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# Effect of Adding Coconut Oil to Feed on the Growth of Climbing Perch (*Anabas testudineus*)

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## Abstract

Natural fishing activities cannot continue to meet market demands. Aquaculture has made a significant contribution to reducing fishing. Nevertheless, fish culture must meet their nutritional needs to support growth, including lipids. Lipids have an essential function in the body as a source of energy reserves to replace protein energy. This research aimed to find out what percentage of coconut oils should be used in feed to increase climbing perch growth. This research used a Completely Randomized Design (CRD) with five treatments and three replications. Coconut oil was added at different percentages to commercial feed, which was composed of commercial feed without adding coconut oil with lipid content of 3.88% ($P_1$) and commercial feed with 5% coconut oil with lipid content of 8.25% ($P_2$), the addition of 10% coconut oil with a total lipid content of 12.16% in a feed (P3), the addition of 15% coconut oil with a total lipid content of 18.98% in a feed (P4), and the addition of 20% coconut oil with total lipid content of 24.15% in a feed (P5). The results showed that the additional coconut oil treatment significantly affected the growth of climbing perch. Adding 15% coconut oil to the feed (total lipid content 18.98%) produced the best results, with a weight gain of 0.74 g, a feed efficiency of 16.68%, and a feed protein efficiency ratio of 0.56. The water quality during rearing was still suitable for the climbing perch's survival.

**Keywords:** Climbing perch; Coconut oil; Growth

## Introduction

The cultivation of climbing perch contributes to meeting market demands that are not reliant on nature or catches. Several studies and efforts have been made to increase aquaculture productivity, including the amount of protein needed in climbing perch feed (Hossain *et al.* 2012), adding *Azolla* supplementation (Mishra 2013), the effect of the type of feed for climbing perch (Begum *et al.* 2014), dietary supplementation with fructooligosaccharide (Chitmanat *et al.* 2017), different feeding rate (Norashikin and Syukri 2018), feeding frequency (Dash *et al.* 2019), replacement of fishmeal by black soldier fly (Vongvichith *et al.* 2020), adding fish oil (Tobigo *et al.* 2021). Fish growth primarily depends on feed (Mukti *et al.* 2014). Protein is the central molecule with the highest composition in feed. Besides protein, fish also require carbohydrates and lipids to fulfil their feed needs in addition to protein. According to Phan *et al.* (2021), a lipid is a macro-nutrient component with the most extensive energy content compared to protein and carbohydrates. The formulation's balance of energy and protein is essential in feeding (Hamre *et al.* 2022). Although the quantity and quality of protein are sufficient, sometimes the energy content needs to be improved, so adding high-calorie ingredients becomes essential. Availability of lipids in fish feed is critical in supporting fish growth because lipids can act as a protein-sparing effect which functions to replace protein as an energy source (Thirunavukkarasar *et al.* 2022; Saputra and Fotedar 2024). Based on several previous studies, fish's composition or lipid requirements vary. Fish generally require 10–20% of their calories as lipids (Ayuba and Iorkohol 2013; Huerta-Ortiz *et al.* 2018).

Coconut oil as a lipid source in fish feed has been studied. Dawood *et al.* (2021) showed that adding 2–3% coconut oil gave the best results on the growth of Nile tilapia. According to Ballestrazzi *et al.* (2006), using 13% coconut oil in feed resulted in the best absolute weight growth of rainbow trout. Based on the research results of Jorge (2011), feeding 13% coconut oil has resulted in the best weight growth of female Nile tilapia. Several studies have been

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conducted on climbing perch's requirements for lipids from various sources. In the research of Pawar *et al*. (2021), feed containing 9% lipid (addition of peanut oil, vegetable oil, and cod liver oil) and 45% protein resulted in the best growth for Indian climbing perch with an initial weight of 1.23 g. According to Ali *et al*. (2012), the feed with lipid content of 9.60–14.64%, carbohydrates of 14.64–28.81%, and protein of 40% performs well for climbing perch with an initial weight of 2.25 g. The results of the study by Varghese and Oommen (2000), female climbing perch measuring 21 ± 1 g were fed with the addition of various sources of oil (palm oil, coconut oil, and cod liver oil) as much as 20% in the feed formulation caused no significant effect.

