



Herbal Way of Remineralization- New Frontier in Dentistry

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ABSTRACT:

BACKGROUND: The prevention of dental decay and treatment of oral health are ongoing challenge until today. Dental caries is a dynamic process characterized by alternating periods of demineralization and remineralization. The present era of preventive and minimally invasive dentistry clearly dominates the need for developing newer approaches to remineralize enamel caries lesions. With growing interest in the field of phytotherapeutics, because of their antimicrobial properties various plant extracts have been studied and used in the field of preventive dentistry. The majority of herbal agents contain polyphenolic active ingredients in nature. Certain polyphenol compounds are effective in killing bacteria or inhibiting biofilms, and to regulate the de/remineralization of dental hard tissue. Various clinical trials have been performed assessing the potential use of herbal products in caries prevention.

AIM: The aim of this review article is to put a light on various herbal products that can be used for remineralization of Incipient caries lesions.

METHOD: A literature search was conducted using the keywords “Herbs” and “Remineralization” published since 2020 in English and Italian in the following databases: PubMed, CINAHL, Med Line. Excluding items which did not meet the inclusion criteria, 35 articles were included in the review.

CONCLUSION: To prevent dental caries and remineralize white spot lesions, herbal-based phytochemicals and bioflavonoids will be more well-liked than synthetic chemical derivatives and fluoride-based systems.

Introduction

In the oral environment, there is constant demineralization and remineralization of tooth structure. Demineralization will advance when this balance is altered, causing the tooth structure to

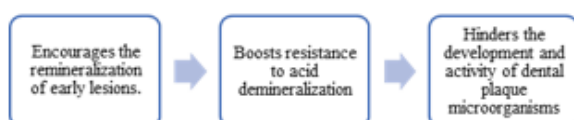
deteriorate. In the other hand remineralization will take place by repair process of restoring minerals again in the form of mineral ions to the hydroxyapatite's latticework structure¹



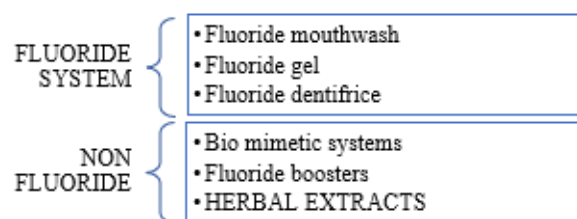
The enamel is the tooth's outermost layer, which is specially organized and has ectodermal origins. Its organic matrix is composed of amelogenin, a non-collagenous protein. The oral cavity's enamel is vulnerable to a variety of problems, and mature enamel cannot be renewed since ameloblasts are not functioning. Because of this enamel's limited capacity to regenerate, demineralization of enamel occurs when the pH drops below a certain threshold. This indicates the beginning of caries with subsurface mineral loss and a superficial layer that is largely intact and appears as white dots. By allowing the enamel surface to air dry, it is simple to identify these white spot lesions (WSL), which are the first lesions of smooth surface caries².

Commercially there are various remineralizing agents accessible in a variety of forms and quantities that contain phosphate, calcium, and fluoride ions. In addition to forming new crystals and repairing the broken ones, these agents release active ions that create stable bonds with the crystalline enamel structures³. Fluorapatite forms in enamel when calcium and phosphate ions are created during enamel demineralization by plaque bacterial organic acids. Here Fluoride ions amount to the main mechanism in preventing enamel demineralization⁴.

In addition, fluoride has a multifaceted effect in preventing dental caries as shown in figure⁵: (Fig 1)



The two main categories of remineralization systems currently in use are fluoridated and non-fluoridated systems⁶. (Fig 2)



High concentrations of fluoride solutions are used in professional applications, including gels and varnishes, and lower amounts are used in toothpastes and mouthwashes for everyday usage⁷.

White spot lesions (WSLs), or incipient caries, can be remineralized using topical gels, varnishes, mouthwashes, and dentifrices that contain multiple therapeutic agents. This is one of the main tenets of the MID concept. Fluoride, casein phospho peptide-amorphous calcium phosphate (CPP-ACP), bioactive glass (BAG), and hydroxyapatite (HAp) are some of these active ingredients⁸.

