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TAXONOMIC INVESTIGATION OF FOUR VARIETIES OF *MANGIFERA* USING MICRO-ANATOMICAL FEATURES

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ABSTRACT: *Taxonomic investigation of four varieties of Mangifera was undertaken in this study. The aim was to explore the use of foliar micro-anatomical traits in resolving the lingering systematic challenges associated with this fruit crop. Leaves of four varieties of Mangifera (Big-no-fibre, Julie, Opioro and Small-fibre varieties) were collected across various locations in the North Central part of Nigeria. Eighty (80) permanent slides were prepared from the foliar abaxial and adaxial surfaces following standard microscopic practices. Micrometry was carried out using the calibrated ocular and stage micrometers mounted on the compound microscope. From each specimen, thirteen (13) characters were examined and analysed. Mean values of all characters were computed and analysed using the SPSS software (20.0 versions). Pearson's correlation matrix was generated to ascertain the association among the characters. Dendrogram was constructed using the Ward's method to classify the varieties on the basis of their similarities and differences. From the result obtained, the Julie mango had the longest epidermal cell length of 57µm (adaxial) followed by the Small-fibre type with 55.3µm (abaxial). Stomata and guard cell displayed huge qualitative and quantitative variation among the varieties. Comparison of the abaxial surfaces revealed that the Big-fibre variety had the highest stomatal index (78%) followed by the Opioro variety (62%). Conversely, the Small-fibre recorded the longest guard cells surrounding the stomata (44µm) while the Big-no-fibre had the shortest (30.3µm). Correlation revealed that SLD and ELA are positively correlated by +0.996. From the dendrogram, the Big-no-fibre was a distinct variety clearly delimited from the rest, but the Julie and Opioro types were more closely related than others. On this note, both the Big-no-fibre and Small-fibre may be assigned different varietal nomenclatures under Mangifera indica and solve the challenges associated with the common names. Micro anatomic features taxonomic audit of mangifera varieties successfully investigated in this study is maiden and novel. This is reported for the first time.*

KEYWORDS: Mangifera indica, Varieties, Micrometry, Dendrogram, Micro-Anatomy

INTRODUCTION

Mangifera indica L. (family Anacardiaceae) popularly known as mango tree has about 180 different cultivars cultivated around the world (EOL, 2015; ITIS, 2015) though many varieties are products of genetic improvement practices (Bompard, 1993). The mango tree is erect, 30-100 feet high with a broad, rounded canopy (NTBG, 2015). The perennial fruit crop, native to Southern Asian countries, was introduced to West Africa in the 16th century by the Portuguese but has since become highly diversified and successful as keystone species in Nigeria and many parts of Africa (Okigbo, 2001). At present, about 63 countries account for more than 1000 million tons of mango fruit production annually with India as the leading producer (FAOSTAT, 2015). Mango fruit is highly nutritive and therefore eaten in all parts of the world (FAOSTAT, 2015). The fruit is a drupe with fleshy mesocarp but hard endocarp. The succulent and juicy mesocarp has characteristic sweet taste and aroma that attracts man, bats and insects. Man in

particular has been an effective agent of dispersal and propagation of the seed (Dutta, 2007). The fruit has varying shape, sizes, fibre, moisture, texture and other characteristics (Dutta, 2007; Taylor *et al*., 2007). Common names are therefore assigned to the diverse varieties on the basis of fruit characteristics. Being an important fruit crop with huge diversity, the plant portends an important genetic resource that may be explored by breeders for improvement purposes especially the fruit characters (IITA, 2015). Medicinal importance of the fruit has been widely reported most especially the unripe fruit. The bark contains 16-20% tannin and mangiferine active principles (Bompard, 1993). The young leaf has been reported to contain high amount of iron hence used to solve anaemic condition among other medicinal uses (Bompard, 1993).

