

# Co-Aggregation of Probiotics in the Dental Biofilm and inhibition of Bacterial Growth in Caries Prevention

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## ABSTRACT

**Introduction:** Probiotics are live microorganisms that are administered in the ideal amounts that generate a balance in the host's natural microbiota, promoting an improvement in dental health without impacting negatively on the microbiota of the oral. **Aim:** Expose the applicability of probiotics and its main mechanism of action in the prevention of the formation of the biofilm bacterial and consequently of the carious lesion, through a review the literature. **Methodology:** The research used electronic databases (PubMed, Bireme, Scielo, Lilacs), in the period 2000 to 2016, with the following descriptors: probiotics, caries dental, mechanism AND biofilms. Were located 62 articles, of which 46 were excluded for not addressing the mechanisms of action of probiotics, resulting in a total of 16 selected articles. **Results:** The mechanism of co-aggregation and growth inhibition consists in the aggregation of probiotics among themselves, triggering different degrees of hydrophobicity, making it difficult the production of the dental biofilm. The action of this mechanism shows promising results for the future when the subject is the use of probiotics in decreasing the incidence of dental caries. **Conclusion:** It is Intended in the future to broaden the forms of presentation and the administration of these probiotics (chewing gums, lozenges, mouth washes will and dairy foods) in the prevention and control of dental caries, especially in children population.

**KEYWORDS:** Probiotics, Dental caries, Mechanism, Biofilm

## INTRODUCTION

Dental caries is the most common chronic childhood disease, but it affects all ages resulting from an ecological imbalance on the tooth surface leading to tooth demineralization.<sup>1</sup> Despite technological advances and the introduction of new prevention initiatives in dentistry, prevalence continues to increase in many populations around the world, leading to large international health expenditures; a wide variety of approaches to its control has been developed and applied, with varying degrees of success.<sup>2</sup>

Dental caries is directly associated with oral biofilm and mainly with *streptococcus mutans*. For this reason, oral biofilm control is important for caries prevention. Recently, the control of the formation of oral biofilms using probiotics has gained considerable space as a preventive strategy of caries.<sup>3</sup>

Conventionally, probiotic is defined by the World Health Organization (WHO) as living microorganisms that when

administered in adequate quantity confer benefits to the health of the host.<sup>4</sup> The use of probiotics promotes an improvement in oral health without negatively impacting the normal oral macrobiotic of the host. A variety of supposed commensal bacteria has been evaluated for its potential to prevent dental caries, this has been popularized or consumption of food containing probiotics such as yogurt, cheese and milk, benefiting health, in addition, as species of *lactobacilli* are known be the most effective in intestinal health for antibacterial production and immune system stimulation.<sup>5</sup>

Probiotics, when they enter the oral cavity, are exposed to saliva, which in addition to their interaction with oral tissues reduces the period of adhesion of probiotics on the dental surface and their interaction with the bacteria that make up the dental biofilm, of its action. Co-aggregation property is one of the ways probiotics inhibit the formation of dental caries by binding pathogenic bacteria already co-aggregated, triggering hydrophobicity tensions

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on the cell surface, providing a better colonization of probiotics and decreasing the action of probiotics pathogens.<sup>6</sup>

Therefore, this study aims to expose the applicability of probiotics and its main mechanism of action in the inhibition of bacterial biofilm formation and consequently of caries lesion, through a literature review.

## METHODOLOGY

The search was done using the main electronic databases of bibliographic cataloging (PubMed, Bireme, Scielo, Lilacs) from December 2000 to September 2016, with the following subject descriptors: probiotics, dental caries, mechanism biofilms, associated or In the English language.

The research of products and services of inclusion has as a presentation the mechanism of action of the proven ones in the process of administration of administration and dental care from December of 2000 to September of 2016, on the other hand, works of literature review to the criterion of exclusion of the research.

## RESULTS

Sixty-two (62) articles were found, of which forty-six (46) were excluded because they did not meet the pre-established criteria for the selection of the works (Table 1), they are: the mechanisms of action of probiotics in the caries inhibition process and year of publication between 2000 and 2016, resulting in a total of sixteen (16) articles selected. Probiotics are composed of several types of species, divided basically into two genera: *Bifidobacterium* and *Lactobacillus*. In addition, there are two other genera that do not interact with these, *Streptococcus thermophilus* and *Escherichia coli*, being used in the therapy of other pathologies.

*Bifidobacterium* and *Lactobacillus* are microorganisms that function as probiotics, these being the most commonly used and reported in the literature. *Lactobacillus* are species of probiotic bacteria used in several dairy products in order to obtain health benefits, besides being used in the maintenance of the oral cavity for the inhibition of biofilm formation. In vitro investigations on adhesion have demonstrated that the production of bacteria by the mechanism of coaggregation and inhibition of growth, in addition to metabolic activity, suggest a fundamental role of probiotics, such as *Bifidobacterium* and *Lactobacillus*, which act in the modulation and microbial ecology of the dental biofilm, But also in the intestine and vaginal wounds.

