

## Review article

# A COMPREHENSIVE REVIEW ON ETHNOBOTANICAL AND PHARMACOLOGICAL USES OF THE TROPICAL HERB *Enydra fluctuans* Lour.

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## Abstract

**Background:** Since the beginning of mankind, herbs possess an important role as therapeutic agents and medicaments for various ailments. Owing to their high availability, less price and fewer side effects, around 80% people throughout the globe still rely on plant base treatment. *Enydrafluctuans*Lour.is an edible plant of the Asteraceae family. This tropical herb is commonly known as helencha. It is mostly found on wet roadside and grows in different parts of the world. *Enydra fluctuans* Lour. are used to heal skin related problems, laxative, bronchitis, inflammation, neurodegenerative diseases, leucoderma, biliousness and small pox.

**Objective:** The objective of the review paper is to provide information about morphology, distribution, chemical constituents, ethnobotanical uses and pharmacological activity of *Enydra fluctuans* Lour.

**Methods:** An extensive search was carried out for suitable literatures upon *Enydra fluctans* Lour. Information was gathered from scientific journals via PubMed, Sience Direct, Researchgate, Google Scholar, Springer and Web of Science.

**Discussion:** Several phytochemicals extracted from *Enydra fluctuans* Lour. such as Carotene, Saponins, Flavonoids, Alkaloids, Tannins, Germacranolide, Sesquiterpene lactone, Essential oil possess various pharmacological properties. Moreover, it is also reported that the extraction obtained from the plant is used as anti-microbial, anti-inflammatory, CNS depressant, anti-oxidant, hepatoprotective, analgesic, anti-diarrheal, thrombolytic, anti-diabetic, phagocytic, cytotoxic and neuroprotective agents.

**Conclusion:** More research works are needed to isolate unexplored phytocontitutents and to evident various ethnopharmamcognostical claims of the plant *Enydra fluctuans* Lour. New bioactive molecules may open new fields of research in therapeutics of several diseases.

**Keywords:** *Enydra fluctuans* Lour., ethanobotany, Antidiabetic, Antioxidant

## **INTRODUCTION:**

Nature always has been a flourishing source of therapeutic agents for thousands of years. Medicinal plants are defined as a group of plants that contain some active chemical components that can be used for medicinal purposes. It is an important element of the health care system practice in India(1,2) . The reasons may include low cost, nutritional value, less side effects, easy availability etc(3).

There are minimum adverse or side effects of herbal drugs, and are more compatible with human body (4). WHO (World health organization) has estimated that worldwide 80 percent of people depend on herbal medicines for their primary health care needs (3). According to WHO, near about 21,000 plant species are used for medicinal purposes(5).

India is a country where huge diversity of plants and herbs are found and the origin of Ayurvedic form of medicine has been started in India (6). The tropical herb *Enydrafluctuans* Lour. mainly found in the marshy lands (7). It belongs to the family Asteraceae and can be found in the tropical and sub-tropical region of India. It is used as an edible plant in many parts of India, Bangladesh, Myanmar, Sri Lanka, Thailand, Malaysia, Vietnam etc. (8). The leaves are bitter in taste with a wide range of therapeutic activity. The plant is also used as traditional medicine for many years for treating liver- tonic, leprosy, coughs, and cooling agent. Moreover, the plant is proved to be useful in the treatment of skin related problems, laxative, swelling, nervous infection, bronchitis, biliousness, leukoderma, and smallpox(9).



Figure 1: Whole plant of *Enydra fluctans* Lour.

**BOTANICAL DESCRIPTION:**

Table 1: Vernacular name of *Enydra fluctans* Lour.

English	Marsh herb, Water cress
Sanskrit	Hilamochika
Hindi	Harkuch
Assamese	Helechi, heleshi
Bengali	Helencha
Oriya	Hidimicha

Table 2: Botanical classification *Enydra fluctuans* Lour.

