

Chemosystematics of some species of *Indigofera*

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Abstract. The distribution pattern of phenolic constituents in 8 species of *Indigofera* is studied. There is uniform occurrence of *p*-coumaric, *p*-OH benzoic and vanillic acids and an unknown phenolic compound 'e' of hR_f value 42/57 in all the taxa studied. There is a chemical similarity between *Indigofera hochstetteri* and *Indigofera tinctoria*. *Indigofera dalzellii*, *Indigofera hirsuta*, *Indigofera oblongifolia* and *Indigofera prostrata* stand out in the unique possession of certain compounds. The overlapping incidence of the constituents indicates the fairly close chemical ties among the species studied. The cluster analysis reveals that it supports earlier sub divisions of the genus to some extent.

Keywords. Phenolic constituents; *Indigofera*; taxonomic significance.

1. Introduction

There are some reports on the chemotaxonomy of *Indigofera* (Bhalla and Dakwale 1978; Mishra *et al* 1981) but none of them deals with the extent of affinity among the species and taxonomy of the genus. Recently Anuradha *et al* (1987) studied the chemotaxonomy of a few species of *Indigofera*, and the present work, a sequel to it, on 8 species, is undertaken to reevaluate the earlier placement of species under different infrageneric divisions and find out the extent of affinity in the light of distribution of phenolic constituents.

2. Materials and methods

The 8 species of *Indigofera* as listed in table 1 were collected from the southern belt of Indian sub-continent including Hyderabad and the voucher specimens are deposited in the Herbarium, Royal Botanic Gardens, Kew and the regional herbaria of Botanical Survey of India at Western Circle (BSI), Pune, Southern Circle (MH), Coimbatore and Central National Herbarium (CNH), Howrah, besides Sardar Patel College, Secunderabad. Herbarium specimens were used (Harborne 1967, 1973) in the present investigation for the detection of phenolic compounds. The material was screened following Nageshwar *et al* (1986). The spots of unidentified phenolics on separate chromatograms, presumed to be identical in position and colour reaction both under ultra violet light and the visualising agent, were marked on a 'master chromatogram' with marginal adjustments of R_f values and were assigned the same code. The chemical data were analysed following Ellison *et al* (1962) for similarity indices and Sokal and Sneath (1963) for clustering technique by weighted pair group method (WPGM).

Table 1. List of taxa studied and their place of collection.

Name of the taxon	Place of collection	Voucher specimen No
<i>I. dalzellii</i> Cooke (<i>I. triquetra</i> Dalz)	Poona	BKV 1278
<i>I. hirsuta</i> L. (<i>I. astragalinu</i> DC)	Hyderabad	BKV 621
<i>I. hochstetteri</i> Baker (<i>I. anabaptista</i> Steud)	Poona	BKV 1283
<i>I. mysorensis</i> Rottl.	Tirupathi	BKV 623
<i>I. oblongifolia</i> Forsskål (<i>I. paucifolia</i> Del)	Karimnagar	BKV 628
<i>I. prostrata</i> Willd.	Khandala	BKV 1287
<i>I. tenuifolia</i> Rottl.	Belgaum	BKV 611
<i>I. tinctoria</i> L.	Hyderabad	BKV 625

Table 2. Distribution of phenolic constituents.

Phenolic constituents	Name of the taxon*							
	1	2	3	4	5	6	7	8
Caffeic acid	+					+		
<i>p</i> -Coumaric acid	+	+	+	+	+	+	+	+
Gallic acid		+						
<i>p</i> -OH benzoic acid	+	+	+	+	+	+	+	+
Salicylic acid					+			
Vanillic acid	+	+	+	+	+	+	+	+
a-24/21	+				+			
b-24/35			+		+	+	+	+
c-30/14						+		
d-40/30	+	+		+	+		+	
e-42/57	+	+	+	+	+	+	+	+
f-54/10			+			+		+
g-54/17	+				+			
h-62/55	+							
i-66/10		+						
j-66/45					+		+	
k-66/82	+	+		+			+	

*Same as in table 1.

