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Probiotics in Dentistry – A Review

L. Malathi, Jayasrikrupaa, N. Balachander, Vidya Rani, V. Anbazhagan* and KMK Masthan

Department of Oral Pathology and Microbiology, Sree Balaji Dental College & Hospital, Bharath University, Chennai, India.

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Probiotics are dietary supplements containing potentially beneficial bacteria or some yeasts. They help in stimulating health promoting flora and also suppressing pathogens which cause and spread diseases. A balanced oral microbial environment is essential for the promotion of health & prevention of diseases. Probiotic technology represents a breakthrough approach to maintain oral health by using natural beneficial bacteria, commonly found in oral cavity of healthy individuals, to provide a natural defense against those bacteria which are thought to be harmful to structures of oral cavity. The aim of this review is to understand the mechanism of action of probiotic bacteria in the oral cavity and summarize observed effects of probiotics as well as their varied applications in the field of dentistry.

Key words: Probiotics, Beneficial bacteria, oral health, lactobacillus, probiotics, synbiotics.

Probiotics was used to improve gastrointestinal health initially and their popularity has increased interest for their responsibility in promotion of oral health**.** Probiotic approach has shown promising results in oral cavity with respect to control of dental caries, periodontitis, halitosis, candidial infections and control of biofilm formation on voice prosthesis.

Definitions

The term probiotic, meaning "for life" is derived from the Greek language. Probiotics was first used by Lilly and Stillwell in 1965.[1]Live microorganisms which, when administered in adequate amounts, give a health benefit on the host.

The term prebiotic was introduced by Gibson and Roberfroid. They defined prebiotics as a "non-digestible" food ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon.[2]

The term synbiotic - when a product contains both probiotics and probiotics.[2]

Prebiotics and synbiotics

Prebiotics are dietary substances that take care of a selected group of microorganisms living in the gut. They support the growth of beneficial bacteria.

1) Oligofructose
2) Inulin
3) Galacto-oligosaccharides
4) Lactulose
5) Breast milk oligosaccharides
6) Mechanisms of probiotic in the oral cavity4
7) Direct interactions in dental plaque
8) Organization in binding of oral pathogens to proteins (biofilm formation).

Action on plaque and on its complex ecosystem by competing and intervening with bacteria - bacteria attachments.

* To whom all correspondence should be addressed.
Mob.: +91-9841782889;
E-mail- anbu20_bds@yahoo.co.in

Microorganisms that are considered to be Probiotics[3]

Lactobacillus spp.	Bifidobacterium spp	Others
L acidophilus	*B. bifidum*	Saccharomyces boulardii
L. casei	*B. breve*	Lactococcus lactis subsp.
L. crispatus	*B. infantis*	Cremoris.
L. gasseri	*B. longum*	Enterococcus faecium.
L. johnsonii	*B. lactis*	Streptococcus salivarius
L. paracasei	*B. adolescentis*	sub sp. Thermophilus.
L. delbrueckii		*S. diaacetylactis.*
L. fermentum		
L. plantarum		
L. reuteri		
L. rhamnosus		

1) Taking part in metabolism of substrates.
2) Production of chemicals (antimicrobial substances) that inhibit oral pathogens.
3) Indirect probiotic actions in the oral structures
4) Modulating systemic immune system.
5) Effect on local immunity.
6) Regulates mucosal permeability.
7) Selective pressure on developing oral microflora towards colonization by pathogenic organisms.

Mechanisms of Probiotic in Oral Cavity

(a) Normalization of intestinal micro biota
(b) Modulation of immune response
(c) Metabolic effects

The mechanisms of probiotic action in the oral cavity could be equivalent to those described for the intestine. Normalization of intestinal/oral microbiota is supported by the ecological plaque hypothesis which suggests that selective pressure in ecological conditions can change the balance between disease and oral health.[5]

As there are bacterial species associated with oral diseases, there are also some bacterial species that seem to be related with oral health. However, it is questionable whether administration of bacteria could influence relatively stable oral microbiota, in particular in adult. Such beneficial bacteria can be used as probiotics to normalize oral microbiota[6]

