Genetic diversity and phylogenetic behavior of some minor legumes

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Abstract

Twenty-four accessions of twelve species minor legumes collected from the germplasm unit of the International Institute of Tropical Agriculture Ibadan, Nigeria were evaluated for their genetic diversities and phylogenetic relatedness. The accessions were planted into plots of 5 ridges of 5 meters long, spaced 1 meter apart and replicated three times at the Federal University Oye-Ekiti Teaching and Research Farm. The diversity and the relative phylogeny of the accessions were assessed through their floral morphological differences and the mean values between two accessions were evaluated by descriptive statistics. Principal component analysis was employed to identify the most discriminatory floral morphological traits and the similarities among the 24 accessions were assessed by cluster analysis (CA). Descriptive statistics through Duncan multiple range test adopted revealed genetic diversity and phylogenetic relatedness among the accessions. The first two principal components explained 64.66% of the total floral morphological variation. Standard petal length, calyx lobe length and stipule length contributed most of the variations in the legume accessions. The study revealed intra-specific similarities and inter-specific floral morphological differences among the studied accessions.

Introduction

All plants of the pea and bean family (leguminosae) are termed legumes. This composed of three major subfamilies viz; caesalpinaceae, mimosaceae and papilionaceae, which are sena family, locust bean family and family of about ten tribes, respectively.1,2 The family of legume (leguminosae) is very large embracing a large group of dicotyledonous plants. Their fruits are in the form of pods, which may be round, flat, winged, straight or curve, and of varying lengths. The fruit may also be fibrous or fleshy and are often split open at maturity. They always have complete and irregular flowers. The flowers are usually hermaphrodite with calyx having five, more or less unequal and partially united sepals.3,4

Grain legume is a major component of grain-based farming system in many parts of the world. Grain legumes can be divided into two groups as major and minor species according to world economy and plant utility.5,6 The major ones are the industrial legumes such as soybean and groundnut.5

These major species are extremely important in the world economy. Others among the list are common beans (Phaseolus vulgaris), Chicken pea (Cicerarietanum) and pea (Pisum sativum). The minor species have a broad spectrum of diversity across various regions worldwide; existing either as cultivated or wild species. They are usually cultivated by traditional farmers. Examples of such minor species includes Kersting groundnut (Kerstingiella geocarpa), Marama bean (Tylosome esculentum).6,7 Consumption of legumes was also highly correlated with reduced mortality resulting from coronary heart diseases.2 Studies have also been carried out on the in vitro multi-enzyme digestibility of flower proteins of six varieties of African Yam Bean (AYB).7

Minor grains legumes could also be referred to as neglected, underutilized etc.8,9 The major legumes have attracted much research attention unlike the minor ones. The long cooking period required for processing of the minor grain legumes for food, the bushy growth habit, long life cycle and extra efforts needed for their cultural field maintenance are factors militating against their cultivation and utilization. Production statistics’ ratio of the minor legumes as compared with the major ones could be as low as one to hundred.1,3,9 Plant floral characters have been indicated to reveal most discriminatory morphological traits among accessions.2

Minor legumes are rich sources of plant proteins in human diet, good sources of genetic factors and chemicals for insect pest resistance. Most of the representative minor legumes have potential to improve nutrition, boost food security, foster rural development and support sustainable land care.10 There is paucity of information on the phylogenetic behavior and the genetic diversity of the major representative minor legumes; for these reasons, this work is designed to establish data on the differences and similarities observed on floral morphology of twenty-four minor legume accessions with a view to revealing their diagnostic features which could serve as a guide to their genetic diversity and relative phylogeny.

Seed acquisition

Seeds of twenty-four accessions of twelve species of miscellaneous legumes were obtained from the Genetic Resources Unit of the International Institute of Tropical Agriculture (IITA), Ibadan, Oyo-State, Nigeria for screening. The species studied are Bambara groundnut [Vigna subterranea (L.) Thous] (TVs 1126 and TVs 1415), Green gram [Vignaradiata (L.) R.Wilczek] (TVr 145 and TVr 1001), Jack bean (JB) [Canavalia enistiformis (L.) DC] (TCe1 and TCe3), Mung bean [Vignamungo (L.) Hepper] (TVm 12 and TVm 13), Pigeon pea [Cajanuscujian (L.) DC] (T Cv 8127 and TCv 156), Rice bean [Vignaangularis (L.) Thous] (TVa 1 and TVa 1173), AYB [Sphenostylisstenocarpa (HochstEx.A Rich)] Harms (TSt 187 and TSts 156), Kersting groundnut [kerstingiellageocarpa (Harms)], (TKg 6 and Tk 12) lablab [Lablab purpureus (var. lignosus)] (TLn 21 and TLn 29), Mexican yam bean [Pachyrhizustuberosus (Lam)] (TPu 1 and TPu 5), Sword bean (SB) [Canavaliangladiata (Jacq.) DC] (TCg 1 and TCg 4) and Winged bean [Psophocarpustetragonolobus (L.) DC] (TPt 12 and TPt 18).

