

The effect of bay leaf (*Syzygium polyanthum*) enrichment in artificial feed on growth and profitability of barramundi (*Lates calcarifer*) cultivation

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Abstract. Barramundi (*Lates calcarifer*) is one of the leading aquaculture commodities in Indonesia. Artificial feed enrichment with nutraceutical ingredients can enhance fish immunity and growth. This research used bay leaf (*Syzygium polyanthum*) liquid to enrich the artificial feed for barramundi culture. The effect of the enrichment on the growth performance (specific growth rate - SGR, and weight gain rate - WGR), survival rate (SR), feed conversion ratio (FCR), and economic returns (benefit cost ratio - BCR) of barramundi were then examined. The experiment was conducted for 53 days using fingerlings with an initial average weight of 11.10 ± 0.28 g per fish, reared in 0.5 m^3 tanks stocked with 34 fish per tank. Commercial pellets were enriched with bay leaf liquid in three different dosages: 1% (treatment A), 2% (treatment B), and 3% (treatment C). Fish were fed at 4% of biomass per day. This research found that the WGR ranged from 72.64 to 73.98%, SGR ranged from 2.50 to 2.60% day^{-1} , SR ranged from 94 to 100%, FCR ranged from 1.34 to 1.46, and BCR ranged from 1.96 to 2.11. Treatment B showed the best overall performance, although statistical analysis indicated no significant differences among treatments. The optimization analysis suggested that the optimal dosage was between 1.7 and 1.8%, while the path analysis revealed a strong relationship between technical aspects (SGR, FCR, SR) and financial aspects (BCR).

Key Words: BCR, FCR, *Lates calcarifer*, SGR, SR, *Syzygium polyanthum*, WGR.

Introduction. The increasing demand for marine fish adds pressure on wild marine fish stocks, thereby the development of marine aquaculture for high-value species. Barramundi (another name: Asian seabass; local Indonesian name: *kakap putih*; scientific name: *Lates calcarifer*) is one of popular high-value fish in tropical regions, including Indonesia. Market preference, market price, and the high tolerance to environmental conditions support the aquaculture of barramundi (Rodwihok et al 2025). Barramundi is euryhaline that live across a wide range of water salinity, hence culturing it in brackish and freshwater environments is feasible (Ghosh 2019; Muyot et al 2021; Wijayanto et al 2022a, b). In Indonesia, the production of barramundi from brackish water culture reached 3,577 tons in 2020, while marine cage culture produced 1,695 tons (KKP 2022). Barramundi aquaculture is also widely practiced in the Asia-Pacific region, with global production increasing from 18.1 thousand tons in 2000 to 105.8 thousand tons in 2020 (FAO 2022).

Nutritional adequacy is a key determinant to the success of intensive fish culture (Asadollahi et al 2025). Optimization of feed composition influences feed conversion efficiency, growth, and survival. Local ingredients can be used to improve the feed formulation which also reduce production costs and environmental impacts for stronger economic sustainability (Wijayanto et al 2022a, b; Ngoh et al 2025). Meanwhile, disease management through the use of synthetic antibiotics has been associated with negative impacts on aquatic environments and farmed fish products. Several researchers have

proposed herbal nutraceuticals as the alternatives to synthetic antibiotics (US-FDA 2018; Park et al 2021; Varghese et al 2021; Wijayanto et al 2022a, b, 2023).

Herbal nutraceuticals are natural plant-derived materials that contain bioactive compounds such as flavonoids, alkaloids, saponins, tannins, and essential oils. These compounds exhibit physiological benefits as they enhance the fish's immune response, improve metabolic efficiency, strengthen endogenous antioxidants, as well as providing antibacterial, antiviral, and antiparasitic effects. Herbal feed supplementation improves the growth and production performance, while also lowering the disease risk for greater sustainability of the aquaculture industry (Chakraborty & Hancz 2011; Harikrishnan et al 2011; Rahmat et al 2021; Setiawan et al 2022).

