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Some Physical and Mechanical characterization of Tunisian planted *Eucalytusloxophleba* and *Eucalyptus salmonophloia* woods

Mohamed Tahar Elaieb^{1*}, Sarra Ben Rhouma¹, Ali Khouaja³, Ali Khorchani¹,
IssamTouhami¹, M.L.Khouja¹, Kévin Candelier^{2*}

¹ LGVRF, INRGREF, B.P. 10, 2080 Ariana, Tunisia.

² CIRAD - Unité de Recherches BioWooEB, TA B 114/16, Montpellier, France

³INAT: 43 Avenue Charle Nicole – Tunis Belvédère 1002 Tunisia

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Abstract: After the independence in 1957 and with the support of the FAO117, *Eucalyptus* species were planted in Tunisia in different arboreta throughout the country for close observation and adaptation to climate and soil. The objective of this study is to evaluate the physical and mechanical properties of two species planted in marginal area in Sousse (arboretum El Hanya) in the east of Tunisia (*Eucalytus loxophleba* and *Eucalyptus salmonophloia*). The moisture content, specific gravity and volumetric shrinkage were measured. The Mechanical tests were performed to evaluate the hardness, the static bending and the resistance to compression parallel to fiber direction.

Preliminary results showed that *Eucalytusloxophleba* and *Eucalyptus salmonophloia* have a low dimensional stability. During the drying period, woods showed signs of collapses. On the other hand, both species were highly resistant to compression strength while they were lower on the static bending. *Eucalytus loxophleba* and *Eucalyptus salmonophloia* characteristics established within this study were similar to other *Eucalyptus* species from Tunisia, Morocco, Australia and Brazil. This wood may be used in furniture, structural material and/or biomass energy.

Keywords: Specific gravity, *Eucalytus loxophleba*, *Eucalyptus salmonophloia*, Mechanical properties, Shrinkage.

1. INTRODUCTION

During the colonial period, the Tunisian forest area significantly decreased by human and climatic aggressions. Indeed, the Tunisian forest area decreased from 1.096 million ha to 844.000 ha between 1912 and 1952 illustrating 23% loss during 40 years¹.

In a reforestation program with the help of the Food and Agriculture Organization (FAO) after the independence, quite few *Eucalyptus* species were planted in different areas of Tunisia. In order to test their compatibility to climate and soil, many arboreta were settled². The objective of this project at the beginning was for pulp production but the wood produced was then reoriented for industrial use such particle board MDF and energy. These species were very well adapted to the Tunisian conditions^{3,4}. In recent decades, *Eucalyptus* trees are increasingly used for their essential oils⁵ and for honey production.

Nevertheless, in Tunisia, the valorization of *Eucalyptus* wood remains under estimated and very little research has been done⁶. However the *Eucalyptus* wood becomes a subject of interest as raw material for composite panels in many tropical and subtropical countries including Thailand, Chile, Brazil and Malaysia⁷.

According to the FAO, the reforestations based on *Eucalyptus* covers a surface of 28535 ha in pure stands and 39000 ha mixed with other species, with an estimated annual *Eucalyptus* wood production of 120.000 m³². These great efforts of reforestation were undergone in all Tunisia in order to overcome the land degradation and improve the forest production.

In order to fill the lacks of information concerning *Eucalyptus* wood properties, the aim of this study is to characterize the physical (specific gravity, dimensional changes, Fibers Saturation Point) and mechanical properties (hardness, compression and bending strengths) of two *Eucalyptus* wood species: *Eucalyptus loxophleba* and *Eucalyptus salmonophloia*, from the arboretum of El Hanyal located near Sousse in the east and the semi-arid climate (400 mm rainfall). The results may be useful in reforestation objectives and forest management strategies.

2. MATERIALS AND METHODS

2.1. Trees selection and sampling:

Eucalyptus loxophleba and *Eucalyptus salmonophloia* wood species of 50 and 53 years old respectively were chosen, in this study, to estimate the physical and mechanical properties of Tunisian reforestation *Eucalyptus* wood species. 3 trees of each wood species were collected in the “El Hanyal” arboretum in the Sousse region (35°49' N, 10°38' E). According to Oger and Lecerq⁸, the sampling for the determination of physical and mechanical properties is optimal when the number of sampled trees is comprised between 1 and 5, and should be healthy, free from defects and alteration and have an almost perfectly straight.

