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Herbal Endodontic Irrigants - A Review

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ABSTRACT
Irrigation plays a significant part in the root canal system's disinfection by lowering the bacterial load in root canals. In endodontics, the use of biologic therapy derived from natural plants is becoming more popular due to the irrigant's cytotoxic effects and inability to remove germs from dentinal tubules. Herbal substitutes are popularised because of their affordability, cost-effectiveness, longer shelf life and minimal toxicity. Lately, it has become more popular to use natural treatments in conjunction with dental care. Ethnopharmacology or phytotherapy may be used to describe this. In this article, the use of numerous herbal products in endodontics is reviewed.

Keywords: Herbal, Irrigants, Endodontics, Root canal, Sodium hypochlorite.

I. INTRODUCTION

[1]Oral microbes, which are typically opportunistic pathogens that might enter a root canal with necrotic tissue and start an infectious process, are the primary cause of primary endodontic infections.[2]The main aim of an endodontic treatment is to remove diseased tissueand to prevent its recontamination. [3]Irrigating solutions are very important during root canal preparation because they aid in the cleaning of root canal, lubricate the files, flush out debris, have antimicrobial effect, provide tissue dissolution without damage to the periapical tissues.

[4]This process mainly revolves around" chemomechanical preparation", where in chemically active solutions are used along with mechanical instrumentation of the root canal space. Sodium hypochlorite [NaOCl] is the chemical that is most frequently utilised in this procedure, and it's concentrations can range from 1 to 6%.[5]Due to its exceptional antibacterial activity and distinct capacity to disintegrate pulp tissue, this chemical is preferred above other irrigants. NaOCl has several drawbacks, such as a nauseating smell, toxicityand the inability to dissolve only organic material, which prevents it from dissolving the smear layer on its own. [4]For this reason Ethylenediaminetetraacetic acid (EDTA) was used, which effectively demineralises the smear layer but has to be used along with NaOCl to remove the organic partand does not have disinfective ability.Chlorhexidine is another commonly used antimicrobial agent which is being used to irrigate the canals due to its wide spectrum antimicrobial activity, biocompatibility and ability to disinfect the infected root canals. [6]However it does not have tissue dissolving capabilities and also has someundesirable effects as it may discolour the teeth, [7]may result in oral dryness and possibly a mouthburn by making the mouth more sensitive to moisture. To overcome the side effects of the above agents and to meet the requirements of an ideal irrigant,wide variety herbal products have been used in the past inmedicine. This method of using herbs to treat a variety of disorders is referred to as "Phytotherapy" or "Phytomedicine" or "Ethnopharmacology". [8]The World Health Organization defines herbal medicine as a plant-derived preparation or substance that contains raw or processed components from one or more plants that have therapeutic characteristics.Traditional Indian medical writings mention Neem(Azadirachta indica)trees for their benefits.[9]Herbal medicines are now being incorporated into toothpaste to preventdental caries. The primary cause of polyphenol's anti-cariogenic effects is their direct interaction with S.mutansand it interacts with microbial membrane proteins to prevent bacterial cells from adhering to the tooth surface. Because of the potential benefits of employing non-ionizing radiation diagnostic tests in dentistry and the difficulties that occur with their use, scientific study in this field has led to some fascinating discoveries that will be beneficial in the future. [10]The most interesting advancements in this sectorare magnetic resonance imaging (MRI)

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and ultrasonic imaging. The purpose of this review is to identify and discuss many herbal substitutes that are now on the market and can be used as efficient endodontic irrigants.

II. HISTORY

[11]Taft suggested sodium chloride as a deodorizer for irrigation.Potassium and sodium metals were employed by Schreir et al. in 1893 to remove necrotic pulp.The root canal was sealed in 1894 by Callahan et al using 5% sulfuric acid.("cascade"platinum concentrating still for sulphuric acid, 1894) Grossman and Meimann used a combination of double strength sodium hypochlorite and hydrogenperoxide for the removal of pulp tissueremnants. Percy marketed this product under the name "Eau de Javel."Bleaching solution made of hypochlorite was employed. Moreover, it was used to stop childbed fever. Koch and Pasteur demonstrated that it has disinfectant properties during the late 19th century. For the irrigation of infected wounds during World War I, sodium hypochlorite buffered solution was employed.A formulation of sodium hypochlorite has tissue-dissolving effects on necrotic tissues and is effective against a variety of bacteria. It's usage as the primary irrigant in endodontics is due to these characteristics. Solutions of sodium hypochlorite are also inexpensive, accessibleand have a long shelf life. In comparison to hypochlorite,otherchlorine-releasing substancesincludingsodium dichloroisocyanurate and chloramine-T were shown to be less efficient. Hence, they were not widely accepted in endodontics.