Bay leaf (*Syzygium polyanthum*) is a herbal nutraceutical that supports the green aquaculture as it offers strong food safety, ecological sustainability, and improvement to the fish health. Bay leaf has been widely used as a culinary ingredient in Southeast Asia. It contains several bioactive compounds, including flavonoids (antioxidant, immunomodulatory), tannins (antibacterial, antiparasitic), saponins (immunostimulant, lipid metabolism enhancer), alkaloids (antimicrobial, antifungal), and essential oils (antimicrobial, anti-inflammatory). Bay leaf grows optimally in lowlands within temperate, subtropical, and tropical climates (Chakraborty & Hancz 2011; Hai 2015; Dawood & Koshio 2016; Ramli et al 2017; Hassan et al 2018; Ismail & Wan Ahmad 2019; Rahmawati & Kaswati 2023; Wijayanto 2023). This research specifically evaluated the effects of bay leaf as enrichment in artificial feed on the growth performance, survival rate, feed conversion ratio, and profitability of barramundi in aquaculture.

Material and Method

Research location and time. This research was conducted for 53 days from January to February 2025 at the Laboratory of the Faculty of Fisheries and Marine Science, Universitas Diponegoro, Semarang.

Experimental animals and rearing conditions. Juvenile barramundi with an average initial body weight of 11.10 ± 0.28 g per fish were reared in tanks with a volume of 0.5 m^3 , each stocked with 34 individuals. The fish were weighed every 10 days to monitor growth performance. The water quality was managed by recirculating aquaculture system through filters made of charcoal, coral, sand, and synthetic fibres and changing 30% of the water every 10 days. The water quality parameters were monitored using a multi-parameter water quality checker (Horiba U-50) to measure dissolved oxygen (DO), pH, and water temperature, while the culture medium was maintained at 0 salinity (freshwater conditions).

Experimental design and feed test. In this completely randomized design (CRD) research, 3 treatments with 3 replications were carried out. The test feed used commercial feed (minimum crude protein 52%), enriched with bay leaf liquid as a treatment at different doses: 1% (treatment A), 2% (treatment B), and 3% (treatment C). Feeding was carried out at 4% of fish biomass per day.

Measured parameters. The parameters observed in this research included weight gain rate (WGR), specific growth rate (SGR), survival rate (SR), feed conversion ratio (FCR), and benefit-cost ratio (BCR). The following formulas were used in the calculations (Muyot et al 2021; Wijayanto et al 2022a, b):

$WGR (\%) = [(Wt - Wo)/Wo] \times 100$	[1]
$SGR (\% \text{ day}^{-1}) = (\ln Wt - \ln Wo) / t$	[2]
$SR (\%) = (Nt/No) \times 100\%$	[3]
$FCR = F / (Wt - Wo)$	[4]
$BCR = B / C$	[5]

SGR and WGR represent the growth rate in terms of body weight, expressed as the percentage increase in fish weight. Wt is the average fish weight (g) at day t, while Wo is

the initial average fish weight (g). Ln refers to the natural logarithm. SR is the survival rate of fish (%), where N_t is the number of fish at the end of the rearing period and N_0 is the number of fish at the beginning. FCR is the feed conversion ratio, which serves as an indicator of feed efficiency, with F denoting the total feed given (g). BCR is the benefit-cost ratio, where a value greater than 1 indicates profitability. B represents the additional income obtained from fish growth (IDR), while C is the feed cost (IDR).

Data analysis. The data obtained in this research were analyzed using one-way ANOVA at a 95% confidence level. If significant differences were found among treatments, Duncan's test was applied. The modelling of the treatments was optimized by applying the first derivative procedure with respect to T (treatment) set equal to zero. Path analysis was then conducted to determine the relationship among fish growth, SR, and feed efficiency toward the BCR.

