Probiotics and Periodontics: A Review

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ABSTRACT
Probiotics are defined as non-pathogenic live microorganisms which when administered in proper amounts imparts health benefits to the host. It has developed as an alluring area for research in recent time. There has been a change in treatment options from eliminating the specific bacteria to modulating the bacterial ecology by administering probiotics. Probiotics cater an fruitful and profitable means to treat periodontal disease. A complete knowledge of the ecologic changes in the oral cavity is necessary to compute their long term effects on oral health and disease. The paper reviews the documentation for the use of probiotics for maintaining the oral health and preventing periodontal disease.

Keywords: Probiotics, Lactobacillus, Bifidobacterium, Dental caries, Halitosis, Guided Pocket Recolonization.

INTRODUCTION
Mostly addressed as delicate microscopic specialty, periodontics has entered the saga of metamorphosis that explores and understands human body mechanisms at biomolecular levels¹. With the arrival of multiresistant strains, antibiotic resistance has become a problem and scientists are developing new means for fighting infectious diseases. There has been a major swing in treatment options from non specific to specific ones. Recent treatment options propose altering ecology of niches, in order to reorient pathological plaque to a biofilm of commensalisms².

A century ago, Elie Metchnikoff (a Russian scientist, Nobel laureate, and professor at the Pasteur Institute in Paris) hypothesized that lactic acid bacteria (LAB) offered health benefits proficient of boosting the survival rate. He advocated that “intestinal auto- intoxication” and the resultant aging could be suppressed by modifying the gut microbiota and replacing proteolytic microbes such as Clostridium which produce toxic substances including phenols, indoles, and ammonia from the digestion of proteins with useful microbes. He developed a diet with milk fermented with the bacterium he called “Bulgarian bacillus.”
Henry Tissier (Pasteur Institute) first isolated Bifidobacterium from a breast-fed infant, and he named the bacterium Bacillus bifidus communis. He claimed that bifidobacteria would displace the proteolytic bacteria that cause diarrhea and recommended the administration of bifidobacteria to infants suffering from this symptom.

The term probiotics was first introduced in 1965 by Lilly & Stillwell as substances produced by microorganisms which promote the growth of other microorganisms. In 1989, Roy Fuller emphasized the requirement of viability for probiotics and introduced the idea that they have a beneficial effect on the host. Fuller in 1989, defined probiotics as an “A live microbial feed supplement which beneficially affects the host animals by improving its intestinal microbial balance”. Probiotics were then defined by FAO/WHO (The Food Agricultural Organization/World Health Organization) as live microorganisms which when administered in adequate amounts (in food or as a dietary supplement) confer a health benefit on the host (improving microbiological balance in intestinal tract).

PROBIOTICS AND ORAL CAVITY

More than 700 species of oral microbiota have been detected in the human mouth and the resident microbiota of one individual may consist of 30-100 species. The most significant requisite for a microorganism to be a probiotic is its ability to adhere and colonize the oral cavity.

Ideal Requisite of Probiotic Products:
- Should have high cell viability
- Should be non-pathogenic and non-toxic
- Should be able to withstand the oral environment conditions and defense mechanisms.
- Should be able to influence local metabolic activity

MECHANISM OF ACTION

Probiotics functions by direct and indirect mechanisms

1. DIRECT ACTION
   - By interacting with the dental plaque it prevents the formation of plaque
   - By emulating with the bacterial attachment seen on the surface of the tooth.

2. INDIRECT ACTION
   - It acts by modifying the systemic immune system thus affecting the local immunity.
   - It modulates the mucosal permeability and also functions as anti-oxidants.
   - It neutralizes the free electrons, thus preventing the plaque formation.

HOW THEY ACT AGAINST PERIODONTAL DISEASES

INHIBITION OF SPECIFIC PATHOGENS-
- By preventing the pathogen adhesion, colonization and biofilm formation
- By preventing growth of the pathogens

EFFECT ON THE HOST RESPONSE-
- By inhibiting the collagenases, by decreasing the inflammation associated molecules and by expressing the cytoprotective proteins on host cell surfaces
- By regulating the pro-inflammatory pathways by pathogens
- By averting the cytokine induced apoptosis and by modulating the host immune response

IMMUNOLOGICAL BENEFITS OF PROBIOTICS-
- They activate the local macrophages and increase antigen presentation to B-lymphocytes
- They increases the immunoglobulin A production (IgA) both locally and systematically
- They regulate the cytokine profiles
- They actuate hyporesponsiveness to food antigens
NON-IMMUNOLOGICAL BENEFITS OF PROBIOTICS:

- They help in digesting the food and competing with the pathogens for the nutrients.
- They create a pH that is not suitable for the growth of pathogens.
- They release bacteriocins which inhibits the growth of pathogens.
- They scavenge superoxide radicals.
- They cause epithelium mucin production.
- They alter the pathogen-derived toxins.

