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by Nurlindah Hamrun

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Nurlindah Hamrun,[1*] Bahruddin Thalib,[2] Dahlang Tahir,[3] Syaharuddin Kasim,[4] Ahmad F. Nugraha[1]

Abstract

Objective: This research aims to explore the potential of brown algae species padina sp. as a dental impression material by examining the physical characteristics of the sodium alginate extraction of brown algae species padina sp.

Material and Methods: This research is a quasi-experimental with one-shot case study design. Samples are brown algae species padina sp. from Punaga and Puntondo beach in South Sulawesi. Brown algae species padina sp. is extracted to obtain sodium alginate and further tested for physical characteristics including viscosity test and water content.

Results: The extraction of brown algae species padina sp. resulted in 250 grams (25%) of brown powdered sodium alginate that smelled fishy. Physical characteristic tests revealed the water content of sodium alginate species from brown algae padina sp. was 8%. This result is acceptable for sodium alginate water content as set by the Food Chemical Codex that requires less than 15% water content. The measurement of the viscosity obtained is 13.33 cps.

Conclusion: These results indicate that the species of brown algae padina sp. has the potential to be one of the basic materials of dental impression material.

Keywords: Brown algae, Padina sp., Sodium alginate, Viscosity, Water content
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Introduction

The printed material is the material used to print the replica details of teeth as well as the hard and soft tissues in the oral cavity. The result of this mould will then be made into a model which is the construction of full artificial denture making, partial denture, bridge denture, and inlay. Therefore, this stage is an important step.[1] One of the most used dental materials in dentistry is alginate. Alginate is chosen because it can produce accurate and convenient prints for patients while being easy to mix and modify.[2]

Alginate printing material has the main composition of algin known in the form of alginic acid or alginate. Algin has been found in several areas in Indonesia but its utilization is limited to industry, especially for food, medicines, cosmetics, and textiles. Within the field of health, especially in the field of dentistry, there is no reference.[3]

Alginate is a salt of alginic acid, a polysaccharide constituted by branched binary copolymers of β-D-mannuronic (M) and α L-guluronic acid (G) structured in MM, MG blocks, joined by β (1-4) bonds, and GG, GM blocks, joined by α (1-4) bonds. Alginate is a structural polysaccharide of the amorphous matrix of brown algae cell wall (Phaeophyta). They serve to provide strength and flexibility for algal tissues.[4]

All types of brown algae contain alginate but most commercially produced alginates are extracted from several species. Some alginate producing countries in Europe, such as England, Norway and France, use Ascophyllum nodosum, Laminaria hyperborea, and Laminaria digitata as alginate feedstock, while Asian countries, such as Japan and Korea, are also significant alginate producers using Ecklonia cava and several other species.[5]

Indonesia is a maritime country and as a result, two-thirds of its territory is waters. One of the most abundant marine resources in Indonesia is seaweed which is approximately 8.6%[6] The types of seaweed are spread in several regions in Indonesia. Generally, seaweed grows wild and is not utilized properly. Utilization of wild seaweed is only limited to fertilizers or burned to reduce disruptions to the conditions around the coast.

Brown seaweed can potentially be used as a source of alginate producers such as Macrocystis, Turbinaria, padina and sargassum sp. Based on

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research, brown algae containing alginate can be processed to produce Sargassum sp., Turbnaria sp., Hormophysa sp., and padina sp.[7,8]

This study aims to explore the potential of brown algae type padina sp. by examining the physical characteristics of sodium alginate extraction of brown algae type padina sp. as preparation for the manufacturing of dental printing material (irreversible hydrocolloid). This study will also determine if the obtained print material meets the standardization quality for printing material used for clinical applications in dentistry.

Material and Methods

Sodium Alginate Extraction; chocolate alga type padina sp. was harvested, washed with fresh water, cut into small pieces and dried in direct sunlight before being soaked with 1% hydrochorlic acid (HCl) solution for 1 hour. After soaking in HCl solution, the brown algae were washed and a 4% sodium carbonate (Na_2CO_3) solution was added to submerge the padina sp. entirely. The mixture was then heated to 60 °C for 2 hours while stirring. It was then diluted with aquades until completely submerged, left for 30 minutes and filtered with filter paper. The result was then bleached by stirring in a 12 % sodium hypochlorite (NaOCl) solution. A 5% HCl solution was added until it reached pH value 2-3. Once clumps of foam alginic acid formed, they were obtained by filtering the mixture. The clumps of foam were washed with water to remove harmful acid deposition and washed with 10% sodium hydroxide (NaOH) solution until the pH was reached.[9] The alginic acid is converted to sodium alginate by adding isopropanol 99% with a 1:2 ratio. The sodium alginate is then separated by filteration and dried. The extraction result is a powdered sodium alginate ready to be prepared as a printed material. The result of this extraction was then weighed with analytical scales.

