

THE AFFECT OF DIFFERENT LIGHT COLOR OF PHYSIOLOGICAL CONDITIONS OF CANTANG GROUPER SEED (*Epinephelus fuscoguttatus lanceolatus*) WITH DIFFERENT SIZE

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ABSTRACT

This study consisted of four treatments and three replications, namely the treatment without the addition of light (WL), the addition of green light (G), the addition of blue light (B) and the addition of red light (R). The grouper seeds used are 5-13 cm in size from Gondol Bali. The results showed that fish fry measuring 5-13 cm prefer blue light compared to other light. A total of 56.67% of fish fry choose blue light, followed by green light as much as 25.56%, red light by 11.11% and the lowest in the treatment without light that was 6.67%. The addition of blue light in the rearing container gave the best growth response at a size of 5-13 cm, and the lowest growth response was given to the treatment with the addition of red light. While the number of rod cells was more than cone cells in all treatments with 5-13 cm cantang grouper seed size. However, the highest number of rods and cones was in the treatment WL compared to other treatments. However, the highest growth response occurred in the treatment B and followed by the treatment G, it is presumed that the cone cells found in treatments B and G were dominated by double cone cells which were very sensitive to color, compared to cells. single cone, so that cantang grouper fry respond more quickly to the feed given. While the treatment WL was more dominated by single cone cells.

Keywords: *Epinephelus fuscoguttatus lanceolatus*, size 5-13 cm, lighting, physiological

INTRODUCTION

Grouper is very sensitive to lighting. Decent water quality conditions, lighting, and intensity of the right light can trigger photoreceptors in fish to actively forage for food (Razak, 2017). Furthermore, Rochman *et al* (2013) stated that the feeding behavior of sea fish fry is influenced by light or is phototaxis positive, and also the color of the container makes it easier for marine fish seeds to detect feed and affects the contrast of the feed. Photoreceptor organs in groupers are organs that are sensitive to light stimuli, namely rod cells, and cone cells. These two cells play a role in the phototransduction process that can convert light stimuli into nerve impulses that will carry messages to the visual cortex so that fish can see objects well. (Gregg *et al* ., 2013). Cone cells in fish are divided into two, namely single cone cells and double cone cells. Double cones are more sensitive to color than single cones (Razak, 2017).

The visual acuity of fish depends on two factors, namely the diameter of the lens and the density of the cone cells in the retina. According to Razak (2017), The speed of the fish eye's retina in capturing images will affect its sensitivity and sharpness, and the fish's eye lens plays a role in focusing the light that enters the water. Furthermore, it is explained that the maximum visibility of fish depends on the diameter of the object being viewed and the length of the fish's body. The larger the object size and the longer the fish's body, the greater the visibility.

According to Fujaya (2004), cone cells are used during daytime activities while rod cells are used at night or in dark conditions.

Seed growth of cantang grouper is faster than other types of grouper. According to BPBAB Situbondo (2021) in 6 months of maintenance Cantang grouper seeds in KJA can reach a size of 500-600 g. The speed of fish growth, of which is influenced by foraging activity. However, the obstacle in the cultivation of grouper seeds is the high level of cannibalism, which causes the survival rate to be low. High light intensity will increase the cannibalism of groupers (Arinah _ *et al.* , 2014; Hseu *et al.* , 2007; Rahmawati *et al.*, 2016). Therefore, it is necessary to make efforts to overcome the nature of cannibalism, namely through environmental engineering. The importance of the role of light in increasing the productivity of cantang grouper is the basis for this research.

Materials and Methods

This research was conducted in June – August 2022 and took place in the dry fishery laboratory of the Faculty of Animal Husbandry, Fisheries, and Marine, Nusa Cendana University, Kupang, East Nusa Tenggara Province, Indonesia. The seeds of cantang grouper (*Epinephelus foscuguttatus lanceolatus*) used were \pm 5-13 cm in length and \pm 2-7 g in initial weight from Gondol, Denpasar Bali. The feed used is Megumi feed.

This research has four treatment and three replication, that is treatment WL (without light), treatment G (green light), B (blue light), and R (red light). All of the data was analysis by descriptive analysis.

