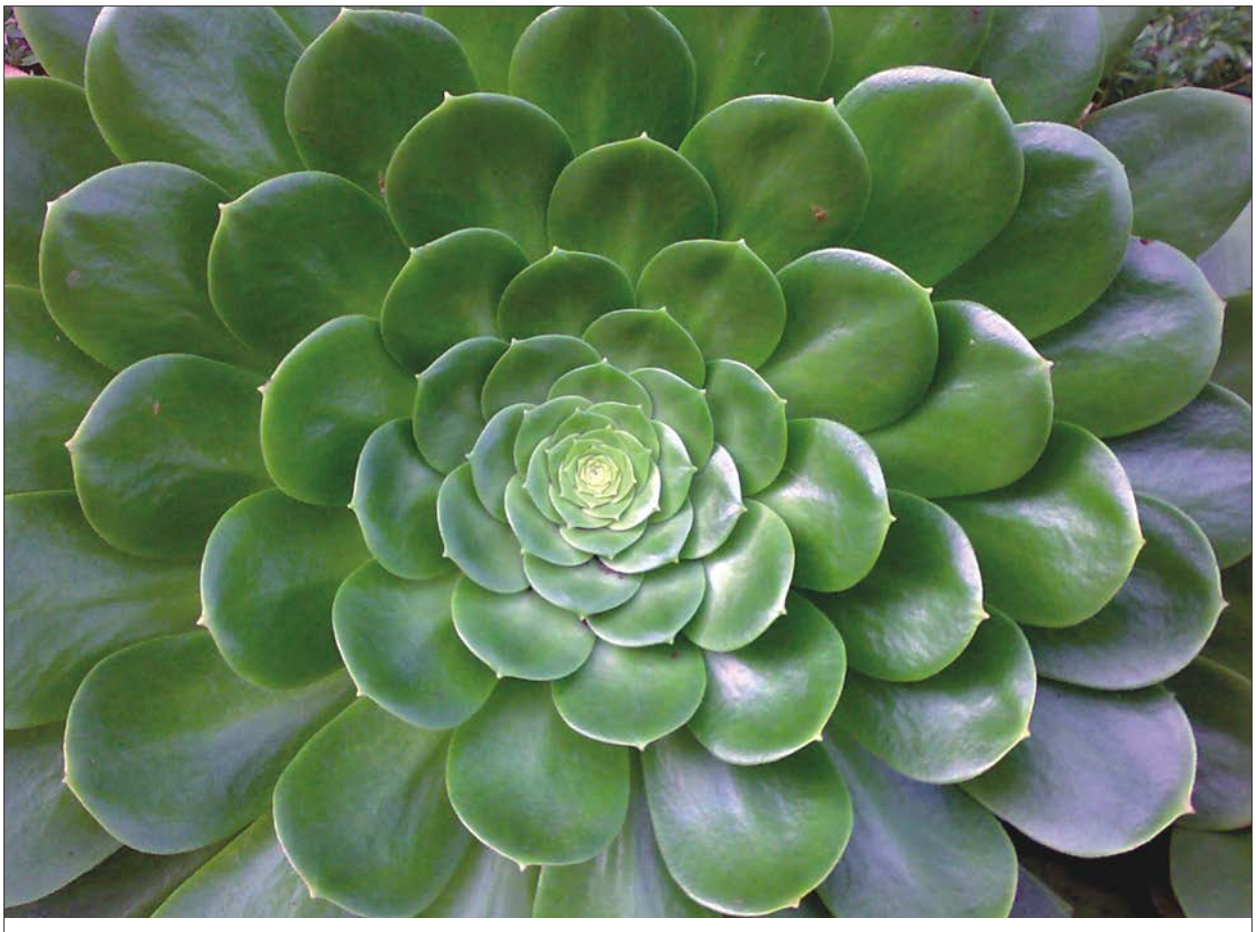

Journal of
Plant Sciences

ISSN 1816-4951

Academic
Journals Inc.

www.academicjournals.com

Journal of Plant Sciences 7 (5): 163-175, 2012
ISSN 1816-4951 / DOI: 10.3923/jps.2012.163.175

