

The magic of magic bugs in oral cavity: Probiotics

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ABSTRACT

The aim of this review is to present an update about the current status of probiotics in the field of dentistry. Oral infections are the most common forms of infections. It is necessary to understand the role of the ecology and microbiology of the oral cavity in better understanding of the pathogenesis of various oral diseases. The concept of bacteriotherapy has been an emerging field in dentistry. The use of health-beneficial micro-organisms to heal diseases or support immune function was first introduced in the beginning of the 20th century. Probiotics are dietary supplements containing potentially beneficial bacteria or yeasts and it has been found to be beneficial to the host health. In medicine, probiotics are used mainly in support therapy for gastro-intestinal diseases. In recent years, probiotics have been used as a treatment to promote oral health. This approach has shown promising results in the oral cavity with respect to control of chronic diseases such as dental caries, periodontitis, and recurring problems such as halitosis and candidal infections. Despite the immense potential of probiotics, data are still deficient on the probiotic action in the oral cavity, which further mandates randomized trials before any concrete clinical recommendations can be arrived.

Key words: Magic bugs, oral health, probiotics

INTRODUCTION

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.^[1]

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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. Looking back through history, however, one forgotten concept of using bacteria beneficial to health has been resurrected and has now come under intensive research using modern study designs and methods. The term “probiotic” was derived from the Greek word meaning “for life”.^[2] Probiotics or health-beneficial bacteria have only recently been introduced in dentistry and oral medicine after years of successful use in mainly gastro-intestinal disorders.

Ellie Metchnikoff postulated that consumption of Bulgarian yoghurt promotes good health in 1907. A probiotics product was expended as a drug for the treatment of scour among pigs in 1950. Lilley and Stillwell in 1965 introduced the term “probiotics.” In 1974, Mann and Spoering determined that the fermented yogurt reduced blood serum cholesterol. Hull in 1984 diagnosed the first probiotic species, the *Lactobacillus acidophilus*. In 1991, Holcomb discovered *Bifidobacterium bifidum*. In 1994 World Health Organization (WHO) described the probiotics as next most important in immune defense system following resistance to antibiotics. These occurrences steered to a new methodology of probiotics in medicine as well as in dentistry [Table 1].^[3-5]

The oral cavity with a well-maintained balance of species and species interactions may be a potential source for health promoting probiotic bacteria hence we called it as magic bugs. Several health-promoting effects of probiotics are well recognized, but their influence on oral health is blemished. The aim of this comprehensive review is to present an update about the current status of probiotics in the field of dentistry.

DEFINITION

- The term Probiotic, meaning “for life,” is derived from the Greek language
- A live microbial food supplement, which beneficially affects the host animal by improving its microbial balance (Fuller in 1989)^[6]
- 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 suggests 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”.^[7]

PREBIOTICS AND SYNBIOTICS

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.^[8]

These prebiotics includes inulin, fructooligosaccharides, 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, albeit by a distinctive mechanism. Yet there are some cases in which probiotics may be beneficial for the probiotic, specifically with favor to *Bifidobacteria* is recognized as the symbiotic concept. 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

Table 1: Brief history of probiotics

Year	Authors	Their discoveries/findings
1907	Ellie Metchnikoff	Consumption Bulgarian yogurt was good for health
1965	Lilley and Stillwell	Coined-probiotic
1984	Hull et al.	Introduced first probiotic species - <i>Lactobacillus acidophilus</i>
1991	Henry Tissier	First to isolate a <i>Bifidobacterium</i>
1991	Holocombh et al.	Introduced it as probiotic

gastro-intestinal tract of the host.^[9] Sometimes, prebiotics and probiotics are combined in the same product and characterized as synbiotics. The various micro-organisms used as probiotics are summarized in Table 2.

MECHANISM OF ACTION

Some of the hypothetical mechanism of probiotics action in the oral cavity includes:^[13-15]

Direct interaction in dental plaque

- Enmeshing in securing of oral micro-organisms to proteins
- Agility on plaque evolution and on its complex ecosystem by competing and intervening with bacterial attachments
- Engaging in metabolism of substrate and yielding of chemicals that inhibit oral bacteria.