This research begins by placing the seeds of cantang grouper measuring 5-13 cm in one main container that is not given light (without lights) measuring 90 x 60 cm designed by installing 4 connecting pipes from the main container to a container that has been equipped with red light (R), green (G), blue (B), and without light (WL) (Figure 1).

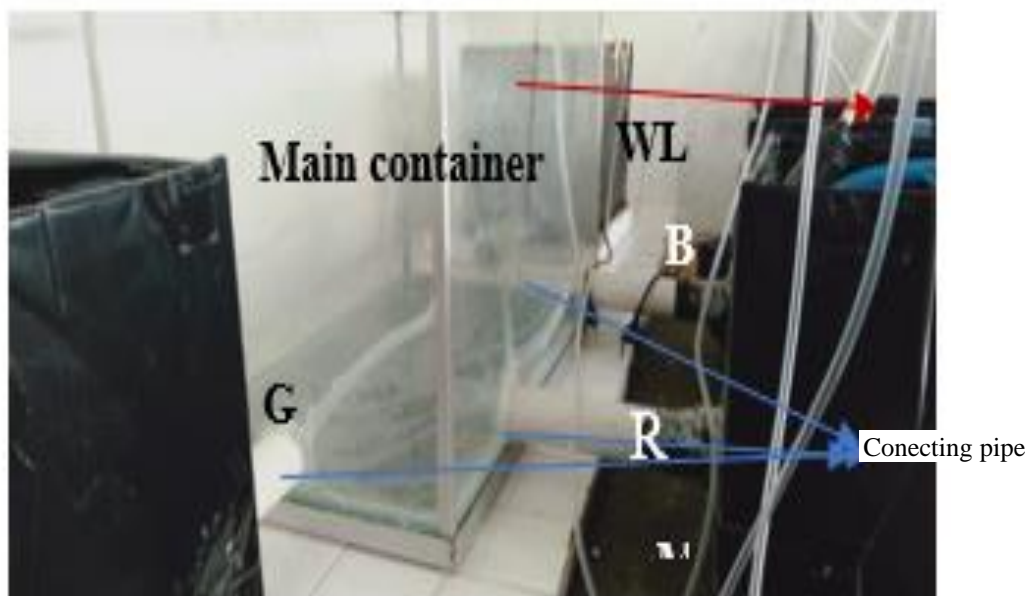


Figure 1. Container design preference
(Note: G : green; R: Red; B: blue; WL: without light)

Next, the main container is filled with 90L of water and put in fish measuring 5-13 cm, consisting of 30 individuals measuring 5-7 cm, 30 individuals measuring 8-10 cm, and 30 individuals measuring 11-13 cm. The fish were left in the main container for 1 day to adapt, after that, the connecting pipe cover was opened for three (3) days to provide an opportunity

for the seeds to make choices about the color of the given light. After that, the pipe was closed again and the number of fish that entered each treatment container was counted and the length was measured.

Parameters observed in this research were survival rate (SR), specific growth rate (SGR) body weight and length, Retention Energy (RE) based on the results of proximate analysis, photoreceptor responses in the form of rods and cones cells in the retina of fish eyes were analyzed by the method retinal histology of the eye, and histology of gill chloride cells in different light colors. The physical and chemical parameters of water are temperature measured using a thermometer, pH measured using a pH meter, DO measure using a DO meter, salinity measured using a refractometer, and ammonia.

Preference data, growth, and the number of rods and cone cells obtained in the research were analyzed using analysis of variance (ANOVA) with the F test at a 95% confidence interval. And continued with the BNT test. Meanwhile, the water physicochemical data were analyzed descriptively and presented in tabular form.

ETHICAL STATEMENTS

This research has fulfilled the basic principles of research ethics, namely respect, beneficiary, and justice. The object used in this research is grouper seeds which has passed testing by the fish quarantine authorities.

RESULTS AND DISCUSSION

Preference and Survival of Cantang Grouper Seeds

The light color preference data by cantang grouper (*E. fuscoguttatus lanceolatus*) seeds are presented in Table 1.

