CHAPTER II
LITERATURE REVIEW

2.1. Classification of Tilapia *(Oreochromis niloticus)*

According to Ningrum (2012) , tilapia *(Oreochromis niloticus)* can be classified as follows:

Kingdom	: Animalia
Phylum	: Chordata
Class	: Osteichthyes
Subclass	: Actinopterygii
Ordo	: Percomorpha
Subordo	: Percoidea
Family	: Cichlidae
Genus	: *Oreochromis*
Spesies	: *Oreochromis sp.*

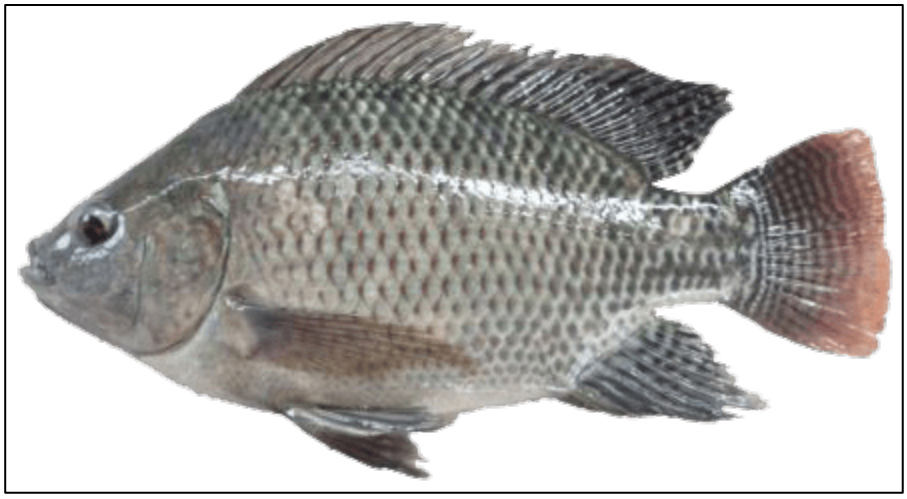

Figure 1. Tilapia

Tilapia is one of the most important and widespread species in the aquaculture world (Battazza *et al.,* 2020) . Tilapia has a characteristic dark vertical stripe on the caudal, dorsal, and anal fins. The body shape is flat towards the vertical (compress), the eyes are slightly protruding and quite large with the white edges of the body, the lips are thick and usually pop out. This fish has complete fins. The position of

the fin ventral to the pectoral is thoracic. The linear line is broken into two, namely the top and bottom (Sinaga & Syammaun, 2015) .

Tilapia *(Oreochromis sp.)* is known as a sexual dimorphism organism, i.e., male fish show faster growth than female fish and the ability to convert feed is better, so that at the same age male body size is larger than female fish. Single sex tilapia cultivation is considered more profitable in terms of production cost efficiency and increased profit, because it can overcome the 30-50% decrease in biomass at harvest caused by early maturation in mixed-sex populations (Soelistyowati *et al.,* 2010) .

Tilapia can live in deep and wide waters as well as in narrow and shallow ponds. Tilapia can also live in lakes, reservoirs, swamps, rice fields, brackish water ponds, and public cages. The optimal pH value of water for rearing tilapia is 6.5-8.5 (Sahubawa *et al.,* 2020) . Meanwhile, the dissolved oxygen level is at least 3 ppm. Optimal salinity for red tilapia cultivation is 0-10 ppt. The temperature of the pond or waters that can be tolerated by tilapia is 15-37 ^{o}C. The optimum temperature for tilapia growth is 25-30 ^{o}C. Therefore, tilapia can be kept in low land up to an altitude of 800 meters above sea level. Tilapia is easy to cultivate and is classified as an omnivorous fish. Fish seeds can eat algae / moss attached to the rocks where they live. Tilapia can also eat plants in aquaculture ponds and are also given various additional feeds such as pellets when cultivated (Ningrum, 2012) .

2.3. Water quality

In fish farming, several parameters/indicators of water quality need to be known because they greatly affect cultured fish. Even if the fish that are farmed are fish that are resistant to extreme water quality. Tilapia is an animal that lives in temperate climates and lives in freshwater areas. According to SNI 7550 (2009), the requirements for water media for tilapia are according to the following table:

Table 1. Water media requirements for tilapia

Parameter	**Unit**	**Requirements**
a. Physics		

Temperature	^{0}C	25-32

Table 1. Continous

Parameter	**Unit**	**Requirements**
Brightness	cm	30-40
b. Chemical		
pH	-	6.5-8.5
Dissolved oxygen	Mg/L	3 mg
Ammonia	Mg/L	< 0.02

Source: SN Indonesia, 2009

2.3.1. Temperature

Drastic changes in water temperature can kill aquatic biota due to changes in blood carrying capacity. Temperature is related to the concentration of dissolved oxygen in the water and the oxygen consumption of aquatic animals. The growth and life of aquatic biota is strongly influenced by water temperature. The optimal temperature range for life in tropical waters is between 28−32 ^{o}C. In this range oxygen consumption reaches 2.2 mg/l body weight-hour. Below 25 ^{o}C, oxygen consumption reaches 1.2 mg/l body weight-hour. At a temperature of 18−25 ^{o}C, fish can still survive but their appetite begins to decline. Water temperatures of 12−18 ^{o}C start to harm fish, while temperatures below 12 ^{o}C will cause tropical fish to freeze to death (Kordi, 2010) .

