NIR Hyperspectral Imaging and Chemometrics as a lab tool for the quality control of agricultural products

Ph. Vermeulen[a*], J. A. Fernández Pierna[a], J. Burger[b], A. Tossens[c], O. Amand[c], P. Dardenne[a] and V. Baeten[a]

[a] Walloon Agricultural Research Centre (CRA-W), Valorisation of Agricultural Products Department (D4), Food and Feed Quality Unit (U15), Henseval building - 24, Chaussée de Namur - 5030 Gembloux, Belgium ,*E-mail : vermeulen@cra.wallonie.be

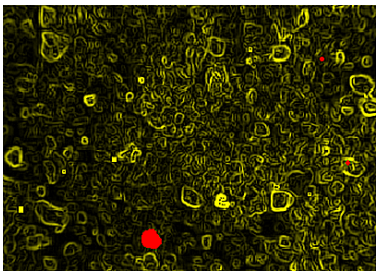
[b] BurgerMetrics SIA, Peldu iela 7, Jelgava, LV-3002, Latvia

[c] SESVANDERHAVE N.V./S.A. – Industriepark - 15, soldatenplein Z2 – 3300 Tienen, Belgium

PROCESSED ANIMAL PROTEINS (PAP) DETECTION IN FEED

In the framework of the SAFEED-PAP FP6 project (http://safeedpap.feedsafety.org), one of the objectives was to propose a NIR hyperspectral imaging method as alternative technique to the EU reference method (i.e. optical microscopy) to detect processed animal proteins (PAP) in feed, according to the legislation issue from the bovine spongiform encephalopathy (BSE) epidemic.

A NIR microscopy protocol was successfully transferred to the plane scan NIR imaging instrument. This transfer was performed by appropriate decision rules based on absorbances at specific wavelengths as well as transfer of discriminant equations using SVM as classification method.

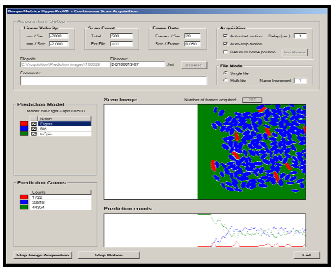


SVM model showing the detection of PAP (red)

Fernández Pierna J.A. , Dardenne P. and Baeten V. (2010). In-house validation of a near infrared hyperspectral imaging method for detecting processed animal proteins (PAP) in compound feed. *Journal of NIRS*, **18**, 121-133.

ERGOT BODIES DETECTION IN WHEAT

In the framework of the CONffIDENCE FP7 project (http://www.conffidence.eu), NIR hyperspectral imaging was investigated in order to develop a fast method for the on-line detection and quantification of ergot bodies in cereals. For the feed and food sectors, the presence of ergot involves high toxicity risk for animal and human due to toxic alkaloids presence in the ergot.



PLSDA model showing the detection of ergot (red)

Samples of wheat containing ergot were measured using a line scan NIR imaging instrument. Three spectral libraries (ergot, wheat and background) were built and a model was developed using PLSDA as classification method. This model was applied on the images acquired from samples adulterated with ergot.

Vermeulen P., Fernández Pierna J.A., Dardenne P. and BaetenV. (2010). Detection of ergot bodies in cereals by NIRS and hyperspectral NIR imaging. NIRS 2009 . *Proceedings 14th International Conference on Near Infrared Spectroscopy (ICNIRS2009), Bangkok - Thailand,* in press

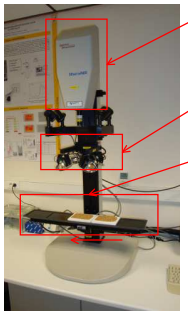
HYPERSPECTRAL IMAGING

Plane scan or whisk-broom instrument parameters (Malvern Ltd):

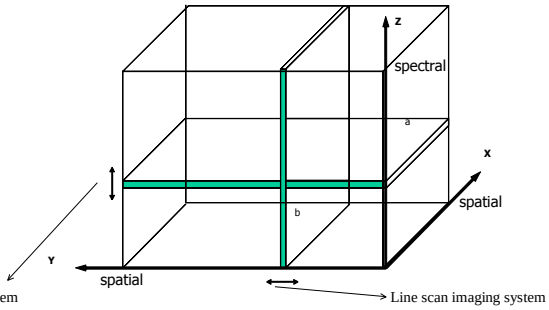
- Instrument: MatrixNIR™ hyperspectral imaging system (Malvern Ltd)
- Detector: InGaAs focal plane array
- Moving samples holder with 10 small plates or 5 large plates (BurgerMetrics)
- Wavelength range: 900-1700 nm by step of 10 nm
- 81 wavelength channels
- 16 coadds/wavelength , average on 4 scans/image
- 1 acquisition = 1 image (X*Y)
  = 240*320 pixels = 76800 spectra
- 1 pixel = 400µm * 400 µm = 0.16 mm2
- Analysed surface = +/- 117cm2 (9cm * 13cm)
- Time of acquisition = 5 min/image

