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Antibacterial Activity of Turmeric Rhizome Extract (*Curcuma longa* Linn.) Against *Staphylococcus aureus*: A Systematic Literature Review

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ABSTRACT

Staphylococcus aureus is a normal flora that exists in the upper respiratory tract but can cause infection if found in amounts that are more than the normal limit (>110 CFU/ml). One of the herbal medicinal plants that is widely used in Indonesia is turmeric (*Curcuma longa* Linn.). Turmeric rhizome (*Curcuma longa* Linn.) contains active substances that have antibacterial properties, such as curcumin, flavonoids, alkaloids, saponins, and tannins. To determine the antibacterial activity of turmeric (*Curcuma longa* Linn.) rhizome extract against the growth of *Staphylococcus aureus* bacteria. This research method is a literature review study. Data collection techniques through Google Scholar, Science Direct, and Pubmed with a time limit of the last 5 years will be eliminated according to the restriction criteria. There were 2005 articles that were found and then excluded according to the restriction criteria. 15 articles were found to be reviewed. Turmeric rhizome extract (*Curcuma longa* Linn.) has antibacterial activity against *Staphylococcus aureus* bacteria.

1. Introduction

Staphylococcus aureus is a gram-positive bacterium and has a cocci shape, widely distributed in nature. Some live as normal flora in humans in the axilla, inguinal and perineal areas, and the nostrils anteriorly. Around 25-30% of people are infected with *Staphylococcus aureus* in the nasal cavity and deep skin. These bacteria are normal flora in the upper respiratory tract but can cause infection if found in amounts that are more than the normal limit (>110 CFU/ml). Thus the need for alternatives to overcome these problems through various antibacterial active ingredients derived from a plant.^{1,2}

In some tropical countries, such as Indonesia, various herbal plants are found with medicinal functions. The plant is turmeric. Turmeric contains

curcumin and essential oils, which are used for antioxidant, anti-cancer, antibacterial, digestive disorders, insect bites, and smallpox. Curcumin has significant antibacterial activity against several strains of both gram-positive and gram-negative bacteria. Extracts of water, methanol, ethanol, and hexane from *Curcuma longa* Linn. have demonstrated their antibacterial activity against *Staphylococcus aureus*. Antibacterial sensitivity test of various fractions of *Curcuma longa* Linn rhizome extract. The clinical isolates of these bacteria showed that all the rhizome fractions of *Curcuma longa* Linn. were highly active against the standard and clinical isolates of *Staphylococcus aureus*, which showed inhibition zones ranging between 9 mm and 21 mm.³⁻⁵

2. Methods

Search review articles used in this literature review using online-based databases, including Google Scholar, Science Direct, and PubMed, to search for evidence-based medicine journals with search keywords ("antibacterial activity" AND "turmeric rhizome" OR "Curcuma longa" OR "Curcuma longa Linn." AND "against *Staphylococcus aureus*"). The search location for *the review* used in this literature review is the place where the articles reviewed were carried out by previous researchers. Then in *setting*, the researchers set a time limit for the search to be 2017-2021 for the antibacterial activity of the turmeric rhizome (*Curcuma longa* Linn.) bacteria against

Staphylococcus aureus. Search abstracts of articles using the PRISMA (preferred reporting items for systematic review and meta-analyses) method. After getting the articles according to the desired inclusion criteria, the researcher then analyzed the study data qualitatively or narratively.

3. Results and Discussion

From the search results found 2005 journals consisting of 998 Google scholar, 7 Pubmed, and 1000 Science Direct. Of the total articles, 15 articles remained after going through full-text screening using the eligibility criteria.