Previously, research on the ratio of carbohydrates to lipids in formulated feed could increase the growth of climbing perch through protein efficiency (Ali *et al.* 2012). In addition, climbing perch sites of different sizes have different lipid requirements. Then, it is thought that the lipid content in fish feed can be modified from various sources, including coconut oil. Coconut oil has a wide distribution and is very abundant in Indonesia. Based on previous references, it is necessary to know how to apply coconut oil with different concentrations to grow climbing perch.

## Materials and Methods

### Experimental design

Coconut oil is the treatment material used in this research. Fish oil is added to feed at different concentrations to find a suitable composition for fish growth. The study used a completely randomized design (CRD) with five treatments and three replications. Coconut oil was added to the commercial feed of climbing perch in different percentages as follows:

$P_1$: Commercial feed without adding coconut oil (total lipid content in feed 3.88%).
$P_2$: Addition of 5% coconut oil (total lipid content in a feed 8.25%).
$P_3$: Addition of 10% coconut oil (total lipid content in a feed 12.16%).
$P_4$: Addition of 15% coconut oil (total lipid content in a feed 18.98%).
$P_5$: Addition of 20% coconut oil (total lipid content in a feed 24.15%).

### The preparation of experimental feed

Research feed was prepared by grinding commercial feed that had been prepared using a blender into flour using a blender. After the coconut oil was mixed and stirred until evenly distributed. Then add warm water little by little while stirring until a paste forms (adding warm water is approximately 30% of the total weight of the mixed ingredients). The ingredients that have been mixed and then the feed that has been formed are dried in an oven, the dried feed to be given to test fish or stored in a dry place.

### The preparation of fish-rearing containers

Fifteen tanks at 50 cm × 40 cm × 40 cm were filled with 40 L water. Then, a water limit was marked on the tank wall to ensure appropriate volume, aeration equipment was installed, and the aerator was connected to the tank. Each tank was given a random treatment label.

### Stocking and rearing fish

The initial data were collected by weighing and measuring acclimatized fish. Then the fish were stocked with as much as 1 fish/L. Fish reared for 30 days. During rearing, the feed was given three times a day at 08.00 a.m., 12.00 a.m., and 04.00 p.m. The siphon process removes the faces accumulated at the bottom of the tank every three days. Next, water is added again according to the volume of water wasted. Sampling of fish was carried out at the beginning and end of rearing. Sampling was carried out by measuring the length and weight of each fish.

### Parameter

**Absolute weight growth:** Absolute weight growth (W) is calculated using the formula below:

$$W(g) = Average\ of\ final\ weight\ (g) - Average\ of\ initial\ weight\ (g)$$

**Absolute length growth:** Absolute length growth (L) is calculated using the formula below:

$$L(cm) = Average\ of\ final\ length\ (cm) - Average\ of\ initial\ length\ (cm)$$

**Feed efficiency:** Feed efficiency (FE) is calculated using the formula below:

$$FE(\%) = \frac{(Final\ biomass\ (g) + Dead\ biomass(g)) - Initial\ biomass\ (g)}{Feed\ consumption\ (g)}$$

**Protein efficiency ratio:** The protein efficiency ratio (PER) is calculated using the formula below:

$$PER = \frac{Final\ biomass\ (g) - Initial\ biomass(g)}{Feed\ intake\ (g)\ x\ dietary\ protein\ content(g)}$$

**Survival rate:** Survival rate (SR) is calculated using the formula below:

$$SR(\%) = \frac{Final\ fish\ number\ (fish)}{Initial\ fish\ number\ (fish)}\ x\ 100$$

### Water quality

Parameters of water quality for climbing perch that were measured included temperature, pH, and dissolved oxygen. Temperature and pH measurements were conducted daily, and dissolved oxygen measurements were performed every ten days. Water quality measurements are carried out using water quality control tools.

### Data analysis

Data were analyzed statistically using Analysis of Variance

(ANOVA) with the help of SPSS 20.0 software. Analysis of variance at 95% was used to analyze growth, feed efficiency, lipid intake, protein efficiency ratio, and survival data. If the results show a significantly different effect, proceed with the Least Significant Difference (LSD) test. Water quality was analyzed descriptively.

## Results

Based on the data in Table 2 shows that the feed intake by the climbing perch has significant effect. However, the amount of lipid intake by the climbing perch varied significantly between treatments, with the addition of 20% oil (total feed lipid content 24.15%) consuming more lipids. Coconut oil can be a source of energy reserves and meet lipid needs by adding coconut oil to feed. Adding 15% coconut oil with a total feed lipid content of 18.98% (P4) and 20% coconut oil with a total feed lipid content of 24.15% (P5) increased weight growth but decreased weight growth again with 20% coconut oil. As indicated by the most significant absolute weight increase in P4, the lowest weight gain was seen in P5. Although based on the analysis of variance, the addition of coconut oil as much as 15% ($P_4$) was not significantly different from the addition of 10% ($P_3$) and 20% ($P_5$) for absolute weight growth, the absolute length growth was not significantly different between treatments.