Immunomodulation

Rather than directly inhibiting the growth or viability of the pathogen, probiotics may participate for an ecological position or, otherwise, create conditions that are unfavorable for the pathogen to take hold in the intestinal tract. First, several probiotics have been demonstrated to alter the ability of pathogens to adhere to or invade colonic epithelial cells in vitro. Second, probiotics could suitable essential nutrients from invading pathogens and impair their colonization capacity. Third, probiotics may modify the gene expression program of pathogens in such a way as to inhibit the expression of virulence effect. Lastly, probiotics may produce an unfavorable environment for pathogen colonization by altering pH, the mucus layer, and more factors in the local surroundings. It is important to note that many of these possible effects have been demonstrated in vitro, the capability of probiotics to exclude pathogens in vivo remains to be proven[7]

Properties of the Probiotic

1) Binding to dental surfaces[8]
2) Produce antimicrobial substances against pathogens[9]
3) Alteration of ecological conditions of the mouth
4) Reduction of the inflammatory response

Role of probiotics in dental caries

Dental caries is a disease where bacterial process effect damage to the hard structure of tooth, characterized by acid demineralization of the tooth enamel[10]. This leads to the formation of cavities on the surface of the tooth. Changes to the micro flora in the oral cavity result in an overgrowth of various bacteria including; Streptococcus sorbinus, Streptococcus mutans and Porphyromonas gingivalis which are recognized as the primary cause of the dental caries[11,12,13].

Probiotics show possibility in reducing the incidence of dental caries.[14,15] A study performed using a strain of L. reuteri found a reduction in the presence of S. mutans[15] Another study compared the use of chlorhexidine, mouth rinse with

probiotic, and a mint-water placebo. The results showed reduction in plaque accumulation in the chlorhexidine and probiotic groups compared to the control group.[14]

Probiotics in periodontal health

P. gingivalis, A.actinomycetemcomitans, T. denticola and T.forsythia are the main periopathogens. S. oralis and S. uberis have been reported to inhibit growth of pathogens both in laboratory and animal models. In the Absence of these bacteria,periodontal tissues become prone to several periodontal diseases[16].

"Perio balance" is a chewing gum specifically formulated to fight periodontal disease. It is a mixture of two strains of *L. reuteri* selected for their synergetic properties in fighting cariogenic bacteria. Krasse et al[17] evaluated L. reuteri in patients with recurrent gingivitis. Patients having moderate to severe gingivitis were selected. *L. reuteri* strains were administered along with scaling and root planing surfaces of tooth. After 2 weeks, the clinical parameters were improved in the group consuming probiotic chewing gums.

Role of Probiotics in Halitosis

Halitosis is caused by a number of volatiles and most of its etiologic factors are present in the orpharynx (gingivitis, periodontitis, tongue coating, tonsillitis). F. nucleatum, P. intermedia, P. gingivalis, and T. denticola are produce "Volatile Sulphur Compounds" (VSC's) are responsible for halitosis. Co-aggregation of F. nucleatum with other periopathogens results in secondary colonization of biofilm and contributes to VSC production in oral cavity [18].

Other gases, such as indole, putrescine, cadaverine and acetone, are also the main cause of halitosis.[19] Most (85%) of the pathology causing halitosis lies within the oropharynx.

Hydrogen peroxide has been concerned in maintenance of an ecological system and protection against microorganisms. It reduces the concentration of sulphur gas considerably.

Kang *et al* [20] reported that W. cibaria has the capacity to co aggregate with F. nucleatum, stick on to epithelial cells and produce hydrogen peroxide as well as bacteriocin which inhibits the production of F. nucleatum. Gargling with a solution containing W. cibaria was associated with a reduction in hydrogen sulphide production and consequently reduction in bad breath

Probiotics in orthodontic treatment

The complex design of orthodontic bands and brackets may create an ecological environment that facilitates the establishment and growth of cariogenic mutans streptococci strains.[21]. Cildir et al in 2009 conducted a clinical study with probiotics and found out that daily consumption of fruit yogurt with Bifidobacterium animalis subsp. Lactis DN -173010 could reduce the salivary levels of mutans streptococci in orthodontic patients with fixed appliances[22]

