NUMERICAL TAXONOMIC STUDY OF SOME *SOLANUM* L. SPECIES (SOLANACEAE) USING VEGETATIVE AND FLORAL MORPHOLOGICAL CHARACTERS

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ABSTRACT

This study employs the all inclusive numerical techniques to evaluate the taxonomic status of some species in the genus *Solanum* (Solanaceae) using vegetative and floral characters. This is an effort to resolve some of the conflicting taxonomic issues which arose as a result of gross morphological variability between and within species due to human interference and other factors. Ten species covering six taxonomic sections were investigated which includes: *S. aethiopicum* Linn., *S. americanum* Mill, *S. anomalum* Thonning, *S. erianthum* D Don, *S. gilo* Raddi, *S. macrocarpon* Linn., *S. melongena* Linn., *S. nigrum* Linn., *S. torvum* Sw. and *S. wrightii* Benth. A total of 49 attributes comprising 35 qualitative and 14 quantitative characters were studied and coded for analysis. Principal Component Analysis (PCA) and Single Linkage Cluster Analysis (SLCA) were employed to elucidate the relationship among the taxa of the genus, while similarity matrix and dendrogram were constructed. PCA factor loading of the characters showed that characters such as plant height, leaf margin and leaf base are important in delimiting the taxa studied. In conclusion, this study has demonstrated the usefulness of numerical techniques in taxonomic work, with the combination of a number of morphological characters to achieve copious delimitation with greater implication for the taxonomy of these species and the genus.

Keywords: Numerical Taxonomy, *Solanum*, Plant Morphology, PCA, SCLA,

INTRODUCTION

The genus *Solanum* L. is the type genus of the family Solanaceae and it is one of the largest and most widespread genus in the plant kingdom with about 2000 species (Gbile, 1979; 1985) constituting one of the largest genera of angiosperms found in both the temperate (Gbile, 1985) and tropical (Okoli, 1988) regions of the world. The genus is represented in Nigeria by 25 species, five of which are introduced and are now cultivated (Hutchison and Dalziel, 1963; Gbile, 1987). The genus also contains wild and cultivated species; the cultivated species are sources of very important leafy vegetables and edible fruits that are rich in proteins, vitamins and minerals (Asaolu and Asaolu, 2002; Oboh *et al.,* 2005). In addition, many members of the genus are known to be important medicinal plants (Cipollini and Levey, 1997; Khan, 1979; Nagaoka *et al*., 2001; Shamim *et al*., 2004).

The taxonomy of this important genus is of general concerns to taxonomists due to the fact that the genus is a complex one and member species are often confused due to diversity in their gross morphology (Gbile, 1979; Knapp, 1991a; Levin *et al*., 2005) and eco-geographical distribution (Whalen, 1984; Wunderlin *et al*., 1993). A number of *Solanum* species have no conclusive subgeneric or sectional affiliation, even where species were well-characterized, infrageneric groups still exist and their phylogenetic relationships to other groups are generally unknown (Bohs and Olmstead, 1997). Most of the taxonomic confusion surrounding *Solanum* is due to its large size (Edmond, 1986; Knapp, 1991b; Oyelana, 1997), morphological variation (Edmond, 1977; Gbile 1987), and predominantly tropical distribution (Bohs and Olmstead, 1997). An additional reason is that cultivated plants are much more difficult to classify than wild plants due to the manipulation by man (Schultze-Motel and Meyer, 2005).

As a result of these elucidated reasons which have resulted in a number of inconsistencies and misconceptions on past attempts to resolve the complexities associated with the taxonomy of the genus**,** there is the need to employ an all-inclusive taxonomic method with the capability to resolve some of the highlighted conflicts especially with respect to gross morphology in this important genus. Therefore, numerical taxonomic techniques seem to be suitable for handling the

great diversity in this genus. Numerical methods have been successfully employed in various plant systematic studies where classification and delimitation are difficult to achieve by conventional taxonomic methods (Illoh *et al.,* 1992). Several workers have stressed the importance of numerical taxonomic method in plants classification and delimitation. For example, Illoh and Olorode (1991) used numerical taxonomy in the classification of *Mangifera indica* varieties in Nigeria. Folorunso and Jayeola (2009) reported that reproductive characters are much better than the vegetative characters earlier used in the distribution of *Polystachya* species into their sections. Other studies such as those of Rhodes *et al.* (1970), Schilling and Heiser (1976), Pickersgill *et al.* (1978), Isawumi (1985), Onyiliagha (1986) among others, have reinforced the usefulness of numerical taxonomic studies in resolving critical taxonomic conflict among species. The current study therefore employs the advantage of numerical techniques to resolve some conflicting taxonomic issues within the genus *Solanum* using 49 discernible morphological characters with the hope of achieving a more reliable description as well as the proper identification of the species within the genus.

