Milk and cheese authentication using FTIR, NIR spectra, fatty acid, and volatile organic compounds

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Introduction

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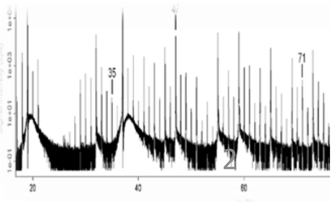
- Consumers are nowadays demanding transparency about the origin of foods

- Several sources of information have been used to authenticate dairy products

- The reference methods of analysis are expensive and not easily adapted to on line monitoring on a large scale

- The new challenge is to develop rapid and low-cost screening techniques to authenticate dairy products with characteristics that meet consumer expectations



Aim

The aim of this work was

to compare different **sources of information** for

discriminating **milk** and **cheese** derived from

different **dairy systems**

Data collection - Cowability Project

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- A total of 1,274 milk samples were transformed to 1,274 individual cheeses
- 85 herds belonging to 5 different farming systems from traditional to intensive ones (Sturaro et al., 2013 Livest Sci)

1. Traditional no automatic feeder — Cows= 225, Herds= 15
2. Traditional with automatic feeder — Cows= 195, Herds= 13
3. Modern hay + compound feed — Cows= 461, Herds= 31
4. Modern TMR no silage — Cows= 253, Herds= 17
5. Modern TMR silage — Cows= 130, Herds= 9

Grouped into:

1. Traditional (from 1 and 2)
2. Modern no silage (from 3 and 4)
3. Modern silage (from 5)

- 15 Italian Brown Swiss cows from each herd were individually sampled once (2 L per cow) during evening milking
- The model cheeses were ripened for 60 days ripening at 15 °C and 85% R. H.

Methods

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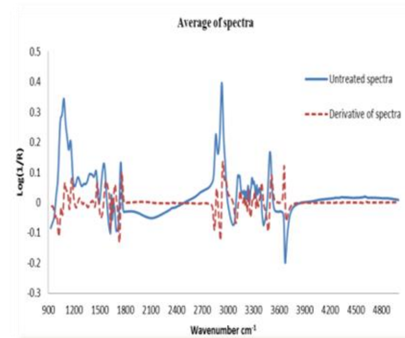
- **Fourier Transform Infrared Spectroscopy (FTIR)**
  (Milkoscan FT 6000, Foss) **1,060** single bands, 2,000 to 10,800 nm
  (Ferragina et al. 2015 , JDS)

- **Milk Fatty Acids (FA)**
  (ThermoQuest GC,ThermoElectron Corp) **47** individual fatty acids
  (Mele et al. 2016, JDS)



- **Near Infrared Spectroscopy (NIR)**
  (Foodscan, Foss) **100** single bands, 850 to 1,050 nm

- **Proton Transfer Reaction-Time of Flight-Mass Spectrometry (VOC)**
  (PTR-ToF-MS 8000, Ionicon Analytik) **619** spectrometric peaks,
  240 Volatile Organic Compounds
  (Bergamaschi et al. 2015, JDS)

Linear Discriminant Analysis (LDA)

- LDA to test the hypothesis of whether *K* groups can be reconstructed based on the set of *P* predictors
- R software (*MASS* package)

Predictors: FTIR spectra (1,060 waves)

FA (47 fatty acids)

NIR spectra (100 waves)

VOCs (240 compounds)

Groups: different dairy systems (3 or 5)

