Miniaturized NIR devices: application to skimmed milk powder authenticity

Yannick Weesepoel – Wageningen Food Safety Research

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100years
1918 — 2018

Researcher @ RIKILT since 2014

Food Chemist - Authenticity

Food Scanner research

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Yannick Weesepoel
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Onderzoeker in Fraude en Authenticiteit van Voedsel bij RIKILT - Wageningen UR. Gepromoveerd Levensmiddelenchemicus.

Wageningen, Gelderland
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Joined June 2014
27 Photos and videos

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Yannick Weesepoel @YWeese
Voedselscan met de mobiel (video)

Translate Tweet

Voedsels
Explosieven opsporen? Onderzoeken of voedsel veilig is? Daarvoor bestaan allerlei mobiele apparaten. Vorige week kwamen medewerkers van onder andere de dou...
resource.wur.nl

Yannick Weesepoel @YWeesepoel · 4h
Meet our mobile food lab tomorrow at #WUR100 innovation square, tests for mycotoxins in beer and pollutants in distilled spirits @WURrikilt

Rapid food safety testing
RIKILT is constantly developing new methods to analyse substances in food. Besides more substances, we also want to measure with greater accuracy, faster and seve...
wur.nl

3 | 5

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WUR RIKILT @WURrikilt · Jun 17
'The mobile #foodlab in your pocket', een lezing van @WURrikilt collega's Toine Bovee en @YWeesepoel over de geschiedenis én toekomst van mobiele voedselkwaliteitstesten tijdens de @WUR World Wide Alumni #Reünie. Meer weten over zaterdag 23 juni? bit.ly/2JUlOfm

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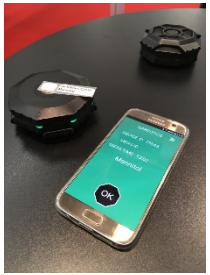
Food scanners anno 2019



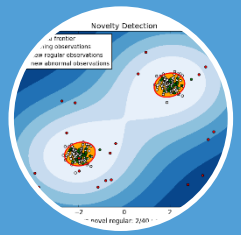
Mass products 0.2-2k€

Portable (5-20+k€)

Lab (20-50k€)

Decision support system

(Portable) Optics advanced / simple



Statistics, rules based techniques, machine learning, deep learning, edge computing

Reference database with verified representative samples

The hardware in this talk

Development Evaluation Toolkit

Enables businesses to develop and evaluate their own molecular sensing models. It requires some prior NIR knowledge.

Includes a SCiO sensor + small object and shade + a single license for The lab modeling software tools

Also includes libraries, sample code and documentation that enable the integration of SCiO functionality in your own mobile app.

$950

Buy Now

NEW

Tellspec Enterprise Scanner

Price US$1899

- Reflective near-infrared spectroscopy.
- Uses Texas Instruments' digital light processing (DLP) chipset.
- Market target B2B; ideal for rapid, nondestructive food quality and food fraud detection.
- Works with all mobile applications below
- Spectral Wavelength: 900nm to 1700nm

Buy Now | Request More Information | Download product specifications

MicroNIR OnSite-W

Interdisciplinary Collaboration Dutch Government Laboratories

- Field of mobile techniques & chemical analysis
  - Customs lab of The Netherlands
  - Netherlands Forensics Institute
  - National Institute for Public Health and the Environment
  - Wageningen Food Safety Research
- **Samples:** drugs of abuse (cocaine and other substances), synthetic drugs (XTC, MDMA, 2CB, 4FA etc.), counterfeit medicines (Amoxicillin), explosives and weapons substances (knitting bombs, gun powders), food safety and authenticity issues (milk powders, distilled spirits)

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Visit Poster V4 on Wednesday!

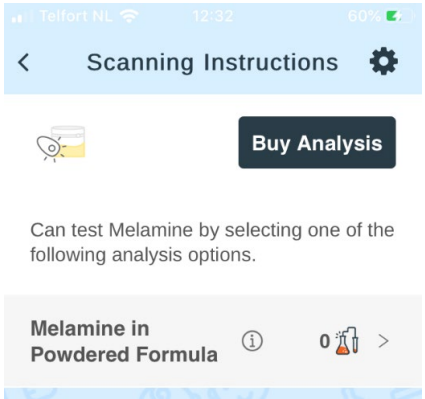
Skimmed milk powders from monitoring program