Table 1. Average preference for light color by grouper seeds of different sizes for 3 days

Treatment	Color Light	Fish size (cm)	Number of fish entered / size (ind)	Percentage (%)
WL	Without Light lamp (WL)	5-7	1	6.67 ^a
		8-10	2	
		11-13	3	
Total			6	
G	Green Light	5-7	5	25.56 ^a
		8-10	12	
		11-13	6	
Total			23	
B	Light Blue	5-7	15	56.67 ^b
		8-10	15	
		11-13	21	
Total			51	
R	Red Light	5-7	2	11.11 ^a
		8-10	6	
		11-13	2	
Total			10	100

The ANOVA results at a 95% confidence interval showed that the preference for light color in treatment B was significantly different from the other treatments. While the light color preference based on size showed that the treatment without light (WL) and green light treatment were not significantly different between sizes, the blue light treatment (B) at a size of 11-13 cm

was significantly different from other sizes, while the red lights treatment (R) size 8-10 cm is significantly different from other sizes.

Based on the results of the research, it was found that the blue light was preferred by cantang grouper seeds at all sizes used in the treatment. Meanwhile, in the treatment without light (WL) the seeds of cantang grouper were chosen at least for all sizes used in the treatment. This is presumably because the blue light that enters the water for 24 hours provides a calm and comfortable AFFECT for the cantang grouper seeds. Cantang grouper is one type of demersal fish with relatively lower visual acuity as a form of ecological adaptation to minimal light (Fitri, 2008). In addition, blue light conditions are thought to produce a threshold of light intensity required by cantang grouper seeds so that it affects the normal behavior of the fish (Yahya *et al.*, 2011).

After the fish chose the color of light, the fish were kept for 10 days in the same container to measure the level of fish aggressiveness. It was found that the level of cannibalism of grouper seeds was different in each rearing container. Data on survival during rearing grouper seeds in different light colors are presented in Figure 2.

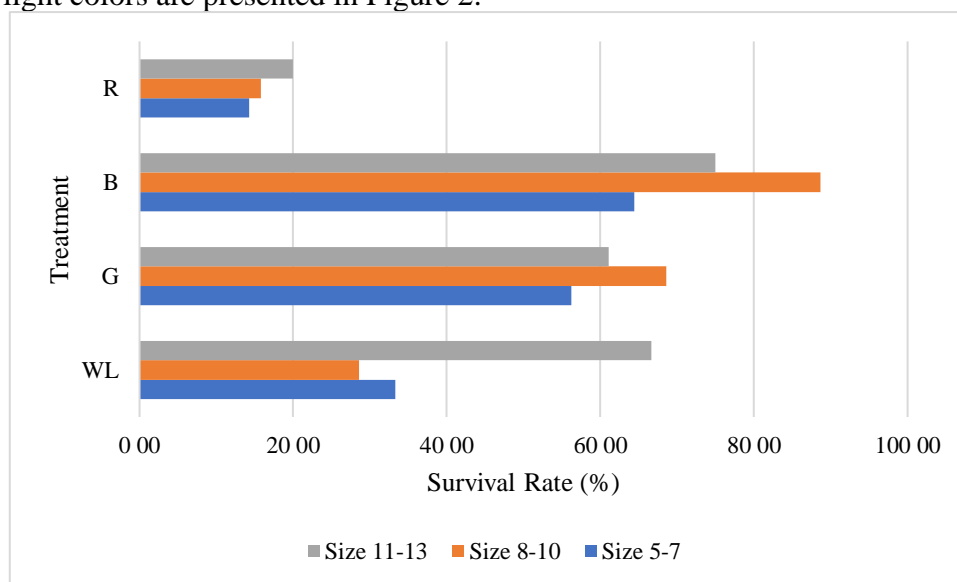


Figure 2 Survival rates of grouper seeds of various sizes for 10 days in preference containers

The highest survival rate of cantang grouper seeds at all size levels was in blue light, followed by green light, and the lowest in treatment red light (R). This is presumably because the color of the blue light creates a calm and comfortable atmosphere for the cantang grouper seeds. It was explained that the bright color of light in the living environment of tiger grouper seeds would increase cannibalism, causing 90% of death (Rahmawati *et al.*, 2016). Furthermore, it was explained that in bright conditions the number of cone cells that play a role in bright vision will increase so that it will affect the aggressiveness of fish and increase the ability of the fish's eye to catch the movement of fast-moving objects (Kandel *et al.*, 2000) so that cannibalism increases.

