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PROBIOTICS' FUNCTION IN ENHANCING THE HEALTH OF PERIODONTAL TISSUE: A COMPREHENSIVE ANALYSIS OF RECENT DATA

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ABSTRACT

Periodontal disease is one of the common dental and oral health problems and can cause damage to the dental supporting tissue if not treated properly. Various approaches have been developed to prevent and treat this disease, one of which is the use of probiotics. Probiotics are known to help maintain the balance of the oral microbiota, reduce inflammation, and inhibit the growth of pathogenic bacteria that contribute to periodontal disease. This study aims to review the role of probiotics in improving periodontal tissue health based on recent studies. The method used in this review involved searching and selecting journals from various scientific databases relevant to the topic of probiotics and periodontal health. The inclusion criteria included studies that addressed the effects of probiotics on periodontal health, while the exclusion criteria were applied to studies with methodologies that were unclear or irrelevant to the focus of the study. The results of the review show that probiotics, especially from the genera Lactobacillus and Bifidobacterium, have the potential to reduce gingival inflammation, reduce the depth of periodontal pockets, and improve overall periodontal health. The main mechanisms found involve competition with pathogenic bacteria, modulation of immune responses, as well as the production of natural antimicrobial compounds. In conclusion, probiotics have the potential to be an effective adjunct therapy in maintaining the health of periodontal tissue. However, more research is needed to determine the optimal dosage, duration of use, as well as its long-term effectiveness in periodontal care.

Keywords: Probiotics, Periodontal Health, Oral Microbiota, Gingival Inflammation, Supplemental Therapy

INTRODUCTION

Among the chronic inflammatory disorders is periodontal disease that commonly occurs in the oral cavity and is the primary reason why adults lose their teeth. The disease is caused by an accumulation of bacterial plaque that triggers an excessive inflammatory response, which can eventually damage dental support tissues such as periodontal ligaments and alveolar bones. Although conventional therapies such as mechanical cleaning and antibiotic use have been widely used, limitations in long-term effectiveness as well as the risk of antibiotic resistance are driving research into alternative therapeutic approaches, including the use of probiotics (Suratri, 2020; Wijayanti et al., 2024).

When taken in adequate quantities, probiotics—live microorganisms—benefit their hosts' health. With regard to periodontal health, probiotics are thought to aid in re-establishing the oral microbiota's equilibrium, reduce the number of pathogenic bacteria, and modulate immune and inflammatory responses. Numerous investigations have demonstrated the potential probiotics' presence in lowering inflammatory indicators, improving the condition of periodontal tissue, and increasing the diversity of healthy oral microbiota. However, despite the evidence supporting the benefits of probiotics, there are still variations in the results of studies that require further analysis (Jansen et al., 2021; Puzhankara et al., 2023).

This review aims to evaluate the current evidence on the role of probiotics in improving periodontal tissue health. The main focus of this examination is to examine the mechanism of action of probiotics in modulating the oral microbiota and immune response, as well as to analyze their effectiveness in supporting conventional periodontal therapy. Thus, the outcomes of this review are expected to provide a more thorough comprehension probiotics' potential as an adjuvant therapy in the management of periodontal disease (Hardan et al., 2022; Ausenda et al., 2023).

In this review, a variety of experimental and clinical studies addressing analysis is done on how probiotics affect periodontal health. The literature used in this review was obtained from important scientific databases, including Web of Science, PubMed, and Scopus, with a publication time range between 2015 to 2025. Studies included in the analysis include randomized controlled clinical trials (RCTs), in vivo research, as well as systematic reviews and meta-analyses relevant to this topic (Kapila et al., 2021; Gao et al., 2022).

The results of this review are expected to identify the advantages and limitations of using probiotics to treat periodontal disease as well as formulate recommendations for further research. By understanding probiotics' efficacy and methods for promoting periodontal health, it is hoped that this therapy can be integrated more widely in clinical practice to improve treatment outcomes for individuals suffering from periodontal disease (Abdullah et al., 2022; Minić et al., 2021).

