BIO Web of Conferences **136**, 01010 (2024) https://doi.org/10.1051/bioconf/202413601010
ISFM XIII 2024

Enhancement of growth and survival rates in asian redtail catfish (*Hemibagrus nemurus* CV) larvae with probiotic soaking technique

Sukendi Sukendi[1]*, *Ridwan* Manda Putra[2], *Efriyeldi*[3], *Delvira* Andriani[1], and *Triani* Cahya Fitri Sabilah[1]

[1]Department of Aquaculture, Faculty of Fisheries and Marine, Riau University, 28293, Pekanbaru, Indonesia
[2]Department of Aquatic Resources Management, Faculty of Fisheries and Marine, Riau University, 28293, Pekanbaru, Indonesia
[3]Department of Marine Science, Faculty of Fisheries and Marine, Riau University, 28293, Pekanbaru, Indonesia

Abstract. One of the freshwater fish commodity has a high economic value is Asian redtail catfish. However, the Asian redtail catfish growth relatively slow between larvae stage until fry stage. The solutions for this problem is giving probiotics that can be increase the growth of fish larvae. The aimed to analyse the effect of immersion on Asian redtail catfish larvae in probiotics to improve growth and survival rate. This study was conducted between May until July 2024 at the Laboratory of Fish Hatchery and Breeding, Faculty of Fisheries and Marine, Riau University. This study used a completely randomized design with immersion treatment using the probiotics trademark raja siam at different dose, namely 0 ml/L, 1.5 ml/L , 2.0 ml/L, and 2.5 ml/L. Based the results of study shown that the best dose of immersion on Asian redtail catfish larvae using probiotics was in 2.5 ml/L, the absolute weight growth at 9.7818 g, absolute length growth at 9.03 cm, specific growth rate at 11.91%/day, cannibalism type A, B were 2.00%, 0.00%, cannibalism index 2.00%, normal mortality 5.33% and survival rate 92.67%.

1 Introduction

One of the important cost fish in Riau province especially in Kampar Riau river freshwater commodities fish is Asian redtail catfish [1]. The Asian redtail catfish cultivation business has grown rapidly in fish farming activities, the public demand for catfish has increased because it has a savory and delicious taste, high protein content, and lower fat content than other types of freshwater fish [2]. One of the factors that determines a success of fish cultivation is quality and quantity of the availability seeds. However, the provision of seeds for these cultivation activities remains an ongoing challenge.

This is attributed to the relatively slow growth of Asian redtail catfish larvae to fry, low survival, cannibalism, and poor water quality during the larval stage [3]. The larval stage is

* Corresponding author: sukendi@lecturer.unri.ac.id

a complicated phase in maintenance because the organs of the body have not yet fully developed to digest the food provided, resulting in insufficient nutrient absorption to support the survival and immunity of the larvae [4]. Therefore, one of the efforts that can support the quality and quantity of larvae can be done by soaking substances to increased the growth and survival larvae.

Substance that contains microorganisms that are good for the body's health is probiotics. Probiotics have benefits in regulating microbial balance in the intestine, inhibiting the growth of pathogenic microorganisms, and increasing digestive efficiency by releasing digestive enzymes [5]. Bacterial activity in the digestive system can change rapidly when microbes are added through feed or water. The addition of probiotics is beneficial in regulating the microbial environment in the fish gut, inhibiting instestinal pathogenic microorganism and improving the process of food digestion with releasing enzymes such as protease and amylase [4]. Probiotics that can be used are probiotics that contain microorganisms and good bacteria that can improve the growth of fish larvae. Bacteria that have a good role for aquatic animals including bacteria in the genus *Bifidobacteri, Pseudomonas, Bacillus*, *Lactobacillus*, and *Micrococcus* has been proven to be a beneficial bacteria in addition to preventing disease and providing vitamins for fish to be healthier [6], as well as *Bacillus subtilis*, *Pseudomonas putida* and *Bacillus licheniformis* can increase fish growth [7].

One of the probiotics that can be used in aquaculture is a probiotic with the trademark Raja Siam which contains *Lactobacillus* sp. bacteria and pro-amino supplements, anti-oxidants, multivitamins and minerals. Probiotic bacteria will decompose useless and toxic organic materials and reduce total ammonia levels in the water. In addition, probiotics given to the maintenance media are able to convert the remaining feed or feces through the biodegradation process so as to produce natural food that participates in increasing the growth of fish larvae [8]. Probiotics are used to increase aquaculture production, and can also increase profits because they increase growth and resistance to disease [9].

