RESEARCH PAPER

Phytochemical Profiling and Antioxidant Potential of Solvent Extracts from Leaves and Flowers of *Jasminum multiflorum* and *Jasminum nitidum*

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ABSTRACT

The present study investigated the phytochemical composition and antioxidant potential of *Jasminum multiflorum* and *Jasminum nitidum* leaves and flowers using different solvent extraction systems. Sequential extraction was carried out with methanol, ethanol, ethyl acetate, chloroform, and aqueous solvents to evaluate solvent-dependent variation in bioactive constituents. Qualitative phytochemical screening revealed the presence of alkaloids, tannins, flavonoids, sterols, terpenoids, and cardiac glycosides in most extracts, whereas saponins and phlobatannins were not detected. Quantitative analysis indicated significant variation ($p < 0.001$) among solvents and plant species. The ethanolic leaf extract of *J. nitidum* recorded the highest total phenolic content (41.26 ± 0.78 mg GAE g^{-1}), while *J. multiflorum* showed 33.10 ± 1.25 mg GAE g^{-1}. Similarly, flavonoid content was higher in *J. multiflorum* (27.14 ± 0.65 mg QE g^{-1}) and *J. nitidum* (26.82 ± 0.58 mg QE g^{-1}). Antioxidant assays revealed that ethanolic extracts exhibited superior activity, with lower EC_{50} values in DPPH radical scavenging (48.73 ± 0.93 µg mL^{-1} for *J. nitidum* and 138.45 ± 1.37 µg mL^{-1} for *J. multiflorum*) and higher ferric reducing power (610.12 ± 2.74 and 468.33 ± 2.56 µmol Fe^{2+} g^{-1}, respectively). Statistical analysis using one-way ANOVA followed by DMRT confirmed significant effects ($p < 0.001$) of solvent and species on phytochemical and antioxidant parameters. The findings indicate that ethanol is an efficient solvent for extracting antioxidant-rich phytoconstituents from *Jasminum* species, suggesting their potential application in pharmaceutical and nutraceutical formulations.

Keywords: *Jasminum* multiflorum, *Jasminum nitidum*, phytochemical analysis, solvent extraction, antioxidant activity.

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INTRODUCTION

Medicinal plants have long been recognized as valuable sources of biologically active compounds that contribute significantly to human health and disease management. Plant-derived phytochemicals such as phenolics, flavonoids, alkaloids, glycosides, terpenoids, and tannins possess diverse pharmacological activities including antioxidant, antimicrobial, anti-inflammatory, and anticancer properties [1,2]. Natural antioxidants derived from plant sources are particularly important because they can neutralize reactive oxygen species (ROS) and reduce oxidative stress, which is implicated in the development of chronic disorders such as cardiovascular diseases, diabetes, cancer, and neurodegenerative conditions [3].

Consequently, the exploration of medicinal plants for their antioxidant potential has become an important area of research in pharmaceutical and nutraceutical sciences. The genus *Jasminum* (family Oleaceae) comprises more than 200 species widely distributed in tropical and subtropical regions of Asia and Africa. Many species of this genus are cultivated for their ornamental, aromatic, and medicinal value [4]. In traditional systems of medicine such as Ayurveda, Siddha, and Unani, various *Jasminum* species have been used for the treatment of fever, skin infections, ulcers, wounds, and inflammatory disorders [5]. The therapeutic efficacy of these plants is attributed to the presence of bioactive phytochemicals including flavonoids, phenolic acids, alkaloids, and glycosides, which exhibit significant antioxidant and antimicrobial activities [2,6]. Among the different species, *Jasminum multiflorum* (Burm.f.) Andrews and *Jasminum nitidum* Roxb. are notable for their ornamental and medicinal importance. J. multiflorum, commonly known as star jasmine or "Kakada," is widely cultivated in southern India for its attractive white star-shaped flowers and is traditionally used for treating skin infections, wounds, and fever [7]. Phytochemical investigations have reported that extracts of *J. multiflorum* leaves and flowers contain significant levels of phenolic and flavonoid compounds that contribute to their antioxidant activity [8]. Similarly, *J. nitidum*, commonly referred to as angel-wing jasmine, has been traditionally used for treating inflammation, headaches, and skin ailments. Although this species shares phytochemical similarities with other *Jasminum* species, detailed studies on its phytochemical composition and antioxidant potential remain limited [9]. Phytochemical profiling plays a crucial role in identifying the chemical constituents responsible for the medicinal properties of plants. Among these compounds, phenolics and flavonoids are considered major contributors to antioxidant activity due to their ability to donate hydrogen atoms or electrons to free radicals and thereby terminate oxidative chain reactions [10]. The efficiency of phytochemical extraction largely depends on the solvent used, as solvent polarity influences the solubility and recovery of different classes of phytochemicals. Polar solvents such as methanol, ethanol, and water are generally effective for extracting phenolic and flavonoid compounds, whereas moderately polar solvents such as ethyl acetate and chloroform are more suitable for terpenoids and steroidal compounds [11]. Among these solvents, ethanol is often preferred due to its moderate polarity, low toxicity, and ability to extract a wide range of bioactive compounds.

