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Research Article
International Journal of Pharmacy and Engineering (IJPE)
ISSN 2320-849X

Prophylaxis and Antibacterial Activity of Curcumin

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Abstract

Curcumin, a naturally occurring molecule with a variety of therapeutic uses, has been shown to be present in turmeric, a spice that is frequently used in Asian cooking. It has been discovered that curcumin works well against Staphylococcus aureus (S. aureus), a bacterium that causes a number of infections, including antibiotic-resistant ones. It has been demonstrated that curcumin works even better when combined with other antibacterial agents. This implies that curcumin may eventually be transformed into a potent antibiotic. Despite its potential, there are challenges to developing curcumin into a practical antibacterial agent. S. aureus infections are a major worldwide health concern, particularly those that are drug-resistant. However, curcumin may be the answer we need to fight these illnesses if we move quickly and conduct adequate study. Thus, it is imperative that we investigate curcumin's antibacterial capabilities against methicillin-resistant and methicillin-sensitive S. aureus (MSSA) and discuss the possible drawbacks of employing this organic substance as an antibiotic. In summary, curcumin has already demonstrated significant promise against S. aureus and may hold the key to future success in treating infections resistant to antibiotics. We can fully utilize curcumin and produce an effective weapon in the fight against infectious diseases by funding research and development.

Keywords – Turmeric, Curcumin, Antibacterial properties, bacterial growth,In -vitro .

Introduction

The active ingredient in turmeric, curcumin, has remarkable antibacterial properties through a variety of mechanisms: its structural characteristics and generation of antioxidation chemicals create an environment that is hostile to the growth of germs; it targets bacterial virulence factors, disrupts the formation of biofilms, and modulates the regulation of quorum sensing, which prevents bacteria from adhering to host cells; when combined with exposure to blue light, curcumin acts as a photosensitizer, preventing bacterial growth and causing phototoxicity; in addition to direct inhibition, curcumin has anti-inflammatory effects that reduce the severity of infections by controlling immune responses and inflammatory pathways; particularly noteworthy is its effectiveness against antibiotic-resistant strains, offering a solution to the urgent problem of antimicrobial resistance. Unlike traditional therapies, its unique manner of action lessens vulnerability to the development of resistance. Additionally, curcumin's wound-healing and antioxidant qualities enhance its therapeutic effectiveness, making it adaptable for use in tissue regeneration and wound care. Curcumin, which comes from natural sources, has a good safety record and few adverse effects, which makes it a desirable choice for people who prefer plant-based antibacterial treatments. In conclusion, curcumin is a promising therapeutic agent that effectively addresses the modern problems of bacterial infections and antibiotic resistance due to its wide range of capabilities.

Kingdom	**Plantae**
Subkingdom	Tracheobionts
Super Division	Spermatophyte
Division	Mangoliophyte
Order	Zingiberales
Family	Zingiberaceae
Genus	Curcuma
Species	Longa

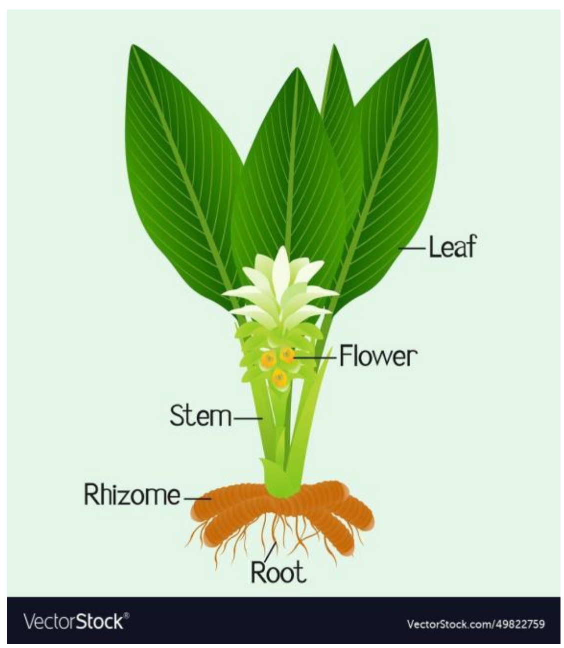

Figure 1 Figure 2

Methodology

This research covered all studies addressing the antimicrobial potential of curcumin approaches to improve the bioavailability of curcumin. For study selection, we used up-to-date databases, including Web of Science, Pubmed, Scopus, and Google Scholar. The keywords used in our search were "turmeric", "Curcuma longa", "curcumin", "curcuminoids", "infections" and "antimicrobial activities".

Materials required for the methodology

Plant Material: Fresh or dried parts of the cucurbitaceous plant (e.g., pumpkin, squash, cucumber). Typically, the seeds or roots are used for extraction.

Solvent:

- Ethanol or methanol (commonly used for extracting plant compounds).
- Acetone or chloroform can also be used in some cases.
- Water or a water-based mixture may be used for specific types of extractions, depending on the solubility of the compound.

Mortar and Pestle or Blender: To grind and crush the plant material to increase surface area for the solvent to act on.

