Combined enzymatic pre-treatment and microfluidization allow production of stable low-viscous suspensions of high-cellulosic dietary fibre by-products

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Pea hull, a high cellulosic dietary fibre by-product, represents a promising ingredient for fibre enrichment of liquid foods. However, due to the dense, compact organisation of the cell wall, its application is limited by poor solubility and a grainy mouthfeel. Conventional strategies for upgrading high-cellulosic dietary fibres rely primarily on mechanical size reduction. This approach results in highly viscous suspensions, restricting their application in liquid matrices. Therefore, complementary pre-treatments capable of modulating fibre functionality are required.

This study aimed to produce low-viscosity, non-sedimenting pea hull suspensions by combining enzymatic hydrolysis and microfluidization, using a crossed mixture–process experimental design to elucidate the role of enzyme composition and hydrolysis time. To this end, the effects of hydrolysis time (30 to 240 min) and enzyme mixture composition (ternary mixtures of cellulase, xylanase, and a 1:1 combination of polygalacturonase and arabinanase) on particle size distribution, insoluble mass (IM), viscosity and physical stability were studied and modelled using a crossed mixture ternary model ($R^2 > 0.93$).

Hydrolysed–microfluidized suspensions produced with 50–75% cellulase and 20–45% xylanase exhibited marked reductions in insoluble mass and viscosity while maintaining physical stability, compared to solely microfluidized samples. Microstructural analysis revealed looser particle architectures and larger voids, indicating that partial enzymatic disruption of the cellulose–hemicellulose network governs pea hull functionality. Viscosity and sedimentation behaviour were primarily determined by insoluble mass concentration and particle-network formation, whereas the soluble fraction, mainly composed of low-molecular-weight carbohydrates, contributed minimally to viscosity. At comparable insoluble mass levels and similar particle sizes, differences in fibre microstructure resulted in distinct viscosity, highlighting the role of fibre architecture.

Overall, this work demonstrates that combining enzymatic pretreatments with microfluidization enables the tailored production of stable, low-viscosity pea hull suspensions, providing a robust strategy for the valorisation of cellulose-rich side streams in liquid food applications.

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