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Review Article

Bacteria in Oral Health – Probiotics and Prebiotics A Review.

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ABSTRACT

As health professionals we prescribe wide range of chemotherapeutics to the patients to control or to prevent the disease. When there is excessive use of antibiotics, which leads to imbalance between the beneficial and harmful microorganisms, making our body more susceptible to infections. Probiotics are living micro-organisms added to food which beneficially affect the host by improving its intestinal microbial balance. And Prebiotics are the non-digestible dietary supplements, which modify the balance of the intestinal microflora by stimulating the growth and activity of beneficial organisms. Combination of probiotics and prebiotics beneficially affect the host by improving the survival and implantation of live microbial dietary supplements into the gastrointestinal flora and by improving the microbial balance of the gastrointestinal tract, thus effectiveness of combining probiotics and prebiotics may have additive and synergistic effect. This review highlights the effectiveness of probiotics in combination with prebiotics for improving the oral health and in turn how they help us to lead a healthy life.

1. Introduction

The intestine's normal microflora is a metabolically active but as yet unexplored organ of host defence. The large intestine contains 300–500 different species of bacteria[1] . Some of these are potential pathogens and cause infection under certain circumstances. Microbial colonization of the intestine begins after birth, and the development of the normal flora is determined by contact with the maternal intestinal flora and surroundings, and possibly by genetic factors [2,3]. It is thought that those who are breast-fed have a natural predominance of bifidobacteria, while formula-fed infants have a more complex “microflora” similar to that in the adults. After weaning, however, the composition of the microflora gradually alters to resemble adult microflora [4,5]

Literature proved that probiotics and prebiotics have an impact on gut flora. Conversely, records of their influence in sites beyond the intestinal tract are now growing. Resident and transient microbes are competent in influencing many colonized and non-colonized systems of human physiology through interrelated organ function and communication systems. Substantiation for prebiotic and probiotic effects on non-intestinal sites spans the range from theoretical to evidence-based, supported by controlled human studies. Endpoints in these studies include pathogen carrier state, infection, tumor incidence, or structural health in targets such as the mouth, vagina, liver, stomach, respiratory system, pancreas, central nervous system, and bone. General health targets include cognitive function, obesity, pediatric growth etc. Although these general health benefits may be the result of improved intestinal function, these findings identify the awareness to the fact that benefits of these dietary microbial agents have broader range than the intestine alone[6]. Studies are being carried out to know the efficacy of probiotics and prebiotics in curing oral diseases.

2. History

The term 'probiotic' is a relatively new word meaning 'for life' and it is currently used when referring to bacteria associated with beneficial effects on humans and animals. The use of microorganisms to promote health is very ancient and can even be traced back to the classical Roman literature where food fermented with microorganisms was used as a therapeutic agent[7].The original observation of the positive role played by some selected bacteria was scientifically investigated by Eli Metchnikoff, the Ukrainian-born Nobel Prize winner working at the Pasteur Institute at the beginning of the last century. He

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proposed, in 1907, that the lactic acid-producing strain Lactobacillus bulgaricus (contained in Bulgarian yoghurt) is able to displace pathological intestinal microbiota. He suggested that 'the dependence of the intestinal microbes on food makes it possible to adopt measures to modify the flora in our bodies and to replace the harmful microbes by useful microbes'[8]The term 'probiotics', the antonym of the term 'antibiotics', was introduced in 1965 by Lilly & Stillwell as 'Substances produced by microorganisms which promote the growth of other microorganisms' . They showed that several species of protozoa, during their logarithmic phases of growth, produce substances that prolong the logarithmic phase in other species.[9]

The importance of living cells in probiotics was emphasized by Fuller, in 1989, who defined probiotics as "A live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance"[10] All the previous research helped the World Health Organization to predict the usefulness of probiotics as the next-most important immune defence system[11,12]. Since then, several definitions of probiotics have been proposed, as shown in Table(1). The currently used consensus definition of probiotics was put forward by the World Health Organization and by the Food and Agriculture Organization of the United States. They defined probiotics as "Live microorganisms which when administered in adequate amounts confer a health benefit on the host."[19]

Table 1. Definitions of probiotics

Year	Definition	Reference
1965	Substances produced by microorganisms that promote the growth of other microorganisms	Lilly & Stillwell [9]
1974	Organisms and substances that contribute to intestinal microbial balance	Parker [14]
1989	A live microbial feed supplement that beneficially affects the host animal by improving its intestinal microbial balance	Fuller [10]
1992	A viable monoculture or mixed-culture of microorganisms that, when applied to animal or human, beneficially affects the host by improving the properties of the indigenous microflora	Havenaar & Huis Int Veld [15]
1996	Living microorganisms that, upon ingestion in certain numbers, exert health benefits beyond inherent basic nutrition	Schaafsma [16]
1999	A microbial dietary adjuvant that beneficially affects the host physiology by modulating mucosal and systemic immunity, as well as by improving nutritional and microbial balance in the intestinal tract	Naidu et al. [17]
2001	A preparation of, or a product containing, viable, defined microorganisms in sufficient numbers, which alter the microflora (by implantation or colonization) in a compartment of the host and as such exert beneficial health effects in this host	Schrezemeir & de Vrese [18]
2001	Live microorganisms that, when administered in adequate amounts, confer a health benefit to the host	FAO/WHO report

