Dental Journal
Majalah Kedokteran Gigi
Volume 45 Number 3 September 2012

Research Report

Physical characteristic of brown algae (*Phaeophyta*) from madura strait as irreversible hydrocolloid impression material

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ABSTRACT

Background: *Brown algae is a raw material for producing natrium alginates. One type of brown algae is Sargassum sp, a member of Phaeophyta division. Sargassum sp could be found in Madura strait Indonesia. Natrium alginate can be extracted from Sargassum sp. The demand of alginate in Indonesia is mainly fulfilled from abroad, meanwhile Sargassum sp is abundantly available.* ***Purpose:*** *The purpose of study were to explore the potency of brown alga Sargassum sp from Madura strait as hydrocolloid impression material and to examine its physical characteristic.* ***Methods****: The methods of research including extraction natrium alginate from Sargassum sp, synthesis of dental impression material and the test of porosity, density, viscosity, and water content of impression material which fulfilled the standard of material used in clinical application in dentistry.* ***Results:*** *Extraction result of Sargassum sp was natrium alginate powder with cream colour, odorless, and water soluble. The water content of natrium alginate was 21.64% and the viscosity was 0.7 cPs. The best porosity result in the sample with the addition of trinatrium phosphate 4% was 3.61%. Density value of impression material was 3 gr/cm3.* ***Conclusion:*** *The research suggested that brown algae Sargassum sp from Madura strait is potential as hydrocolloid impression material, due to its physical properties which close to dental impression material, but still need further research to optimize the physical characteristic.*

Key words: *Brown algae, Madura strait, irreversible hydrocolloid, physical characteristic*

ABSTRAK

Latar belakang: *Alga coklat adalah sumber bahan baku material natrium alginat. Salah satu jenis alga coklat adalah Sargassum sp yang merupakan anggota divisi Phaeophyta. Sargassum sp dapat ditemukan di Selat Madura Indonesia. Natrium alginat dapat diekstraksi dari Sargassum sp. Kebutuhan akan bahan ini di Indonesia sebagian besar dipenuhi dari impor, padahal ketersediaan Sargassum sp di Indonesia sangat melimpah.* ***Tujuan:*** *Penelitian ini bertujuan untuk mengeksplorasi potensi alga coklat Sargassum sp dari Selat Madura sebagai bahan cetak hidrokoloid dan meneliti karakteristik fisiknya.* ***Metode:*** *Tahap pertama adalah ekstraksi natrium alginat dari Sargassum sp, tahap kedua yaitu sintesis bahan cetak gigi dan menguji karakteristik bahan seperti porositas, densitas, viskositas, kadar air, bahan cetak yang memenuhi standar bahan yang digunakan dalam aplikasi klinis bidang Kedokteran Gigi.* ***Hasil:*** *Hasil ekstraksi berupa natrium alginat bubuk dengan warna krem, tidak berbau, dan dapat larut dalam air. Kadar air natrium alginat sebesar 21,64% dengan viskositas 0,7 cPs. Porositas terbaik dalam sampel dengan penambahan trinatrium fosfat 4% yaitu 3,61%. Nilai densitas bahan cetak 3 gr/cm3.* ***Kesimpulan:*** *Penelitian ini menunjukkan bahwa alga coklat Sargassum sp dari Selat Madura memiliki potensi sebagai bahan cetak hydrocolloid kedokteran gigi karena memiliki karakter fisik yang mirip dengan bahan cetak kedokteran gigi, namun masih memerlukan penelitian lebih lanjut untuk mengoptimalkan karakter fisiknya.*

Kata kunci: *Brown algae, selat Madura, hidrokoloid ireversibel, karakteristik fisik*

