La chimiométrie et l'imagerie proche infrarouge comme outils au service de l'authentification et traçabilité des produits agroalimentaires

J.A. Fernández Pierna, Ph. Vermeulen, P. Dardenne & V. Baeten

Département Qualité des Productions agricoles
Centre wallon de Recherches agronomiques (CRA-W)
24, Chaussée de Namur, Gembloux, Belgique
fernandez@cra.wallonie.be

Authenticity & Traceability

Authenticity refers to the quality or condition of being authentic, trustworthy, or genuine.

Authenticity research is engaged in the development of methods allowing verifying if a product corresponds to what its label indicates or suggests. Most of the violations on the authenticity of food products are committed for economic reasons. Moreover the violations also can be a consequence of an accident during production. Beside the fact that consumer trust is violated because he does not get for which he pays, also risks for the public health are possible.

Source: http://www.ilvo.vlaanderen.be

Authenticity & Traceability

Traceability means the ability to track any food, feed, food-producing animal or substance that will be used for consumption, through all stages of production, processing and distribution.

Traceability is a way of responding to potential risks that can arise in food and feed, to ensure that all food products in the EU are safe for European citizens to eat.
It is vital that when national authorities or food businesses identify a risk they can trace it back to its source in order to swiftly isolate the problem and prevent contaminated products from reaching consumers.

Past food crises, such as dioxin contamination and BSE, have illustrated the particular importance of being able to swiftly identify and isolate unsafe foodstuffs in order to prevent them from reaching the consumer.

Authenticity & Traceability – some examples of projects

Community Reference Laboratory for the detection of animal proteins

Tracing Food Commodities in Europe

MEDEO

Development and assessment of methods for the detection of adulteration of olive oil with hazelnut oil

Typical food products in Europe: consumer preference and objective assessment

GM and non-GM supply chains: their CO-EXistence and TRAceability

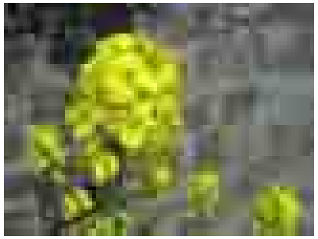
Contaminants in food and feed: Inexpensive detection for control of exposure

Detection of presence of species-specific processed animal proteins in animal feed

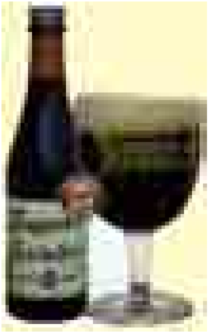
Authenticity & Traceability – some examples of products

Milk

Animal proteins

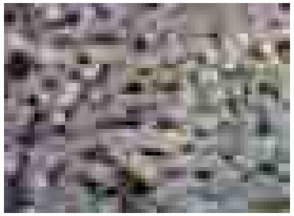


GMO



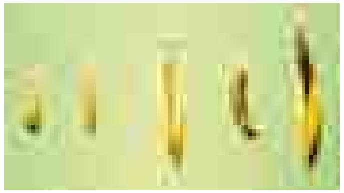
Authentic trappist beer

Polyphenols



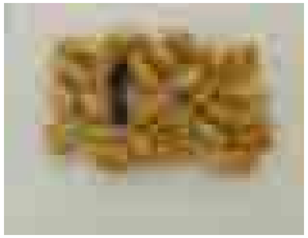
Feed ingredients & compound feeds

Olive oil



Mycotoxins

Honey



Vegetal contaminants

Meat & meat products

Authenticity & Traceability – some examples of techniques

FT-MIR

FT-RAMAN

NMR

NIR

LC-MS

GC-GC-Tof-MS

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Features of these techniques

- ✓ Screening (several hundred samples/day)
- ✓ On-line and in-situ analysis (fibre optics, hand held instrument)
- ✓ Non-destructive (screening method → confirmatory method)
- ✓ Fast (minutes → hours)
- ✓ Easy to use (Push button instruments)
- ✓ Cost effective (<~ 1 €/sample)
- ✓ High sensitive method (< ppm)
- ✓ Confirmatory method (selected and defined markers)

PRO and CONS of NIR

Advantages

- Fast, real time measurements
- Cost Effective
- No sample preparation
- Requires minimum training

Disadvantages

- Indirect measurement
- Possible instrumental shift
- Weak sensitivity to minor constituents

