

Phytomorphological Differences of Male and Female Plants of Guduchi (*Tinospora cordifolia* (Willd.) Miers ex Hk.f. &Thom.)

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ABSTRACT : Physical forms are the first impression by which the individuals are differentiated from each other in any organism and when it is applied with plants, phytomorphology comes to existence. Amid the various species of plants, somatic and sexual variations have been in core to make separate recognition. Sexual characters come to pompous position in case of dioecious plants and Guduchi is one of them. They exhibit differences with physical forms in case of all parts as in aerial and underground viz., stem, leaf, aerial and underground roots etc. Veination is looped in leaves of male plants while it being incomplete in leaves of female plants, which becomes the characters to identify them separately e. g. terminal marginal veination is looped in male plant unlike the female leaves where it is incomplete.

Key words : Dioecious plant; Guduchi.

INTRODUCTION

Phytomorphology is the general term for the study of the morphology (physical form and external structure) of plants.¹ It “represents a study of the development, form, and structure of plants, and, by implication, an attempt to interpret these on the basis of similarity of plan and origin.”² There are four major areas of investigation in plant morphology, and each overlaps with another field of the biological sciences. These are comparison that the morphologist examines structures in many different plants of the same or different species and draws comparisons and formulates ideas about similarities, observation of both the vegetative (somatic) as well as the reproductive structures of plants, studies of plant structure at a range of scales, and examination of the pattern of development, the process by which structures originate and mature as a plant grows. Hence, phytomorphology has been important tool to get the entity of individual plant with its relationship to others to all those who were keen to identify the plants for either of reasons available to them. Number of terminologies and techniques are available for the purpose. Dioecious is one of that dealing with separate male and female flowers of two different plants of same species. Among the dioecious plants, Guduchi (*Tinospora cordifolia* (Willd.) Miers ex Hk.f. &Thom.) is an important plant used in indigenous system of medicine especially in Ayurveda.

Tinospora cordifolia (Willd.) Miers. ex Hk.f. & Thom. Contrib is a large glabrous (hairs fall with the age) dioecious climber with succulent, corky, grooved stems. Bark is grey or creamy-white in colour and with spiral and longitudinal clefts being usually dotted with rosette like lenticels. From the stem branches, slender pendulous fibrous, fleshy aerial roots hang which are terete, striate, with tubercles, pale, sometimes shining or glabrous bark, they produce laterals when damaged. Leaves are membranous when young and more or less coriaceous with age; reticulately veined with microscopically glistening glands beneath.

From the commerce and feasibility on time and utility basis, it automatically becomes momentous to use either male or female plants for medicinal purposes. Efforts to differentiate the same species in these regards have been made to recognize the differences of race varieties etc. But attempts are yet to be done to differentiate the male and female plants of Guduchi on the basis of physical forms.

MATERIAL AND METHODS

For the purpose, Guduchi was identified with help of various floras and herbaria. The collection of male plants of *Tinospora cordifolia* (Willd.) Miers ex Hk.f. &Thom. was made from Vijarakhi dam area and from Ramnagar village near to Siddhi Vinayak temple of Sapda in Jamnagar district on 17th & 24th February of 2002. The female plants were also collected from the same vicinity to avoid any phytogeographical differences.

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To locate the male plant, first fruiting plant of Guduchi was seen and the general pattern of wind direction was discussed as for fruit setting male plant should be present somewhere along the direction of the wind (west to east). Proceeding with the same idea, male plant was found about 50-100 meters towards the west of actual site of female plant of Guduchi. During the collection flowering and fruiting of plants were specially kept in mind and the plants having flowers and fruits were only collected.

After the collection of plants, the male and female plants were separately propagated by stem cuttings (of about 1 to 1.5 ft. in size) at different places in campus of Gujarat Ayurved University, Jamnagar. It was done to sort out the further problems of collection of plants and to avoid any doubts regarding the variations with the ages^{3, 4, 5, 6, 7}.

