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Research Article

Antibacterial Activity of Curcuma longa L. Against Methicillin-resistant Staphylococcus Aureus in Shendi Town, Sudan

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ABSTRACT

Background: Turmeric (Curcuma longa) and its active compound curcumin are known for their antimicrobial properties and have shown promise against resistant pathogens like methicillin-resistant Staphylococcus aureus (MRSA).

Objective: This study aimed to evaluate the antimicrobial activity of Curcuma longa extract against MRSA isolates from Shendi Town, Sudan.

Methodology: An experimental study was conducted from January to March 2025. Fifty MRSA isolates were collected from clinical specimens and identified using standard microbiological methods. An ethanolic extract of turmeric rhizomes was prepared using cold percolation. The antibacterial activity of the extract at concentrations of 100%, 75%, and 50% was tested against MRSA using the agar well diffusion method, with vancomycin discs used as a positive control.

Results: All 50 *S. aureus* isolates were confirmed as MRSA (100% resistance to methicillin). The Curcuma longa extract exhibited concentration-dependent antibacterial activity. The 100% concentration inhibited 90% of isolates with a mean inhibition zone of 13 mm, the 75% concentration inhibited 60% (8 mm), while the 50% concentration showed no inhibition (7 mm). Vancomycin produced a significantly larger mean inhibition zone of 19 mm.

Conclusion: Curcuma longa extract possesses antibacterial activity against MRSA, which is most effective at high concentrations, though it is less potent than vancomycin. Further in vivo studies and advanced extraction techniques are recommended to enhance the potency and yield of active compounds.

KEYWORDS

Curcuma longa, Turmeric, Curcumin, MRSA, Antimicrobial activity, Antibiotic resistance, Sudan.

Introduction

Traditional medicine, as defined by the World Health Organization (WHO), encompasses the totality of knowledge, skills, and practices grounded in theories, beliefs, and experiences indigenous to different cultures. These practices, whether scientifically explicable or not, are employed for maintaining health as well as for the prevention, diagnosis, improvement, or treatment of physical and mental illnesses [1]. The rhizome of turmeric (Curcuma longa) has been widely used for centuries as an herbal remedy, food additive, coloring agent, and spice, particularly across Asian countries. It has been integrated into several traditional medical systems, including Islamic medicine, Chinese medicine, and Ayurveda, for the management of a broad spectrum of diseases [2]. Following the identification of curcumin as the principal bioactive constituent of turmeric, extensive pharmacological properties have been reported, including antimicrobial, antidiabetic, anti-inflammatory, anticancer, and antioxidant effects. Notably, curcumin has also demonstrated synergistic potential, enhancing the efficacy of conventional antibacterial, antifungal, anticancer, and antioxidant agents when used in combination [3]. The continuous emergence and dissemination of antibiotic resistance, coupled with the evolution of novel pathogenic strains, represent critical challenges to global health. Effective disease management depends heavily on the development of new pharmaceuticals, and traditional medicine constitutes a valuable reservoir for the discovery of novel therapeutic agents [4]. Over the last decade, methicillin-resistant Staphylococcus aureus (MRSA) has become a significant pathogen in both hospital-acquired and community-acquired infections. Compared with methicillin-sensitive *S. aureus* (MSSA), MRSA infections are associated with substantially higher hospitalization rates, increased healthcare expenditures, and broader socioeconomic consequences. Furthermore, accumulating evidence indicates that MRSA infections contribute to elevated morbidity and mortality rates [5]. Curcumin has been shown to interfere with bacterial virulence mechanisms. Specifically, it inhibits the expression of Sortase A (SrtA), a surface protein in *S. aureus* involved in bacterial adherence. In vivo experiments further revealed that curcumin reduces the ability of bacteria to adhere to host surfaces in a dose-dependent manner [6]. Antimicrobial resistance is a pressing public health threat worldwide. Given its well-documented antimicrobial properties, turmeric may represent a promising natural alternative for addressing this problem. Accordingly, the present study was designed to investigate the antimicrobial activity of different concentrations of turmeric against methicillin-resistant Staphylococcus aureus (MRSA) isolates from Shendi City, Sudan.

