

ISSN: 2220-4822

Trichome diversity studies in selected species of *Sida*

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ABSTRACT

Sida (Family: Malvaceae) belongs to the genus of flowering plants that possess high medicinal value and is used traditionally in almost all parts of the world. There were about 18 species reported from the state of Kerala (India). Among these, some are with taxonomic controversies. Hence micro-morphological characters of leaves such as trichomes can be used as a taxonomic tool for the identification of plants. Their type, presence, absence and distribution are important diagnostic characters in plant identification and plant taxonomy. Plant samples were collected from different localities of Kerala. Foliar epidermal studies were carried out in order to identify the diversity and distribution of trichomes in the selected species of *Sida* viz., *S. acuta*, *S. alnifolia*, *S. beddomei*, *S. cordata*, *S. cordifolia*, *S. fryxelli*, *S. ravii*, *S. rhombifolia* and *S. rhomboidea*. Six types of trichomes were identified; they were stellate, conical, forked, capitate (short stalked), uniseriate multicellular and peltate. Stellate trichomes were observed in all the species. Conical trichomes were observed in *S. beddomei*, *S. cordata* and *S. fryxelli*. Forked trichome was observed in *S. acuta*, *S. cordata*, *S. cordifolia*, *S. ravii*, *S. rhombifolia* and *S. rhomboidea*. Capitate (short stalked) trichomes were observed in *S. acuta*, *S. alnifolia*, *S. rhombifolia* and *S. rhomboidea*. Uniseriate multicellular trichomes were observed in *S. cordifolia*, *S. fryxelli* and *S. ravii*. Peltate trichomes are observed in all species except *S. beddomei*, *S. cordifolia* and *S. fryxelli*. However, these species could be easily distinguished by their conical trichomes. A bracketed dichotomous key was prepared for the identification of the species considered for the study.

KEYWORDS: *Sida*, Trichomes, Stellate, Forked, Capitate, Conical

Received: March 23, 2020

Revised: May 27, 2020

Accepted: May 29, 2020

Published: June 16, 2020

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INTRODUCTION

Sida is a genus of Angiosperms that belongs to the Family Malvaceae. The name *Sida* was proposed by Linnaeus in 1753 in 'Species Plantarum'. The genus is represented by 200 species around the world, more than 20 species in India and 18 species in Kerala [1-6]. Species of *Sida* has been traditionally used in Ayurvedic, Siddha, Unani, and Homeopathic system of medicine. It is the most widely used raw drug in the treatment of rheumatism. It is also used in the treatment of neurological disorders, headache, leucorrhoeal tuberculosis, diabetes, fever and uterine disorders [7&8]. They are perennial herbs or shrubs, erect or prostrate, glabrous or pubescent, sometimes viscid. Most of them are heliophilous weedy taxa growing in exposed waste lands. But occasionally, they do occur also as under-growths in semi-deciduous and deciduous forests, plantations and in partially shaded habitats [2].

Sida was heterogeneous taxa from the period of Theophrastus, as the generic name was used to denote *Nymphaea* and other aquatic plants at that point of time. It was Linnaeus who

restricted the genus to Malvaceous members [2]. Although earlier works reports the presence of only 150- 200 species distributed worldwide, more than 1000 names have been published in the genus. Hence, there are taxonomic complexities within the genus. Various researchers have worked to unravel the complexities by studying characters of leaves [9&10]. Leaves are usually neglected organs in taxonomic and comparative morphological studies. Leaf morphological and anatomical characters can be of great taxonomic significance. As Metcalfe and Chalk [11] reported, leaves are considered as the most varied organ anatomically in angiosperms which provides a variety of anatomical features that can be employed as useful taxonomic characters. Foliar anatomical characters like stomata and trichomes are found instrumental in solving taxonomic problems and its significance have long been recognized by various workers [12].

Trichomes are epidermal appendages of varying shape, structure, and function. They are found in almost all plant parts *ie.*, leaves, petals, stalks, peduncles, stems and seeds coat surfaces. Leaf trichomes have been shown to scale back herbivory in a number of plant species [13&14]. Trichomes are of great importance

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to the plants as they are used for reducing leaf temperature, increasing light reflectance degree, preventing desiccation and reducing frictional force on the leaves [15]. Gulzar et al. [16], have described the importance of the structure and nature of trichomes in phylogeny. There are also previous works mentioning that the abundance of particular trichome type may aid in taxonomic studies of genera, species and plant families [11&17].

