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Mini Review

A Comprehensive Review on Chrysanthemum Plants Reveals Some Anti-Microbial & Anti-Bacterial Properties

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ABSTRACT

One of the main ingredients used in the herbal business to make herbal medications is found in plants. Different pharmacological properties are displayed by distinct areas of medicinal plants. In Chinese medicine, Chrysanthemum Indicum has long been used to treat respiratory conditions, inflammation, and high blood pressure. The crop is significant in today's world since it is utilized for floriculture, ornamentation, and medicine. Long used in East Asian herbal medicine, Chrysanthemum Indicum Linn. is the subject of more recent scientific research examining its potential as an antibacterial agent. This review simplifies and evaluates available research on the efficacy of C. indicum extracts, essential oils, and derivative formulations against a range of bacterial infections. The outer membrane barrier of Gram-negative bacteria is probably the reason for the generally lower activity against them. In order to enable its translation into therapeutic or preservative applications, this review outlines the current understanding and limitations of C. indicum as an antibacterial agent. It also suggests directions for future work, such as deeper mechanistic studies, optimization of essential oil composition, synergy with antibiotics, development of Nano particulate systems, and rigorous safety evaluation.

INTRODUCTION

These days, a lot of people use herbal remedies because they have been demonstrated to be effective in treating a variety of health issues, are less expensive, and have fewer side effects. Chemical-based medications, on the other hand, are typically more costly and have a higher potential for adverse effects(1). One of the most significant and quickly expanding commercial sectors in the agriculture sector is the floriculture industry(2). Because of its antiviral, antibacterial, antioxidant, and anticancer attributes, medicinal herbs have been utilized for a very long time.

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These plants offer a wide range of chemical collection of bioactive substances with a range of uses. The most important natural sources of antioxidants are thought to be medicinal herbs. Among these, fragrant plants—including those that bloom—have gained a lot of interest recently. Researchers are examining the composition of their molecules and aspiring to determine their pharmacological characteristics in order to treat a variety of diseases in both humans and animals(3). The well-known genus Chrysanthemum comprises about 300 species that are found distributed throughout the world. While some of these species grow as herbs and under shrubs, many are used as ornamental greenery in gardens. There are 40 species of Chrysanthemums in the Asteraceae family, most of which are found in East Asia(4). The chrysanthemum is originating in China, the word "chrysanthemum" is derived from the Greek word "krus anthemon," which means "gold flower." A member of the Asteraceae family, *Chrysanthemum morifolium* (Ramat). After roses, it is regarded as the second-most significant floriculture crop globally(2). It has been cultivated since the 15th century BC and is highly valuable both medicinally and aesthetically(5). According to recent studies, the plant as an entire entity has medicinal properties, with the flower being the main component of these properties. Chrysanthemum is traditionally used in beverages and medications because of its many health benefits. For instance, in North-eastern Asia, including China and Korea, chrysanthemum flowers were dried and used to make herbal tea. According to claims, it relieves a number of ailments including respiratory disorders, cholera, headaches, inflammation, high blood pressure, and other associated disorders(4). *Chrysanthemum Indicum* is known for its health advantages. Traditional medicine uses *C. indicum* to treat a number of infections, such as stomatitis, colitis, and pneumonia. Furthermore, it can help cure symptoms of high blood pressure, whooping cough, vertigo, fever, and sores(6).