COMPOSITION OF PROBIOTICS

Probiotics are accessible as dietary supplements and foods that consist of yeast and bacteria. They are marketed as capsules, pastes, tablets, gels, packets, liquid or powders and are mostly in yoghurt or dairy drinks. Most commonly they are bacteria. Some of the species are:

1. Lactic Acid Producing Bacteria (LAB) –
   - Lactobacillus acidophilus
   - Lactobacillus bulgaricus
   - Lactobacillus casei
   - Lactobacillus crispatus
   - Lactobacillus reuteri
   - Streptococcus

2. Non Lactic Acid Producing Bacteria Species –
   - Bacillus cereus
   - Propionibacterium
   - Enterococcus faecalis
   - Enterococcus faecium
   - Escherichia coli Nissle

3. Non spore forming and non-flagellated rod or Cocobacilli

4. Non pathogenic yeast - Saccharomyces

5. Bifidobacterium species-
   - B. adolescentis
   - B. animalis
   - B. bifidum
   - B. breve
   - B. infantis
   - B. Lactis

| STRAIN | BARND NAME |
|--------|------------|
| Lactobacillus casei DN-114 001 | Actimel, DanActive |
| Lactobacillus casei F19 | Cultura |
| Lactobacillus casei Shirotia | Yakult |
| Lactobacillus reuteri DSM 17938 | L. reuteri ,Protectis |
| Lactobacillus acidophilus CL1285 & L.casei Lbc80r | Bio K+ |
| Bifidobacterium animalis DN 173 010 | Activia |
| Bifidobacterium animalis subsp. lactis Bh-12 | Chr. Hansen |
| Bifidobacterium breve Yakult | Bifiene |
| Bifidobacterium infantis 35624 | Align |
| Bifidobacterium lactis HN019 (DR10) | Howaru Bifido |
| Enterococcus LAB SF 68 | Bioflorin |
| Escherichia coli Nissle 1917 | Mutaflor |
| Saccharomyces cerevisiae (boulardii) lyo | DiarSafe, Ultralevure |

PROBIOTICS AND PERIODONTAL DISEASE

The studies conducted on Streptococcus uberis and Streptococcus oralis and other beneficial bacteria, has turned out to be helpful in inhibiting the growth of disease causing bacteria. Even the presence of Steptococcus oralis and Streptococcus Uberis has proved to be a good indication of healthy gingiva. A study by Koll-Klais et al. revealed higher prevalence of lactobacilli, particularly Lactobacillus gasseri and Lactobacillus fermentum in the mouth of healthy individuals than patients with chronic periodontitis. According to them high levels of Lactobacillus in microbiota caused an 82% inhibition in Porphyromonas gingivalis and 65% inhibition in Prevotella intermedia growth.

Chewing gum “PERIO BALANCE” is the first probiotic gum, designed to combat the periodontal disease. It is a combination of two strains of Lactobacillus reuteri having synergetic properties in inhibiting the cariogenic bacteria and periodontopathogens. Each dose of lozenge contains at least 2×10⁸ living cells of Lactobacillus reuteri prodentis. Lozenge has to be used daily after meal or in the evening after brushing teeth, to allow probiotics to spread and adhere to various oral surfaces. Krasse et al evaluated Lactobacillus reuteri in a recurrent gingivitis case. A parallel, double blind, randomized, placebo controlled study with 59
patients having moderate to severe gingivitis were selected. *Lactobacillus reuteri* strains were administered via chewing gums twice a day for 2 weeks at a concentration of $1 \times 10^8$ CFU along with scaling and root planing. After 2 weeks, the clinical parameters were improved in the group consuming probiotic chewing gums 11.

Hillman et al carried out a parallel open label placebo controlled study on 24 gnotobiotic rats including a single baseline application and showed significant decreased levels of A. actinomycetemcomitans when compared with placebo group 12.

Grudianov et al using a mixture of probiotics, reported improvements in clinical signs of gingivitis. Probiotics have also been employed as antimutagenic and anticariogenic agents 13.

