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ANTIMICROBIAL ACTIVITY OF CURCUMA LONGA AND MIMOSA PUDICA: A COMPREHENSIVE REVIEW

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Abstract

The active ingredient in turmeric, *Curcuma longa*, and the traditional medicinal plant, *Mimosa pudica,* have both been the subject of intensive research due to their wide range of therapeutic applications. The antibacterial, anti-inflammatory, and wound-healing qualities of *Mimosa pudica* have long been employed, whereas curcumin is well known for its anti-inflammatory, antioxidant, and anticancer benefits. The pharmacological advantages of these two naturally occurring substances are summarized in this article, which also discusses their possible synergistic effects, modes of action, and therapeutic uses. Our goal in examining the complimentary qualities of *Mimosa pudica* and curcumin is to present a through analysis that bolsters their application in integrative medicine and offers ideas for further research. Curcumin is known for its powerful anti-inflammatory, antioxidant, and anticancer properties. Its therapeutic success is related to its capacity to affect numerous cellular pathways, such as inhibiting NF-KB and activating AREs. These pathways play a vital role in reducing inflammation and oxidative stress, which contribute to chronic diseases like cancer, cardiovascular disease, and neurodegeneration. Curcumin's antibacterial characteristics make it a promising medicinal agent with broad-spectrum applications. *Mimosa pudica*, often known as the "sensitive plant" for its quick responsiveness to physical stimuli, has a long history in traditional medicine, especially in Ayurvedic and folk treatments. It is used for wound healing,anti-inflammatory, antibacterial, and anti-ulcer properties. The pharmacological actions of *Mimosa pudica* are primarily due to its rich composition of bioactive compounds, including alkaloids,flavonoids, tannins, and phenolic acids.These compounds collectively contribute to the plant's ability to modulate immune responses, promote tissue regeneration, and inhibit microbial growth.Curcumin and *Mimosa pudica* have complimentary mechanisms that can lead to synergistic effects. Curcumin modulates intracellular signaling pathways and transcription factors, while *Mimosa pudica's* bioactive ingredients also interact with extracellular targets and microbial cell walls, indicating a multimodal approach to illness management.

Keywords: *Curcumalonga*, Synergistic effects, *Mimosapudica*,Anti-bacterial, Microbial growth.

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Introduction

Turmeric, or *Curcuma longa*, is a perennial plant native to Southeast Asia and belongs to the Zingiberaceae family. Renowned for its bright yellow color, the rhizome of the turmeric plant has been widely used for centuries in traditional medicine due to its numerous therapeutic benefits. Beyond its medicinal properties, turmeric is also commonly used as a spice in culinary applications [1, 2]. Turmeric is regarded as the best plant in Unani medicine for treating blood issues since it strengthens, purifies, and stimulates blood. Turmeric is referred to as the "KITCHEN QUEEN" by most Indians, including housewives and hermits living in the Himalayas, and is the primary spice used in cooking. Use of triphala, tulsi, and turmeric over an extended period of time is comparable to a brief Pancha Karma treatment. Generally speaking, turmeric has wide antifungal properties [3]. Additionally, a variety of digestive tract-related medical conditions are treated using the plant.Additionally, *Curcumalonga* has shown potent antibacterial activity against various Gram-positive and Gram-negative bacteria. The aqueous extract of C. longa has been effective against Klebsiella pneumoniae, Staphylococcus aureus, Staphylococcus epidermidis, and Escherichia coli.The majority of bacteria that cause cholecystitis, such as strains of Bacillus, Gaffkya, Corynebacterium, and Streptococcus, were suppressed in growth by an alcoholic extract of *C. longa*.Turmeric's methanol extract demonstrated an inhibitory

