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

Detection of ergot bodies in cereals by hyperspectral NIR imaging

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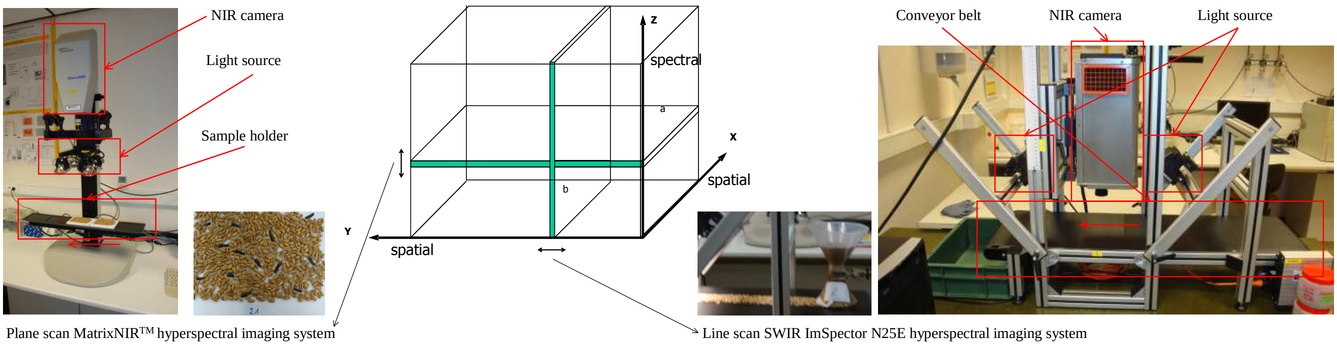
Introduction

Contamination of cereals with ergot (*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 and food sectors, the presence of ergot involves high toxicity risk for animal and human due to toxic alkaloids presence in the ergot. 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 regulation (EEC) No 689/92 restricted to 0.05% the concentration of ergot bodies in cereals for humans. The current work, performed in the framework of the CON*ff*IDENCE project (http://www.conffidence.eu), aims to detect and quantify by hyperspectral NIR imaging the presence of ergot bodies in cereals.

Material and methods

Two hyperspectral NIR imaging systems, a plane scan (900-1700 nm) and a line scan (1100-2400 nm), and the chemometric method PLSDA (Partial Least Squares Discriminant Analysis), have been used and applied on 7 samples of wheat (320g) contaminated with 0, 0.01, 0.05, 0.1, 0.15, 0.5 and 1% of ergot respectively.



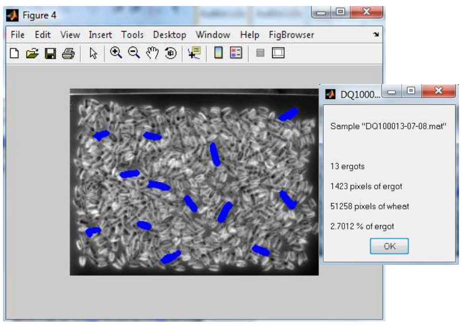
Plane scan MatrixNIR^{TM} hyperspectral imaging system

Line scan SWIR ImSpector N25E hyperspectral imaging system

Results

Plane scan instrument

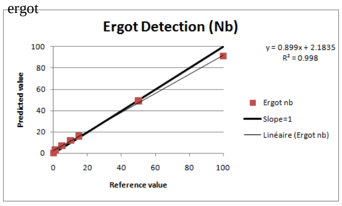
Three spectral libraries (ergot, wheat and background) were built and used for the construction of two discriminant equations (i.e. equation 1: "*background* versus *wheat* + *ergot*", equation 2: "*ergot* versus *wheat*") using PLSDA as classification method. These equations were successively applied to all the pixels of the images acquired from mixtures of adulterated and unadulterated samples. Finally, a density-based clustering method was applied to study the neighborhood of the pixels detected as ergot bodies as shown in the figure here below. All these tests were compiled in a program developed by CRA-W in Matlab v7.0.



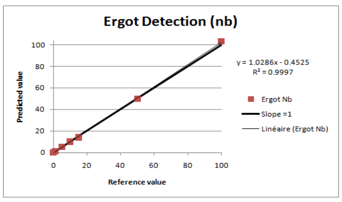
Results provided by the Matlab program: PLSDA model showing the detection of ergot (blue) in wheat (grey)

	Samples		Ergot bodies detected	
Code	Ergot bodies (Nb)	Ergot bodies (%)	Plane scan Matlab (Nb)	Line scan HyperPro (Nb)
DQ100013-01	0	0.00	0	0
DQ100013-02	1	0.01	3	1
DQ100013-03	5	0.05	7	5
DQ100013-04	10	0.10	12	10
DQ100013-05	15	0.15	16	14
DQ100013-06	50	0.50	49	50
DQ100013-07	100	1.00	91	103

Description of the samples and results achieved to assess the potentiality of the hyperspectral NIR imaging instruments and PLSDA model to detect ergot



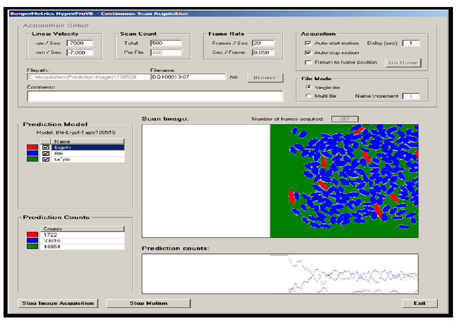
Results of ergot detection in wheat contaminated with different percentages of ergot, using plane scan camera and PLSDA model



Results of ergot detection in wheat contaminated with different percentages of ergot, using line scan camera and PLSDA model

Line scan instrument

Three spectral libraries (ergot, wheat and background) were built and discriminant equations were developed in the same way as for the plane scan instrument, using PLSDA as classification method and HyperProVB v1.31 software (BurgerMetrics). In this case, no density-based clustering method was applied. With this instrument, the prediction by the PLSDA model runs in the same time as the image is acquired as shown in the figure here below.



Results provided by the HyperPro program : PLSDA model showing the on line detection of ergot (red) in wheat (blue)

Conclusion

This study showed the potential of hyperspectral NIR imaging to detect and quantify the ergot bodies in wheat kernels, using plane or line scan camera and PLSDA chemometric model. In particular, the results showed that for a wheat sample containing a level of ergot contamination as low as 0.01 %, it has been possible to detect enough pixels of ergot to conclude that the sample was contaminated as shown in the table and graphs here above. Conversely, for samples with 0% of ergot, not enough pixels of ergot were detected to conclude that the sample was contaminated.

References

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