Vegetative and Floral Morphology of *Jatropha* species in the Niger Delta

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ABSTRACT

The morphology (vegetative and floral) of *Jatropha* L. species (*Jatropha curcas* L., *Jatropha gossypifolia* L., *Jatropha multifida* L. and *Jatropha podagrica* Hook) in parts of the Niger Delta was investigated. The study aimed at establishing taxonomic affinities and differences between these species based on their leaves, inflorescences, flowers, fruits and seed characteristics. Visual observations, measurements and photographs of relevant organs of wild and ornamental collections of the four species were taken. Results obtained showed that the four species differ distinctively in leaf outline, leaf length, leaf base, margin and texture with the glandular leaf margin of *J. gossypifolia* and incised lobes of *J. multifida* being diagnostic and asserting their statuses as taxonomic species. Leaf length varied from 7.01±0.90 cm in *J. gossypifolia* to 24.75±1.18 cm in *J. podagrica*. The distinct yellowish-green flower colour of *J. curcas* distinguishes it from other species which possess different shades of red colour. Variation was observed in fruit shape (ellipsoid and tear-drop shapes) of *J. curcas* showing that intraspecific morphological or ecological types exist within this species. However, similarities were observed in leaf venation which is actinodromous and basal in all species and in floral arrangement which is cymose. These and other features confirm the relatedness of the species.

Key words: Actinodromous, *Jatropha*, floral morphology, inflorescence, Niger Delta, taxonomy, vegetative morphology

INTRODUCTION

The genus *Jatropha* L. belongs to the family Euphorbiaceae with over 175 species. Common *Jatropha* species found in the Niger Delta region are *Jatropha curcas* L., *Jatropha gossypifolia* L., *Jatropha multifida* L. and *Jatropha podagrica* Hook. A number of *Jatropha* species including *J. curcas* yield oils and photochemicals of medicinal and domestic importance while others are being used as ornamentals or as hedge plants (Nwokocha *et al*., 2011; Fairless, 2007; Burkill, 1994). Recently, interest in the use of *J. curcas* as a major source of biofuel has been advocated in Nigeria (http://allafrica.com/). Some members of the genus have been listed as neglected and underutilized because of limited information available on the biology and systematics of the species (Heller, 1996; Csurhes, 1994).

The utilization of morphological characters (vegetative and floral) for delimitation of closely and distantly related taxa is age long. Recently, Akyalcin *et al*. (2006), Mbagwu and Edeoga (2006),

Agbagwa (2007), Ghosh *et al.* (2008), Jafari *et al.* (2009) and Silva *et al.* (2011) employed these important taxonomic characters (vegetative and floral) in the elucidation of different plant genera. Apart from the foundation work of Hutchinson and Dalziel (1958), the authors are unaware of any recently published work which identified and described species of *Jatropha* in Nigeria and particularly Niger Delta, where environmental changes are causing gradual elimination of species.

This study reports part of the results of a project on the biology and systematics of *Jatropha* species in Niger Delta aimed at generating interest on improvement and breeding of *J. curcas*. Therefore, the purpose of this study is to provide (1) detailed information on the morphology of the four *Jatropha* species commonly found in the Niger Delta; (2) morphologically compare the four species to deduce their species affinity and update information contained in Hutchinson and Dalziel (1958) with regards to relatedness of these species and (3) provide some basic information to steer further research on the species in the Niger Delta since one of them (*J. curcas*) is used as biofuel elsewhere.

MATERIALS AND METHODS

Plant materials: Plant materials were collected during field trips to some Local Government Areas in Niger Delta from January 2009 to March 2010. Samples were compared with earlier deposits in the University of Port Harcourt Herbarium and reports in Flora of West Tropical Africa (Hutchinson and Dalziel, 1958). The specimens were lodged at the University of Port Harcourt Herbarium after investigated.

Morphological studies and analysis of data: Observations on morphology were made on matured stands of *J. curcas, J. gossypifolia, J. multifida* and *J. podagrica*. Morphological features were described following the Flora of West Tropical Africa (Hutchinson and Dalziel, 1958), Taxonomy of Flowering Plants (Gill, 1988) and Anatomy of Flowering Plants (Metcalfe and Chalk, 1979). For all characters, 10 specimens from 11 localities were measured using a meter rule and venier calliper to determine the length and breadth dimensions of leaves, stems, flowers, fruits and seeds. Results from measurements were fed into Microsoft Excel 2010; the averages and standard deviations were computed using the Statistics package of the Excel 2010. Minute characters were observed using a hand magnifying lens. Photographs of relevant morphological features were taken using a PowerShot A500 Canon digital camera. The floral diagram of the genus based on the floral formula was derived. The research work was carried out at the Biosystematics and Taxonomy Laboratory, Department of Plant Science and Biotechnology, University of Port Harcourt, Nigeria.

RESULTS AND DISCUSSION

Morphological descriptions of *Jatropha* species in West Africa based on herbarium specimens deposited at Kew are reported by Hutchinson and Dalziel (1958). The vegetative and floral morphological descriptions in this present study were based on fresh specimens collected from different localities as shown in Table 1. Details of vegetative and floral characteristics of the different species are presented in Table 2 while Table 3 contains information on leaf architecture of the species. All the species studied are monoecious, perennial and sub-woody shrubs.

