Detection of melamine and its structural analogues using NIR Hyperspectral Imaging spectroscopy

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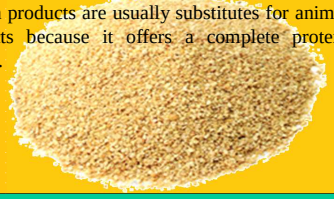
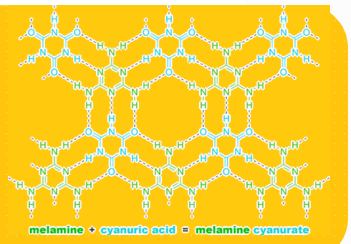
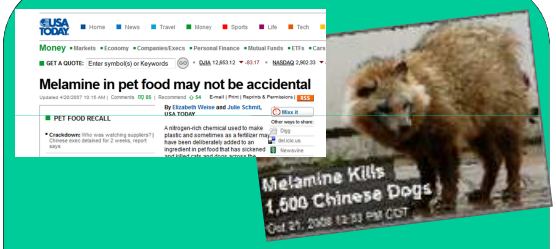
Soybean meal is the material remaining after solvent extraction of oil from soybean flakes. Soy protein products are usually substitutes for animal products because it offers a complete protein profile.

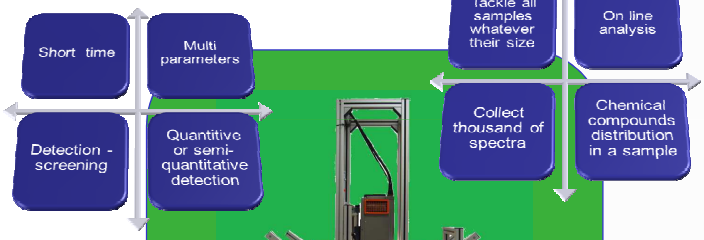


Melamine and Cyanuric acid are organic compounds rich in nitrogen. When combined with formaldehyde they produce melamine-resin, which is widely used in several textiles, plastics, adhesives, flame-resistant products, and some cleaning agents. Melamine and cyanuric acid can combine to form in the kidneys of the animals/infants a crystal called melamine cyanurate.





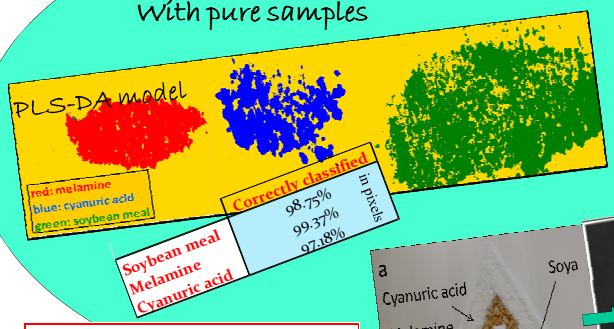
In recent cases, soybean meal has been found to be adulterated with melamine as a protein substitute for animal feed, which can be quite toxic at constant exposure.

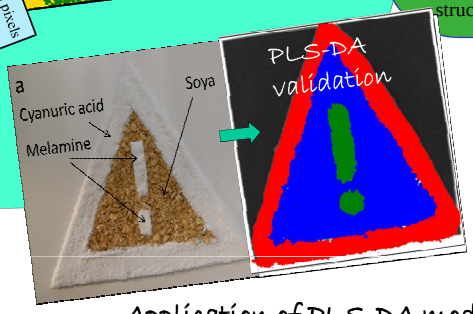


push-broom (line) scan (1100-2500 nm)

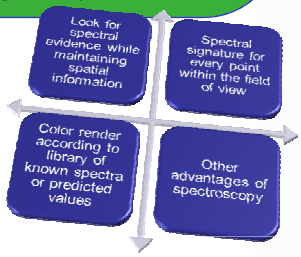
The aim of this work concerns the development of a standardized methodology and algorithm based on NIR Hyperspectral imaging spectroscopy for the acquisition, treatment and interpretation of the images and the spectra as well as for the production of appropriate and optimized answers to the detection of the presence of melamine and its structural analogues in soybean meal.

Model construction and validation With pure samples

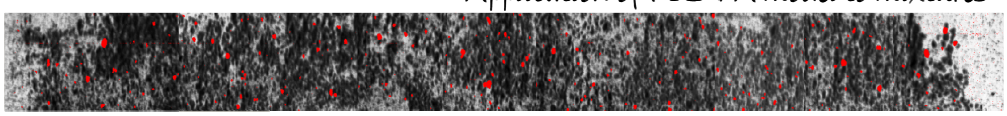


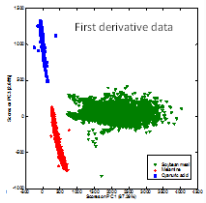


2200 lines x 320 pixels : 704000 pixels (260 MB)
Conveyor belt speed: 0.5 mm/s
Pixel size: 30 µm x 45 µm
Sample weigth: 1 gr
Length: 10 cm
Width: 1 cm



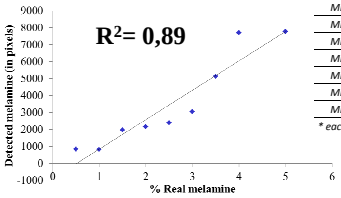
Application of PLS-DA model to mixtures





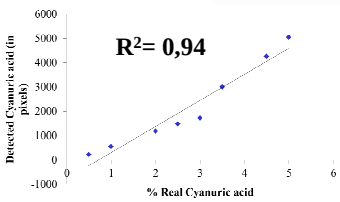
Sample*	% Real melamine	Detected melamine (in pixels)	Detected cyanuric acid (in pixels)	Detected soya (in pixels)
Mix1	0.5	834	48	462043
Mix2	1	831	0	634460
Mix3	1.5	1975	0	568091
Mix4	2	2174	1	636503
Mix5	2.5	2388	0	604950
Mix6	3	3043	0	644489
Mix7	3.5	5134	0	554416
Mix8	4	7700	0	603682
Mix9	5	7771	1	512598

** each sample contains 2200 lines*



Sample*	% Real cyanuric acid	Detected melamine (in pixels)	Detected cyanuric acid (in pixels)	Detected soya (in pixels)
Mix10	0.5	4	223	677264
Mix11	1	8	556	546939
Mix15	2	0	1183	626962
Mix12	2.5	15	1476	639837
Mix13	3	3	1727	464566
Mix16	3.5	4	3006	222171
Mix14	4.5	2	4264	567847
Mix17	5	13	5045	421928

** each sample contains 2200 lines*



The results shown here indicate that NIR hyperspectral imaging can be detect the presence of melamine in soybean meal. Further work need to be done to confirm the sensitivity and specificity as well as quantification of the method. But it can be concluded that NIR Hyperspectral Imaging is a useful technique to detect the presence of a non conformity (contamination and fraud) in feedstuffs.

References

Baeten, V., Fernández Pierna, J.A. & Dardenne, P. (2007). *Hyperspectral imaging techniques: an attractive solution for the analysis of biological and agricultural materials*. In: Techniques and Applications of Hyperspectral Image Analysis, Editors, Hans F. Grahn & Paul Geladi.

Fernández Pierna, J.A., Vermeulen Ph, Amand O., Tossens A., Dardenne P. & Baeten V. (2012) NIR hyperspectral imaging spectroscopy and chemometrics for the detection of undesirable substances in food and feed. Chemometrics and Intelligent Laboratory Systems, 117, 233-239.

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