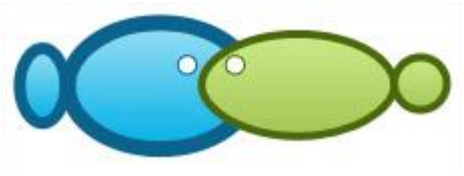

Effects of the salinity media on the osmotic work level, feed utilization efficiency and the growth of "cantang" hybrid grouper *Epinephelus fuscoguttatus x E. lanceolatus*

[1,2]Mohammad B. Syakirin, [3]Sutrisno Anggoro, [3]Slamet B. Prayitno, [3]Suradi W. Saputra

[1] Doctoral Program of Aquatic Resources Management, Diponegoro University, Tembalang, Semarang, Indonesia; [2] Faculty of Fisheries, University of Pekalongan, Centra Java, Indonesia; [3] Faculty of Fisheries and Marine Science, Diponegoro University, Semarang, Indonesia. Corresponding author: M. B. Syakirin, ririn_220164@yahoo.co.id

Abstract. This research aimed to describe the influence of osmotic media pressure to the osmotic work level and the growth of "cantang" hybrid grouper. The salinity levels applied in the present research were A (29 g L^{-1}), B (31 g L^{-1}), C (33 g L^{-1}), and D (35 g L^{-1}). The result of the research shows that the salinity media significantly influences ($p<0.05$) the growth of "cantang" hybrid grouper. The lowest osmotic media level was recorded in the treatment C (33 g L^{-1}) 22.4 $mOsmL^{-1}$ H_2O^{-1}, in treatment B (31 g L^{-1}) 23.14 $mOsmL^{-1}$ H_2O^{-1}, in the treatment D (35 g L^{-1}) 61.71 22.84 $mOsmL^{-1}$ H_2O^{-1}, while in the treatment A (25 g L^{-1}) has the highest osmotic work level with 68.51 $mOsmL^{-1}$ H_2O^{-1}. The highest feed utilization efficiency was recorded in the treatment C (33 g L^{-1}) 91.22%, followed by treatment D (35 g L^{-1}) 90.89%, treatment B (31 g L^{-1}) 88.62% and the lowest feed utilization efficiency was recorded in the treatment A (29 g L^{-1}) 84.84%. The highest biomass growth was observed in the treatment C (31 g L^{-1}) with 212.93 g. The growth response to the salinity media was in the form of quadrics with the regression equation $Y = -2804.46 + 184.4947 X - 2.82 X^2$ ($R^2 = 0.99$) with the optimum salinity level of 32.71 g L^{-1} and the maximum growth with 213.12 g.
Key Words: export product, aquaculture, market, demand, growth rate.

Introduction. Grouper, *Epinephelus* sp. is one of the kinds of fish that are popular in domestic and foreign market and has high economic value in South East Asia. Nowadays it is cultivated and developed as a superior export product. The general problem faced in fish cultivation is how to get fast growing offspring, with low FCR, immune to all infections and to be preferred for consumption (https://growpal.co.id/front/detail_product/6).

"Cantang" grouper *Epinephelus fuscoguttatus-lanceolatus* is a superior kind of *Epinephelus* sp. This kind of fish is the result of crossing between *Epinephelus fuscoguttatus and Epinephellus lanceolatus.* The growth level of this kind of fish is faster than the other kind of *Epinephelus* sp. which needs 7 months to reach a weight of about 500-700 g per fish (Rahmaningsih & Ari 2016).

To get the maximum production of "cantang" hybrid grouper the farmer can optimize the environment especially the salinity. "Cantang" hybrid grouper can easily adapt to low salinity media. Salinity is one of physiological factors which influence feed utilization and growth (Anggoro et al 2010). Salinity is one of the masking factors which modify the influence of other environmental factors into osmotic influence throughout the body (Brett 1979 in Rachmawati et al 2012). Salinity media will influence the fish growth, because the organism can only grow after the homeostasis has been reached or internal conditions are stable (Rachmawati et al 2012).

This research aimed to analyze the influence of salinity on the growth "cantang" hybrid grouper to describe the osmotic work level and the feed utilization efficiency, the

relationship of differences in salinity media to the osmotic work level, feed utilization efficiency and the growth of "cantang" hybrid grouper.