Taxonomy relies greatly on morphology to discriminate groups and leaf morphology is central to plant taxonomy and systematics (Viscosi and Cardini, 2011). A major diagnostic character of *Jatropha* is the leaf which is distinctly different for all four species (Fig. 1). The diagnostic features with respect to leaf morphology include the leaf phyllotaxy and organization, shape, surface, texture, margin, types and shape of lobes, presence and nature of stipules, petioles, venation and architecture of the leaf (Table 2). For instance, the leaf shape of *J. curcas* and *J. gossypifolia* are

Table 1: Sources, Collection localities, collector and sample numbers of *Jatropha* species

Taxa	Collector and sample number	Geographic location	Locality	Date of collection	Remark
J. curcas	Blessing 001	-	Omuhenchi village, ikwerre L.G.A,R/S	11/1/2009	In a private compound as a hedge plant
	Blessing 005	N,04°53.171; E,006°54.079	Choba town, Obio Akpor L.G.A,R/S	15/1/2009	In a private compound as a hedge plant
	Blessing 007	-	Elele town, Emuoha L.G.A,R/S	27/12/2009	Behind a filling station as an escape
	Blessing 008	-	Elele town, Emuoha L.G.A,R/S	27/12/2009	In a private compound as a hedge plant
	Blessing 010	-	Ndele town, Emuoha L.G.A,R/S	27/12/2009	In a private compound as a hedge plant
	Blessing 012	N,04°43.040; E,007°18.005	Sime-tai, Tai L.G.A,R/S	28/3/2010	In a private compound as a hedge plant
	Blessing 013	-	Ukala Okpunor, Oshimili-North L.G.A, D/S	21/3/2010	In a private compound as a hedge plant
J.gossypifolia	Blessing 004	N,04° 51.264; E,006°58.413	Mgbuogba, Obio Akpor L.G.A,R/S	15/1/2009	In a private compound as an ornamental plant
	Blessing 006	-	Omuochiolu, Ikwerre L.G.A,R/S	10/1/2009	In a private compound as a hedge and ornamental plant
	Blessing 009	-	Elele town, Emuoha L.G.A,R/S	27/12/2009	In a private compound as a hedge plant
	Blessing 014	-	Ukala Okpunor, Oshimili-North L.G.A, D/S	21/3/2010	Along the road as an escape
J. multifida	Blessing 003	N,04° 48.630; E,006°56.757	Rumuolumini, Obio/Akpor L.G.A,R/S	15/1/2009	In a private compound as a hedge plant
J. podagrica	Blessing 002	N,04° 53.896; E,006°54.267	Uniport junction, East-West road, R/S	15/1/2009	In a horticultural garden as an ornamental plant
	Blessing 011	N,04°51.886; E,007°03.278	Rumuodara, Obio/Akpor L.G.A,R/S	27/12/2009	In a horticultural garden as an ornamental plant

