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A Review Of Biological Activities Of Curcumin

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ABSTRACT:
Although some in vivo studies revealed less effective results of curcumin's inhibitory influence, all earlier studies have shown the compound's extensive antibacterial action. At least in terms of utilising curcumin as a supplemental ingredient in conjunction with other currently available treatments to alleviate the symptoms of gastritis, the greatest result from all existing studies on curcumin's antibacterial effect is against bacterial pathogens. Curcumin has been suggested as a possible novel antiviral medication candidate for the creation of new natural antivirals against susceptible viruses because of its broad range of antiviral action against many viral infections, notably through the production of various curcumin derivatives. Before using curcumin or its derivatives as antiviral drugs, additional study is necessary.

Keywords: Curcumin, influence, antimicrobial, gastritis, Curcuma longa L.

I. INTRODUCTION:

The primary compounds in the turmeric-flavored rhizome Curcuma longa L. (Zingiberaceae family) include curcumin, diferuloylmethane, and other curcuminoids. Due to its numerous biological actions, this polyphenolic molecule has attracted the interest of several researchers from all over the world.The primary source of curcumin is turmeric, an ancient Asian coloring spice that has been utilized for centuries in numerous treatments [1]. As was evident, curcumin has recently piqued the interest of scientists due to several distinct characteristics.The curcumin concentration of Curcuma longa varies between geographic locations, as it does with many other plant materials. This variation may be the result of hybridization between Curcuma longa and other Curcuma species, which makes it crucial to pick the plant with the highest curcumin content [2].

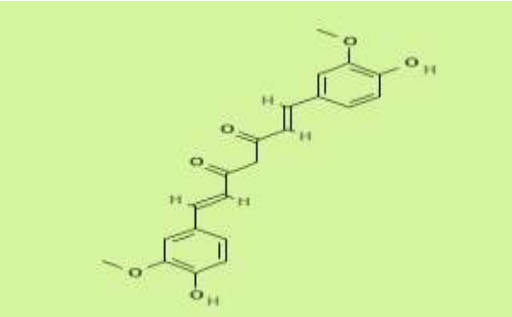

Figure 1: Structure of curcumin

The rhizome of Curcuma longa has long been used as an insect deterrent and antibacterial. Curcumin exhibits broad-spectrum antimicrobial action, including bactericidal, antiviral, fungicide, and antimalarial properties, according to numerous research [3-5].Curcumin was used as a structural sample to design new antibacterial operatives with altered and continued to increase antibacterial properties through to the creation of various derivative products related to curcumin because of its prolonged antimicrobial activity and safety property even at high doses (12 g/day) assessed by clinical trials in humans.It was even investigated as a potential textile-safe antibacterial agent [6-7].

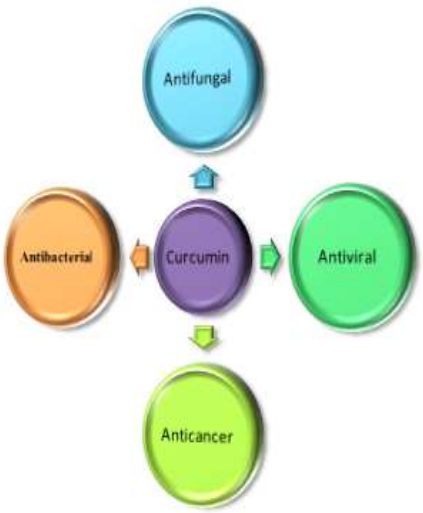

Figure 2: Biological activity of Curcumin

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As determined by the exhaustion technique, the results indicated that curcumin combined with aloe vera and chitosan may have the ability to suppress microbial development in cotton, woolen, and rabbit hair.Curcumin was used for batch or continuous dyeing, and both methods produced textiles with antibacterial qualities in addition to color. After 30 cycles of home laundry, wool treated with curcumin displayed semidurable antimicrobial activity that was less resistant to light exposure than home laundering [8]. The inhibitory rates versus Staphylococcus aureus and Escherichia coli were 45% and 30%, respectively.The manufacture of antibacterial skin gels and emulsions with increased skin protection and wounds dressing qualities utilizes a blend of curcumin with some other antimicrobial compounds [9]. The functionality of hydrogel silver nano-composites as designated substances for antibacterial purposes and wound dressing is increased by combining curcumin with hydrogel silver nanoparticles.A myristic acid microemulsion containing 0.86 g/mL of skin-safe curcumin prevented 50% of the growth of S. epidermidis**,** one of the nosocomial bacterial infections. It demonstrated an inhibitory impact that was 12 times stronger than curcumin activity that was incorporated in dimethyl sulfoxide (DMSO)[10].

