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Viola tricolor L.: A systematic review on ethnopharmacology, phytochemistry and pharmacology of an important traditional medicinal plant

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Abstract
Viola tricolor (Family: Violaceae) is a widely recognized plant known both for its medicinal value and its presence as a weed. The violet family consists of roughly 500 species across 20 genera, many of which are prevalent throughout diverse geographical regions. *Viola tricolor* blossoms in areas such as the Mediterranean, the Caucasus, and across continents including Europe, Asia, North and South America, and Australia. Traditionally, this plant has played a pivotal role in folk medicine, helping to treat conditions like bronchitis, asthma, respiratory inflammation, skin disorders, epilepsy, difficulty breathing, rheumatism, eczema, itching, and impetigo. It's also known for aiding metabolism and offering calming, sedative effects. The plant is rich in bioactive compounds. Its key ingredients include flavonoids—especially rutin—as well as anthocyanins, coumarins, tannins, saponins, phenolic acids, cyclotides, mucilage, violantin, violaxanthin, violaquercetin, anthocyanidin glycosides, vitamin C (ascorbic acid), vitamin E (alpha-tocopherol), alkaloids, and essential oils. Both crude extracts and isolated substances from *Viola tricolor* exhibit a broad spectrum of pharmacological properties. These include antimicrobial, anti-inflammatory, antioxidant, diuretic, antitussive, immunosuppressive, and expectorant activities. This review draws upon literature issued between 2000 and 2025, sourced from reputable databases like Google Scholar, Sci-Hub, ResearchGate, and ScienceDirect. The paper provides a systematic overview of the plant's botanical classification, global distribution, ethnomedicinal uses, chemical makeup, and therapeutic potential.

Keywords: *Viola tricolor*, Violaceae, traditional use, phytochemistry, pharmacology

Introduction
Medicinal plants have long been valued as natural treatments for a wide range of ailments, with their use tracing back to ancient civilizations. In recent decades, scientific research has validated many of these traditional practices, confirming the effectiveness of plant-based remedies in addressing human health issues. Due to their abundance of bioactive compounds, numerous medicinal herbs have been formally incorporated into national pharmacopoeias and are now endorsed by conventional medicine [1]. Over the last years, the reputation of medicinal plants has increased due to their therapeutic efficacy and fewer side effects. Medicinal plants are of prime importance in the treatment of existing as well as emerging diseases due to their cost-effectiveness, better safety profiles, readily accessible sources, and higher yields [2].
Viola tricolor L. (Family: Violaceae) is a widely distributed medicinal plant throughout the world [3]. The Violaceae family comprises around 806 species, predominantly made up of flowering plants. Among them, *Viola tricolor* stands out as one of the most vivid and widely cultivated winter annuals, native to the temperate regions of Europe [4]. The name of the family is derived from its most prominent genus, Viola, which encompasses approximately 450 species [5]. *Viola tricolor* has a long-standing tradition in folk medicine in treating bronchitis and asthma [6]. *Viola tricolor* has a longstanding tradition of medicinal use across Europe, where it's been employed to alleviate a range of ailments such as respiratory inflammation, skin conditions, epilepsy, shortness of breath, rheumatic disorders, and asthma [7]. The major constituents of the plant are flavonoids, particularly rutin, and other compounds, like anthocyanins, coumarins, tannins, saponins, phenolic acids, and cyclotides [3, 8]. This plant is rich in mucilage, violantin, violaxanthin, violaquercetin, anthocyanidin glycosides, and some saponins, ascorbic acid, alpha-tocopherol, alkaloids, and essential oils, with considerable antioxidant activity [7].

It exhibits remarkable pharmacological activities, including antimicrobial [6], diuretic [9], anti-inflammatory, antioxidant, antitussive, immunosuppressive, and expectorant properties [10, 11].

This article aims to comprehensively search and summarize the traditional uses, phytochemistry, and pharmacological studies of the *Viola tricolor* plant by searching diverse databases and providing a literature basis for the in-depth development and systematic research of the discovery of this plant.

