VARIATION OF WOOD ANATOMY IN ELEVEN EUCALYPTUS SPECIES GROWN IN SRI LANKA

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Summary

The present investigation was carried out on eleven species of Eucalyptus namely E. grandis. E. microcorys, E. camaldulensis, E.robusta, E. globulus, E. torelliana. E. tereticornis, E. pilularis, E. citriodora E. urophyla, *and* E. Cloeziana *to study variation of wood anatomy , specific gravity , wood texture and heartwood colour in search of anatomical features of any diagnostic importance for the identification of* Eucayptus *species. The selected 11 Eucalyptus species grown in Sri Lanka had more similarity in relation to wood characteristics such as vessel porosity, growth ring boundary, vessel shape, vessel arrangement and vessel grouping. Rays in all the species were not visible to naked eye, less than half width of the vessels and composed mainly from procumbent cells. Vesicentric axial parenchyma is common to all the species. Vessel frequency varied from 62 in* E. pilularis *to 180 in* E. camaldulensis *in 25mm². Minimum and maximum vessel diameter were recorded as 38 µm (*E.globulus*) to 230 µm (*E.robusta*). However mean minimum vessel diameter and mean maximum vessel diameter were found as 74 µm in* E.camaldulensis *and 178 µm in* E.robusta. *Ray frequency varied from 35 per 5 mm in* E. pilularis *to 70 per 5mm in* E. microcorys. *Mean ray width varied from 10 µm in* E. tereticornis *to 38 µm in* E. torelliana. *Variation of mean ray height from 111 µm to 415 µm were found in* E. camaldulensis *and* E. urophyla *respectively. Specific gravity varied from 1.005 in* E. camaldulensis *to 0.630 in* E. grandis. E. camaldulensis *showed the highest mean specific gravity of 1.005, followed by* E. citridora *(0.940),* E. tereticornis *(0.90).* E. globules *(0.875),* E. cloeziana *(0.840),* E. torelliana *(0.80),* E. microcorys *(0.80),* E. pilularis *(0.765).* E. urophyla *(0.775) .* E. robusta *(0.705) and* E. grandis *(0.63).* E. camaldulensis *and* E. globules *showed the fine wood texture and other species studied in this investigation showed medium or medium to fine textured wood. The colour of heartwood varied from yellow to brown within the species. It was found that* E.torelliana *can be differentiated from other species because most rays in* E. torelliana *consist of ray width of 1 to 3 cells. Even though the studied anatomical parameters varied within the Eucalyptus species, any unique anatomical feature that adequately supports to identify one species from another was not found. Due to this reason, anatomical wood characteristics within the Eucalyptus species must be carefully compared with the idea of distinguishing the Eucalyptus species.*

It can be concluded that anatomical properties studied in this investigation are not sufficient to identify all the eucalyptus species. Therefore more anatomical characteristic such as vessel perforation plates, Inter vessel pits arrangement and size, axial parenchyma cell type and Ray's cellular composition must be investigated. Anatomical wood properties alone with specific gravity and color of heartwood also can be used for the verification and identification of Eucalyptus species.

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INTRODUCTION

Eucalyptus is a diverse genus of flowering tree and shrubs in the family of Myrtaceae. There are more than 700 species of *Eucalyptus* mostly native to Australia. Eucalyptus was introduced to Sri Lanka in the late part of 18 th century. In 1882, a *Eucalyptus* plantation consisting more than 20 species was formed by the Botanical Garden staff in Hakgala Botanical Garden. Forest Department in 1931 took a decision to lay down arboretum plots to test the performance of *Eucalyptus* species in the grasslands of Uva and Nuwara-eliya. At present, there are around 21000 ha of *Eucalyptus* plantations belong to Forest Department other than *Eucalyptus* plantations established in estate sector, by private companies and in home garden s.(Ruwanpathirana, 2012). Reforestation with *Eucalyptus* is highly demanded in term of its rapid growth, remarkably cylindrical tree stem and some favourable wood properties. The main *Eucalyptus* species, *E. grandis, E. microcorys, E. camaldulensis, E. robusta, E. globulus, E. torelliana, E. tereticornis, E. pilularis and E. citriodora* are being used for sawn timber, railway sleepers, transmission poles, fuelwood, paper and pulp. *E. urophyla and E. cloeziana* are yet to come out from the arboretum plots in upcountry. These *Eucalyptus* timber has been categorized in different classes in State Timber Corporation's timber classification based on timber demand and wood properties. The eleven Eucalyptus species studied in this research work have some similar characteristics such as wood external appearance, some gross features and wood specific gravity. Due to these reasons, authenticity of *Eucalyptus* species is questionable when marketing logs or sawn timber. Therefore identification of *Eucalyptus* species by means of anatomical and other wood properties is an imperative exercise to minimize various kinds of fraud taking place in timber industry. Not only timber identification but anatomical properties can be used to describe the grain and texture of timber. In addition, these information is useful in timber utilization aspect also. The texture is concerned with the size of the wood element which depends mainly on the size of the vessel and the size of the rays. Texture is a compromise between vessel size and ray size. Specific gravity which is the best single criterion of the strength of a piece of wood was also determined in order to make use in timber identification process.

The present study examined wood anatomical properties of eleven *Eucalyptus* species namely *E. grandis, E. microcorys, E. camaldulensis, E.robusta, E. globulus, E. torelliana, E. tereticornis, E. pilularis, E. citriodora E. urophyla,* and *E. Cloeziana* in Sri Lanka in search of anatomical features of any diagnostic importance for the identification of *Eucalyptus* species. The objectives of this study were to investigate the variation of wood anatomical features of the eleven *Eucalyptus* species grown in Sri Lanka, with the idea of distinguishing the *Eucalyptus* species among one another and to determine the specific gravity, wood color and wood texture of the selected eleven *Eucalyptus* species grown in Sri Lanka.

