3. REVIEW OF LITERATURE

3.1. *Oldenlandia corymbosa*

3.1.1. Pharmacognostical review

Lin et al. (1987) carried out Pharmacognostical studies of *O. corymbosa* and other drugs under the name of “Pen-hue-juwa-chi-chhau”.

Datta and Sen (1969) carried out Pharmacognostical study of *O. corymbosa*.

Farooq (1953) studied the endosperm and seed structure of *O. corymbosa*.

3.1.2. Phytochemical review

Li et al. (2015) developed UPLC fingerprint of *O. corymbosa* to distinguish it from *O. diffusa*.

Wei and Yang (2015) carried out kinetic studies for ultrasound-assisted supercritical carbon dioxide extraction of triterpenic acids from healthy tea ingredient *Hedyotis diffusa* and *H. corymbosa*. The combined USC-CO$_2$-HPLC method was used to quantitate the oleanolic acid (OA) and ursolic acid (UA) contents in samples obtained from different geographical regions. The OA and UA content in the samples from different sources were found significantly different. Furthermore, the kinetics of USC-CO$_2$ extraction was detected based on a second-order kinetic model. The activation energies of OA and UA were 6.784 and 4.981 kJ/mol, respectively.

Lau et al. (2012) developed a thin-layer chromatography profile to differentiate *H. diffusa* from *H. corymbosa*. TLC study showed a blue zone of hedyotiscone A at R$_f$ 0.36 in *H. corymbosa* but not in *H. diffusa*.

Yadav and Agarwala (2011) detected presence of proteins, carbohydrates, phenols, tannins, flavanoids and saponins in whole plant of *O. corymbosa* along with other
six plants. They also found 11.6 mg of total phenolic contents and 4.4 mg of total flavonoid contents per g of extract.

Kuang et al. (2009) isolated and identified (+)-lyoniresinol-3α-O-β-glucopyranoside, quercetin, esculetin, scopoletin, hedyotiscone A, p-hydroxybenzoic acid, protocatechuic acid, vanillic acid, syringic acid, (+)-vomifoliol, (-)-dihydrovomifoliol, S-(+)-dehydrovomifoliol and alizarin 1-methyl ether from whole plant of H. corymbosa.

Liang et al. (2009) showed that the contents of oleanolic acid and ursolic acid in O. diffusa were generally lower by almost two times than those in its substitute O. corymbosa.

Zhu et al. (2008) developed a method for determination of oleanolic acid and ursolic acid in H. corymbosa by capillary zone electrophoresis with high frequency conductivity detection.

Noiarsa et al. (2008) isolated and elucidated geniposide, 6α-hydroxygeniposide, scandoside methyl ester (6β-hydroxygeniposide), asperulosidic acid, deacetylasperuloside, asperuloside, 10-O-benzoylscandoside methyl ester, 10-O-p-hydroxybenzoylscandoside methyl ester, (+)-lyoniresinol-3α-O-β-glucopyranoside, and rutin from O. corymbosa of Thai origin.

Jiang et al. (2007) isolated and characterized three new iridoid glycosides, hedycorysides A-C from the whole plant of H. corymbosa.

Hu (2007) extracted and separated triterpenoid acid in H. corymbosa.

Liang et al. (2007) reported variations in the abundance of asperuloside, E-6-O-p-coumaroylscandoside methyl ester and E-6-O-p-coumaroylscandoside methyl ester-10-methyl ether in O. diffusa and its substitute O. corymbosa by high performance liquid chromatographic fingerprint and mass spectrometric analysis.
Liang et al. (2006) showed that E-6-O-p-coumaroyl scadadoside methyl ester and E-6-O-p-coumaroyl scadadoside methyl ester-10-methyl ether found to be lower in contents in *O. corymbosa* than *O. diffusa*.

Okeri and Alonge (2006) mentioned that *O. corymbosa* is a rich source of ascorbic acid when compared with some common garden fruits and vegetables.

Banerjee et al. (2006) carried out quantitation of oleanolic acid in *O. corymbosa* whole-plant powder by high-performance thin-layer chromatography and reported 1.892 µg g⁻¹ concentration of oleanolic acid in whole plant of *O. corymbosa*.

Chen et al. (2005) reported 99.82% content of ursolic acid in *H. corymbosa* herb by HPLC and the gain rate is 3.65 ppm.

Chen et al. (2005) identified structure of ursolic acid from *H. corymbosa* herb using HPLC. The yield of ursolic acid found is 3.12%.

Sudarsono (2004) mentioned asperuloside contents in the stem, leaf, fruit, and root were 0.146, 0.470, 0.142, and 0.560%, respectively. Scadadoside methyl ester contents were 0.618% in the stem, 0.156% in the leaf, 0.037% in the fruit, and 0.136% in the root of *O. corymbosa*.

Lai et al. (2002) isolated and characterized two anthraquinones named 3-hydroxy-2-formyl-1-methoxyanthraquinone and 3-hydroxy-2-methyl-1-methoxyanthraquinone from *H. corymbosa*.

Sudarsono (1999) isolated and characterized asperuloside, an iridoid substance from *H. corymbosa*.

Otsuka et al. (1991) isolated deacetyl asperuloside, asperuloside, asperulosidic acid, deacetyl asperulosidic acid, scadadoside methyl ester, 10-O-benzoyl deacetyl asperulosidic acid methyl ester, 10-O-benzoyl, 10-O-p-hydroxybenzoyl, and 10-O-p-trans,cis-coumaroyl scadadoside methyl esters from aerial parts of *O. corymbosa*.
Takagi et al. (1981) isolated six iridoids, asperuloside, scadoside methyl ester, asperulosidic acid, geniposidic acid, scadoside, and deacetylasperulosidic acid from *H. corymbosa*.

Liao et al. (1979) derived 0.0001% of asperglaucide from hexane fraction of methanol extract of whole plant of *H. corymbosa*.

Hui and Lam (1964) isolated stigmaster, γ-sitosterol, ursolic acid and oleanolic acid from *O. corymbosa*.

Khastgir et al. (1960) reported γ-sitosterol, oleanolic and ursolic acids in *O. corymbosa*.

### 3.1.3. Pharmacological review

Nikolajsen et al. (2011) reported that *O. corymbosa* and other Tanzanian plants produce strong uterine contraction and can induce abortion.

Mishra et al. (2009) reported anti-malarial activities of *Andrographis paniculata* and *H. corymbosa* extracts and their combination with curcumin.

Liang et al. (2008) showed slightly antiproliferative effect of chloroform extract of *O. corymbosa*.

Cong et al. (2007) observed effect of *H. corymbosa* herb on the human colon carcinoma cells *in vitro* and generation of new vessels in chorioallantoic membrane of embryonated eggs.

Sadasivan et al. (2006) reported hepatoprotective activity of *H. corymbosa*.

Lin et al. (2002) reported anti-inflammatory and hepatoprotective activity of *H. corymbosa*. 


Thomas et al. (1999) carried out *in vitro* antibacterial activity of methanolic extract and stated that *Staphylococcus epidermidis* is significantly inhibited by *O. corymbosa*.

Yang et al. (1997) suggested use of *H. corymbosa* as an antitumor agent and radioprotector after therapeutic irradiation.

Yang et al. (1997) studied immunocompetent activity of *H. corymbosa*.

Bagchi et al. (1997) studied antibacterial activity of seed and found that *O. corymbosa* is most active on basis of the ratio of inhibition zone to weight of seed.

Sutarrjadi and Bendyrman (1991) showed immunomodulatory activity *O. corymbosa* leaves in mice.

Chiu et al. (1988) reported hepatoprotective effect of *O. corymbosa* from Taiwan.

