Journal section: Oral Medicine and Pathology *doi:10.4317/jced.3.e150*
Publication Types: Review

Probiotics. Going on the natural way.

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Received: 09/08/2010
Accepted: 16/01/2011

Sheikh S, Pallagatti S, Kalucha A, Kaur H. Probiotics. Going on the natural way. J Clin Exp Dent. 2011;3(2):e150-4.
http://www.medicinaoral.com/odo/volumenes/v3i2/jcedv3i2p150.pdf

Article Number: 50373 *http://www.medicinaoral.com/odo/indice.htm*

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Abstract

Science is providing us the tools to diagnose and treat the infection before it causes damage. For some decades now, bacteria known as probiotics have been added to various foods because of their beneficial effects for human health. It comprises knowledge of the relationship between diet and health and the effects of food ingredients on physiological functions and health. Probiotics are commonly consumed as part of fermented foods with specially added active live cultures; such as in yogurt or as dietary supplements. The potential application of probiotics for oral health has recently been the focus of attention for various health researchers. The number of products containing probiotics entering the market is increasing. These products usually contain streptococci, lactobacilli or bifidobacteria. The application of probiotic strategies may, in near future provide an end to many infections occurring in oral cavity. This article summarizes the currently available data on the potential benefits of probiotics for oral health and potential risks associated with them.

Key words: *Probiotics, Dental caries, Bifidobacterium.*

Introduction

With the advancements in the field of asepsis increasing by leaps and bounds, various methodologies for controlling microorganisms and their products is the major innovation amongst the scientists worldwide. At the same time, some microorganisms are being deliberately added during processing of foods such as sausages, cheese, yogurt and fermented milk products (1).

In 1907 the Ukrainian-born biologist and Nobel laureate Elie Metchnikoff realized that consumption of Bulgarian yoghurt (which contains lactic acid bacteria) was good for health. Metchnikoff worked at the Pasteur Institute in Paris and had discovered *Lactobacillus bulgaricus*, a strain he later introduced into commercial production of sour-milk products in France and throughout Europe. The concept of probiotics was thus born and a new field of microbiology and was opened (2).

The term probiotics, the antonym of the term antibiotics, was introduced in 1965 by Lilly and Stillwell (3) as substances produced by microorganisms which promote the growth of other microorganisms. Since then various definitions for probiotics have been proposed (Table 1).

Definition	Year with reference
Substances produced by microorganisms that promote the growth of other microorganisms	1965 Lilly & Stillwell (3).
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	2001 Schrezemeir & de Vrese (4).
Live microorganisms that, when administered in adequate amounts, confer a health benefit to the host	2001 WHO/FAO report

Table 1. *Definitions of probiotics*

The term probiotic is a relatively new word meaning 'for life' (4) and it is currently used when referring to bacteria associated with beneficial effects on humans and animals (5). The belief in the beneficial effects of probiotics is based on the knowledge that the intestinal flora can protect humans against infection and that disturbance of this flora can increase susceptibility to infection. The bacteria in yogurt and fermented milk products constitute the most important source of probiotics for humans. The vast majority of probiotic bacteria belong to the genera *Lactobacillus, Bifidobacterium, Propionibacterium* and *Streptococcus* (1).

Several clinical studies have already demonstrated the effectiveness of certain probiotics in the treatment of systemic and infectious diseases but their relationship with oral health had a limited study. The aim of this review is to highlight possible mechanisms of probiotic bacteria in the oral cavity and to summarize observed effects of probiotics with respect to oral health. Also safety concerns and future aspects are briefly discussed.

Mechanism of probiotics

Several mechanisms have been proposed to explain how probiotics work. The general mechanisms of probiotics can be divided into three main categories (6) (Table 2).

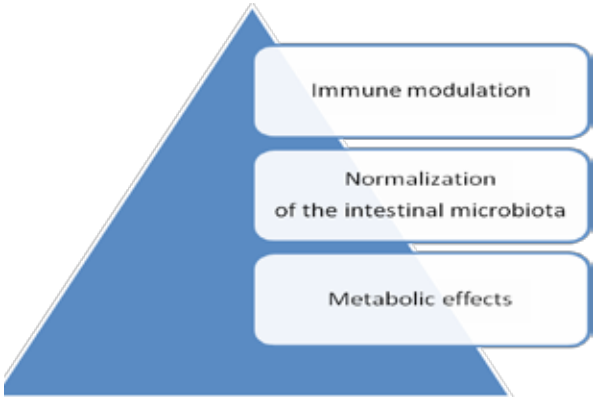

Table 2. *Mechanism of probiotics*

The mechanisms of probiotic action in the oral cavity could be analogous to those described for the intestine. In oral cavity, probiotics tend to create a biofilm, acting as a protective lining for oral tissues against oral diseases. Such a biofilm keeps bacterial pathogens off oral tissues by filling a space which could have served as a niche for pathogens in future; and competing with cariogenic bacteria and periodontal pathogens growth (7).