Results. The modern aquaculture development faces several serious challenges, including infectious diseases, environmental degradation, and the demand for efficient and environmentally friendly feeds. The use of synthetic antibiotics and chemicals to promote growth and prevent diseases in fish has been widely criticized and restricted. In addition to cost-efficiency issue, the use of synthetic antibiotics and chemicals may lead to antimicrobial resistance, harmful residues in fishery products, and negative impacts on aquatic ecosystems. Several researchers have highlighted the benefits of herbal ingredients in enhancing the digestion and immunity of fish (Harikrishnan et al 2011; Park et al 2021; Varghese et al 2021; Wijayanto 2023). The growth performance (WGR and SGR), SR, FCR, and BCR obtained in this research are presented in Table 1 and Table 2. The WGR values for treatments A, B (highest), and C are relatively similar, averaging 73.50%, 73.81%, and 72.92%, respectively. A similar trend is observed for SGR, with treatment B showing the highest growth rate. However, statistical analysis confirmed that treatment dosages do not significantly affect the growth rate.

Table 1
Result of WGR, SGR, SR, FCR and BCR

Parameters	A (1%)			B (2%)			C (3%)		
	A1	A2	A3	B1	B2	B3	C1	C2	C3
Wo (g)	11.24	10.83	11.03	11.13	10.98	10.57	11.34	11.40	11.40
Wt (g)	42.34	41.61	43.67	42.35	42.66	41.10	42.71	44.45	44.39
WGR (%)	73.45	73.98	73.07	73.73	73.43	74.28	72.64	72.64	73.49
SGR (% day ⁻¹)	2.50	2.54	2.60	2.52	2.56	2.56	2.50	2.57	2.56
SR (%)	100	100	94	100	97	100	97	94	97
FCR	1.38	1.35	1.44	1.36	1.40	1.34	1.43	1.46	1.39
BCR	2.08	2.11	1.99	2.10	2.04	2.14	1.99	1.96	2.05

Table 2
Average value of WGR, SGR, SR, FCR and BCR and the results of statistical analysis

Parameters	A (1%)	B (2%)	C (3%)	Sign. value
WGR (%)	73.50	73.81	72.92	0.132
SGR (% day ⁻¹)	2.546	2.548	2.545	0.993
SR (%)	97.92	98.958	95.895	0.390
FCR	1.3878	1.366	1.428	0.177
BCR	2.060	2.092	2.001	0.177

Note: No significant gaps were found among treatments based on the ANOVA test.

During the experiment, water quality remained relatively good and did not act as a limiting factor for fish growth (Table 3). The growth of cultured fish is influenced by the interaction of various factors, including genetics, feed (quality and quantity), water quality, stocking density, fish health, and culture management. Optimizing these factors results in faster

growth, higher feed efficiency, and improved survival. High-quality feed contributes to enhanced growth performance, feed efficiency, and fish health (Hepher & Pruginin 1981; Boyd & Tucker 1998; Lovell 1998; Halver & Hardy 2003).

Table 3

Water quality during the experiment

Code	pH	Temperature (°C)	DO (ppm)
A1	7.57±0.51	27.57±0.35	5.47±0.25
A2	7.50±0.30	27.40±0.36	5.60±0.30
A3	7.43±0.25	27.23±0.42	5.57±0.51
B1	7.43±0.23	27.23±0.35	5.53±0.61
B2	7.40±0.26	27.20±0.36	5.30±0.35
B3	7.47±0.21	27.20±0.40	5.60±0.60
C1	7.53±0.21	27.13±0.35	5.37±0.49
C2	7.50±0.20	27.20±0.40	5.43±0.75
C3	7.43±0.12	27.23±0.40	5.60±0.60
Reference	7.00-8.50 ^a	27.00-30.00 ^b	4.00-8.00 ^b

Note: (a) WWF Indonesia (2015); (b) Yudhiyanto et al (2017).

In this research, the SR across all treatments was very high, exceeding 95%. Statistical analysis showed that treatments did not have a negative impact on survival. The average FCR values were relatively similar and not significantly different among treatments, ranging from 1.37 to 1.43. These values are considered good, as the optimal FCR is reported to be around 1.2-1.5 (Tacon & Metian 2015). The highest BCR value was found in treatment B, at 2.092, indicating that every additional cost of IDR 1 for feed resulted in an additional income of 2.092. However, statistical analysis confirmed that there were no significant differences in BCR among treatments. The result of optimization modeling are presented in Figure 1 and Table 4.

