Effectiveness of mid infrared spectroscopy to predict milk phosphorus content

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Speaker: Marine Gelé

Session 5 - Methods to gather new phenotypes

Effectiveness of mid infrared spectroscopy to predict milk phosphorus content

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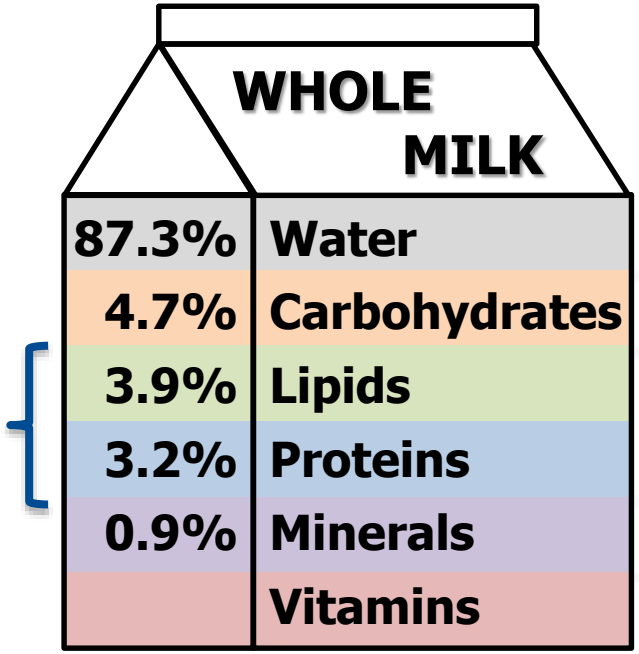
Estimating milk composition by MIR spectroscopy in France

PhénoFinlait
Un programme R&D pour les filières laitières de demain

- **Fatty Acids:** 54 equations of good quality
- **Proteins:** good precision for 4 caseins and 1 whey protein



Lactose: manufacturers' models

Total Calcium: accurately estimated in *FACAVAL* project

What about other minerals?

Phosphorus in milk: a component of interest

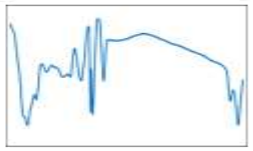
- ✓ Phosphorus is involved in **bone health** and **human development** (Huth et al., 2006)
- ✓ Dairy products provide a third of Phosphorus dietary intakes in the USA (Huth et al., 2006)
- ✓ Phosphorus (and Calcium) plays an important role in **cheese-making process**, especially concerning ability of milk to coagulate and final consistency of the coagulum (Fossa et al., 1994)
- ✓ Methods to measure Phosphorus content are long and expensive

How accurate mid infrared spectroscopy is to predict Phosphorus content in milk?

Phenotyping Phosphorus content in milk with MIR spectroscopy

1 Milk sampling

2 MIR Spectrum extraction



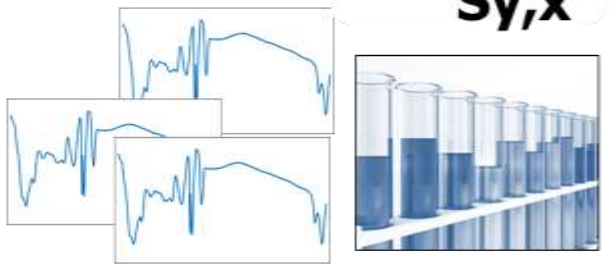
3 Reference measurement

4 Mathematic model

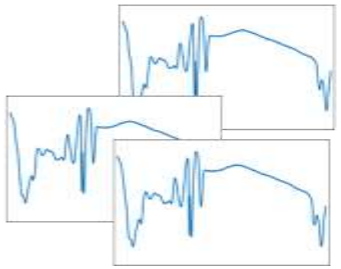
5 Validation of the model

R^2

Sy,x



6 Use in routine



Estimation of the trait

MIR: mid infrared – R^2: coefficient of determination – Sy,x: error of the model

Milk sampling

1

Milk sampling

195 French herds in 2010

Selection of 500 milk samples from PhénoFinlait cryobank combining 7 criteria:

