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Potential of Red Dragon Fruit (*Hylocereus polyrhizus*) to Prevent *Aeromoniasis* in Striped Catfish (*Pangasianodon hypophthalmus*)

Potensi Buah Naga Merah (Hylocereus polyrhizus) untuk Mencegah Aeromoniosis pada Ikan Jambal Siam (Pangasianodon hypophthalmus)

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Abstract

Red dragon fruit peel is a natural material with antibacterial and antifungal properties, owing to its active compounds, including alkaloids, flavonoids, niacin, tannins, and vitamin C. These compounds can inhibit the growth of *Aeromonas hydrophila* and enhance fish immunity. This research was carried out from January to August 2025 at the Parasite and Fish Disease Laboratory, Faculty of Fisheries and Marine Sciences, Universitas Riau. This study aimed to examine the effectiveness of red dragon fruit peel solution (*Hylocereus polyrhizus*) in preventing *Aeromoniasis* in striped catfish (*Pangasianodon hypophthalmus*). The experiment used a Completely Randomized Design (CRD) with five treatments and three replications. Treatments consisted of KN: negative control (without immersion and not infected with *A. hydrophila*), KP: positive control (without immersion and infected with *A. hydrophila*), P1 (immersion at 1 ml/L and infected), P2 (immersion at 1.5 mL/L and infected), and P3 (immersion at 2 ml/L and infected). Fish were immersed in the peel solution for 30 minutes daily for three consecutive days. Blood sampling was conducted at the beginning of maintenance, on the 30th day, and on the 14th day after infection. The findings indicated that the best dose was P2 (1.5 mL/L), producing a total erythrocyte count of (291.40×10^4 cells/mm³), hematocrit (37.66%), haemoglobin (9.43 g/dL), leukocyte count of (10.57×10^4 cells/mm³), phagocytic activity of (32.00%), and survival rate of (92.33%). Water quality parameters remained within optimal ranges: temperature 26.8–28°C, pH 5.5–6.9, and dissolved oxygen (DO) 3.9–5.8 mg/L. These findings suggest that red dragon fruit peel extract at 1.5 ml/L has potential as a natural immunostimulant to prevent *Aeromoniasis* in *P. hypophthalmus*.

Keywords: *Aeromonas hydrophila*, Dragon Fruit, Hemoglobin, Jambal siam

Abstrak

Kulit buah naga merah merupakan bahan alami yang memiliki potensi antibakteri dan antifungal akibat kandungan senyawa aktif seperti alkaloid, flavonoid, niacin, tanin, dan vitamin C. Senyawa-senyawa ini dapat menghambat pertumbuhan *Aeromonas hydrophila* dan meningkatkan kekebalan ikan. Penelitian ini dilakukan dari Januari hingga Agustus 2025 di Laboratorium Parasit dan Penyakit Ikan, Fakultas Perikanan dan Ilmu Kelautan, Universitas Riau. Tujuan penelitian ini adalah untuk menguji efektivitas larutan kulit buah naga merah (*Hylocereus polyrhizus*) dalam mencegah *Aeromoniasis* pada ikan patin siam (*Pangasianodon hypophthalmus*). Eksperimen menggunakan Desain Acak Lengkap (CRD)

dengan lima perlakuan dan tiga ulangan. Perlakuan terdiri dari KN: kontrol negatif (tanpa perendaman dan tidak terinfeksi *A. hydrophila*), KP: kontrol positif (tanpa perendaman dan terinfeksi *A. hydrophila*), P1 (perendaman pada 1 ml/L dan terinfeksi), P2 (perendaman pada 1,5 mL/L dan terinfeksi), dan P3 (perendaman pada 2 mL/L dan terinfeksi). Ikan direndam dalam larutan kulit selama 30 menit setiap hari selama tiga hari berturut-turut. Pengambilan sampel darah dilakukan pada awal pemeliharaan, pada hari ke-30, dan pada hari ke-14 setelah infeksi. Hasil menunjukkan bahwa dosis terbaik adalah P2 (1,5 ml/L), yang menghasilkan jumlah sel darah merah total ($291{,}40\times10^4$ sel/mm³), hematokrit (37,66%), hemoglobin (9,43 g/dL), jumlah leukosit ($10{,}57\times10^4$ sel/mm³), aktivitas fagositik (32,00%), dan tingkat kelangsungan hidup (92,33%). Parameter kualitas air tetap dalam rentang optimal: suhu 26,8–28°C, pH 5,5–6,9, dan oksigen terlarut (DO) 3,9–5,8 mg/L. Temuan ini menunjukkan bahwa ekstrak kulit buah naga merah pada konsentrasi 1,5 mL/L berpotensi sebagai imunostimulan alami untuk mencegah *Aeromoniasis* pada *P. hypophthalmus.*

Kata kunci: *Aeromonas hydrophila*, Buah Naga, Hemoglobin, Jambal siam

1. Introduction

The striped catfish (*Pangasianodon hypophthalmus*) is one of the freshwater fish commodities widely cultivated in Indonesia, especially in Riau Province, due to its high economic value and fast growth rate (Helmizuryani et al., 2024). Increasing market demand has encouraged farmers to engage in intensive cultivation. However, uncontrolled farming practices can lead to the accumulation of feed residues and faeces in water, thereby reducing water quality. This condition triggers an increase in ammonia concentration, causing stress to the fish and weakening their immune systems, making them susceptible to bacterial diseases.

Bacterial diseases are among the main obstacles in freshwater fish farming because they can cause significant economic losses through mass mortality. A case at the Koto Panjang Hydroelectric Dam Fish Farm in 2013 resulted in the death of up to 50 tons of carp due to infection by pathogenic bacteria, including *Aeromonas* sp. and *Pseudomonas* sp. (Pardamean et al., 2021). One of the bacterial diseases that often affects striped catfish is *aeromoniosis*, or *Motile Aeromonas Septicemia* (MAS), caused by *Aeromonas hydrophila*. This disease is very dangerous because it can cause high mortality rates of 80-100% in just 1-2 weeks (Gaol et al., 2024). Symptoms include bleeding on the body, exophthalmos, anorexia, and tissue damage on the skin (Susanti et al., 2021).

