

“Natural Adjuncts for Prevention of Oral Diseases - A Narrative Review of Green Tea, Lemon Grass and Probiotics in Oral Health Promotion”

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Abstract

Oral diseases such as dental caries, periodontal disorders, oral infections, and halitosis continue to represent major global health challenges despite advances in preventive and therapeutic dentistry. Conventional chemical agents including chlorhexidine, antibiotics, and synthetic antimicrobials have demonstrated significant effectiveness in managing oral diseases; however, their long-term use is often associated with adverse effects such as microbial resistance, disruption of oral microbiome balance, mucosal irritation, tooth staining, and reduced patient compliance. In response to these limitations, there has been growing interest in natural and biologically compatible alternatives that can provide effective therapeutic outcomes while minimizing side effects. Herbal compounds and probiotics have emerged as promising adjunctive and preventive approaches due to their antimicrobial, anti-inflammatory, antioxidant, and microbiome-modulating properties. This comprehensive review explores the role of green tea (*Camellia sinensis*), lemongrass (*Cymbopogon citratus*), and probiotics in modern dentistry, focusing on their mechanisms of action, clinical applications, comparative effectiveness, and future perspectives. Green tea contains bioactive polyphenols, particularly catechins such as epigallocatechin gallate (EGCG), which exhibit strong antibacterial, antioxidant, and anti-inflammatory effects. These compounds have demonstrated efficacy in inhibiting cariogenic bacteria, reducing periodontal inflammation, controlling oral malodor, and potentially contributing to oral cancer prevention. Lemongrass essential oil, rich in citral and other phytochemicals, possesses potent antimicrobial and antifungal properties against key oral pathogens, making it a promising candidate for periodontal therapy, endodontic irrigation, and herbal mouthwash formulations. Meanwhile, probiotics represent a novel biological strategy that focuses on restoring microbial balance by introducing beneficial bacteria capable of suppressing pathogenic microorganisms through competitive inhibition, immune modulation, and ecological stabilization of the oral microbiome. This review compares the advantages and limitations of these natural agents, highlighting their safety profiles, patient acceptance, and potential synergistic effects when used in combination therapies.

Keywords:- Green tea; Lemongrass; Probiotics; Herbal dentistry; Oral microbiome; Periodontal disease; Dental caries; Natural oral healthcare.

How to cite this article: Vashisth P, Rathi N, Naik N S, Mittal M. Natural Adjuncts for Prevention of Oral Diseases - A Narrative Review of Green Tea, Lemon Grass and Probiotics in Oral Health Promotion. Int J Drug Deliv Technol. 2026;16(15s): 81-88. DOI: 10.25258/ijddt.16.15s.10.

Introduction

Oral health represents a fundamental component of overall health and well-being, influencing not only physiological functioning but also social interaction, self-esteem, and overall quality of life. Despite significant advancements in preventive dentistry, clinical techniques, and oral hygiene awareness, oral diseases remain among the most prevalent chronic health conditions worldwide. Dental caries, periodontal diseases, oral infections, and halitosis continue to affect individuals across diverse age groups, socioeconomic

backgrounds, and geographic regions, posing substantial public health challenges (1). The multifactorial nature of oral diseases, involving complex interactions between microbial biofilms, host immune responses, lifestyle factors, and environmental influences, makes their prevention and management particularly challenging. Traditional approaches to oral disease management have relied heavily on chemical antiseptics, antibiotics, fluoride-based products, and synthetic antimicrobial agents designed to inhibit pathogenic microorganisms and reduce plaque

