Non-Destructive Brix Sensing of Florida Grapefruit & Honey Tangerine

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Objectives

• Establish accuracy of NIR measurements for measuring Brix levels of whole citrus fruit by both handheld instrumentation and commercial on-line equipment

Other Technologies

• Sonic/ ultrasonic transmission
• Fluorescence
• Dielectric
• Density
• Nuclear magnetic resonance
• X-ray/gamma-ray
• Other (laser induced breakdown spectroscopy)

Scientific Qualifiers

• NIR phenomena is not new. Technology is well established.
• In some instance, measurements may actually be (1 – major constituent)
• Response (absorption, body reflectance, transmission) is an integrated measurement over sampled media

H2O Absorption

700 to 2500 nm

Figure 0.1 Absorption bands of liquid water (Cauld and Petty, 1978)
Test equipment

- Mitsui Q-Scope, on-line, ~ 5.5 objects/s, NIR transmittance, halogen light source
- ATB-Hand-held NIR unit, body reflectance, 400-1100 nm scan analyzed by PLS, 2 light sources tested: halogen and white LEDs
- Mark II Abbe Refractometer, temperature-compensated, 0-85 deg-Brix, +/-0.1% rms accuracy

Hand-held units
ATB- Potsdam

On-line Unit
Mitsui
at Harbor Island Citrus

Schematics-NIR Systems

Indian River red grapefruit, on-line, size 40, 25-30 deg-C

Interior white grapefruit, on-line@ 5 deg-C
Degradation with multiple classification

Correct classification of grapefruit comparing on-line NIR and laboratory Brix measurements

<table>
<thead>
<tr>
<th>Test Set</th>
<th>Breakpoint</th>
<th>Correctly Classified</th>
<th>Accepted (true state=reject)</th>
<th>Rejected (true state=acceptable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior white g'fruit, 5 deg-C</td>
<td>9 deg-brix</td>
<td>52.1 %</td>
<td>47.2 %</td>
<td>26.7 %</td>
</tr>
<tr>
<td>Interior white g'fruit, 5 deg-C</td>
<td>0</td>
<td>78.4</td>
<td>21.6</td>
<td>14.3</td>
</tr>
<tr>
<td>Indian River red g'fruit, size 40</td>
<td>10</td>
<td>88.4</td>
<td>11.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Indian River red g'fruit, size 32</td>
<td>10</td>
<td>77.4</td>
<td>92.1</td>
<td>12.9</td>
</tr>
<tr>
<td>Indian River, size 32 &amp; 40 combined, NN analysis</td>
<td>10</td>
<td>88.3</td>
<td>11.7</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Correct classification of Honey tangerine: hand-held NIR, H-halogen, L-LEDs

Error Levels- Grapefruit & Tangerines (avg. absolute and rms)

Grapefruit Brix Levels 2001-2002

Multiple Reading Differences -absolute
Conclusions

- On-line (OL) and hand-held (HH) NIR measurements significantly correlated with laboratory Brix measurements for individual grapefruit. Poorest results were for Interior fruit tested at 5 deg-C while highest correlations were for smaller size 40 Indian River grapefruit tested at ambient conditions.
- For commercial fruit samples, correct classification, based on single breakpoint, were as follows:
  - 62-79 %, Interior grapefruit @ 9 deg-Brix (HH)
  - 77-84 %, Indian River grapefruit @ 10 deg-Brix (HH)
  - 84-100 %, Honey tangerine @ 14 deg-Brix (HH)
  - 64-78 %, Indian River grapefruit @ 10 deg-Brix (OL)
  - 76-84 %, Indian River grapefruit @ 11 deg-Brix (OL)
- For handheld NIR testing of Honey tangerine, results with halogen and LED light sources were similar.
- Accuracy is not at level to detect Brix level changes in fruit during 1-month storage on Indian River grapefruit.

The End