Annals of Phytomedicine 13(2): 55-62, 2024

DOI: http://dx.doi.org/10.54085/ap.2024.13.2.6

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

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

Review Article : Open Access

A review on the nutritional composition and pharmacological properties of ornamental plants beyond their aesthetic and therapeutic potential

T. Deepikakrishnaveni*, A. Jaya Jasmine◆, M. Ganga*, D. Rajakumar*** and A. Senthil******

** Department of Floriculture and Landscaping, Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India*
*** Horticultural Research Station, Tamil Nadu Agricultural University, Pechiparai, Kanyakumari-629161, Tamil Nadu, India*
**** Department of Agronomy, V.O.C. Agricultural College & Research Institute, Killikulam, Thoothukudi-628252, Tamil Nadu, India*
***** Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India*

Article Info

Article history
Received 5 September 2024
Revised 20 October 2024
Accepted 21 October 2024
Published Online 30 December 2024

Keywords
Ornamentals
Bioactive compounds
Nutraceuticals
Phytoextracts
Phytotherapeutics

Abstract

From ancient remedies to modern pharmaceuticals, the journey of plant-based medicine is a testament to nature's remarkable ability to heal. Among the diverse flora, medicinal plants have historically played a crucial role in treating ailments and promoting well-being. However, ornamental plants, primarily valued for their aesthetic appeal, also possess significant therapeutic properties and can serve as complementary resources to traditional medicinal plants, offering a diverse range of bioactive compounds that enhance health benefits. Besides this, numerous studies have shown that many ornamental species exhibit notable nutraceutical properties too, being rich in essential nutrients such as fibre, protein and minerals that support overall health and wellness. Additionally, the therapeutic potential of ornamental plants extends to mental health, as they have been found to reduce stress and anxiety levels, thereby enhancing overall well-being. Amid the growing interest in herbal remedies and the rising incidence of lifestyle-related and mental health issues, ornamental plants represent a vital link between aesthetics and healthcare, providing valuable alternative therapeutic options. In the field of phytomedicine, the bioactive compounds found in these plants are increasingly recognized for their potential as natural remedies, promoting physical health through their nutraceutical properties while also offering significant benefits for mental well-being. Furthermore, integrating ornamental plants into pharmaceutical research can enhance food and nutritional security, while also creating economic opportunities for rural populations engaged in their cultivation. This review explores the aforementioned potentials in various ornamental crops, with a primary emphasis on their phytochemical profiles and pharmacological properties.

1. Introduction

Ornamental plants can bring numerous benefits in terms of environmental beauty, economic concerns, and human lifestyles (Van Iersel *et al.*, 2016) and growing in homes, offices and organizations to enhance the landscape with their beautiful flowers and attractive leaves (Milstein, 2005). Many ornamental plants also possess proven medicinal properties, though much of the current generation remains unaware of their traditional significance. These plants have been effectively utilized in everyday healthcare practices, as outlined in various Indian medical systems such as Ayurveda, Siddha and Unani, as well as by numerous vaidyas and folk healers across India (Prema *et al.*, 2015). Many ornamental plants are naturally used to treat a variety of ailments, such as rheumatism (inflammation of the joints), cough, malaria, skin disorders, dysentery (severe diarrhoea) and fever (Johri, 2022). Ornamental plants contribute to human health through their bioactive compounds, which include antioxidants, essential oils and other secondary metabolites. For instance, *Lawsonia inermis* (henna) is known for its potent antioxidant properties (Endrini *et al.*, 2002). Similarly, *Achillea millefolium* (yarrow) is effective in alleviating inflammation and soothing stomach discomfort. *Lavandula* species (lavender) are recognized for their ability to reduce anxiety and depression. *Impatiens capensis* (jewelweed) is commonly used to soothe irritated skin, while *Fuchsia* species can help lower blood pressure and contain diuretic tannins that aid in flushing excess sodium from the body. Additionally, *Cichorium intybus* (chicory) promotes bile flow, which aids in detoxification by stimulating urination and some other indoor ornamental plants such as *Hedera helix, Nephrolepis exaltata, Anthurium andreanum, Aglaonema modestum, Areca lutescens, Ficus species, Chrysanthemum leucanthemum, Syngonium podophyllum, Chamaedo reaelegans, Dracaena marginata, Dracaena sanderiana, Epipremnum aureum, Chloro phytumcomosum*, *Sansevieria trifasciata*, *Philodendron, Spathi-phyllum*, *etc*., release volatile compounds that can effectively remove harmful substances such as formaldehyde, ammonia, benzene, xylene, carbon monoxide, chloroform and other pollutants from the air (Wei *et al.*, 2017). Therefore, it is essential to emphasize on the value of ornamental plants as significant medicinal resources. This review on various ornamental plants, focus on their nutritional and phytochemical composition, health benefits and therapeutic considerations.

2. Nutritional factor of ornamental plants

Nowadays, various types of plantations are being promoted by both the government and the public, with a focus on cultivating

Corresponding author: Dr. A. Jaya Jasmine
Professor, Horticultural Research Station, Tamil Nadu Agricultural University, Pechiparai, Kanyakumari-629161, Tamil Nadu, India
E-mail: jayajasmine@tnau.ac.in
Tel.: +91-9994307766

ornamental garden plants to enhance aesthetic appeal through their flowers, fragrance, foliage, fruits, bark and overall structure. While the primary goal often revolves around their economic value, shade provision and visual beauty, little emphasis is placed on their medicinal and nutritional benefits. Despite their widespread use for decorative purposes, many of these ornamental plants possess significant nutraceutical properties that could be harnessed for health and wellness, underscoring the need for greater awareness of their nutritional value (Prema *et al.*, 2015).