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accumulation. Agents such as chlorhexidine have long been considered the gold standard for antimicrobial mouth rinses due to their broad-spectrum antibacterial activity. Nevertheless, prolonged use of chemical agents has been associated with various side effects, including mucosal irritation, tooth staining, altered taste sensation, and disruption of the natural oral microbiota (2). Furthermore, the increasing global concern regarding antimicrobial resistance has prompted researchers and clinicians to reconsider the long-term reliance on synthetic antimicrobial agents. Overuse and misuse of antibiotics in both medical and dental settings contribute to the emergence of resistant bacterial strains, highlighting the need for alternative therapeutic approaches that can maintain efficacy while minimizing adverse outcomes (3). In response to these challenges, there has been growing interest in natural and herbal therapies as adjuncts or alternatives to conventional dental treatments. Modern scientific research has increasingly validated these traditional practices by identifying bioactive phytochemicals responsible for antimicrobial, anti-inflammatory, antioxidant, and immunomodulatory effects (4). Among the wide range of herbal agents investigated, green tea (*Camellia sinensis*) and lemongrass (*Cymbopogon citratus*) have emerged as promising candidates due to their rich phytochemical profiles and demonstrated efficacy against oral pathogens. Green tea is widely recognized for its high concentration of polyphenols, particularly catechins such as epigallocatechin gallate (EGCG), which exhibit strong antibacterial and antioxidant properties (5). These compounds have been shown to inhibit the growth of cariogenic bacteria, reduce periodontal inflammation, and contribute to the prevention of oral diseases through multiple biological mechanisms (6). Similarly, lemongrass contains essential oils rich in citral and other terpenoid compounds known for potent antimicrobial and antifungal activity (7). Studies suggest that lemongrass extracts may be effective in controlling oral pathogens, reducing gingival inflammation, and serving as natural alternatives to synthetic mouth rinses (8). In addition to herbal compounds, probiotics have emerged as a revolutionary approach in modern dentistry, representing a paradigm shift from traditional antimicrobial strategies toward microbiome modulation. Rather than eliminating bacteria indiscriminately, probiotic therapy focuses on restoring ecological balance within the oral microbiome by introducing beneficial microorganisms capable of inhibiting pathogenic species through competitive exclusion, production of antimicrobial substances, and modulation of host immune responses. This concept aligns with

contemporary understanding of oral health as a dynamic balance between beneficial and pathogenic microorganisms, where disruption of microbial equilibrium leads to disease progression (9). The application of probiotics in dentistry has gained attention for its potential in preventing dental caries, managing periodontal disease, reducing halitosis, and improving overall oral health outcomes without contributing to antimicrobial resistance (10).

Role of Herbal and Natural Agents in Dentistry

Herbal medicine has played a significant role in oral healthcare for centuries, particularly within traditional medical systems such as Ayurveda, Traditional Chinese Medicine, and indigenous practices. Historically, plant-based extracts were used for managing toothache, oral infections, gum inflammation, and maintaining oral hygiene. Modern scientific research has confirmed that many herbal agents contain bioactive compounds capable of inhibiting microbial growth, reducing inflammation, and promoting tissue healing (11). The mechanisms underlying herbal efficacy often involve multiple biochemical pathways. Unlike synthetic drugs that typically target a single mechanism, plant-derived compounds frequently exhibit multifunctional properties. For example, polyphenols can disrupt bacterial cell walls, inhibit enzymatic activity essential for plaque formation, and neutralize free radicals that contribute to inflammatory processes (12). This multi-target approach may reduce the likelihood of resistance development while enhancing therapeutic outcomes. Safety and biocompatibility represent major advantages of herbal agents. Many plant-based compounds demonstrate lower toxicity compared with synthetic chemicals, making them suitable for long-term preventive use (13). Furthermore, patient acceptance of herbal formulations is increasing due to growing awareness of natural health products and desire for holistic treatment approaches. Despite promising benefits, challenges remain. Variability in plant composition due to environmental factors, differences in extraction methods, and lack of standardized clinical trials hinder widespread adoption. Therefore, rigorous scientific validation is essential to ensure consistent quality and therapeutic effectiveness (4).

3. Green Tea (*Camellia sinensis*) in Dentistry

3.1 Phytochemical Composition

Green tea is derived from the leaves of *Camellia sinensis* and is rich in biologically active compounds including catechins, polyphenols, flavonoids, tannins, and fluoride. The major catechins found in green tea include epigallocatechin gallate (EGCG), epigallocatechin

(EGC), epicatechin gallate (ECG), and epicatechin (EC). Among these, EGCG has been extensively studied due to its potent antioxidant and antimicrobial properties (5). Polyphenolic compounds present in green tea contribute significantly to its therapeutic effects by neutralizing free radicals and reducing oxidative stress. Oxidative stress plays a critical role in periodontal tissue destruction and inflammatory processes within the oral cavity (14). Additionally, green tea contains trace amounts of fluoride, which may contribute to enamel strengthening and caries prevention (5).

