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Comparison of brittleness and flowability between Cipetir Gutta-Percha and commercial Gutta-Percha

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ABSTRACT

Introduction: Gutta-Percha (GP) is a standard endodontic filling material found in pure form in the Cipetir area, Indonesia. However, a study comparing physical properties (brittleness and flowability) between pure GP and commercially used GP has not been found. Therefore, this study aims to test the brittleness and flowability of Cipetir GP compared to commercial GP. **Methods:** This study was quasi-experimental. Forty samples were prepared for each material and test, according to ANSI/ADA specification-GP cones-no 78 in 2006. The first step began by making a sample of Cipetir GP using moulds from a cuvette, commercial GP (Inline #80), and gypsum stone. The second step was to test the brittleness (Crease Recovery Tester) and flowability (according to ADA No. 78 of 2000) of Cipetir GP and commercial GP. **Results:** The brittleness test of Cipetir GP showed unbroken samples, and the commercial GP showed four broken samples. The Fisher's Exact test showed a p-value of 0.087, which means there was no significant difference in brittleness between Cipetir GP and commercial GP. At the same time, the average value of flowability of Cipetir GP and commercial GP were 6.46 mm and 0.19 mm, respectively. The unpaired t-test showed a p-value<0.05, which means there was a significant difference in the flowability between Cipetir GP and commercial GP. **Conclusions:** There is a brittleness similarity between Cipetir GP and commercial GP, while the flowability value of Cipetir GP is higher than commercial GP. Those initial findings showed that the Cipetir GP might become an excellent candidate to be an alternative endodontic filling.

Keywords: Cipetir gutta-percha; brittleness; flowability

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INTRODUCTION

Gutta-percha (GP) is a root canal filling material that is widely used in endodontic therapy.[1,2] GP is used as a standard filling material to replace infected pulp tissue and prevent re-infection due to bacteria.[3,4] It has minimal toxicity and irritating ability and a relatively low risk of allergy when

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stored in root canals.[5] GP has been tested for years with consistent clinical performance.[6,7] It has been produced for various purposes and from various sources.[6,8]

GP is obtained from the coagulated dry sap of a tropical plant (*Sapotaceae*), about 30 meters in height, and could be in Indonesia and other tropics countries like Malaysia, the Philippines, and Brazil. For dental practice applications, the pure GP is exported from the countries to the manufacturer, in Central South America, for production into commercial GP. That is the reason why the price of commercial GP is relatively high.[1,7]

Fabrication of pure GP to commercial GP is carried out as follows: first, the sap is boiled at 75ºC to obtain flocculated gutta (yellow gutta). The gutta is then cooled to below 0ºC and mixed with cold industrial gasoline to dissolve the resin and remaining protein. The mixture is then heated again and allowed to experience precipitation. The residual greenish-yellow solution was bleached with activated clay and filtered to remove particles and gasoline to obtain pure GP.[7,9] For use in dentistry, Pure GP (20% Gutta) is added with other components such as 56% zinc oxide, 11% sulfate, and 3% wax or resin using a special technology.[4,10,11]

Pure GP has a white form, with the composition including 75%-82% gutta, 14%-16% Alban, 4%-6% fluavil, and other compounds (salt, saccharin, and tannins).[7] Physical properties of pure GP and commercial GP, such as brittleness and flowability, are strongly influenced by their structure's type and the number of components. For example, fluavil contained in pure GP is known to produce brittleness when present in large quantities. Meanwhile, in commercial GP, zinc oxide content is responsible for the brittleness and reduces the flowability.[1,7,11,12] Currently, pure GP is widely produced in Indonesia, especially in the Cipetir area, but studies comparing the brittleness and flowability of Cipetir GP with commercial GP have not been found. Therefore, this study aims to test the brittleness and flowability of Cipetir GP compared to commercial GP.

METHODS

The type of study was quasi-experimental. First, the Cipetir GP was obtained from PT. Perkebunan Nusantara VII (Persero), and commercial GP was from Inline by BM Dentale Torino (#80 size number). Then, for the brittleness and flowability test, ten cone shapes (#80 size number) were prepared from each material and each test. Therefore, there were 40 samples in total, and then the entire preparation was according to ANSI/ADA specification-GP cones-no 78 in 2006.