Nutritional analysis of leaves, roots and stems of *Dracaena cameroonian*a Baker reveal that they are rich in fibre (14.20-53.65%), proteins (4.47-18.58%), lipids (1.53-5.42%), carbohydrates (23.67-70.94%), ash (2.17-15.59%) and mineral elements; namely, K (535.07-1690.00 mg/100 g), Ca (315.87-1459.97 mg/100 g), Mg (95.41- 498.83 mg/100 g), P (76.72-149.56 mg/100 g), Na (105.83-113.60 mg/100 g), Se (75.87-128.51 mg/100 g), Fe (40.88-228.30 mg/100 g), Mn (7.41- 11.39 mg/100 g), Zn (2.94-5.83 g/100 g), Cu (2.30-2.80 mg/100 g) and Co (0.65-2.80 mg/100 g) (Mawunu *et al.*, 2021). The nutrient composition of dried rose petal powder includes 84.5% moisture, 0.4 g ash, 70.4 g carbohydrates, 0.5 g protein, 0.2 g fat, 1.2 g crude fibre, 0.2 mg vitamin C, 3.7 mg Fe and 120 mg Ca (Vijayanchali, 2017). Mineral content of methanolic extracts of *Hemerocallis* was found to be in the following order: K>Ca> P > Mg > Na > Zn >Mn> Fe > Cu > Mo (Mlcek *et al.*, 2021). Grzeszczuk *et al.*(2018) evaluated ornamental species such as Monarda (*M. didyma, M. fistulosa, M. citriodora*), *Antirrhinum majus* (Cavalier*), Dianthus chinensis* (Chianti), *Hemerocallis×hybrida Hort.,* and *Paeonia officinalis* (cultivars Sarah Bernhardt, Dr. Alexander Fleming, Karl Rosenfield). Results revealed that *Mimulus×hybridus* exhibited significantly higher macro- and microelement concentrations, particularly K (30.03 g kg^{-1}) and Fe (154.93 mg kg^{-1}). In contrast, *Paeonia officinalis* cultivars had the lowest concentrations of heavy metals, highlighting their potential for culinary and medicinal use. *Chaenomeles* species (*C. cathayensis, C. japonica, C. speciosa, Cattleya × superba*) showed a rich nutrient content in the flowers and fruits, with significant variation among cultivars. Flowers were high in K, Fe, Mg, Zn, Cu and Mn, while fruits were rich in Ca. Accession P-8-3 stood out for its elevated levels of Ca, Zn, Mn and Cu in flowers and K, Ca, Zn, Mn and Cu in fruits. Chaenomeles fruit jam contained exceptionally high K (2087 mg/100 g), surpassing the daily human requirement by seven times, highlighting its nutritional potential (Komar-Tyomnaya and Dunaevskaya, 2018).

The bark of *Delonix regia* exhibits significant nutrient profile, including β-sitosterol, carotene, hydrocarbons, phytotoxins, saponins, alkaloids and flavonoids. Particularly, carotene, a precursor to vitamin A, is recognized for its antioxidant capabilities, which may play a vital role in mitigating oxidative stress (Suhane *et al.*, 2016). The mineral composition of Snapdragon (*Antirrhinum majus*) grass and flowers included K, Ca, Mg, P, Na and Si, with other elements present in lower concentrations. Toxic substance levels remained within permissible limits. However, these findings support the standardization of snapdragon plant material for potential medicinal applications (González-Barrio *et al.*, 2018). The 'Purple with Blotch' genotype (G5) of pansy (*Viola tricolor* var. *hortensis* L.) holds rich composition of bioactive compounds. It contains significant levels of ascorbic acid (23.89 mg/100 g), anthocyanins (91.06 mg/100 g), flavonoids (217.19 mg/100 g), polyphenols (555 mg/100 g), total sugar content of 6.39% and 8.32°Brix total soluble solids (TSS) (Nidhi, 2023). Dendrobium, an aesthetically important ornamental plant, has applications in phytomedicine due to its remarkable nutraceuticals and biological properties, in addition to its decorative uses (Choudhary *et al*., 2023). Given these benefits, ornamental plants, beyond their aesthetic appeal, possess rich nutritional content, making them valuable for diverse applications, including medicinal and culinary purposes.

3. Pharmacological and biological potential of ornamentals

Phytochemicals, primarily secondary metabolites found in plants, are recognized for their beneficial effects on human health and their role in disease treatment (Ahmad *et al.*, 2021). For instance, Dendrobium is a prominent genus within the Orchidaceae family, has been revered for centuries in traditional medicine, particularly in Chinese herbal practices. Known for its striking beauty and diverse species, it is not only an ornamental gem but also a powerhouse of medicinal properties. Dendrobine, a key phytochemical found in *Dendrobium* species, exhibits considerable pharmacological efficacy, as mentioned in Table 1.

Table 1: Pharmacological efficacy of *Dendrobium nobile* Lindl.

Plant parts and phytoextracts	Phytochemicals	Curative benefits	Reference
Plant derived alkaloid	Dendrobine	Inhibits γ-irradiation-induced cancer cell migration, invasion and metastasis in non-small cell lung cancer cells	Kim *et al.*, 2021b
Ethanol extract of dried stem of the herb	Dendrobine, dendrobine-N-oxide, nobilonine, dendroxine, 6-hyd-roxy-nobilonine,13-hydroxy-14-oxodendrobine	Curative for Alzheimer's disease (AD)	Nie *et al.*, 2016; Das *et al*., 2021
Root	Dendrobine (pyrrolidine derivative)	Reduction of gestational diabetes mellitus	Feng *et al.*, 2021
Flower	Dendrobium nobile alkaloids (DNLA)	Antioxidative effects, alkaloids reduced CCl_4 induced liver injury	Li *et al.*, 2019

Similarly, *Dracaena*, another important genus comprising over 120 species, holds significant pharmacological potential, particularly in traditional medicine practices. As it is a very broad genus, there are numerous species of *Dracaena* that occupy significant proportions in global cultivation. Species such as *Dracaena draco*, known for its iconic red resin called "dragon's

blood," have been utilized for centuries for their therapeutic properties. This resin is not only valued for its vibrant colour but also for its medicinal applications, including wound healing and anti-inflammatory effects (Al-Awthan and Bahattab, 2021). The medicinal and pharmacological potential of *Draceana* species is given in Table 2.