MATERIALS AND METHODS

Authentic timber samples of the 11 *Eucalyptus* species from the Research Division of State Timber Corporation (STC) were collected along with fresh wood samples from the mature trees in the field. Disks of five centimeter thickness were cut from each sample species at breast height of tree. The collected specimens from two sources mentioned above, were compared with each other wood anatomically for confirmation of the identity of the specific *Eucalyptus* species . A radial strip was cut from each disk and divided into upper and lower strips. One was used for the investigation of anatomical characteristics and the other for the measurement of specific gravity and heartwood colour.

Specific gravity

A radial strip cut from each disk was used for the measurement of specific gravity. Specific gravity was determined on the basis of oven-dry weight and green volume. Specific gravity of *Eucalyptus* species studied were grouped into three categories viz. basic specific gravity low (‹= 0.40), basic specific gravity medium (0.40-0.75) and basic specific gravity high ›=0.75.

Wood color

Wood samples containing both heartwood and sapwood were used to determine wood color according to IAWA (1989) category No. 197 to 202 by naked eye. Heartwood color is categorized mainly into three groups namely (i) basically brown or shades of brown (ii) red or shades of red (iii) yellow or shades of yellow. Visible differentiation of heartwood color from sapwood was also studied.

Anatomical characteristics

A radial strip taken from the pith to bark was used for the investigation of anatomical characteristics. So that the wood samples were boiled in water for about two hours to soften them. Each wood sample was shaped and sized into a wood block of 2 cm x 2cm x 3cm. Transverse, radial and tangential sections at the range of 10-15 micrometer thickness were obtained by using a sledge microtome (Model Leica SM2000 R). The permanent slides of wood were prepared after dehydrated and stained in Safranin. Sections were mounted using Canada balsam using standard procedure.

Microscopic observations of each slide were made for qualitative and quantitative analysis of parameters under the light microscope at 4 x 10 magnification. Measurements on wood anatomical features were taken after photomicrographs of each slide were made by Olympus microscope and Micromertics SE Premium 4 software available in Research Division of STC.

Characters of wood anatomy for comparative anatomy were selected with the idea to use these parameters in timber identification with hand lens.Vessel porosity, growth ring, vessel shape, vessel grouping, vessel arrangement were studied under the light

microscope. Mean tangential vessel diameter, vessel tangential diameter range and vessel frequency. Measurement of vessel frequency was based on 10 counts in an area of 25mm^2 field of view. Range of ray height, mean ray height, ray width and ray frequency were studied. The measurement of ray frequency was based on 10 counts in an linear distance of 5mm field of view. The terminology and measurements were taken according to IAWA Committee (1989).

Visibility of vessels and rays on transverse section also done with naked eye. These findings were grouped into fairly visible, just visible and not visible categories.

Wood texture

Mean vessel tangential diameter, ray width and ray height were measured in this study from which average tangential diameter of the vessel (μm) was used to determine wood texture. Vessel size is primarily responsible for texture, however in a wood with large rays and vessels of moderate size or small size, coarse texture may ensure from large rays alone. Table 1 and ray information given in table 4 will serve to roughly indicate the basis of classification. Wider rays that affect to the wood texture, were not found from selected *Eucalyptus* species.

RESULTS AND DISCUSSION

Heartwood and sapwood color in *Eucalyptus* species

The present study showed that some Eucalyptus species such as *E. camaldulensis, Eucalyptus tereticornis, E. urophyla, and E. Cloeziana* had distinct heartwood and sapwood colour, sapwood from heartwood was not easily distinguished in *Eucalyptus* species such as *E. microcorys* and *E. grandis*. The colour of heartwood varied from yellow to brown in

Table 1: Classification of wood texture

Type of wood texture	Average tangential diameter of the vessel (μm)
Fine textured	Less than 100 microns
Medium textured	100 to 200 microns
Coarse textured	More than 200 microns

selected species. All the selected 11 *Eucalyptus* species can be grouped into three categories according to heart wood colour. E. cloeziana, *E. urophyla* , E. globules and *E. microcorys* had yellow or shades of yellow colour heartwood. *E. camaldulensis*, *E. torelliana*, *E. tereticornis* and *E.citriodora* had brown or shades of brown heartwood. *E. grandis* and E. robusta had red and shades of red heartwood (Table.2). *Eucalyptus globules* can be distinguished from *E. camaldulensis* on the basis of heartwood colour and wood specific gravity. Hence heartwood color along with sapwood color can be used for timber identification as a baseline.

Wood texture

E. camaldulensis and E. globules showed the fine wood textured and other species studied in this investigation showed medium or medium to fine textured wood. In some instances the other elements as well, especially where massed in zonate bands (parenchyma, fibers), must be taken into consideration (Pearson & Brown, 1981). It is found that parenchyma and fibers in the *eucalyptus* species studied did not show much difference among the species . Hence an attempt was made to classify *Eucalyptus* species studied into three different classes of wood texture based merely on size of vessels.

Specific gravity.

Specific gravity varied from 1.005 in *E. camaldulensis* to 0.63 in *E. grandis*. *E. camaldulensis* showed the highest mean specific gravity of 1.005, followed by *E. citridora* (0.94), *E. tereticornis* (0.90), *E.globules* (0.875), *E. cloeziana* (0.84), *E. torelliana* (0.80), *E. microcorys* (0.80), *E. pilularis* (0.765), *E. urophyla* (0.775) , *E. robusta* (0.705) and *E. grandis* (0.63)(see table 1). These results comply with findings of previous research carried out by Keating (1982) and sited in web site www.timber.lk

According to IAWA specific gravity classification, *E. grandis* and *E. robusta* were identified as medium density wood and *E. microcorys*, *E. camaldulensis*, *E. globulus*, *E. torelliana*, *E. tereticornis*, *E. pilularis*, *E. citriodora*, *E. cloeziana* and *E. urophyla* were identified as high density wood. IAWA specific gravity classification is too broad to differentiate the *Eucalyptus* species from each other.

