Wood Anatomy and Fibre Quality of the Least Known Timbers Belong to Actinidiaceae from Indonesia

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Abstract

Wood anatomy of 417 genera and 86 families belong to the major, minor, and the lesser known timbers of South-East Asia have been studied and described in 3 volumes of PROSEA books. This paper deals with timber species of the least known timbers, which have not been treated in the above mentioned PROSEA books, i.e.: *Saurauia bracteosa*, *S. capitulata*., and *S. nudiflora* from family Actinidiaceae. The objective of this study was to acquire descriptions of their anatomical features and evaluate the quality of their fibres for pulp and paper manufacture. Samples were provided by Xylarium Bogoriense, which were collected from various forest areas in Indonesia. Microscopic features observed comprise all features those listed by IAWA Committee in 1989. Fibre quality was determined based on their dimension and evaluated according to quality classification developed by FPRDC Bogor. The results indicate that identification of timber up to genera level is possible. Fibres of *Saurauia* spp. fall into quality class I, which means good for pulp and paper. The descriptions of anatomical features were presented. Sauraria have bright color, light yellow to light brown, fine texture, light, smooth to rather rough surface, and make it suitable to substitute ramin (*Gonystylus* spp.)

Keywords: wood anatomy, fibre quality, the least known timbers, Saurauia, Actinidiaceae.

Introduction

Indonesian forest is one the richest biodiversity tropical rain forests in the world which has unique characteristics. Some reports stated that Indonesian forest has about 30,000 floras and 4,000 of them are classified as forest tree species (Sastrosumarto 1987). Among 4,000 tree species, 400 species were known as important species, and 259 species of them were known as commercial species. Those 259 species have been classified into 120 groups of commercial tree species.

Wood anatomy of 417 genera and 86 families belong to the major, minor, and the lesser known timbers of South-East Asia have been studied and described in 3 volumes of PROSEA Books (Soerianegara and Lemmens 1994; Lemmens *et al.* 1995; Sosef *et al.* 1998). Indonesian Xylarium Bogoriense 1915 has approximately 3,667 wood species collection. For this time, there are about 800 species from 251 genera of 77 families where the properties and anatomical structure have never been studied. Those later species are named as *The Least Known Timber*, to continue the Plant Resource of South-East Asia 5:1-3.

This paper deals with three timber species of *the least known timber*, which have not been treated in the above mentioned PROSEA books, i.e.: *Saurauia bracteosa*, *S. capitulata*, and *S. nudiflora* from Family Actinidiaceae. The objective of this study was to acquire descriptions of their anatomical features and evaluate the quality of fibres for pulp and paper manufacturing.

Materials and Methods

The least known timber belongs to Actiniadeae was determined and collected from Xylarium Bogoriense 1915. The profiles of these species accordance with their scientific name, collection number, origin, and durability class as well as strength class based on Oey (1964) are elaborated in Table 1.

Observation on anatomical structures consist of macroscopic (general) and microscopic characteristics. Macroscopic features were observed on the planed surface of the sample as suggested by Mandang and Pandit (2002) including color, figure, texture, slope of grain, hardness, luster, odor and surface impression.

Microscopic characteristics were examined in the sectioned samples. As many as three block representing transverse, radial, and tangential surfaces are prepared from heartwood and used for examination of anatomical features. Wood blocks were at first air-dried and then soaked in distilled water for about one week. After being saturated, the samples were then transferred into a container containing a softening solution of ethanol-glycerin 1:1 and further kept for about one week before being sectioned into 15~25 μ thin slices. The good slices were chosen and washed in stages using ethanol with concentrations consecutively 30%, 50%, 70%, and ultimately absolute ethanol (96%). The slices were cleared by soaking them in xylene and toluene. The last was to mount the slices on the object glass using entellan (Sass 1961).

The characteristics were observed with respect to the anatomical features listed on IAWA Committee List for Hardwood Identification (Wheeler *et al*. 1989). The quantitative data in this study consisted of tangential diameter of vessels (25-time measurements), frequency of vessels per mm square, frequency of rays per mm (10-time over 10 different areas), and heights of rays (25 times), and then calculating the average (Krisdianto and Damayanti 2007).

