

Review Article**Probiotics in Periodontal Health and Diseases****Keerti Sharma^{1*}, Ranjana Mohan², Rohit Rai³, Ambuj mishra⁴, Renuka Gupta⁵, Ankita Chaurasia⁶**¹Senior Resident, Department of Periodontology, Teerthanker Mahaveer Dental College and Research Centre, Moradabad, India²Professor and Head, Department of Periodontology, Teerthanker Mahaveer Dental College and Research Centre, Moradabad, India³Senior Resident, Department of Periodontology, Teerthanker Mahaveer Dental College and Research Centre, Moradabad, India⁴Dental Officer Medical, District Hospital, Mainpuri, Uttar Pradesh, India⁵Senior Resident, Department of Periodontology, Institute of Dental Sciences, Bareilly, India⁶Dental Officer, Army Hospital, Pratapgarh, Uttar Pradesh, India***Corresponding author**

Dr. Keerti Sharma

Email: dr.keerti.sharma@gmail.com

Abstract: Probiotics provide us an alternative way to combat diseases and has been introduced for prevention and treatment of periodontal diseases. This review was initiated to explore whether the use of probiotics can influence the periodontal microbiota and periodontal health. The role of probiotics on periodontal disease was reviewed to analyse the clinical effects of oral probiotics on periodontal disease. The term 'probiotic' is a relatively new word and is currently used to name bacteria with beneficial effects for humans and animals. As an antonym of the term 'antibiotics', it was introduced by Lilly & Stillwell as "Substances produced by micro-organisms which promote the growth of other micro-organisms".**Keywords:** Probiotics, bacteria, periodontal disease and health

INTRODUCTION

"Part of the secret of success in life is to eat, what you like and let the food fight it out inside."

—Mark Twain

Etymologically, the term probiotic appears to be a composite of the Latin preposition pro "for" and the Greek adjective βιωτικός (biotic), the latter deriving from the noun βίος (bios), "life" [1].

The oral cavity harbors a diverse array of more than 1000 species of bacteria. This includes commonly residing species including lactobacillus acidobacillus, lactobacillus casei, lactobacillus fermentus, lactobacillus plantarum, lactobacillus salivarius, and lactobacillus rhamnosus. The balance of these microorganisms can easily be disturbed by conditions such as dental caries & periodontitis. According to definition by World Health Organization, probiotics are "Live microorganisms which when administered in adequate amounts confer a health benefit on the host." They are also called "friendly bacteria" or "good bacteria." Lactic acid bacteria (LAB) and bifidobacteria are the most common types of microbes used as probiotics, but certain yeasts and bacilli may also be

used. Probiotics are commonly consumed as part of fermented foods with specially added active live cultures, such as in yogurt, soy yogurt, or as dietary supplements [2].

The dietary use of living microorganism has a long history. Cultured dairy products have been recorded in the Bible and sacred books of Hinduism. Cultured dairy products such as kefir, koumiss, liben and dahi were often used therapeutically before the existence of microorganisms was recognized. At the start of the 20th century, probiotics were thought to beneficially affect the host by improving its intestinal microbial balance, thus inhibiting pathogens and toxin producing bacteria [2].

The term "probiotics" was first introduced in 1953 by Werner Kollath [1]. Contrasting antibiotics, probiotics were defined as microbially derived factors that stimulate the growth of other microorganisms. Today, specific health effects are being investigated and documented including alleviation of chronic intestinal inflammatory diseases, prevention and treatment of pathogen-induced diarrhea, urogenital infections, and atopic diseases [3]. Probiotics are available to consumers mainly in the form of dietary supplements

and foods. Probiotics are commonly consumed as part of fermented foods with specially added active live cultures as dietary supplements. Only certain types of bacteria or yeast have been shown to work in the digestive tract. It still needs to be proved which probiotics (alone or in combination) work to treat diseases. At this point, even the strains of probiotics that have been proved to work for a specific disease are not widely available.

The vast majority of probiotic bacteria mostly belong to the genera *Lactobacillus*, *Bifidobacterium*, *Propioni bacterium* and *Streptococcus*. Evidence shows the oral cavity is a natural habitat for some probiotic species. Such as *Lactobacillus salivarius*, *Lactobacillus gasseri*, *Lactobacillus fermentum* and *Bifidobacterium* and their presence may be associated with periodontal health status.

