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Systematic Descriptions and Taxonomic studies on Three (3) Species of *Plumeria* in North Central Nigeria

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ABSTRACT: Comparative macro and micromorphology of the leaf and floral features of three species of *Plumeria* was carried out. The aim was to establish the degree of relatedness or separation of the species through the use of macro-morphology, epidermal and floral features as systematic and taxonomic evidences on three species. All the species possessed unvaried anomocytic stomata type on the abaxial surfaces only. Leaf epidermal cells were irregular in shape with the exception of *Plumeria rubra* which possessed pentagonal and hexagonal epidermal cell shapes. Stomata index varied from species to species on the abaxial surfaces and could be applied in their delineation. The index for *Plumeria rubra*, *Plumeria obtusa* and *Plumeria lute* were 62.34%, 63.31% and 49.57% respectively. Macroscopically, the leaves of all the species were simple and lanceolate, except for *P. obtusa* that is elliptic. The apices of *P. rubra* and *P.lutea* are acuminate while that of *P. obtusa* is acute, the leaf margin of *P. rubra* is undulate while those of *P. obtusa* and *P. lutea* are entire. However, flower type, symmetry, inflorescence, arrangement, calyx colour, corolla shapes, floral formula and floral diagram were unvaried and affirm relatedness and placement in same genus. Variations were however observed in the colour of petals. *P. rubra* is red with yellow centre, while the colour of *P. obtusa* is white with yellow centre. *P. lutea* is yellow fading to white at the tip. The similarities and overlaps observed in the leaf and floral morphology, cell shape, stomata type and stomata index of the species have provided evidence for their genetic and evolutionary relationship and justification for their common grouping at the generic and specific taxa circumscription. These are reported for the first and maiden in its application in three species of *Plumeria*.

KEYWORDS: Micromorphology, *Plumeria*, Stomatal index, Epidermal cells, Taxonomy, Systematics.

1 INTRODUCTION

Genus *Plumeria* belongs to the Apocynaceae family and it is native to the new world. The plants from this genus are widely cultivated in the tropical and subtropical regions throughout the world. *Plumeria* L. is indigenous to tropical America and is found from Southern Mexico to Northern South America and also most abundant in India. The plants are famous for their attractiveness and fragrant flowers. The essential oils from the flowers are used for perfumery (Shaida *et al.,* 2008).

According to Tung *et al*. (1999) and Scot (2009), *Plumeria* species grow as small ornamental trees in parks, residential and commercial landscapes. *Plumeria* cultivars also adorn roadways and public lands. The decoction of the bark and roots of *P. rubra* is traditionally used to treat asthma, constipation, promote menstruation and reduce fever. The latex is used to soothe irritation (Wiart, 2002). The fruit is reported to be eaten in West Indies. In India, however, it has been used as an abortifacient (Bobbarala *et al*., 2009). The flowers are aromatic and widely used in pectoral syrups. The flowers decoction of *P. rubra* was reported to use in Mexico for control of diabetes mellitus. The leaves of are used in ulcers, leprosy, inflammations and rubifecient (Kardono *et al.,* 1990). The decoction of the bark of *Plumeria obtusa* is given in varying doses as a purgative or as a remedy against oedemas (Shinde *et al.,* 2014).

Plumeria is generally a small tree growing to about 30 ft high. Its broad, usually round-headed canopy is often about as wide as the tree is tall. The species and hybrids vary somewhat in tree size, compactness, and branching character, leaf and flower size and colour, and deciduousness. The leaves are usually glossy green but may be dull green; they are generally

