Limnophila (Scrophulariaceae): Chemical and Pharmaceutical Aspects

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Abstract: The present resume covers an up-to-date literature on *Limnophila* species. The botanical classification, ethno-pharmacology, and chemical constituents of *Limnophila* plants, as well as the biological activities and pharmacological applications of both distinct phytochemicals and medicinally active plant materials (formulations, extracts, etc.) are discussed in detail.

Keywords: *Limnophila* species, botany, taxonomical classification, ethno-pharmacology, chemical constituents, biological activities, pharmacological applications.

INTRODUCTION

Limnophila (family: Scrophulariaceae) [1-5] is originated from a *Latin* word that means pond-loving indicating its existence in aquatic environments. It is commonly known as 'Ambulia' (Asian marshweed). It is a perennial from Southeast Asia, tropical to subtropical Africa, Australia, and Pacific Islands; also finds adventive distribution in North America. *Limnophila* plants are widely distributed throughout India, and occupy a significant position in traditional systems of medicine. A number of plant species are in use as folk medicines in the treatment of various ailments. A number of works on chemical and pharmacological aspects of genus *Limnophila* have already been done. Here an attempt, for the first time as per the record, has been made to compile all these works that are in scattered in literatures. Although some works on the genus have been done, a major portion remains unexplored. This review is designed in such a fashion so that it would surely boost the ongoing research in this direction. That's why an all round and up-to-date resume — covering its botany to ethnobotany, biological and pharmacological studies as well as phytochemicals as reported so far — on this important plant genus has been compiled.

BOTANICAL ASPECTS

Limnophila [6,7] is an aquatic, or nearly aquatic, perennial herb found as submersed, emergent, and amphibious stem plant. Its natural habitats are rivers, lakes, ponds as well as marshy lands. The submerged stems are smooth and have leaves to 30 mm long, feathery, and in whorls about the stem. These differ from the emergent stems, which are covered with flat shiny hairs and have leaves, generally lance-shaped, up to 3 cm long with toothed margins. Stems may be up to 12 feet long. The emergent stems are usually 2-15 cm above the surface of the water. Single white, pink, purple or blue to lavender flowers, sometimes with conspicuous spots, occasionally occur on the emerged portion of the stem. The flowers are stalkless and borne in the leaf axis, and are axillary and solitary or in axillary or terminal spikes or racemes, sessile or pedicellate. The lower portion (sepals) have five, green, hairy lobes, each 4-5 mm long. The upper portion is purple and composed of five fused petals forming a tube with two lips — adaxial lip (dorsal) is 2-lobed, while abaxial lip (ventral) is 3-lobed. The lips have distinct purple lines on the undersides. The fruit is capsule containing up to 150 seeds.

Limnophila reproduces through fragmentation of the stem or by seeds. In post-rainy session the fruits of *Limnophila* are mature, and the mats break loose from the hydrosoil — as the floating-mats move, they spread out the seeds throughout a wider area.

TAXONOMICAL BACKGROUND

The taxonomical classification [8,9] of *Limanophila* plants are shown below:

Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Asteridae
Order	Scrophulariales
Family	Scrophulariaceae
Genus	*Limnophila* R. Brown

About 40 species [10] of the genus *Limanophila* are known; some common species are cited here:

L. aromatica (Lamarck) Merrill. (Syn. *L.aromaticoides* Yang & Yen; *L. gratissima* Blum)

L. australis Wannan & Waterh.

L. balsamea (Benth.) Benth. (Syn. *L. thorelii* Bonati)

L. borealis Y. Z. Zhao & Maf.

L. laotica Bonati

L. laxa Bentham

L. micrantha (Benth.) Bentham

L. parviflora Yamazaki

L. poilanei Yamazaki

L. polyantha Kurz ex Hook.f.

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L. brownii Wannan

L. chinensis (Osbeck) Merill (Syn. *L. chevalieri* Bonati; *L. hirsuta* (Heyne ex Benth.) Benth.

L. connata (Buchanan-Hamilton ex D. Don)

Handel-Mazzetti

L. erecta Bentham

L. fragrans Seem

L. geoffrayi Bonati

L. hayatae Yamazaki

L. heterophylla (Linnaeus) Druce (Syn. *L. reflexa* Bentham)

L. indica (Linnaeus) Druce (Syn. *L. gratioloides* R. Brown; *L. racemosa* Bentham; *L. aquatica* Roxburgh)

(Syn. *L. polyantha* Yamazaki)