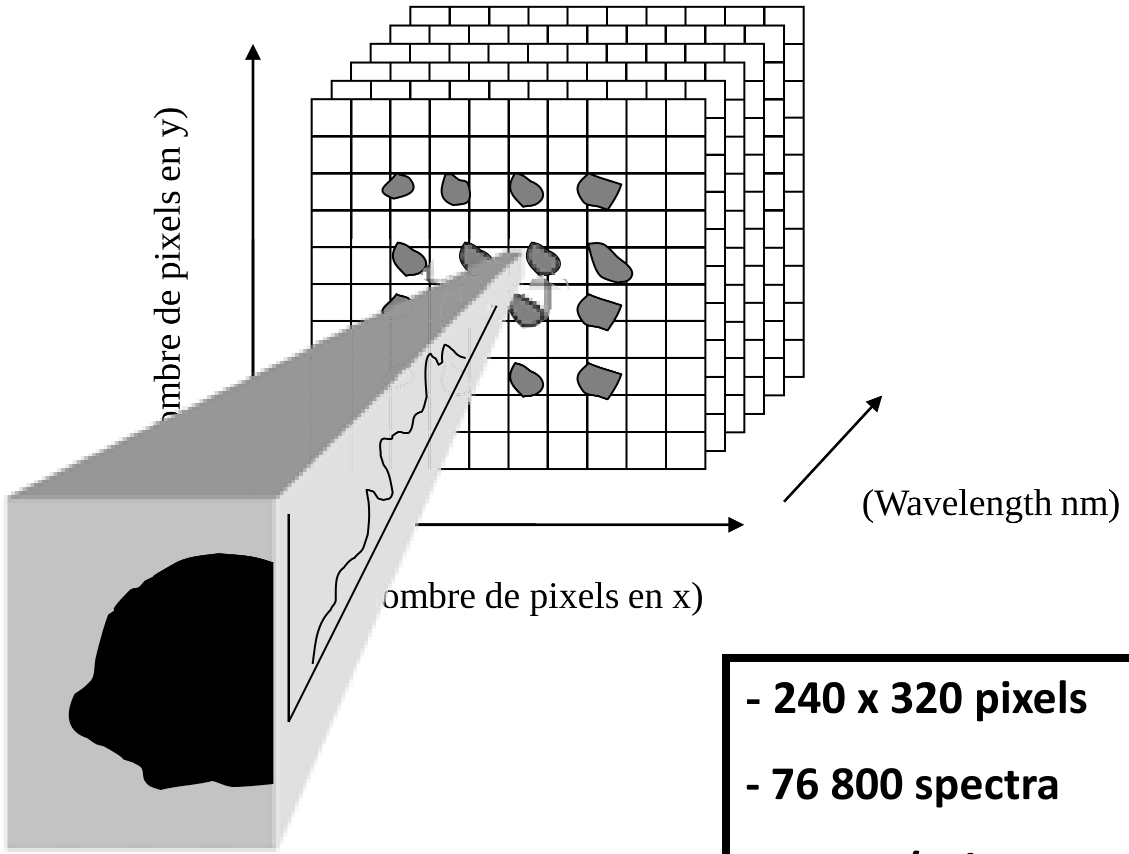
What is hyperspectral imaging?

Spatial information

Frequency information (i.e. wavelengths)

Intensity information (i.e. absorbance)

Features of a NIR hypercube



pixel = spectrum

- 240 x 320 pixels
- 76 800 spectra
- 24 MB/cube
- 3 to 5 minutes
- 900-1700/10 nm

A hyperspectral instrument

Small particles (sedimented fractions,…)

Large particles (fruits, grains,…)

A hyperspectral instrument

Allows extracting all the pixels in a single kernel analysis instead of the mean (classical NIR)

