

Taxonomic Studies on Some Members of the Genus Abutilon Mill. (Malvaceae)

Dhafer A. Alzahrani^{1*}, Enas J. Albokhari^{1,2}, Abrar Khoj¹

¹Department of Biological Sciences, Faculty of Sciences, King Abdulaziz University, Jeddah, Saudi Arabia ²Department of Biological Sciences, Faculty of Applied Sciences, Umm Al-Qura University, Makkah, Saudi Arabia Email: *dalzahrani@kau.edu.sa, *dhaferalzahrani@hotmail.com

How to cite this paper: Alzahrani, D.A., Albokhari, E.J. and Khoj, A. (2021) Taxonomic Studies on Some Members of the Genus Abutilon Mill. (Malvaceae). American Journal of Plant Sciences, 12, 199-220. https://doi.org/10.4236/ajps.2021.122012

Received: January 10, 2021 Accepted: February 23, 2021 Published: February 26, 2021

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Abstract

The relationship between six Abutilon species was examined using different taxonomic investigation tools. The investigation was carried out using morphological and numerical studies. Fresh materials of Abutilon species were collected from different localities in Saudi Arabia during 2018 and 2019. Numerical analysis was based on the Principle Coordinates, the Principle Component and the Unweighted Pair Group Method with Arithmetic Algorithm Clustering. The results indicated that there were significant differences based on the morphological characters especially in the leaves, fruits and flowers features. Morphometric studies revealed that the six species of Abutilon clearly separated in all different analysis.

Keywords

Taxonomy, Malvaceae, Abutilon, Morphological Characters, Morphometric Analysis, UPGMA, PCoA, PCA

1. Introduction

Malvaceae is one of the flowering plants, which has been divided into nine subfamilies, containing about 244 genera, and 4225 species [1], distributed in tropic and subtropical regions and all over the world. This family includes the economically important plants such as cotton, okra and other ornamental shrubs. Genus Abutilon Mill. belongs to subfamily Malvoideae, Malvaceae family, comprising about 200 species, annual or perennial herbs and shrubs or even small trees, distributed in tropics and subtropics of the Americas, Africa, Asia, and Australia. The genus has significant importance, this is due to the fibbers and they contain different chemical compounds such as flavonoids, sterols, triterpenes, anthocyanins and fatty acids [2] [3].

Bentham and Hooker [4] divided Malveae into four subtribes based on the carpel arrangement, the number and position of ovule per carpel: Abutilinae, Malopinae, Malvinae, and Sidinae. While Hutchinson Hutchinson [5] reclassified Malvaceae and its tribes by combined the two subtribes Abutilinae and Sidinae into tribe Abutileae. Fryxell [6] placed *Herrisantia, Robinsonella* and *Sida alliances* into the genus *Abutilon*. The tribes (Abutileae and Malveae) were included in the system of [7]. [8] separated the two subtribes Malveae and Sidinae based on molecular data from Malveae under tribe Sidieae. The only one of *Abutilon* is poorly understood that belongs to infrageneric classification.

Several scientists have observed different species number in genus *Abutilon*. Baker [9] mentioned 172 species, Mattei [10] counted 100 species, while Hutchinson [5] and Husain and Baquar [11] recorded more than 400 species in genus *Abutilon*. Mabberley [12] reported 100 species, whereas Fryxell [13] stated around 160 species in genus *Abutilon*.

Taxonomic studies have been reported on *Abutilon* Mill. by several authors. El Naggar [14] studied pollen morphological characters of 21 species of Egyptian Malvaceae including 2 species for *Abutilon*: (*Abutilon theophrasti* Medik. and *A. pannosum* (G. Forst.) Schledt.), while Shaheen, *et al.* [15] studied pollen morphology for nine species of *Abutilon*. Taia [2] recorded five species of *Abutilon* in Saudi Arabia (*A. bidentatum* Hoch, *A. figarium* Webb, *A. fruticosum* Guill & Perr., *A. hirtum* Don and *A. pannosum* Schlecht.) based on morphological characters of leaves, flowers and fruits.

Floral characters are important features used to identifying and describe *Abutilon* plants as many Angiospermae plants. Flowers were described in several characteristics such as: size, stigma, stamens (number of stamens, forming a staminal tube around the style), number and colour of petals and sepals, length of petioles, bracteate, pedicellate, hermaphrodite, pentamerous, axile placentation [16] [17] [18] [19] [20]. Fruits are one of the most important parts that distinctive *Abutilon* species from each other. Many authors [11] [16] [17] [18] [20] [21] [22] [23] [24] were used fruit characters to distinguish *Abutilon* species such as shape, size, number of seed and carpels and present or absent of awn in carpels. Therefore, the main objectives of this study are to provide constant and reliable diagnostic characters by using numerical taxonomic methods and morphological characters, and to compare the results obtained from the morphological and morphometric data.

2. Materials and Methods

2.1. Collection and Identification of Plant Materials

43 samples were collected during 2018 and 2019 from 19 localities of Saudi Arabia (**Table 1**). For all collection's samples, the type of habits, the height of plants, the latitude and longitude of all sites were recorded. The samples were placed in 70% ethanol to study the morphological features; the sample number, location, the name of the collector, and the date of collection were reported. The plant

