Next-Generation Food Authentication Analysis Technology

Yannick Weesepoel – RIKILT, Wageningen University and Research

Food Sure Summit – May 23rd 2017 - Amsterdam

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Twitter, Inc. [US] | https://twitter.com/YWeesepoel

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Researcher @ RIKILT since 2014

Food Chemist - Authenticity

Food Scanner research

TWEETS 77 FOLLOWING 211 FOLLOWERS 66 LIKES 8 MOMENTS 0

Edit profile

Yannick Weesepoel

@YWeesepoel

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

Wageningen, Nederland

wageningenur.nl/en/Persons/Yan...

Joined June 2014

10 Photos and videos

Tweets Tweets & replies Media

Pinned Tweet

Yannick Weesepoel @YWeesepoel · Feb 10

KvW over Saffraan! keuringsdienstvanwaarde.kro.nl/seizoenen/2017... @Pathh1

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Find friends

Trends · Change

#BulkAlert

Nu 10 dagen lang Super Deals bij bol.com!

Promoted by bol.com

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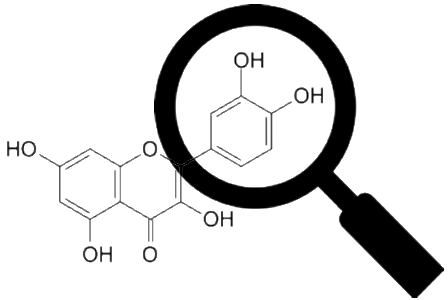
2

Food Authenticity & Analysis

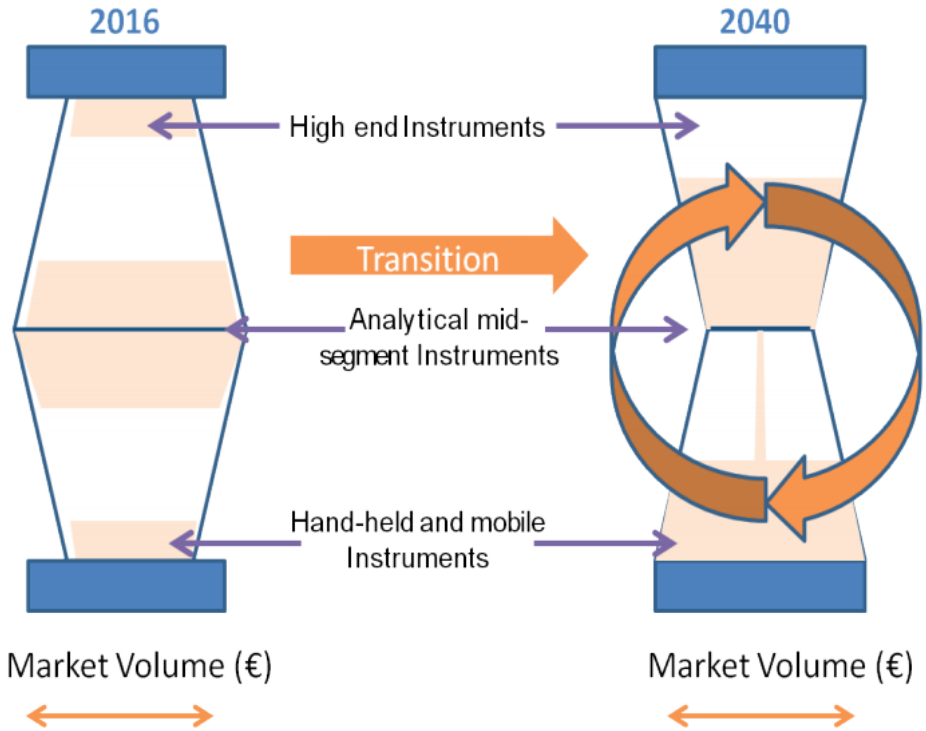
Determining value of the product

Authentic or … ?



Targeted
vs.
non-targeted analysis

Market transition



Source: Citizen Science Innovation Initiative

Trends in Food Analysis

The RIKILT method to detect toxins in seafood

Toxins in seafood are harmful to human health. Therefore, it is of utmost importance to detect them. Current methods to test toxins in seafood cost hundreds of thousands of mice annually worldwide. In the Netherlands, we do not use mice, but an analytical method, although it cannot detect all toxins yet. Therefore, as an alternative, RIKILT uses a cell based effect assay. This test is inexpensive, efficient, animal friendly, and offers the consumer, ultimately, more safety.

Animal friendly

1. Method saves over 300,000 mice per year.

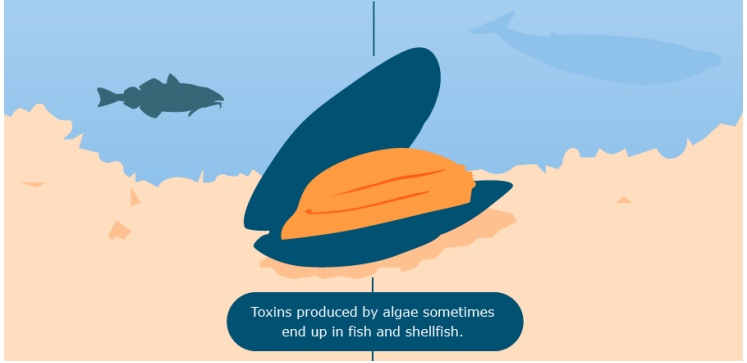
Rapid and inexpensive

2. Expensive and time-consuming analysis is no longer required.

Safe for consumer

3. Method shows both known and new toxins.

Discover how we do this



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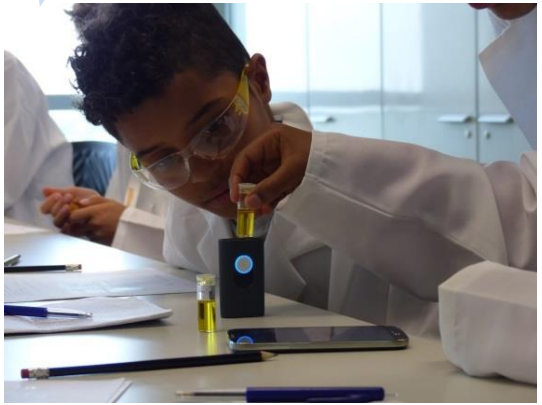
“Democratizing”* spectroscopy

Consumer
0.2-2k€

Portable
(5-20k€)

Lab
(20-50k€)