Table 2: Medicinal and pharmacological potential of *Draceana* sp.

Botanical name	Plant parts and phytoextracts	Phytochemicals	Medicinal and pharmacological use	Reference
Dracaena cameroonia Baker	Leaves, tuberous roots, leafy stem	-	Rich in nutrients and fibre, making it beneficial for improving nutrition, especially in people with anaemia, and may help prevent digestive system cancers.	Mawunu *et al.*, 2021; Gupta and Sarwat, 2022
Dracaena manni Baker	Ethyl acetate extract of stem	Tannins, saponins, alkaloids, anthra quinones	Antimicrobial and antifungal activity	Ameen *et al.*, 2015
	Methanolic extract of stem	Anthraquinones, steroids, terpenoids		
Dracaena reflexa var. *angustifolia* Baker	Methanolic root extract (MRE)	-	Antioxidant activity	Narender *et al.*, 2017
	Aqueous leaf extract (ALE)	-	Antibacterial activity	
Dracaena cinnabari Balf. f.	Leaf, flower, resin	-	Anticancerous property	Mothana *et al.*, 2007

In addition to the phytomedical benefits of popular ornamental crops listed in Table 3, numerous previous studies revealed a vast array of other bioactive compounds and phytochemicals found in various under-utilized ornamental crops also. These compounds possess significant and indispensable roles in the pharmaceutical industry, offering a wide range of applications.

Table 3: Phytomedical benefits of prominent ornamental plants

Botanical name	Plant parts and phytoextracts	Phytochemicals	Phytomedical benefits	Reference
Viola tricolor var. hortensis L.	Whole plant	-	Antioxidant, anti-inflammatory effects	Nidhi, 2023
Delonix regia (Bojer) Raf.	Methanolic and ethanolic extract of flower	Saponins, flavonoids, carotenoids,tannins, steroids, alkaloids, β-sitosterol	Antidiabetic activity, antibacterial activity, antidiarrheal property, hepatoprotective, antimicrobial activity, anti-inflammatory activity	Suhane *et al.*, 2016
	Methanolic extract of leaf	β-sitosterol, lupeol	Decoctions of the leaves are traditionally used to treat gastric issues, used to treat menstrual disorders	
Tabernaemontana aternifolia D.J. Middleton	Root extract	Coronaridine (Ibogatype indole alkaloid)	Antituberculosis activity	Garcellano *et al.*, 2019
Clematis terniflora varm and shurica (Rupr.) Ohwi	Ethanolic extraction (Flower)	-	Composition effective for stress relief, mood improvement, antidepressant, cognitive function improvement	Lee Ji, 2020
Jasminum sambac (L.) Aiton	Hydro-alcoholic leaf extract	Antioxidant, tannins, flavonoids, cardiac glycosides	Vasorelaxant, cardioprotective effects	Khan *et al.*, 2021

Rosa damascena Mill.	Flower petals crushed in mixer grinder	Alkaloids, phenols, flavonoids, saponins, glycosides, tannins, steroids, terpenoids	Anticancer, antiageing, antidiabetic, laxative/ purgative, hypolipidemic, antibacterial, antimicrobial, antioxidant property	Vijayanchali, 2017
Calendula officinalis L.	Aqueous/ethanolic extract, hydroalcoholic extract, hot water extract, floral extract, dichloromethane fraction	Flavonoids, terpenoids, calendulosides	Would healing and skin care, anti-inflammatory, antioxidant, anticancer, gastrointestinal treatment, antiviral, cardiovascular health, antifungal, spasmolytic, hepatoprotective, antibacterial, immunostimulant, hepatoma treatment, pain relief, antigenotoxic, liver and gallbladder function stimulation	Ullah *et al.*, 2023
Nerium oleander L.	Methanolic extracts of whole plant, aqueous and ethanolic extract of leaf, dichloromethane extract of flower and leaf	Phenols, saponins, glycosides, terpenoids	Inhibit cancer progression and migration	James and Jayaprakash, 2023
Dendrosicyos socotrana Balf.f.	Methanolic extracts of stem and leaves	-	Anticancerous property	Mothana *et al.*, 2007
Buxus hildebrandtii Bail.	Leaf			
Clitoria ternatea L.	Whole plant	Anthocyanins, flavanols, lipophilic compounds	Anticancer activity, antimicrobial, anti-inflammatory, antipyretic, neuroprotective activity etc.	Sahu *et al*., 2023
Hibiscus rosa-sinensis L.	Leaves, bark, roots and flowers	-	Antiparasitic, antioxidant antipyretic, antimicrobial, antigenotoxic, antidiabetic, hepatoprotective, anticonvulsant, dermatological, anti-inflammatory and antitussive	Kala *et al.*,2024

Rugosaflavonoid, a secondary metabolite derived from the plant *Rosa rugosa*, revealed cytotoxicity against NB4, SHSY5Y and MCF-7 cells (Breast cancer) (Puranik and Srivastava, 2017). The study of 11 woody peony cultivars (*Paeonia* × *suffruticosa*) revealed chemical diversity in their flower essential oils, influenced by genotype. citronellol-rich cultivars like 'Zhaofen' and 'Jingyu' could serve as rose oil substitutes. Six key compounds, including citronellol and nerol, showed potential medicinal benefits, particularly for CNS disorders like depression, analgesics, psychotics, Alzheimer's and Parkinson's agents (Lei *et al.*, 2022; Kaur *et al*., 2023). The stem bark of *D. regia* contains four triterpenes namely β-sitosterol, stigmasterol, lupeol and epilupeol, which are associated with anti-inflammatory, analgesic and hepatoprotective activities. Additionally, the isolation of p-methoxy-benzaldehyde indicates a potential enhancement of the plant's pharmacological efficacy (Suhane *et al.*, 2016).

