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Analysis on carrageenan content of seaweed *Kappaphycus Alvarezii* at different water condition in Bantaeng District

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Abstract. Seaweed *Kappaphycus alvarezii* has high carrageenan content and highly use as a main ingredient in food industry, cosmetics, pharmacy and organic fertilizer. The research aimed to analyze the seaweed carrageenan content at different water conditions, locations and cultivation distance from coast line. The research conducted in Bantaeng district coastal water during. Experimental method applied and interview with seaweed farmer and also laboratory examination. Each station consists of 3 substations (distance from coast line, near, middle and far) in triplicate. Environmental parameters measured biweekly during 45 days' cultivation periods per season. Samples collected and seaweed weight for carrageenan content analysis conducted at the beginning and at the end of experiment. Univariate analysis of variance applied to analyze the effects of seasons, locations and distance toward seaweed carrageenan content. Result of the study showed that seasons and distance were significantly ($P < 0.05$) affect the seaweed carrageenan content. Carrageenan content were range 44.77 – 63.96%, fulfill the national standard of Ministry of Trade for 25 % as well as the international standard 40%. Carrageenan content were higher during rainy season at cultivation distance 1500 m from the coast line ($P < 0.05$). Carrageenan content was highly correlated with sea current speed and phosphate content during rainy season while salinity and turbidity during dry season.

1. Introduction

Seaweed also called algae which consist of Seaweeds as one of sea plant categorized as low-level plant which has leave, stalk and root but all of their body consist of stalk that its call thally, micro and macro algae that hingly utilize in the daily human life.

The world seaweed demand in the recent year reach 300 metric ton per year and predicted continue to increase in the future, so that seaweed cultivation continuously extended. Indonesia seaweed production targetted to increase up to 10,000,000 ton or incese 389% [1]. As an example, seaweed export from Indonesia during 2001-2005 increase continuously from 27,874 ton to 63020 ton [2]. The reason for high seaweed demand were due to it has many benefit in several applications. Seaweed has a carrageenan content that highly utilize as a main ingredient in food industry, cosmetic, farmacy and organic fertilizer [3–5].

Seaweed *K. alvarezii* as caraginofit species produced carrageenan compound which as polysaccharide compound can extract from seaweed. Carrageenan levels in each species



Kappaphycus sp range 54-73%, depend on species and location were seaweed carrageenan content in Indonesia range 61.5-67.5% [6]. One of the seaweed producer in South Sulawesi is Bantaeng district which it production and cultivation area increased continuously. In the year 2006, coastal area utilized were 2,847 ha with total seaweed production 3,522 ton, whereas by year 2011, coastal area utilized increase become 3,824 ha with total production 8,392.3 ton [7].

Several problems mentioned above as the reason to perform this research. Results of this research are hopefully to become information to seaweed farmer in the research area in Bantaeng district.

2. Materials and methods

The material used in this study is seaweed (*Kappaphycus alvarezii*), which is cultivated in Bantaeng waters.

2.1. Data collection

The research conducted in coastal waters of Bantaeng District, which locate in sub-district of Bissappu, Bantaeng and Pa'jukukang respectively (Fig 1). Dry season period conducted on July through September and rainy season conducted on March through April. Analyses of Carrageenan content conducted in the water quality laboratory, fisheries department, faculty of marine science and fisheries, Hasanuddin University.

