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Probiotics in Dentistry- Beneficial or Baleful: A Review

[1]Maryam Siddiqui, [2]Kalpna Chaudhry, [3]Chanchal Singh

1. *Tutor*, Dept. of Pedodontics, Jamia Millia Islamia, New Delhi, India.
2. *Professor*, Dept. of Pedodontics, Seema dental college, Rishikesh, India.
3. *Professor*, Dept. of Pedodontics, K. D. dental college, Mathura, India.

Corresponding Author: Kalpna Chaudhry

I. ABSTRACT

In this current modern era, the resistance caused by antibiotics is the major concern for the researchers and it is the prime cause for return to the pre-antibiotic dark ages. It is a breakthrough approach which utilizes natural bacteria to provide defense against various pathogenic bacteria. The aim of this research article summarizes the history, suggestive mechanism of action, with a brief overview of certain strains of probiotic bacteria which focusses on the prevention aspect against various diseases pertaining to dentistry.

KEY WORDS: Probiotics, Prebiotics, Streptococcus mutans.

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II. INTRODUCTION

The widespread use of antibiotics and progressively increasing costs of health care system are the leading factors for the research and development in the area of functional foods. Hippocrates introduced the concept of functional foods long ago with their motto "let food be your medicine". The scientific community all over the globe has started supporting the hypothesis that diet may play a significant role in modulation of physiological functions of the human body.[1]

To understand oral diseases there has been an exemplar shift towards an ecological and microbial community based approaches which includes the possibility of developing novel strategies through manipulation of the resident oral microbiota and modulation of host immune responses. The increased popularity of using probiotic bacteria supplements to improve gastrointestinal health has prompted interest in the utility of this approach for oral applications. Dental caries is one of the most frequently occurring preventable childhood disease, people are susceptible to this ailment throughout their lifetime. Various approaches including chemo prophylactic agents, antibiotics, caries vaccine, sugar substitutes, fluorides and restorative materials have been in use. Prevention of dental caries has been attempted with fluoride in different forms but it is considered as double edged sword as excess may lead to dental and skeletal fluorosis. The conventional prevention of dental caries is also focused on the removal of dental plaque by indiscriminate use of antibacterial mouth rinse but it may not be totally effective as it creates open, non-competitive surfaces for pathogens to repopulate the oral cavity. However, the anticaries effects of these approaches are still limited.[2]

The concept of probiotics focuses on the prevention aspect of the diseases, it can be effective in selectively inhibiting the oral pathogens. Hence, there is an emerging interest in the potential capacity of probiotic bacteria and its mechanism of action to prevent and combat oral diseases. The objective of this article is to review various strains of probiotics and their effects on oral health with their future perspective.

The term probiotics was derived from the Greek language, meaning 'for life'. The concept of probiotics came into existence by Noble prize winner, Ukrainian bacteriologist Elie Metchnikoff. The term probiotic was first used in 1965 by Lilly and Stillwell.[3]

Various authors have given definitions of probiotics over many years based on various perspective.

Lilly & Stillwell in 1965 defined probiotics as *"Substances produced by microorganisms that promote the growth of other microorganisms"*.[4] Parker et al in 1974 defined it as *"Organisms and substances that contribute to intestinal microbial balance"*.[5] Fuller et al in 1989 defined it as *"A live microbial feed supplement that beneficially affects the host animal by improving its intestinal microbial balance"*.[6] Havenaar & HuisInt Veld in 1992 defined it as *"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"*.[7]

Schaafsma et al in 1996 defined it as *"Living microorganisms that, upon ingestion in certain numbers, exert health benefits beyond inherent basic nutrition*".[8] Naidu et al. in 1999 defined it *as "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*".[9]. Schrezemeir & de Vrese in 2001 defined it as *"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*".[10]

However, Till now the most acceptable definition of probiotics is *"Live microorganisms that, when administered in adequate amounts, confer a health benefit to the host"*. FAO / WHO report in 2001.[11]
Prebiotics are defined as *non-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*.[12] Synbiotics are defined as *mixtures of probiotics and prebiotics that beneficially affect the host by improving the survival and implantation of live microbial dietary supplements in the gastrointestinal tract of the host*.[13]

II. HISTORICAL BACKGROUND

In the beginning of the 20th century Elie Metchnikoff reported that Bulgarians lived longer than the other populations and he supposed that was due to the consumption of fermented milk products which contains viable bacteria. In 1907 he proposed that the lactic acid producing strain Lactobacillus bulgaricus has the ability to displace pathological intestinal bacteria by useful microbes. The first probiotic bacteria studied were lactic acid bacteria. Around the same time Henry Tissier, a French pediatrician suggested that 'bifid' bacteria (later on called bifidobacterium) could be administered to patients with diarrhea to help restore a healthy gut flora.[14] Alfred Nissle, a German physician used one isolate (E. Coli stain) to treat chronic ulcerative colitis. In spite of all these positive effects, spectacular advent of antibiotics, suppressed the researches on bacteriotherapy but development of different resistant bacterial strain again pushed up the researches on probiotics.[15]

