

Comparative Pharmacognostic study of market samples of *Tagara* collected from five different markets of Kerala with the official source plant *Valeriana jatamansi* Jones ex Roxb

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Abstract

Background: *Tagara* is a very popular Ayurveda herb used in the treatment insomnia, epilepsy, neurosis, hepatoprotective, anticancerous, and analgesic. Characteristic smell is the typical feature of it. As per the Ayurvedic Pharmacopoeia of India and many other classical texts, rhizomes of *Valeriana jatamansi* of the family *Valerianaceae* is the accepted source of the drug. From some of the reports from early 1980s, it was found that roots of some aquatic plants such as *Nymphoides macrospermum*, *Nymphoides hydrophylla*, *Nymphoides indica*, and *Limnanthemum cristatum* were said to be used as *Tagara* instead of *V. jatamansi* in the South Indian markets. **Aim:** This study proposed to assess the present status of *Tagara* available in herbal raw drug markets of Kerala. **Materials and methods:** Five market samples of *Tagara* were collected from selected markets of Kerala, and some of the reported aquatic plants, collected from natural habitats nearby. Macroscopic, microscopic, histochemical, and powder microscopic characterization of all these samples were done as per the standard procedure mentioned in Ayurvedic Pharmacopoeia of India and characters observed were compared with official source plant and pharmacopoeial standard. **Results:** Morphological characters of market samples of *Tagara* collected from the various markets of Kerala were not matching with the rhizomes of genuine drug *V. jatamansi* and that of Uttarakhand sample. The microscopic and histochemical examination also gave the same result. However, these samples showed similarities with the roots of *Nymphoides macrospermum*. Sample collected from Uttarakhand was the rhizome of *V. jatamansi*. **Conclusion:** The collected market samples of *Tagara* from various Kerala markets were not the rhizomes of *V. jatamansi* but the roots of *N. macrospermum*.

Keywords: Market sample study, pharmacognosy, *Tagara*, *Valeriana jatamansi*

Introduction

India has a rich heritage of plant-based health care systems such as Ayurveda, Unani, and Siddha. In the last few decades, while the availability of medicinal plants collected from forests is becoming uncertain, demand for herbs and plants has been increasing due to resurgence in interest in the AYUSH systems. Therefore, the forest resources are under threat as they are insufficient to meet the increasing demand of medicinal plants and herbs. Increased demand, deforestation, and exploitation of natural resources accelerate the problems of adulteration and substitution. The efficacy of Ayurveda system mainly depends on the use of genuine raw material of quality and standardized ingredients in the manufacture of medicines. Hence, quality assurance of market samples is a very important step for getting the global acceptance of this stream of medicine.^[1]

Tagara is an important medicinal and aromatic plant of temperate Himalayan region. The rhizomes and roots of the plant yield high value essential oil for which it is collected from the wild sources since cultivation of this plant is not yet in practice. Indian valerian (English) is also popularly known as *Mushkabala* (Kashmiri/Hindi), *Sugandhbala* or *Tagara* (Sanskrit), grows wild in the temperate Western Himalayan region between 1000 m and 3500 m altitude.^[2] Natural populations of the species are found mostly

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as undercover on moist slopes along the streams. According to the National Medicinal Plant Board, its estimated annual trade is 1000–2000 metric tons.^[3] Over-exploitation of rhizomes for its medicinal and aromatic value has resulted in rapid depletion of natural resources and it is now considered as endangered in the Himalayas.

In market, different varieties are available in the name of *Tagara*. Oil extracted drug is also available in the market. In South India, it is said to be substituted by other botanical sources such as *Nymphoides hydrophylla* (Lour.) Kuntze.^[4] There were some published studies about the market samples of *Tagara* in South India, especially in the Karnataka market and concluded the presence of a water plant *Nymphoides macrospermum* Vasud. Nair as the source of *Tagara* and it was described as *Granthika Tagara*.^[4-7] Some comparative pharmacological activities of this plant with the original source plant of *Tagara* were also available.^[8,9] In some parts of South India, *Cryptocoryne spiralis* (Retz.) Fisch. ex Wydler was also reported to be taken as *Tagara*.^[10] The market samples of *Tagara* in Kerala are often seemed to be a different one as compared to samples from North India and the typical smell of *Tagara* is not at present in samples brought from the Kerala market. Till the date, no Kerala-based market sample studies were published, and hence, this work aimed to check the authenticity of market samples of *Tagara* from five selected Kerala markets by comparing with the official source *Valeriana jatamansi* Jones ex Roxb.

Materials and methods

The genuine samples of the rhizome were collected from the raw drug museum of Center for Medicinal Plant Research (CMPR), Arya Vaidya Sala, Kottakkal, Kerala (Raw drug number CMPR/RDR/249). Market samples of *Tagara* were collected from the local markets of Kasargodu, Kozhikode, Malappuram, Thrissur, and Thiruvananthapuram districts of Kerala. Markets which are famous for herbal trade were selected in such a way that it will be a cross section of entire Kerala market covering southern, middle, and northern areas of the state.

N. macrospermam was collected from a Lotus cultivation field near Thirunavaya, Malappuram, Kerala, and specimens were deposited at the Herbarium of CMPR, Arya Vaidya Sala, Kottakkal, Kerala (Herbarium Voucher No: 12864).

N. hydrophylla was collected from VPSV Ayurveda College, Kottakkal, Kerala and specimens were deposited at the Herbarium of CMPR, Arya Vaidya Sala, Kottakkal, Kerala (Herbarium Voucher No: 12872).

Samples were named as follows:

- Sample 1: Dried Rhizome of *V. jatamansi* Jones ex Roxb
- Sample 2: Sample collected from Kasaragodu market
- Sample 3: Sample collected from Kozhikode market
- Sample 4: Sample collected from Malappuram market
- Sample 5: Sample collected from Thrissur market
- Sample 6: Sample collected from Thiruvananthapuram market (1st and 2nd quality)

- Sample 7: *N. macrospermam*-roots
- Sample 8: *N. hydrophylla*-roots.

The compound microscope was used for the sample analysis as Leica DM 1000 LED Leica, Nussloch, Germany. Trinocular “Leica” microscope attached with “Leica DFC 295” digital camera connected to the computer and Leica Application Software Leica Application Suite Version 3.6.1 were used for viewing and transferring the microscopic images. Plant microtome, automatic MT3 was used for taking fine sections. Digital camera Canon EOS 200 D was used for capturing the macroscopic images.

Chemicals and reagents

Saffranin was used as the staining agent and glycerine (50%) for mounting the specimens during microscopic studies. Ferric chloride (5%), iodine (3%), phloroglucinol (1%) + hydrochloric acid concentrated hydrochloric acid (HCl), and sudan red (0.5%) were used for histochemical localisation tests for tannins, starch grains, lignified cells, and oil globules, respectively.

Methodology

The study was conducted during the period of January–March, 2021 at the Pharmacognosy labs of CMPR, Arya Vaidya Sala, Kottakkal and VPSV Ayurveda College, Kottakkal. Market samples were collected from the local market. Herbarium specimens were deposited in “CMPR herbarium.” Parts studied were dried and stored in “CMPR Raw Drug Museum.”

Thin transverse sections of each plant material were taken using blades by the hand and also using microtome, stained with appropriate reagents, mounted and observed through the microscope. Histological microphotographs were transferred using the computer controlled microscopic system and camera. For examining the cell structure in powder form, materials were powdered, sieved, stained with appropriate stain, mount in glycerin and observed under microscope transferred the image of powder characters to the computer using the computer controlled microscopic system.

