



Research Article

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MORPHOLOGICAL & MICROSCOPICAL FEATURES OF LEAF AND STEM OF *CYPERUS ROTUNDUS* LINN. AND *CYPERUS PROCERUS* ROTTB.: A COMPARATIVE ANALYSIS

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Received on: 02/09/16 Revised on: 22/12/16 Accepted on: 21/01/17

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DOI: 10.7897/2277-4343.08110

ABSTRACT

Mustaka and Nagarmustaka belongs to Cyperaceae family and well reputed in the traditional systems of medicine. Mustaka and Nagarmustaka have wide range of medicinal and pharmacological applications in Ayurveda. Although some differences are present in their morphological characters, they are often considered to be synonymous with each other because of the close similarities present between these two cyperus species. In the markets, also, crude drugs sellers were selling a single drug mostly Nagarmustaka under the name of both. Therefore, it is necessary to have proper identification of these herbs. The present study is aimed to systematically classify both the species through their morphological and microscopic features and to establish the diagnostic features of Mustaka (*Cyperus rotundus* Linn.) and Nagarmustaka (*Cyperus procerus* Rottb.) for their correct identification. Various methods including macroscopic and microscopic methods were applied. Morphology of different parts of both the plants were determined. Images of transverse sections of stem and leaf of both the species revealed useful diagnostic features. This study suggested that Mustaka and Nagarmustaka are different plants based on their difference found in morphology and transverse section of leaf and stem of both.

Keywords: *Cyperus rotundus*, *Cyperus procerus*, Rhizome, Stem, Leaf, identification.

INTRODUCTION

The use of herbs as medicine is the oldest form of healthcare known to humanity and has been used in all cultures throughout history. Early humans recognized their dependence on nature for a healthy life and since that time humanity has depended on the diversity of plant resources for food, clothing, shelter, and medicine to cure myriads of ailments¹. But across the world, adulteration and substitution of herbal drugs is the major problem. The crude drugs are substituted with the inferior commercial varieties and are used as adulterant which may or may not have any therapeutic potential as that of original drug². So, in this study, herbal drugs Mustaka (*Cyperus rotundus* Linn.) and Nagarmustaka (*Cyperus procerus* Rottb.) were selected for their authentication based on macroscopic and microscopic analysis because the drug Mustaka is often mistaken by the Nagarmustaka. In the ayurvedic literature both are considered as synonyms as well as varieties because of very similar morphology. So, the proper identification of both the drugs are necessary.

The medicinal plants Mustaka (*Cyperus rotundus* Linn.) and Nagarmustaka (*Cyperus procerus* Rottb.) belongs to Cyperaceae family and extensively used in the traditional system of medicine. Mustaka is an important drug of Ayurveda and the drug is used as an ingredient of various important classical formulations and also in various medicinal products in pharmaceutical field. The therapeutic utility of Mustaka is wide ranging and is mainly based on their chief action as Sangrahika (absorbent), Dipana (Appetizer), Pachana (Digestive), Lekhaniya (scraping) etc. according to pharmacological consideration in Indian medicine. The drugs Mustaka is prescribed in fever, anorexia, flatulence, diarrhea, thirst, worms,

inflammations, skin diseases, leprosy, wounds, cough, vomiting, dyspepsia, amenorrhea, dysmenorrhea, ophthalmic disorders and general debility and many other medical problems. Like Mustaka, Nagarmustaka is also very useful in curing various diseases like fever, diarrhea, anorexia, fatigue etc. and has great value as a medicine in Ayurveda.

Cyperus rotundus Linn. is regarded as the authentic botanical source of Mustaka and *Cyperus procerus* Rottb. and some other species of *Cyperus* are considered as a botanical source of Nagarmustaka. In the present study *Cyperus procerus* Rottb. is taken as a source of Nagarmustaka¹⁻²³.