3.2 Mechanisms of Action

Green tea exerts multiple beneficial effects in oral healthcare through antimicrobial, anti-inflammatory, antioxidant, and anti-cariogenic mechanisms. Catechins inhibit bacterial adhesion to tooth surfaces, preventing biofilm formation and plaque accumulation. Studies have demonstrated that EGCG interferes with glucosyltransferase enzymes produced by *Streptococcus mutans*, reducing the synthesis of extracellular polysaccharides necessary for plaque development (15). Anti-inflammatory effects are achieved through modulation of cytokine production and inhibition of inflammatory mediators such as interleukin-1 β and tumor necrosis factor-alpha (16). Antioxidant activity protects gingival tissues from oxidative damage caused by bacterial toxins and immune responses. Additionally, green tea polyphenols exhibit potential anticancer properties by inducing apoptosis in malignant cells and inhibiting tumor growth pathways (17).

3.3 Dental Applications of Green Tea

Green tea has been investigated extensively for its potential role in preventing dental caries, managing

periodontal disease, reducing oral malodor, and supporting oral cancer prevention. Clinical studies indicate that green tea mouth rinses reduce plaque index and gingival inflammation when used regularly alongside standard oral hygiene practices (18). The antibacterial properties of catechins help suppress cariogenic bacteria, while antioxidant effects support tissue healing.

3.4 Clinical and Experimental Evidence on Green Tea in Dentistry

Numerous experimental and clinical studies have investigated the role of green tea in oral health, demonstrating its potential as both a preventive and therapeutic agent. In vitro studies consistently show inhibitory effects against cariogenic bacteria such as *Streptococcus mutans*, *Lactobacillus acidophilus*, and periodontal pathogens including *Porphyromonas gingivalis* (6). Clinical trials evaluating green tea mouth rinses have reported reductions in plaque accumulation and gingival bleeding comparable to conventional antiseptics, although outcomes vary depending on concentration and duration of use (19). Longitudinal observational studies also suggest that habitual green tea consumption may correlate with improved periodontal health and reduced tooth loss among adults (20). Emerging research has also explored green tea's potential in oral cancer prevention due to its ability to modulate cell proliferation and apoptosis pathways. Epigallocatechin gallate (EGCG) has demonstrated anti-proliferative effects against oral squamous cell carcinoma cells in laboratory studies, highlighting its potential role as a chemopreventive agent (17).

Table 1 — Major Bioactive Components of Green Tea^{5,6,7,8}

Component	Biological Activity	Dental Relevance
EGCG	Antimicrobial, antioxidant	Periodontal therapy
EGC	Anti-inflammatory	Gingivitis control
ECG	Plaque inhibition	Caries prevention
Fluoride	Enamel strengthening	Remineralization

4. Lemongrass (*Cymbopogon citratus*) in Dentistry

4.1 Phytochemical Composition and Chemical Constituents

Lemongrass (*Cymbopogon citratus*) is a widely used medicinal herb known for its aromatic properties and diverse therapeutic effects. The essential oil extracted from lemongrass contains bioactive compounds such as citral (geranial and neral), geraniol, limonene, myrcene,

flavonoids, and phenolic acids (7). Citral is considered the primary active component responsible for antimicrobial activity (21). Phytochemical analyses reveal that lemongrass essential oil exhibits strong lipophilic characteristics, allowing it to penetrate bacterial membranes and disrupt cellular structures (21). This property enhances its antimicrobial potency against

oral pathogens and supports its application in dental therapeutics.

4.2 Pharmacological Properties

The pharmacological profile of lemongrass includes antimicrobial, antifungal, anti-inflammatory, antioxidant, and analgesic activities. Studies demonstrate significant inhibitory effects against *Streptococcus mutans*, *Enterococcus faecalis*, and *Candida albicans*, indicating potential applications in caries prevention, periodontal therapy, and endodontics (21,22). Anti-inflammatory effects arise from modulation of inflammatory mediators such as prostaglandins and cytokines, reducing gingival inflammation and tissue destruction (23). Antioxidant properties further support tissue healing by neutralizing reactive oxygen species generated during inflammatory processes. Compared with synthetic antimicrobial agents, lemongrass may offer reduced toxicity and fewer side effects, making it suitable for long-term preventive use (13).

