Leaf Architectural Studies on Eight Species of Malvaceae from Lashio Area

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Abstract

Leaf architectural studies have been investigated in 6 genera and 8 species of Malvaceae. In all the species studied, the leaves were simple, symmetrical and alternate with ovate, ovate-elliptic, lanceolate and orbicular lamina; base obtuse, truncate or cordate; apex acute or acuminate. Leaf margin of all species was serrate, crenate-serrate or dentate. Major venation pattern actinodromous type with craspedodromous secondary. Marginal ultimate venation was either incomplete or looped. The number of primary veins varies from 5 to 7. The number of secondary veins on either side of the primary vein varies from 5 to 7. Highest vein order of the family was remarked up to 6º. Areoles are formed by tertiary and higher vein order. Stomata type were anisocytic in most species but in *Abelmoschus esculentus* (L.) Moench, *Hibiscus rosa-sinensis* L. and *Hibiscus cannabinus* L. stomata is paracytic. The texture of leaf was membranous or chartaceous. These leaf architectural characters are considered to be taxonomic and evolutionary value.

Introduction

Malvaceae is also called as the mallow family. It is one of the families of flowering plant comprising about 120 genera and more than 1500 species (Dassanayake 1997). Well known plants of this family include okra, jute, cotton, Bombay hemp and cacao. The largest genera in this family are *Pavonia*, *Sida* and *Hibiscus*. Popular plants of the family Malvaceae are generally value for commercial fiber crops. This family is a globally distributed with mainly genera in tropical and subtropical regions (Hutchison 1967).

Leaf architecture is the general term used for the study of venation pattern of leaf. The arrangement of veins in the lamina is an important component of the study of leaf architecture. It is also a good tool for plant identification especially in the case where flower and fruits are not available. Leaf architecture technique was pioneered by Hickey (1973) to regard the venation pattern, marginal configuration, leaf shape and gland position.

The study of leaf architecture was based on leaf blade characters, major venation pattern, minor venation pattern, marginal ultimate venation, angle of loop-forming branches joining superadjacent secondary veins, areolation and veinlet ending. Areoles are the smallest areas of the leaf tissues, surrounded by veins, which together form a continuous field over most of the leaf area. The number per mm^2, shape and size of areola are varied in different species and even in the same leaves. The nature of stomata is also a diagnostic feature in delimiting some families and genera and sometimes for species. In recent years numerous researcher have successfully used leaf architecture in classifying both extinct and extant plants species of taxonomic group. The meaningful system of terminology of leaf architecture had been given by Hickey (1973) and Dilcher (1974).

The midrib or 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. The first (1º), second (2º) and third (3º) degree veins are regarded as the major venation pattern. The intersecondary veins (inter-2°) are located between the two

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secondaries which are thinner than the secondaries and originated from primary vein. Minor vein is next categories of veins originating from the secondary form the minor venation pattern. The veinlets are the freely ending ultimate veins of the leaf and veins of the same order that occasionally cross the areoles to become connected distally. Hickey (1973) classified the main characteristics of veinlets are divided into three types: no veinlets, simple and branches.

The leaf architecture and venation patterns in different dicotyledonous families have been investigated by many researchers. A review of the literature revealed that the leaf architecture of the members of family Malvaceae had also been done by Saibaba *et al.* (1990), Kunnur and Kotresha (1993), Bhat (1995), Larano *et al.* (2010) and Aworinde *et al.* (2012). But the leaf architectural studies of the species of Malvaceae from Lashio area are yet not carried out. Therefore, it is attempt to collect and identify the species of Malvaceae on the basis of micromorphological characters of the foliar venation pattern.

This study is aimed to record the leaf architecture of some species of family Malvaceae. The objectives of this study are to describe the leaf architecture of Malvaceae, to give the usefulness of leaf architectural characters distinguishable in some species of family Malvaceae and to determine the differences in the leaf architecture that can be used in the taxonomic consideration of the species studied.

Materials and Methods

The plant leaves of eight species of Malvaceae were collected from Lashio area. Specimens collection were carried out during March to August 2019. The suitable matured and fully expanded leaf blades of each species were collected and place on papers on a desk for measurement using ruler. The blade class was measured and classified base on the result of laminar size followed by Leaf Architecture Working Group (LAWG 1999). The fresh collected leaf blades were cleared by Hickey (1973) method. Photographs were taken by using electric light box. The leaf venation patterns were observed using dissecting microscope and light microscope. The angle divergence was measured by using a protractor. The stomata types were documented base on the terminology of Metcalfe and Chalk (1979). The collected specimens were identified with the help of reliable floras (Dassanayake 1981). The leaf venation pattern of each species was classified based on the terminology of Hickey (1973), Pole (1991) and Leaf Architecture Working Group (LAWG 1999). Specimen morphological characters were described and arranged by plant systematic order.

