Evaluation on ethno-medicinal importance and conservation of medicinal plant *Monochoria vaginalis*

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Absstract

Monochoria vaginalis (*Diya habarala*) of family PONTEDERIACEAE is an aquatic plant native to Sri Lanka with many ethno-medicinal values. This plant is used to treat numerous diseases in traditional system of medicine and used as a vegetable in some parts of the country. At present this has been included to lower risk category of IUCN Red Data Records due to reduction from its natural habitat. This study was conducted to evaluate ethno-medicinal importance, propagation and conservation of this plant. Data gathered from literature surveys, survey studies, physical parameter analysis tests and cultivation methods were utilized in this study. Illegal wetland destruction, excessive use of non-selective weedicides, climatic changes have minimized the availability of this plant. As a result, use of correct plant for drug preparation has reduced. Therefore, proper identification of this plant is also a necessity today. *Diya habarala* is a main ingredient of *Neelyaadi oil* which is used in traditional system of medicine. Cold potency of this plant reported to be one of the main Ayurveda pharmacological properties that helps in pacifying vitiated *Pitta Dosha*. Drug recipes including *Diya habarala* mainly act on integumentary system and used to treat skin rashes, ulcers, wounds and skin malignancies. Cultivation using Peat soil mixture showed good results and Tissue culture techniques can be used in conservation of this plant in future.

Keywords: Distribution, Ethno-medicinal values, Identification, *Monochoria vaginalis*, Propagation

Introduction

Monochoria vaginalis (*Diya habarala*/ Pond weed) of family PONTEDERIACEAE is an annual aquatic plant native to Sri Lanka and many other Asian countries. This is found in slow moving or standing water bodies such as border of tanks, near paddy fields, ponds and rivers[1]. This monocotyledonous plant grows about 10-30cm tall with shiny appearance and a short rhizome.

Ethno-medicine refers to range of healthcare systems, practices, remedies and therapeutic techniques that arise from indigenous cultural development[2]. Use of herbs to treat a variety of different ailments is universal and exists in every human culture. *Diya habarala* plant is a medicinal plant used in traditional system of medicine in Sri Lanka and used as a dietary material by native people. This study is carried out to identify the correct plant species, ethno-medicinal importance, risk factors for reduced availability and conservation methods.

Some texts mention that '*Jabara*' is a synonym for *Diya habarala*[3] whereas some texts mention that '*Jabara*' and *Diya habarala* are two different plant varieties. There's a controversy between *Diya habarala* and *Diya beraliya* plant too. Even though this plant is not commonly mentioned as a drug ingredient in Ayurvedic texts, it can be found in many traditional texts. For an example it's well known for anti-poisonous and wound healing action in traditional system of medicine. *Diya habarala* is a main ingredient of *Neelyaadi oil* which is used in fracture healing and wound healing treatments in traditional system of medicine in Sri Lanka[4].

This plant which has been abundantly seen in low country wet zone has shown reduced availability at present due to many reasons such as excessive usage of agro chemicals[5]. According to IUCN Red Data Records *Monochoria vaginalis* is classified under lower risk category and included in least concern version of its criteria[6]. Nowadays Ayurvedic practitioners and drug manufacturers face dearth of this plant for medicinal purposes as well. Unawareness of people about the value of this plant is a main reason for degradation of natural habitat of *Monochoria vaginalis*.

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Identifying the reasons for being reduced in natural habitat and finding innovative and effective methods to improve cultivation of this plant has become a need today. Present study attempted to analyze the medicinal importance, nutritional value and conservation methods of *Monochoria vaginalis*.

Materials and methods

Literature study

Literature study was carried out in order to identify morphological characteristics, ethno-medicinal value of *Monochoria vaginalis* in Ayurvedic and traditional medical texts. Data from various websites and research articles were also collected.

Field visits

Field visits were carried out to find distribution, availability and ethno-medicinal importance. Plants were authenticated at Department of *Dravyaguna Vignana,* Institute of Indigenous Medicine, University of Colombo and Herbarium sheets were prepared using *Monochoria vaginalis* specimens collected from natural habitats[7].

Survey study

Surveys were conducted among Ayurveda doctors, traditional practitioners, general public and paddy farmers using questionnaires to gather data on medicinal and nutritional importance, reasons for reduce availability and conservation methods of *Monochoria vaginalis*. Three types of questionnaires were prepared in both languages and distributed among these populations to gather data (Figure 1).