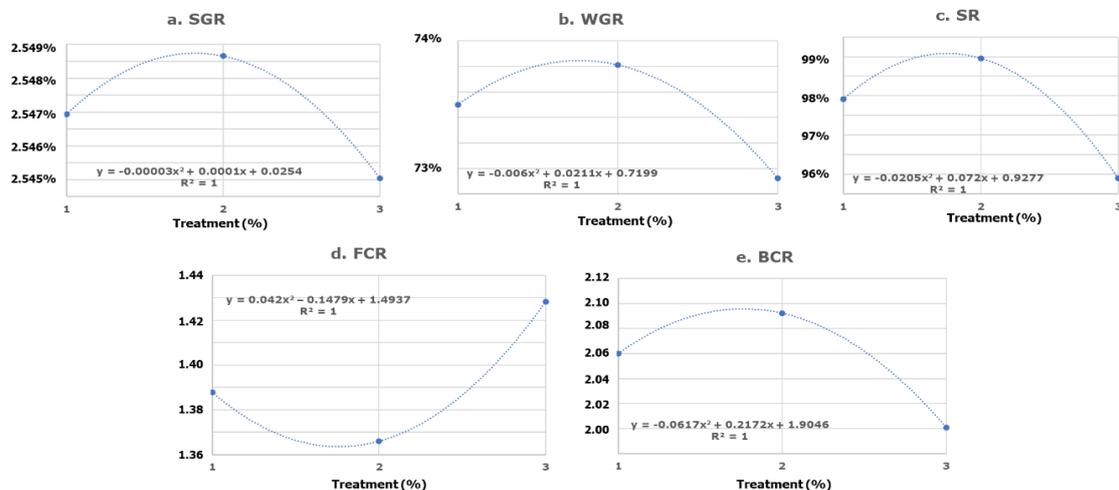


Figure 1. Polynomial modelling of SGR, WGR, FCR and BCR.

Table 4

Optimization of treatment dosage

Parameters	Treatment dosage
SGR	1.7%
WGR	1.8%
SR	1.8%
FCR	1.8%
BCR	1.8%

This research demonstrated that all tested parameters (SGR, WGR, SR, FCR, and BCR) reached their optimal values in treatment B (2% dosage). The quadratic pattern indicates the presence of an optimum point for treatment application, in which dosage that is too low is insufficient in stimulating growth, while excessively high dosage negatively affects fish performance. This condition is consistent with the principle of the dose–response relationship, in which a feed additive can enhance growth performance up to a certain threshold, but excessive concentrations may reduce productivity due to metabolic stress, decreased feed palatability, or potential toxic effects (Klinger & Naylor 2012; Khanjani et al 2024). The optimization modelling further shows that the optimal dosage ranges between 1.7 and 1.8% (Table 4). Figure 2 and Table 5 present the results of the path analysis, where SR, WGR, and FCR affect BCR. Specifically, SR affected WGR, and subsequently, both WGR and FCR contributed to the variation in BCR.

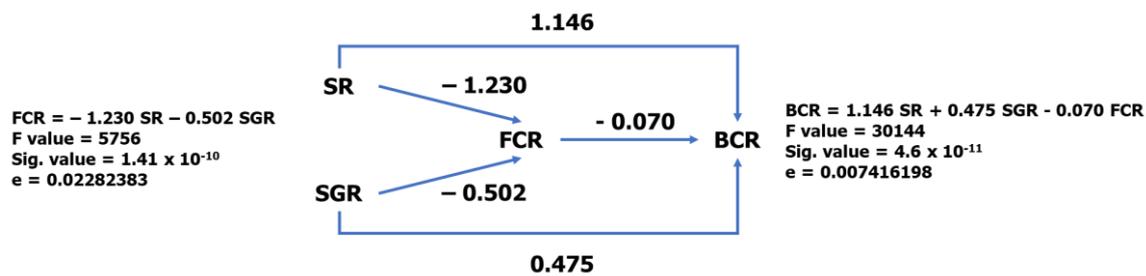


Figure 2. BCR determinant factor in path analysis.

