



11th ITTO-BMLEH Bimonthly Webinar | 7 October 2026

Wood Properties and Quality of Super Teak - Young Teak Wood Properties Enhancement

Dr. Ratih Damayanti

Director of Environment, Maritime, Natural Resources and Nuclear Policy –
National Research and Innovation Agency





Outlines

1. Background - The Gap
2. What is Super Teak
3. Wood Properties - Physical
4. Mechanical Properties
5. Anatomical & Chemical
6. Clone Selection
7. Need for Enhancement
8. Enhancement Methods - Non-Biocide
9. Results - Best Formula & Mechanism
10. Potential Utilization
11. Research Statistics 2010-2026 in Indonesia



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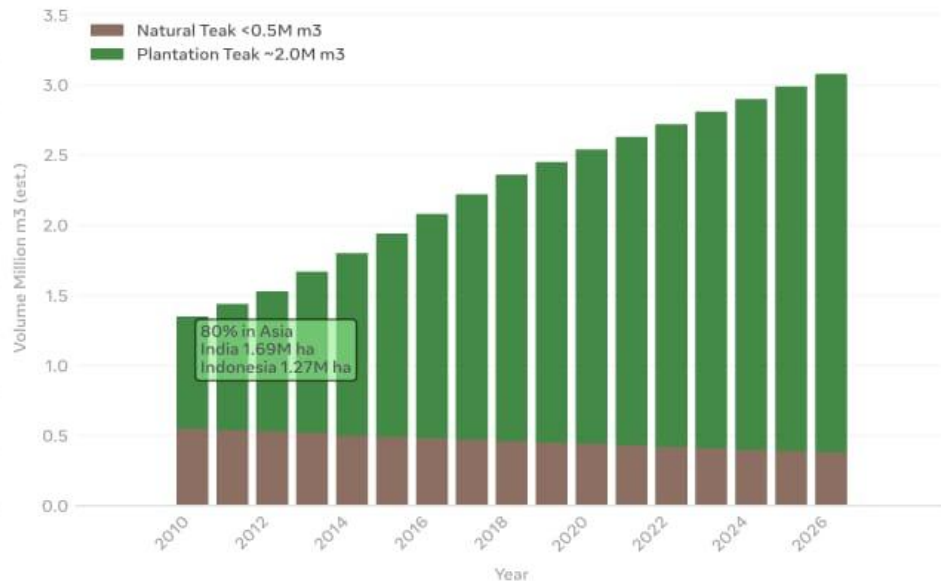
Background – The Gap

Global Teak Demand & Supply 2010-2026: The Quality Gap

Global Demand Index



Global Supply Composition



Demand:

Global teak wood market: USD 8.65B in 2025 → USD 13.49B by 2033, CAGR 5.8%

Furniture >50% of consumption, high-end marine decking 55% is teak
Luxury furniture demand +18% YoY, FSC/PEFC certified demand influences 42% of B2B buying

Supply:

Planted area 4.85M ha globally: India 1.69M ha, Indonesia 1.27M ha, Myanmar 0.44M ha. 80% in Asia.

Natural teak supply <0.5M m3/year and declining; plantation ~2.0M m3/year but 94% <40 years old = small diameter logs

Background – The Gap

- Indonesia Benchmark Price (Ministry of Trade, Sept 2026):
Teak S4S 1000-4000mm² = USD 3,457/m³ - highest among
processed woods (Meranti USD 1,177, Ebony USD 1,847)
- GTI-Indonesia Jan 2026: supply side turned from contraction to
expansion, demand continued growth

The Gap = ITTO - BMLEH

- Justification: Premium market wants large, durable teak, but supply is
shifting to fast-grown small logs.
- Solution: Quality timber production from smallholders + Wood
Properties Enhancement (JUN/Super Teak).
 - Long rotation teak 50-80 years vs Short Rotation Teak (SRT) <16 years
 - SRT exhibits inferior strength, dimensional stability, durability

“We cannot just plant more, we must make smallholder teak better”



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What is Super Teak?



Jati Utama Nasional/Jati Unggul Nusantara (JUN): fast grown teak derived from Jati Plus Perhutani (JPP); widely cultivated in Indonesia grown to 5 years of age



Question: Is 5-year JUN suitable for high value products?

Research Objectives (PhD 2016)

- Part 1: Investigate wood properties of JUN, determine best clone
- Part 2: Relationship ultrastructural characteristics with hardness & dimensional stability to predict properties non-destructively

FAST*wood*
is *fast*wood = *fast*food ?