impact on S. aureus and Bacillus subtilis, respectively [4]. Studies have been conducted on its neuroprotective, anti-inflammatory, antioxidant, and anticancer effects. The antibacterial qualities of *Curcuma longa* are one area that has attracted a lot of interest. *Curcuma longa* makes a strong case as a possible natural source of novel antimicrobial agents, which is crucial in the age of rising antimicrobial resistance *Curcuma longa's* antibacterial qualities are to be thoroughly reviewed in this review.The review also aims to clarify the many tactics used by *Curcuma longa's* bioactive chemicals against bacteria, as optimizing the plant's antimicrobial potential requires an understanding of its methods of action. These comprise, among other things, the modification of the host's immune system, the destruction of microbiological cell structures, and the suppression of microbial enzymes [5, 6]. The antimicrobial properties of *Curcuma longa* are primarily attributed to curcumin. Curcumin exhibits broad-spectrum antimicrobial activity against various pathogens, including bacteria, fungi, and viruses. Research indicates that curcumin disrupts microbial cell membranes, interferes with cell signaling pathways, and inhibits the synthesis of essential microbial proteins and enzymes. Several studies have demonstrated the efficacy of curcumin against Gram-positive bacteria such as Staphylococcus aureus and Bacillus subtilis, as well as Gram-negative bacteria like Escherichia coli and Pseudomonas aeruginosa. Additionally, curcumin has shown antifungal activity against Candida albicans and antiviral effects against viruses such as influenza and hepatitis B [7]. The Mimosaceae family includes *Mimosa pudica L*. The creeping annual or perennial herb *mimosapudica* is frequently grown for its curious compound leaves, which fold inward and droop when touched but quickly reopen. Although *mimosa pudica* is endemic to Brazil, it is currently a widespread tropical weed [8]. This plant folds its leaves in response to external physical perturbations or contact. It experiences nyctinastic movement, or nighttime changes in leaf orientation regulated by a biological clock. It's often grown for the sake of curiosity. When disturbed or shook, the compound leaves fold inward and droop to protect themselves; this movement, known as seismonastic movement, reopens a few minutes later. The plant is between 50 and 70 centimeters tall, with 500 different types [9]. It mostly consists of c-glycoside, alkaloids, glycosides, flavonoids, triterpenes, tannins, and steroids [10]. When it comes to gram-positive and gram-negative bacteria, *mimosa pudica* exhibits strong antibacterial action. Staphylococcus aureus, Escherichia coli, and Salmonella typhi, for example, have been shown to be inhibited in growth by ethanol and methanol extracts of *Mimosa pudica*. By rupturing microbial cell walls and membranes, inhibiting the formation of nucleic acids, and interfering with metabolic processes, *Mimosa pudica* possesses antibacterial properties. It is also a versatile antimicrobial agent because studies have demonstrated its antifungal activities against species including Aspergillus niger and Candida albicans [11]. This current investigation, *Mimosa pudica's* antibacterial efficacy against specific microorganisms can be ascertained.

Overview of *Curcuma Longa*

Turmeric (*Curcuma longa*), a perennial rhizomatous plant, is native to South Asia. The rhizome of the plant gives spices their vivid yellow colour, which is utilised in kitchens as food colouring and preservatives [12]. Turmeric is generally used to treat inflammatory disorders in traditional Chinese and Indian medicine. It is applied topically to heal wounds, lower inflammation, and purify blood [13]. The herbaceous perennial plant *Curcuma longa*, sometimes referred to as turmeric, is rhizomatous and a member of the Zingiberaceae family. India is the country of origin, and it is widely grown in China, Sri Lanka, West and East Africa, and other tropical nations [14]. In China, it is referred to as Huangjiang or Jianghuang. Traditional Chinese Medicine (TCM) employs turmeric to treat, prevent, and manage a variety of illnesses, including psoriasis, hepatobiliary diseases, cancer, coughs, diabetes, arthritis, diarrhea, inflammation, and skin disorders such as gastric and peptic ulcers. It has several health benefits, including increased blood flow, the elimination of stagnation, the reduction of depression, and a significant natural flavoring effect on the color, flavor, and texture of food [15]. It also guards against DNA damage in lymphocytes [16].This plant contains several components that contain curcumin (flavonoids). Powdered turmeric is composed of approximately 60–70% carbohydrates, 6–13% water, 6–8% protein, 5–10% fat, 3–7% dietary minerals, 3–7% essential oil, 2–7% dietary fiber, and 1–6% curcuminoids. (17) The plant's rhizome, which is distinguished by its vivid yellow color, is used in many traditional medical systems as a medicinal agent in addition to being a culinary spic [18,19]. The scientific community's interest in *Curcuma longa's* possible health advantages has grown in recent years. Studies have been conducted on its neuroprotective, anti-inflammatory, antioxidant, and anticancer effects. The antibacterial qualities of *Curcuma longa* are one area that has attracted a lot of interest. *Curcuma longa* makes a strong case as a possible natural source of novel antimicrobial agents, which is crucial in the age of rising antimicrobial resistance [20, 21)].The goal of this review is to give a thorough synopsis of *Curcuma longa's* antibacterial qualities. *Curcuma longa's* main active ingredients are a class of phenolic chemicals called curcuminoids. Curcumin is the most prevalent and physiologically active of the curcuminoids, which also include demethoxycurcumin and bisdemethoxycurcumin. It is this chemical that gives the plant its distinctive yellow color and is primarily responsible for its strong antibacterial, anti-inflammatory, and antioxidant properties [22, 23].

Plant Profile

Common Name: *Curcuma*, Indian saffron

Synonyms:

TABLE 1: Biological Source: Turmeric is obtained from the rhizome of *Curcuma longa* Linn. (*Curcuma domestica Valeton),* belonging to the family Zingiberaceae.

