NIR-hyperspectral imaging and multivariate analysis for cinnamon authentication

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Cinnamon (*Cinnamomum spp.*) is one of the most used spices in the pharmaceutical and food industry due to its medicinal and aromatic properties, where *Cinnamomum verum* (true cinnamon) and *Cinnamomum cassia* (false cinnamon) are among the main different species of the genus *Cinnamomum spp*. Food fraud is a recurrent practice in the industry, in which a food is intentionally modified by substitution, manipulation, addition or falsification. The herbs and spices industry is one of the most vulnerable sectors due to its high economic value. *C. verum* is commonly adulterated with *C. cassia* due to its greater industrial presence for economic purposes. The botanical origin of cinnamon is commonly established through sophisticated analytical techniques such as high-performance liquid chromatography (HPLC), DNA, gas chromatography coupled to a mass spectrometer (GC-MS), nuclear magnetic resonance (NMR), and DART-QToF. -MS in real time. While these methods are efficient and accurate, they are typically time-consuming, reactive, and expensive. This work aimed to develop classification models based on NIR-hyperspectral imaging (NIR-HSI), for authentication of *C. verum* and *C. cassia* sticks (105 samples) from India, Peru and Brazil. The NIR-HSI images were acquired in the spectral range of 953–1710 nm with 5 nm intervals, totaling 159 bands. Initially, principal component analysis (PCA) was applied to reduce dimensionality and explore NIR-HSI data. The scores showed high similarity between the species due to similar concentrations of macronutrients. PC3 allowed better differentiation among classes in relation to PC1 and PC2, with peaks related to phenolic/aromatic compounds, such as coumarin (*C. cassia*) or catechin (*C. verum*). Partial least squares discriminant analysis (PLS-DA) correctly classified more than 90% of the samples according to species, with error = 3.3% and accuracy = 96.7%. A permutation test was applied to validate the reliability of the classification model, indicating that the PLS-DA model presents reliable predictions that are not the result by chance. We demonstrate that the combination of NIR-HSI with chemometric tools provides a reliable, fast and non-invasive analytical system for authenticating cinnamon sticks based on classification of *C. verum* and *C. cassia* species, a promising alternative to conventional destructive methods.