Detection of ergot bodies in cereals by hyperspectral near infrared imaging

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

Quality Department of Agricultural Products, Walloon Agricultural Research Centre (CRA-W), Gembloux, Belgium
vermeulen@cra.wallonie.be

Introduction

Ergot on wheat ear

Contamination of cereals with ergot, formed by the fungi *Claviceps purpurea* is well known. For the farmer, the damage caused by ergot is a yield reduction: the ergot replaces the kernels in the grain ears. 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. The neurotoxic signs comprise feed/food refusal, dizziness but also convulsions. A survey on the presence of undesirable botanic substances in feed, carried out in 2006 inside official control labs from all member states of the European Union, 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 Commission is preparing regulations for ergot alkaloids in food and feed, but methods of analysis are still lacking. No limits have been set for individual alkaloids as yet. The existing microscopy method provides an elegant early warning tool for ergot contamination but is time-consuming. The current work, performed in the framework of the CON*ff*IDENCE project, aims to assess by hyperspectral NIR imaging the presence of ergot bodies in cereals.

Materiel and methods

For this experiment, a total of 85 ergot bodies issue from different sources (Belgium, The Netherlands, Germany and Denmark) and 100 wheat and barley kernels issue from several varieties and Belgian locations have been collected and analyzed with the hyperspectral NIR imaging system.

Ergot bodies

Wheat kernels

Barley kernels

The MatrixNIR™ Chemical Imaging System (Malvern instruments Ltd) used in this study 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.
The main characteristics of the NIR camera are described in figure 1. For each image, around 10 kernels or ergot bodies were analysed. The mean spectrum of each kernel or ergot body is issue from the average of the spectra acquired on the full surface of the kernel or ergot body. The data treatment was carried out with the PLS toolbox 4.0 under Matlab 7.5.0 (R2007b).

- Wavelength range: 900-1700nm by step of 10 nm
- 1 image = 240 x 320 pixels = 76 800 spectra
- Analysed surface = 76800 pixels = +/- 5cm2
- Time of acquisition = 5 min/image
- 1 kernel = +/- 3000 pixels = 1 mean spectrum

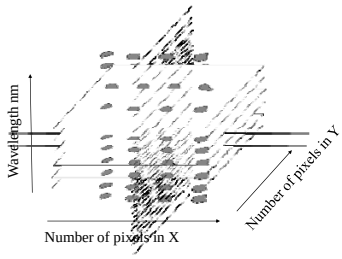

Figure 1: MatrixNIR™ Chemical Imaging System instrument and its characteristics

Results

The preliminary results show a clear discrimination between ergot bodies and wheat/barley kernels using PCA analysis. The figure 2 shows the mean spectra for ergot (85 spectra), wheat (100 spectra) and barley (30 spectra). The figure 3 shows the PC' scores plot of those spectra.

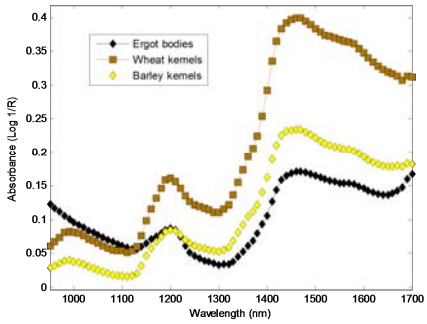

Figure 2: Hyperspectral NIR imaging mean spectra of ergot bodies and wheat/barley kernels

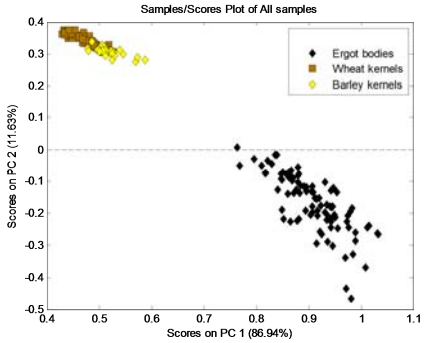

Figure 3: PC 'scores plot of the 187 NIR spectra of ergot bodies and wheat/barley kernels

In a second step, images were acquired on barley or wheat kernels mixed with ergot as shown in the picture here below (Figure 4). The image rebuilt at 1200 nm after 1st Derivative preprocessing shows clearly the different structures: ergot body and barley kernels (Figure 5).

Figure 4: Barley sample including ergot

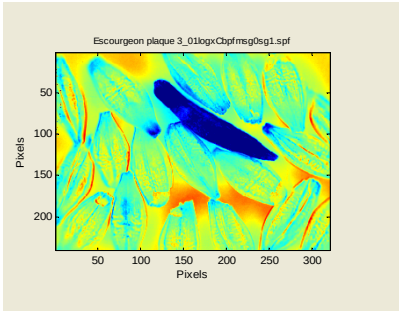

Figure 5: Image rebuilt at 1200 nm after 1st Derivative preprocessing

Conclusion

This study showed the potential of the hyperspectral NIR imaging to discriminate the ergot from barley and wheat kernels. Additional developments will be undertaken for the quantification of ergot bodies in the samples. Further research will be also carried out in order to develop and validate a method allowing the on-line detection of ergot bodies in cereals.

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Walloon Agricultural Research Centre