The soaking of larvae in probiotics is a method employed to accelerate the growth of Asian redtail catfish larvae, given that their growth towards seeds is relatively slower. The results of a study conducted by [10] on the growth of Asian redtail catfish larvae showed a weight growth of 1.3151 g, a length growth of 4.74 cm, and a survival rate of 71.97%. Another study conducted by [11] showed a weight growth in Asian redtail catfish larvae of 1.2561 g, a length growth of 5.54 cm, and a survival rate of 83.52%.

The results of several studies show that the addition of probiotics at dose was 1.5 ml/L in the media for raising catfish seeds (*Pangasius hypophthalmus*) have a good affect on the growth and survival of catfish seeds reared at aquariums [12]. Research [4] showed that larval immersion in Raja Siam probiotic solution had a good effect on survival rate, weight growth, length growth of *Kryptopterus lais* fish larvae in the maintenance media. Because of that, this study aimed to determine the effect immersion on Asian redtail catfish larvae using probiotics to improve growth and survival rate, so that it will be able to increase seed production in hatcheries through artificial spawning.

2 Metode research

This research was conducted between May to July 2024 at Laboratory of Fish Hatchery and Breeding, Faculty of Fisheries and Marine, University of Riau. This study used a complete randomized design with 4 level treatment and 3 replications. The dose used in this study based on the research by [12] the best dose to increase the growth of catfish seed using probiotic was 1.5 ml/L. The duration of immersion of the test larvae in the Raja siam probiotics solution used is based on research [4] which is for 10 minutes for each immersion. The treatment in this research is :

P0 : control treatment
P1 : immersion with a dose of 1.5 ml/L
P2 : immersion with a dose of 2.0 ml/L
P3 : immersion with a dose of 2.5 ml/L

The probiotics used were those produced by the Raja Siam brand. Before use, the bacteria in the probiotic solution were activated by adding sweetened condensed water in a ratio of 1:1:50 where 1 ml of Raja Siam probiotic, 1 ml of sweetened condensed water and 50 ml of water. All these ingredients are put into a measuring cup, then put into a glass bottle and stirred until homogeneous and let stand for 30 minutes [13]. Next, the probiotic solution was put into an immersion container containing 1 liter of water using a syringe based on the dose of treatment, the duration of immersion of the test fish larvae in the probiotic solution was 10 minutes [4]. Larval immersion treatment in probiotic solution was carried out in the morning at 08.00 WIB, with a range of immersion every 10 days for 60 days of rearing. During immersion, the immersion medium was aerated to ensure that the fish larvae did not lack oxygen. After soaking the fish larvae were stocked on the rearing media. The treatment parametes measured is:

1. Absolute weight growth: Wm = Wt - Wo
2. Absolute length growth: Lm = Lt - Lo
3. Specific growth rate: LPS = (LnWt-Ln Wo)/t x 100%
4. Cannibalism index, according to the [14] cannibalism index determined by the type of cannibalism, there are 2 types of cannibalism. Type A cannibalism is a cannibalistic death incident with the loss of body parts due to predation and type B is the incidence of difference in fish loss at the end of the study. To determine the cannibalism index (Type A, Type B, and normal dead) using the formula : Cannibalism Index = (Number of Dead Fish)/(Initial Number of Fish) x 100%
5. Survival: SR = Nt/No x 100%

The data obtained was tabulated using Microsoft excel and analysed using SPSS IBM software version 22 with ANOVA statical analysis at confidence level of 95% and Student Newman-Keuls test.

3 Results and Discussion

3.1 Absolute Weight Growth

The average growth weight of Asian redtail catfish larvae in Figure 1.

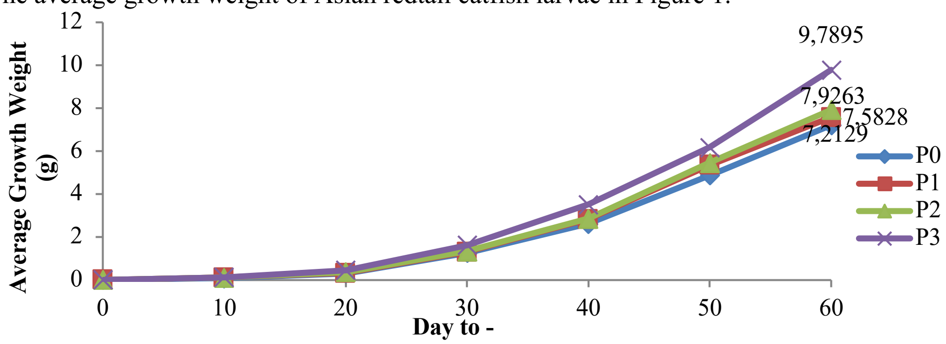

Fig. 1. Average Growth Weight Chart of Asian Redtail Catfish Fish Larvae

Figure 1. shown that the larval weight growth from day 0 to day 20 of rearing in each treatment given is relatively same. Furthermore, between day 30 to day 60 of maintenance, the average weight growth larvae significant increased. This is because the larvae feed consumed can already be used for growth. Histogram of absolute weight growth the Asian redtail catfish larval in Figure 2.

