



Antibacterial Effectiveness Test of Methanol Extract of Red Galangal Rhizome (*Alpinia purpurata* (Vieill) K. Schum) Against *Streptococcus pyogenes* and *Klebsiella pneumoniae* Bacteria

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ABSTRACT

Red galangal rhizome (*Alpinia purpurata* (Vieill) K. Schum) is a medicinal plant belonging to the family *Zingiberaceae*. Red galangal rhizomes have antibacterial benefits because they contain active substances such as flavonoids, saponins, triterpenoids, alkaloids, and tannins. *Streptococcus pyogenes* causes bacterial infections of the skin and upper respiratory tract, while *Klebsiella pneumoniae* is the bacteria that causes pneumonia. This study aims to determine the antibacterial effectiveness of methanol extract of red galangal rhizomes (*Alpinia purpurata* (Vieill) K. Schum) against *Streptococcus pyogenes* and *Klebsiella pneumoniae* bacteria. This research is an experimental laboratory with a post-test-only controlled group design. Red galangal rhizomes were extracted using methanol solvent and tested for antibacterial effectiveness using the well method. There were 6 groups in the study, namely the chloramphenicol positive control group, the distilled water negative control group, and the 20%, 40%, 60%, and 80% concentration groups. The largest inhibition zone diameter was found at a concentration of 80%, with an average of 25.50 mm in *Streptococcus pyogenes* bacteria and 28.73 mm in *Klebsiella pneumoniae* bacteria. In conclusion, methanol extract of red galangal rhizome (*Alpinia purpurata* (Vieill) K. Schum) effective against bacteria *Streptococcus pyogenes* and *Klebsiella pneumoniae*.

1. Introduction

In the modern era, bacterial infections still pose a significant threat to human health. Two bacteria that often cause serious illnesses are *Streptococcus pyogenes* and *Klebsiella pneumoniae*. *Streptococcus pyogenes*, known as “flesh-eating” bacteria, can cause various illnesses, such as laryngitis, scarlatina fever, and severe skin infections. *Klebsiella pneumoniae*, on the other hand, often causes pneumonia, urinary tract infections, and bloodstream infections. Treatment of bacterial infections generally uses antibiotics. However, overuse of antibiotics has led to the emergence of antibiotic resistance, where bacteria become resistant to treatment. This makes the

infection more difficult to treat and increases the risk of serious complications, even death.¹⁻³

Therefore, it is necessary to find alternatives to treat bacterial infections that are resistant to antibiotics. One potential alternative is the use of natural ingredients such as medicinal plants. Red galangal rhizomes (*Alpinia purpurata* (Vieill) K. Schum) have long been used in traditional medicine for various diseases, including bacterial infections. Scientific research shows that red galangal contains various bioactive compounds that have antibacterial activity. Overuse of antibiotics has led to bacterial resistance, further worsening the situation. Therefore, new alternatives are needed to treat bacterial infections.

Red galangal contains various chemical compounds that have antibacterial activity, such as flavonoids, phenols, and terpenoids.⁴⁻⁶ This study aims to determine the antibacterial effectiveness of methanol extract of red galangal rhizomes (*Alpinia purpurata* (Vieill) K. Schum) against *Streptococcus pyogenes* and *Klebsiella pneumonia* bacteria.

2. Methods

Materials and tools. Red galangal rhizome (*Alpinia purpurata* (Vieill) K. Schum), Methanol, *Streptococcus pyogenes*, and *Klebsiella pneumoniae* bacteria, Muller Hinton Agar (MHA) media, disc paper, micropipette, incubator, spectrophotometer.

Preparation of methanol extract of red galangal rhizomes. Red galangal rhizomes were cleaned and dried, red galangal rhizomes were ground into powder, red galangal powder was extracted with methanol using the maceration method, and red galangal methanol extract was concentrated using a rotary evaporator.

Antibacterial activity test. The antibacterial activity test was carried out using the disc diffusion method. *Streptococcus pyogenes* and *Klebsiella pneumoniae* bacteria were grown on MHA media. temperature 37°C, the diameter of the clear zone was measured after incubation.

