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REVIEW ARTICLE

Use of Probiotics For Oral Health

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ABSTRACT

The term "probiotic" was first used in 1965, by Lilly and Stillwell, to describe substances secreted by one organism which stimulate the growth of another. The number of products containing probiotics, viable bacteria with proven health benefits, entering the market is increasing. The use of antibiotics, immunosuppressive therapy and irradiation, amongst other means of treatment, may cause alterations in the composition and have an effect on the GIT flora. Therefore, the introduction of beneficial bacterial species to GI tract may be a very attractive option to re-establish the microbial equilibrium and prevent disease. Traditionally, probiotics have been associated with gut health, and most clinical interest has been focused on their use for prevention or treatment of gastrointestinal infections and diseases; however, during the last decade several investigators have also suggested the use of probiotics for oral health purposes.

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INTRODUCTION

The concept of probiotics probably dates back to 1908, when Noble Prize winner Eli Metchnikoff suggested that the long life of Bulgarian peasants resulted from their consumption of fermented milk products (1). The term "probiotic" was first used in 1965, by Lilly and Stillwell for describing substances secreted by one organism which stimulate the growth of another (2). Probiotics can be defined as living microbes, or as food ingredients containing living microbes, that beneficially influence the health of the host when used in adequate numbers (3).

Various bacterial genera most commonly used in probiotic preparations are *Lactobacillus, Bifidobacterium, Escherichia , Enterococcus, Bacillus* and *Streptococcus* . Some fungal strains belonging to *Saccharomyces* have also been used [Table 1] (4). Traditionally, probiotics have been associated with gut health, and most clinical interest has focused on the prevention or treatment of gastrointestinal infections and diseases; however, during the last decade, an increasing number of established and proposed health effects of probiotic bacteria have been reported, including enhancement of the adaptive immune response, treatment or prevention of urogenital and respiratory tract infections, and prevention or alleviation of allergies and atopic diseases in infants (5,6). Several investigators have also suggested probiotics for oral health purposes.

In the oral cavity, lactobacilli usually comprise fewer than 1% of the total cultivable microbiota, but no species specific to the oral cavity has been found. In contrast, some species are found in both

Table 1: Name of the microorganisms used as probiotics

Lactobacillus sps.	Bifidobacterium sps.	Streptococcus species	Sacchromyces Sps.
L. acidophilus	*B. bifidum*	*S. thermophillus*	*S. boulardii*
L. rhamnosus	*B. breve*	*S. salivarius*	
L. fermentum	*B. lactis*		
L. lactis	*B. adolescentis*		
L. paracasei	*B.infantis*		
L. bulgaricus			
L. salivarius			
L. plantarum			

oral and fecal samples (7,8). Species commonly isolated from saliva samples include *L. paracasei, L. plantarum, L. rhamnosus,* and *L. salivarius (7-10).* Culture-based studies suggest that bifidobacteria are among the first anaerobes in the oral cavity (11). Indeed, both lactobacilli and bifidobacteria can be found in breast milk, suggesting early exposure of the oral cavity to these bacteria (12,13). Bifidobacterial species isolated from oral samples include *B. bifidum, B. dentium,* and *B. longum (14,15).* During the last few years, several authors have suggested that probiotic bacteria originally planned for gut health could also be beneficial to oral health. The aim of this review is to examine potential mechanisms of probiotic bacteria in the oral cavity and to summarize observed effects of probiotics with respect to oral health.

MECHANISM OF ACTION OF PROBIOTIC IN THE ORAL CAVITY

The general mechanisms of probiotics can be divided into three main categories: normalization of the intestinal microbiota, modulation of the immune response, and metabolic effects (16). The mechanisms of probiotic action in the oral cavity could be analogous to those described for the intestine. Possible ways that probiotics might affect oral health are summarized in Figure 1. Thus far oral colonization by probiotic bacteria has often been considered essential for them to exert oral effects; however, the possibility of systemic effects cannot be excluded.