Results

1.*Malvastrum coromandelianum* (L.) Garcke

Leaf blade ovate; leaf area 1200 mm^2, microphyll class; base cuneate; apex acute; margin coarsely dentate; texcture membranous; stoma anisocytic type. Major venation campatodromous, perfect actinodromous, 5 basal. 1º moderate, straight or slightly curved and unbranched. 2º craspedodromous, moderate, angle moderately acute, nearly uniform; inter-2º void. 3º random reticulate, sinuous. The highest vein order is 5º, distinct; 4º and 5º random reticulate and anastomosing to form imperfect and random areoles. Marginal leaf ultimate venation incomplete. The ultimate veinlets unbranched.

2. *Sida chinensis* Retzius,

Leaf blade ovate-elliptic; leaf area 1600 mm^2, microphyll class; base cordate; apex acute; margin dentate; texcture membranous; stoma anisocytic type. Major venation campatodromous, imperfect actinodromous, 3 basal. 1º moderate, straight

and unbranched. 2º, craspedodromous, moderate, angle moderately acute, nearly uniform; inter-2º void. 3º opposite and mix percurrent, sinuous. Predominant angle RA, RR and AR angle. The highest vein order is 5º, distinct; 4ºand 5º random reticulate and anastomosing to form imperfect and random areoles. Marginal leaf ultimate venation incomplete. The ultimate veinlets unbranched.

3. ***Sida acuta* Burm.f.**

Leaf blade lanceolate; leaf area 800 mm^2, microphyll class; base obtuse; apex acuminate; margin dentate; texcture membranous; stoma anisocytic type. Major venation campatodromous, imperfect actinodromous, 3 basal. 1º moderate, straight and unbranched. 2º craspedodromous, moderate thickness, angle moderately acute, nearly uniform; inter-2º simple. 3º opposite percurrent, sinuous. Predominant angle RR, RA, OA and OR. The highest vein order is 5°, not distinct, 4º percurrent and 5° random reticulate; 4º and 5° anastomosing to form imperfect and random areoles. Marginal leaf ultimate venation incomplete. The ultimate veinlets branched.

4. ***Urena lobata* L.**

Leaf blade orbicular in outline; leaf area 4266 mm^2, notophyll class; base obtuse; apex acute; margin serrate; texcture chartaceous; stoma anisocytic type. Major venation campatodromous, perfect actinodromous, 7 basal. 1º moderate, straight and unbranched. 2º mixed craspedodromous, moderate, angle moderately acute, nearly uniform, abruptly curved at the apex and uniformly curved at the rest of the lamina; loop forming branches joining superadjacent at right angles; inter-2º void. 3º random reticulate. The highest vein order is 6º, distinct, 4º and 5º random reticulate and anastomosing to form well developed and random areoles. Marginal leaf ultimate venation incomplete. The ultimate veinlets unbranched.

5. ***Malvaviscus penduliflorus* DC.**

Leaf blade ovate; leaf area3733 mm^2, notophyll class; base obtuse; apex acuminate; margin crenate-serrate; texcture chartaceous; stoma anisocytic type. Major venation campatodromous, perfect actinodromous, 7 basal. 1º moderate, straight and unbranched. 2º craspedodromous, moderate, angle moderately acute, nearly uniform; loop-forming branches joining superadjacent at obtuse angle; inter-2º void. 3º opposite percurrent, orthogonal reticulate, sinuous. Predominant angle RO and RR. The highest vein order is 5º, distinct, 4º and 5º orthogonal reticulate, 5º anastomosing to form well developed and oriented areoles. Marginal leaf ultimate venation looped. The ultimate veinlets unbranched.

6. ***Abelmoschus esculentus* (L.) Moench,**

Leaf blade orbicular in outline; leaf area 50000 mm^2, mesophyll class; base cordate; apex acute; margin sparsely dentate; texcture chartaceous; stoma paracytic type. Major venation campatodromous, perfect actinodromous, 7 basal. 1º massive, straight and unbranched. 2º craspedodromous, massive, angle moderately acute, nearly uniform; inter-2º simple. 3º opposite and mix percurrent, sinuous. Predominant angle RR and OR. The highest vein order is 5º, distinct, 4º and 5º random reticulate and anastomosing to form imperfect and random areoles. Marginal leaf ultimate venation incomplete. The ultimate veinlets unbranched.

