Quality of carrageenan extracted from *Eucheuma cottonii* cultivated at three different locations in Lampung

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Abstract. This study aims to compare the quality of carrageenan extracted from *Eucheuma cottonii* harvested from three different seaweed cultivation locations at Ketapang, South Lampung. The three locations selected were Ruguk, Legundi and Tri Dharma Yoga Villages. Some important quality parameters were observed to compare the quality of carrageenan covering yield, viscosity and gel strength, in addition, the other three supporting parameters were moisture, ash, and acid insoluble ash content. Results showed that the viscosity of carrageenan from the three locations ranged from 736.67 - 936.67 cP and gel strength 487.77 - 538.22 g/cm², while moisture, ash and acid insoluble ash content were 12.09 - 13.94%, 16.28 - 17.13%, and 0.27 - 0.33%, respectively. It was concluded that the quality of carrageenan from Legundi Village was the best compared to those from the two other villages.

1. Introduction

Indonesia is one of the largest producers of *E cottonii* seaweed in the world. Currently Indonesia exports around 209,000 tons dried *E cottonii* per year and become the main exporter of this seaweed in the world. In addition to export of dried seaweed, export in the form of semi-processed products such as alkali treated cottonii (ATC), semi refined carrageenan (SRC) and refined carrageenan (RC) have also been carried out. Total export of carrageenan from Indonesia in 2018 amounted to 71.196 ton [1]. The raw material of this product comes from various places in Indonesia, one of which is from Lampung.

The seaweed cultivation centers of *E cottonii* in Lampung are around Ketapang, a district of South Lampung. The main villages producing this seaweed are Ruguk, Legundi and Tri Dharma Yoga. Results of the previous research showed that the quality of seaweed from Legundi village was the best compared to those from the two other villages.

This study aims to look at the quality of carrageenan produced from the three villages. This information is important because the quality of carrageenan produced in Indonesia is determined by the quality of seaweed from several existing producing centers i.e. the yield and quality of its carrageenan content.
2. Materials and Method

2.1 Material
Seaweed samples were taken from three locations in Lampung namely Ruguk, Legundi and Tri Dharma Yoga Village at Ketapang sub-districts. Dry seaweeds were collected from seaweed farmers, packaged in plastic bags and sealed tightly to take them to the processing laboratory at Research Centre for Marine and Fisheries Product Processing and Biotechnology, Jakarta. To observe the quality of its carrageenan content, the carageenan was firstly extracted and then its physico-chemical parameters were analysed at the chemical laboratory.

2.2 Methods
Carrageenan extraction was conducted according to Setha et al (2016) with some modification [6]. Dry seaweed was washed with fresh water, then alkali pretreatment was conducted in 3% KOH solution at a temperature of 60-70 °C for 2 h. The seaweed was then washed and neutralized with fresh water until the pH of the water closed to 7. Seaweed was extracted in hot water (90-95 °C) for 2 hrs. The proportion of dry seaweed to hot water was 1 : 20 and KCl 2% of the weight of the seaweed was added. The carrageenan extract solution was filtered with a filter cloth and the filtrate was collected in a plastic container. The filtrate was let to cool down at room temperature overnight until a solid gel was formed. The gel was then crushed and some isopropyl alcohol (IPA) was added and let the mixture settle down for 30 minutes to withdraw the water content. The dehydrated carrageenan is then dried in the sun and ground into carrageenan flour.

The quality parameters of carrageenan ie. moisture content, ash content, acid insoluble ash, viscosity and gel strength were analysed. Analysis of moisture, ash and acid insoluble ash content were carried out using gravimetri method according to AOAC 2010 methods [2]. Viscosity was measured using Brookfield viscometer at 1.5% carrageenan concentration [3]. Gel strength were measured using TA-XT texture analyzer according to the methods of Simatupang et al (2021) [4]. To compare the quality of seaweed from the three locations, analysis of variant (ANOVA) test was conducted, the test was continued with least significant different (LSD) test using SPSS program.

3. Result and Discussion
In our previous research, the quality of E. cottonii seaweed has been obtained and the seaweed from Legundi village was the best quality compared to those from the other villages. The yield of carrageenan of seaweed from Ruguk, Legundi and Tri Dharma Yoga village were 13.47; 11.35 and 13.58%, respectively [3].

