

Benefits of Probiotics in Oral cavity – A Detailed Review.

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ABSTRACT

The development of resistance to a range of antibiotics by some important pathogens has raised the possibility of a return of humans to the pre-biotic dark ages. The time has come to shift the paradigm of treatment from specific bacteria elimination to altering the bacterial ecology by probiotics. In order to better understand the pathogenesis of various oral diseases, it is necessary to understand the role of the ecology and microbiology of the oral cavity. Thus, the concept of bacteriotherapy has been an emerging field in dentistry. Probiotics are dietary supplements containing potentially beneficial bacteria or yeasts and has been found beneficial to the host health. They help in stimulating health promoting flora and also suppressing pathogens which cause and spread diseases. In the medical field, probiotics are used mainly in support therapy for gastrointestinal diseases. Recently, probiotics are being used as a treatment for various oral diseases. The aim of this review is to examine potential mechanisms of probiotic bacteria in the oral cavity and summarize observed effects of probiotics with respect to oral health. The review focuses on probiotic lactobacilli and bifidobacteria genera that are most utilized in various probiotic products.

Keywords: Bacteria, Lactobacillus, Oral health, Probiotics.

INTRODUCTION

The human gut contains 10 times more bacteria than cells elsewhere in the human body. The enormous biomass consists of over 400 known bacterial species that generate intense metabolic activity and are of key importance for human health. This ecosystem gets disrupted when exposed to toxics in the form of polluted water and food as well as injudicious use of antibiotics. Antibiotic resistance, with the emergence of multiple resistant strains, is an increasingly important global problem. This causes destruction of beneficial bacteria, leaving resistant ones, pathogenic. Of late, it has been realized by health care professionals and prompted them to seek alternative therapeutic options. One such alternative is the use of beneficial bacteria, the probiotics, which stimulate health-promoting indigenous flora and reverting back the change.^[1-3]

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The mouth dominates a varied, exuberant and heterogenous microbial community. This notably varying microflora inhabits the various surfaces of the normal mouth. Oral bacteria have evolved mechanisms to sense their environment and bypass or reorganize in the host. Bacteria subjugate the

ecological niche divulged by both the tooth surface and gingival epithelium. However, an immensely efficient innate host defense system constantly monitors the bacterial colonization and prevents bacterial invasion of local tissues. A defective steadiness exists between dental plaque bacteria and the innate host defense system.^[4,5]

However, due to increased use of antibiotics, this equilibrium of oral ecology has been altered since three decades. Thus, the perception of bacteriotherapy and use of health-beneficial micro-organisms to heal diseases or support immune function was introduced in the early 20th century.^[4,6]

Definition

According to the currently adopted definition, by WHO/Food and Agriculture Organization (2002), probiotics are: “Live micro-organisms, which when administered in adequate amounts confer a health-benefit on the host”

International Life Science Institute Europe suggested a definition according to which a probiotic is “a live microbial food ingredient that, when consumed in ample volume, exerts health-benefits on the consumer.”^[1,4,7-17]

Prebiotics and synbiotics

The term ‘prebiotic’ was introduced by Gibson and Roberfroid.^[7,9] 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 the colon, and thus in effect improve host health.

These prebiotics includes inulin, fructo-oligosaccharides, galacto oligosaccharides and lactulose. The concept of prebiotics essentially has the same aim as probiotics, which is to ameliorate host health via modulation of the intestinal flora, acting by a distinctive mechanism.^[1,4,7,9,12,13,15,16,18] Synbiotics are outlined as concoctions of probiotics and prebiotics that beneficially affect the host by improving the survival and implantation of live microbial dietary supplements in the gastro-intestinal tract of the host. Sometimes, prebiotics and probiotics are combined in the same product and characterized as synbiotics.^[4,7,9,12,13,15,16,18] Currently available probiotic products include a wide array of bacterial and fungal species which are consumed in a variety of preparations. The use of microbials originated (unintentionally) centuries ago when people first noted the beneficial health effects of eating fermented foods. Modern probiotic-containing foods and products are the direct derivatives of these early fermented foods. The use of fermented milk and yogurt are the part of human history and their role has been with humanity, to date, between legends and historical data.^[11,19]

