**Nonlinear rheological behaviour of mixed plant-dairy matrices: the influence of protein solubility**

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The rising global population has substantially increased the demand for protein sources, prompting the exploration of innovative approaches. One such strategy involves partially replacing animal proteins with plant proteins in mixed food systems1, including emulsion filled gels (EFGs). Limited information is available on how technological approaches designed to modify protein solubility influence the rheological behaviour of food systems2, despite the well-established impact of solubility on rheological properties3. Therefore, the aim of this study was to investigate the impact of protein solubility on the nonlinear rheological behaviour of pea, whey and 1:1 mixed pea:whey EFGs. The solubility of pea proteins was modified by pre-treating protein suspensions (6% total protein content) with high pressure homogenization (HPH; 6-125 MPa), with the pre-treated suspensions used to formulate EFGs. Solubility, particle size distribution and rheological behaviour in the linear (SAOS) and nonlinear viscoelastic regions (LAOS) were evaluated.

The results showed that HPH progressively increased the solubility of pea protein, from 22% in the untreated sample to 96% at 125 MPa. On the other hand, the solubility of the mixed pea:whey suspensions ranged from 53 to 58% across all the pressure range.

Interestingly, the mixed pea:whey EFGs showed an increased storage modulus (G’) in the SAOS region when pre-treated at high pressure, increasing from 5184 Pa in the untreated EFGs to 27203 Pa in those treated at 100 MPa. No significant (p<0.05) changes in G’ were observed in pea EFGs formulated with pea suspensions at different solubility, with G’ ranging from 27203 to 29313 Pa in untreated and 100 MPa treated samples, respectively.

In the Lissajous curves of LAOS analysis, all samples exhibited a similar mechanical transition from solid-like to liquid-like behavior as the applied strain amplitude increased. This transition was characterized by the transformation of tight ellipses into progressively open ellipses, eventually approaching a rectangular shape. To elucidate differences among samples, nonlinear elastic and viscous responses (as a function of strain amplitude and shear rate, respectively) were quantified using the Chebyshev decomposition method4. Both pea and mixed EFGs exhibited strain stiffening (S > 0) and shear thinning (T < 0) behaviour with increasing strain amplitude or shear rate. The results of this study highlighted a positive impact of HPH on the rheological behaviour of mixed EFGs, despite having minimal impact on protein solubility in the mixed suspensions. These findings contribute new fundamental understanding and advancement of developing mixed protein systems.

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