**Chickpea Aquafaba as a Novel Stabiliser for Chili Oleoresin Encapsulation: A Study on Optimisation, Rheological Behaviour and Microstructure**

Selvi Secil Sahin1, Alan J. Hernández-Álvarez 1, Lijing Ke1, Peter Ho1, Francisco M. Goycoolea1,2

*1School of Food Science and Nutrition, University of Leeds, LS2 9JT, United Kingdom*

*2Department of Cell Biology and Histology, Faculty of Biology, University of Murcia, 30100, Murcia, Spain*

Aquafaba, a byproduct generated from the cooking or canning of raw chickpeas, is often undervalued as a food processing waste stream. In previous work, we have addressed the formation of these nanoparticles during cooking and shown their potential techno-functionality as encapsulation or emulsification agents for bioactive compounds, such as capsaicin, the primary alkaloid in chili peppers.1 While our research has demonstrated the potential of aquafaba in facilitating capsaicin encapsulation, the instability of these emulsions during storage underscored the necessity for further optimisation of the formulation1. In light of these findings, this study aims to optimise stable chili oleoresin-in-water emulsions stabilised with British Kabuli chickpea aquafaba, moreover examining their rheological behaviour and morphological characteristics as colloidal systems. To this end, the optimised formulations of chili oleoresin-in-water emulsions stabilised by aquafaba were investigated using Response Surface Methodology (RSM). The components of emulsion formulations, including aquafaba (%), oil (%, oleoresin: MCT, 1:1 (w/w)) and water (%) were optimised through the mixture design approach of RSM to minimise the instability index of emulsions, as measured by a centrifugation/laser scanning device (LUMiSizer). Based on the fitted model of the variables at play, the most stable formulations (overall desirability value ≥ 0.96) were selected for their microstructural (via CLSM and Cryo-SEM) and rheological properties analysis. Additionally, the particle size and zeta potential of the emulsions were monitored over 21 days. The formulations which showed the highest stability (i.e. lower instability index values) had an aquafaba content in the range of 13.85 to 15.0%, oil content between 1.0 and 6.64%, and water content from 78.36 to 85.15%. These emulsions also showed the capacity to gel after freshly prepared upon quiescent standing at 25 ºC, as noted from small-deformation oscillatory rheological evidence, namely a steep increase of the G’ over the G’’ modulus, and gel-like frequency dependence of both moduli after gelation. Also, the complex viscosity (*η*\*) significantly increased with aquafaba contents. Upon shearing and breakup of the gel structure and subsequent standing in the rheometer, the emulsions gelled again. This reversible behaviour was diagnostic of physical interactions underpinning the structure of the gel network. Cryo-SEM images revealed the presence of raspberry-like surface topology at the surface of the oil droplets, consistent with our hypothesis of Pickering emulsion stabilisation by aquafaba nanoparticles. Our results provide compelling evidence that aquafaba has the capacity to be used as a wall material for capsaicin and chili oleoresins encapsulation, leading to gelled emulsions. Ongoing studies are seeking to address the bioactivity, bioavailability, cytotoxicity and sensory properties of these systems, and to the full realisation of these systems in the future formulation of functional foods.

*References:*

1 Sahin, S. S., Hernández-Álvarez, A. J., Ke, L., Sadeghpour, A., Ho, P., & Goycoolea, F. M. (2024). Composition, characterisation and emulsifying properties of natural nanoparticles in chickpea aquafaba for the formation of chilli oleoresin-in-water Pickering emulsions. *Food Hydrocolloids*, *150*, 109728.