In Nigeria, there are many varieties of mango trees often distinguished by their fruit characteristics and therefore assigned common names. In the North central part of the county, the common varieties are the Big-no-fibre, Small-fibre, Julie and Opioro varieties. The challenge therefore remains with lack of accurately named germplasm and cultivars. This is a major limitation on the effective study and communication regarding the general biology among the cultivars. Common names are generally misleading, confusing and universally unacceptable (Aguoru *et al*., 2009; ICBN, 2015). Using fruit macromorphology as a guide, identification of mango trees becomes difficult in non-fruiting state. Detailed taxonomic studies on the crop are generally lacking in Nigeria most especially in the North central part where many varieties flourish. The use of anatomical evidence in plant systematic study has proven to be reliable and conclusive in solving taxonomic difficulties among plants (Aguoru and Okoli, 2008, 2012; Aguoru *et al*., 2014b). Specifically, microanatomical study of foliar characters is an effective tool in this regard (Olowokudejo, 1990; Nbagwu and Nwachukwu, 2008; Aguoru *et al*., 2015b, 2015d). Information on epidermal and stomatal characters is often explored by taxonomists to distinguish even closely related cultivars. This is particularly advantageous as it is fast, objective, quantitative in approach and easy to carry out. Varietal identification using this method does not depend on fruit appearance unlike the macroscopic characterization and therefore unhindered by season. The present study therefore takes advantage of the usefulness of the micrometric approach in the taxonomic investigation of the mango varieties of the North Central part of Nigeria. This study is maiden and novel in the country as a whole. The aim was to explore the use of foliar microanatomical characters in resolving the lingering taxonomic challenges associated with this fruit crop.

MATERIALS AND METHODS

Leaves of four varieties of mango (Big-fibre, Julie, Opioro and Small-fibre varieties) were collected across various locations in the North central part of Nigeria. Ten (10) leaves per variety were transported to the Biology Laboratory of the Federal University of Agriculture Makurdi Nigeria for microscopic analysis. Eighty (80) permanent slides were prepared from all the varieties (20 per variety) on the abaxial and adaxial foliar layers following the methods of Aguoru *et al*. (2014a, 2014b, 2015b, 2015c). Micrometry was carried out using the calibrated ocular and stage micrometers mounted on the compound microscope. From each specimen, thirteen (13) characters were examined and analysed. These include: epidermal length abaxial, epidermal length adaxial, epidermal breadth adaxial, stomatal length abaxial, stomatal length adaxial, stomatal breadth abaxial, stomatal breadth adaxial, stomatal index abaxial, stomatal index adaxial, length of guard cell abaxial, length of guard cell adaxial and number of stomatal type. Mean values of characters per variety were analysed using the SPSS software (20.0

versions). Pearson's correlation matrix was computed to ascertain the association among the characters. Dendrogram was constructed using the Ward's method to classify the varieties on the basis of their similarities and differences.

RESULTS AND DISCUSSION

Photomicrographs of the foliar epidermal features of the four varieties are shown in Plate1-4. The mean values of the micromorphological characters are presented in Table 1. The Julie mango had the longest epidermal length of 57µm on its adaxial surface followed by the Small-fibre type with 55.3µm on the abaxial part. The lowest value of epidermal length was observed on the adaxial surface of the Big-fibre mango with 41.6µm. The adaxial stomata of the Small-fibre type was the longest (20µm) among the four varieties while the Opioro type recorded the shortest stomatal width (8.7µm) observed on the abaxial surface. The small fibre variety had four different types of stomata while Julie variety had three types of stomata. The Big-no-fibre and Opioro had two types each. Comparison of the abaxial surfaces as displayed in Figure 1 has shown that the Big-no-fibre variety had the highest stomatal index (78%) followed by the Opioro variety (62%). Conversely, the Small-fibre recorded the longest guard cells surrounding the stomata (44µm) while the Big-no-fibre had the shortest (30.3µm). Correlation (Figure 2) has revealed that SLD and ELA are positively correlated by +0.996. The same value was also noted between ELA and SLA. High positive correlation was also observed between LGCA and ELA (+0.936). From the dendrogram (Figure 2) the Big-no-fibre is a divergent variety among the four. The Small-fibre, Julie and Opioro may have arisen from the same ancestral stock from where the last two are more closely related than the Small-fibre type.