The studied site is characterized by a semi-arid bio climate, an annual rainfall of 327 mm/year and average annual temperatures varying from 14.9 °C to 18.5 °C. The average of maximum temperature of the warmest month can reach more than 35 °C and the average maximum of the coldest month is around 4 °C. The soil is poorly developed in coastal dunes and leached brown forest in the mountains⁹.

2.2. Physical properties

2.2.1. Moisture content, specific gravity and shrinkage: To perform physical and mechanical tests, a disk 50 mm thick was cut at breast height from each selected tree (**Figure 1**). The samples were free of

defects such tension wood knots, etc¹⁰. From each disk, 12 samples of 30 mm width from bark to bark were cut.

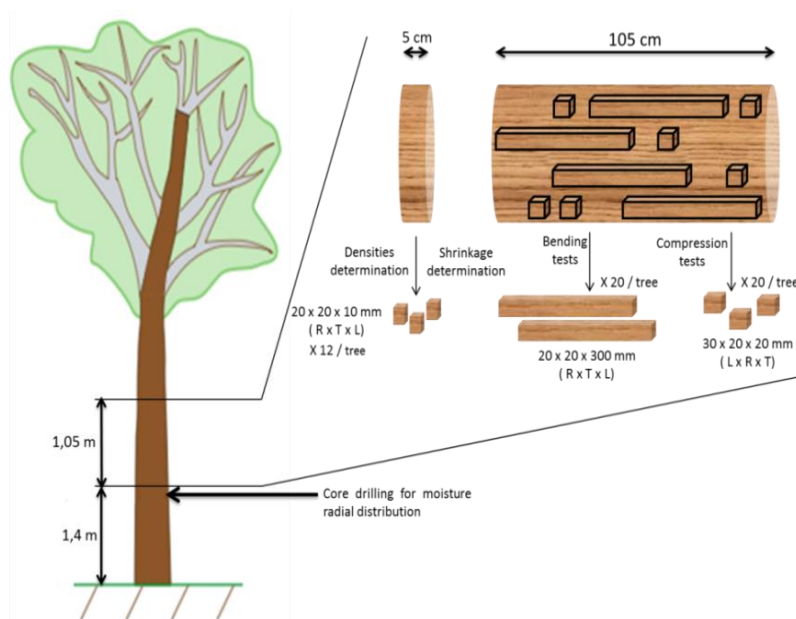


Figure 1: Overview of wood sample selection for the physical and mechanical analyses.

These samples were then cut into strip 20 mm thick. Basic density (D_b), Air-dry density (D_{m12}) [after conditioning in a climatic room at 20 ± 2 °C and $65 \pm 5\%$ RH] and oven-dry [after drying in an oven at 103°C] density (D_{m0})¹¹, shrinkage (β) [tangential (β_t), radial (β_r), longitudinal (β_l) and volumetric (β_v)]¹² of the wood samples were determined using wood specimens of $20 \times 20 \times 10$ mm (along the grain). The Transverse Anisotropy Ratio for Shrinkage (TARS) (β_t / β_r) was the ratio between tangential and radial shrinkage. The densities were determined by the gravimetric method¹³.

$$D_b = \frac{m_0}{V_h} (1) \quad ; \quad D_{m0} = \frac{m_0}{V_0} (2) \quad ; \quad D_{m12} = \frac{m_0}{V_{12}} (3)$$

Where:

m_0 = oven-dried weight of the sample (g);

m_{12} = air-dried weight of the sample (g);

D_b = basic density of wood (g.cm^{-3});

D_{m0} =oven-dried density of wood (g.cm^{-3});

D_{m12} =air-dried density of wood (g.cm^{-3});

V_h = green volume of the specimen (cm^3);

V_0 = oven-dried volume of the sample (cm^3);

V_{12} = air-dried volume of wood sample (cm^3).

Volumetric shrinkage was measured by the following equation (4).

$$\beta_v = \frac{(V_h - V_0)}{V_h} \times 100 \quad (4)$$

Similar operations were used to determine tangential (β_t), radial (β_r) and longitudinal (β_l) shrinkages, using dimensional variation of the respective orientation.

Figure 2 shows the wood samples repartition for moisture content (a), densities and shrinkages (b) determination tests.

