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Review Article

Probiotics in Periodontal Therapy: A Comprehensive Review of their Role and Therapeutic Potential

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Abstract

Probiotics have emerged as a promising adjunct in periodontal therapy, offering a sustainable approach to reducing inflammation, restoring microbial balance, and improving clinical outcomes. This review explores their mechanisms of action, such as modulation of host immune responses and suppression of pathogenic bacteria, and highlights evidence from clinical studies demonstrating their efficacy in managing gingivitis, chronic periodontitis, and peri-implant diseases. Despite these benefits, challenges remain regarding strain specificity, optimal dosage, and long-term efficacy. Addressing these issues could position probiotics as a cornerstone of personalized, preventive, and holistic periodontal care.

Keywords: Probiotics; Periodontal Disease; Gingivitis; Periodontitis; Adjunctive Therapy and Oral Microbiota

Abbreviations

SRP, PPD, CAL, GI, BOP, CFU.

Introduction

Periodontal disease is defined as a chronic inflammatory condition that primarily affects the supporting structures of the dentition, including the gingiva, periodontal ligament, and alveolar bone [1]. The disease progression result from an imbalance between the host's immune response and microbial plaque, leading to tissue destruction and eventual tooth loss if left untreated [22]. It is recognized as one of the most prevalent oral health issues worldwide, significantly impacting the quality of life and systemic health of affected individuals [3-6].

Traditionally, the management of periodontal disease has relied on removal of local factors with mechanical debridement techniques such as scaling and root planing (SRP), often supplemented with chemotherapeutic agents like antibiotics and antiseptics [6-9]. While these approaches are effective in reducing bacterial loads and inflammation, they come with limitations, including the risk of antibiotic resistance, disruption of the natural oral microbiome, and recurrence of disease [4,10]. These challenges have prompted researchers and clinicians to seek alternative or adjunctive therapies that are both effective and sustainable [11,12].

Probiotics have been discussed as a promising therapeutic option in the field of periodontics [13,14]. Defined as live microorganisms that give health benefits to the host when administered in adequate amounts, probiotics have been extensively studied for their role in maintaining gut health [15,16]. More recently, probiotics showed a positive effect on the oral health due to their ability to modulate microbial populations and influence immune responses [17]. Unlike conventional antimicrobial agents, probiotics aim to restore and maintain microbial homeostasis rather than eradicate pathogens indiscriminately, offering a more balanced approach to disease management [18,19].

The use of probiotics in periodontal therapy is supported by a growing body of clinical and laboratory evidence. Studies have demonstrated their efficacy in reducing periodontal inflammation, improving clinical parameters such as probing pocket depth (PPD) and clinical attachment level (CAL), and preventing the recolonization of pathogenic bacteria [3,19]. This review aims to explore the current role of probiotics in managing periodontal disease, emphasizing their mechanisms of action, clinical applications, and potential as adjunctive treatments in periodontal therapy.

Mechanisms of probiotic action in periodontal disease

Probiotics exert their effects through multiple mechanisms that influence oral microbial balance and host immune response. These mechanisms involve complex interactions between probiotics and the oral microbiota, which lead to restoration of microbial homeostasis and boost host defense systems [14]. Colonization of probiotics in the oral cavity led to a direct competition between the beneficial microorganism and pathogenic bacteria, altering the local ecosystem in favor of beneficial species [20]. Additionally, they secrete bioactive molecules that inhibit harmful bacteria while simultaneously supporting the growth of commensal microorganisms. This comprehensive approach not only reduces the overall microbial load but also promotes a healthier oral environment conducive to periodontal tissue repair and maintenance (Figure 1).

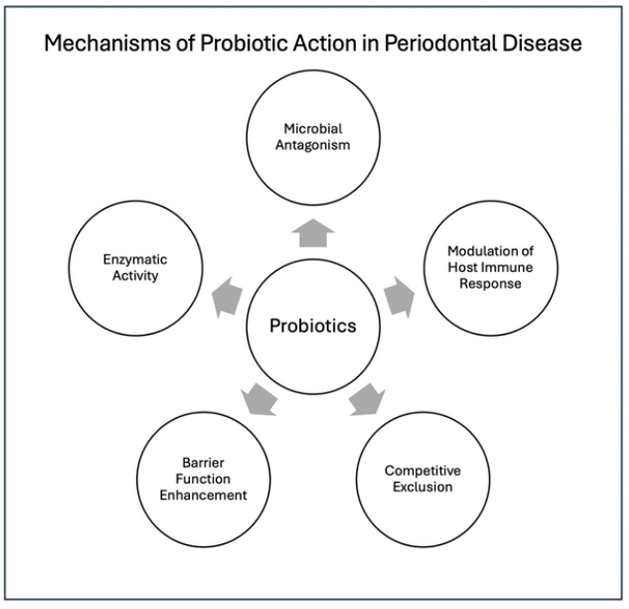

Figure 1

Figure 1 illustrating the key mechanisms of probiotic action in periodontal disease.