Both are able to stimulate the immune system through commensal strains of the intestine, being essential for the regulation of the immune system and the tolerance of a large amount of antigen within the intestine, disorders in the microbiota may result in changes in immune regulation. In view of the high caries rates in the general population, it is necessary to seek new ways to prevent

this disease, in this context supplementation with the use of probiotics is a beneficial strategy. The introduction of probiotics into the microbiota of the oral cavity favors mechanisms that inhibit the aggregation of the dental biofilm.

Among the diverse species of microorganisms as probes, some strains had the capacity to interact with the medium always the imbalance. *Streptococcus salivarius* strain M18 presents viable characteristics such as: absence of determinant virulence, ability to colonize and ability to displace bacteria by competition. *Streptococcus salivarius* has the ability to express bacteriocins that act by inhibiting a cariogenic action of *Streptococcus mutans*, the main microorganism related to the progression of caries lesions.

As the species of microorganisms as you would prove, some strains had the capacity to interact with the buccal environment without causing imbalance, among them to find *Lactobacillus* species of casei, rhamnosus, acidophyllus, salivarius and *Streptococcus salivarius*. These species act in the cariogenic process inhibiting an action of bacteria responsible for biofilm formation.

*Lactobacillus* also has a characteristic of modulating the immune response in living tissues, favoring a release of antibacterial and anti-inflammatory substances by the same, presenting as an indication of use against the periodontopathies, where a response of the affected periodontal tissues is primordial for an evolution of the sickness. At first, probiotics in the presence of saliva need to be able to resist the environmental factors present in the oral cavity, since salivary proteins, for example, may affect the viability or morphology of the probiotic cell surface, compromising adhesion to metabolic activity.

The probiotic of the genus *Lactobacillus* showed positive results in in vitro studies demonstrating varied degrees of hydrophobicity, making it difficult to biofilm and an acidic environment through *Streptococcus mutans*, that is, probiotics can inhibit a pathogenic bacterial environment through competition of the binding of the bacteria in host tissues and also by the competition of nutrients, since they use nutrients in common with the pathogens, reducing the production of acid. The contact of the probiotic bacteria with the oral epithelium can induce the secretion of IL-8 and TNF- $\alpha$ , besides increasing the amount of antibodies and the action of the macrophages, being this one of the forms of the probiotics to act against the formation of the caries process.

## DISCUSSION

Probiotics have several functions when they are present in the body; they act in the allergic process altering the structure of antigens, reducing their immunogenicity. They decrease tissue permeability and inhibit the release of proinflammatory agents from the immune response, stimulate the release of anti-inflammatory cytokines and bone remodeling factors linked to the synthesis of vitamins D, C and K, which participate in the metabolism

