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Curative Efficacy of Yellow Root (*Arcangelisia flava*) Extract Against *Aeromonas hydrophila* Bacterial Infection in Climbing Perch (*Anabas testudineus*)

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Abstract Yellow root (*Arcangelisia flava*) demonstrates potential for combating bacterial infections in aquaculture due to its secondary metabolite content, which includes flavonoids, terpenoids, and protoberberine alkaloids. This study aimed to evaluate the efficacy of yellow root extract as a curative agent against *Aeromonas hydrophila* infection in Climbing Perch (*Anabas testudineus*). The method employed was an *in vivo* study using immersion treatments of yellow root extract at concentrations of 200, 400, and 600 mg/L, alongside a control (0 mg/L). Observations were conducted for 10 days post-infection and treatment, covering clinical symptoms and Survival Rate (SR). Prior to treatment, the fish exhibited clinical symptoms characteristic of *A. hydrophila*, such as red spots and exophthalmia. The results indicated that water quality parameters (temperature 26.4–27.1°C, pH 6.8–7.1, DO 3.28–3.47 mg/L) remained within optimal and stable ranges. In the extract treatment groups (B, C, and D), significant recovery was observed starting from day 3, achieving a 100% SR by day 10. In contrast, the control group (A) only attained an SR of 26.6%. This curative success is attributed to the mechanism of action of active compounds, which disrupt bacterial membranes and inhibit metabolism. It is concluded that *A. flava* extract is effective as a natural alternative treatment for bacterial infections in Climbing Perch.

Keywords: *Aeromonas hydrophila*; bacteria; Climbing Perch; phytobiotics; survival rate; yellow root

INTRODUCTION

The growth and development of Climbing Perch (*Anabas testudineus*) are often hindered by disease attacks, defined as physiological or anatomical disturbances caused by biotic or abiotic factors. The occurrence of disease outbreaks in aquaculture is a manifestation of an imbalance in the interaction between the host (fish), environmental conditions, and pathogenic agents. This discordant interaction triggers stress in fish, which impacts the decline of body defense mechanisms (immunosuppression), thereby increasing susceptibility to infection (Mariyono & Agus, 2005; Samsundari, 2006). Infectious agents in fish generally include parasites, bacteria, and fungi (Syawal & Hidayah, 2008). One of the major pathogens is *Aeromonas hydrophila* (Giyarti, 2000), a bacterium capable of infecting various freshwater fish species, including Climbing Perch. This bacterium utilizes a quorum sensing mechanism to control its virulence, making this system a potential target for the development of chemotherapeutic agents (Maryono & Sundana, 2002; Rasch *et al*., 2004).

Efforts to efficiently combat *Aeromonas hydrophila* infection can be achieved through the utilization of natural bioactive substances, one of which is yellow root (*Arcangelisia flava*). Phytochemical analysis indicates that this plant contains secondary metabolites such as flavonoids, terpenoids, and protoberberine alkaloids, including berberine, jatrorrhizine, and palmatine. Research exploration into medicinal plants in Indonesia is expected not only to develop their pharmacological potential but also to support conservation efforts. Ethnobotanically, yellow root has long been utilized by the Dayak tribes in Kalimantan as a traditional remedy for various ailments, such as hepatitis, fever, infections, digestive disorders, worm infestations, and mouth ulcers (Larisu *et al*., 2010; Maryani *et al*., 2013; Kaharap *et al*., 2016).

Morphologically, *A. flava* is a liana that can attain a length of 20 m and inhabits lowlands up to an altitude of 800 meters above sea level (masl). The leaves are thick with a coriaceous texture, oval with blunt tips, ranging from 7-20 cm in width, and feature a glossy adaxial surface with long petioles. The plant is dioecious, bearing small flowers arranged in glabrous inflorescences 20-50 cm in length, with greenish-white or yellowish lobed corollas. Hanging clusters of yellow fruit are found on the main stem or large branches, containing mucilaginous pulp; the large, flattened seeds are known to possess anesthetic properties for fish (Heyne, 1987; Restu, 2007). In addition to its medicinal potential, the plant is utilized as a natural dye and botanical insecticide (Prosea & Kehati, 2008). Based on these potentials, this study aims to evaluate the efficacy of yellow root extract as a curative agent against *A. hydrophila* bacterial infection in Climbing Perch through scientific investigation.

