Title Infestation detection in wild blueberries using near infrared spectra and multivariate data analysis

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Citation Thesis, Doctor of Philosophy (Chemical Engineering), The University of Maine. 148 pages. 2008.

Keywords Near-infrared spectoscopy; Infestation; Wild blueberries; Larvae infestation

Abstract

The research presented in this thesis describes the development and validation of a non-invasive automated method for larval detection in wild blueberries by near-infrared spectroscopy (NIRS). Considered are the selection of suitable near-infrared (NIR) components and the factors affecting NIR spectra and partial least squares regression (PLS).

Three NER spectrometers were compared and it was concluded that the Perten DA 7000 and the Ocean Optics SD2000 were better suited for infestation prediction. The Oriel MS-257 instrument performance was inferior likely due to the relatively low signal-to-noise ratio and limited wavelength range.

PLS infestation prediction results ranged from 70 to 94 % which was slightly lower than some of the reported prediction accuracy in wheat and other grains. This was attributed to the high water absorption, season variation and the vast genetic diversity in wild blueberries. Water removal or equilibration in blueberry sample sets, spectral preprocessing and wavelength selection showed little advantage in improving prediction accuracy. It was shown that the method is fairly robust in terms of levels of infestation and larvae size and has detection limits similar to the standard visual USDA test for larvae detection.

PLS regression coefficients analysis and NIR absorbance bands interpretation indicated that infestation prediction is enabled by variations in fruit color, water content and carbohydrate content possibly due to larvae feeding combined with detection of larvae protein, chitin and lipids. Fourier Transform Infrared Spectroscopy analysis identified proteins, esters and fatty acids as chemical compounds unique to larvae.

Other factors such as firmness, sugar content, protein content and their combinations likely affect infestation prediction, however strong correlations of these individual factors to infestation were not established. Thus, the PLS prediction models seem to capitalize on changes in multiple chemical and physical parameters affected by internal larval infestation.

The developed infestation detection method offers multiple advantages as a fast screening method which can be applied to all processed fruit reducing substantially the sampling error--the largest fraction of the total analytical error for biological samples. Such an NIRS system can be easily integrated with the currently used optical color sorters and is applicable to other small fruit crops.