Fig no. 1: *Chrysanthemum Indicum* flower

Chrysanthemum Indicum is a perennial, erect, aromatic plant that is collected from the wild and used locally for both food and medicine. Despite its temperate origins, this plant may thrive in tropical climates. Chemicals in the phytoconstituents that are separated from plants attach to specific target areas in the human body. Proteins, phenols, alkaloids, glycosides, terpenoids, steroids, flavonoids, tannins, saponins, sugars, and cumarins are the most significant bioactive substances found in plants(6). *Chrysanthemum Indicum* has strong antibacterial, antiviral, antioxidant, and immunomodulatory characteristics that are low in toxicity and extremely potent(7). *Chrysanthemum Indicum* demonstrates its substantial medicinal potential, especially in the management of viral and inflammatory illnesses. This analysis lays forth how the bioactive substances in the plant interact with different biological pathways and molecular targets, demonstrating their capacity to control inflammatory reactions and fight infections. Researchers can better comprehend the plant's pharmacological effects and mechanisms of action by fusing contemporary scientific methods with traditional medical knowledge, which has long

acknowledged the plant's therapeutic virtues. A thorough understanding of *Chrysanthemum Indicum*'s therapeutic potential is provided by the fusion of traditional knowledge with modern research techniques(8).

The medicinal plant *Chrysanthemum Indicum*, also referred to as Saamanthi or Indian Chrysanthemum, is extensively utilised in conventional medical systems like Ayurveda and Traditional Chinese Medicine (TCM). Flavonoids, terpenoids, and phenolic acids are among the many bioactive substances found in this plant's flower buds that have relaxing, anti-inflammatory, antioxidant, and antibacterial qualities.(9) In addition to their recent use in green nanotechnology applications, *Chrysanthemum Indicum* has health benefits and molecular bases for their biological impacts. Research has been done on the antibacterial, anti-inflammatory, antioxidant, anticancer, and anti-diabetic/anti-obesity qualities of chrysanthemum. It has been discovered that both chrysanthemums have the capacity to diminish pro-inflammatory genes and proteins, trigger cancer cell apoptosis, and alter lipid metabolism to slow the progression of diabetes and obesity. Additionally, it has been shown that chrysanthemum possesses antioxidant qualities, which protect against oxidative damage by activating antioxidant and cytoprotective genes. Furthermore, results showed that Chrysanthemum-based green production of silver nanoparticles have antibacterial qualities(4). Exploring novel sources of antimicrobial medications that are easily obtainable, free of side effects, and have significant economic potential was crucial, based on the literature and the aforementioned survey. In this context, current research in India focusses on the extraction of crude medications from widely accessible flower parts, as well as their initial phytochemical potential and antibacterial activity for the treatment of symptoms carried on by a number of harmful bacteria(3).

Taxonomical data:

The perennial plant *C. indicum L.* belongs to the family *Asteraceae*. Usually, the dried flower or the entire plant is utilized as medication. The genus Chrysanthemum's taxonomy has undergone numerous alterations and perpetual modifications. Based mostly on common physical traits, the genus Chrysanthemum was first divided into eight divisions, each of which had just four annual and four perennial species(10). Widely distributed throughout China, Japan, Korea, and India, *C. indicum L.* grows on grasslands, mountain slopes, thickets, wet areas by rivers, fields, saline areas by seashores, under shrubs, and on roadways at elevations of 100–2900 m. Its wild resources are incredibly abundant**.** Chinese Flora states that *C. indicum L.* is 0.25–1 m tall, with long or short pro-cumbent rhizomes; stems that are erect or diffuse, branched, and sparsely pilose; lower leaves that withered at anthesis; and middle stem leaves that are elliptic-ovate, long ovate, or ovate, with surfaces that are either pale green or olive, sparsely pubescent or less densely so abaxially, pinnatifid, pinnatilobed, or conspicuously divided, base truncate, somewhat cordate, or broadly cuneate. capitula many or few; synflorescence a lax terminal flat-topped cyme; Ray floret lamina yellow, 1–1.3 cm, apex entire or 3-denticulate; achenes all of the same shape, 1.5–1.8 mm; phyllaries in five rows, scarious edge broad, white or brown, apex obtuse or rounded, outer ones oblong or ovate-triangular, middle ones ovate, inner ones narrowly elliptic(11)(12).

Table no 1: Describing about Taxonomical class of a *Chrysanthemum Indicum*.