For present study following characteristics were contemplated :

- i). The growth habit of the plant
- ii). Vegetative features of plants (Size, shape, type, form, venation etc. of leaf, stem, root, aerial root)
- iii). Reproductive features of plants (shape, size, colour, odour, fusion etc. of flowers)

Material adopted for the study was screened out from the various publications on morphological studies in book forms or research paper forms. The very much concerned or easily identified characters are only highlighted here as Shape, Size (after 6 months, 12 months, 18 months and 24 months), Surface, Colour of cut surface, Pith proportion at young age, Fracture of dried material, Odour and Taste in case of stem. Similar characters with few proportionate alterations in other part of plants are also chosen. Methods to get the shape of plant parts was totally based on observations while size in diameter was measured through accepted mathematical calculation method to measure the diameter. The process was repeated after every sixth month up to 2 years. Colour, odour, tastes were judged with help of related sensory organs. Fracture was estimated based on observation after breaking the materials selected during the study. The measurement of diameter of pith of the material at the interval for 2 years helped to get the idea behind the estimation of pith proportion of material with that of age of the part of plant.

In leaves totally different materials^{8,9,10,11,12,13,14,15} were selected to study, based on published materials stated in references. The following characters were adopted for the study:

1. Length and width ratio
2. Size of primary vein (in percentage)
3. Angle of origin of secondary veins
4. Veinlet endings
5. Angle of divergence
6. Type of vein lets on the endings
7. Highest vein order
8. Marginal ultimate venation
9. Shape of leaf base
10. Leaf apex

Length and width ratio was simply measured with help of standard scales (metric). Primary vein (1°) is the thickest vein (s) of the leaf, occurring either singly as the midvein, or as series of veins of relatively equal thickness emerging from the petiole. The size was determined midway between the leaf apex and base as the ratio of vein width to leaf width and to calculate the percentage the formula taken was as:

$$\text{Size of primary vein (in percentage)} = \frac{\text{Vein width}}{\text{Leaf width}} \times 100\%$$

Angle of origin for secondary vein is angle between the midvein and the continuation of secondary vein. It was measured with help of compass and arc.

Similarly angle of divergence was measured. Angle of divergence is angle between the branch and continuation of source vein.

Veinlet is the freely ending ultimate veins of the leaf. It was observed simply with help of 10x lens.

Highest vein order is finer order of veins originating from ultimate venation. It was measured by observation with naked eye and with help of magnifying lens of 10x. Similarly marginal ultimate venation, shape of leaf base and leaf apex was observed.

RESULTS

As the plant is dioecious, it is quite natural to deal separately the male and female plant from botanical point of view. Few morphologically differentiating characters are observed are as mentioned below in table number 1 to 5 respectively for stem, leaf, aerial root, root and inflorescence :

TABLE NO. 1 : COMPARATIVE MORPHOLOGICAL CHARACTERS OF MALE AND FEMALE STEMS :

Characters	Male dominant plants	Female dominant plants
I. Stem		
General Appearance	Succulent, grooved, studded with warty tubercles as a result of the development of vertical and longitudinal rows of lenticels, having characteristic three beaked swelling at nodes.	Similar characters as that of male one but more succulent and less flaky in nature.
A. Shape	Slender, dextrorotatory twisted	Same
B. Size		
6 months old	0.75-1.2 cm	0.83-1.44 cm
12 months old	1.12-1.45 cm	1.23 -1. 79 cm
18 months old	1.24-1.86 cm	1.65-2.12 cm
24 months old	1.35-1.98 cm	1.78-2.25 cm
C. Surface	Rough due to longitudinal fissures of cracks along the rows of lenticels	Similar
D. Colour	Light-grey to Creamish-white	Dark green to Creamish-white
E. Colour of cut surface	White-jelly coloured at centre and greenish at periphery	Cream-jelly coloured at centre and darker at periphery
F. Pith proportion of cut surface $Pith \propto 1/age$	More than half in young plants	Comparatively larger pith area
G. Fracture	Hard, fibrous-brittle	Same
H. Odour	Not specific but characteristic	Comparatively strong
I. Taste	Bitter	Comparatively less bitter

TABLE NO. 2 : COMPARATIVE MORPHOLOGICAL CHARACTERS OF MALE AND FEMALE LEAVES :