Probiotics and oral health

Given the widespread emergence of bacterial resistance to antibiotics, the concept of probiotic therapy has been considered for application in oral health. Dental caries, periodontal disease and halitosis are among the oral disorders that have been targeted. An essential condition for a microorganism to represent a probiotic of interest for oral health is its capacity to adhere to and colonize various surfaces of the oral cavity (1).

Lactobacilli constitute about 1% of the cultivable oral microflora in humans. Lactobacilli are extremely aciduric and can withstand a pH as low as 3.5, which is a prerequisite to survive the low-pH transition into the intestines. Bifidobacteria are the predominant anaerobic bacteria naturally occurring within the small intestinal lumen and play a critical role in maintaining the equilibrium among normal (8). The survival of various probiotics used by the dairy industry (specifically, species

of both *Lactobacillus* and *Bifidobacterium*) in saliva and their adherence to oral surfaces was assessed by Haukioja et al. (9). They found that all of the tested strains survived well in saliva, but they varied widely in their capacity to adhere to the surface of teeth and oral mucosa. More specifically, species in the genus *Lactobacillus* had an adherence capacity superior to that of the *Bifidobacterium* species (9).

Probiotics and dental caries

To have a beneficial effect in limiting or preventing dental caries, a probiotic must be able to adhere to dental surfaces and integrate into the bacterial communities making up the dental biofilm. It must also compete with and antagonize the cariogenic bacteria and thus prevent their proliferation (1). Probiotics can reduce the risk for a high *Streptococcus mutans (S. mutans)* level occurrence (10). Çaglar et al. (11), in a comparative study of *S. mutans* reduction effects by several probiotic administration forms, showed a reduced S. mutans level in patients receiving fluid or tablet probiotic forms. In another recent study by Çaglar et al. (12), the effect of xylitol and probiotic chewing gums on salivary *Streptococci mutans* and *Lactobacilli* was evaluated. The study included 80 healthy young adults randomly divided into four study groups: A, probiotic gum group; B, xylitol gum group; C, probiotic + xylitol gum group; and D, placebo gum group. A reduced *S. mutans* level was observed in subjects using probiotics or xylitol enriched chewing gum. However, no synergic effect was seen when combining both agents.

Nikawa et al. (13) reported that consumption of yoghurt containing *Lactobacillus reuteri (L. reuteri)* over a period of 2 weeks reduced the concentration of *S. mutans* in the saliva by up to 80%. Comparable results were obtained by incorporating probiotics into chewing gum or lozenges (1). In a study by Nase et al. (14), they found that children consuming milk containing probiotic, particularly those 3–4 years of age, had significantly fewer dental caries and lower salivary counts of *S. mutans* than controls. These promising results suggest a potentially beneficial application of probiotics for the prevention of dental caries.

Probiotics and Periodontal Disease

There are fewer experimental studies exploring probiotic use in periodontal diseases, partly reflecting a poorer understanding of the precise aetiology of the disease and of the conditions that promote health. From a periodontal view, the effect of probiotics tablets on gingivitis and different grades of periodontitis was studied by Grudianov et al. (15). The treatment of the patients of control group was provided by drug 'Tantum Verde' (7). Probiotics treatment resulted in better microbiota normalization than control group (7, 10).

