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Growth and Survival of Seabass (*Lates calcarifer*) Cultured under Different Salinity Levels and Tank Colours

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ABSTRACT

This study investigated the interaction between salinity and container colour on survival, growth, and feed conversion ratio in barramundi (*Lates calcarifer*). This study used a Randomised Block Design (RCD), with juvenile sea bass (2-3 g weight, 5-6 cm length) stocked into a 70 litre aquarium. The study was conducted with a combination of three salinity levels (0, 15, and 30 ppt) and three container colours (blue, black, and orange). Each treatment consisted of 35 juveniles fed 40% crude protein pellets (0.7-1 mm) at 7% of biomass, three times a day for 28 days. There was a significant interaction between salinity and container colour on *L. Calcarifers* growth. Blue containers supported better weight gain at all salinity levels. Meanwhile, orange containers reduced the negative impact of high salinity on growth. Although, this interaction was not significant for length growth or feed conversion.

Keyword: container color, growth, salinity, seabass (*Lates calcarifer*), survival

INTRODUCTION

Barramundi (*Lates calcarifer*) stands out for its nutritional profile and economic value. It contains 15-19.5% protein and 3.5 - 9% fat in fresh condition (Simon *et al.*, 2019). These nutrients are good for a healthy diet and are in line with the increasing global awareness of healthy eating (Carton and Jones, 2013). The potential of this fish is also promising in both domestic and export scope (Siddik *et al.*, 2016). The high demand has led to overexploitation and a decline in the number of juvenile stocks in their natural habitat (Blaber *et al.*, 2008). To overcome this problem, intensive culture of *L. Calcarifer* has been developed (Schipp *et al.*, 2007). One of the advantages of *L. Calcarifer* culture is that it can be conducted in coastal floating net cages, brackish water ponds, or freshwater ponds (Nhan *et al.*, 2022). *L. Calcarifer* have tolerance to frequent salinity changes (euryhaline), and are classified as catadromous (Vij *et al.*, 2020). The gills of euryhaline fish have special mechanisms to regulate the balance of osmotic pressure through the action of biological enzymes, hormone regulation, utilization of ion transport channels, and systematic conduction of biological signals (Bao *et al.*, 2022). In addition, another advantage is that it has a high fertility rate, fast growth, and good market acceptance

(Domingos *et al.*, 2021). However, so far the local *L. Calcarifer* parent has performed relatively lower than the Australian strain (Pietoyo *et al.*, 2022).

However, there are challenges in terms of the availability of quality natural seeds, which requires effective breeding efforts. The *L. Calcarifer* breeding phase is an important transitional phase in cultivation, where in this phase fish seeds will be produced for rearing cultivation (Kumaran *et al.*, 2022). This phase is influenced by various factors, such as environmental conditions, especially water quality which includes parameters such as salinity and physical characteristics of rearing containers such as their color (McLean, 2021; Seale *et al.*, 2024; Ullmann *et al.*, 2011).

Extreme salinity changes can cause osmotic stress that causes macromolecular damage to the fish, resulting in decreased fish health (Evans and Kültz, 2020). On the other hand, tank colour has been reported to affect larval survival, health, stress levels and even aggression level (McLean, 2021). Where the colour of the tank relates to the spectral zone that the fish will receive. Certain spectral zones stress fish, which is confirmed by increased cortisol levels. Furthermore, the colour of the environment can activate and suppress fish nutrition. the more contrasting the feed is with a particular environmental colour can affect the amount of food consumed and somatic growth (Ruchin, 2020).

In Asian snapper, it is reported that red is the most suitable background colour for rearing juvenile snapper, followed by white, black and blue (Morshedi *et al.*, 2022). However, information on the interaction effect between salinity and rearing container colour on growth rate, feed conversion and survival in L. calcarifer culture is still very limited. This study aims to elucidate the interaction effects caused by water salinity and rearing container colour on growth, feed conversion and fry survival.