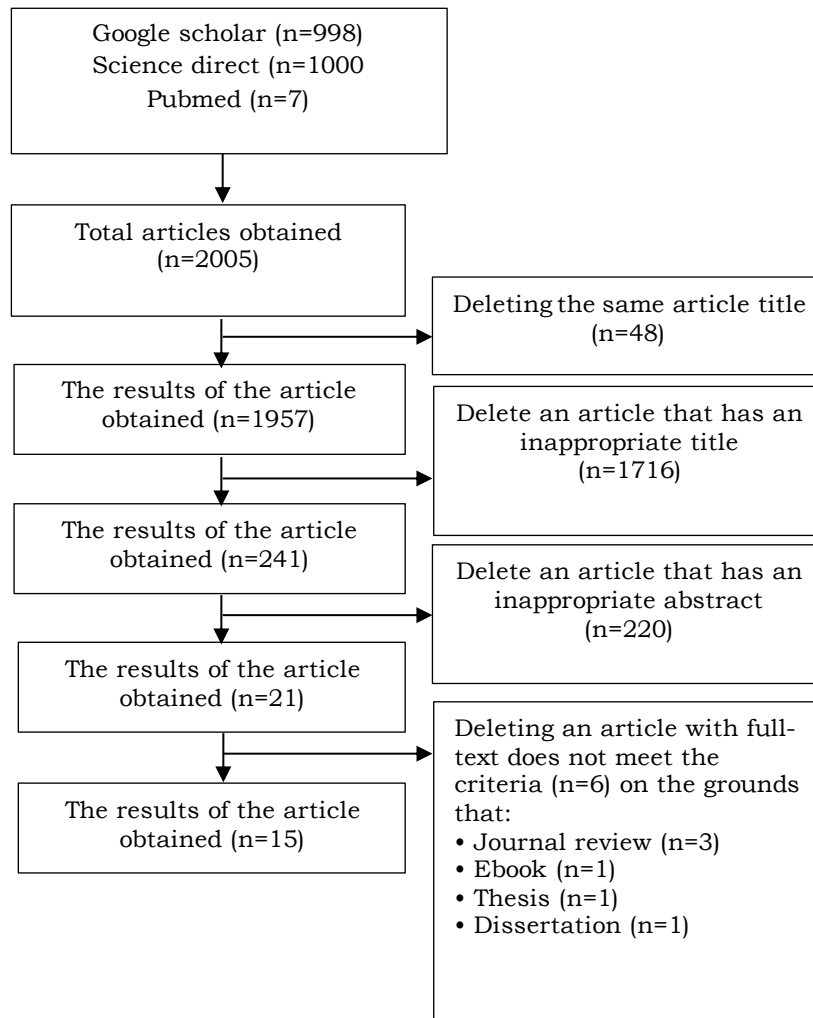


Figure 1. Flow chart screening diagram of PRISMA

Table. 1 Study analysis

No	Solvent extraction	Method	Bacterial test	Research results
1	Ethanol	Diffusion method and dilution method	<i>Staphylococcus aureus</i>	The antibacterial activity of turmeric extract (<i>Curcuma longa</i> Linn.) showed an inhibition zone of about 16 mm against <i>Staphylococcus aureus</i> . Meanwhile, the minimum inhibitory concentration and the minimum bactericidal concentration were 62.5mg/ mL and 125 mg/ mL, respectively. ⁶
2	Dimethyl sulfoxide	Diffusion method	<i>Staphylococcus aureus</i>	<i>Curcumin</i> is active against <i>Staphylococcus aureus</i> with inhibition zones of 8.0 mm, 12.0 mm, and 12.2 mm at concentrations of 1, 10, and 20 mg/mL. While the inclusion of complex Cur-HP β CD with increased solubility showed inhibition zones of 9.05 mm, 13.43 mm, and 15.15 mm against <i>Staphylococcus aureus</i> . ⁷
3	Ethanol	Diffusion method	<i>Staphylococcus aureus</i>	Antibiotic discs 1, 2, 3, and 4 containing turmeric extract (concentrations 100 mg, 50 mg, 12.5 mg, and 6.25 mg) have shown inhibition zones in pure cultures of <i>Staphylococcus aureus</i> with turmeric extract obtained by hot extraction. Antibiotic sensitivity disks 1, 2, and 3 (concentrations 100 mg, 50 mg, and 25 mg) also showed inhibition zones with turmeric extract obtained from cold extraction. obtained concentration minimum inhibitory <i>Staphylococcus aureus</i> from the hot extraction of turmeric rhizome ethanol (<i>Curcuma longa</i> Linn.) at a concentration of 12.5 mg, while for extraction, it was found at a concentration of 25 mg. ⁸
4	Methanol	Diffusion method	<i>Staphylococcus aureus</i>	The methanol extract of turmeric rhizome (<i>Curcuma longa</i> Linn.) showed inhibition zones of 11 mm and 17 mm with concentrations of 10 mg/mL and 100 mg/ mL against <i>Staphylococcus aureus</i> . ⁹
5	Water	Diffusion method	<i>Staphylococcus aureus</i>	The aqueous extract of turmeric rhizome (<i>Curcuma longa</i> Linn.) showed antibacterial activity against <i>Staphylococcus aureus</i> with an inhibition zone of 3,50 \pm 0.28 mm. ¹⁰
6	Ethanol	Diffusion method	<i>Staphylococcus aureus</i>	Inhibition zone of ethanol extract of turmeric rhizome (<i>Curcuma longa</i> Linn.) against <i>Staphylococcus aureus</i> obtained an average value of 15.63 mm at a concentration of 500 mg/mL, 10.92 mm at a concentration of 400 mg/mL, 9,33 mm at a concentration of 300 mg/mL, 8.85 at a concentration of 200 mg/mL, 8.83 at a concentration of 100 mg/mL, 7.88 mm at a concentration of 50 mg/mL, and 7.03 mm at a concentration of 25 mg /mL. ¹¹
7	Water, Ethanol, and Methanol	Diffusion method	<i>Staphylococcus aureus</i>	Aqueous, ethanol, and methanol extracts of turmeric rhizome (<i>Curcuma longa</i> Linn.) have inhibition zones of 22 \pm 0.03 mm, 25 \pm 0.03 mm, and 23 \pm 0, respectively. 03 mm against <i>Staphylococcus aureus</i> . ¹²
