"Comparative study of leaf architecture in the species of genus *Indigofera* L."

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Abstract

Studies of leaf architecture in some species of genus *Indigofera* are investigated. In the present work 9 taxa of the genus are taken for the study. The 9 species include *Indigofera linifolia, Indigofera linnaei, Indigofera cordifolia, Indigofera astragalina, Indigofera tinctoria, Indigofera glandulosa, Indigofera trifoliate, Indigofera purviflora, Indigofera cassioides.* A comprehensive description of leaf architecture for the studied taxa was provided including venation pattern, areolation and marginal ultimate venation. The venation pattern showed mostly pinnate semicraspedodromous; Aeroles are pecfectly developed. Taxonomically significant leaf features of examined taxa showed great diversity in leaf or leaflet from leaf size, leaf apex, leaf base, main venation pattern, secondary vein angle, inter secondary veins, number of veins on either side of midrib, free ending ultimate veins areole size, number of vein endings. Entering the areoles and number of vein terminations, entering the areoles vary from species to species even within the same species looped marginal ultimate venation is observed in all the species. The highest degree of vein order is observed upto 6˚.

Keywords: Leaf Architecture, Venation pattern**,** *Indigofera.*

Introduction:

Indigofera is a large genus of over 750 species of flowering plants of the subfamily Papilionaceae belonging to the pea family Fabaceae. A very large family of herbs, shrubs and trees with a great variety of habit, including hydrophytes, xerophytes and climber (Dallwitz and Watson, 2000). *Indigofera in* Greek means Indigo dye which is famous for the natural blue colour obtained from the leaflets and branches of this herb. *Indigofera* genus possesses wide range of uses ranging from several economic and ecological purposes. The leafy twigs are the main source of Indigo dye. Indigo has been called the King of dyes (Takawira-Nyenya and Cardon, 2005). The present study deals with the leaf architecture from 9 taxa of genus *Indigofera.*

Ettingshausen (1861) made the first effort to systematize the description of the vegetative leaf architecture with his classification of venation pattern. Leaf architectural characters have proved valuable taxonomic and systematic data both in fossil and living plants. (Hickey, 1973; Dilcher, 1974; Hickey and Wolfe, 1975). Leaf architecture and venation pattern studied in different families of dicotyledons; amongst others, compositae (Banerjee and Deshpande, 1973), Solanaceae (Inamdar and Murthy, 1978), Bignoniaceae (Jain, 1978), Leguminosae (Sun *et. al.* 1991), Amaranthaceae (Shanmuka *et. al.* 1994), Ulmaceae (Wang *et. al.* 2001), Fagaceae (Luo and Zhou, 2002) and in some monocots (Inamdar *et. al.* 1983). The present work was undertaken to give detail account of the venation pattern and leaf architecture in 9 species of genus *Indigofera* as no report exists on the subject. It is a contribution towards better understanding the role of leaf architecture, assessing the range of variation among species by applying multivariate analysis.

Material and Methods:

To study leaf architecture, the mature leaves from fresh materials were cleared by treating them with 5% aqueous sodium hydroxide which was repeatedly replace by fresh solution until leaf material got cleared, followed by treatment with 2% acetic acid for 1-2 hours to neutralize residual sodium hydroxide. The cleared leaves after washing with distilled water stained with aqueous safranin and mounted in glycerin or dehydrated. Major and minor venation patterns and details of leaf architecture, were studied under compound microscope. Terminology of Hickey (1971, 1973) is followed for describing leaf architecture. Whole lamina photographs were taken directly using coslab camera fitted with 4X, 10X & 40X microscopic objective lens.

Abbreviations used in the table:

AA - Acute Acute
AO - Acute Obtuse
AR - Acute Right
RA - Right Acute
RR - Right Right
OR - Obtuse Right
OA - Obtuse Acute
RO - Right Obtuse

Observation:

Leaves of two species i.e. *Indigofera linifolia* and *Indigofera cordifolia* are simple and remaining are compound. The lamina is asymmetrical in *Indigofera linnaei.* Leaf base is slightly asymmetrical in *Indigofera linnaei, Indigofera glandulosa* and *Indigofera purviflora.* The common characteristics found in the leaf of all the species are margin is entire, leaf texture is membranous, type of venation is pinnate, semicraspedodromous where a single primary vein serves as the origin for the higher order venation. The first, second and third degree veins are considered as major and the higher order veins are the minor venation patterns.

a) Major Venation Patterns:

The primary vein is the thickest vein of the leaf and its thickness decreases gradually towards the apex and it gives off other degree veins on either side. In all the cases, a single strand enters the base of the lamina from the petiole and forms the primary vein which after travelling a short distance branches laterally. The primary veins are mostly moderate occasionally stout and massive. The secondary veins are strongly semicraspedodromous. The second arises have set of secondary loops. The number of second degree veins on either side of the primary vein vary from 5-9. Inter-secondary veins are observed in *Indigofera linnaei, Indigofera cassioides, Indigofera purviflora, Indigofera linifolia*.