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INTRODUCTION

Sargassum sp., the main substance of natrium alginate as the material of irreversible hydrocolloid impression material in dentistry, could grow in the calm or wavy and craggy seas. *Sargassum sp* has cylindrical thallus shape or flattened, with lots of branching resembles land trees. The main stems are rounded, harsh, with discoid shape. The leaves are wide, tapering like a sword, and has solitaire air bubble. The edge of leaves is a bit serrated and wavy with curved or tapered tip. Its color is brown, relatively large-sized, grow and flourish on strong base substrate. The upper part resembles bilateral symmetrical shaped shrub or radial and equipped with growing part.[1] Brown algae, *Sargassum sp* grow in the shallow sea territorial. It can be found in many places around Madura strait Indonesia and can be easily taken from the sea But the availability in the beach is not so abundant. *Sargassum sp* has not been cultivated yet because the people living around the beach still did not a ware the benefit of these algae.

One of dental impression materials is alginate. Alginate has become the material of choice due to the accuracy of line and shape reproduction, comfortable for patient, and its easy mixing and modification.[2] Alginate impression material is the irreversible hydrocolloid material. So if alginate is mixed with other substance and the chemistry reaction occurred, the alginate cannot turn back to its original form. The main component of hydrocolloid impression material is natrium alginate. If natrium alginate is mixed with water, it would become solution and as booster could be added calsium sulphate. Diatom earth and silica gel was added as filler to increase the strength, hardness, to influence setting time and physical properties of alginate gel. Accelerator and retarder material was needed to arrange the setting time. Kalium sulphate is act as accelerator. Natrium or trinatrium phosphate is act as retarder.[3] Polyethylene glicol is added to coat impression material powder so that the powder cannot easily steam like dust.

Research about the influenced of retarder which were trinatrium phosphate and kalium oxalat to the alginate impression material was performed in 2008.[2] Impression material with addition of trinatrium phosphate 0.3 gram yielded flatter surface, homogen, and the highest decomposition temperature which was 55° C. Up to now the availability of alginate is supported by importing the material from abroad. Since the brown algae are contain alginate and it can be found easily and abundantly in Indonesian Seas, *Sargassum sp* has an economical value. *Sargassum sp* has potency to produce natrium alginate which has been known as raw material for alginate dental impression. Some research has been done but the result has not been used and produced directly as dental impression material. This research aims were to explore the potency of brown algae *Sargassum sp* from Madura strait as hydrocolloid impression material and to examine its physical characteristic.

MATERIALS AND METHODS

Material of this research were brown algae *Sargassum sp*. from Madura strait, aquades, water, 5% HCl, 4% Na_2CO_3, 12% NaOCl, 10% NaOH, isopropanol, calsium sulphate, silica gel, calium sulphat, PEG, diatom earth, and trinatrium phosphate. The research process was divided into 2 parts. The first part was the extraction of natrium alginate and second part was the synthesis of irreversible hydrocolloid.[4,5]

Dry brown algae *Sargassum sp*. was immersed in 1% HCl for 1 hour. After immersion in acid solution brown algae was washed and 4% Na_2CO_3 was added. The mixture was heated in the temperature of 60° C for 2 hours. Brown algae then was diluted with aquades, left for approximately 30 minutes, and filtered. The result then was bleached and stirred with 12% NaOCl solution. Five percent of HCl then was added until pH value reached 2-3 (acid). After foam wadding of alginate acid was gained by filtering the mixture, the foam wadding was washed with water to eliminate dangerous acid sludge and the 10% NaOH was added until pH 9 reached. Alginate acid converted to natrium alginate then added isopropanol (99%) with the ratio 1: 2 (IPA: acid alginate). Separated natrium alginate then was filtered and dried. The extraction result was natrium alginate powder which ready to be composed as impression material.

The irreversible hydrocolloid impression material making was done by mixing all the composition material using mortar and pestle. The composition material consist of 19% natrium alginate, 40% calsium sulphate, 15% calium sulphate, 4% diatom earth, 15% silica gel, and 7% PEG. There were 5 variations of trinatrium phosphate percentage of impression material sample which were 0% (sample A), 1% (sample B), 2% (sample C), 3% (sample D), and 4% (sample E).

