



The Extraction of Brown Algae (*Sargassum sp*) Through Calcium Path to Produce Sodium Alginate

Octovianus SR Pasanda ✉, Abdul Azis

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Departement Chemical Engineering, Politeknik Negeri Ujung Pandang, Makassar, Indonesia, 90245

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Abstract

Brown algae is a source of sodium alginate raw material. One type of brown algae that is found to grow in Indonesian waters is *Sargassum echinocarpum*. Brown algae including one type of seaweed that grows in many waters of Indonesia, especially the waters of Eastern Indonesia. Alginate is a pure polysaccharide of uronic acid contained in a brown algae cell wall arranged in the form of long linear chain alginic acids with levels reaching 40% of the total dry weight. The alginate form in general is sodium alginate, a water soluble alginate salt. The purpose of this research is to know the quality of alginate include alginate content, water content, ash content, and viscosity. Conventional extraction methods from brown algae into sodium alginate produces the highest yield percentage of 32.42%, resulting from the extraction for 7 hours at 60°C. The lowest average yield percentage resulted in 5 hours extraction process of 2.78%, the average water content of 20.37-23.30%, the mean ash content of 22.28-34.87%, and the viscosity ranged between 18.0-19.8 Cp.

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INTRODUCTION

One of the potential marine biota of Indonesian waters is the macro algae, known in trade as seaweed. These marine macro algae do not have roots, stems and leaves which are then called *thallus*, therefore taxonomically grouped into *Divisio Thallophyta*. Four major classes in the divisio are *Chlorophyceae* (green algae), *Phaeophyceae* (brown algae), *Rhodophyceae* (red algae), and *Cyanophyceae* (blue-green algae) (Waryono, 2001). Macroalgae including red, green, and brown algae are commonly referred to as seaweed (Castro & Huber, 2009). Brown seaweed has a pigment that gives a brown color and can produce algin or alginate, laminarin, cellulose, fucoidin and mannitol whose composition is highly dependent on species, developmental period and place of growth

(Maharani & Widyayanti, 2009). The main component of algae is carbohydrates while the other components are protein, fat, ash (sodium and potassium) and water 80-90% (Chapman & Chapman, 1980).

Alginate is a piko-koloid compound produced from brown seaweed (*Phaeophyceae*) that *Macrocystis*, *Laminaria*, *Aschophyllum*, *Nerocystis*, *Eklonia*, *Fucus*, *Turbinaria* and *Sargassum* (Zailanie et al., 2001). Alginofit seaweed species found in Indonesian waters are *Sargassum* and *Turbinaria* (Zailanie et al., 2001). Alginate content in seaweed *Sargassum* ranges between 8-32% depending on the conditions of the waters where it grows (Anggadireja et al., 1993).

Alginate is one of the polysaccharide groups that is a major component of brown algae sap and is an important compound in cell walls

(Belitz & Grosch, 1982; Kloareg & Quatrano, 1988). In the cell wall and the intercellular environment, alginate is found as a mixture of alginic acid salts (calcium, sodium or potassium). Chemically, alginate is a pure polymer of uronic acid composed of long linear alginic acid (Stephen, 1995). This pure polymer is unbranched and contains 1.4 β D-mannuronic acid bonds and 1.4 α L-guluronic acid bonds. The alginate form is generally a sodium alginate, the alginate salts are soluble in water. Other water-soluble alginate forms are potassium alginate or ammonium alginate, whereas the water-insoluble alginate is calcium alginate. Sodium alginate has colloidal, gel-forming, and hydrophilic properties causing this compound widely used as emulsifier and stabilizer in industry (Subaryono, 2010). While the nature of hydrophilic alginate used to bind water to the process of freezing food. In frozen foods, this polymer maintains a food network. In addition, alginates are also utilized in the cosmetic, biomedical, pharmaceutical and widely used in various industrial fields, including textiles, paper, due to their water-binding properties such as gel, viscosity and dispersion stabilization (Draget et al., 2006).

The purpose of this research was to study the effect of temperature and duration of extraction to the yield of sodium alginate by conventional method. Furthermore, know the characteristics of the resulting Sodium alginate, consisting of water content, ash content and viscosity extract.