Methodology

This review draws upon data collected from a variety of reputable academic sources, including Google Scholar, PubMed, ResearchGate, ScienceDirect, Sci-Hub, and other scientific databases. The search was performed using key terms such as "Viola," "phytochemistry," "pharmacological activity," and "traditional use". Covering publications from 2000 to 2025, the study analyzed a total of 61 noteworthy articles. The chemical constituents of *Viola tricolor* are presented based on their structural classifications, while the pharmacological activities are organized according to their shared functional effects.

Taxonomical classification

- **Kingdom:** Plantae
- **Clade:** Angiosperms
- **Order:** Malpighiales
- **Family:** Violaceae
- **Genus:** Viola
- **Species:** *Viola tricolor* [12]
- **Synonyms:** Wild pansy, Heartsease [13]
- **Vernacular Names:** The European and Asian parts are known as Heartsease [14].

Description

Viola tricolor is a popular decorative plant commonly found in urban green spaces. Its English names include "pansy," "viola," and "violet." Typically, the term "pansy" refers to large-flowered, multi-colored hybrids cultivated for bedding displays, while "viola" denotes the smaller, more delicate varieties. Modern gardening has brought forth an extensive palette of pansy colors, ranging from yellow, gold, and orange to purple, red, white, and even deep black. Though pansies belong to the perennial plant group, they are most often grown as biennials: producing foliage in their first year and blooming along with seed formation in the second. These plants are generally sown in autumn, making them ideal for seasonal flower beds. Their tolerance to light frost and brief snow cover allows them to thrive through cooler months. In mild climates, pansies can flower during winter and may even self-seed. However, they struggle with heat, as elevated temperatures and warm air tend to hinder their blooming and may lead to wilting [15]. Pansy flower petals are fairly broad, the lateral ones directed forwards and upwards, 2-3 cms in height and 0.4-0.6 cms in spur [13].

Figure: *Viola tricolor*

Table 1: Plant description of *Viola tricolor* [16]

Plant parts	Description	Figure
Leaves	*Viola tricolor* has alternate, stalked leaves that can be cordate, oblong, or lanceolate. The leaf margins are typically crenate or dentate, meaning they have rounded or small teeth, according to plant identification guides. The stipules, leaf-like appendages at the base of the leaf stalk, are often quite prominent and deeply lobed.	

Flowers	Flowers have various color combinations of yellow, purple-red, violet-blue, or white. The flowers contain antioxidants and are edible	
Seeds	*Viola tricolor* produces small, dark-colored seeds that are typically oval or slightly rounded in shape. These seeds are often described as fine and require careful handling during sowing. They are produced in 3-valved capsules that eject the seeds when dry.	
Stem	*Viola tricolor* has stems that are typically 10-40 cm tall, erect or slightly oblique, and angled. The stems can be simple or numerously branched. They bear alternate leaves and are either glabrous or slightly hairy. The stems are also described as light green to purplish green.	

Geographic range

- **Distribution**

Viola tricolor is an annual, biennial, or perennial herbaceous plant native to European, Asian [17], and African countries [16]. It can be found in the lower Silesia region in Poland [18], Tehran, Iran, the Netherlands [19], and Ukraine [1]. It is widely distributed across northern and southern temperature zones [16].

- **Habitat**

Viola tricolor is found on dry hillsides, flat rocks, dunes, and cultivated lime-deficient soil [20, 21]. It prefers to grow in weakly acidic, neutral, or clay loam soil with a pH of 5.4–7.4, which is well-drained and rich in organic matter [10]. It occurs most frequently in meadows, cultivated ground, and synanthropic habitats linked to woodland and semi-natural land [22].

- **Growth stages**

The favorable soil conditions for this flower are well-drained, and the sun is at varying levels, which allows it to grow up to 23 centimeters or 9 inches. It starts as a seed, then germinates, develops vegetative growth, and eventually flowers [23].

- **Biology and Ecology**

Viola tricolor prefers sun and well-drained soil, but also tolerates low temperatures. The optimal time for transplanting pansy seedlings outdoors is in autumn, although early autumn frosts can affect the insufficient nutrient uptake, which can be a limiting factor for seedling survival [15]. Most commonly annual, but there are a few perennial forms [13]. One of the bedding plants is “Pansy”, possessing the capacity to persist in blossoms from the end of October till May in the Northern Hemisphere under temperate climatic conditions [24].

