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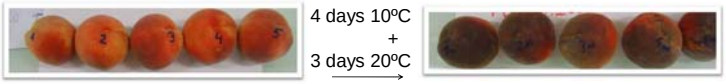
Objectives

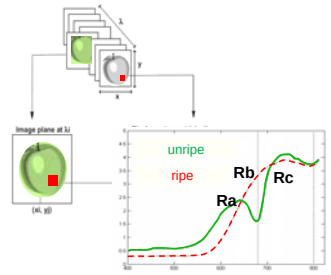
- To develop a new and improved procedure for classification of peaches based on computer vision for handling equipment, through
  - Optical characterization of peaches by spectrometry
  - Developing multispectral and hyper-spectral vision systems
  - To compare and validate the discrimination power of the different systems

Materials

'Red soft-flesh peaches at harvest and postharvest were measured during three seasons n =910 (**Minolta reflectance spectrometer, Duncan-Tech 3-CCD narrow band multispectral camera, HYSPEX VNIR (400-1000 nm,)**



Methods



Ripening is closely related to the Chlorophyll absorption peak 680 nm

1. Optical measurements were locally taken centered on the equator of both sides to chracaterize fruits in a first phase

2. Multispectral images R_{680}/R_{800} of whole fruits

✓ Non supervised classification procedure based on histograms was performed.

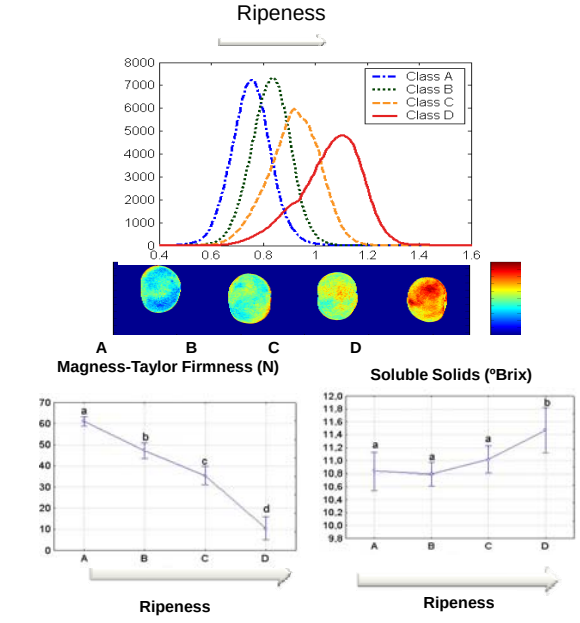
✓ The classifications were compared with reference measurements such as Magness-Taylor firmness.

3. **Hyperspectral images** use the whole spectrum in each pixel (1-2 mm² per pixel) of the **whole fruit**

✓ Different algorithms combining three or more wavelengths around the chlorophyll region were used for discriminating ripeness levels. Raw spectra and images were pre-treated and/or combined in various indexes, with the aim to be compared regarding their discrimination power between ripeness stages.

✓All indexes were compared with well-known indexes such I_{AD} (index of absorbance difference). The effect of convexity in the computed images was also eliminated.

Multispectral images-based classification



✓**Multispectral imaging** is able to **classify** peach in ripeness classes according to handling **Magness-Taylor firmness (N) (MTF) thresholds**:

- ✓95% **Class D** include fruits with MTF<35N = high susceptibility to damages (80% MTF<18N, ready to eat).
- ✓85% **Class A** include fruits with MTF>53N. Needs ripening at selling point
- ✓**Classes B and C** show intermediate firmness and are appropriate for commercial handling

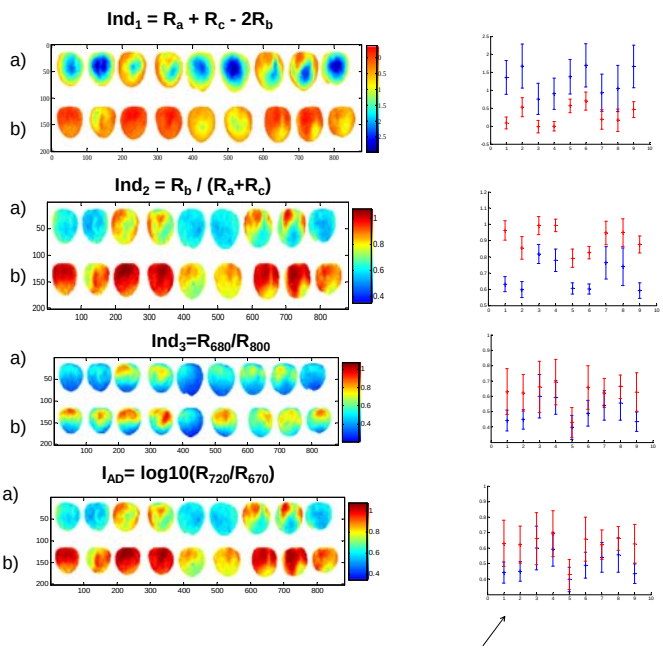
✓**Monitoring** from harvest to selling point:

- ✓Only 22% of fruits of class A at harvest evolved to classes C/D at the end of the ripening process.
- ✓91% of samples from class B at harvest evolved till class C or D.
- ✓83% of samples from class C evolved till class D, identified with very ripe fruits.

Hyperspectral images

Reflectance images for each pair of fruits a) before b) after ripening

Ranges: mean ± STD within fruit before and after ripening



✓Vertical blue and red lines (ranges) show parallel evolution.

✓Fruit specific effect: Original maturity determines final ripeness of every single fruit.

✓Differentiated ripening regions within fruits are observed. Some ripened regions, on the top, near the shoulders, are allocated in the same areas before and after ripening.

✓**Ind_2 presents the best performance in discriminating ripening**.

✓Indexes that combine R800 or R720 together with R680 (as Ind_3 or I_{AD}) show lower discriminating power than Ind_2 that only uses the (amplified) area of the chlorophyll band.

Conclusions

✓ Multi and hyperspectral imaging as well as equatorial optical spectral measurements, showed to be a promising tool to assess ripeness for red skin, melting flesh, early peach varieties.

✓This work proposes and validates a classification procedure for the assessment of peach ripeness into four categories based on multispectral imaging. Image based classes were related to MT firmness as the main current handling reference.

✓Hyperspectral image system is employed for searching the best combination of wavelengths regarding ripening sensing. Ind_2 shows the highest discrimination power for all the fruits because Ind_2 is a normalized index and it is focused on the shape at the chlorophyll absorption peak, at 680 nm. It can be implemented in a common spectral video camera, already installed in fruit handling lines.

✓Multispectral image classification can be used as a potential rejection criterion for problem fruits, as too soft or too unripe, showing high potential for supporting handling decision in fresh peach industries.

Acknowledgements

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