RESEARCH PAPER

Effect of Chemical and Herbal Disinfectants on the Surface Roughness of Gutta-Percha Cones: An In Vitro Study

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ABSTRACT

Aim: To evaluate the effect of chemical and herbal disinfectants on the surface roughness of gutta-percha cones.

Materials and Methods: Eighty F3 ProTaper gutta-percha cones were randomly divided into five groups (n = 16): control, lemongrass oil, basil oil, licorice oil, and 2.5% sodium hypochlorite. Antimicrobial activity of the herbal extracts was assessed against *Enterococcus faecalis* using the agar diffusion test. The cones were immersed in the respective disinfectants for 5 minutes and evaluated under scanning electron microscopy at 100× and 300× magnifications. Surface changes were categorized as mild, moderate, severe, or no changes. Statistical analysis was performed using the Chi-square test.

Results: The control group showed no surface alterations. Sodium hypochlorite produced predominantly moderate surface changes. Licorice oil exhibited minimal surface alterations, whereas lemongrass oil and basil oil caused severe surface changes in most samples. The differences among the groups were statistically significant ($p < 0.001$).

Conclusion: The type of disinfectant significantly influences the surface roughness of gutta-percha cones. Licorice oil demonstrated minimal surface alterations and may be considered a safer herbal alternative for chairside disinfection.

Keywords: Gutta-percha; Surface roughness; Herbal disinfectants; Licorice oil; Sodium hypochlorite; Scanning electron microscopy

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Introduction

Successful endodontic therapy depends on effective elimination of microorganisms from the root canal system and prevention of reinfection during obturation. Gutta-percha remains the most widely used obturating material due to its biocompatibility and handling properties. Although commercially supplied in sealed packages, gutta-percha cones are susceptible to contamination during storage and clinical handling.[1]

Conventional heat sterilization methods cannot be used for gutta-percha because of its thermoplastic nature, making chairside chemical disinfection essential.[2] Various disinfecting solutions such as sodium hypochlorite have been advocated for this purpose. However, these agents may alter the surface characteristics of gutta-percha cones.

Surface roughness is a critical factor as it can influence the adaptation of gutta-percha to canal walls and its interaction with sealers. Increased surface irregularities may compromise the apical seal and increase the risk of microleakage.[2] Recently, herbal alternatives such as lemongrass oil , basil oil and pure Licorice oil have gained attention due to their antimicrobial properties and presumed biocompatibility.

This study focuses exclusively on evaluating the effect of different disinfectants on the surface roughness of gutta-percha cones.

Materials and Methods

Sample Selection

A total of 80 standardized gutta-percha cones (size F3 ProTaper) were obtained from sealed manufacturer packs under aseptic conditions.

Grouping

The cones were randomly divided into five groups (n = 16):

- **Group I:** Untreated control group

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- **Group II**: Lemongrass oil
- **Group III:** Basil oil
- **Group IV:** Pure Licorice oil.
- **Group V:** Sodium hypochlorite (2.5%)

Preparation of samples

Fresh lemon grass and basil leaves were collected, washed and oil was extracted using distillation procedure (Sanghavi Labs Private Ltd., Anjangaonsurji, MH, India), and stored in sterile bottles till use. Ten grams of dried licorice root were coarsely powdered and infused in 100 mL of coconut oil using a double-boiler method at low temperature (below 100 °C) for 45–60 minutes with intermittent stirring. After cooling, the preparation was filtered through muslin cloth and stored in sterile bottles till use. **(Figure 1)**

