

Probiotics and Oral Health

Dr Prathap*, Dr Shruthy Prathap**

Abstract:

Probiotics utilize naturally occurring bacteria to confer a health benefits when administered in adequate amounts. A few conventional foods containing probiotics are yogurt, fermented and unfermented milk, soya beverages etc. Most often, they come from two groups of bacteria, Lactobacillus or Bifidobacterium. Probiotics have been extensively studied for their health promoting effects. Scientific understanding of probiotics and their potential for preventing and treating oral diseases is at its infancy. This review is focused on the use of probiotics as preventive and therapeutic products for oral healthcare.

Key Words: Bifidobacterium, Lactobacillus, Probiotics, Replacement therapy

Introduction:

Chemotherapeutics are widely used to prevent and treat infections caused by indigenous and exogenous microbes. The availability of effective and cheap antibiotics in the latter half of the 20th century revolutionized the treatment of infectious diseases. However, the development of resistance to a range of antibiotics by some important pathogens has realized the possibility of a return to the preantibiotic dark ages. Also, orally, the widespread use of antibiotics is reflected in the level of resistance in the subgingival microbiota.¹ These developments have encouraged researchers in various fields of health care to develop alternative antimicrobial approaches. The application of health promoting bacteria for therapeutic purposes is one of the strongest emerging field in this regard. Although the use of such probiotics specifically to improve oral health is still in its infancy, oral health care workers are probably confronted with dietary probiotics on a daily basis. The widespread oral intake of probiotics as preventive and therapeutic products for gastrointestinal health makes it of considerable interest for oral healthcare workers. These products usually contain streptococci, lactobacilli or

bifidobacteria.² This review is focused on the use of probiotics as preventive and therapeutic products for oral healthcare and the potential risks associated with dietary probiotics.

Probiotics (WHO 2002) are live microorganisms administered in adequate amounts with beneficial health effects on the host. Not all bacteria are bad. Infact, beneficial microbes could represent the future of medicine. **Antibiotics** destroy the harmful bacteria that can cause infection, while also destroying the good bacteria that help to fight infection. Probiotics on the otherhand, repopulate the beneficial bacteria which can help kill pathogenic bacteria and fight against infection.³ They are substances produced by microorganisms which promote the growth of other microorganisms. The term probiotics is an antonym of the term antibiotics.⁴ In contrast **Prebiotics** are generally defined as not digestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacterial species already established in colon, and thus in effect improve host health. These prebiotics include inuline, fructooligisaccharides, galactosoligosaccharides and lactulose. **Synbiotics** are defined as mixtures of probiotics and prebiotics that beneficially affect the host by improving the survival and implantation of live microbial dietary supplements in the gastrointestinal tract of the host. The term **Replacement therapy** (also called bacteriotherapy of bacterial interference is sometimes used interchangeably with probiotics) Although both approaches use live bacteria for prevention or treatment of infectious disease, there are some slight differences. In replacement therapy, effector strain is not ingested and is applied directly on the site of infection, whereas probiotics are generally used as dietary supplements. Replacement therapy involves dramatic and long term

*M.D. S, Professor, Department of conservative dentistry and endodontics, Yenepoya dental college, Mangalore, ** M.D. S, Senior lecturer, Department of Periodontics Yenepoya dental college, Mangalore,

Corresponding Address:

Dr Prathap,
Professor,
Department of Conservative Dentistry and Endodontics,
Yenepoya Dental College, Mangalore,
Karnataka, India.
PIN-575018,
Telephone Number: +91-9980433489
Email Address: sruthysreekumar@yahoo.com

change in the indigenous microbiota with minimal immunological impact unlike the probiotic therapy.

History:

