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Evaluating the effectiveness of coconut oil (*Cocus nucifera*) anti-bacterial benefits in caries prevention: A literature review

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Abstract

Background: Caries is the damage to the hard tooth tissue, which is enamel and dentine due to bacteria, with one of them being *Streptococcus mutans*. Caries is the most widespread non-infectious disease, with 2 billion people in the world suffering from permanent tooth caries and 514 million children suffering from primary tooth caries. The abundance of natural resources in Indonesia can be used as a way to prevent caries, such as using coconut oil which is known to have antibacterial benefits.

Method: Analysis of several scientific findings and research with publication limitation over the last 5 years, recorded after January 1st, 2018.

Results: Based on the results of analysis from several studies, coconut oil is proven to contain lauric acid which can be converted into monolaurin which is an active antibacterial agent. Monolaurin will cover the surface of the bacterial cell wall (peptidoglycan) and penetrate so that metabolism and cell permeability are disrupted and ultimately the cell lysis and cell death occurs. Studies show the effect of coconut oil on the incubation of bacteria that successfully inhibit colonization.

Conclusion: It is proven that the content of coconut oil can effectively prevent the growth of the bacteria causing caries. Coconut oil has the potential to be an important step in preventing caries in the future.

Keywords: Anti-bacteria; Coconut oil; Dental caries; *Streptococcus mutans*

1. Introduction

Our world is currently facing a serious issue in the field of dental and oral diseases. More than a third of the world's population suffer from dental caries. Dental caries itself is the most widespread non-communicable disease and is also one of the major health problems for communities worldwide. According to a report from the World Health Organization (WHO) in 2022, it is estimated that around 2 billion people worldwide suffer from permanent dental caries, while 514 million children suffer from primary dental caries [1].

Caries has significant impacts on daily life, such as weight loss and disrupted child growth, difficulty chewing, difficulty sleeping, and decreased work or school performance [2,3]. Considering the magnitude of dental caries cases and the resulting impacts, have we ever considered whether there are natural materials readily available around us that could play a crucial role in preventing dental caries?

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Caries is the destruction of hard dental tissues, namely enamel and dentin, which occurs when sugars contained in food or drinks are metabolized by bacteria, such as Streptococcus mutans, into acids that gradually damage the teeth [1]. S. mutans is a facultative anaerobic Gram-positive bacterium that plays a crucial role in the occurrence of dental caries. This bacterium adheres to the enamel pellicle of the teeth and, along with other plaque bacteria, creates an acidic environment, thereby increasing the risk of tooth decay [4].

The existence of natural resources in Indonesia can be utilized to help prevent dental caries, one of which is by using coconut to extract its oil. Several previous journals have discussed the various benefits of coconut oil. Coconut oil (*Cocos nucifera*) is a relatively unfamiliar product obtained through the pressing of dried coconut meat. Coconut oil possesses antibacterial, antiviral, antifungal, anti-protozoal properties, and many more. Coconut oil contains 92% saturated fatty acids, 49% of which is lauric acid, a medium-chain saturated fatty acid. Medium-chain saturated fatty acids and their derivatives (e.g., monoglycerides) are effective in destroying various bacteria (lipid-coated bacteria) by disrupting their lipid membranes [5,6].

Based on the brief explanations from various sources, it can be understood that coconut oil is beneficial as an antibacterial agent, particularly due to its lauric acid content. However, there is limited research on the effectiveness of coconut oil's benefits as an antibacterial agent in preventing caries. Therefore, this literature review is conducted to evaluate the effectiveness of coconut oil's benefits as an antibacterial agent for use in caries prevention by discussing the mechanism of coconut oil as an antimicrobial and the antimicrobial activity of lauric acid from coconut oil against human pathogenic bacteria and streptococci in the oral cavity from various findings and scientific studies, so that this natural resource can be considered for use as a material to develop products that can facilitate caries prevention in Indonesia and worldwide.

2. Methods

In the preparation of this Literature Review, we utilized the method of analytical review by collecting comparative data from databases obtained from PubMed, Web of Science, and ScienceDirect with a limitation of publications within the last 5 years, recorded after January 1, 2018. The search terms included were: coconut oil, dental caries, Streptococcus mutans, and Anti-bacteria. All abstracts, studies, and citations retrieved were reviewed. Additionally, we searched the reference sections of selected journals for relevant studies.

3. Results and discussion

3.1. The Mechanism of Coconut Oil as an Antimicrobial Properties

Coconut oil contains lauric acid, a medium-chain saturated fatty acid known for its antimicrobial properties. Upon metabolism within the human body, lauric acid is enzymatically converted into monolaurin, a monoglyceride [7]. Monolaurin serves as an active antimicrobial agent. Two theories elucidate the mechanism by which monolaurin exerts its antimicrobial effects: (i) membrane disintegration and (ii) inhibition of pathogen maturation (Figure 1A - C).

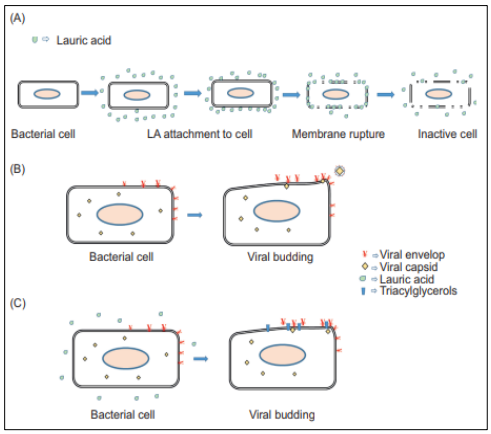

Figure 1 Antibacterial inactivation by lauric acid (A), viral budding without lauric acid (B), and viral budding with lauric acid (C)

Lauric acid possesses the capability to mimic the structural composition of peptidoglycan inherent in bacterial cell walls. Upon contact with bacterial cell surfaces, coconut oil's lauric acid encapsulates the entirety of the bacterial cell surfaces, gradually infiltrating the bacterial cell interior. This process induces alterations in cell membrane fluidity, thereby disrupting cell permeability and ultimately leading to cell wall lysis. Consequently, cellular metabolism is compromised, culminating in bacterial cell demise. This phenomenon is conspicuously evident under electron scanning microscopy when Staphylococcus aureus bacterial strains are subjected to a 0.1% lauric acid solution [8].