8	Water and Ethanol	Diffusion method	<i>Staphylococcus aureus</i>	Antibacterial activity of aqueous and ethanol extracts of turmeric (<i>Curcuma longa</i> Linn.) rhizome at different concentrations (1.0 mg, 1.5 mg, or 2.0 mg and or 3.0 mg). The results showed that at the level of 10 l of aqueous extract of turmeric rhizome, no zone of inhibition (in mm) was observed against <i>Staphylococcus aureus</i> . However, the ethanol extract of turmeric rhizome powder showed significant results on the highest antibacterial activity against <i>Staphylococcus aureus</i> . ¹³
9	Methanol and ethyl acetate	Diffusion method	<i>Staphylococcus aureus</i>	The inhibition zone for the methanolic extract of turmeric (<i>Curcuma longa</i> Linn.) against <i>Staphylococcus aureus</i> was 17 mm. Meanwhile, the inhibition zone of turmeric ethyl acetate extract against <i>Staphylococcus aureus</i> showed a value of 13 mm. ¹⁴
10	Dimethyl sulfoxide	Diffusion method	<i>Staphylococcus aureus</i>	Extract of turmeric (<i>Curcuma longa</i> Linn.) rhizome showed inhibition zones of 39 mm and 49 mm for 50% and 100% against <i>Staphylococcus aureus</i> . ¹⁵
11	Ethanol	Dilution method	<i>Staphylococcus aureus</i>	Result of minimum inhibitory concentration (MIC) <i>Curcuma longa</i> Linn. Able to inhibit the growth of <i>Staphylococcus aureus</i> at a concentration of 10 mg/ml and a minimum bactericidal concentration (KBM) at a concentration of 20 mg/ml, no bacterial growth was found on LB agar. ¹⁶
12	Ethanol	Diffusion method	<i>Staphylococcus aureus</i>	Homemade turmeric sample extract had the highest inhibition zone (17.03 \pm 0.30 mm) against <i>Staphylococcus aureus</i> with a concentration of 500 mg/mL.
13	Ethanol	Diffusion method	<i>Staphylococcus aureus</i>	Ethanol extract of turmeric rhizome (<i>Curcuma longa</i> Linn.) showed a maximum inhibition zone of about 7.0 mm at a concentration of 300 mg/ ml against <i>Staphylococcus aureus</i> . ¹⁷
14	Ethanol and chloroform	Diffusion method	<i>Staphylococcus aureus</i>	Ethanol extract of turmeric rhizome (<i>Curcuma longa</i> Linn.) showed antibacterial activity against <i>Staphylococcus aureus</i> and <i>Methicillin-Resistant Staphylococcus aureus</i> with inhibition zones of 12.17 \pm 0.29 mm and 10.67 \pm 0.58 mm, respectively. Meanwhile, turmeric rhizome chloroform extract (<i>Curcuma longa</i> Linn.) did not show any inhibition zones. ¹⁹
15	Ethanol	Diffusion method	<i>Staphylococcus aureus</i>	The test results showed that curcumin has antibacterial activity against <i>Staphylococcus aureus</i> , with the strongest curcumin activity observed at a concentration of 0.50 mg/ml resulting in a maximum inhibition zone of 14.7 mm. ²⁰

