The effect of red onion (*Allium cepa* L. var. *aggregatum*) in feed on growth, survival and profit of Asian seabass cultivation in freshwater media

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Abstract. Fish farming business needs optimization in order to improve farmers' welfare. Asian seabass (*Lates calcarifer*) has been one of the leading commodities in fish farming in brackish and sea water. Despite being rarely developed, Asian seabass can be cultivated in fresh water. The cultivation of Asian seabass in fresh water requires feed supplementation to increase fish immunity. Good fish immunity will reduce fish mortality and increase profits. This study analyzed the effect of red onion (*Allium cepa*) addition to fish feed on the growth, survival rate and profitability of Asian seabass reared in fresh water. The experiment was carried out in 40 days on Asian seabass seeds with an average size of 0.92 (±0.01) g per fish. The study was designed using a completely randomized design. Fish were reared in fiber tubs with 0.5 m^3 water and 50 fish per tub. In this study, 3 treatments and 2 replications per treatment were carried out. The treatment of red onion supplementation in feed was 0% (treatment A as control), 2.5% (treatment B), and 5% (treatment C). Water quality parameters were measured weekly, including pH level, dissolved oxygen (DO), salinity, and water temperature. The results of this study indicated that the red onion treatment significantly affected the feed conversion ratio (FCR) and benefit/cost ratio (BCR). Treatment C showed the best performance on fish growth (absolute growth weight - W, and specific growth rate - SGR), while treatment B resulted in the best FCR and BCR. Treatments B and C showed slightly different results in SR. The best red onion concentration was found between 3.617 and 4.164%.
Key Words: *Allium cepa*, BCR, FCR, SR, SGR, *Lates calcarifer*.

Introduction. Optimizing the Asian seabass or barramundi (*Lates calcarifer*) cultivation for greater productivity is necessary as it will increase farmers' welfare. Asian seabass is a fish commodity reared in brackish water ponds and marine cages with high demand and selling price, while it can actually be cultivated in fresh water media. Southeast Asia dominates the Asian seabass production, especially Indonesia, Thailand and Malaysia (Cheong 1989; Venkatachalam et al 2018; Wijayanto et al 2020a, 2022a). Cultivation of Asian seabass in freshwater media is not yet popular in Indonesia. Disease control strongly affects the Asian seabass cultivation, including those cultivated in freshwater media, as it affects the survival rate, which in turn affects productivity and profits (Wijayanto et al 2020a; Hidayati et al 2021; Wijayanto et al 2022b).

Disease control can be performed in many ways, including water quality control and immunity boost from feed (WWF Indonesia 2015; Yang et al 2020; Shekarabi et al 2022). Some local ingredients are potential immunostimulants for Asian seabass, including red onions (*Allium cepa*). Garlic content in Asian seabass feed has been proven able of increasing the survival rate of Asian seabass reared in freshwater media (Wijayanto et al 2022b). It is necessary to diversify local ingredients that can act as immunostimulants for Asian seabass, including red onions. Red onions are widely farmed in Indonesia especially in Central Java and East Java provinces, which production reached 1.5 million tons in 2019 (Statistics Indonesia 2020). Red onions are commonly used as cooking spices and they are good sources of several phytonutrients including flavonoids, fructo oligo saccharides (FOS), thio sulfinates and other sulfur components. In addition, red onions contain vitamin C, potassium, fiber, and folic acid. Red onions are also herbal medicines as they have anti-toxic, anti-carcinogenic, anti-asthmatic, anti-thrombotic and anti-biotic properties (Liguori et al 2017; Statistics Indonesia 2020; Dorrigiv et al 2021). Those contents and properties make red onions potential immunostimulant for both humans and animals (including fish). This study analyzed the effect of adding red onions into fish feed on the growth, survival rate and profitability of Asian seabass cultivated in freshwater media.

Material and Method

Research setting. This experimental research was conducted in a laboratory of Faculty of Fisheries and Marine Sciences, Universitas Diponegoro, Semarang (Indonesia) from January to February 2022 (40 days).

Research materials. Asian seabass seeds with an average size of 0.92 g (±0.01 g) per fish were adapted to fresh water media (gradually the salinity of the original medium was reduced to 0 ppt) and reared using fiber tubs containing 0.5 m^3 of water, with 50 fish per tub. Six units of fiber tubs were used in 3 treatments and 2 replications.

