Cultivation of seaweed using the basic stocking system in floating net cages on Salemo Island, Pangkep Regency, South Sulawesi, Indonesia

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Abstract. Seaweed has a large enough potential to be developed, especially in small islands. So far, cultivation activities carried out by seaweed farmers generally use stretch ropes so that they have high operational costs. One of the cultivation technology innovations that can be developed with an operational cost that is quite cheap and easy to operate is seaweed cultivation using floating net cages with a basic stocking system. The purpose of this study was to design a tool/media for seaweed cultivation in the form of marine cage with a bottom stocking system and to analyze the absolute growth rate based on the height of the cages (30, 50 and 70 cm). The method used in this study is the cultivation of seaweed with a bottom stocking system for different heights of the floating net cages (KJA). This study uses a comparative analysis approach of the results of seaweed production, based on different marine cage heights. The results showed that the highest seaweed production was at a depth of 50 cm, followed by 70 cm and the lowest was at a depth of 30 cm. The results of this study are expected to contribute to an increased production and income for seaweed farmers, especially in Pangkep Regency.
Key Words: marine cage, bottom stocking system, absolute growth rate, seaweed production.

Introduction. Pangkep Regency is one of the districts in South Sulawesi Province which has a coastal area with a coastline of about 49.71 km and has a total of 145 islands (Rauf et al 2019) with various coastal geomorphological variations, ranging from hilly areas to sloping beaches. Salemo Island is one of the islands located in Liukang Tupabbiring District, the north of which having the sufficient marine resources with development potential, such as the seaweed cultivation. One type of seaweed that is commonly cultivated by people in this area is *Eucheuma cottonii* (*Kappaphycus alvarezii*) (Anggadiredja et al 2006). This species is widely cultivated because the production technology is relatively cheap and easy, and the post-harvest handling is relatively simple (Meiyana et al 2001). Besides that, the seeds are also available in sufficient quantities (Dahuri 2001; Dahuri 2003). Apart from being an industrial raw material, this type of seaweed can also be processed into food (Restiana & Diana 2009; Ghufran 2010; Sulisetijono 2009) which can be consumed directly.

Seaweed cultivation in Pangkep Regency has encountered many obstacles, which have resulted in reduced yields. Constraints commonly experienced by cultivators in this area include the lack of understanding concerning the correct cultivation techniques and the product quality maintenance, but the dominant issue remains the price, which is determined by the buyer or collector. In addition, the handling of seaweed pests is not appropriate. These can spread and attack the entire production area, which is already vulnerable to ice-ice disease, weather changes or decreases in the quality of the cultivation environment (Effendi 2003), but also conditioned by the quality of human resources. One of the most important factors is the right cultivation method, depending

on the spatial efficiency and the protection against from the pests, the predators (such as baronang fish) and the waves and currents (Hutabarat & Evans 2008; Syamsiah 2007; Wijayanto et al 2011). One of the best seaweed cultivation methods is to use floating net cages (KJA) media. The study refers to the marine cages cultivation media using the off-bottom method, as a modification of the *E. cottonii* seaweed cultivation recommendations of the Directorate General of Fisheries, including the off-bottom, floating (raft) and long line methods (Directorate General of Aquaculture 2005).

The present study aimed to design a tool/media for cultivating seaweed in the form of a marine cage with a basic stocking system and to analyze the seaweed absolute growth rate, based on the cage depth (30, 50 and 70 cm). The results of this study are expected to provide information on the development of *E. cottonii* seaweed cultivation in Salemo Island waters, Pangkep Regency.

Material and Method. The method used in this research is the seaweed cultivation method, with the basic stocking system. The research was carried out around Salemo Island in July 2019 (Figure 1).