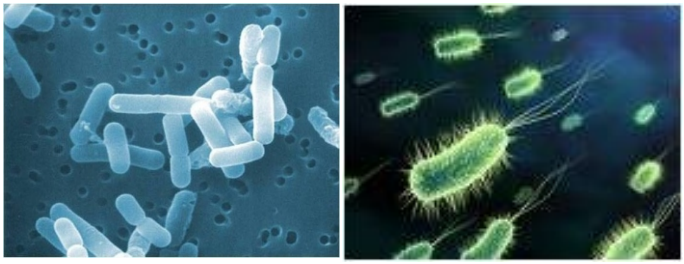
These bacteria have to belong to the natural flora in order to be able to resist acid and bile, to survive during intestinal transit, to adhere to the intestinal mucosa, and to produce antimicrobial substances in order to retain the characteristics that contribute to their beneficial health effects[9]. Probiotic organisms are thought to act through a variety of mechanisms which includes –(a) Compete with potential pathogens for nutrients and growth factors or enterocyte adhesion sites or substract and involved in modifying the gut pH.(b). Degradation of toxins, production of antimicrobial substances, and antioxidants.(c) And local and systemic immunomodulation, by stimulating t-lymphocytes to replicate. They help in the development of a mucosal barrier, activates immune system, produces short chain fatty acids, helps in the metabolism of bile acids, and also synthesis vitamins. [10].

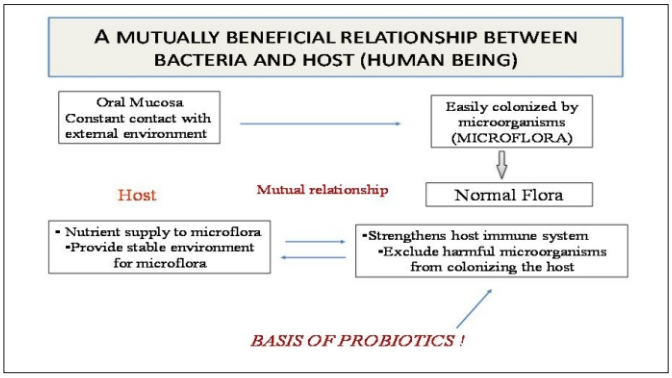
There are a number of different organisms that can be classified as "probiotics". The most common probiotic strains belong to the genera Lactobacillus and Bifidobacterium. *Lactobacillus* species from which probiotic strains have been isolated include *L. acidophilus, L. johnsonii, L. casei, L. rhamnosus, L. gasseri,* and *L. reuteri. Bifidobacterium strains* include *B. bifidum, B. longum,* and *B. infantis*[13]. Table(2)Presents some of the main fields of activity of probiotics in general medicine. Discussing these investigations in detail, however, is beyond the scope of the present review[13].

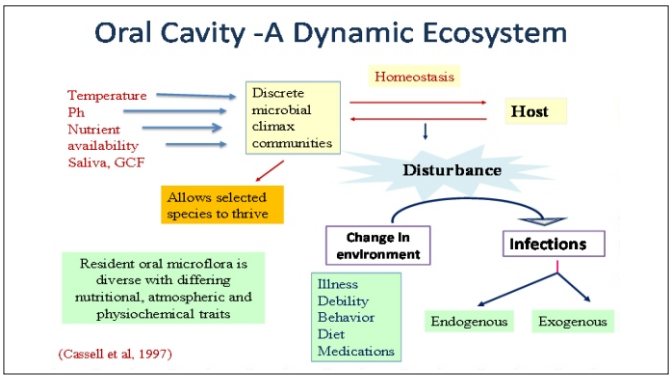
Table 2. Test strains considered probiotics in the oral cavity.

Scope of activity	Reference	Result
Cancer risk reduction	El-Nezami et al (2006)	Possible reduction of liver cancer.[22]
	Mego et al (2005)	Interaction with pathogenic gastrointestinal bacteria leading to decreased cancer risk.[23]
	Commane et al	Multifactorial anticarcinogenic activity[24].
Gastro intestional health	Brzozowski et al (2006)	Attenuation of the adverse effects of Helicobacter pylori.[25]
	Bergonzelli et al (2005)	General review over the issue defining the positive effect of probiotics[26] .
Urinary tract health	Reid et al (2001)	Coaggregation with uropathogens[27].
	Falagas et al (2006)	Prevent urogenital infections in women[28].
Immune respons e induction	Christensen et al (2006)	Insufficient data to prove the positive probiotic effect. [29]
	Rinne et al (2005)	Elevated numbers of IgM,IgA,IgG-secreting cells[30]
Antimicrobial potential	Olivares et al (2006)	Antibacterial activity against different pathogenic bacteria.[31]
	Hutt et al (2006)	Strain-dependent antibacterial effect.[32]
Cardiovascular system	Aihara et al (2005)	High blood pressure reduction.[33]
	Jauhianinen et al (2005)	Blood pressure lowering effect.[34]

