ANATOMICAL VARIATIONS FROM PITH TO BARK IN *EUCALYPTUS CAMALDULENSIS* DEHN. WOOD

Ghulam Mustafa Nasir[1]

Abstract

Locally grown eight years old *E. camaldulensis* wood was studied to observe variation in anatomical properties from pith to bark. Cross and tangential sections of all the sample blocks were prepared under standard laboratory procedures and studied for the frequency and dimensional measurements of different wood elements. Results showed that the fiber length and wall thickness generally increased from pith to bark. The fiber diameter increased progressively upto a distance of 5cm from pith after that it decreased somewhat or remained more or less constant. The vessel diameter was found to increase up to 4cm distance from the pith, reaching to its maximum value beyond that it fluctuated minutely. The frequency of vessels decreased from pith to outward whereas, the frequency of wood rays increased except near the bark where it slightly showed a decreasing trend. The size of wood rays did not show any specific trend of increase or decrease from pith to bark. Maximum impact of the distance from the pith was recorded on fibre length (0.934) and fibre wall thickness (0.915) whereas, the minimum on height of ray (0.00006) as a result of simple linear regression analysis.

Keywords: Anatomical variation, Pith, Bark, *Eucalyptus camaldulensis*, Wood.

Introduction

Eucalyptus is one of the fast growing species native to Australia. It has a wide range of distribution and grows on a variety of soils. In Pakistan it is grown successfully throughout the plains and hills (Sheikh,1993). It has been planted on large scale on farmlands under the social forestry and farm forestry programs and now the trees are ready for harvesting. The volume of eucalyptus wood on farmlands was 0.57 and 0.16 million m^3 in the provinces of Punjab and N.W.F.P., respectively. Its planting was still in progress because of its performance in dry zones and reclamation of waterlogged and saline areas in the plains of Punjab and Sindh. (Amjad, 1991; Amjad et al, 1992).

On the other hand, in comparison to other commercial woods with established uses, eucalyptus wood has low market demand in the country. The wood is locally used for carriages, fuel, charcoal, board making, etc. In order to increase its utilization, it is important to collect information about basic properties of the wood.

[1] Pakistan Forest Institute, Peshawar

Structure of wood is materially affected by a number of factors. Among others, by its position in the tree and the growth rate prevailing when it was formed. Therefore, anatomical variations occur throughout a tree particularly the texture of wood. The wood produced in the early age of tree at any given height in the stem differs from that formed subsequently, as various wood elements increase rapidly in size outwardly in the first few growth rings around the pith (Brown *et. al*, 1949).

In eucalypts the fibre length, diameter and wall thickness increase with age reaching to the maximum at the age of 10-30 years. Furthermore, distance from the pith usually has greater influence on fibre length than height in the tree (Hillis, 1978). In *Eucalyptus camaldulensis* it has also been found that anatomical variation is greater in the radial direction than along the stem axis (Kasir and Barno, 1985).

This study has been carried out to observe variation in frequency and dimensional measurements of different wood elements from pith to bark in *E. camaldulensis* wood. The outcome will also be helpful for researchers to assess quality of the wood produced in different growth periods.

Materials and Methods

A disc of about 4cm in thickness was cut at a height of 1.5m from the but log of an eight years old tree of *E. camaldulensis*. The diameter of the disc was 21-22 cm. Then a radial strip of 1cm in width was removed from center to periphery of the disc, which was further divided continuously into 10 sample blocks of 1cm in thickness along the radii.

Cross and tangential sections of all the sample blocks were prepared with the help of sledge microtome, and stained in safaranin by standard laboratory procedures (Anon, 1971).

Small portion of wood in the form of radial chips from each block was macerated in the boiling mixture of 20% Nitric acid and Potassium chlorate (Wallis,1965) to separate the fibers and measure the dimensions with the help of an eye-piece micrometer. The data were recorded on the following anatomical characteristics in each sample block:

- Number of vessels /mm^2.
- Diameter of vessels.
- Number of rays per mm in cross section.
- Number of rays per mm^2 in tangential section.
- Number of cells along the ray height and width.

- Height and width of rays.
- Fiber Length.
- Fibre diameter.
- Fibre wall thickness.

The data collected were analyzed for descriptive statistics such as mean, standard deviation and co-efficient of variation for each microscopic feature in each sample block. Simple linear regression analysis was also carried out to find out the impact of distance from the pith on the values of different microscopic features.