Potential to kill or inhibit Bacteria

One of the most serious infectious disorders is a bacterial infection. As a result, substantial research has been conducted for more than 50 years to develop new antimicrobial drugs that have been extracted from various sources. Despite advancements in antibacterial agent development, multidrug-resistant bacteria have created a unique demand for novel antibacterial medicines.MIC (minimum inhibitory) values of 4 to 16 g/L and MBC (minimum bactericidal concentration) values of 16 to 32 g/L against S. epidermis, Staph. aureus, Klebsiella pneumoniae, and E. coli were found in the antimicrobial study on the aqueous extract of C. longa rhizome [11].The MIC values towards Bacillus subtilis as well as Staph. aureus for the methanol extract of turmeric was 16 g/mL and 128 g/mL, correspondingly.The ethanol extract had the strongest antibacterial activity when tested against 24 pathogenic bacteria isolated from chicken and shrimp in the research of acetone and alcohol turmeric extraction and curcuminoids (from ethyl acetate extract of curcuminoids obtained from C. longa with 86.5% curcumin value).The preparations of C. longa in ethanol and alcohol showed antibacterial activity against 13 bacteria, includingStaph. aure.Streptococcus agalactiae,Aeromonas hydrophila,B. cereus, Bacillus subtilis,Vibrio cholerae. Curcuminoids did, however, produce inhibitory effects against eight bacteria, including Staph. intermedius,Str. agalactiae, Staph. Aureus. Hexane extract and curcuminoids had MIC values that ranged from 3.91 to 400 ppt and 125 to 999 ppt, correspondingly [12].

It was established that adding 0.3% (w/v) of aqueous curcumin extract to the cheese resulted in a decrease in the numbers of Salmonella typhimurium, Pseudomonas aeruginosa, and E. coli 0157:H7 bacteria in the cheese.Additionally, it has reduced contamination levels of B. cereus, and Listeria monocytogenesStaph. aureus, after 14 days of cold storage.Byproducts of the curcumin manufacturing process, such as turmeric oil, have been proven to be effective against the bacteria P. aeruginosa, E. coli, Staph. aureu. Additionally, methicillin-resistant Staph. aureus (MRSA) bacteria with MIC values of 125–250 g/mL were inhibited by curcumin [13].

Three new curcumin compounds, diacetyl curcumin, indium diacetyl curcumin, and indium curcumin, were tested in vitro against Staph. aureus, S. epidermis, P. aeruginosa, E. coli, and It was found that indium curcumin had a stronger antibacterial effect than curcumin itself and maybe a suitable compound for additional in vivo studies [14].

Diacetylcurcumin, however, had no antibacterial effects on the tested microorganisms. These outcomes also showed many curcumin compounds to have promising antibacterial action.As a potential pharmacological target for antibacterial drugs, the stability and assembly of FtsZ protofilaments, a critical component of bacterial cytokinesis, are introduced. By causing filamentation, curcumin inhibited B. subtilis cytokinesis.Additionally, it dramatically reduced the production of cytokinetic Z-rings in B. subtilis without having a major impact on the segregation and organization of the nucleoids.Curcumin's capacity to bind to FtsZ with a dissociation constant of 7.3 M was shown to inhibit the bundling of FtsZ protofilaments.It demonstrated that curcumin can perhaps reduce bacterial cell growth as one of the most likely antibacterial modes of action by inhibiting the dynamics of FtsZ assembly in the Z-ring.The investigation on E. coli and B. subtilis showed that curcumin might

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decrease the FtsZ assembly resulting inthe interruption of prokaryotic cell division by its inhibitory impact against FtsZ polymerization [15].