Table 2: Macromorphological characters of the four *Jatropha* species

Characters	*J. curcas*	*J. gossypifolia*	*J. multifida*	*J. podagrica*
Habit	Monoecious, succulent shrub or small tree	Monoecious, succulent shrub	Monoecious, succulent shrub or small tree	Monoecious, succulent shrub
Duration	Deciduous	Persistent	Evergreen or semi-decidous	Semi-decidous
Root	A tap root with lateral roots	A tap root with lateral roots	A tap root with lateral roots	A tap root with lateral roots
Stem description	Erect and unarmed with scars, cylindrical and stout, green at the apex and pale brown at the base	Erect and unarmed with scars, cylindrical and stout, green to purplish-red at the apex but pale brown at the base	Erect and unarmed with scars, cylindrical and stout, green at the apex and pale brown at the base	Erect and unarmed with scars, cylindrical but swollen at the base(gout) and stout, green at the apex and pale brown at the base
Internode length (cm)				
Range	1.2-5.7	0.8-2.9	1-3.5	0.5-1.8
Mean	2.72±0.60	2.21±0.20	2.33±0.25	1±0.15
Leaf type	Foliage often green	Foliage of purple tinged	Foliage often green	Foliage often green
Leaf organization	Simple	Simple	Simple	Simple
Phyllotaxy	Alternately arranged	Alternately arranged	Alternately arranged	Alternately arranged
Leaf outline or shape	Broadly ovate	Broadly ovate	Broadly ovate	Orbicularly ovate
Leaf Lamina (whole/base)	Symmetrical	Symmetrical	Symmetrical	Symmetrical
Leaf Base	Deeply cordate	Shallowly cordate	Deeply cordate	Peltate
Leaf apex	Acute or shortly acuminate tip	Acute or acuminate tip	Altenuate tip (or tailed apex)	Acuminate tip
Leaf texture	Chartaceous	Chartaceous	Cariaceous	Cariaceous
Leaf surface	Glabrous but slightly pubescent on the veius of the leaf lower surface	Glabrous	Glabrous and more or less glaucous with whitish under-side	Glabrous and more or less glaucous with whitish under-side
Form of margins	Entire and undulating	Serrated or serrulate, minutely toothed with glandular tips with regular spacing	Iucised with alternatingly arranged leaf projectious or pointed segments	Sinulate
Types of lobes	Palmately lobed into 3 or 7	Palmately or digitately lobed into 3 or 5	Piunatisect or palmately divided into 9 or 11 segments	Palmately lobed into 3 or 5
Shape of lobes	Wide ovate, symmetrical with the middle lobe longest and acute tips	Obovate to oblanceolate, asymmetrical with middle lobe longest and acuminate tips	Narrow oblanceolate, symmetrical with long segments and attennate tips	More or less ovate, symmetrical with middle lobe longest and acuminate tips
Length of leaf (cm)				
Range	13.6-18.1	4-10.6	21.2-26.0	20.3-29.9
Mean	16.2±0.4	7.01±0.90	23.6±0.59	24.75±1.18
Breadth of leaf (cm)				
Range	9.57-20.98	3.5-12.1	34.8-42.8	12.5-30.0
Mean	16.23±1.51	10.35±1.11	38.23±0.99	23.73±2.39
Petiole length (cm)				
Range	15.3-27.5	7.1-18	17.8-29	14.4-28.5
Mean	25.57	12.84	25	15.54

Table 2: Continue

Characters	*J. curcas*	*J. gossypifolia*	*J. multifida*	*J. podagrica*
Stipules length (cm)				
Range	-	0.2-1.1	2.1-2.6	0.1-0.2
Mean	-	0.65	2.35	0.15
No. of stipules	-	2	2	2
Gland position on leaf	Absent	Acropetiolar and marginal (glandular seta)	Absent	Absent
Inflorescence type	Biparous or dichasial cymose	Uniparous or scorpioid cymose	Multiparous or polychasial cymose	Multiparous or polychasial cymose
Peduncle description	Long and smooth, ending with a cyme and branched	Long and smooth ending with a flowered leaf-opposed cyme and branched	Long and smooth ending with a flat topped cluster or multiparous cyme and branched	Long and smoothending with a flat topped cluster or multiparous cyme and branched
Peduncle length (cm)				
Range	3.3-8	7.7-16.8	22.3-26.2	28.7-35.7
Mean	6	13	24.5	32.2
Peduncle width (cm)				
Range	0.2-0.4	0.1-0.3	0.5	0.4-0.6
Mean	0.41	0.17	0.5	0.5
Flower description	Rosaceous in shape, unisexual and sometimes hermaphroditic, regular, pentamerous and polypetalous which is yellowish-green in colour with a faint frangrance	Rosaceous in shape, unisexual, regular, pentamerous and polypetalous which is dark red in colour without frangrance	Rosaceous in shaped, unisexual, regular, pentamerous and polypetalous which is bright red in colour without frangrance	Rosaceous in shape, unisexual, regular, pentamerous and polypetalous which is reddish-orange in colour without frangrance
Bract type	Leafy or foliaceous,	Leafy or foliaceous and margins serrated with glandular tips	Persistent	Persistent
Aestivation	Contorted	Contorted	Contorted	Contorted
Form of sepal and corolla	Petaloid and polysepalous and polypetalous, respectively	Petaloid and polysepalous and polypetalous, respectively	Petaloid and polysepalous and polypetalous, respectively	Petaloid and polysepalous and polypetalous, respectively
Sepal shape	Broadly deltoid in shape and margius non-glandular	Elliptical to lanceolate in shape and glandular margins	Ovate to obovate in shape with red hue on the surface and non-glandular margius	Ovate to obovate in shape and non-glandular margins
Sepal texture	Glabrous but slightly hairy at the basal region	Glabrous but the iuner surface hairy	Glabrous	Glabrous
Corolla shape	Elliptic to oblanceolate in shape and pubescent with whitish hairs and the tip coiled	Obovate in shape and glabrous	Elliptic in shape and glabrous	Elliptic in shape and glabrous
Corolla texture	Glabrous but in surface pubescent with white hairs	Glabrous	Glabrous	Glabrous
No. of floral gland	5 free glands	5 free glands	5 free glands	5 free glands
Male flower	More numerous than female flower	More numerous than female flower	More numerous than female flower	More numerous than female flower
Sepal length (cm)				
Range	0.3-0.4	0.3	0.2	0.1
Mean	0.35	0.3	0.2	0.1