Kingdom	Plantae
Phylum	Magnoliophyta
Order	Asterales
Family	Asteraceae
Genus	Enydra
Specific Epithet	fluctuansLour
Species	<i>Enydra fluctuans</i> Loureiro

**MORPHOLOGY:**

According to researchers, the Asteraceae family is one of the largest families of flowering plants (10). Most members of this family are herbs, shrubs, vines, or rarely trees. Asteraceae is considered as an important family because of their uses in food, ornamental and medicinal purposes (11). Considering the morphology of Asteraceae, the stems are hairy; leaves are simple, spiral and oblong in shape. Flowers are generally bracteate, sessile, complete or incomplete, unisexual, pentamerous, tubular, epigynous and inconspicuous (12).

*Enydra fluctuans* Lour. commonly known as Water Cress or Marsh Herb (13) is a trailing marshy herb that mainly grows on the margin line of fish pond, or in the open rice field or sometimes on floating water(7). It occurs about 1,800 meters above sea level. Stems are generally 30-60 cm long, hollow, fleshy, with a purple tint, internodes are 7-10cm long (14). Leaves are sessile, 2.5- 7.5 cm long, opposite phyllotaxy, oblong to linear in shape with acute apex and distinctly dentate margin or subcrenate. Flower heads are terminal, sessile. Flowers are greenish white to white in color(7). The outer pair of the involucre bracts is ovate, 1 to 1.2 cm long, the inner pair is smaller. Fruits are enclosed within hard receptacle scales. They are achene. Roots are seen on the lower nodes. Pappus is absent. It is able to replicate by fragmentation. The plant occurs so plentifully that it clogs water courses(7).

**GEOGRAPHICAL DISTRIBUTION:**

*Enydra fluctuans* Lour. mostly found between the months of November to January. It is mostly found in Malaysia, China, Bangladesh, several parts of South East Asia, and Tropical Africa (15). In India it is widely found in West Bengal, Assam and North-eastern region. In Assam, the plant is mainly found in the Barak Valley and

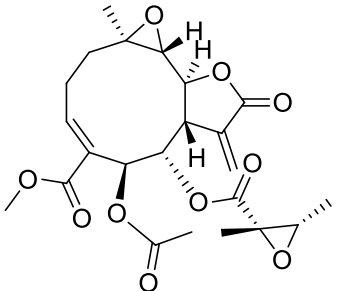
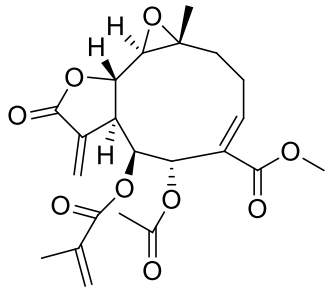
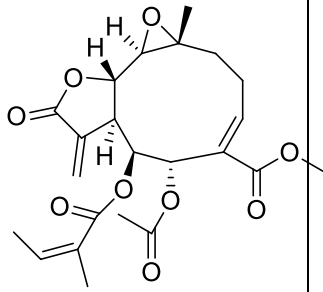
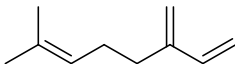
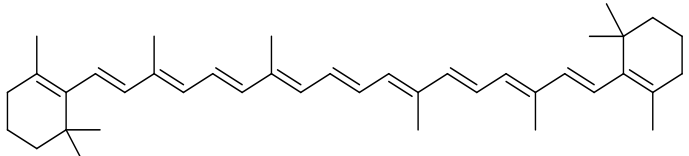
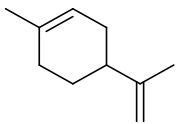
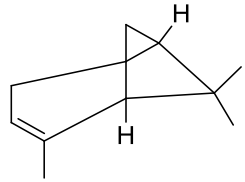
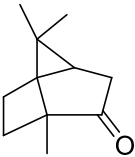
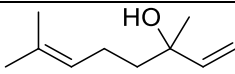
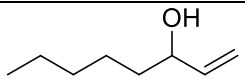
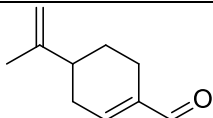
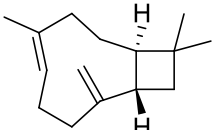
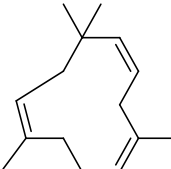
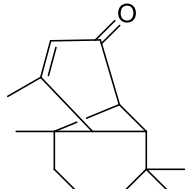
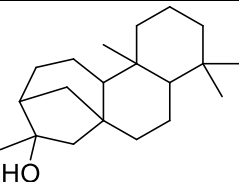
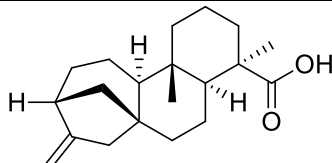
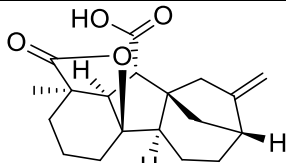
Cachar region (16). It is also found in Dibrugarh and in entire Assam. Nevertheless, this plant is found abundantly in Majuli island of Assam. Additionally, the plant is richly found in the Jaintia hills in Meghalaya, Thoubal district of Manipur and Agartala in Tripura (17).

