REVISTA FLORESTA
Engenharia Florestal
ISSN 1982-4688
Edição 56
Universidade Federal do Paraná
Setor de Ciências Agrárias

POTENTIAL USE OF *Eucalyptus Punctata* PLANTATION WOOD FOR STRUCTURAL COMPONENTS IN BRAZIL: A CHARACTERIZATION OF PHYSICAL AND MECHANICAL PROPERTIES

Marta Cristina de Jesus Albuquerque Nogueira[1], Victor Almeida De Araujo[2,3*], Juliano Souza Vasconcelos[4], André Luis Christoforo[3,2], Francisco Antonio Rocco Lahr[5]

[1]Universidade Federal de Mato Grosso - Programa de Pós-Graduação em Física Ambiental – MT - Brasil – mcjanj@gmail.com
[2*]Universidade Estadual Paulista - Programa de Pós-Graduação em Engenharia Civil – SP - Brasil – va.araujo@unesp.br
[3]Universidade Federal de São Carlos - Programa de Pós-Graduação em Engenharia Civil - São Carlos – SP - Brasil – victor@ufscar.br / alchristoforo@ufscar.br
[4]Universidade Estadual Paulista - Programa de Pós-Graduação em Agronomia – Botucatu – SP - Brasil – julianojsv@gmail.com
[5]Universidade de São Paulo - Programa de Pós-Graduação em Engenharia de Estruturas - São Carlos – SP - Brasil – frocco@sc.usp.br

Received for publication: 19/12/2024 – Accepted for publication: 29/06/2026

Resumo

Potencial de utilização da madeira de plantação Eucalyptus punctata para componentes estruturais no Brasil: uma caracterização de propriedades físicas e mecânicas. A madeira de *Eucalyptus punctata* tem uma limitada participação no setor florestal. Goma cinza, como essa espécie é comercialmente designada, mantém subutilizada na indústria e esquecida na literatura. Alinhado com o tópico indústria contido no nono objetivo de desenvolvimento sustentável (ODS-9), dezesseis propriedades da madeira de reflorestamento de *Eucalyptus punctata* foram investigadas para identificar o seu potencial como uma alternativa de madeira estrutural produzida sustentavelmente, com base no documento normativo brasileiro para estruturas em madeira. Nessa estratégia de evidenciar cientificamente os potenciais usos estruturais do *Eucalyptus punctata*, dois teores de umidade foram adotados para elucidar a madeira verde (ponto inicial à 30%) e madeira seca (ponto padrão à 12%). Em um processo amostral típico, 2299 determinações foram conduzidas. A densidade aparente mostrou influencia estatística quando o teor de umidade foi reduzido da condição verde para seca, indicando uma redução esperada em seu valor. Treze propriedades mecânicas manifestaram influências estatísticas e visíveis aumentos em suas resistências, incluindo todas as cinco propriedades do módulo de ruptura e quatro propriedades do módulo de elasticidade, bem como tensão de cisalhamento, dureza perpendicular, dureza paralela e fendilhamento tangencial. Bons resultados no comparativo com diferentes variedades populares de pinho e eucalipto plantado reforçam o potencial de seu propósito estrutural.
Palavras-chave: Eucalipto cinza, Construção em madeira, Teor de umidade, Densidade, Resistência.

Abstract

The *Eucalyptus punctata* wood has a limited participation in the forestry sector. Grey gum, as this species is commercially known, remains underutilized in industry and forgotten in literature. Aligned with industry topic contained in the nineth Sustainable Development Goal (SDG 9), sixteen properties of *Eucalyptus punctata* plantation woods were investigated to identify its potential as an alternative sustainably-produced structural timber, with the support of the Brazilian code for wooden structures. In this strategy to scientifically evince the potential structural uses of *Eucalyptus punctata*, two moisture contents were adopted to elucidate green wood (initial point at 30%) and dried wood (standard point at 12%). In a typical sample process, 2299 determinations were carried out. Bulk density showed a statistical influence when moisture content is reduced from green to dried condition, indicating an expected decrease in its value. Thirteen mechanical properties manifested statistical influences and visible increases in their resistances, including all five properties of modulus of rupture and four properties of modulus of elasticity, as well as shear stress, perpendicular hardness, parallel hardness, and tangential cleavage. Good results in the comparison with different popular varieties of planted pines and eucalypts reinforce the potential of its structural purpose.
Keywords: Grey eucalypt, Wood construction, Moisture content, Density, Resistance.