Table No.01: Qualitative Leaf features of some *Indigofera* species

Name of Species	Leaf/ Leaflet					
	Leaf Organisation	**Size (cm)**	**Lamina**	**Shape**	**Apex**	**Base**
Indigofera linnaei	Compound	0.7	Asymmetrical, Base slightly Asymmetrical	Narrow Obovate	Obtuse	Acute
Indigofera linifolia	Simple	1	Symmetrical	Narrow Ovate	Acute	Acute
Indigofera cordifolia	Simple	0.9	Symmetrical	Wide Ovate	Obtuse/ Mucronate	Chordate
Indigofera astragalina	Compound	5	Symmetrical	Wide Elliptic	Mucronate	Acute
Indigofera tinctoria	Compound	1.2	Symmetrical	Narrow Ovate	Obtuse	Acute
Indigofera glandulosa	Compound	3	Symmetrical, Base slightly Asymmetrical	Narrow Ovate	Rounded Retuse	Acute
Indigofera trifoliate	Compound	2.5	Symmetrical	Narrow Obovate	Rounded Apiculate	Acute
Indigofera purviflora	Compound	0.8	Symmetrical, Base slightly Asymmetrical	Narrow Ovate	Mucronate	Acute
Indigofera cassioides	Compound	3.5	Symmetrical	Elliptic to Obovate	Mucronate	Acute

Table No.02: Major and Minor venation patterns

Name of Species	Primary vein size	No. of 2 veins along one side of midrib	Angle between 1˚& 2˚ vein	Inter secondary veins	Pre-dominantly tertiary vein origin angle	Veinlet ending
Indigofera linnaei	Moderate	7	25˚- 30˚	Present	RR, RA	Linear, Simple branched once
Indigofera linifolia	Moderate	5	105˚- 110˚	Present	AA, RR	Simple curved
Indigofera cordifolia	Moderate	6	40˚- 45˚	Absent	RR, OR	Simple curved
Indigofera astragalina	Massive	6	42˚- 45˚	Absent	AA, RO	Simple curved
Indigofera tinctoria	Moderate	7	20˚- 25˚	Absent	AA, AR	Branched once
Indigofera glandulosa	Moderate	9	30˚- 35˚	Absent	RR, OR	Simple branched
Indigofera trifoliate	Stout	9	25˚- 30˚	Absent	AA, OR	Simple curved
Indigofera purviflora	Moderate	9	30˚- 35˚	Present	OA, RO	Branched curved
Indigofera cassioides	Moderate	8	60˚- 65˚	Present	AA, RA	Branched curved Once or Twice

b) Minor Venation Patterns:

The highest order veins are identified up to 5 degree in most cases, but in some up to 6 degree. Marginal ultimate venation is looped in all the species studied. The areoles are perfectly developed and the shape may rectangular or polygonal. The size of the areole is not constant, varies in different species and even in same species. The plasticity of venation characters is shown by the variations in areole size, number of veinlet per areole and organization of terminal vein endings in different species.

