

## Bacteria Causing Dental Caries and Their Pathogenesis

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**Abstract:** Caries is one of the most common and serious types of damage to dental tissues and is recognized as a global health problem. Caries is an infectious process caused by the activity of microorganisms in the oral cavity, with the main stages of its development being the demineralization of tooth enamel and the destruction of the dentin layer. The most important pathogens involved in the development of caries are bacteria such as *Streptococcus mutans*, *Lactobacillus* spp., *Actinomyces* spp., and *Bifidobacterium* spp., which have been found to proliferate.[1].

**Keywords:** Dental caries, caries pathogenesis, enamel demineralization, microbial biofilm, *Streptococcus mutans*, acidogenic bacteria, fermentation, demineralization and remineralization, carbohydrate fermentation, low pH.

These microorganisms adhere to the tooth surface in the oral cavity and form a biofilm (dental plaque).[2] Bacteria nourished by sugary products produce organic acids (especially lactate). As demineralization progresses, microscopic cracks appear in the enamel layer, followed by visible holes (cavities). If this process is not stopped in time, caries can progress to the dentin and even the dental pulp, leading to severe complications. A thorough study of caries pathogenesis, especially understanding the biology of the causative microorganisms, their acidic metabolism, and mechanisms of biofilm formation, is of great importance for developing effective treatment and preventive measures.

**Materials and Methods:** The study aimed to identify microorganisms causing dental caries in the oral cavity, evaluate their pathogenic characteristics, and analyze their acid-producing potential. The research was conducted using an experimental-clinical method. A total of 60 patients aged 18–45 years participated in the study.[4] Based on dental examinations, they were divided into two groups:

Group 1 (30 patients): Initial stage of caries (changes on the enamel surface, white spots, cracks).

Group 2 (30 patients): Moderate and deep caries (dentin damage, presence of cavitation).

1. Biofilm (dental plaque) from the tooth surface was collected using sterile cotton swabs and placed in sterile transport media (thioglycollate broth or Amies medium).

2. Identification of bacteria: The Gram staining method was used to determine the Gram-positive or Gram-negative nature and morphology of the bacteria. Specifically, bacteria suspected to be associated with caries such as *Streptococcus mutans*, *Lactobacillus* spp., and *Actinomyces* spp. were isolated by incubation under anaerobic conditions (at 37°C for 48 hours in anaerobic jars).

3. Acid production potential: The pH level in the medium containing bacterial cultures was measured using an electronic pH meter. The acid-producing ability was used as a key indicator to assess the cariogenic potential of the bacteria. A decrease in pH indicated the risk of enamel demineralization by the bacteria.

**Research Results:** The study identified *Streptococcus mutans* and *Lactobacillus* species as the primary causative agents of dental caries. *Streptococcus mutans* is a Gram-positive, chain-forming coccus bacterium that forms dental plaque (biofilm) in the oral cavity. This bacterium ferments sucrose and other carbohydrates to produce lactic acid, which dissolves calcium and phosphate compounds in tooth enamel. The study showed that *Streptococcus mutans* can lower the pH to as low as 5.5, initiating the demineralization process. *Lactobacillus* species are active in the advanced stages of caries, accelerating the destruction of the dentin layer. They proliferate under anaerobic conditions and remain stable in acidic environments. The pathogenic properties of these bacteria are related to their adhesion to the tooth surface, biofilm formation, and acid production.

The stages of caries development are classified as follows:

1. Initial demineralization (white spot stage): Lactic acid produced by *Streptococcus mutans* dissolves mineral compounds in the enamel. At this stage, white, opaque spots appear on the tooth surface, but the tooth structure is not yet damaged. There is no pain at this stage, and the process is reversible.
2. Enamel caries (surface damage): Continuous acid exposure erodes the enamel layer, leading to the formation of surface cavities. Tooth sensitivity may increase, but the dentin remains intact.
3. Dentin caries (moderate damage): Bacteria penetrate through the enamel to reach the dentin layer. Since dentin is softer, caries spread rapidly. Sensitivity and pain in response to hot, cold, or sweet foods occur at this stage.
4. Deep caries (pulp damage): Caries reach the dental pulp, causing inflammation (pulpitis) or necrosis of internal tooth tissues. Severe pain and complications such as root inflammation are observed at this stage.

The study also identified the role of dietary habits in caries development. High consumption of sugary products increases the activity of *Streptococcus mutans*, accelerating acid production.[3] Poor oral hygiene, especially irregular removal of dental plaque, promotes biofilm formation. According to the study results, 82% of patients consumed sugary drinks at least twice a day, contributing to the rapid progression of caries. Antibiotic resistance of bacteria was also observed, complicating treatment. For example, forms of *Streptococcus mutans* located within the biofilm showed resistance to penicillin-group antibiotics.

**Conclusion:** Bacteria causing dental caries, particularly *Streptococcus mutans* and *Lactobacillus* species, play a key role in the destruction of dental tissues. Their pathogenic features are associated with acid production and biofilm formation, processes that begin with enamel demineralization and progress to deep tissue damage. The stages of caries development — demineralization, enamel, dentin, and pulp damage — demonstrate the complex pathogenesis of the disease. Regarding preventive measures, strict oral hygiene, reduction of sugary products, use of fluoride toothpastes, and regular dental check-ups are essential. Additionally, the development of new antibacterial agents and technologies targeting biofilm removal may offer effective solutions for caries treatment and prevention in the future.

#### References:

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