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Review Article

Current Aspects on Phytochemistry and Bioactive Constituents of *Viola odorata* L.

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ABSTRACT

Herbal drugs have received greater attention nowadays because of their diversity of curing diseases, safety and being well tolerated remedies in comparison to the conventional medicines. *Viola odorata* (Violaceae) is a historical well-known medicinal valued herb used for respiratory illnesses including coughing, sore throat, hoarseness and tonsillitis, and as expectorant, diaphoretic, antipyretic, diuretic and laxative, in bilious affections. Moreover, it is used as chief gradient in many cosmetic and perfumery products, cough syrups, joshandah, herbal tea etc. *V. odorata* possesses various bioactivity viz. antimicrobial, antioxidants, anticancer due to its unique phytochemical constituents. Apart from all such properties, this medicinal herb still needs to explore more. Therefore, this review paper aimed to provide the current scenario for the phytochemistry, pharmacological importance and bioactive properties of V. odorata.

Key words: Antimicrobial properties; Antioxidants; Phytochemicals; Respiratory illnesses; *Viola odorata*

1. Introduction

Viola odorata L. (Violaceae) is well known as Sweet Violet, English Violet, Common Violet, or Garden Violet and Gulbanafsa. It is a native of Mediterranean countries and Asia Minor. From old ages it has been grown in gardens, and now it has spread to most of Europe. *V. odorata* is a perennial herb, around 15 cm tall and contains stolons. Plant leaves are orbicular-reniform to broadly ovate, and solitary and axillary flowers with dark violet or white in colour (Fig. 1). Due to sweet and unmistakable scent of this flower, it has been used in production of many cosmetic and perfuming products. *V. odorata* is used as remedy for coughs and sore throat, hoarseness and tonsillitis. The herb is valued as an expectorant, diaphoretic, antipyretic, diuretic and as a laxative, in bilious affections (Vishal et al. 2009).

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The French are also known for their violet syrup, most commonly made from an extract of violets. In the United States, this French violet syrup is used to make violet scones and marshmallows. The scent of violet flowers is distinctive with only a few other flowers having a remotely similar odour. *V. odorata* is used either alone or in mixture with other herbs for catarrhal and pulmonary troubles and for calculous affections (Pullaiah, 2006). The pharmacological studies revealed the role of *V. odorata* in some Unani drugs for treatment of common cold, asthma, cough and associated ailments/fevers (Vohora, 1986). The plant had been used as ingredient of herbal tea for anti-aging, anti-stress, appetizer and stimulant purposes (Naithani et al. 2006).

2. Phytochemistry

V. odorata contains major secondary metabolites including flavonoids, tannins, alkaloids, phenolic contents justified with many workers findings in its various parts. The presence of flavonoids, sterols/triterpenes and tannins were reported by Khatibi et al. (1989). Ebrahimzadeh et al. (2010)

had reported that methanol extract of leaves of *V. odorata* contained total 35.4 mg/g phenolic and 22.8 mg/g flavonoid contents. An alkaloid violin is found in roots, leaves, flowers and seeds of *V. odorata*. It is a volatile oil and forms salts with acids (Prajapati et al. 2004). The elemental composition of *V. odorata* of different parts showed that flowers contained C (47.26%), O (42.39%), Mg (0.9%), Al (0.45%), Si (1.37%), Cl (0.64%), K (5.06%), Ca (1.53%) and Fe (0.39%), leaves with C (48.86%), O (44.60%), Mg (0.51%), Si (0.49%), Cl (0.48%), K (3.96%), and Ca (1.10%), stem with C (43.92%), O (47.13%), Mg (0.76%), Al (0.55%), Si (1.91%), Cl (0.58%), K (2.32%), Ca (2.20%) and Fe (0.62%) respectively (Bibi et al. 2006).