MATERIALS AND METHODS

Plant Materials

The plants material which were taken for study are -
Mustaka
Nagarmustaka

Cyperus rotundus Linn. is taken as a source of Mustaka and
Cyperus procerus Rottb. is taken as a source of Nagarmustaka

Collection of genuine sample from the field

- The genuine sample of Mustaka i.e. *Cyperus rotundus* Linn. were collected from Rishikul Campus, Uttarakhand ayurved university, Haridwar District, State- Uttarakhand
- The genuine sample of Nagarmustaka i.e. *Cyperus procerus* Rottb. were collected from Muni ki reti, State-Uttarakhand.
- From these sources as mentioned above, samples were collected, Herbarium were made and authenticated at Botanical Survey of India (BSI), Dehradun. (Table 1, Figure 1)

Table 1: List of Plants with Herbarium Voucher Specimen Number

S.no	Plant Name	Place of Collection	Herbarium Account No.
1.	<i>Cyperus rotundus</i> Linn.	Rishikul Campus, Haridwar, Uttarakhand	116043
2.	<i>Cyperus procerus</i> Rottb.	Muni ki reti, Uttarakhand	116039

Macroscopic Study

A systematic examination of the shape, size, colour and pattern of leaf, stem, rhizome and floral structure of *Cyperus rotundus* Linn. and *Cyperus procerus* Rottb. were carried out and external features of both the species were observed.

Microscopic Study

Microscopic sections were cut by Microtome sectioning. Numerous temporary and permanent mounts of the microscopical sections of the specimen were made and examined microscopically. Histochemical reactions were applied with staining reagents on transverse sections^{24,25}.

RESULTS AND DISCUSSION**Morphological Features****Table 2: Comparative Morphological Features of Mustaka (*Cyperus rotundus* Linn.) and Nagarmustaka (*Cyperus procerus* Rottb.)^{26,27}**

S.NO	Features	<i>Cyperus rotundus</i> Linn.	<i>Cyperus procerus</i> Rottb.
1.	Habit	Erect and perennial glabrous herb with woody subterranean stoloniferous rhizome.	Erect, perennial and stoloniferous sedge.
2.	Habitat	Weed of marshy and moist areas in plains and hilly region and found throughout India and mostly in North-east part.	Weed which grows in aquatic and sub-aquatic region especially on banks of streams and rivers, found in Bengal, Uttar Pradesh, Kerala, mostly towards east and south part of India.
3.	Stem	Stems nodose at base, trigonous and 10-60 cm. high.	solitary or few together, 55-120 cm. high., triquetrous and spongy type.
4.	Leaves	Leaves basal, shorter or longer than the stem, narrowly linear, finely acuminate at apex and 10-18 cm. long & 0.3-0.5 cm broad.	few, basal, 30-75 x 0.7-1.2 cm linear, gradually acuminate.
5.	Inflorescence	Inflorescence, umbel of condensed spikes. The flowers are reddish-brown . Bracts 3, variable in length, the longest reaching 15cm long, but sometimes abbreviated and much shorter than the head.	Spikelets 0.8-3 x 0.2 - 0.35 cm, oblong to linear-lanceolate, compressed, pale coloured, tinged with red-brown. Glumes ovate-obtuse, pale brownish and stained with reddish-brown . Leafy bracts 3-4, the longest up to 55 cm long.
6.	Rhizome	Oval to spindle shaped , generally range from 1.5-3.5cm. in length, 0.5-2.5cm. in diam	Elongated and cylindrical in shape and range from 5-20cm in length and 0.5-2cm. in thickness.

Table 3: Comparative study of T. S. of Genuine sample of Mustaka (*Cyperus rotundus* Linn.) and Nagarmustaka (*Cyperus procerus* Rottb.) Leaf

S.NO	Parameters	T. S. <i>Cyperus rotundus</i> Linn. Leaf	T. S. of <i>Cyperus procerus</i> Rottb. Leaf
1.	Epidermis a)Cutical layer b)Bulliform cells	Single layer of epidermis found on both upper and lower surface of leaf. Cuticle layer absent. Single layered Bulliform cells present on upper side of epidermis.	Single layer of epidermis on both upper and lower surface of leaf. Thin layer of cuticle present in epidermis. Multilayer Elongated Bulliform cells present on upper side of epidermis.
2.	Mesophyll a)Intracellular space b)Fluid filled vacuoles	Mesophyll not differentiated into pellicide and spongy parenchymatous cell. present Absent	Mesophyll not differentiated into pellicide and spongy parenchymatous cell. absent Large fluid filled vacuoles present on lower surface throughout the leaf which are found attach to lower epidermis on one side and V.B on another side.
3.	Vascular Bundles	Vascular bundles closed, collateral and occur in middle of the leaf Each V.B surrounded by bundle sheath consisting of thin wall parenchymatous cell.	Vascular bundles closed, collateral and present in middle of leaf and attached with large fluid filled vacuoles on lower side of leaf. Each V.B surrounded by bundle sheath consisting of thin wall parenchymatous cell.

