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Take home Message LIPOMEC is the first large-scale integrative project to study lipolysis mechanisms in the milk and mammary gland in cow, goat and ewe.
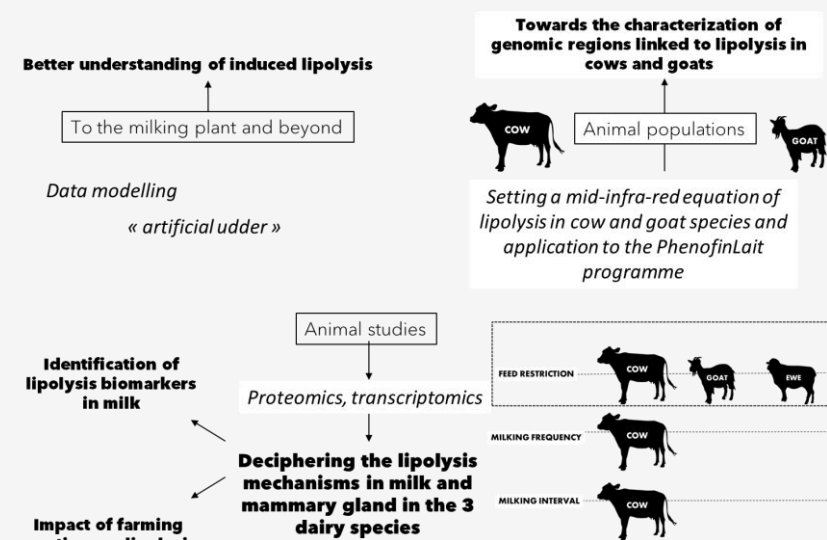

Figure 1: A schematic overview of the LIPOMEC project

Introduction Lipolysis is defined as fat-breakdown through the hydrolysis of triglycerides, the major component of milk fat. Short-chain fatty acids consequently released in milk are responsible for rancid flavor, unacceptable for consumers, in milk and dairy products. In addition, the presence of partial glycerides impairs milk functional properties such as foaming and creaming abilities. Thus, milk lipolysis represents an important criterion to assess milk quality. Spontaneous lipolysis results from a complex interplay between farming practices, animal physiology and animal genetics. However, changes in milk fat breakdown differ markedly between cow (Vanbergue et al., 2018) and goats (Chilliard et al., 2014), whereas ewe milk lipolysis is poorly understood. LIPOMEC, funded both by the French National Research Agency (ANR-19-CE21-0010) and dairy stakeholders (APIS-GENE), is the first large-scale integrative project to study the lipolytic system in the milk and mammary gland in the three dairy species.

Material and methods An overview of the LIPOMEC project is depicted in **Figure 1**. A feed restriction study was conducted in the 3 dairy species (cow, goat and ewe). For each experiment, two levels of feeding were applied: "non-restricted" with animals fed 100% of the dry matter intake (DMI) ad libitum and "restricted" with animals fed at 65% of the DMI ad libitum. The impact of the milking frequency and milking intervals on lipolysis were also studied on cow. Lipolysis values were measured by the reference methods in each species, i.e. the copper-soap method for cow, and the BDI method for goat and ewe. Samples generated (milk, blood, mammary gland biopsies) are currently being used to characterize mechanisms of lipolysis in milk and mammary gland through an integrative approach in the three dairy species. Our approaches include animal science, milk biochemistry and biophysics, proteomics, lipidomics, genetics, transcriptomics, cell biology techniques, data modelling, and statistics. Interactions between genetics, physiology, farming practices and technological factors related to the milking process will be considered.

Results and discussion Milk yield decreased in the three species in response to the nutritional challenge. For cows, feed restriction caused as expected an increase in spontaneous lipolysis of milk (+0.20 Meq/100 g of fat, P<0.001). Conversely, feed restriction induced a decrease in lipolysis in ewe milk (-0.27 Meq/100 g of fat, P<0.01), whereas no significant effect was observed for goats under feed restriction. This strongly suggests that lipolytic systems and their adaptations to physiological challenges sharply differ between species. Omics studies on the samples collected during animal experiments are currently in progress to decipher molecular mechanisms occurring in milk and mammary gland with regard to lipolysis in the three species. In addition, an equation based on mid-infra-red (MIR) spectra has been developed to explore the genetic determinism of spontaneous lipolysis in dairy cows. A similar approach is currently in progress in dairy goats within the frame of the LIPOMEC project.

Conclusion Taken together, these results will improve understanding of the lipolytic systems in the three dairy species and highlight inter-species peculiarities with regard to the regulation of lipolysis in milk.

References
Vanbergue E., Peyraud J. L., Ferlay A., Miranda G., Martin P., Hurtaud C. 2018. Livestock Science 217, 116-125.
Chilliard, Y., Toral P. G., Shingfield K. J., Rouel J., Leroux C., Bernard L. 2014. Small Ruminant Research 122, 31-37.