FOLIAR EPIDERMAL MORPHOLOGY OF SOME MEMBERS OF SUBFAMILY DODONAOIDEAE - SAPINDACEAE

TEMITOPE OLABISI ONUMINYA¹ AND ISMAILA GBADEBO ADEDIRAN²

¹, ²Department of Botany, University of Lagos, Akoka, Yaba, Lagos, Nigeria
*Corresponding author’s email: topssy4u@yahoo.co.uk

Abstract

Dodonaeaevae Burnett is a subfamily of flowering plants in the soapberry family Sapindaceae Juss. Leaf epidermal characteristics of some species in the subfamily Dodonaeaevae were studied with the aid of a compound light and scanning electron microscopes in order to evaluate their reliability as taxonomic markers. Both qualitative and quantitative assessments were carried out using standard methods and the species studied included Zanha golungensis Hiern, Dodonaea viscosa (L.) Jacq. and Majidea fosterii (Sprague) Radlk. Both Z. golungensis and M. fosterii are hypostomatic with stomata restricted to the abaxial surface while D. viscosa is amphistomatic. Their epidermises are composed of cells of various shapes from polygonal in Z. golungensis and adaxial surface of D. viscosa species, to irregular M. fosterii and abaxial surface of D. viscosa. The anticlinal wall patterns vary on abaxial and adaxial surfaces of each species, from straight in D. viscosa to undulate in M. fosterii. Anomocytic stomata are present in M. fosterii and D. viscosa species while paracytic stomata type is found in Z. golungensis. There is variation in the stomata size, number, length and width of the three species. Stellate trichomes were observed on the adaxial surface of Z. golungensis while epicuticular wax is granular in all taxa and mainly especially on the adaxial surface. Also, striations were observed on both surfaces of Z. golungensis. The range of variation in the epidermal characters between the species under investigation renders them of value for taxonomic purposes. An artificial dichotomous key for identifying the species is presented.

Key words: Epidermal cells, Sapindaceae, Stomata, Taxonomic Markers, Trichomes.

Introduction

The role of anatomical data in traditional taxonomy has been long recognized owing to the fact that variation within species, genera or a family is usually reflected in anatomical features. Leaf epidermal features such as stomata, trichomes and other characters are useful anatomical tools and this has been established by several authors including Dilcher (1974), Metcalfe & Chalk (1950, 1979), Kadiri & Ayodele (2003), amongst others. However, aside the studies by Radlkofr (1886, 1890, 1933) and Muller & Leenhouts (1976), and Solereder (1899, 1908) not much has been done on the description of the subfamily Dodonaeaevae of the family Sapindaceae using anatomical data. The Dodonaeaevae as defined by Radlkofr (1890, 1933) is a subfamily of the soapberry family Sapindaceae Juss. Which is comprised of two subgroups: Doratoxylon group (Doratoxyleae, Ganoplyllum and Zanha, without Averrhoidium): indistinct berry-like fruits and Dodonaea group (Cossineae, Dodonaeae, Arfeullea, Averrhoidium, Eurycreymbus, Euphorianthus, Harpullia and Majidea): dehiscence fruits. In West Africa, the subfamily is represented by three genera namely: Dodonaea, Majidea and Zanha, all of which are known to be of economic and medicinal importance (Hutchinson and Dalziel, 1958; Keay et al., 1964; Burkill, 2000). There are few reports on the foliar epidermal characters of Dodonaea (Venkatesh et al., 2008; Al-Aani et al., 2016) however; little has been done on the other two genera. Consequently, this research aims at carrying out foliar anatomical characterization of members of the subfamily Dodonaeaevae represented in west Africa with a view to delimit and show the relationships among the plant species.

Materials and Methods

Source of sample used: The representative specimens deposited in the herbaria of University of Lagos Herbarium (LUH) were collected with permission and investigated in the Department of Botany, University of Lagos, Nigeria. The provenances of the specimens are presented in Table 1.

Epidermal preparations: The adopted method follows Kadiri (2003) and Ogundie et al., (2008). For the study, 2-3 cm² portions were cut from the standard median portion of the lamina near the mid-rib. The leaf pieces were dissolved in Mccartney bottle containing Nitric acid for 5 h. Tissue disintegration was indicated by the bubbles and the epidermises were transferred into Petridishes containing cold water for cleansing before they were separated with forceps and mounting needle.

Table 1. List of specimens studied.

