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Review Article

Probiotics for Oral Health: Boon or Bane

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ABSTRACT

Probiotics are been widely used these days in diseases of the gut to combat the effect of medications and to provide a better beneficial microflora for the Gastrointestinal tract (GIT). The use of probiotics in maintaining an oral health has been widely discussed as the beneficial bacterial could replace the cariogenic and other bacterial which affect the oral health and prove a boon for oral health. The main strains used in GIT include Lactobacillus Species which are known to produce acids and can cause a reciprocal effect on the oral cavity. So everything which seems good is not a boon it might also have some ill effects which can be misery full and prove bane. This review demonstrates the action of Probiotics on oral health and disease with both beneficial and harmful effects.

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INTRODUCTION

Health of an individual relies on various factors of which a balance between beneficial and pathogenic bacteria is an important criterion to prevent us from getting the disease.With the emergence of multiple resistant strains Antibiotic resistance, is becoming an increasingly important global problem. This causes destruction of beneficial bacteria, leaving resistant ones, pathogenic [1]. An alternative for this might be the use of beneficial bacteria, the probiotics, which stimulate health– promoting indigenous flora and reverting back the change [2].

Probiotics reminds us of an old and forgotten concept of 'Bacteriotherapy' which stated that beneficial bacteria occurring naturally in the human body can be administered in the patient's body to restore patient's health and wellbeing. That previous thought of bacteriotherapy gave rise to the concept of modern day probiotics [3].

HISTORY:

The use of microorganisms to promote health of an individual is very ancient concept and can even be traced back to the classical Roman literature where food fermented with microorganisms was used as a therapeutic agent [4]. (Table 1) [1,5-7]

Gibson and Roberfroid	Introduced the term 'prebiotic' 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.
Elie Metchnikoff, Ukranian bacteriologist and (Nobel Laureate -1908) first decade of the 1900s	Introduced the concept of probiotics following his observation that Bulgarian people had a longer life span due to the consumption of fermented milk containing viable bacteria.

Kollath - 1953	Coined probiotics as 'Probiotika', active substances that are essential for a healthy development of life.
Lilley and Stillwell in 1965	Initially proposed the term "Probiotic"
Mann and Spooering in 1974	Discovered that the fermented yogurt, reduced blood serum cholesterol.
Hull et al in 1984	Introduced the first probiotic species in research-*Lactobacillus acidophilus*.
Holcombh et al in 1991.	Introduced *Bifidobacteriumbifidum*.
WHO (1994)	Described 'probiotics' as the next most important in the immune defence system following antibiotic resistance.

DEFINITION:

United Nation's Food and Agricultural Organization (FAO) and the World Health Organization (WHO):

Defined probiotics as living microorganisms, principally bacteria that are safe for human consumption and when ingested in sufficient quantities, have beneficial effects on human health, beyond basic nutrition [8].

Fuller (1989) defined them as 'A live microbial food supplement which beneficially affects the host animal by improving its microbial balance [9].

Table 2: Various bacteria species and yeasts used as a probiotic

Bacteria	Yeast
• Lactobacillus species • Bifidobacterium species • Escherichia coli • Streptococcus species • Lactococcuslactis and some Enterococcus species.	The only probiotic yeast used currently is non-pathogenic *Saccharomyces boulardii*.

SOURCES:

Yogurt	Common source of probiotics.
Bioyoghurts -	Bacteria used for fermentation are of different strains, usually *Lactobacillus acidophilus* [7].
Innoculants in to-milk-based food.	Dairy products such as milk, milk drinks, cheese, sour cream, smoothies[1].
Supplements -	Freeze dried bacteria in tablets, capsules and powders[11,12].

CHARACTERISTICS OF AN IDEAL MICROORGANISM TO BE USED AS PROBIOTIC. [6,13,14]

- Non pathogenic.
- Non-toxigenic.
- Should retain viability during storage and use.

COMMONLY USED PROBIOTICS:

Some of the commonly used probiotics and enlisted as follows. (Table 2)[10]

- Should be of human origin and able to send signals and interact with immune cells.
- Have high cell viability and resistance to low pH.
- Adhesion to cancel the flushing effect.
- Have capacity to influence local metabolic activity. Should have the capacity to survive and metabolise in the gut.
- Should have documented health effects.

1. MECHANISM:

The mechanisms by which probiotics work can be summed up as follows [6,15].

- Passively occupy a niche that may be otherwise colonised by pathogens.
- Actively limit the pathogens ability to adhere to appropriate surfaces.
- Affect adversely the vitality or growth of the pathogen.
- Affect the ability of the pathogen to produce virulence factors.
- By modulating the immunological parameters, epithelial permeability and translocation.
- By providing bioactive or regulatory peptides.

