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Extraction and Characterization of Refined K-carrageenan of Red Algae [*Kappaphycus alvarezii* (Doty ex P.C. Silva, 1996)] Originated from Karimun Jawa Islands

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Abstract

The properties of refined κ-carrageenan (RC) extracted from red algae originated from Karimun Jawa Island has never been studied. The objective of this research was determining the effect of KCl on characteristic of refined κ-carrageenan extracted from the red algae [*Kappaphycus alvarezii* (Doty ex P.C. Silva, 1996)]. The result indicated that higher KCl concentration resulted in the increase of the carrageenan yield, ash and sulphate content, and the decrease of gel strength, moisture and acid-insoluble ash content. The carrageenan viscosity demontrated a fluctuated value due to KCl concentration. This study suggested extraction process by using 2.5 % KCl solution. The carrageenan yield was 34.3 % and the result demonstrated the carrageenan properties as follow: 8.20 cP viscosity, 94.45 g · cm^{-2} gel strength, 6.3 % moisture content, 59.4 % ash content, 1.78 % acid-insoluble ash, and 7.75 % sulphate content. The absrbance peak at 849 cm^{-1} detected from infrared spectrscopy indicated D-galactose-4-sulphate which is related with κ-carrageenan.

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Keywords: Extraction; *Kappaphycus alvarezii* (Doty ex P.C. Silva, 1996); Karimun Jawa Islands; KCl; refined κ-carrageenan.

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1. Introduction

Carrageenan is polysaccharides extracted from certain red algae and formed by D-galactose and 3,6-anhydro-galactose units which is linked by α-1,3 and β-1,4 glycosidic. The carrageenan contain sulphate ester about 15 % to 40 % and average molecule mass above 100 kDa. It is classified into several types such as λ, κ, ι, ε, μ, which contain 22 % to 35 % of sulphate group. Carrageenan characteristic is affected by amount and position of sulphate ester group of 3,6 anhydro-galactose content. Kappa-carrageenan is used in acetic acid production, cleaning of industrial effluents and also as thickening and gelling agent in food industries (Iglauer et al., 2011; Necas and Bartosikova; 2013; Azevedo et.al., 2013). The availability of raw materials for carrageenan production is assured with the large increasing in seaweed farming areas in Philipines and Indonesia (Thomas, 1999).

The properties of semi refined κ-carrageenan (SRC) from red algae [*Kappaphycus alvarezii* (Doty ex P.C. Silva, 1996)] widely cultivated in Karimun Jawa Islands, Central Java had been studied. The finest structure of SRC was resulted from solar tunnel drier which result in high gel strength and lowest sulphate content. The result demonstrated carrageenan characteristic spectra at absorption band at 848,68 cm^{-1} that corresponded to sulphation (galactose-4-sulphate level) and indicated that the carrageenan was kappa type (Dewi et al., 2005). However, refined κ-carrageenan (RC) from red algae (*Kappaphycus alvarezii*) widely cultivated in Karimun Jawa Islands, Central Java has never been studied.

In this study, the κ-carrageenan was extracted by hot alkaline solution ($Ca(OH)_2$) and recovered from the solution. The alkaline solution removes some of the sulphate groups from the molecules and increases the formation of 3,6-AG that leads to increased gel strength of carrageenan (Yasita, 2010). The result of previous research indicated that KCl affected the properties of refined carrageenan. The most optimum result was performed by treatments combination as follow 1 % KCl solution, algae and water ratio (1:20), and precipitation temperature at 30 °C. The application of KCl solution increased refined carrageenan gel strength (Arfini, 2011). Therefore, in this study, various concentration of KCl solution (1.5 %, 2.5 %, and 3.5 %) was employed in coagulation process of carrageenan in order to investigate the effect of KCl solution on the carrageenan properties and finally, the best concentration of KCl solution which demonstrated optimum properties of carrageenan would be determined.

2. Materials and methods

2.1. Materials

The red algae (*K. alvarezii*) was harvested 45 d after planting from Karimun Jawa Islands, Jepara, Central Java. Supporting materials in extracting carrageenan such as water, $Ca(OH)_2$, 96 % alcohol aquades, 1 % HCl, KCl and also materials for analysis were supplied by local distributor.

2.2. Methods

2.2.1. Carrageenan extraction

Dried red algae (*K. alvarezii*) was washed using flowing water and soaked in 3 L water for 24 h. After soaking, the algae was cut by using scissors and minced by using a blender resulting in the pulp of algae. The pulp was then mixed with the water by comparison 1:80 (v / v). The mixture was conditioned into alkaline condition (pH ± 9) by $Ca(OH)_2$ solution, then the extraction was performed by warming at 90 °C for 2 h by stirring continuously. After the extraction, the waste of algae (solid materials) was separated from the viscous filtrate. Then the filtrate was neutralized with of 1 % HCl solution until pH 7, then reheated at 60 °C for 30 min. The filtrate was coagulated by using KCl solution (1.5 %, 2.5 %, or 3.5 %) with filtrate and KCl solution ratio was 1 : 1 and stirred continuously for 15 min, then the final mixture was filtered to separate carrageenan gel and water. Carrageenan gel was then completely soaked in 96 % alcohol for an hour and stirred continuously. The carrageenan gel was separated from alcohol and water by filtration. The carrageenan was dried by using cabinet dryer at 70 °C for 24 h and milled into 80 mesh size.