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Full Length Research Paper

Morphometric study of the genus *Senna* Mill. in South-western Nigeria

Mike O. Soladoye[1], Monsurat A. Onakoya[1], Emmanuel C. Chukwuma[1], Mubo A. Sonibare[2*]

[1]Department of Plant Science and Applied Zoology, Olabisi Onabanjo University, P.M.B. 2002, Ago-Iwoye, Ogun State, Nigeria.
[2]Department of Pharmacognosy, Faculty of Pharmacy, University of Ibadan, Ibadan, Ogun State, Nigeria.

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Thirteen quantitative characters of the leaves, fruits, seeds and flowers were used in the study of eight *Senna* Mill. species. The characters include leaflet length, leaflet width, leaflet length/width, Number of leaflets, lamina length, petiole length, pedicel length, petal length, fruit length, fruit width, fruit length/width, seed length and seed width. These characters were measured with the aid of a line ruler and subjected to principal component analysis (PCA) and cluster analysis. The results revealed that three out of the thirteen characters employed contributed significantly in differentiating each of the species from the other at 95% level of significance. The species have great similarities hence their grouping under the same genus. Results also showed that *Senna hirsuta* (Linn.) H. S. Irwin and Barneby and *Senna sophera* (L.) Roxb. are more closely related, *Senna occidentalis* (Linn.) Link, *Senna siamea* (Lam.) H. S. Irwin and Barneby and *Senna spectabilis* (DC.) Irwin and Barneby all share some resemblance while *S. occidentalis* is distantly related to *S. sophera.*

Key words: Morphometrics, morphology, *Senna*, leguminosae, caesalpinioideae, numerical taxonomy.

INTRODUCTION

The study area: Ogun and Oyo States in South-western Nigeria falls within the tropical rain forest region constituting an evergreen plant community, rich in trees, shrubs and herbs. The climate is characterized by high temperature with distinct wet and dry seasons. Annual rainfall ranges between 1250 - 2190 mm while mean annual minimum and maximum temperatures are 20 and 30°C, respectively. The genus *Senna* Mill. belongs to the family Leguminosae and sub-family Caesalpinioideae having its origin from the Arabic name "Sana". *Senna* is made up of about 250 species throughout the tropics, with a small number of species reaching into the temperate regions (Wikipedia, 2008). Burkill (1995) reported about 19 species in West African floristic region with the whole 19 species in Nigeria (Soladoye and Lewis, 2003) and at least 8 species in South Western Nigeria especially in Oyo and Ogun States. Members of the genus are conspicuous legumes with a characteristic yellow flower.

They consist of annual and perennial trees, herbs, shrubs or even a kind of liane but are typically shrubs or sub-shrubs. *Senna* includes a large number of ornamental plants and roadside trees such as *Senna siamea* (Lam.) H. S. Irwin and Barneby and *Senna occidentalis* (Linn.) Link

The genus has followed several curious lines of classification. The taxonomy of this plant group is still puzzling because of the extreme morphological variability and ambiguous boundaries between taxa. They have rather long leaves with 3 -15 pairs of usually strictly opposite symmetrical leaflets all much the same size or slightly increasing in length up to the common stalk. They also have long stalk, showy flowers which are yellowish in colour. They have round flower buds having 5 overlapping se-pals and five 5 free more or less equal petals narrowed at the base. They have specially and very characteristics stamens which are ten in number with elongated anthers often discharging their pollen from apical pore, two of the filaments being conspicuous sometimes longer than the petals and bent into a hook, while five are medium sized and the remaining three are very short and rudimentary, ovary superior. The fruits are often elongated, more or less cylindrical or flattened, dehiscent but sometimes indehiscent and sometimes with transverse

*Corresponding author. E-mail-sonibaredeola@yahoo.com. Tel: +2348134901273.

partition separating the seed, oblique or longitudinally, usually less horizontal or vertically compressed sometimes with areoles (Burkill, 1995).

The taxonomy of *Senna* is of importance because of the medicinal value of the genus. The genus contains anthraquinones which varies from one species to the other, and may be poisonous if taken in excess hence the need for proper identification of the species. Some poisonous species are used to stupefy fish. Sadly, because of the apparent similarities between these species that are of ethnomedicinal importance, these species are used indiscriminately and many people might have used one species instead of the other. Therefore, there is need for proper taxonomic study of the genus to aid easy identification even when they are not in their fruiting period.