Nevertheless, the use of these synthetic and chemical treatments has systemic side effects, including fluorosis of the skeleton and teeth and gastrointestinal issues⁹.

Plant-based alkaloids are a more recent addition to remineralization systems. They have antibacterial properties and the ability to positively shift the balance towards remineralization by preventing demineralization.

The usage of plants is suggested as a remedy for issues brought on by allopathic pharmaceuticals, such as drug dependence and antibiotic resistance. One of the biggest challenges to humankind is the emergence of antibiotic resistance and the growth of superbugs, or drug-resistant bacteria strains¹⁰.

In lieu of chemical therapies for plaque reduction and demineralization, plant-derived antibacterial substances may be utilized. According to recent studies, plant polyphenol components have the ability to prevent oral diseases and have anticariogenic effects.



Currently, research is being conducted on various foods and beverages, including tea, coffee, grapes, propolis, lemon oil coconut oil, rosemary oil and traditional herbs to check their remineralizing efficacy.

The present review enlightens on the use of various herbs and their products in the field of dentistry.

VARIOUS HERBAL PRODUCTS AVAILABLE FOR REMINERALIZATION:

- Zingiber officinale (ginger rhizome)
- Apis mellifera (manuka honey)
- Proanthocyanidin (grape seed)
- Cocos nucifera (coconut)
- Galla chinensis
- Gum arabic (acacia senegal)
- Oleum limonis (lemon oil)
- Rosmarinus officinalis (rosemary oil)
- Cocoa / cocoa (theobroma cacao)
- Hesperidin
- Xylitol

ZINGIBER OFFICINALE (GINGER RHIZOME) (Fig 3)



The Zingiber officinale Roscoe, a member of the Zingiberaceae family and Zingiber genus, has long been used as a spice and herbal remedy. The phenolic compounds in ginger consists of gingerols, shogaols, and paradols. Many herbs and spices have been created into efficient natural antibacterial agents that can combat a wide range of pathogenic microbes¹¹. There have been reports of ginger's

antiviral, antifungal, and antibacterial properties in recent years. The development of biofilms has a significant role in both infection and antibiotic resistance. Ginger's methanolic fraction and crude extract downregulated virulence genes to prevent Streptococcus mutans from adhering, forming biofilms, and synthesizing glucan¹². Ginger has been researched for its ability to remineralize, and it has been proposed that treating artificially created early caries lesions non-invasively with a solution containing ginger may improve remineralization and have therapeutic benefits for the treatment of this condition. A toothpaste called Gumix has entered the market with honey and ginger as its active ingredients, indicating the potential benefits of ginger for dental health. ¹³

APIS MELLIFERA (MANUKA HONEY)

(Fig 4)



Bees make honey from blossom nectar. Honeybees visit several blooms and ingest nectar in their honey stomachs, where digestive enzymes break sucrose into glucose and fructose. Honey is a naturally occurring food product made by Apismellifera, or honeybees, and is made up of chemicals excreted by insects as well as nectar from flowers. Honey's antibacterial characteristics are primarily determined by its low pH, high sugar content, hydrogen peroxide, low water activity, gluconic acid, and antimicrobial proteins/peptides¹⁴. The use of honey as a substitute medication in the treatment of diseases like gingivitis and dental cavities after



orthodontic therapy has been demonstrated to offer encouraging potential¹⁵.

PROANTHOCYANIDIN (GRAPE SEED)

(Fig 5)



Grape seeds extract (GSE) consisting mainly of proanthocyanidins (PAs), it considered strong antioxidants, it also has vasodilatory effects, antiseptic and anti-carcinogenic effects. Gallic acid is a significant component of GSE and was intended to aid in the deposition of minerals which helps in remineralization¹⁶. A study conducted by GSE using scanning electron microscope (SEM) on the enamel surface, there were scaffolding deposits with cluster-like formations that resembled the start of the remineralization process¹⁷. Research has indicated that during development, PA promotes the synthesis of new collagen and quickens the transformation of soluble collagen to insoluble collagen. GSE enhances the process of remineralization of artificial caries in primary teeth¹⁸. Therefore, it can be considered an effective natural agent for non-invasive carious lesion therapy.