Tests to analyze physical parameters and chemical nature

Tests to analyze physical parameters and chemical nature[8] were conducted using dried powder of *Monochoria vaginalis.* Tests were conducted at Department of *Dravyaguna Vignana*, Institute of Indigenous Medicine, University of Colombo. Raw plant material (3kg) was washed and air dried for 5 days and 900g of powder was obtained after grinding.

Litmus test

Monochoria vaginalis powder (10g) was dissolved in distilled water and separated the mixture into 3 parts. Red litmus paper and blue litmus paper was put into 2 containers separately at the same time. Litmus papers were dipped and after about 30 seconds, took out of containers. Then the colour changes were observed.

Determination of pH value

Measured *Monochoria vaginalis* powder (60g) and made a bolus by covering with a cotton cloth. Then 8 cups (1920ml) of water was added to a fresh clay pot and dipped the bolus and boiled till water volume reduced to 1 cup (240ml). Calibrated the pH meter by measuring the pH of distilled water. After letting the decoction get cooled, checked the pH value using the pH meter[8].

Determination of moisture content

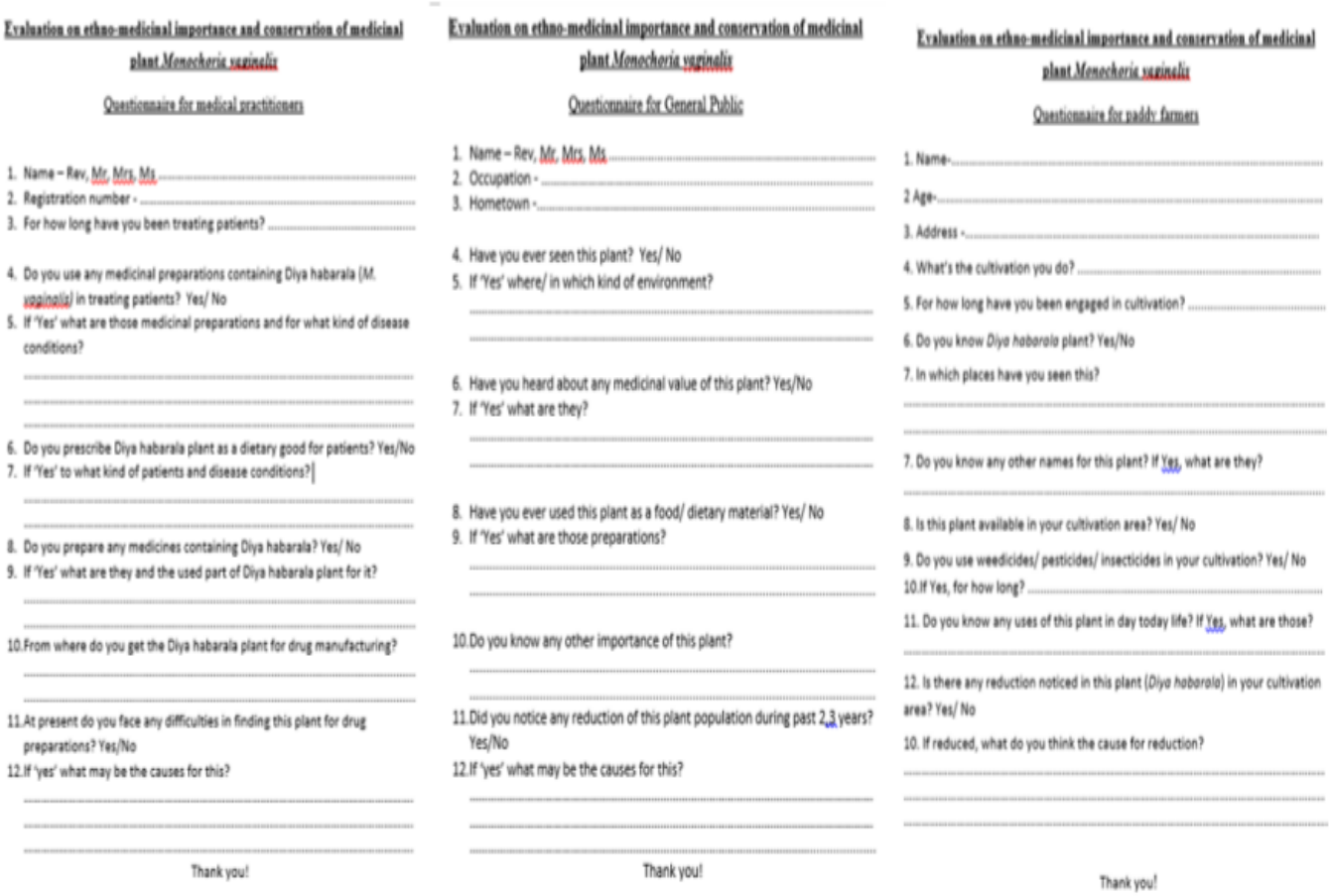
Monochoria vaginalis dried powder (2g) was measured and detected the moisture content using moisture apparatus in room temperature. 3 samples were checked and mean was calculated[9].

