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A Comprehensive insight into the phytoconstituents and health benefits of *Clematis* species

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ABSTRACT

The genus of *Clematis* is a buttercup family (Ranunculaceae), recognized for its flowers and adaptable as an ornamental plant in colder climates**. It contains around 300 species. *Clematis* has a variety** of active **phytoconstituents or secondary metabolites which are responsible for health benefits in human** beings**. Traditionally various species of the *clematis* genus** used for **centuries to treat various ailments including syphilis, bone disorders, gout, rheumatism, diuretics, wound healing, blood sugar control, blood diseases, spleen difficulties, leprosy, fevers, skin diseases. A systematic review of scientific electronic database and reference books were consulted to find all relevant literature for this work. This review discusses the** ethno-medicinal **usage, health advantages, phytoconstituents and bioactivities of *clematis* species.**

Introduction

Plants have served millions of people for centuries as their primary health care (Gakuya *et al.*, 2020). The majority of medicines used to cure ailments in various systems of traditional medicine are based on plants and their phytoconstituents. Secondary metabolites in plants not only participate in their endurance by producing attractants for pollinators, but also act as chemical defenses against herbivores and disease (Yanqun *et al.*, 2020). Traditional medicines are used in Ayurveda, Siddha, Unani and Homeopathic practice for healthiness and to diagnose, treat, and prevent physical or mental-related health problems (Salmerón-Manzano *et al.*, 2020). Plant-based remedies apply various source materials including roots, leaves, bark, fruits, essential oil, etc (Ekpo *et al.*, 2008; Rasool Hassan, 2012).The genus *Clematis* encompasses more than 300 taxonomically accepted species within the Ranunculaceae family; which are widely distributed throughout temperate as well as tropical regions worldwide, especially beyond the tropics in the northern hemisphere. Plants of the *Clematis* genus are woody, climbing vines (Kaur *et al.*, 2020). Various plant parts of the *Clematis* genus are used traditionally to treat gout, bone disorders, syphilis, rheumatism, diuretics and skin disorders (Alvarez *et al.*, 2003). It is also used to treat purulent wounds and ulcers. Biologically antibacterial, cytotoxicity (Ding *et al.*, 2009), antimycotic (Buzzini Pieroni, 2003), anticancer (L.-H. Yan *et al.*, 2009), anti-inflammatory (Park *et al.*, 2006), antifungal activity showed by active phytoconstituents or secondary metabolites present in the plants of the *clematis* genus (Y. Li *et al.*, 2009). Many secondary metabolites of *Clematis* genus, including alkaloids, glycosides, and saponins, have good therapeutic properties (Duke, 1985; Kingsbury, 1964; Turner Szczawinski, 1991). The scientific community will hopefully benefit from the knowledge gained from geographical, botanical, phytochemical, therapeutic

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and pharmacological perspectives to plan safer tests with bioactive mixtures.

Material and Methods

Scientific electronic databases and reference books were used to find all relevant literature for this work. Several databases, including "Plant List" and "Plants of the World Online", confirmed the plant's scientific name.

Results and Discussion

Botanical information

There are more than 300 species of vines that bear flowers in the genus *Clematis*, which is a segment of the buttercup family (Ranunculaceae); known for their flowers, they are adapted as ornamentals in colder climates. Woody climbers of the genus *Clematis* produce stunning, huge flower clusters that are often white; however, some species also produce crimson or violet flowers. More than 70 species are used traditionally in China (Ding *et al.*, 2009). *C. virginiana*, *C. cirrhosa*, *C. vitalba*, and *C. viticella* are some common species. *C. virginiana* (Old Man's Beard) is a trailing climber that usually provides shady shelter as it can grow up to 15 m taller than other plants; this species is native to North America. The leaves of the vine are opposite and divided into leafstalk and leaflets. Some species are shrubby like *C.recta* (European species), and creamy white flowers present bloom during July to September (Duke, 1985) (Ody, 1993).

