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OSEANOGRAPHIC CONDITIONS OF GREEN MUSSEL CULTIVATION (*Perna viridis*) USING MULTILEVEL PLASTIC BASKETS METHOD IN SALEMO ISLAND WATERS, PANGKEP REGENCY, INDONESIA

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ABSTRACT

Cultivation of green mussels (Perna viridis) using multilevel plastic baskets has been carried out in the waters of Salemo Island, Pangkep Regency, Indonesia. The purpose of this study was to determine the oceanographic parameters that affect mussel cultivation at different water depths. The research treatment was placement on the surface and bottom of the waters (five meters deep) with different stocking densities. Green mussel cultivation is carried out for 4 months, namely May, June, July and August. Measurement of oceanographic parameters was carried out every month during green mussel cultivation, in situ, namely temperature, turbidity, salinity, pH, DO and those analyzed in the laboratory, namely TSS, TOM, Nitrate, Phosphate and the composition and abundance of plankton. Growth measurements of green mussels were also carried out, namely absolute weight and survival (SR). The results showed that the condition of oceanographic parameters differed between the surface and bottom waters, especially the parameters of TSS, turbidity, TOM, nutrients and plankton abundance. This situation is related to the absolute growth value and SR of mussels at different stocking densities and depths.

***Keywords**: Oceanographic, green mussels, multilevel baskets, absolute growth, Salemo*

INTRODUCTION

Green mussel (*Perna viridis*) is a fishery commodity with economic value as a food ingredient. This shellfish has a fairly high nutritional content, especially protein and minerals, so it has an important role in meeting the nutritional needs of coastal communities. Various efforts have been made by the community to fulfill the demand for green mussels, both naturally and through cultivation. Various cultivation methods have been carried out, including using poles, rafts, and longlines (Marma *et al.,* 2021). Applying of this method often interferes with community shipping activities, so it is necessary to develop cultivation methods that are more placed both on the surface and at the bottom of the waters. Green mussel cultivation experiments have been carried out on the surface and the bottom of the water using a net box (Putra *et al.,* 2022). The application of green mussel cultivation methods requires physical, chemical and biological oceanographic conditions to support the growth and survival of green mussels. Optimum water conditions as a cultivation medium play a very important role in the success of green mussel production. Therefore, it is necessary to pay attention to the selection of cultivation locations to obtain high production (Haryanti *et al.,* 2019).

Small island waters that are close to the mainland can be used as a location for green mussel cultivation. This is because the location is accessible by the market and does not interfere with other cultivation activities such as seaweed cultivation. However, information on the oceanographic conditions of small island waters needs to be known before implementing green mussel cultivation using the stratified plastic basket method.

This paper informs the oceanographic conditions of the small island of Salemo Island in the Pangkajene Regency as the location for the application of the multilevel plastic basket cultivation method for green mussels. The multilevel plastic basket cultivation method is an alternative for cultivating green mussels. This method is technically easy to implement and move around. Its placement in the waters can be adjusted according to the availability of space. Besides, this method is easy to maintain, so that it can be used many times and for a long time.

MATERIALS AND METHODS

Site Location

This research was conducted in the waters of Salemo Island, Pangkep Regency, Indonesia five km from mainland (**Figure 1**). This location was chosen because it is close to the mainland, so it gets an adequate supply of nutrients and green mussel seeds were found at this location. Green mussel cultivation was carried out for 4 months.