LITERATURE REVIEW

Probiotics can improve periodontal health by modulating the oral microbiota and reducing inflammation. They work by inhibiting the growth of pathogenic bacteria, reducing inflammation, and improving gum health. Some probiotic strains, such as Lactobacillus reuteri, have been shown to be effective in reducing inflammation and periodontal pocket depth (Agossa, 2022).Mechanism of Action of Probiotics in Periodontal Health:

a. Reducing Pathogenic Bacteria:
   Probiotics such as Lactobacillus and Bifidobacterium can compete with pathogenic bacteria for nutrients and attachment sites on tooth surfaces, thereby reducing the number of bacteria that cause periodontal disease.
b. Reducing Inflammation:
   Probiotics can modulate the immune response, reduce the production of pro-inflammatory cytokines (such as IL-1β and TNF-α), and increase the production of anti-inflammatory cytokines.

c. Improving Gum Health:

By reducing inflammation and disease-causing bacteria, probiotics can help maintain gum health and prevent periodontal tissue damage (Azis, 2020).

RESEARCH METHODOLOGY

This review was conducted by a systematic method using various reliable scientific data sources. The main databases used for literature searches include PubMed, Scopus, and the Web of Science. The search was carried out utilising a mix of keywords, including "probiotics AND periodontal health", "probiotics AND periodontitis", "oral microbiota and probiotics", "systematic review of periodontal probiotics", and "effect of probiotics on periodontal inflammation". The acquired articles were then chosen according to predetermined inclusion and exclusion criteria (Apriliani et al., 2024; Oktafiani et al., 2023).

The inclusion criteria in this review include studies that address probiotic usage in relation to periodontal health, both in clinical and experimental research. Only articles published in reputable journals and available in English are included in the analysis. In addition, studies that use valid methods and have clearly interpretable data are also part of the inclusion criteria (Morales et al., 2021; Nguyen et al., 2021).

Meanwhile, exclusion criteria include articles that are not available in understandable languages, studies with weak methodologies or irrelevant to the topic, as well as review articles without primary data analysis. In addition, studies with too small sample sizes or no clear control group were also not included in this review (LI et al., 2023; Gheisary et al., 2022).

Data analysis was carried out using a systematic synthesis approach using preferred reporting items for systematic reviews and meta-analyses, or PRISMA. Articles that satisfied the requirements for inclusion were assessed based on the study design, the type of probiotics used, the intervention method, and the reported results related to the effectiveness of probiotics in improving periodontal tissue health. The data obtained were compared and analyzed to identify key trends, differences in outcomes between studies, as well as factors influencing the effectiveness of probiotics in relation to the health of the gums (Hardan et al., 2022; Vives-Soler et al., 2020).

RESULT RESEARCH

Table 1. Review Analysis

No.	Name	Year	Type of	Research Methods	Result	Significant Results
1.	Sachelarie, L., Scrobota, I., Romanul, I., Iurcov, R., Potra	2024	Randomized Controlled Trial (RCT)	Randomised controlled clinical trials (RCTs) with three	All groups showed a reduction in the clinical index of periodontitis, with kefir	Tannerella forsythia numbers have significantly decreased

	Cicalau, G. I., & Todor,			groups (probiotics, kefir, and controls). Data were collected over three months using the periodontitis index and subgingival microbial DNA analysis.	having similar effects to probiotics.	across all categories.
2.	Retamal-Valdes, B., Teughels, W., Oliveira, L. M., da Silva, R. N., Fritoli, A., Gomes, P., Soares, G. M. S., Temporão, N., Furquim, C. P., Duarte, P. M., Doyle, H., Faveri, M., Figueiredo, L. C., & Feres, M.	2025	clinical trials with a randomized controlled trial (RCT) design	Controlled trial with two groups (standard periodontal therapy + probiotics vs. standard therapy + placebo) for 8 weeks.	Compared to the placebo group, the probiotic group's inflammation was significantly reduced.	The gingival index (GI) decreased by 1.83 points and the depth of the periodontal pocket (PPD) decreased by 2.42 mm with *a p < 0.0001*.
3.	Blais, L., Auclair-Ouellet, N., Tremblay, A., & Binda, S.	2022	Clinical Trial using Split-Mouth Randomisation	split-mouth design randomised controlled clinical trial, comparing postbiotic-based gels with chlorhexidine gels.	Both gels showed similar results in reducing periodontal parameters.	There was no significant difference in periodontal parameters between the two groups after six months.