No.	Col. No.	Species name	Date of collection	Location	Coord	inates
1	A1	A. pannosum (Frost. Fil.) Schltdl	15-8-2018	Khulais	22°7'16"N	39°18'32"E
2	A2	A. pannosum (Frost. Fil.) Schltdl	15-8-2018	Khulais	22°7'16"N	39°18'32"E
3	A3	A. pannosum (Frost. Fil.) Schltdl	15-8-2018	Khulais	22°7'16"N	39°18'32"E
4	A4	A. pannosum (Frost. Fil.) Schltdl	15-8-2018	Badr Al-Madinah	23°45'59"N	38°48'9"E
5	A5	A. pannosum (Frost. Fil.) Schltdl	15-8-2018	Badr Al-Madinah	23°45'59"N	38°48'9"E
6	A6	A. pannosum (Frost. Fil.) Schltdl	15-8-2018	Badr Al-Madinah	23°45'59"N	38°48'9"E
7	A7	A. pannosum (Frost. Fil.) Schltdl	18-8-2018	Jeddah near to Al Estad region	21°26'23"N	39°15'14"E
8	A8	A. pannosum (Frost. Fil.) Schltdl	18-8-2018	Jeddah, east of the highway	21°26'12"N	39°14'57"E
9	A9	A. pannosum (Frost. Fil.) Schltdl	18-8-2018	Jeddah, east of the highway	21°26'12"N	39°14'57"E
10	A10	A. pannosum (Frost. Fil.) Schltdl	18-8-2018	Jeddah, Al-Rehab	21°32'34"N	39°13'41"E
11	A11	A. pannosum (Frost. Fil.) Schltdl	18-8-2018	Jeddah, Al-Rehab	21°32'34"N	39°13'41"E
12	A12	A. pannosum (Frost. Fil.) Schltdl	22-8-2018	Al Bahah, Al-Makhwah Aqaba Haznah	19°46'49"N	41°26'29"E
13	A13	A. pannosum (Frost. Fil.) Schltdl	22-8-2018	Al Bahah, Al-Makhwah Aqaba Haznah	19°46'49"N	41°26'29"E
14	A14	A. pannosum (Frost. Fil.) Schltdl	22-8-2018	Al Bahah, Al-Makhwah Aqaba Haznah	19°46'49"N	41°26'29"E
15	A15	A. pannosum (Frost. Fil.) Schltdl	22-8-2018	Al Bahah, between Al-Makhwah and Al Mudailif	19°38'19"N	41°20'25"E
16	A16	A. pannosum (Frost. Fil.) Schltdl	22-8-2018	Al Bahah, between Al-Makhwah and Al Mudailif	19°38'19"N	41°20'25"E
17	A17	A. pannosum (Frost. Fil.) Schltdl	26-9-2018	Jeddah, near to Harazat	21°31'11"N	39°15'25"E
18	A18	A. figarianum Webb	26-9-2018	Jeddah, near to Harazat	21°31'11"N	39°15'25"E
19	A19	A. pannosum (Frost. Fil.) Schltdl	26-9-2018	Jeddah, near to Harazat	21°31'11"N	39°15'25"E
20	A20	A. pannosum (Frost. Fil.) Schltdl	4-10-2018	Makkah, Al Fayhaa	21°26'24"N	39°46'1"E
21	A21	A. pannosum (Frost. Fil.) Schltdl	4-10-2018	Makkah, Al Awali	21°21'3"N	39°52'35"E
22	A22	A. pannosum (Frost. Fil.) Schltdl	4-10-2018	Makkah, Al Awali	21°21'3"N	39°52'35"E
23	A23	A. pannosum (Frost. Fil.) Schltdl	4-10-2018	Makkah, Al Awali	21°21'3"N	39°52'35"E
24	A24	A. pannosum (Frost. Fil.) Schltdl	5-10-2018	Makkah Wadi Noman	21°20'59"N	40°6'25"E
25	A25	A. pannosum (Frost. Fil.) Schltdl	5-10-2018	Makkah, Wadi Noman	21°20'59"N	40°6'25"E
26	A26	A. pannosum (Frost. Fil.) Schltdl	9-10-2019	Abha, Aqabat Al Samma	18°21'12"N	42°8'9"E
27	A27	A. figarianum Webb	9-10-2019	Abha, Aqabat Al Samma	18°21'12"N	42°8'9"E
28	A28	A. pannosum (Frost. Fil.) Schltdl	9-10-2019	Abha, Aqabat Al Samma	18°21'12"N	42°8'9"E
29	A29	A. grandifolium (Willd.) Sweet	9-10-2019	Abha, Aqabat Al Samma	18°21'12"N	42°8'9"E
30	A30	A. grandifolium (Willd.) Sweet	9-10-2019	Abha, Aqabat Al Samma	18°21'12"N	42°8'9"E
31	A31	A. grandifolium (Willd.) Sweet	9-10-2019	Abha, Aqabat Al Samma	18°21'12"N	42°8'9"E
32	A32	A. pannosum (Frost. Fil.) Schltdl	9-10-2019	Abha, Aqabat Dhela'	17°55'13"N	42°27'10"E
33	A33	A. figarianum Webb	9-10-2019	Abha Aqabat Dhela'	17°55'13"N	42°27'10"E
34	A35	A. pannosum (Frost. Fil.) Schltdl	30-10-2019	Al Qunfudhah Khamis Harb	19°10'45"N	41°31'51"E
35	A36	A. pannosum (Frost. Fil.) Schltdl	30-10-2019	Al Qunfudhah Khamis Harb	19°10'45"N	41°31'51"E

 Table 1. Accessions of Saudi Arabian Abutilon species collected for the morphological studies, including collection number (Col. no.), date of collection, locality and coordinators information. All vouchers were collected by Abrar Khoj and Dhafer Alzahrani.

Continued

36	A37	A. hirtum (Lam). Sweet	10-11-2019	Najran Hadadah	17°35'44"N	43°44'49"E
37	A38	A. pannosum (Frost. Fil.) Schltdl	12-11-2019	Adum	20°27'7"N	40°52'42"E
38	A39	A. pannosum (Frost. Fil.) Schltdl	12-11-2019	Adum	20°27'7"N	40°52'42"E
39	A40	A. pannosum (Frost. Fil.) Schltdl	12-11-2019	Adum	20°26'7"N	40°52'43"E
40	A41	A. pannosum (Frost. Fil.) Schltdl	20-11-2019	Al Dammam	26°25'12"N	50°04'44"E
41	D63	A. pannosum (Frost. Fil.) Schltdl	3-5-2018	Alwasha-Al Taif	21°14'52"N	40°25'54"E
42	D64	A. fruticosum Guill & Perr	3-5-2018	Alwasha-Al Taif	21°14'52"N	40°25'54"E
43	D74	A. bidentatum Hochest. Ex A. Rich	19-10-2018	Al Baha Al Aqiq	20°13'19"N	41°36'20"E

specimens were identified at the herbarium of the King Abdulaziz University, Jeddah, Saudi Arabia. Voucher specimens were deposited in the herbarium for reference and further studies.