Results

Pharmacognostic characters of the genuine and market samples of *Tagara* can be summarized as follows.

Sample 1: *Valeriana jatamansi*-rhizome

Macroscopic characters

Rhizome, of about 2–5 cm long and 4–8 mm thick pieces, dull yellowish-brown. sub-cylindrical and dorsiventrally somewhat flattened, rough, slightly curved and unbranched, under surface bearing numerous, small, circular prominent, root scars and a few stout rootlets, crown bearing remains of aerial stems with scale leaves, fracture short and horny, stolon connecting rhizomes stout, 1–5 mm long and 2–4 mm thick, yellowish-gray in color, longitudinally wrinkled, usually with nodes and internodes and bearing adventitious

roots, occasionally thin stolons 1–2 mm thick. Root were yellowish-brown, 3–5 cm long and 1 mm thick, [Figure 1a-c] strong irritating smell of isovaleric acid. Taste bitter and somewhat camphoraceous. [Table 1]

Microscopic characters

Rhizome

Transverse section (TS) of rhizomes circular with wavy margin, ruptured at places, divided into three distinct regions– cork, cortex and stele. The central portion was occupied by parenchymatous cells. Vascular area was

characterized by the presence of 8–20 vascular bundles of varying sizes. [Figure 1d-f]

Detailed TS showed outer cork composed of 5–10 layers of elongated thick walled suberized cells of irregular margins. The cells of the outer layers showed the presence of reddish brown depositions. The cortex region was characterized by the presence of 3–5 layers of collenchymatous cells followed by the wide parenchymatous cells. The cortical cells were completely filled with starch grains of varying sizes. Individual grains being 16–20 µm. Some of cortical cells were filled with

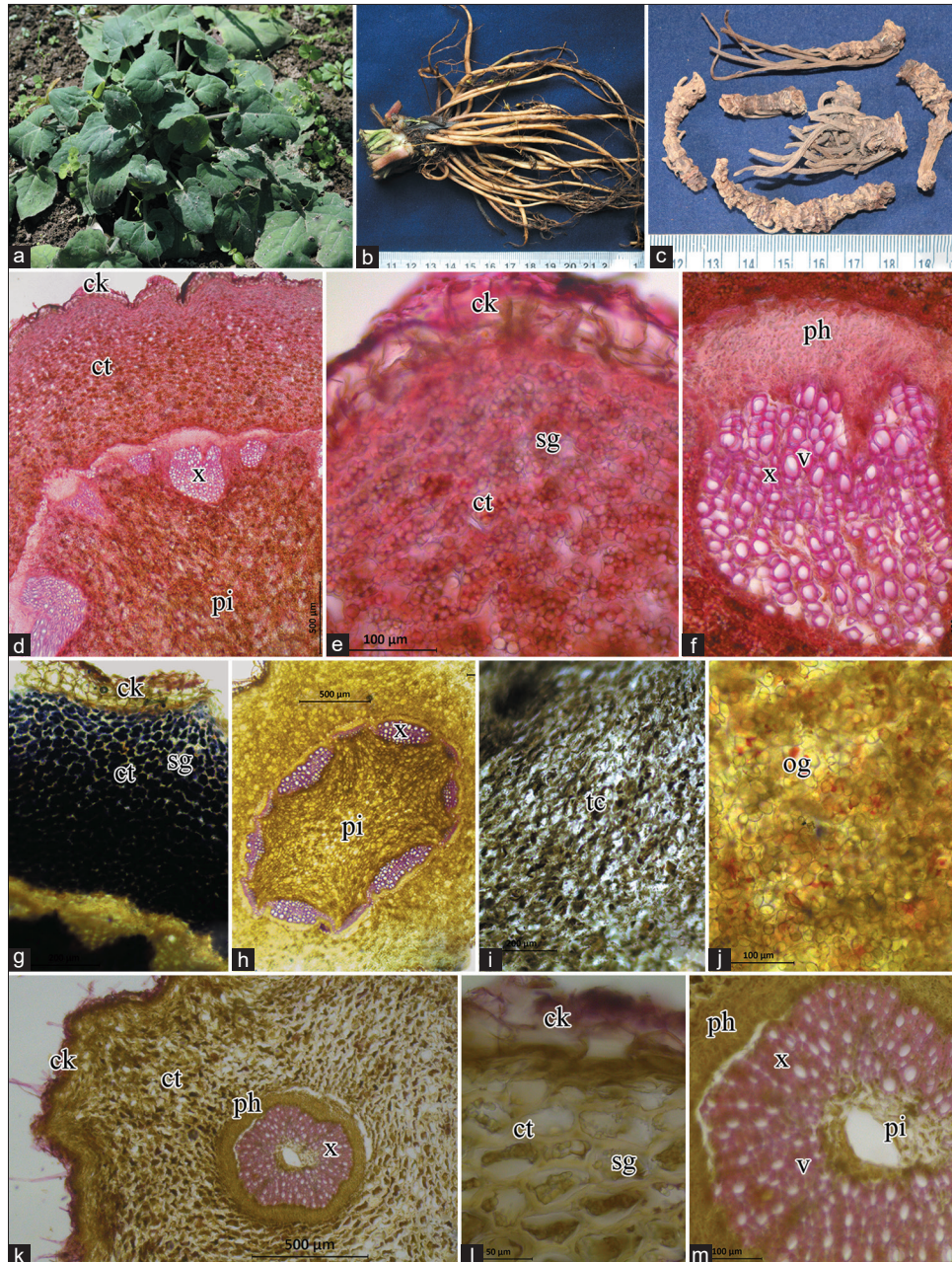


Figure 1: *Valeriana jatamansi* Jones ex Roxb. (a) Habit, (b) Fresh roots, (c) Dried rhizome and roots, (d) TS of rhizome outer portion enlarged, (e) TS of rhizome outer portion enlarged, (f) TS of rhizome showing vascular bundle, (g) Test for starch, (h) Test for lignin, (i) Test for tannin, (j) Test for oil, (k) TS of root entire, (l) TS of root outer portion enlarged, (m) TS of root centre portion enlarged. ck: Cork, ct: Cortex, ph: Phloem, pi: Pith, og: Oil globules, sg: Starch grains, tc: Tannin cells, v: Vessels, x: Xylem

tannin depositions. The cortex was delimited by the single layer of tangentially elongated endodermis. Round-to-oval vascular bundles of varying sizes and number arranged in ring fashion just below the endodermis. Phloem was composed of small sized condensed cells arranged as a cap just above the xylem. Xylem consisted of radially arranged vessels of varying sizes, fibers, and parenchyma. Vessels were radially arranged. Pith was comparatively large and occupy major portion of the section, composed of parenchymatous cells often filled with tannin depositions. Oil globules were present in some of the parenchyma cells of the section. [Figure 1g-j]

Root

Transverse section of the root was circular in outline with wavy margin. Root hairs were found, originating from outer layers. The narrow cork region was composed of 3–5 layers of square to rectangular cells and cortex wide. The outer layers of collenchymatous cells were followed by wide parenchymatous zone often filled with starch grains. Cortex delimited by the presence of single layer endodermis followed by a ring of small-sized condensed phloem cells covering the xylem region. Xylem a continuous ring of radially arranged vessels and fibers, followed by central narrow parenchymatous pith. [Figure 1k-m]

Table 1: Macroscopic comparison of *Valeriana jatamansi* and market samples of *Tagara*