L. repens (Bentham) Bentham

(Syn. *L. conferta* Bentham;

L. dubia Bonati; *L. sessilis* (Bentham) Fischer

L. rugosa (Roth) Merill

(Syn. *L. roxburghii* G. Don)

L. sessiliflora (Vahl) Blume

L. siamensis Yamazaki

L. taoyuanensis Yang & Yen

L. verticillata Yamazaki

L. villifera Miq.

L. X ludoviciana Thieret

L. dasyantha Skan

L. glabra (Benj.) Kerr

L. hottonoides Druce

L. gigantean

TRADITIONAL USES

Limnophila plants are extensively used in the indigenous system of medicine, and are found to be useful and effective. Traditional uses of only a few of these significant plant species finding useful applications in the treatment of various ailments are mentioned here. The medicinal uses of these plant species are being cited on the basis of extensive literature survey.

(i) L. aromatica (Syn. L. gratissima)

The plant is used as a spinach, eaten raw or steamed. It is sour, slight bitter refrigerant emollient antiseptic, galactagogue, aperient, appetizer, digestive, carminative, anthelmintic, anti-inflammatory, diuretic and febrifuge. It is useful in vitiated conditions of *pitta*, foul ulcers, agalactia, galactic impurities, anorexia, dyspepsia, helminthiasis, constipation, inflammations and strangury. The juice of the plant is used as a cooling medicine in fever and pharyngitis. It is given to nursing women, when the milk is sour. The plant emits turpentine-like odour and yields an essential oil [11,12].

(ii) L. rugosa (Syn. L. roxburghii)

The plant shows numerous medicinal applications in the traditional system. The juice of the plant is rubbed over the body in pestilent fever. It is applied on elephantiasis with coconut oil. It is administered in diarrhoea, dysentery and dyspepsia. It is used as carminative and tonic. The essential oil is used as flavouring agent of food and perfuming of hair oils. The essential oil of this plant also exhibits significant anti-bacterial and anti-fungal activities. The plant had been accepted for "*Sugandhabala*" as it responded to Ayurvedic description of the drug. Infusion of leaves is used as diuretic and stomachic in the Philippine Islands and more or less throughout India [12-14].

(iii) L. indica (Syn. L. gratioloides; L. racemosa; L. aquatica)

The plant has a refreshing and agreeable odour resembling to camphor or oil of lemon. *L. indica* is considered to be carminative and antiseptic. A liniment prepared from the plant is used in elephantiasis. The juice of the plant is rubbed over the body in pestilent fever. It is given internally in dysentery combined with ginger, cumin and other aromatics [12,13,15].

(iv) L. conferta

The plant has been employed to treat various types of skin diseases and conditions of inflammation in the indigenous system of medicine [13,16].

(v) L. gratissima

L. gratissima is a stout aromatic herb possessing the odour of turpentine and yields 0.13% of an essential oil .It is regarded as antiseptic galactagogue and aperient [15].

CHEMICAL CONSTITUENTS OF *LIMNOPHILA*

The phytochemical investigation of the genus *Limnophila*, as carried out so far, has afforded some 56 compounds with varying structural skeletons. These compounds are classified into flavonoids (**1-17**; Fig. **1**) (Table **1**), terpenoids (**18-43**; Fig. **2**) (Table **2**), and miscellaneous (**44-56**; Fig. **3**) (Table **3**). These are presented below:

BIOLOGICAL/PHARMACOLOGICAL ACTIVITIES OF CRUDE PLANT MATERIALS AS WELL AS OF CHEMICAL CONSTITUENTS

A good number of biological/pharmacological works with different parts of *Limnophila* plants as crude extracts and also of pure chemical constituents isolated from these plant species have been reported so far. This section is an attempt to sum up all these findings.

Antimicrobial Activity

Limnophila plants are reported to exhibit significant antimicrobial activity. *L. racemosa* and *L. indica* extracts were found to inhibit the growth of *Xanthomonas campestris* and *X. malvacearum in vitro* [42]. Mishra *et al.* [43] also studied the antimicrobial activity of the same plant extracts against a number of bacterial species and obtained a convincing result (Table **4**) on the basis of which the workers pointed out that both the extracts of *L. racemosa* and *L. indica* bear certain antimicrobial components.

