

# Probiotics: An End to Caries?

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## ABSTRACT

Probiotics have been recently introduced in dentistry and is one of the newer approaches in caries management. They have been used successfully for several years mainly for gastrointestinal disorders. Most probiotic strains belong to Lactobacilli or bifidobacteria group. Mechanism of action of probiotics is mainly unknown but may include intermicrobial species interactions and immunostimulatory effects. Randomized controlled trials have shown the inhibitory effect of probiotics against caries. Even though direct recommendations for the use of probiotics cannot yet be given, scientific evidence so far indicates that probiotic therapy may be a reality in dentistry in the future.

**Keywords:** Bifidobacterium, Dental caries, Lactobacillus, Probiotics.

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## INTRODUCTION

Dental caries is as ancient as mankind and has the longest association with the dental profession. It is a disease not yet in our control and with still evolving management approaches. For the past 150 years we have been following the surgical approach of caries management, that is, 'drill and fill', followed by the antimicrobial model, both of which were not highly successful.<sup>2</sup> To overcome the flaws of both these models a probiotic approach was introduced.

The word 'probiotics' derives from two Greek words meaning 'for life.' Probiotics has emerged as a health—

related and commercial target in the last two decades. Endorsed by the Food and Agriculture Organization and the World Health Organization, probiotics are defined as 'live microorganisms which when administered in adequate amounts confer health benefits on the host.'<sup>1</sup>

The hypothesis of positive role of bacteria was first introduced by Ellie Metchnikoff in 1907. He found out that lactic acid bacteria has beneficial effects in human body. The term 'probiotics' was first introduced by Werner Kollat. Most of the species of bacteria with probiotic properties belong to the genera *Lactobacillus* and *Bifidobacterium*. Those bacteria are generally regarded as safe as they can reside in human body without causing any harm.

## Mechanism of Action

Mechanisms of action of probiotic effects include modulation of host immune response leading to strengthening of the resistance to pathogenic challenge, alteration of the composition and metabolic activity of host microbiota at the specific location.

Probiotics should have the following properties to produce the desirable effects needed in the host:

- Adhesion and colonization (at least transitory) of the human body. Adhesion may increase the retention time of a probiotic and place bacteria and host surfaces (body fluids and epithelial cells) in close contact thus facilitating further probiotic activity
- Enhancement of the nonspecific and specific immune response of the host
- Production of antimicrobial substances and competition with pathogens for binding sites.

## Role of Probiotics in Human Health and Diseases

Probiotics has a wide and varied range of clinical applications. They include lactose maldigestion, prevention and treatment of oral infection, dental caries, diarrhea, inflammatory bowel diseases, respiratory tract infections and allergic diseases.<sup>3</sup> They are used in the treatment of irritable bowel syndrome and *Helicobacter pylori* infection.<sup>14</sup> Apart from these applications, the role of probiotics also include antitumor effects, reduction of serum cholesterol and enhancement of vaccine responses.<sup>11</sup>

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## PROBIOTICS AND MOUTH

### Oral Microbiota as a Source of Probiotics

Oral cavity provides the establishment of a great diversity of microbial species. It has been recently estimated that over 1000 bacterial species are present in the oral cavity.<sup>4</sup> Bacteria reside in the mouth either in planktonic/free state or are finely integrated in oral biofilm on various oral surfaces. Oral biofilms are dynamically changing and develop increasingly complex structures as they mature. Bacteria in biofilms differ physiologically from their planktonic counterparts and tend to be much more resistant to environmental factors and antimicrobial agents. Saliva with its flow and with its various proteins having bactericidal and bacteriostatic activity is the essential medium in the mouth contributing to the microbial diversity.

Since probiotic species belong predominantly to the genera *Lactobacillus* and *Bifidobacterium* and because of the presence of 10<sup>3</sup>-10<sup>4</sup> CFU/g lactobacilli found in the oral cavity, there could be some species/strains capable of exerting probiotic properties.<sup>5</sup> Even though conclusive proof is yet to be obtained, some observations show that probiotic properties may indeed exist and reside in the oral cavity.

Adhesion of probiotics to the oral environment is necessary for the action of probiotics to take place. Saliva-mediated aggregation helps in this aspect, that is establishment of the probiotic bacteria in the oral cavity. The beneficial role of probiotics is because of their antagonistic action against pathogens. This is achieved by two mechanisms:

- Competition with pathogens for binding sites
- Production of antimicrobial substances.

Probiotics competing with pathogens for the binding sites are usually of similar strains without the pathogenicity. Production of antimicrobial substances is the more common method for antipathogenicity. These substances include (1) organic acids like lactic acid (2) hydrogen peroxide (3) bacteriocins (4) low molecular weight antimicrobial compound like reuterin (5) other agents like diacetyl, acetaldehyde and ethanol.<sup>7</sup>

Probiotics also has immunotimulatory function. They strengthen the epithelial barrier, initiate immune responses with the presence of ligands for toll like receptors in them. Stimulate interleukin-8 and tumor necrosis factors-alpha (TNF- $\alpha$ ) secretion and has a positive effect on human  $\beta$  defensin secretion by oral epithelial cells.<sup>10</sup> The Flow Chart 1 shows the mechanism of action of probiotic in oral cavity.

