On-Line Measurement – The Next Generation

"Key Customer Day" - 20 April 2018

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On-Line Measurement

- Analysis of a process or product that occurs without stopping the process.
- Non- Destructive, fast and highly desired in the food industry.
- Requires much R&D to produce working models.

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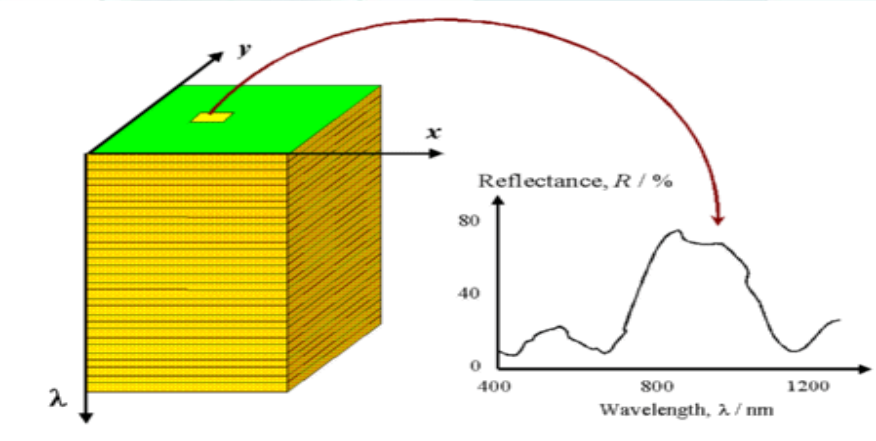
What is Hyperspectral Imaging?

- **Technique that generates a spatial map of spectral variation.**
- Equipment involves 2 cameras, 1 scanner and the creation a data cube:
  - VNIR : 400nm – 900nm
  - SWIR: 900nm – 2493nm
  - Scanner in push broom configuration.



1. **View image at any λ.**
2. **Spectrum of any pixel or ROI.**
3. **> 100K pixels/ λ**

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Hyperspectral Imaging Operation

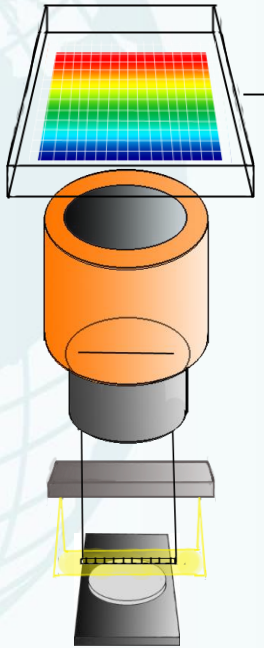
Camera with 2D detector array

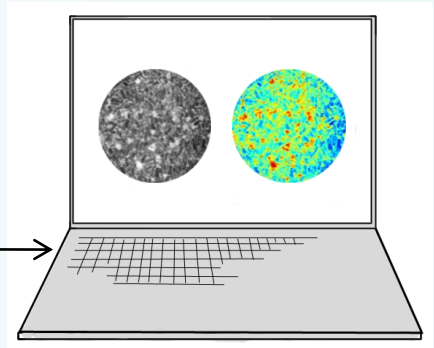
Imaging spectrograph with input slit

Fore lens

Line light source

Sample stage





1 Collection of data.

2.Quantitative & Qualitative Analysis

Schematic: Gilden Photonics, 2015

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What can we measure?

- **Gross Components:** Quantification of the area of components within a scanned image

- **Chemical Composition:** Quantification of non-visible components within a scanned image