The quantitative data of fibers dimension (25-time measurements), diameter and thickness of wall cells (15-time measurements, respectively) and vessel length (25-time measurements) were measured from the sectioned and macerated samples. In this regard, the wood

samples were macerated according to the method of Tesoro (1989). The sample materials were heated slowly at 40~60ºC in the mixture of concentrated nitric acid and hydrogen peroxide at a ratio of 1:1. The heating process took about 12 hours to produce adequately macerated material or a satisfactory separation of cells for further dimensional measurement.

The separated fiber cells were washed by water to rid the cells completely of residual acid and hydrogen peroxide and then were colored by safranin. To examine their dimensions, the cells were placed on the object glass; ethanol-glycerin was then added, and the cells were evenly spread using a coarse needle before closing the object glass with cover glass. The qualification of fiber for pulp and paper was based on the criteria of Rachman and Siagian (1976), through the determination of fiber dimension and its derivative values.

Table 1. Description of collection number, name, durability class, and strength class of eight least known timbers belong to Actinidiaceae from Indonesia.

Species	Collection Number	Specific Gravity*	Strength Class*	Durability Class*	Origin
Saurauia bracteosa DC.	13075	-	-	-	Malang, East Java
Saurauia capitulata Smith	26261	0.40	III	V	Maluku
Saurauia nudiflora DC.	2913	0.43	III	V	Rejang, Bengkulu (Sumatra)

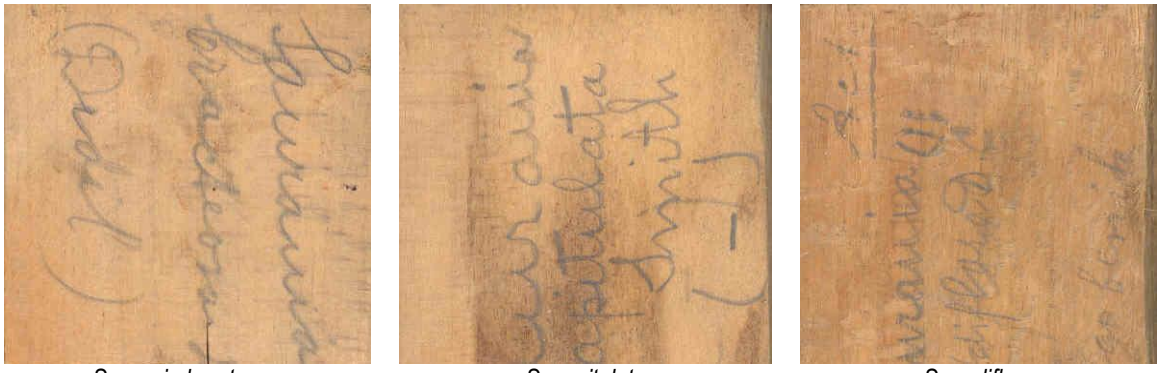
*Source: Oey (1964)

Results and Discussion

Anatomical Properties

The description about Actinidiaceae has been reported by Watson and Dallwitz (1992). According to them, Actinidiaceae or the Chinese Gooseberry, is a small family of plants. It includes three genera and has about 360 species. Saurauia has 300 species, and it is the largest genus in this family. They are temperate and subtropical woody vines, shrubs and trees, native to Asia (Actinidia or kiwifruit, Clematoclethra, Saurauia) and Central America and South America (Saurauia only). Although now confined to Asia and tropical Central and South America, there is evidence that in the past this family had a wider distribution.

Anatomical properties of the least known timbers of Actinidiaceae from Indonesia and its comparison with another observer's result are described in Table 2. The figures of macroscopic and microscopic anatomical sructures of every species are presented in Fig. 1~4.



Saurauia bracteosa *S. capitulate* *S. nudiflora*

Figure 1. Longitudinal surface of *Saurauia bracteosa, S. capitulata and S. nudiflora*, x 1.