The treatment strategies conferred by probiotics against periodontal diseases are mainly

anticipated to be either by inhibition of specific pathogens or by altering the host immune response through multiple factors. The ability of probiotics to adhere to saliva coated surfaces varies among species and it has been reported that *L. Rhamnosus* and *Lactobacillus paracasei* strains possesses strong binding activity. Recently Haukioja *et al.* [4] have shown that probiotics *Lactobacilli* (*L. Rhamnosus GG*, *Lactobacillus casei*) may affect the oral ecology by specifically preventing the adherence of other bacteria and by modifying the protein composition of the salivary pellicle. Antimicrobial activity of probiotics has been validated through various in-vitro and in vivo studies [3].

This review presents the evidence based data currently available on the applications of probiotics for the maintenance of periodontal health.

Table-1: Definitions of Probiotics

Year	Definitions	Author
1965	Substances produced by microorganisms that promote the growth of other microorganisms.	Lilly & Stillwell
1974	Organisms and substances that contribute to intestinal microbial balance.	Parker
1989	A live microbial feed supplement that beneficially affects the host animal by improving its intestinal microbial balance.	Fuller
1992	A viable monoculture or mixed-culture of microorganisms that, when applied to animal or human, beneficially affects the host by improving the properties of the indigenous microflora.	Havenaar & Huis Veld
1996	Living microorganisms that, upon ingestion in certain numbers, exert health benefits beyond inherent basic nutrition	Schaafsma
1999	A microbial dietary adjuvant that beneficially affects the host physiology by modulating mucosal and systemic immunity, as well as by improving nutritional and microbial balance in the intestinal tract	Naidu et al.
2001	A preparation of, or a product containing, viable, defined microorganisms in sufficient numbers, which alter the microflora (by implantation or colonization) in a compartment of the host and as such exert beneficial health effects in this host	Schreuzemir & de Vrese
2001	Live microorganisms that, when administered in adequate amounts, confer a health benefit to the host	FAO/WHO report

The original observation of the positive role played by certain bacteria was first introduced by Russian scientist and Nobel laureate, Élie Metchnikoff, who in the beginning of the 20th century suggested that it would be possible to modify the gut flora and to replace harmful microbes with useful microbes [6]. Metchnikoff, at that time a professor at the Pasteur Institute in Paris, proposed the hypothesis that the aging process results from the activity of putrefactive proteolytic microbes producing toxic substances in the large bowel. Proteolytic bacteria such as clostridia, which are part of the normal gut flora, produce toxic substance including phenols, indoles and ammonia from

the digestion of proteins. According to Metchnikoff, these compounds were responsible for what he called "intestinal auto-intoxication", which caused the physical changes associated with old age [5].

It was known that milk fermented with lactic-acid bacteria inhibits the growth of proteolytic bacteria because of the low pH produced by the fermentation of lactose. Metchnikoff had also observed that certain rural populations in Europe, for example in Bulgaria and the Russian steppes that lived largely on milk fermented by lactic-acid bacteria were exceptionally long lived. Based on these facts,

Metchnikoff proposed that consumption of fermented milk would "seed" the intestine with harmless lactic-acid bacteria and decrease the intestinal pH and that this would suppress the growth of proteolytic bacteria. Metchnikoff himself introduced in his diet sour milk fermented with the bacteria he called "Bulgarian Bacillus" and found that his health benefited. His friends in Paris soon followed his example and physicians began prescribing the sour milk diet for their patients. *Bifidobacteria* were first isolated from a breast-fed infant by Henry Tissier [5] who also worked at the Pasteur Institute. The isolated bacterium named *Bacillus bifidus communis* was later renamed to the genus *Bifidobacterium*. Tissier found that bifidobacteria are dominant in the gut flora of breast-fed babies and he observed clinical benefits from treating diarrhoea in infants with bifidobacteria. The claimed effect was bifidobacterial displacement of proteolytic bacteria causing the diseases.

Mann and Spoering in (1974) proposed that the fermented yogurt reduced blood serum cholesterol. In 1984, Hull identified the first probiotics species, *Lactobacillus acidophilus*. Later in 1991, Holcomb identified *bifidobacterium bifidum*. During an outbreak of shigellosis in 1917, German professor Alfred Nissle isolated a strain of *Escherichia coli* from the feces of a soldier who was not affected by the disease. Methods of treating infectious diseases were needed at that time when antibiotics were not yet available, and Nissle used the *Escherichia coli* strain in acute gastrointestinal infectious salmonellosis and shigellosis [6].

