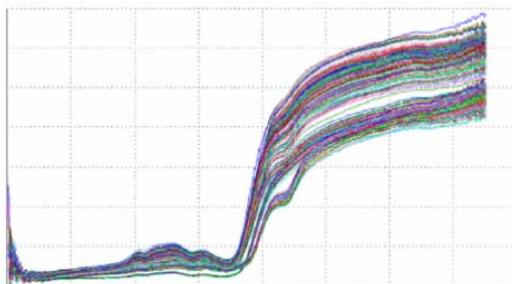


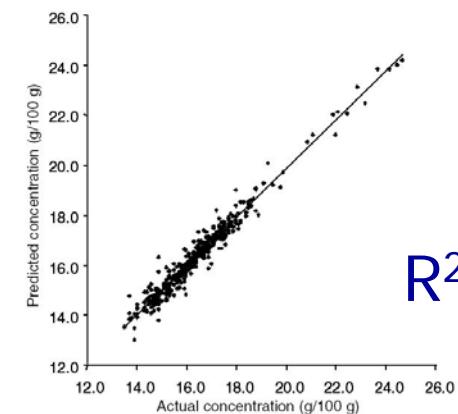
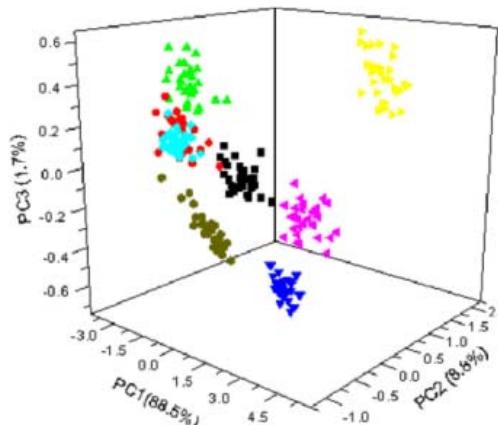
Outline

- General concepts
- Instruments
- Applications
 - reflectance, absorption, fluorescence
- Non-conventional instruments for absorption spectroscopy
- Spectroscopy by mobile devices
- Raman spectroscopy
- The kitchen of the future

..... Steps towards multicomponent analysis



- Spectroscopy
- Chemometrics
- Classification maps
- Library of ref. spectra / analytical data
- Model for prediction of quality indicators
- Validation



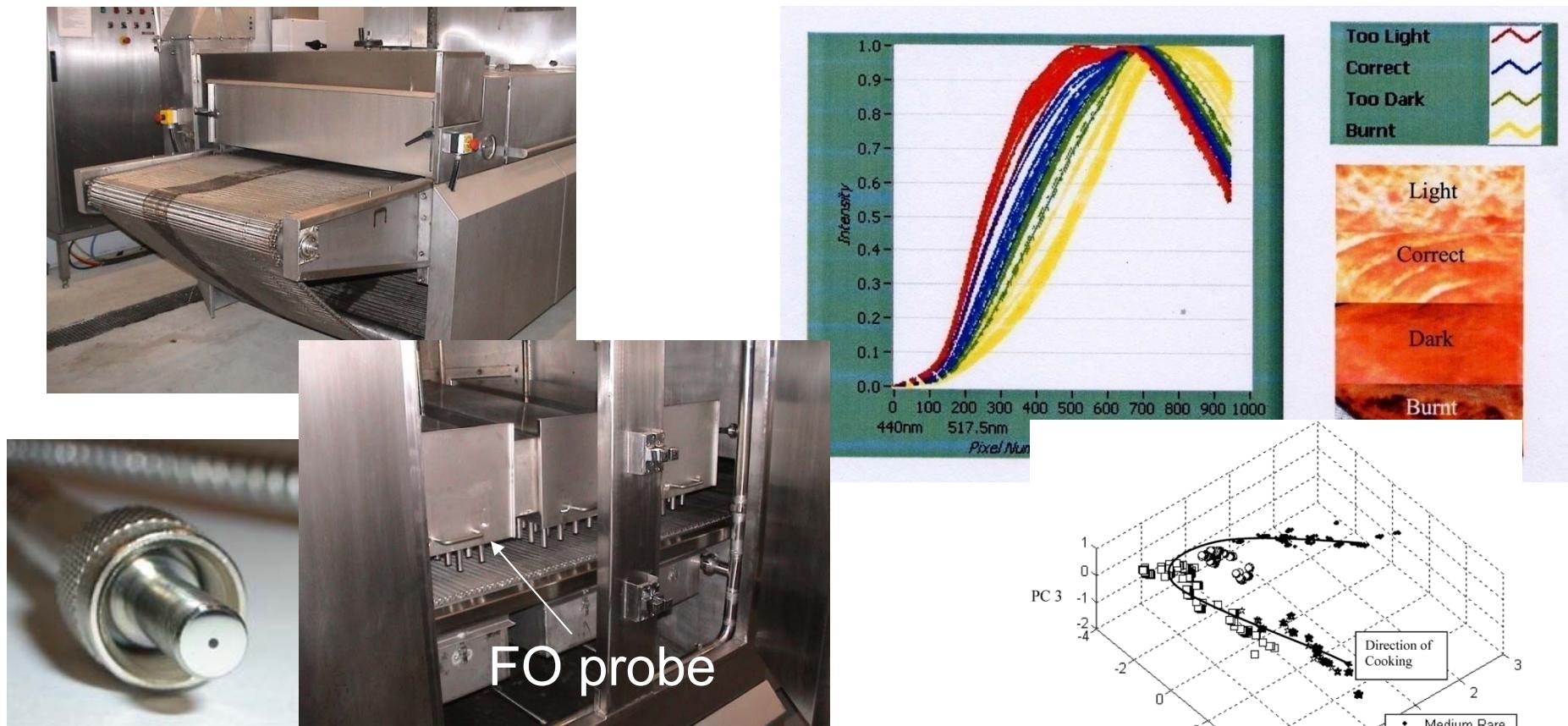


■ Reflection spectroscopy

- Meat
- Cheese
- Tomatoes
- Honey
- Surimi

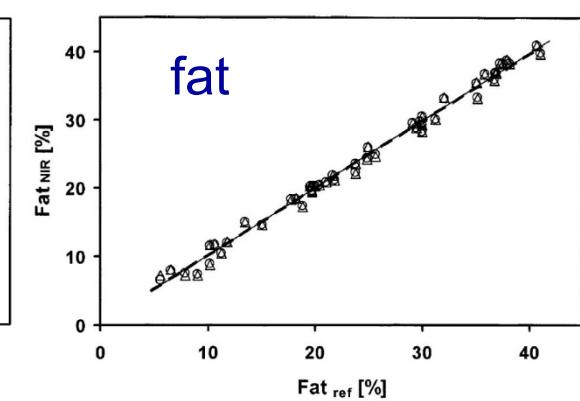
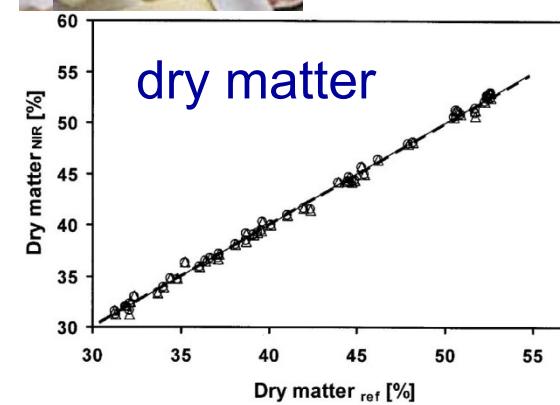
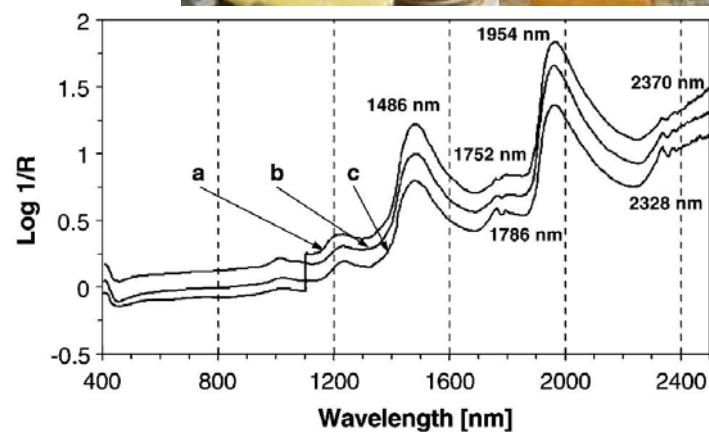
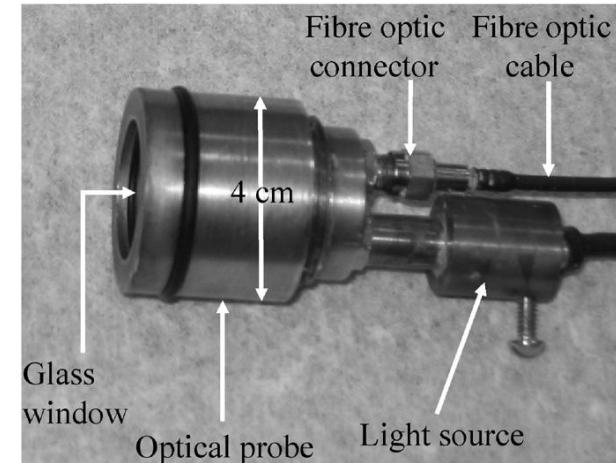
Fiber optic spectroscopy for process control of beef

