

IDENTIFICATION OF EUCALYPTUS SPECIES BY ANATOMICAL FEATURES

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Abstract:

Wood anatomy is considered to be a precise and rapid method in wood identification. *Eucalyptus* is a diverse genus of trees in the family of Myrtaceae. Due to the lack of appropriate systematic approaches, timber identification of *Eucalyptus* species is presently done based on visual observations and personnel skills. Therefore, the authenticity of *Eucalyptus* species is frequently questioned at the timber market. Identification of *Eucalyptus* species based on anatomical properties is recognized to be an imperative exercise as it could minimize possible misleads in the timber industry. In this research, nine *Eucalyptus* species grown in Sri Lanka namely: *E. camaldulensis*, *E. citriodora*, *E. torelliana*, *E. pilularis*, *E. tereticornis*, *E. globulus*, *E. microcorys*, *E. Robusta* and *E. grandis* were employed in identifying the variation of wood anatomical features with the idea of distinguishing the species. Anatomical features published by International Association of Wood Anatomists (IAWA) were used as the reference. Twelve wood sections representing each species (Tangential and Transverse sections of the wood) were used to identify the microscopic features. Micrometrics SE Premium 4 software was used to analyze the anatomical features of the timber. Based on the anatomical features of rays, vessels and parenchyma, a Dichotomous key was developed for the precise identification of *Eucalyptus* species.

Key words: wood anatomy; IAWA features; *Eucalypts*; dichotomous key.

INTRODUCTION

Timber is considered to be an ecologically friendly building material used by man for ages. It is a versatile raw material with lesser requirement of construction energy thus plays a vital role in the economic and industrial development of many countries. Over 400 different timber species which possess a variety of variations in their physical and anatomical features are used in Sri Lanka for a wide range of applications (Mendis et al. 2019). Hence timber identification is a highly important to confirm its authenticity. According to a research work conducted by the State Timber Corporation (STC) of Sri Lanka on identifying timber authenticity of the local and imported timber species used in Sri Lankan timber market in past six years, only 55% of local timber species were correctly identified, 6% of species were incorrectly claimed and 39% of species were not identified by the clients (Siriwardena and Muthumala 2018). Due to the lack of awareness on the uniqueness of timbers, usage of inferior and unfitting timber species is often reported. Apart from the buyers and consumers, timber sellers are also often misled by the forged documents and materials. The accepted standards in this connection, could play a vital role guiding the timber users when selecting species for their specific tasks. Therefore, it is important to learn about the physical and anatomical properties of different timber species in order to be certain that the species selected are appropriate for the purpose of concern.

At present observations on the physical properties such as colour, aroma, texture, figure, density etc., are frequently used in identifying timbers though such properties vary with a number of factors and thus are not reliable. Macroscopic wood identification is considered to be the fastest method for the first identification of an unknown timber (He et al. 2019). The microscopic assessment of the timber anatomy is however time-consuming and expensive (Lens et al. 2020; Mendis et al. 2020). International Association of Wood Anatomists (IAWA) has always been the world's leader in standardizing and summarizing the characters used in microscopic wood identification and the IAWA continues its leadership role in establishing the same type of consensus framework for macroscopic identification (Low et al. 2022). Image recognition techniques have been recently applied to wood images for automated identification (Zhang et al. 2020).

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The genus *Eucalyptus* is a member of the Myrtaceae family, mainly originated from Australia, comprising of more than 700 species (Salehi et al. 2019). The genus, with one exception (*E. deglupta*) is confined to Australia, with a few Australian species extending to Timor and Papua, e.g. *E. alba* and *E. tereticornis*. Many *Eucalyptus* species are employed in producing timbers of commercial importance, and for this reason they have been planted in many parts of the world. The trees are mainly straight stemmed with cylindrical boles and generally without buttresses. The sapwood in all species is comparatively narrow, generally 2.5cm or less in width, and pale in colour; the heartwood colour, excepting straw in a few instances, varies from pale-brown to deep red-brown or chocolate-brown (Collins et al. 2019). Today, several countries in Asia, South America, southern Europe, and Africa, have an estimated area of planted forest around 16-19 million hectares (Mengistu et al. 2022). The predominance species in commercial plantations (around 80%) are *Eucalyptus grandis*, *Eucalyptus globulus*, *Eucalyptus camaldulensis* and their hybrids (Khan et al. 2020).

Most of the *Eucalyptus* species which are grown in the up-country of Sri Lanka can be identified with their physical appearance. However, when it converts into timber, it is difficult to distinguish the species due to the similar characters of wood species. The State Timber Corporation of Sri Lanka had been authorized by a gazette notification to issue timber identification and timber quality certification reports when such a request is made by an interested party.

