##  **Leveraging inherent protein properties to develop readily dispersible plant protein** **protein - colloidal concentrates**

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## Abstract

Pursuing sustainable and efficient plant-based protein ingredients has stimulated research into innovative processing methods, including Liquid/Liquid Phase Separation (LLPS). This study utilises LLPS, inherent to biopolymers, to develop high-quality plant protein ingredients from diverse legumes. We leveraged the phenomenon of coacervation by altering environmental conditions to induce phase transitions, thus forming spherical, protein-rich coacervates from minimally processed materials such as legume flours. Demonstrating that this process occurs consistently across various leguminous plant protein fractions underscores its viability for developing ingredients from diverse sources. Following coacervation, we developed colloids from these phase-separated protein fractions. The colloids underwent heat treatment for pasteurisation and stabilisation, followed by spray drying to mirror industrial processing conditions.

The colloidal concentrates derived from these protein-rich droplets exhibit a very high internal protein content of 35%w/w. Notably, CLSM and SEM imaging revealed significant morphological distinctions from lab-based commercial controls, highlighting the distinctive structural properties conferred by our processing technique. A critical discovery is the monomodal particle size distribution and the porous nature of the colloidal samples, suggesting a deviation from traditional vacuole formation during the spray drying processes. Instead, these samples display a porous structure throughout the colloidal particle. Furthermore, these colloidal concentrates demonstrate substantially increased density and nearly double the water-holding capacity compared to standard commercial preparations.

In assessing potential industrial applications, the dispersibility of the concentrates significantly exceeds that of control samples, achieving rates up to ten times faster. Additionally, these colloidal systems exhibit viscosities up to ten times lower than those of conventional samples, providing a substantial advantage in formulating high-protein dispersion for further processing or developing protein-rich, low-viscosity plant-based beverages. This characteristic permits higher concentrations of protein while maintaining optimal flowability.

This research not only underscores the viability of LLPS in creating superior plant protein concentrates but also paves the way for their practical application in a range of food products. Moreover, using industrial processing conditions in our methods facilitates straightforward scalability, ensuring these innovations seamlessly integrate into large-scale production environments.