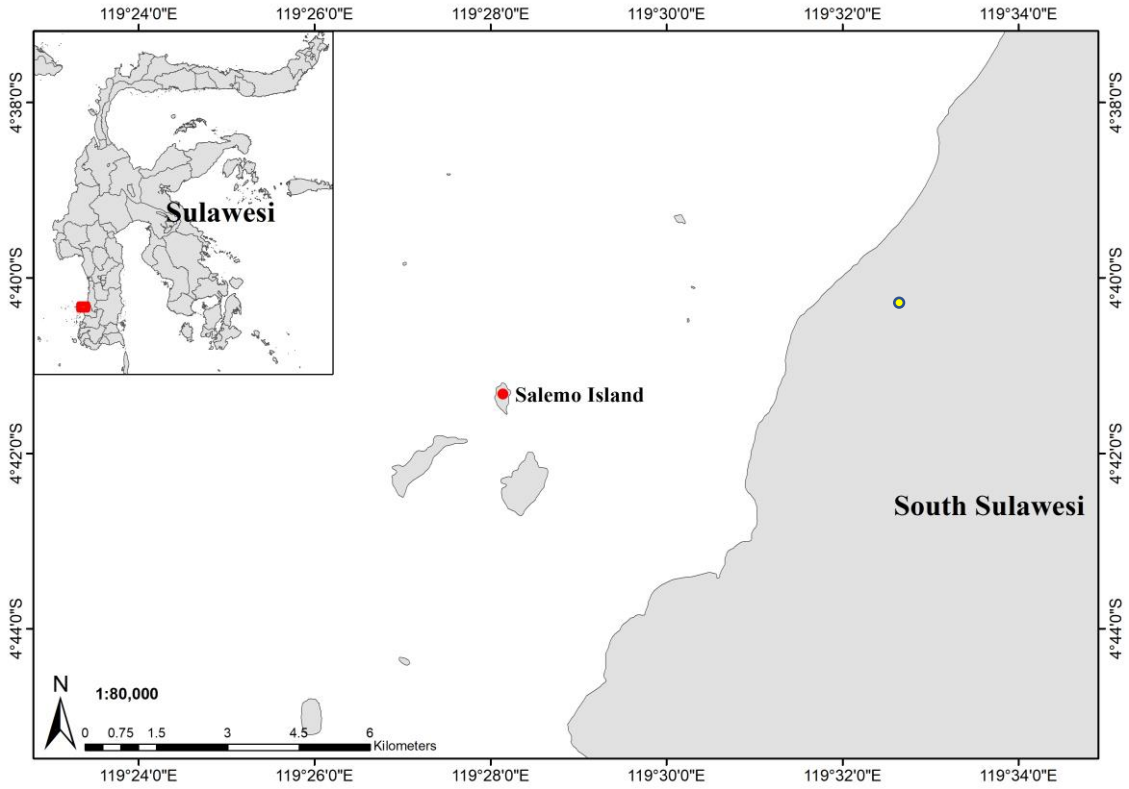

Figure 1. Site Location

Experimental design

Green mussel cultivation experiments were carried out using plastic baskets (**Figure 2**) with two factors, namely the location (surface and bottom waters) and density of mussels. The location treatment is in surface (0.5 m) and bottom (5 m) of the waters of Salemo Island. The density treatment is 20, 30 and 40 mussels per basket with 3 replications. Parameters observed were weight biomass and survival rate of green mussel. Measurements of the biomass weight of mussels were carried out directly beginning and end of cultivation. In measuring the weight of biomass and individual weight of green mussels, a digital scale was used with an accuracy of 0.01 g. Meanwhile, for measuring the length of green mussels using a digital caliper with a 0.01 mm scale.

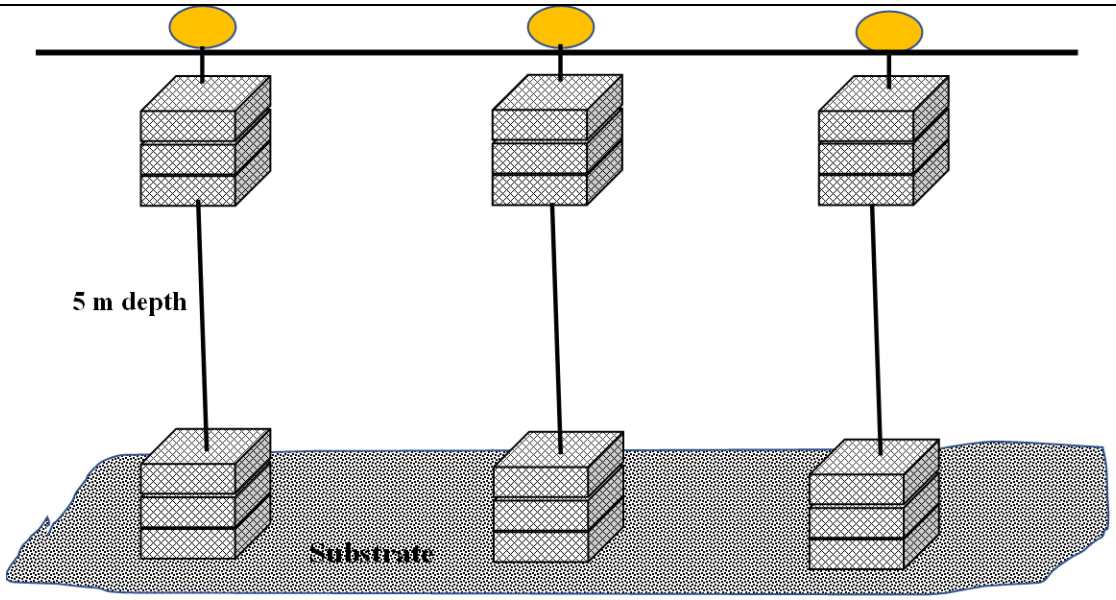

Figure 2. Experimental design of plastic basket placement in the waters of Salemo Island