III. IDEAL REQUIREMENTS OF ROOT CANAL IRRIGANT

- Wide antibacterial spectrum.
- Capacity to degrade remains of necrotic pulp tissue.
- Ability to dissolve a smear layer after it has developed or to prevent its formation during instrumentation.
- Capability to inactivate endotoxins.
- Systemically safe, not corrosive to periodontal tissuesand unlikely to result in allergic responses when they come into touch with vital tissues.
- Non-irritating to the periapical tissues, effective as a fungicide and germicideand active in the presence of blood, serumand tissue protein derivatives.
- Minimal surface tension, no tooth stainingand no negative impacts on the physical characteristics of exposed dentin.
- Has no negative effects on the filler components.
- Capacity to seal.
- Simple to use or apply.
- Inexpensive.

IV. CLASSIFICATION OF ENDODONTIC IRRIGANTS

- [14]Based on the Composition(Kandaswamy and Venkateshbabu, 2010)
  - Chemical - Tissue dissolving, Antibacterial, Chelating
  - Natural - Antibacterial agents
- [15]Commonly used irrigants : The Irrigants currently used are (Gomes et al., 2001)
  - Sodium hypochlorite
  - Chlorhexidine
  - Ethylenediaminetetraacetic acid (EDTA)
- [16]Kale and raut classification (2021)
  - Herbal root canal irrigants with antimicrobial property

E.g., Neem leaf extract (Azadirachta indica), Triphala, Propolis, Morinda citrifolia,Aloe vera, Garlic (Allium sativum), Ginger (Zingiber officinale), Green tea, etc.

- Herbal root canal irrigants with chelating ability

E.g., Neem leaf extract (Azadirachta indica), Triphala extract, Morinda citrifolia,Garlic (Allium sativum), Green tea, Tea tree oil (Melaleuca alternifolia), Tulsi (Ocimum sanctum), etc.

- Root canal irrigants made from herbs that have chelating and antibacterial properties

E.g., Neem leaf extract (Azadirachta indica), Triphala, Morinda citrifolia, Garlic(Allium sativum), Green tea, Tea tree oil (Melaleuca alternifolia), etc.

- Herbal root canal irrigants with the capacity to dissolve pulp tissue

E.g, Sapindus mukorossi, Garlic (Allium sativum),Nepenthes khasiana digestive fluid.

V. HERBAL ENDODONTIC IRRIGANTS

1. Curcuma longa (Turmeric):

[17]Curcumin, is an Indian spice and traditional medicine a member of a Zingiberaceaefamily which is a perennial plant with small stem, large oblong leaves and bears ovate brownish yellow rhizomes, possesses anti-inflammatory,antioxidant, antimicrobial, anticancer activity, antimalarialand hepatocellular.A recent report suggested thatcurcumin in aqueous preparations exhibits phototoxic effect against gram positive and gram negative bacteria.[18]Diferuloylmethane, the primary active

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ingredient in turmeric, is easily soluble in organic solvents but insoluble in water. The possible mechanism of action of curcumin suggests the inhibition of assembly of a proteinfilamenting temperature-sensitive mutant Z (FtsZ) and it also increases the guanosine triphosphatase activity of FtsZ which is lethal for the bacteria.[19]In a study conducted by Prasanna Neelakantan, it has been shown that curcumin has significant anti bacterial activity against E.faecalis and can be used as an alternative to sodium hypochlorite for irrigation. As a result, this herb can be utilised specifically in situations of root canal failure in endodontics.