Until now, disease control in fish has primarily been achieved through antibiotic administration. However, the use of antibiotics is no longer recommended because it can lead to pathogen resistance, leave harmful residues in water, and endanger consumer health (Minjoyo et al., 2021). Therefore, environmentally friendly disease control alternatives are needed, one of which is through the use of natural ingredients as immunostimulants. Several studies have shown that herbal plants can enhance fish immune systems and suppress disease outbreaks (Junaidi et al., 2020). One promising natural ingredient is red dragon fruit peel (*Hylocereus polyrhizus*), which contains active compounds such as alkaloids, flavonoids, tannins, saponins, and vitamin C (Astridwiyanti et al., 2019).

The use of red dragon fruit peel as an immunostimulant remains suboptimal, despite its potential to boost fish immune systems. Flavonoids are known to increase blood cell production and strengthen the body's defence system (Putranto et al., 2019), while vitamin C plays an important role in accelerating erythrocyte maturation, maintaining collagen structure, and repairing fish tissue (Ridwan et al., 2020). To determine the effects of natural ingredients on fish health, one method is hematological analysis. Hematological parameters, such as erythrocyte and leukocyte counts, hemoglobin, hematocrit, and phagocytic activity, are important indicators of the physiological condition and immune response of fish to disease (Maulinia & Herlina, 2022). Thus, research on the use of red dragon fruit peel as an immunostimulant in Siamese carp is highly relevant for further study. The purpose of this study was to determine the optimal dosage of red dragon fruit peel solution to prevent *Aeromoniosis* in striped catfish (*P. hypophthalmus*).

2. Material and Method

2.1. Time and Place

This research was conducted from January to August 2025 at the Parasites and Fish Diseases Laboratory, Faculty of Fisheries and Marine Sciences, Universitas Riau.

2.2. Methods

This study used an experimental method with a completely randomized design (CRD) with one factor and 5 treatment levels, with 3 replicates, resulting in 15 experimental units. The treatment was based on Masfiah et al. (2018), who reported using crude dragon fruit peel extract on tilapia. The treatments applied were: Kn: Negative control (without immersion and without testing for *A. hydrophila*); Kp: Positive control (without immersion and tested against *A. hydrophila*); P1: Soaking dragon fruit peel solution at a dose of 1 mL/L + challenge test *A. hydrophila*; P2: Soaking in a solution of dragon fruit peel at a dose of 1.5 mL/L + challenge test with *A. hydrophila*; P3: Soaking dragon fruit peel solution at a dose of 2 mL/L + challenge test *A. hydrophila*

2.3. Procedures

2.3.1. Making Dragon Fruit Peel Solution

Red dragon fruit peel was obtained from Tuah Karya Market, Tampan District, Pekanbaru. The collected peel was washed with running water, then cut into small pieces. A total of 600 g of dragon fruit peel was blended with 600 mL of distilled water (1:1 ratio), then filtered using gauze to obtain a solution. The filtered solution was heated on a hot plate for ±5 minutes to allow the metabolites from the dragon fruit peel to dissolve in the distilled water.

2.3.2. Soaking Fish in Dragon Fruit Peel Solution

Fish immersion is performed at the beginning of the cultivation period for 3 consecutive days, once daily for 30 minutes. Each treatment uses a 5 L jar containing 10 fish and the specified solution, with aeration to maintain dissolved oxygen. After soaking, the fish are transferred back to the rearing container. This procedure refers to the method of Amanda & Ayuzar (2016).

2.3.3. Blood Sampling

Blood samples were collected three times: at the start of maintenance (before treatment), after 30 days of maintenance, and 14 days after the challenge test with *A. hydrophila*. Two fish per treatment were taken from each replicate. Before sampling, the fish were anaesthetized with 0.1 mL/L clove oil to reduce stress. Blood was collected at a volume of 0.1 mL from the caudal vein using a 1-mL syringe moistened with 10% EDTA as an anticoagulant, then placed in an Eppendorf tube and stored in a cool box to maintain blood quality (Amanda & Ayuzar, 2016).

2.4. Measured Parameters

2.4.1. Clinical Symptoms

Clinical symptoms in test fish can be observed from the beginning of the challenge test through the 14th day after the challenge test, namely, the fish's physical condition and movement. Observations were made daily and presented in tabular form.

2.4.2. Total Red Blood Cells

Total erythrocytes were counted using the Kurniawan (2019) method. Blood samples were taken using an erythrocyte pipette to the 0.5 mark; Hayem's solution was then added to the 101 mark, and the mixture was homogenized with an eight-shaped motion. After discarding the first two drops to avoid air bubbles, the solution was dripped onto a haemocytometer covered with a cover glass. Observations were made using a binocular microscope at 400x magnification (10x40) in five fields of view, then the number of erythrocytes was calculated using the formula:

$$\text{Red Blood Cell Count} = n \times 10^4 \text{sel/mm}^3$$

Note: n = number of erythrocytes counted in 5 fields of view; 10^4 = Dilution factor

2.4.3. Hemoglobin Level

Hemoglobin levels are measured using the Sahli method. The Sahli haemoglobin tube is filled with 0.1 N HCl solution up to the zero mark, then 0.02 mL of the blood sample is added using a Sahli pipette and left for 3 minutes. Next, distilled water is added dropwise while stirring until the solution matches the standard colour on the hemoglobinometer. The reading is taken on the g% scale to determine the haemoglobin level, which is expressed in g/dL or g% (Wedemeyer, 1996).

2.4.4. Hematocrit value

Hematocrit is calculated according to the Anderson & Siwicki (1993) procedure, in which the blood sample in the microtube is transferred to a capillary tube. Once the blood reaches 4/5 of the tube, the end of the tube (marked in red) is sealed with Crystoseal. The capillary tube containing blood is centrifuged for 3-5 minutes at 11,000 rpm. The length of the erythrocyte sediment in the capillary tube is measured using a Microhematocrit Reader and expressed as a percentage of blood volume.

