

Pharmacognostical and physiochemical study of the aquatic weed *Hydrilla verticillata* (L.f.) Royle known as nutrient power house

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ABSTRACT

Hydrilla verticillata (L.f.) Royle (Hydrocharitaceae) is a submerged aquatic angiosperm that is thought to be native in various tropical and subtropical areas such as the warmer regions of Asia, Australia, and United States which become established in a variety of fresh water habitats around the world. Where the plant occurs, it causes substantial economic hardships, interferes with various water uses, displaces native aquatic plant communities, and adversely impacts freshwater habitats. Besides this it has shown promising heavy metals sorbing property because once they contaminate the environment have permanent adverse ecological effects like Cd and it also can take up and store several trace metals for metabolic and biological process like Hg, Ni, and Zn etc. which are toxic to biota above threshold levels. In this present study we have undertaken to evaluate the different pharmacological activities with a correlation of chemical constituents available with this plant so that it may serve as a reference for further studies besides all those above ecological beneficial activities.

Key words: *Hydrilla verticillata* (L.f.) Royle, Morphology, Phytochemical aspects, Nutritional values, Pharmacological activities

INTRODUCTION

Use of herbs and plants for medicinal purposes has a long tradition. Being universal, no one can exactly describe the actual role of plants to our mankind because of the outstanding phenomenon of symbiosis between us. Without the plants it is impossible for the existence of life in the earth. The plants being in tremendous amount are associated with certain unique and a few common active principles known as secondary plant metabolites which are not directly involved in the normal growth, development or reproduction of organism. Unlike primary metabolites, absence of secondary metabolites doesn't cause immediate death, but is involved with the long-term impairment of the organism's survivability or aesthetics and sometimes represents no significant change at all. Numerous data on the uses of plants including medicinal use have been systematically gathered by Gadil and Vartak 1981.¹⁻⁴ In this present study, we will see the versatile role of *Hydrilla verticillata* (L.f.) Royle⁵⁻⁸ (Figure. 1), commonly known as water thyme, Florida elodea, Wasserquirl and Indian star-vine which is a native plant of Asia but first introduced to the United States in Florida in 1960. *Hydrilla's* scientific name is made up of the Greek word "hydro" meaning "water" and the Latin word "verticillus" that means "the

whorl of a spindle". Appropriately named, it is an aquatic plant with leaves that are whorled around the stem and belongs to the Frog's Bit family or Hydrocharitaceae. Some sources give a broad native range of parts of Asia, Africa and Australia. Some sources are more specific and say that the dioecious form of *Hydrilla* originated from the Indian subcontinent and the monoecious form originated from Korea. *Hydrilla* could easily be called the perfect aquatic plant because of the extensive adaptive attributes it possesses to survive in the aquatic habitat but it can grow in both static and flowing water including lakes, ponds, rivers, streams and reservoirs, and can survive few centimetres to 45 feet in depth in some parts of the country. It grows 2.5 cm in one day in fresh water.



Figure 1 – Leaves of *Hydrilla verticillata*.

The monoecious species of Hydrilla plant capable of producing seeds which have been recently reported in the US⁹⁻¹¹ but generally it can reproduce itself through shoot fragmentation or the production of axillary and subterranean turions.¹²⁻¹³ The previous studies about the therapeutic potential of the plant *H. verticillata* found to be use as antioxidant, in detoxification, in digestion and gastrointestinal function, for improvement of blood circulation, for blood sugar control and for neurological health.¹⁴⁻¹⁷ They are noted as aquatic “nutrient power house” (Pal and Nimse 2006), and only limited chemical investigations of *H. verticillata* were reported.¹⁸

DESCRIPTION

Hydrilla is highly polymorphic and a submerged, rooted (usually) perennial with long, sinewy branching stems that often reach the surface and form dense mats. Its appearance may vary considerably depending upon the conditions under which it is growing.¹⁹⁻²⁰ It grows submersed in water and generally is rooted to the bottom, although sometimes fragments will break loose and survive in a free-floating state. Erect stems can be quite long when the plant grows in deep water.²¹

IDENTIFYING CHARACTERISTICS

LEAVES

Usually bright green in colour but could be bleached by the sun and may appear yellowish (width: 2-4 mm length: 6-20 mm). Having pointy teeth like edges. About 4-8 leaves whorled around each nodes and the midrib of the leaf is often red in colour with one or more sharp spines. The main specification which makes it distinguish from other species that it has an axillary leaf scale called squamula intravaginalis which found next to the stem at the base of the leaf (Figure. 2).²²

