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Scanning precision test for organic and inorganic tomatoes at different maturity levels

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Abstract

Near infrared (NIR) spectroscopy is known as a fast and reliable technique to analyse physical and chemical properties of different analysis. The main objective of this paper is to test for the precision of FT-NIR spectrometer at 3 wavenumbers, were 10309.3, 6711.4 and 5154.6 cm^{-1} and the Micro-NIR spectrometer at 3 wavelength, 970, 1450, 1490 nm by evaluating scanning repeatability and reproducibility of organic and inorganic tomatoes at different maturity levels, respecively. Results show by the repeatability and reproducibility of NIR scanning of these two spectrometers that the FT-NIR spectrometer was more precise than the Micro-NIR one due to less fluctuation of the data and less average value of repeatability and reproducibility. The maturity levels (red, orange and green stages) and types (organic and inorganic) of tomato affected the scanning precision of FT-NIR spectrometer. This experiment indicated that the FT-NIR spectrometer might be able to classify the maturity levels of tomato and difference between organic and inorganic tomatoes.

Keywords: organic tomato, inorganic tomato, scanning precision test.

1. Introduction

Organic vegetables are the product of a farming system which avoids the use of chemical fertilizers, pesticides and growth regulators additives. Irradiation and the use of genetically modified organisms (GMOs) are generally prohibited by organic legislation. Organic vegetables were contained significantly higher concentrations of antioxidants and lower levels of undesirable cadmium (a toxic heavy metal) and pesticide residues. There were protected from against chronic diseases, including cardiovascular and neurodegenerative diseases and certain cancers (Brandt el at, 2011). At present, the popular vegetables in consumption are organic tomatoes. Tomatoes have many benefits and a high amount of antioxidants. In terms of conventional antioxidants, tomatoes provide an excellent amount of vitamin C and beta-carotene; a very good amount of the mineral manganese; and a good amount of vitamin E (Aldrich el at, 2010). Researcher has shown that vitamin-C analysis in food and vegetable is identified in variety methods. Burge et al. (1974) reported that the experiment for measuring the vitamin C or ascorbic acid concentration in tomatoes by a modified dye titration method using 2,6-dichlorophenolindophenol, which compared of tomatoes from mechanical or hand harvesting. Spínola el at (2014) studied the development and validation of high-performance liquid chromatography methods for vitamin C analysis in food commodities which is a form of columnchromatography that pumps a sample mixture or analyses in a solvent at high pressure through a column with chromatographic packing material (stationary phase). Both general titration methods and high-performance liquid chromatography methods are difficult, using a long time of test and using chemicals in analysis that cause high cost and can harm the researcher and environment.

The near infrared (NIR) spectroscopy can provide rapid results in seconds, with accuracy. Before NIR spectroscopy models development, the spectral data were checked for both repeatability and reproducibility. The reproducibility of spectral data is the standard deviation of absorbance values, when the sample was re-loaded and re-scanned 10 separate times (Phil Williams, personal communication). The 10th loading was left in the cell and re-scanned 9 more times, to achieve 10 scans with this sample in the same position within the cell. The standard deviation of these 10 absorbance values was the repeatability of the instrument. The method is environmentally friendly because it requires no chemicals. The NIR spectroscopy is currently one of the approaches best suited for industry

requirements, especially for quality analysis and process control.

The purpose of this study was to analyze the parameters for the scanning precision test for the application of NIR spectroscopy to determine the different between organic and inorganic tomatoes.

2. Materials and Methods

2.1 Samples.

Samples of organic tomatoes were collected from the Pramesuk farm, in the Pathum-tani Province and samples of inorganic tomatoes were chosen from the Salaya-orchid farm, in the Nakron-Prathom Province. They are collected in three maturity levels i.e. green orange and red tomatoes.

2.2 NIR scanning.

FT-NIR spectrometer (MPA, Bruker, Germany) in the wavenumber range of 12500 - 3600 cm^{-1} and Micro – NIR Pro (Viavi, USA) in the wavelength range of 950 – 1650 nm were used for scanning of tomatoes at room temperature of 25±2°C.

2.3 Repeatability and Reproducibility of NIR scanning.

Repeatability of NIR scanning was determined by scanning the same sample in the same location for 10 times, then calculating the standard deviation (SD) of the absorption by selecting 3 wavelengths (10309.3, 6711.4 and 5154.6 cm^{-1} which were the absorption bands of water, cellulose and water, respectively, obtained from FT-NIR spectrometer and 970, 1450, 1490 nm which were the absorption bands of water, water and cellulose, respectively, obtain from Micro – NIR spectrometer from 10 spectra and averaged.

