Effect of Thyroxine Hormone on Growth and Survival Rate of Bronze Featherback (*Notopterus notopterus*, Pallas 1769)

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Abstract. Bronze featherback (*Notopterus notopterus*, Pallas 1769) is an Indonesia's endemic fish that has high economic value. This study was conducted from July to August 2020 in Sungai Geringging Village, Kampar Kiri District, Riau Province to determine the effects of thyroxine (T4) on growth and survival rate of bronze featherback for 40 days. The experiment lasted for 40 days and used a completely random design with four treatments and four replications. Treatment were P1 (0 mg thyroxine/kg feed), P2 (2 mg thyroxine/kg feed), P3 (4 mg thyroxine/kg feed) and P4 (6 mg thyroxine/kg feed). The fish caught from the Kampar river were reared for 40 days in 1x1x1 m³ with five individuals per cage. Fish treated in P4 demonstrated high growth in terms of absolute weight (10.05 ± 0.53 g), absolute length (5.27 ± 0.96 cm), daily growth rate (2.97 ± 0.22%) and larval survival rate (95 ± 10%).

1. Introduction
Bronze featherback (*Notopterus notopterus*, Pallas 1769) is an Indonesia's endemic fish that has high economic value [1]. Bronze featherback are used as consumption fish and as ornamental fish [2]. To meet the community's demand for bronze featherback, so far they still rely on catches in nature. As a result, there has been an increase in fishing activities in nature, which has an impact on decreasing the bronze featherback population [1]. Based on IUCN (International Union for Conservation of Nature) data, currently, belida is included in the fish "red list" with the category of least concern fish [3]. If this situation continues, it is feared that there will be an extinction of the bronze featherback population. One of the efforts that can be applied to meet human needs for bronze featherback and reduce bronze featherbacking activities in nature is the implementation of cultivation activities. Aquaculture is a feasible solution to reduce the exploitation of fish from nature for human consumption [4, 5]. In recent years, research has been carried out on bronze featherback cultivation efforts including the behavior and reproduction of bronze featherback [2] and bronze featherback cultivation with a stocking density approach and types of feed [6]. The next problem that is obtained from the bronze featherback cultivation process is the low growth of the fish.

The thyroxine hormone (T4) is a hormone produced by the thyroid gland in addition to the thyriodotironin (T3) hormone which functions in general metabolism and growth [7]. The functions of T4 and T3 have been proven in several freshwater fish that T4 and T3 can promote growth, development, and absorption of eggs during the larval period [8]. The use of the hormone thyroxine to stimulate fish growth has been carried out in several fish including coral platypus fish (*Xiphophorus maculatus*) [9], goldfish (*Carassius auratus*) [10], fish Tambakan (*Helostoma temmincki CV*) [11], baung fish (*Mystus nemurus CV*) [12], monitor fish (*Rasbora lateristriata Blkr*) [13] and motan fish (*Thynnichys thynnoides Blkr*) [14]. Based on this, it is necessary to increase the growth of bronze featherback by giving the hormone thyroxine in the feed.

2. Material and method
This study was conducted in Sungai Paku Village, Kampar Kiri Subdistrict, Kampar Regency, Riau Province from July to August 2020. The bronze featherback came from the catch of fishermen in the Kampar River with a size of 8-10 cm. The fish were reared in a cage with a size of 1x1x1 m³ which is installed in an earthen pond. Fish are fed 3 times a day at a dose of 5% per weight of fish biomass.
Furthermore, the fish were measured for length and weight every 10 days for 40 days. The fish length was measured using graph paper and fish weight was measured using a Shimadzu ELB600 type analytic chart.

The research design in this study was a completely randomized design with one treatment, four levels, and three replications. The treatments were the following: thyroxine hormone consisting of P1 (0 mg thyroxine/kg feed), P2 (2 mg thyroxine/kg feed), P3 (4 mg thyroxine/kg feed) and P4 (6 mg thyroxine/kg feed). The feed used in this study was finely chopped trash fish. The thyroxine hormone used was in tablet form. Thyroxine hormone tablets were crushed by grinding them until smooth. Thyroxine hormone that has been refined was mixed with a little aquadest. then mixed with trash fish by spraying it with a sprayer and stirring evenly. Then the feed is dried to dry. The variables measured to evaluate the treatment given in this study are

2.1. Absolute weight
The measurement of the absolute weight of fish was carried out using the formula according to [15]:

\[ W_m = W_t - W_0 \]

where:
- \( W_m \) = growth in absolute weight (grams)
- \( W_t \) = average weight at the end of the study (grams)
- \( W_0 \) = average weight at the start of the study (grams)

