Towards a genomic evaluation of cheese-making traits including candidate SNP in Montbéliarde cows

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Context

Milk cheese-making properties (**CMP**), strongly related to milk composition, are economically important BUT difficult and costly to measure

From'MIR project 2015-2018

- Equations of prediction of CMP from mid-infrared (**MIR**) spectra[1]
- Genetic analysis of CMP and milk composition traits (proteins, fatty acids and minerals) predicted from 6 million MIR spectra from 400,000 Montbéliarde cows[2,3]

Objectives

1. Estimate the **reliability** of single step GBLUP breeding values (**ssEBV**)[4] by testing **4 models** and **3 scenarios** (different SNP sets including or not candidate variants detected by GWAS) in a **validation** population
2. Estimate **genetic trends** of CMP traits
3. Simulate different **breeding objectives** including CMP traits

For **10 traits** related to CMP:
3 cheese yields
5 coagulation traits
% caseins and Ca in milk

Objective 1
Reliability of ssEBV in a validation population

Training and validation sets

Years of first lactations (L1)

Training: 2012 | 2013 | 2014 | 2015 | 2016 Validation

498 sires | 146 sires

159,919 cows including **12,850** cows with genotypes

2,125 cows with genotypes

Complete and distinct sire families / population (half-sib cows performances removed)

4 models tested

	L1	L1 – L3
Mean per lactation	LACT1 191,532 obs.	LACT3 327,455 obs.
Test-day records	TD1 1,422,782 obs.	TD3 2,659,054 obs.

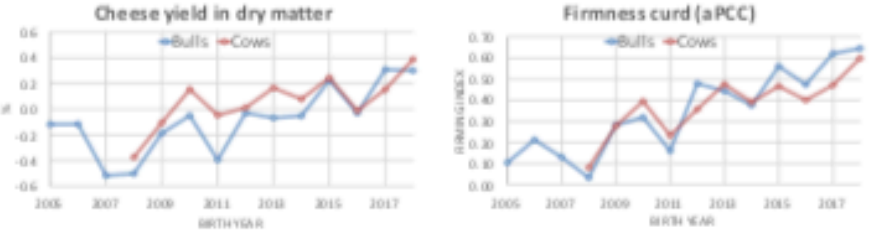
3 scenarios tested with TD3

SNP number	41,942 50K SNPs	47,794 50K + GWAS candidate SNPs
SNP effect variance	Equal for all SNPs	Higher for 5 to 14 SNPs
3 scenarios	50K	50K+	CAND

CD validation = correlation² (ssEBV, adjusted phenotype) / h²

Objective 2
Genetic trends of CMP traits

Application of genomic prediction equations on genotyped Montbéliarde cows (311,761) and bulls (21,171) born between 2005 and 2018



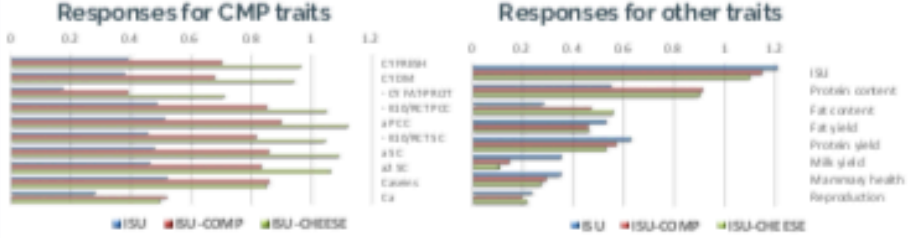
Objective 3
Responses to 3 breeding scenarios

Current total merit index: **ISU** (milk production and composition, mammary health, reproduction, longevity and conformation)

Alternative breeding objectives:

ISU-COMP = 0.7 ISU + 0.3 Caseins

ISU-CHEESE = 0.7 ISU + 0.1 (CY_{DM} + a_{PCC} + (- K10/RCT_{PCC}))



Conclusions

Reliable cheese-making genomic indexes, the most reliable and less biased obtained with:

- A test-day model applied to the first 3 lactations
- 50K SNP + candidate variants detected by GWAS
- Higher weightings for candidate variants

Indirect favorable response for CMP traits with the current breeding objective but possibility to increase responses by directly including CMP traits in the breeding objective with a limited impact on other traits

In 2021: release of Single-Step genomic evaluation of CMP predicted from MIR spectra in Montbéliarde cows

References

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