The first step in this study was to prepare the cone-shaped of Cipetir GP using the following materials and tools: commercial GP (Inline #80), dental stone, vaseline, rubber bowl, spatula, cuvette, cuvette press, and heater. The dental stone was mixed with water in a rubber bowl using a spatula and then poured into the lower cuvette. Next, the commercial GP was immersed lengthwise to the half of its diameter, in order to letting the dental stone dry. Subsequently, a thin layer of vaseline smears on the dental stone surface. Next, the upper cuvette was installed and then another dental stone was poured until full. Next, the cuvette was closed and pressed with the cuvette press. Later, separate the upper and lower cuvettes, then remove the commercial GP to create a cavity. Furthermore, the Cipetir GP was heated with a heater to 65ºC, then put into a cuvette mould and pressed with a cuvette press. Finally, the cone shape of Cipetir GP was obtained.

The tools used for the brittleness test were Crease Recovery Tester (at the Centre for Research and Development of the Textile Industry, Bandung). The brittleness test was performed by placing the sample on an immovable pin with a depth of 5 mm, the other end of which was attached to a movable pin. First, the initial angle was set to 0, and later, the pin was moved 30º counterclockwise, returned to the 0º position, and then moved 30º clockwise. The movement cycle was carried out 20 times for each sample, then the broken and unbroken samples were recorded.

The tools used in the flowability test were a furnace, two glass labs with the following specification: the dimension of 40x40mm, the thickness of 5mm and weight of 20grams, a load of 100grams, a calliper, an analytical balance, a timer, and a thermometer. The test was carried out by ADA no. 78 the year of 2000; the samples were placed in a furnace at 100˚C for ten minutes, then measured with a calliper, placed between two glass labs, given a load of 100 g, then remeasured with a calliper.

RESULTS

The brittleness test resulted in the number of broken and unbroken samples. There were no broken samples for Cipetir GP. On the other hand, four samples were broken for commercial GP (Table 1).

Table 1. Brittleness test of Cipetir GP and commercial GP

Samples	Cipetir GP	Commercial GP
1	unbroken	**broken**
2	unbroken	**broken**
3	unbroken	unbroken
4	unbroken	unbroken
5	unbroken	unbroken
6	unbroken	unbroken
7	unbroken	unbroken
8	unbroken	**broken**
9	unbroken	unbroken
10	unbroken	**broken**

The Exact Fisher statistical test (Table 2) was carried out to see the significance of the results of the study above, with the hypothesis test as follows:

H_0: $X_1 \geq X_2$ The brittleness of the Cipetir GP is similar to commercial GP

H_1: $X_1 \leq X_2$ The brittleness of the Cipetir GP is different from commercial GP.

Table 2. Brittleness crosstabulation of the Exact Fisher test

Groups		Brittleness		Total	p-value
		Broken	Unbroken		
Cipetir GP	Freq	0	10	10	0.087
	Exp count	2.0*	8.0	10.0	
	%	0%	100%	100%	
Commercial GP	Freq	4	6	10	
	Exp count	2.0*	8.0	10.0	
	%	40%	60%	100%	

***two cells (50%) have an expected count of less than 5. The minimum expected count was 2.00.**

The Fisher's Exact test result suggested a p-value>0.05, thus, the H_0 was accepted, which indicated that no difference in the brittleness between the Cipetir GP and commercial GP.

Table 3 shows that the average flowability value of the Cipetir GP sample was higher than the commercial GP sample.

Table 3. The flowability test of Cipetir GP and commercial GP

Samples	Cipetir GP (mm)	Commercial GP (mm)
1	3.35	0.25
2	7.60	0.25
3	5.50	0.10
4	6.95	0.15
5	7.00	0.35
6	7.05	0.20
7	5.90	0.10
8	7.40	0.20
9	8.00	0.10
10	5.85	0.20
Average	**6.46**	**0.19**

Before statistical testing, all data groups were tested for normality to determine the data distribution. The results of the normality test can be seen in Table 4.

