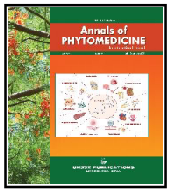
Annals of Phytomedicine 14(1): 1-13, 2025

DOI: http://dx.doi.org/10.54085/ap.2025.14.1.32

Annals of Phytomedicine: An International Journal
http://www.ukaazpublications.com/publications/index.php

Print ISSN : 2278-9839 Online ISSN : 2393-9885



Review Article : Open Access

Therapeutic potential of *Jasminum* species: Exploring anti-inflammatory, antioxidant and anticancer properties

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Article Info

Article history
Received 1 February 2025
Revised 17 March 2025
Accepted 18 March 2025
Published Online 30 June 2025

Keywords
Jasminum species
Anti-inflammatory
Antioxidant
Anticancer properties

Abstract

Jasminum species, commonly referred to as Jasmine, are famous for their aromatic, fragrant flowers and ornamental value. However, over recent decades, *Jasminum* species have drawn a lot of interest due to their promising medicinal potential, especially in the areas of antioxidant, anti-inflammatory, and anticancer actions. The medical effects of these *Jasminum* species have been linked to a wide variety of bioactive components, including terpenoids, alkaloids, flavonoids, and phenolic compounds. The ability of *Jasminum* species to suppress the synthesis of pro-inflammatory cytokines (TNF-α, IL-6, and IL-1β) and alter important inflammatory pathways, such as NF-κB and COX-2, is thought to be responsible for their anti-inflammatory properties. Free radicals and reactive oxygen species (ROS), are linked to aging and a number of disorders connected to oxidative stress, can be neutralized by the antioxidant qualities of *Jasminum* species, which are mainly fuelled by flavonoids and phenolic substances like quercetin and kaempferol. By enhancing the activity of endogenous antioxidant enzymes like superoxide dismutase (SOD) and catalase (CAT), *Jasminum* species demonstrate potential as protective agents against oxidative damage in cells and tissues. The *Jasminum* species exhibit significant anticancer properties. Their bioactive compounds induce programmed cell death in cancer cells, regulate cell cycle arrest, and inhibit metastatic spread by modulating signalling pathways such as PI3K/Akt, MAPK, and Wnt/β-catenin.

1. Introduction

Jasminum species are found throughout the world, especially in tropical and subtropical areas, and are members of the Oleaceae family (Jeyarani *et al.,* 2018). The *Jasminum* contains around 200 species (Kumaresan *et al*., 2023). The main characteristic of these plants is their fragrant blossoms, which are widely grown for aesthetic reasons and as a source of essential oils (Mohammad and Aliyu, 2023). However, *Jasminum* species have a wide range of bioactive chemicals that greatly enhance their therapeutic potential in addition to their aesthetic value (Jayaprakkash *et al.,* 2019). Over the years, *Jasminum* species have been traditionally used in various cultures for their therapeutic properties, particularly in treating conditions such as fever, inflammation, pain, infections, and even cancer (Nomier *et al*., 2014). *Jasminum* species, particularly *J. sambac* have been utilized in India for their therapeutic properties, including anti-inflammatory, antioxidant, and anticancer effects (Reshma *et al*., 2021). Traditionally, it has been employed to treat various diseases such as dysmenorrhoea, amenorrhoea, ringworm, leprosy, and skin diseases (Sarita *et al*., 2024). Research into their phytochemical composition has confirmed the presence of numerous compounds with recognized pharmacological activities, including alkaloids, flavonoids, terpenoids, phenolic acids, and essential oils. Chronic inflammation is a critical underlying factor in many modern diseases, including arthritis, cardiovascular diseases, and neurodegenerative conditions (Umesh *et al*., 2025). *Jasminum* species have been widely investigated for their anti-inflammatory properties, which are attributed to their ability to modulate pro-inflammatory mediators such as cytokines (TNF-α, IL-1β, IL-6) and enzymes like cyclooxygenase (COX-2) and inducible nitric oxide synthase (iNOS) (Dongli *et al.,* 2020). The anti-inflammatory effects of jasmine species have been linked to key bioactive compounds like flavonoids (quercetin, kaempferol), alkaloids (jasminine, nuciferine), and terpenoids (linalool, benzyl acetate) (Rashmi *et al.,* 2022). These compounds exhibit potent inhibition of inflammatory pathways, contributing to reduced swelling, redness, and pain in both acute and chronic inflammatory conditions. As a result, extracts from *Jasminum* species have shown potential as natural alternatives to conventional nonsteroidal anti-inflammatory drugs (NSAIDs), which often have adverse side effects with long-term use (Ain *et al.,* 2024). Oxidative

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stress, which occurs when there is an imbalance between reactive oxygen species (ROS) and antioxidant defences, is a major contributor to cellular damage, ageing, and the development of chronic diseases such as cancer, cardiovascular disorders, and neurodegenerative diseases (Umesh *et al*., 2024). *Jasminum* species have demonstrated significant antioxidant activity, primarily due to the presence of phenolic compounds and flavonoids. Flavonoids such as quercetin and kaempferol, and phenolic acids like caffeic and chlorogenic acids, are known for their ability to neutralize free radicals and protect cells from oxidative damage (Zahra *et al.,* 2024). Additionally, jasmine essential oils, rich in terpenoids like linalool, also exhibit antioxidative effects by scavenging free radicals and preventing lipid peroxidation (Dos Santos *et al.,* 2022). These antioxidant properties make *Jasminum* species valuable in the prevention and management of oxidative stress related diseases, including cardiovascular diseases, diabetes, and neurodegenerative conditions such as Alzheimer's disease (Balkrishna *et al*., 2021). Cancer remains one of the leading causes of mortality worldwide, with conventional treatments such as chemotherapy and radiation often resulting in debilitating side effects (Anand *et al*., 2022). Consequently, there is increasing interest in natural products, including *Jasminum* species, as potential anticancer agents (Nomier *et al*., 2024). Studies have shown that extracts from various *Jasminum* species possess significant anticancer activity, mainly through the induction of apoptosis (programmed cell death), inhibition of cancer cell proliferation, and prevention of metastasis (El-Hawary *et al*., 2021). The key bioactive compounds in jasmine, such as quercetin, kaempferol, and benzyl acetate, have been found to modulate several signaling pathways involved in cancer progression, including the PI3K/Akt, MAPK, and Wnt/β-catenin pathways (Almatroudi *et al.,* 2023). The flavonoids quercetin and kaempferol have demonstrated cytotoxic effects against various cancer cell lines, including breast, colon, and lung cancer cells, by triggering apoptosis and cell cycle arrest (Everton *et al*., 2024). Furthermore, Jasmine essential oils, particularly linalool, have exhibited anticancer activity by inhibiting the growth of tumor cells and reducing the metastasis of cancerous cells. This makes *Jasminum* species promising source for the development of novel anticancer therapies. In addition to their anti-inflammatory, antioxidant, and anticancer properties, *Jasminum* species have also shown antimicrobial, analgesic, and antidiabetic effects, further highlighting their therapeutic versatility (Patchanee *et al*., 2024). These multifaceted medicinal properties underscore the importance of *Jasminum* species as a valuable source of bioactive compounds with potential applications in modern medicine. Given the growing interest in natural products as therapeutic agents with fewer side effects compared to synthetic drugs (Rajeev, 2023), *Jasminum* species represent an important area of research for the development of novel plant based therapies.