Dicotomous keys have long been employed in biological identification (Gulis et al. 2020). In developing keys, necessary calculations relevant to biological features and clustering them into species are done with the use of computer aided programs (Sonsin-Oliveira et al. 2022). Dicotomous keys direct the user to distinguish the features and thereby identify the species (Almeida et al. 2020). In this connection, digital reference databases are used for the analysis of wood anatomical characteristics (Moghadam et al. 2020). Following this, some researchers have developed keys based on anatomical and physical features of wood to facilitate scientific identification of timber species (Olschofsky and Köhl 2020). However, no accepted key has so far been developed for identifying the timbers of different *Eucalyptus* species. Therefore the aim of this research was to develop a timber identification key for *Eucalyptus* spp. found in Sri Lanka.

MATERIALS AND METHODS

In this investigation, nine *Eucalyptus* spp. namely; *E. camaldulensis*, *E. citriodora*, *E. torelliana*, *E. pilularis*, *E. tereticornis*, *E. globulus*, *E. microcorys*, *E. robusta* and *E. grandis* which are available in the up-country and low country of Sri Lanka were selected. Heartwood timber samples of the age between 20-25 years were taken from the breast height of the each tree to prepare specimens. Twelve wood sections representing each species (Tangential and Transverse sections of the wood) were used to identify the microscopic features. All samples were sectioned and macerated using standard techniques (Bass and Zhang 1988).

Preparation of wood for microscopic examination

Section cutting were done by wood samples were boiled in water periodically for three days until the air space of wood is occupied by water. Each specimen was the shaped and sized into wood-block of 2cmx2cmx3cm. Transverse, and tangential sections at the range of 10-15 micrometers thickness were taken using a sledge microtome (model Leica SM2000 R). The piece of wood sample and the knife were flooded with 30% ethanol during the section cutting to facilitate fine sectioning.



Fig. 1.

Preparation of slide in three plains of wood section using sledge microtome A-Preparation of Timber Sample, B-Sledge microtome, C-Preparation of timber slide sample.

Staining and mounting procedure

Thin wood samples were flooded in 50% alcohol for five minutes for the dehydration of the section. Then samples were transferred to another petri dish with Safranin and 50% alcohol and kept for 15 minutes for removal of the remaining moisture and the colour. They were washed with 50% alcohol ensuring further dehydration and kept in another petri dish containing 70% alcohol for 5-10 minutes for further removal of moisture. The procedure was repeated with 90% alcohol also to ensure further dehydration. Samples were then flooded in absolute alcohol for 10 minutes followed by flooding in absolute alcohol and Xylene mixture for 10 minutes. The dehydration procedure was repeated until the milkiness of the specimen was disappeared. After keeping the samples in Xylene for 10 minutes, they were mounted (Transverse -T.S. and Tangential - T.L.S.) in Canada balsam using slides.

Anatomical observations on qualitative and quantitative parameters were made under a light microscope (Mode: ACCU-SCOPE-3001) at 4x10 magnification. Measurements were obtained using anatomical photos and Micrometrics SE Premium 4 software available at Wood laboratory, Research Division of the State Timber Corporation of Sri Lanka. Quantitative wood anatomical features; mean vessel diameter, vessels per square millimeter and mean ray heights were measured according to IAWA list in 1989 (Bass and Zhang 1988).

RESULTS AND DISCUSSION

Identification and differentiating the timber according to wood anatomical features (IAWA)

A new list of wood anatomical features was prepared by modifying the former wood anatomical feature list that has been prepared by IAWA (1989). As described in the section 3 in Nomenclature of the IAWA Committee (1989), vessel diameter was taken as lumen diameter at the widest point. Nine *Eucalyptus* timber species have been investigated for their wood anatomical features. Wood sections were observed with the light microscope to determine vessels per given area (mm^2).

Specific gravity and colour classification were found to be less effective in preparation of a key and ultimately for the identification of timber species in the same family. Fig. 2 shows the photographic representations of anatomical features in three planes of wood sections of nine *Eucalypts* species.

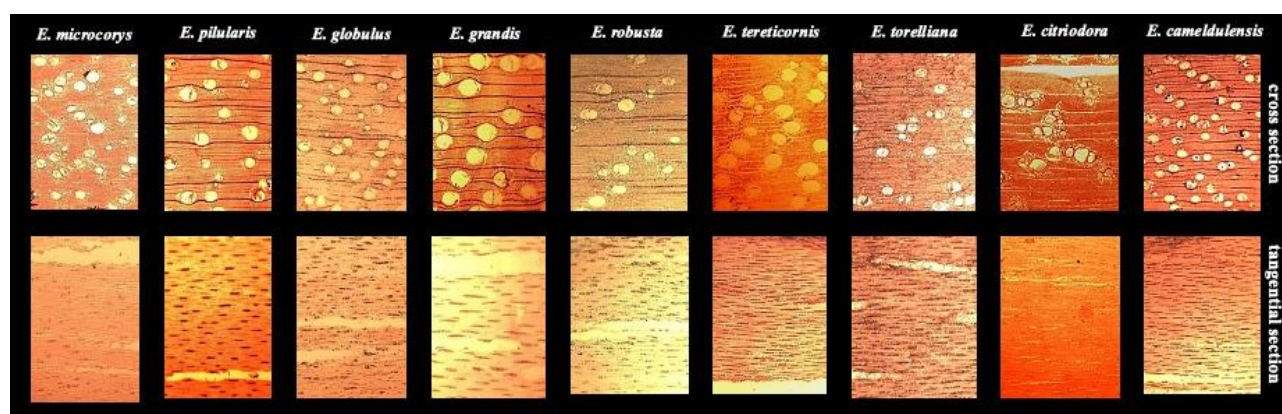


Fig. 2.

