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The potential inhibitory power of cinnamon extract (*Cinnamomum burmanii*) toward the growth of *Streptococcus gordonii* bacteria

Haniya Diva Kurotul Aini [1,*], Hartini Benita [1], Prawati Nuraini [2] and Soegeng Wahluyo [2]

[1] *Faculty of Dental Medicine, Airlangga University, Surabaya, Indonesia.*
[2] *Department of Pediatric Dentistry, Airlangga University, Surabaya, Indonesia.*

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Abstract

Introduction: *S. gordonii* are pioneer bacteria which play a vital role in the process of caries formation. As an alternative of caries prevention agent with minimal side effects, a natural plant, namely cinnamon, can be used. The essential oil in cinnamon contains cinnamaldehyde and eugenol compounds which have been proven effective in inhibiting bacterial growth. Objective: To determine the effect of cinnamon extract on inhibiting the growth of *S. gordonii*. Method: The research was carried out using analytical methods in an in vitro laboratory experiment with a posttest only control group design. The sample used in this study was *S. gordonii* bacteria in Brain Heart Infusion Broth (BHIB) media which was incubated at 37°C for 24 hours. Determination of the inhibitory power of cinnamon extract is carried out by giving cinnamon extract concentrations of 50%, 12.5%, 3.125%, and 0.78% to each paper disk on agar media. Statistical analysis was performed with IBM SPSS Statistics. Results: The inhibitory power of cinnamon extract concentration groups on the growth of *S. gordonii* bacteria had a value of Sig = 0.000 (Sig < 0.05) so there is a significant difference in the inhibitory power between cinnamon extract concentration groups. Conclusion: Based on the results, it can be concluded that the higher the concentration of cinnamon extract used, the more effectively it can inhibit the growth of*S. gordonii* bacteria.

Keywords: Bacteria; Caries; Cinnamon Extract; Inhibitory Power; *S. gordonii*

1. Introduction

Dental and oral health is an important part of the body that every individual must pay attention to. Lack of awareness in Indonesian people maintaining their dental and oral hygiene is one of the causes of dental and oral diseases that occur in Indonesia [1]. This dental and oral disease does not only occur in adults but can also occur in children, therefore maintaining dental and oral hygiene is the obligation of every human being, from children to adults [2]. The main dental health problem that often occurs in children is dental caries. Dental caries is a disease characterized by damage to tooth enamel, dentin, and extends to the pulp. Caries will form because the surface of the tooth is covered with biofilm, where this biofilm is a thin layer on the surface of the tooth and becomes a habitat for bacterial cells and food debris. If it is not cleaned, this biofilm will continue to thicken, becoming an attachment area for colonization and growth of various bacterial species [3]. Results from Riset Kesehatan Dasar (RISKESDAS) in 2018, the prevalence of caries in children aged five to six years reached to 88.8% [4].

Dental caries begins with the formation of plaque on the teeth. The bacteria *Streptococcus gordonii* is a pioneer bacteria that plays a very important role in the plaque formation process, where plaque is the beginning of caries and is oftenfound on the mucosal surface of the oral cavity [5]. *Streptococcus gordonii* is a Gram positive bacterium, shaped like a coccus or spiral and in pairs or clustered chains [6].

* Corresponding author: Haniya Diva Kurotul Aini

There are many herbal ingredients that can be used as medicines, one of which is cinnamon (*Cinnamomum burmannii*). Cinnamon is a traditional medicinal spice plant that is cheap and easy to obtain but is still not widely used to its full potential. Cinnamon is a native Indonesian plant that is spread across several provinces in Indonesia such as Java, Sumatra, Maluku, Nusa Tenggara and Papua [7]. The parts of cinnamon that have many benefits are the bark and leaves. Cinnamon bark and leaves contain many essential oils containing cinnamaldehyde and eugenol, saponins, tannins and flavonoids. The contents of cinnamon have the potential as antibacterial, antioxidant, analgesic, antipyretic and analgesic [8]. Excessive consumption of cinnamon also has side effects that can cause skin rashes, nausea, vomiting and diarrhea [9]. The side effects of cinnamon can be reduced by minimizing the amount of cinnamon consumed.

Based on various studies that have been carried out, it shows that cinnamon can influence the growth of *S. mutans* bacteria. The essential oil in cinnamon contains cinnamaldehyde and eugenol compounds which have been proven effective in inhibiting the growth of *S. mutans* bacteria which play a role in plaque formation and caries development, *Staphylococcus aureus, Escherichia coli,* and *Lactobacillus acidophilus* [10].