The use of microorganisms to promote health is very ancient and can even be traced back to the classical Roman literature where food fermented with microorganisms was used as a therapeutic agent. Observations showing that relatively harmless bacteria can be introduced into the indigenous microbiota of humans, either to enhance resistance to or treat infection, goes back to the very origins of microbiology. Pasteur and his associate, Joubert, noted as early as 1877 that the growth of anthrax bacilli in cocultures with 'common bacilli' (probably *Escherichia coli*) was suppressed. They commented that 'these facts perhaps justify the highest hopes for therapeutics'. The original observation of the positive role played by some selected bacteria was scientifically investigated by Eli Metchnikoff, the Ukrainian – born Nobel prize winner working at the Pasteur Institute at the beginning of the last century. He proposed in 1907 that the lactic acid-producing strain *Lactobacillus bulgaricus* (contained in Bulgarian yoghurt) is able to displace pathological intestinal microbiota. He suggested that the dependence of the intestinal microbes on food makes it possible to adopt measures to modify the flora in our bodies and replace the harmful microbes by useful microbes⁵. Around that time, Henry Tissier a French pediatrician, observed that children with diarrhoea had in their stools a low number of bacteria characterized by a peculiar Y-shaped morphology. These bifid bacteria (later on called bifidobacterium) were on the contrary, abundant in healthy children. Tissier suggested that these bacteria could be administered to patients with diarrhea to help restore a healthy gut flora. Alfred Nissle studied soldiers during World War I and isolated bacteria from the stool of soldiers who remained healthy despite the fact that most of their comrades suffered from diarrhea. He used one isolate (*E. coli* strain Nissle 1907) to treat a 20-year old woman with chronic active ulcerative colitis. After 5 weeks of treatment with 200mg/day of the strain, remission was achieved. By the end of World War II, several protective treatments had been developed for tuberculosis, anthrax and diphtheria. The observation of Metchnikoff, Tissier and others were so appealing that commercial exploitation immediately followed their scientific works. Unfortunately the results were not always positive and most of these were anecdotal.

Liley and Stilwell were the first to use the term "probiotics". The term probiotic is a relatively new word meaning 'for life'.¹ In 1974, Parker defined probiotics as organisms and substances which contribute to intestinal microbial balance. Fuller redefined probiotics as "A live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance⁴. The WHO definition of probiotics is "live microorganisms which when administered in adequate amounts confer a health benefit on the host".⁶ The importance of living cells in probiotics was emphasized by Fuller, in 1989, who defined probiotics as 'A live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance.'⁷

How do Probiotics act?

Probiotics can help prevent and treat disease through several mechanisms.

1. Direct interaction: Probiotics interact directly with the disease causing microbes, making it harder for them to cause the disease.
2. Competitive exclusion: Beneficial microbes directly compete with the disease, developing microbes for nutrition or enterocyte adhesion sites.
3. Modulation of host immune response: Probiotics interact with and strengthen the immune system and help to prevent diseases.⁸

Probiotics and their availability:

Probiotics are generally used as dietary supplements and food. A few conventional foods containing probiotics are yogurt, fermented and unfermented milk, cheese, soy beverages. They are also available as tablets containing bacterial strains, capsules, liquids and even chewing gums. If properly prepared and stored, probiotic bacteria can remain viable in dried form and reach the intestine alive when consumed.

Probiotics in General Health

Gastrointestinal: Probiotics have traditionally been used to treat diseases related to gastrointestinal tract. The most widely used species belong to the genera *Lactobacillus* and *Bifidobacteria*, although these species are not predominant in the gastrointestinal microbial ecology. They are categorized by United States Food and Drug Administration as 'Generally Regarded As Safe (GRAS).

Several gastrointestinal health claims have been made for probiotics, such as relief of enzymatic maldigestion. Probiotic bacteria containing β galactosidase can be added to food to improve lactose maldigestion.⁹ A similar effect has been observed in sucrose deficient children in whom intake of *Saccharomyces cerevisiae* enhances the digestion of a sucrose load.

Antibiotic associated diarrhoea, which occurs in 20% of patients who receive antibiotics, results mainly from microbial imbalance and an overgrowth of *Clostridium difficile* and *Klebsiella oxytoca*, *Saccharomyces boulardii* has been shown to reduce this risk and to shorten the duration of antibiotic-associated diarrhea.¹⁰

For **Rotavirus-associated diarrhoea**, both curative and preventive effects have been shown for selected probiotics. *L. rhamnosus* GG, *Lactobacillus reuteri*, *Lactobacillus casei* etc can shorten the duration of rotavirus associated diarrhea. Mechanisms that may drive the protective effects are production of acids, hydrogenperoxide, antimicrobial substances, competition for nutrients or adhesion receptors, antitoxin actions, and stimulation of immune system.

There are some suggestions that probiotics might reduce the risk of **colorectal cancer**. This hypothesis is based on the observation that selected lactobacilli reduce the activity of certain fecal enzymes that convert procarcinogens into carcinogens and on some epidemiological studies which suggest that regular consumption of fermented dairy products are related to a lower risk for certain types of cancer.

