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The Effect of NaCl Content Reduces Diarrhea Problems as Well as the Efficacy of *Citrus Aurantifolia* in It

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Abstract: Lime peel contains saponins, flavonoids, alkaloids, tannins, and essential oils that have antibacterial activity. This study aims to explain the relationship between the use of lime peel as a traditional medicine and its bioactivity. Antibacterial activity testing used a Completely Randomized Design (CRD) spray method. The concentrations of lime peel extract used were 12.5, 25, 37.5, and 50%. The positive control used ciprofloxacin and the negative control was 10% DMSO. The results obtained were analyzed by Quasi-Experimental test. The use of plants as traditional medicine is related to their bioactivity and secondary metabolite content. Various researchers have successfully proven the bioactivity of lime peel, namely anticholesterol, antimicrobial, antioxidant, antihypertensive, antiosteoporosis, and anticancer. The concentration and length of contact time are directly proportional to the inhibitory power of CA water against Staphylococcus aureus bacteria. The bioactivity of CA extract as an antimicrobial is influenced by various factors, including the type of microbe, concentration, and contact time. This new study shows that lime peel has the benefit of killing harmful bacteria, such as Escherichia coli, which causes diarrhea. The vitamin C and antioxidants in lime peel are believed to be able to ward off these bacteria.

Keywords: *Citrus aurantifolia*; Diare; NaCl; Reduces diarrhea problem

Introduction

Lime (*Citrus aurantifolia*) is one of the plants that has a therapeutic effect to overcome diseases caused by bacteria. The part of the lime plant that is widely used today is the fruit. Antibacterial activity is not only possessed by the lime fruit, but also by its leaves (Ugwuoke et al., 2024). According to Triayu in Elachouri et al. (2023), lime leaves contain limonene, linalool, camphor lemon, fellandrene, geranyl acetate, cadinene, linalin acetate, citric acid, resin, minerals, vitamin B1, and vitamin C. Limonene and linalool are the main active compounds that act as antibacterials that are able to inhibit the growth of bacteria. All active compounds contained in lime leaves will be used to test the potential of lime leaves as antibacterial, namely in the form of crude lime leaf extract (Ishaq et al., 2022). The results of the study showed that the average diameter of the barrier zone of lime to the growth of *Salmonella aureus* was 21.37 mm and *Escherichia coli* was 23.43 mm.

According to research conducted by Pertiwi in Ojha et al. (2023), lime leaf essential oil has inhibitory activity against *Staphylococcus aureus* at concentrations of 20, 40, and 80% and *Escherichia coli* at concentrations of 40 and 80% (Chen et al., 2021). Therefore, it can be said that the right concentration of lime leaf extract as an antibacterial is between 40 and 80%, and in this study also used lower and higher concentration variations, namely 20, 60, and 100% to compare the results with the right concentration. In this study, the potential of lime leaves as an antibacterial will be tested against *Staphylococcus epidermidis* and *Pseudomonas aeruginosa* (Bešlo et al., 2023). The effectiveness of lime fruit as an antibacterial has been widely researched. Nurkalimah in Hafeez et al. (2023) conducted an antibacterial power test of lime juice

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against *Staphylococcus aureus* and *Escherichia coli* using the disc diffusion method (Chassagne et al., 2022).

The test proved that lime juice had an antibacterial effect, but there was no significant difference in inhibition of growth of *Salmonella aureus* and *Escherichia coli* (Cui et al., 2024). Mukhitasari in Paniagua-Zambrana et al. (2024) conducted an antibacterial activity test of lime juice against the growth of *Shigella dysenteriae* bacteria (Chen et al., 2021). This study used a variation in the concentration of the test solution of 0.78, 1.56, 3.12, 6.25, 12.5, 25, 50, and 100%. The results showed that there was antibacterial activity of lime juice against *Shigella dysenteriae* with a KHM value of 6.25% and the higher the concentration of lime juice used, the greater the inhibition against *S. dysenteriae* (Becerril-Sánchez et al., 2021). Previous pharmacological studies revealed that citrus fruits have antimicrobial, anthelminthic, antioxidants, anticancer and many other pharmacological effects.

