MINUTE WOOD ANATOMY AND KEY FOR THE IDENTIFICATION OF IMPORTANT CONIFERS OF PAKISTAN

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ABSTRACT

Wood samples of Juniper, Spruce, Fir, Deodar, Yew and four pine species were collected from different coniferous forests of Pakistan. The objective was to study their microscopic structure for the preparation of an identification key based on minute anatomy. Results showed clear variations in the occurrence, number, size and type of different anatomical structures, such as resin canals, wood rays, pits at ray crossing, ray tracheids, procumbent cells, vascular tracheids, pits on vascular tracheids and pit pores. On the basis of these anatomical variations a key is prepared for the identification of important conifers of Pakistan.

INTRODUCTION

Conifers are of great importance to Pakistan because of their ecological and commercial value. Under ecological consideration they form the dominant forest vegetation of sub-tropical and temperate zones in the north western

mountainous region between an altitude of 1,370 to 3,350 m and serve to preserve the fragile ecosystem in these areas. Their commercial value lies in the supply of timber for construction and many other uses and production of fuelwood for domestic use for cooking and heating in the local villages.

In order to facilitate the work of identification of coniferous timbers for their exact kind and optimum utilization, preparation of a key based upon minute anatomy was long desired. Although under field conditions most of the timbers can easily be identified on the basis of their physical features and gross structure, still this method works well when timber samples are in sound condition. On the other hand when timbers to be identified have close resemblance or have changed in their normal appearance due to one reason or the other then the use of keys based on physical features and gross structure are not of much help. Under such situations, it becomes necessary to go for laboratory methods and study the minute internal structure of timbers for their accurate identification. Brown, (1925) proposed the first scheme (Key) for the identification of commercial timbers of Indian sub-continent (1). This key was based on the physical features and gross structure of timbers and was deficient in fulfilling Pakistani needs because after 1947, the timbers which were not covered by this key became commercially important to Pakistan.

To fill this gap, Ahmad and Ayaz, (1970) prepared a key on the above lines for the identification of commercial timbers of Pakistan (2). This document remained in much use and was subsequently revised in 1984 (3). As all these keys were based on physical features and gross structure and none of them fulfilled the need of timber identification on minute anatomical level. Therefore, an identification key based on minute anatomy is prepared for correct identification of timbers, when conventional methods of timber identification does not work well. This document is also to serve as teaching aid for the students of wood technology and forestry.

MATERIAL AND METHODS

Wood samples of yew *(Taxus baccata)*, deodar *(Cedrus deodara)*, Spruce *(Picea smithiana)*, juniper *(Juniperus excelsa)*, fir *(Abies pindrow)*, Quetta pine *(Pinus eldarica)*, chilghoza pine *(Pinus gerardiana)*, chir pine *(Pinus roxburghii)* and blue pine *(Pinus wallichiana)* were determined from old and fresh collections from different coniferous forests of Pakistan.

Small specimens were removed from these wood samples and studied for their minute anatomy by standard procedures (6). From each specimen permanent microslides of cross, radial and tangential sections were prepared. All these sections were stained in safranin and hematoxylin. From each section the following minute anatomical features were studied:

Cross Section

- Tracheid diameter
- Lumen diameter
- Number of rays/mm
- Number of resin canals/cm^2
- Diameter of longitudinal resin canals
- Type of epithelial cells in longitudinal resin canals

Radial Section

- Type and dimensions of pitting at ray crossing

- Marginal ray tracheids with dimensions

- Type of ray and length of procumbent cells

- Pit and pit pore diameter

- Tertiary thickening in tracheids

Tangential Section

- Number of rays /mm^2

- Ray height

- Ray width

- Number of cells along ray height

- Number of cells along ray width

- Number of radial resin canals/cm^2

Small chips of wood from each sample were also macerated in a boiling mixture of 20% nitric acid and a small quantity, of potassium chlorate to measure tracheid length. Dimensions of anatomical elements and structures were measured with the help of eye-piece micrometer (6).