MATERIALS AND METHODS

Collection of Specimen

Ten out of the twenty five *Solanum* species found in Nigeria were utilized in this study. Specimens were collected from different locations in Ile-Ife, Osun State, Southwest Nigeria (Table 1). A total of 192 specimens were studied. Identification of the specimens was done using the *Flora of West Tropical Africa* (Hutchinson and Dalziel, 1963). Specimens were also confirmed at the Forest Research Institute Ibadan, Nigeria (FHI) and the Department of Botany, Obafemi Awolowo University, Ile-Ife, Nigeria (IFE) Herbaria.

Morphological Data

Discrete characters like the colour of floral parts were recorded in the field. Qualitative characters such as presence of hairs on the stem, leaves and petioles were observed in the laboratory with the aid of hand lens. Characters like leaf shape, apex, base and margin, fruit texture and size and those of the seed and number of seed(s) per fruit were also recorded. Continuous characters were taken from both vegetative and reproductive parts. The length and breadth of the leaves, stem and fruit diameter, length of petiole and floral parts were measured to the nearest centimetre using a metric ruler. The 49 x 10 matrix for the characters and character states coded for numerical analysis are shown in Table 2.

Data Analysis

For each measurement, thirty representative specimens were selected at random for the study in order to reduce the possible effects of individual variability. Means of such measurements were taken for further analysis. Forty-nine characters were studied and coded for analysis (Table 2). Data generated were subjected to multivariate techniques like Principal Components Analysis (PCA) as well as Single Linkage Cluster Analysis (SLCA).

Table 1: *Solanum* Species Studied and Their Locations

Taxa	Localities	Coordinates
S. torvum	Olatunbosun street, Olonade, Ile-Ife.	N 07° 30.380, E 004° 32.706
		N 07° 30.493, E 004° 32.775S
	Along the new road to O.A.U Teaching Hospital, Ile-Ife.	N 07° 30.761, E 004° 32.926
S. anomalum	At the back of St. Barnabas Anglican Church, off Olonade street, Ile-Ife.	N 07° 30.364, E 004° 32.652
		N 07° 30.355, E 004° 32.647
		N 07° 30.353, E 004° 32.641
	Gate farm, along road 7, O.A.U, Ile-Ife.	N 07° 30.796, E 004° 32.919
S. melongena	At the back of St. Barnabas Anglican Church, off Olonade street, Ile-Ife.	N 07° 30.364, E 004° 32.652
		N 07° 30.356, E 004° 32.639
	Gate farm, along road 7, O.A.U, Ile-Ife	N 07° 30.796, E 004° 32.919
S. aethiopicum	At the back of St. Barnabas Anglican Church, off Olonade street, Ile-Ife.	N 07° 30.356, E 004° 32.639
		N 07° 30.353, E 004° 32.641
	Gate farm, along road 7, O.A.U, Ile-Ife.	N 07° 30.819, E 004° 32.906
S. americanum	At the back of St. Barnabas Anglican Church, off Olonade street, Ile-Ife.	N 07° 30.355, E 004° 32.647
	Department of Botany, O.A.U, Ile-Ife (cultivated)	N 07° 31.155, E 004° 31.562
		N 07° 31.154, E 004° 31.569
		N 07° 31.156, E 004° 31.567
S. nigrum	Gate farm, along road 7, O.A.U, Ile-Ife.	N 07° 30.819, E 004° 32.906
		N 07° 30.794, E 004° 32.913
	Old Buka, O.A.U. campus, Ile-Ife.	N 07° 31.303, E 004° 31.195
		N 07° 31.308, E 004° 31.186
		N 07° 31.314, E 004° 31.175
S. erianthum	Olatunbosun street, Olonade Ile-Ife.	N 07° 30.493, E 004° 32.775
		N 07° 30.569, E 004° 32.773
	Security post, road 7 gate, O.A.U., Ife.	N 07° 30.669, E 004° 32.867
	Behind Chemical Engineering Dept. O.A.U, Ife.	N07° 31.149,E 004° 31.678
S. wrightii	All Souls Chapel premises, O.A.U, Ile-Ife.	N 07° 30.720, E 004° 31.092
		N 07° 30.713, E 004° 31.078
		N 07° 30.712, E 004° 31.074
		N 07° 30.694, E 004° 31.090
S. macrocarpon	Faith House, Afeki Road, Opa, Ile-Ife.	N 07° 31.896, E 004° 34.964
		N 07° 31.889, E 004° 34.966
		N 07° 31.842, E 004° 35.006
	Gate farm, along road 7, O.A.U, Ile-Ife.	N 07° 30.788, E 004° 32.930
		N 07° 30.796, E 004° 32.919
S. gilo	Asunle area of Tonkere village, Ile-Ife.	N 07° 31.995, E 004° 31.479
		N 07° 31.996, E 004° 31.477
		N 07° 31.996, E 004° 31.475
		N 07° 31.998, E 004° 31.495