Seed cultivation

Seeds of the twenty-four accessions studied were planted on 5m ridges, spaced 1m apart at the teaching and Research Farm of the Federal University Oye-Ekiti, Ekiti State. Each accession was planted on two rows at 1m intra-row spacing. Initially, two seeds were planted per hill and later thinned to one plant per hill, to

Materials and Methods

Seed acquisition

Seeds of twenty-four accessions of twelve species of miscellaneous legumes were obtained from the Genetic Resources Unit of the International Institute of Tropical Agriculture (IITA), Ibadan, Oyo-State, Nigeria for screening. The species studied are Bambara groundnut [Vigna subterranea (L.) Thous] (TVs 1126 and TVs 1415), Green gram [Vignaradiata (L.) R.Wilczek] (TVr 145 and TVr 1001), Jack bean (JB) [Canavalia enistiformis (L.) DC] (TCe1 and TCe3), Mung bean [Vignamungo (L.) Hepper] (TVm 12 and TVm 13), Pigeon pea [Cajanuscujian (L.) DC] (T Cv 8127 and TCv 156), Rice bean [Vignaangularis (L.) Thous] (TVa 1 and TVa 1173), AYB [Sphenostylisstenocarpa (HochstEx.A Rich)] Harms (TSt 187 and TSts 156), Kersting groundnut [kerstingiellageocarpa (Harms)], (TKg 6 and Tk 12) lablab [Lablab purpureus (var. lignosus)] (TLn 21 and TLn 29), Mexican yam bean [Pachyrhizustuberosus (Lam)] (TPu 1 and TPu 5), Sword bean (SB) [Canavaliangladiata (Jacq.) DC] (TCg 1 and TCg 4) and Winged bean [Psophocarpustetragonolobus (L.) DC] (TPt 12 and TPt 18).

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Data collection

Data for floral morphological studies were generated from four individual plants within the row of each accession. Quantitative characters were determined by measurement and counting. The qualitative characters, which were determined visually, were scored by nominal codes. No descriptor had been developed for most miscellaneous legumes yet. Descrpitors for cowpea were therefore used as a guide to develop the descriptors list for the present morphological characterization.\(^{11}\)

Data analysis

Duncan multiple range tests were employed to analyze the similarities and differences in the mean values of the quantitative characters. The multivariate statistical methods employed were Principal Component Analysis (PCA) and Cluster Analysis (CA). The PCA produced vector loadings for variables on principal component (PC) axes while CA produced a cluster grouping in the form of a Dendrogram. Pearson correlation coefficient was employed to identify the dependence of characters on one another for vegetative, floral as well as pod and seed characters.

Floral character study

The plants in each accession were scored for their qualitative floral characters (pattern of pigmentation on peduncle and flower color). Ten measurements were taken for each quantitative floral character from ten randomly picked flowers from plants in each accession. The means of the measurements were calculated and recorded. The quantitative floral characters measured include standard petal length and width, peduncle length and calyx lobe length.

Table 1. Mean values of six floral characters of the miscellaneous legumes.