2. Description of *Jasminum* species

2.1 *Jasminum sambac* (L.) Aiton

J. sambac, commonly known as Arabian Jasmine, is an evergreen shrub or vine that originates from South and Southeast Asia (Sanika *et al.,* 2024). It is highly valued for its fragrant flowers, which are widely cultivated and used in various cultural, religious, and commercial applications. The flowers are commonly used in perfumes, incense, and garlands due to their strong and pleasant fragrance. In many Asian traditions, they hold symbolic significance and are often used in religious offerings, weddings, and spiritual ceremonies. The plant thrives in tropical and subtropical climates and is extensively grown in countries like India, the Philippines, Thailand, and Indonesia (Zhongyang *et al.,* 2024). It possesses a rich pharmacognostic profile, with different parts of the plant, including the flowers, leaves, and roots, being utilized for their medicinal properties (Kumaresan *et al*., 2019).

The plant contains a variety of bioactive compounds that contribute to its therapeutic effects. These include flavonoids, alkaloids, tannins, terpenoids, saponins, glycosides, and essential oils. Among the essential oil components, benzyl acetate, linalool, and indole are the major constituents responsible for the characteristic fragrance of the flowers and their medicinal benefits (Deepikakrishnaveni *et al*., 2024). The extraction of these bioactive compounds is typically performed through steam distillation for essential oils, which helps in obtaining the volatile aromatic components (Gaurav *et al*., 2024). For other phytochemicals, such as flavonoids and alkaloids, solvent extraction methods are commonly used to isolate and purify the bioactive constituents for pharmacological studies and therapeutic applications. *J. sambac* is widely recognized for its medicinal properties and has been traditionally used in various systems of medicine, including Ayurveda, Unani, and Traditional Chinese Medicine (TCM) (Neeraj *et al*., 2017). Extracts have demonstrated antibacterial and antifungal activities, making them effective against various pathogenic microorganisms. The antimicrobial effects are attributed to the presence of flavonoids, tannins, and essential oils, which inhibit the growth of bacteria and fungi responsible for skin infections, respiratory ailments, and digestive disorders (Ali *et al*., 2018). The plant is traditionally used for reducing inflammation and treating skin conditions such as eczema, rashes, and dermatitis. Its bioactive compounds, including terpenoids and flavonoids, exhibit anti-inflammatory action by inhibiting inflammatory mediators and soothing irritated skin (Rutvi *et al*., 2024). Additionally, the extracts are used in herbal formulations for arthritis and joint pain relief due to their ability to reduce swelling and discomfort. The fragrance of flowers has a calming and relaxing effect on the nervous system. In aromatherapy, its essential oil is used to alleviate stress, anxiety, and depressions. The sedative properties of the plant are linked to the presence of linalool, a compound known for its soothing and mind relaxing effects. Studies have also indicated that inhalation of essential oil can improve sleep quality and reduce insomnia (Sultani *et al*., 2023). The application of flower paste on wounds and cuts has been a common traditional practice. The plant's antimicrobial and anti-inflammatory effects aid in faster wound healing, reducing the risk of infection and promoting tissue regeneration. Additionally, flavonoids and tannins present in the plant contribute to antioxidant activity, which protects the skin from oxidative stress and promotes healing. Scientific studies have shown that the extracts possess hypoglycemic properties, making them beneficial in the management of diabetes (Rambabu and Patnaik, 2014). The presence of alkaloids and flavonoids in the plant is believed to enhance insulin sensitivity and reduce blood sugar levels in diabetic models (Ashokkumar *et al*., 2024). *J. sambac* also known for its gastroprotective properties, and it has been traditionally used in the treatment of ulcers, gastritis, and other stomach related disorders (Alrashdi *et al.,* 2012).

2.2 *Jasminum grandiflorum* L.