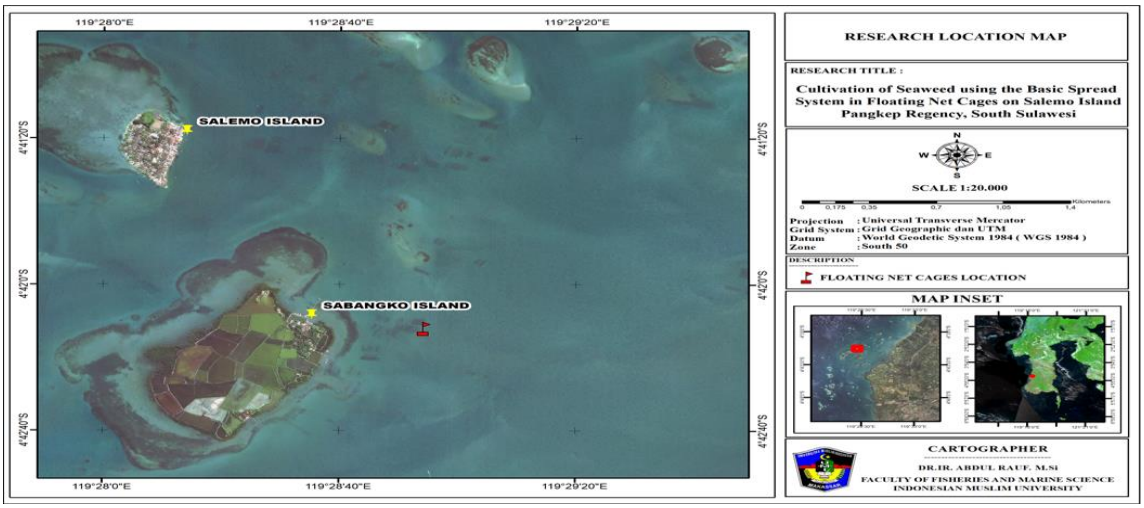

Figure 1. Map of the research location.

The present research was conducted according to the stages described in the bellow diagram (Figure 2).

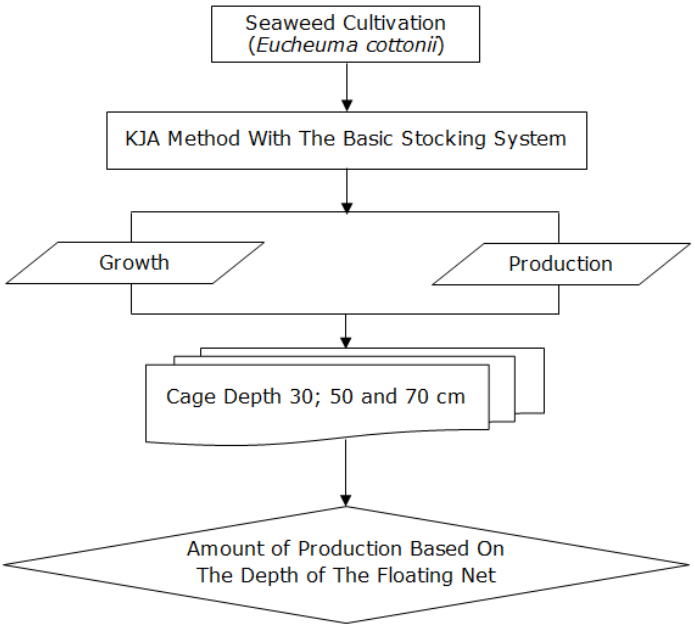

Figure 2. Flowchart of the research on *Eucheuma cottonii* cultivation on Salemo Island.

Research procedure. The present research was conducted using the following procedure:
1. Designing tools/media for seaweed cultivation in the form of floating cages. The tools, made of stainless steel profiles measuring 2 x 2 x 2 cm, had a length of 3 m, a width of 3 m and a depth of 30, 50 and 70 cm, respectively. The finished cage frame was wrapped in trawl no. 12, using a float made from a 4" paralon pipe attached around the KJA. Furthermore, it was operated at sea using a stake (weight replacement) with a weighted rope, at a depth of 7-10 m.
2. Spreading the seaweed seeds in the floating net cages, after weighing the initial quantity of 50 kg, was carried out at harvest time, at 45 days.
3. Determining the seaweed production by calculating the initial weight and final weight values for each cage (treatment).