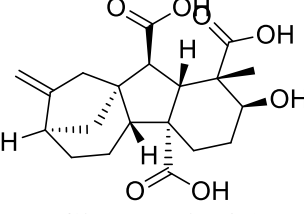
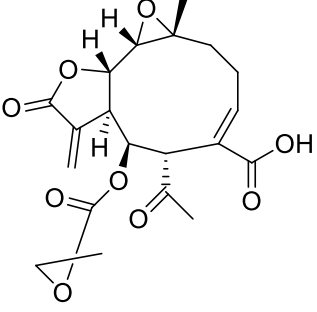
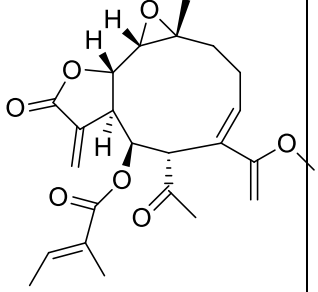
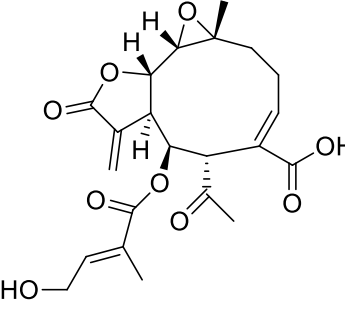
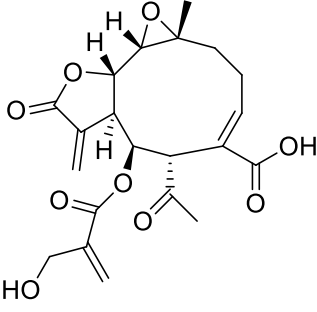
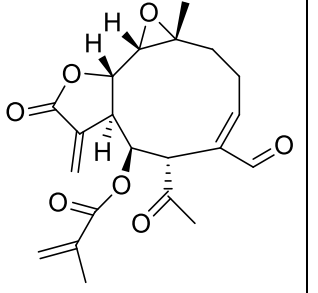
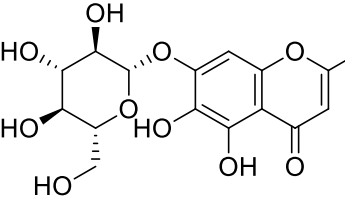
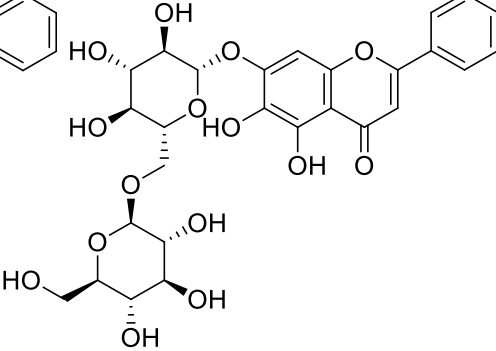
#### **CHEMICAL CONSTITUTION:**