**PROBIOTICS AND HALITOSIS**

Halitosis or bad breath is seen in large number of the population. It is caused by a number of volatiles compounds originating from the oropharynx or from expired alveolar air. In halitosis, the sulphur containing gases (hydrogen sulfide, methyl mercaptan and dimethyl sulfide), derived from the bacterial degradation of sulphur containing amino acids in the oropharynx, are the main culprits.

Kang et al reported that *Weissella cibaria* has the capacity to coaggregate with *Fusobacterium nucleatum*, adhere to epithelial cells and produce hydrogen peroxide as well as bacteriocin which inhibits the proliferation of F. nucleatum. Gargling with a solution containing Weissella cibaria was associated with a net reduction in hydrogen sulphide production and consequently reduction in bad breath 14.

Tomoyuki et al did a randomized controlled trial to evaluate the efficacy of *Lactobacillus salivarius* WB21 tablets in halitosis management and showed that oral malodor parameters significantly reduced at the end of 2 weeks of administration of the probiotic tablet compared to placebo tablets 15.

**PROBIOTICS AND DENTAL CARIES**

Dental caries is one disease of the oral cavity that needs early care and prevention. *Streptococcus mutans* is one of main causative organism for dental caries. Numerous studies depict that the probiotics containing *Lactobacillus rhamnosus GG* and *Lactobacillus casei* or *Bifidobacterium DN-173 010*, reduce the growth of oral streptococci and dental caries risk 16.

**GUIDED POCKET RECOLONIZATION (GPR)**

Recently, Teughels et al reported that the subgingival application of a bacterial mixture including *Streptococcus sanguinis*, *Streptococcus salivarius* (S. salivarius), and *Streptococcus mitis* after scaling and root planing significantly suppressed the recolonization of *Porphyromonas gulae* (canine P. gingivalis) and *Prevotella intermedia* in a beagle dog model 17.

Vivekanad et al performed an animal study to test the concept of bacterial replacement therapy in the treatment of plaque related periodontal disease and assessed quantitative changes in the subgingival microbiota after root planing when beneficial bacteria were applied adjunctively. Although application of beneficial bacteria did not exclude pathogen recolonization, it did delay the recolonization process significantly 18.

Nackaerts et al in an animal study evaluated radiologically the impact of replacement therapy by monitoring bone density changes and alveolar bone level in periodontal pockets in a dog model. The bone density within periodontal pockets treated with beneficial bacteria improved significantly after 12 weeks, there was a significant increase in the bone level at the end of the study for the pockets receiving beneficial bacteria, and no significant changes were noted in the control pockets 19.

This concept of guided pocket recolonization if scrutinize and studied more can emerge as a treatment modality for periodontal diseases.
SAFETY ISSUES
Due to increased probiotics availability in different food products, safety measures are a major issue. Probiotics are often regarded as dietary supplements rather than as pharmaceutical products. When applied orally, a part of them will be ingested and interacts with a patient’s health. When taken orally, they are generally considered safe and well tolerated with bloating and flatulence occurring frequently. The conclusions from antibiotic susceptibility tests showed that the tet- (W) and tet- (S) genes in some probiotic Lactobacilli and Bifido bacteria strains are responsible for sulfamethoxazole, gentamycin, polymyxin B and tetracycline resistance. These findings show the need of minimal safety evaluation during the selection of strains for probiotic use. The present literature suggests that the incidence of Lactobacillus bacteremia is uncommon and that all the cases where it has been registered are individuals with other systemic diseases such as diabetes, cardiovascular diseases, gastrointestinal disorders, malignancies, or organ transplant patients. Although administration of probiotics is safe and each strain of probiotics has its own properties that needs to be considered before using it in any patient.

CONCLUSION
Periodontitis is a risk factor of various systemic diseases like diabetes, atherosclerosis, preterm low birth and Probiotics presents a new era in periodontal therapy. The literature potrays that the use of oral probiotics improves the periodontal health. But the effect of Probiotics and its maintenance that includes administration, dosage and safety issues are not clear. NASA of USA is carrying out research to develop probiotic products which enable humans to live in space. But further more randomized control trials are necessary to check for the efficacy of probiotics in management of periodontal diseases.

