Sodium Alginate Extraction From Brown Seaweed (*Turbinaria conoides*) And Its Structural Property As Bipolymer Electrolyte

Nurhadini  
*Department of Chemistry, Faculty of Engineering, Universitas Bangka Belitung*  
Bangka, Indonesia  
nurhadini@ubb.ac.id

Yudi Setiawan  
*Department of Machine Engineering, Faculty of Engineering*  
Bangka, Indonesia  
yudiuub@yahoo.co.id

Ristika Oktavia Asriza  
*Department of Chemistry, Faculty of Engineering, Universitas Bangka Belitung*  
Bangka, Indonesia  
ristika@ubb.ac.id

Angraeini  
*Department of Biology, Faculty of Agriculture, Fisheries and Biology Universitas Bangka Belitung*  
Bangka, Indonesia  
anggieib@gmail.com

**Abstract**—This research was conducted to extract sodium alginate from *Turbinaria conoides* and its structural property as biopolymer electrolyte. The existence of brown seaweed (Turbinaria conoides) is abundant in Bangka Belitung Islands. The main content of brown seaweed is alginate that it can be used as biopolymer electrolyte. Sodium alginate extraction process in *Turbinaria conoides* was carried out at 60°C with 5% Na₂CO₃ and the yield of sodium alginate was 13%. Sodium alginate is successfully extracted in *Turbinaria conoides*. Sodium alginate was characterized using FTIR. The results showed that sodium alginate extract had similar spectrum and same main functional group with commercial sodium alginate. Characterization structural property of biopolymer electrolyte by FTIR-ATR, the increasing NaI percentage in sodium alginate made shift of peak toward higher wavenumber. These shifting indicated increasing of interaction between NaI with polymer chain in alginate and degree of salt dispersion in polymer, sodium alginate, biopolymer electrolyte, DSSC, Turbinaria conoides

**Keywords**—sodium alginate, biopolymer electrolyte, DSSC, Turbinaria conoides

I. INTRODUCTION

Environment-friendly and sustainable energy is promising for future energy resources. One of these energy resources is solar cells that it converts sunlight become electrical energy. DSSC become alternative solar cell due to cost less, simple fabrication, and easy to obtain materials. Thin and flexible *Dye sensitized solar cell* (DSSC) received more attention for much application. DSSC manufacturing technology is increasing to develop its efficiency[1]. DSSC efficiency is affected by type, preparation condition and surface area of electrolyte [2]. Mostly liquid electrolyte is used in DSSC because it has higher conductivity than other type electrolyte. However, it can lead to leakage, low stability and volatile and toxic solvents [3].

Polymer electrolytes can minimize leakage and solvent evaporation problems, high stability and shape flexibility. Synthetic polymer electrolyte is widely used in polymer electrolyte but it is not biodegradable[2]. Conversely, biopolymer electrolytes are biodegradable, reliable processes, nontoxic, and abundant resources. Therefore, developing natural polymer into good ionic conductivity biopolymer electrolytes are now in main consideration and research. Type of biopolymer is dominated by polysaccharides in electrolyte development to increase DSSC efficiency. Alginate, carrageenan and chitosan are natural resources derived and have been applied as biopolymer electrolyte [4][5][6].

Alginate is polysaccharides derived from brown seaweed which is very interesting because it has properties biodegradable, nontoxic, high ionic conductivity and abundant especially in Bangka Belitung Islands. Further, alginate is easily extracted process from brown seaweed. Biopolymer based alga have been studied by Sing (2016). Gel polymer made from sodium alginate and plasticized glycerol with CH₃COOH had ionic conductivity 3.1 10⁻⁴ S/cm. Yang (2014) synthesized polymer electrolytes from cross-linking alginate and PVA had ionic conductivity 0.091 S/cm [7].

Properties of biopolymer electrolyte determine DSSC efficiency. It can dependent on counter cations of iodides salts in biopolymer host. Structural properties explain interaction between polymer and salts. This paper will be studied about effect of NaI in alginate as polymer host on structural properties and it will be characterized by FTIR-ATR.

II. EXPERIMENTAL

A. Sodium Alginate Extraction

Brown seaweeds (*Turbinaria conoides*) were collected from Bangka Island. Then, it was washed to remove impurities (salt, plastics, sand and other organism) and dried in the air. Next, it was soaked for 1 hour in 2% H₂SO₄ solution, that ratio of seaweed and H₂SO₄ solution was 1:20 (w/v). Brown seaweed was neutralized with the deionized water, soaked for 30 minutes in 0,5% NaOH and
B. Syntheses of Polymer Electrolyte

Biopolymer electrolyte was prepared by dissolving alginate and NaI in water and stirred for 6 hour until homogenous. Biopolymer electrolyte membrane were made in alginate mass 0.5 gram with 5%; 10%; 15% and 20% NaI (b/b). Biopolymer electrolyte solution was filtered by using Whatman paper. Biopolymer electrolyte membrane was prepared by casting biopolymer electrolyte solution in petry dish and dried at 37°C in incubator. The thin biopolymer electrolytes were characterized by FTIR-ATR.