This is because *E. urophyla* which has 0.775 specific gravity and *E. camaldulensis* which has 1.005 specific gravity fall into one specific gravity category. Wood specific gravity also can be used for timber identification when subjected timber sample having either higher or lower specific gravity in the range of above specific gravity variation, however in the case of *Eucalyptus* species verification, specific gravity can be used as a parameter.

Anatomical properties

Vessels.

The anatomical features of Eucalyptus species were shown in the Table 3-4 and figure 1-4. In all the selected species, wood were diffuse-porous and Growth ring boundary were

Table 2. Variation of mean specific gravity, wood colour and wood texture in eleven *Eucalyptus* species

Species	Specific gravity at 12% m.c	Color of wood, heart wood and Sapwood	Texture
Eucalyptus grandis	0.63 medium density	Heartwood basically red or shades of red. Heartwood colour darker than sapwood colour. but it is not always clearly differentiated.	Medium textured
Eucalyptus microcorys	0.80 high density	Heart wood basically yellow or shades of yellow. Heartwood colour darker than sapwood colour.	Medium to fine textured
Eucalyptus camaldu-lensis	1.005 high density	Heart wood basically brown or shade of brown, sapwood brownish yellow.	Fine textured
Eucalyptus robusta	0.705 medium density	Heartwood basically red or shades of red. Heartwood colour darker than sapwood colour.	Medium textured
Eucalyptus globulus	0.875 high density	Heart wood basically yellow or shades of yellow. Heartwood colour slightly darker than sapwood colour.	Fine textured
Eucalyptus torelliana	0.80 high density	Heart wood basically brown or shade of brown, sapwood yellow to white colour.	Medium textured

Eucalyptus tereticornis	0.90 high density	Heart wood basically brown or shade of brown, sapwood brownish yellow.	Medium textured
Eucalyptus pilularis	0.765 high density	Heart wood basically brown or shade of brown, sapwood is slightly paler in colour.	Medium textured
Eucalyptus citriodora	0.940 high density	Heart wood basically brown or shade brown, sapwood white to yellow colour.	Medium to fine textured
Eucalyptus urophyla	0.775 high density	Heart wood basically yellow or shades of yellow, sapwood yellowish white.	Medium textured
Eucalyptus cloeziana	0.84 high density	Heart wood basically yellow or shades of yellow, sapwood yellowish white.	Medium textured

indistinct or absent. Vessels of all the species were oval/round shape, solitary in grouping. Vessel arrangement of all the species found as diagonal and/ or radial arrangement.

Vessel frequency varied 62 in *E. pilularis* to 180 in *E. camaldulensis* in 25mm^2.

Minimum and maximum vessel diameter were recorded as 38 µm (*E.globulus*) to 230 µm (*E.robusta*). However mean minimum vessel diameter and mean maximum vessel diameter were found as 74 µm in *E.camaldulensis* and 178 µm in *E.robusta*. *E. camaldulensis* and *E. globules* showed the smallest mean vessel diameter as 74 µm and 76 µm respectively and followed by 102 µm in *E. citridora* and 103 µm *E. microcorys* .

Vessel of all the *Eucalyptus* species were examined by naked eye. The results show that the vessels of *E.grandis*, *E.robusta*, *E.tereticornis*, *E.pilularis*, and *E.cloeziana* were fairly visible to naked eye and the vessels of *E.microcoris*, *E.torelliana*, *E.citriodora* and *E.urophyla* were just visible to naked eye while vessels of *E.microcorys* and *E.globulus* were not visible to naked eye.(see details in table 3).

Table 3.Variation of growth ring, vessel porosity, vessel arrangement, vessel grouping, Vessel shape, vessel deposit, vessel diameter range, mean vessel tangential diameter and axial parenchyma in eleven Eucalyptus species.

Species	Growth ring, vessel porosity, vessel arrangement, vessel grouping, vessel shape and vessel deposit.	Vessel diameter range (MVD)- µm		Vessel in 25 mm²
Eucalyptus grandis	Growth ring boundary indistinct or absent, diffuse –porous, diagonal and / or radial pattern and exclusively solitary,Oval shape and tyloses common	109-189 (160) fairly visible to naked eye	130	Axial parenchyma vasicentric, rarely confluent
Eucalyptus microcorys	Growth ring boundary indistinct or absent, diffuse –porous, Diagonal and / or radial pattern and exclusively solitary ,Oval shape and tyloses common	58-149 (103) just visible to naked eye	120	Axial parenchyma vasicentric
Eucalyptus camal--dulensis	Growth ring boundary indistinct or absent, diffuse –porous, Diagonal and / or radial pattern and exclusively solitary , Oval shape and tyloses common	45-103 (74) Not visible to naked eye	180	Axial parenchyma vasicentric
Eucalyptus robusta	Growth ring boundary indistinct or absent, diffuse –porous, Diagonal and / or radial pattern and exclusively solitary ,Oval shape and tyloses common	140-230 (178) fairly visible to naked eye	105	Axial parenchyma vasicentric
Eucalyptus globulus	Growth ring boundary indistinct or absent, diffuse –porous, Diagonal and / or radial pattern and exclusively solitary ,Oval/ round shape and tyloses common	38-124 (76) Not visible to naked eye	155	Axial parenchyma scanty, vasicentric