Measurement of Viscosity; material was weighed before adding aquades (50 mL). The mixture was then homogenized with a homogenizer speed of 2000 rpm to homogeneous. The mixture was diluted with 100 mL of aquades. The viscosity of the mixture was then calculated.

$$\text{water content (\%)} = \frac{\text{initial weight} - \text{final weight}}{\text{initial weight}} \times 100\%$$

Results

The research has been done in the Laboratory of Biopharmaca and Pharmaceutics Laboratory of Hasanuddin University Faculty of Pharmacy. The conducted resulted in the extraction of sodium

Figure 1 Sodium alginate extraction padina sp.

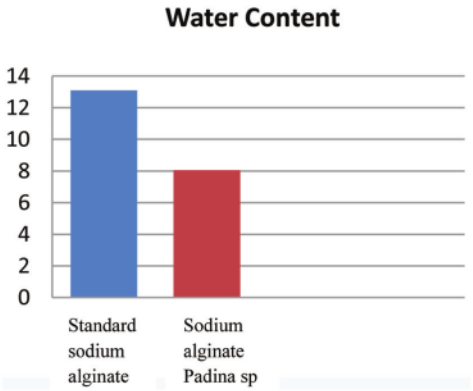

Figure 2 Water content of sodium alginate algae brown type padina sp. and standard sodium alginate

alginate from brown algae type padina sp. obtained in the form of powder weighing 250 grams (25 %) of the total dry weight of brown algae used. The resulting sodium alginate powder was brownish and smelled fishy compared to standard white and odorless printing materials figure 1 and table 1.

The result of viscosity measurement of brown algae sodium algae of padina sp. obtained viscosity value 13.33 cps while in standard sodium alginate obtained viscosity value 683.33 cps table 2 and figure 2 water content of the extracted sodium alginate algae from brown type padina sp. is about 8%, whereas in standard sodium alginate, the water content is 13%. The results showed that alginate water content was below 20% and therefore still eligible. The water content of the alginate salt shows the amount of water still trapped in the alginate molecule and this is proportional to the viscosity of alginate.

Table 1 Data of test result of the water content of sodium alginate algae brown algae type padina sp. and standard sodium alginate

Sample Name	Water Content (% v/b)	Average Water Content (% v/b)
Sodium alginate from brown algae padina sp. 1	8.0864	8.0428
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Sodium alginate standard 1	13.1824	13.1055
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Tabel 2 Data of viscosity result of sodium alginate algae brown type padina sp. and standard sodium alginate

Sample Name	Viscosity (centipoise)
Standard sodium alginate	683.33
Sodium alginate from brown algae padina sp.	13.33

Discussion

The first step of this research required extraction of brown algae type padina sp. to obtain the sodium alginate contained within the brown algae.[10] The extraction resulted in a powder that was examined for sodium alginate content and then tested for its physical characteristics, including the examination of moisture content and viscosity.

The alginate acid content of algal rods of laminaria species in older plants is relatively more stable than the young ones. Possible differences in harvest age (picking time) also affect sodium alginate levels. Another factor is the difference of water conditions at the time sampling is done. Alginate is present in the brown algal cell wall that serves to provide the flexibility properties of the algae itself. That is why brown algae that grow in turbulent waters usually have a higher alginate content than those grown in relatively calm waters.[10]

The number of leaves determines the level of alginate that exists because the leaves have more alginates than the stems and roots. In addition, alginophytic habitats are more exposed to direct waves, living with roots firmly attached to corals, and higher clump sizes have higher alginate levels. The content of alginate brown seaweed depends on the age, type and habitat.[11,12]

The water content of sodium alginate specified by Food Chemical Codex is a maximum of 15%. The permissible water content in sodium alginate ranges from 5-20%.