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ovate, may be blunt-tipped (*P. obtusa*) or pointed (*P. rubra var. acuminata or var. acutifolia*), and range from 2 to 4 inches wide and 8 to 12 inches long. In deciduous types, the leaves fall during wintertime, and new leaves emerge during or following the spring flowering period. *P. obtusa* and its hybrids tend to retain their foliage year-round. The flowers are tubular, expanding into a "pinwheel" of five petals that averages 2– 3 inches diameter and may be white, red, yellow, pink, or multiple colours. Flowers of most cultivars are highly fragrant and bloom from March to October. The hybrids differ in their profusion of blooms, with some producing more than 200 flowers per cluster and others only 50–60 flowers. *Plumerias* only occasionally produce seed. When pollinated, the flower produces two hard, narrow, pointed pods up to 7 inches long containing 20–60 winged seeds. Maturation of the seed pods is usually in early spring from a previous season's pollination (Richard, 1998).

Many studies have been carried out on *Plumeria* species but did not include the leaf and petal epidermal studies. In the findings of Kalam *et al.* (2013) the dried flowers of *Plumeria rubra* f. *rubra* and *Plumeria rubra* f. *lutea* were subjected to successive solvent extraction by soxhlation using n-hexane, chloroform, ethyl acetate and methanol. The extracts were subjected to preliminary phytochemical screening using standard procedures and the data obtained from the flowers of both the species was comparatively evaluated. As essential as genus *Plumeria* is, members of its species must be easily recognized without any difficulty, especially for ornamental or medicinal purposes. Members of this genus are usually identified or recognized with their flowers which are seasonal in appearance. There is therefore, the need for the use of other characteristics which are available all year round, that is, the leaves. Based on the ethno botanical uses of the species, detailed micro and macro morphological studies were carried out. The aim was to establish the phylogenetic relationship among the species (*Plumera rubra, Pluneria obtusa,* and *Plumeria lutea)* on the basis of leaf and floral similarities and differences.

2 MATERIALS AND METHOD

Fresh matured leaves and flowers of three species of *Plumeria* were collected from different parts of North Central zone of Nigeria and identified by plant taxonomists in the Botany Unit of the Federal University of Agriculture, Makurdi, Benue State. Each species was phenotypically observed, measured and compared accordingly. Microscopic preparations of the leaf and petal were made to elucidate the epidermal features following standard methods. All preparations were viewed using appropriate objective lenses of the Olympus Microscope. Ten slides were prepared from the leaf and petal of each species. From each slide, ten fields of views were recorded with respect to the stomata type, number of stomata, and number of epidermal cells, shape of epidermal cells and presence or absence of trichome. Mean values of numeric were computed. Description of stomatal complex type was done in accordance with Dilcher (1974). Photomicrographs were taken using an installed digital camera on the microscope. Stomata indices were calculated in percentages using the formula:

$$SI = S/(S + E) \times 100$$

SI = stomata index

S = number of stomata per square millimetre

E = number of epidermal cells per square millimeter

3 RESULTS AND DISCUSSION

The leaves of the species studied were hypostomatic, that is, stomata were present on the abaxial surface but absent on the adaxial surface. The stomata type present was homogenously anomocytic (stomata with five or more subsidiary cells surrounding the guard cells that are not distinguishable from other epidermal cells) (table 1; plate 1, 3, 5). Trichome was absent.

This observation agrees with the work of Chandra *et al.* (1969) who observed similar features in the leaf epidermal studies of *Plumeria rubra, Holarrhena pubescens, Plumeria alba, Wrightia tinctoria,* and *Wrightia tomentora.* The epidermal cells on all the abaxial and adaxial surfaces were irregular in all the species except in *P. rubra* which possessed pentagonal epidermal cell shape on its abaxial surface and hexagonal epidermal cell shape on the adaxial surface (plate 2). The variation recorded in the epidermal cell aligns with the report of Ghazalah *et al.* (2010) who studied the epidermal cells of 15 species of *Persicaria* Mill. and observed variation among them.