The present investigation is aimed to spot the range and distribution of trichomes within the selected species of *Sida* viz., *S. acuta*, *S. alnifolia*, *S. cordata*, *S. cordifolia*, *S. fryxelli*, *S. ravii*, *S. rhombifolia* and *S. rhomboidea*. to easily delineate the different species.

MATERIALS AND METHODS

1. Collection and identification of plant specimens
Field explorations were carried out in different parts of Kerala (India) and 9 species of *Sida* were collected (Table 1). The collected specimens were identified using standard authentic literature [1,2&3].
2. Trichome study
Foliar anatomical sections were carried out to identify the distribution and diversity of trichomes in *Sida* species. Leaf samples were taken from each species and free hand sections were taken. The sections were stained using 1% aqueous solution of safranin. Excess stain was washed off with water. The sections of each species were mounted in glycerin and observed under the light microscope with 40X resolution (Biolinkz M2000 series). The types of trichomes for each species were noted and photographs were taken.

RESULTS

As a result of field exploration, 9 species of *Sida* were collected. The details of the collected samples are given in Table 1.

Foliar epidermal studies were carried out in order to identify the diversity and distribution of trichomes in the selected species of *Sida* viz., *S. acuta*, *S. alnifolia*, *S. beddomei*, *S. cordata*, *S. cordifolia*, *S. fryxelli*, *S. ravii*, *S. rhombifolia* and *S. rhomboidea*. There were six types of trichomes identified in the species of *Sida* studied viz., conical (simple), forked, stellate, capitate (short stalked), uniseriate multicellular and peltate (Table 2). Stellate trichomes were observed in all the species. Conical trichomes were observed in *S. beddomei*, *S. cordata* and *S. fryxelli*. Forked trichome was observed in *S. acuta*, *S. cordata*, *S. cordifolia*, *S. ravii*, *S. rhombifolia* and *S. rhomboidea*. Capitate (short stalked) trichomes were observed in *S. acuta*, *S. alnifolia*, *S. rhombifolia* and *S. rhomboidea*. Uniseriate multicellular trichomes were observed in *S. cordifolia*, *S. fryxelli* and *S. ravii*. Peltate trichomes are observed in all species except *S. beddomei*, *S. cordifolia* and *S. fryxelli*. Trichome distribution in *Sida* species is given in Table 3.

A bracketed dichotomous key was prepared for the 9 species of *Sida* studied. The key is given below:

Table 1: List of *Sida* species collected for the study

Sl. No.	Species of <i>Sida</i>	Localities
1.	<i>Sida acuta</i> Burm. F.	Panampilly Nagar (Ernakulam Dist.), Eramalloor (Alappuzha Dist.), Peechi (Thrissur Dist.)
2.	<i>Sida alnifolia</i> L.	North Paravoor (Ernakulam Dist.), Bhoothathankettu (Ernakulam Dist.)
3.	<i>Sida beddomei</i> Jacob.	Bhoothathankettu (Ernakulam Dist.)
4.	<i>Sida cordata</i> (Burm. f.) Bross. Waalk.	Peechi (Thrissur Dist.), Eramalloor (Alappuzha Dist.)
5.	<i>Sida cordifolia</i> L.	Cherthala (Alappuzha Dist.)
6.	<i>Sida fryxelli</i> Sivar. & Pradeep.	North Paravoor (Ernakulam Dist.), Eramalloor (Alappuzha Dist.)
7.	<i>Sida rhombifolia</i> L.	Panampilly Nagar (Ernakulam Dist.), Paravoor (Ernakulam Dist.), Eramalloor (Alappuzha Dist.), Peechi (Thrissur Dist.)
8.	<i>Sida rhomboidea</i> Roxb. ex. Flemming.	Panampilly Nagar (Ernakulam Dist.)
9.	<i>Sida ravii</i> Sivad. & Anil Kumar	Maruthoorkulangara (Kollam Dist.)