Line scan or push broom instrument parameters (BurgerMetrics):

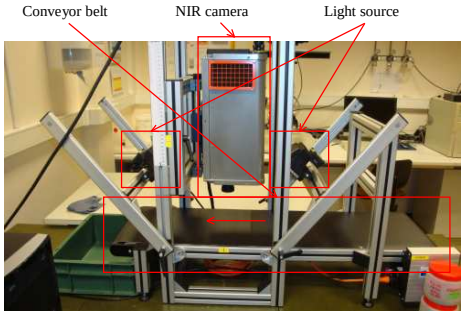
- Instrument: SWIR ImSpector N25E hyperspectral imaging system (Specim Ltd)
- Detector: cooled and temperature stabilized MCT (Xenics)
- Conveyor belt (BurgerMetrics)
- Wavelength range: 1100-2400 nm by step of 6.3 nm
- 209 wavelength channels
- Average on 32 scans/image
- 1 acquisition = 1 line(X)* 500 frames(Y)
  = 320*500 pixels = 160000 spectra
- 1 pixel = 275µm * 275 µm = 0.075 mm2
- Analysed surface = +/- 120 cm2 (8.8*13.7cm)
- Time of acquisition = 0.05 sec/frame = 20 frames/sec = 25sec/image



Plane scan imaging system



Line scan imaging system



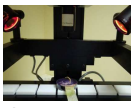
SUGAR BEET CYST NEMATODE QUANTIFICATION

The damage caused by nematodes on the sugar beet root leads to a yield reduction and is related to the cyst number. The current work, carried out in collaboration with SESVANDERHAVE Company, aimed at assessing the presence of cyst nematodes on sugar beet roots by NIR hyperspectral imaging. The number of cyst nematodes was previously counted by optical microscopy at SESVANDERHAVE. Then, images on individual plants were acquired with the plane scan instrument. Four spectral libraries (cyst, root, soil and background) were built and model was developed using SVM as classification method. This model was applied on the images acquired from 30 plants with different levels of resistance.

SUGAR BEET COATED SEEDS DISCRIMINATION

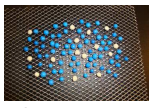
After the pelleting, the next step in the sugar beet seeds processing is the coating using different pesticides colored in blue. Once the seeds are coated, it is impossible to detect with the naked eye, mixtures between coated seeds. The current work, carried out in collaboration with SESVANDERHAVE Company, aimed to discriminate between seed lots coated with different pesticides by NIR hyperspectral imaging. Four lots of coated seeds and one lot of pelleted seeds were analysed using a line scan imaging system. Five spectral libraries, one by product, were built and model was developed using PLSDA as classification method. This model was applied on one image acquired from a mixture of seeds. This approach allowed to identify each lot of seeds.

Plants with cyst nematode

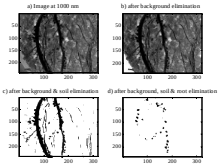


Spectra acquisition

Coated seed lots



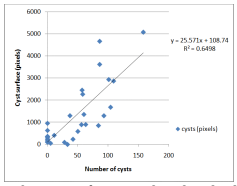
Spectra acquisition



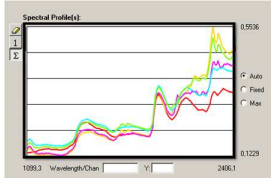
SVM model showing the detection of cyst nematode

Number of cysts counted by optical microscopy (reference)

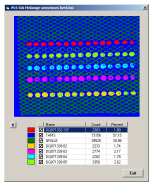
Number of pixels detected as cyst by NIR hyperspectral imaging



Correlation between reference and predicted values



Spectra average of each coated seed lot



PLSDA model showing the discrimination between seed lots

Vermeulen, P., Fernandez Pierna, J.A., Tossens, A., Amand, O., Dardenne, P. and Baeten, V. (2010). Identification and quantification of cyst nematode in sugar beet seeds by hyperspectral NIR imaging. Proceedings 14th International Conference on Near Infrared Spectroscopy (ICNIRS2009), Bangkok - Thailand, in press

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Walloon Agricultural Research Centre