About 100 measurement for tracheid dimensions and 50 measurement for all other microscopic features were taken. The data were analyzed for mean values, standard deviation and co-efficient of variation.

RESULT AND DISCUSSION

The data on different anatomical features of various conifers are given in the table.

Resin canals

As shown in the table, two types of resin canals, longitudinal and radial were found in *Chir pine, Blue pine, Quetta pine, Chilghoza pine* and *Spruce* (1,5,7). It was observed that in *Blue pine, Chilghoza pine* and *Quetta pine*, longitudinal resin canals were wider, but less frequent than radial resin canals. Epithelial cells of resin canals were thin walled in all pine species and thick walled in Spruce (1,5,8). In Yew, Juniper and Fir both types of resin canals were absent (1,8). In Deodar longitudinal resin canals were rarely present and were of abnormal type (traumatic) forming more or less continuous band at the boundary of growth ring (1,4,8).

Rays

As shown in the table, number of wood rays per mm in cross section was highest in Fir, followed by *Chilghoza pine, Deodar* and *Spruce, Yew, Quetta pine, Juniper, Chir pine* and *Blue pine*. The number of rays per mm^2 on tangential section was highest in Juniper, followed by *Chilghoza pine, Yew* and *Spruce, Deodar, Fir, Quetta pine, Chir pine* and *Blue pine*. Ray height for both fine and fusiform rays was highest in *Chir pine* than all the other species.

Rays in almost all the species were mostly uniseriate. However, in *Yew, Deodar, Fir, Quetta pine* and *Chir pine* occasionally biseriate condition was also observed. Number of cells along ray height was highest in *Deodar*, followed by *Fir, Quetta pine* and *Spruce, Chir pine, Chilghoza pine* and *Blue pine, Yew* and *Juniper*.

Pitting at ray crossing was round or oblique in Deodar, oval to lenticular in Spruce, lenticular or oblique in Juniper, orbicular in Fir, round to oval in *Chilghoza pine*, oval to lens shaped in *Quetta pine*, rounded to lopsided in Yew, oval to elliptical in *Chir pine* and window like in *Blue pine* (1,5,7). The pits at ray crossing were widest in *Blue pine* and narrowest in Juniper.

Size of procumbent cells was largest in Spruce and smallest in *Blue pine*. Longest ray tracheids were found in *Quetta pine* and smallest in *Chilghoza pine*. Whereas, width of ray tracheid was highest in Chir pine and lowest in Deodar. In Juniper, Yew and Fir ray tracheid were absent (1,8).

Vascular Tracheids

As shown in table, the longest vascular tracheids were present in Blue pine and smallest in Yew. Tracheids with widest diameter were in *Chir pine* and narrowest in Yew. In Spruce tracheids were more thick walled than all the other species, whereas the wall of tracheids in *Chilghoza pine* was thinnest. The widest lumen width was found in *Chir pine* and narrowest in Yew.

In tracheids of *Blue pine* the pits were largest in size than all the other species. Smallest pits were present in tracheids of Yew. Size of pit pore was largest in Spruce and smallest in Juniper. Spiral thickening was also present in longitudinal tracheid of Spruce and Yew (1,8).

CONCLUSIONS

- The results of the study show clear variation in the minute anatomy of above species in terms of dimensions, frequency and shape of different structures.

- As the study is based on single wood specimens of different species , therefore does not cover minor anatomical variations within a species due to age of trees, position in the stem and locality.

- The observed variations are made use in the preparation of a dichotomous key, based on minute anatomy, for the identification of important conifers of Pakistan which is appended with this article.

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Table-1. Dimensions of different types of anatomical structures and cells in some coniferous species (Average values).