Characters	Male dominant plants	Female dominant plants
II. Leaf		
General Appearance	Simple, alternate, stipulate, long petiolate and arise from and are articulated to short tumid (swollen) nodal projection	Same
A. Size	7-18 (length) x 5-15 (width) cm	8-25 (length)x7-22 (width)cm
B. Length/Width Ratio	1.29 cm	1.15 cm
C. Shape	Broadly ovate to roundish-cordate	Same
D. Surface	Glabrous dorsiventrally, glaucous beneath	Same
E. Texture	Flexible, coriaceous	Same
Size of primary Vein = $\frac{\text{vein width} \times 100}{\text{leaf width}}$	11.42%	9.5%
G. Angle of origin of secondary vein	60°	55°
H. Veinlets ending	Sinously running	Zigzagly running
I. Angle of divergence	58°	65°
J. Veinlet terminals	Intermingly forming islets (closed often)	Both closed and open at the endings
K. Highest Vein Order	5°-6°	7°.8°
L. Marginal Ultimate Veination	Looped	Incomplete
M. Leaf-base	Lobate	Lobate to Cordate
N. Leaf-apex	Acute	Acute to acuminate

Contd....

O. Colour	Upper surface green to yellowish-green and lower paler in colour	Upper surface green to yellowish-green (comparatively darker) and lower paler in colour Reticulate, 7 prominent nerves
P. Veination	Reticulate, 7 prominent nerves	Same
Q. Petiole	Slender with pulvinous (thickened) basal portion which is slightly twisted	Same
R. Length	3.42-7.45 cm	4.12-9.56 cm
S. Diameter	0.22-1.15 cm	0.32-1.76 cm

TABLE NO. 3 : COMPARATIVE MORPHOLOGICAL CHARACTERS OF MALE AND FEMALE AERIAL ROOT :

Characters	Male dominant plants	Female dominant plants
III. Aerial Root	Slender	Slender
A. Size	0.15-0.61 cm in diameter	0.15-0.86 cm in diameter
B. Surface	Smooth in young and with age exfoliation starts leaving thread of fibrous parts in centre	Same
C. Colour	Green to light-grey	Green to whitish-grey
D. Colour of cut surface	Green to whitish-grey	Same
E. Fracture	Short and fibrous	More fibrous
F. Odour	Odourless	Same
G. Taste	Bitter	Same

TABLE NO. 4 : COMPARATIVE MORPHOLOGICAL CHARACTERS OF MALE AND FEMALE ROOT :

Characters	Male dominant plants	Female dominant plants
IV. Root	Slender, tortuous with swellings at the places where secondary roots arise	Same
A. Surface	Rough	Same
B. Size (Diameter)	0.56-2.45 cm	0.45-2.34 cm
C. Colour	Externally light-grey and internally yellowish	Same except less yellowish comparatively inside
D. Colour of cut surface	Green to whitish-grey	Same
E. Fracture	Short	Same
F. Odour	Nil	Nil
G. Taste	Bitter	Same

TABLE NO. 5 : COMPARATIVE MORPHOLOGICAL CHARACTERS OF INFLORESCENCE :

Characters	Male dominant plants	Female dominant plants
V. Inflorescence	Lax raceme, axillary or terminal	Same
A. Flowers	Clustered in axils of small subulate bracts	Usually solitary
B. Shape	Elongated, Sepals 3 outer very small, ovate-oblong, acute, the inner larger, membranous, broadly elliptical, concave 0.3 - 0.5 cm; petals 6 equal about 2 mm long, broadly spatulate, each loosely embracing a stamen, lamina subtrilobed, rhomboidal in shape, reflexed at apex, pistillode absent	Elongated, Similar to male flower, margins of sepals reflexed, petals obovate not rhomboidal, 6 short and linear staminode
C. Size of inflorescence	3.5-7.2 cm	6.2-16.57 cm
D. Colour	Sepals and petals yellow	Sepals and petals comparatively greenish in colour

Such variations were already reported earlier by many scientists in other dioecious plants belonging to family menispermaceae e.g. *Cocculus hirsutus* (L), *Cyclea peltata*, *Cisampelos perrai* etc.

DISCUSSION

Tinospora cordifolia (Willd.) Miers. ex Hk. F. Thom. is large dextrorotatory dioecious climber with succulent, corky and grooved stem. Both male and female dominant plants were found morphologically identical but differed in few characters. Stems of female one was more succulent than male one which might be either adaptation of female towards the aridity of plants or the presence of more mucilaginous cells in the stem of them. Succulence of plants might be reason behind the thicker female stem was confirmed from data when measured after 6, 12, 18 and 24 months respectively.

Surface, colour and cut surface of stems were almost identical in both male and female plants, but in later it was more dark in colour indicating better photosynthetic activity producing more chlorophyll content in female unlike the male plant. Aerial roots also exhibited such differences and showed darker yellow cortical region probably because of more berberin content in male.