J. grandiflorum, is a perennial flowering plant, native to tropical and subtropical regions, including India, Egypt, and China. This species is widely cultivated for its aromatic flowers, which are known for their sweet fragrance and high commercial value. The plant plays a significant role in traditional medicine, perfumery, and cosmetics due to its diverse bioactive compounds. The essential oil extracted from flower is highly sought after for its therapeutic applications in aromatherapy and natural medicine. It possesses a rich phytochemical profile, with various plant parts, including flowers, leaves, and stems, being utilized for medicinal and cosmetic purposes. The primary bioactive constituents present in this species include essential oils (jasmone, benzyl alcohol, linalool), flavonoids, phenolic compounds, and alkaloids, which contribute to its pharmacological effects (Riham *et al*., 2021). The essential oil is typically extracted using hydrodistillation and solvent extraction techniques, ensuring the preservation of its volatile and bioactive components. These extraction methods allow for the isolation of key compounds such as jasmone, which imparts a distinctive floral aroma, and linalool, known for its relaxing and anti-inflammatory properties. The essential oil is widely used in aromatherapy for its calming and stress-relieving properties. The presence of linalool and benzyl alcohol contributes to its sedative effects, making it effective in reducing anxiety, promoting relaxation, and improving sleep quality. Studies suggest that inhalation of Spanish Jasmine oil stimulates the release of neurotransmitters like serotonin and dopamine, helping to alleviate depression and enhance mood. Additionally, the oil is beneficial for treating insomnia and restlessness, further supporting its application in holistic medicine. The extracts have been traditionally used for their antispasmodic effects, making them valuable in treating muscle spasms, menstrual cramps, and digestive discomfort. The flavonoids and alkaloids present in the plant exert a relaxing effect on smooth muscles, helping to relieve abdominal pain, muscle tension, and uterine cramps. Due to these properties, the plant is frequently incorporated into herbal remedies for pain relief and relaxation therapy. It also exhibits anticancer properties, with its phytochemicals demonstrating cytotoxic effects on various cancer cell lines. The presence of phenolic compounds and flavonoids in the plant has been linked to its ability to induce apoptosis (programmed cell death) in tumor cells and inhibit cancer cell proliferation. Research highlights that extract is effective in managing cancers such as breast cancer, cervical cancer, and colorectal cancer through their antioxidant and anti-inflammatory actions (Galovièová *et al*., 2022).

It has been traditionally used to treat gastric ulcers and digestive disorders, thanks to its gastroprotective properties. The plant's flavonoids and alkaloids help in reducing gastric acid secretion, protecting the stomach lining, and promoting mucosal healing. The extracts significantly reduce ulcer formation in animal models, making it a promising natural remedy for acidity, gastritis, and peptic ulcers. The anti-inflammatory properties of the plant aid in soothing the digestive tract and reducing irritation caused by excess stomach acid. The essential oil and extracts are extensively used in the cosmetic and skincare industry for their moisturizing, anti-aging, and anti-inflammatory properties. The presence of benzyl alcohol and phenolic compounds makes the plant highly effective in soothing irritated skin, reducing redness, and preventing microbial infections. It is commonly used in lotions, creams, and serums to improve skin hydration and elasticity, making it beneficial for conditions such as dry skin, eczema, and acne. Its antioxidant activity helps neutralize free radicals, slowing down the aging process and promoting youthful skin (Winai *et al*., 2013).

2.3 *Jasminum officinale* L.

J. officinale is a deciduous climbing shrub native to the Himalayan region and widely cultivated for its ornamental, medicinal, and commercial value. This plant is renowned for its strong, sweet fragrance, making it a popular choice for gardens, perfumes, and traditional medicine. Due to its aesthetic appeal and therapeutic benefits, it has been extensively cultivated in regions across India, China, and Europe. Beyond its decorative use, it holds a significant place in herbal medicine systems, including ayurveda and traditional Chinese medicine (TCM), where it is valued for diverse pharmacological properties. It contains a diverse range of bioactive compounds that contribute to its medicinal properties. Various parts of the plant, including flowers, leaves, and bark, are utilized for their therapeutic benefits. The key phytochemicals are alkaloids, flavonoids, phenolic acids, essential oils, and tannins, which exhibit antioxidant, anti-inflammatory, and neuroprotective properties (Mehak *et al*., 2024). It has traditionally been used as an expectorant and bronchodilator, making it beneficial in the management of respiratory conditions such as cough, asthma, and bronchitis (Balkrishna *et al*., 2021). The presence of essential oils and flavonoids contributes to its ability to clear mucus from the airways, reduce inflammation in the respiratory tract, and ease breathing difficulties. In Ayurvedic medicine, jasmine flower extracts are used in herbal formulations to relieve congestion, soothe sore throats, and alleviate symptoms of chronic respiratory ailments. Additionally, the essential oil has been found to have calming effects on the respiratory system, reducing spasms associated with bronchitis and asthma. In traditional medicine, jasmine tea is often recommended to promote heart health and improve circulation (Abhishek *et al*., 2023). The presence of alkaloids and flavonoids in the plant is believed to enhance cognitive function, reduce neuroinflammation, and prevent neuronal damage. *In vitro* studies indicate that the extracts help in inhibit acetylcholinesterase, an enzyme associated with cognitive decline in Alzheimer's patients (Mehak *et al*., 2024). Additionally, its antioxidant properties play a role in neutralizing free radicals, protecting brain cells from oxidative damage and slowing down age-related cognitive decline. It is widely used for its anti-inflammatory and analgesic effects, making it beneficial in relieving joint pain, arthritis, headaches, and muscle soreness. The presence of tannins and flavonoids reduces the inflammation, alleviate pain, and promote faster recovery from injuries. In Ayurveda, it has been used as a natural remedy for regulating menstrual cycles and alleviating symptoms of premenstrual syndrome (PMS). Its bioactive compounds are believed to have hormone-balancing effects, which help in reducing menstrual irregularities, cramps, and mood swings.

2.4 *Jasminum auriculatum* Vahl.

J. auriculatum is a small flowering shrub native to India and Sri Lanka. It is widely known for its highly fragrant white flowers, which are commonly used in perfumery, religious rituals, and traditional medicine. In Ayurvedic and Siddha medicine, it has been valued for centuries due to its diverse therapeutic applications, particularly in skin health, digestive disorders, pain management, and hepatoprotection. The key phytochemical constituents of includes flavonoids, tannins, glycosides, alkaloids, and volatile oils

(Gupta, and Chaphalkar, 2015). These bioactive compounds play a crucial role in wound healing, liver protection, pain relief, and antimicrobial defines. It is traditionally used for its strong antibacterial and antifungal properties, particularly in the treatment of skin infections, wounds, and microbial diseases (Arun *et al.,* 2016). The volatile oils, flavonoids, and tannins present in the plant exhibit broad spectrum antimicrobial activity against Gram-positive and Gram-negative bacteria such as *Staphylococcus aureus* and *Escherichia coli*, as well as common fungal pathogens like *Candida albicans* (Nathasa *et al*., 2021). The extracts also accelerate wound healing and prevent secondary infections. Ayurvedic medicine recommends the use of Juhi flower paste and oil extracts for treating acne, eczema, and fungal skin conditions. The root and leaf extracts are used in traditional medicine for managing diarrhea and dysentery (Tomar *et al*., 2020). Presence of tannins and glycosides, which exert antispasmodic and astringent effects on the gastrointestinal tract, helping to reduce excessive bowel movements and control intestinal inflammation (Bahuguna *et al*., 2009).