Parameters	<i>Valeriana jatamansi</i>	Market samples
Size	4–6 cm long 4–10 mm thickness	4–7 long 1–2 mm thickness
Shape	Sub cylindrical, curved dorsiventrally, flattened	Cylindrical, tapering downwards
Colour	Yellowish brown to dark brown	Yellowish brown
Surface	Rough	Hairy
Odour	Strong	Absent
Taste	Bitter, camphoraceous	Absent

Histochemical localization

Clusters of round-to-oval shaped starch grains of 5–8 μ m in size were present in parenchyma cells. Oil globules were filled in the some of the cells of cortex. Lignin content is present in xylem elements and outer layers of the cork. Tannin depositions found in parenchyma cells and in cork. [Figure 1g-j]

Powder microscopy

Rhizome

Shows fragments of thick-walled suberized cells of the cork in the surface view and with attached collenchymas in the sectional view; longitudinally cut groups of spiral xylem vessels associated with lignified pitted parenchyma; spherical simple and compound starch grains varying in size, measuring 5–15 μ m in diameter and yellowish brown oil droplets. [Figure 2a-i]

Pharmacognostic characters of market samples

Five market samples of *Tagara* were collected from Kerala, i.e., from Kasaragod, Kozhikode, Malappuram, Thrissur, and Trivandrum. All the samples were macroscopically similar except the second quality sample collected from Trivandrum.

Macroscopic comparison of market samples (sample 2–sample 6)

All the samples, collected from selected markets of Kerala were having similar macroscopic characters, showed a structure having 6–12 cm length a cluster of roots originating from a single point. [Table 1] Roots were brown in color, 6–12 cm long, 1–3 mm thick cylindrical tapering towards one end with plenty of hairs. Surface slightly rough. Fracture was short. Inner surface was white in color. Broken surface was slightly rough. No specific odor and taste. Samples collected from Malappuram (sample 4) were comparatively fresh in nature. Second quality collected from Trivandrum market (sample 6) was of about 2–5 cm long and 4–8 mm thick pieces, dull yellowish-brown, sub-cylindrical and dorsiventrally somewhat

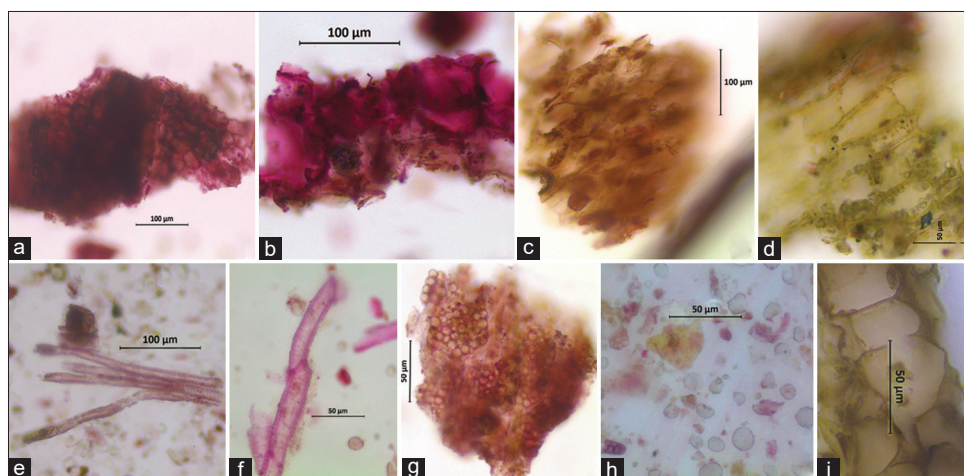


Figure 2: Powder microscopic characters of *Valeriana jatamansi* rhizome. (a) Cork cells in surface view, (b) Cork cells in the sectional view, (c) Cortical cells in the sectional view, (e and f) Fragments of vessels and tracheids, (g) Parenchyma cells with starch grains, (h) Starch grains, (i) Cork cells in sectional view

flattened, rough, slightly curved and unbranched, under surface bearing numerous, small, circular prominent, root scars and a few stout rootlets, crown bearing remains of aerial stems with scale leaves, fracture short and horny, stolon connecting rhizomes stout, 1–5 mm long and 2–4 mm thick, yellowish-grey in color, longitudinally wrinkled, usually with nodes and internodes and bearing adventitious roots, occasionally thin stolons 1–2 mm thick. Root yellowish-brown, 3–5 cm long and 1 mm thick, strong irritating smell of isovaleric acid. Taste bitter and somewhat camphoraceous. [Figure 3a-h]

Microscopic comparison of market samples (sample 2–sample 6)

The comparison of different samples is shown in Table 2. TS of all the five samples are circular in outline with slightly wavy margin. Trichomes were found originating from the epidermis in many regions. The cortex was wide composed of uniformly



Figure 3: Macroscopy of genuine and market samples of *Tagara*. (a) *Valeriana jatamansi* rhizome and roots, (b) Sample collected from Uttarakhand, (c) Trivandrum sample 1, (d) Trivandrum sample 2, (e) Thrissur sample, (f) Malappuram sample, (g) Kozhikode sample, (h) Kasargode sample

arranged parenchymatous cells occupying more than 3/4th of the entire section.

Detailed TS showed outer single layer of the epidermis composed of irregularly shaped cells of varying sizes. Unicellular trichomes of different length and size were originating from the epidermal cells at many places. The first quality sample from Trivandrum contained less number of trichomes. Tannin was present in the epidermis and in trichomes. The cortex was wide composed of uniformly arranged radial rows of round to oval shaped parenchyma cells with large intercellular spaces. Just below the epidermis showed the presence of thick-walled stone cells in single or in groups. Sample from Thrissur (sample 5) and first quality sample from Trivandrum (sample 6) contained less number of stone cells. Sample from Malappuram (sample 4), sample from Thrissur (sample 5), and first quality sample from Trivandrum (sample 6) contained air cavities (aerenchyma) just below the epidermis. Plenty of simple and compound starch grains were present in both inner and outer cortex. Individual grains being 5–8 μ in all the samples. Sample from Kozhikode (sample 3) had oil globules in the inner cortex. First quality sample from Trivandrum contained small oil globules in the outer cortex. Other samples did not contain any oil globules.

The endodermis was distinct and composed of single layer of lignified cells. Xylem was consisting of 10–12 radially arranged polygonal shaped vessels arranged in exarch manner, i.e., protoxylem toward the periphery and metaxylem toward the center. Sample from Thrissur had 8–10 xylem vessels. Comparatively high number of vessels was seen in Thrissur sample (sample 5). In Trivandrum sample (Sample 6), xylem showed comparatively much developed structure in which vessels of almost same sizes arranged in circular manner. Phloem was arranged as a small group in between the xylem patches. Centre portion (pith) was occupied by polygonal-shaped parenchymatous cells. [Table 2, Figure 4a-l, Figure 5a-l and Figure 6a-l]

Powder microscopy

Powder microscopy showed cork cells, stone cells 70–80 μ m in length, cortical cells showed starch graings of 4–7 μ m, fragments of trichomes, tracheids, and vessels. [Figure 7a-h] Microscopic characters of the market samples collected were not matching with genuine sample (*V. jatamansi*) but showed similarities with the roots of aquatic plants. As per the earlier reports, *N. hydrophylla* was available in the Kerala Market as *Tagara*. Pharmacognostic characters of the root of *N. hydrophylla* and allied species were done and the detail results as follows.