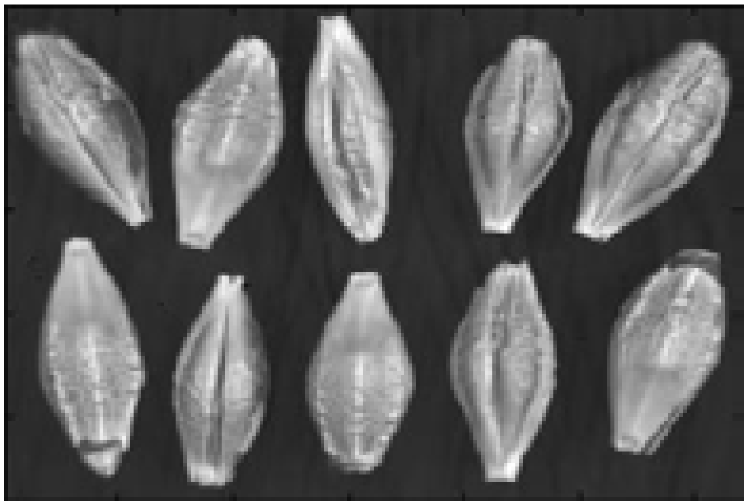
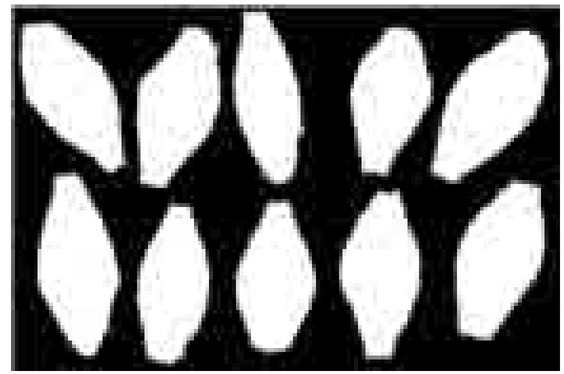
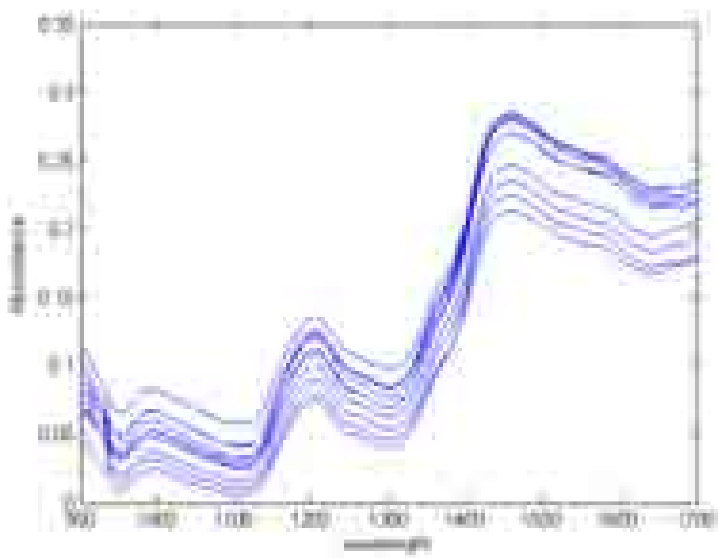


Image obtained with the NIR camera



Mask



Authenticity & Traceability – some chemometric tools

Class Modelling methods

- Fisher discrimination
- Discriminant PLS (PLS-DA)
- k NN
- ANN …

Density methods

Determining the density of samples in a space defined by the original variables (or by the PCs).
Probability calculation.

Boundary methods

- Support Vector Machines (SVM) …

Contamination of cereals with ergot

Ergot: fungi *Claviceps purpurea*

Contamination of cereals with ergot

The ergot replaces the kernels in the grain ears

- for the farmer, the damage caused by ergot is a yield reduction

- for the feed/food sector, the presence of ergot in feedingstuffs and agro-food products involves high toxicity risk for animal and human in relation to the alkaloid composition and content in the ergot.

Contamination of cereals with ergot

In 2006 a survey on the presence of undesirable botanic substances in feed showed a resurgence of the ergot presence in cereals samples.

To reduce the risk of poisoning, the European directive 2002/32/EC on undesirable substances in animal feed fixed a limit in the EU of 0.1% for ergot in all feedingstuffs containing unground cereals.

The existing microscopy method provides an elegant early warning tool for ergot contamination but is time-consuming.

