CHEMOTAXONOMICAL STUDIES ON CAPPARIDACEAE—CLEOMACEAE

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ABSTRACT

12 members belonging to Capparidaceae and Cleomaceae have been analysed for flavonoids and phenolic acids. The distribution pattern of these compounds among the members studied indicate that the two families are quite distinct chemically. Hutchinson's separation of these two families, therefore, is supported. The chemical affinity of Cleomaceae to Brassicaceae has been clearly brought out.

INTRODUCTION

CAPPARIDACEAE (Capparaceae), a comparatively small family, is morphologically peculiar in the presence of a gynophore and uniloculate ovary with parietal placentation. This family comprises members of varying habits which ranges from herbs like *Cleome* to trees like *Crateva*. Based on the habit and other morphological characters it has been segregated into two groups Cleomoideae and Capparideae. Cleomoideae include all the herbaceous members which are having dehiscent fruits with a replum, *i.e.,* a frame like placenta from which the valves fall away in dehiscence and Capparideae of woody perennials having indehiscent fruits. These two segregates have been considered as two natural groups within the family.

Hutchinson in his separation of woody and herbaceous plants to Lignosae and Herbaceae, retained the herbaceous members (Cleomoideae) in the Lignosae, as a subfamily Cleomoideae in Capparidaceae[4]. But after a more intensive study "genus by genus and species by species, in the Kew Herbarium," he came to the conclusion that the family as it then existed consists of two distinct groups which are not really phylogenetically related. In his opinion "the true capparids with Capparis as its generic type are woody plants and have indehiscent fruits without a replum and are closely related to Flacourtiaceae (Bixales), whilst the subfamily Cleomoideae, type genus Cleome, are related to Brassicaceae (Cruciferae), all being with dehiscent fruits provided with a replum." In his later work[5] he raises these two subfamilies to the family status and separates them to very distant groups. Capparidaceae is grouped, in order Capparidales of Lignosae along with Moringaceae and Cleomaceae in Cruciales of Herbaceae with Oxystylidaceae and Brassicaceae.

Not much work has been done on the chemistry of this group. The earlier chemical reports[2,9,11,12] are quite insufficient for a chemotaxonomical treatment of these families. Recently Das and Rao[1] have attempted a phytochemical phylogenetic study of the groups using phenolic compounds as markers. In the present work, 12 members coming under 5 genera have been screened for leaf phenolics. Of these 5 belong to Cleomaceae and the rest to Capparidaceae.

MATERIALS AND METHODS

All the plants were collected fresh. Voucher specimens have been deposited in the Herbarium, Department of Botany, The M.S. University of Baroda, India.

Standard procedures[3,6,8,13] were adopted for the extraction, isolation and identification of various phenols, present in leaves of these plants.

RESULTS AND DISCUSSION

The distribution of various flavonoids and phenolic acids in different members of Capparidaceae—Cleomaceae is presented in Tables I and II.

Flavonols are found to be present in 10 plants screened. They are quercetin, rhamnetin, isorhamnetin, kaempferol and myricetin. Quercetin is present in at least 50% of the species examined, isorhamnetin in more than 40% and rhamnetin about 15%. Kaempferol and myricetin are present in one member each. Of these quercetin in *Cadaba indica*, isorhamnetin in *Cleome chelidonii* and myricetin in *Crateva adansonii* are in traces.

Glycoflavones could be located in 3 plants only, and they are isovitexin from *Crateva adansonii* and isoorientin from *Cadaba indica* and *Capparis sepiaria*. Only *Crateva* gives a strong positive test for leucoanthocyanins, but *Capparis sepiaria* gives a weak positive test for them.

Out of the various phenolic acids identified, *p*-hydroxybenzoic acid is present in all the plants screened and vanillic acid in all but one. Syringic and ferulic acids are present in at least 75% of the plants.

The chemical differences between the two families can be summarised as follows :

1. Quercetin is more frequent in Cleomaceae. Here, out of the 5 plants, 4 contain quercetin and out of the 7 plants of Capparidaceae only 2 contain this compound. (The trace amounts of quercetin in *Cadaba* is to be noted),

TABLE I

The distribution of flavonoids in Capparidaceae—Cleomaceae

	1	2	3	4	5	6	7
CAPPARIDACEAE							
Cadaba indica Lamk.	+	·	·	·	·	+	·
Capparis decidua Edgew.	·	+	·	·	·	·	·
C. grandis Linn. f.	+	·	+	·	·	·	·
C. sepiaria Linn.	·	·	+	·	·	+	+
C. zeylanica Linn.	·	·	·	·	·	·	·
Crateva adansonii DC.	·	·	·	·	+	+	+
Maerua oblongifolia A. Rich.	·	·	·	·	·	·	·
CLEOMACEAE							
Cleome chelidonii Linn. f.	·	+	·	·	·	·	·
C. cynandra Linn.	+	+	·	·	·	·	·
C. monophylla Linn.	+	·	·	+	·	·	·
C. simplicifolia Hf. ahd T.	+	+	·	·	·	·	·
C. viscosa Linn.	+	+	·	·	·	·	·

