Linking colloidal structure to antioxidant function in legume protein-stabilised emulsions

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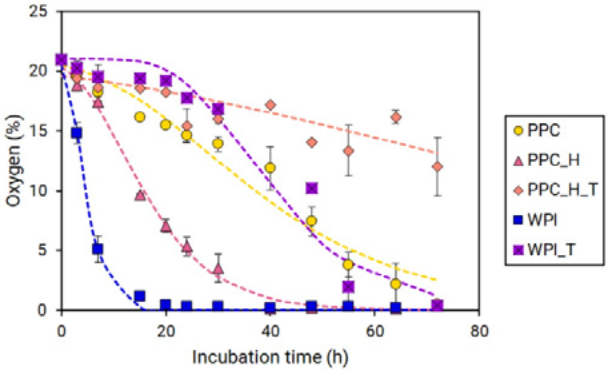
Current environmental challenges are driving a transition from animal-based to plant-based proteins in food applications, which has been particularly prominent in dairy protein-stabilised oil-in-water (O/W) emulsions such as milk or cheese analogues. The use of legume protein ingredients to stabilise O/W emulsions has been largely documented, focussing mainly on differences in emulsion structure and physical stability. In the present study, faba bean and pea protein concentrates and isolates were compared to whey protein isolate (WPI) for their ability to physically and oxidatively stabilise emulsions. Legume protein-stabilised emulsions were found to be prone to flocculation and subsequent coalescence, which was linked to a less negative droplet zeta potential as compared to WPI-stabilised emulsions. Once these physical properties were established, we thoroughly investigated the oxidative stability of the oil droplets in relation to the colloidal structure of the protein ingredients and to their detailed chemical composition. Legume protein-stabilised emulsions had enhanced oxidative stability compared to the WPI-based systems, which was attributed to the presence of various co-passenger molecules in the legume protein ingredients (tocopherols, phytic acid, polyphenols) that may act as antioxidants. Using pea protein concentrate as a model, endogenous tocopherols were found to be effective in delaying lipid oxidation reactions in emulsions. A similar concentration of exogenously added tocopherols was even more effective in that respect. This suggests that, beyond the tocopherol content, their physical organisation may tune their antioxidant activity. Our findings suggest that endogenous tocopherols in legume protein ingredients occur in protein-lipid aggregates, which could limit their antioxidant potential towards oil droplets. This study highlights how the physical organisation of plant protein-based emulsions at the colloidal scale impacts not only their physical stability, but also the availability and efficiency of chemically active endogenous molecules.



Oxygen uptake of 1 wt.% protein 10 wt.% linseed oil-in-water emulsion incubated at 25°C. PPC = pea protein concentrate-based emulsion, PPC_H = PPC stripped of endogenous tocopherol, PPC_H_T = PPC_H with added tocopherol, WPI = whey protein isolate-based emulsion, WPI_T = WPI with added tocopherol

Acknowledgements:
This work benefits of the financial support of the French government through the National Research Agency (ANR) as part of France 2023 in the framework of LETSPROSEED ANR-22-PELG-002, and the financial support of INRAE for the Ph.D. thesis of JK.