Review Article

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Probiotics in Oral Healthcare: An Innovative and Interesting Field of Research and Review

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ABSTRACT

Background: There is a lot of information now in the public domain on the Use of probiotics to gain a beneficial effect within the digestive tract. In recent years, there has been a keen interest in the Use of probiotics in maintaining good oral health and treating oral infections. Few studies have been conducted to date, but those that have been completed show that there are many vital roles for probiotics in the longevity and quality of life. The beneficial effects of probiotics have been demonstrated systemically as well as orally. The oral cavity harbours a diverse array of bacterial species, with reports stating that there are more than 600 species that colonize the oral cavity. This includes a lot of organisms that are not commonly known to reside in the gastrointestinal (GI) tract, but also many that are familiar; *Lactobacillus acidophilus, Lactobacillus casei, Lactobacillus fermentum, Lactobacillus plantarum, Lactobacillus rhamnosus* and *Lactobacillus salivarius*. The balance of all these microorganisms can easily be disturbed, and a prevalence of pathogenic organisms can lead to various oral health problems, including dental caries, periodontitis and halitosis. The Use of probiotics is an interesting, emerging field and not to be neglected in general and oral healthcare.

Keywords: Bifidobacterium, Lactobacillus, Oral healthcare, Probiotics.

INTRODUCTION

Probiotics have been defined as live microorganisms, which, when ingested in appropriate quantities, have a beneficial effect in the prevention and treatment of diseases by improving the host's intestinal microbial balance. In general terms, the word probiotic means for life and the definition issued by the International Scientific Association for Probiotics is live microorganisms administered in adequate amounts that confer a health benefit on the host[1]. These microorganisms are usually part of the normal flora. The general principle of bacteriotherapy or replacement therapy is to change the local micro-ecology and stimulate harmless (no pathogen) bacterial species. Probiotic effects are strain-specific; thus, each individual bacterial strain must be tested separately for the health benefit in question, and the effects described for one strain cannot be directly applied to others.

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The most commonly used probiotic bacterial strains belong to the genera "*Lactobacillus*" and "*Bifidobacterium.*" [1]

Lactobacilli and bifidobacteria are generally regarded as safe. The early writing of Metchnikoff depicted that fermented food products have been associated with health benefits. Based on this result, several authors conducted studies to discover that probiotic bacteria originally planned for gut health could also be beneficial to oral health. In respect to normal microbiota and oral health, there seem to be differences in the ability of lactobacilli isolated from caries-active or healthy subjects to inhibit *Streptococcus mutans* in vitro. In addition, the species composition of both *Lactobacillus* and *Bifidobacterium* microbiota is different between patients with periodontitis and those who are periodontally healthy. Both lactobacilli and bifidobacteria are also associated with dental caries.[2]

It is essential to study these beneficial pro-microorganisms which have the ability to adhere to saliva-coated surfaces, to grow and colonize in the mouth and inhibit the other pathogenic organisms, thus aiding in the oral defence mechanism. This review, therefore, aims to study the roles of probiotics in oral health.

Probiotics and oral diseases

The oral cavity is a rather intense habitat providing the establishment of a great diversity of microbial flora. Each environment within the mouth supports distinct yet overlapping communities of hundreds of species. It has been recently estimated that over 1000 bacterial species are present in the oral cavity. Bacteria reside in the mouth either in the planktonic state or are finely integrated into oral biofilm on various oral surfaces. Interaction between species in biofilms is characteristic as the species may depend on each other to provide a favourable environment for colonization. Furthermore, bacteria in biofilms differ physiologically from their Planktonic counterparts and tend to be much more resistant to environmental factors and antimicrobial agents. It has been established that distinct genes become active when planktonic bacteria bind to surfaces and grow in biofilms. This complexity of biofilm development and interspecies interactions require more thorough investigations in order to assert true probiotic candidates with activity in the oral cavity. It is essential for these beneficial microorganisms to resist the oral environmental conditions and defence mechanisms, to be able to adhere to saliva-coated surfaces, to colonize and grow in the mouth, and to inhibit oral pathogens. So, Probiotics have health beneficial effect on various dental diseases.