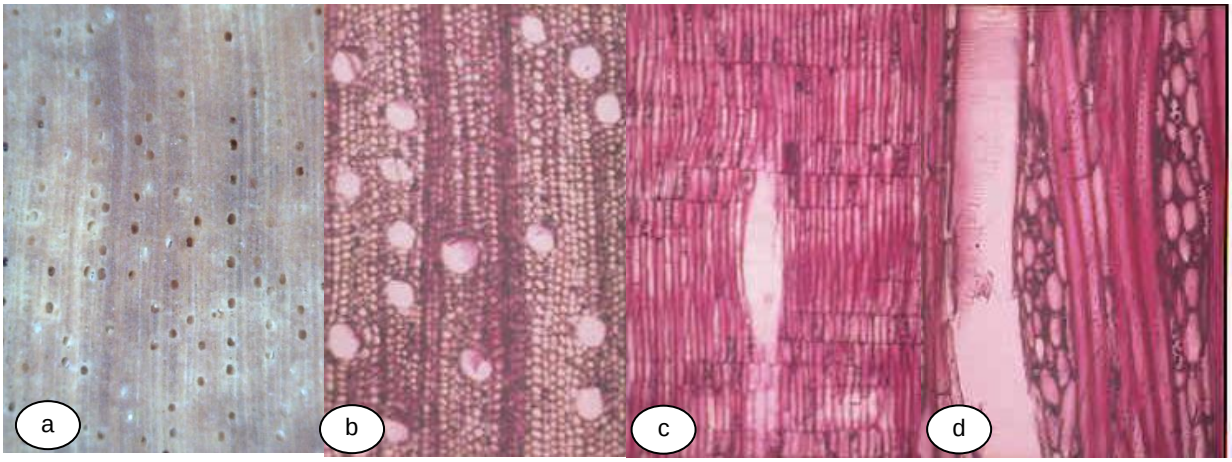


Figure 2. *Saurauia bracteosa* (a) transverse surface (macroscopic), x10; (b) transverse section (microscopic), x40; (c) radial section, x40; and (d) tangential section, x100.

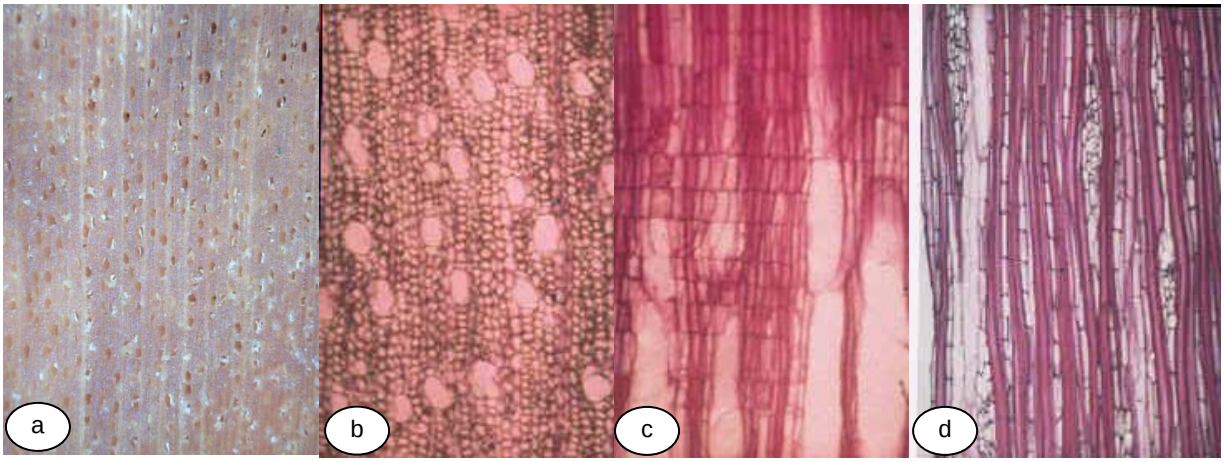


Figure 3. *Saurauia capitulata* (a) transverse surface (macroscopic), x10; (b) transverse section (microscopic), x40; (c) radial section, x100; and (d) tangential section, x40.

