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ABSTRACT

Positional analysis of triacylglycerols from bovine adipose tissue lipids varying in degree of unsaturation

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The objective of this study was to demonstrate that changing the fatty acid composition of bovine adipose tissue concurrently changed (i) proportions of triacylglycerol species, (ii) fatty acid composition of triacylglycerol species, and (iii) positional distribution of the component fatty acids of the triacylglycerol species. To achieve this, we took advantage of adipose tissue lipids, from cattle fed in Australia and Japan, that varied widely in fatty acid composition and melting points. Treatment groups produced in Australia were cattle fed: a cornbased diet (MUFA1); a grain-based diet containing whole cottonseed (SFA); a grain-based diet containing protected cottonseed oil (PUFA); and a grain-based diet that resulted in high contents of trans fatty acids (TFA). Treatment groups produced in Japan (MUFA2 and MUFA3) were diets of unknown composition fed for over 300 d. The MUFA1, MUFA2, and MUFA3 samples all were rich in monounsaturated fatty acids, varying only in the proportions of the individual monounsaturates. The SFA, PUFA, and TFA samples had relatively high concentrations of stearic acid (18:0), PUFA, and TFA, respectively. Slip points (indicative of melting points) were 45.1, 41.5, 38.5, 30.7, 28.4, and 22.8 degrees C, for the SFA, TFA, PUFA, MUFA1, MUFA2, and MUFA3 groups, respectively ($P < 0.05$). Triacylglycerols were separated by high-performance liquid chromatography on a silver nitrate-impregnated column into sn-1,2,3-saturated fatty acid triacylglycerol (SSS); [triacylglycerols containing two saturated acids and one trans-monounsaturated fatty acid (SMMt sn-positions unknown)]; sn-1-saturated, 2-monounsaturated, 3-saturated triacylglycerol (SMS); sn-1-saturated, 2-monounsaturated 3-trans-monounsaturated triacylglycerol (SMMt); sn-1-saturated, 2,3-monounsaturated fatty acid triacylglycerol (SMM); sn-1-saturated, 2-polyunsaturated, 3-trans-monounsaturated triacylglycerol; sn-1,2,3-monounsaturated fatty acid triacylglycerol (MMM); and sn-1-saturated, 2-polyunsaturated, 3-monounsaturated triacylglycerol. Fatty acid methyl esters of each triacylglycerol species also were determined, and further analysis indicated sn-2, and sn-1/3 positions. As the percentage oleic acid increased in the total lipid extract, the proportions of SMM and MMM increased (e.g., from 31.4 and 2.4% in the SFA group to 55.4 and 17.8% in the MUFA3 group). The elevated 18:0 in the SFA group (26%) was reflected in increased percentages of SSS and SSM, and caused an increase in the proportion of 18:0 in all triacylglycerol species relative to the other treatment groups. The percentage of 18:0 in the sn-1/3 positions was elevated markedly in the SMS fraction of the SFA group (to 44%); this would account for the high melting point of the fat of these animals. We conclude that long-term feeding of cattle is sufficient to produce significant alterations in fatty acid composition in bovine adipose tissue. Alterations in the fatty acid composition of bovine adipose tissue changed both the distribution and the composition of the triacylglycerol species, which, in turn, accounted for marked differences in melting points among treatment groups.