Growth, survival and feed conversion of juvenile tiger grouper *Epinephelus fuscoguttatus* in different salinity regimes

[1]Abdullah A. Muhammadar, [2] Abdul G. Mazlan, [2]Abdullah Samat, [3]Muhammad S. Asmawati, [1]Zainal A. Muchlisin, [4]Michael A. Rimmer, [2] Khumar D. Simon

[1] Department of Aquaculture, Syiah Kuala University, Banda Aceh, Indonesia; [2] School of Environmental and Natural Resource Sciences, Faculty of Science and Technology, University of Kebangsaan, Bangi Selangor D. E., Malaysia; [3] Department of Agricultural Product Technology, Syiah Kuala University, Banda Aceh, Indonesia, and Faculty of Veterinary Science, University of Sydney, Australia. Corresponding author: A. A. Muhammadar, m_dar71@yahoo.com

Abstract. Tiger grouper *Epinephelus fuscoguttatus* has been considered as most commercially important cultured species in ASEAN regions. The present study was conducted in order to estimate the growth, and culture efficiency of tiger grouper juvenile in different salinity regimes (22, 28, and 32 psu) in cages at the Brackish water Aquaculture Station, Ujung Batee Aceh-Indonesia. The growth and other culturing efficiency of 25 juvenile grouper from each sample were recorded every 5 days for 45 days period. The data is analyzed with a one-way ANOVA and Duncan test using SAS 9.1 program. The highest growth performance (absolute and specific growth) was observed at 32 psu being 0.095 cm/day for absolute growth and 2.26% for specific growth in comparison to other salinity regimes (22 and 28 psu). Similarly the highest survival rate was observed at 32 psu and the lowest survival rate at 22 psu. Calculation of FCR values for tiger grouper in the present experiment agreed well with the positive culture efficiency at 32 psu. The results obtained from the present study suggested that the tiger grouper performed best growth and culture efficiency (Feeding Conversion Ratio and Survival Rate) at salinity of 32 psu kept in cage for commercial production).
Key words: Culturing efficiency, brackish water, aquaculture station, survival rate.

Introduction. Groupers are carnivorous saltwater fish which have a high tolerance to salinity, so they are easily found in estuarine and marine environments. Bianchi (2006) states that regional coastal aquatic environment such as estuaries, marshes, and tidal streams can be marked with the number of abiotic stress due to changes in temperature, dissolved oxygen and salinity environment. Along with that the variant situation of the territorial waters are greatly influenced by global warming (Scavia et al 2002) and local factors such as an intensive human activities on the use of fish farming areas (Gray et al 1990).

In Indonesia the growth of culturing juvenile tiger grouper *Epinephelus fuscoguttatus* in cages started in 2006 on salt water ponds in coastal waters (Sugama et al 2004). However, these efforts must be coordinated with the needs of the required salinity for juvenile growth. The development and growth of teleost fish highly depends on the type and the character of each species and salinity level around the area (Boeuf & Payan 2001).

Numerous researches have been conducted on different species such as Milkfish (*Chanos-chanos*) (Alava et al 2004; Swanson 1998), Mozambique tilapia (*Oreochromis mossambicus*), Nile tilapia (*Oreochromis niloticus*), Blue tilapia (*Oreochromis aureus*),

Sabaki tilapia (*Oreochromis spilurus spilurus*) (Suresh & Lin 1992), and Seabream (*Sparus sarba*) (Woo & Kelly 1995) and found that their growth is affected by salinity. These studies were conducted to get a good quality of fish with a low cost (Boeuf & Payan 2001). However, the information about the growth, survival rate, and feeding conversion ratio of juvenile grouper under different salinity concentrations are limited, therefore further researches are required.