### 3.1.4. Phyto-pharmacological review

Das et al. (2016) detected presence of polyphenols such as chlorogenic, caffeic, and quinic acid in *O. corymbosa* and also determined their *in vitro* antioxidant activities along with other herbs.

Hazarika et al. (2012) evaluated antioxidant activity of the crude methanolic extract of *O. corymbosa* (MEO) along with *Bryophyllum pinnatum*. IC50 value for DPPH free radical scavenging activity of MEO was found 729.91mg/g and for H2O2 scavenging activity, 705.38mg/g, whereas for standard ascorbic acid it was 583.949 and 56.18mg/g respectively. The polyphenolics content of MEO was found 15.6mg/g (gallic acid equivalent).

Sasikumar et al. (2010) reported *in vitro* antioxidant activity of aerial part of *H. corymbosa* and also detected total phenolics and total flavanoid contents.
Awobajo et al. (2009) carried out acute oral toxicity test in mice and also reported presence of flavonoids, cardiac glycosides, anthocyanosides, saponin and reducing sugar in *O. corymbosa* leaf.

### 3.1.5. Clinical review

Gupta and Dubey (2009) prepared a herbal formulation for the prevention and management of frequent common cold and cough and associated problems.


Huang (2007) developed a method for preparation of a beverage having antibacterial, anti-inflammatory and immunity enhancing effects from *O. corymbosa*.

Chen et al. (2005) prepared a compound Chinese medicinal composition for treating chronic atrophic gastritis from *H. corymbosa* and other drugs.

Qian et al. (2005) prepared an extract from *H. corymbosa* herb for treating colon cancer.

Chen et al. (2002) formulated a traditional Chinese medicine compound preparation for treating chronic atrophic gastritis from *H. corymbosa* and other drugs.


Hao et al. (1999) made baihuashecao mineral water, a health beverage for clearing away heat and toxic materials, removing summer-heat, and supplementing mineral substance.

Li (1998) prepared a cosmetic having skin nourishing, skin blood circulation improving, antibacterial, anti-infective, anti-inflammatory, anti-pruritic, and
immunity enhancing effects, and can be used for preventing and treating acnes from *H. corymbosa* fruit.

### 3.1.6. Agronomical review

Corbineau and Come (1985) studied effect of temperature, oxygen, and gibberellic acid on the development of photosensitivity in *O. corymbosa* seeds during their incubation in darkness.

Corbineau and Come (1982) studied effect of the intensity and duration of light at various temperatures on the germination of *O. corymbosa* seeds.

Corbineau and Come (1981) reported that gibberellic acid enhances the germination of *O. corymbosa* seeds.

### 3.1.7. Miscellaneous review

Wang et al. (2014) provided detailed comparison between the *O. diffusa* and its adulterant *O. corymbosa* for identification under name of traditional Chinese medicine ‘baihuasheshecao’ based on molecular and morphological evidence.

Sun and Hong (2013) distinguished *H. diffusa* and *H. corymbosa* by studying their genetic divergence and phylogenetic analysis based on nuclear ribosomal DNA internal transcribed spacer (ITS) sequence. The total ITS sequence of *H. diffusa* was 791 base pair and of *H. corymbosa* was 785 base pair.

Techaratanakrai et al. (2009) developed a sterilized mixed herbal drink product.

Li et al. (2009) established a RAPD method for identification of spreading hedyotis herb from its confusion variety *H. corymbosa*.

Anuradha et al. (1988) gave the taxonomical status, vernacular names and precise uses of *O. corymbosa* leaves under the name of Pittapapada.
3.2. Rungia repens

3.2.1. Phytochemical review
Seshadri and Vydeeswaran (1972) isolated chrysoeriol 4'-mono and 7, 4'-diglucosides, luteolin 7-glucoside, apigenin 7-glucoside and kaempferol 3-0-α-L-rhamnopyranosyl (1→3) β-D-glucopyranoside from *R. repens* flowers.

Subramanian et al. (1969) reported presence of isosalipurposide along with luteolin, luteolin 7-glucoside, delphinidin 3, 5-diglucoside and lutein in *R. repens* flowers.

Subramanian and Nair (1966) found occurrence of luteolin and chrysoeriol in *R. repens* flowers.

Subramanian and Nair (1964) isolated luteolin, luteolin 7-D-glucoside and delphinidin from *R. repens* flowers.

3.2.2. Pharmacological review
Swain et al. (2008) carried out toxicological studies of the hydroalcoholic extract of *R. repens* leaves and showed that it is non toxic to albino rats.

Swain et al. (2008) studied anti-inflammatory, diuretic and antimicrobial activities of *R. repens* along with *R. pectinata* and found later has better anti-inflammatory activity than *R. repens*. They also observed significant diuretic and antimicrobial activities of both drugs and safety of the extracts even at a dose of 4000 mg/kg through acute toxicity study.

Basu and Arivukkarasu (2006) showed diuretic activity of ethanolic extract of *R. repens* aerial parts in rats and also reported the acute toxicity higher than 3000 mg/kg in mice.

3.2.3. Miscellaneous review
Anuradha et al. (1988) gave the taxonomical status, vernacular names and precise uses of *R. repen* leaves under the name of Pittapapada.
3.3. *Mollugo oppositifolia*

3.3.1. Pharmacognostical review

Sahu et al. (2012) carried out Pharmacognostical and physico-chemical studies of *Glinus oppositifolius* leaf. The study revealed presence of 8% total moisture content, 16.10% total ash, 12.5% water soluble ash, 10% acid insoluble ash, 25.5% sulphated ash, 0.4% petroleum ether extractive, 1.8% chloroform extractive, 3.4% acetone extractive, 2.4% ethyl acetate extractive, 9.8% methanol extractive and 18.5% water extractive. Inorganic element showed the presence of iron, sulfate, chloride and nitrate.

Ridgway and Rowson (1956) described micro- and macroscopical characters of *G. oppositifolius* root as a substitute for senega. The hemolytic index of root was found 1/15 to 1/4 to that of senega root.

3.3.2. Phytochemical review

Chhanda et al. (2014) isolated dotriacontyl docosanoate and trilinoiein from petroleum ether extract and ethyl acetate extract of *G. oppositifolius* respectively and characterized by spectroscopic techniques. They also estimated total vitamin C content and analyzed fatty acid composition by Gas Liquid Chromatography.

Naskar et al. (2012) detected presence of tannins, alkaloids, saponins in the methanol extract of *M. spergula* and found 3.67 µg of β-carotene, 33.9 µg of lycopene, 9.23 mg of Vitamin C, 14.51 µg of pyrocatechol and 2.91 µg of gallic acid per g of the extract.

Ragasa et al. (2012) isolated oppositifolone, spinasterol, squalene and lutein from the dichloromethane extract of the air-dried leaves of *G. oppositifolius* and elucidated their structures by NMR spectroscopy.
Paulsen (2011) studied structural elements in pectins of *G. oppositifolius* which are important for their effects on the immune system.

Sahakitpichan et al. (2010) isolated an amino acid derivative, L-(-)-(N-trans-cinnamoyl)-arginine, from the whole plant of *G. oppositifolius* along with kaempferol 3-O-galactopyranoside, isorhamnetin 3-O-β-D-xylopyanosyl(1→2)-β-D-galactopyranoside, vitexin, vicenin-2, adenosine and L-phenylalanine and determined structures by chemical and spectroscopic methods.

Inngjerdingen et al. (2007) further revealed the structure of the pectic polymer GOA2. Enzymic treatment of GOA2 by endo-α-d-(1→4)-polygalacturonase led to the isolation of three pectic subunits, GOA2-I, GOA2-II, and GOA2-III, in addition to oligogalacturonides. GOA2-I was shown to exhibit a more potent intestinal immune stimulating activity compared to GOA2.