Table 5

Result of BCR determinant factor in path analysis

Description	Value
Effect of SR on BCR	
Direct	1.146
Indirect	0.086
Total	1.232
Effect of SGR on BCR	
Direct	0.475
Indirect	0.035
Total	0.510
Direct effect of FCR on BCR	-0.070

The results of the path analysis show that both SR and SGR positively affect BCR, either directly or indirectly through FCR. The total effect of SR on BCR is 1.232, while the total effect of SGR is 0.510. The values indicate SR as the dominant factor that determines BCR. Based on the component examination, the direct effects of SR and SGR on BCR are significantly greater than their indirect effects through FCR, suggesting that the primary influence of SR and SGR on BCR occurs through direct pathways. On the contrary, the effect of FCR is negative, where greater FCR values indicate less efficient feed utilization, thereby reducing BCR and the profitability of barramundi aquaculture (Baron & Kenny 1986; Kline 2016; Hair et al 2019).

Discussion. Herbal nutraceuticals in aquafeeds offer multiple benefits, both in terms of fish growth and health. Physiologically, bioactive compounds derived from herbs can improve feed efficiency, optimize metabolism, and enhance the immune system through antioxidant and antimicrobial properties. From an environmental perspective, natural ingredients are considered safer, more eco-friendly, and compliant to the principles of sustainable aquaculture (Citarasu 2010; Chakraborty & Hancz 2011; Harikrishnan et al 2011; Dawood & Koshio 2016; Ismail & Wan Ahmad 2019; Rahmat et al 2021; Setiawan et al 2022; Wijayanto 2023). Indonesia itself has abundant herbal resources, including shallot, garlic, ginger, Javanese turmeric, turmeric, and bay leaf, whose potential has

increasingly been investigated. As reported in some research, bay leaf contains phenols, flavonoids, tannins, and volatile compounds that function as antioxidants and antimicrobials to promote fish health (Ramli et al 2017; Wijayanto et al 2022a, b; Julizan et al 2023; Rahmawati & Kaswati 2023; Wijayanto et al 2023).

Optimal aquaculture production is strongly related to the SR which is influenced by internal factors such as genetics, size, and fish health condition, as well as external factors including environment, feed quality, stocking density, disease, and management practices. Optimizing these factors along with adequate implementation of the sustainable aquaculture principles contribute to greater productivity (Boyd & Tucker 1998; Halver & Hardy 2003; FAO 2020). In this research, bay leaf liquid served as an effective nutraceutical when used at specific dose range from 1.7 to 1.8%. This finding is consistent with research on tilapia, in which a 2% dosage increased blood leukocyte count (Putranto et al 2019). However, excessive supplementation of bay leaf negatively affects fish growth, attributable to antinutritional effects that decrease feed palatability, increase metabolic load, and potentially induce toxicity. Tannins in bay leaf can bind to proteins and digestive enzymes, thereby reducing nutrient digestibility. Furthermore, high doses of saponins may damage intestinal membranes and interfere with nutrient absorption. Alkaloids can be toxic at high concentrations, while bitter flavours in concentrated extracts may also reduce feed intake (Citarasu 2010; Harikrishnan et al 2011; Julizan et al 2023; Ngoh et al 2025).

Feed efficiency is a determinant of successful aquaculture business. Feed efficiency is commonly measured by the FCR, which is influenced by feed quality, feeding management, water quality, stocking density, fish species, and health status. Low-quality feeds increase the amount of undigested feed, leading to higher FCR and greater production costs. On the contrary, highly digestible feeds result in lower FCR, indicating improved feed efficiency, shorter culture cycles, and higher profitability. Lower FCR also benefits the culture environment from the lower organic waste that prolongs the optimal water quality and decreases disease risk, leading to higher SR (Boyd & Tucker 1998; Halver & Hardy 2003; Tacon & Metian 2008; FAO 2020). Technical efficiency as represented by low FCR and high SR affects the BCR. A BCR > 1 indicates that aquaculture operations are profitable, as the benefits outweigh production costs. Thus, the adoption of high-quality herbal-based feeds contributes to fish health and the long-term economic viability of aquaculture enterprises (FAO 2020; Wijayanto 2023).