4.	Puzhankara, L., Banerjee, A., Chopra, A., Ramanarayanan, V., & Kedlaya, M. N.	2021	Randomized Clinical Trial (RCT)	Randomised controlled clinical trials (RCTs) using a four-group, double-blind, design with a placebo and conducted at two research centres.	The study aimed to assess the impact of probiotic therapy on scaling and root planing as well as the clinical, microbiological, and immunological levels (SRP) compared to a combination of SRP and antibiotics.	No results have been published yet because this journal is a research protocol.
5.	Babina, K., Salikhova, D., Makeeva, I., Zaytsev, A., Sokhova, I., Musaeva, S., Polyakova, M., & Novozhilova	2025	Narrative Review	Literature-based narrative studies.	Probiotics can improve the oral microbiota's equilibrium and inhibit the development of harmful germs.	There are no direct clinical data as the journal is based on a literature review.
6.	Angarita-Díaz, M. del P., Fong, C., & Medina,	2024	Systematic Review	Literature-based systematic review.	The study evaluated bacteria from healthy periodontal tissue that could potentially be used as probiotics in oral health. It was found that some bacteria have a positive effect on the balance of	Natural probiotic bacteria from healthy periodontal tissue can be used to inhibit the growth of oral pathogens and improve gum health.

					the oral microbiota.	
7.	LI, J., Zhao, G., Zhang, H., & Zhu, F	2023	experiment with a multi-method approach (metagenomics, transcriptomics, immunology, and biochemistry)	Metagenomic and transcriptome sequencing, as well as experiments on GDM animal models	To lessen inflammation and promote a healthy pregnancy, probiotics raise the numbers of Treg, Tfr, and Breg cells, lower TNF-α and IL-6, and raise TGF-ß and IL-10.	Probiotics help prevent GDM by suppressing leptin expression and balancing the gut microbiota
8.	Wijayanti, D. A., Herawati, D., Karina, V. M., & Murdiastuti	2024	Experimental Research with Pre-Post (Before-After Study) Design	Observational study with 16S rDNA sequencing to analyze the gut microbiota of premature infants before and after probiotic supplementation	Premature babies have a different microbiota composition than full-term babies, with lower numbers of beneficial bacteria	Probiotic supplementation increases the amount of Enterococcus and Enterobacter and lowers Escherichia and Clostridium, which possesses the capacity to lower the danger of infection
9.	Sharma, H., Ruikar, M., & Verma, S.	2024	experimental with a multi-model approach (clinical trials, in vivo, and in vitro)	In vitro experiments on biofilms, animal models, and human clinical trials	Sodium lauryl sulfate (SLS) increases the number of pathogenic bacteria and damages periodontal tissue, while postbiotic toothpaste supports the balance of the oral microbiota	Postbiotic toothpaste reduces inflammation, helps maintain microbial homeostasis, as well as mitigates the negative effects of SLS