2. Acacia nilotica (Babool):

[20]Acacia nilotica also known as the Acacia arabica, is an imperative multipurpose plant. It is a medium sized tree and is broadly scattered in tropical and subtropical countries.[21]It consists of tannins, phenolic compounds, essential oils & flavonoids, condensed tannin, gallic acid, protocatechuic acid pyrocatechol, catechin,epigallocatechin-7-gallateand epigallocatechin-5,7- digallate. Epicatechin, dicatechin,quercetin, gallic acid, leucocyanidin gallate, sucrose and catechin- 5-gallate arecompounds usually present in barks of baboolwhichpossesses good antimicrobial,antioxidant, antifungal, antiviral and antibiotic activity. Extracts of Acacia Nilotica damage electrolytic and essential cellular constituents(proteins and nucleic acids) of pathogens, altering the cell integrity and cell wall permeability indicating that acacia extracts damaged the cellular membrane of the pathogens.[22]Extracts of liquorice, clove, cinnamonand babool were examined for their antimicrobial activities in a study by Dhanya Kumar et al. It was shown that babool at a concentration of 50%had the highest activity against E.faecalis.

3. Azadirachta indica (Neem):

[23]Neem, also known as Azadirachta Indica, is a species of tree in the mahogany family. Indian neem, Margosa treeand Indian lilac are other names for it. This ubiquitous medicinal tree in India is valued.US National Academy of Sciences entitled neem as “a tree for solving global problems” as it produces numerous biological activities. It is widely used in Ayurvedic medicines and neem cream is prescribed for skin disease.The tetranortriterpenes nimbin, nimbidinin, nimbolide, and nimbidinic acid are derived from neem. Their leaves, bark, flowers, rootsand seeds have a variety of pharmacologic effects.Neem’s antiviral, antifungal, antibacterialand anticarcinogenic activitymakes it a potential agent for root canal irrigation. [24]Neem leaf extract is also used to treat dental plaque and gingivitis. Being a bio-compatible antioxidant, use of neem is advantageous as it is not likely to cause severe harms to patients that might occur through sodium hypochlorite accidents.Neem's ethanolic extract shown antibacterial efficacy
against E. faecalis, according to research by Naiyak Arathi et al.

4. Propolis:

[25]Propolis is a substance that has been used for generations in traditional medicine. Honeybees [Apis mellifera L.] gather propolis, a resinous substance, from a variety of plant species and combine it with wax. It is composed of resin (55%), essential oilsand waxes (30%) mixed with bee glue (bee salivary secretions), pollen (5%), amino acids, minerals, ethanol, vitamins, and highly active bioflavonoids (10%)and other substances. Scientific research has revealed its antioxidant,antibacterial,antifungal, antiviral, antiinflammatory,antitumor and immunomodulating properties.It possesses anti bacterial activities against streptococcus sobrinus and streptococcus mutans.Viscidone is another ingredient that makes it suitable for use as an irrigating solution. It can also be used to transport teeth that have been avulsed since it keeps the periodontal ligament cells healthy. It has been used as a pulp capping agent, cariostatic agent, as a mouth rinseand in the treatment of periodontitis. [26]Propolis exhibits antibacterial activity that is comparable to sodium hypochlorite, according to research by Al-Qathami and Al-Madi that examined the antimicrobial effectiveness of propolis, sodium hypochloriteand saline as intracanal irrigants.

5. Morinda Citrifolia (noni):

[27]Morinda Citrifolia also known as Indian mulberry, Cheese plant. One of the most important sources of traditional remedies is noni, which is a plant that grows abundantly over the Pacific. Major componentsincludes6α-hydroxyadoxoside,6β,7β-epoxy-8-epi-splendoside,americanin A,scopoletin, octoanoic acid, terpenoids, alkaloids, anthraquinones, bistosterol, carotene, flavone glycosides, linoleic acid, alizarin, acubin, Lasperuloside,caproic acid,caprylic acid, ursolic acid,rutinand proxeronine. Although pectinases and hemicellulases in Morindacitrifolia juice cause differential disintegration of bacterial cell wall

polymers, Morinda Citrifolia juice functions by depolymerizing hydrosoluble pectins. It has a wide range of uses due to its biocompatibility,antibacterial, anti-inflammatory, antiviral, antioxidant and analgesic effects. It is among the earliest herbal substitutes offered for an intra canal irrigant. In an in vitro experiment, the ability of MC juice to clean the smear layer from instrumented teethroot canal walls was compared to that of NaOCl and chlorhexidine.The effectiveness of Morinda Citrifolia as an intracanal irrigant was determined to be comparable to that of NaOCl combined with EDTA.

