

ANTIBACTERIAL POTENTIAL OF LIME (*Citrus aurantifolia*) ON THE GROWTH OF *Streptococcus mutans*
(POTENSI ANTIBAKTERI JERUK NIPIS (*Citrus aurantifolia*) TERHADAP PERTUMBUHAN *Streptococcus mutans*)

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ABSTRACT

Streptococci have a variety of solid virulence factors that allow various infections to occur. *Streptococcus mutans* is an obligate biofilm organism and is considered the primary etiology of dental caries. Lime (*Citrus aurantifolia*) is widely consumed because of its natural safety factors and is a vital ingredient in most herbal ingredients with antibacterial properties. Prevention in dentistry needs to be improved, one of which is through the potential of herbal plants to reduce world health problems, especially in Indonesia. Objective To determine the possibility of lime antibacterial compounds inhibiting the growth of *Streptococcus mutans*. Streptococcal groups, especially *S. mutans*, are aciduric and acidogenic organisms and can create environmental conditions that lethal to other bacteria. *Streptococcus mutans* produces several extracellular sucrose metabolite enzymes that contribute to the

organism's ability to cause dental caries. Streptococcal virulence factors are usually due to adhesion attachment to cell surface proteins, glucosyltransferase (GTF) production, acid production, and acid tolerance. Oranges are one of the largest plant species distributed throughout the world. Plants of the citrus genus are mainly valued for their edible fruit and traditional medicinal value and have an important role in health. Lime is a herbal plant that has the potential as an antibacterial against streptococci because it contains beneficial active compounds such as saponins, flavonoids, citric acid, amino acids, essential oils, resins, glycosides, vitamin B1, vitamin C, citric acid, fats, iron, calcium, sulfur, phosphorus, and is expected to be a choice of chemical drugs that have many side effects. Conclusion Lime is a herbal plant that contains antibacterial compounds that show various biological activities, are proteolytic and lipolytic, and contain active antibacterial compounds that are expected to reduce the incidence of dental and oral diseases.

Keywords: antibacterial; *Citrus aurantifolia*; *Streptococcus mutans*

ABSTRAK

Streptococcus memiliki berbagai faktor virulensi kuat yang memungkinkan terjadinya beragam infeksi. *Streptococcus mutans* merupakan organisme obligat biofilm dan dianggap sebagai etiologi utama karies gigi. Jeruk nipis (*Citrus aurantifolia*) banyak dikonsumsi karena alami, faktor keamanannya, dan menjadi bahan penting dalam sebagian besar ramuan herbal yang memiliki sifat antibakteri. Pencegahan dalam bidang kedokteran gigi perlu ditingkatkan, salah satunya melalui potensi tanaman herbal sehingga dapat mengurangi masalah kesehatan dunia, khususnya di Indonesia. Tujuan penulisan untuk mengetahui potensi senyawa antibakteri jeruk nipis dalam menghambat pertumbuhan *Streptococcus mutans*. Tinjauan Pustaka Kelompok streptococcus terutama *S. mutans* adalah organisme yang

bersifat asidurik dan asidogenik serta dapat menciptakan kondisi lingkungan yang mematikan bagi bakteri lain. Streptococcus mutans menghasilkan sejumlah enzim metabolit sukrosa ekstraseluler yang berkontribusi pada kemampuan organisme untuk menyebabkan karies gigi. Faktor virulensi streptokokus biasanya disebabkan perlekatan adesi pada protein permukaan sel, toleransi asam, produksi asam, dan produksi glukosiltransferase (GTF). Jeruk merupakan salah satu spesies tanaman terbesar yang terdistribusi di seluruh dunia. Tanaman genus jeruk terutama dinilai tidak hanya dari buahnya yang dapat dimakan, tapi juga memiliki nilai obat tradisional dan memiliki peran penting bagi kesehatan. Jeruk nipis merupakan tanaman herbal yang berpotensi sebagai antibakteri terhadap streptokokus karena mengandung senyawa aktif yang bermanfaat seperti saponin, flavonoid, asam sitrat, asam amino, minyak atsiri, damar, glikosida, asam sitrun, lemak, kalsium, fosfor, besi, belerang vitamin B1 dan C, serta diharapkan dapat menjadi alternatif pilihan obat kimia yang memiliki banyak efek samping. Simpulan Jeruk nipis merupakan tanaman herbal yang mengandung senyawa antibakteri yang menunjukkan berbagai aktivitas biologis, bersifat proteolitik dan lipolitik, serta memiliki kandungan senyawa aktif antibakteri sehingga diharapkan dapat menurunkan insidensi penyakit gigi dan mulut.

