AN ANALYSIS OF THE EFFECT OF TEMPERATURE ON NILE TILAPIA (Oreochromis niloticus)

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Abstract

Tilapia is one of the many fish cultivated in Indonesia. Tilapia is a type of fish that has fast growth, eats all food ingredients (omnivore), has wide adaptability, and is also tolerant of various environmental conditions so it is easy to breed. Factors that affect the survival and growth of fish are dissolved oxygen levels, temperature, pH, feeding rate and others. The purpose of this study was to determine the effect of temperature on tilapia (Orechromis niloticus). The method used in this work is a systematic review, in which a number of scientific articles related to this research are analyzed. The results of this study indicate that temperature greatly influences many aspects of life, namely the level of survival,

Keywords: Tilapia, Oreochromis niloticus, Temperature

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Introduction

Tilapia is a fish native to Africa which has been introduced to many countries in the world. Tilapia has many advantages when compared to other types of fish, so that it is widely bred. Tilapia is a type of fish that has fast growth, eats all food ingredients (omnivores), has broad adaptability, and is also tolerant of various environmental conditions so it is easy to grow. for breeding (Ath-thar & Gustiano, 2010). Apart from that, tilapia is also known to have a high protein content, so it is also known as "water chicken" (Dailami et.al, 2020). Tilapia belongs to the Phylum Chordata, Class Pisces, Subclass Teleostei, Order Percomorphi, Suborder percoidea, Family Cichlidae, Genus Oreochromis, with Species Oreochromis niloticus.

In general, tilapia (Oreochromis niloticus) has a slightly flattened body with 6 dark vertical lines on the caudal fin, 10 vertical lines on the body, 8 vertical lines on the tail, and a black tip. Eyes slightly protruding, margins blue-green, mouth terminal position, position from pelvic fins to pectoral fins pectoral fin, lateral line bisected, straddling pectoral fin, number of scales on lateral line 3 , and dorsal fin 17. There are 6 scales on main pelvic fins, 15 scales on the pectoral fins, 3 stiff scales on the anal fin, and 10 scales on the caudal fin (Cahyanti & Awalina, 2022).

Tilapia is known as a fish that is resistant to environmental changes. This fish can live in fresh, brackish and salt water (Lubis et.al, 2016). This makes tilapia fish cultivable in brackish lowlands and low-temperature highlands, and is resistant to a lack of dissolved oxygen in water. However, the survival of this fish is determined by many factors from the environment and habitat. The main environmental and management factors that affect the survival and growth of fish are dissolved oxygen levels, temperature, pH, feed rate, and so on (Cahyati & Awalina, 2022).

The impact of climate change due to rising temperatures on Earth is indeed very worrying for human life (Lubis et.al, 2016). This condition also increases the temperature of water elements, namely lakes, rivers and seas. The effect of increasing water temperature has effects on

various aspects of aquatic composition and life. As the temperature in the water increases, so does the solubility of oxygen, so its toxicity actually increases. The intensity of sunlight hitting the surface can cause morning and evening temperature variations, which can affect the survival of tilapia (Cahyati & Awalina, 2022).

Therefore it can be concluded that temperature greatly affects the survival of tilapia, and several aspects of tilapia life are very dependent on ambient temperature. Therefore, in this study, the authors wanted to investigate further various aspects of the life of tilapia (Oreochromis niloticus) which are affected by the ambient temperature.

Research Methods

The method used in this research is a literature study (systematic review). Literature review or literature review (systematic review) is a method for identifying, evaluating, and interpreting various research findings from scientific journals, theories, and findings of other stakeholders. Systematic reviews usually involve detailed and comprehensive plans and search strategies derived a priori, with the aim of reducing bias by identifying, assessing, and synthesizing all relevant studies on a particular topic (Uman, 2011). This research was conducted by reviewing existing theories and the results of previous research published in academic journals available in databases such as Google Scholar, Web of Science, Research Gate, and Garuda.

The population and samples used in this study are articles taken from at least several articles published in national and international scientific journals that are accredited and relevant to the research being studied. Research procedures include determining research questions, searching for literature that is appropriate to the research question, collecting scientific works or related literature, conducting paper reviews based on the scientific works found, and analyzing the data found. The literature search consists of several steps, namely summarizing all the data from the new study and drawing conclusions from the reviews conducted.