Temperature is one of the most important factors affecting the physiology, growth, reproduction and metabolism of tilapia (El-Sayed, 2020) . Water temperature is very influential on the physical and chemical properties of the waters and the physiological properties of fish. In addition, the effect of temperature on fish growth also depends on the interaction of feed consumption and metabolism. The increase in temperature in a water will increase the metabolic rate in the body so that oxygen demand is more critical in high-temperature water than in water with relatively low temperature (Raharjo, 2004) . The normal temperature for fish development, reproduction and growth of fish ranges from 20-35 ^{o} C but is highly

dependent on the type of fish being cultured, Xie et al. (2011) said that the temperature of tilapia can survive in the temperature range of 20-35 ºC. Tilapia can also tolerate temperatures as low as 7-10 ºC, but only for a short time (Sifa *et al.,* 2002).

At a sudden drop in temperature there will be degradation of red blood cells so that the respiration process interferes. In addition, low temperatures can cause fish to be inactive, flock and fish do not want to swim and eat so that their immunity to disease is reduced. On the other hand, at a high temperature, the fish are actively moving, do not want to stop eating and their metabolism increases rapidly so that there is more feces. While the need for oxygen increases, even though the availability of oxygen in poor water will decrease so that fish will experience a lack of oxygen in the blood (Angin & Setyogati, 2019) .

The reaction speed will increase with increasing temperature until the optimum temperature limit and if above the optimum temperature the enzymes will experience denaturation so that they cannot produce products. Growth will occur if there is an excess of energy 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 (Taufik *et al.,* 2016)

Temperature has a significant effect on energy use for growth. An increase in temperature will increase the need for feed because the fish will move more actively. Increasing the amount of fish feed will cause an increase in the growth rate of fish. Furthermore, at higher temperatures, the conversion of food into meat is more efficient than at lower temperatures (Zonneveld *et al.,* 1991) .

2.3.2. Dissolved Oxygen (DO)

Dissolved oxygen (DO) is an important water quality parameter because the dissolved oxygen value can indicate the level of pollution or the level of wastewater treatment. The solubility of oxygen in water can be affected by temperature. Oxygen solubility is inversely proportional to temperature (Akmal *et al.,* 2021) .

As it is known that oxygen acts as an oxidizing agent and reducing toxic chemicals into other simpler and less toxic compounds. In addition, oxygen is also needed by microorganisms for respiration. Certain organisms, such as microorganisms, play an important role in breaking down toxic chemical compounds into simpler and less toxic compounds. Because of this important role, industrial wastewater and sewage before being discharged into the general environment are enriched with oxygen levels (Salmin, 2005) .

The amount of oxygen needed by aquatic animals varies greatly and depends on the species, size, amount of feed eaten, activity, water temperature, oxygen concentration and others. The need for oxygen for fish has two aspects, namely environmental needs for certain species and consumptive needs which depend on fish metabolism and fish need oxygen for burning feed in the body to produce swimming, reproduction and growth activities. The permissible dissolved oxygen requirement for tilapia cultivation is > 3 mg/l (Pangestu, 2020) .

Good water quality contains at least 5 ml/l of dissolved oxygen. This dissolved oxygen can be increased by adding oxygen to the water using an aerator or running water. Excess plankton can cause the oxygen content in the water to decrease, so with that plankton in the water must always be monitored (Maturbongs, 2015) .

In fresh water, dissolved oxygen levels range between 15 mg/liter at 0 ^{o}C and 8 mg/liter at 25 ^{o}C. Dissolved oxygen levels also fluctuate daily *(diurnal)* and seasonally, depending on mixing *and* movement. *(turbulence)* mass of water, photosynthetic activity, respiration, and waste *(effluent)* entering water bodies, the greater the temperature and *altitude* and the lower the atmospheric pressure, the lower the dissolved oxygen level (Effendi, 2003) .

