

ENHYDRA FLUCTUANS: A REVIEW ON ITS PHARMACOLOGICAL IMPORTANCE AS A MEDICINAL PLANT AND PREVALENCE AND USE IN NORTH-EAST INDIA.

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ABSTRACT

Medicinal plants have played an important role since ancient times in treating various kinds of diseases. Increased drug resistance and side effects of pharmaceutical drugs have led to more research based study on traditionally available plants. *Enhydra fluctuans* is one such plant which is available abundantly in India especially in the North-Eastern states. It has immense potential as a medicinal plant and also has many beneficial effects such as anticancer, antioxidant, antidiabetic, anti-inflammatory, antimicrobial, anti-diarrheal, hepatoprotective and even neuropharmacological effects. These activities can be attributed mainly to the presence of phytochemicals such as flavonoids, alkaloids, saponins, tannins, phenols and carbohydrates. The aim of this paper is to summarize the importance of this plant possessing potent medicinal value and the research work being carried out till now.

Keywords: *Enhydra fluctuans*, Ethnopharmacology, Phytochemicals, Biological activity, North-East India

INTRODUCTION

Medicinal plants may be defined as a group of plants that contain some active medicinal components and special properties or virtues that qualify them as articles of drugs and therapeutic agents and are used for medicinal purposes. Use of plants as a source of medicine has been an ancient practice and is an important component of the health care system in India. In India, many forms of alternative medicines are available for those who do not want conventional medicine or who cannot be helped by conventional medicine. In the last decade, there has been considerable interest in resurrecting medicinal plants in western medicine, and integrating their use into modern medical systems. The reasons include low cost, nutritional value, drug resistance, less side effects, easy availability, economical value to name a few. Ayurvedic form of medicine is believed to be existent in India for thousands of years. It employs various techniques to provide healing or relief to the ailing patients. Ayurveda primarily uses medications of plant origin. North-East states of India are one of the richest repositories of medicinal and aromatic plants in the world. It has a variety of tropical forests, especially the species-rich tropical rain forests. This region is also considered as an important part of the Indo-Myanmar biodiversity hotspot, one of the 25 global biodiversity hotspots acknowledged currently [1]. Out of the many exotic species of plants found in and around the eastern region of India, *Enhydra fluctuans* is one such plant with a wide range of therapeutic applications and has been used for years as traditional medicine in remote areas of this region. Very less importance has been given to its prevalence in the north eastern region of India specifically and its common use amongst the rural population. It is mainly used for its analgesic, anticancer, antioxidant, antimicrobial, anti-diarrheal, hepatoprotective and even neuropharmacological effects.

Classification

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Asterales
Family: Asteraceae
Genus: *Enhydra*
Species: *fluctuans* Lour.

Vernacular names

English: Marsh herb, Water cress
Sanskrit: Hilamochika
Hindi: Harkuch

Assamese: Helechi
Bengali: Helencha
Oriya: Hidimicha

Synonyms

Enhydra angallis Gardner
Meyera fluctuans (Lour) Spreng

Botanical description

Commonly known as Water Cress or Marsh Herb, it is a trailing marsh herb growing annually, also floating on water; stem 30-60 cm long, rooting at the nodes. Leaves are sessile, 2.5-7.5cm in length, linear to oblong, acute or obtuse, and stalk-less and margins are distinctly dented. Flowers are white to greenish white in colour. Stems are fleshy, hairy and branched, 30 centimetres or more in length. Rooting can be seen at the lower nodes. The fruits are achenes enclosed by rigid receptacle-scales. Pappus is absent.