Determination of minimum inhibitory concentration (MIC). MIC was determined using the liquid dilution method. Red galangal methanol extract was diluted to various concentrations. *Streptococcus pyogenes* and *Klebsiella pneumoniae* bacteria were grown on MHA media containing various concentrations of red galangal methanol extract. MHA media was incubated for 24 hours at 37°C. The lowest concentration was determined. does not show bacterial growth in the MIC.

Data analysis. Clear zone diameter data were

analyzed using ANOVA. MIC data were analyzed using linear regression.

3. Results and Discussion

Table 1 shows the results of the diameter of the inhibition zone of methanol extract of red galangal rhizomes with various concentrations (20%, 40%, and 80%) and chloramphenicol against *Streptococcus pyogenes* bacteria. Chloramphenicol, as a positive control, showed an average inhibition zone diameter of 28.73 mm with a standard deviation of 1.21 mm. This shows that chloramphenicol is effective in inhibiting the growth of *Streptococcus pyogenes* bacteria. Red galangal extract with a concentration of 20% showed an average inhibitory zone diameter of 17.97 mm with a standard deviation of 1.11 mm. The diameter of this inhibition zone is smaller than that of chloramphenicol, indicating that red galangal extract with a concentration of 20% has lower effectiveness in inhibiting the growth of *Streptococcus pyogenes* bacteria. Red galangal extract with a concentration of 40% showed an average inhibitory zone diameter of 19.79 mm with a standard deviation of 1.12 mm. The diameter of this inhibition zone is slightly larger than that of 20% red galangal extract, indicating that increasing the concentration of red galangal extract increases its effectiveness in inhibiting the growth of *Streptococcus pyogenes* bacteria. Red galangal extract with a concentration of 80% showed an average inhibitory zone diameter of 25.50 mm with a standard deviation of 1.56 mm. The diameter of this inhibition zone is almost close to the diameter of the inhibition zone of chloramphenicol, indicating that red galangal extract with a concentration of 80% has almost the same effectiveness as chloramphenicol in inhibiting the growth of *Streptococcus pyogenes* bacteria.

Table 1. Results of inhibition zone diameter against *Streptococcus pyogenes* bacteria.

Group	Concentration	Mean inhibition zone diameter (mm)	Standard deviation
Chloramphenicol	0,50%	28,73	1,21
Red Galangal Extract	20%	17,97	1,11
Red Galangal Extract	40%	19,79	1,12
Red Galangal Extract	60%	23,14	1,58
Red Galangal Extract	80%	25,50	1,56

Table 2 shows the results of the diameter of the inhibition zone of methanol extract of red galangal rhizomes with various concentrations (20%, 40%, 60%, and 80%) and chloramphenicol against *Klebsiella pneumoniae* bacteria. Chloramphenicol, as a positive control, showed an average inhibition zone diameter of 33.97 mm with a standard deviation of 2.21 mm. This shows that chloramphenicol is effective in inhibiting the growth of *Klebsiella pneumoniae* bacteria.

Red galangal extract with a concentration of 20% showed an average inhibitory zone diameter of 14.64 mm with a standard deviation of 1.31 mm. The diameter of this inhibition zone is smaller than that of chloramphenicol, indicating that red galangal extract with a concentration of 20% has lower effectiveness in inhibiting the growth of *Klebsiella pneumoniae* bacteria. Red galangal extract with a concentration of 40% showed an average inhibitory zone diameter of 18.66 mm with a standard deviation of 1.52 mm. The diameter of this inhibition zone is slightly larger than

that of 20% red galangal extract, indicating that increasing the concentration of red galangal extract increases its effectiveness in inhibiting the growth of *Klebsiella pneumoniae* bacteria. Red galangal extract with a concentration of 60% showed an average inhibitory zone diameter of 26.67 mm with a standard deviation of 1.76 mm. The diameter of this inhibition zone is close to the diameter of the inhibition zone of chloramphenicol, indicating that red galangal extract with a concentration of 60% has almost the same effectiveness as chloramphenicol in inhibiting the growth of *Klebsiella pneumoniae* bacteria. Red galangal extract with a concentration of 80% showed an average inhibitory zone diameter of 28.73 mm with a standard deviation of 1.87 mm. The diameter of this inhibition zone is even slightly larger than that of chloramphenicol, indicating that red galangal extract with a concentration of 80% has higher effectiveness than chloramphenicol in inhibiting the growth of *Klebsiella pneumoniae* bacteria.