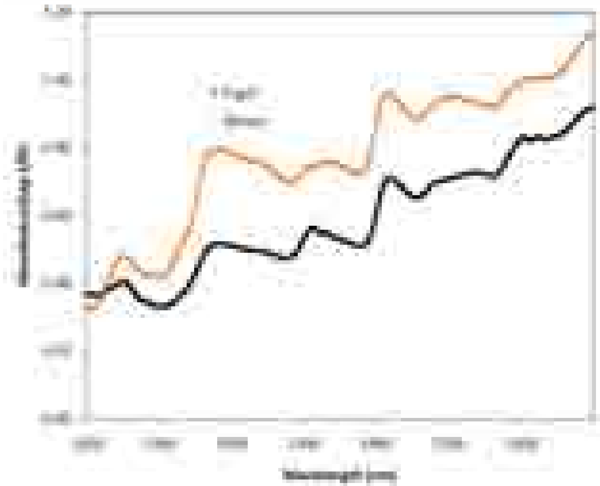
Contamination of cereals with ergot

Ergot bodies

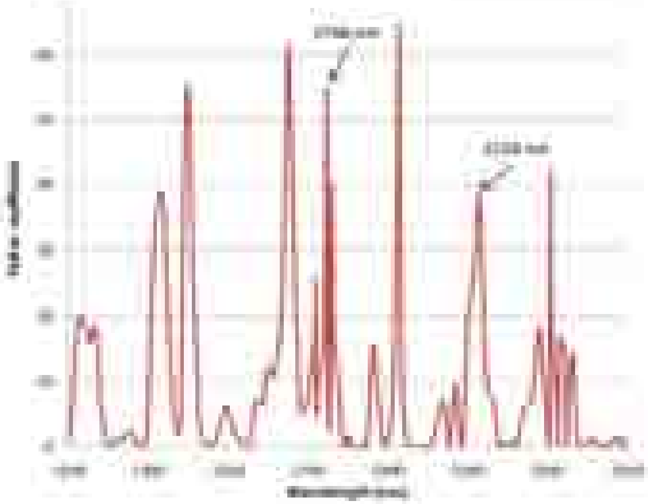
Wheat grains

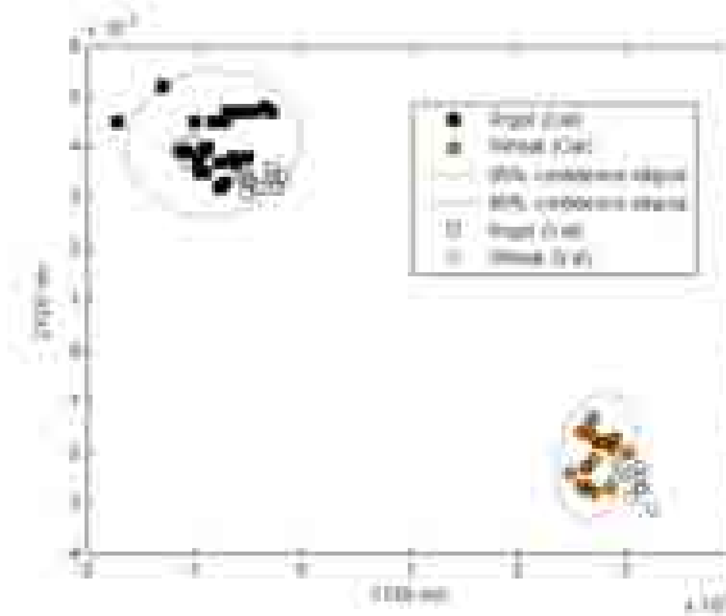
Barley grains

Ergot detection by classical NIR



Fisher discrimination





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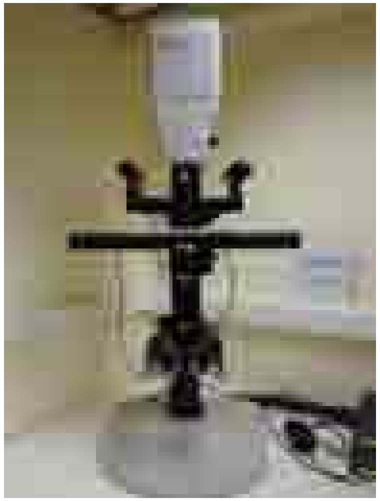
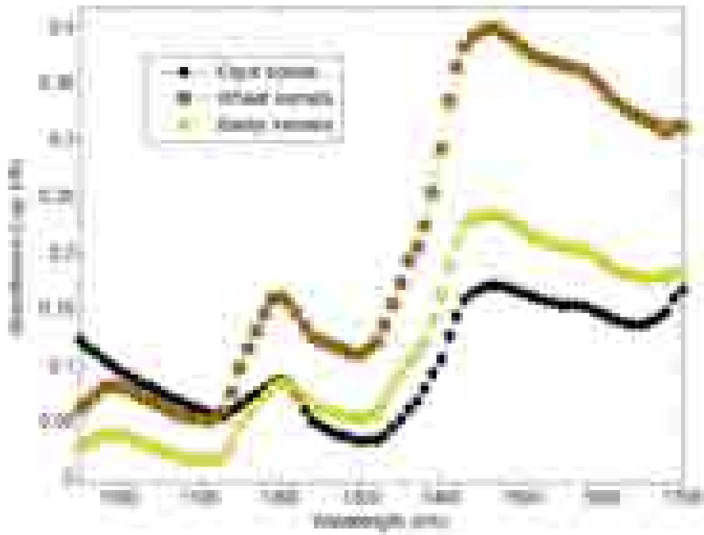
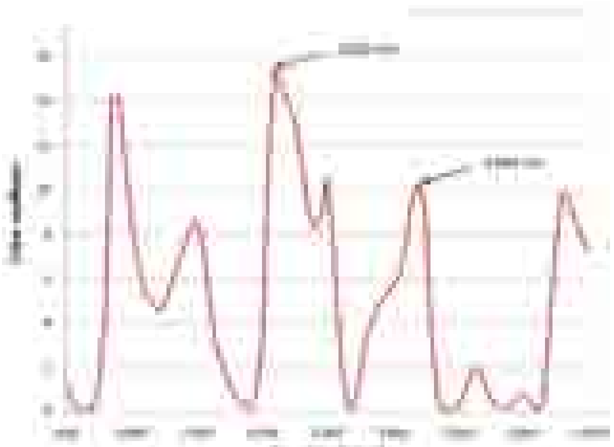
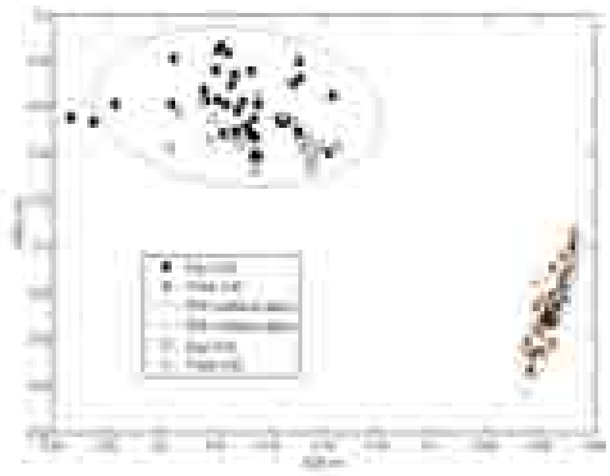
Ergot detection by hyperspectral NIR imaging