3. Results and discussion

Of the phenolic acids identified (table 2) *p*-coumaric, *p*-hydroxy benzoic and vanillic acids and an unknown phenolic compound 'e' of hR_f value 42/57 are present in all the members screened, but salicylic is noticed only in *I. oblongifolia*. The phenolic compounds 'c' (of hR_f value 30/14), 'h' (62/55) and 'i' (66/10) are present in *I. prostrata*, *I. dalzellii* and *I. hirsuta* respectively and these compounds are not shared by others. Further there is restricted occurrence of several other phenolic compounds (table 2) in the different taxa studied. The presence of both known and unknown phenolic compounds is taken into consideration in the numerical analysis.

Studies on distribution of phenolic compounds provide useful information on taxonomic problems at all levels of hierarchy from infraspecific to ordinal level

(Harborne 1975) and also in presumed instances of interspecific hybridisation (Alston and Turner 1963; Pryer *et al* 1983). The distribution of phenolic constituents in *Indigofera* species (table 2) suggest a fair degree of kinship among the taxa studied as evidenced by the uniform presence of certain phenolic compounds and the paired affinity indices (table 3) calculated according to the formula of Ellison *et al* (1962) for the remaining ones. It is very clear from table 3 that the paired affinity values ranging from 0–67 and group affinity values ranging from 294–395 (both excluding the compounds that are uniformly present) indicate a fair degree of affinity. Anuradha *et al* (1987) arrived at a similar conclusion with regard to 9 species of *Indigofera* studied earlier, from the point of view of distribution of different secondary metabolites, phenolic compounds and amino acids.

The different versions on the subdivisions of the genus *Indigofera* appeared from time to time (de Candolle 1825; Bentham and Hooker 1862–1893; Baker 1876; Gillett 1958a, b) on the basis of exomorphological features, but they suffer from some inconsistencies. Vijay Kumar (1983) hence decimated some of the earlier infrageneric ranks, in an attempt to rectify the anomalies on the basis of data on foliar dermatypes and a few macro-morphological features.

A close look at the dendrogram of cluster analysis (figure 1) indicates that *I. hochstetteri* which has been accorded a separate subgeneric status (*Ameocarpus*) by Baker (1876) does not enjoy the same on chemical grounds and shows 67–100% resemblance in some chemical characters to *I. tinctoria* and *I. prostrata*, the species of the subgenus *Indigofera*. Thus Vijay Kumar's (1983) view gains support in this respect. Similarly the placement of the taxa *I. hirsuta* and *I. tenuifolia* in group Pinnatae, section A, Apapillatae *sensu* Vijay Kumar (1983) is also justified chemically. *I. mysorensis* joins these two taxa at a similar level chemically forming a cluster, however is slightly set apart at group/sectional level by Baker (1876) and Vijay Kumar (1983) respectively. *I. dalzellii* of group Simplicifoliae (Baker 1876; Vijay Kumar 1983), however, is close to *I. oblongifolia* (of Tinctoriae *sensu* Baker 1876 or Pinnatae *sensu* Vijay Kumar 1983) and forms a cluster. The reasons for close chemical proximity has to be corroborated by the data from collateral disciplines.

From the foregoing discussion it is held that the present data on distribution of phenolics indicate close relationship among the taxa studied and support the earlier

Table 3. Paired and group affinity values.

Name of the taxon*	Paired affinity								Group affinity
	Name of the taxon*								
	1	2	3	4	5	6	7	8	
1	100	40	0	50	50	20	36	0	296
2		100	0	67	20	0	67	0	294
3			100	0	25	67	29	100	321
4				100	25	0	50	0	292
5					100	20	55	25	320
6						100	22	67	296
7							100	29	357
8								100	321

*Same as in table 1.