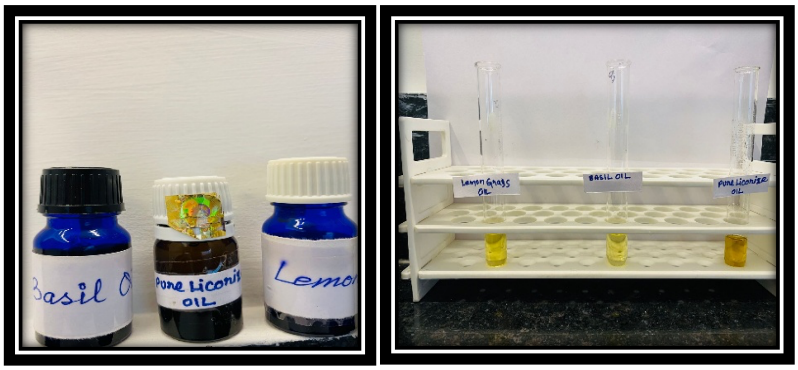

Figure 1: Preparation of the extracts

Evaluation of Antimicrobial activity with agar diffusion test of herbal extracts

Antimicrobial activity of the liquid samples was evaluated using the agar well diffusion technique against *Enterococcus faecalis* ATCC 29212. The organism was cultured on Brain Heart Infusion (BHI) agar, and a single colony was grown in BHI broth at 37 °C for 18–24 h. The culture was adjusted to a 0.5 McFarland standard (1 × 10^8 CFU/mL). Mueller–Hinton agar plates were inoculated to obtain a uniform bacterial lawn, and 6 mm wells were aseptically prepared. Each well received 10 µL of basil, liquorice, sodium hypochlorite, or lemongrass extract. Plates were incubated at 37 °C, and inhibition zones were measured at 24 and 48 h. **(Figure 2)**

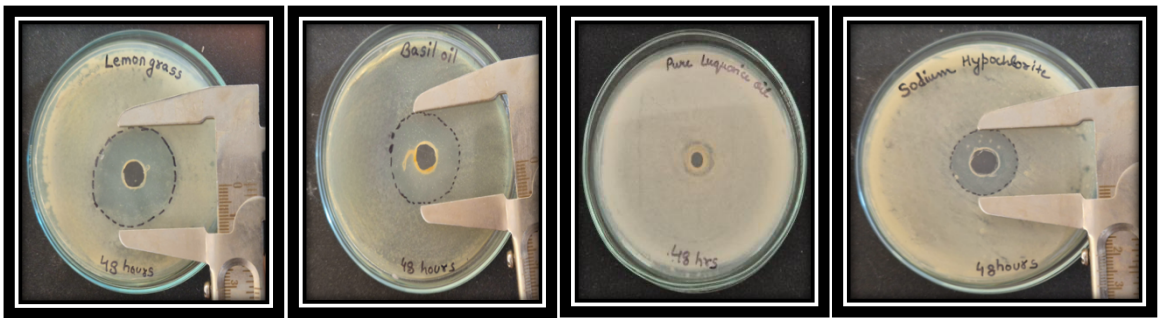

Figure 2: Antimicrobial activity of herbal extracts

Disinfection Procedure

Each experimental group was immersed in the respective disinfecting solution for 5 minutes. Following disinfection, the cones were rinsed with sterile distilled water and dried on sterile filter paper. The control group received no treatment. **(Figure 3)**

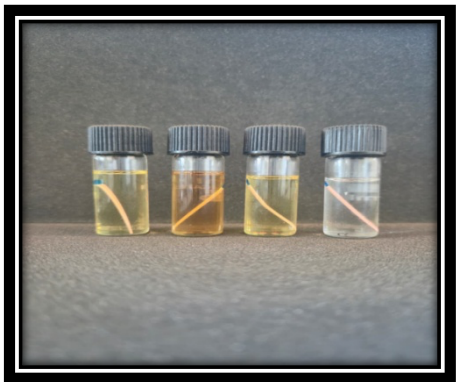

Figure 3: Immersion of samples into herbal and chemical solutions

Surface Roughness Evaluation

The surface topography of the gutta-percha cones was examined using a Scanning electron microscope at 100× and 300x magnification. The cones were evaluated for surface irregularities such as pitting, erosion, and roughness and categorized as mild, moderate, severe, or no changes. **(Figure 4)**

Figure4: (a) Gutta percha cones placed for gold plating, (b) Scanning electron microscope

Statistical Analysis was carried out using Chi- square test to compare the changes seen on the surface of the gutta percha cones between the groups. P value <0.05 was regarded as statistically significant. The tabulated results are given in **Table**

Results

Group	Mild n (%)	Moderate n (%)	Severe n (%)	No Changes n (%)	Total
Group 1 (Control)	0 (0%)	0 (0%)	0 (0%)	16 (100%)	16
Group 2 (NaOCl)	2 (12.5%)	12 (75%)	2 (12.5%)	0 (0%)	16
Group 3 (Licorice oil)	11 (68.75%)	3 (18.75%)	0 (0%)	2 (12.5%)	16
Group 4 (Lemongrass oil)	0 (0%)	5 (31.25%)	11 (68.75%)	0 (0%)	16
Group 5 (Basil oil)	0 (0%)	6 (37.5%)	10 (62.5%)	0 (0%)	16

Table 1: Distribution of the groups based on the changes seen.

