

**Review Article****Ceratophyllum demersum a Free-floating Aquatic Plant: A Review**

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ABSTRACT

Ceratophyllum demersum is a submerged perennial macrophyte normally grow with the base of its stem buried in sandy or silty substrates. It is typically found floating in stagnant and slow moving water. It is a fragile free-floating underwater rootless, but densely leafy, once a year or continuing freshwater aromatic plant, with leaves so crowded at the apices as to give the impression of a bushy animal tail, reproducing vegetatively and by seed. Hornwort flourishes in shaded, warm and gently flowing (1 cm per second) waters at a pH between 7.6 to 8.8, but does not tolerate turbidity or salinity. This plant oxygenates the water, provides food for aquatic herbivores, and rarely causes problems. The volatile oil, whole plant dry extract analysis by GC-MS, 78 components were detected. The major constituents extracted were hexahydro Acacia acetone content accounted for 16.9%, aldehydes and ketones accounted for 21.44%, terpenes accounted for 11.54%, ester hydrocarbons accounted for 20.06% and the other category accounted for 7.21%. *Ceratophyllum demersum* chemical composition systems pre-test tube method, found that the plant contains: flavonoids and glycosides, lactones, coumarin glycosides, steroids, terpenoids, sugars, tannins, amino acids, peptides, proteins volatile oil; may contain phenolic compounds, alkaloids; without cardiac glycosides. Decoction of leaf is used as a cardiogenic and to regulate bile secretion. Leaf juice is used to stop vomiting, as cooling agent. It is also used as antitoxic, analgesic, anti-inflammatory, astringent, antiulcer, etc.

Introduction

Ceratophyllum demersum is a cosmopolitan, perennial, obligate sea plant. It is universally referred to any as Coontail for the reason that its compact whorls resemble a racoon's tail, or as Hornwort. The Latin and frequent names of hornwort get nearer from the Greek keras import horn, phyllon consequence leaf, and wort. This species has been within the aquarium exchange for the scores of days and is ordinarily available. It is too extensively obtainable as a place in the ground for ponds[1]. *Ceratophyllum demersum* is an underwater lasting macrophyte which will on the whole produce with the foundation of its stem hidden in filthy or silty substrates. It does not create roots. It is level to dislodgement, and its jaunty stems may develop into free-floating. It be capable of develop a dense subsurface cover and get a message to a height of 5-6m and habitually grows as a mono-specific cooperative spirit (heights of 10m have been reported in Maraetai, New Zealand. *C. demersum* can form modified leaves when it is growing near the lake bottom, which it uses to anchor to the sediment[2].

Nomenclature

Ceratophyllum is a combination of the Greek *keras*, meaning 'horn', and *phyllon*, a leaf, referring to the antler-like structure of the leaf branches; *demersum* is from the Latin *demerge*, meaning to 'sink' or 'plunge', and alludes to the submerged growth habit of the plant. 'Hornwort' also refers to the leaf structure.

Alternatenames: arigma (Phillippines), common coontail (USA), gang (Java), hornblad (Netherlands), hornweed (Taiwan), marsumo (Japan)

In English: cool water brush, coontail, hornwort.

In China: jin yu zao shu, jin yu zao ke

In India: ambuchamar,ambutala, araka, hathaparni, haval, honaal, Jalaja, jalakesha, jalakuntala, jalanchana, jalmandapi, jalanili, jalaprishthaja, jalashuka, ka, karimpayal, kavara, Manjula, nasu, neeti sambraani, saivala, saivalah, salilakundala, sevar, shaiwal, shaiwar, sheoyala, sheshana, shevala, shivala, sivara, souvala[3].



Figure 1. *Ceratophyllum demersum*

Scientific Classification

Kingdom: Plantae
Phylum: Spermatophyta
Sub-phylum: Angiospermae
Class: Dicotyledonae
Order: Nymphaeales
Family: Ceratophyllaceae
Genus: *Ceratophyllum*
Species: *Demersum*

Habitat: Sheltered sites found in standing or gradually emotive clear water in ponds, dams, streams and reservoirs, particularly those with silty bottom mud.

Description: A fragile free-floating underwater rootless, but densely leafy, twelve-monthly or permanent freshwater herb, with leaves so crowded at the apices as to give the impression of a bushy animal tail, reproducing vegetatively and by seed.