Stomata index varied from species to species on the abaxial surface. The highest stomata index was found on the surface of *P. obtusa* with an index of 63.31% and lowest on the abaxial surface of *P. lutea* with an index of 49.57% (table 1). This

shows that stomata occupied larger proportion of leaf surface in *P. obtusa* and smaller proportion in *P. lutea.* The stomatal index, which indicates the proportion of stomata relative to leaf surface, is also a reliable taxonomic character. This is because it is independent of the changes in epidermal cell size brought about by environmental factors (Metcalfe and Chalk, 1988). Similar approach was used by Aguoru and Okoli (2012) to distinguish West Africa species of *Momordica* L using stem and petiole anatomical evidence.

The anatomical features especially the plant epidermis is mildly influenced by environmental conditions and is of high structural diversity. This character represented genetic variations and have been used to solve taxonomic problems in certain other plant groups by taxonomists (Oladele, 1983; Ogunkunle, 2013; Abdulrahaman *et al.,* 2009). Their proven genetic stability and high structural diversity have been the bases for their use in identification of many groups (Ogunkunle and Oladele, 2000; Abubakar and Yanusa, 1998).

The three species therefore shared common attributes as revealed in the leaf and floral morphology. Similarity is particularly pronounced in their simple leaf type, pinnately netted venation type, alternate leaf arrangement, cuneate leaf bases, green leaf colours**.** Similar floral attributes include; bisexuality, cymose flower type, zygomorphic symmetry, green calyx colour, elliptic corolla shapes, floral formula and floral diagram (fig 6). The petals had no stomata on both the abaxial and adaxial surfaces but it was characterized by irregular epidermal cells However, the differences observed cannot be overlooked. Leaf shapes of *P. rubra* and *P. lutea* were lanceolate while that of *P. obtusa* was elliptic. The leaf apex of *P. rubra* and *P. lutea* were acuminate while that of *P. obtusa* was acute. The leaf margin of *P.rubra* is undulate while those of *P. obtusa* and *P. lutea* were entire (fig 2, 3, 4). The corolla of *P. rubra* was red with yellow centre but that of *P. obtusa* was white with yellow centre . *P. lutea* had yellow corolla fading to white at the tip as (table 2; fig 2, 3, 4).

In conclusion, based on these findings, species of the genus *Plumeria* can readily be distinguished from one another as certain features are considered diagnostic. The overlapping similarities as well as distinguishing characteristics observed among the species have provided evidences for their evolutionary relationship. This work has also provided a justification for their common grouping as well as their divergence at the generic and specific circumscription. The combination of microscopic and macroscopic evidences to establish the phylogenetic relationships among the three species of *Plumeria* has yielded a good result. This may further be enhanced by other approaches such as chemosystematics and molecular characterization.

Table1: Leaf epidermal features

Species	Leaf surface	Shape of epidermal cells	Stomata type	Stomata index (%)	Trichomes	Leaf length (cm)	Leaf breadth (cm)
P. rubra	Abaxial Adaxial	Pentagonal Hexagonal	Anomocytic Anomocytic	62.34	Absent	40.0	11.8
P. obtusa	Abaxial Adaxial	Irregular Irregular	Anomocytic Anomocytic	63.31	Absent	25.2	10.3
P. lutea	Abaxial Adaxial	Irregular Irregular	Anomocytic Anomocytic	49.57	Absent	37.0	12.1

Table 2: Floral features

Characters	*P.rubra*	*P.obtusa*	*P.lutea*
Inflorescence	Compound cyme	Compound cyme	Compound cyme
Floral symmetry	Zygomorphic	Zygomorphic	Zygomorphic
Calyx colour	Green	Green	Green
Corolla colour	Red with small yellow centre	White with small yellow centre	Yellow fading to white at the margin
Corolla free/fused	Fused	Fused	Fused
Nature of sepal	Synsepalous	Synsepalous	Synsepalous
Nature of ovary	2 fused capels to form 1	2 fused capels to form 1	2 fused capels to form 1
Ovary type	Superior	Superior	Superior
Nature of stamen	Epipetalous	Epipetalous	Epipetalous
Sex	Bisexual	Bisexual	Bisexual
Number of sepals	5	5	5
Number of petals	5	5	5
Number of anther	5	5	5
Petal length (cm)	4.5	4.2	6.4
Petal breadth (cm)	2.2	2.1	2.7