EFFECTS OF PROBIOTICS ON ORAL HEALTH

Caries and Caries-associated Microbes

Several studies suggest that consumption of products containing probiotic lactobacilli or bifidobacteria could reduce the number of mutans streptococci in saliva (17-19). The tendency toward a decreased number of mutans streptococci in the saliva seems to be independent of the product or strain used; however, such effect has not been observed in all studies (20). Furthermore, it is important to realize that the salivary level of caries-associated microbes does not equate to dental caries. In fact, the microbiota of unstimulated whole saliva resembles that of the tongue more than of dental plaque (21). Thus, no conclusive statement about the effects of probiotic bacteria on dental caries can be made.

Periodontal Diseases

The first studies of the use of probiotics for enhancing oral health were for the treatment of periodontal inflammation (22). Patients with various periodontal diseases, gingivitis, periodontitis, and pregnancy gingivitis, were locally treated with a culture supernatant of a *L. acidophilus* strain. Significant recovery was reported for almost every patient. There has been significant interest in using probiotics in treatment of periodontal disease recently, too. The probiotic strains used in these studies include *L. reuteri* strains, *L. brevis* (CD2), *L. casei Shirota, L. salivarius* WB21, and *Bacillus subtilis. L. reuteri* and *L. brevis* have improved gingival health, as measured by decreased gum bleeding (23,24).

