The complexity of milk coagulation among breeds

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Posttranslational modifications of the major bovine milk proteins have been suggested to be associated with coagulation properties of milk. A higher fraction of the least phosphorylated form of α_{S1}-CN relative to total α_{S1}-CN and a higher fraction of glycosylated κ-CN have been associated with good coagulation properties. This has been speculated to be related to the protein and mineral content, casein micelle formation and stability and the micelle aggregation in the second phase of milk coagulation. Furthermore, milk proteins from different breeds have large differences in the genetic variants present and their frequencies, which contribute to the complexity and interpretation of the results among breeds.

Compared with Danish Holstein, Danish Jersey cows have superior milk coagulation properties, which previously have been associated with specific composite α_{S1}-, κ-, β-CN genotypes (Poulsen et al., 2013). Thus, Jersey cows have higher frequencies of genetic protein variants associated with higher protein content and good coagulation. Further, it has also been shown that several milk compositional traits are related to milk coagulation, but affect the rheological parameters differently among breeds (Poulsen et al., 2014). Curd firming rate has been shown to be highly correlated with protein and fat contents, whereas longer rennet coagulation times was associated with lower pH and higher lactose contents.

Here, the protein profile for 892 Danish Holstein and Jersey cows was determined by liquid chromatography/electrospray ionization-mass spectrometry (LC/ESI-MS). The breeds had distinct protein profiles. Jersey cows were characterized by a higher fraction of glycosylated κ-CN, whereas Holstein cows had higher relative amounts of β-CN and whey proteins. Using multivariate statistics, 53 and 52 % of the variation in curd firming rate could be explained for Danish Holstein and Danish Jersey cows, respectively, when protein content and detailed protein profile, pH and major genetic variants of the caseins were included in the model. In Danish Jersey cows, which have higher total protein content, the protein content was identified as the main explanatory variable for curd firming rate. In contrast, Holstein cows, which have lower total protein content, the relative content of κ-CN to total protein is almost just as important to the model, as the protein content. It can thus be speculated that for milk from Jersey cows, the variation in coagulation properties are, to a large extent, explained by the protein content. However, in Holstein milk, represented by lower protein content that varies less, as well as higher fractions of β-CN and whey proteins, the relative amount of κ-CN becomes more important. These results underline the importance of breed specific models and propose that risk factors associated with poor coagulation differ among breeds. Furthermore, the results would suggest that development and use of common calibration models for infrared phenotypes to predict milk coagulation properties might not be straightforward.