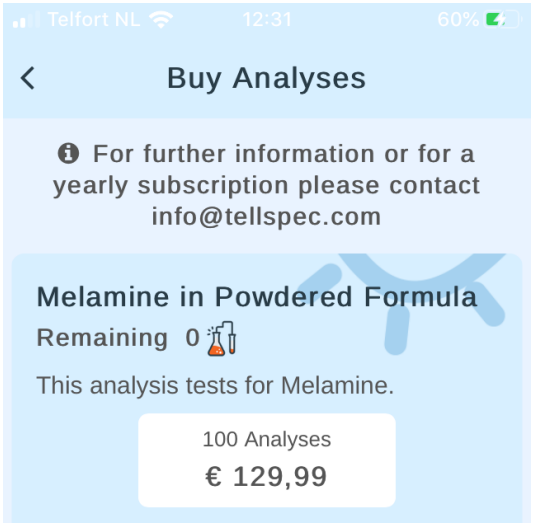
SMP	Protein (%)	Fat (%)	Moisture (%)
1	32.8	0.5	3.5
2	38.6	0.6	3.5
3	34.8	0.5	3.5
4	38.0	0.5	4.0
5	32.4	0.4	3.6
6	37.1	0.6	3.7

ISO 21543:2006(en)
Milk products — Guidelines for the application of near infrared spectrometry

Pollution scheme for SMPs

- 6 SMP's polluted with:
  - 3 Soy powders, 5 whey powders (1 – 50% (%*w/w*))
  - Ammonium Cl, Melamine, Urea (0.1 – 10% (%*w/w*))
  - Always 1 SMP + 1 pollutant
- Total unique samples: 49





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In this talk on exploring handheld NIRs for SMPs

- Comparison of performance of NIR units
    - Discriminative power (PCA)
    - Data pre-processing
    - Adulterant quantification (PLSR)
        - Can we make an ‘all-round’ model?
        - What is approximately the LOD for individual adulterants?
- Conclusions and Prospects

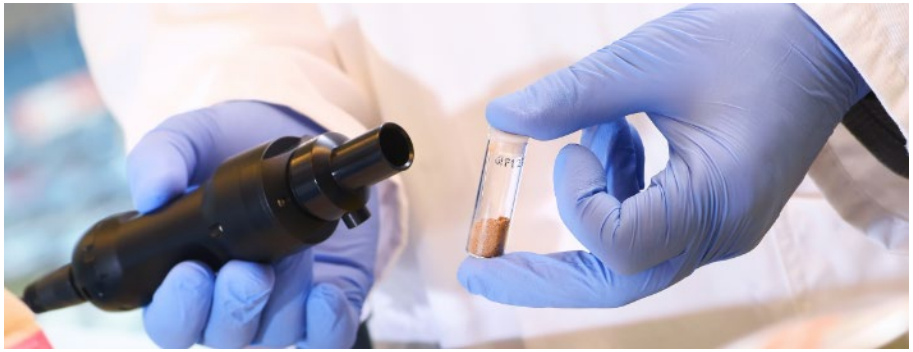
General mode of operation for NIR scanners

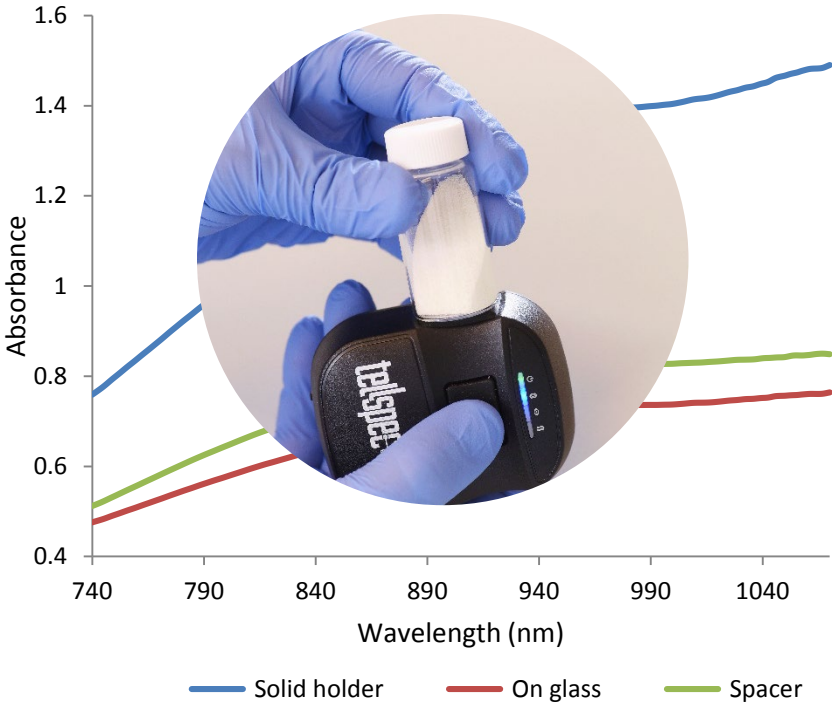
SMP sample set NIR spectra

Outlier removal (Visual; PCA)
data transformation (SNV; 1st Derivative; 2nd Derivative)
(Variable selection)
PLS model