Sampling of sea water was carried out using a Kemmerer Water Sampler, then put in a plastic bottle with a volume of 500mL and stored in a cool box. Measurement of Oceanographic parameters was carried out every month during the green mussel cultivation experiment on the surface and bottom of Salemo Island waters. In situ measurements of oceanographic parameters were Temperature, Turbidity, Salinity, pH, Dissolved Oxygen, while the parameters Nitrate, Phosphate, Total Organic Matter (TOM) (ASTM, 2000), Heavy Metals (APHA, 1992), Plankton Composition and abundance measurements were carried out in the laboratory. Plankton sampling used plankton net no 25, then identified using an identification book (Yamaji, 1966; Newel and Newel, 1979) and the plankton was counted using Sedgwick Rafter Counting (SRC). Calculation of plankton abundance using the formula (APHA, 1992):

$$N = n\,x\,\frac{Vr}{Vo}x\frac{1}{Vs} \quad \text{..... (1)}$$

Where: N = Abundance (cells/mL) or (ind/mL); n = Number of cells/Ind observed; Vr = Volume of filtered water (mL); Vo = Observed water volume (mL); Vs = Volume of filtered water (mL)

The following is a calculation of several growth parameters (weight) and survival of green mussels at the end of cultivation:

Absolute weight biomass can be calculated using the following formula (Effendi, 1979):

$$WA = Wt - Wo \quad \text{..... (2)}$$

Where: WA = Absolute weight biomass (g); Wt = Average biomass weight at the end of the cultivation (g); Wo = Average biomass weight at the beginning of the cultivation (g)

Daily growth rate (DGR) of weight green mussel was calculated with formula (Zonneveld et al., 1991):

$$DGR\ (g/day) = \frac{Wm}{t} \quad \text{..... (3)}$$

Where: DGR (W) = Daily weight growth rate (gr/day); Wm = Total weight (g); t = Period of cultivation of green mussels (day)

Survival rate (SR) is calculated based on the following formula (Zonneveld et al., 1991):

$$SR = \frac{No - Nt}{No}x100\% \quad \text{..... (4)}$$

Where: SR = Survival rate (%); Nt = Total of mussels at the end of the study (tails); No = Total of mussels at the beginning of the study (tails)

Data Analysis

Oceanographic parameter data obtained during green mussel cultivation experiments were

presented in the form of tables and graphs and analyzed descriptively by comparing them with the results of research that had been done. Testing the effect of green mussel density and locations was carried out using the univariate analysis.

RESULTS AND DISCUSSION

Parameters Oceanographic

The dynamics of oceanographic parameters during green mussel cultivation are shown in the following **figures 3**.