2.3.3. Degree of Acidity (pH)

The pH of the water affects the fertility of the waters because it affects the life of micro-organisms. Acidic waters will be less productive and can even kill farmed fish. At low pH (high acidity), the dissolved oxygen content will decrease. As a result, oxygen consumption decreases, respiratory activity increases, and appetite

decreases. The opposite happens in an alkaline environment. Most aquatic biota are sensitive to changes in pH and prefer a pH of around 7-8.5. The pH value greatly affects the biochemical processes of the waters, for example the nitrification process will end if the pH is low (Kordi, 2010) . The pH conditions that can interfere with fish life are too low (very acidic) or too high (very alkaline). Each type of fish will show a different response to changes in pH and the impact it causes is different (Zubaidah *et al.,* 2020) .

The pH value is an indicator of the acidity of a water, several factors that affect the pH of the waters include photosynthetic activity, temperature, and the presence of anions and cations. The pH value also affects the toxicity of a chemical compound, if the pH value is below 6.5 or above 9-9.5 for a long period of time, the rate of reproduction and growth of aquatic organisms will decrease. (Bassey & Ajah, 2010) . The pH value that can be tolerated by tilapia ranges from 6-9, but for optimal growth and development it is in the range of 7-8 (Permatasari, 2012) and (Bahnasawy *et al.* , 2009) , this is confirmed by research (Rebouças *et al . al.,* 2016) assessed the optimum range of water pH for tilapia cultivation with a size of 1.37 g with a pH range of 4.5-9.5 for 8 weeks, with the results showing that pH 5.5-9 can be used for fish culture.

2.4. Growth

Growth in an individual is caused by tissue growth due to mitotic cell division. This occurs when there is an excess of energy input and amino acids (proteins) that come from food. The food will be used by the body for basic metabolism, movement, production of sexual organs and maintenance of body parts or replace damaged cells (Aliyas, 2016) .

Growth is the increase in weight or content according to changes in time. Fish growth is influenced by internal and external factors. External factors include the availability of food for fish and environmental conditions of the waters. Regulation of water quality and feed manipulation can increase fish growth. Furthermore, it is stated that environmental factors that affect the growth rate and consumption of fish feed are temperature, dissolved oxygen, salinity and dissolved ammonia levels.

Growth occurs when the amount of food consumed by fish is more than what is needed for the maintenance of the body (Primaningtyas & Hastuti, 2015) .

Growth can be considered as the result of a metabolic process of feed which ends with the preparation of body elements. Not all feed eaten by fish is used for growth. Most of the energy from feed is used for body maintenance. The rest is used for activity, growth and reproduction (Fujaya, 2004) . Fish growth is closely related to the availability of protein and feed. The nutritional content will affect the behavior, health, physiological function, reproduction, and growth of fish (Pramudiyas, 2014) .

An important factor that affects the growth and survival of fish in addition to feed is water quality, especially temperature. Because the temperature can affect the growth and appetite of fish. Temperature can affect important fish activities such as respiration, growth and reproduction. High temperatures can reduce dissolved oxygen and affect the appetite of fish. Fish have a certain optimum temperature for their appetite. The increase in water temperature is followed by the degree of metabolism and the oxygen demand of organisms will also increase. every chemical change, the reaction rate increases 2-3 times for every 10°C increase in temperature (Kelabora, 2010) .

2.5. Growth Rate

The growth rate is the increase in the length of the total weight of the fish over a certain period of time. Growth is associated with external and internal factors in the fish body. In addition to the aquatic environment (temperature, pH, DO), one of the external factors that greatly affects growth is feed, and the related feed element is protein content. Protein It also functions as a growth process and the main energy source that can affect fish growth. Protein also plays a role in tissue formation/maintenance of the fish body, replacement of damaged tissue , and supporting metabolic processes (Yustiati *et al.,* 2018) .

2.6. Survival Rate

Survival rate (SR) is the percentage of test fish that live at the end of the rearing of the number of test fish stocked during rearing in a container/pond. According to Dedi (2018) , the survival rate is the percentage value of the number of fish that live during the maintenance period. Tilapia survival is largely determined by feed and environmental conditions. Provision of feed with sufficient quality and quantity as well as good environmental conditions can support the survival of tilapia (Iskandar & Elrifadah, 2015) .

Survival rates can be used to determine the tolerance and ability of fish to survive. In aquaculture, mortality factors that affect the survival of larvae or seeds. Fish mortality is caused by several factors, namely internal and external factors. Factors in the body of fish that affect mortality are differences in age and ability to adapt to the environment. External factors include abiotic conditions, competition between species, increased predators, parasites, lack of food, handling, catching and increasing the number of fish populations in the same space. Fish mortality can be caused by several factors including abiotic conditions, aging, predators, parasites, catching and food shortages (Aulia, 2020) . Survival rate 50% is good, 30-50% is moderate and less than 30% is not good. The survival of fish is highly dependent on the adaptability of fish to food and the environment, fish health status, stocking density, and sufficient water quality to support growth (Mulyani & Fitrani, 2014) .