7. ***Hibiscus rosa-sinensis* L.**

Leaf blade ovate; leaf area 3000 mm^2, notophyll class; base truncate; apex acute; margin serrate; texcture chartaceous; stoma paracytic type. Major venation campatodromous, perfect actinodromous, 7 basal. 1º moderate, straight or curved and unbranched. 2º craspedodromous, moderate, angle moderately acute, nearly uniform; inter-2º simple. 3º alternate percurrent, forked, sinuous. Predominant angle AA, OO, RR and AR. The highest vein order is 6º, distinct, 4º and 5º random reticulate and

anastomosing to form imperfect and random areoles. Marginal leaf ultimate venation incomplete. The ultimate veinlets unbranched.

8. ***Hibiscus cannabinus*** **L.**

Leaf blade orbicular in outline; leaf area 7333mm^2, mesophyll class; base cordate; apex acute; margin serrate; texcture chartaceous; stoma paracytic type. Major venation campatodromous, perfect actinodromous, 7 basal. 1º moderate, straight or curved and unbranched. 2º craspedodromous, moderate, angle moderately acute, nearly uniform; loop-forming branches joining superadjacent at obtuse angle, inter-2º weak. 3º alternate percurrent, sinuous. Predominant angle AA, RO, RR and RA. The highest vein order is 5º, distinct, 4º and 5º random reticulate and anastomosing to form imperfect and random areoles. Marginal leaf ultimate venation incomplete. The ultimate veinlets unbranched.

Discussion and Conclusion

According to Hickey (1973), the leaves of Malvaceae are simple and the venation is of actinodromous type. Bhat *et al*. (1995) working on *Hibiscus* recorded actinodromous and pinnate type of venation. According to Larano *et al.* (2010), the leaves of Malvaceae are simple, margin entire or serrate, venation pinnate, secondary veins are craspedodromous and tending to form incomplete or looped marginal vein. The present investigations are in accordance with those of Larano *et al.* (2010).

The shape of leaf blade was also key characters in determining the species of flowering plant. In this research, four different lamina shapes (ovate, ovate elliptic, lanceolate and orbicular) were observed and recorded. Three out of eight species have obtuse base shaped, 3 with cordate base, 1 with cuneate base and 1 with truncate base. The leaf apex is mostly acute and the margin is mostly serrate. In this study three types of blade class were observed namely microphyll, notophyll and mesophyll.

The major venation pattern is campatodromous with perfect or imperfect actinodromous marginal basal type. Bath 1995 classified *Hibiscus* leaves as 3- or 5-veined, on the basis of the number of primary veins entering the base of leaf. In this research all studied species fall within 3 to 7-veined category. The numbers were 3 basal in imperfect actinodrodomous and 5-7 basal in perfect actinodromous. In this research primary veins were mostly moderate. The course of this vein was commonly straight and unbranched. According to Hickey and Doyle (1972), 2º craspedodromous venation is regarded as advanced character. The angles of divergent were acute and nearly uniform. The thickness of secondary veins was usually moderate and mostly straight sometimes abruptly curved upward. The tertiary veins have no definite pattern of origin. Predominant angles were AA, AR, RR and RO. The intersecondary veins were found in some species.

In minor venation pattern, the highest vein order was up to 6° in *Urena lobata* and *Hibiscus rosa-sinensis*, *Malvastrum coromandelianum*, *Malvaviscus penduliflorus*, *Abelmoschus esculentum* and *Hibiscus cannanbinus* and two species of *Sida* was 5°. These finding are in aggrement with Kunnur *et al.* (1988), Bhat (1995) and Larano *et al.* (2010). In this study two types of marginal leaf ultimate venation were observed. Vein ending may be simple or branched. The size and number of the areoles are of little significance because of it can vary in the same leaf. This finding is in accordance with those of Bhat (1995).

Metcalfe and Chalk (1979) stated that nature of stomata are useful diagnostic features in deliminating the families, genera and species. In the present study, the types of stomata were paracytic type in *Abelmoschus esculentus*, *Hibiscus cannabinus* and *H. rosa-sinensis* but anisocytic in the rest species. Nduche (2019) reported that

the stomata of *Sida* were anomocytic type. It does not agree with the present study. In this research, the stomata of *Sida* is anisocytic type.