Sanskrit	Ameshta
English	Indian saffron
Hindi	Haldi
Bengali	Halud
Telugu	Haridra
Tamil	Ameshta
French	*Curcuma*
Indonesian	Kunyi

Malay	Kunyit Basah

Geographical Source: Turmeric is commonly found in Cambodia, China, India, Nepal, Indonesia, Madagascar, Malaysia, the Philippines, and Vietnam.

Indian Scenario: In India, turmeric is commonly found in West Bengal, Tamil Nadu, Maharashtra, and Madras.
Family:Zingiberaceae

Taxonomy

Scientific Classification:

Table 2

Scientific Name	*Curcuma longa*
Kingdom	Plantae
Sub-kingdom	Tracheobionta (Vascular Plants)
Super Division	Spermatophyta
Division	Magnoliophyta(Flowering Plants)
Class	Lilliopsida (Monocotyledons)
Subclass	Zingiberidae
Order	Zingiberales
Genus	*Curcuma L. (Curcuma*)

Microscopic Characters

The outermost 4–6 layers of brick-shaped parenchymatous cork are visible in the transverse slice of turmeric rhizomes, whereas the cork cabin is next to be seen. Circular parenchymatous cells with narrow walls that contain sporadic vascular bundles begin to form the cortex. In the cortex, there are collateral oleo-resin cells with brownish vascular bundles. The endodermis is covered by a discontinuous ring formed by dispersed vascular bundles in the pith area. Starch grains (diameters ranging from 5 to 15) are plentiful, and the endodermis is noticeabl [24, 25].

Macroscopic Characters

The round turmeric rhizome is ovate or pear-shaped, measuring up to 4 cm long and 3 cm thick. Leaf scars encircle the upper half, while secondary rhizome and root scars mark the lower part. Before drying, turmeric is sliced. Secondary rhizomes (also known as long turmeric) typically measure 0.5–1.5 cm in thickness. They are elongated, faintly ringed, and may be simple or have sparse branching. The scaling prior to drying destroys the life of the rhizomes, transforming the grains into lumps. The combination of oil and curcumin released from the oil cells imparts turmeric with its deep yellow hue. The product found in markets is hard, dense, and sinks in water. Its cracked surface is smooth and waxy, displaying an orange-yellow tint [26].

Chemical Constituents

Curcumin, demethoxycurcumin, and bisdemethoxycurcumin (3-6%) are the main polyphenolic chemicals found in turmeric rhizomes (Ravindranath and Satyanarayan 1980; Satyawati et al. 1976). In the 19th century, the major colouring element of turmeric rhizome was identified as 'Curcumin'. Roughley and Whiting established the chemical structure in 1973.Other phenolic compoundsinclude1-hydroxy-1,7bis (4 hydroxy 3 methoxyphenyl) (6E) 6 heptene3,5dione,4hydroxy-3,5-dimethoxyphenyl)-7-(4-hydroxy-3-methoxyphenyl)-(1E,6E)1,6 heptadiene3,4dione,1,5]bis(4-hydroxy-3-methoxyphenyl)-penta-(1E,4E)-1,4-dien-3-one,1-(4-hydroxy-3methoxyphenyl)-5-(4-hydroxyphenyl)-penta-(1E,4E) 1,4dien 3one,1 (4 hydroxy 3 methoxyphenyl) 7(3,4dihydroxyphenyl)-1,6-heptadiene-3, 5-dione, and1, 7-bis(4-hydroxyphenyl)-1,4,6-heptatrien-3-one.Turmericproduces a pale yellow to orange-yellow oil with volatile compounds (4-6%) that contains a variety of mono- and sesquiterpenes [27,28]. Turmeric also includes sequiterpene (6S). -2-methyl -6-(4-hydroxyphe-nyl-3-methyl) -2-hepten-4-one (turmerone, atlantone, zingiberone, turmeronol, germacrone, and bisabolene), carbs, protein, resins, and caffeine [29].