1. **STEMS**-Elongate, 30 to 60 cm long, freely branching and either brittle and stiffly branched or cord-like and flexible; nodes 1 to 3 cm apart but becoming crowded towards the apices.
2. **LEAVES**-Dark green; in whorls of 5 to 12, sessile with thickened bases, 1 to 4 cm long, twice or three times palmately divided, the segments cylindrical, linear, 0.5 mm wide and conspicuously toothed along one side.
3. **FLOWERS**-Greenish, very small to 1 mm long, unisexual, seclued and sessile in leaf axils, each subtended by 9 to 12 calyx-like bracts, perianth absent, male and female flowers at different nodes; female flower a minute ovary surmounted by a single simple style; male flower with 12 to 16 sessile oblong anthers each terminating in 2 sharp points.
4. **FRUIT**-Black ellipsoid achenes 4 to 5 mm long, with 2 basal spines 9 to 12 mm long, and surmounted by the persistent spine-like style.
5. **SEED**-The fruit acts as the seed.
6. **ROOT**-Absent, replaced by finely divided basal stem branches termed 'rhizoid shoots', which may, at times, anchor the otherwise free-floating mass to the stream bed [3].

Origin and distribution

The origin of this truly cosmopolitan plant, having existed in ponds since the Pliocene epoch, is obscure. It dries out quickly

if removed from water and is killed by ice and sea water. Yet, despite this sensitivity to adverse environments, hornwort occurs on many oceanic islands, as well as on all continents of the world other than Antarctica. Hornwort is native to Australia, happening in the entire States except Tasmania. It grows, but is not common, all along the east coast, occasionally reaching pest proportions in parts of south-eastern Queensland. In inland New South Wales it is recorded at several localities along the Murray River and in the Lachlan River downstream of Condobolin where, during a drought, it intertwined with floating pondweed (*Potamogeton tricarlinatus* F. Muell. & A. Benn.), seriously obstructing water flow. Following the introduction of the grass carp it seems to have disappeared from this site. The Murray River colonies extend into South Australia, particularly at Mannum and near Lake Alexandrina. In addition to the Murray River colonies, it is also found near Kyabram in the Goulburn Valley and in the Sale-Bairnsdale area of Gippsland in Victoria, occasionally becoming weedy in the Maffra-Sale drainage channels. Hornworts is also recorded throughout the Top End of the Northern Territory and in the Moore River in Western Australia [3].

Life cycle

In warm-temperature and subtropical regions hornwort overwinters as slowly growing plants, seeds and turions ('winter buds'). In cool-temperature regions where shallow waters are frozen in winter, turions are more prolific and seeds rare. Both these propagules germinate in mud in spring as temperatures and daylength increase. The radicle does not enlarge in any way during seed germination nor do adventitious roots form. Instead, the primary stem elongates and, when about 8 cm long, breaks free from the bottom mud and rises to the surface, growing and branching as the season advances. Flowers are produced in summer but remain fully submerged. Stamens are shed as the male flowers mature and, forming floats, rise to the surface as a group, dehisce and liberate the pollen which, being heavier than water, sinks and contacts the stigmas of the submerged female flowers. The hard-skinned fruits sink to the bottom at maturity. In cooler regions, lateral stem apices cease elongation in autumn and form turions. These are condensed stem tips with very tight clusters of starch-rich, heavily cuticularised scale-like leaves. They may remain attached to the parent plant or, breaking free, sink to the bottom. In spring, axillary buds in the turions

begin to grow, producing new plants that break free from the bottom mud as do the seedling plants [3].

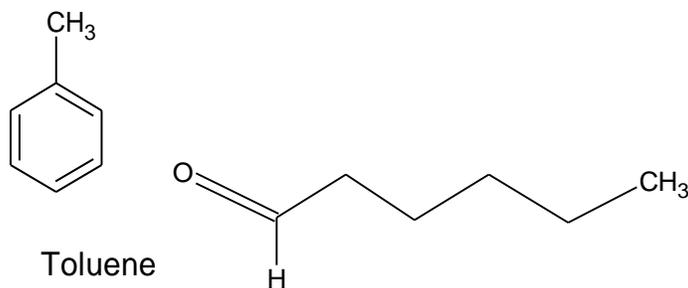
Dispersal

Although hornwort reproduces both sexually and asexually, the environmental requirements for sexual reproduction limit seed production in many areas. Where seed is produced the hooked spines on the fruit catch in waders' clothing and in water birds' feathers and may be carried some distance in this way. Birds, after diving, sometimes carry small fragments of the stem on their beaks for short distances. The two modes of vegetative reproduction, fragmentation and turion formation, however, are probably the principal means of survival and dispersal generally. The relatively fragile plant readily fragments when distributed by strong wave motion, foraging animals, or propeller-driven boats. Each fragment, moving with the stem, is capable of forming a new colony. Turions may also travel considerable distances in stream flow, either attached to stem fragments or as individuals, while sinking slowly to the bottom mud [3].

