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Effect of Different Temperature on Growth Rate and Survival Betta fish fry (*Betta splendens*)

Pengaruh Suhu Berbeda Terhadap Laju Pertumbuhan Dan Kelangsungan Hidup Burayak Ikan Cupang (*Betta splendens*)

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ABSTRACT

Betta splendens is an ornamental fish with a beauty appeal to the shape of the tail fin and color. The purpose of this study was to determine the effect of different temperatures and optimal temperatures on the growth rate and survival of betta fish fry (Betta splendens). The research method was experimental using a completely randomized design (CRD). With 4 treatments, namely P1 (control), P2 (25°C), P3 (27°C), P4 (29°C). The result of the highest specific weight growth rate was in treatment P4 (4.08 g), the lowest treatment was in treatment P2 (3.85 g). The highest specific length growth rate was in treatment P4 (1.78 cm), the lowest treatment was at P2 (1.52 cm). The highest feed conversion ratio (FCR) was in treatment P2 (5.82%), the lowest FCR value was in treatment P4 (6.23%). The survival rate of the highest Betta splendes fry was on average 100% in the P1, P3, and P4 treatments. The survival value of betta fish fry was lowest in treatment P2 (82%). The results of water quality parameters for P1 treatment temperature ranged from 27-28.2□C, pH ranged from 6.3-7.85, dissolved oxygen ranged from 6-8.8. The results of the analysis of variance test (Anova) on the growth of the specific weight of betta fry produced F-count -30.85 > F-table 5% (4.07). Specific length growth resulted in an F-count value of 2.75 < F-table 5% (4.07). Feed conversion ratio (FCR) F-count 1.24 < F-table 5% (4.07). The survival of betta fish fry resulted in F-count 12.60 > F-table 5% (4.07). The conclusion of the study is that temperature has a significant effect on the growth rate and survival of Betta splendens fry. The optimal temperature for growth rate was obtained in treatment P4 (29°C) of 4.08 g, optimal survival rate was obtained in treatments P1 (control), P3 (27°C), and P4 (29°C).

ABSTRAK

Ikan cupang merupakan ikan hias dengan daya tarik keindahan pada bentuk sirip ekor dan warna. Tujuan penelitian adalah mengetahui pengaruh suhu berbeda dan suhu optimal terhadap laju pertumbuhan dan kelangsungan hidup burayak ikan cupang (*Betta splendens*). Metode penelitian adalah eksperimental menggunakan rancangan acak lengkap (RAL). Dengan 4 perlakuan yaitu P1 (kontrol), P2 (25°C), P3(27°C), P4 (29°C). Hasil laju pertumbuhan berat spesifik tertinggi pada perlakuan P4 (4,08 g), perlakuan

terendah pada perlakuan P2 (3,85 g). Laju pertumbuhan panjang spesifik tertinggi pada perlakuan P4 (1,78 cm), perlakuan terendah pada P2 (1,52 cm). Rasio konversi pakan (FCR) tertinggi pada perlakuan P2 (5,82%), nilai FCR terendah pada perlakuan P4 (6,23%). Tingkat kelangsungan hidup burayak ikan cupang tertinggi rata-rata 100% pada perlakuan P1, P3, dan P4. Nilai kelangsungan hidup burayak ikan cupang terendah pada perlakuan P2 (82%). Hasil parameter kualitas air untuk suhu perlakuan P1 berkisar 27-28,2℃, pH berkisar 6,3-7,85, oksigen terlarut berkisar 6-8,8. Hasil uji Anova pertumbuhan berat spesifik burayak ikan cupang menghasilkan F-hitung -30,85 > F-tabel 5% (4,07). Pertumbuhan panjang spesifik menghasilkan nilai F-hitung 2,75 < F-tabel 5% (4,07). Rasio konversi pakan (FCR) nilai F-hitung 1,24 < F-tabel 5% (4,07). Kelangsungan hidup burayak ikan cupang menghasilkan F-hitung 12,60 > F-tabel 5% (4,07). Kesimpulan penelitian adalah suhu memberikan pengaruh nyata terhadap laju pertumbuhan dan kelangsungan hidup burayak ikan cupang. Suhu optimal untuk laju pertumbuhan didapatkan pada perlakuan P4 (29℃) sebesar 4,08 g, tingkat kelangsungan hidup optimal didapatkan pada perlakuan P1 (kontrol), P3 (27℃), dan P4 (29℃).