Senna alata (Linn.) Roxb. is highly medicinal. A root decoction is taken in Nigeria and Guinea Bissau to regulate menstrual flow and for chronic gonorrhoea. Sap from fresh leaves is universally recognized as a remedy for parasitic skin diseases and for many eruptive and pustular skin infection, a property which gives rise to its many European and African names (Burkill, 1995). According to Burkill (1995), the leaves of *Senna obtusifolia* (Linn.) H. S. Irwin and Barneby are chewed for cough and pneumonia in Nigeria and are often mixed with other drugs for fever. The seed is also used in treating conjunctivitis. The leaf of *S. occidentalis* is the most useful part of the plant and is considered to have utilitarian and therapeutic values. The leaves are added to soup as a source of diet in southern parts of Nigeria. The pods of *Senna podocarpa* (Guill. and Perr.) Lock are used in the treatment of skin diseases such as eczema, scabies and ringworm, the extracts of the pod is taken as a purgative and has been shown to be good as commercial "*Senna*" made from the leaves or pod of *Senna alexandrina* Mill. Aside these, there are still many other uses of members of the genus ranging from economical, ornamental to industrial uses.

Tucker (1996) studied the trends in evolution of floral ontogeny in *Cassia sensu stricto, Senna* and *Chamaecrista* and found that the three genera were distin-guished based on their flora ontogeny (floral position in the inflorescence, the presence of bracteole, the position of the first sepal initiation, order of petal initiation, asymmetric initiation, anther morphology, and time of carpel initiation). Sahanat and Bonkerd (2003) also employed numerical taxonomy to distinguish between the 21 species of *Cassia sensu lato* in Thailand, they recognized 12 species of *Senna* with 2 subspecies, 4 species of *Cassia* and 2 species of *Chamaecrista*. In a nut shell, *Senna* Mill. is separated from *Cassia* Linn. on the basis of three adaxial stamens which are short and straight and the pedicels which have no bractioles.

Sneath and Sokal (1973) defined numerical taxonomy as the "grouping by numerical methods of taxonomic units into taxa on the basis of their character state". It thus provides a logical means of expressing the relationship existing between taxa. This method has become important in systematic studies in the past few years. The works of Irwin and Rogers (1967), Bisby and Nicholls (1977), Marechal et al. (1981), Soladoye (1982) are but a few examples of such studies in the Leguminosae. Current thinking among taxonomists is that morphometric analyses are more sensitive in delimiting taxa, and that they provide better keys and classification systems in comparison to the conventional taxonomic methods. The quality of conventional taxonomy has been improved by numerical taxonomy as more and better characters are used in the latter (Davis and Heywood, 1973).

This work aim at identifying and differentiating eight species of *Senna* in South Western part of Nigeria using both herbarium and freshly collected specimens and based on thirteen quantitative morphological characters as well as interpreting the similarities and differences in the existing information about *Senna* species in the light of numerical taxonomy. These species include *Senna alata, S. hirsuta, S. obtusifolia, S. sophera and S. spectabilis*. It is hoped that this work will provide useful clues in the reconstruction of phenetic affinities among species of *Senna* with the eventual erection a good taxonomy of the genus.

MATERIALS AND METHODS

Plant material

In line with taxonomic practice, both fresh specimens from the field and herbarium specimens were used for the study. The fresh specimens were collected in open vegetation, roadsides and bushy areas in various parts of Ogun and Oyo states both in South-Western Nigeria while the herbarium specimens were accessions previously collected from different parts of South Western Nigeria and kept at the Forest Herbarium Ibadan (FHI, Table 1). Upon collection, these specimens were individually placed in-between absorbent papers (newspaper) to reveal both the abaxial and adaxial surfaces of the leaves. They were then pressed using a standard plant press made of wooden frames and dried in the sun for six days, the absorbent papers were changed daily. Poisoning of the dried specimens was also done with a mixture of mercuric chloride and phenol in 70% methylated spirit and applied with a brush to reduce fungal load. They were mounted on mounting sheets, identified and authenticated at the Forest Herbarium Ibadan. Filed notes indicating the collectors name, place and date of collection, habit, name of species and its description were also attached to the mounting sheet. In this study, some characters which were difficult to assess accurately or were unsuitable for rapid and accurate scoring were discarded. Some other characters proved constant throughout the group hence found not useful in delimiting the taxa. Only the thirteen (13) characters listed below were recorded.

