Effectiveness of Moringa oleifera leaf extract nanoparticles in cleaning smear

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Abstract

Objective: To evaluate the cleanliness smear layer on the apical third of the root canal wall in teeth irrigated with 5% and 10% Moringa leaf extract nanoparticles. Material and Methods: This study is an experimental laboratory with a posttest control group design. A total of 30 mandibular permanent premolars were decorated to an average tooth length of 13 mm. The teeth were divided into 5 groups, with 6 samples per group, and each sample was irrigated with 5 ml for 5 minutes. Group 1 (negative control) was irrigated with sterile aquadest, group II (positive control) was irrigated with NaOCl 5.25%, group III (positive control) was irrigated with NaOCl 5.25% and EDTA 17%, group IV (test group) irrigated with Moringa leaf extract nanoparticles 5%, and group V (test group) irrigated with Moringa leaf extract nanoparticles 10%. All samples were tested for cleanliness of the smear layer on the apical third of the root canal wall using a confocal laser scanning microscope.

Results: Average score cleanliness of the smear layer on the apical third of the root canal wall the highest are groups IV and V but not significantly different from group III. Groups IV and V were significantly higher than groups II and I, while the lowest was group I. Conclusion: Moringa leaf extract nanoparticles of 5% and 10% were effective in cleaning the smear layer on the apical third of the root canal wall.

Keywords: Apical, Moringa oleifera, Nanoparticles, Root Canal, Smear layer

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Introduction

The success of endodontic treatment can be influenced by the cleanliness of the root canal from smear layers. The smear layer is an irregular amorphous layer formed during root canal preparation. Its existence is often discussed because it is one of the factors in the failure of endodontic treatment. It is because of smear layer that can reduce dentin permeability, inhibit the penetration of intracanal disinfectants and medicaments and prevent sealer materials from entering the dentinal tubules.

Some researchers suggest that the smear layer should be removed using irrigating material, especially in the most critical area, like the apical third of the root canal wall, because the shape, dimensions and character of the instrument do not match the anatomy of the root canal, so it is not optimally prepared. Irrigation materials often used in endodontic treatment are sodium hypochlorite (NaOCl) and ethylenediaminetetraacetic acid (EDTA). The combination of NaOCl and EDTA effectively removes the smear layer. This is due to the ability of NaOCl as an antibacterial and dissolving organic components and EDTA’s ability to dissolve inorganic components. However, using both irrigation materials is weak because NaOCl is toxic to periapical tissue and has an unpleasant aroma and taste.

The side effect of these irrigation materials is a reason for using innovative natural ingredients as an alternative irrigation material, such as Moringa leaf (Moringa oleifera). Moringa leaves are antibacterial, low toxicity, and contain saponin compounds that act as surfactants. Surfactants can reduce surface tension which can remove organic and inorganic tissues, so they can potentially remove the smear layer.

The effectiveness of the pharmacological content of Moringa leaves is considered more safe to use because it is obtained directly from the plant extract. However, it turns out that the extract preparation has a weakness; its bioavailability decreases. One way to increase the bioavailability of Moringa leaf active compounds is to make solid colloidal particles in the form of nanoparticles diameter of 1-100 nm, which is expected to increase the absorption of the pharmacological benefits of Moringa leaves. Based on this background, it is known that Moringa leaf extract nanoparticles contain saponins which have surfactant properties, so further research is needed to determine the effectiveness of Moringa leaf extract nanoparticles as an alternative root canal irrigation material. It is hoped that the results of this study can provide information about the benefits and potential of Moringa leaf extract nanoparticles as an irrigation solution in removing the smear layer on the apical third of the root canal wall.

Material and Methods

This research uses Moringa leaves which are processed into extracts first by maceration method using ethanol 96% as solvent. Moringa leaf extract was reduced to a mass in 96% as solvent. Moringa leaf extract was precipitated to obtain a mass in nanometer scale and contain saponin compounds that act as surfactants. Surfactants can reduce surface tension which can remove organic and inorganic tissues, so they can potentially remove the smear layer. The combination of NaOCl and EDTA effectively removes the smear layer. This is due to the ability of NaOCl as an antibacterial and dissolving organic components and EDTA’s ability to dissolve inorganic components. However, using both irrigation materials is weak because NaOCl is toxic to periapical tissue and has an unpleasant aroma and taste.

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Results

Sample observations were assessed based on a scoring system. The data can be seen in figure 1 and figure 2.

The Moringa 5% and 10% (1.00) groups showed the effectiveness of the Moringa leaf extract nanoparticle irrigation solution in remove smear layer on the apical third of the root canal wall. This is clearly seen in the diagram below, both groups are lower when compared to the aquadest steril group (4.67), NaOCl 5.25% (3.67) and a combination of 5.25% NaOCl and EDTA 17% (1.17).

Based on the research data, Shapiro-Wilk normality test analysis was carried out to determine the distribution of the sample. The test results obtained a significance value of <0.05, indicating that the data is not normally distributed.

