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Physical analyses of kinetic and polymorphic effects on phase behavior of binary triacylglycerol mixtures

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TAG crystals have stable polymorphs but their meta-stable polymorphs often have more preferable physical properties. However, because most previous work has been done under thermodynamically stable conditions, little systematic work has been done to clarify the effects of kinetic and polymorphic influences on the mixing behavior of the TAGs. This thesis describes our experimental work on the physical analyses of kinetic and polymorphic effects on the phase behavior of four types of TAG binary mixtures.

Chapter 1 describes the background and purpose of the present work. In Chapter 2, polymorphic influences on the phase behavior of three types of binary mixtures of saturated monoacid TAGs are described. In Chapter 3, the crystallization kinetics of SOS/SSO mixtures according to DSC and XRD measurements are described. In particular, formation of three polymorphic forms, named α_c, β'_c, and β_c, of a molecular compound was observed at an SOS/SSO=50/50 concentration ratio.

In Chapter 4, the phase behavior of binary mixtures of POP and SOS are described. When the mixture liquid was quenched and reheated, a miscible solid state formed in the unstable α and γ forms over the entire concentration range. As the temperature was raised, the miscible γ form transformed to the miscible β form when the SOS concentrations ranged from 10 to 80%. In Chapter 5, the clarification of polymorphic transformation of SLiS and the physical analyses of phase behavior of the SOS/SLiS mixtures are described. Four polymorphic forms, sub-α_2, sub-α_1, α, and γ, were isolated. As for the binary phase behavior, solid-solution phases were observed in metastable α and γ forms over the entire concentration range, and the miscible γ form did not transform to β' when the mixtures were cooled from a high temperature liquid to the low temperature solid phases.

This thesis contains useful information about the phase behavior and other physical and chemical properties of binary TAG mixtures. All of the results here are explained partly in terms of a general description of thermodynamic and structural factors that govern polymorphic crystallization and transformation, and partly by using new information about chain-chain interactions between the component TAGs.

Key words: fat crystal, binary mixture, X-ray diffraction, DSC, polymorphism