Morphometric analysis

Morphometric analysis was carried out on mature living and herbarium specimens of each of the eight *Senna* species. The readings were taken from the length and widths of leaflets, leafstalk (petiole), fruit, petal, pedicel and seed using a white thread which was then placed on a line ruler for accurate measurement. No of leaflets were also counted and recorded. These measurements

Table 1. Voucher number of representative specimens of the *Senna* species examined.

Species names	Location	Voucher number
S. alata (Linn.) Roxb.	Ogun State: Owode, Ago-iwoye. Oyo State:Ibadan,Erin Itesha compound Ondo State:Ore Forest Camp	FHI 98802, FHI 96652, FHI 76365, FHI 88147, FHI 94828
S.obtusifolia (L.) H. S. Irwin and Barneby	Ogun State:Egbado, Oyo State: Gambari Forest Reserve, Ibadan University Botanical Garden, Eruwa road.	FHI 70365, FHI 108138, FHI 68068, FHI 43974
S. occidentalis (Linn.) Link	Ogun State: Ijebu-Ode, Abeokuta, Ago-Iwoye. Oyo state: Akindele road, Eleyele.	FHI 82927, FHI 101814, FHI 103064, FHI 47518
S.hirsuta (Linn.) H. S. Irwin and Barneby	Ogun state: Shagamu. Oyo state: Ibadan.	FHI 1822, FHI 107166, FHI 67453, FHI 27330, FHI 27950
S.podocarpa (Guill. and Perr.) Lock	Oyo State: Ibadan, igboora igangan road. Ondo State:Akure	FHI 14701, FHI 13763, FHI 45302, FHI 10735, FHI 96314
S.siamea (Lam.) H. S. Irwin and Barneby	Ogun State: Owode-Ota road, Oru-ijebu. Oyo State: Igboora-Abeokuta road, Akinyele on the Ibadan- Oyo road.	FHI 102040, FHI 99974, FHI 29927, FHI 89471, FHI 99183
S. sophera (L.) Roxb.	Ogun state:Oru Oyo state:Ibadan	FHI 32175, FHI 2775, FHI 14508
S.spectabilis (DC.) Irwin and Barneby	Oyo State:Ibadan	FHI 37199, FHI 57874, FHI 92897, FHI 37199

were then compiled for each operational taxonomic unit (OTU).

The corresponding mean values of the recorded measurements alongside with their standard deviation were also derived. These values were keyed into a Microsoft excel spread sheet and SPSS.11.0 analysis sheet. Principal component analysis (PCA) and cluster analysis values were computed based on 13 selected quantitative characters measured namely: length and width of leaflet, Lamina length, petiole length, No of leaflets, leaflet length/ leaflet width, petal length, pedicel length, length and width of seeds and fruit. The objective of using principal component analysis is to determine the characters that contribute strongly to the delimitation of the taxa while cluster analysis and others were aimed at determining how closely related the species are to one another which is taken as the phenetic similarities. Analysis of Variance (ANOVA) was also per-formed to test the differences between the taxa (Table 6).

RESULTS AND DISCUSSION

The two techniques (Principal component analysis and Cluster analysis) used in this work are the most commonly used in numerical taxonomy. Sonibare et al. (2004) have used these techniques in analyzing quantitative data gotten from 31 species of *Ficus*. Their result revealed the hierarchical classification and visual interpretation of the taxonomic relationship within the 31 *Ficus* species and also sub-sectional discrepancies (distinct differrences) in the existing traditional classification of the genera.

Soladoye et al. (2008) also employed these techniques in the phytochemical and morphometric analysis of the genus *Acalypha*. The results gotten from these techniques are often regarded as unbiased indicators of the similarity or differrences existing between the taxa, which are in turn used to arrange taxa in hierarchical order (Agbagwa and Okoli, 2005).