Fig. 1: Whole plant of *Enhydra fluctuans* Lour. (Taken from Zhao ju, Medicinal plant database, <http://stuartxchange.com/Kangkong-kalabau.html>) [36]

Geographical prevalence

Enhydra fluctuans is a hydrophytic plant and mostly found on wet roadside canals and marshy waste places between the months of November to January. It is highly prevalent in Bangladesh, Malaysia,

China and the rest of South East Asia and Tropical Africa [2]. In India this plant is predominantly found in the North-Eastern region and mostly in Assam [1]. The plant is commonly found in the diverse flora of Cachar and Barak Valley region of the state [3, 4]. A study also reported its common prevalence in other districts of Assam such as Golaghat, Karbi Anglong, Lakhimpur, Dibrugarh and Jorhat [5]. In Dhemaji district and Majuli island of Assam also this plant is abundantly found [6]. In Thoubal district of Manipur, *Enhydra fluctuans* is a common plant used for treating a range of diseases. Jaintia hills in Meghalaya and Agartala in Tripura is also considered to be a zone rich in this plant source [7, 8, 9]

Ethnopharmacology

In Cachar district of Assam, the stem of the plant is used in gastric and ulcers and the whole plant is used in the treatment of constipation [4]. *Enhydra fluctuans* is also considered as a wild edible food plant by the Shan tribe of Assam. The Shan tribe of Assam is a Sino-tibetan race of Mongoloid stock whose ancestors migrated from South-west China. A study was carried out in the districts of Golaghat, Karbi-anglong, Lakhimpur, Dibrugarh and Jorhat of Assam wherein *Enhydra fluctuans* was found to be a supplementary food source and young shoots used as cooked vegetables [5]. The plant locally called as *Helechi*, is also considered as a folk medicine by certain population of Dibrugarh district where the aerial part of the plant are crushed finely and applied over pimples. In Thoubal district of Manipur, this plant known as Komprek tujombi locally is used by the Meitei-pangal community for treatment of diabetes. They prescribe the extract obtained by boiling the plant cut into pieces at the nodes [9]. The whole plant is also used by Muslim herbalists of this region in treating kidney stones by drinking the liquid of boiled leaves mixed with sugar in a prescribed ratio [10]. In Meghalaya, the Jaintia tribe locally call it as Kynbat hingcha and use the leaf juice in skin diseases and as laxative, and orally prescribe it in liver diseases [7, 8]. *Enhydra fluctuans* is also considered as a wild edible plant in Majuli and Darrang district of Assam [11]. Studies have also been carried out on the phagocytic properties of this plant extract from samples collected from Agartala in Tripura as well [6].

Phytochemicals

Different extracts of *Enhydra fluctuans* have been tested for the presence or absence of primary and secondary bioactive compounds like carbohydrates, proteins, oils, alkaloids, flavonoids to name a few. It has been found to be a rich source of flavonoids [12] and moderate presence of alkaloids, tannins, phenolics and carbohydrates have been reported. The plant is also a rich source of β -carotene [13, 14] and was also found to be high on protein content [15]. Presence of saponin too has been stated [16, 17]. A novel bioactive isoflavone glycoside 4',5,6,7-tetrahydroxy-8-methoxyisoflavone-7-O- β -D galactopyranosyl-(1 \rightarrow 3)-O- β -D-xylopyranosyl-(1 \rightarrow 4)-O- α -l-rhamnopyranoside has been reported from the methanolic extract of the leaves of *Enhydra fluctuans* Lour [18]. Also the aqueous extract of revealed the stimulation of a biological response of the carbohydrate polymer of the plant [19]. Based on spectral and chemical evidence the structure of Enhydrin, a germacranolide has been isolated from the leaves and stems of *Enhydra fluctuans* [20]. The structure and stereochemistry of sesquiterpene lactones were elucidated from *Enhydra fluctuans* by NMR techniques and chemical reactions [21].

Biological activity

Antidiabetic uses & Antimicrobial activity

A study carried out by the Meitei-pangal community of the Thoubal district of Manipur states that *Enhydra fluctuans* extract can be effectively used as an antidiabetic plant by boiling and cutting it at the nodes [9]. It was also found that the tribal practitioners of the Marakh sect of the Garo tribe living in Mymensingh of Bangladesh uses twelve medicinal plants for treatment of diabetes out of which *Enhydra fluctuans* is one of them [22]. *Enhydra fluctuans* has been found to have potent antibacterial activity against many gram positive as well as gram negative organisms. Some of them are *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus typhi*,

Staphylococcus aureus, *Shigella boydii*, *Bacillus subtilis* [23, 24]. The plant has also been found to be possessing significant antifungal activities against selected fungi like *Aspergillus niger*, *Fusarium* spp. and *Aspergillus fumigatus* [25].