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Wood Properties - Physical

- Density 500-638 kg/m³ near bark
- Key finding: High lignin content → low shrinkage, comparable to mature teak
- Wet site = larger diameter
- Dry site = more uniform properties



Mechanical Properties

Hardness

Super Teak 5-yr:

- Radial hardness 3080 N
- Tangential 3427 N
- End 4253 N

Comparable to mature Indonesian teak 4197 N

Bending Properties

MOE 8.4 Gpa - MOR 58.5 Mpa
within range 10-15 yr plantation
teak (8.6 GPa/58 MPa)

Stiffness & Bending Properties	Age	MOE (GPa)	MOR (MPa)	Sources
Super teak	5	8.4	58.5	This study
Mature teak	10	8.6-10-13.4	88	Ozarska (2009)
	80	8.6-10-13.4	85-106(-148)	Soerianegara & Lemmens (1994)
Mature teak (Malaysa)		8.6	58	M. Trockenbrodt & J. Jouse (1999)
Plantation teak	15	11.3-20.7		Wahyudi, 2000
	38	12.2-13.2		
Juvenile wood	63			
-Fast grown		12.7	98.3	Bhat et al. (2001b)
-Slow grown		14.5	114	
Mature teak	63			
-Fast grown		15.7	124.2	Bhat et al. (2001b)
-Slow grown		16.2	134.6	

Anatomical & Chemical

Teak	Age (years)	Fibre length (µm)	Vessel length (µm)	Sources
Super teak	5	1350 (970 - 1760)	370 (190 - 550)	This study
Super teak (Bogor)	4 & 5	700 - 1300	340 - 370	Wahyudi et al. (2014)
Super teak (Balapulang)	5	1330	350	Damayanti (2010)
Mature teak	80	700-1400		Soerianegara & Lemmens (1994)
Mature teak	80	1316		Martawijaya et al. (2005)

- Extractives $\pm$ 4%; lignin $\pm$ 36%; cellulose 52%
- Dry site produced higher extractive content, lower lignin and lower cellulose
- Faster tree growth produced higher extractive, lignin and cellulose content
- Within tree at radial position:
 - Transition zone: highest percentage & lowest cellulose
 - Sapwood: lower extractive & cellulose than heartwood
 - Lignin decreased from pith to the bark
- Heartwood formation started at 5 years

Wood Properties of 5-year-old Fast Grown Teak

Ratih Damayanti, Barbara Ozarska, I Ketut N. Pandit, Fauzi Febrianto, and Gustan Pari

Wood Research Journal Vol.9 • No.2 • 2018

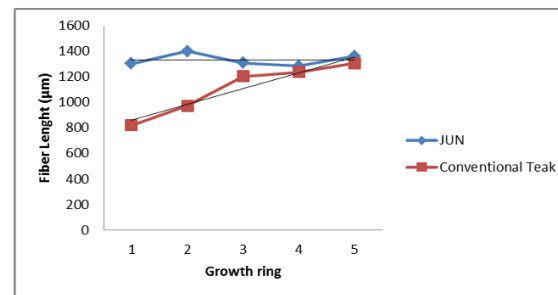
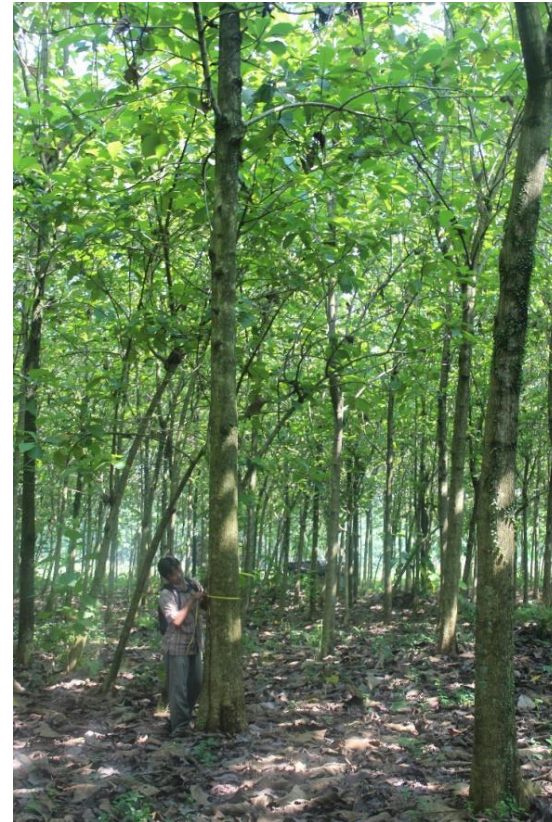