2.5 *Jasminum multiflorum* (Burm. f.) Andrews

J. multiflorum is an evergreen shrub native to India and is extensively cultivated for its ornamental, medicinal, and therapeutic properties. The plant is characterized by its star-shaped white flowers and is traditionally used in Ayurvedic and Unani medicine for its wound healing, antidiabetic, anti-inflammatory, and antipyretic properties. The primary plant parts used for therapeutic purposes include leaves, flowers, and roots, which are rich in flavonoids, tannins, saponins, alkaloids, and essential oils (Kumaresan *et al*., 2019). It has been widely used in traditional medicine for its wound healing properties. In Ayurvedic practice, the paste of fresh leaves is applied topically to cuts, burns, and ulcers to enhance healing and minimize scarring. The alkaloids and flavonoids present in the plant are believed to enhance insulin sensitivity, promote glucose uptake in cells, and inhibit enzymes involved in carbohydrate metabolism (Middleton *et al*., 2000). In traditional medicine, it is used as a natural remedy for fever reduction, particularly in cases of viral infections, malaria, and seasonal flu. The alkaloids and essential oils present in the plant contribute to its antipyretic action by influencing thermoregulatory pathways in the body. Decoctions prepared from leaves and roots are commonly managed to patients experiencing high fever, chills, and body aches. The plant extracts help in lowering body temperature and improving immune response during febrile conditions (Deepika, 2016).

2.6 *Jasminum humile* L. Banfi

J. humile is a medicinal plant native to the Himalayan region and is recognized for its bright yellow flowers and therapeutic properties. Traditionally, the plant has been used in Ayurvedic and folk medicine for treating respiratory, gastrointestinal, and urinary disorders. Due to its bioactive compounds, its exhibits antispasmodic, expectorant, diuretic, and anthelmintic properties, making it an essential component of herbal remedies (Fatima and Khan, 2023). It contains a variety of bioactive compounds, which are rich in terpenoids, flavonoids, tannins, and glycosides (Kushwah *et al*., 2023). It also used in traditional medicine as an expectorant to relieve cough, bronchitis, and respiratory infections. The flavonoids and terpenoids in the plant help to loosen mucus, clear airways, and reduce inflammation in the lungs, making it effective for conditions like chronic bronchitis and asthma. Herbal decoctions made from flowers and leaves are commonly used to treat cough and congestion, improving breathing and lung function. The glycosides and flavonoids present in the plant stimulate urine production, which helps in flushing out toxins, bacteria, and excess fluids from the body. In Ayurvedic medicine, root extracts are traditionally consumed as a natural diuretic to help relieve kidney stones, bladder infections, and fluid imbalances. Herbal infusions of leaves are commonly used for their carminative effects, aiding in reducing bloating, intestinal colic, and painful muscle contractions. In folk medicine, root extracts are commonly administered to children and adults suffering from parasitic infestations, helping to clear intestinal worms and improve digestive health.

2.7 *Jasminum nitidum* Skan

J. nitidum is a species of flowering plant. Native to parts of Southeast Asia, it is recognized for its colourful buds with white flowers and its ornamental value in gardens and landscapes. The leaf extracts help reduce inflammatory markers due to bioactive compounds like flavonoids, alkaloids, and saponins, which inhibit the production of pro-inflammatory cytokines and enzymes like cyclooxygenase (COX). Additionally, it contains antioxidants such as flavonoids that neutralize free radicals, helping to protect cells from oxidative damage and reduce the risk of chronic diseases, including cardiovascular diseases and cancer.

2.8 *Jasminum calophyllum* Wall. ex G. Don

J. calophyllum is native to Southeast Asia. It is used in traditional medicine to treat skin ailments and wounds, with the leaves or extracts applied topically for healing and reducing inflammation. The plant's fragrant flowers are sometimes used in aromatherapy to reduce stress and anxiety. It also has anti-inflammatory, antioxidant, and antimicrobial properties, which may help in reducing swelling, protecting against oxidative stress, and treating minor infections. However, it is not as widely studied as other jasmine species.

3. Phytochemical composition

The therapeutic potential of *Jasminum* species can be attributed to the diverse range of bioactive compounds found within the plant. The major phytochemical components found in *Jasminum* species include alkaloids, flavonoids, terpenoids, phenolic acids, essential oils, and glycosides (Verma *et al*., 2018). These compounds contribute significantly to the medicinal and therapeutic properties of jasmine plants, including anti-inflammatory, antioxidant, antimicrobial, and anticancer effects.

3.1 Alkaloids

Alkaloids such as jasminine and nuciferine are known for their anti-inflammatory, antispasmodic, and neuroprotective effects. These compounds have been shown to reduce inflammation and provide relief from pain and muscle spasms (Heinrich *et al*., 2021).

3.2 Flavonoids

Jasminum species are rich in flavonoids, including quercetin, kaempferol, and rutin. These flavonoids are potent antioxidants that help scavenge free radicals and reduce oxidative stress. Additionally, flavonoids have been shown to possess anti-inflammatory properties by inhibiting the release of proinflammatory cytokines (Zahra *et al*., 2024).

3.3 Terpenoids

Jasmine essential oils, which contain monoterpenes such as linalool, benzyl acetate, and methyl jasmonate, are responsible for the plant's characteristic fragrance and are also attributed to its therapeutic effects. These terpenoids exhibit anti-inflammatory, analgesic, and antimicrobial properties, contributing to the plant's medicinal value.

3.4 Phenolic compounds

Jasminum species also contain phenolic compounds like caffeic acid, chlorogenic acid, and tannins, which have strong antioxidant properties. These compounds act as free radical scavengers, protect cellular structures from oxidative damage, and modulate inflammatory pathways (Tungmunnithum *et al*., 2018).

