# Anatomical Investigation of Thermally Compressed Eucalyptus Wood Panels

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## Abstract

Effects of temperature and press pressure on the anatomical structure of solid-wood panels produced by using Turkish River Gum (*Eucalyptus camaldulensis* Dehnh.) wood were evaluated. The logs were obtained from Mersin, South of Turkey. Solid wood panels with dimensions of 150 by 500 by 18 mm were hot-pressed using a laboratory hot press at a temperature of either 150°C or 180°C and pressure of 2 MPa for 45 min. Light Microscopy (LM) and Stereo Microscopy (SM) were employed to reveal deformations in the anatomical structure of the panels subjected to varying thermal compression conditions. Anatomical investigations were also performed for untreated wood samples for comparison purposes. All microscopic studies were realised visually only on cross sections, radial sections, and tangential sections. Possible cracks, collapse, buckling, degradations, fractures and ruptures on vessel walls, ray parenchyma cells, fibers, axial parenchymas, and pits were investigated.

***Keywords*:** A. Thermal modification, B. Thermal compression, C. Anatomical structure, D. Cellular failures, *Eucalyptus* spp.

## Introduction

Wood modification methods improve the properties of wood (Hill, 2006). Beside these material improvements the timber quality after modification is also of importance. Thermal compression of wood is a modification method that combines thermal and mechanical processes, resulting in densification of wood.

During the thermal compression process solid wood is exposed to compressive stresses in radial or tangential directions in addition to temperature effects. Changes in the anatomical structure of wood at various temperatures have been studied in detail (Fengel and Wegener 1989; Terziev et al. 2002; Boonstra et al. 2006; Persson et al. 2006; Awoyemi and Jones 2010).

Dogu et al. (2010) reported that there are significant interactions between process conditions and anatomical structure of wood during thermal compression. The wood exhibited different behavior in almost all process condition, and the process conditions showed different effect related to anatomical structure of wood. The authors also indicated that same pressure level has much more effect in the wood deformation at higher temperatures.

In this paper preliminary results of the study about on the effects of varying temperatures and press pressures on anatomical structure of solid-wood panels produced by using Turkish River Gum (*Eucalyptus camuldensis* Dehnh.) wood were explained. This study is a part of study which has different press pressure and temperature. So in our next study all details will be given.

## Materials and Methods

### Materials

This study was performed by using wood samples obtained from two different thermal processes. Commercial Turkish River Gum solid panels having no defects with dimensions of 150 by 500 by 18 mm were hot pressed using a laboratory hot press at a temperature of either 150 °C and 180 °C and pressure of 2 Mpa for 45 min. (Table 1).

*Table 1 Experimental Design of the Thermally Compressed Wood Panels*

| Groups | Press Pressure (MPa) | Temperature (°C) | Pressing Time (min) |
|---|---|---|---|
| Control | - | - | - |
| A | 2 | 150 | 45 |
| B | 2 | 180 | 45 |

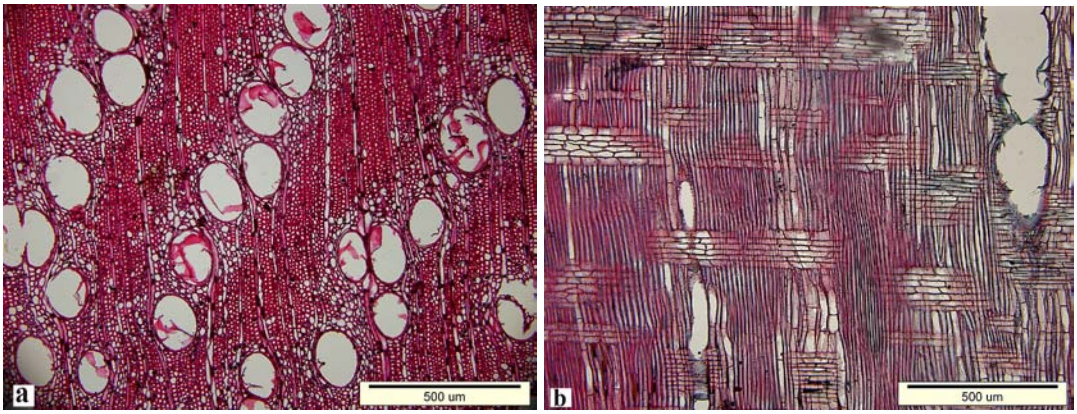
A total of 5 panels two for each group were used. The panels were pre-dried to a moisture content of 19% before hot pressing. Non-treated control specimens were used for comparison purposes.

