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THE EFFECT OF SALINITY ON THE PHYSIOLOGICAL PERFORMANCE OF ASIAN REDTAIL CATFISH SEEDS (*Hemibagrus nemurus)*

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ABSTRACT

This research was conducted 30 days from June to July 2022 at the Aquaculture Laboratory, Faculty of Fisheries and Marine Sciences, Universitas Riau, Pekanbaru. This study aimed to analyze the osmoregulation response of the Asian redtail catfish to different salinities and to obtain optimal salinity for good physiological performance for the Asian redtail catfish. The method used was an experimental method using a completely randomized design (CRD) with five treatments and four replications, namely, three ppt salinity treatment, six ppt salinity treatment, nine ppt salinity treatment, 12 ppt salinity treatment, and 15 ppt salinity treatment. The test fish used were Asian redtail catfish with an average size of 7.17±0.04 cm. Asian redtail catfish seeds were obtained from the Tibun Fish Seed Center, Kampar. The container used is an aquarium with a size of 60x40x40 cm. Research data shows that nine ppt salinity is the best for Asian redtail catfish osmoregulation of 0.5 mOsm/L H_2O. The best cortisol hormone content is found at three ppt salinity, the lowest oxygen consumption is at three ppt salinity of 0.9 mgO_2/g/hour, the best survival was found at three ppt salinity of 100%, and the growth in weight and length was in the three ppt treatment of 8.90 g and 2.04 cm. Water quality parameters include temperature 25-30^oC and dissolved oxygen 5.04-8.04 ppm.

Keywords: Osmotic, Cortisol, Oxygen Consumption Rate, Survival, Growth

1. INTRODUCTION

The Asian redtail catfish has high protein and low-fat consumption. Its meat tastes delicious and has a smooth and delightful texture, making it popular. The protein of Asian redtail catfish was 19.97±0.65% and 21.24±0.64%, and the value of fat content in Asian redtail catfish was 0.76±0.53% (cultivation) and 4.51±0.41% (natural)[1].

The Asian redtail catfish is native to Indonesia and is found only in certain areas. These fish live in calm, fresh waters. Rukmini[2] mentions that the Asian redtail catfish living in freshwater prefers clear waters, often found in lakes, swamps, and other calm waters.

In addition, Asian redtail catfish are also found in brackish waters, to be precise, at the mouth of the river, thus allowing them to have the potential to develop in brackish waters. Muhtarom[3] said Asian redtail catfish have the potential to be cultivated in sea/salty water, such as in coastal areas. Furthermore, Saparinto & Susiana[4] also stated that fish that live in fresh waters have a tolerance for brackish waters to a salinity of 25 ppt.

Hyperosmotic is one of the characteristics of fish in fresh waters, where the fish's osmotic pressure is higher than the osmotic pressure of its environment. Dilution of body fluids will occur when environmental water enters the fish's body. Physiological processes will be disrupted if

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the dilution of body fluids continues because a certain (ideal) osmotic pressure is needed for physiological processes. Fish make efforts to achieve the body's and the environment's osmolarity balance to carry out osmoregulation, namely the entry and exit of water into the body[5].

Tang[6] states that the Asian redtail catfish is found in estuary waters with a salinity of 12 ppt. This shows that the Asian redtail catfish can adapt to brackish waters with a specific salinity and develop and grow. The fish can carry out their metabolism properly and produce energy for respiration and osmolarity to achieve optimal survival. According to Alikunthi et al. *in* Sulastri[7], the survival rate of fish above 50% is considered good, 30-50% is considered moderate, and below 30% is considered low.

The Asian redtail catfish will grow well when it can utilize energy from metabolism; the energy obtained is used for survival and growth and vice versa. The fish will experience a slow development if the power obtained is insufficient for the needs of the fish's body's primary metabolic activity.

According to Sulastri[7], energy requirements in fish are determined by age, temperature, size, food type, physiological training, food composition, and fish hunger level. From this, the question arises: How far does brackish water affect the physiological performance of the Asian redtail catfish, and what is the optimal salinity for survival and growth? For this reason, the authors researched the effect of salinity on the physiological performance of Asian redtail catfish.

2. RESEARCH METHOD

Time and Place

The research was carried out from June to July 2022 at the Aquaculture Laboratory, Faculty of Fisheries and Marine, Universitas Riau, Pekanbaru.