Table 4: Comparative Study of T.S. of Genuine Sample of Mustaka (*Cyperus rotundus* Linn.) and Nagarmustaka (*Cyperus procerus* Rottb.) Stem

S.NO	Parameters	T.S. of <i>Cyperus rotundus</i> Linn. Stem	T.S. of <i>Cyperus procerus</i> Rottb. Stem
1.	Epidermis	Epidermis consist of rounded compact cells.	Epidermis consist of round compact cells.
2.	Ground tissue	Ground tissue consist of thin wall parenchymatous cell. Vacuoles are absent no differentiation of cortex, endodermis, pericycle and pith. Composed of many collateral and closed vascular bundles	Ground tissue consist of thin wall parenchymatous cell with well-defined Vacuoles extending from hypodermis to the centre. no differentiation of cortex, endodermis, pericycle and pith. Composed of many collateral and closed vascular bundles.
3.	Vascular bundles	Vascular bundles scattered in ground tissue.	Vascular bundles scattered in ground tissue.

Based on results, distinguished features of *Cyperus rotundus* Linn and *Cyperus procerus* Rottb. were discussed below.

Morphological Differences between Mustaka (*Cyperus rotundus* Linn.) and Nagarmustaka (*Cyperus procerus* Rottb.) were reported in Table 2 and these are

The plant of *Cyperus rotundus* is about 10-60cm long while *Cyperus procerus* is about 55-120cm tall. Leaves of *Cyperus procerus* are longer and broader than the leaves of *Cyperus rotundus*. It is about 30-75cm long and 0.7-1.2 cm broad in *Cyperus procerus* and 7.5cm long & 0.3-0.5cm broad in *Cyperus rotundus*. The inflorescence of *Cyperus rotundus* is reddish-brown in colour while it is pale coloured, tinged with red-brown in *Cyperus procerus*. Bracts 3, variable in length, the longest reaching 15cm long, but sometimes abbreviated and much shorter than the head in *Cyperus rotundus* plant while leafy bracts 3-4, the longest up to 55 cm long. in *Cyperus procerus*. Rhizomes of both plants are totally different. Rhizomes of *Cyperus rotundus* are oval to spindle shaped, generally range from 1.5-3.5cm. in length, 0.5-2.5cm. in diam. while the rhizomes of *Cyperus procerus* are elongated and cylindrical in shape and range from 5-20cm in length and 0.5- 2 cm. in thickness i.e. larger than the *Cyperus rotundus*. [Figure 2 - 5].

Transverse Section of Genuine Sample of Mustaka (*Cyperus rotundus* Linn.) and Nagarmustaka (*Cyperus procerus* Rottb.) Leaf were reported in Table 3

In T.S of genuine sample of *Cyperus rotundus* leaf, mesophyll was composed of compactly arranged thin walled, iso-diametric cell having well developed intracellular spaces among them while mesophyll was composed of hexagonal cells without any intracellular spaces in genuine sample of *Cyperus procerus* leaf.

Large fluid filled vacuoles were also present on lower surface throughout the leaf of *Cyperus procerus* which are found attach to lower epidermis on one side and V.B on another side while these vacuoles were absent in *Cyperus rotundus* leaf.

Single layered Bulliform cells were present in the upper epidermis of *Cyperus rotundus* leaf while it was multilayered in *Cyperus procerus* leaf. [Figure 6, 7]

Morphology of Mustaka (*Cyperus rotundus* Linn.) and Nagarmustaka (*Cyperus procerus* Rottb.)