Moisture content (MC) was calculated by the following equation (5):

$$EMC(\%) = 100 \times \frac{(m_h - m_0)}{m_0} \quad (5)$$

Where m_h is the humid mass of the initial wood sample and m_0 is the oven-dried mass of the wood sample.

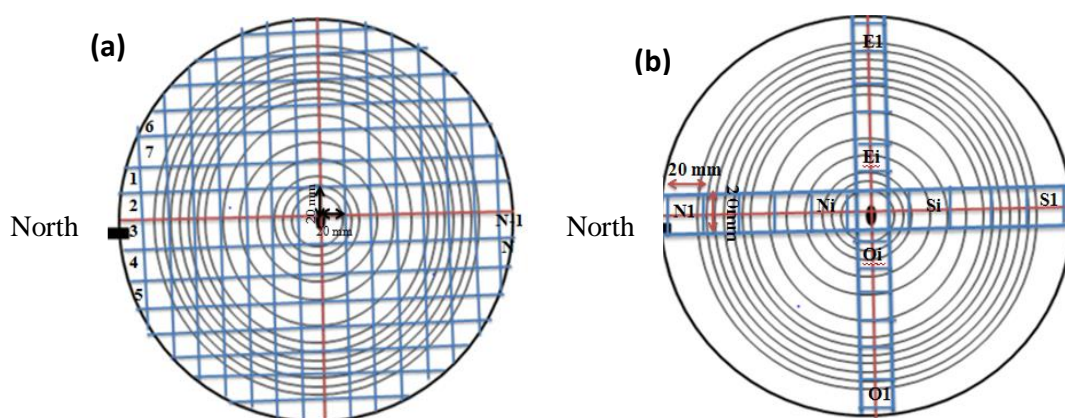


Figure 2: Wood sample repartition for moisture content (a), densities and shrinkages (b) determination tests.

2.2.2. Fibers saturation point (FSP): The Fibers Saturation Point (FSP) of wood is defined as the point in the drying process at which only water bound in the cell walls remains. An accurate knowledge of the FSP is important, because at this point the physical characteristics of wood, such as strength, elasticity and conductivity change markedly. In particular, during drying process of timber, little shrinkage occurs until the MC is below the FSP.

Forty 50 x 20 x 100 mm (R x T x L) specimens of each wood species were used in this experimental part to generate shrinkage curves. All specimens were continuously dried at 65°C. During this drying step, wood samples were taken 2 by 2 (for each wood species), every 15 minutes, to determine the wood dimensional variations according to the relative humidity evolution. These measurements were performed until wood samples were dried until their respective mass was stabilized.

2.3. Mechanical properties

To perform mechanical resistance tests, three point bending (MOR) and compression tests were carried out for each wood samples from the selected trees, and results were compared. An INSTRON 4467 Universal Mechanical Test Machine was used for these measurements. Samples were conditioned in a climate-controlled room with $65 \pm 5\%$ RH and at $20 \pm 2^\circ\text{C}$ for the time required to stabilize the samples weights.

2.3.1. Bending test: Three point static bending tests were carried out according to the EN 408 standard¹⁴. The sample size was $300 \times 20 \text{ mm} \times 20 \text{ mm}^3$ (L x R x T). The moving head speed and span length were 0.09 mm.s^{-1} and 260 mm, respectively. The load deformation data obtained were analyzed to determine the modulus of rupture (MOR). The tests were replicated on 20 samples from each selected *Eucalyptus* tree.

2.3.2. Compression strength parallel to grain: Compression tests were carried out according to the EN 408¹⁴. Deviating from the standard, a reduced specimen size of $30 \times 20 \times 20 \text{ mm}^3$ (L x R x T) was used. The moving head speed was 0.09 mm.s^{-1} to ensure wood sample rupture within 1.5 to 2 minutes. The load deformation data obtained was analyzed to determine the modulus of rupture (MOR). 20 specimens per selected tree were tested.

2.3.3. Brinell Hardness (HB): Brinell hardness tests were performed in accordance with EN 408¹⁴. The force was applied in three steps by a sphere with a diameter of 10 mm. Force was slowly increased by 0.2 kN.s^{-1} over 15 s. Then, a force of 3 kN was maintained for 25 s before being. Brinell hardness tests were repeated ten times (five tests for each wood board). Each test was separated by at least 30 mm from the edge of the wood boards and 25mm from any other test. Ball penetration depth was measured to $\pm 0.01 \text{ mm}$ and applied force was measured to $\pm 0.005 \text{ kN}$.