Seen from the fisheries resource perspective, the high market demand makes barramundi vulnerable to overexploitation. The capture fisheries production of barramundi in Indonesia reached 21,534 quintals in 2021 (Carpenter & Niem 1999; BPS-Statistics Indonesia 2022). The fishermen mostly use handline and gill nets that bring pressure to the nature and overexploitation of natural stocks. As an alternative, barramundi can be cultured under low salinity and even freshwater conditions (Shah et al 2020; Marnn et al 2021; Wijayanto et al 2022a, b), providing opportunities for inland farmers to develop aquaculture enterprises. The present research confirms that bay leaf has potential as a herbal immunostimulant in barramundi feed that improve the fish immunity, enhance the growth, metabolism, and survival, resulting in higher production and profitability (Hidayati et al 2021; Paray et al 2021; Wijayanto 2023).

Conclusions. The enrichment of fish feed with bay leaf liquid (1-3%) did not exert a statistically significant effect on growth (WGR, SGR), survival (SR), feed efficiency (FCR), or profitability (BCR), although the best performance was observed in treatment B (2%). Optimization modelling suggested that the optimal dosage lies between 1.7 and 1.8%. Across treatments, WGR ranged from 72.64 to 73.98% and SGR from 2.50 to 2.60% day⁻¹. Survival rates were consistently high, ranging from 94 to 100%. FCR values ranged from 1.34 to 1.46, while BCR values ranged from 1.96 to 2.11 respectively, as presented in Table 1. Path analysis demonstrated a strong relationship between technical performance indicators (SGR, FCR, SR) and financial outcomes (BCR). Enhancements in growth and feed efficiency were found to generate cascading benefits by improving survival, lowering production costs, and ultimately increasing profitability.

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Conflict of interest. The authors declare that there is no conflict of interest.

References

- Asadollahi M., Baserh J., Abnaroodhelleh F., Kordyani M. B., Samani M. N., Dadar M., 2025 Combined prebiotic and multivitamin supplementation enhance growth, survival, and disease resistance of Asian seabass in floating cages. *Aquaculture Reports* 43: 102919.
- Baron R. M., Kenny D. A., 1986 The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology* 51(6):1173-1182.
- Boyd C. E., Tucker C. S., 1998 Pond aquaculture water quality management. Springer Science & Business Media, New York, 700 pp.
- BPS-Statistics Indonesia, 2022 Statistics of fishing port 2021. BPS-Statistics Indonesia. 80 pp. [bilingual in English and Indonesian]
- Carpenter K. E., Niem V. H., 1999 FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Volume 6. Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine mammals. FAO, Rome, pp. 3381-4218.
- Chakraborty S. B., Hancz C., 2011 Application of phytochemicals as immunostimulant, antipathogenic and antistress agents in finfish culture. *Reviews in Aquaculture* 3(3): 103-119.
- Citarasu T., 2010 Herbal biomedicines: a new opportunity for aquaculture industry. *Aquaculture International* 18:403-414.
- Dawood M. A. O., Koshio S., 2016 Recent advances in the role of probiotics and prebiotics in carp aquaculture: a review. *Aquaculture* 454:243-251.
- FAO, 2020 The state of world fisheries and aquaculture 2020. Sustainability in action. FAO, Rome, 244 pp.
- FAO, 2022 The state of world fisheries and aquaculture 2022. Towards blue transformation. FAO, Rome, 236 pp.
- Ghosh S., 2019 Farming of Asian seabass *Lates calcarifer* in freshwater impoundments in West Bengal, India. *Aquaculture Asia* 23(3):1-9.
- Hai N. V., 2015 The use of medicinal plants as immunostimulants in aquaculture: a review. *Aquaculture* 446:88-96.
- Hair Jr. J. F., Black W. C., Babin B. J., Anderson R. E., 2019 Multivariate data analysis. 8th edition. Cengage Learning, 813 pp.
- Halver J. E., Hardy R. W., 2003 Fish nutrition. 3rd edition. Academic Press, 824 pp.
- Harikrishnan R., Balasundaram C., Heo M. S., 2011 Impact of plant products on innate and adaptive immune system of cultured finfish and shellfish. *Aquaculture* 317(1-4):1-15.
- Hassan A. A. M., Yacout M. H., Khalel M. S., Hafsa S. H. A., Ibrahim M. A. R., Mocuta D. N., Turek Rahoveanu A., Dediu L., 2018 Effects of some herbal plant supplements on growth performance and the immune response in Nile tilapia (*Oreochromis niloticus*). "Agriculture for Life, Life for Agriculture" Conference Proceedings 1:134-141.
- Hepher B., Pruginin Y., 1981 Commercial fish farming: with special reference to fish culture in Israel. Wiley-Interscience, 261 pp.
- Hidayati D., Nurindra A. R., Abdulgani N., Setiawan E., Maulidina N., Syahroni N., Mulyadi Y., 2021 Fish disease study of Asian seabass (*Lates calcarifer*) in a floating marine cage: endoparasite and blood profile. *Biodiversitas* 22(10):4505-4511.
- Ismail A., Wan Ahmad W. A. N., 2019 *Syzygium polyanthum* (Wight) Walp: a potential phytomedicine. *Pharmacognosy Journal* 11(2):429-438.
- Julizan N., Ishmayana S., Zainuddin A., Hung P. V., Kurnia D., 2023 Potential of *Syzygium polyanthum* as natural food preservative: a review. *Foods* 12(12):2275.

