



## PHYTOCHEMISTRY, ETHNOBOTANICAL VALUES & PHARMACOLOGICAL ACTIVITIES OF *Enhydra fluctuans* Lour: A POTENTIAL COMPREHENSIVE REVIEW

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### ABSTRACT:

Medicinal plants are being used worldwide since ancient times and becoming a part of complementary medicine because of their health benefits. Medicinal plants have been successfully used directly for the treatment and prevention of infectious diseases or indirectly by stimulating the immune system. *Enhydra fluctuans* Lour belongs to the family of Asteraceae, an important medicinal plant which is widely available in India especially in North-Eastern region. This plant is a common edible plant with a sound ethno-botanical application in India and South-East Asia. *Enhydra fluctuans* has gained attention in Ayurveda for its pharmacological properties and therapeutic potential. Solvent extract and bio-active phytonutrients of *E. fluctuans* exhibits anti-oxidant, anti-diarrheal, anti-microbial, anti-cancer, neuro protective and other biological activities. The presence of bio-active compounds in *E. fluctuans* such as phenol, alkaloids, flavonoids, saponins, phytosterols, tannins, carbohydrates and essential oils provide strongly contribution to its medicinal properties. This review provides a comprehensive overview on *Enhydra fluctuans* L., with a special highlight to its botanical characteristics, phytochemicals composition, pharmacological activities that will help to predict ways in future investigation for identification of new biologically active compounds and its medicinal role in therapeutic field.

### KEYWORDS:

**ENHYDRA FLUCTUANS, MEDICINAL PLANT, FOLK MEDICINE, BIOACTIVE COMPOUNDS, PHYTOCHEMICALS.**

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### INTRODUCTION

Traditional medicinal systems are rapidly gaining traction as a viable alternative to modern medicine and health research. The importance of herbal plants as a source for medication discovery and development has been recognized widely in recent years. Medical plants have therapeutic capabilities that are highly effective in the treatment of a variety of disorders, and the advantage of these medicinal plants is that they are entirely natural. In emergent nations, 80% of the population relies solely on plants for primary health care. 25% of all prescribed medicines in industrialized countries come from medicinal plants, either directly or indirectly (*Di Pierro et al., 2012*). Medicinal plants possess chemical substances in one or more of its organs that can be utilized for therapeutic purposes or are precursors for the manufacture of valuable pharmaceuticals and exert positive impact to the

human or animal body. A number of plants have been employed in traditional medicine for many years due to their various pharmacological aspects. The medicinal efficacy of these plants resides on secondary metabolites such as alkaloids, flavonoids, tannins, and phenolic compounds. Plant-based drugs were discovered using a multidisciplinary strategy integrating botanical, ethno-botanical, phyto-chemical, and biological approaches. Plants supply us with novel lead compounds to develop medications for diverse therapeutic applications (*Ramkrishna et al., 2011*).

Medicinal plants played a crucial role to treat different diseases since ancient time (*Karimi et al., 2015*). According to World Health Organization (WHO) about 80% people relies on herbal medicines as primary health care *needs* (*Alom et al., 2021*). WHO also reported that

about 21,000 plant species are being used for medicinal purposes in the World (Zhang, 2002). A large diversity of medicinal plants and herbs are found in India and their application in form of Ayurvedic medicinal formula has been started (Veeresham, 2012). Medicinal plants may be defined as a group of plants which contain some bio-active chemical components that elicits pharmacological activities. Traditionally these medicinal plants are used as folk medicine. Folk medicine is an important element of practice in health care system in India (Pal and Shukla, 2002). Folk medicines have natural healing remedies with therapeutic effects such as prevention of cardiovascular disease, inflammation disorder and risk of cancer. In the last decades, medicinal plants have taken considerable interest due to its easy availability in nature, low cost, good nutritional value and fewer side effects (Sarma et al., 2014). Out of several exotic plant species found in Eastern region of India, *Enhydra fluctuans* Lour is a popular medicinal plant with a wide range of therapeutic applications and has been used for several years as traditional medicine (Chakraborty et al., 2012).