MATERIAL AND METHOD

Research place

The research was conducted in May 2022 at the Situbondo Brackish Water Aquaculture Center (BPBAP), which is located at Jalan Raya Pecaron, Klatakan Village, Kendit Subdistrict, Situbondo Regency, East Java, Indonesia.

Research design

This research used a factorial Completely Randomized Design (CRD) method with two treatment variables: different salinity levels and container colors. Each treatment was repeated three times. The first factor is salinity (S), and the second is container color (W). The salinity factor (S) shows three treatment levels, namely S1 (0 ppt), S2 (15 ppt), and S3 (30 ppt), while the container color factor (W) shows three treatments, namely W1 (blue), W2 (black), and W3 (orange).

There was a total of 27 treatments from the combination of the two factors. A total 945 juvenile *L. Calcarifer* fish with a size of 5-6 cm and a weight of 2-3 grams were used in this study, all fish samples came from the Situbondo brackish water aquaculture centre. The number of juveniles used in the study was determined based on nine combinations of experimental units with three replications. Each replication consisted of 35 juvenile seabass with a population density of 1 juvenile per 2 liters of water.

Research Preparation

The container is an aquarium made of clear glass measuring 45 × 45 × 45 cm with a water height of 34.5 cm (volume 70 liters) equipped with one aeration. Juvenile seabass to be used for research are graded first so that they have a uniform size. The feed to be used is commercial feed with a diameter of 700 - 1,000 microns and a minimum protein content of 40%. In making the salinity of the maintenance media, it is adjusted to the salinity factor, namely 0 ppt, 15 ppt, and 30 ppt. Furthermore, cover all sides of the aquarium except the top with blue, black, and orange plastic according to the amount needed for the tank color factor.

Tabel 1. Treatment combination between salinity and rearing container color

	Colour (W)		
Salinity (S)	W1	W2	W3
S1	S1W1	S1W2	S1W3
S2	S2W1	S2W2	S2W3
S3	S3W1	S3W2	S3W3

Rearing of *Lates Calcarifer*

Juvenile sea bass were stocked into the aquarium slowly (acclimatisation) until they reached the desired salinity level in this study (15 and 0 ppt). Furthermore, after adapting to the new salinity the fish were reared for 28 days. During rearing, juveniles were fed 7% of biomass at a frequency of 3 times a day. On the other hand, water quality measurements; temperature, pH, DO, and salinity were measured daily and water changes were a maximum of 80%/day.

Data collecting

Data collected during the study included specific growth rate length and weight, feed conversion ratio, and survival. During maintenance, measurements were taken every seven days. The number of juveniles sampled was seven juveniles from the total, or 20% of the population. The formula used to calculate the daily length growth rate according to Luo *et al*. (2014) is as follows:

$$SGR(w) = \frac{(Ln\ Final\ weight - Ln\ Initial\ Weight)}{Days} x\ 100$$

$$SGR(l) = \frac{(Ln\ Final\ length - Ln\ Initial\ length)}{Days} x\ 100$$

$$FCR = \frac{(Total\ feed)}{Total\ of\ weight\ gain}$$

$$SR = \frac{(Final\ number\ of\ biomass)}{initial\ number\ of\ biomass} x\ 100\%$$

Data analysis

Analysis of variance (ANOVA) was conducted to determine the effect of the treatment, and continued with Duncan's Multiple Range Test (DMRT) at the 5% level to determine the differences in each treatment.

RESULT AND DISCUSSION

Growth and Survival of *Lates Calcalifer*

In this study, SGR_L and SGR_W are used to describe length and weight growth. The best growth of length (SGR_L) of *L. Calcarifer* was found in treatment with 0 ppt salinity and a blue color (S1W1) of 5.56 cm. This treatment resulted in a significant difference ($P < 0.05$) from the other treatments. This value is consistent with specific growth rate (SGR_w) values from the same treatment, which were 14.51 g. However, salinity and container color had no effect on survival rates, as all treatments had a 100% survival rate (Table 2).