Table 2: Characters and Character States Studied.

S/No.	Characters	States
1.	Habit : Herb/Shrub/Tree	3
2.	Plant height(cm): 23 - 87/87.1 - 151/151.1 - 215/215.1 - 279/279.1 343	5
3.	Stem diameter (cm): 0.1 5/5.1 10	2
4.	Stem surface: Pubescent/Glabrous/Coarse	3
5.	Stem ridge: present/absent	2
6.	Structure of stem : Thick/Slender	2
7.	Nature of stem: Erect/Weak	2
8.	Type of stem: Herbaceous/Suffrutescent/Woody	3
9.	Stem Colour : Green/Grey	2
10.	Stem armed or not : Unarmed/Armed	2
11.	Hollow in stem: Absent/Present	2
12.	Leaf armed or not: Unarmed/ Armed	2
13.	Leaf shape: Ovate/Obovate	2
14.	Leaf apex: Acute/Obtuse/Acuminate	3
15.	Leaf margin: Serrate/Lobbed/Entire/Undulate	4
16.	Leaf base: Obtuse/Cuneate/Cordate/Oblique	4
17.	Leaf adaxial surface: Pubescent/Glabrous/Coarse	3
18.	Leaf abaxial surface: Pubescent/Glabrous/Coarse	3
19.	Hair frequency on adaxial surface: None/Dense/Sparse	3
20.	Hair frequency on abaxial surface: None/Dense/Sparse	3
21.	Leaf length(cm) : 7.0 - 14/14.1 - 21/21.1 28	3
22.	Leaf width(cm): 3 10/10.1 17/17.1 24	3
23.	Leaf length/ width ratio: 1:1/ 2:1	2
24.	Venation type: Cladodromous/Brochidodromous/Craspedodromous	3
25.	Leaf stalk: Petiolate/Subsessile/sessile	3
26.	Petiole length (cm) : 0.1 5/5.1 10	2
27.	Petiole surface: Pubescent/Glabrous/Coarse	3
28.	Stipule : absent/Present	2
29.	Stipule length (cm) : 0 - 0.5/0.6 1	2
30.	Pedicel length (cm) : 0 - 1/1.1 2	2
31.	Pedicel surface: Pubescent/ Glabrous/Coarse	3
32.	Corolla colour: White/Purple	2
33.	Corolla length (cm) : 0.1 2/2.1 4	2
34.	Corolla sinus: Deep/Shallow	2
35.	Calyx length (cm) : 0.1 2/2.1 4	2
36.	Calyx sinus : Deep/Shallow	2
37.	Anther length: 0.1 1.0/1-1 2.0	2
38.	Style length: 0.1 1.0/1.1 2.0	2
39.	Style surface: Pubescent/Glabrous	2
40.	Floral aestivation: Valvate/Imbricate	2
41.	Floral symmetry : Actinomorphic/Zygomorphic	2
42.	Inflorescence: Solitary/Cluster	2
43.	Inflorescence orientation: Branched/Simple	2
44.	Number of flower per inflorescence : 1.0 5/6.0 10	2
45.	Unripe fruit colour: Green/ Purple/ White	3
46.	Ripe fruit colour : Green/ Purple/ Red/ Yellow/Black	5
47.	Fruit diameter(Cm) : 0.1 3/3.1 6	2
48.	Fruit shape: Globose/Ovoid/Orbicular	3
49.	Frequency of seed: Numerous/ Few	2

