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Harnessing *Jasminum* Bioactive Compounds: Updated Insights for Therapeutic and Food Preservation Innovations

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ABSTRACT

The *Jasminum* genus, renowned for its aromatic flowers, has been used in traditional medicine across various cultures for its therapeutic properties. Recently, scientific interest has focused on the bioactive compounds present in *Jasminum* species, highlighting their potential applications in health and food preservation. This review evaluates the phytochemical composition of *Jasminum* species, emphasizing their therapeutic and preservative roles while identifying research gaps. A comprehensive literature search was conducted using major scientific databases, including PubMed, Scopus, and Web of Science, focusing on studies from the last two decades. The review includes peer-reviewed articles that provide robust methodologies and detailed results regarding the biological activities of *Jasminum* species. Findings reveal that *Jasminum* is rich in bioactive compounds such as terpenoids, flavonoids, and phenolic acids, contributing to significant antioxidant, anti-inflammatory, antimicrobial, and anticancer properties. Scientific evidence supports traditional uses, such as treating headaches and infections. Additionally, *Jasminum* extracts have shown promise as natural food preservatives due to their potent antimicrobial activity. However, the review identifies significant variability in study methodologies and a lack of clinical trials, which limit the generalizability and application of these findings. *Jasminum* species possess a diverse phytochemical profile that holds promise for advancing health and food preservation applications. Future research should prioritize standardizing methodologies and conducting clinical trials to validate their efficacy. Bridging the gap between traditional knowledge and modern science will unlock the full potential of *Jasminum* as a multifaceted resource for health and nutrition.

1 | Introduction

The genus *Jasminum* L. belongs to the Oleaceae family and contains over 200 species cultivated in subtropical and tropical climates in Africa, Eurasia, Australasia, and Oceania (Balkrishna et al. 2021). The genus *Jasminum* is characterized by shrubs and vines with fragrant, tubular, and lobed white and yellow flowers. The fruit in some species is a two-lobed blackberry. The primary commercial application of the genus *Jasminum* is in the perfumery and aromatherapy industry, using extracted or absolute volatile floral oils; less frequent are the applications of leaves or whole plants. In addition, *Jasminum* species are used as ornamental plants due to the aroma and bright green leaves. Some of the main species include *Jasminum officinale* L., *Jasminum nudiflorum* Lindl., *Jasminum mesnyi* Hance, and *Jasminum sambac* (L.) Aiton. Jasmine is part of the culture and religion of different countries and is widely known worldwide for jasmine tea made from flowers and leaves. Traditional preparations of jasmine alleviate the symptoms of headache, muscle pain, and infectious processes and have antiulcer, antidiarrheal, antioxidant, antihyperlipidemic, antidiabetic, antidepressant, analgesic, wound-healing effects, and, relevantly, anticancer activities (Addae et al. 2017; Wei et al. 2021; Zhang et al. 2021). Some of the main volatile flower odorants include linalool, α-farnesene, (*S*,*E*)-nerolidol, geraniol, α-cadinol, benzyl alcohol, benzaldehyde, benzyl acetate, benzyl benzoate, (*E*)-3-hexen-1-yl benzoate, and (*Z*)-3-hexen-1-yl acetate and confer the typical jasmine fragrance, whereas benzeneacetaldehyde, benzoic acid, methyl anthranilate, methyl 2-(methylamino)benzoate, and (*E*)-2-hexenal constitute the aroma of jasmine (Zhou et al. 2022). The volatile compounds identified in the aromatic concentrate of Chinese Jasmine tea also include aliphatic and aromatics alcohols such as benzyl alcohol, (*Z*)-3-hexenol, 2-phenylethanol, cyclohexanol, phenol; terpene alcohols such as linalool, linalool oxide, 2,6-dimethyl-3,7-octadiene-2,6-diol; esters such as benzyl acetate, methyl benzoate; carbonyl compounds such as 2-methyl-2-hepten-6-one, (*Z*)-jasmone; lactones such as dihydroactinidiolide; acids such as hexanoic acid; *N*-containing compounds such as methyl anthranilate, indole; hydrocarbons such as undecane; and others such as methyl salicylate and furaneol (Ito et al. 2002). However, in the flowers, up to approximately 102 volatile compounds can be identified in species such as *J. sambac*. Metabolome and transcriptome studies of *J. sambac* describe approximately 366,081 isoforms (Zhou et al. 2022); most of the identified transcripts are involved in terpenoid metabolic pathways, phenylpropanoid/benzenoid metabolic pathways, postharvest jasmine aroma formation during flowering, and some heat shock protein transcripts correlated with odorant content. Moreover, methanolic extracts of leaves of some jasmine species include as main constituents in the phenolic acids and phenylethanoids: *p*-coumaric acid, protocatechuic acid, chlorogenic acid, and *p*-hydroxybenzoic acid; and in the category of flavonoids: kaempferol-3-*O*-glucoside, quercetin-3-*O*-glucoside, rutin, and kaempferol-3-*O*-neohesperidoside (El-Hawary, El-Hefnawy, Osman et al. 2021). Several studies have confirmed the analgesic pharmacological effects of *Jasminum* root extracts in addition to their effects against oxidative stress and inflammation (Yue et al. 2013; Sengar et al. 2015). For example, one study confirmed the anti-inflammatory, analgesic, and antipyretic activity of ethanolic extract of *J. sambac* root, rich in hesperidin, in murine models (Sengar et al. 2015). A recent study confirmed the antioxidant and antimicrobial properties of essential oil from *J. sambac* flowers (Supanivatin et al. 2023). Moreover, 14 species of *Jasminum* have antioxidant properties through free radical scavenging (Balkrishna et al. 2021). On the other hand, antibiotic resistance worldwide is an emerging health issue that compromises the lives of a vast number of patients with different diseases (Salam et al. 2023). Moreover, the antimicrobial activities exhibited by *Jasminum* species, such as their ability to inhibit microbial growth in pathogens like *Staphylococcus aureus*, *Shigella flexneri*, and *Escherichia coli*, demonstrate potential for application as natural food preservatives. These activities are primarily attributed to bioactive compounds such as terpenoids, phenolic acids, and flavonoids, which disrupt microbial cell membranes, interfere with protein synthesis, and inhibit enzymatic activity. This highlighted their role in extending shelf life and ensuring food safety (Balkrishna et al. 2021) (Ahmed et al. 2016). The genus Jasminum possesses pharmacological properties such as anti-inflammatory, antimicrobial, antioxidant, and anticancer activities, which address challenges in current medicine, including antibiotic resistance, chronic inflammation, and oxidative stress-related diseases (Wu et al. 2021). Research on these properties remains limited, with key areas such as standardizing extraction methods, identifying molecular mechanisms, and conducting clinical trials requiring further exploration to confirm therapeutic efficacy. This comprehensive review provides a comprehensive analysis of the bioactive compounds present in various *Jasminum* species, highlighting recent advances in their applications in food preservation and therapeutic interventions. By integrating insights from traditional uses, pharmacological studies, and modern applications, this review bridges the gap between traditional medicine and contemporary food science, presenting current evidence and a holistic perspective on the potential of jasmine plants as a multifaceted resource for advancing health and nutrition.

2 | Methodology

This narrative review was conducted through an extensive literature search to gather the most recent and relevant studies on the bioactive compounds in *Jasminum* species and their applications in food and therapeutic contexts. We searched the electronic databases PubMed/MedLine, Scopus, Web of Science, and Google Scholar, employing a strategic use of Medical Subject Headings (MeSH) terms and keywords, combined with

Boolean operators, to ensure a thorough retrieval of relevant literature. The primary search terms included "*Jasminum*" OR "jasmine," "bioactive compounds," "phytochemistry," "antioxidant," "anti-inflammatory," "antimicrobial," "anticancer," "food preservation," and "therapeutic applications." Boolean operators such as AND, OR, and NOT were used to refine the search results. Specific examples of MeSH terms used include "Plants, Medicinal," "Food Preservation," and "Antioxidants." The selection of articles was guided by predefined inclusion and exclusion criteria to ensure the relevance and quality of the studies. We included peer-reviewed articles published in English that focused on the phytochemical analysis of *Jasminum* species, highlighted biological activities such as antioxidant, anti-inflammatory, antimicrobial, and anticancer effects, explored applications in food preservation and therapeutics, and were published within the last 20 years to ensure the inclusion of current evidence. Articles not available in full text, studies not focused on *Jasminum* species, non-peer-reviewed articles, conference abstracts, editorials, duplicate publications, and studies lacking detailed methodological approaches or clear results were excluded from this review. Data extraction was carried out systematically to ensure accuracy and comprehensiveness, focusing on key information such as the species of *Jasminum* investigated, the types of bioactive compounds identified, the methods of phytochemical analysis used, the biological activities assessed, and the applications in food and therapeutics. The most important data from the selected studies are summarized in tables and figures to provide a clear and concise overview. Tables include detailed information on the phytochemical composition of *Jasminum* species, the types of bioactive compounds identified, and the biological activities observed, whereas figures illustrate the mechanisms of action of key bioactive compounds, the pathways involved in their biological activities, and the potential applications in food and health sectors.

3 | Habitat and Cultivation of *Jasminum* Plants

Jasminum plants are reported to be native to tropical and subtropical areas of Europe, Asia, Africa, and the Pacific region (Dickey 1970; Green 2004; Green and Miller 2009; Safeena et al. 2017). Jasmine is cultivated mainly for its attractive fragrance in different parts of the world (Senthilkumar 2019). The center of Jasmine cultivation was previously considered to be France but now it is cultivated commercially in Egypt, India, Morocco, and South Africa (Shrivastava et al. 2011). Jasminum grows best in rich loamy soil with a pH range of 6.5–7.5, which is ideal for nutrient availability and absorption. This pH range supports the uptake of essential macronutrients like nitrogen, phosphorus, and potassium, fundamental for healthy root development and robust flowering. It also enhances the availability of micronutrients such as iron and manganese, further promoting plant health (Gupta 2004). Soils outside this range may cause nutrient deficiencies or toxicities, negatively affecting growth and flower quality. Additionally, a neutral to slightly acidic pH fosters microbial activity, which aids in nutrient cycling and improves soil health. In clay soils, flower production is often hindered due to poor drainage and soil compaction, which limit root aeration and nutrient uptake. Amending clay soil with lime improves its structure by reducing compaction and increasing pH, creating a more favorable environment for plant growth. The addition of organic manures further boosts soil fertility, aeration, and water retention, enhancing yield and flower quality (Gupta 2004). It is a crop that can be cultivated in all types of climates, although it prefers mild and tropical climates. The ideal requirements for successful cultivation of jasmine are mild winters, warm summers, and sunny days. The growing land should be well-drained, free of weeds, and thoroughly plowed. Proper drainage and irrigation facilities are important. Pits are dug before planting and filled with 2 parts of compost or farmyard manure (FYM) and one part each of fresh soil and coarse sand (Rajamohan and Sathish 2019). Continuous supply of balanced fertilizer is beneficial for jasmine cultivation. Application of NPK (nitrogen, phosphorus, and potassium) mixture fertilizer at a rate of 240 g per plant per year at bi-monthly intervals has been reported to be effective for jasmine cultivation (Malhotra 2017). In recent years, the growing demand for jasmine has created a need for high-quality planting materials. Although layering and cuttings are the conventional propagation methods, they do have certain limitations. Long-term cuttings or layering have been reported to contribute to varietal degeneration, susceptibility to diseases, and diminished flower production (Cai et al. 2007). Layering has been the mode of vegetative propagation of jasmine. One year old mature shoots are selected for layering and buried 10–15 cm deep in the soil. Root formation starts within 90–120 days (Burns 1953). Propagation by cutting is the easiest method and has been attempted for many species (Senthilkumar 2019), and propagation by seeds is a very rare phenomenon in jasmine; hence, seed setting is not a regular practice (Indiresh et al. 1994). Other propagation methods have also been reported in jasmine cultivation such as suckers, budding, grafting, and in vitro propagation (Veluswamy et al. 1980). Prior to planting, it is essential to prepare the soil by thoroughly pulverizing it and removing any weeds. Each pit should be filled with well-rooted, healthy, and robust seedlings. In India, the optimal time for planting is during the monsoon season, although it is possible to plant jasmine throughout the year. Once planted, jasmine typically remains in the field for a period of 10–15 years (Senthilkumar 2019). The next immediate practice in jasmine cultivation is pruning. Pruning plays a fundamental role in improving the overall health, vigor, and visual appeal of jasmine plants. Additionally, it is vital for maintaining abundant flowering and ensuring high-quality flowers (Sha and Rajiv 2016). Normally, irrigation is stopped before pruning, and plants are pruned by removing all the dead and diseased branches to a height of about 45 cm from the ground level (Rajamohan and Sathish 2019). *Jasminum auriculatum* pruned to a height of 40 cm has been observed to produce the highest yield (Han et al. 1997). Jasmine plants typically begin flowering approximately 6 months after being planted. However, it is important to note that they only yield commercially viable quantities from the third year onward, with a productive lifespan of about 12–15 years. The timing of harvesting depends on the intended purpose of the flowers. For fresh flower production, the preferred method is hand-picking fully developed but unopened flower buds early in the morning. On the other hand, for extract production, fully opened fresh flowers are harvested. It is fundamental to handle the flowers with care during harvesting and transportation, as this significantly impacts the shelf life of fresh flowers and the quality of extract recovery. Several pests and diseases cause considerable crop losses and damage to jasmine plants. Among them, the most important insect pests are the budworm, leaf weaver, blossom midge, and the eriophyid mite, whereas the fungal diseases mainly include leaf blight, rust, and wilt (Table 1).

4 | *Jasminum* Plants Phytochemical Composition

As per the World Flora Online (2022), there are over 200 recognized species associated with *Jasminum*. Out of these species, phytochemicals have only been described for 18 species. The phytochemicals reported in the literature for the 18 species are presented in the following sections.

4.1 | *Jasminum abyssinicum* R.Br

Craigside A to C (Gallo et al. 2006).

4.2 | *Jasminum auriculatum* Vahl

2-Phenylethyl hexadecanoate; (*E*)-cinnamyl benzoate; (*E*)-heptadec-8-ene; (*Z*)-hex-3-enyl 2-methylbutanoate; (*Z*)-jasmone oxime; (2*E*,6*E*)-farnesol; (2*E*,6*E*)-farnesyl (*E*)-cinnamate; (2*E*,6*E*)-farnesyl hex-3-enoate; (2*E*,6*E*)-farnesyl acetate; (2*E*,6*E*)-farnesyl benzoate; (2*E*,6*E*)-farnesyl butanoate; (2*E*,6*E*)-farnesyl decanoate; (2*E*,6*E*)-farnesyl dodecanoate; (2*E*,6*E*)-farnesyl formate; (2*E*,6*E*)-farnesyl hexadecanoate; (2*E*,6*E*)-farnesyl hexanoate; (2*E*,6*E*)-farnesyl linoleate; (2*E*,6*E*)-farnesyl linolenate; (2*E*,6*E*)-farnesyl octanoate; (2*E*,6*E*)-farnesyl phenylacetate; (2*E*,6*E*)-farnesyl tetradecanoate; (2*E*,6*E*)-farnesyl tiglate; (2*E*,6*E*)-phytyl acetate; (2*Z*,6*E*)-farnesol; (3*E*,6*E*)-α-farnesene; (3*Z*)-hexenyl acetate; (3*Z*)-hexenyl benzoate; (3*Z*,6*E*)-α-farnesene; (*E*)- and (*Z*)-phenylacetaldehydeoxime; (*E*)-cinnamic acid; (*E*)-cinnamyl (*E*)-cinnamate; (*E*)-cinnamyl alcohol; (*E*)-cinnamyl benzoate; (*E*)-cinnamyl tiglate; (*E*)-coniferyl alcohol; (*E*)-isoeugenol; methyl (*E*)-jasmonate; (*E*)-nerolidol; (*E*)-phytol; (*E*)-phytyl acetate; (*Z*)-hex-3-enol; (*Z*)-hex-3-enyl (*E*)-cinnamate; (*Z*)-hex-3-enyl 3-methylbutanoate; (*Z*)-hex-3-enyl anthranilate; (*Z*)-hex-3-enyl butanoate; (*Z*)-hex-3-enyl eicosanoate; (*Z*)-hex-3-enyl linoleate; (*Z*)-hex-3-enyl oleate; (*Z*)-hex-3-enyl oleate; (*Z*)-hex-3-enyl phenylacetate; (*Z*)-hex-3-enyl tiglate; (*Z*)-hex-3-enyl linolenate; (*Z*)-hex-3-enyl 2-butenoate; (*Z*)-jasmone; 1,4-cineole; benzyl benzoate; 1-nitro-2-phenyl-1-ethane; 2,3-epoxy squalene; benzyl linoleate; 2-ethyl hexanol; 2-methyl-6-methylene-1,7-octadien-3-one; 2-*oxo*-phenylacetic acid; 2-phenylethanol; 2-phenylethyl (*E*)-cinnamate; 2-phenylethyl (*E*)-butenoate; 2-phenylethyl acetate; 2-phenylethyl benzoate; 2-phenylethyl butanoate; 2-phenylethyl docosanoate; 2-phenylethyl dodecanoate; 2-phenylethyl eicosanoate; 2-phenylethyl linoleate; 2-phenylethyl linolenate; 2-phenylethyl oleate; 2-phenylethyl octanoate; 2-phenylethyl oleate; 2-phenylethyl phenylacetate; 2-phenylethyl tetradecanoate; 2-phenylethyl tiglate; 4-hydroxybenzyl ethyl ether; 4-vinylguaiacol; 5-hydroxylinalool (*cis* + *trans*); 6-methyl-5-hepten-2-one; α-cadinol; acetanilide; α-copaene; α-humulene; *allo*-aromadendrene; α-muurolene; β-caryophyllene; β-elemene; benzaldehyde; benzaldehyde oxime; benzoic acid; benzyl cyanide; benzyl (*E*)-but-2-enoate; benzyl (*E*)-cinnamate; benzyl (*Z*)-cinnamate; benzyl (*Z*)-hex-3-enoate; benzyl acetate; benzyl alcohol; benzyl benzoate; benzyl butanoate; benzyl cyanide; benzyl docosanoate; benzyl dodecanoate; benzyl eicosanoate; benzyl palmitate; benzyl linolenate; benzyl oleate; benzyl oleate; benzyl palmitate; benzyl phenylacetate; benzyl salicylate; benzyl tetradecanoate; benzyl tiglate; benzylidenacetone; β-farnesene; butyl hexadecanoate; butyl oleate; chavicol; creosol; cubenol; δ-cadinene; δ-cadinol; docosane; docosanol; dodecane; dodecanoic acid; eicosane; eicosanol; *epi*-cubenol; ethyl (*E*)-cinnamate; ethyl benzoate; ethyl hexadecanoate; eugenol; geranyl linalool; geranyl phenylacetate; geranyl acetone; germacrene-D; heneicosane; heptadecane; hexadecane; hexadecanoic acid; hexadecanol; hexahydrofarnesyl acetone; hexanol; hexyl (*E*)-cinnamate; hexyl acetate; hexyl benzoate; hexyl tiglate; indole; isophytol; isoprenyl benzoate; jasmine lactone; jasminol; ledol; limonene; linalool; linalool oxide, furanoid (*cis* + *trans*); linalool oxide, pyranoid; linoleic acid; linolenic acid; maltol; *m*-cresol; methyl (*E*)-cinnamate; methyl (*Z*)-cinnamate; methyl 2-aminobenzoate; methyl anthranilate; methyl benzoate; methyl *cis*-(*Z*) jasmonate oxime; methyl (*Z*)-jasmonate; methyl docosanoate; methyl dodecanoate; methyl eicosanoate; methyl heneicosanoate; methyl hexadecanoate; methyl linolate; methyl linoleate; methyl linolenate; methyl *N*-acetyl anthranilate; methyl *N*-formyl anthranilate; methyl nicotinate; methyl nonadecanoate; methyl oleate; methyl oleate; methyl salicylate; methyl stearate; methyl tetradecanoate; methyl *trans*-(*Z*) jasmonate oxime; methyl (*Z*)-jasmonate; naphthalene; neroli(*E*)-nerolidol; nonadecane; nonanal; octadecane; octadecanoic acid; octadecanol; octanal; oleic acid; *p*-cresol; *p*-cymene; pentadecane; phenol; phenyl acetaldehyde; prenyl benzoate; squalene; *syn*- and *anti*-phenylacetaldehyde oxime; τ-cadinol; tetracosanol; tetradecane; tetradecanoic acid; tridecane; vanillonitrile; δ-jasmine lactone (Deshpande and Upadhyay 1970; Hase et al. 1981; Joulain and Laurent 1995; Braun et al. 2009; Bera et al. 2015; Barman and Mitra 2021; Joulain 2021).