Feed treatment. A commercial feed for Asian seabass (containing 52% crude protein) was added with red onions. Red onions were grated, then added with water and used for soaking the commercial feed. After that, the test feed was aerated to dry. Different red onion concentrations were applied; 0% (treatment A), 2.5% (treatment B), 5% (treatment C). Wijayanto et al (2022a) suggested the administration of 4% of fish biomass feeding per day. Meanwhile, according to Hassan et al (2021), a feeding rate of 6.5% per day is the most optimum one for the growth and survival rate of Asian seabass. The experiment was carried out in a completely randomized design.

Water quality measurement. To maintain water quality, water was recirculated through filters made of charcoal, coral, sand and synthetic fibers. Water was changed every 10 days, where 30% of the water was replaced. Water quality was measured weekly to test the pH level, dissolved oxygen (DO), salinity, and water temperature using Horiba U-50 multi-parameter water quality meter.

Data analysis. Fish weight was measured every 10 days. Several formulas were used in this study, including the ones proposed by Ali et al (2016), Venkatachalam et al (2018), Wijayanto et al (2020a, b), Hassan et al (2021), Chowdhury et al (2021) and Shekarabi et al (2022):

$$W = Wt - Wo \quad [1]$$

$$SGR = (Ln\ Wt - Ln\ Wo) / t \quad [2]$$

$$FCR = F / W \quad [3]$$

$$BCR = B / C \quad [4]$$

$$SR = Nt/No \quad [5]$$

where: W is the absolute growth of fish biomass (in g); Wt is fish biomass (in g) on day t; Wo is fish biomass in g (on first day); SGR is the specific growth rate of fish (in % day^{-1}); FCR is the feed conversion ratio as an indicator of fish feed efficiency; F is the accumulation of feed given to the fish (g); BCR is the benefit/cost ratio which is an indicator of business profits; B is additional income from fish growth (IDR); C is the cost of fish feed (IDR) (the cultivation of Asian seabass is considered profitable if the BC ratio is greater than 1.0); SR is survival rate (%); Nt is the number of fish at the end of the period; No is the number of fish at the beginning of the period.

Anova test was performed and followed with Duncan's test. Treatment optimization modelling employed the derivation procedure of the SR, SGR, FCR and BCR equations for T (treatment) equal to zero (dSR/dT = 0; dSGR/dT = 0; dFCR/dT = 0 and dBCR/dT = 0).

Results. The experiments showed that the red onion supplementation treatment in feed could increase fish growth (W and SGR), SR and FCR, indicated by significant gaps found between treatment A (control) and treatments B and C. Treatment C showed the best performance in SGR, whilst treatment B had the best performance in FCR and BCR (see Table 1). The results of statistical analysis also indicated a significant effect from FCR and BCR variables (see Table 2).

Table 1

SR, W, SGR, FCR and BCR of Asian seabass cultivation

Variables	*A (0%)*		*B (2.5%)*		*C (5%)*	
	A_1	*A_2*	*B_1*	*B_2*	*C_1*	*C_2*
SR (%)	62	68	76	66	72	70
Average of SR (%)	65		71		71	
W_0 (g)	46.04	45.16	46.22	45.15	46.21	45.80
W_t (g)	165.97	169.00	200.61	169.62	186.29	190.30
W (g)	119.93	123.84	154.39	124.47	140.08	144.50
Average of W (g)	121.89		139.43		142.29	
SGR (% day^{-1})	3.05	3.14	3.50	3.15	3.32	3.39
Average of SGR (% day^{-1})	3.10		3.32		3.36	
FCR	1.079	1.061	1.009	1.011	1.024	1.000
Average of FCR	1.07		1.009		1.012	
BCR	5.19	5.28	5.56	5.55	5.46	5.61
Average of BCR	5.23		5.55		5.53	

Table 2

Statistical analysis

Variables	*F value*	*Sig value*	*Duncan test*
SR	1.03	0.46	$C^a = B^a > A^a$
W	1.57	0.34	$C^a > B^a > A^a$
SGR	1.80	0.31	$C^a > B^a > A^a$
FCR	22.79	0.01**	$A^a > B^b > C^b$
BCR	13.46	0.03**	$C^a > B^a > A^b$

Notes:* shows a significant effect with α = 5% (level of confidence); ** shows a significant effect with α = 1%; a and b show a subset group.

Treatments B and C did not show statistically different results in SR, W, SGR, FCR and BCR. Significant statistical differences of treatments B and C were found in FCR and BCR compared to the treatment A as a control. The modelling results (Figure 1 and Table 3) show that the optimal concentration of red onion ranges from 3.617 to 4.164%.