The oral cavity is a complex ecosystem,which has rich and diverse micro biota in it. There is a lot of metabolic activity taking place in the oral cavity. The wide range of pH, nutrient availability, shedding and non shedding surfaces, salivary and crevicular fluids are the contributing elements. These fluids select localized, discrete microbial climax communities in the process of metabolic activity.[13] The surprising fact is that this metabolic activity reaches a kind of homeostasis in balance with the host in spite of its fluctuation in the composition of these fluids. But most important thing is that any change in the environment disturb the homeostasis and lead to endogenous infections or susceptibility to exogenous infections (figure3, 4) Fig:(3): (Mutual beneficial relationship between bacteria and host)







The change in environment may be due to illness, debility, behavior, diet or medications. So, an obvious fact is that a consequence of these changes in ecology may give rise to dental diseases [12,13]. Fig (4):showing Oral cavity - a complex ecosystem. A dental disease is observed even with a slight change in local environment. This promotes the potential pathogens gain competitive advantage under appropriate conditions. Then, the pathogens increase in great numbers to predispose a site to disease. In order to cure the disease, probiotic approach, may be used. The probiotic method is the whole bacteria replacement therapy which may be very effective in eliminating the dangerous pathogens from the oral cavity. [9,10].There has been a lot of study and research on probiotics to prove its efficacy in the treatment of oral diseases. Studies are going on to incorporate probiotics in various food beverages and medicaments.

With in dentistry, studies with L. rhamnosous GG, L. reuteri have defined their potential in interacting with S. mutans by reducing the number of this caries pathogen, thus suggesting a role of probiotics in caries prophylaxis. Similarly, researchers observed that probiotic administration reduced oral Candida counts in the elderly – a finding that might offer a new strategy for controlling oral yeast infections .Yet, there is a paucity of information regarding the contributions of probiotics to oral health[39,45,46]. Larger studies with patient-oriented outcomes such as dental caries or oral infections need to be conducted to better ascertain the value of probiotics in oral health. Table (3) presents the possible probiotic strains in the oral cavity. In 2005 two reviews on probiotics in the oral health perspective were published[12,13]Microbial interference therapy is the use of probiotics in antibiotic resistance. As research is going on in this area, this has been found to be evidently effective in oral ecology. Different probiotics such as medical probiotics(microbial preparation) and other probiotics(functional food) are provided in products in one of four basic ways . The first one is the culture concentration added to a beverage or food such as fruit juice. The second one is the probiotics inoculated into prebiotic fibres. The third one is that probiotic inoculated into a milk-based food(diary products such as milk, milk drink, yoghurt, yoghurt drink, cheese, kefir, biodrink. The last one is that the concentrated and dried cells packaged as dietary supplements(non-diary products such as power, capsule, gelatin tablets[12].

3. Probiotics And Oral Health

Probiotics have many positive influences in creating better oral health. Probiotics have both direct and indirect interactions. The advantages of direct interactions are many. Basically, probiotics help in binding oral microorganisms to proteins & biofilm formation. They fight against plaque formation and on its complex ecosystem by compromising and intervening with bacterial attachments. Through its direct interactions, probiotics compete with oral microorganisms of substances available. This process is the involvement of metabolism of substrate. Probiotics produce chemicals to inhibit oral harmful bacteria that damage oral hygiene.[21]On the other hand, the indirect interactions of probiotics are effective in the process of removing harmful bacteria and stabilizing normal conditions. Probiotics modulate and systematize immune function on local community as well as non-immunologic defence mechanisms. Probiotics have the ability to regulate permeability and also to develop colonies in oral microflora with less pathogenic species. Probiotics have proved to be effective in curing diseases such as dental caries, periodontal diseases, halitosis and candidiasis.[11-13,36,39,40]

The mechanism of adhesion to oral surfaces is an issue of importance for the long-term probiotic effect of the microorganisms. Among the different assays available to study the adhesion phenomenon, two model systems predominate: systems using saliva-coated hydroxylapatite, and hydroxylapatite coated with buffers, proteins and other substances [21]

The pattern of adhesion of different probiotic strains to oral epithelial cells has been tested as well. Most of the experiments on adhesion have been carried out with strains broadly used as probiotics in dairy products such as yogurt and cheese. Table (4)shows different means of probiotic administration for oral health purposes.

Table 3:Test strains considered probiotics in the oral cavity

Test strain	Reference	Feature tested	Result
S.salivarius	Burton et al (2006a)	Reduction of VSC	Reduced VSC levels[35]
L.rhamnosus GG L.acidophilus L.casei	Busscher et al (1999)	Inhibition of S.mutans	Positive correlation to S.mutans inhibition. [46]
L.reuteri	Caglar et al (2006)	Inhibition of S.mutans	Reduced S.mutans levels. [11]
Bifidobacterium DN-173010	Caglar et al (2005a)	Inhibition of S.mutans	Reduces levels of caries pathogens.[12]
L.rhamnous GG Propionibacterium freudenreichii ssp. Shermanii JS	Hatakka et al (2007)	Inhibition of C.albicans	Reduce high yeast counts.[36]
L.rhamosus L.paracasei, L.johnsonii	Haukioja et al (2006a)	Adherence Survival in saliva	Better adherence than bifidobacteria.[44]
L.rhamnosus GG L.casei, L.reuteri	Haukioja et al	Inhibition of S.mutans	Inhibit S.mutans adhesion to salivary pellicle. [45]
W.cibaria	Kang et al (2005)	Adherence	S-protein positively affects adhesion.[39]
W.cibaria	Kang et al (2006)	Reduction of VSC	Inhibited production of VSC. [40]
L.casei Shirota , L.acidophilus	Lima et al (2005)	Adhesion	Different pattern of adhesion according to the test strain. [41]
L.rhamnosus GG	Yli-Knuuttila et al (2006)	Adherence	Only temporary colonization in oral cavity. [43]

VSC: volatile sulfur compounds.

