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The effect of seasonal and environmental parameters to Carageenan production of seaweed *Kappaphycus alvarezii* in Sabutung Island, South Sulawesi Province

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Abstract : The quality of seaweed *Kappaphycus alvarezii* type is determined by the content of carageenan. This research is aimed to assess the relationship between season and carrageen content of *K. alvarezii* seaweed. The design of this research is explanatory reseach by placing the location of cultivation on four sides of the island that is carried out in two seasons, namely the rainy season that lasts between November to February and the dry season between July to October. The environmental parameters measured were nitrate, phosphate, salinity and current velocity. Parameter measurements were performed on a weekly basis during the study, while carrageen was measured at the beginning of the study, second week, fifth week and seventh week. The results of partial seasons were significant for seaweed admixture values. The influence of interaction between station and season with the partial influence of station is not significant to *K. alvarezii*. This is significant in the absence of extreme changes between stations in a given time with relatively homogenous values at the four observation stations. The average of carageenan in rainy season (40.756%) significantly differed lower compared with dry season (49.063%). The relationship between seaweed carageenan with environmental parameters follows the linear equation: Y = -68.780 + 13.869 Nitrate + 44.316 Phosphate + 2.923 Salinity + 0.87 Flow (R2 = 0.976). It can be concluded that the season is very influential on the production of carageenan and environmental parameters have a positive effect on carageenan. To obtain high carragenan production, it is expected that the cultivation of *K. alvarezii* will be done during dry season.
Keywords : Aquaculture of seaweed; dry and rainy season; environmental; Pangkep; quality.

Introduction

Sabutung Island is one of the islands within the sustainable fisheries zone of the Regional Marine Conservation Area (KKLD) of Pangkep Regency. The island has a population of 482 people with a total

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number of 112 families, about 80% of the population livelihood as fishermen with fishing gear and trawl mini fishing gear (drool), while the cultivation activity is the cultivation of fish with Floating Net Cages system and seaweed cultivation. Sabutung Island is about 14 Km from the capital of Pangkep regency, it can be reached by using public transport of four wheel and boat [1].

Referring to the condition of Sabutung Island community still using environmentally friendly fishing gear which contradicts the principle of sustainable fishery zone management, it is reasonable to find a solution in accordance with the principle of sustainable fisheries zone management [1].

Seaweed is species that has a prospect that is still widely open, especially world markets such as Europe, China and Japan. Seaweed cultivation development, in addition does not require too large land can also involve a lot of energy. In fish production, seaweed are used as a source of carbohydrate in feed [2]. Seaweed are known to have many benefits [3], and the world demand is continuously increasing [4, 5].

Carageenan is a seaweed sap extracted with water or an alkaline solution of a particular species in Rhodophyta (red algae). *Eucheuma cotonii* species is a producer of kappa carrageen while *E.spinosum* species is producer of carotene iota. Carageenan is also a polysaccharide derived from algae extraction. Carageenan consists of carotene and cappacarageenan in which their content varies greatly depending on season, species and habitat. In carrageen there is sodium salt, station and calcium. Carrageens of stations consisting of α-carrageen and β-carageenan are soluble in hot water, while sodium carbbage is soluble in cold water [6]. Carrageen content grown around the Chamran Bay of Thailand shows no difference in the number of carrots in each year [7]. However Mulyaningrum[8]get the highest carageenan content is the maintenance age for 45 days.

In addition to age factor, carageenan content is also suspected to be associated with the season and the condition of the cultivation environment. Environmental parameters are play a role in determining the productivity of aquaculture[3, 9]. In relation to this matter, it is necessary to conduct a research that can reveal the influence of seasons and the relation of environmental parameters with the content of carageenan in *K. alvarezii*.

Material and Method

Location and research design

This research was conducted in the waters around Sabutung Island, Pangkep regency of South Sulawesi. In January to February and July to August 2016. Type of research used is an explanatory research designing research to get clarity about the seasonal relationship and environmental parameters with the production of carageenan seaweed species *Kappaphycus alvarezii.*

Method of cultivation

Seaweed cultivation is done by floating method, which is made of rope with size 40 x 20 meter consist of 20 spans with length of each span 20 m. The distance between the clumps is 19 cm so that in each span consisting of 100 clump points, each point consists of 2 clumps so that the number of clumps per stretch is 200, the weight of each clump of seaweed is 20 g (initial weight). Into the 50 cm stretch of water surface. Cultivation stations are placed on all four sides of the island Data collection of environmental parameters is carried out every week, during rainy and dry seasons, data collected at current velocity, phosphate, nitrate and salinity. Carageenan content (CC) is carried out at the beginning of maintenance, second week, fifth week and end of maintenance. The cultivation is done for 45 days. To know the content of carageenan in seaweed done with formula:

$$CC(\%) = \frac{carrageenan\ insulation\ weight}{dry\ sample\ weight} x\ 100\ \%$$

Meanwhile, to obtain the relationship between environmental parameters with seaweed growth is done multiple regression analysis Steel & Torrie [10] with the following formula:

$$Y = b0 + b1X1 + b2X2 + b3X3 + b4X4$$

Where: Y = growth;
bo = constant;
X1 = water salinity measurement;
X2 = nitrate measurement;
X3 = phosphate measurement;
X4 = current velocity measurement;
b1, b2, b3, and b4 = the coefficients of each parameter.