Antibacterial efficacy of the essential oil of *L. conferta* was also established by Reddy *et al.* [30] against the Gram-positive bacteria, *Staphylococcus aureus* and *Bacillus subtilis*, and two Gram-negative bacteria, *Escherichia coli* and *Pseudomonas aeruginosa*. The significant antimicrobial activity of the essential oil of *L. conferta*, comparable with that of chloramphenicol used as standard and ethylene glycol as control solvent justifies the use of this plant in the indigenous system of medicine in controlling some infections. The oil was not found to be toxic at a dose level of 1.6 mL/Kg orally.

Rao *et al.* [30] reported that the essential oil of *L. gratissima* shows a good antimicrobial activity (Table **5**) of the same order of that of the reference standards, streptomycin and chloramphenicol.The results obtained is promising.

Further, Kapil *et al.* [44] reported that *Limnophila rugosa* essential oil and its constituents also show potent anti-

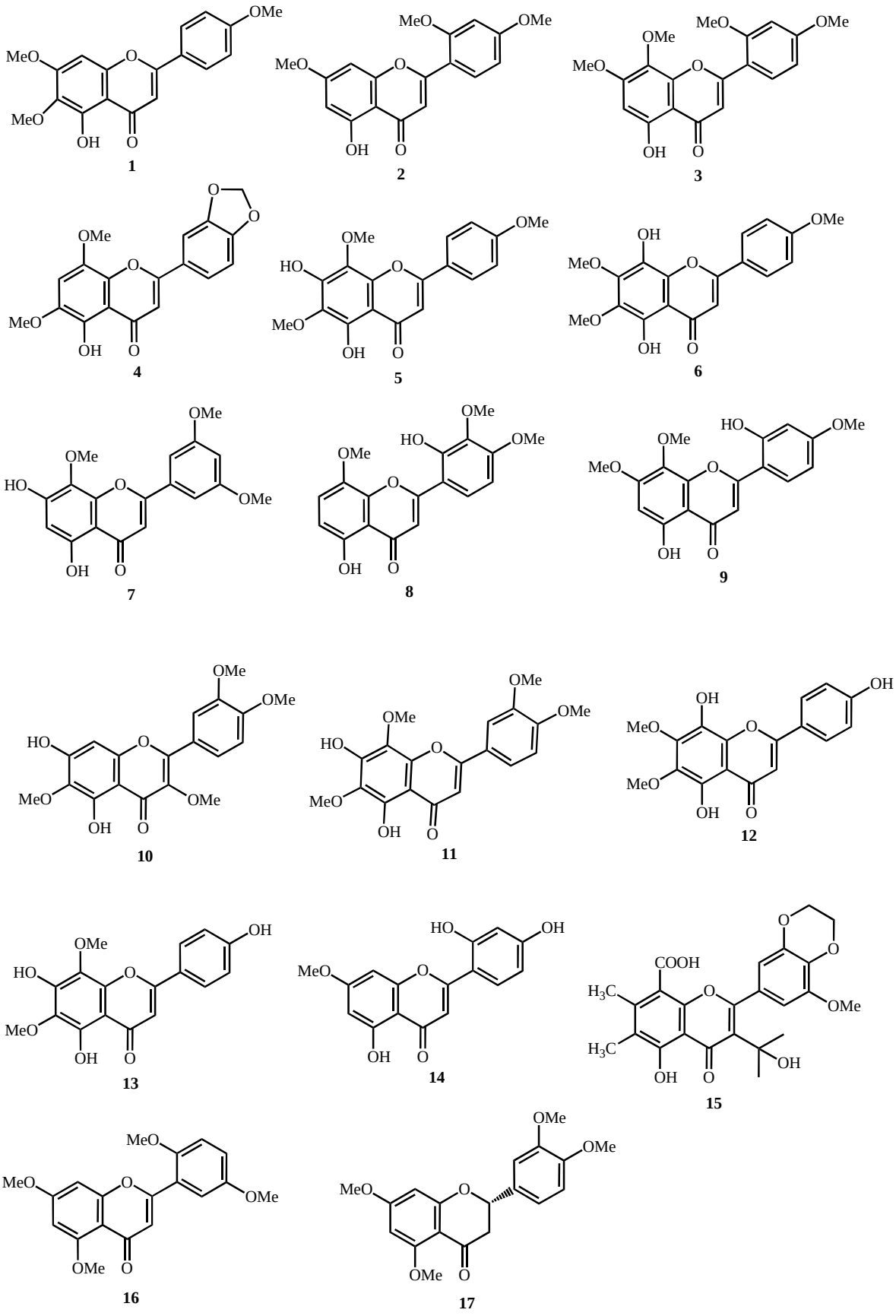


Fig. (1). Structures of flavonoids from *Limnophila*.

