Environmental Sciences Proceedings

Proceedings

Comparative morphology of the leaf epidermis in four species of *Meliaceae* L. family†

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† Presented at the 1st International Electronic Conference on Forests, 15–30 November 2020; Available online: https://sciforum.net/conference/IECF2020

Published: 25 October 2020

Abstract: *Meliaceae* is a family of woody species that are very useful for timber and ethnomedicine in Nigeria. However, there is scarce information on their taxonomic description, which is important in realizing their full potentials. Existing floristic studies on members of *Meliaceae* have revealed overlap in key morphological characters like number of lateral nerves, shape, size and number of leaflets. Aside the floral and fruit characters, the use of leaf epidermal characters has proven to be gene-dependent and as such provides stable and less expensive grouping compared to the molecular methods. This study investigated the leaf epidermal and petiole anatomical significance in four species of *Meliеceae*; *Azadiracta indica*, *Cederella odorata*, *Khaya sensegalensis* and *K. grandifoliola* for taxa delimitation. The choice of leaf for this study is based on their regular availability unlike the flowers, which are seasonal. Plant materials of the species were collected from University of Ibadan, Forest Research Institute of Nigeria and National Center for Genetic Research and Biotechnology in south western Nigeria based on availability. Leaf samples were examined under the microscope for epidermal and petiole anatomical characteristics. Characters like epidermal cell shape, epidermal cell wall pattern, trichome type and stomata abundance were differentiated in the four species. Petiole anatomical characteristics for delimiting the taxa include cuticle thickness, presence or absence of crystal, crystal type and vascular bundles arrangement. The analyzed characters produced two major clusters- Cluster 1: *Khaya senegalensis* and *Khaya grandifoliola;* cluster 2: *Azadiracta indica* and *Cederella odorata*. *Azadiracta indica* and *Cederella odorata* are more closely related species than *Khaya senegalensis* and *Khaya grandifoliola*. The affinity of the studied characters is an evidence of their correlation and supports the relationship existing among the species. These characters support delimitation of the taxa even in fragment condition.

Keywords: Morphology; descriptors; epidermal; delimitation

1. Introduction

The mahogany family (*Meliaceae*) is an average-sized angiosperm family of the order Sapindales found in the tropical part of the world. This family is made up of more than fifty genera having about 1400 species [1]. They are distributed both in the tropics and subtropics. Species of the family are popularly known for their high-quality timbers, traded as ‘mahogany’. The *Meliaceae* family exhibits great morphological variability. Much confusion has been noted in the systematics of this family with regards to the taxonomy demonstrated by inconsistency regarding the correct name and specific epithet. Furthermore, the species delimitations within the genus is complex and this pose a huge task in plant systematics [2]. Morphological diversity is partitioned differently among these species according to various authors. A researcher [3] published the treatment for the genus complexity and took a conservative approach, recognizing one highly variable species which encompasses the diversity represented by both the domesticated one and its closest relatives [3].

However, [3] acknowledged that the material examined was inadequate and mostly sterile, and suggested that further detailed studies were necessary. Literature search has demonstrated that there is a gap and not much research conducted on the taxonomic properties of four species of *Melieceae* namely *Azadiracta indica*, *Cederella odorata, Khaya sensegalensis* and *K. grandifoliola*, especially in the area of their anatomical properties.

The *Meliaceae* family has lower diversity in tropical Africa (102 species) compared with tropical Asia (303 species) or the Neotropics (189 species). Many species of this family are used in traditional medicine for treatment of various diseases and also in pest control [4, 5]. Correct identification of species is very important as several morphological characteristics are species specific. It is not enough to know which plant cures an ailment; it is more important to be able to identify the plant. Current thinking among taxonomist is that morphometric analysis are more sensitive in delimiting taxa and that they provide better keys and classification systems in comparison to the conventional taxonomic methods. The quality of convention taxonomy is improved by numerical taxonomy as more and better characters are used in the latter [6].

Aside the molecular markers that give a relatively stable plant grouping regardless of the environmental vagaries, leaf epidermis is one of the important taxonomic characters that have been used severally in providing solution to taxa identification problems [7]. It was lately discovered to be gene-dependent, hence, taxonomic delimitation without leaf epidermal traits are now considered incomplete. Therefore, the choice of leaf for this study was based on their regular availability unlike the flowers, which are seasonal.