2.2. Absolute length
The measurement of the absolute length of fish was carried out using the formula according to [16]:

\[ L_m = L_t - L_o \]

Where:
- \( L_m \) = absolute length growth (mm)
- \( L_t \) = average length at the end of the study (mm)
- \( L_o \) = average length at the beginning of the study (mm)

2.3. Specific growth rate
Measurement of the specific weight growth rate (SGR) was carried out using the formula according to [17]:

\[ SGR = \frac{\ln W_t - \ln W_0}{t} \times 100\% \]

Where:
- \( SGR \) = Daily weight growth rate (%)
- \( W_t \) = Weight of biomass at the end of the study (grams)
- \( W_0 \) = weight of biomass at the beginning of the study (grams)
- \( t \) = Length of maintenance time (days)

2.4. Survival rate
The measurement of larval survival was carried out using the following formula:

\[ SR = \frac{N_t}{N_0} \times 100\% \]

where:
- \( SR \) = Survival rate (%)
- \( N_t \) = Number of fish at the end of the study (tail)
- \( N_0 \) = Number of fish at the beginning of the study (tail)

Water quality data in the form of temperature, pH, and dissolved oxygen (DO) were obtained by measuring once a week in the morning, afternoon, and evening. Temperature measurements were
carried out using a thermometer, pH measurements were carried out using a pH meter, and DO measurements were carried out using a DO meter.

Growth and survival rate data obtained were tabulated and statistical tests were performed using the IBM SPSS Statistic 22 application. The statistical tests carried out were the homogeneity of variances and one-way Analysis of Variance (ANOVA) tests. If the ANOVA test results showed a significant difference (P < 0.05) then a further test was carried out using the Student Newman Keuls test to determine the differences between treatments. The water quality data obtained were tabulated and described.

3. Results And Discussion

Data on the growth and survival of bronze featherback are presented in Table 1. Giving thyroxine hormone 0.5 mg/kg of feed gives the best growth and survival results. The growth patterns of bronze featherback every 10 days of observation are presented in Figure 1 and Figure 2.

Table 1. Growth performance of bronze featherback treated with different dosage of thyroxine ± Standard Deviation

| Parameters            | Thyroxine dose (mg/kg pakan) |
|-----------------------|------------------------------|
|                       | Control (P1)  | 2 (P2)  | 4 (P3)  | 6 (P4)  |
| Initial Weight (g)    | 4.40 ± 0.16a | 4.40 ± 0.37a | 4.40 ± 0.37a | 4.35 ± 0.34a |
| Final Weight (g)      | 12.50 ± 0.48a | 13.58 ± 0.31b | 9.1 ± 0.32b | 13.5 ± 0.33c |
| Initial Lenght (cm)   | 9.1 ± 0.10a  | 9.1 ± 0.19a  | 9 ± 0.16b   | 9.1 ± 0.10a  |
| Final Lenght (cm)     | 13.0 ± 0.21a | 13.5 ± 0.15b | 13.9 ± 0.26c | 14.3 ± 0.10d |
| Absolute Weight (g)   | 8.1 ± 0.38a  | 9.17 ± 0.59b | 9.67 ± 0.57b | 10.05 ± 0.53b |
| Absolute Lenght (cm)  | 3.92 ± 0.15a | 4.42 ± 0.26b | 4.9 ± 0.38c | 5.27 ± 0.96c |
| SGR (%)               | 2.6 ± 0.81a  | 2.82 ± 0.22a | 2.9 ± 0.25a | 2.97 ± 0.22a |
| SR (%)                | 90 ± 20a     | 90 ± 20b    | 90 ± 11.55a | 95 ± 10a     |

Note: The mean value followed by the same letter in different pools is not significantly different (P > 0.05).

Figure 1. Weight Growth Graph of Bronze featherback
The highest growth of bronze featherback absolute weight was obtained in treatment P4 (6 mg of thyroxine hormone/kg of feed) with a value of 10.05 g, followed by P3 treatment (4 mg of thyroxine hormone/kg of feed) with a value of 9.67 g, treatment P2 (2 mg of thyroxine hormone/kg of feed) with a value of 9.17 g and treatment P1 (0 mg of thyroxine hormone/kg of feed) with a value of 8.1 g (Figure 3). Based on the results of statistical tests using the Analysis of Variance (ANOVA) test, it was found that the treatment given had a very significant effect ($P < 0.01$) on the absolute weight of bronze featherback. The absolute weight value of the best bronze featherback given the thyroxine hormone was higher than the growth in the absolute weight of bronze featherback reared without thyroxine hormone, namely 6.98 g [6].