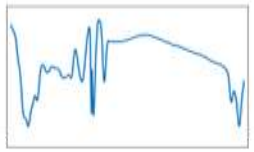
- ✓ **Breed**: 34% Montbeliarde / 33% Holstein / 33% Normande
- ✓ **Days in milk:** 25% early / 43% mid / 33% late lactation
- ✓ **Number of lactation:** 48% primiparous / 52% multiparous
- ✓ **Milk yield level:** 51% low level / 49% high level
- ✓ **Protein content level:** 50% low level / 50% high level
- ✓ **Diet:** 18% grass silage / 24% maize silage – low concentrates / 19% maize silage – high concentrates / 17% hay / 22% pasture
- ✓ **Season:** 50% winter / 50% summer

Milk analysis

MIR Spectrum extraction

1 **Milk sampling**

2



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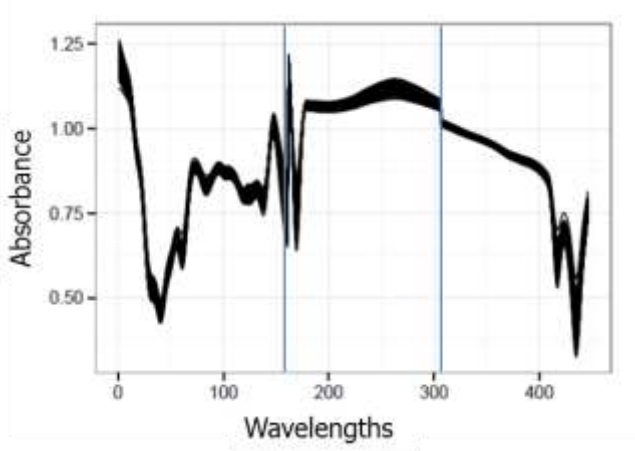
Reference measurement