Dental caries

Dental caries is the interaction over time between cariogenic microflora, a diet rich in fermentable carbohydrates and host factors, including saliva secretion rate and buffering capacity. The main goal for the Use of probiotics in caries prevention is the inhibition of the proliferation of cariogenic bacteria and the reduction of their adherence to the tooth surfaces.

Lactobacillus and Bifidobacterium strains used in commercial probiotic products may affect the oral ecology by specifically preventing the adherence of other bacteria and by modifying the protein composition of the salivary pellicle. The latter seems to occur by binding and degradation of proteins important for bacterial adherence and involved in oral defence systems. The *lactobacillus spp* and bifidobacteria can survive in saliva for at least 24 hours. They also showed that *lactobacillus rhamnosus* GG adheres well to hydroxyapatite, although there is a difference in the quality of adhesion between different individuals.[3]

It seems that saliva components influence adhesion similarly; Wei et al. demonstrated a reduction in adherence of S*. mutans* to enamel hydroxyapatite by 40% when LGG was added to milk without antibodies. However, reduction in adherence of S. *Mutans* increases to 70% in the presence of antibodies in LGG fermented milk. D. Glavina et al. [4] found significant differences in lactobacilli counts, which is similar to the study conducted by Simark – Mattson et al.[4]

Caglar E et al. reported that research on probiotics is concentrated essentially on lactobacilli and bifidobacteria. The novel observation revealed here was a significant diminishing effect of the bifidobacteria containing yoghurt on salivary mutans streptococci. This finding is in agreement with several previous findings with lactobacilli derived probiotics (Nase et al., Ahola AJ et al., and Nikawa – coworkers), which is in contrast with other study conducted by Montalto M et al.[5]

D. Glavina et al. showed that daily consumption of LGG yoghurt could have an inhibitory effect on oral pathogenic microflora. Yoghurt significantly increased saliva buffer capacity and S. mutans salivary counts were significantly decreased after 30 days; a similar result was obtained by Nase et al. and Ahola et al.'s study.[4]

Interestingly, milk fermented with L. rhamnosus GG prevents the in vitro adhesion of S. mutans. Wei H et al. showed that milk containing L. rhamnosus GG seems to decrease the caries risk in children. Hence, it can be hypothesized that the inhibition of adhesion by probiotics could affect the initial colonization of S. mutans also in vivo. By using the adherence of streptococci as a biological indicator, they could show that all probiotic strains tested, modified the composition of saliva and, thereafter, the formed artificial salivary pellicle on HA. Again, the treatment of saliva affected only the adherence of S. mutans, whereas the adherence of S. Gordonii remained unaffected. Their results show that the probiotic bacteria can modify the protein composition of the pellicle by at least two different methods: binding and degradation of salivary proteins. It seems likely that different probiotic strains have different mechanisms of action in the oral cavity. In addition, previously reported probiotic properties do not necessarily correlate with the probiotic activity in the oral cavity. Only two out of six strains tested were effective in the blocking of S. Mutans binding sites. Another type of mechanism by which the oral probiotics can affect the oral microbiota is the inhibition of the growth of the Mutans Streptococci (Meurman JH et al. 1995, Nikawa and Coworkers 2004).[3]

Zaazou et al. in 2012 reported that it might be beneficial to combine immune milk and L.rhamnosus, as LGG is also known to inhibit the growth of cariogenic streptococci by producing anti streptococcal substances, these results were in agreement with Ahola et al. and Maeda et al. who stated that the administration of a dairy product containing L. rhamnosus appeared to reduce the risk of dental caries in a randomized, double-blind placebo-controlled trial. This trial demonstrated reduced levels of dental caries, and lower Mutans Streptococcal counts in probiotics patients after seven months of the administration.[6]