Table (4): Different means of probiotic administration for oral health purposes

Vehicle	Strain	Outcome	Reference
Lozenge[35]	S.Salivarius	Reduces oral VSC levels	Burton et al (2005)
Straw , tablet[11]	L.reuteri ATCC 55 730	S.mutans level reduction	Caglar et al (2006)
yoghurt [12]	Bifidobacterium DN-173 010	Reduction of salivary S.mutans	Caglar et al (2005b)
Cheese[36]	L.rhamnosus GG, Prorionibacterium JS	Reduced risk of high yeast counts and hyposalivation	Hatakka et al (2007)
Rinse solution[39,40]	W.Cibaria	Reduction of VSC.	Kang et al (2006)
Capsule liquid[42]	L.sporogenes, L.bifidum , L.bulgaricus,	Increased salivary counts of lactobacilli without significant decrease in S.mutans counts.	Montalto et al (2004)
	L.thermophilus, L.acidophilus, L.casei, L.rhamnosus		
Yogurt drink[43]	L.rhamnosuss GG	Temporary oral cavity colonization.	Yli-knuuttila et al (2006)

VSC: volatile sulfur compounds.

4. Prebiotics

Prebiotics have been proved to be an aid to complement probiotics in the treatment of oral diseases. Prebiotics are non-digestible dietary supplements. Their function is to enhance the growth and activity of beneficial organisms and simultaneously suppress the growth and activity of potentially deleterious bacteria. In this way prebiotics modify the balance of the intestinal micro-flora. The characteristic feature of prebiotic ingestion is mainly to change microbial population density [12].

Some of the commonly known prebiotics are Lactose, Inulin, Fructo oligosacccharides,Galacto oligosaccharides and Xylo oligosaccharides. Prebiotics are naturally found plenty in certain fruits like bananas, asparagus, garlic, tomato and onion wheat.The characteristic features of ideal prebiotics are as follows . They are neither to be hydrolysed nor absorbed by mammalian enzymes or tissues. They are selectively enriched with a limited number of beneficial bacteria. The most important characteristic feature is that prebiotics can alter the intestinal micro-flora and its activities. Prebiotics can also change luminal or systemic aspects of the host defense system[14].

5. Relationship Between Prebiotics And Probiotics

Prebiotics when combined with probitocs have many advantages. Basically, prebiotics selectively stimulate the growth of probiotics, which is dose and strain dependent. Prebiotics serve as a selective growth substrate for the probiotics strain during fermentation, during the period of storage,or during its passage through the gut[14]. These two combinations implant live microbial dietary supplements and create a congenial environment for their survival in gut flora. Thereby, this environment in gut flora improves healthy microbial balance. So, the combination of prebiotics and probiotics may have additive and synergistic effect in providing better oral health conditions.

An essential requirement for a microorganism to be an oral probiotic is its ability to adhere to and colonize surfaces in the oral cavity. Microorganisms generally considered as probiotics may not have oral cavity as their inherent habitat and, subsequently, their possibility to confer benefit on oral health is then questionable.

Paster et al in an attempt to determine bacterial diversity in the human subgingival plaque by using culture-independent molecular methods have estimated that the total species diversity in the oral cavity ranges between 500 and 600 species. This number was further extended by Kazor et al, who detected 200 additional unknown species on the dorsum of the tongue, making the number of species in the mouth to reach 700.Lactobacilli make approximately 1% of the cultivable oral microflora[38,43] .The most common lactobacilli species recovered from saliva in a study by *Teanpaisan* and *Dahlenwere L. fermentum*, *L. rhamnosus, L. salivarius, L. casei, L. acidophilus* and *L. plantarum.* Three of them are probiotic strains used in dairy products. A similar diversity in the oral lactobacilli flora was observed by Colloca et al who found *L. fermentum, L. plantarum, L. salivarius* and *L. rhamnosus* to be the predominant species in healthy human mouth. Koll-Klais et al found no differences in salivary lactobacilli counts between chronic periodontitis and healthy patients, *L. gasseri* and *L. fermentum* being the predominant species among other isolates: *L. oris, L. plantarum, L. paracasei, L. rhamnosus, L. gasseri, L. acidophilus* and *L. cispatus.* These findings indicate that lactobacilli as members of resident oral microflora could play an important role in the microecological balance in the oral cavity[57].These studies further demonstrated that lactobacilli strains with probiotic properties may indeed be found in the oral cavity. Yet there is no evidence whether these lactobacilli strains were detected due to the frequent consumption of dairy products leading to temporary colonization only, or if the oral environment is their permanent habitat. There are no long-term follow-up studies published to answer this question.