3. RESULTS AND DISCUSSION

3.1 Moisture content (MC): Table 1 gives the minimal, maximal and average values of initial moisture contents of *Eucalytusloxophleba* and *Eucalyptus salmonophloia* woods. The initial average Moisture Contents were 37.1 % for *Eucalytusloxophleba* wood and 37.8 % for *Eucalyptus salmonophloia* wood, with respective minimal values of 21.2 % and 32.3 % and maximal values of 60.8 % and 52.8 % respectively. In comparison with others *Eucalyptus* species, the studied samples can be considered as characterized by low initial moisture content wood when being slaughtered.

Table 1: Average, minimum and maximum wet moisture contents values of *EucalytusLoxophleba* and *Eucalyptus Salmonophloia* woods.

Wood species	Moisture contents (%)				
	Min (%)	Max (%)	Average (%)	SD ^a (%)	CV ^b (%)
<i>Eucalytus loxophleba</i>	21.2	60.8	37.1	6	16.3
<i>Eucalyptus salmonophloia</i>	32.2	52.8	37.8	3.3	8.8

^a Standard Deviation; ^b Coefficient of Variation.

Indeed, Sahbeni¹⁵ mentioned initial moisture content values of 82.9 % and 101.5 % for *Eucalyptus bicostata* and *Eucalyptus coriacea* woods respectively, from the Souniat arboretum, in Tunisia. Ananias et al.¹⁶ found wood initial moisture contents ranged from 132 % to 200 % for different *Eucalyptus nitens* trees from “Las Mellizas” site in the Rucamanque farm located near the city of Huepil in the eighth region of Chile. Results of initial wood moisture contents of the both *Eucalyptus* species, according to the wood sample location within the tree are listed in **Table 2**. Four different locations of wood samples were defined depending on the distance from the pith of the trees. These four locations (**Figure 2**) are juvenile wood, heartwood close sapwood, transition wood and sapwood.

Table 2: Wet moisture contents values of *Eucalytusloxophleba* and *Eucalyptus salmonophloia* woods, according to the location in the trees.

Wood species	Sample location in the tree	Moisture contents (%)			
		Sap wood	Heart wood close to sap wood	Transition wood	Juvenile wood
<i>Eucalytusloxophleba</i>	Tree N°.				
	Tree 1	33.10	32.40	32.80	48.70
	Tree 2	35.40	39.00	34.40	56.60
	Tree 3	35.90	39.70	37.20	46.80
	Average	34.80	37.10	34.80	50.70
<i>Eucalyptus salmonophloia</i>	Tree 1	37.97	40.04	38.30	45.70
	Tree 2	35.80	37.00	37.10	43.60
	Tree 3	36.00	37.00	36.70	48.60
	Average	36.60	38.00	37.60	46.00

The results show (**Table 2**) that the initial MC of juvenile wood was higher than the initial MC of the transition, heartwood and sapwood. Whatever the wood sample location, the both wood species have similar moisture contents. The initial average MC value of juvenile wood is comprised between 43.60 and 56.60 %. For transition, heartwood and sapwoods, the initial MC is comprised between 32.40 and 40.04%

Ananias et al.¹⁶ mentioned similar trends regarding the initial wood moisture content distribution within *Eucalyptus nitens* tree. Their results showed that the initial MC of juvenile wood was considerably higher than those of the transition woods and sapwoods. On average, the initial MC of juvenile wood is comprised between 163 % and 200 %, between 133 % and 156 % for transition wood, and finally between 132 % and 157 % for sapwood. According to the literature¹⁷, we also can highlight the fact of the moisture content decreases from sapwood to heartwood.

3.2. Specific gravity: Air-dried Density (D_{m12}) is commonly used to compare different woods. Basic Density (D_b), Oven-Dried Density (D_{m0}) and Air-dried Density (D_{m12}) have been measured on each wood sample. Average values, maximal and minimal values of these different densities and coefficient of variations are presented in **Table 3**.