A research on antibacterial, cytotoxic activities and phytochemical composition of *Callistemon citrinus*, *Hibiscus rosa-sinensis* and *Plumbago auriculata* shown that the ethanolic extracts of *C. citrinus* leaf and flower exhibited the strongest antibacterial activity, with low cytotoxicity (LC_{50}<600 µg/ml), while *P. auriculata* leaf extract contained lupeol triterpene and lupeol acetate, compounds not previously reported in this genus and *H. rosa-sinensis* extracts showed high levels of linoleic and linolenic acids. Moreover, it was suggested that *C. citrinus* has potential for treating microbial infections due to its broad-spectrum antibacterial activity and low toxicity (Rios-Chavez *et al.*, 2019). The study on beta-sitosterol produces significant dose-dependent central antinociceptive effects in mice, as observed through tail-flick and hot-plate assays. The analgesic effects were associated with the activation of cholinergic and opioidergic pathways (Tiwari *et al*., 2022). Further investigation using receptor antagonists, such as naloxone and atropine, supported the involvement of opioidergic, serotonergic, adrenergic and cholinergic receptors in beta-sitosterol's mechanism of action. These findings suggest that beta-sitosterol may be a promising compound for central pain management through receptor modulation (Aakul and Okur, 2021).

Lantana camara was identified as significant leishmanicidal activity in several fractions of its dichloromethane extract. Notably, compounds such as eicosane, squalene, β-ionone, caryophyllene oxide, β-caryophyllene and the mixture of lantanilic and camaric acids demonstrated potent activity, with the latter showing the highest

potency (IC_{50} = 12.02 µM). These findings suggest *L. camara* has potential for developing phytomedicines or lead compounds for leishmaniasis treatment (Delgado-Altamirano *et al.*, 2019). A novel water-soluble polysaccharide, ICP-1, was isolated from Imperial *Chrysanthemum* and characterized as an acidic hetero-polysaccharide with a molecular weight of 2.98×10³ kDa. ICP-1 enhances acid production and the growth of lactic acid bacteria, showing significant prebiotic potential. It demonstrated good tolerance to simulated gastrointestinal conditions (Liu *et al.*, 2022). The experiment using *Matricaria chamomilla* extracts showed that both alcoholic and aqueous extracts exhibited hydroxyl radical scavenging activity at lower concentrations (10-250 µg/ml), highlighting their antioxidative potential. However, as the concentration increased, a pro-oxidative effect was observed, likely due to the high levels of flavonol glycosides present in the extracts. Additionally, the analysis indicated that the alcoholic extract contained higher concentrations of polyphenolics and flavonol glycosides compared to the aqueous extract (Srivastava *et al.*, 2015). Methanolic extracts of *Zinnia elegans* were fractionated and analyzed, revealing polyphenolic compounds such as chlorogenic acids, apigenin, and kaempferol glycosides. Antioxidant assays demonstrated moderate 15-LOX inhibition and metal chelation activity, with kaempferol glycosides contributing to the bioactivity. NMR spectroscopy also identified a novel guanidine alkaloid, highlighting the potential of the plant as a source of antioxidant compounds (Burlec *et al.*, 2019). The study on methanolic extract of *Tageteserecta* flowers using HR LC-MS, identifying over 50 bioactive compounds, including polyphenolic acids, flavonoids, amino acids and tannins. Further purification yielded a flavonoid-rich fraction with over 85% quercetagitrin, which was characterized using NMR techniques. Biological assays showed that this isolated fraction exhibited stronger antioxidant activity and lower cytotoxicity compared to the total extract (Burlec *et al.*, 2021). The analysis of 13 edible flowers from Japan, including Begonia, Cosmos yellow, Diana elegance pink, Diana pink, Nasturtium, Pentas, Petunia, Primula, Rose 'Purple Fragrance,' Rose 'Yves Piaget,' Snapdragon, Torenia blue and Torenia violet, demonstrates their potential as rich sources of polyphenols and antioxidants. Notably, Cosmos yellow exhibited the highest concentrations of these bioactive compounds. Additionally, several species contain provitamin A precursors, such as β-carotene and β-cryptoxanthin, which contribute to potential health benefits (Chensom *et al.*, 2019). Recent studies on *Dianthus caryophyllus* have highlighted its broad pharmacological activities, including anticancer, antiviral, antibacterial, antifungal, and insecticidal effects. The plant's phenolic compound, kaempferide triglycoside, has shown anticancer potential against colon cancer cell lines (Chandra *et al.,* 2016).