Example 1
Gross components of cheeses

Gross components of a cheese board

Fig1. colour image

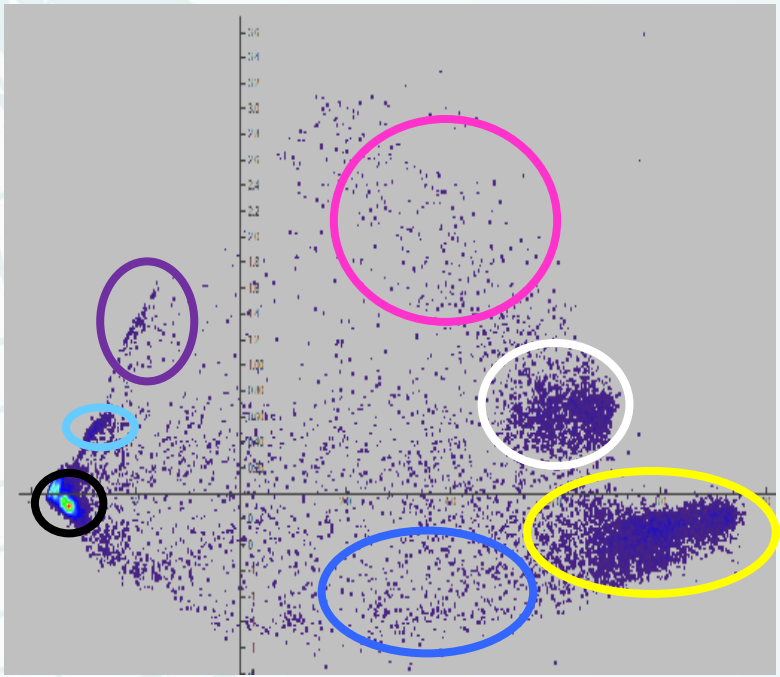

Fig 2. Scatter plot

Fig3. Masked image

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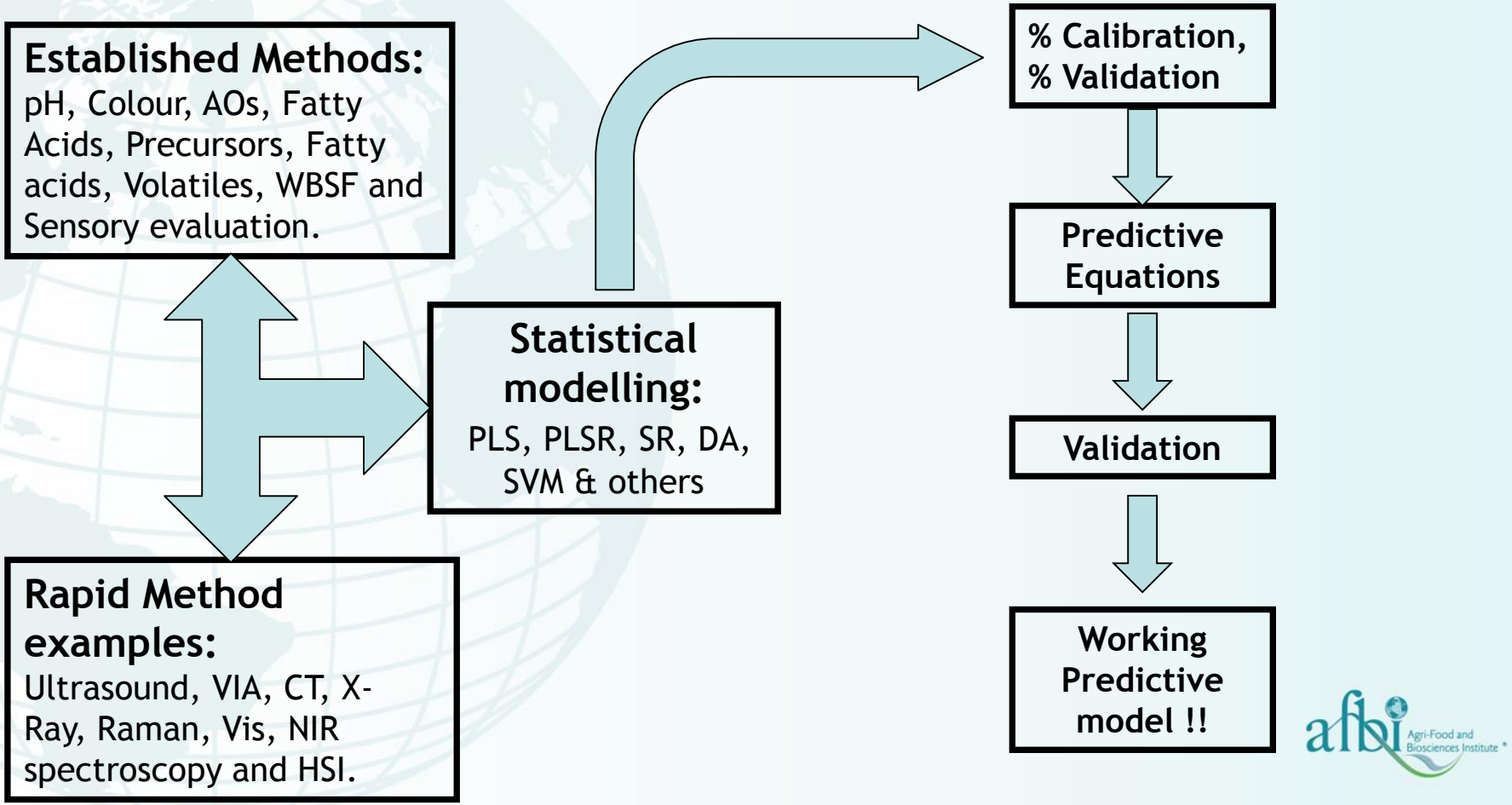
Chemical composition- Concept