Anti-inflammatory activity

The flavonoid isolated from leaves of *Enhydra fluctuans* shows anti-inflammatory activity by inhibiting COX-2 and 5-LOX. Moreover, flavonoid isolated from leaves of *Enhydra fluctuans* exhibits *in vitro* on key enzymes of arachidonic acid cascade involved in the mediation of inflammation. Based on it, *in vivo* anti-inflammatory

activity of flavonoid fraction was evaluated by using carrageenan induced paw oedema and cotton pellet induced granuloma. It significantly reduced the inflammation in such cases [12].

Anti-oxidant activity

The antioxidant potential of crude methanol extract of as well as chloroform, ethyl acetate and n-butanol soluble fractions of *Enhydra fluctuans* Lour., which is widely used in indigenous system of medicine for different purposes were studied. The crude extract and all the fractions showed free radical scavenging activity when tested in different models. Among all the fractions, the ethyl acetate fractions exhibited the highest free radical scavenging activity in all the tested models comparing to crude extract and n-butanol fraction [17, 26, 27].

Anti-cancer activity

Flavonoids obtained from *Enhydra fluctuans* (FEF) were screened for anticancer activity against Ehrlich's ascites carcinoma (EAC) bearing Swiss albino mice. Two flavonoids, baicalein 7-O-glucoside and baicalein 7-O-diglucoside, were isolated from the ethyl acetate fraction. Treatment with FEF caused a significant decrease in the tumour cell volume and increase of life span [14, 28].

Anti-diarrhoeal activity

The methanolic and aqueous extract was evaluated in experimental diarrhoea, induced by castor oil in mice. Both methanolic and aqueous extracts, given orally at a dose of 250mg/kg body weight showed significant anti-diarrhoeal activity. Results indicated strong anti-diarrhoeal activity of *Enhydra fluctuans* [29].

Hepatoprotective activity

The flavonoid rich ethyl acetate fraction of *E. fluctuans* has significant hepatoprotective effects. The possible mechanisms of protection include the inhibition of lipid peroxidation and increase in the content of enzymatic defense system, which cause the recuperation of biological parameters and the integrity of the tissue [30, 31].

Analgesic activity

The methanol extract of *Enhydra fluctuans*, given orally at the dose of 250 and 500 mg/kg, was evaluated for its analgesic activity using the acetic acid induced writhing and the tail-flick methods. The extract showed promising activity in both tests [32, 33].

Neuroprotective potential

Identification and characterization of new medicinal plants to cure neurodegenerative diseases and brain injuries resulting from stroke is the major and increasing scientific interest in recent years. The Indian system of medicine out of the numerous medicinal plants showing promising activity in neuro-psychopharmacology *Enhydra fluctuans* is one of them [34]. Some neuro-pharmacological effects of three fractions (Benzene, Chloroform and Ethyl Acetate) of methanolic extract of *Enhydra fluctuans* were studied in mice using various models. The study concludes that different fractions of *Enhydra fluctuans* aerial parts possess central nervous system depressant activity [35].

Phagocytic and cytotoxic activity

The aqueous extract of this plant have showed effective results on neutrophil phagocytic function. Different concentrations of the leaf

extract were subjected to study its effect on different in-vitro methods of phagocytosis such as neutrophil locomotion, chemotaxis, immunostimulant activity of phagocytosis of killed *Candida albicans* and qualitative nitro blue tetrazolium test using human neutrophils [6].

DISCUSSION

Northeast India is the eastern-most region of India connected to East India via a narrow corridor squeezed between Nepal and Bangladesh. The region can be physio- graphically categorized into the Eastern Himalayas, Northeast Hills and the Brahmaputra and the Barak Valley Plains. This region has a predominantly humid sub-

tropical climate with hot, humid summers, severe monsoons and mild winters. It has always been regarded as an ethnic storehouse of a variety of unexplored medicinal plants. It harbours nearly 50 percent of India's total flora. *Enhydra fluctuans* is one such plant found predominantly in this region. With its wide range of biological activity and traditional uses as medicines, this hydrophytic plant is considered to be a potent tool for treating a number of diseases. The compilation of this data clearly indicates that *Enhydra fluctuans* has abundant applications in treating life threatening diseases like diabetes, cancer, liver problems and even has strong antioxidant, analgesic, anti-inflammatory, anti-diarrhoeal and antimicrobial activity. The role of certain compounds present in the plant, responsible for all its biological activities has been reported. For a better and precise understanding of the medicinal potentials of this plant, further research needs to be done on elucidating the exact structure of all the active compounds present and their mode of action. Development of agricultural based technique for their large-scale cultivation may also prove to be advantageous.

