Success Story
COMET

FFG

ADDA

ADDA
Advancement of Dairying in Austria
Programme: COMET – Competence Centers for Excellent Technologies
Programme line: K-Projects
COMET-subproject, duration and type of project:
ADDA, 01.07.2014 – 30.06.2017, strategic/ multi-firm

Individual differences in lipolysis in dairy cows early post-partum and identification of characteristic metabolites

Early lactating dairy cows typically mobilize large amounts of body lipid stores to fulfill their high energy requirements. However, excessive rates of lipolysis pose serious health risks. In a study with 30 dairy cows marked individual differences in the degree of lipolysis became evident. Furthermore, 142 blood metabolites were investigated to identify early markers of excessive body fat mobilization. In summary, 37 key metabolites associated with excessive lipolysis and disturbed insulin function were identified. These novel markers could be useful in practice to identify high-risk cows at an earlier stage and to alleviate or prevent the onset of peripartal diseases.

Detection of strong individual differences in the degree of body fat mobilization after calving

In this study 30 dairy cows were investigated during the period around calving. Interestingly, no differences in the milk yield and body condition among cows were observed, whereas pronounced divergences in the strategies to fulfill the high energy requirements after parturition became evident. While 8 cows showed a low lipid mobilization, 11 cows each mobilized medium or large amounts of the endogenous lipid stores. Analysis of "classical" metabolic parameters revealed, that cows with excessive lipid mobilization had a lower sensitivity to insulin. On the other hand, lowest ruminal pH values were found in cows with the lowest mobilization (Fig. 1). In conclusion, finding a balance between prevention of rumen fermentation disorders (preventing a too strong decline in ruminal pH) on the one hand, and excessive lipolysis on the other hand, is of utmost importance in periparturient dairy cows.

Figure 1

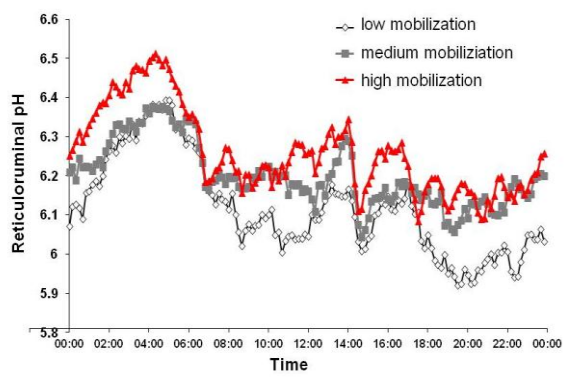

Fig. 1: Diurnal ruminal pH dynamics in dairy cows differing in the degree of lipid mobilization early after parturition

Variation in the degree of lipolysis is accompanied by shifts in the lipidome

A further characterization of the serum lipidome was carried out, to identify possible metabolites associated with excessive lipid mobilization.

bmwfw Federal Ministry of Science, Research and Economy
bmvit Austrian Ministry for Transport, Innovation and Technology

In total, 142 metabolites (including lysophosphatidylcholines, phosphatidylcholines, acylcarnitines, amino acids and biogenic amines) were detected.

Overall, the analysis revealed 37 key metabolites showing characteristic changes in association with the degree of lipid mobilization. More specifically, more than the half of the detected sphingomyelines was increased in cows experiencing high lipomobilization. Additionally, differences in acylcarnitines and phosphatidylcholines became evident.

For instance, mainly those phosphatidylcholines with diacyl-residues showed differences among lipolysis groups. While those with a chain length up to 36 carbons were increased, an opposite effect was noticed for phosphatidylcholines with very long chains (> 40 carbons).

Most acylcarnitines differed among lipolysis groups. While free carnitine and propionylcarnitine were lowest in cows with the highest lipomobilization, those cows showed elevated levels of acetylcarnitine, myristoleylcarnitine, palmitoleylcarnitine, stearoylcarnitine and oleoylcarnitine.

Additionally, the concentrations of the amino acids glycine and threonine differed among lipolysis groups.

Overall, high associations among those metabolites and a disturbed insulin functions became evident. Figure 2 demonstrates a correlation analysis between the sensitivity to insulin and the concentration of several acylcarnitines, phosphatidylcholines with diacyl-residues (PC aa) and sphingomyelins (SM). The X-axis indicates Pearson correlation coefficients.

Figure 2

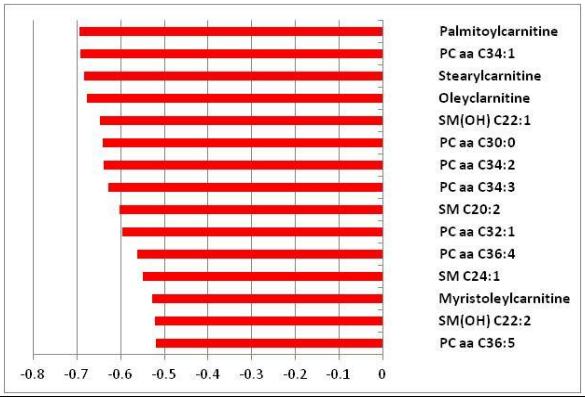

Fig. 2: Association between serum metabolites and disturbed insulin function

Impact and effects

The results reveal different adaptation strategies in early-lactation cows to cope with the high energy requirements at the onset of lactation. The study implies that it is necessary to find a proper balance between prevention of rumen fermentation disorders and excessive lipolysis through appropriate feeding management. Furthermore, 37 key metabolites associated with excessive lipid mobilization and impaired insulin function have been identified. These novel candidates could be useful in practice to identify high-risk cows at an earlier stage and use them to alleviate or prevent the onset of diseases associated with excessive lipid mobilization in cows.

Contact and information
K-Project ADDA

University of Veterinary Medicine Vienna
Veterinaerplatz 1, 1210 Vienna
T +43 (1) 25077-3200
E qendrim.zebeli@vetmeduni.ac.at, http://www.vu-wien.ac.at/tierernaehrung/

Project coordinator
Prof. Dr. Qendrim Zebeli

Project partners

Organization	Country
Institute of Animal Nutrition and Functional Plant Compounds	Austria
University Clinic for Ruminants	Austria
Institute of Livestock Research	Austria
Institute of Veterinary Physiology	Germany
University Clinic for Swine	Austria