75% training, 25 % testing data set, 10-fold cross-validation

Overall correct classification (%) of milk and cheese samples

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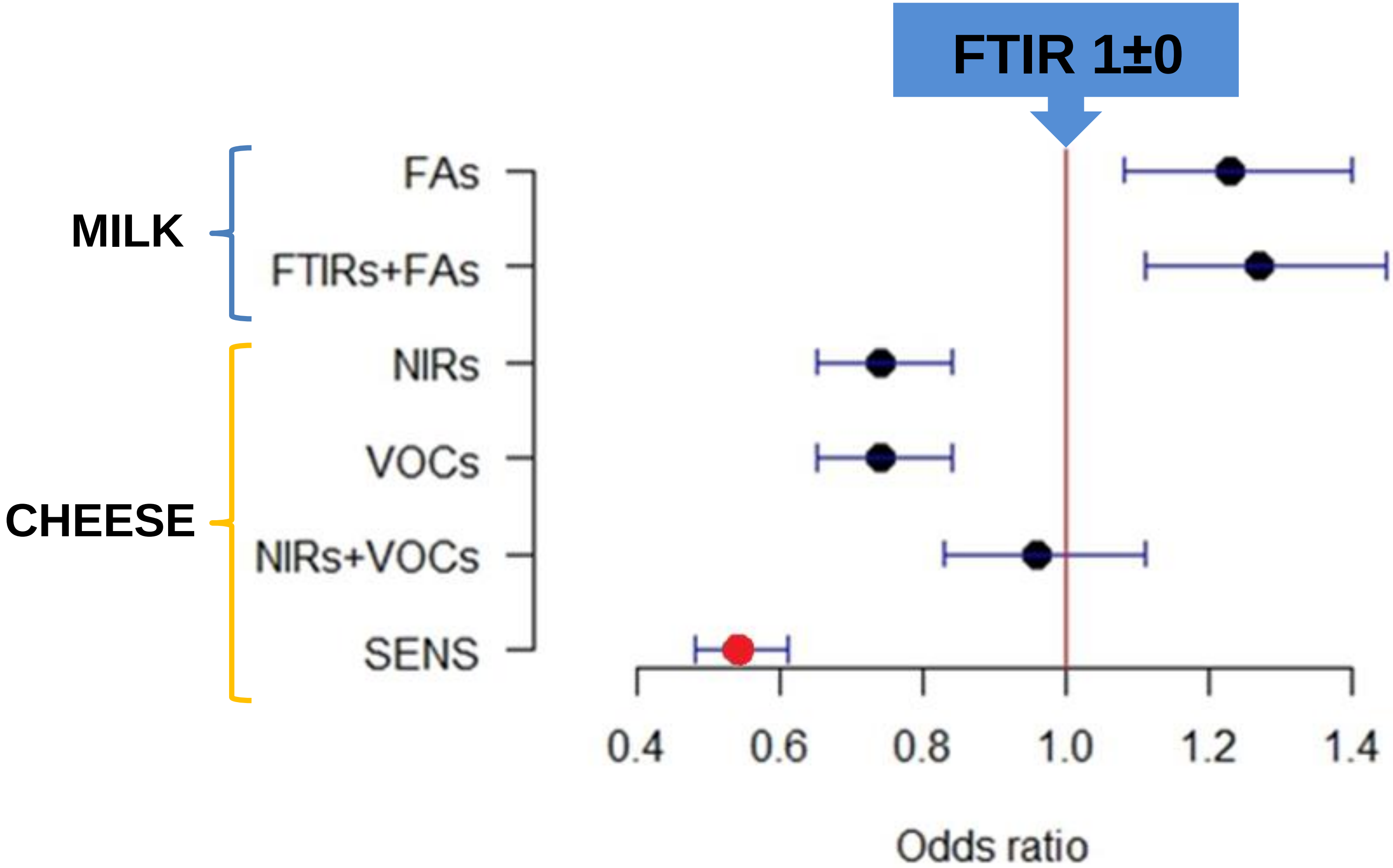
Methods		n	Training	Testing
3 dairy systems:				
FTIR	*Milk*	1,222	97	74
FA	*Milk*	1,175	81	77
FTIR+FA	*Milk*	1,130	99	78
NIR	*Cheese*	903	76	67
VOC	*Cheese*	1,075	83	67
NIR+VOC	*Cheese*	767	94	72
5 dairy systems:				
FTIR	*Milk*	1,222	99	65
FA	*Milk*	1,175	70	65
FTIR+FA	*Milk*	1,130	99	70
NIR	*Cheese*	903	67	52
VOC	*Cheese*	1,075	75	48
NIR+VOC	*Cheese*	767	94	57

Correct classification (%) of milk and cheese samples

Methods	Traditional		Modern		
			Hay+CF	TMR	
	No AF	AF		No silage	Silage
3 dairy systems:					
FTIR	68		78		70
FA	66		82		82
FTIR+FA	73		80		80
NIR	62		79		43
VOC	57		77		31
NIR+VOC	67		75		69
5 dairy systems:					
FTIR	67	55	66	67	69
FA	60	25	74	68	87
FTIR+FA	76	62	70	68	80
NIR	55	29	71	43	44
VOC	40	49	58	38	37
NIR+VOC	56	46	65	44	68

AF=automatic feeder; CF=compound feed; TMR=total mixer ratio

Odds ratio estimates and confidence interval (95%) of correct classification



The results for all LDA were coded as binary variables (0, 1)

Conclusions

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- This study allowed comparing different sources of information for discriminating dairy systems on a large number of individual milk samples and on the individual model cheeses

  - On milk, fatty acid profile tend to be more effective than infrared techniques especially for modern dairy systems with silage

  - On cheese, infrared and volatile fingerprints are equally effective in the discrimination ability but their combination yield acceptable results

- Instrumental methods are more effective than sensory description

Thanks for your attention

Trento Province

Breeder Federation of the Trento Province

Milk analysis: Fatty acid profile

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- **GC analysis**

  ThermoQuest GC flame-ionization detector (ThermoElectron Corp., Waltham, MA)

  High polar fused-silica capillary column (100 m, 0.25 mm i.d.; thickness 0.20 µm)

  Helium flow rate of 1 mL/min

  Oven temperature (60°C) was held for 1 min, 173°C at a rate of 2°C/min, 173°C for 30 min, 185°C at 1°C/min, 85°C for 5 min, increased to 220°C at a rate of 3°C/min, and finally held at 220°C for 19 min

  The injector temperature (270°C) and the detector temperature (300°C)

  Mele et al. (2016)