The contradicting result obtained by several studies, which suggest that consumption of products containing probiotic lactobacilli or bi-fidobacteria could reduce the number of Mutans Streptococci in saliva. The tendency toward a decreased number of Mutans Streptococci in the saliva seems to be independent of the product or strain used; however, such effects have not been observed in all studies. The discrepancies between results cannot be explained by only the Use of different probiotic strains, as different results have also been obtained using the same strains. In most of these studies, the levels of salivary lactobacilli have also been measured. With three products, an increase in the number of salivary *Lactobacillus* has been observed. Unfortunately, with respect to dental caries, the study groups have mainly been relatively small, and the studies fairly short. 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. Thus, no conclusive statement about the effects of probiotic bacteria on dental caries can be made.[2]

Mortazavi et al. reported that probiotic cheese containing L. Casei reducing the risk of the high level of S. Mutans counts which is similar to results obtained by Nase et al., Ahola et al., Nikawa et al., Stecksen et al. and Haukioja et al. while contradicting result is reported by Montalto M et al. and Chuang L.C et al. Mortazavi et al. also reported that no statistically significant change in salivary lactobacillus bacterial count was observed in subjects before and after the intervention despite exposing saliva to 50gram cheese containing at least 1 x 10^6 CFU/gram L. Casei which is similar to Li – Chuan Chuang study but contradicting results obtained by Montalto et al. Aloha's study found increased count levels of lactobacilli after intake of the probiotic-containing cheese.[7]

Caglar E et al. found that the suppressive effect of salivary mutans streptococci was seen by both delivery methods – 1. Probiotic straw (top life straw, BioGaia, Stockholm, Sweden) consisted of a telescopic polypropene membrane with an oil droplet containing L. Reuteri ATCC 55730 (minimum 108 CFU/STRAW). 2. Probiotic tablet (BioGaia ProDenta, BioGaia, Stockholm, Sweden) consisted of L. Reuteri ATCC 55730 (10^8 CFU/ TAB) which is similar to result obtained by Nikawa and coworkers in 2004. They reported that L. Reuteri in bovine milk fermented decreases the oral carriage of Mutans Streptococci. The explanation for the findings and the mechanism of action is not fully clear. However, it is relatively plausible that probiotics competitively inhibit streptococci by replacement because of the direct contact with the oral tissues and biofilm.[8]

The study conducted by Keller and Twetman found, there were no differences in salivary Mutans Streptococci levels between the two groups (test and placebo) and they recorded no changes after intervention period by using the probiotic strains in fruit drinks and in tablets. This was in contrast to several previous studies conducted by Caglar E et al. and Nikawa – Coworkers but in contrast with others (Petersson et al., Cildir S et al. and Lexner MO et al.). Differences in strains and bacterial concentrations, dose regimes and age groups used in the earlier trials hamper any comparison between the trials by Keller and Twetman. It provides no evidence of an increase in plaque acidity by the supply of selected probiotic lactobacilli when challenged by fructose or xylitol. It is generally believed that probiotic supplements may be more effective in preschool ages than in adults, which to some extent may explain their negative findings. The increased lactobacilli counts in the test group were logical and supported the findings of Marttinen and coworkers, although they were not able to analyze whether or not it was due to the specific strain tested. However, it is unlikely that a permanent shift of the microbial compositions occurs.[9]

Li – Chuan Chuang in 2011 reported that there were no significant differences in the S. Mutans counts, lactobacilli counts, and buffer capacity between the probiotic and control groups at T1, T2, and T3, by using the probiotic oral tablets, commercially named as Dental - Lac, which contained 11% Xylitol and 4% of L. Paracasei GMNL – 33 bacteria 3 x 10^8 cells/ tablet (1 g), which is contradicting to results obtained by Nase's study. There were several possible reasons suspected for the non-significant difference in S. Mutans counts between the probiotic and control group could be due to: 1.Small sample size 2. Subjects only took L. Paracasei for 2 weeks. [10]

Chung J et al. reported that L. Fermantum S11 was isolated from the saliva of young children without dental caries and oral diseases with little visible supragingival plaque. Similarly, Colloa et al. and Ishihara et al. suggested L. Fermantum be predominant species in healthy mouths and completely inhibited the growth of S. Mutans.[11]

The increased interest in using of probiotic lactobacilli to improve oral health has raised concerns on its possible side effects. One side effect from a cariological point of view would be an increased production of organic acids in the dental plaque. Therefore, Keller and Twetman wanted to investigate if the addition of probiotic lactobacilli to dental plaque would influence its acidogenicity.

