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Résumés des communications

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HelioSPIR est l'association francophone dédiée à la spectrométrie dans le proche infrarouge.

HelioSPIR a vocation à fédérer les scientifiques et les utilisateurs de la technologie SPIR au sein d'un réseau et à promouvoir l'utilisation de la spectroscopie proche infrarouge. Fondée en 2004 autour de la communauté scientifique d'Agropolis à Montpellier, l'association dépasse maintenant les contours de la région Occitanie et de l'hexagone. C'est un pôle de compétences à dimension internationale dans le domaine de la spectroscopie proche infrarouge.

HélioSPIR organise chaque année une ou deux sessions de rencontres scientifiques. C'est un moment privilégié d'échanges autour de diverses thématiques autour de la spectroscopie proche infrarouge et de découverte des derniers travaux de la communauté. C'est également l'occasion de découvrir ou redécouvrir les équipements de spectroscopie et d'imagerie hyperspectrales des principaux fabricants du secteur.

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Posters

Effect of the sensors on calibrations for wood density in benchtop and portable NIR equipment

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1. CONTEXT

Forestry industries seek practical, fast and effective technologies to optimize production processes, since conventional methods for determining wood properties are time-consuming and expensive. For this reason, the use of technologies for wood selection and monitoring is an alternative to increase the quality control of raw materials and products. Near infrared spectroscopy (NIR) has been used in the forestry sector because it is non-destructive, reliable and provides real-time responses. In general, wood density correlates with NIR spectra and promising models have been developed. However, it is necessary to analyze the predictive capacity of models generated from benchtop and portable equipment. In this context, the objective of the study was to evaluate the effect of NIR sensors on models' predictive capacity for basic density from portable and stationary equipment.

2. MATERIAL AND METHODS

2.1 Sampling: artisanal chips with a nominal dimension of 30 x 30 x 20 mm (length, width and thickness) in the radial direction of the wood were produced using a chisel. Density was determined by the relationship between mass and volume of each chip (determined by immersion).

2.2 Spectral acquisition: The spectra were collected directly on the chip surface using benchtop and portable NIR instruments:

***Benchtop NIR*:** The benchtop instrument was a Fourier transform (FT) NIR spectrometer (MPA, Bruker Optik GmbH, Ettlingen, Germany) with its software OPUS v. 7.0. The spectra were recorded by diffuse reflection from the integration sphere. The spectral range used for the calculations was 1112–2500 nm (9000–4000 cm^{-1}) with a resolution of 8 cm^{-1}, resulting in 1300 spectral variables. Sixteen (16) scans were performed on each wood chip, and then the averages were calculated and compared with the standard to obtain the absorption spectrum of the specimen. Background compensation was performed every 10 min of spectral acquisition and the light leaking from the MPA window was protected.

***Portable NIR*:** The portable instrument was an On-site MicroNIR (Viavi Solutions Inc., CA, United States); it was directly set in reflectance mode on the surface of the wood chip. The acquisition range was from 950 to 1650 nm (10526–6060 cm^{-1}) with a resolution of 5.6 nm, with the generation of 125 spectral variables. Each spectrum had an average of 16 scans. Using the point-and-shoot technique, a dark scan and a reference scan were performed approximately every 10 min, and the data was collected using the software SpectralSoft Solutions (Viavi Solutions Inc., CA, USA).

2.3 Data analysis: The spectral information was analyzed by multivariate statistics in its original form. The Unscrambler v.9.7 software was used to perform Partial Least Squares Regression (PLS-R) analysis. Wood density prediction models were developed by leave-one-out (LOO) cross-validation and independent validation (Test set) with 8 latent variables. For the Test set the selection of the number of validation spectra was carried out using the Random method. The standard deviation to performance ratio (RPD) was obtained by the relationship between the standard deviation of values determined in the laboratory and the standard error of independent validation.

3. RESULTS AND DISCUSSION

The statistics of the models developed to predict the basic density of wood showed satisfactory coefficients of determination for the two NIR sensors (Table 1). In cross-validation, the portable equipment obtained a higher value than the bench-top one, however, in the independent validation the result was opposite, but for both sensors there was a reduction in the prediction values. According to Pasquini (2003), independent validation is more suitable for generating models with more realistic results.

Table 1. Statistics of PLS-R models for predicting density in wood chips (kg/m^3) from benchtop and portable NIR equipment.

Sensor	R^2c	RMSEc	R^2cv	RMSEcv	R^2p	RMSEp	RPD
Benchtop	0.783	41.1	0.754	44.2	0.731	37.5	2.36
Portable	0.776	42.5	0.761	44.2	0.698	53.5	1.65

The standard deviation performance ratio (RPD) was higher for the benchtop device, with a value of 2.36. However, the portable equipment met the requirements indicated in the literature, obtaining more than 1.5, according to Schimleck et al. (2003). In the study by Costa et al. (2018), models for predicting wood density on the radial surface were also evaluated and found $R^2cv = 0.78$ and $R^2p = 0.76$ with a bench sensor, results close to those of the present study.

The results demonstrated that the influence of the type of sensor was incipient on the performance of the models, but the benchtop equipment was the most recommended, however the practicality of the portable equipment associated with the robustness of the results makes its use relevant.

4. FINAL CONSIDERATIONS

The performance of the two NIR sensors was satisfactory for predicting wood density. The difference in the statistical parameters of the models depending on the type of equipment was low, although the most robust model was developed with banking equipment. New studies using portable equipment are recommended for new applications in the forestry sector.

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