Urogenital infections:

In a small scale study, vaginal application of *L. rhamnosus* GR1 in combination with *L. reuteri* strains appeared to prevent urogenital infections at a level similar to that of prebiotic milk or daily antibiotic therapy¹¹. Several other studies showed only indirectly, a possible reduction of the risk for infection. There is no clear evidence that probiotics can help to treat urogenital tract infections.

Atopic disease:

Although the exact mechanism is not known, lactobacilli has the ability to reverse increased permeability, enhance gut-specific IgA responses, promote gut barrier function through the restoration of normal levels of microbes, and enhance gut-specific IgA responses, promote barrier function through the restoration of normal levels of microbes, and enhance

transforming growth factor- β and interleukin-10 production as well as cytokines that promote the production of IgE antibodies.¹²

Oropharyngeal infections:

Acute otitis media is the most common bacterial infection in young children. The causative bacteria typically translocate from the oro-naso-pharyngeal cavity to middle ear via the eustachian tube. The rationale behind the use of antibiotics lies within the observation that children who are prone to acute otitis media harbor fewer α - hemolytic streptococci in the nasopharynx than children who are more resistant to acute otitis media. Additionally some α - hemolytic streptococci have an interfering activity against pathogens that cause otitis media. Roos et al recently reported their experience of spraying α - hemolytic streptococci with interfering activity into the nose of otitis prone children. Forty two percent of the children remained healthy during the follow up period and had normal tympanic membrane compared with 22% of the children in the placebo group.¹³

Streptococcus Pharyngotonsillitis:

Bacterial replacement therapy appears to offer an ecologically sound alternative for the control of streptococcal pharyngotonsillitis. The predominant species in the pharynx of healthy neonates are one or more species of α hemolytic streptococci. The absence of these species was shown to correlate with a significantly increased risk of infections, including sepsis, meningitis, pneumonia and cystitis. Studies have shown that the patients sprayed with strains of α - hemolytic streptococci was known to have a strong growth inhibiting activity against β -hemolytic streptococci. After a followup period of 3 months after the α -hemolytic streptococci treatment, none of the patients contracted new tonsillitis during followup period.¹⁴

Voice prostheses:

In several studies, it was observed that buttermilk containing *Lactobacillus lactis* and *Lactococcus cremoris lactissp* and a fermented milk drink containing *L. casei shirota*, decreased the amount of both bacteria and yeast on voice prostheses. Consumption of the fermented milk drink significantly increased the mean in situ lifetime of voice prostheses by almost fourfold. This increase in the lifetime of voice prostheses was concurrent with a significant decrease in the number of prostheses replacement.¹⁵

Caries management:

Nase et al. were the first to test a dietary lactobacillus strain *L. rhamnosus* GG, on its caries inhibitory ability in vivo. Their hypothesis was based on the invitro inhibition of caries pathogen. They showed in a placebo-controlled randomized double-blind intervention study that the administration of probiotic lactobacilli (LGG) to kindergarten children in Helsinki, Finland, resulted in reduction of their caries risk and initial caries development.¹⁶

According to a study conducted by Caglaretal consumption of bifido-bacterium containing yogurt resulted in a significant decrease in salivary *S. mutans* in contrast to lactobacillus count, which remained unaffected.¹⁷

The vehicle by which probiotics are ingested or delivered in the oral cavity can, however influence the cariogenic potential and the oral colonisation of a probiotic. Fortunately, the most commonly used dietary lactobacilli are consumed in milk products (eg-fermented milk drink, yoghurt, or cheese). When lactic acid bacteria are being consumed in milk products, the buffering capacity of milk will decrease the production of acid. The presence of calcium, calcium lactate and other organic and inorganic compounds in milk are anticariogenic and reduce the colonisation of pathogens.¹⁸

“Probiotic Gum” is a chewing gum that is said to prevent tooth decay. The gum, first developed by a German chemical company, contains probiotics, which are friendly bacteria that helps to prevent harmful bacteria from sticking to the teeth and causing decay. The gum is effective against *Streptococcus mutans* that acts as a major cariogenic strain to humans, which causes the strain to clump together. This renders them far less capable of sticking to the teeth and causing decay.

