World Journal of Biology Pharmacy and Health Sciences
eISSN: 2582-5542
Cross Ref DOI: 10.30574/wjbphs
Journal homepage: https://wjbphs.com/

(RESEARCH ARTICLE)

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Evaluating the antimicrobial properties of garlic and turmeric against *Escherichia coli* and *Staphylococcus aureus*

HARINI GOLI *

Bi. P. C, VINJEE Junior College, Kukatpally, Hyderabad, Telangana, India.

World Journal of Biology Pharmacy and Health Sciences, 2024, 20(03), 642-644

Publication history: Received on 19 November 2024; revised on 26 December 2024; accepted on 28 December 2024

Article DOI: https://doi.org/10.30574/wjbphs.2024.20.3.1090

Abstract

The growing challenge of antibiotic resistance necessitates exploring alternative antimicrobial agents. This study investigates the antimicrobial properties of garlic (*Allium sativum*) and turmeric (*Curcuma longa*) against *Escherichia coli* (Gram-negative) and *Staphylococcus aureus* (Gram-positive). Using an agar diffusion assay, bacterial inhibition zones were measured after applying garlic and turmeric extracts alongside a standard antibiotic (amoxicillin). Garlic showed larger inhibition zones than turmeric, highlighting its superior antimicrobial efficacy. The findings indicate that garlic and turmeric have significant potential as complementary therapies to mitigate bacterial infections and reduce reliance on synthetic antibiotics.

Keywords: Antimicrobial Properties; Garlic (*Allium sativum*); Turmeric (*Curcuma longa*); *Escherichia coli*; *Staphylococcus aureus*; Antibiotic Resistance; Natural Antimicrobials; Biofilm Inhibition; Multi-Target Mechanisms

1. Introduction

Antibiotics have revolutionized medicine, saving millions of lives by combating bacterial infections. However, the overuse and misuse of antibiotics have led to the rise of antibiotic-resistant bacteria, posing a significant public health threat worldwide.[3] To address this challenge, researchers are exploring natural antimicrobials as alternatives or supplements to synthetic antibiotics.

Garlic and turmeric are two such natural products known for their medicinal properties. Garlic contains allicin, a sulfur-containing compound that disrupts multiple bacterial processes, making developing resistance difficult. Conversely, turmeric contains curcumin, which interferes with bacterial communication systems (quorum sensing) and inhibits biofilm formation, reducing bacterial virulence.

This study aims to compare the effectiveness of garlic and turmeric extracts against two bacteria: *Escherichia coli*, a Gram-negative bacterium with a protective outer membrane that often confers resistance, and *Staphylococcus aureus*, a Gram-positive bacterium with simpler cell wall structures. The findings will provide insights into the feasibility of using these natural products to complement existing antibiotic therapies.

2. Materials and Methods

2.1. Materials

- Fresh garlic (*Allium sativum*) and turmeric (*Curcuma longa*)
- Ethanol (as a solvent for extraction)

* Corresponding author: HARINI GOLI.

- Agar plates for culturing bacteria
- Bacterial strains:
    - *Escherichia coli* (harmless laboratory strain representing Gram-negative bacteria)
    - *Staphylococcus aureus* (harmless laboratory strain representing Gram-positive bacteria)
- Amoxicillin discs (10 μg), a standard antibiotic for comparison

2.2. Methodology

- **Preparation of Extracts**: Garlic cloves were peeled and crushed to release allicin. Similarly, turmeric rhizomes were ground into a paste. Each was mixed with ethanol in a 1:5 ratio (weight/volume) and filtered using sterile gauze to obtain clear extracts.
- **Culturing Bacteria**: *E. coli* and *S. aureus* were grown in nutrient broth overnight and then spread uniformly onto sterile agar plates using a cotton swab.
- **Agar Diffusion Assay**: Small wells (6 mm diameter) were punched into the agar using a sterile cork borer. Each well was filled with 50 μL of garlic or turmeric extract. Amoxicillin discs were placed on the same plates as a control. Plates were incubated at 37 °C for 24 hours.
- **Measurement**: Zones of inhibition (clear areas around wells where bacteria did not grow) were measured in millimetres using a ruler. Larger zones indicated stronger antimicrobial activity.

3. Results

The results revealed significant differences in antimicrobial activity between garlic, turmeric, and the antibiotic control:

Table 1 Comparison of Antimicrobial Activity of Garlic, Turmeric, and Amoxicillin Against *Escherichia coli* and *Staphylococcus aureus*

Bacterial Strain	Garlic (mm)	Turmeric (mm)	Amoxicillin (mm)
Escherichia coli	16	9	22
Staphylococcus aureus	18	11	24

- Garlic produced larger zones of inhibition than turmeric for both bacterial species.
- *Staphylococcus aureus* was more sensitive to both natural products compared to *Escherichia coli*.
- Amoxicillin, the standard synthetic antibiotic, had the largest inhibition zones for both bacteria.

4. Discussion

The findings suggest that garlic is a more potent antimicrobial agent than turmeric. Garlic's effectiveness can be attributed to allicin, which targets multiple bacterial systems, including enzymes involved in energy production and cell wall synthesis.[1] This multi-target mechanism reduces the likelihood of resistance development. Turmeric's moderate effectiveness aligns with its mechanism of action, where curcumin disrupts bacterial communication (quorum sensing) rather than directly killing the bacteria.[2]

The greater susceptibility of *S. aureus* compared to *E. coli* is likely due to structural differences. Gram-negative bacteria like *E. coli* have an additional outer membrane, which acts as a barrier against many antimicrobial agents. In contrast, the simpler cell wall of Gram-positive bacteria like *S. aureus* makes them more vulnerable.

Amoxicillin showed the highest efficacy but comes with the risk of resistance development. Combining garlic or turmeric with synthetic antibiotics could enhance their effectiveness while reducing reliance on high antibiotic doses, potentially slowing resistance development.

5. Conclusion

Garlic and turmeric extracts exhibit significant antimicrobial properties, with garlic being more effective against *E. coli* and *S. aureus*. These natural products hold promise as complementary antimicrobial agents, especially in combating

antibiotic resistance. Future studies could investigate the molecular mechanisms of these compounds and evaluate their efficacy against multidrug-resistant bacteria.

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