Determination of total Ash value

For this test 6 porcelain crucibles were washed, dried in hot plate and put 2.5g of *Monochoria vaginalis* powder to each of it. Then placed the 6 crucibles in desiccator and kept in the muffle furnace. Heated up to temperature of 550^{o}c till it became white/carbonized, cooled and weighed the samples[10].

Thin Layer Chromatography

Dried *Monochoria vaginalis* powder (20g) was measured and put into flat bottom flask and added 100ml of Ethanol. Mixed it well and covered the top with an Aluminium foil. Then placed it in the shaker for 24 hours, at the speed of 125rpm. After 24 hours, filtered the solution to a flask using folded filter papers. Then filtrate was changed to round bottom flask of rotary evaporator (Buchi r 3 Switzerland). Solution was taken out and condensed by placing it in a water bath of condenser. Concentrated solution was spotted on 10x10cm TLC plate (Aluminium sheet coated with normal phase silica gel 60, F_{254}) and TLC plate was placed in the solvent tank using Methanol: Hexane (8:2) as the mobile phase. After development, TLC plate was removed from TLC tank and allowed to dry. TLC plate was observed under UV light of 254nm wavelength using an UV cabinet (CAMAG Sr. N. 21317, Switzerland). Viewing TLC plates under UV light is non-destructive (compound is unchanged after process) while using chemical stain is destructive[11].



Evaluation on ethno-medicinal importance and conservation of medicinal plant *Monochoria vaginalis*

Questionnaire for medical practitioners

1. Name – Rev, Mr, Mrs, Ms .....
2. Registration number - .....
3. For how long have you been treating patients? .....

4. Do you use any medicinal preparations containing Diya habarala (*M. vaginalis*) in treating patients? Yes/ No
5. If 'Yes' what are those medicinal preparations and for what kind of disease conditions?

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6. Do you prescribe Diya habarala plant as a dietary good for patients? Yes/No
7. If 'Yes' to what kind of patients and disease conditions?

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.....

8. Do you prepare any medicines containing Diya habarala? Yes/ No
9. If 'Yes' what are they and the used part of Diya habarala plant for it?

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10. From where do you get the Diya habarala plant for drug manufacturing?

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11. At present do you face any difficulties in finding this plant for drug preparations? Yes/No
12. If 'yes' what may be the causes for this?

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.....

.....

Thank you!

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Questionnaire for General Public

1. Name – Rev, Mr, Mrs, Ms .....
2. Occupation - .....
3. Hometown - .....

4. Have you ever seen this plant? Yes/ No
5. If 'Yes' where/ in which kind of environment?

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6. Have you heard about any medicinal value of this plant? Yes/No
7. If 'Yes' what are they?

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8. Have you ever used this plant as a food/ dietary material? Yes/ No
9. If 'Yes' what are those preparations?

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10. Do you know any other importance of this plant?

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11. Did you notice any reduction of this plant population during past 2,3 years? Yes/No
12. If 'yes' what may be the causes for this?

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Thank you!

Evaluation on ethno-medicinal importance and conservation of medicinal plant *Monochoria vaginalis*

Questionnaire for paddy farmers

1. Name- .....
2. Age- .....
3. Address - .....
4. What's the cultivation you do? .....
5. For how long have you been engaged in cultivation? .....
6. Do you know *Diya habarala* plant? Yes/No
7. In which places have you seen this?

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7. Do you know any other names for this plant? If Yes, what are they?

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8. Is this plant available in your cultivation area? Yes/ No
9. Do you use weedicides/ pesticides/ insecticides in your cultivation? Yes/ No
10. If Yes, for how long? .....
11. Do you know any uses of this plant in day today life? If Yes, what are those?

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12. Is there any reduction noticed in this plant (*Diya habarala*) in your cultivation area? Yes/ No
10. If reduced, what do you think the cause for reduction?

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Thank you!

Figure 1: Samples of questionnaires distributed among Ayurvedic Doctors, farmers and general public in survey study

High Performance Thin Layer Chromatography

This technique is widely employed in identification, detection of adulterants in herbal product which helps in identification of pesticide content and in quality control of herbs[12]. This has become the most potent tool for quality control of herbal medicines because of its simplicity and reliability. TLC plate was placed in HPTLC analyzer and results were analyzed.