The antioxidant potential of plant extracts is commonly evaluated using in vitro assays such as DPPH radical scavenging activity and ferric reducing antioxidant power (FRAP), which measure the ability of phytochemicals to donate electrons or hydrogen atoms to neutralize free radicals [6,12]. Previous studies have demonstrated that extracts of several *Jasminum* species such as *Jasminum* grandiflorum, *Jasminum sambac*, and *Jasminum* auriculatum contain high levels of phenolics and flavonoids, which correlate strongly with antioxidant activity [13]. In addition, earlier investigations conducted on *Jasminum multiflorum* leaves and flowers have confirmed the presence of various phytochemicals and significant antioxidant potential [8]. Recent reviews have also highlighted the therapeutic significance of *Jasminum* species, particularly their antioxidant, anti-inflammatory, and anticancer properties, which support their potential use in pharmaceutical formulations [14]. Apart from their medicinal value, *Jasminum* species are also important ornamental crops widely used in landscaping and floriculture industries due to their aesthetic appeal and fragrance [15]. Cultural practices and plant physiology studies have demonstrated that different agronomic interventions influence growth, flowering, and secondary metabolite production in jasmine crops [16]. Despite the growing interest in the pharmacological properties of *Jasminum* species, comparative studies focusing on different species and solvent extraction systems remain limited. Therefore, the present investigation was undertaken to comparatively evaluate the phytochemical composition and antioxidant potential of leaf and flower extracts of *Jasminum multiflorum* and *Jasminum nitidum* using solvents of varying polarity. The study integrates qualitative phytochemical screening, quantitative determination of total phenolic and flavonoid content, and antioxidant assessment using DPPH and FRAP assays. The findings of this study are expected to identify the most effective solvent system for extracting antioxidant-rich phytochemicals and to provide baseline information supporting the utilization of these *Jasminum* species in pharmaceutical, nutraceutical, and cosmetic applications.

Materials and methods

Plant Material Collection

Fresh and healthy leaves and flowers of *Jasminum multiflorum* and *Jasminum nitidum* were collected from the Department of Floriculture and Landscaping, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. The plant materials were washed thoroughly with distilled water to remove adhering dust and impurities and subsequently shade-dried at ambient room temperature for approximately 10 days until a constant weight was obtained. The dried samples were then pulverized into fine powder using a mechanical grinder. The powdered plant material was stored in sterile airtight containers at room temperature until further phytochemical and antioxidant analyses.

Preparation of Extracts

The powdered samples of both *J. multiflorum* and *J. nitidum* (leaves and flowers separately) were subjected to solvent extraction using solvents of varying polarity: distilled water, ethanol (95%), acetone, chloroform, methanol, ethyl acetate, and petroleum ether. Ten grams of each dried sample were extracted with 100 mL of the respective solvent in a Soxhlet apparatus for 6 h at a temperature corresponding to the boiling point of each solvent. After extraction, the mixtures were filtered through Whatman No. 1 filter paper, and the filtrates were concentrated under reduced pressure using a rotary vacuum evaporator (Buchi R-300, Switzerland) at 40 °C to obtain the crude extracts. The extracts were then transferred to pre-weighed vials, dried in a desiccator, and stored at 4 °C until further use [17]. Extraction yield (%) was calculated using the following formula:

$$\text{Extraction Yield }\% = \frac{\text{Weight of dried extract}}{\text{Weight of initial plant material}} \times 100$$

Qualitative Phytochemical Screening

The preliminary phytochemical screening of all solvent extracts was performed according to the standard methods [1,8,18]. The presence or absence of various classes of secondary metabolites was determined using specific qualitative chemical tests as follows:

Phytochemicals	Test	Procedure
Alkaloids	Mayer's test	One millilitre of extract was mixed with 4 mL of 1% HCl and filtered through Whatman No. 40 paper. Six drops of Mayer's reagent were then added to the filtrate.
Flavonoids	Shibita's test	Five millilitres of extract were treated with an equal volume of 20% NaOH solution.
	Pew's test	Five millilitres of extract were combined with 0.1 g of metallic zinc and 8 mL of concentrated sulphuric acid.
Tannins	Ferric chloride test	Two millilitres of extract were treated with a few drops of 10% ferric chloride solution.
Phlobatannins	Hydrochloric acid test	Two millilitres of extract were acidified with dilute HCl and gently heated.
Carbohydrates	Fehling's test	Equal volumes of Fehling's A and Fehling's B reagents were mixed; one millilitre of the mixture was added to the extract and boiled.
Sterols and Terpenoids	Salkowski test	One millilitre of extract was mixed with concentrated H_2SO_4 and left undisturbed.
Cardiac Glycosides	Keller–Kiliani test	To 1 mL of extract, 2 mL of glacial acetic acid containing a few drops of 1% $FeCl_3$ were added, then underlayered with concentrated H_2SO_4.
Proteins	Biuret test	Two millilitres of extract were mixed with 2 mL of 10% NaOH and 5 drops of 1% $CuSO_4$ solution.
Saponins	Frothing test	Three millilitres of extract were shaken vigorously with 10 mL of distilled water and allowed to stand for 30 minutes.

Results were recorded as "+" (present) or "–" (absent) based on visual observation of characteristic color or precipitate formation.

Quantitative Determination of Total Phenolic Content (TPC)

The total phenolic content was estimated using the Folin - Ciocalteu colorimetric method [19] with slight modifications. In brief, 0.2 mL of each extract (1 mg mL^{-1}) was mixed with 0.5 mL of Folin - Ciocalteu reagent (1:10 dilution) and 8.3 mL of distilled water. After 3 min, 1 mL of 7.5% sodium carbonate (Na_2CO_3) solution was added. The mixture was incubated at room temperature for 30 min in the dark, and absorbance was recorded at 765 nm using a UV - Vis spectrophotometer (Shimadzu UV-1800). Gallic acid was used as the standard (10 - 100 µg mL^{-1}), and results were expressed as mg gallic acid equivalents per gram of dry weight (mg GAE g^{-1} DW).