Microscopic comparison of market samples with selected aquatic plants

Sample 8: *Nymphoides hydrophylla* Root

TS is circular in outline. Cortex was wide occupying 3/4th of the entire section composed of parenchyma cells with air

Table 2: Microscopic comparison of market samples of *Tagara* with selected aquatic plants

Sample	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	<i>N. macrospermum</i>	<i>N. hydrophylla</i>
Epidermis	Single layered Radially elongated polygonal cells	Single layered Radially elongated polygonal cells	Single layered Radially elongated polygonal cells	Single layered Radially elongated polygonal cells	Single layered Radially elongated polygonal cells	Single layered Radially elongated polygonal cells	Single layered uniformly arranged cells
Trichomes	Present Unicellular	Present Unicellular	Present Unicellular	Present Unicellular	Present Unicellular - rarely	Present Unicellular - rarely	Absent
Stone cells	Present in outer cortex	Present in outer cortex	Present in outer cortex	Present in outer cortex	Present in outer cortex - less numbers	Present in outer cortex - less numbers	Absent
Cortex	Wide, parenchymatous, with intercellular spaces	Wide, parenchymatous, with intercellular spaces	Wide, parenchymatous, with intercellular spaces	Wide, parenchymatous, with intercellular spaces	Wide, parenchymatous, with intercellular spaces	Wide, parenchymatous, with intercellular spaces	15–20 layered wide, composed of round to oval parenchymatous cells
Air cavities	Absent	Present - 10–12	Absent	Present - 35–40	Present - 16–20	Absent	Present in inner cortex
Endodermis	Single layered, tangentially elongated	Single layered, tangentially elongated	Single layered, tangentially elongated	Single layered, tangentially elongated	Single layered, tangentially elongated	Single layered, tangentially elongated	Single layered, tangentially elongated
Pericycle	Present, single layered polygonal cells	Present, single layered polygonal cells	Present, single layered polygonal cells	Present, single layered polygonal cells	Present, single layered polygonal cells	Present, single layered polygonal cells	Present, single layered
Xylem	10–12, exarch, radially arranged	10–12, exarch, radially arranged	10–12, exarch, radially arranged	8–10, exarch, radially arranged, higher number of vessels	10–12, exarch, radially arranged, much developed, vessels are almost same size	10–12, exarch, radially arranged	5–6, endarch, radially arranged
Phloem	In between two xylem groups	In between two xylem groups	In between two xylem groups	In between two xylem groups	In between two xylem groups	In between two xylem groups	Above the xylem
Pith	Small, parenchymatous	Small, parenchymatous	Small, parenchymatous	Small, parenchymatous	Small, parenchymatous	Small, parenchymatous	Small, parenchymatous
Starch	Present	Present	Present	Present	Present	Present - less	Present - 3–4 µm
Tannin	Present in epidermis and trichomes	Present in epidermis and trichomes	Present in epidermis and trichomes	Present in epidermis and trichomes	Present in epidermis and trichomes	Present in epidermis and trichomes	Present in epidermis
Lignin	Stone cells, xylem vessels are filled with lignin	Stone cells, xylem vessels are filled with lignin	Stone cells, xylem vessels are filled with lignin	Stone cells, xylem vessels are filled with lignin	Stone cells, xylem vessels are filled with lignin	Stone cells, xylem vessels are filled with lignin	Epidermis (less), endodermis (less) and xylem vessels are filled with lignin
Oil	Absent	Present, oil globules in inner cortex	Absent	Absent	Present, oil globules in outer cortex	Absent	Absent
Crystals	Absent	Absent	Absent	Absent	Absent	Absent	Absent

cavities and intercellular spaces. Detailed TS showed outer single layer of epidermis composed of uniformly arranged cells of similar size. Cortex was wide, up to 4–5 layer composed of round to oval parenchymatous cells in similar size (outer cortex). Inner cortex consisted of 10–15 circularly arranged air cavities between the parenchyma cells. Less number of starch grains in cortical region, size 3–4 µm. Cortex was delimited by single layered less lignified tangentially elongated parenchyma cells called endodermis. Just below the endodermis, single layered pericycle was present. Xylem consisted of 5–6 radially arranged vessel groups arranged in end arched manner. Phloem was arranged just above the xylem vessels. Pith was very small occupied by polygonal shaped parenchymatous cells without any intercellular spaces. [Figure 8a-m]

Sample 7: *Nymphoides macrospermam* Root

TS is circular in outline with slightly wavy margin. Trichomes were found originating from the epidermis in many regions. The cortex was wide composed of uniformly arranged parenchymatous cells occupying more than 3/4th of the entire section. Detailed TS showed outer single layer of the epidermis composed of irregularly shaped cells of varying sizes. Unicellular trichomes of different length and size were originating from the epidermal cells at many places. Cortex was wide composed of uniformly arranged radial rows of round-to-oval shaped parenchyma cells with large intercellular spaces. Just below the epidermis showed the presence of thick walled stone cells in single or in groups. Some of the outer cortical cells showed presence of starch