*Enhydra fluctuans* Lour, a tropical herb has attracted the attention of researchers and scientists due to its traditional uses and good medicinal properties. *E. fluctuans* is not only found in marshy land of India, Bangladesh and Nepal but also it is found in tropical and sub-tropical region of India. It belong to Asteraceae family for its eye-catching crimson or purple blossoms (Sarma et al., 2014). The leaves of *E. fluctuans* are edible with bitter in taste with a wide range of therapeutic activity (Barua et al., 2021). *E. fluctuans* has been reported to treat various health conditions like digestive disorder, inflammation, wound healing, fever and respiratory ailment (Sarma et al., 2014). The pharmacological activities of *E. fluctuans* are attributed due to its rich phytochemical composition. Different types of bioactive compounds like alkaloids, flavonoids, phenol, steroids, terpinoids and essential oils are present in *E. fluctuans* which strongly contributes to its therapeutic properties such as anti-microbial, anti-oxidant, anti-inflammatory, hepatoprotective, cytotoxic, analgesic, immunomodulatory and anti-cancer effects (Kumar et al., 2023). In this article we summarize the botanical characteristics, phytochemicals composition and numerous biological activities of *Enhydra fluctuans* L. for the health development of mankind.

#### Methods

The study of the literature review was carried out by searching on the electronic databases including PubMed, Science Direct, Research Gate for studies focusing on the biological and pharmacological activities of *Enhydra fluctuans* Lour. The list of references of all the relevant articles was also studied to include all reports and reviews related to the subject

#### Geographical, Morphological and Taxonomical Description of *E. Flactuans*

Generally this species is Indochinese origin which grown in tropical region such as Asia and Africa. It is common to all countries of South-East Asia like Bangladesh, India, Indonesia, Myanmar, Malaysia, Sri Lanka, Thailand and Vietnam (Das et al., 2008). In India, it is widely found in West Bengal, Assam and North-Eastern region and mostly grown between the months of November to January (Bora et al., 2003). According to its different geographical distribution, *E. fluctuans* has several vernacular name like 'Helencha' known as in Bengali, 'Hidimicha' in Oriya, 'Harkuch' in Hindi, 'Helechi' in Assamese and 'Hilamochika' in Sanskrit.

Asteraceae family belongs to the largest family in flowering plant groups. Generally members of this family are shrubs, herbs, vines or rarely trees. Asteraceae is considered as an important family because of their uses in food, ornamental and medicinal purposes (Ghazal, 2019). The taxonomical classification of *E. fluctuans* is described in Table 1. *E. fluctuans*, a trailing marshy herb is commonly found in tropical region. It mainly grows on the marginal line of the fish pond, or in the open rice field or sometimes floating on the water (Ali et al., 2013). It is also grown about 1800meters above the sea level. Stems of *E. fluctuans* are generally 30-60cm long, hollow, fleshy with a purple tint, internodes of 7-10cm long (Ghani, 2003). At younger stage, *E. fluctuans* is very sensitive to cold. Leaves of this plant are sessile, 2.5-2.7cm long, opposite, phyllotaxy, oblong to linear in shapewith acute apex and distinctly dentate margin or sub crenate. Flower heads of this plant are terminal and sessile; whereas flowers are greenish white to white. The outer pair of the involucre bracts is ovate and 1- 1.2cm long; whereas inner pair is comparatively smaller. Fruits of *E. fluctuans* are enclosed within a hard receptacle scale. The roots of the *E. fluctuans* are seen on the lower nodes, but Pappus is absent. Its multiplication by fragmentation occurs abundantly in clogs water courses (Ali et al., 2013).