Metchnikoff worked at the Pasteur Institute in Paris and discovered *Lactobacillus bulgaricus*, a strain he later introduced into commercial production of sour- milk products in France and throughout Europe. He devoted the last decade of his life to the study of lactic acid- producing bacteria as a means of increasing human longevity.[3]

III. STRAINS OF PROBIOTICS

The most common probiotic strains belong to the genera Lactobacillus and Bifidobacterium. Probiotics can be varied, they can be yeast, bacteria or molds. But, most commonly bacterial species are predominant. They can be classified on the basis of microbiological classification; [16]

The category of bacteria includes lactobacillus species includes *Lactobacillus acidophilus, L. sporogenes, L. piantarum, L. rhamnosum, L. delbruekii, L. reuteri, L. fermentum, L. lactus, L. cellobiosus, L. brevis. The Bifidobacterium species includes B. infantis, B. longum, B. thermophilum, and B. animalis. The Streptococcus species includes S.lactis, S. cremoris, S.salivarius, S.intermedius and the other species includes Leuconostoc spp, Pediococcus spp.· Bacillus spp, Enterococcus spp.*

The category of yeast and moulds includes *Aspergilluscerevisiae, Aspergillusniger, Aspergillusoryzue, Candida pintolopensii, Saccharomyces boulardii.*

Probiotics can also be classified on the basis of their capability of producing lactic acid; [17, 18]

1. Lactic acid-producing bacteria (LAB): Lactobacillus, Bifidobacterium, Streptococcus.
2. ***Nonlactic acid-producing bacterial species:*** Bacillus, Propionibacterium.
3. ***Nonpathogenic yeasts:*** Saccharomyces.
4. Nonspore forming and nonflagellated rod or coccobacilli.
5. Nonpathogenic strain of E. coli, Clostridium butyricum

An effective probiotic agent needs to be non- pathogenic, nontoxic, resistant to gastric acid, adhere to gut epithelial tissue and produce antibacterial substances. It should persistently influence metabolic activities in the GIT such as cholesterol assimilation, lactose activity, and vitamin production. The survival of probiotic organisms in the gut depends on the colonization factors which enable them to resist the antibacterial mechanisms that operate in the gut. The probiotic strain should be significantly resistant to the bile acid, e.g.

Bifidobacteria strains proved significantly less acid- resistant than the *Lactobacillus* strains, when exposed to human gastric juice.[17]

The ideal features of good probiotics are- it should be a strain, which is capable of exerting a beneficial effect on the host, e.g. resistance to disease. It should be present as viable cells, preferably in large numbers. They should be capable of surviving and metabolizing in the gut environment e.g. resistance to low pH and organic acids and most importantly they should be capable of remaining viable for periods under storage and field conditions.[18]

The mechanism of action of probiotics in oral cavity could be comparable to that of gut. Some of the hypothetical mechanism of probiotics action in the oral cavity. [19, 20, 21, 22.]

Direct interaction in dental plaque- The direct mechanism of action involves binding oral microorganisms with the proteins and production of chemicals that inhibit the growth of oral bacteria. It acts on plaque formation and on its complex ecosystem by competing and intervening with bacterial attachments.

Indirect probiotic actions: It comprises of regulating the systemic immune function, which in turn enhances the local immunity. They regulate the mucosal permeability and functions as antioxidants and also produce antioxidants. They have significant effect non-immunologic defence mechanisms eg. Production of bacteriocins to inhibit pathogens.

IV. PROBIOTICS IN ORAL HEALTH

Oral infections constitute to one of the most common diseases among humans. Oral cavity has a complex ecosystem which consist of diverse microbiota. Various studies proved that probiotics creates a protective shield against various microorganisms in the oral cavity.

Probiotics and dental caries:

Dental caries is a multifactorial disease which results in demineralization of the enamel. Streptococcus mutans plays a key role which ferments carbohydrates. During the process of bacterial interaction with carbohydrates, lactic acid is produced which ultimately results in decay. Probiotic bacteria interfere with the oral bacterial communities therefore it prevents the growth and further multiplication of pathogenic bacteria.

Comelli and colleagues reported *Streptococcus thermophiles* and *Lactobacillus lactis* form biofilm on the hydroxyapatite surface and it interferes with growth and multiplication of *Streptococcus sobrinus.*[23] It was demonstrated that isolates of *Weissellacibaria* has the capacity to inhibit biofilm formation both *in vitro* and *in vivo* by *Streptococcus mutans* and to prevent proliferation of this bacterial strain.[24]

Nikawa et al[25] reported a significant reduction in *Streptococcus mutans* in the saliva by up to 80% after consumption of yogurt containing *Lactobacillus reuteri* over a period of 2 weeks. Probiotics seem to be a natural way to maintain dental health, and that daily intake of probiotics in early childhood may result in less dental caries[26]. Nase et al[27]reported a significant reduction in dental caries among children who drank probiotic *Lactobacillus rhamnosus* GG-enriched milk. In a comparative study of the effects of several forms of probiotic administration on *Streptococcus mutans* reduction, Cagler et al[28] showed a greater reduction of *Streptococcus mutans* in patients receiving probiotics in liquid or tablet forms.