Material and Method. This research was done in the Great Hall of Brackishwater Aquaculture Jepara in May 2016. The "cantang" hybrid grouper offspring used in this research were in size of 3–4 cm, maintained in aquarium with a density of 10 individuals per aquarium. The fish were kept in 12 glass aquariums sized 40 x 30 x 20 cm, with 10 L water each. The research was done during 30 days. The feed used in this research was pellets with a protein content of 49.32% given 3 times a day in the quantity of 7% of the weight of biomass/day.

This research was an experimental trial performed in laboratory. The research was based on completely randomized design (CRD) by applying 4 treatments and 3 replications. The treatments were the salinity media levels 29 g L^{-1}, 31 g L^{-1}, 33 g L^{-1}, and 35 g L^{-1}. The parameters observed in this research were the osmotic work level, feed utilization efficiency and the biomass growth of "cantang" hybrid grouper. The growth was measured on 10 days basis.

The data were analyzed using variant analysis based on F-Test (Steel & Torrie 1993) after being tested by having a normality test (Nasoetion & Barizi 1983) and variant homogeneities test (Sudjana 1975). To find out further response of fish to the treatment we used polynomial orthogonal model analysis (Hicks 1973).

Results

Osmotic work level. The average result of the measurement of the fish blood osmolarity and media as well as osmotic work level of "cantang" grouper hybrid is shown in Table 1.

Table 1

Average osmotic work level of the "cantang" hybrid grouper

Salinity (g L^{-1})	*Osmolarity ($mOsmL^{-1}H_2O^{-1}$)*		*Osmotic work level ($mOsmL^{-1}H_2O^{-1}$)*
	Fish blood	*Media*	
29	749.37	680.87	68.50
31	750.90	727.79	23.11
33	751.93	774.78	22.85
35	759.99	821.69	61.70

Table 1 show that the lowest osmotic work level is in the salinity media of 33 g L^{-1} with 22.85 $mOsmL^{-1}$ H_2O^{-1}. The salinity treatment 29 g L^{-1} resulted 68.50 $mOsmL^{-1}$ H_2O^{-1}, the salinity 31 g L^{-1} resulted 23.11 $mOsmL^{-1}$ H_2O and the salinity treatment of 35 g L^{-1} exhibited 61.70 $mOsmL^{-1}$ H_2O^{-1}.

Based on Table 1, it is seen that the lowest osmotic work level of "cantang" hybrid grouper was in the salinity treatment of 33 g L^{-1} with 22.85 $mOsmL^{-1}$ H_2O^{-1} and the highest is the salinity treatment of 29 g L^{-1} with 68.5 $mOsmL^{-1}$ H_2O^{-1}.

Feed utilization efficiency. Feed utilization efficiency of "cantang" hybrid grouper in various salinity media is shown in the Table2.

Table 2 shows that the highest feed utilization efficiency was achieved in the treatment C (33 g L^{-1}) with 91.22%, followed by the treatment D (35 g L^{-1}) with 90.89%, treatment B (31 g L^{-1}) with 88.62%, and the lowest feed utilization efficiency was recorded in treatment A (29 g L^{-1}) with 84.84%.

Table 2

Feed utilization efficiency of "cantang" hybrid grouper according salinity

Salinity (g L^{-1})	*Feed utilization efficiency (%)*
29	84.84
31	88.62
33	91.22
35	90.89

Fish growth. Table 3 shows that the highest growth of "cantang" hybrid grouper was observed in the 33 g L^{-1} salinity media treatment with 212.93 g. The lowest growth of "cantang" hybrid grouper was observed in the 29 g L^{-1} salinity treatment with 174.28 g.

Table 3

Growth of "cantang" hybrid grouper according salinity

Salinity (g L^{-1})	*Replication*	*Fish absolute biomass (g)*		*Growth (g)*
		Early	*End*	
29	1	64.5	247.1	182.60
	2	63.2	235.1	171.94
	3	64.9	233.2	168.30
Average	-	-	-	174.28
31	1	65.1	270.1	205.0
	2	67.5	271.5	204.0
	3	63.6	269.0	205.4
Average	-	-	-	204.80
33	1	69.7	284.4	214.7
	2	67.2	275.0	207.8
	3	67.5	283.8	216.3
Average	-	-	-	212.93
35	1	65.7	261.7	196.0
	2	64.7	262.1	197.4
	3	62.2	263.8	201.6
Average	-	-	-	198.33

The growth response curve of "cantang" hybrid grouper to the salinity level is shown if Figure 1.