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Example 2
Post-slaughter age of chicken

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Measuring post-slaughter age of Chicken fillet

- Obtained150 chicken fillet packets.
- Packets aged between 2 -15 days.
- Profiles extracted.
- Advanced statistics.
- Analysis: Age Groups* and Actual age (PS).
- *Age Groups: 2-4d, 5-8d, 9-11d, 12-14d.

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Results

Scan Description	Measured Variable	% Classified Calibration	% Classified Validation
Fillet in pack	Age group	97	82
Fillet out of pack	Age group	98	95
Fillet out of pack	Age	98	92

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Results

Calibration data set

PGroup	Day 2 - Day 4	Day 5 - Day 8	Day 9 - Day 11	Day 12 - Day 14
Group				
Day 2 - Day 4	20	0	0	0
Day 5 - Day 8	0	19	0	2
Day 9 - Day 11	0	0	21	0
Day 12 - Day 14	0	0	0	27

Validation data set

PGroup	Day 2 - Day 4	Day 5 - Day 8	Day 9 - Day 11	Day 12 - Day 14
Group				
Day 2 - Day 4	9	0	0	0
Day 5 - Day 8	0	7	0	2
Day 9 - Day 11	0	0	9	0
Day 12 - Day 14	0	0	0	12

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Example 3
Aspects of Chicken Quality
AFQCC

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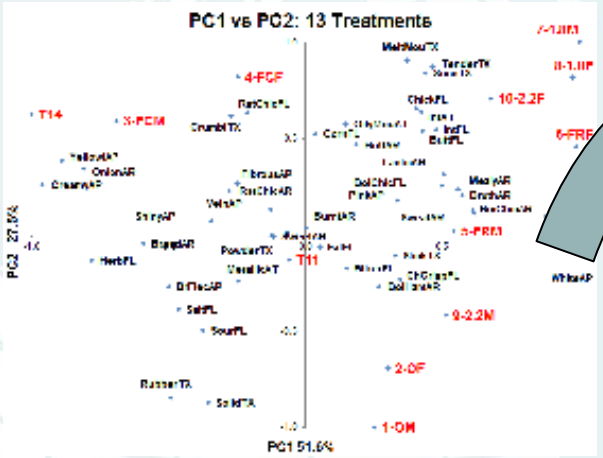
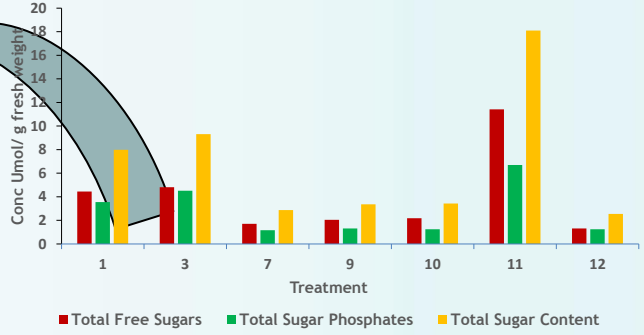
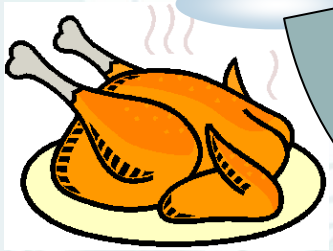
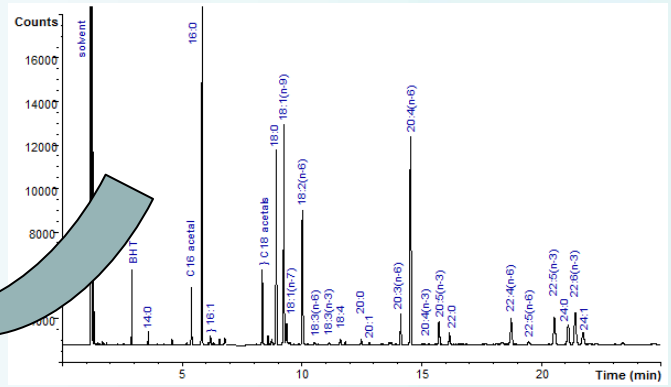
HSI prediction of quality parameters



