The Role of Probiotic in Oral Biofilm

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Abstract:

Dental plaque, a biofilm composed of various bacterial colonies, exists on the tooth surface. The balance of the surrounding environment is disrupted through a change in the composition of the bacterial community when homestasis of dental plaque is disrupted. Probiotics refer to microorganisms that confer health benefits to hosts when administered in adequate amounts. Probiotics can release bioactive substances that can inhibit the growth and biofilm formation of pathogenic microorganisms such as Streptococcus mutans.

The aim of this trial was to detect probiotic bacteria from probiotics in dental biofilm and saliva during and after intake. The article was conducted of PubMed database and were limited to period January 2019 to November 2023 with combination of the following keywords: “role” and “probiotic” and “oral” and “biofilm”. The results obtained were 41 articles found at the beginning of the search in pubmed databases, and the 7 full text articles were selected for further review and discussion.

The potential inhibitory activity probiotic strains on the growth of S. mutans were Lactococcus lactis, L. salivarius, Lactobacillus fermentum, Lactobacillus casei, Lactobacillus plantarum, and Lactobacillus reuteri. The other probiotic, W. cibaria and B. lactis HN019 are a beneficial oral probiotic that improves oral health. The mechanism of action of probiotics in oral health is an imbalance in the composition of the microbiota, known as dysbiosis. This dysbiosis is associated with increased permeability and disruption of the epithelial barrier, leading to inflammation and chronic inflammatory pathologies.

Keywords: Oral biofilm, probiotic, role.

Introduction

The oral cavity is one of the most populated organs for bacteria. Dental plaque, a biofilm composed of various bacterial colonies, exists on the tooth surface. When homestasis of dental plaque is disrupted, the balance of the surrounding environment is also disrupted through a change in the composition of the bacterial community. It leads to pathological conditions that can cause oral disease such as dental caries and periodontal disease. Dental caries is caused by organic acids produced by
microorganisms, the acidogenic potential of all those microorganisms in plaque is important to evaluate (Könönen, Gursoy and Gursoy, 2019). Probiotics refers to microorganisms that confer health benefits to hosts when administered in adequate amounts. A true probiotic should preferably be of human origin, safe, and free of vectors that are able to transfer resistance to antibiotics and of pathogenicity or toxicity factors. A probiotic should exhibit antagonism against pathogens and stimulation of the immune system and, ultimately, must have demonstrable beneficial effects on the host.

Mechanisms of action of probiotic are: colonization and normalization of perturbed intestinal microbial communities in children and adults; competitive exclusion of pathogens and bacteriocin production; enzymatic activity and production of volatile fatty acids; cell adhesion, cell antagonism, and mucin production; modulation of the immune system; and interaction with the brain-gut axis. (Plaza-Diaz et al., 2019)

The role of probiotics in the prevention of health problems, including digestive disorders such as diarrhea caused by infections, antibiotic-associated diarrhea, irritable bowel syndrome (IBS), Clostridium difficile-associated diarrhea in adults and children, inflammatory bowel disease (IBD), only in ulcerative colitis, and allergic disorders such as atopic dermatitis (eczema) and allergic rhinitis. Probiotics can release bioactive substances that can inhibit the growth and biofilm formation of pathogenic microorganisms such as Streptococcus mutans. The supernatants of Lactobacillus strains isolated from caries-free subjects can inhibit S. mutans, one of the most important bacteria for dental caries. The supernatants of Lactobacillus strains were screened for antibacterial activity against S. mutans in planktonic cultures. (Rossoni et al., 2018)

Dental caries is induced by oral biofilm containing Streptococcus mutans. Some strains of genera Lactobacillus and Bifidobacterium have been widely used as probiotics in several foods and dietary supplements to improve gastrointestinal health. However, little is known about the effects of these strains on common oral infections, such as dental caries. Previous studies suggested that consumption of dietary products containing probiotic lactobacilli reduces the number of Streptococcus mutans cells in saliva. Mechanisms of probiotic bacteria, such as their ability to integrate into dental biofilms resulting in displacement of other oral cavity bacteria, remain postulations and have only been shown in vitro. (Arweiler et al., 2020) Probiotics ability to integrate into dental biofilm is not yet clarified. The aim of this trial was to detect probiotic bacteria from probiotics in dental biofilm and saliva during and after intake.