Cultivation and Propagation

Plants were cultivated in 2 different environments and growth was observed and records were taken for 3 months.

- 5 plants were cultivated in an open area near water drainage at home garden. Watered the plants daily.
- 5 plants were planted in 5 pots in University premises. Initially compost soil was used and then added peat soil[13, 14]. Watered the plants daily.

Results

Identification

Literature surveys revealed multiple data on the morphological features for correct identification, vernacular names, distribution and nutritional importance of *Monochoria vaginalis*.

In Sinhala, this is known as *Diya habarala, Diya beraliya, Diya habaru*[3] whereas in Sanskrit *Indeevarah* [15] and *Indeevar*[16]. In English, this is known as Oval leaf pond weed, Pickerel weed, Water hyacinth and in Tamil as *Karim kuwalam* [17], *Karun kuwalai* [15]. *Nanka* [15] is the commonest name in Hindi language for this plant.

Macroscopic identification of plant species was mainly conducted by analyzing morphological features [18] (Table 1) and prepared Herbarium sheets of *Monochoria vaginalis* (Figure 2).

Table 1: Morphological features of *Monochoria vaginalis*

Morphological Feature	Description
Habit	Smooth, fleshy, tufted, annual or perennial aquatic herb about 10-50 cm tall with a glabrous, shiny appearance and a short rhizome
Stem	Inconspicuous, obliquely erect.
Roots	Fibrous at base of petioles. Submerged under water or rooted in the mud. Very short, thick, spongy and purplish green branched rhizome.
Leaves	Size and shape is highly variable. In young plants without lamina, leaves are 2-12.5 cm long and 0.5-10 cm wide and narrow at early stage. In older plants broadly ovate, sharply acuminate with a heart-shaped or rounded base, shiny, deep-green with longitudinal veins.
Inflorescence	Spicate, 3-6 cm long. Spike-like inflorescence opposite the floral leaf, and one stamen with a lateral, oblique, erect tooth. Inflorescences bend downward is special.
Flowers	Pedicelled, bisexual, Opposite the sheath of floral leaf at base, violet or lilac blue in colour. [6] Flowers number from 3-25 and open simultaneously or from top to bottom in quick succession. Flowering: - March – August
Fruits	Capsule of about 1cm diameter, splitting between the partitions into three valves. Fruit may mature below the water surface.
Seeds	Propagated by seeds and vegetative parts. Elliptic to slightly ovate, about 1 mm long and raphe sometimes present as a prominent longitudinal ridge.

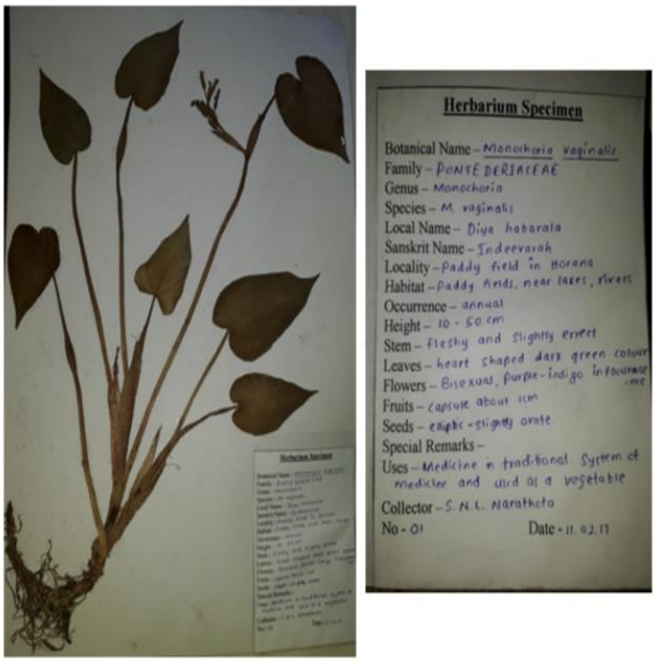

Figure 2: Herbarium sheet of *Monochoria vaginalis* prepared using a specimen collected from a paddy field in Horana, Kalutara district

Distribution

Data on distribution and availability were collected from literature studies and survey studies. This is an annual plant that grows as a perennial in constantly flooded areas. Wide distribution in South East Asia and commonly seen in countries like Philippines, China, Korea, Vietnam, Bhutan, Cambodia, India, Indonesia, Malaysia, Myanmar, Nepal, Pakistan, Taiwan and Sri Lanka[19] In Sri Lanka this grows near paddy fields, riverbanks and lakes especially in low country. This can be seen abundantly in areas such as Rathnapura, Badulla, Makandura, Kegalle, Gampaha, Matale, Galle, Kalutara, Mathugama and Horana. Collected data was interpreted on map [20] indicating 3 climatic zones of Sri Lanka. (Figure 3) It is often abundant in stagnant backwaters or rivers, in open drains, rice fields, swampy places, ditches and wet pastures[19].