In view of the complex taxonomic status in the family *Meliaceae* and the difficulty in identifying members of the genus morphologically, this study was carried out to describe the leaf and petiole anatomy of four species of the genus with a view to providing useful additional information for the delimitation, subsequent identification and the taxonomy of the genus with respect to the characters viz, nature of epidermis, thickness of upper and lower cuticle, number of layers of palisade mesophyll cells in pith, type of vascular bundles, occurrence of cortical and pericyclic fibre etc.

2. Materials and Method

Plant materials of *Azadiracta indica*, *Cederella odorata, Khaya sensegalensis* and *K. grandifoliola* were collected from the lower branch portion of the tree canopies in University of Ibadan (UI), Forest Research Institute of Nigeria (FRIN) and National Center for Genetic Research and Biotechnology (NACGRAB) in south western Nigeria based on availability. The taxonomic study was based on description, identification and classification of the species using their epidermal morphology, leaf transverse section (TS) morphology and petiole TS morphology. The leaf epidermal analysis study was carried out in the Department of Forest Production and Products laboratory, Faculty of Renewable Natural Resources, University of Ibadan while the anatomical studies of the leaves and petioles transverse sections were carried out at wood anatomy laboratory of the Forest Research Institute of Nigeria (FRIN), Jericho, Ibadan, Oyo state.

Ten leaf samples per tree and ten petiole samples per tree were collected from two trees per species in each of the study area. The collected samples were then preserved in fixative of 50% ethanol [8]. The TS of leaf and petiole of each plant were cut at 10 micron thickness using a rotary microtome (Reichert, Austria). These were prepared for further analysis and stained following the procedures of [8]

Microscopic observation of each slide were made and recorded. Photo micrographs of the slides were made using an ACCU-scope trinocular microcope (ACCU-scope 3001 LED Trinocular microscope with 3.2 MP CMOS digital camera attachment). Tissues and cell identification of the *Meliaceae* species were done according to IAWA hardwood features list, definition and illustration [9]. Tissues and cell identification and description of leaf and petiole were done according to [10] Characters like epidermal cell shape, epidermal cell wall pattern, trichome type and stomatal abundance were differentiated in the four species. Petiole anatomical characteristics for delimiting the taxa include cuticle thickness, presence or absence of crystal, crystal type and vascular bundles arrangement. Data were subjected to descriptive statistics, Analysis of variance (ANOVA), Principal component analysis (PCA) and phylogenetic analysis. The PCA was used to identify the most important traits that contributed best to the possible variations using the corresponding factor loadings within the species while the phylogenetic analysis was used to produce a phylogenetic tree based on various characters using *Treecon version 1.3b*.

3. Results

3.1. Leaf Epidermal Characteristics of all the species

The epidermal peels of *Azadiracta indica*, *Cederella odorata, Khaya sensegalensis* and *K. grandifoliola* were largely characterized by the presence of stomata on both the adaxial and abaxial surface in all the species i.e. amphistomatic, although the stomata were more abundant on the abaxial layer and fewer on than the adaxial layer. The cell wall alignment is anticlinal in *Azadiracta indica* and *Cederella odorata* and periclinal in both *Khaya senegalensis* and *Khaya grandifoliola*. The stomatal type is anomocytic in *Azadiracta indica*, Actinocyticin in *Cederella odorata* and Staurocytic in both *Khaya senegalensis* and *Khaya grandifoliola.* The epidermal cell shapes were mainly irregular for all locations of *Azadiracta indica* and *Khaya senegalensis* from NACGRAB and irregular for all locations of *Cederella odorata, Khaya grandifoliola* and *Khaya senegalensis* from FRIN and University of Ibadan. Filiform and sterllate trichomes were observed in all the epidermal peels of *Azadiracta indica* collected from all the three locations. For *Khaya grandifoliola*, Filiform and falcate trichomes were present in the species collected from FRIN and NACGRAB but absent in the species collected from UI. Druses and prismatic crystals were present in all the locations for all the species.

3.1.1. Between species leaf epidermal morphology variation

Table 1 shows that the abaxial epidermal characteristics of all the species were significantly different ($p<0.05$) but those of the adaxial layer are not ($p>0.05$). For the abaxial layer, the species with the highest number of stomata per microscopic field of view was *Khaya senegalensis* (44) while *Khaya grandifoliola* had the least (33). *Khaya grandifoliola* had the highest (88) epidermal cell count, while *Cederella odorata* was the least (63). Highest stomata index (39.31) was reported in *Cederella odorata* while *Khaya grandifoliola* had the least (27.76). In the adaxial layer, *Azadiracta indica* had the highest number of stomata (18), while *Khaya grandifoliola* had the least (10). Also, for epidermal cell count, *Khaya grandifoliola* had the highest (91) and *Azadiracta indica* had the least (83). *Azadiracta indica* had the highest stomatal index (17.28) while *Khaya grandifoliola* had the least (10.12).