Data of feed efficiency data (FE) and protein efficiency ratio (PER) of climbing perch feed for 30 days are presented in Table 3.

## Discussion

Based on this study's results, adding coconut oil to feed shows a significant effect. Previous research shows that adding coconut oil to feed can positively impact fish, especially in supporting growth (Ali *et al.*, 2012). According to Naiel *et al.* (2023), fish should not have too high a lipid content in their feed. Oil can be replaced by oil when used efficiently as an energy source, thereby increasing its utilization efficiency (Kim *et al.*, 2010). Good lipid content for fish ranges from 10–20% (Ayuba and Iorkohol, 2013). One of the adverse effects of unsuitable dietary lipid levels is low growth and decreased fish health (Amadou and Tidiane, 2016). However, the deficiency of essential fatty acids can cause decreased growth (Carr *et al.*, 2023). Adding oil can increase energy content and impact the feed's energy and protein balance. According to Konnert *et al.* (2022), the energy and protein balance in the formulation of feed is very important. The energy value of the protein is often not enough, even if the quantity and quality of the protein are sufficient, so high-calorie ingredients must be added to make up the difference. Craig and Helfrich (2017) state that lipids have about twice as much energy as protein and carbohydrates. Based on Chaparro-Pedraza and de Roos (2021), using energy from fish in a bioenergetic manner will first be used for maintenance (sustaining life).

Furthermore, energy will be stored in the body so that the fish experience growth. Fish can grow optimally if their nutritional availability or adequacy is met. Lipids are a source of nutrition that fish need and also function as energy reserves. The addition of coconut oil in this study resulted in a low percentage of feed protein (Table 1). The addition of 15% (P4) was lower in protein than 10% (P3), 5% (P2), and without the addition of coconut oil (P1), even though it produced the highest growth. This is thought to be related to lipids as a protein-sparing effect (replacing protein as an energy source). Climbing perch are classified as omnivorous fish that tend to be carnivorous (Gokulakrishnan *et al.*, 2022). Lipid is a high-energy source for growth, especially carnivorous fish (Nguyen *et al.*, 2022). Although this study did not provide a significant effect, it is known that based on the study's results, the highest weight growth obtained when adding coconut oil was up to 15% (18.98% total feed lipid content) with a GE/P value of 16.17 kcal/g. The highest addition of coconut oil, as much as 20% (24.15% total feed lipid content) with a GE/P value of 18.66 kcal/g, decreased the growth of the weight of the climbing perch when compared to the addition of 15% coconut oil.

Several studies have been conducted on the growth of climbing perch. According to the research of Pawar *et al.* (2021), climbing perch with a weight of 1.23 ± 0.01 g fed 45% protein and 9% lipid produced the best growth. The results of Hossain *et al.* (2012) showed that feed with a protein content of 40 and 10.20% lipid was recommended for climbing perch with a weight of 1.04 ± 0.02 g. According to Varghese and Oommen (2000), feeding with 35% protein and 20% different types of oil (each given coconut oil, palm oil, and cod liver oil) showed no significant difference in the weight growth of female climbing perch (21±1 g in weight). Furthermore, oil can increase the amounts of fatty acids in feed, as well as the amount of energy. Based on Boateng *et al.* (2016), coconut oil contains caprylic acid C-8:0 (8%), capric acid, C-10:0 (7%), lauric acid C-12:0 (49%), myristic acid C-14:0 (8%), palmitic acid C-16:0 (8%), stearic acid C-18:0 (2%), oleic acid C-18:1 (6%) and 2% of C-18:2 linoleic acid. According to Carr *et al.* (2023), essential lipid acids will function optimally for fish growth if they are available in fish feed as needed, both in quantity and type, because they cannot be synthesized in the fish's body. Fish needs for essential lipid acids are different for each fish species. Based on the NRC (1993), freshwater fish require 18:2 (n-6) linoleic acid or 18:3 (n-3) linolenic acid or both in feed. According to Tocher (2010), the need for essential fatty acids, in general, can be met by C18 PUFA (Polyunsaturated Fatty Acid), 18:3 (n-3) or 18:2 (n-6), about 1% of the feed. According to the NRC (1993), the requirement for fatty acids in American catfish is 1–2% linolenic acid or 0.5–0.75% EPA and DHA, and tilapia requires 0.5% linoleic acid.