Anatomical feature		Yew (*Taxus baccata*)	Deodar (*Cedrus deodara*)	Spruce (*Picea smithiana*)	Juniper (*Juniperus excelsa*)	Fir (*Abies pindrow*)	Q. pine (*Pinus eldarica*)	Chilghoza (*Pinus gerardiana*)	Chir pine (*Pinus roxburghii*)	Blue pine (*Pinus wallichiana*)
Number of longitudinal resin canals	/cm²	-	-	37	-	-	55	121	36	52
Diameter of longitudinal resin canal	u	-	-	87	-	-	138	93	289	145
Number of radial resin canals	/cm²	-	-	82	-	-	35	63	55	28
Diameter of radial resin canal	u	-	-	51	-	-	43	38	59	43
Number of rays in cross section	/mm²	5.6	6.3	6.3	5	7	5.4	6.7	4.9	3.5
Number of rays in tangential section	/mm	41	32	36	55	26	24	44	21.5	19.2
Height of rays	Cells	5	10	8	3	9	8	6	7	6
	u	137	236	174	67	172	192	169	310	162
Width of ray	Cells	1-2	1-2	1	1	1-2	1-2	1	1-2	1
	u	13	18	16	18	16	23	17	28	14
Height of fusiform ray	Cells	-	-	20	-	-	22	24	21	18
	u	-	-	344	-	-	493	509	588	469
Width of fusiform ray	Cells	-	-	3-4	-	-	3-4	3-4	10	9
	u	-	-	49	-	-	51	53	66	57
Width of ray pitting	u	2.41	3.39	2.24	2.16	3.42	7.00	3.56	5.5	18
Length of procumbent cell	u	140	194	233	1.51	164	216	138	189	92
Length of ray tracheid	u	-	151	130	-	-	275	89	255	164
Width of ray tracheid	u	-	18.56	19.14	-	-	18.84	22.75	25.6	22.4
Length of longitudinal tracheid	mm	2.28	2.67	3.96	2.30	3.88	3.37	2.75	4.27	3.97
Diameter of longitudinal tracheid	u	23	26	33.6	24.7	31	38	24	45.6	34.3
Wall thickness of long. tracheid	u	2.67	2.60	4.91	3.18	3.02	3.44	2.07	4.1	4.6
Lumen width of long. tracheid	u	17.8	20.7	23.8	18.3	25	31	19.8	37.4	25.0
Diameter of pit	u	14.42	16.67	19.51	14.69	16.34	20.94	14.43	22.2	24.0
Size of pit pore	u	3.59	6.33	6.63	3.27	5.97	6.03	4.28	5.6	6.5

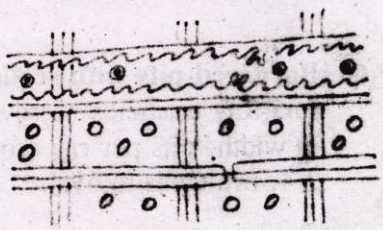
APPENDIX

MICROSCOPIC KEY FOR THE IDENTIFICATION OF IMPORTANT CONIFERS OF PAKISTAN

1. **Ray tracheid present** 2
1. **Ray tracheid absent** 7

2. **Ray tracheid dentate** 3
2. **Ray tracheid non-dentate** 5

3. **Teeth clearly defined in ray tracheid**. Ray tracheid smallest in length; wall thickness of longitudinal tracheid lowest; pits per ray crossing 2-3 (mostly 2), rounded to oval.

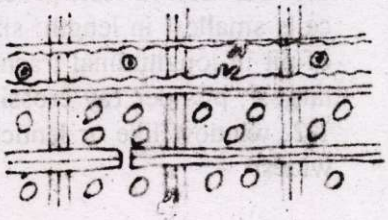


(a)

Chilghoza pine (*Pinus gerardiana*)

3. **Teeth barely emerge in ray tracheids** 4

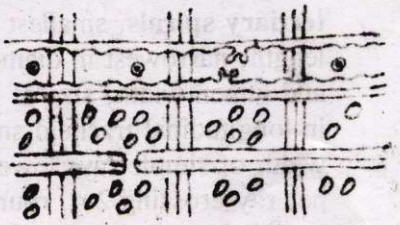
4. **Cross field pits 1-4 per ray crossing**; ray tracheid longest; pits at ray crossing oval to lens shaped.