Physical characteristics was determined by examined the water content, viscosity, porosity and density of materials.[4,5] Water content examination was done by measuring the initial weight, drying material in oven (Thermogravimetri) in high temperature (100–300° C) for 3 minutes to 3 hours or until it reaches constant weight, and the final weight. The difference between the weight before and after the drying process was the amount of water vapor. Viscosity measurement was done using kinematic viscometer bath by entering fluid sample, installing the rotor, and then switching on the machine. The viscosity of substance could be read in the scale.

The porosity test examined dry weight. The material inserted into water and examined the mass. The porosity value could be known by comparing the dry weight material and the wet material mass. The procedure was done by mixing 0.3 gram of material with 150 µL water, after setting, measured the dry weight sample. The material was dipped into 6 ml water, and measured the wet sample weight. The dry and wet weight difference was calculated.

Density test was calculated using Archimedes method. The first step was sample weight measurement using

analytical scales with accuracy 0.001 gram to determine sample mass W, then measured the weight sample in water media Wa (whole sample was drowned). Density test was done to characterize sample and gain the density of sample. It is defined as total mass in one unit volume. The denomination was in unit gram per centimeter cubic (g/cm^3). The mass in gram was the mass in 1 cm^3 water in specific temperature.

RESULTS

Extraction result was natrium alginate powder with cream colour, odorless, dissolved in water (Figure 1). Was the porosity of commercial dental material impression is 1.82%. The porosity of dental impression with addition of 0%, 1%, 2%, 3%, 4% trinatrium fosfat were 6.48%; 6.42%, 6.37%, 6.62% and 3.61% respectively. Density value of impression material were with addition of 0%, 1%, 2%, 3%, 4% trinatrium fosfat were subsequently 3.27, 3.35, 3.33, 3.26, 3.39 gr/cm^3. The data of porosity and density is shown in Figure 2. The water content of natrium alginate was 21.64% and the viscosity was 0.7 cPs.

DISCUSSION

Extraction of natrium alginate from *Sargassum sp* refers to modified extraction method.[4,5] Freeze drying method was used for drying process. Natrium alginate powder was cream in color, odorless and dissolved in water. This result fulfilled the Farmakope requirement 1974.[6]

Maximum water content of natrium alginate which had required by Food Chemical Codex[7] is 15%. The content of natrium alginate in food is at least 13%[8]. According to the research,[9] water content in natrium alginate was in the range between 5% to 20%. Water content of natrium alginate of *Sargassum sp* was 21.64%. It closed to the range of allowed water content of natrium alginate. There was no significant difference in this data (1.64%). This is because

Figure 1. Natrium alginate powder of *Sargassum sp.*

Sargassum sp has hygroscopic properties which need long time in drying process. Drying process which was used in this research was Thermogravimetri method (high heating). This method has some weakness. The first was water the other substance and could evaporated and gone with water vapor. Beside that, the reaction could be happened during the heating. Material contain substance which capable to bind water strongly will difficult to release water even it had been heated. Material which has been dried could be more hygroscopic than the origin material. That is why during cooling process before weighing, material should be placed in closed container like exycator or decycator with water absorbant.[10]

Viscosity value is a measurement of the resistance of a fluid which is being deformed by either shear stress or tensile stress. The lower viscosity, the higher elasticity and the lower permanent deformity of impression material.[11] Viscosity value of natrium alginate of *Sargassum sp* and control was 7000 cPs and 5000 cPs respectively. Viscosity of natrium alginate from *Sargassum sp* higher than the control group, it showed that the sample's elasticity was lower than control. Viscocity of natrium alginat standard value are varied in the range of 10 to 5.000 cps (solution