Discussion

Seaweed seawater measurements measured at weeks 1, 2, 5 and 7. show that carageenan increases with increasing length of maintenance. In the rainy season the value of carragenan at seventh week ranged from 44.48-49.64%, increased by 15.96-21.12% compared to start of research (28.52%). In the dry season the value of carageenan at seventh week ranged between 55.60-61.63%, increased by 25.38-31.41% compared to the beginning of the research (30.22%). The Figure 1 presents data about the results of carageenan measurements during the study.

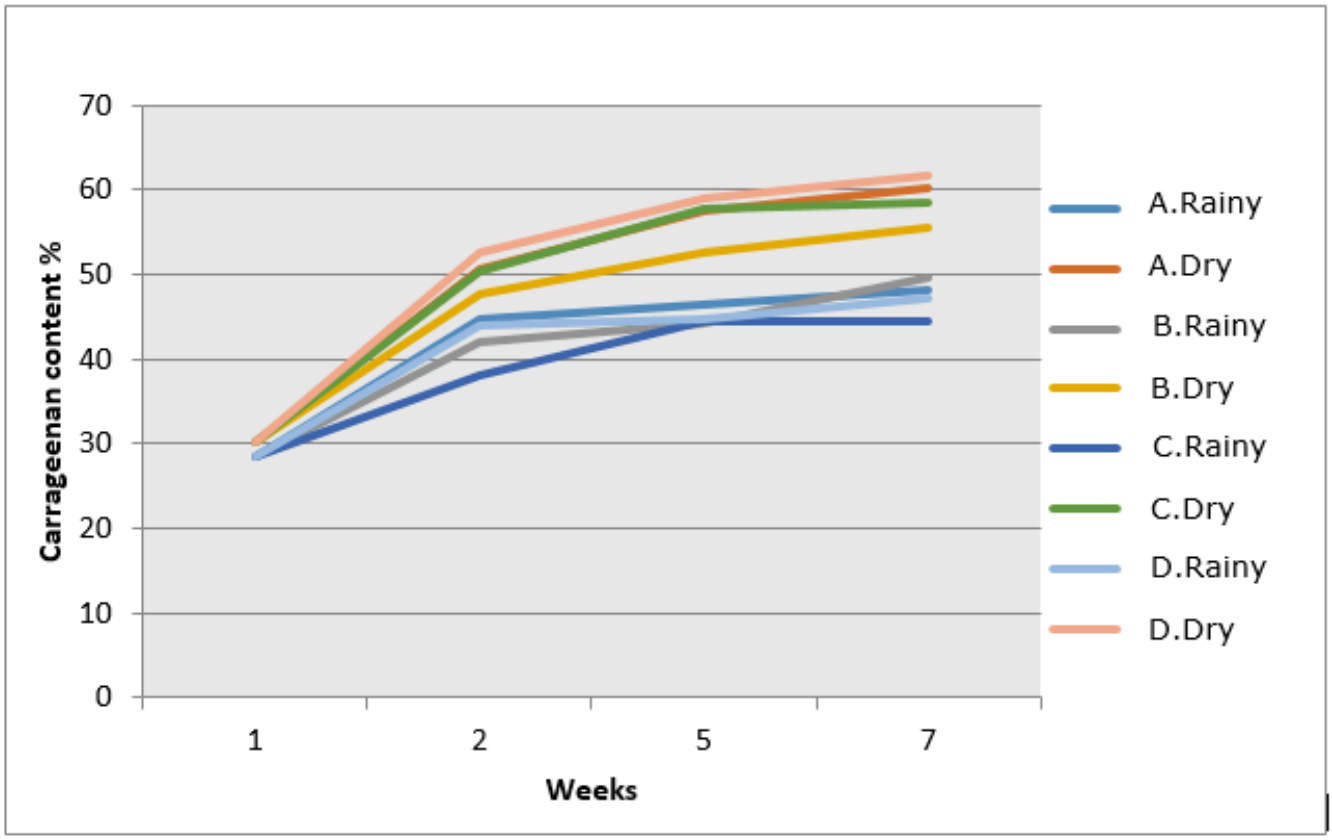

Figure 1. Carageenan content during study seasons.