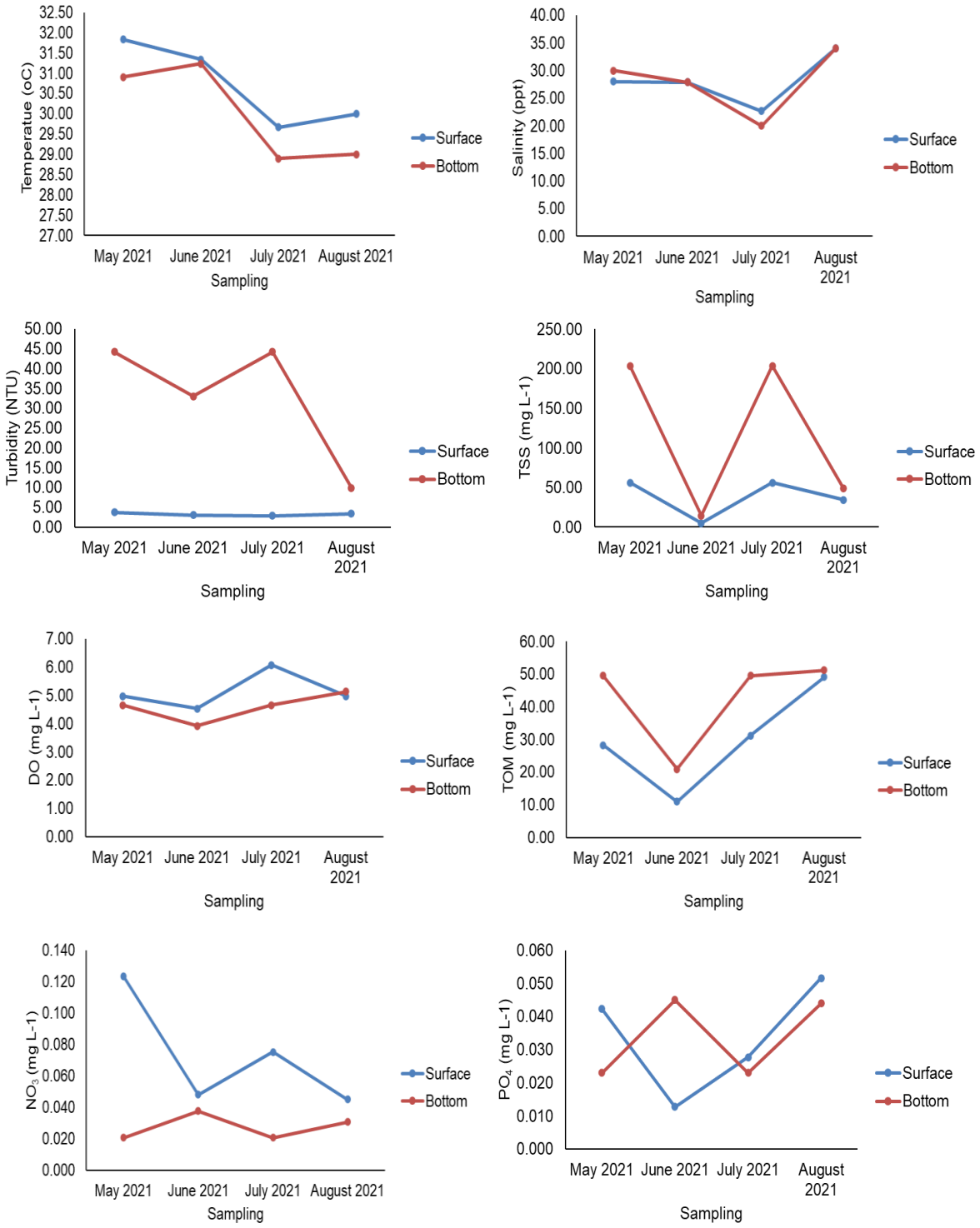

Figure 3. Dynamics of Oceanographic parameters during green mussel cultivation

Figure 3 shows the differences in oceanographic parameters on the surface and bottom of the waters during green mussel cultivation. Turbidity, TSS and TOM parameters show higher values at the bottom, while Temperature, Salinity, DO and Nutrients are high at the surface of the waters

Average data of oceanographic parameters measured during the cultivation of green mussels using the multilevel plastic basket method on Salemo Island are shown in **Table 1**.

Table 1. Oceanographic parameter data related to green mussel cultivation on Salemo Island

Parameters	Unit	Location		Standard
		Surface	Bottom	
Physical Parameters				
Temperature	^{0}C	30.71±0.19	29.80±0.03	27-30 (Aypa, 1990)
Turbidity	NTU	10.72±0.38	32.83±0.63	25 (Lovatelli, 1998)
Total Suspended Solid (TSS)	mg/L	37.91±3.23	115.30±1.93	20 mg/L (PP 22 Tahun 2021)
Depth	m	0.5	5	>8 (Kusuadi 2005)
Substrate (Sand : Silt)	%		20 : 80	0 : 100 (Sallih dan Þórðarson 2005)
Current velocity	m/s	0.2 – 0.3		0.1 – 0,6 (Alvaro, 2005)
Chemical Parameters				
pH	-	7.79±0.03	7.68±0.03	7-9. (Sreedevi *et al*. 2014)
Salinity	$^0/_{00}$	24.88±0.15	25.47±0.01	24-33 (Kripa *et al.* 2008)
Dissolved Oxygen (DO)	mg/L	7.09±1.93	4.39±0.46	2-12 (Alfaro, 2005)
Phosphate (P-PO_4)	mg/L	0.063±0.05	0.04±0.02	0.015 (PP 22 Tahun 2021)
Nitrate (N-NO_3)	mg/L	0.07±0.03	0.03±0.01	0.06 (PP 22 Tahun 2021)

The data in **Table 1** shows the average value of the oceanographic parameters of the waters of Salemo Island during the cultivation of green mussels using the multilevel plastic baskets method. Several parameters show differences between surface and bottom waters. namely turbidity. TSS. TOM and abundance of plankton. In general. the oceanographic parameters are still at the appropriate value for the growth of green mussels.