4.3 | *Jasminum azoricum* L

(*E*)-Cinnamic alcohol; (*E*)-nerolidol; (*Z*)-nerolidol; (*E*)-β-farnesene; (*E*)-phenylacetaldoxime; (*Z*)-phenylacetaldoxime; (*E*,*E*)-farnesol; (*E*,*E*)-farnesyl acetate; (*Z*)-3-hexenol; 2-phenylethyl alcohol; 4-formylbenzyl acetate; α-humulene; azirocin; β-caryophyllene; benzaldehyde; benzoic acid; benzyl acetate; benzyl alcohol; chlorogenic acid; coumaric acid; demethyl oleuropein; docosane; geranyl linalool; geranylacetone; heneicosane; hydroxytyrosol; hydroxytyrosol hexoside; indole; jaslanceoside E; jasmolactone B; kaempferol; kaempferol-3-one-*O*-hesperidoside; linalool; methyl 1-vinylnicotinate; methyl anthranilate; methyl benzoate; methyl linoleate; methyl linolenate; methyl oleate; methyl oleoside hexoside; methyl palmitate; methyl stearate; molihauside A to C and E; myricetin dihexoside; oleuropein; oleuropein hexoside; olivil hexoside; *p*-coumaric acid; phenyl acetaldehyde; phenyl acetonitrile; phytatetraene; phytol; protocatechualdehyde; protocatechuic acid; quercetin dihexoside; quercetin-3-*O*-glucoside; rosmarinic acid; rutin; sambacein I–III; sambacoside A; sinapoyl hexoside; syringic acid; syringic acid hexoside (Peyrot et al. 1995; Somanadhan et al. 1998; Pragadheesh et al. 2011; El-Hawary, El-Hefnawy, El-Raey et al. 2021; El-Hawary, El-Hefnawy, Osman et al. 2021).

TABLE 1 | Common pests and diseases affecting *Jasminum* plants.

Name of the disease	Pest/Pathogen	Damage symptoms	Management strategies	References
Jasmine budworm	*Hendecasis duplifascialis*	The pest holes the flower bud and feeds on the inner content Larvae attack 2–3 flower buds Petals are eaten by the larvae	Damaged buds with larvae should be collected and destroyed Light traps should be used to attract and kill adult moths Spraying with neem seed kernel extract (NSKE) 5% or malathion 50% E.C. (2 mL/L) is effective Proper pruning and hygiene should be maintained	Lanfang et al. (2007), Kiran (2017), Chaitanya and Kumar (2018)
Leaf webber	*Nausinoe geometralis*	The pest builts an elaborate network of webbing on the leaves, especially on the underside, causing severe injury The lower foliage becomes infested during rainy days Infestation is severe on terminal shoots during dry and sunny weather	Spraying imidacloprid (2 mL/L) or dimethoate (2 mL/L) provides systemic control throughout the season Insecticidal soaps and certain plant extracts such as neem kernel, *Vitex negundo* leaf extract, *Catharanthus roseus* extract may reduce populations Natural enemies such as green lacewings, *Scymnus* spp., *Mallada boninensis, Chrysoperla oculata*, and larval parasitoids like *Bracon* spp., *Elasmus* spp., and *Apanteles* spp. play a vital role in natural suppression of the pest	Rajabhaskar (2006), Kamala and J.S. (2017), Kamala et al. (2017), Kiran (2017)
Blossom midge	*Contarinia maculipennis*	The pest maggots penetrate the buds, causing them to swell at the base The infestation leads to stunted growth and ultimately to the drying out of the plants	Spraying chlorantraniliprole (0.5 mL/L) or novaluron (1 mL/L) in water is effective Thiamethoxam 2.5% (0.75 g/L) or flufenoxuron (1.5 g/L) reduce the population	Kiran (2017), Kamala (2018)
Jasmine eriophyid mite	*Aceria jasmini*	The pest infests the leaf surface, tender stems and buds A velvet like hairy growth is produced on the leaf surface Plant growth is stunted, and flower production is suppressed	The affected parts must be removed a destroyed NSKE and other botanicals are effective. Spraying fenazaquin magister (10% EC) (2 mL/L) is effective	Umapathy and Rajendran (1999), Kamala (2020)

(Continues)

TABLE 1 | (Continued)

Name of the disease	Pest/Pathogen	Damage symptoms	Management strategies	References
Leaf-blight	*Cercospora jasminicola* and *Alternaria jasmini, Alternaria alternata*	In *Cercospora* leaf spot, irregular reddish-brown circular spots are produced on the upper surface of the leaves, spreading rapidly in the rainy season In *Alternaria*, dark brown leaf spots appear on the leaves and become enlarged covering large areas, and concentric rings can be seen in the lesions. Stem, petiole, and flowers are also affected	Fallen leaves should be collected and removed Spraying mancozeb 0.25% or carbendazim 0.1%; copper oxychloride 0.25% is effective Spraying various plant extracts can reduce fungal populations	Conn and Tewari (1990), Hemanandhini et al. (2019), Nivedha et al. (2019)
Rust	*Uromyces hobsonii, Puccinia aizazii*	Yellowish orange pustules appear on the aerial parts of plants, including young twigs and flowers buds Infected parts become distorted	Branches should be pruned Spraying copper oxychloride (0.3%) or mancozeb (0.2%) is effective Sulfur at the rate of 20–25 kg/ha is useful	Parndekar (1964), Rao et al. (1989)
Wilt	*Fusarium solani*	The early symptom is yellowing of the lower leaves which gradually spread upwards and finally causes the death of the plant The disease occurs in patches	Application of benomy1 (0.1%) + copper oxychloride (0.3%) and carbendazim (0.2%) + copper oxychloride (0.3%) in two drench applications at an interval of 15 days is effective *Pseudomonas fluorescens, Bacillus subtilis*, and *Trichoderma viride* are effective against the pathogen	Ravikumar et al. (2004), Devappa and Archith (2019)
Collar rot and root rot	*Sclerotium rolfsii*	First the oldest leaves become yellow followed by the youngest leaves and finally the plant dies Plants at all stages are infected Black discoloration is observed on the root. White strands of mycelia and mustard like sclerotia are observed in infected tissues and on the stem surface	Soil drenching with copper oxychloride 0.25% is effective Heavy application of farmyard manure (FYM) with *T. viride* also reduce disease incidence	Umamaheswari et al. (2002)

Abbreviations: FYM, farmyard manure; NSKE, neem seed kernel extract.

4.4 | *Jasminum flexile* Vahl

(*E*)-Nerolidol; (2*E*,6*E*)-farnesol; (2*E*,6*E*)-farnesyl acetate; (3*E*,6*E*)-α-farnesene; (3*Z*)-hexenyl acetate; (3*Z*)-hexenyl benzoate; (3*Z*,6*E*)-α-farnesene; (*E*)- and (*Z*)-phenylacetaldehydeoxime; (*Z*)-jasmone; 2,3-epoxy squalene; 2-phenylethyl salicylate; 2-phenylethyl alcohol; benzyl acetate; benzyl alcohol; benzyl benzoate; benzyl cyanide; benzyl linolenate; benzyl palmitate; benzyl salicylate; eugenol; geranyl linalool; indole; linalool; methyl anthranilate; methyl hexadecanoate; methyl linolate; methyl linolenate; methyl oleate; methyl salicylate; methyl stearate; squalene; δ-jasmine lactone (Christensen et al. 1997).

4.5 | *Jasminum grandiflorum* L

(−)-*cis*-5-Pent-2′-enyl-pentanolide-(5,1); (2″*R*)- and (2″*S*)-2″-methyl oleuropein; (3*E*,6*E*)-α-farnesene; (3*E*,6*E*)-α-farnesene; (3*Z*)-hexenyl acetate; (3*Z*)-hexenyl benzoate; (3*Z*,6*E*)-α-farnesene; (*E*)-nerolidol; (*E*)-phytol; (*E*)-phytyl acetate; (*Z*)-jasmone; methyl (*Z*)-*epi*-jasmonate (*cis*-3); methyl (*Z*)-jasmonate (*trans*-3); (*Z*)-phytol; 1,4-cineole; 10-hydroxyligstroside; 10-hydroxyoleuropein; 1*H*-indole; α-terpineol; 2-(3,4-dihydroxyphenyl)ethanol; 2-(4-hydroxyphenyl)ethanol; 2,3-dihydroxypropyl 1-hexacosanoate; 2,3-dihydroxypropyl docosanoate; 2,3-epoxy squalene; 2″-epifraxamoside; 2-ethylhexanol; phenyl 2-hydroxymethyl-3-methylbutanoate; 2-vinylpyridine; 2α,3β,23-trihydroxyolean-12-en-28-oic-*O*-β-D-glucopyranosylester, 2α,3β,23-trihydroxyolean-12-en-28-oic-*O*-α-L-rhamnopyranosyl-(1 → 4)-*O*-β-D-glucopyranosyl-(1 → 6)-*O*-β-D-glucopyranosylester; 3′,4′,5,5′,7-pentamethoxyflavone; 4-hydroxyphenyl 3,5-dihydroxy-2,4-dimethylhexanoate; 3-amino-1-phenylbutane; 3-hexenyl benzoate; 3-*O*-α-L-rhamnopyranosyl-(1 → 2)-β-D-xylopyranosyl-hederagenin-28-*O*-β-D-galacto pyranosyl-(1 → 6)-β-D-galactopyranosylester; 5-dihydrocaffeoylquinic acid; 5-dihydromethoxycaffeoylquinic acid; 6,10,14-trimethyl-2-pentadecanone; 6-methyl-5-hepten-2-one; 6-*O*-methycatalpol; 7-glucosyl-11 methyloleoside; 7-ketologanin; 8-dehydroxy shanzhiside; 8-*epi*-kingiside; aucubin; behenyl-*O*-α-D-glucopyranosyl-(6′ → 1″)-*O*-α-D-glucopyranosyl-(6″ → 1‴)-*O*-α-D-glucopyranoside; benzoic acid; benzyl acetate; benzyl alcohol; benzyl benzoate; benzyl cyanide; benzyl linolenate; benzyl palmitate; benzyl salicylate; cerotyl-*O*-β-D-diarabinoside; (3*Z*)-hexenol; (3*Z*)-hexenyl benzoate; (3*Z*)-hexenyl 2-methyl-(2*E*)-butenoate; (*Z*)-jasmone; (+)- and (±)-linalool; deacetylasperulosidic acid; decanal; demethyl-2″-epifraxamoside; dodecane; methyl *epi*-jasmonate; eugenol; farnesol; geraniol, geranyl linalool; geranyl acetone; geranyl linalool; hederagenin-3-*O*-β-D-glucopyranosyl (1 → 3)-α-L-arabinopyranoside, hederagenin-3-*O*-β-D-xylopyranosyl (1 → 3)-α-L-rhamnopyranosyl(1 → 2)-α-L-arabinopyranoside, hederagenin-3-*O*-α-L-rhamnopyranosyl(1 → 2)-α-L-arabinopyranoside; hexadecane; indole; isophytol; isophytyl acetate; isoquercitrin; jasgranoside; jasgranoside B; jasminan hydride; jasmine lactone; jasmonates; jasmone; jaspolyoside; kaempferol-3-*O*-(2,6-di-rhamnosyl)glucoside; kaempferol-3-*O*-rutinoside; kaempferol-3-*O*-α-L-rhamnopyranosyl-(1 → 3)-[α-L-rhamnopyranosyl-(1 → 6)]-β-D-galactopyranoside; ladones; ligstroside; limonene; linalool; linalyl acetate; loganin; *m*-cresol; methyl 2-aminobenzoate; methyl anthranilate; methyl benzoate; methyl dihydrojasmonate; methyl jasmonate; methyl linolate; methyl linoleate; methyl linolenate; methyl nicotinate; methyl oleate; methyl palmitate; methyl salicylate; methyl stearate; methyl-*N*-methyl anthranilate; myrcene; naphthalene; nerol; nerolidol; nonanal; octanal; oleacein; oleacin; oleoside dimethyl ester; oleoside-7,11-dimethylester; oleuropein; olivil; *p*-cresol; *p*-cymene; pentadecane; phytol; phytyl acetate; quercetin-3-*O*-(2,6-di-rhamnosyl)glucoside; quercetin-3-*O*-rutinoside; racemic (5-pent-2-enyl)-5,1-pentanolide; squalene; squalene-2,3-oxide; stearyl-*O*-α-D-triglucoside; tetradecane; tricosene; ursolic acid; vanillin; α-terpineol; 2-hexenal; γ-jasmolactone; δ-jasmine lactone (Winter et al. 1962; Anac 1986; Somanadhan et al. 1998; Utaka et al. 2002; Sadhu et al. 2007; Bhosale et al. 2011; Bera et al. 2015; Arun et al. 2016b; de Groot and Schmidt 2017; Oliveira et al. 2017; Sultana et al. 2018; Umukoro et al. 2018; Braun and Sim 2020; Issa et al. 2020).

4.6 | *Jasminum lanceolarium* Roxb

(−)-Olivil 4″-*O*-β-D-glucopyranoside; (+)-cycloolivil; (+)-cycloolivil-4′-*O*-β-D-glucopyranoside; (+)-cycloolivil-6-*O*-β-D-glucopyranoside; (+)-pinoresinol; (2*S*)-5,7,3′,4′-tetrahydroxyflavanone-5-*O*-β-D-glucopyranoside; (2*S*)-5,7,3′,5′-tetrahydroxyflavanone-7-*O*-β-D-allopyranoside; (7*S*, 8*R*)-9′-methoxydehydrodiconiferyl alcohol; (*threo*)-dihydro-dehydrodiconiferyl alcohol 4-*O*-β-D-glucopyran; 10-hydroxyoleoside; 10-hydroxyoleoside 11-methyl ester; 10-hydroxyoleoside dimethyl ester; 3,5-dimethoxy-benzyl alcohol 4-*O*-β-D-glucopyranoside; 4-*O*-β-D-glucopyranosyl coniferyl aldehyde; 5,7,3′,5′-tetrahydroxyflavanone; 8-hydroxyepipinoresinol 4-*O*-β-D-glucopyranoside; adenosine; aslanceoside D dimethyl ether; betulin; betulinaldehyde; betulinic acid; caffeic acid; (*Z*)-*p*-coumaric acid; daucosterol; dihydrodehydrodiconiferyl alcohol-4-*O*-β-D-glucopyranoside; (*E*)-coniferin; (*E*)-*p*-coumaric acid; epipinoresinol-4-*O*-β-D-glucoside; *erythro*-1-(4-hydroxy-3-methoxyphenyl)-2-[4-[(*E*)-3-hydroxy-1-propenyl]-2-methoxyphenoxy-1,3-propanediol; ferulic acid; janceolaroside A; janceoside A; jaslanceoside A to H; jaslanceoside A pentaacetate; jaslanceoside B pentaacetate; jaslanceoside C dimethyl ether; jaslanceoside C pentaacetate; jaslanceoside E hexaacetate; jasminlan A; jasminlanoside A; jasminoside; ligstrosid; liriodenine; mannitol; medioresinol 4′-*O*-β-D-glucopyranoside (eucommin A); medioresinol-4-*O*-β-D-glucopyranoside; methylconiferin; nonacosane; nonacosanoic acid; oleanolic acid; oleuropein; sinapic aldehyde 4-*O*-β-D-glucopyranoside; sypringin; syringaresinol-4-*O*-β-D-glucoside; syringin; *threo*-1-(4-hydroxy-3-methoxyphenyl)-2-[4-[(*E*)-3-hydroxy-1-propenyl]-2-methoxyphenoxy]-1,3-propanediol; (*E*)-cinnamic acid; vanillic acid glucoside; vanilloloside; β-sitosterol (Shen and Lin 1996; Ya-Ching et al. 1997; Sun and Yang 2007; Sun et al. 2007, 2008, 2010; Lou et al. 2011; Ning et al. 2013; Wang et al. 2018; Liu et al. 2021).