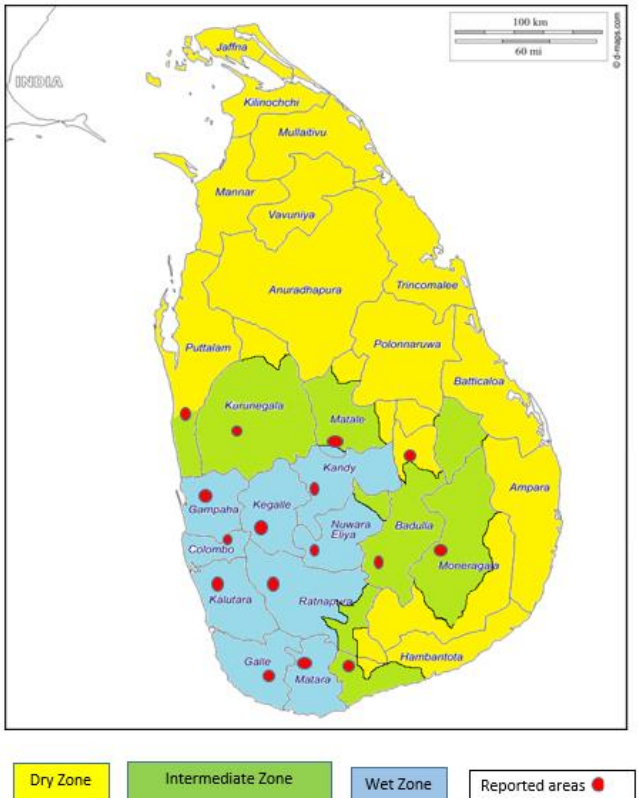

Figure 3: Data collected on distribution of *Monochoria vaginalis* illustrated on a map of Sri Lanka with different climate zones

Ethno - Medicinal importance

Details mentioned in Ayurveda pharmacopoeias and traditional medical texts about the pharmacodynamic properties of *Monochoria vaginalis*

Rasa (Taste): *Madhura* (Sweet)
Guna (Properties): *Laghu* (Lightness)
Veerya (Potency): *Sheetha* (Cold)
Vipaka (Final digestive transformation): *Katu* (Pungent)

Used parts: *Svarasa* or Water extraction / fresh juice of whole plant and leaves [4]

Therapeutic importance supported by clinical data

Leaf juice of *Monochoria. vaginalis* is used to treat cough, asthma, toothache, stomach and liver problems. Fraction of n-butanol from *Monochoria. vaginalis* exhibited anti-oxidant activity and root extracts were evaluated for anti-inflammatory and anti-nephrotoxic activities. Tail immersion and hot plate studies of alcoholic extract of *Monochoria vaginalis* had showed significant analgesic activity. Effective in preventing liver fibrosis, cirrhosis and hepato-carcinogenesis [21]

Disorders that can be cured with drug recipes including *Diya habarala* [22]

GIT: Constipation, Gastritis, Ulcerative colitis, Indigestion, Dyspepsia, Scurvy, Hepatic ailments, Piles, Hemorrhoids, Rectal prolapse
Respiratory system: Asthma, Cough
Circulatory system: Anemia, Blood poisoning
Integumentary system: Skin disorders such as rashes, wounds, ulcers
Genitourinary tract: Anuria, Dysuria, burning sensation in urinating, Menorrhagia
Endocrine system: Diabetes[4] (Figure 4)