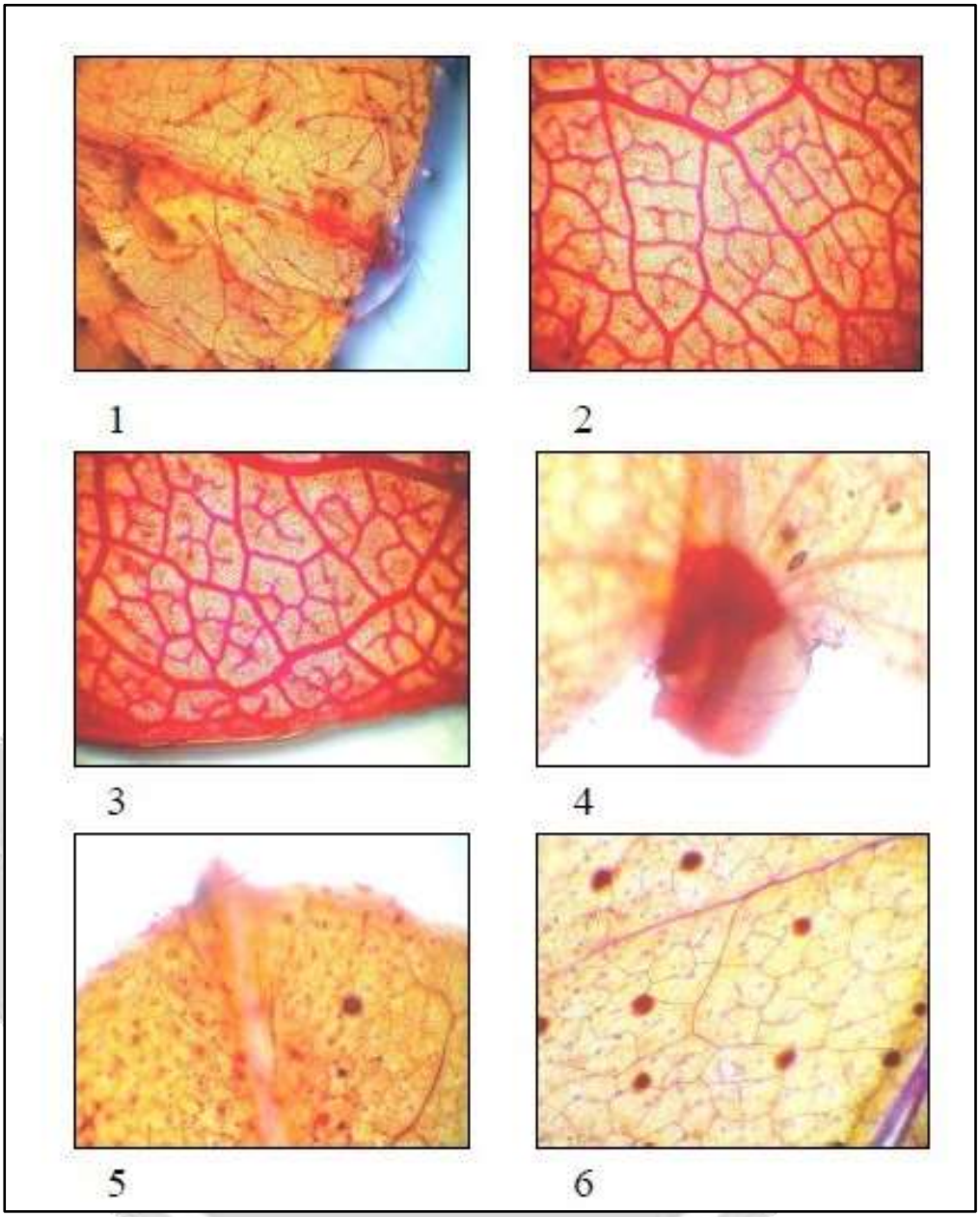

Plate No. 01: Figure 1: *I. astragalina* showing massive primary vein with mucronate apex; Figure 2: *I. cassioides* showing lamina: Perfectly developed areoles with branched veinlet ending; Figure 3: *I. cassioides* with looped marginal venation; Figure 4: *I. cordifolia* showing chordate base; Figure 5: *I. cordifolia* with moderate primary vein; Figure 6: *I. glandulosa* showing veinlet ending simple branched.

c) Vein Endings:

The ultimate veins of the leaf are either simple or branched simple vein ending may be linear or curved. The branched ones may divide once or twice. Veinlets may be long and thin or thick and short.