Inngjerdingen et al. (2007) further elucidated the structure of peptic polymer GOA1 from aerial parts of *G. oppositifolius* and reported its immunomodulatory activity.

Inngjerdingen et al. (2005) isolated and characterized bioactive peptic polysaccharides GOA1 and GOA2 from aerial parts of *G. oppositifolius*. GOA1 showed to contain arabinose (26.4 mol percent), galactose (42.9 mol percent), arabinogalactans type I and type II. GOA2 was rich in galactouronic acid (68.3 mol percent) along with rhamnose, arabinose and galactose.

Sahu et al. (2001) isolated two novel triterpenoid saponins spergulin A {3-O-(β-D-xylopyranosyl 3-sulfate)-spergulagenin A} and spergulin B {3-O-[α-rhamnopyranosyl (1→2)-β-D-xylopyranosyl]-spergulatriol} from the aerial part of *M. spergula* along with spergulacin and spergulacin A and detected their structures.

Barua et al. (1986) isolated a new triterpene saponin, spergulacin from *M. spergula* and detected its structure as spergulagenin-A-3-O-[α-L-rhamnopyranosyl](1→3)-β-D-xylopyranoside.
Barua et al. (1986) isolated a new triterpenoid saponin, spergulacin A from *M. spergula* and established its structure.

Chopin et al. (1984) isolated vitexin 7-glucoside and 2"-p-coumaroylvitexin 7-glucoside from *M. oppositifolia*.

Barua et al. (1983) isolated triterpenoid sapogenol, spergulagenol from the ethanol extract of *M. spergula* and elucidated its structure as 3β,12β,16β,22-tetrahydroxy-(21α-H)-hopane.

Singh et al. (1982) reported presence of apigenin-8-C-glucoside, pelargonidin-3-sophoroside-7-glucoside and naringenin-7-rhamnoglucoside in *G. oppositifolius*.

Singh et al. (1982) detected presence of wax alkanes from *G. oppositifolius*.

Barua et al. (1980) isolated triterpene, spergulagenol from *M. spergula* and detected its structure by chemical and spectral means.

Barua et al. (1978) mentioned that CrO₃ oxidation of spergulagenin A (I, Z = Z1 = Z2 = α-H, β-OH) gave I (Z-Z2 = O), whose Huang-Minlon reduction gave the 17-epimerized hydrocarbon II (Z-Z2 = H2). Treatment of II (Z-Z2 = O) with alkali also gave a 17-epimerized product (II, Z-Z2 = H2).

Kitagawa et al. (1977) isolated a new bisnorhopane-type sapogenol named spergulatriol and elucidated its structure.

Chakrabarti et al. (1977) detected stereostructure of spergulagenin A, a new sapogenin from *M. spergula* by comparing its IR, UV and NMR spectra with those of its acetylation, elimination, saponification, and oxidation products.
Kitagawa et al. (1976) isolated spergulatriol from an enzymic hydrolysate of *M. spergula* saponins and detected its molecular structure from chemical and spectral data.

Kitagawa et al. (1975) detected structure of spergulagenin A isolated from the root of *M. spergula* along with oleanolic acid and methyl spergulagenate on the basis of chemical investigations and X-ray structure evidence.

Kitagawa et al. (1975) described chemical correlation of spergulagenin A, a new migrated hopane-type sapogenol, with hydroxyhopane.

Kitagawa et al. (1974) assigned structure to spergulagenin A isolated from *M. spergula* from chemical and spectral data, and X-ray analysis of the monoacetyl ketal.

Hariharan and Rangaswami (1971) elucidated structure of mollugo glycoside A, one of the saponin components of the roots of *M. spergula* as D-xylopyranosyl 1-β 4 D-xylopyranosyl 1-β-OOC(28)-spergulagenic acid (30) methyl ester and also reported presence of α-spinasterol and β-sitosterol-D-glucopyranoside in root.

Sengupta and Pal (1970) analyzed *M. spergula* for moisture, protein, fat, carbohydrate, ash, crude fiber, calcium, phosphorus, ferrous, nicotinic acid, ascorbic acid, and calories and found that nutritive value of leaves is very low.

Kitagawa et al. (1970) described transformation of spergulagenic acid, a dicarboxylic triterpenoid, to eupteleogenin, a unique nortriterpenoid by photooxidation followed by Pb(OAc)₄ decarboxylation.

Chakrabarti et al. (1968) established structure and stereochemistry of the acid sapogenin, spergulagenic acid, C₃₀H₄₆O₅, by spectral and chemical analysis as 3β-hydroxy-Δ12-oleanene-28, 29-dioic acid.
Chakrabarti (1967) studied constitution of spergulagenin A, triterpene from *M. spergula*.

Chakrabarti et al. (1965) isolated spergulagenic acid, a new sapogenin from whole plant of *M. spergula*.

Chakrabarti and Barua (1964) carried out chemical investigation of *M. spergula*.

### 3.3.3. Pharmacological review

Akter et al. (2014) carried out cytotoxic activity of *G. oppositifolius* whole plant along with other Bangladeshi medicinal plants. It showed cytotoxicity against both of the breast cancer cell lines (MCF-7 and MDA-MB-231).

Vasincu et al. (2014) found ethanol extract of *G. oppositifolius* more potent than aqueous extract for anti-nociceptive and anti-inflammatory effects.

Sahu et al. (2012) performed hypoglycemic activity of ethanolic extract of the aerial parts of *G. oppositifolius* along with *M. pentaphylla*. The extracts produced significant decrease in the blood glucose level when compared with the controls in alloxan induced hyperglycemic, normoglycemic and oral glucose tolerance test in suitable rat models and is comparable with the standard drug glibenclamide.

Hoque et al. (2011) observed significant peripheral and central analgesic effect of the methanolic extract of *G. oppositifolius* at both 200 (p<0.05) and 400 mg/kg (p<0.001) doses. The extract (500 mg/kg) also reduced the paw inflammation of mice (p<0.001) induced by carrageenan.

Behera et al. (2010) studied anti-hyperglycemic, anti-hyperlipidemic and antioxidant activity of methanol extract and aqueous extract of *G. oppositifolius* at the dose of 200 and 400 mg/kg body weight respectively.

Asokkumar et al. (2009) proved *G. oppositifolius*, a potential source of natural antioxidant by performing free radical scavenging and antioxidant activities using
different *in vitro* assays i.e. H-donor activity, nitric oxide scavenging, superoxide anion scavenging, reducing ability, hydroxyl radical, hydrogen peroxide scavenging, total phenolic content, total flavonoid content, total antioxidant activity by thiocyanate and phosphomolybdenum method, metal chelating, β-carotene bleaching and total peroxyl radical assays.

Diallo et al. (2001) reported antifungal, larvicidal, molluscicidal, antioxidant and radical scavenging activities of *G. oppositifolius* along with other Malian medicinal plants.

Traore-Keita et al. (2000) evaluated antimalarial activity of *G. oppositifolius* by microscopic and flow cytometric analysis.

### 3.3.4. Phyto-pharmacological review

Martin et al. (2015) reported the free-radical scavenging activity for the first time and quantified total phenolic and total flavonoid contents in *G. oppositifolius* roots, stems and leaves. The root chloroform extract was found the highest DPPH inhibition activity i.e. 70% relative to gallic acid, followed by its methanolic and ethanolic extracts exhibiting 37% and 28% DPPH inhibition activity, respectively.

Ragasa et al. (2015) isolated oppositifolone, squalene, spinasterol, oleanolic acid, phytol, lutein and spergulagenin A from dichloromethane extract of *G. oppositifolius*. They found oppositifolone, a triterpene, cytotoxic against human colon carcinoma 116 with an IC₅₀ value of 28.7 and also observed hypoglycemic activity of the aqueous leaf extract at 200 mg/kg body weight with a pronounced % blood glucose reduction of 70.76% ±17.4% within 0.5 h.

