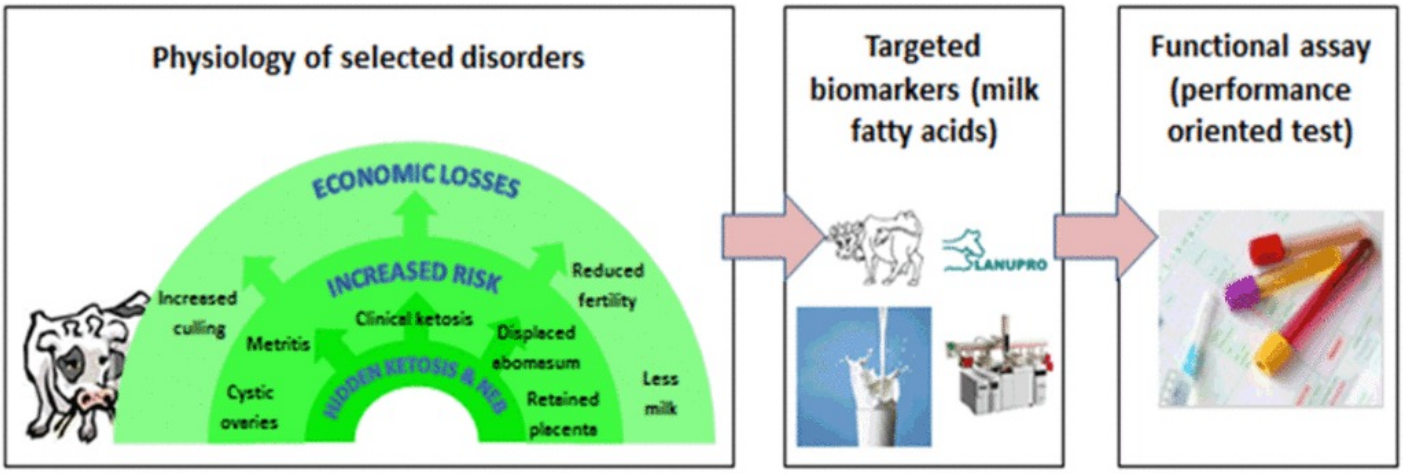
Milk fatty acids as possible biomarkers to diagnose hyperketonemia in early lactation

Aim of this study was to assess the potential of milk fatty acids (FA) as a diagnostic tool for hyperketonemia. Negative energy balance is a common phenomenon in the transition period in dairy cows. During this period, increase in feed intake is lagging behind increasing energy demand for milk production, which results in an often-serious energy imbalance. As a result, blood glucose and insulin concentrations are low and body fat is mobilized and transported as non-esterified FA (NEFA) to several organs, particularly to the liver in which these FA are oxidized to produce energy. Due to the limited availability of propionate however, complete oxidation of NEFA is impaired, resulting in the production of ketone bodies. Hyperketonemia is detrimental to the cow's health and production. It increases disease risk and might result in substantial milk yield losses in early lactation.

Excessive amounts of NEFA released during body fat mobilization are transferred to the milk. Because these NEFA are particularly rich in long-chain FA, concentrations in milk fat of those FA were identified as valuable early warning biomarkers for hyperketonemia. These findings, however, were based on a limited data set. Moreover, excessive mobilization of body reserves will not result in the development of hyperketonemia when sufficient glucogenic precursors (particularly propionate) are available in the liver. Hence, besides a biomarker in milk for body fat mobilization, a biomarker for energy status might be required to accurately assess the cow's risk for hyperketonemia. Milk FA that could provide additional information on the cow's glucose status are odd-chain FA that are positively related to propionate (e.g., C15:0 and C17:0).

For the experimental setup, milk and blood plasma sampled during the first 8 weeks after calving were used. Samples were obtained from 93 lactating cows (Holstein-Friesian dairy cows from the Dairy Campus Research dairy herd - WUR Livestock Research, Lelystad, the Netherlands) receiving either a glucogenic or a lipogenic diet in early lactation after a normal (60 d) or shortened (30 d) dry period or without dry period.

Based on Blood Plasma (BHBA) Ketone Thresholds and Influence of Experimental Factors (Dietary and Dry Period Management), collected over 372 observations in weeks 2, 3, 4, and 8 after calving, 19.6% were classified as suffering from hyperketonemia. We then proceeded with the identification of Milk FA that could predominantly be linked with this status. Given the highest incidence of hyperketonemia during the first month of lactation, milk FA data from weeks 2, 3, and 4 were used to identify the most powerful variable for diagnosis of hyperketonemia. We ended up with the milk fat C18:1 cis-9 (indicating body fat mobilization) -to- C15:0 (indicating glucose status) ratio.



One-half of the cows showing hyperketonemia during the first 8 weeks in lactation showed a milk fat C18:1 cis-9-to-C15:0 ratio of 45 or more in week 2 with a false positive rate of 9.0%. Only 15% of the hyperketonemia cows had a milk fat C18:1 cis-9-to-C15:0 ratio of 30 or lower, whereas one-half of the non-hyperketonemia cows had these low ratios in milk fat.

We can conclude that the milk fat C18:1 cis-9-to-C15:0 ratio does show potential for diagnosis of hyperketonemia in dairy cows: based on the current data set, a ratio between 34 and 45 seems to be a valuable threshold. Because differentiation should be made in relation to the lactation week when milk sampling takes place, the current experimental setup could be improved by sampling more frequently. Also the importance of adding test day information should be emphasized when further developing this diagnostic test.

Veerle Fievez
Laboratory for Animal Nutrition and Animal Product Quality, Ghent University, Belgium

Publication

Milk fatty acids as possible biomarkers to diagnose hyperketonemia in early lactation.
Jorjong S, van Knegsel AT, Verwaeren J, Bruckmaier RM, De Baets B, Kemp B, Fievez V
J Dairy Sci. 2015 Aug