Results and Discussion

Variation in frequency and size of vessels

Results shown in table 1, reveal that the frequency of vessels was 11/mm^2 (from 0 to 3 cm) in the wood and lower in the remaining portion 8-9/mm^2 (3-10 cm).

The diameter of vessels increased from the pith up to 4cm in the wood reaching to its maximum value (176μ). After that it fluctuated by a decrease or increase in the subsequent samples up to the bark and ranged from 160-169μ. The minimum value of vessel diameter (147μ) was observed near the pith (0–1 cm).

Variation in frequency and size of wood rays

Number of rays per mm in cross section was less in portion of the wood near the pith (0-4cm) as compared to the remaining portion (4-10 cm). The highest frequency (13/mm) was observed at 6-8cm from the pith after which it slightly decreased near the bark but the value was still higher than that of near the pith.

Number of rays in tangential section was found to be ranged from 90-96/mm^2 in portion of the wood from 0 to 5cm. After that it increased up to the utmost value (109/mm^2) at 6-7cm from the pith and then showed somewhat downward trend up to the bark.

The height of wood rays both in cells and microns fluctuated by a decrease or increase in the subsequent samples from pith to bark. Maximum height of rays (213μ) was observed in middle portion of the wood (4-5cm) whereas, the minimum (145μ) at 7-8cm from the pith.

Table.1. Variation in different microscopic features from pith to bark in *E. camaldulensis* (Average values)

Sample No.	Distance from the pith	No. of vessels	Diameter of vessels	No. of rays in cross section	No. of rays in tang. section	Height of ray		Width of ray		Fibre length	Fibre diameter	Fibre wall thickness
	Cm	/mm^2	μ	/mm	/mm^2	Cells	μ	cells	μ	μ	μ	μ
1	0-1	11	147	6	90	10	184	1-2	30.24	643	14.23	3.06
2	1-2	11	148	7	95	10	176	1-2	24.27	667	14.32	3.04
3	2-3	11	153	6	94	9	156	1-2	26.57	673	16.47	3.20
4	3-4	8	176	6	96	9	164	1-2	27.15	684	16.72	3.12
5	4-5	8	169	11	92	11	213	1-2	28.43	719	17.12	3.22
6	5-6	9	162	11	104	7	148	1-2	29.37	782	16.91	3.24
7	6-7	8	164	13	109	9	178	1-2	25.37	754	16.06	3.33
8	7-8	9	160	13	101	7	145	1-2	27.15	843	16.31	3.47
9	8-9	9	163	10	100	9	200	1-2	27.41	829	16.12	3.53
10	9-10	8	161	11	90	9	175	1-2	32.38	889	16.78	3.66

Width of ray covered 1-2 cells however, in microns it fluctuated from pith to bark. Maximum value of ray width (32.38μ) was determined close to the bark whereas, the minimum (24.27μ) at 1-2 cm from the pith.

Variation in fibre dimensions.

The fiber length was found to be increased from 0-10cm in the wood. It was 643μ near the pith and 889μ (maximum value) close to the bark. However, a reduction in the value was observed at 6-7cm & 8-9cm than the former points

The fiber diameter increased progressively from the pith up to 5cm in the wood reaching to its highest value (17.12μ). After that it reduced somewhat and ranged from 16.06μ-16.91μ up to the bark. The lowest value of this dimension was determined as 14.23μ near the pith.

The fiber wall thickness also increased from center to periphery in the wood. It was 3.06μ near the pith and 3.66μ (maximum value) close to the bark. However, a decrease in the value was observed at 1-2cm & 3-4cm than the preceding.

In order to determine the dependency of different microscopic features on the distance from the pith, simple linear regression analysis was done. The results are shown in table 2.

Table 2. Regression analysis of results of different microscopic features in *E.camaldulensis*.

S. No.	Microscopic feature	Regression co-efficient (R)
1	Frequency of vessels	0.485
2	Diameter of vessels	0.207
3	Frequency of rays in cross section	0.606
4	Frequency of rays in tang. section	0.125
5	Height of ray	0.00006
6	Width of ray	0.094
7	Fibre length	0.934
8	Fibre diameter	0.342
9	Fibre wall thickness	0.915

Maximum impact of distance from the pith was recorded on fiber length (0.934) and fibre wall thickness (0.915) whereas, the minimum on height of ray (0.00006). It means that the distance has linear correlation with fibre length and fibre wall thickness. However, it is not applicable for the rest of the anatomical features studied.