Characteristic results of research articles on the antibacterial activity of turmeric rhizome extract (*Curcuma longa* Linn.) against *Staphylococcus aureus* are shown in Table 1. Two research journals were found that did not have antibacterial activity against *Staphylococcus aureus*, while another study, showed *Staphylococcus aureus*. The aqueous extract of turmeric (*Curcuma longa* Linn.) rhizome at a concentration of 1 mg/ml did not show any inhibition zones against *Staphylococcus aureus*. Turmeric rhizome chloroform extract showed no inhibition zone against *Staphylococcus aureus*. This result contradicts thirteen other pieces of literature that discuss that turmeric rhizome extract (*Curcuma longa* Linn.) has antibacterial activity against *Staphylococcus aureus*. This difference in results may be due to differences in the solvent used for extraction and the large concentration of extract used.⁶⁻¹⁰

The methanol and ethanol extracts of turmeric (*Curcuma longa* Linn.) rhizomes against *Staphylococcus aureus* had higher antibacterial activity than aqueous extracts. This is due to the difference in polarity of each solvent. Solvent polarity refers to the dielectric constant, wherein the dielectric constant is defined as the solvent polarity index. Methanol has a dielectric constant of 32.7 while ethanol is 24.5, acetone 21, chloroform 4.81, diethyl ether 4.267, and water 80. The greater the dielectric constant, the greater the polarity. However, highly polar solvents such as water and non-polar solvents such as ethyl ether are not suitable for extracting highly polar compounds. According to the principle of like dissolves like, a compound will dissolve in a solvent of the same polarity. Therefore, polar compounds will dissolve in polar solvents, and non-polar compounds will dissolve in non-polar solvents. Examples of polar solvents are water, acetonitrile, methanol, and ethanol. While non-polar solvents are acetone, chloroform, and ethyl ether.¹¹⁻¹⁶

The results of the analysis of the antibacterial activity of the turmeric rhizome extract (*Curcuma longa* Linn.) found that the methanol and ethanol extracts of the turmeric (*Curcuma longa* Linn.) rhizome extract

had a larger inhibition zone than other extracts on *Staphylococcus aureus* bacteria. The diameters of the largest inhibition zones for *Staphylococcus aureus* were 25 mm and 22 mm at a concentration of 2000 mg/ml methanol extract and ethanol extract of turmeric (*Curcuma longa* Linn.) rhizome.¹⁴⁻¹⁷

There is a difference in the value of the minimum inhibitory concentration between hot extraction of ethanol and cold extraction of turmeric rhizome ethanol (*Curcuma longa* Linn.). This is because when using the hot extraction method, the ethanol solvent is volatile because it has a low boiling point of around 70°C, so the extraction of the active compound from the turmeric rhizome (*Curcuma longa* Linn.) is higher than using cold extraction. Turmeric rhizome extract (*Curcuma longa* Linn.) has a higher antibacterial activity than turmeric extract obtained from the open market. This is because when extracted with ethanol, the homemade turmeric extract produces more active compounds such as flavonoids, alkaloids, saponins, terpenoids, and curcuminoids compared to turmeric rhizome extract from the open market.¹⁸

The results of phytochemical screening of the ethanol extract of turmeric rhizome (*Curcuma longa* Linn.) showed the presence of alkaloids, flavonoids, saponins, tannins, and curcumin. The mechanism of action of alkaloids as an antibacterial against *Staphylococcus aureus* is by inhibiting nucleic acid synthesis by inhibiting the enzymes dihydrofolate reductase and topoisomerase I. The mechanism of action of alkaloids is to interfere with the components that make up peptidoglycan in a bacterial cell so that the cell wall layer is not formed intact and causes cell death. Flavonoids have a bacteriolytic effect against *Staphylococcus aureus*, inhibit protein synthesis, DNA, and RNA synthesis and damage the permeability of bacterial cell membranes. The mechanism of action of saponins as an antibacterial is causing lysis of bacterial cell walls and leakage of AKP (alkaline phosphatase). Increasing the concentration of saponins causes proteins to become soluble, causing intracellular compounds to diffuse through the outer membrane and cell walls. As a result, there is a

leakage of the cytoplasm so that the compounds that are inside come out of the cell, which causes bacterial cell death. Tannins are water-soluble polyphenolic compounds that can precipitate proteins. Tannins have antibacterial activity by precipitating bacterial protein, causing protein as a nutrient for *Staphylococcus aureus* to be no longer available. The mechanism of action of curcumin as an antibacterial is to cause changes in gene expression, inhibit bacterial DNA replication, and disrupt bacterial cell membranes.^{19,20}

4. Conclusion

Turmeric rhizome extract (*Curcuma longa* Linn.) has antibacterial activity in inhibiting the growth of *Staphylococcus aureus*.

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