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Extraction of Sodium Alginate from *Charophyceae* Algae †

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Abstract. Algae to the rheological properties of alginates, one of the main products obtained from algae, these polysaccharides are widely used in fields such as pharmaceuticals, medical technology, cosmetics, food, agriculture, textile and paper industry. Therefore, sodium alginate was obtained from waterweed (*Charophyceae*) in the following experiment. The structure and composition of sodium alginate were analyzed using physical and chemical research methods: IR spectroscopy and XRD.

Keywords: algae; sodium alginate**;** *Charophyceae*; IR spectroscopy; XRD

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1. Introduction

In recent years, the use of algae as biomass resources for biorefineries is very promising [1] and they are attracting great interest as excellent sources of nutrients. Polysaccharides are the main constituents of algae, so they have many beneficial effects on human health, also much attention has been paid to the isolation and characterization of polysaccharides from algae [2].

Alginates are mainly used in industry for their stabilizing, thickening and emulsifying properties, and depending on specific properties such as gel strength, porosity or biocompatibility, they are expanding into applications such as biomaterials for tissue engineering and bioprinting [3]. Alginates are analogs of pectin from land plants [4]. According to their structure, it is a linear copolymer of β-D-mannuronic acid (M) and α-L-gulurone connected with (1–4) [5].

2. Materials and Methods

2.1. Infrared Spectroscopy (IR)

IR spectroscopy analysis was acquired at 400–4000 cm^{-1} wavenumbers with a 4 cm^{-1} resolution utilizing a INVENIO S (Bruker, Germany) equipped with a diamond ATR cell.

The IR spectra of the isolated sodium alginate showed in curve a and pure sodium alginate in curve. Both spectra have the similarities in which IR spectra of isolated sodium alginate and standard showed mannuronic acid functional group at wavenumber 896 sm^{-1} and the uronic acid at wavenumber 1058 sm^{-1}, OH functional group at wavenumber 3226–3454 sm^{-1}, and CH_2 stretching at wavenumber 2895–2967 sm^{-1}.

2.2. X-ray Diffraction (XRD)

Sodium alginate were characterized using a powder X-ray diffraction on a Shimadzu instrument, XRD-6100 model, It can be seen that *Charophyceae* algae has an amorphous structure with a peak 2θ = 22.76° the crystallinity index 32.54%)

3. Results and Discussion

3.1. Separation of the Following Compounds from the Composition of Algae

The main structural elements of algae cell walls are polysaccharides. They consist of mixtures of neutral or acidic, linear and branched polysaccharides. These polysaccharides are usually extracted with hot water [6], it is a popular and convenient method, but the disadvantages of the method are that it takes a lot of time, has high temperature and low extraction efficiency. In general, extraction methods involve the removal of interfering substances (eg, low molecular weight compounds, lipids, and colored substances from the alginate sample) using a methanol/chloroform mixture (1:1) [7]. In addition, 2% formaldehyde, one of the widely used extraction methods, binds the color pigments present in the cell wall for 24 h at room temperature (25 °C) [8].

3.2. Extraction

First, collected *Charophyceae* algae were cleaned and dried. 20 g of dried seaweed was extracted with 2% formaldehyde, and as a result, lower molecular compounds of the plant were released. It was then washed with distilled water and extracted 0.2 M H_2SO_4 for 4 h. After a certain time, it is washed again with distilled water and extraction 5% (pH 12.4) sodium carbonate is continued. The resulting extract is centrifuged, the dissolved fraction is collected and precipitated with ethanol. Then the sediment fraction was filtered, washed twice in acetone and dried in a 40 °C drying oven. Product yield 22.5%.

4. Conclusions

4.68 g of sodium alginate was extracted from *Charophyceae* algae by extraction method. So it is 22.5% compared to the amount of dry mass of waterweed. All experiments were performed in triplicate, and extraction time (2, 3, 4 h), temperature (40, 60, 80 °C), concentration of alkali (3% (pH 12.0), 4% (pH 12.2), 5% (pH 12.4)) and the amount of ethanol (1:1; 1:2; 1:3) were studied.

Sodium alginate structure and composition physical chemical research IR spectroscopy (OH—3226–3454 cm^{-1}, CH2—2928 cm^{-1}, mannuronic acid functional group—896 cm^{-1} and uronic acid—1058 cm^{-1}), XRD (crystalline index: 32.54%) were analyzed using methods.

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