6. Probiotics And Dental Caries

The impact of oral administration of probiotics on dental caries has been studied in several experiments utilizing different test strains. Lactobacillus rhamnosus GG and *L. casei* have proved their potential to hamper growth of these oral streptococci.[12,46,45] Definite S. mutans count reduction after a 2-week consumption of yoghurt containing *L. reuteri.* A temporary reduction in S. mutans was observed during the period of yogurt intake and few days after cessation of consumption, indicating the necessity of continual administration of the probiotic in order to achieve an effect.[12]

Studies showed in a placebo-controlled randomized double-blind intervention study that the administration of probiotic lactobacilli (LGG) to kindergarten children in Helsinki, Finland, resulted in reduction of their caries risk and initial caries development[21]. Certain conditions are required to remove cariogenic bacteria from the surface of the teeth to fight against dental caries. First, probiotic bacteria must be able to stick to the tooth surface where cariogenic bacteria reside. Secondly, they must become a part of the biofilm that develops on teeth. Finally, they must compete with cariogenic bacteria. All this process helps display a probiotic effect against carries by drastic reduction of the levels of cariogenic bacterial growth[19].

7. Probiotics And Periodontal Disease

The study on Streptococcus oralis and Streptococcus uberis, beneficial bacteria, have proved to be useful in decreasing the growth of disease causing bacteria. Even the presence of *S.oralis* and *S.Uberis* have proved to be a good indication of healthy gingiva. Grudianov et al found that when compared to mouth wash Tantum Verde, selected strains of *L.reuteri* have reduced gingivitis& plaque much better and have reduced the counts of *S.mutans* as well [11,12,45]. All this is with respect to the cases of gingivitis and periodontitis . Tablets containing 6.7 X 108 colony forming units (CFU) tablet of *L.salivarius* and Xylitol (280mg/tab) significantly decreased the plaque index. This was proved to be effective in the case of smokers.[19] In this way,probiotics can be a useful tool in the treatment of inflammation and clinical symptoms of periodontitis, specially in high risk subjects. It has been proved in a recent study by Quirynen et al that applying beneficial bacteria as a replacement to traditional therapy may become a valid,non-antibiotic treatment approach for periodontal disease. After scaling and root planning, researchers have applied a mixture of beneficial bacteria. Owing to this, gum disease associated with repopulated bacteria has been delayed and later reduced. This concept called as Guided Pocket Recolonization or GPR.[19]

8. Probiotics And Halitosis

Halitosis (bad breath) is believed to affect a large proportion of the population. It has a significant socio-economic impact and may reveal an underlying disease. 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. A diverse consortium of bacteria has been found to contribute to the problem, including *Fusobacterium nucleatum, P. gingivalis, P. intermedia* and Treponema denticola. Other gases, such as indole, skatole, putrescine, cadaverine and acetone, are also relevant and sometimes even the dominant cause of halitosis, although their substantively is much lower[19]. Most (85%) of the pathology causing halitosis lies within the oropharynx (tongue coating, gingivitis, periodontitis, tonsillitis).

Kang et al. were the first to use a more scientifically based step-by-step approach in their quest to find a probiotic for the treatment or prevention of halitosis[39,40]. In children, halitosis has been reduced after gargling with W.cibaria containing rinse. Because of this, there has been a marked reduction in the levels of H_2S and CH_3SH by approximately 48.2% and 59.4% respectively[39,40]. Studies carried out to investigate the effect of S. salivarius on oral malodour parameters. The aim was to alleviate halitosis by pre-emptively colonizing the oral cavity with a competitive commensal bacterium following a short course of mechanical and chemical treatment to reduce the numbers of odor-causing organisms and possibly provide additional attachment sites for the colonizing strain. S. salivarius was selected as an oral probiotic because it is an early colonizer of oral surfaces and is amongst the most numerically predominant members of the tongue microbiota of 'healthy' individuals. This species also has only a limited ability to produce volatile sulphur compounds and is unlikely to contribute significantly to oral odor. S. salivarius has not been implicated either in caries or in other infectious diseases of humans and is most closely related to S. thermophilus, a bacterium which is widely used in the dairy food industry[35,40,42].

9. Probiotics And Candidiasis

Oral cavity with its variety of functions and complex structures is a specific site with its inherent pathology and diseases although the mouth is of course closely related to other parts and systems of the body. Candida albicans is among the most common infectious agents in the oral cavity. The incidence of yeast infections is higher at older age and under conditions of impaired immunity[13]. Hatakka et al were the first to perform a randomized, double-blind, placebo-controlled study on the effect of probiotics on the prevalence of oral candida. A decrease in the prevalence of C. albicans in the elderly after consumption of probiotic cheese containing L. rhamnosus GG and Propionibacterium freudenreichii ssp. shermanii JS which was as an interesting observation in this randomized placebo-controlled trial[36]. A concomitant feature of the probiotic activity observed in this study was the diminished risk of hyposalivation and the feeling of dry mouth of the subjects.
It could be hypothesized that extending research on oral pathology, such as yeast infections, with respect to probiotics, and analyzing the molecular mechanisms of probiotic activity, might further broaden the field of their potential applications[21].