Basic Density (D_b), Air-dried Density (D_{m12}) and Oven-Dried Density (D_{m0}) are respectively $0.860^{+0.024}_{-0.015}$ g/cm³, $1.038^{+0.015}_{-0.015}$ g/cm³ and $0.937^{+0.024}_{-0.015}$ g/cm³ for *Eucalytus loxophleba* and $0.894^{+0.016}_{-0.016}$ g/cm³, $1.161^{+0.019}_{-0.019}$ g/cm³ and $0.993^{+0.016}_{-0.016}$ g/cm³ for *Eucalyptus salmonophloia*. Although Air-dried Density (D_{m12}) of

Eucalytus loxophleba is lower than those of *Eucalyptus salmonophloia*. According to Campredon¹⁸, the both wood species whose have been tested in this study can be classified as a highly heavy weight wood ($D_{m12} > 0.85$).

Table 3: Values of air dried, anhydrous and basic densities of *Eucalytusloxophleba* and *Eucalyptus salmonophloia* woods.

		Min	Max	Average	IC ^a à 95%	SD ^b	CV ^c (%)
D_{m12} (g/cm ³)	<i>E.loxophleba</i>	0.914	1.127	1.038	0.015	0.045	0.043
	<i>E.salmonophloia</i>	1.026	1.670	1.161	0.019	0.063	0.052
D_{m0} (g/cm ³)	<i>E.loxophleba</i>	0.836	1.041	0.937	0.024	0.051	0.054
	<i>E.salmonophloia</i>	0.858	1.095	0.993	0.016	0.056	0.056
D_b (g/cm ³)	<i>E.loxophleba</i>	0.729	0.994	0.860	0.024	0.062	0.072
	<i>E.salmonophloia</i>	0.785	0.982	0.894	0.016	0.049	0.053

^a Confidence Interval; ^b Standard Deviation; ^c Coefficient of Variation.

Similar results have been found by Ilicet *al.*¹⁹. Through a study on 590 Australian tree species, including 61 different *Eucalytus* tree species, Ilicet *al.*¹⁹ shown that *Eucalytus* wood basic density was 0.690 and 0.940 g/cm³ for *Eucalyptus camaldulensis* and *Eucalyptus platycorys* species respectively. Concerning *Eucalytusloxophleba* and *Eucalyptus salmonophloia* wood basic densities, these authors found 0.860 and 0.800 g/cm³ respectively. In Tunisia, a few studies on wood characterization have been conducted in the past two years on the following local *Eucalytus* wood species: *Eucalytusbicostata*¹⁵, *Eucalytuscinerea*²⁰, *Eucalytuscoriacea*¹⁵, *Eucalytusmaidenii*²⁰ and *Eucalytustorquata*²¹. The respective basic densities of these wood species are 0.630, 0.619, 0.711, 0.691 and 0.870 g/cm³. Comparing our results with those from other Tunisians *Eucalyptus* species, *Eucalytus loxophleba* and *Eucalyptus salmonophloia* seems to be classified among the heaviest *Eucalyptus* woods.

3.3. Shrinkages: According to the shrinkage analyses, results figuring in **Table 4** show the volumetric (β_v), tangential (β_t), radial (β_r), longitudinal (β_l) shrinkages and the shape factor (β_t/β_r) values of *Eucalytus loxophleba* and *Eucalyptus Salmonophloia* woods.

These results show clearly that *Eucalytus loxophleba* wood is more sensible to moisture content variations than *Eucalyptus salmonophloia* wood. Indeed, average value of shape factor *Eucalytus loxophleba* (2.5) is higher than those of *Eucalyptus salmonophloia* (1.2). According to Gérard *et al.*²², *Eucalytus loxophleba* is classified among the woods with a high volumetric shrinkage ($\beta_v > 13\%$), a high tangential shrinkage ($\beta_t > 10\%$) and a high radial shrinkage ($\beta_r > 6.5\%$) and *salmonophloia* is classified among the woods with a high volumetric shrinkage ($\beta_v > 13\%$), a medium tangential shrinkage ($6.5\% < \beta_t < 10\%$) and a high radial shrinkage ($\beta_r > 6.5\%$).

