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Pollen morphology and diversity in some Nigerian species of *Jatropha* L. (Euphorbiaceae)

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ABSTRACT

Pollen morphology and diversity were studied in five Nigerian species of *Jatropha* L. (Euphorbiaceae) using acetolysis method and Light Microscopy (LM) with a view to assessing the taxonomic importance of pollen characters in the classification and delimitation of members of genus *Jatropha* L. Overall results showed that pollens in this genus are generally inaperturate or monocolpate. Occasionally, bicolpate grains are observed in *J. curcas* and *J. podagrica*. Exine sculpturing generally consists of rounded depressions/ornamentation across the taxa while triangular pattern on the pollen wall is common to some of the taxa. Pollen attributes like pollen diameter, pollen wall thickness, depth of colpi and distance between colpi vary significantly ($p<0.05$) among the taxa. The results of this study show that pollen characters are important in the classification of the genus *Jatropha* and also support previous revision of the genus based on anatomical and morphological characters.

Keywords: Taxonomy, delimitation, acetolysis, exine, aperture.

INTRODUCTION

The genus *Jatropha* L, which belongs to the family Euphorbiaceae and tribe Crotonae is large and has wide geographical distribution covering the Americas, Africa, India and Arabia. Dehgan (1982) reported about 150-175 species globally and these figures consist of the old and new world species. Hutchinson and Dalziel (1958) reported eight species for West Africa with only five of them endemic in Nigeria. However, apart from the five species of *Jatropha* found in Nigeria as reported by Hutchinson and Dalziel (1958), there exist two additional exotic species not originally listed in the Floral of West Tropical Africa and these are *J. tanjorensis* Ellis and Saroja and *J. integerrima* Jacq. The genus is morphologically diverse both in floral and vegetative structures. Dehgan (1980) describes the habit of members of the genus as ranging between trees and shrubs. Leaf in the genus is characteristically simple to palmately 3, 5 or 7 lobed or sometimes up to 11 segments. Dehgan and Webster (1979) observed that a number of the species in the genus have long petioles and a few taxa are sub sessile. Leaf shapes vary from ovate-lanceolate to narrowly lanceolate, stipules may or may not be present, but when present, they could be foliaceious, glandular,

filiform or spinose (Dehgan,1982). In addition, leaf sizes vary within the genus particularly from species in xeric to those in mesic environments. Flower configuration within the genus *Jatropha* also varies and generally monoecious while inflorescence is compoundly dichasial (Dehgan, 1982).

This genus *Jatropha* has been variously circumscribed by various authors. Dehgan and Webster (1979) as well as Dehgan (1980) reviewed the early taxonomic treatments of the genus using anatomical and morphological attributes. These revisions have led to the current recognition of two subgenera (*Curcas* and *Jatropha*), 10 sections and 10 subsections.

It has been reported that pollen architecture has great significance in the taxonomy of angiosperms and in interpreting evolutionary relationships. In the work of Erdtman (1952), pollen morphology was shown to provide clues required to establish systematic relationship within the family Euphorbiaceae. Pollen characters such as apertural morphoforms (number and position), exine ornamentation and stratification pattern as well as pollen association have been listed as characters of taxonomic importance and this because they are constant characters and easily visible on the microscope hence they have been used in routine taxonomic work (Blackmore, 1984). Erdtman (1952) classified pollen grains into six groups based on the range of their sizes: Perminuta (< 10 µm), Minuta (10-25 µm), Media (25-50 µm), Magna (50-100 µm), Permagna (100-200 µm) and Giganta (> 200 µm).

Some works have been carried out which were aimed at revising the genus *Jatropha* in Nigeria. Foliar epidermal anatomy was used by Isawumi (1989) *and* Aworinde et al. (2009) while Oladipo et al. (2008) utilised seed protein banding pattern in carrying out classification and delimitation of the taxa in Nigeria. However, there is no known work that has explored pollen characters in elucidating taxonomic relationships among Nigerian *Jatropha* species.

The objectives of this study are to provide a description of the pollen diversity in the genus as well as to utilise pollen taxonomic characters in revising the genus with a view to filling the knowledge gap currently existing.

