Difference in Porosity Value of Mata Kucing Gum Dammar and Batu Gum Dammar

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Abstract

Indonesia is an archipelago which rich in forest products that are widely distributed from Sabang to Marauke. Various kinds of resins can be found in Indonesia, e.g. gum dammar resin or gum dammar. Two types of gum dammar that have good market value were mata kucing gum dammar (MKGD) and batu gum dammar (BGD).

The aims of this study is to determine the difference in porosity value of the two gums that can be considered in the use as a dental material. The porosity test was carried out on gum samples using the Scanning Electron Microscopy based on ASTM E-986 97 and analyzed using Image-J Software. The results showed that the average of porosity values of MKGD was 3.368%, while for BGD was 12.212%. It can be stated that both of gum damar have different porosity values that batu gum dammar was higher than mata kucing gum dammar.

Experimental article (J Int Dent Med Res 2021; 14(2): 529-533)

Keywords: Mata kucing gum dammar, batu gum dammar, porosity, Scanning Electron Microscopy, Software Image-J.

Received date: 01 March 2021 **Accept date:** 18 April 2021

Introduction

Indonesia is an archipelago that is rich in forest products and is widely distributed from Sabang to Merauke. As a tropical region with biodiversity overgrown by plants and trees, making Indonesia's forests as a source of life for all living things. By storing a variety of natural resources, many things can certainly be obtained from Indonesian forest products[1].

Indonesian forest products are divided into wood forest products and non-wood forest products. According to the Minister of Forestry Regulation Number, P.35 / Menhut-II / 2007 concerning Non-Timber Forest Products, one of which can be obtained from non-timber forest products is in the form of thick liquid that comes out from open stems, leaves or skin commonly referred to as sap or scientifically called natural resin[2]. With the potential of natural resins that came by Indonesia's natural forests, making Indonesia as one of the sources of world resin producers with a diversity of types. Actually, the resin formed was an effort to protect plants. The wound on the bark of the tree due to attack by insects or tapping has quite a lot of benefits in everyday life. The type of resin is determined by the type of the tree that produces it[3].

Various kinds of resin can be found in Indonesia; recently, one of which is attention was gum dammar[3]. Gum Dammar is one type of resin that came from secretions of Dipterocarpaceace and Burseraceae families. Dammar trees grow well in various parts of Indonesia's Island such as Sulawesi, Kalimantan, Sumatra, and many more, made gum dammar become one of the potential natural resources in Indonesia [4].

Dammar is a solid resin, physiologically softer than copal[5]. This is the reason why gum dammar is more popular to be used and utilized by the wider community[6]. Resin is commonly used as industrial raw material. In the field of dentistry, the use of resin resins can be found in several materials such as varnishes and sticky wax[7,8]. Several types of resin are targeted by many people, two of them were mata kucing gum dammar/MKGD (cat's eye gum dammar) and

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batu gum dammar/BGD (stone gum dammar)[9]. Both of these resins have good quality and high selling price make gum dammar different from other types of natural resins. Currently, public known better about this and widely used in everyday life[10,11].

The difference of MKGD and BGD due to its different trees that produce and different ways of harvesting[12,13]. The difference in characteristics between two of them, make a difference in the quality also. Boer and Ella (2001) stated that the difference affects the value of its use, this can be adjusted to what product we want to produce from the gum dammar[14]. The difference can be seen i.e. from the physical properties in a variety of ways, one of which is the porosity[11,15,16].

The difference between two types of gum dammar affecting to different in properties and characteristics. Testing of certain properties can be the way to be able to find out further differences in the characteristics of the two types of gum dammar. Various types of trials can be adjusted according to the nature of what is expected in the material in its use later[9]. One of the tests conducted is to see the value of porosity[15,17].

Porosity is defined as the ratio of pore cavity volume values to the whole volume of solid material. This comparison value is expressed as a percentage[18]. The porosity of the material is influenced by the microstructure. This provides information about the distribution of material, grain size or pore, and crystalline orientation[19]. Porosity becomes a level that can determine the density of the material[20,21]. Porosity is a variable that needs to be considered as one of the parameters determining the number of fluid reserves contained in a material mass[22,23].

Porosity has the benefits provided for daily practice. Porous material widely used in practical applications such as thermal insulation, geothermal applications, cooling systems, heat exchangers, and so on[23,24]. The associated flow in porous material has been extensively studied over the past few decades and in various aspects, it has been considered for different applications. This makes the porosity of the material need to be considered before making a good raw material. Besides, the porosity of material also affect the density and durability of the material in the future[23].