The importance of micromorphological characterization as a reliable taxonomic tool in plant systematics cannot be over emphasized (Olowokudejo, 1990; Nbagwu and Nwachukwu, 2008; Aguoru and Okoli, 2008, 2012; Aguoru *et al*., 2014b, 2015c). Comparative foliar anatomical features and gross vegetative characterization had been used to partition many varieties of other crops and resolve their taxonomic challenges (Olowokudejo, 1990; Aguoru *et al*., 2015b, 2015d). Based on the findings of Aguoru *et al*. (2015a), results obtained from molecular evidences in other crops and compared with those of microtaxonomic tools have corroborated and confirmed the efficacy of the latter. This is because differences in microphenotypic characters often arise as a result of varying genotypic information (Oboh *et al*., 2008).

In the present investigation, the four varieties of *Mangifera indica* have been clearly dermacated. This result agrees with earlier reports on *Ipomoe batatas* where three varieties were separated on the basis of micromorphological characters (Aguoru *et al*., 2015b). In this study, differences in the sizes of stomata and guard cells that regulate their opening and closing could reflect different water conservation mechanisms among the varieties. The fleshy mesocarp of the fruit is juicy in nature with each variety having different tastes. Differences in stomata, guard cells and epidermal cells have grouped the four varieties into three types: Big-no-fibre, Small-fibre and Julie-Opioro ecotypes. The divergence of the Big-no-fibre variety cannot be overlooked and it is likely to belong to a different parental stock. The photomicrograph of this divergent variety is distinct in its fibrous or latex-like features covering the abaxial epidermal cells (Plate 1a). Similarly, the Small-fibre type is unique for the possession of large guard cells surrounding the stomata and therefore occupying the bulk of the abaxial and adaxial surfaces. Plant geneticists and breeders often emphasize on the need to ensure proper nomenclature of varieties to enable them communicate decisively during crop improvement programme (Furini and Wunder, 2003; IBPGR, 2015). Plant taxonomists are also saddled with the responsibility of identification, classification and nomenclature in order to

bring orderliness to the enormous diversity amongst plants (Taylor *et al*., 2007). On this note, both the Big-no-fibre and Small-fibre may be assigned different varietal nomenclatures under *Mangifera indica* and solve the challenges associated with the common names. Microtaxonomic audit of mango varieties successfully investigated in this study is maiden and novel. This is reported for the first time in Nigeria. Further studies may be required to substantiate this report most especially the use of chemosystematic or molecular evidence.

Table 1: Mean values of micromorphological characters of the four varieties

Varieties	ELA (µm)	ELD (µm)	EBA (µm)	EBD (µm)	SLA (µm)	SLD (µm)	SBA (µm)	SBD (µm)	SIA (%)	SID (%)	LGCA (µm)	LGCD (µm)	NST
Bigfibre	43.2	41.6	17.8	16.5	16	18.5	10.1	9.7	78	42	30.3	38.4	2
Julie	44.8	57	21.6	18	17.2	18.1	9.8	12.3	57	36	33.1	30.6	3
Opioro	42	48.5	19.5	19.6	16.5	18.6	8.7	10.5	62	46	34.3	35.6	2
Smallfibre	55.3	49.3	22.2	16.7	19.5	20	10	9.3	60	44	44	43.4	4

Legend:

ELA= Epidermal Length Abaxial
ELD= Epidermal Length Adaxial
EBA= Epidermal Breadth Abaxial
EBD= Epidermal Breadth Adaxial
SID= Stomatal Index Adaxial
LGCD= Length of Guard Cell Adaxial
NST= Number of Stomatal Type
SLA= Stomatal Length Abaxial
SLD= Stomatal Length Adaxial
SBA= Stomatal Breadth Abaxial
SBD= Stomatal Breadth Adaxial
SIA= Stomatal Index Abaxial
LGCA= Length of Guard Cell Abaxial
Bigfibre= Big-no-fibre variety

Table 2: Correlation matrices of micrometric characters

	ELA	ELD	EBA	EBD	SLA	SLD	SBA	SBD	SIA	SID	LGCA	LGCD
ELA	1	.154	.627	-.352	.996	.773	.475	-.500	-.376	.103	.936	.686
ELD	.154	1	.847	.380	.229	-.056	.108	.688	-.875	-.651	.178	-.588
EBA	.627	.847	1	.255	.690	.455	.174	.208	-.936	-.322	.673	-.070
EBD	-.352	.380	.255	1	-.284	.153	-.878	.194	-.577	.271	-.024	-.393
SLA	.996	.229	.690	-.284	1	.782	.440	-.455	-.455	.082	.949	.638
SLD	.773	-.056	.455	.153	.782	1	-.174	-.761	-.398	.645	.931	.771
SBA	.475	.108	.174	-.878	.440	-.174	1	.132	.160	-.617	.137	.134
SBD	-.500	.688	.208	.194	-.455	-.761	.132	1	-.289	-.858	-.578	-.960

