Urtica dioica L., (Urticaceae): A Stinging Nettle

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ABSTRACT

Urtica dioica L., is a perennial herb with a long history of traditional medicinal uses in many countries in the world, especially in the tropical and subtropical regions. A wide range of chemical compounds including flavonoids, agglutins, lignans, carotenoids, phenolic compounds and terpenoids have been isolated from this species. Extracts and metabolites from this plant have been found to possess various pharmacological activities. In recent years, there has been growing interest in alternative therapies and the therapeutic use of natural products, especially those derived from natural products. Based on literature, U. dioica and its phytoconstituents were reported for various pharmacological activities which includes hypoglycemic and anti-inflammatory activities. A thorough review is required to avoid repetition of future research on this plant. Further, this review will also help to continue research based on previous reports. This review will also provide comprehensive information on U. dioica which could be useful article for researchers on this plant. The comprehensive account of the chemical constituents and the biological activities are presented in this review such that the potential use of this plant for the future drug.

Key words: Urtica dioica, Stinging nettle, Phytochemistry.


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DOI :10.5530/srp.2014.1.3

INTRODUCTION

Nettle, or stinging nettle, is a perennial plant growing in temperate and tropical wasteland areas around the world. It grows 2 to 4 meters high and produces pointed leaves and white to yellowish flowers and it belongs to the family of Urticaceae.¹ The genus name Urtica comes from the Latin verb urere, meaning ‘to burn,’ because of these stinging hairs. The species name dioica means ‘two houses’ because the plant usually contains either male or female flowers. Nettle has a well-known reputation for giving a savage sting when the skin touches the hairs and bristles on the leaves and stems.² In the last few years, Urtica dioica L., has been accepted as a healing plant because of its considerable effects on human health in many countries all over the world.²⁻⁴

TAXONOMY

Kingdom- Plantae - Plants
Subkingdom- Tracheobionta - Vascular plants
Superdivision- Spermatophyta - Seed plants
Division- Magnoliophyta - Flowering plants
Class- Magnoliopsida - Dicotyledons
Subclass- Hamamelidae
Order- Urticales
Family- Urticaceae - Nettle family
Genus- Urtica L.
Species- Urtica dioica L., - stinging nettle P(5)

PLANT PROFILE

U. dioica is originally from the colder regions of northern Europe and Asia, today this herbaceous shrub grows all over the world. Stinging nettle grows well in nitrogen-rich soil, blooms between June and September of every year, and reaches nearly 3 feet high. The stem is erect and green, the leaves are opposite, cordate at the base, oblong or ovate, finely toothed, dark green above and paler beneath. The flowers are in reddish-brown to greenish-white colour. The small, green, dioecious flowers occur as racemes in the axils of the upper leaves. Usually, the plant has either male or female flowers, in separate inflorescences, hence the specific name of the plant, dioica. U. dioica flowers from May to September every year.⁶

TRADITIONAL USES

U. dioica have a long history of use in the household home remedies and nutritious diet. The powered leaf extract used as antihemorrhagic agent to reduce excessive menstrual flow and nose bleedings. This plant was used for the treatment of arthritis, anemia, hay fever and used as diuretics, astringents and blood builders in folk medicine.⁷⁻⁸ Traditionally, a tea made from the leaves of U. dioica has been used as a cleansing tonic and blood purifier.¹ Externally, this plant is used to treat skin complaints, gout, sciatica, neuralgia, haemorrhoids, hair problems etc.⁹⁻¹⁰ For medicinal purposes, the plant is harvested between May and June of every year as it is coming into flower and dried for later use.

