Effect of Simultaneous Application of Tempering and Shear Stress on Cocoa Butter Crystallization

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Cocoa butter (CB) is the main ingredient of chocolate and shows six crystal polymorphs from form I to form VI. It has already revealed that shear stress promotes phase transformation to form V, however this observation was made during the simple cooling process, and the effect of shear stress during tempering has not been clarified. The objective of this study was to quantitatively elucidate the effect of shear stress applied during tempering on the crystallization of cocoa butter, and to elucidate the crystallization of cocoa butter at different temperatures during the tempering process.

The sample CB was provided by Tokyo Food Co. The cell was hollowed out at the center, covered with polyimide film, and the area was irradiated with x-rays. The sample cell was made of polycarbonate, and the temperature of the sample was changed by circulating water from a thermostatic bath. For the tempering process, the product was held at 45°C for 15 min to eliminate the crystal history, then held at 15°C for 10 min, 26, 28, 30°C for 20 min, and 15°C for 10 min. Shear stress was applied to each sample at 0 rpm and 300 rpm. Synchrotron radiation X-ray diffraction measurements (SR-XRD) were performed at the High Energy Accelerator Research Organization to observe changes over time in cocoa butter crystallization during tempering.

SR-XRD measurements showed that only the diffraction peak of form II appeared at 0 rpm, however, the phase transformation from form II to form V was promoted under application of the shear stress. Furthermore, by performing the tempering operation, form II completely disappeared completely with an increase in temperature, and only form V crystals grew. It was also found that the higher the temperature rise, the greater the amount of form V crystals and the growth of form V crystals. From these results, it is revealed that the simultaneous application of tempering and shear stress can promote crystallization of cocoa butter.