Results and Discussion

No.	Author and Year	Affected aspect	Research result		
			Low temperature	**Normal temperature**	**High temperature**
1.	Sihombing & Usman (2018)	Growth in fish length		Tall	
		Fish weight		Normal	
		Life sustainability	Causing lesser mortality	Can live well	May cause death
2.	Arifin (2016)	Survival rates	Can turn off (lower)	Can live optimally	Can turn off
3.	Azhari & Tamasoa (2018)	Growth rate		Optimal	
4.	Lubis et.al (2016)	Leukocyte count		Normal	Decrease
5.	Yanuar (2018)	Seed growth		Well	
6.	Khater et.al (2017)	Fish seed weight	Low	Normal	Higher than low temperature
7.	Siegers et.al (2019)	Fish activity			
		Appetite			

8.	Asmaa et.al (2017)	Fish stress level			
9.	Sangwan et.al (2017)	Swimming speed	Slow	Fast	Slow
10.	Pandit & Nakamura (2010)	Life sustainability		Tall	Low
		Heavy			Slow / low
		Long			Slow / low
11.	Ningtiyas & Suwartiningsih (2019)	Appetite and digestion of food	Slow	Fast	
12.	Putri et.al (2021)	Fecundity of fish eggs			
13.	Alam et.al (2021)	Seed production			
14.	Jin et.al (2019)	Tilapia weight	Lower	normal	Lower
15.	Yustiati et.al (2017)	Viscosity and blood flow	The viscosity is thickened and the blood flow is slow	Normal	
		Oxygen consumption	Decrease	Normal	
16.	Aliza et.al (2013)	Fish behavior			
		Anatomical pathology			
		Gill histopathology			
17.	Ramadhan et.al (2018)	Survival	Low		
18.	Saparuddin (2019)	Glucose		normal	increase
		Erythrocyte		normal	
		Platelets	No effect	normal	No effect
19.	Azaza & Dhraief (2020)	Gastric evacuation rate	Decrease	Normal	Increase
20.	Habibah et.al (2017)	The structure of the reproductive organs in males and females	Influential	No effect	Influential

Based on the results of an analysis of a number of articles above regarding the effect of temperature on tilapia (Oreochromis niloticus), it was found that temperature has a very large influence on many aspects of tilapia life. These aspects include survival rate, fish growth rate, appetite, food digestion process, body stability level against disease, fish movement, blood viscosity and flow, oxygen consumption, leukocyte count, blood glucose level, erythrocyte count. , platelet count, fry maintenance, tilapia fry weight, gastric evacuation rate, egg production, swimming speed, response to feeding, infertility level in female fish, tilapia fry weight, stress level of fish, structure of reproductive organs in males and females .

Temperature is very influential on the survival of tilapia. Sihombing & Usman (2018) stated that high temperatures can result in the death of fish. This is in line with what was said by Wardoyo (1975) in Waruwu (2014) that even though fish are

used to relatively high temperatures, an increase in temperature at a certain level can still cause death in fish. High temperatures (35 and 37°C) slow tilapia growth and increase the risk of death. Even though tilapia are only exposed to high temperatures in the short term, the effects will still be very detrimental (Pandit & Nakamura, 2010). This is also in line with the findings from Yanuar (2018), which is a low temperature (less than 14^{o} C or a temperature that is too high, namely 42^{o} C can cause disruption of the growth of tilapia and even cause death. According to Gupta and Acosta (2004), a good temperature for tilapia is in the range of 25-30^{o}C.

In addition, temperature also greatly affects the growth of tilapia, namely the increase in length and weight. Tilapia that live at 27oC experience a faster increase in length compared to tilapia that live at 29oC and 31oC. This is reinforced by the statement of Sihombing & Usman, (2018), which states that in addition to affecting the growth of fish length , temperature also affects the weight of tilapia, according to Jin et.al (2019), when the temperature where tilapia lives is optimal, the metabolism in the fish's body will also be optimal so that the weight of tilapia will also increase.