Table 3 shows that adding coconut oil with different percentages causes significantly different feed efficiency.

**Table 1:** The nutrient content of the experimental feed

| Nutrient | Content (%) | | | | |
|---|---|---|---|---|---|
| | $P_1$ | $P_2$ | $P_3$ | $P_4$ | $P_5$ |
| Protein | 36.91 | 34.28 | 31.35 | 29.71 | 27.33 |
| Lipid | 3.88 | 8.25 | 12.16 | 18.98 | 24.15 |
| Water | 8.68 | 8.29 | 7.83 | 8.98 | 9.50 |
| Ash | 11.36 | 7.52 | 8.79 | 9.23 | 7.33 |
| Crude Fiber | 2.23 | 2.24 | 2.23 | 2.66 | 2.37 |
| Nitrogen-free extract | 36.94 | 39.42 | 37.64 | 30.44 | 29.32 |
| Total | 100 | 100 | 100 | 100 | 100 |
| GE (kcal/100g)* | 403.77 | 440.33 | 453.33 | 480.50 | 509.99 |
| GE/P (kcal/g protein) | 10.94 | 12.85 | 14.46 | 16.17 | 18.66 |

*GE (Gross Energy) is calculated based on NRC (1993); protein is 5.6 kcal/g, the lipid is 9.4 kcal/g, and carbohydrates are 4.1 kcal/g

Data on feed intake, lipid intake, and absolute growth of climbing perch for 30 days are presented in Table 2

**Table 2:** Feed and lipid intake data and absolute growth of climbing perch for 30 days

| Treatment | Feed intake (g/fish) | Lipid intake (g/fish) $LSD_{\alpha 0,05} = 0.09$ | Growth | |
|---|---|---|---|---|
| | | | Weight (g) $LSD_{\alpha 0,05} = 0.13$ | Length (cm) |
| $P_1$ | 4.52±0.19 | $0.17±0.01^a$ | $0.53±0.03^a$ | 0.26±0.02 |
| $P_2$ | 4.82±0,29 | $0.40±0.02^b$ | $0.55±0.10^a$ | 0.26±0.09 |
| $P_3$ | 4.98±0.18 | $0.60±0.02^c$ | $0.61±0.08^{ab}$ | 0.29±0.03 |
| $P_4$ | 4.48±0.42 | $0.85±0.08^d$ | $0.74±0.08^b$ | 0.24±0.06 |
| $P_5$ | 4.96±0.42 | $1.20±0.10^e$ | $0.63±0.05^{ab}$ | 0.18±0.05 |

Description: According to the 95% LSD test, numbers in the same column with the same superscript letter have no significant differences

**Table 3:** Data of feed efficiency (FE) and protein efficiency ratio (PER) of climbing perch

| Treatment | FE (%) ($LSD_{\alpha 0,05} = 3.34$) | PER ($LSD_{\alpha 0,05} = 0.05$) |
|---|---|---|
| $P_1$ | $11.40±1.06^a$ | $0.31±0.03^a$ |
| $P_2$ | $11.43±1.30^a$ | $0.33±0.04^{ab}$ |
| $P_3$ | $11.95±1.21^a$ | $0.38±0.04^b$ |
| $P_4$ | $16.68±3.03^b$ | $0.56±0.10^d$ |
| $P_5$ | $12.98±1.87^a$ | $0.48±0.07^c$ |

Description: According to the 95% LSD test, numbers in the same column with the same superscript letter have no significant differences

The survival rate of the climbing perch data for 30 days is presented in Table 4

Adding 15% coconut oil (P4) was found to have the highest feed efficiency. The higher the percentage of coconut oil given, the higher the feed efficiency of the climbing perch, up to the limit of adding 15% coconut oil ($P_4$), but decreasing again at the addition of 20% ($P_5$). Feed efficiency shows the percentage of feed converted into weight gain. Feed efficiency can be calculated by comparing the body weight gain of the fish with the amount of feed consumed during the rearing process (Rodde *et al.*, 2021). The LSD test results showed that the catfish feed's efficiency at adding 15% coconut oil ($P_4$) was significantly higher than the other treatments. The addition of 20% coconut oil ($P_5$) was not significantly different from the addition of 5% ($P_2$), 10% ($P_3$), and feed without the addition of coconut oil ($P_1$). Based on the research, adding coconut oil with different percentages resulted in significantly different protein efficiency ratio values for climbing perch. The highest protein efficiency ratio for climbing perch was found by adding 15% coconut oil ($P_4$), and the lowest was found in feed without adding coconut oil ($P_1$). Higher the percentage of adding coconut oil, the higher the efficiency ratio of feed protein, up to the limit of adding 15% coconut oil ($P_4$) and then decreasing with the addition of 20% ($P_5$).