4. Phytochemical composition of different *Jasminum* species

4.1 *Jasminum sambac* (L.) Aiton

The phytochemical composition is dominated by flavonoids, phenolic acids, and terpenoids. The major flavonoids identified include quercetin and kaempferol, while phenolic acids such as caffeic acid and chlorogenic acid are abundant (Poonam *et al.,* 2021). These compounds have been shown to exhibit strong antioxidant, anti-inflammatory, and antimicrobial activities, contributing to the plant's use in traditional medicine for conditions such as fever and infections (Periferakis *et al*., 2022 and Jan *et al*., 2022).

4.2 *Jasminum grandiflorum* L.

The plant contains alkaloids such as jasminine and nuciferine, flavonoids like quercetin, kaempferol, and rutin, and terpenoids like linalool and methyl jasmonate (Rajeev, 2023). The essential oils extracted from flowers are characterized by high amounts of linalool, which is primarily responsible for the plant's fragrance and its antioxidant, anti-inflammatory, and analgesic properties (Bharathi *et al*., 2020).

4.3 *Jasminum officinale* L.

It contains essential oils rich in terpenoids, especially linalool, which contributes to its calming and analgesic effects. Flavonoids such as quercetin and kaempferol have been identified, alongside alkaloids like jasminine.

The plant's essential oil also exhibits strong antimicrobial properties, providing the basis for its traditional use in treating respiratory infections and other ailments (Kunhachan *et al*., 2012).

4.4 *Jasminum mesnyi* Hance

J. mesnyi contains various phenolic compounds, flavonoids, and essential oils. Flavonoids like kaempferol and phenolic acids such as caffeic and chlorogenic acids have been identified in its extracts. These compounds are mainly responsible for its antioxidant and anti-inflammatory properties, as well as its ability to combat microbial infections (Alrumaihi *et al.,* 2009).

4.5 *Jasminum azoricum* L.

J. azoricum has a varied chemical composition rich in alkaloids, flavonoids, and terpenoids. Alkaloids like jasminine and nuciferine are prevalent, along with terpenoids such as linalool. These components contribute to its anti-inflammatory, analgesic, and antioxidant activities, as well as to its use in traditional medicine for alleviating pain and inflammation (Thiruvengadam *et al*., 2018).

4.6 *Jasminum parkeri* Dunn

J. parkeri, also known as the Parker's Jasmine, is a lesser known species with promising therapeutic potential. It contains alkaloids like jasminine, flavonoids like quercetin, and essential oils rich in terpenoids.

The biological activities of *J. parkeri* are similar to those of other *Jasminum* species, including antioxidant, anti-inflammatory, and antimicrobial effects. Its extracts are also used in the treatment of common ailments like fever and pain (Kashyap *et al*., 2021).

4.7 *Jasminum polyanthum* Franch

The leaves exhibit good DPPH activity; however, the blossom has a high phenol content and FRAP activity. While the flower has good anti-inflammatory properties, the leaf has good antidiabetic properties. Flower extract has more antibacterial activity than leaf extract, while the opposite is true for antifungal extract (Jaya *et al*., 2019).

Table 1: Phytochemical composition of different *Jasminum* species

S.No.	Species	Phytochemical components	Key bioactive compounds	Biological activities	Reference
1.	*Jasminum sambac* (L.) Aiton	Flavonoids, Phenolic acids, Glycosides, Terpenoids	Rutin, Kaempferol, Caffeic acid, Chlorogenic acid	Antioxidant, Anti-inflammatory, Antimicrobial	Lakshmi *et al.,* 2024
2.	*Jasminum grandiflorum* L.	Alkaloids, Flavonoids, Phenolics, Essential oils	Jasminine, Nuciferine, Quercetin, Kaempferol, Linalool	Anti-inflammatory, Antioxidant, Anticancer, Analgesic	El-Shiekh *et al*., 2021
3.	*Jasminum officinale* L.	Flavonoids, Alkaloids, Terpenoids, Essential oils	Quercetin, Linalool, Benzyl acetate	Antioxidant, Anti-inflammatory, Anticancer, Analgesic	Reshma *et al.,* 2022; Mehak *et al*., 2024
4.	*Jasminum mesnyi* Hance	Phenolics, Flavonoids, Essential oils	Kaempferol, Caffeic acid, Chlorogenic acid	Antioxidant, Anti-inflammatory, Antimicrobial	Alrumaihi *et al.,* 2009
5.	*Jasminum azoricum* L.	Alkaloids, Flavonoids, Terpenoids, Essential oils	Nuciferine, Jasminine, Linalool	Anti-inflammatory, Analgesic, Antioxidant	Balkrishna *et al*., 2021; Thiruvengadam *et al.,* 2018
6.	*Jasminum parkeri* Dunn	Alkaloids, Flavonoids, Terpenoids, Glycosides	Jasminine, Quercetin, Benzyl acetate	Antioxidant, Anti-inflammatory, Antimicrobial	Kashyap *et al*., 2021

5. Chemical composition of various *Jasminum* species

The chemical composition of various *Jasminum* species exhibits a broad spectrum of bioactive compounds, particularly in their essential oils. *J. sambac* contains compounds such as benzyl acetate, indole, methyl jasmonate, and cis-jasmone, which contribute to its aromatic profile and pharmacological effects, including anti-inflammatory and antioxidant activities (Nafees *et al*., 2016). Similarly, the essential oil of *J. grandiflorum* (Royal Jasmine) is rich in benzyl alcohol, linalool, indole, and benzyl acetate, which have been shown to possess antimicrobial and sedative properties (Galovièová *et al.,* 2012). *J. officinale* also shares many of these components, particularly benzyl acetate, linalool, and eugenol, which give the plant its distinctive floral aroma and are associated with its therapeutic benefits (Rani *et al*., 2017; Mehak *et al*., 2024). *J. azoricum* has essential oils dominated by linalool, beta-caryophyllene, and alpha-pinene, which contribute to its antioxidant and antimicrobial properties (Balkrishna *et al*., 2021, Thiruvengadam *et al*., 2018).