This means that the water content of sodium alginate obtained in this study is still within the range at 14.97%. While the water content of sodium alginate for foodstuffs is a maximum of 13%.[10]

The seaweed portion and the time of extraction treatment on alginate salt causing the free water content (surface water) to associate with the has a noticeable effect on water content. The highest water content is found at the base (16.77%) and the lowest in the leaf (14.14%). It is suspected that the leaves are still forming the guluronate hydrogen bond. The old treatment of extraction showed the highest water content produced on the extraction time of 2 hours (16.20%). Allegedly, during longer extractions, the water will be bound by alginate due to its hydrophilic properties that trap water. The water content allowed for alginate is 5-20%.[13]

The water content of sodium alginate extracted has fulfilled the requirement set by Food Chemical Codex that is less than 15%. This type of seaweed also determines the water content of alginate. Types that have habitat bound to a basin that is always inundated by sea water have higher water content than those in tidal areas. The presence of this water is also determined by the role of isopropanol which added there is a purification process, drying process and storage. Isopropanol has the ability to bind water from an alginate solution so it can be left behind and settle.[12]

The highest viscosity of sodium alginate was produced by S. crassifolium and S. duplicatum (39 and 38 cps, respectively) while the viscosity of padina sp. is 37 cps. This result is slightly higher than result of this research. This viscosity difference can indicate the presence of degradation occurring during the extraction process. This degradation can decrease the molecular weight of alginate, which results in decreased viscosity. In general, the molecular weight of alginate is about 200.000 amu but that may change if degradation occurs during the extraction process and the bonds between polyglucuronic acids become disconnected resulting in decreased alginate viscosity.[12]

The viscosity value of sodium alginate varies considerably between 10-5.000 cps (1% solution concentration). In addition, there are three types of standard viscosity values for traded sodium alginate; 14.000 cps (high viscosity), 3.500 cps (medium viscosity) and 250 cps (low viscosity).[10] Judging from the above viscosity division, the viscosity of sodium alginate extracted by padina sp. obtained from the waters of South Sulawesi is included in the low viscosity category.

The viscosity value of Sargassum echinocarpum brown algae obtained from the waters of the Paria Islands is 6.100 cps. This value is the highest viscosity value obtained during the research activity of sodium alginate extraction from brown algae in the LIPI Marine Products laboratory.[10]

The viscosity value of sodium alginate obtained from Sargassum sp. is 45.3 mPas. Results are also included in the low viscosity category. The low viscosity properties affect the viscosity of an alginate printing material to be made. For the manufacture of alginate printing materials, the viscosity of sodium alginate must be at least 300 mPas or medium viscosity.[14]

Possible differences in the location where it grows (including water conditions, pH, salinity, light, depth and nutrients) is one of the causes of the difference in the value of the resulting viscosity. Another factor that may cause differences in viscosity values generated in this study is the quality of the samples used. Morphologically, the tallus form of each type of brown algae varies. This tallus form is also likely to have an effect on the sodium alginate content and the resulting viscosity values.[5]

Alginophytes that grow in areas affected by direct waves have a strong holdfast and are strongly bound to the reef where it lives. They also have a higher polyglucuronate which can increase the viscosity of alginate. The level of polyglucuronate is determined by the type and habitat of its life. High content of polyglucuronic acid, can increase the viscosity of alginate.[12]

The change of extraction method by soaking padina sp. using a 0.1% potassium hydroxide (KOH) solution for 60 minutes rather than an HCl solution may increase the viscosity of the printed material padina sp.[14]

Conclusion

The research carried out resulted in the extraction of sodium alginate from brown algae type padina sp. The resulting sodium alginate powder is brownish in colour and smells fishy compared to standard white and odorless printing materials. The levels of sodium alginate obtained in powder form weighed 250 grams or 25% of the total dry weight of brown algae. On the test of physical characteristics, the water content of sodium alginate algae brown type padina sp. was 8% and the viscosity was 13.33 cps.

Acknowledgment

Authors are also grateful to the Dean of Faculty of Dentistry Hasanuddin University for their support and assistance.

Conflict of Interest

The authors report no conflict of interest.

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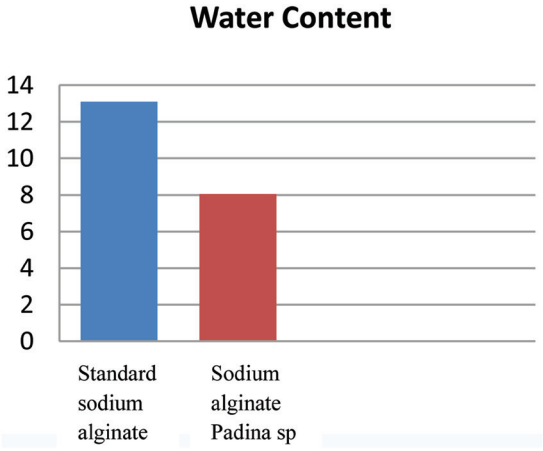

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The water content of sodium alginate specified by Food Chemical Codex is a maximum of 15%. The permissible water content in sodium alginate ranges from 5-20%.