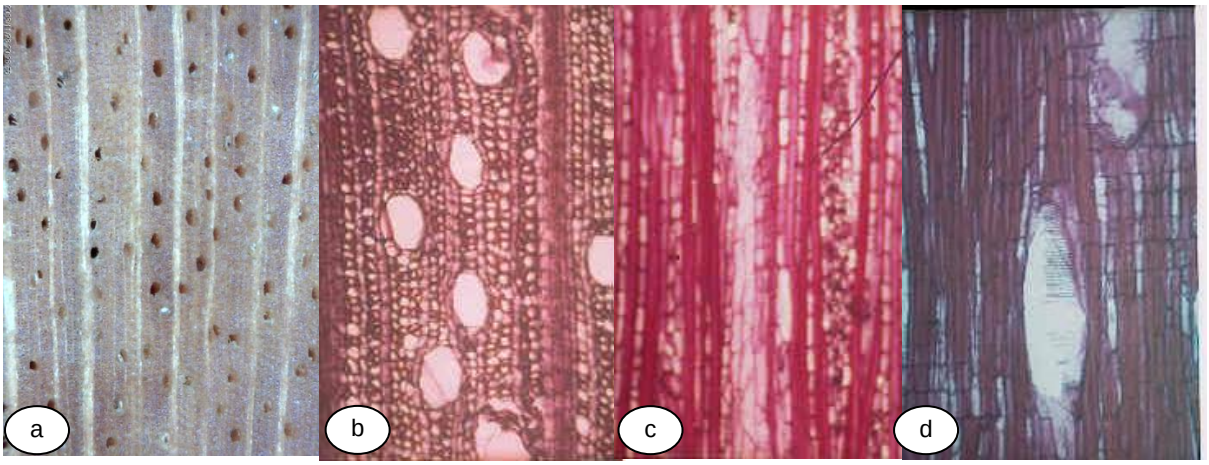


Figure 4. *Saurauia nudiflora* (a) transverse surface (macroscopic), x10; (b) transverse section (microscopic), x40; (c) radial section, x40; and (d) tangential section, x40.

Table 2. Description of anatomical characteristics of least known timbers of Sauraria.

Species	Origin	General Characters	Anatomical Characteristics (Wheeler *et al*. 1989)	Comparison with Other Observers	
				Wilkins (1987)*	Watson and Dalwitz (2009)
Saurauia bracteosa DC. (Coll. Number: 13075)	Malang, East Java	Color: light-brown. Figure: plain. Texture: fine. Grain: interlock. Wood is light; moderately soft to hard. Its surface is lusterless and smooth to moderately rough. No special odor.	Growth ring: 2 Vessel: 5, 9, 12, 14, 17, 18, 21, 29, 30, 31, 32, 33. Axial parenchyma: 76, 92. Rays parenchyma: 97, 98, 107, 109. Fibres: 62, 63. Mineral inclusion: - Others: 110.		Cork cambium present; initially deep-seated, or superficial. Nodes unilacunar (usually), or tri-lacunar. Secondary thickening developing from a conventional cambial ring. Xylem with tracheids; with vessels. Vessel end-walls in tangential direction; simple, or scalariform and simple. Wood parenchyma apotracheal. Pith with diaphragms.
Saurauia capitulata Smith. (Coll. Number: 26261)	Hollandia, Molluken	Color: cream (light-yellow). Figure: plain. Texture: very fine. Grain: straight. Wood is light and soft. Its surface is lusterless and smooth. No special odor.	Growth ring: 2 Vessel: 5, 12, 14, 18, 19, 21, 25, 30, 31, 41, 47. Axial parenchyma: 76, 78, 93. Rays parenchyma: 97, 108. Fibres: 62, 63, 66, 69. Mineral inclusion: - Others: 110.		
Saurauia nudiflora DC. (Coll. Number: 2913)	Rejang, Bengkoelen (Sumatera)	Color: light-brown. Figure: plain. Texture: moderately coarse. Grain: straight, moderately in tangential direction to interlock. Wood is light and rather soft. Its surface is lusterless and smooth. No special odor.	Growth ring: 2 Vessel: 5, 12, 14, 17, 19, 30, 31, 41, 47, 60. Axial parenchyma: 78, 84, 92. Rays parenchyma: 97, 98, 107. Fibres: 63, 66, 69. Mineral inclusion: 149 (in axial parenchyma), 150 (separated observed, needle shape, ± 6 in amount). Others: 110.	1, 7, 8, 9, 11, 18, 21, 25, 28, 30, 33, 35, 36, 45, 46, 64, 75.	

* Computer key for the identification of the word commercial timbers in OXFORD List.

From Table 3, it can be seen that there are some differences between this study and another study by Wilkins (1987). It might be caused by different site conditions where they were grown which is tropical and temperate forest. The difference was predominantly shown by the presence of distinct growth ring in wood samples studied by Wilkins (1987). It is commonly understood that most of tropical wood species has indistinct growth rings due to even climate conditions along the annual growth period.

