



# A Few Potential of Turmeric as Feed Additive on Fish Growth

Kiki Haetami <sup>a\*</sup>, Elit Erdiasari <sup>b</sup>, Roffi Grandiosa Herman <sup>a</sup>  
and RuskyIntan Pratama <sup>a</sup>

<sup>a</sup> Faculty of Fisheries and Marine Sciences, Padjadjaran University, Jl. Raya Bandung Sumedang KM.21, Jatinangor, Kabupaten Sumedang, Jawa Barat-45363, Indonesia.

<sup>b</sup> Tropical Marine Science Program, Padjadjaran University, Jl. Raya Bandung Sumedang KM.21, Jatinangor, Kabupaten Sumedang, Jawa Barat-45363, Indonesia.

## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

## **Article Information**

DOI: 10.9734/AJFAR/2023/v24i3632

## **Open Peer Review History:**

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/103483>

**Review Article**

**Received: 29/05/2023**

**Accepted: 02/08/2023**

**Published: 09/08/2023**

## **ABSTRACT**

Nutrition is the major crucial factor determining the potential of cultured fish. The increased in costs and formulation quality of fish feed have given reason to the need to increase research for substitutes. Therefore, the fish feeds require to be enriched with additives. The use of synthetic feed additives in the form of antibiotics is currently prohibited because it often causes negative effects and has an expensive price, so an alternative to synthetic feed additives is needed, including from the rhizome group such as turmeric.

**Aims:** This article review aims to collect and provide information about some research results regarding the use of turmeric as a feed additive in fish feed.

**Study Design:** Literature review. The data collection method is carried out by literature study. The data was obtained by searching the literature related to the use of turmeric extract in fish farming activities through search sites on internet media published in the last twenty-three years (2000-2023). The literature used in this article review is obtained from internet media with the keywords "Turmeric", "Turmeric Flour", "Turmeric Extract", "Fish Feed", "Fish Farming", "Feed Additive".

\*Corresponding author: Email: [kiki.haetami@unpad.ac.id](mailto:kiki.haetami@unpad.ac.id), [kiki.haetami@unpad.ac.id](mailto:kiki.haetami@unpad.ac.id);

**Results:** The addition of turmeric (turmeric flour, turmeric extract, and turmeric juice) to fish feed can have a significant effect on growth, feed conversion ratio, feed utilization efficiency, gonad development, survival, and digestive enzymes. Feed additives are added to fish feed in small quantities, but their presence is needed for special functions such as antioxidants or antimicrobials in increasing the growth and efficiency of fish feed. The addition of doses to turmeric varies greatly, as turmeric flour ranges 2-60 ml/kg of feed. This is influenced by the variety and type of fish, feed quality, and aquaculture environmental conditions. So it requires further research to determine the use of the right dose to obtain maximum results.

**Keywords:** Feed additive; fish; survival; turmeric; growth.

## 1. INTRODUCTION

Feed is one source of nutrients that are very important for the development and growth of fish. Feed also plays an important role in controlling the metabolic system of fish and to help maintain the immune system of fish to avoid disease attacks [1]. Feed is the largest operational cost in fish farming activities, so it requires effective and efficient feed processing including by providing additional feed or feed additives [2]. Feed additives added to fish feed in small quantities with the aim of increasing fish growth and fish feed efficiency, and to reduce the accumulation of waste in aquaculture aquatic environments derived from feed consumption that is not utilized optimally by the farmed fish [3]. Feed additives are eatable substances that are included in fish feeds in very little quantity to improve the feeds which in returns improve the growth performance and decrease mortality rate in fish.

Feeding synthetic additives that are usually used to be mixed into feed are synthetic enzymes, antibiotics, antimicrobials and probiotics [4]. The use of synthetic feed additives in the form of synthetic enzymes, probiotics, antimicrobials and antibiotics including feed additives at relatively expensive prices that can increase feed production costs [5]. The use of synthetic feed additives also includes ingredients that are less guaranteed security aspects because there are chemical residues in the feed [6]. So it requires efforts or substitutes for synthetic feed additives in the feed, one of which is the use of feed additives or natural feed additives in the form of turmeric [7].

