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FRUITGRADING: Development of a fruit sorting technology based on internal quality parameters

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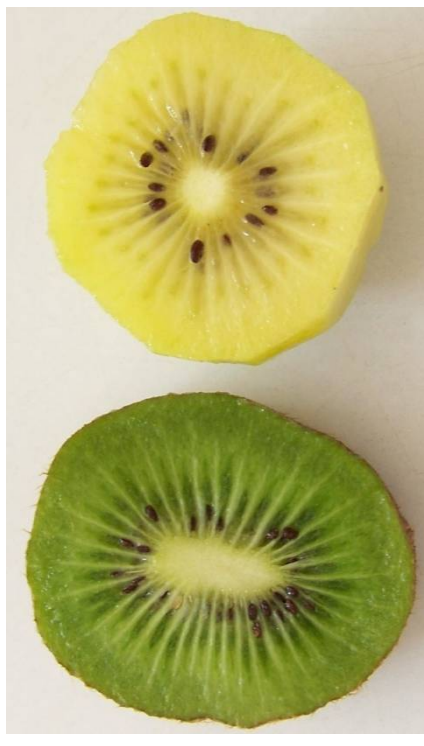
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The European project Fruitgrading (FP7-SME, 2011-2014) aims to develop a new technology to grade fruits based on internal quality. The proposed technology is based on the combination of two contactless techniques: Near Infrared Reflectance Spectroscopy (NIRS) and Magnetic Induction Spectroscopy (MIS).



Characterization of 135 kiwis, 236 pears, 350 apples, 378 peaches and nectarines :

- i) Non-destructively, by NIRS (800 and 2500 nm) and MIS (8 frequencies)
- ii) Destructively for the determination of flesh firmness, soluble solids contents (SSC) and titratable acidity (TA).

Development of predictive models using PLS1 regression and a procedure to randomly divide each data collection into 3 sets: 1) set for calibration (50% spectra), 2) set for validation (25% spectra) and 3) set for test (25% spectra), repeated 20 times.



Large fruit variability

The samples covered a wide range of characteristics for each of the four species, apple, kiwi, pear and peach and nectarine. Fruits had been chosen to cover most of the possible range of quality traits, by analyzing different varieties, and for several varieties, different ripening stages or different quality classes. For example the ratio between min and max was > 2 for SSC in all species, and covering most of the acceptable commercial range for these products.

Performance of prediction

1. NIRS

The results confirm that NIRS is a useful technique to estimate SSC in different fruits ($R^2 \geq 0.72$ and $RMSE \leq 1.30$) (Table), even when a very large diversity of fruits (origins and cultivation methods) were analyzed together. However, concerning the other quality parameters, the results are dependent on fruit. In fact, the prediction results are acceptable for TA only in pear ($R^2 = 0.74$ and $RMSE = 0.84$) and only in apple for firmness ($R^2 = 0.76$ and $RMSE = 0.0034$).

Table. Performance of prediction by NIRS

Mean Values	SSC	TA	Firmness
Peach	$R^2 = 0.78$ RMSE = 0.99 ✓	$R^2 = 0.30$ RMSE = 2.66 ✗	$R^2 = 0.32$ RMSE = 0.007 ✗
Pear	$R^2 = 0.76$ RMSE = 0.84 ✓	$R^2 = 0.74$ RMSE = 0.84 ✓	$R^2 = 0.40$ RMSE = 0.007 ✗
Apple	$R^2 = 0.82$ RMSE = 0.73 ✓	$R^2 = 0.65$ RMSE = 1.30 ✗	$R^2 = 0.76$ RMSE = 0.0034 ✓
Kiwi	$R^2 = 0.72$ RMSE = 1.30 ✓	$R^2 = 0.20$ RMSE = 1.75 ✗	$R^2 = 0.51$ RMSE = 0.0056 ✗