2.2. Macromorphological Investigation

36 Morphological characteristics include 26 quantitative characters (**Table 2**) and 10 qualitative characters (**Table 3**) and (**Table 4**) such as leaves, flowers and fruits characters, were examined and scored using a light microscope M6C-10 and hand lens X10. The average measurements for ten mature leaves, flowers, and fruits were taken for each sample. Measurements are given in centimetres and millimetres. Also photographs of relevant morphological features were taken.

2.3. Numerical Analysis

Based on the qualitative and quantitative characters were analysed the Principle Coordinates Analysis (PCoA) and the Unweighted Pair Group Method with Arithmetic Algorithm (UPGMA) based on the similarity matrix generated using Gower's general similarity coefficient [25]. Both analyses were performed using the package MVSP version 3.1 [26]. While, based on quantitative characters were analysed the Principle Component Analysis (PCA) using Minitab package 15.1.30 [27].

The Cluster Analysis: One of the commonly used approaches is the unweighted pair group method with arithmetic algorithm (UPGMA) [28] approach to cluster analysis and is also a simple method for tree construction. The UPGMA was implemented using the MVSP version 3.1 package [26], and the clustering introduced the general similarity coefficient of Gower [25].

The Principle Coordinate Analysis (PCoA): The Principle Coordinate Analysis was conducted employ version 3.1 of the MVSP package [26], utilize the same matrix of similarity generated using the general coefficient of similarity of Gower [25].

The Principle Component Analysis (PCA): For quantitative morphological characteristics (Table 5), Principle Component Analysis was performed and the

No.	Characters	No.	Characters
1.	Plant high (m)	14.	Length of stamens (mm)
2.	Length of stipulate (mm)	15.	Length of filaments (mm)
3.	Length of petiolate (mm)	16.	Number of filaments
4.	Length of midrib (mm)	17.	Length of style (mm)
5.	Length of leaf (mm)	18.	Length of mericarp (mm)
6.	Length of petal (mm)	19.	Width of mericarp (mm)
7.	Width of petal (mm)	20.	Number of mericarps
8.	Flower diameter (mm)	21.	Length of fruit (mm)
9.	Length of upper part of the pedicle (mm)	22.	Width of fruit (mm)
10.	Length of lower part of the pedicle (mm)	23.	Length of seed (mm)
11.	Length of whole pedicle (mm)	24.	Width of seed (mm)
12.	Length of sepals (mm)	25.	Number of seeds per mericarp
13.	Width of sepals (mm)	26.	Length of awn on seed (mm)

Table 2. 26 quantitative morphological characters of 43 Abutilon samples.

Table 3. Ten qualitative morphological characters and character states used in morphometric analysis of Abutilon samples.

No.	Character	Character state	Code
		Shrub ≤ 1 m	1
1	Habit	Shrub > 1 m \leq 2.5 m	2
		Shrub > 2.5 m	3
		Glabrous	1
2	I ash such as	Pubescent to tomentose	2
2	Leaf surface	Velvety	3
		Hairy	4
		Green	1
3	Leaf colour	Greyish green	2
		Yellowish green	3
4	T f .h	Cordate	1
4	Leaf shape	Ovate to broadly ovate	2
		Acute	1
-	T C	Cuspidate	2
5	Leaf apex	Acute to cuspidate	3
		Obtuse	4
		Truncate	1
6	Leaf base	Cordate	2
		Truncate to Cordate	3
		Double serrate	1
7	Leaf margin	Double Denticulate to Dentate	2
		Entire	3
		Yellow	1
8	Flower colour	Yellow with a red centre	2
		Yellow pale	3
0	Eruit shape	Globose schizocarp	1
7	Fruit snape	Cylindric schizocarp	2
10	Mericarn shape	Reniform with rounded apex	1
10	Mericarp Shape	Reniform with pointed apex	2

specimen code	Habit	Leaf surface	Leaf colour	Leaf shape	Leaf apex	Leaf base	Leaf margin	Flower colour	Fruit shape	Mericarp shape	Location
A1	Shrub > 1 m ≤ 2.5 m	Velvety	Green	Ovate to broadly ovate	Acute to Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Khulais
A2	Shrub > 1 m ≤ 2.5 m	Velvety	Green	Cordate	Acute to Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Khulais
A3	Shrub > 1 m ≤ 2.5 m	Velvety	Green	Ovate to broadly ovate	Acute to Cuspidate	Truncate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Khulais
A4	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Yellowish green	Ovate to broadly ovate	Cuspidate	Cordate	Double serrate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Madinah
A5	Shrub ≤ 1 m	Pubescent to tomentosa	Yellowish green	Ovate to broadly ovate	Acute to Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Madinah
A6	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Yellowish green	Ovate to broadly ovate	Acute to Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Madinah
A7	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Yellowish green	Ovate to broadly ovate	Acute to Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Jeddah
A8	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Ovate to broadly ovate	Acute to Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Jeddah
A9	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Yellowish green	Ovate to broadly ovate	Cuspidate	Cordate	Double serrate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Jeddah
A10	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Cordate	Acute	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Jeddah
A11	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Ovate to broadly ovate	Acute to Cuspidate	Cordate	Double serrate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Jeddah
A12	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Ovate to broadly ovate	Acute	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Al baha
A13	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Cordate	Acute	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Al baha
A14	Shrub $\leq 1 \text{ m}$	Pubescent to tomentosa	Green	Cordate	Obtuse	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Al baha
A15	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Cordate	Obtuse	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Al baha

Table 4. Qualitative morphological characters and character states used in morphometric analysis of Saudi Arabian Abutilon plants.

