**Rheological and Tribological Characterization of Different Commercial Hazelnut Based Spreads**

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**Highlights**

* 5 hazelnut-cocoa base spreads characterized for rheological properties
* Influence of used geometry on the obtained flow-curves
* Substantial differences in tribological behavior with both recipe and temperature

**1. Introduction**

The principal aim of this work was the knowledge development in the research area of rheological characterisation of food semi-solid systems as hazelnut-cocoa based spreads. Five commercial cocoa spreads with different hazelnut/fat compositions were selected and rheological and tribological tests were carried out. Bulk and lubrication properties were estimated to investigate the occurring of microstructural changes from handling and storage step to oral consumption, respectively.

**2. Methods**

Both rheological and tribological tests were carried out with a laboratory rheometer (Anton Paar MCR 302). Spread flow curves were obtained at different temperatures with different geometries. Oscillatory mode test was conducted to determine linear viscoelastic region (LVR) , storage and loss modulus (G’ and G’’), complex viscosity (η) and tan(δ). Three-run flow cycle was applied to estimate the variation of thixotropic properties with temperature. Finally, tribological Stribeck curves were evaluated.

**3. Results and discussion**

Rheological analysis highlighted a pseudo-plastic behaviour in all spreads with the elastic component prevalent on the viscous one (G’>G’’). Rotational analysis showed the strictly dependency of flow curve from temperature in all cases. Moreover, geometry changing determined only flow index (n) value modification. Curves obtained with parallel plates showed n value lower than cup and bob device. Furthermore, in the same way as viscosity, consistency index (K) decreased with temperature in all samples. The effect of temperature on K may be modelled by Arrhenius equation obtaining a linear correlation between ln(K) and 1/T. A stronger dependency of consistency index (K) on temperature may be related to higher sensitivity of microstructural change to thermal stress. Spread with greater K variation demonstrated a higher tendency of G’ and G’’ curves to cross-over at higher temperature. The occurring of cross-over point expressed the shift from solid-like to liquid-like behaviour due to melting of solid lipid fraction. In addition, a greater decrease of friction factor and more significant shape modification of the Stribeck curves highlight thermal structural changes. Three-run flow cycle showed that palm oil based spread exhibit higher thixotropic behaviour meanwhile the sample with the highest hazelnut percentage (45%) displays the narrowest hysteresis area. Finally by Casson regression, it was found plastic viscosity (ηCA) increase by decreasing the fat/sugar ratio. This latter result may be related to lower lubrication and emulsifying properties of fat layer around solid particle with consequently higher friction.

**4. Conclusions**

The principal aim of this work was the knowledge development in the research area of rheological characterization of food semi-solid systems as hazelnut-cocoa based spreads. Rheological analysis highlighted a pseudo-plastic behavior in all spreads with the elastic component prevalent on the viscous one (G’>G’’). Rotational analysis showed the strictly dependency of flow curve from temperature in all cases. Moreover, geometry changing determined only flow index (n) value modification. Spread with greater K variation demonstrated a higher tendency of G’ and G’’ curves to cross-over at higher temperature. In addition, a greater decrease of friction factor and more significant shape modification of the Stribeck curves highlight thermal structural changes. Palm oil based spread exhibited higher thixotropic behaviour meanwhile the sample with the highest hazelnut percentage (45%) displayed the narrowest hysteresis area.

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