Estimation of the basic density of *Eucalyptus grandis* wood chips at different moisture levels using benchtop and handheld NIR instruments

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Abstract

This study aimed to evaluate whether moisture content affects basic density estimation, determine if portable and benchtop devices provide equivalent precision, and investigate the impact of wood anatomical planes on the spectral analysis of *Eucalyptus grandis* wood.

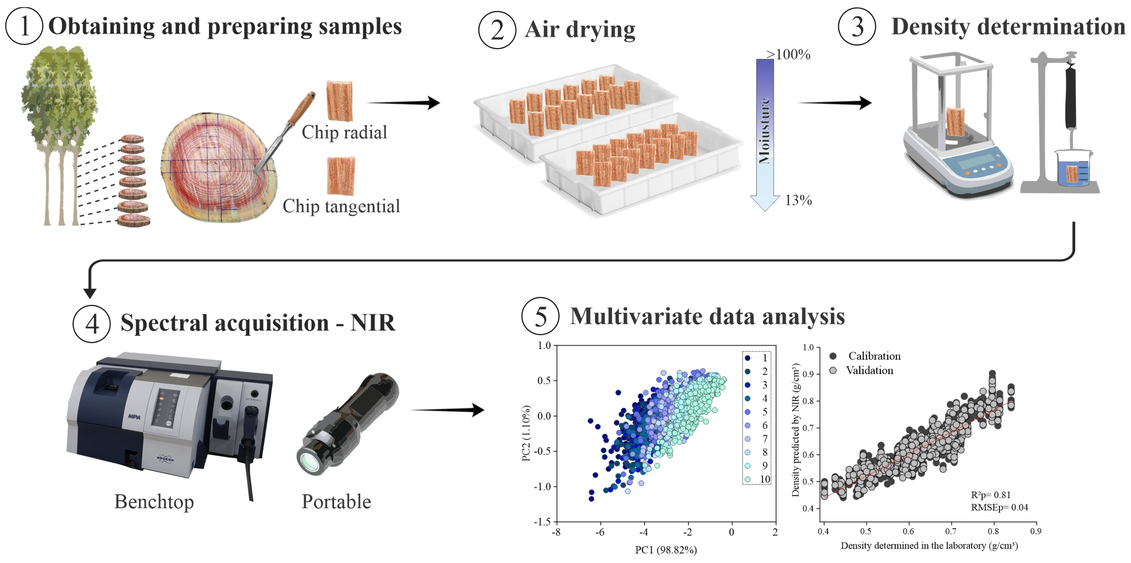

Fig. 1. Flowchart of the study stages.

Results

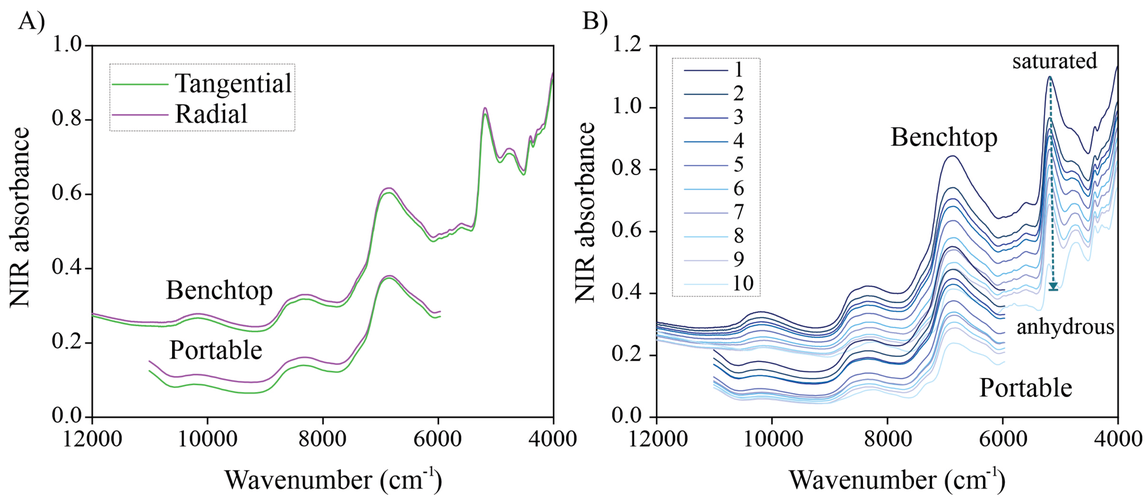

Fig. 2. Mean raw spectral signatures of the chips in different anatomical planes (Fig. 2A) and by drying stage (Fig. 2B) in *Eucalyptus grandis* wood obtained with benchtop and portable NIR instruments.