Material and Method. As research materials two months juvenile tiger grouper was considered with a total length of 2.8-3.2 cm. Juveniles (4200 individuals) were kept in 3 ponds (size: 5 x 3 x 2 m) with different salinity concentrations as follows: 22, 28 and 32 psu. Each pond contained 4 cages (size: 2 x 1.5 x 1 m) with 400 juveniles tiger grouper per cage. Calculation and statistical analysis were performed on three parameters, namely, growth (specific and absolute), feeding conversion ratio (%) and survival rate (%). Absolute growth rate (AGR) = $(L_2-L_1) / \Delta t$ (Jones 2002). Notes are L_1 =Initial Length, L_2 = final length and Δt = period.

The average specific growth (SGR) = [(Ln final weight - Ln initial weight) / day] x 100 (Sharpawi et al 2011). Feeding conversion ratio (FCR) = F / [(Wt+D)-Wo] (Djarijah 2010). Notes are F = the total amount of given food, Wo = the total initial weight of the fish, Wt = the total final weight of fish, D = the total weight of dead fish. Survival rates (SR%) = [(final mortality – early mortality) / early mortality] x 100 (Djarijah 2010; Hseu et al 2003). These data firstly will be recorded in Window Program and then analyzed statistically with a one-way ANOVA using SAS 9.1 program (Institute Inc., Cory, NC. 27 513, USA).

Results and Discussion

Growth. During the culturing period, the absolute growth rate (AGR) vary sequentially from the highest value to the lowest, at 32 psu salinity treatment was 0.095±0.004 cm/day, at 28 psu 0.078±0.012 cm/day, and at 22 psu 0.065±0.009 cm/day, statistically the value varying significantly (p<0.05) (Figure 1).
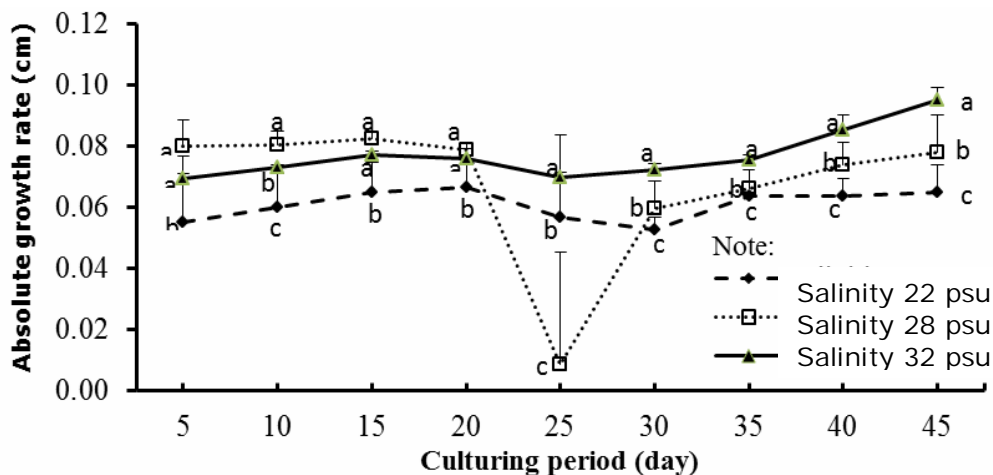

Figure 1. Absolute growth rate (AGR) (cm/day) of juvenile tiger grouper *(Epinephelus fuscoguttatus)* cultured in three different salinity regimes for 45 days. Different superscripts (vertical) at each stage of the culturing period shows a different value (p<0.05).

The figure shows that the treatment with 32 psu salinity has the highest absolute growth compared to other treatments during the culturing period. The treatment with 28 psu

salinity shows high absolute growth rate only during the first 20 days, then in the next few days decreased rapidly to the lower level. The "lag phase" occurs on this treatments on the 25th day, thereby increases the chance of specific growth (Figure 2). Treatment with 22 psu salinity appears as the lowest absolute growth throughout the culturing time compared to other treatments and the value vary significantly (p<0.05).

The percentage of AGR in every treatment has declined during the 25-30 days culturing time due to "lag phase". However, the "lag phase" occurs as their energy has been allocated to SGR. For example the juveniles of Red drum (*Sciaenops ocellatus)* in the range of 0-6 g weight also experience a "lag phase", but after they reach 6-15 g they grow faster, i.e., the "lag phase" will accelerate the growth in the next stage (Wurts & Stickney 1993). Although the pellets have a good nutrition quality, "lag phase" still occurs in the absolute growth. This indicates that the ontogeny character is still carried in the culturing period and the "lag phase" was found to vary depending on age and species.