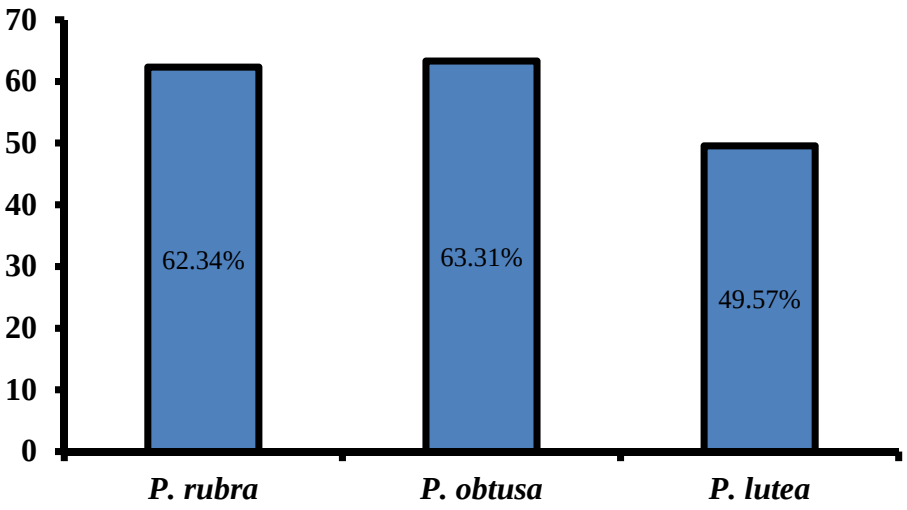


Figure 1: Stomata indices of three species of Plumeria

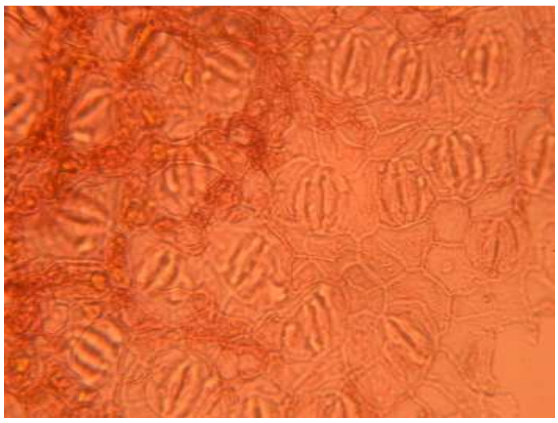
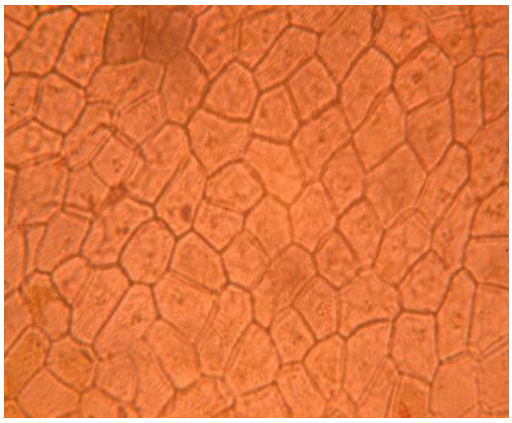