Table 1. Abaxial and adaxial epidermal characteristics of Azadiracta indica, Cederella odorata, Khaya sensegalensis and K. grandifoliola.

Species	NSAB	NECAB	SIAB	NSAD	NECAD	SIAD
Azadiracta indica	38.25±8.79ab	70.17±8.23ab	34.64±5.61a	17.58±14.99a	82.75±16.43a	17.28±13.08a
Cederella odorata	40.08±6.96ab	63.25±12.41a	39.31±6.25b	12±5.44a	84.17±7.30a	12.44±5.61a
Khaya senegalensis	43.83±9.24b	77.92±12.91bc	36.38±8.41b	13±6.31a	87.66±6.75a	12.74±6.01a
Khaya grandifoliola	32.58±10.99a	88.25±8.98c	27.76±6.61b	10.25±5.92a	90.83±7.32a	10.12±5.97a
P-value	**0.033***	**0.000***	**0.001***	**0.247ns**	**0.228ns**	**0.21ns**

Note: means bearing the same letter along the same column are not significantly different from each other.

NSAB= number of stomata on the leaf abaxial layer, NECAB= number of epidermal cell per view on the abaxial layer, SIAB= stomata index for the abaxial layer, NSAD number of stomata on the leaf adaxial layer, NECAD= number of epidermal cells per view on the adaxial layer, SIAD= stomata index for the adaxial layer

3.1.2. Between location leaf epidermal morphology variation

Table 2 reveals that there was no significant difference within each species from different operational taxonomic units (OTUs) ($p>0.05$) except for the stomata index of the abaxial layer of *Azadiracta indica*, Number of epidermal cells for the abaxial layer of *Cederella odorata* and *Khaya* *senegalensis*, and number of stomata (NS) and number of epidermal cells (NEC) for the abaxial layer of *Khaya grandifoliola.* For the abaxial layer of *Azadiracta indica*, NACGRAB OTU had the highest number of stomata per field of view (49) while UI OTU had the least (33). FRIN OTU had the highest number of epidermal cell (75) while UI OTU had the least (64). NACGRAB OTU had the highest stomata index (42.97) while FRIN OTU had the least (31.71). For *Cederella odorata*, UI OTU had the highest number of stomata per field of view (43) while FRIN OTU had the least (36). NACGRAB OTU had the highest number of epidermal cells per field of view (77) while FRIN OTU had the least (52). UI OTU had the highest stomatal index (45.11) while NACGRAB OTU had the least (34.13). For *Khaya senegalensis*, UI OTU had the highest number of stomata per field of view (49) while FRIN OTU had the least (36). FRIN OTU had the highest number of epidermal cells per field of view (99) while NACGRAB OTU had the least (66). UI OTU had the highest stomatal index (42.22) while FRIN OTU had the least (25.53). For *Khaya grandifoliola*, NACGRAB OTU had the highest number of stomata per field of view (43) while FRIN OTU had the least (20). UI OTU had the highest number of epidermal cells per field of view (97) while FRIN OTU had the least (78). NACGRAB OTU had the highest stomatal index (33.07) while FRIN OTU had the least (23.23).

3.2. Principal Component Analysis of the Leaf Epidermal Characteristics

Figure 1 showed the scree plot for principal component analysis of *Khaya grandifoliola, K. senegalensis, Azadiracta indica* and *Cederella odorata* using leaf epidermal taxonomic characters from different operational taxonomic units (OTUs). The plot flattened out at the third principal component, therefore only the first and second are retained for the taxonomic delimitation of the species. Approximately 52% of the total variation in the characters were observed in the first principal component having about 0.571742 Eigen value and approximately 36% of the total variation was observed in the second principal component having 0.397588 Eigen value (Table 3). Of all the epidermal characters subjected to principal component analysis, only the epidermal cell shape, epidermal cell wall pattern, trichome type, and stomatal abundance with 0.45016, 0.47407, 0.72354 and 0.31068 loadings respectively are significant for the delimitation of the tree species (Table 3). (Figure 2a) derived from the PCA separated the species into different groups with some located close to each other.