INTRODUCTION

Rapid growth, wide adaptability range to tropical and subtropical climates and soils, diversity species, and the broad range of industrial purposes are features that rank the eucalypt among the most successfully and widely spread genus as a plantation crop (Henry, 2015). According to Albuquerque et al. (2024), Brazil has around 10 million hectares of timber plantation, and 76% of this planted area is formed by eucalypt capable of producing around 158.284 million m³ roundwood. Part of planted eucalypt woods have been converted into machined planks, beams, rafters, boards and battens (Baraldi et al., 2024).

The versatility of eucalypt woods justifies new prototypes aligned to the advances in wood technology. For example, Iwakiri *et al.* (2019) identified that, using isocianate polymeric emulsion adhesive, some eucalypt species can be potentially viable for the edge-glued panel production.

In addition to the most usual *Corymbia citriodora* wood, four eucalypt species were verified as raw materials in use by timber housing production sector in Brazil, whose popularity is ranked as follows: *Eucalyptus saligna*, *E. grandis*, *E. urophylla*, and *E. urophylla var. grandis* (De Araujo *et al.*, 2021). Therefore, there is a space for the expansion of consumed woods by inserting alternative eucalypt varieties, especially underused species such *Eucalyptus punctata* and other woods.

The following item addresses this species in order to clarify main information and justify research gaps and objectives.

Eucalyptus punctata and its grey gum wood

The *Eucalyptus punctata* species is commercially known as Grey gum, as confirmed by Maiden (1922), Webb and Shine (1997) and Centre for Australian National Biodiversity Research (2020). This commercial name is due to the dull grey appearance of the bark (Maiden 1922). The Grey gums occur naturally in the central eastern New South Wales from south of Nowra to the Liverpool range in Australia (Boland *et al.*, 2006; Webb; Shine, 1997; Schnell *et al.*, 2003; Todarello; Chalmers, 2007). Belonging to *Eucalyptus* subgenus *Symphyomyrtus* section *Latoangulatae* due to bilobed cotyledons, the *Eucalyptus punctata* trees are lignotuber absent, having discolored leaves with side-veins, two-opercula buds and fruits with exserted valves (Centre for Australian National Biodiversity Research, 2020). Punctata trees efficiently develop in sandy-loamy, well-drained soils, but in a good form, can attain up to 35 meters in height and a diameter about 1 meter (Gutiérrez, 1976), but on poorer soils, these eucalypts may be reduced to less than 10 meters tall (Boland *et al.*, 2006).

Eucalyptus punctata wood has pale red sapwood seldom attacked by *Lyctus* borers, and its red heartwood is hard, heavy, strong and durable, with a uniform texture and interlocked grain, often marked with grub holes (Boland *et al.*, 2006). Its bark is smooth throughout and granular with age, spotted due to the oil glands, and predominantly grey with pink, brown, cream, yellow and orange, shedding in patches (Centre for Australian National Biodiversity Research, 2020). Regarding applications, *Eucalyptus punctata* trees can be converted in leaf oils, cellulose and paper, and lumber for carpentry and cabinetmaking (Gutiérrez, 1976; Boland *et al.*, 2006). Its wood is recommended for timber, poles and railway sleepers, plywood panels, wooden structures, and light and heavy construction (Gutiérrez, 1976, Boland *et al.*, 2006). This species reaches intermediate behavior regarding natural durability, with post resistance around 50% and stake resistance around 47% (Gaeta Montagna *et al.*, 2025). Even so, no mechanical property was specified by these and other authors to endorse the structural potentiality.

In view of this little information, a structured literature search was performed using three main scientific databases (Scopus, Web of Science, and Periodicos CAPES) to identify indexed studies on *Eucalyptus punctata* wood. Initially, a string was tested involving both the common name (grey gum) and the main synonyms for wood term (wood, timber, and lumber), but no study exclusively on *Eucalyptus punctata* was identified as this term has been simultaneously used for other eucalypt species, for example, for propinqua. Sequentially, another string was tested involving both the scientific name (*Eucalyptus punctata*) and the main synonyms for wood term (wood, timber, and lumber), and only three papers specifically on this species were screened (Table 1).

Table 1. Results of structured literature search on the studied topic in mid-2026.
Tabela 1. Resultados da busca estruturada de literatura sobre o tópico estudado em meados de 2026.