Figure 2. Regression curves of the fiber length from pith towards bark for 5-year-old JUN and conventional teak. It appears the trend is still pointing upwards, yet there is a constant point. It can be seen that the fiber length of JUN started above 1200 µm (similar as in mature teak), and fiber length addition of JUN is more sloping than conventional teak. JUN may reach a wood maturity faster than conventional teak wood.

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Clone Selection

Variation between and within clone → wood properties affected by clone:

- Density
- Stiffness
- Colour
- Shrinkage

Assessment on wood properties and uniformity within clone

- Clone B had the closest wood properties to mature teak
- Clone C had the most uniform wood properties



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Wood Properties Enhancement

**Young teak: low durability & stability -
increase density + durability + stability**

Enhancement Methods - Non-Biocide

- Chemical modification without harmful chemicals
- Materials: Lactic Acid (LA), Citric Acid (CA), Glycerol (G) 20% aqueous
- Process: Vacuum 1h + Pressure 12.2 bar 2h + Thermal 150°C 6h

(Basri et al. 2024)

PEER-REVIEWED ARTICLE

bioresources.cnr.ncsu.edu

Enhancement on Physicomechanical Properties of Short-Rotation Teak Woods by Non-Biocide Chemical and Thermal Treatments

Efrida Basri,^{a,b} Istie Sekartining Rahayu,^a Saefudin,^b Adi Santoso,^b Ignasia Maria Sulastiningsih,^b Ratih Damayanti,^c Resa Martha,^{a,d} and Wayan Darmawan^{a,*}

Lactic acid (LA), citric acid (CA), and glycerol (G) are renewable and environmentally friendly chemicals that could improve the qualities of short-rotation teak (SRT) woods. This study investigated the effect of thermal and chemical modification using 20% aqueous solutions (w/w) of LA, CA, and G and their mixtures in the same composition on physical and mechanical properties of SRT teak wood. The impregnation process was initiated by vacuum process for 1 h and pressure (12.2 bar) for 2 h, followed by thermal (150 °C) treatment for 6 h on the SRT wood samples after being removed from the vacuum-pressure tube. Retention (R), weight percent gain (WPG), density (D), anti-swelling efficiency (ASE), leachability (WL), modulus of elasticity (MOE), and modulus of rupture (MOR) were measured. FTIR spectrometry and SEM analyses were performed. The wood impregnated with a mixture of 10% LA + 10% CA provided the highest ASE values of 50.1%, and the lowest leaching resistance of 1.54%. Based on wood strengths (MOE and MOR) and physical properties, as well as supported by FTIR and SEM analysis, the use of 10% LA + 10% CA is the most prospective as an impregnant formula for SRT wood modification of this research.