Conclusions:

- On the basis of these results it is concluded that in *E. camaldulensis* wood, generally the fiber length and wall thickness increase from the pith towards bark.
- The fiber diameter and vessel diameter increase up to a certain limit in the wood reaching to the maximum, beyond that the value of each dimension decreases somewhat and remains more or less constant, thereafter.
- The frequency of vessels decreases from pith to outwards in the wood whereas, the frequency of wood rays increases. However, after attaining the maximum value, the frequency of rays decreases slightly.
- The size of wood rays do not show any specific trend of increase or decrease from pith to bark.

References

Anon., 1971. Examination of timbers. Teaching aid No.7. Timber Research and development Association. Hughenden Valley, High Wycombe Bucks.

Amjad M., 1991. Report on tree growth on farmlands of NWFP. Forest Economics Branch Pakistan Forest Institute, Peshawar, Pakistan. pp.14.

Amjad M.,H. Shah and M.I. Bakhsh, 1992. Report on the tree growth on farmlands of Punjab. Forest Economics Branch Pakistan Forest Institute, Peshawar, Pakistan. pp.50.

Brown H.P, A.J Panshin and C.C Forsaith, 1949. Text book of wood technology Vol. 1, McGraw Hill Book Co., New York. pp.248,251.

Hillis W. E and A.G. Brown, 1978. Eucalyptus for wood Production. CSIRO, Australia, pp: 263-264.

Kasir, W. A. and J. S. Barno, 1985. A study on the effect of stump height and number of coppice shoots per stump on some anatomical properties of *Eucalyptus camaldulensis*. Dehn. Iraqi Jour. Agri. Sci., ZANCO. 3(3): 97-108.

Sheikh, M.I. 1993. Trees of Pakistan, Pakistan Forest Institute, Peshawar, Pakistan. pp.65.

Wallis,T.E.1965. Analytical microscopy. 3rd edition, Little Brown and company, Boston. p.111.

Appencix-1.Frequency and diameter of vessels from pith to bark in *E.camaldulensis* wood (Statistical values)

Sample number	Distance from the pith	No. of vessels /mm^2			Diameter of vessels μ		
	Cm	A.V	±S.D	C.V%	A.V	±S.D	C.V%
1	0-1	11	2.82	24.58	146.75	34.04	23.19
2	1-2	11	3.19	30.12	147.74	40.21	27.21
3	2-3	11	1.90	18.08	152.89	28.91	18.90
4	3-4	8	1.87	24.41	176.40	33.88	19.20
5	4-5	8	2.90	36.61	169.09	37.94	22.43
6	5-6	9	2.23	25.48	162.35	22.23	13.69
7	6-7	8	1.61	21.07	163.63	31.92	19.50
8	7-8	9	1.59	18.44	160.47	33.30	20.75
9	8-9	9	1.65	18.68	162.74	50.00	30.72
10	9-10	8	1.17	14.92	160.54	40.34	25.12

Appendix-2 Frequency and size of wood rays from pith to bark in *E. camaldulensis* wood (Statistical values)

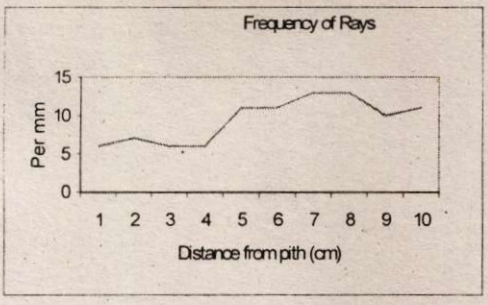
Sample number	Distance from the pith	No.of rays in cross section	No. of rays in tangential section			Height of ray				width of ray			
	Cm	/mm	/mm^2	±S.D	C.V%	cells	µ	±S.D	C.V%	Cells	µ	±S.D	C.V%
1	0-1	6	90	13.40	14.83	10	184	69.96	38.02	1-2	30.24	11.52	38.09
2	1-2	7	95	15.30	16.07	10	176	75.55	42.84	1-2	24.27	7.06	29.08
3	2-3	6	94	14.46	15.39	9	156	87.56	55.99	1-2	26.57	11.04	41.55
4	3-4	6	96	14.01	14.52	9	164	61.83	37.51	1-2	27.15	8.74	32.19
5	4-5	11	92	8.90	9.66	11	213	69.30	32.51	1-2	28.43	10.17	35.77
6	5-6	11	104	9.34	8.96	7	148	35.21	23.18	1-2	29.37	9.12	31.05
7	6-7	13	109	16.80	15.35	9	178	66.60	37.39	1-2	25.37	10.88	42.88
8	7-8	13	101	14.48	14.30	7	145	58.34	40.13	1-2	27.15	9.46	34.84
9	8-9	10	100	16.36	16.39	9	200	103.4	51.59	1-2	27.41	9.43	34.40
10	9-10	11	90	15.98	17.83	9	175	59.49	33.98	1-2	32.38	14.89	45.98

