A study of temperature on growth performance in kancra fish (Tor soro) seed maintenance

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Abstract. Kancra fish (Tor soro) is one of specific freshwater fish in Indonesia. The main problem of Kancra fish cultivation is the sustainable availability of seeds. The hatchery efforts are still constrained by environmental conditions that are less supportive, because fish seeds are more sensitive due to environmental changes. Temperature is one of the environmental factors that really affect the hatching rate and seeds growth. The purpose of this experiment is to find out the optimal temperature for Kancra fish culture. Kancra fish with average initial weight 0.08 ± 0.0001g were used, maintained on aquarium with size of 66 x 24 x 30 cm³, with 90 fish/aquarium (density of 3 fish/L). Feeding was done with satiation method (feeding rate of 5%). The treatment was several different water temperatures, which were 24°C, 26°C, 28°C, 30°C and 32°C. This experiment used completely randomized design with 3 treatments and 3 replications. An automatic heater RH9000 was used to stabilized the water temperature. The best results found on the treatment of 28°C and 30°C with percentage of survival rate 97.74% and 95.52%, and specific growth rate 2.34% and 2.12%.

1. Introduction
Kancra fish (Tor soro, Valenciennes 1842) is one of the specific freshwater fish in Indonesia. In some areas, this fish known as soro, kancra, or semah, depends on the region. Many kancra fish formerly found on the waters of Sumatera, Kalimantan, and Java, but because of some factors such as water pollution and deforestation and the high intensity of fishing, then the genus Tor is included in the threatened species category [1,2]. There are some reasons that make kancra fish in great demand, because it has high economical value, due to its tender, thick, and tasty meat.

In freshwater fish cultivation, it is known that the highest growth rate will occur during the seed stage. This means the efforts to stimulate fish growth at the seed stage are one of the supporting factors for the success of the Torsoro cultivation. In addition, the availability of fish seeds in sufficient quantities with good quality and on a sustainable basis is also needed to support enlargement cultivation.

Environmental parameters are supporting factors and have a very big role in supporting the survival and growth of cultivated organisms including fish. Producing a high growth rate of fish seeds requires a comfortable environmental condition because fish seeds are very sensitive to environmental changes [3].
Water temperature is one of the abiotic factors, low water temperature can cause kancra fish seeds to be susceptible to disease, decreased appetite, and decreased metabolic rate which results in slow growth and high fish mortality. Temperature also affects the growth and survival rate of aquatic organisms [4]. Therefore, to improve kancra fish seed maintenance method, it is necessary to make an effort to determine and maintain the optimal water temperature, so a higher survival rate can be obtained with a better growth rate.

2. Material and method
The research was conducted at the Aquaculture and Toxicology Environmental Research Installation, Cibalagung - Bogor from October to December 2020. This research was conducted on a laboratory scale for 28 days of maintenance. The container used is a glass aquarium measuring 66x24x30 cm (lxwxh). Before use, the container is washed with clean water then disinfected using chlorine at a dose of 30 mg/l left for one day and then rinsed using clean and running water. The treatment container (aquarium) is filled with water until it reaches a volume of 30 liters, an automatic heater is set according to the temperature treatment, and a thermometer and aeration are installed in each aquarium.

The test animal used was Kancra fish (*Tor soro*) with a length of 2-3 cm and an average weight of 0.08 ± 0.0001 g/fish. Obtained from the results of controlled hatcheries and stocked with a density of 3 fish/l water (90 fish/aquarium). This experiment used a completely randomized design with water temperature differences treatment, namely: A. 24±0.5°C, B. 26±0.5°C, C. 28±0.5°C, D. 30±0.5°C, and E. 32±0.5°C where each treatment was replicated three times. Feeding was carried out by satiation as much as 5% of the biomass weight and given three times a day.

During maintenance of the fish, the water removal and replacement is done as much as 20% every two days. The main parameters of the observed growth performance of Kancra fish include:

2.1. Survival rate
Survival rate is the proportion of the number of fish alive at the end of rearing, which is calculated using the Goddard formula [5]:

\[
\text{Survival rate} = \frac{\text{Number of fish at the end of culture}}{\text{Number of fish at the beginning of culture}} \times 100\%
\]

2.2. Absolute Weight Growth (AWG)
Absolute weight growth (AWG) is the increase in weight (difference in final weight and initial weight) during maintenance time, calculated by the Zonneveld formula [6]:

\[
\text{Absolute weight growth} = \frac{\text{Average final weight (g)} - \text{average initial weight (g)}}{\text{No. of days} \times 100}
\]

2.3. Specific Growth Rate (SGR)
The specific growth rate of fish weight gain (g) during maintenance time (t) and expressed in percent (%), is calculated using the Effendi formula [7]:

\[
\text{Specific growth rate (%/day)} = \frac{(\text{Ln final body weight} - \text{Ln initial body weight})}{\text{No. of days} \times 100}
\]

2.4. Water Quality Parameters
Measurement of water quality parameters, including: pH, DO, ammonia, and alkalinity, were carried out on days 7, 14, 21 and 28 of the maintenance time. Ammonia and alkalinity analyze were carried out at the Environmental and Toxicology Laboratory of BRPBATPP Cibalagung, Bogor.