4.3 Dental and Oral Health Applications

Control of Oral Pathogens Lemongrass essential oil demonstrates broad-spectrum antibacterial activity against cariogenic and periodontal pathogens. Laboratory studies indicate significant inhibition zones against bacterial strains associated with dental plaque formation (22). **Periodontal Therapy** Clinical studies evaluating lemongrass-based mouth rinses report improvements in plaque index, gingival index, and bleeding scores comparable to chlorhexidine mouthwash (8). **Endodontic Applications** In endodontics, lemongrass oil has been studied as a natural root canal irrigant due to its antimicrobial activity against resistant bacteria such as *Enterococcus faecalis* (22). **Management of Oral Inflammation** Anti-inflammatory effects contribute to reduced gingival swelling and improved healing (23).

Table 2 — Major Properties of Lemongrass in Dentistry^{21,22,23}

Property	Mechanism	Dental Application
Antibacterial	Membrane disruption	Caries prevention
Antifungal	Growth inhibition	Oral candidiasis
Anti-inflammatory	Cytokine regulation	Gingivitis management
Antioxidant	Free radical neutralization	Tissue protection

5. Probiotics in Dentistry

5.1 Concept and Types of Oral Probiotics

Probiotics are defined as live microorganisms that provide health benefits when administered in adequate amounts (24). In dentistry, probiotics aim to restore microbial balance by promoting beneficial bacteria capable of inhibiting pathogenic species. Common probiotic strains include *Lactobacillus reuteri*, *Lactobacillus rhamnosus*, *Bifidobacterium lactis*, and *Streptococcus salivarius*.

Unlike traditional antimicrobial agents that eliminate bacteria broadly, probiotics focus on ecological modulation, promoting a balanced oral microbiome. This approach aligns with current understanding that oral health depends on microbial homeostasis rather than complete sterilization (9).

5.2 Mechanisms of Action in Oral Health

Probiotics exert therapeutic effects through several mechanisms (25):

1. Competitive exclusion of pathogenic bacteria by occupying adhesion sites.

2. Production of bacteriocins and antimicrobial peptides.
 3. Modulation of immune responses and reduction of inflammatory cytokines.
 4. Alteration of environmental conditions such as pH, limiting growth of cariogenic bacteria.
- These mechanisms contribute to improved oral health outcomes without disrupting beneficial microbial communities.

5.3 Applications of Probiotics in Dentistry

Probiotics have been studied extensively for prevention and management of dental caries, periodontal diseases, halitosis, and oral candidiasis. Clinical trials demonstrate reductions in *Streptococcus mutans* counts following probiotic supplementation, suggesting potential caries-preventive effects (10). In periodontal therapy, probiotics may reduce inflammation and improve clinical attachment levels when used as adjuncts to scaling and root planing (26). Halitosis management represents another promising application, as probiotic strains such as *Streptococcus salivarius* produce enzymes that neutralize volatile

sulfur compounds responsible for bad breath (27). Furthermore, probiotic therapy may support oral health

in orthodontic and implant patients by reducing biofilm accumulation around appliances (28).

1. Table 3 — Probiotic Strains and Dental Benefits^{25,26,27,28}

2. Probiotic Strain	3. Mechanism	4. Oral Health Benefit
5. Lactobacillus reuteri	6. Antimicrobial peptides	7. Periodontal support
8. Streptococcus salivarius	9. Competitive inhibition	10. Halitosis control
11. Bifidobacterium lactis	12. Immune modulation	13. Gingivitis prevention
14. Lactobacillus rhamnosus	15. Biofilm reduction	16. Caries prevention