Wood Properties Enhancement

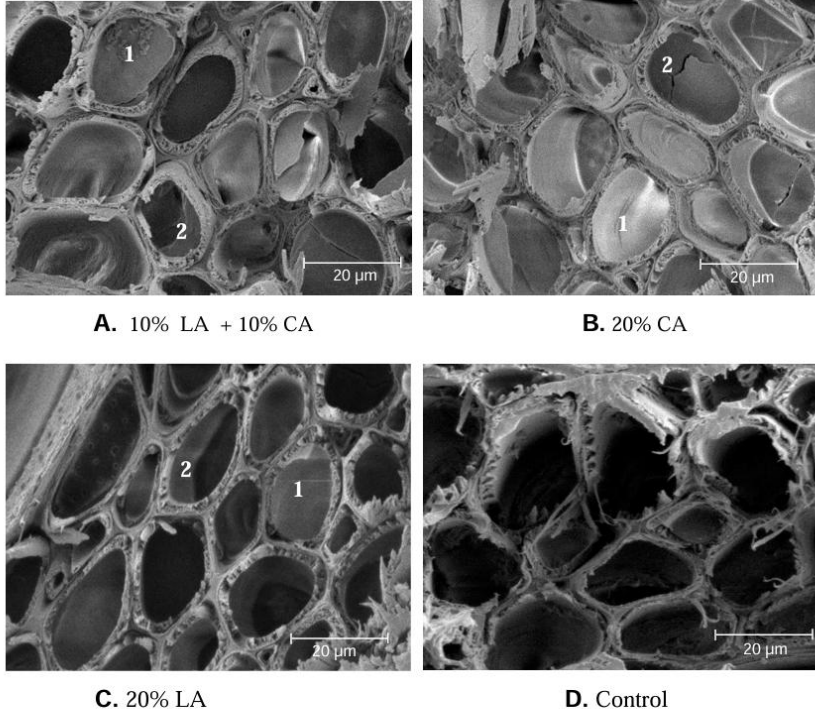


Fig. 4. Visual features from SEM analysis of untreated and chemical thermal modified short rotation teak (SRT) wood samples. Notes: LA= Lactic acid; CA=Citric acid; D=Control (untreated); Form of a thick layer in the lumen (1), and which attached to the cell wall (2)

Results - Best Formula

- WPG highest 22.30% with 20% CA (strong ester bonds)
- Best: 10% LA + 10% CA
 - ASE = 50.1% (Anti-Swelling Efficiency)
 - Leaching WL = 1.54% (lowest = most resistant)
- MC drops to ~5% after thermal

Mechanism

- FTIR confirms ester bond formation -OOC-R, cross-linking [LA-CA]_n bridging cellulose, replacing hygroscopic OH groups
- SEM: densification, pores flattened

Benefits of Wood Modification



Feature	Conventional Preservation	Thermal Modification	Chemical-Thermal Modification (LA+CA) - Best ✓ RECOMMENDED
Chemicals	Toxic	Chemical-free	Non-toxic readily available
Eco-friendly	No	Yes	Yes
Dimensional Stability	Low	High	Very High 50.1% ASE
Durability vs Organisms	High vs fungi/termites	Moderate fungi only	High fungi+termites
UV Resistance	Low	Low	Improved
Strength	Maintained	Reduced	Maintained-Improved
Service Life	Long	Medium	Long
Suitability for Community	Low	Medium	High

* ASE = Anti-Shrink Efficiency • Assessment based on comparative performance for sustainable wood enhancement methods

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Potential Utilization

- Suitable for: light construction, furniture components, decorative veneer, musical instruments, soft flooring, laminated products
- 5-year super teak promising, comparable to 10-15 yr plantation teak
- Site management: dry site more uniform, focus on growing large trees → better dimensional stability, more heartwood
- Chemical + Thermal enhancement (LA+CA) improves stability 50% → Enhanced SRT can extend to exterior products - key for smallholder plantations quality timber (ITTO goal)

RESEARCH ARTICLE | MARCH 13 2024

Assessing the potential utilization of super teak for furniture, flooring, veneer, pulp paper and wood pellets



D. A. Indrawan; R. Damayanti ; B. Ozarska; J. Illic; G. Pari; Krisdianto; L. M. Dewi; R. Pari;
D. A. Agustiningrum; D. S. Adi; I. A. Sofianto; Djarwanto; R. G. H. Rahmanto



Indonesian Teak Research 2010–2026: Properties, Enhancement & Utilization

No	Research Focus	Key Reference (Indonesia)	Highlight
1	Properties	Rizanti et al. 2018 • Ann. Forest Sci.	Short vs Long rotation similar MOE/MOR
2	Properties	Hidayati et al. 2024	20-yr clonal teak physical-mechanical
3	Enhancement	★ Basri et al. 2024 • BioResources BEST PAPER	★ 10% LA + 10% CA • ASE 50.1%; low leach
4	Enhancement	Hanifah et al. 2025 / Martha et al. 2023	Chemical-thermal CA + PEG, BPTCA improves stability
5	Utilization	Sushardi et al. 2017	8–10 yr meets SNI export furniture
6	Utilization	Budiadi 2018 & Ozarska 2010	Short-rotation thinning → early income; value-added furniture potential

Color key: • Properties • Enhancement • Utilization

Source: Compiled literature | ITTO Webinar • 2010–2026

Potential utilization of super teak

Classified into Grade C (SNI 7732.1:2011)



- ✓ Sapwood
- ✓ Auger hole
- ✓ Tight & lose knots



Potential utilization of super teak

Australian Timber Flooring Association: Soft flooring group (side hardness)