SIA	-.376	-.875	-.936	-.577	-.455	-.398	.160	-.289	1	.214	-.527	.243
SID	.103	-.651	-.322	.271	.082	.645	-.617	-.858	.214	1	.330	.684
LGCA	.936	.178	.673	-.024	.949	.931	.137	-.578	-.527	.330	1	.685
LGCD	.686	-.588	-.070	-.393	.638	.771	.134	-.960	.243	.684	.685	1

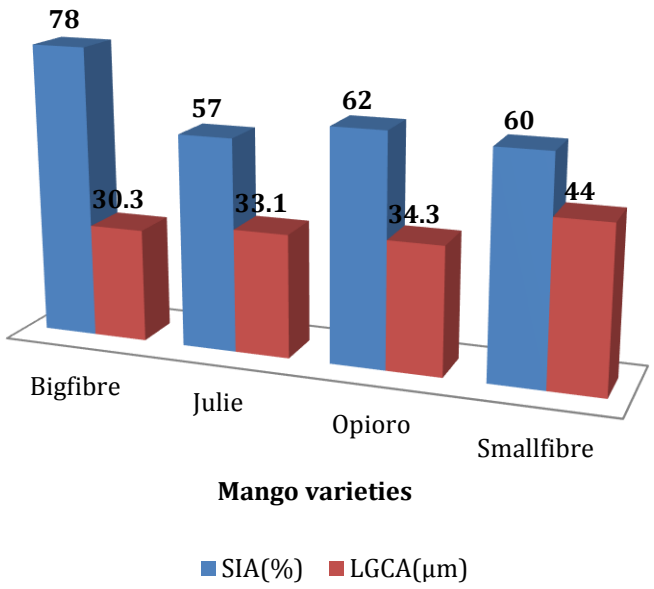


Figure 1: Stomatal indices (SI) and length of guard cell (LGC) on the abaxial surfaces of the four varieties

