66th EAAP ANNUAL MEETING

INNOVATION IN LIVESTOCK PRODUCTION: FROM IDEAS TO PRACTICE

Milk Mineral Variation of Italian Dairy Cattle Breeds Predicted by Mid-Infrared Spectroscopy Analysis

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Product Quality – Dynamism

- ‘The totality of **features and characteristics** of a product [...] that bear on its **ability to satisfy stated** or **implied needs**’ – ISO definition

- **Stated** needs → Industry/distribution → **Objective**

- **Implied** needs → Consumer → **Perceived** (both objective and subjective)... **Health Quality**!!

Milk Minerals – Why so important?

- Approximately **62 L/person** annual fluid milk consumption in EU (Canadian Dairy Information Centre)

- Cow milk important source of **essential nutrients** (LC-FA, CLA, vitamins, minerals; Haug et al., 2007) and **antioxidant molecules** (i.e. Thiols, Niero et al., 2015)

- Major minerals (Ca, P, Mg, Na, K) are involved in **bone**, **muscular**, and **cardiac health** (Cashman, 2006; Haug et al., 2007; Caroli et al., 2011; Orchard et al., 2014; Whelton and Jiang, 2014)

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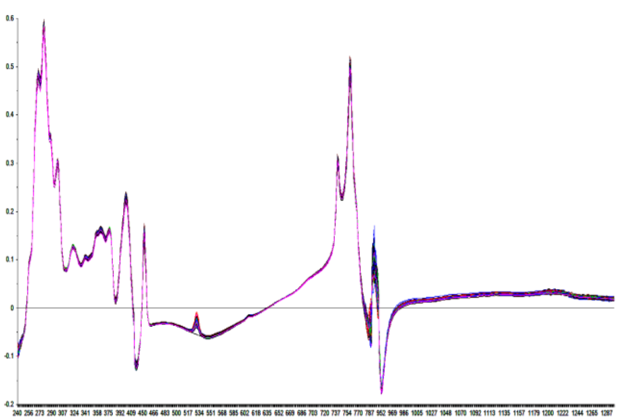
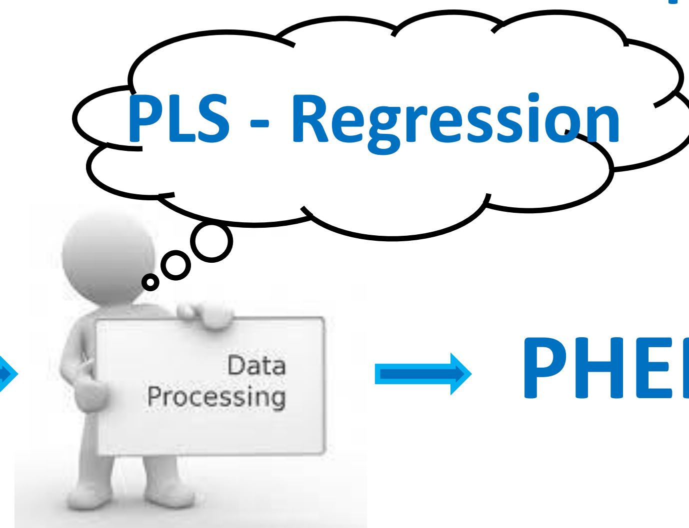
- Ca & P influence **speed** and **rate of aggregation** of paracasein micelles during cheese-making (Malacarne et al., 2014; Toffanin et al., 2015)

Milk Minerals – Issues

- **Reference** laboratory analysis is **time-consuming** and **expensive** – limit for a population level phenotypic characterization

- **Mid-Infrared Spectroscopy** (MIRS) can overlap this issue (Soyeurt et al., 2009; Toffanin et al., 2015), allowing the (*a posteriori*) **prediction** of **innovative milk quality traits** (De Marchi et al., 2014)