The root has a beneficial effect upon enlarged prostate glands and it is
used for the treatment of rheumatic gout, nettle rash and chickenpox, externally is applied to bruises.\textsuperscript{11}

The plant has been widely used by herbalists around the world for centuries. In the first century, Greek physicians Pedanius Dioscorides and Galen reported the leaf of \textit{U. dioica} had diuretic and laxative properties and was useful for treatment of asthma, pleurisy and spleen illnesses. The nettle leaves is used as a nutritional supplement and as weight loss aid.\textsuperscript{11}

Now-a-days, in Germany this plant was sold as herbal drug for prostate diseases and as a diuretic.\textsuperscript{13}

**GENERAL USES**

Stinging nettle has been used for hundreds of years to treat rheumatism, arthritis, gout, eczema, anemia, urinary tract infections, kidney stones, hay fever and early stages of an enlarged prostate (called benign prostatic hyperplasia or BPH). Recent laboratory studies and clinical studies on antirheumatic activity on stinging nettle showed possible antiarthritic activity. Riehemann \textbf{et al.}, reported the inhibition of NF-κB activation (protein complex that controls transcription of DNA and cytokine production) and Randall \textbf{et al.}, reported the clinical possible antiarthritic activity of stinging nettle.\textsuperscript{14,15}

**Benign Prostatic Hyperplasia (BPH)**

Reports claim that as many as 80% of European men with BPH are given the option of herbal remedies for their symptoms, including saw palmetto and stinging nettle roots, rather than medication or surgery.\textsuperscript{16} Studies in people suggest that the root of the stinging nettle, in combination with other herbs especially saw palmetto, may be an effective treatment for BPH, relieving urinary symptoms such as reduced urinary flow, incomplete emptying of the bladder, post voiding dribbling, and the constant urge to urinate.

**Others:** In animal studies, nettle has been shown to have anti-inflammatory and hypoglycemic effects. The hydro-alcoholic extract of \textit{U. dioica} at 100 and 200 mg/kg showed significant antidiabetic effect against fructose induced diabetics.\textsuperscript{17} Active compounds in stinging nettle may act as an expectorant (meaning that it can loosen and break up a cough) and have antiviral properties.\textsuperscript{18}

Nettle may also be effective for treating certain individuals with allergic rhinitis (hay fever). This traditional use has had a lot of historical value for individuals. Early studies of people suggest that this historic use is likely scientifically valid. However, while the studies thus far have been favorable, they have not been overwhelmingly so.

**ETHNOPHARMACOLOGY**

In pre-clinical animal experiments \textit{U. dioica} along with \textit{Nigella sativa} reduced carbon tetrachloride induced elevated levels of serum potassium and calcium levels and decreased the levels of red blood cells, weight blood cells, packed cell volume and haemoglobin levels.\textsuperscript{19} Turkdogan \textbf{et al.}, and Kanter \textbf{et al.}, also reported the hepatoprotective effects of \textit{N. sativa} and \textit{U. dioica} in carbon tetrachloride induced liver fibrosis and cirrhosis model.\textsuperscript{20,21} In another study, the effects of ethanol-water (80%-20%) extract of \textit{U. dioica}. and butylated hydroxyanisole were investigated, for comparative HPLC analysis using Sephadex column. One of the fractions contain different cinnamic acid derivatives, coumarins and homovanillyl alcohol, some of the phenolic compounds were studied in derivatezed form using trimethyl silyl esters in GC-MS analysis.\textsuperscript{17} The derivatization of phenolic compounds yielded 34 compounds and structures were interpreted by using mass fragmentations, retention time and compared with commercially available compounds. Some of the compounds were identified as homovanillic alcohol, vanillin, vanillic acid, (+) isorhamnetin, (-) secolaricinresinol, (-) secolarinresinol. Methylated derivatives of phenolic compounds and flavonoids from \textit{U. dioica} and with other plants were prepared by using methyl iodide, and subjected chromatographic analysis. Based on derivatization, GC-MS analysis of \textit{U. dioica} methanolic leaf extract resulted in the presence of 3.0 ng/mg of homo vanillic acid, 2.5 mg/mg of vanillic acid, 43.65 ng/mg of 4-hydroxy cinnamic acid and 574 ng/mg of ferulic acid.\textsuperscript{27}