Kata Kunci: antibakteri; *Citrus aurantifolia*; *Streptococcus mutans*;

INTRODUCTION

Normal microbes in the oral cavity are varied and consist of many species. Most of the bacteria found in the oral cavity can be classified into gram-positive bacteria and gram-negative bacteria, as well as several other normal microbial species such

as spirochaetes, protozoa, mycoplasmas, and *Candida albicans*.^{1,2}

Organisms can grow well in acidic conditions and adhere to tooth surfaces because of their ability to synthesize highly sticky extracellular polysaccharides. This polysaccharide consists of a glucose

polymer so bacteria can adhere to each other on the tooth surface. Bacteriological studies have shown that in children with caries, 30% of *S. mutans* is found in their dental plaque. In contrast, only about 10% of *S. mutans* were found in children who did not have caries. *Streptococcus mutans* is the essential bacterium that plays a role in the initial process of caries.³⁻⁷

One of the maintenances of dental and oral health can be done mechanically by brushing teeth regularly. Still, these efforts are less effective, so chemical prevention efforts are needed to suppress the growth of bacteria in the oral cavity by using a chemical mouthwash. Using mouthwash-containing chemicals can help maintain dental and oral health. Still, continuous use in the long term can disrupt the balance of microbes in the mouth, cause staining of the teeth, unpleasant taste, irritation of the oral mucosa, to the problem of increasing bacterial resistance to antimicrobials. Therefore, it is necessary to develop efforts to find alternative materials that can be used long-term, ideal, and safe with minimal side effects, using the potential of natural ingredients from plants for oral prophylaxis.⁸⁻¹¹

Natural ingredients have recently become a new source of antibacterial. Research on antibacterial activity associated with extracts from various plants

has been widely reported. Plants with secondary metabolites in the form of polyphenols, such as phenolic acids, flavonoids, anthocyanins, stilbenes, coumarins, lignans, lignins, and tannins showed antibacterial activity. Substances that are abundant in fruits, seeds, and vegetables have an important role in the process of resistance against various kinds of pathogenic microbes and as protection against free radicals and toxins.¹²⁻¹⁴

Research on the active compounds by-products of lime continues to be developed due to the consideration that costs are not too high, the availability of fruit residues is easy to obtain, and it is rich in bioactive compounds. Using good lime will also help reduce pollution problems caused by poor residue disposal.^{15,16}

DISCUSSION

Bacteria are a group of organisms that do not have a cell nuclear membrane and are chemically composed of polysaccharides, proteins, fats, nucleic acids, and peptidoglycan. All these structures must be present and necessary for the growth of these bacteria. In addition, several other factors can affect the growth of bacteria: anatomical factors, saliva, gingival crevicular fluid, microbial factors, nutrition, and other factors.^{2,17}

Streptococcus mutans are gram-

positive cocci, facultative anaerobic, nonmotile, and acidogenic bacteria, which produces lactic acid by metabolizing glucose. *Streptococcus mutans* is the main etiologic factor in caries formation. The virulence of *S. mutans* is its ability to produce extracellular polysaccharides from sucrose. These bacteria grow optimally at temperatures around 18-40°C.¹⁸⁻²³

Microbes in the oral cavity can interact with each other by increasing and suppressing other bacteria. The mechanism consists of competition for receptors for attachment, production of toxins such as bacteriocins which will kill cells of the same bacteria or other bacterial species, producing metabolic end products such as short chain carboxylic acids with low pH and also acting as harmful agents and antagonists, using the end products metabolism of other bacteria for nutrition, coaggregation with the same bacterial species (homotypic) or different bacterial species (heterotypic). Bacteria in the oral cavity can obtain nutrients from various sources, consisting of: sources from the host (oxygen and hydrogen, carbon, inorganic ions, organic nutrients) and sources of microbes (extracellular products of microbes, especially in thick communities such as dental plaque and intracellular nutrient reserves (glycogen)).^{2,17,24-26}

Other factors include local pH of the oral environment, oxidation-reduction potential, antimicrobial therapy, diet, and iatrogenic factors. Many microbes require a normal pH for growth. For the oral cavity, this is influenced by saliva (pH 6.7). Depending on the frequent intake of carbohydrates, plaque pH can drop to 5.0 due to bacterial metabolism; under these conditions, acidophilic bacteria can grow well.^{24,17,27}

Natural ingredients have recently become a new source of antibacterial that can be used clinically. Several studies regarding the antibacterial activity associated with extracts from various plants have been found. Plants with secondary metabolites in the form of polyphenols, such as flavonoids, anthocyanins, phenolic acids, stilbenes, coumarins, lignans, lignins, and tannins showed antibacterial and antibiofilm activity. Substances that are abundant in fruits, seeds, and vegetables have an important role in the process of resistance against various kinds of pathogenic microbes and as protection against free radicals and toxins.²⁸⁻³⁰

Therefore, it is necessary to develop a prevention effort by finding alternative natural potential ingredients that can be used in the long term, ideal, safe with minimal side effects, so that they can be

used as substitutes for chemicals. One of the natural ingredients that can be used is lime. Lime is a herbal plant that contains antibacterial compounds that have the potential as antibacterial against *S. mutans* which plays a role in the formation of biofilms and are expected to be a choice of chemical mouthwash.^{18,29}

