Genetics of body energy status of Holstein cows predicted by mid-infrared spectrometry

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Energy balance (EB)

Energy balance = energy intake – energy requirements

- Negative EB in high-yielding cows in early lactation
- Important factor impacting health and fertility


- Routine collection of EB data within milk recording schemes
  ➔ daily management decisions and breeding programs
Energy balance (EB)

- Direct measure of EB not feasible in commercial herds
- Potential of mid-infrared analysis of milk to predict body energy status (McParland et al., 2011, 2012, J. Dairy Sci.)
  - quick, easy, inexpensive
  - as a part of milk recording

- Direct energy balance (dEB; MJ/d)
  \[ R_{cv} = 0.68 \quad R_{ev} = 0.65 \]

- Body energy content (EC; MJ)
  \[ R_{cv} = 0.57 \quad R_{ev} = 0.53 \]

- Effective energy intake (EEI; MJ/d)
  \[ R_{cv} = 0.80 \quad R_{ev} = 0.78 \]

\[ R_{cv} \text{ and } R_{ev} = \text{correlation coefficient of split-sample cross-validation and of external validation} \]
Objectives

- Genetic parameters for body energy status traits predicted by mid-infrared spectrometry
  - Walloon Holstein cows, parity 1 to 3

- Genetic correlations with fertility
The equations obtained by McParland et al. (2011, 2012) were applied on the Walloon spectral database.

Only dEB, EEI, and EC predictions that encompassed the variability represented in the calibration dataset retained

<table>
<thead>
<tr>
<th>Trait</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct energy balance (dEB, MJ/d)</td>
<td>777,303</td>
<td>-1.30</td>
<td>11.48</td>
</tr>
<tr>
<td>Body energy content (EC, MJ)</td>
<td>791,502</td>
<td>6012</td>
<td>753</td>
</tr>
<tr>
<td>Effective energy intake (EEI, MJ/d)</td>
<td>791,502</td>
<td>172.07</td>
<td>56.67</td>
</tr>
</tbody>
</table>
Data – dEB over lactation

[Graph showing energy balance (MJ/d) over days in milk for different parities (Parity 1, Parity 2, Parity 3).]
Data – EC over lactation

![Graph showing Body Energy Content (MJ) over Days in milk for different parities.]

- **Parity 1**: Blue line
- **Parity 2**: Red line
- **Parity 3**: Green line
Data – EEI over lactation

Effective energy intake (MJ/cd)

Days in milk

Parity 1
Parity 2
Parity 3
Genetic parameters

Data after edits

- parity 1 to 3
- 336,142 dEB records from 36,694 cows in 580 herds
- 354,900 EC and EEI records from 38,531 cows in 607 herds

Single-trait 3-lactation random regression model

- fixed effects: herd x test day, lactation stage (classes of 5 days), gestation stage, age at calving x season of calving x lactation stage
- random effect: herd x year of calving, permanent environmental, additive genetic
  - regression curves modelled with 2nd order Legendre polynomials
Genetic parameters

<table>
<thead>
<tr>
<th>Trait</th>
<th>dEB</th>
<th>EC</th>
<th>EEI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heritability (averaged across DIM and parities)</td>
<td>0.43</td>
<td>0.21</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Genetic correlation within traits across lactation > 0.85
Correlation with fertility

- Data after edits
  - 124,921 dEB, EC and EEI records
  - 24,419 days open (DO) records for fertility
  - 24,419 first-parity cows in 361 herds

- Bivariate model including random regressions for body energy status traits
  - dEB, EC, EEI: same model than above
  - DO:
    - fixed effects: year of calving x month of calving, season of calving x age at calving, herd
    - random effects: herd x year of calving, non-genetic animal, additive genetic
Correlation with fertility

Days in milk

Genetic correlation with DO

-0.4
-0.3
-0.2
-0.1
0

0 35 70 105 140 175 210 245 280

dEB  EEI  EC
Summary

- Mid-infrared prediction of body energy status traits
  - “indicator” of body energy status
  - variability of the data should be represented in the calibration data set

- Heritable traits
  - $h^2$ from 0.10 to 0.55, dEB more heritable
  - $h^2$ higher in mid to late lactation

- Genetic correlation with DO
  - favorable, low to moderate

- Mid-infrared prediction of body energy status traits could be considered in selection programs.
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