Data analysis
Absolute growth rate. The absolute growth rate was calculated using the formula Pongarrang et al (2013):

$$G = Wt - Wo$$

Where:
G - absolute growth (kg);
Wt - weight of seaweed seeds at the end of the study (kg);
Wo - weight of seaweed seeds at the beginning of the study (kg).

Seaweed production. The seaweed production was calculated based on the results of the final weighing (after being maintained for 45 days) in each cage. The effect of cage depth (30, 50 and 70 cm) on the seaweed production was calculated based on the amount of production obtained for each cage variant.

Results

Seaweed cultivation in KJA. Seaweed is generally harvested after the age of 40-45 days (Harun et al 2013), considering its high degree of porosity (Restiana et al 2009; Sulisetijono 2009), in accordance with the market demand. The results obtained from the three cage sizes after weighing can be seen in Table 1 and Figure 4.

Table 1
Measurement results of the average weight (kg) of *Eucheuma cottonii* kept in floating net cages for 45 days

X-Coordinates	*Y-Coordinates*	*Measurement results (kg)*		
		Beginning	*End*	*Depth (cm)*
119° 28' 56.018" E	04° 42' 11.470" S	50	249	30
119° 28' 56.087" E	04° 42' 11.745" S	50	316	50
119° 28' 55.916" E	04° 42' 11.736" S	50	273	70

Figure 4. *Eucheuma cottonii* production maintained in KJA (original).

Absolute growth rate. The weighing of the final quantity of *E. cottonii*, after being maintained for 45 days in floating net cages placed at different depths, namely 30, 50 and 70 cm, resulted in 249, 316 and 273 kg, respectively (Table 2).

Table 2

The measurement results of the average weight (kg) of *Eucheuma cottonii* reared in the marine cage for 45 days

X-Coordinates	*Y-Coordinates*	*Measurement results (kg)*			
		Beginning	*End*	*Absolute growth*	*Depth (cm)*
119° 28' 56.018" E	04° 42' 11.470" S	50	249	199	30
119° 28' 56.087" E	04° 42' 11.745" S	50	316	266	50
119° 28' 55.916" E	04° 42' 11.736" S	50	273	223	70

The results of the growth analysis showed that the best absolute growth rate occurred in floating net cages with a height of 50 cm and a yield of 266 kg, while the lowest was found in floating cages with a height of 30 cm and a yield of 199 kg.

Discussion

From Table 2 it can be seen that there was a difference of final weights between the three treatments, where the lowest *E. cottonii* production was found in cages with a height of 30 cm, presumably due to a higher temperature from the sunlight, compared to those with a height of 50 and 70 cm (Pongarrang et al 2013). Cages with a height of 50 cm had a higher production, presumably because the temperature decreased and was optimal, while in cages with a height of 70 cm, the production was lower than in the 50 cm variants, probably because the penetration of sunlight has started to decrease due to a high sedimentation (turbidity) at the research location. The very high light intensity actually inhibits the photosynthesis process (photoinhibition), while the too low intensity becomes a barrier for the photosynthetic process that occurs in seaweed (Sunarto 2008). Kune (2007) stated that an important factor affecting the growth rate of seaweed is that the difference in light intensity received by seaweed at different depths will affect the stretch of new cell walls which hardly changes when the expansion of seaweed growth is inhibited by light.

Conclusions. It was demonstrated by the experimental method of the present study that tools or media for cultivating *E. cottonii* with the KJA method and a basic stocking system are appropriate for use in seaweed cultivation. The best absolute growth rate and yields of *E. cottonii* in marine floating cages, with a maintenance time of 45 days, were observed in cages with a height of 50 cm, where as much as 266 kg were produced from an initial weight of 50 kg.

Conflict of interest. The authors declare no conflict of interest.

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Received: 18 January 2021. Accepted: 26 March 2021. Published online: 11 April 2021.
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How to cite this article:
Rauf A., Wamnebo M. I., Fattah M. H., Harlina H., Asni A., 2021 Cultivation of seaweed using the basic stocking system in floating net cages on Salemo Island, Pangkep Regency, South Sulawesi, Indonesia. AACL Bioflux 14(2):976-980.