Traditional medicinal uses

A well-known plant in the *Clematis* genus is *C. montana* of the Rannuculaceae family; found primarily in India, although it is also available in Pakistan, Nepal, Bhutan, and China. In North India, it is commonly known as Garol, Geor Bel, Kanguli, Kaunie-Bali. In Germany it is known as Berg-Walrebe; bjerg-skovranke in Danish; Himalayan clematis, Anemone *clematis* in English. This species is used in many nations to cure a variety of diseases and disorders because of its exceptional healing powers. This plant is traditionally used against various diseases such as syphilis, bone diseases, gout; rheumatism, diuretic and skin diseases (Rana *et al.*, 2015). The well-known perennial herb from East Asia is called *Clematis gouriana*. Locals use it extensively for wound healing, blood sugar control, blood diseases, spleen problems, leprosy and fevers; and herbal cream of leaves extract prepared to treat skin infection (Sheela, 2014). By inhaling the fumes of freshly crushed leaves, *C. glycinoids* DC. has long been used in Australia to relieve headaches and colds (R. W. Li *et al.*, 2003). *C. pickeringii* is used to treat respiratory problems, joint pain, fever, edema, infection, snakebite and other inflammatory diseases (Muthaura *et al.*, 2007). In Kenya, *C. brachiata* is broadly used in headaches, malaria, abdominal pain, skin disorders, toothaches, and sore throats. The whole flowering plant of *C. dioica* is used in Guatemala to treat gonorrhea (Caceres *et al.*, 1995). According to popular folklore in Turkish *C. flammna* flowering herbs are used as an anti-inflammatory remedy, such as for rheumatism, and to reduce fever (Yeşilada *et al.*, 1997). Roots of *C. mandshurica* native to Korea are used to treat arthritis problems (Park *et al.*, 2006). *C. terniflora* and *C. chinensis* roots are regarded as a substitute for traditional Chinese drugs like analgesic, diuretic, antitumor, rheumatic arthritis, laryngitis, skin and breast infection (Xu *et al.*, 1996). The root extract of *C. chinensis, C. mashurica* are used traditionally to treat joint pain. In China and the north of Burma, *C. armandii* is used to treat gynecological diseases and dermatoses. *C. chinensis* is a deciduous climber native to China, Japan, Taiwan and Vietnam; possesses health benefits and clinically, it is used in cardiovascular and cerebrovascular diseases, rheumatoid arthritis, ischemic necrosis of bone, osteo-hyperplasia and protrusion of intervertebral disc, bone disease and fracture (Shi *et al.*, 2007). *Clematis gouriana* is a woody climber found in tropical and subtropical forests of India, Nepal, and China; widely used for malaria, headache, psoriasis, wound healing and skin problems (Naika Krishna, 2007). *C. apiifolia DC* is well-known plant in South Korea, Japan, and China. In Korean traditional medicine this plant species is reported to be used in neuralgia, facial paralysis, rheumatoid arthritis, and toothache (Lee *et al.*, 2019). *C. aethusifolia* Turczb is a Mongolian medicinal plant; its leaf and stem are extensively used to care for joint pain, vomiting, and indigestion (Shi *et al.*, 2007). *C. lasiandra* native to China used in their traditional system of medicine due to its antitoxic, diuretic, analgesic, and antipyretic action (Tian *et al.*, 2013). Leaf extract of *C. chinensis* Osbeck has been widely used in joint pain, and sore throat in China (C. Peng *et al.*, 2012).

C. florida Thunb is used to treat rheumatic arthritis, diuretics, stomachache, and jaundice in China (Feng Zhang). The roots of *C. henryi* Oliv are used traditionally to treat gout, and arthritis in Tujja (Sun *et al.*, 2016).

Phytoconstituents of the Genus *Clematis*

Nowadays, phytopharmaceuticals play an important role in geomedicine, plant science, food science, cosmetics industry, nano-life science, pharmacology, toxicology, agro chemistry and so on**.** Isoprenoids compounds, alkaloids, glycosides, volatile oils, steroids, organic acids, and phenols are the diverse ingredients found in the plants of *Clematis* genus; triterpenoid saponins, flavonoids and their glucosides, and lignans are the primary constituents present in plant species of *Clematis* genus (Table 1). Bidesmosidic saponins of the oleanolic and hederagenin types are the major triterpenoid saponins present in *Clematis* species. Flavones, flavonols, flavanones, isoflavones, xanthones are the major flavonoids present in *Clematis* genus. Eupomatene lignans, cyclolignans, monoepoxy lignans, bisepoxy lignans, and lignanolides make up the majority of the lignans in *clematis* (F. Sun Yang, 2009).

