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SOFT INDEPENDENT MODELLING OF CLASS ANALOGY FOR NEAR-INFRARED SPECTROSCOPIC CLASSIFYING SOME KOREAN DOMESTIC CONIFERS

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ABSTRACT

In this study, five species of Korean domestic conifers, which are larch (*Larix kaempferi*), cedar (*Cryptomeria japonica*), Korean pine (*Pinus koraiensis*), red pine (*Pinus densiflora*) and cypress (*Chamaecyparis obtusa*) were classified using near-infrared spectroscopy. 50 lumbers for each species were collected from several of the National Forestry Cooperative Federation. Near-infrared absorbance spectra (wavelength range = 680 ~ 2500nm) were acquired on the wide face (radial or tangential face) of each sample located sound parts of heartwood when the lumbers were air-dried (25°C and 65 ± 10% relative humidity). After the acquired near-infrared spectra were mathematically preprocessed (standard normal variate and Savitzky-Golay 2nd derivative), then soft independent modelling class analogy including principal component analysis was performed to classify the species of lumber.

KEYWORDS: Near-infrared spectroscopy, Lumber, Soft independent modelling of class analogy, Wood species classification

1. INTRODUCTION

Since wood has various properties for each species, the species is an important factor in determining the price of wood. However, it is limited to identify the species of lumber, which is sawn wood, exactly. As methods for identifying wood species, anatomical analysis using microscopes and DNA analysis are widely used. However, Both methods require a cutting of the specimen for test preparation, take a lot of time and expenses. Near-infrared (NIR) is electromagnetic wave ranging from the 780 and 2500 nm. The low energy level of NIR allows rapid and non-destructive analysis of the sample. NIR spectroscopy has recently been actively studied in the field of wood science and is known to accurately and readily predict the physical, mechanical and chemical properties of wood. Several studies have reported that NIR spectroscopy is useful technique to classify wood species by principal component analysis (PCA) and soft independent modelling of class analogy (SIMCA). In this study, five Korean domestic coniferous species which are larch (*Larix kaempferi*), cedar (*Cryptomeria japonica*), Korean pine (*Pinus koraiensis*), red pine (*Pinus densiflora*) and cypress (*Chamaecyparis obtusa*) were classified by application of NIR spectroscopy, PCA and SIMCA.

2. MATERIAL AND METHODS

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Fifty lumbers of each species [larch (*Larix kaempferi*), Korean pine (*Pinus koraiensis*), red pine (*Pinus densiflora*), cedar (*Cryptomeria japonica*), and cypress (*Chamaecyparis obtusa*)] were purchased from several of the National Forestry Cooperative Federation. The lumbers had dimensions of 50 × 100 × 1200 mm (thickness × width × length). As the lumbers were air-dried in a constant temperature and humidity room maintained at 25°C and 65 ± 10% relative humidity, NIR absorbance spectra (wavelength range = 680 ~ 2500nm) were acquired at sound parts on the widest face (radial or tangential face) of the lumbers. A total 250 NIR spectra were collected from each species. All NIR absorbance spectra were acquired using a SpectraStar 2500XL (Unity Scientific, US) from 680 ~ 2500 nm at intervals of 1 nm. The 12 scans were averaged per every spectra acquisition. The mathematical preprocessings applied to NIR spectra were combination of standard normal variate (SNV) and Savitzky-Golay 2nd derivative. The spectra transformation, PCA and SIMCA were performed using The Unscrambler 10.3 (Camo, US). There were 250 spectra for each wood species: 200 were used for the calibration model and 50 were used for validation.

3. RESULTS AND DISCUSSION

SIMCA is a supervised classification technique that builds a distinct confidence region around each class after applying PCA. New measurements are projected in each principle components space that describes a certain class to evaluate whether they belong to it or not according to the residuals [1]. Table 1 showed classification result of the validation samples. In the validation results, at least 62% of the samples were classified to itself by SIMCA. Especially, larch and cypress showed high correct prediction (more than 80%) results (they had only 10% of misclassification). Otherwise, red pine and cedar had relatively high misclassifications that one validation sample were belonged to more than one class: 30% of red pine validation samples were classified as both red pine and Korean pine, and 54% of cedar validation samples were classified as both cedar and cypress. However, Korean pine and cypress had less misclassification than red pine and cedar.

Table 1 Classification results of the validation samples by SIMCA

	Species				
Class / Validation set	Larch	Red pine	Korean pine	Cedar	Cypress
Larch	80%	0%	0%	0%	10%
Red pine	0%	64%	30%	0%	6%
Korean pine	0%	2%	62%	0%	16%
Cedar	0%	0%	0%	84%	54%
Cypress	0%	0%	0%	10%	84%

4. CONCLUSIONS

Near-infrared spectroscopy classification by PCA and SIMCA had potential to classify five coniferous species in Korea. Larch and cypress were classified more precisely than red pine, Korean pine and cedar.

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