Genetic relationships between milk fatty acids and fertility of dairy cows

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Indicator traits for fertility

Fertility traits
- potentially difficult to measure
- often not readily available
- have low heritabilities

Indicator traits are of interest to increase accuracy of EBVs for fertility
- if easier to measure, higher heritability, and well correlated with fertility
- e.g., milk yield, type traits, body condition score
- milk fatty acids profile?

→ in relation to body fat mobilization
Objective

Investigate the opportunity to use fatty acid traits as indicators of fertility

- Estimate genetic correlations between days open and contents of major fatty acids in milk for 1\textsuperscript{st}-parity Walloon Holstein cows
- Opportunity to include fatty acid EBVs into the Walloon fertility index?
Part of ROBUSTMILK project

Develop innovative and practical breeding tools for improved dairy products from more robust dairy cows

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Data & model

- 22 bivariate models: DO and one of the following traits
  - Milk, fat, protein yields, fat and protein contents
  - Fatty acid (FA) contents (g/dl of milk)
    - predicted by MIR (Soyeurt et al., 2011; MIR spectra are routinely collected through milk recording)

- 29,792 first-parity Holstein cows with both DO and FA records and at least 2 FA records

- 143,332 FA records and 29,792 DO records

- Effects of the models similar to those used for genetic evaluations
Correlations did not change greatly over DIM

Higher yields → higher DO

Selection for higher yields is likely to reduce fertility
Daily genetic correlations with DO

In early lactation

- Milk production ↑
- Body fat mobilization ↑
- Release of C18:0 and C18:1 cis-9 in milk
- Inhibition of de novo synthesis in mammary gland

Higher contents of C18:0 and C18:1 cis-9 in milk
= indicator of body fat mobilization → poor fertility
Daily genetic correlations with DO

In early lactation

Milk production ↑ → Body fat mobilization ↑ → Release of C18:0 and C18:1 cis-9 in milk → Inhibition of *de novo* synthesis in mammary gland

Lower contents of C6:0 to C14:0 in milk = indicator of body fat mobilization → poor fertility
Daily genetic correlations with DO

After 150 DIM

- C4:0 to C16:0 → correlations between -0.20 and 0
- Higher contents in milk of C18:0 and C18:1 cis-9 → better fertility
Groups of FA: trends similar to individual FA
Polyunsaturated FA: no strong associations
Using FA to select fertility?

Fatty acid contents in milk are correlated to fertility and are therefore potential indicator traits for fertility.

How integrate FA into Walloon evaluation?

- Genetic evaluation for saturated FA and monounsaturated FA \( \Rightarrow \) dUNSAT and dMONO

  = 2 indices representing the relative part of milk fat that is unsaturated and monounsaturated
Fatty acid contents in milk are correlated to fertility and are therefore potential indicator traits for fertility.

**How integrate FA into Walloon evaluation?**

- Genetic evaluation for saturated FA and monounsaturated FA ➔ dUNSAT and dMONO
- Walloon female fertility index (CFF) composed of:
  - Direct female fertility index (DFF)
    - = linear combination of Interbull international female fertility proofs available on the Walloon scale
Fatty acid contents in milk are correlated to fertility and are therefore potential indicator traits for fertility.

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- Genetic evaluation for saturated FA and monounsaturated FA $\Rightarrow$ dUNSAT and dMONO
- Walloon female fertility index (CFF) composed of:
  - Direct female fertility index (DFF)
  - Indirect female fertility index (IFF)
    
    \[ \text{IFF} = \text{linear combination of EBVs of fertility-correlated traits including BCS (IFF}_{\text{BCS}}) \text{ or angularity (IFF}_{\text{ANG}}) \]
Fatty acid contents in milk are correlated to fertility and are therefore potential indicator traits for fertility

**How integrate FA into Walloon evaluation?**

- Genetic evaluation for saturated FA and monounsaturated FA ➔ dUNSAT and dMONO
- Walloon female fertility index (CFF) composed of:
  - Direct female fertility index (DFF)
  - Indirect female fertility index (IFF)

**Gain in reliability when including dUNSAT and dMONO into IFF_{BCS} and IFF_{ANG}?**
Using FA to select fertility?

Gain in reliability when including $d\text{UNSAT}$ and $d\text{MONO}$ into $\text{IFF}_{BCS}$ and $\text{IFF}_{ANG}$?

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<th>$\text{IFF}_{BCS-FA}$</th>
<th>$\text{IFF}_{ANG}$</th>
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Conclusions

- Fatty acid contents in milk are correlated to fertility
  - correlations change throughout the lactation
  - it emphasizes relationship between body fat mobilization and fertility

- Interest of using milk FA contents in indirect selection for better fertility in dairy cows
  - further studies will investigate all FA (C18:1 cis-9)
  - but all features of FA should be considered
    - e.g., nutritional, sensory, and technological qualities of milk fat, relationships with methane emissions
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