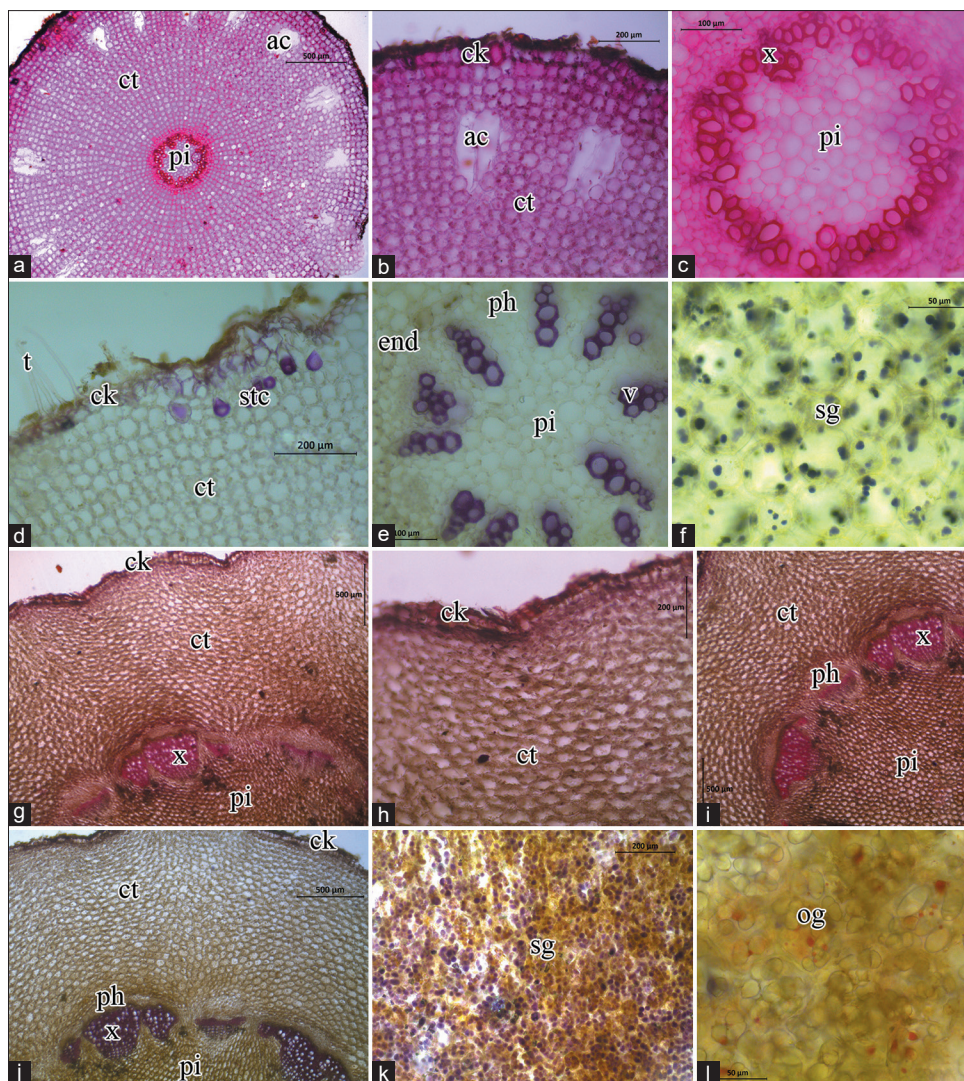


Figure 4: Microscopy of *Tagara* sample collected from Trivandrum market. (a-f) TS of first quality sample. (a) TS entire, (b) TS outer portion enlarged, (c) TS stelar portion enlarged, (d) TS of outer portion of young sample, (e) TS of inner portion of young sample, (f) Histochemical test for starch. (g-l) TS of the second quality sample. (g) TS portion enlarged, (h) TS outer portion enlarged, (i) TS inner portion enlarged, (j) Histochemical test for lignin, (k) Test for starch, (l) Test for oil. ac: Air cavity, ck: Cork, ct: Cortex, end: Endodermis, og: Oil globules, ph: Phloem, pi: Pith, sg: Starch grains, stc: Stone cell, t: Trichome, v: Vessels, x: Xylem

grains. Simple and compound starch grains were present in the inner cortex. Individual grains being 4–7 μm . Endodermis was distinct and composed of single layer of lignified cells. Xylem consisted of 10–15 radially arranged polygonal vessel groups in end arched manner. Phloem was arranged as a small group in between the xylem patches. Center portion (pith) was occupied by polygonal-shaped parenchymatous cells. [Figure 9a-m]

Powder microscopy

Powder microscopy showed cork cells, fragments of trichomes, stone cells in groups, parenchyma cells from cortex with starch grains, fragments of vessels, and sclereids [Figure 10a-g].

Discussion

Tagara is an important drug using in conditions such as *Visha* (poisoning), *Unmada* (psychosis), *Apasmara* (epilepsy), and

general neurotoxicity. In Ayurvedic texts, it is popularly known as *Nata*. Rhizome of *V. jatamansi* is the official source of the drug and the plant is a perennial herb, growing in temperate Himalayas from Kashmir to Bhutan and Khasia hills up to an altitude of 3000 m.^[10] From the literature review, lots of pharmacological researches are done on *V. jatamansi*. The quality standards of Indian medicinal plants state that *V. jatamansi* is the botanical identity of *Tagara*.^[11] It has typical odor due to the presence of volatile oils. The oils are using in perfume and leather industry. There are some notions that it is sold in market after oil extraction. There are reports that *N. hydrophylla* is used as substitute for *Tagara* in South India. Hence, it is very important to identify the exact botanical identity of the market sample of *Tagara*.

From this study, it was understood that roots of *N. hydrophylla* had no similarity with *V. jatamansi* morphologically and it is sold in the name of *Tagara* in Kerala markets.

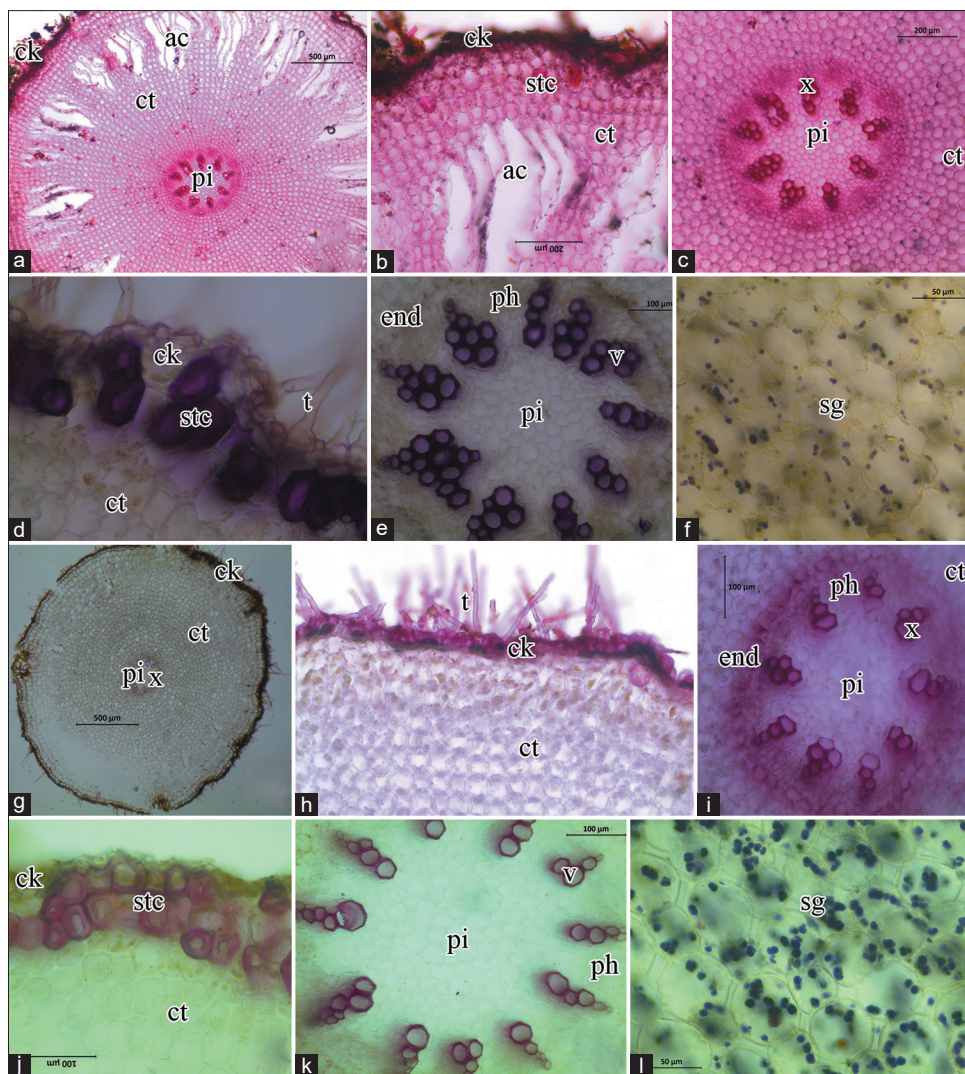


Figure 5: Microscopy of *Tagara* market samples. (a-f) TS of sample collected from Thrissur market. (a) TS entire, (b) TS outer portion enlarged, (c) TS stelar portion enlarged, (d) TS of outer portion showing lignified cells, (e) Histochemical test for Lignin in stelar region, (f) Histochemical test for starch. (g-l) TS of sample collected from Malappuram market. (g) TS entire, (h) TS outer portion enlarged, (i) TS stelar portion enlarged, (j) TS of outer portion showing lignified cells, (k) Histochemical test for Lignin in stelar region, (l) Histochemical test for starch. ac: Air cavity, ck: Cork, ct: Cortex, end: Endodermis, ph: Phloem, pi: Pith, sg: Starch grains, stc: Stone cell, t: Trichome, v: Vessels, x: Xylem

Pharmacognostic characters of sample 1 had the characters of the genuine drug which are characters mentioned in API^[12] and ICMR Quality standards of Indian Medicinal Plants.^[11] Hence, sample 1 was identified as genuine one. Morphologically samples 2–6 did not match with sample number 1, i.e., the original rhizome collected from raw drug museum CMPR. Hence, it was observed that *Tagara* available in Kerala markets are different one. Samples 2–6, i.e., market samples, looked like root portion, clusters of roots running vertically downwards, tapering toward the base with brownish yellow in color without an odor. Genuine sample 1 was the rhizome with characteristic smell. Hence, as per the above observation, it was clear that market samples 2–6 did not match morphologically with sample 1 (genuine). Genuine one possessed rhizome while all the market samples were root.

