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LITERATURE REVIEW:

Exploring the Potential of Probiotics in Dentistry: A Literature Review

Explorando el potencial de los probióticos en odontología: una revisión de la literatura

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ABSTRACT: To describe the scientific literature on the uses and application of probiotics in dentistry. An electronic search was carried out without date restriction in the PubMed and Scopus databases. The articles were compiled, and their characteristics, objectives and methods were studied using the following keywords: "probiotics", "*S. mutans*", "oral health", "biofilm", among others. For the present literature review, 10 studies were chosen that investigate the probiotic action of certain strains such as *Lactobaccillus* and *Bifidobacterium* in periodontal and orthodontic treatments, among others. These studies proved their efficacy in different types of presentations such as tablets and yogurt, in different types of populations such as infants, young people and older adults. Finally, a large part of these studies determined biofilm reduction. Based on the research articles, strains such as *Lactobaccillus* and *Bifidobacterium* showed positive effects in the reduction of bacterial plaque such as *S. mutans* in short- and long-term periods in different populations. There is a large production of studies concerning the application of probiotics in dentistry. However, it is necessary to carry out studies with other types of bacteria and different vehicles to determine more precisely which species help to maintain oral health.

KEYWORDS: Dentistry; Oral health; Probiotics.

RESUMEN: Describir la literatura científica sobre los usos y la aplicación de los probióticos en odontología. Se realizó una búsqueda electrónica sin restricción de fechas en las bases de datos PubMed y Scopus. Se recopilaron los artículos y se estudiaron sus características, objetivos y métodos utilizando las siguientes palabras clave: "probióticos", "*S. mutans*", "salud oral", "biofilm", entre otras. Para la presente revisión bibliográfica se escogieron 10 estudios que investigan la acción probiótica de determinadas cepas como *Lactobaccillus* y *Bifidobacterium* en tratamientos periodontales y ortodóncicos, entre otros. Estos estudios demostraron su eficacia en diferentes tipos de presentaciones como comprimidos y yogur, en diferentes tipos de poblaciones como lactantes, jóvenes y adultos mayores. Por último, gran parte de estos estudios determinaron la reducción del biofilm. Con base en los artículos de investigación, cepas como *Lactobaccillus* y *Bifidobacterium* mostraron efectos positivos en la reducción de placa bacteriana como *S. mutans* en periodos de corto y largo plazo en diferentes poblaciones. Existe una gran producción de estudios relativos a la aplicación de probióticos en odontología. Sin embargo, es necesario realizar estudios con otros tipos de bacterias y diferentes vehículos para determinar con mayor precisión qué especies ayudan a mantener la salud bucodental.

PALABRAS CLAVE: Odontología; Salud bucodental; Probióticos.

INTRODUCTION

The human oral cavity is a complex system that harbors a wide variety of bacterial species. An increased incidence of microbial populations can easily be impaired, and the proliferation of pathogenic organisms can be the initiation or progression of stomatology diseases (1).

Currently, scientific studies have shown that a homeostasis between non-pathogenic bacteria and the bacteria that cause the diseases is a determining factor for oral health. For example, the appearance of caries reduces the balance within the oral cavity, i.e., there is a greater number of cariogenic agents such as *streptococci*, *lactobacilli*, *actinomyces*, *bacteroides* and *bifidobacteria* (2, 3). Therefore, the ingestion of foods containing probiotics has been proposed as preventive adjuvants or for the treatment of dental diseases such as caries, gingivitis, and periodontitis, thus restoring the balance of the microflora (4). In addition to the above, the use of probiotics in the treatment of periodontal disease has been proposed as a preventive adjuvant for the treatment of tooth decay (4, 5).

Dental caries and periodontal disease are the most common oral diseases worldwide within the field of dentistry and require treatment due to their high incidence, being usually as first alternative the prescription of antimicrobial drugs achieving to restore a healthy microbiome; however, it can cause gastrointestinal adverse effects because of broad-spectrum antibiotics, bacterial resistance, and possible allergic reactions (5). Consequently, the consumption of probiotics has been considered to have preventive and therapeutic effects, making it a non-invasive option for the control of carious and periodontal disease (6). On the other hand, *Lactobacillus albicans* is an effective treatment for caries and periodontal disease.

On the other hand, *Lactobacillus* and *bifidobacterium* are the most used probiotics against oral cavity alterations, these strains present a balanced immune function, a healthy intestinal microbiome and better absorption of nutrients,

therefore, leading to a healthy host. It has been demonstrated that the consumption of fruit juice has a positive effect in the control of caries and periodontal disease (7, 8). It has been shown that the consumption of probiotics presents preventive and therapeutic effects.