Search String: TITLE-ABS-KEY: ("eucalypt* punctata" AND (wood OR timber OR lumber))					
SN	**NC**	**PT**	**Journal Name**	**Main Research Goal**	**Author**
Database Results: Scopus and Web of Science					
#1	9	SP	Proc. Linn. Soc. N.S.W.	Characteristics of eucalypt trees	Todarello and Chalmers (2007)
Database Results: Periodicos CAPES					
#2	103	SP	Biol. Conserv.	Habitat of snakes in plantations	Webb and Shine (1997)
#3	34	SP	Austral Ecol.	Ants in eucalypt plantations	Schnell et al. (2003)

Caption: SN, Study number; NC: number of citations; PT: publication type: SP, scientific paper; RP, review paper; CP, conference paper.

All three studies were developed in the New South Wales region in Australia. According to Todarello and Chalmers (2007), this species is among the main species with the highest proportion of hollow-bearing trees in that region. Moreover, Webb and Shine (1997) and Schnell et al. (2003) confirmed that punctata plantations can become habitats of ants and snakes. In contrast, results of Table 1 show that no publications had any relation to the structural characterization of this wood species, evincing the novelty of this type of scientific approach. Furthermore, this lack of research about *Eucalyptus punctata* wood suggests the plausible unfamiliarity of physical and mechanical properties compared to other woods, possibly contributing to the limitation of its commercial use.

Given this visible gap, our study was designed to evince the potential of alternative species such as Duong *et al.* (2022). Before this promising perspective for wood industry and civil construction, this paper investigates two physical and fourteen mechanical properties of *Eucalyptus punctata* wood in two moisture contents (30 and 12%), according to the prescriptions of Brazilian code and the statistical support of t-test, in order to verify the construction potential of this wood for structural purposes in bio-based buildings.

MATERIAL AND METHODS

Collection of Vegetable Material

The region of origin, age, diameter, number of logs, and number of beams extracted by wood log were identified in Table 2. Many logs and beams were utilized in order to ensure a more diversified sample condition.

In total, 71 wood beams originated from 13 *Eucalyptus punctata* trees with distinct ages were collected in three cities of São Paulo state, Brazil: Rio Claro, Manduri, and Bebedouro (Table 2).

Table 2. Details of wood samples.
Tabela 2. Detalhes das amostras de madeira.

Log	Beam Amount	Age	Diameter (cm)	Region of Forest
1	5	26	38.5	Rio Claro
2	4	26	38.0	Manduri
3	2	26	23.5	Rio Claro
4	2	26	23.5	Rio Claro
5	2	26	23.0	Rio Claro
6	3	26	36.0	Rio Claro
7	2	26	23.0	Rio Claro
8	6	21	44.5	Rio Claro
9	9	21	43.5	Rio Claro
10	10	23	38.5	Manduri
11	7	23	35.0	Manduri
12	13	42	49.5	Bebedouro
13	6	42	49.5	Bebedouro

Wood properties, characterization tests, and statistical evaluation

Following similar wood characterizations led by Lahr *et al.* (2017, 2018), Nogueira *et al.* (2018, 2024) and other studies, standardized samples were obtained according to different specific sizes required for each test. All tests strictly followed the requirements prescribed by the ABNT NBR 7190 (1997) – the national standard code on the wood characterization for structural applications, established by the Brazilian Technical Standards Association (ABNT) in line with the International Standardization Organization (ISO).

In this methodological route according to the ABNT NBR 7190 (1997), wood samples were machined according to each test and, sequentially, they were conditioned at two moisture contents: green point at 30% and standard point at 12%. Volumetric mass density and bulk density were estimated following these parameters, using a caliper (0.1% accuracy) and a digital scale (0.1%).

About mechanical properties, 14 tests were carried out using the ABNT NBR 7190 (1997) as follows:

- Compression and tensile (perpendicular and parallel) and static bending in modulus of rupture;
- Compression (perpendicular and parallel), parallel tensile, and static bending in modulus of elasticity;
- Shear stress, cleavage, parallel and perpendicular hardness, and toughness.

As demonstrated in Table 3, different wood samples were manufactured following all prescriptions of the ABNT NBR 7190 (1997), in order to carry out standardized tests for all 16 physical-mechanical properties, including rectangular blocks with different dimensions and specificities.

Mechanical tests were carried out through a universal test machine, AMSLER model with 250 kN load capacity (1% accuracy) with two indicators (0.01%). All means were analyzed with t-test at 5% significance level through Microsoft Excel 2021 software. The resistance results to efforts were obtained using standardized test in defect-free specimens and stable at same moisture content.