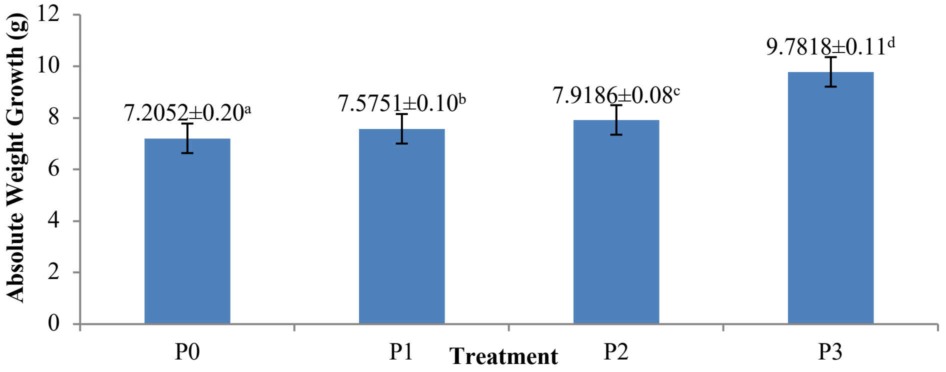

Fig. 2. Histogram of Weight Growth of Asian Redtail Catfish Fish Larvae

Based on Figure 2. it shows the highest value in P3 was 9.7818 g, P2 was 7.9186 g, P1 was 7.5751 g and P0 was 7.2052 g. This shows that the provision of probiotics through fish larva immersion is better than without immersion. This shows that the provision of probiotics through immersion of fish larvae is better than without immersion. The high larval growth weight in P3 treatment is thought to be due to the number of bacteria induced into the digestive tract of larvae during the soaking process, which helps balance the microbes in the fish's digestive tract. Probiotics are live microorganisms beneficial to living organisms, the microorganisms in probiotics aid the process of digesting food in fish so that the feed can be more effectively digested and absorbed, thus enchancing fish immunity against disease [15]. The bacteria in probiotics can stimulate enzyme producing enzymes in the digestive tract.

The basic principle of probiotics is the utilization of the ability of microorganisms to break down or decompose the chains of carbohydrates, proteins and fats that make up the feed given. This ability is obtained due to the presence of special enzymes owned by microbes to break these bonds, these enzymes are usually not owned by fish, even if there is a limited quantity and quality [16]. Probiotics as a live microbial enhancer that has a beneficial effect on the microbial community of its environment [17]. Presumably due to the influence of probiotics, protease activity works greater so that the absorption of amino acids in the intestines of fish is more optimal so that the weight is higher than the treatment without probiotics (control)

According to [18], the process of osmoregulation allows probiotics to enter the digestive tract. Probiotics enter through the gills and then enter the body (liver, kidneys, and digestive tract) through the blood vessels. The dose of probiotics given is in line with the amount of bacteria that enter the fish's digestive tract and live in it during immersion. In the digestive tract, these bacteria secrete digestive enzymes such as amylase, lipase and protease. The amount of these enzymes increases with the dose of probiotics administered, which in turn results in an increase in the amount of food digested [19].

In addition, the *Tubifex* sp. feed given during the study has many enzymes can stimulate the digestive enzymes and made the larval growth can be better [20]. The of Asian redtail catfish weight growth reared without probiotics during 42 days adlibitum reached 1.32 g [21]. As well as research conducted by [4] on the difference in the time span of immersion in probiotic solutin the highest weight growth of *Kryptopterus lais* fish larvae was 0.60g.

The analysis of variance test shown that a significant effect on the absolute weight growth of Asian redtail catfish. The Student-Newman-Keuls test shown that all treatments had a significantly different effect ($P<0.05$).

3.2 Absolute Length Growth

The average length growth of larval asian redtail catfish in Figure 3.

