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Research Report

The cleanliness differences of root canal irrigated with 0.002% saponin of mangosteen peel extract and 2.5% NaOCl

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ABSTRACT

Background: *Root canal treatment consists of preparation, sterilization, and obturation. During root canal preparation, debris is smeared over the dentinal surface forming a smear layer. Smear layer will reduce the attachment of root canal filling materials. Organic material in smear layer can be substrated for microorganism. Preparation of root canal should be followed by irrigation. NaOCl is common irrigation solution in endodontics. It has been very effective for their disinfecting and tissue-dissolving properties, but it is incapable of removing the smear layer. On the other hand, saponin of mangosteen peel extract has an ability as a surfactant to lower the surface tension, and it can dissolve debris containing of anorganic and organic materials.* ***Purpose:*** *This study aims to know the differences between 2.5% NaOCl and 0.002% saponin of mangosteen peel extract in removing the debris in the root canal after the preparation procedure.* ***Method:*** *Three groups of teeth (7 teeth in each) were instrumented with K-file and irrigated as follow: group 1 (control) with aquadest; group 2 with 2.5% NaOCl; and group 3 with 0.002% saponin of mangosteen peel extract. Furthermore, those teeth were split horizontally and longitudinally 4mm above the apical. The apical third of root canal walls was observed by a scanning electron microscope (SEM).* ***Result:*** *There were significant differences between each group ($p<0.05$). Median value of the group 3 was score 1 considered as the smallest value. It indicates that Group 3 with 0.002% saponin of mangosteen peel extract was the cleanest group.* ***Conclusion:*** *It can be concluded that 0.002% saponin of mangosteen peel extract can clean the smear layer of the root canal better than 2.5% NaOCl.*

Keywords: *Saponin; mangosteen peel extract; NaOCl; debris*

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INTRODUCTION

Endodontic treatment is a procedure to maintain teeth for long time, consisting of three main steps of preparation, sterilization, and obturation. One of the primary reasons for irrigating root canal is to ensure the cleanliness of the canals prior to obturation. This cleanliness involves both elimination of microorganisms and removal of organic matter.[1] The procedure of root canal preparation can produce smear layer, involving organic material, odontoblastic processes, bacteria and blood cells. The presence of an infected smear layer may prevent antimicrobial agents from gaining access to the infected dentinal tubules. Increased penetration of smear material into dentinal tubules may cause the reduction of surface tension of irrigants during instrumentation. Removal of the smear layer may enhance the penetration of sealers into dentinal tubules and the adaptation of obturation materials to the root canal walls.[2,3]

Several irrigants and irrigant delivery systems are available, which behave differently and have relative advantages and disadvantages. Common root-canal irrigants consist of sodium hypochlorite (NaOCl), chlorhexidine gluconate, alcohol, hydrogen peroxide and ethylene diamine tetra acetic acid (EDTA).[4] However, the most effective and commonly used is NaOCl. They have a unique ability to dissolve necrotic tissue and organic components of the smear layer. In general, the concentration

of NaOCl commonly used is 2.5%, since this concentration has the ability to dissolve the tissue and has the power as antibiofilm.[5] Nevertheless, NaOCl also has some negative effects. NaOCl has a toxic effect on the tissue, and can cause allergic reactions.[6] NaOCl is alkaline and corrosive to metals that can damage the instrument used. Thus, NaOCl cannot dissolve inorganic dentin particles and cannot prevent the formation of smear layer during instrumentation process.[4] NaOCl solution can cause pain to the periapical tissues and swelling spontaneously.[5]

Mangosteen fruit has the latin name *Garcinia mangostana L. Mangosteen* is being used to heal diarrhea, tonsillitis, whitish, dysentery and toothache. Mangosteen peel can be used as a medicine for ulcers, dysentery, diarrhea and uric acid.[8] Methanol extract of mangosteen peel (*Garcinia mangostana L.*) contain saponin, triterpenoids, tannins, polyphenols, flavonoids and alkaloid.[9] Mangosteen peel consists 1.82% of saponin.[10] Due to the presence of a lipid-soluble aglycone and water-soluble sugar chain in their structure (amphiphilic nature), saponin is surface active compound with detergent, wetting, emulsifying, and foaming properties, so saponin can dissolve the organic and inorganic debris of dentin.[11] Therefore, this study aims to study the effects of saponin extract of mangosteen peel on the cleanliness of the root canal walls.