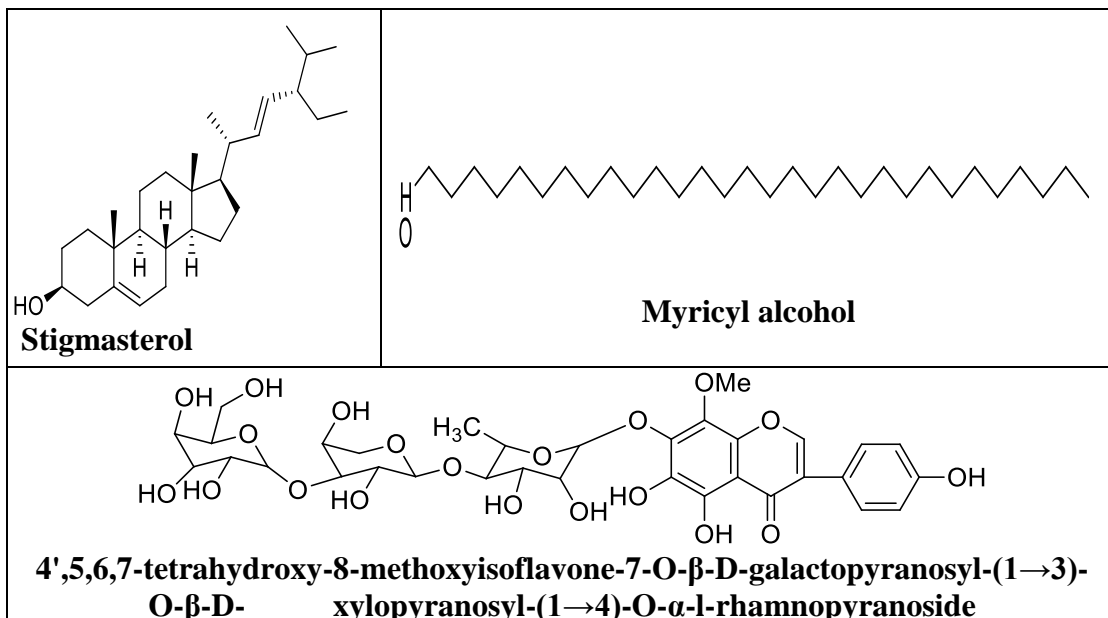
*Enydra fluctuans* Lour. is a good source of phytochemicals. Presence of wide varieties of phytochemicals makes the plant traditionally as well as medicinally beneficial. Phytochemicals are present in the whole plant especially in stem and leaves. *Enydra fluctuans* Lour. contains various phytoconstituents such as flavonoids, terpenoids, glycosides, essential oils and moderate amount of alkaloids, tannins, phenolics and carbohydrates. The plant is rich in  $\beta$ -carotene and protein (18). Different studies of *Enydra fluctuans* Lour. shows presence of many phytochemicals such as saponins, myricyl alcohol, enhydrin, fluctuanin, fluctuanidin, several kaurene derivatives, 4-hydroxy farnesyl acetate and gibberellins, cholesterol, sitosterol, stigmasterol, glucosides, etc. (19–21).