The "lag phase" in the absolute growth of the fish indicates a weight gain of the fish and a morphological changes involving metabolism through physiological processes (Fuiman 2002).

The result of specific growth (SGR) in different salinity treatments reach the highest value at 32 psu, followed by 28 psu, and the lowest at 22 psu. Specific growth at the end of the culturing period (45 days) also showed a similar trend pattern or there is no significant difference (p>0.05) between treatments at salinity of 28 and 32 psu. However, both values are significantly different (p<0.05) from specific growth observed at 22 psu salinity (Figure 2).
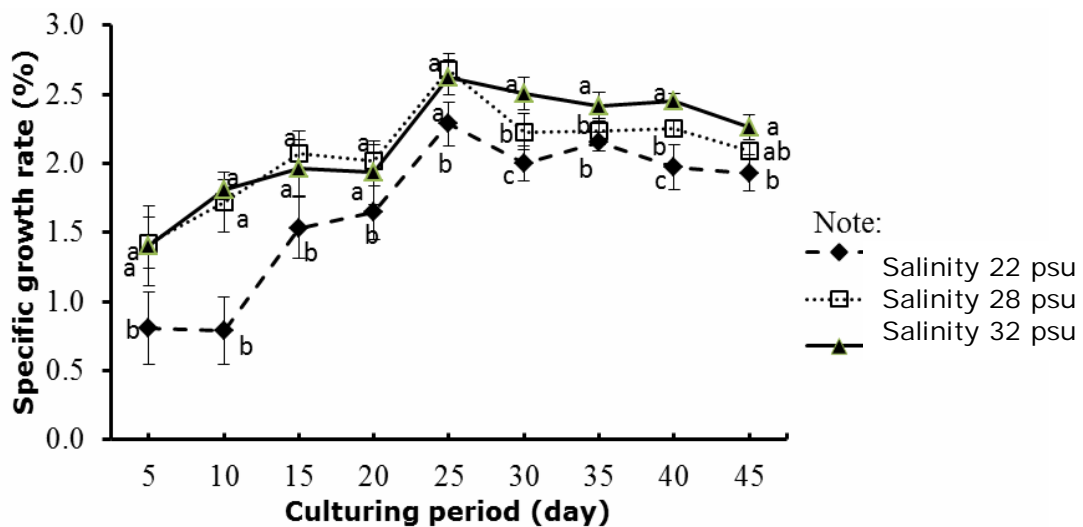

Figure 2. Specific growth rate (AGR) of juvenile tiger grouper *(Epinephelus fuscoguttatus)* observed in three different salinity conditions for 45 days. Different superscripts (vertical) at each stage of the culturing period shows a different value (p<0.05).