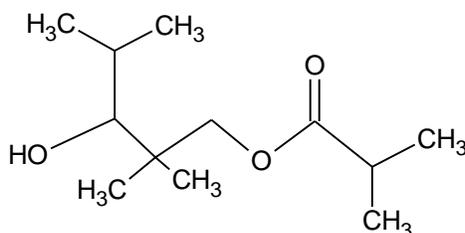
Chemical Constituents

C. demersum plant extracts consist of different classes of phytomolecules such as alkaloids, cardiac glycoside, glycosides, tannins and flavonoids [4]. The constituents of the essential oils were identified by matching their mass spectra with those from the Wiley 7.0 mass library compilation series and by comparison of their retention indices with those from the literature. Co-chromatography with pure compounds was used for further confirmation of compound identity. The major constituents revealed from the analysis along with their percentage composition reported are toluene, hexanal, 1-hexanol, heptanal, nonanal, 2,6-dimethylcyclohexanol, 3-ethyl-4-methyl-1H-pyrrole-2,5-dione, 2-methylpropanoic acid 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester, 2-methylpropanoic acid 3-hydroxy-2,4,4-trimethylpentyl ester, B-ionone-5,6-epoxide, dihydroactinidiolide, B-asarone, pentadecanal, 6,10,14-trimethyl-2-pentadecanone, 1,2-benzenedicarboxylic acid di (2-methylpropyl) ester and 1,2-benzenedicarboxylic acid dibutyl ester 6.8%, 5.4%, 1.9%, 1.7%, 1%, 2.9%, 2.2%, 7.6%, 15%, 7.6%, 3.7%, 3%, 3.3%, 2.8%, 5% and 1% respectively [5].

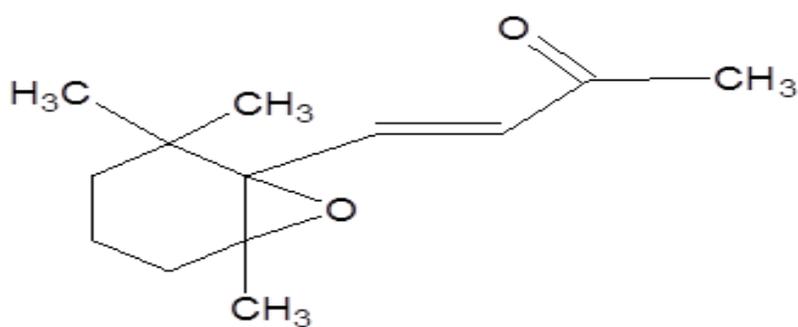
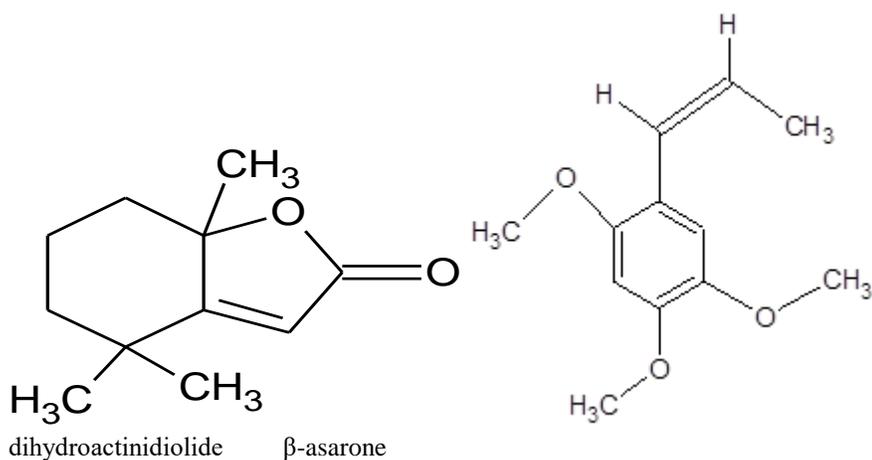
Structures