Methodology

Study Design and Duration

This research was designed as an experimental study and was conducted over three months, from January 2025 to March 2025.

Study Setting

The study was carried out in Shendi Town, located in northern Sudan on the southeastern bank of the Nile River, approximately 150 km northeast of Khartoum. Geographically, Shendi is situated between latitudes 18.17° N and longitudes 24.23° E, with coordinates 16°41,

Figure 1: *Curcuma longa L.* – turmeric rhizomes and powder.

N and 33°26° E, covering a total area of approximately 14,596 km². Clinical specimens were collected from Shendi hospitals and the surrounding community, and subsequently transferred to the Microbiology Laboratory at Shendi University for handling, isolation, and microbiological examination.

Study Population

The study population consisted of methicillin-resistant *Staphylococcus aureus* (MRSA) isolates obtained from both hospitalized patients and individuals from the community in Shendi.

Inclusion Criteria

All MRSA isolates were obtained from different types of clinical specimens of individuals with a confirmed positive MRSA culture.

Exclusion Criteria

Any bacterial culture negative for MRSA. Any patient or community individual suspected of MRSA infection but lacking confirmatory culture data.

Sample Size and Sampling

Various types of clinical specimens were collected between January 30, 2025, and February 17, 2025. From these specimens, a total of 50 isolates were confirmed as *Staphylococcus aureus* using standard microbiological procedures.

Data Collection

Data were collected using a self-administered questionnaire that contained specific and clear questions. Coding numbers were applied to facilitate data organization and analysis.

Collection of Plant Material

Dried rhizomes of turmeric (*Curcuma longa*) were purchased from the Atbara local market in January 2025. The rhizomes were cleaned, dried, and ground thoroughly into fine powder.

Preparation of Extract

Turmeric extracts were prepared in the Microbiology Laboratory, University of Shendi, on January 25, 2025, using the cold percolation method. Briefly, 100 g of dried turmeric rhizome powder was placed in a clean flask containing 1000 mL of 70% ethanol with continuous shaking. The mixture was kept soaked for 24 hours and subsequently percolated several times until the soaking solution became faint in color. The extract was then filtered using Whatman No. 1 filter paper and concentrated under reduced pressure using a rotary evaporator to remove the solvent. The final extract was stored at 4 °C until use [7].

Collection of Clinical Specimens

Clinical specimens, including wound swabs, nasal swabs, high vaginal swabs (HVS), eye swabs, sputum, and urine samples, were collected under aseptic conditions. Wound and nasal swabs were obtained using sterile cotton swabs moistened with sterile physiological saline, while urine samples were collected in sterile containers. All specimens were properly labeled and immediately transported to the laboratory for further processing.

Culture and Identification of Isolates

Clinical specimens were cultured on Mannitol Salt Agar (MSA), which is selective for *Staphylococcus aureus* and particularly useful for the isolation of MRSA. Depending on the type of specimen, additional media such as blood agar and Cystine Lysine Electrolyte Deficient (CLED) agar were also used for bacterial isolation and preliminary identification.

Culture Growth Interpretation

Colonies with a golden-yellow appearance, indicative of mannitol fermentation, were observed on the growth plates. These colonies were subsequently isolated and characterized based on colony morphology, indirect Gram staining, and biochemical tests.

Preservation of the Organism

The isolated pure cultures of the identified target organisms were incubated for 24 hours and then sealed with parafilm (or sole tape) and stored at 4°C in the refrigerator.

Methicillin Susceptibility Testing

Both the disk diffusion and MIC methods are used for the phenotypic determination of antibiotic susceptibility. The disk diffusion method, also known as the Kirby-Bauer test, is suitable for rapidly growing organisms. In this procedure, a standard turbidity solution (0.5 McFarland) is prepared and compared with the turbidity of the bacterial suspension. Using a sterile loop, 3–5 well-isolated colonies of the test organism are suspended in 3–4 mL of saline or nutrient broth. A sterile swab is then used to inoculate a Mueller-Hinton agar plate by streaking the swab over the surface in three directions to ensure even coverage. Antibiotic-impregnated disks are placed on the inoculated agar plates using sterile forceps. After incubation, typically for 16–18 hours, the diameter of the zone of inhibition around each disk is measured. The size of the clear zone indicates whether the organism is susceptible, intermediate, or resistant to the antibiotic, with specific interpretive criteria for each organism-antibiotic combination.