Minor variations were also noticed in leaves of both the plants. They being bigger in size with more thicker cuticle in female than in male.

The percentage of ratio of vein width to the leaf width is termed as size of primary vein. It can be differentiated into massive, stout, moderate and weak for the percentage as more than 4 %, to 2-4%, 1.25-2% and 1.25% respectively. In case of Guduchi both male and female dominant leaves were found to be fit under massive with slight percentage difference as 11.42% and 9.5% respectively for male and female dominant. In both the cases, primary veins were found *actinodromous* i.e., 3 or more primary veins diverging radially from the single point. The veinlet ending of male dominant plant was found being repeated smooth changes in direction of curvature, i.e. sinuous while that of female dominant was observed with repeated angular changes in direction. It was almost closed at the ending in male dominant while in female dominant both open and closed were observed. The major portion of marginal venation was found recurved to form loop in male dominant while in the female dominant veinlets were with freely ending directly adjacent to the margin. The highest vein order was observed different in both male and female dominant plant which 5° - 6° in the male while in female it was 7° - 8° .

Angle of origin of secondary veins is considered taxonomically useful characters which was seen slight greater in male dominant but it was not so much differentiating to be taken as important one. Angle of divergence was measured between the branch and continuation of the source vein above the point of branching. It was found more in female dominant than the male dominant.

Leaf-apex and leaf-base of both male and female dominant leaves were observed different. In the male dominant leaf-apex and leaf-base were respectively acute and lobate; while in female dominant they were acute to acuminate and lobate to cordate in order.

CONCLUSION

Looking to the origin or evolution of sexes among the plants, it is better to say male dominant and female dominant rather than male and female plant. Male dominant plants were thinner in diameter, lighter in colour and bitter in taste in compare to their female counterparts. Size of leaves was less in male dominant plants than female dominant plants but the length and width ratio was more in male dominant plants. Size of primary vein in leaves of male dominant plants was more than those of female dominant plants. Angle of origin of secondary vein of leaves of male dominant plants was an average 60° , whereas it is 55° in leaves of female dominant plants. Angle of divergence also varies among the leaves of both male and female dominant plants being 58° and 65° respectively in male and female dominant plants. Marginal ultimate venation was looped in male dominant plants while it is incomplete in female dominant one. Length and diameter of petiole was also lesser in male dominant plants than female dominant plants. There were not any much differentiating characters marked to differentiate aerial roots of both male and female dominant plants except the size and diameter, which were less in case of male dominant plants than those of female dominant plants. In case of root also, not any marked differentiating character was noted except the colour of internal surface of root, which was more yellowish in case of male dominant than those of female dominant plants.

Flowering differences among the male and female dominant plants were well marked. But few of untouched interesting things are studied as, rhomboidal petals in male dominant while obovate in female dominant plants along with more yellowish sepals and petals in male dominant plants, whereas more greenish sepals and petals in female dominant plants. Hence, it can be said that differences do exist on the basis of sex in dioecious plant like Guduchi.

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Author's elucidation on reviewer's comments: The present study is restricted to morphological differences, and not upon the medicinal or therapeutic utilities. By the time it is also true that bitters are more in amount in male plants than female plants, then we may prefer the use of male as antipyretic or antidiabetic than female (this is based on the chemical differences). Again it is emphasized that our work is based on the experiment rather than elaboration of references. The flowering time is almost same in both cases, while fruiting is only restricted to female plants and hardly morphological differences with external appearances not on chemical constituent of plant. *Sattva* (Starch) is primary metabolic product of chemical reactions on cellular level.

हिन्दी सारांश

गुडूची का पुल्लिंग एवं स्त्रीलिंग भेद से बाह्य परिचयात्मक अध्ययन

प्रशांत कुमार झा, एम.जी. चौहान एवं टी.एन. पण्ड्या

कुछ औषधि वनस्पतियों के बाह्य स्वरूप में लिंग भेद के अनुसार अंतर पाया जाता है। प्रस्तुत अध्ययन में गुडूची का पुल्लिंग एवं स्त्रीलिंग भेद से बाह्य परिचयात्मक गुणधर्मों का विश्लेषण किया गया है। प्राप्त परिणामों के अनुसार दोनों के मूल, पर्ण इत्यादि में अंतर पाया गया।