Effect on candidal infections:

More recently, probiotic cheese was investigated in 294 self-acting elderly, aged 70–100 yr. The subjects were randomized for a double blind, placebo-controlled intervention study. The results showed that the probiotics reduced the prevalence of oral *Candida* and surprisingly, the risk for hyposalivation in the elderly. Probiotic intervention diminished the risk for belonging to a high yeast count class ($> 10^5$ colony-forming units (cfu) ml⁻¹) by 75% (OR = 0.25, 95% CI 0.10–0.65)¹⁹. Because antifungal drug resistance of *Candida* sp. is increasing, this

preliminary observation is interesting, and it opens future visions for eventually controlling oral yeast infection by use of probiotics as an adjunct therapy.

Probiotics in aphthous ulcers:

Studies have shown that use of lactic acid bacteria OMX capsules is beneficial in treatment of recurrent aphthous ulcers (RAS) of the mouth. The ability of LAB to increase the activity of the phagocytes must be the key factor in combating RAS, as Porter and Scully have stated that in RAS, phagocytosis by PMNLs (Polymorphonuclear leukocytes) and the chemotaxis to PMNLs are defective.²⁰

Periodontal diseases:

In 1954, a beneficial effect of lactic acid bacteria on inflammatory infections of oral mucosa was reported²⁰. The use of a Russian probiotic preparation called Acilact, a complex of five live lyophilized lactic acid bacteria, with or without ‘Bifidobacterium’ is claimed to improve both clinical and microbiological parameters. Recently, a periodontal dressing consisting of collagen and *L. casei* 37 was reported to exert a beneficial effect on the subgingival microbiota of periodontal pockets.²¹

Since the beginning of the 21st century, the appreciation of the beneficial oral microbiota and their use in the prevention and treatment of plaque related periodontal inflammation has undergone a revival. In Japan, an *L. salivarius* strain is currently being investigated regarding its potential to suppress periodontopathogens and improve periodontal health. It was also observed that there was a significant reduction in black pigmented anaerobic rods after the intake of probiotics.²²

Halitosis:

Halitosis (bad breath) is caused by a number of volatiles, which originate from the oro-pharynx or from expired alveolar air. In halitosis, the sulphur containing gases (hydrogen sulphide, methyl mercaptan and dimethyl sulfide) which are derived from the bacterial degradation of sulphur – containing amini acids in the oropharynx, play a significant role. A diverse consortium of bacteria has been found to contribute to the problem. The current treatment focuses on the use of chemical or physical antibacterial regimes to reduce the numbers of these bacteria. However, most of these treatments exhibit only a temporary effect or are associated undesirable side-effects when used over a

long period of time. To prevent the regrowth of odour causing organisms, pre-emptive colonization of oral cavity with probiotics might have a potential application as adjuncts for both the treatment and prevention of halitosis. Burton et al investigated the effect of *S.salivarius* on oral malodour parameters. *S.salivarius* was selected as an oral probiotic because it is an early colonizer of oral surfaces and is amongst the most numerically predominant members of the tongue microbiota of healthy individuals. The species have only limited ability to produce volatile sulphur compounds and is unlikely to contribute significantly to oral malodour. 85% of the patients in the experimental group had a substantial reduction in volatile sulphur compound scores²³.

Conclusion:

Probiotics play an important role in combating issues with overuse of antibiotics and antimicrobial resistance. Today's new technological era would be the right time to change the way bacteria are treated. Furthermore, no negative effects of probiotic use on oral health have been reported to date. Despite our rapidly increasing knowledge of pathogen-host interactions, the role of beneficial bacteria in preventing the emergence of pathogenic species and oral health remains obscure. There is a great need to elucidate the role of oral beneficial microbiota, to identify beneficial bacteria and to conduct proper large-scale studies on the usefulness of probiotics to maintain or improve oral health.

References:

1. Van Winkelhoff AJ, Herrere GD, Winkel EG, DelleMijn Kippuw N, Vandenbroucke- Grauls CM, et al. Antimicrobial resistance in the subgingival microflora in patients with adult periodontitis. A comparison between the Netherlands and Spain. *J Clin Periodontol* 2000; 27:79-86.
2. Wim Teughels, Mark Van Essche, Isabelle Sliepen and Marc Quirynen. Probiotics and oral healthcare. *Periodontol* 2000; 48:111-147.
3. Shimauchi H, Mayanagi G, Nakaya S, Minamibuchi M, Ito Y, Yamaki K, et al. Improvement of periodontal condition by probiotics with *Lactobacillus salivarius* WB21: A randomized, placebo -controlled study. *J Clin Periodontol* 2008;35:897-905.
4. Lilly DM, Stillwell RH. Probiotics :growth promoting factors produced by microorganisms. *Science* 1965;147:747-748.
5. Metchnikoff E. Lactic acid as inhibiting intestinal putrefactions. In: Metchnikoff E, Mitchell PC, editors. *The prolongation of life ; Optimistic Studies* W Heinemann, London 1907:161-183.
6. Parker RB. Probiotics, the other half of antibiotic story. *Anim Nutr Health* 1974;29:4-8.
7. Fuller R. Probiotics in man and animals. *J Appl Bacteriol* 1989;66:365-378.
8. Deepa D, D.S. Mehta. Is the role of probiotics friendly in the treatment of periodontal diseases. *J Ind Soc Periodontol*;2009;13:145-147.
9. Kim HS, Gilliland SE. *Lactobacillus acidophilus* as a dietary adjunct for milk to aid lactose digestion in humans. *J Dairy Sci* 1983;66:959-966.
10. Mc Farland LV, Surwicz CM, Greenberg RN, Elmer GW, Moyer KA, Melcher SA et al. Prevention of beta-lactam-associated diarrhea by *Saccharomyces boulardii* compared with placebo. *Am J Gastroenterol* 1995;90:439-448.
11. Hilton E, Isenberg HD, Alperstein P, France K, Borenstein MT. Ingestion of yogurt containing *Lactobacillus acidophilus* as a prophylaxis for candidal vaginitis. *Ann Intern Med* 1992;116:353-357.
12. Isolauri E. Probiotics in the prevention and treatment of allergic disease. *Pediatr Allergy Immunol* 2001; 12 (Suppl 14):56-59.
13. Roos K, Hakansson EG, Holm S. Effect of recolonisation with interfering alpha streptococci on recurrences of acute and secretory otitis media in children: randomized placebo controlled trial. *Br Med J* 2001;322:210-212.
14. Roos K, Grahn E, Holm SE, Johansson H, Lind L. Interfering alpha-streptococci as a protection against recurrent streptococcal tonsillitis in children. *Int J Pediatr Otorhinolaryngol* 1993;25:141-148.
15. Schwandt LQ, van Weissenbruch R, Van der Mei Hc, Busscher HJ, Albers FW. Effect of dairy products on the lifetime of Provox2 voice prostheses in vitro and in vivo. *Head Neck* 2005;27:471-477.
16. Nase L, Hatakka K, Savilahti E, Saxelin M, Ponka A, Poussa T, et al. Effect of long-term consumption of a probiotic bacterium, *Lactobacillus rhamnosus* GG, in milk on dental caries and caries risk in children. *Caries Res* 2001; 35: 412-420.
17. Caglar E, Sandalli N, Twetman S, Kavalglu S, Ergeli S, Selvi S. Effect of yogurt with *Bifidobacterium* DN-173010 on salivary mutans streptococci and lactobacilli in young adults. *Acta Odontol Scand* 2005;63:317-320.
18. Schupbach P, Neeser JR, Golliard M, Rouvet M, Guggenheim B. Incorporation of caseinoglycomacropeptide and caseinophosphopeptide into the salivary pellicle inhibits adherence of mutans streptococci. *J Dent Res* 1996;75:1779-1788.
19. Hatakka K, Ahola A, Yli - Knuuttila H, Richardson M, Poussa T, Suomalainen T, et al. Cheese with probiotic bacteria reduces prevalence of oral *Candida* in the

- elderly. *Am J Clin Nutr* 2005; In Press .
20. Kragen H. The treatment of inflammatory affections of the oral mucosa with a lactic acid bacterial culture preparation. *Zarnarztl Welt* 1954; 9:306-308.
 21. Grudianov AI, Dmitrieva NA, Fomenko EV. Use of probiotics Bifidumbacterin and Acilact in tablets in therapy of periodontal inflammations. *Stomatologia* 2002;81:39-43.
 22. Ishikawa H, Aiba Y, Nakanishi M, Oh-hashii, Koga Y. Suppression of periodontal pathogenic bacteria in the saliva of humans by administration of *Lactobacillus salivarius* TI2711. *J Jpn Soc Periodontol* 2003;45:105-112.
 23. Burton JP, Chilcott CN , Tagg J. The rationale and potential for the reduction of oral malodour using *Streptococcus salivarius* K12 on oral malodour parameters. *J Appl Microbiol* 2006;100:754-764.