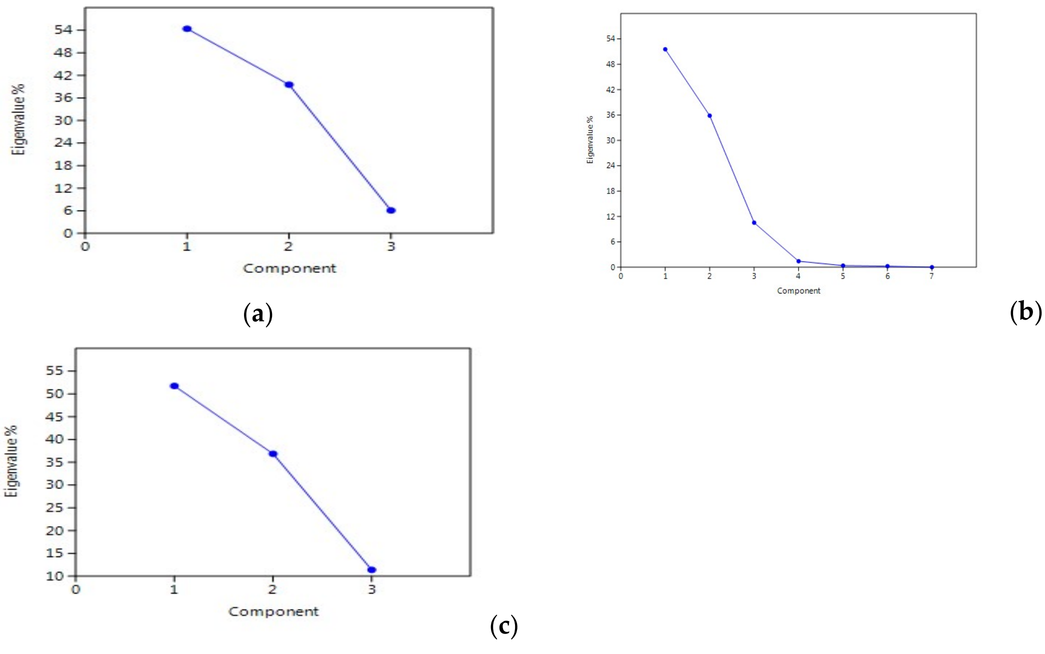

Figure 1. Scree plot for principal component analysis for *Azadiracta indica, Cederella odorata, Khaya senegalensis, Khaya grandifoliola* from different taxonomic units using {a} Leaf Epidermal characters {b} Leaf transverse section characters {c} Petiole transverse section characters.

Table 2. Leaf epidermal characters of different operational taxonomic units (OTU).

	OTUs	NSAB	NECAB	SIAB	NSAD	NECAD	SIAD
Azadiracta indica	**FRIN**	**36.50±2.12a**	**75.00±2.82a**	**31.71±1.14a**	8.50±2.12a	98.50±10.60a	7.68±2.42a
	UI	33.00±9.89a	64.40±14.84a	33.40±1.27a	13.5±10.6a	72.50±26.16a	16.92±15.67a
	NACGRAB	49.00±2.82a	65.00±0.00a	42.97±1.42b	31.50±19.09a	79.50±3.53a	27.44±13.36a
	P-value	**0.149ns**	**0.488ns**	**0.006***	**0.303ns**	**0.384ns**	**0.379ns**
Cederella odorata	FRIN	36.00±9.89a	51.50±0.71a	40.78±7.04a	8.50±7.78a	86.50±3.54a	8.46±7.08a
	UI	43.00±7.07a	52.00±0.00a	45.11±4.09a	16.00±2.83a	84.50±3.54a	15.86±1.81a
	NACGRAB	39.50±3.54a	76.50±7.78b	34.13±4.30a	10.50±2.12a	83.83±2.12a	11.17±2.26a
	P-value	**0.671ns**	**0.018***	**0.262ns**	**0.405ns**	**0.662ns**	**0.365ns**
Khaya senegalensis	FRIN	36.00±15.56a	99.00±2.83b	25.53±8.04a	5.50±4.95a	85.50±2.12a	5.97±5.23a
	UI	48.50±4.95a	71.00±4.24a	42.55±6.68a	17.50±0.71a	88.50±9.19a	16.55±0.88a
	NACGRAB	46.50±6.36a	66.00±2.83a	41.27±4.36a	18.50±6.36a	79.00±5.66a	18.95±6.39a
	P-value	**0.500ns**	**0.004***	**0.135ns**	**0.116ns**	**0.421ns**	**0.137ns**
Khaya grandifoliola	FRIN	20.00±1.42a	77.50±3.54a	23.23±4.27a	5.50±2.12a	89.50±3.54a	5.81±2.32a
	UI	38.00±0.00b	96.50±3.34b	28.27±0.74a	9.50±2.12a	97.50±0.71a	8.87±1.87a
	NACGRAB	42.50±2.12b	86.67±1.41ab	33.07±1.47a	12.50±7.78a	90.50±2.12a	11.95±6.89a
	P-value	**0.001***	**0.018***	**0.075ns**	**0.447ns**	**0.81ns**	**0.464ns**

