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THE EFFECT OF MANGROVE LEAF EXTRACT (AVICENNIA MARINA) FEED ON GROWTH AND SURVIVAL RATE OF CLIMBING PERCH (ANABAS TESTUDINEUS)

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ABSTRACT
The climbing perch (*Anabas testudineus*) is a type of local fish that is popular by the people of South Kalimantan and has high economic value. One of the factors that influence the growth of climbing perch is feed. One of the natural ingredients that can be used to increase fish growth is mangrove leaf extract. The purpose of this study was to determine the effect of adding of *Avicennia marina* leaf extract to increase the growth and survival of climbing perch. The study used a completely randomized design (CRD) with 4 (four) treatments, namely treatment P1 feeding with no addition of leaf extracts of *A. marina* as control, treatment P2 feeding with addition of leaf extracts of *A. marina* as much as 100 ppm/kg of feed, P3 treatment 200 ppm/kg of feed and P4 treatment of 300 ppm/kg of feed. The parameters observed were absolute weight growth, relative growth rate, survival, feed conversion, feed efficiency, and water quality. Climbing perch were fed 5% of fish biomass per day and the frequency of feeding was 2 times a day for 45 days. The results of the study showed that the climbing perch fed with the addition of *A. maria* leaf extract 300 ppm/kg of feed resulted in weight growth, relative growth rate, feed conversion, feed efficiency in the P4 treatment of 4.71 g, 71.36%, 1.32, 112.59% and SR 100% respectively. Water quality parameters were still in reasonable conditions, ideal for the growth of climbing perch kept during the study.

KEY WORDS
Climbing perch, *Anabas testudineus*, *Avicennia marina*, growth, survival rate.

Climbing perch (*Anabas testudineus*) is one type of black fish or swamp fish that has the potential to be developed, because it has high adaptability and economic value as a consumption fish (Akbar, 2017, 2018; Hanafie *et al*., 2023, 2024). Climbing perch live, grow and reproduce in wetland environments such as swamps, rivers and brackish waters (Akbar, 2012, 2018; Akbar *et al*., 2011). Some problems for fish farmers are pests and fish diseases (Akbar, 2011), feed (Akbar *et al*., 2011, 2016; Fauzana *et al*., 2024), and environmental conditions (Hanafie *et al*., 2024). Feed is a source of material and energy to support fish survival and growth. Feed costs around 60-70% of the total production cost (Akbar, 2021; Akbar *et al*., 2023). Feed must contain the necessary nutrients such as protein, carbohydrates, fat, vitamins, minerals and feed additives in sufficient and balanced amounts. The presence of feed additives added to feed to improve the quality and content of the feed.

Indonesia is a country with the largest mangrove forest in the world, covering 21%. Mangrove forests in Indonesia cover an area of 3,442,614 Ha spread throughout Indonesia, including mangrove forests in South Kalimantan covering an area of 81,765 Ha (Kementerian Lingkungan Hidup dan Kehutanan RI, 2024; Nugroho *et al*., 2022; Rahardian *et al*., 2019). The total area of the world's mangroves is around 16 million Ha (Murdiyarso *et al*., 2015). Mangrove has ecological and economic functions (Saprudin & Halidah, 2012). The ecological function of mangrove forests is as a barrier to abrasion (Matatula *et al*., 2012), a barrier to the fury of hurricanes and tsunamis (Sadono *et al*., 2020), an absorber of heavy metal waste (Syauqiah *et al*., 2020), reducing carbon emissions in the atmosphere (Purwanto *et al*., 2021), preventing sea water intrusion (Sadono *et al*., 2020), providing nutrients for aquatic biota such as gastropods (Nugroho *et al*., 2019), a spawning and nursery ground for various types of biota such as birds (Riefani *et al*., 2019), shrimp, fish, and crabs (Matatula *et al*., 2019). Mangrove forests also have important economic functions such as providing wood (Rosulva et al., 2021), leaves as raw materials for medicines (Cerri *et al*., 2022), and as

ecotourism areas (Budiningsih & Aryadi, 2021). Knowledge about the function and role of mangrove forests is very much needed in maintaining and preserving mangrove forests sustainably by paying attention to socio-ecological, socio-cultural and socio-economic aspects (Asyari *et al*., 2021) with a SWOT analysis (Hidayat, 2017).