In 1920, Rettger [7] demonstrated that Metchnikoff's "Bulgarian Bacillus", later called *Lactobacillus delbrueckii subsp. bulgaricus*, could not live in the human intestine, and the fermented food phenomenon petered out. At this stage Metchnikoff's theory was disputable and people doubted his theory of longevity. After Metchnikoff's death in 1916, the centre of activity moved to the United States. It was reasoned that bacteria originating from the gut were more likely to produce the desired effect in the gut, and in 1935 certain strains of *Lactobacillus acidophilus* were found to be very active when implanted in the human digestive tract. Trials were carried out using this organism, and encouraging results were obtained especially in the relief of chronic constipation. In the following decades, intestinal lactic acid bacterial species with alleged health beneficial properties have been introduced as probiotics, including *Lactobacillus rhamnosus*, *Lactobacillus casei*, and *Lactobacillus johnsonii*. Probiotics are broadly categorised in two genera *Lactobacillus* and *Bifidobacterium*. Other microorganisms also classified into this group includes yeast and moulds e.g., *Saccharomyces cerevisiae*, *Aspergillus Niger*, *Aspergillus oryzae*, *Sochromyces boulardii*. Water kefir, alternatively known as tibicos and Japanese water crystals, is a probiotic beverage similar to Kombucha and Ginger Beer (traditional

sybiotic culture of bacteria and yeasts and with powdered ginger and sugar). Moroccan preserved lemons are naturally fermented without the use of a starter [6].

Coconut kefir is a probiotic beverage prepared from young coconut water and a starter culture. Sour pickles are the traditional alternative to vinegar pickles and are prepared using a simple solution of unrefined sea salt and clean, chlorine-free water encouraging the growth of *Lactobacillus*, which customarily outcompetes pathogenic bacteria. Recently, Hisayama showed that daily intake of dairy product containing lactic acid is good for periodontal health.

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

- As a culture concentrate added to a beverage or food (such as fruit juice),
- 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, gelatine tablets)[6].

Mechanism of Action

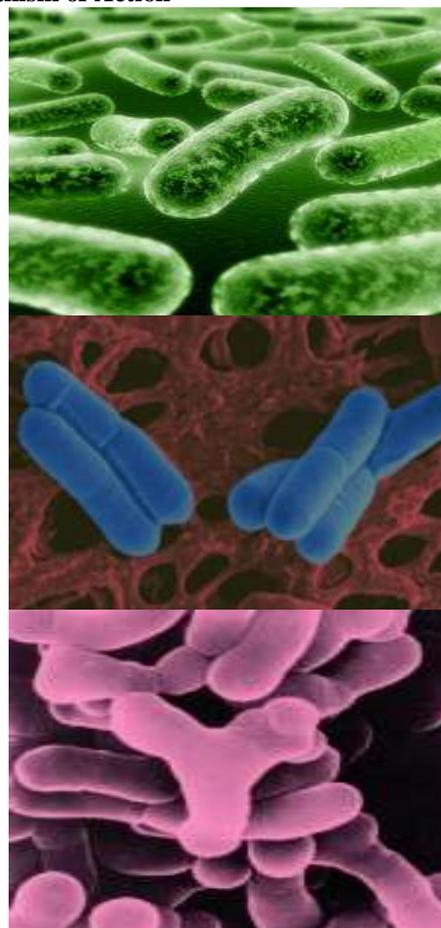


Fig-1: Type of Probiotics

Probiotics are expected to be similar to those observed in other parts of the body. However, it has been suggested that gastrointestinal tract probiotics may need some additional properties when used as oral probiotics. For instance, oral probiotic bacteria should adhere to and colonize periodontal tissue including hard non-shedding surfaces and should become part of the biofilm. They should not ferment sugars, which subsequently lowers the pH and can be detrimental, resulting in caries. Probiotics can help prevent and treat disease through several mechanisms [8].

Designer Probiotic

The term "Patho-Biotechnology" was introduced by Sletor and Hill.⁸ It comprises of three basic approaches

1. Use of attenuated bacterial pathogens as vaccine.
2. Isolation and purification of pathogen specific immunogenic protein for direct application.
3. Equipping probiotics bacteria with genetic element necessary to overcome stress outside host inside host and antagonise invading pathogens.

The third approach is what is termed as "designer probiotics". This approach employs probiotics to be engineered to express receptor mimic structures on their surface. Few studies done are limited to the gut, periodontal studies are lacking, but pose a great potential in this field for future development. Designer probiotics have been employed in treatment of HIV, also employs as a novel vaccine delivery vehicle. Improving the stress tolerance profile of probiotic cultures significantly improves tolerance to processing stress and prolongs survival during subsequent storage. This in turn contributes to a significantly larger proportion of the administered probiotics would reach the desired location (e.g., the gastrointestinal tract/periodontium) in a bioactive form [9].