Some studies have also used ethanol as a solvent for its extraction process. Ethanol extract and lime juice have also been studied by Salih in Lubis et al. (2023), who found that ethanol extract and lime juice have high effectiveness in inhibiting the growth of pathogenic bacteria that are successfully isolated from nasal swabs, which can cause inflammation and serious infections for asthma and sinusitis sufferers (Siti et al., 2022).

Method

Research Design

The research design used was a Quasi Experiment with a Non-Randomized Control Group Pretest Posttest Design.

Participant

The sample size was 30 respondents, which were selected based on inclusion and exclusion criteria.

Data Collection

Furthermore, respondents were given 30 ml of lime juice for 3 days. After that, the frequency of nausea and vomiting was measured on the 1st day before the administration of lime and the 4th day after the administration of lime (Yu et al., 2022).

Instrument

The lime given is a local lime (*Citrus aurantifolia*) grown in the Bintan area and has been tested in the laboratory for testing for vitamin B6, essential oil, vitamin C, citric acid, total flavonoids, essential oils, and vitamin B.

Result and Discussion

Result

Giving Lime Juice to relieve nausea, one way that can be done is to consume a warm lime juice drink. Acidic fruits, such as limes, can stimulate the production of saliva or saliva, which play an important role in breaking down nutrients in the digestive system. Simply imagining or hearing the word lime can increase saliva production, as the brain responds to acidic foods by stimulating the glands inside the mouth to produce more saliva. Furthermore, the flavonoid content in lime can neutralize digestive fluids that are acidic, as well as help in the process of eliminating toxins in the body.

Citrus aurantifolia

Rutaceae is one of the families whose species are widely used as food ingredients and traditional medicine. This family is characterized by the presence of essential oils so that it is easy to dig from its aroma. Lime or with the scientific name *Citrus aurantifolia* is one of the types that is widely used as traditional medicine. *Citrus aurantifolia* has a habitus in the form of shrubs to small trees, usually with many branches and thorns. Leaves are spirally arranged with a single-leaf seeded compound type, short stalks, leaf saplings in the shape of a prowl or round egg widened, 5−8 × 2−4 cm, with rounded edge shape, curled edges with blunt and sometimes punctured ends. Flowers appear solitary or strung in inflorescences with a maximum number of flowers up to 7. The fruits are greenish-yellow, the shape varies from rounded, jumbo or ovoid breech, with a diameter ranging from 4−5 cm, smooth with many oil glands, sarcocarp with 9-12 segments, very sour. The seeds are oval with milky white cotyledons (Liu et al., 2021). CA is a commercial fruit that has long been cultivated by the state. CA fruits have different acidity which is thought to occur due to differences in genetic variation. Kumar et al. (2013) analyzed 6 varieties of CA using ten primary random amplified polymorphic DNA (RAPD). The average genetic similarity in the 6 varieties is 60.5% (Karthikeyan & Karthikeyan, 2014).

Anti-Bacterial

The ability of CA extract to inhibit the growth of *Bacillus subtilis*, *Salmonella sp*., *Escherichia coli*, *Streptococcus faecalis* and Staphylococcus shows that CA extract has great potential to be used to treat gastrointestinal disorders and fever (Zhu et al., 2025), while the ability to inhibit *Staphylococcus aureus* has potential in the field of beauty, especially as an anti-acne (Zou et al., 2023) and wounds. CA fruit juice and fruit peel have anti-microbial activity that is pathogenic as well as anaerobic bacteria such as *Bacteroides spp*., *Porphyromonas spp*, and *Clostridium spp*. The bioactivity

of CA extract as an anti-microbial is influenced by various factors including the type of microbe, concentration, contact time (Gupta et al., 2021) and the compounds used for extraction. CA juice has an inhibition to the growth of *Staphylococcus aureus* bacteria with various concentrations of 25, 50, 75, and 100%. CA fruit peel extract inhibits the growth of *Mycobacterium tuberculosis* H37Rv which is sensitive and resistant to isoniazid, streptomycin and etambutol. The bioactivity of CA hexane extract is associated with the compound 5.8-dimethoxypsoralen and palmitic acid being the compounds with the most active activity as anti-microbacteria. The compound has activity (MICs = 25–50 µg/mL) (Puri et al., 2022).