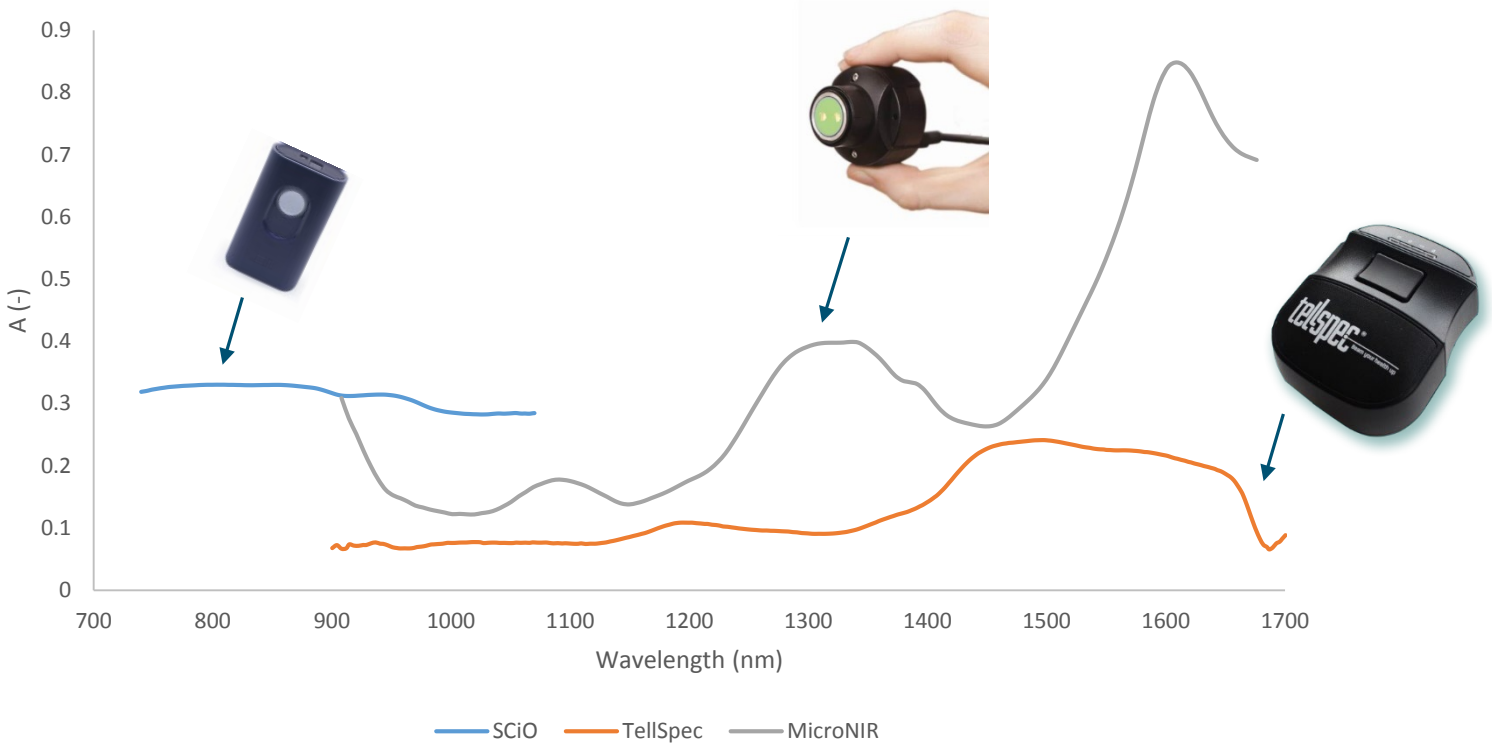
Feasibility on RMSEC
(When R^2 is ok)

Influence of sample presentation (nutmeg)