The growth performance of seabass is influenced by various factors such as salinity and container color. Salinity has been identified as an important parameter affecting *L. Calcarifers* growth. Several studies have shown that a certain level of salinity is optimal for this fish's growth (Seale *et al.*, 2024; Weakley *et al.*, 2012).

The results of this study indicate that zero ppt salinity (fresh water) produces better growth compared to brackish water and seawater. This condition can occur because *L. Calcarifer* can live in freshwater for less than one year to 11 years before migrating to salt water in the estuary (Roberts *et al.*, 2024). This finding aligns with the research of Wijayanto *et al*. (2020), who reported that seabass reared at low salinity showed better specific growth rate (SGR_w) compared to those reared at higher salinity. In addition, seawater salinity variations affect snapper's survival rate and growth in the seeding phase (Young and Almoutiri, 2021). The effect of salinity on growth can be associated with a shift in energy consumption from growth to osmoregulation, which is an active mechanism in maintaining the body's osmotic balance.

Table 2. Interaction between salinity and tank color on growth and FCR of *L. calcarifer*.

Treatment	Salinity	Container colour	SR (%)	SGR_L (%/day)	SGR_w (%day)	FCR
S1W1	0 ppt	Blue	100± 0,00[a]	5,56±0,61[a]	14,51±0,93[a]	0,67±0,01[c]
S1W2	0 ppt	Black	100± 0,00 [a]	3,40±0,27[bc]	10,55±2,04[b]	0,87±0,12[bc]
S1W3	0 ppt	Orange	100± 0,00 [a]	3,88±0,69[b]	13,71±0,38[a]	0,70±0,02[c]
S2W1	15 ppt	Blue	100± 0,00 [a]	2,9±0,12[c]	11,79±1,5[b]	0,86±0,08[bc]
S2W2	15 ppt	Black	100± 0,00 [a]	2,86±0,25[c]	10,27±0,75[b]	0,91±0,04[bc]
S2W3	15 ppt	Orange	100± 0,00 [a]	3,5±0,6[bc]	11,90±0,34[ab]	0,83±0,04[bc]
S3W1	30 ppt	Blue	100± 0,00 [a]	4,04±0,25[b]	10,54±0,49[ab]	0,85±0,06[bc]
S3W2	30 ppt	Black	100± 0,00 [a]	2,95±0,71[c]	9,5±1,83[b]	0,97±0,09[a]
S3W3	30 ppt	Orange	100± 0,00 [a]	3,33±0,17[bc]	12,21±2,69[ab]	0,79±0,09[c]

In addition, increased cortisol levels in response to osmotic stress also contribute to growth retardation (Triantaphyllopoulos *et al.*, 2020). Santisathitkul *et al*. (2020) showed that background color affects the growth of *L. calcarifer*. This suggests the physical characteristics of the container have a potential impact on the growth of snappers (Arechavala-Lopez *et al.*, 2022). Regarding the color of the container, although Banan *et al*. (2011) emphasized that container color has a limited effect on growth performance and physiological parameters of beluga fish (*Huso huso*), light color has a significant effect (Banan *et al.*, 2011). Noureldin *et al*. (2021) reported that keeping *C. auratus* under monochromatic blue light improves their performance and immune-physiological response to stress. This suggests that the effect of container color on growth may be species-specific and requires further investigation.

FCR of *Lates Calcarifer*

Feed Conversion Ratio (FCR) is the feed given per unit of body weight gain (Prakash *et al.*, 2020). The FCR value can be influenced by several factors, namely the feeding frequency, stocking density, and water quality (Oliveira *et al.*, 2012; Mengistu *et al.*, 2020; Huang *et al.*, 2025). In addition, according to Dopeikar *et al*. (2024), FCR can also be influenced by the color of the maintenance media. Based on the results of the study, the best FCR value was in treatment S1W1 with a value of 0.67, which was significantly different ($P < 0.05$) from treatment S3W2 but not significantly different ($P > 0.05$) from other treatments (Table 2). Treatment S1W1 has a salinity value of 0 ppt, with blue as the tank color.