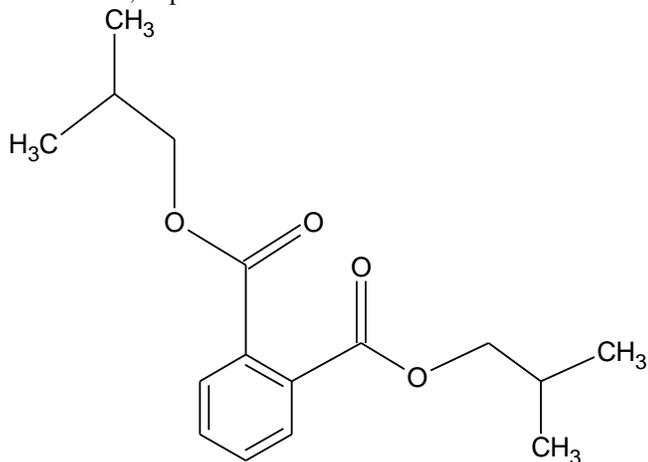
Hexanal



2-methylpropanoic acid 3-hydroxy-2,4,4-trimethylpentyl ester



B-ionone-5,6-epoxide



1,2-Benzenedicarboxylic acid (2-methylpropyl) ester

Ceratophyllum demersum chemical composition of the volatile oil, whole plant dry powder extracted volatile oil extracted 6 hours, pale yellow with a special scent of essential oils, and qualitative and quantitative analysis by GC-MS, 78 components were detected analysis identified 32 ingredients, the results show that the highest: hexahydro Acacia acetone content, 16.9% of total detectable amount; according to the type of component, accounted for 21.44% of aldehydes and ketones, terpenes accounted for 11.54%, accounted for 20.06% of esters hydrocarbons accounted for 9.39%, and the other category accounted for 7.21% [5].*Ceratophyllum*

demersum chemical composition systems pre-test tube method, found that the plant contains: flavonoids and glycosides, lactones, coumarin and glycosides, steroids, terpenoids, sugars, tannins, amino acids, peptides, proteins volatile oil; may contain phenolic compounds, alkaloids; without cardiac glycosides. To *Ceratophyllum demersum* whole grass powder solvent extraction method, extraction with 95% ethanol was heated under reflux, the alcohol extract was washed successively with chloroform, ethyl acetate, n-butanol extraction from chloroform, ethyl acetate portion was separated to obtain 13 compounds, the use of modern spectroscopy identified 11 compounds were: palmitic acid(1),

stearic acid(2), xxii carbonate(3), β -sitosterol alcohol(4), 7α -hydroxy- β -sitosterol or alcohol(5), 7α -methoxy- β -sitosterol(6), the tricin- 7α -O- β -D-glucoside(7), naringenin-

7α -O-of β -the D-glucoside(8), esculetin(9), UFA alcohol, stigmasterol(10), (11). Which compounds 5,6,7,8,9,11 for the first time from the genus isolated [5].

Ayurvedic Uses

Table 1: Shows ayurvedic uses of *Ceratophyllum demersum*[6].