REVISTA FLORESTA Engenharia Florestal
ISSN 1982-4688
Edição 56
Universidade Federal do Paraná
Setor de Ciências Agrárias

According to Rocha et al. (2018), this consideration of specimens can avoid the uncertainty of results from parts with defects or injuries. Simultaneously, Spiecker (2021) confirmed that no mechanical damage in parts is a relevant characteristic to ensure a valuable wood.

Table 3. Details of wood specimens according to studied test.
Tabela 3. Detalhes dos corpos-de-prova de madeira conforme o teste estudado.

Characterization Test	Specimen Characteristics	
	Format	**Dimensions (cm)**
Bulk Density Volumetric Mass Density	Rectangular block	2.0 x 3.0 x 5.0
Parallel Compression Perpendicular Hardness Parallel Hardness	Rectangular block	5.0 x 5.0 x 15.0
Static Bending	Rectangular block	5.0 x 5.0 x 115.0
Perpendicular Compression	Rectangular block	5.0 x 5.0 x 10.0
Parallel Tensile	Rectangular block recessed in the center (dogbone)	2.0 x 5.0 x 45.0 (with a centralized recess of 5.0 x 0.7 x 21.0)
Perpendicular Tensile	Rectangular block with two holes	5.0 x 5.0 x 6.35 (with two holes with diameter of 2.54 and centers 0.65 from the edges)
Shear Stress	Rectangular block recessed in a side	6.4 x 5.0 x 3.0 (with a recess of 5.0 x 5.0 x 2.0)
Tangential Cleavage	Rectangular block with a hole	5.0 x 5.0 x 10.69 (with a hole with diameter of 2.54 with center 0.65 from the edge)
Tangential Toughness	Rectangular block	2.0 x 2.0 x 30.0

Source: ABNT NBR 7190 (1997)

RESULTS

A total of 2299 clear, straight and defect-free samples were extracted from *Eucalyptus punctata* wood beams. Sequentially, they were tested to determine 16 physical-mechanical properties carried out using different specimens (Table 3) in this wood characterization for structural purposes. Tables 4, 5, 6 and 7 refer to the results from performed tests and their statistical analysis for density, modulus of rupture, modulus of elasticity, and other strength properties for *Eucalyptus punctata*, respectively.

Decreasing the moisture content (30% to 12%), stable volumetric mass density and the occurrence of a decrease in bulk density of 13.64% (0.15 g/cm^3) in relation to the initial values were identified (Table 4).

Applying the t-test analysis was observed the bulk density rejected the null hypothesis of mean equality, that is, moisture content had a significant difference in the means when it was reduced (P-value < 0.05).

Table 4. Results for density.
Tabela 4. Resultados para a densidade.

Characteristic	MC (%)	n	M_D	sd	P-value
Bulk Density (g/cm³)	30	73	1.10	0.10	0.0000
	12	75	0.95	0.12	
Volumetric Mass Density (g/cm³)	30	73	0.74	0.08	–
	12	75	0.74	0.08	

Caption: MC: moisture content; n: repeat; M_D: density mean; sd: standard deviation

Increases in all the modulus of rupture were verified for *Eucalyptus punctata* (Table 5), including 41.32% (33.8 MPa) for parallel compression, 37.68% (2.6 MPa) for perpendicular compression, 17.04% (21.5 MPa) for parallel tensile, 31.67% (1.9 MPa) for perpendicular tensile, and 48.33% (83.8 MPa) for static bending.

The t-test for rupture moduli verified all their properties rejected the null hypothesis of mean equality, *i.e.*, there were significant differences in means with the moisture reduction from 30 to 12% (P-value < 0.05).

It can be observed that with the decrease of the moisture content (30% to 12%) in Table 6, all the modulus of elasticity for *Eucalyptus punctata* increased their values in relation to their initial values such as 14.44% (2788.6 MPa) for parallel compression, 32.34% (219.5 MPa) for perpendicular compression, 11.31% (2418.4 MPa) parallel tensile, and 18.46% (3547.5 MPa) for static bending.

The t-test applied for elasticity moduli verified all their properties rejected the null hypothesis of mean equality, i.e., there were significant differences in their means with the moisture reduction from 30 to 12%, likewise in rupture ones (P-value < 0.05).