The types of mangrove that have been identified in South Kalimantan are 37 types of mangrove species (Nugroho *et al*., 2022). One type of mangrove that is widely found in South Kalimantan is the *Avicennia marina* (*A. marina*). The part of the plant that is commonly used is mangrove leaves. *Avicennia marina* leaves have a high content of bioactive compounds, such as alkaloids, flavonoids, tannins, phenols, hydroquinones, and saponins which are antimicrobial, anti-inflammatory, antioxidants, and act as detoxifiers of poisons and are able to increase the body's immune system against disease (Rosulva *et al*., 2022b, 2022a; Witoyo & Utoro, 2023). It is not surprising that many studies have been conducted to investigate its bioactivity and potential applications. One important application of *A. marina* leaf extract is in fish feed.

Several studies have provided *A. marina* leaf extract as a feed additive for several fish, such as tilapia (*Oreochromis niloticus*) (Arghifari *et al*., 2019; Wulansari *et al*., 2020b), milkfish (*Chanos chanos*) (Wijianto *et al*., 2023), gourami (*Osphronemus gourami*) (Astinisa *et al*., 2023), vanname shrimp (*Litopenaeus vannamei*) (Junaidi *et al*., 2020; Linayati, Mardiana, *et al*., 2023; Linayati, Nugroho, *et al*., 2023; Samuria *et al*., 2018), catfish (*Pangasius* sp.) (Aprilianda *et al*., 2023; Rahmadona *et al*., 2020; Zissalwa *et al*., 2020), and white snapper *(Lates calcarifer*) (Girsang et al., 2013). The addition of *A. marina* leaf extract increases the survival, growth, and health of fish.

The purpose of this study was to determine the positive impact of adding *A. marina* leaf extract on increasing the survival and growth of climbing perch (*Anabas testudineus*).

METHODS OF RESEARCH

This research was conducted on July 15-August 26, 2024, at the Basic Laboratory, Faculty of Fisheries and Marine Sciences, University of Lambung Mangkurat, Banjarbaru, South Kalimantan, Indonesia.

The test animals were climbing perch seeds measuring 4-5 cm. The test container was a basin measuring 48 cm x 29 cm x 38 cm with a water volume of 10 liters for each treatment. The stocking density is 1 fish/L. The frequency of feeding is 2 times (08.00 and 16.00). The experimental design used was a completely randomized design (CRD) with 4 treatments and 3 replications with different mangrove leaf extract concentrations as follows:

- Treatment P1 = No addition of *A. marina* leaf extract to the feed;
- Treatment P2 = Addition *A. marina* leaf extract of 100 ppm/kg of feed;
- Treatment P3 = Addition *A. marina* leaf extract of 200 ppm/kg of feed;
- Treatment P4 = Addition *A. marina* leaf extract of 300 ppm/kg of feed.

The making of *A. marina* leaf extract begins with taking leaf samples and washing them with water until clean. Cut the *A. marina* leaves into small pieces and place them in a dry place with a base. The leaves are dried indirectly in the sun for 7-10 days. Can be left for 24 hours in the oven at a temperature of 40°C and the process can be repeated until the leaves are completely dry. Furthermore, the leaves that are dried in the oven are then ground using a blender and sieved into a fine powder and *A. marina* leaf simplicia is produced.

The next process is the extraction of *A. marina* leaf simplicia by applying the maceration method using ethanol solvent with a ratio of 1: 5 for 72 hours. The results of the *A. marina* leaf maceration process are filtrated and separated from the substrate with filter paper and collected in a beaker.

A. marina leaf extract added to feed using the spray method or sprayed onto commercial feed. Prepare approximately 4 kg of commercial feed (PF 1000-protein 39%), then divide into 4 containers, namely 1 kg for each treatment feed. For the dose of *A. marina* leaf extract with a concentration of 100 ppm, 200 ppm, and 300 ppm, 100 mg, 200 mg and 300 mg are needed. Prepare three containers of commercial feed that will be given the *A. marina* leaf extract. Pour the *A. marina* leaf extract paste solution into a measuring cup as

much as the dose needed for each treatment then add 100 ml of distilled water into the container and stir until mixed. After mixing evenly, put the extract into a spray bottle. Spray the extract onto the feed evenly. The sprayed fish feed is then air-dried until it is no longer sticky. Drying is done in a closed room with sunlight still coming in. Drying is done to protect the content of the feed from being damaged.