Studies suggested that the leaf oil of *Enydra fluctuans* Lour. shows the presence of myrcene (37%), limonene (28%) and other components (5%). The essential oil of this plant includes  $\alpha$ -Pinene, 1-Octen-3-ol,  $\epsilon$ - $\beta$ -Ocimene, Linalool, Camphor, cis-1, 2-dihydroperillaldehyde, Perillaldehyde,  $\epsilon$ -Caryophyllene,  $\alpha$ -Humulene, and Longiverbenone (22). Methanolic extraction of the plant showed the presence of two flavonoids i.e. Baicalein 7- O- glucoside, Baicalein 7- O- diglucoside (9). Muselli *et al.* reported the presence of two steroids Stigmasterol and Stigmasta-5,22,25-trien-3 $\beta$ -ol (22). Some diterpenoids isolated from plants are Myricyl alcohol, (-)-Kauran-16-ol, and (-)-Kaur-16-en-19-oic acid (23). Gibberellin A9 and Gibberellin A13 have also been isolated from this plant (24). An isoflavone glycoside 4',5,6,7-tetrahydroxy-8-methoxyisoflavone-7-O- $\beta$ -D-galactopyranosyl-(1 $\rightarrow$ 3)-O- $\beta$ -D-xylopyranosyl-(1 $\rightarrow$ 4)-O- $\alpha$ -l-rhamnopyranoside; which is a novel bioactive constituent was reported from the methanolic extraction of *Enydra fluctuans* Lour. (25). This plant also contains some sesquiterpene lactone such as Fluctuanin, Fluctuanidin, 8-Desacyl enhydrin-8-ylidene-4-hydroxymethylacrylate, 8-Desacyl enhydrin-[4-hydroxytiglate], 8-Desacyl enhydrin-[2,3-epoxyisobutyrate] and 8- $\beta$ -Methacryloyloxy-9- $\alpha$ -acetoxy-14-oxoacanthospermolide (26).

Table 1: Some important Phytoconstituents of *Enydra fluctuans* Lour.

 <p><b>Enhydrin</b></p>	 <p><b>Fluctanidin</b></p>	 <p><b>Fluctanin</b></p>
 <p><b>Myrcene</b></p>	 <p><b>β-carotene</b></p>	
 <p><b>Limonene</b></p>	 <p><b>α-Pinene</b></p>	 <p><b>Camphor</b></p>
 <p><b>Linalool</b></p>	 <p><b>1-Octen-3-ol</b></p>	 <p><b>E-β-Ocimene Perilaldehyde</b></p>
 <p><b>(E)-Caryophyllene</b></p>	 <p><b>α-Humulene</b></p>	 <p><b>Longiverbenone</b></p>
 <p><b>HO</b></p>	 <p><b>HO</b></p>	 <p><b>HO</b></p>

(-)-Kauran-16-ol	(-)-Kaur-16-en-19-oic acid	Gibberellin A9
 <p><b>Gibberellin A13</b></p>	 <p><b>8-Desacyl enhydrin-[2,3-epoxyisobutyrate]</b></p>	 <p><b>8-Desacyl enhydrintiglate</b></p>
 <p><b>8-Desacyl enhydrin-[4-hydroxytiglate]</b></p>	 <p><b>8-Desacyl enhydrin-[4-hydroxymethacrylate]</b></p>	 <p><b>8-β-Methacryloyloxy-9α-acetoxy-14oxo-acanthospermolid</b></p>
 <p><b>Baicalein 7-O-glucoside</b></p>	 <p><b>Baicalein 7-O-diglucoside</b></p>	



#### ETHNOBOTANICAL USES:

The plant is used as a food supplement by the tribal community of North-East India, West Bengal, and Bangladesh. Additionally, the Shan tribe from Majuli and Darrang district of Assam considers this plant as a wild edible food plant. The stem of the plant is used in gastric problems and ulcers (27). The whole plant is used in treating constipation by the people of North-East India. Certain populations of Dibrugarh district of Assam use the aerial part of the plant for curing pimples by finely crushing it. The Meitei-pangal community of Manipur, uses this plant for the medication of diabetes by using the extract of plant, which obtained by boiling the plant after cutting from the nodes into pieces (28). Muslim herbalists of Thoubal district of Manipur used the whole plant in treating kidney stones (28). Tribes of Meghalaya use the juices orally which are obtained by crushing the leaves for the treatment of liver diseases. They also use the juice in skin diseases and as laxative (29). Many tribes use *Enydrafluctuans* Lour. in the therapy of Diabetes. Meitei-pangal population of the Thoubal district of Manipur states use this plant by boiling the plant after cutting into pieces at the nodes. It has been found that the tribal experts of the Marakh group of the Garo tribe living in Mymensingh of Bangladesh also use *Enydrafluctuans* Lour. as an anti-diabetic medicine (30). In Malaysia, young parts of the plant are used in salad. In Philippines, the leaves are used to cure skin problems(7).



