PD Research Report for the 2016 year

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Research Theme Investigation of lycopene aggregation structure in tomato using UV-VIS and Raman spectroscopy

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Research Results

Summary: This study aimed to investigate the lycopene aggregation/crystallization structure in tomato using Raman and UV-VIS spectroscopy.

Introduction: The ripening stage of tomato can be observed as the differentiation of the chloroplast to chromoplast which is originated from the biosynthesis of lycopene. Lycopene plays important roles in tomato as the precursor for β-carotene and is accumulated during the tomato ripening stage. In tomato chromoplast, lycopene crystals can be found as its concentration increase during the maturation. However, the natural form of true of lycopene structure packed in the tomato is still mysterious.

Methods: Tomato sections were placed on a motorized stage for acquiring Raman imaging spectra. The in Via confocal Raman microscope (Renishaw Inc., UK) system was equipped with a Nikon objective lens (50x), a laser diode, and a CCD. The laser spot was refocused at each point to compensate the surface roughness prior to the measurement. The spectra were measured using 532 nm excitation wavelength with 10 mW at sampling point. The Raman spectra were acquired in 1 second.

Lycopene aggregates were prepared using acetone/water solution. H-aggregate of lycopene was synthesized by adding water to the lycopene solution while rigorously sonicated. The aggregates were then filled in the quartz cuvette for Raman and UV-VIS measurement. Data analysis: Raman spectra were pretreated with baseline correction for comparison with the lycopene aggregates. Principal component analysis was employed to analyze the variation of the whole data set.

Results and Discussion: Chemical imaging spectroscopy is a technique where molecular and spatial information about a sample can be obtained simultaneously. Raman images of tomato provide the information of lycopene in the nondestructive manner. By using principal component analysis, the characteristic variation of lycopene in the tomato can be simplified. The $\nu 1$, $\nu 2$ and $\nu 3$ located at 1516, 1157 and 1005 cm^{-1} are the

major component in the tomato, Figure 2, PC1. The peak shift in *v*1 band shows the different structure of lycopene in different location mainly in the peel. The *v*1 band shift to the lower frequency can be observed. We found that the 1607 cm^{-1} peak was found mainly at the peel of tomato shown in Figure 2. PC4. This peak possibly due to the wax in the cuticle matrix of tomato. The structure of lycopene from the tomato Raman images depict the localization of different lycopene structure. The Raman spectra observed between peel and pulp of tomato at 1520 cm^{-1} peak suggests different aggregation structure. The absorbance spectra of tomato show significant red shift from the lycopene monomer. Contrary to the red shift UV-VIS spectra, *v*1 band of tomato was found to be shifted to higher frequency. We found that H-aggregation of lycopene is the only form which can be synthesized. This suggest the special characteristic of lycopene in tomato.