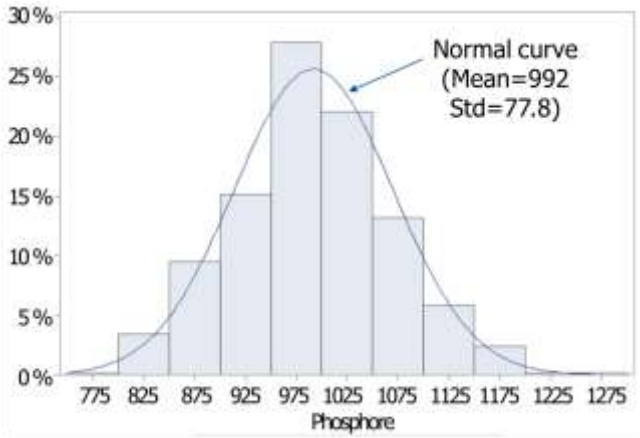
Allen's colorimetric method

Spectra were standardized 446 wavelengths were kept



495 samples with valid values

Mean=992 mg/kg
StD=77.8 mg/kg



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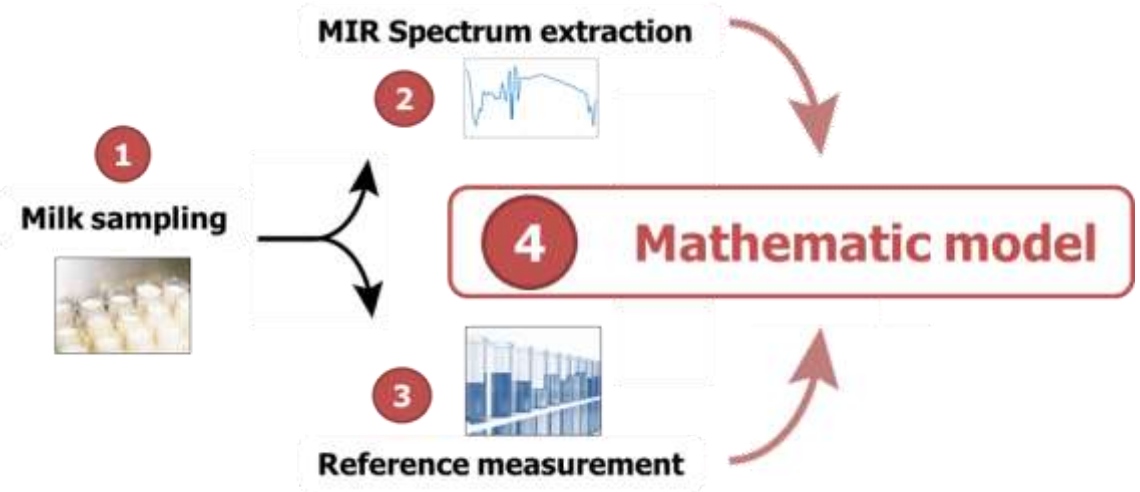
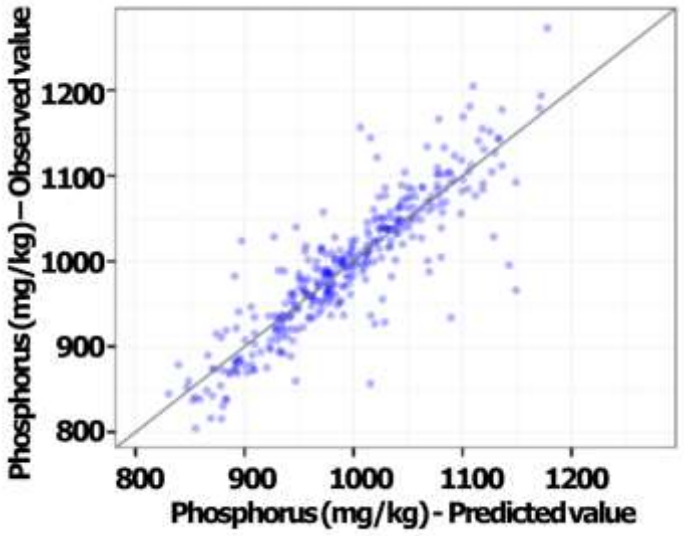
MIR: mid infrared – StD: standard deviation

Calibration & cross-validation of the model



Calibration and cross-validation on 70% of the database:

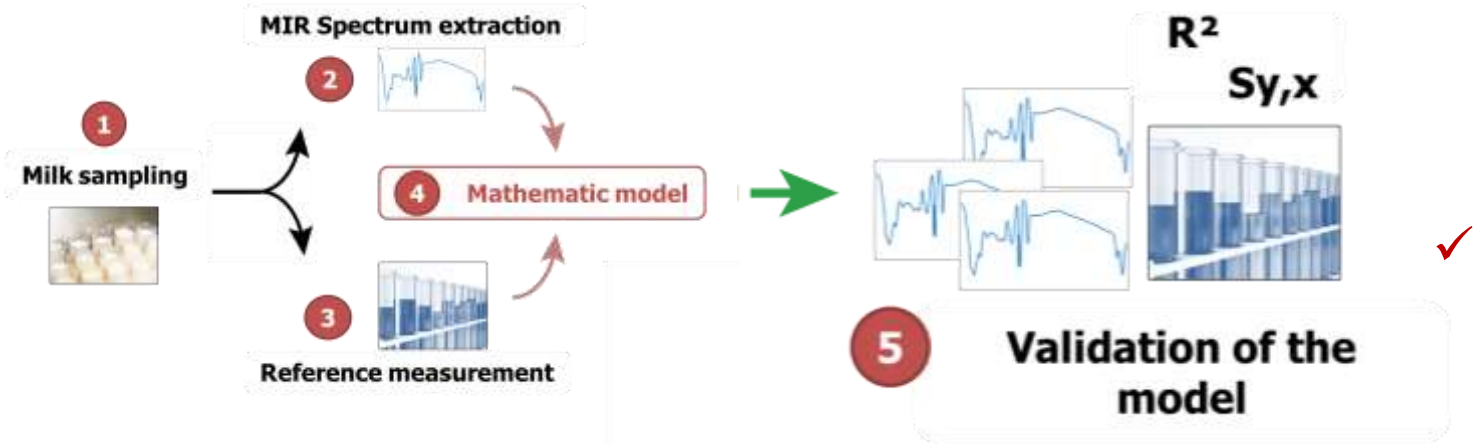
- ✓ **136 herds – 348 cows – 348 samples**
- ✓ **Partial Least Square regression**
- ✓ K-fold cross-validation
- ✓ Number of components = 10