10. Safety Issues

The issue of protection is of particular concern during the past few years due to the amplified probiotic supplementation of different food products. From the safety point of view, the putative probiotic microorganisms should not be pathogenic, should not have any growth-stimulating effects on bacteria causing diarrhea, and should not have an ability to transfer antibiotic resistance genes. The probiotics should rather be able to maintain genetic stability in oral microflora.[54] The increased probiotic utilization inevitably leadsto increased concentrations of these species in the host organism. Lactobacillus bacteremia is a rare entity, and data on its clinical significance are mainly found through case reports. For the last 30 years there have been approximately 180 reported cases.[53,55]

Clinical characteristics of Lactobacillus bacteremia are highly variable, ranging from asymptomatic to septic shock-like symptoms. Any viable microorganism is capable of causing bacteremia, however, especially in patients with severe underlying diseases or in immunocompromised state. Nevertheless,the present literature supports the conclusion that the incidence of Lactobacillus bacteremia is unsubstantialand that all the cases where it has been registered are individuals with other systemic diseases such as diabetes, cardiovascular diseases, gastrointestinal disorders, malignancies, or organ transplant patients.

11. Conclusion

There is scientific evidence that specific strains of probiotic microorganisms confer benefits to the health of the host and are safe for human use. However, considerable work is required to affirm the benefits of probiotics. Probiotics are, nevertheless, a new, interesting field of research in oral microbiology and oral medicine. The research is still in the initial stage. The idea of probiotics casts new light on the connections between diet and health, including oral health. The complex interplay with respect to the mechanisms of probiotics' actions in the development of microbial colonies as well as oral biofilms is yet to be known[21]. Further studies on the combined effect of different probiotics & prebiotics should be carried out in order to authenticate the possible additive, cumulative, or competitive modes of action in the oral environment. So far, a little has been known about the possible naturally occurring resident probiotics of the mouth. In this regard, it might be interesting to conduct studies on patients with lichen planus, pemphigus vulgaris, cicatricial pemphigoid or apthous stomatitis. Probably, different probiotics are needed for therapy in oral mucosal diseases as there is difference in the microbial attachment sites on the keratinized, and non keratinized epithelium .[13,21]

In order to assess the best means of administering probiotics, randomized controlled trails are needed. In addition, variation in the dosage for different preventive or therapeutic purposes are also to be studied carefully in order to avoid ill-effects of the species that ferment sugar and lower oral pH that are detrimental to the teeth. Apart from this, general safety aspects such as those related to potential invasiveness and antibiotic resistance genes must be screened. [12,19] Probiotics can be used with caution in immunocompomised patients, and contraindicated in premature infants and patients with central venous access in place. Finally, possibilities to genetically modify or engineer potential probiotic strains may offer totally new visions need to studied[13,19,21].

12.Future Prospects

In field of oral immunology, probiotics are being used as passive local immunization vehicles against dental caries. Recently, by means of systemic immunization with a multivalent vaccine, *L. rhamnosus* GG was chosen as the vehicle to harbor IgG because of its widely known health benefits in humans and animals. High titers of antibodies against human cariogenic bacteria, *S. mutans* and *S. sobrinus*, were produced in bovine colostrum by a vehicle of fermented milk.[21]

It was found that early mucosal colonization with *E. coli* bacteria stimulates the mucosal immune system to produce specific antibodies as well as non-specific secretory immunoglobulins. Regarding both studies, probiotics seems to improve of oral immune response.[52]

In the process of enhancing immunity in humans and animals, dairy products which have probiotic lactobacilli in combination with prebiotics are also being currently developed[30].

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 chemotherapized animals. Chosen probiotic strain reinforces the oral cavity, along with the gastrointestinal tract, as a source for bacterial dissemination [51,53]. The capacity to assess the gut microbiota has expanded dramatically with the advent of molecular techniques. 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. 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

In the present day technology has improved drastically. Very soon, people will be able to go into space to live on the planets like the moon. NASA of USA is carrying out research to develop probiotic products which enable humans live in space [12]. 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. So,It can be rightly said that bacteria might someday keep the dentist away.

13. References

[1] Simon GL, Gorbach SL. Intestinal flora in health and disease. Gastroenterology.1984; 86: 174–193.

[2] Wijnkoop IL, Sanders M E , Cabana MD, Caglar E, Corthier G. Probiotic and Prebiotic Influence Beyond the Intestinal Tract .Nutr Rev.2007; 65 (11):469-489.

[3] Salminen S, Boyley C, Boutron-Ruault M.C, Cummings Jh . Functional food science and gastrointestinal physiology and function. Br J Nutr.1998; 80: 147–171.

[4] Gronlund MM, Arvilommi H, Kero P, Lehtonen OP, Isolauri E . Importance of intestinal colonisation in the maturation of humoral immunity in early infancy: a prospective follow up study of healthy infants aged 0–6 months. Arch Dis Child Fetal Neonatal Ed.2000; 83: 186–192.

[5] Ouwehand A.C, Isolauri E, Kirjavainen PV, Salminen SJ. Adhesion of four Bidobacterium strains to human intestinal mucus from subjects in different age groups. FEMS Microb Lett.1999; 172: 61–64.

[6] Isolauri E, Kirjavainen PV, Salminen SJ. Probiotics-a role in the treatment of intestinal infection and inflammation? Gut.2002; 50(Suppl III): 54–59.

