Pharmacognostical studies on the root and rhizome of *Nymphoides hydrophylla* (Linn.) O. Kuntze –An alternate source for *Tagara* drug

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Received 13 October 2011; Accepted 19 January 2012

Tagara is an important drug used in Ayurvedic medicine for the treatment of several diseases. The accepted botanical source of Tagara is *Valeriana jatamansi* Jones, although different species of *Nymphoides* Hill are used by the physicians. The pharmacognostical evaluation of the root and rhizome of *Nymphoides hydrophylla*, a potential alternative source for Tagara is presented in this paper. Important details like morphology of the plant, macro-, microscopical characters, macerate, histochemical tests, UV studies of the root and rhizome along with physico-chemical constants, phytochemical analysis and HPTLC finger print profile are presented, all of which will be useful in the standardization of this drug. Isolation of β-sitosterol, betulinic, salicylic and tannic acids are reported for the first time from *N. hydrophylla*. The pharmacognostical and phytochemical studies help in the identification of *N. hydrophylla* from other species used as Tagara.

**Keywords:** *Nymphoides hydrophylla*, Pharmacognosy, Root, Rhizome, HPTLC, Tagara.

**IPC code; Int. cl. (2011.01)—**A61K 36/00

**Introduction**

*Tagara* is an important drug used in Ayurvedic medicine for the treatment of diseases like anaemia (*pandu*), epilepsy (*apasmara*), fever (*jwara*), jaundice (*kamala*), mental disorders (*unmada*), tuberculosis (*yakshma*) and also as a general and brain tonic1. *Valeriana jatamansii* Jones (Valerianaceae) is the accepted botanical source of *Tagara* which constitutes as one of the ingredients in ayurvedic formulations like *Bala taila*, *Bilvadi gutika*, *Dasanga lepa*, *Jatiphaladya curna*, *Karpuradyarka*, *Maha kalyanaka ghrita*, *Maha narayana taila*, *Puga khanda*, *Sahacaradi taila*, *Srikhandasava*, to name a few2. In South India, a drug under the name *Granthika tagara* (Kannada), botanically identified as *Nymphoides macropsernum* Vasudevan (Menyanthaceae) is used in place of *Tagara* (*Valeriana jatamansii*) for the same ayurvedic preparations, under the same formulations supporting the fact that *Granthika tagara* (*N. macropsernum*) may have similar therapeutic properties to that of *Tagara* (*V. jatamansii*); furthermore, it is often found that *Granthika tagara* is an admixture of different species of *Nymphoides* Hill found in S. India, viz. *N. aurantiacum* (Dalz.) O. Kuntze, *N. indica* (Linn.) O. Kuntze and *N. macropsernum* Vasudevan3. *N. indica* is used as an antiscorbutic and febrifuge, and as a substitute for chiretta [*Swertia chirayita* (Roxb. ex Flem.) Kars.] to treat fever and jaundice4. Literature review revealed that while pharmacognostical studies have been carried out on the roots and rhizome of *N. macropsernum*5 and *N. indica*6, no work is available on *N. hydrophylla*7-9. Hence, the present investigation on the root and rhizome of *N. hydrophylla* was undertaken.

**Materials and Methods**

Plant material was collected from a water tank in the vicinity of Nagercoil, Kanyakumari district, Tamil Nadu, during November 2007, processed into herbarium specimen10; voucher herbarium specimen (Jayashree 025) and a sample of the crude drug are preserved at the herbarium and crude drug museum of the Department of Pharmacognosy, M S Ramaiah College of Pharmacy, Bangalore (MSRCP). The plant material was identified following local floras11-13 and authenticated by S N Yoganarasimhan, Plant Taxonomist. For pharmacognostical studies, a small quantity of rhizome and root were preserved in 70% alcohol; free hand sections were taken for macro- and microscopical observations14,15. Photomicrographs were obtained by observing the free hand sections under a compound binocular microscope (Olympus-
Results

Plant morphology


Aquatic herbs with long floating stem (stolon). Rhizome short, erect, with petiole-like branches reaching the surface of water and producing a node from which arise a tuft of adventitious roots, a cluster of flowers, a single floating leaf and a single branch, which again proceeds similarly. Leaves orbicular, deeply cordate at base, often purplish, to 10 cm in diameter, lobes rounded, faintly crenate, pale green above, glandless and with prominent nerves beneath; petioles to 3.5 cm long. Flowers white, with yellow centre, delicate, with a ring of white hairs round the throat, numerous, in dense clusters; pedicels to 6 cm long, unequal. Calyx divided almost to the base, oblong-lanceolate, obtuse. Corolla white, when expanded; lobes obovate, rounded at apex, glabrous, with a broad longitudinal crest down the middle of each lobe, margins not ciliate. Capsule broadly ovoid or subglobose. Seeds numerous with prominent, small, slightly glochidiate tubercles, scabrous, pale yellowish-brown (Plates 1, 2).