Panda et al. (2014) carried out free radical scavenging activity of *G. oppositifolius* along with *Sesbania grandiflora*. Its antioxidant activity of was found to be more potent than *S. grandiflora*. They also found 12.2±0.12 w/w of total phenolic content and 4.9±0.02 % w/w of total flavonoid content in *G. oppositifolius*. 
Kumar et al. (2013) isolated glinoside C from aerial parts of *G. oppositifolius* along with 3-O-(β-D-xylopyranosyl)-spargulagenin A, spargulacin, spargulin A, spargulacin A and spargulcin B. They established structure of glinoside C as 16-O-(β-D-glucopyranosyl)-3β,12β,16β,21αβ,22αβ,22-pterahydroxy hopane by 1-D, 2-D NMR and mass spectral techniques and also observed greatest inhibition of the α-glucosidase with IC₅₀ of 127±30 µM.

Dutta et al. (2012) performed anthelmintic and free-radical scavenging activity of various fractions obtained from foliar parts of *G. oppositifolius*. *In vitro* anthelmintic activity was carried out against aquarium worm, *Tubifex tubifex*. Both, petroleum ether and diethyl ether fractions were observed to have higher level of phenolic content (32.12 ± 0.83 and 47.82 ± 1.04 mg gallic acid equiv./g respectively) and flavonoids content (10.45 ± 0.94 and 4.09 ± 0.52 mg quercetin equiv./g respectively) with potential free radical scavenging activity (IC₅₀ = 0.267 ± 0.0006 mg/mL and IC₅₀ = 0.176 ± 0.0015 mg/mL respectively). The anthelmintic activity of petroleum ether, diethyl ether and ethyl acetate fractions were found to be more effective than that of reference standard, piperazine citrate. Highest paralyzing activity was obtained by petroleum ether fraction whereas the death potency was optimum in case of ethyl acetate.

Traore et al. (2000) isolated two new triterpenoid saponins, glinides A and B. Their structures were established as 16-O-(β-arabinopyranosyl)-3-oxo-12, 16β, 21β, 22-tetrahydroxyhopane for glinoside A and 16-O-(β-arabinopyranosyl)-3-oxo-12, 16β, 22-trioryoxyhopane for glinoside B. They also observed their antiprotozoal activity against *Plasmodium falciparum*.

### 3.3.5. Miscellaneous review

Roosemont (1957) studied *G. oppositifolius* as adulterant of *Polygala senega*. 
3.4. *Fumaria parviflora*

3.4.1. Pharmacognostical review

Gupta and Rao (2012) carried out morpho-anatomical and physicochemical studies of *F. indica* and showed that plant has compound and pinnatifid leaf with linear and oblong shape and anomocytic stomata, thin walled parenchymatous cells, scattered, sclerenchymatous, capped vascular bundles and radiating medullary rays. They reported foreign matter 0.2%, loss on drying 6.8%, total ash 16.77%, alcohol and water soluble extractives 8.92% and 20.26%, respectively, sugar 17.75%, starch 22.97% and tannins 2.37% in F. indica. Phytochemical evaluation revealed the presence of carbohydrate, alkaloids, flavonoids, saponins, tannins and sterol. Thin layer chromatography was carried out with different solvents and the best solvent system found was chloroform and methanol in 80:20 ratio and revealed 12 spots with different Rf value under UV light 366 λ.

Hilal et al. (1995) performed macro-and micro-morphological investigation, preliminary phytochemical screening and TLC investigation of successive extracts of the flower of *F. parviflora.*

Hilal et al. (1995) carried out Pharmacognostical study comprising of macro-and micro-morphological investigation, preliminary phytochemical screening and TLC investigation of successive extracts of the leaf and fruit of *F. parviflora.*

Hilal et al. (1995) performed macro-and micro-morphological investigation, preliminary phytochemical screening and TLC investigation of successive extracts of the root and stem of *F. parviflora.*

3.4.2. Phytochemical review

Mohammad et al. (2014) isolated n-propyl-3,4-dioxymethylene benzene, 5β, 6, 7, 8, 9, 10 β-hexahydrocoumarin and 2,6-di- methyl dodecan-10-oyl-12,15-olide along with n-tetradecanyl n-octadec-9-enoate, propanyltriol- 3, 2- n-di-octadecanoyl-1-n-
octadeca-9',12'-dienoate, and n-tetradecanyl n-octadec-9,12-dienoate from aerial parts of *F. parviflora* and established their structures on the basis of spectral data analysis and chemical reactions.

Mohammad et al. (2014) isolated (5αH,11αH)-8-oxo-homoiridoliide, n-docosanyl-2-O-β-D-glucopyranosyl salicylate, 2-methyl-6-hydroxymethylenedodecan-10-oyl-12,15-olide14-O-β-D-xylopyranoside,4-oxo-stigmast-5-en-3β-ol-D-glucopyranoside and salicylic acid-O-β-D-xylopyranoside along with α-D-glucopyranosyl hexadecanoate and α-D-glucopyranosyl- (2→1')- α-D-glucopyranoside from the methanolic extract of aerial parts of *F. parviflora* and established their structures on the basis of spectral data analysis and chemical reactions.

Kumar et al. (2009) reported 0.0533 - 0.2133 µg mL⁻¹ of protopine in *F. parviflora* whole plant powder by high-performance liquid chromatography.

Pandey et al. (2008) isolated a new alkaloid, fuyuziphine together with (±)-α-hydrastine from the whole plant of *F. indica* and established their structures by spectral and chemical evidences.

Ashnagar et al. (2007) carried out gas chromatography-mass spectrometry analysis of essential oil from *F. parviflora* grown in Ahwaz, Iran and reported that it consists of eight major components (72.7%), 11 minor components (19.9%) and 10 components with smaller amounts (4.5%).

Suau et al. (2002) detected and identified isoquinoline alkaloids protopine, cryptopine, sinactine, stylopine, bicuculline, adlumine, parfumine, fumariline, fumarophycine, fumaritine, dihydrofumariline, parfumidine and dihydrosanguinarine by gas chromatography-mass spectrometry in *F. parviflora*.

Sousek et al. (1999) identified isoquinoline alkaloids adlumiceine, adlumidiceine, coptisine, corytuberine, cryptopine, fumaricine, fumariline, fumaritine, fumarophycine, O-methylfumarophycine, palmatine, parfumine, protopine, sinactine, stylopine, and N-methylstylopin by reversed phase high performance
liquid chromatography and organic acids, namely citric, coumaric, ferulic, fumaric, malic, 3-hydroxybenzoic, protocatechuic and caffeic acid (and its methylester), by gas chromatography-mass spectrometry in *F. parviflora*. The total content of phenolic constituents was quantified by a colorimetric method using a phosphomolybdic-phosphotungstic reagent.

Rahimizadeh et al. (1998) detected (-)-corledine, (+)-corlumidine and (-)-α-hydrastine for the first time from the aerial parts of *F. parviflora*.

Siddiqui and Khan (1997) identified bisnorargonionine paprazine, papracine fumariflorine and its ester in *F. parviflora* and *F. indica*.

Khan and Sharma (1997) isolated two isoquinoline alkaloids, pseudoprotopine and a glucoside of stylopin from *F. indica* and confirmed their structures by chemical and spectroscopic methods.

Tyagi et al. (1995) mentioned greater amount of total sugar in leaves of *F. parviflora* as compared to *Ageratum conyzoides, Colebrookea oppositifolia* and *Pogostemon plectranthoides*. They also showed presence of vitamin A (in the leaves) and Vitamin B in *F. parviflora*.

