Rapid Nondestructive Grading of Agarwood Oil Using Near-Infrared Spectroscopy

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Agarwood oil is produced by using resinous wood that forms in Thymelaeaceae family trees due to its self-defense mechanism at stress. Though the oil is extremely rare and high valued, there is no quick quality detection methodologies have been developed to support the trade. This study presents rapid and noninvasive technique for grading agarwood oil utilizing shortwave Near-Infrared (NIR) spectroscopy by focusing on three distinct grades of agarwood oil (AA, AA+, and AAA). The samples were procured from an agarwood grower and perfume producer in Sri Lanka. Transmittance spectra were obtained at 558-1100 nm range for 4 mm path length by using a customized NIR instrument. Samples were replicated thrice and the reference analysis of the agarwood oil samples was carried out using Gas Chromatography-Mass Spectrometry (GC-MS) to validate the findings. Partial Least Square (PLS) regression was established and optimized using multivariate chemometric software Pirouette 4.5 (Infomatrix.inc Woodinville, WA, USA). GC-MS analysis revealed four common chemical compounds shared among all grades of agarwood oil, namely Pentanoic acid, n-Hexadecanoic acid, (3S,3aS,6R,8aS)-3,8,8-Trimethyl-7-methyleneoctahydro-1H-3a,6-methano azulene, and Longifolene. Based on the NIR spectral data and GC-MS analysis, PLS models were optimized, leading to the identification of the best configurations for each dependent variable. Remarkably, the optimized PLS models successfully predicted the Pentanoic acid content (SEP=0.14751, R^2=0.743547) accuracy. Notably, a specific wavelength at 1012 nm displayed a significant correlation to Pentanoic acid content (R^2 = 0.9716), suggesting its potential application in the development of a single-wavelength, cost-effective device for agarwood oil grading. The study underscores the substantial potential of NIR spectrometry as a practical tool for quality control and grading of agarwood during the oil production process and the trading.

Keywords: Agarwood oil, Grading, Near-infrared spectroscopy, Nondestructive, Gas Chromatography-Mass Spectrometry

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