In other study, it was demonstrated that lauric acid can effectively exterminate gram-positive bacteria whose cellular membranes are lipid-rich, by impeding or obliterating bacterial protein synthesis. As lauric acid exhibits nonpolar characteristics, it can traverse bacterial cell membranes, instigating detrimental effects on the bilayered phospholipid architecture and resulting in cellular lysis [9].

3.2. Antimicrobial Activity of Lauric Acid against Human Pathogenic Bacteria and Streptococci in the Oral Cavity

Numerous studies have demonstrated the antibacterial effects of lauric acid. Lauric acid exhibits significant effects on Streptococcus bacteria (gram-positive) compared to Bacillus bacteria (gram-negative) [10]. This is also associated with the mechanism of action of lauric acid through the peptidoglycan wall lysis mechanism.

Matsue conducted research using the bacterial incubation method for 12 hours at 37°C, employing lauric acid concentrations ranging from 0 mM to 2.5 mM on 9 bacteria: *S. aureus, S. agalactiae, S. pneumoniae, S. pyogenes, K. pneumoniae*, and *K. oxytoca*, 1–3 × 105 CFU/mL; *S. salivarius, S. sanguinis, E. coli,* and *S. marcescens*, 1–3 × 107 CFU/mL. Treatment involved applying 100 µL of agar medium with lauric acid in the bottom layer and 300 µL of medium solution in the top layer in a 96-well microplate [10].

The results indicate significant changes in gram-positive bacterial colonies (oral streptococci) compared to gram-negative bacteria.

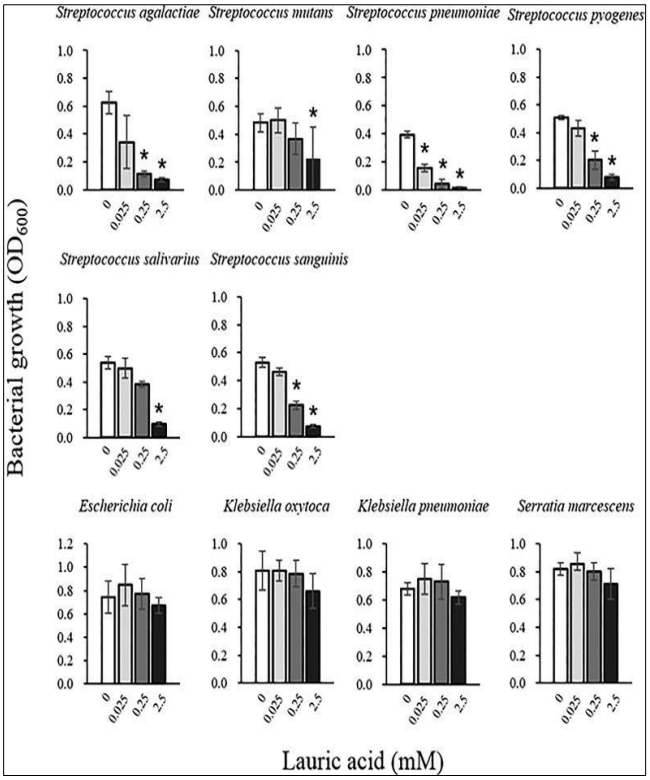

Figure 2 The Effect of Lauric Acid on the Colonies of Several Gram-Positive and Gram-Negative Bacteria [10]

There is also in vitro research conducted by Vasquez and Guardia (2021) on the effects of coconut oil on *S. mutans* bacteria. The study used bacteria given different concentrations of coconut oil (25%, 50%, 75%). In this study, two controls were used, namely positive and negative controls as indicators. The positive control used procaine penicillin G, while the negative control used *Streptococcus mutans* bacteria. There were twelve replicates per concentration of

coconut oil. The study showed significant results in the inhibition of bacterial colonies along with the high concentration of coconut oil. At a concentration of 25%, an inhibition zone of 17 mm was formed and bacterial colonies were 2.23 x 102 CFU, at a concentration of 50%, an inhibition zone of 21.75 mm was obtained and bacterial colonies were 0.17 x 102, and at a concentration of 75%, the highest level of inhibition was with an inhibition zone area of 22 mm and no bacterial colonies were found. The positive control using procaine penicillin G gave an inhibition zone of 14.25 mm and no bacterial colonies. Whereas the negative control using Streptococcus mutans produced no inhibition zone with bacterial colonies of 2.8 x 105. This proves that coconut oil has an effective antibacterial effect according to the concentration level of coconut oil itself. The higher the concentration used, the higher the effectiveness in killing and inhibiting the growth of caries-causing bacteria, namely *Streptococcus mutans* [11].

4. Conclusion

Coconut oil can be used as an adjunct to to improve oral health and dental hygiene, although further research is needed to determine its effectiveness. Limited evidence suggests that coconut oil may have beneficial effects in improving oral health and dental hygiene particularly in people with caries. Future clinical trials are needed given the easy availability of coconut in Indonesia. Other prospective studies should have a robust design with rigorous implementation to provide higher quality evidence.

Compliance with ethical standards

Disclosure of conflict of interest

The authors have no conflict of interest to declare.

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