Fiber optic reflectometer for online detection of beef premature browning



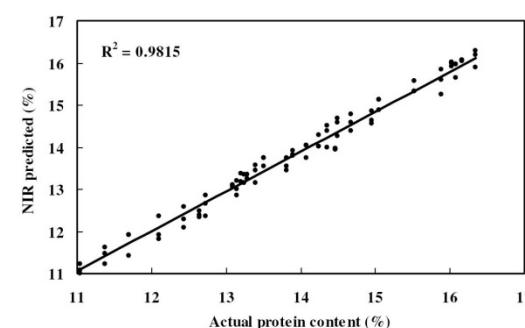
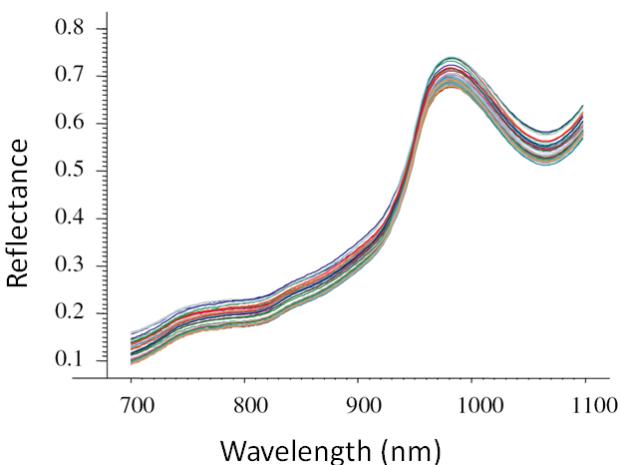
M. O'Farrell et alii, *IEEE Sensors J.*, vol. 5, 2005, pp. 1407
M. O'Farrell et alii, *IEEE Sensors J.*, vol. 7, 2007, pp. 1685

Cheese – quality

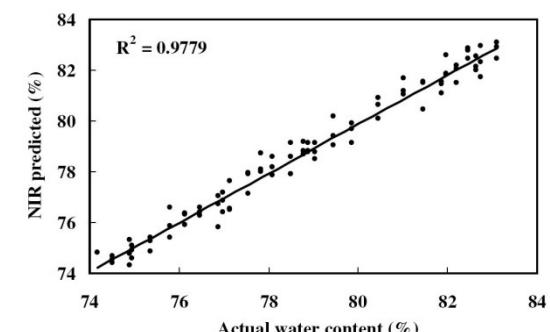


Čurda et alii, *J. Food Eng.*, vol. 61, 2004, pp.557-560
C.C. Fagan et alii, *Int. Dairy J.*, vol. 18, 2008, pp. 120-128

Surimi – quality

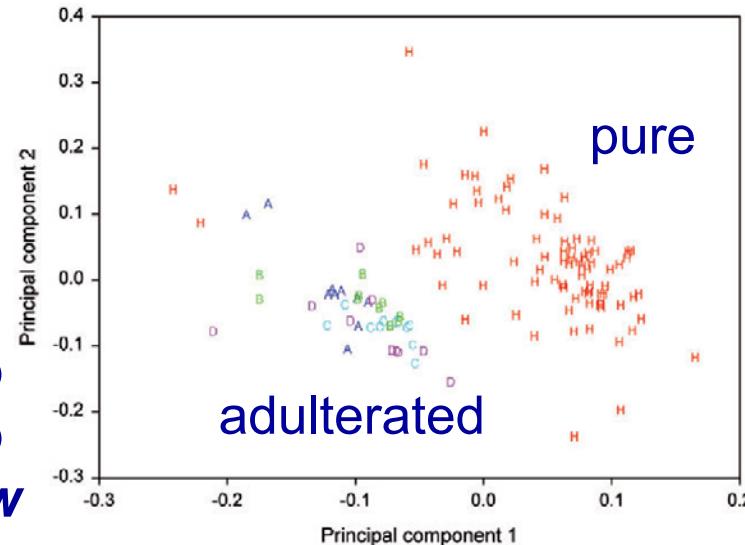
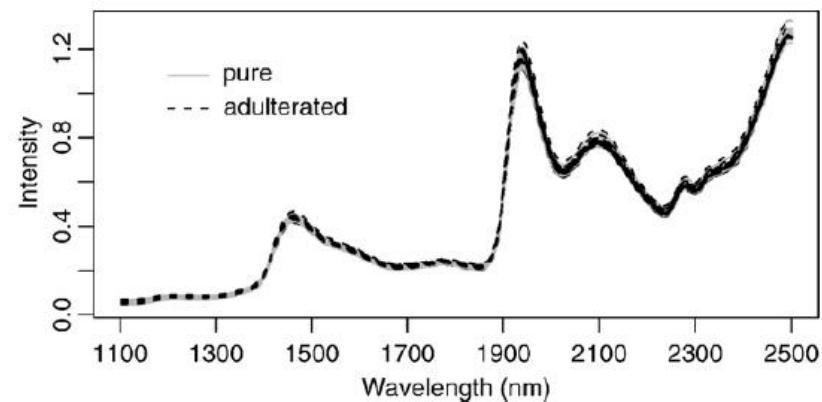


protein content



water content

Honey – adulteration



- beet syrup
- corn syrup
- 10-50% w/w**

G. Downey et alii, *J. Near Infrared Spectr.* vol. 11, 2003, pp. 447-456
T. Woodcock et alii, *Food Chem.*, vol. 114, 2009, pp. 742-746

Tomato – nutraceutical labelling of lycopene

Nutrition Facts

Serving Size about 4 tomatoes (100g)
Servings Per Container about 4.5

Amount Per Serving	% Daily Value*
Calories 30	Calories from Fat 0
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 6g	2%
Dietary Fiber 1g	4%
Sugars 3g	
Protein 1g	
Vitamin A 15% • Vitamin C 25%	
Calcium 2% • Iron 0%	

