ISSN: 2321-3132

Research Article

International Journal of Chemistry and Pharmaceutical Sciences

www.pharmaresearchlibrary.com/ijcps

Volatile oils and phenolics of *Stemodia serrata* Benth

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Received: 2 February 2014, Accepted: 21 April 2014, Published Online: 27 May 2014

Abstract

Stemodia serrata Benth., an aromatic weed on the verge of extinction, is analysed for its volatile oils and phenolics. The plant yielded 1.15% of a light greenish yellow volatile oil consisting of β- caryophyllene (32 %), endo-fenchol(29.8%) and p-mentha-1-(7)-8-diene (20.8%) as major components. The phenolics identified were a flavone scutellarein and phenolic acids like ferulic, o-coumaric, vanillic, p-OH benzoic and protocatechuic acids. All these compounds are found to be of great therapeutic potential and therefore large scale cultivation to preserve and utilize this species is recommended.
Keywords: *Stemodia serrata*, volatile oil, β-Caryophyllene, Scutellarein, Ferulic acid, Protocatechuic acid

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PAPER-QR CODE

1. Introduction

Stemodia Benth. is a genus of about 40 species belonging to the family Scrophulariaceae, occurring in tropical and subtropical regions of the world. The chemical investigation of this genus is restricted to five species from which flavonoids, labdane diterpenes, and diterpenes derivatives with a rare tetracyclic skeletal, named stemodane, were isolated (Rodrigues *et al*., 2010; Ramesh *et al*., 1979; Da Silva *et al*., 2008). The diterpenes of this genus are found to possess cytotoxic and antiviral properties (Hufford *et al*., 1991). *Stemodia serrata* Benth. is a species found restricted to the Timbi region of Baroda, India. There were only very few plants available occurring as weeds in fields which are now almost lost due urbanization. It is also reported from waste lands of South India, Senegal, Sudan, Tanganyika and Ghana, and in NE Africa and Malawi where it occurs as a weed of cultivated land and paddy fields.

The plant is an aromatic robust leafy erect viscidly-pubescent annual with 4-angled stem. Leaves sessile, obovate-oblong, up to 3 cm, serrulate above the middle, leaf base amplexicaul. Flowers subsessile, axillary, solitary; bracteoles 2 beneath the calyx, linear-subulate. Calyx 5-partite, segments linear-lanceolate. Corolla greenish white, 2-lipped; upper lip bifid; lower lip with 3 subequal, oblong-obtuse lobes. Stamens 4, didynamous; anther-cells stalked. Ovary 2-celled; ovules numerous in each cell; stigma 2-lobed. Capsules linear-oblong, acute, slightly shoeter than the persistant calyx. Seeds minute, oblong-ellipsoid. The plant contained glands with single to many celled head and multicellular uniseriate stalks. It flowers in December-February.Though the plant is highly aromatic, so far it is not utilized by local people and absolutely no work is conducted on any of the chemical components of this plant. Therefore in the present work the whole plant is analyzed for its volatile oils and phenolics.

2. Materials and Methods

The plant material was collected from the fields of Timbi near Vadodara and its voucher specimen was submitted in BARO, the Herbarium of the Maharaja Sayajirao University of Baroda,Vadodara. The plant was dried in the shade and subjected to steam distillation for extracting volatile oils. The technical details of GC-MS analysis of the oil is already explained (Denni and Daniel, 2013). The residual plant material left after steam distillation was extracted in methanol and analyzed for flavonoids and phenolic acids. For flavonoids standard methods prescribed by Mabry and co-workers (1970) which included UV spectral studies involving spectral shifts with six reagents and by co-chromatography with standard compounds were followed. Standard scutellarein was isolated from leaves of *Scoparia dulcis* (Ramesh *et al.,* 1979). The phenolic acids were analyzed following Ibrahim *et al* (1960) and by co-chromatography with standard compounds.

3. Results and Discussion

The plant is found to contain 1.15% of light greenish yellow oil with a clove oil like smell which was found to contain both mono and sesquiterpenoids in almost equal amounts. The major components were β- caryophyllene (32 %), endo-fenchol(29.8%) and p-mentha-1-(7)-8-diene (20.8%). The minor constituents were α- humulene (5.12%), α- cadinene (2.9%) and Δ3- carene (2%). The ethanolic plant extract on hydrolysis yielded a flavone scutellarein and phenolic acids like ferulic, o-coumaric, vanillic, p-OH benzoic and protocatechuic acids.

The present study is of great significance because it unearthed the fact that *Stemodia serrata*, a insignificant common weed, is a source of valuable phytochemicals. Both the terpenoid and phenolic components are found to be of commercial and pharmacological importance. The major component of volatile oil, β-caryophyllene, is a FDA approved food additive. It is found to be a dietary cannabinoid. In a significant study, β-caryophyllene is shown to selectively bind to the cannabinoid receptor type-2 (CB2) to exert marked cannabinomimetic anti-inflammatory effects in mice (Gertsch *et al.,* 2008). It is considered as an alternative to medical marijuana, because it offers the same anti -inflammatory effects without the mental and neurological side-effects. It is also found to be active against bowel inflammation and rheumatoid arthritis. Duke's database describes this compound as aldose-reductase-inhibitor, analgesic, antispasmodic, antistaphylococcic; antistreptococcic , antitumor and antiulcer. The second component of the volatile oil, endofenchol (an isomer of borneol) is used extensively in perfumery. p-Mentha-1-(7)-8- diene (pseudolimonene) is a flavoring agent, pesticide and a valuable solvent.