| CLASSICAL & COMMON NAMES | PARTS USED | DOSE | CLASSICAL USE | ACTIVE PRINCIPLES AND PHARMACOLOGY |
|--|--------------|---|---|--|
| <p>Ayurvedic: Shaivaala, Jalnili, Jalaj, Shaivaala has also been equated with Vallisneria spiralis Linn.</p> <p>Unani: Tuhlub (Arabic); Pashm vazg (Persian).</p> <p>English: Coontail, Hornwort.</p> | Whole plant. | Juice 10-20ml, decoction 50-100ml. | <p>Charaka used the weed, in prescriptions, for haemothermia, digginess, morbid thirst; externally in rheumatism, erysipelas.</p> <p>Shaivaal, in Ayurvedic texts, belongs to Bhadrashriyaadi Group, which is prescribed in intrinsic haemorrhages. Shaivaala was an ingredient of a medicated clarified butter prescribed by Charaka in cardiac affections. Shushruta used the weed, in prescription, for spermaturia.</p> <p>In folk medicine, Shaivaala is used as a styptic; also prescribed in leucorrhoea and venereal diseases. Its ash, mixed with sesamum oil, is applied over discoloured skin. Externally the paste is used for resolving inflammations.</p> | <p>The herb is rich in protein (24.6%), calcium and magnesium. It contains ferredoxin and plastocyanin. Exhibits purgative, antibilious and antimicrobial properties.</p> <p>The extract of the herb has shown activity against Mycobacterium smegmatis, Candida albicans and Fusarium sambucinum syn.F.roseum.</p> <p>Wallisneria spiralis L. showed stomachic, antileucorrhoeic and demulcent activities. INSA scientists equated the drug with Shaivaala of Charaka and Shushruta.</p> <p>The extract of the plant yielded polysaccharides, containing D-galactose, D-xylose, L-arabinose, L-rhamnose, uronic acid and acidic xylan, and an arbinogalactan.</p> |
| <p>Ayurveda: Chanaka, Chanakaa, Harimanth, Vajimanth, Jivan, Sakalpriya.</p> <p>Unani: Chanaa.</p> <p>Siddha: Kodalai.</p> <p>English: Gram.</p> | Seed. | Saktu (Sattu) with water 50-100ml. (Saktu is prepared by pounding the presoaked, dried and fried seeds of Cicer arietinum. Mixed with salt or sugar Saktu was prescribed during summer due to its cooling properties in the form of a | <p>Charaka prescribed Chanaka mixed with Ushira (Vetiveria zizanioides) and Dhaanyaka (Coriandrum sativum) in vomiting caused by biliousness.</p> <p>The Saktu was given in colic as a diet (Gadanigraha). In the case of excessive burning sensation and in fever, the soup of Chanaka was recommended (Bhaavaprakaasha).</p> <p>Maadhava Dravyaguna attributed antibilious, blood-purifying properties to Chanaka but also considered it punsatvaghna i.e. it causes impotency. This seems to be an erroneous interpretation of the cooling properties of the herb.</p> | |

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|--|--|----------------|--|--|
| | | thin linctus.) | | |
|--|--|----------------|--|--|

Traditional Uses

Decoction of leaf is used as cardio tonic, antipyretic and to regulate bile secretion. Leaf pest is applied externally in case of scorpion sting. Leaf juice is old to bar vomiting, as cooling agent [7]. It is used as antitoxic, analgesic, antipyretic, anti-inflammatory, astringent, hepatoprotective, gastric, anti-diarrheals, healing agent, used in the respiratory diseases [8]. The plant is astringent, bitter, sweet, oleaginous, fragrant, constipating, refrigerant, haemostatic and antipyretic, and is useful in vitiligo conditions of pitta, diarrhea, dysentery, burning sensation, hyperdipsia, epistaxis, haematemesis, haemoptysis, haemorrhoids, ulcers and intermittent fevers [9]. In Indian medicine, the aromatic plant *Ceratophyllum demersum* L. is used in jaundice, for scorpion bites, as an antipyretic and antimalarial [10]; in China it is old with hemoptysis; aqueous dig up of the set has anti-diarrhoeal and wound curing effect [11].

Pharmacological Review

Antimicrobial Activity

Ceratophyllum demersum extract with three different solvents like acetone, butanol and methanol were used to determine the activity against two pathogenic organisms both Gram positive (*Staphylococcus aureus*) and Gram negative (*Escherichia coli*) bacteria and fungi (*Aspergillus niger*) by agar well diffusion method. Antifungal property was determined in 50% acetone extract causing inhibition zone 18mm of *C. demersum* against *Aspergillus niger* [12-13]. The antimicrobial activities of aqueous and organic solvents (chloroform, ethanol and methanol) extracts of *Ceratophyllum demersum* L., with other plants were tested in vitro against seventeen different microorganisms. The extract showed antimicrobial activity against the used organisms. The efficiency of the extracts varied with, solvent used in the extraction. The aqueous extract appeared to be the highly effective extract against all tested organisms. Ethanol extract showed antimicrobial activities against all tested organisms except *Aspergillus niger*. On using chloroform extracts *Escherichia coli*, *Aspergillus niger* and *Penicillium italicum* showed resistance [14].

Analgesic Activity

Methanolic extract (250 and 500 mg/kg of b.w., p.o.), were used to determine the pain-relieving activity of *Ceratophyllum demersum* by using acetic acid induced writhing model in Albino mice. The extract showed significant reduction in number of writhes thus indicating its analgesic activity in the dose dependent manner [15].

Antipyretic Activity

Methanolic extract (250 and 500 of mg/kg b.w., p.o.) were used to evaluate the antipyretic activity of *Ceratophyllum demersum* using Brewer's yeast (*Saccharomyces cerevisiae*) induced pyrexia method in Wistar rats. The extract showed significant reduced pyrexia, the dose of 250 mg/kg body weight showed significantly reduction in number of writhes and paw volume, and at the dose 500 mg/kg body weight showed significantly reduction in pyrexia, thus indicating its antipyretic activity [16].

