



Taxonomical Studies of Some Acacia spp. Growing in Saudi Arabia

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ABSTRACT

The present study has been carried out to investigate eight Acacia spp. growing in the Holy places in Makah and adjacent areas along Al-Hada and El-Sail Roads: *A. asak*; *A. ehrenbergiana*; *A. etbaica*; *A. gerrardii*; *A. hamulosa*; *A. nubica*; *A. raddiana* and *A. tortilis*. It will provide a preliminary interpretation of the taxonomic implications of the morphological and anatomic characters of these species. anatomic features of stem undergoing secondary growth as well as details of wood anatomy were used to describe different anatomical patterns, and help in the construction of artificial key using major and minor characters using as a tool to help for splitting the examined species of the genus Acacia

Key words: Acacia spp., Makah road, morphological characters, wood anatomical characters, axial parenchyma.

INTRODUCTION

The genus Acacia considered one of the most important tree and shrub group in the sub-family Mimosoideae of the Saudi Arabia. Most species are centered in the western region, and they are little represented in Eastern and Northern parts of Saudi Arabia in different types of soils [1-4]. Acacia species from Saudi Arabia constitute two distinct groups, one with stipule spines plus globular flower-heads and the other with prickles plus spikes or spicate inflorescence *Acacia albida* Del. forms a third group with stipule spines and spicate inflorescence [5].

Characteristics related to the internal structure of the plants (anatomy) have been employed for systematic purposes and are useful in both practical identification and determination of phylogenetic relationships [6]. Anatomic features will be studied, to those Acacia species systematically revised. Anatomic features of stem undergoing secondary growth as well as details of wood anatomy will be considered [7,8, 9].

STUDY AREA

It comprises three locations:

1. Holly places in Makah city which situated in Hejaz- region of Saudi Arabia, and about 80 kms from Jeddah on the Red Sea coast. It lies between 21-26 N and 39-46 E with an altitude ranging from 240 to 277 m ASL. It is bordered by almost continuous granite and granite gneiss ridges [10].

The vegetation in this arid area is of restricted type and is found only in runnels, wadis and depressions with deep fine sediments that receive adequate water supply, and is mainly ground - water dependent.

2. El – Sail Road, along Makah - Al- Taif Road that extends for about 70 kms . The western part of the road lies at the level of 277 m above sea level at Makah, and then rises sharply to reach 1540 m at Al- Taif city. Three main sectors were distinguished in this area according to the soil type, topography and climatologically conditions. The landscape of this part is characterized by its mean dense, steep ridges crossed by numerous runnels and narrow wadis. Generally, the habitat is rocky and subjected to severe erosion. The soil is coarse, textured and shallow except in some sites where fine sediments were found [11]

2-3-Al-Hada Road , along Makkah – Al-Taif Road is characterized by its open landscape of sandy plains. It is sparsely traversed by shallow wadis. The soil is coarse-textured whereas the ground surface is covered by gravels and rock fragments. Regarding altitudinal variation from 1630- 2050 m above the sea level [12]

MATERIALS AND METHODS**Collecting plant materials:**

Three botanical excursions were done in different seasons in Makah, Taif and El-Hada road (spring 2002, winter 2002 and spring 2003), for collecting materials and morphologic description. The complete morphologic characters of the genus *Acacia* are described fully in the Floras of Saudi Arabia [1],[2], [4]; however, two distinct characters are mentioned here, the stipules and the pods.

Species	Date of collection
1- <i>Acacia asak</i> (Forssk.) Willd	Spring 2002
2- <i>Acacia ehrenbergiana</i> Hayne, Arzn. Gebr. Gewachsa	Spring 2002
3- <i>Acacia etbaica</i> Schweinf.	Spring 2003
4- <i>Acacia gerrardii</i> Benth	Winter 2002
5- <i>Acacia hamulosa</i> Benth	Spring 2003
6- <i>Acacia nubica</i> Benth	Winter 2002
7- <i>Acacia raddiana</i> Savi.,	Spring 2002
8- <i>Acacia tortilis</i> (Forssk.) Hayne	Spring 2003

Anatomical investigation

For each *Acacia* species collected (eight species), representative samples were selected conforming to the most typical and ideal specimens; branch woods, at least 3 years old were used for the anatomical investigation. Preserved material in F.A.A. (Formalin- acetic acid – alcohol) were free sectioned (T.S and L.S) (20- 50 μ m thick) using table microtome, double stained (using safranin and light green), dehydration in alcohol xylol series; and mounted in Canada balsam [13], Photographs were taken using a Nikon Camera.