[7] Plinius Secundus Maior G. Naturalis historiae AD. Metchnikoff E. Lactic acid as inhibiting intestinal putrefactions. In: Metchnikoff E, Mitchell PC, editors. The prolongation of life; optimistic studies. London: W. Heinemann,1907; 161–183.

[8] Lilly DM, Stillwell RH. Probiotics: growth-promoting factors produced by microorganisms. Science.1965; 147: 747–748.

[9] Fuller R. Probiotics in man and animals. J Appl Bacteriol.1989; 66: 365–378.

[10] Caglar E, Cilder SK, Ergeneli S, Sandalli N, Twetman S. Salivary mutans streptococci and lactobacilli levels after ingestion of the probiotic bacteriumLactobacillus reuteri ATCC 55739 by straws or tablets. Acta OdontolScand . 2006; 64: 314–318.

[11] Caglar E, Kargul B, Tanboga I . Bacteriotherapy and probiotics' role on oral health. Oral Dis.2005a; 11: 131–137.

[12] Meruman J H, Stamatova I. Probiotics;Contribution To Oral Health. Oral Dis.2007; 13:443-451.

[13] Parker R B. Probiotics, the other half of the antibiotic story. Anim Nutr Health.1974;29:4–8.

[14] Havenaar R, Huis Int Veld MJH. Probiotics: a general view. In: Lactic acid bacteria in health and disease. Vol.1 Amsterdam: Elsevier Applied Science Publishers,1992.

[15] Schaafsma G. State of art concerning probiotic strains in milk products. IDF Nutr News Lett.1996; 5: 23–24.

[16] Naidu AS, Bidlack WR, Clemens RA. Probiotic spectra of lactic acid bacteria (LAB). Crit Rev Food Sci Nutr.1999; 39: 13–126.

[17] Schrezenmeir J, de Vrese M. Probiotics, prebiotics, and synbiotics: approaching a definition. Am J Clin Nutr.2001; 73: 361S–364S.

[18] Teughels W, Van Essche M, Sliepen I& Quirynen M.Probiotics and oral health care; periodontal 2000.2008; 48:111-147.

[19] Corcoran BM, Ross RP, Fitzgerald GF et al. Comparative survival of probiotic lactobacilli spray-dried in the presence of prebiotic substances. J Appl Microbiol.2004; 96: 1024–1039.

[20] Meurman JH. Probiotics: do they have a role in oral medicine and dentistry? Eur J Oral Sci. 2005; 113(3): 188-196.

[21] El-Nezami HS, Polychronaki NN, Ma J et al .Probiotic supplementation reduces a biomarker for increased risk of liver cancer in young men from Southern China. Am J Clin Nutr.2006. 83: 1199–1203.

[22] Mego M, Majek J, Koncekova R et al.Intramucosal bacteria in colon cancer and their elimination by probiotic strain Enterococcus faecium M-74 with organic selenium. Folia Microbiol .2005; 50: 443–447.

[23] Commane D, Hughes R, Shortt C, Rowland I .The potential mechanisms involved in the anti-carcinogenic action of probiotics. Mutat Res. 2005; 11: 276–289.

[24] Brzozowski T, Konturek PC, Mierzwa M et al. Effect of probiotics and triple eradication therapy on the cyclooxygenase (COX)-2 expression, apoptosis, and functional gastric mucosal impairment in Helicobacter pylori-infected Mongolian gerbils. Helicobacter. 2006; 11: 10–20.

[25] Bergonzelli GE, Blum S, Brussow H, Corthesy-Theulaz I .Probiotics as a treatment strategy for gastrointestinal diseases? Digestion. 2005; 72: 57–68.

[26] Reid G, Bruce AW, Fraser N, Heinemann C, Owen J, Henning B.Oral probiotics can resolve urogenital infections. FEMS Immunol Med Microbiol .2001; 30: 49–52.

[27] Falagas ME, Betsi GI, Tokas T, Athanasiou S. Probiotics for prevention of recurrent urinary tract infections in women: a review of the evidence from microbiological and clinical studies. Drugs.2006; 66: 1253–1261.

[28] Christensen HR, Larsen CN, Kaestel P et al .Immunomodulating potential of supplementation with probiotics: a dose-response study in healthy young adults. FEMS Immunol Med Microbiol.2006; 47: 380–390.

[29] Rinne M, Kalliomaki M, Arvilommi H, Salminen S, Isolauri E . Effect of probiotics and breastfeeding on the bifidobacterium and lactobacillus/enterococcus microbiota and humoral immune responses. J Pediatr.2005; 147: 186–191.

[30] Olivares M, Diaz-Ropero MP, Martin R, Rodriguez JM, XausJ .Antimicrobial potential of four Lactobacillus strains isolated from breast milk. J Appl Microbiol. 2006; 101:72–79.

[31] Hutt P, Shchepetova J, Loivukene K, Kullisaar T, Mikelsaar M .Antagonistic activity of probiotic lactobacilli and bifidobacteria against entero- and uropathogens. J Appl Microbiol .2006; 100: 1324–1332.