Preparation of *Curcuma longa* Extract for Antimicrobial Susceptibility Testing

The *Curcuma longa* extract was prepared at three different concentrations—100%, 75%, and 50%—to evaluate its activity against the isolated MRSA strains.

Preparation of Bacterial Suspension

Bacterial isolates obtained from various clinical specimens were first subcultured. Fifty milliliters of sterile normal saline were distributed into 50 separate glass tubes, each top-closed with sterile cotton, and sterilized in an autoclave at 121°C for 15 minutes. After sterilization, the tubes were allowed to cool. The isolated bacteria were then inoculated into the sterile saline tubes, and the turbidity of each bacterial suspension was adjusted to match the 0.5 McFarland standard.

Curcuma longa *Extract Testing Against Methicillin-Resistant* Staphylococcus aureus *(MRSA)*

The agar well diffusion method was employed, as it is widely used in microbiology laboratories for evaluating herbal extracts. For each of the 50 test tubes, 1 mL of sterile physiological saline was added. Several purified bacterial colonies were collected using a sterile loop and suspended in saline. The turbidity of each bacterial suspension was adjusted to match the 0.5 McFarland standard, using a well-illuminated background for accurate comparison. The standardized bacterial suspensions were then evenly distributed on Mueller-Hinton agar (MHA) plates using the swabbing technique. Wells of 5 mm diameter were prepared in the agar using a sterile Durham tube, and different volumes of *Curcuma longa* extract were added to these wells. Methicillin antibiotic disks (5 µg) were included on the plates as a control for comparison. After the complete distribution of the extract, the inoculated MHA plates were incubated at 37°C for 24 hours under aerobic conditions. Following incubation, the zones of inhibition around each well were visually measured and recorded in millimeters (mm) [8].

Data Collection and Analysis

A self-administered questionnaire was used and supported with coding numbers to facilitate the sorting of data. Data were entered, checked, and analyzed using Microsoft Excel 2007. The final results were presented as frequencies and percentages.

Results

A total of 50 *Staphylococcus aureus* isolates were obtained from swab specimens collected from various hospitals and the community in Shendi Town between January 2025 and February 2025. The study population consisted of 74% males (37/50) and 26% females (13/50), with an age distribution of 34% (17/50) between 20 and 40 years, 36% (18/50) between 41 and 60 years, and 30% (15/50) above 60 years. Specimens were collected from wounds in 76% (38/50) of cases, urine catheters in 12% (6/50), urine in 2% (1/50), high vaginal swabs in 2% (1/50), eye swabs in 2% (1/50), nasal swabs in 4% (2/50), and sputum in 2% (1/50). Regarding patient status, 76% of isolates were obtained from inpatients, while 24% were from outpatients. A history of chronic disease was reported in 20% (10/50) of patients and absent in 80% (40/50). Antimicrobial testing showed that methicillin (5 µg) exhibited 100% activity against all *S. aureus* isolates (Table 1). The antibacterial activity of *Curcuma longa* extract against MRSA varied with concentration, showing 90% inhibition at 100% concentration (45/50), 60% at 75% concentration (30/50), and no inhibition at 50% concentration (0/50) (Table 2). The mean diameters of inhibition zones produced by ethanolic *Curcuma longa* extract were 13 mm at 100% concentration, 8 mm at 75% concentration, and 7 mm at 50% concentration, compared to 19 mm for vancomycin (30 µg) (Table 3).

Table 1: Antimicrobial Activity of Methicillin (5µg) against *S. aureus* Isolates.

MRSA Status	No	Percent (%)
Resistant	50	100%
Sensitive	0	0%
Total	**50**	**100%**

Table 2: Antimicrobial Activity of Curcuma longa Extract against MRSA.

Concentration	No	Percent of Inhibition (%)
100%	45	90%
75%	30	60%
50%	0	0%

Table 3: Comparison of Inhibitory Zones: Curcuma longa Extract vs. Vancomycin.