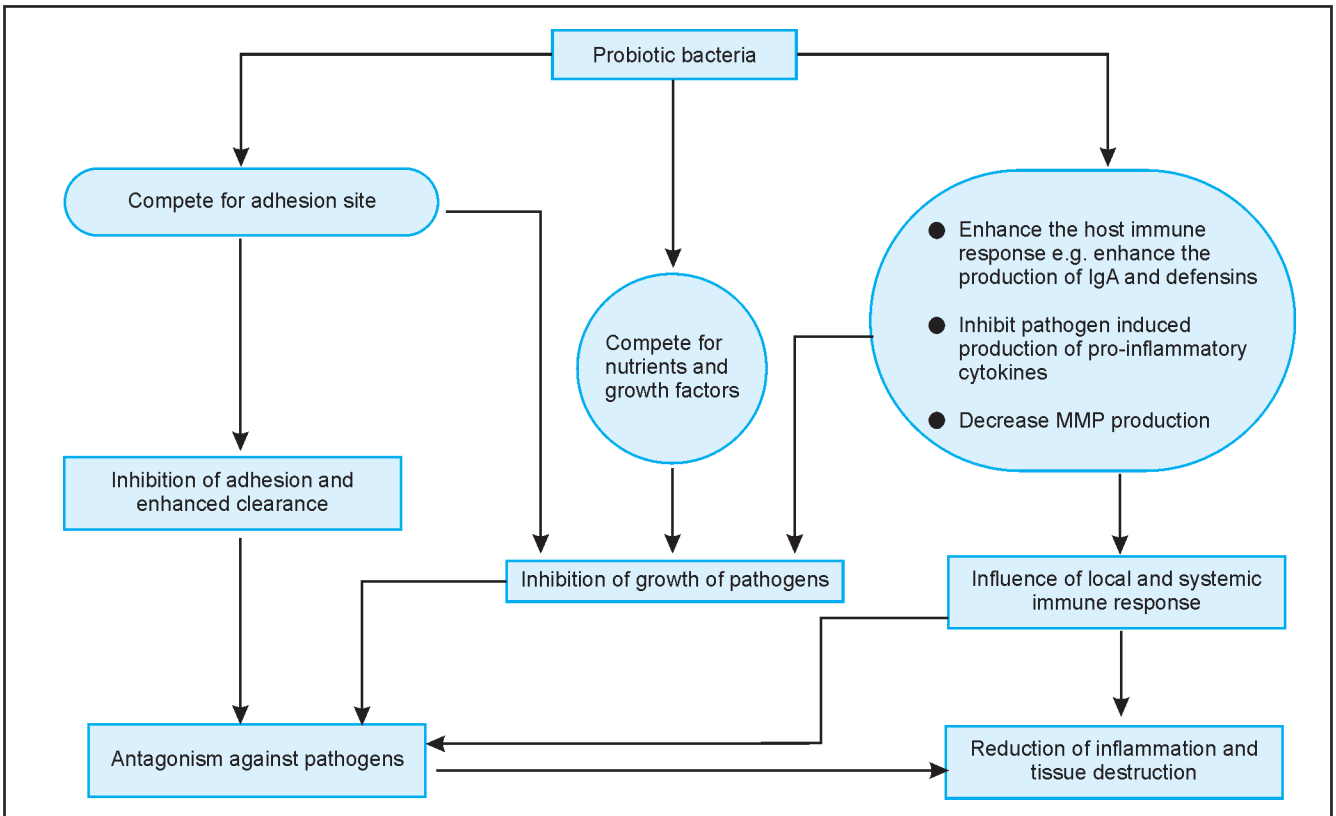

Figure 1: Possible ways by which probiotics might affect oral health

The use of probiotic chewing gum containing *L. reuteri* ATCC 55730 and ATCC PTA 5289 also decreased levels of pro-inflammatory cytokines in GCF (24), and the use of *L. brevis* decreased MMP (collagenase) activity and other inflammatory markers in saliva (23). *B. subtilis* seemed to reduce the number of periodontal pathogens (25). Use of tablets containing *L. salivarius* WB21 has been shown to decrease gingival pocket depth, particularly in high-risk groups such as smokers, and also affect the number of periodontopathogens in plaque (26). Again, although encouraging results have been observed, most studies have been fairly short. Furthermore, in some studies the observed differences were quite small, though statistically significant.

Halitosis

Halitosis is not a disease but a discomfort, probiotics are marketed for the treatment of both mouth- and gut-associated halitosis. Despite that, only a few clinical studies have found different probiotic strains or products to be efficacious. The studied strains include *E. coli* Nisle 1917, *S. salivarius* K12, three *Weissella confusa* isolates, and a lactic acid–forming bacterial mixture, not specified by the authors of that work (27-29).

SAFETY ISSUES

Probiotics are live micro-organisms and hence, it is possible that they may result in infection in the host. Different strains of probiotics have different safety profiles. Although probiotic therapy is generally considered safe, the concept of willingly ingesting live bacteria remains somewhat counter intuitive. Systemic infection has rarely been reported with *Bifidobacterium,* although many cases of sepsis secondary to *Lactobacillus rhamnosus* GG or *Lactobacillus casei* have been reported (30,31). The risk and morbidity of sepsis due to probiotic bacteria should be weighed against the potential for sepsis due to more pathological bacteria and the morbidity of the diseases for which probiotic bacteria are being used as therapeutic agents. The reports of sepsis are mainly seen in immunocompromised or infants (30,31). Maybe because long-term colonization of oral cavity by probiotic bacteria is unlikely, albeit possible, potential adverse effects of probiotic bacteria in the oral cavity have not been a subject of much intensive research; however, probiotic products are used widely; therefore, when dental health is considered, the acidogenicity of lactobacilli and bifidobacteria cannot be overlooked. For example, one *L. salivarius* strain is able to induce caries in an animal model (32), and another is able to make a biofilm model more cariogenic (33).

FUTURE STRATEGIES

Genetically modified microbes bring a new dimension to the concept of probiotics. One approach is to reduce the harmful properties of pathogenic strains naturally colonizing the oral cavity. The modified strain could then be used to replace the original pathogen. One ambitious and promising example is the generation of an *S. mutans* strain with a complete deletion of the open reading frame of lactate hydrogenase and thus significantly reduced cariogenicity (34). Another option could be to enhance the properties of a potentially beneficial strain. One example is the construction of an *L. paracasei* strain with a functional scFV (single-chain variable fragment) antibody binding to the surface of *Porphyromonas gingivalis (35)*. Thus, the new probiotic products targeted for oral health purposes do not necessarily comprise the same species as products now in market.

CONCLUSION

Probiotic therapy has already made its way in the treatment of number of conditions- Infectious, inflammatory, neoplastic and allergic. There is a long list of potentials of giving probiotics in a number of these conditions, and there is no reason to restrict the use of probiotic products because their effects on oral health are not yet well understood.

At least some of the probiotic bacteria used in various probiotic products may colonize the oral cavity during the time they are in use; thus, the effects of probiotic bacteria in the oral cavity are important to understand. Probiotic bacteria seem to affect both oral microbiota and immune responses. On the other hand, the extent to which bacteria in food or in food ingredients can influence relatively stable oral microbiota is difficult to predict. Thus, both research to unravel the mechanisms of possible probiotic action and long-term clinical trials are needed if probiotics are to provide a new scientifically proven means of preventing or treating oral diseases.

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