The results of the test data on Survival Rate (SR), absolute weight growth (AWG) and specific growth rate (SGR) were statistically analyzed by ANOVA at 95% confidence levels, if there were a significant effect, continued with Duncan's test. Meanwhile, water quality data (pH, DO, ammonia,
and alkalinity) were analyzed descriptively.

3. Result and discussion

3.1 Survival Rate (SR)
The survival rate of kancra fish after 28 days of rearing time were quite high, ranging from 77.85% to 97.74%. The highest value was obtained at a temperature treatment of 28 °C which was 97.74% which was statistically not significantly different (P>0.05) with a temperature of 30 °C and both were significant (P<0.05) higher with a temperature treatment of 24 °C (81.92%), 26 °C (84.03%) and 32 °C (77.85%). Between treatment temperatures of 24 °C and 26 °C were not significantly different, but both were significantly different with a temperature of 32 °C (Figure 1).

Figure 1. Survival rate of kancra fish after maintained at different temperatures for 28 days of research

Naturally, fish have the ability to adapt to water temperature, but if there is a change in the temperature of the aquatic environment beyond its tolerance limits, it can cause stress and even death. The tolerance of fish to changes in the temperature of the aquatic environment varies, depending on the type and size of the fish.

Water temperature parameters play an important role in regulating the life processes and distribution of fish because they will directly affect the metabolic process of fish. According to Kelabora (2010), one of the obstacles in the fish hatchery business is the low survival rate and the relatively slow growth of fish, where these conditions are strongly influenced by temperature [8]. In the 28°C and 30°C treatments, high survival rates were achieved. It is assumed that the temperature in the treatment is the best condition for kancra fish seeds where all life activities can take place optimally so that it will guarantee its survival.

The mortality of kancra fish at 24°C and 32°C treatment was caused by several things related to physiological processes in the fish body. According to Monalisa and Minggawati (2010), temperatures that are too low or too high from the optimal range can cause fish mortality due to insufficient energy produced for living activities [9]. Although aquatic organisms such as fish and shrimp can live well in the temperature range of 20-30°C, temperature conditions below 20°C or above 30°C cause the fish to become stressed which is usually followed by decreased digestibility. If
if this condition continues, it can result in death for fish.

3.2. Absolute Weight Growth (AWG)

The increase in absolute weight growth (AWG) of kancra fish seeds after being maintained for 28 days ranged from 0.040 - 0.075 g/fish with a sigmoid pattern where an increase in water temperature was followed by an increase in the absolute weight of the fish to a certain extent and then decreased again. This illustrated that in a certain temperature range, the optimum conditions for kancra fish are achieved so that absolute growth occurs optimally.

The highest absolute growth value was achieved at 28°C, with absolute weight growth of 0.075 g/fish, which was significantly lower (P > 0.05) with a temperature of 30 °C (0.073 g/fish) but both were significantly higher than 26 °C (0.057 g/fish), 24 °C (0.053 g/fish), and 32°C (0.040 g/fish) (Figure 2). These results indicate that the optimum water temperature conditions for kancra fish were at a temperature of 28 – 30 °C so that absolute growth can be achieved optimally.

The optimum temperature is needed by fish for growth because it greatly affects fish activity, where temperature fluctuations are closely related to energy use and feed consumption which has an impact on the fast - slow growth of fish. Growth occurs when there is excess energy derived from food after the energy produced is reduced by the energy used for all life activities including energy lost through feces and urine. The excess energy will be used to build new networks that result in growth.

![Figure 2](image_url)

Note: Different superscript letters show significantly different results (P<0.05)

**Figure 2.** Absolute weight growth of torsoro seeds after being maintained at different temperatures for 28 days of maintenance

At water temperatures of 28 and 30 °C, the absolute weight growth of kancra fish is higher than other treatments because it is thought that at that temperature, can trigger metabolism in the body, making the fish hungry quickly so that the rate of feed consumption increases and consequently an increase in growth. According to Schulte (2011), temperature has a major influence on the biological processes of an organism from cell size to ecosystem, because the things that are affected are the level of biological reactions and the balance of intermolecular interactions [10]. Fish have a certain optimum temperature for their appetite, where the temperature increase will be followed by the degree of metabolism and the fish's oxygen demand also increases. According to Madinawati and Yoel (2011), the optimal water temperature will increase the activity of eating fish, thereby accelerating growth [11].
Temperature greatly affects metabolic processes and metabolic processes will affect fish growth. The difference in water temperature between the media and the fish's body will cause metabolic disorders. This condition can result in most of the energy stored in the fish's body being used for adjustment to the less supportive environment, so that it can damage the metabolic system or exchange of substances. This can interfere with fish growth due to digestive system disorders.