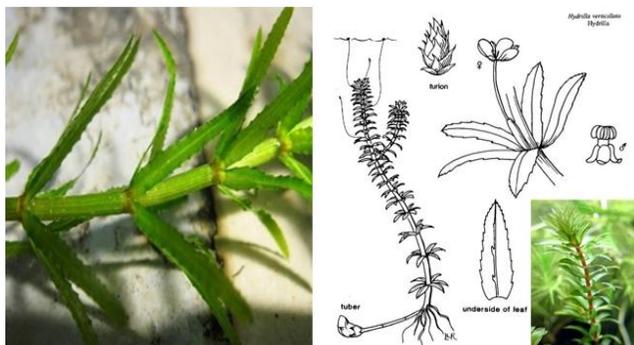


Figure 2 - *H. verticillata* leaf.

ROOT/ STEM

It produces hibernacula, turions in leaf axils and tubers terminally on rhizomes (Figure. 3). The tubers or subterranean turions are very compact dormant buds and fall from the plant when mature. The turions are 5-8 mm in length, dark green in colour and having spiny appearance. The tubers on the terminal of the rhizomes may be found 30 cm deep in the sediment. New root sprout are generally white in nature but may be brown when grown in highly

organic soil. Stems are only 1/32 of an inch wide; grow up to 30 feet length. The stem form branches when near the water’s surface, specially the monoecious form start to branch out at the sediment level.²³



Figure 3 - Monoecious Hydrilla axillary turions

FLOWERS

The flowers are imperfect depending on the two forms of Hydrilla presents. The monoecious type contains male and female on the same plants. The dioecious type contains only female per plants, generally found in US. Female flower (Figure. 4) consists of three whitish sepals and three petals each are 10-50 mm long and 4-8 mm wide attached at leaf axils and are lustered towards the lips of the stems from which female flowers arise are often very compact and have very short leaves. Where male flower Contains three whitish red or brown sepals each are 3 mm length and 2 mm wide having three stamens formed in leaf axils as they approach maturity these are released and float on the surface.^{24, 25}



Figure 4 - *H. verticillata* flower

CHEMICAL CONSTITUENTS

The lipophilic extract of *H. verticillata* after extracted with petroleum ether and acetone (1:1 ratio) showed the presence of 3, 5, 11, 15-tetramethyl-1-hexadecen-3-ol (C₂₀H₄₀O) and an acrylic diterpenoid alcohol known as phytol (C₂₀H₄₀O) as major components. Other than the above two components some other unsaponifiable lipophilic compounds are also detected by GC-MS.²⁶ John et al.1992 analyzed the phenolic content of *Hydrilla verticillata* (L. f.) Royle by high-pressure liquid chromatography and thin-layer chromatography which showed the presence of phenols in trace amounts included

ferulic, chlorogenic, and caffeic acids.²⁷ Flavonoids anthocyanins are accumulated in internodes as the tissues matured. The major compound in both leaves and internodes was a caffeic acid ester which inhibited germination and germ tube elongation of conidia of the fungal pathogen *Fusarium culmorum*. Mainly five compounds were isolated by different methods. For examples 1-(5'-Hydroxy-4'-hydroxymethyl-1'-methyl-1H-pyrrol-2'-yl)-henicosa-2,12,15-trien-1-one and thymidine was identified by EIMS, 1H NMR, 13C NMR and IR spectra. Crystal loliolide and sulphur-gamma were identified by X-ray diffraction. Octadecanedioic acid was also elucidated.²⁷