3.1. Moisture content
Moisture content of carrageenan obtained from E. cottonii from the three villages at Ketapang, Lampung were shown in Table 1. According to Indonesian standard (SNI 8391-1:2017 for refined carrageenan), the moisture content of carrageenan should not be more than 12% [4]. from the three locations, the moisture content of carrageenan from Legundi was slightly above the set standard, which was 13.94%. The moisture content of carrageenan is largely determined by the drying process during carrageenan production. Sufficient drying process will produce carrageenan with moisture content according to standard.

| Villages             | Moisture content (%) |
|----------------------|----------------------|
| Ruguk                | 12.52 ± 2.63         |
| Legundi              | 13.94 ± 1.89         |
| Tri Dharma Yoga      | 12.09 ± 1.05         |
3.2. Ash and acid insoluble ash content

Ash and acid insoluble ash of carrageenan from Lampung were shown in Figure 1 and Figure 2. Ash content of carrageenan from the three locations are almost the same, and range between 16.28 to 17.13%. Ash content value of a foodstuff indicates the amount of minerals contained in the foodstuffs [8]. It was mostly determined by the purity level of the seaweed used for carrageenan production [7]. Ash content of *E. cottonii* seaweed from Lampung was 33.68 to 46.4% [3,5]. According to Indonesian standard (SNI 8391-1:2017 for refined carrageenan), ash content of carrageenan must be between 15 – 40% [4]. From this data, ash content of carrageenan from the three locations still meet the standard.

Acid insoluble ash of this carrageenan were between 0.27% and 0.33%. Insoluble acid ash is chloride salts the insoluble acids are partly heavy metal salts and silica. Acid insoluble ash content is one of the criteria in determining the level of cleanliness in the process of processing [9]. Acid insoluble ash content of carrageenan was closely related to the mineral content of material, and was highly correlated with the heavy metal content on a material [7]. According to Indonesian standard (SNI 8391-1:2017 for refined carrageenan), acid insoluble ash content of carrageenan must not be more than 1% [4]. From this data it was shown that acid insoluble ash content of carrageenan from three locations still meet the standard.

3.3. Viscosity

The viscosity of carrageenan from three villages ranged between 737 and 937 cP. Viscosity testing is performed to determine the viscosity level of carrageenan as a solution in a certain concentration and temperature. Viscosity of a carrageenan is affected by the length of the carrageenan polymer. The longer the carrageenan polymer, the higher the viscosity, and vice versa [7]. The viscosity carrageenan of Legundi was the highest among the three, followed by carrageenan from Tri Dharma Yoga and Legundi. This was probably due to the difference in the age of seaweed when harvested. The longer the age of the seaweed, the longer is its carrageenan polymer [9].

![Figure 1. Ash content of carrageenan.](image1.png)

![Figure 2. Acid insoluble ash of carrageenan.](image2.png)
3.4. Gel strength

Gel strength is the main quality parameter of carrageenan. One of the important properties of carrageenan is being able to convert liquid into solids or change the shape of the sole into an irreversible gel. It is this ability that causes carrageenan very wide use, both in the field of food and non-food [7]. of the three villages, carrageenan of *E. cottonii* from Legundi village has the best gel strength compared to the others. This is in line with previous research that showed that *E cottonii* seaweed from Legundi has a better quality than other villages in Lampung. The quality of carrageenan gel is strongly influenced by the quality of seaweed from which the carrageenan is extracted. It is usually related to the seaweed harvest period, the longer the seaweed harvest period is harvested the higher the gel strength obtained [9]. Generally *E cottonii* seaweed is harvested at the age of more than 45 days in order to produce a high strength gel [7]

4. Conclusion

Parameters of moisture content, ash and acid insoluble ash of carrageenan from Ketapang Lampung meet the Indonesian standard for refined carrageenan. The viscosity of carrageenan from Ketapang Lampung ranged from 736.67-936.67 cP and gel strength 487.77-538.22 g/cm. The quality of *E. cottonii* carrageenan from Legundi Village was the best compared to those from the two other villages.
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