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Probiotics for Oral Health: An Upcoming Natural Way Forward

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Abstract

The oral infections and tooth decay are now-a-day a common disease. This occurs mainly due to changes in environment by way of illness debility, diet, medication etc. To prevent this, an effective treatment by antimicrobial therapy is in use, but some side effects are associated with this treatment. Hence, the researchers are searching for other alternative treatment of dental infection. One such alternative treatment is use of Probiotics which is a promising way to fight infections by using harmless bacteria. These products help in protecting health by promoting flora and also suppressing the pathogens. Various studies revealed anti-cariogenic effects of probiotics and their use in the treatment of periodontal diseases. However, an actual result on the use of probiotics for the treatment of oral cavity is still waited. The present review is an attempt in brief to focus the potential role of probiotics in improving oral and dental health.

Keywords: Dentistry; Dental infection; Probiotics; Tooth decay.

1. Introduction

The planet earth is full of bacteria and they play an important role in different functions whether they are related to humans, plants or animals. Each day, every human being ingests a large number of living microorganisms, predominantly bacteria. Although these organisms are naturally present in food and water, they can also be deliberately added during the processing of foods such as sausages, cheese, yogourt and fermented milk products. For several decades now, bacteria called probiotics have been added to some foods because of their beneficial effects on human health[1]. Probiotics are live microorganisms which, when administered in adequate amounts, confer a health benefit for the host. A number of potential benefits arising from the use of probiotics have been demonstrated, including increased resistance to infectious diseases, alleviation of lactose intolerance, prevention of gut diseases, diarrhea and vaginal and urogenital infections, reduced allergy and respiratory infections, reduced serum cholesterol concentration, increased resistance to cancer chemotherapy and decreased risk of colon cancer. It has been stated that oral administration of probiotics may also benefit oral health by preventing the growth of harmful microbiota or by modulating mucosal immunity in the oral cavity[2]. The vast majority of probiotic bacteria belong to the genera *Lactobacillus, Bifidobacterium, Propionibacterium* and *Streptococcus*[3].

According to the currently adopted definition by FAO/ WHO, probiotics are: "living micro-organisms, principally bacteria, safe for human consumption and when ingested in sufficient quantities, have beneficial effects on human health, beyond basic nutrition".

The term prebiotic was introduced by Gibson and

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Roberfroid. A prebiotic is a non-digestible food ingredient conferring benefits on the host by selectively stimulating the growth and/or activity of one species of bacteria or group of bacteria in the colon, thus improving the host's health. In the oral cavity, probiotics can create a biofilm, acting as a protective lining for oral tissues against oral diseases. Such a biofilm keeps bacterial pathogens off oral tissues, by filling a space which pathogens would otherwise invade, and by competing with cariogenic bacteria and growth of periodontal pathogens. The term synbiotic is used when a product contains both probiotics and prebiotics. As the word alludes to synergism, this term should be reserved for products in which the prebiotic compound selectively favours the probiotic compound.

The term replacement therapy, also called bacteriotherapy or bacterial interference, is sometimes used interchangeably with the term probiotics. Although both treatment modalities use live bacteria for the prevention or treatment of infectious diseases, there are some slight differences. Replacement therapy involves the direct application of the effectors strain to the site of infection and it is directed at displacing or preventing colonization by a pathogen[4].

2. Historical background

There is a long history of health claims concerning living microorganisms in food, particularly lactic acid bacteria. In a Persian version of the Old Testament (Gn 18,8) it states that "Abraham owed his longevity to the consumption of sour milk". In 76 BC the Roman historian Plinius recommended the administration of fermented milk products for treating gastroenteritis[5]. The concept of probiotics was conceptualized in 1908 when the Ukrainian bacteriologist and Nobel Laureate, Ilya Metchnikof (1908), proposed that lactic acid bacilli may have beneficial health effects.The term 'probiotics', which is the antonym of the term 'antibiotics', was introduced in 1965 by Lilly and Stillwell[4]. Mann and Spoering in 1974 discovered that the fermented yogurt reduces the blood serum cholesterol. The first probiotic species introduced into research were *Lactobacillus acidophilus* by Hull et al. and *Bifidobacterium bifidum* by Holcombh et al.[6].

3. Probiotics for oral health

Given the widespread emergence of bacterial resistance to antibiotics, the concept of probiotic therapy has been considered for application in oral health. Dental caries, periodontal disease and halitosis are among the oral disorders that have been targeted. An essential condition for a microorganism to represent a probiotic of interest for oral health is its capacity to adhere to and colonize various surfaces of the oral cavity.