Additionally, curcumin demonstrated substantial antibacterial action against 65 clinical isolates of Helicobacter pylori, with MIC values ranging from 5 to 50 g/mL.The primary impact of curcumin on H. pylori in the gut is a decrease in inflammation of the gastric tissue due to its inhibitory effect on NF-B activation and the release of IL-8 and cell scattering.It blocks the action of NF-B DNA-binding, IB kinase A and B (IKK A and B), and IB degradation.As inflammation molecules implicated in H. pylori infections in mice and cell culture, matrix metalloproteinase-3 and metalloproteinase-9 activity was reduced by curcumin in a dose-dependent manner.Through the lowering of activator protein-1 and activation of proinflammatory molecules in H. pylori-infected gastric tissues, curcumin demonstrated a more effective therapeutic index than traditional triple therapy of H. pylori on MMP-3 and MMP-9. Curcumin's antibacterial effectiveness against H. pylori was ineffective in vivo research when contrasted to OAM (amoxicillin, metronidazole, omeprazole,) treatment (5.9% versus 78.9%).Patients with Helicobacter Pylori infection who received curcumin treatment did not report a decrease in inflammatory cytokine production. Curcumin, pantoprazole, N-acetylcysteine, and lactoferrin were used in an in vivo trial to treat H. pylori infection for one week without the need for antibiotics.After two months of therapy, there was a documented decrease in the immunological indicators of stomach inflammation and dyspeptic symptoms.However, curcumin treatment significantly reduced macromolecular leakage and NF-B activation in rats with H. pylori-induced stomach inflammation.Curcumin has shown tremendous therapeutic potential and a strong eradication impact against H. pylori infection in an in vivo study of H. pylori-infected C57BL/6 mice, along with the restoration of stomach damage [16].

Synergistic Antimicrobial Activity

To create an antibacterial cocktail with a broader spectrum of action and a reduction in negative side effects of antimicrobial agents, studies for the synergetic effect of antibiotics in a mixture with plant derivatives are required due to the outburst of drug-resistant microbial strains.Aureus staph Antibiotics in the penicillin family are becoming less effective, which is correlated with the emergence of unfavorable side effects such as hypersensitivity and anaphylactic responses.When employed over either the hospital strain or the Staph. aureus, curcuminoids, and ampicillin combined to drastically lower the MIC of ampicillin. Combining encapsulated curcumin with the B. amyloliquefaciens-isolated bacteriocin subtilisin demonstrated partial synergism against wild-type and nisin-sensitive strains of L. monocytogenes [17]

In another in vivo study using 500 μg/disc of curcumin against a clinical isolate of Staph. aureus the synergistic activity with antibiotics of cefixime, cefotaxime, vancomycin, and tetracycline was demonstrated.The findings demonstrated that consuming turmeric while using these antibiotics, particularly cefixime, to treat Staph. aureus infections may be beneficial. Additionally, against a methicillin-resistant strain of Staph. aureus, curcumin showed a synergistic impact when combined with various medicines, such as ampicillin, oxacillin, and norfloxacin. While there is an indication of its inhibitory action when combined with ciprofloxacin, curcumin has been shown to have a synergistic impact with ciprofloxacin against MRSA [17].

Strongly bonded metal compounds to antimicrobial drugs are presented as another potential method for enhancing the antimicrobial agents' ability to attach to bacterial walls, which would result in synergistic effects.Curcumin complexes with cobalt nanoparticles showed improved antibacterial action against E. coli.

Curcumin-impregnated silver nanocomposite films were also made, and these demonstrated greater antibacterial action against E. coli. It was demonstrated that adding curcumin to sodium carboxymethyl cellulose silver nanocomposite films (SCMC SNCFs), an efficient antibacterial substance, enhanced their bactericidal efficacy.The synergistic impact of curcumin-encapsulated chitosan-silver nanocomposite films was demonstrated in another in situ study. The new antimicrobial films with strong antimicrobial activity against E. coli were found to be viable antibacterial materials for wound dressing or infection treatment. [17]

Antifungal Activity

For combating fungal infections as well as spoilage, chemicals, and extracts obtained from various natural resources, particularly plants, have historically been a potent armament.Due to the widespread conventional use of turmeric in food products, numerous studies on the effects of

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curcumin as well as turmeric on the infections and spoilage caused by fungi have been conducted.Turmeric displayed a substantial inhibitory effect against fungal contamination issues at the concentrations of 0.8 and 1.0 g/L, according to research on the introduction of turmeric powder to plant tissue culture.With MIC values of 126 and 254 g/mL for Cryptococcus neoformans as well as Candida albicans, correspondingly, the methanolic extracts of turmeric showed antimicrobial activities.R infestansand E.graminis were all resistant to the antifungal effects of the C. longa extraction in hexane at a concentration of 1000 mg/L [18].

