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Character and Property Evaluation of Sacred Figure Tree (*Ficus religiosa* L.: Moraceae) Wood

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ABSTRACT

Wood of *Ficus religiosa* L. was collected from the old trunk. The anatomical character of wood was analysed to evaluate its properties. The permanent slides of wood samples were made using a sliding microtome and tissue maceration methods. The specimens were observed under light microscope and scanning electron microscope. It was found that the wood is diffuse porous with solitary and multiple pores. Tyloses are present in vessels. Rays are uniseriate heterocellular and multiseriate heterocellular (Krib's Type II). Axial parenchyma are banded paratracheal. Starch grains are observed in axial parenchyma. Fibers are septate libriform. In term of property, wood is light when dry and has a low hardness. From the results, it can be concluded that *Ficus religiosa* L. wood has a potential for mushroom cultivation and furniture making but not suitable for heavy construction.

INTRODUCTION

Sacred Figure tree (*Ficus religiosa* L.) belongs to the family Moraceae. The species is native to tropics and subtropics [1]. It distributes throughout the Indian subcontinent and South-East Asian countries including Bangladesh, Bhutan, China, India (all states except Andaman and Nicobar islands), Laos, Nepal, Pakistan, Vietnam and Thailand [2]. It is an evergreen or deciduous tree. The plant can grow up to 20 meters with wide- spreading branches [1]. The wood is used for house construction, furniture making, packing cases, spoons and bowls [3,4]. Bark is used as skin wash to treat scabies [2]. Wood anatomy of some *Ficus* species in India were investigated [5,6].

Ficus religiosa L. is common in Thailand. It is evergreen, fast growing and obtains a large number of wood. However, the utilization of the species is limited. This study aims to investigate the wood characteristics which relate to wood properties. The obtained information would be benefit wood utilization of the species.

METHODOLOGY

Wood samples of *Ficus religiosa* L. were collected from Kasetsart University, Bangkhen campus, Bangkok, Thailand. The wood anatomy and wood properties were investigated using the following methods:

1. Macroscopic study

Wood sample was trimmed into a 1x1x3 cm. block and then was cut into 80 µm thickness by a sliding microtome (Leica, SM 2010 R). The sections were observed under a light microscope.

2. Microscopic study

2.1 Permanent slide preparation of wood sections

Wood samples were cut into sections in three surfaces (transverse, tangential and radial long sections) using a sliding microtome (Leica, SM 2010 R) with 20-30 µm thickness. The sections were stained with safranin T for 1 hour, washed with water and then subjected to ethanol series (30, 50, 70 and 95%) for tissue dehydration, stained with fast green for 5 minutes, washed with 95% ethanol and absolute ethanol, respectively. The sections were immersed in xylene for 6 hours before mounted with permount.

2.2 Permanent slide preparation of macerated tissue

Wood sample was cut into small pieces (toothpick size) and then boiled in a mixture of 10 % chromic acid and 1 % nitric acid (1:1) for 3 hours (until the cells were separated). The macerated cells were washed 3 times with water and stained with safranin T for 1 hour. Then the samples were washed with water for 3 times and dehydrated with

ethanol series (30, 50, 70, 95, 100 %). Centrifugation was used in each step. The specimens were immersed in xylene for 6 hours and then mixed with permount before mounting.

2.3 Scanning electron microscopy

Wood sample was cut into 3 surfaces (transverse, tangential and radial long sections) using a sliding microtome with 120 µm thickness. The sections were dried in an oven (80°c) for 3 days before subjected to the critical point dryer (CPD) (Emitech, K850) and coated with gold particles. The samples were observed under a scanning electron microscope (Hitachi, SU8020).

RESULTS

Macroscopic characters

The wood is pale white, no luster and odorless. Growth rings are indistinct. (Figure.1A). Wood grain is straight.