*Nymphaoides hydrophylla* usually flowers and fruits in the winter season. In this species polystely occurs in the cortical region of the stolon and in the petiole of the leaves. It is very common throughout India and is gregarious in habit, generally growing near the margins of tanks and lakes. Also found in Sri Lanka, China and Malaysia.

Vernacular names


Macro- and microscopical characters of the root and rhizome

Macrosopic characters of the root

Roots arise in tufts all around the rhizome, running vertically downwards, very slender, spongy, brownish, measuring to 32 cm long when fresh, and has no characteristic odour or taste. Young fresh roots are minutely hairy and white to brownish while dry roots are slender, brownish (Plates 3, 4).

Macrosopic characters of the rhizome

The rhizomes are slender, running horizontally, cone-like with many leaf bases, rough, brittle, brownish...
without, white within, with several fragments of roots arising from different points, measuring to 9 cm long; it possesses no characteristic odour or taste; dry rhizomes are blackish with a few slender roots and covered by several leaf bases (Plates 5, 6); when transversely cut, it shows a broad whitish cortex and a narrow creamy-white central stele (Plate 7).

**Microscopical characters of the root**

A transverse section of the root is wheel-like and exhibits an epidermis, an outer, middle and inner cortex, a stele region with 7 vascular strands (Plate 8). Epidermis is single layered, made up of compactly arranged rectangular cells, measuring 14-18-21 × 16-21-30 µm; a few root hairs arise from the epidermal

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cells. Next to the epidermis is the outer cortex which is 5 to 6 layered, consisting of compactly arranged parenchymatous cells with intercellular spaces, measuring 26-49-65 × 23-36-48 µm (Plates 9, 10), followed by a broad zone of middle cortex comprising of vertically arranged layers of parenchymatous cells, traversed by large air cavities comprising the aerenchyma, measuring 20-32-51 × 16-32-46 µm (Plate 11); the aerenchyma cells in young roots are interconnected by plug-like structures (Plate 12). Next to the aerenchyma lies 3-4-layered inner cortex consisting of compactly arranged oval shaped parenchymatous cells measuring 27-45-66 × 17-34-33 µm (Plate 13). Endodermis cells measure 16-24-33 × 16-15-25 µm and pericycle cells measure 5-7-8 × 5-9-12 µm, single layered which is followed by the stele. Vascular bundles are radially arranged; xylem is exarch, cells measure 5-10-15 × 10-14-18 µm, with a central parenchymatous pith, cells measuring 6-8-11 × 7-11-16 µm (Plate 14). Starch is absent in pith cells.

Macerate of the root exhibited: 1. Parenchyma cells which are oval and compactly arranged, measuring 40-63-80 × 301-38-50 µm (Plates 15, 16). 2. Vessels with reticulate and spiral thickenings, measuring 84-105-122 × 5-9-12 µm) (Plates 17, 18).

Microscopical characters of rhizome

Transverse section of rhizome exhibits epidermis which is one layered, made up of narrow, tangentially elongated parenchymatous cells, measuring 15-20-25 × 21-28-40 µm. It is followed by 4-5-layered hypodermis, made up of compactly arranged parenchymatous cells, measuring 20-29-38 × 29-35-42 µm. Next to the hypodermis lies a broad aerenchymatous cortex, cells measuring 14-21-33 × 10-15-23 µm and large air cavities, measuring 13-20-31×18-24-29 µm (Plates 19-21). Sclereids are present in the cortex, protruding into the air cavities (Plate 22). The innermost few layers of the cortex consists of compactly arranged cells, without air cavities; a few root traces are found in the cortex (Plate 23) giving the appearance of individual stele which represent a pseudo polystele condition. Stele consists of concentrically arranged vascular bundles, with conjunctive tissue found in between. Vascular bundles are conjoint, collateral, open, endarch; metaxylem cells measure 166-242-323 × 68-98-124 µm; cambium is multilayered, cells measuring 5-10-20 × 3-8-15 µm (Plates 24-26). Pith is large, parenchymatous, cells measuring 20-27-41 × 10-15-18 µm (Plate 27). Starch grains are found in the cortex and pith; they are simple, solitary or aggregated, oval or rounded (Plates 28, 29).