In the present study, eight species of *Senna* that are widely distributed in south western part of Nigeria were examined. The most prominent species is *Senna siamea* followed by *S. occidentalis, S. alata, S. hirsuta, S. podocarpa, S. obtuse-folia, S. sophera. S. spectabilis* was only found in few places in Ibadan where it is cultivated. Table 1 shows the distribution and voucher numbers of the specimens studied. The mean and standard deviation of the quantitative characters are shown in Table 2. Table 3 shows the cumula-

Table 2. Mean and standard deviation of the quantitative characters of *Senna* species studied in cm.

Lflt. leng	Lflt. width	Lflt. leng/width	Lam. Leng	Pet. leng	No. lflt	Frt leng.	Frt width	Frt leng/width	Pet. leng	Ped. leng	Sd. leng.	Sd. width
9.9±1.3565	5.2±1.6683	1.95±0.2886	12.7±2.7532	5.5±2.3811	7.5±2.3805	15.8±3.5500	1.5±0.1825	10.5±0.4243	2.1±0.2828	0.8±0.1421	0.69±0.0721	0.23±0.0450
6.4±2.2782	2.65±0.4202	2.4±1.0099	7.5±0.8185	5.0±2.2434	4.0±0.0000	16.6±0.7746	0.6±0.6065	3.3±15.6866	1.4±0.3785	1.6±0.1414	0.3±0.0000	0.2±0.0000
6.4±0.7895	2.0±0.6164	3.1±0.9899	7.0±2.0672	4.2±1.3589	4.5±1.8248	12.6±1.4572	0.8±0.2161	16.45±5.1251	1.2±0.5477	0.6±0.8485	0.47±0.1292	0.35±0.0707
4.2±1.1930	2.2±0.6856	1.8±0.5831	4.96±0.1746	2.86±0.4690	3.0±0.0000	29.7±9.3963	0.46±0.1414	67.6±31.7468	1.56±0.2345	2.0±0.6519	5.16±1.7944	0.4±0.1000
13.0±2.8803	6.2±1.6872	2.2±1.5209	15.1±3.7041	8.5±3.3808	3.5±0.5773	10.8±1.9331	1.4±0.1664	8.2±2.4139	3.0±1.4142	2.4±0.1414	1.5±0.1825	0.35±0.0400
5.3±0.3000	2.2±0.2516	2.5±1.5208	6.3±0.2000	3.27±1.0263	7.5±6.0274	19.30±2.0372	1.05±0.6351	19.0±3.5594	1.80±2.2161	2.85±0.3553	0.8±0.3214	0.70±0.0700
4.4±1.1930	1.4±0.7394	3.3±1.0817	4.8±1.1874	4.4±1.9000	8.67±1.1180	11.0±1.5588	0.36±0.6557	31.8±8.9446	1.3±0.2000	1.85±0.2132	0.4±0.1458	0.26±0.1050
7.2±1.4036	2.61±0.9513	2.8±1.4731	8.5±1.2268	6.4±1.7869	9.0±1.0000	22.0±3.7054	1.8±0.0000	12.26±1.7748	2.25±0.2000	2.3±0.0000	2.4±0.1000	0.5±0.1000

Key: Lflt. leng = Leaflet length, Lflt. width = Leaflet width, Lflt. leng/width = Leaflet length/width, Lam. leng = Lamina length, Pet. leng = Petiole length, No. lflt = No. of leaflet, Leaf leng. = Frt length, Frt width = Fruit width, Frt leng/width = Fruit length/width, Pet. leng = Petal length, Ped. leng = Pedicel length, Sd. leng. = Sd. length, Sd. width = Seed width. The species are represented by the following numbers (1) *Senna alata,* (2) *Senna hirsuta,* (3) *Senna occidentalis*, (4) *Senna obtusifolia*, (5) *Senna podocarpa*, (6) *Senna siamea*, (7) *Senna sophera* and (8) *Senna spectabilis*.

Table 3. Variance in the observed characters under principal component analysis.