RESULTS AND DISCUSSIONS

The results of both qualitative and quantitative morphological characters of the *Solanum* species studied are presented in Tables 3 and 4 respectively. Specific characters that could be used for taxonomic delimitation are revealed showing the variations among the taxa. The dendrogram (Fig.1) obtained from 49 x 10 matrix shows the grouping of the taxa into two major clusters. The first major cluster consists of *S. nigrum* and *S. americanum*, having a low level relationship with other taxa (48%). The characters that separate these two taxa from others are the presence of few seeds in their fruits, the slender stem structure, habit form, leaf length, brochidodromous venation and simple cluster inflorescence. They show a lot of similarities in their characters and only show variations in characters such as plant height, stem surface and ridge, nature of stem, stipule, ripe fruit colour etc. The second major cluster links all other taxa with *S. wrightii* and *S. torvum* having the highest level of similarities, (75%) followed by *S. anomalum*, *S. gilo* and *S. melongena* (68%). *Solanum wrightii* and *S. torvum* show variations in characters such as: the plant habit, stem diameter, leaf apex, stipule length, pedicel length, calyx sinus, corolla colour, length and sinus, anther length, floral symmetry and fruit size.

The Principal Components Analysis scatter plot (Fig. 2) shows variation among the taxa. The first two components from the PCA are found to be very important and accounted for 49.8 % of the total variance (Table 5). The remaining components were increasingly uninformative. The Principal Components Analysis factor loading of the characters shows that vegetative characters like leaf base, plant height and leaf margin with a high loading in the component are very important in the separation of the taxa. This suggests that vegetative characters play key role in the identification of *Solanum*.

It can be observed from this study that the morphological characters established are quite stable and useful even in conventional comparative taxonomy. However, this study further employs the numerical taxonomic techniques in analysing these data with a greater advantage of combination of forty nine characters and their eventual contributions to the taxonomy of these species. The characters used for the cluster analysis represent both vegetative and floral characters of the species of *Solanum*. Our data shows that *S. americanum* is very closely related to *S. nigrum* and perhaps that was the reason why they are sometimes considered as synonyms (Bruce, 2008). These two taxa show similarities in characters which support their classification into the section *Solanum* (Gbile, 1979; Bohs and Olmstead, 1997; Benitez and Ferrarotto, 2009). However, the weak nature of stem, unridged stem, black colour of ripe fruit, absence of stipules, which were established in this study, are indicative of *S. nigrum* as a distinct species from *S. americanum*.

It is important to note that *S. nigrum* and *S. erianthum* also share some common features (Tables 3 and 4) which indicate subgeneric relationship between the two taxa. There are other characters such as the plant habit and height, grey and woody stem, densely pubescent leaf surfaces, leaf length and width, coarsely pubescent petiole and pedicel, zygomorphic flower, branched inflorescence, ripe fruit colour, numerous seeds, which are found to separate *S. erianthum* from *S. nigrum*. The cluster which contains *S. anomalum, S. melongena and S. gilo* is formed because they are all shrubs with green and erect stem that is relatively thick and ridged. Their leaves are ovate with unequal base, which is coarse on the adaxial and densely pubescent on the abaxial. They also possess actinomorphic flowers, white and valvate corolla, with numerous seeds in their fruits. However, they show variations in characters like plant height, leaf apex, margin and size, petiole and pedicel length, calyx and corolla sinous, calyx length, inflorescence, fruit shape, colour and size.

Table 3: Summary of the Qualitative Morphological Characters of *Solanum* Species Studied.