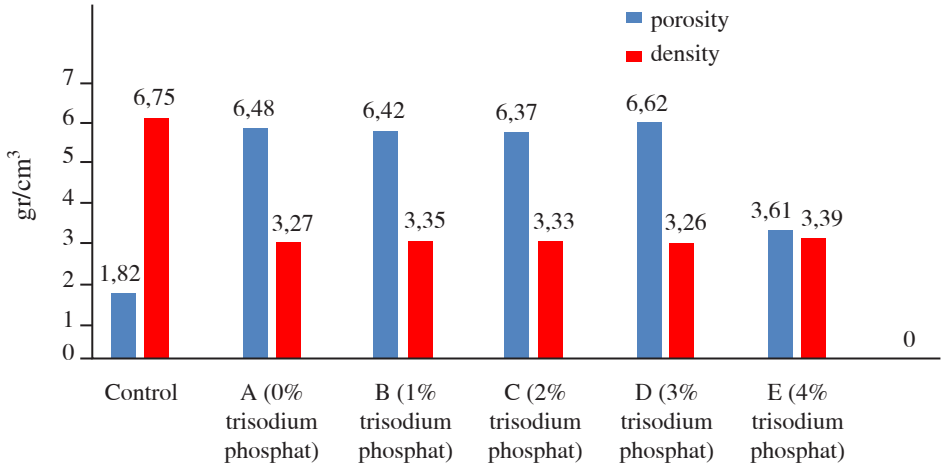

Figure 2. The porosity and density of impression material with natrium alginate from *Sargassum sp.*

concentration 1%).[9] Beside that, there are 3 type of viscocity standard commercial (SIGMA 2008) which are 14.000 cps (high viscosity), 3.500 cps (medium viscosity) and 250 cps (low viscosity). It has been suggested that the viscosity property of all alginates is affected by method of extraction.[12] Prolong extraction period with higher Na^2 C03 concentration also causes degradation of alginates. Sargassum habitat is rocky areas and is affected by direct waves, so the concentration of polygalacturonate is higher than alginofit which live in different habitat and has weak holdfast. The viscosity was also determined by the presence of cations such as Ca^{2+} and the residue of galacturonate.[13] The difference of viscosity value may cause of the different of sample viability and quality. Compare with the commercial viscosity standard of SIGMA, the viscosity result in this research was in the range of "medium viscosity" and "high viscosity". It showed that *Sargassum sp* has high potential as raw material of natrium alginate processing in Indonesia.

The density value of sample was much lower than the density value of control which was 6.75 gr/cm^3. It might be caused by the procedures of milling and the quality of brown algae. The quality of brown algae is depend on the salinity of sea water, humidity etc. It revealed that we still need more advanced research of natrium alginate from *Sargassum sp* Density was supporting the porosity value.

The high density, the minimum amount of extractable fraction, and the good mechanical properties of cross-linked alginate were found to be responsible for the elasticity of water-swollen hydro gel hybrid.[14] The density standard of natrium alginate were 2.54 g/cm^3 (anhydrous), 2.25 g/cm^3 (monohydrate), 1.51 g/cm^3 (heptahydrate) and 1.46 g/cm^3 (decahydrate).[15] The porosity value of natrium alginate commercial product was 1.82%. The porosity value of sample without addition of trinatrium phosphate was 6,48%, and with the addition of trinatrium phosphate were 1%, 2%, 3%, 4% were 6.42%, 6.37%, 6.62%, 3.61% respectively. Compared with commercial product, impression material with natrium alginate from *Sargassum sp* had higher porosity value, which was not caused by the retarder (trinatrium phosphate). Addition of 4% trinatrum phosphate in impression material will decrease the porosity value. In porosity test, the weight of impression material and the volume of water were constant so the porosity value was not influenced by both factors. Porosity value is drived by the size of particle. The mixing process of impression material which used mortar and pestle (manual) could be considered as one of the reasons. This manual method provided different pressure to the particle of sample.[16] The research suggested that brown algae *Sargassum sp* from Madura strait is potential as hydrocolloid impression material, due to its physical properties which close to dental impression material, but still need further research to optimize the physical characteristic.

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