*= significant at 5% probability level, ns= not significant at 5% probability level NSAB= number of stomata on the leaf abaxial layer, NECAB= number of epidermal cell per view on the abaxial layer, SIAB= stomata index for the abaxial layer, NSAD number of stomata on the leaf adaxial layer, NECAD= number of epidermal cell per view on the abaxial layer, SIAD= stomata index for the abaxial layer.

Table 3. Eigen value, Percentage variance and Loadings for the Principal components from the leaf epidermal section characters of all the species in all locations.

	Principal Components						
	1	2	3	4	5	6	7
Eigenvalue	0.571742	0.397588	0.116878	0.015842	0.00426801	0.00277054	4.52E-05
% variance	51.549	35.847	10.538	1.4283	0.38481	0.24979	0.0040709
Character Epidermal Cell Shape	**0.45016**	**0.44618**	**0.3804**	0.12363	-0.12463	-0.1258	-0.6379
Epidermal Cell Wall Pattern	**0.47407**	**0.3928**	**0.25374**	-0.19213	0.31112	0.10864	0.64115
Cell Wall Alignment	2.31E-17	-1.92E-17	-5.58E-17	3.48E-17	-5.50E-17	2.54E-16	2.12E-15
Trichome (P/A)	0.074685	-0.15156	0.049768	0.79786	0.39666	-0.39709	0.13183
Trichome Type	-0.23069	**0.72354**	-0.61997	0.1022	0.018223	-0.16619	0.022597
Crystal Present/Absent	-0.000951	0.026288	-0.14048	0.19244	0.5111	0.77589	-0.28163
Crystal Type	0.15676	0.054208	-0.034832	0.501	-0.68456	0.4189	0.276
Stomata Abundance	-0.69946	**0.31068**	**0.61897**	0.11286	0.012885	0.097908	0.092863