In the field of dentistry, resins are widely used as a component of dental materials made from artificial resins due to unavailability of natural resin resources at mostly countries. With abundant natural resin resources in Indonesia, one of which is gum dammar, making it an advantage for developing natural resins as the raw materials for dentistry needed[9]. According to the development of science in the present, the use of Indonesian product of gum dammar, can become a new reference as a material[7]. Therefore it is necessary to do a deeper assessment of the characteristics of gum dammar.[25]. To be a material that can be utilized, especially in the field of dentistry, several things need to be considered when choosing the material used. One of them is the porosity value of materials, in this case, resin porosity values[7,19,25].

The aim of this study is to provide information about the difference in porosity values of MKGD and BGD. It can be considered and be the preliminary data for dentists when choosing the type of gum dammar that will be used as a base material and be adjusted to the needs in the field of dentistry, in the future.

This study intends to find out the difference in porosity values of MKGD and BGD.

Materials and methods

The type of this research is quasi-experimental to obtain the porosity value of MKGD and BGD. The samples were made by mata kucing gum dammar that taken from the *Shorea javanica* tree consisting of two specimens of polycadinene polymer and batu gum dammar that taken from the *Shorea sp* tree which consisted of two polycadinene polymers based on ASTM E 986 & ASTM E 562-02.

In this study, the following equipments were used *Scanning Electron Microscopy* (SEM) JSM-6510A, Software Image-J, Carbon, and Platinum. The following materials that we used are mata kucing gum dammar (MKGD) and batu gum dammar (BGD).

First step of this research was, cleaned all samples with a size of $\pm (1 \times 1 \times 1) cm^3$ which is adjusted to the size of the SEM test instrument holder. Next, coated the samples with platinum for microstructure characterization using SEM. The method of measuring porosity was done by using the Scanning Electron Microscopy (SEM) JSM-6510A and analyzed using Image-J

Software. From the SEM data, the total pore area of the sample (A_P) and the total surface area of the sample (A_{TP}) were obtained. Then the porosity can be calculated by the equation:

$$\phi = \frac{A_P}{A_{TP}} x\ 100\%$$

With an analysis using Image-J Software.

Results

The results of microstructure characterization of MKGD and BGD using SEM, can be seen on figure 1 and 2.

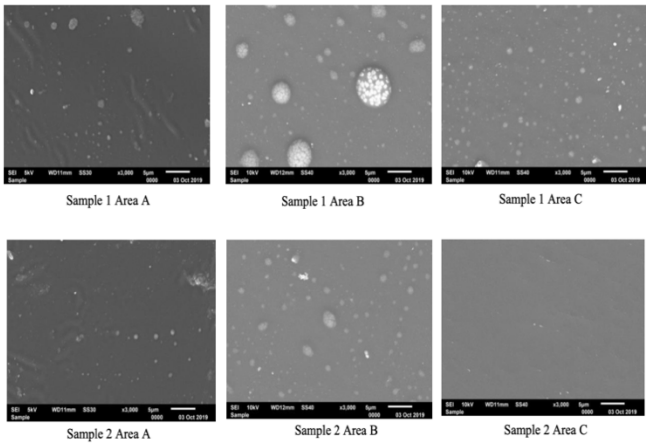

Figure 1. SEM results of mata kucing gum dammar.

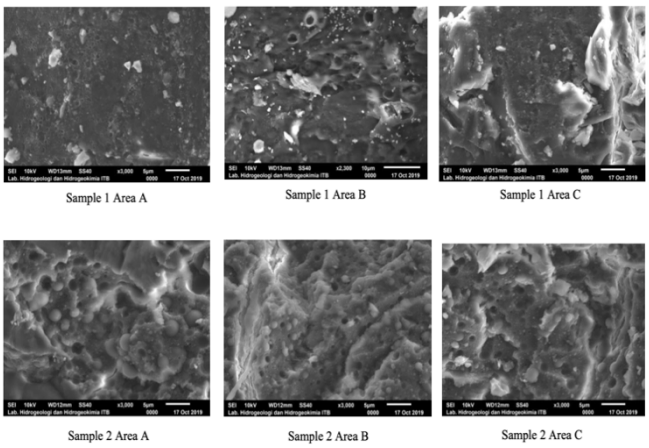

Figure 2. SEM results of batu gum dammar.

The results of porosity calculation can be seen on table 1.

Porosity of Mata Kucing Gum Dammar %			
	Sample 1	Sample 2	Average
Area A	2.558	1.800	2.179
Area B	8.163	2.704	5.434
Area C	3.812	1.171	2.492
Average	4.844	1.892	3.368

Porosity of Batu Gum Dammar %			
	Sample 1	Sample 2	Average
Area A	14.287	11.669	12.978
Area B	14.447	8.501	11.474
Area C	5.995	18.371	12.183
Average	11.576	12.847	12.212

Table 1. Porosity calculation of MKGD and BGD.

Mata Kucing Gum Dammar	Batu Gum Dammar
0.767 ± 0.326	1.000 ± 0.321

Tabel 2. Pore Size.

