African Journal of Food Science Vol. 5(6), pp. 349 – 352, June 2011
Available online http://www.academicjournals.org/ajfs
ISSN 1996-0794 ©2011 Academic Journals

Full Length Research Paper

The physicochemical characteristics of sodium alginate from Indonesian brown seaweeds

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Accepted 2 May, 2011

This study aimed to know the physichochemical characteristic of sodium alginate that was obtained from *Sargassum crassifolium*, *Sargassum polycystum*, *Padina* sp., and *Sargassum echinocarpum*, which grew on the coral coast of Gunung Kidul Yogyakarta Indonesia. The result showed that the average of the yield was 16.93 to 30.50%. The chemical properties, that is, water, ash, Pb and Hg were 12.50 to 13.43%, 18.20 to 8.59%, 0.083±0.01 to 0.36±0.04 ppm and 0.002±0.01 to 0.3±0.05 ppm. The physical properties such as viscosity and lightness were 25 to 39 cps and 46.2 to 52.3 (the color was yellow to light brown).

Key words: Sodium alginate, psychochemical, characteristic.

INTRODUCTION

Alginofit type that grew in Indonesia were species of the genus *Sargassum* and *Turbinaria* (Sediadi and Budihardjo, 2000). Alginate is the main content of alginofit cell wall, which is composed of alginic acid, mannuronate and galacturonate, with β-D bond-1.4 mannuronate and α-L-galacturonate (Draget et al., 2005; Donati and Paoletti, 2009; Ertesvag et al., 2009). The alginate content in brown seaweed varies depend on the species, environmental conditions, season of harvest, and the method of extraction used (Draget et al., 2000; Mirshafiey and Rehm, 2009)

Extracts of alginate plays a role in the food industry, food, textiles, health and cosmetics (Sime, 1990). In the food industry, alginates were used to stabilize mixtures, dispersions and emulsions, which increases viscosity and forms gel, such as jams and jellies (Toft et al., 1986)

Alginate can be used in the manufacture of soft capsules and consumed as a beverage for lowering blood sugar level. In the textile industry, alginate was used as an additive for textile dye (McCormick and Ali, 2005)

Constraints in alginofit utilization in Indonesia, was the lack information about their types and components. The potential resource for alginofit in Indonesia was huge, but it's still dependent on import. The process of extracting alginate from Indonesian *Sargassum* and *Turbinaria*, has been develop by the author, which used 5% HCl solution in preextraction and 2.25% Na_2CO_3 in extraction. This experiment was aimed to know the physicochemical characteristic of alginate from Indonesian alginofit, that is, *Sargassum crassifolium, Sargassum polycystum, Padina sp.,* and *Sargassum echinocarpum,* which grew on the craggy coast of Gunung Kidul in Yogyakarta Indonesia. Until recently, the existence and potential utilization of ("this") alginofit, was still unexplored. These characterization data for alginate can be used by governments and researchers as a base for further utilization.

MATERIALS AND METHODS

The extraction process of alginate that been develop by the author (Mushollaeni, 2007) and previous experiment (McHugh, 2003; Hernandez et al., 2002), were first leaching with 1% $CaCl_2$ for 30 min, second leaching with 5% HCl for 30 min at 30 to 40°C, soaked with 0.5% KOH for 60 min at 50 to 60°C, extraction with 2.25% Na_2CO_3 at 50 to 60°C for 1 h, discolorization with 10% NaOCl for 5 h, precipitated with 5% HCl, neutralized with 10% Na_2CO_3, purified with 95% isopropanol, dried at 50 to 60°C and milled.

Water content

The water content was obtained by gravimetric method (AOAC, 1990), by drying the sample of alginate at a temperature of 105°C. The water content was the dry weight of alginate which was percentage of dry weight to its initial weight.

