

Curcumin nanoformulations as potential antimicrobial agent

Abstract

Turmeric has been widely used as antimicrobial agent in Asian countries for centuries. The demand for a safe and reliable antimicrobial agent has increased world over due to the side effects of existing drugs and the development of newer drug-resistant microbes. Curcumin, the active ingredient of turmeric, has come up as a potential solution to these problems. This research article summarizes the recent developments in the field of curcumin nanoformulations and their applications as antimicrobial agent.

Keywords: curcumin, nanoformulations, antimicrobial activity, turmeric

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Abbreviations: *E. Coli*, *escherichia coli*; LED, light emitting diode; *B. macerans*, *bacillus macerans*; *B. licheniformis*, *bacillus licheniformis*; PVA, polyvinyl acetate

Introduction

Globally, a very large human population has been affected by microbes like bacteria, fungi, yeast, protozoa etc. This has led to prolonged and costly treatment and mortality risk. Scientists have come up with numerous advancements in drug-development newer anti-microbial agents to combat these infections but over a period of time, the drug-resistant organisms evolve making the drug ineffective. Hence, a need of effective anti-microbial agent has been felt for long.

The public interest in traditional medicine, particularly plant based medicine, has grown to a great extent due to their known and proven medicinal properties and limited or no side effects. This has led to an extensive research on the potential of using natural origin substances in human healthcare. Hundreds of studies were conducted to investigate the effect of herbs and spices on human health and their impact on prevention and treatment of chronic diseases. Turmeric (*Curcuma longa*) is a perennial Indian herb with large aromatic rhizomes that has been used for centuries in India and China as traditional herbal remedy¹ and victory spice. Turmeric has been used traditionally for treatment of liver diseases, bacterial infections, skin disorders, cough, asthma, osteoarthritis, heart diseases and indigestion.²⁻⁶ It has been used in medicinal form in two ways: as topical application for the treatment of wounds, tumours and inflammation and by oral intake for the treatment of wide variety of diseases such as asthma, anorexia, sour throat, cough and cold.^{7,8} Turmeric has been used as a home remedy against microbial infections in many Asian countries. Its antimicrobial activity has been widely reported in literature.⁹ Curcumin (diferuloylmethane with chemical name of (1,7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione)) is the main ingredient of turmeric. It is highly potent, nontoxic and bioactive. Curcumin has been found to be an effective antibacterial agent against bacteria such as *Bacillus subtilis*, *B. macerans*, *B. licheniformis*, and *Azotobacter*¹⁰ and *Staphylococcus aureus*, *Salmonella paratyphi*.¹¹ The effectiveness of Curcumin against 20 types of *Candida* species¹² has also been reported. The main reason for the limited application of curcumin as antimicrobial agent has been its poor aqueous solubility which adversely affects its bioavailability. In the past two

decades, the scientists have found its solution in nanotechnology. A variety of nanoparticles formulations have been developed which have demonstrated the enhanced effectiveness of curcumin as an antimicrobial agent.

Antimicrobial activity

Numerous studies have reported the effectiveness of curcumin nanoformulations against different microbes at a very low concentration. Gopal J et al.,¹³ compared the bactericidal property of macro, micro and nanocurcumin against four bacteria: *E. Coli*, *Salmonella enteritidis* 12021, *Streptococcus mutans* 11823 and *Staphylococcus aureus sub. aureus* and demonstrated the enhanced bactericidal activity of nanocurcumin when compared to macro and micro curcumin. The nanoformulations of curcumin was prepared using wet milling technique. Vimala et al.,¹⁴ have fabricated Curcumin encapsulated chitosan-PVA silver nanocomposite films by in situ fabrication of chitosan-PVA-silver nanocomposite films and demonstrated its effectiveness against *E. Coli*, *Pseudomonas*, *Staphylococcus*, *Micrococcus*, *Candida albicans*, and *P. aeruginosa* by disk diffusion method. The antimicrobial effectiveness of formulated curcumin is confirmed as clear zone of inhibitions are formed in case of formulated curcumin. A very interesting study of LED-activated curcumin-gold nanoparticles by Courrol et al.,¹⁵ tested the effectiveness of curcumin nanoformulations against Gram positive and Gram negative bacteria. This nanoformulations of gold and curcumin was prepared by mixing, stirring and illuminating the mixture of chloroauric acid, PEG and curcumin. The study showed 98% inhibition at 30µg/ml nanoformulations concentration for both Gram positive and Gram negative bacteria. The study by Johromi et al.,¹⁶ demonstrated the effectiveness of curcumin-loaded chitosan-TPP nanoparticles, prepared by ionotropic gelation method, in treating the infections caused by *Staphylococcus aureus* and *Pseudomonas aeruginosa*.

The enhanced effectiveness of curcumin nanoformulations prepared by wet milling technique was also demonstrated by Bhawna et al.,¹⁷ against *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Penicillium notatum* and *Aspergillus niger*. Their study proved the superior solubility of curcumin as nanoformulations and elevated effect against these Gram positive and negative bacterial and fungal stains. The study by Shlar et al.,¹⁸ of

curcumin nanoparticles against *E. Coli* proves the effectiveness of curcumin nanoparticles as antibacterial agent even at a concentration as low as 500µM. The curcumin nanoformulations used in this study was prepared using antisolvent precipitation technique. The study of Adahoun et al.,^{19,20} proved better effectiveness of curcumin nanoparticles against Gram positive bacteria as compared to Gram negative bacteria. For this study, they used the nanocurcumin in combination with 8mT AC static magnetic field. They studied the curcumin nanoformulation effectiveness against two gram-positive (*Micrococcus luteus* *Staphylococcus aureus*) and two gram-negative (*Escherichia coli*, *Pseudomonas aeruginosa*). The selected gram-positive bacteria had higher sensitivity than the selected gram-negative bacteria for both curcumin and nanocurcumin prepared by wet-milling technique.

Conclusion

All the above studies confirm the enhanced antimicrobial activity of curcumin as nanoformulations. This enhancement in activity of curcumin is due to increased solubility of curcumin resulting in its better bioavailability. Almost all the nanoformulations of curcumin have been found to be effective against Gram positive and Gram negative bacteria's. Also, most of them have shown promising antifungal activity as well, thereby establishing curcumin as a potential antimicrobial agent for further investigations.

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Conflict of interest

The author declares no conflict of interest.

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