TS of the genuine rhizome of *V. jatamansi* (sample 1) were compared with that of market les. All the characters of the

market samples were having no similarities with that of genuine rhizome (sample 1). There is no difference between the market samples. All possessed same microscopic characters. Samples 3–6 had air cavities in outer cortex. All the market samples 2–6 had wider cortex and small pith. Sample from Kozhikode, Malappuram, and Trivandrum contained some oil contents. Genuine rhizome had lots of oil globule. Market samples 2–6 had no significant oil content. Both genuine and market samples possessed starch grains and were about 16–20 μm and 5–8 μm , respectively.

Hence, it was necessary to identify the botanical source of market sample as all market samples were not matching with genuine one. Market samples showed similarities with roots of aquatic plants. On interrogation with suppliers, it was known that they were getting it from Thirunavaya, Malappuram district, Kerala. By the help of local people, it was found that *Tagara* (local

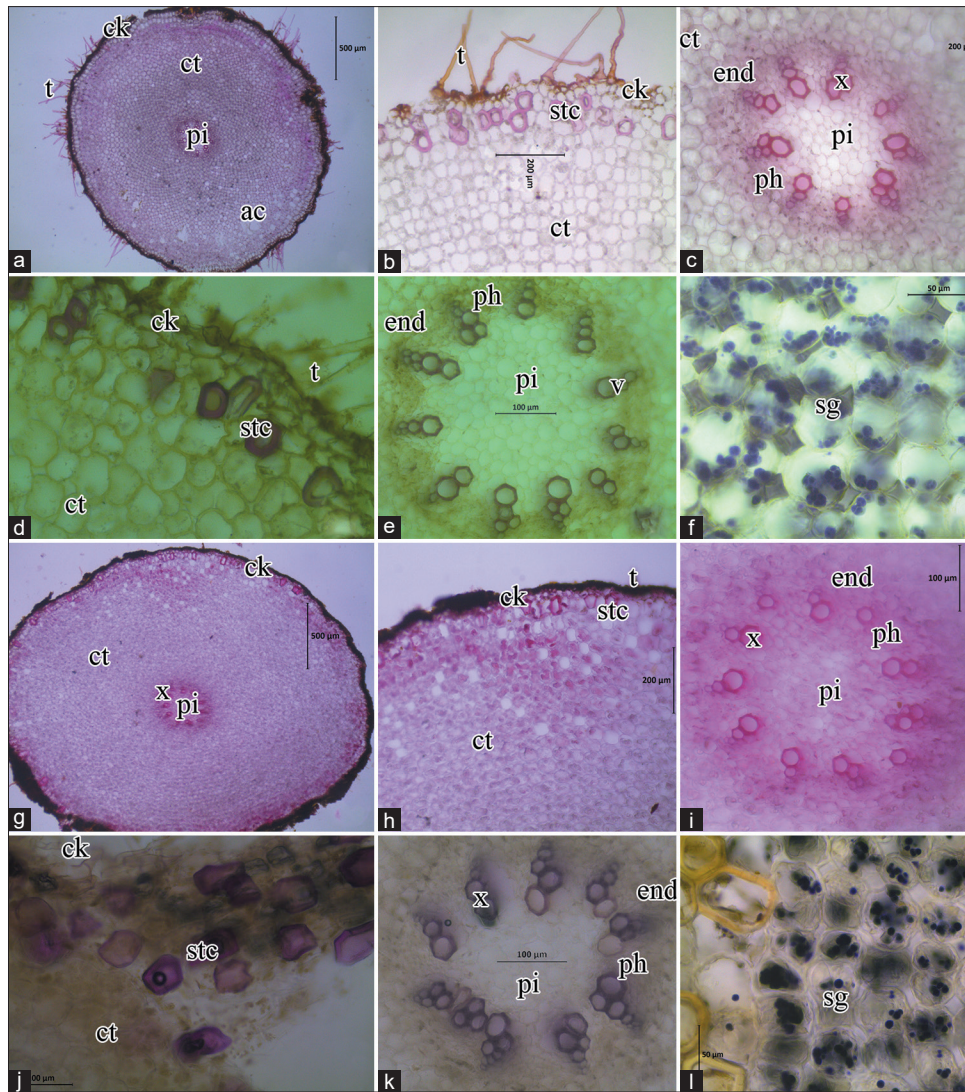


Figure 6: Microscopy of *Tagara* market samples. (a-f) TS of sample collected from Kozhikode market. (a) TS entire, (b) TS outer portion enlarged, (c) TS stelar portion enlarged, (d) TS of outer portion showing lignified cells, (e) Histochemical test for Lignin in stelar region, (f) Histochemical test for starch. (g-l) TS of sample collected from Kasargode market. (g) TS entire, (h) TS outer portion enlarged, (i) TS stelar portion enlarged, (j) TS of outer portion showing lignified cells, (k) Histochemical test for Lignin in stelar region, (l) Histochemical test for starch. ac: Air cavity, ck: Cork, ct: Cortex, end: Endodermis, ph: Phloem, pi: Pith, sg: Starch grains, stc: Stone cell, t: Trichome, v: Vessels, x: Xylem

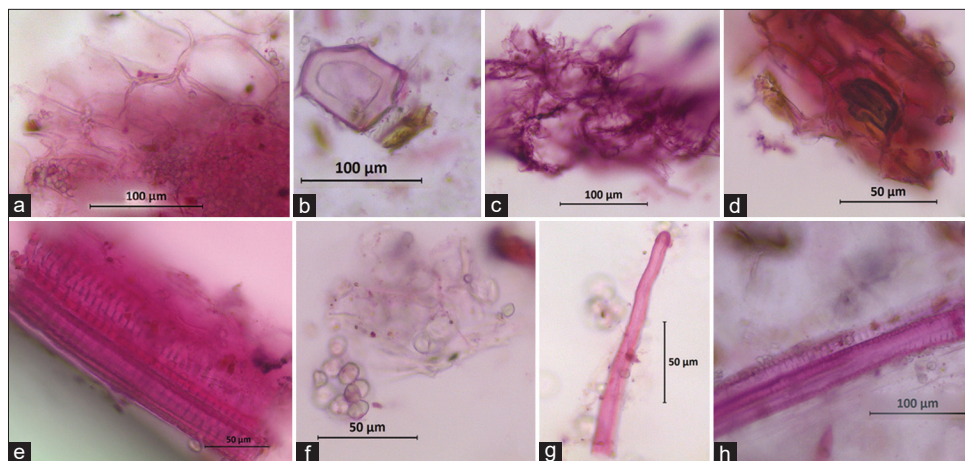


Figure 7: Powder microscopic characters of market samples of *Tagara*. (a) Cork cells in sectional view, (b) Stone cell, (c) Fragments of cork, (d) Cork in sectional view, (e) Fragments of vessels, (f) Parenchyma cells from cortex with starch grains, (g) Fragments of trichomes, (h) Fragments of tracheids and vessels