Table 5. Results for modulus of rupture (MOR).
Tabela 5. Resultados para o módulo de ruptura.

Characteristic	MC (%)	n	M_{MOR}	sd	P-value
Parallel Compression (MPa)	30	75	48.0	8.8	0.0000
	12	70	81.8	9.3	
Perpendicular Compression (MPa)	30	76	4.3	2.1	0.0000
	12	72	6.9	4.1	
Parallel Tensile (MPa)	30	73	104.7	41. 6	0.0085
	12	62	126.2	50.3	
Perpendicular Tensile (MPa)	30	69	4.1	1.7	0.0000
	12	71	6.0	1.8	
Static Bending (MPa)	30	72	89.6	23.3	0.0000
	12	67	173.4	84.6	

Caption: MC: moisture content; n: repeat; M_{MOR}: modulus of rupture mean; sd: standard deviation

Table 6. Results for modulus of elasticity (MOE).
Tabela 6. Resultados para o módulo de elasticidade.

Characteristic	MC (%)	n	M_{MOE}	sd	P-value
Parallel Compression (MPa)	30	75	16528.1	4545.6	0.0006
	12	70	19316.7	5034.4	
Perpendicular Compression (MPa)	30	76	459.2	280.1	0.0002
	12	72	678.7	408.2	
Parallel Tensile (MPa)	30	73	18958.1	4260.2	0.0119
	12	62	21376.5	6322.6	
Static Bending (MPa)	30	72	15668.2	3596.0	0.0000
	12	67	19215.7	4032.4	

Caption: MC: moisture content; n: repeat; M_{MOE}: modulus of elasticity mean; sd: standard deviation

With the decrease of the moisture content (30% to 12%), we observed that the properties of tangential cleavage, shear stress, parallel hardness, perpendicular hardness, and tangential toughness increased their values in order to 41.30% (0.57 MPa), 33.02% (7.1 MPa), 18.33% (1.95 kN), 28.16% (3.16 kN), and 2.56% (0.4 N.m), respectively (Table 7).

The t-test revealed that the moduli of shear stress, parallel hardness, perpendicular hardness, and tangential cleavage rejected the null hypothesis of mean equality, presenting significant differences in their means when the moisture content of each sample was reduced (P-value < 0.05). Only in the tangential toughness resistance this situation was not similar, because this property did not present any difference in the means with the moisture content reduction.

Table 7. Results for other strength properties.
Tabela 7. Resultados para outras propriedades resistivas.

Characteristic	MC (%)	n	M_{OSP}	sd	P-value
Shear Stress (MPa)	30	76	14.4	2.5	0.0000
	12	72	21.5	4.2	
Tangential Cleavage (MPa)	30	76	0.810	0.320	0.0000
	12	73	1.38	0.141	
Perpendicular Hardness (kN)	30	73	8.06	1.73	0.0000
	12	73	11.22	2.66	
Parallel Hardness (kN)	30	73	8.69	1.79	0.0000
	12	73	10.64	2.32	
Tangential Toughness (N.m)	30	74	15.2	7.2	0.7608
	12	66	15.6	8.2	

Caption: MC: moisture content; n: repeat; M_{OSP}: other strength property mean; sd: standard deviation

DISCUSSION

No previous physical-mechanical characterization study on this wood species is available so far, as it was confirmed by structured literature searches in Table 1, justifying the demand of studies to evince the species potentiality for industrialization and construction purposes, for example, in added-value structural products.

Due to this limited knowledge on *Eucalyptus punctata*, this research considered a significant number of repeats (n) in all tests (Tables 3 to 6), exceeding by 5 to 6 times the recommendation of samples ($d \geq 12$) for the characterization of unknown species as prescribed by the Brazilian standard code ABNT NBR 7190 (1997).

Due to the unprecedented results, it was not possible to establish a comparison with values of this same wood species. However, the confirmation of the structural capacity of punctata wood for structural purposes was established by a comparison of its mechanical performance with eight popular plantation woods (Table 8).

Comparing to values obtained by this study (Tables 4 to 7) and values suggested by the Brazilian standard code for wood-based structures for construction (Table 8), it is possible to confirm that *Eucalyptus punctata* wood demonstrated better performances than eight popular plantation species (*Corymbia citriodora*, *C. maculata*, *Eucalyptus grandis*, *E. saligna*, *Pinus caribaea*, *P. elliottii*, *P. oocarpa*, and *P. taeda*) in five relevant mechanical properties (modulus of rupture in parallel compression, modulus of rupture in perpendicular tensile and parallel tensile, modulus of elasticity in parallel compression, and shear stress). In addition, punctata wood is slightly less dense than *C. citriodora*, being similar to *C. maculata*, and visibly heavier than other six eucalypt and pine species.