6. Qualitative phytochemical analysis of different *Jasminum* species

Qualitative phytochemical analysis of *Jasminum* species involves the identification of bioactive compounds present in various parts of the plant, such as flowers, leaves, and roots. These compounds, including alkaloids, flavonoids, saponins, terpenoids, tannins, and phenolic compounds, contribute significantly to the therapeutic potential of jasmine plants. Different *Jasminum* species shows varying profiles of these phytochemicals, which are associated with activities such as anti-inflammatory, antioxidant, and anticancer properties (Polat *et al*., 2022). Understanding the phytochemical composition of these species is crucial for their medicinal application and development. This analysis supports the traditional and modern use of jasmine in pharmaceutical and cosmetic industries.

Table 2: Qualitative phytochemical analysis of different *Jasminum* species

Jasminum Species	Alkaloids	Flavonoids	Saponins	Tannins	Terpenoids	Phenolic compounds	Glycosides	Reference
Jasminum sambac (L.) Aiton	+	+	-	+	+	+	+	Tomar, 2020
Jasminum grandiflorum L.	+	+	-	+	+	+	-	Raja *et al*., 2010
Jasminum multiflorum (Burm. f.) Andrews	+	+	+	+	+	+	+	Kumaresan *et al*., 2019
Jasminum mesnyi Hance	+	+	+	+	+	+	+	Verma *et al*., 2018.
Jasminum azoricum L.	-	+	+	+	+	+	+	Vandana, 2018
Jasminum officinale L.	+	+	-	+	+	+	+	Dubey *et al.,* 2019.
Jasminum parkeri Dunn	+	+	-	+	+	+	-	Brij *et al*., 2014.
Jasminum lanceolarium Roxb.	+	+	+	+	+	+	-	Ke-Quan *et al*., 2013.

7. Anti-inflammatory properties of different *Jasminum* species

Inflammation is a complex biological response to harmful stimuli, such as pathogens, damaged cells, or irritants (Lukas Freund, 2023). Chronic inflammation is linked to various diseases, including cardiovascular diseases, cancer, diabetes, and neurodegenerative disorders. Natural products, particularly plant-derived compounds, have gained significant attention for their potential anti-inflammatory effects, as they offer a safer alternative to synthetic drugs, which can have side effects when used long-term (Ginwala *et al*., 2019). *Jasminum* species, known for their bioactive compounds, have been shown to exhibit substantial anti-inflammatory properties.

7.1 *Jasminum grandiflorum* L.

It has been found to significantly reduce inflammation in experimental animal models. The plant's extract was shown to lower the levels of pro-inflammatory cytokines like IL-1β, IL-6, and TNF-α in rats subjected to inflammation induced by carrageenan (Kandilarov *et al*., 2023). Additionally, the essential oil of *J. grandiflorum*, rich in linalool, demonstrated significant inhibition of COX-2 expression, which is a key enzyme involved in the production of pro-inflammatory prostaglandins (Stojanoviæ *et al*., 2024).

7.2 *Jasminum sambac* (L.) Aiton

J. sambac extracts are significantly reducing inflammation by inhibiting the production of inflammatory cytokines like TNF-α, IL-6, and IL-1β *in vitro* and *in vivo*. The plant's essential oil, containing linalool and benzyl acetate, has demonstrated effective anti-inflammatory properties in models of acute and chronic inflammation (Ain *et al*., 2024). In a rat model of arthritis, the extract was found to reduce paw swelling and inflammation, suggesting its potential as an anti-inflammatory agent for treating inflammatory diseases (Dhote *et al*., 2020).

7.3 *Jasminum officinale* L.

J. officinale extracts inhibited the production of inflammatory cytokines like TNF-α and IL-1β in lipopolysaccharide (LPS)-induced macrophages (Riham *et al.,* 2021).

8. Antioxidant applications of different *Jasminum* species

Jasminum species, renowned for their rich content of bioactive compounds, have garnered significant interest in antioxidant applications, thanks to their ability to neutralize free radicals and reduce oxidative stress (Chintada *et al*., 2025). Oxidative stress is a key contributor to the development of chronic diseases, including cardiovascular diseases, neurodegenerative disorders, and cancer

(Sharifi-Rad *et al*., 2020). The antioxidant properties of jasmine species can be applied in various industries, particularly in the development of natural products aimed at preventing oxidative damage to cells and tissues.

8.1 Antioxidant properties in skin care products

The antioxidant properties of *Jasminum* species, particularly those of flavonoids, phenolic acids, and terpenoids, make them ideal candidates for inclusion in anti-ageing and skin care formulations. The high antioxidant content helps protect the skin from oxidative stress caused by environmental factors such as UV radiation, pollution, and smoking, all of which can accelerate the aging process and lead to skin damage. Jasmine extracts, especially from *J. grandiflorum* and *J. sambac*, have been shown to enhance skin hydration, promote collagen synthesis, and improve skin elasticity by scavenging free radicals.

8.2 Antioxidants in cardiovascular protection

Antioxidant activity of *Jasminum* species plays a significant role in cardiovascular health. By neutralizing free radicals, jasmine compounds can help prevent the oxidation of low density lipoproteins (LDL), a key factor in the development of atherosclerosis and cardiovascular diseases. Flavonoids and phenolic compounds in jasmine plants have been found to reduce the formation of reactive oxygen species (ROS) and enhance the activity of endogenous antioxidant enzymes like superoxide dismutase (SOD) and catalase, which protect the blood vessels and heart from oxidative damage.

8.3 Neuroprotective applications in cognitive disorders

The antioxidant capacity of jasmine species, especially in the form of phenolic compounds like gallic acid and caffeic acid, is critical for protecting the brain from oxidative stress. These compounds have been shown to reduce neuronal damage and improve cognitive function, making jasmine an attractive option for the development of neuroprotective supplements. *Jasminum* species such as *J. sambac* have demonstrated potential in reducing oxidative damage in neurodegenerative conditions like Alzheimer's and Parkinson's disease.

