

## The effect of gargling with green tea extract solution (*Camelia sinensis*) in efforts to prevent caries incidence: A systematic review

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### Abstract

**Background:** One of the main dental and oral health problems that occur throughout the world is dental caries. Cariogenic bacteria such as *Streptococcus mutans* and *Lactobacillus acidophilus* are the main microorganisms that cause dental caries. Saliva plays a significant function in maintaining optimal dental health and oral cavity especially because of its components such as pH, flow, and buffering capacity. These three components have a significant role in the initiation and development of dental caries. Gargling is one of the activities that can be done as a prevention of dental caries. Green tea contains the compound Epigallocatechin gallate (EGCG) which is a flavonoid compound that has antioxidant, anti-inflammatory, antifungal, antibacterial, and anticariogenic properties. This systematic review aims to describe the effect of gargling with green tea to prevent dental caries incidents.

**Method:** The method used is a systematic review which is done by searching articles through Google Scholar, PubMed, and ScienceDirect.

**Discussion:** Gargling with green tea regularly can help to increase the pH of saliva. It will help the tooth remineralization process and prevent caries. Green tea contains catechins that inhibit acid formation and reduce the work of the glucosyltransferase enzyme of *Streptococcus mutans*. The largest catechin content in green tea is EGCG. EGCG can reduce the quantity of *Streptococcus mutans*.

**Conclusion:** Gargling with green tea is effective in preventing dental caries incidents because it contains catechins, especially EGCG, tannins, and fluoride.

**Keywords:** Green tea (*Camelia sinensis*); Mouthwash; Dental Caries; Salivary pH

### 1. Introduction

Dental caries is one of the main problems in dental and oral health that is most common in society, including in Indonesia. Based on the research conducted by Basic Health Research (Riskesdas) in 2018, it showed an increase in the incidence of dental caries or cavities in Indonesian society of 88.55% from 53.2% in 2013. 25.9%<sup>(1)</sup>. Dental caries is an oral infection in the form of demineralization of dental hard tissue that occurs in a multifactorial manner<sup>(2)</sup>. Several factors can cause dental caries, including interactions between saliva and teeth as hosts, normal flora of the oral cavity in the form of bacteria and other microorganisms as agents, and foods that are easily fermented by bacteria to become acidic as an environment<sup>(3)</sup>.

There are more than 400 species of microbes that constitute the commensal flora of the oral cavity of healthy adults. Dental caries is classified as an infectious disease that occurs in the oral cavity caused by the presence of

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microorganisms in the form of bacteria. *Streptococcus mutans* is a cariogenic microorganism that dominates the oral cavity. In addition, there are also *Lactobacillus* organisms that play a role in the formation of dental caries. *Streptococcus* plays a role in the early stages of caries by destroying the outer enamel, while *Lactobacillus* will play a role in deeper caries<sup>(4)(5)</sup>. These cariogenic microorganisms enhance the accumulation and adhesion of biofilm plaques by metabolizing sucrose to glucan. The pathogenicity of *Streptococcus mutans* is due to its acidogenicity coupled with the food's sucrose content and acid tolerance. All of these things contribute to an ecological imbalance of dental plaque by increasing the amount of cariogenic microorganism increasing the demineralization of enamel and the formation of dental caries. <sup>(5)(6)</sup>.

Saliva has several benefits for the oral cavity. Saliva plays a significant function in maintaining optimal dental health and oral cavity especially because of its components such as pH, flow, and buffering capacity. These three components have a significant role in the initiation and development of dental caries and periodontal disease. But among the three components, saliva pH is the main component to maintain the integrity and ecological balance of the oral cavity. If the pH value of saliva is low or low, it can cause dental caries. Based on research conducted by Fitriati in 2017, it was found that respondents who have a critical saliva pH are more likely to experience dental caries<sup>(7)</sup>. Several things such as fluoridated drinking water, fluoride toothpaste, mouthwash, varnish, and gel have an important role in reducing and preventing dental caries. <sup>(6)</sup>. Gargling can clean food debris stuck in the gaps between the teeth that cannot be reached when brushing your teeth. You can do various ways to rinse your mouth, generally using plain water or mouthwash, or using other ingredients. One of them is tea Gargling with tea has great benefits in preventing dental and oral diseases<sup>(8)</sup>.