RESULTS**Morphological results:*****Acacia asak* (Forssk.) Willd.**

Stipules spines absent, stout prickles present usually in threes; of the three prickles the middle downwardly directed and the two laterals horizontal. Pods with thin margined, and reddish-brown to purplish- red veined glabrous.

***Acacia ehrenbergiana* Hayne, Arzn. Gebr. Gewachsa**

Stipules spines white, mostly long rather thin, divaricated. Pods greenish- red, glabrous, strongly falcate, thin, prominently narrow- margined undulating constricted between seeds

***Acacia etbaica* Schweinf.**

Stipules spines very small slender and straight. Pods reddish- purple, narrowed at the tip, thin narrowly margined, very sparsely pubescent and appearing almost glaucous.

***Acacia gerrardii* Bent**

Stipules spines large, stout, ivory- colored, pubescent at base. Pods spirally coiled or rolled densely shortly pubescent, yellowish- brown to light- brown, dehiscent.

***Acacia hamulosa* Benth.**

Spines absent; only dark- grey to purplish prickles present in threes; the prickles short, stout. Pods flat, thin, glabrous, bright- green to yellowish- green prominently reticulate, oval to oblong

***Acacia nubica* Benth.**

Stipules spines relatively short falcate or hooked downwards. Pod broad, flat, straight, acute at both ends, with narrowly winged margins, pale yellow with longitudinal strips.

***Acacia raddiana* Savi.**

Stipules spines of two kinds, large straight and small hooked. Pods spirally contorted or twisted, glabrous and prominently veined.

***Acacia tortilis* (Forssk.) Hayne.**

Stipules spines of two kinds; the long one white with brown tipped, the short less falcate or hooked downwards. Pods most often spirally contorted or twisted, green, densely pubescent, often constricted between see.

Anatomical results

Anatomical features of *Acacia* species under investigation are as follows:
(V=Vessels, P= Parenchyma, F= Fibre, R=Ray)

Acacia asak

Growth ring faint to distinct. **Vessels** diffuse solitary round in cross section, with two distinct sizes, small vessel up to 80 μ m, large up to 170 μ m. Inter- vessels pit vestured alternate round. **Fibres** in tangential bands alternating with parenchyma, fibre wall thick to medium thick. **Parenchyma**, continuous abundant paratacheal aliforme confluent of varying thickness (Fig. 1.a). **Ray** from 1-2 seriate, 2 cells long and up to 40 cells height, homocellular (Fig. 1.b)

Fig.1.a- T.S in the woody stem of *A. asak* x 100

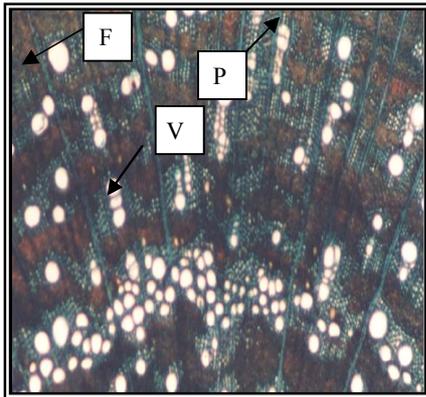
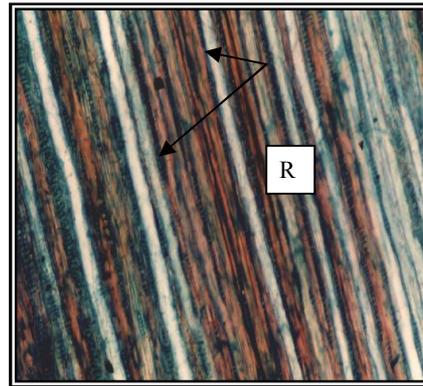