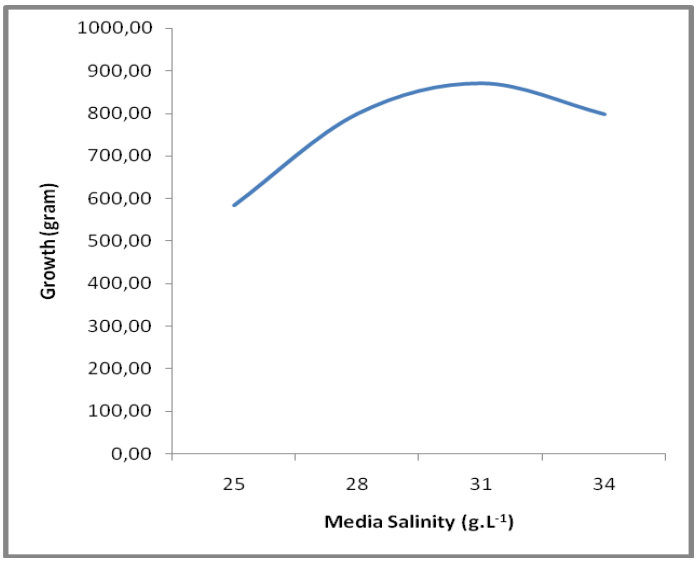

Figure 1. Growth of "cantang" hybrid grouper at different salinity levels.

The curve shown the growth response of "cantang" hybrid grouper to the salinity level in the form of quadratics equation $Y = -2804.46 + 184.4947 X - 2.82 X^2$ ($R^2 = 0.99$) with the optimum salinity level of 32.71 g L^{-1} with a maximum growth of 213.12 g.

Discussion

Osmotic work level. Salinity is one of water quality factors which influence the fish's life and growth. Water salinity is a masking factor through the content of salt which indeed will influence the osmotic pressure of the sea water. The water osmotic characteristics depend on the number of ion in the water itself. The more ions in the water, the osmotic concentration will be higher (Nybakken 1988).

The media with high osmotic pressure is caused by increasing number of the ion concentration such as Sodium (Na^+), Potassium (K^+), Calcium (Ca^{2+}), Chloride (Cl^-), Sulfate (SO_4^{2-}), and Bicarbonate (HCO_{3-}) (Effendy 2003). Hence, the more ions are contained in the water the higher is the salinity level and osmolar density.

The "cantang" hybrid grouper is a kind of marine fish that has blood osmolarity (internal osmotic fluid pressure) lower than environment osmotic pressure. Therefore the water will pass from the body of the fish to the environment by osmotic process through the kidney, gill, as well as the body.

Salinity has relationship with the osmoregulation of aquatic animals. If there is a sudden fluctuation of salinity, it will provoke difficulty to have the osmoregulation in their body and cause the death of the animals.

Osmoregulation is stated with the osmoregulation capacity which is the difference between the blood osmotic pressure (fish) or osmotic pressure of hemolymph (*Crustacea)* with the media osmotic pressure (Campbell et al 2002). Osmoregulation relates to the difference of osmotic pressure in fish blood osmolarity and media osmolarity in the environment. The difference between fish blood osmolarity and media osmolarity is called osmotic work level. The larger the difference of the two osmolarities the higher is the osmotic work level performed by the fish.

In the treatment of salinity level 29 g L^{-1} and 31 g L^{-1}, the "cantang" hybrid grouper has osmotic work level of 68.50 mOsmL^{-1} H_2O^{-1} and 23.11 mOsmL^{-1} H_2O^{-1}. Both of those salinities are hipoosmotic media to the fish and the "cantang" hybrid grouper body fluid is hiper osmotic. According to Lantu (2010), the fish gets the balance of their body fluid by drinking or sucking a small amount of water, if the water is more than they need, it will be excreted become urine.