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
<th>Accession number</th>
<th>SPL</th>
<th>SPW</th>
<th>PDL</th>
<th>CLL</th>
<th>D50%F</th>
<th>NFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canavalia gladiate</td>
<td>Sword bean</td>
<td>TCg1</td>
<td>3.40</td>
<td>0.90</td>
<td>30.63</td>
<td>2.05</td>
<td>56.00</td>
<td>3.20bc</td>
</tr>
<tr>
<td>Canavalia gladiate</td>
<td>Sword bean</td>
<td>TCg4</td>
<td>2.68</td>
<td>0.90</td>
<td>20.45</td>
<td>1.67</td>
<td>66.00</td>
<td>3.20bc</td>
</tr>
<tr>
<td>Pachyrhizus tuberosus</td>
<td>Mexican yam bean</td>
<td>TPt1</td>
<td>1.79</td>
<td>0.63</td>
<td>17.86</td>
<td>1.02</td>
<td>57.00</td>
<td>5.30fg</td>
</tr>
<tr>
<td>Pachyrhizus tuberosus</td>
<td>Mexican yam bean</td>
<td>TPt5</td>
<td>1.80</td>
<td>0.66</td>
<td>17.89</td>
<td>1.04</td>
<td>57.00</td>
<td>5.30fg</td>
</tr>
<tr>
<td>Psophocarpustetragonolobus</td>
<td>Winged bean</td>
<td>TPt12</td>
<td>2.56</td>
<td>1.40</td>
<td>17.76</td>
<td>1.07</td>
<td>63.00</td>
<td>13.30</td>
</tr>
<tr>
<td>Psophocarpustetragonolobus</td>
<td>Winged bean</td>
<td>TPt18</td>
<td>1.88</td>
<td>0.65</td>
<td>18.13</td>
<td>1.03</td>
<td>45.00</td>
<td>14.10</td>
</tr>
<tr>
<td>Canavalia ensiforms</td>
<td>Jack bean</td>
<td>TCc1</td>
<td>1.64</td>
<td>0.80</td>
<td>23.12</td>
<td>1.26</td>
<td>63.00</td>
<td>5.30fg</td>
</tr>
<tr>
<td>Canavalia ensiforms</td>
<td>Jack bean</td>
<td>TCc3</td>
<td>2.62</td>
<td>0.89</td>
<td>23.23</td>
<td>1.52</td>
<td>70.00</td>
<td>7.37fg</td>
</tr>
<tr>
<td>Vigna angularis</td>
<td>Rice bean</td>
<td>TVa1</td>
<td>2.58</td>
<td>1.39</td>
<td>12.87</td>
<td>1.07</td>
<td>66.00</td>
<td>5.60fg</td>
</tr>
<tr>
<td>Vigna angularis</td>
<td>Rice bean</td>
<td>TVa1173</td>
<td>1.20</td>
<td>1.07</td>
<td>12.90</td>
<td>0.92</td>
<td>125.00</td>
<td>5.60fg</td>
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<tr>
<td>Vignamango</td>
<td>Mung bean</td>
<td>TVn12</td>
<td>1.34</td>
<td>0.73</td>
<td>12.06</td>
<td>1.03</td>
<td>43.00</td>
<td>5.70fg</td>
</tr>
<tr>
<td>Vignamango</td>
<td>Mung bean</td>
<td>TVn13</td>
<td>1.56</td>
<td>0.78</td>
<td>11.45</td>
<td>0.99</td>
<td>42.00</td>
<td>2.80fg</td>
</tr>
<tr>
<td>Lablab purpureus</td>
<td>Lablab bean</td>
<td>TLn21</td>
<td>1.56</td>
<td>0.40</td>
<td>22.01</td>
<td>0.80</td>
<td>57.00</td>
<td>5.30fg</td>
</tr>
<tr>
<td>Lablab purpureus</td>
<td>Lablab bean</td>
<td>TLn29</td>
<td>1.64</td>
<td>0.40</td>
<td>21.93</td>
<td>0.77</td>
<td>57.00</td>
<td>8.60fg</td>
</tr>
<tr>
<td>Sphenostylisstenocarpa</td>
<td>African yam bean</td>
<td>TSs137</td>
<td>2.11</td>
<td>0.93</td>
<td>18.13</td>
<td>0.71</td>
<td>84.00</td>
<td>14.50fg</td>
</tr>
<tr>
<td>Sphenostylisstenocarpa</td>
<td>African yam bean</td>
<td>TSs156</td>
<td>2.62</td>
<td>1.11</td>
<td>16.18</td>
<td>0.81</td>
<td>83.00</td>
<td>15.00fg</td>
</tr>
<tr>
<td>Vigna subteraneae</td>
<td>Bambara groundnut</td>
<td>TVsu1126</td>
<td>0.72</td>
<td>0.30</td>
<td>4.09</td>
<td>0.20</td>
<td>55.00</td>
<td>1.80fg</td>
</tr>
<tr>
<td>Vigna subteraneae</td>
<td>Bambara groundnut</td>
<td>TVsu1415</td>
<td>0.73</td>
<td>0.30</td>
<td>4.05</td>
<td>0.19</td>
<td>55.00</td>
<td>1.80fg</td>
</tr>
<tr>
<td>Kerstingiellageocarpa</td>
<td>Kersting groundnut</td>
<td>TKg6</td>
<td>0.76</td>
<td>0.30</td>
<td>3.96</td>
<td>0.22</td>
<td>20.00</td>
<td>1.80fg</td>
</tr>
<tr>
<td>Kerstingiellageocarpa</td>
<td>Kersting groundnut</td>
<td>TKg12</td>
<td>0.76</td>
<td>0.30</td>
<td>3.99</td>
<td>0.20</td>
<td>20.00</td>
<td>1.90fg</td>
</tr>
<tr>
<td>Vigna radiate</td>
<td>Green gram</td>
<td>TVg45</td>
<td>1.35</td>
<td>0.59</td>
<td>13.81</td>
<td>0.50</td>
<td>75.00</td>
<td>4.80fg</td>
</tr>
<tr>
<td>Vigna radiate</td>
<td>Green gram</td>
<td>TVv1001</td>
<td>1.48</td>
<td>0.68</td>
<td>14.26</td>
<td>0.50</td>
<td>41.00</td>
<td>4.60fg</td>
</tr>
<tr>
<td>Cajanuscajan</td>
<td>Pigeon pea</td>
<td>TCCc127</td>
<td>1.58</td>
<td>0.79</td>
<td>20.10</td>
<td>0.93</td>
<td>80.00</td>
<td>1.90fg</td>
</tr>
<tr>
<td>Cajanuscajan</td>
<td>Pigeon pea</td>
<td>TCCc156</td>
<td>1.57</td>
<td>0.72</td>
<td>20.04</td>
<td>0.98</td>
<td>78.00</td>
<td>2.00fg</td>
</tr>
<tr>
<td>Total mean</td>
<td></td>
<td></td>
<td>1.74</td>
<td>0.73</td>
<td>15.84</td>
<td>0.89</td>
<td>60.75</td>
<td>5.50fg</td>
</tr>
</tbody>
</table>

