



MORPHOLOGICAL VARIATIONS FOR THE TAXONOMIC IDENTIFICATION OF SOME SPECIES OF ACACIA FROM ZARIA, KADUNA STATE NIGERIA

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ABSTRACT

Acacia belongs to the family fabaceae among the largest legume genera consisting of eighteen species with the majority of the species distributed in tropical and sub-tropical Africa. Classification of Acacia have remained a daunting task due to its wide spread and also hampered by its large number of species, prevalence of morphological convergence. Morphological variations in foliar, thorn, inflorescence of some *Acacia* species found in Zaria for their taxonomic identification at species level were evaluated. Seven species and one variety of Acacia were taxonomically classified using morphological characters. In almost all the species leaves were compound bipinnate, alternate and pinnules are oblong. However the pinnules of *A. senegal* are obovate. In *A. auriculiformis* the leaves are simple and sickle-like in shape. Leaf texture ranges from glabrous to pubescent and leaf margin were entire in all the species. The morphological measurement parameters were analyzed using ANOVA cooperation and the results indicate variations among the species. The variations observed in some of the characters could be of taxonomic importance in the identification of the species. Overall ranking indicated that *Acacia sieberiana* var *sieberiana* and *Acacia sieberiana* var *villosa* were the best with high values of morphological characters of pinna length (3.50 ± 0.11 cm and 3.82 ± 0.16 cm respectively) and number of pinna (18.80 ± 1.32 and 41.70 ± 1.52 respectively). The high values of pinna could be used in solving taxonomic problems associated with Acacia species and in mapping out breeding strategies for the production of cultivars with better foliar yield of Acacia species in Nigeria.

Keywords:- Taxonomy, Morphological, Acacia, inflorescence

INTRODUCTION

The genus *Acacia* was first described in 1754 by Philip Miller who based his description on the Egyptian thorn *A. nilotica* (Ross, 1979). The generic name is believed to have been described from the Greek (*Akazo*) meaning (Sharpen) alluding to the spinning stipules of many African and Asiatic species (Ross, 1979). More than one thousand and three hundred species of *Acacia* are distributed worldwide with over nine hundred and fifty found in Australia and others in America, Africa and Asia (Judd *et al.*, 1999). There are about 115 species in Africa (Ross, 1973) while the remainder occurs in Asia and Americas. In Nigeria 14 species and 3 varieties have been reported by Keay *et al.* (1964). *Acacia* species are utilized for medicinal, cultural and agricultural purposes worldwide. In Nigeria species such as *A. albida*, *A. nilotica*, *A. raddiana*, *A. senegal* and *A. tortilis* are used as fodder. *A. nilotica*, *A. senegal*, *A. seyal*, and *A. tortilis* yield gum (FAO, 1983). The gum is used in pharmaceutical industries, cosmetic industries, soft drinks and pops, hard candies, shoe polish, ink, paints,

textiles, and papers (Nuhu and Ademoh, 2009; Umar *et al.*, 2014; Dagba and Harris, 2014).

According to literature, over the past decades Botanists have argued that the *Acacia* genus was too massive and not monophyletic and hence needed to be split along the lines of sub-genera identified by Vassal (1972). Contribution of morphological, anatomical, ontogenic and some phytochemical characters has been useful for the classification of the genus *Acacia* (Bentham 1875; Vassal 1972, 1981; Evans *et al.*, 1993; Padley 1986; Guinet 1990; Dube *et al.*, 2001; Bouchen-Akchelladi *et al.*, 2010; Abubakar and Yunusa, 1998; Yagi *et al.*, 2012). Despite this there is still some controversy regarding the intrageneric taxonomy (Yagi *et al.*, 2012). Limited literature is available on morphological features in Nigerian species. The result from this study will provide information that will contribute towards future taxonomic revision of the genus in Nigeria.

Morphology which has been defined as the study of forms, particularly external structures (Bailey, 2006) has been used

extensively in the area of plant taxonomy and it has been proven to be very significance in delimitation of taxa. These characters have been used for a longer time than anatomical or molecular evidence and have constituted the primary source of taxonomic evidence since the beginning of plant systematics (Judd *et al.*, 1999). Several reports were published on the morphology of plants all over the world (Anyanwu and Okoli 2004; Hayakawa *et al.*, 2012).

The aim of this research is to evaluate the morphological variations in foliar, thorn, inflorescence and pollen grain of some *Acacia* species found in Zaria for their taxonomic identification at species level and it objectives is to determine

the variations in the foliar and thorn morphology of some species of *Acacia* found in Zaria.