- **Natural enemies**

Viola tricolor has several natural enemies, including various insects, diseases, and even environmental factors. Common insect pests include aphids, caterpillars and thrips. Diseases like black root rot can also affect *Viola tricolor*. Additionally, slugs and snails can be a nuisance, feeding on the flowers and foliage [24].

Traditional uses

The various phytochemicals present in plants have been reported to possess great potential in the treatment of multiple diseases [25]. The aerial parts are used as expectorant and diuretic, for skin conditions, bronchitis, cystitis, and rheumatism [26]. The whole of the plant can be used in medicine, such as lowering the temperature, detoxification, dispersing blood stasis, and relieving coughs [27]. It is a well-known herb in traditional medicine, prescribed for the treatment of illnesses such as coughs and inflammatory skin diseases [6, 28-30]. It is used to treat rheumatic pains, asthma,

and respiratory problems [31, 32, 33]. It has been used by folk healers to treat and control a variety of human diseases, including infectious diseases, diabetes, lung diseases, cough, fatigue, and several other conditions [34].

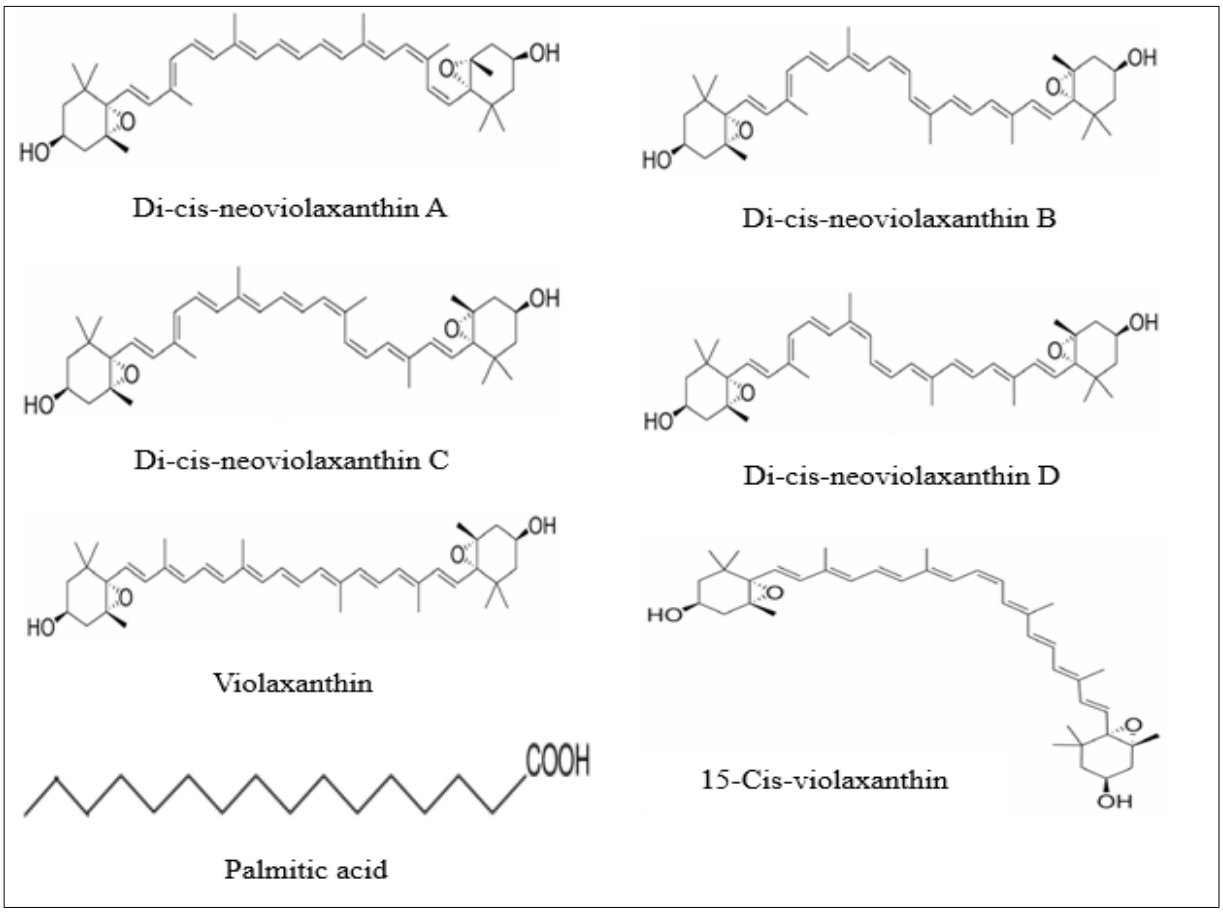
In traditional medicine, fragrant violets played a significant therapeutic role. Sweet violet decoctions were employed as choleretics, blood pressure reducers, and remedies for fever, heart palpitations, and fainting. The plant was commonly prescribed for respiratory issues such as coughs, sore throats, pleurisy, and lung inflammation, as well as disorders of the digestive and urinary systems. The aroma of fresh violet flowers was believed to alleviate headaches, promote calmness, combat insomnia, and counteract various toxins. Violet oil was historically used to treat dry skin, wounds, and hair loss. Additionally, all parts of the plant—including the stems, leaves, flowers, fruits, and seeds—were used in the management of skin conditions, cystitis, bronchitis, inflammation, and served as a diuretic [26]. A concentrated decoction made from grass and violet roots is traditionally used to induce vomiting. Milder doses serve as a remedy for jaundice and epilepsy. Violet syrup is commonly employed to relieve asthma and airway obstruction. For children suffering from chickenpox, 5–7 drops of fresh plant sap are recommended. An infusion of the herb is applied externally to treat eye conditions, while both internal and external applications are used to address pneumonia, scrofula, and cutaneous tuberculosis [1].