MATERIALS AND METHODS

This study is a laboratory experimental research with post-test only control group design. Twenty-one mandibular premolars were extracted for orthodontic treatment with the provisions of a single root canal with apical tip that has grown perfectly by inserting files no. 15 due to the working length. It means that the root canal had to be straight without any caries, restoration, and obstruction.

The teeth were stored in isotonic saline solution to avoid any effect that fixative might have on the dissolution of organic tissue then randomly selected and divided in the three groups. Access opening was done with endo access bur, and working length was determined. Afterwards, root canals were prepared using a needle K-File no. 15 to no. 60 using standard techniques. Each sample was irrigated by 3 ml of treatment solution with a pressure of 1 atm using irrigation needle 27 G. After irrigated, root canals were rinsed with aquadest to stop the chemical process. Root canal wall was dried with paper points 3 times, and then cotton pellets were put at the orifice and closed with temporary seals. All roots were grooved longitudinally on the buccal and lingual surfaces, and horizontally at the apical third (4 mm from apex) with a small round diamond bur, avoiding penetration into the cavity. The roots were then split longitudinally with a small chisel into two halves. Roots that have been cut were placed on the sample holder, and coating process was performed.

All specimens were examined using Hitachi TM 3000 scanning electron microscope (SEM) with 1000x magnification at the apical third. Scoring was performed by three observers. Assessment of the cleanliness of the root canal was then conducted with transparent plastic tools divided into 12 fields. Transparent plastic was attached to a picture, and an assessment was determined by the percentage for each field. The percentage results were averaged and converted into a score.

Superficial debris was independently subjected to a standardized semiquantitative evaluation in four grades based on the classification of Gutmann *et al.* (1994). Criteria for the scoring were as follow: score 1: little or no superficial debris covering up to 25% of the specimen; score 2: little to moderate debris covering between 25 and 50% of the specimen; score 3: moderate to heavy debris covering between 50 and 75% of the specimen; and score 4: heavy amounts of aggregated or scattered debris over 75% of the specimen.

The data were processed and analyzed using a frequency test to determine the median of each treatment group, and also a non-parametric test, Kruskal-Wallis test, to determine differences between groups of aquadest (control), saponins, and NaOCl. Mann-Whitney test was conducted to determine the differences between the treatment groups.

RESULTS

There were 7 pieces of tooth samples with 0.002% saponin extract of mangosteen peel median with median score 1. It indicates that there was little or no superficial debris covering up to 25% of the specimen. Meanwhile, the score of the group with 2.5% NaOCl was 2. It means that there was little to moderate debris covering between 25% and 50% of the specimen. And the score of the group with aquadest (control) was 3. It indicates that there was moderate to heavy debris covering between 50 and 75% of the specimen (Table 1).

Table 1. The results of frequency test in each group

No.	Group	N	Median	SD
1.	Aquadest (control)	7	3	0.48795
2.	2.5% NaOCl	7	2	0.53452
3.	0.002% Saponin extract of *mangosteen peel*	7	1	0.53452

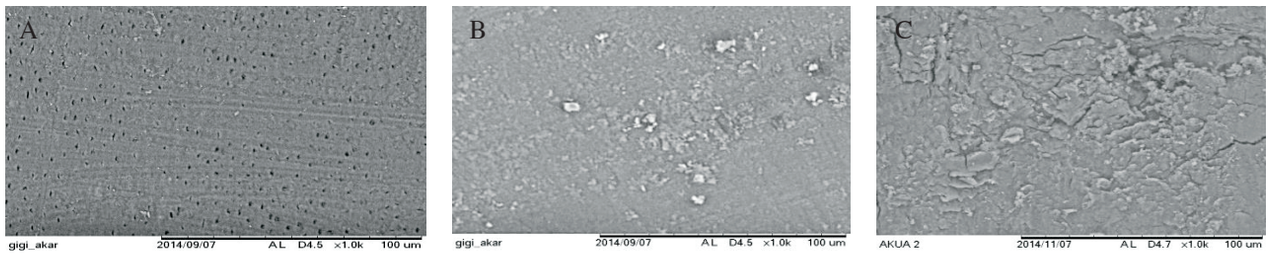

Figure 1. The results of SEM with 1000x magnification on the root canal walls irrigated with (a) 0.002% saponin extract of mangosteen peel; (b) 2.5% NaOCl; (c) aquadest (control).