Temperature is also very influential on appetite and the digestive process of food in tilapia. Sangwan et.al (2019) said that tilapia (Oreochromis niloticus) kept at too low and too high temperatures did not respond when given food. This is in line with the statements of Arifin (2016) and Siegers et.al (2019) that with temperatures below 25^{o} C can cause a decrease in fish movement activity, and at temperatures higher than normal temperatures cause a decrease in fish appetite. This happens because of a decrease in the body's physiological response and a decrease in the body's metabolic rate, causing a decrease in the appetite of tilapia (Cahyati & Awalina, 2022). In addition to appetite, temperature also affects the digestive process of food in fish. According to Ningtiyas and Suwartiningsih (2019) cold temperatures slow down digestion, while warm temperatures speed up digestion

Furthermore, temperature also affects the movement of fish. Fish swim at a slow speed and always hide at low temperatures, whereas at temperatures that are too high the fish do not move at all, whereas at normal temperatures fish can move actively all over the place (Sangwan et.al., 2019; Siegers et.al., 2019). In addition, temperature also affects the viscosity and blood flow in fish. Cold temperatures can affect body temperature and blood temperature of tilapia. Blood viscosity will thicken at cold temperatures, causing blood flow to slow down (Yustiati et.al, 2017).

The level of body stability of tilapia and the level of ease with which it is attacked by disease are also affected by temperature. Low water temperatures can cause tilapia to be susceptible to disease (Arifin, 2016). Azhari & Tamasoa (2018) said that metabolic processes in the body of fish which play an important role in productivity and survival are influenced by various physical factors of water quality and temperature. The low metabolism causes the fish's immune system to weaken so that it is susceptible to disease. An increase in water temperature increases the fish's immune response. One of the things that plays a role in the body's immune response is leukocytes (Cahyati & Awalina, 2022). Leukocytes function to destroy infectious and toxic materials through phagocytosis by forming antibodies (Lubis et.al, 2016).

In addition, temperature also affects glucose levels in the blood of tilapia. When fish get used to the water temperature or temperature range and then experience a rapid decrease in temperature, this can cause physiological and behavioral changes in fish that stress fish out. Coldshock stress will be a neuroendocrine response in the central nervous system. Furthermore, there will be a primary response in which the release of corticosteroid hormones and catecholamines (Donaldson et al., in Yustiati et al., 2017). Tilapia glucose levels will increase at high temperatures. Next is the number of tilapia erythrocytes. The number of erythrocytes will increase in hot temperatures. This happens because the uptake of oxygen by erythrocytes increases. In contrast to the number of erythrocytes, the platelet count of tilapia is not affected by hot or cold temperatures (Saparuddin, 2019).

Some of the physical activity of tilapia which is also affected by temperature include swimming speed, response to feeding, and also the level of stress on the fish. Fish swim at a slow speed at low temperatures, whereas at high temperatures, fish do not move (Sangwan et.al, 2019). In addition, decreasing and increasing temperature also affects the response of fish to the feed given, where fish will not respond at low or too high temperatures. This happens because both low and high temperatures cause the level of stress on fish to increase so that the metabolic rate is low (Asmaa et.al, 2017).

Temperature can affect the structure of the reproductive organs of tilapia because low and high temperatures can change the sex determination mechanism and cause fish sex reversal when the gonads are not differentiated (Habibah et.al, 2017). Tilapia treated with high temperature of 36°C resulted in significantly smaller ovaries than fish ovaries at normal temperature. Meanwhile, the testes that were given high temperature treatment became bigger, this was due to impaired reproductive function due to the influence of the temperature (Sun et al., 2016). This temperature also affects the development of tilapia seeds, namely the number of seeds produced by tilapia brooders and the weight of tilapia seeds (Alam et al., 2021; Khater et al., 2017; Iskandar et al., 2021).

Conclusion

Tilapia is an easy fish to cultivate because it can live in wide waters or even in narrow places or ponds. The survival of tilapia is also influenced by many factors from the environment. Environmental factors that affect the survival and growth of fish are dissolved oxygen levels, temperature, pH, feeding rate and others. One factor that greatly influences the life of tilapia is temperature. The research results from a literature review of several relevant articles found that the life of tilapia (Oreochromis niloticus) is strongly influenced by temperature. Temperature affects many aspects of the life of tilapia, namely survival rate, fish growth rate, appetite, food digestion process, body stability level for disease, fish movement,

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