<table>
<thead>
<tr>
<th>Species</th>
<th>Habit</th>
<th>Place of collection</th>
<th>Collector</th>
<th>Date of collection</th>
<th>Accession No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z. golungensis</td>
<td>Shrub</td>
<td>F.R.I.N (Ibadan)</td>
<td>Daramola, B.O</td>
<td>10-02-2011</td>
<td>LUH 3317</td>
</tr>
<tr>
<td>Z. golungensis</td>
<td>Shrub</td>
<td>F.R.I.N (Ibadan)</td>
<td>Adeyemi, T.O</td>
<td>08-Jul-2008</td>
<td>LUH 3462</td>
</tr>
<tr>
<td>D. viscosa</td>
<td>Shrub</td>
<td>LEKKI (swamp)</td>
<td>Kadiri, A. B.</td>
<td>24-07-2011</td>
<td>LUH 3119</td>
</tr>
<tr>
<td>D. viscosa</td>
<td>Shrub</td>
<td>ABU, Zaria</td>
<td>Adeyemi, T.O</td>
<td>02-Jun-2009</td>
<td>LUH 037</td>
</tr>
<tr>
<td>M. fosterii</td>
<td>Shrub</td>
<td>Limbe Botanic Gardens</td>
<td>Adeyemi, T.O</td>
<td>16-09-2009</td>
<td>LUH 1718</td>
</tr>
</tbody>
</table>
Tissue debris was removed from the epidermis with fine hair brush and rinsed for some time in water. Few drops of ethanol were added in turn to harden the cells. It was then stained with 1-3 drops of Safranin, and mounted in glycerine on the glass slide. The slides were labelled carefully and appropriately and viewed under the light microscope. Photographs of the micro-morphological features were taken at magnification x400 using photomicroscopic camera attached to a Pentium IV computer. Quantitative and qualitative characters of the leaf epidermis were assessed and stomatal index was calculated using the formula as reported by Stace (1965).

Data analysis: Twenty epidermal cells and stomata were randomly selected for measurement using micrometer eye piece. Statistical analysis was carried out using the data analysis tool (Microsoft 2007 Excel) and calculations include mean, standard deviation, standard error and stomata index.

Scanning electron microscopy (SEM): For scanning electron microscopy, Hitachi S-4700 SEM protocol was adopted. Approximately 8 mm² of the preserved dried leaves was cut with knives under an OPTECH microscope and the surfaces were cleansed with a soft brush. With the aid of forceps, this was placed on labelled aluminium stubs covered with sticky tapes so that both adaxial and abaxial surfaces faced upward; they were placed in a sputter coater stub holder and coated with argon for 2-5 mins. The samples were exposed to infrared radiation and observed using Hitachi S-4700 Scanning Electron Microscope. Photographs were taken with the computer using the Hitachi program. The Study was carried out at Jodrell laboratory, Royal Botanic Gardens, Kew, UK.

Results
All the species investigated showed variation in their foliar epidermal characters which are useful in species delimitation. Anatomical characterization of the Dodonacoideae - Sapindaceae using light and scanning electron microscopy revealed that the surface features consisted of hairs, papillae and stomata. Anomocytic stomata type was common in Dodonaea viscosa (Fig. 1A and 1B) and Majidea fosterii (Fig. 1C and 1D) but paracytic type was recorded only in Zanha golungensis (Fig. 1E and 1F). This observation was supported by Venkatesh et al., (2008), who reported the presence of anomocytic stoma in D. vicosa. Members bear stomata on the abaxial surface only i.e., they are hypostomatic exceptions is however recorded in Dodonaea viscosa which is amphistomatic in nature with stomata ridges on the abaxial surface (Fig. 2). Anticlinal wall pattern ranges from straight to undulate form with polygonal or irregular shape. On both adaxial and abaxial epidermal surfaces of D. viscosa, the epidermal cell shape varies from polygonal to irregular respectively however it is entirely polygonal in Z. golungensis and irregular on both surfaces of M. fosterii. The anticlinal wall pattern is straight in Z. golungensis and D. viscosa however, it is undulate in M. fosterii (Table 2). Stellate multicellular trichomes are present on the adaxial surface of D. viscosa and M. fosterii while striations were observed on the surfaces of Z. golungensis (Fig. 2).
Table 2. Qualitative epidermal features of the specimens studied.