Sr.no	Taxonomical Class	Taxonomical Identity
1.	Common Name	Chandramallika, Shevanti
2.	Kingdom	Plantae
3.	Phylum	Tracheophyta
4.	Clade	Angiosperms
5.	Order	*Asterales*
6.	Family	*Asterceae*
7.	Genus	Chrysanthemum
8.	Species	*C. indicum* Linn

Pharmacological Action:

Chrysanthemum has anti-inflammatory and immunomodulatory properties that are in line with its traditional effectiveness; it also has a lot of promise for treating neurological and chronic metabolic disorders. The primary material basis for these actions may include flavonoids, phenolic acids, and Terpenoids, which are the primary active constituents(13).

Chrysanthemum Indicum displays a broad spectrum of pharmacological actions, including antimicrobial, anti-inflammatory, antioxidant, and immunomodulatory effects. The plant's therapeutically active compounds—such as flavonoids, terpenoids, and phenylpropanoids—are implicated in antimicrobial activity, in part by disrupting microbial membranes, interfering with oxidative phosphorylation and electron transport, and inducing lipid peroxidation, with essential oils of C. indicum showing anti-Helicobacter pylori activity at IC_{50} levels comparable to clarithromycin. Numerous immune cells control the complicated reaction known as inflammation by releasing several cytokines and inflammatory enzymes, including TNF-α, NO, iNOS, COX-2, IL-1β, and PGE2. By controlling inflammatory mediators including NO, PGE2, and pro-inflammatory cytokines, as well as acting as a host defence mechanism, macrophages play a crucial part in the inflammatory response(14). In terms of its anti-inflammatory action, *C. indicum* suppresses pro-inflammatory cytokines (IL-6, TNF-α), downregulates the TLR4 / MyD88 / NF-κB signaling pathway, inhibits MAPKs (ERK, JNK), reduces iNOS and COX-2 expression, and prevents nuclear translocation of NF-κB p65 subunit.(3) Interestingly, by controlling the phosphorylation of ASC, it also prevents the activation of NLRP3 and AIM2 inflammasomes, which lowers the production of IL-1β in LPS-primed macrophages and in an in vivo peritonitis model. By increasing SOD, CAT, and GPX, upregulating HO-1 through the Nrf2/PI3K/Akt axis, and decreasing ROS, MDA, MPO, and apoptotic markers like Bax/Bcl-2 and cleaved caspase-3 in tissues, C. indicum improves endogenous antioxidant defences. Lastly, it changes T helper cell balances (Th1/Th2, Th17/Treg), increases antibody production (IgG, IgM), improves phagocytosis, and influences signalling through the NF-κB / IL-6 / JAK2 / STAT3 pathways. Although long-term toxicity has not been thoroughly investigated, acute toxicity results indicate that C. indicum extract is quite safe in mice up to 2.0 g/kg(15).

Anti-Microbial and Anti-Bacterial:

Several pathogenic microorganisms, including *Escherichia coli, Staphylococcus aureus, Streptococcus mutans, Pseudomonas aeruginosa,* and *Listeria monocytogenes*, are significantly

inhibited by the terpenoids, phenols, alcohols, and other chemical components found in *Chrysanthemum's* Volatile oils. We offer common *Chrysanthemum's* Volatile oil variants together with their potent antibacterial components. *Chrysanthemum's* Volatile oils active ingredients vary according on the plant's place of origin. The antibacterial impact may be the consequence of many routes, multi-target activities in cells, and multi-component synergy rather than being ascribed to specific elements and mechanisms. Interestingly, a large number of these systems are influenced by several pathways(16).