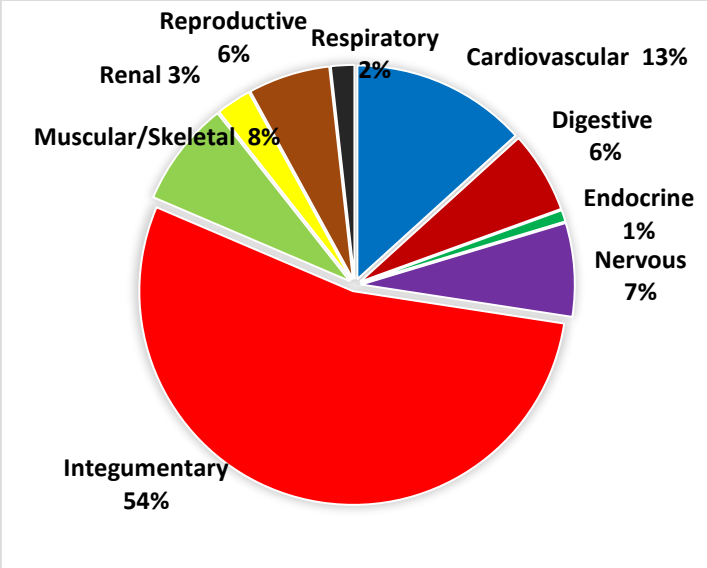

Figure 4: Percentage of drug recipes including *Monochoria vaginalis* stated in *Thalpathe Piliyam* book series according to target body system

Multiple home remedies including *Monochoria vaginalis* were collected by survey study (Table 2). Integumentary system includes skin and its appendages acting to protect body from various kinds of damage from outside. This includes hair, gland and nerves. *Neelyaadi thailaya* is a commonly used oil in Sri Lankan traditional medicine which acts against diseases of integumentary system. This oil is well known for wound healing, fracture healing, lowering blood pressure, headaches and skin diseases. Although there are different drug recipes for preparing this oil, *Diya habarala* is included as a main ingredient in all those recipes[4, 23].

Table 2: Home remedies using *Monochoria vaginalis* found in survey study

Disease Condition	Treatment
Constipation	Prepare gruel with rice and drink. Apply grinded paste around anus in small children.
Urinary calculi	Grind the plant and eat with ghee.
Toothache	Keep grinded plant on painful tooth.
Burning sensation of body	Eat raw salad prepared using this plant.
Hemorrhoids	Eat curry prepared with these leaves.

Nutritional and other importance

All parts of *Monochoria. vaginalis* except the roots are relished as a vegetable[3]. It's mentioned that this plant can be used as an alternative food to alleviate protein–energy malnutrition in populations in developing countries[24]. Carbohydrate, protein and phosphate levels in tissues were similar in leaves and flowers which indicate that both leaves and flowers have nutritional properties equally. There were differences in mineral and protein levels in leaves and flowers of *Monochoria vaginalis*. Amount of non-essential amino acids especially aspartic and glutamic acids were higher in flowers than leaves. Minerals like calcium, potassium, magnesium also found in this plant which helps in gaining adequate nutrition. Anti-nutritional compounds like phenol and tannins had also found in nutritional assessment[24]. Organic compounds of plant origin have pronounced physiological actions on humans. Remarkable presence of organic compounds like alkaloids, flavonoids, glycosides in this plant proves the nutritional value of this plant well[25]. Some food recipes prepared using *Monochoria vaginalis* with medicinal importance were collected in this study (Table 3).

It has also said that this provides a friendly environment to fish and other animals living in water and has found that areas where *Monochoria vaginalis* is more the fish population is also higher[26]. Other than above mentioned benefits this plant is used as cattle fodder in countries like Indonesia[20].

Physical parameter analysis

Litmus test

Red litmus paper showed no change and blue litmus has turned to light pinkish colour, which indicates that *Monochoria vaginalis* solution was having acidic properties.

Determination of pH value

pH value of decoction of *Monochoria vaginalis* was tested and repeated the test for 3 times and the average value was taken. pH value of decoction of *Monochoria vaginalis* = 5.87

Determination of moisture percentage

Moisture content of crude drug is directly related to its stability when there are chances of microbial growth. The shelf life of the drug also increases with lowering the moisture contents. Moisture value of 2g of *Monochoria vaginalis* = 12.12%.

Determination of total Ash value

The total Ash value was 15.23% with a standard deviation of 2.6154. Standard deviation is used to tell how the measurements of a set of results are spread out from the average (mean), or expected value[27]. Depending on the level of contaminations total Ash value can be varied[10].

$$\text{Total Ash Percentage} = \frac{\text{Weight of total ash}}{\text{Weight of raw powder}} \times 100\%$$

$$= (14.96+18.08+10.16+16.84+14.24+17.12)/6$$

$$= 15.233\%$$

Table 3: Common food recipes found from survey study including *Monochoria vaginalis*