Plate 1



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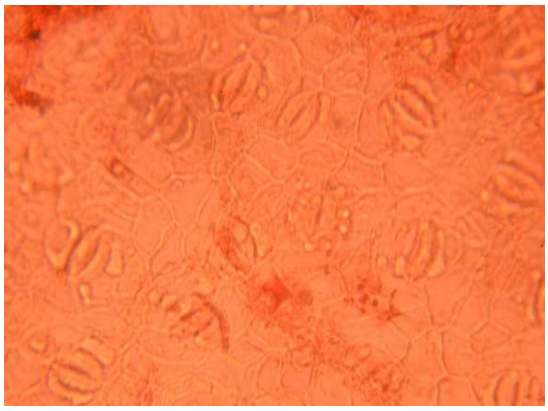

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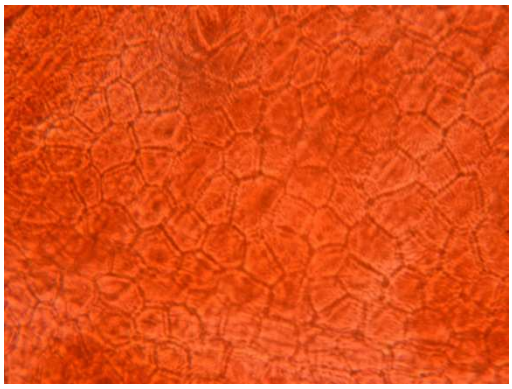

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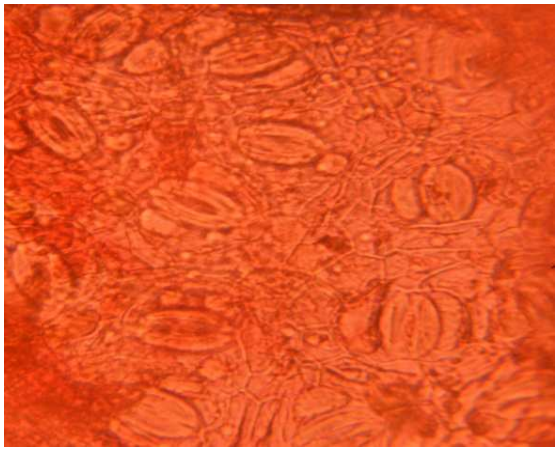

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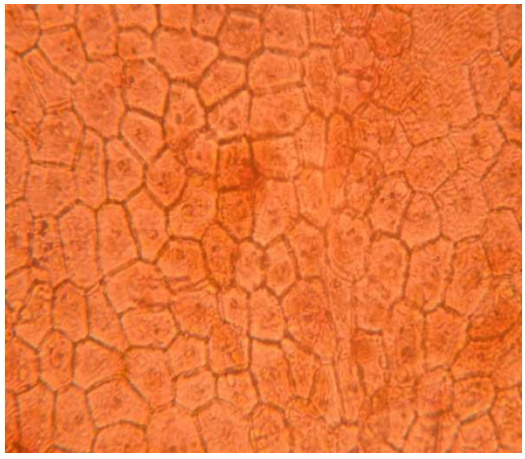

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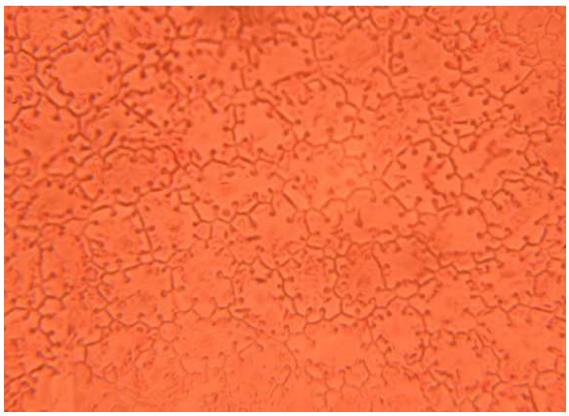