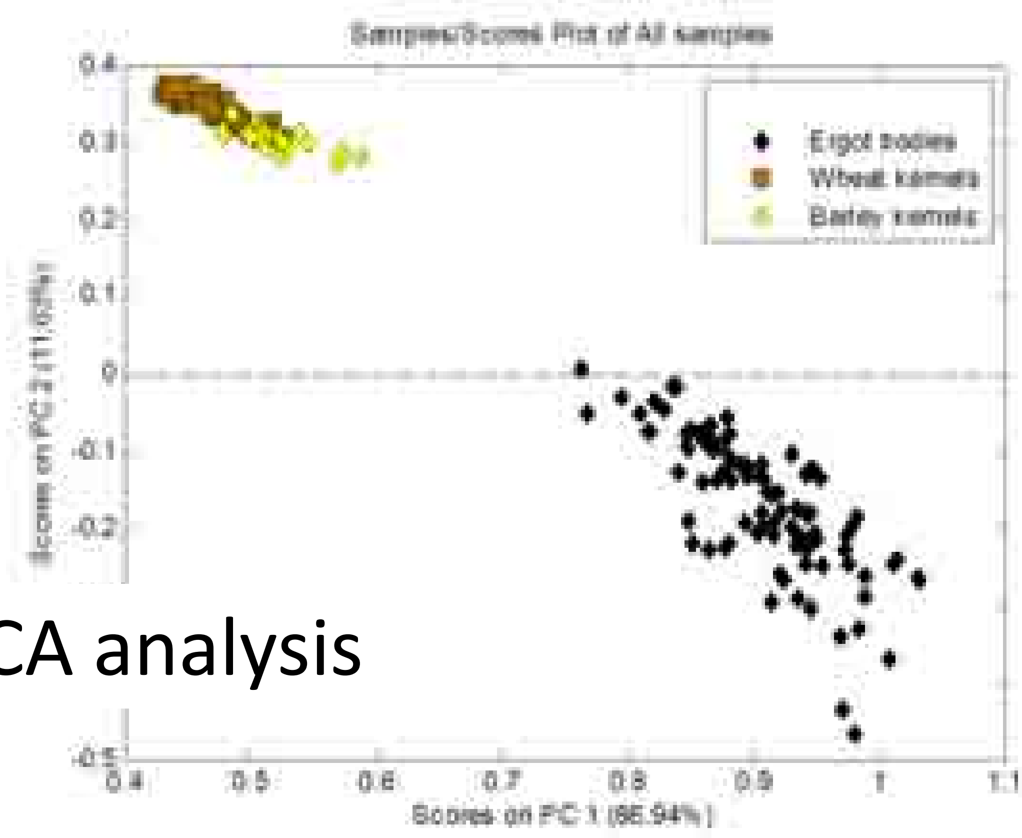


Fisher discrimination





Ergot detection by hyperspectral NIR imaging



PCA analysis

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