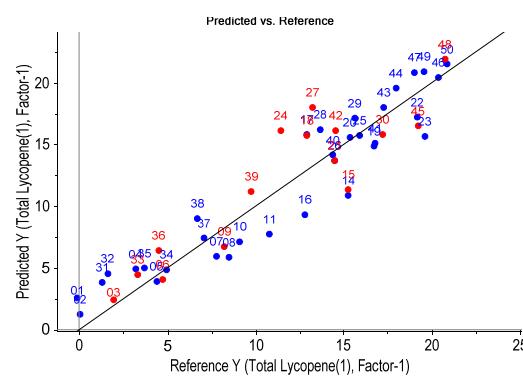
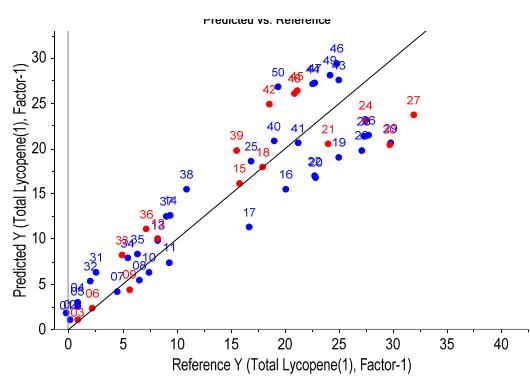
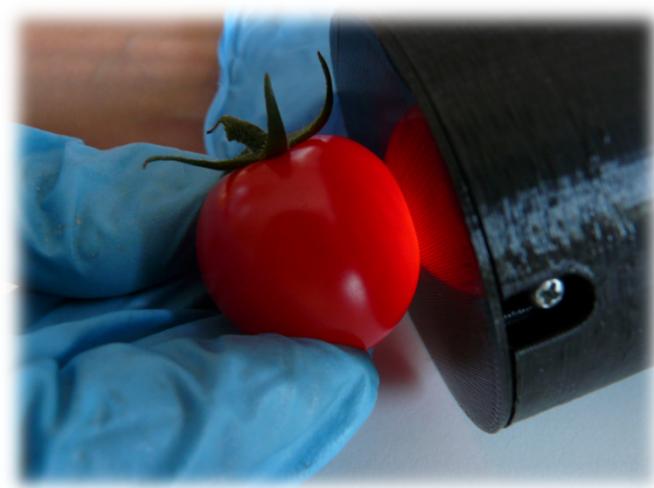
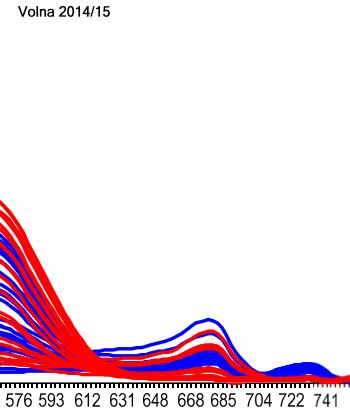
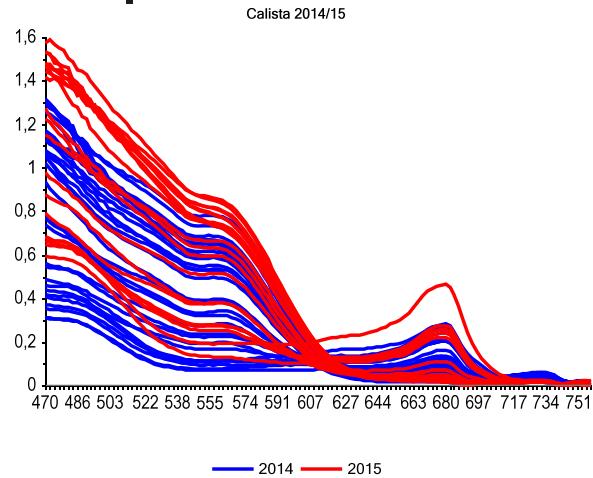
* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

	Calories: 2,000	2,500
Total Fat	Less than 65g	80g
Sat Fat	Less than 20g	25g
Cholesterol	Less than 300mg	300mg
Sodium	Less than 2,400mg	2,400mg
Total Carbohydrate	300g	375g
Dietary Fiber	25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

+ lycopene

Tomato – nutraceutinc labelling of lycopene



	R^2 (cal)	RMSEC mg/hg	R^2 (val)	RMSECV mg/hg
Calista	0,81	4,2	0,78	4,6
Volna	0,9	2,1	0,81	2,5

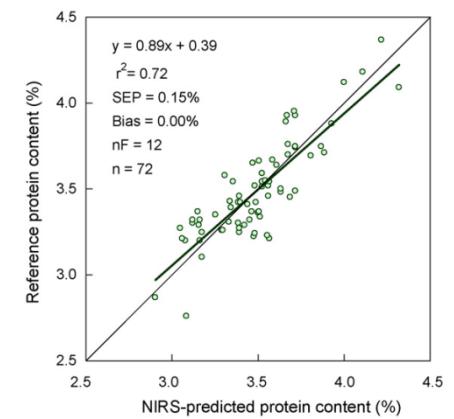
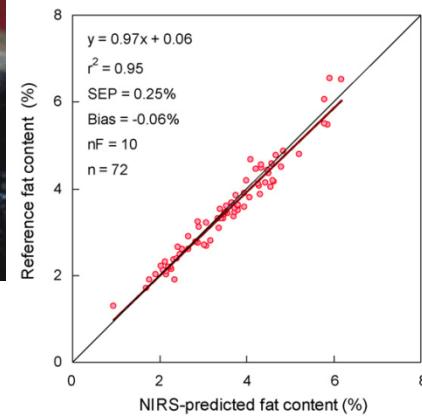
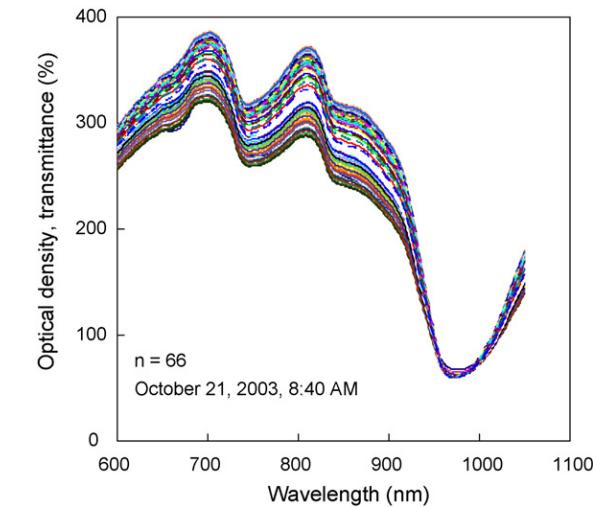
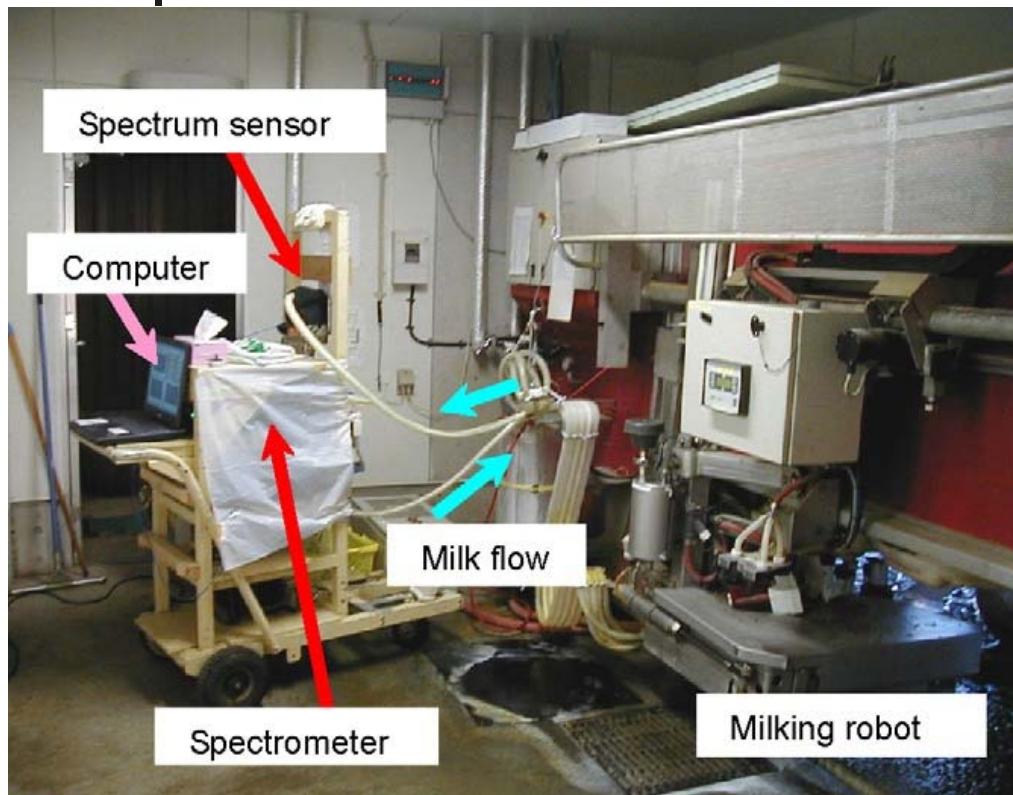




