Review Article **ISSN: 2349 – 7106**

Asian Journal of Research in Chemistry and Pharmaceutical Sciences

Journal home page: www.ajrcps.com

PHYTOPHARMACOLOGICAL ACTIVITIES OF *LUDWIGIA HYSSOPIFOLIA* (G. DON) EXELL: A REVIEW

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ABSTRACT

Ludwigia hyssopifolia (G. Don) Exell, commonly known as the water primrose is a broad leaf weed which is extensively grown in Bangladesh, Ceylon and in all parts of India. In the traditional system of medicine, *Ludwigia hyssopifolia* have been recommended for the treatment of diarrhoea, dysentery, flatulence, jaundice, spitting of blood, leucorrhoea. The plant has also been suggested to possess astringent, anthelmintic, carminative and diuretic actions. Previous phytochemical investigation of plant revealed the presence of flavonoids like vitexin, isovitexin, orietin, Isorietin, alkaloid like piperine and the plant sterol like β-sitosterol. The present review highlights the taxonomical, botanical, phytoconstituents, pharmacological discussion on *Ludwigia hyssopifolia*.

KEYWORDS

Ludwigia hyssopifolia (G. Don) Exell, Onagraceae, Traditional use, Phytochemical constituents, Pharmacological activity and Bioactivity.

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INTRODUCTON

People have been using medicinal plants for various therapeutic purposes since prehistoric period. The knowledge about the traditional use of medicinal plants has always explored the search for new therapeutic cures. The traditional systems of treatments with medicinal plants are often cheaper, locally available, simple medicinal preparations which bring out beneficial results[1]. World Health Organization (WHO) estimates that the use of herbal medicines exceeds the conventional drugs by two to three times throughout the world[2]. Many of the plant species have been documented for their pharmacological and clinical properties with phytochemical marked activity on different

pathological condition of different diseases. Today numerous clinically used medicines are derived directly or indirectly from plant sources. There are a good number of purified plant constituents that are developed as modern medicines, but there are a vast majority of population still using herbal medicines for their primary health care purposes.

Population rise, inadequate supply of drugs, prohibitive cost of treatments, side effects of synthetic drugs, development of resistance etc., led the people to greatly dependent on plant materials for the treatment of various diseases. Herbal plants having a rich source of structurally diverse classes of secondary metabolites, are effectively used in the treatment and/or prevention of various acute and chronic diseases such as neurological diseases, cardiovascular disorders, diabetes, cancer, hepatic diseases, renal disease, infections, etc[3]. The therapeutic effects of herbs and spices in traditional medicines have been documented in early literature, for example, the Ayurveda, mainly based upon their folkloric use. However, many of the medicinal herbs are still used in traditional therapies without being examined for their claimed therapeutic benefits. Thus, the systematic evaluation of the chemical properties, and biological activities of medicinally important herbs and species is, therefore, an utmost necessity.

The Onagraceae family is one of the largest well-defined families of flowering plants. It is also known as willow herb family or evening primrose family. The family comprises about 7 tribes, 17 genera with around 650 species of herbs, shrubs and trees of worldwide distribution[4,5]. It is widely spread and occurs on every continent from boreal to tropical region. The family includes a number of garden plants and also some common weeds in garden. Onagraceae belongs to the well-marked order 'Myrtales' but its members shares few common features found nowhere else in the order like distinctive 4-nucleate embryo sac, abundant presence of raphides in the vegetative cells, "paracrystalline beaded" pollen, and viscin threads[6].

Ludwigia is a cosmopolitan genus of the Onagraceae family distinct from all members of the family and is the only genus of the tribe Jussiaceae. It consists of about 82 species of aquatic plants with mainly of tropical distribution. In India the genus *Ludwigia* consists of seven species and one infraspecific taxon. One such species is *Ludwigia hyssopifolia* (G. Don) Exell[7,8].