Kata Kunci	*Betta splendens, FCR, Kelangsungan hidup, Laju Pertumbuhan, Suhu*
Keywords	*Betta splendes, FCR, Growth Rate, Survival, Temperature*
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INTRODUCTION

Betta fish (*Betta splendens*) is a type of freshwater ornamental fish originating from the waters of Kalimantan. The attraction of this fish is its slender and elongated body shape, butterfly fin shape, where the tail fin is wide and large and half of the tail is transparent so that the fin bones are clearly visible. Having a variety of body colors, namely dark, light, and attractive patterns, from an economic perspective, this fish has high economic value. Rahmatullah (2021) stated that the cheapest price for betta fish is 5000 rupiah per fish and the most expensive price can reach 20 million rupiah per fish.

Market demand for the availability of this fish is increasing from year to year. Based on data from the Ministry of Maritime Affairs and Fisheries, (2021), from 2017 to 2018 the volume of fish exports increased from 1.19 billion fish to 1.22 billion fish and in 2019 it was 1.68 billion fish. So the increase from 2017 to 2018 was around 3 billion head and from 2018 to 2019 it increased to 46 billion head. The attraction for the development of the betta fish cultivation business is due to the high demand both from within and outside the country. However, according to Nanda & Fitryani., (2021) in spawning betta fish there are several problems that cause the fish to be stressed so they cannot be forced to mate. So the fry of the Betta fish themselves will be very fragile if not handled in a good way, which can later cause the death of the fry. There are several components that can influence the success of raising Betta fish (Betta splendens) fry, namely feed, water quality, pests and diseases. These components must be in accordance with the needs and living habits of fish in their natural habitat, so that they can help the growth rate and survival of Betta fish fry (Mustaqim et al., 2019).

Water is a medium for fish farming activities, therefore understanding water quality is very important. Good water quality (according to cultivation standards) will be able to

support optimal growth rates for cultivated fish. Based on knowledge and literature studies, the most important thing in managing water quality in the media for keeping Betta fish fry in a closed room is the parameter that is very influential on the survival of the fish, namely the parameter that can be seen physically is temperature (Deriyanti, 2016). The chemical parameters looked at include pH, dissolved oxygen (DO) (Setiawati et al., 2020).

Temperature is a water quality parameter that is related to other water qualities. Water temperature is based on Ichsan's (2020) statement the most important factor that must always be considered because it can influence the rate of the fish's body's metabolic processes in its growth. so that temperature can later affect the survival rate of betta fish fry. Good temperature management needs to be implemented if cultivation activities are to be successful, both in terms of quality and quantity (Yuliani et al., 2020).

Based on previous research from Mustaqim (2019) regarding the effect of temperature on the development of Betta splendens Betta fish embryos. The results of this research showed that there was a close relationship between temperature and the hatchability of fish eggs, where the higher the temperature, the higher the hatching rate of fish eggs. Therefore, this research on the effect of different temperatures on the growth rate and survival of betta fish (Betta splendens) fry was taken because previous research was only carried out to see the hatchability of the eggs and the development of the embryo, whereas this has never been done on betta fish fry. This research aims to determine the effect of different temperature treatments on the growth rate and survival of Betta fish fry (Betta splendens), and to determine the optimal temperature for the growth rate and survival of Betta fish fry. (Betta splendens).

METHODS

Place and Time

The research was carried out for 45 days starting from March to April 2022 in an independent unit located in the Gomong Lawata neighborhood, No.35, Alley Watermelon.

Material and tools

The equipment used was 12 units of 10 L volume jars, digital scales, fine scoop, water hose, pH meter, cellphone camera, heater, DO meter, bucket and writing utensils. The materials used in this research were tubifex worms, fresh water, non-iodized salt, potassium permanganate, methylene blue, and 15 betta fish fry in 3 l of water for each treatment and replication. The fry used come from betta fish farmers located in Mbung Pas Village, Lingsar District, West Lombok Regency, West Nusa Tenggara.