These results are in accordance with the research of Wijayanto *et al*. (2020), which states that the best FCR value is found at low salinity compared to high salinity. This statement is also supported by Noval *et al.* (2018), who stated that grouper fish can live at low salinity because part of their life grows at low salinity. This is because juvenile seabass fish have catadromous properties, so juvenile seabass fish migrate to fresh and brackish waters to grow and, after adulthood, return to the sea to spawn (Blaber *et al.,* 2008). In addition, seabass fish have flat type 1 ionocytes on their gills, which function to absorb ions in low-salinity environments so that grouper fish can live and grow at low salinity (Ding *et al.*, 2022).

In addition to salinity, tank color can also affect the FCR value. Fish kept in blue tanks have better FCR values. The effect of the background color is likely related to the ability of fish to see objects clearly when they contrast with the background color, thus contributing to a high growth rate and feed utilization (Ninwichian *et al.*, 2022).

CONCLUSION

Salinity significantly affects growth (daily length and weight) and feed conversion in *L. Calcarifer*. Freshwater gives the best results for growth in length, weight, and feed conversion compared to brackish water and seawater. The blue color of the culture container supports SGR and the most optimal feed conversion. Further research is needed to understand the physiological mechanisms behind the interaction effect of container color on salinity.

CONFLICT OF INTEREST

All authors declare that they have no conflict of interest.

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REFERENCES

Arechavala-Lopez, P., Nuñez-Velazquez, S., Diaz-Gil, C., Follana-Berná, G., & Saraiva, J.L., (2022). Suspended Structures Reduce Variability of Group Risk-Taking Responses of *Dicentrarchus labrax* Juvenile Reared in Tanks. Juvenilees 7, 126.

Banan, A., Kalbassi, M. R., Bahmani, M., & Sadati, M. A. Y., (2011). Effects of colored light and tank color on growth indices and some physiological parameters of juvenile beluga (*Huso huso*). J. Appl. Ichthyol. 27, 565–570.

Bao, Y., Shen, Y., Li, X., Wu, Z., Jiao, L., Li, J., ... & Jin, M. (2022). A new insight into the underlying adaptive strategies of euryhaline marine fish to low salinity environment: through cholesterol nutrition to regulate physiological responses. Frontiers in Nutrition, 9, 855369.

Blaber, S. J. M., Milton, D. A., & Salini, J. P. (2008). Chapter 11 The Biology of barramundi (*Lates calcarifer*) in the Fly River System, in: Bolton, B. (Ed.), Developments in Earth and Environmental Sciences, The Fly River, Papu a New Guinea: Environmental Studies in an Impacted Tropical River System. Elsevier, pp. 411–426.

Carton, A.G., & Jones, B., (2013). Post-Harvest Quality in Farmed *Lates calcarifer*, in: Biology and Culture of Asian Seabass *Lates calcarifer*. CRC Press.

Ding, Y. C., Lee, S. S., Peng, S. K., Yang, W. K., & Lee, T. H. (2023). Salinity-dependent changes in branchial morphometry and Na+, K+-ATPase responses of euryhaline Asian sea bass, *Lates calcarifer*. Journal of Experimental Zoology Part A: Ecological and Integrative Physiology, 339(5), 451-463.

Domingos, J. A., Goldsbury, J. A., Gomes, G. B., Smith, B. G., Tomlinson, C., Bade, T., ... & Jerry, D. R. (2021). Genotype by environment interactions of harvest growth traits for barramundi (*Lates calcarifer*) commercially farmed in marine vs. freshwater conditions. Aquaculture, 532, 735989.