REFERENCES
1. Nihal Devkar et al. Probiotics and Prebiotics in Periodontal Disease- Revisited. Journal of Dental & Allied Sciences 2012;1(1):18-20.
2. Chatterjee A, Bhattacharya H, Kandwal A. Probiotics in periodontal healthanddisease. JIndianSocPeriodontol2011;15(1):23-28.
3. Rinkee Mohanty1 Bianca Nazareth2 Neha Shrivastava1 The potential role of probiotics in periodontal health, RSBO. 2012 Jan-Mar;9(1):858 – 87.
4. Lilly DM, Stillman RH. Probiotics: growth promoting factors produced by microorganisms. Science. 1965;147:747-748.
5. Grajek W, Olejnik A and Sip A. Probiotics in periodontal health and disease. J Indian Soc Periodontol 2011;15(1):23-28.
6. Food and Health Agricultural Organization of the United Nations and World Health Organization. Guidelines for the evaluation of probiotics in food. FAO/WHO Working Group Report on Drafting Guidelines for the Evaluation of Probiotics in Food. 2002. Available from: URL: ftp://ftp.fao.org/es/esn/food/wgreport2.pdf.
7. Meurman JH, Stamatova I. Probiotics: contributions to oral health. Oral Dis 2007;13(5): 443451.
8. Toure R, Kheadr E, Lacroix C, Moroni O, Fliss I. Production of antibacterial substances by bifidobacterial isolates from infant stool active against Listeria monocytogenes. J Appl Microbiol. 2003:95: 1058–1069.
9. Koll-Klais P, Mändar R, Leibur E, Marcotte H, Hammarström L, Mikelsaar M. Oral lactobacilli in chronic periodontitis and periodontal health: species composition and antimicrobial activity. Oral Microbiol Immunol. 2005;20(6):354-61.
10. Rokka S, Mylllykangas S, Joutsjoki V. Effect of specific colostral antibodies and selected lactobacilli on the adhesion of Helicobacter pylori on AGS cells and the Helicobacter-induced IL-8 production. Scand J Immunol. 2008: 68:280–286.

11. Krasse P, Carlsson B, Dahl C, Paulsson A, Nilsson A, Sinkiewicz G. Decreased gum bleeding and reduced gingivitis by the probiotic Lactobacillus reuteri. Swed Dent J. 2006: 30:55–60.

12. Hillman JD, Shivers M. Interaction between wild type, mutant and revertant forms of the bacterium Streptococcus sanguis and the bacterium Actinobacillus actinomycetemcomitans in vitro and in the gnotobiotic rat. Arch Oral Biol. 1988;33:395-401 18.

13. Grudianov AI, Dmitrieva NA, Formenko EV. Use of probiotics Bifidumbacterin and Acilact in tablets in therapy of periodontal inflammations. Stomatologia. 2001;81:39-43.

14. Kang MS, Kim BG, Chung J, Lee HC, Oh JS. Inhibitory effect of Weissella cibaria isolates on the production of volatile sulphur compounds. J Clin Periodontol. 2006;33(3):226-32.

15. Tomoyuki I, Suzuki N, Tanabe K, Takeshita T. Effects of probiotic Lactobacillus salivarius WB21 on halitosis and oral health: an open label pilot trial. Oral Med. 2010;110:201-8.

16. Corcoran BM, Ross RR Fitzgerald GF et al. Comparative survival of probiotic lactobacilli spray-dried in the presence of prebiotic substances. I Appl Microbiol.2004; 96: 1024-1039.

17. Teughels W, Newman MG, Coucke W, Haffajee AD, van der Mei HC, Haake SK, et al. Guiding periodontal pocket recolonization: A proof of concept. J Dent Res 2007; 86:107882.

18. Vivekananda MR, Vandana KL, Bhat KG. Effect of the probiotic Lactobacilli reuteri (Prodentis) in the management of periodontal disease: a preliminary randomized clinical trial. J Oral Microbiol. 2010; 2(2): 5344.

19. Nackaerts O, Jacobs R, Quirynen M, Rober M, Sun Y, Teughels W. Replacement therapy for periodontitis: pilot radiographic evaluation in a dog model. J Clin Periodontol 2008;35(12):1048-52.

20. Falagas ME and Betsi GI and Tokas 'II Athanasiou S. Probiotics for prevention of recurrent urinary tract infections in women: a review of the evidence from microbiological and clinical studies. Drugs.2006; 66: 1253-1261.

21. RaoY, Lingameneni B and Reddy,Probiotic ;A role in oral Medicine and Dentistry, D. JNJ Dent Assoc,2012 Spring;83(2)28-32.