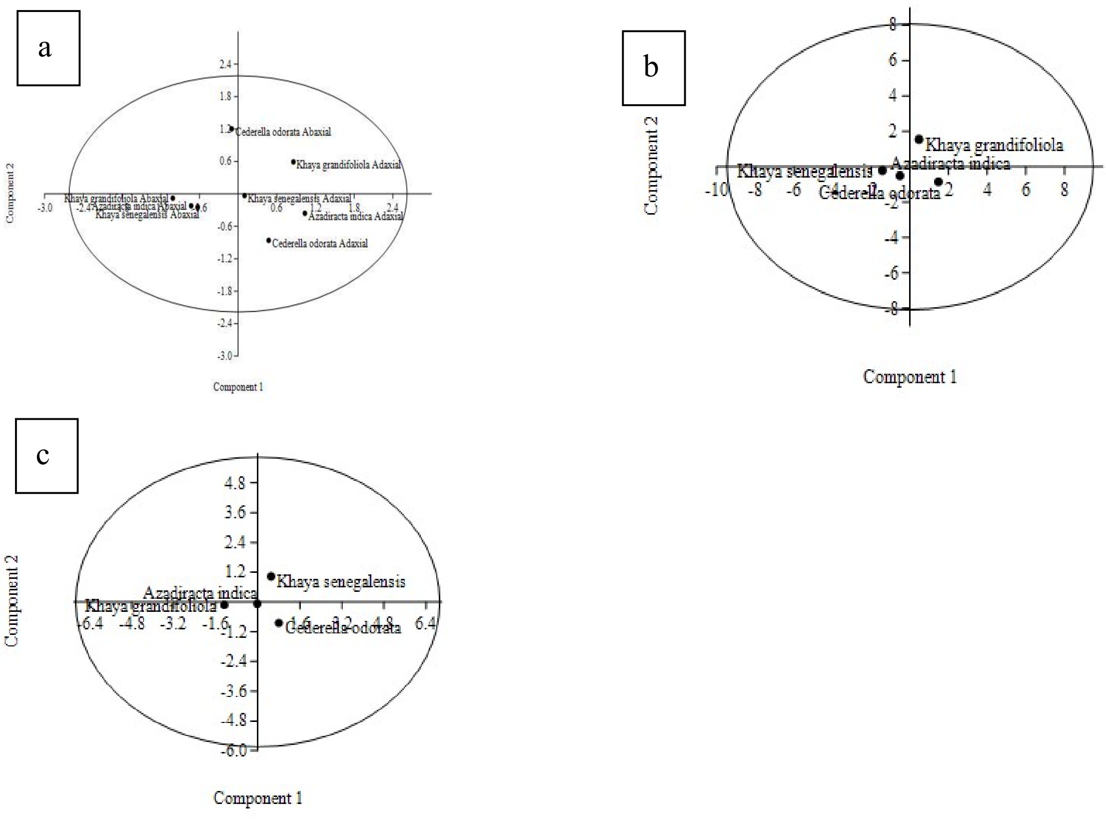

Figure 2. Scatter plot for *Azadiracta indica, Cederella odorata, Khaya senegalensis, Khaya grandifoliola* from different taxonomic units using {a} Leaf Epidermal characters {b} Leaf transverse section characters {c} Petiole transverse section characters.

3.2.1. Principal Component Analysis of the Leaf Transverse Sections

Figure 1b shows the scree plot for principal component analysis of *Khaya grandifoliola, Khaya senegalensis, Azadiracta indica* and *Cederella odorata* using leaf transverse section taxonomic characters from. The plot did not flatten out at all, only the first and second principal components are retained for the taxonomic delimitation of the species. Approximately 54% of the total variation in the characters is observed in the first principal component having about 1.57647 eigen value and approximately 40% of the total variation was observed in the second principal component having 1.14543 eigen value (Table 4). Of all the leaf TS characters subjected to principal component analysis, only the epidermal layer form, cuticle thickness, epidermal layer thickness, mesophyll organization, shape of xylem, presence or absence of trichome and trichome type with 0.24793, 0.39352, 0.67081, 0.31746, 0.44013, 0.2614 and 0.36595 loadings respectively are significant for the delimitation of the tree species (Table 4; Figure 2b) derived from the PCA separated the species into different groups with some located close to each other.

Table 4. Eigen value, Percentage variance and Loadings for the Principal components from the Leaf transverse section characters of all the species in all locations.

	Principal Component		
	1	**2**	**3**
Eigenvalue	1.57647	1.14543	0.176239
% variance	54.396	39.523	6.0811
Characters			
Epidermal Layer	-0.10461	**0.24793**	0.16735
Cuticle Thickness	-0.20571	**0.39352**	**0.7116**
Epidermal layer Thickness	**0.67081**	-0.11589	0.1577
Mesophyll Type	0.00182	-0.21646	-0.10331
Location of Crystals	0.0017897	-0.21647	-0.10324
Mesophyll Organisation	**0.31746**	**0.68164**	-0.078538
Vascular Bundle Arrangement	0	0	0
Shape of Xylem	**0.44013**	**0.29266**	-0.35685
Trichome Present/Absent	**0.2614**	-0.20652	**0.31079**
Trichome Type	**0.36595**	-0.28913	**0.4351**

3.2.2. Principal Component Analysis of the Petiole Transverse Sections

Figure 1c indicated the scree plot for principal component analysis of *Khaya grandifoliola, K. senegalensis, Azadiracta indica* and *Cederella odorata* using petiole transverse section taxonomic characters. The plot did not flatten out at all, only the first and second are retained for the taxonomic delimitation of the species. Approximately 52% of the total variation in the characters is observed in the first principal component having about 0.84091 eigen value and approximately 37% of the total variation was observed in the second principal component having 0.59901 eigen value (Table 5). Of all the petiole TS characters subjected to principal component analysis, only the cuticle thickness, epidermal layer, presence or absence of crystals, crystal type and vascular bundles arrangement with 0.46974, 0.37399, 0.39017, 0.55663 and 0.3063 loadings respectively are significant for the delimitation of the tree species (Table 5). The scatter plot (Figure 2c) derived from the PCA separated the species into different groups with some located close to each other.