Table 1. Flavonoid Constituents of *Limnophila*

Compounds (Str. No.)	Source	Ref.
5-Hydroxy-6,7,4'-trimethoxyflavone (**1**) (Salvigenin)	*L. rugosa* (aerial parts and roots)	[17]
5-Hydroxy-7,2',4'-trimethoxyflavone (**2**)	*L. rugosa* (aerial parts and roots)	[18]
5-Hydroxy-7,8,2',4'-tetramethoxyflavone (**3**)	*L. rugosa* (aerial parts and roots) *L. hetero-phylla* (aerial parts and roots)	[19] [20]
5-Hydroxy-6,8-di-methoxy-3',4'-methylene- dioxyflavone (**4**)	*L. indica* (aerial parts and roots)	[21]
5,7-Dihydroxy-6,8,4'-trimethoxyflavone (Nevadensin) (**5**)	*L. geoffrayi* (aerial parts) *L. hetero-phylla* (aerial parts and roots) *L. rugosa*	[22] [23] [24]
5,8-Dihydroxy-6,7,4'-trimethoxyflavone (**6**)	*L. indica* (aerial parts and roots)	[25]
5,7-Dihydroxy-8,3',5'-trimethoxyflavone (**7**)	*L. rugosa* (aerial parts and roots)	[26]
5,2'-Dihydroxy-8,3',4'-trimethoxyflavone (**8**)	*L. indica* (aerial parts and roots)	[27]
5,2'-Dihydroxy-7,8,4'-trimethoxyflavone (**9**)	*L. heterophylla* (aerial parts and roots)	[28]
5,7-Dihydroxy-3,6,3',4'-tetramethoxyflavone (7-desmethyl artemetin, **10**)	*L. gratissima* (aerial parts and roots)	[29]
5,7-Dihydroxy-6,8,3',4'-tetramethoxyflavone (Hymenoxin, **11**)	*L. heterophylla*	[30]
5,8,4'-Trihydroxy-6,7-dimethoxyflavone (Isothymusin, **12**)	*L. geoffrayi* (aerial parts)	[23]
5,7,4'-Trihydroxy-6,8-dimethoxyflavone (Demethoxysudachitin, **13**)	*L. rugosa*	[24]
5,2',4'-Trihydroxy-7-methoxyflavone (Artocarpetin, **14**)	*L. rugosa* (aerial parts and roots)	[31]
3',4'-Ethylenedioxy-5-hydroxy-3-(1-hydroxy-1-methylethyl)-6,7-dimethyl-5'-methoxy-flavone-8-carboxylic acid (**15**)	*L. indica* (aerial parts and roots)	[32]
5,7,2',5'-Tetramethoxyflavone (**16**)	*L. indica* (aerial parts and roots)	[33]
5,7,3',4'-Tetramethoxyflavanone (**17**)		[33]