Probiotics and Periodontal disease:

Periodontal disease are the most prevalent disease worldwide.Periodontitis is a multifactorial disease that results in destruction of the hard and soft tissues due to microbial colonization, inflammatory responses and adaptive immune responses. The complexity of the diseases process depends upon the type of bacteria and/or their products and virtually the status of the host response mechanisms.

Treatment of periodontal diseases in recent years has deviated from antibiotic/anti- microbial model of disease management. Probiotics might be a promising area of research in the treatment of periodontitis as it intercepts the disease process by decreasing the pH of the oral cavity which further prevents dental plaque and calculus formation.[29] Probiotics produce antioxidants which prevents plaque formation by neutralizing the free electrons that are needed for the mineral formation. They are able to breakdown putrescence odors by fixating on the toxic gases (volatile sulfur compounds) and changing them to gases needed for metabolism.

Teughels *et al*[30] reported that the subgingival application of a bacterial mixture including *Streptococcus sanguis*, *Streptococcus salivarius*, and *Streptococcus mitis* after scaling and root planning significantly suppressed the re- colonization of *Porphyromona gulae* (*P. gingivalis*) and *P. intermedia*. Pocket guided re- colonization approach may work as an alternative to the armamentarium of treatment options for periodontitis.

Probiotics and Halitosis:

Halitosis (bad breath) is believed to affect a large proportion of the population. It may reveal an underlying disease and it has a significant socio-economic impact too. Halitosis is caused by a number of

volatiles, which originate from the oropharynx or from expired alveolar air. In oral malodor, the sulphur containing gases (hydrogen sulfide, methyl mercaptan and dimethyl sulfide), which are derived from the bacterial degradation of sulphur containing amino acids in the oropharynx, play a significant role. Most of the pathology causing halitosis lies within the oropharynx (tongue coating, gingivitis, periodontitis, and tonsillitis).

Probiotics could also be used in the treatment of halitosis. Kang, *et al.*[31] reported a significant reduction of volatile sulfur compounds after gargling twice daily with 15 ml *Weissella cibaria* CMU for 2 minutes.

TABLE 1: VARIOUS SIGNIFICANT STUDIES THAT HAVE BEEN STUDIED SO FAR ALONG WITH THE CHARACTERISTICS, UTILISED PROBIOTICS STRAINS AND OUTCOMES ARE SUMMARISED BELOW.

AUTHOR	YEAR	STUDY DETAILS	VEHICLE	TESTED STRAINS	CONCLUSION
E Caglar et a.l[32]	2005	Examined the effect of short-term consumption of yogurt on the salivary levels of mutans streptococci and lactobacilli. (21 subjects; 4 weeks)	Yogurt containing Bifidobacteria	Mutans streptococci and lactobacilli	A statistically significant reduction (<0.05) of salivary mutans streptococci was recorded.
Haukioja A et al.[33]	2008	Investigated in vitro if the probiotic strains could affect the oral ecology (i) By preventing the adherence of other bacteria or (ii) By modifying the pellicle protein composition.	Four commercial probiotic products- L. rhamnosusGG (ATCC 53103), Lactobacillus casei Shirota(Yakult, Yakult Honsha, Japan), L. reuteriSD2112 (DSM 20016, Rela, Ingman Foods, Finland, also known as ATCC 55730), and Bifidobacteriumlactis Bb12 (Chr. Hansen, Denmark).	Streptococcus mutans and Streptococcus gordonii,	Results showed that probiotics may affect the oral ecology by specifically preventing the adherence of other bacteria and by modifying the protein composition of the salivary pellicle.
E Çaglar, et al.[34]	2008	Examined whether the consumption of ice-cream can affect the salivary levels of mutans streptococci and lactobacilli. (24 subjects; 4 weeks)	Ice-cream containing bifidobacteria	Streptococci and lactobacilli	Significant reduction in the levels of caries-associated mutans streptococci in saliva.
E Çaglar, et al.[35]	2008	Investigated the effect of the probiotic on the levels of salivary mutans streptococci and lactobacilli. (20 subjects;10 days)	Probiotic Lactobacillus reuteri, delivered by a new medical device.	Mutans streptococci and lactobacilli	The short-term daily ingestion of lactobacilli-derived probiotics delivered via medical device containing probiotic lozenge reduced the levels of salivary mutans.
S Twetman et al[36]	2009	Investigated the effect of a chewing gum containing probiotic bacteria on gingival inflammation and the levels of selected inflammatory mediators in gingival crevicular fluid (42 subjects; 2 weeks)	Chewing gum containing Lactobacillus reuteri: ATCC 55730 and ATCC PTA 5289 ($1x10^8$ CFU/gum, respectively).		The reduction of pro-inflammatory cytokines in GCF may be proof of principle for the probiotic approach combating inflammation in the oral cavity.