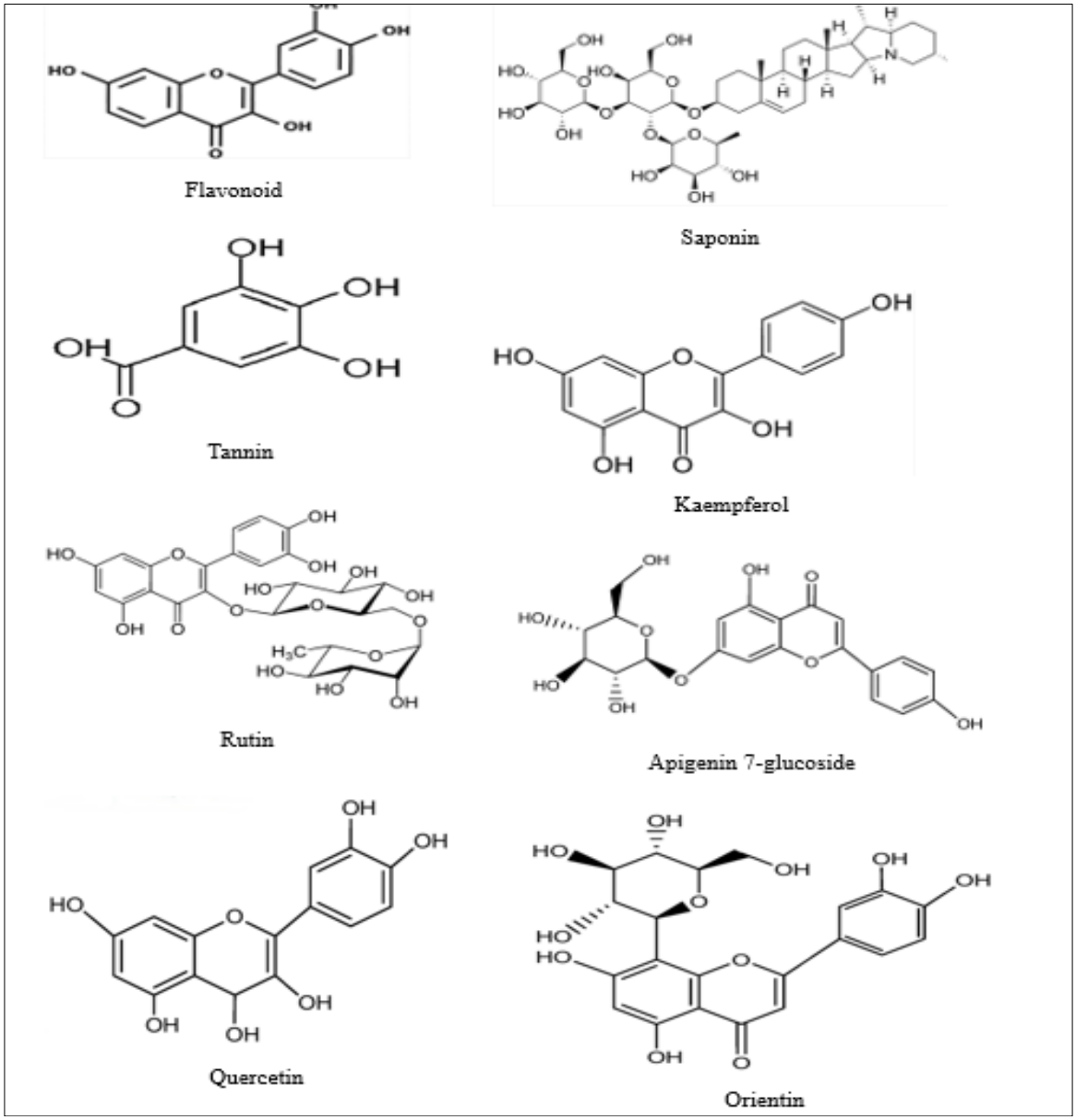
Phytochemical Constituents

The major constituents of the plant are flavonoids, particularly rutin, and other compounds, like anthocyanins, coumarins, tannins, saponins, phenolic acids, and cyclotides [3,8]. The essential oil obtained from fresh aerial parts of *Viola tricolor* has been reported to contain 35 compounds representing 97.76% of the total oil. Sesquiterpenes were the major component (59.27%), followed by aliphatics (29.81%), shikimic acid derivatives (8.05%), and monoterpenes (0.30%). The main volatile compounds were bisabolone oxide (43.25%), trans-β-farnesene (4.01%), and bisabolol oxide A and B (7.78 and 2.28%) [26, 34, 35]. The essential oil extracted from dried aerial parts of *Viola tricolor* has been reported to contain 24 compounds representing 60.53% of the total oil. The main volatile compounds found were hexahydrofarnesyl acetone (4.06%), methyl salicylate (1.22%), and β-ionone (1.00%). Aliphatic were the major components (42.21%), followed by shikimic acid derivatives (11.20%), sesquiterpenes (4.79%), and monoterpenes (2.32%) [26].