*Quote: D. Goldring - ConsumerPhysics

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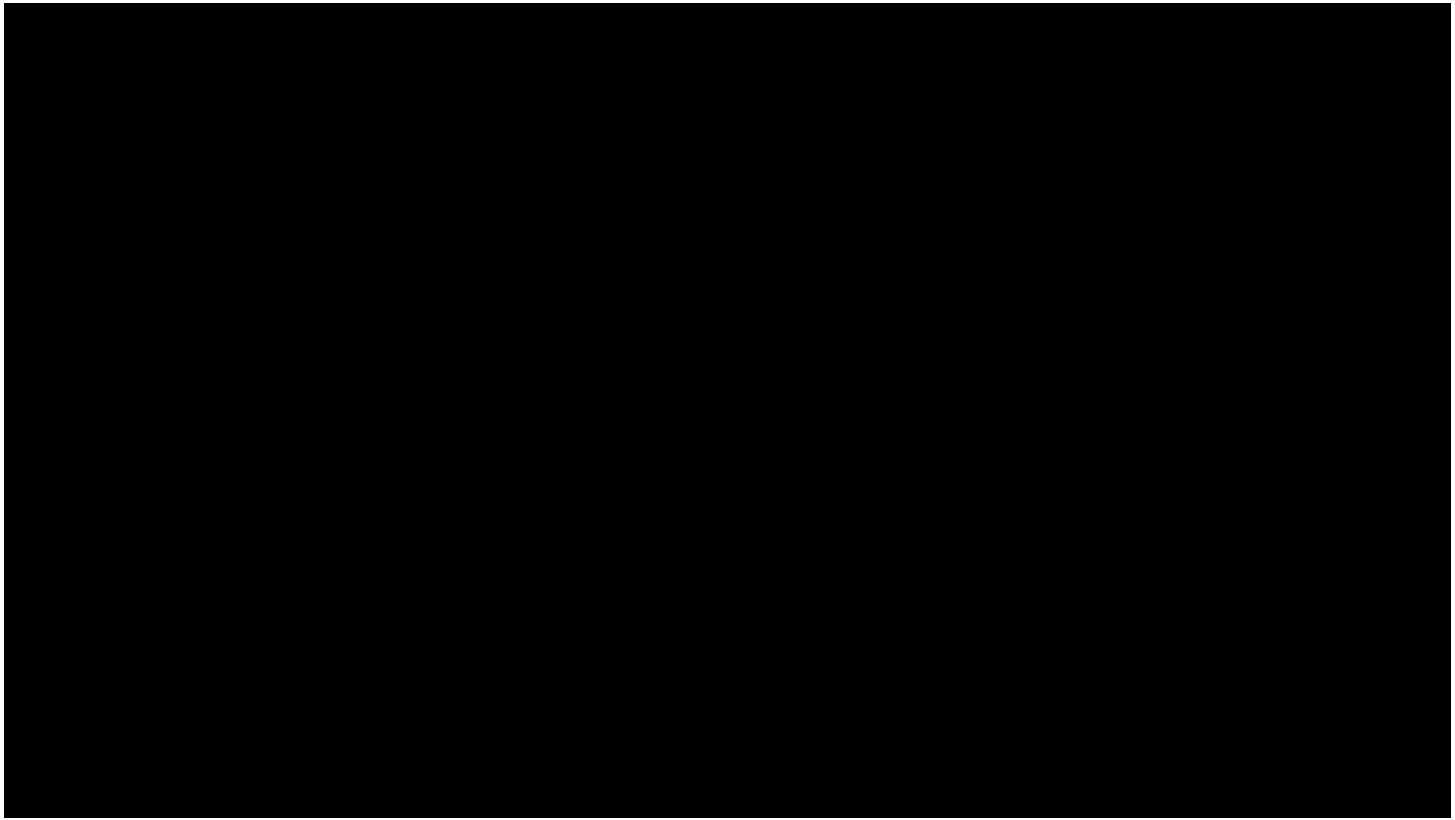
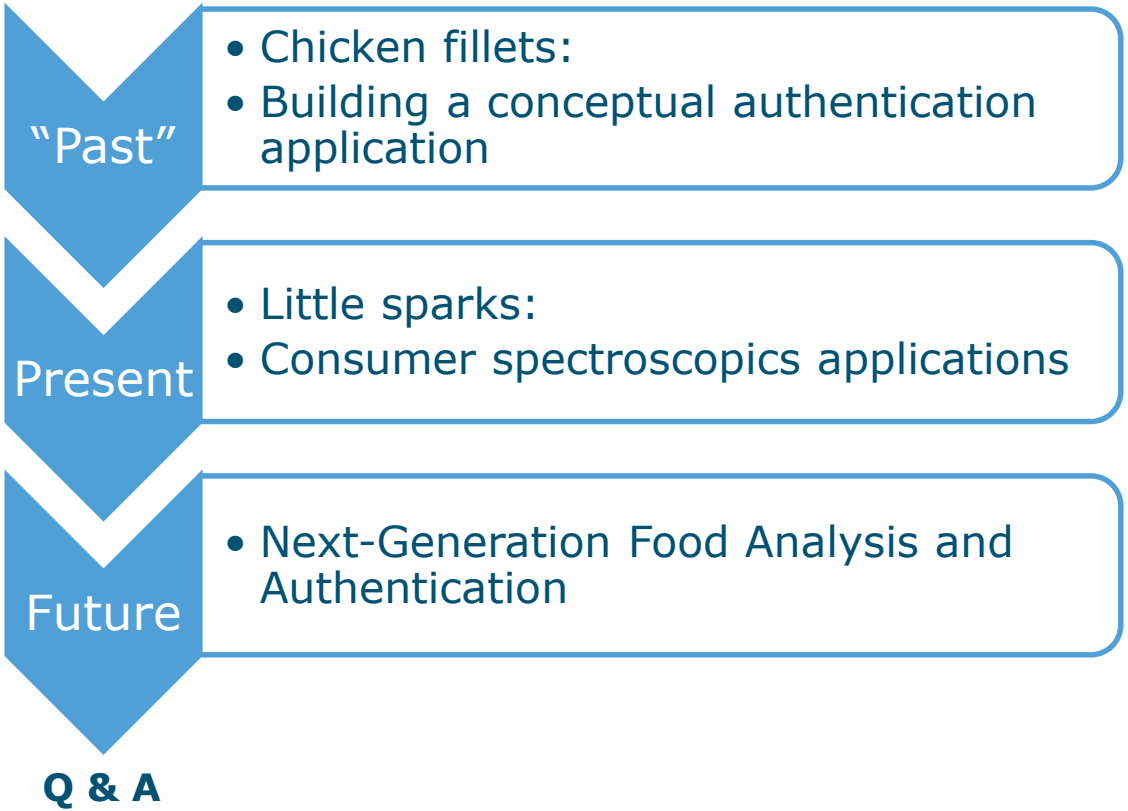
Smartphone sensors – Expected *very* soon