- **Microbial Antagonism**: Probiotics constrain pathogenic microorganisms by producing bacteriocins, lactic acid, and other antimicrobial compounds. For instance, *Lactobacillus reuteri* produces reuterin, which suppresses periodontopathogens such as *Porphyromonas gingivalis* and Aggregatibacter actinomycetemcomitans (21,22).
- **Competitive Exclusion**: Probiotics has the ability to adhere to oral tissues and dental surfaces, it prevents colonization by pathogenic bacteria, thereby reducing biofilm formation [23,24].
- **Modulation of Host Immune Response**: Probiotics reduce inflammatory action by downregulating pro-inflammatory cytokines (e.g., IL-1β, IL-6, TNF-α) and enhancing anti-inflammatory mediators such as IL-10 [4,11,25].
- **Enzymatic Activity**: *Lactobacillus salivarius* is a probiotic that produce enzymes like proteases that degrade pathogenic bacterial toxins and virulence factors [22].
- **Barrier Function Enhancement**: Probiotics enhance the epithelial barrier function by increasing mucin production and tight junction integrity. This prevents the penetration of harmful bacterial toxins and reduces local inflammation in periodontal tissues. For instance, strains such as *Lactobacillus rhamnosus* and *Bifidobacterium animalis* have been shown to improve barrier properties and epithelial cell viability, further protecting periodontal structures [3,18,26].

Clinical evidence of probiotics in periodontal disease

The role of probiotics in periodontal therapy has been extensively evaluated through a variety of clinical studies and trials. These studies provide compelling evidence of their ability to reduce inflammation, modulate microbial populations, and enhance periodontal healing. The following sections highlight the significant findings related to gingivitis, chronic periodontitis, and peri-implant diseases, emphasizing the clinical relevance of probiotics in improving oral health outcomes.

Probiotics and gingivitis

Numerous studies have demonstrated the advantageous effects of probiotics on gingival inflammation. Hallström., *et al*. (2013) reported a significant reduction in gingival index (GI) and bleeding on probing (BOP) in participants using *Lactobacillus reuteri* lozenges compared to placebo group. Similarly, Slawik., *et al*. (2011) showed that probiotics effectively reduced the incidence of experimental gingivitis markers by modulating the host immune response.

Probiotics in chronic periodontitis

Probiotics have been shown to be a potential adjunct to conventional therapies in the management of chronic periodontitis, offering benefits in reducing pathogenic bacterial load, enhancing the healing process, and restoring microbial homeostasis. Clinical trials have evaluated the efficacy of probiotics as adjuncts to SRP. Invernici., *et al*. (2018) observed that the administration of Bifidobacterium animalis significantly improved CAL and reduced PPD compared to SRP alone. Similarly, Tekce., *et al*. (2015) demonstrated that *Lactobacillus reuteri* enhanced periodontal healing and reduced inflammation post-SRP. Morales., *et al*. (2016) highlighted a marked decrease in P. gingivalis and Tannerella forsythia levels following probiotic supplementation *[27]*.

Peri-implant diseases

Probiotics have also been studied for managing peri-implant mucositis and peri-implantitis. Hallström., *et al*. (2015) found that *Lactobacillus reuteri* lozenges combined with mechanical debridement reduced inflammation and plaque scores around implants.

Prevention of recurrence

Probiotic supplementation may help maintain periodontal health post-treatment by preventing recolonization of pathogenic bacteria. Schlagenhauf., *et al*. (2020) observed sustained improvement in periodontal parameters in individuals consuming *Lactobacillus reuteri*-containing lozenges during long sea voyages.