After mineral water, tea is the second drink most consumed by humans<sup>(8)</sup>. One type of tea that is often consumed so far is green tea. Green tea (*Camelia sinensis*) is a type of tea that is not fermented and is considered as one of the ancient therapies and is widespread throughout the world. Green tea extract mouthwash is a mouthwash that is classified as safe and nontoxic when used. The indirect antibacterial effect of green tea is evidenced by its ability to stimulate protective components such as immunoglobulins (Ig), lactoferrin, lysosomes, histatins, and mucins. <sup>(6)</sup>. The medical effects that green tea has are attributed to its polyphenol components namely catechins. Green tea contains the compound Epigallocatechin gallate (EGCG), which is a flavonoid compound from the catechin group. These compounds have antioxidant, anti-inflammatory, antifungal, antibacterial, and anticariogenic<sup>(9)(10)</sup>. The catechins contained in green tea have the potential to inhibit the action of the glucosyltransferase (GTF) enzyme on *Streptococcus mutans* bacteria where these bacteria are involved in the formation of plaque and dental caries<sup>(8)(11)</sup>. Gargling with green tea has a higher effectiveness in increasing salivary pH when compared to chlorhexidine and sodium fluoride mouthwash<sup>(12)</sup>. Green tea also has the property of reducing pain after orthodontic fitting<sup>(13)</sup>.

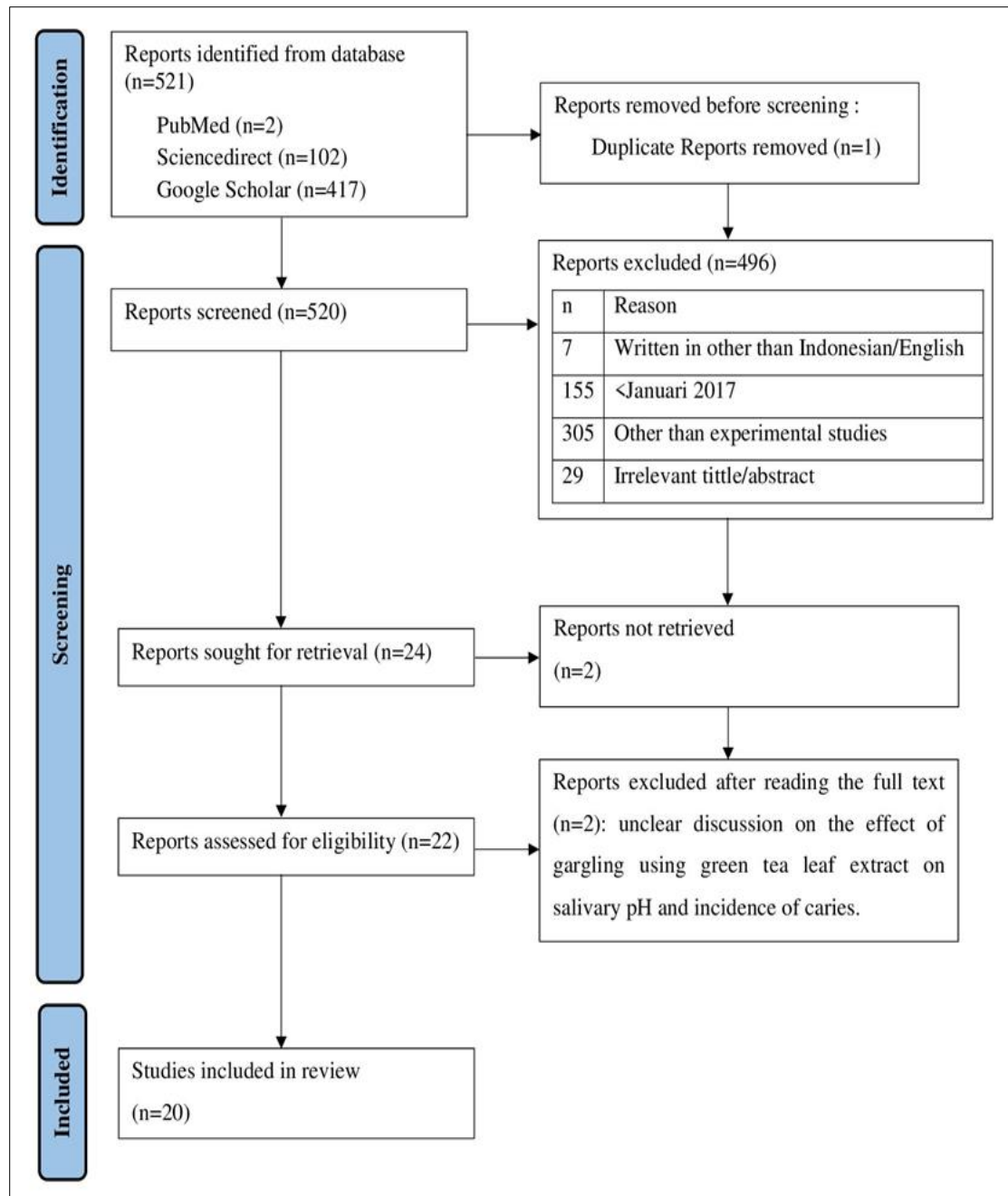
The purpose of writing this systematic review is to describe the effect of gargling with green tea solution in preventing caries incidents.