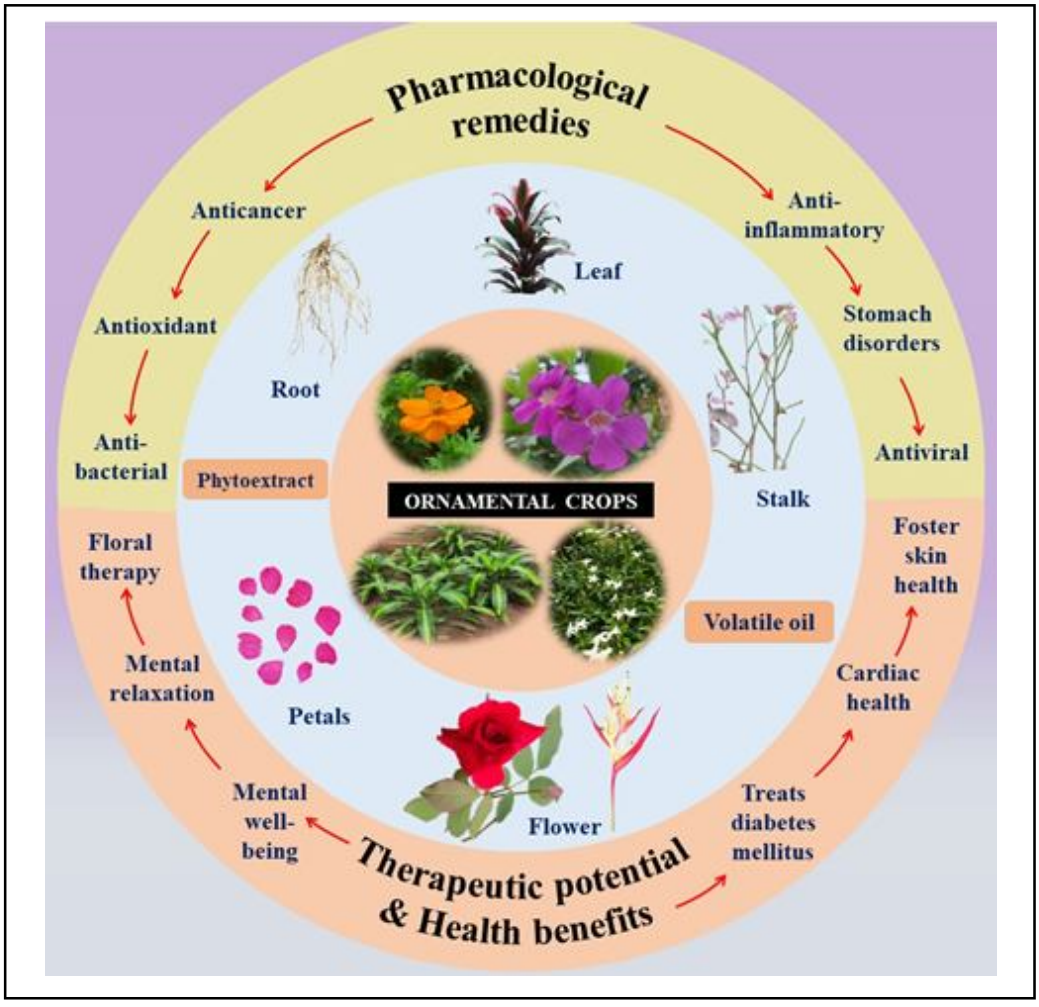

Figure 1: Phytomedicinal contributions of ornamental plants and their multifaceted roles.

A widely targeted LC-MS/MS-based metabolomics analysis of purple, green, yellow and white carnation flowers identified 932 metabolites, with significant variations based on colour. Purple flowers exhibited the highest antioxidant and anticancer activities, linked to key metabolites such as 6-hydroxykaempferol-3,6-O-diglucoside, quercetin-3-O-sophoroside and 20-deoxyguanosine, the latter showing potent antiproliferative effects on A549 and U2OS cells. The combination of 20-deoxyguanosine with other flavonoids enhanced its antitumor properties. These findings highlight the phytochemical diversity in carnations and their potential medicinal applications (Zhou *et al.*, 2023). This further underscores the importance of continued research and exploration in ornamental species for their pharmaceutical utility. Beyond this valuable contribution, their therapeutic potential also highlights the untapped value of ornamental plants as a resource for developing new medicinal products and drug formulations. Notably, the presence of saponins and flavonoids in the bark of *D. regia* significantly enhances its therapeutic profile, as these compounds are known for their immunomodulatory, anti-inflammatory and cardioprotective activities (Suhane *et al.*, 2016). The diverse contributions of various ornamental plants, including their potential applications in pharmacology and healthcare medicine, are represented in Figure 1.

4. Therapeutic benefits and mental well-being

In present-day society, mental stress and various psychiatric disorders are significant issues that negatively impact working conditions and daily activities. Research has shown that olfactory stimulation caused by inhalation of the fragrance spread by ornamental plants, plays a critical role in improving human psychophysiological states, particularly by alleviating mental stress (Park *et al.,* 2015). Engaging in horticultural activities such as flower basket-making, significantly reduced anxiety level and induced notable brainwave changes in 40 Chinese females, suggesting its potential as an effective intervention for promoting relaxation and enhancing well-being (Tao *et al.*, 2020). Interacting with nature, particularly touching real grass, has notable pharmacological effects. Research shows that contact with natural grass significantly lowers systolic and diastolic blood pressure, suggesting a calming influence similar to anti-hypertensive medications. EEG studies indicate enhanced brainwave activity linked to relaxation and focus, akin to anxiolytic drugs. Participants report reduced anxiety and improved attentiveness, highlighting the potential of natural environments as non-pharmacological interventions for stress relief and overall well-being in urban settings (Hassan and Deshun, 2024). Investigation on the physiological and psychological effects of touching Hinoki cypress wood (an ornamental tree grown in gardens) with the soles of the feet, showed that contact with Hinoki significantly decreased prefrontal cortex activity, increased parasympathetic nervous activityand reduced sympathetic nervous activity and also participants reported that, feeling more relaxed, comfortable and natural compared to when they touched a marble surface. These findings suggest that tactile stimulation with Hinoki wood promotes physiological relaxation and positive psychological responses (Ikei *et al.*, 2018). Key findings on evaluating the physiological effects of tactile stimulation on the soles of the feet using sugi (*Cryptomeria japonica*) wood among 27 female university students included significant decreases in oxy-hemoglobin (oxy-Hb) concentrations in the prefrontal cortex, indicating reduced brain activity, especially with uzukuri-finished wood compared to marble. Additionally, there was an increase in parasympathetic activity (ln(HF)) and a decrease in sympathetic activity (ln (LF/HF) ratio) (Ikei and Miyazaki, 2020).

