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Review Article

Effectiveness of Herbal Root Canal Irrigants on Endodontic Bacteria: A Review Article

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Introduction

Herbal Root Canal Irrigants have been popular for the last decade, and there has been a lot of research on their advantages and effectiveness. Also, traditional herbs are well-known for their minimal side effects and long-term healing capabilities. Tropical countries have abundant forest reserves, which contribute to producing these Herbal Irrigants. For instance, countries like India have Neem trees all around, and Neem leaf extract (Azadirachta indica) is good with chelating ability.

In Endodontic infection, many microbial species are involved. The endodontic microbiome's wide range and host interactions present a persistent challenge to treatment and a potential risk for systemic disease in other parts of the body. For example, endodontic bacteria release harmful toxins, eventually leading to an auto-immune response (Innate immune or Adaptive Immune); therefore, RANKL cells initiate osteoclast activity **[**8**]**.

The objective of an Endodontic Treatment:

The principal objective of root canal treatment is to disinfect the entire root canal system. Cleaning, shaping, and using antimicrobial medicaments reduce the bacterial load to some extent, and avoid factors causing re-infection **[**4**]**.

Endodontic treatment aims at disinfection and then obturation of the root canal system to prevent re-infection. Root canal irrigants play a pivotal role in the disinfection process. One of the essential properties of irrigants is the removal of a complete smear layer and debris. The smear layer can potentially protect bacteria within the dentinal tubules; therefore, removal may be prudent. Smear layer removal increases resin sealers' bond strength, resulting in a better apical seal.**[**1**]**

Most common bacteria in Endodontic infections:

E. faecalis and yeast, mainly C. albicans, have been repeatedly identified as the species most recovered from root canals undergoing retreatment in cases of failed endodontic therapy and canals with persistent infections. E. faecalis are gram-positive cocci and facultative anaerobes, and they are typical intestinal organisms and

may inhabit the oral cavity and gingival sulcus. When this bacterium is present in small numbers, it is quickly eliminated; but if it is in large numbers, it is not easy to eradicate. E. faecalis has many distinct features, making it an exceptional survivor in the root canal **[**3**]**.

E. faecalis is a tough microbe it can withstand nutrient scarcity and is tolerant to anti-microbial medication/dressing placement during endodontic treatment. Prominent characteristic features that make E. faecalis different from others are dense biofilms on canal walls by a biofilm-associated pili (Ebp) and its collagen-binding protein (Ace), which tunes this microbe able to pass through dentinal tubes and root canal curvatures. This complex environment makes it difficult for endodontic disinfects and intracanal irrigants to work up to maximum potential. Additionally, there are some virulent factors and predispositions to be resistant to some antibiotics **[**9**]**.

C. albicans binds to both organic and non-organic surfaces, such as dental prostheses and tooth dentin. It is a fungal infection that spreads on the dentin walls of root canals, passes through the dentinal tubules, and forms hard biofilms. The round C. albicans cells attach to dentin surfaces over 60–90 minutes and then proliferate to form a basal layer of biofilm that matures in 24 hours. Mature biofilms contain multiple layers of polymorphic cells consisting of hyphal, pseudohyphal, and yeast forms that are embedded within extracellular matrices, creating thick and physiochemically hard structures. Then, round yeast cells from mature biofilms disperse to infect distant sites. C. albicans within biofilms are 10–100 fold more resistant to host immune responses and antifungal treatment because the cell growth and metabolism are slowed and protected by extracellular polymeric substances (EPS) and protective factors. Thus, C. albicans in biofilms are more difficult to remove than planktonic cells, and it is commonly found in persistent/refractory endodontic infections that do not respond to root canal treatment **[**9**]**.

