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Bioactivity of *Amomum Compactum* Soland Ex Maton (Java Cardamom) as a Natural Antibacterial

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ABSTRACT

Amomum compactum Soland Ex Maton (Java cardamom) known as "Queen of Spices", has various functions and benefits. However, the potential of Java cardamom as a natural antibacterial has not yet been well documented. The review is aimed to review the hidden potential of Java cardamom as natural antibacterial by literature study and analysis. This review describes basic understanding of Java cardamom as herbal medicine in order to minimise the antimicrobial resistance as the effect of synthetic antibiotic consumption and to find the alternative. Leading references were searched electronically from 2010 up to 2020. The inductive approach was used to identify topic related to the bioactivity of Java cardamom as a natural antibacterial. While references that not related to the review topic will be excluded. Twenty-six articles were identified and the content that contribute to the Java cardamom as antimicrobial were involved. The bioactive compound and the contributions of the Java cardamom for health were explored. Furthermore, the comparison among bioactives reflecting the potential contained in Java cardamom. The findings highlight the aim of the study and public need to have an alternative regiments as natural antimicrobial that easily found in people's neighbourhood.

Keywords: *Amomum compactum* Soland Ex Maton, Java cardamom, natural antibacterial, essential oil, herbal medicine, antimicrobial resistance.

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INTRODUCTION

Antimicrobial resistance (AMR) is a global health threat which has become a major cause for concern. In 2016, Ministry of Health Republic Indonesia reported that the death rate due to AMR until 2014 was 700,000 per year. These was promoted by human and animal health professionals over-prescribed antibiotics, people don't take antibiotics as directed, poor hygiene and a lack of infection prevention and control, people traveling around the world and spreading resistant bacteria (Australian Government, 2017). Plants is believed has healing powers since ancient reflected by cures or symptom relief resulted with minimum side effect. *Amomum compactum* is one of the herbs that potential as a natural medicine since long time ago. People all over the world use the herbs with various purposes. India and Saudi Arabia are countries that consume cardamom the most as flavoring ingredient for coffee and tea. Western countries like Scandinavia, Germany and Russia, also used to flavor cakes, pastries, and sausages. Indian and South Asian cooking and used to make spice blends, such as curries and garam masala (Qonita *et al.,* 2018). In Indonesia, *A. compactum* is used for various purposes such as: spices, health drinks, traditional medicine and as aroma therapy (Setyawan *et al.,* 2014). Not surprisingly, cardamom is known as the "Queen of Seasoning" because it is the third most expensive herb, after turmeric and vanilla, but it also has various benefits such as being easily found in nature, having special tastes and odors, and containing high bioactive compounds.

Amomum compactum is one of the black cardamoms originating from genera of *Zingiberaceae* (Setiawan *et al.,* 2014). The genus *Amomum* has about 170 species (Lamxay, 2011 in Silalahi, 2017), which are dominantly distributed in the tropical countries, especially in Southeast Asia. *A. compactum* is a native plant of Indonesia consist of two types include false cardamom or Java cardamom (*A. compactum* Soland ex. Maton) and true cardamom *(Elettaria cardamomum* (L.) Maton or *A. cardamomum* L.*)*. Java cardamom is a member of the genus *Amomum* which is the second largest genus after Alpinia in the *Zingiberaceae* family and the Zingiberales order (Setyawan *et al.,* 2014). However, A. compactum Soland ex. Maton is used more often instead of the *Elettaria cardamomum* (L.) Maton, whereas green cardamom has a higher economic value in international trade.

Cardamom has been years used as aromatic herbaceous. The aroma produced by the plants is related to the volatile sesquiterpenoid or monoterpenoid content at room temperature. *Amomum compactum* contains about 60-80% cineole and other components such as α-pinene, β-pinene, camphene, limonene, ρ-cymene, α-terpineol and α-humulene (Feng *et al.,* 2011 and Lim, 2013 in Silalahi, 2017). Its distinctive aroma makes many people use it as aromatherapy and beneficial for respiratory medication such as influenza, infections, asthma, bronchitis, nausea, and for strengthening the nervous system (Ravindran 2002 in Qonita *et al.,* 2018).

The chemical properties of *Amomum compactum* were effective as a natural antimicrobial. It considered as a safe medicine compared to synthetic chemicals because of their carcinogenic effect, acute toxicity and environmental hazards (Akhtar *et al.,* 2014). Thus, consumption of *A. compactum* has been proven promising to control epidemic multi-drug resistant microorganisms (Mulyaningsih *et al.,* 2010).

METHODS

Leading references were searched electronically from 2010 up to 2020. The inductive approach was used to identify topics related to the bioactivity of Java cardamom as a natural antibacterial. While references that are not related to the review topic will be excluded. Twenty-six articles were identified and the content that contributed to the Java cardamom as antimicrobial were involved. The bioactive compound and the contributions of the Java cardamom for health were explored. Furthermore, comparison among bioactives reflects the potential contained in Java cardamom.

RESULTS AND DISCUSSION

Antimicrobial compounds

Sixty to eighty percent of cineole contained by cardamom seeds, with types 2,9-dihydroxy-1,8-cineol and 2,4-dihydroxy-1,8-cineol. The rest are α-pinene, β-pinene, camphene, limonene, ρ-cymene, α-terpineol and α-humulene and 2,2 '-methylene bis [6- (1,1-dimethyletyl) -4-ethyl] phenol (Lim, 2013; Sukandar, 2015). According to Widowati (2015), phenolic compound of *A. compactum* is considered high (Widowati *et al.,* 2015).