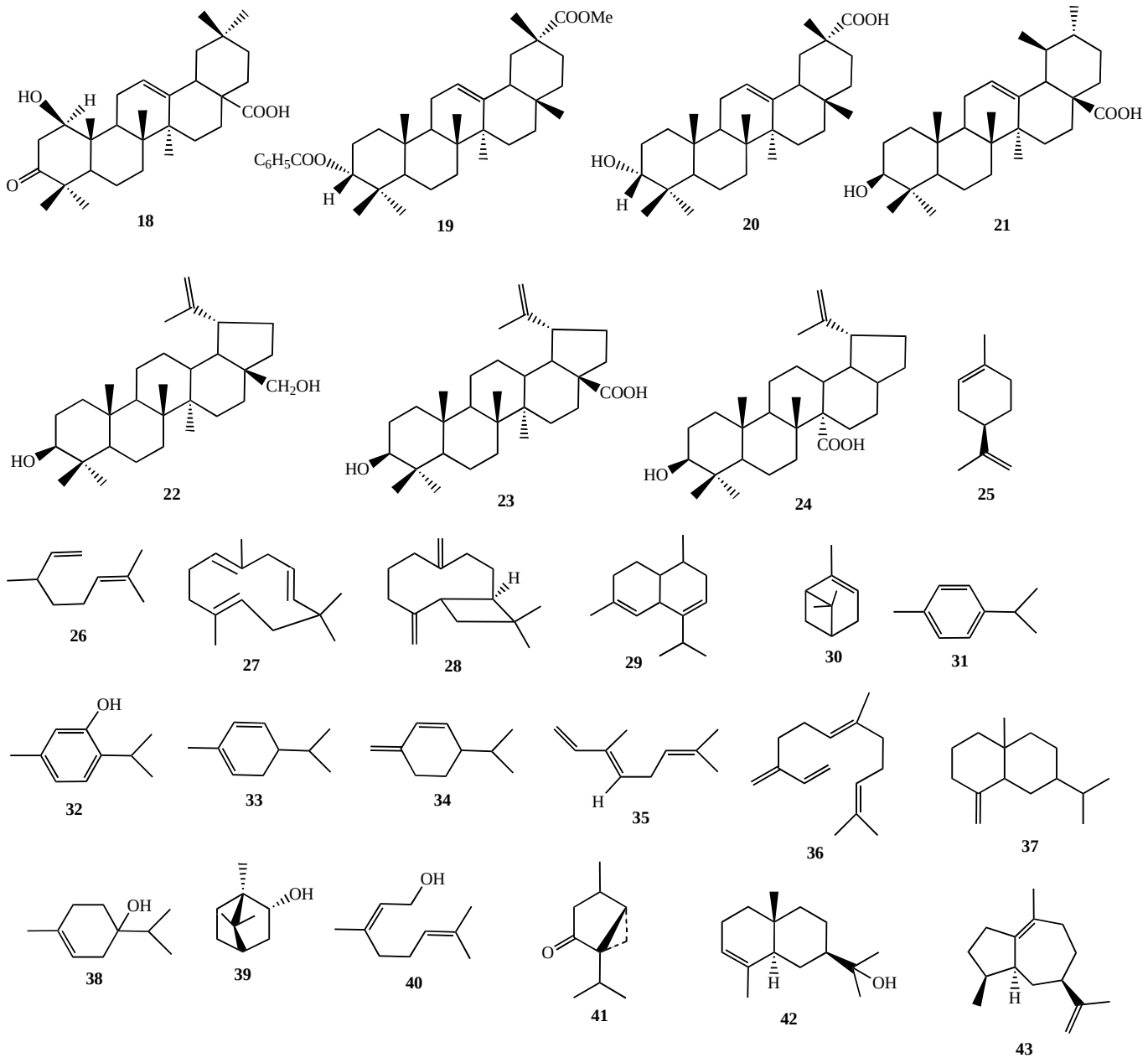


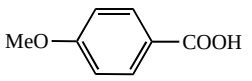
Fig. (2). Structures of terpenoids from *Limnophila*.

Table 2. Terpenoid Constituents of *Limnophila*

Compounds (Str. No.)	Source	Ref.
1β-Hydroxy-3-keto-olean-12-en-28-oic acid (**18**)	*L. rugosa* (aerial parts and roots)	[34]
Methyl-olean-12-ene-3α-benzoyloxy-29-carboxylate (**19**)	*L. heterophylla* (aerial parts and roots)	[35]
3α-Hydroxyolean-12-ene-29-oic acid (Katonic acid) (**20**)	*L. heterophylla* (aerial parts and roots)	[36]
Ursolic acid (**21**)	*L. heterophylla* (aerial parts and roots) *L. rugosa* (aerial parts and roots)	[20] [37]

(Table 2). Contd…..

