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Review Article

Probiotics and Oral Health: A Review

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Abstract:

Background: Probiotics, live cells with different beneficiary properties, are widely researched commercially all around the world. Beneficial effects of probiotics to human health have been proven to review the potential benefits of probiotics in oral health.

Materials and Methods: Data were retrieved from MEDLINE (via PubMed) using the keywords probiotics, oral health, *Lactobacillus,* micro-flora.

Results: A total of 70 relevant articles were found. 35 were literature review, 15 were clinical studies, 10 were conducted in animals, and 10 were retrospective studies. The vast emergence of bacterial resistant antibiotics has led to the use of probiotics for treatment in oral health. Oral disorders that have been targeted are periodontal disease, dental caries, and halitosis. There is a great need to elucidate benefits of the probiotics to know bacteria which are beneficial and then conduct a proper wide range of studies on the benefits of probiotics to enhance oral health.

Conclusion: *Lactobacillus* and *Bifidobacterium* are the most common probiotics that are used, but *Pediococcus*, *Lactococcus*, *Bacillus,* and yeasts have also shown probiotic effects. Probiotics are one of these new agents which are widely used for their effective action.

Key Words: *Lactobacillus,* micro-flora, oral health, probiotics

Introduction

Probiotics are live microorganisms, or ingredients of food which contain microbes containing living microbes that influence the health of the host. An easy and simple way to define probiotics is "those supplements of food which contain microbial flora that has the capacity to effect human health in a beneficial way." The probiotic microorganisms must reside in natural flora in order to inhibit gastric secretion and being survived. They must be present in intestinal mucosa so that they can inhibit gut pathogens.[1]

In general, probiotics are used to influence have gut health, and several studies are focused to find out beneficial effects of probiotics in the treatment of gastrointestinal diseases.

Several investigators have also suggested probiotics for oral health purposes. The most commonly used probiotic bacterial strains are *Lactobacillus* and *Bifidobacterium.* They are also present normally in humans. Lactobacilli is <1% of the total microbiota.[2]

Prebiotics are non-digestible oligosaccharides that alter the proliferation of bacteria that are residents of gastrointestinal tract. Prebiotics and probiotics can work simultaneously and when they are used same product, they become synbiotics. Synbiotics have the capacity to increase survival rate of microorganisms, which leads to increase in growth of bacteria in the intestinal tract.[3]

Probiotic bacterial strains should be characterized by their resistant power of antibiotics, toxin-producing capacity, their infectious power in animal models, which are immunosuppressed and has potential side effects. The probiotic bacteria which are identified by such characteristics are then submitted to randomized controlled trials. The properties of probiotics include dental surface binding, antimicrobial substances production, alteration of environmental conditions of mouth, and reduction of inflammatory response.[4]

Material and Methods

Study selection was conducted to evaluate the different use of probiotics in the treatment and implementation of dental health and oral hygiene. The keywords were selected from a broad range, so that maximum amount of data can be collected. The article titles were searched both manually and electronically. After that, an electronic search of abstract and full text were performed to identify similar articles. The references of article used were checked.

Results

A total of 70 relevant articles were found. 35 were literature review, 15 were clinical studies, 10 were conducted in animals, and 10 were retrospective studies.

Probiotics and oral health

The vast production of antibiotics that are bacterial resistant are the main reason behind the use of probiotics in oral diseases. Probiotics are extensively used for prevention and treatment of dental caries, periodontal disease, and halitosis. For a microorganism to be used as probiotic bacteria for oral health, it must adhere to gastrointestinal tract and should colonize oral cavity. The most commonly used probiotic bacteria are *Lactobacillus* and *Bifidobacterium*. Table 1 shows different microorganisms and their strains which are used as probiotics. Out of total oral microflora, *Lactobacilli* constitute about 1.5%. In saliva, most common species present are, *Lactobacillus plantarum, Lactobacillus rhamnosus, Lactobacillus salivarius, Lactobacillus acidophilus, Lactobacillus scasei*, and *Lactobacillus fermentum*. The species found in dairy products are of genus *Lactobacillus* which secretes a particular amount of hydrogen peroxide and a bacteriocin that may act against Gram-positive bacteria. They may also work with *Fusobacterium nucleatum*. *Weissella cibaria* can reside in the oral cavity.[5]