RESEARCH METHODOLOGY

Sodium alginate extraction procedure is carried out as follows: Brown seaweed (*Sargassum sp*) collected on Jenepono beach. This biomass is washed with water, then dried with direct sunlight. The extraction was performed in accordance with Calumpong et al. method (1999) with some minor improvements of the method. The sample was dried to constant weight at 60°C in the oven, soaked for 24 hours in a solution of formaldehyde 2% (1:30 w/v) to remove the pigment thus simplifying the process of formation of alginic acid, then washed with distilled water and then soaked again in a solution of HCl 0,2 M (1:30 w/v) for 24 hours. After this period, the sample was washed once again with aquades until neutral. The next process is done by reference to the work of Torres et al. (2007) with a few minor modifications, adding 2% Na₂CO₃ (1:10

w/v), stirred for 5 hours. To determine the effect of temperature then extraction is done at different temperature (50°C and 60°C), then filtered through muslin cloth. The filtrate is aerated for 3 hours, and the clear bottom is removed. The filtrate was added CaCl₂ 0.5 M to form calcium alginate fibers are then added technical NaOCl 0.1% (1:10 w/v) for bleaching. Soaked in 0.5 M HCl solution (1:10 w/v) for calcium alginate to be converted to alginic acid. Reduction of the water content of alginate acid gel is by pressing up to its moisture content of about 25%. The sodium carbonate powder is then added in the mixer so that the alginate acid gel is converted to sodium alginate in paste form and then immersed in technical ethanol, dried in the sun for \pm 12 hours until the water content of 12%. Furthermore, crushed and analyzed for levels of sodium alginate using AOAC method (1995), the water content and viscosity value using Brookfield Viscometer.

Processing Technique and data analysis

Water content (AOAC, 1984)

Drying of the sample is carried out for several hours at a temperature of 105°C to a constant sample weight.

$$\text{Water content(\%)} = \{W_0 - W_1\} / W_0 \times 100\% \quad (1)$$

where W_0 is initial sample weight and W_1 is sample weight after drying.

Ash content (AOAC, 1984)

The ash content test was carried out as follows: Porcelain cup was dried in the oven for 1 hour at 105°C, then cooled in desiccator and weighed to obtain a constant weight (A). Weigh a few grams of sample (B), inserted in a porcelain dish, then put in a furnace with a temperature of 650°C for \pm 5 hours. The porcelain cup is then cooled for 30 minutes in the desiccator, then weighed until to obtain the constant weight (C).

$$\text{Ash content (\%)} = [(C-A)/B] \times 100\% \quad (2)$$

Viscosity (AOAC, 1984; FMC Crop., 1997)

1.5% alginate solution is heated in a boiling water bath while stirring regularly to 75°C. Viscosity was measured using Brookfield Viscometer model LVP with spindle 3 at a speed of 30 rpm.

Table 1. Yield percent of Sodium Alginate conventional extraction results

Brown Algae mass (gram)	Temperature (°C)	Extraction Time (h)	Na-Alginat mass (gram)	Yield (%)
80.19	50	5	2.23	2.78
80.07	50	6	4.52	5.65
80.04	50	7	7.34	9.18
80.10	60	5	17.41	21.73
80.12	60	6	20.02	24.99
80.08	60	7	25.96	32.42

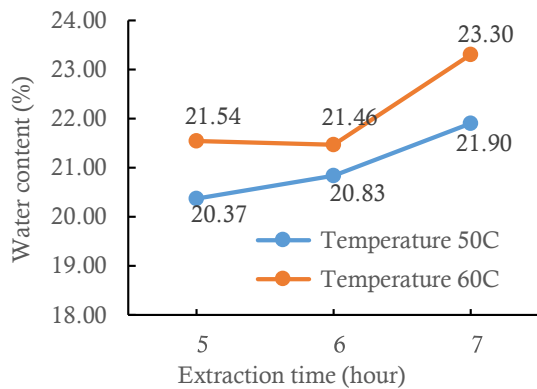


Figure 1. The water content of sodium alginate by conventional method

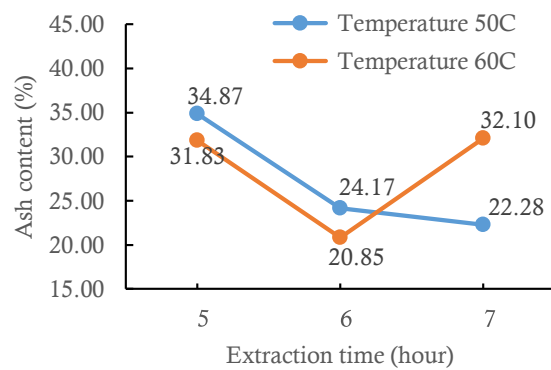


Figure 2. The ash content of Natrium Alginat by conventional method

RESULTS AND DISCUSSION

The research was conducted by experiment of brown seaweed extract conventionally (through calcium alginate) with 5, 6, and 7 hours extraction time variables at 50 and 60°C respectively.

The alginate extraction process is carried out by converting alginic acid to sodium alginate having water soluble properties using 2% Na₂CO₃ solution as stated by Helmiyati and Aprilliza (2017) that extraction using Na₂CO₃ (sodium carbonate) is capable of separating the cellulose and alginate present in brown algae cells. After the depigmentation process and the removal of fat sequentially with 2% formalin and 0.2 M HCl (1:30 w/v) for 24 hours at 30°C under constant stirring, the average sodium alginate yield as shown in Table 1.