Macerate of the rhizome exhibited: i. Epidermal cells which are compactly arranged, measuring 13-21-28 × 10-15-28 µm (Plate 30); ii. Parenchyma cells which are thin walled, measuring 23-33-51 × 16-22-24 µm (Plate 31); iii. Fibers which are long and with pointed ends, having a broad lumen, measuring 331 × 9 µm (Plate 32); iv. Sclereids of different sizes and shapes- U-, Y-, Z-, and H-shaped, some are with thick walled arms, some with fragmented arms, measure 55-106-121 × 9.5-12.5-16.6 µm (Plates 33 to 39); v. Tracheids which are long, narrow and with pitted thickenings, measure 505 × 20 µm (Plate 40); vi. Vessels of different size and shape, linear or drum shaped, with reticulate and spiral thickenings, measure 30-72-133 × 13-16-24 µm (Plates 41 to 43).

Histochemical tests

The sections of root and rhizome when treated with phloroglucinol and HCl turned pink indicating the presence of lignin; with ferric chloride turned black, indicating presence of tannin; with iodine solution, rhizome sections turned blue indicating presence of starch whereas root sections did not turn blue, indicating absence of starch.

Powder studies

The powder is greenish-brown, possesses no characteristic odour and taste. When treated with phloroglucinol and HCl, stained with safranin, following elements were observed as: i. Fragments of epidermal peel showing compactly arranged cells
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(Plate 44); ii. Aerenchyma cells with intercellular spaces (Plate 45); iii. Sclereids of different size and shape, some with thick walled arms, some with fragmented arms (Plates 46 to 49); iv. Fragments of vessels with reticulate and spiral thickenings (Plate 50, 51).

**Ultra-violet studies**

The powder exhibited the following fluorescence under 425 nm, 254 nm, and 365 nm, respectively when treated with different reagents. Powder as such emitted royal crown, dark green, nickel grey; with dil.
Ammoniacal solution gave teak brown, dark green, aquamarine; with ethanol (70%) gave brown, french blue, satin blue; with 1N methanolic NaOH gave teak brown, dark iced tea, light iced tea; with 1N ethanolic NaOH gave teak brown, wild purple, wild lilac; with 50% H₂SO₄ royal crown, walnut brown, bottle green; with 50% HNO₃ gave mid buff, walnut brown, satin brown; with 5% KOH gave teak brown, walnut brown, satin brown; with 1N HCl gave timber brown, satin grey, smoke grey; with acetone gave teak brown,


Plates 44 to 51—Powder studies— 44. Epidermal peel, 45. Aerenchyma cells, 46 to 49. Sclereids, 50, 51. Vessels with reticulate and spiral thickenings.
royal blue, grey (the colours are based on the Asian paints limited, Mumbai).

**Physico-chemical studies**

The moisture content percent of the drug was found to be 10.35, total ash 8.5, acid insoluble ash 7.6, water soluble ash 0.3, sulphated ash 10.0, alcohol soluble extractive 12.0 and water soluble extractive 22.0. Successive Soxhlet % extractive values, and the colour and consistency were found to be: petroleum ether (60-80ºC) (olive-green, solid, 2.2), chloroform (walnut brown, solid, 1.48), acetone (brown, sticky mass, 4.24), ethanol (brown, solid, 3.7) and aqueous extract (walnut brown, solid, 6.66).

**Phytochemical analysis**

The petroleum ether (60-80ºC), benzene, chloroform, acetone, ethanol (95%) and chloroform-water (2%) (aqueous) extracts were subjected to preliminary phytochemical analysis. It was found that carbohydrates, glycosides, phenolic compounds, tannins and saponins were all present in ethanol and aqueous extracts, coumarins in ethanol extract, fixed oils and fats in pet. ether and benzene extracts, phenols, tannin and flavonoids in acetone, ethanol and water extracts, saponins, phytosterols in pet ether, benzene, acetone and ethanol extracts whereas alkaloids, flavonoids, gums and mucilage, proteins and amino acids were absent in all extracts; besides traces of volatile oil was found to be present on hyrodistillation.