S K Cildir et al. [37]	2009	Examined the short-term consumption of fruit yogurt containing probiotic bifidobacteria would affect the levels of salivary mutans streptococci and lactobacilli in patients with fixed orthodontic appliances. (24 subjects,2 weeks)	Fruit yogurt containing probiotic bifidobacteria	salivary mutans streptococci and lactobacilli	Results demonstrated that daily consumption Bifidobacterium animalis subsp. Lactis DN-173010 could reduce the salivary levels of mutans streptococci.
Staab B et al. [38]	2009	Determined the effect of a probiotic milk drink on gingival health and the development of experimental gingivitis. (50 subjects; 8 weeks)	Probiotic milk drink (Yakults, Homsha Co., Tokyo, Japan) daily, containing Lactobacillus casei strain Shirota.		The results showed a beneficial effect of the on gingival inflammation in non-immunocompromised subjects. Probiotics may have reversible immune modulating effect on plaque – induced inflammation of the gingiva.
Mayanagi G at al[39]	2009	Evaluated whether the oral administration of lactobacilli could change the bacterial population in supra/subgingival plaque. (66 subjects;8 weeks)	Lactobacillus salivarius WB21 and xylitol in tablets.		Oral administration of probiotic lactobacilli reduced the numerical sum of five selected periodontopathic bacteria and could contribute to the beneficial effects on periodontal condition.
Pamela Hasslof et al[40]	2010	Investigated the ability of a selection of lactobacilli strains, used in commercially available probiotic products, to inhibit growth of oral mutans streptococci and C. albicans in vitro.	Eight strains of probiotic lactobacilli (L. plantarum299v, L. plantarum931, L. rhamnosusGG ATCC 53103, L. rhamnosusLB21, L. paracaseiF19, L. reuteriPTA 5289, L. reuteriATCC 55730, L. acidophilus La5).	Five strains of mutans streptococci (MS) including both laboratory reference strains (S. mutansNCTC 10449, S. mutansIngbritt, and S. sobrinusOMZ176) and clinical isolates (S. mutansP1:27 and S. mutansP2:29) and candida strains	The commercial probiotic lactobacilli could inhibit growth of reference strains and oral isolates of mutans streptococci and candida but the capacity differed significantly between the strains.

Mette Kirstine Keller et al.[41]	2011	Investigated in vitro ability of selected commercial probiotic lactobacilli to co-aggregate and inhibit growth of oral mutans steptococci isolated from adults with contrasting levels of caries.	Eight commercially availble probiotic lactobacillus strains, L. plantarum 931 (Essum, Umeå, Sweden), L. plantarum 299v (Probi AB, Lund, Sweden), L. paracasei F19 (Arla, Stockholm, Sweden), L. rhamnosus GG (Valio Ltd., Helsinki Finland), L. rhamnosus LB21 (Essum, Umeå, Sweden), L. reuteri DSM17938 (Biogaia, Stockholm, Sweden), L. reuteri ATCC PTA 5289 (Biogaia, Stockholm, Sweden) and L. acidophilus La5 (Arla, Stockholm, Sweden)	Mutans steptococci	They concluded that commercial lactobacilli-derived probiotic bacteria were able to co-aggregate with clinical isolates of mutans streptococci, but the ratio varied significantly between strains isolated from different subjects. The ability to inhibit growth was strain-specific, with no apparent relationship to the caries susceptibility of the subject.
G Jindal et al. [42]	2011	Investigated the effect of oral probiotics on salivary MS count and to evaluate the relative efficacy of two commercially available probiotic preparations. (150 subjects; 14 days)	Darolac (Aristo pharmaceuticals, India) containing 1.25 billion freeze dried bacterial combination, comprised of a mixture of, Lactobacillus rhamnosus, Bifidobacteriumlongum, and Saccharomyces cereviasae. Sporolac (Uni-Sankyo Ltd., India) containing 150 million Spores of Bacillus coagulans.	Mutans streptococci	Results showed a significant reduction of a cariogenic microorganisms, mutans streptococci.
E Çaglar et al.[43]	2011	Conducted a study to determine the pH, titratable acidity of a selection of various probiotic yogurts, their buffering effects with emphasis on the pH range in which the buffer is efficient.	Probiotic yogurt (Activia®; Danone, Istanbul, Turkey) contained Bifidobacterium		Buffering capacities of probiotic yogurt should be undermined and there was no significant differences observed between yogurts within any of the five groups compared as a whole with one another.
Mariella Vieira Pereira Leao et al. [44]	2011	Conducted a study to evaluate the influence of consumption of probiotics on the presence of enterobacteria in the oral cavity and the specific secretory response against these microorganism. (112 subjects; 20 days)	Yakult LB (Yakult S/A Indústria e Comércio, Lorena, Brazil) (Lactobacillus casei and Bifidobacterium.	Enterobacter cloacae and Klebsiellaoxytoca,	Probiotic consumption reduced the prevalence of enterobacteria in the oral cavity, but did not affect enterobacterialcounts or the specific immune secretory response against them.