Oceanographic factors contribute to the success of green mussel cultivation using the multilevel plastic basket method. Placement of cultivation units on the surface and bottom of the waters is very closely related to oceanographic parameters in the waters of Salemo Island. Oceanographic parameters in the waters of Salemo Island are at values that support the life of green mussels. The turbidity, TSS and TOM parameters have quite high values (**Figure 3**), each with an average turbidity value of 10.72±0.38 NTU on the surface and 32.83±0.63 NTU at the bottom of the water, the average TSS value of 37.91±3.23 mg/L on the surface and 115.30±1.93 mg/L at the bottom of the water. The value of turbidity and TSS of waters is strongly influenced by land use on the mainland (Azman *et al.,* 2012) The total organic matter (TOM) content on the surface of the waters was on average 27.36±4.21 mg/L and at the bottom the average was 37.79±11.95 mg/L. The high value of turbidity, TSS and TOM is because the location of Salemo Island is close to the mainland where there are river mouths that carry sediment to sea waters. TSS were mostly utilized by the bivalves (Melendres, 2021).

The pH value of the waters with an average of 7.79±0.03 on the surface and 7.68±0.03 at the bottom strongly supports the growth of green mussels. The growth of green mussels requires a pH in the range of 6 - 9 (Putra, 2022). This condition is also supported by the dissolved oxygen content of the waters during cultivation,

which is 7.09±1.93 mg/L on average and 4.39±0.46 mg/L on the surface and bottom. The low DO level at the bottom is due to the inhibition of the photosynthesis process due to the high turbidity level, but this condition is still able to support the growth of green mussels. Based on environmental quality standards for the growth of marine life requires DO levels> 5 mg/L (Lovatelli, 1988).

The depth, type of substrate and current velocity of the waters of Salemo Island are in a condition that supports the cultivation of green mussels. Green mussel cultivation requires a maximum depth of 8 meters, the type of substrate is muddy sand with a ratio of 20:80 and the current velocity is in the range of 0.1 - 0.3 m/s. The average temperature values of 30.71±0.19 ^{o}C on the surface and 29.8±0.03 ^{o}C are still in the optimum range for the growth of green mussels, namely 26-33^{o}C (Lovatelli, 1988)

Nitrate and phosphate nutrients in the waters of Salemo Island are at concentrations that support the growth of phytoplankton as food for green mussels. The concentrations obtained were 0.07±0.03 mg/L N-NO_3 and 0.063±0.05 mg/L P-PO_4. Meanwhile, heavy metal parameters as indicators of water pollution show low concentrations, concentrations of Pb, Cd, Cu and Hg are below the seawater quality standard for biota (Indonesian Government Regulation, 2021).