Continued

A16	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Ovate to broadly ovate	Acute	Cordate	Double serrate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Al baha
A17	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Cordate	Acute to Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Jeddah
A18	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Ovate to broadly ovate	Acute	Cordate to truncate	Double denticulate to dentate	Yellow	Globose Schizocarp	Reniform with rounded apex	Jeddah
A19	Shrub > 2.5 m	Pubescent to tomentosa	Green	Ovate to broadly ovate	Obtuse	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Jeddah
A20	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Ovate to broadly ovate	Acute to Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Makka
A21	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Ovate to broadly ovate	Acute to Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Makka
A22	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Ovate to broadly ovate	Acute to Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Makka
A23	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Ovate to broadly ovate	Acute	Cordate to truncate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Makka
A24	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Yellowish green	Cordate	Acute	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Makka
A25											
	Shrub ≤ 1 m	Pubescent to tomentosa	Yellowish green	Ovate to broadly ovate	Acute to Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Makka
A26	Shrub $\leq 1 \text{ m}$ Shrub $> 1 \text{ m}$ $\leq 2.5 \text{ m}$	Pubescent to tomentosa Pubescent to tomentosa	Yellowish green Yellowish green	Ovate to broadly ovate Ovate to broadly ovate	Acute to Cuspidate Acute	Cordate Truncate	Double denticulate to dentate Double denticulate to dentate	Yellow with red center Yellow with red center	Globose Schizocarp Globose Schizocarp	Reniform with rounded apex Reniform with rounded apex	Makka Abaha
A26 A27	Shrub $\leq 1 \text{ m}$ Shrub $> 1 \text{ m}$ $\leq 2.5 \text{ m}$ Shrub $> 1 \text{ m}$ $\leq 2.5 \text{ m}$	Pubescent to tomentosa Pubescent to tomentosa	Yellowish green Yellowish green Yellowish green	Ovate to broadly ovate Ovate to broadly ovate to broadly ovate	Acute to Cuspidate Acute Acute to Cuspidate	Cordate Truncate Cordate	Double denticulate to dentate Double denticulate to dentate denticulate to dentate	Yellow with red center Yellow with red center Yellow	Globose Schizocarp Globose Schizocarp Globose Schizocarp	Reniform with rounded apex Reniform with rounded apex Reniform with rounded apex	Makka Abaha Abaha
A26 A27 A28	Shrub $\leq 1 \text{ m}$ Shrub $> 1 \text{ m}$ $\leq 2.5 \text{ m}$ Shrub $> 1 \text{ m}$ $\leq 2.5 \text{ m}$ Shrub $> 1 \text{ m}$ $\leq 2.5 \text{ m}$	Pubescent to tomentosa Pubescent to tomentosa Pubescent to tomentosa	Yellowish green Yellowish green Yellowish green	Ovate to broadly ovate broadly ovate Ovate to broadly ovate Ovate to broadly ovate	Acute to Cuspidate Acute Acute to Cuspidate Cuspidate	Cordate Truncate Cordate Cordate	Double denticulate to dentate denticulate to dentate Double denticulate to dentate to dentate	Yellow with red center Yellow with red center Yellow Yellow with red center	Globose Schizocarp Globose Schizocarp Globose Schizocarp	Reniform with rounded apex Reniform with rounded apex Reniform with rounded apex	Makka Abaha Abaha Abaha
A26 A27 A28 A29	Shrub $\leq 1 \text{ m}$ Shrub $> 1 \text{ m}$ $\leq 2.5 \text{ m}$ Shrub $> 1 \text{ m}$ $\leq 2.5 \text{ m}$ Shrub $> 1 \text{ m}$ $\leq 2.5 \text{ m}$ Shrub $> 1 \text{ m}$	Pubescent to tomentosa Pubescent to tomentosa Pubescent to tomentosa Hairy	Yellowish green Yellowish green Yellowish green Green	Ovate to broadly ovate Ovate to broadly ovate Ovate to broadly ovate Ovate to broadly ovate	Acute to Cuspidate Acute to Cuspidate Cuspidate	Cordate Truncate Cordate Cordate	Double denticulate to dentate denticulate to dentate Double denticulate to dentate to dentate denticulate to dentate	Yellow with red center Yellow with red center Yellow with red center Yellow	Globose Schizocarp Globose Schizocarp Globose Schizocarp Cylindric Schizocarp	Reniform with rounded apex Reniform with rounded apex Reniform with rounded apex Reniform with rounded apex	Makka Abaha Abaha Abaha
A26 A27 A28 A29 A30	Shrub $\leq 1 \text{ m}$ Shrub $\geq 1 \text{ m}$ $\leq 2.5 \text{ m}$ Shrub $\geq 1 \text{ m}$ $\leq 2.5 \text{ m}$ Shrub $\geq 1 \text{ m}$ Shrub $\leq 1 \text{ m}$ Shrub $\leq 1 \text{ m}$	Pubescent to tomentosa Pubescent to tomentosa Pubescent to tomentosa Hairy Hairy	Yellowish green Yellowish green Yellowish green Green	Ovate to broadly ovate broadly ovate broadly ovate Ovate to broadly ovate Cordate Ovate to broadly	Acute to Cuspidate Acute Acute to Cuspidate Cuspidate Cuspidate	Cordate Cordate Cordate Cordate Cordate	Double denticulate to dentate benticulate to dentate Double denticulate to dentate Double denticulate to dentate Double denticulate to dentate	Yellow with red center Yellow with red center Yellow with red center Yellow Yellow	Globose Schizocarp Globose Schizocarp Globose Schizocarp Cylindric Schizocarp Cylindric	Reniform with rounded apex Reniform with rounded apex Reniform with rounded apex Reniform with pointed apex Reniform with	Makka Abaha Abaha Abaha