Scutellarein, the 6-hydroxy flavone identified from this plant, also is found to possess a number of therapeutic features. It inhibits hypoxia and moderately high glucose-induced proliferation and vascular endothelial growth factor (VEGF) expression in human retinal endothelial cells (Gao *et al.,* 2008). It is found to offer better protective effect on free-radical induced cytotoxicity in PC12 cells and therefore considered a potential therapeuticagent for ischemic cerebrovascular disease (Qian et al., 2012). This flavone is recently found out to be a novel chemical inhibitor of Severe Acute Respiratory Syndrome (SARS) corona virus (Yu *et al.,* 2012).

Out of the five phenolic acids located in *S.serrata*, i.e. ferulic acid, vanillic acid and p-hydroxy benzoic acid, protocatechuic acid and o-coumaric acid, all are found to possess various pharmacological properties. Ferulic acid is found to exert protective and therapeutic effects on diabetic nephropathy by reducing oxidative stress and inflammation (Choi *et al*., 2011). Supplementation of this phenolic acid to the in the food of diabetic rats resulted in a decrease in the levels of glucose, TBARS, hydroperoxides, FFA and an increase in reduced glutathione (GSH). FA also resulted in increased activities of SOD, CAT, GPx and expansion of pancreatic islets. The effect was much pronounced with lower dose treatment. Thus it is proved that administration of ferulic acid helps in enhancing the antioxidant capacity of these diabetic animals by neutralizing the free radicals formed thereby reducing the intensity of diabetes (Balasubashini *et al.,* 2004). Addition of ferulic acid at 0.01% and 0.1% of basal diet showed to suppress significantly blood glucose levels in STZ-induced diabetic mice. In KK-A^{y} mice 0.05% FA suppressed effectively blood glucose levels. These findings suggest that dietary ferulic acid is useful in alleviating oxidative stress and attenuating the hyperglycemic response associated with diabetes (Ohnishi *et al.,* 2004). This compound possesses antioxidant properties that make it an important anti-aging supplement, and they also contribute to its other potential uses. These include applications in cancer, neuroprotection, bone degeneration, menopause, immunity, and (perhaps) athletic performance. In addition it has a cardioprotective effect via increasing SOD activity and NO levels in plasma and myocardium, inhibiting oxidative stress in plasma and myocardium, and inhibiting the expression of CTGF in myocardium in diabetes rats (Xu *et al*., 2012). o-Coumaric acid and other cinnamic acid derivatives are now known therapeutic agents to fight cancer (Del *et al.,* 2011). Recently, vanillic acid is established to contribute to the prevention of the development of diabetic neuropathy by blocking the methylglyoxal-mediated intracellular glycation system (Huang *et al.,* 2008). It increased cell viability and decreased apoptosis of cells, among other effects when exposed to methylglyoxal and was found to be the most inhibitory of the p38 MAPK pathway that leads to apoptosis of the Schwann cells. Hypoglycemic activity of ρ-hydroxybenzoic acid, was proved when activity -guided fraction from *Pandanus odorus* Ridl. (Thai name: Toei-hom, Pandanaceae), containing this compound showed a hypoglycemic effect in normal rats after the oral administration of 5 mg/kg. Additionally, the compound increased serum insulin levels and liver glycogen content in normal rats (Peungvicha, *et al.,* 1998). Protocatechuic acid is one of the biologically active substances isolated from a number of popular medicinal plants growing indifferent parts of the world. Research conducted over the past several years indicates that it may be used in conventional medicine to prevent cardiovascular diseases and cancer (Tanaka *et al.,* 2011). All the above mentioned phenolics are highly active antioxidants. The role of antioxidants in human diet is being increasingly felt these days. Since it is understood that all the chronic diseases like diabetes, cancer, stroke, atherosclerosis etc are caused either by the reduced levels of antioxidants in the body or the increased levels of free radicals, Stemodane diterpenes consisting of rare tetracyclic skeletal structures, which are characteristic compounds of the genus *Stemodia,* are found to possess cytotoxic and antiviral activities (Hufford, *et al.,* 1992). The screening of *Stemodia serrata* for these compounds is expected to elevate the drug potential of this plant. But the rarity of this plant in the study area does not permit its harvesting and utilization and since it is an important commercial source of phytopharmaceuticals, it has to be propagated in large scales so that commercial exploitation can be achieved.

4. Conclusion

Stemodia serrata Benth, an aromatic weed on the verge of extinction in India, is studied for its volatile oil and phenolics. The plant is found to contain 1.15% of light greenish yellow oil with a clove oil like smell which was found to contain β- caryophyllene (32 %), endo-fenchol (29.8%) and p-mentha-1-(7)-8-diene (20.8%)as major constituents. The other constituents of this plant were a flavone scutellarein and phenolic acids like ferulic, o-coumaric, vanillic, p-OH benzoic and protocatechuic acids. All these compounds are found to be of great therapeutic potential and therefore large scale cultivation to preserve this species is recommended.

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