Most common endodontic-resistant bacteria:

- C. albicans
- E. faecalis
- Fusobacterium nucleatum
- Prevotella spp.
- Campylobacter rectus

Need for Herbal Root Canal Irrigants:

Taking the ineffectiveness, potential side effects, and safety concerns of synthetic drugs into consideration, herbal alternatives for endodontic usage are advantageous. Over the past decade, interest in drugs derived from medicinal plants has markedly increased. **[4]**

Herbal formulations are advantageous in many ways. They are safe, readily available, have a better shelf life, are economical, and have no microbial resistance. They are most effective when used with proper knowledge. Considering the low toxicity and antibacterial effectiveness, these herbs could be used as an adjunct to NaOCl, lowering its toxicity and providing the added antioxidant advantage. Due to their high safety profile, these Irrigants can replace chemical irrigants in patients with a history of allergic reactions to NaOCl and in pediatric patients where open apices limit the use of chemical Irrigants.**[4]**

Properties of Herbal Irrigants:

- Biocompatible
- Anti-bacterial Effect
- Anti-Microbial Efficiency
- Chelating agent
- Safe
- Easily available
- Better shelf life
- Economical and absence of microbial resistance
- Antioxidant

Classification of Herbal Endodontic Infection:

To understand and remember them better, Kale and Raut proposed a classification of Herbal Endodontic Irrigants. **[**2**]**

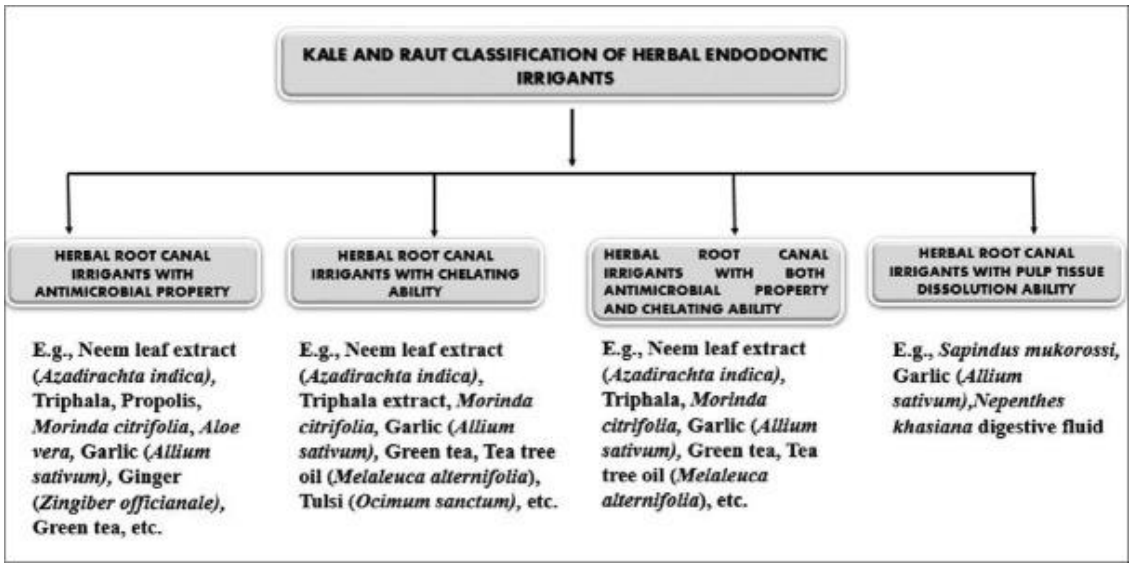

Fig-1

Positive Outcomes of Herbal Irrigants:

A. indica A. juss demonstrated significant efficacy against E. faecalis and C. albicans and proved to be as efficacious as NaOCl at various concentrations (2.5%, 3%, 5%).

Triphala has been used conventionally in Ayurvedic medicine as an antimicrobial agent. The citric acids from the fruits aid in removing the smear layer and act as chelating agents.

M. citrifolia had shown significant antibacterial effects against E. faecalis and C. albicans. Various studies showed M. citrifolia juice (MCJ) has antimicrobial efficacy equivalent to 1% NaOCl and Triphala in DMSO, comparable to 2.5% and 5% NaOCl.

