



## Effect of salinity on growth and benefit-cost ratio of Asian seabass reared in artificial media

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**Abstract.** Research on Asian seabass (*Lates calcarifer*) cultivation in artificial media is required for its cultivation far from the coastal area. Thereby, fish farmers living far from the coast can cultivate Asian seabass for its high selling value. This study evaluated the effect of salinity on the growth and benefit-cost ratio (BCR) of Asian seabass. This experimental study was conducted in fiber tanks in the indoor laboratory for 30 days. The Asian seabass juveniles in this study had an average weight of 55.65 g with a rearing density of 25 fish m<sup>-3</sup>. The 3 treatments given were salinity of 5 ppt (treatment A), salinity of 15 ppt (treatment B), and salinity of 30 ppt (treatment C). Asian seabass were fed with commercial feed (pellets) with a minimum of 52% crude protein. A water recirculation system was applied to maintain water quality during the experiment. Weekly measurements of dissolved oxygen, temperature, pH, and salinity of the experimental media were carried out. Statistical analysis was performed for data analysis. The results indicate a significant effect of different treatments of salinity on fish growth, food conversion ratio, and benefit-cost ratio. This study showed that treatment A exhibited the best results.

**Key Words:** absolute growth, FCR, BC ratio, SGR, *Lates calcarifer*.

**Introduction.** *Lates calcarifer* (commercial name of barramundi or Asian seabass) is a euryhaline fish with high commercial value (Rajkumar et al 2006; Irmawati et al 2020; Vij et al 2020). Asian seabass (both from capture fisheries and aquaculture) is one of the main fishery commodities in several countries in Asia (Rajkumar et al 2006; WWF Indonesia 2015; Wijayanto et al 2020a). Fish resources in Indonesian waters are vulnerable to overexploitation, including Asian seabass (The Decree of Ministry of Marine Affairs and Fisheries No. 47 of 2016). Therefore, it is important to intensify the cultivation of Asian seabass.

The Indonesian government is trying to increase Asian seabass aquaculture production. The target for Asian seabass aquaculture production in 2024 is 14,000 tons (Ministry of Marine Affairs and Fisheries 2020). In Indonesia, Asian seabass is cultivated in brackish water and seawater (Wijayanto et al 2020a) although it can also be cultivated in freshwater. This opens up the opportunity for fish farmers in Indonesia who live far from coastal areas. Developing Asian seabass cultivation in areas far from the coast potentially increases its production in Indonesia. A study conducted by Wijayanto et al (2020a) showed that Asian seabass was best cultivated in an artificial medium with a salinity of 5 ppt. Comparison of Asian seabass cultivation in media with low and high salinity is prominent as further evidence from previous research. This research is a continuation of previous research related to the effect of salinity on Asian seabass cultivation. This study evaluated the effect of salinity on the growth of Asian seabass and its benefit-cost ratio (BCR).

## Material and Method

**Time and location of research.** This experimental research was carried out in the Fisheries Laboratory of Universitas Diponegoro from April 2021 to May 2021. The experiment was carried out for 30 days of cultivation.

**Tools and materials.** The study was conducted with Asian seabass juveniles with an average weight of 55.65 g fish<sup>-1</sup> (one cohort). Fish juveniles were reared in fiber tanks (in an indoor laboratory). The tanks did not connect to each other. The density of fish in the fiber tank was 25 fish m<sup>-3</sup>. The fish were fed commercial feed (sinking feed) about 4% per biomass per day with a minimum of 52% crude protein, a minimum of 14.5% fat, a maximum of 3% fiber, and a maximum of 10% moisture. The composition of commercial feed was considered optimum to support the growth and survival of Asian seabass (Williams et al 2003). Water filtration was carried out by a recirculation system using stone, coral, sand, and synthetic fibers.

**Treatments.** This study conducted 3 treatments of artificial media with a salinity of 5 ppt (treatment A), 15 ppt (treatment B), and 30 ppt (treatment C). Each treatment was repeated 3 times. Media with a certain salinity were made using sea salt dissolved and mixed with freshwater (homogenized and aerated). The fiber tanks were disinfected prior to use.

**Measurement of water quality.** Measurements of dissolved oxygen (DO), salinity, temperature, and pH were carried out every week using a multi-parameter water quality meter (Horiba U-50).