Author / year	Published Article	Type of study	Synthesis
Bagramian RA et al., 2009 <sup>1</sup>	American Journal of Dentistry	Epidemiological study	Prevalence of dental caries in children and adults, deciduous and permanent teeth, signaling a crisis in public health.
Takahashi N e Nyvad B, 2011 <sup>2</sup>	Journal of Dental Research	Analytical Study	<i>Streptococci mutans</i> , <i>Actinomyces</i> , <i>bifidobacteria</i> , and yeasts may become dominant in acidic strains of <i>Streptococci non-mutans</i> , such as <i>Streptococci mutans</i> and <i>Lactobacilli</i> , and may be involved in caries.
Lee SH et al., 2012 <sup>3</sup>	Archives of Oral Biology	Experimental	Xylitol has been used as a viable substitute for carbohydrate to inhibit the production of <i>S. mutans</i> acid.
Gill H e Prasad J, 2008 <sup>4</sup>	Advances in Experimental Medicine and Biology	Analytical Study	The effectiveness of probiotics against bacterial infections and immune disorders, such as asthma, cancer, diabetes and arthritis in humans continues to be proven.
Koll P et al., 2008 <sup>5</sup>	Oral Microbiology and Immunology	Experimental	Strains of <i>L. plantarum</i> , <i>Lactobacillus paracasei</i> , <i>Lactobacillus salivarius</i> and <i>Lactobacillus rhamnosus</i> expressed high antimicrobial activity, in addition to tolerance to environmental stress, suggest a potential for oral lactobacilli to be used as probiotics for oral health.
Burton JP et al., 2013 <sup>6</sup>	Journal of Medical Microbiology	Randomized (double-blind) placebo-controlled.	The probiotic <i>Streptococcus salivarius</i> strain M18 offers beneficial potential for oral health, as it produces bacteriocins targeting cariogenic species, <i>Streptococcus mutans</i> , as well as enzymes like dextranase and urease, which help reduce plaque buildup and acidification.
Forestier C et al., 2001 <sup>7</sup>	Research in Microbiology	Clinical Trial	Anti-bacterial activity of the cell-free Lcr35 were examined against nine human pathogenic bacteria: <i>EPEC</i> , <i>EPEC</i> , <i>K. pneumoniae</i> , <i>Shigella flexneri</i> , <i>Salmonella typhimurium</i> , <i>Enterobacter cloacae</i> , <i>Pseudomonas aeruginosa</i> , <i>Enterococcus faecalis</i> and <i>Clostridium difficile</i> , showing inhibited growth of all strains.
Botes M et al., 2008 <sup>8</sup>	Archives of Microbiology	Clinical Trial	<i>Enterococcus</i> and <i>Lactobacillus plantarum</i> mundtii ST4SA 423 to Caco-2 cells showed good adhesion to MB1 <i>L. casei</i> in comparison, <i>L. casei</i> Shirota, <i>L. johnsonii</i> and <i>L. rhamnosus</i> GG. No correlation was found between hydrophobicity, aggregation, and adhesion to Caco-2 cells.
Caglar E et al., 2005 <sup>9</sup>	Acta Odontologica Scandinavica	Double-blind, randomized crossover study.	<i>Bifidobacteria</i> Probiotics in yogurt may reduce the levels of microorganisms associated with caries in saliva.
Nase L et al., 2001 <sup>10</sup>	Caries Research	Randomized, double-blind, placebo-controlled intervention study.	Milk containing probiotic <i>LGG bacteria</i> may have beneficial effects on children's dental health.
Vuotto C et al., 2014 <sup>11</sup>	International Journal of Oral Science	Epidemiological study	Evidence for its effect in the prevention and treatment of diseases, including oral diseases, such as dental caries, periodontal diseases, as well as genitourinary and wound infections.
Ahmed A et al., 2014 <sup>12</sup>	Pakistan Journal of Pharmaceutical Sciences	Observational Study	Probiotic species of <i>Lactobacillus</i> can be used as an alternative instead of antibiotics to decrease the chance of dental caries, reducing the counting of <i>S. mutans</i> and its gene expression to maintain good oral health.
Lee SH e Kim YJ, 2014 <sup>13</sup>	Archives of Microbiology	Clinical trial	<i>L. rhamnosus</i> can inhibit oral biofilm formation by decreasing the glucan production of <i>S. mutans</i> .
Baca-Castañón ML et al., 2015 <sup>14</sup>	Probiotics and Antimicrobial Proteins	In vitro study	<i>L. reuteri</i> was shown to have an inhibitory effect against <i>S. mutans</i> , followed by <i>T. forsythia</i> and <i>S. gordonii</i> , and a less significant effect against <i>A. naeslundii</i> .
Wu CC et al., 2014 <sup>15</sup>	Molecular Oral Microbiology	Experimental study (in situ)	<i>L. salivarius</i> , K35 and K43 strains significantly inhibited <i>S. mutans</i> biofilm formation with more pronounced inhibitory activities than <i>Lactobacillus rhamnosus</i> GG (LGG), a prototypic probiotic showing anti-caries activity.
Majstorovi M et al., 2012 <sup>16</sup>	Collegium Antropologicum	Observational Study	Significant efficacy of the tested toothpaste, which can be attributed to the effect of the synthesized probiotic substance contained.

Table 1. Results presented by the author's approaches

of calcium, an important mineral the formation of the bone matrix.<sup>7-9</sup>

The anti-streptococcal action of *S. salivarius* is characterized by the production of the enzymes Dextranase and Urfique that reduce the aggregation and acidification of the placa bacteriana inhibiting an activity of *S. mutans* and the liberation of glucan by the same, thus preventing a process of biofilm production. Dental structure demineralization process.<sup>10-12</sup>

Other species of probiotics show positive action on the processes of caries establishment is the *Lactobacillus* of the species, *casei*, *rhamnosus*, *Acidophilus salivarius*. These present the ability to release bacteriocins, antibacterial substances active against *Streptococcus mutans*, inhibiting their growth and adhesion to the dental biofilm, as well as, the decrease of the oral Ph, neutralizing their action in bacterial plaque colonization.<sup>13,14</sup>

*Lactobacillus* contributes to the balance of the oral microflora through mechanisms of competition and inhibition of the activity of cariogenic bacteria. They restore adequate Ph levels; some do not integrate the dental biofilm, inhibit growth and an expression of virulence genes by *S. mutans*, as exopolysaccharides of the glucan type that is related to the demineralization of the hard tissues.<sup>15,16</sup>

## CONCLUSION

It can be concluded from this study that Dental caries occupies a level among the most prevalent diseases, in children, adults and the elderly, it is necessary to use all possible means that are effective in controlling and preventing its development. According to the literature, probiotics work well in this context, since they interfere in the aggregation of the pathogenic, as well as the obtaining of the nutrients by the competition, that they

need to ferment, being the acid of this process the promoter of surface demineralization enamel and causing the disease. In view of the high caries rates in the general population, it is necessary to seek new ways of preventing this disease, in this context supplementation with the use of probiotics is a beneficial strategy. The introduction of probiotics into the microbiota of the oral cavity favors mechanisms that inhibit the aggregation of the dental biofilm.

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