Effect of Cooling Rate and Temperature Cycles on Polymorphic Behavior of Sunflower Oil Stearins for Applications as Trans-fat Alternatives in Foods

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Abstract

The new Food and Drug Administration (FDA) announcement makes it even more necessary to find alternatives to trans fats. The effect of cooling rate and temperature cycles on crystallization behavior and polymorphism of two solid fractions (stearins) obtained from a new variety of high-stearic high-oleic sunflower oil was studied by pulsed nuclear magnetic resonance (p-NMR), small-angle X-ray scattering (SAXS), and wide-angle X-ray scattering (WAXS) using synchrotron light and differential scanning calorimetry (DSC). Two stearins, hard (HS) and soft (SS), were crystallized in different processing conditions with the aim of obtaining the polymorphic forms required for different industrial applications. Data obtained from p-NMR studies showed that for both stearins, the maximum solid fat content decreased when crystallization temperature ($T_c$) increased; besides, crystallization rate decreased for slower cooling rate and higher $T_c$. When HS was crystallized at 10 °C/min to 23 °C, it fractionated and two different $\beta'$ forms appeared together which was not suitable for processing purposes. SAXS and WAXS patterns indicated that slow cooling (1 or 0.5 °C/min) promoted crystallization of $\beta'$ polymorph and retarded nucleation and growth of $\beta''$ form. Slow cooling also promoted crystallization of $\beta'$ form at two $T_c$: 24 and 25 °C. When SS was kept isothermally at 17 °C for 90 min, three polymorphic forms appeared: $\alpha$, $\beta'$, and $\beta_2$. Crystallization of the $\beta_2$ polymorph was promoted with slow cooling and temperature cycles. DSC results were in agreement with X-ray findings. Selecting the proper thermal treatment, it was possible to obtain the $\beta'$ form for bakery products or the $\beta_2$ form for chocolate production.

Keywords

High-stearic high-oleic sunflower oil stearins Trans-fat alternatives Cooling rate Temperature cycles Synchrotron radiation X-ray scattering DSC p-NMR
References


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