Survival rate. The highest survival rate (SR%) was found in treatment at 32 psu salinity (80.19±1.14%), and followed by treatment at 28 psu (68.38±1.98%) and treatment at 22 psu as the lowest level (62.00±2.47%) (Figure 3).
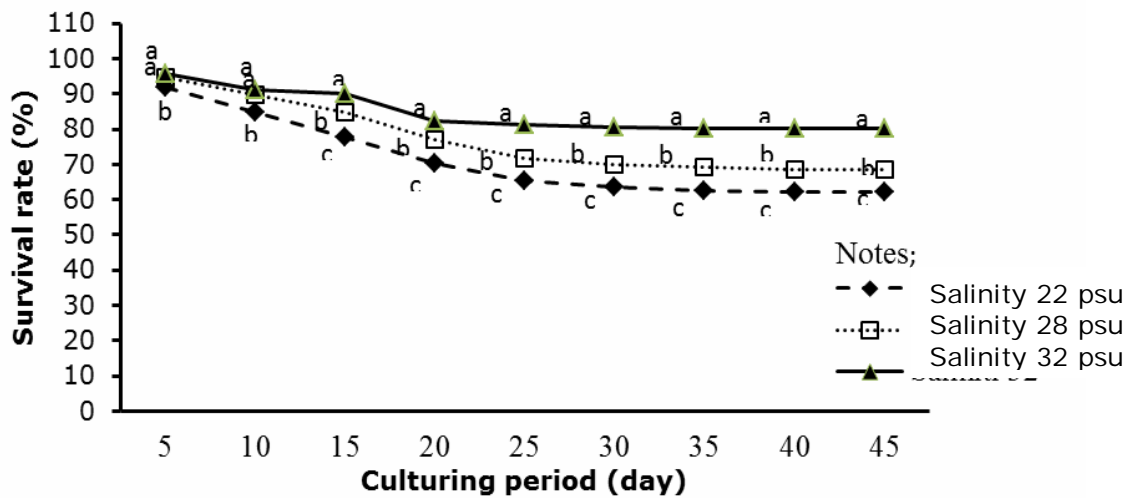
Figure 3. Survival rate (%) of juvenile tiger grouper *(Epinephelus fuscoguttatus)* cultured in different salinity (22, 28 and 32 psu) for 45 days. Different superscripts (vertical) at each stage of the culturing period showing different values (p<0.05).

Throughout the 45 days of culturing period, it was found that juvenile tiger grouper cultured in 32 psu salinity has the highest survival rate (80.19±1.14%) and the lowest value was obtained in juveniles cultured in 22 psu salinity water (62.00±2.47%), the results are significantly different (p<0.05). A high survival rate value of juvenile tiger grouper cultured in 32 psu salinity treatment is due to a low juvenile mortality and a more appropriate salinity compared to other treatments.

Unlike the juvenile tiger grouper cultured in 32 psu, the juvenile cultured in 22 psu has a low survival rate since the number of lost juveniles is higher than in other treatments. The death of juvenile tiger grouper basically is caused by stress. Consequently, the stress will raise the potential infection, suffocation and mortality rate. In a stressful situation, most juveniles take resistant actions such as eating a lot, saving energy of not doing an active swimming and even not eating, for a few of them. Thus, make them vulnerable against infections which lead to disease and death. Another reason is the increasing of their natural tendency for cannibalism as a result of a low salinity, so a higher amount of food is needed to lower their nature of cannibalism. Although, this prevention action is done the juveniles are still wounded bitten by their own species and infected disease and drowning. In addition, it is reasonable to assume that a low rate of salinity can lead to loss of appetite on juveniles. However, it was found that feed pellets have a high nutrition content (Muhammadar et al 2011) and are easy to be digested by juveniles grouper (Muhammadar et al 2012). Therefore, this situation can reduced the amount of cannibalism and infectious disease compare to juvenile that fed by trash fish that their survival rate is lower than juvenile that fed by pellets (Sharpawi et al 2011).

Feed conversion. In the early stage of culturing period, it was found that the feeding conversion ratio (FCR) of the observed juvenile in 22 psu salinity is 19.76±3.18%, while in 28 psu salinity is 2.29±0.09% and in 32 psu salinity is 2.56±0.36%. These indicate significant differences between each treatment (Figure 4). On the other hand, in the final stage of culturing period, it was found that the same indicator in 22 psu salinity is 8.67±0.86%, in 28 psu is 8.31±1.45% and in 32 psu is 7.39±1.70% did not differ significantly one from each other. Therefore, the FCR of juvenile grouper at a salinity of 22 psu, 28 psu and 32 psu for the early period of culturing period was 10:1:1 and for the final period was 1:1:1. The result shows that a high FCR is often obtained in treatment with 22