Turmeric is an herbal ingredient that is often used in fish farming activities as a feed additive in feed [8]. This is because turmeric is an herbal plant that is easily found, has a very affordable selling price, and its existence is quite abundant [9]. Therefore, based on the description above, the author is very interested in making a review

article by collecting and providing information about some research results that use turmeric as a feed additive in fish feed.

## 2. TURMERIC POTENTIAL

Turmeric is an herbal plant originating from the Asian region, especially Southeast Asia [10]. Turmeric also includes herbal plants that can help increase the productivity of living things [11]. This is because turmeric contains curcuminoid compounds that are useful as antioxidants, as well as anti-inflammatory [12].

Turmeric also has a rhizome-shaped root (turmeric tuber) which is often used for traditional medicine, preservatives, cooking spices, or used in the field of aquaculture [13]. The turmeric rhizome includes bioactive compounds that act as antioxidants that can give curcuminoids their yellow color [14]. Turmeric rhizomes have an elongated and rounded shape with a diameter ranging from 1-2 cm and a length ranging from 3-6 cm. Turmeric also has hairy, contented, lanceolate flower stalks, and tubular hairy petal leaves, and has a length ranging from 9-13 mm [15]. The classification of turmeric plants according to, among others, as follows:

Phyllum : Spermatophyta  
Class : Monocotyledoneae  
Ordo : Zingiberales  
Family : Zingiberaceae  
Genus : *Curcuma*  
Species : *Curcuma domestica* [16]

### 2.1 Advantages and Potential of Turmeric

The use of turmeric as a feed additive is because turmeric contains curcumin, essential oils, fats, carbohydrates, proteins, vitamin C, mineral salts in the form of phosphorus, iron, and calcium [11]. The main content that plays an important role in turmeric is curcumin which ranges from 9.61%.

Curcumin is the main active substance that is antioxidant, as an appetite enhancer, and serves to prevent tissue damage in fish [18].

Curcumin in turmeric can function to stimulate the gallbladder wall in fish in order to remove bile into the small intestine, so that it can affect the increasing process of digestion of carbohydrates, fats, and proteins. Increasing the process of digestion of carbohydrates, fats, and proteins can also have an impact on the process of absorption of food substances or nutrients derived from feed consumed by the fish [9]. Furthermore, it is known that turmeric also contains active substances other than curcumin, namely essential oils ranging from 3.18% which play a role in helping the digestive process of fish by stimulating the secretory nervous system to secrete gastric juice containing enzymes to be secreted in the stomach and intestines. This process can certainly cause an increase in the metabolic process of food substances that can accelerate gastric emptying, so that it can affect the level of fish feed consumption [9].



Fig. 1. Tumeric (*Curcuma domestica*) [17]

Table 1. Proximat analysis of tumeric

Composition	NilaiGizi (%)
Crude Protein	11,70
Crude Fat	3,79
Carbohydrat	65,77
Ash	7,12
Moisture	11,62

Reference: [13]

Based on (Table 2) the use of turmeric in aquaculture activities can act as an antioxidant, as well as an antibacterial which plays an important role in aquaculture activities [20]. This is related to the content of turmeric which consists of curcumin, essential oils,

carbohydrates, protein, vitamin C, fat, and there are mineral salts such as phosphorus, calcium, and iron [11]. The antioxidant properties of turmeric come from the bioactive compounds of turmeric. Turmeric bioactive compounds are often referred to as curcumin. Curcumin is one of the yellow active compounds. Curcumin also has polyphenolic and phenol compounds which cause curcumin to act as an antioxidant [21]. The antioxidant properties of turmeric are due to the presence of curcuminoids in turmeric. The content of curcuminoids in turmeric consists of curcumin ranging from 70-76%, desmethoxycurcumin ranging from 16%, and bisdesmethoxycurcumin ranging from 8% [22]. The content of curcumin compounds which are antioxidants in turmeric can be useful for increasing the appetite of fish or animals, so that it can accelerate gastric emptying which has an impact on increasing the appetite of fish or livestock, so that it can increase the activity of the ducts in these fish or livestock. Increased appetite will affect the growth rate and weight gain rate of barramundi [9], and can affect weight growth in male laying hens [23].