Flowers of *V. odorata* contain 4.0% anthocyanins, 1.1% flavonoids, 0.4% outside, 18.0% mucilage and 8.5% ash (Lamaison et al. 1991). Karioti et al. (2011) had reported total ten constituents in preparations of *V. odorata* including quercetin-3-O-α-rhamnopyranosyl-(1→2)-[α-rhamnopyranosyl (1→6)]-β-glucopyranoside-7-O-α-rhamnopyranoside, kaempferol 3-O-α-rhamnopyranosyl-(1→2)-[α-rhamnopyranosyl(1→6)]-β-glucopyranoside-7-O-α- rhamnopyranoside, quercetin-3-O-α-rhamnopyranosyl (1→2)-[α-rhamnopyranosyl-(1→6)]-β-glucopyranoside, kaempferol-3-O-α-rhamnopyranosyl (1→2)[α-rhamnopyranosyl-(1→6)]-β-glucopyranoside, rutin, quercetin-3-O-glucopyranoside, nikotiflorin, kaempferol-3-Oglucopyranoside, kaempferol-7-O-glucopyranoside, and apigenin-7-O-glucopyranoside. Three flavonoid compounds from various extracts including rutin, isovitexin and Kaempferol-6-glucoside (Orhan et al. 2015). Cyclotide cycloviolacin O_2, a cyclotide are such type of small disulfide rich peptides isolated from this plant (Pranting et al. 2010). α-ionone first found in the essence concrete of *Boronia megastima*, in roots of *Aplotaxis lappa*, in *Rubus idaeus*, and in *V. odorata* (Brenna et al. 2002). 3-(2′,4′,6′,6′-tetramethylcyclohexa-1′,4′-dienyl)acrylic acid was isolated from methanol fraction of *V. odorata* (Gautam et al. 2016).

Viola species contain the phenolic substances including rutin (Lamaison et al. 1991), violarvensin, violanthin (Carnat et al. 1998), isoschaftoside, schaftoside, neoschaftoside, vicenin-2, apigenin 6-C-α-Larabinopyranosyl-8-C-β-D- xylopyranoside, apigenin 6-C-β-D-xylopyranosyl-8-C-α-L-arabinopyranoside, isoorientin, isocarlinoside (Xie et al. 2003), luteolin, apigenin, quercetin, isorhamnetin, hyperoside, hesperidin, isoferulic acid, ferulic acid, ellagic acid, dicoumarin, catechol, and arbutin (Bubenchikov and Goncharov, 2005).

2.1 Essential oil

Essential oils with their distinctive properties can have a lot of potential in human disease cure. Major studies have been reported the presence of monoterpenes and sesquiterpenes in high percentage. Akhbari et al. (2012) who reported the essential oil composition of *V. odorata* leaves showed the presence of 25 identified compounds representing total 92.77% of oil, investigated in Kashan, central Iran. The major components were butyl-2-ethylhexylphthalate (30.10%) and 5,6,7,7a-tetrahydro-4,4,7a-trimethyl-2(4H)-benzofuranone (12.03%) respectively. It was reported that *V. odorata* contains triterpene saponins (5.2%) constituted of ursolic acid as a glycone and galactose or galacturonic acid, trans-caffeic, protocatechuic, gentisic, p-hydroxybenzoic, 4-hydroxyphenylacetic, trans- and cis- coumaric, vanillic and salicylic acids isolated with two unidentified acids (Evans, 1996). Hammami et al. (2011) had reported 63 different compounds amounting 83.05% of total oil from flowers of *V. odorata* including para-methyl anisole (1.09%), benzyl alcohol (5.65%), linalool (7.33%), terpinen-4-ol (2.31), pulegone (3.33%), 1-phenyl butanone (22.43%), viridiflorene (3.51%), globulol (4.32%), viridiflorol (3.65%), epi-α-cadinol (4.91%), and benzyl benzoate (1.67%) as major constituents. Cu et al. (1992) had identified 23 compounds in *V. odorata* representing 95% of the total oil including hex-2-enal, cis-hex-3-en-1-ol, trans-hex-3-en-1-ol, butyl acetate, oct-7-en-4-ol, 3,4-dimethylheptane, 3,7-dimethylnonane, 2,4-dimethyldodecane, 2,6,11-trimethyldodecane, 2,7,11-trimethyldodecane, hex-3-en-1-yl formate, benzyl alcohol, nona-2,6-

dienal, hepta-2,5-dien-1-ol, nona-2,6-dien-1-ol, dodecan-1-ol, pentadeca-5,10-dien-1-ol, hexadec-1-ene, pentadec-3-enal, octadec-1-ene, icos-1-ene, hexadecanoic acid, octadeca-9,12-dienoic acid respectively.