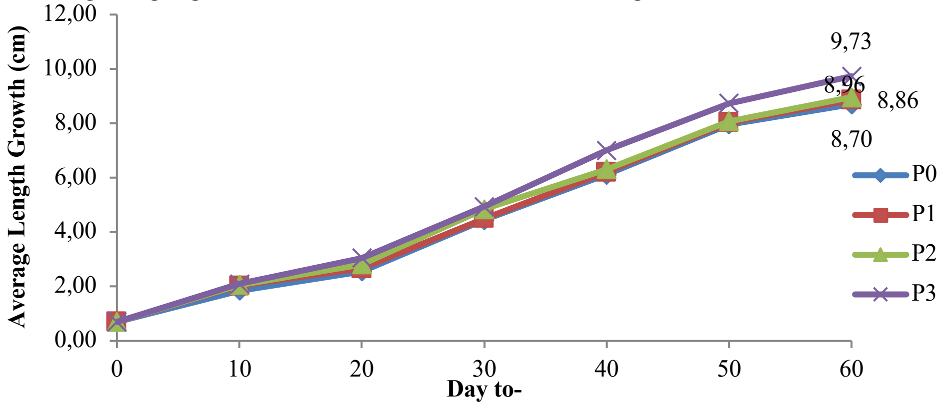

Fig. 3. Average Length Growth Chart of Asian Redtail Catfish Fish Larvae

Figure 3 shown that the growth of larval length from day 0 to day 20 of rearing is relatively the same and between day 30 to day 60 the weight growth of the larvae increased. Histogram of absolute length growth of larvae in Figure 4.

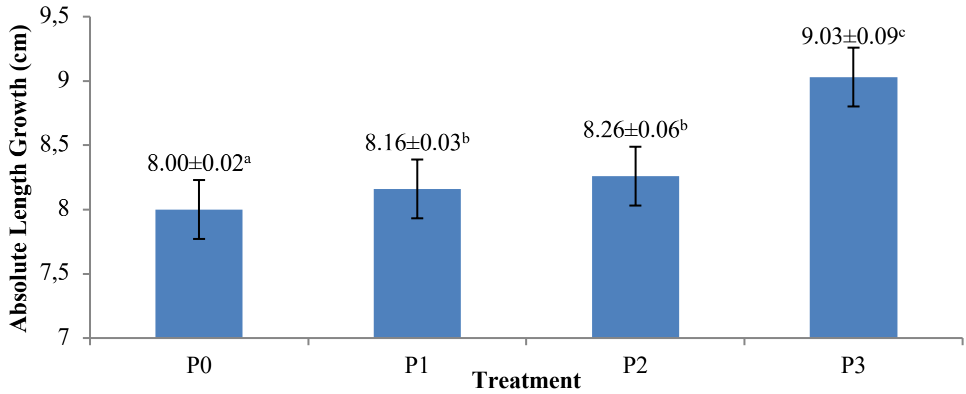

Fig. 4. Histogram of Absolute Length Growth of Asian Redtail Catfish Fish

Figure 4. shows that the largest absolute length growth values in treatments were observed in P3 at 9.03 cm, P2 at 8.26 cm, P1 at 8.16 cm and P0 at 8.00 cm. This is due to the presence of bacteria contained in probiotics can make fish utilize the feed given optimally, so as to increase the length growth of larval asian redtail catfish. Probiotics given through immersion in fish can help break down water and induce bacteria contained in the digestive tract so as to increase digestibility in fish. The bacteria contained in this probiotic are *Lactobacillus*, which according to [22, 23] states that *Lactobacillus* contains extracellular enzymes that help digestion and improve water quality by decomposing and

breaking down organic matter in water. In addition, *Lactobacillus* bacteria function to increase fish digestibility of feed so that it can spur fish growth [24].

In addition, according to [25] that nutritional factors influenced the growth of fish larvae. [26] also provides a statement that the increase in fish length will go hand in hand with the increase in weight. If the feed given to the fish can be utilized perfectly, there will be an increase in the length of the fish.

The analysis of variance test shown that a significant effect on the absolute length growth of Asian redtail catfish. The Student-Newman-Keuls test showed that P0 and P3 were significantly different with P1 and P2 ($P<0.05$), while P1 was not significantly different with P2 ($P>0.05$).

3.3 Spesific Growth Rate

The specific growth rate of asian redtail catfish larvae in Figure 5.