6. Aloe Vera (Aloe barbadensis miller):

[4]The green portion of the leaf that surrounds the clear gel in aloe vera. Aloin and aloe-emodin are the two substances that make aloe vera active. Due to protein synthesis in bacterial cells, aloe vera has strong antibacterial effect. It is also high in vitamins, minerals, enzymes, carbohydrates, lignin, saponins, salicyclic acids, amino acidsand has antifungal activity. In a study conductedby Suresh Chandra, antimicrobial effect of water, alcohol, chloroform extracts of aloevera gel were investigated and it was found that chloroform extract of aloe vera had significantantimicrobial effect against E.faecalis.

7. Triphala and Green tea polyphenols:

[28]The dried and powdered fruits of the three medicinal plants Terminalia bellerica, Terminalia chebulaand Emblica officinalis make up the Indian ayurvedic herbal mixture known as triphala. Citric acid, which is abundant in triphala's fruit, aids in the removal of the smear layer. Triphala may also disrupt microbial membranes. For root canal irrigation, its chelating ability makes it a useful substitute for sodium hypochlorite. Green tea prepared only from Camellia sinensis leaves.Green tea polyphenols have significant antioxidant, anticariogenic,anti-inflammatory, thermogenic, probiotic andantimicrobial properties.The bacterial enzyme gyrase is inhibited by binding to the ATP B subunit, which results in the antimicrobial action. In a study by Madhu Pujar et al, antimicrobial efficiency of triphala, gren tea polyphenols and 3% sodium hypochlorite were compared against and E.faecalis and it was observed that triphala and green tea polyphenols showed significantly better antibacterial activity against 2 week biofilm.

8. Salvadora Persica Solution (Miswaksiwak):

[4]Miswak is a word which is traditionally known for the wooden stick used for cleaningteethand it is derived from a plant called “Arak”. Miswak or Siwak is the name of this stick. Miswak translates to "stick to clean your teeth" in Arabic. The Babylonians have been brushing their teeth with miswak since over 7,000 years ago. Salvodara persica's antibacterial properties are assumed to be a result of its rich chemical composition, which includes tannins, chlorides, trimethylamine, salvadorine, nitrate, thiocyanate and sulphur. It has been demonstrated that these anionic chemicals exhibit antibacterial activity against different microorganisms. These substances interact with the sulfhydryl groups in the bacterial enzymes, ultimately causing the death of the bacterium. Alcoholic Salvadora persica extract was compared to 5.25% sodium hypochlorite, 0.2% chlorhexidineand normal saline in a research by Nawal A.K. AlSabawi et al.It was shown that Salvadora Persica extract had a significant antimicrobial effect against both aerobic and anaerobic bacteria with its efficacy being maximum at 15%.

9. Allium sativum (Garlic)

[29]Throughout Asia and Europe, garlic was utilised for other health benefits, including as strengthening the immune system against cold and cough.The major component is Diallyl sulphide (allicin)which is like Penicillin. The active constituents are several complex sulphurcontaining compounds such as Allin, Ajoene and Flavonoids that are rapidly absorbed, transformed and metabolized.Plants bulbis mostly commonly used. It is an antidiabetic agent. Garlic contains allicin whichdestroys the cell membrane of root canal bacteria which is used as an alternativeirrigant for NaOCl.It inhibits the growth of oral pathogens like streptococcus mutantsand porphyomonsgingivalis used for management of dental infections like periodontitis.

10. Tea Tree Oil(Melaleucaalternifolia)

[30]Australia's lowland wet regions are native to this tree. Its height is usually 10-25feet and has a papery white bark, dark green needle-like leaves and colourful blossomswith many properties like antiseptic,antifungaland mild solvent has an active component of terpinen-4-ol have efficacy of removingsmear layer superior to NaOCl but less than EDTA.

