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

Contribution to the FP7-CONffIDENCE project of near infrared (NIR) hyperspectral imaging: Detection of contaminants

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Introduction

The EU Rapid Alert System for Food and Feed (RASFF) shows that controls on chemical contaminants in food and feed are essential for food safety in Europe. Safer food, through rapid and cost-efficient tests for detecting chemical contaminants in food and animal feed, is the major goal of a new four-year European Commission funded research project. This project, launched in May 2008, is entitled "CON*ff*IDENCE, Contaminants in Food and Feed: Inexpensive Detection for Control of Exposure". The project is coordinated by RIKILT and the consortium consists of 17 partners from 10 European countries. The CON*ff*IDENCE project has been designed to provide validated screening tools, which are simple, inexpensive and rapid and are able to detect as many chemical contaminants in parallel as possible. These include persistent organic pollutants (POPs), perfluorinated compounds (PFCs), pesticides, veterinary pharmaceuticals (coccidiostats and antibiotics), heavy metals and biotoxins such as alkaloids, marine toxins and mycotoxins. Rapid tests are developed and validated for meat, eggs, fish and fish feed, cereal-based food/feed and vegetables. Various new methods based on multiplex technologies are developed. After validation the new methods will be applied in demonstration activities which will help to gauge contaminant exposure and validate the risk assessment models. For more information, visit http://www.conffidence.eu .

Amongst the methods developed in the framework of this project, one of them is based on the near infrared hyperspectral imaging for detection of ergot (*Claviceps purpurea*) in cereals. Ergot was selected because of its increasing presence in recent years in cereals and food products. 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.

Materiel and methods

Wheat kernels

Ergot bodies

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

The MatrixNIR^{TM} Chemical Imaging System (Malvern instruments Ltd) used in this study is a near infrared (NIR) 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.

- 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

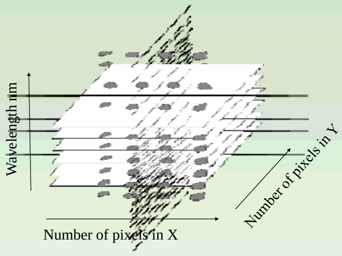

Figure 1: MatrixNIR^{TM} Chemical Imaging System instrument and its characteristics

Results

For this study, a calibration set (40 ergot bodies and 40 wheat kernels) and a validation set (20 ergot bodies and 20 wheat kernels) have been built from the database by selecting, for the validation set, samples from different sources than the calibration set. The figure 2 shows the mean spectra for ergot and wheat. The data were preprocessed by the Standard Normal Variate transform followed by 1st derivative Savitzky-Golay treatment (7,2,1). The figure 3 shows the preprocessed spectra. In order to discriminate between ergot bodies and wheat kernels, the Fisher coefficient was used to select the wavelengths where the between-classes variation is higher than the within-classes variation. The figure 4 shows the Fisher coefficient calculated on preprocessed data for the wavelength range of the NIR camera. Two wavelengths, 1220 nm and 1440 nm were selected. The figure 5 shows the discrimination between ergot bodies and wheat kernels using in X axis the preprocessed data near 1220 nm and in Y axis the preprocessed data near 1440 nm. The validation samples (empty squares for wheat kernels and circles for ergot bodies) are clearly included inside the ellipse corresponding to the 95% confidence limit.

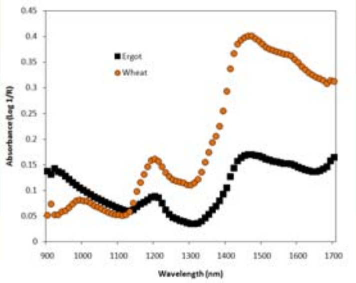

Figure 2: Hyperspectral NIR imaging mean spectra

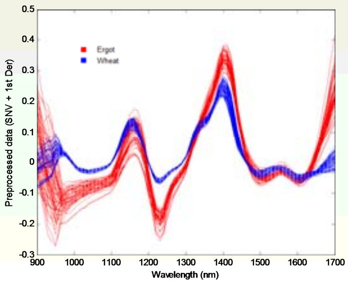

Figure 3: Preprocessed spectra: SNV + Derivative 7.2.1

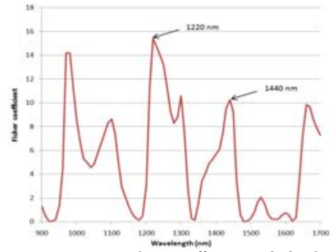

Figure 4: Fisher coefficient calculated from preprocessed spectra

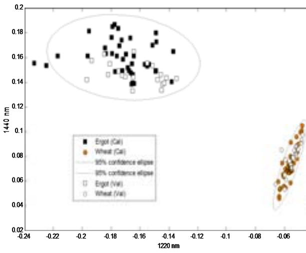

Figure 5: Discrimination Ergot/Wheat based on 2 wavelengths (1220 nm/ 1440 nm)

Conclusion

This study showed the potential of the near infrared (NIR) hyperspectral imaging to discriminate the ergot bodies from wheat kernels using 2 wavelengths 1220 nm and 1440 nm selected based on the Fisher coefficient. 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 site detection of ergot bodies in cereals.

References

European Commission (2003). Directive 2002/32/EC of the European parliament and of the council of 7 May 2002 on undesirable substances in animal feed. *Official Journal of the European communities*, **L140**, 10-21.

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