Quantitative Determination of Total Flavonoid Content (TFC)

Total flavonoid content was measured using the aluminum chloride colorimetric assay [4]. One mL of extract (1 mg mL^{-1}) was mixed with 0.1 mL of 10% aluminum chloride ($AlCl_3$), 0.1 mL of 1 M potassium acetate, and 4.3 mL of distilled water. The reaction mixture was incubated for 30 min at room temperature, and absorbance was measured at 415 nm. Quercetin (10 - 100 µg mL^{-1}) was used as the calibration standard, and results were expressed as mg quercetin equivalents per gram of dry weight (mg QE g^{-1} DW).

Antioxidant Assays

DPPH Radical Scavenging Activity

The antioxidant potential of extracts was determined by their ability to scavenge the stable free radical 2,2-diphenyl-1-picrylhydrazyl (DPPH) following the method of Blois [10]. A 0.1 mM DPPH solution was freshly prepared in methanol. To 1 mL of DPPH solution, 1 mL of extract at various concentrations (25 - 500 µg mL^{-1}) was added. The mixture was incubated in the dark for 30 min at room temperature, and absorbance was measured at 517 nm. Methanol served as the blank, and ascorbic acid (vitamin C) was used as a reference antioxidant. The percentage of DPPH inhibition was calculated using:

$$\textbf{Scavenging Activity (\%)} = \frac{A_0 - A_1}{A_0} \times 100$$

where $A0$is the absorbance of the control and $A1$is the absorbance of the sample. IC_{50} values (concentration required to inhibit 50% of DPPH radicals) were obtained from dose–response curves.

Ferric Reducing Antioxidant Power (FRAP) Assay

The reducing power of extracts was evaluated using the FRAP method [6]. The FRAP reagent was prepared freshly by mixing 300 mM acetate buffer (pH 3.6), 10 mM 2,4,6-tripyridyl-s-triazine (TPTZ) in 40 mM HCl, and 20 mM $FeCl_3 \cdot 6H_2O$ in a ratio of 10:1:1 (v/v/v). 200 µL of extract was mixed with 1.8 mL of FRAP reagent and incubated at 37 °C for 30 min. The blue color developed due to the reduction of Fe^{3+}-TPTZ to Fe^{2+}-TPTZ complex was measured at 593 nm. Results were expressed as µmol Fe^{2+} equivalents per gram dry weight (µmol Fe^{2+} g^{-1} DW) using ferrous sulfate as the calibration standard.

Determination of Extraction Yield and Correlation Analysis

Extraction yields were calculated for each solvent and compared between species and plant parts. The relationship between total phenolic content, total flavonoid content, and antioxidant assays (DPPH and FRAP) was analyzed using Pearson's correlation coefficient (r). High positive correlation values ($r > 0.8$) were interpreted as a strong association between phenolic concentration and antioxidant capacity [20].

Statistical Analysis

All experiments were conducted in triplicate ($n = 3$), and results were expressed as mean ± standard deviation (SD). Statistical analyses were performed using SPSS version 20.0 (IBM Corp., USA). One-way analysis of variance (ANOVA) was applied to assess significant differences among means, followed by Duncan's Multiple Range Test (DMRT) for pairwise comparison at $p < 0.05$. For comparative evaluation between *J. multiflorum* and *J. nitidum*, two-way ANOVA was used considering "species" and "solvent" as independent factors. The significance of correlation between phenolic content and antioxidant activity was also evaluated ($p < 0.01$). Graphical representations were created using Origin Pro 2023 [21].

Results

Extraction Yield and Physical Characteristics

The extraction yield of *Jasminum multiflorum* and *Jasminum nitidum* differed significantly ($p < 0.001$) across solvent systems, reflecting the influence of solvent polarity on solute solubility (Table 1). Polar solvents ethanol and methanol produced markedly higher extraction yields compared to less polar solvents such as petroleum ether and chloroform. In *J. multiflorum*, the ethanolic leaf extract exhibited the maximum yield (12.86 ± 0.18%), closely followed by the methanolic extract (11.92 ± 0.27%), whereas petroleum ether yielded the lowest (2.13 ± 0.05%). *J. nitidum* showed a similar pattern, with its highest yield also in ethanolic leaf extract (11.64 ± 0.22%). However, its flower extracts displayed marginally higher yields than those of *J. multiflorum*, suggesting a slightly richer matrix of extractable compounds in the floral tissues. Visual and physical examination indicated distinct solvent-dependent characteristics. Ethanolic and methanolic extracts were dark brown and viscous, aqueous extracts were light brown and sticky, and non-polar extracts (chloroform, petroleum ether) were pale yellow and oily. The intensity of coloration in ethanolic and methanolic extracts corresponded to their elevated phenolic and flavonoid concentrations, highlighting the strong affinity of polar solvents for phenolic compounds. These yield and appearance trends are consistent with solvent–solute polarity interactions and previously reported phytochemical extraction principles.

Qualitative Phytochemical Composition

Phytochemical screening revealed a wide distribution of secondary metabolites across both species and solvent systems (Table 2). Polar solvents extracted a broader array of phytochemicals particularly alkaloids, flavonoids, tannins, and cardiac glycosides while non-polar solvents favored the extraction of sterols and terpenoids.

In *J. multiflorum*, ethanol and methanol leaf and flower extracts exhibited strong positive reactions for phenolics, flavonoids, and tannins, indicating a high abundance of antioxidant constituents. Ethyl acetate and chloroform extracts tested positive primarily for sterols and terpenoids, consistent with their intermediate polarity. Cardiac glycosides were prominent in methanol and ethanol extracts, whereas saponins and phlobatannins were completely absent in all solvent fractions, confirming their negligible presence in these tissues. *J. nitidum* exhibited a

similar phytochemical profile but with relatively stronger intensity for terpenoids and glycosides, suggesting a greater abundance of semi-polar bioactives. Among solvents, ethanol consistently extracted the widest spectrum of metabolites, reaffirming its efficiency as a universal solvent for phytochemical recovery.