<table>
<thead>
<tr>
<th>Species</th>
<th>Epidermal cell shape</th>
<th>Anticlinal wall pattern</th>
<th>Stomata type</th>
<th>Trichomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zanha golungensis</td>
<td>Polygonal</td>
<td>Straight</td>
<td>Paracytic</td>
<td>----</td>
</tr>
<tr>
<td>Abaxial</td>
<td>Polygonal</td>
<td>Straight</td>
<td>Absent</td>
<td>Stellate</td>
</tr>
<tr>
<td>Adaxial</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Majidea fosterii</td>
<td>Irregular</td>
<td>Undulate</td>
<td>Anomocytic</td>
<td>----</td>
</tr>
<tr>
<td>Abaxial</td>
<td>Polygonal/Irregular</td>
<td>Straight/Undulate</td>
<td>Absent</td>
<td>----</td>
</tr>
<tr>
<td>Adaxial</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dodonaea viscosa</td>
<td>Irregular</td>
<td>Straight</td>
<td>Anomocytic</td>
<td>----</td>
</tr>
<tr>
<td>Abaxial</td>
<td>Polygonal</td>
<td>Straight</td>
<td>Anomocytic</td>
<td>----</td>
</tr>
<tr>
<td>Adaxial</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Epidermal cell size varies from 4(5.50 ± 0.35)8 μm x 6(7.60 ± 0.65)10 μm to 4(6.70 ± 0.65)10 μm x 7(9.92 ± 1.02)12 μm in Z. golungensis on the abaxial and adaxial surface respectively while the stomatal size is 5(6.1±1.24)9 μm x 6(7.20±2.16)10 μm. In M. fosterii, epidermal cell size varies from 4(4.80±0.39)6μm x 7(9.95±1.20)13 μm to 7(8.00±0.55)9 μm x 7(8.00±0.25)9 μm on the abaxial and adaxial surfaces respectively while the stomatal size is 3(3.50±0.35)4 μm x 6(7.00±0.59)8 μm. Again in D. viscosa, epidermal cell size varies from 4(6.10±0.29)9 μm x 5(9.40±2.12)13 μm to 5(7.15±0.31)9 μm x 10(12.10±2.12)15 μm in Z. golungensis on the abaxial and adaxial surface respectively while the stomatal size ranges from 3(4.00±0.54)5 μm x 6(6.90±0.46)8 μm to 4(5.50±0.35)6 μm x 6(7.50 ± 0.35)10 μm. The highest number of stomata as well as epidermal cells was recorded in Z. golungensis while the least was observed in M. fosterii (Table 3).

Discussion

In spite of the fact that vegetative and floral characters are markedly modified in relation to the habitat and pollination mechanisms, anatomical characters have been found to be very useful in taxonomic studies. The leaf epidermal characteristics of the three species studied proved useful for identification and discrimination.

Stace (1965) highlighted stomata distribution as a reliable feature of angiosperm leaf which can be employed for delimiting taxa. In this study, anomocytic stomata were observed in all the taxa studied. This observation is consistent with that of Venkatesh et al., (2008) and Pole (2010), who reported the presence of anomocytic stomata in D. viscosa. Also hypostomatic stomata was recorded in the species of Zanha and Majidea studied and this is similar to the report of Metcalfe and Chalk (1979) and Pole (2010). Our findings also corroborate the works of Buijsen, (1995) who reported polygonal epidermal cells with undulate anticlinal walls and crystals on the epidermal surface of M. fosterii.

Furthermore, it can be seen that the shape, size and cell wall thickness of the species studied varied greatly, this according to Sheteolu and Ayodele (1997) is often genotypic in nature, and in many cases have definite taxonomic application. Ugbe & Ayodele, (2008), also opined that the presence of large epidermal cells with thin walls is an adaptation for water storage. Examination of the leaf epidermal layer of Z. golungensis, D. viscosa and M. fosterii shows that there are wide variations in the morphology and distribution of stomata. Naturally these variations in the morphology and distribution of the adjacent epidermal cells raise the question of how far they can be reliably employed by systematic taxonomy.

Epidermal characters such as trichomes, crystal deposits and striaions were useful in delimitation of the three species studied. Functionally, trichomes prevent herbivory, excessive heat and sunlight; and they are offensive to animals when in contact (Stace, 1965). In view of the foregoing observations, a key to the identification of each species based on observed characters is presented below:

**Key to West African genera in the subfamily dodonaeoideae**

1a. Stomata type Anomocytic, striations absent, epidermal cell width not more than 9 μm ………………….. 2

2a. Anticlinal wall pattern undulate, stomata restricted to abaxial surface epidermal cell shape irregular, stomata width not more than 4 μm ……………………………………………………………….. M. fosterii

2b. Anticlinal wall pattern straight, stomata present on both surfaces, epidermal cell shape polygonal, stomata width is up to 6 μm …………………………………………………………………………………………….. D. viscosa

1b. Stomata type paracytic, striations present, epidermal cell width up to 10 μm ………………… Z. golungensis

**Conclusions**

In conclusion, taxonomically both the quantitative and qualitative characters are useful in the practical identification of these three species studied. The features that emphasized the distinctiveness and differences in the three species when compared are the epidermal shapes, epidermal numbers, stomata types, stomata numbers and the anticlinal pattern.


References


(Received for publication 28 September 2017)