**Data analysis.** Asian seabass was weighed every 10 days to evaluate its growth and to determine the feed amount (4% of fish biomass per day). Data analysis performed included absolute growth (W), specific growth rate (SGR), feed conversion ratio (FCR), and benefit-cost ratio (BCR). We performed statistical tests of the analysis of variance (ANOVA) and the least significant difference (LSD) with a 95% confidence level. In this study, several formulas were used, including (Daet 2019; Wijayanto et al 2020a; Wijayanto et al 2020b):

$$W = W_t - W_o \quad [1]$$

$$SGR = (\ln W_t - \ln W_o) / t \quad [2]$$

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

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

W is the absolute growth of fish biomass (g fish<sup>-1</sup>); SGR is the specific growth rate of fish (% day<sup>-1</sup>); W<sub>t</sub> is the average weight of the fish (in t days); W<sub>o</sub> is the initial average weight of the fish (first day); F is the accumulation of feed that has been given to the fish (g); B is profit (income), i.e. additional income due to fish growth (IDR); C is the cost for feeding (IDR). The cultivation of Asian seabass is considered profitable if the BC ratio is greater than 1.0.

**Results.** During rearing, Asian seabass' growth is depicted in Figure 1 and Table 1. In general, the treatment of 5 ppt salinity showed the best results for W, SGR, FCR, and BCR. This finding supports the results of previous studies (Wijayanto et al 2020a).

Statistically, the treatments resulted in significant difference of fish growth (W and SGR), FCR, and BCR (Table 2). Treatment A (as the best result) showed a significant difference in variables of W and SGR compared to treatments B and C. However, treatment A and treatment B did not show significant difference on the variables of FCR and BCR.

Treatment C showed a BCR of less than 1. This indicates that it is not profitable. The simulation of the relationship between SGR and BCR is presented in Figure 2. The simulation shows that to produce a BCR of more than 1, it requires an SGR of more than 0.68%.

Table 1

W, SGR, FCR, and BCR of Asian seabass

Days	Salinity treatment								
	5 ppt (A)			10 ppt (B)			15 ppt (C)		
	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>
1	55.74	55.61	55.78	55.31	55.45	55.77	55.22	55.98	56.00
10	66.86	60.84	57.88	56.09	59.33	58.68	59.98	56.09	57.98
20	77.30	76.06	62.26	65.95	68.96	64.33	57.68	64.35	60.49
30	79.50	83.62	81.69	77.00	73.18	75.71	67.49	66.17	62.13
W (g)	23.76	28.01	25.91	21.69	17.72	19.93	12.27	10.19	6.13
SGR (%)	1.18%	1.36%	1.27%	1.10%	0.92%	1.02%	0.67%	0.56%	0.35%
FCR	3.36	2.75	2.72	3.27	4.15	3.59	5.64	6.93	11.38
BCR	1.66	2.04	2.06	1.71	1.35	1.56	0.99	0.81	0.49

Note: Assume the price of Asian seabass is IDR 140,000/kg. The price of fish feed is IDR 25,000/kg. The sea salt costs among treatments were not significant since the price of sea salt was cheap (IDR 1000/kg) and the cost of sea salt was very small in Asian seabass cultivation.