Table 2. Content of turmeric Phytochemical compounds

Phytochemical Compounds	Phytochemical Activity
Alkaloid	
Saponin	Antibacterial
Tanin	
Flavonoids	
Phenol	
Poliphenol (gingerols, shogols, and paradols)	Antiooxidant

Reference : [19], [20]

Turmeric also contains active compounds of essential oils which are useful for inhibiting the growth of microorganisms. This is because essential oils contain Alkaloid, Saponin, Tanin, andFlavonoidscompounds as antibacterial activity [24]. The content of essential oil compounds that are antibacterial can be useful for killing bacteria from the *Bacillus caerus*, *Bacillus subtilis*, and *Bacillus megetenium* groups, and can be useful for inhibiting the growth of *vegetative bacillus* cells with their spores [25]. The content of curcumin compounds and essential oils can affect antioxidant and antibacterial activity, the higher the dose of turmeric extract used, the higher the antioxidant and antibacterial properties. The content of essential oils in turmeric

which is an antioxidant can be useful for killing bacteria from livestock and fish that are detected with disease, for example as a treatment for Motile Aeromonas Septicemia (MAS) disease which attacks catfish (*Pangasius*) [26], and can treat broiler chickens infected with *Escherichia coli* [27].

### 3. USED OF TURMERIC FEED ADDITIVE IN FISH

The addition of turmeric flour (*Curcuma longa* Linn.) can affect barramundi (*Latescalcarifer*, Bloch) with the best dose of around 20 grams/kg of feed with an absolute biomass growth of 6.6 grams and an FCR of 1.4 [20]. This is because the use of high doses will increase the growth of fish, so that the addition of a dose of 20 g/kg of feed does not cause toxicity or death in the barramundi, and can affect the decrease in the FCR value of the fish [28]. The use of turmeric can affect the growth and efficiency of utilization of barramundi (*Latescalcarifer*) feed with the best dose of around 20 ml/kg of feed [9]. Increased growth and efficiency of utilization of barramundi feed is because turmeric contains curcumin which can increase appetite and is an antioxidant so that it can stimulate digestive enzymes to absorb nutrients from the feed consumed [9]. Growth in fish can be influenced by several factors such as feed, cultivation containers, temperature, and salinity. Feed is a factor that plays an important role in fish growth, the higher the feed given, the slightly higher the growth of cultivated fish [29]. The conversion value of snapper feed is 1.4 including the value with more effective use of feed for fish growth. This is influenced by good cultivation environmental conditions so that it can have an impact on fish metabolic processes to utilize their energy to achieve optimal growth [30].

The addition of turmeric extract also affected the growth of tilapia with the best dose of 10% in the P3 treatment with an average weight gain of around 1 g/head, and an increase in body length of about 0.5 cm. This is because the higher the dose given, it will affect the increase in fish appetite to consume feed added to turmeric extract [25]. Growth in fish can also occur if the amount of feed consumed by the fish exceeds the needs of the fish for maintenance of its body [31]. One of the factors that can affect the growth of fish is feed. The requirements for feed for aquaculture activities are that the quantity and quality of feed must be available in sufficient condition and in accordance with the

environmental conditions of the cultivation so that growth in fish can occur optimally [32]. The addition of turmeric to feed can affect fish growth because turmeric can increase the performance of fish metabolism in the digestive system, and can increase the absorption of nutrients so that fish feed consumption increases. Increasing feed consumption will certainly affect the rate of gastric emptying so that it will have an impact on increasing the digestive process of fish [28].

The addition of turmeric flour can also affect the increase in the weight and length of the Seruka fish with the best dose of around 0.6%/kg of feed [11]. This is influenced because turmeric has the benefit of increasing appetite so that it can increase the growth of Seruka fish. The increase in the growth of the Seruka fish is also due to the maximum absorption of nutrients from the feed added with turmeric [9]. The addition of turmeric powder to *Cyprinus carpio* carp feed can increase amylase 7.012 U/mg, protease 0.032 U/mg and carp growth performance 2.22% with the best dose ranging from 2% [26]. This is because turmeric contains curcumin which can increase the amount of feed consumed, so that the higher the feed consumed by the fish, the higher the amount of substrate for enzymes which has an impact on increasing the activity of these digestive enzymes. Increased activity of digestive enzymes will lead to high utilization of the feed consumed so that it affects the growth rate of these fish [33]. Growth in carp can also be affected by the feed given which functions for its survival and growth. The feed consumed by carp serves as a source of energy for the process of raising fish so that growth can occur in these fish [34].