This means that the water content of sodium alginate obtained in this study is still within the range at 14.97%. While the water content of sodium alginate for foodstuffs is a maximum of 13%.[10]

The seaweed portion and the time of extraction treatment on alginate salt causing the free water content (surface water) to associate with the has a noticeable effect on water content. The highest water content is found at the base (16.77%) and the lowest in the leaf (14.14%). It is suspected that the leaves are still forming the guluronate hydrogen bond. The old treatment of extraction showed the highest water content produced on the extraction time of 2 hours (16.20%). Allegedly, during longer extractions, the water will be bound by alginate due to its hydrophilic properties that trap water. The water content allowed for alginate is 5-20%.[13]

The water content of sodium alginate extracted has fulfilled the requirement set by Food Chemical Codex that is less than 15%. This type of seaweed also determines the water content of alginate. Types that have habitat bound to a basin that is always inundated by sea water have higher water content than those in tidal areas. The presence of this water is also determined by the role of isopropanol which added there is a purification process, drying process and storage. Isopropanol has the ability to bind water from an alginate solution so it can be left behind and settle.[12]

The highest viscosity of sodium alginate was produced by S. crassifolium and S. duplicatum (39 and 38 cps, respectively) while the viscosity of padina sp. is 37 cps. This result is slightly higher than result of this research. This viscosity difference can indicate the presence of degradation occurring during the extraction process. This degradation can decrease the molecular weight of alginate, which results in decreased viscosity. In general, the molecular weight of alginate is about 200.000 amu but that may change if degradation occurs during the extraction process and the bonds between polyglucuronic acids become disconnected resulting in decreased alginate viscosity.[12]

The viscosity value of sodium alginate varies considerably between 10-5.000 cps (1% solution concentration). In addition, there are three types of standard viscosity values for traded sodium alginate; 14.000 cps (high viscosity), 3.500 cps (medium viscosity) and 250 cps (low viscosity).[10] Judging from the above viscosity division, the viscosity of sodium alginate extracted by padina sp. obtained from the waters of South Sulawesi is included in the low viscosity category.

The viscosity value of Sargassum echinocarpum brown algae obtained from the waters of the Paria Islands is 6.100 cps. This value is the highest viscosity value obtained during the research activity of sodium alginate extraction from brown algae in the LIPI Marine Products laboratory.[10]

The viscosity value of sodium alginate obtained from Sargassum sp. is 45.3 mPas. Results are also included in the low viscosity category. The low viscosity properties affect the viscosity of an alginate printing material to be made. For the manufacture of alginate printing materials, the viscosity of sodium alginate must be at least 300 mPas or medium viscosity.[14]

Possible differences in the location where it grows (including water conditions, pH, salinity, light, depth and nutrients) is one of the causes of the difference in the value of the resulting viscosity. Another factor that may cause differences in viscosity values generated in this study is the quality of the samples used. Morphologically, the tallus form of each type of brown algae varies. This tallus form is also likely to have an effect on the sodium alginate content and the resulting viscosity values.[5]

Alginophytes that grow in areas affected by direct waves have a strong holdfast and are strongly bound to the reef where it lives. They also have a higher polyglucuronate which can increase the viscosity of alginate. The level of polyglucuronate is determined by the type and habitat of its life. High content of polyglucuronic acid, can increase the viscosity of alginate.[12]

The change of extraction method by soaking padina sp. using a 0.1% potassium hydroxide (KOH) solution for 60 minutes rather than an HCl solution may increase the viscosity of the printed material padina sp.[14]

Conclusion

The research carried out resulted in the extraction of sodium alginate from brown algae type padina sp. The resulting sodium alginate powder is brownish in colour and smells fishy compared to standard white and odorless printing materials. The levels of sodium alginate obtained in powder form weighed 250 grams or 25% of the total dry weight of brown algae. On the test of physical characteristics, the water content of sodium alginate algae brown type padina sp. was 8% and the viscosity was 13.33 cps.

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Conflict of Interest

The authors report no conflict of interest.

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