4.7 | *Jasminum laurifolium* Var. Laurifolium

Jaslanceoside B; jasminoside; molihuaside D; oleoside 7,11-dimethyl ester; sambacoside A; syringalactones A and B (Shen et al. 2000).

4.8 | *Jasminum malabaricum* Wight

(*E*)-Nerolidol; ±-farnesene; benzyl alcohol; (*Z*)-jasmone; indole; methyl benzoate; methyl salicylate (Barman and Mitra 2019).

4.9 | *Jasminum mesnyi* Hance

9″-Hydroxyjasmesoside; 9″-hydroxyjasmesosidic acid; jasmesoside; jasminin; jasminin 10″-O-*β*-D-glucoside; jasmoside; rutin; syringin (Inoue 1985; Tanahashi et al. 1989; Inoue et al. 1991; Mahadeva Rao et al. 2015).

4.10 | *Jasminum multiflorum* Andrews

(3*E*,6*E*)-*α*-Farnesene; (3*Z*)-hexenyl acetate; 10-hydroxyligustroside; 10-hydroxyoleoside 11-methyl ester; 10-hydroxyoleuropein; 2-methyl-6-methylene-1,7-octadien-3-one; 2-*p*-acetoxyphenylethanol; 2-phenylethanol; 3-hexenyl jbenzoate; 6-methyl-5-hepten-2-one; *α*-cadinol; *α*-humulene; benzyl acetate; benzyl alcohol; benzyl benzoate; *β*-farnesene; (3*Z*)-hexenyl butyrate; (3*Z*)-hexenyl tiglate; (3*Z*)-hexenyl-2-methyl (2*E*)-butenoate; (*Z*)-jasmone; decanal; *δ*-elemene; dodecane; ethyl benzoate; eugenol; farnesol; *γ*-cadinene; geranylacetone; heptacosane; hexyl benzoate; hydroxytyrosol; indole; isoamyl benzoate; jasmolactone; jasmolactone A to D; jasmone; jasmultiside; kaempferol-3-*O*-glucoside; kaempferol-3-*O*-neohesperidoside; limonene; linalool; *cis*-linalool oxide (furanoid); *trans*-linalool oxide (furanoid); methyl 2-aminobenzoate; methyl benzoate; methyl palmitate; methyl salicylate; multiflorin; multifloroside; multiroside; naphthalene; nerolidol; nonanal; *n*-tritetracontane; *p*-coumaric acid; phenylethyl alcohol; phenylethyl benzoate; *p*-hydroxybenzoic acid; protocatechuic acid; quercetin-3-*O*-glucoside; rosmarinic acid; rutin; tolualdehyde (Shen and Chen 1989; Shen et al. 1990; Shen and Chen 1994; Ahmad et al. 1998; Singh et al. 2014; Bera et al. 2015; Khidzir et al. 2015; Singh, 2016; El-Hawary, El-Hefnawy, Osman et al. 2021).

4.11 | *Jasminum nervosum* Lour

(*E*)-Nerolidol; (3Z)-hexen-1-ol; 10-hydroxyoleoside dimethyl ester; 6′-*O*-(*Z*)-*p*-coumaroylloganin; 6′-*O*-(*E*)-coumaroylloganin; 7-dehydrologanin; 6,10,14-trimethyl-2-pentadecanone; 6′-*O*-menthiafoloylverbascoside; apiosylverbascoside; astragalin; *β*-sitosterol; (*Z*)-2,6-dimethyl-2,6-octadiene; *cis*-linalool oxide (pyranoid); geraniol; isooleoverbascoside; isoquercitrin; isoverbascoside; jasamplexoside A to C; jashemsloside A to E; jasminoside; jasnervoside A to H; jaspolyanthoside; lariciresinol-4-*O*-*β*-D-glucoside; limonene; linalool; loganin; lupeol; phytol; poliumoside; *p*-menth-1-en-7-al; *p*-mentha-1,5,8-triene; rutin; stigmast-5-en-3-ol; teresantalol; *trans*-sobrerol; verbascoside; *α*-copaene; *α*-terpineol; *β*-myrcene; verbascoside; *α*-L-rhamnopyranosyl-(1 → 3)-*O*-(*α*-L-rhamnopyranosyl(1 → 6)-1-*O*-(*E*)-caffeoyl-*β*-D-glucopyranoside (Tanahashi et al. 1992, 1995; Tanahashi, Shimada et al. 1996; Huong et al. 2008; Ngan et al. 2008; Guo et al. 2014; Dai et al. 2016).

4.12 | *Jasminum nudiflorum* Lindl

Acteoside; isooleoacteoside; jasnudifloside A to L; nudifloside A to D; oleoside 11-methyl ester; poliumoside; syringin. (Tanahashi, Takenaka et al. 1999; Tanahashi et al. 2000; Takenaka et al. 2002).

4.13 | *Jasminum officinale* L

(−)-Olivil; (+)-jasminoid A; (2″*R*)-2″-methoxyoleuropein; (2″*S*)-2″-methoxyoleuropein; (*E*)-3-(4-hydroxyphenyl)-2-propenoic acid; (3*E*)-hexenyl benzoate; 1(2*H*)-naphthalenone; 1*H*-indole; 1-pentanol 1-pentene; 2-methyl2-butenol; 2-propanol; 3-(4-hydroxy-3-methoxyphenyl)-2-propenal; 2*α*,3*β*,23-trihydroxyolean-12-en-28-oic-*O*-*β*-D-glucopyranosyl ester; 2*α*,3*β*,23-trihydroxyolean-12-en-28-oic-*O*-*α*-L-rhamnopyranosyl-(1 → 4)-*β*-D-glucopyranosyl-(1 → 6)-*β*-D-glucopyranosyl ester; methyl 3,7,11,15-tetramethylhexadecanoate; 3,7,11-trimethyl-1,3,6,10-dodecatetraene (*α*-farnesene); 3,7,11-trimethyl-1,6,10-dodecatrien-3-ol; 3,7-dimethylocta-1,6-dien-3-ol (linalool); ethyl 3-butanoate; 3-butyn-2-ol; 3-methylglutaric anhydride; 3-*O*-*α*-L-rhamnopyranosyl-(1 → 2)-*β*-D-xylopyranosyl-hederagenin-28-*O*-*β*-D-galactopyranosyl-(1 → 6)-*β*-D-galactopyranosyl ester; 5-hexene-2-one; 3,7,11,15-tetramethyl-1-hexadecen-3-ol; 7-glucosyl-11-methyl oleoside; 7-ketologanin; 7-tetradecene; 9,12,15-octadecatrienoic acid; methyl 9,12,15-octadecatrienoate; benzyl acetate; *β*-butyrolactone; cedrol; chlorogenic acid; (2*Z*)-hexene; (4*Z*)-heptenal; demethyloleuropein; docosane; ethyl 4-hydroxycinnamate; ethyl ferulate; ferulic acid; geranyl linalool; hederagenin-3-*O*-*α*-L-rhamnopyranosyl-(1 → 2)-*α*-L-arabinopyranoside; hederagenin-3-*O*-*β*-D-xylopyranosyl-(1 → 3)-*α*-L-rhamnopyranosyl-(1 → 2)-*α*-L-arabinopyranoside; hederagenin-3-*O*-*β*-D-glucopyranosyl-(1 → 3)-*α*-L-arabinopyranoside; heneicosane; heptacosane; hexacosane; hexadecanoic acid; pentylhydroperoxide; hydroxytyrosol; isobutylene epoxide; jasminol A, G and H; jasminol B; kaempferol-3-*O*-glucoside; kaempferol-3-*O*-neohesperidoside; kaempferol-3-*O*-rutinoside; kaempferol-3-*O*-*α*-L-rhamnopyranosyl-(1 → 3)-[*α*-L-rhamnopyranosyl-(1 → 6)]-*β*-D-galactopyranoside; ligstroside; methyl 2-aminobenzoate (methyl anthranilate); methyl dihydrojasmonate; methyl myristate; methyl palmitate; neophytadiene; nerolidol; nonacosane; nonadecane; octacosane; methyl octadecanoate; oleoside dimethyl ester; oleoside-11-methyl ester; oleuropein; *p*-hydroxyphenethyl alcohol; *p*-coumaric acid; pentacosane; perhydrofarnesyl acetone; phenylmethanol; *p*-hydroxybenzoic acid; phytol; phytyl acetate; protocatechuic acid; quercetin-3-*O*-glucoside; rosmarinic acid; rutin; sinapaldehyde; squalene; syringic acid; tetracosane; tricosane (Tanahashi, Sakai et al. 1999; Zhao et al. 2007; Zhao and Dong 2008; Wei et al. 2015; Lu et al. 2019; Lo et al. 2020; Rasheed 2020; El-Hawary, El-Hefnawy, Osman et al. 2021).

4.14 | *Jasminum pentaneurum* Hand.-Mazz

10-(3-Hydroxy-4-methoxybenzoate)-ligustroside; 10-hydroxyoleoside 11-methyl-ester; 10-hydroxyoleoside dimethyl ester; 4-hydroxy-3,5-dimethoxybenzaldehyde; 4-hydroxybenzyaldehyde; coniferaldehyde; ethyl 4-hydroxy-

3-methoxybenzoate; jasminoside; syringic acid ethyl ester; vanillin (Wei et al. 2021).

4.15 | *Jasminum polyanthum* Franch

(−)-Methyl jasmonate; (2*E*)-hexenal; (2*E*)-hexenyl acetate; (3*Z*)-hexenyl acetate; (2*E*)-hexenyl butyrate; (3*Z*)-hexenyl butyrate; (*E*)-isoeugenol; (*Z*)-isoeugenol; methyl (*E*)-cinnamate; (*E*,*E*)-farnesol; (*E*,*E*)-farnesyl acetate; (3*Z*)-hexenol; 10-hydroxyoleoside dimethyl ester; 2-methoxy-*p*-cresol; 6-methyl-5-hepten-2-one; 6″-*O*-*β*-D-glucopyranosyl oleuropein; 8-*epi*-kingiside; *α*-humulene; angustifolioside B; benzyl acetate; benzyl alcohol; docosane; eugenol; heneicosane; hexadecane; hexanal; indole; isobutyl acetate; isojaspolyoside A to C; isopropyl butyrate; jasmin lactone; jaspofoliamoside A, B, E to G; jaspogeranoside A and B; jaspolinaloside B; jaspolyanoside; jaspolyanthoside; jaspolyoside; jaspolyside A to C; kaempferol-3-*O*-(2-*O*-α-L-rhamnopyranosyl-*β*-D-galactopyranoside); ligustroside; linalool; mauritianin; methyl benzoate; methyl-glucooleoside; neopolyanoside; nicotiflorine; oleoacetoside; oleopolyanthoside A and B; oleoside 11-methyl ester; oleoside dimethyl ester; oleuropein; *p*-cresol; pentacosane; phenethyl acetate; phenethyl alcohol; tricosane; verbascoside (Shen, Lin, and Chein 1996; Shen, Lin, Hsieh et al. 1996; Tanahashi, Takenaka et al. 1996; Christensen et al. 1997; Tanahashi, Takenaka, Akimoto et al. 1997; Tanahashi, Takenaka, and Nagakura 1997; Takenaka, Takahashi et al. 1998; Takenaka, Tanahashi et al. 1998; Blanch et al. 2009).

4.16 | *Jasminum sambac* (L.) Aiton

(+)-Jasminoid A to D; (2*E*,6*E*)-farnesol; (2*E*,6*E*)-farnesyl acetate; (3*E*,6*E*)-*α*-farnesene; (3*Z*,6*E*)-*α*-farnesene; (*E*)-*β*-farnesene; (3*Z*)-hexenyl acetate; (3*Z*)-hexenyl benzoate; (*E*)- and (*Z*)-phenylacetaldehyde oxime; (*E*)-cinnamoyl benzoate; methyl (*E*)-jasmonate; (*E*)-nerolidol; (*Z*)-nerolidol; (*E*)-phytol; (*Z*)-phytol; (*E*)-*β*-ocimene; (*Z*)-jasmone; (*Z*)-*trans*-*α*-bergamatol; (*Z*)-*β*-ocimene; [1(10)*E*,5*E*]-germacradien-4*α*-ol; 1-hydroxylinalool; 1,3-dimethyl-4-azaphenanthrene; 1-*epi*-cubenol; 1*H*-indole; 1-hydroxy-1,7-dimethyl-4-isopropyl-2,7-cyclodecadiene; 2,3-epoxysqualene; 2-aminononadecane; 2-hexenol; 2-*oxo*-2,3-dihydroindole; 2-phenethyl ester; 2-phenylacetaldehyde; 2-phenylethyl acetate; 2-phenylethyl salicylate; 2-phenylethyl alcohol; 3-hexenol; 6-methyl-5-hepten-2-one; 8-hydroxylinalool; *α*-cadinene; *γ*-cadinene; *δ*-cadinene; *α*-cadinol; *δ*-cadinol; *α*-copaene; *α*-humulene; amyl salicylate; *anti*-phenylacetaldoxime; *α*-terpineol; (*E*)-*β*-caryophyllene; *β*-elemene; benzaldehyde; benzyl acetate; benzyl alcohol; benzyl benzoate; benzyl cyanide; benzyl linolenate; benzyl palmitate; benzyl salicylate; bicyclogermacrene; 2-phenylethyl benzoate; cinammyl alcohol; *cis*- and *trans*-linalool oxide; (3*Z*)-hexenyl butyrate; (*Z*)-jasmone; cyclooctyl alcohol; *δ*-cadinene; decanal, *δ*-elemene; dihydromyrcenol; docosane; epoxylinalool; ethyl acetate; ethyl benzoate; ethyl hexadecanoate; ethyl linoleate; ethyl oleate; ethyl palmitate; ethyl salicylate; ethyl stearate; eugenol; (*E*)-*α*-bisabolene; farnesol; furyl pentyl ketone; geranial; geranyl linalool; geranylacetone; germacradiene-4-ol; germacrene A and D; germacrene D-4-ol; heneicosane; hexadecyl acetate; hexanol; hexyl salicylate; indole; indole-3-acetic acid; indole-3-butyric acid (IBA), naphthalene acetic acid (NAA); (*Z*)-*β*-caryophyllene; isopropyl myristate; kaempferol; kaempferol-3-*O*-glucoside; kaempferol-3-*O*-neohesperidoside; limonene; linalool; linalyl acetate; linalyl *β*-D-glucopyranoside; linoleic acid; methyl 2-aminobenzoate (methyl anthranilate); methyl benzoate; methyl jasmonate; methyl linolate; methyl linoleate; methyl linolenate; methyl oleate; methyl palmitate; methyl palmitoleate; methyl salicylate; ethyl salicylate; methyl stearate; molihuaside A to E; mycrene; naphthalene; nerol; octadecane; oleoside 11-methyl ester; oplopanone; palmitic acid; palmitinic acid; *p*-coumaric acid; phenylethyl alcohol; phenylacetonitrile; phenylethyl acetate; phenylethyl benzoate; *p*-hydroxybenzoic acid; phytolacetate; pimaradiene; quercetin-3-*O*-glucoside; rosmarinic acid; rutin; sambacolignoside; sambacoside A,E and F; spongesterol; squalene; stigmasterol; syringic acid; tetradecanol; *τ*-muurolol; tolualdehyde; (4*E*)-hexenal; (*E*)-*β*-caryophyllene; tricosane; tricosene; viridiflorol; (11*Z*)-tricosene; (3*Z*)-hexenol; *cis*-linalool oxide; *α*-muurolene; *α*-terpineol; *α*-terpinolene; *β*-aminocrotonitrile; *β*-myrcene; *β*-ocimene; *β*-sitosterol; *δ*-jasmine lactone (Tanahashi et al. 1987, 1988; Moon et al. 1994; Peyrot et al. 1995; Zhang et al. 1995; Rao and Rout 2003; Edris et al. 2007; Braun et al. 2009; Rout et al. 2010; Paibon et al. 2011; Pragadheesh et al. 2011; Braun and Sim 2012; Zeng et al. 2012; Kanlayavattanakul et al. 2013; Bera et al. 2015; Alex Isac et al. 2016; de Groot and Schmidt 2017; Zhang et al. 2020; El-Hawary, El-Hefnawy, Osman et al. 2021; M and SİVaraj 2021).

4.17 | *Jasminum tortuosum* Willd

Ginkgool; oleoside 11-methyl ester; oleoside dimethyl ester; olivil-4′-*O*-*β*-glucopyranoside (Temraz et al. 2009; Tomassini et al. 2018).

4.18 | *Jasminum urophyllum* Hemsl

Jasurolignoside; jasuroside A to G; urolignoside (Shen and Hsieh 1997a, 1997b; Ya-Ching et al. 1998).