**Determination of total phenolic compounds**

The total polyphenolic compounds found in the aqueous extract was 1.11 (±0.318) (mg/g) and 1.80 (± 0.35) (mg/g) (mean ± SEM) in alcohol extract (Figure 1).

**Chromatographic studies**

**HPTLC profile of aqueous and alcohol extract**

Before derivatisation, the chromatogram was developed in toluene:chloroform:ethanol (28.5:57:14.5). The aqueous extract revealed 10 phytoconstituents having Rf 0.13, 0.14, 0.16, 0.20, 0.22, 0.28, 0.31, 0.40, 0.47, 0.58, 0.86 (Figure 2a) and the alcohol extract gave 10 phytoconstituents having Rf 0.13, 0.16, 0.25, 0.28, 0.31, 0.35, 0.40, 0.47, 0.76, 0.87 under 254 nm (Figure 2b). At 366 nm, aqueous extract revealed 1 phytoconstituent having Rf 0.39 (Figure 2c) and alcohol extract revealed 3 phytoconstituents having Rf 0.37, 0.53, 0.65 (Figure 2d). At 425 nm, aqueous extract revealed 2 phytoconstituents having Rf 0.31, 0.42 (Figure 2e) and alcohol extract revealed 7 phytoconstituents having Rf 0.12, 0.15, 0.28, 0.37, 0.53, 0.68 and 0.75 (Figure 2f). The chromatograms of both aqueous and alcohol extracts were observed under 254 nm (Figure 3a, 3b), 366 nm (Figure 3c, 3d) and 425 nm (Figure 3e, 3f) and Rf values of prominent spots are represented in respective figures.

The plate was derivatised with Libermann-Buchardt reagent and scanned under all the three wavelengths. At 254 nm, aqueous extract revealed 17 constituents having Rf 0.11, 0.15, 0.16, 0.20, 0.24, 0.28, 0.34, 0.41, 0.46, 0.51, 0.52, 0.61, 0.65, 0.68, 0.82, 0.86 (Figure 4a) and alcohol extract revealed 13 phytoconstituents having Rf 0.14, 0.19, 0.23, 0.27, 0.30, 0.36, 0.38, 0.45, 0.50, 0.73, 0.81, 0.87, 0.99 (Figure 4b). At 366 nm, aqueous extract revealed 5 phytoconstituents having Rf 0.32, 0.33, 0.40, 0.63, 0.86 (Figure 4c) and 11 phytoconstituents in alcohol extract having Rf 0.10, 0.15, 0.23, 0.27, 0.32, 0.38, 0.45, 0.50, 0.59, 0.81, 0.87 (Figure 4d). At 425 nm, aqueous extract revealed 8 phytoconstituents having Rf 0.11, 0.17, 0.21, 0.26, 0.32, 0.33, 0.42, 0.50 (Figure 4e) and the alcohol extract revealed 11 phytoconstituents having Rf 0.14, 0.23, 0.28, 0.30, 0.36, 0.38, 0.45, 0.50, 0.62, 0.81, 0.87 (Figure 4f). The chromatograms of both aqueous and alcohol extract were observed under 254 nm (Figures 5a, 5b), 366 nm (Figures 5c, 5d) and 425 nm (Figures 5e, 5f) and Rf values of prominent spots are represented in respective figures.

**Identification of phenolic compounds**

To identify the presence of phenolic compounds in aqueous and alcohol extracts, phenolic compounds such as tannic acid and salicylic acid were used as standards. Standard tannic acid was identified having Rf 0.42 (Figure 6a) and standard salicylic acid was detected at Rf 0.57 (Figure 6b) at 254 nm. Both

![Figure 1—Calibration curve for total phenolic contents.](image-url)
aqueous and alcoholic extracts at 254 nm resolved into 15 and 14 phytoconstituents having $R_f$ 0.42, 0.45, 0.48, 0.50, 0.53, 0.55, 0.57, 0.59, 0.62, 0.64, 0.67, 0.70, 0.71, 0.73, 0.75 (Figure 7a) and having $R_f$ 0.42, 0.44, 0.48, 0.54, 0.55, 0.57, 0.61, 0.62, 0.65, 0.67, 0.69, 0.70, 0.72, 0.73 (Figure 7b), respectively in ethyl acetate: benzene: formic acid (9:11:0.5) solvent system. The peaks and spots having $R_f$ 0.42 and 0.57 corresponded to that of tannic acid and salicylic acid, respectively in both the extracts which was further confirmed by overlay spectrum of standard phenolic compounds (Figures 8-10).