MATERIALS AND METHODS

Study Area

The study was conducted in Zaria and its environs which is located within longitude 96°15'E to 98°60'E and latitude 9°02'N to 11°32'N with a Guinea Savanna vegetation belt. Annual rainfall starts in April and ends in October. The location of sample collection covers Karau-Karau, Galadimawa, Dogarawa and Ahmadu Bello University Samaru Zaria.

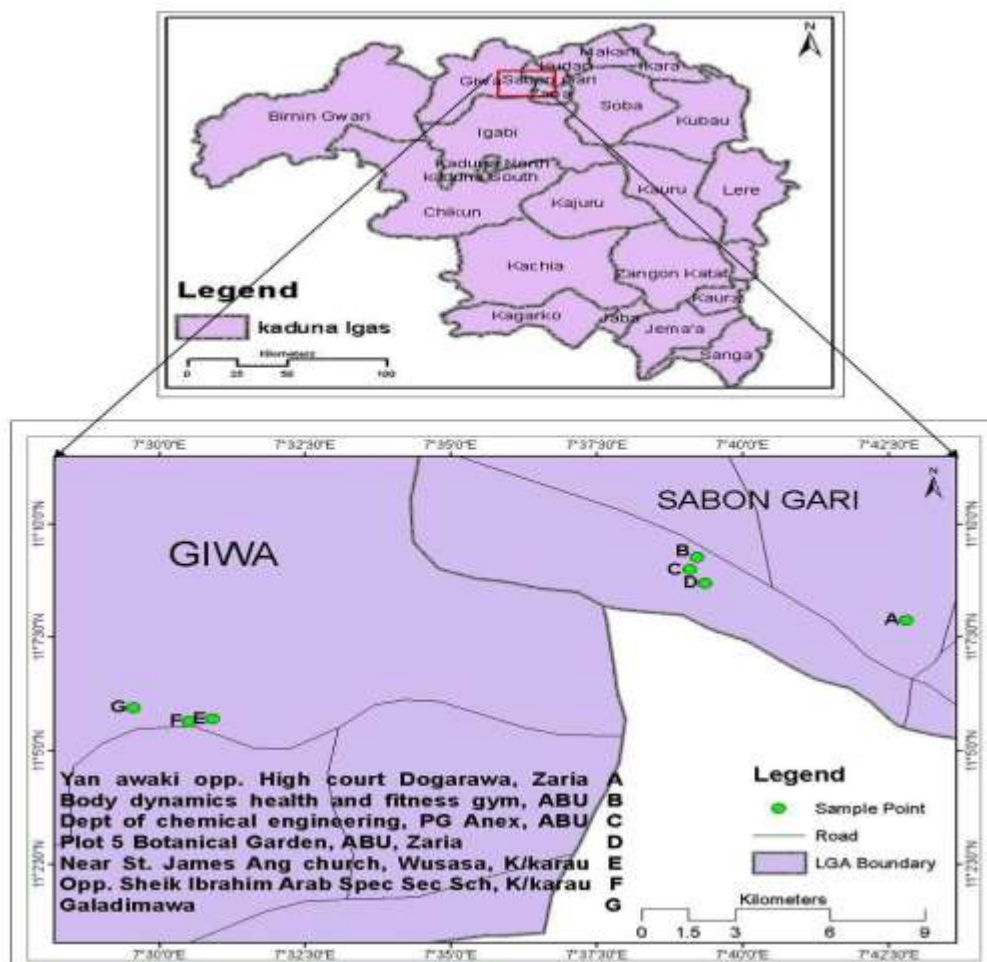


Fig.1: Map of Kaduna State showing Local Governments Area and sites of sample collection

Source: Department of Geography, Ahmadu Bello University, Zaria

Collection of Materials

Stem branches of eight individual species of *Acacia* containing the leaves, thorn and inflorescence (Table 1) were collected with the help of secateurs and placed separately in polyethyl bag and labeled.