The result of multiple linear regression analysis between seaweed carageenan value (Y variable) with some environmental parameter (X variables) showed that carageenan significantly correlated linearly with, phosphate, salinity, current velocity and Nitrate. The partial correlation between the carageenan with each environmental parameter shows a positive linear correlation. This means that the value of carageenan tends to increase with increasing phosphate, salinity, current velocity and Nitrate.

The relationship between seaweed carageenan with environmental parameters follows the linear equation: Y = -68.780 + 13.869 Nitrate + 44.316 Phosphate + 2.923 Salinity + 0.87 Flow (R2 = 0.976). The diversity of seaweed carageenan that can be explained through the regression equation is about 97.6%. This regression equation can be interpreted that when other parameters are constant then if the nitrate level increases

by one unit (ppm) the density also increases by 13.869%. The same thing happens when the other parameters do not change so with increasing phosphate (ppm) carageenan will increase equal to 44.316%. Conversely, with increasing currents of 1 cm/sec, the carageenan will decrease by 0.445% assuming other environmental parameters other than the current velocity do not conform to the change. The same meaning can be determined from the value of the salinity regression coefficient in the regression equation.

Based on the results of regression analysis it is seen that the phosphate content in the waters is an important parameter that affects the value of carageenan seaweed. A positive linear relationship between carageenan with phosphate levels indicated that phosphate levels measured between 0.042-0.307 ppm in this study had not reached the saturation level limit to increase the seaweed carageenantity level. Consequently, the noticeable difference in average phosphate levels between the lower rainy seasons compared with the dry season leads to higher average carageenan in the dry season.

The result of analysis of carageenan variety based on season and observation station showed that only partial influence of season to the value of carageenan seaweed. The influence of the interaction between the station and the season and the partial influence of the station is not significant on seaweed carageenan. This means that there is no extreme carageenan change at the station within a certain time and the relative kerosene value is homogeneous within the four observation stations. The average of carageenan in rainy season (40.756%) is significant

Differed in comparison with the dry season (49.063%). The results of this analysis are consistent with the results of phosphate variety analysis, salinity and current velocity.

Combining the two variation analysis results (environmental parameters and carageenan) with the results of multiple linear regression analysis of carageenan with environmental parameters it is very clear role of phosphate and salinity in controlling the value of carageenan. The positive effect of phosphate and salinity on seaweed weights can be explained through the mechanism of seaweed cell wall filled by carageenan[11], furthermore it is said that carageenan is a hydrocoloid compound consisting of potassium, sodium, sulphate, phosphate and magnesium ester

More high levels of phosphate in the dry season compared with the rainy season due to the weathering process is higher in the dry season In addition to the dry season there is a process of stirring the mass of water from upwards [12].

The effect of nitrate positive on the value of carageenan although from partial correlation analysis did not show significant correlation, it shows that although not as big as phosphate influence but increase of nitrate level in waters also trigger increase of carageenan value. This is thought to be related to the interaction effects along with other parameters, especially phosphates, which can directly or indirectly affect the value of carageenan. Conceptually, chlorophyll plants including plankton (algae), aquatic plants and korfofil seaweed have a preperence to the value of a certain N: P ratio to grow optimally, and possibly related to the carageenan.

According to Atmadja [13], if the ratio N/P is below 16, then element N becomes the limiting element, whereas if the N/P ratio is greater than 16, then element P is the limiting element. Furthermore, the need for phosphate for optimum growth of algae is influenced by the form of nitrogen compounds. The highest limit of phosphate concentration will be lower if nitrogen is in the form of ammonium salt [14], vice versa if nitrogen is in the form of nitrates then the required phosphate concentration will be higher Therefore the nitrate effect on the carageenan may be indirectly through growth because it is proven that nitrates have an important effect on seaweed growth.

The relationship between salinity and carageenan indicates that seaweed carageenan tends to increase with increasing salinity. The salinity difference of about 1.9 ppt between the dry season and the rainy season significantly influences the effect of higher carageenan differences in the dry season compared with the rainy season.

Current velocity does not directly affect the height of seaweed carageenan. The indirect effect of seaweed can occur through the influence of currents on phosphate levels, where at a slower current rate in the dry season than in the wet season causes phosphate transport out of the seaweed maintenance area to be slower

so that the phosphate accumulation in the waters is higher. Furthermore, with high phosphate it causes higher levels of carageenan as described previously.

Conclusion

Carageenan content of Kappaphycus alvarezii seaweed on Sabutung Island is strongly influenced by the season where carageenan content in dry season is higher when compared with carageenan content in rainy season and positively correlated with environmental parameters of Nitrate, Phosphate, current velocity and salinity. It is expected that to obtain high carageenan content then the cultivation of Kappaphycus alvarezii seaweed intensified in the dry season.

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