Image analysis and classification applied to red soft-flesh peach (‘Richlady’) ripeness assessment


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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, HISPEX VNIR (480-1000 nm))

Methods
1. Optical measurements were locally taken centered on the equator of both sides to characterize fruits in a first phase
2. Multispectral images R480/R650 of whole fruits
   ✓ Non supervised classification procedure based on histograms was performed.
   ✓ The classifications were compared with reference measurements such as Magnness-Taylor firmness.
3. Hyperspectral images use the whole spectrum in each pixel (1-2 nm² 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 I660 (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 Magnness-Taylor firmness (N) (MTF) thresholds:
✓ 95% Class D include fruits with MTF<35N = high susceptibility to damages (80% MTF<15N, ready to eat).
✓ 85% Class A include fruits with MTF>35N. 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

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. Ind5 shows the highest discrimination power for all the fruits because Ind5 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.

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