5 | Traditional Medicine Use of *Jasminum* Plants

Traditional medicine encompasses a comprehensive body of knowledge, skills, approaches, and practices rooted in indigenous theories, beliefs, and experiences across diverse cultures. It is employed for the purpose of maintaining health, as well as diagnosing, preventing, improving, or treating various physical and mental ailments. This form of medicine often integrates animal- and plant-based remedies, utilizing herbal plants either in isolation or in combination to address diseases or promote overall well-being (Kuete 2013). Traditional medicine plays an important role in medical care. The use of alternative and herbal medicine is an antique practice around the world. Recent advances in contemporary therapeutics have enthused the use of natural products because of their availability, effectiveness, affordability, and safety (Wachtel-Galor and Benzie 2011). Throughout history, various species within the *Jasminum* genus have held significant importance as remedies for addressing a multitude of health issues across different parts of the world. The Latin name "*Jasminum*" derives from the Persian term "Yasmin," which translates to "sweetly scented plants" (Gledhill 2008). Indeed, Jasmine flowers have played a fundamental role in the progression of civilizations, providing resources for traditional medicine. Jasmine is known throughout the world for its fragrance. It was introduced to Europe in the 16th century. Due to its pleasing scent, *Jasminum grandiflorum* is a source of a wide array of essential oils, perfumes, soaps, and cosmetics worldwide (Khare 2004). All parts of the Jasmine, namely, flowers, leaves, and root, are used for different purposes. For instance, in India, its leaves are widely used as an Ayurvedic medicinal herb, and its flowers are used to adorn women's coiffures (Khare 2004). Jasmine has been mentioned in the Avicenna's Canon of Medicine and in the Persian ethnobotany for its anti-inflammatory action (Mosavat et al. 2017). The leaves of *J. grandiflorum* have been utilized in the treatment of a diverse range of ailments, including ulcerative stomatitis, toothache, leprosy, skin diseases, earache, otorrhea, painful menstruation, ulcers, wounds, urinary disorders, and corns. Moreover, this plant is recognized for its diuretic properties and is used as a spasmolytic agent during childbirth in different regions of India (Umamaheswari et al. 2007). In addition, the flowers are traditionally used in India to relieve muscular pain, calm irritating coughs, and treat conjunctivitis, dermatitis, and gut pain, as well as inhibit breast cancer and interrupt uterine bleeding (Wu et al. 2021). Otherwise, in the Western Madhya Pradesh (India), a floral poultice of *J. auriculatum* is used to treat scorpion stings (Wagh and Jain 2020). *Jasminum syringifolium* was used as a component of the medicinal plant mixes to remedy 19 illnesses as reported by tribes in the Nicobar and Andaman Islands of India (Chander et al. 2014). In Asian and Indian traditional medicine, Jasmine leaves are also commonly prescribed for liver ailments, dysentery, different types of pain, including painful menstruation, and skin conditions like leprosy. In Southern China, the leaves are employed in the treatment of cirrhosis, hepatitis, and duodenitis (Arun et al. 2016b). In some parts of India, *J. sambac* is traditionally used to suppress puerperal lactation (Shweta and Boaz 2015). In the traditional Chinese medicine, *Jasminum lanceolarium* Roxb. is used to expel the gaseous element, eliminate dampness, and as a component in analgesic formulations, as well as to treat skelalgia and lumbodynia, and to treat cervicitis and other female diseases as an anti-inflammatory agent. Although stems and roots have been utilized in the treatment of fever and rheumatism, the leaves have been incorporated into certain preparations to alleviate eye pain (Yan et al. 2015). On the other hand, *J. officinale* leaves are often mouth-chewed and used to relieve ulcers, whereas a paste of the leaves is traditionally used for corns. Otherwise, *J. officinale* leaves and flowers are used for fever, cough, as a blood purifier, and to increase lactation in Battagram (Pakistan) as reported by Haq et al. (2010). However, in Bilecik (Turkey), *J. officinale* is traditionally used by folklore healers as a neuroleptic (Guler et al. 2015). In the Himalayan region of Pakistan, the whole plant juice is used as an anthelmintic, emmenagogue, and diuretic. The flower paste is also used for eye diseases, skin diseases, and headache (Rashid et al. 2015). In Southern Pakistan, *J. grandiflorum* whole plant juice is orally consumed and used to treat diabetes (Tariq et al. 2020). In other regions of Pakistan (Azad Jammu and Kashmir), *J. mesnyi* leaf powder is used topically to cure dandruff and muscular pains. Plant leaves are chewed to treat mouth ulcers. The ashes from the branches of *J. mesnyi* are applied externally to treat minor joint pains and migraines. Moreover, the powder of the dried flower is used to cure hepatic disorders (Amjad et al. 2017). In traditional medicine in Thailand (Songkhla province), *J. sambac* flower has been used to expel the gaseous element and to treat high blood pressure (Neamsuvan et al. 2018). On the other hand, in Jazan, Saudi Arabia, the water decoction of the fruit and flowers of *J. sambac* is consumed orally to treat liver diseases, intestinal worms, cirrhosis, diarrhea, skin diseases, skin redness, sexual desire, skin rashes, leprosy, ulcers, as an analgesic, and wound-healing agent (Tounekti et al. 2019). Although in Bangladesh, *J. sambac* leaves are soaked in water and consumed as a remedy for acidity. The leaves are also directly consumed for addressing menstrual problems. Moreover, macerated leaves of *J. sambac* are topically applied to affected areas of the skin to treat various skin diseases (Sharkar et al. 2013). In Northern Ethiopia, *J. grandiflorum* leaves together with other herbs are crushed and shade-dried, then powdered and made into a cream. The cream is used in the vagina to treat hemorrhage in childbirth, as well as to treat eye injuries and trachoma (Meragiaw et al. 2016). The pounded leaves and roots of *J. abyssinicum* are traditionally consumed orally in Ethiopian folklore medicine to treat *Ascaris* or beef tapeworm infections (Meragiaw et al. 2016).

Traditional medicine highlighted the diverse therapeutic applications of Jasminum species. Modern pharmaceutical industries can capitalize on this knowledge by isolating bioactive compounds for drug development. Validating traditional uses through pharmacological studies and clinical trials can facilitate the creation of novel therapeutics; by incorporating advanced techniques like bioinformatics and high-throughput screening, we could accelerate the transition of Jasminum-derived compounds into mainstream medicine.

6 | Pharmacological Activities of *Jasminum* Plants

6.1 | In Vitro Studies

6.1.1 | Antioxidant Activity

Oxidative stress is a general physio-pathological condition caused by the imbalance between reactive oxygen species (ROS) and cellular antioxidants (Chaudhary et al. 2023). Such condition has drawn in the last decades a growing interest from scientific community as it can be linked to several pathological conditions such as cardiovascular diseases, diabetes, obesity, cancer, and neurodegenerative diseases (Amin et al. 2022; Chaudhary et al. 2023). Different species of *Jasminum* genus have been identified to possess radical scavenging activity, as summarized in Table 2 (Balkrishna et al. 2021). This property has been extensively confirmed in vitro for all *Jasminum* species studied, providing a solid basis for further in vivo studies on correlated effects (see below). Leaves are the most frequently used part of the plants, followed by flowers and stems. Antioxidant activity has usually been correlated with the total phenolic content of plants. However, these data are greatly affected by the extraction method, leading to a huge variability (0.047–104 mg gallic acid equivalent [GAE]/g, as shown in Table 2). Many studies do not report these data, which do not allow a direct correlation analysis between total phenols and antioxidant activity. Many in vitro assays have been developed to assess the ability of *Jasminum* spp. samples to quench ROS and free radicals, including DPPH•, OH•,

TABLE 2 | Traditional medicinal uses of *Jasminum* species.

Jasminum species	Parts used	Traditional uses	References
Jasminum grandiflorum	Leaves Flowers Whole plant	Treatment of ulcerative stomatitis, toothache, leprosy, skin diseases, earache, otorrhea, painful menstruation, ulcers, wounds, urinary disorders, corns; diuretic; spasmolytic agent during childbirth; diabetes treatment	Umamaheswari et al. (2007), Tariq et al. (2020), Meragiaw et al. (2016)
Jasminum sambac	Flowers Leaves	Relieves muscular pain, cough, conjunctivitis, dermatitis, gut pain; breast cancer inhibition; uterine bleeding interruption; suppress puerperal lactation; treat high blood pressure, liver diseases, intestinal worms, cirrhosis, diarrhea, skin diseases, leprosy, ulcers; analgesic; wound healing	Wu et al. (2021), Shweta and Boaz (2015), Neamsuvan et al. (2018), Tounekti et al. (2019), Sharkar et al. (2013)
Jasminum officinale	Leaves Flowers	Ulcer relief, corns treatment, fever, cough, blood purifier, increase lactation; neuroleptic	Haq et al. (2010), Guler et al. (2015)
Jasminum auriculatum	Flowers	Treat scorpion stings	Wagh and Jain (2020)
Jasminum syringifolium	Flowers	Remedy for various illnesses in traditional mixes	Chander et al. (2014)
Jasminum lanceolarium	Leaves Stems Roots	Expel gaseous element, eliminate dampness, analgesic formulations, treat skelalgia, lumbodynia, cervicitis, other female diseases, fever, rheumatism, eye pain	Yan et al. (2015)
Jasminum mesnyi	Leaves Branches Flowers	Treat dandruff, muscular pains, mouth ulcers, joint pains, migraines, hepatic disorders	Amjad et al. (2017)
Jasminum malabaricum	Whole plant	Used in various traditional applications	Arun et al. (2016b)
Jasminum abyssinicum	Leaves Roots	Treat *Ascaris* or beef tapeworm infections	Meragiaw et al. (2016)

$NO\bullet$, H_2O_2, $O_2^{-}\bullet$, $ABTS^{+}\bullet$ scavenging assays, Oxygen Radical Absorbance Capacity (ORAC), Ferric Ion Reducing Antioxidant Power Assay (FRAP), LPO inhibition capacity (LPIC) assay, *β*-carotene-linoleic acid (linoleate) assay, and so on (Huang et al. 2005; Zucca et al. 2019; Ben Attia et al. 2020). These techniques can be roughly classified as electron transfer (ET) and hydrogen atom transfer (HAT) assays and have different costs, equipment requirements, and analysis times (Huang et al. 2005; Zucca et al. 2010; Ben Attia et al. 2018). Almost all of these assays have been included in the various studies reporting on antioxidant activity. However, the most frequently used are $DPPH\bullet > NO\bullet > O_2^{-}\bullet > H_2O_2$ scavenging assays (Balkrishna et al. 2021), 2,2-diphenyl-1-picrylhydrazyl (DPPH) being the quickest, simplest, most affordable, and reliable test. In accordance, this is the only assay that allows a direct comparison between different studies. In fact, the other methods are only used in a limited number of studies and can be expressed in different units of measurements. The DPPH quenching ability of *Jasminum* spp. is reported in Table 3 to allow a direct comparison. The measured IC_{50} ranged from 6.2 to 208 μg/mL. The highest activity has been highlighted for the *n*-butanol extract from *J. mesnyi*, whereas its ethyl acetate extract had an almost 20 times higher IC_{50} (Borar et al. 2011). The methanol extract of the same species has also been reported to possess a high activity ($IC_{50} = 25$ μg/mL) (Poonia et al. 2011). Most used solvents have been ethanol and methanol, whereas there is a lack of studies focusing on the comparison of the effect of different polarity solvents. A similar comparison has been performed by Bhagath et al. (2010) with *Jasminum arborescens* leaf extracts. A dose-dependent (25–400 μg/mL) free-radical-scavenging action of ethanol, chloroform, and petroleum ether extracts was detected. Very slight differences were detected, revealing a maximum effect of the ethanol extract, followed by chloroform and petroleum ether, with DPPH inhibition ranging from 40% to 90%. Other *Jasminum* spp. have been studied not including DPPH IC_{50}. For instance, aqueous extracts of leaves, roots, and bark of *Jasminum malabaricum* have been tested using the hydrogen peroxide scavenging activity (Prabhat and Sawant 2018). The extracts (500, 1000, 1500, and 2000 μg/mL) effectively quenched ROS with an efficiency ranging from 7% to 66.6% (ascorbic acid 200 μg/mL, used as standard, presented 86% activity).

6.1.2 | Anti-Inflammatory Properties

Inflammation is a physiological process that plays an important role in the body's defense mechanisms by recruiting immune cells from the bloodstream to sites of injury or infection (Scheau et al. 2020; Megha et al. 2021). However, when this activation becomes prolonged, it can lead to a pathological condition known as chronic inflammation associated with the production of free radicals, which can be both a cause and an effect of various diseases, particularly chronic degenerative diseases and cancer (Zlatian et al. 2015; Li et al. 2023; Iqbal et al. 2024). Therefore,

TABLE 3 | In vitro antioxidant activities of *Jasminum* spp.

Plant	Part used	Solvent	DPPH IC_{50} (μg/mL)	TPC (mg GAE/g)	References
Jasminum abyssinicum R.Br.	Leaves	Ethanol	26.3	0.4	Tauchen et al. (2015)
Jasminum angustifolium var. *sessiliflorum* (Vahl) P.S.Green	Leaves	Ethanol		2	Moe et al. (2018)
	Stems	Ethanol		23	
Jasminum auriculatum Vahl	Leaves	Ethanol	33.4	8.5	Arun et al. (2016a)
	Stems	Methanol	∼40		Jyotsana et al. (2015)
Jasminum azoricum L.	Leaves	Methanol 80%	199	0.057	El-Hawary, El-Hefnawy, Osman et al. (2021)
Jasminum grandiflorum L.	Flowers	Ethanol	75		Chandran et al. (2016)
	Flowers	Water	151	55[a]	Ferreres et al. (2014)
		Water/Methanol	189	45[a]	
	Leaves	Ethanol 70%	15		Umamaheswari et al. (2007)
		Ethanol	33.6	22	Mittal et al. (2015)
Jasminum mesnyi Hance	Leaves	*n*-Butanol	6.2		Borar et al. (2011)
		Ethyl acetate	153		
	Leaves	Methanol 90%	25		Poonia et al. (2011)
		Water	72		
Jasminum multiflorum Andrews	Flowers	Methanol	81		Khidzir et al. (2015)
	Leaves	Methanol 80%	34.8	0.167	El-Hawary, El-Hefnawy, Osman et al. (2021)
Jasminum officinale L.	Leaves	Water	41.2	104	Dubey et al. (2016)
	Leaves	Methanol 80%	76.6	0.133	El-Hawary, El-Hefnawy, Osman et al. (2021)
Jasminum sambac (L.) Aiton	Flowers	Methanol	208		Khidzir et al. (2015)
		Ethanol 70%	94		Widowati et al. (2018)
		Supercritical fluid extraction		20.6	Wu et al. (2021)
	Leaves	Methanol 80% (Arabian Nights cv)	131	0.047	El-Hawary, El-Hefnawy, Osman et al. (2021)
		Methanol 80% (Grand Duke of Tuscany cv)	156	0.050	

Abbreviations: DPPH, 2,2-diphenyl-1-picrylhydrazyl; GAE, gallic acid equivalent; TPC, total phenolic content.
[a]Determined in HPLC-DAD.

therapeutic interventions targeting cellular oxidative stress may provide a valuable strategy for mitigating the progression of these conditions and slowing their clinical course (Sharifi-Rad et al. 2022). Almost all studies reporting on the anti-inflammatory and analgesic effects of the genus *Jasminum* are attempts to explain the effects attributed by traditional oriental medicine to plants of this species. Research based on the use of extracts from plants of the *Jasminum* genus has tried to obtain results that could provide important answers to counter inflammatory diseases. The enzyme inhibitory activity of various types of extracts from many species of the genus *Jasminum* has been reported. In most cases, the inhibition targets enzymes involved in the inflammatory mechanism: cyclooxygenase (COX-1, COX-2) and lipoxygenase (LOX) (Yan et al. 2015; El-Shiekh et al. 2021). In vitro studies have demonstrated that the ethanolic extract of *J. sambac* inhibits COX enzymes, a key mediator in the inflammatory pathway, at various concentrations. This inhibition has been attributed to specific phytocomponents identified in the extract, including isoquercetin, *β*-sitosterol, and linalool. Molecular docking studies revealed that these compounds exhibit significant binding affinity to COX enzymes via non-covalent interactions, such as hydrogen bonding and hydrophobic interactions, leading to a stabilization of the enzyme-inhibitor complex and subsequent inhibition of its catalytic activity. This mechanism highlights the potential of Jasminum phytocomponents in modulating inflammation through the suppression of COX-mediated prostaglandin (PG) synthesis (Dhote et al. 2021). The carrageenan-induced inflammatory response has been shown to be due to the release of PG, histamine, cytokines, and proteinase mediated by free radicals (Hollander et al. 2003). Therefore, the inhibition of this inflammatory process can be achieved by trapping free radicals with antioxidants. The carrageenan-induced paw edema test is widely used as a highly sensitive and reproducible method for screening anti-inflammatory drugs. This test consists of two phases (Vinegar et al. 1969). The first phase is characterized by the release of histamine, 5-hydroxy tryptamine, and kinins, whereas the release of PGs is associated with the later stage (Dzoyem et al. 2017). Methanolic extract of *J. grandiflorum* leaves acted more effectively in the early stage of carrageenan-induced inflammation on primary culture of rat peritoneal macrophages than the later stage, which suggested its action in the early phase of inflammation (Chaturvedi and Tripathi 2011). This may be due to the presence of phytol, isoquercitrin, or unsaturated fatty acid, which had anti-inflammatory response. The methanolic extract also reduced the production of nitric oxide (NO) in peritoneal macrophages cultures from healthy rats, which further supported its anti-inflammatory action. Thus, it could be suggested that the presence of several polyphenolic compounds might be responsible of the reported antioxidant and anti-inflammatory property of the methanolic extract of *J. grandiflorum* leaves. The anti-inflammatory effect due to the inhibition of NO synthesis was also confirmed with extracts of *J. grandiflorum* subsp. *floribundum* (El-Shiekh et al. 2021). This result, attributed to the inhibition of the inducible NO synthase expression, is further proof of the anti-inflammatory efficacy of *J. grandiflorum* extracts. Anti-inflammatory activity has also been highlighted with extracts from the stem of a species of jasmine widespread in the south-western regions of China, *J. officinale* used in folk medicine for the treatment of chronic inflammatory diseases. An in vitro study with dried stems of *J. officinale*, powdered and extracted with 95% ethanol, and then partitioned with ethyl acetate, was aimed to evaluate the anti-inflammatory properties on NO production in lipopolysaccharide (LPS)-stimulated RAW 264.7 murine macrophage cells. As a result, some fractions of the extract exhibited a moderate activity against NO production in macrophages with an IC_{50} value at μM level. Part of this anti-inflammatory effect has been attributed to sesquiterpenoids known as jasminols (Lu et al. 2019).