2.4.5. Total White Blood Cells

Total leukocytes were counted using the Blaxhall & Daisley (1973) method. Blood samples were aspirated with a leukocyte pipette to the 0.5 mark, then Turk's solution was added to the 11 mark, and the mixture was homogenized with an eight-shaped motion for 3–5 minutes. The first two drops were discarded to avoid air pockets, then the sample was dripped onto a haemocytometer and covered with a cover glass. Observations were made with a binocular microscope at 400x magnification (10x40), then the number of leukocytes was counted in four large squares of the hemocytometer using the formula:

$$\sum \text{Leukosit} = \sum n \times 50 \text{ sel/mm}^3$$

Description: ∑n = Total number of leukocytes in 4 large squares; 50 = Dilution factor

2.4.6. Phagocytosis Activity

Phagocytosis activity was measured using the method described by Anderson & Siwicki (1993). A 50 µL blood sample was mixed with 50 µL of *Staphylococcus aureus* suspension (10^7 cells/mL), homogenized, and incubated for 20 minutes. A 5 µL mixture was prepared on a glass slide, then air-dried, fixed with methanol for 5–10 minutes, and stained with Giemsa solution for 10–15 minutes. The preparation was then rinsed with distilled water, air-dried again, and observed under a microscope. The percentage of phagocytic cells can be calculated by counting the number of cells that phagocytose bacteria among 100 cells. The calculation method is as follows:

$$\text{Phagocytosis Activity} = \frac{\Sigma \text{ active phagocytic cell}}{\Sigma \text{ phagocytic cell observed}} \text{ x } 100\ \%$$

Description: Phagocytic cells = number of phagocytosis cells

2.4.7. Survival Rate

The survival rate of test fish during the study was calculated using the formula (Effendie, 2002), namely:

$$SR = \frac{Nt}{No} x\ 100\%$$

Description: SR = Survival rate (%); Nt = number of fish at the end of the study (tails); No = Number of fish at the beginning of the study (tails)

3. Result and Discussion

3.1. Clinical Symptoms of Striped Catfish (P. hypophthalmus)

Clinical symptoms in striped catfish after challenge with *A. hydrophila* include changes in the body, eyes, fins, movement, and appetite. For more details on the clinical symptoms in striped catfish during the study, see Table 1.

Table 1. Clinical symptoms of striped catfish 14 days after infection with *A. hydrophila*

Treatment	Clinical Symptoms				
	Body Surface	Fish movement	Appetite	Eye	Fin
KN	- Normal	- Active	- Normal	- Normal	-Normal
KP	- Ulcer - Skin Peeling	- Passive	- Descending	- *Exophthalmia*	-Geripis
P1	- Ulcer	- Passive	- Descending	- *Exophthalmia*	-Normal
P2	- Normal	- Active	- Normal	- *Exophthalmia*	-Normal
P3	-.Swollen stomach - pale complexion	- Passive	- Descending	- *Exophthalmia*	-Normal

Based on Table 1, clinical symptoms in striped catfish challenged with *A. hydrophila* began to appear after 24 hours, characterized by ulcers, fin rot, excessive mucus production, protruding eyes (exophthalmus), reduced activity, and decreased feeding response (Figure 1). Clinical observations on the fourth day after the challenge test showed that fish in the Kn (negative control) treatment did not exhibit any abnormal symptoms. The fish were active, had normal mucus production, normal eyes, intact fins, and a good appetite. This is consistent with Pardamean et al. (2021), who stated that healthy fish have a normal body shape, brightly colored skin and gills, and no changes in body colour.

In contrast, the Kp (positive control) showed clinical symptoms characteristic of *A. hydrophila* infection, namely exophthalmia, ulcers, frayed dorsal and tail fins, excessive mucus production, slowed swimming movement, and decreased feeding response. This condition is caused by the hemolysin toxin produced by *A. hydrophila*, which damages fish tissue. Hermawan et al. (2022) explained that hemolysin breaks down various tissue cells and causes red spots. In contrast, Sheikh et al. (2023) reported that blood hemolysis can cause haemorrhage and septicemia, reducing fish survival. Clinical symptoms in P1 and P3 also included ulcers, exophthalmos, slowed swimming, and decreased appetite. This is in line with Endang et al. (2018), who reported that striped catfish infected with *A. hydrophila* generally exhibit protruding eyes, a swollen abdomen, a curled tail, pale body colour, and loss of appetite. These symptoms arise from the weakened condition and stress of the fish, resulting from bacterial infection and organ damage.

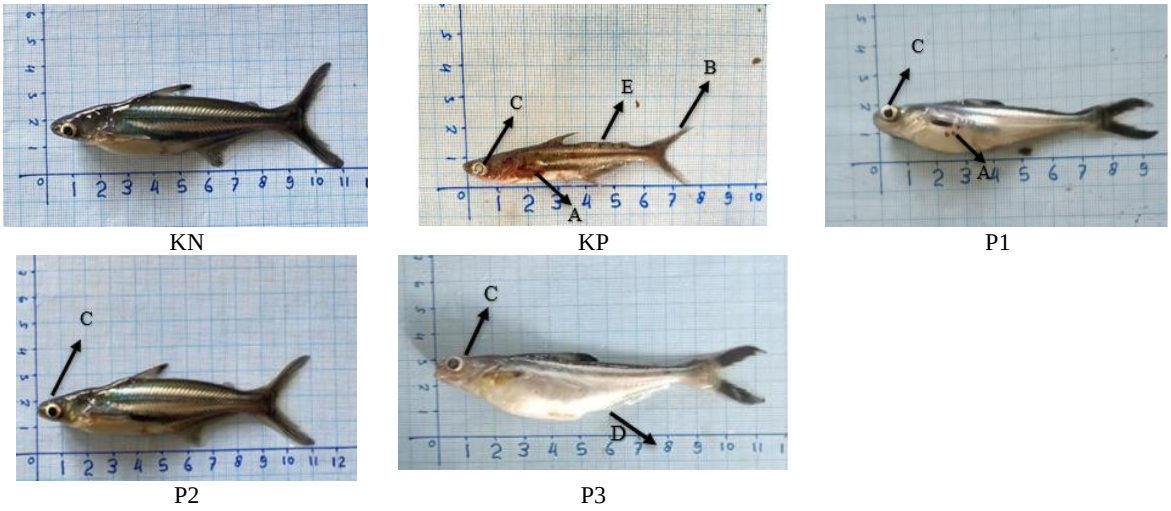

Figure 1. Clinical symptoms of *P.hypophthalmus*

Interestingly, the P2 showed milder clinical symptoms, namely, only exophthalmia with intact fins and normal appetite. This indicates that immersion in a red dragon fruit peel solution at a dose of 1.5 mL/L can improve the immune system of striped catfish. Bioactive compounds such as flavonoids, alkaloids, and vitamin C in dragon fruit peel play a role in repairing damaged tissue (Kusumastuti et al., 2021). Khairuman et al. (2022) emphasized that vitamin C is important for boosting the immunity of fish fry against stress, while flavonoids are lipophilic compounds that function as anti-inflammatories and can damage microbial membranes (Lase et al., 2020). The combination of these compounds is believed to reduce infection symptoms and strengthen the fish's immune system against pathogenic bacterial attacks.