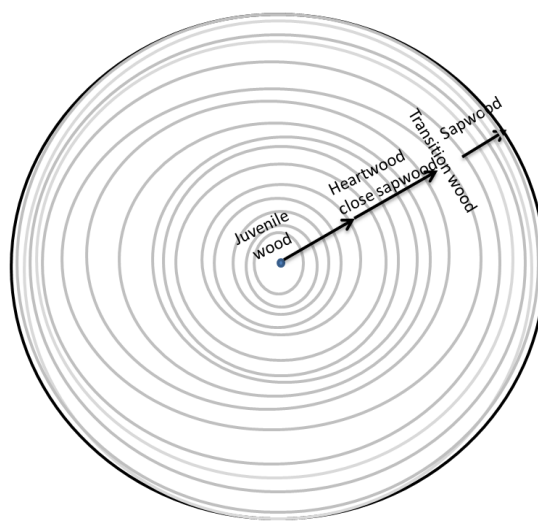
According to the literature, shrinkages of Tunisian *Eucalytus loxophleba* and *Eucalyptus salmonophloia* woods are relatively closed to those of other *Eucalyptus* species such as *Eucalytus globulus* ($\beta_t/\beta_r = 1.6$) from Morocco²³, *Eucalytus citrodiora* ($\beta_t/\beta_r = 1.43$) and *Eucalytus grandis* ($\beta_t/\beta_r = 1.64$) from Brazil²⁴ and *Eucalytus torquata* ($\beta_t/\beta_r = 1.27$) from Tunisia^{15, 20, 21}.

Table 4: Values of shrinkages in different directions of *Eucalytus loxophleba* and *Eucalyptus salmonphloia* woods.

	Wood species	Min	Average	Max	CI 95% ^a	SD ^b	CV ^c
β_v (%)	<i>E.loxophleba</i>	13.6	19.1	25.2	1.1	3.5	0.2
	<i>E.salmonphloia</i>	11.9	15.9	19.3	0.6	1.9	0.1
β_t (%)	<i>E.loxophleba</i>	7	10.2	17.4	0.9	2.9	0.3
	<i>E.salmonphloia</i>	5.1	8.5	10.6	0.3	1.1	0.1
β_r (%)	<i>E.loxophleba</i>	3.7	7.7	11.2	0.4	1.2	0.2
	<i>E.salmonphloia</i>	3.3	7.2	9.7	0.4	1.4	0.2
β_l (%)	<i>E.loxophleba</i>	0.1	1.1	2.6	0.2	0.6	0.6
	<i>E.salmonphloia</i>	0.1	0.7	1.6	0.1	0.4	0.6
Shape factor β_t / β_r	<i>E.loxophleba</i>	3.3	2.5	6.2			
	<i>E.salmonphloia</i>	1.5	1.2	1.1			

^a Confidence Interval; ^b Standard Deviation; ^c Coefficient of Variation.

3.4. Fibers Saturation Point: Fiber Saturation Point (FSP) is defined as the maximum possible amount of water that the composite polymers of the cell wall can hold at a particular temperature and pressure. Above this amount of water voids within the wood substance, particularly the cell lumens begin to fill and this excess is defined as free water (**Figure 4**). Physical characteristics of wood such as strength properties are highly changed at the FSP. Above the FSP, dimensional changes with varying water content are small whereas below the FSP dimensional changes are marked ²⁵. FSP is therefore an important parameter to estimate shrinkage properties of wood ²⁶. According to previous results on shrinkages values and the literature ²⁷, we can observe also on the Figure 3 that in eucalyptus wood species, shrinkage across the tangential plane is approximately twice than those of the radial plane, while shrinkage is negligible in the longitudinal plane. It is for this reason that longitudinal shrinkage does not appear on the **Figure 4**.