Cyperus rotundus Linn. (10-60cm. in height)

Transverse Section of Genuine Sample of Mustaka (*Cyperus rotundus* Linn.) and Nagarmustaka (*Cyperus procerus* Rottb.) Stem were reported in Table 4

Epidermis consist of rounded compact cells in *Cyperus rotundus* and *Cyperus procerus* both.

Ground tissue consist of thin wall parenchymatous cell with well-defined Vacuoles extending from hypodermis to the centre in *Cyperus procerus* while these vacuoles were absent in the *Cyperus rotundus*.

Vascular bundles were numerous, scattered in ground tissue in *Cyperus rotundus* and *Cyperus procerus* both. [Figure 8, 9]

From these features Mustaka i.e. *Cyperus rotundus* Linn. can be distinguished from the Nagarmustaka i.e. *Cyperus procerus* Rottb.

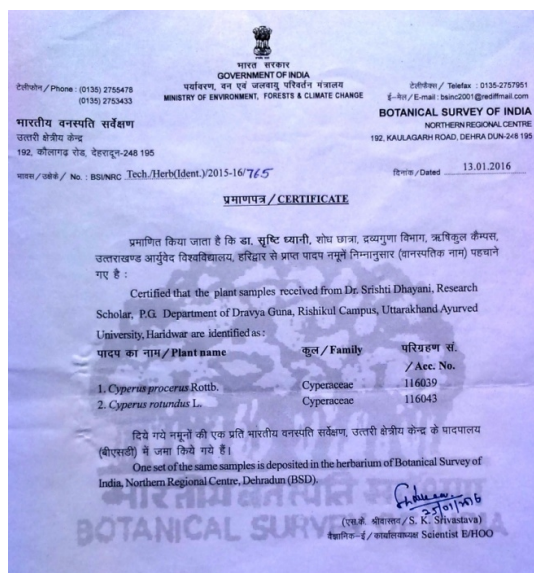


Figure 1: Herbarium Authentication Certificate



Cyperus procerus Rottb. (55-120cm. in height)

Figure 2: Stem



Cyperus rotundus Linn. (10-18cm. long and 0.3-0.5 cm. broad)



Cyperus procerus Rottb. (30-75cm. long and 0.7-1.2 cm. broad)

Figure 3: Leaf



Cyperus rotundus Linn. (Reddish brown inflorescence)



Cyperus procerus Rottb. (Pale coloured, tinged with red-brown)

Figure 4: Inflorescence



Cyperus rotundus Linn. (Ovoid and bluntly conical shaped rhizome)



Cyperus procerus Rottb. (Elongated and Cylindrical rhizomes)