Aqueous extract of \textit{U. dioica} leaves yielded two major fractions on preparative HPLC analysis using Sephadex column. One of the fractions was found to contain a mixture of carbohydrates and proteins called glycoprotein.\textsuperscript{22} Blumenthal \textbf{et al.}, were made an attempt to study the link between protein and carbohydrate by hydrolysing with sodium hydroxide and sodium borohydride. Results indicated that the protein and carbohydrate are connected with \textit{via} serine and O-galactosidic linkages, further methylation indicated the nettle glycoproteins were branched and indicated the presence of 3,5 and 2,5 di-O-methyl arabinose is linked with 1-2, 1-3 and 1-4/5 arabinose, whereas unbranched galactose are connected mainly 1-3 and some 1-4 and 1-6 linkages. However the second fraction was unsuccessful in its methylation process.\textsuperscript{28} The roots of \textit{U. dioica} showed the presence of trans neo-olivil, a lignans glycoside.\textsuperscript{29-33}

The leaves of \textit{U. dioica} were used in animal husbandry traditionally, various reports indicated the carotenoids and chlorophyll are used to improve full productive of animals.\textsuperscript{34} The traditional methods for extraction from plant material include steam distillation, soxhlet percolation using organic solvents, perhaps these procedures have lots of disadvantages such as degradation, loss of biologically active compounds, duration etc. Sovova \textit{et al} utilized supercritical fluid extraction using liquid CO\textsubscript{2} inorder to isolate carotenoids and chlorophyll from the leaves of \textit{U. dioica} also studied for its antioxidant, antimicrobial, antiulcer and analgesic properties and the study was concluded for the presence of antioxidant properties, antimicrobial activity, antiulcer activity and analgesic effect.\textsuperscript{24}

In another study the \textit{U. dioica} roots extract hypotensive effects by decrease of vascular pressure.\textsuperscript{25}

**Phytochemistry**

The seeds and leaves of \textit{U. dioica} contain vitamins, minerals and amino acids.\textsuperscript{1} Chemical interest in \textit{U. dioica} was stimulated by reports that they cause irritation when comes in contact with skin. The leaves of \textit{U. dioica} possess sharp spines with stinging hairs that contains histamine and formic acid, which causes irritation.\textsuperscript{1} Many compounds were previously isolated by different researchers on \textit{U. dioica}, viz., phytoestrogens\textsuperscript{1}, lignans\textsuperscript{2}, carotenoids\textsuperscript{1}, fatty acids\textsuperscript{1}, phenolics\textsuperscript{8} etc.

The leaves of \textit{U. dioica} are being used a a herbal tea for the treatment of different ailments, such as hypertension, benign prostatic hyperplasia etc. the leaves were reported to contain caffeic acid, chlorogenic acid\textsuperscript{8}, high content of chlorophyll and other pigments.\textsuperscript{29} Phytochemical literature on \textit{U. dioica} gave a weak indication for the presence of alkaloids, there are no reports published elsewhere.

Rhizomes of \textit{U. dioica} are found to contain agglutin, a series of long chain amino acid linkages.\textsuperscript{1} The structure of agglutin was also confirmed as a member of proteins family with two hevein like domains present in each subunit.\textsuperscript{7} Studies on phytochemical investigations showed the leaves and rhizomes are rich in phenolic compounds.\textsuperscript{10} It was reported to contain different cinnamic acid derivatives, coumarins and homovanillyl alcohol, some of the phenolic compounds were studied in derivatezed form using trimethyl silyl esters in GC-MS analysis.\textsuperscript{17} The derivatization of phenolic compounds yielded 34 compounds and structures were interpreted by using mass fragmentations, retention time and compared with commercially available compounds. Some of the compounds were identified as homovanillic alcohol, vanillin, vanillic acid, (+) isorhamnetin, (-) secolaricinresinol, (-) secolarinresinol. Methylated derivatives of phenolic compounds and flavonoids from \textit{U. dioica} and with other plants were prepared by using methyl iodide, and subjected chromatographic analysis. Based on derivatization, GC-MS analysis of \textit{U. dioica} methanolic leaf extract resulted in the presence of 3.0 ng/mg of homo vanillic acid, 2.5 mg/mg of vanillic acid, 43.65 ng/mg of 4-hydroxy cinnamic acid and 574 ng/mg of ferulic acid.\textsuperscript{27}

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