Lactobacilli constitute about 1% of the cultivable oral microflora in humans[3]. Lactobacillus species from which probiotic strains have been isolated include *L. acidophilus, L. johnsonii, L. casei, L. rhamnosus, L. gasseri* and *L. reuteri. Bifidobacterium strains* include *B. bifidum, B. longum* and *B. infantis*.

Within dentistry, studies with *L. rhamnosous* GG, *L. reuteri* have defined their potential in interacting with *Streptococcus mutans* by reducing the number of this caries pathogen, thus suggesting a role of probiotics in caries prophylaxis. A few studies also revealed that probiotic *Lactobacillus* strains were useful in reducing gingival inflammation[7]. Sookkhee and colleagues[3] isolated 3,790 strains of lactic acid bacteria from 130 individuals and found that the isolates identified as *Lactobacillus paracasei* ssp. and *L. rhamnosus* had a high capacity to antagonize important oral pathogens, including *Streptococcus mutans* and *Porphyromonas gingivalis*.

Weissella cibaria, a Gram-positive facultative anaerobic lactic acid bacterium14 that has been isolated from humans, is present in fermented foods and is considered a potential probiotic agent. W. cibaria secretes a significant quantity of hydrogen peroxide, as well as a bacteriocin that acts against Gram-positive bacteria. This bacterial species has the capacity to coaggregate with *Fusobacterium nucleatum* and to adhere to epithelial cells. These properties could enable *W. cibaria* to effectively colonize the oral cavity and limit the

proliferation of pathogenic bacteria[3].

Also, *Streptococccus salivarius* strains appear to be excellent candidates for an oral probiotic, since they are early colonizers of oral surfaces and are amongst the most numerically predominant members of the tongue microbiota of healthy individuals[5].

4. Mechanism of action

Mechanisms of action explaining beneficial probiotic effects include modulation of host immune response leading to strengthening of the resistance to pathogenic challenge, alteration of the composition and metabolic activity of host microbiota at the specific location. Among paramount selection criteria for probiotics are:

• Adhesion and colonization (at least transitory) of the human body. Adhesion may increase the retention time of a probiotic and place bacteria and host surfaces (body fluids and epithelial cells) in close contact thus facilitating further probiotic activity;

• Enhancement of the non-specific and specific immuneresponse of the host;

• Production of antimicrobial substances and competition with pathogens for binding sites;

• Survival and resistance to human defense mechanisms during the oro-gastro-intestinal transit;

• Safety to the macro-organism[8].

The oral cavity represents the first part of the gastrointestinal tract, there is every reason to believe that at least some probiotic mechanisms may also play a role in that part of the system. It may also be anticipated that resident probiotics could exist in the oral microflora, and that they may function in the complex ecosystem of dental plaque and in the formation and development of oral biofilm. Suggested mechanism in the oral cavity include following.

1. Direct interaction in dental plaque: which includes involvement in binding of oral micro-organisms to proteins (biofilm formation). Action on plaque formation and on its complex ecosystem by competing and intervening with bacteria-to-bacteria attachments. Involvement in metabolism of substrates. Production of chemicals that inhibits oral bacteria.

2. Indirect probiotic actions are also featured such as modulating systemic immune function. Effect on local immunity. Effect on non-immunologic defense mechanisms. Regulation of mucosal permeability. Probiotics as an antioxidant and by producing antioxidants. Prevent plaque formation by neutralizing the free electrons[9].

There is also evidence of production of anti-microbial substances, such as organic acids, hydrogen peroxide and bacteriocins[10].

PROBIOTIC PRODUCTS

Probiotics are provided in products in one of our basic ways: as a culture concentrate added to a beverage or food(such as fruit juice), inoculated into prebiotic fibers, inoculated into a milk-based food (dairy products such as milk, milk drink, yoghurt, yoghurt drink, cheese, kefir, biodrink) and as concentrated and dried cells packaged as dietary supplements (non-dairy products such as powder, capsule, gelatin tablets) [11].

5. Role of probiotics in dental caries

In caries, there is an increase in acidogenic and acid-toleratingspecies[12]. “Probiotic”, as used here, means that mechanisms are employed to selectively remove only the (odonto) pathogen while leaving the remainder of the oral ecosystem intact[13]. A probiotic must be able to adhere to dental surfaces and integrate into the bacterial communities making up the dental biofilm. It must also compete with and antagonize the cariogenic bacteria and thus prevent their proliferation[3]. The probiotic bacteria attach to the pathogenic Fusobacterium, thus preventing secondary colonisation by other pathogenic microorganisms. Comelli and colleagues[14] reported that of 23 bacterial strains used in the dairy industry, Streptococcus thermophilus and Lactobacillus lactis were the only ones with the capacity to integrate into a biofilms present on a hydroxyapatite surface and to interfere with development of the cariogenic species Streptococcus sobrinus[14]. Little information is available

about the relationship between probiotic bifidobacteria and counts of *S. mutans*. The only study addressing this study question tested *Bifidobacterium* DN-173 010.25 A statistically significant reduction in salivary mutans streptococci was observed. Due to the limitations of the study protocol with bifidobacteria, however, further investigations are needed for drawing final conclusions[11].