Fig.1.b- L.S in the woody stem of *A. asak* x 100



A. ehrenbergiana

Growth ring not observed. **Vessels** diffuse solitary or in radial multiple 2-4 round in cross section, radial diameter up to 200 μ m. Inter- vessels pit vestured alternate round. **Fibres** in tangential bands alternating with parenchyma, fibre wall thick to medium thick. **Parenchyma**, in predominant apotracheal (Fig. 2.a). **Ray** from 1-5 seriate, up to 80 cells height, homocellular (Fig. 2.b)

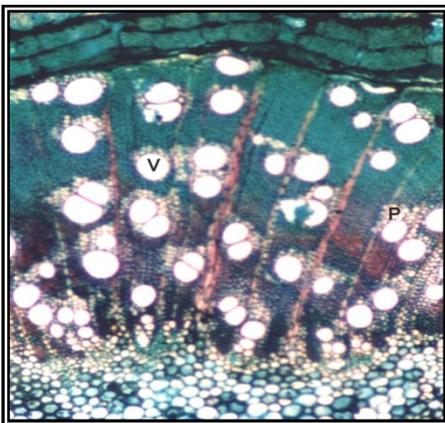


Fig. 2.a- T.S in the woody stem of *A. ehrenbergiana* x 100.

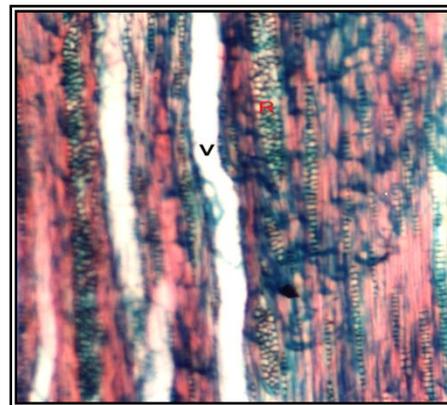


Fig. 2.b- L.S in the woody stem of *A. ehrenbergiana* x 100

A. etbaica

Growth ring faint to distinct. **Vessels** diffuse solitary round in cross section, radial diameter up to 180 μ m. Inter- vessels pit vestured alternate round. **Fibres** in tangential bands alternating with parenchyma, fibre wall thick to very thick. **Parenchyma**, in confluent bands alternating with fibre bands of different thickness (Fig. 3.a). **Rays**, from 1-3 seriate, up to 25 cells height, homocellular (Fig.3.b).

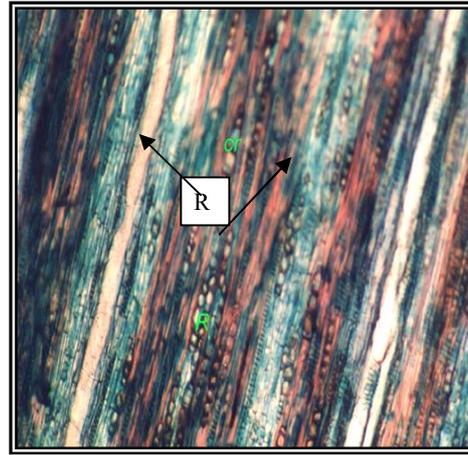
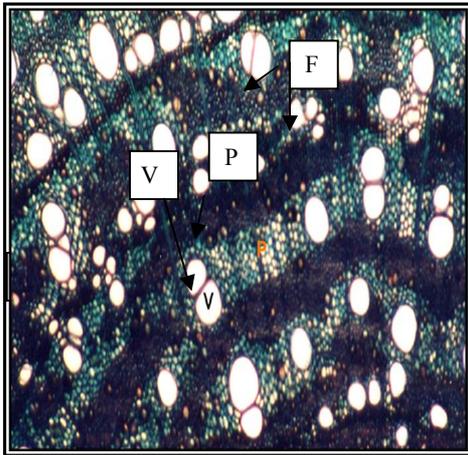


Fig.3.a- T.S in the woody stem of *A. etbaica* x 100 Fig. 3.b- L.S in the woody stem of *A. etbaica* x 100

