

UMR Herbivores

Performances of animals and herds Team (Peraq)

Prediction of production and composition of milk fat by modeling: effect of absorbed nutrient

By a quantitative statistic approach (meta-analysis of databases), we have predicted duodenal flows of fatty acids (FA) in ruminants (bovine and ovine species), FA transfer from duodenum to mammary gland and the FA flows secreted in the milk in dairy cows. The duodenal and absorbed FA flows were predicted from FA intake, taking into account forage nature, concentrate percentage, lipid supplementation, and interaction among these factors. The transfer of each FA from duodenum to mammary gland was predicted from duodenum of this FA and/or ruminal (pH) and fermentation (volatil FA) parameters. The 2 models were coupled and the quality of their prediction was evaluated. This work will contribute to the new French INRA feed systems.

Most of the predictions of the milk FA composition by meta-analyses are either focused on specific feeding practices (grass-based feeding systems, Elgersma, 2015, oilseeds supplementation, Glasser et al., 2008a; Meignan et al., 2017) and/or on specific FA (C18:2 n-6, C18:3 n-3, Khiaosa-ard et al., 2015), and few attempts have been made to produce quantitative laws of responses of milk FA profile to interactions among feeding factors. Nevertheless, it would be essential to quantify the milk FA composition in actual dairy systems that combine different feeding practices. This work is necessary to continue to work on new French INRA feed systems (2018). By meta-analyses of databases including data from FA intake, duodenal FA flows and milk FA secreted in ruminants, we want to predict the FA transfer from duodenum to mammary gland, and the FA flows secreted in the milk according to a large diversity of diets.

The duodenal and absorbed flows of isomers of C18 :1, C18 :2 and C18 :3, as well as certain saturated FA, odd- and branched-chain FA and long-chain FA (EPA, DPA and DHA) were predicted from FA intake, taking into account forage nature (including grazing), concentrate percentage, lipid supplementation, and interaction among these factors. A total of 90 models was obtained. The ruminal biohydrogenation (RBH) of C18 :3n-3 was slightly lower with oleaginous seeds than with oils (94.8 vs 96.7%). In contrast, this effect was not obtained with C18 :2 isomers, suggesting that this factor does not act at the first step of RBH. The RBH of C18 :3n-3 providing from diets rich in Leguminosae was lower than that from diets rich in Gramineae. The duodenal C17 :0 flow increased with starch content in the diet and decreased with ruminal pH. The respective effects of C22:6n-3 on duodenal flows of C18 :0 (inhibitory), trans11- and trans10-C18 :1 (activator) were quantified. The set of these first predictive equations confirms the already acquired knowledge on rumen FA metabolism. Concerning the transfer of each FA from duodenum to mammary gland, the predictive equations used the duodenal FA flow as preferred predictor, but also rumen (pH) and fermentation (volatils FA) parameters. The efficiency of transfer of FA with 18 atoms of carbon (C18FA) from duodenum to milk was relatively high (66%). An important supply of C18FA at the mammary gland increased their uptake and decreased the mammary de novo synthesis of short- and medium-chain FA. The effects of long-chain FA of marine products on de novo synthesis, Δ^9 -desaturase activity and C18FA uptake were quantified. The 2 sets of predictive equations were further coupled concerning 23 models and the quality of their prediction was evaluated. Generally, this validation was satisfactory, except for the long-chain FA. Indeed, coupling the models of these FA was characterized by a systemic bias of prediction proportional to the intake level and/or milk yield, these 2 variables being correlated. The improvement of accuracy of the exiting equations will aim to taking account these latter effects by reassessing the equations using a database with data obtained exclusively from dairy cows.

The approach developed in this work was based on prediction of each individual FA in milk by partially integrating the interactions among the metabolic pathways (uptake of long-chain FA, de novo synthesis, desaturation and esterification). The continuation of this work will consist to model these interactions. Moreover, the use of relationships between FA intake (or duodenal) and milk FA could allow, on one hand, to define the requirements of essential FA in dairy cows, and on the other hand the response-laws of dairy performance to dietary supply of individual FA or groups of FA. The in-depth analysis of these data may enable to establish a French INRA feed systems relative to the digestion and mammary metabolism of lipids in ruminants, in line with the new French INRA feed systems (2018). A ANR project (DAFADAR : Dietary Allowances of Fatty Acids for Dairy Ruminants) has been submitted to the 2019 call in order to answer this objective.

Valorisation

Prado LA, Ferlay A, Nozière P and Schmidely P 2018. Predicting duodenal flows and absorption of fatty acids from dietary characteristics in ovine and bovine species: a meta-analysis approach. *Animal* doi:10.1017/S1751731118001982

Prado LA, Schmidely P, Nozière P and Ferlay A 2018. Milk saturated fatty acids, odd- and branched fatty acids, isomers of C18:1, C18:2 and C18:3n-3 according to their duodenal flows in dairy cows: approach by meta-analysis. *J. Dairy Sci.* (in press).

Contact: Ferlay Anne, anne.ferlay@inra.fr, UMR Herbivores, F-63122 Saint-Genès-Champagnelle, France.