MATERIALS AND METHODS

Time and location

This research was conducted from January to March 2021. The study was carried out at the Wet Laboratory of Aquaculture, Department of Fisheries, Faculty of Agriculture, University of Palangka Raya.

Tools and materials

The tools utilized in this study included syringes, scales, bowls, a blender, fiber tanks, aquariums, aerators, stationery, and a digital camera. Meanwhile, the materials used in this research were yellow root, Climbing Perch, *A. hydrophila* bacteria, distilled water, tissues, and pellets.

Research procedure

Aquarium preparation and acclimatization

The research procedure commenced with the preparation of 12 aquariums, which were thoroughly washed using de-

tergent, rinsed, and dried. The aquariums were then filled with groundwater (pump water) serving as the test medium, which was aerated to stabilize dissolved oxygen levels. The test medium was allowed to settle for approximately 2 days prior to use. Subsequently, acclimatization was conducted on 60 Climbing Perch (*Anabas testudineus*) measuring 5-7 cm in length within fiber tanks for a period of 2 days. During the acclimatization period, the fish were fed sufficient pellets twice daily, at 08.00 and 17.00 WIB.

Preparation of yellow root extract

The preparation process of yellow root (*Arcangelisia flava*) extract commenced by cutting the dried roots into small pieces. Subsequently, the roots were blended into a fine powder. The resulting yellow root powder was then weighed according to the specific amounts required for the treatments.

Preliminary test (toxicity test)

A preliminary test was conducted to establish the upper threshold (N) and lower threshold (n) of yellow root extracting potential toxicity towards the fish, with the ultimate objective of determining a safe dosage for the main study. The procedure began with the preparation of 10 aquariums; each filled with 15 liters of water. Yellow root extract was then administered into each aquarium at graded concentrations, ranging sequentially from 100 mg/L to 1000 mg/L. Subsequently, 5 Climbing Perch were introduced into each aquarium. Observations were performed to monitor fish mortality at intervals of 2, 4, 8, 16, 32, 48, and 96 hours. These observations aimed to determine the upper threshold (N), defined as the concentration causing 100% mortality of the fish population, and the lower threshold (n), defined as the concentration resulting in 0% mortality. Throughout the preliminary test period, the fish were fed twice daily, in the morning and afternoon.

Infection of climbing perch

The infection process was performed immediately after the acclimatization period concluded, using the intramuscular injection method into the fish's body. Each fish was infected by injecting 0.1 ml of *Aeromonas hydrophila* bacteria at a density of 10^7 CFU/mL. Following injection, the fish were transferred back to the aquariums for observation. Post-infection observations were conducted until clinical symptoms of *A. hydrophila* infection appeared, with an observation frequency of every 2 hours.

Treatment of infection in climbing perch

The treatment of infection in Climbing Perch was performed using the immersion method with yellow root extract solution. The infected fish were immersed for 24 hours in extract concentrations corresponding to the established treatments.

The procedure commenced with the preparation of 12 buckets; each filled with 3 liters of water. Yellow root extract was then added to the buckets in accordance with the assigned dosage treatments. This study employed three replicates for each treatment, necessitating three buckets per treatment. Each bucket was stocked with 5 Climbing Perch.

After 24 hours of immersion, the Climbing Perch was transferred to rearing aquariums. The rearing water in the aquariums was replaced after the 24-hour treatment was completed. Subsequently, observations of fish condition and survival were conducted for 10 days, with an observation frequency of every 2 hours. During this observation period, the fish continued to be fed twice daily, in the morning and afternoon.