Table 1: *Acacia* species Collected from the Study Sites and their Coordinates

S./No	Species	Common Name	Local name	Date of collection	Sites of collection	Coordinates	Voucher number
1	<i>Acacia albida</i>		Gawo(H), Egunewon(Y)	30/11/2014	Sheik Ibrahim Arab Spec. Sec. Sch. k/karau	Lat.11°05'39.3 ¹¹ N Long 7°30'29.6 ¹¹ E	877ABUZ
2	<i>Acacia ataxacantha</i> D.C	Benin rope Acacia	Kunbarshaho(H)	14/7/2014	Galadimawa	Lat.11°05'57.7 ¹¹ N Long 7°29'33.2 ¹¹ E	2417ABUZ
3	<i>Acacia auriculiformis</i> Cunn ex Benth.	Ear-leaf Acacia	-	23/6/2014	Chemical Eng. Dept. A.B.U. Samara Zaria	Lat.11°08'59.8 ¹¹ N Long 7°39'15.0 ¹¹ E	1227ABUZ
4	<i>Acacia nilotica</i> (L) Willd. Ex Del.		Bagaruwa(H)	2/2/2014	Yan awaki opp. High court. Dogarawa, Zaria	Lat.11°07'53.1 ¹¹ N Long 7°42'48.2 ¹¹ E	6924ABUZ
5	<i>Acacia polyacantha</i> Willd.	Falcons' claws	Farecenharamata(H), Ede(Y),Ugbaoyigbo	7/7/2014	Opp. Sheik Ibrahim Arab Spec. Sec. Sch. k/karau	Lat.11°05'39.3 ¹¹ N Long 7°30'29.6 ¹¹ E	1905ABUZ
6	<i>Acacia sieberiana</i> DC.var. <i>sieberiana</i>		Farar kaya(H), Aluki(Y)	20/5/2014	Plot 5 Botanical Garden, A.B.U. samaru Zaria	Lat.11°08'42.2 ¹¹ N Long 7°39'21.0 ¹¹ E	438ABUZ
7	<i>Acacia sieberiana</i> var. <i>villosa</i> A. Chev.	Farar kaya(H), Aluki(Y)	5/5/2014	Body Dynamics Health and Fitness Gym. A.B.U, Samaru Zaria	Lat.11°09'16.3 ¹¹ N Long 7°39'15.0 ¹¹ E	900248ABUZ	
8	<i>Acacia senegal</i> (L) Willd.	Dakwara(H)	14/7/2014	Near St. James Ang. Church, K/Karau, Zaria	Lat.11°05'42.7 ¹¹ N Long 7°30'54.4 ¹¹ E	332ABUZ	

Morphological Study

Thirty (30) samples of leaves per species were used for assessment of leaf morphological characters as described by Soladoye (2010). Characters such as type of leaf, arrangement, pinnules (shape and texture), pinnules margin were observed and recorded. Measurement of leaf length (cm), pinnules length (cm) and width (cm) were done with a rule. Number of pinnae, pinnules number per pinna and gland number were counted and recorded. Type of thorn, arrangement, number per leaf, length, basal width and size were determined. Length of individual thorn of the different *Acacia* species was measured with the help of a rule.

Data Analysis

The means of all the characters were compared using one-way ANOVA SPSS, version 21 (2011) IBM corporation. Thereafter Duncan's multiple range tests was used to separate the means where significant. Significance level was at $P < 0.05$

RESULTS

It is evident that seven of the collected species have compound bipinnate leaves except in one species *A. auriculiformis* which had simple leaves (Table 2). Similarly all the leaves were alternately arranged, pinnules of different species however showed variations in their shape and texture (Fig. 2a-h).

Table 2: Foliar Morphology of *Acacia* species found in Zaria, Kaduna State

Species	External morphology
<i>Acacia albida</i>	Leaves alternate, bipinnate, leaflet linear, oblong and entire
<i>Acacia ataxacantha</i>	Leaves alternate, bipinnate, leaflet linear more or less glabrous and entire
<i>Acacia auriculiformis</i>	Leaves alternate, simple, linear and oblong and entire
<i>Acacia polyacantha</i>	Leaves alternate, bipinnate, leaflet linear, pubescent and entire
<i>Acacia nilotica</i>	Leaves alternate, bipinnate, leaflet glabrous, oblong and entire
<i>Acacia sieberiana</i> var. <i>sieberiana</i>	Leaves alternate, bipinnate, leaflet glabrous, oblong and entire
<i>Acacia sieberiana</i> var. <i>villosa</i>	Leaves alternate, bipinnate, leaflet glabrous, oblong and entire
<i>Acacia Senegal</i>	Leaves alternate, bipinnate, leaflet glabrous, obovate and entire



a: *A. albida*



b: *A. auriculiformis*



c: *A. ataxacantha*



d: *A. polyacantha*

Fig. 2(a-d): Variations in *Acacia* species in Zaria and its environs

e: *A. nilotica*f: *A. sieberiana* var *sieberiana*g: *A. sieberiana* var *villosa*h: *A. senegal*Fig. 2(e-h): Variations in *Acacia* species in Zaria and its environs