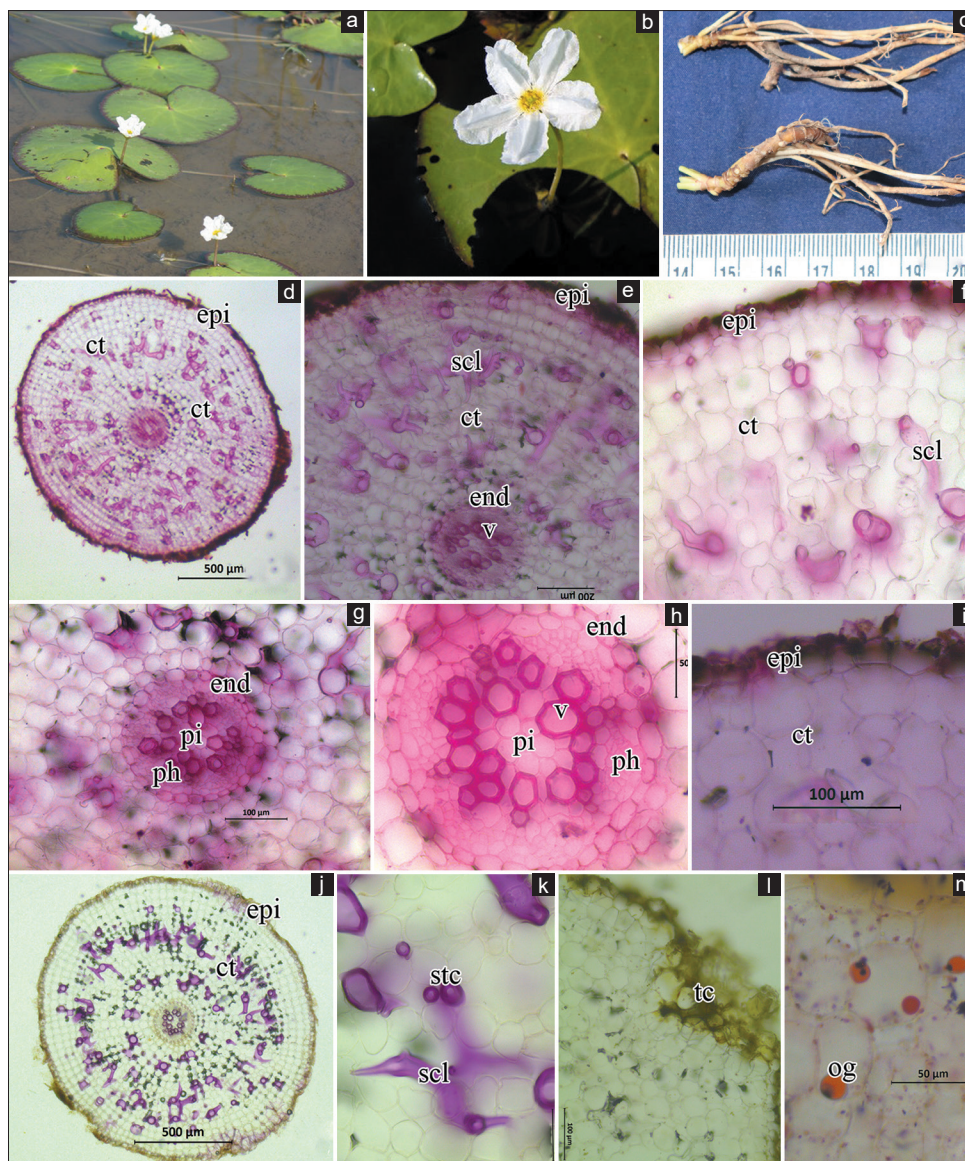


Figure 8: Macroscopy and microscopy of *Nymphoides hydrophylla*. (a) Habit, (b) Flower, (c) Roots, (d) TS of root entire, (e) TS portion enlarged, (f) TS root outer portion enlarged, (g) TS centre portion enlarged, (h) TS showing vascular elements, (i) TS enlarged view outer portion, (j and k) Histochemical test for tannin, (l) Test for oil. ct: Cortex, epi: Epidermis, end: Endodermis, og: Oil globule, per: Pericycle, ph: Phloem, pi: Pith, scl: Sclereids, sg: Starch grains, stc: Stone cells, tc: Tannin cell, v: Vessels

name – “*Kozhikkal*”-roots resembling like the foot of hen) was collected from Lotus cultivation fields where it was growing together with the lotus plant. A live plant with flower was collected from there and authenticated as *N. macrospermam* (sample 7). Root macroscopy and microscopy of sample 7 matched with the market samples 2–6. And also, as per the earlier reports, *N. hydrophylla* was available in Kerala market as *Tagara*. The plant was collected from VPSV Ayurveda College, Kottakkal, Kerala and pharmacognostic studies were done. The characters did not match with market samples (samples 2–6). Thus, it was confirmed that pharmacognostic characters of market samples were matching with *N. macrospermam* and not *N. hydrophylla*.

In order to check the North Indian market sample, a sample was collected from Uttarakhand, India [Figure 3b], and

pharmacognostic analysis was done. The characters were matching with genuine sample of *V. jatamansi* (sample 1).

Conclusion

After subjecting pharmacognostic investigations of all the samples as per the standard guidelines, it was concluded that, pharmacognostic characters of five market samples of *Tagara*, in Kerala, are not matching with that of official drug *V. jatamansi* Jones ex Roxb. All the market samples of *Tagara*, in Kerala were having similar pharmacognostic characters. Market sample of *Tagara* was morphologically and histologically similar to that of an aquatic plant of *N. macrospermam*. The study concluded that *N. macrospermam* is being used as adulterant for *V. jatamansi* in Kerala. As per