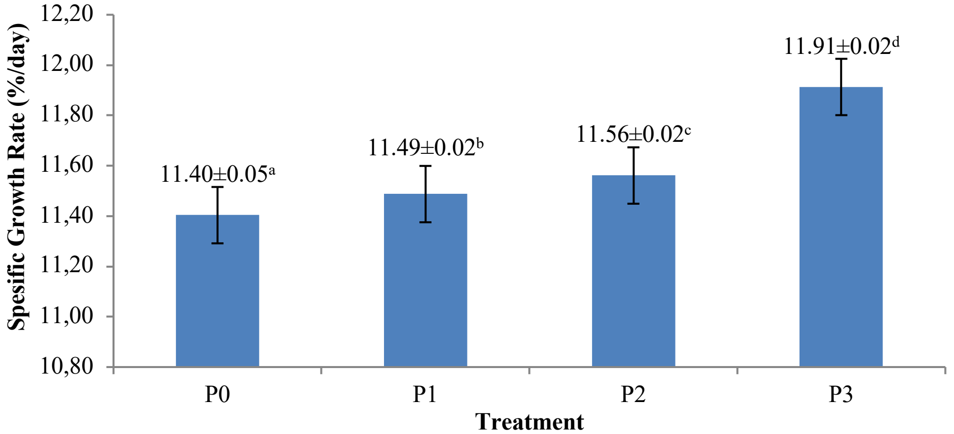

Fig. 5. Histogram of Specific Growth Rate of Asian Redtail Catfish Fish Larvae

Figure 5. shown that the highest specific growth rate values by treatment were observed in P3 at 11.91% / day, P2 at 11.56% / day, P1 at 11.49% / day and P0 at 11.40% / day. Probiotics entering the fish's digestive tract enhance digestion and improve feed digestibility. As feed digestibility improve, the body absorbs nutrients from the feed more effeiciently, leading to increased protein retention [27]. Probiotics also produce beneficial substances that support fish immunity, growth performance, and feed conversion efficiency. Probiotics are characterized by their ability to produce extracellular enzymes such as lipase, chitinase, amylase, cellulase, phytase, and protease. Fish produce several endogenous enzymes, but the amount and activity are insufficient to process all digested food. Thus, both probiotics and enzymes secreted by gut endosymbionts play essential roles fish nutrition and digestion [28].

According to [29] factor biotic likes age, the ability of fish food need, and abiotic likes food availability, quality of fish media can be influenced the growth. In addition, according to [30] explained that the growth rate and specific growth rate are closely related to body weight gain derived from feed consumption.

The analysis of variance test shown that a significant effect on the specific growth rate of Asian redtail catfish larvae, The Student-Newman-Keuls test shown that all treatments had an effect significantly different ($P<0.05$).

3.4 Cannibalism Level

The level of cannibalism of asian redtail catfish larvae in Table 1.

Table 1. Cannibalism Level of Asian Redtail Catfish Fish Larvae

Treatment	Cannibalism Type A	Cannibalism Type B	Canibalism Index	Normal Mortality
P0	8.00±2.00^{c}	4.00±2.00^{b}	12.00±4.00^{b}	20.00±2.00^{d}
P1	5.33±1.15^{b}	2.67±1.15^{ab}	7.33±2.31^{a}	14.00±2.00^{c}
P2	3.33±1.15^{ab}	1.33±1.15^{ab}	4.67±1.15^{a}	8.67±1.15^{b}
P3	2.00±0.00^{a}	0.00±0.00^{a}	2.00±0.00^{a}	5.33±1.15^{a}

Based on Table 1 shown that cannibalism type A Asian redtail catfish larvae the smallest treatment was 2.00% (P3), 3.33% (P2), 5.33% (P1), 8.00% (P0). Type B cannibalism of asian redtail catfish larvae the smallest treatment was 0.00% (P3), 1.33% (P2), 2.67% (P1), 4.00% (P0). The cannibalism index of the larvae was 2.00% (P3), 4.67% (P2), 7.33% (P1), 12.00% (P0). Normal mortality of larvae was 5.33% (P3), 8.67% (P2), 14.00% (P1), 20.00% (P0). The analysis of variance test shown that the significant effect on cannibalism type A, B, cannibalism index and normal mortality.

Cannibalism is defined as predation among individuals within population, where one individual consumes part or all of another's body. According to [14] the cannibalism index is based on cannibalism tuype, where there are 2 types of cannibalism, namely type A cannibalism is the incidence of cannibal death with loss of body parts due to predation and type B, death without leaving a body. Nutrients absorption was optimized in P3, reducing cannibalism and increasing larval survival. Probiotics enhance digestion by improving nutrients absorption and boosting the fish's metabolic rate. Enzyme activity in the larval digestive tract accelerates food breakdown, resulting in greater protein deposits useful for growth and reducing cannibalism. Mortality can also result from prolonged starvation due to insufficient energy derived from feed, which lack adequate nutrient content for growth and mobility [31].