Filtration Materials:

Cheesecloth or filter paper: To filter out plant debris after the extraction.

Rotary Evaporator (optional): For concentrating and removing the solvent under reduced pressure if you want to obtain a purified compound.

Heating Source: Some extraction methods require heating, so a heating plate or water bath may be necessary.

Separation Funnel (if using liquid-liquid extraction): For separating different layers of solvent after extraction.

Method of extraction

Curcuminoids were extracted by using Soxhlet extraction method Fresh rhizomes were cleaned, washed with deionized water, sliced and dried in the sun for one week and dried again at 50ºC in a hot air oven for six hours. These Dried rhizomes were cut in small pieces, powdered by an electronic mill. 6 gm of samples were taken into a thimble and placed in a Soxhlet apparatus; 250 ml of ethanol solvent was added and extracted according to their boiling point for seven hours. After completion of extraction the dark brown extract was then cooled, concentrated using a Hot Magnetic plate . This crude dried extract was turning black orange in colour.

Figure 3

Figure 4

UV -Cabinet Examination

Make sure the space is tidy. Turn on the primary power source. Turn on the switch labeled "VISIBLE LIGHT." Take a 250 mL conical flask, add 200 mL of ethanol, and dissolve 5 g of turmeric in 250 mL of ethanol in a beaker. Put the beaker in the chamber after opening the door. Turn off the "visible light." Shut the door. Turn on the necessary UV light, such as long wave (360 nm) and shortwave (254 nm). Use the included glass to see the sample inside the chamber while viewing it from the outside. Once you have seen the sample, record your observations, turn off the UV light, and take the beaker out of the chamber. Be careful that no portion of the body is exposed to UV rays directly.

In-vitro Assay

Initially an equal number of overnight grown culture was aseptically inoculated into several glass tubes containing 5mL of sterile growth media. Subsequently all the tubes were exposed to varying concentrations of curcumin. Following 24 hours of incubation at 37 degree Celsius . The growth of test organisms in each tube was assessed by measuring the turbidity at 600nm using a colorimeter. The materials used for **MIC (Minimum inhibitory concentration)** are Nutrient broth media, overnight grown bacterial culture, Curcumin 10 µg/ml , Autoclave, Incubator, Micropipette and tips.

5mL Broth (Media)+ Test Concentration (50,55,60,65,70) µL solution + 50mL culture – Turbidity has been observed

5mL Broth (Media)+ Test Concentration (100,105,110,115,120) µL solution + 50mL culture – Turbidity has been observed

Figure 5

Observation

UV- Cabinet Examination –

We observed that when turmeric powder was dissolved in the ethanol the colour of the solution is orange but when we kept the solution at the UV- cabinet and passed the UV light the colour of the solution changes from orange to yellow.

Figure 6

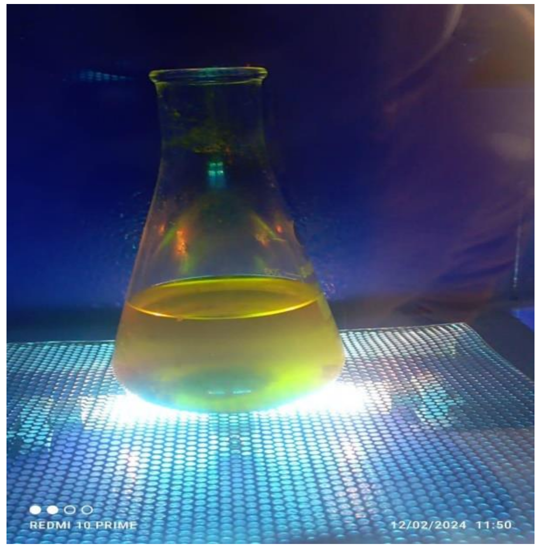

Figure 7

In -vitro assay –

We observed that in a particular concentration the bacterial growth was not observed .

Table 1.1

S.No	Media concentration	Test concentration	Culture concentration	Observation
1.	5mL Broth	50 µL	50mL	Turbidity was observed
2.	5mL Broth	55 µL	50mL	Turbidity was observed
3.	5mL Broth	60 µL	50mL	Turbidity was observed
4.	5mL Broth	65 µL	50mL	Turbidity was observed
5.	5mL Broth	70 µL	50mL	Turbidity was observed

Turbidity was observed which shows that there is the **bacterial growth** in the solution which doesn’t passes our criteria.

Table 1.2

S.No	Media concentration	Test concentration	Culture concentration	Observation
1.	5mL Broth	80 µL	50mL	Turbidity was observed
2.	5mL Broth	90 µL	50mL	Turbidity was observed
3.	5mL Broth	100 µL	50mL	Turbidity was observed
4.	5mL Broth	110 µL	50mL	Turbidity was observed
5.	5mL Broth	120 µL	50mL	Turbidity was observed

Again, Turbidity was observed which shows that there is **bacterial growth** in the solution which doesn't pass our criteria.