A statistically significant difference was observed between the groups ($\chi^2 = 58.74$, df = 12, $p < 0.001$).

The control group showed no surface alterations in all samples. Sodium hypochlorite demonstrated predominantly moderate surface changes (75%) with additional mild and severe alterations. Licorice oil showed the least surface damage among the experimental groups, with the majority of samples exhibiting only mild changes. Lemongrass oil and basil oil produced severe surface alterations in 68.75% and 62.5% of samples respectively, indicating greater surface deterioration compared to other disinfectants. **(Figure 5-9)**

Figure 5: *SEM images of gutta percha cones in Control group under 100X and 300X*

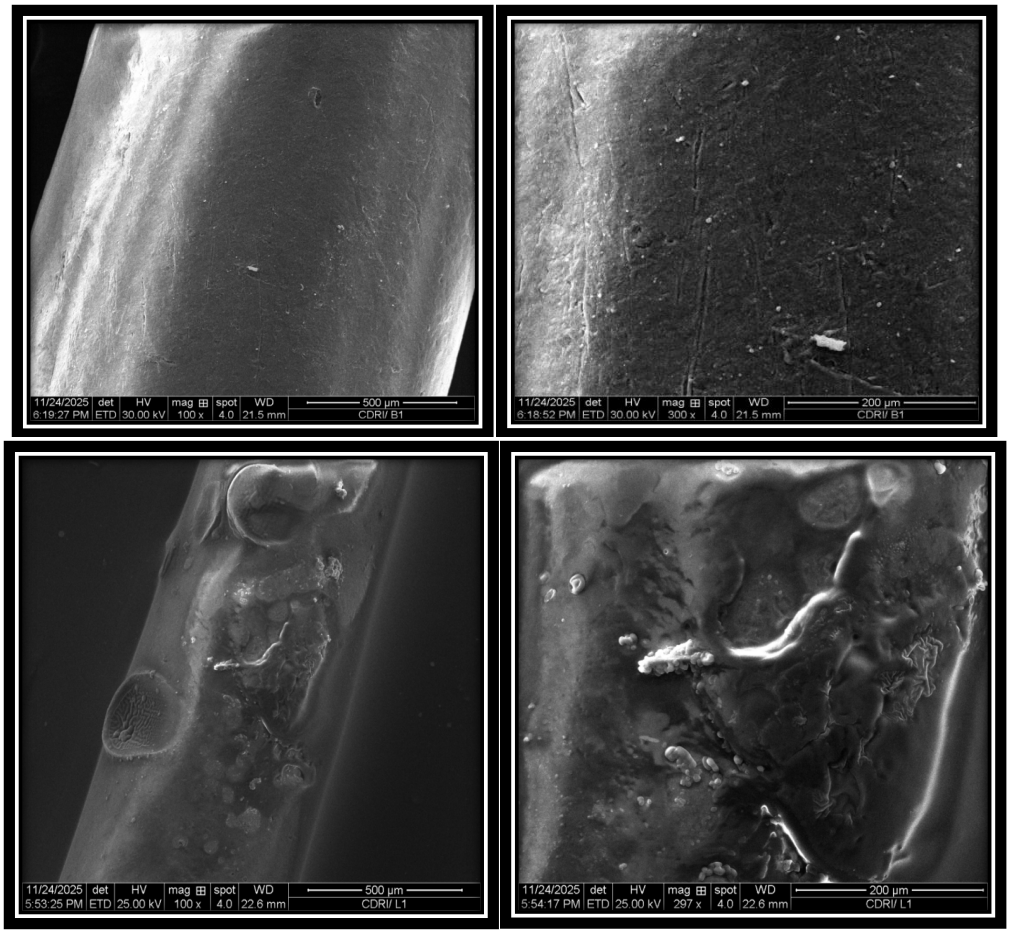

Figure 6: *SEM images of gutta percha cones in Lemongrass oil under 100X and 300X*