**TABLE 1: TAXONOMICAL CLASSIFICATION OF *E. FLUCTUANS* LOUR**

<b>Kingdom</b>	Plantae
<b>Phylum</b>	Magnoliophyta
<b>Class</b>	Magnoliopsida
<b>Order</b>	Asterales
<b>Family</b>	Asteraceae
<b>Genus</b>	Enhydra
<b>Species</b>	fluctuans Lour
<b>Binomial Name</b>	<i>Enhydra fluctuans</i> Loureiro

### Ethno-botanical Values of *E. Flactuans*

Tribal people in West Bengal, Bangladesh and North-East region use *E. fluctuans* as food supplements. In India, Shan tribal community of Majuli and Darrang district of Assam consider this plant as a wild type food supplement (Pandey et al., 1997). People of North-East India use this plant for the treatment of constipation. Stems of these plants are used for the treatment of gastritis and ulcer treatment (Kona and Rahman, 2016). Rural people uses finely crushed aerial parts of this plant to prevent pimples (Sarma et al., 2014). The Meitei-pangal community of Manipur uses the plant extract of *E. fluctuans* for medication of diabetes (Khan et al., 2010). *E. fluctuans* is also used to cure several skin diseases, inflammation and small pox diseases (Ghani, 2003). Leaves of this plant are anti-bilious and leaf juice is used as demulcent in gonorrhoea (Sharma et al., 2020). Tribal people of Meghalaya intake leaf juices of *E. fluctuans* for the treatment of liver diseases (Dolui et al., 2014).

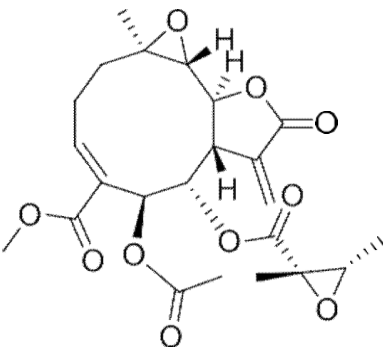
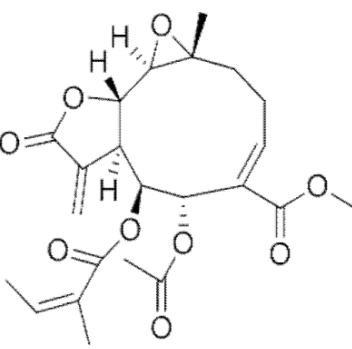
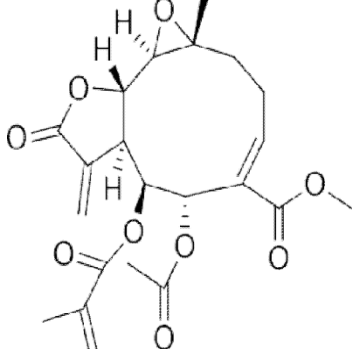
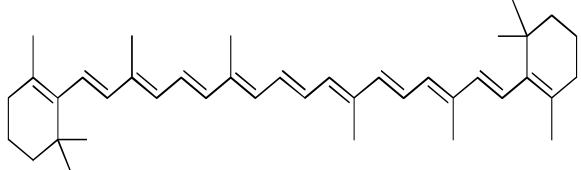
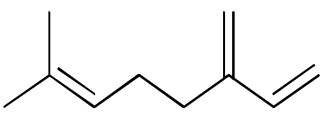
### Bio-chemical Constituents of *E. Flactuans*

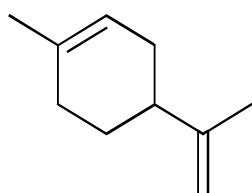
*Enhydra fluctuans* Lour shows the presence of myrcene, limonene and other components. The essential oil of this plant includes  $\alpha$ -Pinene, 1-Octen-3-ol,  $\epsilon$ - $\beta$ -Ocimene, Linalool, Perillaldehyde,  $\epsilon$ - *Enhydra fluctuans* Lour itself enriched with phytochemicals. Presence of different types of phytochemicals makes the plant traditionally as well as medicinally beneficial (Bayala et al., 2014). In medicinal plant, mainly phytochemical present in stem and leaves. *E. fluctuans* contains various phytoconstituents with high level such as flavonoids, terpenoids, glycosides, essential

oils and moderate level of alkaloids, tannins, phenolics and carbohydrates (Dewanji et al., 1993). *E. fluctuans* is a very good source of  $\beta$ -carotene, protein, myricil, alcohol or triacontanol, saponins; phytosterols like cholesterol, sitosterol, stigmata-5,22,25-triene-3 $\beta$ -ol, stigmasterol, glucosides; a number of diterpenoid acids and their isovalerate and angelate derivatives; sesquiterpene lactones including germacranolides like enhydrin, fluctuanin, fluctuanidin, several kaurene derivatives, 4-hydroxy farnesyl acetate and gibberelins (Dutta, 2013; Joshi et al., 1972). Chemical structures of some biologically important phytochemicals present in *E. fluctuans* are summarized in Table 2.