Iniesta M et al. [45]	2012	Investigated the effects of an orally administered probiotic on the oral microbiota. (40 subjecst; 8 weeks)	Lactobacillus reuteri	Prevotella intermedia and P. gingivalis	The effect of L. reuteri administered in placebo probiotic tablets resulted in a reduction in the number of selected periodontal pathogens in the subgingival microbiota (reduction in total bacterial count), without an associated clinical impact.
S K Cildir et al. [46]	2012	Investigated the effect of the probiotic bacterium Lactobacillus reuteri on the levels of salivary mutans streptococci and lactobacilli. (19 subjects; 25 days)	Lactobacillus reuteri	Salivary mutans streptococci and lactobacilli.	They concluded that the novel drop containing L. reuteri may not reduce the levels of salivary mutans streptococci and lactobacilli in cleft lip/palate children
Mette K Keller et al. [47]	2012	Investigated the effect of probiotic lactobacilli on plaque lactic acid (LA) production in vitro and in vivo. (25 subjects; 2 weeks)	(L. reuteri DSM 17938, L. plantarum 299v)	Mutans streptococci (MS) and lactobacilli	Results showed Lactic acid production in suspensions of plaque and probiotic lactobacilli was strain-dependant and provides no evidence of an increase in plaque acidity by the supply of selected probiotic lactobacilli when challenged by fructose or xylitol. The acidogenicity of suspension of dental plaque and probiotic lactobacilli is strain dependent and influenced by the type of sugar available.
Shiva Mortazavi et al. [48]	2012	Evaluated the effects of conventional or probiotic cheese containing Lactobacillus caseion salivary Streptococcus mutans (SM) and Lactobacilli levels. (60 subjects; 2 weeks)	Lactobacillus casei	Salivary Streptococcus mutans (SM) and Lactobacilli levels.	Probiotic cheese containing L. casei was not effective in salivary SM levels reduction comparing to conventional cheese.
Anita Khanafari et al. [49]	2012	Compared the ability of ordinary and probiotic chocolate to induce or inhibit the growth of S. mutans.	Lactobacillus rhamnosus PTCC 1637, L. plantarum PTCC 1058 and L. acidophilus PTCC 1643,	Streptococcus mutans (SM)	Results suggest that probiotic chocolate is able to inhibit the growth of S. mutans.

A Juneja et al. [50]	2012	Evaluated the changes in mutans streptococci counts in saliva after short term probiotic intervention (Lactobacillus rhamnosus hct 70) and it's delayed effects on salivary mutans streptococci count. (40 subjects; 3 weeks)	Lactobacillus rhamnosus hct 70)	Mutans streptococci	Statistically significant reduction in salivary mutans streptococci counts immediately after consumption of probiotic Lactobacillus rhamnosus hct 70 containing milk suggest a beneficial effect of probiotic Lactobacillus rhamnosus hct 70 in the prevention of dental caries
Rajan Dhawan et al. [51]	2013	Investigated commercially available combined probiotic formulation for its effect on plaque, gingivitis, and salivary Streptococcus mutans levels in subjects with chronic gingivitis. (36 subjects; 2 weeks)	Capsule Bifilac- Hp) contains Lactobacillus sporogenes 100 million, Streptococcus faecalis T- 110JPC 60 million, Clostridium butyrium 4 million, and Bacillus mesentericus 2 Million.	Mutans streptococci	Probiotic could be useful in the improvement or maintenance of oral health
Hamidreza Poureslameet al. [52]	2013	Analyzed the effects of daily consumption of Espar on the number of salivary mutans streptococci and the level of calcium content. (50 subjects; 2 weeks)	Espar and yogut.	Streptococcus mutans	Daily consumption of Espar decreases the number of cariogenic bacteria in the saliva compared to that of the plain yogurt. Espar can be used as preventive product targeting dental caries in efforts towards enamel re-mineralization by increasing concentration level of salivary calcium content.
Wipapun Ritthagol et al[53]	2014	Investigated the effect of probiotic bacterium Lactobacillus paracasei SD1 on the level of salivary mutans streptococci and lactobacilli, and (2) the oral persistence of L. paracasei SD1 in orthodontically treated non-syndromic cleft lip and palate patients. (30 subjects; 4 weeks)	Probiotic milk powder containing L. paracasei SD1	salivary mutans streptococci and lactobacilli	Reduction in mutans streptococci counts and was apparently able to colonize the oral cavity of the orthodontically treated cleft lip and palate patients.
Siddiqui M et al[54]	2016	Evaluated the Streptococcus mutans Levels in Saliva before and after Consumption of Probiotic Milk: A Clinical Study (20 subjects; 7 days)	Lactobacillus casei Shirota,	salivary Streptococcus mutans	A statistically significant reduction of salivary S. mutans