HISTORY

Bacteria have always been associated with the disease and have caused the human race much grief. Hence the concept of harnessing bacteria for health benefits has a poetic ring to it.^[20] The idea of probiotics dates back to the first decade of the 1900s, when the Ukranian bacteriologist and Nobel Laureate Metchnikof (1908) studying the flora of the human intestine developed a theory that senility in humans is caused by poisoning of the body by the products of some of these bacteria. To prevent the multiplication of these organisms he proposed a diet containing milk fermented by lactobacilli, which produce large amounts of lactic acid that could increase the life span of humans. The concept of probiotics was thus born and a new field of bacteriology was opened.^[1,17,21] Lilley and Stillwell (1965) introduced the term probiotics, the antonym of the term “antibiotics.” Mann and Spooering in 1974 discovered that the fermented yogurt, reduced blood serum cholesterol. In 1984 Hull identified the first probiotic species, the lactobacillus acidophilus. Later in 1991, Holcomb identified *bifidobacterium bifidum*. WHO in 1994 described the probiotics as the next most important in the immune defense system following antibiotic resistance. These incidences paved way for a new concept of probiotics in medicine and dentistry.^[1,2] The term “probiotic” is derived from Latin (pro) and Greek (bios) word meaning “For life.”^[1,3] The first probiotic species to be introduced in research was Lactobacillus acidophilus by Hull et al in 1984,

followed by Bifidobacterium bifidum by Holcomb et al in 1991.^[2,5-7,10,14,15,17,20,21]

PROBIOTIC CONCEPTS

The human body is more like a complex ecosystem containing trillions of bacteria that inhabit our skin, genital areas, mouth and especially the intestines. The microbes not only threaten us, but offer vital help with basic physiological processes ranging from digestion to growth to self defense. A balance is maintained between beneficial bacteria and pathogenic bacteria to prevent us from getting the disease. Dysbiosis occurs when there is an alteration in the normal balance of micro-flora or organisms of the human body. Thus, it becomes imperative to control dysbiosis by fortifying the body with “good bacteria” known as probiotics.^[6]

Species used as probiotics

They can be yeast, bacteria or moulds. But most commonly, bacterial species are predominant which mainly includes –

1. **Lactic acid producing bacteria** – Lactobacillus acidophilus, Lactobacillus bulgaricus, Lactobacillus casei, Lactobacillus fermentum, Lactobacillus lactis etc
2. **Nonlactic acid producing bacteria** – Enterococcus faecalis, Enterococcus faecium, Esherichia coli Nissle, Streptococcus thermophiles, Propionobacterium etc
3. **Bifidobacterium species** – Bifidobacterium adolescentis, bifidobacterium bifidum, bifidobacterium breve, bifidobacterium lactis, bifidobacterium longum etc
4. **Nonpathogenic yeast** – Sacchromyces boulardii
5. **Non spore forming** – Coccobacillus^[1-4,8,11]

The lactobacillus species help in the production of enzymes to digest and metabolize proteins and carbohydrates. They aid in the synthesis of vitamin B and vitamin K and facilitates breakdown of bile salts. They enhance innate and acquired immunity as well as help in the inhibition of pro-inflammatory mediators. More recently, a study demonstrated that long term consumption of milk caused a significant reduction in caries risk.

Bifidobacterium species are strictly anaerobic and predominate the large intestines. Over 30 species had been identified. The benefits from these include metabolization of lactose, generate lactic ions from lactic acid and synthesize vitamins. They also ferment indigestible carbohydrates and produce beneficial short chain fatty acids. They are believed to be beneficial in reducing antibiotic associated Diarrhoea and traveler’s Diarrhoea. They relieve constipation, alleviate inflammatory bowel disease and prevent DNA damage. Finally, they may prevent or delay the onset of cancers.^[1-3,5]

Mechanism of actions of probiotics in general and specifically in oral health

The mechanisms by which probiotics exert their effects are largely unknown, but may involve modifying gut pH, antagonizing pathogens through the production of antimicrobial compounds, competing for pathogen binding and receptor sites as well as for available nutrients and growth factors, stimulating immunomodulatory cells, and producing lactase. Probiotic bacteria have been shown to influence the immune system through several molecular mechanisms.^[9]