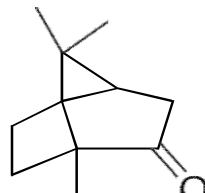
Researchers reported that leaf oil of *E. fluctuans* contains Caryophyllene,  $\alpha$ -Humulene, Camphor, cis-1, 2-dihydroperillaldehyde and Longiverbenone (Muselli et al., 2000). 4',5,6,7-tetrahydroxy-8-methoxyisoflavone-7-O- $\beta$ -D-galactopyranosyl-(1 $\rightarrow$ 3)-O- $\beta$ -D-xylopyranosyl-(1 $\rightarrow$ 4)-O- $\alpha$ -l-rhamnopyranoside is considered as novel bioactive components was reported from methanolic extract of *E. fluctuans* (Yadava et al., 2007). It was reported that methanolic extract of *E. fluctuans* extract contains two flavonoids i.e. Baicalein 7-O-glucoside and Baicalein 7-O-diglucoside. Several studies reported that pure compounds of *E. fluctuans* elicits significant pharmacological activities in different systems which infer its various biomedical properties (Barua et al., 2021). Pharmacological activities of different biomolecules isolated from *E. fluctuans* have been listed in Table 3.

**TABLE 2: CHEMICAL STRUCTURE OF SOME BIOLOGICALLY IMPORTANT PHYTOCHEMICALS PRESENT IN *E. FLUCTUANS* L.**

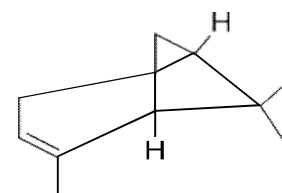
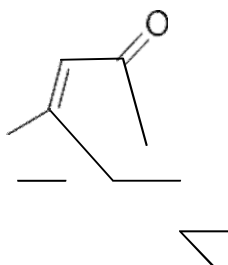
 <p style="text-align: center;">Enhydrin</p>	 <p style="text-align: center;">Fluctanin</p>	 <p style="text-align: center;">Fluctanidin</p>
 <p style="text-align: center;"><math>\beta</math>-carotene</p>	 <p style="text-align: center;">Myrcene</p>	



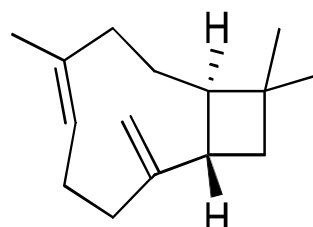
Limonene



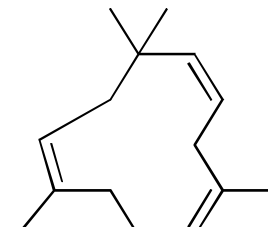
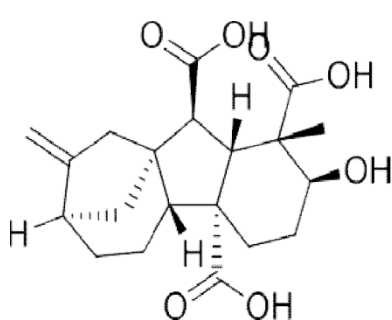
Camphor