■ Absorption spectroscopy

- Milk
- Tea
- Olive oil
- Wines
- Tequila
- Whisky

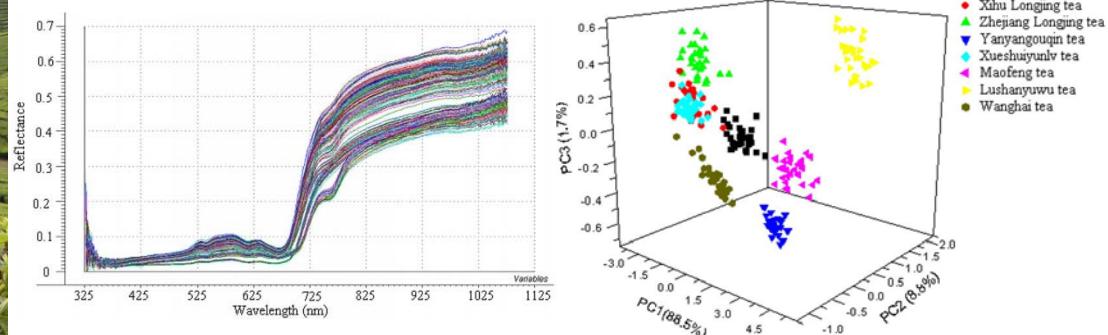
Milk – quality



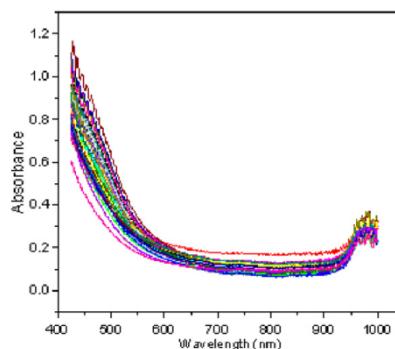
Tea – authentication & multianalytics



from leaves



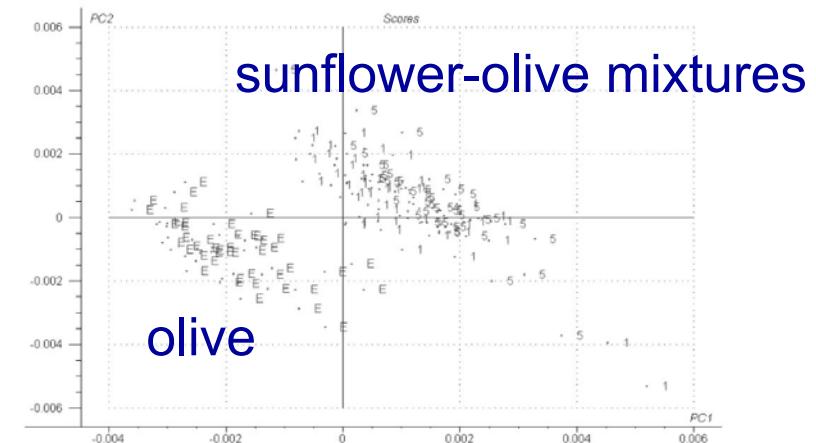
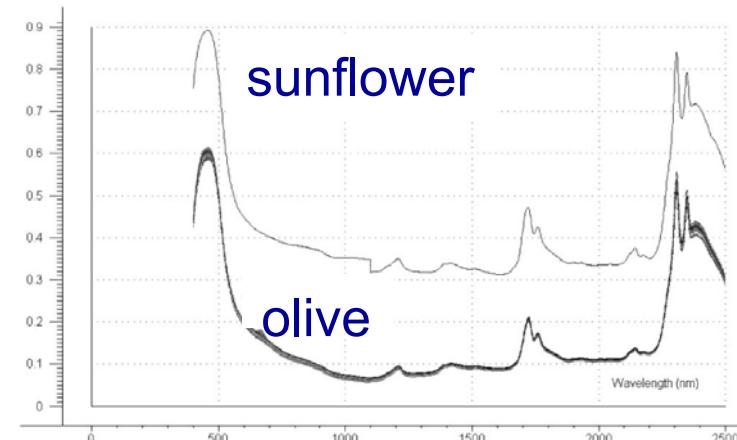
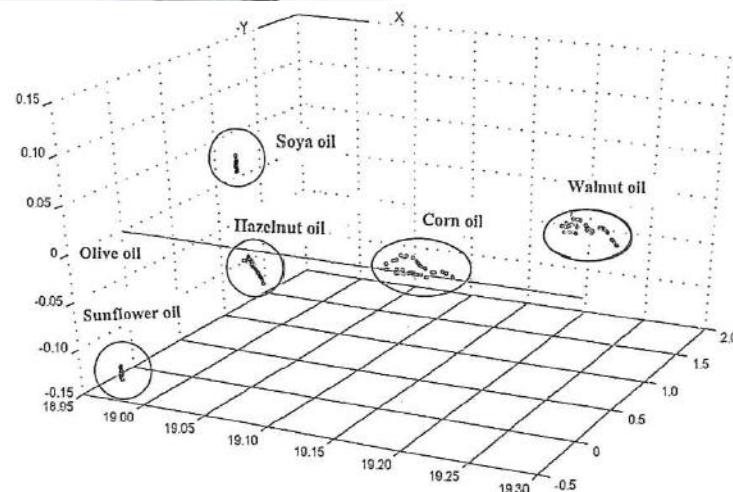
from infusion



- Multicomponent analysis of antioxidants and product features
- Excellent correlation ($R^2 > 0.87$) to polyphenols, caffeine, amino-acids, lignin

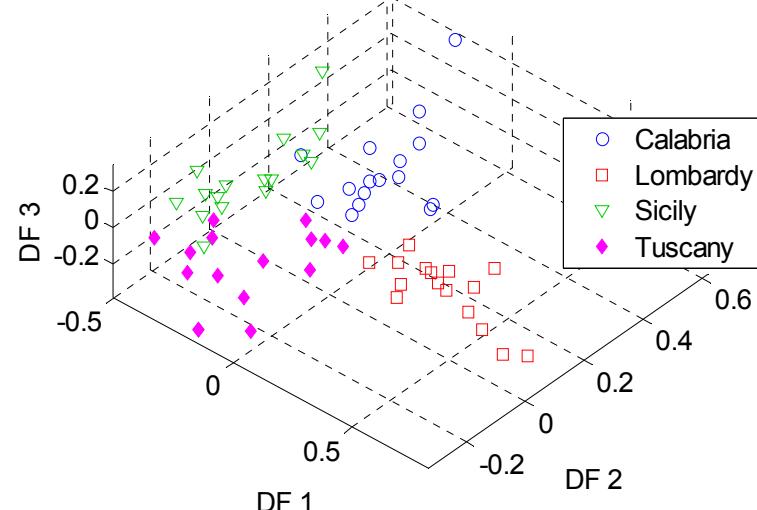
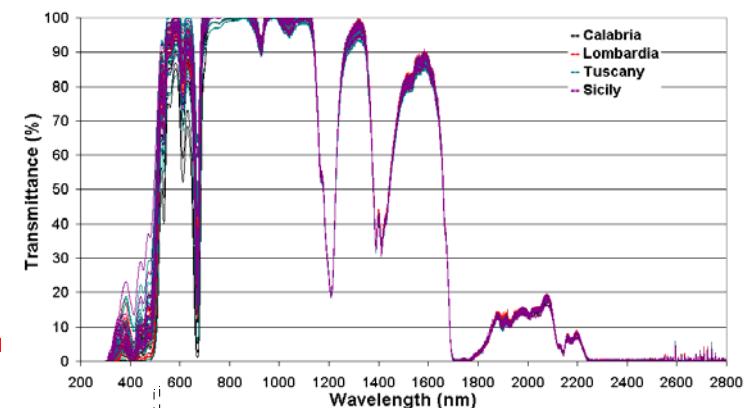
Y. He et alii, *J. Food Eng.* vol. 79, 2007, pp. 1238-1242
S. He Yan, *J. NIR Spectr.* vol. 13, 2007, pp. 313-325

Extra virgin olive oil – adulteration



A.A. Christy et alii, *Anal. Sci.* vol. 20, 2004, pp. 935-940
G. Downey et alii, *J. Agric. Food Chem.* vol. 50, 2002, 5520-5525