Eucalyptus torelliana	Growth ring boundary indistinct or absent, diffuse –porous, Diagonal and / or radial pattern and exclusively solitary ,Oval/ round shape and tyloses common	94-172 (128) Just visible to naked eye	152	Axial parenchyma scanty, vasicentric
Eucalyptus tereticornis	Growth ring boundary indistinct or absent, , diffuse –porous, Diagonal and / or radial pattern and exclusively solitary , Oval/ round shape and tyloses common	91-201 (144) Fairly visible to naked eye	145	Axial parenchyma scanty, vasicentric
Eucalyptus pilularis	Growth ring boundary indistinct or absent, , diffuse –porous, Diagonal and / or radial pattern and exclusively solitary ,Oval/ roundshape and tyloses common	88-188 (138) Fairly visible to naked eye	62	Axial parenchyma vasicentric surrounding pores in the form of a sheath or halo.
Eucalyptus citriodora	Growth ring boundary indistinct or absent, , diffuse –porous, Diagonal and / or radial pattern and exclusivelysolitary ,Oval/ round shape	55-155 (102) Just visible to naked eye	90	Axial parenchyma scanty vasicentric aliform
Eucalyptus urophyla	Growth ring boundary indistinct or absent, , diffuse –porous, Diagonal and / or radial pattern and exclusively solitary , Oval shape	116-182 (145) Just visible to naked eye	142	Axial parenchyma scanty , vasicentric
Eucalyptus cloeziana	Growth ring boundary indistinct or absent, , diffuse –porous, Diagonal and / or radial pattern and exclusively solitary , Oval shape	42-205 (165) Fairly visible to naked eye	144	Axial parenchyma scanty vasicentric

MVD : Mean Vessel Diameter

Table 4. Variation of ray width , ray width range (µm), mean ray width(µm), ray height range (µm), mean ray height(µm), ray per 5mm in eleven *Eucalyptus* species.

Species	Ray width (µm)	Ray width range (µm) Mean ray width (µm)	Ray height range (µm) Mean ray height(µm)	Ray per 5mm
Eucalyptus grandis	Not visible to naked eye. less than half width of the pore. Ray exclusively uniseriate, rarely rays width 1 to 2 cells,	13-33 (24)	198-384 (281)	50
Eucalyptus microcorys	Not visible to naked eye . Less than half width of the pore. Ray exclusively uniseriate, very rarely rays width 1 to 2 cells.	13-26 (19)	85-253 (172)	70
Eucalyptus camaldulensis	Not visible to naked eye. Less than half the width of the pore. mostly uniseriate, rarely ray width 1-2 cells.	10-20 (14)	*68-155 (111)*	57
Eucalyptus robusta	Not visible to naked eye. Less than half width of the pore. mostly uniseriate , rarely ray width 1-2 cells.	20-39 (27)	198-535 (321)	50
Eucalyptus globulus	Not visible to naked eye. Less than half width of the pore. uniseriate , rarely rays width 1-2 cells.	16-30 (22)	120-353 (177)	54

Eucalyptus torelliana	Not visible to naked eye Less than half width of the pore. Mostly rays width 2-3 cells, rarely uniseriate.	23-49 (38)	123-454 (281)	64
Eucalyptus tereticornis	Not visible to naked eye. Less than half the width of the pore. Rays uniseriate, rarely ray width 1-2 cells.	16-26 (10)	101-400 (196)	53
Eucalyptus pilularis	Not visible to naked eye Less than half the width of the pore. Rays uniseriate, rarely ray width 1-2 cells.	16-32 (23)	55-211 (180)	35
Eucalyptus citriodora	Not visible to naked eye Less than half the width of the pores. Rays uniseriate, rarely ray width 1-3 cells.	13-32 (22)	107-247 (190)	51
Eucalyptus urophyla	Not visible to naked eye Less than half the width of the pore. Rays uniseriate, rarely ray width 1-2 cells.	20-42 (30)	185-981 (415)	44
Eucalyptus cloeziana	Not visible to naked eye. Less than half the width of the pore. Rays uniseriate, rarely ray width 1-2 cells.	10-29 (19)	150-332 (222)	40

This information is practicably useful when timber is identified by a hand lens. Ruwanpathirana (2002) found that vessel frequency and vessel size vary in radial direction from pith to bark in *E. grandis*. Therefore this variation may effect to the results of the comparative wood anatomy if wood samples were not taken in a consistent manner from all *Eucalyptus* species.

Axial parenchyma.

In all the selected species, paratracheal vasicentric axial parenchyma was found which means the parenchyma cells associate with the vessels and where the parenchyma cells is sufficiently abundant to form complete sheath or borders around the vessel. It was observed that vasicentric type parenchyma formation had some small variation among the species. It is found that *E. grandis* occasionally had confluent type paratracheal parenchyma. However this variation is not significant to differentiate Eucalyptus species in the process of timber identification by hand lens.

Ray

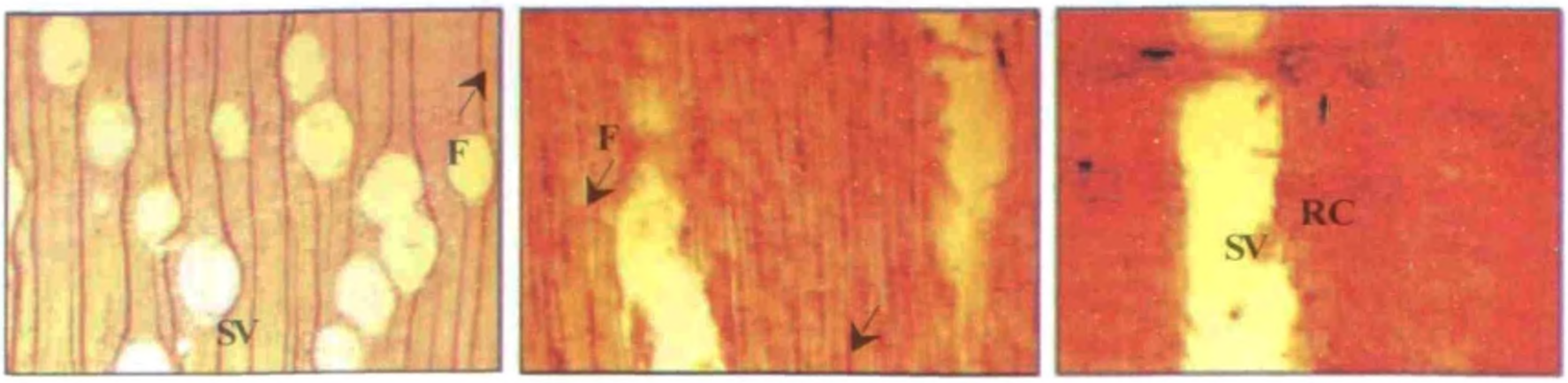
In all the selected *Eucalyptus* species, rays were not visible to naked eye and less than half width of the vessels. (Detailed information on rays is given in table 4 and in figure 1 to figure 4). Ray cells are procumbent in all the species. All the studied species except *E. torelliana* , ray was uniseriate and very few rays having ray width of 1 to 2 cell. Most rays in *E. torelliana* consist of ray width of 1 to 3 cells which can be used to distinguish *E. torelliana* from other species. The characteristics of highest ray height belong to *E. urophyla*, can be used as anatomical parameter to differentiate *E. urophyla* from other *Eucalyptus* species.