Dopeikar, H., Khoshkholgh, M., Ghasemi, S. A., & Morshedi, V. (2024). Effects of Background Color on Growth, Stress, Biochemical, Hematological, and Immunological Responses, and Expression of Growth-Related Genes in Oscar Fish (*Astronotus ocellatus*). Aquaculture Research, 2024(1), 6957201.

Evans, T. G., & Kültz, D. (2020). The cellular stress response in fish exposed to salinity fluctuations. Journal of Experimental Zoology Part A: Ecological and Integrative Physiology, 333(6), 421-435.

Huang, M., Zhou, Y. G., Yang, X. G., Gao, Q. F., Chen, Y. N., Ren, Y. C., & Dong, S. L. 2025. Optimizing feeding frequencies in fish: A meta-analysis and machine learning approach. Aquaculture, 595, 741678.

Kumaran, M., Vasagam, K. K., Subburaj, R., Anand, P. R., Ramachandran, K., Geetha, R., ... & Sairam, C. V. (2022). Techno-economic evaluation of Asian seabass (*Lates calcarifer*) nursery rearing in small net cages (hapas) under different coastal salinities. Aquaculture International, 1-16.

Luo, G., Gao, Q., Wang, C., Liu, W., Sun, D., Li, L., & Tan, H. (2014). Growth, digestive activity, welfare, and partial cost-effectiveness of genetically improved farmed tilapia (*Oreochromis niloticus*) cultured in a recirculating aquaculture system and an indoor biofloc system. Aquaculture, 422, 1-7.

McLean, E., 2021. Juvenile tank color: An overview. Aquaculture 530, 735750.

Mengistu, S. B., Mulder, H. A., Benzie, J. A., & Komen, H. (2020). A systematic literature review of the major factors causing yield gap by affecting growth, feed conversion ratio and survival in Nile tilapia (*Oreochromis niloticus*). Reviews in Aquaculture, 12(2), 524-541.

Morshedi, V., Pradhoshini, K. P., Tangestani, N., Ghasemi, A., Sotoudeh, E., Gamoori, R., & Musthafa, M. S. (2022). Effects of rearing tank colour on growth indices, blood chemistry, digestive enzymes, expression of stress and growth-related genes of Seabass juvenile (*Lates calcarifer*). Aquaculture Research, 53(10), 3780-3787.

Nhan, D. T., Tu, N. P. C., & Van Tu, N. (2022). Comparison of growth performance, survival rate and economic efficiency of Asian seabass (*Lates calcarifer*) intensively cultured in earthen ponds with high densities. Aquaculture, 554, 738151.

Ninwichian, P., Phuwan, N., & Limlek, P. (2022). Effects of tank color on the growth, survival rate, stress response, and skin color of juvenile hybrid catfish (*Clarias macrocephalus*× *Clarias gariepinus*). Aquaculture, 554, 738129.

Noureldin, S. M., Diab, A. M., Salah, A. S., & Mohamed, R. A. (2021). Effect of different monochromatic LED light colors on growth performance, behavior, immune-physiological responses of gold fish, *Carassius auratus*. Aquaculture, 538, 736532.

Noval, M., Handajani, H., & Hariyadi. (2019). Effect of different stocking densities on growth and survival of seabass fish (*Lates calcarifer*) nursery phase in low salinity. IJOTA, 2(2), 73-79.

Oliveira, E. G., Pinheiro, A. B., de Oliveira, V. Q., da Silva Júnior, A. R. M., de Moraes, M. G., Rocha, Í. R. C. B., ... & Costa, F. H. F. (2012). Effects of stocking density on the performance of juvenile pirarucu (*Arapaima gigas*) in cages. Aquaculture, 370, 96-101.

Pietoyo, A., Tarigan, R. R., Astiyani, W. P., Febriani, V. T., & Syah, I. F. (2022). Performa Hasil Pemijahan Ikan Kakap Putih (*Lates calcarifer*) Strain Lokal dan Australia. Journal of Aquaculture Science, 7(2), 135 -139.