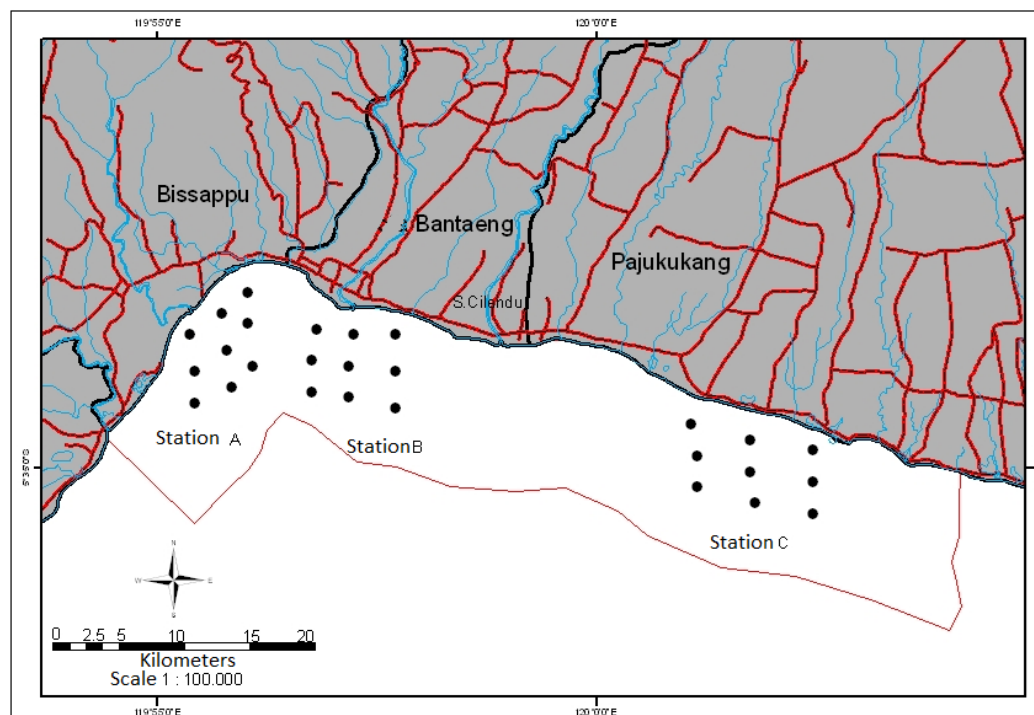


Figure 1. Map of research locations

2.2. Materials and equipments

Research materials were seaweed *K. alvarezii* which collected from seaweed farmer in subdistricts of Bissappu, Bantaeng and Pa'jukukang. Materials for carrageenan extracts were KCl, KOH and for seaweed cultivation experiment were seed, polyethylene rope, and seaweed frame system. Tools uses were boat for transportation to research locations, GPS (Global Positioning System) for fixed positions and cool box for sample storage.

2.3. Research protocol

Experimental methods applied in the seaweed farmer cultivation area and also laboratory examination. Research site in three subdistricts mainly Bissappu, Bantaeng and Pa'jukukang. Each experimental station applied three sub-stations based on distance from coast line and classified as 0-500m (near), 500-1000m (middle) and 1000-1500m (far) in triplicate.

Carrageenan content measured at the experiment start and the end in order to observe the carrageenan content rising during the experimental periods. Floating long line methods applied with 18 m rope length, seed weight average 50 g and tight to the rope at 10 cm distance. The initial seed weight for one line was approximately 5 kg.

Data for seaweed quality conducted after harvesting and then samples drying up under direct sun light after that perform laboratory analyses.

2.4. Calculation for Carrageenan Content (CC)

Carrageenan content (CC) in percent unit (%) was calculated according to [8] formula as follows:

$$\text{Carrageenan (\%)} = \frac{\text{Carrageenan weight}}{\text{Sample weight}} \times 100\%$$

2.5. Data analysis

Univariate with factorial design were applied to analyze the effect of season, location and distance from coast line toward seaweed carrageenan content using SPSS statistical software [9].

3. Results and discussion

3.1. Carrageenan content

In general carrageenan content in all research area in rainy and dry seasons were range 44.77 – 74.06% and 41.86 – 61.24% respectively. Distribution pattern for the highest carrageenan content during rainy season toward bantaeng subdistrict in the far distant and tend to decrease in Bissappu and Pa'jukukang subdistrict area. Whileas during dry season the highest carrageenan content direct to Bissappu subdistrict area (Figure 2 and 3).