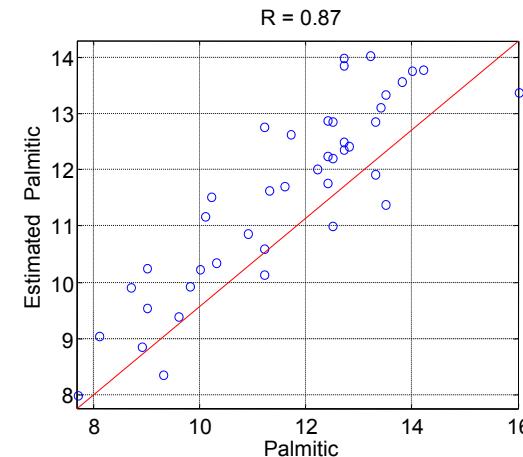
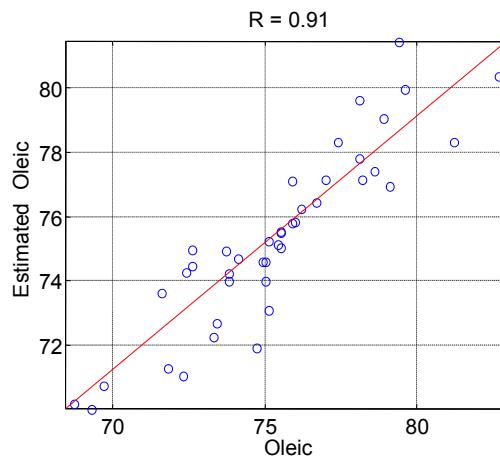
Extra virgin olive oil – authentication



A.G. Mignani et alii, SPIE vol. 7003, 2008, pp. 700326-1/6
A.G. Mignani et alii, SPIE vol. 6585, 2007, pp. 65852C-1/6

Olive oil – correlation to nutritional factors

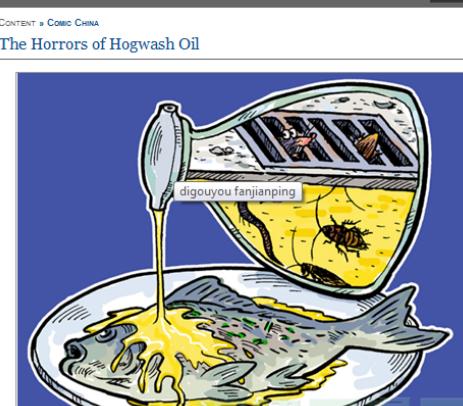
Parameter	Average content	SECV	R
% Oleic Acid	74.4 %	2.5 %	0.91
% Palmitic Acid	11.9 %	1.7 %	0.87
% Palmitoleic Acid	0.8 %	0.4 %	0.81
% Palmitic + Stearic Acids	14.1 %	1.4 %	0.97
% Eptadecanoic Acid	0.1 %	0.05 %	0.70
% Eptadecenoic Acid	0.2 %	0.07 %	0.80
% Linoleic + Linolenic Acids	9.6 %	1.8 %	0.66



Our experiment with Chinese soy-bean oils



Hogwash oil



<http://www.youtube.com/watch?v=aZE9XK4PBL>

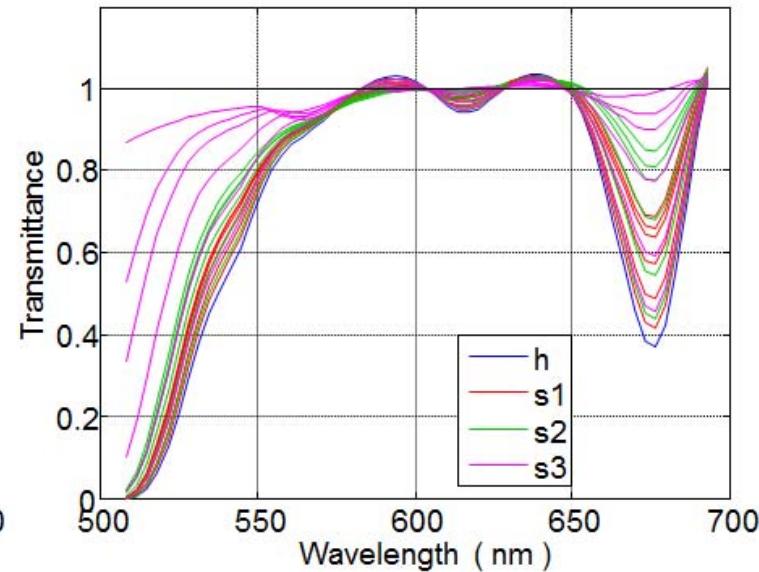
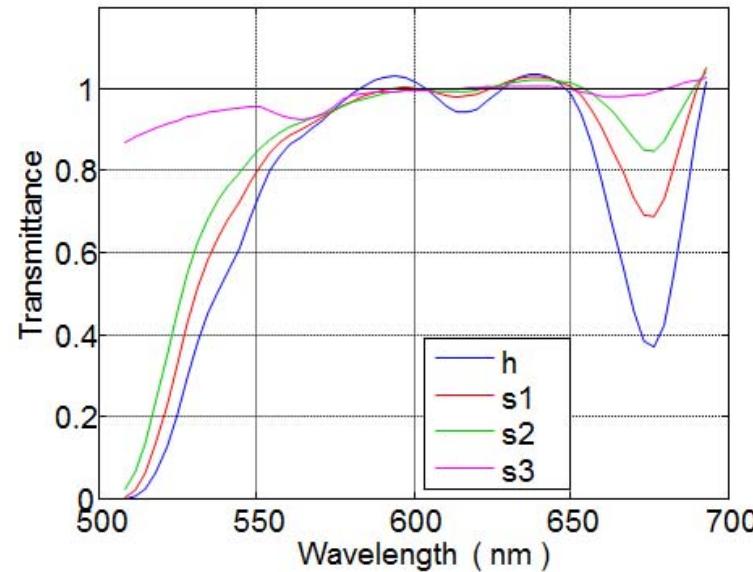
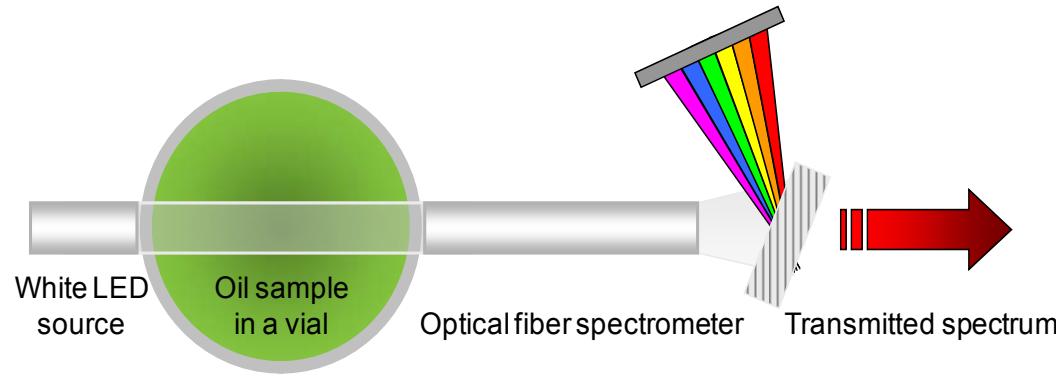
Detection of hogwash oil in soy-bean oils using optical spectroscopy