Table 8. Properties of commercial plantation structural woods at 12% of moisture.
Tabela 8. Propriedades das madeiras estruturais de reflorestamento comerciais à 12% de teor de umidade.

Wood species	ρ (g/cm3)	f_{c0} (MPa)	f_{t0} (MPa)	f_{t90} (MPa)	f_v (MPa)	E_{c0} (MPa)
Corymbia citriodora	1.0	62	123	4	11	18400
Corymbia maculata	0.93	64	116	4	11	18100
Eucalyptus grandis	0.64	40	70	5	10	12800
Eucalyptus saligna	0.73	47	96	4	8	14900
Pinus caribaea var. *caribaea*	0.58	35	65	3	8	8500
Pinus elliottii var. *elliottii*	0.56	40	66	3	7	11900
Pinus oocarpa	0.54	44	61	3	8	10900
Pinus taeda	0.65	44	83	3	8	13300
This study (Tables 4 to 7)*	0.95	82	126	6	22	19300

Caption: ρ: bulk density; f_{c0}: modulus of rupture in parallel compression; f_{t0} modulus of rupture in parallel tensile; f_{t90} modulus of rupture in perpendicular tensile; f_v: shear stress; E_{c0}: modulus of elasticity in parallel compression; *values of this present study.
Source: ABNT NBR 7190 (1997).

It is possible to confirm that *Eucalyptus punctata* wood is able to offer interesting conditions compared to other hardwoods used in structures, such as *Zanthoxylum gilletii* and *Enthandrophragma cylindricum*, as both species from Ghana studied by Domekyiir *et al.* (2026) reached similar values in modulus of rupture, as well as slightly lower values in modulus of elasticity and bulk density at 12% moisture content. Compared to other study on the characterization of *Eucalyptus globulus*, *Cedrelinga cateniformis* and *Aniba amazónica* woods from Peru, Carrión Rabanal *et al.* (2024), it was possible to confirm that the performance of *Eucalyptus punctata* was visibly superior, as it was denser, and stronger in parallel compression and static bending. This species also overcame shear strength, parallel compressive strength, strength and stiffness on static bending, and wood density studied by Balboni et al. (2021) of timber produced for bioenergy from young forests of eucalypt clones in Brazil.

Lastly, the *Eucalyptus punctata* can be classified as a high-density wood considering that medium-density woods have been classified by Ashaari (2017) in the range from 0.72 to 0.88 g/cm^3, being that lower values are considered low density woods and higher values are high density species. This is confirmed by another study led by Gaeta Montagna et al. (2025) on natural durability of poles, which classified this species as high-density wood.

Given this fact, punctata wood also becomes an interesting species in the low-carbon strategies, as De Araujo et al. (2020) confirmed that high-density woods are capable of offering higher carbon and carbon dioxide fixations. Due to these good performance against other plantation woods used in structural parts, this studied wood can be efficiently applied for construction.

CONCLUSION

From this research, it is possible to conclude that:

- As expected, bulk density of *Eucalyptus punctata* wood decreases its initial value at 30% as the moisture content was reduced to 12%, although it remained as a high-density species according to the parameters from literature and standard codes.
- Among fourteen mechanical properties studied for *Eucalyptus punctata* wood, thirteen of them suffered increases when they were submitted to a moisture reduction from 30% to 12%. Specifically, all properties of both modulus of rupture and elasticity, shear stress, parallel hardness, perpendicular hardness and tangential cleavage were the positively affected properties according to the statistics. Only the tangential toughness did not have change in its resistance when specimens were submitted to the moisture reduction.
- The comparison with other plantation woods commercially used for construction evinced that this wood can satisfactorily be utilized in structural parts, as this studied species exceeded all varieties in main mechanical properties. Therefore, *Eucalyptus punctata* can be an alternative wood to supply industry and construction towards global growing interests to utilize wood in the production of greener buildings and bio-based infrastructures.
- Further research can consider other different conditions and aspects (*e.g.*, moisture content, age, position in trunk, region, *etc.*), as well as the durability of treated parts, preservation using natural and chemical compounds, and resistances against weather and insect attacks.
- Given the increased interests on industrialized buildings and the use of plantation woods in structural engineered products, this *Eucalyptus punctata* wood species could be tested as raw material for massive panels and beams, including glued and glued-free solutions.