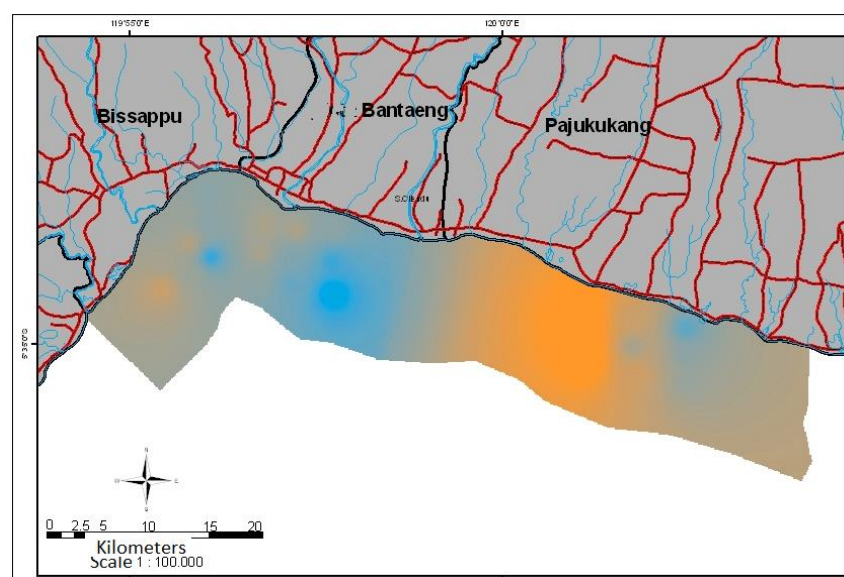


Figure 2. Figure for the average of seaweed carrageenan content during rainy season

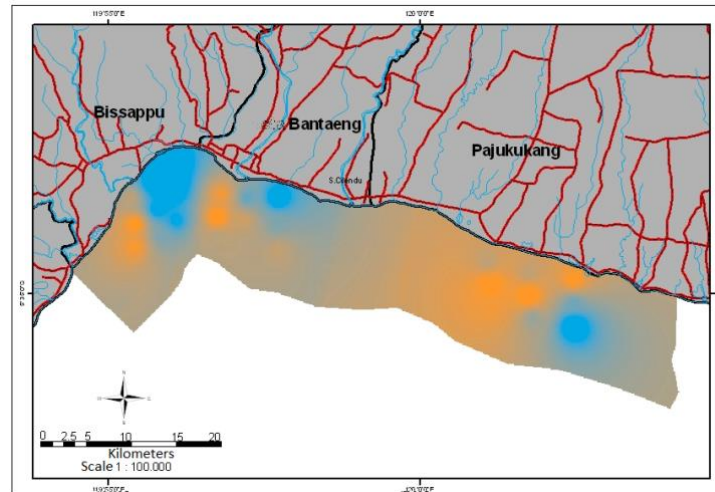


Figure 3. Figure for the average of seaweed carrageenan content during dry season

Result of seaweed carrageenan content showed the highest in the rainy season at Bantaeng city $55.40\% \pm 12.87$ at the far cultivation distance. While during dry season the average carrageenan content was highest in Bissappu subdistrict $51.03\% \pm 10.10$ at the far cultivation distance (Figure 4).

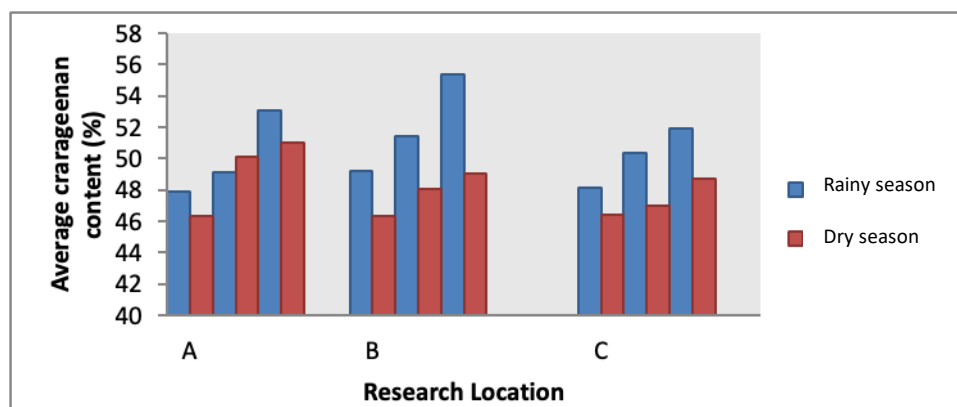


Figure 4. Observation data range, average and standar deviation (SD) of seaweed carrageenan (%) based on location and season.

The carrageenan content in this research based on average values from 3 locations showed trend higher in cultivation site away from coastal line. The main possible reason was salinity as stated by [10] found the highest carrageenan content in the cultivation area away from coast line. Carrageenan was also very important factor for seaweed resistant to the environment with high salinity due to act as maintaining ion balance in the cell [11].

Result of ANOVA showed that season and distance from coastline significantly affect the carrageenan content of seaweed ($P < 0.05$). Locations were not significantly significant ($P > 0.05$) toward the seaweed carrageenan content. LSD analyses showed that all distance from coast line significantly different ($P < 0.05$).