Microscopic characters

The wood is diffuse porous with solitary pores and multiple (2-5) pores (Figure 1B). Vessels are round to oval shaped with simple perforation, 57-229 µm diameter and 50-226 µm length (Figure. 1C). There are 3.65 pores/mm^2. Intervessel pits are bordered with opposite arrangement (Figure 1D). Tyloses are present in vessels (Figure 1E).

Rays are uniseriate heterocellular and multiseriate heterocellular (Krib's type II) (Figure 1F). The uniseriate ray is 22.58 µm width and 178.20 µm height. The multiseriate ray is 110.26 µm width (2-6 rows) and 528.60 µm height. The numbers of rays are 5 rays/mm and ray covered area are 24.72 %.

Axial parenchyma are banded paratracheal (Figure 1B). Starch grains are observed in axial parenchyma (Figure 2D).

Fibers are septate libriform with 70.44 µm long, 5.55 µm diameter and 1.98 µm wall thickness. The quantitative data and wood characteristics were presented in table 1.

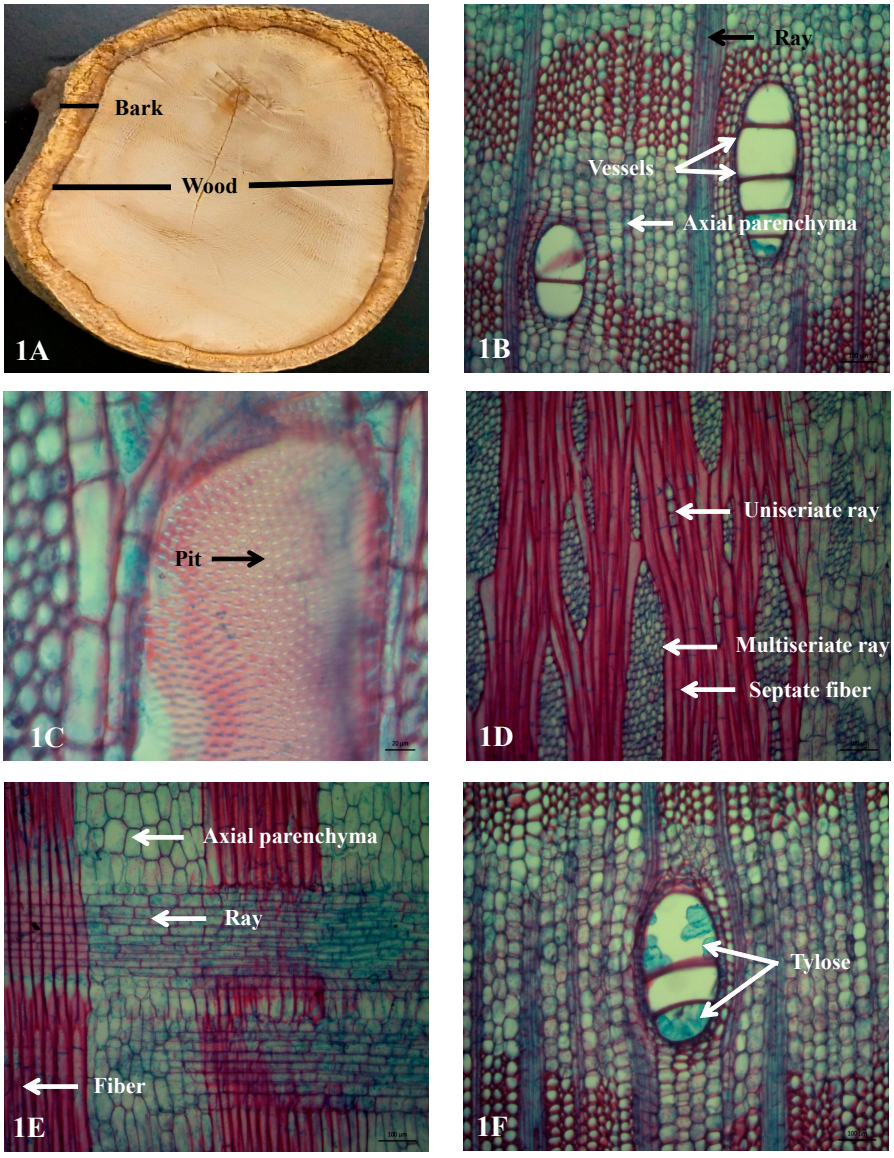

Figure 1. Wood characteristics of *Ficus religiosa* L. A. Transverse surface of trunk B. Multiple pores in transverse surface C. Intervessel-pits D. Uniseriate and multiseriate rays in tangential surface E. Multiseriate heterocellular ray and axial parenchyma in radial surface F. Tyloses invessels.