Table 2: Types of Trichomes identified in *Sida* species

Sl. No.	Type of Trichomes	Description
1.	Conical (simple)	Axillary elongated, unicellular, broad at the base and tapering above
2.	Forked	Two ray cells present in the same cell cavity
3.	Stellate	Formed of considerable number of ray cells held together in the center
4.	Capitate (Short stalked)	Flask shaped with a multicellular bulging base, short stalk and an oval shaped head.
5.	Uniseriate multicellular	Uniseriate, Erect, formed of single row of cells. Number of cells vary 4-5
6.	Peltate	Sessile, cup shaped or rounded with narrow apical opening

1. Forked
 - 1a. peltate
 - Capitate (short stalked)..... *S. acuta*,
S. rhombifolia, *S. rhomboidea*
 - Conical *S. cordata*
 - Uniseriate multicellular *S. ravii*
 - 1b. not peltate
 - Uniseriate multicellular *S. cordifolia*
2. Not forked
 - 2a. peltate
 - Short stalked, capitate *S. alnifolia*
 - 2b. not peltate
 - Uniseriate multicellular *S. fryxelli*
 - Conical *S. beddomei*

DISCUSSION

Sida is a medicinally important genus and many species belonging to the genus have been traditionally used in India since long. It is a heterogenous taxa with many taxonomic controversies. As mentioned earlier, leaves are generally neglected organs in taxonomic and comparative morphological studies. Studies on leaf architecture of dicotyledons by Hickey [18] have created much interest in the leaf characters as an aid in resolving taxonomic problems. The present

Table 3: Trichome distribution in *Sida* species investigated

Sl. No.	Species	Conical	Forked	Stellate	Short stalked capitate	Uniseriate multicellular	Peltate
1.	<i>S. acuta</i>		✓	✓	✓		✓
2.	<i>S. alnifolia</i>			✓	✓		✓
3.	<i>S. beddomei</i>	✓		✓			
4.	<i>S. cordata</i>		✓	✓			✓
5.	<i>S. cordifolia</i>	✓	✓	✓		✓	
6.	<i>S. fryxelli</i>	✓		✓		✓	
7.	<i>S. rhombifolia</i>		✓	✓	✓		✓
8.	<i>S. rhomboidea</i>		✓	✓	✓		✓
9.	<i>S. ravii</i>		✓	✓		✓	✓

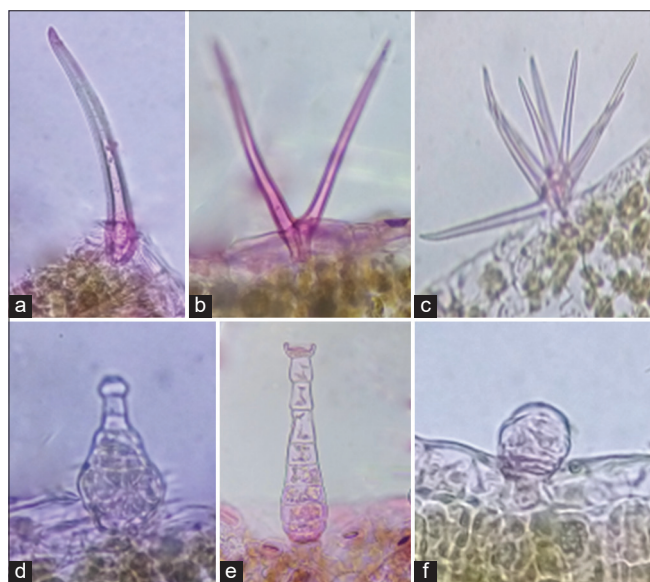


Figure 1: Photomicrographs of types of trichomes observed in *Sida* species. a) Conical (simple) trichome; b) Forked trichome; c) Stellate trichome; d) Capitate (short stalked) trichome; e) Uniseriate multicellular trichome; f) Peltate