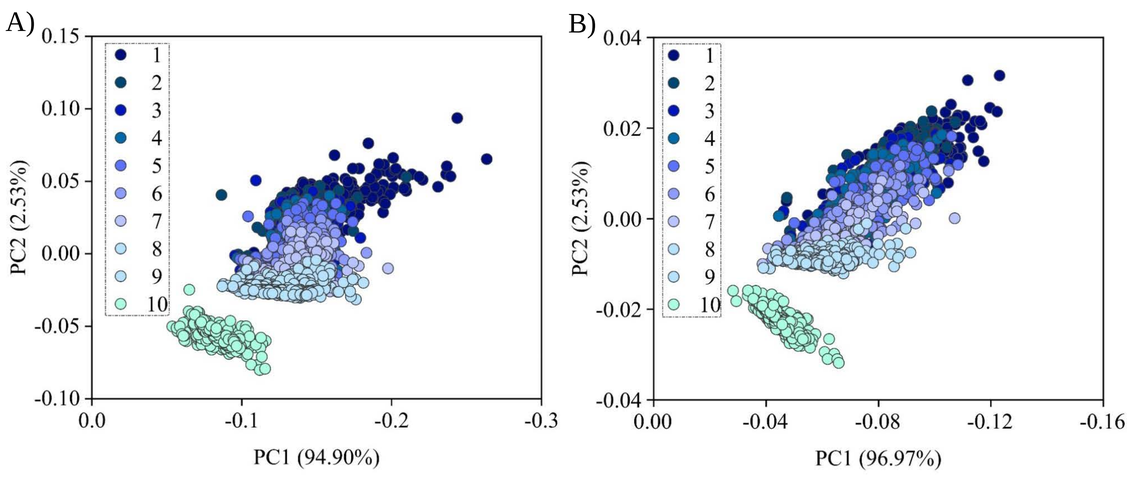

Fig. 3. PCA scores by wood drying stage for the spectra treated with the first derivative from the benchtop NIR (A) and the portable NIR instrument (B).

Conclusion

The PLS-R models showed adequate coefficients of determination (R^2 of 0.77–0.85) to predict the basic density of *Eucalyptus grandis* wood at different moisture levels, and the performances of the models were not affected by moisture content. The radial surface, with the spectra without mathematical treatment, was the most suitable for spectral collection. The instruments showed equivalent application potential.

Table 1. Statistical parameters of the PLS-R models to predict the basic density of *Eucalyptus grandis* wood at different moisture levels.

Instrument	Surface	Treatment	R²cv	RMSEcv	R²p	RMSEp	RPDcv
Benchtop	RD	untreated	0.817	0.038			
	TG		0.794	0.054	0.810	0.053	2.20
	RD	1°D	0.833	0.036	0.831	0.037	2.45
	TG		0.857	0.045			
	RD	2°D	0.798	0.040			
	TG		0.831	0.049			
	RD	SNV	0.797	0.040			
	TG		0.796	0.054			
Portable	RD	untreated	0.815	0.038	0.813	0.038	2.33
	TG		0.771	0.057			
	RD	1°D	0.780	0.041			
	TG		0.827	0.049	0.833	0.048	2.44
	RD	2°D	0.777	0.042			
	TG		0.815	0.051			
	RD	SNV	0.788	0.041			
	TG		0.815	0.050			