Probiotics in infections and oral diseases

Only two studies have investigated the effects of probiotic bacteria on oral candida infection in humans. When a test group of older people consumed cheese containing Propionibacterium freudenreichii ssp. Shermanii JS and L. rhamnosus strains GG and LC705 for 16 weeks, the number of high oral yeast counts decreased but no changes were observed in mucosal lesions.[23]

In a study with younger subjects, no considerable difference was observed between effects of probiotic and those of control cheese on salivary candida counts.

It was postulated recently that AIDS progression can be deferred using probiotic bacteria. Lin Tay and his colleagues conducted a study in hundred volunteers,they collected saliva sample from them and screened for bacteria.they found that lactobacilli strains secreted a protein that has ability to bind to sugar called mannose. Which is present in HIV envelope. This property helps these bacteria to get attached to oral mucosa and mucosal linings. They, thus can neutralize HIV by binding to mannose. Immune cells formed a clump when trapped by lactobacilli this prevented HIV from infecting other cells. [24, 25]

Probiotics and voice prosthesis

There is anecdotal evidence among patients in The Netherlands that the consumption of buttermilk, which contains Lactococcus lactis spp, Lactococcus cremoris that can produce antimycotics and substances, prolongs the lifetime of indwelling voice prostheses. 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. Lactobacilli have long been known for their capacity

to interfere with the adhesion of uropathogens to epithelial cells while S. thermophilus can effectively participate with yeasts in their adhesion to substratum surfaces, like silicone rubber.[26]

Probiotic Dosage

No consensus exists regarding the minimum number of microorganisms that must be ingested to obtain a beneficial effect.[27,28] Typically, a probiotic should contain several billion microorganisms to increase the likelihood of adequate gut colonization . Various studies have reported different values, $1\times10^{8-10}$, $1\times10^{9-10}$, $1\times10^{10-11}$. [27,28]

Probiotics are supplied along with prebiotic in form of powder sachet, gelatin capsules, or suspension. Combination of pre and pro-biotic has 0.48 billion spores of Lactobacillus bifidum, Streptococcus thermophilus, and 0.10 billion spores of Saccharomyces boulardi along with 300 mg of fructo-oligosaccharides, is given as single dose daily before meals in the morning.[28]

CONCLUSION

Probiotics play an important role in combating issues with overuse of antibiotics and antimicrobial resistance. Further studies to understand the ability of probiotic bacteria to grow survive, and have a beneficial effect when used for treatment. With fast evolving technology and integration of biophysics with molecular biology, designer probiotics pose huge opportunity to treat diseases in a natural and non invasive way.

List of Abbreviations

1) L- lactobacillus
2) S- Steptococcus
3) F- Fusobacterium
4) W- Weissella
5) A.a-Aggregatibacter actinomycetemcomitans
6) P. gingivalis- Porphyromonas gingivalis
7) P. intermedia- Prevotella intermedia
8) T. denticola- Treponema denticola
9) T. forsythia- Tenerella forsythis
10) S. oralis- Streptococcus oralis
11) S. uberis- Streptococcus uberis
12) C. rectus- Campylobacter rectus
13) VSC- Volatile sulphur compounds