## PHARMACOLOGICAL ACTIVITIES:

As there are large numbers of phytoconstituents present in *Enydrafluctuans*Lour., it shows different pharmacological activities such as anti-oxidant, CNS depressant, anti-microbial, thrombolytic, anti-inflammatory, analgesic, cytotoxicity, neuroprotective potential, etc.(31).

### 1. Anti-diarrheal activity:

Uddin *et al.* from their study showed that methanolic and aqueous extracts of *Enydrafluctuans*Lour. give significant results against castor oil-induced diarrhea in mice(32). Components reported from methanolic extract are flavonoids, carbohydrates, reducing sugars, phenolic compounds and tannins (33). While performing the experiments by Uddin *et al.*, both methanolic and aqueous extracts were given orally at a dose of 250mg/kg body weight. The rate of inhibition is 41.18% in aqueous and 67.07% in methanolic extract as compared to 84.70% inhibition produced by standard drug loperamide (32). The methanolic extract is capable of inhibiting the growing of *Shigella dysenteriae*, *Shigella boydii* and *Shigella flexneri*. Its anti-diarrheal activity may be caused by the inhibition of prostaglandins (21).

### 2. Anti-cancer activity:

Owing to the presence of flavonoids i.e., baicalein 7-O-glucoside and baicalein 7-O-diglucoside in the *Enydrafluctuans*Lour., it shows anti-oxidant properties. Reactive oxygen species may cause carcinogenicity. Cellular damages such as mitosis, increasing the risk of DNA damage leading to mutations are caused by reactive oxygen species (34). Thus the plant shows its anticancer activity (mainly against Ehrlich's ascites carcinoma (EAC) bearing Swiss albino mice)(35). Sannigrahi *et al.* examined the anti-cancer activity by studying tumor cell count, tumor volume, and the percentage of the viable and nonviable cell count (36). Treatment with flavonoids significantly reduces the volume of tumor cells and increases the life span. It restored the hematological parameters like malonaldehyde content and anti-oxidant enzyme activity (36). Stefani *et al.* from their experiment suggested that flavonoids prevent carcinogenesis either by modulation of the defense enzyme system or by interfering with lipid peroxidation(37).

### 3. CNS depressant activity:

Roy *et al.* during their experiment showed that chloroform, benzene, and ethyl acetate extract of *Enydrafluctuans*Lour. can cause central Nervous System depressant activity. Studies reveal that extracts of

*Enydrafluctuans*Lour. significantly possesses spontaneous motility sedative, depressant, anti-convulsant and anti- stress activities in Swiss Albino mice (38).

**4. Cytoprotective activity:**

Aqueous extracts of *Enydrafluctuans*Lour.exhibit cytoprotective activity and defensive role against toxicity caused by heavy metal. The aqueous extract restores lead acetate induced decrease in cell viability in hepatocytes. It also provides protection against  $\text{NaAsO}_2$  induced cytotoxic effects(39). Cytotoxic effects include protein carboxylation, lipid peroxidation, alterations in the levels of extrinsic and intrinsic transcription proteins and reduction in glutathione levels in hepatocytes. Using the aqueous extract of the plant, it has been confirmed that the plant possess cytoprotective activity against bioaccumulation of arsenic as well as arsenic-induced abnormal hematological constraints and redox discrepancy in mice liver (40).  $\text{CdCl}_2$  induced reduction in cell viability can also be significantly altered by treatment with aqueous extract of the plant. *In-vivo* assays have proved aqueous extract of *Enydrafluctuans*Lour. have remarkable counter reactions against Cadmium bioaccumulation and oxidative stress in liver, kidney, heart, brain and testes of mice (41).