6. Comparative Evaluation of Green Tea, Lemongrass, and Probiotics in Dentistry

Green tea, lemongrass, and probiotics represent three distinct yet complementary approaches within natural oral healthcare. While green tea and lemongrass primarily function through phytochemical-mediated antimicrobial and anti-inflammatory mechanisms, probiotics offer a biological strategy that modifies microbial ecology and promotes beneficial bacterial populations. Understanding these differences is essential for determining clinical applications and potential synergistic effects. Green tea's therapeutic effects are largely attributed to catechins such as epigallocatechin gallate (EGCG), which inhibit bacterial adhesion, suppress inflammatory mediators, and provide antioxidant protection (5). These properties make green tea particularly effective in preventing dental caries and managing periodontal inflammation. Additionally, green tea's antioxidant activity supports tissue regeneration, suggesting potential benefits in oral wound healing (14). Lemongrass essential oil demonstrates strong antimicrobial properties due to citral and other terpenoid compounds (21). Compared with green tea, lemongrass may exhibit stronger immediate bactericidal effects against certain oral pathogens. This makes it particularly suitable for topical applications such as mouth rinses and endodontic irrigants. However, essential oils require careful formulation to prevent mucosal irritation and ensure patient safety (13).

Probiotics differ fundamentally from herbal agents because they focus on restoring microbial balance rather than directly eliminating pathogens. By promoting beneficial bacterial species, probiotics may provide long-term ecological stability and reduce recurrence of oral diseases. This approach aligns with modern concepts of microbiome-based therapy, which emphasize maintaining microbial diversity as a key determinant of oral health (9).

7. Formulation and Commercial Dental Products

The increasing global demand for natural and preventive oral healthcare solutions has significantly influenced the development of commercial dental formulations incorporating herbal extracts and probiotic technologies. Green tea extracts, lemongrass essential oils, and probiotic strains have gained substantial attention due to their demonstrated antimicrobial, anti-inflammatory, antioxidant, and microbiome-modulating properties (5,21,25).

Green tea-based formulations have become increasingly popular in commercial oral care products, particularly in herbal toothpastes and mouth rinses. Mouth rinses containing standardized green tea polyphenols have demonstrated promising results in improving gingival indices and reducing bleeding scores (18).

Lemongrass-based dental formulations are being explored as natural substitutes for chlorhexidine. Clinical studies suggest that herbal mouth rinses formulated with lemongrass may achieve comparable antimicrobial outcomes (8).

Probiotic dental products represent a rapidly expanding segment of the oral healthcare market. Commercial probiotic formulations include lozenges, chewing gums, tablets, and mouth sprays designed to deliver viable probiotic strains to oral tissues (25). However, maintaining viability and stability of live microorganisms during manufacturing and storage remains a critical challenge (29).

8. Limitations and Challenges

Despite promising findings, several limitations must be addressed before widespread clinical adoption of these natural agents. One major challenge is variability in phytochemical composition due to differences in plant cultivation, harvesting, and extraction methods. Standardization of herbal products remains essential for ensuring consistent efficacy.

Clinical evidence also remains limited by small sample sizes and heterogeneous study designs. Large-scale randomized controlled trials are needed to establish definitive therapeutic guidelines. Additionally, long-

term safety data for high-concentration herbal extracts and probiotic supplementation remain insufficient.

Regulatory issues represent another significant barrier. Herbal and probiotic products are often categorized as dietary supplements rather than pharmaceutical agents, leading to variability in quality control and labeling standards. Establishing rigorous regulatory frameworks will be crucial for integrating natural therapies into mainstream dental practice.

9. Future Perspectives

Future research is expected to focus on combined herbal-probiotic formulations that leverage synergistic effects between antimicrobial phytochemicals and microbiome-modulating probiotics. Advances in nanotechnology may enhance delivery systems by improving stability and targeted release of bioactive compounds.

Personalized dentistry represents another promising direction, where treatments are tailored based on individual microbiome profiles. Probiotic therapy, in particular, aligns with this concept by addressing microbial imbalance rather than relying solely on broad-spectrum antimicrobial agents.

Artificial intelligence and digital health technologies may also play a role in optimizing formulation design and predicting therapeutic outcomes. Continued interdisciplinary research combining microbiology, pharmacology, and clinical dentistry will be essential for advancing natural oral healthcare solutions.

10. Conclusion

The integration of natural therapeutic agents such as green tea, lemongrass, and probiotics into dentistry reflects a broader transformation in modern healthcare toward preventive, biologically compatible, and patient-centered treatment approaches. As awareness grows regarding the limitations associated with long-term use of synthetic antimicrobial agents, including antimicrobial resistance, adverse side effects, and disruption of the oral microbiome, there is increasing interest in natural alternatives capable of supporting oral health through multifaceted biological mechanisms. Herbal compounds and probiotics represent promising adjunctive strategies that align with contemporary concepts of holistic healthcare and microbiome-based therapy, emphasizing balance and prevention rather than solely targeting disease symptoms.