Method

The experiment used in this study was a completely randomized design (CRD) with five treatments and four replications each. The treatment used is the difference in salinity, consisting of 5 levels: three ppt, six ppt, nine ppt, 12 ppt, and 15 ppt.

Procedure

The research was carried out through the stages of activity starting with the preparation of containers, preparation of test fish, measurement of osmotic work levels, cortisol hormone content, oxygen consumption levels, survival and growth of Asian redtail catfish, measurements were carried out at the beginning and end of the study.

The container used in this study was cleaned using a potassium permanganate solution and left to dry for 24 hours. After that, the container was filled with 30 L of water. The aquarium is given aeration to supply oxygen and labeled with each treatment. Then, the Asian redtail catfish seeds were sown into the research aquarium at a density of 10 fish/aquarium with a volume of 30 L of water and seed size of 7.17±0.04 cm.

Data Analysis

Data were analyzed using SPSS, which included Analysis of Variance (ANOVA) at 95% confidence intervals if statistical tests show significant differences between treatments conducted further tests Student Newman Keuls.

3. RESULT AND DISCUSSION

Osmolarity

Media osmolarity data and plasma osmolarity of Asian redtail catfish in each salinity can be seen in the following Table 1.

The effort of fish or aquatic animals to control the balance between body fluids and their environment is called osmoregulation. Hyperosmotic in the environment is one of the characteristics of freshwater fish; this will push the water

from the outside environment to enter the fish's body, and the salt in the body will come out. This should not be allowed because there will be dilution of body fluids due to loss of salt in the body. Thus disrupting its physiological function. Moreover, the opposite will happen to hypoosmotic marine fish, where the body's osmotic pressure is lower than seawater. This makes salt enter through the diffusing and water through the kidneys, gills, and skin. Fish will urinate less and drink lots of seawater to maintain the concentration of salt and fluids in their bodies[8].

Table 1. Osmoregulation patterns and osmosis working levels of Asian redtail catfish (*Hemibagrus nemurus*) kept at different salinities

Salinity	Fish plasma (mOsm/L H_2O)	Media (mOsm/L H_2O)	TKO	Osmoregulation patterns
3 ppt	224,00±0,82	88±0,00	136,00±0,82[a]	Hiperosmotik
6 ppt	249,75±0,96	175±0,00	74,75±0,96[b]	Hiperosmotik
9 ppt	263,50±0,58	263±0,00	0,5±0,58[c]	Isoosmotik
12 ppt	287,50±0,58	351±0,00	63,5±0,58[d]	Hipoosmotik
15 ppt	299,00±0,00	438±0,00	139±0,00[e]	Hipoosmotik

The data shows that the osmosis level is low at nine ppt salinity with an osmolarity of fish plasma of 0.5 mOsm/L H_2O. This condition is called an osmoregulatory isosmotic regulation pattern in which a balance point is reached between the media's osmolarity and the test fish's osmolarity. 3 and 15 ppt salinities showed the highest TKO values, 136 and 139 mOsm/L H_2O. In this condition, the Asian redtail catfish was forced to be in a hypoosmotic osmoregulation pattern where the osmolarity value of the media was more significant than the osmolarity value of the test fish. In this condition, the Asian redtail catfish will need much energy to adapt to its environment.

According to Suharyanto & Tjaronge[9], salinity waters have a high influence on osmotic pressure in water, the pressure obtained along with the salinity of the media; if the salinity is high, the pressure will also be higher. Furthermore, Anggoro & Nakamura[10] stated that the difference in the salinity of the media with iso-osmotic media would affect the osmotic performance for balancing media and plasma pressure; the energy used for osmoregulation will be more incredible if the osmotic pressure is high.

Different salinities affect the osmotic performance of the Asian redtail catfish fish. The higher the salinity at each salinity will affect the TKO of the fish, which is also higher. This shows that the Asian redtail catfish continues to adapt to its saline environment using osmoregulation. In the osmoregulation process of the Asian redtail catfish fish, the higher the salinity, the greater the work done by the Asian redtail catfish fish, so it takes much energy for the osmoregulation. Rachmawati et al.[11] stated that fish's osmotic pressure regulation follows the medium's salinity level. High salinity will cause a high workload when fish try to equalize the pressure of the media and plasma.