1.1 Mechanism of probiotics in oral cavity [11,16,17] (Table 3)

Table 3: Possible mechanism of action of probiotics in the oral cavity

DIRECT INTERACTION	COMPETITIVE EXCLUSION AGILITY	INDIRECT ACTIONS
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.	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.	Modulating systemic immune function, effect on local immunity, eventuality on non-immunologic defence mechanisms, modulation of cell proliferation and cytokine induced apoptosis, regulation of mucosal permeability, as antioxidants and hamper plaque induction by neutralizing the free electrons.

2. GENERAL HEALTH AND PROBIOTICS:

The human intestine has a reservoir of microorganisms that naturally inhabitant the intestine as symbiont. These are referred to as 'gut or the intestinal flora'[3].The process by which probiotics are used to restore the normal intestinal microflora to provide resistance against antibiotics is termed 'Microbial interference therapy'. Probiotics being safe for human consumption and resistant to bile and acidic environment survives in the intestine, colonize the human gut and show bacteriocin production to block the invasion of intestine cells by enter invasive bacteria [18].

The gastrointestinal tract of human, at different site is habited by beneficial bacteria which have a relationship of symbiosis with the host. There are sites where the potentially beneficial micro-organisms are more in number than potentially harmful bacteria. This type of ecosystem composition is called Normobiosis. The environment where the potentially harmful bacteria dominate over health beneficial bacteria is called Dysbiosis[19].

3. PROBIOTICS AND ORAL CAVITY

9.1 Dental caries and probiotics:

Dental caries is a disease of bacterial origin characterized by acid demineralization of the tooth enamel that often leads to cavitation. It is also well-recognized that streptococcus mutans is the most destructive bacterial strain in the oral cavity as it attaches easily to the teeth and produces acid[20].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 [21,22]. Studies have proven that one strain of *Lactobacillusrhamnosus* and the species *Lactobacilluscasei* inhibited in vitro growth of 2 important cariogenic streptococci, *Streptococcusmutans* and *Streptococcussobrinus* [1].

A number of studies have proven that probiotics can reduce the risk of occurrence of *Streptococcus mutans* in the oral cavity. In an in vitro study, it was suggested that *Lactobacillus rhamnosus GG* can inhibit colonization by streptococcal cariogenic pathogens and therefore reduce tooth decay incidence in children[23]. Näse et al. reported a reduced tooth decay incidence in children taking probiotic *Lactobacillusrhamnosus GG*-enriched milk versus a control group of children taking milk without probiotic enrichment [24]. Nikawa et al. showed that bovine milk fermented with *Lactobacillus reuteri* was effective against *Streptococcusmutans*, resulting in a reduced risk for tooth decay [25].

Lactobacillus and other lactic acid bacteria are capable of preventing pathogenic colonisation in the oral cavity because of their ability to produce acids. However, this can create an environment conducive to the development of caries[6] and depict the cariogenic nature of these bacteria but there are evidences that lactobacilli are much more related to caries progression than to the initiation of a caries lesion[26].

***Lactobacillus rhamnosus*:** The inhibitory effect of this bacterium was evaluated by Ahola and collaborators using two vehicles: milk and cheese to assess if short-term consumption of cheese containing *Lactobacillusrahmonosus GG* (LGG) and *Lactobacillusrhamnosus LC* 705 would reduce *Streptococcus mutans* levels. The study consisted of three 3 weeks periods: baseline, intervention and posttreatment. During the interventional period, the levels of *Streptococcusmutans* decreased in eight subjects (21%) of probiotic group and in seven (19%) of control group [23].

Lactobacillus reuteri: Several studies showed that *Lactobacillusreuteri* has inhibitory properties towards *Strptococcusmutans*. These studies used different vehicles such as chewing gum, lozenge, straw, tablet and yogurt. It was demonstrated that different vehicles similarly exert inhibitory effects on the levels of *Streptococcusmutans*[27].

Bifidobacterium: The effect of an ice cream containing *Bifidobacteriumlactis* on the number of salivary *Streptococcusmutans* and *Lactobacilli* was tested by Caglar and collaborators. This protocol reduced the *Streptococcusmutans* counts but did not modify the *Lactobacilli* ones [28].

9.2 Probiotics and periodontal disease: Periodontal disease is known to be initiated by plaque formation. Probiotics, indirectly, helps to prevent periodontal diseases as they have proved to inhibit plaque formation by lowering the salivary pH and producing antioxidants which utilize the free electrons required for mineralization of plaque [3].

Grudianov et al. studied the effect of probiotic tablets on gingivitis and different grades of periodontitis and found that probiotics treatment resulted in better microbiota normalization than control group [29]. Krasse et al. showed a significantly reduced gingival index and bacterial plaque amount in patients treated with *Lactobacillusreuteri* than in a placebo group and concluded that this probiotic was effective to reduce gingivitis and bacterial plaque deposition in patients with moderate-to-severe gingivitis[30].Probiotic strains included in periodontal dressings at optimal concentration of 108 CFU/ml have been shown to diminish the number of most frequently isolated periodontal pathogens*: Actinomycessp, bacteroides sp.* and *S. intermedius*and also *Candidaalbicans* [31].