The AFFECT of Different Light Colors on the Number of Rod and Cone Cells

Rod cells are more sensitive to light than cones and play a role in dark vision (Okawa, 2007), whereas cone cells play a role in bright vision and color discrimination (Razak, 2017). Both of these cell have a functional structure in the form of an outer segment and an inner segment that enables the two cells to receive light stimuli (Razak, 2017). The number of rods and cones in cantang grouper seeds of different sizes is shown in Figure 3.

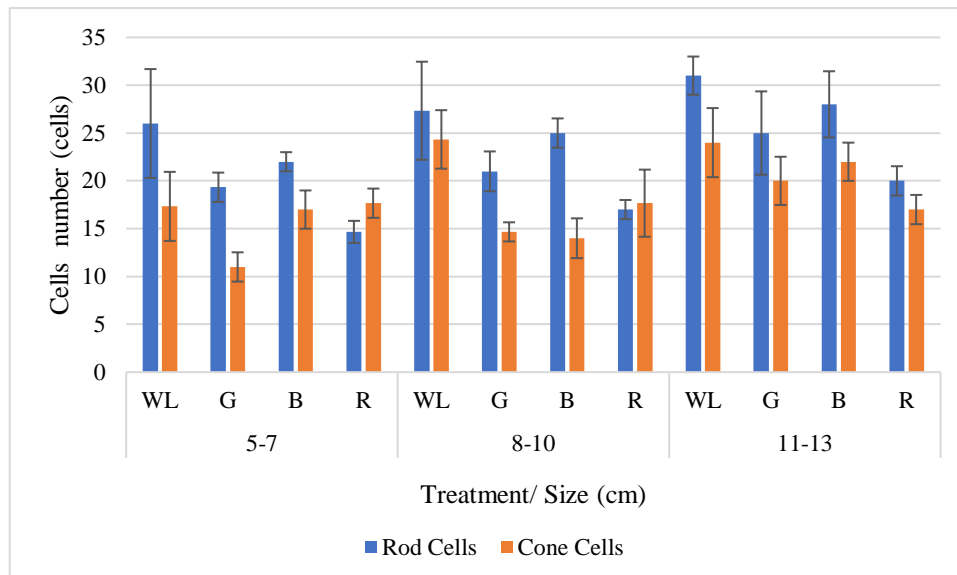


Figure 3. Graph of the number of rods and cones cells based on the size of grouper seeds in each treatment at the end of the research

Based on the results of the research, it was found that the larger the size of the fish, the more number of rod cells contained in the retina of the fish eye. The number of rods in each size of fish formed a uniform pattern, which was the highest in the WL, B, G treatment and the lowest in the R treatment. The rods in the retina do not have the ability to distinguish colors and their reaction is slow in catching fast-moving objects but can absorb them (Kandel *et al.*, 2000). Meanwhile, the highest number of cone cells was found in the 5-13 cm cantang grouper seed size, namely the treatment without the addition of light (WL). At a size of 5-10 cm the lowest number of cone cells was in the treatment of adding green light (G), while at a size of 11-13 cm the lowest number of cones was in the treatment of adding red light (R). According to Razak (2017) cone cells are very sensitive to light stimuli when looking for food, but further explained that double cone cells are more sensitive than single cone cells. Double cone cells have ability to distinguish colors. Based on the results of the study, although the number of cone cells was highest in the treatment without the addition of light (WL), the growth response was low compared to green (G) and blue (B) light. It is suspected that the number of cones found in the WL treatment was dominated by single cone cells, while in treatments G and B, double cones were more dominant.