The addition of turmeric extract to feed had a significant effect ( $P < 0.05$ ) on eel seeds (*Anguilla spp.*) with the best dose of 60 mL/kg for growth in body weight around 17.00 grams, growth in length around 27.33 cm, survival around 100%, EPP around 73.03, and the FCR is around 1.09 [35]. The survival of fish is one of the determining factors for the success of a culture. The survival value of eel seeds ranges from 100% including the value with the tolerance limit of fish for cultivation environmental conditions so that the survival value can reach the maximum limit. The survival rate in aquaculture activities is influenced by internal factors including body weight, sex, age, fish health, and external factors including temperature, oxygen content, pH, and metabolites ( $\text{CO}_2$  and  $\text{NH}_3$ ) [36].

**Tabel 3. Some research on the use of turmeric (*Curcuma domestica*) in fish feed**

No	Species of Fish	Form and Usage	Result	Reference
1	Snapper ( <i>Latescalcarifer</i> , Bloch)	Turmeric flour with levels 5, 10, 15, and 20 g/kg of feed.	Increasing absolute biomass growth (6.6 g), FCR (1.4), as well as 100% survival rate with the best level at 20 g / kg feed, water quality during the study was in optimal condition	[16]
2	Nilem Fish <i>Osteochilus</i> sp	Turmeric flour with dose levels of 0, 0.2, 0.4, and 0.6%/kg of feed.	Increase growth and accelerate the process of gonad development with the best dose ranging from 0.6% per kg of feed.	[9]
3	White Snapper ( <i>Latescalcarifer</i> )	Turmeric extract with dose levels of 0, 0.1, 1.15, and 0.2% / kg feed.	Increase the growth and feed efficiency with the best dose at a dose of 20 ml / kg.	[7]
4	Eel Seed ( <i>Anguilla spp.</i> )	Turmeric juice with dose levels of 0, 20, 40, and 60 ml/kg of feed.	Increases weight growth (17.00 ± 3.61 g), length growth (27.33 ± 8.74 cm), survival 100 ± 0.00 %, PER (73.03 ± 2.80 %), FCR (1.09 ± 0.36) with the best dose of 60 ml/kg feed.	[20]
5	Tilapia ( <i>Oreochromis niloticus</i> )	Turmeric extract with dose levels of 0, 5, and 10% / kg feed.	Increase tilapia growth with the best dose of 10% with weight gain ranging from 1 gram, and body length increases by about 0.5 cm.	[17]
6	Carp, <i>Cyprinus carpio</i> Linnaeus, 1758)	Turmeric flour with dose levels of 0, 1, 2, and 3%/kg of feed.	Increased amylase enzyme 7.012 U/mg, protease 0.032 U/mg and carp growth performance 2.22% with the best dose of tumeric flour at 2%/kg feed.	[18]
7	Pomfret( <i>Colossomamacropomum</i> )	Turmeric flour with dose levels of 0, 5, 10, 15, and 20 g/kg of feed.	Increase absolute weight (21.08 g), specific growth (7.12%) at the best dose 15 g/kg feed.	[19]
8	Patin Catfish( <i>Pangasiushypophthalmus</i> )	Turmeric juice with dose levels of 0, 0.5, 0.7, and 0.9 g/kg feed.	Increased weight (55.8 g), & absolute length (89.3 cm), daily growth rate (5.17%), 97% survival rate, and condition factor range 3.50. Feed efficiency is 86%, and FCR(1.16) with the best dose being in the dark 24-hour treatment with turmeric juice dose ranging from 0.7 g / kg feed.	[21]
9	Peres Fish ( <i>Osteochilluskappeni</i> )	Turmeric extract with dose of 1, 2, 4, and 6 ml/kg of feed.	Increase the growth of absolute weight of peres fish by 1,332 g with the best dose ranging from 2 ml / kg of feed.	[15]