**Figure 3:** Location and definition of juvenile wood, heartwood, transition wood, and sapwoods.

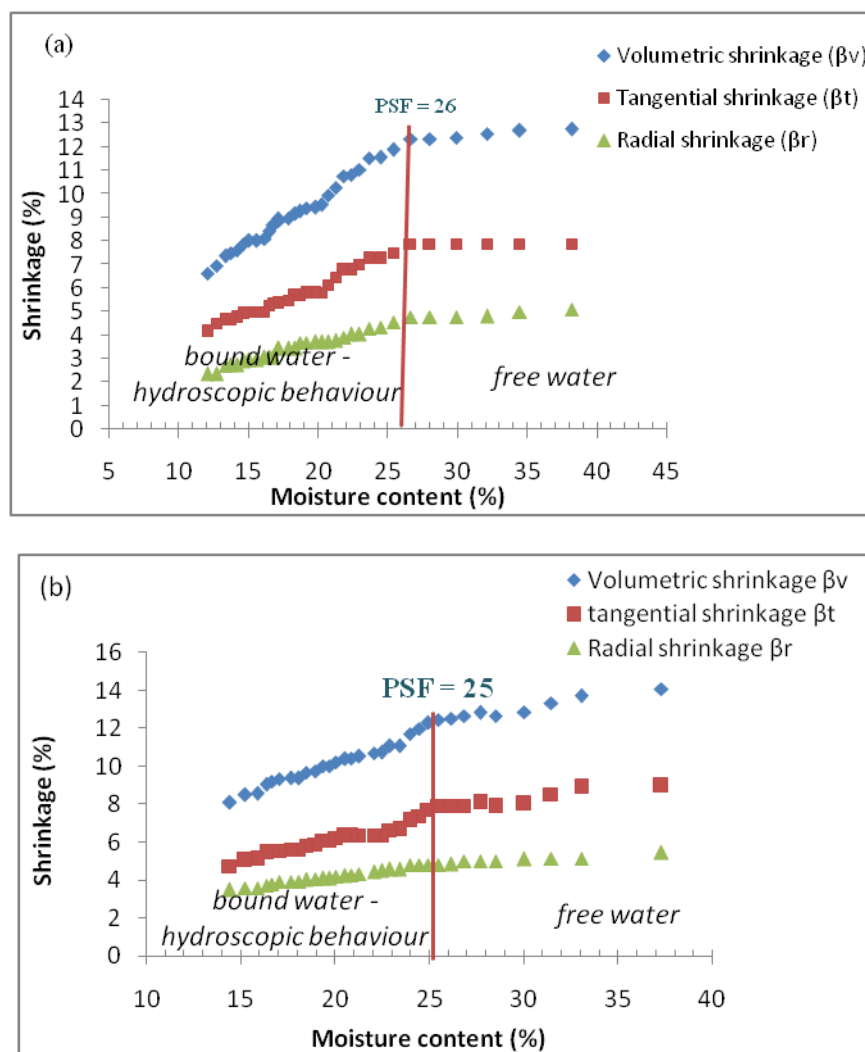


Figure 4: Volumetric β_v (%), Tangential β_t (%) and Radial β_r (%) shrinkage variations of *Eucalyptus loxophleba* (a) and *Eucalyptus salmonophloia* (b) woods, according to Moisture Content (%) evolution.

Figure 4 shows that the both *Eucalyptus* wood species studied in this work have a similar Fiber Saturation Point. FSP has a value of 26 % for *Eucalyptus loxophleba* and 25 % for *Eucalyptus salmonophloia*. According to Gérard *et al.*²², these both wood species are classified among the woods with medium FSP ($25\% < \text{PSF} < 35\%$). According to previous studied, shrinkages of Tunisian *Eucalyptus loxophleba* and *Eucalyptus salmonophloia* woods are very similar to those of other *Eucalyptus* species such as *Eucalytu smaculata* (FSP = 29) and *Eucalytus citrodiora* (FSP = 27) from Australia²⁸, and slightly lower than other Moroccan *Eucalyptus* species as *Eucalytus camaldulensis* (FSP = 32) and *Eucalytus globulus* (FSP = 34)²³. We can observe on Figure 4, and more particularly concerning the *Eucalyptus Salmonophloia*, that some shrinkage variations are already occurred above the FSP. This phenomenon is probably due to collapse reaction. Indeed, collapse of the cells during drying is commonly observed in certain timber species and is particularly pronounced in some members of the genus *Eucalyptus*²⁹. According to Chafe *et al.*³⁰, collapse can be defined as a form of shrinkage which is occurred above the Fiber Saturation Point (FSP). The most common explanation for collapse reaction is the capillary tension. This explanation assumes that one of the causes of collapse is that the cell walls cannot withstand the surface tension of the water which is removed from the lumen of the fibers. On the

other hand, macroscopic stresses arising in the wood during its drying have been suspected to contribute to collapse³¹ and have been claimed by some workers to be the sole cause of the collapse reaction³². However, the literature highlighted also that collapse can be occurred below the FSP³³.

3.5. Mechanical properties: The mechanical test results of *Eucalytus loxophleba* and *Eucalyptus salmonophloia* woods conditioned at a temperature of 20°C and 65% RH are shown in **Table 5**. The MOR average values of *Eucalytus loxophleba* and *Eucalyptus salmonophloia* woods were respectively 95.8 MPa and 97.2 MPa in bending test and 56.3 MPa and 56.9 MPa in compression test.