Indirect probiotic actions featured are

- Modulating systemic immune function
- Effect on local immunity
- Eventuality on nonimmunologic defense mechanisms
- Regulation of mucosal permeability
- Probiotics function as antioxidants and also produce antioxidants
- Hamper plaque induction by neutralizing the free electrons.

The mechanisms of probiotic action in the oral cavity could be analogous to those described for the intestine. Conceivable means through which probiotics might affect oral health are summarized in Figure 1.

Features of a good probiotic

- It should be a strain, which is capable of exerting a beneficial effect on the host animal, e.g., elevated growth or hindrance to disease

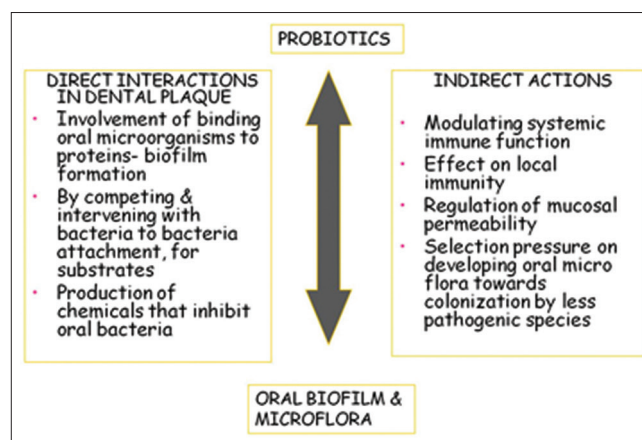


Figure 1: Hypothetical mechanism of action of probiotics in oral cavity

Table 2: Micro-organisms used as probiotics

Lactic acid producing bacteria	Nonlactic acid producing bacteria	Bifidobacterium species	Nonpathogenic Yeast	Non spore forming
<i>Lactobacillus acidophilus</i>	<i>Enterococcus faecalis</i>	<i>Bifidobacterium adolescentis</i>	<i>Saccharomyces boulardii</i>	<i>Coccolobacillus</i>
<i>Lactobacillus bulgaricus</i>	<i>Enterococcus faecium</i>	<i>Bifidobacterium animalis</i>		
<i>Lactobacillus casei</i>	<i>Escherichia coli</i> Nissle	<i>Bifidobacterium bifidum</i>		
<i>Lactobacillus crispatus</i>	<i>Streptococcus thermophilus</i>	<i>Bifidobacterium breve</i>		
<i>Lactobacillus fermentum</i>	<i>Propionibacterium</i>	<i>Bifidobacterium infantis</i>		
<i>Lactobacillus gasseri</i>	<i>Bacillus cereus</i>	<i>Bifidobacterium lactis</i>		
<i>Lactobacillus johnsonii</i>		<i>Bifidobacterium longum</i>		
<i>Lactobacillus lactis</i>				
<i>Lactobacillus plantarum</i>				
<i>Lactobacillus reuteri</i>				
<i>Lactobacillus rhamnosus</i> GG				

- It should be nonvirulent and nonpathogenic^[10-12]
- Preferred to be present as viable cells in large numbers
- It should be capable of surviving and metabolizing in the gut environment, e.g., endurance to low pH and carbon-based acids, and should be able to maintain genetic stability in oral microflora
- It should be stable and adept of permanently viable for periods under storage and field conditions.^[16]

Probiotic delivery system

They are provided in four basic forms:^[17]

- Beverage or food (fruit juice)
- Prebiotic fibers
- Milk-based products
- Dried cell packages such as powder, capsule, gelatin tablets.

PROBIOTICS AND DENTAL CARIES

The impact of oral administration of probiotics on dental caries has been studied in several experiments utilizing different test strains [Table 3]. Considering the emerging and growing body of evidence about the role of probiotics on caries pathogens, nonetheless, it has been recommended that the operative approach in caries treatment might be challenged by probiotic implementation with subsequent less invasive intervention in clinical dentistry.^[20] Conversely, further studies are definitely mandatory before this goal could be achieved.