Antimicrobial Activity of *Curcuma Longa*

The disc diffusion method—which involves measuring microbial susceptibility to a specific chemical that may have antibacterial activity—was used to examine the ethanol extract of the rhizome of turmeric [30]. Because of the chemical components in the ethanol extract, 96% of the active rhizome of turmeric has antibacterial properties. Turmeric rhizome ethanol extract contains alkaloid, flavonoid, saponin, tannin, and triterpenoid/steroid chemicals, according to phytochemical screening [31]. One of the major categories of infectious disorders is bacterial infection. Therefore, a great deal of research has been conducted over the past 50 years to develop novel antimicrobial medications that are extracted from various sources. Despite advancements in the creation of antibacterial agents, the emergence of germs resistant to several drugs highlights the particular need for the discovery of novel antibacterial medicines [32]. Many innovative strategies have been used to address these shortcomings. Using natural substances as antimicrobial agents as a finishing fabric glaze is one example of this. Due to its dual usage as a natural color and antibacterial, curcumin is frequently used for this purpose. Curcumin-treated wool fabric has been shown in numerous experiments to display enhanced antibacterial activity, even after lengthy washing cycles [33]. The effectiveness of curcumin in antimicrobial wound dressing applications has also been reported in a number of studies [34, 35]. All C. pseudomontana rhizome extracts were tested in vitro for their antibacterial properties against clinically isolated strains of bacteria and fungi, including Aspergillus terreus, Salmonella typhi, S. aureus, and E. coli. The methanolic extract was observed to have a 4 mm area of reduction towards S. typhi, a 6 mm area of reduction against the bacteria S. aureus, and an 8 mm area of reduction against E. coli. A. terreus was inhibited by a 2 mm zone in acetone and a 6 mm zone in methanol and aqueous. Chloroform did not exhibit any zone of inhibition against any of the bacteria, and neither did acetone or aqueous against S. aureus, S. typhi, or E. coli. The effectiveness of C. pseudomontana was demonstrated in a study by Begam et al [36]. Curcumin also demonstrated antimicrobial activity, as evidenced by MIC values between 125 and 250 µg/ml and a decrease in the number of S. aureus strains [37]. Tyagi et al.

reported that curcumin exhibits antibacterial activity against Salmonella aureus, Enterococcus faecalis, E. coli, and Pseudomonas aeruginosa. Their investigation also demonstrated decreased Minimum Inhibitory Concentration (MIC) values of four antibiotics-oxacillin, ampicillin, ciprofloxacin, and norfloxacin-when used in combination therapies [38]. Kim and colleagues evaluated the antimicrobial activity of several *C. longa* extracts (hexane, butanol, methanol, the solvent chloroform ethyl acetate, and water) towards Pyricularia grisea, R. solani, B. cinerea, and P. infestans. Additionally, several *C. longa*-derived compounds-borneol, 1,8-cineole, sabinene, and turmerone-were examined in relation to phytopathogenic fungi. Curcumin from *Curcuma longa* has been identified as the most effective fungicidal agent against the tested bacteria [39]. The antimicrobial efficacy of *Curcuma longa* is attributed to a complex interaction of mechanisms involving its bioactive constituents, primarily curcuminoids and essential oils. These mechanisms include disrupting microbial cell structures, inhibiting crucial microbial enzymes, and potentially modulating host immune responses [40, 41]. In view of their lipophilic characteristics, curcumin and its related chemicals can interact with the membranes of bacteria. This interaction changes the membrane's permeability and fluidity, which ultimately causes cell death and internal leaking. Furthermore, curcuminoids have the ability to obstruct the development of bacterial biofilms, which are intricate structures that shield bacteria from immune system responses and antimicrobial drugs [42,43]. In addition to causing structural disruption, *curcuma longa* constituents have been shown to regulate the host immune system and improve antimicrobial defenses. Curcumin possesses the ability to modulate various signaling molecules implicated in inflammation, such as cytokines, transcription factors, and enzymes, thereby supporting the body's innate immune response in combating pathogens. Additionally, curcumin's antioxidant properties enable it to protect host cells from damage inflicted by microbial toxins [44, 45].

Overview of *Mimosa Pudica*

"Mimosa pudica" is the name of a perennial or evergreen creeper plant [46]. Carl Linnaeus published Species Planttarum in 1753 and provided the first description of it. "Mimic" is the meaning of the Greek word "mosa," whereas "pudica" is a Latin word meaning "shy." The leaves of this plant fold in response to external contact or physical disturbances. It undergoes nyctinastic movement, which is a nighttime shift in leaf orientation governed by a biological clock. Many times, people cultivate it out of pure curiosity. Compound leaves fold and droop in a seismonastic manner in reaction to contact or shaking as a kind of self-defense. A few minutes later, the leaves open again. 500 species make up the plant, which is about 50–70 cm tall [47]. This is called lajjalu in Ayurveda and is very valued as decoration. French scientist Jean-Jacques d'Ortous de Mairan first studied the leaf-closing response of the sensitive plant *Mimosa pudica* to both mechanical and electrical stimulation [48]. Plant memorizing and habituation have been extensively studied with mimosa because of its unique response to touch. Studies on phytochemicals are just one of the many medical uses for it. According to those research, *M. pudica* contains alkaloids, flavonoids, C-glycosides, terpenoids, tannins, fatty acids, and mimosine, a non-protein amino acid [49]. Due to its well-known anticonvulsant, antiasthmatic, aphrodisiac, analgesic, antidepressant, sedative, emetic, and tonic qualities, *M. pudica* has long been used to treat a variety of urinary tract infections, tumors, piles, alopecia, diarrhea, and dysentery. Because of its antioxidant qualities, it aids in blood sugar regulation by promoting insulin secretion [50]. Because lajvanti paste has anti-inflammatory, antibacterial, and antioxidant properties, it can help wounds heal more quickly by lowering pain and swelling.