Table 3

Estimated optimal concentration of red onion

Variables	*Optimal treatment (% red onions)*	*Values*
SR	3.750	71.8%
SGR	4.164	3.369% per day
FCR	3.618	1.0025
BCR	3.617	5.587

The results of water quality monitoring are presented in Table 4. In general, the pH level, DO, and temperature are relatively supportive in Asian seabass cultivation (Cheong 1989; WWF Indonesia 2015; Yudhiyanto et al 2017). Whereas, water salinity was made equal in all treatment of 0 ppt. This research presented another evidence that Asian seabass can be reared at low salinity water (fresh water), although water salinity of 5 ppt provides more optimal results (Wijayanto et al 2020a, 2022a).

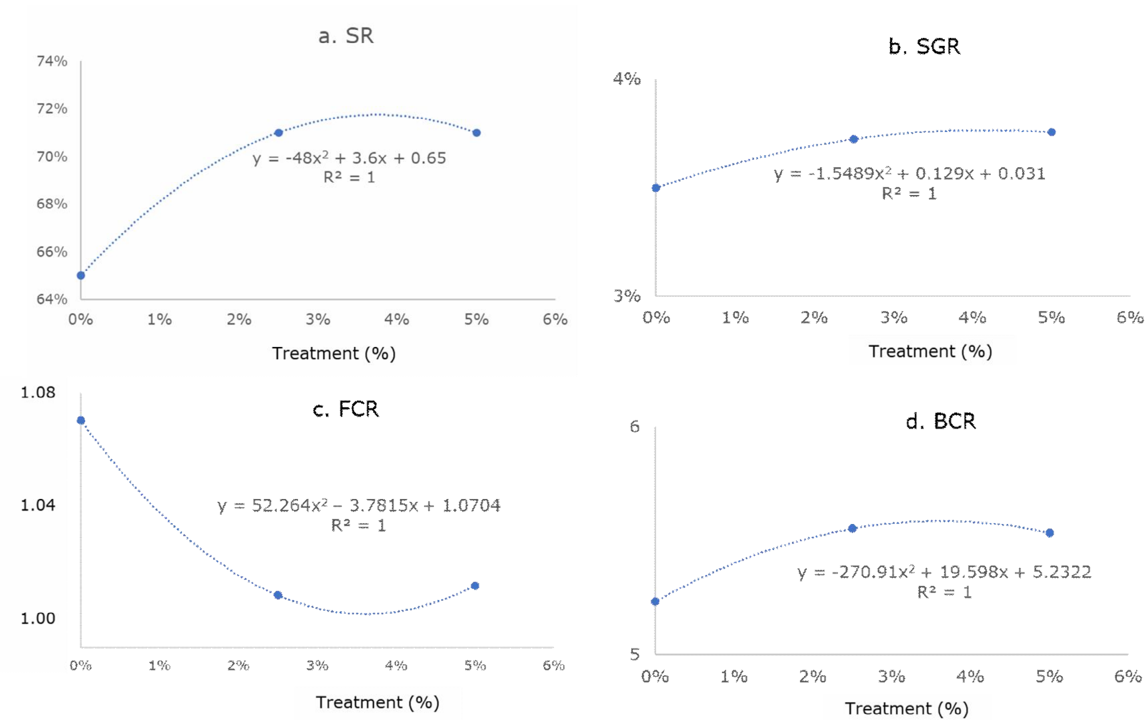

Figure 1. The relationship between SR, SGR, FCR, BCR and red onion treatment.

Table 4

Water quality of media cultivation

Variables	*A (0%)*		*B (2.5%)*		*C (5%)*	
	A_1	A_2	B_1	B_2	C_1	C_2
In the morning						
pH	7.93±0.09	7.81±0.04	7.63±0.02	7.64±0.02	7.61±0.08	7.62±0.08
Temperature (°C)	24.90±0.64	24.60±0.55	24.60±0.59	24.60±0.60	24.60±0.55	24.60±0.54
DO (ppm)	5.64±0.24	5.46±0.38	5.20±0.28	5.18±0.36	5.24±0.31	5.24±0.33
Salinity (ppt)	0.00±0.0	0.00±0.0	0.00±0.0	0.00±0.0	0.00±0.0	0.00±0.0
In the afternoon						
pH	7.65±0.15	7.59±0.05	7.54±0.03	7.53±0.06	7.48±0.06	7.52±0.07
Temperature (°C)	25.34±0.83	25.10±0.70	25.14±0.63	25.10±0.66	25.06±0.64	25.06±0.65
DO (ppm)	5.64±0.63	5.46±0.36	5.20±0.20	5.18±0.18	5.24±0.23	5.24±0.26
Salinity (ppt)	0.00±0.0	0.00±0.0	0.00±0.0	0.00±0.0	0.00±0.0	0.00±0.0