Atta-ur-Rahman et al. (1995) isolated paprafumine, paprarine and papraline from the aerial parts of *F. indica* and detected their structures by spectral studies. They also identified cryptopine, raddeanine, and oxocoptisine isolated from this species.

Tyagi et al. (1994) found that leaves of *C. oppositifolia, F. parviflora* and *P. plectranthoides* contain greater amount of protein in comparison to *A. conyzoides*.

Atta-ur-Rahman et al. (1992) isolated papracine, oxyhydrastinine, noroxyhydrastinine, fumaramine, stylopin, bisnoragemonine, fumaritine and β-hydrastine from *F. indica*.

Atta-ur-Rahman et al. (1992) isolated papracinine and paprazine from the aerial parts of *F. indica* and detected their structures by spectral studies. They also
identified six more alkaloids fumaritine N-oxide, parfumine, lastourvilline, feruloyl tyramine, fumariflorine and N-methyl corydaldine.

Tripathi and Pandey (1992) isolated narlumicine, protopine, protopine nitrate, DL-tetrahydrocoptisine and narlumidine from the stems of *F. indica* and established its structure by spectroscopic methods.

Atta-ur-Rahman et al. (1989) isolated (+)-papraine, a new phthalide isoquinoline alkaloid from *F. indica* and assigned its structure and abs. configuration.

Atta-ur-Rahman et al. (1989) isolated fumarizine, a benzylisoquinoline alkaloid from *F. indica*, a commonly grown herb from northern Pakistan and detected its structure by $1^H$ NMR, NOE and other spectroscopic techniques.

Tripathi et al. (1988) isolated narceimicine, a new seco-phthalideisoquinoline alkaloid from the seeds of *F. indica* and established its structure by spectroscopic methods.

Sener (1988) reported 1.10%, 1.45% and 1.58% yield of total alkaloids from the aerial parts of *F. parviflora*, *F. petteri thuretii* and *F. kralikii* respectively.

Valka and Simanek (1988) detected adlumidiceine, coptisine, crytopine, parfumine, and protopine in extracts of *F. parviflora* and *F. capreolata* by HPLC and capillary isotachophoresis. Isotachophoresis appears to be a sufficiently selective method for the analysis of the alkaloids specifically for tertiary and quaternary bases.

Tripathi and Pandey (1987) reported occurrence of dihydrocoptisine, a new alkaloid from the seeds of *F. indica* first time.

Saleh et al. (1987) mentioned presence of 3 kaempferol and 2 quercetin glycosides in *F. parviflora*.

Valka et al. (1985) carried out isotachophoretic separation of isoquinoline alkaloids like (-)-stylopine, (-)-canadine, coptisine, berberine, protopine, cryptopine,
chelidonine, bulbocapnine, papaverine, and parfumine as well as quantification of protopine and parfumine from *F. parviflora* extract.

Forgacs and Provost (1985) isolated first time rhoeadine-type alkaloid, rhoegenine from the leaves and twigs of *F. parviflora*.

Dasgupta et al. (1984) substantiated structures of the *F. indica* alkaloids narceimine and narlumidine by further chemical reactions. They also isolated and characterized protopine nitrate and tetrahydrocoptisine-HCl along with (+)-adlumidine, and norsanguinarine.

Guinaudeau et al. (1983) isolated izmirine, first protopine type alkaloid using column chromatography from *F. parviflora*.

Pandey et al. (1982) carried out isolation of protopine, dl-tetrahydrocoptisine, \( \beta \)-sitosterol, and octacosanol from the roots of *F. indica* and confirmation of their identity by color tests, physical data including IR, UV, \( 1^H \)NMR, mass spectroscopy and direct comparison with authentic samples.

Popova et al. (1982) isolated protopine, adlumidine, parfumine, fumariline, dihydrofumariline, cryptoptine, (-)-stylopine, 8-oxocoptisine, sanguinarine, and oxysanguinarine, coptisine, adlumidine, dihydrofumariline, 8-oxocoptisine, sanguinarine, and oxysanguinarine from *F. parviflora*. Among them, adlumidine, dihydrofumariline, 8-oxocoptisine, sanguinarine, and oxysanguinarine were found for the first time.

Forgacs et al. (1982) detected presence of phthalidetetraisohydroquinoleic or hydrasteine-hydrastenimide alkaloids in *F. parviflora*.

Alimova et al. (1982) carried out chromatographic separation of phenolic alkaloids like cheilanthifoline, sculerine, parfumine, isoboldine, noryuziphine, coclaurine; nonphenolic alkaloids such as dihydrosanguinarine, sanguinarine, stylopine, oxosanguinarine, adlumine, adlumidine, bicuculline, \( d-\alpha \)-hydrastine, protopine,
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fumaricine, cryptopine, adlumidine, d-fumaricine, and quaternary alkaloid, N-methyladlumine.

Hussain et al. (1981) isolated fumariflorine, parviflorine and fumaramidine from *F. parviflora*.

Blasko et al. (1981) carried out isolation of the new phthalideisoquinoline alkaloid (-)-corlumine from *F. parviflora*.

Blasko et al. (1981) isolated the indenobenzazepine alkaloids, lahorine (I) and lahoramine (II) from *F. parviflora* and detected their structures by spectral analysis. These structures were confirmed by the preparation of I and II from the spirobenzylisoquinolines dihydrofumariline and dihydrofumaridine, respectively, by ring expansion followed by iodine oxidation.

Popova et al. (1981) isolated adlumidine, fumariline, dihydrofumariline, stylopine, 8-oxocoptisine, and oxysanguinarine in *F. parviflora* for the first time.

Hussain and Shamma (1980) isolated a glycosidic spirobenzylisoquinoline alkaloid, (+)-parviflorine from *F. parviflora* and identified by spectral data.

Hussain and Shamma (1980) isolated phthalideisoquinoline alkaloids like fumariflorine ethyl ester as well as fumaramidine from *F. parviflora* and detected their structure by chemical and spectral analysis. They also mentioned that presence of phthalideisoquinoline alkaloids in this plant indicates a catabolic path for lactonic phthalideisoquinolines via quaternization to an N-metho salt, Hofmann elimination, and oxidative cleavage of the resulting olefin to yield a substituted o-(β-dimethylaminoethyl) benzoic acid.

Radu et al. (1979) reported 0.21 per cent total alkaloids in *F. vaillantii* on dry weight basis. They also identified protopin, stylopin, cryptopine and synactine by paper and thin layer chromatography. The presence of fumaric acid was confirmed by chromatographic analysis.
Seth et al. (1979) detected structures of narlumidine and narceimine from *F. indica* from spectral data.

Pandey et al. (1979) identified structure of (-)-8-methoxydihydrosanguinarine from *F. indica* from chemical and spectral data.

Pandey et al. (1979) identified structure of (-)-8-methoxydihydrosanguinarine from *F. indica* from chemical and spectral data.

Pandey et al. (1976) isolated dehydrocheilanthifoline, a phenolic protoberberine alkaloid, first time from the whole plant of *F. indica* together with coptisine.

Shamma and Moniot (1975) revised the structures of fumaridine and fumaramine after reappraisal of the data available and their preparation from (-)-β-hydrastine methiodide and (-)-bicuculline methiodide, respectively.

Pandey et al. (1974) isolated fumariline, fumarilicine and narceimine along with (+) and (±)-bicuculline, protopine, and (±)-tetrahydrocoptisine from *F. indica*.

Pandey et al. (1974) isolated fumariline, fumarilicine and narceimine along with (+) and (±)-bicuculline, protopine, and (±)-tetrahydrocoptisine from *F. indica*.

Pandey et al. (1974) isolated and identified 1-tetrahydrocoptisine and protopine from *F. indica* seeds.