Table 5. Eigen value, Percentage variance and Loadings for the Principal components from the Petiole transverse section characters of all the species in all locations.

	Principal Component		
	1	2	3
Eigenvalue	0.84091	0.59901	0.185047
% variance	51.749	36.863	11.388
Characters			
Cuticle Thickness	-0.31657	**0.46974**	**0.42581**
Epidermal Layer	-0.34987	**0.37399**	**0.47895**
Shape of Epidermal Cell	1.45E-16	1.80E-16	-1.53E-16
PO	-0.47056	-0.42719	-0.064372
Crystal Present/Absent	**0.39017**	-0.034076	**0.20595**

Crystal Type	**0.55663**	**0.44464**	-0.059759
Vascular Bundles Arrangement	**0.3064**	-0.50806	**0.73427**

3.3. Phylogenetic Analysis of the Studied Species

The phylogenetic tree (Figure 3) produced two major clusters. The first cluster consists of *Khaya senegalensis* and *Khaya grandifoliola* while the second cluster consists of *Azadiracta indica* and *Cederella odorata.* According to the phylogenetic tree, the most closely related species of meliaceae considered in this study are *Azadiracta indica* and *Cederella odorata*, which formed a paraphyletic group with 87% branch support. *Khaya senegalensis* and *Khaya grandifoliola* also shared a common ancestor having a branch support of 83%. For *Azadiracta indica*, the phylogenetic tree reveals that OTU of NACGRAB is 100% supported to UI and FRIN OTUs as a monophyletic group. However, UI and FRIN OTUs are more closely related compared to NACGRAB. For *Cederella odorata*, the phylogenetic tree reveals that l the OTUs of UI and NACGRAB OTU are more closely related with 99% branch support to OTU of FRIN. Among the OTUs of *Khaya senegalensis*, UIUI was found to be closely related toFRIN, which are distantly related to NACGRAB at 73% branch support. *Khaya grandifoliola* of FRIN OTU had a branch support of 100% with NACGRAB OTU and are more closely related compared to UI OTU.

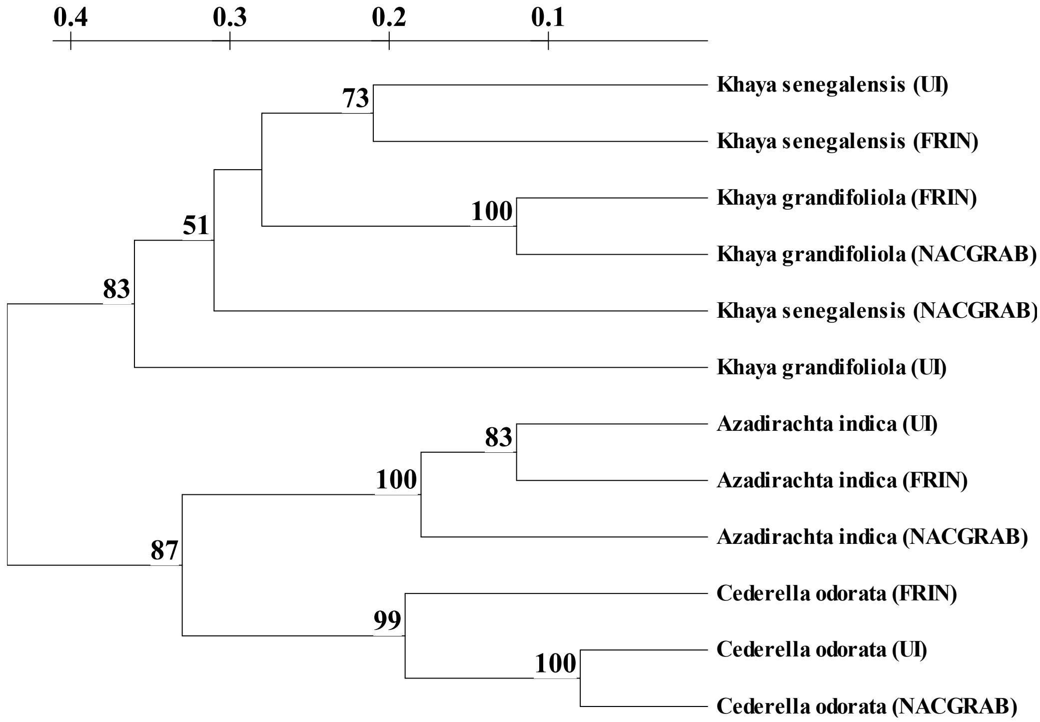

Figure 3. Phylogenetic tree produced based on the overall characters (i.e. Adaxial leaf epidermal characters, Abaxial leaf epidermal characters, Morphology of petiole transverse section, Morphology of leaf transverse section).