Discussion. The results of this experimental research indicate that the application of red onion in the feed of Asian seabass can affect to SR and fish growth (both W and SGR), which in turn will affect the profit (BCR). SR is an indicator of fish health. Fish that are healthy and grow optimally are sustained by a supportive feed. Previous research also show that the addition of red onions in feed can affect fish farming performance. Shekarabi et al (2022) stated that final weight, weight gain, and SGR can be significantly increased by giving red onions supplementation in fish feed. In addition, red onion supplementation in fish feed can reduce the FCR.

In recent progress, herbal nutraceutical-based feed treatments (including red onions) are increasingly being considered for fish farming. Herbal extracts in fish farming can be done orally, through injection and immersion. Oral application is the most efficient method as it reduces the stress level of fish (Gabriel 2019). Herbal nutraceutical ingredients boost feed digestion and body immunity and it also improves the fish resistance to stressors from both biotic and abiotic environment (Chowdhury et al 2021; Paray et al 2021; Shekarabi et al 2022). Several medicinal plants (herbal medicines) are also safe and effective substitutes for chemotherapy. Herbal medicines have antibiotic properties in fish farming, including *Allium* sp. (including red onion and garlic). *Allium* sp. contains high levels of phenolic compounds, flavonoids, polyphenols, terpenoids, lectins, alkaloids, and quinine polypeptides. In addition, *Allium* sp. also contains sulfur, trace minerals, vitamins, and fatty acids (Gabriel 2019; Shekarabi et al 2022). Inulin (which is also contained in red onion) significantly affects the SGR and FCR of Asian seabass (Ali et al 2016; Aisara et al 2021).

There are several benefits from giving the Alliaceae family to fish feed for it contains anti-oxidant, anti-inflammatory, anti-bacterial, anti-fungal, anti-parasitic and anti-cancer properties and improves the digestive system (Talpur & Ikhwanuddin 2012; Asimi et al 2013; Yang et al 2020; Liguori et al 2017; Shang et al 2019; Yousefi et al 2020; Xu et al 2020; Chowdhury et al 2021; Dorrigiv et al 2021). The species in Alliaceae family (including red onions) contain allicin or diallyl thiosulfinate which has strong anti-bacterial and anti-pathogenic properties (Shekarabi et al 2022). Allicin can also boost immunity and act as an antioxidant. Allicin can also increase the appetite. Allicin content in feed can improve the activity of alkaline phosphatase and leucine aminopeptidase which positively affect the intestinal development in fish larvae (Huang et al 2020). However, excessive amount of alkaline phosphatase can also indicate kidney and heart disorders in human (Yamazoe et al 2016).

The addition of red onions in fish feed also increases the activity of amylase, lipase, and protease in the intestines of fish (Shekarabi et al 2022). As a herbal bioactive substance, allicin can bind oxygen free radicals, and increase the activity of endogenous antioxidant enzymes (Alam et al 2018). Allicin was also proven an effective antioxidant agent in tilapia aquaculture (Hamed et al 2021). Shekarabi et al (2022) recommended the optimum dose of red onion powder based on the FCR and SGR of between 1.27 and 1.35% in rainbow trout cultivation. Meanwhile, in this study, the optimal dose was found ranging between 3.617 and 4.164%.

Water sources greatly determine the quality of water in the culture media which in turn affect the survival and growth of Asian seabass (Venkatachalam et al 2018). Water pollution is one of the challenges in fish farming. Chemical pollutants from anthropogenic activities can negatively affect the fish farming business. Long-term water contamination by contaminants (including fertilizers, pesticides, feed residues and fish feces) can lower the blood health of fish, decreasing the immunity of various fish species (Ghazala et al 2014; Hamed et al 2021). Fish farmers have been using medicinal plants and their active constituents as inexpensive natural products that help increasing fish growth, fish immunity and fish resistance to disease (Shekarabi et al 2022). In this study, the water quality during the experiment was relatively supportive for the rearing of Asian seabass; DO (between 5.18 and 5.64 ppm), water temperature (between 24.60 and 25.34^{o}C) and pH (between 7.48 and 7.93) (WWF Indonesia 2015; Yudhiyanto et al 2017).