Ray frequency varied from 35 per 5 mm in *E. pilularis to* 70 per 5mm in *E. microcorys*. Mean ray width varied from 10 µm in *E. tereticornis* to 38 µm in *E. torelliana*. This indicates that ray width difference between the two species is not big enough to be used practically for timber identification. A Variation of mean ray height from 111 µm to 415 µm was found in *E. camaldulensis* and *E. urophyla* respectively.

Mean ray height may be used for timber identification when ray height differences between two species are significant

CONCLUSION

The selected 11 *Eucalyptus* species grown in Sri Lanka had more similarity in relation to wood characteristics such as vessel porosity, growth ring boundary, vessel shape, vessel arrangement and vessel grouping. Rays in all the species were not visible to naked eye, less than half width of the vessels and composed mainly from procumbent cells. Vesicentric axial parenchyma is common to all the species. Most rays in *E. torelliana* consist of ray width of 1 to 3 cells which can be used to distinguish *E. torelliana* from other species. Even though the studied anatomical parameters varied within the *Eucalyptus* species, any unique anatomical



(1a) (1b) (1c)

1. Eucalyptus grandis

(2a) (2b) (2c)

2. Eucalyptus microcorys

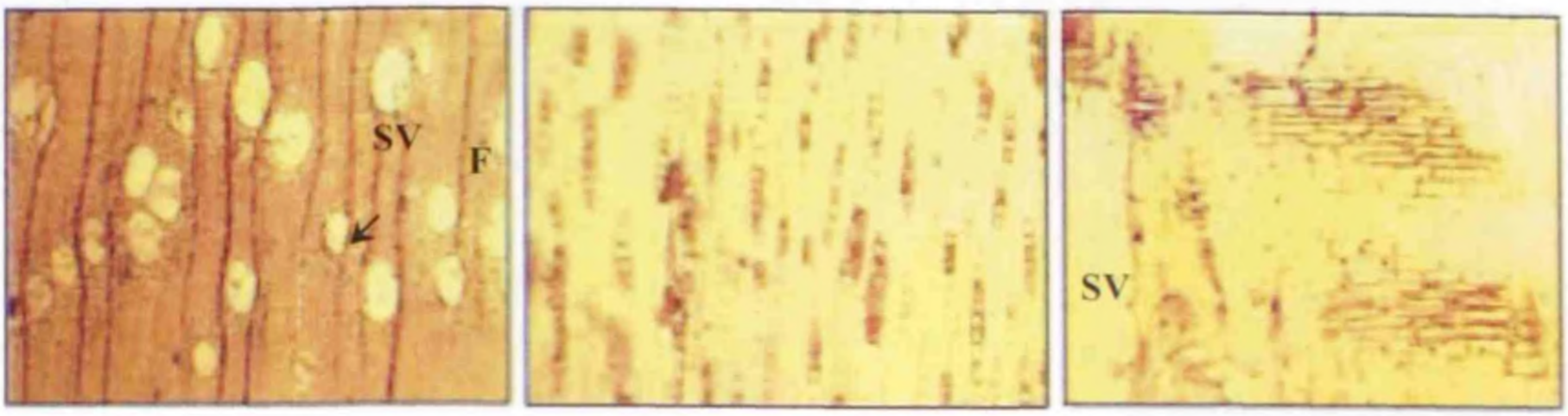
(3a) (3b) (3c)

3. Eucalyptus camaldulensis

Figure 1: Wood anatomical features of the *E. grandis*, *E. microcorys* and *E. camaldulensis* belong to genus *Eucalyptus* grown in Sri Lanka.