REFERENCES

- Chakraborty R, De R, Devanna N, Sen S. North East India an ethnic Storehouse of Unexplored Medicinal Plants. *J Nat Prod Plant Resour* 2012; 2(1):143-152.
- Bora P, Kumar Y. Floristic diversity of Assam. Study of Pabitora Wildlife Sanctuary. Daya Publishing House; 2002.
- Barbhuiya AR, Sharma GD, Arunachalam A, Deb S. Diversity and Conservation of Medicinal Plants in Barak Valley, North East India. *Indian Journal Of Traditional Knowledge* 2009; 8(2):169-175.
- Das AK, Dutta BK, Sharma GD. Medicinal Plants Used by different tribes of Cachar District, Assam. *Indian Journal Of Traditional Knowledge* 2008; 7(3):446-454.
- Pandey AK, Bora HR. Edible plants of Shan Tribe of Assam. *Ancient Science of Life* 1997; XVI(4): 258-276.
- Patil KS, Majumdar P, Wadekar RR. Effect of *Enhydra fluctuans* Lour leaf extract on phagocytosis by human neutrophils. *Journal Of Natural Remedies* 2008; 8(1):76-81.
- Jaiswal V. Culture and ethnobotany of Jaintia tribal community of Meghalaya North East India- A mini review. *Indian Journal of Traditional Knowledge* 2010; 9(1):38-44.
- Dolui AK, Sharma HK, Marein TB, Lalhriatpuii TC. Folk herbal remedies from Meghalaya. *Indian Journal Of Traditional Knowledge* 2004; 3(4):358-364.
- Khan, H Mohd, Yadava PS. Antidiabetic plants used in Thoubal District of Manipur, *Indian Journal Of Traditional Knowledge* 2010; 9(3):510-514
- Arunachal Pradesh possible GI Resources.
- Barua U, Hore DK, Sarma R. Wild edible plants of Majuli Island and Darrang Districts of Assam. *Indian Journal of Traditional Knowledge* 2007; 6(1):191-194.
- Satyajit, Pradhan D. Natural flavonoids isolated from the leaves of *Enhydra fluctuans* inhibits cyclooxygenase-2 and 5-lipoxygenase inflammation in various models. *International Journal of Research in Pharmacology and Pharmacotherapeutics* 2012; 1(1): 2278-2648.
- Dewanji A, Matai S, Barik S, Nag A. Chemical compositions of two semi-aquatic plants for food use. *Plant foods for human nutrition* 1993; 44:11-16.
- Yellowdawn TH The Sun, Human, Food: A Self Treatment and Practice with Natural Food. Herbs and Spices. 2nd Edition. USA: Author House; 2011:97-125
- Hazra H, Alfasane MA, Khondker M. Biochemical composition of some selected aquatic macrophytes. Bangladesh: Lambert Academic Publishing; 2012
- Dutta J. Phytochemicals analysis and TLC fingerprinting of methanolic extracts of three medicinal plants. *International Research Journal of Pharmacy* 2013; 4(6):123-126
- Sanigrahi S, Mazudar UK, Pal DK, Parida S, Jain S. Antioxidants potential of crude extract and different fractions of *Enhydra fluctuans* Lour. *Iranian Journal of Pharmaceutical Research* 2010; 9(1):75-82.
- Yadava RN, Singh SK. Novel bioactive constituents from *Enhydra fluctuans*. *Natural Product Research* 2007; 21(6):481-486.
- Ghosh D, Ray S, Ghosh K, Micard V, Chatterjee UR, Ghosal PK et al. Antioxidative carbohydrate polymer from *Enhydra fluctuans* and its interaction with bovine serum albumin. *Biomacromolecules*; 14(6):1761-1768.