Scientific Classification

Table 3

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Fabales
Family	Fabaceae
Genus	Mimosa
Species	*Mimosa pudica*

Morphology

Colour, Size and Shape

Root: The cylindrical roots of *Mimosa pudica* taper into secondary and tertiary branches, which can vary in length and thickness up to 2 cm. They have a longitudinally wrinkled surface that ranges from grayish-brown to brown, with hard, woody fractures [51].

Stem: The stem has a light brown exterior and a grey interior. It is cylindrical, branching, and measures up to 1.5 m in length and 2.5 cm in diameter. It also has longitudinal grooves. When a plant is young, its stem is upright; as it ages, it becomes creeping.

Leaf: The plant has five main leaves that are bipinnate, compound sessile, and have linear lanceolate, stipulate, and petiolate segments. Ten to twenty pairs of secondary leaflets, each measuring 0.6 to 1.2 cm in length and 0.3 to 0.4 cm in width, are present. It is known as a "sensitive tree" because of its symmetrical leaf arrangement and its tendency to close upon contact.

Odour: Distinct

Part of plant used: Whole plant or roots [52].

Seismonastic Movement of Leaves

The pulvini, which are swellings found at the base of leafstalks, serve as specialized motor organs in plants. They enable rapid responses to stimuli such as shaking by facilitating quick leaf folding or movement, thus enhancing the plant's ability to react swiftly to environmental changes. This adaptation aids in various plant behaviors, including defense mechanisms and optimizing light exposure. Water flows into and out of the pulvini cells, causing changes in their turgor pressure. The movement of water is also influenced by different ion concentrations. The pulvini's parenchymatous motor cells, which also include strands that transmit nutrients and water, are the units of contractibility in the response. Certain physical stimuli, such as touch, wind, heat, and intense light, trigger the action potential in motor cells within the pulvini. This process involves the movement of potassium ions from the cells to the intercellular spaces, facilitating the rapid response of the plant

to these stimuli. This mechanism allows plants to adjust their leaf positions, thereby optimizing their exposure to light and enhancing their ability to adapt to environmental changes. These signals also lower trigger pressure mostly found in the tannic vacuole and released upon activation are calcium ions. As a result, the pulvini contracts, affecting the flow of water and causing water to collect on one side. Seismonastic movement of leaves is thus defined as an action potential created that is conveyed to the pulvinus and from there to the pulvini of other leaflets that run along the length of the leaf.Leaves close for 4–5 seconds, yet it takes 600 seconds for them to open again. Gene on/off regulation may be regulated by information transmitted along, potentially serving as a long-term memory mode. It suggests that plants were not disregarding the stimulation that was decreasing because they were tired and had the capacity to form habits. Nyctinastic Movement: Leaflets are folded at night and reopen in the morning. This happens as a result of the biological clock or intrinsic rhythm that plants have. This type of movement is referred to as nyctinastic movement [53].

Chemical Constituents

Preliminary phytochemical screening of the *Mimosa pudica* leaf extract detected the presence of several bioactive substances. These include terpenoids, quinones, phenols, tannins, saponins, and coumarins. Mimosine, 4-O-gallic acid, and other alkaloids with a broad range of carbon to mineral content are found in chloroform extract of leaves. Plant roots have 10% tannins and 55% ash.These include terpenoids, quinones, phenols, tannins, saponins, and coumarins, along with organic and organosulfur compounds such as SO_2, phytosterol, alkaloids, amino acids, glycosides, and fatty acids like methylsulfinic acid, pyruvic acid, lactic acid, ethanesulfinic acid, propanesulfinic acid, 2-mercaptoaniline, S-propyl propane, 1-thiosulfinate, and thioformaldehyde. The extract also contains saclike structures..D-glucuronic acid and D-xylose combine to form mucilage in seeds. The components of benzoene extract include green-yellow fatty oils, tubulin, and crocetin-dimethyl ester. Gallic acid 4-O-(β-D-glucopyranosyl-6'-sulfate) is the source of a novel class of phytohormones called turgorines. Nitric acid (3-mono-methyl ether of inositol), d-pinitol, and b-sitosterol are released from fresh tissues [54,55].