Hardness of super teak $\equiv$ Mature teak & Radiata Pine

Potential utilization of super teak

- ✓ Wood pellet (National Indonesian Standard (draft) Wood Pellet
- ✓ This product is recommended as by-product for utilising the wood waste

Parameter	Requirements	Values	Assessment
Moisture Content (%)	Maximum 12	4.93	Passed
Volatile substance (%)	Maximum 12	79.84	Passed
Density (cm ⁻¹)	Minimum 80	0.83 g	Passed
Ash content (%)	Maximum 1.5	1.36	Passed
Fixed Carbon (%)	Minimum 14	18.80	Passed
Calorific value (Cal g ⁻¹)	Minimum 4000	4790	Passed



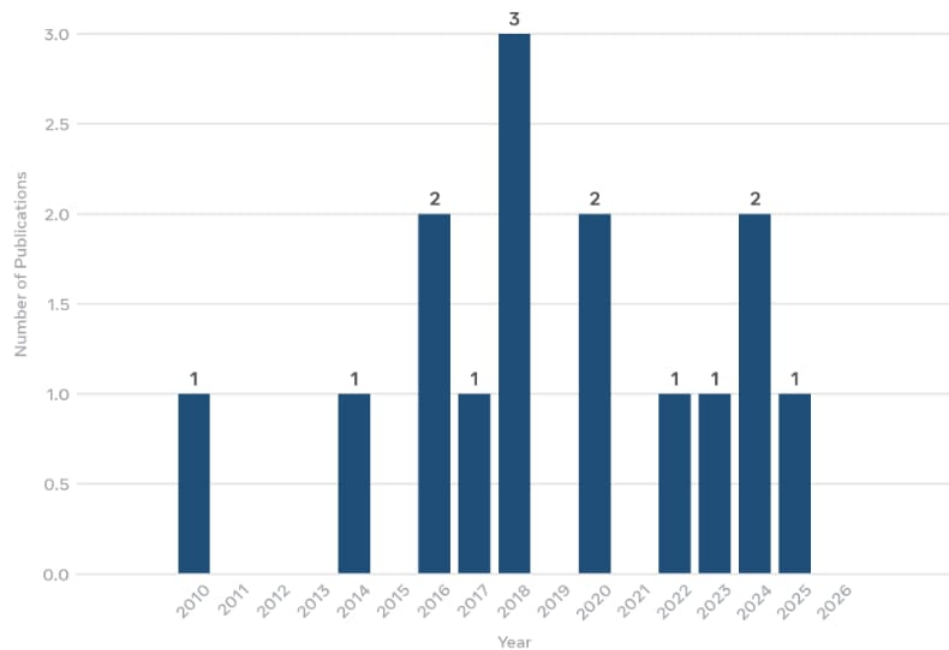
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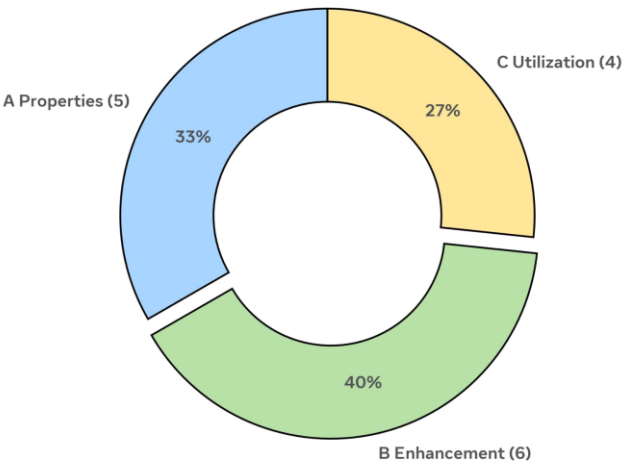
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Research Trend on Wood Properties and Enhancement 2010-2026 in Indonesia

Total Publications per Year
Indonesian Teak Wood 2010-2026 (n=15)



Distribution of Indonesian Teak Publications 2010-2026
A+B+C (n=15)



“Still need standardized qualities and enhancement for community level”

CALL FOR ACTION:

New Standard for Young Fast-Growing Teak

-  Young teak 8-10 years MEETS export SNI 7534.2
-  Chemical-Thermal Enhancement
10% Lactic Acid + 10% Citric Acid
ASE 50.1% • leaching 1.54% • non-toxic
-  Need new ITTO certifiable standard
• Enhanced Young Teak
for community early income — year 8 not year 40

THANK YOU

ratih.damayanti@brin.go.id