The psychophysiological effects of viewing purple and blue hydrangea flowers among stressed finance workers for three minutes, demonstrated notable increases in alpha brain wave activity and enhanced parasympathetic nervous activity and also increased sensations of comfort, relaxation, and cheerfulness, with blue flowers having the most pronounced effect. These findings highlight the potential benefits of incorporating blue and purple flowering plants into office environments as a therapeutic strategy to promote relaxation and improve overall well-being (Elsadek and Liu, 2021). The meta-analysis on lavender's efficacy revealed significant reductions in anxiety (Hedges' g = 0.72) and depression (Hedges' g = 0.43), with limited effects on physiological parameters like systolic blood pressure (Hedges' g = 0.23). The route of administration and frequency of treatment sessions influenced outcomes, particularly for anxiety. Lavender aromatherapy showed notable psychological benefits, though physiological effects were minimal (Kim *et al.*, 2021a). The randomized clinical trial investigated the impact of lavender essential oil on well-being in 30 hemodialysis patients. The experimental group inhaled lavender at concentrations increasing from 10% to 50% over five weeks, while the control group received routine care. Significant improvements in well-being were observed in the experimental group during the fourth and fifth weeks, particularly at 40% and 50% lavender concentrations. Lavender inhalation aromatherapy showed positive effects on the well-being of haemodialysis patients, suggesting its potential as a complementary therapy (Bagheri-Nesami *et al.*, 2018). Incorporating ornamental and decorative plants into our environments not only allows us to benefit from their medicinal properties but also provides non-pharmacological interventions that can improve overall health and quality of life.

5. Conclusion

Ornamental plants are not merely decorative; they represent a vital resource with significant pharmacological benefits. Rich in bioactive compounds such as antioxidants and essential oils, these plants play a crucial role in traditional healthcare systems like Ayurveda and Siddha. Their under appreciated nutraceutical potential includes essential nutrients that can enhance health. Research highlights the therapeutic applications of phytochemicals from ornamental plants, revealing properties that may combat cancer and bacterial infections. Additionally, the mental health benefits of these plants, through engagement with nature and the calming effects of plant fragrances, underscore their value as non-pharmacological interventions. Ultimately, the diverse benefits of ornamental plants highlight the need for continued research and awareness, as they hold great promise for enhancing human health in both pharmacological and psychological realms.

Conflict of interest

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

References

Aakul, A. A. and Okur, M. E. (2021). Beta-sitosterol and its antinociceptive mechanism action. J. Fac. Pharm. Ankara Univ., **45**(2):238-252.

Ahmad, R.; Srivastava, S.; Ghosh, S. and Khare, S. K. (2021). Phytochemical delivery through nanocarriers: A review. Colloids Surf. B: Biointerfaces, **197**:111389.

Al-Awthan, Y. S. and Bahattab, O. S. (2021). Phytochemistry and pharmacological activities of *Dracaena cinnabari* resin. Biomed. Res. Int., **2021**:1-7.

Ameen, O. M.; Olatunji, G. A.; Usman, L. A.; Adebayo, M. A.; Zubair, M. F.; Opabola, T. O. and Agboola, D. O. (2015). The phytochemical screening and toxicity of the stem extracts of *Dracaena manni* Baker. Int. J. Chem. Sci., **7**:17-25.

Bagheri-Nesami, M.; Shorofi, S. A.; Nikkhah, A.; Roohi Moghaddam, H. and Mahdavi, A. (2018). The effect of lavender aromatherapy on well-being in hemodialysis patients: A randomized clinical trial. Pharm. Biomed. Res., **4**(2):18-22.

Burlec, A. F.; Pecio, Ł.; Kozachok, S.; Mircea, C.; Corciovă, A.; Vere'tiuc, L.; Cioancă, O.; Oleszek, W. and Hăncianu, M. (2021). Phytochemical profile, antioxidant activity, and cytotoxicity assessment of *Tagetes erecta* L. flowers. Molecules, **26**(5):1201.

Burlec, A. F.; Pecio, Ł.; Mircea, C.; Cioancă, O.; Corciovă, A.; Nicolescu, A.; Oleszek, W. and Hăncianu, M. (2019). Chemical profile and antioxidant activity of *Zinnia elegans* Jacq. fractions. Molecules, **24**(16):2934.

Chandra, S.; Rawat, D.; Chandra, D. and Rastogi, J. (2016). Nativity, phytochemistry, ethnobotany and pharmacology of *Dianthus caryophyllus* L. J. Med. Plant Res., **10**(1):1-9.

Chensom, S.; Okumura, H. and Mishima, T. (2019). Primary screening of antioxidant activity, total polyphenol content, carotenoid content and nutritional composition of 13 edible flowers from Japan. Prev. Nutr. Food Sci., **24**(2):171.

Choudhary, D.; Mashkey, V. K.; Goutam, E.; Shrivastava, M.; Rawat, M.; Kumari, A. and Tripathi, V. (2023). Medicinal orchids: Traditional uses and recent advances. Ann. Phytomed., **12**(1):1-9. http://dx.doi.org/10.54085/ap.2023.12.1.4.

Das, P.; Preethi, K.; Kiruba, A. A.; Nikhil, K. and Nayak, A. (2021). Flavonoids: An alternative pathway for the treatment of Alzheimer's disease. Ann. Phytomed., **10**(2):240-251. http://dx.doi.org/10.21276/ap.2021.10.2.33.

Delgado-Altamirano, R.; López-Palma, R. I.; Monzote, L.; Delgado-Domínguez, J.; Becker, I.; Rivero-Cruz, J. F.; Esturau-Escofet, N.; Vázquez-Landaverde, P. A. and Rojas-Molina, A. (2019). Chemical constituents with leishmanicidal activity from a pink-yellow cultivar of *Lantana camara* var. aculeata (L.) collected in Central Mexico. Int. J. Mol. Sci., **20**(4):872.