A. gerrardii

Growth ring faint to fairly distinct. **Vessels** diffuse, solitary or in radial multiple 2-4 round in cross section, of two distinct size radial diameter 100 - 120 μ m. for small vessels and 180- 200 μ m. for large vessels, many vessels with gummy contents. Inter- vessels pit vestured alternate round. **Fibres** in tangential bands alternating with parenchyma, fibre wall thick to very thick. **Parenchyma** ,abundant paratacheal aliforme confluent of varying thickness (Fig. 4.a). **Rays**, from 1-6 seriate, up to 4 cells height, homocellular composed of strongly procumbent cells. (Fig. 4.b).

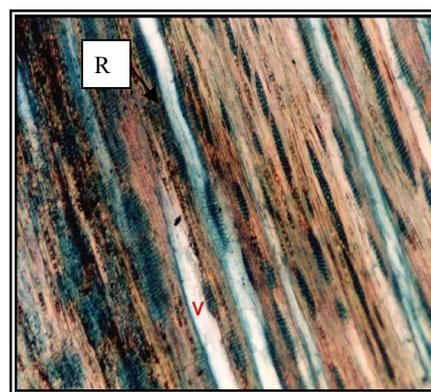
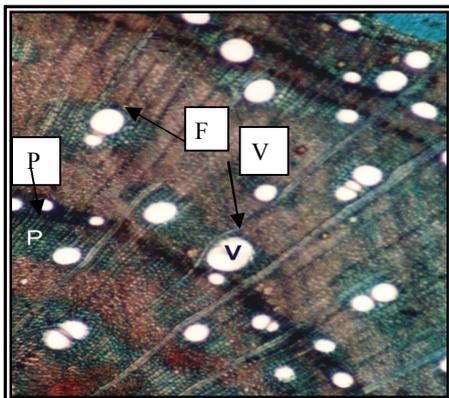


Fig. 4.a & b- L.S in the woody stem of *A. gerrardii* x 100

A. hamulosa

Growth ring not observed. **Vessels** diffuse solitary or in radial multiple 2-4 round in cross section, radial diameter up to 200 μ m. Inter- vessels pit vestured alternate round in cross section. **Fibres** in tangential bands alternating with parenchyma, fibre wall medium thick to very thick. **Parenchyma**, abundant in paratacheal aliforme confluent of varying thickness (Fig. 5.a). **Rays**, from 1-3 seriate, up to 40 cells height, homocellular composed of strongly procumbent cells (Fig. 5.b).

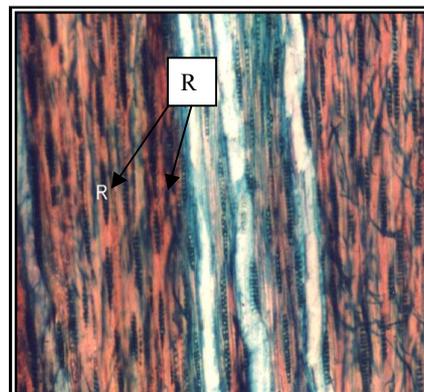
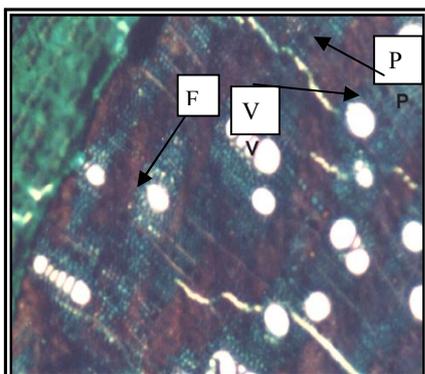


Fig. 5.a- T.S in the woody stem of *A. hamulosa* x 100 Fig. 5.b- L.S in the woody stem of *A. hamulosa* x 100.

A. nubica

Growth ring faint. **Vessels** diffuse, solitary round in cross section radial diameter up to 170 μ m. Inter- vessels pit vestured alternate round. **Fibres** in tangential bands alternating with parenchyma, fibre wall thick to medium thick. **Parenchyma**, in confluent bands alternated with fibre bands (Fig.6.a). **Rays** from 1-6 seriate, up to 60 cells height, homocellular composed of strongly procumbent cells (Fig. 6.b).