3.2. Total Erythrocytes of P.hypophthalmus

Total erythrocytes after 30 days of maintenance with red dragon fruit skin solution immersion, and after challenge with *A. hydrophila* bacteria. The total erythrocyte count of striped catfish during the study is presented in Table 2.

Table 2. Total erythrocytes of striped catfish (*P. hypophthalmus*)

Treatment	Total red blood cells (x 10^4 cells/mm^3)		
	Start of maintenance	Day 30 of maintenance	14 days after the challenge
KN	110.68	186,01±1,70^a	189,59±1,66^b
KP	112.64	186,46±4,91^a	100,92±0,60^a
P1	113.80	237,94±6,65^c	260,03±3,22^d
P2	113.58	255,22±7,31^d	291,40±1,22^e
P3	114.09	228,59±2,25^b	247,22±1,95^c

Based on Table 2, the total erythrocytes of striped catfish after 30 days of maintenance with red dragon fruit peel solution immersion ranged from 186.01 to 255.22 x 10^4 cells/mm^3. This range is still within normal limits. The increase in erythrocyte numbers across all treatments indicates that the maintenance process continues to affect the physiology of fish blood. In the KN (negative control) and KP (positive control), the increase remained within normal limits. In contrast, in the red dragon fruit skin solution immersion treatments (P1, P2, and P3), the increase was more significant. This is thought to be due to the content of bioactive compounds such as flavonoids, tannins, alkaloids, and vitamin C, which act as antioxidants and immunostimulants. According to Syawal et al. (2021), flavonoids can improve the performance of blood-forming organs, thereby increasing erythrocyte production.

After testing with *A. hydrophila*, the total erythrocyte count of striped catfish fighting fish ranged from 100.92 to 291.40 x 10^4 cells/mm^3. The most significant decrease in erythrocyte count occurred with KP, to 100.92 × 10^4 cells/mm^3. This is thought to be due to the action of *A. hydrophila*, which produces a hemolysin that causes red blood cell hemolysis. Pulungan et al. (2022) stated that hemolysin can lyse erythrocytes, while Cahyani (2020) added that this bacterial infection also damages blood-forming organs, such as the kidneys, further reducing the number of erythrocytes. This condition differs from the treatment of red dragon fruit skin solution immersion, in which bioactive compounds maintain erythrocyte count and protect blood cells from damage.

P1 after the challenge test showed a total erythrocyte count of 260.03 × 10^4 cells/mm^3, indicating that a low dose remains effective in maintaining erythrocyte production. The highest increase occurred in P2 (291.40 x 10^4 cells/mm^3), indicating that a moderate dose provides the most optimal protection against erythrocyte decline due to bacterial infection. In P3, the total erythrocyte count was 247.22 × 10^4 cells/mm^3, lower than in P2. This is

thought to be because high concentrations of saponin can be toxic, disrupting fish physiology and reducing the effectiveness of immersion. Andayani et al. (2018) reported that high doses of saponin can hemolyze red blood cells, thereby inhibiting oxygen transport.

3.3. Hematocrit Value of Striped catfish (P.hypophthalmus)

Hematocrit is the presentation of erythrocyte volume in fish blood. Hematocrit values can serve as indicators of health conditions in fish. The average hematocrit values of striped catfish during the study are presented in Table 3.

Table 3. Hematocrit values of striped catfish (*P. hypophthalmus*)

	Hematocrit value (%)		
Treatment	Start of maintenance	Day 30 of Maintenance	14 Days Post-challenge
KN	24	29,33± 0,57^{a}	30,33± 1,15^{b}
KP	24	30,00± 10,0^{a}	24,66 ± 0,57^{a}
P1	25	33,66± 0,57^{b}	35,66 ± 0,57^{d}
P2	25	35,66± 0,57^{c}	37,33 ± 0,57^{e}
P3	24	32,26 ± 0,57^{b}	33,00 ± 1,00^{c}

Based on Table 3, the hematocrit values of striped catfish after 30 days of immersion in a red dragon fruit peel solution ranged from 29.33 to 35.66%. This range is still considered normal, in accordance with Zissalwa et al. (2020), who reported that the hematocrit values of striped catfish ranged from 26.67 to 38.33%. The increase in hematocrit values across all treatments during the 30-day rearing period is thought to reflect the fact that the fish were not yet infected with *A. hydrophila*, so their physiological condition and feeding response remained normal.

After 14 days post-challenge with *A. hydrophila*, the hematocrit value in the Kn (negative control) increased steadily to 30.33%. This indicates that the fish did not experience stress because they were not infected with bacteria, their feeding response remained normal, and water quality was maintained, resulting in stable growth. Conversely, in the Kp (positive control), the hematocrit value decreased to 24.66%. This decrease occurred because bacterial infection caused stress and suppressed the fish's appetite, resulting in reduced nutrient intake. This condition led to a decrease in erythrocyte production and directly lowered the hematocrit value. Pulungan et al. (2022) reported that fish infected with bacteria tend to exhibit decreased appetite, thereby reducing nutrient supply for erythrocyte formation.

Treatment with red dragon fruit peel solution immersion showed a protective effect on hematocrit values. In P1, hematocrit values increased to 35.66%, indicating the effectiveness of low doses in maintaining blood condition. P2 showed the highest increase, namely 37.33%, in line with the increase in total erythrocytes. This indicates a positive correlation between hematocrit and erythrocyte count, as hematocrit and hemoglobin are found in erythrocytes (Syawal et al., 2021). This increase is thought to be related to the role of bioactive compounds such as flavonoids, alkaloids, and vitamin C in red dragon fruit peel extract, which function as immunostimulants. This is consistent with the statement by Pakpahan et al. (2020) that administering natural immunostimulants can improve fish blood health parameters. Meanwhile, the P3 increased hematocrit to up to 33.00%, but not higher than in P2. This is because at high doses, the saponin content in red dragon fruit peel can be toxic. This compound has the potential to disrupt fish physiology, thereby limiting the effectiveness of immersion in increasing hematocrit.