Adding coconut oil with the highest percentage in this study (20% or $P_5$) did not lead to a higher feed efficiency than adding 15% ($P_4$). Even if the highest feed efficiency value is at P4, this feed efficiency number is still relatively low because, according to Craig and Helfrich (2017), good feed efficiency is greater than 50%. The greater the feed efficiency value, the more efficiently the fish utilize the feed intake for growth (Iskandar and Elrifadah, 2015). Feed that contains lipids can provide a more prolonged feeling of satiety (Shapira, 2019). Protein efficiency ratios are expressed as grams of body weight gained per gram of protein intake. The value Obtained indicates the protein's effectiveness (Ayuba and Iorkohol, 2013). According to Craig and Helfrich (2017), lipids are high-energy nutrients that are used as a reserve to replace protein energy in food. According to Manam (2023), the correct total energy in feed causes a protein to be used efficiently to construct new body tissues to produce high growth. According to Jauralde *et al.* (2021), protein is used for body growth and maintenance, while lipids and carbohydrates are used for body maintenance. Research on climbing perch feed has been carried out, which resulted in different protein efficiency ratio values. According to Hossain *et al*. (2012), regarding feeding with different protein content, the best protein was 40%, which resulted in a protein efficiency ratio of Thai

climbing perch with an initial weight of 1.04 ± 0.02 g of 1.27, which was reared for eight weeks. In addition, the research of Norashikin and Syukri (2018), climbing perch with an initial length and weight of 3–3.5 inches and 3–4.5 g, respectively, which were fed with different feeding rates, showed a feeding rate of 4% the best resulted in a protein efficiency ratio of 0.89 which was reared for 12 weeks. Based on Table 4, the highest survival of the climbing perch was found in the addition of 5% ($P_2$) and 15% ($P_4$) coconut oil, and the lowest survival was found in the addition of 10% coconut oil ($P_3$). However, the analysis of the variance of the survival of the climbing perch during rearing was not significantly different between treatments. In aquaculture, the survival rate of fish is an important factor because it is a factor of fish culture success. Factors that affect fish survival are stocking density, feeding, disease, and water quality (Abd El-Hack *et al.*, 2022). Fish survival indicates that the waters are in good condition and that the feed provided meets the fish's survival needs (quantity and quality) (Tumwesigye *et al.*, 2021). The optimum water quality of the rearing medium can support maximum fish survival.

Water quality is one of the main factors in fish culture. In this study, overall water quality values are within the standard range. During the study, water quality data for the climbing perch were obtained, namely temperature, dissolved oxygen, and pH, which continue to encourage the climbing perch's survival throughout this study (Table 5). High-quality water will support optimal growth. Decreasing water quality will cause stress to fish and even cause death.

**Table 4:** The survival rate of the climbing perch

| Treatment | Survival Rate (%) |
|---|---|
| $P_1$ | 97.5±2.50 |
| $P_2$ | 100±0 |
| $P_3$ | 95±6.61 |
| $P_4$ | 100±0 |
| $P_5$ | 99.2±1.44 |

Water quality data of climbing perch rearing media for 30 days are presented in Table 5

**Table 5:** Water quality data

| Parameter | Value |
|---|---|
| Temperature (°C) | 27.3-29.4 |
| pH | 6.0-7.3 |
| DO (mg/L) | 3.26-4.87 |

## Conclusion

The experimental results of adding coconut oil with different concentrations showed significant difference between treatments. The best percentage of coconut oil added for climbing perch is 15% (18.98% total feed lipid content) on commercial feed with 36.91% protein (39–41% protein in packaging and 5% minimum packaging lipid). During rearing, the climbing perch has access to water of a quality that is sufficient to support its survival.

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## Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

## Data Availability

Not applicable.

## Ethics Approval

Not applicable.

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