Quantitative Phytochemical Content

Quantitative determination of total phenolic content (TPC) and total flavonoid content (TFC) revealed significant differences ($p < 0.001$) between solvents, species, and plant parts (Table 3). In both species, ethanol extracted the highest levels of phenolics and flavonoids, followed by methanol and ethyl acetate. For *J. multiflorum*, the ethanolic leaf extract exhibited the maximum TPC (33.10 ± 1.25 mg GAE g^{-1} DW) and TFC (27.14 ± 0.65 mg QE g^{-1} DW). Methanolic leaf extract followed with TPC 29.45 ± 1.31 mg GAE g^{-1} DW and TFC 21.74 ± 0.92 mg QE g^{-1} DW. Among flower extracts, ethanol again yielded superior values (TPC 26.47 ± 1.18; TFC 22.63 ± 0.74). *J. nitidum* showed comparatively higher quantitative values across all solvent systems, indicating its richer polyphenolic profile. The ethanolic leaf extract recorded the highest TPC (41.26 ± 0.78 mg GAE g^{-1} DW) and TFC (26.82 ± 0.58 mg QE g^{-1} DW), followed by methanol (TPC 38.64 ± 0.88; TFC 25.54 ± 0.71).

Statistical comparison (DMRT) grouped ethanolic and methanolic extracts as the top performers ($p < 0.05$), signifying that moderately polar solvents are ideal for recovering phenolic and flavonoid compounds. Leaves consistently showed higher phenolic and flavonoid levels than flowers, aligning with the physiological role of leaves as the primary sites for biosynthesis of phenolic antioxidants. Two-way ANOVA (species × solvent) revealed significant interaction ($p < 0.01$), suggesting that extraction efficiency varied slightly between the two species. However, ethanol remained the most effective solvent for both, confirming its suitability for maximum phenolic recovery.

Antioxidant Activity

Antioxidant capacity was evaluated using DPPH radical scavenging, FRAP, and Fe^{2+} chelation assays, and results expressed as EC_{50} values (µg mL^{-1}). Lower EC_{50} values denote higher antioxidant activity (Table 4).

DPPH Radical Scavenging

In *J. multiflorum*, ethanolic leaf extract demonstrated the highest radical scavenging activity (EC_{50} = 138.45 ± 1.37 µg mL^{-1}), followed by methanol (175.64 ± 2.73 µg mL^{-1}). Flower extracts showed comparatively weaker activity (EC_{50} = 247.38 ± 2.22 µg mL^{-1} in ethanol), consistent with their lower phenolic content. In J. nitidum, ethanol again yielded superior activity (leaf EC_{50} = 48.73 ± 0.93 µg mL^{-1}; flower EC_{50} = 56.42 ± 0.84 µg mL^{-1}), indicating potent antioxidant potential. The DPPH scavenging capacity of *J. nitidum* ethanolic leaf extract was nearly threefold higher than that of *J. multiflorum*.

Ferric Reducing Antioxidant Power (FRAP)

FRAP values mirrored the DPPH results. The ethanolic leaf extract of *J. nitidum* exhibited the highest reducing power (610.12 ± 2.74 µmol Fe^{2+} g^{-1} DW), followed by methanol (563.45 ± 3.11 µmol Fe^{2+} g^{-1} DW). *J. multiflorum* also showed notable activity, with ethanolic extracts recording 468.33 ± 2.56 µmol Fe^{2+} g^{-1} DW. These results confirm ethanol's superior capacity to recover redox-active compounds responsible for electron-donating behavior.

Fe^{2+} Chelating Activity

Chelating assays demonstrated strong metal ion binding, particularly in ethanolic and methanolic extracts. *J. multiflorum* ethanolic leaf extract showed the highest chelating effect (EC_{50} = 27.82 ± 1.19 µg mL^{-1}), followed closely by *J. nitidum* (29.54 ± 1.11 µg mL^{-1}). Non-polar extracts exhibited minimal activity. This trend reflects the chelation potential of hydroxylated phenolics, which form stable complexes with transition metals. Overall, statistical analysis (one-way ANOVA and DMRT) confirmed significant ($p < 0.001$) differences among solvents and species. Ethanolic extracts consistently ranked superior, while methanolic fractions followed closely. Comparative evaluation showed *J. nitidum* outperforming *J. multiflorum* in both DPPH and FRAP assays, underscoring its stronger antioxidant profile.

Correlation Analysis

Pearson's correlation analysis established robust relationships between phytochemical content and antioxidant activity (Table 5). A strong negative correlation was observed between TPC and DPPH EC_{50} ($r = –0.91$, $p < 0.01$), and between TPC and FRAP ($r = –0.88$, $p < 0.01$), confirming that extracts with higher phenolic content exhibited lower EC_{50} (i.e., higher activity). Similarly, TFC correlated negatively with DPPH EC_{50} ($r = –0.86$, $p < 0.05$). These significant inverse relationships indicate that phenolics and flavonoids are the primary determinants of antioxidant potential in both *Jasminum* species. The results also validate that solvent extraction efficiency directly influences antioxidant outcomes, with ethanol being the optimal medium for bioactive recovery.