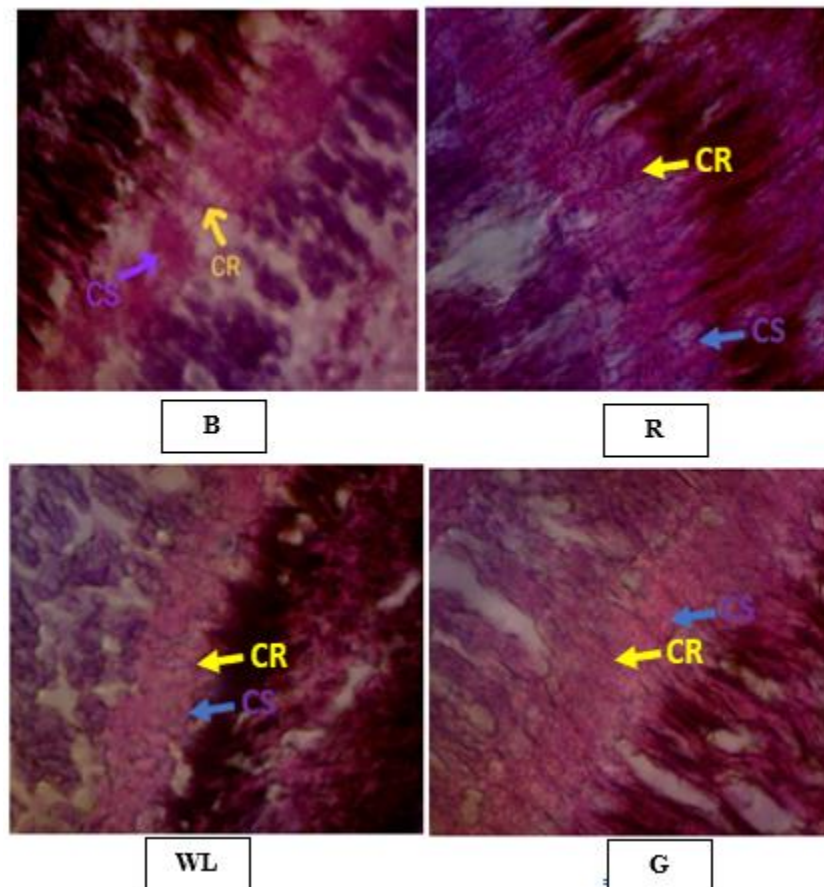


Figure 4. Rod cells (CR) and cone cells (CS) in the retina of cantang grouper eyes in various colors of light with different sizes

The treatment without light (WL) on different sizes of grouper fish showed a higher number of rods and cones than the other light color treatments. This is presumably because this condition is in accordance with the conditions of the grouper's natural habitat. Without the provision of light creates suitable conditions in nature, namely 12 hours of light and 12 hours of darkness. According to Fujaya (2004), The greater the number of rods in the retina of the fish's eye, the better the ability to see in dim conditions (scotopic), while the number of cone cells enables the fish to see objects in bright conditions (phototropic).

The low number of rods and cones in the light color treatment compared to the treatment without light was thought to be because for 24 hours the fish-rearing container received light so that the photoreceptor organs adapted to the color of the light received. The rod and cone cells of the cantang grouper are shown in Figure 4.

Rod cells also react slower than cone cells, the stimulus received will be processed in more than 100 milliseconds, so although rods are more sensitive to dim light, rods are less able to detect fast-moving objects (Kandel et al., 2000; Fujaya, 2004). Rod cells are sensitive enough to respond to a beam of photons, and their sensitivity is about 100 times that of cone cells. Rod cells have a large visual pigment area, so they have ability to absorb light well. Because rods have only one type that is sensitive to light, (cone cells have three or more types of pigment) so rods cannot distinguish colors.

Growth of Cantang Grouper Seeds in Different Light Colors

Fish that chose light color according to the treatment were kept for 10 days in preference containers. Based on the ANOVA test, it was found that different light color treatments had a significant AFFECT on the absolute growth of cantang grouper seeds. The results showed that there was an increase in growth in each treatment. However, the highest growth of cantang grouper seeds at all levels of size, namely 5 – 13 cm, occurred in treatment B, namely the provision of blue light. The absolute growth of cantang grouper seeds at the end of rearing is shown in Figure 5.