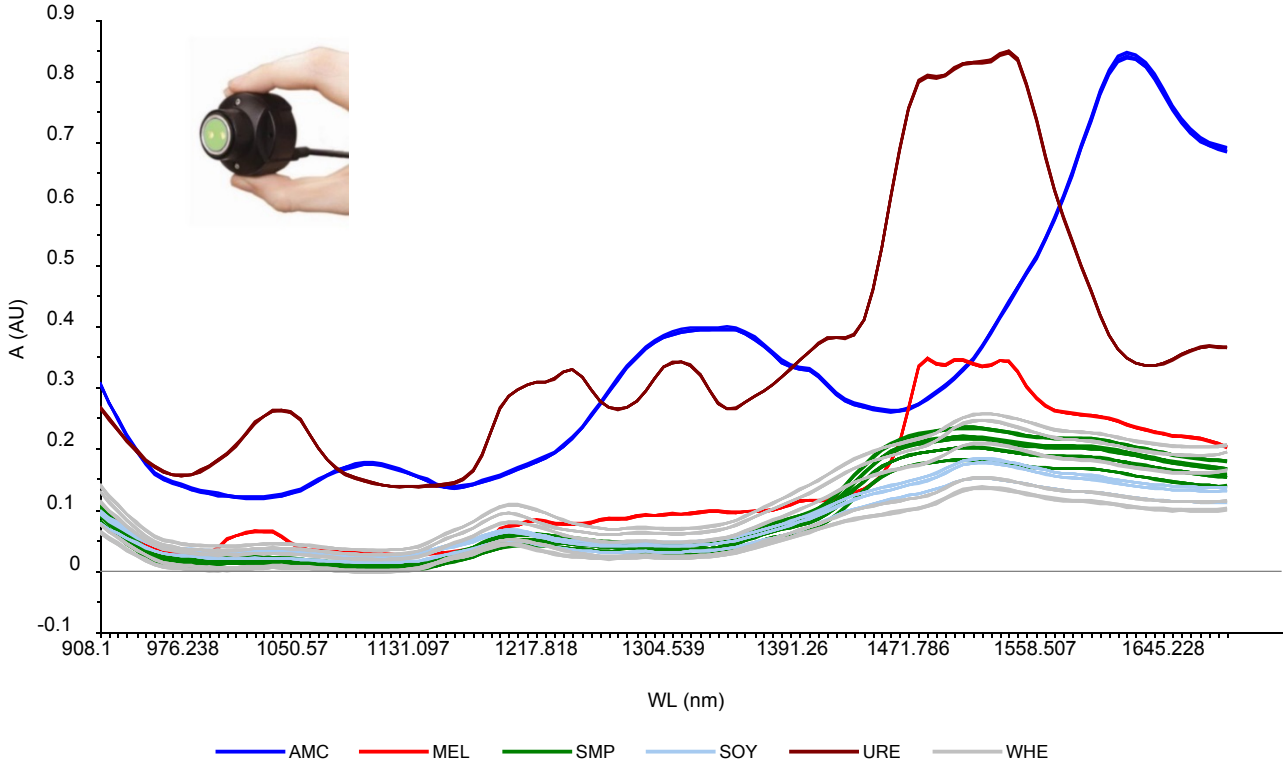


So what are we dealing with here?