A32	Shrub > 2.5 m	Pubescent to tomentosa	Green	Ovate to broadly ovate	Acute	Cordate to truncate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Abaha
A33	Shrub > 2.5 m	Pubescent to tomentosa	Green	Ovate to broadly ovate	Cuspidate	Cordate to truncate	Double denticulate to dentate	Yellow	Globose Schizocarp	Reniform with rounded apex	Abaha
A35	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Yellowish green	Cordate	Acute to Cuspidate	Cordate to truncate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Al Qunfudhah
A36	Shrub > 2.5 m	Velvety	Green	Ovate to broadly ovate	Acute to Cuspidate	Cordate to truncate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Al Qunfudhah
A37	Shrub > 1 m ≤ 2.5 m	Velvety	Green	Ovate to broadly ovate	Acute to Cuspidate	Cordate	Double denticulate to dentate	Yellow pale	Cylindric Schizocarp	Reniform with pointed apex	Najran
A38	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Cordate	Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Adum
A39	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Cordate	Acute to Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Adum
A40	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Green	Ovate to broadly ovate	Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	-	-	Adum
A41	Shrub > 1 m ≤ 2.5 m	Velvety	Green	Ovate to broadly ovate	Cuspidate	Cordate to truncate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Al Dam- mam
D63	-	Pubescent to tomentosa	Green	Ovate to broadly ovate	Cuspidate	Cordate	Double denticulate to dentate	Yellow with red center	Globose Schizocarp	Reniform with rounded apex	Al Taif
D64	-	Glabrous	Grayish green	Ovate to broadly ovate	Acute to Cuspidate	Cordate	Entire	Yellow pale	Cylindric Schizocarp	Reniform with pointed apex	Al Taif
D74	Shrub > 1 m ≤ 2.5 m	Pubescent to tomentosa	Yellowish green	Ovate to broadly ovate	Cuspidate	Cordate	Double denticulate to dentate	Yellow	Cylindric Schizocarp	Reniform with pointed apex	Al baha

Continued

Table 5. Oualitative mo	orphological characters	and their cods used in m	orphometric analy	vsis of Saudi Arabian	Abutilon plants.

Sample No.	Specimens No.	Habit	Leaf surface	Leaf colour	Leaf shape	Leaf apex	Leaf base	Leaf margin	Flower colour	Fruit shape	Mericarp shape
1	A 1	2	3	1	2	3	2	2	2	1	1
2	A 2	2	3	1	1	3	2	2	2	1	1
3	A 3	2	3	1	2	3	1	2	2	1	1
4	A 4	2	2	3	2	2	2	1	2	1	1
5	A 5	1	2	3	2	3	2	2	2	1	1
6	A 6	2	2	3	2	3	2	2	2	1	1

Continued											
7	A 7	2	2	3	2	3	2	2	2	1	1
8	A 8	2	2	1	2	3	2	2	2	1	1
9	A 9	2	2	3	2	2	2	1	2	1	1
10	A 10	2	2	1	1	1	2	2	2	1	1
11	A 11	2	2	1	2	3	2	1	2	1	1
12	A 12	2	2	1	2	1	2	2	2	1	1
13	A 13	2	2	1	1	1	2	2	2	1	1
14	A 14	1	2	1	1	4	2	2	2	1	1
15	A 15	2	2	1	1	4	2	2	2	1	1
16	A 16	2	2	1	2	1	2	1	2	1	1
17	A 17	2	2	1	1	3	2	2	2	1	1
18	A 18	2	2	1	2	1	3	2	1	1	1
19	A 19	3	2	1	2	4	2	2	2	1	1
20	A 20	2	2	1	2	3	2	2	2	1	1
21	A 21	2	2	1	2	3	2	2	2	1	1
22	A 22	2	2	1	2	3	2	2	2	1	1
23	A 23	2	2	1	2	1	3	2	2	1	1
24	A 24	2	2	3	1	1	2	2	2	1	1
25	A 25	1	2	3	2	3	2	2	2	1	1
26	A 26	2	2	3	2	1	1	2	2	1	1
27	A 27	2	2	3	2	3	2	2	1	1	1
28	A 28	2	2	3	2	2	2	2	2	1	1
29	A 29	1	4	1	1	2	2	2	1	2	2
30	A 30	1	4	1	2	2	2	2	1	2	2
31	A 31	2	4	1	2	2	2	2	1	2	2
32	A 32	3	2	1	2	1	3	2	2	1	1
33	A 33	3	2	1	2	2	3	2	1	1	1
34	A 35	2	2	3	1	3	3	2	2	1	1
35	A 36	3	3	1	2	3	3	2	2	1	1
36	A 37	2	3	1	2	3	2	2	3	2	2
37	A 38	2	2	1	1	2	2	2	2	1	1
38	A 39	2	2	1	1	3	2	2	2	1	1
39	A 40	2	2	1	2	2	2	2	2	0	0
40	A 41	2	3	1	2	2	3	2	2	1	1
41	D 63	0	2	1	2	2	2	2	2	1	1
42	D 64	0	1	2	2	3	2	3	3	2	2
43	D 74	2	2	3	2	2	2	2	1	2	2

component values for each plant were measured in two dimensions. For each character, the PCA was employed to assess the distinctions between species, to decide how well the morphology helps to separate groups from each other, and to recognize any morphological discontinuities or overlaps within and between the *Abutilon* species taxa under study. PCA tests were performed using Minitab package 15.1.30 [27].

3. Results

3.1. Morphological Characters

Growth Habit. The habit of the species under study was defer from small shrub about 0.8 m high to large shrub up 3.7 m high. This character has divided the six species into three groups, first group include plants high ranging from meter or less, as in *A. grandifolium* and *A. pannosum* (Figure 1(A)), the second group contains species high form meter and less or equal to two and a half meters, as in *A. grandifolum*, *A. pannosum*, *A. hirtum*, *A. figarianum*, *A. frutico-sum* and *A. bidentatum* (Figure 1(B)) and the third group compress species that range greater than two and a half meters, as in *A. pannosum* (Figure 1(C)).

Colour of Plant: The main colour of *Abutilon* plants are green as in *A. hirtum*, *A. figarianum*, *A. grandifolum*, *A. pannosum* (Figure 2(A)), greyish green as in



Figure 1. Shows different habit of *Abutilon* plants, (A) Shrub ≤ 1 m; (B) Shrub > 1 m ≤ 2.5 m; (C) Shrub > 2.5 m.



Figure 2. Shows different colour of *Abutilon* plants in the field: (A) Green colour, (B) Greyish green, (C) Yellowish green.