Fruit juice, cheese, yogurt, and fermented milk, as well as their inclusion as a component in tablets and capsules, have been shown to have beneficial effects on oral tissues by reducing the incidence of caries, halitosis, periodontitis, and oral thrush (9).

Thus, the present literature review aimed to describe the uses and applications of probiotics in dentistry.

MATERIALS AND METHODS

SEARCH STRATEGY

For the recognition of the studies, a search without date restrictions was carried out in the online database of scientific literature research in medical and biological sciences, accessed through PubMed and Scopus.

The following search terms were used, which were adapted for each database, respectively: ("probiotic s"[All Fields] OR "probiotical"[All Fields] OR "probiotics"[MeSH Terms] OR "probiotics"[All Fields] OR "probiotic"[All Fields]) AND ("dentistry"[MeSH Terms] OR "dentistry"[All Fields] OR "dentistry s"[All Fields]).

INCLUSION CRITERIA

The present study searched for randomized controlled trial type articles concerning the use of probiotics in dentistry for plaque reduction. The search was limited to research articles published in the English language.

EXCLUSION CRITERIA

Clinical case studies on the use of probiotics were not included in the present research. Likewise, articles that were not found in PubMed, Scopus and are in any language other than English were excluded.

RISK-OF-BIAS ASSESSMENT

Because the study is only a literature review, it is not intended to evaluate the potential risk of bias, nor does it perform a systematized search for information.

RESULTS

Significant studies related to the level of efficacy of probiotics were obtained from the searches performed. Ten studies investigating their capacity as adjuvants during cariogenic or preventive treatments were considered for the present review. Details of the reviewed studies are shown according to their objective, population, study method and conclusion.

The characteristics of the 10 selected articles (10-19) were randomized clinical trial design (RCT) from the last 5 years (2018-2023). The probiotic strains studied in different presentations such as tablets, yogurt, probiotic-based mouthwashes, drops; were *W. cibaria CMU*, *L.rhamnosus SP1*, *B. lactis HN19*, *L. reuteri*, *L. acidophilus La5* and *B. lactis Bb12* to know their effect in different types of populations to preserve oral health. Also, patients suffering from oral diseases such as periodontitis or undergoing orthodontic treatment were included in certain studies (Table 1).

Table 1. Characteristics of the studies.

Author	Design	Population	Limitation	Follow-up	Main findings
Shaalan O., *et al.* 2021 (10)	Randomized clinical trial (RCT)	96	Requires further studies in older adults and long-term follow-up.	2 weeks and 3 months	Probiotic yogurt acts as an antibacterial agent capable of attacking salivary and plaque bacteria in older adults.
Alhallak E., *et al.* 2022 (11)	RCT	30	Use of mouthwash only once a day due to orphanage policy.	7, 14 and 30 days.	Probiotic mouthwashes are an alternative to maintain oral health.
Kang M.S. *et al.* 2020 (12)	RCT	92	The study group were people who did not suffer from gingival disease, therefore the results could not be generalized.	8 weeks	*W. cibaria CMU* is a probiotic that can maintain and prevent oral diseases.
Staszczyk M., *et al.* 2022 (13)	RCT	140	Short-term follow-up period.	12 months	Regular short-term intake of probiotics may reduce the incidence of caries.
Morales A., *et al.* 2018 (14)	RCT	47	Small population to detect real differences between groups.	3,6 and 9 months	The utilization of *L. rhamnosus SP1* sachets in conjunction with azithromycin for the management of chronic periodontitis produces outcomes comparable to those achieved +through scaling and root planing alone
Kamble A., *et al.* 2022 (15)	RCT	75	More studies with a larger sample to understand the therapeutic properties of oral probiotics as a mouthwash.	21 days	Oral probiotics show similar efficacy to chlorhexidine in reducing oral *S. mutans.*
Invernici M., *et al.* 2018 (16)	RCT	41	The short evaluation period.	30 and 90 days	The employment of *B. lactis HN019* in conjunction with scaling and root planing fosters additional clinical, microbiological, and immunological enhancements in the treatment of chronic periodontitis
Alforaidí S. *et al.* 2021(17)	RCT	28	Long-term studies in these orthodontic patients are needed to know if probiotics have a preventive action on caries formation.	3 weeks	*Lactobacillus reuteri* diminishes the decrease in pH after three weeks of monitoring. Nonetheless, the short-term administration of probiotics does not seem to affect the counts of salivary *S. mutans* and *lactobacilli* within the oral cavity.
Bafna H.P. *et al.* 2018 (18)	RCT	70	Limited intervention time.	4 weeks	*L. acidophilus La5* and *Bifidobacterium lactis Bb12* were effective in reducing *S. mutans*.
Krupa N.C. *et al.* 2022 (19)	RCT	30	Small sample. In addition, the effect of mouth rinses was tested only on *S. mutans*.	14 days	The antimicrobial effectiveness of xylitol and probiotic mouthwashes was found to be like that of chlorhexidine in both pediatric and geriatric populations