3.4. Hemoglobin Levels in Striped Catfish (P. hypophthalmus)

Hemoglobin binds oxygen for catabolism, thereby producing energy. Hemoglobin levels were calculated to observe changes in haemoglobin after 30 days of maintenance by immersion in red dragon fruit skin solution and after testing with *A. hydrophila* bacteria. The results of the average haemoglobin level calculations for striped catfish during the observation period are shown in Table 4.

Table 4. Hemoglobin levels in striped catfish (*P. hypophthalmus)*

	Hemoglobin Level (g/dL)		
Treatment	Start of maintenance	Day 30 of maintenance	14 days after the challenge
KN	6,20	7,23± 0,15^{a}	8,20 ± 0,20^{b}
KP	6,20	7,20 ± 0,20^{a}	5,46 ± 0,23^{a}
P1	6,40	8,43 ± 0,15^{c}	9,10 ± 0,10^{d}
P2	6,45	8,76 ± 0,20^{d}	9,43 ± 0,20^{e}
P3	6,35	8,06 ±0,11^{b}	8,63 ± 0,57^{c}

Based on Table 4, the hemoglobin levels of striped catfish after 30 days of maintenance with red dragon fruit skin solution immersion ranged from 7.20 to 8.76 g/dL. This value is still within the normal range reported by Pulungan et al. (2022), 5.7–10.4 g/dL. An increase in hemoglobin levels was observed across all treatments, including the negative control (Kn) and positive control (Kp), indicating that even without additional treatment,

good rearing conditions can still increase fish hemoglobin levels. The treatment with red dragon fruit peel solution immersion yielded higher results than the control. In P1, the hemoglobin level reached 8.43 g/dL, while in P2 it increased to 8.76 g/dL, the highest value among all treatments. This indicates that a moderate dose has the most optimal effect on increasing hemoglobin. Meanwhile, P3 produced a hemoglobin level of 8.06 g/dL, lower than in P1 and P2 but still within the normal range. This condition indicates that high doses are less effective, presumably because bioactive compounds such as saponins can be toxic to fish at high concentrations.

After 14 days following the challenge test with *A. hydrophila*, the hemoglobin levels of the striped catfish ranged from 5.46 to 9.43 g/dL. In the Kn, hemoglobin levels continued to increase, reaching 8.20 g/dL, indicating that the fish were healthy and free from infection. Conversely, in the Kp, hemoglobin levels decreased drastically to 5.46 g/dL. This decrease is thought to be caused by *A. hydrophila* infection, which causes wounds and weakens the fish's immune system. This condition aligns with the statement by Cerlina et al. (2021) that bacterial infection can inhibit hemoglobin's oxygen-transport function due to tissue damage.

Soaking in a red dragon fruit peel solution can provide nonspecific protection against hemoglobin reduction caused by bacterial infection. P1, P2, and P3 increased hemoglobin levels, with the highest value in P2 at 9.43 g/dL. This increase was in line with the increase in total erythrocytes, because hemoglobin is found in erythrocyte cells. This effectiveness is thought to originate from the flavonoids, tannins, and vitamin C content in red dragon fruit peel, which act as antioxidants. According to Hasibuan et al. (2021), flavonoids and tannins can protect haemoglobin from oxidative damage, while Puspitowati et al. (2022) state that vitamin C plays a role in the maintenance and formation of blood cells, including erythrocytes.

3.5. Total Leukocytes of Striped Catfish (P.hypophthalmus)

Total leukocytes after 46 days of maintenance with red dragon fruit peel solution immersion and challenged with *A. hydrophila.* The total leukocyte count of the striped catfish during the study is shown in Table 5.

Table 5. Total Leukocytes of Striped catfish (*P. hypophthalmus)*

Treatment	Total Leukocytes (10^4 x cells/mm^3)		
	Start of Maintenance	30 days of maintenance	14 days post-Test Challenge
KN	6,61	7,49± 0,18[a]	7,55± 0,29[a]
KP	6,67	7,47± 0,23[a]	9,01 ± 0,21[b]
P1	6,84	8,40 ± 0,15[b]	9,73 ± 0,43[c]
P2	6,84	8,83± 0,45[c]	10,57 ± 0,23[d]
P3	6,82	8,39 ± 0,12[b]	9,66 ± 0,23[c]

Based on Table 5, the average total leukocyte counts of striped catfish after 30 days of maintenance ranged from 7.47 to 8.83 x 10^4 cells/mm^3. According to Rahmadona et al. (2020), the normal range for striped catfish leukocytes is 7.67–11.17 × 10^4 cells/mm^3, so the results obtained are still within this range. The increase in total leukocytes in all treatments indicates a physiological response to maintenance. In the negative control (Kn) and positive control (Kp), the increase in leukocytes was relatively stable, indicating that even without additional treatment, the maintenance process still affected the physiological condition of the fish within normal limits. Meanwhile, in P1, P2, and P3, the increase in leukocytes was greater, presumably due to immersion in the red dragon fruit peel solution. This is in line with Astridwiyanti et al. (2019), who reported that red dragon fruit peel contains active compounds, including flavonoids, alkaloids, tannins, saponins, and vitamin C, with antibacterial potential.

After 14 days post-challenge with *A. hydrophila*, the total leukocyte counts of striped catfish ranged from 7.55 to 10.57 x10^4 cells/mm^3. In the Kn, the leukocyte count did not increase significantly because the fish were not infected with bacteria, so the cell count remained stable. In Kp, there was an increase to 9.01 × 10^4 cells/mm^3 as a natural response to infection, but the value remained within normal limits. A greater increase was observed in P1 (9.73 × 10^4 cells/mm^3), indicating that a low dose of red dragon fruit peel solution effectively stimulated the immune system. P2 showed the highest result of 10.57 x10^4 cells/mm^3, presumably because the moderate dose provided optimal stimulation through the bioactive content of red dragon fruit peel, especially flavonoids, saponins, and tannins, which can increase leukocyte production. This is in accordance with A'yunin et al. (2020), who stated that high leukocyte levels indicate bacterial infection, prompting the fish's body to increase resistance through leukocyte activity. Conversely, in P3, the total leukocyte count was slightly lower than in P1 and P2 (9.66 x10^4 cells/mm^3). It is suspected that high doses cause toxic effects, particularly from saponins, thereby reducing the effectiveness of the immune response, even though the levels remain within normal limits.