Reproducibility of NIR scanning was determined by scanning the sample for 10 times, but it was reloaded every time, then the SD of the absorption of the 3 selected wavelengths was calculated and average.

3. Results and Discussion

Table 1 shows the repeatability and reproducibility of NIR spectra for organic and inorganic tomatoes at different maturity levels obtained from FT-NIR spectroscopy at 3 wavenumbers, were 10309.3, 6711.4 and 5154.6 cm^{-1}. The repeatability and reproducibility of organic and inorganic tomatoes at 3 wavenumbers, were decreased with the degree of maturity except the fluctuated value at 10309.3 cm^{-1}. This fluctuation was occured because there was only one spectrum in 10 repetitions which was abrupt change at this wave number. There were the different in the precision value between the organic and inorganic tomatoes.

Table 1 Standard deviation of repeatability and reproducibility of NIR spectra for organic and inorganic tomato at different maturity obtained from FT-NIR spectrometer.

Wavenumber	Tomato samples	Scanned time	Repeatability		Reproducibility	
			Organic	Inorganic	Organic	Inorganic
At 10309.3 cm^{-1}	Green	10 time	0.00312	0.00262	0.02937	0.04881
	Orange	10 time	0.00254	**0.08026**	0.04120	0.03971
	Red	10 time	0.00244	0.00148	0.04034	0.02762
At 6711.4 cm^{-1}	Green	10 time	0.00365	0.00487	0.03852	0.08185
	Orange	10 time	0.00312	0.00579	0.05761	0.04539
	Red	10 time	0.00252	0.00298	0.04034	0.03632
At 5154.6 cm^{-1}	Green	10 time	0.00406	0.00482	0.04116	0.09732
	Orange	10 time	0.00360	0.00673	0.07106	0.05316
	Red	10 time	0.00271	0.00469	0.05250	0.04264
Average	Green	10 time	0.00361	0.00410	0.02726	0.07599
	Orange	10 time	0.00309	**0.03093**	0.05663	0.04609
	Red	10 time	0.00256	0.00305	0.04650	0.03552

Table 2 Standard deviation of repeatability and reproducibility of NIR spectra for organic and inorganic tomatoes at different maturity from Micro – NIR spectrometer.

Wavelength	Tomato samples	Scanned time	Repeatability		Reproducibility	
			Organic	Inorganic	Organic	Inorganic
At 970 nm	Green	10 time	0.00316	0.01009	0.08449	0.07437
	Orange	10 time	0.00227	0.02196	0.08157	0.03666
	Red	10 time	0.02490	0.00699	0.05800	0.08620
At 1450 nm	Green	10 time	0.00071	0.00204	0.03079	0.02262
	Orange	10 time	0.00080	0.00824	0.02524	0.01563
	Red	10 time	0.00502	0.00217	0.02382	0.03311
At 1490 nm	Green	10 time	0.00069	0.00166	0.03241	0.02434
	Orange	10 time	0.00082	0.00876	0.02646	0.01631
	Red	10 time	0.00546	0.00224	0.02476	0.03417
Average	Green	10 time	0.00152	0.00459	0.04923	0.04044
	Orange	10 time	0.00130	0.01299	0.04442	0.02287
	Red	10 time	0.01179	0.00380	0.03553	0.05116

Table 2 shows the repeatability and reproducibility of NIR spectra for organic and inorganic tomatoes obtained from Micro–NIR spectrometer at 3 wavelength, 970, 1450, 1490 nm. The repeatability of organic tomato and reproducibility of inorganic tomatoes at 3 wavelength, were decreased with the maturity levels. The repeatability of inorganic tomatoes and reproducibility of organic tomatoes were fluctuated at every wavelength.

When the scanning precision of these two spectrometers were compared, it is clearly seen that the FT-NIR spectrometer was more precise than the Micro-NIR one due to less fluctuation of the data and less average value of the repeatability and reproducibility.

4. Conclusions

It can be concluded that the maturity levels and types of tomato affected the scanning precision of FT-NIR spectrometer , the Micro-NIR spectrometer was less precise. The FT-NIR spectrometer might be able to classify the maturity levels of tomato and difference between organic and inorganic tomatoes. Anyway the more robust model should be developed using more samples and more variation of samples.

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