 $\alpha$ -Pinene

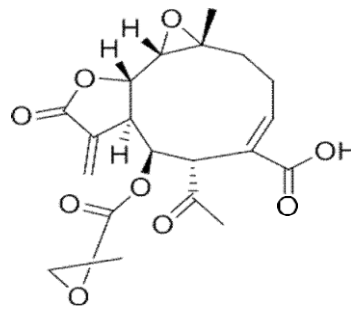
Longiverbenone



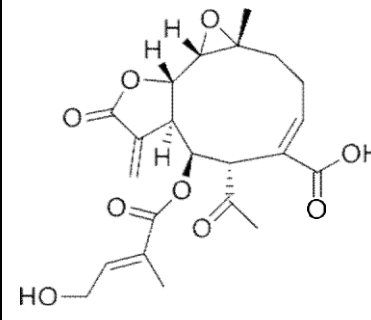
(E)-Caryophyllene

 $\alpha$ -Humulene

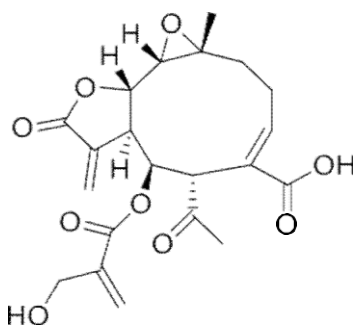
GibberellinA13



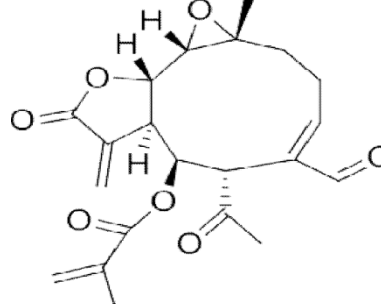
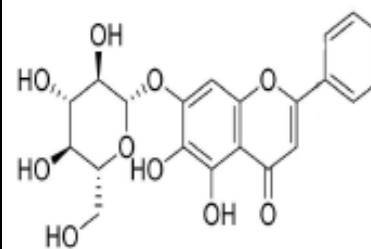
8-Desacylenhydrin-[2,3-epoxyisobutyrate]



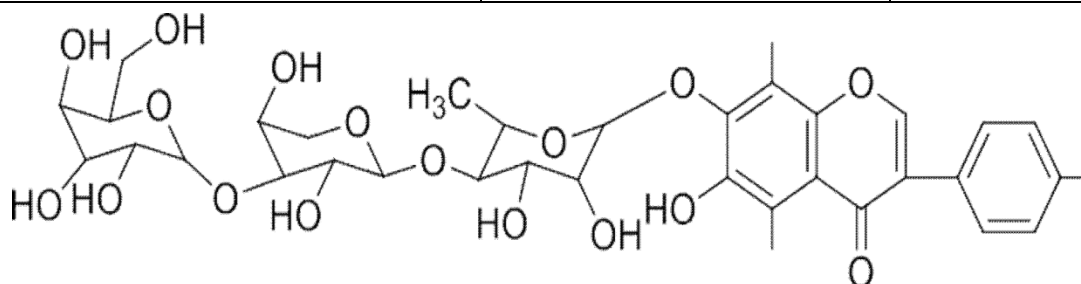
8-Desacylenhydrin-[4-hydroxytiglate]



8-Desacylenhydrin-[4-hydroxymethacrylate]

