



## Chemical and Pharmacological Aspects of *Limnophila heterophylla* (Scrophulariaceae): An Overview

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### ABSTRACT

The present work offers a review addressing the chemistry and pharmacology of *Limnophila heterophylla* (Roxb.) Benth. (belonging to Scrophulariaceae family) regarded as one of the most significant plant species in traditional system of medicine and is established as a source of flavonoids, terpenoids etc. The isolated phytochemicals as well as different extracts exhibited some kind of biological activities such as antimicrobial, anti-inflammatory, wound healing. Exhaustive research regarding isolation of more phytochemicals and pharmacology study on this medicinal plant is still necessary so as to explore the plant regarding its medicinal importance. Therefore, the aim of this review is to boost up present day researchers in this direction to undertake further investigation of this plant. The present review covers literature up to middle of January 2014 and enlists 22 references.

**Keywords:** *Limnophila heterophylla*, Scrophulariaceae, Chemical constituents, Biological activity.

### INTRODUCTION

*Limnophila heterophylla* [Synonyms: *Columnea heterophylla* Roxb., *Limnophila reflexa* Benth., *Limnophila heterophylla* var. *reflexa* (Benth.) Hook. f., *Limnophila roxburghii* G. Don] is an aquatic herb, mainly submerged, but with shoots that often emerge above the water surface, rooting at nodes.<sup>1-2</sup> Leaves are arranged in whorls of four to ten, sessile, 2–3 cm long. Below water, they are finely twice pinnatifid. Above water, they are undivided but shallowly toothed. Flowers occur singly, sessile, in the axils of the upper leaves, above water. The corolla tube is 3–4 mm long with four lobes, the upper bifid, spreading to about 3 mm across. Calyx tubular, 1–2 mm long, with five teeth; capsule ovoid, with many very small seeds irregularly ovoid in shape and less than 1 mm long.<sup>1</sup>

The plant occurs mainly in still or slowly moving water, at the edges of streams and irrigation channels, and in rice and jute fields. It flowers and fruits from October to March in India.<sup>2</sup> It may propagate from stem fragments as well as from seeds. While this plant appears to be restricted to the true tropics, it poses a significant threat to tropical and possibly subtropical regions and islands of United States. It is native in Asia including India, Laos, Malaysia, Philippines, Sri Lanka, Thailand, and Vietnam.<sup>3-6</sup> This plant is listed as a "serious" weed in India and a "common" weed in Thailand and regarded as among the most problematic weeds of deep-water rice in West Bengal, India.<sup>7</sup> Dense growth of this plant can restrict the flow of water in irrigation channels and choke ponds.

### Taxonomical Background of the plant

The taxonomical classification of *Limnophila heterophylla* is shown below:

Kingdom	Plantae
Sub-kingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Sub-class	Asteridae
Order	Scrophulariales
Family	Scrophulariaceae
Genus	<i>Limnophila</i>
Species	<i>L. heterophylla</i>
Binomial name	<i>Limnophila heterophylla</i> (Roxb.)Benth.

### Traditional use

The plant finds lot of applications in the traditional system of medicine against various ailments.<sup>8-11</sup> The plant leaves are crushed with coconut oil and applied on the wound to quicken healing<sup>12</sup> and is established as a source of flavonoids, terpenoids etc. The isolated phytochemicals as well as different extracts exhibited some kind of biological activities. Exhaustive research regarding isolation of more phytochemicals and pharmacology study on this medicinal plant is still necessary so as to explore the plant regarding its medicinal importance. Therefore, the aim of this review is to boost up present day researchers in this direction to undertake further investigation of this plant.

### METHODS

The chemical constituents isolated and identified from *Limnophila heterophylla*, pharmacological activities exhibited by the isolated compounds as well as by the crude plant extracts were searched across the Medline (National Library of Medicine) and Science Direct

databases. The data were updated in middle of January 2014, using the search-terms *Limnophila heterophylla*, chemical constituents, biological activities, pharmacological activities or properties of *Limnophila heterophylla* as keywords. In addition, the reference lists of all papers identified were reviewed.