Probiotics and dental caries

In caries, acidogenic and non-acidogenic species, such as *Streptococci mutans* and Lactobacilli increases in the number and other bacteria like *Propionibacterium* spp., *Bifidobacteria*, non-mutans streptococci, *Actinomyces* spp., *Veillonella* spp., and *Atopobium* spp., have same properties. Probiotic bacteria and genetics have the capacity to dislodge cariogenic bacteria and replace it with non-cariogenic bacteria. Despite the presence of vast range of probiotic bacterial strains only two strains are capable of preventing occurrence of dental caries and these two bacteria are *Streptococcus thermophilus* and *Lactococcus lactis*, which can adhere to hydroxyapatite and then they can gain entry into biofilm similar to the plaque. These bacteria also have the property to grow with a microorganism that is found in plaque. These studies have employed different approaches.

Probiotics in periodontal disease

In vitro studies have shown that the ability to induce secretion of tumor necrosis factor-α and interleukin 8 by oral epithelial cells is strain dependent and the response is generally low. However, the addition of *Porphyromonas gingivalis* to the *in vitro* system was able to completely prevent the detection of cytokines tested. This result again underlines the intricate communication between species. Probiotics or putative probiotic species belonged mainly to the *Bifidobacterium* and *Lactobacillus* genera. But, because of the presence of vast range of species in oral cavity, other bacterial groups can also provide probiotic effect. The microbes which are capable of inhibiting adhesion of periodontal pathogens can recolonize gingival pocket. The concept of the re-colonization is based on the use of *Streptococcus sanguinis* KTH-4, oral streptococci, *Streptococcus mitis* BMS, *Streptococcus salivarius* that will lead to the microbial shift away from periodontal pathogens. Better radiographic results of healing of periodontal pockets after scaling and root planning were registered when beneficial bacteria were applied compared to controls in a dog model. However, more *in vivo* studies are needed to sustain the replacement therapy approach.[6]

Table 1: Microorganisms and their strains used as probiotics.

Microorganism	Strain
Lactic acid bacteria	*Lactobacillus rhamnosus GG*
	Lactobacillus casei
	Lactobacillus casei Shirota
	Lactobacillus acidophillus
	Lactobacillus jhonsonii
Bifidobacteria	*Bifidobacteria breve*
	Bifidobacteria bifidum
	Bifidobacteria infantis
	Bifidobacteria animalis
Yeasts	*Saccharomyces cerevisae boulardii*

Table 2 shows the effect of lactobacilli derived probiotics on adults.

Probiotics and halitosis

Halitosis which is also known as malodor occurs due to the formation of volatile sulfur compounds which are generated from anaerobic bacteria which degrades the salivary food proteins. *S. salivarius* produces a particular byproduct known as bacteriocins which decreases the total quantity of Volatile sulfide producing species.[7]

Role of probiotics in orthodontic treatment

Dental health is affected by fixed orthodontic appliances because they cause accumulation of microorganisms which leads to demineralization of enamel. An ecological environment is created every time when orthodontic bands and brackets are used due to their complex designs which favors the growth of *S. mutans* strains. Formation of white spot occurs due to an imbalance between mineral loss and mineral gain And. In 2009, a clinical study was conducted by Cildir *et al*. with probiotics using *Bifidobacterium animalis* subsp. Lactis DN-173010 and found that it could reduce the salivary count of mutans streptococci in orthodontic patients which use fixed orthodontic appliances. There are still doubts about the effectiveness of this approach to prevent formation of white spots, hence more studies should be conducted.[8]

Discussion

The issue of protection is of particular concern during the past few years due to the amplified probiotic supplementation of different food products. From the safety point of view, the probiotic bacteria must be non-pathogenic, non-transferrable to antibiotic resistance genes, and should have stimulating effects on growth of bacteria should not have any growth-stimulating effects on bacteria.[9] The probiotic bacteria should be capable to maintain genetic stability. The consistent use of probiotics increases the concentration of these species. Allergic effects of Lactobacilli are very rare, and very less amount of data is available. Only 175 cases were reported from past 30 years.

Table 2: Clinical studies in adults with lactobacilli derived probiotics.