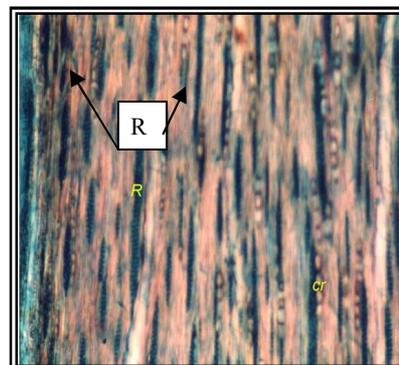
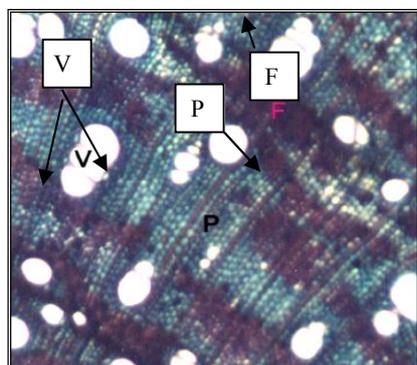


Fig.6.a. b.- T.S and L.S. in the woody of stem *A. nubica* x 100

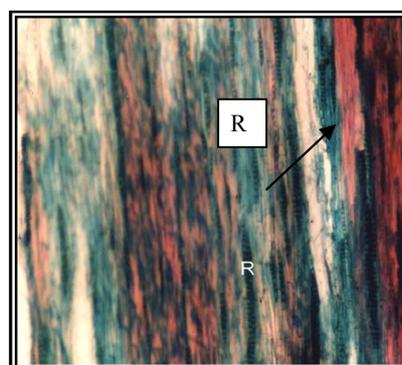
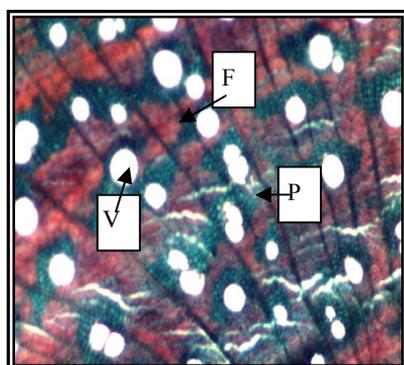


Fig.7.a.b- T.S and L.S. in the woody stem of *A. raddiana* x 100

A. raddiana

Growth ring absent. **Vessels** diffuse solitary or in radial multiple 2-4 rounds in cross section, with gummy contents, radial diameter up to 190 μ m. Inter- vessels pit vestured alternate round in cross section. **Fibres** in tangential bands alternating with parenchyma, fibre wall thick to very thick. **Parenchyma**, abundant paratacheal in long confluent bands (winged aliform) (Fig. 7.a). **Rays** from 1-6 seriate, of two distinct size, uniseriate 2-10 cells height, multiseriate up to 60 cells height, homocellular composed of strongly procumbent cells (Fig.7.b).

A. tortilis

Growth ring not observed, vessels diffuse solitary or in radial multiple 2-4 round in cross section, radial diameter up to 200 μ m. Inter- vessels pit vestured alternate round in cross section. Fibers in tangential bands alternating with parenchyma, fiber wall thick to very thick. Parenchyma abundant paratacheal in aliforme confluent bands (lozenge-aliform) (Fig.8.a). Rays from 1-6 seriate of two distinct size, 1-2 seriate up to 12 cells height, multiseriate 3-6 seriate up to 30 cells height, homocellular (Fig. 8.b).