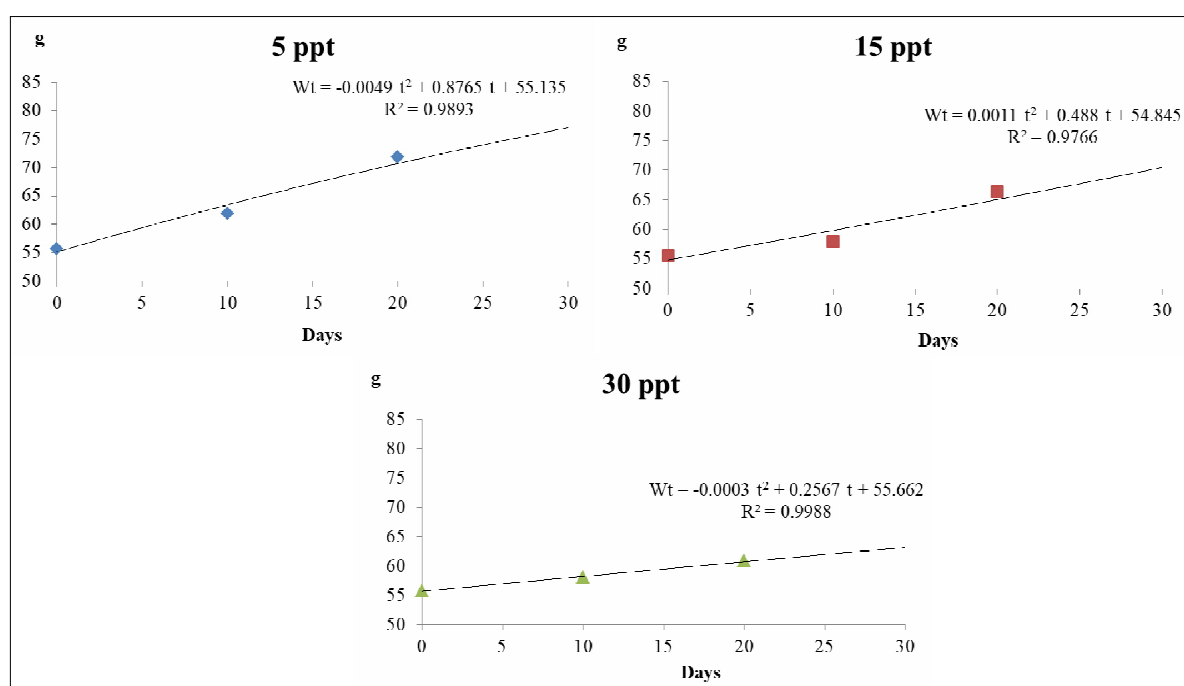


Figure 1. Asian seabass growth during experiment.

Table 2

## Statistical analysis

Variables	Statistical significance values	LSD test
W	0.001*	A-B: 0.0229* A-C: 0.0002* B-C: 0.0023*
SGR	0.001*	A-B: 0.0385* A-C: 0.0002* B-C: 0.00232*
FCR	0.026*	A-B: 0.6335 A-C: 0.0135* B-C: 0.0245*
BC ratio	0.011*	A-B: 0.0800 A-C: 0.0007* B-C: 0.0051*

Note: \* at confidence level of 95%.

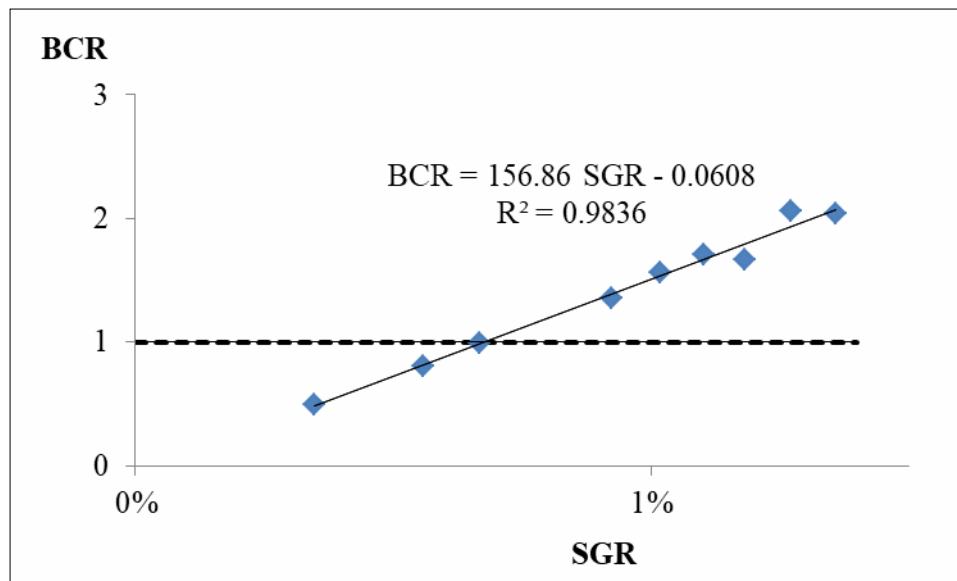


Figure 2. Relationship between SGR and BCR.

During the study, the range of DO was 4.20 to 5.50 ppm. While the pH of the water was in the range of 7.19 to 7.47. The water temperature ranged from 25.0 to 28.5°C. The salinity of the cultivation media was stable according to the treatment specified. Thus, the media used during the experiment suited the needs of Asian seabass (Cheong 1989; WWF Indonesia 2015).

