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A REVIEW ON PROBIOTICS IN DENTISTRY

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ABSTRACT

The aim of this review article is to present an update about the current status of probiotics in the field of dentistry. The probiotic concept is the administration of beneficial bacteria to replace harmful microbes with useful ones. The importance of probiotics mainly lies in the gastrointestinal tract still there are many cases where these have been successfully used in the oral health perspective also. Probiotic approach has shown promising results in oral cavity with respect to control of chronic disease such as dental caries, periodontitis and recurring problems like halitosis and candidial infections. Control of biofilm formation on voice prosthesis has also been presented in one article.

Key words: Probiotics, Dentistry, Oral health etc.

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INTRODUCTION

There are many cases in the history of health claims concerning living microorganisms in food, particularly lactic acid bacteria. In 76 BC the Roman historian Plinius recommended the administration of fermented milk products for treating gastroenteritis [1]. In 1907 the Ukrainian-born biologist and Nobel laureate, working at the Pasteur Institute in Paris, discovered Lactobacillus bulgaricus. He developed a theory that lactic acid bacteria in the gastrointestinal tract could, by preventing putrefaction, prolong life. This was based on his observation that Bulgarians lived longer than other people [2].

The most commonly used strains belong to the genera Lactobacillus and Bifido-bacterium and are commonly found in the oral cavity. These were the first probiotic species to be introduced into research. The role of diet in health and well-being is widely known. With the evolution of the science of nutrition, research is now being directed towards improving the understanding of specific physiologic effects of the diet beyond its nutritional effect. In this aspect, probiotics are the subject of intense and widespread research in food and nutritional science [3]. Probiotics are described as live micro-organisms which when administered in adequate numbers confer a health benefit on the host. The term probiotic, means "for life," and is derived from the Greek language. It was first used by Lilly and Stillwell in 1965 to describe substances secreted by one microorganism which stimulates the growth of another and thus was contrasted with the term antibiotic. Another common word prebiotics are the short-length carbohydrates, such as fructooligosaccharides, that resist digestion or are fermented in the colon to produce short-chain fatty acids, such as acetate, butyrate and propionate, which have positive effects on colonic cell growth and stability, generate many of the same bacteria as provided in probiotics.

The term synbiotic is used when a product contains both probiotics and prebiotics. According to this approach, a food or food supplement will include both the live cells of the beneficial bacteria and the selective substrate [4].

Mechanism of Probiotic Action on Oral Health [5]:

Several mechanisms have been suggested to contribute to the probiotic action in systemic health. They relate to immune modulation, modulation of gut immunological mechanisms, mucin production, down regulation of inflammatory responses, secretion of antimicrobial substances, competition with other flora, including potential pathogens by competitive blocking of adhesion sites at epithelial and mucosal surfaces, and inhibition of epithelial invasion by regulation of intestinal permeability, inhibition of pathogens mucosal adherence and stimulation of immunoglobin-A production. There is also evidence of production of anti-microbial substances, such as organic acids, hydrogen peroxide and bacteriocins. It may also be anticipated that resident probiotics could exist in the oral micro flora and that they may function in the complex ecosystem of dental plaque and in the formation and development of oral biofilm in general.

Probiotics and Dental Caries:

Role of Probiotics in Prevention of Dental Caries

In caries, there is an increase in acidogenic and acid-tolerating species, such as mutans streptococci and lactobacilli, although other bacteria, like Bifidobacteria, nonmutans streptococci, Actinomyces spp., Propionibacterium spp., Veillonella spp. and Atopobium spp., with similar properties can also be found. The use of probiotics and molecular genetics to replace and displace cariogenic bacteria with noncariogenic bacteria has shown promising results. Use of probiotic method is becoming useful for many of the researchers around the world. One of the replacement therapy options entails the application of a genetically engineered effector strain of S. mutans that will replace the cariogenic or wild strain to prevent or arrest caries and to promote optimal re-mineralization of tooth surfaces that have been de-mineralized but that have not become cavitated. S. mutans strain BCS3-L1 is a genetically modified effector strain designed for use in replacement therapy to prevent risk for caries [6]. Lactobacillus rhamnosus strain GG, ATCC 53103 was originally isolated from the human intestinal flora. Also, Streptococccussalivarius 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. Other strains considered as probiotics in the oral cavity include: L. acidophilus, L. casei, L. caseiShirota, L. paracasei, L. reuteri, L .johnsonii, propionibacterium, W. cibaria. A successful effector strain for replacement therapy of a bacterial disease must have the properties like it must not cause disease itself or otherwise predispose the host to other disease states by disrupting the ecosystem in which it resides; they should be to have probiotic effects in the mouth, etc. Current evidence indicates that probiotic effects are strain-specific and beneficial effect attributed to one strain cannot be assumed to be provided by another strain, even when it belongs to the same species [7].