Food Recipe	Method of Preparation
 ***Diya habarala kola maaluwa***	*Diya habarala* leaves are well washed and cut. Add some onions, raw chillies, curry leaves, powder of Maldive fish (*Umbalakada*), salt, turmeric powder, chillie powder and cook it on fire. Temper with ghee. Taste can be further increased by adding cooked dhal or jack seeds.
 **Tempered *Diya habarala* leaf curry**	Tender *Diya habarala* leaves and stems are washed well and cut into pieces. Add some onions, raw chillie, *Umbalakada*, turmeric, curry powder, salt and mix well. Temper the curry with coconut oil.
 ***Diya habarala kola malluma***	*Diya habarala* leaves are washed well and cut into small pieces. Add some onions, raw chillie, curry leaves, salt, *Umbalakada* and cook on low fire. Mix scraped coconut, turmeric powder. Temper with oil. Effective for hemorrhoids.
***Diya habarala* raw salad**	*Diya habarala* leaves are washed well and cut into small pieces and onion, raw chille, *Umbalakada* powder and salt is mixed.

Thin Layer Chromatography

Thin layer chromatogram of ethanol extract was observed from *Monochoria vaginalis* powder. Solvent system used was Methanol: Hexane, 8:2 and after development, visualized 2 spots under UV light of 254nm wavelength (Figure 5).

High Performance Thin Layer Chromatography

An extension of TLC is high performance thin layer chromatography (HPTLC) which is robust, simplest, rapid, and efficient tool in quantitative analysis of compounds. Obtained 5 RF values in this test which showed the presence of chemical compounds (Figure 6).

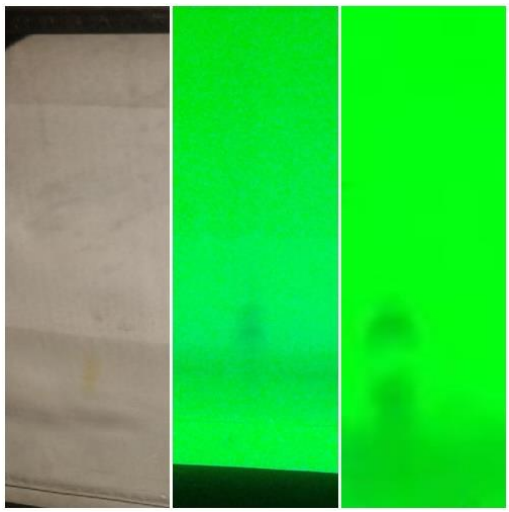

Figure 5: Results of Thin Layer Chromatography visualized under 254nm UV wavelength

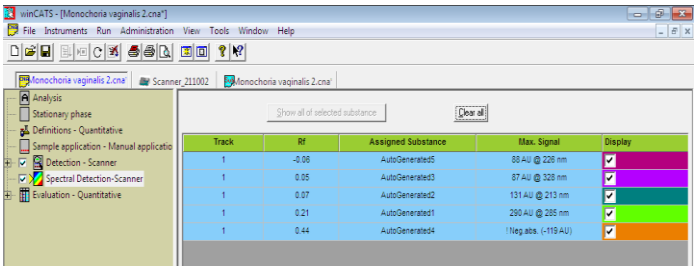

Figure 6: Results of High-Performance Thin Layer Chromatography

Reasons for the lack of availability

- Heavy usage of agro-chemicals such as non-selective weedicides in paddy cultivation
- Illegal wetland destruction
- Land reclamation for development purposes
- Environmental pollution
- Climatic changes
- Difficulty in competing for basic requirements like sunlight, air, apace, soil with plant species like moss/*Paasi* (plants belonging to division Bryophyta) and other invasive plants like *Japan jabara*
- Destruction as a result of unawareness of people about the importance of this plant
- Hardness of water
    - Main cause for reduction in North Central province in Sri Lanka
- Salty wind and sandy soil
    - Main reasons for reduction in coastal margin of Sri Lanka

Cultivation and Propagation

Plants were cultivated in 2 different environments and observations were recorded for 3 months.

Plants cultivated near water drainage

Height of plant, number and size of leaves had increased. Three plants had flowers over the past 3 months and flowering occurred well during March and April. Plants grew well (Table 4).

Plants cultivated in clay pots

Initially cultivated in clay pots with compost soil and after 1 month plants started to become weak, smaller in size and the number of leaves also got reduced. Then the Peat soil [27] was prepared and added. Watered the plants daily. After about a week plants started to grow well. Flowering was mostly in March. At the end of 3 months only 3 plants had liveliness and healthy appearance. Overall, the growth was successful compared to compost soil mixture (Table 5).

