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REBALANCING THE ORAL MICROBIOME: ARE PROBIOTICS THE NEXT STEP IN PERIODONTAL THERAPY?

REEQUILIBRANDO O MICROBIOMA ORAL: SÃO OS PROBIÓTICOS O PRÓXIMO PASSO NA TERAPIA PERIODONTAL?

REEQUILIBRANDO EL MICROBIOMA ORAL: ¿SON LOS PROBIÓTICOS EL PRÓXIMO PASO EN LA TERAPIA PERIODONTAL?

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Pedro Guimarães Sampaio Trajano dos Santos
Undergraduate in Dentistry
Institution: Faculdade de Odontologia do Recife, Brazil
Address: Pernambuco, Brazil
E-mail: pedroguimaraessampaio@gmail.com

Rosana Maria Coelho Travassos
PhD in Endodontics
Institution: Universidade de Pernambuco
Address: Pernambuco, Brazil
E-mail: rosana.travassos@upe.br

Vânia Cavalcanti Ribeiro da Silva
PhD in Dentistry
Institution: Universidade de Pernambuco
Address: Pernambuco, Brazil
E-mail: vania.silva@upe.br

Priscylla Gonçalves Correia Leite de Marcelos
PhD
Institution: Universidade Federal de Alagoas
Address: Pernambuco, Brazil
E-mail: priscylla.marcelos@foufal.u-fal.br

Priscila Prosini
PhD
Institution: Universidade de Pernambuco
Address: Pernambuco, Brazil
E-mail:priscila.prosini@upe.br

Josué Alves
PhD
Institutio: University of Pernambuco
Address: Pernambuco, Brazil
E-mail: Josue.alves@upe.br

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Adriane Tenório Dourado Chaves
PhD
Institution: University of Pernambuco
Address: Pernambuco, Brazil
E-mail: adriane.chaves@upe.br

Eliana Santos Lyra da Paz
Doutorado em Ciências Biológicas
Institution: Universidade de Pernambuco (UPE)
Address: Pernambuco, Brasil
E-mail: eliana.lyra@upe.br

ABSTRACT
Objective: To assess the effectiveness of probiotics as an adjunct to scaling and root planing (SRP) in improving clinical, microbiological, and inflammatory outcomes in patients with periodontitis. Methods: A review of randomized clinical trials published in the last decade was performed, focusing on studies evaluating probiotic administration alongside SRP. Results: Most included studies reported significant improvements in clinical periodontal parameters in groups receiving probiotics compared to placebo. Reductions in PD and BOP were consistently observed, along with favorable changes in the composition of subgingival microbiota, including decreased levels of periodontal pathogens. Additionally, some studies demonstrated reductions in pro-inflammatory cytokines. No significant adverse effects were reported, supporting the safety profile of probiotics. Conclusion: Probiotics appear to be a promising adjunctive strategy in periodontal therapy, contributing to microbial balance and improved clinical outcomes. However, variations in probiotic strains, dosages, and treatment protocols highlight the need for standardized clinical guidelines and further high-quality trials.

Keywords: Probiotics. Periodontitis. Oral Microbiome. Scaling and Root Planing. Dysbiosis. Inflammation. Adjunctive Therapy.

RESUMO
Objetivo: Avaliar a eficácia dos probióticos como adjuvante à raspagem e alisamento radicular (RAR) na melhoria dos desfechos clínicos, microbiológicos e inflamatórios em pacientes com periodontite. Métodos: Foi realizada uma revisão de ensaios clínicos randomizados publicados na última década, com foco em estudos que avaliaram a administração de probióticos juntamente com a RAR. Resultados: A maioria dos estudos incluídos relatou melhorias significativas nos parâmetros periodontais clínicos nos grupos que receberam probióticos em comparação ao placebo. Reduções na PS e no SS foram consistentemente observadas, juntamente com mudanças favoráveis na composição da microbiota subgengival, incluindo a diminuição dos níveis de patógenos periodontais. Além disso, alguns estudos demonstraram reduções de citocinas pró-inflamatórias. Não foram relatados efeitos adversos significativos, apoiando o perfil de segurança dos probióticos. Conclusão: Os probióticos parecem ser uma estratégia adjuvante promissora na terapia periodontal, contribuindo para o equilíbrio microbiano e a melhoria dos desfechos clínicos. No entanto, as variações nas cepas probióticas, dosagens e protocolos de tratamento destacam a necessidade de diretrizes clínicas padronizadas e de mais ensaios de alta qualidade.

Palavras-chave: Probióticos. Periodontite. Microbioma Oral. Raspagem e Alisamento Radicular. Disbiose. Inflamação. Terapia Adjuvante.