1. Adherence and colonization of the gut
2. Suppression of growth or epithelial binding/invasion by pathogenic bacteria and production of antimicrobial substances
3. Improvement of intestinal barrier function
4. Controlled transfer of dietary antigens
5. Stimulation of mucosal and systemic host immunity.^[11,12,18,22]

Mechanism of probiotics in oral cavity

Probiotics can help prevent and treat oral diseases through several mechanisms that includes-

1. **Direct interaction** – causing enmeshing in securing of oral microorganism to proteins, inhibition of pathogen adhesion, colonization and biofilm formation, induction of cyto-protective proteins expression on host cell surfaces, inhibition of collagenases.
2. **Competitive exclusion** – agility on plaque evolution and on its complex ecosystem by competing and intervening with bacterial attachments and engaging in metabolism of substrate and yielding of chemicals like organic acids, hydrogen peroxide and bacteriocins that inhibit oral bacteria.
3. **Indirect actions** – modulating systemic immune function, effect on local immunity, eventuality on non-immunologic defense mechanisms, modulation of cell proliferation and cytokine induced apoptosis, regulation of mucosal permeability, as antioxidants and hamper plaque induction by neutralizing the free electrons.^[4,8-10,15,20]

Characteristics of a good probiotic

To be considered for use as probiotic following criteria needs to be fulfilled –

1. It should be capable of exerting a beneficial effect on host animal like increased growth or resistance to diseases
2. It should be of human origin
3. It should have high cell viability
4. It should be non-pathogenic and non-toxic
5. It should be able to interact or send signals to immune cells
6. It should have capacity to influence local metabolic activity
7. It should be capable of surviving and metabolizing in the gut environment like resistance to low pH and organic acids

8. It should be stable and capable of remaining viable for periods under storage and field conditions
9. It should reinstate and replace the intestinal microflora
10. It should have anti-carcinogenic and anti-mutagenic activity, cholesterol lowering effects, can maintain mucosal integrity and can enhance bowel motility.^[1,2,4-6,10,12,17,23,24]

Sources and probiotics products

Probiotics are provided in products in one of the following basic ways –

1. A culture concentrate added to a beverage or food (such as fruit juice, infant formulas, asparagus, soyabeans)
2. Inoculated in to prebiotic fibres
3. Inoculants in to a milk-based food (dairy products such as milk, milk drinks, cheese, sour cream, smoothies and yoghurt)
4. As concentrated and dried cells packaged as dietary supplements (non-dairy products)
5. As powder, capsule, gelatin tablets, sachets, gel, paste, granules^[6,8,13,17,18,20,23,24]

A probiotic may be made out of a single bacterial strain or it may be a consortium as well (may contain any number up to eight strains). The advantage of multiple strain preparations is that they are active against a wide range of conditions and in a wider range of animal species.^[8]

Different general forms of commercially available probiotics includes –

1. Yakult – probiotic dairy product made by fermenting mixture of skimmed milk with a special strain of bacterium *Lactobacillus casei* Shirota.
2. Probiotic juice deliver a powerful daily dose of live and active probiotic cultures of *Lactobacillus plantarum* 299v, a well-studied probiotic strain formulated for daily digestive health
3. Choconat includes nature's "good bacteria."^[8]
4. Sporolac is manufactured using sporebacilli. *Lactobacilli* solution is a probiotic usually prescribed to paediatric patients
5. The latest and recent addition to the list of probiotics in India is made up of genetically modified *Bacillus mesentericus*, which act as an alternate to B-complex capsules. Only sporulating *Lactobacilli* are used with some antibiotic preparations.^[5]

General indications of probiotics

1. Prevention of colorectal cancer
2. Prevention of *Clostridium Difficile* Diarrhoea
3. Functional gastrointestinal disorders in children and adults
4. Calcium absorption
5. Lactose intolerance patients
6. Slows down AIDS progression
7. Antibiotic associated diarrhoea
8. Infective/ Rota virus associated diarrhoea
9. Traveller's diarrhoea

10. Inflammatory bowel disease
11. Ulcerative colitis
12. Constipation
13. Helicobacter pylori infections
14. Urogenital infections
15. Atopic disease
16. Allergies
17. Anti-hypertension
18. Irritable bowel syndrome
19. Hypercholesterolemia and cardiovascular diseases
20. Pancreatitis
21. Kidney stones
22. Necrotizing enterocolitis
23. Ventilator associated pneumonia
24. Obesity and Insulin resistance
25. In veterinary practice
26. Restore soil fertility^[2,3,8,12,1923-27]

