Rheology and soft tribology characterization of yoghurt with curcumin-loaded solid lipid nanoparticles

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Consistency and mouthfeel arising from the consumption of yoghurts are crucial factors for the consumers' acceptability. The aim of this work was to identify potential differences in sensory perceptions of yoghurts with curcumin-loaded solid lipid nanoparticles (SLN) incorporation. Rheology coupled with tribology were considered to simulate the dynamic aspects of oral processing. The friction behaviour showed significant differences in the various lubrication regimes, which suggests that the incorporation of nanoparticles in the yoghurt did not affect its structure but may impact on the after-feel during swallowing.
Keywords: tribology, rheology, sensory perceptions, curcumin-loaded SLN, yoghurt

1. Introduction

The increasing consumers' awareness about the link between food and wellness/health led to a rising interest in the development of new functional food products. Curcumin is a polyphenol present in turmeric with several health benefits such as antioxidant, anti-microbial, anti-inflammatory and anti-tumoral effects [1]. The relationship between rheological and tribological properties has been increasingly studied and constitutes a valuable tool to achieve indicatives of in-mouth sensory perceptions of functional foods [2].

2. Methods

Flow curves were obtained by an up–down–up step program to assess rheological properties. Herschel-Bulkley equation was fitted to the data to obtain the rheological properties. Oscillatory measurements were performed within the linear viscoelastic domain.

Tribological characterization of yoghurt samples was carried out on a ball-on-disc tribometer, applying a constant load (1 N) with increasing linear speeds up to 105 mm/s, to span the in-mouth deglutition velocities. Polydimethylsiloxane (PDMS) hemispheres and discs were used to mimic the oral soft tissues and confine the samples during tribotesting.

3. Results

The effects of curcumin-loaded SLN incorporation on the rheological and tribological properties of yoghurt, as well as for control yoghurt, are indicated in Tab. 1 and plotted in Fig. 1.

Table 1: Rheological properties (k, n and $\eta^*_{50\ rad/s}$) of yogurt control and yogurt with curcumin-loaded SLN.

Sample	k (Pa.s^n)	n	$\eta^*_{50\ rad/s}$ (Pa.s)
Yogurt	1.51 ± 0.02	0.567 ± 0.005	1.89 ± 026
Yogurt (SLN)	1.50 ± 0.10	0.568 ± 0.005	1.85 ± 0.30

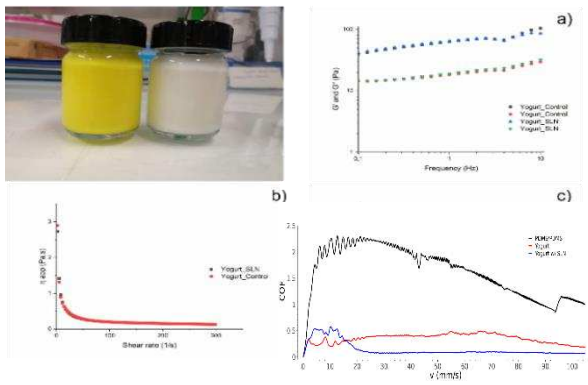

Figure 1: a) Storage modulus (G') and loss modulus (G'') *versus* frequency; b) viscosity profile of yoghurts; c) COF *versus* sliding speed for yoghurts and PDMS.

4. Discussion

Rheological analysis showed that the incorporation of curcumin-loaded SLN did not change the apparent and complex viscosity, pseudoplasticity and viscoelasticity of the original matrix. Thus, the new molecular bonds did not alter its firmness, consistency, smooth texture and stability/microstructure. However, as the particles' size of the yoghurt systematically decreases, tribology starts to predominate and differences can be observed between types of yoghurts. Incorporation of curcumin-loaded SLN potentially increased the creaminess, fattiness and slipperiness, since the lubricating capacity has significantly increased. Nonetheless, the lubricating properties of yoghurts cannot be related only to their viscosity, since the COF obtained for yoghurt/SLN is significantly lower than the control (μ_{st} ~ 0.15 and μ_{st} ~ 0.35, respectively), despite having similar rheological parameters.

5. References

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