Research design and treatments

This study employed a design consisting of four treatments and three replicates. The treatments applied involved immersion in yellow root extract solutions at different dosages on Climbing Perch previously infected with *A. hydrophila* bacteria. The arrangement of the tested treatments was as follows:

- Treatment A (Control): Dosage of 0 mg yellow root extract.
- Treatment B: Dosage of 200 mg yellow root extract per 1 liter of water.
- Treatment C: Dosage of 400 mg yellow root extract per 1 liter of water.
- Treatment D: Dosage of 600 mg yellow root extract per 1 liter of water.

Observation parameters

Observations in this study were conducted from the time the fish were infected with *Aeromonas hydrophila* bacteria until the end of the treatment period. The primary parameters observed included:

Clinical symptoms

This encompassed observations of fish movement reflexes (assessed by tapping the water surface), feeding response (appetite), and physical changes in the fish. Observations of clinical symptoms were conducted for 10 days.

Survival rate (SR)

The fish Survival Rate (SR) during the study was calculated using the formula according to Yusni (2016), as follows:

$$SR = \frac{Nt}{NO} X\ 100\%$$

Description:

Nt = Number of fish at the end of the study (individuals)

NO = Number of fish at the beginning of the study (individuals)

Water quality (Temperature, pH, and DO)

This encompassed the measurement of Temperature, pH, and Dissolved Oxygen (DO). The measurement of water quality parameters was conducted three times during the observation period: at the beginning, middle, and end of the study.

Data analysis

Data regarding the clinical symptoms of fish infected with *Aeromonas hydrophila* bacteria were analyzed descriptively. These data were recorded and presented in the form of tables and photographs. Similar recording in tabular form was also performed for data from each treatment dosage utilized. All collected data, including quantitative data on Survival Rate (SR) and Water Quality (Temperature, pH, DO), were then discussed descriptively. This discussion was conducted by referring to various relevant literature to draw research conclusions.

RESULTS AND DISCUSSION

Preliminary test

The selection of yellow root extract dosages (200 mg/L, 400 mg/L, and 600 mg/L) was based on the results of the preliminary test (toxicity test), which aimed to establish a safe and non-toxic concentration range for Climbing Perch. The preliminary test of yellow root (*Arcangelisia flava*) extract was conducted using dosage variations ranging from 100 mg/L up to the highest dosage of 1000 mg/L. Observations of the Climbing Perch were performed at intervals of 2 hours, 4 hours, 8 hours, 16 hours, 32 hours, 48 hours, and 96 hours.

Based on the observation results over 96 hours, no mortality was detected in the test fish across all yellow root extract concentrations, even up to the highest dosage of 1000 mg/L. This indicated that the yellow root extract within this concentration range is safe for Climbing Perch. Consequently, the dosages selected and utilized for the main test were 200 mg/L, 400 mg/L, and 600 mg/L.

Main test

Based on the finding that the extract was non-toxic up to 1000 mg/L, the dosages selected for the main test (200 mg/L, 400 mg/L, and 600 mg/L) constituted sub-toxic dosage variations situated within safe limits and were anticipated to provide graded curative effects against *A. hydrophila* infection.

Clinical symptoms

Following the injection procedure of A. hydrophila bacteria into Climbing Perch, comprehensive observations of the emerging clinical symptoms were conducted. These observations included movement reflexes, feeding responses, and physical manifestations of the disease.

Movement reflexes of test fish

The observation results regarding the movement reflexes of Climbing Perch during the period following A. hydrophila bacterial injection are presented in Table 1.

Observations of Climbing Perch movement reflexes were conducted following the injection of *A. hydrophila* bacteria. On Day 1 post-injection, fish in all treatments (A, B, C, and D) exhibited negative movement reflexes when the water surface was tapped. The inactivity of movement reflexes on the first day was presumably attributed to post-bacterial injection stress. The fish tended to remain at the bottom of the aquarium, exhibited weak movements, and occasionally struggled to maintain an upright body position. The swimming behavior of diseased fish generally changes, becoming either lethargic or erratic. When lethargic, the fish may appear to have difficulty maintaining an upright position, often tilting, or even becoming inverted with the belly facing upwards.