Citrus fruits are consumed worldwide as fresh fruit or processed into other citrus products. About a third of the total citrus production is used for processing. Lime juice (*Citrus aurantifolia*) is a flavouring in beverages and is also used by companies producing juice. This juice is produced from fresh fruit without being pasteurized and packaged in glass, paper cartons, or plastic containers. Furthermore, lime fruit can be processed to obtain other food products such as dried Citrus, candies, pickles, jams, and jellies. Citrus essential oil is a by-product of citrus fruits, which is used to flavor beverages and foods by the food industry and is a component for the pharmaceutical industry in the preparation of medicines, soaps, hair creams, perfumes, body oils, and other cosmetics as well as for household cleaning products. Lime juice and fruit peel can produce a disinfectant when combined with vinegar.^{18,31,32}

Lime is a polyembryonic plant cultivated in many countries worldwide and grows in subtropical or tropical areas such

as South Florida, India, Mexico, Egypt, and the West Indies. Lime is also known as lime (Nigerian), Mexican lime, key lime, sour lime, dayap, bilolo, Indian lime, and Egyptian lime. Based on taxonomy and morphology, the position of lime plants in plant systematics is classified as follows:³²⁻

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Kingdom: Plantae (plants)

Division: *Magnoliophyta*

Class: *Magnoliopsida*

Ordo: *Sapindales*

Family: *Rutaceae*

Genus: *Citrus*

Species: *Citrus aurantifolia*

Lime is a type of Citrus that is included in the type of shrubs, many have branches and twigs. The height is about 0.5-3.5 meters, the trunk is woody, thorny and hard, while the outer surface of the bark is dark and dull. The leaves are elliptic or oblong (4-8cm × 2-5cm) and have crenulate margins. The flowers are small white flowers that grow in the axils of the leaves or at the end of the stem with a diameter of 1.5-2.5 cm. At the age of 2.5 years, lime plants begin to bear fruit. The fruit is round, the size of a ping pong ball with a diameter of 3.5-5 cm, green or yellowish (outer skin). The juice is sour and fragrant, like lemon juice, but more aromatic. It is usually rated

for its unique taste compared to other oranges. The seeds are small, ovoid, pale, and smooth with a white embryo. Citrus plants generally like places that can get direct sunlight.³³⁻³⁵

There is increasing interest in the consumption of citrus fruits worldwide because they are rich sources of vitamin C, folate, dietary fibre, minerals, and many phytochemicals, including flavonoids, amino acids, and triterpenes, phenolic acids and carotenoids. There are about 37 limonoid aglycones and 19 glycosides in lime. Limonoids are found in orange peels, which give it a bitter taste and pungent aroma. Limonoids are also found in large amounts in citrus juices and seeds. Limonoids have the ability to stimulate the enzyme glutathione S-transferase (GST), a detoxifying enzyme that catalyzes the glutathione reaction and can be easily removed from the body, thereby inhibiting tumor formation. Lime is rich in flavonoids and the most abundant in its extract are: hesperitin, hesperidin, kaempferol, nobiletin, neohesperidin, apigenin, rutin, and quercetin.³²⁻³⁵

Flavonoids have a solid inherent ability to modify the body's reaction to viruses, allergens, and carcinogens. Flavonoids exhibit antimicrobial, anti-allergic, anti-inflammatory, and anti-cancer

activities. It has been observed that quercetin, one of the most active flavonoids, has significant anti-inflammatory activity due to its direct inhibition of several early inflammatory processes. Quercetin also exhibits remarkable anti-tumour properties and may positively prevent heart disease, cancer, prostatitis, cataracts, allergies/inflammation, and respiratory diseases such as bronchitis or asthma. Carotenoids are also found in oranges and can reduce the incidence of age-related macular degeneration, the leading cause of blindness in humans after age 65. This substance has an essential role as a source of vitamin A. The most active role is protection against severe disorders such as cancer, heart disease, and degenerative eye disease. Carotenoids are antioxidants and act as immune system regulators. Carotenoids commonly found in limes are lutein, β -carotene, zeaxanthin, and cryptoxanthin. Lime is one of the main sources of vitamin C. In the body, ascorbic acid plays a role in helping the absorption of iron from the intestines, producing collagen needed in the normal wound healing process, tissue metabolism, especially in bones and teeth, anti-stress, protection against colds and flu, and also prevents muscle fatigue.³²⁻³⁵

Lime is one type of Citrus which contains elements of beneficial chemical compounds, for example amino acids (lysine, tryptophan), citric acid, essential oils (limonene, citral, felandren, kadinen, lemon camphor, actylaldehyde, nonyldehyd, gerani-lacetate, linali-lacetate), glycosides, resins, fats, calcium, iron, phosphorus, sulfur, vitamins B1 and vitamin C. Lime also contains flavonoid and saponin compounds, namely hesperidin (hesperetin 7-rutinoside), tangeretin, eriocitrin, naringin, and eriocitrocid.^{34,36,37}

CONCLUSION

Lime is a herbal plant that contains antibacterial compounds that show various biological activities, are proteolytic and lipolytic, and have active antibacterial compounds that are expected to reduce the incidence of dental and oral diseases.

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