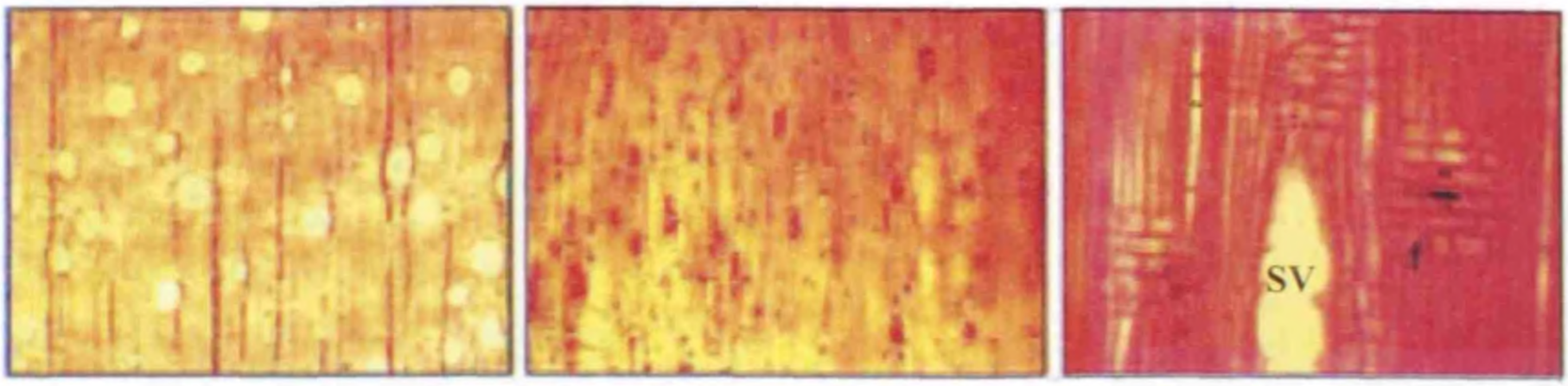
(1a) Cross sectional view of *E. grandis* ×25 (1b) Tangential longitudinal section of *E.grandis* × 40 (1c) Radial longitudinal section of *E. grandis* ×40 (2a) Cross sectional view of *E. microcorys* × 35 (2b) Tangential longitudinal section of *E. microcorys* × 50 (2c) Radial longitudinal section of *E. microcorys* × 40 (3a) Cross sectional view of *E. camaldulensis* × 25 (3b) Tangential longitudinal section of *E. camaldulensis* × 65 (3c) Radial longitudinal section of *E. camaldulensis* × 65

RC- **ray cell compose of procumbent cell;** SV- **solitary;** USR-**Uniseriate rays;**F-**Fibers.**



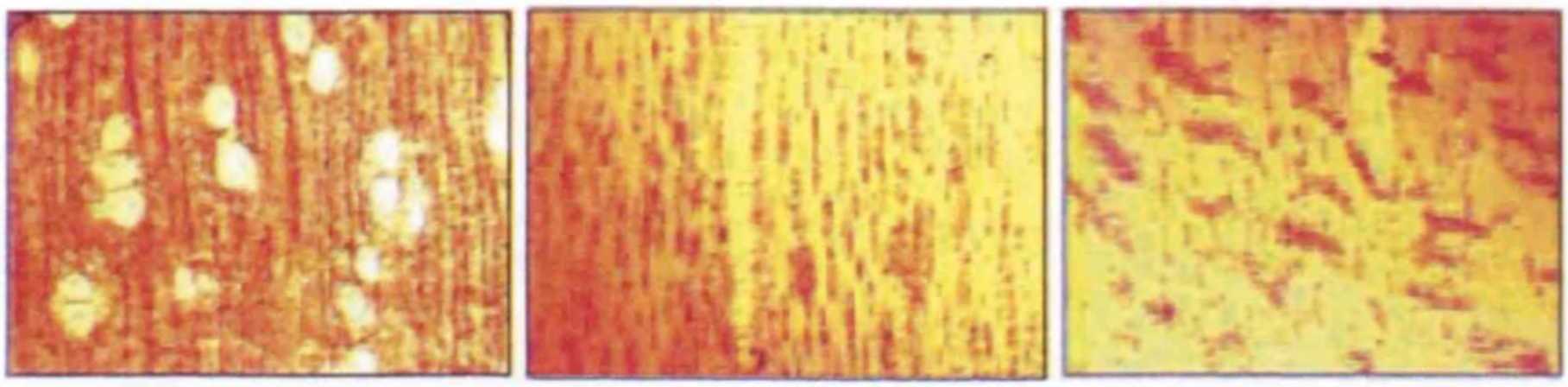
(4a) (4b) (4c)

4. Eucalyptus robusta



(5a) (5b) (5c)

5. Eucalyptus globulus



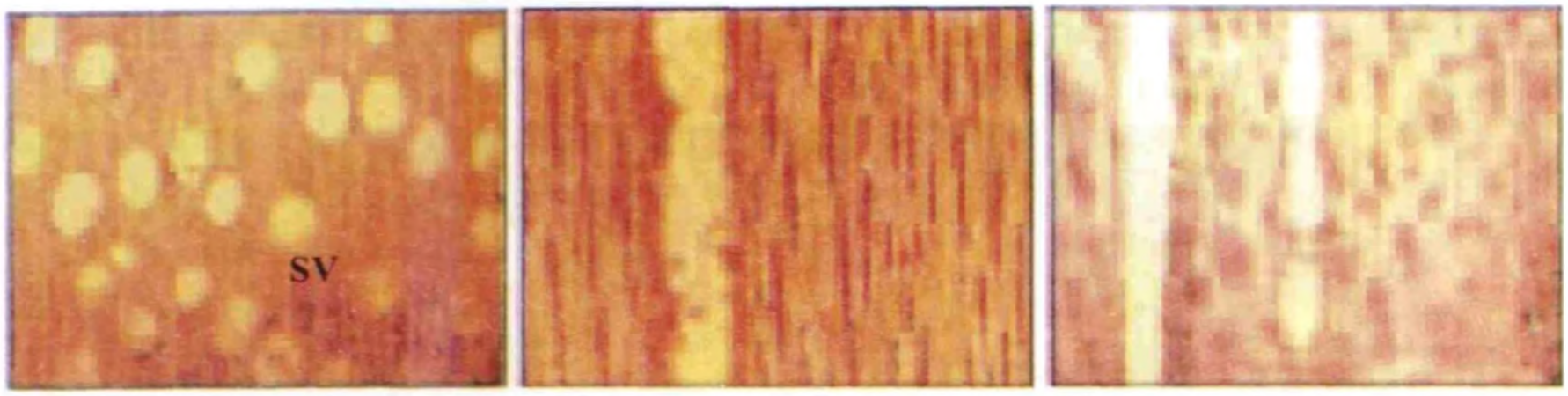
(6a) (6b) (6c)

6. Eucalyptus torelliana

Figure 2: Wood anatomical features of *E. robusta, E. globulus and E. torelliana* belong to the genus *Eucalyptus* grown in Sri Lanka.