	N	Mean	StD	R^2_C	SE_C	R^2_{CV}	SE_{CV}	RPD_{CV}
Phosphorus (mg/kg)	**348**	**994**	**80**	**0.78**	**38**	**0.72**	**42**	**1.90**
Soyeurt et al., 2009	*87*	*1093*	*127*	*0.89*	*42*	*0.85*	*50*	*2.54*
Toffanin et al., 2015	*207*	*933*	*104*			*0.72*	*55*	*1.89*
Visentin et al., 2016	*210*	*1010*	*181*			*0.71*	*84*	*2.16*
Stocco et al., 2014 (Buffalo)	*167*	*1172*	*232*	*0.79*	*107*	*0.72*	*122*	*1.90*

N: number of samples - StD: standard deviation – R^2_C and SE_C: coef. determination and standard error of calibration – R^2_{CV}, SE_{CV} and RPD_{CV}: coef. determination, standard error and Ratio performance to deviation of cross-valdiation

External validation of the model

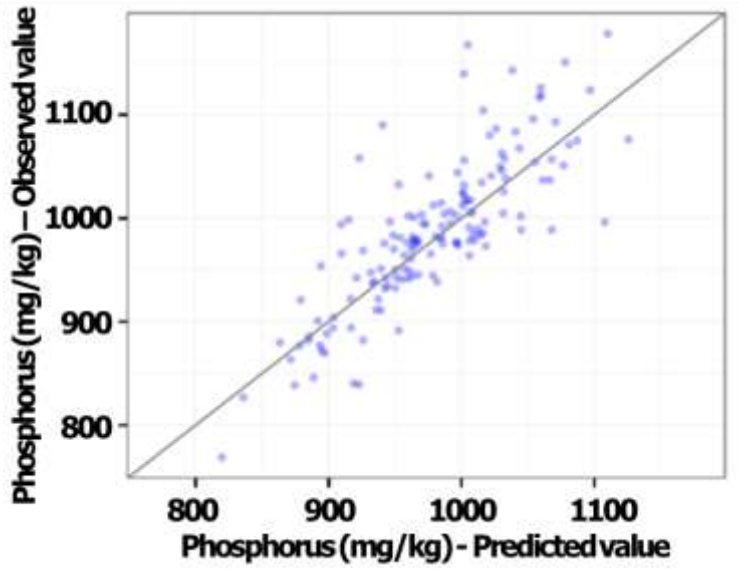


External validation on 30% of the database:

- ✓ **59 herds – 147 cows – 147 samples**

	N	Mean	StD	R^2_{EV}	SE_{EV}	RPD_{EV}
Phosphorus (mg/kg)	**147**	**987**	**73**	**0.76**	**60**	**1.21**
Soyeurt et al., 2009				*0.88*		*1.88*
Visentin et al., 2016	*210*			*0.68*		*2.05*

N: number of samples - StD: standard deviation –R^2_{EV}, SE_{EV} and RPD_{EV}: coef. determination, standard error and Ratio performance to deviation of external validation



Take home messages

- ✓ **Phosphorus in milk = a component of interest for dairy sector**
  - **Nutrition**
  - **Technology**
- ✓ **An accurate prediction equation of Phosphorus content in milk was developed**
  - **Will be used for research during a thesis on the relationship between milk mineral content and skeletal reserves in dairy cows**
  - **Should be improved before being implemented and used in routine**

Special thanks

To my co-authors

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L. Brun-Lafleur

INRA SCIENCE & IMPACT

A. Boudon
B. P. Gaignon
C. Hurtaud
Th. Le Mouel

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Thank you for your attention!