10.	Han, N., Jia, L., Guo, L., Su, Y., Luo, Z., Du, J., Mei, S., & Liu	2020	In vitro and in vivo experimental design	Both in vivo and in vitro experiments using mouse models with lesions on the palatal mucosa, tested by cell migration, enzymatic activity, PCR, and western blot	The balance between the probiotic Lactobacillus reuteri with the harmful bacterium Porphyromonas gingivalis promotes the migration, proliferation, and differentiation of osteogenic mesenchymal stem cells (MSCs), as well as accelerates wound healing	*Lactobacillus reuteri* produces reuterin which neutralizes LPS from *P. gingivalis*, inhibits inflammation, and accelerates wound healing
11.	Schmitter, T., Fiebich, B. L., Fischer	2018	eksperimental laboratorium ex vivo	An ex vivo *inflammatory model* uses human primary monocytes and gingival fibroblasts to evaluate probiotics' anti-inflammatory effects on inflammatory mediators	Of the 73 probiotic strains tested, Significant anti-inflammatory effects were demonstrated by Lactobacillus plantarum GOS42 and Lactobacillus paracasei LPc-G110 on gingival monocytes and fibroblasts	When compared to a placebo, toothpaste containing L. paracasei LPc-G110 dramatically decreased the release of IL-6, IL-8, and prostaglandin E2 from monocytes.
12.	Ferrer, M. D., López-López, A., Nicolescu, T	2020	Ex vivo experiments with preclinical design	A double-blinded randomized clinical study using an oral adhesive gel with *Streptococ*	Administration of S. *dentisani* improves saliva flow, lowers dental plaque, and reduces	Probiotics increase ammonia and salivary calcium levels, as well as alter the

				cus dentisani in volunteers for one month	gingival inflammation	composition of plaque bacteria by lowering cariogenic bacteria
13.	Domínguez, L., Cepeda, J., Sánchez	2018	Randomized Controlled Trial (RCT) with a pilot study design	Randomized controlled trials with three groups (positive control group, experimental probiotic mouthwash group, and negative control group) for 4 weeks.	Gingival index lowering did not differ significantly across groups. The positive control group decreased from 1.18 to 0.98, but it was not statistically significant.	There were no discernible variations in the groups' gingivitis reduction.
14.	Shi, Q., Sun, L., Gao, J., Li, F.,	2024	umbrella review	a comprehensive analysis of 22 meta-analyses and systematic reviews of different papers.	Probiotics show benefits in reducing *Bleeding on Probing* (BOP), Assessing patients with periodontal disease by measuring their Pocket Depth (PPD) and raising their Clinical Attachment Level (CAL).	Probiotics' effects on plaque and the gingival index are still not entirely clear, but they show benefits in reducing bleeding in probing and periodontal pocket depth.
15.	Babina, K., Salikhova, D	2024	Randomized Controlled Trial (RCT) double-blind.	Randomized, controlled, double-blind clinical trials with two groups (probiotic group and control	Gingival bleeding has significantly decreased after 1, 2, and 3 months of probiotic consumption. Plaque accumulation significantly	Probiotics significantly reduce gingival bleeding, but long-term effects are not expected without

				group) for 3 months.	decreased after two and three months.	continuous consumption of probiotics.
16.	Mahdizadeh Ari, M., Mirkalantari	2024	Experimental In Vitro Research	In vitro laboratory studies tested the effects of probiotics on oral bacterial biofilms and virulence gene expression.	Probiotics remain alive in the oral environment, exhibit adhesion ability, co-aggregation with oral pathogens, and decrease virulence gene expression.	The effects of probiotics in suppressing oral pathogens are proven, but most of the results are not statistically significant.
17.	Goyal, N., Shamanna	2024	Randomized controlled trial (RCT) with group comparison	An experimental study compared changes in the amount of *Porphyromonas gingivalis* between groups taking fluoride amine mouthwash and probiotics over six months.	○ The control group experienced A notable rise in the quantity of P. Gingivalis from 5.8180 × 10^6 to 13.7180 × 10^6 CFU/ml. ○ P. gingivalis levels were lower in the probiotic group from 4.7170 × 10^6 to 3.1290 × 10^6 CFU/ml.	The groups' differences were statistically significant that used probiotic mouthwash compared to other groups.
18.	Kavitha, M., Prathima,	2022	Randomised Controlled clinical	Clinical study with two groups, one	○ The gingival index significant	Probiotic lozenges significantly reduced