## Methods

Light microscopy (LM) was employed to reveal deformations in the anatomical structure of the panels subjected to varying thermal compression conditions. Small samples with dimensions of 10 mm (R)x10 mm (T)x20mm (L) were cut for LM evaluations. The samples were kept under vacuum in the presence of alcohol, glycerin, and at room temperature in order to become softened and were then cut into thin sections (about 20 µm) by using a Leica sliding microtome. The sections were then stained with picro aniline blue to supply good contrast between cell walls. The sections were observed under an Olympus BX51 Light Microscope. Images were taken by using analysis FIVE Software and DP71 Digital Camera installed and adopted on the microscope.

## Results and Discussion

Microscope investigations performed on the each treatment group were evaluated together for cross-section, radial section and tangential section to better understand the effects of temperature and pres pressure on the anatomical structure of the wood. Images of untreated wood samples are shown in Fig.1 (LM).



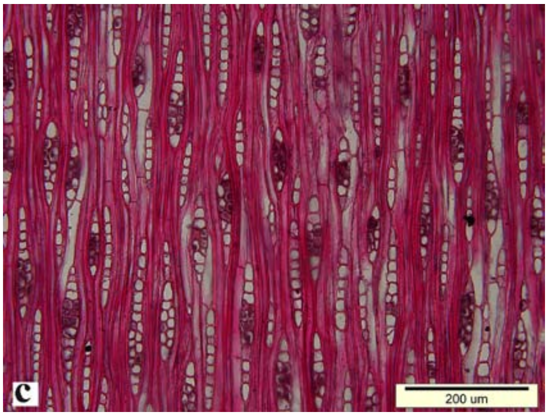



*Fig 1. Light micrographs of untreated wood: a) Cross section, b) Radial section, c) Tangential section*

**Cross Section**

Depending on the effects of press pressures and varying temperatures, rays and fibers showed squeeze in the radial directions in Group A (150ºC – 2 MPa) and Group B (180 ºC – 2 MPa).