Ludwigia hyssopifolia (G. Don) Exell commonly known as water primrose belonging to Onagraceae family is an erect aquatic or semi aquatic annual herbaceous marshy plant. It is an extremely widespread weed of rice and wetlands in many countries, including India, Malaysia, Philippines and Sri Lanka. In Asia, this weed has been observed season long in both direct-seeded rice and transplanted rice fields, irrespective of water level. Recently, *Ludwigia hyssopifolia* has been reported to occur in seven countries in dry-seeded rice and six countries in wet-seeded rice. In addition to occurring in the crop fields, the weed is also known to frequent pools, shallow ditches, and river edges. *L. hyssopifolia*is similar in appearance to two close relatives, *Ludwigi aperennis* L. and *Ludwigia octovalvis* (Jacq.) Raven, and young plants may easily be confused until in flower. These species are all weeds of transplanted and direct-seeded rice systems in Asia and Africa[9].

HABITAT AND DISTRIBUTION

General Habitat

Ludwigia hyssopifolia grows in wet places in the tropical zone, usually in standing water, rice paddies, edges of streams and swamps**,** also along the wet road sides and in moist grasslands. It recorded as a common weed on both clay-loam and clay soils[9].

Distribution

Ludwigia hyssopifolia is a pantropical weed seen in wet places, likely native to America. It is found in Bangladesh, Bhutan, Burma, Sri Lanka, India and Nepal. It is also found in Colombia, Benin, Egypt, Ghana, Honduras, Iraq, New Guinea, Nigeria, Senegal, Sudan, Suriname, Myanmar, Laos, Cambodia, Hong Kong, Ausralia, Samao, Caroline Islands and Christmas Islands. In India, it is widely distributed in Andaman & Nicobar Islands, Assam, Andhra Pradesh, Bihar, Gujarat, Goa, Kerala, Manipur, Mizoram, Orissa, Rajasthan, and Tamil Nadu[10].

Cyclicity

Flowering and fruiting: June – November.

Biology and Ecology

Genetics chromosome number: 2n = 18.

Reproductive biology

Ludwigia hyssopifolia possesses both endocarp and non-endocarp seeds. The non-endocarp seeds will get dispersed first at the ripening of fruit whereas the endocarp seeds will remain on the plant for several weeks or months before they are eventually dispersed into the water. The dispersed seeds will remain floating in water upto 16 days before they sink. Seeds do not undergo germination under submerged conditions or when buried in soil. They germinate at a temperature of 10-40°C and require light for germination. *Ludwigia hyssopifolia* can produce approximately 75,000 seeds per plant.

Physiology and phenology

Ludwigia hyssopifolia is a C_3 plant.

Environmental requirements

Require warm, moist to wet conditions and is largely restricted to the moist tropics though it may thrive in wetlands in less wet climates. It is presumed that the plant is sensitive to frost[9].

Taxonomical Classification

The taxonomic classification of *Ludwigia hyssopifolia* is given in the Table No.1[11].

Synonyms

Fissendo carpalinifolia (vahl) Bennet, *Jussiaea fissendocarpa* Haines, *Jussiaea hyssopifolia* G.Don, *Jussiaea hyssopifolia* Illus, *Jussiaea linifolia* Vahl, *Jussiaea micrantha* Kunze, *Jussiaea weddelii* M. Micheli, *Ludwigia linifolia* (Vahl) R.S. Rao, *Ludwigia micrantha* Kunze Hara[12].

Vernacular Names

Morphological Characters

Ludwigia hyssopifolia (G. Don) Exell is an upright aquatic or semi-aquatic annual herb, well branched which grows upto a height of 2 to 3 m.

Stem semi woody, quadrangular, and narrowly winged. Green or purplish in colour with white spongy pneumatophores arising from submerged roots. Occasionally grows into a shrub. Stem base spongy and swollen with aerenchyma, sometimes becoming woody, upper stem ribbed.

Leaves are simple, narrowly oblong, lanceolate or sometimes ovate elliptic, spirally arranged, alternate, or occasionally whorled, entire or toothed to pinnatifid, 1.6 – 8.4 ×1 – 2.8 cm, cuneate at base, acute or sub acuminate at apex, glabrate with short-ad-pressed hairs; lateral nerves 11 – 17 pairs; petiole 2 cm long. Lateral veins forms specific loops inside the leaf blade margin. Stipules present are reddish, very small, about 0.25 mm long and usually caduceus.