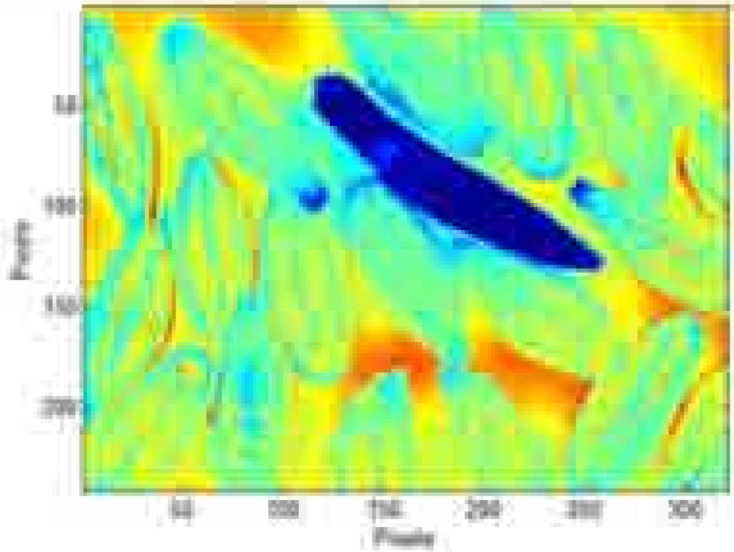
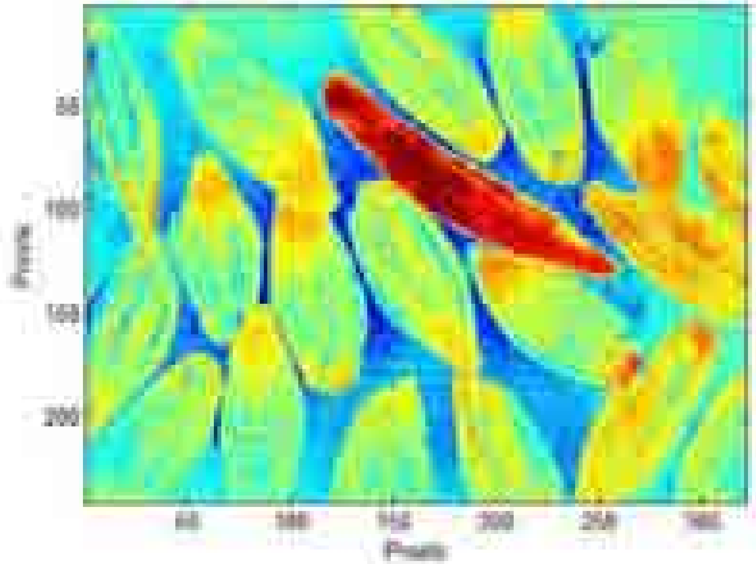
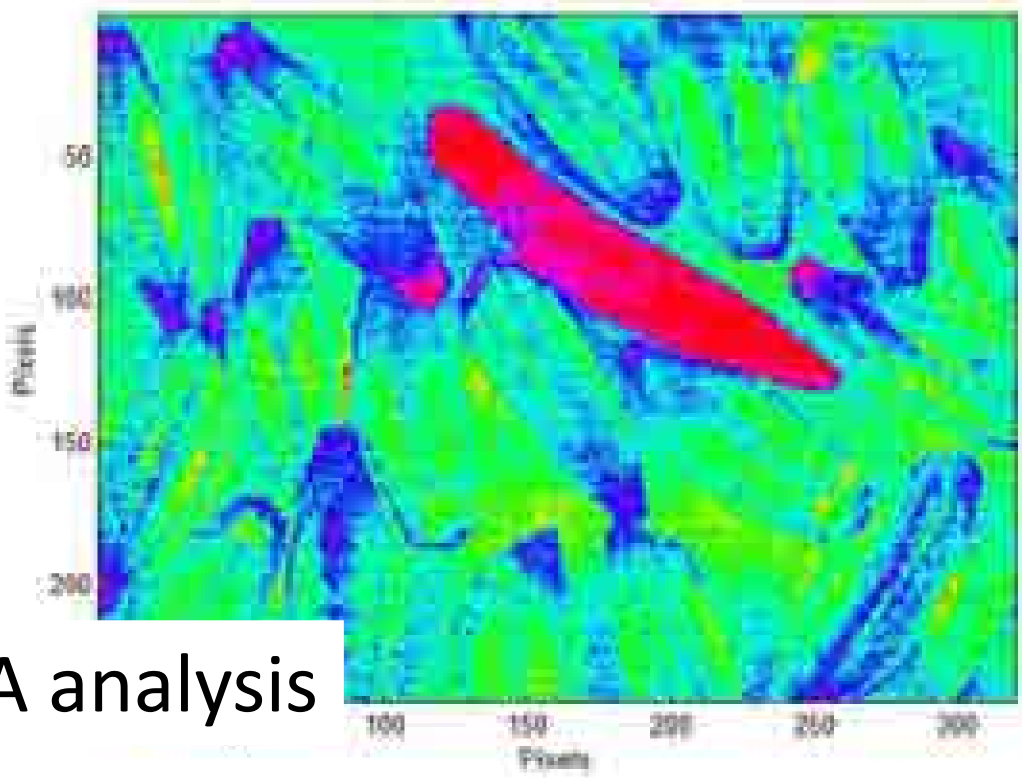
Ergot detection by hyperspectral NIR imaging