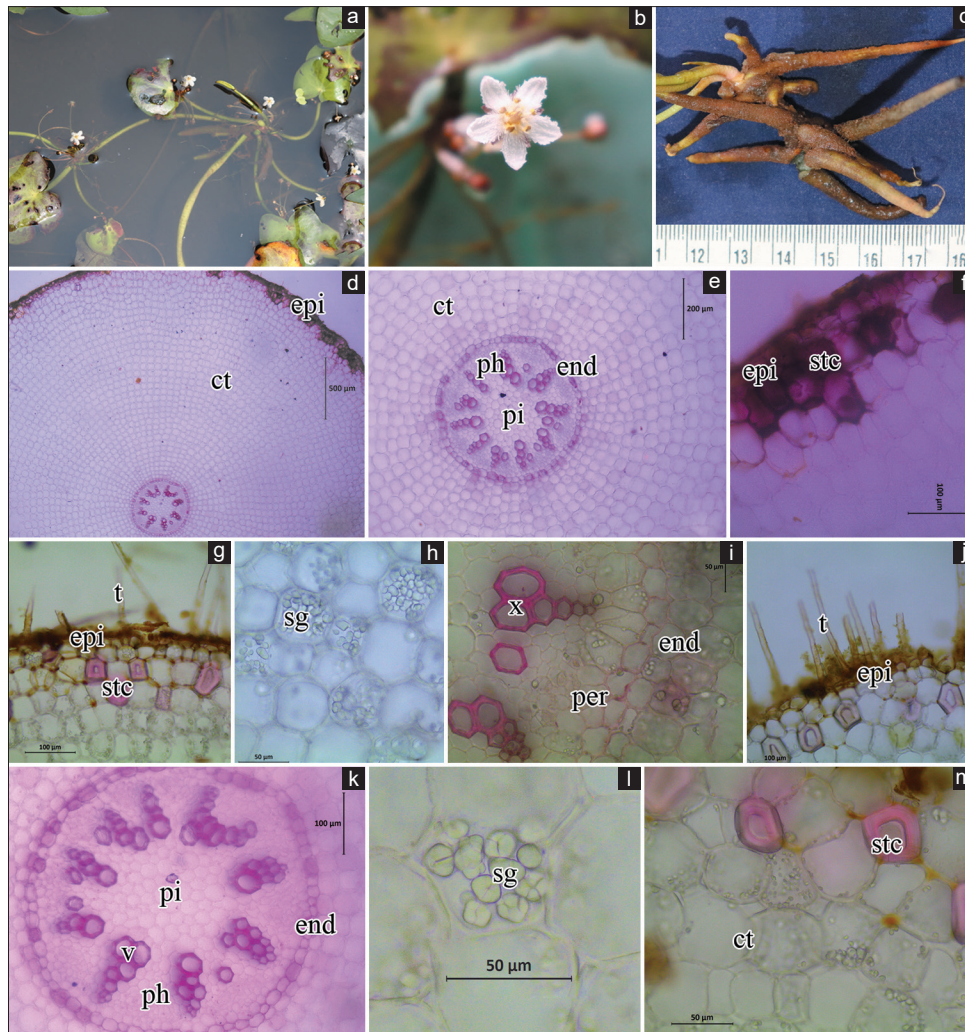


Figure 9: Macroscopy and microscopy of *Nymphoides macrospermam*. (a) Habit, (b) Flower, (c) Roots, (d) TS of root entire, (e) TS root centre portion enlarged, (f and g) TS root outer portion enlarged, (h) Cortical region showing starch grains, (i) TS enlarged view of stelar region, (j) TS showing trichomes, (k) TS showing vascular arrangement, (l) Parenchyma cells with starch grains, (m) TS showing stone cells in outer cortical region. ct: Cortex, epi: Epidermis, end: Endodermis, per: Pericycle, ph: Phloem, pi: Pith, sg: Starch grains, stc: Stone cells, v: Vessels

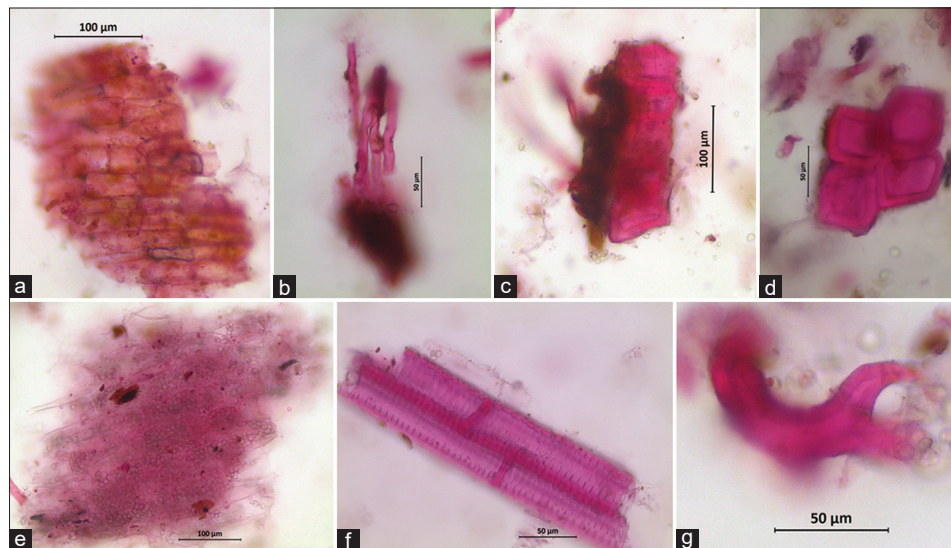


Figure 10: Powder microscopic characters of *Nymphoides macrospermam* rhizome. (a) Cork cells in surface view, (b) Fragments of trichomes, (c and d) Stone cells, (e) Parenchyma cells from cortex with starch grains, (f) Fragments of vessels, (g) Sclereids

the earlier reports, *N. hydrophylla* is used as substitute for *V. jatamansi*. However, this plant was not found as *Tagara* in Kerala markets in this study. It is recommended that clear pharmacological comparative studies should be done to ensure the efficacy of *N. macrospermam* with that of *V. jatamansi* Jones ex Roxb. for accepting it as a substitute for *Tagara*. The sample collected from Uttarakhand, India, was matching with the original drug in macroscopic, microscopic, and histochemical characters.

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Conflicts of interest

There are no conflicts of interest.

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हिन्दी सारांश

केरल के पांच अलग-अलग बाजारों से एकत्र किए गए तगर के बाजार नमूनों की वास्तविक दवा वेलेरियाना जटामांसी जोन्स एक्स रॉक्सब के साथ फार्माकोग्नॉस्टिक तुलना

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पृष्ठभूमि: तगर एक बहुत लोकप्रिय आयुर्वेद जड़ी बूटी है जिसका उपयोग अनिद्रा, मिर्गी, न्यूरोसिस, हेपेटोप्रोटेक्टिव, एंटीकैंसर और एनाल्जेसिक के रूप में उपचार हेतु किया जाता है। इसमें अत्यधिक औषधीय क्रियाओं का समन्वय है। विशिष्ट गंध इसकी विशेषता है। तगर, वेलेरियाना जटामांसी जोन्स एक्स रॉक्सब (फेमली- वेलेरियनसिया) से संबंधित माना जाता है। विस्तृत साहित्य समीक्षा पर यह पाया गया कि वेलेरियाना जटामांसी जोन्स एक्स रॉक्सब के विकल्प के रूप में लिमानेंथेमम क्रिस्टेटम (रॉक्सब.)ग्रिसेब, को बाजार में इस्तेमाल किया जाता है। **उद्देश्य:** अध्ययन का उद्देश्य बाजार के नमूनों के साथ वास्तविक दवा वेलेरियाना जटामांसी जोन्स एक्स रॉक्सब के फार्माकोग्नॉस्टिक गुणों की तुलना करना है। इस अध्ययन में केरल के हर्बल दवा बाजारों में उपलब्ध तगर की प्रामाणिकता का आंकलन किया गया है। **सामग्री एवं विधि:** इस प्रयोजन के लिए केरल के चयनित पाँच बाजारों से तगर के पाँच नमूने एकत्र किए गए और उनके फार्माकोग्नॉस्टिक गुणों की तुलना वेलेरियाना जटामांसी जोन्स एक्स रॉक्सब के वानस्पतिक रूप से पहचाने गए नमूने से की गई। **परिणाम:** तगर के बाजार नमूने के फार्माकोग्नॉस्टिक लक्षण वास्तविक दवा वेलेरियाना जटामांसी जोन्स एक्स रॉक्सब से मेल नहीं खा रहे थे। केरल के थिरुनावाया से एकत्र किए गए पौधे की जड़ के फार्माकोग्नॉस्टिक गुण बाजार के नमूनों से मेल खा रहे थे। **निष्कर्ष:** केरल के बाजार से एकत्रित तगर के नमूने असली नहीं थे क्योंकि यह असली दवा वेलेरियाना जटामांसी जोन्स एक्स रॉक्सब से मेल नहीं खा रहे थे। बाजार में उपलब्ध तगर की पहचान निम्फोइड्स मैक्रोस्पर्म के रूप में की गई थी।

कुंजी शब्द: तगर, फार्माकोग्नॉसी, बाजार नमूना अध्ययन, वेलेरियाना जटामांसी,