Component	Initial Eigen values (Total)	% of variance	Cumulative (%)	Extraction sums of squared loadings(Total)	% of variance	Cumulative (%)
1	5.785	44.500	44.500	5.785	44.500	44.500
2	3.110	23.925	68.425	3.110	23.925	68.425
3	2.106	16.198	84.623	2.106	16.198	84.623
4	.807	6.206	90.829			
5	.553	4.256	95.085			
6	.361	2.778	97.863			
7	.278	2.137	100.000			
8	1.453E-15	1.118E-14	100.000			
9	3.051E-16	2.347E-15	100.000			
10	1.629E-16	1.253E-15	100.000			
11	2.281E-17	1.755E-16	100.000			
12	-9.595E-17	-7.381E-16	100.000			
13	-2.686E-16	-2.066E-15	100.000			

Extraction method: Principal component analysis.

tive principal component analysis. At least three of the characters (leaflet length, leaflet width and leaflet length/width ratio) contributed greatly to the delimitation of the taxa. Table 4 shows the correlation coefficient of the thirteen quantitative parameters. It indicates that there is significant

Table 4. Correlation matrix of the species of *Senna* using the quantitative characters.

Correlation	Lflt. leng	Lflt. width	Lflt. leng/ width	Lam. Leng	Pet. leng	No. lflt	Frt leng.	Frt width	Frt_leng/ width	Pet. Leng	Ped. Leng	Sd. leng.	Sd. width
Lflt. leng	1.000	.958	-.338	.992	.887	-.175	-.454	.675	-.581	.847	-.051	-.203	-.218
Lflt. width	.958	1.000	-.566	.975	.770	-.232	-.295	.608	-.420	.841	-.031	-.065	-.235
Lflt. leng/width	-.338	-.566	1.000	-.405	-.054	.478	-.515	-.187	-.234	-.419	-.097	-.524	.029
Lam. Leng	.992	.975	-.405	1.000	.854	-.135	-.402	.704	-.571	.846	-.072	-.189	-.222
Pet. leng	.887	.770	-.054	.854	1.000	-.012	-.485	.654	-.616	.817	.100	-.204	-.246
No. lflt	-.175	-.232	.478	-.135	-.012	1.000	-.132	.357	-.231	-.010	.135	-.337	.253
Frt leng.	-.454	-.295	-.515	-.402	-.485	-.132	1.000	-.040	.647	-.105	.287	.839	.394
Frt width	.675	.608	-.187	.704	.654	.357	-.040	1.000	-.545	.770	.130	-.050	.279
Frt_leng/width	-.581	-.420	-.234	-.571	-.616	-.231	.647	-.545	1.000	-.335	.135	.784	.137
Pet. leng	.847	.841	-.419	.846	.817	-.010	-.105	.770	-.335	1.000	.417	.135	.172
Ped. leng	-.051	-.031	-.097	-.072	.100	.135	.287	.130	.135	.417	1.000	.298	.670
Sd. leng.	-.203	-.065	-.524	-.189	-.204	-.337	.839	-.050	.784	.135	.298	1.000	.241
Sd. width	-.218	-.235	.029	-.222	-.246	.253	.394	.279	.137	.172	.670	.241	1.000

Lflt. leng = Leaflet length, Lflt. width = Leaflet width, Lflt. leng/width = Leaflet length/width, Lam. leng = Lamina length, Pet. leng = Petiole length, No. lflt = No. of leaflet, Leaf leng. = Frt length, Frt width = Fruit width, Frt_leng/width = Fruit length/width, Pet. leng = Petal length, Ped. leng = Pedicel length, Sd. leng. = Sd. length, Sd. width = Seed width.

correlation between: leaflet length and leaflet width, leaflet length and lamina length, leaflet length and petiole length, leaflet length and petal length, leaflet width and lamina length, leaflet width and petiole length, leaflet width and petal length, lamina length and petiole length, lamina length and fruit width, lamina length and petal length, petiole length and petal length, fruit length and seed length, fruit width and petal length, fruit length/fruit width ratio and seed length, pedicel length and seed width. They are highly positively significant. Table 5 also indicates the component matrix after extraction of the characters that contributed strongly in differentiating between the species. The result in Table 6 shows that the differences between the taxa are highly significant when all of the species are considered.