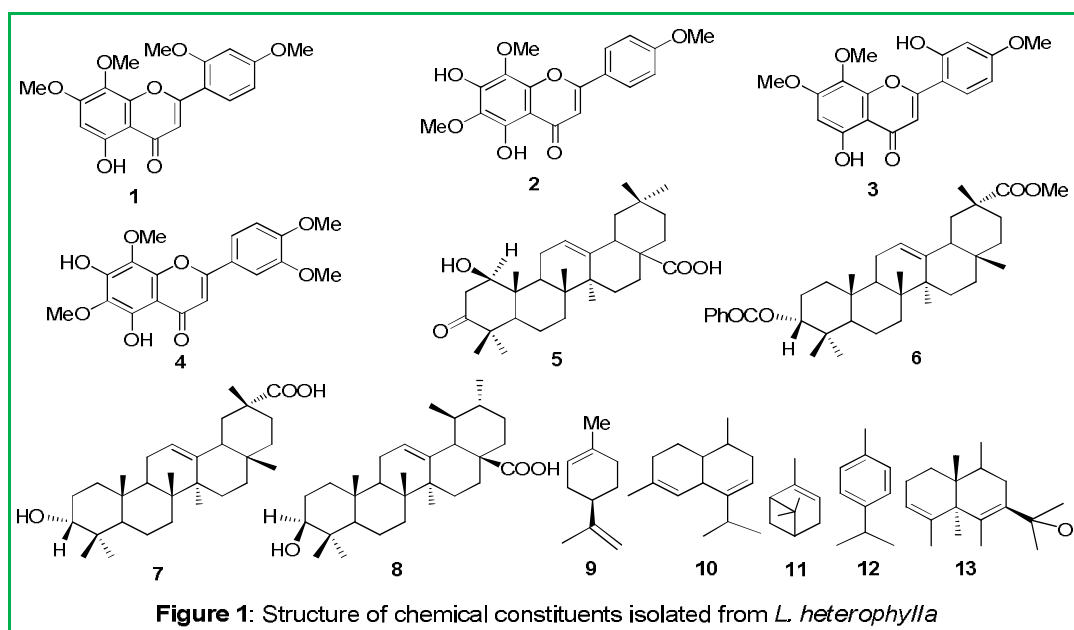
## RESULTS AND DISCUSSION

### Chemical constituents isolated from *L. heterophylla*

Few phytochemical studies on this plant have been done so far and four flavonoids and nine terpenoids were reported (**Table-1**). Structures of these phytochemicals are included in **Figure-1**.

**Table 1:** List of phytochemical constituents isolated from *L. heterophylla*

5-Hydroxy-7,8,2',4'-tetramethoxyflavone (1)	Aerial parts and roots	13
5,7-Dihydroxy-6,8,4'-trimethoxyflavone (Nevadensin) (2)	Aerial parts and roots	14-15
5,2'-Dihydroxy-7,8,4'-trimethoxyflavone (3)	Aerial parts and roots	16
5,7-Dihydroxy-6,8,3',4'-tetramethoxyflavone (Hymenoxin, 4)	Aerial parts and roots	17
1 $\beta$ -Hydroxy-3-keto-olean-12-en-28-oic acid (5)	Aerial parts and roots	18
Methyl-olean-12-ene-3 $\alpha$ -benzoyloxy-29-carboxylate (6)	Aerial parts and roots	9
3 $\alpha$ -Hydroxyolean-12-ene-29-oic acid (Katic acid, 7)	Aerial parts and roots	19
Ursolic acid (8)	Aerial parts and roots	13
(+)-Limonene (9)	Essential oil	20
(+)-Cadinene (10)	Essential oil	20
$\alpha$ -Pinene (11)	Essential oil	20
<i>p</i> -Cymene (12)	Essential oil	20
$\alpha$ -Eudesmol (13)	Essential oil	20



### Biological activity exhibited by the plant and its phytoconstituents

A few pharmacological studies were performed on this plant. The biological activities exhibited by this plant as well as its phytoconstituents have been discussed below:

The flavone, Nevadensin (2), isolated from the aerial parts and roots of the plant was found to exhibit *in vitro* cyclooxygenase-1 and 2 (COX-1 and COX-2) inhibitory efficacy measured by COX catalyzed prostaglandin biosynthesis assay method.<sup>15</sup> The compound 2 was found to exhibit weak activity against the COX-2 (0.65% inhibition) but moderate inhibitory activity (7.37% inhibition) against COX-1 at 10 $\mu$ M concentration in DMSO. The investigators are in opinion that this

compound may be used as a 'lead molecule' for drugs against inflammatory and related diseases.<sup>15</sup> Nevadensin (2) was also reported to exhibit antimicrobial activities against a number of microbial strains including bacteria and fungi such as *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Salmonella typhimurium*, *Alternaria solani*, and *Candida albicans*.<sup>21</sup> The compound 2 showed bactericidal effect against *E. coli* (Gram-positive bacteria) and *S. aureus* (Gram-negative bacteria) having MIC values of 200 and 250  $\mu$ g/mL, respectively and also inhibited the growth of *A. solani* (fungal strain).<sup>21</sup>

A research group<sup>22</sup> reported significant antibacterial as well as anti-fungal activities of the ethanol extract of the whole plant. The extracts at concentrations of 5, 25, 50,

100 and 250 µg/mL exhibited remarkable inhibition activity against two pathogenic Gram-positive bacterial strains (*Bacillus subtilis* and *Staphylococcus aureus*), two pathogenic Gram-negative bacterial strains (*Escherichia coli* and *Klebsiella pneumoniae*) and two fungal strains such as *S. flavus* and *C. albicans*.<sup>22</sup> Alcoholic extract was found to have wound healing activity on rats as investigated by a research group.<sup>17</sup>

## CONCLUSION

The present article deals with an up-to-date review on the chemistry and pharmacology of *Limnophila heterophylla*, a useful medicinal plant from Scrophulariaceae family finding applications in indigenous systems of medicine. The plant is used in different parts of the world for the treatment of several ailments and is the source of a chemical constituents such as flavonoids, terpenoids etc. The isolated phytochemicals as well as different extracts exhibited significant biological activities such as antimicrobial, anti-inflammatory, wound healing. Exhaustive research regarding isolation of more phytochemicals and pharmacology study on this medicinal plant is essentially urgent so as to explore the plant regarding its medicinal importance. Therefore, the aim of this review is to boost up present day researchers in this direction to undertake further investigations of this plant and we do anticipate that this plant will be much effective in drug development programme in near future.