A. fruticosum (Figure 2(B)) and yellowish-green as in *A. bidentatum*, *A. figarianum* and *A. pannosum* (Figure 2(C)).

3.2. Leaf Characters

Leaf Shape: there are two type of leaf shape in the six studding *Abutilon* species. The common shape is cordate as in *A. grandifolium* and *A. pannosum* (Figure 3(A)), the second shape is ovate to broadly ovate as in *A. fruticosum*, *A. bidenta-tum*, *A. hirtum*, *A. figarianum*, *A. grandifolium* and *A. pannosum* (Figure 3(B)).

Leaf Surface. plants of *A. fruticosum* species have glabrous leaf surface (Figure 4(A)), while leaves are velvety in *A. hirtum* and *A. pannosum* (Figure 4(B)), pubescent to tomentose as in *A. bidentatum*, *A. figarianum* and *A. pannosum* (Figure 4(C)) and the leaves are hairy surface in *A. grandifolium* (Figure 4(D)).

Leaf Apex: Several shapes for leaf apex were discovered in the six *Abutilon* species. Acute apex as in *A. figarianum* and *A. pannosum* (Figure 5(A)), cuspidate apex as in *A. bidentatum*, *A. figarianum* and *A. grandifolium* (Figure 5(B)), acute to cuspidate apex as in *A. fruticosum A. hirtum*, *A. figarianum* and *A. pannosum* (Figure 5(C)) and obtuse apex as in *A. pannosum* (Figure 5(D)).



Figure 3. Shows two shapes of leaves, (A) Cordate, (B) Ovate to broadly ovate.



Figure 4. Shows variations in the leaf surface, (A) Glabrous, (B) Velvety, (C) Pubescent to tomentose, (D) Hairy.



Figure 5. Shows four leaf apex shapes, (A) Acute, (B) Cuspidate, (C) Acute to cuspidate, (D) Obtuse.

Leaf Base: three types of leaf base were observed in the six *Abutilon* species, the cordate leaf base as in the *A. fruticosum*, *A. bidentatum*, *A. hirtum*, *A. figarianum*, *A. grandifolium* and *A. pannosum* species (**Figure 6(A)**), truncate leaf base as in the *A. pannosum* species (**Figure 6(B)**) and cordate to truncate leaf base were recorded in the *A. figarianum* and the *A. pannosum* species (**Figure 6(B)**).

Leaf Margin: There are three types of leaf margin shapes were observed in the studying *Abutilon* species. Double serrate margin in *A. pannosum* (Figure 7(A)), double denticulate to dentate leaf margin as in *A. bidentatum*, *A. hirtum* and *A. figarianum* (Figure 7(B)) and entire leaf margin as in the *A. fruticosum A. grandifolium* and *A. pannosum* species (Figure 7(C)).

3.3. Flower Characters

Colour of Petal: the colour of petal in the six *Abutilon* species is differ. Flowers of some species have yellow colour such as *A. bidentatum*, *A. figarianum* and *A. grandifolium* (Figure 8(A)), yellow pale flower as in the *A. fruticosum* and *A. hirtum* species (Figure 8(B)) and yellow with red in the centre as in the plants of *A. pannosum* species (Figure 8(C)).

3.4. Fruit Characters

Fruit Shape. there are two types of shape that can distinguish the six Abutilon species; globose shape as in *A. figarianum* and *A. pannosum* species (**Figure 9(A)**), and cylindric shape as in the *A. fruticosum*, *A. bidentatum*, *A. hirtum* and *A. grandifolium* (**Figure 9(B**)).

Carpel Shape: This study presented two different shapes of carpel, the first shape is a reniform with a rounded apex as in *A. figarianum* and *A. pannosum* species (Figure 10(A)), while the second shape is a reniform with pointed apex as in the *A. fruticosum*, *A. hirtum*, *A. bidentatum* and *A. grandifolium* species (Figure 10(B)).

3.5. Morphometric Analysis

Cluster Analysis (*UPGMA*): The UPGMA analysis separated the six *Abutilon* species into three major clusters (Figure 11). Cluster I divided into two subclades, first subclade includes three samples of *A. grandifolium*, while the second



Figure 6. Shows different types of leaf base, (A) Cordate, (B) Truncate, (C) Cordate to truncate.



Figure 7. Shows different shapes of the leaf margin of the studied *Abutilon* species, (A) Double serrate, (B) Double denticulate to dentate, (C) Entire.



Figure 8. Shows different petal colours in *Abutilon* species: (A) Yellow, (B) Yellow pale, (C) Yellow with red centre.



Figure 9. Shows different shapes of fruits in Abutilon species: (A) Globose, (B) Cylindric.

subclade contains three samples of *A. figarianum*. Cluster II divided into two subclades, first clade includes one samples of *A. hirtum* and whereas the second clade includes *A. bidentatum*, and *A. fruticosum*. Cluster III includes samples of the *A. pannosum* species.

Principle Coordinate Analysis (PCoA): Based on morphological data, the Gower's general similarity coefficient (Gower, 1966) was used for first three axis in the PCoA (Figure 12(A) and Figure 12(B)). The first three principle coordinate

0.52



Figure 10. Shows carpel shapes of *Abutilon* species: (A) Reniform with rounded apex; (B) Reniform with pointed apex.



Figure 11. The UPGMA analysis representation of morphological data of 43 accessions of *Abutilon* species. Roman numerals indicate clades number.

axis accounted for axis 1 (24.996%), axis 2 (12.835%) and axis 3 (7.562%). The variance of the first and second principle coordinate accounted 37.831% and the first and third principle coordinate accounted 32.558% of the total variation and the ordination of these three-axis showed six groups (Figure 12(A) and Figure 12(B)). Group 1 includes three samples of *A. grandifolium*, group 2 includes three samples of *A. figarianum*, group 3 includes one sample of *A. hirtum*, group 4 includes one sample of *A. bidentatum*, group 5 includes one sample of *A. fruticosum*, group 6 includes 34 samples of *A. pannosum* species (Figure 12(A)).

