News
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Team Biomarkers of performances, adaptation and qualities (Biomarkers)

HIGHLIGHT

# Identification of biomarkers of nutritional status in milk and nutrigenomic study of the mammary gland of Holstein and Montbéliarde cows

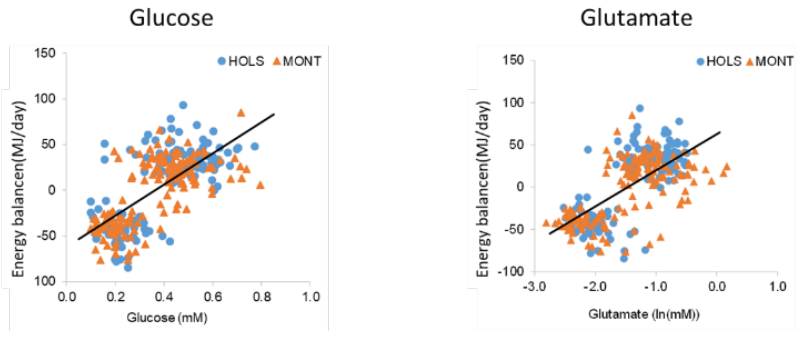
Today, dairy farmes are turning to precision farming to be able to adapt the management of their animals in real time, while maintaining product quality. It is therefore essential to identify molecules indicating a particular status (nutrition, disease, stress, etc.). The objective of our work was to identify noninvasive indicators of a nutritional deficit and to study the molecular mechanisms of mammary gland responses to a feed restriction. The study of seven metabolites present in milk showed that glucose and glutamate may be potential noninvasive biomarkers of negative energy balance in Holstein and Montbéliarde cows. Feed restriction also affected the expression of 27 microRNAs (small non-coding RNAs that regulate the expression of coding genes; miRNAs) and 374 messenger RNAs (mRNAs), some of which are involved in lipid synthesis in the mammary gland of Holstein cows. Bioinformatics analyses showed that the nutritional regulation of miRNAs and mRNAs may play a role in the decrease of milk production and changes in milk fatty acid profiles.

In a changing environmental and socioeconomic context, where livestock farming is being questioned, it is now essential to develop novel husbandry methods.

To advance towards precision farming, the identification of new and easily available and accessible biomarkers of a particular status (nutritional, sanitary, stress...) is necessary.

At the beginning of lactation, cows can suffer from an energy deficit leading to metabolic processes that affect milk production and composition, as well as animal welfare and health. Such disturbances can also occur during periods of feed shortages. The objective of our work was to identify biomarkers of such metabolic stress and to evaluate their effects on milk synthesis and secretion.

| | Milk metabolites | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Glucose | | Glucose-6-P | | Glutamate | | BHB | | Isocitrate | |
| Energy balance | 0.63 | *** | - 0.31 | *** | 0.61 | *** | 0.48 | *** | - 0.45 | *** |




*Legend: Spearman correlations and regression between metabolites in milk and energy balance. ***P<0.001*

Feed restriction for 6 days at 50% of energy requirements in mid-lactation cows (9 Holstein and 10 Montbéliarde) induced a decrease in milk production and in fat and protein secretion, altered milk fatty acid profiles and plasma metabolite concentrations. The feed restriction changed the concentration of seven milk metabolites (β-hydroxybutyrate, glucose, glucose-6-phosphate, isocitrate, glutamate, uric acid and free amino groups). These concentrations were correlated with the energy balance (Fig. 1). Milk glucose and glutamate are two potential non-invasive biomarkers of negative energy balance in both breeds of dairy cows (Billa et al., 2020). Studies of miRNAs in the mammary gland revealed 22 miRNAs differentially expressed between the two breeds (Billa et al., 2019).
The restriction affected the expression of 27 miRNAs and of 374 mRNAs but only in Holstein breed. Bioinformatics analyses of differential miRNAs and mRNAs suggest a role of miRNAs via mRNA regulation in changes in fatty acid profile and in milk production decrease in response to the restriction (Billa et al).

The perspectives are to validate these results on a larger population, and to study miRNA profiles in milk fat globules (Biomarq'Lait project). In the longer term, it will be necessary to set up biomarker assay methods that can be applied on farm.

**Learn more:**

Billa P-A, Faulconnier Y, Larsen T, Leroux C, Pires J. Milk metabolites as noninvasive indicators ofnutritional status of mid-lactation Holstein and Montbeliarde cows. Journal of Dairy Science, 103(4):3133{3146, 2020.

Billa P-A, Faulconnier Y, Ye T, Chervet M, Le Provost F, Pires J, Leroux C. Deep RNA-Seq reveals miRNome differences in mammary tissue of lactating Holstein and Montb´eliarde cows. BMC Genomics, 20, 2019.

Billa P-A., Faulconnier Y, Ye T, Bourdon C, Pires J and Leroux C. Nutrigenomic analyses revealed miRNAs and mRNAs affected by feed restriction in mammary gland of midlactation dairy cows. Plos One.

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