Considering the growing body of evidence about the role of probiotics on caries pathogens, however, it has been suggested that the operative approach in caries treatment might be challenged by probiotic implementation with subsequent less invasive intervention in clinical dentistry[13].

6. Role of probiotics in periodontal disease

It is generally accepted that in a susceptible host, the presence of pathogenic bacteria and the absence of beneficial bacteria play a role in the development of periodontal disease. Since it is difficult to interfere with host susceptibility, actual treatments focus on reducing the pathogenic bacteria[15]. Probiotic strains included in periodontal dressings at optimal concentration of 108 CFU/ml have been shown to diminish the number of most frequently isolated periodontal pathogens: *Bacteroides* sp., *Actinomyces* sp. and *S. intermedius*, and also *C. albicans*. A decrease in gingival bleeding and reduced gingivitis has been observed by Krasse et al [7] a with the application of L. reuteri. Koll-Klais et al [7] reported that resident lactobacilli flora inhibits the growth of *P. gingivalis* and *Prevotella intermedia* (*P. intermedia*) in 82% and 65%, respectively[7]. Teughels et al.[12] reported that the subgingival application of a mixture including *S. sanguis, S. salivarius* and *S. mitis* after scaling and root planing significantly suppressed the re-colonization of *P. gingivalis* and *P. intermedia* in the beagle dog model. This guided pocket recolonization approach may provide a valuable addition or alternative to the armamentarium of treatment options for periodontitis[12]. Nevertheless, similar to the case with dental caries, however, there is not yet any true evidence on the effect of probiotic therapy on periodontal disease[16].

7. Probiotics and halitosis

Halitosis, foetor ex ore, or bad breath, is a condition affecting comparatively large section of the population. Documentation of early Egyptian and other cultures indicate that people were aware of this problem and sweetening their breath with various herbs and spices, a practice that continues to this day. Bad breath in the oral cavity is mainly ascribed to the production of volatile sulfur compounds (VSC) predominantly by Gram negative anaerobes residing in periodontal pockets and on the tongue dorsum. It can be assumed that bacterio-therapy can also improve this condition. The replacement of bacteria implicated in halitosis by colonization with probiotic bacterial strains from the indigenous oral microbiota of healthy humans may have potential application as adjuncts for the prevention and treatment of halitosis[8]. Increased VSC levels also may play a role in the link between oral infection and systemic diseases such as heart disease and preterm low birth weight. A study by Kang et al. [17] reported the ability of various strains of *Weissella cibariato* decrease the production of volatile sulphur compounds by *Fusobacterium nucleatum*[17].

8. Probiotics and candidiasis

Candida albicans, a normal inhabitant of the oral cavity, is the most common cause of oral fungal infections. Probiotic applications in the oral cavity may alleviate symptoms and reduce pathogenic potential of *Candida* species. A 16-week probiotic intervention study demonstrated a significant reduction by 75% of high yeast counts in the elderly. Hyposalivation reduction was also observed by the intake of *L. rhamnosus* GG containing cheese associated with control of oral *Candida*[8]. Probiotic bacteria also modulated antibody and cell mediated immune responses to *C. albicans*[18].

9. Safety issues related to use of Probiotics

The increased probiotic consumption inevitably leads to increased concentrations of these species in the host. From the safety point of view, the putative probiotic microorganisms should not be pathogenic, should not

have any growth-stimulating effects on bacteria causing diarrhea, and should not have an ability to transfer antibiotic resistance genes. The probiotics should rather be able to maintain genetic stability in oral microflora[16]. There is a large amount of promising data on the preventive and therapeutic effects of probiotics in several diseases. Nevertheless, due to some contraries among results of different trial studies on probiotics effects, they should be considered with caution[19].

10. Conclusion

The interest in oral probiotics has been growing during the last decades. Most of the studies have been conducted with probiotic strains originally suggested for gut health; however, it is important to realize that each of the suggested health benefits should be studied for each bacterial strain individually. Thus, a probiotic bacterium in the mouth is not necessarily an oral probiotic[20]. The oral cavity with its diversity of microbial species has been shown to harbor strains also distinguished as such as probiotics. In this regard further studies identifying resident probiotics of the mouth, clarifying the mechanism of their colonization, and the eventual effect on the oral environment are needed. Randomized controlled trials are needed to assess the best means of administering probiotics and the dosages needed for different preventive or therapeutic purposes[7].

Conflict of interest

The author' s declares none.

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