COCOS NUCIFERA (COCONUT):

(Fig 6)



The three main minerals in raw coconut milk are potassium, calcium, and phosphorus. One of the essential raw materials in any ordinary home is coconut, or *Cocos nucifera*. A vast array of products in the food industry use coconut. Moreover, the calcium content was the highest. Oil pulling, a long-standing custom in Indian culture, involves using edible oils as mouthwash, such as sesame, coconut, and sunflower oil. Prior research on oil pulling demonstrated that the technique might avoid halitosis, discoloration, and allergic reactions while suppressing the formation of oral microbiota and preventing gingivitis¹⁹. *Streptococcus mutans* was found to be reduced in a study using virgin coconut oil (VCO) for oil pulling. This suggests that as a remineralizing agent, virgin coconut oil (VCO), coconut milk (CM), and coconut water have comparable effects on enamel²⁰.

GALLA CHINENSIS: (fig 7)





The origin of *Galla chinensis* (GC), a popular traditional Chinese medicine in China, is the aberrant growth of *Rhus* leaf tissue in reaction to parasitic aphid secretion (family Pemphigidae). Gallic acid (GA) and methyl gallate make up around 20% of the gallotannins found in GC. GC has been shown to be successful in promoting remineralization and blocking demineralization in a number of earlier investigations, suggesting that it may be a useful agent in the prevention of dental caries²¹. Additionally, it has been demonstrated that GC can suppress dental biofilms containing *Actinomyces naeslundii*, *Lactobacillus rhamnosus*, *Streptococcus sanguis*, and *Streptococcus mutans* infections²². Cheng et al. discovered that GCE improved fluoride's ability to shift tooth enamel's de- and remineralization. Huang et al also observed a noteworthy synergistic remineralization effect upon combining GCE with nanohydroxyapatite (n-HAp)²³.

GUM ARABIC (ACACIA SENEGAL): (Fig 8)



Branches of *Acacia senegal* and other related African *Acacia* species is known as gum arabic. It is mostly made up of high molecular weight polysaccharides and has significant amounts of potassium, magnesium, and calcium salts, which produce rhamnose, arabinose, galactose. GA's high calcium content may act as an oral care agent to reduce dental plaque production at an early stage and encourage caries remineralization²⁴. Gum arabic-based remineralizing solutions, with their high Ca²⁺ content, demonstrated exceptional remineralization activity when applied to caries-like

enamel lesions. *Acacia arabica* gum was claimed to inhibit *Porphyromonas gingivalis* and *Prevotella intermedia*. Gum arabic has the potential to be a caries preventative agent due to its remineralizing and plaque inhibitory properties²⁵.

OLEUM LIMONIS (LEMON OIL) (fig 9)



Lemon essential oil (LEO) is a mixture extracted from the peel of lemon and its main component is Limonene (LIM). Limonene (LIM) is the primary ingredient in lemon essential oil (LEO), a combination made from lemon peels. According to earlier research, LEO and LIM can prevent the growth, adhesion, acid generation, and synthesis of additional cariogenic virulence factors including insoluble glucan by cariogenic bacteria²⁶. According to Ma et al., essential oils such as lemon oil have the ability to stabilize the structure of teeth against collagen degradation and to stimulate remineralization during the early stages of caries development. Thus, whether its primary component, LIM, or other components contribute to the development of early caries, in addition to having an impact on cariogenic bacteria, is known²⁷.