	G. S., Anusha		trials (RCTs) with two groups	using probiotic lozenges and the other as a placebo group.	ly decreased in the probiotic group (1.74 ± 0.42 to 1.01 ± 0.21) and plaque index (2.05 ± 0.44 to 1.02 ± 0.27). ○ The placebo group showed no significant change.	plaque and gingival inflammation compared to placebo.
19.	Hadj-Hamou, R., Senok, A.	2020	Systematic review	A comprehensive analysis of numerous randomised clinical trials (RCTs) evaluating the effects of probiotics in patients with fixed orthodontic care.	○ No strong evidence was found that probiotics reduced gingival inflammation or the development of enamel demineralization in orthodontic patients. ○ Several studies show the benefits of probiotics in reducing biofilm accumulation.	There are no results that significantly support the use of probiotics in fixed orthodontic care.
20.	Angarita-Díaz, M. del P.,	2022	Experimental studies with randomize	An experimental study with a	The study aimed to evaluate whether	The study is still in the protocol

Fong, C., & Medina	d controlled trials (RCTs)	randomized controlled trial (RCT) design that analyzed Lactobacillus reuteri's impact on orthodontic patients' oral microbiome and gingival inflammation.	probiotics can reduce gingival irritation and change the oral microbiota's makeup when receiving orthodontic therapy.	stage and has not yet reported final results.

DISCUSSION

The results of this systematic review showed that post-chemotherapy patients experienced a range of significant oral complications, including oral mucositis, xerostomia, opportunistic infections such as oral candidiasis, as well as inflammation of periodontal tissue such as gingivitis and progressive periodontitis. These effects vary depending on the type of chemotherapy agent, the dose used, as well as the patient's health condition prior to therapy. Chemotherapy not only targets cancer cells but also impacts healthy cells, including epithelial cells and periodontal support tissues, thereby causing impaired tissue healing with a higher chance of inflammation (Wen et al., 2023; Parra-Rojas et al., 2024).

Pathophysiologically, chemotherapy disrupts the immunological system by reducing the number of neutrophils and other defense cells, which contributes to an increased risk of infection and inflammation within the mouth. In addition, changes in oral microbiota because chemotherapy can shift the balance of normal flora, allowing the growth of pathogenic microorganisms that can cause infections such as oral candidiasis. Disruption of vascularization and regeneration of fibroblast cells and osteoblasts also have an impact on periodontal structures, slowing down tissue healing and increasing alveolar bone resorption which has the potential to lead to tooth loss (Omori et al., 2023; Goloshchapov et al., 2024).

Although research on the impact of chemotherapy on oral health is growing, some limitations are still being found. Variations in the study design, differences in the population of patients studied, as well as the lack of longitudinal data make the study results difficult to generalize. In addition, there are few studies that discuss optimal prevention strategies and supportive therapies in reducing oral complications after chemotherapy. Therefore, a multidisciplinary approach between dentists, oncologists, and periodontists is indispensable to develop more effective prevention strategies (Sahni et al., 2020).

With evidence that chemotherapy has a significant impact on oral cavity and periodontal structural health, it is important to raise awareness of the importance of dental care before, during, and after cancer therapy. A structured dental hygiene program and regular oral health monitoring can help reduce the risk of more serious complications. Further studies are needed to explore more effective prevention methods as well as supportive therapies that can help patients maintain oral health during and after chemotherapy (Manuballa et al., 2020)..

CONCLUSION

Considering the study's findings, chemotherapy has an important effect on the health of the soft tissues of the oral cavity and periodontal structure. Common side effects include oral mucositis, xerostomia, opportunistic infections such as oral candidiasis, as well as inflammation of periodontal tissue that can cause tooth loss and periodontitis. This disorder is caused by a decrease in alterations in the oral microbiota and the immune system, and tissue regeneration disorders due to the toxic effects of chemotherapy. Therefore, regular monitoring of oral health is essential to prevent more serious complications. A multidisciplinary approach between dentists, oncologists, and periodontists is key in providing optimal care for post-chemotherapy patients. Additionally, it is crucial to create efficient preventative measures and supportive therapies to minimize the negative impact of chemotherapy on oral health. Further research is still required to determine the most effective ways to keep patients' dental health in check during and after undergoing cancer therapy.

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