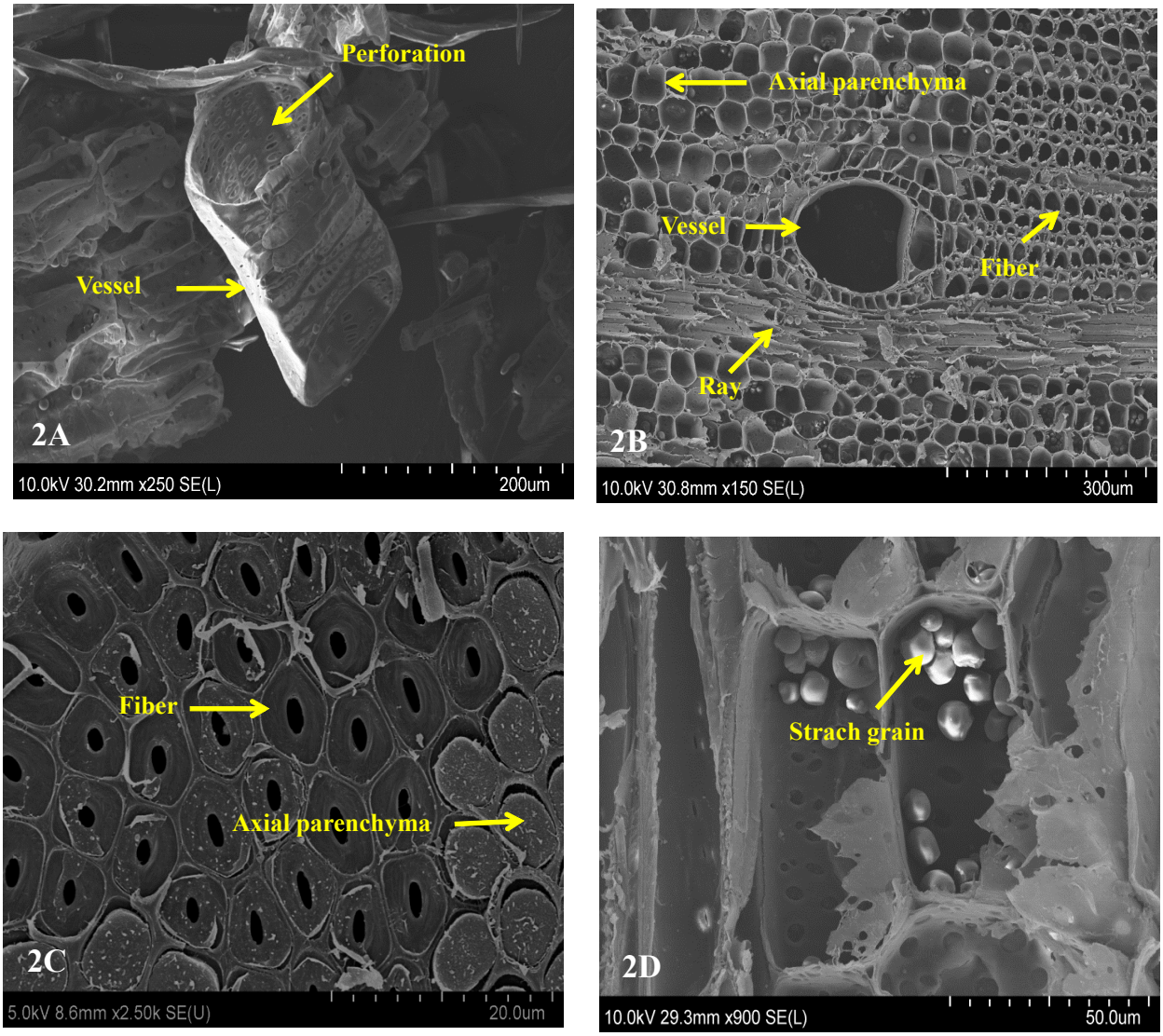

Figure 2. Scanning electron micrographs of *Ficus religiosa* L. wood A. Macerated vessel showing a simple perforation B. Transverse surface C. Transverse surface of fibers and axial parenchyma D. Starch grains in axial parenchyma.

Table 1. Quantitive data and anatomical characteristics of *Ficus religiosa* L. wood.

Vessel Diameter (µm)	Vessel Length (µm)	Uniseriate ray		Multiseriate ray		Ray number (Rays/mm)	Fiber		
		Width (µm)	Length (µm)	Width (µm)	Length (µm)		Length (µm)	Diameter (µm)	Wall Thickness (µm)
127±29.92 (57-229)	137±36.84 (50-226)	22.58±4.74 (14.72-32.12)	178.20±54.14 (100.50-278.40)	110.26±26.97 (64.34-165.56)	528.60±50.82 (253.47-931.54)	5±1.14 (3-6)	70.44±48.59 (16.77-243.08)	5.55±0.42 (4.92-6.17)	1.98±0.25 (1.69-2.46)

DISCUSSION

Ficus religiosa L. was indistinct growth ring according to it grows in a tropical zone where the precipitation is not much different in the year round. While the growth rings normally occur in dry season. This phenomenon is similar to *Spondias* (Anacardiaceae) woods [7] and *Castanopsis* (Fagaceae) woods [8]. The wood has small to medium size vessels so it is classified to a fine-textured [9]. This is an advantage for furniture making [4]. Tyloses are observed in vessels. Tylose is a phenomenon that the paratracheal axial parenchyma protrude a part of cell into vessel lumen causing transportation block. The wood having tyloses are preferred for liquid storage. For instance, white oak wood is used for beverage barrels [10]. In addition, tyloses play a role to obstruct fungal invasion. *Ficus religiosa* L.wood composes of large rays and a high percentage