Regulation and safety issue

Probiotics are regulated in the United States as dietary supplements or foods versus drugs. The U.S. Food and Drug Administration (FDA) regulate the safety, labelling and health or well-being statements made on food and dietary supplement products, and the Federal Trade Commission (FTC) regulates advertising. Drugs are allowed to claim effectiveness in the treatment, mitigation or cure of a disease, whereas foods, feed additives and dietary supplements can only make authorized and qualified health claims and claims of well-being (structure function claims). There are no FDA-approved health claims for probiotic supplements or foods.

It is generally agreed the consumption of probiotics is safe and that benefits outweigh the risk of sepsis. Few adverse events survive the stomach acid as they journey into the intestine, but it is impossible to know how much of these beneficial bacteria actually reach their targeted site. Quality research on the benefits

of functional foods is lacking. Powders, tablets and capsules containing bacteria in freeze dried form do not require refrigeration, but concerns regarding viability of the bacteria, their ability to resist stomach acids and their shelf life are hotly debated." Liquid probiotic formulations, other than milk products, that require refrigeration are available.

Numerous probiotics have a long history of safe use and no health concerns have been observed. There are, however, isolated reports of fungemia with *Saccharomyces* following its use as a probiotic especially in immunocompromised or ICU patients. Thus although administration of probiotics generally can be considered safe, each strain of probiotic has specific properties that should be considered before its use in any patient. Novel microbes, including probiotics and genetically modified probiotics need to be assessed for their safety on a strain- by-strain basis. The safety of probiotics in conditions where the mucosal integrity of gastrointestinal tract is compromised requires more studies before sweeping safety recommendations can be formulated [10].

CONCLUSION

Probiotics are counter of parts of antibiotics thus are from concerns for developing resistance. Further they are body's own resident flora hence are most easily adapted to host. Periodontitis have established risk of various systemic diseases like

- Diabetes,
- Atherosclerosis,
- Hyperlipidemia,
- Chronic Kidney Diseases
- And Spontaneous Preterm Birth

Thus, a critical need to establish good periodontal health for attuning good systemic health is of most importance and probiotics are promising, safe, and natural and side effects free option, which are required to be explored in depth for periodontal application. Advances and accomplishments attained give us the ability to employ these friendly bacteria (probiotics) as nano soldiers in combating periodontal diseases. Despite great promises, probiotics works are limited to gut.

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. Of particular interest might be studies on the combined effect of different probiotics applied simultaneously, thus testing the possible additive, cumulative, or competitive modes of action in the oral environment. Randomized controlled trials are needed to assess the best means of administering probiotics and the dosages needed for different preventive or therapeutic purposes. It can be said probiotics are still in "infancy" in terms of periodontal

health benefits, but surely have opened door for a new paradigm of treating periodontal disease.

REFERENCES

1. Hamilton M, Gibson GR, Bruck W; Some insights into the derivation and early uses of the word probiotic. *Br J Nutrition* 2003; 90: 845.
2. Report of a Joint FAO/WHO Expert consultation on evaluation of health and nutritional properties of probiotics in food including powder milk with live lactic acid bacteria (October 2001). Health and nutritional properties of probiotics in food including powder milk with lactic acid bacteria. FAO, WHO.
3. Fuller R; Probiotics in man and animals. *J App Bacteriol* 1989; 66: 365–78.
4. Haukioja A; Probiotics and Oral Health. *Eur Dent* 2010; 4:348-356.
5. Teughels W; Probiotics and oral healthcare. *Periodontol*, 2000, 2008; 48: 147.
6. Metchnikoff E; *Essais optimistes* Paris the prolongation of life. *Optimistic studies*. London Heinemann 1907.
7. Rettger LF, WN, Levy L, Weinstein JE; *Lactobacillus acidophilus* and its therapeutic application. Yale University Press, New Haven. 1935.
8. Anirban C, Hira B; Probiotics in periodontal health and disease. *J Ind Soc Periodontol*, 2011; 15: 23–28.
9. Sleator RD, Hill C; Patho-biotechnology; using bad bugs to make good bugs better. *Sci Prog*, 2007; 90:1–14.
10. Iva Stamatova; Probiotics: health benefits in the mouth. *Am J Dent*, 2009; 22:329-338.