III. RESULT AND DISCUSSION

A. Analysis of FTIR Sodium Alginate from Turbinaria conoides

Turbinaria conoides is one of brown seaweed species. It is consist of polysaccharide, protein and fatty acid etc. Main functional group in Turbinaria conoides before treatment is presented in Figure 1.

Broad band at 3264 cm\(^{-1}\) was assigned to hydrogen bonded (-O-H) stretching related to polysaccharide and protein compound. The peak at 2942 cm\(^{-1}\) and 2146 cm\(^{-1}\) were attributed to C-H bond related to protein compound. The peak at 1949 cm\(^{-1}\) and 868 cm\(^{-1}\) were attributed to C=C and C-H vibration related to aromatic ring.

The peak at 1615 cm\(^{-1}\) and 1405 cm\(^{-1}\) were assigned to asymmetric and symmetric stretching of carboxylic vibration related to alginic compound. The peak at 1328 cm\(^{-1}\) was attributed to sulfur group (S-O-) associated to fucoidan compound. The peak at 1017 cm\(^{-1}\) is assigned to C-O stretching vibration associated to polysaccharide and fucoidan compound [10].

The yield alginate extract from Turbinaria conoides is 13% which is higher than for alginate from Sargassum sp. However it was lower alginate from other Turbinaria species. FTIR-ATR spectrum of sodium alginate from Turbinaria conoides is presented in Fig. 2.

Fig. 2 showed that a broad band at 3364 cm\(^{-1}\) was attributed to hydrogen bonded (O-H) stretching. Weak absorption at 2929 cm\(^{-1}\) was attributed to C-H bond. Medium absorption at 1609 cm\(^{-1}\) and weak absorption at 1405 cm\(^{-1}\) were assigned asymmetric and symmetric stretching of carboxylic (C=O) vibration, respectively. Strong band at 1098 cm\(^{-1}\) indicate (C-O-C) stretching vibrations of mannuronic acids. The characteristics mannuronic acid residues which is the anemic or fingerprint region of sodium alginate (950–750 cm\(^{-1}\)) was assigned band at 807 cm\(^{-1}\). Summary of wavenumbers and band assignments and from sodium alginate extract (SAE) and sodium alginate commercial (SAC) are presented in Table 1.

**TABLE 1: WAVENUMBERS AND BAND ASSIGNMENTS OF ALGINATE**

| Wavenumbers (cm\(^{-1}\)) | Band assignments |
|---------------------------|-----------------|
| 3364 | 3263 | O-H |
| 2929 | 2925 | C-H |
| 1609 | 1595 | C=O |
| 1405 | 1408 | C=O |
| 1098 | 1027 | C-O-C |
Spectrum of sodium alginate extract is similar to sodium alginate commercial. Furthermore, sodium alginate extract and sodium alginate had same main functional group. Based on FTIR-ATR spectrum indicated sodium alginate successful extracted from Turbinaria conoides [11][12][13].

B. Analysis of FTIR-ATR Alginate and NaI

Structural properties of biopolymer electrolyte depends on interaction between biopolymer with salt. Interaction biopolymer with salt is studied by FTIR-ATR characterization. FTIR-ATR spectra in various percentage of NaI in sodium alginate are presented in Fig. 3. Fig. 3 showed that the increasing NaI percentage in sodium alginate membranes made shift of peak toward higher wavenumber.

The peak shifted from 3307 cm$^{-1}$ to 3413 cm$^{-1}$ was assigned O-H stretching vibration. Peak shifted from 1602 cm$^{-1}$ to 1619 cm$^{-1}$ and another peak shifted from 1408 to 1420 cm$^{-1}$ were assigned asymmetric and symmetric stretching of carboxylic (C=O) vibration, respectively. Peak shifted from 1084 cm$^{-1}$ to 1096 cm$^{-1}$ was attributed C-O-C stretching vibration of mannuronic acid. These shifting indicated increasing of interaction between NaI with polymer chain in alginate. Furthermore, the shifting indicated degree of salt dispersion in polymer [11][14][15].

IV. CONCLUSION

Sodium alginate successful extracted from Turbinaria conoides with 13% yield and characterization by FTIR. Based on FTIR spectrum, sodium alginate extract is similar to sodium alginate commercial. Furthermore, sodium alginate extract and sodium alginate had same main functional group. Structural property biopolymer electrolyte is investigated by interaction between NaI and sodium alginate. The increasing NaI percentage in sodium alginate membranes made shift of peak toward higher wavenumber.

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