



# Evaluation of the Basic Properties for the Korean Major Domestic Wood Species IV. Mossy Locust (*Robinia pseudoacacia*) in Chungju-si, Chungcheongbuk-do

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## ABSTRACT

Wood is composed of various cell types and therefore exhibits heterogeneous characteristics, unlike metals or plastics. Such variability occurs not only among species but also within the same species depending on age and growing conditions. This study aimed to establish a database of basic material properties for major domestic species by evaluating the anatomical, physical, mechanical, and chemical characteristics of 32-year-old Mossy locust (*Robinia pseudoacacia*) grown in Chungju, Korea. The results showed that Mossy locust is a high-density hardwood with relatively high strength, and its chemical composition was within the range commonly reported for hardwood species. Although the study is limited to samples from a single region, it provides integrated information on the material properties of Korean-grown Mossy locust. These findings can serve as fundamental data for the efficient utilization and further value-added applications of this species.

**Keywords:** Mossy locust, anatomical property, physical property, mechanical property, chemical composition

## 1. INTRODUCTION

Wood has been widely applied in various fields for a long time, because it is easily available and facile to process. Compared to other materials produced artificially, since wood is naturally grown by photosynthesis, it has been highlighted again as an eco-friendly material. However, as wood consists of diverse cells, it possesses

heterogeneous properties unlike metals or plastics. In this sense, careful attention is required in the processing process for utilizing wood (Chong and Park, 2008). Wood properties vary not only between tree species but also within the same tree species influenced by such factors as age and growing environment. Additionally, there are differences found within a single individual under various growth processes. Therefore, when mate-

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rial properties per tree species and their suitable applications are first understood, wood can be efficiently utilized (Park *et al.*, 2024a).

Mossy locust (*Robinia pseudoacacia*) is a deciduous broad-leaved tree species native to North America, and was planted throughout South Korea in the early 1900s for creating fuel production forests and restoring denuded land (Kim *et al.*, 2007). Especially, from 1960 to 1992, as part of the reforestation project, 1.2 billion trees of Mossy locust were planted in an area of 320,000 ha, and were utilized as a nectar source. However, in the 1980s, Mossy locust was excluded from the list of recommended tree species for afforestation. It was then indiscriminately logged due to misunderstandings about it being a remnant of Japanese colonial rule, and widespread public resentment, consequently greatly reducing its forest area. As for its current status, it is estimated to remain scattered across areas of approximately 120,000 ha, specifically, across coastal areas like Uljin-Samcheok in Gyeongsangbuk-do, the Seoul-Gyeonggi southern region, and Chungcheongbuk-do, South Korea (Lim *et al.*, 2023).

According to Lim *et al.* (2023), Mossy locust shows rapid and vigorous growth; one-year-old seedlings reach a height of approximately 1 m; under favorable conditions, its height increases by 1–2 m annually over 2–5 years. Height growth remains active until it becomes 10–12 years old, gradually slowing down thereafter and nearly ceasing its growth after it becomes 30 years old. Volume growth is rapid until it becomes 30–40 years old, then it tends to slow significantly. Forty-year-old trees typically reach an average height of 25 m and a diameter at breast height of 27 cm. In fertile sites, trees aged 30–40 years are considered appropriate for harvesting. Furthermore, Mossy locust is highly cold-resistant and grows well under dry conditions.

Mossy locust is hard and highly durable, making it suitable for outdoor usage without applying preservative treatment. It is widely utilized for children’s playground equipment, outdoor furniture, and stakes. It has also

been employed as furniture materials such as chairs, desks, plywood, and boards (Lim *et al.*, 2023). However, as Mossy locust has a high specific gravity and is difficult to dry, there is a limitation of low processing yield. In response to overcoming such limitations, there have been various studies on improving conditions for drying the species (Lee and Kim, 2001; Park *et al.*, 2022; Song *et al.*, 2020). Meanwhile, as chemical components extracted from Mossy locust have advantages such as various physiological activities, including antioxidant and anti-inflammatory properties, there have been a great number of application studies in progress (Bae and Ham, 2000a, 2000b; Bae *et al.*, 2000; Choi *et al.*, 2002; Kang *et al.*, 2022). Recently, as advancements in processing technology have led to more distribution and higher resource volume of Mossy locust (Eom *et al.*, 2021; Park *et al.*, 2021), various studies, such as aroma component analysis and pellet utilization evaluations, are underway (Lee and Kim, 2020; Lee *et al.*, 2019). However, these previous studies have remained as individual research mainly focused on specific utilization purposes, and few studies have comprehensively handled the basic material properties of Mossy locust.