Content of the Hormone Cortisol

The results of observations during the study, as well as the cortisol levels of the Asian redtail catfish, are attached in Table 2.

A salinity of 3 ppt is the best medium because the low cortisol hormone indicates that the stress level of the Asian redtail catfish is also low at this salinity; it is suspected that this is because the salinity of 3 ppt is a medium that is close to its natural waters so that the Asian redtail catfish can adapt well. Tina et al.[12] stated that cortisol is a hormone that plays a vital role in fish. It is secreted by the adrenal glands, whose functions include glucose metabolism,

blood pressure regulation, the immune system, and stress response.

The level of the hormone cortisol increases at higher salinity; this indicates that the Asian redtail catfish experiences stress to the higher salinity; based on observations, when the Asian redtail catfish is put into the media at the beginning of rearing, it is found that the Asian redtail catfish looks quiet when it is put into the media with the salinity six ppt, nine ppt, 12 ppt, and 15 ppt. This was the effect of the media with the salinity, but the next day, the fish seemed to have been actively moving at several salinities.

Table 2. Fish cortisol levels

Salinity	Cortisol hormone content (ng/mL)	
	Beginning	End
3 ppt	11,21±0,60	12,56±3,47^{c}
6 ppt	11,17±0,65	13,95±0,86^{d}
9 ppt	11,22±0,58	29,40±0,84^{b}
12 ppt	11,20±0,60	20,23±0,63^{a}
15 ppt	11,22±0,61	66,65±1,97^{a}

The level of the hormone cortisol increases at higher salinity; this indicates that the Asian redtail catfish experiences stress to the higher salinity; based on observations, when the Asian redtail catfish is put into the media at the beginning of rearing, it is found that the Asian redtail catfish looks quiet when it is put into the media with the salinity six ppt, nine ppt, 12 ppt, and 15 ppt. This was the effect of the media with the salinity, but the next day, the fish seemed to have been actively moving at several salinities.

The level of the cortisol hormone in the Asian redtail catfish increases with increasing salinity in the media. For each salinity, the stress experienced by the Asian redtail catfish has the effect that the Asian redtail catfish does not eat the feed given, so the Asian redtail catfish fish's energy to survive and grow is not fulfilled properly. The growth of the Asian redtail catfish has slowed down because it does not metabolize optimally to obtain energy when stressed. Mudjiman[13] stated that fish need protein. The primary energy source for fish is protein, the quality of which depends on the source and levels of amino acids.

The Asian redtail catfish will adapt to the salinity environment; this will undoubtedly require increasing energy because it goes hand in hand with higher needs. The energy obtained by the Asian redtail catfish is not only used to survive but is also used to grow and develop in this medium. Furthermore, Syawal et al.[14] stated that changes in plasma cortisol levels are often used as the leading indicator of stress, while the second indicator is an increase in glucose levels.

Oxygen Consumption Rate

Table 3 shows that the lowest oxygen consumption of Asian redtail catfish was at a salinity of 3 ppt of 0.9 mgO_2/g/hour, and at a salinity of 12 ppt, the highest oxygen consumption was 1.9 mgO_2/g/hour. Putra[15] states that the increase in fish oxygen consumption is in line with the increase in metabolic processes because stressed fish require much energy to adapt to their environment.

The high level of oxygen consumption at a salinity of 12 ppt in this study is thought to be due to the influence of the high media salinity of 12 ppt. The Asian redtail catfish requires much oxygen to survive and grow. At a salinity of 15 ppt, the Asian redtail catfish experienced a decrease in oxygen consumption, the same as at a salinity of 6 ppt of 1.0 ppt. This is because at a salinity of 15 ppt, many Asian redtail catfish have died, as many as 32 tails, so the results of the calculation of

oxygen consumption are low. At the same time, the salinity of 12 ppt is still included in the tolerance limit for Asian redtail catfish fish, and according to Tang[6] stated that the Asian redtail catfish habitat is in fresh waters such as swamps, reservoirs, rivers, and lakes, and is also found in estuaries where the water is brackish and is often found during floods. In estuaries, the Asian redtail catfish is found in brackish waters down to a salinity of 12 ppt.

Table 3. Asian redtail catfish oxygen consumption rate.