The study of Larano and Buot (2010) proved that leaf architectural characters indicate the taxonomic character in family Malvaceae. Thus, leaf architecture characters are indeed served as taxonomic characters in plant identification. The most important characters in the study of leaf architecture were stomata type, laminar shape, base and apex shape, margin type, blade class, 2º, 3º vein category, spacing and angle. Leaf architectural characters can be very good taxonomic character during non-flowering period.

Based on the type of venation observed in the studied species it has been concluded that campatodromous with perfect and imperfect actinodromous type of venation is the characteristic of Malvaceae. It is recommended that further detailed investigation of minor character of venation of a species will provide for a better understanding of leaf architecture. Finally, it is hoped that this research attributes to recognize the use of leaf architecture and the knowledge of leaf architecture is a tool for identification and evolution of the different plant species.

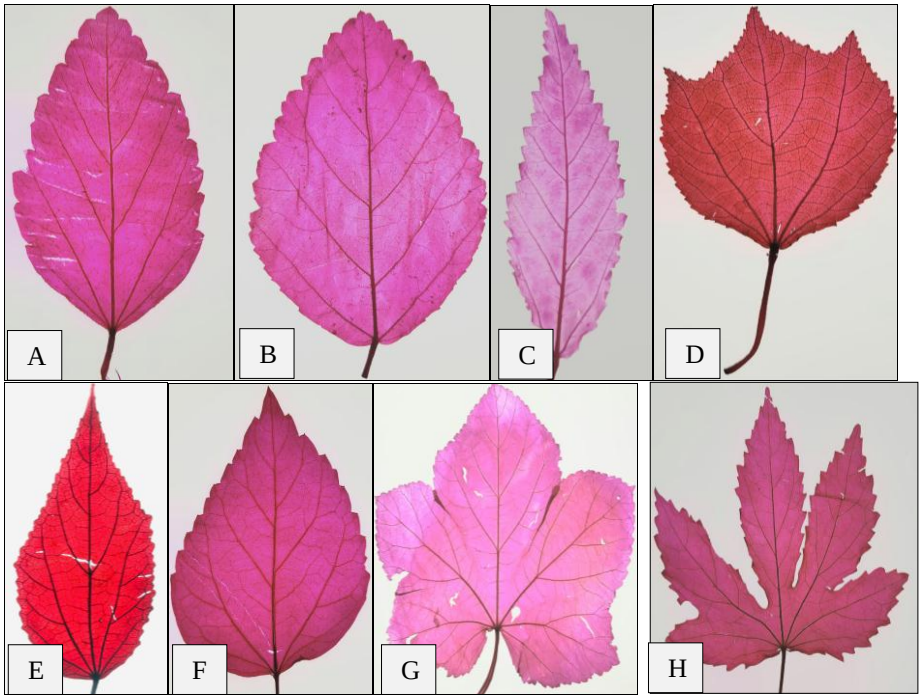

Fig.1. Leaf blade of collected species A. *Malvastrum coromandelianum* B. *Sida chinensis* C. *S. acuta* D. *Urena lobata* E. *Malvaviscus penduliflorus* F. *Hibiscus rosa-sinensis* G. *Abelmoschus esculentus* H. *Hibiscus cannabinus*

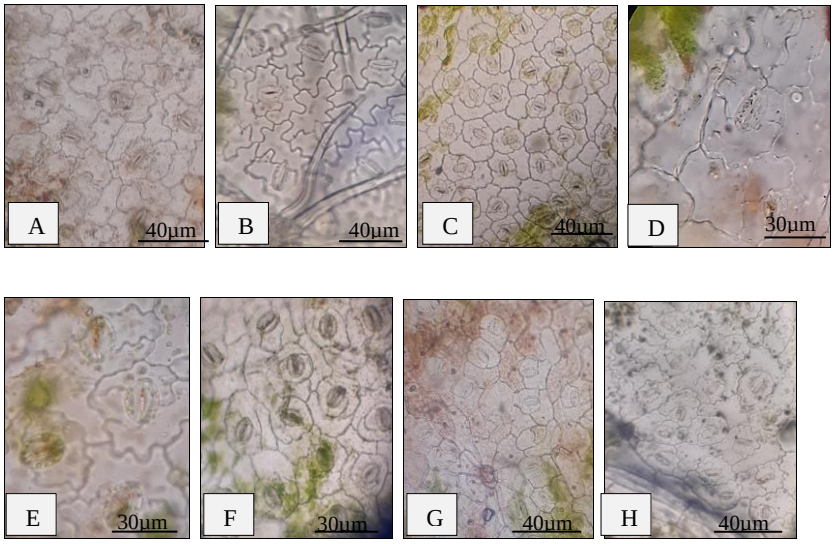

Fig. 2. Stomata of collected species A. *Malvastrum coromandelianum* B. *Sida chinensis* C. *S. acuta* D. *Urena lobata* E. *Malvaviscus penduliflorus* F. *Hibiscus rosa-sinensis* G. *Abelmoschus esculentus* H. *Hibiscus cannabinus*