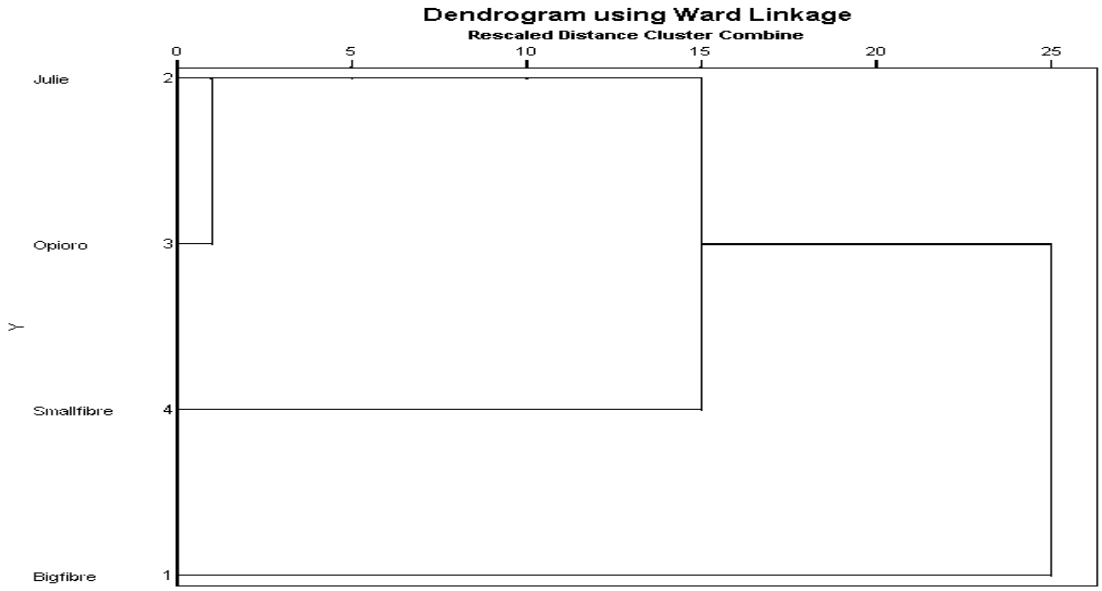


Figure 2: Dendrogram of the four varieties of *Mangifera indica*

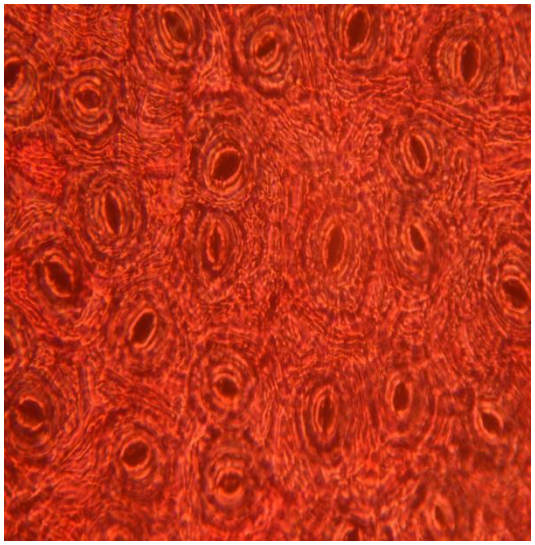


Plate 1a: Big-no-fibre abaxial

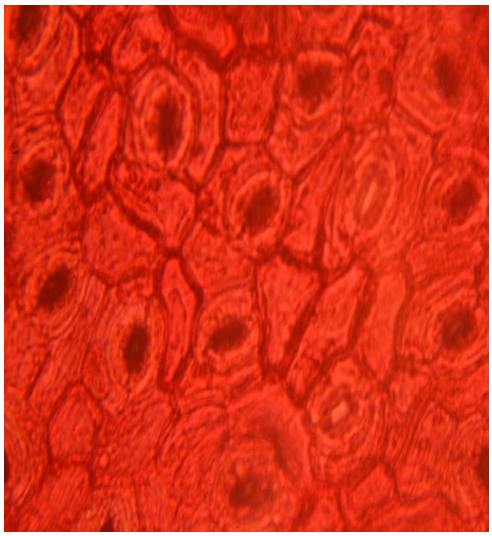


Plate 1b: Big-no-fibre adaxial

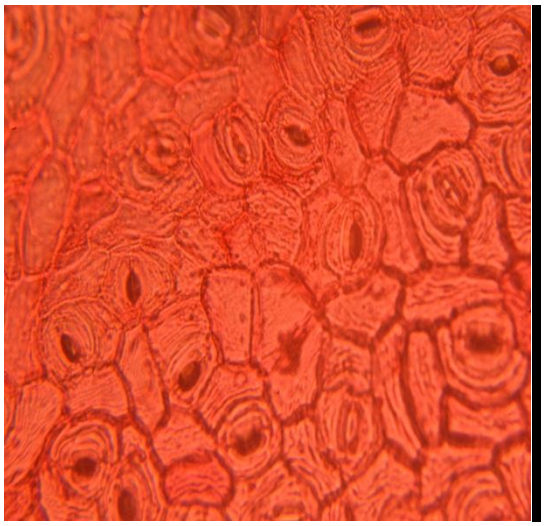


Plate 2a: Julie abaxial

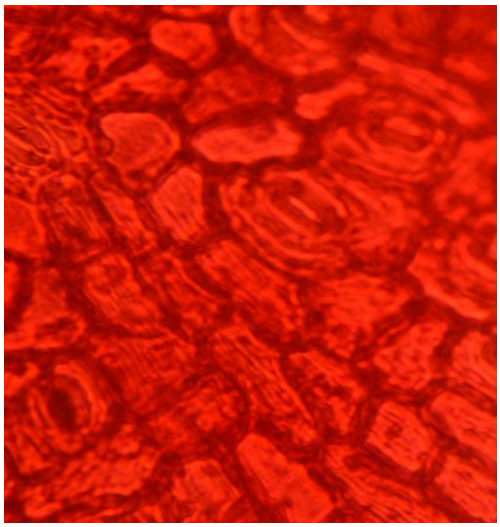