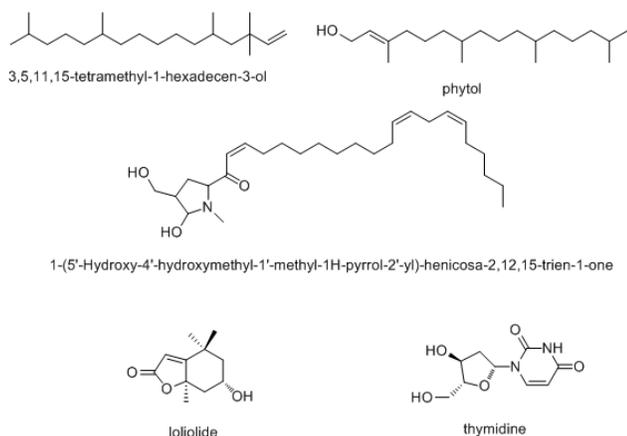


Figure 5 - Chemical structure of some isolated compounds from *H. verticillata*

NUTRITIONAL VALUES

Hydrilla verticillata has high concentration of many vitamins and minerals that are typically hard to obtain from plant foods, for example- it contains 15% elemental calcium a dry weight basis, which is bound to carbohydrates, proteins and polyphenols. Besides, this are also a rich source of B- vitamins and a host of other minerals (chromium, selenium, boron, silica etc.), amino acids, essential fatty acids, enzymes, antioxidants and health promoting compounds. It contains about 50-60% complete protein and furthermore contains high amount of lysine. So, this little known nutritional power house is a true green super food in every sense of the word. Hydrilla also found to contains chlorophyll, which has a chemical structure nearly identical to haemoglobin which increases the oxygen carrying capacity of the blood.²⁸⁻²⁹

Table 1 – Nutrients generally present in *H. verticillata*

Nutrients	Amounts (mg/10.5gm)	Nutrients	Amounts (mg/10.5gm)
Vitamin B-1	26.25mg	Potassium	244.65mg
Vitamin B-2	0.084mg	Phosphorus	29.74mg
Vitamin B-3	5.25mg	Iron	35.8mg
Vitamin B-5	11.36mg	Zinc	6.3mg
Vitamin B-6	35.91mg	Copper	0.22mg
Vitamin B-12	1.05mg	Cobalt	0.43mg
Calcium	1460.7mg	Molybdenum	14.7mg
Magnesium	76.13mg	Beta carotene	29593 IU

PHARMACOLOGICAL ACTIVITIES

1. ANTIOXIDANT ACTIVITY

Pal et al. 2006 performed the antioxidant activity of *Hydrilla verticillata*. In this experiment the plant materials were exhaustively extracted successively with petroleum ether (40-60°C), benzene, chloroform, ethyl acetate, ethanol and distilled water using a Soxhlet extractor. Those extracts were evaluated for possessing antioxidant properties by non-enzymatic haemoglycosylation method and DPPH free radical scavenging activity methods. This showed that the chloroform extract has the highest and petroleum ether extract has the lowest antioxidant activity.³⁰

2. CNS ACTIVITY

In another study Pal et al. 2006 showed that the plant extract of *H. verticillata* potentiated the sleeping time in mice. Here the sleeping time in mice (induced by standard hypnotics, for example- pentobarbitone sodium, diazepam and meprobamate) was potentiated by aqueous extract of *H. verticillata* (AEHV) in different concentrations which proved that the AEHV has significant CNS activity in a dose dependent manner.³⁰

3. ANALGESIC ACTIVITY

AEHV produced analgesia in mice, to prove these two different methods were used namely-acetic acid induced writhing & eddy's hot plate method. In the first method the aqueous extract inhibited the percentage of writhing episode compared with those of acetyl salicylic acid, paracetamol & morphine and in the another method after administration of AEHV the reaction time of the mice licking its feet or jumping out of the cylinder when reached to the hot plate was reduced. The plant extract not only produced analgesia but also potentiated the analgesic action of morphine and pethidine.³⁰

4. ANTICONVULSANT ACTIVITY

Introduction of strychnine and leptazol cause tonic type of convulsions with clonus in mice. By the administration of AEHV the average survival time was increased and the percentage mortality decreased at different doses. This proves that the aqueous plant extract has anticonvulsant property in a dose dependent manner. But it was observed that different combinations of strychnine or leptazol with plant extract did not show any significant protective action against convulsions.³⁰

CONCLUSION

It is concluded that, scientific parameters based on taxonomical, pharmacognostical and phytochemical studies are essential to identify the plant and many bioactive constituents. Besides this many pure compounds

have so far been neglected by phytochemists and pharmacologists and a large amounts of works have been done only on extracts and not on the isolated fraction(s). This present review article pointing Hydrilla as a huge source of different nutrients, aims at focusing the attention of research scientists on the unexplored and untouched areas related to *Hydrilla verticillata*.

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