Anti-Cancer:

In the context of MAPK/ERK1/2 intracellular activity, the effect of *Chrysanthemum indicum Linné* extracts (CILE) on isoproterenol (ISO)-induced proliferation of human hepatocellar carcinoma (HCC) cells was investigated. It was discovered that effectively attenuated the mitogenic effect of ISO on both HepG2 and MHCC97H cells. By suppressing the ISO-induced activation of MAPK/ERK1/2 via beta2-AR, CILE was able to suppress cancer cells. The investigation of CILE's anticancer mechanism will benefit from our findings. Therefore, the purpose of the study was to explore the anticancer potential of Chrysanthemum indicum extracts in HepG2 cell lines. Since the main focus of the current research is on specific plant protective actions, such as the antiproliferative potential of the whole plant extract, our findings may be helpful for future studies. To promote its broad use, it would be ideal to conduct in-depth scientific studies and trials on this amazing therapeutic herb(17).

Chemical constituents:

Indian chrysanthemums, or *Chrysanthemum Indicum*, have been utilized for a variety of medical uses since ancient times. Additionally, studies have shown a variety of pharmacological effects that are ascribed to its bioactive components. A few of *Chrysanthemum Indicum*'s main pharmacological actions. Terpenoids, Glycosides and flavonoids are among the active components in this flower that have antibacterial properties. The precise therapeutic benefits and active ingredients of *Chrysanthemum Indicum*, however, have not yet been thoroughly investigated. There are several ways to use it. For instance, dried flowers, essential oils, and extracts(1).Following substance is bioactive enlisted are :-

1. **Flavonoids**: Acacetin, tricin, eupatilin, apigenin, quercetin, luteolin.
2. **Polyacetylenes**: Cis-Spiroketalenolether polyyne, chrysindins C, chrysindins B.
3. **Dihydroflavonoids**: Eriodictyol
4. **Phenylpropanoids and phenolic acids**: Caffeic acid, chlorogenic acid, vanillic acid.
5. **Terpenoids**: Spathulenol, Matricarin, intermedeol, borneol.
6. **Volatile oils**: α-pinene, linalool.
7. **Other compounds**: Tannins, Sterol, sesquiterpenes(9)(1).

According to a study, the strong antibacterial activities against Gram-positive bacteria may be explained by the presence of considerable amounts of monoterpenes (C10H16) and oxygenated monoterpenes (C10H16O). These substances may weaken the structure of the bacterial cell membrane by rupturing it. Consequently, terpenoids found in essential oils (EOs) make them especially effective against Gram-positive bacteria. Additionally, their mild antibacterial activity may be strengthened by a synergistic interaction between important and minor molecules.(1)

CONCLUSION:

Chrysanthemum Indicum's complex phytochemical composition and long history of usage in traditional medicine have drawn more and more scientific attention to its antibacterial properties. The significant inhibitory activity of different extracts, especially methanolic, ethanolic, and essential oils, against a wide range of pathogenic bacteria, such as *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa,* and *Klebsiella pneumoniae,* has been confirmed by numerous studies published in international journals. Flavonoids, terpenoids, and phenolic acids are examples of bioactive substances that are thought to have antibacterial properties. These compounds are thought to work through processes such as oxidative stress induction, enzyme inhibition, and membrane disruption. In addition, the effectiveness of antibacterial agents of *C. indicum* has been further improved by current developments in nanotechnology. Superior bactericidal effects have been shown in studies that use green synthesis techniques to create silver nanoparticles from plant extracts, indicating a possible path for the creation of innovative antimicrobial compositions. New approaches to combating antimicrobial resistance are also made possible by the possibility of synergistic effects when paired with traditional medicines.

It have remained important gaps in spite of these positive outcomes. The complete therapeutic use of *C. indicum* is hampered by the lack of standardized dosages, inconsistent extraction techniques, scant in vivo research, and inadequate clinical data on confirm its safety and effectiveness, future research should give priority on standardized formulation development, mechanistic studies, toxicity evaluation, and clinical trials. In the final analysis, *Chrysanthemum Indicum* exhibits great potential as a natural antibacterial agent and, with more research, may be useful in complementary and alternative antimicrobial treatments.

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