Research design

This research used an experimental method with a Completely Randomized Design (CRD), namely four treatments and three replications. Treatment 1 (P1), namely without heater (control), Treatment 2 (P2), namely with a temperature of 25^{o}C, Treatment 3 (P3), namely with a temperature of 27^{o}C, Treatment 4 (P4), namely with a temperature of 29^{o}C.

Procedure

The research procedure begins with preparing the maintenance container, namely washing the jar and soaking it using 10 mg/l potassium permanganate for 24 hours. This aims to kill parasitic organisms. After drying the jar, fill it with water for maintenance media with a water volume of 3 liters. The water used is previously settled in a holding

bucket for 3 days with the aim of ensuring that the chlorine in the water does not enter the fish rearing media, because the water used is PDAM water.

Distribution of Betta fish fry (Betta splendens) begins with acclimatization by placing a plastic bag containing Betta fish fry on the surface of the bucket for several minutes. Then tilt the plastic until the betta fish fry emerge from the plastic. Next, the fry are first soaked in a container dripping with Methylene blue for 10 minutes at a dose of 0.2 mg/l. This drug aims to treat fungal, bacterial and parasitic diseases in freshwater ornamental fish. Betta fish fry were distributed into a 3 liter volume of rearing media at 5 fish/l in the prepared rearing media. Adaptation of treatment feed was carried out for 24 hours. Maintenance feed in the form of natural silkworm food (Tubifex sp.) with a dose for good growth and survival of fish seeds according to Pamulu et al., (2017) is 10% of the total biomass weight.

The temperature is regulated using a heater whose temperature level is appropriate to the research treatment. Lowering the temperature by 1oC in ± 30 minutes requires 10 g/l of ice cubes, while to increase the temperature by 1oC it takes ± 40 minutes and requires a heating device in the form of a heater. temperature is controlled every 24 hours. This is an activity as a precaution if the temperature suddenly changes during the research. Maintenance is carried out for 35 days while always maintaining stable water quality according to the fish's needs as a living medium. The maintenance process involves always siphoning off 20% of the total water volume before feeding and adding water. This activity is good for dealing with waste products from fish metabolism. Water quality management by changing the water by 50% every morning or evening can overcome the toxic impact of fish metabolic waste. Water quality measurements, in the form of temperature, were only carried out in treatment P1 (control), while pH and dissolved oxygen (DO) were measured once every week during the research, namely every time the weight and length of the test fish were measured.

Data Analysis

Observational data analyzed included specific weight growth rate, specific length growth rate, feed conversion ratio (FCR) and survival rate of betta fish fry. The data calculation results were analyzed using the Microsoft Excel program to be tabulated in tabular data or presented with graphs and data analysis using analysis of variance (ANOVA) with a one-factor (temperature) randomized design. If the calculated F value is ≥ table F value (5%, 1%) or shows a real influence between treatments, then data analysis continues with the Honest Value test or often called Tukey (BNJ).

RESULT AND DISCUSSION

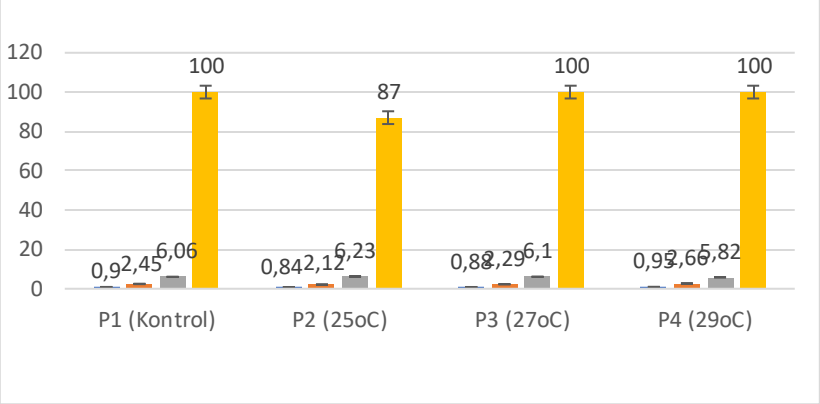
Result

Observation of the growth of Betta fish fry which were reared at different temperatures for 35 days in an independent unit located in the Gomong Lawata neighborhood, No.35, Watermelon Alley. The temperature ranges used in this study were 25oC, 27oC, 29oC, and control. Based on the results of observations, different temperatures can affect the specific weight growth rate, specific length growth rate, feed conversion ratio (FCR), and survival rate of Betta fish fry which are presented in the table 1.