In the salinity treatment of 35 g L^{-1} "cantang" hybrid grouper has the osmotic work level of 61.70 mOsmL^{-1} H_2O^{-1}. In the salinity treatment of 35 g L^{-1} the fish will be in the hiperosmotic media and therefore the body fluid of the "cantang" hybrid grouper will be hipoosmotic to the media. In this condition water will flow osmotically from the body through the kidney, gill and skin to the environment while ions enter the body by diffusion process (Lantu 2010).

In the media of 31 g L^{-1} salinity treatment "cantang" hybrid grouper has the osmotic work level of 22.85 mOsmL^{-1} H_2O^{-1} which becomes the lowest osmotic work level compare to the other treatments. The media salinity of 31 g L^{-1} is the isoosmotic media in which the fish body fluid concentration is similar with the media concentration. In the isoosmotic media the difference of the fish body fluid pressure from the media is very low so that the osmotic work done by "cantang" hybrid grouper is also low.

Feed utilization efficiency. According to Ferraris et al (1987) in Anggoro et al (2013) the feed utilization efficiency shows the percentage of feed which can be used by the fish. The frequency and quality of the fish feed influence the growth of the fish. The feed utilization efficiency is influenced by three factors: the quality and quantity of the feed, the way of feeding (frequency and time), and media quality or the environment support (salinity, temperature, and oxygen).

The result of the present research shows that the highest utilization efficiency was recorded in the treatment C (33 g L^{-1}) with 91.22%, followed by treatment D (35 g L^{-1}) with 90.89%, treatment B (31 g L^{-1}) with 88.62% and the lowest feed utilization

efficiency was exhibited in treatment A (29 g L^{-1}) with 84.84%. At the salinity level of 33 g L^{-1} which is the salinity level similar with the isoosmosis, the function of the cell will be normal as well as the metabolic rate (catabolism and anabolism) and the feed consumption is increased, the feed consumed is digested and absorbed. This condition makes the feed consumption of "cantang" hybrid grouper become high and the percentage of the absorbed feed to get higher, resulting in more mass accumulation because the digestive process runs well, so that the feed utilization efficiency becomes higher.

The Epinephelus fuscoguttatus-lanceolatus growth. The influence of salinity (by the osmotic pressure) on the growth and feed utilization efficiency can be direct and indirect. The direct influence is the osmotic effect on the osmoregulation, the digestion and absorption ability of feed nutrients (Gilles & Pequeux 1983). While the indirect effect is when salinity influences aquatic organisms by the change of water quality.

According to Weatherley (1975), the fish growth is influenced by internal and external factors. The internal factors are genetic and physiologic. The external factors are feed and water physics and chemistry. Water salinity is one of chemical water factors relate to the fish growth.

The results of the present research shows that the highest growth of "cantang" hybrid grouper is in the salinity treatment of 33 g L^{-1} with 212.93 g and the lowest is in the salinity of 29 g L^{-1} with 174.28 g. In the media with salinity of 33 g L^{-1} which is the isoosmotic media "cantang" hybrid grouper has a low osmoregulation process as the result of the balance of body fluid and environment so that the rest of the energy can be used for growth. According to Jobling (1994) the use of the energy for osmoregulation can be reduced only if the fish are cultivated in the isoosmotic media so that the feed utilization is efficient and the growth is increased. According to Stickney (1979), fish which are cultivated in isoosmotic media, use the energy to grow more than for osmoregulation.

Conclusions. Osmotic work level of "cantang" hybrid grouper was 33 g L^{-1} salinity with 22.85 $mOsmL^{-1}$ H_2O^{-1} at the lowest and the highest was at salinity of 29 g L^{-1} with 68.5 $mOsmL^{-1}$ H_2O^{-1}. The best feed utilization efficiency was demonstrated by treatment C (33 g L^{-1} salinity) with the value of 91.22%. Whilst the best growth was achieved by treatment C of 33 g L^{-1} with 212.93 g. It can be concluded that the best treatment was salinity 33 g L^{-1} in terms of osmotic work level, feed utilization efficiency, and total biomass.

Acknowledgements. The authors would like to thank the Great Hall of Brackishwater Aquaculture of Jepara for the permission to use laboratory facilities as a place for research. We are also greatly indebted for the to two anonymous reviewers.