In Today's Talk

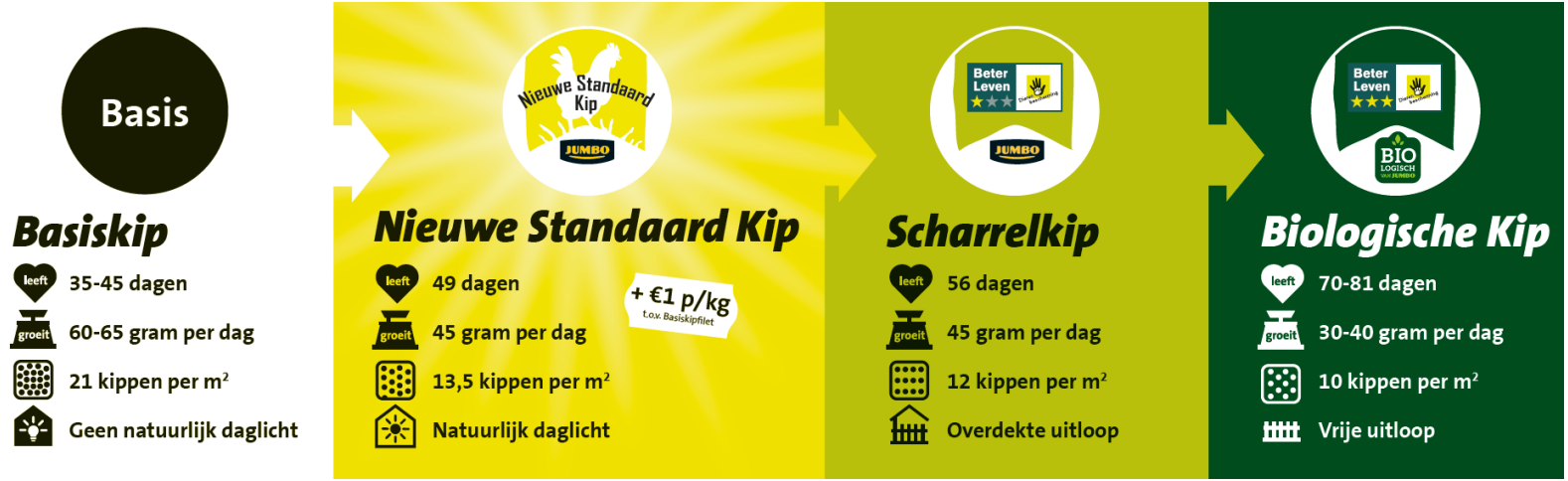


Past - Case Study: Chicken fillets

Macro component: Moisture/Protein

Micro component: Chilled vs. Thawed

Increase in animal welfare awareness



'Basic' chick
€ 5 – 7 / kg

'New standard' chick
€ 6 – 9 / kg

'Free range' chick
€ 11 – 13 / kg

'Biological' chick
€ 25 – 27 / kg

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Real-life
Stray light
Day-to-day light
Day-to-day Temp.
Ref. Material?
Human factor
Day-to-day equipment
Sensor position
Floc variation
Slaughter House
Packaging
Transportation
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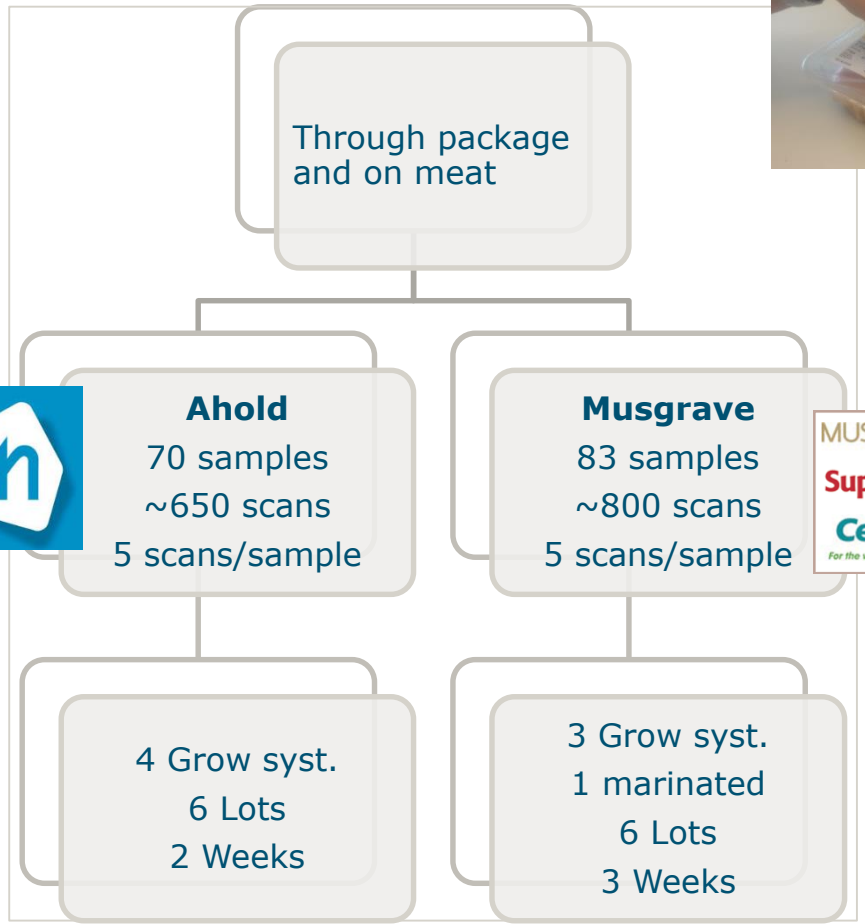
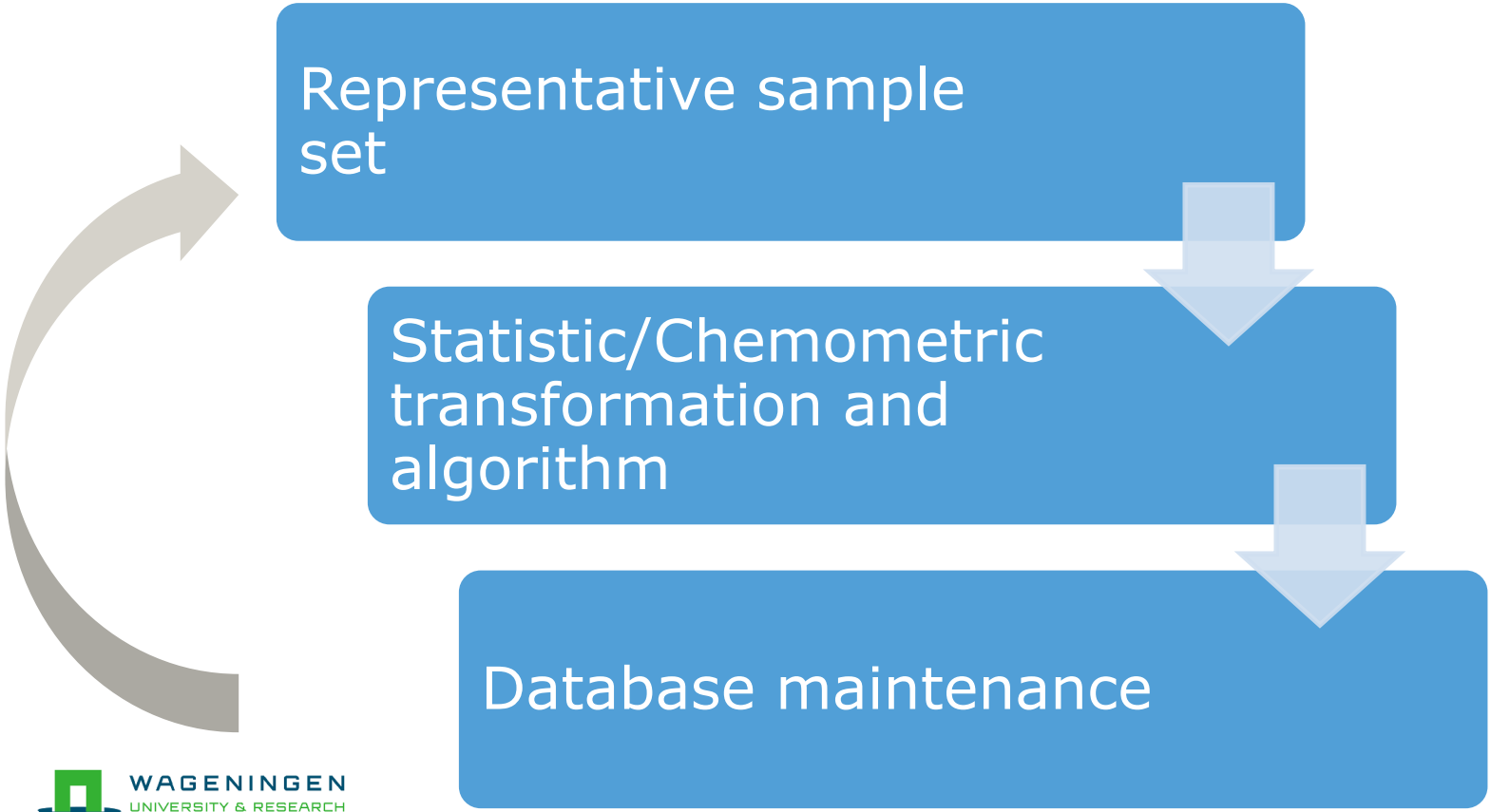
Sample plan



Reference methods for:

- "Freshness" (in-house HADH method)
- Moisture content
- Protein content

How to ‘teach’ your scanner



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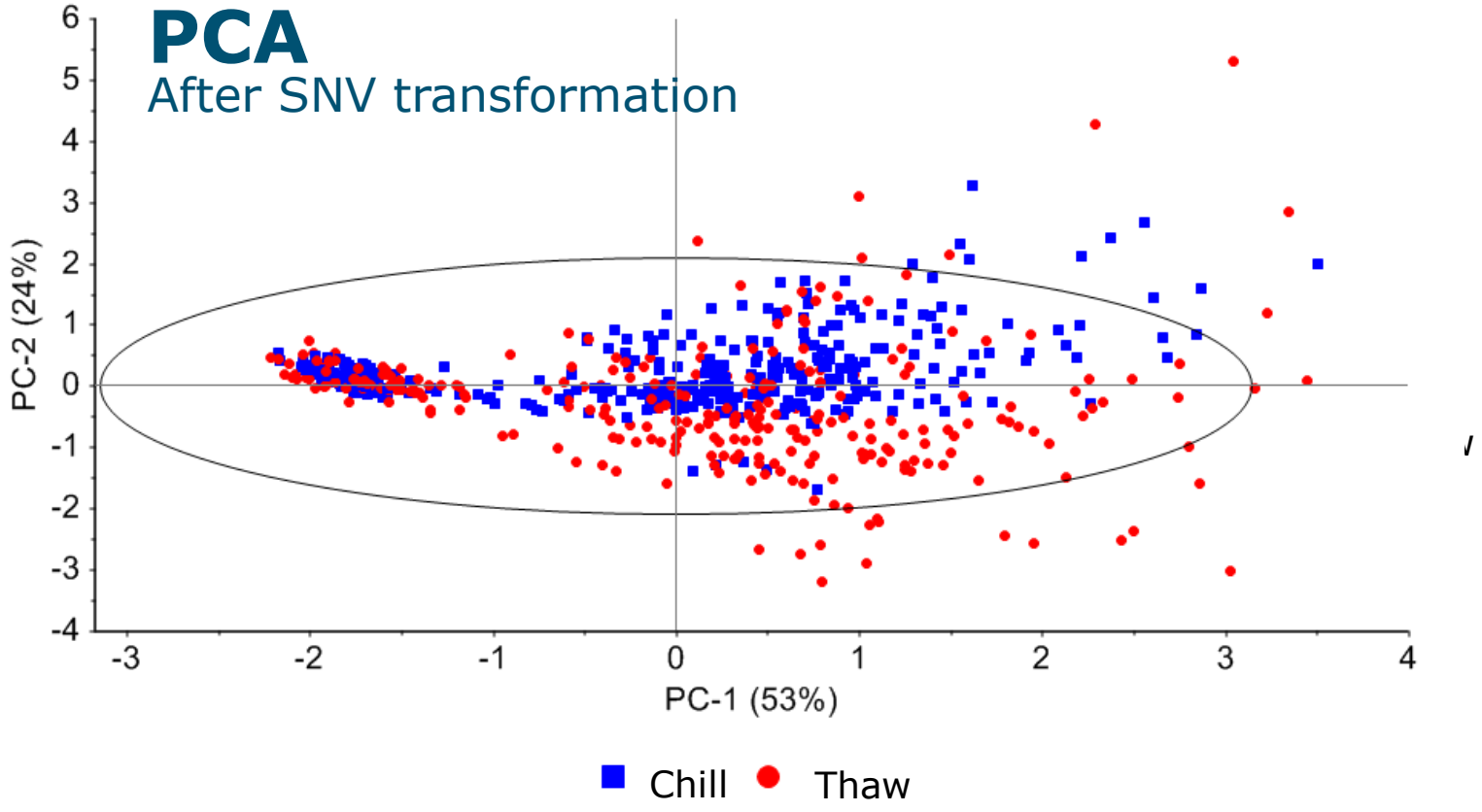
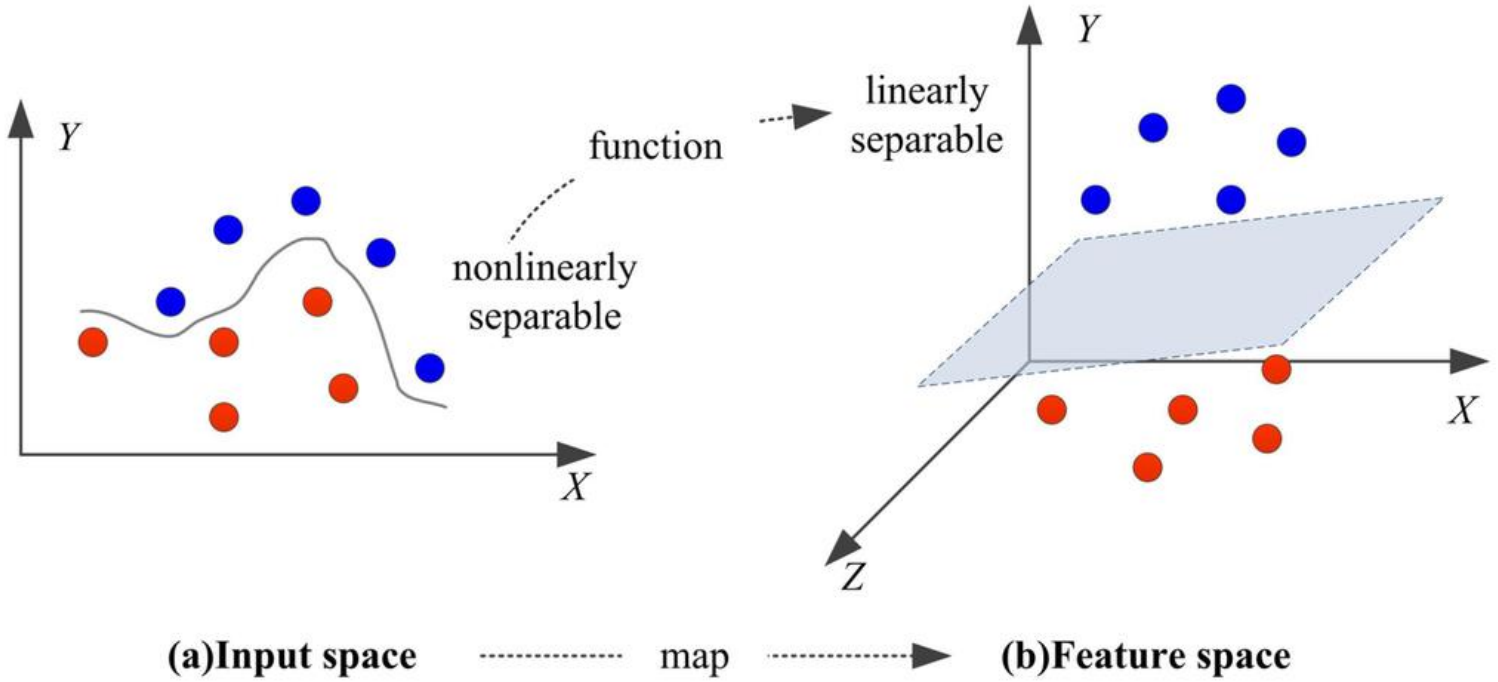
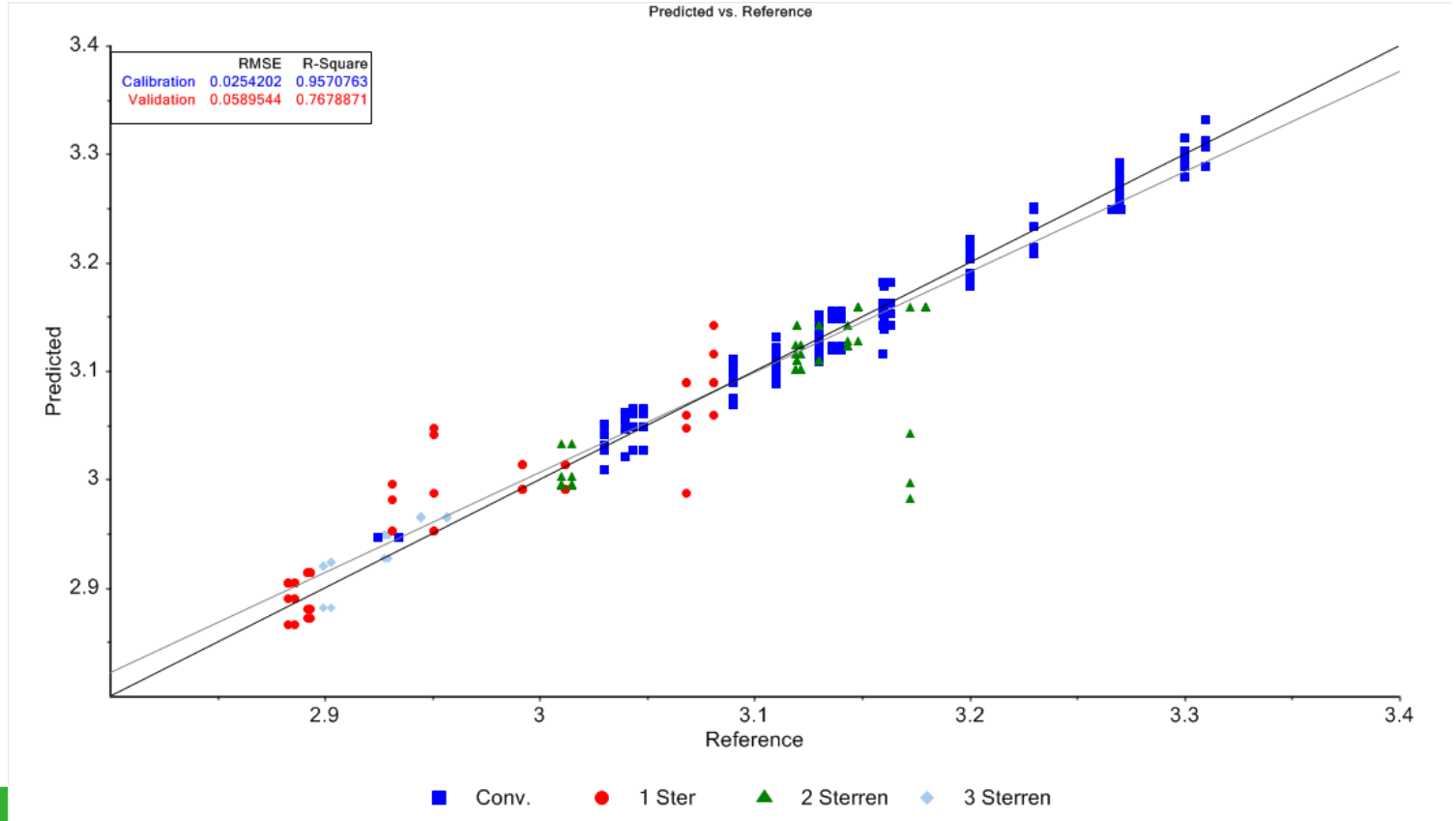
Spectroscopic data is relatively chaotic