Table 2: Continue

Characters	*J. curcas*	*J. gossypifolia*	*J. multifida*	*J. podagrica*
Sepal width (cm)				
Range	0.15-0.3	0.3	0.2	0.1
Mean	0.23			
Corolla length (cm)				
Range	0.5-0.8	0.5	0.6-0.7	0.5-0.6
Mean	0.65	0.5	0.65	0.55
Corolla width (cm)				
Range	0.2-0.3	0.3	0.2	0.2
Mean	0.25	0.3	0.2	0.2
No. of stamen	10	8	7	8
Length of stamen (cm)				
Range	0.5-0.6	0.3	0.5	0.3
Mean	0.55	0.3	0.5	0.3
Length of filament (cm)	0.3	0.2	0.3	0.2
Length of anther (cm)	0.2	0.1	0.2	0.1
Attachment of filament to anther	Basifixed	Dorsifixed	Basifixed	Basifixed
Female flower	Fewer than male but bigger in size	Fewer than male but bigger in size	Fewer than male but bigger in size	Fewer than male but bigger in size
Sepal length (cm)				
Range	0.4	0.6-0.7	0.1	0.1
Mean	0.4	0.4	0.1	0.1
Sepal width (cm)				
Range	0.2-0.3	0.2	0.1	0.1
Mean	0.15	0.2	0.1	0.1
Corolla length (cm)				
Range	0.6	0.6	0.7	0.5-0.6
Mean	0.6	0.6	0.7	0.55
Corolla width (cm)	0.2	0.4	0.4	0.3
Position of ovary in the flower	Superior or hypogynous	Superior or hypogynous	Superior or hypogynous	Superior or hypogynous
Pistil type	Elliptic syncarpous,3-celled, triovulate, 3 spreading bifurcate style that is fused at the base with 2-lobed stigma per style	Globose sycarpous, 6-ribbed and 3-celled, triovulate, 3 spreading style that is fused at the base with 2-lobed stigma per style	Elliptic syncarpous, 3-celled, triovulate, 3 spreading bifurcate style that is fused at the base with 2-lobed stigma per style	Globose sycarpous, 6-ribbed and 3-celled, triovulate,3 spreading style that is fused at the base with 2-lobed stigma per style
Fruit type	Simple	Simple	Simple	Simple
Fruit shape	Ellipsoid to tear-drop-shaped	Globose capsule and 3 seeded capsule and 3 seed	Ellipsoid capsule, glabrousand 3 seeded	Globose capsule and 3 seeded
Fruit texture	Glabrous	Slightly pubescent with white hairs	Glabrous	Glabrous
Fruit dehiscence	Septifrugal	Septicidal	Septifrugal	Septicidal
Fruit length (cm)				
Range	2.5-3.5	1.3-1.8	2.5-2.7	1.5-1.6
Mean	2.5±0.14	1.8±0.071	2. 5±0.02	1.6±0.013

Table 2: Contimue

Characters	*J. curcas*	*J. gossypifolia*	*J. multifida*	*J. podagrica*
Fruit width (cm)				
Range	2.2-3.1	1.3-1.6	2.8-3.2	1.1-1.34
Mean	2.7±0.131	1.46±0.04	2.942±0.046	1.185±0.039
No. of fruit per peduncle	1-6	1-6	1-4	1-9
Seed description	Ellipsoid and triangular-convex in shape with brown hue aril	Ellipsoid in shape and a dark brown aril	Spherical to oval in shape and whitish brown aril	Ellipsoid in shape and dark brown aril
Seed length (cm)				
Range	1.6-1.8	0.7-0.8	1.6-1.7	0.9-1.1
Mean	1.72±0.54	0.74±0.234	1.665±0.526	1±0.316
Seed width (cm)				
Range	0.7-1.0	0.38-0.4	1.6	0.4-0.6
Mean	0.803±0.253	0.39±0.12	1.6±0.506	0.517±0.16
No. of seed per fruit	3	3	3	3
Seed dispersal	Fruit dehisces but seeds remain intact till the fruit drops to the ground	Fruit dehisces and the seed are released by explosion	Fruit dehisces but seeds remain intact till the fruit drops to the ground	Fruit dehisces and the seed are released by explosion