Table 5: Mechanical properties of Tunisian *Eucalytus loxophleba* and *Eucalyptus salmonophloia* woods: bending strength (σ_b), compression strength (σ_c) and Brinell Hardness (HB).

	Wood species	Min	Average	Max	SD ^a	CV ^b
σ_b (MPa)	<i>E.loxophleba</i>	65.9	95.8	131.9	17.9	0.2
	<i>E.salmonphloia</i>	67.3	97.3	122.4	14.3	0.1
σ_c (MPa)	<i>E.loxophleba</i>	40.6	56.3	56.3	2.7	0.06
	<i>E.salmonphloia</i>	43.1	56.9	56.9	2.8	0.03
HB (N/mm ²)	<i>E.loxophleba</i>	43.5	43.2	46.2	1.3	0.03
	<i>E.salmonphloia</i>	39	40.9	43.2	1.6	0.04

^aStandard Deviation; ^b Coefficient of Variation.

These results show that these both *Eucalyptus* species can be classified among the wood having a medium static bending strength (75 MPa < σ_b < 110 MPa) and a high axial compressive strength (55 MPa < σ_c < 75 MPa)³⁴.

According to the **Table 5**, *Eucalytus loxophleba* and *Eucalyptus salmonophloia* woods have respectively Brinell Hardness values of 43.2 N/mm² and 40.9 N/mm², that classify them among the very hard wood species (HB > 40 N/mm²), according to the Technical Center for Wood and Furniture (CTBA)³⁵.

In comparison with literature, it results that *Eucalytus loxophleba* and *Eucalyptus salmonophloia* woods have lower bending strength properties and higher compression strength properties than other Tunisian *Eucalyptus* species. Ghodhbéne³⁶ characterized Tunisian *Eucalyptus cinerea* and *Eucalyptus maidenii* woods and found respective bending strength values of 132.5 MPa and 107.2 MPa, and compression strength values of 54 MPa and 48.7 MPa. Sahbani¹⁵ found also similar results for *Eucalyptus bicostata* with a compression strength value of 50.40 MPa. The obtained results through our study classify *Eucalytus loxophleba* and *Eucalyptus salmonophloia* woods among woods with a high static bending strength (110 MPa < σ_b < 140 MPa) and a medium axial compressive strength (40 MPa < σ_c < 55 MPa).

CONCLUSION

The two species of *Eucalyptus* woods studied in this article reflect clearly the physical and mechanical properties of other kind of *Eucalyptus* woods which were already studied in Tunisia and in other countries such as Brazil, Australia and Morocco.

Results show that *Eucalyptus loxophleba* and *Eucalyptus salmonophloia* are classified among the woods with medium Fiber Saturation Point (FSP) and among the woods with high volumetric, tangential and radial shrinkages, except for *Eucalyptus salmonophloia* which has a highest tangential shrinkage than *Eucalyptus loxophleba* and which is classified as a medium tangential shrinkage. This study also highlighted and confirmed that the *Eucalyptus* wood species were easily subject to collapse phenomenon during their drying and present a high nervousness, arguments whose be often advanced by the wood industrial to ignore *Eucalyptus* wood.

The moisture content obtained from the different wooden disks was very similar. They showed a small decline of moisture between the sapwood and heartwood (transition zone, heartwood close sapwood and juvenile wood). The results indicated that the wood of the studied species has a MC near FSP (34.8 to 50.7%), there is near no free water into vessels. As a result, wood material being a very efficient insulator material, boiling of *Eucalyptus loxophleba* and *Eucalyptus salmonophloia* prior to peeling for veneer production for example will take a very long time compared to other wet *Eucalyptus* species as free water is the main medium allowing heat transfer into green wood.

Mechanical properties show that the both studied wood species have lower bending strength properties and higher compression strength properties than those of other Tunisian *Eucalyptus* species.

It appears that *Eucalyptus loxophleba* and *Eucalyptus salmonophloia* woods could be used as material sources to produce flooring, interior joinery, furniture, glulam and light frame for wood construction. This study confirms the fact of the *Eucalyptus* wood is an important source of wood material around the world, because of its rapid growth. In Brazil, an important part of the production of *Eucalyptus* is actually converted into charcoal for use by the steel industry.

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Corresponding author: Mohamed Tahar Elaieb ;

LGVRF, INRGREF, B.P. 10, 2080 Ariana, Tunisia.

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