Leaf morphological characters of leaves like leaf length, pinnae length, width and size, number of pinnae, pinnules number per pinna, glands number as shown in (Table 3) varied in the different species. In some species they are significant and in others they are not. Highest leaf length observed in *A. auriculiformis* 14.13 ± 0.48 cm and the least were in *Acacia nilotica* and *Acacia senegal* 4.76 ± 0.31 cm and 3.85 ± 0.18 cm respectively. *Acacia sieberiana* var *villosa* had the highest pinna length 3.82 ± 0.16 cm and *Acacia albida* and *Acacia nilotica* had the least 1.20 ± 0.03 cm and 1.48 ± 0.08 cm. Number of pinna among the species varied with *A. sieberiana* var *villosa* having the highest number 41.70 ± 1.52 cm and *A. Albida* had the least 6.20 ± 0.29 cm.

Similarly pinnules number per pinna varied significantly with *Acacia polyacantha* having the highest number 73.10 ± 4.27 cm and *A. albida* had the least 16.10 ± 0.49 . *A. polyacantha* 6.10 ± 0.38 had the highest number of glands, the least value was with *A. sieberiana* var *sieberiana* 2.00 ± 0.00) and *.auriculiformis* had no glands at all.

Table 3: Foliar Morphological Measurement of *Acacia* Species found in Zaria, Kaduna State

Species	LeafLengthWhole (cm)	PinnaLength (cm)	PinnulesLength (cm)	PinnulesWidth (cm)	Pinnules Size (cm ²)	No. of Pinna	Pinnules Number Per Pinna	Glands Number
<i>Acacia albida</i>	1.81±0.12 ^e (0.90 - 2.80)	1.20±0.03 ^d (1.00 - 1.40)	0.29±0.01 ^b (0.20 - 0.40)	0.10±0.00 ^b (0.10 - 0.10)	0.03±0.00 ^b (0.02 - 0.04)	6.20±0.29 ^f (4.00 - 8.00)	16.10±0.49 ^f (12.00 20.00)	3.00±0.00 ^c (3.00 - 3.00)
<i>Acacia ataxacantha</i>	8.31±0.34 ^c (5.10 - 12.00)	2.24±0.13 ^c (1.10 - 3.10)	0.34±0.02 ^b (0.20 - 0.40)	0.09±0.00 ^b (0.05 - 0.10)	0.03±0.00 ^b (0.01 - 0.04)	12.70±0.22 ^d (11.0014.00)	31.10±1.73 ^e (22.0040.00)	2.45±0.17 ^{cd} (1.00 - 4.00)
<i>Acacia auriculiformis</i>	14.13±0.48 ^a (10.00-17.50)	-	-	1.98±0.08 ^a (1.20 - 2.60)	28.41±1.79 ^a (12.0040.25)	1.00±0.00 ^g (1.00 - 1.00)	16.90±1.52 ^f (8.00 -28.00)	-
<i>Acacia nilotica</i>	4.76±0.31 ^d (1.80 - 7.10)	1.48±0.08 ^d (1.00 - 2.20)	0.53±0.03 ^b (0.20 - 0.70)	0.10±0.01 ^b (0.01 - 0.15)	0.06±0.01 ^b (0.01 - 0.11)	9.20±0.42 ^e (6.00 -12.00)	29.80±0.77 ^e (24.0036.00)	3.00±0.00 ^c (3.00 - 3.00)
<i>Acacia polyacantha</i>	9.67±0.58 ^b (3.00 - 12.60)	3.39±0.28 ^b (1.20 - 5.00)	0.32±0.03 ^b (0.10 - 0.50)	0.10±0.00 ^b (0.10 - 0.10)	0.03±0.00 ^b (0.01 - 0.05)	16.55±0.70 ^c (12.0022.00)	73.10±4.27 ^a (32.00100.00)	6.10±0.38 ^a (4.00 10.00)
<i>Acacia sieberianavar. sieberiana</i>	7.52±0.11 ^c (7.00 - 8.20)	3.50±0.11 ^{ab} (3.00 - 4.20)	0.38±0.03 ^b (0.20 - 0.50)	0.12±0.01 ^b (0.05 - 0.20)	0.09±0.03 ^b (0.02 - 0.56)	18.80±1.32 ^b (12.0036.00)	45.90±3.32 ^c (26.00 70.00)	2.00±0.00 ^d (2.00 - 2.00)
<i>Acacia sieberianavar. villosa</i>	11.86±0.59 ^{ab} (6.70 - 15.30)	3.82±0.16 ^a (2.80 - 5.00)	0.33±0.01 ^b (0.20 - 0.40)	0.10±0.00 ^b (0.10 - 0.10)	0.03±0.00 ^b (0.02 - 0.04)	41.70±1.52 ^a (32.0056.00)	60.70±3.14 ^b (32.00 80.00)	4.00±0.16 ^b (3.00 - 5.00)
<i>Acacia senegal</i>	3.85±0.18 ^d (2.70 - 6.10)	1.93±0.09 ^c (1.40 - 2.90)	0.33±0.02 ^b (0.20 - 0.50)	0.12±0.01 ^b (0.10 - 0.15)	0.04±0.00 ^b (0.02 - 0.05)	11.80±0.35 ^d (10.0016.00)	38.40±1.57 ^d (30.00 58.00)	2.85±0.15 ^c (1.00 - 4.00)
Total	6.82±0.31	2.51±0.10	2.08±0.37	0.34±0.05	3.59±0.78	14.74±0.95	39.00±1.72	2.91±0.16
P value	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**