Additionally, it was demonstrated that a C. longa ethyl acetate extract at a concentration of 1000 mg/L had an inhibitory impact on P. infestans, R. solani, and B. cinerea.At 500 mg/L, turmeric also showed antifungal efficacy against P. infestan,and R. solani. Two phytophagous fungi, Helminthosporiumoryzae,andFusarium solani, are insensitive to the antifungal properties of turmeric but also turmeric oil.With an IC50 of 19.73 as well as 12.7 g/mL, however, turmeric oil displayed the most potent antifungal efficacy against F. solani but also H. oryzae.Several different strains of dermatophytes are inhibited by the raw methanol extraction of C. longa. With MIC values of 7.2 and 7.8 mg/mL, correspondingly, it was shown that 18-month-old and newly distilled oil extracted from the rhizome of C. longa had the most antifungal action against 29 clinical isolates of dermatophytes.Turmeric oil diluted 1:40-1:320 reduced T. mentagrophytes, Trichophyton rubrum, Microsporumgypseum, Epidermophyton floccosum[19].

An in vivo investigation on T. rubrum-infected guinea pigs showed that topical application of turmeric oil (diluted 1:80) improved the recovery of the sores after 2–5 days and enabled the lesions to disappear after 6-7 days.With MIC values of 114.9, 459.6, 114.9, and 114.9 g/mL, respectively, turmeric oil also demonstrated action against pathogenic molds such as Exophialajeanselmei,Sporothrixschenckii, Scedosporiumapiospermum,Fonsecaeapedrosoi.Curcumin, however, showed a more notable effect on Paracoccidioides brasiliensis than fluconazole, even though it had no impact on Aspergillus species' growth.

The development of resistant strains of the Candida species against the available antifungal medications became a serious issue for therapeutic approaches. Finding new anti-Candida chemicals, therefore, appears to be essential.Curcumin is a powerful fungicide agent against Candida species, with MIC values ranging from 250 to 2000 g/mL, according to research of curcumin over 14 strains of Candida, comprising 4 ATCC strains as well as 10 clinical isolates.Additional study found that curcumin had anti-Candida properties against 38 various Candida strains, along with some fluconazole-resistant strains and clinical isolates of Candida albicans, and C. tropicalis, Sensitive and resistant strains' respective MIC90 values were 250–650 and 250–500 g/mL. Candida species cell death has been linked to intracellular acidification via suppression of H+-extrusion.Curcumin has been shown to reduce the growth of hyphae by focusing on the global inhibitor thymidine uptake 1. Cryptococcus neoformans and C. dubliniensis were also inhibited by curcumin, with MIC values of 32 mg/L. One of the most common adverse reactions to therapy for persistent asthma is oropharyngeal candidiasis. In a mouse model of asthma, curcumin was investigated as a prospective therapy option for candidosis with anti-inflammatory action.Curcumin administered orally is superior than dexamethasone in terms of lowering the fungal infection in BALB/c mice. Additionally, it dramatically reduced the pathogenic alterations in asthma. Curcumin was found to be more efficient than fluconazole at inhibiting the adhesion of Candida species obtained from AIDS patients to buccal epithelial cells [20].

The study of curcumin administration for photodynamic treatment can lessen the biomass of Candida albicans, Candida glabrata, and Candida tropicalis biofilms. The outcomes showed that up to 85% of the metabolic activity of the investigated Candida species was suppressed by combining four LED fluences for light stimulation with a 40 M dosage of curcumin at an energy density of 18 J/cm2.The antifungal efficacy of curcumin against yeasts in their planktonic phase was significantly improved when used in conjunction with light, which was found to be an efficient strategy.The photodynamic impact significantly reduced the viability of C. albicans in both planktonic and biofilm cultures, most likely by enhancing the uptake of curcumin by cells. However, photodynamic treatment was discovered to be somewhat phototoxic to macrophages. To obtain trustworthy information about the in vivo effectiveness of curcumin-mediated photodynamic treatment, a study using a mouse model of oral candidiasis was conducted.Results showed that all

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curcumin LED light exposures significantly reduced C. albicans survival during photodynamic treatment without causing any injury to the mice's host organism. However, the best reduction in C. albicans colony counts was seen when 80 M of curcumin was combined with light. These findings demonstrated the significant potential of curcumin as a photosensitizer for fungicidal photodynamic therapy, particularly against Candida species [18].