Caries prevention can be done by inhibiting the growth of *S. gordonii* bacteria to minimize the process of caries, where this bacteria is a pioneer bacteria in the formation of dental plaque which is the beginning of caries. If this plaque is left for a long period of time it will cause caries on the teeth. There is still very little research on the effect of cinnamon extract on the growth of the *S. gordonii* bacteria that causes caries. Therefore, in this research we will test the inhibitory power of cinnamon extract on the growth of *S. gordonii* bacteria. The aim of this research is to determine the effect of cinnamon extract and its concentration on inhibiting the growth of *S. gordonii* bacteria.

2. Material and methods

The research is carried out using in vitro laboratory experimental analytical methods with a posttest only control group design. The sample used in this study is *S. gordonii* bacteria in Brain Heart Infusion Broth (BHIB) media which is incubated at 37°C for 24 hours. This research is conducted at the Research Center of the Faculty of Dentistry, Airlangga University.

The research began with sterilization of the tools used in the research. Next, cinnamon extract is made from 1000 grams of cinnamon bark. The extract is made using the maceration method. Inoculation of *S. gordonii* ATCC 51656 bacterial colonies for research samples which were incubated for 2 x 24 hours at 37°C in the incubator. The cinnamon extract that has been made will undergo serial dilution until it reaches concentrations of 50%, 12.5%, 3.125% and 0.78%. Determination of the inhibitory power of cinnamon extract was carried out by giving cinnamon extract concentrations of 50%, 12.5%, 3.125%, and 0.78% to each paper disk of 0.01 ml using a sterile micropipette on the Mueller Hinton Agar medium that had been provided with bacterial suspension. The paper disk is attached to the surface of the agar medium and incubated for 48 hours anaerobically at 37°C. After 48 hours, the zone of inhibition that forms around the paper disk is observed and the diameter of the clear zone that appears around the paper disk is measured.

Statistical data data analysis is carried out to determine significant differences in the effect of cinnamon on the growth of *S. gordonii* bacteria in each treatment. The data obtained from the research is the size of the inhibitory zone for *S. gordonii* bacteria growing in petri dishes containing MHA (Mueller Hinton Agar). The data obtained were analyzed using the One-Way ANOVA test method to determine differences between treatments. The statistical calculations are carried out using the IBM SPSS Statistics 26.

3. Results and discussion

This research is an in vitro laboratory experimental study by adding subjects whose effectiveness is measured, namely cinnamon extract, to *S. gordonii* bacteria. *S. gordonii* bacteria in Brain Heart Infusion Broth (BHIB) media were incubated for 24 hours at 37°C. The number of treatments given in this study contained 5 types of concentrations, namely the negative control group (K-), cinnamon extract with a concentration of 50%; 12.5%; 3.125%; and 0.78%. Each treatment group is done in 3 times replication, therefore the total number of samples is 15 samples. The calculation of inhibitory power is measured by the diameter of the inhibition zone.

The result of this study shows that 50% cinnamon extract has an average inhibitory power for the growth of *S. gordonii* bacteria of 19.28 + 0.28 mm with the smallest inhibitory power being 19.05 mm and the largest being 19.60 mm. The result also shows that 50% cinnamon extract is classified as moderate and the highest inhibitory power compared to other concentrations. Cinnamon extract 0.78%, and the negative control did not have inhibitory power against *S. gordonii* bacteria or were classified as resistant bacteria.

The normality test shows that the resistance data is normally distributed and meets the requirements for using the One-Way Anova test (p<0.05). The homogeneity test showed that the data on the growth inhibition power of *S. gordonii* bacteria had no homogeneous data diversity (p>0.05). The test analysis of differences in the growth inhibitory power of *S. gordonii* bacteria in 5 concentration groups can still be continued with the One-Way Anova test analysis and continued with the post hoc test using the Games-Howell test (equal variance not assumed).

