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First steps to implement genomic evaluations for butter softness and spreadability in Dual-Purpose Belgian Blue cattle

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This Session…..

- Implementing new traits in genetic and genomic evaluation systems: Feed Efficiency & Environmental Impact

➔ But our presentation ????

- About other new traits

➔ Increasing economic (but also social and environmental) sustainability

How ? Thinking Local…. ➔ Walloon Strategy

Consumers

- seeking for local, healthy and direct-from-producers dairy products

Dairy farmers

- regain added value from milk production
- maintain traditions
- re-establish direct contact with consumers

Authorities

- support these efforts (e.g., incentives, technical support)

➔ Increasing number of farms producing their own dairy products:

- **~ 15% of Walloon milk producers**
- butter, cheese (fresh or mature), yoghurt, ice cream

New Traits?

- Need of simple, reliable, clear and helpful indicators
- A large range of mid-infrared predictions from research:
  - Milk fatty acids, minerals
  - Milk coagulation properties and related traits

Soyeurt et al., J. Dairy Sci., 94:1657-1667
Soyeurt et al., J. Dairy Sci., 92:2444-2454
Colinet et al., ICAR 37th Annual Meeting
Colinet et al., 64th annual EAAP Meeting

→ **5 groups of traits**

- ☑ Milk coagulation
- ☑ Cheese yield
- ☑ Nutritional quality of fat
- ☑ Texture (butter spreadability)
- ☑ Sensory properties

Local Products ← Local Breed: DP-BBB

- Belgian Blue breed (BBB) originated in central and upper Belgium in the 19th century, from crossing local Belgian dairy cattle with Shorthorns

- BBB now composed of two strains:
  - Beef Belgian Blue → majority of animals
  - Dual-Purpose Belgian Blue (DP-BBB) → also north of France: “Bleue du Nord”

- DP-BBB cattle has been only moderately selected for milk production

- But strong “local” connection and to local products

Blue Cheese from Blue Cows

Aims of This Study

- General:
  - Characterizing the breed and its specificity compared to other breeds
  - Including first steps to implement genomic evaluations for product quality traits
  - Supporting the development of high value products

- Specific:
  - Work on texture (butter spreadability and softness) ← example traits

- Reported here:
  - Estimate genetic parameters
  - Identify genomic regions → gene-based selection

Texture (Butter Spreadability and Softness)

- DP-BBB ➔ quality butter
  - Interesting ratio of saturated to unsaturated milk FA
  - Also linked to lower fat percentage

- Risk of negative correlated response
  ➔ Feature needs to be protected

- Traits of interest
  - Butter softness: defined as unsaturated to saturated FA
  - Butter spreadability: defined as the ratio of FA: C18:1 cis-9 to C16:0

Variance Components: Materials and Methods

- Edited data 69,349 TD records in 12,577 lactations (1st, 2nd) of 7392 animals
  - Milk yield (MY), fat percentage (FP), protein percentage (PP) + selected fatty acids (FA)
  - Collected from 2007 to 2020 distributed in 104 herds in the Walloon Region of Belgium

- MT multiple-lactation random regression (RR) test-day ssGBLUP animal model
  - First and second lactation with 4 traits:
    - MY, FP, PP with
    - Butter softness (ratio unsaturated to saturated FA) / Butter spreadability (ratio of C18:1 cis-9 to C16:0)
  - Genotypes: 1,699 animals (639 males and 1060 females)
    - Usable SNP: 28,427 located on 29 autosomal chromosomes

Results

Average daily genetic correlation (above diagonal), heritability (diagonal), and phenotypic correlations (below diagonal) among milk yield (MY), fat percentage (FP), protein percentage (PP), and butter spreadability (BSp) in the first and second lactation

	First lactation				Second lactation			
Trait	MY	FP	PP	BSp	MY	FP	PP	BSp
MY	0.36	-0.19	-0.47	-0.27	0.80	0.04	-0.23	-0.31
FP	-0.21	0.28	0.55	-0.38	-0.10	0.80	0.54	-0.28
PP	-0.35	0.42	0.39	-0.06	-0.37	0.53	0.84	-0.05
BS	-0.13	-0.11	0.02	0.24	-0.18	-0.45	-0.18	0.85
MY	0.46	-0.03	-0.13	-0.14	0.28	-0.01	-0.31	-0.27
FP	-0.06	0.33	0.24	-0.10	-0.14	0.29	0.63	-0.45
PP	-0.18	0.19	0.43	0.11	-0.33	0.45	0.36	-0.17
BSp	-0.09	-0.13	-0.05	0.38	-0.16	-0.14	-0.05	0.32

Butter spreadability (BSp) was defined as the ratio of C18:1 cis-9 to C16:0 FA

Results

- "Butter softness" results nearly identical to "Butter spreadability" (BSp)
  - Quasi same traits

- Advantage for Butter spreadability
  - Well documented in literature *Couvreur et al., 2006, JDS, 89:1956-1969*
    O'Callaghan et al., 2016, JDS 99:9441-9460

- Advantage for Butter softness
  - Easier definition ➔ UFA / SFA often provided by manufacturer