Principle Component Analysis (PCA): The patterns variations of the quantitative morphological characters are represented in the first two axis in the PCA score plot (Figure 13). The result of the PCA showed that the plants of the six *Abutilon* species under this study are separated into six groups (Figure 13). The Loading plot (Figure 14) is used for investigating the importance of each variable to each component and to define the eigenvalue of each axis (Table 6). A scree plot is useful to get information on the importance of the eigenvalues that are represented by PCA (Figure 15).



Figure 12. The PCoA representation of morphological data of 43 samples of the six *Abutilon* species. (A) Principle coordinate axis 1 and 2. (B) Principle coordinate axis 1 and 3.







Figure 14. Loading plot of PCA for 26 quantitative morphological characters of 43 *Ab*-*utilon* species.



Figure 15. Scree plot of PCA for the 26 quantitative morphological characters of *Abuti-lon* species.

 Table 6. Characters description and character abbreviation, loading on principal axis and Eigen analysis of principle component analysis of 43 plants of Saudi Arabian Abutilon species based on 26 quantitative morphological characters.

Morphological characters and character abbreviation	PC1	PC2	PC3	Eigenvalue	Proportion	Cumulative
C1: Plant high (m)	0.118	0.038	0.022	9.9289	0.382	0.382
C2: Length of stipulate (mm)	0.146	-0.328	-0.116	5.9846	0.23	0.612
C3: Length of petiolate (cm)	-0.007	-0.381	0.067	2.4129	0.093	0.705
C4: Length of midrib (cm)	0.146	-0.283	0.146	1.6646	0.064	0.769
C5: Length of leaf (cm)	0.125	-0.332	0.128	1.0805	0.042	0.81

Continued						
C6: Length of petal (cm)	0.229	-0.118	-0.201	1.0098	0.039	0.849
C7: Width of petal (cm)	0.298	-0.008	-0.106	0.9464	0.036	0.886
C8: Flower diameter (cm)	0.289	0.11	-0.06	0.729	0.028	0.914
C9: Length of pedicle from lower node (cm)	0.112	-0.151	0.414	0.6559	0.025	0.939
C10: Length of pedicle from upper node (cm)	0.128	0.083	0.48	0.4646	0.018	0.957
C11: Length of whole pedicle (cm)	0.132	-0.079	0.514	0.3563	0.014	0.971
C12: Length of sepals (mm)	0.303	0.081	-0.044	0.2715	0.01	0.981
C13: Width of sepals (mm)	0.228	0.239	0.029	0.1973	0.008	0.989
C14: Length of stamens (mm)	0.228	0.115	0.022	0.1183	0.005	0.993
C15: Length of filaments (mm)	0.211	-0.241	-0.169	0.1002	0.004	0.997
C16: Number of filaments	0.229	0.142	-0.103	0.0322	0.001	0.998
C17: Length of style (mm)	0.258	0.147	0.098	0.0298	0.001	0.999
C18: Length of mericarp (mm)	-0.002	-0.368	-0.113	0.0115	0	1
C19: Width of mericarp (mm)	0.21	0.024	0.081	0.0059	0	1
C20: Number of mericarp	0.225	0.141	-0.05	0	0	1
C21: Length of fruit (mm)	0.202	-0.253	-0.051	0	0	1
C22: Width of fruit (mm)	0.285	-0.056	0.013	0	0	1
C23: Length of seed (mm)	0.086	-0.029	-0.267	0	0	1
C24: Width of seed (mm)	0.05	-0.202	-0.133	0	0	1
C25: Number of seeds per mericarp	-0.229	-0.226	0.045	0	0	1
C26: Lentgh of awn on seed (mm)	0.116	0.016	-0.235	0	0	1

4. Discussion

Some morphological characters can be used in the field to differentiate *Abutilon* species from each other such as: habit, plant colour, leaf structures, flower colour and fruit features. This study distinguished six species of *Abutilon (A. frutico-sum, A. bidentatum, A. hirtum, A. figarianum, A. grandifolium* and *A. Panno-sum*) that were collected from different locations of Saudi Arabia based on morphological and morphometric data.

The *A. fruticosum* species is well known in Saudi Arabia and were reported by previous authors (Collenette 1985, 1999; Migahid 1996; Chaudhary 2001; Taia 2009). Collenette (1999) cited two taxa affinities to *A. fruticosum* species and she called one *A.* sp. *aff. fruticosum* and the second *A.* sp. nov. *aff. fruticosum*. However, our study's findings did not agree with these taxa affinities. Plants of this species are distributed in the central and from north-western to southwestern of Saudi Arabia (Table 1 and Figure 16) and they are distinguished by several characters, colour of leaf is grayish green (Figure 2(B)), leaf shape is ovate to broadly ovate (Figure 3(B)), leaf surface is glabrous (Figure 4(A)), leaf apex is acute to cuspidate (Figure 5(C)), leaf base is cordate (Figure 6(A)), leaf margin is entire (Figure 7(C)), colour of flower is yellow pale (Figure 8(B)), fruit



Figure 16. A distribution map of Abutilon species in Saudi Arabia.

shape is cylindric (Figure 9(B)), the mericarp is reniform with pointed apex (Figure 10(B)).

Species of *A. bidentatum* is also well known in Saudi Arabia and was recorded by previous authors (Collenette 1985, 1999; Migahid 1996; Chaudhary 2001; Taia 2009). Collenette (1999) reported two taxa affinity to *A. bidentatum* species and she called one *A.* sp. *aff. bidentatum* and the second is *A.* sp. nov. *aff. bidentatum*. However, our study's findings did not agree with these taxa affinities. Plants of this species are distributed in the western to southern regions of Saudi Arabia (Table 1 and Figure 16) and they are distinguished by several characters, colour of leaf is yellowish green (Figure 2(C)), leaf shape is ovate to broadly ovate (Figure 3(B)), leaf surface is pubescent to tomentosa (Figure 4(C)), leaf apex is cuspidate (Figure 5(B)), leaf base is cordate (Figure 6(A)), leaf margin is double denticulate to dentate (Figure 7(B)), colour of flower is yellow (Figure 8(A)), fruit shape is cylindric (Figure 9(B)), the mericarp is reniform with pointed apex (Figure 10(B)).