Flowers in almost all leaf-axils, are perfect, solitary in leaf axills, sessile or nearly so, usually four partite, sometimes 5 partite, 5 mm across, 4-merous; pedicels 2 mm long; bracteoles 2, short, usually at base of the upper enlarged portion of the ovary. Calyx lobes 3-4mm. Petals 4, elliptic-obovate, 4 × 2 mm, base and tip narrow, 1-nerved, bright yellow or white fading to orange yellow. Stamens normally 8, 1-2mm long. Interior ovary 4-5 celled, style club shaped. Sepals 4, lanceolate, 4×1 mm, tip pointed, equalling the petals, persistant, tube narrow, glabrous or finely pubescent, 3-nerved, green colored, and valvate. Stamens are usually 8, 2-whorled, slightly shorter. Filaments 0.4 – 1.5 mm long and white; anthers 0.5 mm long, pale yellow, versatile or basifixed, dithecal, sometimes cross-partitioned, opening by longitudinal slits; Disc not or slightly elevated, glabrous; nectary reniform, with long-white hairs, between the petaliferous stamens and style, encircles the stamen at base; pollen grains almost always united by viscin threads, shed as monads, tetrads, or polyads. Ovary inferior, placentation axile or parietal, quadrangular, 7 – 1 mm long, glabrous, 4-loculed; ovules 2 per locule in upper region and solitary in lower region of the ovary; style 1, simple, 1.5 mm long, glabrous, pale greenish yellow; stigma with as many lobes as sepals, depressed to globose, 1 mm across.

Fruits are finely hairy, almost cylindrical, about 1.75-3 cm long subterate capsule, slender and thin walled. 8 ribbed, base torulose, seeds many, multiseriate. Sepals persistent at the apex of the fruit. Two types of seed are formed in each capsule. Normal seeds will remain in the upper half and the seeds in the lower half are contained in a corky seed carrier.

Seeds are small, ellipsoid, multiseriate in the upper half, uniseriate in the lower, 0.66 × 0.39 × 0.28 mm, light brown, smooth or variously sculptured, smooth integument and a deep brown raphe, with straight oily embryo, coated with endocarpus tissue[13-15].

Traditional Uses

Ludwigia hyssopifolia (G. Don) Exell possess much importance in the traditional system of medicine. The plant was considered to act as astringent, anthelminthic, carminative and diuretic. It is used in the treatment of diarrhoea, dysentery, enteritis and sprue. Traditionally the plant is used in the treatment of Jaundice. A poultice of the plant is used for the treatment of pimples, boils and other skin infections. The decoction of the dried materials used as gargle for mouth ulcer. Pounded fresh materials may be applied as a poultice to the area afflicted by eczema. In Bangladesh and India, decoction of the plant material is used for treating diarrhoea and dysentery, flatulence, leucorrhoea and hemotysis. Leaves are used for poulticing in orchitis and neck gland enlargement. The leaves are used in a febrifuge decoction. Decoction of the plant material is also used as vermifuge and purgative. Cold infusion of root is swallowed by Malays for the treatment of syphilis[3,16].

Phytochemical Constituents

The previous phytochemical investigation on the plant revealed the presence of various chemical constituents namely vitexin, isovitexin, orientin and isoorietin and piperine[17].

Ayinampudi Sridhar Rao *et al.,* in their research program to identify chemical biomarkers from medicinal plants, reported the isolation of a new pentacyclic triterpenoid, 6β, 24-pentahydroxyl tormnetic acid. Seven known compounds which were isolated were identified as xantylein (+) trans-decursidinol, β-sitosterol, β-sitosterol-β-D-glucopyranoside, 6β-hydroxytormentic acid, 23-hydroxy tormentic acid and 6β, 23-hydroxy tormentic acid[18].

Pharmacological Activity

Anti-tumour activity

Banibrata Das *et al*, has reported the antitumour activity of *Ludwigia hyssopifolia* extract and also of the alkaloid piperine that is isolated from the plant.