Machine learning: e.g. Support vector machine

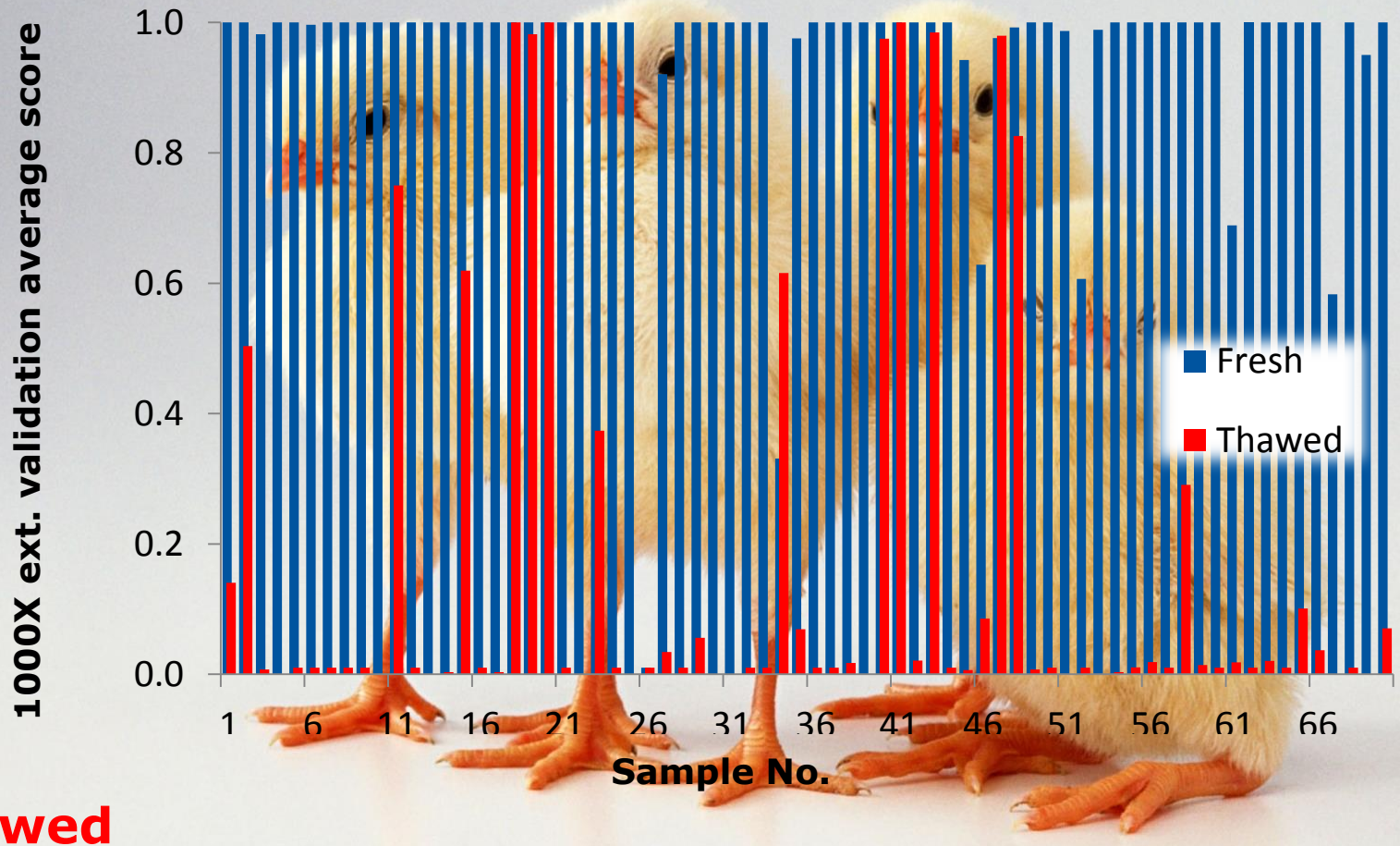


Moisture-Protein ratio by machine learning



Predicted as:

Chilled



Thawed

Lessons learned from the fillet case

- Moisture and protein regression promising
- 95% correct prediction of chilled products and 80% for thawed products → In the lab!

→Transferability outside lab?

→How do you cover all chicken meat in the world?

→Relatively expensive scanners for an authenticity problem

→NIR has limitations! Realistic expectations

Present: Consumer spectroscopics

Spectroscopic analysis

Short-wavelength near infrared (SW-NIR) 750-1059 nm

Smartphone

Easy to use

Time: ≈ 5 sec

Modelling

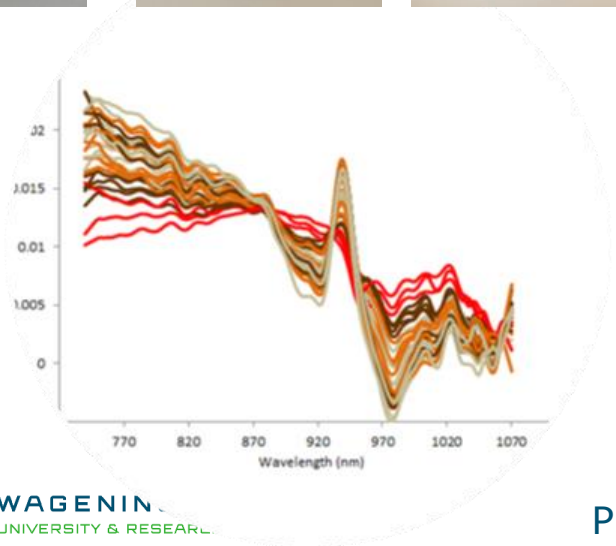
Classification

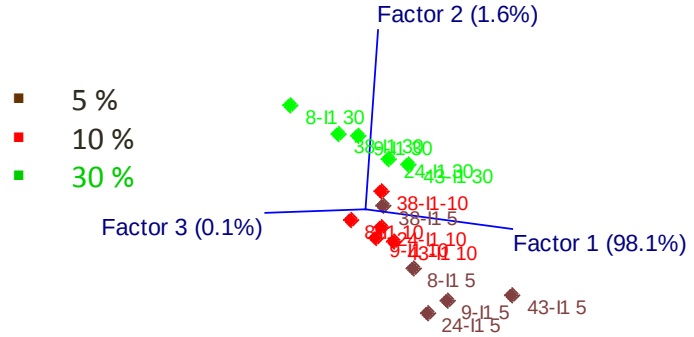
To which of the defined classes does the sample belong?

Estimation

What is the concentration of x in the sample?