Ash content

The ash content was obtained by gravimetric method (AOAC,

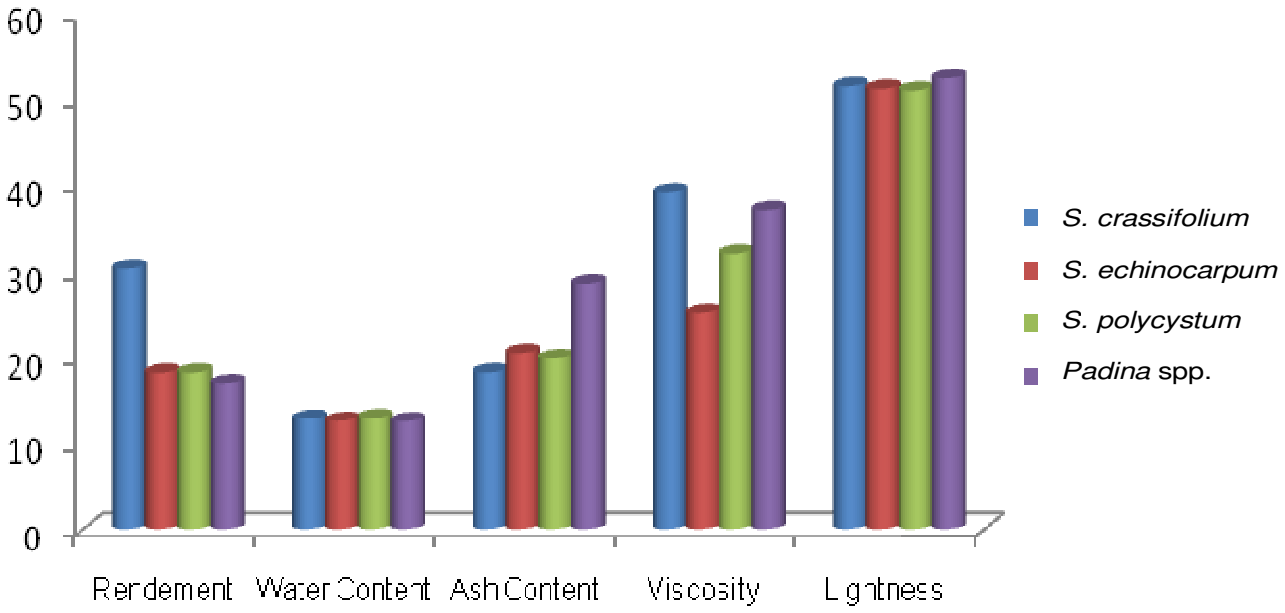

Figure 1. Characteristics of sodium alginate.

1990), by burning the sample in a furnace at a temperature of 600°C till it formed an ash. The ash content was expressed as a percentage of ash weight to dry sample weight.

Lead and mercury content

Determination of lead (Pb) and mercury (Hg) was done using atomic absorption spectrophotometer (Christian, 1986; James, 1995) that been analized at Brawijaya University.

Yield

Yield was expressed as weight percentage of alginate with initial weight of alginofit, according to AOAC (1990) method.

Viscosity

The viscosity of alginate dispersion was determined using the method of James (1995), using viscotester VT-04 Rion Co, LTD. An aliquot of 250 ml of 1% alginate solution was heated at 50°C until it turned to gel and ready to determine its viscosity by viscotester.

Lightness

The lightness of alginate was determined using the method of James (1995), by color reader CR-10 Minolta Japan. Lightness level of the sample was indicated by the L value, where L ranged from 0-100 (dark to light).

Water content

The water content that permitted by Food Chemical Codex (FCC) was less than 15% (FCC, 1993). The average of water content for *Sargassum* and *Padina* was 12.7% (Figure 1). This water content has already fulfilled the permitted condition by FCC.

Ash content

The ash content of sodium alginate from *Padina* was 28.59% that highest than others. The varying ash content of each type of seaweed, shows the differences in the amount of mineral salts that attaches to their surface (Salasa, 2002). The mineral salt amount of seaweed depends on the type, age and condition of hydrology and hydro-chemical nature, where the habitat of sea grass (Salasa, 2002).

Heavy metals of Pb and Hg

The level of Hg from *S. polycystum* was 0.015 ppm that highest than other type of *Sargassum* and the level of Pb from *S. crassifolium* was 0.36 ppm that highest than others. The maximum level of Pb and Hg permitted in Na-alginate by FCC were less than 10 ppm and less than 40 ppm (FCC, 1993). So, these heavy metals content has already fulfill the permitted condition by FCC. Inorganic materials and the types of metals in sea grass, is derived from the aquatic environment (Salasa, 2002)

Yield

The highest yield of sodium alginate was obtained from alginofit type *S. crassifolium* amounted to 30.3% and the lowest was the yield of *Padina* amounted to 16.93%. *Sargassum* species in this experiment gave relatively higher yield than *Padina*. *Sargassum* species had more leaf than *Padina*. *Sargassum* species gave yield in accordance with those of Ekstra Farmakope Indonesia (1974) that was less than 18%, except for *Padina* species (Figure 1).

Viscosity

The highest viscosity of sodium alginate was obtained from *S. crassifolium* amounted to 39 cps and the lowest was the viscocity of *S.echinocarpum* amounted to 25 cps (Figure 1). However, the viscosity that obtained from alginofit in this experiment, was higher

than viscosity that obtained from another species of *Sargassum,* that only 2.83 cps (Wikanta et al., 1998). This condition showed that although in the Genus like *Sargassum*, was not always has the same viscosity. This caused by degradation that could be happen during the extraction.

Lightness

Lightness value of sodium alginate was influenced by the presence of NaOCl, a bleaching agent that can oxidize the dark color of alginate solution became light color. Fucoxantin was responsible for making the color of alginate solution became darker (Glasby, 1982). The color of sodium alginate was also influenced by the type of alginofit. The lightness (L) of sodium alginate powder in this experiment was 46.2 to 52.3 (Figure 1). It mean that the final color were yellow to light brown.