Forgacs et al. (1974) studied presence of N-methylhydrastine and N-methylhydrasteine in total alkaloids of *F. parviflora*.

Kiryakov and Panov (1974) isolated protopine, cryptopine, d-bicuculline, parfumine, and parfumidine from *F. parviflora*.

Pandey et al. (1973) separated four nonnitrogenous constituents such as 19-methyloctacosan-1-ol, C27-29 n-alkanes, sterols, (β-sitosterol, stigmasterol, campesterol; 4:2:1), and 3-methyloctacosan-1,3-diol from petroleum ether extract of *F. indica*.

Satish and Bhakuni (1972) found protopine, nonacosanol and sitosterol from ethanolic extract of leaf and stem of *F. indica*.
Israilov et al. (1970) gave structure of fumaridine and fumaramine isolated from *F. parviflora*.

Israilov et al. (1970) presented the structure of parfumidin isolated from *F. parviflora*.

Israilov et al. (1969) revealed the structure of a base, parfumine isolated from *F. parviflora*.

Susplugas et al. (1968) carried out isolation of sanguinarine from *F. parviflora* and characterized it on basis of solubility and melting point.

Israilov et al. (1968) isolated protopine, cryptopine, d-bicuculine, l-adlumine, fumaridine, and fumaramine from *F. parviflora*; and identified by their IR, UV, and NMR spectra as d-α-hydrastine.

Susplugas et al. (1966) showed presence and distribution of choline in root, stem, leaf and fruit of *F. parviflora* by paper chromatography.

Wahid (1961) reported pentatriacontane, glucose, tannin, fumaric acid, and considerable amounts of KNO₃ and KCl in leaves and stems of *F. parviflora*.

Govindachari et al. (1958) studied different plants under the name of Khet-papra along with *F. parviflora* and they mentioned presence of protopine in *F. parviflora*.

**3.4.3. Pharmacological review**

Shakya et al. (2015) studied gastro-protective and anti-stress effect of monomethyl fumarate and *F. indica* extract in chronically stressed rats.

Chandra et al. (2015) evaluated antisecretory, gastroprotective and *in-vitro* antacid capacity of ethanol extract of *F. indica* in rats.
Dorostghoal et al. (2014) stated that ethanolic extract of *F. parviflora* leaves has a potential to restore the suppressed reproduction associated with lead exposure and prevented lead-induced testicular toxicity in male wistar rats.

Raza et al. (2014) carried out evaluation of oxidative stability of sunflower oil at frying temperature in presence of butylated hydroxytoluene and methanolic extracts of *F. indica* and found it most potent source of natural antioxidants by extensive inhibition of lipid oxidation parameters.

Dorostghoal et al. (2013) indicated that ethanolic extract of *F. parviflora* leaves have a potential to improve reproductive parameters and enhance male fertility in rats.

Singh et al. (2013) reported nootropic-like beneficial effects of an ethanolic extract of *F. indica* on rat cognitive dysfunctions.

Singh et al. (2013) carried out a preclinical study for antianxiety activity of *F. indica* and stated that inhibition of cytokine expressions in the brain could be involved in its mode of action.

Fathiazad et al. (2013) observed significant hypoglycemic effect of methanolic extract of *F. parviflora* on streptozotocin-induced diabetic rats.

Hussain et al. (2012) reported that *F. indica* exert chemopreventive effect by suppressing the tumor burden and restoring the activities of hepatic cancer marker enzymes on N-nitrosodiethylamine and CCl₄ induced hepatocarcinogenesis in wistar rats.

Humayun et al. (2012) evaluated *F. indica* for its cytotoxic and phytotoxic activities and said that n-hexane extract was found more effective as cytotoxic and phytotoxic agent than chloroform and ethanol extract.

Shakya et al. (2012) mentioned holistic strategy used for defining psychopharmacological activity profile of *F. indica*. 
Najeeb-ur-Rehman et al. (2012) reported that antidiarrheal, antispasmodic and bronchodilator activities of *F. parviflora* possibly mediated through dual blockade of muscarinic receptors and Ca$^{2+}$ channels.

Najeeb-ur-Rehman et al. (2012) observed prokinetic, laxative and spasmodic effects of aqueous-methanol extract of *F. parviflora* partially mediated through cholinergic pathways.

Ozaslan (2011) carried out comparison of *F. parviflora* and *Momordica balsamina* hepatoprotection.

Singh and Kumar (2011) found no acute and sub-chronic toxicity of standardized extract of *F. indica* in rodents.

Tripathi et al. (2010) studied involvement of mitochondria mediated pathways in hepatoprotection conferred by *F. parviflora* extract against nimesulide induced apoptosis *in vitro*.

Rathi et al. (2008) investigated hepatoprotective activity of 50% ethanolic water extract of *F. indica* whole plant; its hexane, chloroform and butanol fractions and an isolated alkaloid protopine against D-galactosamine induced hepatotoxicity in rats. Among fractions more than 90% protection was found with butanol fraction. The isolated protopine in doses of 10-20 mg p.o. also proved equally effective hepatoprotectants as standard drug silymarine (single dose 25 mg p.o.).

Rao et al. (2007) observed significant anti-inflammatory and anti-nociceptive activities of 50% ethanolic extract of *F. indica* whole plant extract in experimental animals.

Hordegen et al. (2006) carried out *in vitro* screening of six anthelmintic plant products along with *F. parviflora* against larval *Haemonchus contortus* with a modified methyl-thiazolyl-tetrazolium reduction assay. The ethanolic extract of whole plant of *F. parviflora* showed an anthelmintic efficacy of up to 93%, relative to pyrantel tartrate.
Gilani et al. (2005) indicated that the presence of cholinergic and calcium channel blockade constituents in crude extract of *F. indica* may explain its traditional use in constipation and diarrhoea respectively.

Orhan et al. (2004) screened *F. parviflora* and *F. vaillantii* along with other Turkish medicinal plants for their anticholinesterase activity on acetylcholinesterase (AChE) and butyrylcholinesterase (BChE) enzymes by *in vitro* Ellman method. All the Fumaria extracts displayed highly potent inhibition against both of the enzymes at 1 mg/mL concentration compared to the standard.

Sener and Orhan (2004) reported acetylcholinesterase inhibitory activity of *F. parviflora*.

Maqbool et al. (2004) studied comparative efficacy of various indigenous and allopathic drugs including *F. parviflora* against fasciolosis in buffalo. The drug at a rate of 40, 50 and 60 mg/kg body mass, reduced eggs per g feces by 50.0, 57.44 and 78.72 per cent, respectively, whereas efficacy at two dose levels with the same dose rate was 82.6, 89.36 and 95.74 per cent, respectively.

Hordegen et al. (2003) studied anthelmintic efficacy of ethanol extract of *F. parviflora* with other plant products against gastrointestinal trichostrongylids in artificially infected lambs. They stated that only *F. parviflora* caused a strong reduction of the faecal egg counts (100%) and a 78.2 and 88.8% reduction of adult *H. contortus* and *T. colubriformis* on day 13 post-treatment. The extract was as effective as the reference compound pyrantel tartrate.

Chatterjee and Das (1999) evaluated protective activity of a polyherbal formulation LIVP-7 (composed of *Andrographis paniculata*, *Picrorhiza kurroa*, *Eclipta alba*, *Boerhaavia diffusa*, *Azadirachta indica*, *Swertia chirata*, *Solanum nigrum*, *Terminalia arjuna*, *Aphanamixis rohituka*, *Terminalia chebula* and *F. indica*) against *CCl₄* induced hepatopathy in rats using bromsulphalein uptake model in liver.
Sousek et al. (1999) carried out antioxidant and antilipoperoxidant activities of alkaloid and phenolic extract of *F. parviflora* in rat mitochondrial membrane alkaloid extract showed higher antioxidant activity against tBH-induced lipoperoxidation than the phenolic extract. The phenolic extract was 2-3 fold more effective as scavengers of 1,1-diphenyl-2-picrylhydrazyl radical than the alkaloid extract.