Following previous studies on pine tree (*Pinus densiflora*) in Pyeongchang, Gangwon-do, tulip tree (*Liriodendron tulipifera*) in Gangjin, Jeollanam-do, and Korean pine (*Pinus koraiensis*) in Jinan, Jeollabuk-do, South Korea (Park *et al.*, 2024a, 2024b, 2025), this study targeted Mossy locust grown in Chungju, Chungcheongbuk-do, analyzed its basic material properties comprehensively, and suggested the outcomes, in order to provide foundational data for constructing a database of Korean wood material properties.

## 2. MATERIALS and METHODS

### 2.1. Specimen tree species

This study employed 40 pieces of Mossy locust grown at Mountain 81, Gachun-ri, Eomjeong-myeon,

Chungju-si, Chungcheongbuk-do (N37.13°, E127.93°). The target logs were straight-grained wood with a small-end diameter of more than 300 mm, and the average age was approximately 32 years (Fig. 1).

## 2.2. Evaluation of basic material properties

The basic material properties of Mossy locust were analyzed by dividing them into anatomical, physical and mechanical properties, and chemical composition. Anatomical characteristics were evaluated by measuring the length, width, and cell wall thickness of wood fibers and vessel elements. Regarding physical properties, specific gravity and shrinkage rates were measured. As for mechanical properties, bending strength, compression strength parallel to the grain, tensile strength parallel to the grain, shear strength, and hardness were measured. Chemical composition analysis included ash, extractives, lignin, and sugars. Tests for each item were performed according to methods applied in previous studies based on KS and ASTM standards, as shown in Table 1 (Park *et al.*, 2024a). Evaluation methods for anatomical proper-

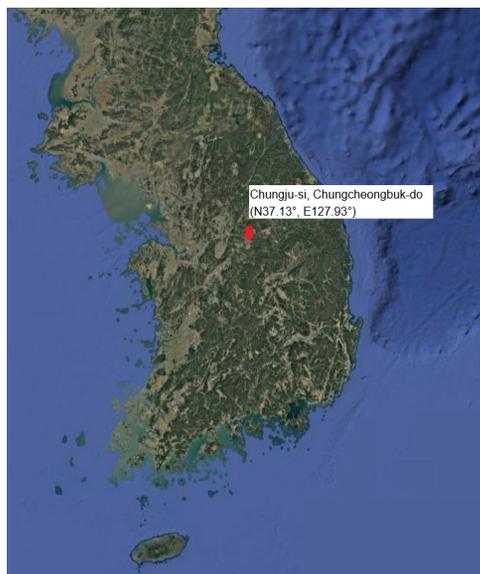


Fig. 1. Mossy locust production site.

ties were determined based on similar previous studies, due to the absence of standard specifications for the properties (Kim *et al.*, 2024; Lee and Bae, 2021; Lee *et al.*, 2021a, 2021b, 2021c; Nam and Kim, 2021). Specimens for each evaluation item were collected from the heartwood part, excluding pith and juvenile wood, while using sound wood free of knots or splitting checks and splits (Fig. 2).

## 3. RESULTS and DISCUSSION

### 3.1. Anatomical properties

The earlywood fiber length of Mossy locust was 0.86 mm, and the latewood fiber length was 1.13 mm. The width of the earlywood was 18.09  $\mu\text{m}$  in the radial direction and 11.57  $\mu\text{m}$  in the tangential direction; that of the latewood was 10.51  $\mu\text{m}$  in the radial direction and 9.16  $\mu\text{m}$  in the tangential direction. The cell wall thickness of the earlywood was 1.12  $\mu\text{m}$ , and that of the latewood was 2.23  $\mu\text{m}$ . The length of the vessel element of the earlywood was 0.14 mm, and that of the latewood was 0.17 mm. The width of the earlywood was 293.56  $\mu\text{m}$  in the radial direction and 239.79  $\mu\text{m}$  in the tangential direction; that of the latewood was 178.77  $\mu\text{m}$  in the radial direction and 140.72  $\mu\text{m}$  in the tangential direction. The cell wall thickness of the earlywood was 1.64  $\mu\text{m}$ , and that of the latewood was 2.08  $\mu\text{m}$ , indicating a tendency to be slightly thicker in latewood. These outcomes are assumed to reflect the characteristics of Mossy locust cells, which gradually become denser during the growth process. Figs. 3 and 4 present optical microscope images and wood surface images of three sections of Mossy locust.