Antimicrobial Activity of *Mimosa Pudica*:

The *Mimosa pudica* aqueous thorn extracts showed the maximum zone of inhibition for Escherichia coli, measuring 24.2±0.34mm. Similarly, the ethanolic thorn extracts *of Mimosa pudica* demonstrated significant antibacterial activity against Escherichia coli, exhibiting the largest zone of inhibition measuring 16.23±0.4 mm at a concentration of 100 µg per well.Aqueous extracts of *Mimosa Pudica* leaf extracts were found to exhibit a maximal zone of inhibition against *Escherichia coli* in a prior antibacterial investigation [56].The phytoconstituents may be the cause of the extracts from *Mimosa Pudica* thorns' effectiveness against Escherichia coli. According to a study, the phytochemical content of the plant extract may be the cause of its antibacterial activity [57]. It has been observed that diarrhea and other intestinal infections are caused by Escherichia coli. Because alkaloids affect the small intestine's transit time, they have an anti diarrheal action [58]. Thus, alkaloids may have played a role in the current study's antibacterial activity against Escherichia coli in the *Mimosa pudica* thorn extracts. *Mimosa pudica* thorn extracts with ethanolic thorn shown a moderate level of efficacy against *Klebsiella pneumoniae* .However, at a concentration of 100 µg per well, the ethanolic thorn extracts of *Mimosa pudica* exhibited the lowest zone of inhibition, measuring 8.1±0.17 mm, and the Escherichia coli was resistant to the aqueous extracts of *Mimosa pudica* thorns.A study that found Klebsiella pneumoniae to be the least vulnerable bacterium *to Mimosa pudica* extracts [59]. Supports the findings.In comparison to *Pseudomonas aeruginosa* and *Bacillus cereus*, the ethanolic extracts of *Mimosa pudica* demonstrated a relatively smaller zone of inhibition at 100µg/well, despite their strong antibacterial activity against Escherichia coli Previous investigations have shown that *Mimosapudica* leaf extracts demonstrated maximum zones of inhibition against *Escherichia coli* and *Pseudomonas aeruginosa*, indicating good sensitivity towards these bacteria. Additionally, the positive control, streptomycin, produced zones of inhibition against all selected microorganisms [60]. Previous research has demonstrated that *Mimosa pudica* ethanolic extracts have antibacterial action at higher doses and do not exhibit a defined zone of inhibition at lower concentrations, which is consistent with the findings of the current investigation [61). Twigs from *Mimosa pudica* were found to have antibacterial properties in an earlier investigation when the ethanolic extracts were examined [62]. Higher amounts of phenolic chemicals in plant extracts may be the cause of the extracts' greater antibacterial action, according to earlier research [63]. It was shown that flavonoids had antibacterial activity through mechanisms such as energy metabolism, cytoplasmic membrane activities, and inhibition of nucleic acid production [64]. The antifungal activity of *Mimosa pudica's* thorn extracts, both aqueous and ethanolic, was assessed using *Candida albicans*. The results unequivocally demonstrate that, when tested at 100µg/well, the *Mimosa pudica* aqueous thorn extracts showed the largest zone of inhibition against Candida albicans, measuring 18.1±0.17mm.*Mimosa pudica* ethanolic thorn extracts demonstrated the lowest zone of inhibition against *Candida albicans* at 100µg/well, measuring 13.3±0.3 mm.Since clotrimazole created a zone of inhibition against *Candida albicans*, it was employed as a positive control in the antifungal experiment.It was previously reported that coumarin inhibited *Candida albicans* in an in vitro study [65]. According to a study, extracts of *Mimosa pudica* may have antifungal properties because of their capacity to form complexes with cellwalls, soluble and extracellular proteins.A small amount of activity was shown by the *Mimosa pudica* extract against Candida albicans [66].

Plants Extraction Process

In pharmaceutical contexts, "extraction" refers to the process of using specific solvents to separate the medicinally active components from the inactive or inert parts of plant or animal tissues through routine extraction techniques. The resulting plant products are typically crude liquids, semisolids, or powders intended strictly for external or oral use [67].

Solvents Used For Extraction:

The solvent utilized for extracting medicinal herbs is commonly referred to as a menstruum. The solvent used for

extraction varies on the plant type, component being extracted, bioactive compound composition, and availability. Polar solvents such as water, methanol, and ethanol are employed for extracting polar molecules, whereas nonpolar solvents like hexane and dichloromethane are utilized for extracting nonpolar compounds [68, 69]. Traditionally, liquid-liquid extraction involves choosing two solvents that are miscible, such as dichloromethane with water, ether with water, or hexane with water. Water is included in all these combinations because of its high polarity and ability to mix well with organic solvents [69, 70]. Ethanol is a polar solvent that has been used to extract polyphenols and is safe for human consumption. It possesses several advantages that contribute to its popularity in extraction, such as affordability, a suitable boiling point, and a strong ability to penetrate plant cells. Ethanol can dissolve most organic substances except for proteins, mucilage, pectin, starch, and polysaccharides(71).Water is used as the extraction solvent by some researchers because it has many benefits over traditional solvent extractions, including being safer, less expensive, and able to adjust the properties of the material by adjusting its temperature [72].