Gilani et al. (1996) observed selective protective effect of an aqueous-methanolic ext. of *F. parviflora* against paracetamol-induced hepatotoxicity, probably mediated through microsomal drug metabolizing enzymes (MDME) inhibition.

Patki et al. (1990) studied efficacy of a herbomineral indigenous compound preparation containing *F. parviflora* in experimentally induced hepatocellular jaundice in albino rats and observed significant acceleration of recovery process.

Kumar et al. (1986) reported that fumariline, from *F. indica* seeds, has anticonvulsant effect against maximal electroshock-induced seizures in rats and CNS depressant without significant muscle relaxant properties.

Khattak et al. (1985) observed significant oral antipyretic activity in rabbits exhibited by hexane-, chloroform- and water-soluble extracts of *F. parviflora* with other plants which is comparable to potency of aspirin. Antipyretic activity was more prominent in the hexane-soluble portions of the plants.

Akhtar et al. (1984) studied effects of *Euphorbia prostrata* and *F. parviflora* in normoglycaemic and alloxan-treated hyperglycaemic rabbits.

Bhattacharya et al. (1970) stated that total tertiary alkaloids of *F. parviflora* has relaxant and nonspecific antispasmodic activity on isolated intestines of rabbit, guinea pig, and rat, isolated uteri of rat and guinea pig, dog tracheal chain, and dog intestine in situ. The drug given intravenous showed a moderate but prolonged hydrocholeretic effect.
Mishkinsky (1965) observed convulsions in experimental animals by protropine, the alkaloid of *F. parviflora* at the dose of 180-200 mg/kg.

### 3.4.4. Phyto-pharmacological review

Naz et al. (2013) isolated nonacosane-10-ol and 23a-homostigmast-5-en-3β-ol from the n-hexane fraction of the roots of *F. parviflora* and elucidated their structures using 13^C and 1^H NMR. They also observed nematicidal activity of both compounds against *M. incognita*.

Rao and Mishra (1998) isolated and characterized monomethyl fumarate from the methanolic extract of the whole plant of *F. indica*. They also viewed its significant antihepatotoxic activity in albino rats against thioacetamide *in vitro*, and against CCl₄, paracetamol and rifampicin *in vivo* to an extent almost similar to that of silymarin.

Rao and Mishra (1997) isolated and characterized n-octacosanol from the whole plants of *F. indica*. The compound was found to exhibit significant *in vitro* antihepatotoxic activity against galactosamine and thioacetamide induced hepatocytotoxicities at the concentration of 100 ug/mL.

Hilal et al. (1993) isolated phytosterol like β-sitosterol, stigmasterol, campesterol; fatty acids such as capric (1%), lauric (1.9%), myristic (1.16%), myristoleic (4.55%), palmitic (3.9%), stearic (29%), linoleic (10.5%), and arachidonic (7.23%) acids and flavonoids like 3,5,3′,4′-tetrahydroxyflavone-3-arabinoside, 3′-4′-dihydroxy flavone and 3,7,4′-trihydroxy flavone. They also observed uterine stimulant and estrogen-like effects of the ethanolic extract.

Hilal et al. (1989) isolated from *F. parviflora* and characterized protopine and demethyl congener of the synthetic tetrahydroescholamine by their melting points, chromatography, UV, IR, NMR, and mass spectra. An ethanolic extract of the plant as well as protopine exhibited a significant decrease in intestinal muscle contractions and showed cardio inhibitory, anti arrhythmic, hypotensive and antipyretic effects.
Pandey et al. (1971) attributed relaxant and nonspecific antispasmodic activity on isolated intestines and uteri, and the moderate but prolonged hydrocholeretic effects in vivo of a water-soluble fraction of an ethanolic extract of *F. indica* to protopine.

### 3.4.5. Clinical review

Singh et al. (2011) found *F. indica* safe during chronic toxicity and cytotoxicity through a preclinical study.

Paramesh et al. (2011) prepared a hepatoprotective herbal composition comprising of extracts of *Eclipta prostrata* whole parts and/or *Cichorium intybus* seeds and/or *Andrographis paniculata* whole parts and/or *F. indica* whole parts and/or *Oroxylum indicum* leaves and/or *Ailanthus excelsa* leaves.

Jowkar et al. (2011) considered alcoholic extract of *F. parviflora* as an effective agent for treatment of chronic hand eczema by a randomized double-blind placebo controlled clinical trial.


Kulkarni (1995) carried out clinical study of bhunimbadi ghanasar tablets containing *F. parviflora* along with other nine plants in treatment of seven common symptoms of amlapitta (acid dyspeptic disease) and found it very useful.

### 3.4.6. Agronomical review

Zia-ud-Din et al. (2012) evaluated acaricidal activity aqueous-methanol extract of *F. parviflora* against *Rhipicephalus microplus*.

Pandey et al. (2007) observed inhibitive effect of fuyuziphine isolated from *F. indica* on spore germination of some plant pathogenic fungi such as *Collectotrichum* sp., *C. gloeosporioides*, *C. falcatum*, *Curvularia maculans*, *C. lunata*, *Erysiphe*
cichoracearum, Helminthosporium pennisetti, Oidium erysiphoides, Ustilago cynodontis, Alternaria cheiranthi, A. melongenae, A. brassicicola and A. solani.

Sarma et al. (1999) isolated berberine iodide, an isoquinoline alkaloid, from *F. indica* and reported its antifungal activity against *Curvularia lunata, Erysiphe cichoracearum, E. pisi, Fusarium udum* and Penicillium species.

Singh et al. (1997) observed hundred percent inhibition of spore germination in *Culvularia sp.* and *F. lini* by narlumidine and fumariline alkaloids isolated from *F. indica* at 125 µg/mL.

Srivastava et al. (1994) studied effect of adlumidine, fumariline, nor-sanguinarine, protopine and tetrahydrocoptisine isolated from *F. indica* on conidial germination. All the alkaloids inhibited germination to some extent, but adlumidine was found highly effective at 100 µg/mL.

Tripathi et al. (1994) estimated the concentration of alkaloidal constituents of *F. indica* at different stages of its life span and it was found maximum between 21-40 days.

**3.4.7. Miscellaneous review**

Latif et al. (2015) documented ethnopharmacological use of *F. indica* for hypertension among the local communities of DIR Lower, Pakistan.

Khan and Gilani (2015) presented a review showing bronchodilation via dual blockade of muscarinic receptors and Ca\(^{++}\) influx caused by *F. parviflora*.

Ravikanth et al. (2014) evaluated *F. indica* for nutritional constituents and detected protein content 10.68-14.81%, fiber 23.59-28.97%, carbohydrate 4.93-6.24%, calcium 1.61-1.86%, vitamin A 916.52-1666.05 IU/g and energy 300.25-356.75 Kcal/100g using spectroscopic, calorimetric, flame photometric and chemical assay methods.
Fazal et al. (2013) carried out palynological studies of *F. indica* and reported its pollen grain morphology.

Gupta et al. (2012) made a review on *F. indica* and stated that the plant is reputed for its anthelmintic, diuretic, diaphoretic, laxative, cholagogue, stomachic and sedative activities and is used to purify blood and in liver obstruction in ethnopharmacology. They also mentioned that the phytochemical constituents separated from the plant possesses important pharmacological activities like smooth muscle relaxant, spasmogenic and spasmylytic, analgesic, anti-inflammatory, neuropharmacological and antibacterial activities.

