Structuring starch–protein systems from pea dry fractionation side streams for sustainable food applications

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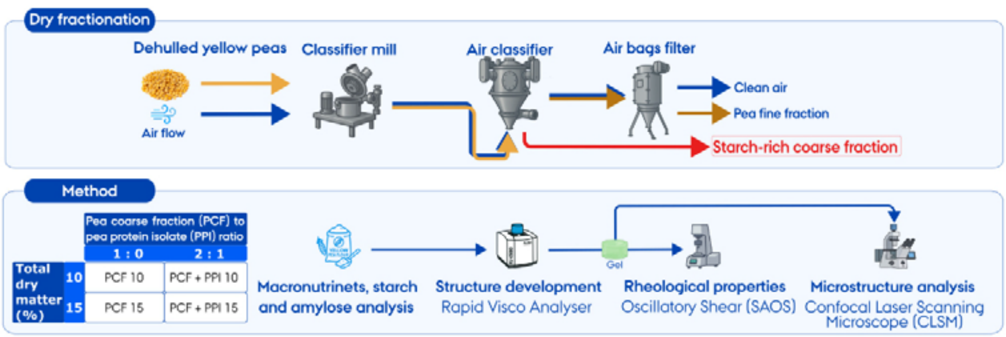
Dry fractionation of legume flours generates a high volume of starch-rich co-products, which remain underutilized despite their promising functional properties. Unlocking their potential as a structuring agent represents an opportunity to fully valorize all components of the legumes and foster a more circular and sustainable value chain. In this study, the colloidal properties of the starch-rich fraction from pea were investigated, exploring its multi-functionality when mixed with plant proteins.

The fraction was characterized for its macronutrient composition and starch properties. Gels were prepared at two dry matter levels (10% and 15%) with and without the addition of pea protein isolate (PPI). Structural development was monitored through Rapid Visco Analysis during thermal treatment, while the viscoelastic properties of the resulting gels were evaluated using oscillatory rheology (SAOS). Confocal Laser Scanning Microscopy (CLSM) provided complementary insight into the microstructural organization at the colloidal scale.

RVA analysis showed that at higher DM, the values of peak, trough, breakdown, final viscosity, and setback were higher for both formulations. Interestingly, the addition of PPI had the opposite effect at 10 and 15% DM. In the first case, it determined lower values for all the RVA parameters, whereas in the second case, the values increased with higher protein content. SAOS measurements showed, as expected, higher elastic (G') and viscous (G'') moduli at higher DM. Meanwhile, the addition of PPI had a weakening effect on the gel structure. Under these conditions, the samples at 10% DM containing only the coarse fraction exhibited similar textural characteristics to those at 15% DM with added PPI. CLSM imaging showed different starch-protein structures in each sample. Higher DM resulted in greater rupture of the starch granules, leading to the formation of a stronger network upon starch retrogradation. At the same time, the proteins present in the coarse fraction and those added with PPI interrupted the network, weakening the structure.

This work highlights the ability of minimally processed, plant-based co-products to act as functional structuring elements in colloidal systems, offering new routes for designing clean-label and sustainable food matrices. The findings demonstrate how controlling the balance between polysaccharide-rich fractions and proteins can be used strategically to engineer desirable textural properties, contributing to more resource-efficient food innovation.

Keywords:
Dry fractionation; Pea side streams; Structure design; Starch–protein systems; Rheology and microstructure



Overview of the dry fractionation process and experimental workflow