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An Herbal Approach towards the Management of Periodontists among Diabetic and Nondiabetic Persons

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1. Introduction

Herbal medicines are made up of plant constituents that are said to have therapeutic properties, preferred over traditional drugs due to their extensive natural activity, advanced safety margin, and lower costs. Furthermore, modern drugs are known to cause a variety of side effects. Because the continuous use of modern drugs has sometimes resulted in antibiotic resistance, herbal medicines are gradually being used as dietary supplements to combat or prevent common ailments affecting the human body and oral cavity.They are increasingly being used as dietary supplements to prevent common diseases. Periodontal diseases are extremely common, affecting up to 90% of the world's population. Gingivitis is the mildest form, whereas periodontitis causes irreversible loss of tooth supporting structures. Despite the fact that periodontal pathogens play an important role in the etiopathogenesis of periodontitis, there is a growing body of evidence suggesting that oxidative stress plays a critical role in disease initiation and progression. Infectious diseases are primarily caused by microorganisms, which account for a large number of hospitalizations and deaths each year. There are numerous antimicrobial formulations available to treat these infections, but bacterial pathogens are rapidly developing resistance to these antibiotics, making these infections difficult to treat. As a result, researchers all over the world are now focusing on the discovery of new antimicrobial substances. Plants and their compounds could be one of the promising candidates against drug resistance in the current scenario.A large number of Indian plants are recommended in the treatment of infectious diseases in Ayurveda and Unani medicine. According to WHO, approximately 80% of the world's population uses medicinal plants to treat human diseases.

Diabetics with periodontitis have worse glycemic control, making periodontitis more common and severe. Microangiopathy, retinopathy, nephropathy, neuropathy, and accelerated atherosclerosis are all diabetic complications. Because of its complexity, listing the oral flora is nearly impossible, because phylogenetic heterogeneity is linked to increased ecological resilience to changes in the oral environment, such as chemical imbalances or pathogenic microbe invasion, a healthy flora is usually more diverse. The subgingival microenvironment changes from a shallow sulcus with minimal GCF flow, where Gram-positive cocci and rods predominate, to a deeper pocket with increased GCF flow during the pathogenesis of gingivitis and periodontitis.

Plaque is a build-up of food particles and germs on the teeth above and below the gum line. Gingivitis is caused by dental plaque, which forms on the teeth within minutes of brushing. Collagen is the most common protein, and it is responsible for the structure of gingiva, periodontal ligament, cementum, and alveolar bone, as well as blood vessels. Hyperglycemia can cause changes in collagen synthesis, which can lead to changes in the appearance of periodontal disease. Researchers are becoming increasingly interested in a growing number of natural chemicals, essential oils, and vegetable extracts due to their antioxidant properties and benefits for human health.

Herbal extracts have been used for medicinal purposes since antiquity. Biofilm was inhibited in nano emulsions, compared to ethanolic oil solution. Synergistic effects can be observed when essential oils are encapsulated in lipid-based nano systems. Emblica officinalis (Amla), Syzygiumaromaticum (Clove), Piper nigrum (Black pepper), Withaniasomnifera(Ashwagandha), Zingiber officinale (Ginger), Azadirachta indica (Neem), Mentha piperita (Mint), Momordica charantia (Karela), Carica papaya (Papaya), and Crocus sativus are some (Saffron). However, the production of reactive oxygen species (ROS) during normal metabolism caused oxidative damage to protein and DNA. Furthermore, ROS are a leading cause of cancer and cardiovascular disease. ROS and their harmful effects can be neutralized by antioxidants. Fruits such as jamun (Syzygiumcumini), apricot (Prunus armeniaca), raspberries (Rubus ellipticus), and plum (Prunus domestica) were found to be high in antioxidants. A large number of plants have been reported to have antibacterial and antioxidant properties.

The nano size allows for easier diffusion into bacterial cell membranes. According to researchers, micro/nano emulsions, produce better results in terms of bacterial resistance. The presence of surfactants in the formulation, combined with the nanosized, results in a high surface tension and wetting ability for the delivery system.

All assays were performed in separate experiments, each with triplicates, and each microplate contains a sterility control. The lids were removed after the incubation period, the medium was discarded, and the wells were rinsed three

