Novel pea/whey protein complexes cross-linked by microbial transglutaminase for β-carotene emulsion stabilisation

Woojeong Kim, Yong Wang, Qianyu Ye, Cordelia Selomulya

School of Chemical Engineering, UNSW Sydney, 2052, Australia

UNSW SYDNEY | Australia's Global University

Introduction

- **Commercial pea proteins** are emerging plant-based ingredients, while poor solubility and sensory profiles limit their applicability.
- **Plant/dairy protein blends** can be used as natural emulsifiers in food products.
- This study aimed to **modify the pea protein structure using whey protein** by transglutaminase **cross-linking** to form rigid protein networks *via* dialysis for **β-carotene-loaded emulsion** production.
- A pea/whey protein ratio of 2:1 was selected here to present results clearly, although various ratios were investigated.

Materials and Methods

Pea/whey protein complex (1.25%, w/v, a ratio of 2:1) was prepared by dissolving into 1% NaCl solution with or without transglutaminase (5 U/g protein) and dialysed for 48 h to remove salt ions. β-carotene-loaded canola oil was prepared by dissolving 1 mg/g β-carotene into oil and sonication. Emulsions consisting 20% (v/v) oil and 80% (v/v) protein solution were prepared by high-pressure homogeniser Panda PLUS 2000 (GEA) at 10 MPa for 3 passes. The samples were stored at 4°C for analysis.

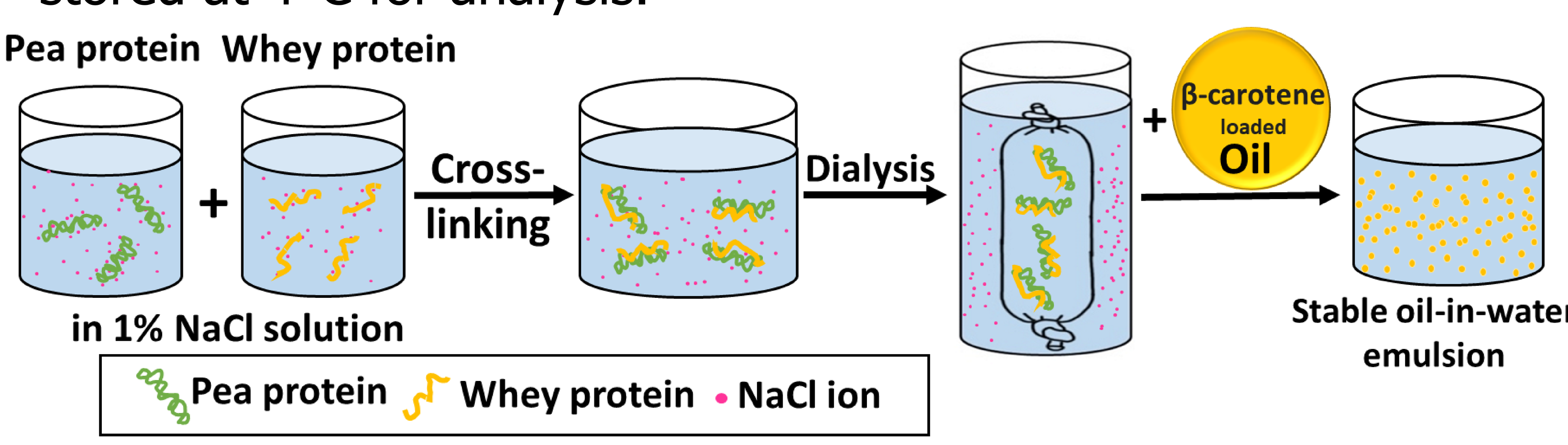

Figure 1. A schematic of pea/whey protein complex and β-carotene loaded oil-in-water emulsion preparation.