PROBIOTICS AND ROLE IN ORAL HEALTH

The use of health promoting bacteria for therapeutic purposes is one of the novel and latest approaches in dentistry. Probiotics are useful in promoting oral health and in prevention of dental caries and periodontal diseases. Probiotic bacteria is recently being used in dentistry as oral replacement therapy where probiotics adhere to dental tissues as part of the biofilm or plaque and compete with the cariogenic and periodontal pathogens for colonization and hence prevent caries, gingivitis and improve oral health. A great advantage is the ease of administration in the oral cavity. Live cultures can be used in a patient's mouth as there is no danger from stomach acidity as in the GIT. Probiotics lower the pH in the oral cavity so that plaque-forming bacteria cannot form plaque and calculus. One of the most important benefits of probiotics in the oral cavity is reduction of inflammation. Probiotics can help fight harmful bacteria in the oral cavity and helps in maintenance of healthy teeth and gums. Since probiotics is an all natural treatment it should not have any side effects.^[21]

Bacteria reside in the mouth either in planktonic state or are finely integrated in oral biofilm on various oral surfaces. Oral biofilms are dynamically changing and develop increasingly complex structures as they mature. Interaction between species is characteristic in biofilms. Some species may depend on others to provide favorite environment for colonization. Furthermore, bacteria in biofilms differ physiologically from their planktonic counterparts and tend to be much more resistant to environmental factors and antimicrobial agents. It has been established that distinct genes become active when planktonic bacteria bind to surfaces and grow in biofilms. On the other hand, saliva is the essential medium in the mouth contributing to the microbial diversity. It plays an integral role in propagating oral biofilms. Salivary

flow can easily lead to detachment of some microbes from biofilm surfaces, and thus modulate microbial colonization. Furthermore, as a complex medium, saliva contains different proteins with bactericidal, bacteriostatic, or inhibitory activity that collectively may damage a variety of species in planktonic state. Biofilm species composition can also depend on phenomena like auto or co-aggregation that may prevent microorganisms from establishing themselves in the biofilms. Taking into consideration the multifaceted nature of biofilm development and multivariate species interactions, we can acquire better understanding and interpretation of studies with probiotics in the oral cavity. Since probiotic species belong predominantly to the genera *Lactobacillus* and *Bifidobacterium*, it is of special interest to find out whether such microbes with beneficial properties naturally inhabit the oral cavity. Generally, there is scarce evidence that probiotics permanently reside in the human body and in the mouth, in particular. However, it can be anticipated that among the 10³-10⁴ CFU/g lactobacilli found in the oral cavity. There could be some species/strains capable of exerting probiotic properties.^[22,28]

Probiotics and dental caries

Dental caries is a multifactorial disease of bacterial origin that is characterized by acid demineralization of the tooth enamel. It appears following changes in the homeostasis of the oral ecosystem leading to proliferation of the bacterial biofilm, composed notably of streptococci from the mutans group. To have a beneficial effect in limiting or preventing dental caries, a probiotic must be able to adhere to dental surfaces and integrate into the bacterial communities making up the dental biofilm. It must also compete with and antagonize the cariogenic bacteria and thus prevent their proliferation. Finally, metabolism of food-grade sugars by the probiotic should result in low acid production. The advantage of incorporating probiotics into dairy products lies in their capacity to neutralize acidic conditions. For example, it has already been reported that cheese prevents demineralization of the enamel and promotes its remineralisation.^[11,17,22,28]

Studies have proven that one strain of *L. rhamnosus* and the species *L. casei* inhibited in vitro growth of 2 important cariogenic streptococci, *S. mutans* and *S. sobrinus*. Some studies have proved that children consuming milk containing probiotic, particularly those 3-4 years of age, had significantly fewer dental caries and lower salivary counts of *S. mutans* than controls. These promising results suggest a potentially beneficial application of probiotics for the prevention of dental caries.^[11]

Probiotics and periodontal diseases

The main pathogenic agents associated with periodontitis are *P. gingivalis*, *Treponema denticola*,