Methods of Extraction

The various extraction methods used for plant extraction are,

- Maceration
- Digestion
- Infusion
- Decoction
- Counter-current extraction
- Microwave assisted extraction
- Ultrasound assisted extraction
- Soxhlet extraction
- Supercritical fluid extraction

1. **Maceration**

   This method uses a stoppered container to hold the solvent and the entire or granularly powdered crude medication. After repeated mixing, the mixture is left at room temperature for approximately three to seven days, or until the soluble components are evenly distributed.The marc, or damp solid material, is obtained by filtering the mixture and pressing it. Filtration or decantation are used to refine the combined liquids that are obtained after a standing time. For thermolabile plant material, this method is suitable and practical [73, 74].

2. **Digestion**

   During the extraction process, this method applies gentle heat. The medicinal substance is ground into a powder and combined with the extraction solvent in a clean container. The mixture is then placed in an oven set around 50°C or heated using a water bath.This technique works well with easily soluble plant components [75].

3. **Infusion**

   An infusion refers to a solution where the easily soluble components of the plant material are diluted. In this extraction method, the plant material is immersed in a boiling solvent, typically water, and left in a sealed container for about fifteen minutes. Afterward, the resulting extract (tea) is separated from the solid residue (marc) by filtering.

4. **Decoction:**

   This extraction method is effective for phytochemicals that remain stable at higher temperatures. During the decoction process, the plant material is simmered in water for 15 to 60 minutes [76]. Usually, delicate plant components such as leaves, stems, flowers, and roots are simmered for fifteen minutes. For instance, decoction and infusion methods have been employed to extract phenols and flavonoids from fruits, rhizomes, and leaves at temperatures around 100°C [77, 78]. When the combination reaches the desired level of solution, it is filtered, chilled, and then added cold water. Following the completion of the decoction procedure, the resulting mixture is filtered to extract the liquid [79].

5. **Counter current extraction:**

   Countercurrent extraction is a method for numerous liquid-liquid extractions that allows the separation of compounds with various distribution coefficients (ratios). This is accomplished through the use of the Craig apparatus, a brilliant design.Craig apparatus is made up of a sequence of glass tubes (r: 0, 1, 2, etc.) that are built and positioned in such a way that the liquid that is lighter phase moves from one tube to the next. The liquid-liquid extractions occur concurrently in all tubes of the equipment, which is typically electromechanically powered [80].

6. **Microwave assisted extraction**

   The process involves dipole rotation and ionic transfer, displacing charged ions in both the solvent and the drug substance. This method is particularly effective for extracting flavonoids. This involves using electromagnetic radiation with frequencies ranging from 300 MHz to 300 GHz and wavelengths between 1 cm to 1 meter. Microwaves applied at 2450 MHz generate energy ranging from 600 to 700 watts. Microwave radiation is used to bombard an item, causing it to absorb energy and generate heat. The generated heat aids in promoting the penetration of solvents into the drug matrix.Using a polar solvent leads to dipole rotation and ion migration, which improves solvent penetration and aids the extraction process [81,82].

7. **Ultrasound assisted extraction**

   Ultrasounds are electromagnetic waves that travel at higher frequencies than sound waves that can be heard by humans. The ultrasonic frequency ranges from twenty kHz to two thousand kHz. Utilizing the mechanical effect of ultrasound on plant cell walls, the ultrasonic-assisted extraction approach extracts bioactive chemicals. The solvent molecules' surface contact with the plant sample's matrix is improved through the mechanism of ultrasonic waves. Therefore, ultrasonography alters and disturbs the physical and chemical properties of plant materials, promotes the ejection of phytochemicals, and strengthens the mass flow of the solvent system into plant cells [83].

8. **Soxhlet extraction**

   This extraction is done by using a laboratory apparatus called soxhlet extractor. The thimble chamber of the

Soxhlet apparatus is filled with a porous bag, known as a "thimble," typically made of cellulose or robust filter paper, containing the powdered sample. The round-bottom flask containing the extraction solvent is heated using a heat source like a heating mantle. The specific heating temperature is determined by the solvent chosen for extraction. The solvent in the bottom flask vaporizes under heat, condenses in the condenser, and drips back into the sample thimble. The process continues until the clear solution in the siphon tube indicates that the liquid has reached the siphon arm and is returned to the bottom flask. This method is unsuitable for thermolabile compounds because prolonged heating can cause degradation of the compounds [84].

