NEAR INFRARED HYPERSPECTRAL IMAGING FOR SINGLE KERNEL ANALYSIS

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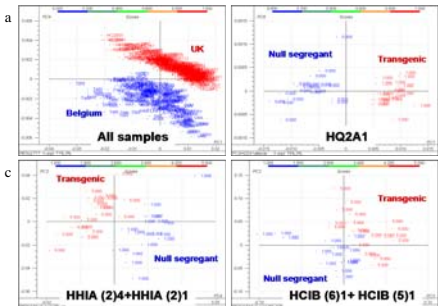[3] SESVANDERHAVE N.V./S.A., Tienen, Belgium
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GM & NON GM SEEDS DETECTION

In the framework of the COEXTRA FP6 project (GM and non-GM supply chains: their CO-EXistence and TRAceability), the CRA-W is in charge to investigate the potential of NIR hyperspectral imaging together with chemometrics for GMO (Genetically modified organisms) detection.

Soybean and barley samples coming from different origins and some being transgenic have been analysed for this purpose. In all data sets the results have shown that a good discrimination could be performed according to the variety and the presence of GM material.

PCA results showing the differentiating according to the origin (a) and according to the presence or not of transgenic material (b,c,d) in barley
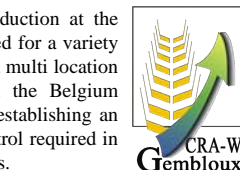
BARLEY VARIETIES CLASSIFICATION

In collaboration with the department of crop production at the CRA-W different barley samples have been analysed for a variety discrimination study. These samples are issued from multi location and multiannual trials for barley registration on the Belgium catalog. This discrimination study is essential for establishing an efficient system for the traceability and quality control required in the seed sector as well as in the food and feed sectors.

The study results presented here concern the discrimination between 6 varieties based on the spectral data acquired with the NIR-camera. A set of 1080 spectra (10 kernels X 6 varieties X 6 locations X 3 years) was constructed.

PLSDA	Nikel	Seychelles	Palmyra	Jolival	Mandy	Pelican
Sensitivity (Cal):	0.608	0.782	0.800	0.717	0.780	0.801
Specificity (Cal):	0.799	0.554	0.738	0.694	0.739	0.746
Sensitivity (CV):	0.585	0.721	0.776	0.675	0.767	0.795
Specificity (CV):	0.790	0.542	0.728	0.692	0.733	0.742
Sensitivity (Pred):	0.889	0.867	0.867	0.714	0.810	0.714
Specificity (Pred):	0.722	0.603	0.699	0.581	0.806	0.797
Class. Err (Cal):	0.296	0.332	0.231	0.295	0.240	0.227
Class. Err (CV):	0.312	0.369	0.248	0.316	0.250	0.231
Class. Err (Pred):	0.195	0.265	0.217	0.352	0.192	0.244
RMSEC:	0.349	0.361	0.332	0.353	0.330	0.332
RMSEP:	0.318	0.381	0.380	0.342	0.367	0.388

PLSDA results showing the classification of 6 barley varieties

The table here beside shows the sensitivity and the specificity for each of the 6 varieties in calibration, leave one out cross-validation and prediction. The correct classification in prediction vary from 71 to 89%.

HYPERSPECTRAL IMAGING

The MatrixNIR[TM] Chemical Imaging System (Malvern instruments Ltd) is a near infrared hyperspectral imaging spectrometer gathering spectral and spatial data (hypercube) simultaneously by recording sequential images of a pre-defined sample; each image plane is collected at a single wavelength band.
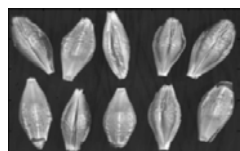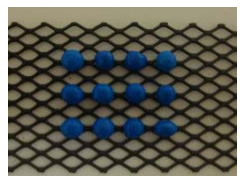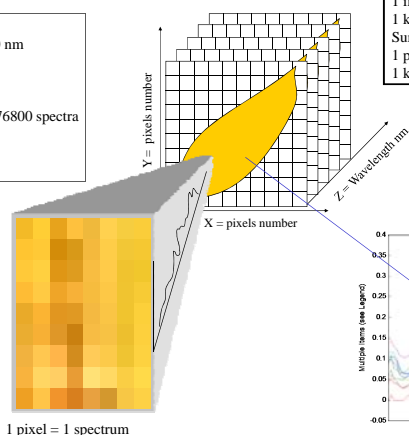

