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Research Report

Compressive Strength Test on Calcium Hydroxide with Propolis Combination

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ABSTRACT

Background: *Calcium hydroxide is a dental material used as a gold standard for pulp capping materials. However, calcium hydroxide has several weaknesses which cause many researchers to look for alternative ingredients that come from nature. Propolis in the field of dentistry has long been used because of its ability as an anti-inflammatory, anti-microbial, anti-fungal, and can cure scars. The combination of calcium hydroxide and propolis is proven to have good biocompatibility and anti-bacterial properties. One of the requirements of pulp capping material is to have sufficient compressive strength. Therefore, a research to test the compressive strength value of the combination of calcium hydroxide with propolis is needed.* ***Purpose:*** *To find out the difference in compressive strength of the combination of calcium hydroxide-propolis with a ratio of 1: 1, 1: 1.5, and 1: 2.* ***Methods:*** *The study used 4 treatment groups with each group consisting of 6 replications. Group 1 is a combination of calcium hydroxide-propolis with a ratio of 1: 1, group 2 with a ratio of 1: 1.5, group 3 with a ratio of 1: 2, and a positive control group using calcium hydroxide - sterile aquadest. Calcium hydroxide powder and propolis extract liquid is mixed according to comparison and printed on a cylindrical mold with the size of 4 mm x 6 mm. Then, the compressive strength was tested using an Autograph test instrument. Result: Compressive strength was smaller in group 3 compared to group 2, group 2 compared to group 1, and group 1 compared to the control group.* ***Conclusion:*** *In calcium hydroxide-propolis combination, the more propolis extract used in the combination the lower the compressive strength of the combination will be.*

Key words: *Combination of Calcium Hydroxide-Propolis; Compressive strength.*

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INTRODUCTION

Calcium hydroxide is a gold standard pulp capping material because it has a great antibacterial properties, ability to induce mineralization, and also has low cytotoxicity.[1] However, calcium hydroxide also has weaknesses. This material is highly soluble, has a weak adhesive quality, causes resorption in primary teeth, creates a "tunnel defect" in tertiary dentine which forms under calcium hydroxide, and is less effective in eliminating certain bacteria. All these weaknesses leads to several researches to try combining calcium hydroxide with natural products to gain pulp capping material with better ability. One of that natural product is propolis.

Propolis is a natural resin substance obtained by honey bees through various plants to build and repair honeycomb. Propolis has anti-bacterial, anti-inflammatory properties, non-toxic, causes pulp regeneration, does not cause inflammation, and shows dentinal tubular formation without porous.[5,6] Adding propolis extract on calcium hydroxide can increase the antimicrobial activity of

calcium hydroxide, biocompatible, and does not cause inflammation. [4,7]

Pulp capping material has to meet several conditions, one of which has sufficient compressive strength.[8] Sufficient compressive strength enable pulp capping material to remain in position despite receiving force from operative procedure and resisting condensation compressive force from the material above. Compressive strength is needed so that the pulp capping material is able to withstand pressure during placement and during the lifetime of the material above it. The pulp capping material should withstand indirect pressure forces from mastication.[8,11]

Some studies have combined calcium hydroxide and propolis. Comparisons used in the combination of calcium hydroxide-propolis are also various. There are studies that use a combination ratio of calcium hydroxide-propolis 1: 1, 1: 1.5, and 1: 2. [7,12]
It is not yet known how the material compressive strength of the three comparisons in these studies. Because of that, the aim of this study is to determine the difference in compressive strength of the combination of calcium hydroxide-propolis with a ratio of 1: 1, 1: 1.5, and 1: 2. This study is expected to provide information on the compressive strength of the combination of calcium hydroxide-propolis with a ratio of 1: 1, 1: 1.5, and 1: 2 and to be considered an alternative material for pulp capping.

MATERIAL AND METHOD

The study was conducted using 4 treatment groups with each group consisting of 6 replications. Group 1 is a combination of calcium hydroxide-propolis with a ratio of 1: 1, group 2 is 1: 1.5, group 3 is 1: 2, and group 4 is a positive control group using calcium hydroxide - sterile distilled water.

Propolis extract was obtained by maceration technique from *Apis melifera* honeycomb using 96% ethanol, then diluted to produce a propolis solution with a concentration of 8%.[13] Calcium hydroxide used in this research is a pro analysis Merck brand calcium hydroxide powder.

Samples are made using 4 x 6 mm diameter molds according to ISO 9917-1: 2007 standard. Calcium hydroxide powder with propolis extract / sterile distilled water is stirred on a glass slab using a cement spatula until it is homogeneous and then put into the mold. The lower part of the mold is given a celluloid strip and placed on a glass slab and the combination of calcium hydroxide-propolis is put into the mold with a plastic filling instrument, the mixture is added from the mold and then given a celluloid strip on top and pressed with another glass slab on top as shown in figure 1.[14]

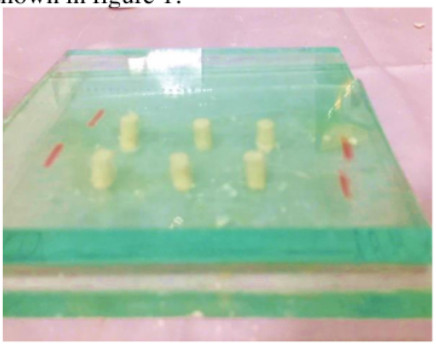

Figure 1. Making of calcium hydroxide-propolis sample

After the sample hardens, it is removed from the mold and then physically evaluated. Uneven or distorted samples are not used as samples. Then, the sample is left for 48 hours at 37oC.[14]
Testing the compressive strength value of the sample used the Autograph tool. The sample is placed in the center of the pressure device by positioning the vertical axis of the sample perpendicular to the flat plane. The autograph tool is turned on and the pressing part moves slowly with a pressure of 1kN and the speed of 1mm / minute presses to shred. After the sample is destroyed, the numbers printed on the autograph device are recorded. The

numbers listed in kgF are converted in Newton and then divided into cross-sectional areas so that the compressive strength is obtained in Pascal units according to the following formula.