Discussion

Gum dammar is a material that has many benefits for everyday life including dentistry, e.g. use as a varnish mixture. This study intends to carried out the differences in porosity value of two types of gum dammar which are currently popularly and have high economic value; MKGD and BGD. By looking at the differences between these two resins, choosing the type of resin can be a consideration for later use.

Evaluation of the material better carried out at first the material will be used. By looking at the porosity value of a material, the composition and structure of the material can be more easily predicted[15]. In addition, the porosity value determined the density of a material that related to the strength of the material[20,21]. Moreover, this evaluation is carried out to strengthen the considerations to choose which type of dammar gum to be used as a dental base in particular.

MKGD from the *Shorea javanica* species was obtained through tapping and screening before trading the resin[3]. With the filtering process, this resin has a clearer colour compared to other resin types[3,26,27]. This type of resin undergoes a simple distribution process by selling directly from farmers to traders. Feintrenie and Levang (2009) stated that on merchant level, the resin is then sorted visually by colour, cleanliness, and chunk size. This properties, affects from the inside of material, also from the process of how to taking resin[27–29].

BGD has dark brown appearance that came from the wounded tree of the *Shorea sp* species. It is a fossilized sap, and this resin is obtained by taking the sap that has fallen into the soil which undergoes a natural hardening process[16,17,18]. The drops fall into clumps on the

ground, made the clods must be obtained by looking for the soil around the tree. This is the reason why this type of resin has a higher hardness than other resins[32]. The term stone refers to opaque resin, rock, or gravel collected from the ground. This also makes stone gum dammar resin appear darker than the others while other resin are yellowish in color[6,32]. This type of resin is slightly more complex and it is mixed with air and other substances in the soil.

Many researcher have studied the difference of the composition between MKGD and BGD as a commodity resin and for mata kucing gum dammar was conducted in 2005[11,26]. The results of this research showed that the ash content and acid number are still in the range of SNI for resin, while the soft point (95 - 1800 C) is different from SNI resin (95 - 1200 C)[11]. The results of the research using the blow and soak method showed that no clean resin was produced because of this method only removes dirt that is outside the sap[9]. MKGD can be purified without using solvents. In general, the physico-chemical properties of resin that are refined are still included in the Indonesian National Standard (SNI) for MKGD. However, the colour of the refined resin is still a bit dark[11,27].

The difference in the hardening process that occurs in the batu gum dammar, can be seen by many factors e.g. environmental factors such as temperature changes. A theory stated by Joseph Black (1760) became the basis for the theory of temperature change[33]. It was explained that if two kinds of substances of different temperatures are mixed, the substance with a higher temperature will release some heat as that heat will absorbed by a substance with a lower temperature[33]. If both objects work well, the amount of heat released will be the same as the amount of heat received. The Black Principle (1761) is another form of the law of conservation of energy. In general perspective, substances can be grouped into three i.e. solids, liquids, and gases. The form of a substance can change to another form. Changes in form can be caused by the influence of heat[34].

Resins can be change in shape when exposed to heat and harden when exposed to air[12,35]. This phenomenon also occurs in gum dammar. It can lead to resolve in the structure and porosity value of MKGD and BGD. The difference between both resins especially in the species that they came from and the method of taking from the tree[9]. The temperature changes that occur also can be a supporting factor for the structure and porosity value of both resins. BGD which undergoes a natural hardening process and was taken directly from the ground probably mixed with other substances and also exposed to a longer temperature, thus making the content and structure different from MKGD which is taken directly from the tree and through filtering beforehand[3,13].

The results showed that SEM micrography provides information on crystalline orientation, distribution of constituent materials, defects, grain boundaries, grain, or pore sizes which form the basis for estimating material properties. The micrographic display of SEM resin shows that the microstructure texture of SEM resin has been transmitted from pores of different sizes[20,36]. The distribution affects most of the areas in one sample area, the more even the pores are more evenly distributed. This situation has an impact on the density and porosity of the sample. The thicker the pore boundary, the greater the density while the smaller the porosity[37].

With the results obtained using SEM and after analysis using image-J software, the porosity value of MKGD resin was 3.368% and BGD resin porosity value was 12.212%. Both resins have different porosity values which were statistically significant due to different tree species and undergoes a different uptake process. With this explanation, it can be found why were MKGD and BGD have different porosity values and the difference were significant.

Conclusions

MKGD and BGD have different porosity value due to different of derived types of trees from and how to harvest. MKGD was obtained from the tapping of the *Shorea javanica* tree, while BGD is the result of the *Shorea eximia* tree. MKGD taking directly from the tree, on the contrary; BGD was obtained by taking solid resin that has fallen to the ground in the whole tree and probably has mixed with another substances. The results showed that the average of porosity values of BGD (12.212%) was higher than MKGD (3.368%). In further research this raw material can be considered in the use of Indonesian resin as a dental material.

Declaration of Interest

The authors report no conflict of interest.

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