Can HSI Predict?







Example 4
Adulterated Olive Oil
CAFRE Student Projects

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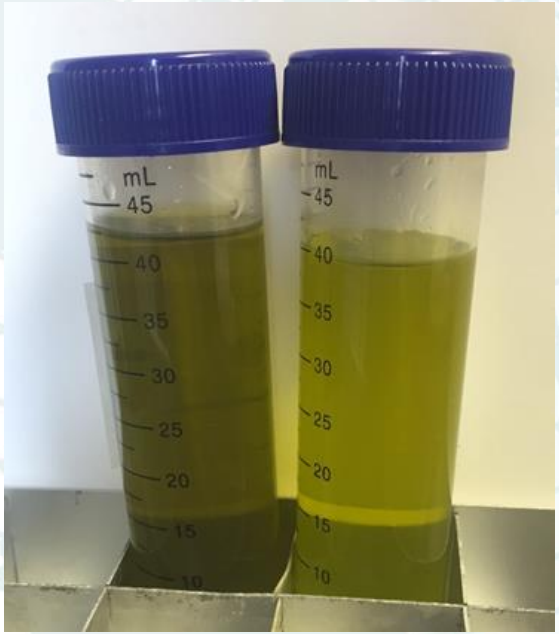
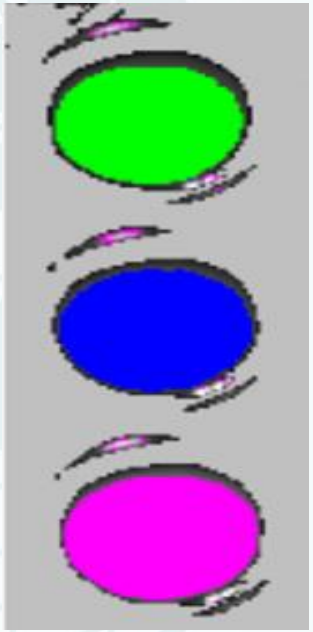
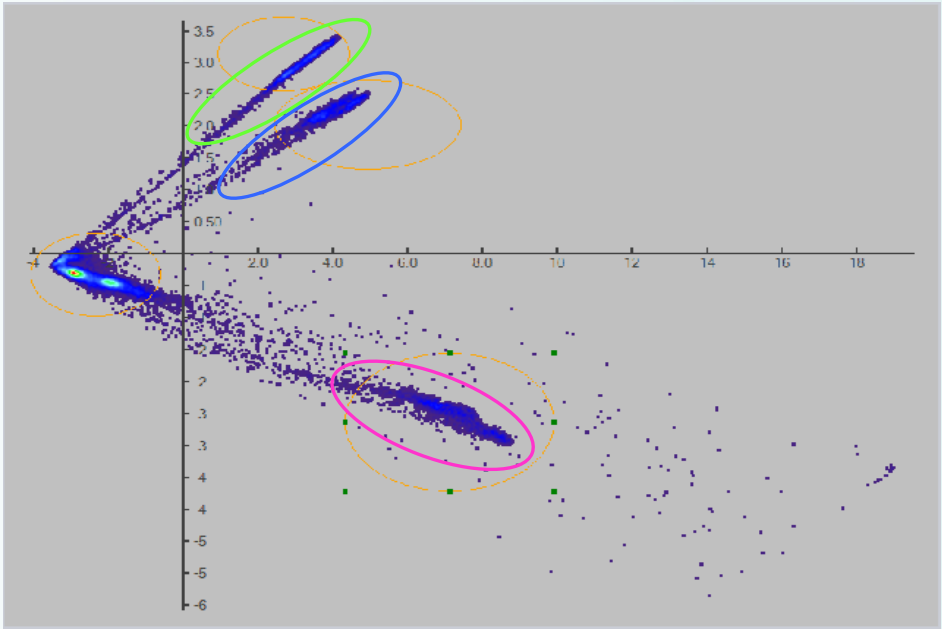
Authenticating Extra Virgin Olive Oil