3.5 Survival Rate

The survival of larval asian redtail catfish in Figure 6.

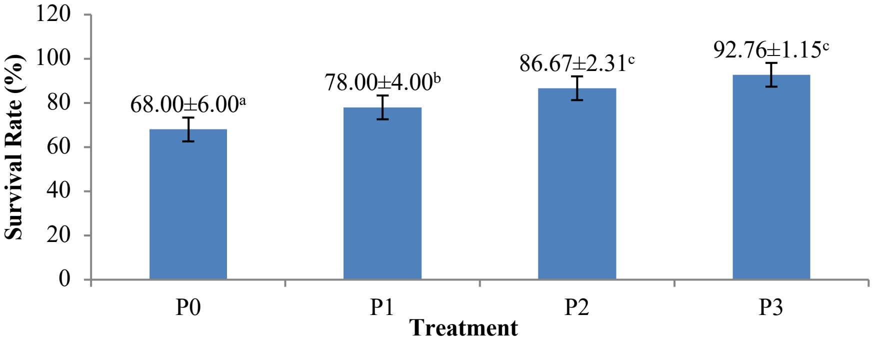

Fig 6. Histogram of larval survival of asian redtail catfish.

Figure 6 shown that the highest survival rate values was treatment P3 at 92.76%, P2 at 86.67%, P1 at 78.00% and P0 at 68.00%. The high survival rate of Asian redtail catfish larvae immersed in probiotic solution is likely due to probiotics entering the fish's body, aiding in the digestive process of provided feed and inhibiting pathogenic microbes. In addition to impacting the cultivation environment, probiotics assist with digestion and nutrient absorption, inhibit pathogenic microbes in the digestive system, increasing feed digestibility and increasing appetite, thereby influencing the metabolic process to increase in the body [32]. Factors biotic likes density, competitors, age and the ability of organisms with the environment and factors abiotic likes pH, temperature, dissoloved oxygen, and ammonia influenced the survival rate [33].

The Analysis of Variance test shown that a significant effect ($P<0.05$) on survival rate. The Student-Newman-Keuls test shown that P0 and P1 were significantly different with P2 and P3 ($P<0.05$), while, P2 was not significantly different with P3 ($P>0.05$).

4 Conclusion

Immersion larvae asian redtail catfish in probiotics with Raja Siam trademark is able to increase growth and survival, and reduce the level of cannibalism. From the study, the best dose in P3 (2.5 ml/L) with absolute weight growth of 9.7818 g, absolute length growth of 9.03 cm, spesific growth rate of 11.91% / day, cannibalism types A and B 2.00% and 0.00%, cannibalism index 2.00%, normal mortality of 5.33% and survival rate is 92.67%.

Acknowledgments. Thanks to the Institute for Research and Community Service (LPPM) and Riau University for providing funding assistance in research activities through the Riau University professor research scheme until the completion of the activity.

References

1. Sukendi, Getting to know several types of economically important fish from the Kampar River Waters, Riau, (UR Press, 2014)
2. O.W. Gultom, S. Lestari, R. Nopianti, Proximate analysis, water soluble protein, and salt soluble protein in some freshwater fish species of South Sumatra. J. FishtecH. **4**, 120 (2015). https://doi.org/10.36706/fishtech.v4i2.3506
3. L. Andriani, Nuraini, Sukendi, Effect of substitusion of *Tubifex* sp. with artificial feed on growth, survival rate and feed eficiency of *Hemibagrus nemurus* fingerling with resirculation system. Jom FPK UNRI. **8**, 1 (2021). https://jom.unri.ac.id/index.php/JOMFAPERIKA/article/view/30348
4. H. Efendi, Agusnimar, E. Warman, Effect of interval time of submersion of larvae in probiotic's solution on survival and growth of *Kryptopterus lais*. J. Agricultural Dynamics. **32**, 143 (2016). https://journal.uir.ac.id/index.php/dinamikapertanian/article/view/583
5. H. Ahmadi, Iskandar, N. Kurniawati, Addition of probiotic in commercial feed to growth of sangkuriang catfish (*Clarias gariepinus*) on nursery II. J. Fisheries and Marine Affairs **2**, 99 (2021). https://jurnal.unpad.ac.id/jpk/article/view/2550/2308
6. A.Z. Sidiq, I. Kurniawan, A.M. Firdaus, Feasibility analysis of probiotic product business from market and marketing, technical, and financial aspects. Cipasung Techno Pesantren Journal **17**, 12 (2023). https://journal.sttcipasung.ac.id/index.php/CTP/article/view/25
7. Suminto, T. Susilowat, I, Sarjito, D. Chilmawati, Pemanfaatan limbah produk pertanian dalam pakan buatan yang berprobiotik terhadap efisiensi pakan, pertumbuhan, dan kelulushidupan lele dumbo (*Clarias gariepinus*). PENA Aquatics Journa.l **18**, 1 (2019). http://dx.doi.org/10.31941/penaakuatika.v18i1.733