Figure 1 shows the screen plot that gives the weight of individual characters in graphical form. Eigen value of +1 is taken to be determinant and those above this value are considered to be much stronger. Table 7 shows the agglomeration schedule of the *Senna* species viewed from the perspective of cluster. It indicates the degree of relationship between the eight *Senna* species while Table 8 shows the apparent differences between the confused species of *Senna* including *S. occidenttalis* and *S. sophera.* Figure 2 represents the component plots on rotated axis for the thirteen quantitative characters employed and Figure 3 is the dendogram using average linkage between the groups which also shows the degree of relation-degree of relationship between the *Senna* species. From the Tables and Figures, the importance of morphometry which is a branch of numerical taxonomy is inherent. In this study, only three out of the thirteen quantitative characters have been shown by PCA and Cluster analysis to have about 95% level of significance in delimiting the taxa. The characters include leaflet length, leaflet width and leaflet length/width ratio, while the remaining ten indicate the similarities that exist between the species of *Senna* studied. *S. hirsuta* and *S. sophera* are more closely related. However, *S. occidentalis, S. siamea and S. spectabilis* all share some resemblance. Morphometrically, *S. obtusifolia* and *S. sophera* are the most distantly related species to *S. alata.*

The cluster that exists between *S. occidentalis* and *S. siamea* is 69.074, while that which exists between *S. occidentalis* and *S. spectabilis* is

Table 5. Component matrix.

	Component		
	1	2	3
Leaflet length	.983	7.241E-02	-.128
Leaflet width	.923	.241	-.229
Leaflet length/width	-.262	-.766	.395
Laminal length	.981	.103	-.131
Petiole length	.915	-3.818E-02	5.157E-02
No of Leaflets	-2.648E-02	-.351	.729
Fruit Length	-.481	.784	5.388E-02
Fruit width	.745	.191	.451
Fruit Length/width	-.684	.545	-.215
Petal length	.852	.437	.231
Pedicel length	-5.676E-03	.495	.643
Seed length	-.291	.880	-.122
Seed width	-.186	.407	.772

Extraction method: Principal component analysis. A 3 components extracted.

Table 6. Analysis of variance (ANOVA) of the characters.

	Cluster	df	Error	df	F	Sig.
	Mean square		Mean square			
Leaflet length	9.611	1	8.828	6	1.089	.337
Leaflet Width	.838	1	3.223	6	.260	.628
Leaflet length/width	.570	1	.235	6	2.422	.171
Laminal length	13.192	1	13.693	6	.963	.364
Petiole Length	5.314	1	2.953	6	1.800	.228
No of Leaflets	10.005	1	5.352	6	1.869	.221
Fruit length	177.858	1	18.120	6	9.816	.020
Fruit width	.329	1	.271	6	1.213	.313
Fruit Length/width	2467.026	1	84.915	6	29.053	.002
Petal length	8.102E-02	1	.412	6	.197	.673
Pedicel length	4.571E-02	1	.698	6	.065	.807
Seed length	15.603	1	.575	6	27.142	.002
Seed Width	7.875E-04	1	3.120E-02	6	.025	.879

110.109 showing great degree of variation in their morphometry though morphologically, they are similar. Also from the dendogram (Figure 3), it is evident that *S. occidentalis* is distantly related to *S. sophera* though they appear to be morpho-logically similar.

Based on the result of this work, it is evident that the existing classification of *Senna sensu stricto* grouping in *Senna* is justified since almost the characters are similar and only three of the characters used contributed significantly in differentiating between the *Senna* species thus facilitating their grouping together as the same genus. However, more work still need to be done on species of *Cassia sensu stricto* and *Chama-ecrista sensu stricto* in order to totally justify their separation from *C. sensu lato.* Observations from this work have also shown that there are differences in the quantitative characters of the same species measured at various locations. For example, the leaflet length of *S. alata* measured at Ibadan was between 8.5 - 10.5 cm while those measured In Ago-Iwoye were between 9.1 - 11.5 cm. This variation within species may be due to the following; age of plant, location and place of collection and genetic factor (Gbile, 1976; Jongebloed et al., 2004) which mostly occur as a result of mutation. Sunlight also causes variation in plant. This is because sunlight aids manufacturing of food during photosynthesis (Aborg, 1943).