11. Marticaria Recutitia Linn(German chamomile)

[31]German Chamomile also known as MatricariaChamomilla L belongs to Asteraceae family is one of the very important medicinal

plants native of Europe of south and east Europe.A range of chemically active substances may be found in the chamomile plant's flowers (chamazulene, capric acid and caprylic acid). Moreover, it contains terpenoids, flavonoidsand other chemical components.German chamomile oil concentrates on the bacterial cell membrane.It has an anti-inflammatory, analgesic, antimicrobial, antispasmic and sedative properties. It disinfects root canal system with less toxicity when used as irrigants. An endodontic irrigant is good for irrigation at a field capacity of 70%, according to a study done on various content and compositions of chamomile using various irrigation regimes, however if water supply is adequate, 85% field capacity of German chamomile may be employed.

12. Jeeryin Solution:

[32]This is a Chinese herbal compound with antibacterial, antiinflammatory anddetoxifying effects.When used at 30% concentration for irrigation of root canal, ithad a similar effect to that of sodium hypochlorite.

13. Syzigium aromaticum - Clove

[33]Eugenol, isoeugenoland vanillin, which are included in clove essential oils, have antioxidant, antibacterialand anodyne properties. The calming effects of clove oil reduce pulpal inflammation. Three distinct plant extracts, Syzigium aromaticum (clove), Ocimum sanctum (tulsi), and Cinnamum zeylanicum (cinnamon), were the subject of a SEM investigation conducted by Gupta et al. to assess their efficacy as endodontic irrigants. According to the study findings, Syzigium aromaticum and EDTA were the most successful experimental groups at removing smear layer.

14. Agaricus bisporus - Mushroom

[34]It contains active substances with both low and high molecular weights (LMW, HMW).It has therapeutic qualities including immune-modulating, anti-inflammatory, antiviral, anti-oxidant and antibacterial capabilities because of these components. Plectasin, confuentin, grifolin, and neogrifolin are low molecular weight components found in mushrooms that have the ability to deeply enter dentinal tubules.Mushroom gel is used as an intracanal medication.

15. Citrus limonum - Lemon solution

[34]Lower acidity and a pH of 2.21 describe lemon solution. It functions as a chelating agent by removing the smear layer effectively. Due to its antimicrobial properties, fresh lemon solution is a perfect, risk-free root canal treatment.Fresh lemon solution has been proven in a research by Abuziad & Eissa et al. to have broad antibacterial effectiveness against E. faecalis and may thus be utilised as an intracanal medication.

16. Papaine

[35]Papaine, a proteolytic cysteine enzyme, is derived from the latex of the green mature papaya's leaves and fruits. Significant bacteriostatic and bactericidal effects are present. The antibacterial activity of natural extracts of M. citrifolia, papine, A. vera gel, 2% CHX and calcium hydroxide against E. faecalis was compared in the study by Anug Bhardwaj et al. Papaine provided findings that were significantly different from those of CHX and the other evaluated drugs.

17. Riccinus communis - Castor

[34]Castor contains ricinoleic acid which is abundant in it. Both an irrigant and an intracanal medication can be utilised with it. Castor was reported to be able to eradicate Candida albicans in an in vitro investigation by Marcio Carneiro Valera et al. It was also discovered that castor considerably decreased the number of E. faecalis. It was discovered in another study by Lucas da Fonseca Roberti Garcia et al. that calcium hydroxide and Castor oil paste showed superior action than calcium hydroxide and propylene glycol paste against bacteria usually seen in endodontic infections.

VI. CONCLUSION

Herbal medicines are becoming popular and employed in endodontics because they are mostly harmless when used correctly and can be dangerous if overused. Considering that they have been shown to be beneficial and have few adverse effects, herbs can also be used in endodontic treatment techniques. Safety, ease of accessibility, longer shelf life, economic efficiency and the absence of microbiological resistance thus far are the main benefits of herbal irrigants. Combining irrigants and using them sequentially will assist to meet all of the requirements for irrigation of the root canal, which will result in successful root canal therapy.

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