Table 1. Specific Weight Growth Rate, Specific Length Growth Rate, Feed Conversion Ratio (FCR), and Survival of Betta fish fry

Treatment	Growth rate specific weight (g)	Growth rate specific length (cm)	Feed Conversion Ratio (%)	Life sustainability (%)
P1 (kontrol)	3,99±0,08[a]	1,68±0,13[a]	6,06±0,23[a]	100±0[a]
P2 (25oc)	3,85±0,07[a]	1,52±0,04[a]	6,23±0,17[a]	87±0,82[b]
P3 (27oc)	3,94±0,00[ab]	1,61±0,05[ab]	6,10±0,01[a]	100±0[b]
P4 (29oc)	4,08±0,014[ab]	1,78±0,12[b]	5,82±0,34[a]	100±0[b]

Note: Different letters on the same line indicate significant differences between treatments (P<0,05).



Discussion

Growth rate of specific weight of Betta fish fry (*Betta splendens*)

The highest specific weight growth rate for Betta fish fry was found in the P4 treatment at a temperature of 29oC of 4.08 grams. In treatment P2 with a temperature of 25oC, the growth rate of Betta fish fry was the lowest, namely 3.85 grams. Meanwhile, in treatment P1 it was 3.99 grams and in treatment P3 it was 3.94. The optimal temperature for growth of Betta fish fry is based on the average specific weight growth rate, namely treatments P4, P3 and P1.

The results of the analysis of variance in the specific weight growth of Betta fish fry produced a calculated F of -30.85 which was greater than the F table of 5% (4.07), and the F table of 1% (7.59). F Table 5% > F Hit > F Table 1% then the different treatments are very significant.

The research results of further tests used were the honest significant difference test (BNJ) or often called the Tukey test because the differences were very significant and the resulting coefficient of diversity (KK) was 5.33%. In the BNJ further test it was found that the different treatments were very significant (P>5%). The results of further tests (BNJ) obtained by Treatment P1 were significantly different from treatments P2, P3, and P4.

The results of the research show that Betta fish fry have a tolerance limit for environmental conditions, especially temperature. It was found that treatments P1 (control), P3 (27oC), and P4 (29oC) gave better growth results. Compared with treatment P2(25oC). Betta fish fry that live in water with low temperatures will experience stress. This can interfere with the appetite of Betta fish fry. In accordance with Ahmad's (2020) opinion, the decrease in water temperature is followed by the degree of metabolism. However, a higher temperature decrease will reduce growth, because the fish's appetite

has an optimal temperature. This statement is in accordance with (Fauzan et al., 2018) that a good temperature for the growth of betta fish fry is between 27-28oC. Therefore, temperature has an important role in increasing the growth of Betta fish fry.

Specific Length Growth Rate of Betta Fish Fry (*Betta splendens*)

The growth rate for the specific length of Betta fish fry was the lowest on average, namely in treatment P2 at 1.52 cm with a temperature level of 25oC. Meanwhile, the highest average specific length growth rate in treatment P4 was 1.78 cm with a temperature level of 29oC. The average specific length growth in treatment P3 was 1.61 cm with a temperature level of 27oC, lower than in treatment P1, which was 1.68 cm.

The results of analysis of variance (Anova) of specific length growth of Betta fish fry produced a calculated F of 2.75 (attachment). The calculated F value of 2.75 is smaller than the F table of 5% (4.07) or the F table of 1% (7.59). F count < F table, then the data is not significantly different.

Based on the results of research on P2 treatment with a temperature of 25oC, length growth shows that the temperature of the rearing media does not increase the length of Betta fish fry. The water quality parameter that influences fish growth is temperature. Water temperatures that are too low can cause fish to grow poorly. All types of fish have low tolerance to sudden changes in water temperature (Andriyanto et al., 2013). This is in accordance with the statement (Ari et al., 2017) that increasing density affects the physiological processes and behavior of fish regarding movement space which in the end can reduce the health and physiological conditions of fish. This causes specific length growth, and survival decreases.