of axial parenchyma. As they are living cells which contain high moisture, the wood is light when dry. Septate fibers were observed. These are storage fibers. The anatomical structures show that the wood preserved large amount of water in ray cells, axial parenchyma as well as septate fibers. This implies that the wood has a potential of drought tolerance.

The wood hardness relates to cell components. *Ficus religiosa* L. wood contains a high ratio of parenchyma (axial and ray parenchyma) but has small amount of fibers. The parenchyma have thin wall (only primary wall) which cause low hardness. As a result, the wood is not suitable for heavy construction.

Interestingly, a number of starch grains were stored in axial parenchyma. This food storage supports adventitious bud formation. Starch is a food source of insects and fungi. Consequently, the wood is often infected by insect pests such as powder post beetle (*Lyctus bruneus*). However, this wood may be used as a medium for mushroom cultivation. It has been known that *Catanopsis* woods are widely used for shitake mushroom cultivation in Thailand. Promprasit et al. (2016) have proven that the species contain starch grains in axial parenchyma and ray cells [8].

CONCLUSION

Ficus religiosa L. wood is diffuse porous and growth ring indistinct. There are two types of rays, uniseriate heterocellular
and multiseriate heterocellular rays. Axial parenchyma are banded paratracheal. Fibers are septate libriform. Starch grains are present in axial parenchyma. The wood shows a potential for furniture making but not suitable for heavy construction.

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