Involvement in binding of oral micro-organisms to proteins (biofilm formation): Calgar et al evaluated the effect of xylitol and probiotic chewing gums on salivary mutans streptococci and lactobacilli and concluded that daily chewing on gums containing probiotic bacteria or xylitol reduced the levels of salivary mutans streptococci in a significant way [8]. Hasslof et al reported that at concentrations ranging from 10^9 to 10^5 CFU/ml, all lactobacilli strains inhibited the growth of the MS strains completely with the exception of L. acidophilus La5 that executed only a slight inhibition of some strains at concentrations corresponding to 10^7 and 10^5 CFU/ml. L.acidophilus La5 had a statistically significant weaker inhibition capacity in comparison with the other probiotic strains [9]. Cildir et al demonstrated that daily consumption of fruit yogurt with Bifidobacteriumanimalis subsp. Lactis DN-173010 could reduce the salivary levels of mutans streptococci in orthodontic patients with fixed appliances [10]. Suzuki N et al evaluated the capacity of E. faecium WB2000 to inhibit biofilm formation by oral viridians group and mutans group streptococci [11]. Heng et al reported that S. salivarius M18 (formerly strain Mia) exhibited broad-spectrum inhibitory activity against several streptococcal pathogens, notably the caries-causing Streptococcus mutans [12]. Twetman et al carried out a study to assess the effectivity of probiotics in caries reduction in children and reported a significant caries reduction in 3 to 4 year-old children after7 months of daily consumption of probiotic milk [13]. Singh et al reported that probiotic ice-cream containing Bifidobacteriumlactis Bb-12 ATCC27536 and Lactobacillus acidophilus La-5 can reduce the levels of certain caries-associated microorganisms in saliva [14]. Keller et al concluded that selected lactobacilli displayed co-aggregation activity and inhibited growth of clinical mutans streptococci. The growth inhibition was strain-specific and dependent on pH and cell concentration [15]. B. adolescentis SPM1005 cells decreased the growth of S. mutans, which is a risk factor for dental caries. Glavina et al reported significant reduction in S. mutans and Lactobacillus spp. salivary counts in children after 14 days consumption of commercially available yoghurt containing Lactobacillus rhamnosusn [16].

Probiotics Products [17]:

Probiotics are provided in products in one of the four basic ways:

- A culture concentrate added to a beverage or food.
- Inoculated into probiotic fibers.
- Inoculants into a milk-based food.
- As concentrated and dried cells packaged as dietary supplements.

- **Ideal Properties of Probiotics [18]:**

1. Exert a beneficial effect on the host
2. Be non-pathogenic and non-toxic
3. Contain a large number of viable cells
4. Be capable of surviving and metabolizing in the gut
5. Remain viable during storage and use
6. Have good sensory properties
7. Be isolated from the same species as its intended host.

- **Mechanism of Action in Oral Cavity [19]:**

1. Prevention of adhesion of pathogens to host tissues.
2. Stimulation and modulation of the mucosal immune system, e.g. by reducing production of proinflammatory cytokines through actions on NFkB pathways, increasing production of anti-inflammatory cytokines such as IL-10 and host defense peptides such as b-defensin 2, enhancing IgA defences and influencing dendritic cell maturation.
3. Modulation of cell proliferation and apoptosis through cell responses to, for example, microbially produced short chain fatty acids.
4. Improvement of intestinal barrier integrity and upregulation of mucin production.
5. Killing or inhibition of growth of pathogens through production of bacteriocins or other products, such as acid or peroxide, which are antagonistic towards pathogenic bacteria.
6. Involvement in binding of oral microorganisms to proteins (biofilm formation).
7. Action on plaque formation and on its complex ecosystem by competing and intervening with bacteria-to-bacteria attachments.
8. Involvement in metabolism of substrates (competing with oral microorganisms of substrates available).

Probiotics and Malodour:

A wide variety of gram-negative and gram-positive bacteria have been found to contribute to the problem and by contrast, certain bacterial species that predominate in the mouths of healthy subjects become noticeably absent in subjects with halitosis [20]. The current treatment method used by a dentist focus on the use of chemical or physical antibacterial regimes for reduction in the numbers of such bacteria. Probiotic method generally focuses on replacement therapy. A clinical trial was conducted early in 2005 to test the effectiveness of replacement therapy which was found to be effective. Another approach is based on a genetic modification of the halitosis causing micro organisms. Effectors strains are useful in such conditions. If the effector strain is better adapted than the pathogen, colonization or outgrowth of the pathogen will be prevented by blocking the attachment sites, by competing for essential nutrients, or via other mechanisms. As long as the effector strain persists as a resident of the indigenous flora, the host is protected potentially for an unlimited period of time [21].