Compounds (Str. No.)	**Source**	**Ref.**
Betulin (**22**)	*L. rugosa*	[38]
Betulinic acid (**23**)	*L. rugosa*	[38]
3β-Hydroxy-lup-20(**29**)-en-27-oic acid (**24**)	*L. rugosa*	[24]
(+)-Limonene (**25**)	Essential oil of *L. heterophylla*	[39]
Linalool (**26**)	Essential oil of *L. rugosa*	[39]
Humulene (**27**)	Essential oil of *L. rugosa*	[39]
Caryophyllene (**28**)	Essential oil of *L. rugosa*	[39]
(+)-Cadinene (**29**)	Essential oil of *L. heterophylla*	[39]
α-Pinene (**30**)	Essential oil of *L. heterophylla*	[39]
p-Cymene (**31**)	Essential oil of *L. heterophylla*	[39]
Thymol (**32**)	Essential oil of *L. conferta*	[30]
α-Phellandrene (**33**)	Essential oil of *L. conferta*	[30]
β-Phellandrene (**34**)	Essential oil of *L. conferta*	[30]
β–Ocimene (**35**)	Essential oil of *L. conferta*	[30]
Trans-β-farnesene (**36**)	Essential oil of *L. conferta*	[30]
β-Selinene (**37**)	Essential oil of *L. conferta*	[30]
Terpinen-4-ol (**38**)	Essential oil of *L. conferta*	[30]
Borneol (**39**)	Essential oil of *L. conferta*	[30]
Nerol (**40**)	Essential oil of *L. conferta*	[30]
Dihydroumbellulone (**41**)	Essential oil of *L. conferta*	[30]
α-Eudesmol (**42**)	Essential oil of *L. heterophylla*	[39]
α-Bulnesene (**43**)	Essential oil of *L. rugosa*	[39]



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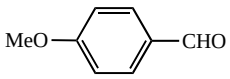

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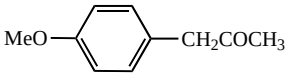

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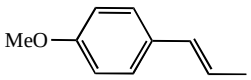

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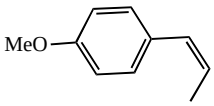

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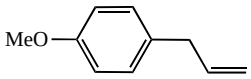

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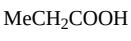

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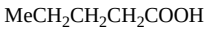

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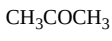

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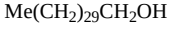

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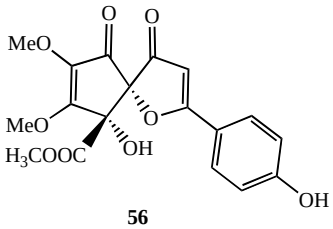

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Fig. (3). Structures of miscellaneous compounds from *Limnophila*.

Table 3. Miscellaneous Compounds of *Limnophila*

Compounds (Str. No.)	Source	Ref.
p-Methoxybenzoic acid (**44**)	Essential oil of *L. rugosa*	[40]
Anisaldehyde (**45**)	Essential oil of *L. rugosa*	[40]
Anisylacetone (**46**)	Essential oil of *L. rugosa*	[39]
Trans-anethole (**47**)	Essential oil of *L. rugosa*	[39]
Cis-anethole (**48**)	Essential oil of *L. rugosa*	[39]
Methylchavicol (**49**)	Essential oil of *L. rugosa*	[40]
Formic acid (**50**)	Essential oil of *L. rugosa*	[40]
Propionic acid (**51**)	Essential oil of *L. rugosa*	[40]
Acetic acid (**52**)	Essential oil of *L. rugosa*	[40]
Valeric acid (**53**)	Essential oil of *L. rugosa*	[40]
Acetone (**54**)	Essential oil of *L. rugosa*	[40]
Hentriacontanol (**55**)	Essential oil of *L. rugosa*	[37]
Limnophila-spiroketone (**56**)	*L. geoffrayi* (aerial parts)	[41]

Table 4. Antimicrobial Activity of *L. racemosa* and *L. indica*

Plant Extracts	Diameter of the Inhibition Zone Including Diameter of Well (10 mm) in mm									
	Species*	1	2	3	4	5	6	7	8	9
L. racemosa (whole plant)		29	30	28	32	25	24	22	19	20
L. indica (whole plant)		18	28	25	30	26	25	26	18	17
Control		28	24	20	20	26	22	18	16	16

*[1. *Bacillus anthracis* 2. *Bacillus mycoides* 3. *Bacillus pumilus* 4. *Bacillus subtilis* 5. *Pseudomonas* sp. 6. *Salmonella paratyphii* 7. *Staphylococcus albus* 8. *Xanthomonas campestris* 9. *Xanthomonas malvacearum*].

bacterial activity against *Bacillus subtilis* and *Salmonella typhi*. Chloroform extract of the aerial parts of *L. geoffrayi* also found to possess antimycobacterial activities [22]. The essential oil of *L. rugosa* is reported to exhibit antifungal activity [15]. The essential oil of *L. conferta* is also a useful antifungal antidote. The antifungal activity of the oil at 1: 50 dilution in ethylene glycol was found to be of the same order as that of griseofulvin in chloroform used as standard (100 µg/0.1ml). In case of the dermatophytes viz. *Trichophyton mentagrophytes* and *Microsporum gypseum* the oil at a concentration of 100 µg/mL inhibited the growth of both the fungi, however less effective than the standard, miconazole (10µg/mL) [30].