Salinity	Oxygen Consumption Rate (mgO_2/g/hours)	
	Beginning	End
3 ppt	0.1±0,05	0.9±0,18[a]
6 ppt	0.1±0,04	1.0±0,13[a]
9 ppt	0.1±0,05	1.6±0,10b
12 ppt	0.2±0,05	1.9±0,13c
15 ppt	0.2±0,06	1.0±0,17[a]

Changes in salinity in the media cause physiological changes in osmoregulation in Asian redtail catfish. Osmoregulation is carried out to adjust the body's pressure to the environmental media; this is done when the Asian redtail catfish enters an environment that is not the same as its natural habitat. The Asian redtail catfish must control the salt levels that enter and leave its body; this process requires much energy, which causes high metabolic activity in the fish, requiring high oxygen. Therefore, the Asian redtail catfish will consume higher oxygen at high salinity. Asian redtail catfish will grow well when their energy needs are met. According to Budiardi[16]; Apriyanto[17], fish require much energy to adapt to an environment of salinity different from their natural habitat.

Survival Rate and Growth

The average survival rate of the Asian redtail catfish can be seen in Table 4.

Table 4. Survival rate of Asian redtail catfish

Salinity	Survival rate (%)	
	Beginning	End
3 ppt	100±0.00	100±0.00[c]
6 ppt	100±0.00	100±0.00[c]
9 ppt	100±0.00	100±0.00[c]
12 ppt	100±0.00	85±10.00[b]
15 ppt	100±0.00	20±14.14[a]

Based on Table 4 data. Then, the lowest survival rate is found at a salinity of 15 ppt. It is suspected that the Asian redtail catfish experience stress because they are reared at high salinity. The higher salinity causes the metabolism in the body to increase and causes the Asian redtail catfish to need quite a lot of energy to carry out osmoregulation; for this reason, the fish need much food as an energy supply. In stressful conditions, the appetite of the Asian redtail catfish decreases because the Asian redtail catfish experiences high stress, so the feed is not eaten optimally. This further worsens the condition of the Asian redtail catfish fish, causing low survival.

In this study, the Asian redtail catfish experienced a low survival rate at a salinity of 15 ppt, which was 20%. This was the lowest survival rate when compared to other salinities. Alikunthi et al. in Sulastri[18] state that the survival rate of fish above 50% is quite good. The 30-50% range is

moderate, and below 30% is classified as low. Furthermore, Effendie[19] said the survival rate is the ratio of fish at the end and the beginning of rearing. This opinion was confirmed by Wilson *in* Kurnia[20], who said that sufficient food for pet fish could reduce death and hunger.

The growth of the Asian redtail catfish during the study was calculated at the beginning and end. The data measured was the weight growth of the Asian redtail catfish, shown in Table 5.

Table 5. Growth of Asian redtail catfish weight

Salinity	Average weight (g)		Absolute weight (g)
	Beginning	End	
3 ppt	3.01±0,01	11,91±0,14	8.90±0,14^{e}
6 ppt	2.85±0,01	9,22±0,13	6.37±0,13^{d}
9 ppt	2.85±0,02	8,88±0,62	6.03±0,62^{c}
12 ppt	2.92±0,02	7,33±0,60	4.41±0,60^{b}
15 ppt	2.94±0,01	4,36±0,45	1.42±0,45^{a}

Table 5 shows that the absolute weight of the Asian redtail catfish after being reared for 30 days, the highest weight growth rate of the Asian redtail catfish was obtained at a salinity of 3 ppt of 8.90 g. This is presumably because a salinity of 3 ppt is still a naturally excellent and optimal medium for the life of the hyperosmotic asian redtail catfish fish so that metabolic processes can run optimally. The energy obtained can meet the needs for survival and growth. Sulastri[18] states that fish's energy requirements are determined by age, temperature, fish size, type of food, physiological activity, food composition, and hunger level.

The growth of the absolute weight of the Asian redtail catfish was lower at salinities of 6, 9, 12, and 15 ppt. It is suspected that the increase in salinity with the increase in salinity causes the Asian redtail catfish to experience stress, disrupting its metabolic processes. As a result, the energy obtained to adapt to the environment decreases. So that the energy is not only partially utilized for growth but also for the adaptation process. As a result, the growth of the Asian redtail catfish is hampered. According to Tang[6], fish need food vitamins to support body development, such as expected growth, reproduction, and body maintenance. Appetite will decrease, stunted growth, and can cause disease if the fish lacks vitamins.