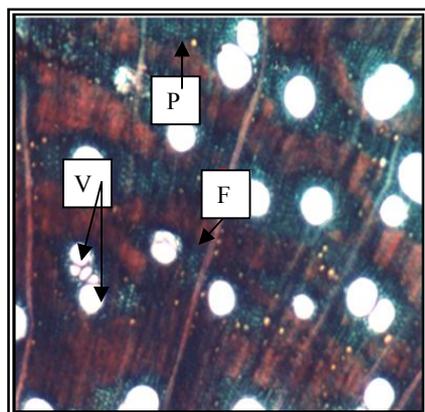


Fig.8.a- T.S in the woody stem of *A. tortilis* x 100

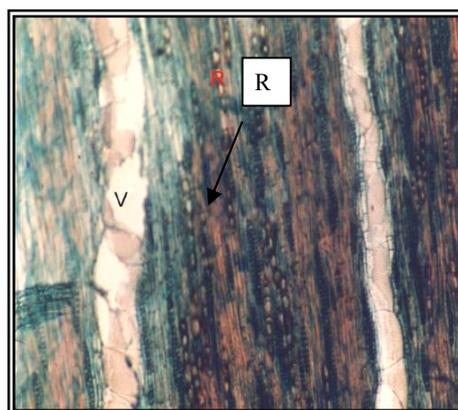


Fig.8.b- L.S in the woody stem of *A. tortilis* x 100.

Artificial key of *Acacia* species under investigation:

Morphological key

- A. Stipule spines present
 - 1. Stipule spines of one kind
 - a. Stipule spines long rather thin, divaricated
 - i. Pods strongly falcate constricted between seeds....
..... *A. ehrenbergiana*
 - ii. Pods spirally coiled or rolled*A. gerrardii*
 - b. Stipule spines very small
 - i. slender and straight..... *A. etbaica*
 - ii. hooked downwards*A. nubica*
 - 2. Stipule spines of two kinds
 - a. Pods, glabrous and prominently veined..... *A. raddiana*
 - b. Pods green, densely pubescent, constricted between seeds..... *A. tortilis*
- B. Stipules spines absent
 - 1. Pods with thin margined, reddish- brown to purplish- red
..... *A. asak*
 - 2. Pods flat, thin, bright- green to yellowish- green *A. hamulosa*

Anatomical key

- A. Parenchyma abundant paratracheal aliforme confluent
 - 1. Vessels of two distinct size
 - a. Rays 1-6 seriate*A .gerrardii*
 - b. Rays 1-2 seriate *A. asak*
 - 2. Vessels of one size
 - a. Rays of two distinct size
 - i. Multiseriate up to 60 cells high..... *A. raddiana*
 - ii. Multiseriate up to 30 cells high *A. tortilis*
 - b. Rays of one size *A. hamulosa*
- B. Parenchyma predominant apotracheal
 - Rays 1-4 seriate..... *A. ehrenbergiana*
- C. Parenchyma confluent bands alternating with fiber bands
 - a. Rays 1-6 seriate up to 60 cells height..... *A. nubica*
 - b. Rays 1-3 seriate up to 25 cells height*A. etbaica*

DISSCUTION

Acacia trees are known as thorn trees, this is due to that the plants often bear spines, especially those species growing in arid regions. These sometimes represent branches, which have become short, hard and pungent. Presence, absence of stipule spines and pod characters were recognized

as the major characters helping in identifying the studied species [14] suggests that spine (existence and length) are the characteristics that can be aided in the identification of *Acacia*. Presence and absence of stipules spines divided our eight investigated species into two main group:

A. First group included six species *A. ehrenbergiana*, *A. gerrardii*, *A. etbaica*, *A. nubica*, *A. raddiana* and *A. tortilis*. characterising by the presence of stipules spines Shape and types of stipule spines help to differentiate between the six species of the first group were *A. ehrenbergiana* and *A. gerrardii* specialized by one kind and long stipules spine while *A. etbaica* and *A. nubica* were of one kind and short stipules spines straight into *A. etbaica* and hooked in *A. nubica*.

Pods shape, and sizes considered as important characters to differentiate between *Acacia* species. Pods were strongly falcate in *A. ehrenbergiana* and spirally coiled in *A. gerrardii* also it was glabrous in *A. raddiana* and densely pubescent in *A. tortilis*.

B. Second group included only two species *A. asak* and *A. hamulosa* were stipules spines were absent. Pod's colour differentiated between *A. asak* and *A. hamulosa*, reddish- brown to purplish-red in the first while bright- green with yellowish- green in the second.