The highest absolute length was obtained in treatment P4 (6 mg of thyroxine hormone/kg of feed) with a value of 5.27 cm, followed by P3 treatment (4 mg of thyroxine hormone/kg of feed) with a value of 4.9 cm, treatment P2 (2 mg thyroxine hormone/kg feed) with a value of 4.42 cm and treatment P1 (0 mg thyroxine hormone/kg of feed) with a value of 8.92 cm (Figure 4). Based on the results of statistical tests using the Analysis of Variance (ANOVA) test, it is known that the treatment given had a very significant effect ($P < 0.01$) on the absolute length growth of bronze featherback. The absolute length growth value of the best bronze featherback given the thyroxine hormone was higher than the absolute length of bronze featherback kept without thyroxine hormone, which was 3.61 cm [6].

The highest value of specific growth rate (SGR) of bronze featherback was obtained in the P4 treatment (6 mg of thyroxine hormone/kg of feed) with a value of 2.97%, followed by P3 treatment (4 mg of thyroxine hormone/kg of feed) with a value of 2.9%, P2 treatment (2 mg thyroxine hormone/kg feed) with a value of 2.82% and treatment P1 (0 mg thyroxine hormone/kg feed) with a value of 2.6% (Figure 5). Based on the results of statistical tests using the analysis of variance (ANOVA) test, it was found that the treatment is given had no significant effect ($P > 0.05$) on the SGR of bronze featherback. The SGR value of the best bronze featherback given the thyroxine hormone was also higher than the SGR value of bronze featherback reared without thyroxine hormone, with a value of 0.83% [6].

The highest survival rate (SR) value of bronze featherback was obtained in treatment P4 (6 mg of thyroxine hormone/kg of feed) with a value of 95%, followed by P3 treatment (4 mg of thyroxine hormone/kg of feed) with a value of 90%, treatment P2 (2 mg thyroxine hormone/kg feed) with a value of 90% and treatment P1 (0 mg of thyroxine hormone/kg of feed) with a value of 90% (Figure 6). Based on the results of statistical tests using the Analysis of Variance (ANOVA) test, it was found that the treatment is given had no significant effect ($P > 0.05$) on SR of bronze featherback. This is the same as research conducted on pink zebrafish, where giving thyroxine hormone treatment does not affect the survival rate of these fish [18].

The thyroxine hormone (T4) is a hormone produced by the thyroid gland in addition to the triiodothyronine (T3) hormone which functions in general metabolism and growth and reproduction [7, 19]. Fish thyroxine hormone is involved in controlling osmoregulation, metabolism, somatic
growth, skin pigmentation, reproduction, and post-hatching [20, 21]. Thyroxine has the effect of increasing the excretion of cholesterol and bile salts in the liver. In fish, the presence of the T4 hormone has existed during the eggs and larvae of Salmon coho fish [22]. The function of T4 / T3 has been proven in some freshwater fish that T4 and T3 can stimulate growth, development, and absorption of eggs in the larval period [8].

The hormone produced by the thyroid gland is a substance that contains iodine and is known as the thyroid hormone which consists of thyroxine and triiodothyronine. Giving the hormone thyroxine 6 mg/kg of feed was able to increase the growth of fish (M. nemurus) [12]. The main effect of the thyroxine hormone is to increase the metabolic activity of somebody tissues so that the speed of using food for energy is greatly accelerated [23]. Giving thyroid hormone to goramy can increase the activity of protease and lipase enzymes which cause fat retention and body protein retention to increase as well [24].

![Figure 3. Growth of Absolute Weight of Bronze featherback](image1.png)

![Figure 4. Absolute Length Growth of Bronze featherback](image2.png)
Figure 5. Specific Growth Rate of Bronze Featherback

Figure 6. Survival Rate of Bronze Featherback

The quality of belida rearing water is presented in Table 2. Water quality of bronze featherback rearing are generally classified as good for freshwater fish farming.

| Parameter | Value     |
|-----------|-----------|
| Temperature | 27-30°C   |
| pH        | 6.5-6.7   |
| DO        | 5-5.3 ppm |

4. Conclusion
Based on the results obtained, it can be concluded that giving the thyroxine hormone can increase the growth of bronze featherback. The best dose of thyroxine hormone for growth and survival rate of bronze featherback is 6 mg/kg of feed.

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