8- $\beta$ -Methacryloyloxy-9- $\alpha$ -acetoxy-14oxo-acanthospermolid

Baicelain 7-O-glucoside

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

**TABLE 3: PHARMACOLOGICAL ACTIVITIES OF SEVERAL BIOMOLECULES ISOLATED FROM *E. FLUCTUANS* L.**

Name of the biomolecules	Class of phytochemicals	Biological activities	Concern Reference
Saponins	Terpinoids	<ul style="list-style-type: none"> <li>✓ Inhibition of tumor angiogenesis.</li> <li>✓ Inhibition of invasion and metastasis of tumor cells.</li> </ul>	Rahman et al., 2000
baicalein 7- O-glucoside and baicalein 7- O-diglucoside	Flavonoids	<ul style="list-style-type: none"> <li>✓ Inhibits cell proliferation.</li> <li>✓ Exhibits cytotoxic effect on leukemia cells and triggers mitochondria mediated apoptosis.</li> </ul>	Bhakta et al., 2009
$\beta$ - Carotene	Isoterpene	<ul style="list-style-type: none"> <li>✓ Provitamin A activity.</li> <li>✓ Lipid oxide and lipid peroxide radical scavenging activity.</li> <li>✓ Singlet oxygen quencher.</li> </ul>	Saha and Paul, 2019
Enhydrin, Fluctuanin and Fluctuanidin	Sesquiterpene	<ul style="list-style-type: none"> <li>✓ Anti-cancer activity by inhibiting inflammatory response.</li> <li>✓ Prevention of metastasis and induction of apoptosis.</li> </ul>	Uddin et al., 2005
Myrcene	Monoterpene	<ul style="list-style-type: none"> <li>✓ Decreases the production of Reactive Oxygen Species (ROS), Matrix metalloproteinase-1 and 3, and increased transforming growth factor-6 and type I procollagen secretion in UVB irradiated human dermal fibroblast.</li> </ul>	Dua et al., 2015
Sitosterol	Phytosteroid	<ul style="list-style-type: none"> <li>✓ Induces apoptosis of cultured human prostate, breast and colon cancer cells.</li> </ul>	Amin et al., 2012
Stigmasterol	Steroid	<ul style="list-style-type: none"> <li>✓ Cytotoxic activity.</li> <li>✓ Inhibits tumor promotion.</li> <li>✓ Enhances activities of catalase, superoxide dismutase and glutathione dependent enzymes.</li> <li>✓ Anti- mutagenic effects.</li> </ul>	Roy et al., 2011
$\alpha$ -l-Araf and $\beta$ -d-Galp	Carbohydrate polymer	<ul style="list-style-type: none"> <li>✓ Anti-oxidant property.</li> </ul>	Ghosh et al., 2013
<i>Limonene</i>	Monoterpene, volatile oil	<ul style="list-style-type: none"> <li>✓ Decreases cyclin D1 expression and several other changes in metabolic pathways.</li> </ul>	Swaine et al., 2012

### Pharmacological Activities of *E. fluctuans*

#### Phagocytic and cytotoxic activity

*Enhydra fluctuans* may have the ability to enhance the activity of immune cells; particularly phagocytes which play a crucial role in eliminating and engulfing foreign pathogens. Aqueous extract of *E. fluctuans* has efficient *in-vitro* effective results in neutrophil phagocyte function (Patil et al., 2008).

#### Anti-oxidant activity

Crude methanolic extract of *Enhydra fluctuans* as well as chloroform, ethyl acetate and n- butanol extracts possess free radicals scavenging activity by reducing total phenolic

content, DPPH scavenging activity, reducing power, nitric oxide (NO) scavenging activity and superoxide radical scavenging activity (Panigrahi and Bhatnagar, 2015). Flavonoids of *E. fluctuans* including apigenin, luteolin, kaempferol, and quercetin have been reported to exhibit potent antioxidant activity by scavenging free radicals and inhibiting lipid peroxidation; that finally protect cells from oxidative damage (Sharma et al., 2020). As there is a direct relation between antioxidant activity and phenolic content of *E. fluctuans* so this plant extracts can be used for the prevention and treatment of oxidative stress related disorders such as cancer, vascular disease and rheumatism (Swain et al., 2012).

### Anti-diabetic activity

In Ayurvedic medicine *Enhydra fluctuans* is traditionally used for various ailments including diabetes. Studies revealed that blood glucose level was significantly reduced after application of *E. fluctuans* plant extract (**Shojaii et al., 2015**). *E. fluctuans* can reduce the post-prandial hyperglycemia due to its potent *alpha-amylase* and *alpha-glucosidase* inhibitory activities (**Dutta et al., 2016**).

### Anti-microbial activity

Methanolic extract of *Enhydra fluctuans* showed moderate anti-bacterial activity against several Gram negative bacteria like *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Salmonella paratyphi* and few Gram positive bacteria like *Bacillus megaterium* and *Staphylococcus aureus* (**Ullah et al., 2013**). Report from experiments reveals that methanolic extract of *E. fluctuans* possess maximum anti-bacterial activity against *Staphylococcus aureus* followed by *Escherichia coli* and *Pseudomonas aeruginosa* (**Bhakta et al., 2009**).