**5. Analgesic activity:**

Rahamanet *al.* evaluated the analgesic activity of *Enydrafluctuans*Lour. According to their studies, methanolic extract of *Enydrafluctuans*Lour. was given orally, showed promising analgesic activity against acetic acid-induced writhing and tail-flick method(42).

**6. Anti-inflammatory activity:**

Flavonoids isolated from leaves of *Enydrafluctuans*Lour. shows anti-inflammatory activity. It works by inhibiting COX-2 and 5-LOX with an  $\text{IC}_{50}$  value of  $80\mu\text{g/mL}$  and  $92\mu\text{g/mL}$  respectively. The flavonoids extracted from this plant also showed potent anti-inflammatory activity against carrageenan and histamine-induced acute inflammation. Additionally it possesses significant *in-vivo* anti-inflammatory activity in carrageenan induced rat paw edema and cotton pallet induced granuloma in rats (43).

**7. Hepatoprotective activity:**

The phytoconstituents present in *Enydrafluctuans*Lour. also shows some hepatoprotective activity. The hepatoprotective potential of the plant extract was evaluated against carbon-tetrachloride-induced oxidative damage in rats (44). Petroleum ether, ethyl acetate, chloroform and ethanol extract of aerial parts of *Enydrafluctuans*Lour.shows significant decrease in  $\text{CCl}_4$  induced elevation of SGOT, SGPT, alkaline phosphatase and total bilirubin levels in rats. It also shows safety effects against  $\text{CCl}_4$  induced extensive

necrosis and steatosis. The mechanisms of protection include the inhibition of lipid peroxidation and increase in the content of enzymatic defence system. This causes the recuperation of biological parameters and the integrity of the tissue (44,45).

**8. Anti-helmintic activity:**

The anti-helmintic activity of the plant was studied on earthworm species *Pheretimaposthumaby* Kuriet *al.* using the methanolic extraction. Different concentrations of the extract were taken ranging from 10mg/mL to 80mg/mL during the experiment performed by Kuriet *al.* The paralysis time and death time of the earthworm was calculated. The study results were found significant when compared with standard drug Albendazole(46).

**9. Anti-microbial activity:**

Currently resistance to antibiotics has become a major health problem. For new and re-emerging infectious illnesses, there is an ongoing and urgent need to identify new antimicrobial agents with varied chemical structures and unique modes of action(47).Bhakta *et al.* have reported that methanolic extract of *Enydrafluctuans* Lour. possess promising antimicrobial activity mainly against *S. aureus*(48). Moreover, it is also reported that methanolic extract of the plant has moderate anti-bacterial activity against several Gram-negative bacteria such as *Escherichia coli*, *Pseudomonas aeruginosa*, *S. paratyphi*, *Salmonella typhi* and few Gram-positive bacteria such as *Bacillus megaterium* and *Staphylococcus aureus*. The methanolic extract of the plant possesses maximum anti-bacterial activity against *Staphylococcus aureus*. The anti-bacterial activity was determined by agar-well diffusion method and measuring the diameter of the zone of inhibition(49). According to report the plant also possess some anti-fungal activities against *Aspergillusniger*, *Fusarium* sp. and *Aspergillus fumigates*(50). Akheet *al.* extracted bioactive phytochemicals from *Enydrafluctuans* Lour. using HPLC and evaluated their anti-bacterial activity (51).

**10. Thrombolytic activity:**

Thrombolytic agents are used in treating of myocardial infarction, thromboembolic strokes and deep vein thrombosis (52). *Enydrafluctuans*Lour.methanolic extract shows thrombolytic activity. The plant extract may act as plasminogen activator which causes blood clot(53).Kuriet *al.* determined the thrombolytic activity of *Enydrafluctuans*Lour. It has been reported that 10mg/mL of methanolic extract exhibits 31% thrombolytic activity which was compared with standard streptokinase which gives 41% activity.Additionally, it has been shown that the thrombolytic activity of the methanolic extract increases with the increase in the concentration (46).