However, from Day 2 to Day 4 of observation, fish in all treatments demonstrated positive movement reflexes, indicating that the fish had begun to recover from stress and were able to resume normal movement.

Table 1. Results of fish movement reflexes during observation after *A. hydrophila* bacterial injection.

Day	Treatment											
	A			B			C			D		
	Replicate			Replicate			Replicate			Replicate		
	1	2	3	1	2	3	1	2	3	1	2	3
1	×	×	×	×	×	×	×	×	×	×	×	×
2	√	√	√	√	√	√	√	√	√	√	√	√
3	√	√	√	√	√	√	√	√	√	√	√	√
4	√	√	√	√	√	√	√	√	√	√	√	√

Note: √ = Fish movement reflex present / good.
× = Fish movement reflex absent / poor.

Table 2. Fish feeding response during observation after *A. hydrophila* bacterial injection

Day	Treatment											
	A			B			C			D		
	Replicate			Replicate			Replicate			Replicate		
	1	2	3	1	2	3	1	2	3	1	2	3
1	×	×	×	×	×	×	×	×	×	×	×	×
2	×	×	×	×	×	×	×	×	×	×	×	×
3	√	√	√	√	√	√	√	√	√	√	√	√
4	√	√	√	√	√	√	√	√	√	√	√	√

Note: √ = Fish feeding response present / good.
× = Fish feeding response absent / poor.

Feeding response of test fish

The observation results regarding the feeding response of Climbing Perch during the period following *A. hydrophila* bacterial injection are presented in Table 2.

Observations of the feeding response of Climbing Perch after *A. hydrophila* bacterial injection indicated that on Day 1 and Day 2 post-injection, fish in all treatments did not exhibit a feeding response. The decreased or even completely lost appetite during these early days is strongly suspected to be caused by stress conditions and the disease attack experienced by the fish. However, on Day 3 and Day 4 of observation, fish in all treatments began to show a positive feeding response, indicating an improvement in health conditions and reduced stress levels.

Physical symptoms of test fish infected by A. hydrophila bacteria

Observations of the physical symptoms of the fish following the injection of *A. hydrophila* bacteria demonstrated a progressive development of the disease. On Day 1 post-injection, no distinct physical symptoms were yet apparent.

Figure 1. Red spots on climbing perch.

Symptoms became apparent on Day 2, where the fish exhibited red spots at the site of the *A. hydrophila* injection (Figure 1). On Day 3, additional symptoms emerged, characterized by pallor and red spots on the body region adjacent to the caudal fin (Figure 2). *A. hydrophila* bacterial infection is widely recognized for causing external symptoms such as the appearance of red hemorrhagic spots on the body.

Figure 2. Pale coloration and hemorrhagic spots on climbing perch.

On Day 4, the condition of the fish deteriorated further, characterized by exophthalmia (protruding eyes) and erratic swimming behavior (whirling) (Figure 3). Severe symptoms of *A. hydrophila* infection may indeed include exophthalmia, epidermal sloughing (peeling skin), red spots, and loss of appetite. The appearance of redness on the body surface is attributed to the activity of the hemolysin enzyme produced by *A. hydrophila*, which lyses red blood cells (Mulia *et al.*, 2003).

Figure 3. Protruding eyes in climbing perch.

Clinical results and treatment success (day 1 to day 10)

Following the infection procedure and the administration of immersion therapy for 24 hours with yellow root extract (*Arcangelisia flava*), the Climbing Perch was observed for 10 days to evaluate the curative efficacy of the extract.