3.3. Specific Growth Rate (SGR)
After 28 days of rearing time, the specific growth rate (SGR) of kancra fish ranged from 1.49 to 2.34%. The highest SGR value was obtained from the treatment temperature of 28 °C which was 2.34% which was statistically not significantly different (P> 0.05) with a temperature of 30 °C (2.12%) but both were significant (P <0.05) higher than the high treatment temperature 24 °C (1.79%), 26 °C (1.92%) and 32 °C (1.49%).

![Graph showing Specific Growth Rate of kancra fish after being maintained at different temperatures for 28 days of rearing.](image)

Note: Different superscript letters show significantly different results (P <0.05)

**Figure 3.** Specific Growth Rate of kancra fish after being maintained at different temperatures for 28 days of rearing.

An increase in water temperature to a certain extent can stimulate the metabolic process of fish and increase the rate of feed consumption thereby accelerating growth [12]. The increase in temperature has triggered the SGR of kancra fish seeds, from 24°C to 26°C water temperature until the optimum water temperature is reached (28°C) which then decreases again at 30°C and 32°C. The decrease in SGR of kancra fish at temperatures >28°C. According to Stickney (1979), occurs because the metabolic rate of most fish species will increase above the optimum temperature then energy begins to be diverted from growth [13]. A high metabolic rate so that the growth rate decreases. In addition, high water temperatures can result in most of the energy stored in the fish's body being used for adjustment to an unfavorable environment, which can damage the metabolic system and substance exchange [8]. This condition causes the specific growth rate of kancra fish a will slow down at temperatures below (24 and 26°C) or above (30 and 32°C) the optimum water temperature is 28°C.

3.4. Water quality
Apart from temperature, other water quality parameters such as pH, oxygen and ammonia also play an important role in fish life. The results of measurements of several water quality parameters in the rearing medium of kancra fish larvae in all treatments for 28 days of maintenance are as follows.
Table 1. The range of several water quality parameters on the kancra fish rearing media with different temperatures

| Water quality parameters | Treatments |
|--------------------------|------------|
|                          | 24 °C      | 26 °C      | 28 °C      | 30 °C      | 32 °C      |
| pH                       | 6.57 - 6.69| 6.60 - 6.78| 7.37 - 7.52| 7.09 - 7.25| 5.75 - 6.42|
| DO (mg L⁻¹)              | 5.75 - 6.18| 5.93 - 6.28| 6.94 - 7.27| 6.61 - 6.85| 4.92 - 5.51|
| NH₃ (mg L⁻¹)             | 0.050 - 0.052| 0.050 - 0.054| 0.044 - 0.046| 0.047 - 0.049| 0.052 - 0.076|

The pH value in this experiment ranged from 5.75 - 7.52. This range is still within a good limit for cultivation because according to Froese (2009), a good pH value range for fish seed rearing is 6.5 - 9.0 [14].

Dissolved oxygen (DO) is a parameter of water quality that is very important for life. Oxygen molecules are electron acceptors in the aerobic metabolic system, so all organisms must have an adequate oxygen supply. The DO content measured during the maintenance of kancra fish seed ranged from 4.92 to 7.27 mg L⁻¹. According to Boyd (2015), a good DO range for aquaculture media for fish seeds is above 5 mg L⁻¹ and the DO value will decrease if the temperature parameter increases. In addition, dissolved oxygen will decrease due to decay and respiration of animals and plants which is then followed by an increase in free CO₂ and a decrease in pH [15]. The oxygen consumption rate varies depending on the species, size, activity, sex, feed consumption rate, temperature, and dissolved oxygen concentration in the water. At the seed stage, the oxygen consumption rate is more per unit time and weight than adult-sized fish. This happens because small fish require more energy for growth.

Ammonia (NH₃) is an inorganic nitrogen which is easily soluble in water. The source of ammonia in waters comes from the breakdown of organic nitrogen (protein, urea and feces) and inorganic nitrogen from the decomposition of organic matter (dead aquatic biota) by microbes or fungi [15]. An increase in ammonia above 0.3 mg L⁻¹ will reduce dissolved oxygen content and increase the content of carbon dioxide (CO₂) in the blood. Ammonia measured in the kancra fish seed rearing medium ranged from 0.044 - 0.076 mg L⁻¹ (Table 1). The ammonia level is still within the tolerance limits of fish, because according to Boyd [15], the normal concentration of ammonia in uncontaminated waters is below 0.25 mg L⁻¹ and polluted waters have concentrations below 1.0 mg L⁻¹.

4. Conclusion

Water temperature has a significant effect on the life of kancra fish seeds. The optimal water temperature for the maintenance of kancra fish fry is in the range of 28 °C and 30 °C where at these temperatures can produce survival rates (97.41% and 95.52%), AWG (0.075 g/fish and 0.073 g/fish) and SGR (2.34% and 2.12%) which were significantly higher than the temperatures of 24 °C, 26 °C and 32 °C.

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