Unique Aspects of Ruminant Lipid Metabolism

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As the gut physiology of herbivores evolved to that of modern ruminant digestion, many coordinated adaptations occurred in metabolism of the animal, such as gluconeogenesis rather than lipogenesis in the liver, and metabolism of highly saturated (SAT) absorbed fatty acids (FA). Low fat intake and >80% biohydrogenation (BH) of linoleic and linolenic acids in the rumen cause low supply of absorbed essential FA, which is compensated by their incorporation primarily into phospholipids of intestinal lipoproteins, thus conserving them from oxidation.

Whereas the molar ratio of SAT:unsaturated (UNSAT) FA in skeletal muscle and liver membrane phospholipids varies little among species and diets, the UNSAT FA of adipose tissue reflect the nature and amount of absorbed dietary fat. Regulation of FA UNSAT in tissues by Δ-9 desaturase is important but largely uncharacterized in ruminants. Milk fat is maintained liquid at body temperature by a unique combination of Δ-9 desaturase activity, mammary synthesis of low-melting short chain FA and randomization of glyceride structure.

Not only do physiological adaptations of ruminants to their diets present challenges for developing animal food products that are more acceptable to current public tastes; but also, modern feeding systems have caused tissue FA profiles to be more SAT, with lower n-3 FA and CLA, compared with earlier grazing systems. By research, feeding protocols have been developed that increase the UNSAT FA of ruminant membrane and storage lipids and modify the composition of milk fat to more desirable profiles for human diets. These include lowering proportions of medium chain FA in milk fat and increasing proportions of n-3 FA and CLA in both milk fat and tissue lipids to an even greater extent than occur in grazing animals. Further, although research has demonstrated important biological effects of ruminant-derived CLA, other BH intermediates and products of ruminal microbial metabolism have been described, but few have been characterized for their potential biological activities. Which of the other 400 FA of milk fat remain to be discovered as key metabolic regulators?