study was carried out as an attempt to find out the diversity and distribution of trichomes on the leaf surface of selected species of *Sida* to distinguish the species. Trichomes are hair-like appendages extending from the epidermis of aerial tissues [19]. They range in different forms and sizes. In the present study, six types of trichomes were observed; viz., stellate, conical, forked, capitate (short stalked), uniseriate multicellular and peltate (Table 3). Stellate trichomes were observed in all the species. Conical trichomes were observed in *S. beddomei*, *S. cordata* and *S. fryxelli*. Forked trichome was observed in *S. acuta*, *S. cordata*, *S. cordifolia*, *S. ravii*, *S. rhombifolia* and *S. rhomboidea*. Capitate (short stalked) trichomes were observed in *S. acuta*, *S. alnifolia*, *S. rhombifolia* and *S. rhomboidea*. Uniseriate multicellular trichomes were observed in *S. cordifolia*, *S. fryxelli* and *S. ravii*. Peltate trichomes are observed in all species except *S. beddomei*, *S. cordifolia* and *S. fryxelli* (Figure 1). Earlier studies on *Sida* species collected elsewhere [20] reported that peltate and stellate trichomes were found in all species under study viz., *Sida alba* L., *S. alii* S. Abedin var. *alii*, *S. cordata* (Burm. F.) Borss., *S. mysorensis* Wight and Arn., *S. ovata* Forssk. *S. spinosa* L and *S. yunnanensis* S.Y.Hu. Long-stalked and short-stalked capitate trichomes were observed in *S. alii* and *S. spinosa*

respectively. Uniseriate multicellular trichomes were found only in *S. mysorensis*. This revealed that peltate and stellate trichomes are common in the genus *Sida*. Among the nine species studied *S. beddomei*, *S. cordata* and *S. fryxelli* could be easily distinguished by their characteristic conical trichomes.

An investigation on the glandular and non-glandular type of trichomes in *Orthosiphon labiatus* revealed that there were three types of trichome in the species under study; two glandular type (capitate and peltate) and one non-glandular type [21]. Thirteen types of trichomes were identified with *Salvia nemarosa* [22]; of which capitate and peltate trichomes dominated. Leaf trichome study of *Hyptis suaveolens* [23] revealed the presence of two types of non-glandular trichomes (monocellular and multicellular) and three types of glandular trichomes (peltate, capitate type I and capitate type II). A study conducted on the foliar epidermal characters of ten *Senna* species and found that Stomatal types of anisocytic, anomocytic, paracytic, tetracytic and haxacytic were found across the species, glandular trichomes were observed in *S. hirsuta* and *S. occidentalis*, while non-glandular trichomes are dominant in the remaining species [12].

Trichome diversity studies of the family Caryophyllaceae of Western Himalayas revealed the presence of six types of trichomes viz., unicellular eglandular, unicellular glandular, multicellular uniseriate glandular, multicellular uniseriate eglandular, multicellular eglandular bifurcate and multicellular multiseriate eglandular [28]. A recent study [29] on the trichome idversity of wild and cultivated egg plants revealed that The wild species viz., *S. viarum* and *S. mammosum* have seven (Type II to VIII) morphologically distinguishable types of trichomes including two types of glandular trichomes (Type VI, VII) as against uniform occurrence of branched stellate trichomes (Type VIII) alone in cultivated species.

Earlier workers [17,24,25,26&27] have proved that abundance of a particular type of trichome can aid in taxonomic studies of genera, species and plant families. They carried out their work in the genus *Osbeckia*, family Asteraceae, *Elaeis guineensis*, genus *Vitis*, genus *Hibiscus* respectively. Their work had been successful in delineating the species based on leaf epidermal characters. Trichome morphological study within the genus *Monardella* of Lamiaceae family was used as powerful tool in differentiating taxa and resolving taxonomic ambiguities led to the revision of the genus [30].

In the present investigation only few species of *Sida* could be delineated using trichome characters. Hence further micrometry and molecular characterization studies have to be carried out in order to clearly distinguish the species of *Sida*. Molecular studies using marker genes like ITS1, trnH-psbA and matK are to be conducted to delineate the species.

CONCLUSION

The present study revealed the presence of six different types of trichomes in the species of *Sida*. They were stellate, conical, forked, capitate (short stalked), uniseriate multicellular and peltate. These results were quite useful in identifying the species up to a certain level. However, the trichome characters investigated in selected species of *Sida* could not delineate the species clearly. Hence, the molecular studies like DNA barcoding using different marker genes like ITS2, trnH-psbA, matK etc. have to be carried out in order to clearly delineate the species of *Sida* for clearing all the taxonomic controversies.

ACKNOWLEDGEMENT

The authors are grateful to Council of Scientific and Industrial Research, Government of India for financial assistance.

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