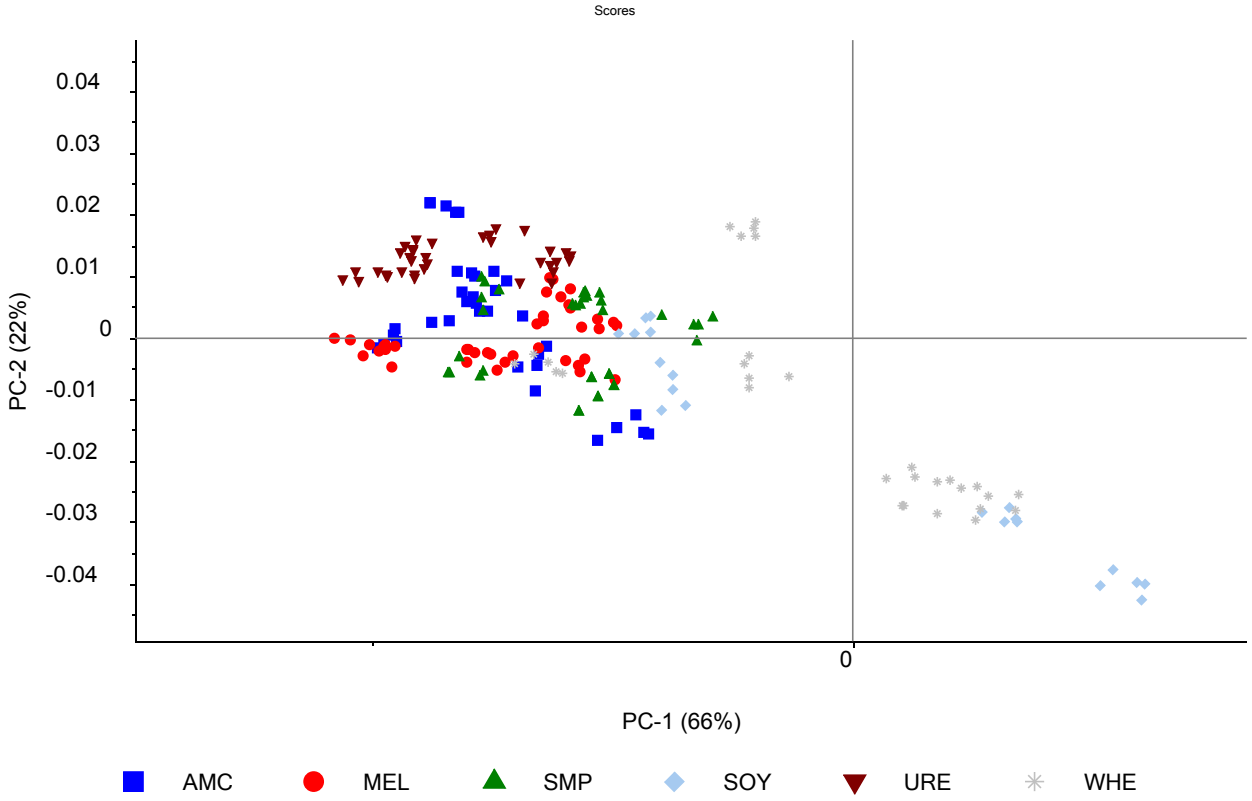


Displayed: scans of skimmed milk powder

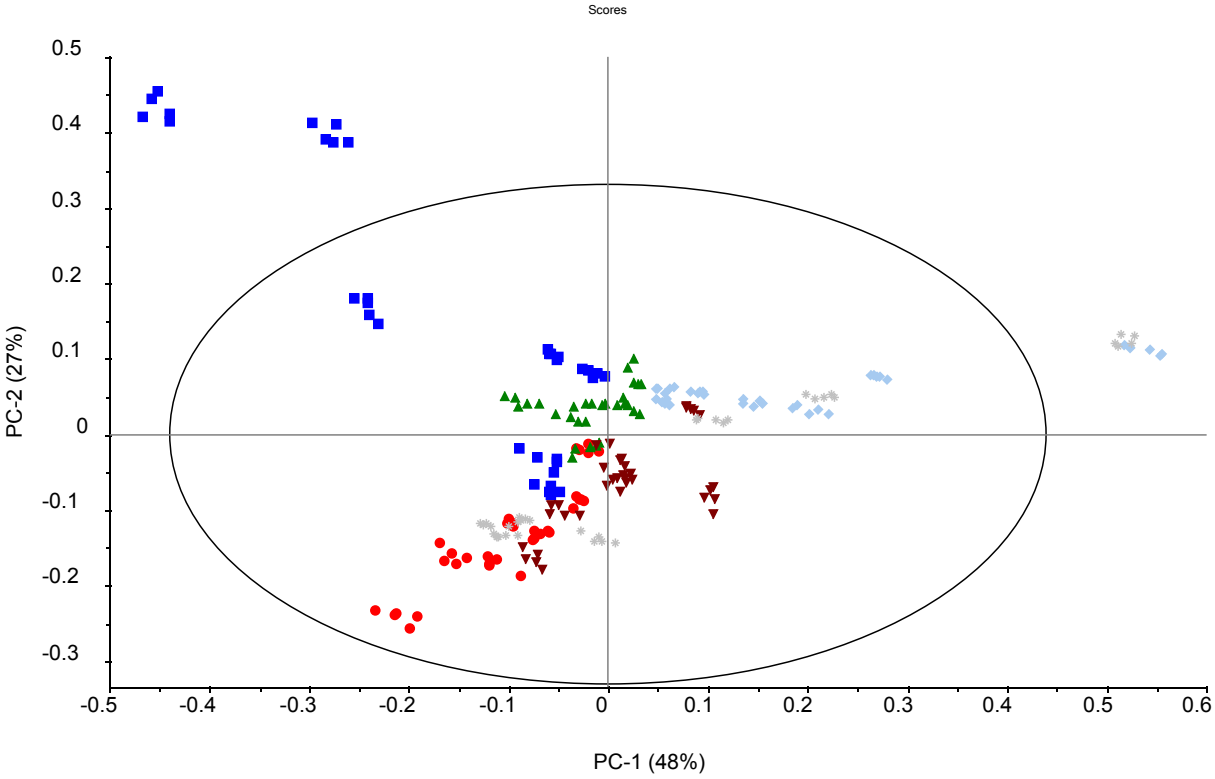
Discriminative power – Raw materials, raw data



