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Compressive and tensile strength measurement of irreversible hydrocolloid impression material made of brown algae Padina

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Thank you

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Compressive and tensile strength measurement of irreversible hydrocolloid impression material made of brown algae *Padina* sp



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Nurlindah Hamrun^{1*}, Rafikah Hasyim¹, Acing H. Mude², Muhammd Ikbal², Teiza Nabilah³, Mutiaranisa Safitri¹, Fuad H. Akbar⁴

Abstract

Objective: This study aimed to explore the potential of brown algae (*Padina* sp) by measuring its compressive and tensile strength as a preparation step for making standardized dental impression materials from sodium alginate *Padina* sp.

Material and Methods: This study was a quasi-experimental study with one-shot case design. Brown algae were taken from the waters of Punaga and Puntondo, Takalar. Sodium alginate was extracted from algae then mixed with other compositions to form alginate

impression material. Compressive and tensile were tested using the Point Load Test.

Results: Compressive strength of impression material made of *Padina* sp was higher than that of standard impression material with pressure mean 0.011 Mpa and 0.009 Mpa. The mean tensile strength measurement was 0.003 Mpa.

Conclusion: Mean compressive and tensile strength of impression material made of *Padina* sp were still relatively weak.

Keywords: Compressive strength, Impression material, Na alginate, *Padina* sp, Tensile strength

Cite this Article: Hamrun N, Hasyim R, Mude AH, Ikbal M, Nabilah T, Safitri M, Akbar FH. 2021. Compressive and tensile strength measurement of irreversible hydrocolloid impression material made of brown algae *Padina* sp. *Journal of Dentomaxillofacial Science* 6(1): 51-53. DOI: [10.15562/jdmfs.v6i1.1190](https://doi.org/10.15562/jdmfs.v6i1.1190)

¹Department of Oral Biology, Faculty of Dentistry, Hasanuddin University, Makassar, Indonesia

²Department of Prosthodontic, Faculty of Dentistry, Hasanuddin University, Makassar, Indonesia

³Dental Hospital, Faculty of Dentistry, Hasanuddin University, Makassar, Indonesia

⁴Department of Dental Public Health, Faculty of Dentistry, Hasanuddin University, Makassar, Indonesia

Introduction

Alginate impression material (irreversible hydrocolloid) is a colloidal material that can be dissolved in water, and its shape cannot be returned to its original form. Impression material that has been manipulated will be placed in the patient mouth to make negative reproduction of teeth and oral tissue. The impression is then cast to obtain a working model or study model, a replica of teeth, and oral tissue.^{1,2} The advantage of this impression material far exceeds other materials, because it is easily manipulated, comfortable for patients, and relatively inexpensive because it does not require a lot of equipment.³

The main composition of alginate impression material is algin, which is known as alginic or alginic acid. Algin is widely found in several regions in Indonesia, but their use is still limited. Seaweed is one of the promising potentials in Indonesia as a maritime country. The ecological and biological role of seaweed in maintaining the stability of the marine ecosystem and as a place to live as well as protection for other biotas. Brown alga (Phaeophyta) with chlorophyll, a-pigments, chlorophyll c (c1 and c2) and carotenoids (fucoxanthin, violaxanthin, zeaxanthin) contain alginic acid as a constituent of cell walls make brown algae economically valuable, easily available, and abundant in the Indonesian sea.⁴ This makes brown algae the potential agent to produce sodium and potassium alginate, which has been known as a raw material for impression

materials in dentistry.

Material and Methods

This study was a quasi-experimental study with one-shot case design. The sample used in this research was *Padina* sp. obtained from Puntondo and Punaga waters, Takalar, South Sulawesi. Brown algae were then extracted and made into irreversible hydrocolloid impression material, then tested for its physical characteristics by testing the compressive strength (Compressive Strength Test) and traction (Tensile Strength test).

Dried brown algae *Padina* sp was soaked in 1% HCl for 1 hour, washed and added with 4% Na₂CO₃, then heated and stirred at 60°C for 2 hours, followed by diluting with distilled water, let stand for about 30 minutes and filtered with a filter cloth. The result was bleached with a 12% NaOCl solution, added with 5% HCl to obtain a pH value of 2-3 (acid) and added 10% NaOH to reach pH 9. Alginic acid was converted to sodium alginate, then 99% isopropanol was combined with a ratio of 1: 2. Separated sodium alginate then filtered and dried. The extraction result was sodium alginate powder that was ready to be made to impression material.