PHENOTYPES

Objectives

- To **apply** MIRS prediction **models** for milk minerals to a **large spectral dataset** of four Italian dairy cattle breeds

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- To **investigate sources of variation** of MIRS-predicted milk minerals

Data Collection and MIRS models

- October 2011 - Nowadays: more than 2,500,000 individual cow milk spectra stored in internal dataset from South Tirol Dairy Association (Bolzano, Italy)

Data Collection and MIRS models

- 132,380 **individual milk samples** from 2012-2013 **(validation dataset)**

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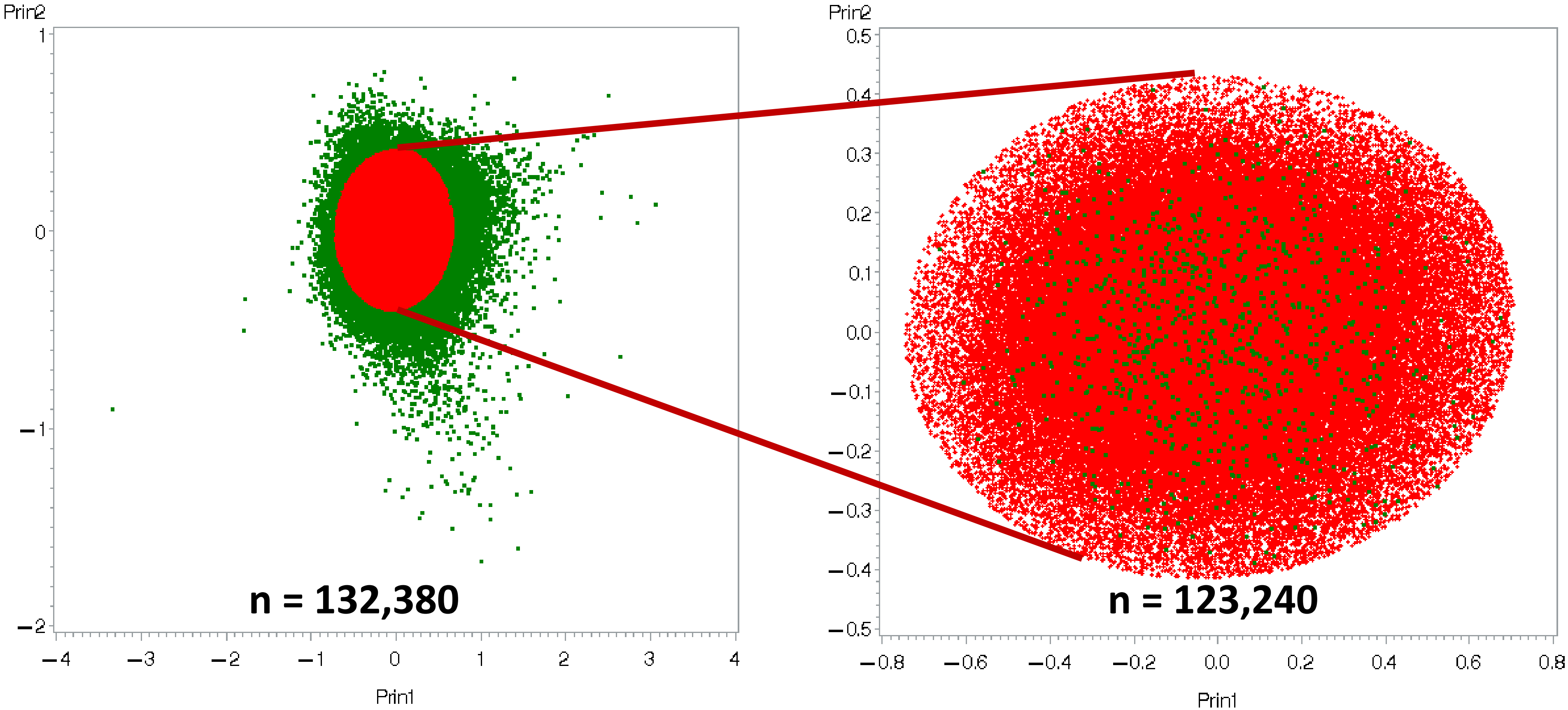
- Milk MIR spectra from **MilkoScan FT6000** (Foss)