Probiotics and Yeasts:

A recent study showed a reduction in the prevalence of C. albicans in the elderly after consumption of probiotic cheese containing L. rhamnosus GG and Propionibacteriumfreudenreichii ssp. has been seen [22]. An important feature of the probiotic activity observed in this study was the diminished risk of hypo salivation and the feeling of dry mouth of the subjects. There is a need of extended research on oral pathology, such as yeast infections, with respect to probiotics and analyzing the molecular mechanisms of probiotic activity, might further broaden the field of their potential applications. In a study using probiotic tablets in complex treatment of gingivitis and different degrees of periodontitis, the effect of probiotics to the normalization of microflora was found to be higher in comparison to the controls, particularly in the cases of gingivitis and periodontitis. Probiotic bifido-bacterium species reduced gingival and periodontal inflammation [23].

Probiotics and Voice Prosthesis:

There is still a lot to be researched in field of dental restorations and probiotics use and effect of it on such restorations. However in larynx, the second barrier after oropharynx, probiotics strongly reduce the occurrence of pathogenic bacteria in voice prosthetic biofilm [24]. There is anecdotal evidence among patients in The Netherlands that the consumption of buttermilk, which contains Lactococcuscremoris, Lactococcuslactis spp. that can produce antimycotics and indiscriminately depletes populations of both the problematic bacteria and those bacteria that are not thought to be implicated in halitosis, but which are likely to be important in the maintenance of a normal oral microenvironment. Antimicrobial treatment only reduces the malodour not cures it [25]. Only when the halitosis causing bacteria are re-established then only the malodour is corrected. Preventing the re-growth of odour-causing organisms by pre-emptive colonization of the oral cavity with non-virulent, commensal microorganisms is another alternative available to us. In some recent studies, a definite inhibitory effect on the production of volatile sulfur compounds (VSC) by F. nucleatum was observed after ingestion of Weissellacibaria both in vitro and in vivo. In children, a marked reduction in the levels of H2S and CH3SH was registered after gargling with W. cibaria containing rinse. The possible mechanism in the VSC reduction is the hydrogen peroxide generated by W. cibaria that inhibits the proliferation of F. nucleatum [26]. Streptococcus salivarius, also a possible candidate for an oral probiotic, has demonstrated inhibitory effect on VSC by competing for colonization sites with species causing

an increase in levels of VSC. S. salivarius strain K12 produced two lantibioticbacteriocins, compounds that are inhibitory to strains of several species of gram-positive bacteria implicated in halitosis. The replacement of bacteria implicated in halitosis with the bacteriocin producing commensal bacterium S. salivarius K12 appears is an alternative method for the long-term reduction of halitosis [27].

Probiotics and Periodontal Diseases:

Mucosal immune responses may be seen by probiotic immunization. Recent research has suggested that consumption of 2 kg/day of Turkish yogurt effectively eliminates biofilm formation on indwelling voice prostheses, possibly related to the presence of Streptococcus thermophilus and Lactobacillus bulgaricus in Turkish yogurt [28]. Lactobacilli have long been known for their capacity to interfere with the adhesion of uropathogens to epithelial cells and catheter materials, while S. thermophilus can effectively compete with yeasts in their adhesion to substratum surfaces, like silicone rubber. Studies of adhesion molecules have shown that superficial cell layers of the gingiva can be affected and can be stimulated to enhance the presence of immune potent cells. Regulation of micro flora composition may offer the possibility to influence the development of mucosal and systemic immunity but it can also play a role in the prevention in nutrition and health [29]. A decrease in gum bleeding and reduced gingivitis has been observed with the application of L. reuteri. Probiotic strains included in periodontal dressings at optimal concentration of 108 CFU mL-1 were shown to diminish the number of most frequently isolated periodontal pathogens like Bacteroides sp., Actinomyces sp. and S. intermedius and C. albicans [30]. Periodontal disease can be classed into two types; gingivitis –inflammation of the gingiva and periodontitis – progressive disease that affects all supporting tissues of the teeth. The main pathogenic agents linked with periodontitis are P. gingivalis, Treponemadenticola, Tannerella forsythia and Aggregatibacteractinomycetemcomitans. The same researchers found that these pathogens have a complex advantage of possessing a variety of virulent factors that allow them to colonise the subgingival sites, escape the host's defense system and cause damage to the whole tooth structure [31].

Koll-Klais and teamfound a prevalence of Lactobacillus gasseri and L. fermentum in the oral cavity of healthy individuals compared to those with chronic periodontitis [32]. Further to this, the same researchers have found that lactobacilli inhibit the growth of periodontopathogens, demonstrating the influence of lactobacilli in the oral cavity of a healthy individual. Another study15 found that the daily consumption of lactic acid bacteria in a drink reduces the probing depths and less loss of clinical attachment (gingiva to supporting bone) compared to individuals who consumed fewer of these dairy drinks. Another group who consumed daily cheese and milk products did not exert the same characteristics [33].

CONCLUSION

There have been much research in field of probiotics and dentistry in recent years. Though there is still a need for more research and controlled trials for the betterment of result and effect of the probiotics. Despite the immense potential of probiotics, data is still deficient on its action in the oral cavity.

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