Green tea has emerged as one of the most extensively studied natural agents in dentistry due to its rich phytochemical composition, particularly catechins such as epigallocatechin gallate (EGCG). These bioactive compounds exhibit strong antioxidant, anti-

inflammatory, and antimicrobial properties that contribute to improved oral health outcomes. The ability of green tea catechins to inhibit bacterial adhesion, suppress plaque formation, and modulate inflammatory responses highlights its potential as both a preventive and therapeutic agent. Evidence suggests that green tea-based products may assist in reducing dental caries risk, improving periodontal health, and controlling oral malodor. Furthermore, the antioxidant capacity of green tea supports tissue protection against oxidative stress, which plays a significant role in periodontal disease progression. Although current research demonstrates promising clinical outcomes, further investigations are necessary to determine optimal concentrations, delivery methods, and long-term effectiveness in diverse patient populations. Lemongrass represents another valuable natural agent with significant potential in dental applications. The essential oil of lemongrass contains active compounds such as citral that provide potent antibacterial and antifungal activity against key oral pathogens. These properties make lemongrass a promising candidate for periodontal therapy, herbal mouth rinses, and even endodontic procedures where antimicrobial efficacy is critical. Compared with conventional chemical antiseptics, lemongrass-based formulations may offer advantages such as reduced toxicity, improved patient acceptance, and fewer adverse effects. Additionally, its anti-inflammatory and antioxidant properties contribute to tissue healing and reduction of gingival inflammation. However, challenges related to formulation stability, standardization of extraction processes, and determination of safe therapeutic dosages must be addressed before widespread clinical adoption can be achieved. Probiotics introduce a fundamentally different approach to oral healthcare by focusing on ecological modulation rather than direct eradication of microorganisms. The concept of introducing beneficial bacterial strains to restore microbial balance represents a paradigm shift in dentistry, reflecting advances in understanding the oral microbiome as a complex and dynamic ecosystem. Probiotic therapy offers potential benefits in reducing pathogenic bacterial colonization, enhancing immune responses, and maintaining long-term microbial stability within the oral cavity. Clinical studies indicate promising outcomes in managing dental caries, periodontal diseases, halitosis, and oral candidiasis through probiotic supplementation. Furthermore, probiotic approaches may reduce reliance on broad-spectrum antimicrobial agents, thereby minimizing the risk of resistance development and preserving beneficial microbial communities. Despite the encouraging therapeutic potential of green tea,

lemongrass, and probiotics, several limitations must be considered. Current research is often characterized by variability in study design, differences in dosage and formulation, and limited long-term clinical trials. Standardization of herbal extracts and probiotic strains remains a critical challenge, as variations in preparation methods can significantly influence therapeutic outcomes. Additionally, regulatory frameworks governing herbal and probiotic products vary widely across regions, creating challenges in ensuring quality control, safety, and clinical reliability. Addressing these issues will require collaborative efforts among researchers, clinicians, regulatory authorities, and industry stakeholders to establish evidence-based guidelines for clinical use. Looking forward, the future of natural therapies in dentistry appears promising, particularly as advances in microbiome research, nanotechnology, and personalized medicine continue to evolve. Combined formulations integrating herbal compounds and probiotics may offer synergistic effects, enhancing antimicrobial efficacy while supporting microbial balance. Innovative delivery systems such as nanoencapsulation and targeted release technologies may further improve stability and bioavailability of natural agents. Additionally, personalized dentistry approaches that consider individual microbiome profiles could optimize treatment strategies and improve patient outcomes. In conclusion, green tea, lemongrass, and probiotics represent valuable natural agents with significant potential to complement traditional dental therapies. Their integration into modern dentistry supports the transition toward preventive and holistic oral healthcare models that prioritize safety, sustainability, and long-term health outcomes. Continued research and clinical validation will be essential for establishing standardized protocols and ensuring that these natural therapies can be effectively incorporated into routine dental practice, ultimately contributing to improved oral health and overall well-being.

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