- Joshi VS, Kamat VN. Structure of Enhydrin, a Germacranolide from *Enhydra fluctuans* Lour. *Indian Journal of Chemistry*; 10:771-776.
- Krishnaswamy NR, Ramji N Sesquiterpenes lactones from *Enhydra fluctuans*. *Phytochemistry* 1995; 38(2):433-435.
- Rahmatullah M, Azam NK, Khatun Z, Seraj S, Islam F, Rahman A et al. Medicinal plants used for the treatment of diabetes by the Marakh sect of the Garo tribe living in Mymensingh District, Bangladesh. *Afr J Tradit Complement Altern Med* 2012; 9(3):380-385.
- Ullah MO, Haque M, Urmi KF, Zulfiker AHM, Anita ES, Begum M et al. Anti-bacterial activity and brine shrimp lethality bioassay of methanolic extracts of fourteen different edible vegetables from Bangladesh. *Asian Pacific Journal of Tropical Biomedicine* 2013; 3(1):1-7.
- Bhakta J, Majumdar P, Munekage Y. Antimicrobial efficacies of methanol extract of *Asteracantha longifolia*, *Ipomoea aquatica* and *Enhydra fluctuans* against *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Micrococcus luteus*. *The Internet Journal of Alternative Medicine* 2008; 7(2).
- Amin MR, Mondol R, Hossain MT et al. Antimicrobial activity and cytotoxic activity of three bitter plants *Enhydra fluctuans*, *Andrographis paniculata* and *Clerodendrum viscosum*. *Advanced Pharmaceutical Bulletin* 2012; 2(2):207-211.
- Dasgupta N, De B. Antioxidant activity of some leafy vegetables of India: A comparative Study. *Food Chemistry* 2007; 101:471-474.
- Patralekh LN, Mukherjee G. *In vitro* studies on antioxidant and iron chelating activity of *Enhydra fluctuans* Lour. *Sci & Cult* 2010; 76(11-12):537-539.
- Sannigrahi S, Majumdar UK, Mondal A, Pal D, Mishra SL, Roy S. Flavonoids of *Enhydra fluctuans* exhibit anticancer activity against Ehrlich's ascites carcinoma in mice. *Nat Product Commun*. 2010; 5(8):1239-42.
- Uddin SJ, Ferdous MS, Rouf R, Alam MS, Sarker MAM, Shilpi JA. Evaluation of Anti diarrhoeal activity of *Enhydra fluctuans*. *J Med Sci* 2005; 5(4):324-327.
- Sannigrahi S, Majumdar UK, Pal DK, Mondal A, Roy S. Hepatoprotective potential of flavonoid rich fraction of *Enhydra fluctuans* against CCl₄-induced oxidative damage in rats. *Pharmacologyonline* 2009; 2:575-586.
- Kumar SP, Jagannath PV, Chandra DS, Prasan ND. Hepatoprotective activity of *Enhydra fluctuans* Lour aerial parts against CCl₄ induced hepatotoxicity in rats. *International Journal of Research in Ayurveda and Pharmacy* 2012; 3(6):893-896.
- Rahman MT, Begum N, Alimuzzamam M, Khan MOF. Analgesic activity of *Enhydra fluctuans*. *Fitoterapia* 2002; 73(7-8):707-709.
- Akram M. Comprehensive review on Medicinal Plants used as analgesic, retrieved <http://share.pdfonline.com/b79b96bc218c4524b897d004fba77b97/analgesics.pdf>
- Kumar GP, Khanum F. Neuroprotective potentials of Phytochemicals. *Pharmacognosy Review* 2012; 6(12):81-90.
- Roy SK, Majumdar UK, Islam A. Pharmacological evaluation of *Enhydra fluctuans* aerial parts for central nervous system depressant activity. *Pharmacologyonline*, 2011; (1):632-643.
- Zhao ju. Medicinal plant database, retrieved <http://stuartxchange.com/Kangkong-kalabau.html>.