PRESCRIBED DOSAGE OF PROBIOTICS

Probiotics are available in the form of capsules, powder, tablets, liquid, or are incorporated into food. The specific number of colony forming unit (CFUs) contained in a given dose or serving of food usually varies

among brands. Patients should be advised to read products label carefully to make sure that they are getting the right dose. Interestingly, probiotics are available over the counter and are not regulated by FDA but generally regarded as safe. Providers typically use half the adult dose for pediatric patients and a one-fourth dose for infants.[55]

K Suresh et al[56] reported the recommended daily dosage for various probiotic strains- Lactobacillus species and Rhamnosus GG which are available in capsules, therapeutic yogurts, fermented milks are recommended in the dose of 10 billion CFUs. Bifidobacterium species which are available in therapeutic yogurts and fermented milks are recommended in the dose of 100 million to 35 billion CFUs. *Saccharomyces Boulardii which are available in* Capsules (Florastor) are recommended in the dose of *250-500 mg. Bacillus sp which are available in* Powder (Bibactyl) are recommended in the dose of 10^7-10^8 spores.

V. SUMMARY AND CONCLUSIONS

The research in oral probiotics has been growing during the last decades. Most of the studies have been conducted suggests the role of probiotic strains in maintenance of gut health, however, it is important to realize that results obtained from one probiotic strain cannot applied to the whole species instead every strain should be studied separately.

Probiotic bacteria seem to affect both oral microbiota and immune responses. On the other hand, the extent to which bacteria in food or in food ingredients can influence relatively stable oral microbiota is difficult to predict. Thus, both research to unravel the mechanisms of possible probiotic action and long-term clinical trials are needed to provide a new scientifically proven means of preventing or treating oral diseases by probiotics.

The ability of probiotics to prevent diseases and improving health at all ages is the prime factor for its progressively increasing market potential. The development of successful probiotic products depends on positive probiotic action as well as the maximum numbers of viable microorganisms survival at the time of consumption as well as at the time it reaches the colon. Internationally accepted methodologies like Pulsed Field Gel Electrophoresis, DNA-DNA hybridization or Randomly Amplified Polymorphic DNA should be carried out for identification and characterization of genus and species of probiotic organisms. The labelling of the products must have the basic details regarding the type of strains, dose which help in the awareness of the general population regarding the product.

The technological issues regarding the shelf life of the probiotic foods with the sufficient amount of viable bacteria throughout the shelf life of the product needs to be overcome. Current findings on the potential use of probiotics against oral conditions are very encouraging. More research is needed in this area, but the use of probiotics to manage the oral microflora is looking to be a very effective adjunct way to control oral conditions that affect so many people worldwide.

In spite of many health benefits of probiotics, the mechanisms by which the probiotic organisms exert their effects are still at nascent stage. Therefore, researches should focus on understanding the mechanisms of health-promoting effects of probiotic cultures for safe future of probiotics as functional food ingredients.

REFERENCES

1. Chawla A, Arora H, Singh N. Safety issues in Probiotic use. Guident 2012; 5(9):68-70.
2. Devine AD, Marsh PD. Prospects for the development of probiotics and prebiotics for oral applications. J Oral Microbial 2009; 1(10):86-90.
3. Metchnikoff E. The prolongation of life. Optimistic studies New York: Putman′s Sons 1908; p. 161-83.
4. Lilly DM, Stillwell RH. Probiotics growth-promoting factors produced by microorganisms. Science 1965;147: 747– 748.
5. Parker RB. Probiotics the other half of the antibiotic story. Anim Nutr Health 1974; 29: 4–8.
6. Fuller R. Probiotics in man and animals. J Appl Bacteriol 1989; 66: 365–378.
7. Havenaar R, Huis Int Veld, M. J. H. Probiotics: a general view. In Lactic acid bacteria in health and disease. Amsterdam: Elsevier Applied Science Publishers, 1992; 1(1).
8. Schaafsma G. State of art concerning probiotic strains in milk products. IDF Nutr News Lett 1996; 5: 23–24.
9. Naidu AS, Bidlack WR, Clemens RA. Probiotic spectra of lactic acid bacteria (LAB). Crit Rev Food Sci Nutr 1999; 39: 13–126.
10. Schrezenmeir J, De Vrese M. Probiotics, prebiotics and synbiotics: Approaching a definition. Am J Clin Nutr 2001; 73: 361S–364S.
11. FAO/WHO. Regulatory and clinical aspects of dairy probiotics. Cordoba, Argentina: FAO/WHO, 2001.
12. Gibson GR, Roberfroid MB. Dietary modulation of the human colonic microbiota: Introducing the concept of prebiotics. J Nutr 1995; 125: 1401–1412.
13. Andersson H, Asp NG, Bruce A, Roos S, Wadstrom T, Wold AE. Health effects of probiotics and prebiotics: a literature review on human studies. Scand J Nutr 2001; 45: 58–75.
14. Tissier H. Traitement des infections intestinal espar la methode de la florebacterienne de l_intestin. C R Soc Biol Paris 1906; 60: 359–361.
15. A. Nissle. Die antagonistische behandlung chronischer darmstorungen mit colibakterien. Med klein1918; 2(1) p.29-33.
16. S Anuradha, K rajeshwari; Probiotics in Health and Disease. Journal of Indian Academy of Clinical Medicine 2005; 6(1):67-72.
17. Suvana VC, Boby V. Probiotics in Oral Health. A Current Assessment. Current Science 2005; 88:1744-48.