Image of 10 barley kernels obtained with the NIR camera

Mask of the image of 10 barley kernels used to calculate the mean spectrum of each barley kernel

Instrument parameters:
- Wavelength range: 900-1700 nm by step of 10 nm
- Reflection mode
- 16 coadds/wavelength
- Average on 4 scans/image
- 1 acquisition = 1 image = 240 * 320 pixels = 76800 spectra
- 1 pixel = 80μm * 80 μm = 0.0064 mm2
- Analysed surface = +/- 5cm2
- Time of acquisition = 5 min/image

1 image = 10 - 100 kernels
1 kernel = 100 - 3500 pixels
Surface analysed : 1 - 25 mm²/kernel
1 pixel = 1 spectrum
1 kernel = 1 mean spectrum

Y = pixels number
X = pixels number
Z = Wavelength nm

10 mean spectra for 10 kernels

Wire netting on ceramic plate with 12 sugar beet seeds

1 pixel = 1 spectrum

NIR camera and its characteristics.

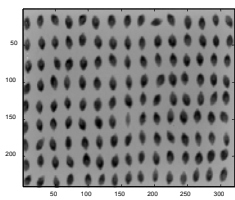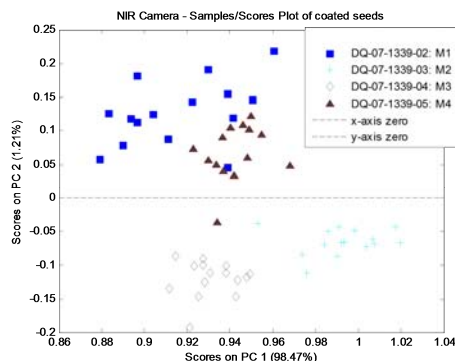MatrixNIR[TM] Chemical Imaging System instrument

Image of 135 fonio kernels obtained with the NIR camera

SEEDS COATING SOLUTIONS DISCRIMINATION

The study carried out in collaboration with SESVANDERHAVE Company, aims to develop single kernel measurements in order to control the pesticides used on the sugar beet coated seeds.

Differentiation with the naked eye between several lots of blue seeds is impossible. Then the aim of this study is to identify and quantify pesticide on sugar beet coated seeds and to assess the homogeneity of the coating.


NIR Camera - Samples/Scores Plot of coated seeds

Preliminary results show that seeds coated with different pesticide mixtures can be discriminated. The possibilities of hyperspectral imaging have been investigated to study the homogeneity of the coating. Further analysis is on-going.

PCA results showing the discrimination between 4 sugar beet seeds coating solutions

FONIO SEEDS PROPERTIES PREDICTION

In the framework of the FONIO FP6 project (Upgrading quality and competitiveness of fonio for improved livelihoods in West Africa), the CRA-W contributes to study possible improvements in terms of productivity of this traditional cereal. NIR hyperspectral imaging has been used for the characterisation of different origins.

The 3 sites (BARENG, KANKAN, CINZANA) studied were easily discriminated using PLS-DA with more than 90% of correct classification. Regression models have been built to predict the main properties as dry matter, starch, NDF, ADF, ADL, fat and ash on the kernels.
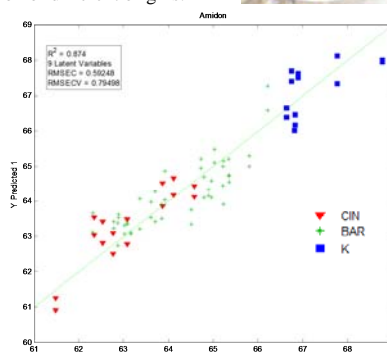
PLS results showing the prediction of starch on fonio seeds issued from 3 sites

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