Tricolor violets contain mucilage, tartaric acid salt, salicylic acid, vitamin C, beta-carotene, violoquercetin alkaloid, yellow pigment, phytoncides, catechins, gallic acid; flavonoid compounds: hyperoside, rutin, kaempferol, quercetin, apigenin, and dihydrocoumarin [36]. *Viola tricolor* directly contains significant amounts of: *p*-coumaric acid, cycloides, glucose, sterols, essential oils, aromatic acids and their derivatives [34]. In the flowers of *Viola tricolor*, anthocyanin glycosides were found: delphinidin, peonidin; violanin, the latter consisting of delphinidin, glucose, rhamnose and cinnamic acid. The essential oil composition of these species is mainly represented by methyl ester of salicylic acid [37]. *Viola tricolor* also contains Di-cis-neoviolaxanthin A (C40 H56 O4), Di-cis-neoviolaxanthin B (C40 H56 O4), Di-cis-neoviolaxanthin C (C40 H56 O4), Di-cis-neoviolaxanthin D (C40 H56 O4), Violaxanthin (C40 H56 O4) [38], 15-Cis-violaxanthin (C40 H56 O4) [39], 2-Methyl benzyl alcohol, Bisabolone oxide, Bisabolol oxide A, Palmitic acid, Phytol [26], Apegenin 7-glucoside, Quercetin, Orientin [40].