ORAL MICROBIOME

The microbiome of the oral cavity determines the oral health conditions of the patient. However, when there is an imbalance, the bacterial plaque located in the mouth produces dysbiosis and these bacteria are responsible for the formation of oral diseases (20).

The oral microbiome is composed of a community of microorganisms that are organized in biofilms. These biofilms are polymicrobial communities that are complex in both structure and function and are embedded in an extracellular matrix and attached to the hard and soft tissues of the oral mucosa. The formation of pathogenic biofilms can trigger the onset and progression of dental diseases such as caries, gingivitis, periodontitis and peri-implantitis (21, 22).

BIOFILM AND ORAL DISEASES

Biofilm organization varies in different areas of the oral cavity due to variations in ecological niches. In the supragingival zone, the dominant species include facultatively anaerobic saccharolytic anaerobic organisms of the genera *Actinomyces*, *Veillonellag*, *Granulicatella*, *Streptococcus*, and *Rothia*, whereas in the subgingival zone, gram-negative, anaerobic, and proteolytic species are found (23, 24). In the subgingival zone, gram-negative, anaerobic, and proteolytic species are found. In the subgingival zone, the organisms are found to be anaerobic and proteolytic.

It has been observed that the organisms of the biofilm precede the presence of a layer of macromolecules. This layer was initially thought to primarily originate from salivary glycoproteins. However, a recent study has indicated a significant contribution from gingival crevicular fluid in the formation of this layer (25).

PROBIOTICS

Several studies have shown that probiotics are live microorganisms that confer advantages in maintaining or improving host health when administered in adequate amounts. For example, one of the contributions of probiotic consumption is that they can stop periodontal bacterial plaque and regulate the host's immune response (26, 27). Therefore, they can help to better control biofilm, reverse dysbiosis and even decrease periodontal inflammation (28).

PROBIOTICS AND PREVENTION OF DENTAL CARIES

There are several predisposing factors in the manifestation and proliferation of carious processes such as changes in diet, poor oral hygiene methods, consumption of medications that can alter salivary flow and variations in immune response (29). Consequently, it leads to the appearance of *S. mutans*, the most common bacterial microorganism responsible for the demineralization of dental enamel and the onset of a carious process (30). Probiotics for periodontal health and the prevention of periodontal caries.

PROBIOTICS FOR PERIODONTAL HEALTH

Chronic periodontitis is considered a predominant polymicrobial disease and represents an inflammatory process where there is involvement of the soft and hard tissues of the teeth such as the gingiva, periodontal ligament. However, it is associated with other changes at the systemic level when left untreated (24). The strains such as *Lactobaccus* and *Lactobacterium spp*.

Strains such as *Lactobaccillus* and *Bifidobacterium* have been characterized by their ability to alter periodontal biofilm. In studies testing *Bifidobacterium animalis*, a reduction in biofilm

virulence was observed, such as gingival inflammation, and an improvement in the pathogenic bacteria of periodontal diseases (32-34). The results of these studies show that *Bifidobacterium animalis* is associated with a reduction in the virulence of the biofilm as gingival inflammation and an amelioration of pathogenic bacteria for periodontal disease.

PROBIOTICS IN RELATION TO HALITOSIS

Halitosis is a problem that can have a negative impact on the social and professional life and quality of life of people who suffer from it due to the unpleasant odor that comes from the breath (35). The causes of this problem can vary and may be related to factors such as diet, poor oral hygiene, diseases with periodontal involvement, ulcers, lack of salivary flow, use of prostheses, consumption of toxic substances such as alcohol, tobacco, among others (36). For a better control of halitosis, the patient should undergo certain treatments or change of habits, including the use of mouthwashes, periodontal treatment, implementation of periodontal treatment, and the implementation of probiotics.

For better control of halitosis, the patient should undergo certain treatments or change of habits, including the use of mouthwashes, periodontal treatment, implementation of supplements such as interdental brushes for better hygiene and cleaning of the tongue coating. In addition, various resources, such as the use of probiotics, can be employed to combat halitosis (37). Several investigations have shown that strains of *Lactobacillus*, which are active ingredients in probiotics, can be effective in combating bad breath (38).