18. Patil M, Reddy N. Bacteriotherapy and Probiotics in Dentistry. KSDJ 2006; 2:98-02.
19. Saha S, Tomaro-Duchesneau, C Tabrizian, M Prakash. Probiotics as oral health biotherapeutics. Expert Opin. Biol. Ther 2012; 12:1207–1220.
20. Santosa S, Farnworth E, Jones PJ. Probiotics and their potential health claims. Nutr Rev 2006; 64 (6): 265-74.
21. Huovinen P. Bacteriotherapy the time has come. *BMJ* 2001; 323 (7309): 353-4.
22. Salminen MK, Tynkkynen S, Rautelin H *et al*. Lactobacillus bacteraemia during a rapid increase in probiotic use of *Lactobacillus rhamnosus* GG in Finland. Clin Infect Dis 2002; 35 (10): 1155-60.
23. Comelli EM, Guggenheim B, Stinglele F, Nesser JR. Selection of dairy bacterial strains as probiotics for oral health. Eur J Oral Sci 2002; 110:218–224.
24. Kanf MS, Chung J, Kim SM, Yang KH. Effect of Weissellacibaria isolates on the formation of streptococcus mutans biofilm. Caries Res 2006; 40:418–425.
25. Nikawa H, Makihira S, Fukushima H, Nishimura H, Ozaki K, Darmawan S. Lactobacillus reuteri in bovine milk fermented decreases the oral carriage of mutans streptococci. Int J Food Microbiol 2004; 95:219–223.
26. Twetman S, Stecksen-Blicks C. Probiotics and oral health effects in children. Int J Paediatr Dent 2008; 18:3–10.
27. Nase L, Hatakka K, Savilahti E, Saxelin M, Ponka A, PoussaT. 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.
28. Cagler E, Cidir SK, Ergeneli S, Sandalli N. Salivary mutans streptococci and lactobacillus levels after ingestion of the probitic bacterium Lactobacillus reuteri ATCC557339 by straws or tablets. ActaOdontolScand 2006; 64:314–318.
29. Shivamanjunath RG. Benefits of live microorganisms (probiotics) in periodontal health. Int J Contemp Dent 2011; 2(1):97- 100.
30. Teughels W, Newman MG, Coucke W, Haffajee AD, Van Der Mei HC, Haake SK, *et al*. guiding periodontal pocket recolonization: A proof of concept. J Dent Res 2007; 86:1078- 82.
31. Kang MS, Kim BG, Chung J, Lee HC, Oh JS. Inhibitory effect of Weissellacibaria isolates on the production of volatile sulphur compounds. J Clin Periodontol 2006; 33:226- 32.
32. E Caglar, N Sandalll, S Twetman, S Kavaloglu, S Ergeneli, S Selvl. Effect of yogurt with bifidobacterium dn-173 010 on salivary mutans streptococci and lactobacilli in young adults. ActaOdontologica Scandinavica 2005;63(1):317-320.
33. Haukioja A, Loimaranta V, Tenovuo J. Probiotic bacteria affect the composition of salivary pellicle and streptococcal adhesion in vitro. Oral Microbiol Immunol 2008; 23: 336–343.
34. E Cagler, O Kuscu, S Kuvvetli, S K Cildir, N Sandalli, S Twetman. Short-term effect of ice-cream containing Bifidobacteriumlactis Bb-12 on the number of salivary mutans streptococci and lactobacilli. Acta OdontologicaScandinavica 2008; 66: 154-158.
35. E Çaglar, O Kuscu, S K Cildir, S SKuvvetli, N Sandalli. A probiotic lozenge administered medical device and its effect on salivary mutans streptococci and lactobacilli. International J of Paediatric Dentistry 2008; 18: 35–39.
36. S Twetman, B Derawi, M Keller, K Ekstrand, T Y Lindberg, C Stecksen-Blicks. Short-term effect of chewing gums containing probiotic Lactobacillus reuteri on the levels of inflammatory mediators in gingival crevicular fluid. Acta OdontologicaScandinavica 2009; 67: 19-24.
37. S K Cildir, D Germec, N Sandalli. Reduction of salivary mutans streptococci in orthodontic patients during daily consumption of yoghurt containing probiotic bacteria. European J of Orthodontics 2009; 31:407–411.
38. Staab B, Eick S, Knofler G, Jentsch H. The influence of a probiotic milk drink on the development of gingivitis- A pilot study. J Clin Periodontol 2009; 36: 850–856.
39. Mayanagi G, Kimura M, Nakaya S, Hirata H, Sakamoto M, Benno Y, Shimauchi H. Probiotic effects of orally administered Lactobacillus salivarius WB21-containing tablets on periodontopathic bacteria: A double-blinded, placebo-controlled, randomized clinical trial. J Clin Periodontol 2009; 36: 506–513.