Seaweed carrageenan content found were range 44.77-63.96%, already fit to the standar Ministry of Trade (1989) 25% and for international standar 40%. The research finding was higher than found 18 – 56.65% and lower than [11–13] that found carrageenan content 74–80%, 61.62–73.03%, 53.8757-64.9123% respectively.

In the rainy season, seaweed carrageenan content was higher than in dry season. Carrageenan content was affected by severals factors such as cultivation length, season, habitat and reproduction stages. Another factor that may affect carrageenan content was the quality and quantity of sun light that rich the seaweed. stated that quality and quantity of sun light enter to the water column will increase seaweed photosynthesis rate and at the same time will increase the carrageenan content of cultivated seaweed [14].

Through photosynthesis process, seaweed cells can absorbe nutrients (carbon, hydrogen, oxygen, sulphat and nitrate) and the change to polysaccharide in the carrageenan form and finally deposit in the cell wall [15]. Photosynthesis products as polysaccharide compound that part of the carrageenan. The terminology of carrageenan is including group of linear sulphate polysaccharide from D galactose and 3, 6 anhidro D galactose that mainly extract from red algae. For that reason, when photosynthesis activities disturbed than will cause the seaweed

Carraageenan is one quality parameter for seaweed, found in the cell wall and as a big composer part in the dry seaweed weight compare to others component. As carrageenan content high than will become better can increase economic value of seaweed. Microwave hydrolysis process is first optimized on a commercially available carrageenan and further applied on carrageenans extracted from two algae, namely *Kappaphycus alvarezii* or *Eucheuma spinosum* that are produced in large quantities in the world and have a high content of carrageenans [16].

3.2. Effect of distance from coastline and season on carrageenan content of seaweed

ANOVA test results show that season and distance from the coastline have a significant effect on the carrageenan content of seaweed ($P < 0.05$). A further BNT test perform against of the distance from the coastline. The carrageenan content of seaweed in the rainy season is higher than in the dry season. The carrageenan content of seaweed is influenced by several factors, namely plant age, season, habitat and reproductive stages. Another factor is the quality and quantity of sunlight received by the seaweed. According to the quality and quantity of sunlight entering the waters will increase the rate of photosynthesis in seaweed, thereby increasing the carrageenan content in cultivated seaweed [13]. Through the process of photosynthesis, seaweed cells can absorb nutrients (carbon, hydrogen, oxygen, sulfate and nitrate) then convert them into polysaccharides in the form of carrageenan to be deposited on the cell walls [17]. So the results of photosynthesis are polysaccharide compounds which are part of carrageenan. The term carrageenan includes a group of sulfated linear polysaccharides from D-galactose and 3,6-anhydro-D-galactose extracted from types of red algae. Therefore, if photosynthetic activity is disrupted, it will result in suboptimal growth of seaweed and carrageenan levels [10].

The carrageenan content obtained based on the different distance between the short distance and the long distance from the coastline, where the tendency is that the farther the maintenance distance from the beach the higher the percentage value of carrageenan. This is due to the influence of the salinity of the waters, because the farther from the beach the higher the salinity, this is according to the opinion [11]. Carrageenan is very important for the resistance of seaweed in high salinity environments because it plays a role in maintaining ion balance in cells. Likewise with the research results showed that the average yield value of carrageenan ranged from 30.32 ± 1.54 - $60.89 \pm 1.81\%$, where the highest yield value was obtained from the treatment of 30 days of harvesting age on maintenance in waters far from the coast and the lowest yield value was obtained at the treatment of 25 days of harvesting in nearshore waters [9].

Carrageenan is one of the parameters determining the quality of seaweed. Carrageenan is present in the cell walls of seaweed and is a large constituent part of the dry weight of seaweed compared to other components. The higher carrageenan content will better because it can increase the economic value of seaweed [18].

4. Conclusion

Carrageenan content of seaweed (*Kappaphycus alvarezii*) during rainy season was higher than dry season in the cultivation area away from coast line (1500 m). Carrageenan content of seaweed (*Kappaphycus alvarezii*) range 44.77 – 63.96%. In order to find out the optimal seaweed carrageenan content in the coastal waters of Bantaeng, it was need to manage the cultivation area and relocate from near coast line area to away of coast line (approx 1500 m).

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