Tannerella forsythia and Aggregatibacter actinomycetemcomitans. These bacteria have a variety of virulent characteristics allowing them to colonize the sub-gingival sites, escape the host's defence system and cause tissue damage. The persistence of the host's immune response also constitutes a determining factor in progression of the disease. Studies have proved that the prevalence of lactobacilli, particularly Lactobacillus gasseri and L. fermentum, in the oral cavity was greater among healthy participants than among patients with chronic periodontitis. Various studies have reported the capacity of lactobacilli to inhibit the growth of periodontopathogens, including P. gingivalis, Prevotella intermedia and A. actinomycetemcomitans. Together, these observations suggest that lactobacilli residing in the oral cavity could play a role in the oral ecological balance.^[11,15]

Probiotics and halitosis

Halitosis has many causes (including consumption of particular foods, metabolic disorders, respiratory tract infections), but in most cases it is associated with an imbalance of the commensal microflora of the oral cavity. More specifically, halitosis results from the action of anaerobic bacteria that degrade salivary and food proteins to generate amino acids, which are in turn transformed into volatile sulphur compounds, including hydrogen sulphide and methane thiol. Streptococcus salivarius, was detected most frequently among people without halitosis and is therefore considered a commensal probiotic of the oral cavity.^[11,22] S. salivarius is known to produce bacteriocins, which could contribute to reducing the number of bacteria that produce volatile sulphur compounds. The use of gum or lozenges containing S. salivarius K12 (BLIS Technologies Ltd., Dunedin, New Zealand) reduced levels of volatile sulphur compounds among patients diagnosed with halitosis.^[11]

Probiotics and Orthodontic treatment

Fixed orthodontic appliances are considered to jeopardize dental health due to accumulation of microorganisms that may cause enamel demineralization, clinically visible as white spot lesions. Furthermore, the complex design of orthodontic bands and brackets may create an ecological environment that facilitates the establishment and growth of cariogenic mutans streptococci strains. White spot lesion formation can be seen as an imbalance as an imbalance between mineral loss and mineral gain and recent systematic reviews have examined methods to prevent this side effect of orthodontic treatment. Studies are needed to clarify if use of probiotics can be effective as an alternative strategy for prevention of demineralization and white spots.^[1]

Probiotics and candidiasis

Candida species constitute part of the commensal oral flora in about 50% of healthy subjects,^[29] but are able to cause a clinically apparent lesion if the immune defenses are breached either on the local or systemic level. One study has shown that the subjects who consumed cheese containing the probiotic L. rhamnosus G exhibited reduction in the prevalence of oral Candida which subsequently may confer protective effect against oral candidosis. However, others investigated the effect of various lactobacilli and could not find an effect on oral Candida. This may be partly explained by the finding of the ex vivo experiment which demonstrated a profound but variable abilities of commercially available strain of lactobacilli probiotics to inhibit the growth of C. albicans possibly due to the low pH milieu produced by the lactobacilli.^[18]

Probiotics and voice prosthesis

There is no research regarding relationship between dental restorative materials and probiotics. However in larynx, the second barrier after oropharynx, probiotics strongly reduce the occurrence of pathogenic bacteria in voice prosthetic biofilms. There is anecdotal evidence among patients in The Netherlands that the consumption of buttermilk, which contains Lactococcus cremoris, Lactococcus lactis spp. that can produce antimycotics and other 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 and catheter materials, while S. thermophilus can effectively compete with yeasts in their adhesion to substratum surfaces, like silicone rubber. Further research should be carried out to determine if it will possible to treat other infections of the upper digestive tract, like esophagitis, with probiotic containing dairy products rather than with antibiotics.^[13,18]

Evidence suggests that probiotics can also reduce the risk of hypo-salivation and feeling of dry mouth.^[24]

COMMERCIAL ORAL PREPARATIONS AVAILABLE

Gum PerioBalance (marketed by Sunstar, Etoy, Switzerland)

This is probably the first probiotic specifically formulated to fight periodontal disease. It contains a patented combination of two strains of L. reuteri specially selected for their synergistic properties in fighting cariogenic bacteria and periodonto

pathogens. Each dose of lozenge contains at least 2×10^8 living cells of *L. reuteri* Prodentis. Users are advised to use a lozenge every day, either after a meal or in the evening after brushing their teeth, to allow the probiotics to spread throughout the oral cavity and attach to the various dental surfaces.