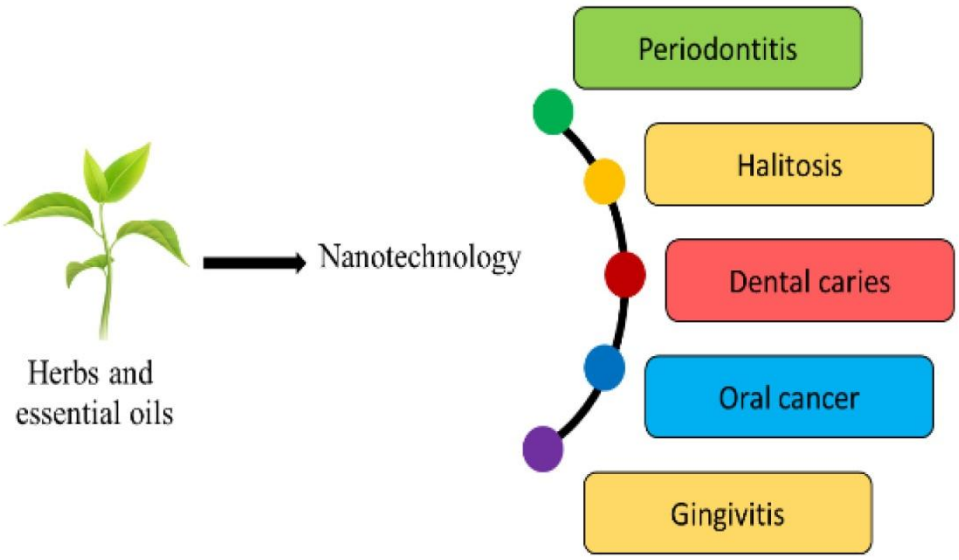
times with 0.1-M phosphate-buffered saline (PBS). In the incubation microplate, the well bottom was used as an adhesion surface, which was then colored with crystal violet to test for biofilm formation.

According to the Clinical and Laboratory Standards Institute's (CLSI) guidelines bacterial inoculum used in studies were cultured and kept overnight, suspended in 0.1 mol/L PBS to achieve a turbidity equivalent to a 0.5 McFarland standard diluted 1:20 in the same buffer and used for inoculation to achieve a final microbial concentration colony-forming units (CFUs)/ml. Essential oils showed promising antibiofilm abilities against oral microflora in a biofilm state with biofilm eradication (i.e., disruption of pre-formed biofilm) requiring higher concentrations than biofilm inhibition.

The effects of thymol and eugenol, two known components of thyme and clove essential oils metabolites, on the oral microbiota were studied, and the results revealed a reduction in plaque formation in the teeth and supragingival areas.Essential oils of thyme and oregano showed promising antibacterial activity in the inhibition and death of cells in planktonic and biofilm states, respectively. In periodontal disease and diabetes mellitus, the therapeutic effects of carvacrol and magnololdemonstrates that carvacrol and magnolol have beneficial properties in the disorders studied, because they are effective at reducing gingival inflammation and periodontal pockets while controlling blood sugar levels in diabetics. These natural extracts have the potential to be a future "key-role player" in new treatment formulae.

2. Discussion

For the prevention and treatment of oral and periodontal infections, herbal medications containing natural phytochemicals aresafe and effective alternative as antibiotics. The baseline treatmentshowed decreased level of plaque and gingival index.The attached diagram shows the graphical abstract of nano herbal technology in various domains.



Applications of nano-herbal technology in diverse dental domains

Biofilms are hydrophilic in nature, and so hydrophobic essential oils can be converted into nano emulsions with a size of less than 300 nm, which facilitates the penetration of the active ingredient into the biofilm matrix. Cinnamon oil loaded in nano emulsions inhibited a *S. mutans* biofilm by 86%, compared to 60% observed by an ethanolic oil solution. Synergistic effects can be observed when essential oils are encapsulated in lipid-based nano delivery systems. The nano size facilitates higher diffusion into bacterial cell membranes. Researchers have suggested that micro-nano emulsions give more favourable outcomes in terms of bacterial resistance. The presence of surfactants in the formulation, coupled with the nano size, provides high surface tension and wetting ability to the delivery system. This allows fusion with the cell membranes of microorganisms and eventually kills them.Lemongrass oil is thought to have antibacterial and antifungal properties similar to penicillin, making it useful for controlling periodontal bacteria elimination. It raises the levels of superoxide dismutase and thiol in gingival tissue, causing free radical-induced periodontal tissue.

The link between periodontitis and diabetes will becomeclearerwhen we will learn about the impact of periodontal inflammation on the composition of the subgingival biofilm. The number of anaerobic species in subgingival plaque increases as periodontal disease progresses or as systemic inflammation. The study's findings include the composition of the herbal product used in the studyand conclusions as presented in tabular format below.

Table 1: List of phytoconstituents obtained from herbal sources along with their potential pharmacological activity in periodontitis.

S. No	Plant	Biological Name	Active Phyto-Constituent	Part of Plant Used	Activity
1	Neem	*Azadirachtain indica*	Azadirachtin	Leaves	Antimicrobial, anti-inflammatory and antiplaque activity
2	Triphala	*Emblica officinalis*	Gallic acid, tannic acid, syringic	Fruits	antimicrobial, anti-inflammatory