RESUMEN
Objetivo: Evaluar la efectividad de los probióticos como complemento del raspado y alisado radicular (RAR) en la mejora de los resultados clínicos, microbiológicos e inflamatorios en pacientes con

periodontitis. Métodos: Se realizó una revisión de ensayos clínicos aleatorizados publicados en la última década, centrándose en estudios que evaluaron la administración de probióticos junto con el RAR. Resultados: La mayoría de los estudios incluidos reportaron mejoras significativas en los parámetros periodontales clínicos en los grupos que recibieron probióticos en comparación con el placebo. Se observaron consistentemente reducciones en la PS y el SS, junto con cambios favorables en la composición de la microbiota subgingival, incluyendo niveles disminuidos de patógenos periodontales. Además, algunos estudios demostraron reducciones en las citocinas proinflamatorias. No se reportaron efectos adversos significativos, lo que respalda el perfil de seguridad de los probióticos. Conclusión: Los probióticos parecen ser una estrategia complementaria prometedora en la terapia periodontal, contribuyendo al equilibrio microbiano y a la mejora de los resultados clínicos. Sin embargo, las variaciones en las cepas probióticas, dosis y protocolos de tratamiento resaltan la necesidad de directrices clínicas estandarizadas y más ensayos de alta calidad.

Palabras clave: Probióticos. Periodontitis. Microbioma Oral. Raspado y Alisado Radicular. Disbiosis. Inflamación. Terapia Complementaria.

1 INTRODUCTION

Periodontitis is a highly prevalent chronic inflammatory disease characterized by the progressive destruction of periodontal tissues, ultimately leading to tooth loss if untreated. Its pathogenesis is closely associated with a disruption in the ecological balance of the oral microbiome, shifting from a symbiotic state to a dysbiotic biofilm enriched with pathogenic species such as Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola (Hajishengallis & Lamont, 2012). This dysbiosis triggers a dysregulated host immune response, which plays a central role in tissue destruction rather than the microbial challenge alone.

Conventional periodontal therapy, particularly scaling and root planing (SRP), remains the gold standard for the management of periodontitis by effectively reducing bacterial load and disrupting subgingival biofilm. However, despite its clinical effectiveness, limitations persist. One of the main challenges is the rapid recolonization of periodontal pockets by pathogenic microorganisms, which may compromise long-term treatment outcomes (Teughels *et al.*, 2011). Additionally, the adjunctive use of systemic antibiotics, although beneficial in specific cases, raises concerns regarding antimicrobial resistance and potential adverse effects.

In this context, alternative and adjunctive therapeutic strategies aimed at modulating the oral microbiome have gained increasing attention. Probiotics, defined as live microorganisms that confer health benefits to the host when administered in adequate amounts, represent a promising approach in this regard (Hill *et al.*, 2014). Originally studied for their gastrointestinal effects, probiotics have more recently been investigated for their potential role in oral health, particularly in the management of periodontal diseases.

The rationale for probiotic use in periodontology is based on their ability to restore microbial balance and interfere with pathogenic biofilm formation. Probiotics can exert direct effects by competing with pathogenic bacteria for adhesion sites and nutrients, as well as by producing antimicrobial substances such as bacteriocins and organic acids (Allaker & Stephen, 2017). In addition to these direct antimicrobial actions, probiotics may also modulate host immune responses by influencing cytokine production, enhancing barrier function, and promoting anti-inflammatory pathways.

Several clinical studies have evaluated the adjunctive use of probiotics in periodontal therapy, reporting improvements in clinical parameters and shifts in the composition of the subgingival microbiota (Gruner *et al.*, 2016; Martin-Cabezas *et al.*, 2016). These findings suggest that probiotics may contribute not only to microbial control but also to the modulation of host response, addressing key aspects of periodontal disease pathogenesis.

Despite growing interest and promising results, the clinical application of probiotics in periodontology remains heterogeneous, with variations in bacterial strains, dosages, delivery methods, and treatment duration. Moreover, the long-term sustainability of their effects and their integration into standard periodontal protocols are still under investigation.

Therefore, a comprehensive understanding of the role of probiotics in periodontal disease is essential to clarify their therapeutic potential and to support their incorporation into evidence-based clinical practice.

2 METHODOLOGY

A narrative review was conducted to explore the role of probiotics in periodontal disease, with emphasis on their interaction with the oral microbiome and potential therapeutic applications. Searches were performed in PubMed/MEDLINE, Scopus, and Cochrane Library for studies using keywords such as “probiotics,” “periodontitis,” “oral microbiome,” and “dysbiosis.”

A wide range of study designs was included, such as clinical studies, experimental research, microbiological investigations, and relevant in vitro studies. This broad inclusion aimed to capture both mechanistic insights and applied perspectives.

Articles were selected based on their relevance to probiotic effects on microbial balance, host response, and periodontal health.

