, and accelerate the process of metamorphosis. Administration of the thyroxine hormone can affect the digestive system and excretory system of fish. This makes fish more active in searching for food, resulting in a faster daily growth rate compared to other treatments (Kurniawan *et al.*, 2014).

Immersion of *Barbonymus gonionotus* larvae in rGH solution can enhance their specific growth rate (SGR). Once absorbed, rGH stimulates the hypothalamus to increase the secretion of growth hormone-releasing hormone (GH-RH), which in turn activates the pituitary gland to produce GH. According to

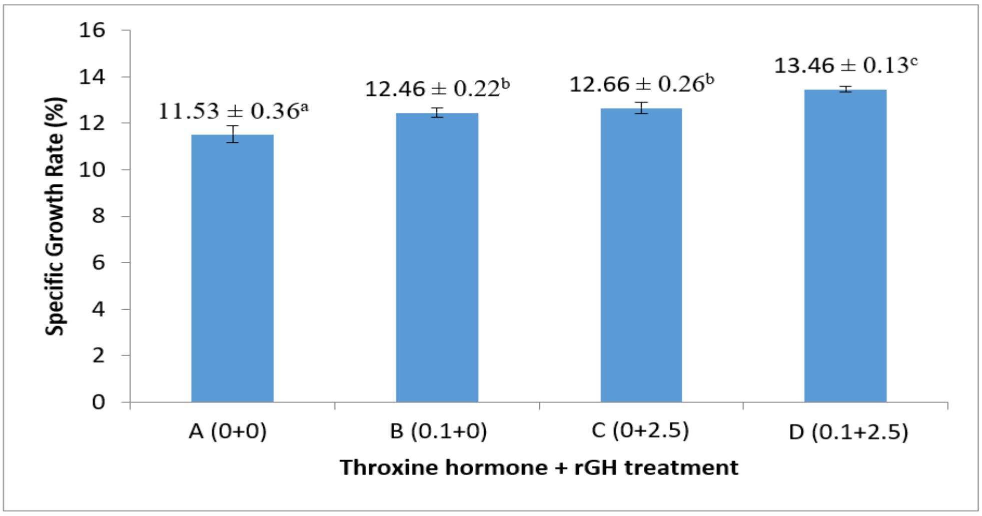

Figure 4. Histogram of Absolute Length Values of Tawes Fish.

Setyawan *et al*. (2014), this GH is then distributed to internal organs such as the liver, kidneys, muscles, and bones, thereby accelerating overall growth in the fish.

In parallel, the findings of Hastuti *et al*. (2024) on Java barb (*Barbonymus gonionotus*) fry identified an optimal temperature range of 31.12°C to 32.9°C for promoting robust growth and high survival rates. While this present study specifically investigated the effects of hormonal manipulation on the specific growth rate of tawes larvae under controlled conditions (presumably within a suitable temperature range, although not explicitly reported), Hastuti *et al*. (2024) research underscore the critical role of environmental factors particularly temperature, in optimizing larval development in *Barbonymus* species.

It is plausible that the effectiveness of thyroxine and rGH in enhancing the specific growth rate of tawes larvae could be further optimized by maintaining water temperatures within the optimal range identified by Hastuti *et al*. (2024). Suboptimal temperatures could potentially limit the metabolic responses to the hormones or hinder the efficiency of growth processes.

Survival Rate (SR)

Survival rate (SR) is a fundamental metric in aquaculture that reflects the viability and resilience of fish larvae throughout the rearing period. It provides crucial insights into the suitability of environmental conditions, nutritional protocols, and experimental treatments. In this study, the survival rate was assessed at the end of the 28-day maintenance period to evaluate the potential effects of thyroxine and rGH on larval mortality. Figure 5 presents the survival percentages observed across all treatment groups, offering a comparative view of how hormone exposure influenced larval survival under controlled rearing conditions.

The results of the analysis of variance showed that the treatment of thyroxine and rGH hormones affected the survival rate with F count > F table. The results of the Duncan test showed that treatment A was significantly different from treatments C and D but not significantly different from treatment B. Treatment B was significantly different from treatments C and D, but not significantly different from treatment A. Treatment C was significantly different from treatments A and B but not significantly different from treatment D.