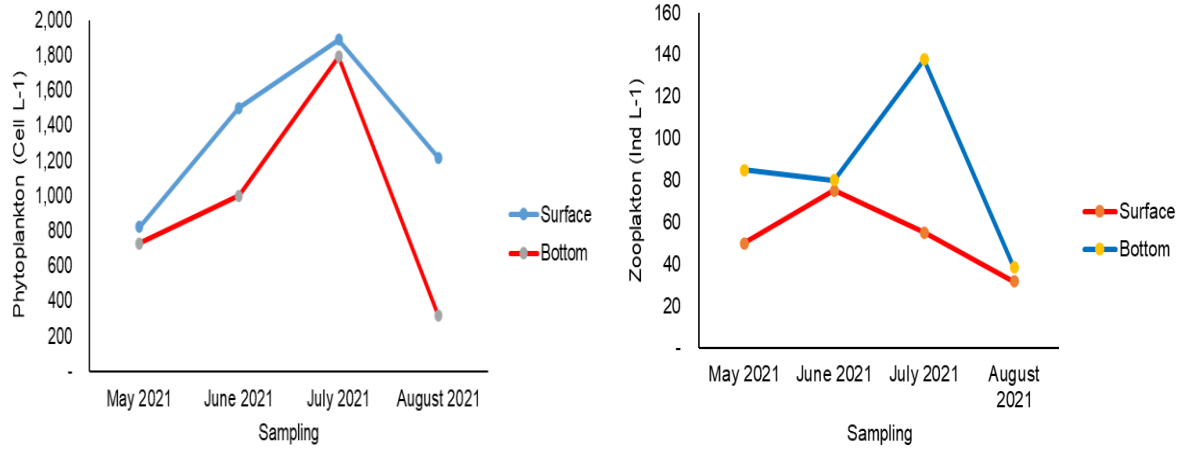

Figure 4. Dynamics of Phytoplankton and Zooplankton Abundance during green mussel cultivation on Salemo Island

Placement on the bottom of the waters with a depth of 5 meters below the value of the brightness of the waters affects the number of species and abundance of plankton and other oceanographic parameters. Found 24 types of phytoplankton and 13 types of zooplankton on the surface while at the bottom of the waters found 21 types of phytoplankton and 12 types of zooplankton. The abundance of phytoplankton is high on the surface of the waters on average 1356+450 cell/L at the bottom of 959+620 cells/L, but on the other hand the abundance of surface zooplankton is lower on average by 53+1.78 Ind/ L while at the base average of 84+41 Ind/L. A site with a high concentration of diatoms is considered good for the cultivation of green mussels, an area with high turbidity, low salinity, and low dissolved oxygen should be avoided (Sing and Ransangan, 2019).

Absolute Growth and Survival Rate

The result of absolute growth and survival rate of green mussels cultured using the multilevel plastic basket method on the surface and bottom of the waters on Salemo Island is shown in **Table 2**.

Table 2. Data of green mussel variables at end of cultivation

Dependent Variable	Source of Variation	df	MS	F	Sig
WA (g)	Location	1	170,195	,136	,719
	Density	2	78,321,633	62,528	,000
	Location*Densitiy	2	6,142,138	4,904	,028
DGR (g/day)	Location	1	28,678	711,605	,000
	Density	2	10,638	263,963	,000
	Location*Densitiy	2	1,257	31,187	,000
SR (%)	Location	1	172,049,780	.	.
	Density	1	89,780	.	.
	Location*Densitiy	2	22,445	.	.

Notes: Wa (absolute weight), DGR (daily growth rate), SR (survival rate)

Table 2 data shows an increase in the absolute weight of green mussels during cultivation. The highest production was at a density of 40 ind/basket. both surface and bottom cultivation. There is no difference in absolute weight and survival of green mussels between surface and bottom culture (P<0.05)

The growth of green mussels cultured using the multilevel plastic basket method with different density treatments showed that 40 ind/basket gave the best absolute growth on average of 418.33 g on the surface and 427.11 g on the bottom (P>0.05). While the survival value of green mussels was in the range between 93.3 - 100%, low values were found in bottom cultivation, but there was no difference between surface and bottom cultivation (P<0.05). The survival value showed that green mussels were able to live with the multilevel plastic basket cultivation method on both the surface and the bottom of the water.

Cultivation of green mussels for 90 days with the multilevel plastic basket method gave different daily weight gains between treatments of mussel density. The higher the density of green mussels, the greater the daily weight gain. Mussel culture on the surface and bottom of the water gave the same pattern of weight gain. The density of 40 Ind/basket gives the best daily weight growth rate (DGR) of 4.65+0.03 g/day on the surface and 4.75+0.03 g/day on the bottom of the water. The value of the DGR from this experiment shows a fairly high daily growth compared to other studies, namely 1.27 ± 0.03%/day and 0.11 ± 0.004 %/day (Putra *et al.,* 2022).

CONCLUSIONS and SUGGESTION

Some of the Oceanographic parameters of the small island of Salemo namely TSS, Turbidity, TOM, Nitrate and Phosphate as well as the availability of plankton are strongly related to the cultivation of green mussels (Perna viridis) using multilevel plastic baskets. During the time of mussel cultivation, Oceanographic parameters on Salemo Island fluctuated both on the surface and bottom of the waters, but supported the growth and survival of green mussels. The application of green mussel cultivation methods using plastic baskets can be applied on the surface or bottom of the waters, because Oceanographic parameter conditions support the life of green mussels.

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