40. Pamela Hasslöf, Maria Hedberg, SvanteTwetman, Christina Stecksén- Blicks.growth inhibition of oral mutans streptococci and candida by commercial probiotic lactobacilli - an in vitro study. BMC Oral Health 2010, 10(18):1-5.
41. Mette Kirstine Keller, Pamela Hasslöf, Christina Stecksén-Blicks, SvanteTwetman. Co-aggregation and growth inhibition of probiotic lactobacilli and clinical isolates of mutans streptococci: An in vitro study. Acta OdontologicaScandinavica 2011; 69: 263–268.
42. G. Jindal, R.K. Pandey, J. Agarwal, M. Singh. A comparative evaluation of probiotics on salivary mutans streptococci counts in Indian children. European Archives of Paediatric Dentistry 2011; 12 (4).
43. Esber Çaglar, Nukhet Sandalli, Ozgur OnderKuscu, Betul Kargul. The Buffering Capacity of Probiotic Yogurt. Acta Stomatol Croat. 2011; 45(1):41-45.
44. Mariella Vieira Pereira Leão, Ricardo Coelho Cassia, SilvanaSoléo Ferreira dos, Santos, Célia Regina Gonçalves e Silva, AntônioOlavo Cardoso Jorge. Influence of consumption of probiotics on presence of enterobacteria in the oral cavity. Braz Oral Res. 2011 Sep-Oct; 25(5):401-6.
45. Iniesta M, Herrera D, Montero E, Zurbriggen M, Matos AR, Marı´n MJ, Sa´nchez- Beltra´n MC, Llama-Palacio A, Sanz M. Probiotic effects of orally administered Lactobacillus reuteri-containing tablets on the subgingival and salivary microbiota in patients with gingivitis. A randomized clinical trial. J Clin Periodontol 2012; 39:736–744.
46. Sule Kavaloglu Cildir, Nuket Sandalli, Serpil Nazli, Fatos Alp, Esber Caglar, A Novel Delivery System of Probiotic Drop and Its Effect on Dental Caries Risk Factors in Cleft Lip/Palate Children. Cleft Palate–Craniofacial Journal 2012; 49(3): 369-373.
47. Mette K Keller, Svante Twetman. Acid production in dental plaque after exposure to probiotic bacteria. BMC Oral Health 2012; 12(1):44-6.
48. Shiva Mortazavi, Najme Akhlaghi. Salivary Streptococcus mutans and Lactobacilli levels following probiotic cheese consumption in adults: A double blind randomized clinical trial. J Res Med Sci 2012; 17(1): 57-66.
49. Anita Khanafahi, Sepideh Hosseini Porgham, Maryam Tajabadi Ebrahimi. Investigation of probiotic chocolate effect on streptococcus mutans growth inhibition. Jundishpur J Microbial 2012; 5(4): 590-597.
50. Juneja A, Kakade A. Evaluating the effect of probiotic containing milk on salivary mutans streptococci levels. J. Clin. Pediatr. Dent 2012; 37: 9–14.
51. Rajan Dhawan, Shivani Dhawan. Role of probiotics on oral health: A randomized, double- blind, placebo- controlled study. J Interdisciplinary Dentistry 2013; 3(2): 71-77.

52. Hamidreza Poureslami, Lida Pishbi, Zahra Eslamineja, Fatemeh Jahani Moqada, Moshtagh Rashid Farokh. The Effects of a Dairy Probiotic Product Espar on Salivary Calcium and Mutans Streptococci. J Dental Research, Dental Clinics, Dental Prospects 2013; 7(3): 147-150.
53. Wipapun Ritthagol, Chontira Saetang, Rawee Teanpaisan. Effect of Probiotics Containing Lactobacillus paracasei SD1 on Salivary Mutans Streptococci and Lactobacilli in Orthodontic Cleft Patients: A Double-Blinded, Randomized, Placebo-Controlled Study. The Cleft Palate–Craniofacial Journal 2014; 51(3): 257–263.
54. Siddiqui M et al. Evaluation of Streptococcus mutans Levels in Saliva before and after Consumption of Probiotic Milk: A Clinical Study: Journal of International Oral Health 2016; 8(2):1-4.
55. Cabana MD, Shane AL, Chao C, Hemker MO. Probiotics in primary care pediatrics. Clin Pediatr; 45(1):405-410.
56. K Suresh, K Jamila, G Patrick. The use of probiotics and safety concerns: A review. Afr J. Microbiol Res 2012; 6(41):6871-77.

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