			acid,		
3	Garlic	*Alliumsativum*	Allicin	Rhizomes	Antimicrobial, antioxidant activities
4	Gum acacia	*Acacia catechu*	Catechin, alkaloids, and tannins	Bark	Antibacterial, anti-inflammatory
5	Roselle	*Hibiscus sabdariffa*	Hibiscus acid andprotocatechuic acid	Seeds, leaves, fruits, and roots	Antimicrobial, antibacterial effect
6	Ginger	*Zingiber officinale*	Gingerols	Rhizome	Antimicrobial effect
7	Green tea	*Camellia sinensis*	Catechins	Dried leaves	Antibacterial activity
8	Liquorice	*Glycyrrhiza glabra*	Glycyrrhizin	Root extracts	Anti-inflammatory properties
9	Meswak	*Salvadora persica*	Volatile oils, flavonoids	Roots	Antibacterial, anti-inflammatory, anticariogenic
10	Turmeric	*Curcuma longa*	Curcumin	Rhizome	Analgesic, anti-inflammatory, antioxidant, antimicrobial activity
11	Cinnamon oil	*Cinnamomum zeylanicum*	Cinnamaldehyde, cinnamic acid	Leaves, bark, root, and fruit	Antimicrobial activity
12	Citronella oil	*Cymbopogon nardus*	Citronellal,geraniol, limonene	Leaves and fruit peel	Antibiofilm, antibacterial, anticariogenic activity
13	Tea tree oil	*Melaleuca alternifolia*	Terpinen-4-ol,γ-terpinene	Leaves	Antimicrobial properties
14	Eucalyptus oil	*Eucalyptus globulus*	Eucalyptol, α-pinene	Leaves	antimicrobial, anti-inflammatory effect, properties
15	Lemongrass	*Cymbopogon citratus*	Citral	Leaves	antifungal, antioxidant
16	Myrtle oil	*Myrtus-communis*	α-pinene, limonene, 4-terpineol	Leaves	Anti-inflammatory, antimicrobial activity
17	Ajwain oil	*Trachyspermumammi*	Thymol, camphene, myrcene, and α-3-carene	Leavesand the seed-like fruit	Antimicrobial, germicidal, antifungal activity
18	Red sage	*Salvia miltiorrhiza*	Tanshinone IIA	Stem, leaves, fruit	Anticancer activity against oral squamous cancer cell line
19	Thunder duke vine	*Tripterygium wilfordii*	Triptolide	Peeled roots	Anti-inflammatory in oral lichen planus, mouth ulcers
20	Bitter bean	*Sophora alopecuroides*	Sophora alkaloids	Seeds and aerial parts	Antibacterial, anti-inflammatory
21	Happy tree	*Camptotheca acuminata*	Camptothecin	Bark, wood	Anticancer activity against oral squamous cancer cell line
22	Korean red ginseng	*Panax ginseng*	Ginsenosides	Root	Bone regeneration in dental implant

3. Limitations

Traditional herbal remedies are few and far between when it comes to determining the efficacy and safety of clinical trials. Each of the 22 plants used in the MIC testing study is used in various traditional medicinal systems in everyday dental hygiene care or as treatments for periodontitis symptoms, so the results of this study validated their traditional use. These 22 plants also represent a promising group of natural product sources that could be used in the development of pharmaceutical and oral hygiene products.

In addition to the intriguing findings of this study, we propose a method for evaluating plant antibacterial properties against P. gingivalis. Indeed, because P. gingivalis is an obligate anaerobe, cultivating it requires specialized laboratory equipment and knowledge. This could explain why there have been so few ethnopharmacological studies on this plant. In this study, we developed a rigorous and repeatable methodology for assessing the antibacterial activity of plant extracts against this disease, which scientists can apply in future studies.The goal of this research was to look at clinical studies of herbal drugs used as root planning and scaling supplements. One possible outcome of these findings could be the development of a mouthwash containing the tested extracts and/or fractions of these extracts. Long-term growth suppression as part of a regular oral hygiene regimen could be quite beneficial because P. gingivalis is a slow-growing bacteria that can take years to flourish in the oral cavity.Periodontal infections affect 47.2 percent of adults over the age of 30 and 70.1 percent of people over the age of 65, and developing long-term prevention strategies could have far-reaching consequences. These findings could indicate that plant extract enhances antibiotics' antibacterial activity. Therefore, the leaves of the studied plants can be used in the development of antibacterial formulations and antioxidant-rich value-added products after detailed follow-up studies.

4. Future Prospects

Phytochemical screening has already established the pharmacological properties of several biological actives. During screening studies, it was found that ingredients such as flavonoids, terpenes, and terpenoids are responsible for therapeutic effects. Invitro studies have proven that herbal remedies have potential in the treatment of dental diseasesdue to their poor lipid solubilization and improper molecular size of herbal active molecules. In order to achieve the desired therapeutic effects of herbal ingredients, researchers are continuously working to achieve the delivery of herbal active molecules at the desired concentrations in the blood.

The greatest challenge in the development of herbal formulations is to cross the membrane with an enhanced pharmacokinetic profile and therapeutic efficacy. Lipid-based and oil-based carriers can be used to resolve these challenges. Bioactive molecules with a greater half-life have a long duration of action and long rate of elimination too as compared to molecules with a shorter half-life.

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