Table 1.3

S.No	Media concentration	Test concentration	Culture concentration	Observation
1.	5mL Broth	130 µL	50mL	Turbidity was not observed
2.	5mL Broth	150 µL	50mL	Turbidity was not observed
3.	5mL Broth	170 µL	50mL	Turbidity was not observed
4.	5mL Broth	190 µL	50mL	Turbidity was not observed
5.	5mL Broth	2000 µL	50mL	Turbidity was not observed

Turbidity was not observed which shows that there is **no bacterial growth** in the solution and passes our criteria.

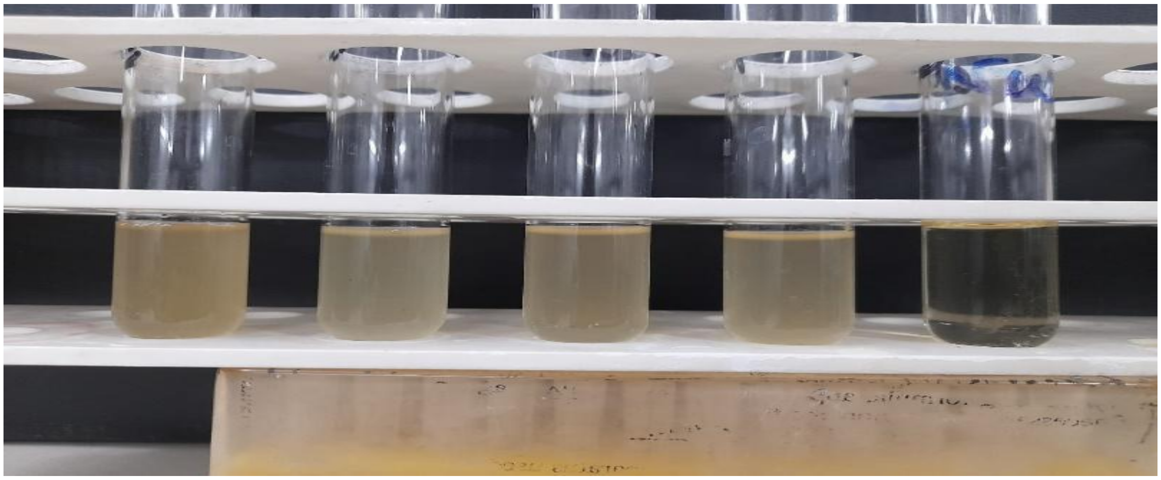

Figure-8

Conclusion –

The turmeric plant contains a natural substance called curcumin, which has attracted a lot of interest from the scientific and medical sectors due to its wide range of pharmacological characteristics. Numerous studies conducted over the last fifty years have demonstrated its strong antibacterial properties as well as a wide range of additional medicinal benefits. This substance has gained international recognition as a health supplement due to its anti-inflammatory and antioxidant qualities, which make it a desirable option for a number of therapeutic uses.

Curcumin's potential as an antibiotic against bacterial strains, including the well-known **Staphylococcus aureus (S. aureus)**, is among its most promising features. This bacterium causes a variety of infections, ranging from mild skin disorders to serious illnesses including sepsis and pneumonia. Curcumin is an interesting research topic since the increase in antibiotic resistance in S. aureus strains has prompted the search for substitute therapies.

Curcumin or its derivatives must overcome a number of obstacles before they may be used as antibiotics, despite their encouraging qualities. These difficulties could involve problems with pharmacokinetics, stability, and bioavailability. Curcumin's low solubility and quick metabolism in the body result in poor bioavailability in its natural form. To improve its absorption and retention in biological systems, this constraint calls for the creation of innovative delivery methods or adjustments.

So, when the concentration of the test solution was greater than **130µL,**Turbidity was not observed which shows that there is **no bacterial growth** in the solution and passes our criteria so it shows the antibacterial activity due to the presence of flavonoids in the Curcumin.

Furthermore, further research is needed to determine curcumin's effectiveness in clinical settings and its capacity to fight infections in vivo, even though it exhibits strong antibacterial activity against S. aureus and other bacterial strains in lab settings. The creation of more potent derivatives with improved biological activity and selectivity requires an understanding of the mechanisms behind curcumin's broad-spectrum antibacterial action.

The mentioned review seems to be the first thorough attempt to compare and summarize the antibacterial activity of curcumin against S. aureus in particular. This kind of synthesis of the body of information is essential for determining knowledge gaps and guiding future research. To fully realize curcumin's medicinal potential, more research is necessary to understand its antibacterial processes, interactions with bacterial cells, and possible synergy with already available medicines.

In conclusion, while curcumin holds promise as a natural antibiotic against S. aureus and other bacterial pathogens, its development into a clinically viable treatment requires overcoming various challenges and gaps in knowledge. Continued research efforts aimed at elucidating its mechanisms of action, improving its bioavailability, and optimizing its pharmacological properties are necessary steps toward harnessing the full therapeutic potential of curcumin and its derivatives in combating infectious diseases.

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Received: March 25th 2025, Accepted: April 4th 2025