The manufacture of irreversible hydrocolloid impression material was done by mixing all ingredients (20% sodium alginate, 40% calcium sulfate, 15% potassium sulfate, 4% diatom earth, 15% silica gel, 7% poly ethylene glycol and 1% trisodium

*Correspondence to: Nurlindah Hamrun, Department of Oral Biology, Faculty of Dentistry, Hasanuddin University, Makassar, Indonesia
lindahamrun@unhas.ac.id
pmc@agri.unhas.ac.id

Received: 7 January 2021
Revised: 8 February 2021
Accepted: 3 March 2021
Available Online: 1 April 2021

Table 1 Formulation of material composition

Composition	Percentage (%)			
	F1	F2	F3	F4
Sodium alginate	18	19	20	21
Calcium sulfate	40	40	40	40
Potassium sulfate	15	15	15	15
Sodium triphosphate	1	1	1	1
Diatom earth	4	4	4	4
Silica gel	15	14	13	12
PEG	7	7	7	7

F1: Formula 1; F2: Formula 2; F3: Formula 3; F4: Formula 4

Table 2 Mean of compressive strength test and tensile strength test of standard impression material and impression material made of padina sp

Sample	Compressive Strength (Kg/cm ²)	Tensile Strength (N/Cm ²)
Standard F1	0.044	0.026
Padina F1	0.088	0.026
Standard F2	0.088	0.026
Padina F2	0.131	0.025
Standard F3	0.131	0.033
Padina F3	0.131	0.009
Standard F4	0.131	0.021
Padina F4	0.044	0.008

phosphate) using mortar and pestle. Then the formulation of material composition was made as to the following [table 1](#).

The standard impression material was made from standard sodium alginate with the same composition as impression material made of Padina sp.

Weigh the material as much as 5 grams, mix with water, the sample used in this test was prepared with a diameter of 20 mm. The sample was placed between a two-cone pressure point load device; then, the hydraulic jack was pressured so that both ends of the cone directly press the surface sample. Record the measurement bar at the initial position of pressure cones. The pressure was applied regularly until the sample break. Loading was stopped after the sample has broken. Turn of the device, read the maximum gauge value (dial gauge) given by the device that makes the sample break.

Impression material samples were prepared before testing. The sample was made in a tube container with a diameter of 20 mm. After sample preparation, one by one test material was pressed on the test machine, using an additional steel plate to suppress the overall area of impression material.

The load/pressure value received by material N/cm² is the limit of the tensile strength value of the content.

Results

The result of the compressive strength test and tensile strength test impression material made of Padina sp can be seen in [table 2](#).

Discussion

The results of the compressive strength test showed the highest compressive strength values on formula 2 and formula 3. In formula 2, impression materials made of Padina sp have higher compressive strength values than standard impression materials. The lowest compressive strength value of Padina sp impression material was found on formula 4. The compressive strength value (sc) was then converted to a pressure value with a unit of MPa (Mega Pascal). In this study, we obtained pressure value 0.011 for Padina sp impression material and 0.009 MPa for standard impression materials. The normal value of impression materials compressive strength, according to ISO 1563/78, could not exceed 0.30 Mpa.^{5,6} Although the results were by the standard value of less than 0.30 MPa, the value of irreversible hydrocolloid impression material made of Padina sp was still deficient because it did not reach 0.10 Mpa.

The highest tensile strength test results were obtained on impression material made of Padina sp formula 1 and the lowest on formula 3. From these values, it is known that the tensile strength of padina sp impression materials was still weak compared with standard impression material tensile strength. This was due to grain size factor, as stated in a study conducted by Carlo et al.⁶ that the smaller the mesh size used, the higher the compressive strength value.⁷ This was also in line study by Widiyanti et al. that suggested porosity was influenced by particle size.^{8,9} Small grain size has a large contact area and greater surface diffusion between surfaces compared to large grain size.¹⁰

Material mixing was done using the manual method with mortar and pestle, which can also be a cause of differences in compressive strength due to unevenly mixed composition.¹¹ Time and state of storage can also affect alginate; the longer the alginate is kept at room temperature and not in an airtight state, the quality of the alginate will be more reduced.⁹ Based on the above study, the grain size differences between irreversible hydrocolloid material composition and mixing method can affect homogenization between each material, hence further affect the yield of compressive strength.

Conclusion

The mean of compressive strength test on impression material made of padina sp was higher than that of standard impression materials, and the mean of the tensile strength of padina sp impression material was still relatively weak.

Acknowledgment

Thank you for the support Faculty of Dentistry Hasanuddin University.

Conflict of Interest

The authors report no conflict of interest.

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