Figure 1 – Maceration process

Samples for the test were taken every 15 days for 45 days to measure the following parameters.

The relative and absolute weight growth of climbing perch and it's analysis was calculated using the formulas proposed by Effendi (1997).

The feed conversion ratio of climbing perch was calculated using the formula proposed by Effendi (1997) as follows:

$$FCR = F/[Wt + D] – Wo \times 100\%$$

Where: FCR - Feed efficiency (%); F - Weight of feed given (grams); Wt - Fish biomass at the end of the study (grams); D - Biomass of dead fish during the study (grams); Wo - Fish biomass at the beginning of maintenance (grams).

The formula for calculating feed efficiency can be calculated using the following formula Takeuchi (1988):

$$EP = [Wt + D] – Wo/F \times 100\%$$

Where: EP - Feed efficiency (%); Wt - Fish biomass at the end of the study (grams); D - Biomass of dead fish during the study (grams); Wo - Fish biomass at the beginning of maintenance (grams); F - Weight of feed given (grams).

The data of this research was analyzed using the ANOVA (Analysis of Variance) test after the normality and homogeneity of the data had been ensured. The Tukey test would be carried out if the results of the variance test indicated a significant effect on the growth and FCR of climbing perch. The data on the relationship between treatments were put in Microsoft Excel 2013, while the data of water quality were descriptively analyzed.

RESULTS AND DISCUSSION

The growth of climbing perch (*Anabas testudineus*) during rearing varied and increased along with longer rearing time for all treatments as shown in the following Figure 2. The highest absolute growth value was obtained in treatment P4 with an average value of 4.71 g, and the lowest was in treatment P1 with an average value of 3.64 g.

Based on Figure 3, the relative growth rate showed the highest results, namely in treatment P4 of (71.36%), followed by treatment P2 of (66.56%), treatment P3 of (58.12%), and treatment P1 of (55.23%).

The survival of climbing perch (*Anabas testudineus*) given different api-api mangrove leaf extracts can be seen in Table 2.

Table 1 – Phytochemical Screening Test Results of *A. marina* Mangrove Leaf Flour

Compound Identification	Testing	Results	Figure
Flavonoids	Alkaline Reagent Test and Lead Acetate Test	+	
Alkaloids	Dragendorff Test	+	
Tannis	Gelatin Test	+	
Fenol	Iron (III) Chloride Test	+	
Saponins	Foam Method	+	
Anthraquinones	Anthraquinone Test	+	
Steroids	Libermann Burchard's Test	+	
Terpenoids	Salkowski's Test	+	