Identification of betulinic acid

The $R_f$ of standard betulinic acid$^{24}$ is 0.59 which was detected in both the aqueous and alcohol extracts under 425 nm (Figures 11a & b, 12).
Isolation and identification of $\beta$-sitosterol

The % yield of the isolated compound was found to be 24% and the melting point 136-137°C. It was subjected to IR analysis and the peaks obtained were recorded. The peaks of the isolated compound was observed to be as follows: Peak 3200-3550 and 1330-1420/cm was due to O-H stretching, peak 2937 and 675-900/cm was due to aromatic C-H bending, while peak 1608-1456/cm was due to aromatic C-C stretching (Figure 13). HPTLC profile of the aqueous extract gave a peak having $R_f$ 0.56 (Figure 14a), alcohol extract ($R_f$ 0.55) (Figure 14b), chloroform extract ($R_f$ 0.56) (Figure 14c) and isolated $\beta$-sitosterol ($R_f$ 0.56) (Figure 14d) at 425 nm. $R_f$ of standard sitosterol was found to be 0.55 (Ref. 25). $R_f$ 0.54 was detected in both aqueous and chloroform extracts and $R_f$ 0.53 in alcohol extract which were identified as $\beta$-sitosterol (Figure 15) and confirmed by IR spectra (Figure 13).

Diagnostic characters

*N. hydrophylla* plant and the drug consisting of roots and rhizome are identified by the following characters:
Figure 6a-b—HPTLC of standard Tannic acid at 254 nm (R_f 0.42) and standard Salicylic acid at 254 nm (R_f 0.57).

Figure 7a-b—HPTLC of aqueous extract at 254 nm (R_f 0.42-tannic acid) and alcohol extract at 254 nm (R_f 0.42-tannic acid and 0.57-salicylic acid).

Figure 8—Overlay spectrum of tannic acid, aqueous and alcohol extracts.
1. Aquatic free-floating habit; 2. Presence of corolla lobes which are entire, white and seeds with glochidiate tubercles; 3. Presence of large aerenchyma; 4. Presence of different types of sclereids in the rhizome; 5. Vessels of spiral and reticulate thickenings in both the root and rhizome.

Discussion

The stagnant and depleting ayurvedic materia medica is replenished by bringing into light new plant sources for some useful and established ayurvedic drugs like Tagara, whose accepted botanical sources are either becoming endangered or are not available in adequate quantities for medicinal preparations\textsuperscript{26}. Nymphoides Hill is a genus of aquatic flowering plants belonging to the family Menyanthaceae. It consists of 20 species, out of which \textit{N. hydrophyl\textit{la}} (Lour.) O. Kuntze, \textit{N. macrospermum} Vasudevan, \textit{N. aurantiacum} (Dalz.) O. Kuntze, \textit{N. indica} (Lour.) O. Kuntze, \textit{N. parvijolium} (Griseb.) O. Kuntze, \textit{N. peltata} (S.G. Gmel.) O. Kuntze, \textit{N. sivarajanii} Joseph and \textit{N. krishnakesara} Joseph and Sivar. are found in India\textsuperscript{27,28,29}. The accepted botanical source of Tagara is \textit{Valeriana jatamansi} Jones. In South India, \textit{Granthika Tagara} (Kannada), botanically identified as \textit{Nymphoides macrospermum}, is used as Tagara in several therapeutic preparations. Granthika Tagara is often found as an admixture of above mentioned species of \textit{Nymphoides} occurring in South India. Also, species like \textit{V. hardwickii} Wall. var. \textit{arnottiana} (Wt.) C.B. Clarke, \textit{V. beddomei} C.B. Clarke, \textit{V. hookeriana} Wt., \textit{V. leschenaultiana} DC. and \textit{Cryptocoryne spiralis} (Retz.) Fisch. ex Wydl., are also treated as

Figure 9—Overlay spectrum of salicylic acid, aqueous and alcohol extracts at 254 m.

