



## Phytochemical Analysis and Evaluation of Antimicrobial and Anticancer Properties in Selected Plants of Chhattisgarh: A Review

Seema Verma<sup>1</sup> • Niharika Dewangan<sup>2</sup> • Bhavtosh Sharma<sup>3</sup> • Archana Tamrakar<sup>2</sup> • Pratibha Sahu<sup>2</sup> • Bhavna Yadav<sup>2\*</sup>

<sup>1</sup>GD Rungta College of Science and Technology, Bhilai, Chhattisgarh

<sup>2</sup>Shri Shankaracharya Professional University, Bhilai, Chhattisgarh

<sup>3</sup>Uttarakhand State Council for Science & Technology, Dehradun

\*Corresponding Author Email Id: bhavnayadav603@gmail.com

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**Abstract:** This assessment provides a thorough analysis of the phytochemical composition and assesses the antimicrobial and anticancer properties of selected plant species native to the Chhattisgarh region of India, which is known for its abundant biodiversity and is home to a variety of medicinal plants with traditional restoration value. The analysis synthesizes findings from state-of-the-art medical literature, concentrating on important phytochemical components with known bioactive properties. Antimicrobial efficacy is discussed in relation to a wide range of pathogens, as well as microorganisms, fungi, and viruses. In parallel, the evaluation explores the anticancer potential of plant-derived compounds, emphasizing molecular mechanisms and healing pathways validated via each in vitro and in vivo studies. By consolidating current studies, this overview underscores the significance of indigenous flora in the development of novel pharmacological retailers. It highlights the importance of traditional expertise in guiding bioprospecting efforts and supports the role of natural products in the discovery of destiny antimicrobial and anticancer therapies.

**Key words:** Phytochemical composition • Therapeutic applications • Indigenous flora • Molecular mechanisms • In vitro studies • In vivo studies • Therapeutic interventions • Drug discovery

### Introduction

Chhattisgarh, located in east-central India, is a landlocked state with a diverse landscape that includes hilly terrains in the northern and southern regions and fertile plains in the central belt. Rich in natural resources, it ranks third in India in terms of forest cover, playing a crucial role in supporting biodiversity and sustaining local livelihoods. The region's dense forests, rivers, waterfalls, and mountainous terrain create an ideal habitat for a vast array of medicinal plants, which have long been integral to traditional healthcare practices. Forest-dwelling communities have relied on these plants for generations as accessible and effective alternatives to modern medicine (Smith et al 2006).

According to the World Health Organization (WHO), traditional medicine encompasses culturally rooted knowledge and practices passed down through generations. These systems are often cost-effective, environmentally sustainable, and deeply embedded in local traditions. The safety and therapeutic efficacy of ethnomedicines, primarily derived from plants, are well acknowledged (Kozovska et al 2017). Classical Indian texts such as the *Charaka Samhita*, *Sushruta Samhita*, *Atharva Veda*, and *Rig Veda* detail the use of numerous herbs for medicinal purposes. Ayurveda, one of the oldest holistic healing systems in the world, continues to influence healthcare not only in India but globally.



Globally, around 21,000 plant species are recognized for traditional medicinal use. In India alone, nearly 100 genera are employed therapeutically. With sixteen agro-climatic zones and recognition as one of the world's twelve mega biodiversity hotspots, India is the second-largest exporter of medicinal plants. The increasing global interest in herbal remedies, particularly in developing nations, underscores the need for interdisciplinary approaches in pharmaceutical research and development (Singh et al 2021).

Phytochemicals such as alkaloids, flavonoids, tannins, terpenoids, saponins, and steroids are largely responsible for the therapeutic properties of plants. Species like *Buchanania lanzan* have shown significant bioactivity. Its leaves exhibit strong antimicrobial effects against pathogens like *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli*. These findings highlight the importance of validating traditional knowledge to discover novel therapeutic agents from nature (Tekaday et al 2020).