Elsadek, M. and Liu, B. (2021). Effects of viewing flowering plants on employees' wellbeing in an office-like environment. Indoor Built Environ., **30**(9):1429-1440.

Endrini, S.; Rahmat, A.; Ismail, P. and Hin, T. Y. (2002). Anticarcinogenic properties and antioxidant activity of henna (*Lawsonia inermis*). J. Med. Sci., **2**(4):194-197.

Feng, Y.; Jia, B.; Feng, Q.; Zhang, Y.; Chen, Y. and Meng, J. (2021). Dendrobine attenuates gestational diabetes mellitus in mice by inhibiting Th17 cells. Basic Clin. Pharmacol. Toxicol., **128**(3):379-385.

Garcellano, R. C.; Cort, J. R.; Moinuddin, S. G. A.; Franzblau, S. G.; Ma, R. and Aguinaldo, A. M. (2019). An iboga alkaloid chemotaxonomic marker from endemic *Tabernaemontana ternifolia* with antitubercular activity. Nat. Prod. Res., **34**(8):1175-1179. https://doi.org/10.1080/14786419.2018.1550759.

González-Barrio, R.; Periago, M. J.; Luna-Recio, C.; Garcia-Alonso, F. J. and Navarro-González, I. (2018). Chemical composition of the edible flowers, pansy (*Viola wittrockiana*) and snapdragon (*Antirrhinum majus*) as new sources of bioactive compounds. Food Chem., **252**:373-380.

Grzeszczuk, M.; Stefaniak, A.; Meller, E. and Wysocka, G. (2018). Mineral composition of some edible flowers. J. Elementol., **23**(1):151-162.

Gupta, M. and Sarwat, M. (2022). Nutraceutical interventions for anaemia. Ann. Phytomed., **11**(2):75-81.http://dx.doi.org/10.54085/ap.2022.11.2.8.

Hassan, A. and Deshun, Z. (2024). Nature's therapeutic power: A study on the psychophysiological effects of touching ornamental grass in Chinese women. J. Health Popul. Nutr., **43**(1):23.

Ikei, H. and Miyazaki, Y. (2020). Positive physiological effects of touching sugi (*Cryptomeria japonica*) with the sole of the feet. J. Wood Sci., **66**(1):29.

Ikei, H.; Song, C. and Miyazaki, Y. (2018). Physiological effects of touching the wood of hinoki cypress (*Chamaecyparis obtusa*) with the soles of the feet. Int. J. Environ. Res. Public Health, **15**(10):2135.

James, A. R. and Jayaprakash, S. (2023). Therapeutic and anticancer properties of *Nerium oleander*- A poison as medicine. Int. J. Drug Deliv. Technol., **13**(4):1563-1567. https://doi.org/10.25258/ijddt.13.4.68.

Johri, D. A. (2022). Ornamental medicinal plants for primary healthcare. Int. J. Res. Publ. Rev., **3**(12):2267-2272.

Kalam, M. A.; Jalal, B.; Zahoor, U. and Ahmed, A. (2024). Gurhal (*Hibiscus rosa-sinensis*): Medicinal importance in perspective of unani medicine and pharmacological studies. Eur. J. Pharm. Med. Res., **11**(4):322-329.

Kaur, A.; Alam, Md.A.; Mahmood, T. and Ahsan, F. (2023). Herbal medicinal plants for the treatment of memory impairment: A futuristic approach for neurological studies. Ann. Phytomed., **12**(2):29-40. http://dx.doi.org/10.54085/ap.2023.12.2.5.

Khan, I. A.; Hussain, M.; Munawar, S. H.; Iqbal, M. O.; Arshad, S.; Manzoor, A.; Shah, M. A.; Abbas, K.; Shakeel, W. and Syed, S. K. (2021). *Jasminum sambac*: A potential candidate for drug development to cure cardiovascular ailments. Molecules, **26**(18):56-64.

Kim, M.; Nam, E. S.; Lee, Y. and Kang, H.J. (2021a). Effects of lavender on anxiety, depression, and physiological parameters: Systematic review and meta-analysis. Asian Nurs. Res., **15**(5):279-290.

Kim, Y.R.; Han, A.R.; Kim, J.B. and Jung, C.H. (2021b). Dendrobine inhibits γ-irradiation-induced cancer cell migration, invasion and metastasis in non-small cell lung cancer cells. Biomedicines, **9**(8):954.

Komar-Tyomnaya, L. and Dunaevskaya, E. (2018). The content of essential elements in the flowers and fruits of chaenomeles (Chaenomeles Lindl.). Agrofor., **2**(1):48-54.

Lee Ji, W. O. N. (2020). Composition for improving cognitive function including *Clematis terniflora* var. Mandshurica extract as active ingredient. EP 3659617 A1.

Lei, G.; Song, C.; Wen, X.; Gao, G. and Qi, Y. (2022). Chemical diversity and potential target network of woody peony flower essential oil from eleven representative cultivars (*Paeonia* × *suffruticosa* Andr.). Molecules, **27**(9):2829.

Li, S.; Zhou, J.; Xu, S.; Li, J.; Liu, J.; Lu, Y.; Shi, J.; Zhou, S. and Wu, Q. (2019). Induction of Nrf2 pathway by *Dendrobium nobile* Lindl. alkaloids protects against carbon tetrachloride induced acute liver injury. Biomedicine Pharmacother., **117**:109073.

Liu, C.Y.; Meng, J.; Qiu, J.Y.; Geng, X.Q.; Sun, H.Q. and Zhu, Z.Y. (2022). Structural characterization and prebiotic potential of an acidic polysaccharide from Imperial Chrysanthemum. Nat. Prod. Res., **36**(2):586-594.