- Khanjani M. H., Mozanzadeh M. T., Gisbert E., Hoseinifar S. H., 2024 Probiotics, prebiotics, and synbiotics in shrimp aquaculture: their effects on growth performance, immune responses, and gut microbiome. *Aquaculture Reports* 38:102362.
- KKP, 2022 Marine and fisheries in figures 2022. Kementerian Kelautan dan Perikanan (KKP), 376 pp. [bilingual in English and Indonesian]
- Kline R. B., 2016 Principles and practice of structural equation modeling. 4th edition. Guilford Press, New York, 534 pp.
- Klinger D., Naylor R., 2012 Searching for solutions in aquaculture: charting a sustainable course. *Annual Review of Environment and Resources* 37:247-276.
- Lovell R. T., 1998 Nutrition and feeding of fish. Springer Science & Business Media, Boston, 267 pp.
- Marnn P., He C., Ali H., Tun S. M., Wynn K. S., Moe N. N., Yang T., Claude N. J., Hasnain M., Oo T. T., Al-Masnay Y. A., 2021 Size distribution and economic status of sea bass in the Gulf of Mottama Wetland (GoMW) in Myanmar. *Agricultural and Biological Sciences Journal* 7(4):118-135.
- Muyot F. B., Magistrado M. L., Muyot M. C., Mutia M. T. M., 2021 Growth performance of the mangrove red snapper (*Lutjanus argentimaculatus*) in freshwater pond comparing two stocking densities and three feed types. *The Philippine Journal of Fisheries* 28(1):1-17.
- Ngoh S. Y., Shen X., Nankervis L., Chia I., Hua K., 2025 Evaluation of nutritional value and quality of aquafeed ingredients for Malabar snapper (*Lutjanus malabaricus*). *Aquaculture* 600:742253.
- Paray B. A., El-Basuini M. F., Alagawany M., Albeshr M. F., Farah M. A., Dawood M. A. O., 2021 *Yucca schidigera* usage for healthy aquatic animals: potential roles for sustainability. *Animals* 11(1):93.
- Park Y., Park M., Hamidoghli A., Kim C. H., Bai S. C., 2021 Optimum dietary processed sulfur (Immuno-F) level has antibiotic effects on the growth, hematology and disease resistance of juvenile olive flounder, *Paralichthys olivaceus*. *Animal Feed Science and Technology* 279:115035.
- Putranto W. D., Syaputra D., Prasetyono E., 2019 Blood preview of tilapia (*Oreochromis niloticus*) given fortified feed of salam leaf (*Syzygium polyanthum*) liquid extract. *Journal of Aquatropica Asia* 4(2):22-28.
- Rahmat E., Lee J., Kang Y., 2021 Javanese turmeric (*Curcuma xanthorrhiza* Roxb.): ethnobotany, phytochemistry, biotechnology, and pharmacological activities. *Evidence-Based Complementary and Alternative Medicine* 2021:9960813.
- Rahmawati I., Kaswati L., 2023 Comparison of phenolic content of Indonesian bay leaves (*Syzygium polyanthum*) fresh decoction and herbal tea. *Indonesian Journal of Pharmaceutical Science and Technology* 5(2):140-145.
- Ramli S., Radu S., Shaari K., Rukayadi Y., 2017 Antibacterial activity of ethanolic extract of *Syzygium polyanthum* L. (Salam) leaves against foodborne pathogens and application as food sanitizer. *BioMed Research International* 2017:9024246.
- Rodwihok C., Thompson K. D., Srisapoome P., Thangsunan P., Thangsunan P., Buncharoen W., Saenphet K., Saenphet S., Meachasompop P., Kumwan B., Tangal J. K., Wiratama N., Mai T. T., Uchuwittayakul A., 2025 Evaluation of immune responses and protection in Asian seabass (*Lates calcarifer* Bloch, 1790) against *Vibrio vulnificus* using immersion and oral nanoemulsion vaccines. *Fish and Shellfish Immunology* 162: 110354.
- Setiawan P. Y. B., Kertia N., Nurrochmad A., Wahyuono S., 2022 Synergistic anti-inflammatory effects of *Curcuma xanthorrhiza* rhizomes and *Physalis angulata* herb extract on lipopolysaccharide-stimulated RAW 264.7 cells. *Journal of Applied Pharmaceutical Science* 12(7):88-98.
- Shah S. B. H., Yongtong M., Narejo N. T., Jarwar A., Oad S., Ali M., Li Y., Nisar U., 2020 Economic analysis of barramundi (*Lates calcarifer*) (Bloch, 1790), in Pakistan and opportunities for its aquaculture development. *Indian Journal of Geo Marine Sciences* 49(8):1425-1434.
- Tacon A. G. J., Metian M., 2015 Feed matters: satisfying the feed demand of aquaculture. *Reviews in Fisheries Science and Aquaculture* 23(1):1-10.