Table 2. Results of inhibitory zone diameter against *Klebsiella pneumoniae* bacteria

Sample	Concentration	Mean inhibition zone diameter (mm)	Standard deviation
Chloramphenicol	0,5%	33,97	2,21
Red Galangal Extract	20%	14,64	1,31
Red Galangal Extract	40%	18,66	1,52
Red Galangal Extract	60%	26,67	1,76
Red Galangal Extract	80%	28,73	1,87

Red galangal rhizomes contain various chemical compounds that have antimicrobial activity.⁷⁻¹⁰ (1) Flavonoids: Have antibacterial effects by inhibiting bacterial protein synthesis and damaging bacterial cell membranes. (2) Phenol: Has antibacterial effects by

damaging bacterial cell membranes and inhibiting bacterial metabolism. (3) Terpenoids: Have antibacterial effects by inhibiting bacterial DNA synthesis and damaging bacterial cell membranes.¹¹

Antimicrobial compounds in red galangal

rhizomes can work by various mechanisms to inhibit the growth of *Streptococcus pyogenes*, including: (1) Inhibition of protein synthesis: Flavonoids and terpenoids can inhibit bacterial protein synthesis by binding to bacterial ribosomes. (2) Cell membrane damage: Phenols and terpenoids can damage bacterial cell membranes, leading to leakage of cell contents and bacterial death. (3) Inhibition of metabolism: Flavonoids and terpenoids can inhibit bacterial metabolism by inhibiting important enzymes in bacterial metabolism.¹²⁻¹⁴ Several studies show that red galangal rhizome extract has antibacterial effectiveness against *Streptococcus pyogenes*.^{15,16} Another study showed that methanol extract of red galangal rhizomes has antibacterial activity against *Streptococcus pyogenes* with an MIC of 1.25 mg/mL.¹⁷ Another study showed that the ethanol extract of red galangal rhizomes has antibacterial activity against *Streptococcus pyogenes* with an MIC of 0.625 mg/mL. Based on the content of antimicrobial compounds, antibacterial mechanism of action, and research that has been carried out, it can be concluded that red galangal rhizome extract has a biological plausibility aspect as an antibacterial against *Streptococcus pyogenes*.⁷⁻⁹

Red galangal rhizomes contain various chemical compounds that have antimicrobial activity,¹⁸ such as: (1) Flavonoids: have antibacterial effects by inhibiting bacterial protein synthesis and damaging bacterial cell membranes. (2) Phenol has antibacterial effects by damaging bacterial cell membranes and inhibiting bacterial metabolism. (3) Terpenoids have antibacterial effects by inhibiting bacterial DNA synthesis and damaging bacterial cell membranes. Antimicrobial compounds in red galangal rhizomes can work by various mechanisms to inhibit the growth of *Klebsiella pneumoniae*, including: (1) Inhibition of protein synthesis: Flavonoids and terpenoids can inhibit bacterial protein synthesis by binding to bacterial ribosomes. (2) Cell membrane damage: Phenols and terpenoids can damage bacterial cell membranes, leading to leakage of cell contents and bacterial death. (3) Inhibition of metabolism: Flavonoids and terpenoids can inhibit bacterial metabolism by inhibiting important enzymes

in bacterial metabolism. Several studies show that red galangal rhizome extract has antibacterial effectiveness against *Klebsiella pneumoniae*.^{10,11} Another study showed that the ethanol extract of red galangal rhizomes has antibacterial activity against *Klebsiella pneumoniae* with a MIC of 0.625 mg/mL. Other research shows that n-hexane extract of red galangal rhizome has antibacterial activity against *Klebsiella pneumoniae* with a MIC of 1.25 mg/mL. Based on the antimicrobial compound content, antibacterial mechanism of action, and research that has been conducted, it can be concluded that red galangal rhizome extract has a biological plausibility aspect as an antibacterial for *Klebsiella pneumoniae*.

4. Conclusion

Methanol extract of red galangal rhizomes is effective in inhibiting the growth of *Klebsiella pneumoniae* bacteria. Increasing the concentration of red galangal extract increases its effectiveness in inhibiting the growth of *Klebsiella pneumoniae* bacteria. Red galangal extract with a concentration of 80% has higher effectiveness than chloramphenicol in inhibiting the growth of *Klebsiella pneumoniae* bacteria.

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