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## 2. Methods

The procedure used in writing this systematic review is a literature search through several databases such as PubMed, ScienceDirect, and Google Scholar. The design of this review follows the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) method. The search terms used were: '*Camelia sinensis*'; 'mouthwash'; 'pH of saliva'; 'dental caries'; 'original research'; 'research article'. The inclusion criteria in this study was an experimental study written in Indonesian/English which explained the effect of gargling with green tea (*Camelia sinensis*) on the incidence of caries. The studies that were excluded from this narrative review were (1) duplication studies; (2) research published before January 2017; (3) studies other than experimental studies (letters to the editor, opinions, conference abstracts, dissertations, theses, ecological correlation studies); (4) research with irrelevant titles or abstracts; and (5) a study with unclear discussion about the effect of gargling with green tea (*Camelia sinensis*) on the incidence of caries.

After screening, a total of 520 studies were obtained. Only 20 studies were included in this review after screening based on inclusion and exclusion criteria (Figure 1). Data sets created and analyzed using Microsoft® Excel 2019 for Windows. Data extraction details are tabulated, and data are presented as indication, product, number of participants, and findings, as shown in Table 1.



**Figure 1** Flowchart illustrating the process of selecting and categorizing studies for search results ‘green tea (*Camellia sinensis*)’, ‘mouthwash’, ‘salivary pH’, and ‘dental caries’

### 3. Results

This study is a systematic review to examine the effect of green tea mouthwash to prevent dental caries incidents. This study was conducted by conducting a review of 20 journals obtained through the database. The results obtained from this study are that gargling with green tea can reduce the number of *Streptococcus mutans* bacteria so that it has the potential to prevent dental caries. In addition, gargling with green tea can also increase salivary pH and salivary volume which can indirectly help the process of remineralizing teeth to prevent dental caries.