Table 3: Summary of leaf architecture of the *Jatropha* species studied

Characters	*J. curcas*	*J. gossypifolia*	*J. multifida*	*J. podagrica*
Types of venation	Reticulate, palmate and divergent	Reticulate, palmate and divergent	Reticulate, pinnate or unicostate	Reticulate, palmate and divergent
Type of primary venation	Actinodromous with 7-9 veins diverging radially from a single point	Actinodromous with 5-9 veins diverging radially from a single point	Actinodromous with 9-11 veins diverging radially from a single point	Actinodromous with 5-8 veins diverging radially from a single point
Position of the first point of primary vein radiation	Basal	Basal	Basal	Basal
Number of basal vein	7-9 i.e. 2 units of 7 big and 2 small veins	5-9 i.e. 2 units of 5 big and 4 small veins	9-11 i.e. 2 units of 9 big and 2 small veins	5-8 i.e. 2 units of 5 big and 3 small veins
Development of primary vein	Perfect and marginal	Perfect and marginal	Perfect and marginal	Perfect and marginal
Size of primary vein Vw/lw X 100%	1.8% Moderate	1.5% Moderate	1.04% Stout	1.04% Stout
Course of primary veins	Straight and branched	Straight and branched	Straight and branched	Straight and branched
Secondary veins	Acute angle of divergence with loose forming branches	Acute angle of divergence with loose forming branches	Acute angle of divergence with loose forming branches	Acute angle of divergence with loose forming branches
Angle of divergence (°)	Acute angled and moderate (50°)	Acute angled and narrow (40°)	Acute angled and wide (70°)	Acute angled and wide (70°)
Variations of angle of divergence	Upper secondary veins more acute angled than the lower veins	Upper secondary veins more acute angled than the lower veins	Upper secondary veins more acute angled than the lower veins	Lower secondary veins more acute than the upper vein
Angle of upper vein	50°	50°	70°	60°
Angle of lower vein	40°	40°	60°	80°
Behaviour of loop-	Enclosed by 3° and 4°	Enclosed by 3° and 4°	Enclosed by 3° and 4°	Enclosed by 3° and 4°

Table 3: Continue

Characters	*J. curcas*	*J. gossypifolia*	*J. multifida*	*J. podagrica*
Forming branches	arch of secondary veins joining super-adjacent secondary veins at an acute angle of 40°-50°	arch of secondary veins joining super-adjacent secondary veins at an acute angle of 40°-50°	arch of secondary veins joining super-adjacent secondary veins at an acute angle of 50°	arch of secondary veins joining super-adjacent secondary veins at an acute angle of 40°-50°
Course of secondary veins	Branched and abruptly curved	Branched and abruptly curved	Branched and abrnptly curved	Branched and abrnptly curved
Inter-secondary veins	Composite	Composite	Composite	Composite
Tertiary vein pattern	Orthogonal, reticulate and sometime precurrently forked	Orthogonal, reticulate and sometime precurrently forked	Orthogonal, reticulate and sometime precurrently forked	Orthogonal, reticulate and sometime precurrently forked
Tertiary vein relationship with midvein	Constantly obligued	Constantly obligued	Constantly obligued	Constantly obligued
Arrangement of tertiary vein	Predominately alternate	Predominately alternate	Predominately alternate	Predominately alternate
Areoles development	Well developed	Well developed	Well developed	Well developed
Areoles arrangement	Oriented	Oriented	Oriented	Oriented
Areoles shape	Pentagonal	Pentagonal	Pentagonal	Pentagonal
Tooth architecture Glandularity	Non-glandular	Clear glandular	Non-glandular	Non-glandular
Apical termination of the tooth	Simple	Spherulate	Simple	Simple

broadly ovate with deeply to shallowly cordate leaf base and acute or acuminate tip; *J. multifida* has altenuate tip (or tailed apex) while *Jatropha podagrica* is orbicularly ovate with peltate leaf base and acuminate tip. Likewise the leaf margin of the species varied from entire to undulating in *J. curcas*, to serrated or serrulate and minutely toothed with glandular tips in *J. gossypifolia*, incised with alternately arranged leaf projections or pointed segments in *J. multifida* and sinulate for *J. podagrica*. While leaf lobes ranged from 3 to 5 palmate lobes in *J. gossypifolia* and *J. podagrica*, 3 to 7 palmate lobes were observed in *J. curcas* while *J. multifida* was pinnately lobed into 9 or 11 segments (Fig. 1). Extensive use of leaf morphological characters in delimitation of related species abounds in literature. Recently, Ratha and Paramathma (2009) attempted separation of twelve *Jatropha* species in India based on leaf morphological features. Similarly, Agbagwa (2007) and Mbagwu and Edeoga (2006) utilized related leaf characters in delimitation of members of the genera *Abrus* and *Vigna*, respectively. Thus, leaf morphology is critical in identification of common *Jatropha* species in Niger Delta.

