Genetics and genomics of energy balance measured in milk using mid-infrared spectroscopy

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Introduction

- Energy balance is related to animal health and fertility
- Energy balance would be an ideal candidate trait for inclusion in a breeding program but difficult and expensive to measure routinely
- Mid-infrared spectroscopy (MIR) of milk is used to routinely quantify milk composition; preliminary analysis suggests also useful predictor of energy balance – limited dataset

Objective

- To validate milk-MIR predicted energy balance in an independent dataset and estimate genetic parameters and genomic regions putatively associated with energy balance

Methods

- Total of 2,992 morning, 2,742 mid-day, and 2,989 evening milk MIR spectral records from 564 lactations on 337 Scottish cows managed in confinement on two diets
- Additional 844 morning and 820 evening milk MIR spectral records from 338 lactations on 244 Irish cows managed outdoors on grazed grass were also available
- All records had associated energy balance recorded information from measured energy intake and energy output
- Energy balance prediction equations developed from MIR spectra + milk yield using partial least squares
  - Externally validated within and across countries and production system
- Genetic parameters for predicted and true energy balance estimated using a linear animal mixed model analysis of the combined Irish and Scottish datasets
  - Fixed effects included treatment*year, age at calving, parity, and stage of lactation
- Illumina Bovine50 Beadchip data available on selection of cows
- Bayesian stochastic search variable selection performed using Gibbs sampling used to identify genomic regions associated with energy balance

Results

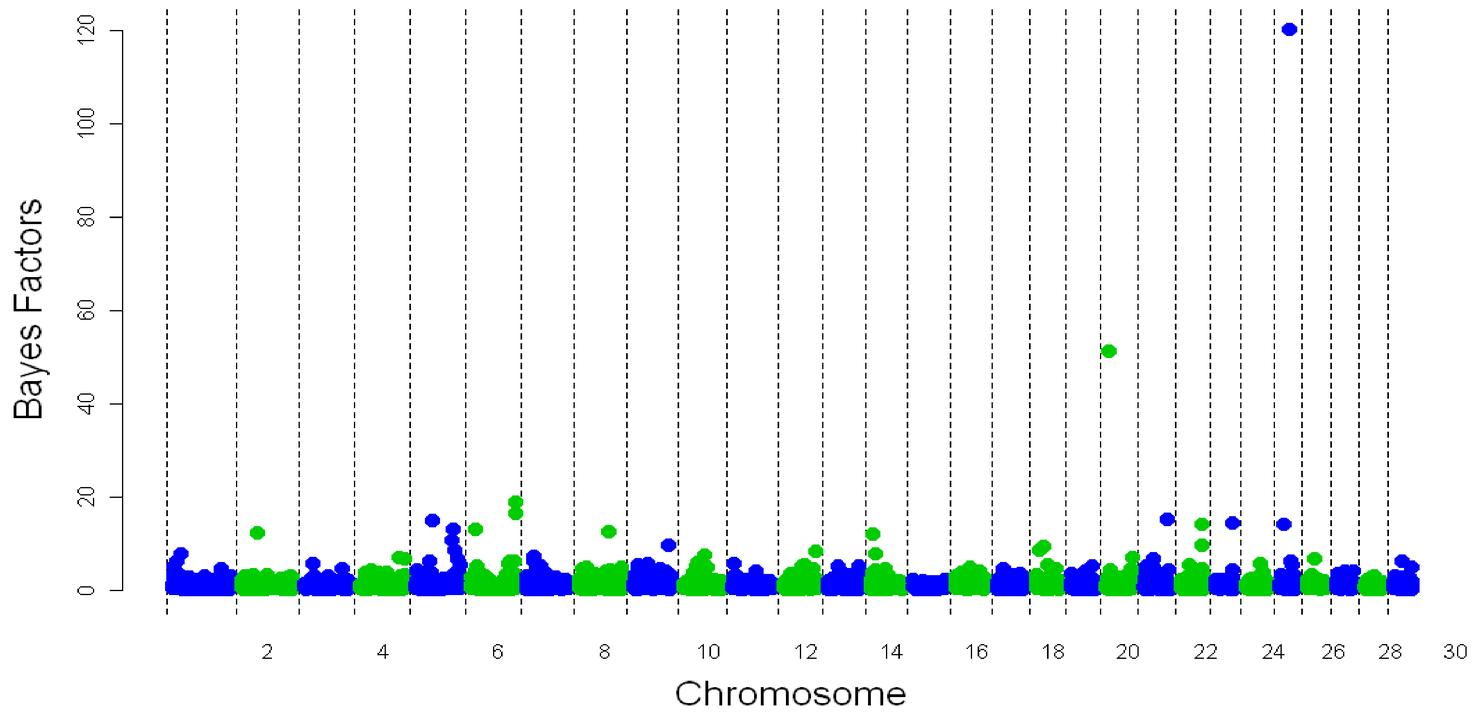
Prediction accuracy

- The accuracy (i.e., correlation) from external validation (i.e., records used for validation were not part of the calibration) of predicting energy balance from milk MIR was 0.47 to 0.69
  - Accuracy of prediction was 0.61 to 0.64 in early lactation (i.e., <60 days post-calving)
  - Accuracy of predicting energy balance in grazing Irish cows from milk MIR prediction equations derived in confinement Scottish cows was poor, and vice versa

Genetics of predicted energy balance

- Heritability of MIR-predicted and true energy balance was 0.20 (se=0.017) and 0.11 (se=0.029), respectively
- The genetic correlation between MIR-predicted and true energy balance was 0.59 (se=0. 096)

Genomics of energy balance



Bayes factors:

- >3.1 indicates 'substantial evidence' of a QTL
- > 10.1 indicates 'strong evidence' of a QTL
- > 30.1 indicates 'very strong evidence' of a QTL

Conclusions

- Energy balance can be predicted from milk MIR with greater accuracy than previously proposed milk fat:protein ratio
- Heritable genetic variation in predicted energy balance which is genetically correlated with true energy balance
- Genomic variation identified underlying energy balance

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