FCR=Feed Conversion Ratio; PER =Protein Efficiency Ratio

The combination of Photoperiod and turmeric feed can affect the growth of body weight, body length, daily growth rate, survival rate. The best treatment was G24K0.7 with an average body weight of 55.8 grams, an average absolute length of 189.3 with a daily growth rate of 5.17% and survival rate of 97%, condition factor 3.50, feed efficiency in the photoperiod group with a value of 86%, the feed conversion value was 1.16 [37]. The feed conversion ratio can be involved when the feed conversion is getting smaller, it means that the amount of feed given is more effective for fish growth. Meanwhile, when the feed conversion value is greater, it can be interpreted that the amount of feed given is less effective for growth [28]. The growth of these fish is also affected because turmeric has an active compound in the form of curcumin which functions as an antioxidant so that it can increase the immunity of fish which can also affect the growth of these fish [37].

The addition of turmeric extract to the fish feed can affect the growth of the absolute weight of the fish by 1.332 grams with the best dose of around 2 ml/kg of feed. Growth in fish is also influenced by the availability of protein in feed, protein in feed is a source of energy and nutrients that are needed by fish to stimulate growth [38]. Growth in fish added with turmeric extract can also increase fish growth because it has a balance of protein components so that it can increase growth in these fish [26]. The addition of turmeric flour to pomfret feed can affect absolute growth of 21.08 grams and specific growth of 7.12% with the best dose of around 15 grams/kg of feed [39]. This is because turmeric contains curcumin which can influence the emergence of sufficient antibacterial inhibition, so that it can spur growth and increase feed efficiency by reducing disturbing microorganisms or increasing beneficial microbial populations in the digestive tract so that feed use efficiency will increase [25].

However, based on literature studies there are several studies that state that the addition of turmeric does not affect fish growth. Some of these studies state that the addition of turmeric has no real effect on the growth performance of baung fish (*Hemibargus nemurus*) [8]. This can be seen from the absolute length of good baung fish seeds ranging from 3.34-3.45 g, daily growth rates ranging from 2.88-2.93%, food conversion ratio ranging from 1.37-1.40, and survival rate of 100 % in each treatment. The effect was not significantly different from the addition of turmeric

extract to the baung fish because the number of treatment doses given to the baung fish had not been able to increase fish appetite, so the feed given to the baung fish was not optimally utilized [8]. This is very different from the addition of turmeric extract to barramundi, tilapia, eel fry, peres, catfish, goldfish, pomfret, and serukan fish which has a significant effect on growth.

#### 4. CONCLUSION

The use of turmeric (turmeric flour, turmeric extract, and turmeric juice) in fish feed can have a significant effect on growth, feed conversion ratio, feed utilization efficiency, gonad development, survival, and digestive enzymes. The use of turmeric in feed varies greatly, such as turmeric flour ranging from 1-20 g/kg feed, turmeric extract and turmeric juice ranging from 2-60 ml/kg feed. However, in some studies there are cases that the addition of turmeric does not have a real effect on fish growth performance. This is influenced by the lack of the right dose of turmeric addition to fish feed so that it does not get maximum results.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

1. Rusydi R, Hartami P, Khalil M. Nutritional Characteristics and Stability of Ampelous Combined Feed (Tofu Dregs and Pellets). *Journal of Acta Aquatica*. 2017;4(1):4-7.
2. Pradana WN, Mulyadi, Putra I. Giving herbal supplements to feed on the growth and survival of freshwater pomfret (*Colossoma macropomum*) with a Recirculation System. *Journal of Fisheries and Marine*. 2022;27(1):62-66.
3. Aisyah K, Haetami, Andriani Y, Mulyani Y. Application of Probiotic Bacteria to Fish Feed. *Road Journal*. 2022;10(1):1-7.
4. Bilyaro W. Article review: The effect of adding turmeric (*Curcuma domestica*) to Broiler Chicken Feed. *Animal Husbandry Journal*. 2021;05(01):44-48.
5. Nuningtyas YF. The effect of adding garlic powder (*Allium sativum*) as an Additive on the Appearance of Broiler Production. *Journal of Tropical Livestock*. 2014;15(1):21-30.
6. Bartono MD. Antibiotic use in animal feed and its impact on human health. *Journal OF Nurt*. 2000;13:279-299.