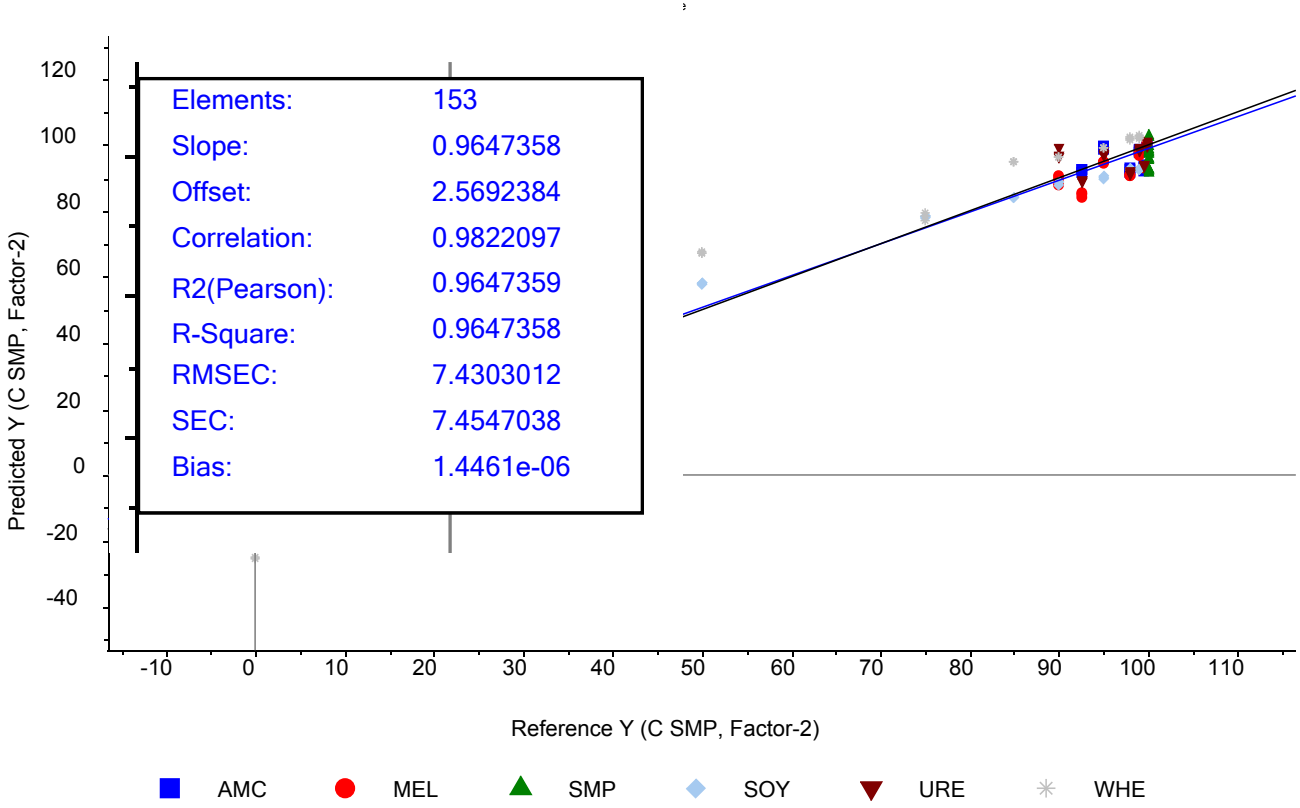
Discriminative power – Mixtures, Der1 data, PCA



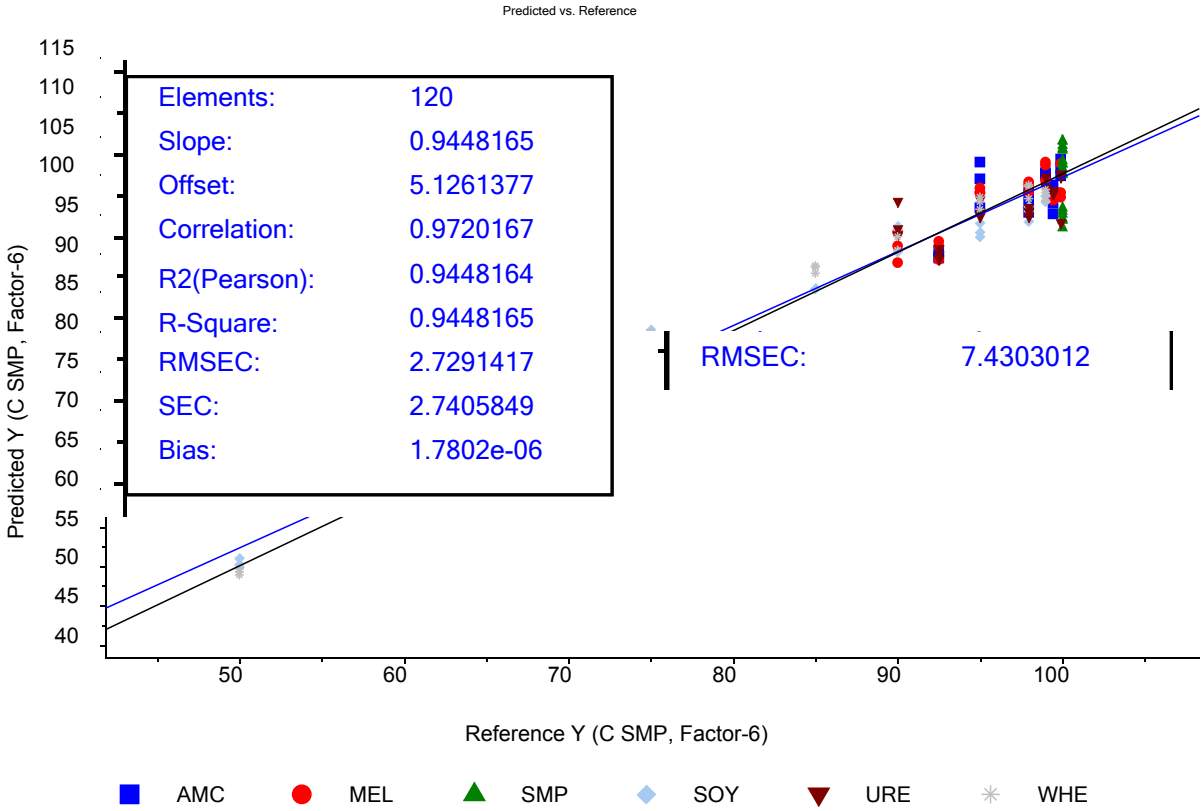
Discriminative power – Mixtures, SNV data, PCA