The usefulness of flowers and inflorescences in taxonomic discrimination of species cannot be overemphasized. Ratha and Paramathma (2009) demonstrated this fact in Indian *Jatropha* species where different distinct shades of colours of flowers and inflorescences were reported for the different species. The identified *Jatropha* species in this present study are unisexual with inflorescences made up of solitary to clustered cymose flowers. However, their forms varied with *J. curcas* possessing biparous or dichasial cyme type while *J. multifida* and *J. podagrica* had the multiparous or polychasial cyme as shown in Fig. 2 and 3 and Table 2. Variation was observed in *J. gossypifolia* whose peduncle is pubescent with fine, whitish hairs ending with a flowered leaf opposed, uniparous or scorpioid cyme. All species possessed rosaceous-shaped flowers which are regular, pentamerous, polypetalous and unisexual. Hermaphroditic flowers were observed in

Fig. 1(a-d): Habit of (a) *J. curcas*, (b) *J. gossypifolia*, (c) *J. multifida* and (d) *J. podagrica*

Fig. 2(a-d): Inflorescence of (a) *J. curcas*, (b) *J. gossypifolia*, (c) *J. multifida* and (d) *J. podagrica*

Fig. 3(a-d): Androecium (m), gynoecium (f) and hermaphroidite (h) of (a) *J. curcas*, (b) *J. gossypifolia*, (c) *J. multifida* and (d) *J. podagrica*

J. curcas (Fig. 3a). Variations were observed in the flower colour. The flowers of *J. curcas* were yellowish-green in colour, purplish-red for *J. gossypifolia*, bright red and reddish orange in *J. multifida* and *J. podagrica*, respectively. The floral formula for the species studied (Fig. 4) can be represented as follows:

Male flower: ⊗, ♂, ♀, K_5, C_5, A_1, G_0
Female flower: ⊗, ♀, K_5, C_5, A_0, G_3
Hermaphrodite flowers (*J. curcas*): ⊗, ♀, ♂, K_5, C_5, A_1, G_3

The fruits and seeds of the *Jatropha* species showed variations of taxonomic relevance (Fig. 5 and 6, Table 2). *J. gossypifolia* and *J. podagrica* fruits are 3-seeded globose capsule, sparingly pubescent to glabrous, usually green in colour, turning brown and dehiscing into 2-valved cocci when mature; comparatively, *J. multifida* are 3-seeded ellipsoid capsule, glabrous, green to yellow in colour turning dark brown when mature and dehisces. *J. curcas* was observed to have both ellipsoid and tear-drop-shaped fruits (Fig. 5a, b) implying that there may be morph-or ecotypes in this species. This fact is of significant important since only the ellipsoid shaped fruit has been reported (Fairless, 2007; www.desert-tropicals.com; http://www.latimes.com/; Ratha and Paramathma, 2009). Based on overall morphological data, a taxonomic key to the species of the genus studied is hereby presented as follows:

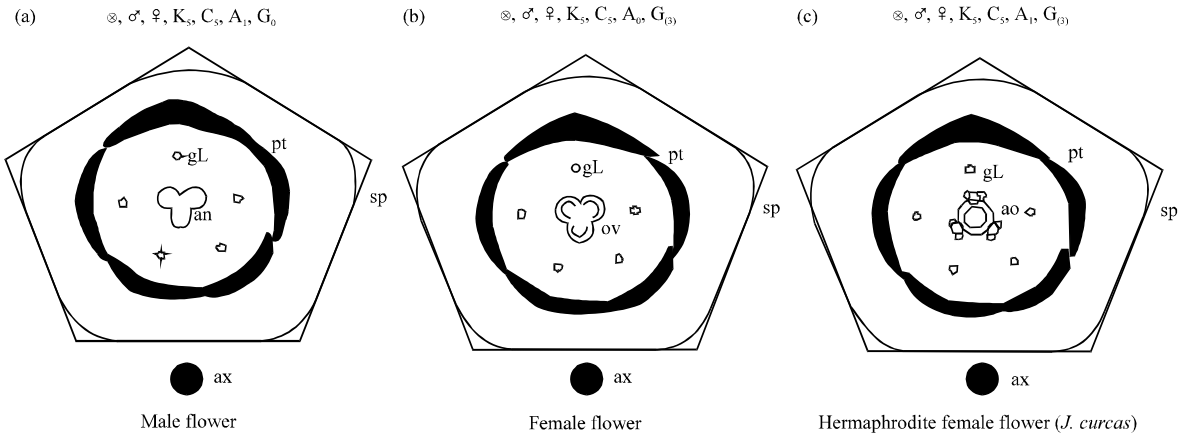

Fig. 4: Floral diagram of *Jatropha* (a) Male plant, (b) Female plant and (c) Hermaphrodite