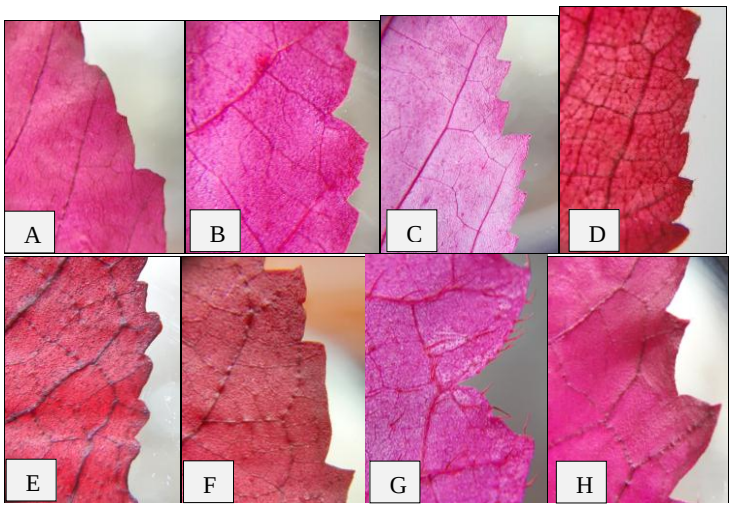

Fig. 3. Leaf margin of collected species A. *Malvastrum coromandelianum* B. *Sida chinensis* C. *S. acuta* D. *Urena lobata* E. *Malvaviscus penduliflorus* F. *Hibiscus rosa-sinensis* G. *Abelmoschus esculentus* H. *Hibiscus cannabinus*

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References

Angiosperm Phylogeny Group.2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV, Botanical Journal of the Linnean Society, 181: 1-20.

Aworinde D.O., B. O. Ogundairo, S. M. Erinoso and A. O. Olanloye 2012. Foliar epidermal studies of some Nigerian species of *Sida* Linn. (Malvaceae). *Scholarly Journal of Agriclutural Science.* Vol. 2(2), pp. 18-22.

Bhat R. B. 1995. Taxonomic implications of leaf architecture in the genus *Hibiscus* S. Afr. J. Bot. 61(4): 209 – 214.

Dassanayake, M.D.1981.A reversed handbook to the flora of Ceylon. Vol.11. New Dehli: Amerind Publishing Co. Rt. Ltd.

Dilcher,m L. J., 1974. Approaches to the identification of angiosperm leaf remains. *The Botanical Review* 40:1-85.

Hickey L. J., 1973. Classification of the architecture of dicotyledonous leaves, *American Journal of Botany*, 60:17-33.

Hutchinson J. 1967. The genera of flowering plants. UK. Oxford University Press.

Kunnur S. B. and K. Kotresha. 1993. Foliar studies in some species of *Sida* L. (Malvaceae), *International Seminar on "Multidisciplinary Approaches in Angiosperm Systematics"*. PP.73-79.

Larano A. and Buot I. E., 2010. Leaf architecture of selected species of Malvaceae sensu APG and its taxonomic significance, *Philippines Journal of Systematic Biology*. 4, 21-54.

Leaf Architecture Working Group, (LAWG), 1999. Manual of Leaf architecture – morphological description and categorization of dicotyledonous and net-veined monocotyledonous angiosperms.Washingdon DC: Smithsonian Institution. 65p.

Metcalfe C. R. and Chalk L. 1950. Anatomy of the Dicotyledons. Vol. 2. Clarendon Press.

Nduche, M. U. and I.C. Offor. 2019. Anatomical studies of *Sida acuta* Burm, *Spigelia anthelmia* L., *Centrosema pubescens* Benth, *Pueraria phaseoloides* (Roxb.) Benth, *Justicia carnea* Lindl and their taxonomic significance. *International Journal of Research in Pharmacy and Biosciences.* Vol. 6. Issue 2, PP 21-32.

Pole M. 1991. A modified terminology or angiosperm leaf architecture, *Journal of the Royal Society of New Zealand*, 21:4, 297-312.

Saibaba A. M. and R. S. Rao. 1990. Leaf venation studies in Indian *Sida* (Malvaceae). *The Botanical Research Institute of Texas*. Inc. 14 (2): 215-222.