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Ayous Wood (*Triplochiton scleroxylon* K. Schum) physical characterisation after three different cycles of heat treatment

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Ayous wood is obtained from the species *Triplochiton scleroxylon* K Schum, widely diffused in tropical areas of central western Africa with uneven annual rainfall distribution.

This species can easily reach 50 m in height and 2 m in diameter, and often shows trunks with no branches for the first 30 m.

Ayous wood is a low durable wood, so it usually needs treatments to improve the natural durability of the material.

Thermal modification of wood

Consists in expose the wood to temperatures upper than 160 °C for some hours. Is considered a key method to improve some interesting properties of wood, with the reduction of some others. The heat treatment effect on the wood properties varies with different time of exposure and reached temperatures.

- Dimensional stability
- Natural durability
- Interesting darker colour

- General reduction of all the mechanical properties
- Reduction of hygroscopicity
- Reduction of wood density

The effects of thermal modification are related to the alteration of the cell wall compounds. The reached temperatures cause the degradation of the hemicelluloses and the amorphous region of cellulose reducing the free bonding sites available for water molecules.

The samples were heat-treated for six hours using a ventilated oven to three different maximum temperature:

- 180 °C
- 190 °C
- 215 °C

Applied methods

The samples preparation and the determination of wood properties were carried out according to the following ISO reference standards:

- ISO 3129
- ISO 13061-1
- ISO 13061-2
- ISO 13061-13
- ISO CIE 11664-4

Results of wood density and basic density

	Wood density (g/cm^3)		Basic density (g/cm^3)	
	Mean	**St. Dv.**	**Mean**	**St. Dv.**
180 °C	0.40	0.06	0.34	0.05
190 °C	0.36	0.01	0.31	0.01
215 °C	0.34	0.01	0.29	0.01

Both wood density and basic density showed a greater reduction at higher treatment temperature. If compared to the results obtained in a similar study on untreated ayous wood, these data show a percentage reduction in wood density of 10%, 14%, and 20% and a reduction of 10%, 18%, and 22% in basic density, respectively for the treatment temperatures of 180 ° C, 190 ° C, and 215 ° C.

Results of wood shrinkage

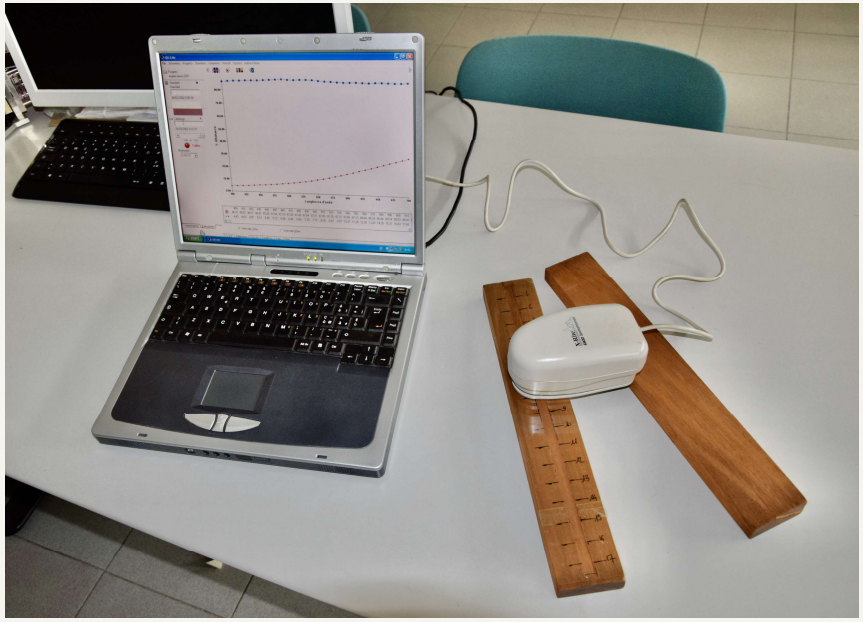
	180 °C		190 °C		215 °C	
	Mean	**St. Dv.**	**Mean**	**St. Dv.**	**Mean**	**St. Dv.**
Radial (%)	2.6	0.5	2.4	0.3	1.4	0.2
Tangential (%)	4.1	0.5	3.5	0.2	2.4	0.2
Volumetric (%)	6.6	1.0	5.8	0.4	3.7	0.3

Compared to the linear and volumetric shrinkage of untreated ayous wood, there is a percentage reduction in radial shrinkage of 6%,14%, and 50%; a reduction of 17%, 29%, and 53% of the tangential shrinkage; and a reduction of 13%, 51%, and 80% in volumetric shrinkage respectively for the treatment temperatures of 180 ° C, 190 ° C, and 215 ° C.

Results of colour characterization

	L*		a*		b*	
	Mean	**St.Dv.**	**Mean**	**St.Dv.**	**Mean**	**St.Dv.**
180 °C	57.42	1.66	11.44	0.40	27.96	0.78
190 °C	56.03	1.74	11.84	0.35	27.33	0.58
215 °C	39.29	2.39	10.60	0.70	19.53	1.64

Colour differences with untreated ayous wood



	ΔL*	Δa*	Δb*	ΔE*
180 °C	-12.79	0.56	3.80	13.35
190 °C	-14.17	0.64	4.20	14.79
215 °C	-30.91	1.29	2.96	31.08

Discussion and conclusion

The observed reduction of wood density results from the effect of the modification cycle on the cell wall components, particularly on hemicelluloses and amorphous regions of cellulose. Furthermore, hemicelluloses are the most hydrophilic among the cell wall components and their thermal degradation results in the reduction of wood hygroscopicity and this leads to an increase in dimensional stability and material durability.

Besides, the thermal modification influences the colour of the heat-treated wood that becomes darker with the increase of treatment temperature and time. In relation to the products formed by the degradation of hemicelluloses, to the present extractives, and to the formation of quinones as oxidation products.

This study highlights that the thermal modification of wood is an important method to improve some of its physical properties and the improvement of the material durability and dimensional stability makes the heat-treated wood suitable for outdoor using with no need for toxic preservative compounds. These findings add substantially to our understanding about the influence of the modification cycle on the physical properties of tropical hardwoods and their possible uses.

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