6.1.3 | Antimicrobial, Antifungal and Antiviral Activities

Drug resistance among microbial pathogens is an escalating scientific issue, necessitating the development of new and safe antimicrobials (Taheri et al. 2021). In this context, the antimicrobial activity of *Jasminum* species offers a promising avenue for research, as their bioactive compounds have shown potential in combating resistant strains of bacteria, fungi, and viruses, thus contributing to the development of innovative therapeutic solutions (Balkrishna et al. 2021). In accordance with the use in folk medicine, about 14 *Jasminum* species have been investigated for this activity and recently reviewed (Balkrishna et al. 2021). Antimicrobial activity has been confirmed on biogenic gold nanoparticles produced from *J. auriculatum* leaves (Balasubramanian et al. 2020). In this case, disc inhibition was observed against human pathogenic bacteria (*Streptococcus pyogenes*, *S. aureus*, *E. coli*, and *Klebsiella pneumoniae*) and fungi (*Candida albicans*, *Aspergillus fumigatus*, *Lecanicillium lecanii*, and *Trichoderma viride*). The bactericidal activity of steam-distilled essential oil of *J. sambac* on *E. coli* was also studied, using the tube dilution technique (minimum inhibitory concentration [MIC] ranging between 1.9 and 31.25 μL/mL) (Rath et al. 2008). In this case, the authors suggested that the oil acted by inhibiting the synthesis of bacterial cell membranes. On the whole, 14 *Jasminum* species have been studied. *Jasminum azoricum* and *Jasminum brevilobum* seemed to be the most promising sources for drug development, with encouraging results especially against Gram-positive pathogens (Balkrishna et al. 2021). The different results between Gram-positive and negative bacteria could be due to the fact that the target of action is the bacterial cell membrane. Antimicrobial activity could also find applications in dental hygiene. In fact, Bhagath et al. (2013) used the agar well diffusion method to highlight inhibition against seven clinical isolates of *Streptococcus mutans* by an ethanolic Soxhlet extract of *J. arborescens* (Bhagath et al. 2013). Such findings open the way to possible applications of *Jasminum* species as anticaries agents. Several Jasminum species have demonstrated antifungal activity. For example, a methanolic extract of *J. grandiflorum* subsp. *floribundum* was active against *C. albicans* (Abdel-Sattar et al. 2008), and essential oil of *J. officinale* against *Trichosporon ovoides* (Saxena et al. 2012). Even a potential antiviral activity has been described for this genus. Oleuropein derived from the flowers of *J. officinale* var. *grandiflorum* effectively blocked hepatitis B virus replication in HepG2/2.2.15 cell line in vitro (Zhao et al. 2009).

6.1.4 | Antihelmintic Activity

Helminth infections are very common infections worldwide, widespread among the poorest and most deprived communities. They cause diseases like anemia, malnutrition, eosinophilia, and pneumonia (Mali and Mehta 2008). These public health problems, compounded by the phenomenon of parasite resistance to different drugs currently used, require new and more effective and safer parasiticides. On the basis of these premises, many authors focused their attention on the role of *Jasminum* spp. extracts as anthelminthic sources. The anthelmintic activity of different *Jasminum* extracts has been tested on the adult Indian earthworm model. *Pheretima pasthuma* is often used in this research field because of its anatomical and physiological similarity to the intestinal parasitic roundworm parasite of humans. Ethanol, chloroform, ethyl acetate, and petroleum ether extracts were found to have a certain degree of anthelmintic activity but the ethanolic extract caused paralysis and death of the worms faster than the others. This result was achieved using both *J. arborescens* (Bhagath et al. 2010) and *Jasminum angustifolium* var. *sessiliflorum* (Vahl) P.S.Green extracts (Philip et al. 2019). These data are in accordance with that observed for *J. mesnyi* ethanolic extracts (Dullu 2014). In this case, the anthelmintic activity was tested on adult *Eisenia fetida* specimens. Two different concentrations of extract were tested (20 and 40 mg/mL), and albendazole (10 mg/mL) was used as the reference standard drug. Both of extracts had significant anthelmintic activity but the higher concentration led to paralysis of the parasite faster. A recent study has investigated the anthelmintic power of *J. grandiflorum* subsp. *floribundum* (Hussein et al. 2021). The methanolic extract was partitioned into dichloromethane and *n*-

butanol fractions. Four compounds were isolated from *n*-butanol fraction (kaempferol-3-*O*-neohesperidoside, rutin, oleuropein, ligstroside), and the whole extract, the fractions, and the isolated compound were tested on different parasites: a dangerous metacestode (hydatid cyst), one arthropod (*Pediculus humanus capitis*) and two nematodes (larvae of *Parascaris equorum* and adult *Habronema muscae*). Rutin was found to show the highest anthelmintic activity followed by ligstroside, in a dose-dependent manner, against the *H. muscae* adult worm. Though *Jasminum* is already used in traditional medicine for its anthelmintic activity and these preliminary data are promising, further in vivo studies could be done to evaluate the effective anthelmintic properties of *Jasminum* extracts in humans.

6.1.5 | Neuroprotective Activity

The use of medicinal plants over the centuries has ensured a certain safety, although not necessarily therapeutic efficacy, above all, against complex organs and systems such as the central nervous system (CNS) (Bhuia et al. 2023; Azzini et al. 2024). Furthermore, such studies are complex and difficult to perform in vivo. In fact, there are few reports describing the effects of Jasmine extracts on CNS. An interesting in vitro study was carried out using a flower bud extract of *J. grandiflorum* on the activity of some CNS enzymes (acetyl-cholinesterase, butyryl-cholinesterase, and monoamine oxidase-A (Ferreres et al. 2014). This study investigated the anticholinesterase activity of both a boiling water extract and a hydromethanolic extract of *J.* grandiflorum. The extracts exhibited weaker anticholinesterase activity compared to galantamine, a reference drug. Similarly, the inhibition of monoamine oxidase MAO-A by the extracts was lower than that achieved with clorgyline, a well-known enzyme inhibitor used as a reference. Although this study does not provide strong evidence supporting the effectiveness of *J. grandiflorum* extract for the treatment of CNS disorders, it highlighted the potential for further research. Given the vast number of species within the *Jasminum* genus, future studies could explore their potential interest in treating neurological disorders.

6.1.6 | Cardioprotective Activity

The ability of *Jasminum* spp. to affect the cardiovascular system has also been assessed in vitro, in accordance with folkloristic reports on these plants. For instance, the vasorelaxant activity of the *J. officinale* essential oil has recently been investigated (Rasheed 2020). Ca^{2+} channel blocking effect was studied using rabbit aortic rings and jejunal tissue. *Jasminum* oil exerted vascular relaxation against potassium ion and phenylephrine-induced vasoconstrictions (median effective concentration of 5.39 and 7.04 mg/mL, similar to that of the standard calcium channel blocker verapamil). Such results seem to confirm the ethnopharmaceutical use of this plant in cardiovascular conditions. Similar vasodilating activity has recently been reported for the dichloromethanolic and *n*-butanolic fractions of the methanolic extract of the aerial parts of *J. grandiflorum* subsp. *floribundum* (El-Shiekh et al. 2020). The angiotensin-I-converting enzyme (ACE) and renin inhibitory activity have been tested, with the n-butanol fraction showing the strongest activity (compared to the standard drugs lisinopril and aliskiren). Several secoiridoids have been quantified in high concentrations in this fraction, being possibly linked to this potential in the hypertension treatment.

6.1.7 | Antidiabetic Activity

Many plant components have been identified as inhibitors of α-amylase, a key enzyme involved in the digestion of dietary starch. In particular, protein inhibitors of α-amylase, often derived from legumes, have been studied for their potential use in weight control and in reducing postprandial insulin spikes in individuals with hyperglycemic disorders. Plant-derived antidiabetic agents have been used in traditional medicine worldwide and are generally considered safe with no apparent side effects (Sati et al. 2024). Such nonprotein compounds are often capable of inhibiting this enzyme but with lesser efficacy. The α-amylase inhibitory activity of leaf extract of *J. arborescens* has been reported as a potential source for the development of active agents for diabetes mellitus (Bhagath et al. 2013). The extract showed a dose-dependent inhibition of α-amylase activity, but such inhibition has not been studied from a kinetic point of view, so many uncertainties remain about the type of inhibition observed.

6.1.8 | Antiaging and Anti-Hyperpigmentation Activities on Skin

The active compounds extracted from plants are widely used in skin care because they are perceived as more harmless than the use of drugs. For this reason, some *Jasminum* spp. have also been studied to obtain extracts that can be used to counteract the signs of skin aging. As is well known, skin aging is characterized, among other things, by a reduction in the amount of collagen and elastin, and glycosaminoglycans such as hyaluronic acid. It is therefore understandable that the enzymes involved in the degradation of these substances are the target of many active compounds of herbal plants. The antiaging properties of ethanolic extracts of *Jasminum* were measured through collagenase, elastase, and hyaluronidase inhibitory activities in vitro. The 70% ethanolic extracts of *J. sambac* exhibited anti-collagenase, anti-elastase, and anti-hyaluronidase activity at levels ranging between 250 and 340 µg/mL. These results, although interesting, were substantially lower than those obtained with the pure compounds used as reference, hesperidin, and eugenol (Widowati et al. 2018). Hyperpigmentation (brown spots on the skin) can have different causes: freckles, UV rays, increased melanin, melasma gravidarum, but also senility. The unsightly increase in these skin spots is linked to the activity of tyrosinase, the key enzyme in the production of melanin. This is the reason why human tyrosinase is also a target of many natural-based products used in aesthetic improvement of the skin. *J. sambac* flowers were subjected to supercritical fluid extraction (SFE) (Wu et al. 2021). Normally, this technique is used to extract volatile substances for different types of uses, but mainly oils and fragrances for cosmetic use. In the case of *J. sambac*, both the SFE extract and the non-volatile residue showed a marked anti-tyrosinase activity. Previously, Marongiu et al. (2007) highlighted an intense anti-tyrosinase activity in SFE extracts of *Cinnamomum zeylanicum* bark attributing much of this effect to the inhibition of the tyrosinase enzyme by eugenol, also present in the extract of *J. sambac*.

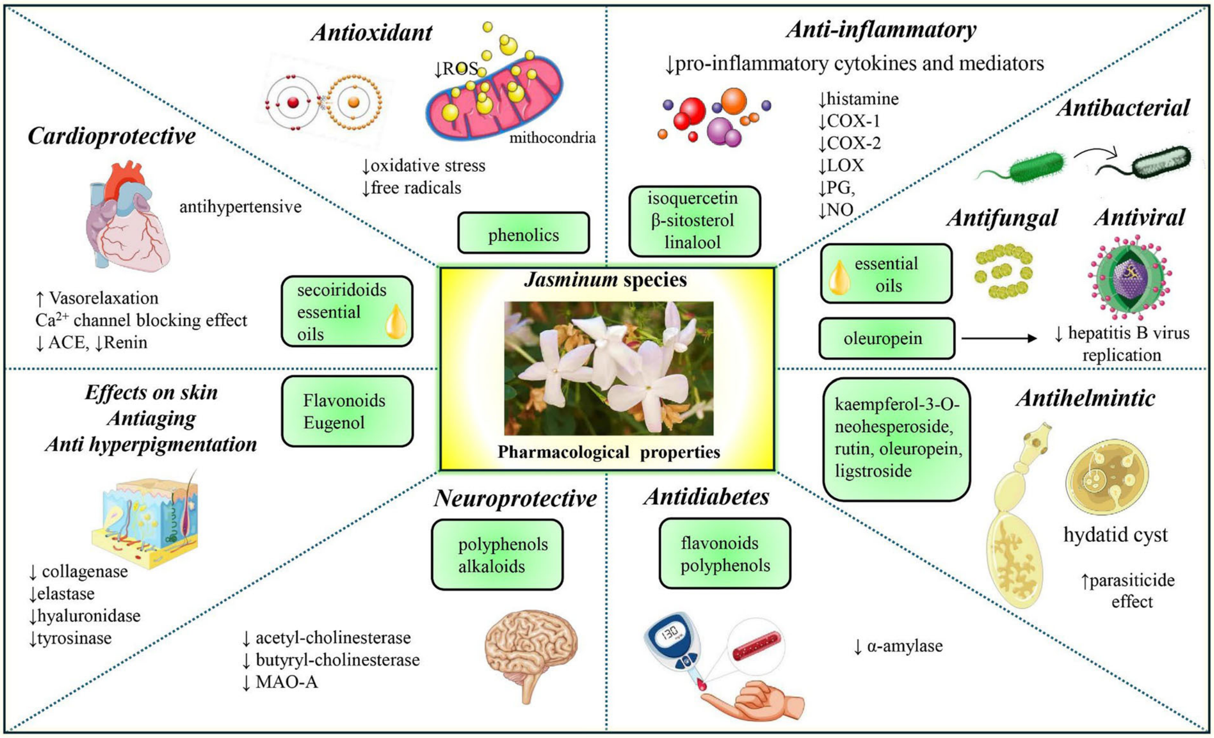

FIGURE 1 | Pharmacological properties of *Jasminum* species: a multifaceted approach to health benefits. The diagram illustrates the pharmacological properties of *Jasminum* species, highlighting their therapeutic potential across multiple health domains. The antioxidant activity is primarily due to phenolic compounds that reduce reactive oxygen species (ROS) and oxidative stress, thus neutralizing free radicals. Anti-inflammatory effects are mediated by compounds such as isoquercetin, β-sitosterol, and linalool, which inhibit pro-inflammatory cytokines and enzymes including COX-1, COX-2, LOX, and nitric oxide (NO). Antimicrobial activity is demonstrated by essential oils and oleuropein, which effectively combat bacteria, fungi, and viruses, including the hepatitis B virus. The anthelmintic activity involves compounds like kaempferol-3-*O*-neohesperidoside and rutin, showing efficacy against parasitic worms. Neuroprotective effects are seen with the inhibition of acetyl-cholinesterase and MAO-A, with polyphenols and alkaloids contributing to potential treatments for neurodegenerative disorders. Cardioprotective benefits include vasorelaxation and the reduction of ACE and renin levels, aided by secoiridoids and essential oils. The antidiabetic effects are characterized by the inhibition of α-amylase, attributed to flavonoids and polyphenols, which help manage blood glucose levels. Antiaging and anti-hyperpigmentation effects are due to the inhibition of enzymes such as collagenase and tyrosinase, with flavonoids and eugenol supporting skin health. This diagram underscores the therapeutic potential of *Jasminum* species, highlighting their multifaceted applications in health and wellness. ↑, increase; ↓, decrease. ACE, angiotensin-converting enzyme; COX, cyclooxygenase; LOX, lipoxygenase; NO, nitric oxide; ROS, reactive oxygen species.

6.1.9 | Anti-Gout Property

Commercial Jasmine oil from *J. officinale* has been reported to be effective in inhibiting the activity of xanthine oxidase. Xanthine oxidase enzyme is involved in the metabolism of purine bases and transforms hypoxanthine into xanthine and xanthine into uric acid; thus, jasmine oil has been proposed in the treatment of gout and other hyperuricemic diseases (Pushparathna et al. 2020). It should be emphasized that the results obtained with the extracts of the various plant species of the genus *Jasminum* and the biological effects observed may not be found even in specimens of the same species, as the geographical location, the nature of the soil, and the environmental climatic conditions can strongly influence the composition of plant metabolites.

Figure 1 and Table 4 summarize the most representative in vitro pharmacological activities of *Jasminum* species, highlighting the mechanisms and compounds involved.

6.1.10 | Anticancer Activity of *Jasminum* Plants

Cancer is one of the most common causes of death worldwide. In 2020, nearly 10 million of deaths were caused by tumors (Ferlay et al. 2021). It is therefore necessary to find new therapeutic approaches that can limit the growth of cancer cells with few side effects on healthy cells (Sharma et al. 2024). The *Jasminum* genus, known for its aromatic flowers and extensive use in traditional medicine, has shown promising anticancer properties attributed to its diverse array of phytochemicals. Recent scientific studies have focused on identifying and elucidating the mechanisms by which these bioactive compounds exert their anticancer effects, offering potential therapeutic applications against various cancer types (Figure 2). *Jasminum* species are rich in bioactive compounds such as flavonoids, alkaloids, terpenes, and phenolics; among these, flavonoids like quercetin and kaempferol have been extensively studied for their anticancer properties (Mansour et al. 2022). These compounds are known to interfere with multiple cellular pathways fundamental for cancer development and progression.

TABLE 4 | In vitro pharmacological properties of *Jasminum* species.