In the *in vitro* anti-tumour activity performed by potato bioassay method, the ethyl acetate extracts of the plant exhibits 73.05 and 84.14% inhibition of *Agrobacterium tumefaciens* induced crown gall tumor formation on potato discs at concentrations of 500 and 1000 µg/disc, respectively. The alkaloid piperine inhibited the crown gall tumour formation by 66.68%, 59.09%, 37.90% and 24.27% at concentrations of 20, 15, 10 and 5 µg/disc, respectively[19,20].

Antibacterial activity

The whole plant extract of *L. hyssopifolia* showed significant antibacterial activity. The antibacterial activity of ethyl acetate extract of *L. hyssopifolia* Linn and its isolated compound piperine was checked against Gram-positive (*Staphyllococcus aureus, Bacillus subtilis, Bacillus cereus, Bacillus megatorium*) and Gram-negative (*Shigella flexneri, Shigella dysenteriae, Shigella boydii, Salmonella typhi, Vibrio cholerae, Escherichia coli*) pathogenic bacteria by disc diffusion method at a concentration of 400 and 200 µg/disc, respectively, taking streptomycin (100 µg/disc) as the reference standard. Among the bacterial strains tested, *Shigella dysenteriae, Staphylococcus aureus and Bacillus subtilis* exhibited good sensitivity (17-20 mm) to ethyl acetate extract, while piperine showed only weak antibacterial activity (13-15 mm) against *Shigella flexneri, Shigella dysenteriae, Staphylococcus aureus and Bacillus subtilis*[19].

Antidiarrheal activity

The antidiarrheal activity of the plant's methanolic extract was tested in Swiss albino mice with castor oil and serotonin as experimental diarrhea inducing agents. The extract showed significant antidiarrheal property by reducing diarrheal episodes in both the experimental groups at a dose of higher than 100mg/kg body weight as compared to standard drug Loperamide given at a dose of 66.67 µg/kg body weight. The percent reduction in diarrheal episodes were observed at doses 200 mg/kg and 400mg/kg[21].

Anti-inflammatory activity

Banibrata Das *et al*, have reported the anti-inflammatory, analgesic and diuretic activity of hexane, ethyl acetate and methanolic extract of *L.*

hyssopifolia. The anti-inflammatory activity was carried out on carrageenan induced rat paw edema. It has been exhibited that the hexane and ethyl acetate extracts showed maximal inhibition of carrageenan induced paw edema by 33.96% and 27.39% respectively, while the methanolic extract showed no remarkable effects. An alkaloid compound piperine which posseses anti-inflammatory property has been isolated from *L. hyssopifolia* and it was concluded that the anti-inflammatory effect of *L. hyssopifolia* is due to the presence of piperine[3,22].

Analgesic activity

The analgesic activity of hexane, ethyl acetate and methanolic extract of *L. hyssopifolia* employing the acetic acid induced writhing test in mice was studied. The hexane extract of the plant showed statistically significant analgesic activity as compared to that of the standard drug aminopyrine. The ethyl acetate and methanolic extracts exhibited only a moderate level of action[3,23].

Diuretic activity

The hexane, ethyl acetate and methanolic extarcts of *L. hyssopifolia* were pharmacologically evaluated for its diuretic activity on experimental Swiss albino mice. All the extracts showed maximum diuretic activity on the third hour of the study at a dose of 250 mg/kg. The onset of diuretic activity of ethyl acetate and methanolic extracts at an oral dose of 250 mg/kg was found to be about one hour, which was similar to the standard drug Furosemide given at a dose of 3 mg/kg body weight orally[3,24].

Antioxidant activity

The methanolic extract of the aerial parts of the *L. hyssopifolia* showed antioxidant properties. The extract was screened by Pallerla Praneetha *et al*, to assess its antioxidant property by DPPH radical, superoxide, nitric oxide, and hydroxyl radical assay methods and also by reducing power assay. The extract showed a concentration-dependent *in vitro* free radical scavenging activity and also a concentration-dependent reducing power. The reducing power of the extract, was found to be 49.41 ± 1.36 mg of AAE/g of extract[25].

Cytotoxic activity

Pallerla Praneetha *et al*, determined the cytotoxic activity of *L. hyssopifolia* by estimating mitochondrial synthesis using tetrazolium assay. The 50% cytotoxic concentration (CTC_{50}) was found to be 1870.45 ± 8.31µg/ml in HepG2 cell line.