Means with different superscripts along the column differed significantly ($P < 0.05$) Values in parenthesis are range

Thorn description and morphology of *Acacia* species showed (Table 4) that *A. albida* had its thorns occurring in pairs at the base of the petiole and they are straight in shape. In *A. auriculiformis* thorns are absent while in *A. ataxacantha* the thorns had swollen base, scattered and arranged along the stem and branches of the plant. *A. polyacantha* had its thorns also occurring in pairs at the base of a leaf. In *A. nilotica* thorns are straight and thin also occurring in pairs at the base of a leaf. *A. sieberiana* thorns are straight, in pairs one longer than other at the base of a leaf, straight one longer than the other. *A. senegal* had its thorn curved, occurring in threes two curved upward and the third one curved/bent downwards. Highest number of thorn per wide was observed in *A. ataxacantha* had the highest number of thorns per node with values ranging 6.90 ± 0.71 followed by *A. senegal*, *A. albida*, *A. nilotica*, *A. polyacantha*, *A. sieberiana* var. *sieberiana* and *A. sieberiana* var. *villosa* while *A. auriculiformis* had no thorns at all.

A. nilotica 3.87 ± 0.13 cm and *A. sieberiana* var. *sieberiana* 4.13 ± 0.52 cm had the highest thorn length while *A. ataxacantha* 0.56 ± 0.03 cm had the least. Basal width of *A. albida* thorn was the highest 2.90 ± 0.19 cm and the least was with *A. sieberiana* var. *sieberiana* 0.21 ± 0.02 cm. *A. nilotica* which had the highest thorn length also had the highest thorn size 7.50 ± 0.33 cm² and *A. senegal* had the least 0.21 ± 0.02 cm².

Table 4: Thorn Description and morphological measurement of *Acacia* species found in Zaria Kaduna State