[32] Aihara K, Kajimoto O, Hirata H, Takahashi R, Nakamura Y. Effect of powdered fermented milk with Lactobacillus helveticus on subjects with high-normal blood pressure or mild hypertension. J Am Coll Nutr .2005; 24: 257–265.

[33] Jauhiainen T, Vapaatalo H, Poussa T, Kyronpalo S, Rasmussen M, Korpela R .Lactobacillus helveticus fermented milk lowers blood pressure in hypertensive subjects in 24-hambulatory blood pressure measurement. Am J Hypertens. 2005; 18: 1600–1605.

[34] Burton JP, Wescombe PA, Moore CJ, Chilcott CN, Tagg JR .Safety assessment of the oral cavity probiotic Streptococcus salivarius K12. Appl Environ Microbiol.2006a; 72:3050–3053.

[35] Hatakka K, Ahola AJ, Yli-Knuuttila H, Richardson M, Poussa T, Meurman JK .Probiotics reduce the prevalence of oral Candida in the elderly – a randomized controlled trial. J Dent Res .2007; 86: 125–130.

[36] Haukioja A, Yli-Knuuttila H, Liomaranta V et al. Oral adhesion and survival of probiotic and other lactobacilli and bifidobacteria in vitro. Oral Micorbiol Immunol .2006a; 21:326–332.

[37] Haukioja A, Loimarant V, Tenovuo J. Effect of lactobacilli and bifidobacterium on streptococcal adherence. IADR Congress, Dublin. 13–16 September 2006 b; (Abstract 0702).

[38] Kang MS, Na HS, Oh LS. Coaggregation ability of Weissella cibaria isolates with Fusobacterium nucleatum and their adhesiveness to epithelial cells. FEMS Microbiol Lett .2005; 253: 323–329.

[39] Kang M-S, Kim B-G, Lee H-C, Oh J-S. Inhibitory effect of Weissella cibaria isolates on the production of volatile sulphur compounds. J Clin Periodontol. 2006; 33: 226–232.

[40] Lima LM, Motisuki C, Spolidorio DM, Santos-Pintol L. In vitro evaluation of probiotics microorganisms adhesion to an artificial caries model. Eur J Clin Nutr. 2005; 59:884–886.

[41] Montalto M, Vastola M, Marigo L et al. Probiotics treatment increases salivary counts of lactobacilli: a double-blind, randomized, controlled study. Digestion. 2004; 69:53–56.

[42] Yli-Knuuttila H, Sna¨ ll J, Kari K, Meurman JH. Colonization of Lactobacillus rhamnosus GG in the oral cavity. Oral Microbiol Immunol .2006; 21: 129–131.

[43] Busscher HJ, Mulder AF, van der Mei CH. In vitro adhesion to enamel and in vivo colonization of tooth surfaces by lactobacilli from a bio-yogurt. Caries Res .1999; 33: 403–404.

[44] Von Bultzingslowen I, Adlerberth I, Wold AE et al. Oral and intestinal microflora in 5-fluorouracil treated rats, translocation to cervical and mesenteric lymph nodes and effects of probiotic bacteria. Oral Microbiol Immunol .2003; 18: 278–284.

[45] Burton JP, Chilcott CN, Tagg JR .The rationale and potential for the reduction of oral malodour using Streptococcus salivarius probiotics. Oral Dis.2005; 11 (Suppl. 1): 29–31.

[46] Gibson GR, Beatty EB, Wang X et al .Selective stimulation of bifidobacteria in the human colon by oligofructose and inulin. Gastroenterol.1995; 108: 975–982.

[47] Guigoz Y, Rochat F, Perruisseau-Carrier G et al .Effects of oligosaccharide on the faecal flora and nonspecific immune system in the elderly people. Nutr Res .2002; 22: 13–25.

[48] Zimmer CJ,Gibson GR.An overview of Probiotics ,Prebiotics and Synbiotics in the functional food concept: perspectives and future strategies. Int Dairy J. 1998; 8:473-479.

[49] Vancikova Z, Lodinova-Zadnikova R, Radl J et al .The early postnatal development of salivary antibody and immunoglobulin response in children orally colonized with a nonpathogenic, probiotic strain of E. coli. Folia Microbiol Praha .2003; 48: 281–287.

[50] Von Bultzingslowen I, Adlerberth I, Wold AE et al. Oral and intestinal microflora in 5-fluorouracil treated rats, translocation to cervical and mesenteric lymph nodes and effects of probiotic bacteria. Oral Microbiol Immunol .2003; 18: 278–284.

[51] Grajek W, Olejnik A, Sip A. Probiotics, prebiotics and antioxidants as functional foods. Acta Biochim Pol. 2005; 52:665–671.

[52] Boriello SP, Hammes WP, Holzapfel W et al. Safety of probiotics that contain lactobacilli or bifidobacteria. Clin Infect Dis. 2003; 36: 775–780.

[53] Cannon JP, Lee TA, Bolanos JT, Danzinger LH. Pathogenic relevance of Lactobacillus: a retrospective review of over 200 cases. Eur J Clin Microbiol Infect Dis. 2005; 24: 31–40.

[54] Agarwal E, Bajaj P, Guruprasad C N, Naik S, Pradeep A R. Probiotics: A Novel Step Towards Oral Health. AOSR. 2011; 1(2): 108-115.

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