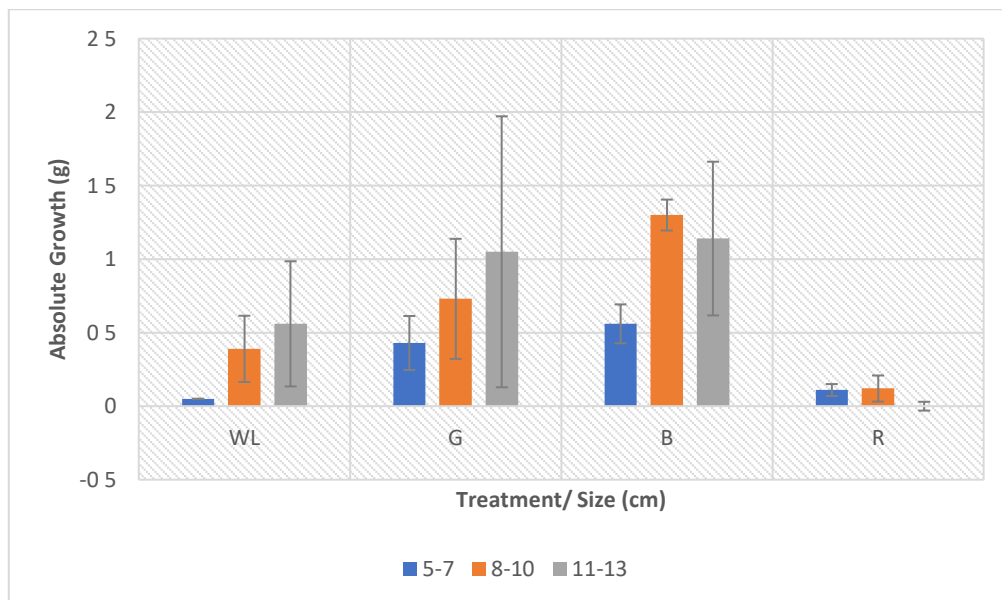


Figure 5. Absolute growth of cantang grouper seeds of various sizes during 10 days of rearing

The high rate of weight gain of cantang grouper seeds measuring 5-13 cm in the blue light treatment was thought to be because less energy entering the body was used for metabolic activities so that more energy was stored in the meat. This is in accordance with the statement of Linder (1992) which states that the energy in feed is physiologically used for maintenance and metabolism, the rest will be deposited as body tissues in the growth process and for the synthesis of reproductive products.

Energy Retention of Cantang Grouper Seeds in Different Colors of Light

Energy retention shows the large contribution of feed energy consumed to the increase in fish energy. The feed provided is a source of energy used for fish maintenance, metabolic activity, and growth (Cui *et al.* 1992 in Purnamawati 2019). Based on the results of the proximate analysis of fish meat, it was found that the highest energy retention occurred in the blue light treatment (B) and the lowest in the red lights treatment (R). Energy retention (ER) data are presented in Table 2.

Table 2. Percentage of energy retention and protein retention of cantang grouper seeds in different light color treatments

Treatment	Energy Retention Individual (%)
WL	17.27
G	19.84
B	20,15
R	13.29

The amount of energy stored in the body of the cantang grouper is related to the resulting weight gain. The greater the energy retention value, the more energy stored in the fish's body will be used to carry out metabolic activities. According to Brill *et al.* (2005) Tuna fish require 54-65% energy for metabolic activities excluding swimming activities. While Ern *et al.* (2014) 20-50% of the energy is used for the metabolism of species with low metabolic rates.

The number of Chloride Cells in Grouper Seeds in Different Light Colors

Chloride cells are part of the gills that play a role in osmoregulatory activity. Osmoregulation is the process of balancing the concentration of fluid in the body with its environment (Pamungkas, 2012) so that the physiological process runs optimally. Environmental changes will affect the body's metabolic ability and osmoregulation activity. Based on the results of the research, it was found that the number of gill cells of cantang grouper reared in green, blue, and red lights treatment was less than without color light treatment. The number of chloride cells in each treatment is presented in Figure 6.