SPL, Standard petal length; SPW, Standard petal width; PDL, Peduncle length; CLL, Calyx lobe length; NFP, Number of flower per peduncle; D50%F days to 50% flowering. Different letters in the same row denote significant differences among parameters.
characters of the miscellaneous legumes. AYB, Lablab bean, SB, JB, Pigeon pea, Winged bean were highly prolific in flower production. However, a large number of the flowers were aborted and dropped without developing into fruit. The two accessions of TSs (156 and 137) produced the highest number (15.00 and 14.50) of flowers per peduncle respectively while TVs/126, TVs/1415 and TKg6 had the least (1.80). Standard petal length ranged between 3.40 in TCg1 to 0.72 in TVs/126 while standard petal width ranged from 1.40 in TP12 and 0.30 both in the two accessions of TVs (1126 and1415) and TKg (6 and 12). The two accessions of each of the twelve species of the miscellaneous legumes displayed similarities in their floral characters. This is however with the exception of TCg1 and TCg4, Tp12 and Tp18, TCc1 and TCc3, TVa1 and TVa1173 which showed significant differences in standard petal length. Tp12 and Tp18 also showed significant differences in their standard petal width. TCc1 and TCc3, TVm12 and TVm13, TLa21 and TLa29 were remarkably different in the number of flowers per peduncle.

Principal component analysis

The Eigen values, variance proportion of five PC axes and the Eigen vectors of five floral morphological traits are presented in Table 2. Although, five PC axes were identified by the PCA, only two had Eigen value greater than or equal to 1.0. The percentage variances reduced progressively from PC1 to PC5. The percentages of the total variance within the first two PC-axes were 64.66 and 20.19 respectively. The Eigen value for each of the first two PC-axes was greater than 2.5 and this explained 64.66% of the total variation. In the table, floral morphological traits with Eigen vector greater than or equal to 0.2 were significant in their contribution to loading each PC-axis. All the five floral characters from standard petal length, standard petal width, peduncle length, calyx lobe length to number of flowers per peduncle loaded PC 1. Two out of these characters in PC1 re-

Table 2. Eigen values, variance proportion of five pc-axes and eigen vectors of five floral morphological characters.