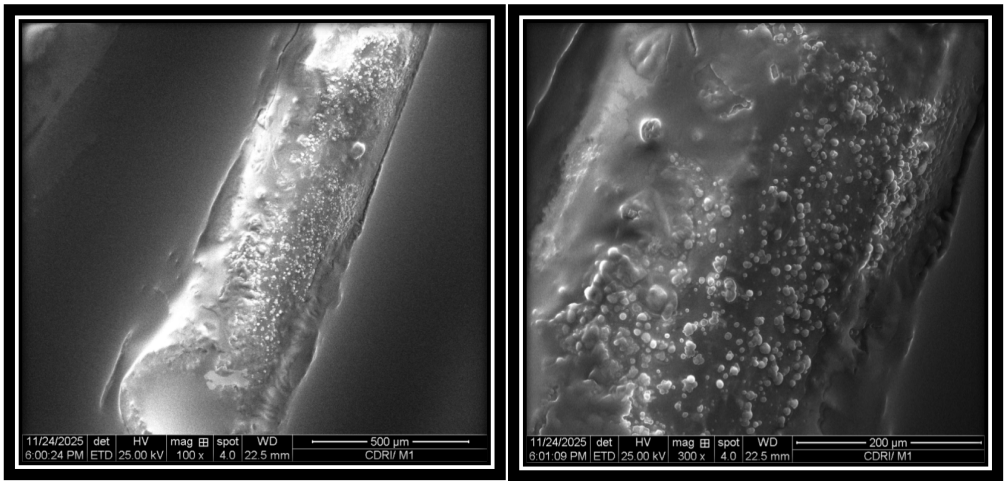

Figure 7: *SEM images of gutta percha cones in Basil oil under 100X and 300X*

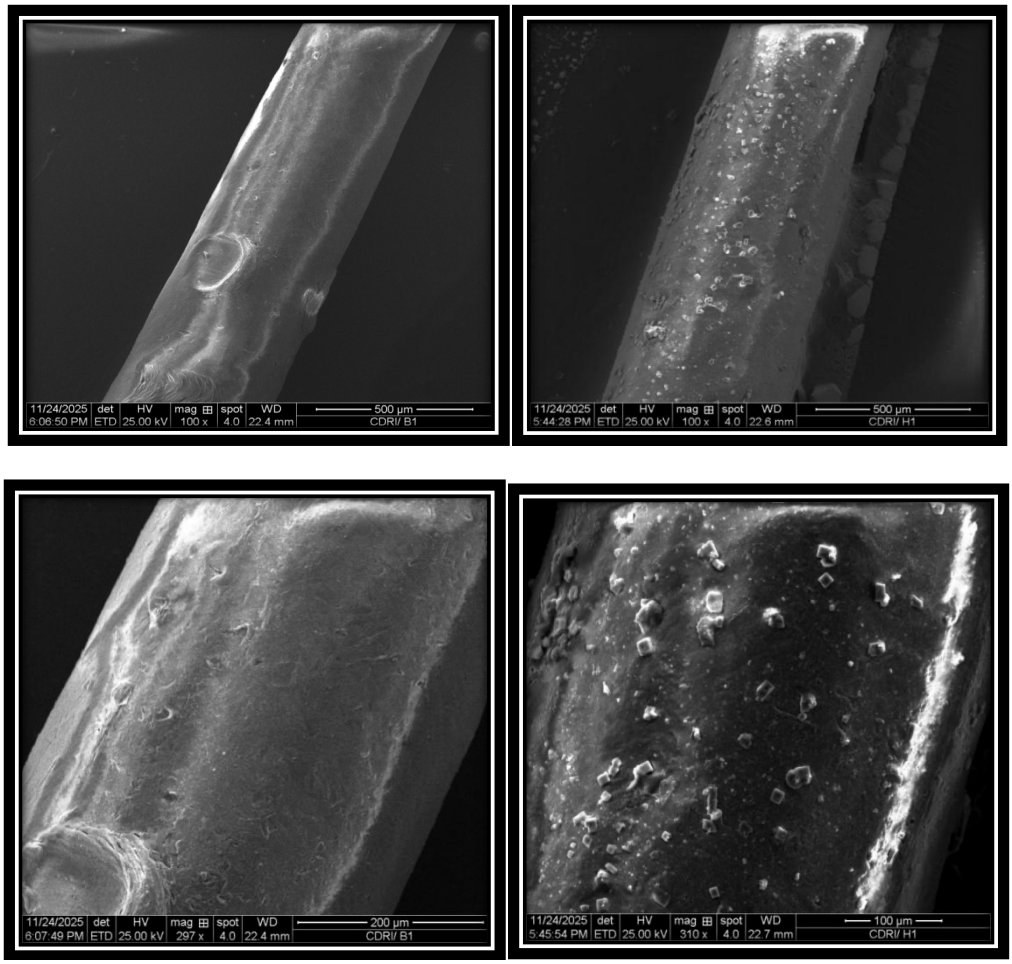

Figure 9: *SEM images of gutta percha cones in Sodium hypochloride under 100X and 300X*

Discussion

Surface alteration of gutta-percha cones following chairside disinfection is of clinical importance, as excessive changes in surface topography may adversely affect cone adaptation, sealing ability, and ultimately the success of root canal obturation. In the present study, statistically significant differences were observed among the tested disinfectants ($p < 0.001$), indicating that the type of disinfecting agent plays a crucial role in preserving the surface integrity of gutta-percha cones.

The control group demonstrated no surface alterations, confirming that the changes observed in the experimental groups were attributable to the disinfecting agents rather than handling or environmental contamination. Similar findings have been reported by Pang et al., who emphasized that gutta-percha cones taken directly from sealed packets exhibit minimal surface irregularities under SEM evaluation[1].

Sodium hypochlorite showed predominantly moderate to severe surface alterations in the present study. These findings are consistent with earlier reports demonstrating that NaOCl, particularly at higher concentrations, causes surface pitting, crystal deposition, and structural degradation of gutta-percha cones[2,3]. Pang et al. observed significant surface irregularities and reduction in physical properties of gutta-percha after short-term exposure to NaOCl[1]. The oxidative action of NaOCl on the polymeric matrix and wax components of gutta-percha is believed to be responsible for these changes[4].

Among the herbal disinfectants evaluated, licorice oil demonstrated the most favorable results, with the majority of samples showing only mild surface changes and some exhibiting no detectable alterations. Although limited studies have evaluated licorice oil specifically, similar findings have been reported with other herbal agents such as aloe vera, neem, and propolis, which showed minimal surface changes when compared to sodium hypochlorite[5–7]. Athiban et al. reported that aloe vera gel effectively disinfected gutta-percha cones without causing significant surface alterations, suggesting its safety as a chairside disinfectant[8]. The results of the present study suggest that licorice oil may behave in a comparable manner, possibly due to its bioactive flavonoids and glycyrrhizin content, which provide antimicrobial action with reduced material aggression.