Feed Conversion Ratio (FCR)

Based on research, it was found that the highest feed efficiency measurement was in the P2 treatment at a temperature of 25oC, namely 6.23%. Meanwhile, the lowest value in the P4 treatment at 29oC was 5.82%. From the data in table 1, it can be seen that clothing efficiency is influenced by temperature. This is in accordance with Effendie's (2004) statement in Ridwan et al. (2019) which states that feed efficiency depends on the type of species, water quality and feed.

The results of analysis of variance (Anova) show that the feed conversion ratio obtained is a calculated F value of 1.24 (attachment). The calculated F value of 1.24 is smaller than the F table of 5% (4.07) or the F table of 1% (7.59). F count < F table, then the data is not significantly different. Based on the research results presented in table 1. Temperature influences the feed conversion ratio for betta fish fry. These results are illustrated by a graph of the relationship between the feed conversion ratio of Betta fish fry and the treatment temperature during the study (Figure 1.)

Based on the research results, the highest feed efficiency treatment was in the P2 treatment with a temperature of 25oC. This is thought to occur because it is largely influenced by water quality. The water quality parameter that influences fish feed efficiency is temperature. Water temperatures that are too low can cause fish to grow poorly. All types of fish have a low tolerance for sudden changes in water temperature (Andriyanto et al., 2013).

Betta Fish Fry Survival Rate (*Betta splendens*)

The highest survival value of betta fish fry was obtained from treatments P1 (Control), P3 (27oC), and P4 (29oC) with an average of 100% and the lowest survival value of betta fish fry was obtained in treatment P2 (25oC). So the total number of fry

remaining alive during the 45 day rearing period was 174.

The survival value in treatment P2 with a rearing temperature of 25□C gave the lowest value. This is because during the research, 6 fry died due to fungal infections. At a temperature of 25□C, fungi can infect seeds quickly. According to Kordi (2019) in (Manigasi et al., 2013), fungal infections in fish can occur due to a weakness in the fish's immune system. When a fish's immune system is weakened, the chance of being exposed to fungus is higher. According to Ahmad (2020), using a temperature of 25□C can cause fish seeds to be easily attacked by fungi so that the fish seeds are unable to survive. Low temperatures in the rearing media can result in mucus deposits produced by fish and mold in the rearing media. Fish seeds infected with the fungus experience a change in body color from normal to whitish. Disease infections can easily occur at cold maintenance media temperatures. Cold temperatures can cause a decrease in fish metabolism which will result in a decrease in the fish's resistance to disease. According to Nasrullah (2019) fish deaths can be caused by disease infections that the fish's immune system cannot fight. Environmental conditions greatly influence the survival of fish because fish metabolism and immunity are very dependent on their environment. The highest fry survival was in treatments P1 (Control), P3 (27□C), and P4 (29□C) during rearing with a survival percentage of 100% and the number of live fry was 45/treatment. Using a temperature of 27-29□C provides the most optimal survival results, this is in accordance with the statement of Pratama., (2021) which says that seed survival can be influenced by external factors of the fish. The external factor that has the most influence on fish seeds is temperature. The temperature range of 28-30□C is the optimal temperature in the process of raising fish seeds. Using optimal temperatures for fish is the key to achieving high survival values according to Kordi., (2019) in (Manigasi et al., 2013) a temperature of 29^{o}C is the optimal temperature in the fish rearing process.

Water Quality Parameters

Water quality is a supporting factor in raising betta fish fry. The water quality measured in this study included temperature, dissolved oxygen (DO), and acidity degree (pH). Temperature measurements are carried out every day along with feeding, while pH and dissolved oxygen measurements are carried out every week before the feeding process. The results of water quality measurements during the research are presented in table 2 below.

Table 2. Water Quality Parameter Values for Betta fish fry during 45 days of research.