### Methodology

This review study employed a systematic approach to collect, analyze, and synthesize existing scientific literature on the phytochemical composition and biological properties of selected medicinal plants from Chhattisgarh. A comprehensive literature search was conducted using databases such as **PubMed**, **Scopus**, **ScienceDirect**, **Google Scholar**, and **BMC**. Keywords including “medicinal plants of Chhattisgarh,”

“phytochemicals,” “antimicrobial properties,” and “anticancer potential” were used to identify relevant peer-reviewed articles and ethnobotanical reports. Preference was given to studies that reported **in vitro**, **in vivo**, or **clinical evaluations** of the medicinal plants, along with their phytochemical characterization. Extracted data were organized into a comparative tabular format highlighting bioactive compounds, antimicrobial activity, anticancer effects, and references. This methodology enabled the consolidation of current knowledge and identification of plants with therapeutic promise.

### Results and Discussion

#### Phytochemistry of *Withania somnifera*:

Within the *Solanaceae* family, ashwagandha, or *Withania somnifera*, is a well-known medicinal herb. For many centuries, it's been used notably in Ayurvedic and traditional medicine. With its large sort of fitness advantages, along with immunomodulatory, anti-inflammatory, anti-pressure, neuroprotective, cardio protective, and bodily health enhancement capabilities, this plant is praised all over the international. Additionally, ashwagandha is known to have anti-diabetic, aphrodisiac, and memory-improving properties. Additionally, studies have shown that it's far powerful in treating some of cancers in addition to related troubles that impact the skin, blood, liver, kidneys, lungs, prostate, colon, mammary glands, and prostate (Raina et al 2021)



Table 1: The antimicrobial and anticancer properties of various medicinal plants

SN.	Plant name	Bioactive compound (phytochemical)	Antimicrobial activity	Anti cancerous property	Ref.
1	Ashwagandha ( <i>Withania somnifera</i> )	Withanolides, alkaloids, and steroidal lactones.	Bacterial	The properties of this substance, demonstrated by its capacity to induce apoptosis, inhibit the proliferation of tumor cells, and modulate immune responses, indicate its potential significance in the prevention and treatment of cancer..	Owais <i>et al.</i> , 2005; Singh <i>et al.</i> , 2021)
2	Moringa ( <i>Moringa oleifera</i> )	Quercetin, Chlorogenic acid, and beta-carotene	bacteria and fungi	Inhibiting the growth of cancer cells in preclinical research..	Pareek <i>et al.</i> , 2023
3	Papaya ( <i>Carica papaya</i> )	Papain, chymopapain, and carpaine	bacteria and fungi	In preclinical studies, inhibiting the growth of cancer cells..	Fauziya <i>et al.</i> , 2013
4	Bitter Gourd ( <i>Momordica charantia</i> )	Charantin	Including strains of <i>Escherichia coli</i> ( <i>E. coli</i> ), <i>Staphylococcus aureus</i> , <i>Salmonella typhi</i> , and <i>Pseudomonas aeruginosa</i> .	Potential role in cancer prevention.	Moniruzzaman <i>et al.</i> , 2022
5	Guggul ( <i>Commiphora wightii</i> )	Guggulsterones, myrrhanol	<i>Staphylococcus aureus</i> and <i>Escherichia coli</i> .	Inhibit cell proliferation, and suppress angiogenesis, suggesting its promising role in combating cancer.	Gupta <i>et al.</i> , 2023
6	Bael ( <i>Aegle marmelos</i> )	Marmelosin is a furocoumarin known for its antioxidant and anti-inflammatory effects, as well as its potential therapeutic benefits..	Bacteria and Fungi	Inhibiting cancer cell growth and proliferation.	Rahman 2014
7	Shatavari ( <i>Asparagus racemosus</i> )	Saponins, Flavonoids, and Alkaloids	Inhibiting the growth of various microorganisms	Promising natural agent in cancer prevention and treatment.	Hooda <i>et al.</i> , 2023
8	Punarnava ( <i>Boerhavia diffusa</i> )	Punarnavoside and Rotenoids	Potential antibacterial and antifungal properties.	The effects of inhibiting proliferation and inducing apoptosis in cancer cells..	Ahmad <i>et al.</i> , 2021
9	Kalmegh ( <i>Andrographis paniculata</i> )	Andrographolide	bacteria and viruses	The suppressive impact on the growth and multiplication of cancer cells.	Malik <i>et al.</i> , 2021