8.4 Antioxidant role in reducing cancer risk

Cancer development is strongly associated with oxidative stress and the damage caused by free radicals. Compounds found in *Jasminum* species, such as flavonoids, saponins, and terpenoids, have shown significant anticancer properties by reducing oxidative damage to DNA and inhibiting the formation of cancerous cells. Antioxidants from *Jasminum* species may act by neutralizing free radicals and reducing the risk of mutation, thus contributing to cancer prevention.

8.5 Antioxidant supplementation for general health

Jasmine have been utilized in the production of antioxidant rich supplements that are beneficial for overall health. The antioxidant properties of jasmine help to protect the body's cells and tissues from oxidative damage, which is a leading cause of aging and chronic diseases. Supplements containing extracts of *Jasminum* species are often used to boost the body's natural defense mechanisms, prevent cell aging, and enhance immune function (Bahar *et al*., 2022).

9. Anticancer applications

Jasmine species have long been appreciated for their fragrance and ornamental value, but recent studies have shown that several species within the *Jasminum* genus exhibit significant potential as sources of anticancer compounds. These species have attracted attention for their bioactive chemical constituents, which include flavonoids, terpenoids, and essential oils that may contribute to their anticancer properties (Balkrishna *et al*., 2021).

9.1 *Jasminum sambac* (L.) Aiton

It is used in the traditional medicine and its promising anticancer properties. A study by Manzoor *et al*. (2016) demonstrated that extracts possess cytotoxic effects against a range of cancer cell lines, including breast, lung, and liver cancer cells (Mohamed *et al*., 2023). The bioactive compounds, such as flavonoids and alkaloids, found in extracts are believed to be responsible for its anticancer activity. These compounds exhibit strong antioxidant and anti-inflammatory properties that may help in preventing the oxidative stress and inflammation often associated with cancer development (Zahra *et al*., 2024). Researchers have explored its role in inhibiting cancer cell proliferation and promoting apoptosis (programmed cell death) through the regulation of various molecular pathways (Yousra *et al.,* 2024).

9.2 *Jasminum azoricum* L.

J. azoricum has been evaluated for its anticancer potential, particularly in liver cancer. the methanolic extract shows significant cytotoxic effects against liver cancer cell lines, including HepG2 cells (Nair *et al*., 2014). The study suggested that, the extract inhibits cell growth through the induction of apoptosis, and its antioxidant properties play a crucial role in reducing oxidative stress in cancerous cells (Sies *et al*., 2022). The chemical profile includes flavonoids, which are known to possess anticancer and anti-inflammatory properties. These flavonoids have been shown to interact with key signaling pathways involved in cancer cell survival and proliferation. (Kopustinskiene *et al*., 2020; Nelly *et al.,* 2025).

9.3 *Jasminum grandiflorum* L.

The essential oil exhibited strong antiproliferative activity against human colorectal cancer cells (HT-29), as well as breast cancer cell lines. The oil's major constituents, such as linalool and benzyl acetate, have been shown to induce cell cycle arrest and apoptosis in cancer cells, suggesting their effectiveness in controlling cancer cell growth (Garzoli *et al*., 2022). Moreover, the antioxidant activity of the essential oil is believed to contribute to its protective effects against oxidative damage, a key factor in cancer progression. The essential oil could be a valuable adjunct in the prevention or treatment of cancer, particularly for cancers with high oxidative stress (Galovièová *et al*., 2022).

9.4 *Jasminum officinale* L.

J. officinale has been explored for its potential anticancer properties. The extract shown significant anticancer effects *in vitro*. A study by Mehak *et al*. (2024) examined the anticancer potential of leaf extract against human breast cancer cell lines and found that it inhibits cell proliferation and induces apoptosis. The active compounds, including flavonoids and terpenoids, are thought to exert their effects through the inhibition of cancer cell migration and invasion, as well as by

modulating signaling pathways involved in cancer cell survival (Mir *et al*., 2023). Furthermore, the antioxidant properties shown to reduce oxidative stress, which is a critical factor in cancer progression.

9.5 *Jasminum multiflorum* (Burm. f.) Andrews

The flowers are known for their bitter, refrigerant, laxative, cardiotonic, and digestive attributes, making them useful in treating conditions like inflammation, rheumatism, and cephalalgia. These traditional applications align with the plant's observed anticancer potential, as inflammation and oxidative stress are key factors in cancer progression (El-Hawary *et al*., 2021). A study published in Anticancer Agents in Medicinal Chemistry investigated the hydro methanolic leaf extract of *J. multiflorum* and identified 39 compounds, including secoiridoid glycosides, kaempferol, and quercetin glycosides. These compounds exhibited significant cytotoxic activity against MCF-7 breast cancer and HCT 116 colorectal cancer cell lines, with IC_{50} values of 24.81 µg/ml and 11.38 µg/ml, respectively (Seham *et al*., 2021).

10. Antimicrobial properties

Jasminum species, renowned for their fragrant flowers, also exhibit notable antimicrobial properties. Several species, including *Jasminum sambac*, *Jasminum grandiflorum*, and *Jasminum officinale*, have been found to contain essential oils with antibacterial and antifungal activities. Studies highlight their effectiveness against pathogens such as *Staphylococcus aureus* and *Escherichia coli* (Balkrishna *et al*., 2021).

11. Antifungal activity

Jasminum species exhibit significant antifungal activity, primarily due to the bioactive compounds found in their essential oils. *Jasminum sambac*, *Jasminum grandiflorum*, and *Jasminum officinale* have been shown to inhibit the growth of fungi like *Candida albicans* and *Aspergillus niger* (Reshma *et al*., 2021; Jain *et al*., 2011). The antifungal effects are attributed to compounds such as flavonoids, terpenoids, and alkaloids, which disrupt fungal cell walls and metabolic processes.

12. Mechanisms of action of bioactive compounds in different *Jasminum* species

The mechanisms of action of bioactive compounds in *Jasminum* species play a crucial role in the therapeutic potential of these plants, contributing to their wide use in traditional medicine. *Jasminum* species contain a variety of bioactive compounds, such as alkaloids, flavonoids, saponins, terpenoids, phenolic compounds, and glycosides, each of which exhibits distinct biological activities (Zeenath, 2024). These compounds have been shown to exhibit anti-inflammatory, antioxidant, anticancer, antimicrobial, and neuroprotective effects, which are linked to specific mechanisms at the molecular and cellular levels. For instance, flavonoids are known to modulate inflammatory pathways, alkaloids can act on the central nervous system to reduce pain and inflammation, while terpenoids exhibit potent antioxidant properties by scavenging free radicals. Moreover, saponins and glycosides enhance immune responses and induce apoptosis in cancer cells.