1. Quercetin, 2. Isorhamnetin, 3. Rhamnetin, 4. Kaempferol, 5. Myricetain, 6. Glycoflavones, 7. Leucoanthocyanins.

TABLE II

The distribution of Phenolic acids in Capparidaceae—Cleomaceae

	1	2	3	4	5	6	7	8	9	10	11	12
CAPPARIDACEAE												
Cadaba indica Lamk.	+	·	·	+	+	·	·	+	·	·	·	·
Capparis decidua Edgew.	+	+	+	+	+	+	+	·	+	·	+	+
C. grandis Linn. f.	+	+	+	+	+	+	+	·	+	·	+	·
C. sepiaria Linn.	+	+	+	+	+	+	+	·	+	·	+	+
C. zeylanica Linn.	+	·	·	+	+	·	·	·	+	·	+	·
Crateva adansonii DC.	+	·	·	·	+	·	·	+	+	+	·	·
Maeura oblongifolia A. Rich.	+	·	+	·	·	·	·	·	·	·	·	·
CLEOMACEAE												
Cleome chelidonii Linn. f.	+	·	·	+	+	·	·	·	·	+	·	+
C. gynandra Linn.	+	·	·	+	+	·	·	+	+	+	·	·
C. monophylla Linn.	+	+	·	·	+	·	·	·	+	+	·	·
C. simplicifolia Hf. and T.	+	·	·	+	+	+	·	·	+	·	+	·
C. viscosa Linn.	+	·	·	+	+	·	·	·	+	+	·	·

1. *p*-Hydroxybenzoic acid, 2. Protocatechuic acid, 3. Salicylic acid, 4. Syringic acid, 5. Vanillic acid 6. Genetisic acid, 7. 2-Hydroxy 6-methoxy benzoic acid, 8. 2-Hydroxy 4-methoxy benzoic acid, 9. Ferulic acid 10. Sinapic acid, 11. *p*-Coumaric acid, 12. *o*-Coumaric acid.

2. Isorhamnetin is present in 4/5 plants of Cleomaceae and 1/7 of Capparidaceae,

3. Rhamnetin, leucoanthocyanins and glyco-, flavones are present only in Capparidaceae.

4. Salicylic and 2-hydroxy, 6-methoxy benzoic acids are confined to Capparidaceae and also there is more frequency of protocatechuic, *p*-coumaric, *o*-coumaric and gentisic acids here. Whereas sinapic acid is more frequent in Cleomaceae.

The distribution of flavonoids and phenolic acids clearly define the two famalies. Not only the higher frequency, but also the higher concentration of flavonols in Cleomaceae is noteworthy. The phenolic acids also show clear separation of the groups. All these facts point to the justification of splitting the old family Capparidaceae to Capparidaceae sensulato and Cleomaceae, on morphological grounds by Hutchinson[4]. The distribution of alkaloids is also in agreement with this. Form Capparidaceae sensulato stachydrines and Capparis base are reported whereas from Cleamaceae brassicines[10], emphasizing the chemical distinctiveness of both.

These two families can be considered as natural groups. Cleamaceae have a high frequency of isorhamnetin and sinapic acid. Capparidaceae have glycoflavones, salicylic acid and 2-hydroxy, 6-methoxy benzoic acid confined to them and a comparatively higher frequency of some other phenolic acids among the members. This is also in close agreement with the view that these two taxa are phylogenetically not very closely related. The overlapping chemical characters can be looked upon as mere cases of parallel evolution. However, a clear picture will emerge only after a detailed analysis of a large number of taxa belonging to these families.

The presence of isorhamnetin in most of the members of Cleomaceae seems to be phylogenetically importent. Isorhamnetin is said to be a characteristic compound of the Brassicaceae[2] (Cruciferae), which indicates a closer chemical affinity between Cleomaceae and Cruciferae. The alkaloids. Brassicines reportel from *Brassica, Lepidium* and *Sinapis* are also present in *Cleome* and *Gynandropsis*[10]. This is also in support of Hutchinson's grouping of these two families in order Cruciales[5] on morphological grounds. Das and Rao[1], although recognising the similarity between the herbaceous *Cleome* and the Brassicaceae, derive the latter from the arborescent Capparids. Based on the chemical data regarding isothiocynate-producing glucosides, such a grouping has also not been favoured and Capparidaceae (including Cleomaceae) have been grouped with other thioglucoside containing families like Resedaceae, Moringaceae and Cruciferae under order Rhoeodales[7]. The thioglucosides have been detected in a number of unrelated families. Their occurrence has been found to be sporadic and unreliable even in otherwise very related species, thereby reducing considerably the value of this chemical marker. According to Kjaer[7] "Many more species must be examined before we can properly evaluate the more detailed distribution patterns of the isothiocyanate-producing glucosides."

Taking into consideration all the known chemical data, more weightage has been given to the value of phenolics and alkaloids as markers, at least for the present.

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