The result of One-Way Anova test shows that the inhibitory power of 5 cinnamon extract concentration groups on the growth of *S. gordonii* bacteria has a value of Sig = 0.000 (Sig < 0.05) so there is a significant difference in the inhibitory power between wood extract concentration groups. sweet. Significant differences indicate that it is necessary to analyse further using the Games-Howell post hoc test to find out which concentration groups have significantly different inhibitory power from other concentrations

Table 1 Results of Games-Howell Test

Group	K(-)	50%	12.5%	3.125%	0.788
K(-)					
50%	0.000*				
12.5%	0.001*	0.000*			
3.125%	0.007*	0.001*	0.003*		
0.78%	1.000	0.000*	0.001*	0.007*	

Explanation: *= Significantly different in 5% significance (p < 0,05)

The results of the Post Hoc Test using the Gamess-Howell test showed that cinnamon extract with a concentration of 0.78% and the negative control had the same inhibitory power. The cinnamon extract has a concentration of 50%; 12.5%; and 3.125% have significantly different values from each other and are significantly different from the concentration of 0.78% and the negative control. Based on the average value, the cinnamon extract that produces the best inhibitory power is a concentration of 50% with an average diameter of 19.28 + 0.28 mm. After that there is a concentration of 12.5% which has a lower inhibitory power the lower the cinnamon extract concentration. The worst concentrations were 3.125% and 0.78% because they had no inhibitory power with a diameter of <10 mm.

The type of experiment carried out in this research is determination of the diameter inhibition method for bacterial growth, by placing a paper disk in a cinnamon extract solution on Muller Hinton Agar media which had been inoculated with *S. gordonii* bacteria. The antibacterial activity of cinnamon extract was measured using a caliper to measure the diameter of the inhibition zone formed in the media after incubation for 24 hours.

The results of this research showed an effective concentration of cinnamon extract which can inhibit a pioneer cariogenic bacteria, *S. gordonii.* The antibacterial activity of a plant extract can be influenced by several factors. Factors that can influence antibacterial activity are extract concentration, extract diffusion power, extract solvent, type of bacteria and bacterial resistance to compounds contained in plant extracts.

Cinnamon extract is used because it has several compounds such as essential oils, flavonoids, saponins and tannins which work as antibacterials, which these three compounds can damage bacterial cell walls so that the growth of *S. gordonii* bacteria is inhibited [12]. This research shows that the four concentrations of cinnamon extract show antibacterial activity by forming different inhibition zones. The largest inhibition zone results were shown by a 50% concentration of cinnamon extract followed by concentrations of 12.5%, 3.125%, and 0.28% respectively. The experimental sample with a cinnamon extract concentration of 50% produced the highest antibacterial power as indicated by the largest diameter of the inhibition zone formed. It can be concluded that the higher the concentration of cinnamon extract used, the more effective it will be in inhibiting the growth of *S. gordonii* bacteria. The results of this study are in accordance with research by Waty et al. (2018) which explained that the contents of cinnamon are believed to inhibit the growth of bacteria in the oral cavity [11].

The cinnamon extract used in this research came from UPT Materia Medica, Batu. The antibacterial activity caused by cinnamon extract is related to the chemical compound content of cinnamon. The main contents of cinnamon extract are essential oils, saponins, flavonoids and tannins. The main mechanism by which these compounds can inhibit bacterial growth is related to the interaction of these compounds with bacterial cell walls. The most abundant ingredient in cinnamon extract is essential oil. The essential oil content of cinnamon is cinnamaldehyde (34.44%), eugenol (25.67%),

coumarin (16.82%), borneol (3.28%), and methyl cinnamate (3.16%). Essential oils work by disrupting the process of forming cell membranes or bacterial cell walls so that bacterial cell walls do not form optimally. Essential oils have hydroxyl (-OH) and carbonyl groups which will work to inhibit bacterial growth by denaturing proteins [2].

Apart from essential oils, other chemical compounds contained in cinnamon extract are flavonoids. This compound will bind to the bacterial cell wall to form a complex with extracellular proteins and will also form a complex with the bacterial cell wall [12]. Tannin compounds are also contained in cinnamon which will work by causing bacterial cells to lyse. This happens because tannins target the polypeptide walls of bacterial cell walls, therefore it will make the formation of bacterial cell walls imperfect, which will result in bacterial cell lysis [13]. The saponin compound contained in cinnamon will work to inhibit essential enzymes to destroy bacterial cell membranes [14].

4. Conclusion

Based on the results of the research, it can be concluded that there is potential inhibitory power of turmeric extract on the growth of *Streptococcus gordonii* bacteria.

In this research, only results about potential inhibitory power of bacteria against turmeric extract is obtained, therefore further research is needed:

There is a need for research on turmeric extract in inhibiting other cariogenic bacteria that cause dental caries.toxicity test research is needed on the active content of turmeric extract (*Cinnamomum burmannii*) for better results.

Compliance with ethical standards

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Disclosure of Conflict of interest

We declare no conflict of interest.

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