Table 3: Antimicrobial properties of different *Jasminum* species

Species	Antimicrobial properties	Pathogens tested	Reference
Jasminum sambac (L.) Aiton	Antibacterial and antifungal activity	*Staphylococcus aureus*, *Escherichia coli*, *Candida albicans*	Rakhmawati, 2022
Jasminum grandiflorum L.	Broad-spectrum antimicrobial properties	*Escherichia coli*, *Bacillus subtilis*, *Aspergillus niger*	Joulain, 2021, Padmaa *et al*., 2009; Thaweboon *et al*., 2018
Jasminum officinale L.	Antibacterial, antioxidant, and antifungal properties	*Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*	Balkrishna *et al*., 2021; Patchanee *et al*., 2024
Jasminum azoricum L.	Antibacterial activity	*Escherichia coli*, *Staphylococcus aureus*	Rath *et al*., 2008
Jasminum fluminense Vell.	Antibacterial and antifungal effects	*Escherichia coli*, *Candida albicans*	Balkrishna *et al*., 2021
Jasminum primulinum Hemsl. ex Baker	Antibacterial and anti-inflammatory effects	*Staphylococcus aureus*	Balkrishna *et al*., 2021

Table 4: Antifungal activity of different *Jasminum* species

Species	Antifungal activity	Pathogens tested	Reference
Jasminum sambac (L.) Aiton	Exhibits antifungal activity against	*Candida albicans Candida albicans*	Jacinta *et al*., 2014
Jasminum grandiflorum L.	Exhibits antifungal activity against	*Aspergillus niger Aspergillus niger*	Gizaw *et al*., 2022
Jasminum officinale L.	Demonstrates antifungal activity against	*Candida albicans Candida albicans*	Hirasawa and Takada, 2003
Jasminum azoricum L.	Antifungal effects shown, especially against	fungi like *Aspergillus niger*	*Aspergillus niger* Balkrishna *et al*., 2021

Table 5: Mechanisms of action of bioactive compounds in different *Jasminum* species

Bioactive compound	Mechanism of action	Species	Reference
Alkaloids (Jasminine)	Modulates the nervous system, reduces pain and inflammation by inhibiting pro-inflammatory cytokines	*Jasminum sambac*	Nidhi Sengar *et al*., 2015
Flavonoids (Quercetin, Kaempferol)	Inhibits COX-2, scavenges free radicals, suppresses NF-κB signaling, reducing inflammation and cancer cell proliferation	*Jasminum grandiflorum*, *Jasminum mesnyi*	Li *et al*., 2020.
Saponins	Induces apoptosis in cancer cells, enhances immune function, reduces inflammatory cytokines	*Jasminum mesnyi*, *Jasminum azoricum*	Tian *et al*., 2020; Chen *et al*., 2018; Liu *et al*., 2014).
Terpenoids (Linalool, Geraniol)	Scavenges free radicals, inhibits COX-2, induces apoptosis in cancer cells	*Jasminum grandiflorum*, *Jasminum sambac*	Kamran *et al*., 2022; Ayu Masyita *et al*., 2022
Phenolic Compounds (Gallic acid)	Antioxidant action, modulates inflammatory pathways, promotes apoptosis in cancer cells	*Jasminum officinale*, *Jasminum dichotomum*	Merecz-Sadowska *et al*., 2021
Glycosides	Enhances cell membrane interactions, induces apoptosis in cancer cells, and has cardioprotective effects	*Jasminum parkeri*, *Jasminum lanceolarium*	Reddy *et al.,* 2020
Tannins	Antioxidant, inhibits inflammatory pathways, and reduces cancer cell proliferation	*Jasminum azoricum*, *Jasminum lanceolarium*	Darvin *et al*., 2017; Wang Jing *et al*., 2022.

Table 6.: Alkaloids present in different *Jasminum* species

Species	Major alkaloids	Reference
Jasminum sambac (L.) Aiton	Kaempferol, quercetin, rutoside	Kunhachan *et al*., 2012
Jasminum grandiflorum L.	Benzyl benzoate, linalool	Galovièová *et al*., 2022
Jasminum officinale L.	Aucubin, jasgranoside B, ligstroside, loganin, oleoside, oleuropein, 8-dehydroxy shanzhiside	Zhao *et al*., 2007
Jasminum azoricum L.	Kaempferol, quercetin, rutoside	Balkrishna *et al*., 2021
Jasminum fluminense Vell.	Alkaloids, flavonoids, glycosides, phenols, saponins, triterpenes (squalene), tannins	Balkrishna *et al*., 2021

13. Conclusion

Jasminum species, have demonstrated significant therapeutic potential, particularly in their anti-inflammatory, antioxidant, and anticancer properties. The rich phytochemical composition of *Jasminum* species, including phenolics, terpenoids, and glycosides, contributes to their diverse medicinal effects. These compounds have been linked to various pharmacological activities, such as antioxidant, anti-inflammatory, and anticancer effects. While the therapeutic potential of *Jasminum* species is promising, further research is essential to fully understand their mechanisms of action and to develop standardized extracts for clinical applications. Future studies should focus on conducting well designed clinical trials, identifying specific bioactive compounds, and investigating the molecular pathways through which these compounds exert their effects. By addressing these areas, the medicinal applications of *Jasminum* species can be better understood and potentially integrated into therapeutic practices.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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Citation **Kumaresan Marappan, Kovvasu Khanchana, Kathari Lakshmaiah, Vijai Ananth Arumugam and Shakila Sadasivam (2025). Therapeutic potential of *Jasminum* species: Exploring antiinflammatory, antioxidant and anticancer properties. Ann. Phytomed., 14(1):1-13. http://dx.doi.org/10.54085/ap.2025.14.1.32.**