(a) Extra Virgin Olive oil and "Fake" Olive oil. (b) Masked Image of Extra Virgin Olive oil, Sunflower oil and Sunflower oil spiked with chlorophyll (C) Principal Component Plot of extra virgin olive oil, sunflower oil and sunflower oil spiked with chlorophyll.

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Example 5
Ossification

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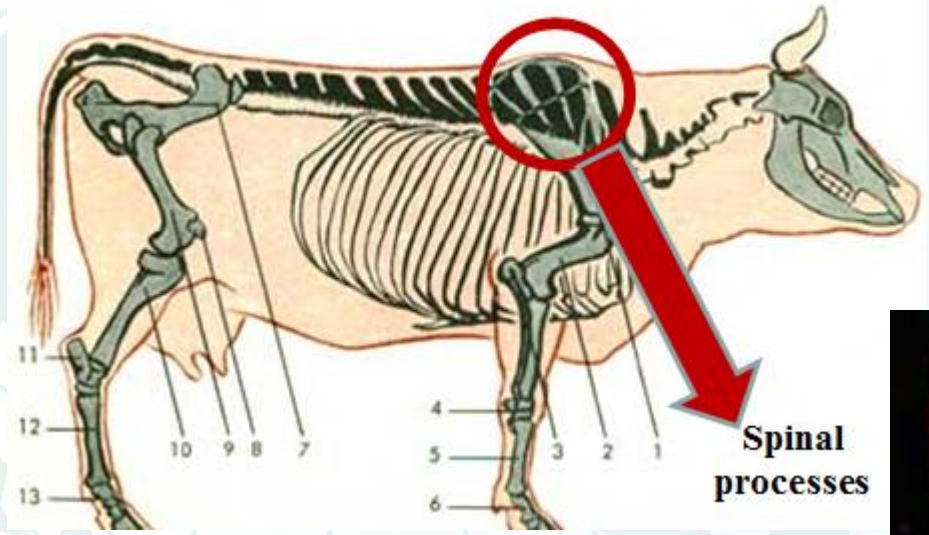
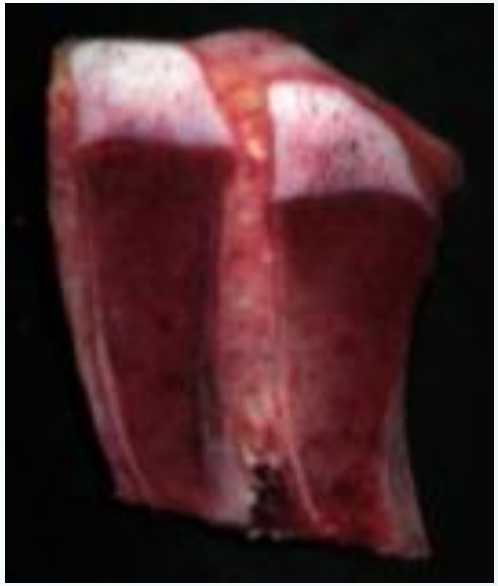
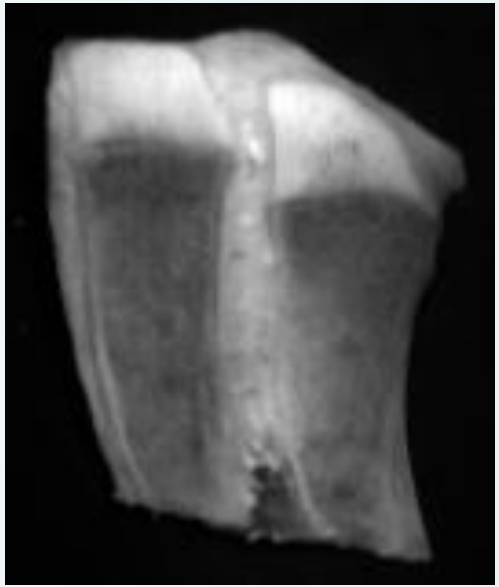
Ossification in Spinal Processes