References

Anggoro S., Subandiyono, Supratno T., 2010 Osmotic response, efficiency of feed utilization and ginger shrimp energy retention (*Metapenaeus elegons*) domesticated in various isosmotic media. (Respon Osmotik, Efisiensi Pemanfaatan Pakan dan Retensi Energi Udang Jahe *(Metapenaeus elegons)* yang Didomestikasi dalam Berbagai Media Isosmotik). Aquacultura Indonesiana 11(3):217-223.

Anggoro S., Rudiyanti S., Rahmawati I. Y., 2013 Domestication of tiger grouper fish (*Epinephelus fuscoguttatus*) through media and feed optimization. Journal of Aquatic Resources Management 2(3):119-127.

Campbell N. A., Reece J. B., Mitchell L. G., 2002 Biology. 3rd edition. Volume 3, Erlangga, Jakarta.

Effendy H., 2003, Water quality review. (Telaah Kualitas Air), Kanisius, Yogyakarta.

Gilles R., Pequeux A., 1983 Interaction of chemical and osmotic regulation with the environment. In: The biology of Crustacea. Volume 8. Environmental Adaptation. Vernberg F. J., Vernberg W. B. (eds), pp. 109–177, Academic Press, New York.

Hicks C. R., 1973 Fundamental concepts in the design of experiments. Holt, Rinehart and Winston, New York.
Jobling M., 1994 Fish bioenergetics. Fish and Fisheries Series 13. Chapman and Hall, London, 309 p.
Lantu S., 2010 Osmoregulasi Pada Hewan Akuatik. Jurnal Perikanan dan Kelautan 6(1):46-50.
Nasoetion A. H., Barizi, 1983 Statistical method for withdrawing examples. Publisher P.T. Gramedia, Jakarta.
Nybakken J. M., 1988 Marine biology. An ecological approach. Publisher P.T. Gramedia, Jakarta.
Rahmaningsih S., Ari A. I., 2016 Feed and growth of Cantang grouper fish (*Epinephellus fuscoguttatus-lanceolatus*). Ecologia Journals. Scientific Journal of Basic Science and Environment, Faculty of Mathematics and Natural Sciences, Pakuan University. 13(2):25-30.
Rachmawati D., Hutabarat J., Anggoro S., 2012 Effect of different salinity media on *Babylonia spirata* L. on domestication process. Marine Science 17(3):141-147.
Steel R. G. D., Torrie J. H., 1993 Principles and procedures of statistics: a biometrical approach. Toronto.
Stickney R. R., 1979 Principles of warmwater aquaculture. John Willey and Sons, Toronto, pp. 161–221.
Sudjana, 1975 Statistical method. Publisher Tarsito, Bandung. (Metoda Statistika). Penerbit Tarsito, Bandung.
Weatherley A. H., 1975 Growth and ecology of fish populations. Academic Press Inc., New York, 287 p.
*** https://growpal.co.id/front/detail_produk/6

Received: 12 April 2018. Accepted: 20 August 2018. Published online: 29 August 2018.
Authors:
Mohammad Bahrus Syakirin, Diponegoro University, Doctoral Program of Aquatic Resources Management, Indonesia, Semarang, Tembalang, 50275; University of Pekalongan, Faculty of Fisheries, Indonesia, Central Java, 51115, e-mail: ririn_220164@yahoo.co.id
Sutrisno Anggoro, Diponegoro University, Faculty of Fisheries and Marine Science, Indonesia, Central Java, Semarang 50275, Tembalang Campus. Jl. Prof. Sudarto SH, e-mail: sutrisno.anggoro@yahoo.co.id
Slamet Budi Prayitno, Diponegoro University, Faculty of Fisheries and Marine Science, Indonesia, Central Java, Semarang 50275, Tembalang Campus. Jl. Prof. Sudarto SH, e-mail: sbudiprayitno@gmail.com
Suradi Wijaya Saputra, Diponegoro University, Faculty of Fisheries and Marine Science, Indonesia, Central Java, Semarang 50275, Tembalang Campus. Jl. Prof. Sudarto SH, e-mail: suradiwsaputra@yahoo.co.id

How to cite this article:
Syakirin M. B., Anggoro S., Prayitno S. B., Saputra S. W., 2018 Effects of the salinity media on the osmotic work level, feed utilization efficiency and the growth of "cantang" hybrid grouper *Epinephelus fuscoguttatus x E. lanceolatus*. AACL Bioflux 11(4):1274-1279.