Furthermore, the results of Kruskal-Wallis test showed that there were significant differences between the root canal wall cleanliness irrigated with aquadest water group (control), 2.5% NaOCl and 0.002% saponin extract of mangosteen peel ($p<0.05$). Mann-Whitney test showed that there was a significant difference between the root canal wall cleanliness of the two groups, aquadest (control) and 2.5% NaOCl, about 0.015 ($p<0.05$). There was also a significant difference between the root canal wall cleanliness of the two groups, aquadest (control) and 0.002% saponin extract of mangosteen peel, about 0.001 ($p <0.05$). And, there was a significant difference between the root canal wall cleanliness of the two groups, 2.5% NaOCl and 0.002% Mangosteen peel extract, about $p=0.010$ ($p<0.05$). Finally, further analyzing of the data was conducted using the scanning electron microscope photomicrograph (SEM) with the results as shown on Figure 1.

DISCUSSION

The main purpose of irrigation is generallly to clean root canal prior to obturation and also to eliminate microorganisms and organic components. Based on previous researches, it can be said that 41.5% of researchers support the cleaning process because the smear layer can block the filling materials contacting with the root canal wall. Organic debris of the smear layer even can became the media for growth of bacteria.[12]

The most effective irrigation material often used is NaOCl. NaOCl has a good antibacterial ability. As a lubricant, NaOCl can remove the organic debris and smear layer on root canal. However, NaOCl has some disadvantages because it has a toxic effect on the periapical tissue and can cause allergic reaction.[4]

Saponins in mangosteen peel contains approximately 1.82% surfactant properties, often referred to as natural detergent. Surfactant properties due to the non-sugar group can be called sapogenin. Sapogenin which have both hydrophilic and lipophilic groups are able to lower surface tension to function as detergents, emulsifiers, wetting and foaming, consequently, it can dissolve impurities, such as organic and inorganic debris dentin.[10]

Thus, this study was conducted to analyze the differences of 0.002% saponin extract of mangosteen peel and 2.5% NaOCl in cleaning debris on the surface of the root canal walls. The examination of debris was conducted through a laboratory research using SEM. The results of SEM were evaluated with the photomicrograph using the criteria of how much debris covering the walls of the root canal. The apical third was then selected since this section is smaller than the other parts, so the root canal debris can be more easily buried in this part.[13]

The results of SEM photomicrograph assessment showed a little debris on the surface of the root canal walls and plenty of opened dentin tubules on the canal walls irrigated by 0.002% saponin extract of Mangosteen peel. Meanwhile, the surface of the root canal wall and dentin tubules irrigated with 2.5% NaOCl were covered with debris, and opened dentin tubules were rarely seen.

In addition, 0.002% saponin extract of mangosteen peel was better in cleaning debris on the canal wall because it has surfactant effects able to bind impurities, such as organic and inorganic debris. Surfactants can clean up by lowering the surface tension of the root canal wall covered with debris, consequently, the surface was wetted. Saponins particles, as a result, can penetrate into the dentin tubules and bind with debris to form an emulsion in water, and then the emulsion will be held in suspension to be carried out by the water, so root canal debris will be removed and the dentin tubules will be opened.[14]

Saponins can remove organic debris because it has a lipophilic group which can bind impurities, such as fat. Saponins then form a stable emulsion that can be dispersed into water, so the debris will be carried out by irrigant. Saponins also can remove inorganic debris because its hydrophilic group can bind Ca^{2+} ions in the root canal wall that contains of hydroxyapatite, so saponins can remove organic and inorganic debris of root canal wall.[3]

The group irrigated with 2.5% NaOCl showed poor results compared to the group irrigated with 0.002% saponin extract of mangosteen peel. This is because NaOCl does not have any ability to clean up inorganic debris. This irrigant actually has a chemical reaction stage only with organic materials, namely saponification reaction. Dissolved organic will be formed when the saponification reaction

breaks down organic matter and fats into fatty acids (soaps) and glycerol (alcohol), so NaOCl only can clean debris of organic materials and does not have any ability to clean the inorganic debris materials.[4] Finally, the control group irrigated with aquadest was the dirtiest group with a lot of debris since aquadest does not have any ability to remove debris, but merely as a rinse. In conclusion, 0.002% saponin of mangosteen peel extract can clean the smear layer of the root canal better than 2.5% NaOCl.

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