7. Nurdin P, Haroen U, Sumadja AW. The effect of using white ginger (*Curcuma zedoaria*) as a Natural Feed Additive in Rasum on Intestinal Length, Liver Weight and Pancreatic Weight of Broiler Chickens. Scientific Journal of Animal Sciences. 2022;25(2):148-160.
8. Sukendar W, Pratama C, Anggraini IS. Performance of baung fish (*Hemibagrus nemurus*) artificial feed with the addition of turmeric (*Curcuma longa* Linn). Aquamarine Journal. 2021;8(1):8-13.
9. Santika L, Diniarti N, Astriana HB. The effect of adding turmeric extract to artificial feed on the growth and efficiency of white snapper feed utilization (*Lates calcarifer*). Marine Journal. 2021;14(1):48-57.
10. Pujianti NA, Jaelani A, Widaningsih N. Psix ingredients of turmeric flour (*Curcuma domestica*) in rasum on protein digestibility and dry matter in broilers. Ziraa'ah Journal. 2013;36(1):49-59.
11. Ibrahim Y, Saputra F, Yusnita D, Karim A. Evaluation of growth and development of gonads of seruka fish *Osteochilus sp* fed with turmeric flour. Auaculture Journal. 2018;2(2):1-6.
12. Mainassy MC, Manalu A, Andriyanto O, Sudrajat A, Kapelle BI, Gunandi B. Curcumin analog supplementation may improve liver performance to support red tilapia reproduction (*Oreochromis niloticus*). Veterinary Journal. 2022;23(2): 217-227.
13. Malahayati N, Widowati WT, Febrianti A. Characteristics of curcumin extract from white turmeric (*Kefemferia ronduta* L.) and kunyit kuning (*Curcuma domestica* Val.). Agri Tech Journal. 2021;41(2):134-144.
14. Yuan C, Iskandar Y. Study of chemical content and activity turmeric plant pharmacology (*Curcuma longa* L.). Pharmacology Journal. 2018;16(2):547-555.
15. Maheshwari RK, Singh KA, Gaddipati J, Srimal CR. Multiole biological activities of curcumin: A short review. Journal Life Sciences. 2006;78(18):2081-2087.
16. Hapsah, Yahya H. Cultivation medicinal plants and spices. USU Press; 2011.
17. Nurhayati DR, Yusoff SF. Herbs and spices. Surabaya: Publisher Scopindo Media Pustaka; 2022.
18. Ranggayoni NP, Febri PS, Isma FM, Hasri I. The effect of the addition of turmeric extract (*Curcuma domestica*) to commercial feed on the growth and survival of nilem fish fry (*Osteochillus kappeni*). Scientific Journal of Auatic Studies Program. 2021;3(2):75-81.
19. Oghenejobo M, Opajobi AO, Bethel UO. Antibacterial Evaluation, Phytochemical Screening and Ascorbic Acid Assay of Turmeric (*Curcuma longa*). Journal MOJ Bioequiv Availab. 2017;4(2):232-239.
20. Fagnon MS, Thorin C, Calvez S. Meta-analysis of dietary supplementation effect of turmeric and curcumin on growth performance in fish. Reviews in Aquaculture; 2020. DOI:10.1111/raq.12433
21. Kusniantoro D, Purwaningrum Y. Utilization of secondary metabolite content in turmeric plants in supporting increased community income. Journal of Cultivation. 2018;17(1):554-549.
22. Prasetyo Y, Suyatmi, Hanim D. The effect of giving yellow turmeric extract (*Curcuma longa*) in Preventing the Hepar of Alcohol-Induced Mice. Journal of Biopharmaceuticals. 2012;10(1):28-33.
23. Efendi AD, Kusranti ON, Andaka A. Addition of turmeric extract (*Curcuma domestica* Val) to body weight increase and frrd consumption male layers. Aves Journal. 2017;11(1):14-20.
24. Giofana F, Putra MA. Characteristics of Turmeric (*Curcuma domestica* Val) Essential Oil and Antibacterial Activity Test Against Acne-causing Bacteria (*Propionibacterium acnes*). Journal of Indonesia Natural Research Pharmaceutical. 2019;4(2):76-84.
25. Prihandini A, Umami M. Effects of turmeric extract addition (*Curcuma domestica* Val.) on feed against tilapia growth (*Oreochromis niloticus*). Scientific Journal of Basic Science and the Enviroment. 2022;22(1):37-43.
26. Umi Karmila SK. *Curcuma domestica* turmeric extract as *Aeromonas hydrophila* antibacterial on *Pangasius* sp. Unsyiah Maritime and Fisheries Student Scientific Journal. 2017; 2(1):150-157.
27. Widhyari SD, Wientarsih I. Addition of turmeric and zinc oxide in improving the ability of broiler chickens in eliminating the challenges of escherichia coli infection. Veterinary Journal. 2014;15(3): 337-344.
28. Fahrurrozi A, Linayati L. The effect of adding turmeric flour (*Curcuma longa* Linn.) on the growth and feed conversion ratio of white snapper (*Lates calcarifer*,

