Emulsification properties of heat-induced > 50 kDa pea protein aggregates

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Introduction

Emulsification is a technology commonly used in the processing of a variety of food products (for example, milk, yoghurt, salad dressing, desserts, toppings, and marshmallows) and more recently in encapsulation technology for the delivery of nutrients and bioactive compounds. The main feature of a food emulsion is two immiscible liquid phases separated by a thin layer (interface) with one phase dispersed into another as droplets after agitation using an external force. Molecular incompatibility between the two phases necessitates a phase separation overtime to minimize the interfacial contact area and increase free energy, and this is caused by several interrelated factors and emulsifying ingredients are required to ensure kinetic stability. Food proteins are natural emulsifiers because of a good balance between the different classes of amino acid (amphiphilicity) and electrostatic stability (repulsive and attractive forces). Research has shown that pea protein performed well as an emulsifier comparable to other legumes in stabilizing oil-in-water emulsions. However, the compact nature of pea protein impedes flexibility and solubility necessary for emulsification activities, therefore, structural modulation is required. The aim of this study was to determine the emulsification properties of a novel pea protein ingredient obtained by heat treatment and membrane ultrafiltration/diafiltration.

Methodology

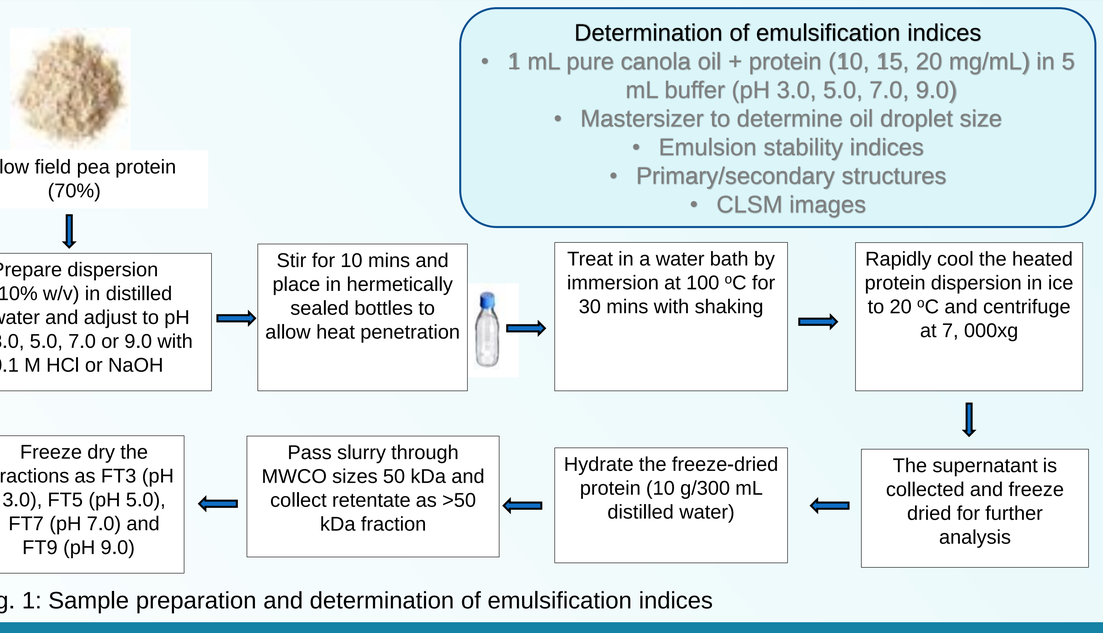

Fig. 1: Sample preparation and determination of emulsification indices

Results

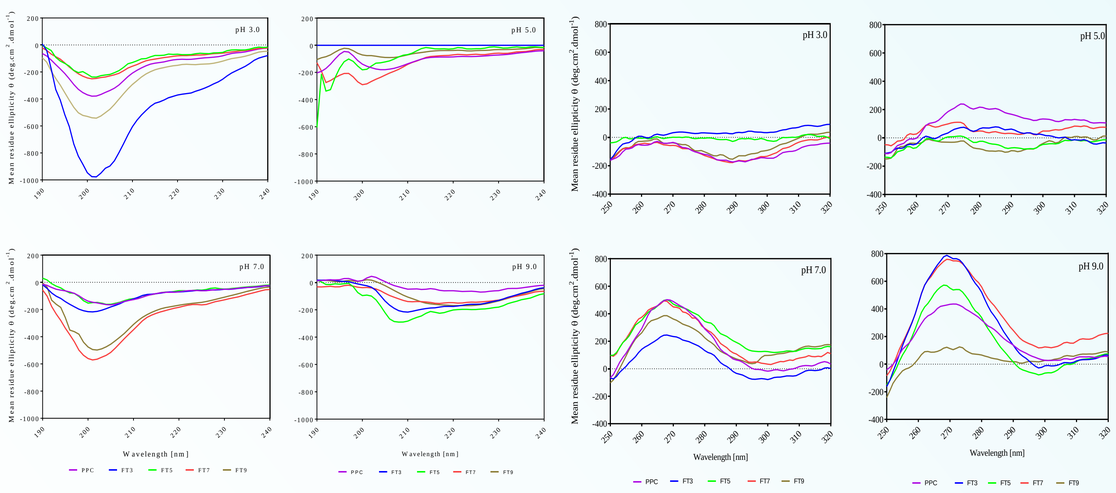

Fig. 2: Far and near UV circular dichroism spectra of native pea protein (PPC) and >50 kDa membrane ultrafiltration fractions (FT3, FT5, FT7 and FT9) at different pH values

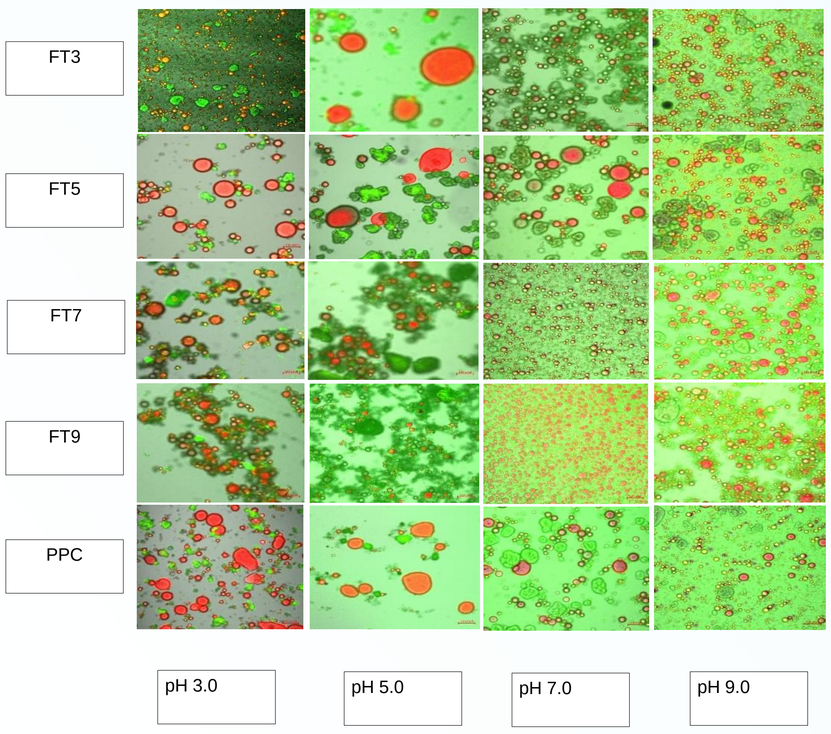

Fig. 3: Confocal laser scanning microscopy images for the native pea protein (PPC) and > 50 kDa membrane ultrafiltration fractions (FT3, FT5, FT7 and FT9) at different pH values

Results continuation

Table 1: Surface protein concentration (mg m^{-2}) for native pea protein (PPC) and the membrane ultrafiltration fractions (>50 kDa)