MATERIALS AND METHODS

Fresh and mature anthers (containing pollen grains) for the different taxa used in this study were collected from mature plants of the species from different locations in Nigeria (Table 1). The anthers were acetolysed following Erdtman (1960) method. The pollens were subsequently mounted in glycerine and observed under the Light Microscope (LM). Measurements were made using ocular micrometer inserted into the eyepiece of the LM at X400. Pollen morphological parameters measured (50 measurements per species) were: length of polar axis and equatorial diameter, pollen diameter, depth of colpi, distance between colpi, pollen wall thickness, polar axis/equatorial diameter ratios (using the classification of Erdtman, 1952). The measurements were multiplied with the ocular constant with respect to the power of objective in which they were taken. Data generated from the measurements of morphological features were subjected to Principal Component Analysis, Single Linkage Cluster Analysis (SLCA) as well as One Way Anova (with Duncan Multiple Range Test (DMRT) for test of significant difference). Coefficients of Variation for the pollen morphological attributes were also generated. Photomicrographs were taken using moticam MC1000 photomicroscope at X400.

RESULTS

The result of measurements (mean ± S.E) of the pollen parameters studied in the five *Jatropha* species is presented in Table 2 while photomicrographs of pollen types in each taxon are presented in Plates 1-5. Figures 1 and 2 show the Principal Component

Analysis scatter diagram and Single Linkage Cluster Analysis (SLCA) dendrogram of the species based on their pollen attributes. Components 1 and 2 account for a total of 91.6% (66.9 and 24.7% respectively) of the variance among the species. *Jatropha curcas* is placed highest in the axis relative to other species. In the same vein, in the dendrogram, the species have been clustered into two groups with *J. curcas and J. podagrica* being distinctly separated in the two main clusters.

In all the species studied, pollen types are generally monad, inaperturate, monocolpate and occasionally bicolpate as found in *J. curcas* and *J. podagrica* (Plates 1c and 2b). Mean pollen diameter in the species ranges between 68.5 – 91.4 µm. Pollen shapes are diverse across the taxa and generally vary from elliptic, spheroidal, circular and occasionally quinangular (Plate 2c). There is a significant difference ($p<0.05$) in pollen diameter among the taxa with *J. multifida* grains having the longest diameter. Similarly pollen wall thickness also varies significantly ($p<0.05$) among the species with *J. curcas* having grains with thicker wall compared to other taxa. Mean colpal length in the species lies between 1.32 – 25.1 µm and also varies significantly among the species with *J. multifida* grains having the longest. Exine ornamentation in the five species generally consists of rounded depressions/ ornamentation. However, *J. podagrica*, *J gossypifolia, J. integerrima* and *J. multifida* have distinct triangular pattern on their exine wall (Plates 2, 3, 4 and 5). The Coefficients of Variation of the various pollen attributes in the five taxa are presented in Table 3. Depth of colpi and distance between colpi were the most varied pollen attributes among the taxa with coefficients of variation of 117.9% and 190.6% respectively.

Main description of pollen types in the species

J. curcas (JC) (Plates 1a-d)

Pollens of the species are oblate spheroidal to prolate (p/e =0.96- 1.48) and large (Magnae) with pollen diameter ranging from 69.9- 96.3 µm with a mean of 74.2 ± 1.10 µm (Table 2).

J. podagrica (JP) (Plates 2a-d)

This species has subprolate to prolate pollen grains (the p/e ratio for *J. podagrica* ranges between 1.20–1.66). The pollen grains vary from medium size (mediae) to very large grains (permagnae) (29.1- 127.0 µm) (mean = 68.5 ± 2.34 µm) (Table 2).

J. gossypifolia (JG) (Plates 3a-f)

Pollens of *J. gossypifolia* vary in size from large to very large (Magnae – permagnae) with pollen diameter ranging from 54.6 – 120.0 µm (mean= 81.8 ± 2.63 µm) (Table 2) and are majorly oblate spheroidal to perprolate (p/e = 0.97- 2.25).

J. integerrima. (JI) (Plates 4a-d)

Pollen sizes range from large to very large (magnae – permagnae) and generally prolate (p/e ranges from 1.36 – 1.68). Pollen diameter ranges from 58.2 – 127.0 µm (mean = 89.3 ± 2.42) µm (Table 2).