Exploration of an ‘all-round’ PLSR model (der2)



PLSR, include **all** samples? (der2)



Influence of pre-treatment on RMSEC (all-round model)?

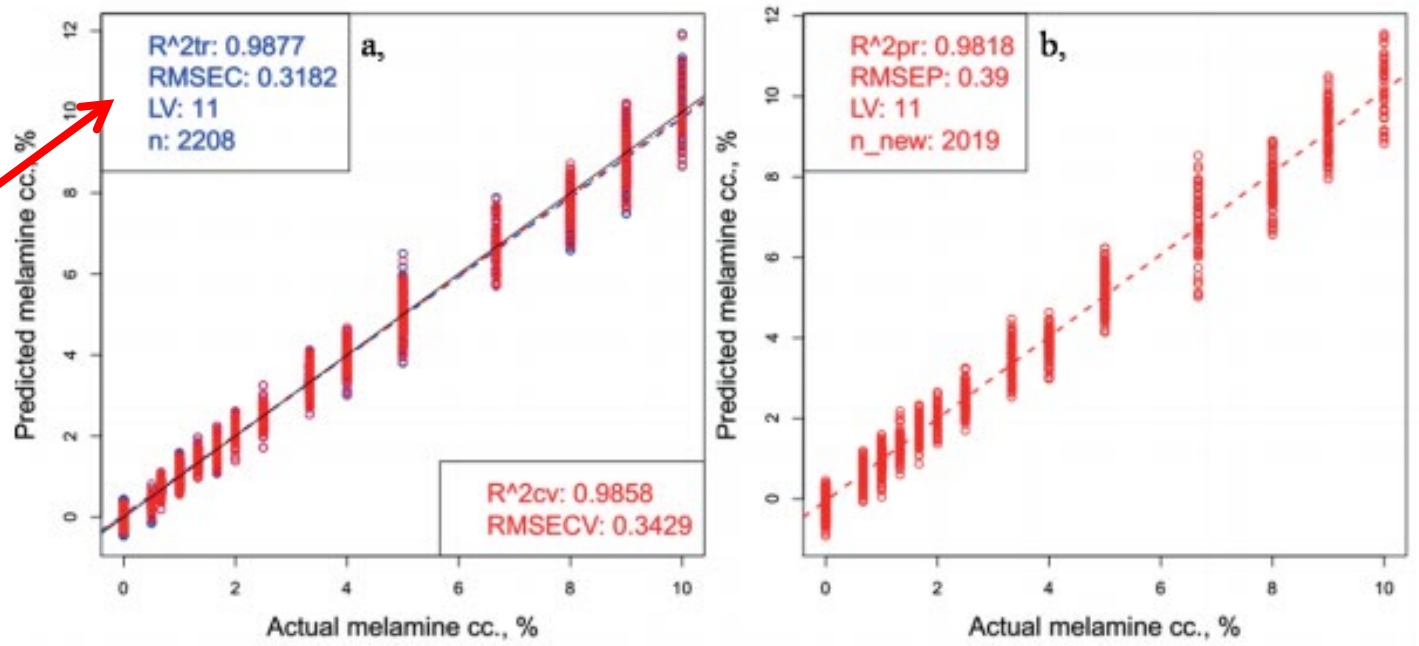
		SNV	Der1	Der2
	SCiO	3.9	4.0	4.0
	Tellspec	4.6	4.6	2.7
	MicroNIR	3.1	2.8	3.6

For each adulterant an individual model (RMSEC)?