Moreover, *V. tricolor* reported 35 compounds representing 97.76% of total oil in fresh aerial parts with 8 sesquiterpenes, 17 aliphatics, 6 shikimic acid derivatives, and 4 monoterpenes. Sesquiterpenes were the major component (59.27%), followed by aliphatics (29.81%), shikimic acid derivatives (8.05%), and monoterpenes (0.30%). The main volatile components found were bisabolone oxide (43.25%), trans-β-farnesene (4.01%), and bisabolol oxide A and B (7.78% and 2.28%). In dried aerial parts total 24 compounds were identified representing 60.53% of the total oil with 14 aliphatics, 4 shikimic acid derivatives, 2 sesquiterpenes, and 4 monoterpenes. The main volatile components found were hexahydrofarnesyl acetone (4.06%), methyl salicylate (1.22%), and β-ionone (1.00%). Aliphatics were the major components (42.21%), followed by shikimic acid derivatives (11.20%), sesquiterpenes (4.79%), and monoterpenes (2.32%). 26 components representing 72.13% of total essential oil obtained from dried aerial parts of *V. arvensis* were identified as 18 aliphatics, 5 shikimic acid derivatives, 2 monoterpenes, and 1 sesquiterpene. Aliphatics were the major components (59.94%), followed by shikimic acid derivatives (8.35%), monoterpenes (2.15%), and sesquiterpenes (1.69%). The main volatile components found were 2-pentyl-furan (5.48%), β-ionone (2.09%), and hexahydrofarnesyl acetone (1.69%) (Anca et al. 2009).

3. Bioactivity

3.1 Antimicrobial properties

V. odorata has a long historical well-known medicinal value in management of cough, genital tumors, sclerosis of spleen, inflammatory tumors and ulcers (Hartwell, 1982). Various researches had been reported the antibacterial potential of different parts of *V. odorata* i.e. leaves, flowers, aerial parts, roots etc. against respiratory pathogens, enteric bacteria, commensal bacteria (Khan et al. 2011; Khatibi et al. 1989; Ramezani et al. 2012). Khan et al. (2011) reported that aqueous extract of *V. odorata* (flowers) showed antibacterial action against *B. subtilis*, *E. coli* and *S. aureus* but failed to inhibit *S. typhi* at 20 mg/ml. The percentage inhibition against *S. aureus* was reported 41.8±2.4 by them. Khatibi et al. (1989) documented the antimicrobial activity of aqueous extract of *V. odorata* (aerial part) against *S. aureus*, *B. subtilis*, *E. coli* and *S. flexneri* at three concentrations including 3 mg, 2 mg and 1 mg and concluded *S. aureus* as most sensitive organism in comparison to others. Arora and Kaur (2007) showed the most effective antibacterial activity of *V. odorata* hot water extract against *S. aureus* (21 mm) and *S. flexneri* (20 mm) respectively. Ramezani et al. (2012) grown the *V. odorata* at three different temperature (10°C, 20°C and 30°C) and extraction was performed by percolation method. The aqueous extract showed maximum antibacterial activity against *S. aureus* (1 µg/ml) and minimum effect on *P. aeruginosa* (8 µg/ml). Moreover, cold treatment showed more antibacterial effect than warm treatment. Sudhanshu et al. (2012) had extracted *V. odorata* (whole plant) in four different solvents i.e. petroleum ether, benzene, chloroform, ethyl acetate, methanol and water and tested them against ten organisms including *S. flexneri*, *S. aureus*, *S. typhi*, *P. aeruginosa*, *K. pneumoniae*, *P. vulgaris*, *E. aerogenes*, *A. niger*, *C. albicans*, and *T. rubrum*. The methanol extract was reported as most effective against *S. aureus* with 21.33 mm zone of inhibition at 200 mg/ml concentration. Hassan and Naeem (2014) reported the antibacterial activity of extracts and pure constituents of *V. odorata* against *M. tuberculosis* H37Rv and clinical isolate of MDR-TB (*M. avium*). The results showed that n-hexane and DCM extracts of *V. odorata* showed 100% inhibition of *M. tuberculosis* and *M. avium* with MIC at 40 µg/ml concentration.