**Discussion.** Different fish has different habitat. Asian seabass has a life cycle. The phase of its life cycle is influenced by the salinity of the waters where it lives in. However, due to its high tolerance to salinity (euryhaline), Asian seabass can be cultured in freshwater, brackish water, and seawater. According to Vij et al (2020), the aquatic environment is categorized as freshwater if the salinity is less than 0.5 ppt, categorized as brackish water if the salinity is between 0.5 ppt to 30 ppt, and categorized as seawater if the salinity ranges from 30 ppt to 40 ppt. According to Irmawati et al (2020), the Asian seabass is a catadromous fish. It grows in freshwater then migrates to seawater (breeding migration and spawning migration). According to Rajkumar et al (2006), Asian seabass can be found in freshwater, estuary, and coast, from the Arabian Gulf, Southeast Asia, to northern Australia. Vij et al (2020) further describe that Asian seabass inhabits coastal waters, estuaries, and freshwater that are connected to the sea along the tropical Indo-West Pacific region.

Asian seabass has become an important fishery commodity in terms of capture fisheries and aquaculture in the Arabian Gulf, Southeast Asia, to Australia. Fish farming in brackish water (including Asian seabass) developed worldwide since shrimp farming experienced shocks due to disease (Rajkumar et al 2006). In Thailand, Asian seabass has been cultivated in freshwater ponds. Whereas in Tahiti, Asian seabass is cultivated at 35‰ salinity (Cheong 1989).

According to Vij et al (2020), euryhaline fish usually inhabit estuary waters with frequent changes in salinity. These fish tend to migrate frequently and enable to survive in fresh and saltwater during the various phases of their life cycle. Euryhaline fish can adapt to osmoregulation problems due to different levels of salinity. Euryhaline fish (including Asian seabass) can maintain homeostasis even though they live in waters with fluctuated salinity. Physiologically, Asian seabass juveniles have physio-regulation like freshwater fish in low salinity waters and change to be like seawater fish in high salinity waters.

Fish growth is determined by complex factors. It is influenced by water quality (including salinity), feed (quantity and quality), fish density, and quality of juvenile. According to Hart & Reynolds (2002), fish growth is affected by many complex factors, including environmental conditions, juvenile quality, feed (both quantity and quality),

gonadal development, age, and fish health. In the long term, fish growth tends to follow a sigmoid growth curve and fit a second-order polynomial model (Hamre et al 2014). Variations in the length-weight relationship and the condition of Asian seabass are due to food availability, competition, water quality, and gonad maturity (Rajkumar et al 2006).

Feed quality, feed quantity, and feeding frequency affect the efficiency and effectiveness of feeding, including FCR. According to Williams et al (2003), the FCR of Asian seabass is positively correlated with the protein content of the feed given. A study conducted by Daet (2019) also shows that the lower the density of Asian seabass, the easier the cultivation control and the better the feed conversion (more effective and efficient). According to Hassan et al (2021), feeding is crucial in fish farming. Uneaten food can reduce water quality.

Regarding the profit of fish farming, each actor (fish farmer) assuredly try to increase the income and streamline the costs. BCR is influenced by income and costs. Income in aquaculture is influenced by fish growth and fish prices. Meanwhile, the cost of cultivation is influenced by, among others, the cost of tools, materials, workers, and juveniles used in fish farming. Increasing income can be done by encouraging fish growth and increasing fish prices. As presented in Figure 2, it is recommended that Asian seabass farmers can achieve an SGR of more than 0.68%. Increasing fish growth can be done by managing water quality, feed, fish density, grading fish, and selecting juveniles. The price of fish is influenced by the quality of the fish and the factors that affect demand (which are complex). The study of Bozoglu & Ceyhan (2009) shows that the benefit-cost ratio of Asian seabass farming can reach 1.1003 with feed costs as the largest proportion of total cost (47.73%). Aswathy & Joseph (2018) describe that Asian seabass cage farming produces a BCR of 1.04 and 1.26. BCR is influenced by cage dimensions, density, cultivation period, and location. Considering the cost of artificial feed in Asian seabass farming provides the largest component of working capital, feed management is one of the key factors for the success of Asian seabass cultivation.

**Conclusions.** The results of this study indicate that there is a significant effect of different salinity treatments on Asian seabass' growth (W and SGR), FCR, and BCR. The treatment that resulted in the best results was treatment A (5 ppt salinity). Profits can be achieved if the SGR is more than 0.68%.

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