Discussion

Monochoria vaginalis is an annual aquatic monocotyledonous plant which belongs to Order Liliales, Family PONTEDERIACEAE and Genus *Monochoria C. presl* (*Monochoria*). *Diya habarala* is known as Diya habaru, Diya beraliya and Jabara. Jabara is a vernacular name for *Japan jabara* (*Eichchornia crassipes*) too. Even though *Eichchornia crassipes* [28] belongs to Family PONTEDERIACEAE, Genus differed as *Eichchornia*. This is an invasive plant with no specific ethno-medicinal value and propagated by runners and destroys natural habitat of many aquatic plants.

Low country wet zone recorded the highest population of *Monochoria vaginalis* and at present it has showed drastic reduction in areas where the use of weedicides is higher. Non selective weedicides, illegal wetland destruction, climatic changes are the main reasons for the lack of availability of this plant in natural habitat and has resulted in inclusion of this plant under lower risk category of IUCN Red Data Records.

By this study, it was cleared that this plant has important ethno medicinal values. Other than the medicinal importance this has nutritional value and used as a vegetable in many parts of the country by native people. Commonly the leaves are used as a vegetable because of the higher nutritional values. It has also mentioned that this plant can be used as a food supplement in protein energy malnutrition for people in developing countries. *Diya habarala* is used in many drug recipes of traditional system of medicine and *Neelyaadiya* oil is one of the widly used drugs prepared using this plant. Most of other drug recipes are used for treating wounds (*Gadu*, *Odu*), skin malignancies and other disease conditions of Integumentary system. This plant is used in treating different ailments such as anuria and constipation in day today life. Most of the therapeutic values of this plant are due to its cold potency. This helps in pacifying and alleviating vitiated *Pitta dosha*.

Monochoria vaginalis decoction was Acidic with a pH of 5.87. Decoction was used as the extraction of chemicals was higher and powder didn't dissolve well in water. Increased moisture was a proof to assume the reduced shelf life of this drug powder. Total Ash value was tested in this study. Ash value is useful in determining authenticity and purity of sample and these values are important in qualitative standards.

Table 4: Records on plants cultivated near water drainage

16.01.17	06.02.17
	
5 plants were planted near water drainage in home garden	After 2 weeks height has increased a bit. No any other significant observations
06.03.17	13.03.17
	
Small flowers were observed	Height and leaf size also increased
27.03.17	03.04.17
	
Height and number of leaves have increased	Plants have well adapted to natural environment. Height and average size of leaves have increased. Fully grown flowers were observed

Table 5: Records on plants cultivated in clay pots

10.02.17  5 plants were cultivated in clay pots	22.02.17  Roots have become fixed. Average height was nearly 12cm. Average breadth of leaves was around 4cm
06.03.17  One plant has shed all the leaves and has started to become weak. Others had no change in number or size of leaves.	Peat Soil was added  
27.03.17  Weakened plants has got fresh with increased height, size and number of leaves	07.04.17  Fully grown flowers were observed in all 5 pots
25.04.17  Flowers were observed in all pots.	15.05.17  Plants have become thin and dried. One plant has died. Environmental temperature has increased to 32ºC

By TLC and HPTLC studies, 5R_f values were obtained which revealed the presence of chemical groups such as Alkaloids, Tannins and Glycosides that may be accountable for therapeutic effects in treating above mentioned diseases.

Sufficient water supply, space, sunlight and moisture were essential for these plants to grow well. Plants cultivated in pots showed successful growth after adding peat soil mixture and started flowering. Peat soil was prepared using soil collected from a paddy field which was similar to their natural habitat. Peat forms when plant material does not fully decay in acidic and anaerobic conditions. It is mainly composed of wetland vegetation including mosses and shrubs. As it accumulates, peat holds water[13]. Peat soil which was prepared using decaying organic components was effective in cultivation and propagation of this plant and can be used in conservation and commercial cultivation. [14] Even a slight change in climate can severely affect the growth of *Monochoria vaginalis* mainly when they are not in natural habitat. These plants propagate from seeds and vegetative parts in a way much similar to propagation of aquatic plants.

Conclusion

Monochoria vaginalis (*Diya habarala*) is an annual aquatic monocotyledonous plant with many ethno-medicinal values. This drug is mainly used in Traditional system of medicine for diseases of Integumentary system and reported to have anti-oxidant activity. At present this has been included in IUCN Red Data Records due to degradation of its natural habitat. This is used as a vegetable in many areas and can take necessary steps to encourage the use of this nutritious plant as a food article. Cultivation using peat soil mixture showed the best results in propagation. Further analysis through isolation of chemical constituents and structure elucidation can be used in development of new drugs which can be beneficial in treating above mentioned diseases. Micro-propagation methods such as Tissue culture techniques can be used for conservation and commercial cultivation of this plant for future.

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