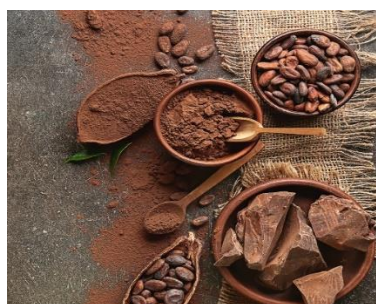
ROSMARINUS OFFICINALIS (ROSEMARY OIL) (Fig 10)





Rosemary (*Rosmarinus officinalis* L., Lamiaceae) are natural herbals with their antimicrobial activities. Rosemary (*Salvia rosmarinus*) is a small aromatic bush, and is made of terpenoids, flavonoids, phenols and essential oils with antimicrobial, antifungal and antioxidant therapeutic properties. The methanolic extract of rosemary has inhibitory effects on mutans streptococci and concluded that the rosemary extract was effective in the remineralization of enamel on fluorescence and microhardness assessments²⁸. Tsai et al. demonstrated an inhibitory effect of rosemary on *S. sobrinus*. They found the minimum inhibitory concentrations of aqueous and methanolic rosemary extracts against *S. sobrinus*. Dalirsani et al. compared rosemary methanolic extract (30 g/100 mL) with chlorhexidine and found that rosemary has inhibitory effects on *S. mutans* and found that the rosemary-containing mixture was effective in enhancing the remineralization process of enamel²⁹.

COCOA / COCOA (THEOBROMA CACAO): (Fig 11)



Cocoa / cocoa (*Theobroma cacao*) is a natural material containing theobromine. The husk extract of cacao beans might be able to change a cariogenic into non- cariogenic by reduction of streptococcus mutans³⁰. It enhances crystalline growth, resistance to acid attack and increased enamel micro hardness and has comparable remineralization capacity to that of fluoridated dentifrices. Amaechi et al. conducted a comparative assessment of the remineralizing potential of sodium fluoride and theobromine dentifrice. They found that

theobromine and fluoride toothpaste considerably increased mineral gain when compared to artificial saliva.³¹

XYLITOL: (Fig 12)



Xylitol contains a five-carbon sugar polyol and is a naturally found in fruits, vegetables and berries. Xylitol, also known as $(\text{CHOH})_3(\text{CH}_2\text{OH})_2$, is a sugar alcohol sweetener that is non-toxic and resistant to the caries-causing streptococcal bacteria in plaque³². Exposure to xylitol in the mouth can decrease the activity of acidogenic bacteria and the development of plaque on dental surfaces. It is significant that researchers have emphasized the role that xylitol-containing chewing gums could potentially have as a preventive measure and increases salivary flow rate, improves protective properties of saliva and enhancing remineralization³³. xylitol was found to limit dental caries even in the presence of a strong cariogenic challenge and was more effective than sorbitol.

HESPERIDIN: (Fig 13)





Hesperidin is a flavonoid glycoside produced from citrus that has remineralizing and antibacterial qualities. Additionally, it has been proposed that hesperidin's capacity to promote dentin remineralization may result from its interactions with collagen proteins. The remineralization process seems to be aided by a stable organic matrix, since it prevents the further escape of calcium and phosphorus ions from tooth tissues while also facilitating their deposition³⁴. Hesperidin has been proven in restorative dentistry to lessen dentin lesions' vulnerability to acid-dependent demineralization, potentially accelerating the remineralization process. Due to its ability to bind with collagen and/or non-collagenous proteins, hesperidin was able to protect bovine dentin collagen from proteolytic destruction, resulting in the stabilization of the collagen matrix and induction of remineralization³⁵.

CONCLUSION:

The applications of various herbal medicaments had shown inhibitory effect on demineralization, and have enhanced remineralization in the field of dentistry. The field of phytomedicine has drawn more attention lately. As per the current investigation, numerous herbal medicines include possible therapeutic attributes; nonetheless, there is a dearth of research about the effectiveness, safety, and caliber of herbal plants when it comes to dental applications.

Further research is required to determine the safety and biocompatibility of using herbal compounds, even if it is believed that they are less harmful than those containing heavy chemicals.

Why this review is important to dentists and paediatric dentists

❖ Gain a knowledge on various herbs and their products that can be utilized as a remineralising agents

❖ To broaden the knowledge on the availability and use of various herbal products in the dental field

Conflict of Interest:

Every author certifies that they have no financial relationships (such as stock ownership, consulting, equity interests, patent/licensing arrangements, etc.) that could create a conflict of interest with the work that has been submitted.

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