**Methods**

This study is a descriptive and qualitative literature review. The literature review text was structured according to the PRISMA items. This review was conducted in October-November 2023. The inclusion criteria of studies that included in this review were articles in English and published in 2019-2023. Articles that were not available in full text, review articles, articles from conference proceedings or book sections, and animal studies were excluded. Research articles were searched using electronic databases such as Pubmed. The combination of keywords used were (“Role”), AND (“Probiotic”), AND (“oral biofilm”). The selection of studies was following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) protocols.

**Results**

The article selection (41 articles) were selected from PubMed. After reviewing titles and abstracts, 38 articles were excluded as they were not related to the review topic. 7 articles were selected as they were related with the topic.
Table 1. The Results of Data Extraction

<table>
<thead>
<tr>
<th>Authors</th>
<th>Study Setting</th>
<th>Target Population</th>
<th>Study Design</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arweiler NB et al., (2020)</td>
<td>Philipps University Marburg, Germany</td>
<td>35 subjects</td>
<td>Clinical in situ study</td>
<td>Probiotic bacteria from all products were not able to integrate or persist in dental biofilm and saliva, but they did influence the growth of streptococci in biofilm.</td>
</tr>
<tr>
<td>Chen Z et al., (2020)</td>
<td>Berlin</td>
<td>21/group</td>
<td>Experimental</td>
<td>Biofilm architecture was not considerably affected by probiotic applications. Viable probiotics L. reuteri and S. oligofermentans, but not their culture supernatants, could reduce the caries activity of multi-species biofilms in vitro.</td>
</tr>
<tr>
<td>Kang SM et al., (2021)</td>
<td>Basel, Switzerland</td>
<td>92 adults aged 20 years or older</td>
<td>A randomized double-blind, placebo controlled trial</td>
<td>The intake of the W. cibaria CMU tablets eliminated the risk of developing dental caries from acid production in the oral flora because the W. cibaria colonizes and lives in the dental plaque and the oral cavity and suppresses acids.</td>
</tr>
<tr>
<td>Jung JI et al., (2021)</td>
<td>Seoul, Korea</td>
<td>Eight probiotic strains</td>
<td>Experimental</td>
<td>SCS of L. salivarius MG4265 has great potential as a multifunctional oral health ingredient that inhibit biofilm formation and suppresses the alveolar bone loss that is associated with periodontitis.</td>
</tr>
<tr>
<td>Gu M et al., (2022)</td>
<td>Republic Korea</td>
<td>S. mutans biofilm formation</td>
<td>Experimental</td>
<td>Lactic acid bacteria that inhibit streptococcal biofilm from the oral cavity of infants and identified two novel compounds from supernatant of their culture broth.</td>
</tr>
<tr>
<td>Araujo LDC et al., (2022)</td>
<td>Basel, Switzerland</td>
<td>1 strain bacteria (B. lactis)</td>
<td>Experimental</td>
<td>The probiotic strain B. lactis HN019 has been shown to play a role in modulating the immunoinflammatory response of the human organism, including promoting oral health benefits, when administered in adequate does.</td>
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</table>

Discussion

The potential inhibitory activity probiotic strains on the growth of S. mutans were Lactococcus lactis MG5125 and L. salivarius MG4265 (the highest inhibitory activity), Lactobacillus fermentum MG901 (lower inhibitory effect), Lactobacillus salivarius, Lactobacillus casei, Lactobacillus plantarum, and Lactobacillus reuteri (significant reduction in the growth S. mutans as determined at 600 nm but no difference among the samples). These results suggest that the tested probiotic strains produced metabolites or extracellular components that have an ability to inhibit growth of S. mutans (Jung et al., 2021).

