Rapid prediction of teak wood natural durability using near-infrared spectroscopy

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Teak wood is known to be highly durable for wood from natural forest and less durable for wood from short rotation plantations. Near-infrared spectroscopy (NIRS) is useful for estimating chemical and physico-mechanical properties such as decay resistance.

In this study, the natural durability of commercially-grown teak wood was determined and correlated with NIRS data for rapid prediction of teak durability and to address conditions for future applications.

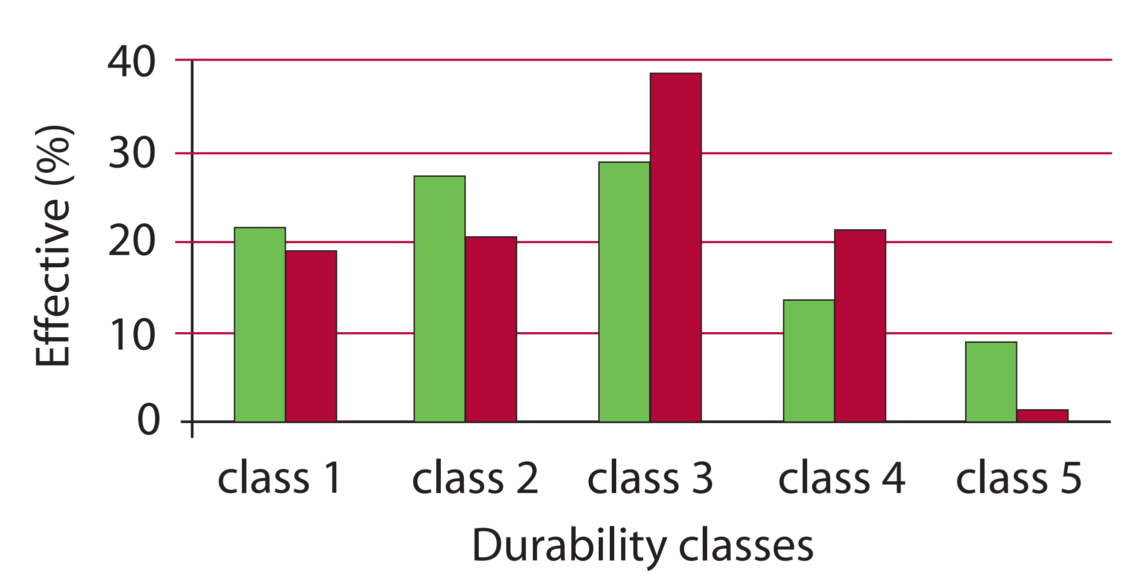
Materials and methods

Teak wood samples (116) came from Togo, Ghana and Malaysia reflecting a range of growth, ecology and age. Natural durability tests were performed using *Antrodia* sp. and *Coriolus versicolor* during 16 weeks according to European standard EN 350-1. The durability classes were based on "x-value" obtained by sample weight-loss after fungal attack. Near-infrared (NIR) spectra were recorded on a Bruker FT-IR spectrometer to measure diffuse reflected light from 12,500 to 4,100 cm^{-1}. Spectra taken from every cross-section were used in the calibration modelling. After preprocessing spectra, calibrations were developed using partial least squares (PLS) regression (with Unscrambler 9.6 software) based on NIR spectra and x-value. Calibrations were tested by cross-validation and predicted x-values were compared to measured ones.

Results

The natural durability classes deduced from x-values measured and predicted are indicated in Figure 1. Figure 2 summarizes the calibration model which refers to *Antrodia* results and to longitudinal section spectra. The predicted classes show on the average 68% of good classification compared to measured classes (Table 1). Only neighbour errors are identified and no mismatch among samples from high and low classes was observed.

Figure 1. Durability class distributions (green bars: class on measured x-value, red bars: class on predicted x-value).



		Predicted classes 1	2	3	4	5	Total	Bad prediction Nb	%	Good prediction Nb	%
Measured classes	1	20	5	1	0	0	26	6	23	20	77
	2	1	18	12	0	0	31	13	42	18	58
	3	0	3	27	5	0	35	8	23	27	77
	4	0	0	3	13	0	16	3	19	13	81
	5	0	0	0	7	1	8	7	88	1	13
Total		21	26	43	25	1	116	37	32	79	68

Table 1. Contingency table for durability classes: measured vs predicted (yellow box: good prediction; white box: bad prediction but neighbour error; red box: very bad prediction).

Elements	116
R^2	0.76
RMSEP	0.14
Rank	4

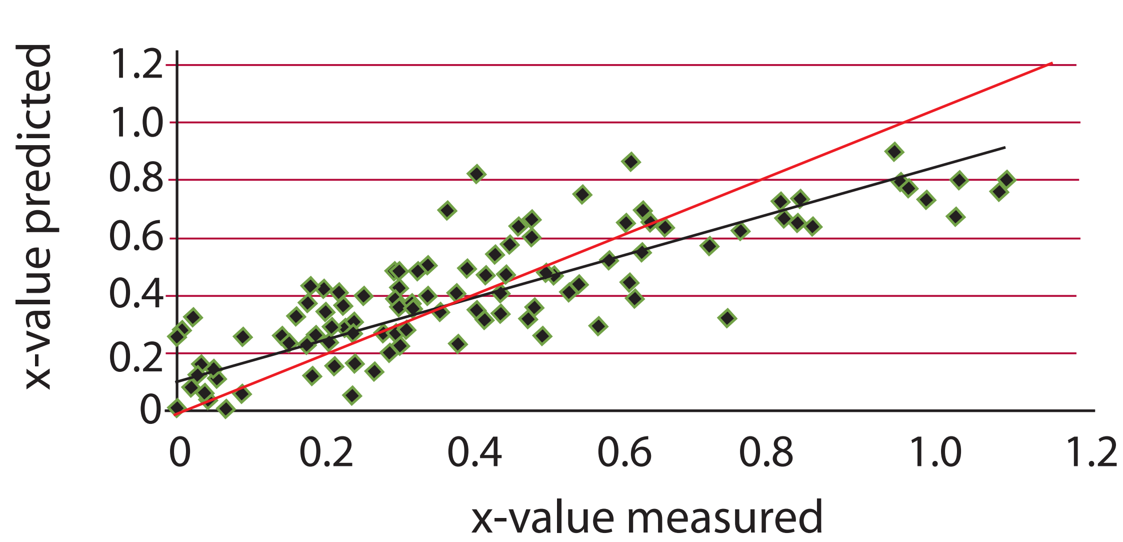


Figure 2. Comparison x-value measured vs x-value predicted obtained after cross-validation (red line: target, black line: regression).

Conclusion

PLS regression calibration models based on NIR absorbance and reference data for standardised wood decay tests were applied with success to rapidly predict the natural durability of teak wood from different ecological zones and of different ages from three countries.

Associated with core sampling, this approach will allow us to predict natural durability of a large number of wood samples as breeding programs require.

Further work is needed to perform prediction models based on a larger sampling to improve the prediction and to extend sampling variability to wood from short rotation plantations in particular.

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