Furthermore, a non-parametric test was conducted using the Kruskal-Wallis test to determine the differences in all groups. The results of statistical calculations from the test obtained p value <0.05. This shows that there are significant differences between groups.

The next test is Mann Whitney test to determine the differences between each group. The test results obtained significant differences in each group. The smaller the median value, the better the results obtained. The smallest median value (1.00) was found in the combination group of NaOCl 5.25%, EDTA 17%, and Moringa leaf extract nanoparticles 5% and 10%. This indicated that the three groups effectively cleaned the smear layer on the apical third of the root canal wall.
Discussion

This study used aquadest steril, NaOCl 5.25% and a combination of NaOCl 5.25% and EDTA 17% as the control group and Moringa leaf extract nanoparticles 5% and 10% as the test group. The concentration was taken based on the Minimum Inhibitory Concentration (MIC) test that had been carried out previously. Moringa leaf extract nanoparticles 5% and 10% gave good results in removing smear layer with an average value of 1.00. The results showed that 5% and 10% Moringa leaf extract nanoparticles were better than NaOCl 5.25% but almost the same result as the cleaning effectiveness of NaOCl 5.25% and EDTA 17% combination. This shows that Moringa leaf extract nanoparticles are able to remove the smear layer because they contain phenolic acid compounds and saponins. Phenolic acid in Moringa leaves is a weak acid compound when in contact with root canal walls, will decompose hydroxyapatite and release calcium ions (Ca²⁺) and hydrogen (HPO₄²⁻) soluble in water and demineralization occurs. The more acidic material, the more dissolved hydroxyapatite. Saponins in Moringa leaves are by 14.92% with the ability to reduce surface tension and also function as emulsifiers, cleansers, and soaps that can remove organic and inorganic debris from dentin.17-19 Ramadhani et al.20 also stated that the surfactant’s ability to play an active role in reducing the cohesive strength of smear layer particles and increasing the adhesion strength between the saponins and smear layer so as to reduce the surface tension between smear layer and the root canal wall. This ability occurs because of the hydrophilic and hydrophobic groups in saponins. The hydrophilic group binds to organic polar smear layer compounds, while the hydrophobic group binds to inorganic non-polar smear layer compounds. The hydrophilic group attracts water molecules, while the hydrophobic group binds to the smear layer. During the root canal cleaning process, the smear layer is absorbed into a substance that is dispersed and dissolved in water. Furthermore, the hydrophobic group dissolves in water to form foam and binds the smear layer to become an emulsifier, and when turbulence occurs, the smear layer is carried out of the root canal.20-22

The data from this study showed that Moringa leaf extract nanoparticles 5% and 10% showed the best effectiveness in removing the smear layer on the apical third of the root canal wall when compared to other groups. This is because apart from the phenolic acids and saponins in Moringa leaves, it is also due to the smaller particle size despite low concentration. This is comparable to the results of the meta-analysis. Herbal ingredients such as Morinda citrifolia extract and oregano were also more effective in removing the smear layer than EDTA. That oregano extract as an alternative herbal ingredient for root canal irrigation was able to remove the smear layer on the coronal, middle and apical thirds of the root canal wall, but it was more effective and optimal if the oregano extract was combined with EDTA because the effects other than the smear layer were lost also does not cause erosion of the root canal walls.

Moringa leaf extract nanoparticles 5% and 10% were best at removing the smear layer in the apical third of the root canal wall, also affected by particle size of the nanoparticles used in this study. The advantages of nanoparticles with a size of less than 100 nm make the effectiveness and efficiency of the material work more optimally when compared to the particle size in the extract, which tends to be larger (micro and macro particles). Therefore, the nanoparticles in this study can be developed as an alternative irrigation material because they affect the solubility of organic and inorganic smear layers in the apical third of the root canal wall.

The effectiveness of Moringa leaf extract nanoparticles 5% and 10% produced insignificant values (p=0.001 or p>0.05). Statistically the difference is insignificant, but when the CLSM test gives an overview of the number of different smear layers. This is because the viscosity of the solution is affected by concentration. The lower the viscosity of the solution, the higher the flow rate so that it can penetrate deeper and narrower areas of the root canal wall.16

Although 5% and 10% Moringa leaf extract nanoparticles have the same ability to remove the smear layer on the apical third of the root canal wall, however, when used as an irritant, it is recommended that 5% Moringa leaf extract nanoparticles be used. This is because the concentration has a relatively minimal risk of agglomeration, so that the ability of bioavailability as an alternative irrigation solution is quite maximal. In addition, using the main ingredients and operational costs in manufacturing irrigation solutions are also other considerations so that 5% Moringa leaf extract nanoparticles are quite effective and efficient in removing the smear layer on the apical third of the root canal wall.

Conclusion

Based on the results of the study, it can be concluded that Moringa leaf extract nanoparticles 5% and 10% were significantly more effective in removing the smear layer on the apical third of the root canal wall compared to NaOCl 5.25% but almost as effective in cleaning as the combination of NaOCl 5.25% and EDTA 17%.
Acknowledgment
None

Conflict Of Interest
The authors report no conflict of interest.

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