Granular Crystals Formation in Plastic Fats—Mechanisms and Inhibitions

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Abstract  Beef tallow (BT) and Palm oil (PO) are extensivly used in the bakery shortening and margarine manufacturing ascribable its advantageous properties, such as (i) high thermal and oxidative stability, (ii) good plasticity at room temperature, etc. However, the use of BT or PO for solid fats in plastic fat products has encountered serious structural defects, the formation of granular crystals, which impair the consistency and plasticity of fat products. Thus, the understanding and control of granular crystal formation in plastic fats are very important points in the fat industry. In the present study, all BT-based and all PO-based model shortenings prepared on a laboratory scale, respectively, denoted BTMS and POMS, were stored under temperature fluctuation cycles of 5–20 °C until granular crystals were observed. The lipid composition, thermal, polymorphic and isothermal crystallization behavior of the granular crystals and their surrounding materials separated from BTMS and POMS, respectively, were evaluated. The changes of nanostructure including the aggregation of high-melting triacylglycerols and polymorphic transformation from $\beta'$ form of double chain length structures to complicated crystal structures, in which the $\beta$ and $\beta'$ form crystals of triple and double chain length structures simultaneously coexist, had occurred in granular crystals compared with surrounding materials, whether in BTMS or in POMS. Accompanyingly, a slower crystallization rate appeared in granular crystal parts of both model shortenings noted above, which would yield larger and fewer numerous crystals indicated by the Avrami model analysis, and further aggregate to form large granular crystals. The produced fat which was obtained via chemically modification, interesterifing BT with canola oil, had stable $\beta'$ polymorphs, crystal sizes (< 20 $\mu$m). Additionally, adding 1% monoglyceride or lecithin to the fats to inhibit the crystal growth and retard the polymorphic transformation can make the products resist temperature fluctuations with reduced granular crystal formation.

Key Words  plastic fats, granular crystal, polymorphic transformation, crystallization behavior