Biological activity	Species/Extract	Mechanism of action and compounds involved	Results	References
Antioxidant	*Jasminum* spp. (various extracts)	↑ Radical scavenging Compounds: Flavonoids, phenolics	Significant radical scavenging correlated with total phenolic content, particularly quercetin and rutin, which act by donating electrons to neutralize free radicals	Chaudhary et al. (2023), Balkrishna et al. (2021)
Anti-inflammatory	*J. sambac* *J. officinale* (ethanol, methanol)	↓ COX-1, COX-2, LOX ↓ NO production Phytocompounds: Iso-quercetin, β-sitosterol, linalool, phytol, isoquercitrin	Inhibition of inflammatory enzymes (COX, LOX) and NO pathways reduces prostaglandin synthesis, highlighting anti-inflammatory effects attributed to bioactive terpenoids and flavonoids	Yan et al. (2015), El-Shiekh et al. (2021)
Antimicrobial	*J. auriculatum* *J. sambac* (gold nanoparticles)	↓ Bacterial/Fungal cell membrane synthesis Compounds: Essential oils	Effective against *Streptococcus pyogenes, Staphylococcus aureus, Escherichia coli* Essential oils, rich in monoterpenes, disrupt bacterial membranes, demonstrating potential for drug-resistant pathogen control	Balasubramanian et al. (2020), Rath et al. (2008)
Antifungal	*J. grandiflorum* *J. officinale* (methanol)	↓ Fungal growth (*Candida albicans, Trichospora ovoides*) Compounds: Essential oils, terpenes	Essential oils and terpenes inhibit fungal cell wall synthesis and disrupt fungal metabolism, confirming potential for antifungal therapies	Abdel-Sattar et al. (2008), Saxena et al. (2012)
Antiviral	*J. officinale* var. grandiflorum (oleuropein)	↓ Hepatitis B virus replication Compound: Oleuropein	Oleuropein from flower extract effectively inhibits hepatitis B virus replication by interfering with viral DNA polymerase activity	Zhao et al. (2009)
Antihelminthic	*J. arborescens*, *J. angustifolium* (ethanol)	↑ Worm paralysis/Death Compounds: Rutin, ligstroside	Significant anthelmintic activity demonstrated against various parasitic worms; compounds act by disrupting the integrity of worm nervous system pathways	Bhagath et al. (2010), Philip et al. (2019)
Neuroprotective	*J. grandiflorum* (boiling water, hydromethanol)	↓ Acetyl-cholinesterase, butyryl-cholinesterase, MAO-A Compounds: Polyphenols, alkaloids	Polyphenols and alkaloids inhibit key CNS enzymes, reducing oxidative damage and supporting potential neuroprotective properties	Ferreres et al. (2014)

(Continues)

TABLE 4 | (Continued)

Biological activity	Species/Extract	Mechanism of action and compounds involved	Results	References
Cardioprotective	*J. officinale* *J. grandiflorum* (essential oil)	↑ Vasorelaxation (Ca^{2+} Channel blocking) ↓ ACE, Renin Compounds: Secoiridoids, essential oils	Secoiridoids exhibit vasodilatory effects by inhibiting calcium channels and ACE activity, offering potential in managing hypertension	Rasheed (2020), El-Shiekh et al. (2020)
Antidiabetic	*J. arborescens* (leaf extract)	↓ α-Amylase activity Compounds: Flavonoids, polyphenols	Flavonoids and polyphenols inhibit α-amylase, reducing glucose absorption and supporting blood sugar regulation	Bhagath et al. (2013)
Antiaging/Anti-hyperpigmentation	*J. sambac* (ethanol)	↓ Collagenase ↓Elastase ↓Hyaluronidase ↓Tyrosinase Compounds: Flavonoids, eugenol	Flavonoids and eugenol inhibit enzymes involved in skin aging and pigmentation, demonstrating applications in cosmetics and antiaging formulations	Widowati et al. (2018), Wu et al. (2021)
Anti-gout	*J. officinale* (Jasmine oil)	↓ Xanthine oxidase activity; Compounds: Essential oils	Jasmine oil reduces uric acid levels by inhibiting xanthine oxidase activity, offering potential therapeutic applications in managing gout	Pushparathna et al. (2020)
Anticancer	*J. officinale* *J. sambac* *J. auriculatum* (various)	↑ Apoptosis (↑ Bax, ↑ Caspases) ↓ Cell Proliferation (↓ Cyclins, CDKs) ↓ VEGF ↓ MMPs Compounds: Flavonoids, alkaloids, nanoparticles	Induction of apoptosis, inhibition of angiogenesis and proliferation via VEGF and MMP suppression; nanoparticles enhance cytotoxic effects in cancer cells	Mansour et al. (2022), El-Hawary et al. (2019), Balasubramanian et al. (2020)

Note: "↑" increase; "↓" decrease.

Abbreviations: ACE, angiotensin-converting enzyme; Bax, bcl-2-associated X protein; CDKs, cyclin-dependent kinases; CNS, central nervous system; COX, cyclooxygenase; LOX, lipoxygenase; MAO-A, monoamine oxidase A; MMPs, matrix metalloproteinases; NO, nitric oxide; VEGF, vascular endothelial growth factor.

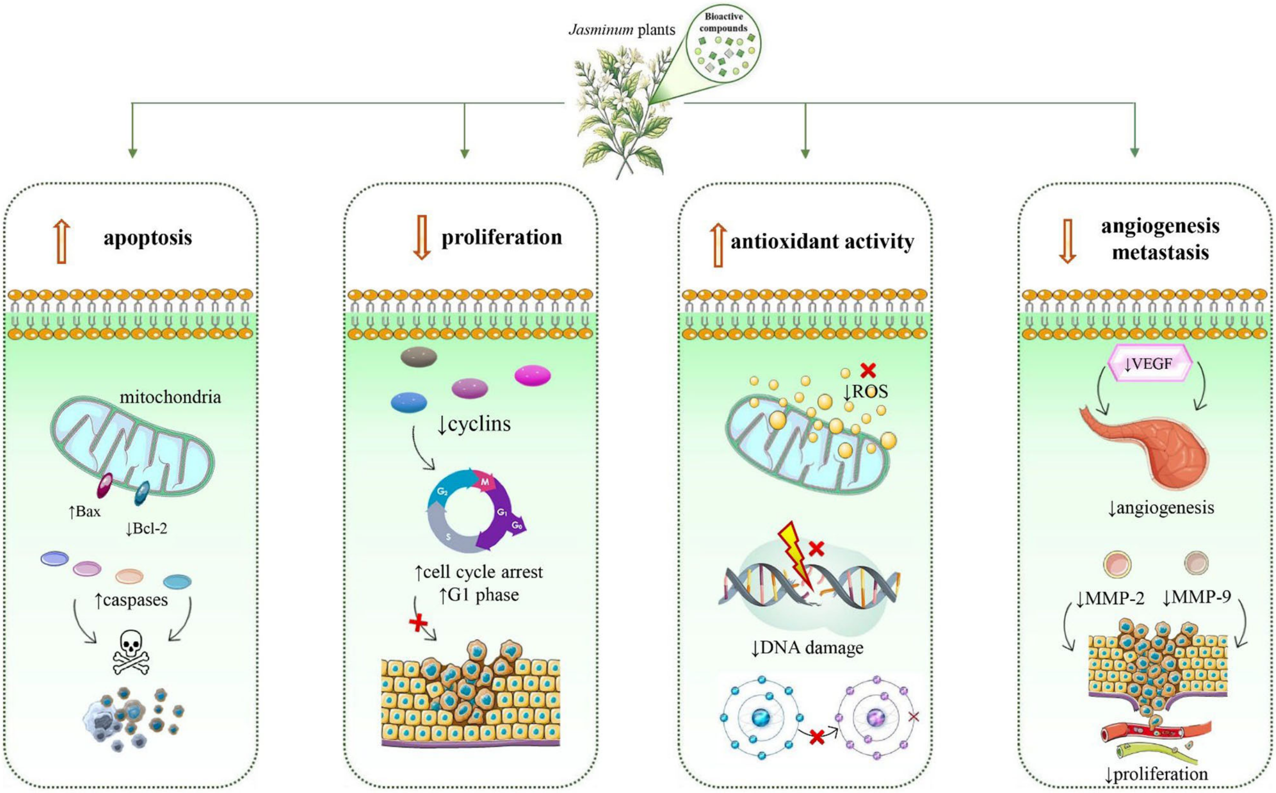

FIGURE 2 | Anticancer mechanisms of *Jasminum* plant bioactive compounds. These compounds promote apoptosis by increasing the expression of pro-apoptotic protein Bax and decreasing the antiapoptotic protein Bcl-2, leading to the activation of caspases and programmed cell death in cancer cells. Additionally, *Jasminum* compounds inhibit cancer cell proliferation by reducing cyclin expression, causing cell cycle arrest at the G1 phase. They also exhibit antioxidant activity by lowering reactive oxygen species (ROS) levels, which decreases oxidative stress and DNA damage, thus protecting cells from cancerous transformations. Furthermore, these compounds inhibit angiogenesis and metastasis by downregulating vascular endothelial growth factor (VEGF) and matrix metalloproteinases (MMP-2 and MMP-9), thereby preventing the formation of new blood vessels and reducing the spread of cancer cells. This image highlighted the potential of *Jasminum* plant compounds in cancer prevention and treatment through multiple biological pathways. ↑, increase; ↓, decrease. Bax, Bcl-2-associated X protein; Bcl-2, B-cell lymphoma 2; MMP, matrix metalloproteinase; ROS, reactive oxygen species; VEGF, vascular endothelial growth factor.

6.1.10.1. Induction of Apoptosis. Apoptosis, or programmed cell death, is a critical mechanism by which the body eliminates cancerous cells (Morana et al. 2022). Studies have shown that extracts from *J. officinale* and *J. sambac* induce apoptosis in cancer cells by activating both intrinsic and extrinsic apoptotic pathways. This is achieved through the upregulation of pro-apoptotic proteins such as Bax and the downregulation of antiapoptotic proteins like Bcl-2, leading to the activation of caspases, which are pivotal in executing apoptosis (Chaudhry et al. 2022).

6.1.10.2. Inhibition of Cell Proliferation. *Jasminum* extracts have demonstrated the ability to inhibit cancer cell proliferation by arresting the cell cycle at various phases (Ahmed et al. 2022). For example, a study on *J. sambac* showed that its ethanolic extract caused G1 phase arrest in breast cancer cells (MCF-7) by modulating the expression of cyclins and cyclin-dependent kinases (CDKs), thereby preventing cell cycle progression (El-Hawary et al. 2023).

6.1.10.3. Antioxidant Activity. The antioxidant properties of *Jasminum* compounds play a significant role in their anticancer effects (Lakshmi et al. 2024). ROS are known to contribute to cancer progression by inducing DNA damage and promoting tumor growth (Yu et al. 2024). The flavonoids and phenolic compounds present in *Jasminum* extracts can scavenge ROS, reduce oxidative stress, and protect cells from DNA damage, thus inhibiting cancer (Kopustinskiene et al. 2020).

6.1.10.4. Antiangiogenic Properties. Angiogenesis, the formation of new blood vessels, is essential for tumor growth and metastasis (Liu et al. 2023). *Jasminum* extracts have been shown to possess antiangiogenic properties, inhibiting the growth of new blood vessels and thereby restricting the nutrient supply to tumors (Hoseinkhani et al. 2020). *J. officinale* extract, for example, was found to downregulate the expression of vascular endothelial growth factor (VEGF) in ovarian cancer cells, impeding angiogenesis and tumor growth (Jia et al. 2024).

6.1.10.5. Inhibition of Metastasis. Metastasis, the spread of cancer cells to distant organs, is a major challenge in cancer treatment (Parker et al. 2022). Compounds found in *Jasminum* species have been reported to inhibit metastasis by modulating the expression of matrix metalloproteinases (MMPs), which are enzymes involved in the degradation of the extracellular matrix and facilitation of cancer cell invasion (Piperigkou et al. 2021). A study on *J. sambac* demonstrated its ability to reduce MMP-2 and

MMP-9 activity in colorectal cancer cells, thereby inhibiting cell invasion and metastasis (Islam et al. 2024).

Several studies have documented the cytotoxic effects of *Jasminum* extracts on various cancer cell lines.

In recent research, El-Hawary et al. (2019) studied the cytotoxicity of ethanolic extract of *J. sambac* and *J. officinalis* leaves and of the silver nano-derived particles (AgNPs) toward bladder (5637) and breast cancer (MCF-7) cell lines. Two cultivars of *J. sambac* were considered a source for the green synthesis of AgNPs: Arabian Nights (JSA) and Grand Duke of Tuscany (JSG) (El-Hawary et al. 2019). Cytotoxicity was evaluated with the neutral red uptake (NRU) assay, and normal keratinocyte (HaCaT) cells were used as control. The cytotoxicity was higher for AgNps than that produced by the total extract in all plants with the advantage that all extracts and their corresponding AgNPs have very low toxicity toward HaCaT cells. Therefore, the results indicated an improvement of the cytotoxicity characteristics of *Jasminum* spp. Leaf extract upon formation of its corresponding AgNPs with low toxicity toward normal cells. In addition, new compounds from the roots of *J. sambac* also showed cytotoxic activity against cancer cell lines (Olatunde et al. 2023a, 2023b). In another recent work, the anticancer potential of gold nanoparticles (AuNPs) synthetized from *J. auriculatum* leaves was investigated toward HeLa cells (Balasubramanian et al. 2020). The cytotoxicity was evaluated with MTT assay for different concentrations (12.5, 25, 50, 100, and 200 μg/mL) of the biogenic gold nanoparticles. AuNPs inhibited HeLa cells growth in a dose- and time-dependent manner. The IC_{50} value for AuNPs on HeLa cancer cells was found to be 104 μg/mL. As suggested by the authors, the anticancer power of nanoparticles could be related to their amphiphilic character. The nanoparticles could penetrate the cell membrane and change the hypoxic status of the tumoral cell. This appears to be confirmed by the microscopic observation of the morphological change in the treated HeLa cells, which decreased the contact surface and appeared contracted.

Many other studies are necessary to develop a real therapeutic protocol, but the green synthesis of metal nanoparticles could represent a new medical approach to tackle cancer cell growth; low toxicity and low production costs are two major strengths of this research field.

6.2 | In Vivo Studies

Several biological activities previously described in vitro have also been studied and partially confirmed by in vivo studies (Table 5).

6.2.1 | Anti-Inflammatory, Analgesic, and Antioxidant Effects

Findings of anti-ulcerative colitis and anti-arthritic effects were highlighted in a histopathological study when a methanolic extract of the aerial parts of *J. grandiflorum* subsp. *floribundum* was given to rats (El-Shiekh et al. 2021). The methanolic extract showed positive and dose-dependent effects in both models as evidenced by the preservation of histopathological features of colitis and arthritis lesions. The extract protected cartilage and bone from degeneration by decreasing the high levels of enzymes responsible for bone resorption, such as cathepsins, probably by preventing the lysosomal release of these enzymes. COX inhibition also contributes to the reduction of arthritis symptoms. The ethanolic extract of *J. sambac* leaves showed an anti-arthritic effect by increasing ROS scavenging activity, inhibition of COXs, and overall achieving a decrease in structural damage after paw edema in Fisher rats (Dhote et al. 2021). The activity of *J. sambac* against various chronic inflammation disorders has also been demonstrated with ethanolic extracts of the root. The presence of significant quantities of hesperidin in *J. sambac* root extract could explain the triple anti-inflammatory, antinociceptive, and antipyretic effect observed in mice (Sengar et al. 2015). These effects, together with those of other unidentified phytoconstituents, could be attributed to the inhibitory activity of PGs. Similarly, the ethanolic extract of dried *J. sambac* leaves produced a significant pain inhibition in the acetic-induced writhing test in mice at the oral dose ten times greater than that of the active substance diclofenac. This effect is remarkable considering that this oral dosage refers to the crude ethanolic extract (Rahman et al. 2011). An interesting antioxidant and collagen-promoting effect on UVB/H_2O_2-induced HS68 dermal fibroblast cell damage of fermented *J. sambac* leaf extract has been reported. The commercial jasmine flower extracts (0.2 g) were fermented with *Lactobacillus rhamnosus* (2.2×10^7 cfu/mL) by incubation at 37°C for 48 h. The increased fibroblast cytotoxicity in response to UVB/H_2O_2 exposure was ameliorated, thus increasing cell survival, collagen biosynthesis, and promoting some cellular defense mechanisms (Ho et al. 2021). Although most scientific reports concern the use of *J. sambac* extracts, there are reports of anti-inflammatory and analgesic effects obtained with less common jasmine species but equally used in folk medicine. *J. abyssinicum* is a climbing shrub that grows at various altitudes in East Africa. The 80% methanolic extract of *J. abyssinicum* root showed analgesic and anti-inflammatory activity. Oral administration of the root extract inhibited pain and inflammation in model mice and could be due to its secondary metabolites, which possibly include flavonoids, saponins, terpenoids, triterpenes, and glycosides (Tadiwos et al. 2017). Preliminary results were obtained with the whole plant of *J. sessiliflorum*, whose extracts with nonpolar solvents were used in tests involving both the central and peripheral nervous system. Ethyl acetate and ethanolic extract demonstrated significant, dose-dependent antinociceptive activity in animal models using the acetic acid-induced writhing test and the tail-immersion test (Philip et al. 2020). Antinociceptive properties were probably mediated via inhibition of PG synthesis as well as central inhibitory mechanisms. Unfortunately, the extracts were not chemically characterized so the issue of which of the compounds present is responsible for these effects remains unsolved. The potential anti-inflammatory effect of the *J. angustifolium var. sessiliflorum* extracts was also evaluated by inducing paw edema in rats using carrageenan (Philip et al. 2019) but with modest results, in agreement with other findings (Liu et al. 2012). Despite the large number of species of the genus *Jasminum* and the studies carried out with the relative extracts, only limited data are reported to show the skin-protective and anti-inflammatory effects of Jasmine. Li et al. (2020) evaluated the anti-inflammatory effects of four *J. grandiflorum* flower extracts (ethanol, petroleum ether, ethyl acetate, and *n*-butanol) in a mouse ear edema induced with tetradecanoylphorbol acetate. All extracts were shown to enhance skin inflammation biomarkers, including

TABLE 5 | In vivo pharmacological activities of *Jasminum* species.

