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Estimation of *Myostatin* gene effects on production traits and fatty acid contents in bovine milk

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Context

- **High interest in the milk fat composition**
  - Nutritional quality
  - Technical properties of dairy products
- **Improvement of milk fat quality**
  - Genetic variability of milk fatty acids (FA)
    (Soyeurt *et al.*, 2008; Stoop *et al.*, 2008)
  - Calibration equations to predict FA composition of milk
    - From mid-infrared (MIR) spectra (Soyeurt *et al.*, 2011)
  - Desirable gene variants

Context

- **Mutations in *Myostatin* gene: 'mh' allele**
  - Responsible for double-muscling phenotype in all cattle breeds (Bellinge *et al.*, 2005)
  - Influence on FA composition of meat (Raes *et al.*, 2001)
  - Deletion in Dual-Purpose Belgian Blue (DP-BBB)
    - Influence on milk performance traits (Buske *et al.*, 2010 & 2011)

➔Influence of 'mh' allele on milk fat composition?

Objectives

- **Estimation of genetic parameters in DP-BBB of:**
  - Milk, fat, and protein yields
  - Saturated (SFA) and monounsaturated FA (MUFA) contents in milk

- **Estimation of 'mh' allele effects on these traits**

Materials & Methods

- **Data structure & genotypes**
  - Data used for the official routine genetic evaluation for Walloon Region of Belgium
  - 3,098 DP-BBB cows
    - 1,082 genotyped DP-BBB cows
    - 2,016 non-genotyped DP-BBB cows
      - With known sire
      - From 38 herds

Materials & Methods

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    - 24,124; 16,144; and 11,345 records for 1^{st}, 2^{nd}, and 3^{rd} lactations, respectively

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  - 3,098 DP-BBB cows
  - 51,613 test-day records
    - 24,124; 16,144; and 11,345 records for 1^{st}, 2^{nd}, and 3^{rd} lactations, respectively
    - Milk, fat, and protein yields (kg/day)
    - SFA and MUFA contents (g/dL of milk)
      - Predicted from MIR spectral data
      - Calibration equations (Soyeurt *et al.*, 2011)

Materials & Methods

- **Data structure & genotypes**
  - Pedigree file: 5,796 animals
  - 1,250 genotyped DP-BBB animals
    - Few genotyped animals
- **Gene content estimation**
  - For non-genotyped animals
    - Estimation of gene content (Gengler *et al.*, 2007)

Materials & Methods

- **Statistical model to estimate variance components**
  - Based on routine genetic evaluation model for milk production traits (Auvray & Gengler, 2002; Croquet *et al.*, 2006)
    - Multi-lactation, multi-trait random regression model
    - 3 datasets
- **Statistical model to estimate 'mh' effects**
  - Same model
    + Fixed regression on observed or estimated gene content

Materials & Methods

- **Statistical model to estimate 'mh' effect**
  - 3-lactations 5-traits model

$$y = X\beta + \begin{bmatrix} q \\ \hat{q} \end{bmatrix} g_s + Q(Wh + Zp + Za) + e$$

  - g_s = Fixed regression coefficient
    - $\mathbf{q}$ = observed gene content
    - $\hat{\mathbf{q}}$ = estimated gene content

Results & Discussion

- **Genotype frequencies of the *Myostatin* gene**
  – For genotyped animals (n=1,250)

Genotype	Frequency (%)
+/+	9.84
mh/+	25.12
mh/mh	65.04

High frequency for genotype mh/mh

Results & Discussion

- **Genetic parameters of studied traits**

Averaged daily heritabilities across lactations

Trait	Milk (kg/day)	Fat (kg/day)	Protein (kg/day)	SFA (g/dL of milk)	MUFA (g/dL of milk)
Milk	0.14	0.69	0.86	-0.10	0.17
Fat	0.66	0.11	0.81	0.52	0.65
Protein	0.76	0.66	0.12	0.15	0.39
SFA	0.06	0.21	0.11	0.34	0.73
MUFA	-0.05	0.05	-0.02	0.28	0.15

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Averaged phenotypic correlations across lactations

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Results & Discussion

- **Allele substitution effects of the 'mh' allele**
  - Milk, fat, and protein yields (kg per lactation) for each lactation & averaged through all lactations (n=51,613)

kg per lactation	All lactations	Lactation 1	Lactation 2	Lactation 3
Milk yield	-209.39	-211.06	-154.97	-262.13
Fat yield	-8.18	-7.97	-6.61	-9.96
Protein yield	-7.17	-6.86	-5.92	-8.72

✓ 1 copy of the 'mh' allele

- Decrease in milk, fat, and protein yields

Similar to Buske et al. (2010; 2011) and Colinet et al. (2010)

Results & Discussion

- **Allele substitution effects of the 'mh' allele**
  - On SFA & MUFA contents (g/dL of milk) (n=6,296)

g/dL of milk	All lactations	Lactation 1	Lactation 2	Lactation 3
SFA	-0.021	-0.014	-0.039	-0.009
MUFA	0.024	0.024	0.008	0.038

✓ 1 copy of the 'mh' allele
- Decrease in SFA content in milk
- Increase in MUFA content in milk

Similar to Buske et al. (2011)

Conclusions

- **High averaged daily heritability for SFA in DP-BBB**
- **Estimation of the 'mh' allele effects**
  - **Negative effect**
    - **Milk, fat, and protein yield**
    - **SFA content in milk**
  - **Positive effect**
    - **MUFA content in milk**

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