SPECIES CHARACTERS	*S. torvum*	*S. anomalum*	*S. melongena*	*S. aethiopicum*	*S. americanum*	*S. nigrum*	*S. erianthum*	*S. wrightii*	*S. macrocarpon*	*S. gilo*
Habit	Shrub	Shrub	Shrub	Herb	Herb	Herb	Shrub	Tree	Shrub	Shrub
Stem surface	Coarse	Coarse	Pubescent	Coarse	Coarse	Pubescent	Coarse	Coarse	Coarse	Coarse
Structure of stem	Thick	Thick	Thick	Thick	Slender	Slender	Thick	Thick	Thick	Thick
Nature of stem	Erect	Erect	Erect	Erect	Erect	Weak	Erect	Erect	Erect	Erect
Type of stem	Suffrutescent	Herbaceous	Herbaceous	Herbaceous	Herbaceous	Herbaceous	Woody	Woody	Herbaceous	Herbaceou
Leaf spined	Present	Absent	Absent	Absent	Absent	Absent	Absent	Present	Absent	Absent
Leaf shape	Ovate	Ovate	Ovate	Ovate	Ovate	Ovate	Ovate	Ovate	Obovate	Ovate
Leaf apex	Acute	Acute	Acuminate	Acute	Acuminate	Acuminate	Acuminate	Acuminat	Obtuse	Acute
Leaf margin	Lobed	Undulate	Undulate	Serrate	Entire	Entire	Entire	Lobed	Serrate	Lobed
Leaf base	Oblique	Oblique	Oblique	Obtuse	Obtuse	Obtuse	Obtuse	Oblique	Cuneate	Oblique
Leaf adaxial surface	Pubescent	Coarse	Coarse	Pubescent	Pubescent	Pubescent	Pubescent	Pubescent	Glabrous	Coarse
Leaf abaxial surface	Pubescent	Pubescent	Pubescent	Pubescent	Pubescent	Glabrous	Pubescent	Pubescent	Glabrous	Pubescent
Venation type	Clado	Clado	Clado	Clado	Brochi	Brochi	Brochi	Craspe	Clado	Clado
Leaf stalk	Petiolate	Petiolate	Petiolate	Petiolate	Petiolate	Petiolate	Petiolate	Petiolate	Subsessile	Petiolate
Stipule	Present	Present	Present	Present	Present	Absent	Present	Present	Present	Present
Corolla colour	White	White	White	White	White	White	White	Purple	Purple	White
Floral aestivation	Valvate	Valvate	Valvate	Valvate	Imbricate	Imbricate	Imbricate	Valvate	Imbricate	Valvate
Floral symmetry	Zygo	Actino	Actino	Actino	Actino	Actino	Zygo	Actino	Zygo	Actino
Inflorescence	Cluster	Cluster	Solitary	Cluster	Cluster	Cluster	Cluster	Cluster	Solitary	Solitary
Inflorescence orientation	Branched	Branched	Branched	Branched	Simple	Simple	Branched	Branched	Branched	Branched
Colour of unriped fruit	Green	Green	Purple	Green	Green	Green	Green	Green	Green	White
Colour of riped fruit	Yellow	Yellow	Yellow	Red	Purple	Black	Yellow	Yellow	Yellow	Red
Fruit shape	Globose	Orbicular	Ovoid	Orbicular	Globose	Globose	Globose	Globose	Globose	Globose

Table 4: Summary of the Quantitative Morphological Characters of *Solanum* Species Studied (± Standard Deviation).