Parameter	Observation result		Standard
	Treatment	Range Value	
Temperature	P1 (Kontrol)	27-28,2	25º-30ºC (Ahmad, A.A.F., 2020)
	P2 (25^{o}C)	25	
	P3 (27^{o}C)	27	
	P4 (29^{o}C)	29	
Ph	P1 (Kontrol)	6,51-7,61	6,9-8 (Deriyanti, 2016)
	P2 (25^{o}C)	7-7,68	
	P3 (27^{o}C)	7,08-7,66	
	P4 (29^{o}C)	6,3-7,85	
Dissolved Oxygen	P1 (Kontrol)	6-7,1	> 5ppm (Fauzan et al., 2018)
	P2 (25^{o}C)	7,3-8,8	
	P3 (27^{o}C)	6,4-7,6	
	P4 (29^{o}C)	5,6-7,1	

Temperature conditions during the study experienced fluctuations of 0.1 – 1 ⍰C. This is due to changes in room temperature from morning to evening, as well as the water heater working system which will automatically stop when the water temperature reaches the set value and will automatically turn on when the water temperature is below the value that was set at the beginning. Based on the temperature values used for research, a temperature of 25 – 31^{o}C is a temperature that can still be tolerated by betta fish. Ahmad (2020) said that Betta fish generally live in an environment with a temperature range of between 24-30^{o}C. However, Betta fish can also live in environments with temperatures ranging between 20-32^{o}C. Cold temperatures will affect the ability to expand the fins of betta fish. In general, cold temperatures will cause Betta fish's fins to bud and make it difficult to expand. High and low water temperatures will affect the life of the biota that is maintained. Water temperature affects the metabolic system and development of organisms and influences the amount of food consumed by fish. Ridwantara et al., (2019) said that water temperature can affect fish metabolism through the amount of feed consumed by the fish.

The results of measuring the pH value in treatment P4 showed that the lowest value was 6.3 and the highest value was 7.85. The range of pH values in treatment P1 is between 6.51-7.61. The range of pH values in treatment P2 ranges from 7 – 7.68 and the range of pH values in treatment P3 ranges from 7.08-7.66. The pH range of the water during the research can be said to be in accordance with the tolerance range of Betta fish. According to Ladyescha et al., (2015) Betta fish are fish that live in tropical climates and live in rivers, swamps and other shallow waters. The pH range of water that is suitable for bettas is 6.5 – 7.5. According to Ahmad A.A.F., (2020) Betta fish are very suitable for living in waters that have a pH value between 6.5 – 7.5 or close to the value of fresh water. According to Ahmad (2020) ideal pH will make fish healthy and less susceptible to disease and reproduction and breeding will be optimal. On the other hand, a low pH that is too acidic or too high can cause fish death. A pH mismatch can affect the life of betta fish. Betta fish that are kept in water that has a pH value that is not ideal can easily get disease because their appetite decreases (Yulan *et al*., 2013).

The dissolved oxygen (DO) value in the P4 treatment was found to be the lowest, ranging from 5.6-7.1 ppm and the highest dissolved oxygen value was obtained in the P2 treatment at 7.3-8.8 ppm. The dissolved oxygen value in treatment P3 ranged from 6.4 – 7.6 ppm and the dissolved oxygen value in treatment P1 ranged from 6 – 7.1 ppm. The dissolved oxygen value during the research can be said to be high. According to (Fauzan et al., 2018) a good dissolved oxygen value for fish rearing media is >5 ppm. Dissolved oxygen is needed by decomposing bacteria in the process of breaking down organic material. When keeping betta fish, the oxygen solubility value does not have a big influence because betta fish can take oxygen directly from the air (Abidin & Hutami., 2018). According to Destrana & Didin., (2019) Betta fish can be kept in media without requiring an oxygen supply from certain tools. Betta fish have a respiratory system that allows them to take in oxygen from the free air. In the Betta fish's respiratory system there is a labyrinth which functions to take oxygen directly from the air. This ability of betta fish is what makes betta fish easy for many people to keep.

CONCLUSSION

The conclusion from the research obtained is that temperature has a real influence on the growth rate and survival of betta fish fry. The optimal temperature for growth rate

was obtained in treatment P4 with a temperature (29°C) of 4.08 g, the optimal survival rate was obtained in treatments P1 (control), P3 (27°C), and P4 (29°C).

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