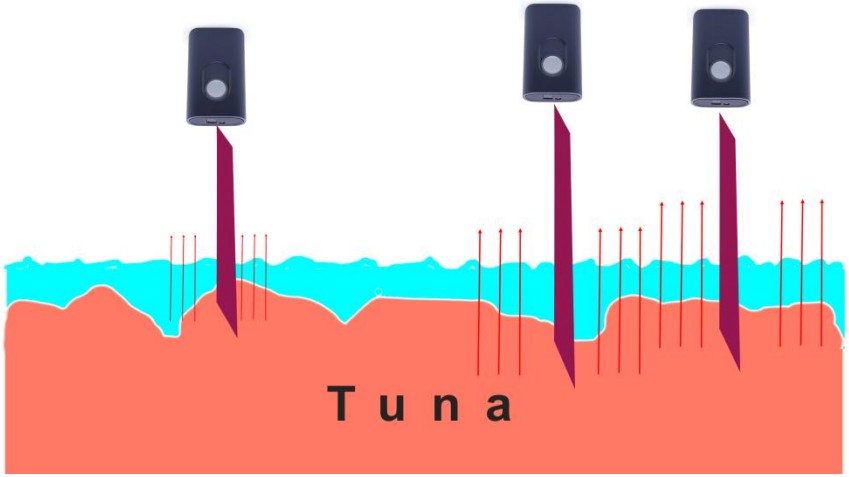
Powders: Adulteration of ground nutmeg

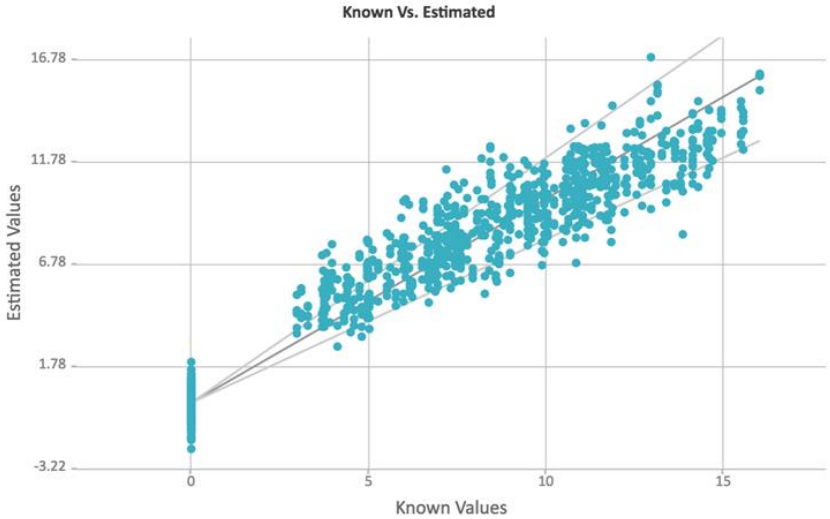




Pilot: Approximately 30% adulteration detectable

Frozen produce: Fish Glaze





Pilot: Accuracy approximately 3%

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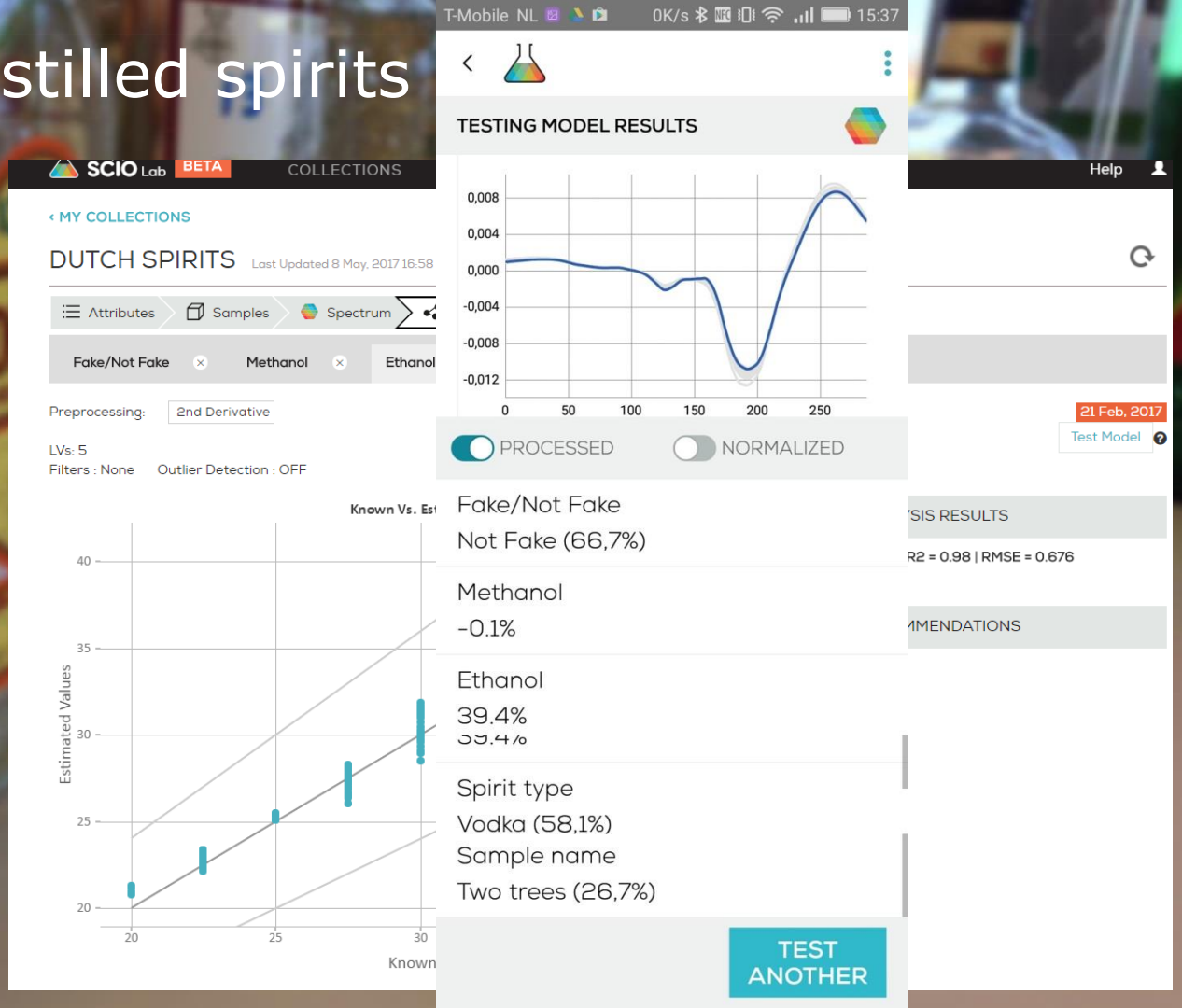
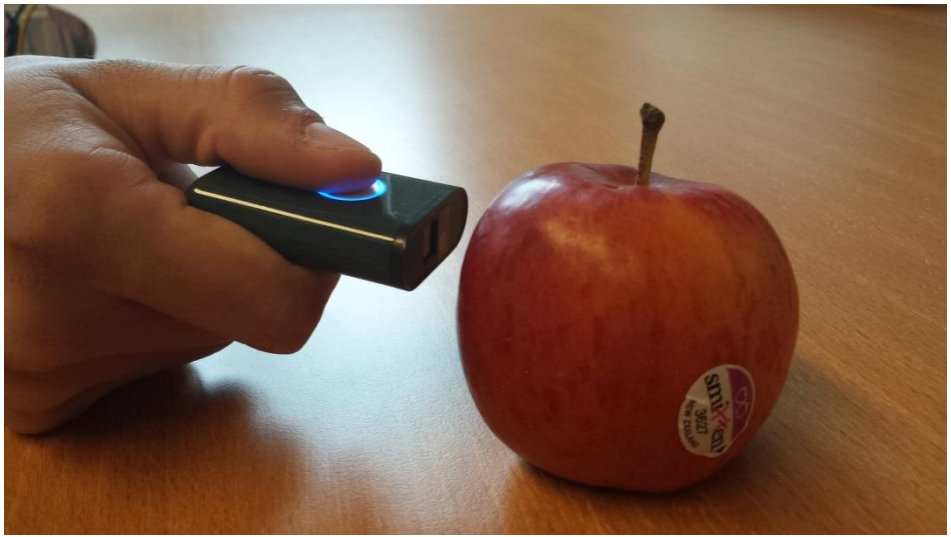
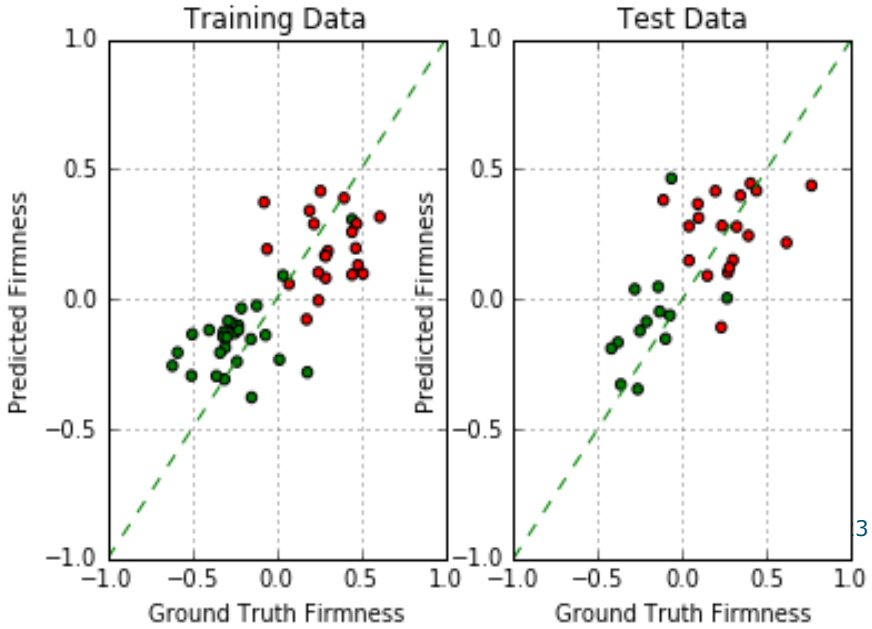
pH7