PROBIOTICS AND ORTHODONTICS

Previous studies have found that increased numbers of *Streptococcus mutans* are considered a major risk factor for dental caries and have been linked to the placement of fixed orthodontic appliances (39). In the field of dentistry, patients receiving orthodontic treatment or wearing fixed prostheses on dental implants rely more on chemical or probiotic cleaning to remove bacterial plaque than physical removal by brushing or rinsing the mouth (40).

PROBIOTIC ACTION IN THE ORAL CAVITY

Microorganisms inhabiting the oral cavity are grouped in biofilms and perform various functions such as regulating homeostasis, immunity, digestion, and detoxification. Despite this, there are probiotics that help maintain oral health (41). In an in vitro study, postbiotic lactic acid bacteria were shown to reduce colonization of *A. actinomycetemcomitans*, which is associated with periodontal disease (42). Other studies indicate that topical use of the probiotic strain *Bifidobacterium lactis HN019* protects against alveolar bone loss and connective tissue attachment loss attributable to periodontitis (43). Besides, the use of this strain in conjunction with periodontitis treatment has been shown to provide additional clinical improvements, such as decreased probing pocket depth, clinical attachment gain, and reduced bleeding on probing (16). In addition, the use of this strain in conjunction with periodontitis treatment has been shown to provide additional clinical improvements, such as decreased probing pocket depth, clinical attachment gain, and reduced bleeding on probing.

PROBIOTIC AND CHEMICAL-BASED RINSES

Mouthwashes such as chlorhexidine are very popular due to their effectiveness. However, adverse effects associated with its use have led to the consideration of other products to inhibit *Streptococcus mutans* activity (44). On the other hand, studies have been conducted on a probiotic mouthwash containing *Lactobacillus salivarius* and *Lactobacillus reuteri* to evaluate its effect in patients with periodontitis. The results indicate

that the use of this mouthrinse together with a plaque and calculus removal technique for a period of 15 days can significantly reduce the plaque index, which promotes oral health. The results indicate that the use of this mouth rinse together with a plaque and calculus removal technique for a period of 15 days can significantly reduce the plaque index, which supports oral health (45).

DISCUSSION

Microbes could generate chemicals like hydrogen peroxide, bacteriocins, and organic acids that possess defined bactericidal properties. These substances act on adhesion sites in the mucosa through competitive inhibition, preventing the proliferation of harmful microorganisms. Therefore, there are changes in pH and alter the ability of microorganisms to achieve oral homeostasis. In addition, probiotics trigger non-specific immunity in individuals and alter their cellular and humoral immune mechanisms. Lactogenic bacteria can exert their modulatory influence on immunocompetent cells, such as T cells and macrophages. As a result, they can impair cytokine production in these cells and influence the individual's overall immune response. It is worth mentioning that the addition of probiotic strains produces a synergistic effect, i.e., it has greater beneficial effects than individually (46).

The consumption of probiotics in dentistry is a subject of current research as they may succeed in producing changes in the oral microbiota and may contribute to ensure proper physiological function by acting as a preventive method for caries and periodontal disease (47). Nowadays, probiotics found in daily consumption such as yogurt, cheese are the third most consumed dietary supplement after vitamins and minerals (48). In addition, they are characterized by being able to integrate with other agents of the oral biofilm and favor the growth of other acidogenic bacteria (49).

Various etiologic factors such as smoking, type of diet and poor oral hygiene contribute to a progressive development of parts of the microbiota at the expense of others (50-52). Bacterial therapy or replacement therapy is a very effective way to prevent the development of microbiota in the oral cavity.

Bacterial therapy is a treatment that employs harmless bacteria as opposed to pathogenic bacteria to treat disease. Thanks to the characteristics and beneficial effects they confer, such as caries treatment, halitosis, and the onset of gingival disease, probiotics are added in mouthwashes and toothpastes. As a result, probiotics are truly new and innovative agents that can be used to treat a variety of oral diseases (53). In addition, probiotics can be used to treat a wide range of oral diseases.

The consumption of probiotics added to the diet for therapeutic purposes as an adjuvant in oral health care has grown significantly in the last decade. Several studies have shown that the intake of probiotics as a complement to an optimal diet and dental hygiene promotes clinical and microbiological benefits during the treatment of caries, gingivitis, chronic periodontitis in different age groups. The consumption of probiotics in the treatment of caries, gingivitis, and chronic periodontitis in different age groups has been shown to be beneficial (16,17,19).