Data extraction focused on study characteristics, probiotic strains investigated, and key findings. The synthesis was conducted qualitatively, organizing evidence into themes such as mechanisms of action, microbiome modulation, and therapeutic perspectives.

3 RESULTS

The included evidence, predominantly derived from randomized clinical trials and systematic reviews published over the past decade, consistently indicates that probiotics used as adjuncts to scaling and root planing (SRP) provide additional clinical, microbiological, and immunological benefits compared to SRP alone.

3.1 CLINICAL PERIODONTAL OUTCOMES

Most randomized clinical trials reported statistically significant improvements in key periodontal parameters in probiotic groups. Reductions in probing depth (PD) and bleeding on probing (BOP) were the most consistently observed findings. For instance, studies evaluating Lactobacillus reuteri demonstrated greater PD reduction and clinical attachment level (CAL) gain when compared

to placebo groups following SRP (Teughels *et al.*, 2013; Vicario *et al.*, 2013). These improvements were particularly evident in moderate to deep periodontal pockets.

A systematic review by Martin-Cabezas *et al.* (2016) confirmed that adjunctive probiotic therapy resulted in modest but significant clinical benefits, especially in BOP reduction. Similarly, Gruner *et al.* (2016) reported that probiotics improved periodontal parameters, although heterogeneity among studies was noted.

3.2 MICROBIOLOGICAL EFFECTS

Several studies demonstrated that probiotics contribute to shifts in the subgingival microbiota toward a more health-associated composition. Significant reductions in key periodontal pathogens, including Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola, were observed following probiotic use (Iniesta *et al.*, 2012; Tekce *et al.*, 2015).

These microbiological changes are attributed to mechanisms such as competitive exclusion, production of antimicrobial compounds, and disruption of pathogenic biofilm formation. Importantly, some studies also reported increased levels of beneficial commensal bacteria, suggesting a true ecological rebalancing rather than simple bacterial suppression.

3.3 IMMUNOLOGICAL AND INFLAMMATORY MARKERS

Adjunctive probiotic therapy has also been associated with modulation of the host immune response. Clinical trials reported reductions in pro-inflammatory cytokines such as interleukin-1β (IL-1β), tumor necrosis factor-alpha (TNF-α), and interleukin-6 (IL-6) in gingival crevicular fluid (GCF) (Szkaradkiewicz *et al.*, 2014).

These findings support the hypothesis that probiotics not only act on microbial composition but also attenuate the exaggerated host inflammatory response that drives periodontal tissue destruction. Some evidence also suggests increased levels of anti-inflammatory mediators, indicating a shift toward immune homeostasis.

3.4 VARIABILITY IN PROBIOTIC PROTOCOLS

Despite overall positive findings, substantial heterogeneity exists among studies. Variations were observed in:

a) Probiotic strains (Lactobacillus reuteri, Lactobacillus brevis, Bifidobacterium spp.)

b) Dosage and concentration

c) Delivery methods (lozenges, tablets, sachets)

d) Duration of administration (ranging from 2 weeks to 3 months)

This variability limits direct comparison across studies and complicates the establishment of standardized clinical protocols.

3.5 SAFETY PROFILE

Across the included studies, probiotics were well tolerated, with no significant adverse effects reported. This favorable safety profile represents an advantage over systemic antibiotics, particularly in the context of increasing antimicrobial resistance.

4 DISCUSSION

The present review reinforces the growing body of evidence suggesting that probiotics may serve as a valuable adjunct in periodontal therapy by targeting two fundamental components of periodontitis pathogenesis: microbial dysbiosis and host-mediated inflammation. This dual-action approach aligns with the contemporary paradigm shift in periodontology, which increasingly recognizes that disease progression is not solely driven by specific pathogens, but by a dysregulated ecological and immunological network.

From a clinical standpoint, the additional improvements observed in probing depth (PD), bleeding on probing (BOP), and, to a lesser extent, clinical attachment level (CAL), indicate that probiotics may enhance the outcomes of conventional scaling and root planing (SRP). Although these improvements are often described as modest, their clinical relevance should not be underestimated. Even small reductions in PD and inflammation can significantly impact disease progression, particularly in patients with moderate to severe periodontitis or in sites that are less responsive to mechanical debridement alone. Furthermore, the consistency of BOP reduction across studies suggests a reproducible anti-inflammatory effect, which is a critical parameter given its strong association with disease activity.

A key strength of probiotic therapy lies in its ecological mechanism of action. Unlike systemic antibiotics, which broadly suppress bacterial populations and may disrupt commensal microbiota, probiotics appear to promote a rebalancing of the microbial ecosystem. This concept is particularly relevant within the framework of the polymicrobial synergy and dysbiosis model, where disease is driven by a shift in the overall microbial community rather than the presence of isolated pathogens. By competing for adhesion sites, producing antimicrobial substances, and interfering with quorum sensing, probiotics may limit the recolonization of periodontal pockets by keystone pathogens such as Porphyromonas gingivalis. Importantly, some studies suggest that probiotics may also facilitate the re-establishment of beneficial commensal species, supporting a more stable and resilient biofilm.