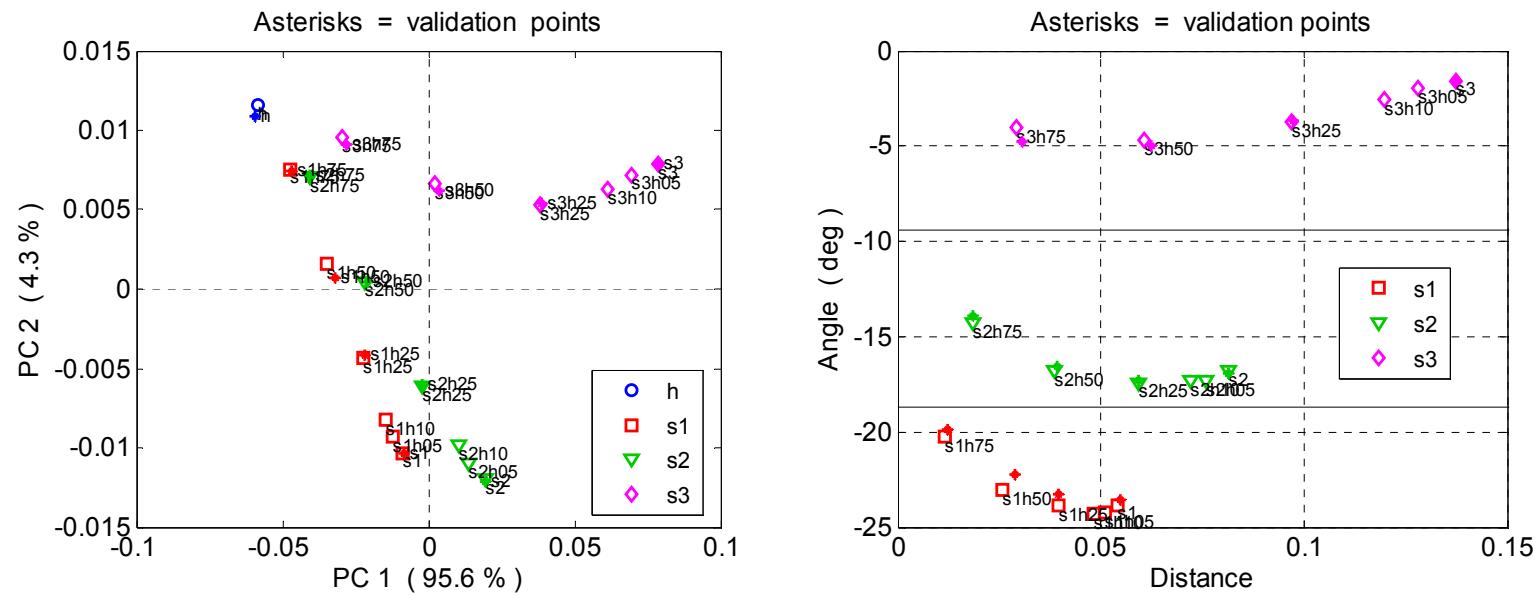
- ✓ H: hogwash oil
 - ✓ S1: Arawana Dragonfish soy-bean oil
 - ✓ S2: soy-bean oil, local production
 - ✓ S3: Italian soy-bean oil
-
- ✓ Mixs: 5%-10%-25%-50%-75% v/v
 - ✓ Replicas: 25%-50%-75% v/v and pure oils



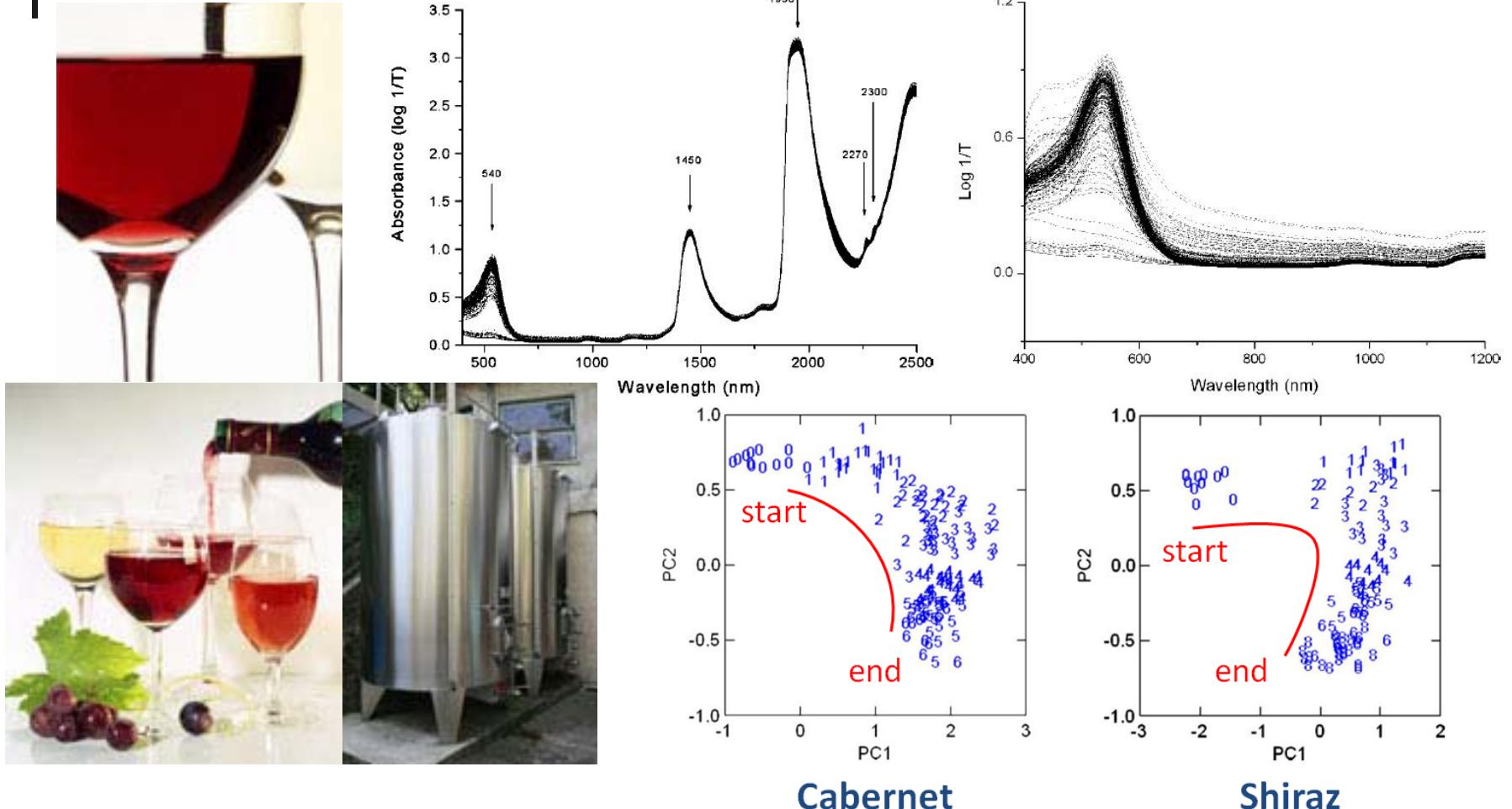
Absorption spectroscopy – in transmission



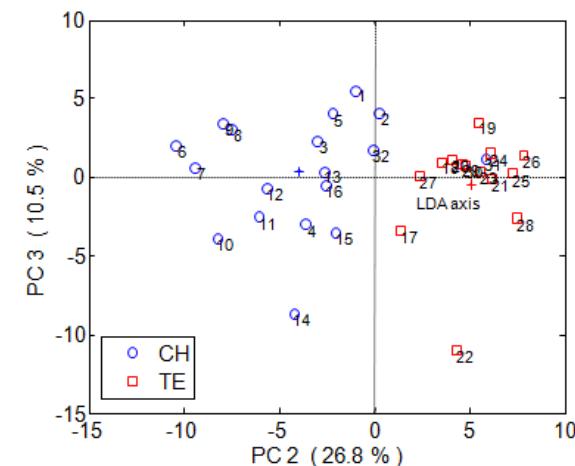
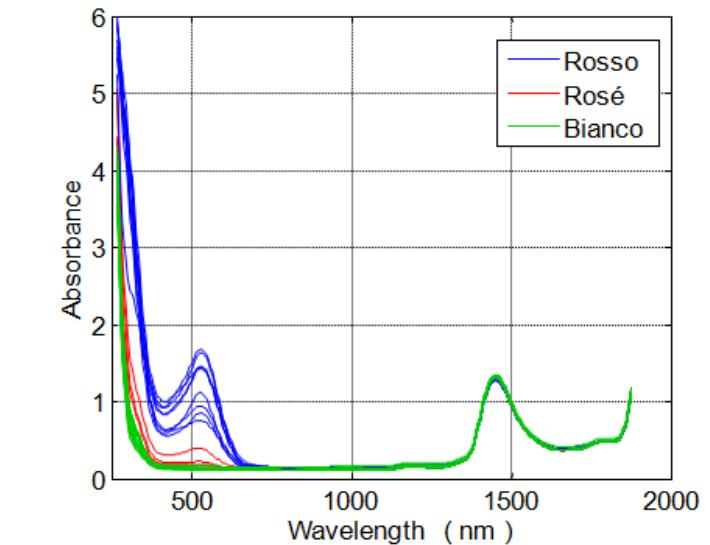
Detection of hogwash oil using full-band absorption spectroscopy



