Prediction of Brix and lycopene content in tomato fruit by portable Vis-NIR and NIR spectrophotometer

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Introduction

The quality of tomato are mainly determined by Brix and lycopene content. Particularly, lycopene has received much attention, because of its antioxidant properties.

Using NIR spectrophotometer, Kusumiya et al. reported to measure lycopene content of various maturities of tomato fruits with high accuracy [standard error of prediction (SEP) = 8.35 mg/100g, R² = 0.80]. Clement et al. found that Vis-NIR spectrophotometer can be used to measure lycopene content of various maturities of tomato fruits with good accuracy [standard error of cross validation (SECV) = 0.32 mg/100g, R²cv = 0.98].

In this work, we tried to develop calibration models to predict Brix and lycopene content in only mature tomato fruit by using portable Vis-NIR and NIR spectrophotometer.

Materials and Methods

Sample

Fifty tomato fruits (cv. Momotaro) were obtained from supermarket. All tomato was matured.

Spectral Measurements

Spectral data measurements were performed using two types of portable spectrophotometers (Vis-NIR and NIR).

- Vis-NIR spectrophotometer K-BA100R (KUBOTA, wavelength range 500-1010nm)
- NIR spectrophotometer MicroNIR1700 (JDSU, wavelength range 908-1676nm)

Reference Analysis

Extracted the juice from tomato fruits, Brix was measured using Brix meter IPR201 (ATAGO). Lycopene content measurements were commissioned in Japan Food Research Laboratories, and measurements were carried out by high performance liquid chromatography (HPLC).

Data Analysis

Data analysis was performed with MATLAB (MathWorks). First spectral pretreatments of standard normal variate (SNV) and Savitzky-Golay derivations were applied. Then the calibration equation was developed using partial least squares regression (PLSR). Calibration model was evaluated by leave-one-out cross validation (CV), and best model was chosen based on standard error of cross validation (SECV).

Result

Table 1. Lycopene content and Brix of intact tomato fruits.

<table>
<thead>
<tr>
<th>Number of Samples</th>
<th>Lycopene (mg/100g)</th>
<th>Brix (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>Max</td>
<td>Mean</td>
</tr>
<tr>
<td>50</td>
<td>4.12</td>
<td>8.32</td>
</tr>
<tr>
<td>50</td>
<td>3.73</td>
<td>6.70</td>
</tr>
</tbody>
</table>

Table 2. Calibration and Cross Validation results.

<table>
<thead>
<tr>
<th>Lycopene (mg/100g)</th>
<th>Vis-NIR</th>
<th>NIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength range (nm)</td>
<td>Pretreat Factors</td>
<td>R²cv</td>
</tr>
<tr>
<td>600-1010</td>
<td>1st</td>
<td>0.96</td>
</tr>
<tr>
<td>908-1490</td>
<td>/</td>
<td>0.73</td>
</tr>
<tr>
<td>600-970</td>
<td>SNV,2nd</td>
<td>0.96</td>
</tr>
<tr>
<td>914-1385</td>
<td>SNV,2nd</td>
<td>0.93</td>
</tr>
</tbody>
</table>

Figure 1, Structure of lycopene

Figure 2, Original spectra of intact mature tomato fruits (a) Vis-NIR (b) NIR.

Figure 3, Measured vs Predicted values for (A) lycopene, (B) Brix based on Vis-NIR spectrophotometer, (C) lycopene, (D) Brix based on NIR spectrophotometer.

The reference data of Brix and lycopene content of intact mature tomato fruits are shown in Table1. The range of reference data was smaller than other research, because we used only mature tomato fruits.

The calibration results for predicting lycopene content and Brix of intact mature tomato fruits are shown in Table 2. The best prediction quality was achieved using a model based on Vis-NIR spectrophotometer (lycopene: R²cv = 0.79, SECV = 0.38 mg/100g, Brix: R²cv = 0.90, SECV = 0.17 %). On the other hand, the model based on NIR spectrophotometer gives lower reliability (lycopene: R²cv = 0.62, SECV = 0.58 mg/100g, Brix: R²cv = 0.69, SECV = 0.31 %).

Conclusion

Vis-NIR and NIR spectrophotometer has potential to predict lycopene content and Brix of intact mature tomato fruits. We could obtain good result, by using the visible spectrum as well as the near infrared spectrum. This study showed the possibility of portable NIR spectrophotometer to evaluate mature tomato quality.

Reference