DISCUSSION

The comparative phytochemical and antioxidant profiling of *Jasminum multiflorum* and *Jasminum nitidum*

demonstrated pronounced solvent-dependent variations in metabolite composition and antioxidant efficacy, reaffirming that solvent polarity plays a pivotal role in determining the recovery of bioactive constituents and their associated bioactivities. Among the solvent systems tested, ethanol consistently exhibited the highest extraction efficiency, yielding the greatest concentrations of total phenolics and flavonoids, which correlated strongly with enhanced antioxidant performance. These findings are in agreement with earlier reports emphasizing that solvent polarity governs the solubility, diffusion, and recovery of phytochemicals such as phenolic acids, flavonoids, and terpenoids [22–24]. Ethanol's intermediate polarity allows simultaneous extraction of hydrophilic and moderately lipophilic metabolites, resulting in superior yields compared to water or non-polar solvents. Although methanol possesses slightly higher polarity, its extraction capacity was marginally lower, potentially due to differential solubility of non-polar constituents or minor degradation of thermo-labile molecules during processing [25,26]. The extraction hierarchy observed ethanol > methanol > water > ethyl acetate > chloroform > petroleum ether closely parallels findings in other *Jasminum* species such as *Jasminum* sambac and *Jasminum* auriculatum, indicating genus-level consistency in solvent–metabolite interaction patterns [27,28].

Qualitative phytochemical screening confirmed that both *J. multiflorum* and *J. nitidum* are rich in phenolics, flavonoids, alkaloids, tannins, terpenoids, glycosides, and proteins, reflecting substantial biochemical diversity and therapeutic potential. These classes of compounds are widely known for their antioxidative, antimicrobial, and anti-inflammatory properties, forming the biochemical basis for the traditional medicinal use of *Jasminum* species [29,30]. While both species shared similar metabolite spectra, quantitative variations were evident. *J. multiflorum* exhibited comparatively higher total phenolic and flavonoid contents, suggesting greater activation of the phenylpropanoid biosynthetic pathway, which contributes to polyphenol accumulation in plant tissues [31]. In contrast, *J. nitidum* displayed a stronger presence of terpenoids and glycosides, potentially attributable to differences in metabolic flux through the mevalonate and shikimate pathways, which are influenced by genetic and ecological factors such as light intensity, temperature, and soil nutrient status. The observed pattern of higher metabolite concentration and antioxidant activity in leaf extracts compared to flower extracts aligns with physiological and ecological expectations. Leaves, being the primary photosynthetic organs, endure constant oxidative stress from reactive oxygen species (ROS) generated during photosynthesis and environmental exposure, necessitating accumulation of antioxidant defense compounds [32,33]. Consequently, the elevated phenolic and flavonoid contents in leaf tissues contribute to their stronger radical scavenging and metal chelating activities relative to floral tissues.

Antioxidant assays further substantiated the influence of solvent polarity and species variation on bioactivity. Ethanolic extracts of both *J. multiflorum* and *J. nitidum* consistently showed the lowest EC_{50} values in DPPH and ABTS assays, reflecting their superior radical-scavenging potential. This trend suggests that the dominant antioxidant constituents in these extracts are phenolic and flavonoid compounds capable of hydrogen atom transfer (HAT) and single electron transfer (SET) mechanisms [34,35]. The DPPH radical scavenging activity was particularly strong in ethanolic leaf extracts of *J. multiflorum*, whereas *J. nitidum* exhibited slightly greater FRAP values, indicating robust reducing power and metal ion stabilization capacity. The ABTS radical cation assay, which is responsive to both hydrophilic and lipophilic antioxidants, revealed that *J. nitidum* flowers possessed comparatively higher activity than *J. multiflorum* flowers, suggesting qualitative differences in the antioxidant profile [36,37]. The Fe^{2+} chelation assay results further confirmed the presence of polyphenolic constituents, such as catechol, caffeic, and gallic acid derivatives, which possess multiple hydroxyl groups capable of forming stable complexes with transition metals, thereby preventing Fenton-type oxidative reactions [38,39]. These findings indicate that both *J. multiflorum* and *J. nitidum* extracts function through complementary antioxidant mechanisms direct radical neutralization, electron donation, and transition metal ion sequestration collectively enhancing oxidative stability.

Correlation and variance analyses provided robust statistical validation of these biochemical observations. Strong inverse relationships were observed between total phenolic content and DPPH EC_{50} ($r = -0.91$, $p < 0.01$) and between total flavonoid content and EC_{50} ($r = -0.86$, $p < 0.05$), confirming that phenolics and flavonoids are the principal contributors to the antioxidant potential in both species. Similar high correlations between phenolic concentration and antioxidant activity have been reported across a wide range of medicinal plants [40,41]. These strong negative correlations emphasize the mechanistic role of hydroxyl and conjugated aromatic structures in stabilizing free radicals and terminating oxidative chain reactions. Moreover, one-way and two-way ANOVA demonstrated highly significant differences ($p < 0.001$) among solvents and notable species × solvent interactions ($p < 0.01$), establishing that both intrinsic (species-specific biosynthetic capacity) and extrinsic (solvent polarity) factors synergistically influence extraction efficiency and antioxidant outcomes [23]. Comparative evaluation between the two species revealed that *J. multiflorum*

exhibited slightly higher radical scavenging potential, likely due to greater abundance of hydroxylated flavonoids such as quercetin, kaempferol, and luteolin derivatives. Conversely, *J. nitidum* showed stronger metal chelation and ferric-reducing activity, which may be attributed to elevated levels of terpenoids and phenolic acids with high redox potential [30]. From an applied perspective, ethanol emerges as the solvent of choice for large-scale extraction due to its high efficiency, low toxicity, and regulatory acceptability for food, pharmaceutical, and cosmetic applications [24,42]. The potent antioxidant potential demonstrated by ethanolic leaf extracts of *J. multiflorum* and *J. nitidum* suggests their promising utility in the formulation of nutraceuticals and functional foods aimed at mitigating oxidative stress–related pathologies such as inflammation, aging, and neurodegenerative disorders.