Figure 10—Chromatogram of phenolic compounds (alcohol and aqueous extracts, standard and salicylic acid at 254 nm).
potential candidates of Tagara\textsuperscript{30,31}. The different species of \textit{Nymphoides}, viz.. \textit{N. macrospermum}, \textit{N. hydrophylla} and \textit{N. indica} does not exhibit much differences exomorphologically. The corolla is pure white in \textit{N. macrospermum} and \textit{N. hydrophylla} whereas it is yellow in \textit{N. indica}. The seeds are larger in size in \textit{N. macrospermum} while they are very small in \textit{N. hydrophylla} and \textit{N. indica}. The roots are of spongy and stout type in \textit{N. macrospermum} while it is of only spongy type in \textit{N. hydrophylla} and \textit{N. indica}. The rhizome and root of all the three species show similar characters microscopically\textsuperscript{5,6,29}. Ultra-Violet analysis of the powder gave characteristic fluorescence which helps to distinguish the drug from other species considered as Tagara. Preliminary phytochemical analysis of \textit{N. hydrophylla} revealed the presence of carbohydrates and glycosides, coumarins, phytosterols, saponins, phenolic compounds and tannins and traces of volatile oil (present work) whereas steroids, phenols, tannins, saponins, sugars, iridoid or monoterpene derivative, known as valepotriates, an iridoid ester glycoside and essential oils are some of the phytoconstituents present in \textit{V. jatamansi}\textsuperscript{32} which is the accepted source of Tagara. In the alternate sources of Tagara, viz. \textit{N. macrospermum}, steroids, phenols, tannins, saponins, sugars and in \textit{N. indica}, glycosides, phytosterols, saponins, phenolic compounds, gums and mucilage and traces of volatile oil have been reported\textsuperscript{33}.

\textit{N. macrospermum} gave 3 phytoconstituents in petroleum ether extract, while chloroform extract gave 4 phytoconstituents; the alcoholic extract of \textit{N. indica} gave 7 phytoconstituents, while the aqueous extract gave 9 phytoconstituents\textsuperscript{5,6}; both aqueous and alcoholic extracts of \textit{N. hydrophylla} gave 10 phytoconstituents before derivatisation (present work). A triterpenoid compound, β-sitosterol reported in the alcohol extract of roots and rhizomes of \textit{N. hydrophylla} was also found in \textit{N. hydrophylla}. Betulinic acid from the aqueous and alcohol extracts and β-sitosterol from aqueous and chloroform extracts were also detected in \textit{N. hydrophylla} using HPTLC. The sedative and anticonvulsant property in \textit{N. macrospermum}\textsuperscript{34} and the anticonvulsant property in \textit{N. indica}\textsuperscript{35} are reported which are also assigned to Tagara in Ayurveda\textsuperscript{1}.

**Conclusion**

The taxonomical characters dealing with the exomorphology of \textit{N. hydrophylla}, a potential source of the drug Tagara in Ayurveda, is described to helps in the identification of the plant in the field. Other studies, viz. macro- and microscopical studies of the drug (root and rhizome), chromatographic studies,
Phytochemical analysis, etc carried out during this study will help in evolving diagnostic characters, in determining pharmacopoeial parameters, standardisation of therapeutic formulations, besides in the isolation and identification of bioactive principles/biomarkers. HPTLC fingerprinting of tannic acid and salicylic acid was carried out in alcohol and aqueous extracts and betulinic acid from aqueous and alcohol extracts and β-sitosterol from aqueous and chloroform extracts were detected for the first time in this species. *N. hydrophylla* which is an allied species of *N. macrospermum* and *N. indica* may
serve as a substitute source of Tagara as it may have similar therapeutic properties.

Acknowledgements
The authors are thankful to the authorities of the Gokula Education Foundation and V V Pura College of Science, Bangalore for providing necessary facilities and encouragement. They are also thankful to Mr. V Chelladurai of Tirunelveli for help in providing plant material.

References
8. Iyengar MA, Bibliography of investigated Indian Plants, Manipal, Manipal Power Press, 1976, 1-144.
33 Shilpi Arora, Pharmacognostical, phytochemical and pharmacological studies on root and rhizome of *Nymphoides indica*, M. Pharm Dissertation, RGUHS, Bangalore, 2008.