Fig. 5(a-d): Fruits of (a) *J. curcas* and its variation in shape (i and ii) (b) *J. gossypifolia* (c) *J. multifida* and (d) *J. podagrica*

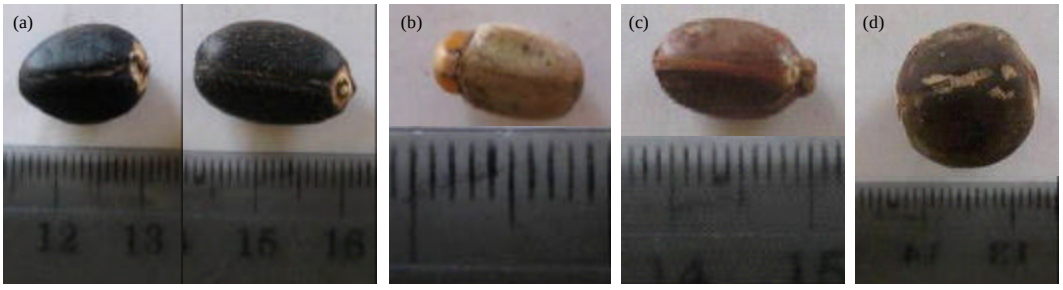

Fig. 6(a-d): Seed of Jatropha species studied. (a) The ellipsoid shape of *J. curcas* and its variation in shape (i and ii) (b) *J. gossypifolia* (c) *J. multifida* and (d) *J. podagrica*

- Pistil elliptic syncarpous, 3-celled, triovulate, 3 spreading bifurcate style that is fused atthe base with 2-lobed stigma per style..... 2
- Pistil globose syncarpous, 6-ribbed and 3-celled, triovulate of about 0.2 cm long, 3 spreading style of about 0.2 cm long that is fused at the base with 2-lobed stigma per style..... 3
- Seed ellipsoid and triangular-convex in shape, black in colour some mottled with grey to cream thin lines and cream with brown hue aril..... ..... *J. curcas*
- Seed spherical to oval in shape, pale brown in colour and whitish brown aril..... ..... *J. multifida*
- Flowers is dark red in colour, seed length 0.7-0.8 cm long, pale grey to brown in colour and dark brown aril, stem stout and cylindrical..... ..... *J. gossypifolia*
- Flowers reddish-orange in colour, seed length 0.9-1.1 cm, pale brown with grey hue in colour and dark brown aril, stem stout; stem cylindrical and swollen at the base..... ..... *J. podagrica*

One major factor hampering the breeding and development of sustainable conservation of *Jatropha* in Nigeria is that the information available on germplasm of *Jatropha* is scattered and not readily accessible. This has resulted, frequently, in uncoordinated research efforts as well as inefficient approaches to the conservation of these genetic resources. This study however, has unequivocally identified four *Jatropha* species in the Niger Delta. It is hoped that the information compiled will contribute to: (1) ease of identification of the species by researchers based on the taxonomic key (2) identifying constraints in and possible solutions to the use of the crops (3) identifying possible untapped genetic diversity for breeding and crop improvement programmes and (4) detecting existing gaps in available conservation and use approaches. It also intends to contribute to improvement of the potential value of these crops through increased use of the available genetic diversity and forms a valuable reference source for all researchers involved in conservation, improvement and promotion of *J. curcas* as a biofuel plant in Nigeria.

CONCLUSION

Taxonomy relies greatly on morphology to discriminate groups. This study has identified and confirmed for the first time the occurrence of four species of *Jatropha* (*J. curcas*, *J. gossypifolia*, *J. multifida* and *J. podagrica*) in the Niger Delta based on gross morphology. The morphological description of the species provided herein clearly separates the identified species into distinct species and provides easy identification guide to researchers from different background wishing to collect and perform studies on *Jatropha* species. More especially, the descriptions shall be of incalculable help to horticulturists seeking to breed and domesticate species like *J. multifida* and *J. podagrica* for their beautiful and showy flowers. The information also solves the problems of identification which may arise during sample collection in the field/wild between the members of the genus and other morphologically similar genera. This study therefore affirms and authenticates the species as individual species occurring in the Niger Delta.

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