9.3 Probiotics and halitosis: Halitosis is not a disease but a discomfort mainly 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 [1]. The use of *Weisellacibaria* resulted in reduced levels of volatile sulfide components produced by *Fusobacteriumnucleatum*. This effect could be due to hydrogen peroxide production by *Weisellacibaria* which caused *F. nucleatum* inhibition. *Streptococcus salivarius* also suppress volatile sulfide compounds by competing for colonization areas with volatile sulfide-producing species [30].

9.4 For oral cancer: The anti-cancerous effects of probiotics were long recognized but evidence in literature is minimal. Probiotics can interfere at various stages of cancer process, by interfering with chromosomes and DNA damage but more research is required to develop specific regulations on their consumption [20].

9.5 Oral candida: In a test group of elderly people consumed cheese *containing Lactobacillusrhamnosus strains GG* and *LC705* and *Propionibacteriumfreudenreichiissp. shermanii JS* for 16 weeks, the number of high oral yeast counts decreased, but no changes were observed in mucosal lesions [32]. In another shorter study with younger subjects, no significant difference was observed between effects of probiotic and those of control cheese on salivary Candida counts [33].

9.6 Probiotics and Orthodontic treatment: The complex design of orthodontic bands and brackets jeopardize dental health due to accumulation of microorganisms that may cause enamel demineralization, clinically visible as white spot lesions. Cildir et al in 2009 conducted a clinical study with probiotics and found out that daily consumption of fruit yogurt with B*ifidobacteriumanimalis subsp. Lactis DN-173010* could reduce the salivary levels of *Streptococcusmutans* in orthodontic patients with fixed appliances [34].

9.7 Probiotics and voice prosthesis: Voice prosthesis is an artificial device, usually made up of silicone that is used to help the laryngectomized patients to speak. This device has a very short life time because of the excessive growth of the microorganisms [3]. Probiotics strongly reduce the occurrence of pathogenic bacteria in voice prosthetic biofilms. 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. 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 [1,12].

SIDE EFFECTS OF PROBIOTICS

Probiotics are generally considered as non-harmful bacteria that exert health benefit to the host and it seems to be true in most cases but all the strains of bacteria used as probiotic do not have similar properties and thus it is essential to study the various strains carefully before their use as a probiotic. Though difficult and complex procedure it will help in minimizing the drawbacks and enhancing the benefits associated with the use of probiotics [6].

Usually the side effects are mild and related to the digestive system which include gas and bloating [20], more serious effects have rarely been reported. None of

the cases with serious side effects were reported in healthy individuals [6].

Table 4: Various complications of probiotics with species involved

Bacteraemia and fungaemia	Following use of probiotics in immunocompromised individuals, infants, patients with chronic disease, short gut syndrome and individuals with prior history of prolonged hospitalization and surgical intervention.
Lactobacillus endocarditis	Reported following dental treatment in a patient with mitral regurgitation who was taking a probiotic preparation containing *Lactobacillus rhamnosus*.
Liver abscess	Reported in a 74 year old diabetic female. *Lactobacillus rhamnosus GG*.
LGG endocarditis	4 month old infant who developed *Lactobacillus rhamnosus GGendocarditis* 3 weeks after being on a probiotic therapy of *LGG 1010* CFU/day for antibiotic related diarrhoea after cardiac surgery.
Bacteremia	Richard et al reported four cases of that developed following use of an oral preparation containing *Bacillus subtilis* spores which was used for treatment of tube feeding related diarrhea.
Bacteraemia, Meningitis	*Sacharomycesbulardi, Bfidobacteria*.
Abdominal abscess	*Bfidobacteria, Lactobecillus.*
Liver abscess	*Lactobacillusrhamnosis.*
Pneumonia and sepsis	*Lactobacilluscasei.*

In quantitative terms, the existing data suggests that the risk of bacteraemia which is the most commonly reported of these infections is < 1 case per million individuals. It is virtually impossible to propose a risk of death because of the common association of infections involving lactobacilli with fatal underlying conditions or the presence of polymicrobial infections [37].

Probiotics are also grouped into two classes based on their risk to health [7]. Risk group 1(No risk) - *Lactobecillus and Bfidobacteria.* Risk group 2 (small risk)- *L. rhamnosus and Bfidobacteriumdentium.*

CONCLUSION:

No doubt probiotics have proven as a boon for humans till now with very mild side effects but the strains which can be misery full should be kept in mind by the pharmaceutical companies for health risk potentials. So these strains should be properly studied, assessed before launching them to avoid any incidence of unexpected harmful effect.

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