Table 1: Structures of phytochemicals collected from *Viola tricolor* [26,38,39,40,41,42]





Pharmacological activities

- **Anti-inflammatory activity and Anti-nociceptive effects**

Viola tricolor demonstrated both anti-inflammatory and pain-reducing effects in rat models with thermal burn injuries. Additionally, it suppressed the growth of activated lymphocytes by lowering IL-2 cytokine production, without influencing the expression of IL-2 receptors, suggesting its potential as a treatment for conditions linked to an overactive immune system [1]1,4[3]. Toiu *et al*. found a large amount of salicylic acid in the aerial parts of this plant [44], which exerts anti-inflammatory properties [45].

- **Anti-oxidant activity**

The crude methanol/water extract of *Viola tricolor* was found to possess significant antioxidant activity. DPPH radical-scavenging activity and the Folin-Ciocalteu assay method were used to determine the antioxidant activity. Phenolic compounds, flavonoids, particularly flavone, flavonol, and anthocyanin isolated from the plant extract, have been proven to show antioxidant activity [46]. Much better antioxidant capacity was found for the extract of the flowers of *Viola tricolor*. Higher amounts of rutin also contribute to the antioxidant capacity of this species [25].

- **Antibacterial activity**

Witkowska-Banaszczak *et al*. (2005) found antimicrobial activity of infusion, decoction, and alcoholic extract of *Viola tricolor* with significant inhibitory effect against *Staphylococcus aureus*, *Bacillus cereus*, *Staphylococcus epidermidis*, and *Candida albicans* and moderate activity against *Pseudomonas aeruginosa*, *Enterococcus faecalis*, *Escherichia coli*, and *Klebsiella pneumoniae* [1].

- **Antifungal activity**

In vitro tests of *Viola tricolor* extracts rich in tannins showed fungicidal activity. They can also help in the healing process of wounds, burns, and inflammation by forming a protective layer in the damaged skin [47].

- **Antimicrobial activity**

The antimicrobial test was carried out using the crude extract of the plant *Viola tricolor*. Cyclotides isolated from the crude extracts have been reported to have antimicrobial activity. The crude ethanol and butanoic extracts also showed better activities against the gram-negative *E. coli* and *P. aeruginosa* than *S. aureus* [48].

- **Anti-asthmatic effects**

Anti-asthmatic effects have been identified for *Viola tricolor* During the final seven days of the Ovalbumin (OVA) challenge, asthmatic mice received oral treatment with *Viola tricolor* at a dose of 200 mg/kg. This regimen led to a notable reduction in asthma symptoms and proved more effective than dexamethasone, delivering the most promising therapeutic outcomes [19].

- **Anti-cytokine activity**

Viola tricolor possesses significant anti-cytokine activity. It was shown that this herbal preparation significantly inhibited inflammatory cytokines in cell culture models. The effect of a single dose of inflaminat administration on the expression of inflammatory cytokines was studied. Results showed that taking three tablets in one dose enhanced its anti-cytokine properties. When compared to diclofenac, a widely used reference for anti-cytokine efficacy, no statistically significant difference was observed [49].

- **Anti-tumour activity**

Recently, antitumor and cytostatic properties of violets have been identified [50]. The antitumor properties of violets have been attributed to the presence of cycloviolacin [51].

- **Anticancer activity**

In an animal cancer model, the ethyl acetate and n-butanol extracts of *Viola tricolor* aerial parts from flowering plants exhibited *in vitro* cytotoxic and antiproliferative activity. Phytochemicals with polyphenolic or flavonoid structure, such as kaempferol, luteolin, and resveratrol, have been reported to induce cancer cell death [52].

- **Anti-anxiety activity**

The results of the present study showed that the hydro alcoholic extract of *Viola tricolor* reduces anxiety-like behavior in OVA-sensitized mice. These results suggest unlike corticosteroid therapy, which cannot improve anxiety, *Viola tricolor* appears to be beneficial for managing asthma-associated anxiety [53].

- **Neuro-protective activity**

The ethanolic extract of *Viola tricolor* was tested *in vitro* for neuroprotective activity. Pharmacological studies have shown that *Viola tricolor* possesses neuroprotective effects by reducing cell death and DNA damage of nerve cells [41].