8. G. Beauty, Y. Ayi, G. Roffi, Effect of doses of probiotic microorganism in the media and density on survival and growth rates of goldfish (*Carrasius auratus*). J. Fisheries and Marine. **3**, 1 (2012). https://jurnal.unpad.ac.id/jpk/article/view/1385
9. A.S. Abadi, A.M. Hariati, A. Yuniarti, The addition of indigenous probiotic *Bacillus* sp. (NL004) enriched in tofu liquid waste (TLW) on specific growth rate of nile (*Oreochromis niloticus*). J. Aquaculture Media. **18**, 15 (2023). http://dx.doi.org/10.15578/ma.18.1.2023.15-20
10. Sukendi, Thamrin, R.M. Putra, Nuraini, D. Andriani, The use of pineapple extract to remove egg adhesiveness in the production of asian redtail catfish fry *(Hemibagrus nemurus* CV*)*, in IOP Conference Series: Earth and Environmental Science. **1118** (2022). https://doi.org/10.1088/1755-1315/1118/1/012021
11. Sukendi, Thamrin, R.M. Putra, D. Andriani, A.R. Safitri, The use of different natural plant extract to remove egg adhesiveness in the procution of asian redtail catfish fry *(Hemibagrus nemurus* CV*)*, in Bio Web of Conferences. **74** (2023). https://doi.org/10.1051/bioconf/20237401004
12. K. Khotimah, E.D. Harmila, R. Sari, Provision of probiotics in the rearing medium of catfish fry (*Pangasius hypophthalmus*) in aquarium. Indonesian Swamp Aquaculture Journal. **4**, 152 (2016). https://doi.org/10.36706/jari.v4i2.4432
13. L. Zayanti, The effect of probiotic administration with different doses on the growth and survival of peres fish larvae (University of Riau, 2020). Unpublished.
14. B. Heltonika, M.Z. Jr, Widanarni, M.A. Suprayudi, W. Manalu, Y. Hadiroseyani, Green catfish *(Hemibargus nemurus) seeds cannibali at different stocking densities*, in IOP Conference Series: Earth and Environmental Science. **695** (2021). https://doi.org/10.1088/1755-1315/695/1/012028
15. Y. Narayana, Hasniar. The influence of probiotic use with the difference dosages in the diet to nile tilapia (*Orechromis niloticus*) culture in cement pond. Agrokompleks. **19**, 1 (2019). https://doi.org/10.51978/japp.v19i2.136
16. D.P. Oktaviani, S. Fadlilah, U.J. Muwakhidah, E. Damaiyanti, Fatimatuzzahroh, S.N. Agustin, Evaluation of the addition of probiotic lactic acid bacteria to feed on the growth of carp (*Osphronemus gouramy*). Manfish Journal. **2**, 44 (2021). https://doi.org/10.31573/manfish.v2i01.331
17. L. Verschere, G. Rumbaut, P. Sorgeloos, W. Verstraete, Probiotic bacteria as biological control agents in aquaculture. Microbiology and Molecular Biology Review. **64**, 655 (2000). https://doi.org/10.1128/mmbr.64.4.655-671.2000
18. H. Hanifa, N. Aryani, Sukendi, The effect thyroxine hormone with different doses and age of larvae on growth and survival rate of snakehead (*Channa striata*) larvae. Jurnal Kelautan dan Perikanan Indonesia. **2,** 151 (2022). https://doi.org/10.24815/jkpi.v2i3.28244
19. B.W. Kesuma, B. Budiyanto, B. Brata, Efektifitas pemberian probiotik dalam pakan terhadap kualitas air dan laju pertumbuhan pada pemeliharaan lele sangkuriang (*Clarias Gariepinus*) sistem terpal. Naturalis: J. Natural Resources and Environmental Management Research. **8**, 21 (2019). https://doi.org/10.31186/naturalis.8.2.9206
20. O.E.S. Prasetya, F.S. Muarif, Mumpuni, The feed effect of bloodworm (*Tubifex* sp.) and *Daphnia* sp. on growth and survival rate of sangkuriang catfish (*Clarias gariepinus*) larvae. Mina Sains Journal. **6**, 8 (2020). https://doi.org/10.30997/jms.v6i1.2732
21. Sukendi, Thamrin, R.M. Putra, Nuraini, Khofifah, The use of jamaican cherry leaves solution to remove eggs adhesiveness in the production of asian redtail catfish fry (*Hemibagrus nemurus* Valencinnes, 1840). AACL Bioflux. **16**, 2197 (2023). http://www.bioflux.com.ro/docs/2023.2197-2206.pdf