Asian redtail catfish live in rivers, ponds, reservoirs, and other freshwater media. The difference between freshwater and salinity media certainly makes the Asian redtail catfish experience stress; the more significant the salinity, the higher the stress level of the fish. This is thought to be a physiological response of the Asian redtail catfish to salinity, one of its physiological organs in the form of gills. The gills will immediately respond to the media because the fish carry out the respiration process to bind oxygen. The response is the faster movement of the operculum of the Asian redtail catfish when binding oxygen. In addition, salinity will affect the fish's appetite for some time, so the fish will run out of energy and become weak, further worsening the condition of the Asian redtail catfish. So, the growth of Asian redtail catfish has slowed down. Sulastri[18] states that age, temperature, size, food type, physiological activity, food composition, and hunger level determine fish's energy requirements.

Table 6 shows growth at three ppt salinity has the highest growth compared to other salinities, and this is presumably due to the limitations of the Asian redtail catfish in tolerating its hyperosmotic environment (the osmotic pressure in the body is higher

than the environment), the Asian redtail catfish has a tolerance limit to salinity, the greater the salinity. The Asian redtail catfish media, the lower the growth rate and vice versa. The smaller the salinity of the Asian redtail catfish media, the greater the growth rate of the fish. It is suspected that the Asian redtail catfish can maximize the use of food and carry out their metabolism correctly to produce energy that is then used to grow. Growth is an increase or decrease in the size of both weight and length according to the addition of time.

Table 6. Length growth of Asian redtail catfish

Salinity	Length (cm)		Absolute length (cm)
	Beginning	End	
3 ppt	7,18±0,10	9,21±0,22	2,04±0,22[c]
6 ppt	7,23±0,10	8,69±0,29	1,47±0,29[b]
9 ppt	7,15±0,06	8,13±0,15	0,98±0,15[a]
12 ppt	7,15±0,06	7,86±0,06	0,71±0,06[a]
15 ppt	7,13±0,05	7,56±0,29	0,44±0,29[a]

The salinity value at each salinity affects the growth of the Asian redtail catfish fish; the more significant the salinity, the smaller the growth value of the fish. It is suspected that at high salinity, the Asian redtail catfish will carry out osmoregulation to adjust its body pressure to its environment. The higher the salinity, the greater the effort needed by the Asian redtail catfish to adjust its body condition to the environment, so it will require much energy for the osmoregulation process. Rachmawati et al.[11] stated that the energy for growth will decrease if much energy is used for osmoregulation, causing a decrease in the growth rate of fish.

Water Quality

Observation of water quality measured several parameters, such as temperature and dissolved oxygen (DO). The data for water quality observation can be seen in Table 7.

Table 7. Water quality

Salinity	Temperature (^{0}C)		DO (ppm)	
	Beginning	End	Beginning	End
3 ppt	26,00	30,25	8,5	5,04
6 ppt	26,00	29,75	8,4	7,5
9 ppt	26,00	29,25	8,5	7,65
12 ppt	25,25	30,25	8,5	5,51
15 ppt	25,50	29,50	8,6	8,04

Table 7 shows that the temperature in this study was measured at 25-30°C. The difference in temperature in this study is the temperature in the morning and at night. The temperature in this study is a condition that supports the development and survival rate of fish. Water quality is essential for hatchery success. The water used can be drilled well water (springs), dam water, rivers, lakes, and springs and is supported by chemical properties such as a temperature of 25-30^{o}C.

The Asian redtail catfish utilize dissolved oxygen to carry out osmoregulation and metabolic processes to obtain energy to survive in saline media. During the study, DO ranged between 5.4 and 8.6 ppm. According to Tang[6], Asian redtail catfish can live very well in an environment with oxygen levels ranging from 5-6 mg/L.

4. CONCLUSION

The results of research conducted on the effect of salinity on the physiological performance of Asian redtail catfish seeds can be summarized as follows: the best plasma and media osmolarity is at a salinity of 9 ppt, a salinity of 3 ppt indicates that the physiological performance of the Asian redtail catfish in the form of cortisol hormone levels and oxygen consumption is the best, and the best survival and growth of the Asian redtail catfish was in the three PPT treatments.

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