Figure 5: Rhizome

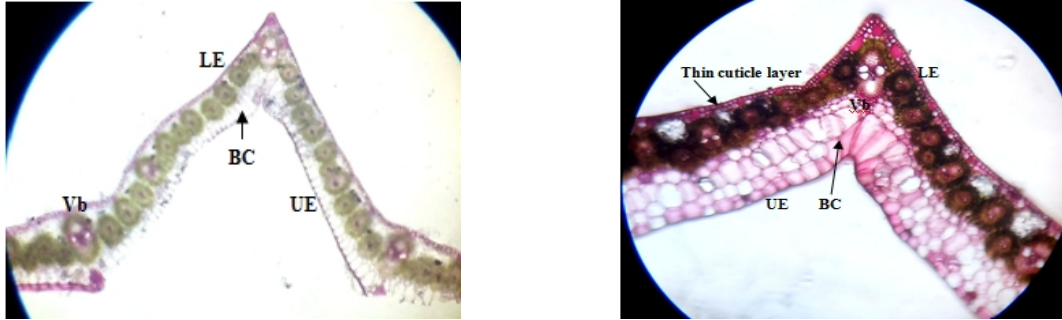


Figure 6: Transverse Section of *Cyperus rotundus* Linn. Leaf

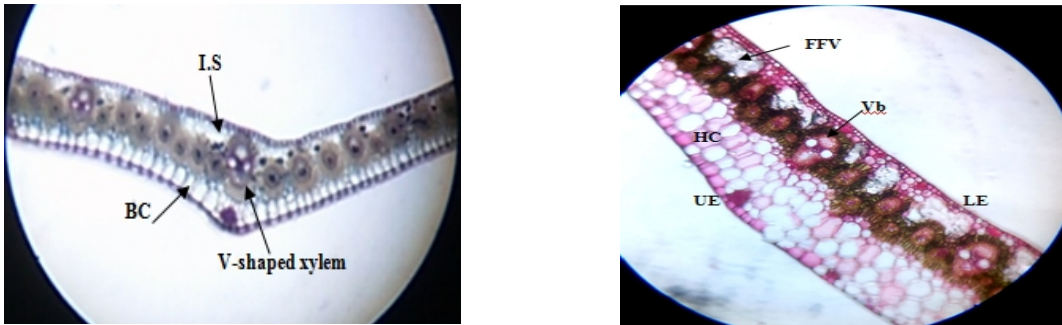


Figure 7: Transverse Section of *Cyperus procerus* Rottb. Leaf

UE: Upper Epidermis, LE: Lower Epidermis, BC: Bulliform Cells, V : Vascular bundles, LS: Intracellular spaces, FFV: Fluid filled vacuoles, HC: Hexagonal cells

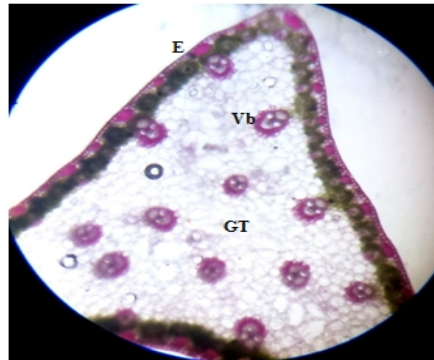


Figure 8: Transverse Section of *Cyperus rotundus* Linn. Stem

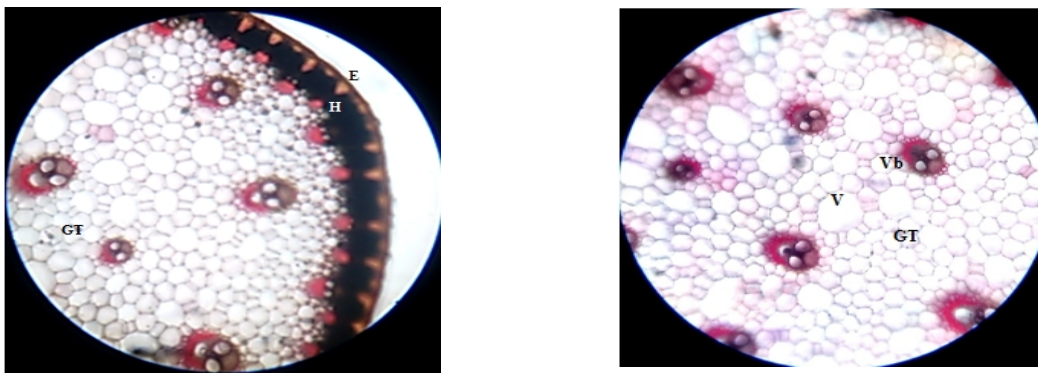


Figure 9: Transverse Section of *Cyperus procerus* Rottb. Stem
E: Epidermis, H: Hypodermis, Vb: Vascular bundles, V: Vacuoles, G : Ground tissue

CONCLUSION

In this study, comparative analysis of morphology of Mustaka (*Cyperus rotundus* Linn.) and Nagarmustaka (*Cyperus procerus* Rottb.) were done and transverse section of leaf and stem of both the plants were also carried out which could help in the identification and authentication of both the species. This macroscopic and microscopic study of both the plants clearly suggested that Mustaka and Nagarmustaka are two different species of Cyperus.

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Cite this article as:

Srishti Dhyani. Morphological & microscopical features of leaf and stem of *Cyperus rotundus* Linn. and *Cyperus procerus* Rottb.: A comparative analysis. Int. J. Res. Ayurveda Pharm. 2017;8(1):46-51 <http://dx.doi.org/10.7897/2277-4343.08110>

Source of support: Nil, Conflict of interest: None Declared

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