9. **Supercritical fluid extraction**

Supercritical fluid extraction (SFE) involves adjusting pressure and temperature to transform a gas into a liquid state where the distinction between the two phases disappears. At its critical point, a supercritical fluid exhibits physical properties that combine characteristics of both gas and liquid phases [19]. Temperature and pressure determine the critical zone for supercritical fluids. Above critical temperatures (Tc) and pressures (Pc), both the gas and fluid phases become indistinguishable. This process involves solubilizing and separating extractable compounds.As the solvent moves through the packed bed, it dissolves compounds present in the sample. After leaving the extractor, the extract becomes solvent-free owing to temperature and pressure changes [85].

Uses of *Curcuma Longa* And *Mimosa Pudica*:

Curcuma longa Uses:

1. When taken orally, turmeric appears to lessen hay fever symptoms like runny nose, sneezing, and itching.
2. When taken orally, curcumin, a compound present in turmeric, lessens the symptoms of depression in those who are already on antidepressants.
3. Turmeric extracts, whether used alone or in conjunction with other herbal remedies, can alleviate pain and improve knee function in patients suffering from osteoarthritis [86].
4. It is used to treat dyspeptic symptoms such as appetite loss, fullness after eating, and problems with the liver and gallbladder.
5. It has choleretic, carminative, antibacterial, and anti-inflammatory properties [87].
6. Turmeric may increase the production of bile, which could aid in the body's better fat digestion. Both improved digestion and the liver's ability to expel toxins may benefit from this.
7. It has the potential to be an antibiotic, as well as having astringent (cell-constricting) and anti-inflammatory properties. It could be beneficial in combating the germs that cause cavities and in maintaining the health of the gums.
8. The main ingredient in turmeric, curcumin, may bond to heavy metals like cadmium and lead, reducing their toxicity. Moreover, blood purification and poisoning treatments with turmeric may be successful [88].
9. Turmeric improves glucose management and enhances diabetic medication effectiveness. It also reduces insulin resistance, perhaps preventing Type 2 diabetes.
10. Turmeric offers numerous skin advantages, including faster wound healing, relaxing pores, and reducing acne [89].

Mimosa pudica uses

1. *Mimosa pudica* leaves are thought to offer wound healing qualities. They can be pulverized and used topically to treat small cuts and wounds.
2. Compounds discovered in *Mimosa pudica* have antibacterial and antifungal activity. This indicates possible benefits in treating various microbial diseases.
3. The plant includes antioxidants that may assist neural cells resist oxidative stress. Research indicates potential neuroprotective effects [90].
4. *Mimosa pudica* has a history in traditional medicine for alleviating depression symptoms and promoting calming effects. Research suggests that extracts from this plant may possess antidepressant properties, potentially by modulating neurotransmitter activity.
5. *Mimosa pudica* leaves have been shown in studies to possess bioactive chemicals with strong anti-inflammatory and analgesic activity [91].
6. It effectively treats diarrhea, amoebic dysentery, bleeding piles, and urinary infections.
7. The bark of *Mimosa tenuiflora* is traditionally utilized to soothe the mind and alleviate symptoms such as amnesia, severe palpitations, irritability, depression, and mental distress [92].
8. Use the plant's root decoction as a gargle to keep your mouth healthy and ease tooth pain. To treat caries teeth and relieve toothache, apply a paste made of fried roots in ghee [93].
9. The *M. pudica* root's aqueous extract reduces the potency of cobra venom. Lajvanti functions as an anti-venom by aiding in the neutralization of blood venom prior to its arrival at the intended spot.
10. It has been noted that mimosine structurally resembles L-tyrosine and that it likely functions as a tyrosine analog or antagonist, inhibiting the body's ability to synthesise proteins and resulting in toxic symptoms such growth retardation [94,95].

Conclusion

In conclusion, the comprehensive review of the antimicrobial activities of *Curcuma longa* (turmeric) and *Mimosa pudica* (sensitive plant) highlights their significant potential as natural antimicrobial agents. *Curcuma longa*, particularly due to its active component curcumin, demonstrates extensive antimicrobial properties that effectively combat a variety of bacteria, fungi, and viruses .Its mechanism includes disrupting microbial cell membranes and inhibiting essential microbial enzymes.Similarly, *Mimosa pudica* demonstrates notable antimicrobial effects, attributed to its rich phytochemical content, including tannins, flavonoids, and alkaloids. Studies have shown its efficacy in inhibiting the growth of diverse pathogenic microorganisms, reinforcing its traditional use in folk medicine for treating infections.Both plants offer

promising alternatives to synthetic antimicrobials, which are increasingly challenged by the rise of drug-resistant pathogens. However, despite their potential, further research is necessary to optimize extraction methods, determine effective dosages, and understand the precise mechanisms of action. Additionally, clinical trials are essential to establish their safety and efficacy in human applications. Overall, *Curcuma longa* and *Mimosa pudica* represent valuable resources in the quest for novel antimicrobial agents, aligning with the global need for sustainable and effective treatments against infectious diseases.

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