Substance Tested	Mean Zone of Inhibition (mm)
Curcuma longa 100%	13
Curcuma longa 75%	8
Curcuma longa 50%	7
Vancomycin (30µg)	19

Discussion

This study was conducted to evaluate the antimicrobial activity of turmeric (*Curcuma longa*) extract against MRSA isolates obtained from clinical samples in Shendi Town between January and February 2025. A total of 50 *S. aureus* isolates were collected, all of which were confirmed as MRSA (100%). This high prevalence reflects the growing problem of antibiotic resistance in the region and underscores the urgent need for alternative antimicrobial agents. To assess the potential of *Curcuma longa* as an alternative or complementary therapy, ethanolic extracts at different concentrations (100%, 75%, and 50%) were tested against the MRSA isolates. The results demonstrated a clear concentration-dependent antimicrobial effect. At 100% concentration, 90% of isolates were inhibited, with a mean zone of inhibition of 13 mm. At 75% concentration, only 60% of isolates were inhibited (mean zone 8 mm), while the 50% concentration showed no inhibitory effect on any isolate (mean zone 7 mm), suggesting that the active components in turmeric are effective only at higher concentrations. When compared with vancomycin, a standard antibiotic used against MRSA, turmeric extract showed lower antibacterial activity. Vancomycin produced a mean inhibition zone of 19 mm, compared to a maximum of 13 mm for turmeric extract. These findings are consistent with previous studies, such as those by Lee et al. and Mun et al., which reported that curcumin exhibits moderate antibacterial activity and may be more effective when used in combination with antibiotics due to possible synergistic effects [9,10]. Similarly, a study by M.M. Abdul Aziz et al. confirmed that ethanolic extracts of turmeric rhizomes possess notable antibacterial activity against *S. aureus*, reinforcing the evidence for turmeric's efficacy as a natural antimicrobial agent [11]. Additional studies support these results. Aşkar et al. and Shimaa Saleh et al. reported selective activity of turmeric against *S. aureus* (including MRSA) with no effect on Gram-negative bacteria [7,12]. Furthermore, Kim et al. and Baitul Fatimah et al. observed improved antimicrobial performance using ethanol extracts of turmeric, likely due to better preservation of curcumin compared to aqueous extracts [13,14]. Maisa Alqahtani et al. demonstrated that curcumin, in combination with trans-resveratrol, may effectively treat MRSA infections by mitigating bacterial virulence and suggested that combining such compounds with conventional antibiotics could enhance antimicrobial efficacy through synergistic mechanisms.

The complete lack of inhibition at 50% concentration indicates a threshold effect, below which curcumin content is insufficient to exert antimicrobial action [15]. The alarming increase in bacterial strains resistant to current antimicrobial agents highlights the urgent need to develop new agents effective against these resistant pathogens. Novel antimicrobial agents are expected to address and overcome this growing problem [16]. This emphasizes the importance of optimizing extract concentration and exploring potential combinations with conventional antibiotics to improve efficacy. In summary, turmeric extract, particularly at higher concentrations, exhibits promising antimicrobial activity against MRSA, although it remains less potent than vancomycin. Future studies should investigate synergistic interactions between turmeric and antibiotics, elucidate mechanisms to enhance curcumin bioavailability, and further improve antibacterial performance.

Limitation

A limitation of this study is the use of a crude extract, where the exact concentration of curcumin is unknown. The relatively low solubility and bioavailability of curcumin may also explain its lower efficacy compared to vancomycin.

Conclusion

Curcuma longa extract exhibits concentration-dependent antibacterial activity against MRSA. The 100% concentration was the most effective, though its activity was lower than that of vancomycin. Turmeric shows potential as a complementary or alternative therapeutic agent against MRSA.

Recommendations

1. Further *in vivo* studies are needed to confirm the efficacy and safety of turmeric extract.
2. Advanced extraction and purification techniques should be employed to isolate and concentrate curcumin and other active compounds.
3. Future research should explore the synergistic effects of curcumin in combination with standard antibiotics against MRSA.
4. Investigation into the mechanism of action of turmeric against bacterial virulence factors is recommended.

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