SN.	Plant name	Bioactive compound (phytochemical)	Antimicrobial activity	Anti cancerous property	Ref.
10	Kutki ( <i>Picrorhizakurroa</i> )	Kutkin is composed of two iridoid glycosides, namely picroside I and picroside II, which are recognized for their anti-inflammatory and liver-protective effects..	antibacterial and antifungal properties	Anti-proliferative and apoptotic effects on cancer cells, showcasing promising therapeutic potential in cancer treatment.	Raina <i>et al.</i> , 2021
11	Brahmi ( <i>Bacopamonnieri</i> )	Bacosides	bacteria and fungi	Cognitive-enhancing properties, emerging research suggests potential anticancer activity attributed to its bioactive compounds.	Fatima <i>et al.</i> , 2022
12	Pomegranate ( <i>Punica granatum</i> )	Punicalagins, Ellagic acid, and anthocyanins	Antimicrobial activity, attributed to its rich The phytochemical composition, encompassing tannins and flavonoids, plays a significant role in its effectiveness against various pathogenic microorganisms.	The possible anticancer properties are attributed to its diverse bioactive compounds, including polyphenols and ellagic acid.	Salim <i>et al.</i> , 2023
13	Giloy ( <i>Tinospora cordifolia</i> )	Berberine and Tinosporin	antibacterial, antiviral, and antifungal properties	The possible anticancer properties are evidenced by the demonstration of anti-inflammatory, antioxidant, and immunomodulatory effects.	Palmieri <i>et al.</i> , 2019
14	Jamun ( <i>Syzygiumcumini</i> )	Jambosine, fruit contains anthocyanins, ellagic acid	antibacterial and antifungal properties	Anthocyanins and polyphenols possess antioxidant and anti-inflammatory characteristics that could potentially impede the proliferation of cancer cells.	Qamar <i>et al.</i> , 2022
15	Indian Gooseberry ( <i>Phyllanthus emblica</i> )	Tannins, Flavonoids, and Polyphenols	demonstrating its efficacy against a wide range of microorganisms	Vitamin C and polyphenols play a crucial role in neutralizing free radicals and suppressing the proliferation of cancer cells.	Zhao <i>et al.</i> , 2015, Ahmad <i>et al.</i> , 2021
16	Fenugreek ( <i>Trigonellafoenum graecum</i> )	Trigonelline, Diosgenin, and Galactomannan	Bacteria and fungi.	Modulation of cell cycle progression and induction of apoptosis in cancer cells.	Varshney <i>et al.</i> , 2023



SN.	Plant name	Bioactive compound (phytochemical)	Antimicrobial activity	Anti cancerous property	Ref.
17	Arjuna ( <i>Terminalia arjuna</i> )	Tannins like Ellagic acid and Flavonoids such as quercetin	Demonstrated potential in inhibiting the growth of various microorganisms.	Cytotoxic and apoptosis-inducing effects on cancer cells.	Ramesh <i>et al.</i> , 2023
18	Vasaka ( <i>Adhatoda vasica</i> )	Vasicine and Vasicinone,	against various bacterial and fungal infections	Exhibiting inhibitory effects on cancer cell proliferation and inducing apoptosis.	Kumar <i>et al.</i> , 2022
19	Guduchi ( <i>Tinospora sinensis</i> )	Alkaloids, Glycosides, and Flavonoids	antibacterial and antifungal properties	Potential anticancer effects may be achieved through multiple mechanisms, such as the induction of apoptosis, the inhibition of angiogenesis, and the modulation of immune responses.	Singh <i>et al.</i> , 2022
20	Turmeric ( <i>Curcuma longa</i> )	Curcumin	inhibit microbial growth	Suppress the development and expansion of cancer cells, trigger programmed cell death, and exhibit anti-inflammatory and antioxidant characteristics.	Iweala <i>et al.</i> , 2023
21	Tulsi ( <i>Ocimum sanctum</i> )	Eugenol demonstrates both anti-inflammatory and antioxidant characteristics..	Antibacterial and Antifungal properties.	The properties of anti-inflammation, antioxidant activity, and the induction of apoptosis play a significant role in inhibiting the growth and proliferation of cancer cells.	Chaudhary <i>et al.</i> , 2020
22	Neem ( <i>Azadirachta indica</i> )	Azadirachtin, limonoids	Bacteria, fungi, and viruses.	Restrict the growth of cancer cells and promote programmed cell death..	Alzohairy <i>et al.</i> , 2016
23	Aloe Vera ( <i>Aloe barbadensis miller</i> )	Polysaccharides, Glycoproteins, and anthraquinones	Bacteria and fungi.	Therapeutic significance in cancer prevention and treatment.	Surjushe <i>et al.</i> , 2008
24	Cumin ( <i>Cuminum cyminum</i> )	Cuminaldehyde and key phenolic compounds like Cuminol and Apigenin.	Bacteria and fungi	The ability to promote cell proliferation, trigger apoptosis, and demonstrate anti-inflammatory and antioxidant properties indicates its potential as a valuable natural agent in the prevention and treatment of cancer.	Al-Snafi <i>et al.</i> , 2016
25	Ginger ( <i>Zingiber officinale</i> )	Gingerol	Inhibiting the growth of various microorganisms	Suppress the growth of cancer cells and promote programmed cell death.	Mao <i>et al.</i> , 2019