DISCUSSION

Water content

The water content was influenced by the presence of isopropanol that used in the purification process. Isopropanol has ability to bind water from alginate solution, so it would reduced the water content (Mairamo, 1977; Haryanti et al., 2008).

Ash content

The presence of ash content showed that there were mineral salt. The amount of mineral salt could be different in each alginofit. Mineral salt could be found on surface and in thallus. Conditions of hydrology and hydrochemistry on the habitat also influence the ash content. *Padina* which had their habitat on the bottom of the shore had much ash content than *Sargassum* which life not directly connected with the shore. It could be showed that there was much mineral salt on the surface of their leaves (Salasa, 2002; Truss et al., 2001). *Padina* contains much calcium salt than the other types. This was clearly showed on the surface after drying, which looked like white patches. *Padina* also had softer and thinner body, so its more easily destroyed during extraction and this condition could lead to difficulties during the separation and purification of alginate that results in the presence of some impurities (Truss et al., 2001; Taylor, 1979). In general, much mineral salt contains halogen compound (Br and I), but less in sodium and chlorine. Leaching in 1% $CaCl_2$ and soaking in 5% HCl could decreased the amount of mineral salt (Mushollaeni, 2007; Chapman and Chapman, 1980).

Heavy metals of Pb and Hg

Brown seaweed contains trace amounts of Hg (Truss et al., 2001).The levels of Pb and Hg for all Na-alginate that were produced from alginofit in this experiment were less than 0.3 ppm and less than 0.015 ppm. The maximum level of Pb by FCC was less than 10 ppm and Hg permitted in Na-alginate was less than 40 ppm (FCC, 1993). So, this heavy metals content has already fulfill the permitted condition by FCC. Low levels of heavy metals in sodium alginate showed that the sea water as habitat of alginofit was not polluted (Salasa, 2002).

Yield

S. crassifolium had higher yield of Na-alginate than other alginofit in this experiment, which was 30.3%. The less yield of Na-alginate of *Padina* was 16.93%. Use of 5% HCl solution during pre-extraction could hydrolyzed the alginofit cell walls, reduced the impurities and made the alginate more easy to extract (Mushollaeni, 2007; Truss et al., 2001). Use of 2.25% Na_2CO_3 during extraction was able to separate the cellulose from alginate contained in alginofit cell walls, so this process could increased the yield (Mushollaeni, 2007; Truss et al., 2001).Use of 95% Isopropanol was also could increased the yield, because of its ability to bind water from alginate solution, so Na-alginate could be separated. Another experiment showed that 75 to 95% concentration of isopropanol was the finest concentration to get Na- alginate in higher yield (Mairamo, 1977; Yunizal et al., 1999; Yani, 1998)

Viscosity

Alginofit that grew in areas affected by the direct waves had a strong holdfast. It has high polygalacturonate, which enhanced the viscosity of alginate. *Sargassum* had habitat in the rocky areas and is affected by direct waves, so the concentration of polygalacturonate was higher than alginofit which habitat was not in this place and which had not a strong holdfast such as *Padina*. The viscosity was also determined by the presence of cations such as Ca^{2+} and the residue of galacturonate (Ertesvag et al., 2009)

Lightness

The brown color of alginofit was caused by fucoxantin pigment and by the type of alginofit. If the type of alginofit had a dark color, so it would implied with the final color of Na-alginate (Glasby, 1982). Lightness (L) represented the final color of Na-alginate and it was determined using the method of James (1995), by color reader CR-10 Minolta Japan. The color of Na-alginate that was produced in this experiment was 46.2 to 52.3. It means that the color of Na-alginate was yellow to light brown. Standard of lightness for Na-alginate by Ekstra Farmakope Indonesia (1974) was white to brownish yellow, so the color of Na-alginate that was produced in this experiment was still in the range of that standard.

Conclusion

The brown seaweed grew on the rocky coast of Gunung Kidul in Yogyakarta had the potential to produce alginate. The result showed that the average yield was 16.93 to 30.50%. The physicochemical characteristic of Na-alginate that obtained from *S. crassifolium*, *S. polycystum*, *Padina* sp., and *S. echinocarpum,* that is, water content, ash content, Pb and Hg were 12.50 to 13.43%; 18.20 - 28.59%; 0.083±0.01 to 0.36 ± 0.04 ppm and 0.002 ± 0.01 to 0.3 ± 0.05 ppm. The physical properties such as viscosity and lightness were 25 to 39 cps and 46.2 to 52.3 (the color was yellow to light brown).

ACKNOWLEDGEMENTS

This work was supported by Directorate Jenderal for Higher Education, National Education Department, Republic of Indonesia. Contract Number: 116/SP2H/PP/DP2M/III/2010; March 1, 2010.

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