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Review Article

Antimicrobial Activity of Turmeric: A Systematic Review

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ABSTRACT

Turmeric or Curcuma longa is a popular healing herb in Ayurvedic medicine. Due to its potential health benefits including antimicrobial properties, it is being used in herbal medicines in the treatment of several systemic diseases, especially in the Indian subcontinent.

In this review, we have given an up-to-date overview of the anti-infective properties of the Turmeric plant with a special focus on its antibacterial activity. Published articles relevant to the research questions were searched in their database (PubMed, Scopus, Web of Science). Additionally, studies were searched through snowballing. The articles were included as per eligibility for data extraction. The included articles were assessed on quality reporting and results were presented using descriptive analysis. This literature review aimed to illustrate the therapeutic properties of the plant "Curcuma longa".A total of 32 publications out of 671 articles were selected through online and snowballing literature searches. Out of these 32 articles, 22 were original research articles and 9 were systematic reviews after removing the duplicates and non-eligible studies. Most of the original articles analyzed were from India.

In view of rapidly emerging antimicrobial resistance amongst the prevailing pathogens, the present study highlights the need of exploring alternate preventive and treatment strategies that are safe, effective, and economical when compared to existing methods. There is immense scope of such studies focused on the possibilities of mining the antimicrobial potential of bioactive phytochemicals derived from herbal sources like Turmeric.

Keywords: Anti-bacterial; Anti-fungal; Anti-microbial; Curcuma longa; Plant extract; Turmeric

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INTRODUCTION

Turmeric (Curcumin), a yellow-colored molecule derived from the rhizome of Curcuma longa, has been identified as the bioactive compound responsible for numerous pharmacological activities of turmeric, including anticancer, antimicrobial, anti-inflammatory, antioxidant, antidiabetic, etc.[1]

Curcumin is being recognized and used worldwide in many different forms for multiple potential health benefits. For example, in India, turmeric containing curcumin has been used in curries; in Japan, it is served in tea; in Thailand, it is used in cosmetics; in China, it is used as a colorant; in Korea, it is served in drinks; in Malaysia, it is used as an antiseptic; in Pakistan, it is used as an anti-inflammatory agent; and in the United States, it is used in mustard sauce, cheese, butter, and chips, as a preservative and a coloring agent, in addition to capsules and powder forms. Curcumin is available in several forms including capsules, tablets, ointments, energy drinks, soaps, and cosmetics.[2]

Curcuminoids have been approved by the US Food and Drug Administration (FDA) as "Generally Recognized As Safe"

(GRAS), and good tolerability and safety profiles have been shown by clinical trials, even at doses between 4000 and 8000 mg/day and of doses up to 12,000 mg/day of 95% concentration of three curcuminoids: curcumin, bisdemethoxycurcumin, and demethoxycurcumin.[3,4]

In traditional Indian and Chinese medications, the turmeric plant, Curcuma longa Linn., has been widely used, owing to its therapeutic magnitude.[5] It is one of the major bioactive components of the rhizome extract of turmeric is curcumin, which is a polyphenol natural product extracted from C. longa. Significantly, this natural polyphenol is commonly called the "wonder drug of life".[6,7]

Curcumin has been used in various forms for centuries around the world for a variety of potential health benefits, as well as a food-coloring agent.[8]

Chemically, curcumin is known as 1,7-bis (4-hydroxy-3 methoxyphenyl) hepta- 1,6-diene- 3,5-dione or, precisely, diferuloylmethane hydroxy-3-methoxyphenyl) hepta-1,6-diene-3,5-dione or, precisely, diferuloylmethane.[9]

The medicinal usage of curcumin was started more than 2500 years ago in Asia, especially by the native population of India. In the scientific community, the medicinal use of curcumin was first reported to be against chronic cholecystitis and allied diseases in 1937. To date, there are more than 8000 studies/articles available in the PubMed database demonstrating the various biological properties of curcumin, such as antioxidant, antibacterial, antifungal, antiviral, anti-inflammatory, anticancer, antiproliferative, proapoptotic and anti-atherosclerotic effects, and its medicinal benefits against various forms of human illnesses, including neurodegenerative diseases, arthritis, allergy, inflammatory bowel disease, nephrotoxicity, diabetes, multiple sclerosis, cardiovascular disease, lung fibrosis.[10,11]

In recent decades, nanomedicine has been rising as a promising field. Nanoscale bioactive structures have shown increased physical and chemical properties and thus are utilized in numerous diagnostic and therapeutic applications.[10]

Due to the hydrophobic nature of curcumin, its modification to nanoform has shown increased therapeutic efficiency, bioavailability, and stability. The most common forms of curcumin nanoformulations include nanoparticles, nanoencapsulation, micelles, and liposomes.[12]

Curcumin nanoencapsulation and nanocrystals have demonstrated antimicrobial activity against several Gram-positive and Gram-negative pathogens, including *S. aureus*, *E. coli*, *P. aeruginosa*, *L. monocytogenes*, *S. epidermidis*, etc.[13-15]

Similarly, the nano-gel form of curcumin has been used as a topical antimicrobial for wound burns.[18] It is not only limited to antibacterial activity; it possesses a broad spectrum of antimicrobial activity when it is formulated using nanotechnology, by which it can act against fungi, parasites, and also viruses.[17-19]

In this review, we have given an up-to-date overview of the anti-infective properties of the Turmeric plant with a special focus on its antibacterial activity.