Methanolic extract of this plant also possess some anti-fungal activities against *Aspergillusniger*, *Fusarium sp.* and *Aspergillus fumigates* (**Amin et al., 2012**).

### Anti-inflammatory activity

Flavonoids of *Enhydra fluctuans* are reported to have anti-inflammatory activity by inhibiting COX-2 and 5-LOX with an IC<sub>50</sub> value of 80µg/mL and 92µg/mL respectively. Studies shows that flavonoids isolated from this plant extract have potent anti-inflammatory activity against carrageen and histamine-induced acute inflammation. *E. fluctuans* possesses significant *in-vivo* anti-inflammatory activity in carrageen and histamine induced rat paw edema and cotton pallet induced granuloma in rats (**Satyajit, 2012**). The extracts of *E. fluctuans* have been found to inhibit the migration of leukocytes (WBCs) to the inflamed site. This effect helps to reduce the infiltration of inflammatory cells into the inflamed tissues which ultimately leads to decrease the inflammatory response (**Saha and Paul, 2019**).

### Anti-cancer activity

*Enhydra fluctuans* has been investigated for anti-cancer activity due to its high rich source of phytochemicals. Although research on this area is limited but still some studies have established its potential source of bioactive compounds with anti-cancer properties (**Patel et al., 2017**). Presence of two flavonoids i.e., baicalein 7-O-glucoside and baicalein 7-O- diglucoside in *E. fluctuans* is responsible for its anti-oxidant activity. Reactive oxygen species are one of the causative agents of mutation, increased DNA damaged and cellular dysfunction (**Pryor, 1997**). *E. fluctuans* shows anti- cancer activity against Ehrlich's ascites carcinoma (EAC) bearing Swiss albino mice by significantly decreasing the volume of tumor cell and increases the life span of mice (**Patralekh and Mukherjee., 2010**).

### Anti-diarrheal and anti-helmintic activity

Methanolic and aqueous extract of *Enhydra fluctuans* exhibits significant result against castor oil induced diarrhea in mice. Oral methanol and aqueous extract administration at a dose of 250mg/kg body weight also exhibit the same result with an inhibition rate of 41.18% for aqueous extract and 67.07% for methanol extracts for compared to loperamide (**Uddin et al., 2005; Sannigrahi et al., 2010**). The methanolic extract of the *E. fluctuans* also showed anti- helminthic activity on earthworm species *Pheretima posthuma* with different concentration from 10mg/mL to 80mg/mL. The paralysis time and prognostic death time of the earthworm was found significant as compared to Albendazole, a standard drug (**Kuri et al., 2014**).

### Thrombolytic and analgesic activity

10mg/mL of methanolic extract of *Enhydra fluactuans* exhibits 31% thrombolytic activity as compared to standard *Streptokinase* which gives 41% activity (**Kuri et al., 2014**). This extract acts as a plasminogen activator which causes blood coagulation (**Lijnen and Collen, 1995**). Methanolic extract of *E. fluctuans* shows promising analgesic activity against acetic acid induced writhing and tail-flick method (**Saha and Paul., 2012**).The total flavonoids of *E. fluctuans* is responsible for 27.05% and 55.49% protection against 200mg/kg body weight and 400mg/kg body weight oral administration of acetic acid induced writhing response in Swiss albino mice (**Rahman et al., 2002**).

### Cytoprotective activity

Aqueous extract of *Enhydra fluctuans* exhibits cytoprotective and defensive role against heavy metal (lead acetate) induced toxicity by increasing cell viability in hepatocytes. Aqueous extract of this plant also protect NaAsO<sub>2</sub> induced cytotoxic effects in hepatocytes by altering lipid peroxidation, protein carboxylation, levels of extrinsic and intrinsic transcription proteins and glutathione levels. Aqueous extract of this plant posse's *in vivo* cytoprotective activity against bioaccumulation of arsenic as well as arsenic-induced abnormal hematological constraints and redox discrepancy in liver of mice (**Dua et al., 2016**). Studies reported that CdCl<sub>2</sub> induced reduction in cell viability can also be significantly altered by treatment of aqueous extract of *E. fluctuans*. It is already established that aqueous extract of *E. fluctuans* have remarkable counter reactions against *in vivo* Cadmium bioaccumulation and oxidative stress in liver, kidney, heart, brain and testis of mice (**Dua et al., 2015**).