REFERENCES

1. Caglar E, Kargul B, Tanboga I. Bacteriotherapy and probiotics' role on oral health. *Oral Dis.*2005; **11**(3): 131-7.
2. Schrezenmeir J, de Vresne M. Probiotics, prebiotics,and synbiotics - approaching a definition. *Am J Clin Nutr.* 2001; **73** (2 Suppl): 361S-4S.
3. Alvarez-Olmos MI, Oberhelman RA. Probiotic agents and infectious diseases: a modern perspective on a traditional therapy. *Clin Infect Dis.* 2001; **32**: 1567-1576.
4. Meurman JH. Probiotics: do they have a role in oral medicine and dentistry? *Eur J Oral Sci.* 2005; **113**(3): 188-96.
5. Marsh PD Are dental diseases examples of ecological catastrophes? *Microbiology*., 2003; **149**: 279-294.
6. Haukioja A Probiotica and Oral Health. *European Journal of Dentistry* 2010; **4**: 348-355.
7. Britton RA, Versalovic J Probiotics and Gastrointestinal Infections.Interdiscip Perspect Infect Dis [Epub Ahead of Print 2008.
8. Gueimonde M, Salminen S. New methods for selecting and evaluating probiotics. *Dig Liver Dis.* 2006; **38** (Suppl 2): S242-7.
9. Reid G, Jass J, Sebulsky MT, McCormick JK. Potential uses of probiotics in clinical practice. *Clin Microbiol Rev.* 2003; **16**(4): 658-72.
10. Selwitz RH, Ismail AI, Pitts NB., Dental Caries. *Lancet*. 2007; **369:** 9555.
11. Islam B, Khan S, Khan A., Dental Caries: From Infection to Prevention. *Med Sci Monit.* 2007; **13**(11): RA196-203.
12. Bonifait L, Chandad F, Grenier D., Probiotics for Oral Health: Myth or reality? *JCDA*. 2009; **75**(8): 555-590.
13. Stamatova I, Kari K, Meurman H., In Vitro evaluation of antimicrobial activity of putative probiotic lactobacilli against oral pathogens. *Intl. J. Probiotics and Prebiotics*. 2007; **2**(4): 225-232.
14. Harini PM, Anegundi RT. Efficacy of a probiotic and chlorhexidine mouth rinses: a short-term clinical study. *J Indian Soc Pedod Prev Dent*. 2010; **28**:179-182.
15. Caglar E, Cildir SK, Ergeneli S, Sandalli N, Twetman S. Salivary mutans streptococci and lactobacilli levels after ingestion of the probiotic bacterium Lactobacillus reuteri ATCC 55730 by straws or tablets. *Acta Odontol Scand.* 2006; **64**: 314-318.

16. Hillman JD, Socransky SS, Shivers M. The relationships between streptococcal species and periodontopathic bacteria in human dental plaque. *Arch Oral Biol*. 1985; **30**: 791-5
17. 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
18. Shimazaki Y, Shirota T, Uchida K, Yonemoto K, Kiyohara Y, Iida M et al. Intake of dairy product and periodontal diseases: *The hisayama study. J Periodontol*. 2008; **79**: 131-7 .
19. Teughels W, Newman MG, Coucke W, Haffajee A, Van DerMei HC, Haake SK, et al. Guiding periodontal pocket recolonization: A proof of concept. *J Dent Res.* 2007; **86**: 1078-82 .
20. 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
21. Ahn SJ, Lim BS, Lee SJ Prevalence of cariogenic streptococci on incisor brackets detected by polymerase chain reaction. Am J Orthod Dentofacial Orthop 2007; **131**: 736-741.
22. Cildir SK, Germec D, Sandalli N, Ozdemir FI, Arun T, et al., Reduction of salivary mutans streptococci in orthodontic patients during daily consumption of yogurt containing probiotic bacteria. *Eur J Orthod* 2009; **31**: 407-411
23. Nase L, Hatakka K, Savilahti E, Saxelin M, Ponka A, 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.
24. Lin T Current opinion in HIV and AIDS., 2008; **3**: 599-602.
25. Narwal A Probiotics in Dentistry – A Review. *J Nutr Food Sci* 2011; **1**:114. doi:10.4172/2155-9600.1000114
26. Busscher HJ, Free RH, Weissenbruch RV, Albers FWJ, Van Der Mei HC Preliminary observations on infl uence of dairy products on biofi lm removal from silicone rubber voice prostheses *in vitro*. *J Dairy Sci.* 2000; **83**(4): 641-7.
27. Farnworth ER. The evidence to support health claims for probiotics. J Nutr. 2008; 138(suppl):1250S-4S
28. Deepak H Dave, Sujal C Shah*, Monali Shah, and Neeraj Deshpande, RRJDS 2013; **1**(1).