In the clinical part of the study, Keller and Twetman found no differences in acid production before and after the intervention with L. Reuteri or placebo when the plaque samples were fermenting fructose. The findings were in accordance with Marttinen et al., who failed to demonstrate any differences in lactic acid production after the intervention with either L. Reuteri or L. Rhamnosus GG. It could be argued that the decreased acidogenic of the plaque samples could be caused by the antibacterial activity of L. Reuteri, but due to the relatively short period of administration, they believe that this was not the case.

In the laboratory part, they found clear differences between the lactic acid production in suspensions of pooled plaque and L. Reuteri DSM 17938 on one hand and plaque plus L. Plantarum 299v or pure controls on the other. This was in agreement with the in vitro study of Hedberg et al., who found L. Plantarum 299v to be most prone to produce acid among six different commercial strains tested. Conversely, Haukioja and coworkers, found that both L. Reuteri DSM (formerly ATCC 55730) and L. Plantarum 299v lowered the pH significantly after fermentation of glucose and sucrose. According to Hedberg et al., the fermentation of sucrose and glucose by L. PTA 5289 resulted in a lowering of the pH (pH 5.2-6.8), whereas the fermentation of fructose caused a minor increase in pH (pH>6.8). This, together with our present results, indicates that the sugar chosen for fermentation has a strong impact on the LA production of L. Reuteri. Thus, from the first part of this study, it seems clear that the acidogenicity of suspensions of dental plaque and probiotic bacteria is strain dependant and highly influenced by the type of sugar available.[9]

Periodontal diseases

Periodontal disease is classified into two types: gingivitis and periodontitis. Gingivitis is characterized by inflammation limited to the gingiva, whereas periodontitis is a progressive, destructive disease that affects all supporting tissues of the teeth, including the alveolar bone. The main pathogenic agents associated with periodontitis are *P. Gingivalis, Treponema denticola, Tannerella forsythus* and *Aggregatibacter Actinomycetemcomitans*. These bacteria have a variety of virulent characteristics allowing them to colonize the subgingival sites, escape the host's defence system and cause tissue damage. The persistence of the host's immune response also constitutes a determining factor in the progression of the disease.

There are fewer experimental studies exploring probiotic Use in periodontal diseases, partly reflecting a poor understanding of the precise aetiology of the disease and the conditions that promote health. Probiotics may effectively reduce the levels of inflammation-associated molecules, such as prostaglandin E2 and interferon-c, and weaken matrix metalloproteinase activities in saliva**,** which affect the periodontal disease.[12]

G. campus in 2014 reported that L. Brevis CD2 lozenges were effective in reducing plaque acidogenicity and salivary Mutans Streptococci concentration, which is in contrast to results obtained by Marttinen A et al. The probable reason for different result could be: 1. Use of different probiotic products 2. Administration time. Similar findings obtained by Nase et al., Ahola et al. and Caglar E suggested that the intake of various strains of the lactobacilli species may reduce the counts of salivary mutans streptococci in children even if it is only for the observational period. Riccia DN et al. in 2007 found a significant reduction in gingival bleeding, which is similar to the result obtained by G Campus et al.[13]

The Use of probiotics for enhancing oral health was for the treatment of periodontal inflammation. Patients with various periodontal diseases, gingivitis, periodontitis, and pregnancy gingivitis, were locally treated with culture supernatant of an *L. Acidophilus* strain. Significant recovery was reported for almost every patient. There has been significant interest in using probiotics in the 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. The Use of probiotic chewing gum containing *L. Reuteri* ATCC 55730 and ATCC PTA 5289 also decreased levels of pro-inflammatory cytokines in GCF, and the Use of *L. Brevis* decreased MMP (collagenase) activity and other inflammatory markers in saliva. With *L. Casei* Shirota and *Bacillus subtilis* no difference in test and control groups in gingival bleeding or measured plaque index was observed, but the Use of *L. Casei* Shirota decreased PMN elastase and MMP-3 activities in GCF, and gingival inflammation was lower in the group consuming the probiotic product, as measured by MPO activity after a four-day period of experimental gingivitis. *B. subtilis* seemed to reduce the number of periodontal pathogens. 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. 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.[2]