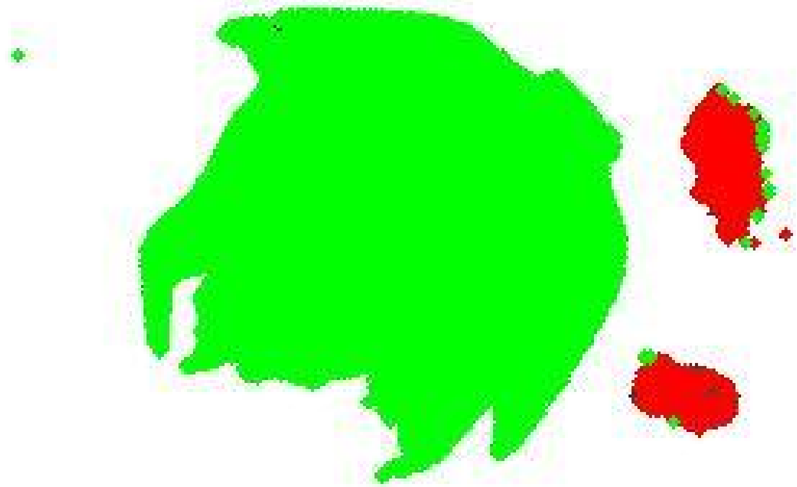


Ergot detection by hyperspectral NIR imaging



PCA analysis

Contaminant detection by hyperspectral NIR imaging



SVM discrimination models

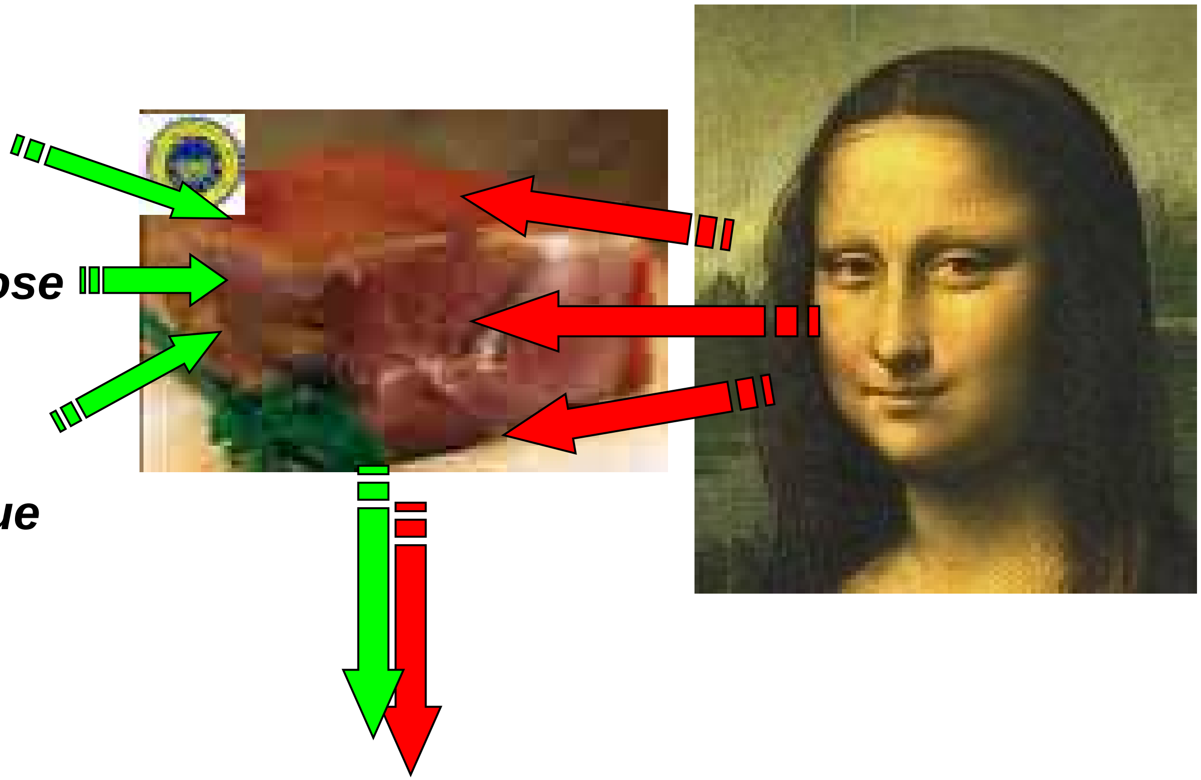
And the future?