Feed conversion and profitability are closely related. This research found the degree of closeness between FCR and BCR of 99.87% (very strong). Fish feed in fish farming has the largest cost, especially in intensive aquaculture. Feed expense Asian seabass aquaculture can reach 40% (Cheong 1989). Efficient feed that encourages fish growth can increase the productivity and revenue, while it saves more and optimizes the profit (Wijayanto et al 2022a, b). However, the concentration of red onion should not be excessive. The sulfur content in the Alliaceae family (including red onions) can act as an antibiotic, anti-oxidant and anti-bactericidal, but they can also be toxic at high concentrations (Kim et al 2015; Park et al 2021; Wijayanto et al 2022b).

Conclusions. Red onion supplementation had significant effects on FCR and BCR. Treatment C (5%) had the best performance on fish growth (W and SGR), while treatment B (2.5%) showed best performance on FCR (1.009) and BCR (5.55). Treatments B and C resulted in slightly different results in SR (about 71%). The modelling results showed that the optimal concentration of red onion administration ranged between 3.617% to 4.164%.

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

References

Aisara J., Wongputtisin P., Deejing S., Maneewong C., Unban K., Khanongnuch C., Kosma P., Blaukopf M., Kanpiengjai A., 2021 Potential of inulin-fructooligosaccharides extract produced from red onion (*Allium cepa* var. *viviparum* (Metz) Mansf.) as an alternative prebiotic product. Plants 10(11):2401.

Alam R. T. M., Fawzi E. M., Alkhalf M. I., Alansari W. S., Aleya L., Abdel-Daim M. M., 2018 Anti-inflammatory, immunomodulatory, and antioxidant activities of allicin, norfloxacin, or their combination against *Pasteurella multocida* infection in male New Zealand rabbits. Hindawi Oxidative Medicine and Cellular Longevity 2018: 1780956.

Ali S. S. R., Ambasankar K., Nandakumar S., Praveena P. E., Syamadayal J., 2016 Effect of dietary prebiotic inulin on growth, body composition and gut microbiota of Asian seabass (*Lates calcarifer*). Animal Feed Science and Technology 217:87-94.

Asimi O. A., Sahu N. P., Pal A. K., 2013 Antioxidant activity and antimicrobial property of some Indian spices. International Journal of Scientific and Research Publications 3(3):1-8.

Cheong L., 1989 Status of knowledge on farming of seabass (*Lates calcarifer*) in South East Asia. AQUACOP, IFREMER. Actes de Colloque 9:421-428.

Chowdhury D. K., Sahu N. P., Sardar P., Deo A. D., Bedekar M. K., Singha K. P., Maiti M. K., 2021 Feeding turmeric in combination with ginger or garlic enhances the digestive enzyme activities, growth and immunity in *Labeo rohita* fingerlings. Animal Feed Science and Technology 277:114964.

Dorrigiv M., Zareiyan A., Hosseinzadeh H., 2021 Onion (*Allium cepa*) and its main constituents as antidotes or protective agents against natural or chemical toxicities: a comprehensive review. Iranian Journal of Pharmaceutical Research 20(1):3-26.

Gabriel N. N., 2019 Review on the progress in the role of herbal extracts in tilapia culture. Cogent Food and Agriculture 5(1):1619651.

Ghazala, Mahboob S., Al-Ghanim K. A., Sultana S., Al- Balawi H. F. A., Sultana T., Al-Misned F., Ahmed Z., 2014 Acute toxicity II: effect of organophospates and carbmates to *Catla catla* fingerlings. The Journal of Animal and Plant Sciences 24(6):1795-1801.

Hamed H. S., Ismal S. M., Faggio C., 2021 Effect of allicin on antioxidant defense system, and immune response after carbofuran exposure in Nile tilapia, *Oreochromis niloticus.* Comparative Biochemistry and Physiology, Part C 240: 108919.

Hassan H. U. I., Ali Q. M., Ahmad N., Masood Z., Hossain M. Y., Gabol K., Khan W., Hussain M., Ali A., Attaullah M., Kamal M., 2021 Assessment of growth characteristics, the survival rate and body composition of Asian sea bass *Lates calcarifer* (Bloch, 1790) under different feeding rates in closed aquaculture system. Saudi Journal of Biological Sciences 28(2):1324-1330.