- Ca, K, Mg, Na, and P determined with reference analysis (**ICP-OES**) for 246 samples and subsequently used to develop **MIRS prediction models** using **PLS-post UVE** (**calibration dataset**) (Gottardo et al., 2015, Abstract pag. 355, September 2nd, Session 37, h 15:00)

Phenotypic Characterization

- **Principal Component Analysis** (PCA; SAS, 2008) carried out to identify **similarities and differences between spectra** in both calibration and validation datasets



Phenotypic Characterization

- **Mixed analysis** (PROC MIXED; SAS, 2008) carried out to **identify sources of variation** of MIRS-predicted Ca, K, Na, Mg, and P

- **Fixed effects:** breed, month and year of sampling, days-in-milk (10 classes of 30 days each), parity (5 classes with class 5 including parity => 5), and their interactions

- **Random effects:** herd nested within breed, cow nested within breed, and residual

Descriptive Statistics

	Calibration dataset (n = 246)			
Mineral, mg/kg	Mean	SD[1]	Range	CV[2]
Ca	1,348.22	229.60	1,281.52	0.17
K	1,500.52	228.04	1,108.58	0.15
Mg	128.30	22.10	112.71	0.17
Na	401.80	98.95	708.29	0.25
P	1,010.04	181.04	1,010.96	0.18
	Validation dataset (n = 123,240)			
Predicted Mineral, mg/kg	Mean	SD[1]	Range	CV[2]
Ca	1,364.56	182.26	1,597.53	0.13
K	1,668.84	297.05	1,699.42	0.18
Mg	140.63	32.85	198.90	0.23
Na	442.83	71.37	690.50	0.16
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[1] Standard Deviation; [2] Coefficient of Variation

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Sources of Variation

- **All fixed effects** were **highly significant** in explaining minerals content variation

- **Days-in-Milk effect:** Minerals content **same trend of milk yield** (exception of Na)

- **Parity effect:** Minerals content the **highest for primiparous**, then tended to decrease

Sources of Variation – Breed Effect

Mineral, mg/kg	Holstein-Friesian	Brown Swiss	Alpine Grey	Simmental
Ca	1,306.60 (6.54)[a]	1,350.42 (3.08)[b]	1,370.06 (3.99)[c]	1,426.44 (3.60)[d]
K	1,686.26 (8.47)[a]	1,660.07 (3.98)[b]	1,665.4 (5.32)[ab]	1,675.73 (4.73)[ab]
Mg	138.52 (0.80)[a]	143.13 (0.38)[b]	137.24 (0.52)[a]	144.69 (0.46)[b]
Na	454.71 (1.97)[a]	452.52 (0.94)[a]	454.79 (1.24)[a]	460.69 (1.10)[b]
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Results consistent with

- van Hulzen et al. (2009) for **Holstein-Friesian**
- Carroll et al. (2006) for **Brown Swiss**
- Barlowska et al. (2006) for **Simmental**

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- **Dual purposes breeds:** "better" **health and technological quality** compared to cosmopolitan breeds

- MIRS **prediction models** can be applied at the population level to predicted minerals content and to **study sources of variation**

- Milk mineral contents were greater for **dual purposes breeds** respect to other dairy breeds

- Next research will be aimed in **estimating genetic parameters** of predicted milk minerals content

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GRAZIE!

DZIĘKUJEMY!

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Luis Kerschbaumer and Thomas Kerschbamer (Sennereiverband Südtirol, Bolzano, Italy) and Claudio Stecchi (CTS informatica srl, Bolzano, Italy) for technical support

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