A promising antifungal efficacy of *L. gratissima* (essential oil) was reported by Venkata Rao *et al*. [45]. At a dose of 0.1 mL, the essential oil of the plant showed inhibition zones of 20, 28 & 25 mm (diameter) respectively against *Aspergilus niger*, *Rhizopus oryzae* and *Candida albicans* while the reference standard, griseofulvin exhibited the respective inhibition zones of 18, 24 & 14 mm at a dose of 100 mg in $CHCl_3$. It appeared that the oil of *L. gratissima* is mostly active against *Rhizopus oryzae*, and the efficacy is greater

Table 5. Antimicrobial Activity of *L. gratissima*

Bacteria	Diameter of Inhibition Zone (mm)		
	Essential oil *L. gratissima* (0.1mL)	Chloramphenicol (positive control) 25µg	Streptomycin (positive control) 50µg
Bacillus subtilis	18	19	21
Staphylococcus aureus	16	15	21
Escherichia coli	14	18	23
Pseudomonas aeruginosa	15	17	20

than grisofulvin; thus the above findings are in support with the traditional uses of the plant oil as antiseptic [45].

Anti-Inflammatory Activity

Reddy *et al.* [30] studied the anti-inflammatory activity of the essential oil and crude extract of *L. conferta* and also of nevadensin (a chemical constituent), isolated from the plant, in acute and chronic inflammatory model employing the method of Winter *et al.* [46]. Carrageenan-induced rat paw edema was compared at '0' and '3' hours with that of control (4% gum acacia mucilage). In tests for acute inflammatory activity, nevadensin (5,7-dihydroxy-6,8,4'-trimethoxy- flavone) showed significant inhibition ($P< 0.001$, dose 75 mg/Kg oral, % inhibition 45.28) but neither the volatile oil nor the crude extract, showed any significant activity compared to the control. However, in chronic inflammation model, the crude extract of *L. conferta* reduced ($P< 0.001$, dose 500 mg/Kg/day oral) the weight of dry granuloma (22.1±1.4 mg % of body weight) compared to the control value (36± 1.86 mg % of body weight). Nevadensin (5,7-dihydroxy-6,8,4'-trimethoxyflavone) has recently been reported to have *in vitro* weak inhibitory activity against cyclooxygenase-1 and 2 (COX-1 and COX-2) as studied in COX catalyzed prostaglandin biosynthesis assay [47].

Antitubercular Activity

Nevadensin and isothymusin (6,7-dimethoxy-5,8,4'-trihydroxyflavone), isolated from the chloroform extract of the aerial parts of *L. geoffrayi*, were reported to exhibit growth-inhibitory activity against *mycobacterium tuberculosis* H 37Ra with equal MIC value of 200 μg/mL [14]; however the efficacy is relatively lower than those of the standard drugs (used during the experiment) rifampicin (MIC 0.003-0.0047 μg/mL), isoniazid (MIC 0.025-0.05μg/mL) and kanamycin sulphate (MIC 1.25-2.5μg/mL). But the flavone, nevadensin was found to be more effective (MIC values: 100 μg/mL for nevadensin; 10μg/mL for streptomycin used as standard) against the H 37Rv strain of *M. tuberculosis* as reported by Reddy *et al.* [30]. The investigators suggested that the compound shows no toxicity up to 600 μg/Kg orally in acute toxicity studies.

Wound Healing Activity

The crude alcoholic extract of *Limnophila conferta* was reported to possess wound-healing property [30]. The effect was studied in three different experimental wound models. Animals were wounded under pentobarbitone (40mg/Kg/IP) anesthesia (supplemented with ether) to bear either incision/ or excision/ dead space wound. The crude extract was given in the dose of 500mg/Kg/orally, (once daily) up to 10 days (incision and dead space wound) or until complete healing (excision wound) and the tensile strength was measured on the 10^{th} day.

In the excision wound model, the crude extract showed significant ($P<0.001$) reduction on the epithelisation period (17.22±0.46 days) compared to that of the control (unreacted wounded animals); (21±0.1 days) and significant inhibition in the rate of wound contraction on the 4^{th}, 8^{th}, 10^{th} and 12^{th} days. The 16^{th} day onwards significant enhancement ($P<0.001$) in wound contraction (97.59±0.64%) was shown by crude extract compared to that of control (93.2±1.48). Effects of crude extract on other wound models were insignificant.