Leaf shapes and sizes have been shown by the work of previous authors to vary within the same plant due to the action of light intensity on the leaves, thereby affecting the carbohydrate balance which in turn affects the

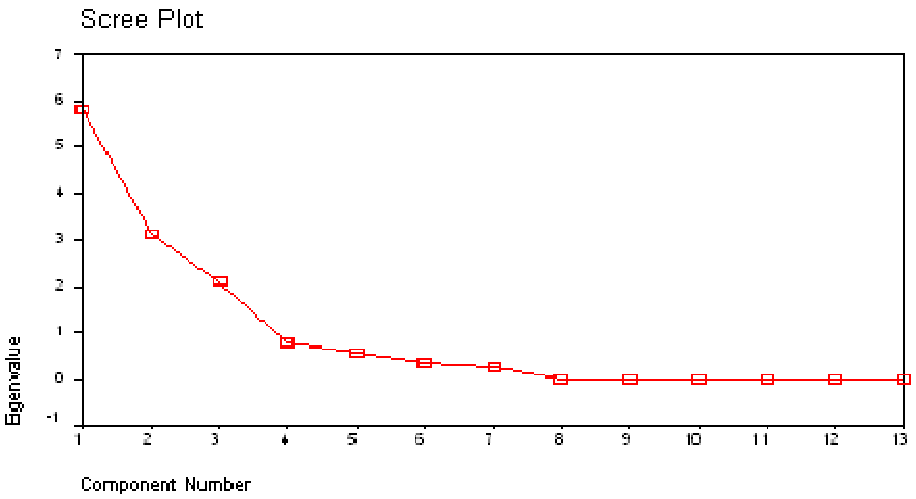

Figure 1. Scree plot for the thirteen quantitative used in the morphometric study of *Senna* species.

Table 7. Agglomeration schedule of the *Senna* species viewed from the perspective of clusters.

Stage	Cluster combined		Coefficients	Stage cluster first appears		Next stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	3	6	69.074	0	0	3
2	1	5	75.773	0	0	4
3	3	8	110.109	1	0	5
4	1	2	151.242	2	0	5
5	1	3	206.247	4	3	6
6	1	7	554.513	5	0	7
7	1	4	3205.660	6	0	0

Table 8. Differences between the two species of *Senna*.

Features/characters	*Senna occidentalis*	*Senna sophera*
Nature of stem	Round	Angular
Plant height	1 - 2 m tall	2 - 5 m tall
Size of the upper pair of leaflets	Always larger than the ones beneath	More or less the same as the ones below
No of leaflets	4 - 6 pairs	5 - 9 pairs
Pedicel length	Mostly 1 - 2 cm. long	1.7 - 2.0 cm. long
Seed length	4 - 5.5 mm	4 - 4.5 MM

length of the cells in the direction of the long axis which in turn gives rise to differences in shapes, length and width of the leaves (Wilson et al., 1998; Campey et al., 2000). Also, variation in the morphology of plant may be due to the fact that some of the species are growing naturally in their habitat while some are cultivated with care and proper management. Some of the species of *Senna* seen growing in their natural habitat are *S. siamea, S. sophera, S. occidentalis, S. obtusifolia* and S*. hirsuta,* while those cultivated in an undisturbed environment are *S. alata, S. podocarpa and S. spectabilis*.

With the help of morphometry used in this study, it is possible to distinguish between the eight species of *Senna* studied even when they are not in their fruiting period.

This work has helped in bringing out the characters that contributed greatly in differentiating individual species from each other and those characters that made the