The anatomical study of the woody stems -wood anatomy- of the eight investigated species shows the occurrence of major and minor characters that can be used in the separation of studied species [15]. Paratracheal and paratracheal parenchyma were considered the two major characters, while the ray parenchyma length, in addition of fibre wall thickness were of minor characters. Based on these characters, investigated species can be divided into three groups:

A. First group included five *Acacia* species: *A. asak*, *A. gerrardii*, *A. hamulosa*, *A. raddiana* and *A. tortilis*; where the parenchyma is abundant paratracheal and aliform confluent in all species. We can also recognize the close relationships between *A. asak* and *A. hamulosa*; where the rays thickness range between 1- 2 seriate in both species.

B. Second group contained one *Acacia* species: *A. ehrenbergiana*; where the parenchyma is predominant apotracheal and rays 1- 4 seriate.

C. Third group contained two *Acacia* species: *A. etbaica* and *A. nubica*; where the parenchyma was found in confluent bands alternating with fibre bands.

In anatomical investigation qualitative characters based on fibre and parenchyma divided the investigated species into three groups, while quantitative characters such as vessels diameter, length and width rays show a great variation between the *acacia* species [13].

REFERENCES

1. Migahid, A. M. (1978). Flora of Saudi Arabia. Second Edition. Riyadh University Publication .
2. Migahid, A. M. (1990). Flora of Saudi Arabia. Third Edition, Riyadh University Publication.
3. Collonette, S. (1985). An Illustrated Guide to the flowers of Saudi Arabia. Scorpion Publishing LTD. London
4. Chaudhary, S. A. and Al-Jawaid, A. A. (1999). Vegetation of the Kingdom of Saudi Arabia. Ministry of Agriculture and Water. Kingdom of Saudi Arabia.
5. Chaudhary, A. A. (1983). *Acacia* and other genera of *Mimosoideae* in Saudi Arabia. National Herbarium Regional Agriculture and Water Research Center. Al-Khaled Offset Press, Riyadh
6. Barthlott, W. (1990). Scanning electron microscopy of the epidermal surface in plants. In applications of the scanning electron microscopy in taxonomy and functional morphology, D. Claugher (ed.), 69-94. Claredon Press. Oxford. pp. 501.
7. Jagiella, Ch. und Kurschver, H. (1987). Atlas Der Holzer Saudi Arabiens.
8. Fahn, A.; Werker, E. and Baas, P. (1986). Wood Anatomy and Identification of Tree and Shrubs from Israel and Adjacent regions. The Israel Academy of Science and Humanities Jerusalem
9. Wheeler, E. A.; Baas & P. E. Gasson (1989). IWWA list of Microscopic features for hardwood identification. IAWA Bulletin, 10, 3 pp. 221- 332.
10. Abd El-Ghani, M.M.,1997. Vegetation analysis and species diversity along an altitudinal gradient in the central Hijaz Mountains of Saudi Arabia. *Arab Gulf J. Sci. Res.* , 15: 399-414.
11. Fayed, A.A. and K.M. Zayed, 1989 . Vegetation along Makkah - Taief Road , Saudi Arabia . *Arab Gulf J. Sci. Res.* 7: 97- 117.
12. Zayed , K.M. and A.R. El- Karemy , 1989 . Vegetation between Taif and El - Shafa highland (Asir mountains , Saudi Arabia). Feddes Repertorium 100 Berlin , 11-12, 661-672.
13. Waly, N. M. (1987). Morphological and Comparative Anatomical Studied of Native woody species in Egypt (MSC. Thesis, faculty of Science, Cairo University).
14. Elkhalfifa F. Kamal and Ibrahim M. Aref (2004) Morphological studies on fourteen *Acacia* species seedlings grown in Saudi Arabia Res. Bult., No. (122), Agric. Res. Center, King Saud Univ., pp. (5-11).
15. Waly, N. M. (1994). Documentary and Comparative Anatomical study of the wood and charcoal plants of Ancient Egypt (Ph. Thesis, Faculty of Science, Cairo University).



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