Probiotics could be useful in the improvement of periodontal condition. However, only a limited number of studies have examined the effectiveness of probiotics for periodontal diseases. Probiotics were effective for normalization of microbiota in periodontitis and gingivitis patients when compared with a control group. Decreased gingival bleeding and reduced gingivitis were observed after the administration of probiotic Lactobacillus Reuteri. Oral administration of probiotic tablets containing L. Salivarius TI2711 (LS1) to healthy volunteers significantly reduced the number of P. Gingivalis in the saliva and subgingival plaque, although no significant change was observed in the placebo group.[14,15,16,17]

The effect of probiotic lactobacilli on oral microbiota in the same subjects found that oral administration of probiotic lactobacilli successfully reduced the prevalence of periodontopathic bacteria even in nonsmokers.[14] They selected L. Salivarius WB21 as the probiotic strain in their study, as several strains of lactobacilli have shown potential growth inhibition of S. mutans.[18] The presence of an obligatory homofermentative group of lactobacilli, including L. salivarius was inversely associated with chronic periodontitis related clinical parameters and periodontal pathogens.[19] Very recently, they characterized 22 strains of orally isolated lactobacilli with regard to antimicrobial activities on oral pathogens, including periodontopathic bacteria and tolerance to environmental stress in vitro.[20] The majority of strains including L. Salivarius were shown to suppress the growth of A. Actinomycetemcomitans (formerly Actinobacillus actinomycetemcomitans), P. Gingivalis, and Prevotella intermedia, suggesting a potential for oral lactobacilli to be used as probiotics for periodontal health. Recently, they reported that the subgingival application of a bacterial mixture including Streptococcus Sanguinis, S. Salivarius, and Streptococcus Mitis after scaling and root planing significantly suppressed the re-colonization of Porphyromonas Gulae (canine P. Gingivalis) and P. Intermedia in a beagle dog model.[21] Therefore, more research is needed to identify appropriate effector strains for oral probiotics specifically designed to prevent and treat periodontal diseases.

Koll Klais et al. reported that most oral lactobacilli were able to inhibit the growth of both periodontitis and caries related pathogens in vitro.[19] No differences in salivary lactobacilli counts were observed between chronic periodontitis and healthy patients. Good antimicrobial activity of oral L. Paracasei and L. Rhamnosus against periodontal pathogen P. Gingivalis has previously been shown by Sookkhee et al. However, Testa et al. found no antagonistic interactions between oral lactobacilli (L. Casei, L. Rhamnosus, L. Plantarum, and L. Salivarius) and the anaerobes P. Intermedia and Fusobacterium nucleatum, contradicting Koll Klais et al. results. These conflicting results could be strain related from both sides (lactobacilli and target bacteria) as few strains were tested in that study; they observed strain-specific differences in their investigation. Koll Klais et al. also found that as a whole, the lactobacillus strains isolated from chronic periodontitis patients were more active against S. Mutans and their finding may at least partly explain an inverse association between dental caries and periodontal diseases observed by Sioson et al. Differences in methodology might also influence the outcome of the antagonism tests.

The composition of oral lactoflora between healthy subjects and patients with chronic periodontitis differs, with a higher prevalence of homofermentative lactobacilli, particularly L. Gasseri, in the former group. Both homo- and heterofermentative oral lactobacilli suppress the growth of periodontal pathogens, yet the antimicrobial properties are strain, species and origin-specific. These findings indicate that lactobacilli may play a crucial role in the maintenance of the micro ecologic balance in the oral cavity.[19]

Maeda et al. also stated that from the viewpoint of periodontal diseases, it had been suggested that L. Salivarius decrease the risk of periodontal disease by eliminating black-pigmented anaerobic rods which have been suspected of playing a role in periodontal disease.[6]