Early post-therapy phase and symptom escalation (day 1 to day 2)

On Day 1 post-treatment, fish in treatments B, C, and D receiving yellow root extract still exhibited persistent clinical manifestations, such as red spot lesions at the injection site, exophthalmia (protruding eyes), and pale skin coloration. In contrast to the treatment groups, the control group (A: 0 mg/L) experienced a more severe condition, characterized by hemorrhagic spots on the body region above the anal fin, and recorded the mortality of 2 fish.

The condition of the control group continued to deteriorate on Day 2, where the fish still exhibited red spots and skin pallor, accompanied by the mortality of 1 additional fish. This initial phase confirms the virulence of the pathogen (*A. hydrophila*), which can cause severe tissue damage (hemorrhagic) through hemolysin enzyme activity.

Turning point and early remission phase (day 3 to day 6)

Day 3 marked a significant turning point for the groups receiving yellow root extract (B, C, and D). Infection symptoms began to subside, clinically identified by the fish's improving appetite and the reduction in size of the lesions at the injection site.

Figure 4. Red spots on climbing perch starting to diminish.

The improvement in appetite indicated that the physiological response of the fish was beginning to recover and stress levels due to infection were reduced. Meanwhile, the control group (A) continued to demonstrate an exacerbation of lesions and recorded the mortality of 2 fish. On Day 4, remission in the extract treatments became increasingly stable. Infection symptoms continued to decline, and the black spot lesions progressively diminished in size. Conversely, the control treatment (A)

showed an increase in red spot symptoms, erratic swimming movements (whirling), decreased appetite, and the mortality of another 2 fish. On Day 6, treatments B, C, and D showed further development, where the injured body parts of the fish had begun to fade.

Full recovery and stability phase (day 7 to day 10)

Dramatic improvement was observed on Day 7. Fish in treatments B, C, and D demonstrated a near-perfect recovery process, with remaining infection symptoms limited to minor lesions and improved appetite. The control treatment (A) experienced the most severe deterioration with the mortality of 3 fish, and the surviving fish still exhibited poor physical condition. On Day 8, the extract treatment groups displayed normal swimming movements and improved physical condition, while the control treatment (A) began to show erratic swimming movements (whirling). On Day 9, treatments B, C, and D indicated that previous lesions had disappeared (healed), fish morphology and behavior improved, and feeding responses remained normal. The peak of treatment success was achieved on Day 10. Fish in treatments B, C, and D attained total recovery, characterized by the healing of injured body parts, disappearance of red spots, improved appetite, and normal swimming movements. Quantitatively, treatment groups B, C, and D achieved a Survival Rate (SR) of 100%. This stands in sharp contrast to the control group (A), which still exhibited lesions and poor appetite, with a final SR of only 26.6%.

Figure 5. The wounds of the climbing perch that have healed.

Discussion

Infection caused by *Aeromonas hydrophila* bacteria in Climbing Perch (*Anabas testudineus*) is characterized by a series of severe clinical symptoms and constitutes a major infectious agent triggering significant losses in aquaculture (Wang *et al*., 2022). Symptoms of fish attacked by *A. hydrophila* include lesions (red spots) on the body surface, gill hemorrhage, and abdominal distension, as stated by Austin & Austin (1993). The emergence of redness on the fish's body surface is attributed to the activity of the hemolysin enzyme produced by *A. hydrophila*, which targets the lysis of red blood cells, causing them to leak from blood vessels and manifest as redness on the skin surface (Sartika, 2011).

The development of external disease symptoms in Climbing Perch and body responses following the injection of *A. hydrophila* bacteria were observed sequentially. Initially, swelling and red spot lesions occurred at the injection site on the dorsal region of the fish, followed by a loss of appetite. On Day 2, the skin appeared pale, and red spots emerged on the body region adjacent to the caudal fin. By Day 3, swimming conditions deteriorated; the fish frequently exhibited lethargic swimming, whirling movements, and a tendency to isolate themselves (Laith & Najiah, 2013). These physical symptoms are manifestations of the inflammatory process, a fundamental reaction of the fish to bacteria entering the body and causing tissue damage. Hemorrhaging occurs due to the rupture of blood vessels and subsequent leakage of blood, caused by bacteria capable of entering, adhering to, and damaging blood vessel walls (Sutama, 2002). This aligns with the statement by Post (1987) that most *A. hydrophila* bacteria produce brown to reddish-brown pigments, and the presence of clinical symptoms such as red spots and brownish pigmentation indicates that a bacterial attack has occurred in the fish.