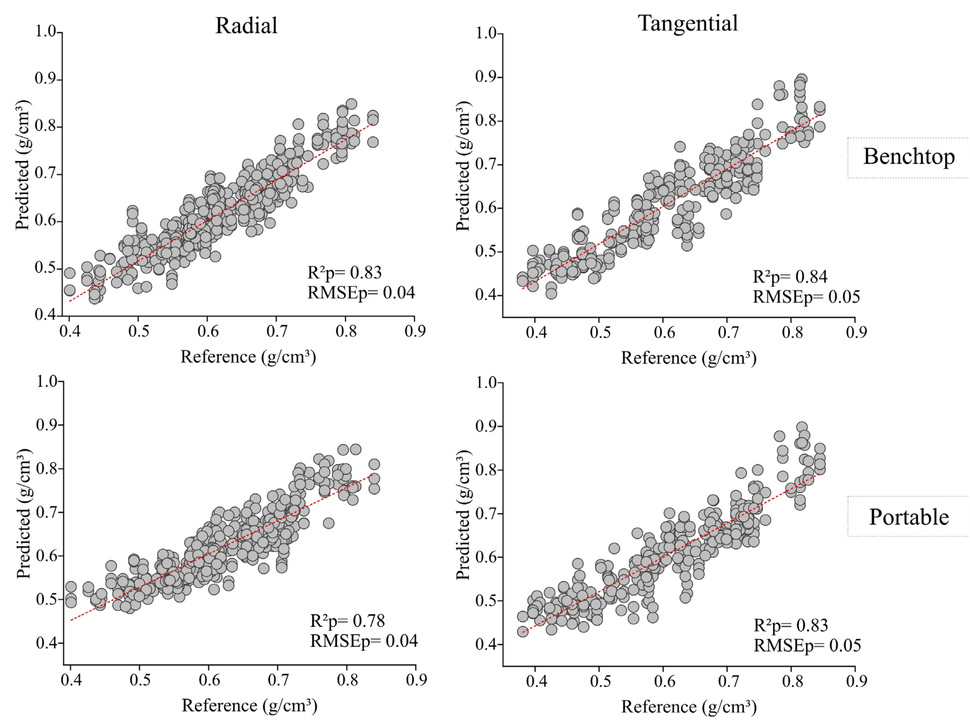

Fig. 4. Plot of the PLS-R validations treated with first derivative to predict the basic density at different moisture contents by type of instrument and wood surface.

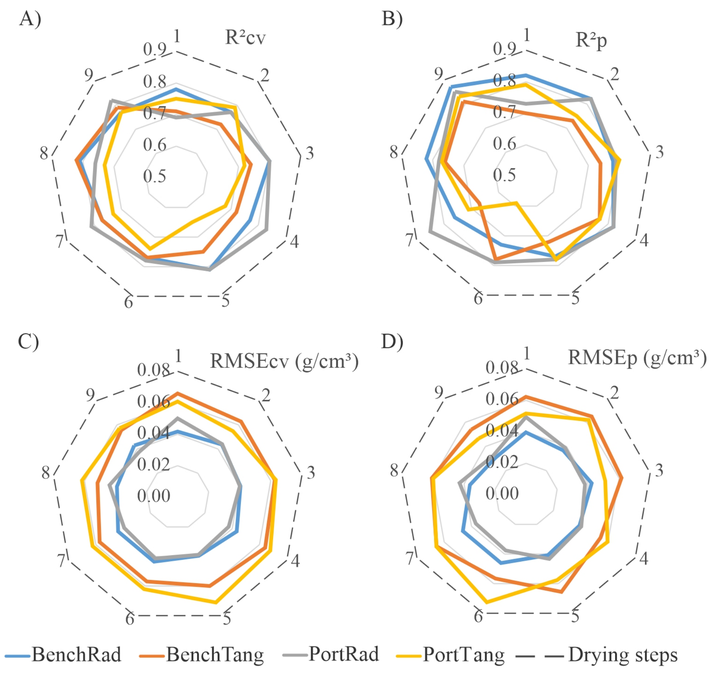

Fig. 5. Graphs of the prediction of the basic density per drying stage (stage 1 - wetter to stage 9 - drier) in different surfaces and instruments in the cross-validation (A) and in the independent validation (B) and their respective errors (C and D).

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