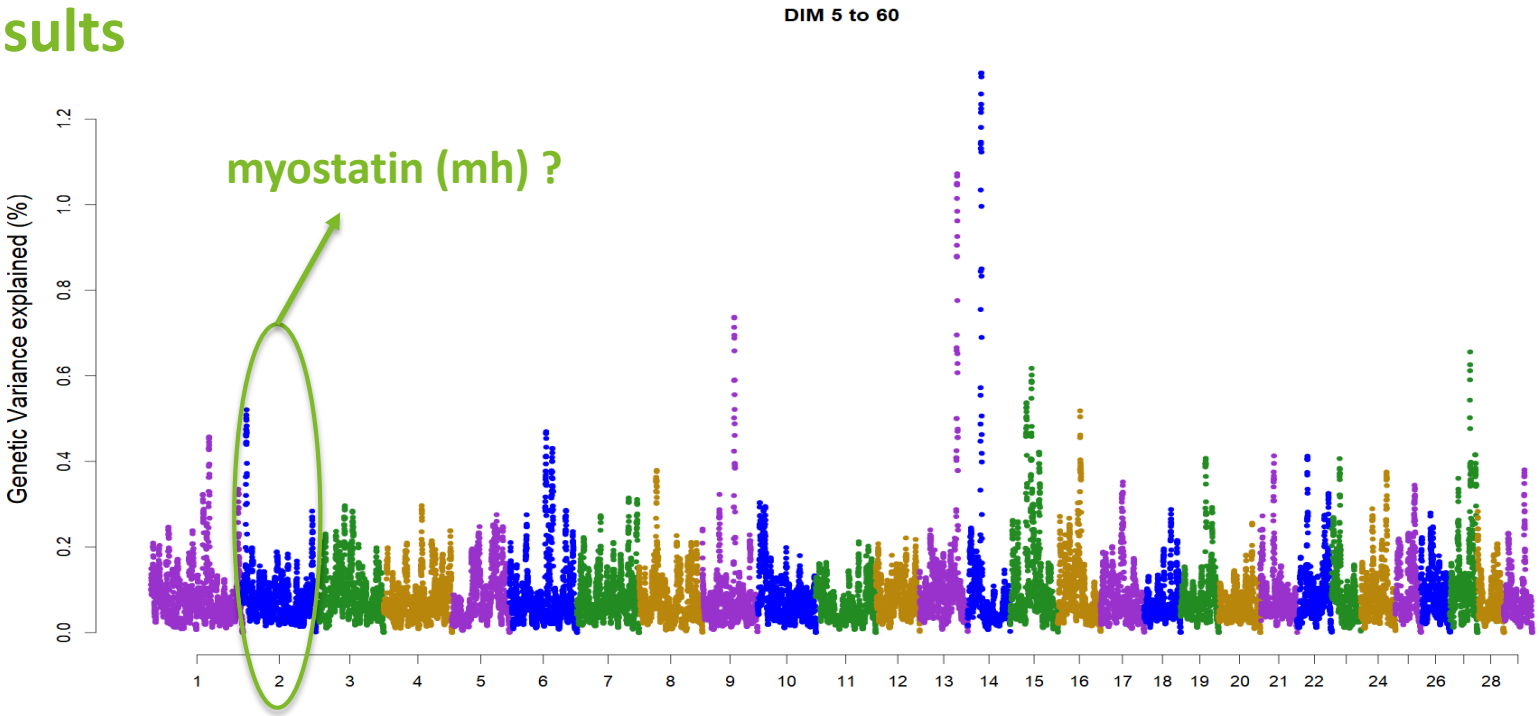
GWAS Analyses ➔ Genes of Interest

- Based ssGBLUP ➔ Three stages of lactation as following:
  - From 5 to 60 DIM, 61 to 200 DIM, 201 to 365 DIM

- Proportion of additive genetic variance computed
  - Explained by windows of 25 consecutive SNP (with an average of 2 Mb)

- Regions accounting for more than 1.0% used to search for candidate genes

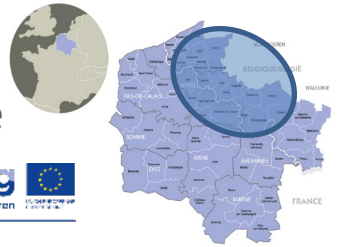
Results



Additive genetic variance explained by windows of 25 adjacent SNP across chromosomes for butter spreadability in DIM 5 to 60 of the first parity Dual-Purpose Belgian Blue cows

Genomic Evaluation: Material and Methods

- Material
  - 317,126 TD records (parities 1-14) in 42,882 lactations by 15,029 animals collected from 1976 to 2020 for MY, FP, (PP) + recent data FA ➔ MT model
  - Future additional genotyping ➔ at least all sires (mh)
  - Cross-border genomic evaluation will include also data from NFrance ➔ near future FA also available in France



- Methods
  - MT random regression (RR) test-day ssGBLUP animal model
    - 4 traits: MY, FP, PP, Butter softness or Butter spreadability ➔ series of evaluations
  - Multi-lactation ➔ 2+ repetition of 2nd parity (at least first 5 parities)

Next …

- Additional traits ➔ genomic characterization of DP-BBB milk
  - Milk coagulation
  - Cheese yield
  - Nutritional quality of fat
  - Texture (butter spreadability)
  - Sensory properties

- Final objective:
  - Provide genomic advisory tools on nutritional and technological properties
  - Protect against negative correlated response ➔ adapted “production” index

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Thank you

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