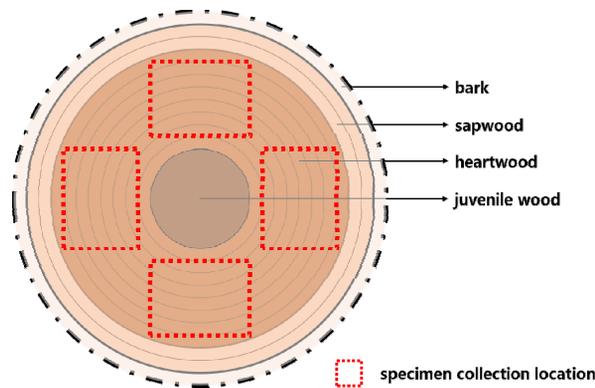
### 3.2. Physical properties

The specific gravity was 0.614 for green wood, 0.664 for air-dried wood, and 0.713 for oven-dried wood. The total shrinkage was 0.38% in the longitudinal direction,

**Table 1.** Standard for the evaluation of wood properties

		Standard
Anatomical properties	Length of cell	-
	Width of cell	-
	Thickness of cell wall	-
Physical properties	Specific gravity	KS F 2198 (KSA, 2016)
	Shrinkage	KS F 2203 (KSA, 2020a)
Mechanical properties	Bending strength	KS F 2208 (KSA, 2020d)
	Compression strength	KS F 2206 (KSA, 2020b)
	Tensile strength	KS F 2207 (KSA, 2020c)
	Shear strength	KS F 2209 (KSA, 2020e)
	Hardness	KS F 2212 (KSA, 2020f)
Chemical composition	Ash	KS M ISO 18122 (KSA, 2015)
	Extractives	ASTM E 1690 (ASTM, 2021)
	Lignin	ASTM E 1758-01 (ASTM, 2020)
	Sugars	

Adapted from Park *et al.* (2024b) with CC-BY-NC.

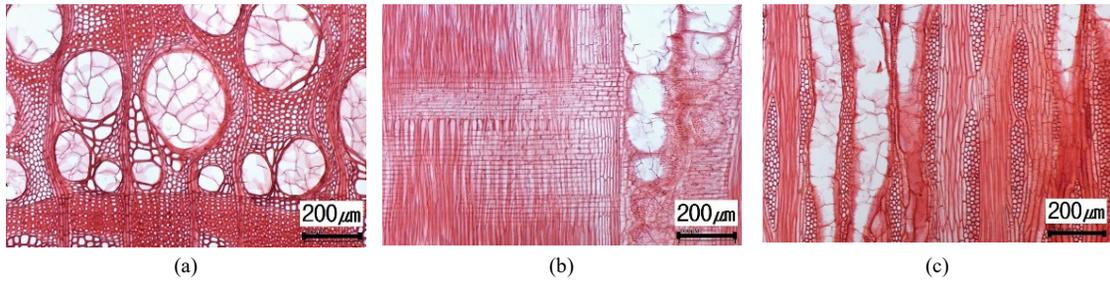


**Fig. 2.** Location of specimen collection within the log. Adapted from Park *et al.* (2024a) with CC-BY-NC.

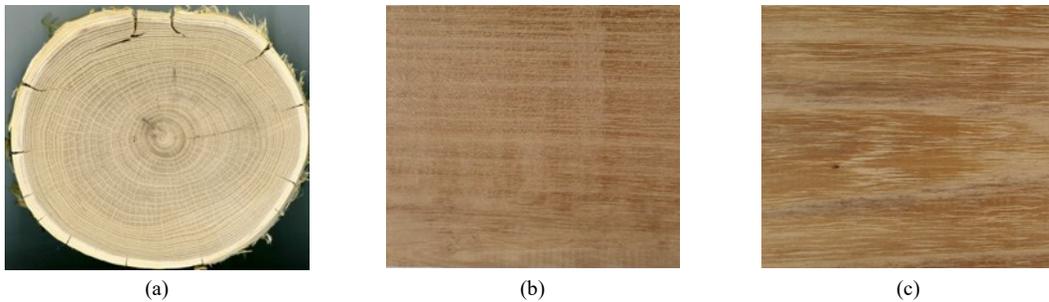
5.48% in the radial direction, and 8.62% in the tangential direction, along with a total volumetric shrinkage rate of 13.94%. These results indicate that Mossy locust is a tree species with relatively high specific gravity and volumetric shrinkage, compared to typical broad-leaved trees.

### 3.3. Mechanical properties

The bending strength was 129.0 MPa for air-dried wood and 59.1 MPa for green wood. Compression strength parallel to the grain was 46.0 MPa for air-dried wood and 23.5 MPa for green wood. Tensile strength



**Fig. 3.** Optical microscope images of Mossy locust wood sections stained with 1% safranin solution. (a) Cross section, (b) radial section, and (c) tangential section.



**Fig. 4.** Macroscopic views of Mossy locust wood surface. (a) Cross section, (b) radial section, and (c) tangential section.

parallel to the grain was 165.7 MPa for air-dried wood and 98.0 MPa for green wood. Shear strength was 14.2 MPa in the radial section and 15.7 MPa in the tangential section for air-dried wood; it was 9.7 MPa and 10.2 MPa, respectively, for green wood. The hardness of the air-dried wood was confirmed to be 9.3 kN in the cross section, 8.7 kN in the radial section, and 8.6 kN in the tangential section. These results show that Mossy locust is a species with generally high strength characteristics, as it belongs to a high-density hardwood.