Lactobacilli produce various secondary metabolites that have been characterized as antibacterial substances, such as organic acids (primarily acetic acid and lactic acid), peptides (biosurfactant and bacteriocins), and hydrogen peroxide. L.lactis MG5125, L. salivarius MG4265, Lactobacillus casei MG311, and Lactobacillus rhamnosus MG316 supernatants showed a
stronger reducing activity on the S. mutans induced biofilm than other SCS (Lin et al., 2017).

L. plantarum demonstrated superior inhibition on the growth of C. albicans and S. mutans, disruption of virulent biofilm structure with reduced EPS (extracellular polymeric substances), and virulent microcolony formation. Future assessment of using L. plantarum 14917 as a novel caries prevention strategy in animal and clinical studies.(Zeng et al., 2022)

Probiotics have been demonstrated as a potentially useful agent for the prevention or treatment of oral diseases. L. reuteri tended to show superior anti-caries potential compared with S. oligofermentans, while the supernatants exerted no evident beneficial effects. L. reuteri and S. oligofermentans were able to constantly neutralize acid products via the ADS route and slow down the caries process. In the supernatant groups, without the persistent participation of active probiotic bacteria, biofilms had no opportunity to reverse the disadvantages pH milieu and hence remained in a pathologically metabolic pattern. The addition of probiotic microorganisms could prevent further ecological shifts toward disease and improve biofilm resilience. Probiotic could offer a chance to reconstruct a host-compatible community, while for healthy ones, to maintain health status and improve the resilience of the ecosystem (Chen et al., 2020).

There was insufficient evidence for recommending probiotics for managing dental caries and refer to only short-term studies or parameters with limited value for the caries process. Cariogenicity of lactobacilli, as in their biofilm model they found significant mineral loss in dentin cavities caused by L. rhamnosus GG during sucrose supply concurrent with a lack of S. mutans inhibition. Changes in biofilm thickness under the influence of probiotics have not been examined and are therefore not comparable. Significant reductions in biofilm thickness were only found in the group (E. faecalis). Probiotic bacteria (Lactobacillus casei, Lactobacillus rhamnosus, Enterococcus faecalis) were not able to integrate or persist in dental biofilm and saliva, but they did influence the growth of streptococci in biofilm (Arweiler et al., 2020).

The bacteria that produced a lot of lactic acid are not good for oral health because they can cause tooth decay. Jang et al reported that W. cibaria had the lowest risk of dental caries because its PAV (production of acid value) was higher than that other oral probiotics, such as Lactobacillus salivarius, Lactobacillus reuteri, and Streptococcus salivarius. W. cibaria is a beneficial oral probiotic that improves oral health. This bacteria an oral probiotic, was proven safe to consume since the Cariview test showed that there was no risk of caries activity (Kang et al., 2021).

The mechanism of action of probiotics in oral health is an imbalance in the composition of the microbiota, known as dysbiosis. Dysbiosis can cause changes to and negatively impact the oral cavity. This dysbiosis can be caused by a loss of beneficial microorganisms and an increase in pathogens, as well as by the loss of microbial diversity. This dysbiosis is associated with increased permeability and disruption of the epithelial barrier, leading to inflammation and chronic inflammatory pathologies (Homayouni Rad, Pourjafar and Mirzakhami, 2023). The probiotic strain B. lactis HN019 has been shown to play a role in modulating the immunoinflammatory response of the human organism, including promoting oral health benefits, when administered in adequate doses (Araujo et al., 2022).

Conclusion

The potential inhibitory activity probiotic strains on the growth of S. mutans were Lactococcus lactis, L. salivarius, Lactobacillus fermentum, Lactobacillus casei, Lactobacillus plantarum, and Lactobacillus reuteri. The other probiotic, W. cibaria and B. lactis HN019 are a beneficial oral probiotic that improves oral health. The mechanism of action of probiotics in oral health is an imbalance in the composition of the microbiota, known as dysbiosis. This dysbiosis is associated with increased permeability and disruption of the epithelial barrier, leading to inflammation and chronic inflammatory pathologies.
Conflict of Interests
No conflict of interest.

References