Table 4. Shapiro-Wilk normality test results

Groups	p-Value	
	Cipetir GP	Commercial GP
Shapiro-Wilk	0.129	0.248

The normality test with the Shapiro-Wilk test shows a p-value>0.05, which indicated that the data in the two test groups were normally distributed, therefore, it was suitable if the next comparative test carried out was an unpaired t-test.

The unpaired t-test (results presented in Table 5) was performed to analyse the significance of the study result, with the hypothesis test as follows:

H_0: $X_1 \geq X_2$ The flowability of the Cipetir GP is similar to commercial GP

H_1: $X_1 \leq X_2$ The flowability of the Cipetir GP is different from commercial GP

Table 5. Statistical analysis test of flowability value using unpaired t-test

Groups	n	Flowability average value (mm)	SD	p-value
Cipetir GP	10	6.46	1.36	0.000
Commercial GP	10	0.19	0.08	

Statistical analysis shows the p-value<0.05, which means that the H_0 was rejected, while the H_1 was accepted. This result indicated a significant difference in flowability between Cipetir GP and commercial GP.

DISCUSSION

GP is a viscoelastic material that exists in a stiff and solid state.[10] It is known as thermoplastic material which means sensitive to temperature. GP has two crystal forms, namely alpha and beta. Alpha crystals have brittle properties at room temperature, while beta crystals are stable and flexible at room temperature. The oxidation process through air and lights can cause GP to experience brittleness.[13,14]

Cipetir GP group shows unbroken samples in the brittleness test (Table 1) due to the GP having a beta phase crystal form. It possesses inherent flexibility and stability, preventing fracture when subjected to load.[7,10] The author suspects that the fluavil content in Cipetir GP is relatively small, so the material does not produce brittleness. Besides that, it can be due to moisture around the samples that may prevent them from becoming dry and brittle.[7,15]

Commercial GP, which is utilised for the cold condensation technique, also has beta phase crystalline. However, the brittleness test shows some broken samples in the commercial GP group (Table 1). The author predicted the phenomenon due to the zinc oxide content in the bodies.[1,16] Basically, adding zinc oxide to GP aims to increase thermal conductivity, but a high zinc oxide content can increase the brittleness and reduce the percentage of elongation and tensile strength. Moreover, the oxidation process in GP can be the cause that makes GP brittle. The ageing process may ruin the flexibility of some samples in the commercial GP group.[7] Based on the statistical test (Table 2), there was no difference between Cipetir GP and the commercial GP group for the brittleness characteristics. It means the Cipetir GP itself, without additives, can be one of the possible choices for endodontic filling resistant to condensation load.

Flowability is one of the important properties of endodontic filling material, which allows the material to flow over the root canal and seal the cavity under condensation load.[7] Table 3 shows that the flowability value of Cipetir GP (6.46 mm) was higher than commercial GP (0.19 mm). However, the average flowability value of the two groups was lower than the minimum standard value contained in ADA specification no 57, which was ≥ 20 mm.[17] Flowability values below 20 mm result in space in the root canal.[17] Cipetir GP and commercial GP can produce cavities when used alone in the warm vertical condensation technique. however, this shortcoming can be overcome by using the cold lateral condensation technique, which uses more than one gutta-percha to fill the root canal.[7,12,14]

Table 4 and Table 5 show the statistical result of the flowability test in both groups. The higher statistical flowability of Cipetir GP was influenced by the higher gutta content (75-82%). Gutta plays a role in producing elasticity and plasticity properties when the temperature changes. On the other hand, the value of flowability in commercial GP is minimal, and it is due to the high amount and large particle size of zinc oxide contained in commercial GP.[7]

This study has several limitations, including the absence of characteristic data from Cipetir GP that can support the brittleness and flowability test results. Therefore, it is suggested that further research is needed regarding the characteristics, mechanical, and biological properties to become the basis for the development of Cipetir GP research as a domestically made endodontic filling material.

CONCLUSIONS

There is a brittleness similarity between Cipetir GP and commercial GP, while the flowability value of Cipetir GP is higher than commercial GP. Those initial findings showed that the Cipetir GP might become an excellent candidate to be an alternative endodontic filling.

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