Hepatoprotective activity

The hepatoprotective activity of the methanolic extract of aerial parts of *Ludwigia hyssopifolia* G. Don Exell was determined for the first time by Pallerla Praneetha *et al*, through both *in vivo* and *in vitro* methods. In the *in vitro* study, HepG2 cells treated with different concentrations of plant extract showed a significant restoration of the altered levels of hepatic enzymes and improved cell viability. The hepatoprotective effect of *L.hyssopifolia* on liver injuries induced by ethanol, paracetamol and D-galactosamine were investigated by means of serum biochemical and histopathological examinations. Post treatment with *L. hyssopifolia* extract significantly brought down the elevated serum (ALT, AST, and ALP), LDH, GGT, TB, DB, CHOL, and PT and increased the reduced serum TP and ALB levels. The minimized histopathological abnormalities also revealed the hepatoprotective action of *L.hyssopifolia*[25].

Table No.1: Taxonomy of *Ludwigia hyssopifolia* (G. Don) Exell

Kingdom	Plantae
Phylum	Tracheophyta
Subphylum	Angiospermae
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Rosidae
Order	Myrtales
Family	Onagraceae
Tribe	Jussiaceae
Genus	*Ludwigia*
Species	*Ludwigia hyssopifolia*
Binomial name	*Ludwigia hyssopifolia* (G.Don) exell

Table No.2: Vernacular names of *Ludwigia hyssopifolia* (G. Don) Exell

S.No	Language	Name
1	English	Water primrose, Seedbox
2	Malayalam	Neergrambu, Vasalaccira
3	Spanish	Mimbra, palo de agua

Table No.3: Chemical constituents of *Ludwigia hyssopifolia*

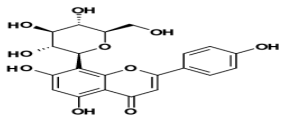
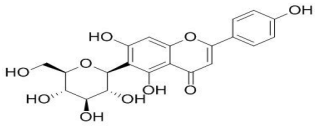
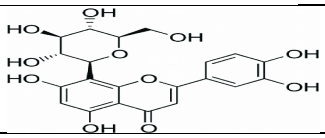
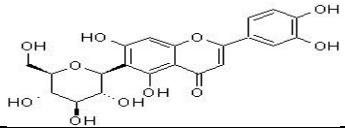
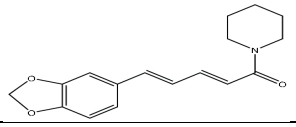
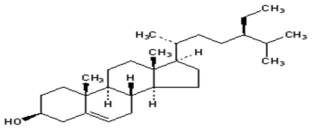
S.No	Chemical constituents	Structure
1	Vitexin	
2	Isovitexin	
3	Orientin	
4	Isoorientin	
5	Piperine	
6	β-sitosterol	

Figure No.1: *L. hyssopifolia* plant

Figure No.2: Flower and Fruit of *L. hyssopifolia*

CONCLUSION

Ludwigia hyssopifolia is one most important valuable weed of the Onagraceae family which has most significant medicinal values. The literature survey shows that *Ludwigia hyssopifolia* is traditionally in mouth ulcer, eczema, diarrhoea, dysentery, flatulence, leucorrhoea and hemotysis. *L. hyssopifolia* is an important source of many pharmacological and medicinally important phytochemicals such as piperine, vitexin, isovitexin, orientin, isoorietin, β sitosterol etc. Many pharmacological activities like antibacterial activity, anti-inflammatory, analgesic, antidiarrheal activity, diuretic activity have also been studied. However the plant had not yet gathered much attention of the researchers. There is a scope to do more detailed phytochemical and biological study on this plant in future.

ACKNOWLEDGEMENT

We are very thankful to Pharmacology department, Devaki Amma Memorial College of Pharmacy, Malappuram.

CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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Please cite this article in press as: Deepak V S *et al*. Phytopharmacological activities of *ludwigia hyssopifolia* (G. Don) Exell: a review, *Asian Journal of Research in Chemistry and Pharmaceutical Sciences,* 7(2), 2019, 781-789.