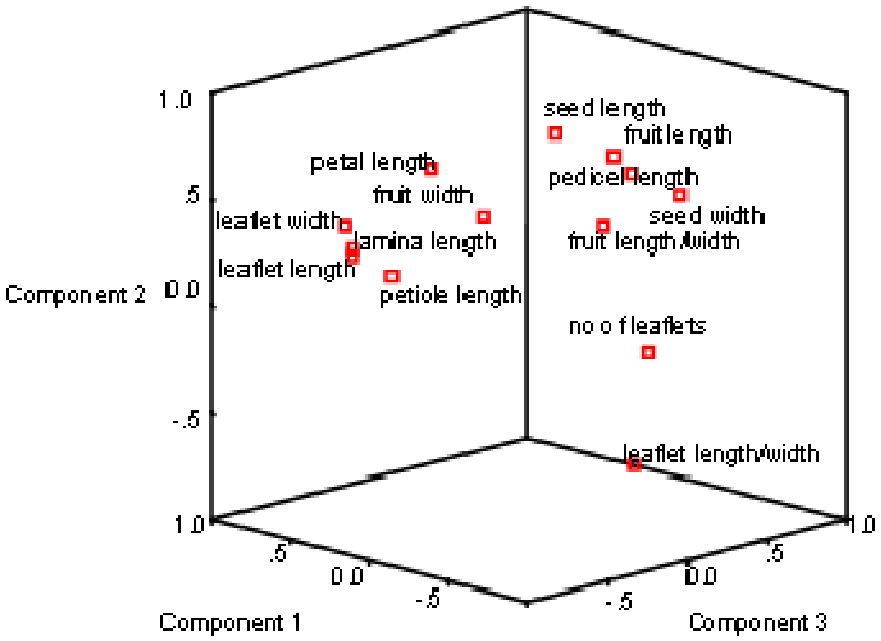

Figure 2. Component plot in rotated space for the 13 characters examined.

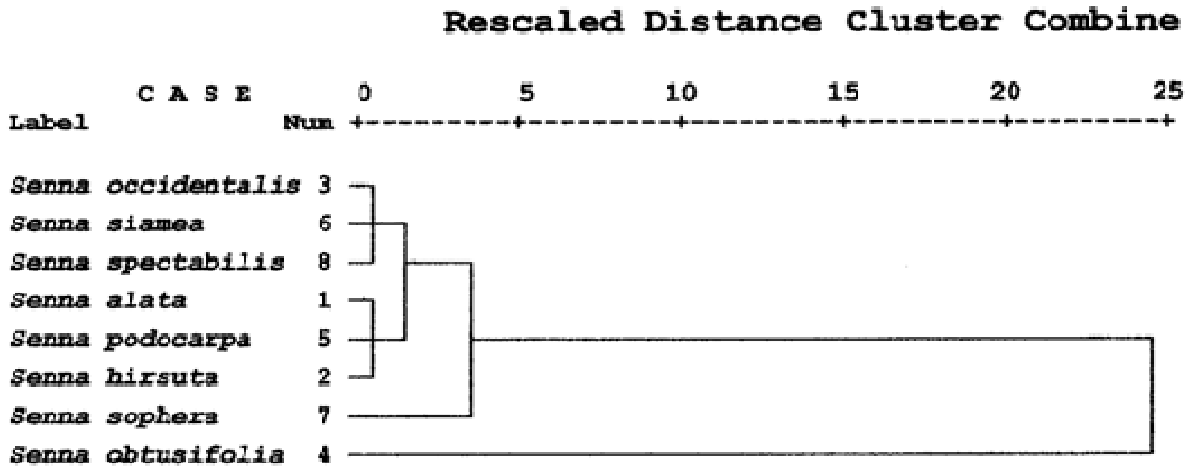

Figure 3. Cluster analysis showing the relationship of eight *Senna* species based on 13 quantitative characters (Dendrogram using Average Linkage).

species of *Senna* studied to be grouped together as one genus. However, with all the shortcomings of numerical methods (as in all other forms of taxonomic methods) one should not be led to believe that "numerical taxonomy is an excursion to futility" as claimed by Ross (1964).

Due to the various ethnobotanical importance of *Senna* species such as treating of infection, dysentery and their laxative effects, and because they present future prospects in the production of raw materials for laxatives, antimicrobial and anti tumor drugs, extensive research needs to be done on the species not only in Nigeria but globally.

Conclusion

Morphometric analysis of eight species of *Senna*: *S. alata, S. hirsuta*, *S. obtusifolia*, *S. occidentalis*, *S. podocarpa*, *S. siamea*, *S. sophera* and *S. spectabilis* using 13 quantitative characters provided justification for

the existing classification of the genus. Three characters which, include leaflet length, leaflet width and leaflet length/width ratio contributed significantly to the delimitation of the species of *Senna* studied. Cluster analysis based on the quantitative parameters showed that *S. hirsuta* and *S. sophera* were more closely related whereas *S. obtusifolia* and *S. sophera* were most distantly related to *S. alata*. We recommend an application of this method in an elaborate taxonomic review of the genus *Senna* in the future.

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