### Hepatoprotective activity

Phytochemicals present in different solvent extract of *E. fluctuans* exhibits hepatoprotective activity. Petroleum ether, chloroform, ethyl acetate and ethanol extract of aerial parts of *E. fluctuans* significantly decreases CCl<sub>4</sub> induced elevation of SGOT, SGPT, alkaline phosphatase and total billurubin levels in rats (**Swain et al., 2012**).This plant also shows safety effects against CCl<sub>4</sub> induced extensive necrosis and steatosis. The protective mechanism of *E. fluctuans* is achieved by inhibition of lipid

peroxidation and improvement of enzymatic defense system (*Sannigrahi and Majumdar, 2010*).

### Neuroprotective and Central Nervous System (CNS) depressant activity

Now-a-days, identification and characterization of new medicinal plants to cure neurodegenerative diseases and brain injuries due to stroke is very interesting field in current scientific research. *Enhydra fluctuans* is one of them which have promising activity in neuro-psychopharmacology. Benzene, Chloroform and ethyl acetate extract of *E. fluctuans* possess a significant central nervous system (CNS) depressant in experimental mice (*Kumar and Khanum, 2012*). Studies also reveal that extract of *E. fluctuans* significantly possesses spontaneous motility sedative, depressant, anti-convulsing and anti-stress activities in Swiss Albino mice (*Roy et al, 2011*).

### Conclusion

Traditional uses, biologically active phytonutrients and pharmacological activities of *Enhydra fluctuans* have been carefully considered in this review article. *E. fluctuans* is easily available in nature and need not require any special condition for cultivation. It is widely available in India, Bangladesh, China, Malaysia and many other countries. The Ayurvedic formulas of *E. fluctuans* are traditionally used to cure gastric ulcer, skin diseases, pimples and many more. Several studies shows that different solvent extract of *E. fluctuans* and some bioactive compounds exhibits anti-microbial, anti-oxidant, anti-cancer, anti-inflammatory, analgesic, thrombolytic, cytotoxic, CNS

depressant activities. Due to the presence of various bioactive phytoconstituents, *E. fluctuans* has a wide application in medical science. Nearly about 35 bioactive phytoconstituents have been isolated from *E. fluctuans* and reported so far. The crude extract of *E. fluctuans* possesses various biological activities but all the mechanism behind these activities is not clear. Hence further mechanistic investigation on biological activities of *E. fluctuans* is highly required in current science trend for its pharmaceutical application. *E. fluctuans* also exhibits anti-cancer activity against few carcinoma like Ehrlich's ascites carcinoma and lungs carcinoma. So, further investigation on anti-cancer activity of *E. fluctuans* needs to be explored near future to combat with cancer. Isolation and characterization of new bioactive compounds from *E. fluctuans* along with clinical trials will highlight and explore new fields of research in therapeutics of several diseases. In summary, *E. fluctuans* has been thoroughly explored in terms of taxonomy, ethnobotany, phytochemistry, biological activity and future implications related with conservation and clinical trials. However, new discoveries may improve *E. fluctuans's* current medicinal value and promote its future usage in modern medicine.

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### Conflict of Interest

The authors declare that there are no conflicts of interest.

Abbreviations:	
CNS	: Central nervous system
COX	: Cyclooxygenase
<i>E. fluctuans</i>	: <i>Enhydra fluctuans</i>
EAC	: Ehrlich's ascites carcinoma
IC	: Inhibitory concentration
LOX	: Lysyloxidase
NaAsO <sub>2</sub>	: Sodium Arsenite
NO	: Nitric Oxide
ROS	: Reactive oxygen species
SGOT	: Serum glutamic oxaloacetic transaminase
SGPT	: Serum glutamic pyruvic transaminase
WHO	: World health organization

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