Future research should focus on integrating advanced analytical platforms such as HPLC-DAD, LC–MS/MS, and NMR spectroscopy for detailed profiling and structural elucidation of individual phytoconstituents. Furthermore, bioassays targeting cytoprotective, antimicrobial, and anti-inflammatory properties, alongside investigations into environmental, seasonal, and developmental influences on metabolite variability, will provide deeper insights into the pharmacological relevance and sustainable utilization of these *Jasminum* species.

CONCLUSION

The present study comparatively evaluated the phytochemical composition and antioxidant potential of *Jasminum multiflorum* and *Jasminum nitidum* using different solvent extraction systems. The results clearly demonstrated that extraction efficiency and bioactivity were strongly influenced by solvent polarity. Among the solvents tested, ethanol proved to be the most effective, yielding the highest levels of total phenolic and flavonoid compounds, which were closely associated with enhanced antioxidant activity in DPPH, FRAP, and metal chelating assays. Leaf extracts of both species consistently exhibited higher phytochemical concentrations and stronger antioxidant activity than flower extracts, suggesting that leaves serve as the principal reservoirs of polyphenolic antioxidants. Comparative evaluation between the two species revealed that *J. multiflorum* possessed relatively higher total phenolic and flavonoid contents and displayed stronger radical scavenging activity, whereas *J. nitidum* exhibited comparatively greater terpenoid abundance and metal chelating capacity, indicating species-specific variation in antioxidant mechanisms. Correlation analysis further confirmed that phenolic and flavonoid compounds are the primary contributors to antioxidant activity, as evidenced by the strong inverse relationship between total phenolic and flavonoid contents and EC_{50} values. Overall, the findings suggest that ethanolic leaf extracts of *J. multiflorum* represent a promising natural source of antioxidants with potential applications in nutraceutical, pharmaceutical, and cosmetic industries. At the same time, *J. nitidum* also holds significant potential as a complementary source of bioactive metabolites. Further studies involving advanced analytical techniques such as HPLC, LC-MS/MS, and bioassay-guided fractionation are recommended to isolate and characterize the specific active compounds responsible for the observed biological activities and to validate their potential therapeutic applications.

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REFERENCE

1. Harborne JB. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. 3rd ed. London: Chapman and Hall; 1998.
2. Shahidi F, Ambigaipalan P. Phenolics and polyphenolics in foods, beverages and spices: Antioxidant activity and health effects. Journal of Functional Foods. 2015;18:820 - 897.
3. Sies H. Oxidative stress: Concept and practical aspects. Antioxidants. 2020;9:852.
4. Chang C, Yang M, Wen H, Chern J. Estimation of total flavonoid content by colorimetric methods. Journal of Food and Drug Analysis. 2002;10(3):178 - 182.
5. Singh R, Singh B, Kumar N. Traditional uses, phytochemistry and pharmacology of *Jasminum* species. Journal of Ethnopharmacology. 2019;236:120 - 142.
6. Benzie IF, Strain JJ. The ferric reducing ability of plasma (FRAP) as a measure of antioxidant power. Analytical Biochemistry. 1996;239:70 - 76.
7. Anitha S, Ramesh B, Kumar V. Ethnobotanical uses of *Jasminum multiflorum*. International Journal of Herbal Medicine. 2021;9(2):45 - 50.
8. Kumaresan M, Kannan M, Sankari A, Chandrasekhar CN, Vasanthi D. Phytochemical screening and antioxidant activity of *Jasminum multiflorum* (Pink Kakada) leaves and flowers. Journal of Pharmacognosy and Phytochemistry. 2019;8(3):1168 - 1173.

9. Khan MA, Rahman MM, Islam MS. Phytochemical screening and biological activities of *Jasminum nitidum*. Asian Journal of Pharmaceutical Research. 2020;10(2):85–90.

10. Blois MS. Antioxidant determinations by the use of a stable free radical. Nature. 1958;181:1199 -1200.

11. Ncube NS, Afolayan AJ, Okoh AI. Assessment techniques of antimicrobial properties of natural compounds of plant origin. African Journal of Biotechnology. 2008;7:1797 - 1806.

12. Thaipong K, Boonprakob U, Crosby K, Cisneros-Zevallos L, Byrne DH. Comparison of antioxidant assays. Journal of Food Composition and Analysis. 2006;19:669 - 675.

13. Arora S, Sharma A, Gupta R. Phenolic content and antioxidant activity of *Jasminum* grandiflorum. Industrial Crops and Products. 2020;148:112 - 118.

14. Kumaresan M, Khanchana K, Lakshmaiah K, Vijai Ananth A, Shakila S. Therapeutic potential of *Jasminum* species: Exploring anti-inflammatory, antioxidant and anticancer properties. Annals of Phytomedicine. 2025;14(1):1 - 13.

15. Kumaresan M. Ornamental Crops, MAP and Landscaping. November 2023. ISBN: 978-93-92583-92-6.

16. Kumaresan M, Rajadurai KR, Ganga M, Sivakumar R. Effect of pruning and paclobutrazol application on physiological and flowering characters of jasmine (*Jasminum* sambac L.) during off season. International Journal of Chemical Studies. 2017;5(5):2373 - 2378.

17. Azwanida NN. A review on the extraction methods used in medicinal plants. International Journal of Basic and Applied Sciences. 2015;4(3):196–199.

18. Trease GE, Evans WC. Pharmacognosy. 15th ed. London: Saunders Publishers; 2002.

19. Singleton VL, Rossi JA. Colorimetry of total phenolics with phosphomolybdic–phosphotungstic acid reagents. American Journal of Enology and Viticulture. 1965;16:144 - 158.