Once clinical symptoms were observed, the Climbing Perch was immediately administered treatment via immersion in yellow root extract for 24 hours at graded dosages (200 mg/L, 400 mg/L, and 600 mg/L). The control group (0 mg/L) experienced high mortality, whereas fish in the extract treatments demonstrated significant recovery starting from Day 3 to Day 10, achieving a 100% Survival Rate (SR). Recovery was characterized by the disappearance of red spots and the diminishing size of lesions. This success indicates that the use of phytobiotics from *A. flava* can serve as an alternative antimicrobial agent to reduce reliance on antibiotics in aquaculture (Wang *et al*., 2022).

The observed recovery demonstrates that the active compounds contained in yellow root extract can inhibit the growth of *A. hydrophila* bacteria. Maryani *et al*. (2013) detected that yellow root contains secondary metabolite compounds, namely alkaloids, saponins, terpenoids, flavonoids, and tannins, which are classified as para-immunity agents and can activate cellular defense cells.

The mechanism of action of antibacterial compounds from yellow root extract involves several main pathways, namely: Flavonoids: These are phenolic compounds that function by denaturing proteins and damaging bacterial cell membranes. Protein denaturation causes cellular metabolic activity to cease, resulting in bacterial cell death (Noventi & Novita, 2016). Setiawan (2003) also stated that flavonoids possess antibacterial potential, with a mechanism of action predicted to involve the inhibition of bacterial cell wall synthesis, leading to bacterial cell lysis and subsequent death (Lamothe, 2009). Alkaloid: The primary alkaloid in *A. flava* is protoberberine. Sami & Nur (2024) confirmed the isolation of berberine from *A. flava* stems and its antibacterial activity. Mechanistically, berberine is known to inhibit bacterial cell division by targeting the FtsZ protein, which disrupts Z-ring formation (Liu *et al*., 2025). Treatment using berberine has been proven to trigger immune defense pathways in aquatic organisms infected with *A. hydrophila* (Han *et al*., 2021). Tannin: Tannins possess antibacterial activity related to their ability to inactivate microbial cell adhesins, inactivate enzymes, and disrupt protein transport in the inner layer of the cell (Cowan, 1999). Tannin compounds are also reported to inhibit reverse transcriptase and DNA topoisomerase enzymes, thereby preventing bacterial cell formation (Nuria *et al*., 2009). Tannins target cell wall polypeptides, causing imperfect cell wall formation. This causes the bacterial cell to undergo lysis due to osmotic or physical pressure, resulting in bacterial cell death (Larisu *et al*., 2010; Sari *et al*., 2011). Saponins: The mechanism of action of saponin compounds involves

causing the leakage of proteins and enzymes from within the cell (Madduluri *et al*., 2013). Saponins bind to the cytoplasmic membrane, disrupting and reducing its stability, which causes the cytoplasm to leak out and results in cell death. Antimicrobial agents that disrupt the cytoplasmic membrane are bactericidal (Cavalieri *et al*., 2005). In general, the accumulation of lipophilic components found in the cell wall or cell membrane causes changes in the structural composition of the cell wall (Nychas & Tassou, 2000).

Under such conditions, the bacteria will experience growth inhibition or even death. The efficacy of *A. flava* extract, supported by these phytochemical findings and antimicrobial activity, underscores its potential as an effective natural treatment for bacterial infections in Climbing Perch.

Survival rate (SR)

Data on the Survival Rate (SR) of Climbing Perch (*Anabas testudineus*) following the treatment period are presented in Table 3. The results indicate variations among treatments, wherein Treatment A recorded the lowest SR, while Treatments B, C, and D achieved a perfect SR.