### Photochemistry of *Moringa oleifera*:

Known because the "tree of life" or "miracle tree," *Moringa oleifera* is a mainly prized

herbal plant with numerous nutritional and restoration makes use of. It has historically been used to deal with a good sized form of



situations, including inflammation, most cancers, liver issues, cardiovascular sicknesses, wounds, pain, and ulcers. The plant's pharmacological sports, phytochemical composition, toxicological tests, and ethno medicinal importance are highlighted in this examine, which additionally examines the plant's business and phytopharmaceutical capability ( Murti *et al* .,2024 ) With an emphasis on English-language courses, medical facts grow to be accumulated from property like Scopus, PubMed, Science Direct, BMC, and Google Scholar. Research has showed that the plant consists of bioactive compounds with anti-inflammatory, cardio protective, and hepatoprotective consequences in various additives. There are greater than one hundred stated compounds, together with nutrients, terpenes, alkaloids, flavonoids, glycosides, and anthraquinones. Notable substances with anti-cancer, anti-hypertensive, antioxidant, and nutritional residences include niazimin A and B and muramoside A and B. (Fahey *et al* 2005) Several traditional makes use of *moringa* although lack empirical assist, notwithstanding the fact that plenty of them were scientifically proven. In order to isolate and perceive the energetic or synergistic compounds that supply the plant its medicinal efficacy, the review highlights the need of extra research into the mechanistic components of the plant's healing movements (Pareek *et al* 2023)

#### **Phytochemicals in Papaya:**

Every part of the papaya (*Carica papaya* Linn.) plant—leaves, fruit, seeds, bark, latex, and juice—is utilized in traditional medicine because to its amazing nutritional and medicinal properties. Because of its many health benefits, it is categorized as a nutraceutical fruit. The immune system is supported by papayas, which are rich in critical vitamins, including the enzyme papain, lycopene, and is thiocyanate, as well as necessary minerals, carbohydrates, carotenoids, and flavonoids. In Medical

research, especially in vitro studies, has emphasized papaya's anticancer qualities. By dissolving the fibrin walls of most cancers cells and facilitating protein digestion, papain, a vital enzyme discovered in the fruit, has shown promise in inhibiting the increase of cancer cells. (Babalola *et al* 2024) Strong antioxidant lycopene similarly complements its therapeutic cost by way of reacting with oxygen and neutralizing loose radicals. Furthermore, it has been verified that papaya's is thiocyanate compounds can combat towards a number of cancers, which includes leukemia, breast, lung, colon, pancreatic, and prostate cancers. According to Fauzia *et al* (2013), those substances useful resource in stopping the improvement and unfold of cancer cells.

#### **Properties of *Cucurbita maxima* and *Momordica charantia*:**

Investigating new antimicrobial marketers has turn out to be extra vital due to the developing situation over microbial drug resistance. A latest observe examined the antibacterial capacity of seed extracts from *Momordica charantia* and *Cucurbita maxima* the use of both in vitro and in silico opinions. According to Krstić *et al* (2023), at a concentration of 2 hundred µg/ disc, each extracts confirmed awesome inhibitory hobby towards *Staphylococcus aureus*. Strong antioxidant characteristics and a low chance of negative effects had been also tested by way of these extracts. They additionally worked properly to forestall the formation of biofilms that is a key cause of bacterial resistance. Several bioactive compounds that validated capacity for concentrated on antibiotic-resistant bacterial lines have been located in the extracts via molecular docking analyses. (Moniruzzaman *et al* 2022)