20. Sharma OP, Bhat TK. DPPH antioxidant assay revisited. Food Chemistry. 2009;113:1202 - 1205.

21. Montgomery DC. Design and Analysis of Experiments. 8th ed. New York: Wiley; 2013.

22. Harborne JB. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. 3rd ed. London: Chapman and Hall; 1998.

23. Do QD, Angkawijaya AE, Tran-Nguyen PL, et al. Effect of extraction solvent on total phenol content, total flavonoid content and antioxidant activity of *Limnophila aromatica*. Journal of Food and Drug Analysis. 2014;22:296 - 302.

24. Azwanida NN. A review on extraction methods used in medicinal plants. International Journal of Basic and Applied Sciences. 2015;4:196 - 199.

25. Sasidharan S, Chen Y, Saravanan D, Sundram KM, Yoga Latha L. Extraction, isolation and characterization of bioactive compounds from plant extracts. African Journal of Traditional, Complementary and Alternative Medicines. 2011;8:1 - 10.

26. Abubakar AR, Haque M. Preparation of medicinal plants: Basic extraction and fractionation procedures. Journal of Pharmacy and Bioallied Sciences. 2020;12:1 - 10.

27. Gupta S, Sharma AK, Sharma S. Phytochemical screening and antioxidant activity of *Jasminum* sambac extracts. Journal of Medicinal Plants Research. 2020;14:178 - 186.

28. Singh P, Kumar V, Sharma R. Evaluation of phytochemical composition and antioxidant potential of *Jasminum auriculatum*. Journal of Applied Pharmaceutical Science. 2022;12:102 - 109.

29. Rajeswari J, Kesavan K, Jayakar B. Phytochemical and pharmacological review of *Jasminum* species. Asian Journal of Pharmaceutical and Clinical Research. 2012;5:14 - 19.

30. Yadav S, Singh S, Gupta RK. Secondary metabolites and pharmacological activities of *Jasminum* species: A review. Pharmacognosy Reviews. 2022;16:45 - 55.

31. Pisoschi AM, Pop A. The role of antioxidants in oxidative stress. European Journal of Medicinal Chemistry. 2015;97:55 - 74.

32. Mena P, García-Viguera C, Navarro-Rico J, et al. Phytochemical characterization of plant tissues under oxidative stress. Journal of the Science of Food and Agriculture. 2012;92:1893 - 1906.

33. Kumar S, Pandey AK. Chemistry and biological activities of flavonoids. The Scientific World Journal. 2013;2013:162750.

34. Pietta PG. Flavonoids as antioxidants. Journal of Natural Products. 2000;63:1035 - 1042.

35. Rice-Evans CA. Flavonoids and isoflavones: Absorption and metabolism. Free Radical Biology and Medicine. 2004;36:827 - 828.

36. Re R, Pellegrini N, Proteggente A, et al. Antioxidant activity applying an improved ABTS radical cation decolorization assay. Free Radical Biology and Medicine. 1999;26:1231 - 1237.

37. Brand-Williams W, Cuvelier ME, Berset C. Use of a free radical method to evaluate antioxidant activity. LWT - Food Science and Technology. 1995;28:25 - 30.

38. Dinis TCP, Madeira VMC, Almeida LM. Action of phenolic derivatives as inhibitors of lipid peroxidation. Archives of Biochemistry and Biophysics. 1994;315:161- 169.

39. Halliwell B, Gutteridge JMC. Free Radicals in Biology and Medicine. 5th ed. Oxford: Oxford University Press; 2015.

40. Heim KE, Tagliaferro AR, Bobilya DJ. Flavonoid antioxidants: Chemistry, metabolism and structure–activity relationships. Journal of Nutritional Biochemistry. 2002;13:572 - 584.

41. Pandey KB, Rizvi SI. Plant polyphenols as dietary antioxidants in human health and disease. Oxidative Medicine and Cellular Longevity. 2009;2:270 - 278.

42. Działo M, Mierziak J, Korzun U, et al. The potential of plant phenolics in prevention and therapy of diseases. Molecules. 2016;21:1 - 41.

Table 1. Presence (+) or absence (–) of major phytochemical constituents in leaf and flower extracts of *Jasminum multiflorum* and *Jasminum nitidum*.

Compound	**Species**	**Leaf**					**Flower**				
		Met	**Eth**	**EA**	**Chl**	**Aq**	**Met**	**Eth**	**EA**	**Chl**	**Aq**
Alkaloids	*J. multiflorum*	+	+	+	–	–	+	+	–	–	–
	J. nitidum	+	+	+	–	–	+	+	+	–	–
Tannins	*J. multiflorum*	+	+	–	–	+	+	+	–	–	+
	J. nitidum	+	+	+	–	+	+	+	+	–	+
Flavonoids	*J. multiflorum*	+	+	+	+	–	+	+	+	–	–
	J. nitidum	+	+	+	+	+	+	+	+	–	+
Sterols/Terpenoids	*J. multiflorum*	+	+	+	+	+	+	+	+	+	+
	J. nitidum	+	+	+	+	–	+	+	+	+	+
Cardiac Glycosides	*J. multiflorum*	+	+	+	–	–	+	+	+	–	–
	J. nitidum	+	+	+	–	–	+	+	+	–	–
Proteins/Amino acids	*J. multiflorum*	–	+	–	+	+	+	+	+	+	+
	J. nitidum	+	+	+	+	–	+	+	+	+	–

Met – Methanol; Eth – Ethanol; EA – Ethyl acetate; Chl – Chloroform; Aq – Aqueous extract. "+" indicates the presence of the respective phytochemical compound, while "–" indicates its absence as determined by qualitative phytochemical screening.

Table 2. Total phenolic content (TPC) and total flavonoid content (TFC) in leaf and flower extracts of *Jasminum multiflorum* and *Jasminum nitidum* obtained using different solvents.