Number of dimensions between 3 and 11

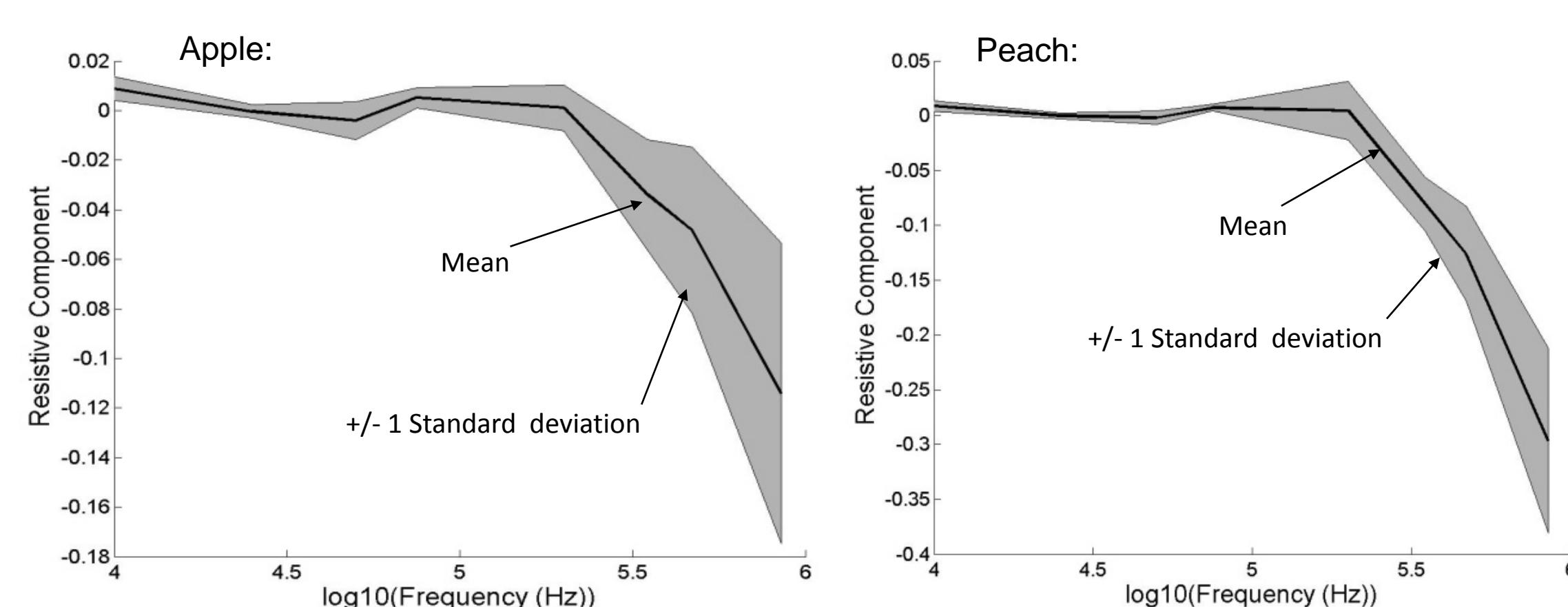


Figure. Resistive components with the conveyor-based system

2. MIS

Figure shows the mean and standard deviation for scanned apples (left) and peaches (right). It is possible to observe a negative trend with respect to increasing frequency, this indicates a possible dispersion in the conductivity of the fruit.

Development of the system is on-going with a view to improving the signal-to-noise ratio. It is believed that by understanding the trends of fruit samples, it will be possible to identify changes in the conductivity of the samples as the fruit matures.

The future work will be dedicated to the development, validation and integration into existing fruit sorting lines of the module using MIS technique and a low cost NIR spectrometer. This prototype should contribute to the segmentation of the fruit production with an effective approach to increase the overall value of the production.

SME partners involved in this project:

SME-AGs: AJAP - Associação dos Jovens Agricultores de Portugal / Portugal; SOTO - Asociación para la promoción de la pera de Rincón de Soto / Spain; TRSK - Towarzystwo Rozwoju Sadów Karłowych / Poland
SMEs: VALLE - S.A.T. Frutas y verduras Valle de Rincón / Spain; OWOC - Sąddecka Grupa Producentów Owoców i Warzyw "Owoc Łącki" Sp. z o.o. / Poland; STC - Société de Technologie de Calibrage. / France; SAFELINE - Mettler Toledo – Safeline Limited / United Kingdom