$$C = 4P / \pi D^2$$

Information :

C= Compressive power value (in Mega Pascal)

P= The maximum force applied to the sample when the sample is destroyed (in Newton)

D= Diameter of sample (in millimeters)

The data obtained were processed using Kolmogorof-Smirnof statistical analysis for normality test, Levene test for Homogeneity test, One Way Anova for difference test, and Post hoc test to see comparison between samples (Tukey HSD).

RESULTS

From figure 2 it can be seen that the average compressive strength of positive controls is 1.24 MPa, group I 0.84 MPa, group II 0.54 MPa, and group III 0.24 MPa.

The results of data analysis show that data is normally distributed and homogeneous. In the ANOVA test results obtained p = 0.000 (p <0.05), which means there are differences between treatment groups. The Tukey HSD test results showed that each sample group had a significant difference between one sample group and another. This means a combination of calcium hydroxide-propolis with a ratio of 1: 1. 1: 1.5 and 1: 2 have significant compressive strength differences.

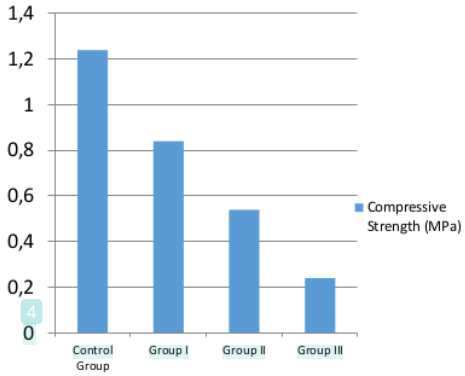

Figure 2. Diagram of research result

From the results of data analysis it was found that the combination of calcium hydroxide-propolis with a ratio of 1: 2 had a lower compressive strength than the combination of calcium hydroxide-propolis with a ratio of 1: 1.5 and a combination of calcium hydroxide-propolis with a ratio of 1: 1.5 compressive is lower than the combination of calcium hydroxide-propolis with a ratio of 1: 1. The combination of calcium hydroxide-propolis with a ratio of 1: 1 has a compressive strength lower than the control group.

DISCUSSION

In the results of the study it can be seen that the combination of calcium hydroxide-propolis with a ratio of 1: 1, 1: 1.5, and 1: 2 has a significant difference in compressive strength. The increase in the ratio of propolis to calcium hydroxide causes compressive strength to decrease significantly according to the results of the study. This is because with the increase in propolis extract in the combination of calcium hydroxide-propolis, the structure of the combination in the form of solid after the setting is affected and results in

decreased compressive strength. There are several things that can affect the compressive strength of a combination of calcium hydroxide with propolis.

In the combination of calcium hydroxide with propolis, there is a bond between molecules that occurs between hydrogen atoms aromatic compounds from propolis with oxygen atoms from water or ethanol. This bond is a weak hydrogen bond.[15] Based on phytochemical tests carried out along with the increasing number of propolis from a ratio of 1: 1 to 1: 1.5 and 1: 2, the concentration of aromatic compounds will increase. Therefore, the weaker bonds will be more so that the material structure will have lower compressive strength. In addition to hydrogen bonds, aromatic compounds in propolis have van der waals bonds with hydroxyl groups derived from calcium hydroxide and active ingredients in propolis. The van der waals bond is a weak bond and can make molecules in the material bond tightly so that it produces a weaker structure and will make the compressive strength lower.[15]

Propolis contains phenolic acid, this compound is a weak acid and is able to react with strong bases to form salt. In the combination of calcium hydroxide with propolis, phenolic acid can react with calcium hydroxide which is a strong base forming salt and water.[16] Compressive strength can also be reduced by the acid-base reaction that occurs This acid-base reaction can form salt and water. Material with a higher water level will certainly produce material with a more watery consistency, this can affect the structure of the material and ultimately reduce the compressive strength.[17] Physically, mixing with the addition of liquid propolis extract will decrease the ratio of powder: liquid and make saturated liquid which is not entirely able to react with calcium hydroxide powder to produce a less strong structure. This can ultimately make the compressive strength of the material drop.[18]

The pH of the mixture can affect the compressive strength of a material. At higher pH the material has higher surface strength and lower porosity. At lower pH, changes in material microstructure occur due to increased porosity and eventually will result in decreased compressive strength. This is because in an acidic atmosphere, OH- ions which can play a role in the initial stage hardening are disrupted.[19–21] Several studies have shown that the addition of propolis to calcium hydroxide can reduce the pH value of calcium hydroxide.[4,22,23] Therefore, there are the possibility that propolis pH can affect the compressive strength of a combination of calcium hydroxide with propolis. However, in several studies of the effect of pH on the compressive strength of material, pH can be found to have no significant effect due to the interaction of the particle content and size of complex substances in the material.[24]

From the research result, showed that increases of propolis extract in the combination will result in decreasing compressive strength. This research hasn't prove yet if pH really played role in the compressive strength of calcium hydroxide-propolis combination.

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