



Physical and mechanical properties of *Paulownia clone in vitro 112*

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Abstract

For the *Paulownia Clone in vitro 112* hybrid to be used in the wood industry, it is necessary to know its basic properties. Its air dry density of 231 kg/m³ is nearly 20% lower than that of *Paulownia tomentosa*. Its average compressive strength is 19.9 MPa, its shear strength is 4.1 MPa, the static modulus of rupture (MOR) is 32.3 MPa, and the modulus of elasticity (MOE) is 3800 MPa. Its volumetric shrinkage is 8.47%, with longitudinal 0.6%, radial 3.2% and tangential 5.0%. The ratio of tangential to radial shrinkage is very favorable, just 1.6.

1 Introduction

Paulownia tree species are one of the fastest growing species in the world, with 6 species within the family (some studies claiming as many as 17). One of the selected cultivars of Paulownia is *Paulownia Clone in vitro 112*, of which trunks of sufficient size are already available for use in the wood industry. Though there has recently been growing interest in Paulownia in Europe, literature analysing the properties of its timber in sufficient scientific depth will take longer to become widely available. However, in order to determine the possible uses of the timber, it is essential to know its basic properties. Knowledge of the air-dry density is essential for the usability of wood, from which the strength properties can be inferred. Paulownia is considered to have one of the lowest densities among the wood species with an air dry density of approx. 0.25–0.3 g/cm³. The basic density value is an important fundamental parameter, for example, for determining the bulk density of wood chips, or in pulp or particleboard production. The dimensional stability of the wood influences the results of some technological treatments (e.g. steaming, drying) and the area of usage. Knowledge of the anisotropy coefficient (T/R ratio) is a very important feature because of deformation during wood drying. Different

Paulownia varieties, as in the case of poplar trees, can vary a lot in their properties. The aim of this study is to map and compare the properties of *Paulownia Clone in vitro 112* to those of the better-known *Paulownia tomentosa*.

2 Materials and methods

The samples were obtained from 6 different trunks, which were 9 years old and harvested in Spain. The trees were felled at a section 1 m below breast height. The tests were conducted according to the following standards:

- Density (DIN 68364:2003)
- Compression strength (DIN 52185:1976)
- Shearing strength (DIN 52187:1979)
- Static bending strength (DIN 52186:1978)
- Modulus of elasticity (DIN 68364:2003)
- Shrinkage and swelling (DIN 52184:1979) (The requirement for a minimum number of annual rings could not be achieved)

The equipment used was a universal testing machine, type Instron 4208 (Instron, USA).

Until the beginning of the tests, the specimens were stored in a normal climate (T = 20 °C; φ = 65%). 50 samples for each test were used. A one-way analysis of variance (ANOVA) of the strengths was performed with the SPSS (IBM, USA) software. The statistical significance was set at P < 0.05.

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3 Results and discussion

To compare the characteristics of the samples examined with other *Paulownia* species, the values of the best known *Paulownia tomentosa* species were used, which have been determined in a previous study (Koman and Feher 2017).

Air-dry density is more than 20% lower than that of *Paulownia tomentosa* (Table 1), already meeting the upper range of the corresponding values of balsa wood. No values lower than those could be found for *Paulownia* species in any authentic source. Among others, the basic density value that is important from the aspects of peeling, machining properties or estimating the papermaking potential is extremely low.

The shrinkage values (longitudinal 0.6%, radial 3.2%, tangential 5.0%, volumetric 8.5%) are greater for *Paulownia tomentosa*, both in the different anatomical directions and in the volumetric volume changes. However, the values of *Paulownia Clone in vitro 112* are still very favourable in comparison to the majority of wood species. The ratio of tangential to radial shrinkage is particularly

favourable (1.6). This is an important feature for the wood drying capability and warping.

The low density results in a low value of the strength characteristics (Fig. 1). In general, *Paulownia Clone in vitro 112* has lower values than *Paulownia tomentosa*. The average value of the clone's compression strength parallel to the grain was 19.9 MPa and its MOR was 32.3 MPa, these being respectively 10% and 20% greater than the corresponding values for *Paulownia tomentosa* while its shearing value was nearly 40% lower than that of *Paulownia tomentosa*. Although the MOE value of 3800 MPa is nearly 9% higher, the values for this property have a very high standard deviation value.

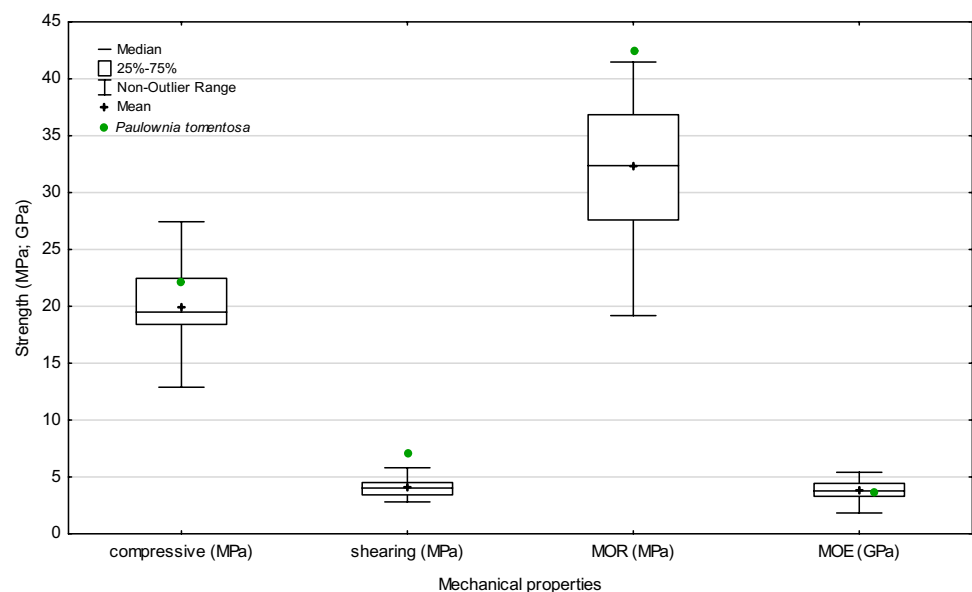
4 Conclusion

There are significant differences in the individual characteristics of the material between *Paulownia Clone in vitro 112* and *Paulownia tomentosa*. The air-dry density of the wood is extremely low, and such small values are not found among *Paulownia* species, so it is advisable to consider the different species as having different material properties. The low density in some areas, for example in the packaging industry, may be an advantage. Due to the density, the strength values are also very low. Compared to *Paulownia tomentosa*, the values of compressive strength, flexural strength and shear strength are lower. Shrinkage values are also very low in different anatomical directions and volume. The ratio of tangential to radial shrinkage is also very favorable compared to other tree species, which is advantageous in terms of wood drying quality and warping tendency.

Table 1 Values of the measured densities

Density type (kg/m ³)	<i>Paulownia tomentosa</i>	<i>Paulownia Clone in vitro 112</i>			
	Average	Average	Min	Max	St.dev
Air-dry (u = 12%)	300.2	231.6	171.4	321.2	34.4
Oven-dry (u = 0%)	275.5	215.1	164.5	334.7	35.6
Basic	264.2	198.3	152.3	236.6	29.8

Fig. 1 Mechanical properties of *Paulownia* species



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