The same number of chloride cells in the light treatment was thought to be related to the duration of the lighting. The lighting causes the lighting duration to occur for 24 hours, while without the lighting, the lighting duration is 12 hours. The long duration of lighting causes the water temperature to be more stable so that it suppresses the metabolic rate of fish.

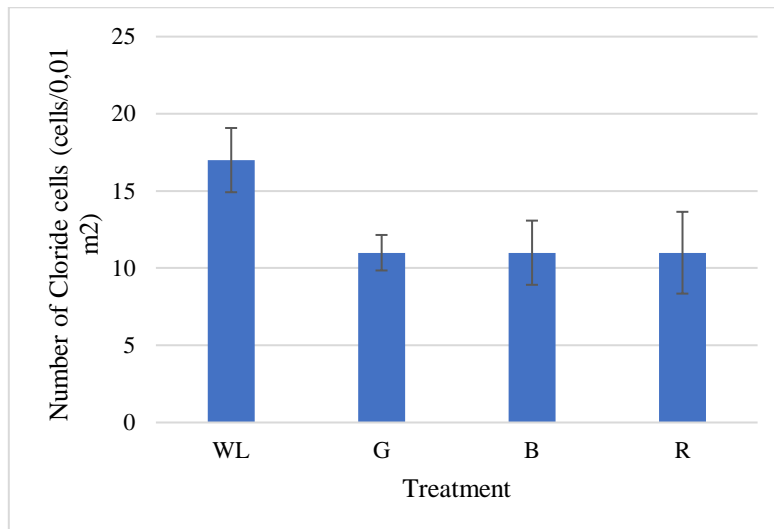


Figure 6. The number of chloride cells in each treatment at the end of the research

The organs that play a very important role in the osmoregulation process are the gills, because they are the way in and out of water and NaCl in the fish body, to carry out the osmoregulation process and survive. Based on the results of the research Hasita *et al.* (2013), explained that the relationship between temperature and salinity is inversely proportional. Chloride cells found in cantang grouper seeds are shown in Figure 7.



Figure 7. Chloride cells in cantang grouper seeds

Water Chemical Physics Parameters During Research

The water physicochemical data during the research on the treatment with different lamp colors are presented in Table 3.

Table 3. Range of Physical Chemical Parameters of Water During Maintenance

Treatment	Temperature (°C)	DO (mg/l)	pH	Salinity (ppt)
WL	27.7 – 28	5.17 - 6.7	8.4 - 8.5	28 – 30
G	27.7 - 28.1	5.55 - 6.8	8.3 - 8.5	26 – 29
B	27.2 - 28.3	5.18 - 6.8	8.2 - 8.5	28 - 29
R	26.9 - 27.7	5.27 - 7.1	8.2 - 8.6	26 - 29
SNI 8036.2:2014	26 – 31	Minimum 4	7.5 – 8.5	24 – 33

The physical and chemical parameters of the water during the research were within the range suitable for the maintenance of cantang grouper seeds with a size of 3-11 cm according to SNI.

CONCLUSION

The highest preference of cantang grouper seeds with a size of 5-13 cm is in blue light, which is 56.67%. Physiological response in the form of the highest growth in blue light for seeds measuring 5-13 cm and the lowest in the treatment without light for seeds measuring 5-7 cm while the lowest absolute growth for seeds measuring 8-13 cm was in the red lights treatment. The highest energy retention was in the blue light treatment and the lowest was in the red lights treatment, but the highest protein retention occurred in the no light treatment and the lowest in the red lights treatment. The highest survival rate was in the blue light treatment and the lowest was in the no light treatment. The difference in the number of rods and cones was the lowest at a size of 5-13 cm, namely in the treatment without light, and the highest in the green light treatment for a size of 5-7 cm and the blue treatment for a size of 8-13 cm. While the highest number of chloride cells was in the treatment without lamp light.

SUGGESTION

Further research is needed on the AFFECT of light color and the presence of food on the preference of cantang grouper seeds, and the AFFECT of the duration of blue light illumination with an intensity of 59 lux on the physiological response of cantang grouper seeds.

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