In focus of potential novel and future antibacterial drugs, biologically active plant proteins can play an intensive role. Cyclotides are such type of small disulfide rich peptides isolated from plants. Cyclotide cycloviolacin O_2 is a cyclotide isolated from dried aerial parts of *V. odorata* efficiently inhibited the growth of *S. enterica*

serovar Typhimurium LT2, *E. coli*, *K. pneumoniae* and *P. aeruginosa* and no activity against *S. aureus* (Pranting et al. 2010). Moreover, *V. odorata* displayed a basis for use of extract in treatment of respiratory diseases in human which could be caused by *H. influenzae*, *P. aeruginosa*, *S. aureus*, *S. pneumoniae* and *S. pyogenes*. Former pharmacological studies revealed the role of *V. odorata* in some Unani drugs for treatment of common cold, asthma, cough and associated ailments/fevers (Vohora, 1986). Antimicrobial activities of methanol and chloroform extracts and essential oil of *V. odorata* were reported against a set of 11 microorganisms including *P. aeruginosa*, *B. subtilis*, *E. coli*, *S. aureus*, *K. pneumoniae*, *S. epidermidis*, *S. dysenteriae*, *P. vulgaris*, *S. paratyphi*-A serotype, *C. albicans* and *A. niger* and found methanol extract as most efficient against *S. epidermidis* with 19 mm zone of inhibition tested by disc diffusion method (Akhbari et al. 2012).

The minimum inhibitory concentration was documented by Ziad et al. (2011) with ethyl acetate fraction of *V. odorata* at 10 µg/µl for *E. coli* and at 5.5 µg/µl for *K. pneumoniae*. 3-(2′,4′,6′,6′-tetramethylcyclohexa-1′,4′-dienyl)acrylic acid was isolated from methanol fraction of *V. Odorata* exhibiting antibacterial activity against respiratory disease causing bacterial organisms. This compound exhibit minimum inhibitory concentrations (MICs) was observed similar at 64 µg/ml against *H. influenzae* and *S. aureus*, 128 µg/ml against *P. aeruginosa* and *S. pneumoniae*, and 32 µg/ml against *S. pyogenes* respectively (Gautam et al. 2016).

3.2 Antioxidant activity

The antioxidant activity of *V. odorata* extracts confirmed that the chloroform extract was weaker than that of the methanol extract, both have ability as a natural antioxidant in the inhibition of β-carotene/linoleic acid and 2,2-diphenyl-1-pycril hydrazyl (DPPH) bleaching assays. While, essential oil did not show antioxidant activity due to lack of flavonoids, phenolic and other antioxidative active components (Akhbari et al. 2012). Moreover, *V. odorata* extracts (i.e. DCM, ethyl acetate, ethanol and aqueous) displayed a low to moderate level of antioxidant activity tested by DPPH scavenging activity, metal chelating capacity, ferric reducing antioxidant power assay and phosphomolybdenum reducing antioxidant assay (Orhan et al. 2015).

4. Other pharmacological properties

V. odorata cyclotide named as cycloviolacin O8 has been reported for anticancer activity against PC-3 prostate, MDA-MB-231 breast, and OVCAR-3 ovarian cancer cell lines (Parsley et al. 2018). Similarly, Gerlach et al. (2010) reported that Cycloviolacin O2 (CyO2), from *V. odorata* has antitumor effects and responsible for cell death by membrane permeabilization. *V. odorata* has been reported in reduction of body weight and antidyslipidemic effect by inhibition of synthesis and absorption of lipids and antioxidants (Siddiqi et al. 2012).

Conflict of Interest

The authors declare that they have no conflict of interest.

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