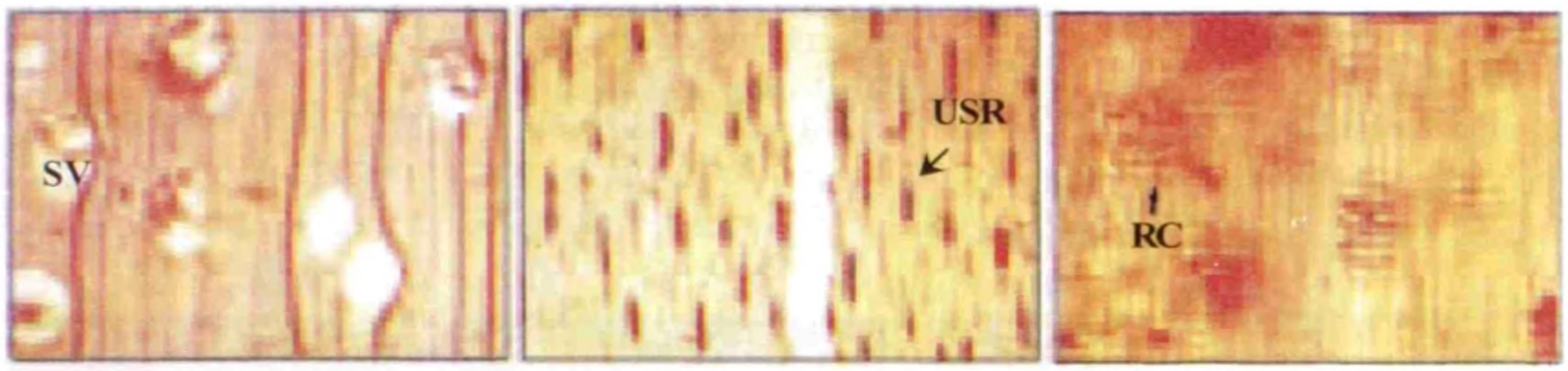
(4a) Cross sectional view of *E. robusta* ×25 (4b) Tangential longitudinal section of *E.robusta* ×75 (4c) Radial longitudinal section of *E. robusta* ×50 (5a) Cross sectional view of *E. globulus* ×25 (5b) Tangential longitudinal section of *E. globulus*×50 (5c)Radial longitudinal section of *E.globulus.*×75 (6a) Cross sectional view of *E. torelliana* ×25 (6b) Tangential longitudinal section of *E. torelliana* ×30 (6c) Radial longitudinal section of *E.torelliana.*×30

RC-**ray cell compose of procumbent cell;** SV-**solitary ;** USR-**Uniseriate rays;**F-**Fibers.**



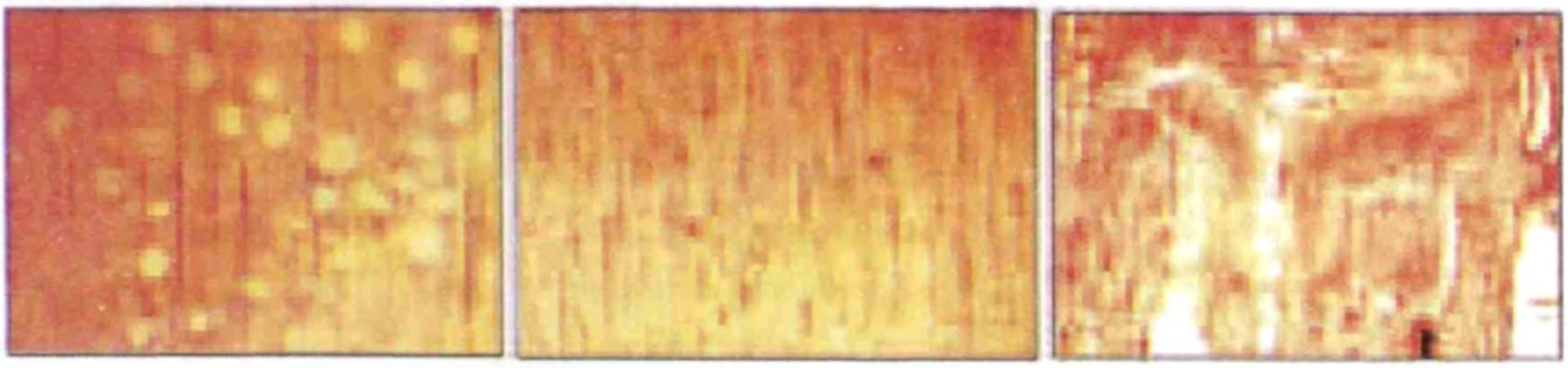
(7a) (7b) (7c)

7.Eucalyptus tereticornis



(8a) (8b) (8c)