J. multifida (JM) (Plates 5a-h)

Pollen diameter in this species ranges from 54.6-124.0 µm (mean = 91.4 ± 2.32) µm. The pollens are oblate spheroidal to perprolate (p/e = 0.97-2.54) and also vary from large (magnae) to very large ones (permagnae) (Table 2).

DISCUSSION

The subfamily Crotonoideae to which the genus *Jatropha* belongs comprises more than 1500 species having inaperturate pollen grains (Nowicke, 1994). This assertion is confirmed by the result of the present study, as all the taxa have both inaperturate and monocolpate grains. The presence of monocolpate pollens in all the taxa studied shows it is a generic feature thereby justifying the taxonomic placement of the five taxa in the genus *Jatropha*. The bicolpate pollens found only in *J. curcas* and *J. podagrica* indicate some forms of evolutionary relationship between the species and advancement over other taxa.

Table 1: The *Jatropha* species under study and the area of collection of the species.

Species	Area of Collection
Jatropha curcas	National Centre for Cereal Research Institute (NCCRI), Bida Niger State and Borgu Games Reserve, Borgu Niger State.
Jatropha gossypifolia	Rubber Research Institute of Nigeria (RRIN), Benin and NCCRI Bida Niger State
Jatropha integerrima	Conference Centre Obafemi Awolowo University, Ile-Ife and NCCRI, Bida Niger State, Nigeria
Jatropha multifida	Department of Botany OAU Ife, Stadium Road Ile-Ife and Aladanla line 1, Ile-Ife
Jatropha podagrica	Cocoa Research Institute of Nigeria (CRIN) Ibadan and Faculty of agriculture Building OAU, Ife

In addition, the results of the Principal Component Analysis as well as the hierarchical cluster analysis of the five taxa based on the pollen attributes agree with the revision of the genus *Jatropha* by Dehgan and Webster (1979) using morphological characters. In the work of Dehgan and Webster (1979), the genus was circumscribed into two subgenera (*Curcas* and *Jatropha*).

The presence of triangular pattern on the exine wall of *J. podagrica, J. multifida, J. integerrima* and *J. gossypifolia* is clearly of classificatory value of the four taxa and this conforms to the morphological grouping of the species under the subgenus *Jatropha* by Dehgan and Webster (1979). Moore and Web (1978) have observed that there are many pollen attributes like pollen shape, pollen size and pollen apertures which can be used as diagnostic attributes for plant species. The high variability of depth of colpi and distance between colpi in both *J. curcas and J. podagrica* as well as the complete absence of these attributes in the other taxa studied indicates that they are important taxonomic characters for the species and will be important in the infrageneric grouping of the taxa. Sivarajan (1991) argued that in selecting characters for taxonomic purposes, characters that vary within the group should be given consideration as invariant characters are of no use in intragroup classification. The significant difference observed in the pollen attributes of the taxa in section peltatae (subgenus *Jatropha*) does not agree with the sectional placement of the species by Dehgan and Webster (1979). For instance, the fact that *J. podagrica* and *J. multifida* have significant differences in their pollen diameter, pollen wall thickness, depth of colpi, and distance between colpi and P/E ratio necessitate a review of the sectional placement of the two species.

Though palynological data alone may not be sufficient for the revision of current taxonomic placement of members of this genus, the result of this study revealed that pollen characters should be given strong consideration in the future revision of the genus; in view of the high variability of these characters within the genus coupled with the minimal intra specific variation of the attributes.

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Table 2: Variation in pollen quantitative characters (mean value in µm ± standard error) and Duncan grouping of five *Jatropha* species in Nigeria (means with same alphabet along the columns are not significantly different).