3.6. Phagocytosis Activity of Striped catfish (P. hypophthalmus)

Phagocytosis activity was calculated to determine the ability of leukocytes to ingest foreign particles, particularly pathogenic bacteria. The phagocytosis activity of Striped catfish (*P. hypopthalmus*) during the study is presented in Table 6.

Table 6. Phagocytosis activity of striped catfish (*P. hypophthalmus*)

Treatment	Phagocytosis activity (%)		
	Start of Maintenance	30 Days of Maintenance	14 days post-Test Challenge
KN	19,66± 0,57[a]	20,33 ± 0,57[a]	21.33± 1.52[b]
KP	19,00± 1,00[a]	20,00 ± 1,00[a]	18,66± 0,57[a]
P1	19,66± 0,57[a]	24,33 ± 0,57[b]	25,66 ± 1,52[c]
P2	20,00 ± 1,00[a]	27,00 ± 2,00[c]	32,00 ± 1,00[d]
P3	20,66 ± 1,52[a]	22,66± 1,15[b]	24,00 ± 1,00[c]

Based on Table 6, the phagocytosis activity value of striped catfish after 30 days of maintenance with red dragon fruit peel solution immersion ranged from 20.00 to 27.00%. According to Lestari et al. (2021), the normal range of phagocytosis activity in striped catfish is 19.00–36.33%, so the results obtained fall within this range. Phagocytosis activity increased in P1 (24.33%), P2 (27.00%), and P3 (22.60%) compared to the control, indicating that the bioactive compounds in red dragon fruit peel can stimulate the immune system, particularly macrophage phagocytosis.

After testing with *A.hydrophila*, phagocytosis activity ranged from 18.66 to 32.00%. In the Kn (negative control) treatment, phagocytosis activity increased to 21.33% because the fish were not infected with bacteria, so the immune response remained normal. Conversely, in Kp (positive control), phagocytosis activity decreased to 18.66%, indicating reduced immunity due to the absence of immunostimulatory treatment. This condition is consistent with the statement by Syaieba et al. (2019) that phagocytic activity can increase with improvements in the immune system but can also decrease if there is no stimulation from immunostimulants.

The increase in phagocytic activity was more clearly observed in P1, P2, and P3, indicating that immersion in red dragon fruit peel solution maintained the immune system of striped catfish after exposure to infection. Active compounds such as flavonoids, alkaloids, saponins, and vitamin C are thought to help maintain optimal phagocytosis. Flavonoids are anti-inflammatory and support the effectiveness of vitamin C in enhancing immune responses, while saponins and alkaloids can stimulate phagocyte activity. This is in line with Rosnizar et al. (2017), who reported that flavonoids can rapidly enhance phagocytosis, destroy antigens and intracellular microorganisms, and strengthen defences against extracellular antigens. Thus, the use of red dragon fruit peel solution has the potential to be an effective natural immunostimulant, enhancing phagocytosis and the resistance of striped catfish to bacterial infections.

3.7. Survival of the Striped Catfish (P.hypophthalmus)

The survival rate of the striped catfish in this study is shown in Figure 2.

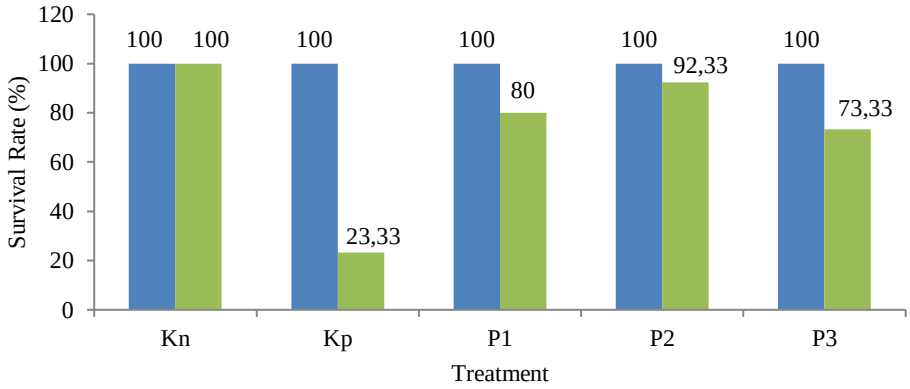

Figure 2. Survival rate of striped catfish during maintenance

Based on Figure 2, the highest survival rate for the striped catfish was observed in the negative control treatment (100%). This is because the fish were healthy and not infected with *A. hydrophila*, allowing them to survive stably on commercial feed alone. In contrast, the positive control had the lowest survival rate of 23%. This low value is due to the fish being challenged with *A. hydrophila* without treatment with a red dragon fruit peel solution, allowing the pathogen to spread throughout the body and weaken the fish's defence system. This condition caused clinical symptoms and ultimately led to death.

Treatment with red dragon fruit peel solution immersion showed differences in survival rates. In P2, survival reached 92.33%, which was the highest value compared to P1 (80%) and P3 (73.33%). The high survival rate in P2 is likely due to the moderate and optimal dosages used, which improved the fish's physiological condition and strengthened their immune system. Meanwhile, the low dosage in P1 was still effective in boosting the immune response, but not to the maximum extent. The low survival rate in P3 is thought to be due to the excessive dosage, which caused toxic effects and reduced the fish's immunity. The results in P2 indicate that immersion in a red dragon fruit peel solution enhances the immunity of striped catfish. Bioactive compounds such as flavonoids, alkaloids, saponins, tannins, and vitamin C function as antioxidants and immunostimulants. According to Aprilia

et al. (2021), the vitamin C content in dragon fruit peel can strengthen the immune system by maintaining tissue health and skin quality, thereby protecting the body's cells. Furthermore, Aprilia et al. (2021) stated that flavonoids play an important role as antioxidants, neutralizing free radicals and preventing oxidative cell damage. Thus, the active content in red dragon fruit peel helps increase the fish's endurance, so that when attacked by *A. hydrophila*, the fish can maintain its survival.