	Fillers	AMC	MEL	URE
 SCiO (Der1)	4.3	0.8	1.3	0.5
 Tellspec (Der2)	2.5	0.7	0.5	1.0
 MicroNIR (Der1)	3.2	0.5	0.4	0.4

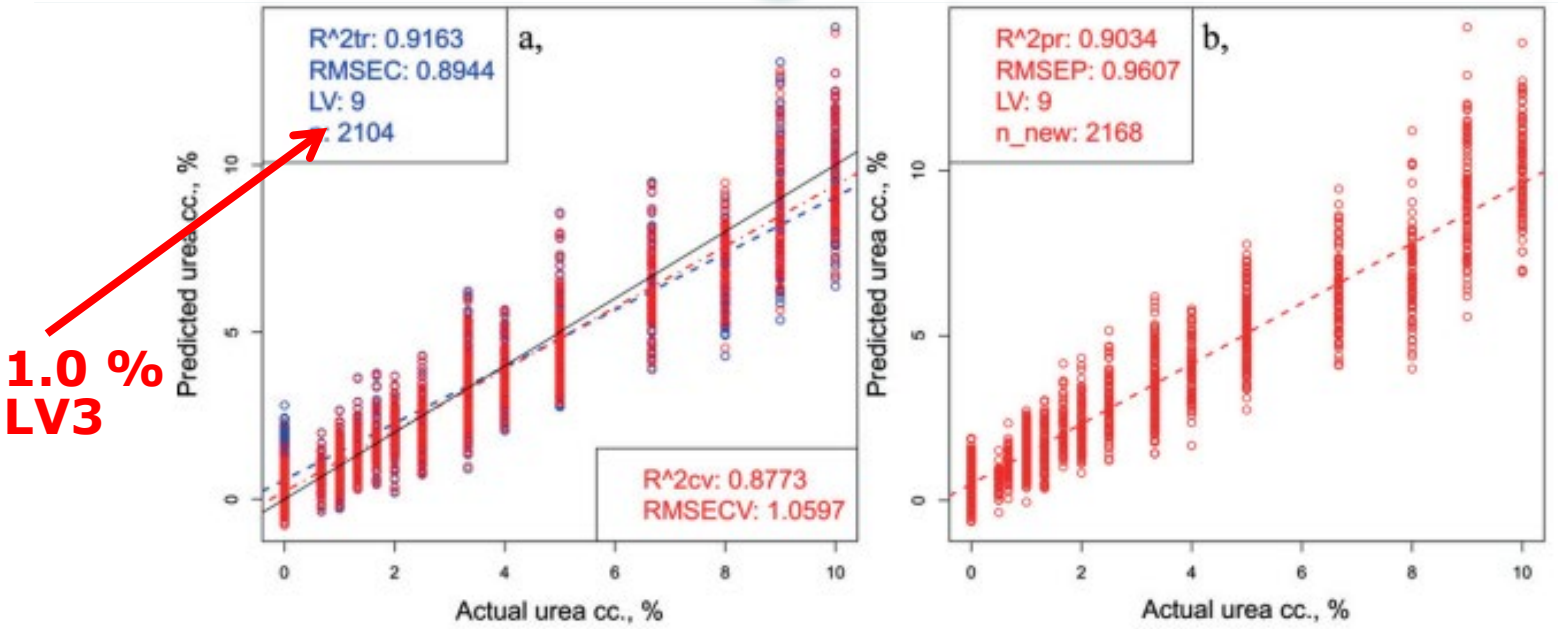
Comparison with publication (**Melamine** in **Wheat** n=10)

0.5 %
LV: 2



Kovacs, Z., et al(2017): Simultaneous detection of melamine and urea in gluten with a handheld NIR scanner. In: OCM 2017: 3rd International Conference on Optical Characterization of Materials

Comparison with publication (**Urea** in **Wheat** n=10)



Kovacs, Z., et al(2017): Simultaneous detection of melamine and urea in gluten with a handheld NIR scanner. In: OCM 2017: 3rd International Conference on Optical Characterization of Materials

Concluding remarks

+ Price, availability, mobile - short range, deg. Freedom

+ Range, mobile - data acquisition (app), chemometrics

+Speed, robustness, range, chemometrics - price

Thank you!

Colleagues @ WFSR

Colleagues Dutch Labs:

G. Koomen (DL) M. Heerschop (DL) F. Bakker (RIVM) P. Keizers (RIVM) M. van der Geest (NFI) A. van Esch (NFI) A. Hulsbergen-van den Berg (NFI) F. Wallace (NFI) A.C. van Asten (UvA/NFI), Ruben Kranenburg (Police/UvA)