Liquids: Distilled spirits



Fruits: Sensing of firmness





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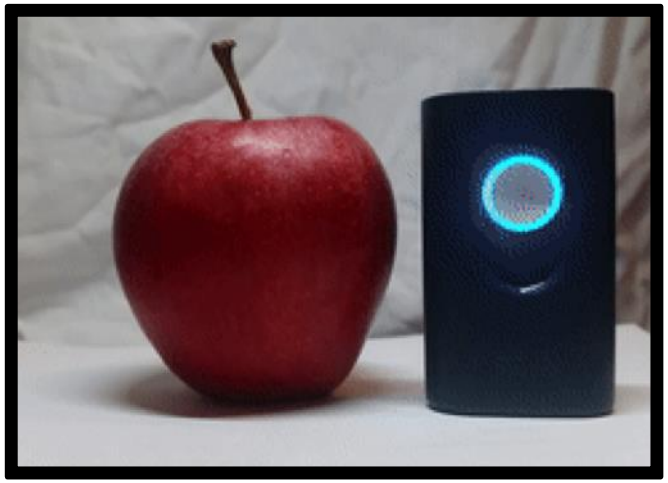
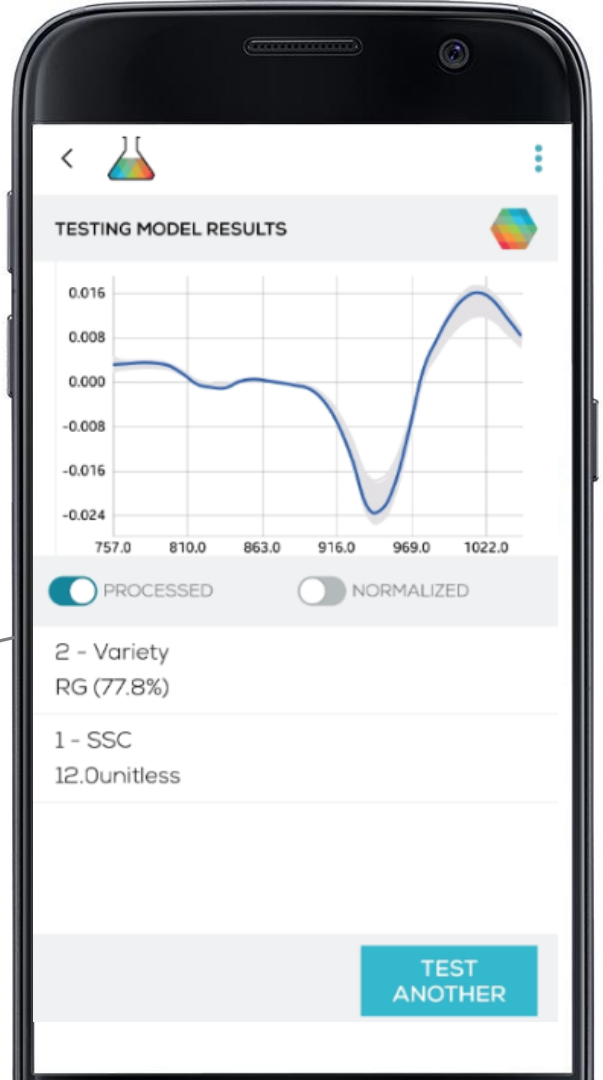
Sensing of Fruits





Variety: Variety X (78%)

Soluble Solids Content: 12%

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Still...

- What happens when consumers start using the models?

PhD

Mom

Student

Gf(!) - Dad

Phd

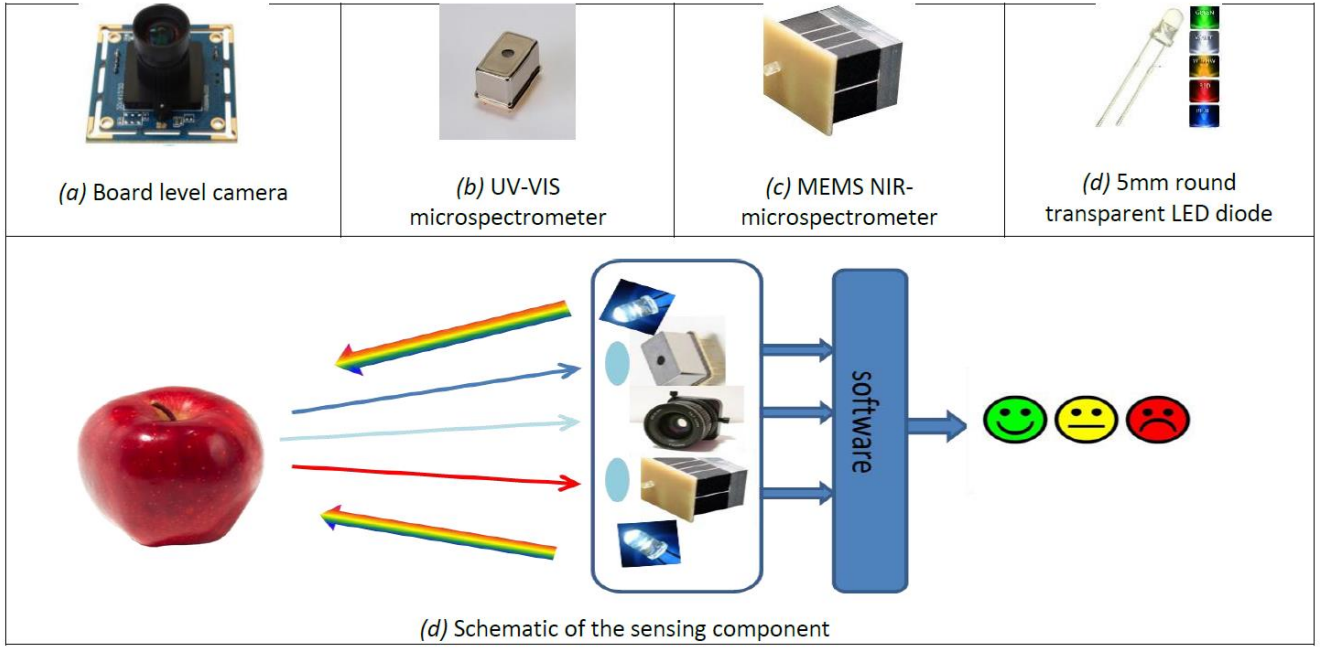
Student

Me

- What about...
  - Toxins, allergens, pesticides, ...
  - Shelf life of products
- 'Universal device'?