Prakash, A., Saxena, V. K., & Singh, M. K. (2020). Genetic analysis of residual feed intake, feed conversion ratio and related growth parameters in broiler chicken: a review. World's Poultry Science Journal, 76(2), 304-317.

Roberts, B. H., Morrongiello, J. R., Morgan, D. L., King, A. J., Saunders, T. M., Banks, S. C., & Crook, D. A. (2024). Monsoonal wet season influences the migration tendency of a catadromous fish (barramundi *Lates calcarifer*). Journal of Animal Ecology, 93(1), 83-94.

Ruchin, A. B. (2020). Environmental colour impact on the life of lower aquatic vertebrates: development, growth, physiological and biochemical processes. Reviews in Aquaculture, 12(1), 310-327.

Santisathitkul, N., Thongprajukaew, K., Saekhow, S., Sandos, P., Buntomnimit, S., & Kanghae, H. (2020). Optimal background colour for rearing Asian seabass (*Lates calcarifer*). Aquaculture Research, 51(4), 1743-1752.

Schipp, G., Bosmans, J., Humphrey, J., 2007. *L. calcarifer* Farming Handbook. Department of Primary Industry, Juvenileeries and Mines, Australia.

Seale, A.P., Cao, K., Chang, R.J.A., Goodearly, T.R., Malintha, G.H.T., Merlo, R.S., Peterson, T.L., Reighard, J.R., 2024. Salinity tolerance of juvenilees: Experimental approaches and implications for aquaculture production. Rev. Aquac. 16, 1351–1373.

Siddik, M. A. B., Islam, M. A., Hanif, M. A., Chaklader, M. R., Kleindienst, R. (2016). Barramundi, *Lates calcarifer* (Bloch, 1790): a new dimension to the juvenile farming in coastal Bangladesh. J. Aquac. Res. Dev. 7, 1000461.

Simon, C.J., Salini, M.J., Irvin, S., Blyth, D., Bourne, N., & Smullen, R. (2019). The effect of poultry protein concentrate and phosphorus supplementation on growth, digestibility and nutrient retention efficiency in barramundi *Lates calcarifer*. Aquaculture 498, 305–314.

Triantaphyllopoulos, K. A., Cartas, D., & Miliou, H. (2020). Factors influencing GH and IGF-I gene expression on growth in teleost fish: how can aquaculture industry benefit?. Reviews in Aquaculture, 12(3), 1637-1662.

Ullmann, J. F. P., Gallagher, T., Hart, N. S., Barnes, A. C., Smullen, R. P., Collin, S. P., & Temple, S. E. (2011). Tank color increases growth, and alters color preference and spectral sensitivity, in barramundi (*Lates calcarifer*). Aquaculture 322–323, 235–240.

Vij, S., Purushothaman, K., Sridatta, P. S. R., & Jerry, D. R. (2020). Transcriptomic analysis of gill and kidney from Asian seabass (*Lates calcarifer*) acclimated to different salinities reveals pathways involved with euryhalinity. Genes, 11(7), 733.

Weakley, J. C., Claiborne, J. B., Hyndman, K. A., & Edwards, S. L. (2012_. The effect of environmental salinity on H+ efflux in the euryhaline barramundi (*Lates calcarifer*). Aquaculture 338–341, 190–196.

Wijayanto, D., Bambang, A. N., Nugroho, R. A., Kurohman, F., & Nursanto, D. B. (2020). The effect of different low salinities on growth, feed conversion ratio, survival rate and profit of Asian seabass cultivation. Aquaculture, Aquarium, Conservation & Legislation, 13(6), 3706-3712.

Young, B., & AlMoutiri, I. (2021). Effects of High Salinity on the Larviculture of Asian Seabass *Lates calcarifer* in Outdoor Systems. North Am. J. Aquac. 84.