Species	Thorn description	Thorn Number	Thorn Length (cm)	Basal Width (cm)	Thorn Size (cm ²)
<i>Acacia albida</i>	Straight, in pairs at the base of the petiole	2.00 ± 0.00^b (2.00 - 2.00)	1.35 ± 0.08^c (0.70 - 1.70)	2.90 ± 0.19^a (1.00 - 4.00)	3.89 ± 0.32^b (1.70 - 6.80)
<i>Acacia ataxacantha</i>	Scattered along the stem and branches with swollen base	6.90 ± 0.71^a (1.00 - 12.00)	0.56 ± 0.03^{cd} (0.30 - 0.70)	0.58 ± 0.05^{cd} (0.30 - 0.90)	0.32 ± 0.03^{cd} (0.12 - 0.56)
<i>Acacia auriculiformis</i>	-	-	-	-	-
<i>Acacia nilotica</i>	Straight and thin in pairs at the base of leaf	2.00 ± 0.00^b (2.00 - 2.00)	3.87 ± 0.13^a (2.70 - 4.60)	1.95 ± 0.06^b (1.50 - 2.50)	7.50 ± 0.33^a (5.40 - 11.50)
<i>Acacia polyacantha</i>	Hooked in pairs at the base of the petiole	2.00 ± 0.00^b (2.00 - 2.00)	0.79 ± 0.10^{cd} (0.30 - 1.60)	0.72 ± 0.10^c (0.30 - 1.60)	0.75 ± 0.18^{cd} (0.09 - 2.56)
<i>Acacia sieberiana</i> var. <i>sieberiana</i>	Straight in pairs at the base of leaf, one longer than the other	2.00 ± 0.00^b (2.00 - 2.00)	4.13 ± 0.52^a (0.80 - 8.00)	0.21 ± 0.02^e (0.10 - 0.30)	0.86 ± 0.12^c (0.05 - 1.83)
<i>Acacia sieberiana</i> var. <i>villosa</i>	Straight in pairs at the base of leaf, one longer than the other	2.00 ± 0.00^b (2.00 - 2.00)	2.57 ± 0.46^b (0.50 - 5.80)	0.31 ± 0.09^{de} (0.10 - 2.00)	0.56 ± 0.11^{cd} (0.05 - 1.74)
<i>Acacia senegal</i>	In threes at the base of the leaf, two curved up and the third bent downward	3.00 ± 0.00^b (3.00 - 3.00)	0.51 ± 0.03^d (0.30 - 0.70)	0.39 ± 0.02^{de} (0.20 - 0.60)	0.21 ± 0.02^d (0.06 - 0.42)
Total		2.84 ± 0.17	1.96 ± 0.16	1.01 ± 0.09	2.01 ± 0.23
P value		0.000**	0.000**	0.000**	0.000**

Means with different superscripts along the column differed significantly ($P < 0.05$)

Values in parenthesis are range

DISCUSSION

Foliar morphological characters in the studied *Acacia* species revealed that in almost all the species leaves were compound bipinnate, alternate, pinnules oblong. However the pinnules of *A. senegal* are obovate. In *A. auriculiformis* the leaves are simple and sickle-like in shape. Leaves texture ranges from glabrous to pubescent. Uniformity in the type of leaves may be due to their monophyletic origin but variation in the structure of leaves also lies towards their polyphyletic origin. This is in agreement with Kull and Rangen (2012) who claim that *Acacia* species are polyphyletic in origin. The descriptions of the studied species are in line with works of Arbonnier (2004), Dagba and Harris (2014) who outlined the distinguishing features of some *Acacia* species.

All species showed variation in whole leaf length however there was no difference between *A. ataxacantha* and *A. sieberiana* var. *sieberiana* and also between *A. nilotica* and *A. senegal*. Generally variations were recorded in pinna length however the length of pinna was the same in *A. albida* and *A. nilotica* and between *A. ataxacantha* and *A. senegal*. Similarly variations were recorded in number of pinna, pinnules number per pinna and gland number. Variations in different morphological characters are of taxonomic importance in the identification of each species. These similarities and differences in morphological characters might not be due to variation in environmental conditions. The eight species which have been studied in this work were collected from Zaria and its environs which are within 150 kilometers and this area could play a role in these variations and similarities. Genetic factors of individual species could also determine these characters. However variation and similarities may also determine productivity of the plant as also reported by Abubakar *et al.* (2011); Dagba and Harris (2014)

All the species had thorns of various shapes, size and numbers. Variations in thorn characteristics and their measurement are inherent among the species; these variations could be taxonomically significance in the identification of the various *Acacia* species found in Zaria Arbonnier (2004); Dagba and Harris (2014) also reported variations in thorn characteristics of some *Acacia* species from Nigeria.

CONCLUSION

It was concluded that significant morphological variations were found among *Acacia* species in Zaria with *Acacia sieberiana* var. *sieberiana* and *Acacia sieberiana* var. *villosa* having the largest leaves (Pinna lengths: 3.50 ± 0.11 cm and 3.82 ± 0.16 μ m respectively) that were highest in number (18.80 ± 1.32 and 41.70 ± 1.52 respectively). However, the spines in *A. ataxacantha* were the largest (6.90 ± 0.71 cm).

RECOMMENDATION

Studies involving detailed structure of anatomical characteristics, inflorescence and seed morphology of *Acacia* species found in Nigeria

Observation of pollen grains with scanning electron microscope so as to provide detailed structures of the pollen grains

Molecular studies of *Acacia* species found in Nigeria for the detailed information on their taxonomy.

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