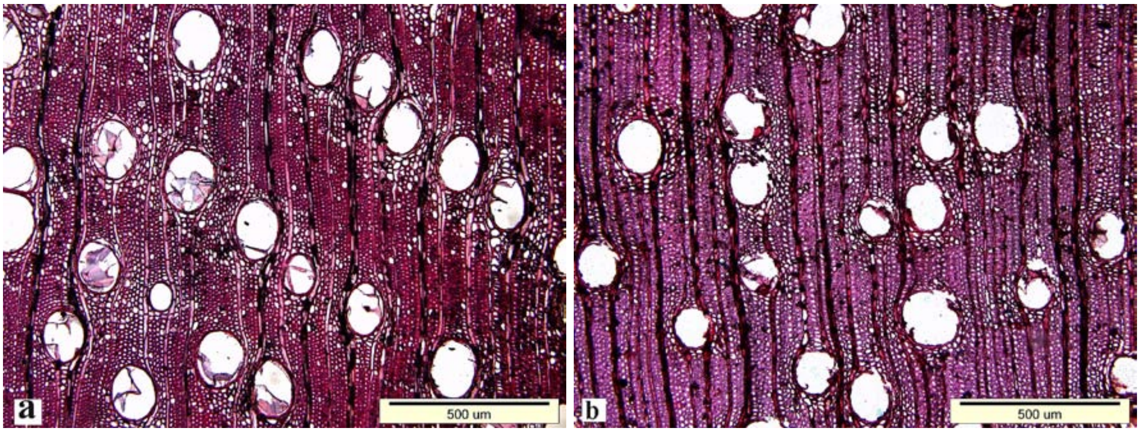



*Fig 3. Radial squeeze in Group A(a) and Group B(b)*

Turkish River Gum is a diffuse-porous hardwood with similar sized vessels distributed over its structure. The vessel surrounded by paratraheal parenchyma which are thin-walled elements. So cell collapse occurred in almost axial parenchyma in Group A (Fig 4b, arrow 1) and Group B (Fig. 4c, arrow 2). Severe degradation and cracks was observed in the vessel cell wall in Group B (Fig 4c and Fig 4d), whilst severe degradation and cracks was not observed in Group A (Fig. 4a and Fig 4b, arrow 2).