Different forms and concentrations of probiotics used in periodontal therapy

Probiotics have been administered in various forms and concentrations to maximize their therapeutic efficacy in periodontal therapy. Common forms include lozenges, tablets, capsules, powders, mouth rinses, and dairy products fortified with probiotic strains (Table 1). Lozenges containing *Lactobacillus reuteri* have demonstrated significant reductions in gingival inflammation and biofilm formation [11]. Tablets with *Bifidobacterium animalis* and *Lactobacillus salivarius* have been shown to improve clinical attachment levels and reduce probing depths in chronic periodontitis [18].

Concentrations of probiotics vary across studies, typically ranging from 10^6 to 10^9 colony-forming units (CFU) per dose. Higher concentrations, such as those above 10^8 CFU, are generally associated with more pronounced effects on periodontal parameters [19,26]. The mode of delivery also influences efficacy; for instance, mouth rinses allow probiotics to come into direct contact with oral tissues, while capsules provide systemic effects. The choice of probiotic formulation and concentration should be tailored to the patient's clinical condition and treatment goals.

Among these forms, lozenges and tablets are the most commonly used in periodontal therapy due to their ease of use and direct application to the oral cavity. Lozenges containing *Lactobacillus reuteri* have been widely studied and have shown consistent benefits in reducing BOP and improving GI. Similarly, tablets with high CFU counts of strains like *Lactobacillus salivarius* are preferred in chronic periodontitis cases for their ability to penetrate periodontal pockets effectively. Probiotic mouth rinses, while less common, are gaining attention as an adjunct for patients seeking non-invasive applications, particularly in cases of gingivitis or mild periodontal disease [28].

Table 1 summary of the different forms and concentrations of probiotics used in periodontal therapy.

Form	Probiotic Strains	Typical Concentration (CFU/dose)	Clinical Notes
Lozenges	*Lactobacillus reuteri*	10^8 to 10^9	Reduces gingival inflammation and biofilm formation
Tablets	*Bifidobacterium animalis, Lactobacillus salivarius*	10^8 to 10^9	Improves attachment levels and reduces probing depths
Capsules	Multiple strains based on formulation	10^6 to 10^9	Systemic effects based on formulation
Mouth Rinses	*Lactobacillus reuteri, Lactobacillus rhamnosus*	10^7 to 10^9	Direct application to oral tissues; adjunctive use
Powders	Custom formulations	Varies	Flexible usage in custom regimens
Dairy Products	Fortified with *Lactobacillus* and *Bifidobacterium* species	10^6 to 10^8	Convenient but limited in targeted delivery

Table 1

Comparison with conventional therapies

Probiotics offer several advantages over conventional adjunctive treatments:

- **Safety**: Unlike antibiotics, probiotics do not contribute to resistance or systemic side effects.
- **Sustainability**: Probiotics promote long-term oral health by restoring microbial balance rather than eradicating pathogens indiscriminately.
- **Complementary Effects**: Probiotics enhance the outcomes of mechanical therapies and may serve as an alternative in patients contraindicated for antibiotics use [12].

Challenges and future directions

While probiotics have shown significant promise in periodontal therapy, their application is not without challenges. Understanding the limitations and addressing the gaps in current research are crucial for optimizing their use. Despite promising results, the use of probiotics in periodontal therapy faces several challenges:

- **Strain-Specific Effects**: Probiotic efficacy depends on the strain and its ability to survive oral conditions. Comparative studies are needed to identify the most effective strains [24,28].
- **Optimal Dosage and Delivery**: Standardized dosing and delivery mechanisms (e.g., tablets, lozenges, mouth rinses) must be established [4].
- **Individual Variability**: Genetic and lifestyle factors influence host response to probiotics. Personalized approaches may be required.
- **Long-Term Efficacy**: Further research is necessary to evaluate the sustained benefits of probiotics and their impact on recurrence rates [27].

Conclusion

Probiotics represent a promising adjunct in the management of periodontal disease, offering benefits in reducing inflammation, restoring microbial balance, and enhancing the outcomes of conventional therapies. Their ability to modulate host immune responses and suppress pathogenic bacteria provides a unique and sustainable approach to oral health management. Furthermore, probiotics show potential in reducing the recurrence of periodontal disease, promoting long-term maintenance of periodontal health. While current evidence supports their use, further studies are needed to address challenges related to strain selection, dosing, and long-term efficacy. As the field evolves, probiotics may become a cornerstone in holistic periodontal care, emphasizing prevention, health maintenance, and individualized treatment approaches tailored to patient-specific needs.

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Conflict of Interest

The authors declare no conflict of interest regarding the publication of this research.

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