Species	Pollen diameter (µm) ± s.e	Pollenwall thickness (µm) ± s.e	Depth of colpi (µm) ± s.e	Distance Between colpi (µm) ± s.e	Length of polar axis (µm) ± s.e	Length of equatorial diameter(µm) ± s.e	P/E
J. curcas	74.2 ± 1.10^{c}	9.88 ± 0.31^{a}	1.32 ± 0.54^{a}	69.2 ± 0.10^{a}	166.0 ± 5.40^{a}	125 ± 10.4^{a}	1.36^{b}
J.gossypifolia	81.8 ± 2.63^{b}	7.93 ± 0.11^{b}	1.14 ± 0.55^{b}	-	99.1 ± 15.1^{a}	77.5 ± 13.6^{a}	1.45^{a}
J.integerrima	89.3 ± 2.42^{a}	7.57 ± 0.51^{b}	18.3 ± 0.05^{b}	-	148.0 ± 14.6^{a}	89.9 ± 21.2^{a}	1.18^{b}
J. multifida	91.4 ± 2.32^{a}	6.26 ± 0.29^{c}	25.1 ± 4.84^{a}	-	117.0 ± 15.2^{a}	91.6 ± 12.7^{a}	1.42^{a}
J.podagrica	68.5 ± 2.34^{c}	7.88 ± 0.38^{b}	11.6 ± 5.12^{b}	5.16 ± 4.54^{b}	169.0 ± 9.16^{a}	128 ± 8.15^{a}	1.34^{b}

Table 3: Coefficients of Variation of pollen attributes in five Nigerian species of *Jatropha* Linn.

Pollen Attributes	Coefficient of Variation (%)
Pollen diameter	11.9
Pollen wall thickness	16.5
Depth of colpi	117.9
Distance between colpi	190.6
Polar axis	25.4
Equatorial diameter	29.7

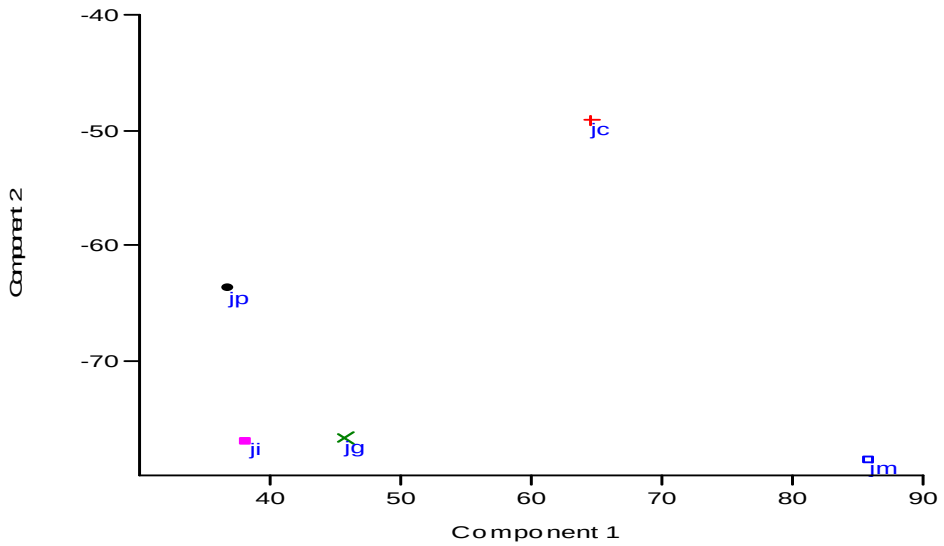

Figure 1: Principal component analysis scatter diagram of five *Jatropha* species based on their pollen attributes.