REFERENCES

ALBUQUERQUE, A. C.; OGURI, G.; BALISTA, B. Z.; RAMANTSWANA, M.; GUERRA, S. P. S**. Overview of eucalypt plantation in Brazil**. Botucatu: FEPAF, 2024. pp.1-34.

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS (ABNT). **NBR 7190:** Projeto de estruturas de madeira. Rio de Janeiro, 1997.

ASHAARI, Z. **Low density wood:** from poor to excellent. Serdang: Universiti Putra Malaysia Press, 2017. 96 p.

BALBONI, B. M.; BATISTA, A. S.; GARCIA, J. N. Evaluating the potential for timber production of young forests of Eucalyptus spp. clones used for bioenergy: wood density and mechanical properties. **Australian Forestry**, North Ringwood, v. 84, p. 122-132, 2021. https://doi.org/10.1080/00049158.2021.1945238

BARALDI, L.; DOCHA, M. C. D.; ROCHA, M. P.; KLITZKE, R. J.; BARAÚNA, E. E. P.; ROBERT, R. C. G. Change in the production line for better operational performance in machining *Eucalyptus* spp. wood. **Floresta**, Curitiba, v. 54, n. 1, e-95838, 2024. https://doi.org/10.5380/rf.v54i1. 95838

BOLAND, D. J.; BROOKER, M. I. H.; CHIPPENDALE, G. M.; HALL, N.; HYLAND, B. P. M.; JOHNSTON, R. D.; KLEINIG, D. A.; MCDONALD, M. W.; TURNER, J. D**. Forest trees of Australia**. 5.ed. Clayton: Csiro Publishing, 2006.

CARRIÓN RABANAL, K. N.; ANTICONA RUIZ, D. A.; CASTAÑEDA DIAZ, D. A. Comparative analysis of the physical-mechanical properties of eucalyptus, tornillo and moena wood for structural use in houses in Cajamarca. **Proceedings of the LACCEI international Multi-conference for Engineering, Education and Technology Conference**, p 1-6, 2024. https://doi.org/10.18687/LACCEI2024.1.1.1318

CENTRE FOR AUSTRALIAN NATIONAL BIODIVERSITY RESEARCH. **Eucalyptus punctata: grey gum**. Camberra: Centre for Australian National Biodiversity Research / Csiro Publishing, 2020. Disponível em: https://apps.lucidcentral.org/euclid/text/entities/eucalyptus_punctata.htm. Acesso em 06/06/2026.

DE ARAUJO, V.; VASCONCELOS, J.; CORTEZ-BARBOSA, J.; MORALES, E.; CHRISTOFORO, A.; GAVA, M.; LAHR, F.; GARCIA, J. Wood consumption and fixations of carbon dioxide and carbon from timber housing techniques: a Brazilian panorama. **Energy and Buildings**, Amsterdam, v. 216, e109960, 2020. https://doi.org/10.1016/j.enbuild.2020.109960

DE ARAUJO, V.; VASCONCELOS, J.; GAVA, M.; CHRISTOFORO, A.; LAHR, F.; GARCIA, J. What does Brazil know about the origin and uses of tree species employed in the housing sector? Perspectives on available species, origin and current challenges. **International Forestry Review**, Craven Arms, v. 23, n. 3, p. 392-404, 2021. https://doi.org/10.1505/146554821833992794

DOMEKYIIR, D.; APPIAH-KUBI, E.; ANTWI, K.; AWOTWE-MENSAH, M. Evaluation of mechanical and physical properties of *Zanthoxylum gilletii* wood and comparative strength analysis with *Enthandrophragma cylindricum* for furniture and structural applications. **Journal of Indian Academy of Wood Science**, 2026. https://doi.org/10.1007/s13196-025-00401-5

DUONG, D. V.; SCHIMLECK, L.; TRAN, D. L. Variation in wood density and mechanical properties of *Acacia mangium* provenances planted in Vietnam. **Journal of Sustainable Forestry**, Philadelphia, v. 42, n. 5, p. 518-532, 2022. https://doi.org/10.1080/10549811.2022.2045507

GAETA MONTAGNA, R.; DE FREITAS, J. A.; FREIRE NETO, A. O. L.; FIORUCI, W. J.; BUCCI, L. A.; RANZINI, M.; DE LIMA, I. L.; LONGUI, E. L. Natural durability of wood for fifteen *Eucalyptus* and two *Corymbia* species in contact with the soil. **Maderas Ciencia y Tecnología**. v. 27, n. 44, p. 1-14, 2025. https://doi.org/10.22320/s0718221x/2025.44

GUTIÉRREZ, G. L. **Atlas del eucalipto.** información y ecología. v.1. Sevilla: INIA-ICONA, 1976. 140 p.