<table>
<thead>
<tr>
<th>PC1</th>
<th>PC2</th>
<th>PC3</th>
<th>PC4</th>
<th>PC5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eigen values</td>
<td>3.3229</td>
<td>1.0096</td>
<td>0.5408</td>
<td>0.1341</td>
</tr>
<tr>
<td>Variance per PC-axes, %</td>
<td>0.6466</td>
<td>0.2819</td>
<td>0.1082</td>
<td>0.0268</td>
</tr>
<tr>
<td>Cumulative variance across PC-axes, %</td>
<td>0.6466</td>
<td>0.8485</td>
<td>0.9567</td>
<td>0.9835</td>
</tr>
</tbody>
</table>

Eigen vectors

<table>
<thead>
<tr>
<th>Morphological traits</th>
<th>Eigen vectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard petal length</td>
<td>0.5326*</td>
</tr>
<tr>
<td>Standard petal width</td>
<td>0.4326*</td>
</tr>
<tr>
<td>Peduncle length</td>
<td>0.4698*</td>
</tr>
<tr>
<td>Calyx lobe length</td>
<td>0.4963*</td>
</tr>
<tr>
<td>Number of flower per peduncle</td>
<td>0.2494*</td>
</tr>
</tbody>
</table>

*Eigen vectors ≥ 0.2.

Figure 1. Flower colour of some of the miscellaneous legumes. A) TCg1, sword bean; B) TCg4, sword bean; C) TCc1, jack bean; D) TCc3, jack bean; E) TVa1, rice bean; F) TVa1173, rice bean; G) TVm12, mung bean; H) TVm13, mung bean; I) TLh21, lablab bean; J) TLa29, lablab bean.
Cluster analysis

The two dimensional spatial configuration of 24 accessions of the miscellaneous legumes based on their floral characters is presented in Figure 3. The configuration explained almost 85% of the total variation among the species and accessions. Six distinct sub-specific clusters could be delimited among the taxa. Accessions coded 21, 22 (TV 145 and TVr1001), 9, 10 (TvA1 and TvA1173), all bearing the same generic nomenclature fell within a cluster and also in association with one accession of Lablab purpureus (TLn29 coded 14). This was similar to occurrence in vegetative morphological character. Three out of the four accessions of the genus Canavalia formed a separate cluster (coded 2, 8 and 1). Accessions coded 2 and 8 of the species Canavalia gladiata and Canavalia ensiformis appeared to be more closely related based on their floral morphology. Table 3 shows the cluster history of the 24 accessions of the miscellaneous legumes based on their floral characters. The analysis produced 23 morphotypes just as observed in vegetative morphological analysis. Accessions TVsu1126 and TVsu1415 were the most similar phenotype based on the five floral characteristics employed to discriminate among the 24 accessions as both had the least distance of 0.0042. Diversity of the 24 accessions spanned a distance between 0.0042 and 0.7446 (Table 3). Figure 4 shows the dendrogram obtained from CA for quantitative floral characters. The clustering technique was based on similarity for some morphological traits among the 24 accessions. At 0.0 similarity level, each of the 24 accessions maintained uniqueness. However, at about 30% similarity level, about seven clusters were identified. At this level (30%), TPtu1 and TPtu5 were clustered together, TCg1 stood alone and all the TVs were together with the exception of TVu which clustered with TKgs. Expectedly, only four clusters could be identified at about 70% similarity level. All the Vigna species (TvA1 and TvA1173; TVm12 and TVm13; TVr145 and TVr1001) appeared to cluster together at nearly the same similarity level with the exception of Vigna subterranea (TVsu1126 and TVsu1415). Only one accession of Lablab purpureus (TLn29) appeared clustered with the Vigna species at nearly the same similarity level.

Floral characters correlation studies

Table 4 shows correlation coefficients among five floral characters of the miscellaneous legumes. Calyx lobe length positively and strongly (P≤0.01) correlated with standard petal length (r=0.753). Number of flower per pedun- cle (P=0.05) also correlated with standard petal length (r=0.413) and there was no negative correlation at any level.

Discussion

Occurrence of intra and inter variables in the species of many organisms is a surety for evolutionary survival and also a signal for improvement of these species for character of significance.12,13 The floral morphological characters (qualitative and quantitative) that were examined in the current study differentiated the twelve species of the 24 accessions of the studied taxa. Variations observed in the qualitative characters depicted different genetic basis for the phenotypic expressions of each trait among the minor legumes studied. The range of differences among species for the quantitative characters has evident by high coefficient of variation in the mean values of the Duncan multiple range test’ scores is indicative of wild genetic variability among the studied taxa.