Biological activity	Species/Extract	Animal model	Effects and mechanisms	Key findings	References
Anti-inflammatory and analgesic effects	*J. grandiflorum* subsp. floribundum (methanol)	Rats	↓ COX ↓ Cathepsins Preservation of histopathological features in colitis and arthritis models	Effective reduction in inflammation and cartilage protection	El-Shiekh et al. (2021)
	J. sambac (ethanol)	Fisher rats, Mice	↑ ROS scavenging ↓ COX Anti-inflammatory and antinociceptive effects; hesperidin involved	Decreased structural damage in arthritis models; significant pain inhibition	Dhote et al. (2021), Sengar et al. (2015), Rahman et al. (2011)
	J. abyssinicum (methanol)	Mice	Inhibition of pain and inflammation; Compounds: Flavonoids, saponins, terpenoids, triterpenes, glycosides	Demonstrated analgesic and anti-inflammatory activity	Tadiwos et al. (2017)
	J. sessiliflorum (ethyl acetate, ethanol)	Mice	Antinociceptive properties via PG synthesis inhibition and central inhibitory mechanisms	Significant antinociceptive activity; exact compounds not characterized	Philip et al. (2020)
	J. lanceolarium (ethanol)	Various animal models	Dual inhibition of COX-2 and 5-LOX; Iridoids and lignanoids identified	Superior anti-inflammatory and analgesic effects compared to indomethacin and aspirin	Yan et al. (2015)
Neuroprotective effects	*J. officinale* (ethanol)	Mice	CNS depression, prolonged sleep time with pentobarbitone No significant effect on strychnine-induced seizures	Dose-dependent CNS depressant effects; no anesthetic or hypnotic properties	Elisha et al. (2008)
	J. grandiflorum (methanol)	Mice	Anticonvulsant effects via MES and PTZ methods; reduced epileptiform discharges	Effective anticonvulsant activity; increased latency of seizure onset	Patil and Saini (2012)
	J. sambac (ethanol)	Swiss albino mice	Improved learning and memory, decreased escape latency in Morris water maze Neural cell protection	Significant cholinergic activity, potential neuroprotective effects in neurodegenerative disorders	Gupta and Kulshreshtha (2018)

(Continues)

TABLE 5 | (Continued)

Biological activity	Species/Extract	Animal model	Effects and mechanisms	Key findings	References
Wound healing effects	*J. grandiflorum* (methanol, ethanol)	Albino mice, rats	Enhanced wound healing ↑ Superoxide dismutase ↑ Catalase Ethanol extract most effective	Accelerated wound healing process; increased hydroxyproline content	Chaturvedi et al. (2013), Mittal et al. (2015)
	J. auriculatum (ethanol)	Albino rats	Enhanced epithelialization rate, antimicrobial activity observed	Reduced wound area, increased hydroxyproline content	Arun et al. (2016a)
	J. sambac (water, ethanol)	Albino mice	Enhanced wound healing ↑ Antioxidant enzyme activity	Aqueous extract showed superior performance	Sabharwal et al. (2012)
Gastroprotective effects	*J. grandiflorum* (ethanol)	Albino Wistar rats	↓ Gastric fluid volume ↑ pH Antisecretory and free radical scavenging effects	Dose-dependent reduction in ulcerative lesions; superior to famotidine	Umamaheswari et al. (2007)
	J. sambac (ethanol)	Sprague Dawley rats	↓ Edema ↓ Leucocyte infiltration ↑ Gastric mucus ↓ Total acidity	Significant ulcer protection; comparable to omeprazole	Alrashdi et al. (2012)
Hepatoprotective effects	*J. angustifolium* (ethanol, chloroform)	Albino Wistar rats	Restoration of hepatic injury markers to near normal Ethanol extract more effective	Protective effects against carbon tetrachloride-induced hepatic damage	Joshi et al. (2008)
	J. grandiflorum (ethanol)	Albino Wistar rats	↓ Tumor formation Reduction in preneoplastic lesions; ↑ Antioxidant defenses	Prevention of 7,12-dimethylbenz(a)anthracene-induced tumors; improved antioxidant status	Kolanjiappan and Manoharan (2005)
Antifertility effects	*J. officinale* var. grandiflorum (aqueous)	Female albino rats	↓ Serum progesterone Dose-dependent anti-implantation action	Partial antifertility effect; not complete infertility	Iqbal et al. (1993)
Antilithiatic effects	*J. auriculatum* (aqueous, ethanol)	Male albino rats	↓ Urinary oxalate levels, regulation of oxalate metabolism	Potential preventive treatment for nephrolithiasis; reduced kidney stone formation	Bahuguna et al. (2009)
Vasodilatory effects	*J. sambac* (ethanol)	Wistar rats, ICR mice	↓ Endothelial tone Interaction with muscarinic receptors Modulation of NO pathway	Effective vasodilation; potential application in cardiovascular health	Kunhachan et al. (2012)
Hypoglycemic effects	*J. mesnyi* (extract)	Nicotinamide–streptozotocin-induced diabetic rats	Minor effects on glycemic levels; potential limitations in diabetes management	Limited hypoglycemic activity; less effective than *Clerodendrum inerme*	Bhushan et al. (2015)

Abbreviations and symbols: ↑: increase; ↓: decrease; 5-LOX: 5-lipoxygenase; CNS: central nervous system; COX: cyclooxygenase; MES: maximal electroshock seizure; NO: nitric oxide; PG: prostaglandin; PTZ: pentylenetetrazol; ROS: reactive oxygen species.

skin redness and increased inflammatory cells in mouse ears, and this effect was partly due to their ability to downregulate COX-2 and kappa-B kinase expression (Li et al. 2020). These anti-inflammatory effects were supported by data from immunohistochemical assays. A complex in vivo study was conducted on five animal models to investigate the anti-inflammatory and analgesic properties of the 70% ethanolic extract of *J. lanceolarium* (Yan et al. 2015). Furthermore, the in-depth characterization of some of its components made it possible to test their effects on the production of phospholipase A2 in vitro. The extract of *J. lanceolarium* exhibited a higher anti-inflammation effect than that of indomethacin and better analgesic activity than that of aspirin. Possible targets of *J. lanceolarium* ethanolic extract could be both COX-2 and 5-LOX enzymes, and inhibition of released PGs, which suggested that extract has a nonselective inhibitory effect on the release or action of these mediators and could be a potent dual LOX-COX inhibitor for the treatment of inflammation. Isolated compounds from the ethanolic extract were iridoids and lignanoids, revealing that the possible mechanism is related to its inhibitory effect on phospholipase A2 production (Yan et al. 2015).

6.2.2 | Neuroprotective and CNS Effects of *Jasminum* Species: Implications for Epilepsy, Anxiety, and Neurodegenerative Disorders

Neuropsychiatric effects of administration of *Jasminum* spp. extracts have been evaluated in different ways using mice as model animals. The CNS depressant effects of the ethanolic extract of *J. officinale* flower on mice were already tested in the 80s (Elisha et al. 2008). Intraperitoneal administration of extract was found to cause a CNS depression between 15 min and 2 h after administration in a dose-dependent manner. Aggressive behavior was suppressed or abolished after administration of the extract (25 or 100 mg/kg). No anesthetic or hypnotic effect of the drug was recorded but the time of sleep after administration of pentobarbitone sodium was prolonged in the treated mice. Moreover, the protective action toward strychnine-induced seizures was also tested, but the results were not promising, with no significant change between the control and treated groups. Anticonvulsant activity of the methanolic extract of *J. grandiflorum* was deeply investigated in a more recent study (Patil and Saini 2012). Seizures were induced in albino mice by Maximal Electroshock Test (MES) or pentylenetetrazole (PTZ) administration. The effect of the extract was compared with that produced by diphenylhydantoin in MES method and sodium valproate in the PTZ method as standard control, respectively. *J. grandiflorum* extract, administrated orally in different concentrations (100, 200, and 400 mg/kg), had anticonvulsant properties in both experiments. Tonic extensor convulsions were induced in mice subjected to MES test. At the same time, the latency of chronic convulsion onset was increased. Quite differently, the ethanolic extract of *Jasminum multiflorum* leaves did not increase the current needed to induce hind limb extension in Sprague Dawley rats in MES test (Addae et al. 2017). In the same study, Patil and Saini (2012) verified, however, the antiepileptic power of the extract in mice treated topically with bicuculline, a compound that mimics epilepsy and causes convulsions. Intraperitoneal or oral administration of the diluted extract reduced the bicuculline-induced epileptiform discharges in a dose-dependent manner. Anxiolytic properties were also evaluated with the elevated plus maze method (EPM). Mice treated with 200 mg/kg visited open arms more frequently showing less anxiety; the same results were reached with diazepam 2 mg/kg. *Jasminum* extract was also tested as new approach against neurodegenerative disorders such as Alzheimer's disease (AD) (Gupta and Kulshreshtha 2018). Ethanolic floral extract of *J. sambac* was administrated to Swiss albino mice along with scopolamine, a drug used to induce memory loss, at two different concentrations (200 and 400 mg/kg). Different models were used to investigate the effects of extract administration on different neurodegenerative disorders such as dementia, cognitive impairment, amnesia, and AD. In Morris water maze experiments, mice treated with the plant drug showed a significant improvement in the learning and memory and a decrease in escape latency compared to the control group. In the Passive Shock Avoidance Paradigm test, the treated mice spent a longer period in the step-down latency phase, suggesting that memory was preserved in the treated animals, whereas in EPM test, the administration of the extract led to decreased transfer latency of the mice. Gupta and Kulshreshtha (2018) concluded that *J. sambac* extract has neural cell protective activity with good cholinergic activity. On the basis of these evidences, it can be concluded that *Jasminum* spp. extracts could have potential effects to treat epilepsy, anxiety disorders, and neurodegenerative disorders in animals, but further studies are needed to investigate these proprieties in human models.

6.2.3 | Wound Healing Effects

Traditional medicine has frequently used *Jasminum* spp. in the treatment of several skin diseases, ulcers, various types of wounds, corns, stomatitis, and so on (Stedman 2006). In accordance, several studies have been performed to confirm this activity in vivo. For instance, Chaturvedi et al. (2013) used methanolic extracts of *J. grandiflorum* to treat skin wounds in adult albino mice. The healing process was accelerated, and the activity of the antioxidant enzymes superoxide dismutase and catalase was also increased. However, it has been proposed that, to get more reliable results, similar studies should be performed under experimental conditions affecting the physiological wound recovery (such as infection, repeated trauma, and ischemia) (Nagoba and Wadher 2016). Similar results were obtained by Mittal et al. (2015) using an excisional wound model in albino rats (Mittal et al. 2015). Four *J. grandiflorum* extracts (petroleum ether, chloroform, ethanol, and water as solvents) were administered topically to the damaged skin area. All samples reduced the healing time, being the ethanol extract the most effective. The same research group obtained similar results using the extracts of *J. auriculatum* (Arun et al. 2016a). Even in this case, the ethanolic extracts significantly reduced the wound area, increasing the epithelialization rate and hydroxyproline content. Antimicrobial activity was also detected in the extracts from both plants (Mittal et al. 2015; Arun et al. 2016a). The same effects (increased wound healing, hydroxyproline content, and decreased epithelization period) have been obtained using *J. sambac* water and ethanolic extracts (Sabharwal et al. 2012). Albino mice were treated using the excisional wound model at two dose levels (200 and 400 mg/kg body weight) topically for 16 days. The aqueous extract gave better performance, possibly due to the antioxidant and antimicrobial activity of its phytochemicals (as argued by the authors).

6.2.4 | Gastroprotective Effects

Jasminum spp. can also be used in the prevention and treatment of gastric ulcers. Ethanolic extract of *J. grandiflorum* was orally administered (100 and 200 mg/kg body weight), to albino Wistar rats with ulcers induced by different methods (Umamaheswari et al. 2007). The extract exerted a greater dose-dependent effect in decreasing the ulcerative lesions in all models, compared with the standard drug famotidine. Reduction in gastric fluid volume and increase in pH demonstrated antisecretory activity. Umamaheswari et al. (2007) suggested that these biological effects could be linked to the free radical scavenging power of *J. grandiflorum*. The anti-ulcerative activity of *J. sambac* for gastric ulcers has also been confirmed using Sprague Dawley rats (Alrashdi et al. 2012). The ethanolic extract was administered orally (62.5, 125, 250, and 500 mg/kg) and compared with the standard drug omeprazole. Significant ulcer protection was measured, with reduction of edema and leucocyte infiltration of the submucosal layer. Also in this case, a significant decrease in total acidity was detected, as well as increase in gastric mucus content and high levels of PGE_2, superoxide dismutase and a reduced amount of malondialdehyde were observed, possibly correlating the antiulcerative effect with quenching of ROS. On the whole, all these data seem to confirm the use of *Jasminum* spp. in the treatment of wounds and ulcers in folk medicine. However, more insights about the mechanism of action and the connection with antimicrobial activity should be further investigated.

6.2.5 | Hepatoprotective Effects

Ethanol and chloroform extracts from *J. angustifolium* were analyzed for their potential protective action against carbon tetrachloride-induced hepatic damage in albino Wister rats (Joshi et al. 2008). After 28 days of treatment, the rats presented near normal levels of several hepatic injury markers (alkaline phosphatase, alanine amino transferase, aspartate amino transferase, alkaline amino transferase). The ethanol extract was more efficient overall than the chloroform extract. A hepatoprotective effect of ethanolic extract of *J. grandiflorum* was observed (Kolanjiappan and Manoharan 2005). Oral administration (300 mg/kg body weight) for 14 weeks to albino Wistar rats injected with 7,12-dimethylbenz(a)anthracene prevented formation of tumors. Preneoplastic lesions (hyperplasia, keratosis, and dysplasia) were also greatly reduced in the treated animals. In addition, a link with improved antioxidant defenses was highlighted: Levels of vitamin E, glutathione, glutathione peroxidase, superoxide dismutase, and catalase were increased, normalizing the oxidative stress in the treated animals.

6.2.6 | Antifertility Effects

In traditional medicine, several plants have been ascribed the ability to affect male and female fertility (Leonti et al. 2020). *J. officinale* var. *grandiflorum* was listed among potential antifertility drugs of plant origin, in accordance to some folk use of this herb in India (Iqbal et al. 1993). This effect was confirmed in mature female albino rats using an aqueous extract of the plant. A dose-dependent anti-implantation action was detected, but without complete infertility (Iqbal et al. 1993). The significant decrease in serum progesterone levels on Day 5 of pregnancy could be responsible for the activity described.

6.2.7 | Antilithiatic Effects

In addition to their well-known therapeutic applications, *Jasminum* species have been identified for their antilithiatic effects, suggesting a potential role in the prevention and management of nephrolithiasis, commonly known as kidney stones. In a recent study, aqueous and ethanolic extracts of *J. auriculatum* were shown to reduce urinary oxalate in male albino rats (Bahuguna et al. 2009). A regulation of endogenous oxalate synthesis was observed for both extracts, suggesting this plant as a potential preventive treatment for nephrolithiasis. This biological activity has been also observed in *J. auriculatum*, a species traditionally used in herbal medicine for urinary and kidney health. A study conducted by Bahuguna et al. investigated the antilithiatic properties of aqueous and ethanolic extracts of *J. auriculatum* in male albino rats. The study demonstrated that both extracts effectively reduced urinary oxalate levels, a critical factor in kidney stone formation (Bahuguna et al. 2009). By regulating endogenous oxalate synthesis, the extracts helped prevent the formation of kidney stones, highlighting their potential as a preventive treatment for nephrolithiasis. The regulation of oxalate metabolism is central to the antilithiatic effects of *J.* auriculatum. Oxalate is a key component in the formation of calcium oxalate stones, which are the most common type of kidney stones. The study suggests that the phytochemicals present in *Jasminum* extracts may interact with metabolic pathways involved in oxalate production, thereby reducing its synthesis and excretion in urine. Additionally, the antioxidant properties of these extracts may further contribute to their protective effects by mitigating oxidative stress, which is known to play a role in stone formation. These findings provide scientific validation for the traditional use of *J.* auriculatum in managing kidney stones and underscore its potential as a natural remedy for nephrolithiasis.

6.2.8 | Vasodilatory Effects

The vasodilatory effects of *J. sambac* have been substantiated through both in vitro and in vivo studies, demonstrating its potential role in promoting cardiovascular health. This effect is particularly relevant in the context of traditional medicine, where *Jasminum* species have been used to support heart and vascular functions. In a study conducted by Kunhachan et al. (2012), the ethanolic extract of *J. sambac* was tested on Wistar rats and ICR mice to investigate its vasodilatory properties. The study confirmed that the extract induced vasodilation by reducing the endothelial tone of isolated thoracic aortic rings (Kunhachan et al. 2012). These findings align with previous in vitro studies, which also reported the vasodilatory activity of *J. sambac*, highlighting the consistency of the results across different experimental models. The mechanisms underlying the vasodilatory effects of *J. sambac* are believed to involve interactions with muscarinic receptors and the modulation of the NO pathway. Phytochemicals present in the extract may bind to muscarinic receptors on vascular smooth muscle cells, promoting relaxation and reducing vascular tone. Additionally, the impairment of NO release may play a role in mediating these effects. NO is a fundamental signaling molecule involved in vasodilation, and its enhanced release can lead to improved endothelial function and reduced blood pressure. These findings suggest that *J. sambac* has the potential to be developed as a natural therapeutic agent for managing cardiovascular disorders, particularly those related to hypertension and vascular dysfunction. The vasodilatory effect described in vitro (vide supra) has also been confirmed in Wistar rats and ICR mice (Kunhachan et al. 2012). Ethanolic extract of *J. sambac* produced vasodilatation, reducing the endothelial tone of isolated thoracic aortic rings. The mechanism of action could be due to the interaction of some phytochemical with muscarinic receptors or to impairment affecting of NO release.

6.2.9 | Hypoglycemic Effect

The hypoglycemic activity of various plant extracts has been explored to identify potential alternatives for managing Type 2 diabetes. In a study conducted by Bhushan et al. (2015), the hypoglycemic effects of extracts from *Clerodendrum inerme*, *J. mesnyi*, and *Callistemon citrinus* were evaluated in nicotinamide–streptozotocin-induced Type 2 diabetic Wistar rats. The study aimed to assess the potential of these plants in reducing blood glucose levels and providing a natural therapeutic option for diabetes management (Bhushan et al. 2015). The results indicated that *C. inerme* extract was effective in significantly lowering glycemic levels in the diabetic rats, demonstrating promising potential as a hypoglycemic agent. In contrast, the extracts of *J. mesnyi* and *C. citrinus* exhibited only minor effects on glycemic levels, suggesting limited efficacy in this context. The modest impact of *J. mesnyi* and *C. citrinus* on blood glucose regulation highlighted the need for further investigation to understand their potential roles in diabetes management. These findings suggest that although *J. mesnyi* may not be a strong candidate for standalone hypoglycemic therapy, it may still possess other beneficial properties that could be explored in combination with other treatments. Even the hypoglycemic activity has been tested, but in this case with poor results (Bhushan et al. 2015). The effects of *C. inerme J. mesnyi* and *C. citrinus* extracts on glycemic levels in nicotinamide–streptozotocin induced Type 2 diabetic Wistar rats were tested. Glycemic levels recovered better using *C. inerme*. On the contrary, *J. mesnyi* and *C. citrinus* extracts exerted only a small effect on this parameter; thus, the results are not very promising for further investigation.

6.3 | Clinical Studies

Despite the many in vitro and in vivo studies investigating the role of *Jasminum* plants as valuable tools to prevent the onset of some diseases or to relieve symptoms or cure illnesses, very little human research has been carried out in clinical trials. Kemps et al. (2012) studied the effectiveness of jasmine on chocolate craving reduction. This plant as a nonfood odorant significantly reduced chocolate craving. Thus, *Jasmine* spp. with its characteristic flavor profile offers potential scope for curbing unwanted food cravings. Two studies have focused on the role of *Jasminum* flower on human health. In the first study, the role of *J. sambac* in the suppression of puerperal lactation was investigated in comparison with the action of bromocriptine (Shrivastav et al. 1988). Sixty women requiring suppression of lactation were selected for this study and divided into two matched for age and number. Patients in the first group received bromocriptine mesylate 2.5 mg every 8-h for 5 days. Patients in the second group were treated with fresh *Jasminum* flowers. Each breast was covered by 50 cm *Jasminum* flowers blocked in situ with surgical adhesive. The flowers were replaced every 24 h for 5 days. No placebo group was considered for ethical reason. Before the trial started and after 72 h, blood samples were taken to evaluate serum prolactin levels. The efficacy of the two different treatments was based on serum prolactin levels, breast engorgement, milk production, and analgesic request. It was found that even though both of treatments significatively reduced serum prolactin level, the decrease was higher in Group 1 after 72 h. Both groups had the same degree of breast engorgement, milk production, and analgesic intake, but return of lactation was more frequent in patients treated with bromocriptine.