- Bloch). Tropical Aquaculture Science Journal. 2022;6(2):266-272.
29. Karimah U, Samidjan I, Pinandoyo. Growth and survival performance of gift tilapia (*Oreochromis niloticus*) given different amounts of feed. Journal of Aquaculture Management and Technology. 2018;7(1):128-135.
  30. Zulkhasyni, Andriyeni, Utami R. The effect of different pellet feed doses on the growth of red tilapia (*Oreochromis sp.*). Journal of Agroqua. 2017;15(2):35-42.
  31. Hidayat D, Sasanti DA, Yulisman. Survival, growth and feed efficiency of snakehead fish (*Channa striata*) fed golden snail flour (*Pomacea sp.*). Journal of Indonesian Swamp Aquaculture. 2013;1(2):162-172.
  32. Siegers WH, Prayitno Y, Sari A. The effect of water quality on the growth of tilapia nirwana (*Oreochromis sp.*) in brackish ponds. The Journal of Fisheries Development. 2019;3(2):95-104.
  33. Putri IW, Setiawati M, Jusadi D. Digestive enzymes and goldfish growth performance (*Cyprinus carpio* Linnaeus, 1758) yang given Feed with the Addition of Turmeric Flour *Curcuma longa* Linn. Journal of Indonesian Ichthyology. 2016;17(1):11-20.
  34. Utomo NB, Kumalasari F, Mokoginta I. Effect of different feeding methods on feed conversion and growth of goldfish (*Cyprinus carpio*) in Floating Net Cage Jatiluhur Reservoir. Journal of Indonesian Aquaculture. 2005;4(1):63-67.
  35. Nurizki M, Nainggolan A, Rahmatia F. The effectiveness of turmeric juice (*Curcuma domestica*) in feed on the growth performance and survival of eel seeds (*Anguilla spp.*). Scientific Journal Satya Minabahari. 2022;08(01):22-35.
  36. Azhari A, Muchlisin ZA, Dewiyanti I. The effect of stocking density on the survival and growth of seruka fish seeds (*Osteochilus vittaus*). Marine and Fisheries Student Scientific Journal. 2017;2(1):12-19.
  37. magwa rj, windarti smr. the effect of photoperiod manipulation and turmeric-enriched feed on the growth of patin fish (*Pangasius hypophthalmus*). Roada Journal. 2020;8(2):104-106.
  38. Anggraeni NM, Abdulgani N. Effect of natural feeding and artificial feeding on the growth of betutu fish (*Oxyeleotris marmorata*) at the laboratory scale. Pomits Journal of Science and Arts. 2013;2(1):198-200.
  39. Mose et al. The effectiveness of turmeric flour in feed on the growth performance of pomfret (*Colossoma macopomum*). Tindalung Scientific Journal. 2019;5(1): 7-13.

© 2023 Haetami et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:  
<https://www.sdiarticle5.com/review-history/103483>