PeriBiotic (Designs for Health, Inc.)

This toothpaste is an all-natural, fluoride-free oral hygiene supplement containing Dental-Lac, a functional *Lactobacillus paracasei* probiotics not found in any other toothpaste.

Bifidumbacterin, Acilact , Vitanar (marketed by Alfarm Ltd., Moscow, Russia)

This probiotics preparation of a complex of five live lyophilized lactic acid bacteria, is claimed to improve both clinical and microbiologic parameters in gingivitis and mild periodontitis patients. After routine mechanical debridement, 2 tablets to be dissolved in the mouth, three times a day for 20-30 days for improved outcome.

Wakamate D (Wakamoto Pharmaceutical Co., Tokyo, Japan)

This probiotic tablet contains 6.5×10^8 colony forming units (CFU) per tablet of *Lactobacillus salivarius* WB21 and xylitol (280 mg/ tablet) was originally prepared to contribute for the intestinal microbial balance by providing acid tolerant *L. salivarius* WB.

Prodentis (BioGaia, Stockholm, Sweden)

This probiotic lozenge is a blend of two *Lactobacillus reuteri* strains containing a minimum of 1×10^8 colony forming units (CFU) for each of the strains DSM 17938 and ATCC PTA 5289. Additional studies are however required to evaluate the long-term effects of using these commercially available products.^[10]

PROBIOTICS STATUS IN INDIA

In India, probiotics are often used as animal feed supplements for cattle, poultry and piggery. This requirement is also met by importing probiotics from other countries. It is rarely used for human beings – Sporolac, *Saccharomyces boulardii* and yogurt (*L. bulgaricus* + *L. thermophilus*) are the most common ones. Sporolac is manufactured using Sporolactobacilli. Lactobacilli solution is an example of a probiotic, usually given to paediatric patients in India. The latest and recent addition to the list of probiotics in India is ViBact (which is made up of genetically modified *Bacillus mesentericus*), which acts as an alternate to B-complex capsules. In India, only sporulating lactobacilli are produced and they are sold with some of the antibiotic preparations.^[23] A formulation of approximately 10^8 probiotic

bacteria per gram or mililitre (10^8 /ml) with a daily intake of 1.5-2 dl per day is recommended dose.^[21]

PRECAUTIONS AND SAFETY ASSOCIATED WITH PROBIOTICS

Some live micro-organisms have a long history of use as probiotics without causing illness in people. Probiotics' safety has not been thoroughly studied scientifically. More information is especially needed on how safe they are for young children, elderly people, and people with compromised immune systems. Side effects of probiotics, if they occur, tend to be mild and digestive (such as gas or bloating). More serious effects have been seen in some people. Probiotics might theoretically cause infections that need to be treated with antibiotics, especially in people with underlying health conditions. They could also cause unhealthy metabolic activities, too much stimulation of the immune system, or gene transfer (insertion of genetic material into a cell). Probiotic products taken by mouth as a dietary supplement are manufactured and regulated as foods, not drugs. Furthermore, uncertainty about specificity of probiotics effects and their mechanism of action is a cause of concern.

Precautions and contraindications

Since probiotics contain live micro-organisms, there is a slight chance that these preparations might cause pathological infection, particularly in critically ill or severely immunocompromised patients. Probiotic strains of *Lactobacillus* have also been reported to cause bacteremia in patients with short-bowel syndrome, possibly due to altered gut integrity. Caution is also warranted in patients with central venous catheters, since contamination leading to fungemia has been reported when *Saccharomyces* capsules were opened and administered at the bedside.

Lactobacillus preparations are contraindicated in persons with a hypersensitivity to lactose or milk. *S. boulardii* is contraindicated in patients with a yeast allergy. However, no contraindications are listed for *Bifidobacteria*, since most species are considered nonpathogenic and non-toxicogenic.^[18]