- US-FDA, 2018 Summary report on antimicrobials sold or distributed for use in food-producing animals. The United States-Food and Drug Administration (US-FDA), 52 pp.
- Varghese T., Ebenezeza S., Dar S. A., Pal A. K., 2021 Mitigation of stress in fish through nutraceuticals. *World Journal of Aquaculture Research and Development* 3(1):1014.
- Wijayanto D., 2023 The optimization of growth, survival rate, feeding efficiency and benefit cost ratio of Asian seabass reared in freshwater media with fish feed enrichment using Javanese turmeric (*Curcuma xanthorrhiza*). *AACL Bioflux* 16(2):1000-1006.
- Wijayanto D., Nugroho R. A., Kurohman F., Nursanto D. B., 2022a The effect of garlic (*Allium sativum*) supplementation in feed on the growth, survival and profits of Asian seabass (*Lates calcarifer*) cultivation reared in freshwater media. *AACL Bioflux* 15(4):1882-1890.
- Wijayanto D., Nugroho R. A., Kurohman F., Nursanto D. B., 2022b The effect of red onion (*Allium cepa* L. var. *aggregatum*) in feed on growth, survival and profit of Asian seabass cultivation in freshwater media. *AACL Bioflux* 15(5):2388-2395.
- WWF-Indonesia, 2015 [Asian seabass farming (*Lates calcarifer*, Bloch, 1790) in floating cages and brackish water ponds]. WWF-Indonesia, 52 pp. [in Indonesian]
- Yudhiyanto T., Suminto, Rachmawati D., 2017 The effect of dietary soybean meal with phytase supplementation on digestibility and growth of Asian seabass *Lates calcarifer*. *Omni-Akuatika* 13(2):144-154.

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