Table 1: List of chemical constituents of various *Clematis* species

S. No.	*Clematis* species	Chemical Constituents	References
1.	*C. parviloba*	Aporphine alkaloids: α-magnoflorine and β-magnoflorine. Phenolic glycosides: 2-((E)-3-carboxybut-2-en-yl)-4-hydroxy-3-methyl-phenyl-O-beta-D-glucopyranoside, 4'-hydroxy-3'-methoxy-phenol-beta-D-[6-O-(4"-hydroxy-3",5"-dimethoxy-benzoate)], glucopyranoside, clemaparviloside A. Megastigmane glycosides: Linarionoside A, B, & C, staphylionoside. Lignan: Syringaresinol, medioresinol.	(Chen *et al.*, 2009; L. H. Yan *et al.*, 2009; Yan *et al.*, 2008; Yan *et al.*, 2010)
2.	*C. argentilucida*	Triterpenoid saponin: Cussonside, 3β-O-[β-D-ribopyranosyl-(1 → 3)-α-L-rhamnopyranosyl-(1 → 2)-α-L-arabinopyranosyl] hederagenin-11,13-dien-28-oic acid, and 3β-O-{β-D-ribopyranosyl-(1→ 3)-α-L-rhamnopyranosyl-(1 → 2)-[β-D-glucopyranosyl-(1 → 4)]-β-D-xylopyranosyl}oleanolic acid. Ursane triterpenoid, oleanane triterpenoid and taraxerane saponin.	(Mei Zhao *et al.*, 2014)
3.	*C. hirsuta*	Sterols and Terpenes: β-Amyrin, lupeol, β-sitosterol, oleanolic acid, stigmasterol, (S)- (+)-dihydro-5-(hydroxymethyl)-2(3H)-furanone and (s)-(-)-5-hydroxymethyl-2(5H)-furanone, anemonin, dihydro-4-hydroxyl-5-(hydroxymethyl)-2(3H)-furanone (2- deoxy-D-ribono-1,4-lactone), biophenol, glucose and sucrose.	(Abdel-Kader *et al.*, 2008), (Ameya *et al.*, 2022)
4.	*C. montana*	Hederagenin based saponin: Hederagenin-3-O-α-L-arabinopyranosyl (1-3)-α-L- rhamnopyranosyl (1-2)-α-L-arabinopyranoside. Saponin: (3-0-β-ribopyranosyl) (l-3)-α-rhamnopyranosyl (l-2)-α-arabinopyranosido-28-0-α-L-rhamnopyranosyl (l-4)-β-D-glucopyranosyl (l-6)-β-D-glucopyranoside, and (3-0-β-ribopyranosyl (l-3)-α-rhamnopyranosyl - (l-2)-a-arabinopyranoside. Oleanolic acid based biglycoside: Clemontanoside B, E & F.	(Thapliyal Bahuguna, 1993a) (Thapliyal Bahuguna, 1993b) (Thapliyal Bahuguna, 1994) (Lu *et al.*, 2014) (H. Peng *et al.*, 2009)
5.	*C. armandii*	Lignan: (7R, 8S)-9-acetyl-dehydrodiconiferyl alcohol. Flavanone glycoside: 5, 4′-dihydroxy-3′-methoxyflavanone-7-(6″-O-β-L-rhamnopyranosyl)-β-D-glucopyranoside.	(Yan *et al.*, 2007)