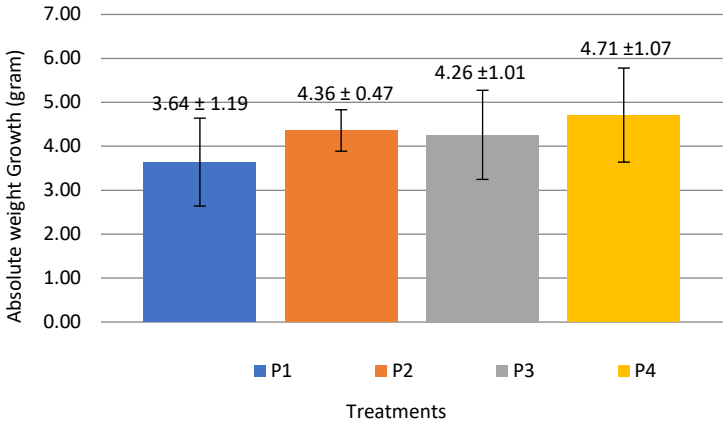

Figure 2 – Absolute growth (g) of climbing perch

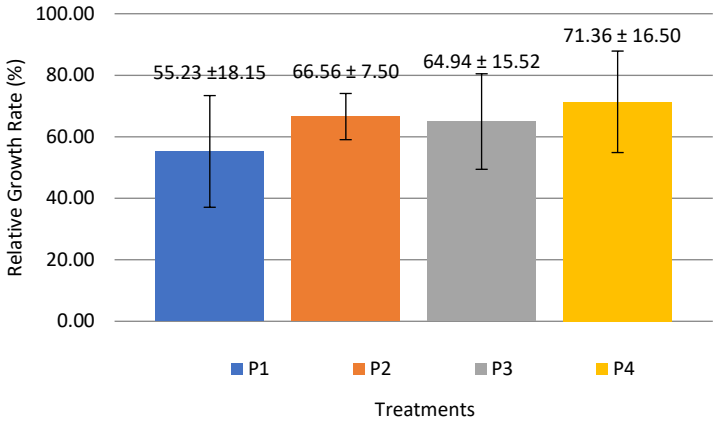

Figure 3 – Relative growth rate (%) of climbing perch

Table 2 – Survival Rate of Climbing Perch

Treatment	No	Nt	SR (%)
P1	10	10	100
P2	10	10	100
P3	10	10	100
P4	10	10	100

Each repetition in each treatment P1, P2, P3 and P4 resulted in a survival rate of 100%, which means that there were no fish deaths during the study. The survival rate is categorized as good if the SR value is higher than 70%, SR is categorized as moderate if it is between 50-60%, and low if it is lower than 50% (Linayati *et al*., 2024).

The feed conversion ratio (FCR) data for climbing perch (*Anabas testudineus*) observed in this study are presented in Figure 4.

The FCR results of climbing perch during the study obtained the lowest value in the P4 treatment with a value of 1.32, in the P2 treatment with a value of 1.35, in the P3 treatment with a value of 1.37, and the highest value was obtained in the P1 treatment with a value of 1.46.

Data on the level of utilization of climbing perch (*Anabas testudineus*) feed observed in the study are presented in Figure 5.

The best feed efficiency value was shown in treatment P4 with the highest value of 112.59%, then continued in treatment P2 with a value of 108.69%, treatment P3 with a value of 107.73%, and finally in treatment P1 with the lowest value of 101.89%.

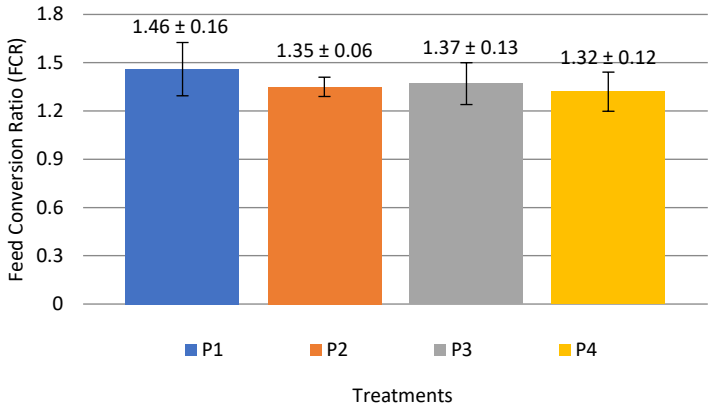

Figure 4 – Feed conversion ratio (FCR) of climbing perch

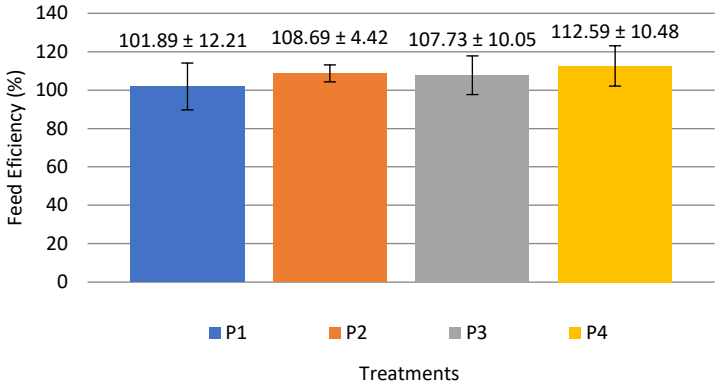

Figure 5 – Feed eficiency (%) of climbing perch

Table 3 – Parameters of Water Quality in This Research

Parameters	Outcome	Reference [48]
Temperature (^{0}C)	28.4-30.2	25-32^{0}C
DO (mg/L)	5.2-5.9	> 2 mg/L
pH	6.2-7.1	6.5-9.0
Ammonia (mg/L)	0.03-1.88	< 1 mg/L