Therefore, it is considered that the pathogenic bacteria originating in the mouth because of multiple factors previously mentioned, will encourage alterations in the intestinal microbiota, and therefore can cause inflammation and changes in the system. This is why it is convenient to have a

microbiota in homeostasis that achieves benefits in the patient (54,55). In particular, the continuous consumption of probiotics and probiotics in the intestinal microbiota should be avoided.

The continued consumption of probiotics for caries prevention produces an inhibitory effect on bacterial proliferation and reduction of bacterial adhesion to tooth surfaces. Also, a decrease in the acidogenicity of plaque and reversal of caries lesions at the root level (56,57). In addition, a decrease in the acidogenicity of plaque and a reversal of caries lesions at the root level.

Non-surgical periodontal treatments such as scaling and root planing for people with periodontal disease have been studied so that the usefulness of probiotics can be applied as a complementary therapy. Several studies have found positive results such as a decrease in periodontal pathogens and in turn a clinical improvement of the patient (58). It has been described that the therapeutic intake of *Limosyloactobacillus [L.] reuteri* led to clinical improvements in pregnant patients who are at risk population for acquiring gingival and/or periodontal disease Probiotic bacteria that have been used in the treatment of periodontal disease have been shown to be effective in the treatment of periodontal disease in pregnant women (59).

Probiotic bacteria that have been the subject of study such as "*Lactobacilli* and *Bifidobacterium*" as they are able to survive in acidic environments such as carious lesions. This is due to their ability to regulate their pH in the face of extracellular acidification. Additionally, they display a high level of resistance in their cell membranes and possess the capability to produce intracellular alkalis, allowing them to survive (60).

It is important to note that, in the various studies previously described, different vehicles have been used such as chewing gum, lozenges, among others; and each of them is going to have a more potent effect than another probably, therefore, suggesting different washout times. For example, in one study, participants who consumed probiotic ice cream evidenced a decrease in *S. mutans* as opposed to a probiotic beverage after a three month washout period (61). In another study, participants ingested probiotic curd, so gradual recolonization was observed after a 14-day washout period (62). In the clinical cases analyzed, the use of probiotics has been shown to be more effective than the use of a probiotic beverage (63). In the clinical cases analyzed, the use of a probiotic beverage has been shown to be more effective than a probiotic beverage.

In the clinical cases analyzed they have used different types of "vehicles" containing the probiotics such as tablets, drops and yogurt. Despite this, it is still not possible to decipher which is the most suitable vehicle for the administration of probiotics for children, youth and elderly and if they are undergoing any treatment plan such as orthodontics it may influence a prevalence of bacterial plaque (10,17). The use of probiotics in children, youth and the elderly is not yet clear.

Among the limitations to produce this literature review is that the clinical studies were mainly based on the probiotic action of *Lactobacillus* and *Bifidubacterium*, which restricts a broader vision for the knowledge of other types of probiotics. Likewise, some of the selected studies had a short-term follow-up period and small sample size. On the other hand, most of these articles are based on diseases such as caries and periodontitis, when it is necessary to know if probiotics have a favorable effect on other oral diseases.

The strengths and importance of this research study is that it encourages the production of more trials to determine with greater certainty the benefits of the daily consumption of probiotics. Because of this research topic, it could be of great help in preventive dentistry in the entire population.

CONCLUSION

Within the limitations of this literature review and based on the evidence consulted, the most tested and studied strains were *Lactobacillus* and *Bifidobacterium*, most of which showed positive effects in the reduction of bacterial plaque such as *S. mutans* in pediatric, adult, and geriatric patients. Additionally, their efficacy was compared with mouthwashes based on probiotics, which also showed biofilm reduction. Therefore, it serves as a coadjutant in the established oral hygiene of the patient and the consumption of a balanced diet free of sugars. In summary, there is a large production of studies on the application of probiotics in dentistry. However, it is necessary to carry out more robust studies with other types of bacteria, different vehicles, and long-term follow-up to determine with greater precision which species help to maintain oral health and at the same time to observe the statistical significance of probiotic action against oral diseases.

CONFLICTS OF INTEREST

There are no conflicts of interest.

AUTHOR CONTRIBUTIONS STATEMENT

Conceived the ideas: S.C., S.G. and F.M.T.
Contributed to data collection: F.E.C.; R.M. and F.M.T.
Analyzed the data: S.C., S.G., F.M. and F.M.T.
Led the writing: F.M.T.

All authors critically revised the manuscript and gave final approval.

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