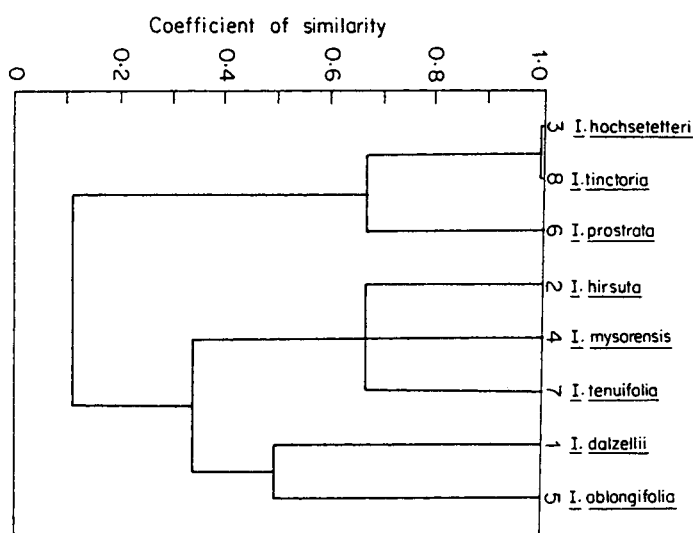


Figure 1. Dendrogram of cluster analysis based on the coefficients of similarity by WPGM.

subdivisions of the genus only in parts. A complete correlation of chemical and morphological characters, however, invariably is an exception (Cronquist 1980).

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References

- Alston R E and Turner B L 1963 *Biochemical systematics* (New Jersey: Prentice Hall)
- Anuradha S M J, Vijay Kumar B K, Radhakrishnaiah M and Narayana L L 1987 Chemotaxonomy of some species of *Indigofera* L; *Feddes Rep.* **98** 449–453
- Baker J G 1876 Leguminosae; in *Flora of British India* (ed.) J D Hooker (Ashford, Kent: L Reeve & Co. Ltd.) vol 2, pp 57–306
- Bentham G and Hooker J D 1862–1893 *Genera Plantarum* (London: R Reeve and Co)
- Bhalla N P and Dakwale J D 1978 Chemotaxonomy of *Indigofera*; *J. Indian Bot. Soc.* **57** 180–185
- Cronquist A 1980 Chemistry in plant taxonomy: an assessment of where we stand; in *Chemosystematics: principles and practice* (eds) F A Bisby, J G Vaughan and C A Wright (London, New York: Academic Press) pp 1–27
- de Candolle A P 1825 *Prodromus systematics Naturalis Regni Vegetabilis* vol 11 (Paris: Treutten and Würtz)
- Ellison W L, Alston R E and Turner B L 1962 Methods of presentation of crude biochemical data for systematic purposes with particular reference to the genus *Bahia* (Compositae); *Am. J. Bot.* **49** 599–604
- Gillett J B 1958a *Indigofera* (Microcharis) in Tropical Africa; *Kew Bull.* (add Ser I) 1–166
- Gillett J B 1958b *Indigofera*; in *Flora of west tropical Africa* 2nd edition (eds) J Hutchinson and J M Dalziel (London: Crown Agents) pp 533–543
- Harborne J B 1967 *Comparative biochemistry of flavonoids* (London: Academic Press)
- Harborne J B 1973 *Phytochemical methods* (London: Chapman and Hall)

- Harborne J B 1975 The Biochemical systematics of flavonoids; in *The flavonoids* (eds) J B Harborne, T J Mabry and H Mabry (London: Chapman and Hall) pp 1056–1095
- Mishra S P, Daniel M and Sabnis S D 1981 Chemotaxonomical studies on the genus *Indigofera*; *J. M. S. Univ. Baroda* **27** and **28** 7–10
- Nageshwar G, Anuradha S M J, Radhakrishnaiah M and Narayana L L 1986 Distribution pattern of phenolic constituents in *Bauhinia* and its taxonomic significance; *Proc. Indian Acad. Sci. (Plant Sci.)* **93** 621–627
- Pryer K M N, Britton D M and McNeill J 1983 A numerical analysis of the chromatographic profiles in North American taxa of the fern genus *Gymnocarpium*; *Can. J. Bot.* **61** 2592–2602
- Sokal R R and Sneath 1963 *Principles of Numerical Taxonomy* (San Francisco: W H Freeman and Co)
- Vijay Kumar B K 1983 *Systematics and anatomical studies of some South Indian species of Indigofera L.*, Ph.D. thesis, Osmania University, Hyderabad