22. D. Ernawati, Prayogo, B.S. Rahardja, Effect of heterotrophic bacteria on water quality in dumbo catfish (*Clarias* sp.) cultivation without water change. Journal of Aquaculture and Fish Health. **5**, 1 (2016). https://doi.org/10.20473/jafh.v5i1.11314
23. M.A. Kusuma, U.M. Tang. Mulyadi, The effect of addition of probiotics with different dosage in maintenance media on the growth of striped catfish (*Pangasionodon hypophthalmus*) with aquaponic recirculation system. J. Aquatic Science. **9**, 222 (2021). http://dx.doi.org/10.31258/jipas.9.3.p.222-229
24. P. Noviana, Subandiyono, Pinandoyo, The effect of probiotics in practical diets on the diet consumption and growth rate of tilapia (*Oreochromis niloticus*) juvenile. Journal of Aquaculture Management and Technology. **3**, 183 (2014). https://ejournal3.undip.ac.id/index.php/jamt/article/view/7332
25. A. Mullah, N. Diniarti, B.H. Astriana, Pengaruh penambahan cacing sutra (tubifex) sebagai kombinasi pakan buatan terhadap efisiensi pemanfaatan pakan dan pertumbuhan larva ikan lele sangkuriang (*Clarias gariepinus*). Fisheries Journal **9**, 160 (2019). https://doi.org/10.29303/jp.v9i2.163
26. A. Nazar, F.M.A. Jabbar, H. Melati, The effect of the time span of increasing salinity on survival and growth of baung fish larvae (*H. nemurus*). J. Agricultural Dynamics. **35**, 179 (2019). https://doi.org/10.25299/dp.2019.vol35(3).7707
27. R. Ezraneti, E. Erlangga, E. Marzuki, Probiotics fortification in feed to increase the growth of gourami (*Osphronemus goramy*). Acta Aquatica. **5**, 64 (2018). https://doi.org/10.29103/aa.v5i2.812
28. R. Simon, F. Docando, N.N. Ortiz, C. Tafalla, P.D. Rosales, Mechanisms used by probiotics to confer pathogen resistance to teleost fish. Front. Immunol. **12** (2021). https://doi.org/10.3389/fimmu.2021.653025
29. Y.I. Siregar, Adelina, Pengaruh vitamin C terhadap peningkatan hemoglobin (hb) darah dan kelulushidupan benih ikan kerapu bebek (*Cromileptes altivelis*). Natur Indonesia Journal. **12**, 75 (2012). http://dx.doi.org/10.31258/jnat.12.1.75-81
30. Saruni, N.D. Sulystyaningsih, Hamid, L.G. Sumahiradewi, A. Furkan, I. Soraya, The effect of different doses of trucah fish on the growth of banggai cardinal fish (*Pterapogon kauderni*). Jurnal Agroqua. **22**, 140 (2024). https://doi.org/10.32663/ja.v22i1.4399
31. M. Sobirin, Rusliadi, N.A. Pamukas, Growth and survival rate of fish (*Channa striata*) Fed *Tubifex* spwith different amounts. Jom FPK UNRI. **5**, 1 (2017). https://jom.unri.ac.id/index.php/JOMFAPERIKA/article/view/17622/17022
32. J. Setiaji, J. Hardianto, Rosyadi, Effect of probiotics addition on artificial feed for *Mystus nemurus* growth. Jurnal Dinamika Pertanian. **29**, 307 (2014). https://journal.uir.ac.id/index.php/dinamikapertanian/article/view/839
33. N.M. Susanti, Sukendi, Syafriadiman, The effectiveness of thyroxine hormone (T4) on the growth of pawas fish (*Osteochillus hasselti* CV). J. Fisheries and Marine Sciences. **21**, 26 (2017). http://dx.doi.org/10.31258/jpk.21.2.26-31