Species of *A. hirtum* was recorded by previous authors such as: Collenette 1999; Migahid 1996; Chaudhary 2001; Taia 2009. Plants of this species are distributed western and in the southern region of Saudi Arabia (Table 5 and Figure 16) and they are distinguished by several characters, colour of leaf is green (Figure 2(A)), leaf shape is ovate to broadly ovate (Figure 3(B)) leaf surface is velvety (Figure 4(B)), leaf apex is acute to cuspidate (Figure 5(C)), leaf base is cordate (Figure 6(A)), leaf margin is double denticulate to dentate (Figure 7(B)), colour of flower is yellow pale (Figure 8(B)), fruit shape is cylindric (Figure 9(B)), the mericarp is reniform with pointed apex (Figure 10(B)).

Species of *A. figarianum* was recorded by previous authors such as: Collenette 1999; Migahid 1996; Chaudhary 2001. Taia (2009) cited incorrect scientific name of *A. figarium*, the correct scientific name is *A. figarianum*. Plants of this species are distributed in the southern and western to southwestern regions of Saudi Arabia (Table 1 and Figure 16) and they are distinguished by several

characters, colour of leaf is green (Figure 2(A)) but sometimes in some samples yellowish green (Figure 2(C)), leaf shape is ovate to broadly ovate (Figure 3(B)), leaf surface is pubescent to tomentosa (Figure 4(C)), leaf apex is cuspidate (Figure 5(B)), or sometimes acute (Figure 5(A)) or acute to cuspidate (Figure 5(C)), leaf base is cordate to truncate (Figure 6(C)) sometimes cordate (Figure 6(A)), leaf margin is double denticulate to dentate (Figure 7(B)), colour of flower is yellow (Figure 8(A)), fruit shape is globose (Figure 9(A)) and the mericarp is reniform with rounded apex (Figure 10(A)).

The species of *A. grandifolium* was previously reported by Chaudhary (2001) only. Collentte (1985, 1999) nor Taia (2009) recorded this species distributed in Saudi Arabia. Plants of this species are distributed in the western region (**Table 1** and **Figure 16**) and they are distinguished by several characters, colour of leaf is green (**Figure 2(A)**), leaf shape is ovate to broadly ovate (**Figure 3(B)**) in some specimen are cordate (**Figure 3(B)**), leaf surface is hairy (**Figure 4(D)**), leaf apex is cuspidate (**Figure 5(B)**), leaf base is cordate (**Figure 6(A)**), leaf margin is double denticulate to dentate (**Figure 7(B)**), colour of flower is yellow (**Figure 8(A)**), fruit shape is cylindric (**Figure 9(B)**) and the mericarp is reniform with pointed apex (**Figure 10(B)**).

The species of *A. pannosum* is well known in Saudi Arabia and was reported by previous authors (Collenette 1999; Migahid 1996; Chaudhary 2001; Taia 2009). Plants of this species are widespread in Saudi Arabia, from north-western to southwestern of the country and in the eastern region (Table 1 and Figure 16) and they are distinguished by several characters, there is a variation of leaf formation in this species. Its Colour of leaf is green (Figure 2(A)) sometimes yellowish green (Figure 2(C)), leaf shape is ovate to broadly ovate (Figure 3(B)) sometimes in some specimens is cordate (Figure 3(A)), leaf surface is pubescent to tomentosa (Figure 4(C)) but sometimes is velvety (Figure 4(B)), leaf apex is differ, it can be cuspidate (Figure 5(B)) or acute to cuspidate (Figure 5(C)) obtuse (Figure 5(D)) and sometimes acute (Figure 5(A)), leaf base is also differ, cordate (Figure 6(A)) or truncate (Figure 6(B)) and cordate to truncate (Figure 6(C)), leaf margin is double denticulate to dentate (Figure 7(B)) and sometime double serrate (Figure 7(A)), colour of flower is consistent color, its yellow with red center (Figure 8(C)), and the fruit shape is globose (Figure 9(A)), the mericarp is reniform with rounded apex (Figure 10(B)).

The numerical taxonomy based on the morphological characters including quantitative and qualitative in the PCoA and the UPGMA analysis and based on quantitative characters in the PCO analysis indicated that the *Abutilon* plants under this study distinguished into six groups with realistic agreement in all analysis results. The results of the UPGMA analysis (**Figure 11**) separated all 43 examined samples into three main clusters. First cluster includes all plants of *A. grandifolium* and *A. figarianum*, second cluster includes all plants of *A. hirtum*, *A. bidentatum* and *A. fruticosum*, while all 34 plants of the *A. pannosum* species are located in the third cluster. In the PCoA based on 26 quantitative and 10 qualitative characters (**Figure 12(A)** and **Figure 12(B)**) and PCA analyses based on

only 26 quantitative morphological characters (Figure 13) of the *Abutilon* accessions are clearly separated into six main groups in the axis one and three (Figure 12(A) and Figure 12(B); Figure 13). The group 1 includes three samples of *A. grandifolium* species, likewise, group 2 includes three samples of *A. figarianum* species, while only one sample of *A. hirtum* in group 3, *A. bidenta-tum* in group 4, *A. fruticosum* in group 5 and 34 samples of *A. pannosum* species gathered in group 7 (Figure 12(A) and Figure 12(B); Figure 13).

5. Conclusion

This current study provides the morphological characteristics which are effective in *Abutilon* species identification. Six species of genus *Abutilon* were distinguished and identified using morphological characteristics and morphometric analysis of the PCoA, the UPGMA and the PCA.

Statement of Ethics

Ethical approval is not required for this type of research.

Funding Sources

The authors received no financial support for the research.

Acknowledgements

Thanks to Maryam Alshebramy, Salehm Algharbi, Amer Alasiri, Muhammed Althawabi, Muhammed Almalki, Muhammed Alshawi for their help during field trips.

Conflicts of Interest

The authors declared no conflict of interest.

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