			Surface protein concentration (mg m^2)		
Sample	Conc (mg/mL)	pH 3	pH 5	pH 7	pH 9
PPC	10	1.53±0.00	3.65±0.00	1.89±0.02	1.87±0.02
	15	2.38±0.00	4.82±0.05	3.61±0.06	2.64±0.05
	20	4.23±0.00	6.74±0.00	3.71±0.06	3.37±0.07
FT3	10	1.14±0.03	6.35±0.00	1.79±0.03	1.69±0.04
	15	1.17±0.01	7.94±0.18	2.23±0.07	2.24±0.06
	20	2.01±0.04	10.68±0.23	2.41±0.07	4.26±0.09
FT5	10	2.23±0.00	3.54±0.00	1.89±0.09	2.03±0.00
	15	3.54±0.09	4.84±0.34	3.13±0.07	3.10±0.02
	20	4.48±0.14	5.90±0.01	3.33±0.08	4.19±0.08
FT7	10	1.70±0.00	4.40±0.00	1.44±0.02	1.63±0.00
	15	3.47±0.00	6.60±0.00	1.20±0.06	2.00±0.05
	20	7.85±0.09	6.61±0.14	1.86±0.15	2.12±0.08
FT9	10	4.00±0.00	6.10±0.00	1.75±0.04	0.74±0.01
	15	7.55±0.15	11.11±0.00	1.04±0.07	1.11±0.02
	20	12.70±0.00	12.53±0.00	2.29±0.05	1.90±0.04

†Different letters (a - e) indicate significant differences at $P \leq .05$ level for each pH value. Each value is the mean and standard deviation of triplicate determinations.*Native pea protein concentrate (PPC); fractions (FT3, FT5, FT7) and FT9). **Protein concentrations at 10, 15 and 20 mg/mL.

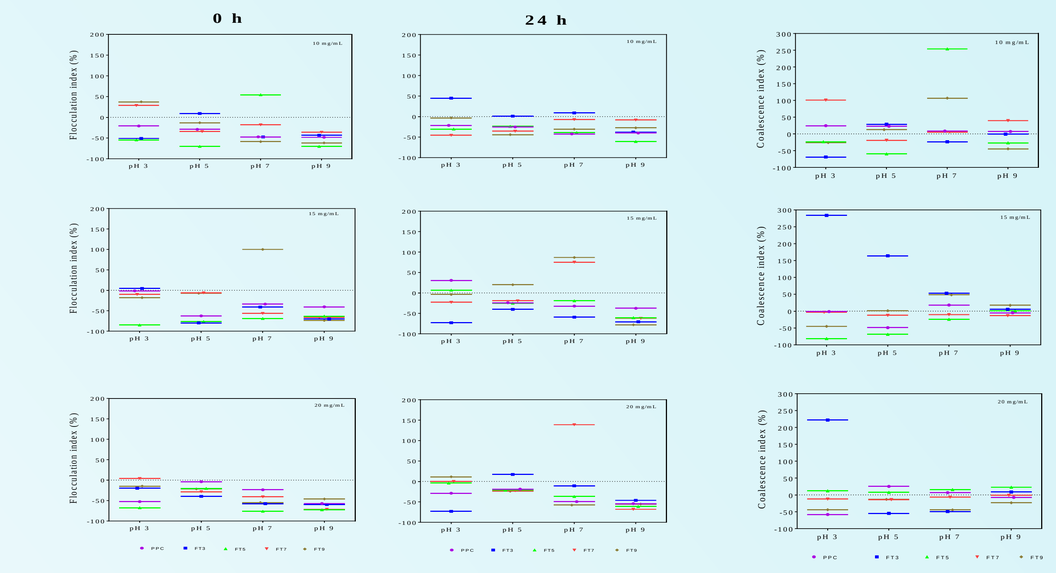

Fig. 4: Flocculation and coalescence indices of the native protein and heated fractions

Findings and conclusions

- The unheated and heated protein were high in β-strands and unordered polypeptides
- Near UV dichroic spectra showed high unfolding at the processing pH of protein fractions
- CLSM images of fresh emulsions showed that heated protein fractions exhibited small and spherical droplets
- Low CI and FI values at corresponding fractionation pH of the fractions at low protein concentration was observed which is suggestive of a more unfolded and flexible structure
- FT9 had low flocculation index as protein concentration increased corresponding to smaller droplet sizes
- Lower Γ values for the fractions suggest better emulsification capacity was achieved after treatments
- Increase in Γ values with increasing protein concentration (c values) for most samples suggest formation of protein multiple layers at the oil-water interface at high c values and better emulsion capacity at low c values
- The result showed improved emulsification properties for the heated proteins when compared with the unheated protein ($p<0.05$)
- Heated pea protein fractions (>50 kDa) could be used as surface active ingredients in food emulsions

Acknowledgements

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