Fiber Quality

Measurements and calculations of wood fiber dimensions are presented in Table 3.

Table 3. Average value of fiber wood dimension.

Collection Number	Timber Species	Length (L) (μm)	Diameter (d) (μm)	Lumen (e) (μm)	Wall thickness (w) (μm)
13075	*Saurauia bracteosa*	3078.22±399,15	54.54±5,32	48.26±5,15	3.14±0,46
26261	*Saurauia capitulata*	2986.69±289.96	59.50±8.97	53.25±8.14	3.13±0.74
2913	*Saurauia nudiflora*	3396.15±453.17	56.66±7.71	50.35±7.04	3.15±0.54

Table 4. Fiber dimension derivative value and fiber class quality for pulp and paper.

Wood Species	Fiber lenght (µm)	Runkel ratio	Felting point	Flexibility ratio	Coeficient of rigidity	Muhlsteph ratio	Score total	Class Quality
Saurauia bracteosa (13075)	3078.22	0.13	56.44	0.88	0.01	21.70		
Grade	100	100	50	100	100	100	550	I
Saurauia capitulata (26261)	2986.69	0.12	50.20	0.89	0.05	19.91		
Grade	100	100	50	100	100	100	550	I
Saurauia nudiflora (2913)	3396.15	0.13	59.94	0.89	0.06	21.03		
Grade	100	100	50	100	100	100	550	I

Remarks (Rahman and Siagian, 1976):

1) Runkel Ratio = 2w/l
2) Felting point = L/d
3) Flexibilty ratio = l/d
4) Coeficient of rigidity = w/d
5) Muhlstep ratio = $\frac{(d^2-l^2)}{d^2} \times 100\ \%$

L = Fiber length
d = Fiber diameter
l = Lumen diameter
w = Wall thickness

Fiber dimension derivative value and class quality of the fiber are presented in Table 4. Based on Table 4, the fiber quality as a proposed material of pulp and paper of *Sauraria* spp. fall into class I. According to Rachman and Siagian (1976), the wood characteristics of class I cover moderate to low density wood species (strength class IV/V) with extremely thin wall and wide lumen. Fibers collapse completely during pulp sheet forming; flattening and felting characteristics are high, resulting in high tear, burst and tensile strength of the corresponding pulp.

From the result of fiber quality and their bright color, the entire of species have good potency to be used as raw material of pulp and paper, but the low value of their specific gravity (less than 0.5) can be a weakness that must be considered because they will produce small recovery. Moreover, to obtain more reliable results to support basic classification in determining the quality of pulp and paper processing, future research should also examine the chemical components of the wood such as cellulose, lignin, pentosan, extractives and ash contents. The presence of mineral inclusion of *Saurauia nudiflora* might affect refining process during the pulping process.

Evaluation of Possible Uses

In agreement with Oey (1964), without take any consideration into other properties; in wood construction, strength and durability class of the timber have main effects for utilization. The strength class of all specimen are medium (range from II to IV, majoring in III), while durability class are very low, so the species barely suitable for temporary and light construction, except there are preservation treatment.

Literature on utilization of the least known timbers is very limited. Sauraria has good appearance (bright color-light yellow to light brown, fine texture, light, smooth to rather rough surface) make it suitable for ramin (*Gonistylus* sp.) substitution.

Utilization based on anatomical properties for every timber need more observation. By sufficient knowledge in basic properties of wood as raw material, it is possible to make an appropriate product to increase the economic value of the least known timbers.

Conclusions

This study has examined deeply the anatomical properties of the least known timbers from family Actinidiaceae, which have not been treated in PROSEA books: *Saurauia bracteosa*, *S. capitulata*, and *S. nudiflora*. Fibres of *Saurauia* spp. fall into quality class I, which means good for pulp and paper. The good appearance ofSaurauria is suitable to substitute ramin (*Gonystylus* sp.). Exploration on the properties of the least known timber in Indonesia should be continued intensively. Based on the economical aspect, timbers from this group are potential to be developed.

Acknowledgements

The authors would like to appreciate and thank Dra. Sri Rulliaty, M.Sc. (RIP) for the support of this study, Mr. Usep Sudardji and Ms. Tutiana for their meticulous help in preparing the sectioned and macerated slides, and in measuring the dimensions of wood fibers.

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