SPECIES CHARACTERS	*S. torvum*	*S. anomalum*	*S. melongena*	*S. aethiopicum*	*S. americanum*	*S. nigrum*	*S. erianthum*	*S. wrightii*	*S. macrocarpon*	*S. Gilo*
PH (cm)	230.1 ±6.99	202.6 ±2.84	139.9 ±5.09	96.4 ±2.19	116.8 ±8.76	23.8 ±1.24	340.2 ±5.04	243.6 ±19.06	124.7 ±2.15	112.6 ±2.02
SD (cm)	3.2 ±0.39	4.6 ±0.07	3.1 ±0.20	1.4 ±0.05	1.2 ±0.04	0.8 ±0.05	4.9 ±0.56	9.2 ±0.33	1.7 ±0.04	2.0 ±0.09
LL(cm)	26.8 ±0.46	20.9 ±0.50	21.4 ±0.37	11.9 ±0.13	10.2 ±0.25	8.3 ±0.14	19.2 ±0.31	26.5 ±0.92	14.9 ±0.35	20.4 ±0.34
LW(cm):	21.9 ±0.53	12.2 ±0.41	15.7 ±0.53	7.7 ±0.14	7.5 ±0.23	4.7 ±0.07	11.9 ±0.18	20.0 ±0.93	8.7 ±0.15	14.1±0.35
PL (cm)	8.7 ±0.31	3.8 ±0.16	6.0 ±0.12	1.7 ±0.06	2.1 ±0.11	1.7 ±0.07	4.0 ±0.08	5.9 ±0.25	1.6 ±0.05	2.2 ±0.08
SL (cm)	0.6 ±0.03	0.3 ±0.02	0.4 ±0.02	0.2 ±0.02	0.2 ±0.01	-	0.3 ±0.02	0.3 ±0.02	0.3 ±0.02	0.2 ±0.01
PDL (cm)	1.0 ±0.03	0.8 ±0.02	1.0 ±0.04	0.6 ±0.04	0.8 ±0.02	0.7 ±0.02	0.9 ±0.04	1.6 ±0.04	0.6 ±0.03	1.6 ±0.02
CL (cm)	1.7 ±0.04	1.0 ±0.01	2.0 ±0.01	0.8 ±0.02	0.6 ±0.01	0.4 ±0.01	0.8 ±0.02	4.0 ±0.09	1.9 ±0.02	1.1 ±0.02
CLL (cm)	0.7 ±0.02	1.2 ±0.03	2.1 ±0.03	0.5 ±0.02	0.3 ±0.01	0.5 ±0.01	0.6 ±0.01	1.4 ±0.01	1.3 ±0.02	1.4 ±0.02
AL	0.7 ±0.01	0.5 ±0.01	0.8 ±0.01	0.6 ±0.02	0.3 ±0.01	0.3 ±0.01	0.3 ±0.01	1.6 ±0.01	0.6 ±0.01	0.6 ±0.01
SLL	1.1 ±0.01	0.5 ±0.01	1.1 ±0.01	0.8 ±0.03	0.5 ±0.01	0.4 ±0.01	0.6 ±0.01	1.8 ±0.02	1.1 ±0.01	0.8 ±0.02
NFI	9.0 ±0.29	5.0 ±0.19	1	5.8 ±0.29	4.4 ±0.09	6.9 ±0.35	9.6 ±0.34	8.8 ±0.39	1	1
FD (cm)	1.1 ±0.02	2.8 ±0.06	5.3 ±0.08	2.6 ±0.02	1.5 ±0.02	0.7 ±0.02	1.2 ±0.03	5.2 ±0.06	4.1 ±0.06	2.9 ±0.1

PH = Plant height; SD = Stem diameter; LL = Leaf length; LW = Leaf width; PL = Petiole length; SL = Stipule length; PDL = Pedicel length; CL = Corolla length; CLL = Calyx length; AL = Anther length; SLL = Style length; NFI = Number of flower per inflorescence; FD = Fruit diameter.