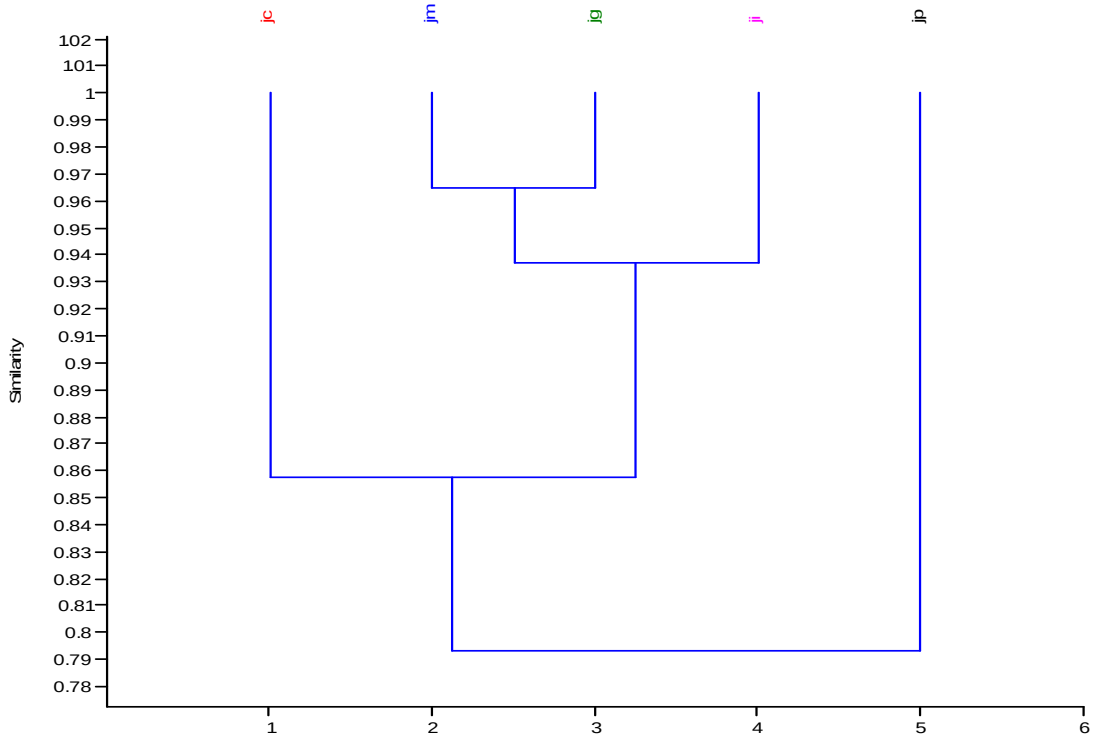

Figure 2: Single linkage cluster analysis dendrogram of *Jatropha* species based on their pollen morphology.

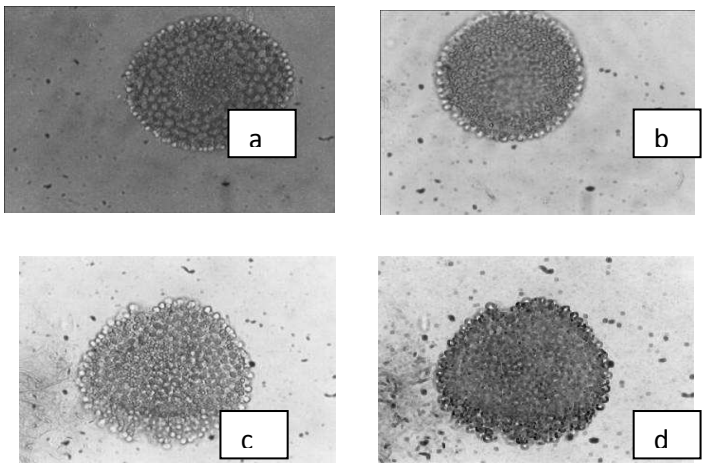

Plate 1: *Jatropha curcas* pollens.

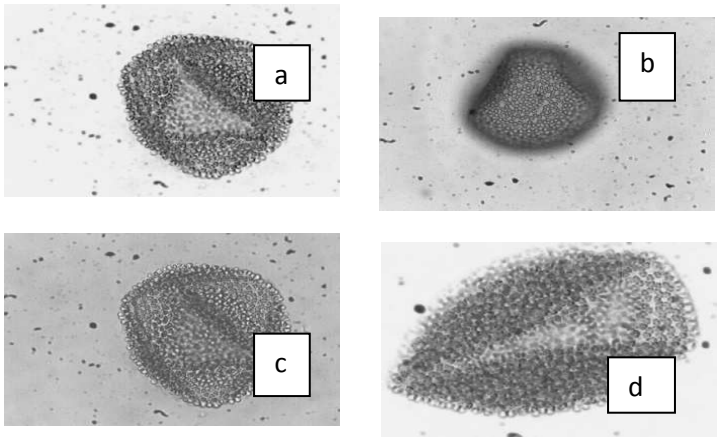

Plate 2: *Jatropha podagrica* pollens.