The effect of soaking thyroxine, rGH, and combination hormones on tawes fish larvae has a significant effect on the survival rate of tawes fish larvae (($P>0.05$), with the best tawes fish survival value in the study being treatment A with an average value of (70% ± 2.00), treatment B with an average of (67.33% ± 4.16), Treatment C with an average value of (61.33% ± 2.31), Treatment D with an average value of (61.33% ± 4.16). These results indicate that the survival rate in the study was better than that of SNI, where, according to KEPMEN-KP (2017), the survival rate in the first nursery phase was 51%. The hormones given had a significant effect on survival. According to Kordi (2009), survival or synthesis (Survival Rate) is the percentage of the number of biota cultivated that live in a specific period. Like growth, many factors can affect survival, including stocking density, feed, environment (such as water quality), seed quality, pests, and diseases.

Immersion in thyroxine and rGH solutions can influence the survival rate of tawes larvae. This study observed the highest survival rate in the control group without hormone treatment, indicating that

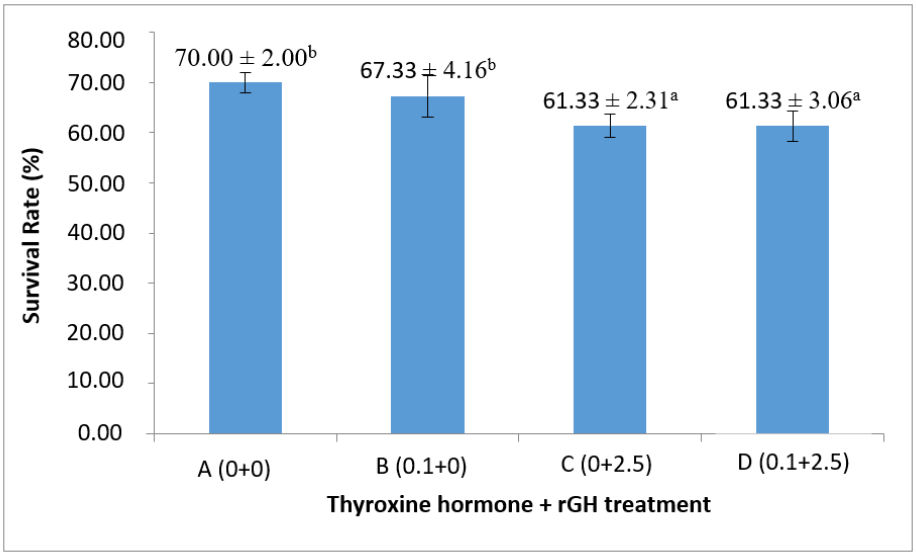

Figure 5. Histogram of Tawes Fish Survival.

hormone immersion significantly affects larval survival. Notably, the combined treatment involving both thyroxine and rGH resulted in the lowest survival rate. This reduced survival is likely due to stress induced by hormone exposure, as suggested by Sudrajat *et al.* (2013).

In addition to hormonal factors, the immersion environment also plays a critical role in larval viability. Triwinarso *et al.* (2014) reported that using containers that are too small during rGH immersion can restrict fish movement, contributing to stress. Prolonged immersion may also damage the gill structures, which serve as the primary entry point for hormones. Such gill damage is believed to impair respiratory function and contribute to reduced survival rates in hormone-treated larvae.

The study by Nisa & Khairunissa (2023) on tawes fish breeding practices at the Government Unit of Technical Implementing Service of Freshwater Aquaculture in Jember provides valuable context regarding standard hatchery procedures and acceptable ranges for key parameters like Fertilization Rate (FR), Hatching Rate (HR), and Survival Rate (SR), as well as water quality. Their findings indicate that established tawes hatcheries can achieve acceptable survival rates under standard operating procedures, which aligns with the relatively high survival observed in our control group.

The discrepancy between the positive effects of hormone immersion on growth and the adverse effects on survival warrants further investigation. As suggested by Triwinarso *et al.* (2014), the immersion method itself, including the size of the container and the duration of soaking, may contribute to stress and potentially damage sensitive tissues, such as the gills, which serve as the entry point for hormones. Such gill damage could impair respiration and overall physiological function, leading to decreased survival. The lower survival rates in the hormone-treated groups in our study might be attributed to such factors associated with the immersion process.

CONCLUSION

Soaking in thyroxin and recombinant growth hormones affects egg yolk absorption and growth of Tawes (*B. gonionotus*). The best doses in trestmen D with doses of thyroxine hormon 0.1 mg/L and rGH 2.5 mg/L. The rate of egg yolk absorption 3%/hour, Absolute weight growth 0.045±0.002 gram, absolute length 12.77±0.15 and Specific Growth rate 13.46±0.13%

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