In addition to their microbiological effects, probiotics exert important immunomodulatory actions. The observed reductions in pro-inflammatory cytokines such as IL-1β, TNF-α, and IL-6 highlight their potential to attenuate the host's destructive inflammatory response. This is particularly significant given that periodontal tissue breakdown is largely mediated by the host rather than by direct bacterial damage. By modulating immune pathways, probiotics may help shift the balance from a destructive to a protective response, potentially enhancing tissue stability and healing. This host-modulatory effect places probiotics within a broader category of adjunctive therapies aimed at controlling inflammation, alongside agents such as subantimicrobial-dose doxycycline and omega-3 fatty acids.

Another relevant aspect is the safety and tolerability of probiotics. Across the reviewed studies, no significant adverse effects were reported, which contrasts favorably with systemic antibiotics that may cause gastrointestinal disturbances and contribute to antimicrobial resistance. In an era where antibiotic stewardship is increasingly emphasized, probiotics offer an attractive alternative that aligns with efforts to reduce unnecessary antibiotic use in periodontal therapy.

Despite these promising findings, several limitations must be critically considered. One of the most significant challenges is the marked heterogeneity across studies. Differences in probiotic strains, formulations, dosages, frequency of administration, and duration of treatment make it difficult to directly compare results or establish standardized clinical recommendations. Importantly, probiotic effects are strain-specific, meaning that findings associated with one strain cannot be generalized to others. This variability underscores the need for more rigorous and standardized clinical trial designs.

Additionally, the duration of probiotic effects remains unclear. Many studies evaluate outcomes over relatively short follow-up periods, typically ranging from a few weeks to a few months. As a result, it is uncertain whether the observed benefits are sustained over time or whether continuous administration is required to maintain clinical and microbiological improvements. The concept of transient colonization is particularly relevant, as many probiotic strains do not permanently integrate into the oral microbiome, potentially limiting their long-term efficacy.

Another important consideration is patient-related variability. Factors such as oral hygiene practices, smoking status, systemic conditions, and baseline microbiological profile may influence the effectiveness of probiotics. This suggests that probiotic therapy may not be equally beneficial for all patients, highlighting the potential need for personalized or precision-based approaches in periodontal treatment.

Furthermore, while reductions in periodontal pathogens are frequently reported, the methodologies used to assess microbiological changes vary considerably, ranging from culture-based techniques to advanced molecular methods. This inconsistency may affect the reliability and

comparability of findings. Future studies employing standardized, high-resolution microbiome analysis could provide deeper insights into how probiotics influence microbial networks and functional pathways.

It is also important to contextualize probiotics within the broader landscape of adjunctive periodontal therapies. While they offer clear advantages in terms of safety and biological plausibility, their clinical effects appear to be less pronounced than those observed with systemic antibiotics in certain high-risk cases. Therefore, probiotics should not be viewed as a replacement for established therapies, but rather as a complementary strategy that may be particularly useful in maintenance phases, in patients with contraindications to antibiotics, or as part of long-term biofilm control strategies.

Finally, the translation of current evidence into clinical practice remains limited by the absence of clear guidelines. Clinicians are often faced with a wide variety of commercially available probiotic products, many of which differ significantly in composition and quality. Without standardized recommendations regarding strain selection, dosage, and treatment protocols, the integration of probiotics into routine periodontal care remains inconsistent.

In summary, probiotics represent a promising and biologically sound adjunct in periodontal therapy, with demonstrated benefits in clinical, microbiological, and immunological parameters. However, their full therapeutic potential has yet to be clearly defined. Future research should focus on well-designed, large-scale randomized clinical trials with standardized methodologies, longer follow-up periods, and stratification of patient populations. Such efforts will be essential to establish evidence-based protocols and to determine the precise role of probiotics within modern periodontal treatment strategies.

5 CONCLUSION

Probiotics show promise as an adjunctive strategy in periodontal therapy, contributing to improved clinical outcomes, modulation of the oral microbiome, and attenuation of inflammatory responses. Their use aligns with contemporary approaches that emphasize ecological and host-modulatory treatment strategies.

Despite encouraging results, current evidence is limited by methodological variability and lack of standardization. Future well-designed randomized clinical trials are necessary to establish definitive protocols regarding strain selection, dosage, delivery methods, and treatment duration.

The integration of probiotics into periodontal therapy may represent an important step toward more personalized and biologically driven treatment approaches, but their routine clinical use should be guided by stronger and more consistent evidence.

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