Water quality parameters observed in this research were temperature, DO, pH, and ammonia level as presented in Table 3.

DISCUSSION OF RESULTS

During this research period, climbing perch experienced growth marked by an increase in body weight. Based on Figure 2, the highest absolute growth was in treatment P4 (300 ppm), which was 4.71 g/individual, followed by treatment P2 (100 ppm), which was 4.36 g/individual, and treatment P3 (200 ppm), which was 4.26 g/individual. While the lowest absolute growth occurred in treatment P1 (0 ppm), which was 3.64 g/individual.

The addition of *A. marina* leaf extract to the feed is an effort to improve the quality of the feed in helping the digestibility of nutrients that can encourage the growth rate of climbing perch. Based on the results of the study, it was obtained that the treatments given *A. marina* leaf extract, namely treatments P2, P3, and P4, provided a higher growth effect than the P1 treatment without the addition of mangrove leaf extract.

The best results were produced by P4 treatment with a dose of 300 ppm/kg with an average value of 4.71 grams which gave a positive value from the research of Syakirin *et al*. (2023), which used *Rhizophora mucronata* mangrove leaf extract in milkfish with a dose of

1.7 mg/kg feed resulting in a weight growth of 2.23 grams. However, it is still lower than the research of Wijianto *et al*. (2023), using milkfish using *A. marina* leaf extract with a dose of 75 ppm/500 grams of feed resulting in a growth of 6.39 grams.

The best growth value was obtained in the P4 treatment when compared to other treatments. Fish growth is due to the use of feed consumed by fish. The utilization of these nutrients is indicated by the ability of fish to convert nutrients in food into nutrients for the body and convert these nutrients into energy. This causes the nutrients in the feed to be absorbed well and the fish weight is faster than other treatments. This growth can be achieved because the addition of mangrove leaf extract affects the metabolism in the fish's body, especially in the process of changing the feed consumed into additional energy to run all the mechanisms in the fish's body. Furthermore, the remaining energy is used for the growth process. According to Ananthavalli & Karpagam (2017) mangroves are a source of carbohydrates, amino acids, and minerals. Plus, mangrove leaves contain several active compounds such as flavonoids, terpenoids and several vitamins such as B and C.

The flavonoid content in mangroves also acts as an immunostimulant for the fish's body. This indirectly flavonoids help in maintaining and forming new cells in the body and increasing appetite by strengthening the immune system in fish. An increased immune system results in the fish's body becoming healthy which ultimately results in the body's performance including fish digestion being able to work well. This is in accordance with Rahmadona *et al*. (2020) which states that the function of flavonoids in mangrove leaves functions to maintain and form cells and according to Cushnie & Lamb (2005) another function of flavonoid compounds is to increase the effectiveness of vitamin C and increase appetite. According to Linayati, Nugroho, *et al*. (2023) that the flavonoids contained in *A. marina* mangroves can increase the growth of vannamei shrimp.

A. marina leaves contain saponin and flavonoid compounds. Saponin as an active compound acts as an antibacterial that is useful for protecting fish health so that it can play a role in stimulating growth (Linayati et al., 2022). Flavonoid content functions as a prebiotic so that it can increase the growth of good bacteria that stimulate growth in fish. Flavonoids as active substances are useful for stimulating increased growth of good bacteria in the digestive tract (Linayati et al., 2022).

The high survival rate of papuyu fish is due to maintaining the quality of the maintenance water by checking it every day and always maintaining the quality of the maintenance water by siphoning to remove organic materials due to leftover feed and feces from fish that accumulate at the bottom of the container, changing the water, and selecting feed with quality nutritional content (PF 1000-protein 39%). Optimal growth performance of papuyu fish depends on providing feed with a protein level of around 20-40% (Hossain *et al*., 2012).