In contrast, lemongrass oil and basil oil caused pronounced surface alterations, with a high percentage of severe changes observed. These findings are in agreement with studies evaluating essential oils, which have reported that despite strong antimicrobial efficacy, certain oils can cause considerable surface deterioration of gutta-percha cones[9,10]. Gaware et al. demonstrated

that lemongrass oil produced significant surface irregularities compared to aloe vera, despite its potent antimicrobial properties[11]. The aggressive interaction of essential oils with the organic components of gutta-percha may explain the severe alterations observed in the present study.

While herbal disinfectants are often advocated due to their biocompatibility and antimicrobial potential, the present findings emphasize that not all herbal agents are equally safe for gutta-percha surface integrity. Excessive surface roughness may compromise the adaptation of obturating material and increase the risk of microleakage, as reported in previous SEM and AFM-based investigations[12].

The statistically significant difference among the groups reinforces the need to balance antimicrobial efficacy with preservation of material properties when selecting a disinfectant for clinical use. Based on the present findings, licorice oil demonstrated minimal adverse effects on gutta-percha surface compared to sodium hypochlorite, lemongrass oil, and basil oil.

CONCLUSION

Within the limitations of this in vitro study, chairside disinfection was found to significantly influence the surface topography of gutta-percha cones. Sodium hypochlorite produced greater surface alterations, whereas among the herbal disinfectants tested, licorice oil demonstrated minimal surface changes and better preservation of surface integrity. Lemongrass oil and basil oil caused pronounced surface deterioration despite their antimicrobial potential. Licorice oil may therefore be considered a safer herbal alternative for gutta-percha cone disinfection. Further studies evaluating antimicrobial efficacy and clinical performance are recommended.

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