Appendix-3. Fiber dimensions from pith to bark in *E. camaldulensis* wood (Statistical values)

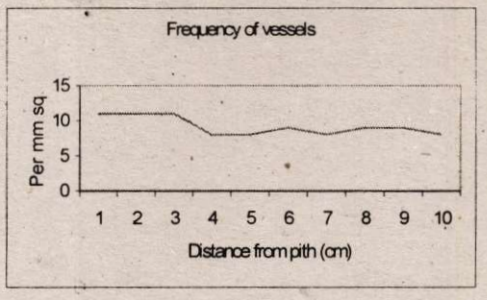
Sample number	Distance from the pith	Fiber length (μ)			fiber diameter (μ)			fiber wall thickness (μ)		
	Cm	A.V	±S.D	C.V%	A.V	±S.D	C.V%	A.V	±S.D	C.V%
1	0-2	643	84	13.06	14.23	1.83	12.86	3.06	0.23	7.51
2	1-2	667	84	12.59	14.32	1.73	12.08	3.04	0.17	5.59
3	2-3	673	113	16.79	16.47	2.11	12.81	3.20	0.20	6.25
4	3-4	684	94	13.74	16.72	2.08	12.44	3.12	0.21	6.41
5	4-5	719	100	13.90	17.12	1.88	10.98	3.22	0.25	7.76
6	5-6	782	149	19.05	16.91	1.73	10.23	3.24	0.27	8.33
7	6-7	754	70	9.28	16.06	1.66	10.33	3.33	0.24	7.20
8	7-8	843	131	15.53	16.31	3.34	20.47	3.47	0.16	4.61
9	8-9	829	106	12.78	16.12	2.14	13.27	3.53	0.20	5.66
10	9-10	889	75	8.43	16.78	2.05	12.21	3.66	0.26	7.10

Figure: A – F Showing the trend of different microscopic features from pith to bark in *E.camaldulensis*

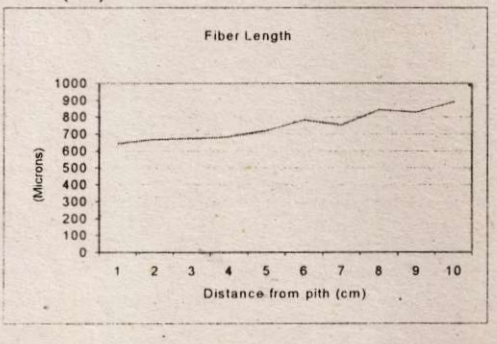
(A)



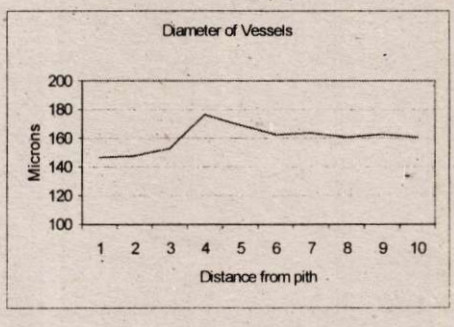
(B)



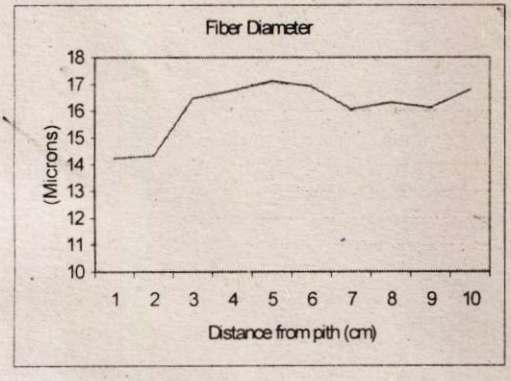
(C)



(D)



(E)



(F)