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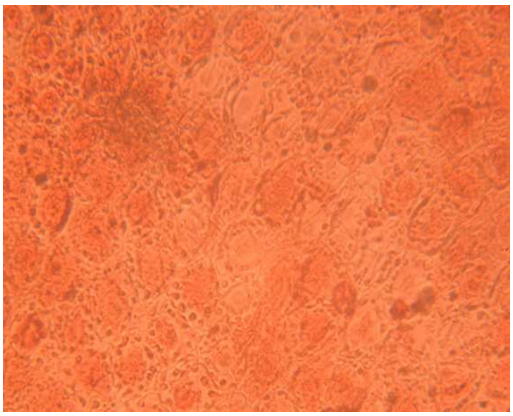

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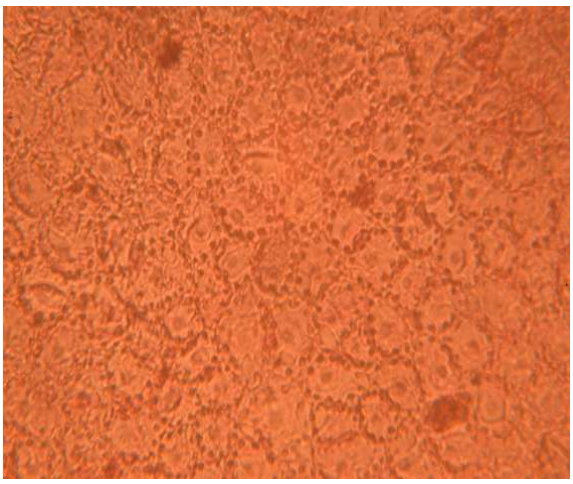

Plate 9

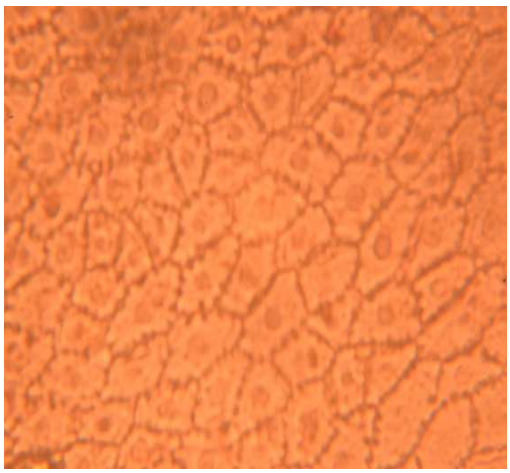

Plate 10

LEGEND:

Plate 1: *Plumeria rubra* leaf abaxial surface showing anomocytic stomata type and pentagonal epidermal cells
Plate 2: *Plumeria rubra* leaf adaxial surface showing hexagonal epidermal cells without stomata.
Plate 3: *Plumeria obtusa* leaf abaxial surface showing anomocytic stomata type and irregular epidermal cells
Plate 4: *Plumeria obtusa* leaf adaxial surface showing irregular epidermal cells without stomata
Plate 5: *Plumeria lutea* leaf abaxial surface showing anomocytic stomata type and irregular epidermal cells
Plate 6: *Plumeria lutea* leaf adaxial surface showing irregular epidermal cells without stomata
Plate 7: *Plumeria rubra* petal abaxial surface showing irregular epidermal cells without stomata
Plate 8: *Plumeria rubra* petal adaxial surface showing irregular epidermal cells without stomata
Plate 9: *Plumeria obtusa* petal abaxial surface showing irregular epidermal cells without stomata
Plate 10: *Plumeria lutea* petal abaxial surface showing irregular epidermal cells without stomata.

Fig2:P. rubra (red petal)

Fig3: P. obtusa (white petal)

Fig4: lutea (yellow petal)

$$+ \; ♀ \; K_{(5)} \; \overline{C_{(5)} A_5} \; \underline{G_{(2)}}$$

Fig.5: Floral formula of Plumeria species

LEGEND:

+= Zygomorphic symmetry; K=Calyx; C=Corolla; A=Androecium; G=Gymnoecium with superior ovary.

Fig 6: Floral diagram of Plumeria species

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