The PCA employed in this study is a multivariate statistical technique of importance for classification of species.2,14 The main phenotypic characters, which made significant contribution to detecting variation among the accessions studied, were calyx length, stipule length and numbers of flowers per pedun- cle. Agreement of the PCA and CA observed lends credence to the existing variability’s...
among the minor legumes species and accessions, which is the justice to their classification.

Variabilities revealed in the floral morphological characters were expressed in their reproductive traits such as standard petal length and width, peduncle length, calyx lobe length, flower color and number of flowers per peduncle.

There were indications of more relative intra-specific relatedness as accessions of each species had very close-recorded values for both quantitative and qualitative characters. This is in line with the findings of Adewale.15

Psophocarpustetragonolobus and Sphenophylisstenocarpa showed relatively high numbers of flowers per peduncle which is indicative of high floral productivity and hence, high pod and seed yields. This was reflected in Psophocarpustetragonolobus but most of the flowers produced by Sphenophylisstenocarpa were miscarried.

Dendrogram revealed broad groupings, which resulted in fewer groups than the original numbers of the species and accession; this enable and easy logical reference to the studied taxa. Although the passport data of most of the species were not known, the dendrogram

Table 3. Cluster history of the 24 accessions miscellaneous legumes based on their floral characters.

<table>
<thead>
<tr>
<th>Morphotypes</th>
<th>Paired, accession or cluster</th>
<th>Rate</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>TVsu1126</td>
<td>TVsu1415</td>
<td>2</td>
</tr>
<tr>
<td>22</td>
<td>CL23</td>
<td>Tkg6</td>
<td>3</td>
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<tr>
<td>21</td>
<td>CL22</td>
<td>Tkg12</td>
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</tr>
<tr>
<td>20</td>
<td>TcC8127</td>
<td>TcC8156</td>
<td>2</td>
</tr>
<tr>
<td>19</td>
<td>Tvr145</td>
<td>Tvr1001</td>
<td>2</td>
</tr>
<tr>
<td>18</td>
<td>Tpt1</td>
<td>Tpt5</td>
<td>2</td>
</tr>
<tr>
<td>17</td>
<td>Tpt18</td>
<td>Ts137</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
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<tr>
<td>14</td>
<td>Cl15</td>
<td>Cl19</td>
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</tr>
<tr>
<td>13</td>
<td>Tcg4</td>
<td>Cl20</td>
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Figure 3. Dendrogram showing grouping of 24 accessions of the miscellaneous legumes based on their quantitative floral characters.
analysis grouping might have implicated linkage between the sources of species and accessions and the characters exhibited. Both nature and nurture contribute to the phenotypic character of an organism. The observed differences and similarities among the studied taxa were basically genetic, since the influence of the nurture has being removed by raising the plants under the same environment. Hence, these genetic variations could be utilized as raw materials for genetic improvement.

The result of the floral morphological features of the studied taxa showed some diagnostic characteristics that could be employed for taxonomic decisions. Morphologically, the observed features that separated the species from another shared relevance with the studies of Okwulechi and Okoli, and Edeoga and Emeka, who employed comparative morphology of different species in establishing relation among the studied taxa.

**Conclusions**

The essence of diversity studies in crop species is to reveal variation and its pattern within the crop’s germplasm. Products of such assessments become materials(s) for crop improvement. The current report clearly reveals diversity and phylogeny studies on twenty-four accessions of twelve species of miscellaneous legumes. Values recorded are representative of the genetic variants and overlaps among and within the species of these taxa, and may serve as future reference for other studies in this field.

![Figure 4. Two dimensional spatial configurations of the twelve species of twenty-four accessions miscellaneous legumes according to their floral characters.](image)

### Table 4. Correlation coefficients of five floral characters of the miscellaneous legumes.

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<th>Characters</th>
<th>SPL</th>
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<th>PL</th>
<th>CLL</th>
<th>NFP</th>
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<td></td>
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<tr>
<td>CLL</td>
<td>1</td>
<td>0.091</td>
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</tbody>
</table>

*Correlation is significant at the 0.01 level (2-tailed). °Correlation is significant at the 0.05 level (2-tailed). SPL, Standard Petal length; SPW, Standard Petal width; PL, Peduncle length; CLL, Calyx Lobe Length; DSE, Days from sowing to emergence; NFP, Number of Flower of Peduncle.

### References

15. Adewale DB. Genetic diversity, stability and reproductive biology of African Yam Bean, Sphenostylisstenocarpis (Hochst. Ex