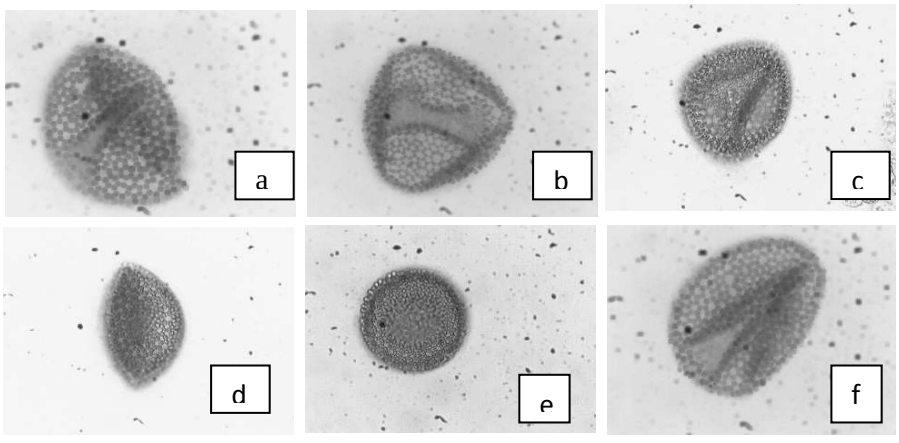

Plate 3: *Jatropha gossypifolia* pollens.

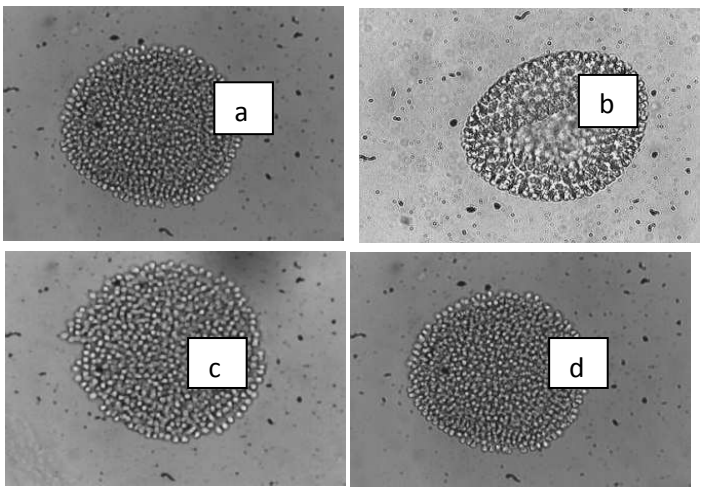

Plate 4: *Jatropha integerrima* pollens.

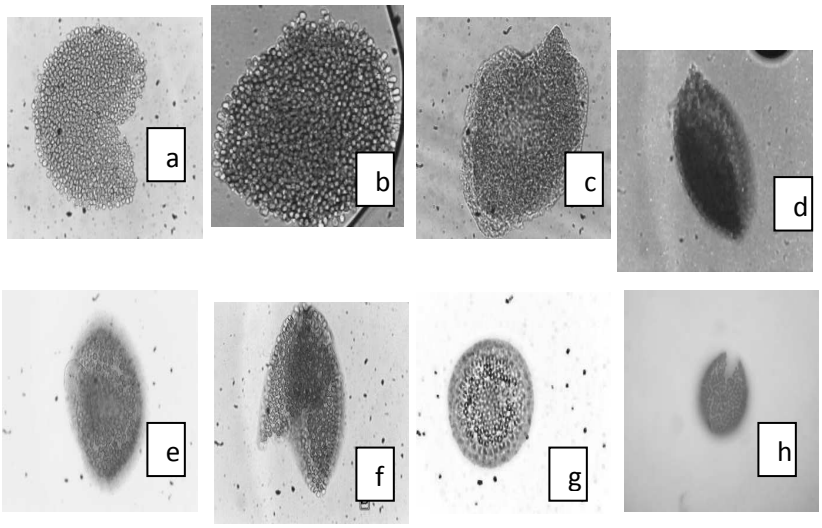

Plate 5: *Jatropha multifida* pollens.

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