PROBIOTICS AND PERIODONTAL DISEASES

Orally administered probiotics could be beneficial in the treatment of chronic Periodontitis [Table 4]. The presence of periodontal pathogens could be regulated by means of antagonistic interactions. Probiotic strains comprised in periodontal dressings at optimal concentration of 10⁸ CFU/ml have been shown to diminish the number of most frequently isolated periodontal pathogens: *Bacteroides* sp.,

Actinomyces sp. and *Staphylococcus intermedius*, and also *Candida albicans*.^[24]

PROBIOTICS AND YEAST

Various studies are being carried out to find out the correlation of use of probiotics in the reduction of yeast, which are summarized in Table 5. However, authors had no explanation. It could be hypothesized that extending research on oral pathology, such as yeast infections, with respect to probiotics, and scrutinizing the molecular means of probiotic activity, might further broaden the field of their potential applications.^[27]

PROBIOTICS AND IMBALANCED ORAL ECOSYSTEM

Halitosis the oral malodor is the condition normally ascribed to the disturbed commensal micro flora equilibrium. Inhibitory effect on the production of volatile sulfur compounds (VSC) by *Fusobacterium nucleatum* after ingestion of *Weissella cibaria* was noticed in a study done by Kang *et al.* in 2006 both *in vitro* and *in vivo*. The possible mechanism in VSC reduction is hydrogen peroxide engendered by *W. cibaria* that dissuades the procreation of *F. nucleatum*.^[28] Although various probiotic products are marketed for both mouth and gut associated halitosis, their efficacy demands more clinical studies.

SAFETY ISSUES

The issue of safety is of special concern during the past few years due to the increased probiotic supplementation of different food products. From the safety argument of view, the recognized probiotic microbes must not be pathogenic, should never have any growth exhilarating effects on bacteria instigating diarrhea, and should not possess and capability to relocate antibiotic resistance genes. The probiotics should satisfactorily be adept to maintain genetic stability in the oral microflora.^[29]

Table 3: Summary of various studies done on probiotics and dental caries

Various studies	Authors
An vitro study <i>Lactobacillus rhamnosus</i> GG can inhibit colonization of <i>S. mutans</i> in children	Meurman et al. ^[18]
Oral administration of probiotics increased salivary counts of lactobacilli while <i>S. mutans</i> levels were not modified	Montalto et al. ^[19]
<i>S. mutans</i> count reduction after a 2 weeks consumption of yogurt containing <i>Lactobacillus reuteri</i>	Caglar et al. 2005 ^[17]

S. mutans: Streptococcus mutans

Table 4: Summary of various studies done on probiotics and periodontal disease

Various studies	Authors
Probiotics were effective in normalization of microbiota in periodontitis and gingivitis patients when compared with a control group	Grudianov et al. ^[21]
Decrease in gum bleeding and reduced gingivitis with the application of <i>L. Reuteri</i>	Krasse et al. ^[22]
Resident <i>lactobacilli</i> flora inhibits growth of <i>Porphyromonas gingivalis</i> and <i>Prevotella intermedia</i> in 82% and 65%	Köll-Klais et al. 2005 ^[23]

L. Reuteri: Lactobacillus reuteri

Table 5: Summary of various studies done on probiotics and yeast

Various studies	Authors
Reduction in the prevalence of <i>Candida albicans</i> in the elderly-Probiotic cheese containing <i>L. Rhamnosus</i> GG (LGG) and <i>Propionobacteria Freudenreichii</i>	Hatakka et al. ^[25]
Inhibition effect on counts of <i>S. mutans</i> and yeasts by using a combination of LGG and <i>bifido</i>	Ahola et al. ^[26]

S. Mutans: Streptococcus mutans, L. Rhamnosus: Lactobacillus rhamnosus

CONCLUSION

The oral cavity with a well-maintained balance of species and species interactions may be a potential source for health promoting probiotic bacteria hence we called it as magic bugs. Several health-promoting effects of probiotics are well recognized, but their influence on oral health is blemished. There is limited evidence supporting some uses of probiotics. Extensive scientific acquaintance is required about probiotics, embracing their safety and suitable use. Effects unearthed from one genera or strain of probiotics do not necessarily hold accurate for others, or equal for distinctive preparations of the same species or strain. The full potential of probiotics can be realized when their benefits can be established scientifically. Genetic modification of probiotic strains to suit the oral conditions is indispensable. Systematic studies and randomized control

trials are therefore needed to find out the best probiotic strains and means of administration in different oral health conditions.

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