6.	*C. vitalba*.	Vitalboside, n-triacontan, n-nonacosan, ginnon, ginnol, β-sitosterol, chlorogenic acid, caffeic acid, colneleic acid, colnelenic acid.	(Ulubelen, 1970)
7.	*Clematis delavayi* var. *spines cens*	7-hydroxyl-4,6-dimethoxy-5- methylcoumarin, (*E*)-para- coumatic acid, coniferaldehyde, 4,6,7-trimethoxy -5-methylcoumarin.	(Y. Li *et al.*, 2009)
8.	*Clematis akebioides* (Maximowicz) Veitch	Benzenoids, monoterpene glycoside, and triterpenoid saponin.	(Y.-M. Zhang *et al.*, 2019)
9.	*Clematis tangutica*	Triterpenoid saponin: Tanguticoside A & B, clematangoticosides, 3-O-α-L-arabinopyranosyl hederagenin 28-O-α-L-rhamnopyranosyl ester. Saponin: vitalboside B, β-hederin	(Min Zhao *et al.*, 2016) (Wei *et al.*, 2022)
10.	*C. heracleifolia*	Heracleifolianosides.	(Du *et al.*, 2003; Q. Zhang *et al.*, 2022)
11.	*Clematis lasiandra* Maxim	3-O-β-D-ribopyranosyl-(1 → 3)-*α*-L-rhamnopyranosyl-(1 → 2)-[β-D-glucopyranosyl-(1 → 4)]-β-D-xylopyranosyl hederagenin , 3-O-β-D-ribopyranosyl-(1 → 3)-*α*-L-rhamnopyranosyl-(1 → 2)-β-D-xylopyranosyl oleanolic acid 28-O-β -D-glucopyranosyl ester, 3-O-β-D-ribopyranosyl-(1 → 3)-*α*-L-rhamnopyranosyl-(1 → 2)-β-D-xylopyranosyl hederagenin, and 3-O- β-D - ribopyranosyl-(1 → 3)-*α*-L-rhamnopyranosyl-(1 → 2)-[β-D-glucopyranosyl -(1 → 4)]-*α*-L-arabinopyranosyl hederagenin.	(Tian *et al.*, 2013)
12.	*Clematis chinensis*	Clematochinenoside H-K, mandshunoside-B, 3-O-β-d-ribopyranosyl-(1 → 3)-α-l-rhamnopyranosyl-(1→2)-[β-d-glucopyranosyl-(1→4)]-α-l-arabinopyranosyl oleanolic acid28-O-α-l-rhamnopyranosyl-(1→4)-β-d-glucopyranosyl-(1→6)-β-d-glucopyranoside,3-O-β-d-xylopyranosyl-(1→ 2)-α-l-arabinopyranosyl hederagenin 28-O-α-l-rhamnopyranosyl-(1→4)-β-d-glucopyranosyl-(1→6)-β-d-glucopyranoside, clematichinenoside A .	(Fu *et al.*, 2017)
13.	*Clematis ganpiniana*	Clematiganoside-A ,3β-[(α-L-arabinopyranosyl)-oxy]olean-12-en-28-oic acid, hederagenin 3β-O-α-L-arabinopyranoside, 3β-O-α-L-rhamnopyranosyl-(1→2)-α-L-arabinopyranosyl oleanolic acid , α-hederin.	(Ding *et al.*, 2009; F. Sun *et al.*, 2007)
14.	*Clematis viticella*	flavonoid: Isoorientin, isoorientin 3′-O-methyl ether, quercetin 7-O-α-L-rhamnopyranoside, quercetin 3,7-di-O-α-L-rhamnopyranoside, manghaslin and chrysoeriol 7-O-β-D-glucopyranoside. Phenolic acids: Caffeic acid, (E)-p-coumaric acid and p-hydroxybenzoic acid.	(Kırmızıbekmez *et al.*, 2019)
15.	*Clematis Gouriana*	Alkaloids, carbohydrates, steroids, saponins, tanins, flavonoids, phenolic compounds, and terpeniods.	(Sheela, 2014)
16.	*Clematis parviloba*	Aporphine alkaloid: β-magnoflorine, α-magnoflorine.	(Chen *et al.*, 2009)
17.	*C. orientalis*	Resorcinol	(Karimi *et al.*, 2018)
18.	*C. ispahanica.*	Ellagic acid	(Karimi *et al.*, 2018)
19.	*Clematis grata*	Clematoside-S,hederagenin-3-O-β-F-ribopyranosyl (1→3)-α-L-rhamnopyranosyl(1→2)-α-L-arabino-pyranoside.	(Sati *et al.*, 1990)

20.	*Clematis akebioides* (Maximowicz) Veitch	Benzenoids, monoterpene glycoside, and triterpenoid saponins.	(Y.-M. Zhang *et al.*, 2019)
21.	*Clematis mandshurica*	Triterpene saponin: mandshunosides C–E	(L. Li *et al.*, 2013)

Conclusion

Clematis species are widely used around the world for their known health benefits. They have analgesic, diuretic, anti-cancer and anti-rheumatic properties. These numerous biological activities are carried out by various chemicals, the main components of which include saponins, flavonoids, and lignin and ranunculin glycosides. *Clematis* has great potential for human health and its medicinal effects should be studied more closely and thoroughly. There is a need for preclinical and clinical research into the use of these plants, as well as more detailed studies of all bioactive phytoconstituents and their mechanisms at the cellular and tissue levels.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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