Anti-Inflammatory Activity

Anti-inflammatory activity of *C. demersum* was tested by using the carrageenan induced rat paw edema model in male Wistar albino rats using methanolic extract (250 and 500 of mg/kg b.w., p.o.), respectively. The extract showed significant reduction in the paw volume thus indicating its anti-inflammatory activity [17].

Anti-neoplastic Activity

The most important components of essential oil of *C. demersum* were evaluated for their antineoplastic activity. The antineoplastic activity was observed for 12 compounds (2Z,4Z)-Hepta-2,4-dienal; 2-Phenylacetaldehyde; (3E,5E)Octa-3,5-dien-2-one; 2,6-Dimethylcyclohexan-1-ol; geranylacetone; α -muurolene; β -ionone; β -eudesmol; α eudesmol; biformen; kaurene and manool [17].

Anti-oxidant and anti-acetylcholinesterase (AChE) activity

The ethanol extracts from *Ceratophyllum demersum* L. was assessed in vitro for their antioxidant and anti-acetylcholinesterase (AChE) activities. Antioxidant activity was evaluated by 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity test and ferric-reducing antioxidant power assay (FRAP). In FRAP method significant anti-oxidant potential was recorded against GA and BHA. In the anti-AChE assay, the extract exerted insignificant inhibition against the enzyme [18-20].

Anti-ulcer Activity

Antiulcer activity of methanolic and aqueous extracts of *Ceratophyllum demersum* was determined at a dose of 250 mg/kg and 500 mg/kg body weight using rats. Glycosides, flavonoids, alkaloids, steroids and tannins have been reported to be present in the entire plant of *Ceratophyllum demersum*. It indicates that, both the extracts at a dose of 500 mg/kg showed significant increase in pH and mucus content and decrease in gastric acid volume, free acidity, total acidity and ulcer index. Therefore, *Ceratophyllum demersum* exhibits antiulcer

activity, which bear witness to the consumption of entire plant in habitual medicine to take care of the ulcer conditions [21-22].

Anti-diarrhoeal and Wound healing Activity

The methanolic and aqueous extracts of entire plant of *Ceratophyllum demersum* were evaluated for anti-diarrhoeal and wound curing potentials using experimental models in rats. Anti-diarrhoeal activity at a dose of 250 and 500 mg/kg was evaluated. Both the extracts showed significant anti-diarrhoeal and also showed significant wound curing activities (5 % w/w). Percentage inhibition of defecation of methanolic and aqueous extract (250 mg/kg) were 37.14 % and 41.88 % and at a dose of 500 mg/kg were 50.47 % and 48.88 %, respectively. Percentage inhibition of diarrhoeic drops at a dose of 250 mg/kg was 35.24 % and 48.87 % and at a dose of 500 mg/kg was 52.28 % and 51.40 %, respectively. It can be concluded that, the methanolic and aqueous extracts possesses anti-diarrhoeal and wound curing activities, which sustain the utilize of complete plant in habitual medicine to deal with the diarrhoea and wound [23-26].

Conclusion

Actual foodstuffs are the chief reserve for the maintenance of being since ages and are appropriate escalating vital as unorthodox medicine. *C. demersum* had a sustained history of habitual uses for varied choice of diseases. The foremost constituents of this plant contain glycosides, flavonoids, alkaloids, steroids and tannins. Flavonoids grant in the haul out are famous to be directed at prostaglandins which are occupied in the nick of time stage of acute inflammation, pyrexia and grief perception. From now the manifestation of flavonoids in the methanolic extract of *C. demersum* may be contributed to its analgesic, antipyretic and anti-inflammatory activities. *C. demersum* stand considered in this re-examined article be able to be painstaking as interchange for the action and explore of a range of diseases. This work and its long-established pharmacological profile ought to be preserved. The experimentally proved biological behavior of this plant be utilized in combating the various diseases. However, precise confirmation of the set as a prevailing medicine is lacking. The foremost challenges in the advanced day medicine are the undesirable feature possessions and the efficiency in treatment. Expand investigations are essential to explore its impending and other river macrophytes in the cure of diseases by means of lonely compounds with nominal or no elevation effects. This deposit be utilized in sort out to variety a trademark through ample diseases alleviate and inexpensive regimen to be had for average people portion in budding probable biopharmaceutical product.

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