Mawunu, M.; Lautenschläger, T.; Luyeye, L. and Ndiku, L. (2021). Proximate and mineral composition of Nsala Bakala (*Dracaena camerooniana* Baker) leaves, stems and roots from Nzenze forest in Uíge Province, Angola. Eur. J. Biol. Biotechnol., **2**(4):11-19.

Milstein, G. P. (2005). The uses and potential of wildflower seed in landscaping. In: Flower seeds: Biology and technology (ed. M. B. McDonald), CABI Publishing, Wallingford, UK, pp:39-51.

Mlcek, J.; Plaskova, A.; Jurikova, T.; Sochor, J.; Baron, M. and Ercisli, S. (2021). Chemical, nutritional and sensory characteristics of six ornamental edible flowers species. Foods, **10**(9):2053.

Mothana, R. A. A.; Gruenert, R.; Lindequist, U. and Bednarski, P. J. (2007). Study of the anticancer potential of Yemeni plants used in folk medicine. Die Pharmazie, **62**(4):305-307.

Narender, B.; Naveena, N.; Pravalika, P.; Kaleem, S.; Vamshi, M. and Mandhadi, J. R. (2017). Pharmacological evaluation of root and leaf extracts of *Dracaena reflexa* var. angustifolia. Innov. Pharm. Pharmacother, **5**(3):141-146.

Nidhi, S. (2023). Studies on utilization of pansy (*Viola tricolor* var. Hortensis L.) in landscape, food industry and improving the mental well-being of humans. Doctoral Thesis submitted to Department of Floriculture and Landscape Architecture, UHF, Nauni.

Nie, J.; Tian, Y.; Zhang, Y.; Lu, Y.L.; Li, L.S. and Shi, J.S. (2016). Dendrobium alkaloids prevent Aâ25-35-induced neuronal and synaptic loss *via* promoting neurotrophic factors expression in mice. Peer J., **4**:1-16.

Park, H.J.; Lim, E.J.; Zhao, R. J.; Oh, S. R.; Jung, J. W.; Ahn, E.M.; Lee, E. S.; Koo, J. S.; Kim, H. Y. and Chang, S. (2015). Effect of the fragrance inhalation of essential oil from *Asarum heterotropoides* on depression-like behaviors in mice. BMC Complement Altern. Med., **15**:1-8.

Prema; Tripathi, A. K.; Dwivedi, A. and Rosy, R. (2015). Medicinally useful ornamental plants of kitchen garden. World J. Pharm. Pharm. Sci., **4**(9):424-445.

Puranik, N. V. and Srivastava, P. (2017). First synthesis of rugosaflavonoid and its derivatives and their activity against breast cancer. RSC Advances, **7**(52):33052-33060.

Rios-Chavez, P.; Perez-Gonzalez, J.; Salgado-Garciglia, R.; Ramirez-Chavez, E.; Molina-Torres, J.; Martinez-Trujillo, M. and Carreon-Abud, Y. (2019). Antibacterial and cytotoxicity activities and phytochemical analysis of three ornamental plants grown in Mexico. Anais Acad. Bras. Cienc., **91**(2):e20180468.

Sahu, D.; Sahu, J. K.; Kumar, V. and Tamrakar, S. K. (2023). Phytochemicals and medicinal uses of *Clitoria ternatea* L. Int. J. Plant Soil Sci., **35**(18):942-951.

Srivastava, S.; Kumar, R. and Luqman, S. (2015). Antioxidative and pro-oxidative property of *Matricaria chamomilla* L. flower for the variants of deoxyribose degradation. Ann. Phytomed., **4**(2):52-58.

Suhane, N.; Shrivastava, R. R. and Singh, M. (2016). Gulmohar an ornamental plant with medicinal uses. J. Pharmacogn. Phytochem., **5**(6):245-248.

Tao, J.; Hassan, A.; Qibing, C.; Yinggao, L.; Li, G.; Jiang, M.; Li, D.; Nian, L.; Bing-Yang, L. and Ziqin, Z. (2020). Psychological and physiological relaxation induced by nature working with ornamental plants. Discrete Dyn. Nat. Soc.,**2020**:1-7.

Tiwari, P.; Ansari, V. A.; Mahmood, T. and Ahsan, F. (2022). Augumentation and evaluation of betasitosterol based liposomes. Ann. Phytomed., **11**(1):648-656.http://dx.doi.org/10.54085/ap.2022.11.1.76.

Ullah, M. A.; Hassan, A. and Hamza, A. (2023). Calendula (*Calendula officinalis*) marigold as medicinal plant. Orthop. Case Rep., **2**(1):1-9.

Van Iersel, M. W.; Chappell, M. R. and Thomas, P. A. (2016). Optimizing growth, quality, and profits through precision irrigation in ornamental plant production. Acta Hortic., **1131**:57-64.

Vijayanchali, S. (2017). Nutrient, phytonutrient and antioxidant activity of the dried rose petals. J. Res. Ext. Dev., **6**(2):36-39.

Wei, X.; Lyu, S.; Yu, Y.; Wang, Z.; Liu, H.; Pan, D. and Chen, J. (2017). Phylloremediation of air pollutants: Exploiting the potential of plant leaves and leaf-associated microbes. Front. Plant Sci., **8**:1318.

Zhou, X.; Wang, M.; Li, H.; Ye, S. and Tang, W. (2023). Widely targeted metabolomics reveals the antioxidant and anticancer activities of different colors of *Dianthus caryophyllus*. Front. Nutr., **10**:1166375.

Citation **T. Deepikakrishnaveni, A. Jaya Jasmine, M. Ganga, D. Rajakumar and A. Senthil (2024). A review on the nutritional composition and pharmacological properties of ornamental plants beyond their aesthetic and therapeutic potential. Ann. Phytomed., 13(2):55-62. http://dx.doi.org/10.54085/ap.2024.13.2.6.**