Development of an original strategy

VIS technique

Advanced electronic nose

Spectroscopic technique



Authentic product

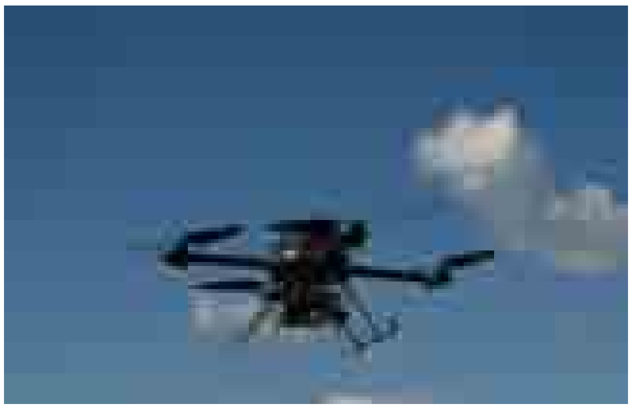
Need of rapid, cost effective, portable, repeatable…methods, which can deal with all kind of products

And the future?

Spectroscopic techniques go to samples ….
What is missing is the way to extract, transform and exploit the data rapidly acquired

And the future?

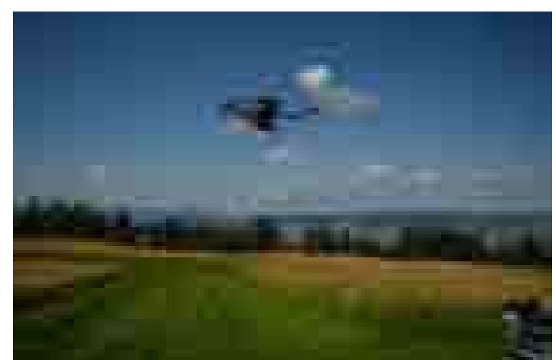
- UAV – Unmanned Aerial Vehicle



- Lightweight spectrometer sensor (Hamamatsu 640 nm to 1050 nm)

+

Great possibilities for hyperspectral imaging!



A team at your service

Quality of Agricultural products Department
Head of Department: **Dr. Pierre Dardenne**
Spectroscopy and Chemometrics Section
Head of Section: **Dr. Vincent Baeten**

TRAINING

on

Infrared spectroscopy
and Chemometrics

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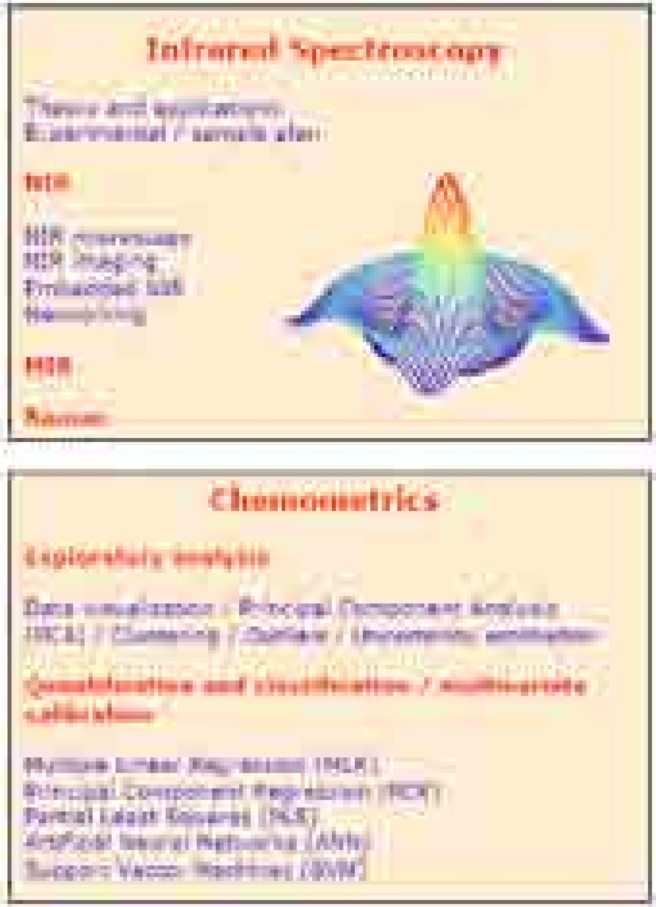

For info:

fernandez@cra.wallonie.be
dardenne@cra.wallonie.be

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