### Probiotic Approach to Caries Management

*Streptococcus mutans* is the main causative microorganism in caries development because of its ability to produce

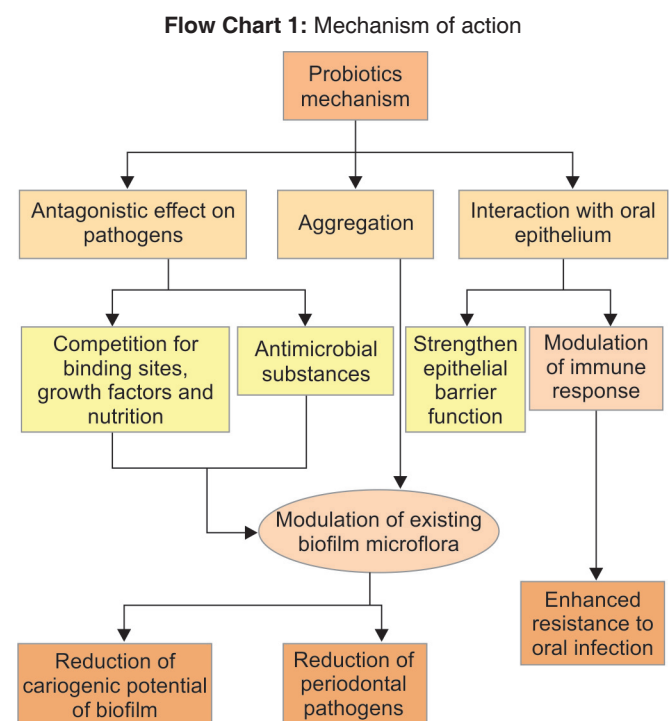
highly branched, water-insoluble glucan, mutan, which facilitates its establishment in the oral biofilm.<sup>13</sup> Its acidogenic properties and rapid metabolism of sucrose, fructose and glucose generates low pH that induce caries. Moreover, elevated salivary counts of *S. mutans* are associated with higher caries risk and disease progression.

Various clinical trials with probiotics like *Lactobacillus rhamnosus*, *Lactobacillus reuteri*, *Bifidobacterium* DN—173010 has shown reduction in *S. mutans* count.<sup>6</sup> This might be because of probiotic bacteria's ability to modify the composition of salivary pellicle by binding and degrading proteins important for bacterial adhesion thereby preventing adhesion of *S. mutans* to the oral biofilm.

A newer probiotic approach is the substitution strategy developed by Hillman et al.<sup>8</sup> They have genetically modified *S. mutans* so that it no longer produces acid and displaces the wild strain of *S. mutans* from the ecological niche. Another method to remove pathogens is to develop targeted antimicrobials. Shi et al are developing targeting molecule which when attached with a killer molecule can eliminate the targeted molecule.<sup>9</sup>

Since lactobacilli themselves can be associated with caries progression, there is safety aspects to be considered. But the present strains commonly used, *L. rhamnosus* and *L. reuteri* does not ferment sucrose to produce acids and hence is relatively safe for prophylaxis.<sup>12</sup>

Proper delivery of probiotics to the target area is very important for which we rely upon vehicles. There are various vehicles available like milk, cheese, yogurt, ice cream, tablets, lozenges, etc.<sup>15</sup> Each of these different vehicles deliver different strains of probiotic bacteria as seen in Table 1.



**Table 1:** Probiotic strains and their vehicles

Probiotic strain	Vehicle of administration	Duration of administration	Clinical effectiveness	References
<i>L. rhamnosus</i> GG	Milk	7 months	Less dental caries and lower <i>S. mutans</i> levels	Nese et al
<i>L. rhamnosus</i> GG L rhamnosus LC705	Cheese	3 weeks	Reduction of levels of <i>S. mutans</i> , caries risk reduction	Ahola et al
<i>Bifidobacterium</i> DN-173 010	Yogurt	2 weeks	Reduction of salivary <i>S. mutans</i>	Çaglar et al
<i>B. lactis</i> Bb-12	Ice cream	10 days	Reduction of salivary <i>S. mutans</i>	Çaglar et al
<i>L. reuteri</i> AICC 55730	Chewing gum	3 weeks	Reduction of salivary <i>S. mutans</i>	Çaglar et al

Apart from caries management other clinical applications of probiotics in relation to oral cavity include as follow:

- Periodontal disease
- Halitosis
- *Candida* infections

## CONCLUSION

The oral cavity with a well maintained balance of the species and species interactions may be a potential source for health-promoting probiotic bacteria. On the other hand, daily intake of probiotic supplements may be used to control common oral and dental infections. The exact molecular mechanisms of the action of probiotics are still unclear. Furthermore, the dosage of probiotic administration in each indication needs to be defined. Even with many doubts a tremendous amount of research is going on in this field. The application of probiotic strategy may, in the not so distant future provide the end of new cavities in treated populations.

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