The content of essential oils in cardamom fruit varies between 2-5% with the main composition of 1.8% cineole (up to 70%) and α-pinene (16%) (Lim, 2013; Pudjiarti, 2019). In addition, cardamom essential oil also contains α-Terpinyl acetate, linalyl acetate, linalool, sabinene and limonene (Mutlu-Ingok and Karbancioglu-Guler, 2017). Other study by Utami (2013) showed that cardamom contains essential oils, saponins and flavonoids. While alkaloid, tannin, polyphenol, saponin, flavonoid and triterpenoid were observed in a study by Afrina *et al.* (2016).

Antimicrobial activity of A. compactum

According to Zaidi *et al.* (2012), cardamom has an anti-*Helicobacter pylori* activity, known as bacteria, related gastric cancer that are more frequent in developing countries such as India, Pakistan and Bangladesh. *Amomum compactum* also contributing in protect stomach from gastric ulcer. Together with turmeric and Sembung leaf, they built a gastroprotective effect (Mutmainah and Nugroho, 2013). Similarly, Mutlu-Ingok and Karbancioglu-Guler (2017) reported the antibacterial activity of cardamom against other causative agents of gastroenteritis, *Campylobacter jejuni* and *Campylobacter coli*. Furthermore, Romulo *et al.* (2018) observed that *A. compactum* are very helpful in curing oral disease and acne. Cineole of the cardamom essential oil is a potential antiseptic that was sensitive against bacteria in oral cavities that produce bad breath and other infection such as *Streptococcus mutans* and *Candida albicans* (Aneja and Radhika, 2009; Sharma, 2012). Similar report also stated that *A. compactum* effective against *Porphyromonas gingivalis* by reducing volatile sulphur compounds concentration (Erawati *et al.,* 2014), or by minimize the methyl mercaptant produced by the pathogen (Utami *et al.,* 2012) and *Aggregatibacter actinomycetemcomitans* by inhibit the pathogen growth (Afrina *et al.,* 2016). Agustin (2019) also studied about antibacterial activity test against the bacteria *Streptococcus mutans,* other pathogen that cause *halitosis,* using edible film formulation from cardamom fruit ethanol extract. The cineol of cardamom fruit has showed an inhibition zone value of antibacterial activity that can reduce *halitosis*.

Ethanol extract from dried cardamom showed the highest antibacterial activity in *Streptococcus pyogenes* which was shown with inhibition zone of 1425.96 mm^2 (Utami, 2013). The half-dried cardamom ethyl acetate extract showed the highest antibacterial activity in *Escherichia coli* which was shown with an inhibition zone area of 751.64 mm^2. The results of the study also showed the minimum inhibitory concentration of cardamom extract against *Streptococcus pyogenes* bacteria at a concentration of 2.5% and against the *Escherichia coli* bacteria at a concentration of 5%.

Various studies have shown that *A. compactum* seeds potential to inhibit various microbes such as *Staphylococcus aureus* and *Escherichia coli* which are influenced by the solvent used in the extraction method (Silalahi, 2017). Not only method of oil extraction, genetic and environmental condition has been known contributed to oil production (Setyawan *et al.,* 2014). *Staphylococcus aureus* and *Escherichia coli* are both normal flora and can produce exotoxins that cause diarrhea, both in humans and animals. Sari *et al.* (2014) suggested that the ethanol extract of *A. compactum* seeds can inhibit various microbes such as *Staphylococcus aureus* and *Escherichia coli.* While Sukandar *et al.* (2015) proved that ethyl acetate extract from *A. compactum* seeds had antibacterial activity against *S. aureus* and *E. coli* with inhibition zone diameters of 15.15 ± 1.34 and 13.50 ± 0.70 mm, respectively. Different method in a study by Anugrah *et al.* (2018) also showed positive result where topical *Amomum compactum* Soland ex Maton-base cream challenged with *S. aureus*.

Mechanism of action of cardamom antimicrobial bioactive against pathogenic microorganisms

It was explained earlier that in cardamom essential oils contain high cineole which is a bioactive that kill bacteria. When cardamom essential oil is used as a mouthwash, methyl mercaptan produced by *Porphyromonas gingivalis*, the bacteria cause unpleasant odors in halithosis can be reduced. This is because cardamom essential oils are able to break down the cell membrane of pathogens which will inhibit bacterial growth until death (Utami, 2012; Erawati *et al.,* 2014). Javanese cardamom essential oils are able to inhibit the formation of biofilms produced by MRSA and biofilms are known as bacterial protectors composed of an extracellular polymer matrix that can protect it against the host immune system (Sari *et al.,* 2013).

The spices also have a strong inhibitory effect on IL-8 secretion caused by *H. pylori* or generation of reactive oxygen species (ROS) in gastric epithelial cells in cases of gastric cancer (Zaidi *et al.,* 2012). It has also been reported that the cardamom's antibacterial activity against other causative agents of gastroenteritis, *Campylobacter jejuni* and *Campylobacter coli* by damaging bacterial cell membranes (Mutlu-Ingok and Karbancioglu-Guler, 2017). Afrina *et al.* (2016) stated that the alkaloids and tannins contained in Javanese cardamom were able to inhibit DNA replication *of A. actinomycetemcomitans*. Flavonoids cause cell wall permeability to disappear and interfere with the formation of bacterial cell membranes and cell walls, which affect cell growth disorders. Pathogen cell death is believed to be the result of polyphenols which are capable in disrupting the physiological functions of bacteria. The phenolics are capable in delaying the microbial invasion and avoiding the decomposition.

CONCLUSION

The result of our study suggesting *Amomum compactum* Soland ex Maton possess considerable antibacterial capacity. The bioactive compound showed various antibacterial activity that recommend *Amomum compactum* Soland ex Maton as potential natural antibacterial.

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