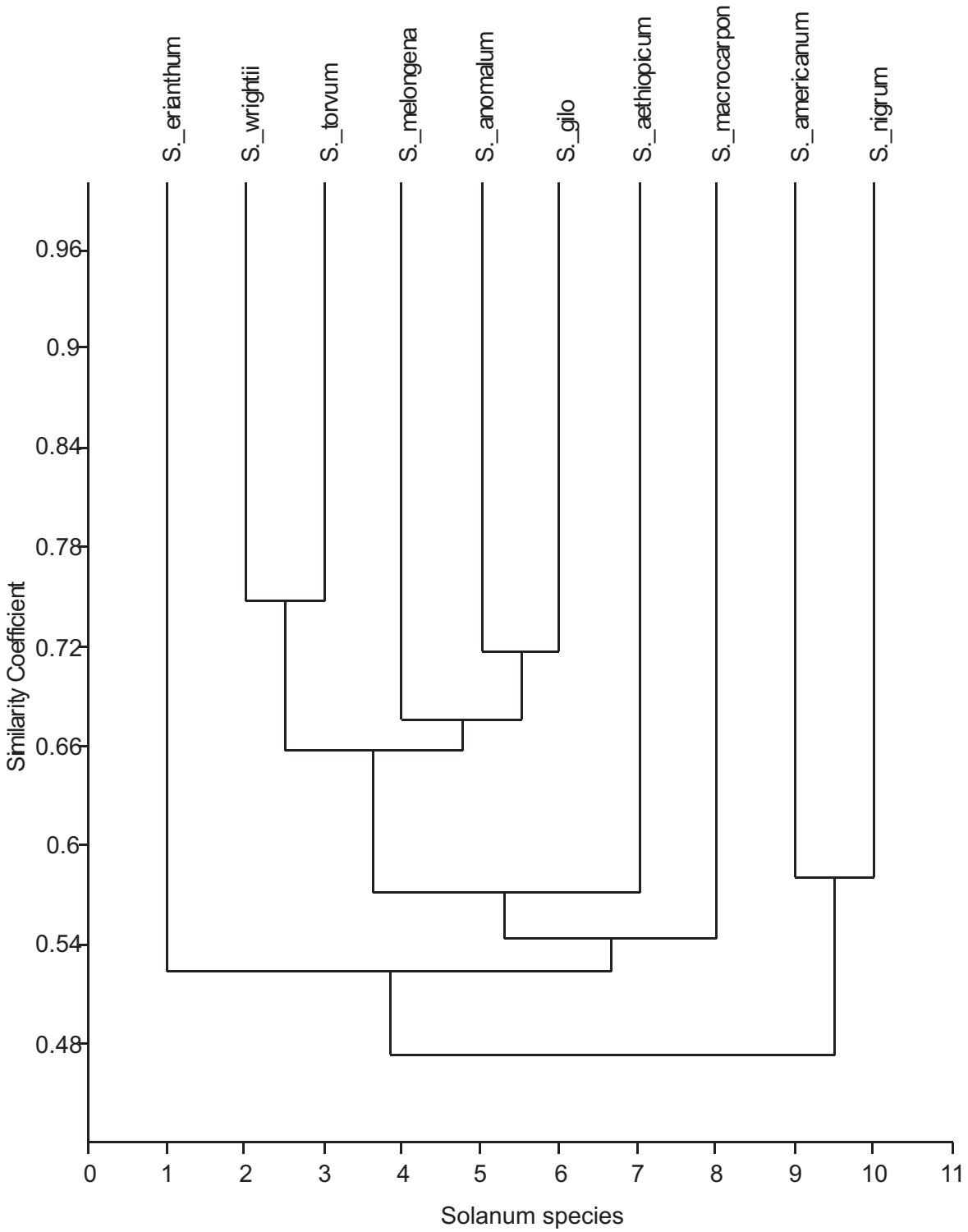

Fig. 1: Dendrogram of Cluster Analysis (CA) Showing the Relationship of *Solanum* Species.

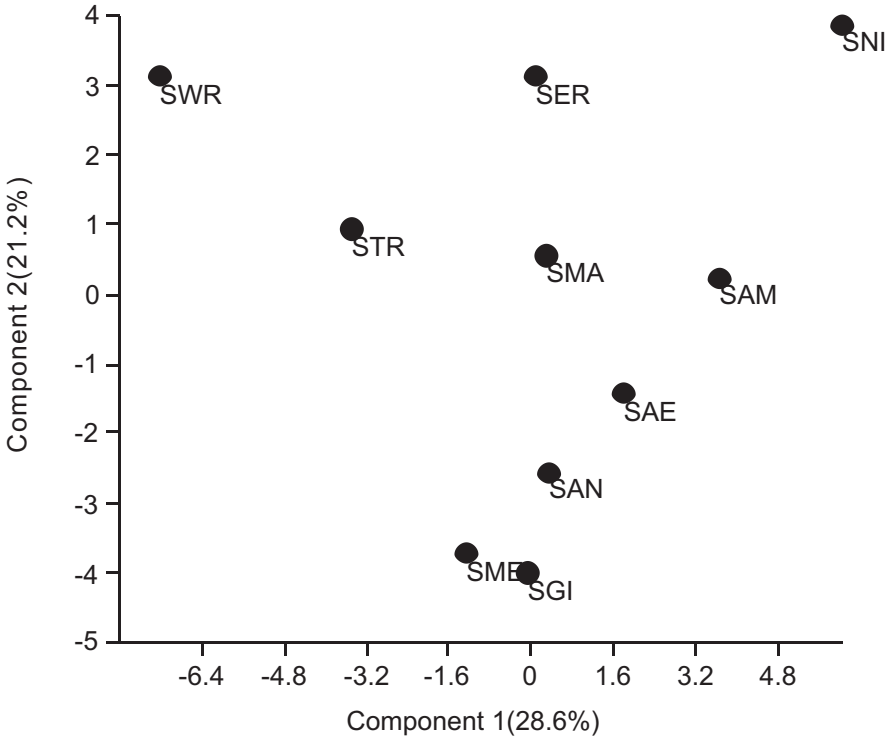

Fig. 2: Two Dimensional Component Space Showing Relationship between Solanum Species Based on Characters (Components I and II).