**Table 1** Randomized controlled trials effect of green tea leaf mouthwash on the prevention of dental caries

Author/Year	Indication	Formula	Participants (n)	Result
<sup>(14)</sup> Aljufri/2017	pH adjustment	<i>Camelia sinensis</i> leaf extract	39	Change in salivary pH from acidic (before gargling) to neutral (after gargling)
<sup>(3)</sup> Hervina/2017	pH adjustment	<i>Camelia sinensis</i> leaf extract 3%	44	Elevated pH saliva
<sup>(15)</sup> Manikandan/2020	pH adjustment	<i>Camelia sinensis</i> leaf extract 2%	40	Elevated pH saliva compared to probiotics
<sup>(6)</sup> Salama/2019	Oral antiseptic	<i>Camelia sinensis</i> leaf extract	40	There was a decrease in <i>S. mutans</i> colonies compared to the control group
<sup>(16)</sup> Ahmadi/2019	Oral antiseptic	<i>Camelia sinensis</i> leaf extract mouthwas 0,5% and gel	30	Colonies of <i>S. mutans</i> were significantly reduced by mouthwash and green tea gel formulations
<sup>(17)</sup> Khanchemehr /2018	Antiseptic for orally intubated patients	<i>Camelia sinensis</i> leaf extract 5%	46	Decreased bacterial load in the pharynx compared to chlorhexidine
<sup>(5)</sup> Prabakar/2018	Oral antiseptic	<i>Camelia sinensis</i> leaf extract	52	Less effective than chlorhexidine in reducing the number of <i>S. mutans</i> colonies
<sup>(18)</sup> Hegde/2017	Oral antiseptic	<i>Camelia sinensis</i> leaf extract 0,5%	75	Colonies of <i>S. mutans</i> and <i>Lactobacillus spp.</i> from the chlorhexidine group have decreased
<sup>(19)</sup> Goyal/2017	Oral antiseptic	<i>Camelia sinensis</i> leaf extract	30	Reduced <i>S. mutans</i> colonies in comparison to saliva
<sup>(20)</sup> Kamalaksharappa/2018	pH adjustment	<i>Camelia sinensis</i> leaf extract 2%	40	Elevated pH saliva compared to the probiotic group.
<sup>(21)</sup> Wibisono/2019	pH adjustment	Green tea solution mouthwash	32	Increased salivary pH compared to the black tea group
<sup>(22)</sup> Fajriani/2018	pH adjustment	Green tea solution mouthwash	120	Green tea leaf extract solution is less effective than cocoa bean extract solution to change the salivary pH to alkaline and prevent dental caries
<sup>(23)</sup> Gok/2020	Oral antiseptic	Green tea solution mouthwash	-	Green tea extract shows effectiveness in inhibiting the growth of dental caries bacteria and is recommended as an alternative mouthwash because it tastes better for daily oral hygiene
<sup>(4)</sup> Armidin & Yanti/2019	Oral antiseptic	Green tea solution mouthwash	60	Gargling using green tea solution is more effective than black tea solution, because

				green tea has bactericidal properties against <i>S. mutans</i> in the mouth
<sup>(24)</sup> Vilela/2020	Oral antiseptic	Green tea solution mouthwash	47	EGCG content has better antimicrobial activity. This research supports the effectiveness of green tea extract as an antibacterial mouthwash of choice
<sup>(25)</sup> Nedyani/2018	Saliva volume and oral antiseptic	Green tea extract 0.5% as much as 10 ml	10	Gargling using green tea extract is effective in increasing the volume of saliva and can also improve the health of the supporting tissues of the teeth and prevent the formation of plaque
<sup>(8)</sup> Putri/2019	pH adjustment	Green tea solution mouthwash	-	The high content of catechins in green tea makes green tea effective in increasing salivary pH compared to black tea. The catechins in tea itself are anti-cariogenic and antibacterial
<sup>(26)</sup> Thomas/2017	Oral antiseptic	Green tea solution mouthwash	45	Green tea extract as an antibacterial mouthwash is very effective against the bacterial group <i>S. mutans</i> and <i>Lactobacilli spp.</i> and coupled with some antifungal activity against <i>C. albicans</i>
<sup>(27)</sup> Shirzaiy/2021	Oral antiseptic and pH adjustment	Green tea solution mouthwash	50	This study showed that gargling black and green tea elevated salivary pH and may reduce the prevalence of caries
<sup>(28)</sup> Hajiahmadi/2019	Oral antiseptic	Green tea solution mouthwash 0.5%	64	Salivary <i>S. mutans</i> levels were significantly decreased after using green tea mouthwash. However, green tea combined with xylitol resulted in a significantly higher reduction in the amount of <i>S. mutans</i> in saliva