Oral malodor

Halitosis, more commonly known as oral malodour, affects up to half the adult human population to various degrees. Although generally not considered to be a medical concern, it certainly can confer a significant social stigma. The most common oral malodour compounds are by-products of the metabolism of oral bacteria, especially anaerobes, located on the dorsum of the tongue. Volatile sulphur compounds (VSC), valeric acid, butyric acid and putrescine are thought to contribute to the odour. Halitosis includes E.coli Nisle 1917, S. Salivarius K12, three Weisella confusa isolates and a lactic acid-forming bacterial mixture. The administration of bacteriocin producing S. Salivarius after an oral antimicrobial mouthwash reduces oral volatile sulphur compound levels.[22]

A study conducted by Kang MS et al. in 2006 reported that W. Cibaria isolates from children's saliva resulted in a significant reduction in the level of volatile sulphur compound (VSC) by inhibition of F. Nucleatum due to hydrogen peroxide production and might be applied as adjuncts for the prevention and treatment of halitosis which is similar to result obtained by Suarez et al. 2000, Burton et al. 2005.[23]

Oral candida

C. Albicans is a leading cause of infection in the oral cavity; it is particularly common in the elderly and in immunocompromised patients. A limited number of studies have reported the effects of probiotic bacteria on oral Candida infection in humans. Hatakka et al. in 2007 carried out the randomized, double-blind, placebo-controlled study, on the effect of probiotics on the prevalence of oral candida. The elderly people (age 70 – 100 years) recruited from retirement homes and sheltered housing, were selected because they are vulnerable to candida infection. During the 16 week intervention, after a 3 week run-in period, the participants consumed daily either 50g of probiotic cheese or 50g of control cheese. In probiotic cheese, lactobacillus Lactis and Lactobacillus Helveticus were used as starter cultures and 107CFU/g of each of probiotic strains, Lactobacillus Rhamnosus GG (ATCC 53103), Lactobacillus Rhamnosus LC705 and P. Freudenreichii species Shermanii JS were added. Controlled cheese contained only Lactobacillus lactis as a starter culture, and no probiotic strains were added. After the intervention, the author noticed the prevalence of high yeast counts in the probiotic group was reduced by 32%.[24]

Similar results obtained by Hasslof P et al. investigated the ability of a selection of lactobacilli strains, used in commercially available probiotic products, to inhibit the growth of C. albicans in vitro by agar overlay method. At concentrations ranging from 109 to 105 CFU/ml, all the tested lactobacilli strain reduced candida growth. The two L. Plantarum strains and L. reuteri ATCC 55730 displayed the strongest inhibition on Candida albicans.[25]

The previous study contradicting the results obtained by Koll P et al. was found to have no inhibition for C. Albicans growth; when assessing the effects of various lactobacillus strains in the oral cavity.[20] Recently, oral lactic acid bacteria and bifidobacteria have been isolated and characterized for various oral health purposes, including caries, periodontal diseases, and halitosis. In addition, dairy strains have been studied with the aim of characterizing potential new oral probiotics; thus, the new probiotic products targeted for oral health purposes do not necessarily comprise the same species as products now in the market. Furthermore, the species might not necessarily belong only to genera *Lactobacillus* or *Bifidobacterium.* Indeed, *S. salivarius* K12 is used to treat oral malodor, and preliminary results have been published on the safety and efficacy of a probiotic mouthwash containing three different oral streptococci for reducing the number of bacteria associated with dental caries and periodontitis.

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 *S. Mutans* strain with a complete deletion of the open reading frame of lactate hydrogenase and thus significantly reduced cariogenicity. 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.*

CONCLUSION

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.

Additionally, it should be noted that manufacturers of probiotic foods can sometimes add a lot of sugar to their product to improve the taste. This, as such, can confer an oral health risk. Therefore well designed long term follow up studies should be conducted to elucidate the oral health risk of long term use of dietary probiotics. Probiotics are a new and interesting field of research in oral microbiology and oral medicine. Bacteriotherapy in the form of probiotics seems to be a natural way to maintain health and protect oral tissues from diseases. But, this area of research in relation to oral health is still in its infancy, and further long term randomized controlled studies are required before definite conclusions are drawn regarding their effective action on oral health.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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