Treatments B, C, and D recorded optimal success by achieving an SR of 100%. This figure serves as a strong indication that the treatment regimen applied in these three treatments was highly effective in eradicating pathogens and maintaining fish health, consistent with literature emphasizing the importance of treatment management and optimal water quality to achieve high SR

Table 3. Survival rate (SR) after treatment period.

Treatment	Post-Treatment SR Value
A	26.6 %
B	100%
C	100%
D	100%

(Bakrie *et al*., 2020; Akbar, 2021). This perfect survival rate also demonstrates that the post-treatment environment supported the fish recovery process.

However, Treatment A showed contrasting and alarming results with an SR of only 26.6%. This value is categorized as a poor result (Hanafi *et al*., 2018), indicating a serious failure. The low SR in Treatment A was likely caused by several factors. First, the treatment applied may not have been specific or sufficient in dosage to combat the disease agent attacking the Climbing Perch. Second, fish in Treatment A may have experienced severe post-treatment stress or secondary infections, exacerbated by unstable environmental conditions. Factors such as ammonia toxicity or extreme water parameters, although Climbing Perch are known to be hardy, remain major risk factors in increasing mortality in sick or weak fish (Ezraneti *et al*., 2019; Bakrie *et al*., 2020).

Water quality

The water quality parameters measured were pH, temperature, and dissolved oxygen (DO), which were measured three times during the study: at the beginning, middle, and end of the research. Based on the research conducted, the average data for temperature, pH, and dissolved oxygen (DO) were obtained and can be seen in Table 4.

The measurement results of water quality, including temperature, pH, and Dissolved Oxygen (DO), indicated that the rearing media in all four treatments (A, B, C, and D) were in a very stable and optimal condition for Climbing Perch. The average water temperature ranged from 26.4 °C to 27.1 °C. This range falls within the optimal tolerance limits of 25-33 °C, which supports the growth and

Table 4. Average values of temperature, pH, and DO during observation.

No	Treatment	Temperature (°C)	pH	DO
1.	A	26.4	6.8	3.35
2.	B	27.1	6.8	3.28
3.	C	26.5	7.1	3.35
4.	D	26.7	6.9	3.47

physiology of Climbing Perch (Bakrie *et al*., 2020; Akbar, 2021). The pH values were stable between 6.8 and 7.1, indicating near-neutral water conditions. This controlled pH is crucial, as it remains below the threshold that can trigger high toxicity from un-ionized ammonia, rendering the aquatic environment classified as safe (Bakrie *et al*., 2020). The average DO was recorded between 3.28 mg/L and 3.47 mg/L. Although classified as low, this value is still well-tolerated by Climbing Perch because this species is equipped with a labyrinth organ to uptake atmospheric oxygen (Azrianto *et al*., 2021).

Based on these data, it can be concluded that water quality factors were not significantly limiting variables or the primary cause of the differences in results across each treatment. The stability of this rearing environment reinforces the validity that the observed differences in SR results were solely attributed to the treatment factors (medication) being tested.

CONCLUSION AND RECOMMENDATION

Conclusion

The administration of yellow root extract (*Arcangelisia flava*) proved effective as a curative agent against *Aeromonas hydrophila* infection in Climbing Perch. This efficacy was demonstrated by the achievement of a 100% Survival Rate (SR) in the treatment groups, confirming that this phytobiotic has high potential as a natural antimicrobial alternative to reduce reliance on antibiotics in aquaculture practices.

Recommendation

The study recommends using yellow root extract via immersion as the most efficient treatment for *Aeromonas hydrophila* infection. Future research should investigate oral administration (via feed) to evaluate its efficacy for large scale aquaculture application.

AUTHORS' CONTRIBUTION

All authors contributed to the study design, material preparation, data collection, and analysis. The manuscript was drafted by MM & RE, and all authors approved the final version.

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