Twetman et al. (16) used *L. reuteri* containing chewing gum in 42 healthy patients and assessed its effects on crevicular fluid volume, cytokine (interleukin-1β, interleukin-6, interleukin-10, and TNF-α) levels, and bleeding on probing. Crevicular fluid volume, as well as TNF-α and interleukin-8 levels, and bleeding were significantly reduced (10, 16). In a similar study, patients with moderate to severe gingivitis who were given either one of two L. reuteri formulations had reduced plaque and gingivitis scores compared to a placebo group (17). Similarly, the regular (three times daily for eight weeks) intake of tablets containing *Lactobacillus salivarius (L. salivarius*) WB21 resulted in benefits in terms of pocket probing depth and plaque index in individuals at high risk of periodontal disease (smokers) compared to a placebo control group (18). In one recent study published in 2005 (19), the prevalence of lactobacilli, particularly *Lactobacillus gasseri (L. gasseri)* and *Lactobacillus fermentum (L. fermentum),* in the oral cavity was greater among healthy participants than among patients with chronic periodontitis. Riccia et al. (20) studied the anti-inflammatory effects of *Lactobacillus brevis (L. brevis*) in a group of patients with chronic periodontitis. The treatment, which involved sucking on lozenges containing *L. Brevis* over a period of 4 days, led to significant improvements in the targeted clinical parameters (plaque index, gingival index, bleeding on probing) for all patients.

Together, these observations suggest that lactobacilli residing in the oral cavity could play a role in the oral ecological balance. Again, although encouraging results have been observed, most studies have been fairly short. Furthermore, in some studies the observed differences were quite small, though statistically significant.

Probiotics and halitosis

Oral halitosis refers to bad breath originating from the oral cavity. It regularly affects about one in four adults and frequently is caused by bacteria infecting the dorsal surface of the tongue and producing volatile sulfur compounds (VSCs) (21). Although halitosis generally is considered to be an aesthetic problem, it may have implications for systemic health. Increased VSC levels also may play a role in the link between oral infection and systemic diseases such as heart disease and preterm low birth weight. A study by Kang et al. (22) reported the ability of various strains of *Weissella cibaria (W. Cibaria*) to decrease the production of volatile sulphur compounds by *Fusobacterium nucleatum (F. Nucleatum)*. Various probiotic products are marketed for both mouth and gut associated halitosis, although their efficacy demands more clinical studies.

Safety of probiotics

Different strains of same species may possess different

characteristics, necessitating rigorous strain selection before being labelled as probiotic. Some probiotic strains have been in use for many years and have excellent safety records. Most probiotic bacteria are weakly proteolytic and, for example, *Lactobacillus bulgaricus*, was shown to be incapable of degrading some host tissue components. However, there have been some cases of bacteraemia and fungaemia associated with probiotic use, although these have been in subjects who are immunocompromised, or who suffer from chronic disease (23). An individual who had been consuming *Lactobacillus rhamnosus (L. rhamnosus*) in a probiotic preparation developed Lactobacillus endocarditis following dental treatment in finland (24).

Although long-term colonization by probiotic bacteria is unlikely, albeit possible, potential adverse effects of probiotic bacteria in the oral cavity have not been a subject of much intensive research; however, probiotic products are widely in use; therefore, when dental health is considered, the acidogenicity of lactobacilli and bifidobacteria cannot be overlooked. For example, in animal models, a strain of L. salivarius is able to induce caries, and another is able to make a biofilm model more cariogenic (6).

Future directions

Recently, oral lactic acid bacteria and bifidobacteria have been isolated and characterized for various oral health purposes, including caries, periodontal diseases, and halitosis (6). The new probiotic products targeted for oral health purposes do not necessarily comprise the same species as products now in market (6). Genetically modified microbes bring a new dimension to the concept of probiotics. Their main thrush is on reducing the harmful properties of pathogenic strains naturally colonizing the oral cavity. The modified strain could then be used to replace the original pathogen. Also they could be used to enhance the properties of a potentially beneficial strain.

In field of oral immunology, probiotics are being used as passive local immunization vehicles against dental caries (7). Bacteriophages, viruses that kill bacteria, have been detected in oral pathogens, such as *Actinobacillus actinomycetemcomitans*, and they may play a role in the pathogenicity. Subsequently, future studies should be conducted to investigate if phage therapy might be applied for oral and dental diseases in the same way as has been attempted for systemic infections. Furthermore, prebiotic substances, which are nondigestible food ingredients believed to beneficially affect the gut microflora, have already been tested in clinical trials (2). The selection of the best probiotic for oral health is also an issue that calls for further study (2).

Conclusion

Probiotics represent an upcoming field of research in oral medicine, the examination of the close relationships between oral health and our daily diet. It is a natural way of maintaining health and protecting oral tissues from disease, and data suggest that the potential benefits increase with an early childhood start. It still remains to be seen, the extent to which probiotics are applicable to promoting oral health. Although the results of past studies are encouraging, still much needs to be done for identification of the probiotics that are best suited to oral use, as well as the most appropriate vehicles for its delivery.

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