Figure1: Turmeric (Curcuma longa)

This systematic review was prepared in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.[20]

SEARCH STRATEGY

An initial search with predefined keywords was performed and a later detailed search strategy was developed. We searched Medline/PubMed, Scopus, Google Scholar, EMBASE, and Cochrane databases for eligible original reports. Articles published between Jan 2005 to Dec 2021 were included for assessment in this systematic review (most of the articles were chosen from the last 15 years). Bibliographical references of potentially related articles were checked and searched for additional articles.

STUDY SELECTION

Two reviewers independently screened the retrieved titles and abstracts of articles for relevance after duplicates were removed. The third reviewer performed a full-text screening. The articles were excluded after the mutual consensus of the reviewers. Any differences were resolved through discussion with a fourth reviewer. Final eligible articles were selected for data extraction.

DATA EXTRACTION

Data were extracted in standardized Microsoft excel format all authors reviewed and verified the data. Discrepancies were rectified through in-depth discussions and revisiting the full text of case reports if needed. Articles were estimated and summarized descriptively.

A total of 32 publications out of 671 articles were selected through online and snowballing literature searches. Out of these 32 articles, 21 were original research articles and 8 were systematic reviews after removing the duplicates and non-eligible studies. Most of the original articles analyzed were from India, followed by Saudi Arabia.

ANTIMICROBIAL PROPERTIES

Bacterial infections are among the important infectious diseases. Hence, over 50 years of extensive research have been launched for achieving new antimicrobial medicines isolated from different sources. Despite progress in the development of antibacterial agents, there is still a special need to find new antibacterial agents due to the development of multidrug-resistant bacteria.[21]

Niamsa and Sittiwet *et al* in their study showed an antibacterial study on an aqueous extract of C. longa rhizome demonstrating the MIC (minimum inhibitory concentration) value of 4 to 16 g/L and MBC (minimum bactericidal concentration) value of 16 to 32 g/L against *S. epidermis* ATCC 12228, *S.aureus* ATCC 25923, *Klebsiella pneumoniae* ATCC 10031, and *E. coli* ATCC 25922.[22]

A similar study was done by Ungphaiboon and Supavita *et al* wherein the methanol extract of turmeric revealed MIC values of 16 μg/mL and 128 μg/mL against *Bacillus subtilis* and *S. aureus*, respectively.[23]

In another study conducted by De and Kundu *et al;* curcumin showed significant antibacterial activity with MIC values between 5 and 50 μg/mL against 65 clinical isolates of *Helicobacter pylori.*[24] In contrast to it, in one in vivo study done by Koosirirat *et al, the* antibacterial effect of curcumin on *H. pylori* compared to OAM (Omeprazole, Amoxicillin, and Metronidazole) treatment revealed poor activity for eradication of *H. pylori* (5.9% versus 78.9% for OAM treatment).[25]

Mun and Joung *et al* in their study reported that Curcumin also demonstrated a synergistic effect in combination with some antibiotics, including ampicillin, oxacillin, and norfloxacin against methicillin-resistant *S. aureus* strain (MRSA).[26]

Another study conducted by Varaprasad *et al* revealed that additionally, the fabrication of silver nanocomposite films impregnated with curcumin showed stronger antibacterial activity against *E.coli*. [27]

Among the indoor microbial contaminations of several industries, the textile industry is more susceptible to the growth of pathogenic organisms. Factors such as large surface area, moisture content, etc., provide a favorable environment for microbial colonization, which often leads to deterioration in the quality of the fabric and an unpleasant odor that affects the product as well as those who wear it.[28]

To overcome these shortcomings, a variety of novel approaches have been implemented. One such is the use of natural ingredients as antimicrobial agents as a final glaze for fabrics. Curcumin is commonly used for this purpose due to its dual function, viz., natural dye, and antimicrobial property. Numerous studies have reported that wool fabric treated with curcumin exhibits increased antimicrobial activity even after prolonged wash cycles.[29]

Several investigations have described the proficiency of curcumin in antimicrobial wound dressing applications as well.[30-32]

CONCLUSIONS

From time and again various studies conducted globally in diverse backgrounds have reported that the different crude extracts derived from the rhizome of Curcuma longa popularly known as Turmeric in the Indian subcontinent have exhibited remarkably significant antimicrobial activity esp. against the common bacterial & fungal pathogens. By reviewing some of the studies relevant to this aspect, we tried to explore the hidden herbal treasure of folklore medicines. Our findings indicate an immense potential of the exploratory studies for deriving the bioactive phytochemicals from the Turmeric extracts which could be utilized at least partially in developing and delivering pharmaceutical products which could be used either as an alternative to conventional antimicrobial therapy or synergistically as an adjuvant along with the standard antimicrobials. This strategy could help in tackling the growing menace of the rapidly emerging multidrug resistance amongst the pathogens wherein most of the antibiotics will be rendered ineffective paving the way for a new group of herbal antimicrobials.

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