4. Discussion and Conclusion

The leaf epidermal morphology of the collected species was assessed in terms of their overall aspect such as the stomata morphology, trichome morphology, anticlinal/periclinal wall pattern and Crystal structures. The principal component analysis revealed that the valuable epidermal characters that can be used for differentiating the species are the epidermal cell shape, epidermal cell wall pattern, trichome type and stomata abundance. These can be used to distinctly separate the taxa under study. This agrees with the findings of [11] who used the presence or absence of trichomes to separate the general *Senna* and *Chamaecrista* from their initial genus. They therefore affirmed that the trichomes of different types, sizes and numbers are therefore good diagnostic features for taxonomic studies. [12] discovered that variation in leaf epidermal cell size, shape and thickness form the premise for the taxonomic position of some angiosperm families. More so, [13] revealed that the combination of leaf epidermal data and stomatal data can further give information concerning species identification.

For the anatomical study of the leaf transverse sections, the principal component analysis revealed that the best descriptors that can be used for easy and correct identification are; epidermal layer, cuticle thickness, epidermal layer thickness, Mesophyll organization, shape of xylem, presence or absence of trichome and trichome type. These characters are diagnostic and can be used in separating the species. More so, the Petiole anatomical characteristics that are best for delimiting the taxa as revealed by the principal component analysis are the; cuticle thickness, epidermal layer thickness, Crystal presence or absence, crystal type and vascular bundles arrangement. The repetition of characters such as cuticle thickness and epidermal layer thickness that was listed among the valuable characters for the Leaf TS affirms their strength in delimiting the taxa. The macro morphological characters that are of taxonomic importance are the stem colour, leaf type, leaf shape, leaf margin, leaf base, leaf adaxial surface, leaf abaxial surface, petiole shape and leaf texture.

The techniques that was used in this work i.e. Principal component analysis is the most commonly tool used in numerical taxonomy. [14] used this technique in analyzing quantitative data gotten from 31 species of *Ficus* their result revealed the hierarchical classification and visual interpretation of the taxonomic relationships between the thirty-one *Ficus* species and also sub-sectional discrepancies (discrete differences) in the existing traditional classification of the genera. [15] also utilised these techniques in the phytochemical and morphometric analysis of the genus *Acalypha*. The results obtained from these techniques are often regarded as unbiased indicators of the similarities and/or differences existing among the taxa.

The finding obtained from the phylogenetic analysis of this family supported and served as epidermal basis for molecular classification of the taxa. This is occasioned from the fact that the genus *Cedrella*, which shares the same subfamily *Swietenioideae* with *Khaya* formed a paraphyletic group with *Azadirachta* that belongs to the subfamily *melioideae*. According to [4], who studied the molecular phylogenetics of *meliaceae* using nuclear and plastid DNA sequences, the subfamily *Swietenioideae* exhibited paraphyly while *Melioideae* formed a monophyletic group. The monophyletic grouping of *Azadirachta indica* achieved from this study also agrees with the finding of [8]. The high branch support recorded from the phylogenetic analysis is a confirmation of the fact that epidermal markers are of taxonomic significance in the family *Meliaceae.* These characters therefore support the delimitation of the taxa even in fragment condition.

Author Contributions: Conceptualization, Adejoke Olukemi Akinyele, Alfred Ossai Onefeli and Grace Fabowale; Methodology, Adejoke Olukemi Akinyele, Alfred Ossai Onefeli and Grace Fabowale Analysis, Adejoke Olukemi Akinyele, Alfred Ossai Onefeli and Grace Fabowale Original draft preparation, Adejoke Olukemi Akinyele, Writing—review and editing, Adejoke Olukemi Akinyele and Alfred Ossai Onefeli, Supervision, Adejoke Olukemi Akinyele

Funding: This research received no external funding.

Acknowledgments: The authors appreciate the contributions and support of Forestry Research Institute (FRIN), National Center for Genetic Research and Biotechnology (NACGRAB) and University of Ibadan, Nigeria.

Conflicts of Interest: The authors declare no conflict of interest.

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