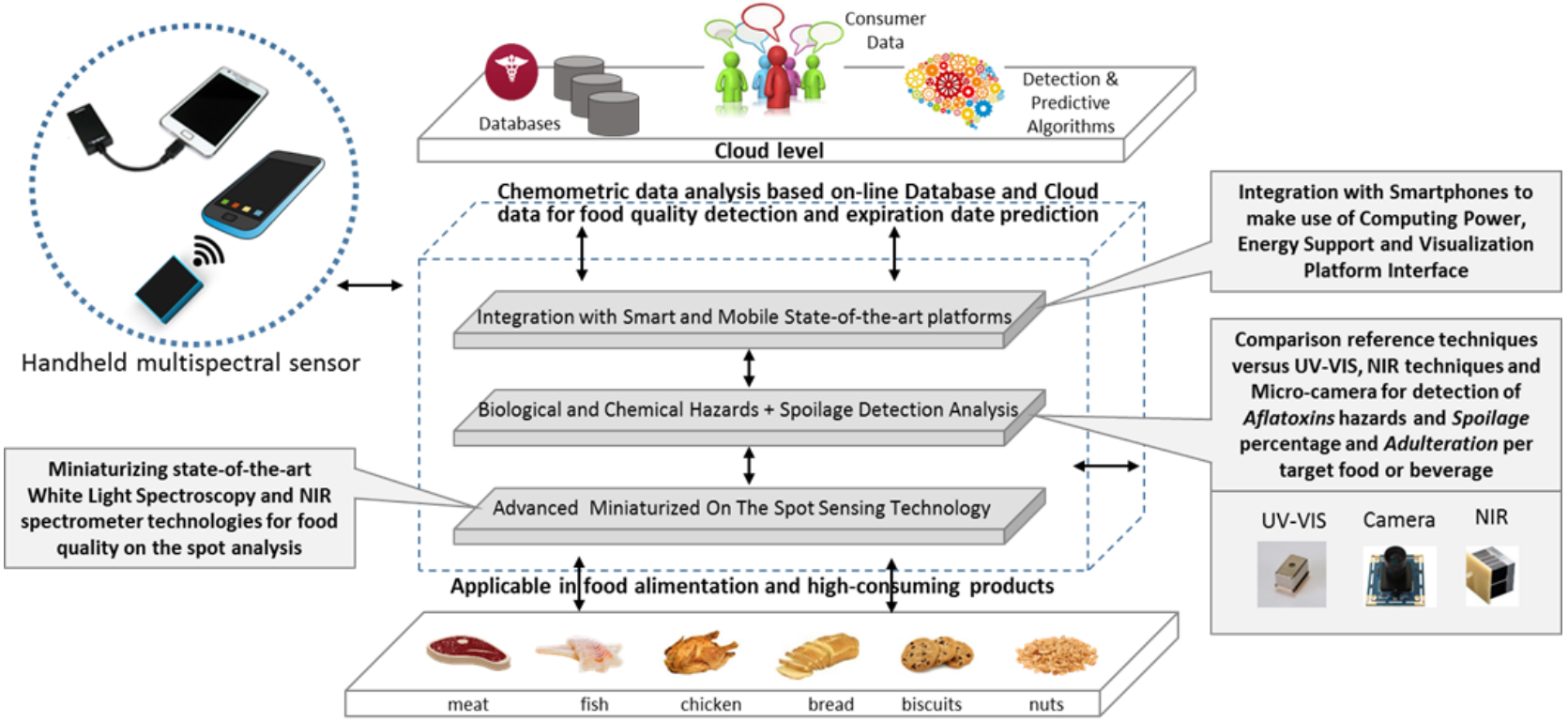
Future: Sensor fusion

"Portable photonic miniaturised smart system for on-the-spot food quality sensing"



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 732541

Sensor combination & data fusion for a more universal food scanner



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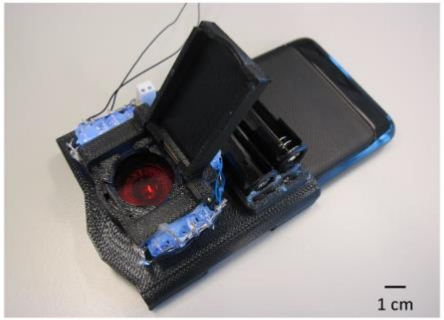
PhasmaFood

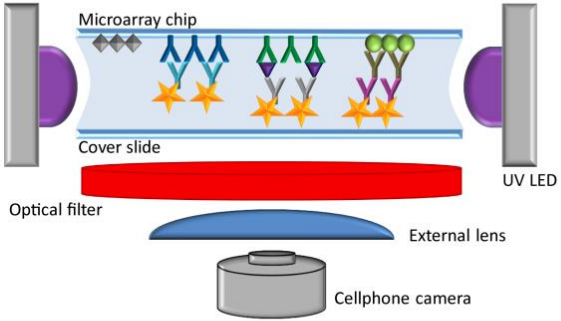
Future: FoodSmartphone

FoodSmartphone.eu

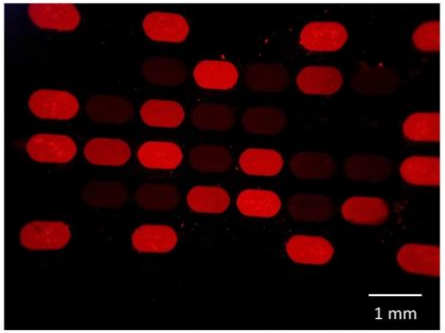
A



B



C



D

	1	2	3	4	5	6	7	8
A	P	N	P	N	N	P	N	P
B	N	N	IGF-1 100	P	IGF-1 100	α-rbST	IGF-1 250	N
C	P	IGF-1 250	α-rbST	IGF-1 100	IGF-1 250	N	N	P
D	P	α-rbST	P	IGF-1 250	α-rbST	IGF-1 100	IGF-1 100	P
E	N	IGF-1 100	IGF-1 250	α-rbST	P	IGF-1 250	α-rbST	N
F	P	N	P	N	N	P	N	P

Immunoassay *microarray* on your smartphone (2015) for biomarkers!

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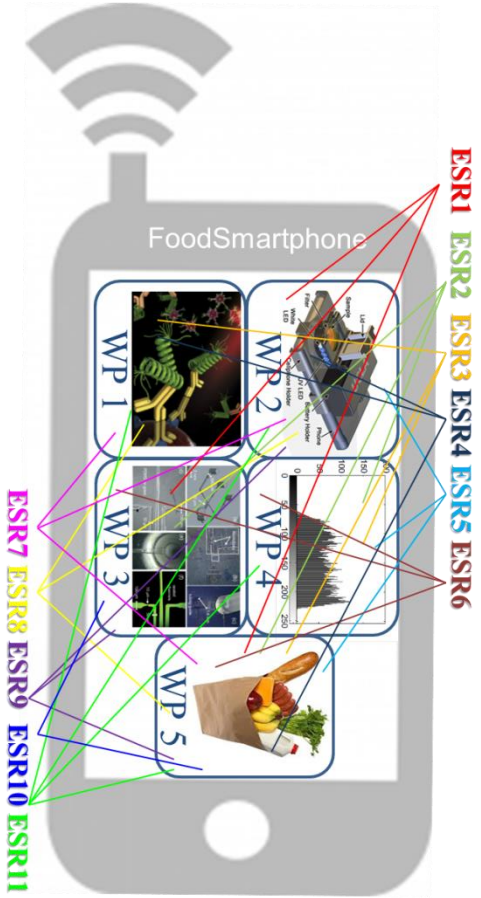
This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 720325

FoodSmartphone objectives

- Smartphone-based (bio)analytical screening tools
- User-friendly, rapid, integrated sample prep.
- Image data handling, communication, apps
- On-site demonstrators: pesticides, allergens, mycotoxins, food spoilage, food spoilage, marine toxins



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On-going initiatives on enabling citizen science

nationale wetenschaps agenda

world food center

COAST
Community of Innovation

Topsector Agri& Food

European Commission
HORIZON 2020

Topsector Chemie

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Further reading...

- Popular Science (Dutch) – Quest 05/2017

Technologie / Voeding

Spoor je straks zelf bedorven eten op met je smartphone?

Scan je schnitzel

Kan ik die melk nog drinken? Bevat dit koekje gluten? En hoeveel calorieën zitten er in dit stuk taart? Met een handzame voedselscanner zou je die vragen zelf kunnen beant-

duurt het uren, dagen of weken voordat je een uitslag hebt. 'Als je de analyse ter plekke kunt doen, dan kun je direct ingrijpen als er iets mis is', zegt Nielen. 'Dat is handig als je een partij vlees vindt waarmee gesjoemeld is. Zoals het nu gaat, is de partij al lang verwerkt voordat je de resultaten hebt.'

Luciferdoosje meet vet

Een scanner die je al sinds 2014 kunt kopen, is

- Scientific literature (English)

Analytical Methods

ROYAL SOCIETY OF CHEMISTRY

CRITICAL REVIEW

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Cite this: *Anal. Methods*, 2015, 7, 9401

Point-and-shoot: rapid quantitative detection methods for on-site food fraud analysis – moving out of the laboratory and into the food supply chain

David I. Ellis,*[a] Howbeer Muhamadali,[a] Simon A. Haughey,[b] Christopher T. Elliott[b] and Royston Goodacre[a]

Thank you! – Q & A - Credits

Chicken fillet case:

RIKILT – Authenticity:
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Consumer spectroscopics:

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- Fish Glaze: Paul Hiscoe (paul@ph-7.co.uk) – PH Seven London – www.ph-7.co.uk
- Distilled spirits (RIKILT): Stevan van der Hoek, Yannick Weesepoel
- Fruits:
  - Wageningen Food & Biobased Research, Computer Vision: Lydia Meesters (lydia.meesters@wur.nl) & Hendrik de Villiers (hendrik.devilliers@wur.nl)
  - Pieter Dekker (RIKILT): (pieter.dekker@wur.nl)

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