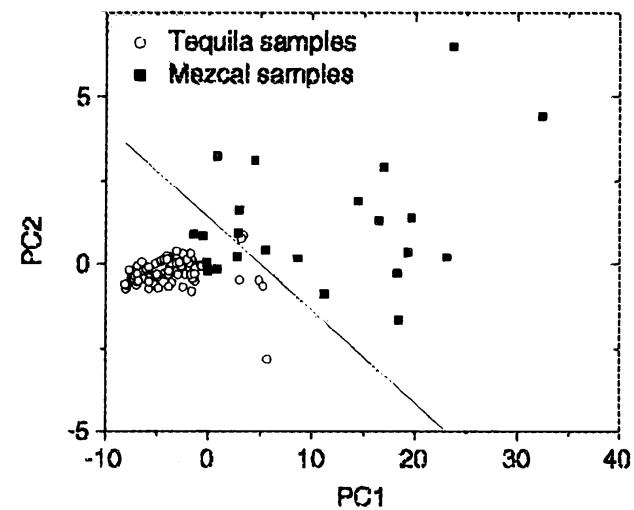
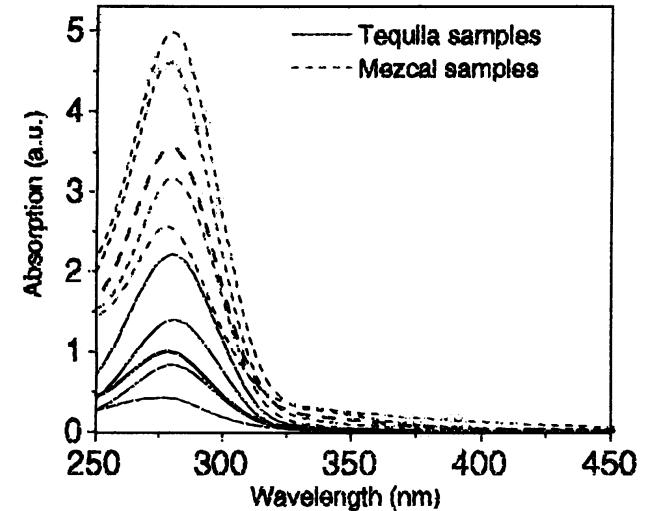
Wines – process monitoring



Wine – authentication



Tequila – fraud detection

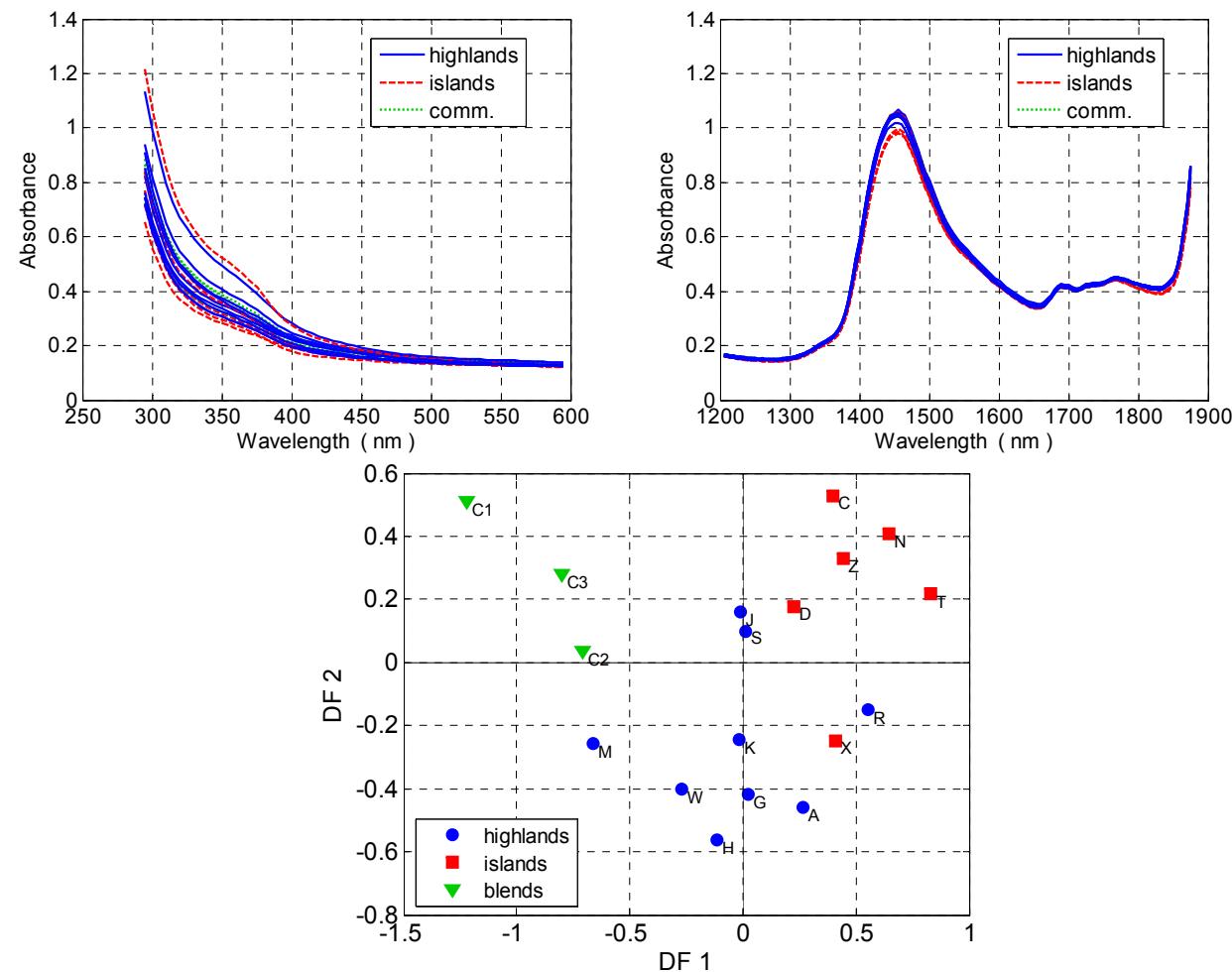


Whisky – authentication

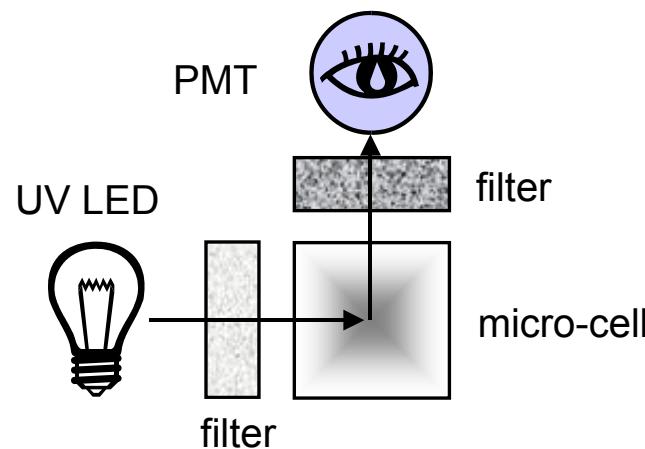


Area	ID code	Brand
Islands	C	Bruichladdich
	D	Tobermory
	N	Arran
	T	Ardbeg
	X	Islay Mist
	Z	Bunnahabhain
Highlands	A	Macallan 10
	G	Stronachie
	H	Ancnoc
	J	Speyburn
	K	Tomatin
	M	Tomintoul
	R	Deanston
	S	Ben Riach
	W	Balblair
Commercial-grade blends	C1	Chivas Regal
	C2	Ballantines
	C3	Johnny Walker