Ginger extract is considered low risk, with excellent wettability, and active compounds of ginger extract, it can be a promising viable risk-free solution for root canal treatments **[**5**]**.

Salvadora persica (miswak-siwak) chewing sticks contain trimethylamine, salvadorime chloride, and fluoride in large amounts. A significant reduction in the microbial count was observed when 15% ethanolic extract of S. persica was used. 5 mg/ml of S. persica solution was as active as 17% EDTA in smear layer removal from the coronal third of the root canal **[**6**]**.

Miswak extracts at 50% concentration showed better antimicrobial activity against Lactobacillus acidophilus when compared to neem and mango extracts. It might be due to benzyl isothiocyanate, a natural component of miswak, which acts as an inhibitor of bacterial multiplication. 50% aqueous mango extract was effective against Streptococcus mutans and L. acidophilus. It could be due to the antioxidant and anti-lipid peroxidation activities of sore gum, resins, and mangiferin (polyphenol) **[**6**]**.

Mango leaf extract significantly produced a larger zone of inhibition when tested against E. faecalis, Staphylococcus aureus, S. mutans, Escherichia coli, and Candida albicans. The presence of bioactive components in plant extracts could have been attributed to the inhibitory effect further disrupting microbial biofilm **[**6**]**.

A. vera (Aloe barbadenis) is a naturally occurring herbal medicament having antibacterial properties. It has anti-inflammatory, antibacterial, antifungal, and antiviral properties. Because it contains anthrax quinine, it inhibits E. faecalis and Streptococcus pyogenes. A. vera showed the highest zone of inhibition against E. faecalis like NaOCl, which contrasts our results. The highest inhibitory site against E. faecalis for NaOCl was followed by garlic extract, neem, and ginger extract, and the least for A. vera **[**7**]**

Reviewing of Surface Tension:

Because of the complexity of root canal morphology, some intra-radicular areas remain inaccessible to chemo-mechanical preparation. Modifying the surface tension of irrigating solutions may improve irrigation efficacy by allowing irrigants to flow into remote areas, as surface tension inhibits the spread of a liquid over a surface and its ability to permeate capillary tubes **[**5**]**.

A lower surface tension enhances the penetration into inaccessible areas of root canals and improves the overall effect of the solution. CHX (2%) showed the best wettability with the other tested irrigant, followed by 2.5% NaOCl **[**5**]**.

The surface tension of distilled water, used as a control, was measured to be 73 mN/m2. When two different concentrations of NaOCl solution were compared, it was observed that 2.5% NaOCl had lower surface tension than 5.25% NaOCl. The surface tension of 2% CHX was lower than 5.25% NaOCI. The surface tension of 80% DMSO was 43 mN/m2 **[**5**]**.

The addition of the 10% ginger extract also enhanced the hydrophilicity on the surface by lowering the water contact angle from 93° to 85°. The presence of oxygen-containing functional groups, such as hydroxyl (−OH) and carboxyl (−COOH), is well-known to improve the membrane hydrophilicity because it creates strong intramolecular dipole moments. Therefore, hydroxyl (−OH) groups in ginger extract-based chemicals were expected to enhance the membrane hydrophilicity **[**5**]**.

Conclusion

Herbal Endodontic Irrigants are safe and equally effective as other traditional Irrigants. Also, Herbal Irrigants showed the least changes in microhardness and flexural strength of root dentin. Moreover, clinicians should consider the surface tension of Irrigants, root canal diameter, and curvature when choosing canal Irrigants. Additionally, manufacturing costs make herbal Irrigants expensive.

On the other hand, common endodontic bacteria like E. faecalis and C. albicans need precise BMP (Bio-Mechanical Preparation) with vigorous irrigation because these two microbes are tough to eradicate and have a high chance for re-infection that eventually leads to root canal treatment failure.

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