4. Conclusions

Based on the results of the study, it can be concluded that administering a red dragon fruit peel solution prevents *Aeromoniosis* in striped catfish infected with *A. hydrophila* via immersion. A dose of 1.5 ml/L was found to be optimal, with immersion in red dragon fruit peel solution having a significant effect ($P<0.05$) on preventing *A. hydrophila* infection, as seen from the post-challenge total erythrocyte count of 291.40 x 10^4 cells/mm^3, hematocrit value of 37.66%, hemoglobin level of 9.43 g/dL, total leukocyte count of 10.57 x 104 cells/mm^3, phagocytosis activity of 32.00%, survival rate of 92.33%, and water quality during the study of 26-28^oC, pH 5.5-6.9, and DO 3.9-5.8 mg/L.

5. References

Amanda, C.S., & Ayuzar, E. (2016). Efektifitas bubuk rumput laut merah (*Gracillaria* sp) sebagai imunostimulan terhadap infeksi bakteri *Streptococcus iniae* pada ikan lele dumbo (*Clarias gariepinus*). *Acta Aquatica: Aquatica Sciences Journal*, 3(2): 81-86.

Andayani, S., Heny, S., & Ifatul, M. (2018). Pengaruh pemberian ekstrak kasar kulit buah naga (*Hylocereus costaricensis*) terhadap histopatologi hati ikan nila (*Oreochromis niloticus*) yang terinfeksi *Aeromonas hydrophila. J. Fisheries and Marine Research, 3(2):149-159.*

Anderson, D., & Siwicki, A. (1993). *Basic hematology and serology for fish health programs*. Paper Presented in Second Symposium on Diseases in Asian Aquaculture. Aquatic Animal Health and the Environment. *Phuket, Thailand. 25 – 29 th October 1993. 185-202*

Aprilia, T., & Rakhmawati, R. (2021). Quality improvement of feed chemical composition with the addition of dragon fruit skin flour (*Hylocereus polyrhizus*). *e-Jurnal Rekayasa dan Teknologi Budidaya Perairan,* 9(2): 1101-1108.

Astridwiyanti, A.A.B., Mahendra, A.N., & Dewi, N.W.S. (2019). Uji efektivitas ekstrak etanol kulit buah naga merah (*Hylocereus polyrhizus*) terhadap *Staphylococcus aureus ATCC 25923* secara in vitro. *Intisari Sains Medis*, 10(3).

A'yunin, Q., Budianto, B., Andayani, S., & Pratiswi, D.C. (2020). Analisis kondisi kesehatan ikan patin (*Pangasius* sp) yang terinfeksi bakteri *Edwardsiella tarda. Journal of Aquaculture and Fish Health*, 9(2): 161-169.

Blaxhall, P.C., & Daisley, K.W. (1973). Routine haematological methods for use with fishblood. *Journal Fish Biology*, 5: 771-781.

Cahyani, A. (2020). Identifikasi bakteri *Aeromonas hydrophila* serta pengaruhnya terhadap histologi organ hati pada ikan lele dumbo *(Clarias gariepinus*). Universitas Hasanuddin.

Cerlina, M., Riauwaty, M., & Syawal, H. (2021). Gambaran eritrosit ikan lele dumbo (*Clarias gariepinus*) yang terinfeksi *Aeromonas hydrophila* dan diobati dengan larutan daun salam (*Syzygium polyantha*). *Jurnal Perikanan dan Kelautan*, 27(1): 105-113.

Effendi, H. (2002). *Telaah kualitas air bagi pengelolaan sumber daya dan lingkungan perairan*. Kanisius. Yogyakarta.

Endang, S., Gunaedi, T., & Indrayani, E. (2018). Pengendalian infeksi bakteri *Aeromonas hydrophila* pada ikan nila (*Oreochromis niloticus*) dengan ekstrak rimpang lengkuas merah (*Alpinia purpurata*). *Jurnal Biologi Papua*, 9(2): 37–42.

Gaol, D.P.L., Riauwaty, M., & Syawal, H. (2024). Histopatologi insang ikan jambal siam (*Pangasianodon hypophthalmus*) yang terinfeksi *Aeromonas hydrophila* dan diobati dengan larutan kulit kayu manis (*Cinnamomum burmannii*). *Ilmu Perairan (Aquatic Science)*, 12(1): 21-29.

Hasibuan, Y.P., Syawal, H., & Lukistyowati, I. (2021). Gambaran darah merah ikan jambal siam (*Pangasianodon hypophthalmus*) yang diberi pakan mengandung jamu fermentasi untuk mencegah penyakit *Motile Aeromonas Septicemia*. *Jurnal Ruaya*, 9(1): 2541 – 3155.

Helmizuryani, H., Khotimah, H., Iswarini, H., Sari, P.M., & Apriyanti, D. (2024). *Budidaya ikan patin strategi dan praktik berkelanjutan*. Seval Literindo Kreasi. Lombok Barat.

Hermawan, R. (2022). Effectivity of canbat herb from PT. Media herbal to *aeromonas hydrophilla* infection on Nile fish (*Oreochromi*s sp.). *Journal of Aquatropica Asia*, *7*(1): 34-42.

Junaidi, M., Azhar, F., Setyono, B.D.H., & Waspodo, S. (2020). Pengaruh pemberian ekstrak daun mangrove *Rizhophora apiculata* terhadap performa pertumbuhan udang vaname. *Buletin Veteriner Udayana*, 4(21): 198.

Khairuman, K., Mulyani, S., & Budi, S. (2022). Pengaruh bionkapsulasi vitamin C pada rotifer dan artemia terhadap rasio RNA/DNA, pertumbuhan dan tingkat kelangsungan hidup larva ikan bandeng *Chanos chanos. Journal of Aquaculture and Environment*, 4(2): 33-38.

Kurniawan, A.J. (2019*). Profil hematologis ikan lele dumbo (Clarias gariepinus) yang dipelihara sistem bioflok*. Universitas Riau. Pekanbaru.

Kusumastuti, D.M., Cholid, Z., & Adriatmoko, W. (2021). Pengaruh ekstrak kulit buah naga merah (*Hylocereus polyrhizus*) terhadap waktu perdarahan (*bleeding time*) pada mencit strain Balb-C. *Stomatognatic-Jurnal Kedokteran Gigi*, *18*(2): 61-64.