HENRY, R. J. **Genetics, genomics and breeding of eucalypts**. Boca Raton: CRC Press, 2015. pp.1-206.

LAHR, F. A. R.; NOGUEIRA, M. C. J. A.; DE ARAUJO, V. A.; VASCONCELOS, J. S.; CHRISTOFORO, A. L. Physical-mechanical characterization of *Eucalyptus urophylla* wood. **Engenharia Agrícola**, Jaboticabal, v. 37, n. 5, p. 900-906, 2017. https://doi.org/10.1590/1809-4430-Eng.Agric.v37n5p900-906/2017

LAHR, F. A. R.; NOGUEIRA, M. C. J. A.; DE ARAUJO, V. A.; VASCONCELOS, J. S.; CHRISTOFORO, A. L. Wood utilization of *Eucalyptus grandis* in structural elements: densities and mechanical properties. **Engenharia Agrícola**, Jaboticabal, v. 38, n. 5, p. 642-647, 2018. https://doi.org/10.1590/1809-4430-Eng.Agric.v38n5p642-647/2018

MAIDEN, J. H. **The forest flora of New South Wales**. Parts 61-70. v. 7. 1.ed. Sydney: University of Sydney Library, 1922. pp.1-565.

NOGUEIRA, M. C. J. A.; DE ARAUJO, V. A.; VASCONCELOS, J. S.; GUTIÉRREZ-AGUILAR, C. M.; CRUZ, J. N.; VASCONCELOS, J. C. S.; PRATAVIERA, F.; CHRISTOFORO, A. L.; LAHR, F. A. R. Caracterización físico-mecánica de la madera de *Eucalyptus camaldulensis* para uso estructural proveniente de Restinga, Brasil. **Revista Forestal del Perú**, La Molina, v. 33, n. 1, p. 52-62, 2018. https://doi.org/10.21704/rfp.v33i1.1155

NOGUEIRA, M. C. J. A.; DE ARAUJO, V. A.; VASCONCELOS, J. S.; GUTIÉRREZ-AGUILAR, C. M.; CHRISTOFORO, A. L.; LAHR, F. A. R. Gomero manchado producido en Brasil para madera maciza estructural: una caracterización física y mecánica. **Nexo Revista Científica**, Managua, v. 37, n. 1, p. 22-33, 2024. https://doi.org/10.5377/nrc.v37i01.18321

ROCHA, M. F. V.; COSTA, L. R.; COSTA, L. J.; ARAUJO, A. C. C.; SOARES, B. C. D.; HEIN, P. R. G. Wood knots influence the modulus of elasticity and resistance to compression. F**loresta e Ambiente**, Rio de Janeiro, v. 25, n. 4, e.20170906, 2018. https://doi.org/ 10.1590/2179-8087.090617

SCHNELL, M. R.; PIK, A. J.; DANGERFIELD, J. M. Ant community succession within eucalypt plantations on used pasture and implications for taxonomic sufficiency in biomonitoring. **Austral Ecology**, Camberra, v. 28, n. 5, p. 553 – 565, 2003. https://doi.org/10.1046/j.1442-9993.2003.01312.x

SPIECKER, H. Production of valuable oak wood in Europe. **Annals of Forest Research**, Bucareste, v. 64, n. 1, p. 5-12, 2021. https://doi.org/10.15287/afr.2021.2207

TODARELLO, P.; CHALMERS, A. The characteristics of five species of hollow-bearing trees on the New South Wales central coast. **Proceedings of the Linnean Society of New South Wales**, Sydney, v. 128, p. 1-14, 2007.

WEBB, J. K.; SHINE, R. Out on a limb: Conservation implications of tree-hollow use by a threatened snake species (*Hoplocephalus bungaroides*: Serpentes, Elapidae). **Biological Conservation**, Amsterdam, v. 81, n. 1–2, p. 21-33, 1997. https://doi.org/10.1016/S0006-3207(96)00160-7