Kamil (1994) discussed a few traditional plants including *F. parviflora* used in skin diseases, in respect of their chemical constituents and medicinal action.
3.5. Polycarpacea corymbosa

3.5.1. Phytochemical review

Subramanian and Manorama (2014) made attempt to quantify phenol, flavonoid and steroid in methanol extract of aerial and root parts of *P. corymbosa* by HPTLC method and found Phenol and flavonoid have higher concentration compared to steroids.

Sindhu and Manorama (2013) carried out GC-MS analysis of methanolic extract of root and aerial part *P. corymbosa* and identified n-hexadecanoic acid in aerial part and 5-hydroxymethyl furfural in root.

Chiang (1978) isolated camelliagenin A, A1-barrigenol, stigmastanol and 2 unidentified compounds, C_{84}H_{162}O_{2} melting point 80-81°C and C_{35}H_{70}O_{2} melting point 84-85°C from *P. corymbosa*.

3.5.2. Phyto-pharmacological review

Manase et al. (2014) isolated four triterpenoid saponins from *P. corymbosa* along with the known apoanagallosaponin IV and elucidated their structures by spectroscopic data analysis. They also carried out evaluation of cytotoxicity of these compounds against three tumor cell lines (SW480, DU145 and EMT6) and one compound exhibited cytotoxicity with IC_{50} values ranging from 4.61-22.61 mM, which was greater than that of etoposide.

Abirami and Muthuswamy (2013) evaluated antioxidant potential of various extracts of *P. corymbosa* by using DPPH assay, superoxide radical scavenging assay and total antioxidant activity method. The ethanolic extract was found to have significant radical scavenging activity. They also observed higher content phenolic and flavonoids in ethanolic extract in comparison with other two extracts.
Rajopadhye and Upadhye (2013) determined phenolic content and in vitro antioxidant potential of ethanol extract of seven botanically different sources of Ayurvedic drug “Pittapapda” such as *Glossocardia bosvallia*, *Rostellularia procumbens*, *Rungia repens*, *Naregamia alata*, *Fumaria vaillantii*, *Mollugo pentaphylla* and *Polycarpaea corymbosa*. The trend of phenol content was as: *G. boswallea* > *F. vaillantii* > *N. alata* > *P. corymbosa* > *M. pentaphylla* > *R. procumbens* > *R. repens*. Ethanol extracts of *G. bosvallia*, *F. vaillantii* and *N. alata* were found to have potent in vitro antioxidant activity followed by moderate activity of *M. pentaphylla* and *P. corymbosa*.

Hukkeri and Kenganora (2009) reported antioxidant and antiradical activity of leaves of *P. corymbosa* due to flavonoids.

3.5.3. Pharmacological review

Kiran et al. (2011) crafted a review on traditional plants with hepatoprotective activity including *P. corymbosa*.

3.5.4. Clinical review

Yue et al. (2016) made a compound preparation containing traditional Chinese medicines and Western medicines for treating menstruation periodic psychosis and developed formulations such as tablet, hard capsule, soft capsule etc. using *P. corymbosa* along with other herbs. The compound preparation has good effects of promoting blood circulation, dispelling blood stasis, purging pathogenic fire, removing dampness, relieving constipation, clearing away heart fire for tranquillization, regulating nervous system, relaxing cardiovascular and cerebrovascular vessels, reducing stress, overcoming disappointment emotion, preventing depression, maintaining immunity.

Yu (2016) prepared western and Chinese medicine for treating gout from *P. corymbosa* and other herbs.
Wang et al. (2015) developed Chinese and western medicine compound preparation with good effects for treatment of *Pseudomembranous colitis* from *P. corymbosa* and other herbs.

Meng et al. (2015) prepared a traditional Chinese medicine for treating spleen qi deficiency-type acute cystitis using *P. corymbosa* along with other herbs which has clear curative effect, little toxicity and adverse side effect, and low adverse reaction rate.

Xue et al. (2015) formulated a Chinese medicine for treating dampness-toxicity accumulation-type colpomycosis from *P. corymbosa* and other herbs with exact efficacy, little toxic or side effects, short course, less recurrence.

Gao and Li (2015) made a traditional Chinese medicine for treating kidney essence deficiency nerve deafness from *P. corymbosa* and other herbs. It determines the treatment according to differentiation of symptom and sign principles, has strong effective pertinence on deficiency of kidney essence nerve deafness, has quick onset of curative effect, has little toxicity and adverse side effect and is low in relapse rate.

Li (2015) invented a Chinese medicine composition for treating heat-toxin skin ulcer by external application with short cure time, obvious efficacy, safety and reliability, no toxicity and other adverse effects using *P. corymbosa* along with other herbs.

Zhang (2015) prepared a traditional Chinese medicine preparation for treating infantile dyspeptic gastroenteropathy from *P. corymbosa* and other herbs.


Lv (2014) developed a kind of Chinese medicine preparation for the treatment of enteritis having significant curative effect for the symptoms such as stomachache, diarrhoea, rare aquiform stool or the mucus bloody purulent stool caused by enteritis, non-relapse after healing, safe without toxic side effect, with low cost, taking conveniently with *P. corymbosa* and other herbs.
Cui (2013) made a preparation from various traditional Chinese medicines including *P. corymbosa* which has good effects on treating bronchitis, nourishing lung and removing phlegm, with good therapeutic effect, short course required, no side effect and no toxicity.

Zhou (2013) prepared a traditional Chinese medicine composition for treating atrophic gastritis with good and quick effect and without any side effects using *P. corymbosa* along with other herbs.

Fang (2013) composed a traditional Chinese medicine from *P. corymbosa* and other herbs for treating intolerance of cold, fever, and weakness caused by dilatancy of spleen and stomach, and has the advantages of high speed of curative effect and no toxic or side effect.

Fang (2013) formulated a traditional Chinese medicine from *P. corymbosa* and other herbs for treating upper respiratory tract infection which has the effects of dispelling cold, relieving exterior syndrome, dissipating fever and reducing phlegm.

Feng et al. (2013) prepared a Chinese medicinal composition for treating infantile mycotic enteritis with *P. corymbosa* and other herbs.

Ji (2013) composed a Chinese medicine for treating male infertility having good effect of treating dysspermatism and infertility caused by asthenozoospermia using *P. corymbosa* along with other herbs.

Wu (2013) developed a traditional Chinese medicine composition for treating chest obstruction and cardiodynia from *P. corymbosa* and other herbs.

Jin et al. (2013) prepared a traditional Chinese medicine composition from *P. corymbosa* and other herbs for treating alzheimer's disease with the advantages of good curative effect, quick drug action, low cost and no side effects.
Jin et al. (2013) invented a traditional Chinese medicine composition with *P. corymbosa* and other herbs which can treat flat wart and avoid scar and has quick drug action and no toxicity and side effects.

Jin et al. (2013) prepared a traditional Chinese medicine composition from *P. corymbosa* and other herbs for treating chronic nephritis with good kidney-tonifying effect.

Zhang (2012) made a Chinese medicine for treating severe cough from *P. corymbosa* and other herbs.

Chen (2012) developed a Chinese medical external-use liniment comprising of *P. corymbosa* and other herbs for treating scald, burn, trauma, etc. and carried out its quality control based on TLC and gas chromatography.

### 3.5.5. Agronomical review

Wang et al. (2004) carried out microscopic identification of *P. corymbosa* herb under the name of baitouweng by digital imaging technique.

Veeranjaneyulu and Das (1982) considered *P. corymbosa* tolerant to Copper at 450 ppm and Zinc at 4 ppm but not tolerant to Cobalt at 1.2 ppm or Nickel at 0.8 ppm when grown in soil.

### 3.5.6. Miscellaneous review

Gopal (1984) described botanical characters and medicinal uses of *P. corymbosa*. 