Percent Yield of Sodium Alginate

Table 1 shows that the longer the extraction time and temperature the greater the sodium alginate also increases. This is because in the extraction process there are several things that affect, one of which is the contact time between the solvent with brown seaweed. The longer the contact

time then the solvent will have a longer chance to dissolve all the alginate content contained in the brown seaweed cell. Another factor is that with the treatment at a greater temperature, the yield of sodium alginate is also greater, this is because if the temperature increases then the frequency of collisions between molecules is also increased so that more easily penetrated by the solvent (Pasanda et al., 2016). According to Fertah et al. (2017), with rising temperatures, the degradation occurring in macromolecular chains is also greater. However, the alginate content in brown seaweed is also affected by several parameters such as age, species and habitat of brown seaweed (Taylor, 1979). Characterization of sodium alginate was done to find out the physical and chemical properties of extracted sodium alginate which include analysis of water content, ash content, viscosity, and structural analysis.

Water content analysis

The water content of sodium alginate extracted can be seen in Figure 1. Based on the result of the research shows that the extracted sodium alginate water content is much greater when compared to Food Chemical Codex standard

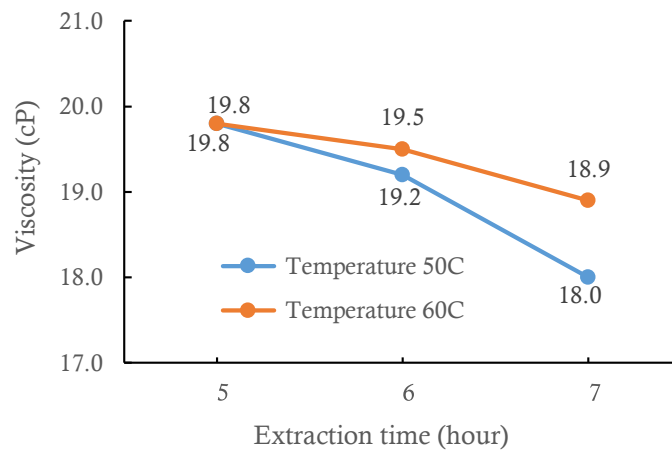


Figure 3. Viscosity of Sodium Alginate Solution (1% Na-alginate in water)

(1993), where the water content of sodium alginate according to Food Chemical Codex (FCC) is not more than 15%.

This is due to the use of ethanol as a sodium alginate extract wash less water. Ethanol polarity that has polar properties approaching water makes it more difficult to attract water.

Ash Content

The ash content of sodium alginate extracted by conventional method can be seen in Figure 2. The results obtained are ash content of sodium alginate is still much greater when compared with the standard according to Food Chemical Codex (FCC) is <15%. The results obtained are ash content of sodium alginate is still much greater when compared with the standard according to Food Chemical Codex (FCC) is <15%. While the specification of sodium alginate for food by 23% (Chapman & Chapman, 1980). So some treatment when compared with the conditions according to Chapman & Chapman (1980), still qualified.

Viscosity

Viscosity is a parametric quality of Na-alginate which is very necessary because the assessment of Na-alginate is determined by the high viscosity. The viscosity value of sodium alginate extracted by conventional method as in Figure 3 ranged from 18.0 - 20.4 cP. The trading standards established by Sigma (1997) for viscosity Na-alginate were divided into three groups of quality that is grade I (high grade) viscosity of 14,000 cP, grade II (medium grade) viscosity of 3500 cP, grade III (low grade) viscosity of 250 cP. Meanwhile,

according to Winarno (1990), the viscosity of Na-alginate is very varied i.e. from 10-5000 cP (1% solution of Na-alginate in water). When compared with the standard Na-alginate determined by Sigma, the Na-alginate produced from this study has not entered criteria I, II, or III (low grade). The viscosity of Na-alginate is highly dependent on the age of harvest of brown seaweed, extraction technique (concentration, temperature, pH, and presence of polyvalent metal cations) and molecular weight of the seaweed extract (Basmal et al., 1998). The viscosity of the alginate solution will decrease due to overheating. On heating for too long will result in molecular degradation and subsequently lead to a decreased viscosity (Basmal et al., 1998; Murtini et al., 1998).

CONCLUSION

The results of the research concluded that the extraction of brown seaweed by conventional method produce sodium alginate with highest yield percentage of 32.42% with 7 hours extraction time at temperature 60°C. The lowest percentage of yield produced in the extraction process for 5 hours was 2.78%, the average water content of 20.37 – 23.30%, the average ash content of 22.28 – 34.87%, and the viscosity ranged from 18.0 – 19.8 cP.

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