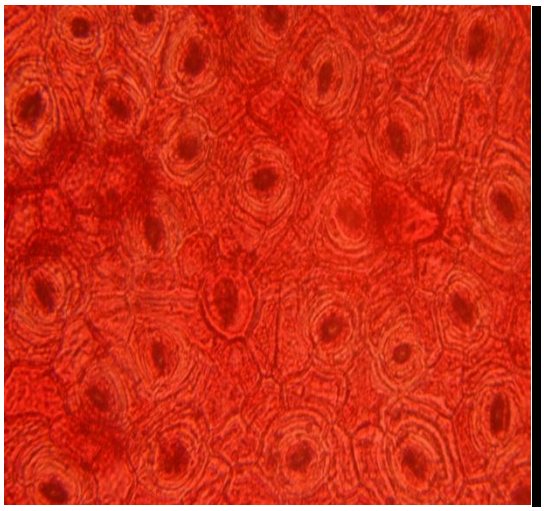


Plate 2b: Julie adaxial



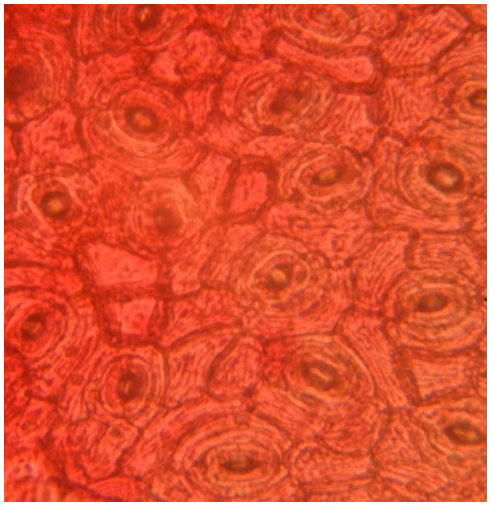


Plate 3a: Opioro abaxial

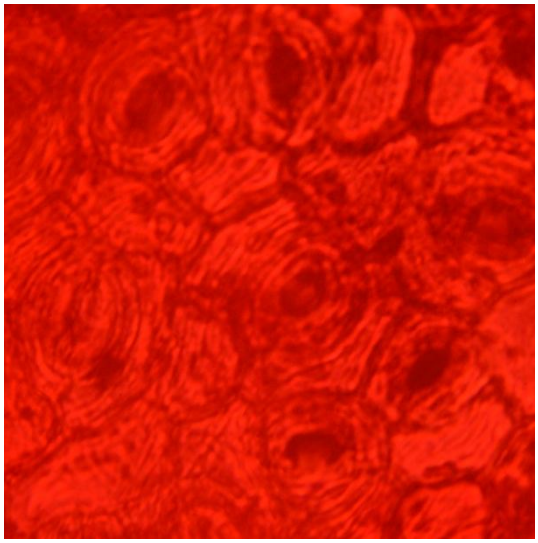


Plate 3b: Opioro adaxial

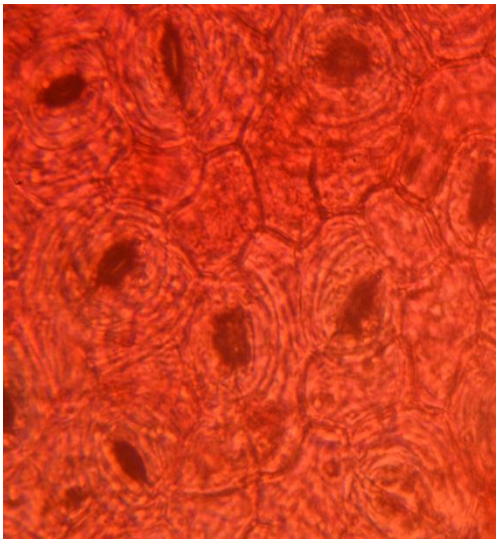


Plate 4a: Small-fibre abaxial

Plate 4b: Small-fibre adaxial

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