Abstract:
Fat crystal networks result from a crystallization process, forming interlinked crystal aggregates of viscoelastic character. Palm oil-based fat crystal networks, such as chocolate and nougat spreads, often show liquid oil separation during storage because the fat crystal network is too weak to retain the liquid oils trapped within its structure. To explore the relationship between crystallization kinetics and subsequent mechanical properties, i) palm oil from three different geographical origins and with diverging crystallization properties, ii) mixtures of Ghanaian palm oil with gradually increasing additions of hazelnut oil, and iii) blends of Ecuadorian palm oil with palm stearin as a tripalmitin (PPP)-rich fraction were investigated. Kinetic parameters were acquired from an extended Avrami model by isothermal differential scanning calorimetry measurements, and the results combined with the elastic properties measured by oscillation rheology since studying crystallization kinetics alone insufficiently informs about the mechanical/structural properties needed to overcome liquid oil separation. Rate constants of all investigated fats followed bell-shaped curves, with curve progression strongly dependent on the lipid composition. Ameliorating crystallization properties entailed enhanced elastic properties. The higher the maximum rate constants, the higher the elastic modulus and
the gel rigidity of the respective fats. However, two different linear regions of elastic modulus versus PPP or solid fat content resulted, depending on whether palm oil was diluted with hazelnut oil or blended with a PPP-rich fraction. Hazelnut oil strongly diluted crystallizable portions of the structuring fat, thereby decreasing the mechanical properties in a power-law fashion, because the fat crystal network became less connected between fat crystal aggregates.