Following the antitumoral potential of *Jasminum* spp. (vide supra), the effect of *Jasminum* tea (a type of green tea made from *Jasminum* flower) intake on upper gastrointestinal cancer was investigated (Gao et al. 2009). In this work, 600 cases of esophageal squamous cell carcinoma (ESCC), 598 cases of gastric cardia cancer (GCA), and 316 cases of gastric non-cardia cancer (GNCA) were studied in comparison with 1514 control subjects. The control group was composed of people with lifestyles similar to those of the patients. Statistical analyses were adjusted for matching factors and potential confounders, considering risk factors such as smoking, alcohol consumption, cancer familiarity, dietary habits, as well as other parameters such as type of employment, source of drinking water, and tea consumption. Total cumulative lifetime intake of *Jasminum* tea was calculated as the product of intensity (grams/month) and duration (years). *Jasminum* tea intake (ever vs. never) was not found to be associated with risk of ESCC, GCA, or GNCA in males and females combined, but a positive relation was observed between cumulative lifetime consumption and ESCC risk in males, but not for GCA and GNCA. Moreover, the only statistically significant tea-ESCC association was recorded among males who did not work in offices. Although this research had the advantage of relying on a large sample of patients, no protective effect of *Jasminum* tea intake on upper gastrointestinal cancer was recorded. In addition, as suggested by the authors, further studies are needed to understand whether other confounding factors, such as tea temperature and tea and water quality, could influence the relation between *Jasminum* tea intake and upper gastrointestinal cancer.

7 | Bioactive Compounds of *Jasminum* Plants as Food Preservatives

In today's food industry, one of the most significant concerns is maintaining the quality, enhancing safety, and extending the shelf life of food products (Jahdkaran et al. 2021) (Table 6). Food

TABLE 6 | Applications of jasmine oil in the food industry.

Category	Description	Compounds	Applications	References
Antimicrobial	Jasmine oil and linalool demonstrated significant antimicrobial properties against various bacteria and fungi	Linalool, benzyl acetate, methyl salicylate, methyl anthranilate, benzyl benzoate	Preservative in food products by inhibiting the growth of bacteria such as *Escherichia coli*, *Shigella*, and fungi like *Aspergillus*	Bagamboula et al. (2004), Rath et al. (2008), Abdoul-Latif et al. (2010), Singh et al. (2011), Hyldgaard et al. (2012)
Antioxidant	Acts as a potent antioxidant, preventing oxidative degradation in foods and extending shelf life	Linalool, epoxylinalool	Prevents rancidity and color changes in foods, maintaining quality and nutritional value Effective in DPPH and β-carotene-linoleic acid free radical assays	Wei and Shibamoto (2007), Abdoul-Latif et al. (2010)
Flavoring	Enhances aroma and taste in various food products due to its floral and sweet clove aroma	Linalool, benzyl acetate, methyl anthranilate	Flavoring agent in sweets, candies, snacks, chewing gum, and especially in scented teas	Samakradhamrongthai et al. (2009), Ito et al. (2002), Abdoul-Latif et al. (2010)
Food packaging	Jasmine oil, particularly linalool, is used in innovative food packaging solutions to extend shelf life and improve food safety by preventing microbial contamination	Linalool, benzyl acetate	Used in active packaging films that inhibit microbial growth on stored foods, such as mozzarella cheese, and protect against insect pests	Chang et al. (2021), Das et al. (2019)
Nanoencapsulation	Advances in nanoencapsulation techniques allow for the controlled release of jasmine oil components, enhancing their effectiveness in food preservation	Linalool	Enables controlled and slow release of antimicrobial compounds, improving their stability and effectiveness in food applications	Felix da Silva Barbosa et al. (2021)
Safety and regulation	Jasmine oil is generally recognized as safe (GRAS) by the FDA for food use, but caution is advised, particularly in dietary supplements	Linalool	Used with caution in dietary supplements; potential allergic reactions Requires careful regulation and safety evaluation	Drugs and Lactation Database (LactMed) (2006)

spoilage is primarily caused by various microorganisms, including bacteria, fungi, and yeasts. Bacteria typically affect low-acid foods such as protein-rich vegetables and meat, whereas yeasts thrive in high-sugar-content foods. Additionally, numerous mold species grow on the surface of food, leading to discoloration and a fuzzy appearance. The presence of these microorganisms results in changes in the food's appearance, including color, texture, toxin production, and unpleasant odor or taste. These destructive processes can deteriorate the quality of food, reducing its organoleptic properties and nutritional value (Belasli et al. 2020). Microbial contamination of food can occur at multiple stages within the food chain. It can begin during harvesting due to attacks by microorganisms, enzymes, and oxidation (from atmospheric oxygen) and continue during subsequent stages such as food processing, transportation, or distribution (Gómez-Gaete et al. 2024). Food spoilage refers to the process in which food degrades to a point where it is no longer suitable for human consumption or its edible quality is significantly diminished. Several external factors contribute to food spoilage (Gómez-Gaete et al. 2024). In recent studies, many natural alternatives to synthetic food preservatives have been investigated, with a focus on plant-based options. The use of natural plant antimicrobials for food preservation is an emerging trend embraced by both consumers and food manufacturers. However, simple plant infusions often do not effectively reduce foodborne bacteria in food matrices (Kim et al. 2004). Therefore, extracts in raw or purified forms, particularly essential oils, have gained significant interest (Bouarab Chibane et al. 2019). Jasmine oil, renowned for its antimicrobial and antioxidant properties, has been utilized as a preservative in food preparations. Since the Middle Ages, this essential oil has been known for its strong aroma and antiseptic and therapeutic attributes. Presently, jasmine oil can be incorporated into food and beverage products to provide antimicrobial, antioxidant, and flavoring properties (Ahmed et al. 2016). Linalool, which is abundantly present in Jasmine species, can be used in food formulations due to its antimicrobial properties, such as reducing tooth decay processes. Park et al. (2012) tested linalool on various strains of periodontopathogens and found that it exhibited strong antimicrobial activity. Periodontopathogens are responsible for oral infectious diseases, including dental caries and periodontal diseases, by colonizing the tooth surface. Dental caries is mainly caused by *S. mutans* and *Streptococcus sobrinus*, whereas periodontal diseases involve Gram-negative bacteria such as *Porphyromonas gingivalis*, *Prevotella intermedia*, *Aggregatibacter actinomycetemcomitans*, and *Fusobacterium nucleatum*. The MIC and minimum bactericidal concentration (MBC) of linalool varied against different strains of microorganisms. Jasmine oil is extracted from the flowers using solvent extraction and enfleurage methods. The primary constituents of jasmine oil obtained from the flowers are linalool and benzyl acetate. The volatile components present in the flowers contribute to their unique floral and sweet clove aroma. These volatile components include epoxylinalool, linalool, benzyl acetate, indole, (*E,E*)-α-farnesene, (3*Z*)-hexenyl benzoate, benzyl alcohol, and methyl anthranilate. The antimicrobial activity of jasmine essential oil against various Gram-negative and Gram-positive bacteria and fungi has been investigated in several studies, with evidence supporting the antimicrobial properties of its constituents, particularly linalool (Ahmed et al. 2016). Linalool, an alcoholic monoterpene, exhibits antimicrobial effects through specific mechanisms (Rodríguez-López et al. 2020). It disrupts microbial cell membranes by causing membrane expansion, increasing membrane fluidity and permeability, and interfering with membrane-embedded proteins. These actions compromise the structural integrity of the microbial cell, leading to leakage of essential ions and metabolites; it also inhibits microbial respiration and alters ion transport processes, further disrupting cellular homeostasis and leading to microbial death. These detailed mechanisms highlight the potential of linalool as an effective natural preservative in food systems (Liu et al. 2020).

7.1 | Antimicrobial Action

Around 20 years ago, Bagamboula et al. (2004) conducted a study on the antibacterial activity of commercially pure linalool against foodborne bacteria, including *Shigella sonnei*, *S. flexneri*, and *E. coli*. Rath et al. (2008) investigated the antibacterial properties of steam-distilled essential oil from *J. sambac* flowers (natural oil), synthetic oil (a combination of major components), synthetic blends (including linalool, benzyl acetate, methyl anthranilate, and methyl salicylate), and six major individual components (linalool, benzyl acetate, methyl salicylate, methyl anthranilate, and benzyl benzoate) against *E. coli*. They reported that the MIC value for jasmine oil was significantly higher compared to the other tested samples. Two years later, Abdoul-Latif et al. (2010) evaluated the antimicrobial activity of essential oil and methanol extract of *J. sambac*. Their findings indicated that the tested preparations exhibited better activity against bacterial species compared to yeasts. Additionally, Singh et al. (2011) investigated the antifungal activity of oil prepared from *J. sambac* against various fungal strains isolated from soil, including *Aspergillus flavus*, *Trichophyton mentagrophytes*, *Trichophyton tonsurans*, *Trichophyton verrucosum, Epidermophyton floccosum*, and *Microsporum nanum*. Jasmine oil demonstrated good activity against all the tested strains. Furthermore, a study by Hyldgaard et al. (2012) revealed that the combination of linalool and eugenol, another essential oil component, exhibited the highest synergy, suggesting that a combination of a monoterpene alcohol and a monoterpene phenol could be an effective antimicrobial blend. On the basis of the available data on the antimicrobial properties of jasmine oil and its main component, linalool, it can be inferred that they have the potential to aid in food preservation efforts.

7.2 | Antioxidant

Atmospheric oxygen is one of the sources of the oxidation process that occurs in food, leading to rancidity and color changes that degrade food quality. Antioxidants play a fundamental role in inhibiting the oxidation of other molecules by undergoing their own oxidation. They interrupt free radical chain reactions by neutralizing free radical intermediates and inhibiting further oxidation reactions. In a study conducted by Wei and Shibamoto (2007), the antioxidant activity of 13 essential oils was tested using various antioxidant assays. It was observed that jasmine essential oil exhibited significant antioxidant activity at a concentration of 500 µg/mL even after 40 days. The antioxidant activity of jasmine oil was further evaluated using the DPPH and β-carotene-linoleic acid free radical scavenging assays. The oil demonstrated a half maximal inhibitory concentration (IC_{50}) value of 7.43 µg/mL and a relative antioxidant activity (RAA) value of 96.6% in the DPPH

FIGURE 3 | Summarized diagram regarding the application of *Jasminum* plant bioactive compounds in active food packaging. Bioactive compounds, extracted from *Jasminum* plants, are depicted as being incorporated into various types of food packaging. This innovative approach enhances the antimicrobial and antioxidant activities of the packaging, along with providing flavoring benefits. The nanoencapsulation process offers several advantages, including improved water solubility, increased stability, fast-dissolving characteristics, extended shelf life of food products, and enhanced antibacterial properties. These benefits highlight the potential of *Jasminum* bioactive compounds in contributing to food preservation and safety in the active packaging industry. ↑ Increase.

and β-carotene-linoleic acid assays, respectively (Abdoul-Latif et al. 2010). The antioxidant potency of jasmine oil was found to be similar to that of α-tocopherol, a well-known antioxidant. Therefore, jasmine oil, as a whole or its main component, linalool, can be utilized to prevent oxidation in food products, thereby preserving their quality and extending their shelf life (Wei and Shibamoto 2007).

7.3 | Flavoring

The production of scented tea has a long tradition in China and Thailand, where the fragrance of various flowers is absorbed into dried green tea leaves. Jasmine oil, which is rich in linalool, is commonly used for this purpose. Jasmine tea is the most well-known variety, but researchers are exploring the creation of more scented green tea options to cater to consumer preferences (Samakradhamrongthai et al. 2009). In Japan, scented jasmine green tea is also popular due to its historical presence in Chinese restaurants, and it is even sold in polyethylene terephthalate containers (Ito et al. 2002). Aside from tea production, jasmine oil finds its application in the food industry for flavoring purposes. It is used to add a pleasant aroma and taste to food products such as sweets, candies, cookies, snacks, and chewing gum (Abdoul-Latif et al. 2010).

7.4 | Jasmine Oil Application: New Trends

The application of linalool in food is currently limited due to its high volatility, limited water solubility, and low stability. However, there is an increasing demand for natural compounds in the food industry to obtain more biodegradable and effective preservatives (Rodríguez-López et al. 2020). Aytac et al. (2017) demonstrated the electrospinning of polymer-free nanofibrous structures using a cyclodextrin/linalool-inclusion complex, which exhibited fast-dissolving characteristics. Moreover, the release of linalool from these structures inhibited the growth of both Gram-negative and Gram-positive bacteria. Nanoencapsulation techniques also offer new possibilities for the food industry by enabling controlled and slow release of antimicrobial active essential oils (Felix da Silva Barbosa et al. 2021). Hu et al. (2020) proposed an effective encapsulation method for linalool, and they modified emulsified linalool droplets with carbon–carbon double bonds, followed by precipitation polymerization with a thermosensitive monomer, *N*-vinyl caprolactam. The resulting linalool capsules exhibited thermal-redox dual response properties and demonstrated good antioxidant and antibacterial performance. Food packaging plays a fundamental role in protecting food products from various environmental factors and contamination, thereby improving their shelf life and safety (Jahdkaran et al. 2021) (Figure 3). Incorporating jasmine oils, including linalool, into food packaging has shown potential in protecting against insect pests and microorganisms. Chang et al. (2021) developed an active polyethylene film containing linalool, which effectively extended the shelf life of mozzarella cheese by reducing the growth rate of bacteria, molds, and yeasts. Similar results were obtained by Silva et al. (2021) with linalool encapsulated in biodegradable poly(lactic acid), exhibiting antimicrobial activity against various bacteria. These findings indicate that incorporating linalool into various polymers for active packaging offers a promising solution to extend the shelf life of food products (Das et al. 2019). Furthermore, linalool has also been investigated as a potential corrosion inhibitor for aluminum in highly acidic media (Halambek et al. 2020). Although jasmine is generally recognized as safe (GRAS) as a food ingredient by the FDA, caution should still be exercised, especially in the case of dietary supplements. It is important to note that jasmine intake during nursing has not been extensively studied, and potential allergic reactions have been reported. Manufacturers of dietary supplements are responsible for ensuring safety, although they are not required to provide extensive premarket approval or prove safety and effectiveness before marketing (Drugs and Lactation Database (LactMed) 2006). In conclusion, the modified forms of jasmine oil or linalool, as well as their incorporation into packaging materials and corrosion inhibitors, present new avenues for the application of linalool in the food industry. However, further research and safety evaluations are necessary to fully understand their potential benefits and ensure their safe use in different contexts.

8 | Limitations

Despite the comprehensive analysis presented in this review, several limitations must be acknowledged. First, the availability and quality of the literature on the bioactive compounds in *Jasminum* species are uneven, with a substantial number of studies focusing on only a few well-known species, such as *J. sambac* and *J. grandiflorum*. This bias may limit the generalizability of the findings across all species within the genus. Furthermore, many studies included in this review rely heavily on in vitro and animal models, which may not fully capture the complexity of in vivo interactions in humans. The extrapolation of these results to human applications should thus be approached with caution. Additionally, the methodologies used in phytochemical analyses and bioactivity assessments vary widely across studies, leading to potential inconsistencies in the data. The lack of standardized methods makes it challenging to compare results directly and draw definitive conclusions. Moreover, although traditional uses of *Jasminum* species are well-documented, there is a paucity of clinical trials investigating their efficacy and safety in modern therapeutic contexts. This gap in clinical evidence underscores the need for further research to validate traditional claims and explore the therapeutic potential of jasmine in contemporary settings. Finally, environmental factors, such as soil conditions and climate, can significantly influence the phytochemical composition of jasmine plants, introducing another layer of variability that must be considered when evaluating their bioactive properties. Future studies should aim to address these limitations by employing standardized methodologies, expanding the range of species studied, and conducting rigorous clinical trials to establish the therapeutic efficacy and safety of *Jasminum* species in humans.

9 | Conclusions and Future Perspectives

Jasminum species are renowned globally and have been utilized in traditional medicine for centuries. Jasmine oil, known for its antiseptic, aromatic, and therapeutic properties has been widely used since the Middle Ages and continues to be an integral part of Ayurvedic medicine. Recognized as a GRAS food ingredient, jasmine oil is valued for its flavor, antimicrobial and antioxidant activities, making it a promising natural food preservative in the food industry. The antimicrobial properties of linalool, a major component of jasmine essential oil, position it as a key candidate for the development of preservative agents. Incorporating jasmine oils into packaging systems represents a potential solution to meet industrial requirements for natural preservation methods. In addition to linalool, *Jasminum* plants contain a diverse range of bioactive compounds. Although no single compound has been definitively linked to specific pharmacological activity, studies have demonstrated their antioxidant, anti-inflammatory, anthelmintic, and antitumoral properties in vitro, as well as neuropsychiatric and wound-healing effects in vivo. Furthermore, a clinical trial reported that *Jasminum* flowers suppressed puerperal lactation, suggesting an affordable treatment option for milk suppression, particularly in resource-limited settings where conventional treatments like bromocriptine are inaccessible. To amplify the preservative potential of *Jasminum* bioactive compounds, future research should explore their synergistic effects when combined with other natural preservatives or food additives. Such combinations could enhance their antimicrobial and antioxidant properties, offering a comprehensive natural preservation solution. Moreover, future clinical studies are fundamental to validate the therapeutic applications of *Jasminum* and expand its utility in modern medicine and food preservation.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation or all these areas. All authors reviewed and approved the final version of the manuscript and agreed on the journal for submission.

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The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The authors have nothing to report.

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