Recently, major and minor risk factors for probiotics-associated sepsis have been identified. Major risk factors include immunosuppression (including a debilitated state or malignancy) and prematurity in infants. Minor risk factors are the presence of a central venous catheter, impairment of the intestinal epithelial barrier (such as with diarrhoeal illness), cardiac valvular disease (*Lactobacillus* probiotics only), concurrent administration with broad-spectrum antibiotics to which the probiotic is resistant and administration of probiotics via a jejunostomy tube (this method of delivery could increase the number of viable probiotics organisms reaching the intestine by

bypassing the acidic contents of the stomach). Therefore, it is recommended that probiotics should be used cautiously in patients with one major risk factor or more than one minor risk factor. Although administration of probiotics generally can be considered safe, each strain of probiotics has specific properties that should be considered before its use in any patient. In addition, a particular concern when evaluating probiotic effects on periodontal disease relates to the means of administration of these bacteria. Generally probiotics are delivered in dairy products (mainly fermented milks), as food supplements in tablet forms or in soft drinks. However, these routes of administration cannot provide prolonged contact with oral tissues, facilitating probiotic adhesion to saliva-coated surfaces. A lozenge form or chewing gum tablet or gum might better serve the needs for periodontal health prophylaxis. Controlled clinical trials and long term studies are required to investigate the concentration of probiotics bacteria in the specific means of administration.^[10,14,21]

FUTURE PROSPECTS

Probiotics can be used as passive local immunization against dental caries. High titres of antibodies can also be directed against human cariogenic bacteria produced in bovine colostrums over the vehicle of fermented milk. Early mucosal colonization with E.coli bacteria in newborns stimulates mucosal immune system to produce specific antibodies as well nonspecific secretory immunoglobulins. Research is directed at the reduction of severity and occurrence of mucosal lesions, specifically aphthous ulcers.^[3]

Dairy products which have probiotic lactobacilli in combination with prebiotics are also being currently developed. In oncology field, serious systemic infections may occur during cancer chemotherapy because of disturbances in the oropharyngeal and gastrointestinal microflora, impaired mucosal barrier functions and immunosuppression. Regarding the present condition treatment with probiotics "L. plantarum 299v" improves food intake and body weight in chemo-therapized animals. Real-time quantitative polymerase chain reaction procedures are among the promising tools for studies on intestinal microbiota composition. Such advancement will lead to the development of a new generation of probiotics, the action of which could be selected for defined disease-associated deviations in gut microbiota. This may also facilitate the potential use of genetically modified probiotic bacteria for pharmaceutical uses. Genetically modified lactic acid bacteria have been proposed as a vehicle to deliver vaccines in the gastro-intestinal tract. Several secretion-expression probiotic vectors have been constructed and are currently being tested in animal models. Other probiotics carrying different

immunomodulating molecules are currently being tested. Also, the probiotic vector have been modified to provide a way to deliver the active ingredient at specific targets in the gastrointestinal tract.^[14] Various processing advances, such as microencapsulation and bacterial coating and addition of prebiotic compounds used as growth factors for probiotic organisms, will provide a means to optimize the delivery and survival of strains at the site of action.^[14] The Given Imaging's PillCam is a good example of engineering technology in medicine. This tiny capsule is swallowed, and, as it passes through the host, it takes photographs of the mucosal tissues. In time, such devices will be controlled remotely, will have sensors and sampling devices, and will deliver payloads at the desired site. Such science fiction will become reality within 10 years. Thus, molecular, nano, biochemical, microbiological, immunological, and engineering sciences hold the key to future advances in the clinical application of probiotic and prebiotic products.^[30] NASA of USA is carrying out research to develop probiotic products which enable humans live in space. For all these valid reasons, the use of probiotics has become an emerging subject in the field of dentistry at present. Probiotics combined with prebiotics are innovative and revolutionary method in the treatment of dental diseases.^[14]

CONCLUSION

The consumption of probiotic dairy products to help lead a healthy life is a well-accepted concept globally. In India too, with the growing interest in self care and optimum health at all ages' recognition of a link between diet and health has never been stronger. As a result, a spurt of health foods including probiotics has made their foray into the market. While the optimism associated with the use of these foods is undeniable, it is often counter balanced by the fact that this area has been highly unregulated from the scientific point of view. Guidelines governing the labeling of probiotics, such as indicating the species, strain and the number of bacteria present are required from regulatory authorities in India. Like an old quote by Hippocrates goes, "Let food be thy medicine and medicine be thy food". Today more and more people are becoming increasingly aware that the key to a healthy life lies in the gut and there is a greater focus on eating right and healthy.

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