8. Eucalyptus pilularis



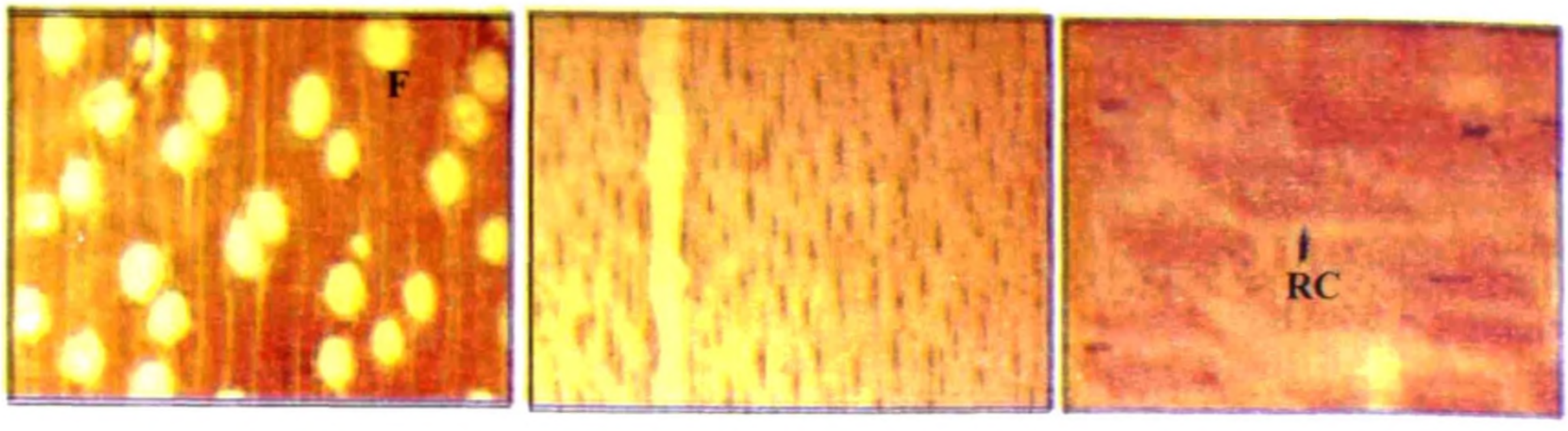
(9a) (9b) (9c)

9. Eucalyptus citridora

Figure 3: Wood anatomical features of *E.tereticornis* , *E. pilularis* and *E. citridora* belong to the genus *Eucalyptus* grown in Sri Lanka.

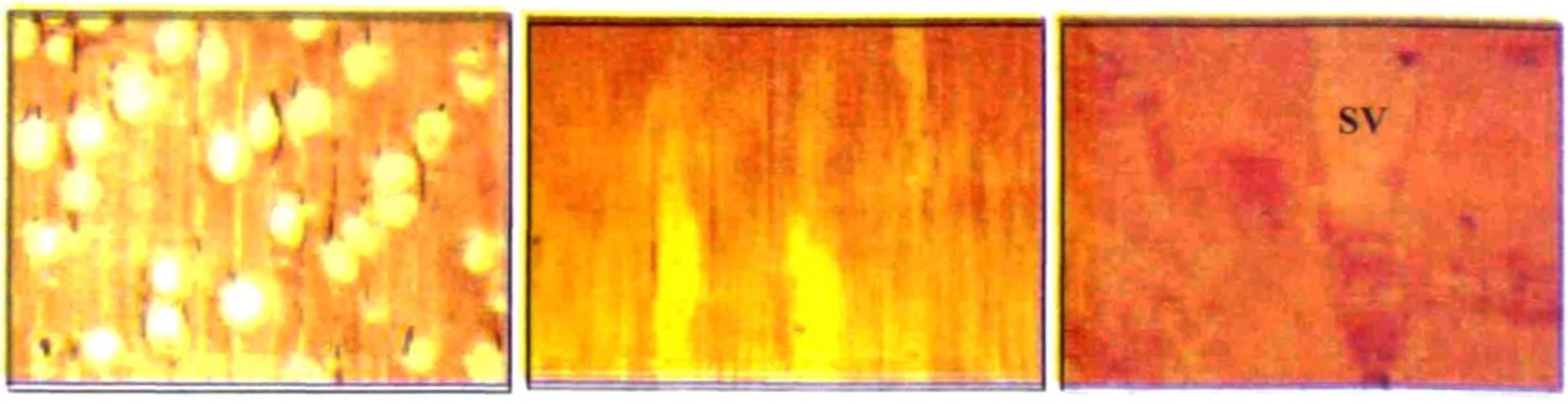
(7a) Cross sectional view of *E. tereticornis* ×30 (7b) Tangential longitudinal section of *E.tereticornis* ×50 (7c) Radial longitudinal section of *E. tereticornis* ×25 (8a) Cross sectional view of *E. pilularis* ×35 (8b) Tangential longitudinal section of *E. pilularis* ×35 (8c) Radial longitudinal section of *E.pilularis.* ×60 (9a) Cross sectional view of *E. citridora* ×25 (9b) Tangential longitudinal section of *E. citridora* ×40 (9c) Radial longitudinal section of *E.citridora*×50

RC-ray cell compose of procumbent cell, SV-solitary, USR-Uniseriate rays,F-Fibers.



(10a) (10b) (10c)

10. Eucalyptus urophyla



(11a) (11b) (11c)

11. Eucalyptus cloeziana

Figure 4: Wood anatomical features of *E.urophyla* and *E.cloeziana* belong to the genus *Eucalyptus* grown in Sri Lanka.

(10a) Cross sectional view of *E.urophyla* ×25 (10b) Tangential longitudinal section of *E.urophyla* ×25 (10c) Radial longitudinal section of *E. urohyla* ×30 (11a) Cross sectional view of *E. cloeziana* ×25 (11b) Tangential longitudinal section of *E. cloeziana* ×40 (11c) Radial longitudinal section of *E.cloeziana* ×50

RC-**ray cell compose of procumbent cell;** SV- **solitary;** USR-**Uniseriate rays;** F-**Fibers.**

feature that adequately supports to identify one species from another was not found. Due to this reason, anatomical wood characteristics within the *Eucalyptus* species must be carefully compared with the idea of distinguishing the *Eucalyptus* species.

It can be concluded that anatomical properties studied in this investigation is not sufficient to identify all the *Eucalyptus* species. Therefore more anatomical characteristics such as vessel perforation plates, inter vessel pits arrangement and size, axial parenchyma cell type, ray's cellular composition must be investigated to construct a identification key for selected species. However anatomical wood properties alone with specific gravity and color of heartwood of *Eucalyptus* species studied in this research work can be used for verification and identification of *Eucalyptus* species in Sri Lanka.

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