(b)

Quetta pine (*Pinus eldarica*)

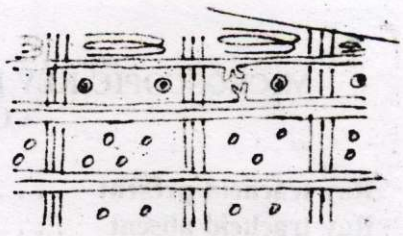
4. **Cross field pits 2-6 per ray crossing**, ray tracheids widest; longitudinal tracheids longest, and widest, lumen width highest; fusiform and simple rays highest and widest; pits at ray crossing oval to elliptical.



(c)

Chirpine (*Pinus roxburghii*)

5. **Longitudinal tracheids with tertiary spirals**, wall thickness of longitudinal tracheids highest; size of pit pore largest; procumbent cells longest; pits per ray crossing 2-4, oval to lenticular.

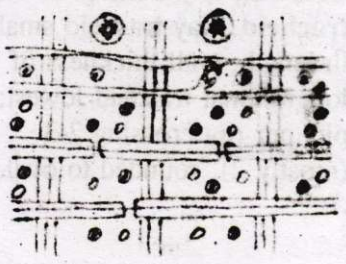


(d)

Spruce (*Picea smithiana*)

5. **Longitudinal tracheids without tertiary spirals** 6

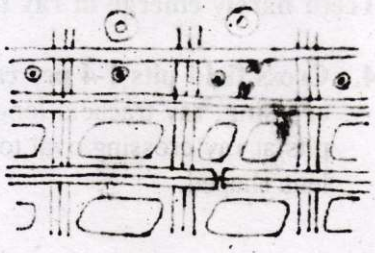
6. **Bordered pits with scalloped tori**;Ray tracheids narrowest in width; pits per ray crossing 2-4, orbicular to oval.



(e)

Deodar (*Cedrus deodara*)

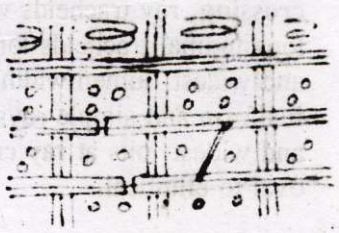
6. **Bordered pits with non-scalloped tori**; number of rays per mm in cross section lowest; procumbent cells smallest in length; size of pit in longitudinal tracheid largest; pits per ray crossing 1-2, window like or lenticular and widest.



(f)

Blue pine (*Pinus wallichiana*)

7. **Longitudinal tracheids with fine tertiary spirals**, smallest in length, narrowest in diameter and lumen width; size of pit in longitudinal tracheid smallest; width of simple rays lowest; pits per ray crossing 2-4, round and lopsided.

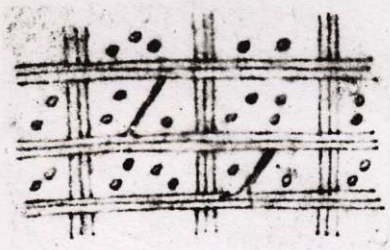


(g)

Yew (*Taxus baccata*)

7. **Longitudinal tracheids without tertiary spirals** 8

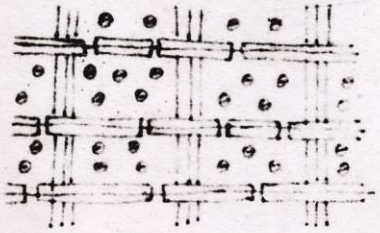
8. **Horizontal walls of ray cells sparsely pitted**; number of rays per mm^2 in tangential section highest; pits per ray crossing 2-4, orbicular or lenticular, narrowest in width.



(h)

Juniper (*Juniperus excelsa*)

8. **Horizontal walls of ray cells strongly pitted**; number of rays per mm in cross section highest; pits per ray crossing 2-5, orbicular.



(i)

Fir (*Abies pindrow*)

Note: Figures **a**,**b**,**c**,**d**,**e**,**f**,**g**,**h** and **i** show the region of ray crossing with different anatomical features present in different species.