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## REFERENCES

- Pancho JV, Soerjani M, Aquatic Weeds of Southeast Asia, National Publishing Cooperative, Inc, Quezon City, Philippines, 1978, 130.
- Ambasta SP, The Useful Plants of India, Publications & Information Directorate, CSIR, New Delhi, 1986.
- Holm LG, Pancho JV, Herberger JP, Plucknett DL, A Geographical Atlas of World Weeds, Wiley, New York, 1979,391.
- Islam M, Aquatic Weeds of North-east India, International Book Distributors, Dehra Dun, India, 1989, 155.
- Moody K, Weeds Reported in Rice in South and Southeast Asia, International Rice Research Institute (IRRI), Manila, Philippines, 1989, 442.
- Yong SH, Goh AK, Weeds in Padi-fields (Peninsular Malaysia), Malaysian Ministry of Agriculture, Kuala Lumpur, 1977, 74.
- Sahu R, Control of annual aquatic weeds of deep-water paddy fields by pre-emergence spray of butachlor, Indian Agriculturist, 36(1), 1992, 49-51.
- Mukherjee KS, Gorai D, Sohel SMA, Chatterjee D, Mistri B, Mukherjee B, Brahmachari G, A new flavonoid from *Limnophila rugosa*, Fitoterapia, 74, 2003,188-190.
- Mukherjee KS, Brahmachari G, Manna TK, Triterpene from *Limnophila heterophylla*, Phytochemistry, 38, 1995, 1273-1274.
- Kapil VB, Sinha AK, Sinha GK, Antibacterial and antifungal study of some essential oils and their constituents from the plants of Kumaon and its Tarai tract, Bull. Med. Ethnobot. Res., 4, 1983, 124-129.
- Misra OP, Botanical identity of Sugandhabala, J. Res. Ind. Med. Yoga Homoeo., 13, 1978, 110-114.
- Arul Manikandan PN, Folk herbal medicine: a survey on the Paniya tribes of Mundakunnu village of the Nilgiri hills, South India, XXV (1) July, August, September, Ancient Science of Life, 2005, 21-27.
- Mukherjee KS, Manna TK, Laha S, Brahmachari G, Chemical investigation of *Limnophila heterophylla* and *Borrerio articularis*, J. Indian Chem. Soc., 71, 1994, 655-656.
- Brahmachari G, Mondal S, Jash SK, Mandal KS, Chattopadhyay S, Gangopadhyay A, Naturally occurring bioactive O-heterocycles: a quest for new sources, Nat. Prod. Indian J., 2, 2006, 74-77.
- Brahmachari G, Jash SK, Mandal LC, Mondal A, Roy R, Cyclooxygenase (COX)-inhibitory flavonoid from *Limnophila heterophylla*, Rasayan J. Chem, 1(2), 2008, 288-291.
- Mukherjee KS, Brahmachari G, Manna TK, Mukherjee P, A new flavone from *Limnophila heterophylla*, J. Indian Chem. Soc., 75, 1998, 260-261.
- Reddy GBS, Melkhani AB, Kalyani GA, Rao JV, Shirwaikar A, Kotian M, Ramani R, Aithal KS, Udupa AL, Bhat G, Srinivasan KK, Chemical and pharmacological investigations of *Limnophila conferta* and *Limnophila heterophylla*, Int. J. Pharmacognosy, 29, 1991, 145-153.
- Mukherjee KS, Brahmachari G, Manna TK, Laha S, A new triterpene from *Limnophila rugosa* (Roth.) Merrill., J. Indian Chem. Soc., 72, 1995, 741.
- Mukherjee KS, Brahmachari G, Manna TK, Chemistry of *Flacourtia jangomas*, *Limnophila heterophylla* and *Hoppea fastigiata*, J. Indian Chem. Soc., 74, 1997, 738-739.
- Rastogi RP, Mehrotra BN, Compendium of Indian Medicinal Plants, Eds., Vol. 4, CDRI and NISCOM, New Delhi, India, 1998, 435.
- Brahmachari G, Mandal NC, Jash SK, Roy R, Mandal LC, Mukhopadhyay A, Behera B, Majhi S, Mondal A, Gangopadhyay A., Evaluation of the antimicrobial potential of two flavonoids isolated from *Limnophila* plants, Chem. Biodivers., 8, 2011, 1139-1151.
- Padiya RH, Patel ED, Acharya RN, Evaluation of antimicrobial activity of *Limnophila heterophylla* (Roxb.) Benth. (Scrophulariaceae) whole plant, International Journal of Ayurvedic Medicine, 4(1), 2013.

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