Lase, L.H., Lukistyowati, I., & Syawal, H. (2020). Efektivitas pemberian pakan mengandung larutan daun papaya (*Carica papaya L*) fermentasi terhadap gambaran eritrosit dan pertumbuhan ikan jambal siam (*Pangasianodon hypopthalmus). Jurnal Akuakultur Sebatin*, 3(1): 63-77

Lestari, S., Rahmawati, F.F., & Jumadi, R. (2018). Pengaruh penambahan serbuk daun tanaman kayu manis (*Cinnamomum burmannii*) pada pakan terhadap profil darah (kadar hematokrit, kadar hemoglobin, total leukosit dan total eritrosit) ikan nila (*Oreochromis niloticus*) yang diuji tantang *Streptococcus agalactiae*. *Jurnal Perikanan Pantura*, 1(1): 24

Masfiah, I., Andayani, S., & Suprastyani, H. (2018). Pengaruh pemberian ekstrak kasar kulit buah naga (*Hylocereus costaricensis*) terhadap histopatologi hati ikan nila (*Oreochromis niloticus*) yang terinfeksi *Aeromonas hydrophila*. *Journal of Fisheries and Marine Research*, 2(3): 149-159.

Maulinia, M., & Herlina, S. (2022). Gambaran darah sebagai indikator kesehatan ikan nila (*Oreochromis niloticus*) yang diberi pakan tambahan probiotik rabbal. *Jurnal Ilmu Hewani Tropika (Journal of Tropical Animal Science)*, 11(1): 11-16.

Minjoyo, H., Prihaningrum, A., Rivaie, A.R., & Dharmawanti, V. (2021). Growth performance and immune response of silver pompano seeds (*Trachinotus blocii*) fed with feed containing immunostimulant supplement. e-*Jurnal Rekayasa dan Teknologi Budidaya Perairan,* 9(2): 1117-1130.

Pakpahan, P., Syawal, H., & Riauwaty, M. (2020). Pengaruh pemberian kurkumin pada pakan terhadap pengobatan ikan jambal siam (*Pangasiodon hypopthalmus)* yang terinfeksi bakteri *Aeromonas hydrophila*. *Jurnal Perikanan dan Kelautan*, *25*(3): 224-231.

Pardamean, E.S., Riauwaty, M., & Syawal, H. (2021). Identifikasi bakteri patogen pada ikan mas (*Cyprinus carpio*) yang dipelihara dalam keramba jaring apung. *Jurnal Perikanan dan Kelautan,* 26(1): 26-32.

Pulungan, L.A., Riauwaty, M., & Lukistyowati, I. (2022). Hematology of *Pangasianodon hypophthalmus* that were fed with containing fermented red ginger (*Zingiber officinale var. Rubrum*) to prevent the *Motile Aeromonas septicaemia* disease. *Asian Journal of Aquatic Sciences,* 5(2): 291-300.

Puspitowati, D., Lukistyowati, I., & Syawal, H. (2022). Gambaran leukosit ikan jambal siam (*Pangasianodon hypophthalmus*) yang diberi pakan mengandung larutan daun pepaya (*Carica papaya* L.) fermentasi. *Jurnal Akuakultur Sebatin,* 3(1): 78-92.

Putranto, W.D., Denny, S., & Eva, P. (2019). Gambaran darah ikan nila *(Oreochromis niloticus)* yang diberi pakan terfortifikasi ekstrak cair daun salam *(Syzygium polyanthum*). *Journal of Aquatropica Asia*, 4(2): 22-28.

Rahmadona, Z., Syawal, H., & Lukistyowati, I. (2020). Description of leukocytes (*Pangasius hypophthalmus)* which is fed with extracts of mangrove leaf *(Rhizophora apiculata*) and maintained in the floating cages. *Jurnal Perikanan dan Kelautan,* 25 (1): 79-87.

Ridwan, M., Lukistyowati, I., & Syawal, H. (2020). Hematologi eritrosit ikan patin siam *(Pangasius hypophthalmus)* yang diberi pakan dengan penambahan larutan biji mangga harumanis *(Mangifera indica* L.*). Jurnal Ruaya*, 8(2): 114-121.

Rosnizar, R., Maulida, S., Eriani, K., & Suwarno, S. (2017). Potensi ekstrak daun flamboyan *Delonix regia (Boj.Ex Hook) Raf* terhadap peningkatan aktifitas dan kapasitas makrofag. *Journal Bioleuser,*1(3)

Sheikh, H.I., Nordin, B., Paharuddin, N., Liew, H.J., Fadhlina, A., Abdulrazzak, L.A., Jalal, K.C.A., & Musa, N. (2023). Virulence factors and mechanisms of *Aeromonas hydrophila* infection in catfish Siluriformes: a review and bibliometric analysis. *Desalination and Water Treatment,* 315: 538–547.

Susanti, E., Wahjuningrum, D., Nuryati, S., & Setiawati, M. (2021). The effectiveness of cinnamon powder and cinnamon leaf extract to prevent *Aeromonas hydrophila* infection on striped catfish (*Pangasianodon hypophthalamus*). *Jurnal Akuakultur Indonesia*, 20(2): 163–173.

Syaieba, M., Lukistyowati, I., & Syawal, H. (2019). Description of leukocyte of siam patin fish (*Pangasius hypophthalmus*) that feed by addition of harumanis mango seeds (*Mangifera indica L). Asian Journal of Aquatic Sciences*, 2(3): 235-24

Syawal, H., Effendi, I., & Kurniawan, R. (2021). Perbaikan profil hematologi ikan patin (*Pangasius hypophthalmus*) setelah penambahan suplemen herbal pada pakan. *Jurnal Veteriner*, 22(1): 16 - 25.

Wedemeyer, G.A. (1996). *Physiology of fish in intensive culture system*. Chapman and Hall. New York. p11-27

Zissalwa, F., Syawal, H., & Lukistyowati, I. (2020). Erythrocyte profile of *Pangasius hypophthalmus* feed with *Rhizophora apiculata* leaf extract and maintained in net cages. *Jurnal Perikanan dan Kelautan*, *25*(1): 70-78.