The primary motivations for looking into the potential synergistic effects of C. longa rhizome with currently available fungicides were its potent antifungal action and negligible side effects. Curcumin's synergistic effects with the fungicides voriconazole, ketoconazole, itraconazole, fluconazole, and miconazole,resulted in a 10- to 35-fold decrease in their minimum inhibitory concentrations (MIC) against 21 clinical isolates of Candida albicans.The increase of ROS, which would be decreased by the addition of an antioxidant, could be linked to the synergistic effect of curcumin alongside amphotericin B and fluconazole.Curcumin showed fungicidal action with a MIC value of 32-128 g/mL in the examination of 200 clinical isolates of Candida species, comprising C. tropicalis, C.krusei, C. glabrata, and C. albicans.While fluconazole as well as curcumin sometimes had additive impacts rather than synergistic action, the combining of curcumin as well as amphotericin B also indicated synergistic effectiveness against testing Candida species.These findings demonstrated that curcumin can have a more potent effect on systemic fungal infections including candidemia and candidiasis when combined with currently available fungicidal medications.. An in silico investigation showed that curcumin reduced the negative side impact of amphotericin B by delaying red cell lysis by interacting to albumin serum in a different ligand binding of amphotericin B. Visceral leishmaniasis and systemic fungal infections may be treated with the durability and water solubility of the combination of curcumin as well as amphotericin B with albumin serum.Curcumin, as well as piperine, together had a synergistic impact that significantly reduced the amount of fungal burden in Swiss mouse kidneys in vivo research using a murine model of Candida infection. In comparison to when curcumin was evaluated alone, the combination of curcumin as well as ascorbic acid showed a 5- to 10-fold reduction in MIC values against several strains of Candida.These synergistic effects demonstrated that curcumin can greatly elicit synergistic effects to increase the effectiveness of current antifungal techniques when combined with various fungicide ingredients [19].

Bioavailability and Solubility for Antimicrobial Activities

Curcumin's maximum effectiveness is constrained by its poor gastrointestinal bioavailability as well as inadequate dispersion in aqueous systems, which produce poor absorption, rapid metabolism, and rapid systemic clearance.Nanocarriers such as curcumin-loaded PLGA and curcumin nanoparticle formulation were studied to overcome this challenge, and it was found that they had superior bioactivity and bioavailability as well as higher cellular absorption than curcumin alone.According to a different study, curcumin that had been heated up increased its solubility by a factor of 12 without significantly disintegrating. Heat-solubilized curcumin inhibits the modification of 4-hydroxy-2-nominal (HNE), a significant oxidative by-product implicated in disease pathogenesis via toxicity, mutagenic, and genotoxicity, by 80%, suggesting a potential method for producing curcumin's bioactivity.According to research on nanocurcumin, which is a form of curcumin that has been processed into nanoparticles with sizes ranging from 2 to 40 nm using a wet milling method, curcumin is more readily soluble in water and has stronger antimicrobial effects against a variety of bacteria and fungi, including Staph. aureus, P. aeruginosa, P. notatum .Nevertheless, nanocurcumin showed a more notable effect against Gram-positive pathogens than it did against Gram-negative pathogens. Another study looked into the microencapsulation procedure to increase the stability and solubility of curcumin.MIC values ranged from 15.7 to 250 g/mL against food-borne pathogens like E. coli, B. subtilis, Yersinia enterocolitica.The microcapsule of curcumin with enhanced solubilization is appropriate as a fixative and colorant in the food industry.Gram-positive bacteria were shown to be more sensitive to the microencapsulated curcumin than Gram-negative bacteria. The antifungal effect, however, was discovered to be more potent than the antibacterial effects [20].

II. CONCLUSION

Although in vivo research in some cases indicated the less effective findings of curcumin inhibitory impact, all prior investigations have demonstrated the wide antibacterial action of curcumin.The best outcome from all prior research

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on curcumin's antibacterial action is against Helicobacter pylori, at least in terms of using curcumin as a supplementary substance in conjunction with other already available medications to lessen the symptoms of gastritis.As a result of curcumin's broad spectrum of antiviral activity against various viral pathogens, this substance has been proposed as a potential new antiviral drug candidate for the development of new natural antivirals against vulnerable viruses, particularly through the development of various curcumin derivatives.However, more research is required before employing curcumin or its derivatives as antiviral agents. In research on the antifungal properties of curcumin, Candida species and Paracoccidioides brasiliensis were found to have the most significant effects, however curcumin also showed fungicide properties against other fungi.Despite the fact that curcumin has a variety of biological activities, no true clinical applications for this substance have been reported, and clinical trials are still being conducted for a variety of conditions and illnesses, including colon and pancreatic cancer, myeloma, myeloproliferative, Alzheimer's disease, and psoriatic arthritis.

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