Antioxidant Activity

Suksamrarn *et al.* [22] reported significant antioxidant activity of chloroform extract of aerial part of *Limnophila geoffrayi*. Bioassay-guided fractionation of the extract led to the isolation of two pentaoxygenated flavones — one is nevadensin (5,7-dihydroxy-6,8,4'-trimethoxyflavone) and the other is isothymusin (6,7-dimethoxy-5,8,4'-trihydroxyflavone), of which only the latter exhibited antioxidant activity against the radical scavenging ability of 1,1-diphenyl-2-picrylhydrazyl (DPPH) with the IC_{50} value of 7.7μg/mL.The efficacy is almost comparative with the standard antioxidant compound 2,6-di-(tert-butyl)-4-methylphenol (BHT, IC_{50} =5.7μg/mL).

It is interesting to note that isothymusin while shows strong antioxidant property, nevadensin can't — this contrasting difference in the behaviour may be explained on the basis of structure/activity relationship. The free 4'-hydroxy group in isothymusin (6,7-dimethoxy-5,8,4'-trihydroxyflavone) molecule exerts delocalisation with the 4-keto group after the 4'-hydrogen being abstracted. The *p*-hydroquinone nature of the A-ring possibly also contributes to the relatively high antioxidant activity of the compound. It should also be noted that the free 7-hydroxyl group of nevadensin does not exert any radical scavenging activity by similar mechanism to that of the free 4'-hydroxyl group as observed in case of isothymusin; one possible cause may be the steric hindrance developed due to the two adjacent methoxyls, although such effect is not observed in case of BHT. The antioxidant efficacy of isothymusin, isolated from other sources was also established by Wang *et al.* [48] and also by Kelm *et al.* [49].

Cytotoxic Activity

The dihydroxytrimethoxyflavone, nevadensin isolated from the plant *L. conferta* was also reported to display moderate cytotoxic activity [30]; the test compound showed 100% cytotoxicity at a concentration of 75 μg/mL both in Dalton's lymphoma ascites tumour and Ehrlich ascites tumour (using Swiss albino mice model). The compound was found to be more effective than wogonin that showed only 24.1% cytotoxicity in both the tumours at the same concentration [30]. This findings support the view of Dong *et al.* that the methoxylated flavones possess moderate cytotoxic activity [50].

Anthelmintic Activity

From the studies of Reddy group [30] with the essential oil of *L. conferta* on a variety of worms, it appears that the oil might be used as a potent and effective antidote against such parasites. The oil exhibited dose-dependent anthelmintic activity against the test organisms, and in each case the oil was found to be more effective than the standards used. The experimental results are tabulated in Tables **6-8**:

CONCLUDING REMARKS

Limnophila plants are widely distributed world-wide, and find immense applications in traditional systems of medicine in many countries. Although some works on the chemical

Table 6. Essential oil of *L. conferta* Against Earth Worm Model [30]

Test Material/Positive Controls	Worms	Dose (mg/mL)	Time Required for Paralysis (min.)	Time Required for Death (min.)
Oil of *L. conferta*	Earth	1.7	125	142
Piperazine citrate	worm	1.7	188	242
Mebendazole		4.0	180	238

Table 7. Essential oil of *L. conferta* Against Round Worm Model [30]

Test Material/Positive Controls	Worms	Dose (mg/mL)	Time Required for Death (min.)
Oil of *L. conferta*	Round worm	2.0	240
Thymol		2.0	378
Mebendazole		2.0	380
Piperazine citrate		2.0	323

Table 8. Essential oil of *L. conferta* Against Tape Worm Model [30]

Test Material/Positive Control	Worms	Dose (mg/mL)	Time Required for Paralysis & Death (min.)
Oil of *L. conferta*	Tape worm	1.7	55
Piperazine citrate		1.7	165

and pharmacological aspects of these plants have already been done, a major portion remains unexplored. This present resume is an attempt to compile an all round and up-to-date literature covering its botany to ethnobotany, biological and pharmacological studies as well as phytochemicals as reported so far, with a goal to boost the ongoing research in the field of dynamic bioactive natural products directed toward the searches for 'promising leads' in modern drug development processes.

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