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.

Huang W., Yao C., Liu Y., Xu N., Yin Z., Xu W., Miao Y., Mai K., Ai Q., 2020 Dietary allicin improved the survival and growth of large yellow croaker (*Larimichthys crocea*) larvae via promoting intestinal development, alleviating inflammation and enhancing appetite. Frontiers in Physiology 11:587674.

Kim J. H., Noh H. Y., Kim G. H., Hong G. E., Kim S. K., Lee C. H., 2015 Effect of dietary supplementation with processed sulfur on meat quality and oxidative stability in *Longissimus dorsi* of pigs. Korean Journal for Food Science of Animal Resources 35(3):330-338.

Liguori L., Califano R., Albanese D., Raimo F., Crescitelli A., Di Matteo M., 2017 Chemical composition and antioxidant properties of five white onion (*Allium cepa* L.) Landraces. Hindawi Journal of Food Quality 2017:6873651.

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.
Shang A., Cao S., Xu X., Gan R., Tang G., Corke H., Mavumengwana V., Li H., 2019 Bioactive compounds and biological functions of garlic (*Allium sativum* L.). Foods 8(7):246
Shekarabi S. P. H., Javarsiani L., Mehrgan M. S., Dawood M. A. O., Adel M., 2022 Growth performance, blood biochemistry profile, and immune response of rainbow trout (*Oncorhynchus mykiss*) fed dietary Persian shallot (*Allium stipitatum*) powder. Aquaculture 548(1):737627.
Statistics Indonesia, 2020 [The trade distribution of red onions in Indonesia]. BPS - Statistics Indonesia, 116 pp. ISSN: 2745-6749. [in Indonesian]
Talpur A. D., Ikhwanuddin M., 2012 Dietary effects of garlic (*Allium sativum*) on haemato-immunological parameters, survival, growth, and disease resistance against *Vibrio harveyi* infection in Asian sea bass, *Lates calcarifer* (Bloch). Aquaculture 364-365:6-12.
Venkatachalam S., Kandasamy K., Krishnamoorthy I., Narayanasamy R., 2018 Survival and growth of fish (*Lates calcarifer*) under integrated mangrove-aquaculture and open-aquaculture systems. Aquaculture Reports 9:18-24.
Wijayanto D., Bambang A. N., Nugroho R. A., Kurohman F., Nursanto D. B., 2020a The effect of different low salinities on growth, feed conversion ratio, survival rate and profit of Asian seabass cultivation. AACL Bioflux 13(6):3706-3712.
Wijayanto D., Bambang A. N., Nugroho R. A., Kurohman F., 2020b The impact of planting distance on productivity and profit of *Eucheuma cottonii* seaweed cultivation in Karimunjawa Islands, Indonesia. AACL Bioflux 13(4):2170-2179.
Wijayanto D., Bambang A. N., Nugroho R. A., Kurohman F., Nursanto D. B., 2022a The effect of feeding rate on growth and BC ratio of Asian seabass reared in artificial low salinity water. AACL Bioflux 15(1):188-194.
Wijayanto D., Nugroho R. A., Kurohman F., Nursanto D. B., 2022b 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.
WWF Indonesia, 2015 [The Asian seabass cultivation in floating cages and brackishwater ponds]. WWF Indonesia, 54 pp. [in Indonesian]
Xu A., Shang-Guan J., Li Z., Gao Z., Huang Y., Chen Q., 2020 Effects of garlic powder on feeding attraction activity, growth and digestive enzyme activities of Japanese seabass, *Lateolabrax japonicus*. Aquaculture Nutrition 26(2):390-399.
Yamazoe M., Mizuno A., Nishi Y., Niwa K., Isobe M., 2016 Serum alkaline phosphatase as a predictor of worsening renal function in patients with acute decompensated heart failure. Journal of Cardiology 67(5):412-417.
Yang R., Han M., Fu Z., Wang Y., Zhao W., Yu G., Ma Z., 2020 Immune responses of Asian seabass *Lates calcarifer* to dietary *Glycyrrhiza uralensis*. Animals 10(9):1629.
Yousefi M., Vatnikov Y. A., Kulikov E. V., Plushikov V. G., Drukovsky S. G., Hoseinifar S. H., Doan H. V., 2020 The protective effects of dietary garlic on common carp (*Cyprinus carpio*) exposed to ambient ammonia toxicity. Aquaculture 526:735400.
Yudhiyanto T., Suminto, Rachmawato 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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