Mangrove leaves contain flavonoid compounds that function as immunostimulants where their function is to ward off the growth of fish diseases such as pathogenic bacteria. Active plant compounds such as flavonoids can stimulate the body's immune system and provide primary protection from bacteria, viruses, or other substances (Suhirman & Winarti, 2013).

Factors that affect survival are good quality climbing perch seeds and are characterized by active movement and high appetite. Feed is also a major supporting factor because quality feed will contain lots of nutrients to spur fish performance to maintain its body. Some factors that affect fish survival are factors from the fish itself such as genes and immunity, while other factors such as feed, stocking density and water quality (Supu *et al*., 2021).

The addition of *A. marina* leaf extract to feed has a good effect because it contains compounds that can help the growth process in climbing perch. Feed additives in *A. marina* leaves also have an effect to stimulate growth because *A. marina* leaves have phenolic compounds in the form of flavonoids and tannins which are natural antioxidants to increase fish survival (Wulansari *et al*., 2020a). Feed additives function to increase appetite, digestibility, endurance, in addition to reducing stress levels and increasing growth.

The feed conversion ratio value describes how effectively the fish digest the feed they eat. Based on Figure 3, the feed conversion rate of climbing perch is quite good, ranging from 1.32-1.46. A large feed conversion ratio value indicates that the feed conversion process is ineffective and vice versa.

The feed conversion ratio value depends on many factors, but the best response is thought to be closely related to optimizing the environment to approach the usual conditions for fish (Nahar *et al*., 2016). The high growth rate and effective utilization of feed will have an impact on the good feed conversion value by fish. The ideal feed conversion ratio for climbing perch cultivation is 1.8-3.0 (Chowdhury *et al*., 2014).

Feed efficiency refers to the high or low intensity of feed entry into digestive metabolism, processed and utilized for growth energy. The higher the feed efficiency value, the more optimal the use of feed in increasing growth and good feed quality (Chowdhury *et al*., 2014). A good feed efficiency value indicates that the feed can be digested efficiently and is of good quality.

There is a correlation between feed conversion value, biomass, and feed utilization efficiency. The higher the fish biomass, the more effective it is in utilizing feed in the digestion process. Fish grow well if the environmental habitat and body metabolism conditions are stable (Nahar *et al*., 2016). These conditions will have a very good effect on the level of productivity of fish farming.

The feed efficiency value of this study is quite high, because it has reached 100%. In addition to the metabolic process, the feed consumed can also be accumulated for growth. The feed consumed by fish is mostly used for the metabolic process and body maintenance, the excess is only used for growth (Effendi, 1997). In the P1 treatment, the value was low compared to other treatments because the P1 treatment did not have the addition of api-api mangrove leaf extract which caused the fish to absorb protein longer than the treatment containing mangrove leaf extract.

Feed that does not contain flavonoids cannot provide protection against pathogenic bacteria for fish that consume the feed. Because the content of flavonoids is good bacteria that can digest food so that it can be better utilized in the fish's digestive system. Flavonoids have the function of repairing damaged cells due to free radicals that can inhibit growth (Linayati *et al*., 2022).

Water quality is one of the factors that affect the growth and survival of climbing perch that are kept during the study. Water quality measurements during the experiment showed that it was suitable for fish farming. According to Cholik *et al*. (1986), water temperature of 25-32^{0}C is suitable for fish farming. According to Cholik *et al*. (1986), dissolved oxygen (DO) > 2 mg/L is good for fish farming. Meanwhile, pH ranges from 6.5-9.0 which is a good pH range for fish farming (Cholik *et al*., 1986). The ammonia content in this experiment ranged from 0.03-1.88 mg/L. This condition still allows the climbing perch to survive. These water quality parameters are still in reasonable conditions, ideal for the growth of the climbing perch kept during the experiment.

CONCLUSION

The addition of *A. marina* leaf extract in feed can improve the growth performance of climbing perch (*Anabas testudineus*) with an extract dose of 300 ppm/kg feed.

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