Authors	Year	Vehicle	Species	Outcome in oral cavity
Ahola *et al.*	2002	Cheese	*Lactobacillus rhamnosus*	Decreased count of yeasts and streptococcus mutans in saliva
Newton biomedicals	2003	Tablet	Lactobacillus paracasei	Inhibit caries causing bacteria and reduces dental plaque
Krasse *et al.*	2006	Chewing gum	*Lactobacillus reuteri*	Reduction in gingivitis and dental plaque
Caglar *et al.*	2006	Straw	*Lactobacillus reuteri*	Reduction in level of *Streptococcus mutans*
Della *et al.*	2007	Lozenges	*Lactobacillus bravis*	85% reduction in gingival inflammation
Shimauchi *et al.*	2008	Tablet	*Lactobacillus salivarius*	Decreased plaque index and probing pocket depth
Stephen	2009	Milk	*Lactobacillus casei*	Reduction in elastase activity and gingival inflammation

Clinical sign and symptoms of *Lactobacillus* bacteremia are inconsistent, which ranges from asymptomatic to death. Microorganism irrespective of their genera is capable of causing bacteremia. Preliminary data obtained were satisfying, but vast range of studies are required to know exact effect of probiotics in treatment of dental caries.[10]

The concept of Elie Metchnikoff is now supported by increasing evidence that some members of the gut microflora indeed are beneficial. Probiotics more specifically are useful in dealing with the problems which arise from Alteration in normal flora of oral cavity.[11] Probiotic microorganisms can inhibit bacteria growth either by creating biofilm or by competing for substrates which are used by cariogenic bacteria. For exerting oral effects, oral colonization of probiotic bacteria is important.[12] By using probiotics in dairy products acidic conditions can be neutralized.[13]

Consistent uptake of probiotics may help to prevent halitosis. The use of *W. cibaria* results in decreased amount of volatile sulfide components because of hydrogen peroxide production. This occurs because *W. cibaria* produces hydrogen peroxide which may cause *F. nucleatum* inhibition.[14] *S. salivarius* is known to produce a particular byproduct known as "bacteriocins," which reduces the number of volatile sulfur compounds. *S. salivarius* K12 incorporated in gum or lozenges results in decreased number of volatile sulfur compound in case of halitosis.[4] Widespread production of antibiotic resistance and non-availability of other treatment modalities, this probiotic approach may act as an armamentarium of treatment options for periodontitis.[15]

F. nucleatum is the main microorganism in plaque formation that is capable to coaggregate with other wide range of bacteria.[16] In addition to the production of endogenous and exogenous pathogens, probiotic bacteria may also promote the beneficial host response.[17] Some oral bacteria act as antagonists to periodontal pathogens and inhibit their growth.[18]

Lactobacillus brevis is probiotic on the periodontal disease. *L. brevis* has induced a significant decrease in the activity of metalloproteinase, prostaglandin E2 level, and interferon-γ.[19] Bacteriocins, salivaricin Type A, and Type B salivaricin. This strain is used in the prevention of dental caries in humans produced by *Streptococcus mutans* and *Streptococcus sorbinus*. Salivaricin B has been used in the treatment of halitosis produced by *Prevotella* spp. and *Micromona micra*.[20] BB-12 (strain of bifidobacteria) is effective in preventing and treating diarrhea and respiratory tract infections. Their combination can result in effective treatment of wide range of diseases.[21]

From the safety point of view, the probiotic bacteria must be non-pathogenic, should not have any growth-stimulating effects on bacteria causing diarrhea, and should be non-transferrable to antibiotic resistance genes.[22] Genetic stability is main requisite for probiotic bacteria and the main risk is sepsis.[23] Problem with probiotics is their ability to adhere with intestinal mucosa which may also increase bacterial translocation and virulence.[24]

Conclusion

Probiotics are nevertheless, an innovative and a new field to be researched in oral microbiology. The probiotic therapy gives a clue about the correlation between diet and health, including oral health. However, this concept is in its early stages. Although knowledge about pathogen and host interactions is increasing day by day but this area is still doubtful. There is a great need to find out the role of beneficial bacteria to identify and to conduct proper studies on the uses of probiotics to treat oral health.

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