#### 4. Discussions

Green tea (*Camelia sinensis*) is one of the most popular drinks worldwide. This drink is made from an infusion of *Camellia sinensis* leaves. Green tea leaves contain numerous health advantages, such as anti-inflammatory, anti-cariogenic, anti-mutagenic, antioxidant, and antibacterial properties, as well as hypolipidemic effects. In several countries such as Japan and China, green tea is used as a herbal treatment because it has many health benefits. Previous studies have shown that this is because green tea contains flavonoid compounds (catechins)<sup>(10)(29)</sup> and tannins<sup>(30)(31)(32)</sup>. Flavonoids are the most abundant phenol group compounds found in nature. Flavonoids are secondary metabolite compounds present in green pigmented plants. The mechanism of action of flavonoids is known as an anti-bacterial

agent because it forms an extracellular and dissolved protein environment with the bacterial cell wall and can interfere with the function of bacterial cells<sup>(33)(34)</sup>.

The catechins in green tea have many health benefits, especially as anticariogenic or antibacterial<sup>(10)</sup>. The catechins contained in green tea leaves are bactericidal and bacteriostatic. Catechins are the primary bioactive components of green tea which have antibacterial properties and have shown their use in the treatment of oral and topical infections<sup>(6)</sup>. There are several catechin derivatives in green tea (*Camelia sinensis*), namely epicatechin, epigallocatechin, epicatechin gallate and EGCG. Among the catechin derivatives, EGCG is the most potent catechin derivative and is believed to improve health. Epigallocatechin-3-gallate (EGCG) is the most active class of catechin compounds in green tea leaf extract and its content is distributed in catechins by 59%<sup>(26)(35)</sup>.

EGCG has been proven in its anticariogenic properties to prevent caries incidents through various mechanisms. EGCG is able to bind to the bacterial cell membrane, especially in gram-positive bacteria which will cause disruption and even damage to the bacterial cell membrane so that it can interfere with the attachment of *Streptococcus mutans* to the enamel<sup>(36)(37)</sup>. Inhibition of glucosyltransferase (GTF) enzyme activity produced by *Streptococcus mutans* was also carried out by EGCG. The glucosyltransferase enzyme will convert sucrose into glucan thereby inhibiting the formation of easily fermentable carbohydrates (maltose) by *Streptococcus mutans*<sup>(4)(36)</sup>. In addition, EGCG dissolves in human saliva to inhibit the decrease in oral pH induced by glucose by inhibiting the metabolic activity of *Streptococcus mutans* and maintaining a neutral environment through its buffer capacity<sup>(36)</sup>. This causes the growth of bacteria (*Streptococcus mutans*) to be inhibited and also decreases the production of acid in dental plaque.

Apart from catechins, there are several other compounds that can increase the effectiveness of green tea in preventing dental caries, namely tannins and fluoride. Tannins are compounds contained in tea leaves. The tannin content is generally higher in non-fermented teas such as green tea. The tannins contained in green tea have the potential to prevent caries because of their ability to inhibit the growth of *Streptococcus mutans* by binding to iron content, inhibiting the glucosyltransferase enzyme, preventing bacterial adhesion, inactivating bacterial adhesin, enzymes and bacterial protein transport<sup>(3)(33)(34)</sup>. Tea also contains high quantity of fluoride in it. In a study conducted by Ing, et al., fluoride content was found in green tea samples examined<sup>(35)</sup>. Fluoride has an antibacterial and anti-plaque effect. The fluoride present in green tea can help strengthen the tooth enamel structure and prevent tooth decay<sup>(4)(18)(35)</sup>.

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## 5. Conclusion

Gargling with green tea is effective in preventing dental caries incidents.

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## Compliance with ethical standards

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### Disclosure of conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this document.

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