Identification of Anatomical characteristics by Photographic representations of cross section and tangential section (magnification 4x10).

Table 1

Physical features of rays and vessels of selected timber species

No	Common name	Botanical name	Vessel diameter(μm)	Mean V. D. (μm)	Vessel/mm ²	Ray width (μm)	Mean RW (μm)	Ray height (μm)	Mean Ray height (μm)
01	<i>E. grandis</i>	<i>Eucalyptus grandis</i>	109-189	161	5-20	13-10	24	198-384	281
02	<i>E. micro</i>	<i>Eucalyptus microcoris</i>	58-149	103	13	13-26	19	85-253	172
03	<i>camaldulensis</i>	<i>Eucalyptus camaldulensis</i>	45-103	74	47	10-20	14	68-355	190
04	Red gum	<i>Eucalyptus robusta</i>	140-230	176	8	20-39	27	198-335	321
05	Blue gum	<i>Eucalyptus globulus</i>	38-124	76	13	16-30	22	80-253	150
06	<i>E. torelliana</i>	<i>Eucalyptus torelliana</i>	94-172	128	20	23-49	38	123-454	281
07	<i>E. tereticornis</i>	<i>Eucalyptus tereticornis</i>	91-201	144	23	16-26	10	101-400	196
08	<i>E. pilularis</i>	<i>Eucalyptus pilularis</i>	88-188	138	6	16-32	23	55-211	180
09	<i>E. citriodora</i>	<i>Eucalyptus citriodora</i>	55-155	102	10	13-32	22	107-2447	190

Table 1 presents the anatomical measurements of vessels and rays of *Eucalyptus* species. Anatomical measurements shown in Table 1 were used to prepare the dichotomous key for *Eucalyptus* spp. Vessels in the nine *Eucalyptus* species are solitary, out of nine species, eight species are show in diagonal pattern and one species (*E. citriodora*) shows in clusters. Parenchyma is usually abundantly paratracheal, scanty and vasicentric. Vessels are variable in size from very small (invisible without 10X lens) to large. The mean tangential vessel diameter ranges from 74μm in *E. cameldulensis* to 176μm in *E. robusta*. The mean vessel diameter varies from moderately short (< 74μm) in *E. cameldulensis* to medium-sized > 74μm (90-200μm) in other species. The vessels number per mm² is generally within the range of 5 to 20 in *E. grandis*, and high in a *E. cameldulensis* (47 vessels per mm²). Growth rings are generally indistinct or not well defined in the all species.

In tangential sections, the rays are uniseriate to triseriate in nearly all the species and up to 3 cells wide. They are weakly heterocellular. In some species, middle cells (majority) are dark in color in tangential longitudinal section of rays except *E. microcoris*. In some species, aggregate rays are present. Mean ray height varied from 111μm (range - 68-155μm) to 321μm (range - 198-535μm). Dichotomous key was prepared using anatomical characters of nine *Eucalyptus* species to facilitate scientific identification of timber species based on anatomical features.

Dichotomous Key

- (01) A. Vessel are not exclusively solitary..... *E. citriodora*
B. Vessel are exclusively solitary..... (02)
- (02) A. Rays are exclusively uniseriate..... (03)
B. Rays are not exclusively uniseriate..... (04)
- (03) A. Middle cells (majority) are not thickened in tangential longitudinal section of rays *E. pilularis*
B. Middle cells (majority) are not thickened in color in tangential longitudinal section of rays *E. microcoris*
- (04) A. Ray width 1-2 cells *E. robusta*
B. Ray width 1-3 cells (05)
- (05) A. Vasicentric axial parenchyma present..... *E. grandis*
B. Vasicentric axial parenchyma absent
(Scanty parenchyma present) (06)
- (06) A. Mean ray height 150μm *E. globulus*
B. Mean ray height > 150μm (07)
- (07) A. Mean vessel diameter < 74μm (range 45-103μm)..... *E. cameldulensis*
B. Mean vessel diameter >74μm (range 90-200μm)..... (08)
- (08) A. Mean ray width 38μm..... *E. tereticornis*
B. Mean ray width 10μm *E. torelliana*

Based on the results of the present study it can be concluded that the end users get higher percentage of authentic *Eucalyptus* timber species using prepared dichotomous key.

CONCLUSION AND RECOMMENDATIONS

The majority of the morphological characters and external appearance of wood of *Eucalypts* species grown in Sri Lanka is almost alike. Therefore precise identification of *Eucalyptus* species as timber was found to be a hard task. Based on the present findings, microscopic features listed in IAWA could be employed much effectively in identifying the significant anatomical characters of timber species enabling consumers and merchants to distinguish timber materials of closely related species. Present dichotomous key will benefit them in distinguishing *Eucalypts* species.

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