### 3.4. Chemical composition

The ash content was 0.54%, and the extractive content was 4.98%. The lignin content was 27.81% acid-insoluble and 2.18% acid-soluble, totaling 29.99%. Total sugars comprised 40.73% glucan, 17.09% XMG, and 0.33% arabinan, totaling 58.15%. This chemical composition

shows that Mossy locust belongs to the typical range for broad-leaved trees.

## 4. CONCLUSIONS

This study evaluated the anatomical, physical and mechanical properties, and chemical composition of 32-year-old Mossy locust grown in Chungju, Chungcheongbuk-do, South Korea, in order to establish a database (DB) on wood properties for Korean major domestic wood species (Table 2). Although this study has a limitation in targeting Mossy locust grown in a single region, it provided a benchmark for future comparative and expanded research by comprehensively analyzing and quantitatively illustrating the basic material properties of the domestic Mossy locust. Since the material properties of domestic tree species, including Mossy locust, can vary greatly under different regions and site

**Table 2.** Basic properties of Mossy locust

Anatomical properties							
Length of fiber (n = 30)		Width of fiber (n = 30)				Thickness of cell wall for fiber (n = 30)	
Earlywood	Latewood	Earlywood		Latewood		Earlywood	Latewood
		R section	T section	R section	T section		
0.86 mm (0.06)*	1.13 mm (0.09)	18.09 μm (1.80)	11.57 μm (1.59)	10.51 μm (1.52)	9.16 μm (1.35)	1.12 μm (0.17)	2.23 μm (0.30)
Length of vessel element (n = 30)		Width of vessel element (n = 30)				Thickness of cell wall for vessel element (n = 30)	
Earlywood	Latewood	Earlywood		Latewood		Earlywood	Latewood
		R section	T section	R section	T section		
0.14 mm (0.01)*	0.17 mm (0.00)	293.56 μm (32.88)	239.79 μm (28.54)	178.77 μm (25.75)	140.72 μm (18.94)	1.64 μm (0.33)	2.08 μm (0.44)
Physical properties							
Specific gravity (n = 100)			Total shrinkage (n = 100)				
Green	Air-dry	Oven-dry	Linear			Volumetric	
			L direction	R direction	T direction		
0.614 (0.028)	0.664 (0.029)	0.713 (0.032)	0.38% (0.18)	5.48% (0.95)	8.62% (1.18)	13.94% (1.89)	
Mechanical properties							
Bending strength		Compression strength parallel to the grain			Tensile strength parallel to the grain		
Air-dry (12% MC*) (n = 28)	Green (n = 20)	Air-dry (12% MC) (n = 29)	Green (n = 28)	Air-dry (9.5% MC) (n = 18)	Green (n = 26)		
129.0 MPa (12.3)	59.1 MPa (14.3)	46.0 MPa (5.5)	23.5 MPa (5.3)	165.7 MPa (55.4)	98.0 MPa (19.0)		
Shear strength				Hardness			
R section		T section		C section	R section	T section	
Air-dry (13.7% MC) (n = 27)	Green (n = 19)	Air-dry (13% MC) (n = 18)	Green (n = 19)	Air-dry (12% MC) (n = 25)	Air-dry (12% MC) (n = 25)	Air-dry (12% MC) (n = 25)	
14.2 MPa (1.1)	9.7 MPa (0.9)	15.7 MPa (1.5)	10.2 MPa (1.4)	9.3 kN (1.2)	8.7 kN (1.5)	8.6 kN (1.4)	
Chemical compositions							
Ash (n = 6)	Extractives (n = 6)	Lignin (n = 6)					
		Acid-insoluble		Acid-soluble	Total		
0.54% (0.10)	4.98% (0.21)	27.81% (0.92)		2.18% (0.46)	29.99% (1.36)		
Sugars (n = 6)							
Glucan		XMG**		Arabinan		Total	
40.73% (0.54)		17.09% (0.30)		0.33% (0.00)		58.15% (0.84)	

SD in parentheses.

n: number of specimens used in the evaluation or number of repetitions of evaluation.

R section: radial section, T section: tangential section, L direction: longitudinal direction, R direction: radial direction, T direction: tangential direction, C section: cross section.

\* MC: moisture content.

\*\* XMG: xylan + mannan + galactan.

conditions, it is necessary to continuously evaluate diverse species and origins so as to derive representative values. This study serves as a starting point for such long-term research, and the findings of the study are expected to be utilized as foundational data for establishing domestic wood material property databases for each region, and for efficient utilization.

## CONFLICT of INTEREST

No potential conflict of interest relevant to this article was reported.

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