#### **11. Anti-oxidant activity:**

All extracts of *Enydrafluctuans* Lour. such as chloroform, ethyl acetate, methanol and n-butanol extracts, possess free radicals. They possess anti-oxidant activity as demonstrated by reducing total phenolic content, the DPPH scavenging activity, reducing power, NO-scavenging activity and superoxide scavenging activity (54). The free radical present in the extract, was analyzed by Kuriet *et al.*, using the scavenging activity of the stable DPPH free radical. Among all the extracts, the ethyl acetate fraction was found to have higher antioxidant activity (46,55). Swain *et al.*, proved that there is a direct relation between antioxidant activity and phenolic content of *Enydrafluctuans* Lour. Therefore, the extracts can be used for the prevention and treatment of oxidative stress related disorders such as cancer, vascular disease and rheumatism (56).

#### **12. Anti-diabetic activity:**

Mohammad Nazmulet *et al.* from their experiment suggested that the extract of *Enydrafluctuans* Lour. can produce anti-hyperglycemic and partial anti-hyperlipidemic activities in both diabetes and Cd toxicity conditions (57). Jayashree *et al.* determined the *in-vitro* hypoglycaemic effect of seven culinary plants of North East India, *Enydrafluctuans* Lour. is one of them. From their experiment they found that the plant have potent alpha-amylase and alpha-glucosidase inhibitory activities, therefore they can reduce post-prandial hyperglycaemia (58).

#### **13. Phagocytic and cytotoxic activity:**

Patil *et al.* proved that aqueous extract of *Enydrafluctuans* Lour. has efficient effective results in neutrophil phagocytic function. Different concentrations of the leaf extract were taken for the study of phagocytic effect. The study was carried out by different *in-vitro* methods of phagocytosis. The methods include immunostimulant activity of phagocytosis of killed *Candida albicans*, neutrophil locomotion, chemotaxis and qualitative nitro blue tetrazolium test using human neutrophils (59).

#### **14. Neuroprotective potential:**

New medicinal plants have been tested continuously to identify and use to cure brain injuries resulting from stroke and neurodegenerative diseases. Some of the plants are showing favourable activity in neuro-psychopharmacology and *Enydrafluctuans* Lour. is one of them. Ethyl Acetate, Benzene and Chloroform extract of the plant are being used in different mice models for carrying out the study by Kumar *et al.* The result of the study shows that it possesses a significant central nervous system depressant activity (60).

### **CONCLUSION:**

This review has shed a light on the traditional uses, phytochemicals and pharmacological activities of the *Enydrafluctuans* Lour. It is an easily available plant in nature. It does not need any special condition for cultivation. The plant is widely available throughout many counties like India, Bangladesh, China, Malaysia etc. Traditionally the plant is used to cure many problems such as gastric ulcer, pimples, skin diseases, inflammations any many more. The plant is also well known as food supplement among the tribal people of India and Bangladesh. Because of the presence of many chemical constituents, it is used in different diseases such as diarrhoea, inflammation, cancer, CNS depressants etc. Due to the presence of varieties of phytoconstituents *Enydrafluctuans* Lour. has a wide application in medical science. Nearly about 35 phytochemical constituents have been found and isolated from the plant extract so far. The crude extracts of *Enydrafluctuans* Lour. possesses various activities but all the mechanism behind these activities are not clear, hence further investigation on this plant to explore this activities are the need of the hour. Isolation and structural elucidation of different components from this plant might open new fields of research in therapeutics of several diseases and will help to better and precise understanding of the medicinal properties of the plant.

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### **CONFLICT OF INTEREST:**

The authors have no any conflict of interest.

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