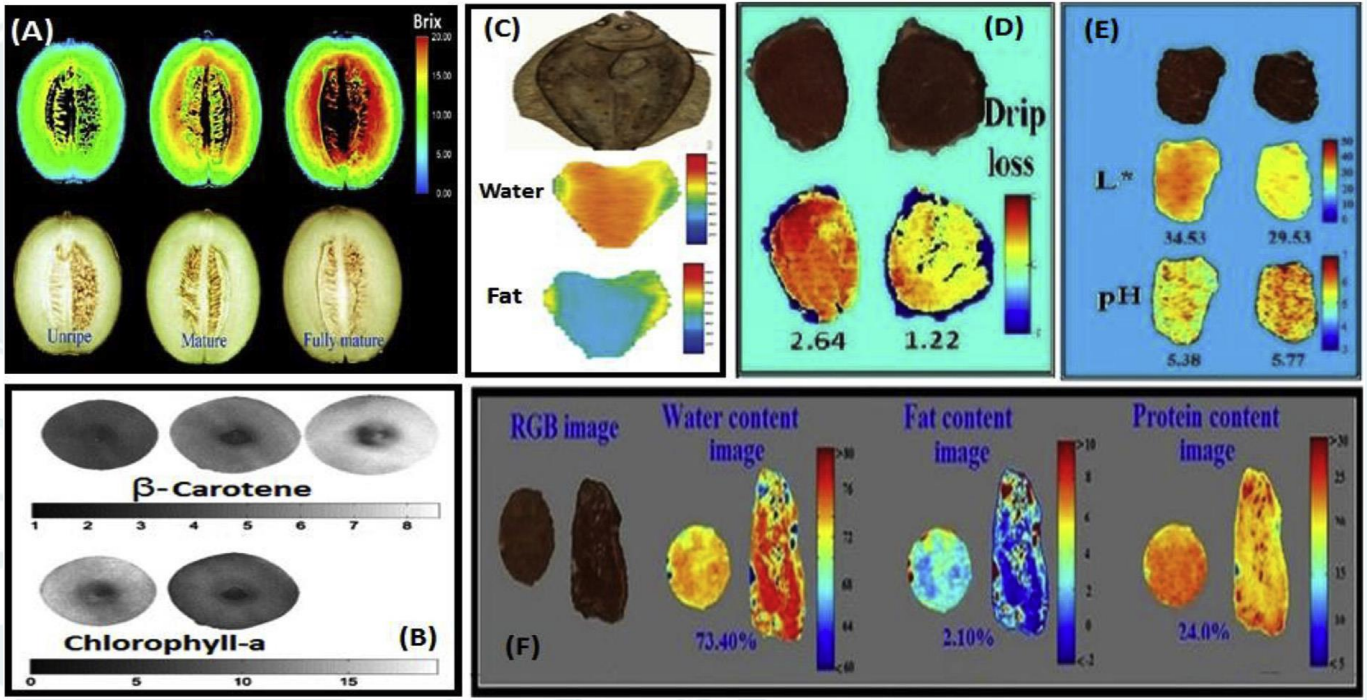
VNIR image of spinal process



PCA image of spinal process



Other Researchers:



Distribution maps of:

(A) Sugars in melon,
(B) Carotene and chlorophyll contents in tomato,
(C) Water and fat contents in fish,
(D) Drip loss in beef water,
(E) Colour lightness and pH in raw meat
(F) Water, fat and protein contents in minced and raw meat.

ElMasry & Nakauchi, Biosystems Engineering, 142 (2016) 53-82

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HSI and Your Interests

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