Anti-Cancer

CA 6 µg/mL fruit peel extract induces apoptosis and cell accumulation in the G1 phase, while CPE 15 µg/mL induces apoptosis and cell accumulation in the G2/M phase (Shaik et al., 2023).

The combination of 200 nM doxorubicin with CA 6 µg/mL fruit peel extract increased the induction of apoptosis and cell accumulation in the G2/M phase rather than single administration (Shaik et al., 2023). The administration of CA only extract and the combination of CA and doxorubicin fruit peel extract was able to increase MCF-7 cell apoptosis as evidenced by the increased expression of p53 and Bcl-2 proteins (Komolafe et al., 2025). This suggests that CA fruit peel extract can be developed as a co-chemotherapy agent with doxorubicin in breast cancer cells (Munteanu & Apetrei, 2021).

Figure 1. Lime

Findings

CA 6 µg/mL fruit peel extract induces apoptosis and cell accumulation in the G1 phase, while CPE 15 µg/mL induces apoptosis and cell accumulation in the G2/M phase (Lu et al., 2022).

The combination of 200 nM doxorubicin with CA 6 µg/mL fruit peel extract increased the induction of apoptosis and cell accumulation in the G2/M phase rather than single administration (Christodoulou et al., 2022). The administration of CA-only extract and the combination of CA and doxorubicin fruit peel extract was able to increase the apoptosis of MCF-7 cells as evidenced by the increased expression of p53 and Bcl-2 proteins (Sun et al., 2022). This suggests that CA fruit peel extract can be developed as a co-chemotherapy agent with doxorubicin in breast cancer cells (Stobiecka et al., 2022).

CA fruit juice and fruit peel have anti-microbial activity that is pathogenic as well as anaerobic bacteria such as *Bacteroides spp., Porphyromonas spp,* and *Clostridium spp.* (Shen et al., 2022). The bioactivity of CA extract as an anti-microbial is influenced by various factors including the type of microbe, concentration, contact time (Liu et al., 2022) and the compounds used for extraction. CA juice has an inhibition to the growth of *Staphylococcus aureus* bacteria with various concentrations of 25, 50, 75, and 100% (Muflihah et al., 2021). The concentration and length of contact time are directly proportional to the inhibition of CA water against *Staphylococcus aureus* bacteria. The average diameter of the inhibition zone of *Staphylococcus sp*., *Escherichia coli*, *Klebsiella sp*., *Proteus sp*., and *Pseudomonas sp*. who were given CA extracts with a concentration of 5 µL of 10, 12, 11, 17, and 16 mm respectively.

Conclusion

Based on the results and discussion, it can be concluded that the bioactivity of CA extract as an antimicrobial is influenced by various factors, including the type of microbe, concentration, and contact time. Ethnobotanically, *Citrus aurantifolia* is used to treat fever, sauna ingredients, cough medicine, increase stamina, treat hypertension, and anticholesterol. The bioactivity of *Citrus aurantifolia* is anticholesterol, antimicrobial, antioxidant, antihypertensive, antiosteoporosis, and anticancer. The concentration and length of contact time are directly proportional to the inhibitory power of CA water against *Staphylococcus aureus* bacteria. The average diameter of the inhibition zone of *Staphylococcus sp*., *Escherichia coli*, *Klebsiella sp*., *Proteus sp*., and *Pseudomonas sp*. given CA extract with a concentration of 5 µL were 10, 12, 11, 17, and 16 mm, respectively. In conclusion, the results of this study have shown that *Citrus aurantiifolia* demonstrates significant anti-diarrhoeal activity and may be working through anti-secretory and anti-motility mechanisms or through inhibition of prostaglandin activities and/or synthesis.

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Authors Contributions
This article prepared by two people, namely: S.S. designed the study, wrote the manuscript, and analyzed the data; and C.G.P.R. carried out the laboratory work. All authors read and approved the final version of the manuscript.

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The authors declare that there are no competing interests.

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