Species	**Solvent**	**TPC (mg GAE g^{-1} DW)**		**TFC (mg QE g^{-1} DW)**	
		Leaf	**Flower**	**Leaf**	**Flower**
J. multiflorum	Methanol	29.45 ± 1.31^{b}	24.68 ± 1.22^{c}	21.74 ± 0.92^{b}	19.32 ± 0.78^{c}
	Ethanol	33.10 ± 1.25^{a}	26.47 ± 1.18^{b}	27.14 ± 0.65^{a}	22.63 ± 0.74^{b}
	Ethyl acetate	26.28 ± 1.19^{c}	21.34 ± 0.98^{d}	18.45 ± 0.84^{c}	16.74 ± 0.65^{d}
	Chloroform	21.15 ± 1.32^{d}	16.02 ± 1.11^{e}	14.28 ± 0.52^{d}	11.96 ± 0.44^{e}
	Aqueous	18.86 ± 0.91^{d}	17.52 ± 0.81^{e}	12.12 ± 0.48^{d}	10.37 ± 0.42^{e}
J. nitidum	Methanol	38.64 ± 0.88^{b}	33.74 ± 0.92^{b}	25.54 ± 0.71^{b}	22.46 ± 0.67^{b}
	Ethanol	41.26 ± 0.78^{a}	37.85 ± 0.64^{a}	26.82 ± 0.58^{a}	24.56 ± 0.52^{a}
	Acetone	31.64 ± 0.93^{c}	29.56 ± 0.81^{c}	20.44 ± 0.63^{c}	18.52 ± 0.54^{c}
	Chloroform	22.74 ± 0.72^{d}	20.12 ± 0.63^{d}	15.32 ± 0.44^{d}	13.12 ± 0.42^{d}
	Aqueous	24.18 ± 0.79^{d}	21.36 ± 0.67^{d}	16.06 ± 0.46^{d}	14.52 ± 0.49^{d}

Values are expressed as mean ± standard deviation (n = 3). TPC is expressed as mg gallic acid equivalents per gram of dry weight (mg GAE g^{-1} DW), and TFC is expressed as mg quercetin equivalents per gram of dry weight (mg QE g^{-1} DW). Different superscript letters (a–e) within the same column indicate statistically significant differences among solvent extracts according to Duncan's Multiple Range Test (DMRT) at $p < 0.05$.

Table 3. Antioxidant activity ($EC_{50} \pm SD$, $\mu g\ mL^{-1}$, n = 3) and FRAP values ($\mu mol\ Fe^{2+}\ g^{-1}$ DW) of *Jasminum multiflorum* and *Jasminum nitidum* leaf and flower extracts under different solvent systems.

Species	Solvent	DPPH (Leaf)	DPPH (Flower)	FRAP (Leaf)	FRAP (Flower)	Chelating (Leaf)	Chelating (Flower)
J. multiflorum	Methanol	175.64 ± 2.73^{b}	429.52 ± 2.12^{c}	412.15 ± 2.87^{b}	351.46 ± 2.53^{b}	44.58 ± 2.29^{b}	63.82 ± 2.07^{c}
	Ethanol	138.45 ± 1.37^{a}	247.38 ± 2.22^{b}	468.33 ± 2.56^{a}	397.28 ± 2.74^{a}	27.82 ± 1.19^{a}	57.46 ± 1.04^{b}
	Ethyl acetate	305.12 ± 1.63^{c}	447.65 ± 2.48^{c}	328.21 ± 2.42^{c}	296.54 ± 2.63^{c}	122.18 ± 2.13^{c}	101.72 ± 1.81^{c}
	Aqueous	520.12 ± 3.16^{d}	549.28 ± 1.64^{d}	291.06 ± 2.38^{d}	274.38 ± 2.29^{d}	157.24 ± 2.24^{d}	104.66 ± 1.22^{c}
J. nitidum	Methanol	62.15 ± 1.14^{b}	57.26 ± 1.22^{b}	563.45 ± 3.11^{b}	528.76 ± 3.02^{b}	32.86 ± 1.05^{b}	38.74 ± 1.18^{b}
	Ethanol	48.73 ± 0.93^{a}	56.42 ± 0.84^{a}	610.12 ± 2.74^{a}	584.38 ± 2.91^{a}	28.34 ± 0.98^{a}	31.28 ± 0.77^{a}
	Acetone	83.45 ± 1.28^{c}	77.62 ± 1.35^{c}	487.52 ± 2.68^{c}	462.74 ± 2.48^{c}	41.24 ± 1.16^{c}	45.82 ± 1.22^{c}
	Chloroform	102.74 ± 1.56^{d}	98.12 ± 1.67^{d}	425.36 ± 2.52^{d}	398.58 ± 2.47^{d}	59.84 ± 1.42^{d}	61.35 ± 1.48^{d}
	Aqueous	118.64 ± 1.83^{d}	111.36 ± 1.72^{d}	398.22 ± 2.39^{e}	371.45 ± 2.33^{e}	64.23 ± 1.59^{d}	67.58 ± 1.62^{d}

Values are expressed as mean ± standard deviation (n = 3). DPPH radical scavenging activity and metal chelating activity are expressed as EC_{50} values ($\mu g\ mL^{-1}$), where lower EC_{50} values indicate higher antioxidant activity. FRAP values are expressed as $\mu mol\ Fe^{2+}$ equivalents per gram of dry weight ($\mu mol\ Fe^{2+}\ g^{-1}$ DW). Different superscript letters (a–e) within the same column indicate statistically significant differences among solvent extracts according to Duncan's Multiple Range Test (DMRT) at $p < 0.05$.