SAE = *S. aethiopicum;* SAM = *S. americanum; SAN* = *S. anomalum;* SER = *S. erianthum;* SGI = *S. gilo; SMA* = *S. macrocarpon;* SME = *S. melongena*; SNI = *S. nigrum*; STR = *S. torvum*; SWR = *S. Wrightii.*

Table 5: Eigen-values and Percentage of Total Variation Accounted for By the First Five Principal Component Axes of the Ordination of *Solanum* Species.

PCA	EIGEN VALUE	% VARIANCE	CUMULATIVE %
1	5.77385	28.6	28.6
2	4.26978	21.2	49.8
3	3.37689	16.8	66.6
4	2.15684	10.7	77.3
5	1.42411	7.1	84.4

Table 6: Characters with High Component Loading.

CHARACTERS	PC 1	PC2
Leaf Base	- 0.56	
Plant Height		0.42

Although, *S. anomalum* share some common features with *S. torvum* in the section Torva, this study shows that it is more closely related to *S. gilo* in the section Oliganthes. Our data corroborate the work of Essiett and Illoh (2008) which reported that *S. anomalum* which has been placed in the same section Torva with *S. torvum*, shared common protein bands with members of the section Oliganthes whereas it does not share common bands with *S. torvum* in their protein electrophoretic study of ten *Solanum* species. In addition, Omidiji (1982), using crossability test reported that *S. anomalum* showed close affinity to series Aethiopica (section Oliganthes) than with other members of section Torva. There are a number of other characters identified in this study that clearly distinguish *S. anomalum* from *S. torvum* (Tables 3 and 4). Interestingly, this study has revealed that *S. macrocarpon* is distantly related to *S. melongena a*nd should rather be considered as distinct from *S. melongena.* Our position disagrees with the suggestion earlier made by Omidiji (1975) using crossability tests that both species should be considered as varieties or sub-species.

That only three out of the 49 characters were found to show variations among the species can be explained by the fact that a large percentage of the characters are shared by most members of the genus. This large similarity in characters employed could be the reason for the apparent overlaps in the groupings of OTUs by the ordination technique shown in Fig. 2. For example, *S. wrightii* and *S. torvum* show variations in characters such as: the plant habit, stem diameter, leaf apex, venation type, stipule length, pedicel length, calyx sinus, corolla colour, length and sinus, anther length, floral symmetry, fruit size. However, they are related by the fact that their leaves are armed with spines, deeply lobed leaves with oblique base, leaf length etc. The habit of *S. wrightii* as a small tree with large purple flowers and fruit size distinguish it from *S. torvum*. Primarily medium to large trees and large purple flowers are diagnostic characters of species in section Crinitum (Farruggia *et al.,* 2010).

Generally, the common features shared among the various species of *Solanum* studied show evidence of common evolutionary origin of the species. Each of *S. americanum, S. macrocarpon, S. wrightii, S. torvum,* and *S. aethiopicum* stands as distinct species whereas *S. anomalum, S. melongena* and *S. gilo form o*ne distinct cluster while *S. nigrum and S. erianthum* form another cluster. The species studied present affinity in their morphological features. However, the results show some specific characteristics that can be used for taxonomic delimitation of the species of the genus *Solanum.* The component loadings suggest that the three identified morphological characters play key role in the identification of *Solanum* species. Morphological similarities of characters contributed a lot towards the difficulty in the identification of these species (Zubaida *et al.,* 2006).

In conclusion, though this study has succeeded in highlighting a number albeit few, of morphological markers for distinguishing these species, the data obtained could be taken along with data from other sources such as anatomy, cytology and molecular techniques in a bid to enhance proper taxonomic characterisation of these species and the genus *Solanum.*

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