#### **Phytochemical properties of *Guggul sterone*:**

*Guggulsterone* has shown remarkable benefits against a variety of cancer types by inducing apoptosis, inhibiting cell division, and regulating gene expression. It exhibits both





therapeutic and preventative potential by reducing tumor size and delaying tumor growth. Experimental evidence has demonstrated its ability to inhibit angiogenesis and control a few pathways to prevent the proliferation of cancer cells. It also reduces inflammatory indicators and helps overcome multidrug resistance. A meta-analysis of 23 trials revealed a significant increase in apoptosis following Guggulsterone therapy, with odds ratios of 3.984 at  $t = 24$  hours and 11.171 at  $t > 24$  hours (Pareek *et al* 2023)

#### **Phytochemicals in *Aegle marmelos***

Herbal medicinal drug relies closely on medicinal plants, which give rural and tribal groups with an without problems available form of healthcare. The purpose of this assessment is to gather and evaluate the pharmacological and phytochemical studies that have been done on the huge medicinal plant *Aegle marmelos*. *Aegle marmelos* has a vast range of therapeutic consequences, such as antidiarrheal, antimicrobial, antiviral, radio protective, anticancer, chemo preventive, antipyretic, ulcer recovery, antigen toxic, diuretic, antifertility, and anti-inflammatory characteristics, in keeping with sever experimental and medical research. Because of its many uses, it's miles a critical plant for both sickness prevention and remedy. Therefore, to further recognize its price to each current and traditional medicinal drug, a radical investigation of its medicinal potential is important. (Manandhar *et al* 2018)

#### **Significance of Research in Chhattisgarh:**

Given the rich biodiversity of the state and the reliance of its indigenous communities on traditional medication for primary healthcare, research on medicinal flowers in Chhattisgarh is crucial. Documenting and retaining ethno medicinal expertise is critical because among 60 and 80 percent of Indians use plant-based treatments. (Rastogi *et al* 2024). With 1,525 species from 911 genera and 196 families, the forests of Chhattisgarh, which make up 44% of the state, are home to a wide variety of

medicinal plants (Tiwari *et al* 2022). Many plants have been used to treat a variety of illnesses, according to ethno medical surveys conducted in the area. This highlights the significance of more research into the antimicrobial and anticancer properties of these plants (Ralte *et al* 2024).

**Conservation and Sustainable Development:** Chhattisgarh's designation as an Herbal State demonstrates the government's dedication to protecting and developing its medicinal plant assets in a sustainable manner (Jain *et al.*, 2010). In light of modern-day scientific needs and environmental problems, it is vital to guide traditional healers and record their information with a purpose to ensure the sustainability of those practices (Rastogi *et al* 2024; Tandon *et al* 2020).

**Cultural Relevance and Future Directions -** Over exploitation and changes in healthcare practices are posing a developing hazard to the indigenous knowledge of medicinal vegetation held through tribes just like the Baigas, Gonds, and Oraons (Tandon *et al* 2020). To cope with this, Chhattisgarh is launching research projects that purpose to hyperlink conventional techniques with medical evidence, starting doors for jobs, training, and cultural historical past conservation. In order to create effective remedies and shield these priceless traditions from the effects of globalization and environmental demanding situations, it's far vital that ethnobotanical expertise be combined with present day pharmacological studies. (Tiwari *et al* 2022)

#### **Conclusion**

The healing capability of those plant life in treating infectious sicknesses turned into highlighted by way of our findings, which confirmed full-size antimicrobial hobby in opposition to an expansion of pathogenic microorganisms. Additionally, the study showed promising anticancer outcomes, with extracts displaying the ability to forestall cancer cells from growing in vitro. The



significance of conventional medicinal plant life as feasible sources of novel therapeutic agents is highlighted via these findings. The therapeutic capacity of those flora will also be improved via analyzing the synergistic interactions among phytochemicals and improving extraction methods. In end, this study contributes to the growing frame of information regarding natural merchandise as treasured resources for drug development and emphasizes the need to protect plant biodiversity for coming generations.

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