psu salinity, whereas treatment in 28 and 32 psu salinity FCR is slightly lower. Juvenile grouper cultured in low salinity (22 psu) always shows a higher FCR (in the first 5-25 days) and vary significantly from every other treatments ($p < 0.05$). The result proves that culturing at low salinity (22 psu) causes stress reduction and encourage individuals for high feed intake in order to restore lost energy by the organism. However, at the end of observation (days 40-45) the study shows the same FCR for all salinity treatments and did not differ significantly one from each other ($p > 0.05$). This indicates that the FCR is not affected by difference salinity (22-32 psu) of water after 40 days (100 days of age) of juvenile tiger grouper.
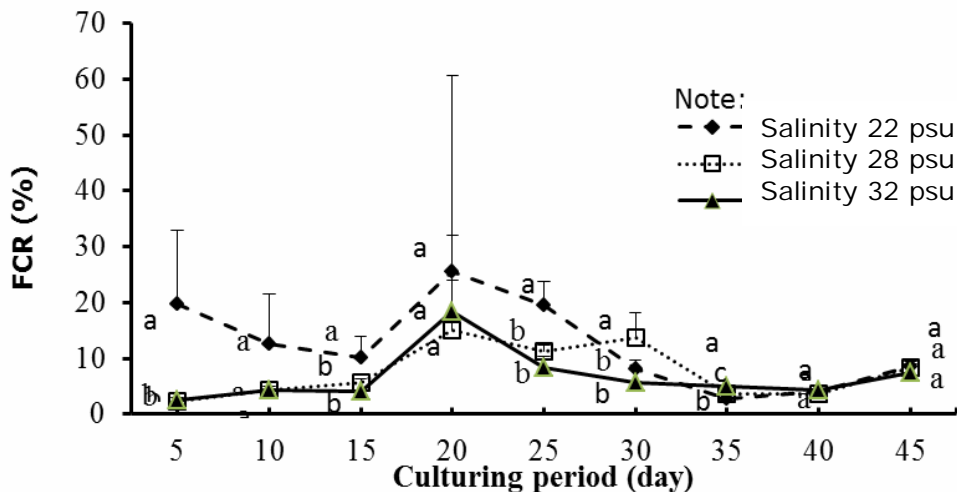

Figure 4. FCR (%) of juvenile tiger grouper *(Epinephelus fuscoguttatus)* cultured in different salinity (22, 28, and 32 psu) for 45 days. Different superscripts (vertical) at each stage of the culturing period showing different values ($p < 0.05$).

Conclusions. The observation of juvenile tiger grouper for the duration of 45 days shows that the value of the, absolute growth, specific growth and survival rate at salinity of 32 psu treatment in every sample is often higher compared with salinity of 22 and 28 psu. At the end of the culturing period (day 45) it is found that the value of the total length (AGR) and survival rate from high to low salinity is 0.095% respectively 80.19% at 32 psu, 0.078% respectively 68.38% at 28 psu, and 0.065% respectively 62% at 22 psu, values which vary significantly one from each other ($p < 0.05$).

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Authors:

Abdullah Abbas Muhammadar, Syiah Kuala University, Department of Aquaculture, Indonesia, Banda Aceh 23111 e-mail: m_dar71@yahoo.com

Abdul Ghaffar Mazlan, University of Kebangsaan, Faculty of Science and Technology, School of Environmental and Natural Resource Sciences, Malaysia, Bangi Selangor D. E., e-mail: magfish05@yahoo.com

Abdullah Samat, University of Kebangsaan, Faculty of Science and Technology, School of Environmental and Natural Resource Sciences, Malaysia, Bangi Selangor D. E., e-mail: nature@ukm.my

Muhammad Sail Asmawati, Syiah Kuala University, Department of Agricultural Product Technology, Indonesia, Banda Aceh 23111, e-mail: asmawati.shakila@yahoo.com

Zainal Abidin Muchlisin, Syiah Kuala University, Department of Aquaculture, Indonesia, Banda Aceh 23111, e-mail: muchlisinza@yahoo.com

Michael A. Rimmer, University of Sydney, Faculty of Veterinary Science, Australia, e-mail: mike.rimmer@sydney.edu.au.

Khumar Das Simon, University of Kebangsaan, Faculty of Science and Technology, School of Environmental and Natural Resource Sciences, Malaysia, Bangi Selangor D. E., e-mail: skdas_maa@yahoo.com
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