Rheological and thermal insights into temperature-dependent viscoelasticity of corn oil oleogels

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Oleogels are lipophilic colloidal systems in which a vegetable oil is structured into a three-dimensional solid network, providing consistency and viscoelastic properties similar to those of solid fats. In this study, corn oil was used due to its high content of unsaturated fatty acids and its potential for application in functional food products. Oleogels were formulated with three types of oleogelators: CO_BW (beeswax), CO_CW (carnauba wax), and CO_SW (sunflower wax), at concentrations ranging from 2 to 10 % w/w.

Rheological properties were investigated using a Haake MARS 40 rheometer, through oscillatory frequency sweep tests and temperature-dependent measurements, while thermal transitions were analyzed by differential scanning calorimetry (DSC). All oleogels exhibited pseudoplastic behavior, with viscosity decreasing as shear rate and temperature increased. At 20 °C, the viscosity at 1 Hz increased proportionally with wax concentration: CO_BW ranged from 6 to 80 Pa·s (2–10 % wax); CO_CW from 2 to 90 Pa·s; and CO_SW from 6 to 85 Pa·s.

Frequency-dependent analysis of the viscoelastic moduli showed a predominance of elastic behavior (G′ > G″), with G′ at 1 Hz ranging from 500 Pa (2 % CO_BW) to 4200 Pa (10 % CO_BW). Networks displayed reduced frequency dependence at higher concentrations, indicating increased colloidal stability. Temperature-dependent measurements revealed a progressive decrease in G′ between 5 °C and 90 °C, correlating with melting and solidification transitions. DSC analysis identified melting/solidification points consistent with the rheological data: CO_BW 62/58 °C, CO_CW 82/78 °C, CO_SW 55/52 °C.

The results indicate that both the type and concentration of the oleogelator govern the viscoelastic and thermal properties of corn oil-based oleogels. Correlating rheological behavior with thermal transitions provides essential insights for the design of functional lipid colloidal systems with optimized mechanical and thermal performance.

Keywords:
oleogels, corn oil, rheology, viscoelasticity, DSC

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