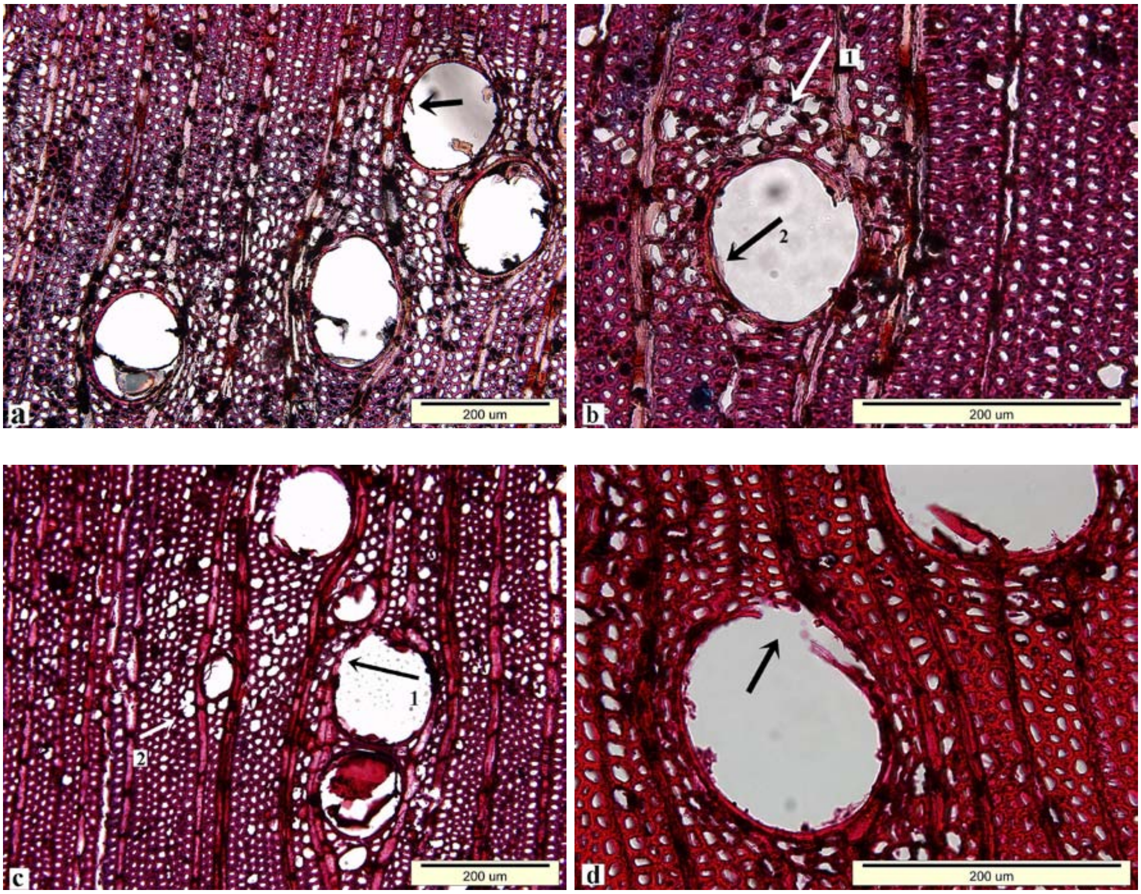



*Fig 4. a) Axial parenchyma collapse (arrow ) in Group A, b) Vessel cell wall degradation (arrow 2) in Group A c) Vessel cell wall degradation (arrow 1 ) and axial parenchyma collapse (arrow 2) in Group B, d) vessel cell wall degradation (arrow) in Group B.*

**Radial Section**

No radial and tangential cracks were observed on vessel cell wall while ruptures were seen on vessel cell wall layers.  Ruptures in the cell walls of ray parenchyma and cross-field pits were seen in each group, especially severe in Group B (Fig 5).

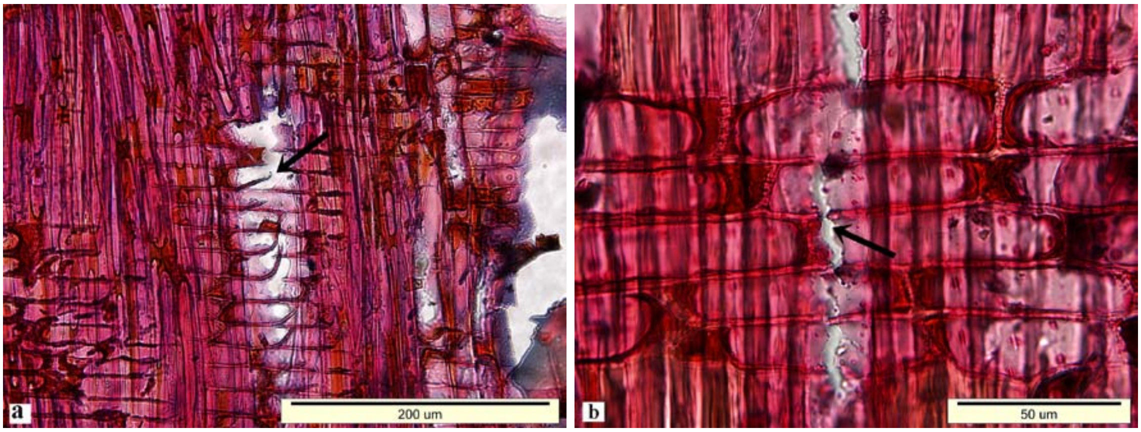



*Fig 5. a) Ruptures on cross-field pits and ray parenchyma in Group A, b) Longitudinal ruptures on cross-pitting and ray parenchyma in Group B.*

**Tangential Section**

Cell wall degradation in ray parenchyma in Group A and cracks between ray parenchyma were occurred in Group B were observed (Fig 6). No visible cracks and deformation were in fibre cells.


*Fig 5.a) Deformation in ray parenchyma cells in Group A, b) Cracks between ray parenchyma cells in Group B.*

## Conclusions

The influences of varying temperature (150 ºC and 180 ºC) and press pressure ( 2 MPa) on the anatomical structure on thermally compressed solid-wood panels were investigated. Microscopic investigations showed that deformations were on axial parenchyma and vessel cell walls. The results show that the same pressure level has much more effect in the wood deformation at higher temperatures.

The wood exhibited much degradation in Group B (180 ºC – 2 MPa), vessel cell walls were all degraded and axial parenchyma were collapsed.

Tabarsa and Chui (2001) stated that when radial compression to aspen, the weakest elements (vessels) exhibited the most deformation in the elastic regime. With increasing compressive load, deformation in the vessels increased until they collapse.

Determination of changes in anatomical structure of wood is important for the development of a new product by means of using wood modification methods. Wood species show specific anatomical properties all modifications affect them differently. Therefore, it is important to know the effects of modification methods on the anatomical properties of wood species.

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