- **Diuretic activity**

The diuretic effect of violet extracts is attributed to the presence of flavonoids in them. The aqueous extract has diuretic activity at 400 mg/kg, as evidenced by increased levels of potassium and sodium ions in urine products [54]. Polysaccharides, phenolic compounds, and saponins were found to exert diuretic activity [1].

- **Metabolic disorders**

The Analysis of lipid metabolism showed an increase in high-density lipoprotein (HDL) cholesterol and a decrease in low-density lipoprotein (LDL) cholesterol in the blood of rats fed the herb compared to rats fed the high-fat di*et al*one. The results presented in this study add to the growing body of literature on the multi pharmacological activity of *Viola tricolor*, which can be applied to the development of biological products for the treatment of metabolic diseases [1].

- **Immunosuppressive Activity**

Viola tricolor is one of the medical herbs that has immunosuppressive properties. Due to bioactive cyclotides, extracts of *Viola tricolor* have a pronounced immunosuppressive effect [11]. Cyclotides are known to block T-lymphocyte proliferation by acting as immunosuppressive peptides [55].

- **Cardio protective activity**

Viola tricolor is used as a cardio-protective agent in traditional medicine. Gallic acid and polyphenols extracted from *Viola tricolor* were shown to possess cardioprotective activity [17].

- **Anti-hypertensive agent**

During *in vivo* invasive blood pressure studies, *Viola tricolor* crude extract was seen to decrease the blood pressure in a dose-dependent manner. Gallic acid, a polyphenol found in crude plant extracts, plays a dominant role in reducing raised blood pressure, showing therapeutic utility as an antihypertensive [56].

- **Food value**

Viola tricolor is a commonly consumed floral plant known for its diverse uses and health-promoting qualities, largely attributed to its rich flavonoid composition [46]. Edible flowers have long enhanced culinary creations by elevating both the sensory and nutritional aspects of food. Their vibrant colors, distinctive flavors, and aromatic qualities contribute to the overall appeal of dishes. These blossoms are incorporated into a wide array of preparations, including sauces, jellies, syrups, liqueurs, vinegars, infused honeys and oils, candied treats, decorative ice cubes, salads, teas, beverages, and assorted desserts. Beyond their aesthetic and taste-enhancing roles, edible flowers are also valued for their abundance of bioactive and nutraceutical compounds, which offer potential health benefits and contribute to overall well-being [57,58,59]. *Viola tricolor* offers a pleasant, refreshing flavor and a smooth, velvety mouthfeel, making it a versatile ingredient in culinary creations such as desserts, salads, soups, vinegars, and beverages. Additionally, it serves as a natural source for extracting blue and yellow food pigments, enhancing both the visual and nutritional appeal of various dishes [57,60]. Studies have also shown that *Viola tricolor* flowers have high nutritional value because they are rich in anthocyanins and carotenoids [61].

- **Sedative-hypnotic effect**

Viola tricolor has been recommended for its sedative properties. *Viola tricolor* potentiates pentobarbital-induced sleeping behaviours in mice. We found that EAF has the best sleep-prolonging effect. The hypnotic activity of medicinal plants has been attributed to different phytochemical compounds such as flavonoids, terpenes, and saponins. In addition, Nassiri-Asl *et al*. (2008) showed that rutin, a major flavonoid component in *Viola tricolor*, has sedative effects in the brain [2].

Conclusion

Viola tricolor is a well-known herb in traditional medicine. It has a long history of usage in the treatment of a wide range of ailments in many countries. The *in vitro* studies and *in vivo* models have provided evidence for pharmacological activities that strongly indicate that *Viola tricolor* is useful in different diseases. Research work on *Viola tricolor* has recently

become popular, but there are few reports on the toxicity of *Viola tricolor*, and it is necessary to carry out relevant toxicological research, which contributes to ensuring the safety of these medicinal plants, their extract, and isolated compounds in clinical practice and validates their safety in humans. The present review reveals that *Viola tricolor* is a valuable source of medicinally important molecules and provides convincing support for its future use in modern medicine. However, further studies and well-structured clinical trials are necessary to establish its use in medical practices worldwide.

Conflict of interest statement

We declare that we do not have any competing interests.

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