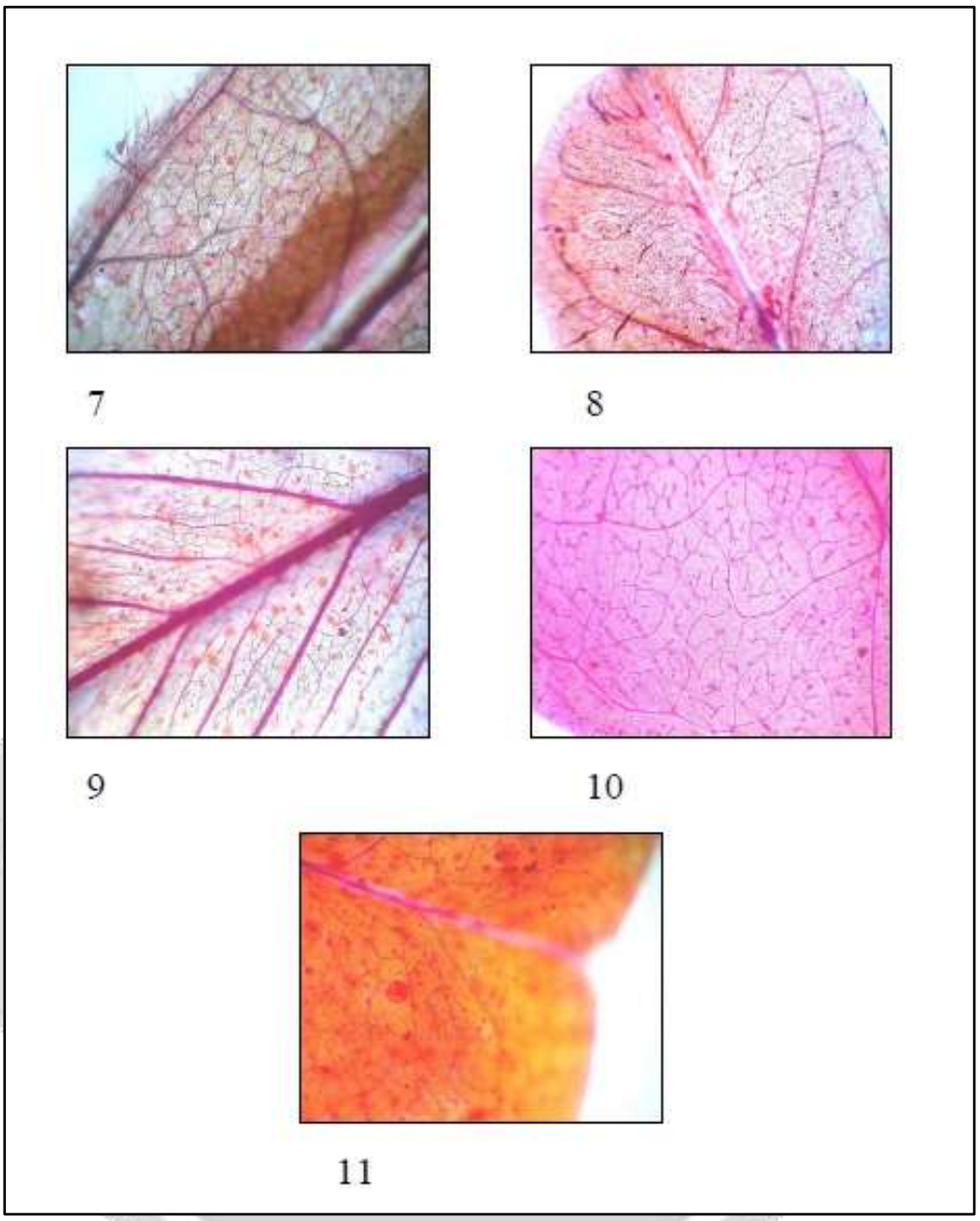

Plate No. 02: Figure 7: *I. linifolia* showing moderate primary vein with simple curved veinlet ending; Figure 8: *I. linnaei* showing moderate primary vein and marginal loop formation;
Figure 9: *I. purviflora* showing moderate primary vein with intersecondaries, veinlet ending branched, curved; Figure10: *I. tinctoria* showing simple branched veinlet endings; Figure 11: *I. trifoliata* showing stout primary vein with simple curved veinlet endings, apex rounded, apiculate;

Result and Discussion:

Leaf venation in angiosperm varies both in pattern (Hickey, 1973) and regularity (Hickey and Doyle, 1972). According to Pray (1954), the veins of first, second and third order form major venation pattern and those of subsequent orders constitute minor venation patterns. The venation pattern studied in 9 species of the genus *Indigofera*: Leaves are basically compound except in *Indigofera linifolia* and *Indigofera cordifolia*. Margin entire, venation pinnate, secondary veins are strongly semicraspedodromous and tending to form an intramarginal vein. The plasticity of venation varies in different species and sometimes in the same species by variations in areole shape and size number of vein endings and other qualitative features. The numbers of vein endings are in no way connected to the size of the areole as the nearby areoles even though more or less equal in size vary in their number of vein endings. Loop formation is a common feature as marginal ultimate venation is looped. Hickey (1973) classified the vein endings into simple and branched. Branched ones divided once, twice or thrice.

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