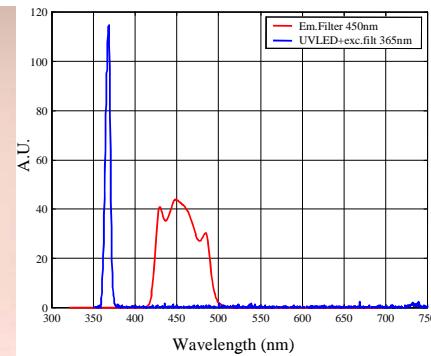
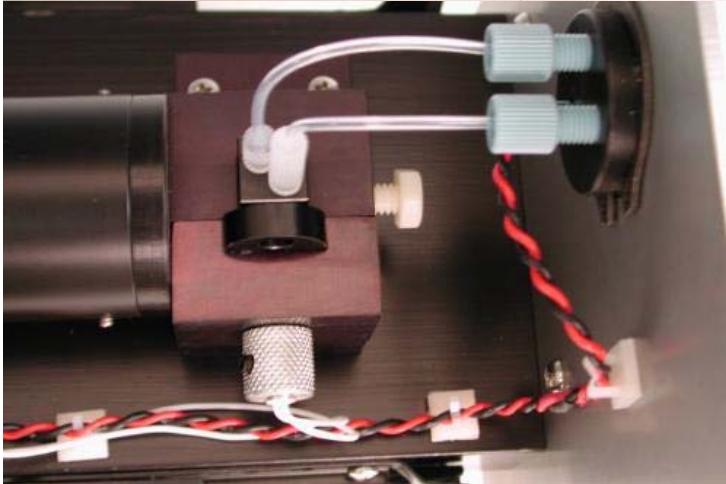
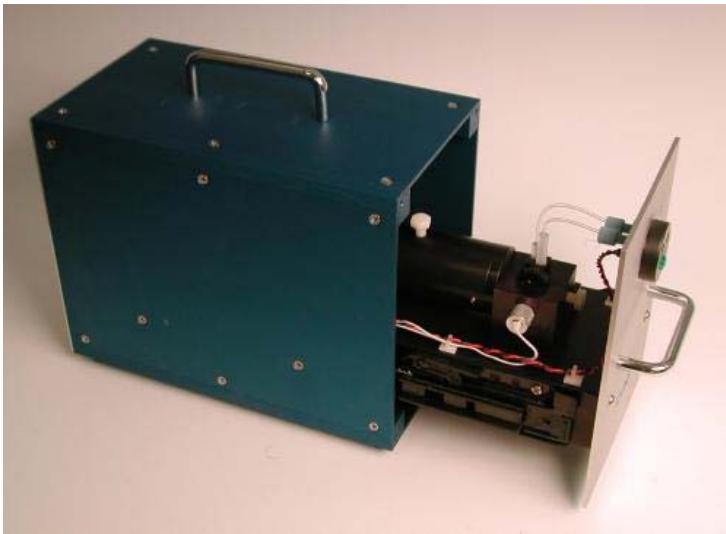
Whisky – authentication



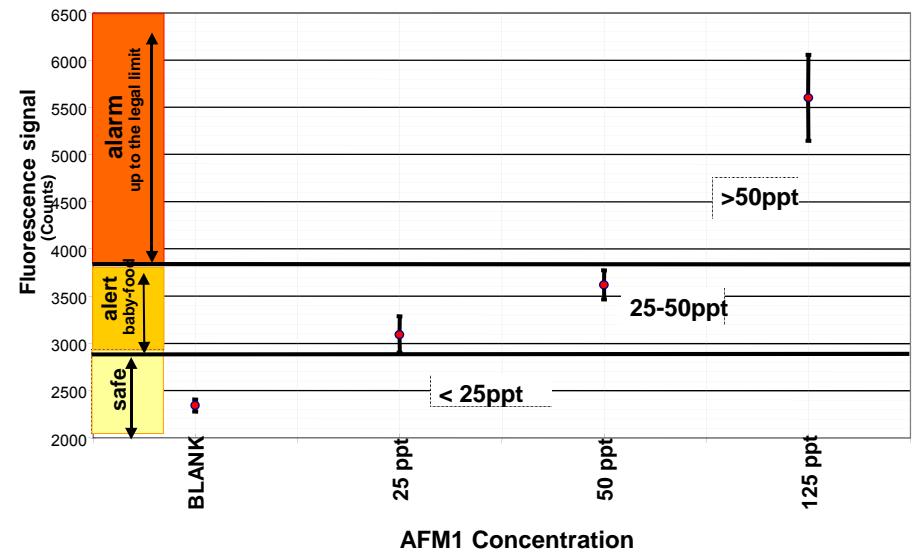
Fluorescence spectroscopy - Milk



A portable fluorometer for the rapid detection of the carcinogenic M1 aflatoxin in milk – the instrumentation

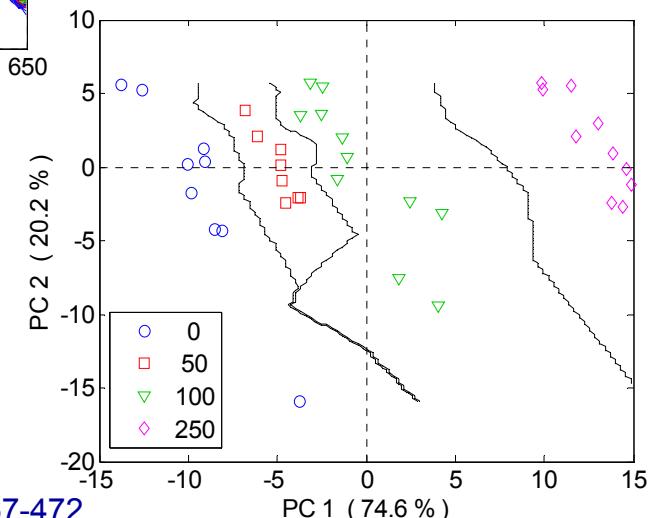
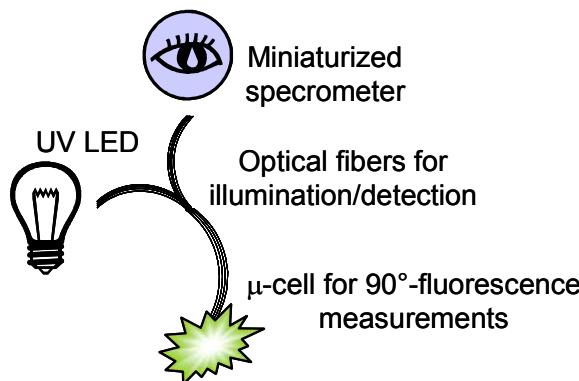
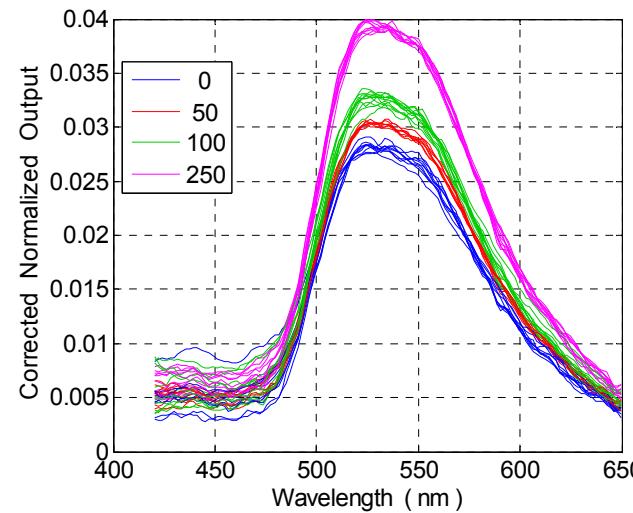
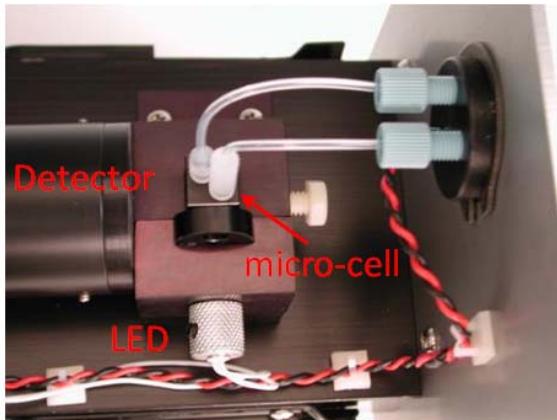


AFM1
cell: quartz ultra-micro



Milk – AFM1 monitoring by fluorescence meas.

Adult food: AFM1 < 50 ppt



C. Cucci et alii, *Sens. Act. B*, vol. 126, 2007, pp. 467-472

A.G. Mignani et alii, *SPIE* vol. 7004, 2008, pp. 70045S-1/4