Results and Discussion

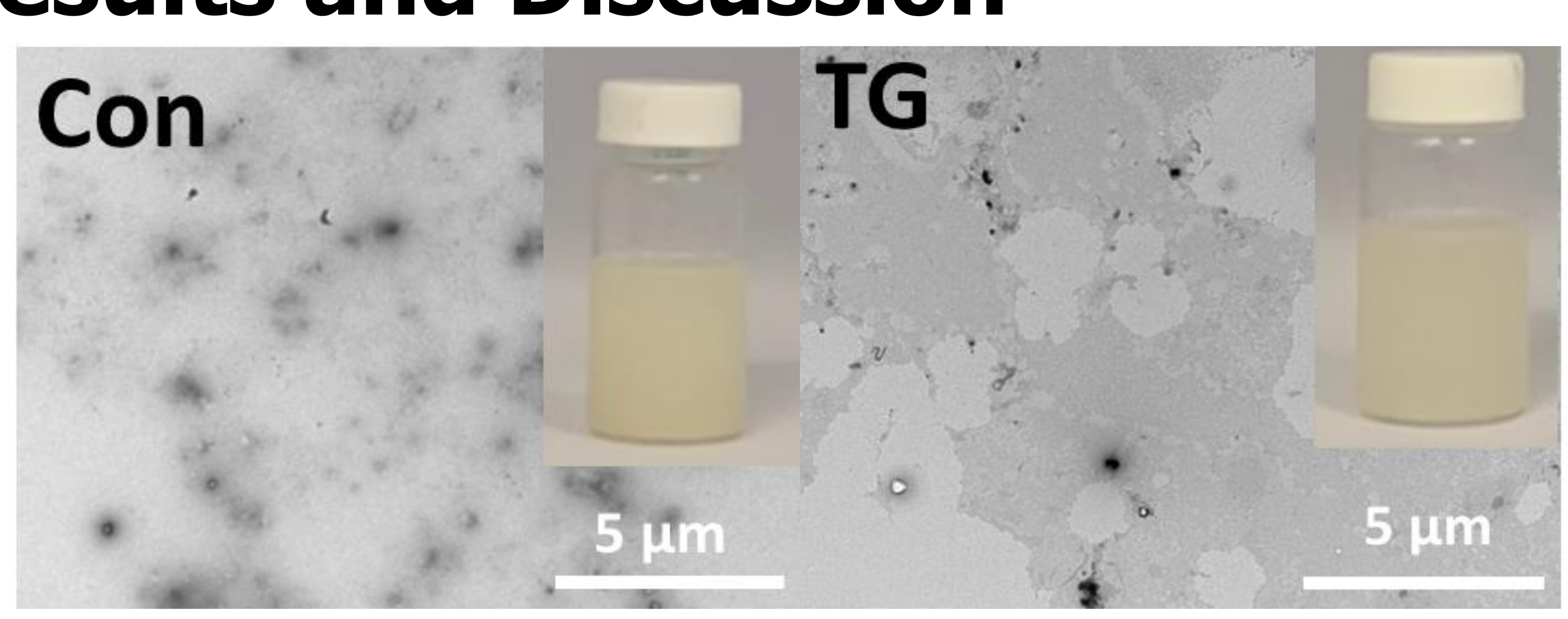

Figure 2. Transmission electron microscopic (TEM) images of pea/whey protein complex (Con) and cross-linked protein complex (TG).

> Cross-linking of pea and whey proteins resulted in reduced particle size and more dispersed structure.

Table 1. Characteristics of pea/whey protein complexes.

Measurement	Con	TG
Particle size (µm)	1.7 ± 0.4	0.3 ± 0.0*
Free SH content (µmol/g)	40.4 ± 3.4	20.6 ± 1.2*
Surface hydrophobicity (H_0)	18.8 ± 4.5	27.4 ± 5.4*

A star (*) indicates a significant difference ($p < 0.05$) between samples.

Table 2. Characteristics of pea/whey protein complex-stabilised emulsions.

Measurement	Con	TG
Droplet size (D50, µm)	0.6 ± 0.1	0.1 ± 0.0*
Creaming index on D14 (%)	25.4 ± 1.0	0.0 ± 0.0*
Encapsulation efficiency (EE, %)	83.6 ± 8.7	92.3 ± 8.4*

A star (*) indicates a significant difference ($p < 0.05$) between samples.

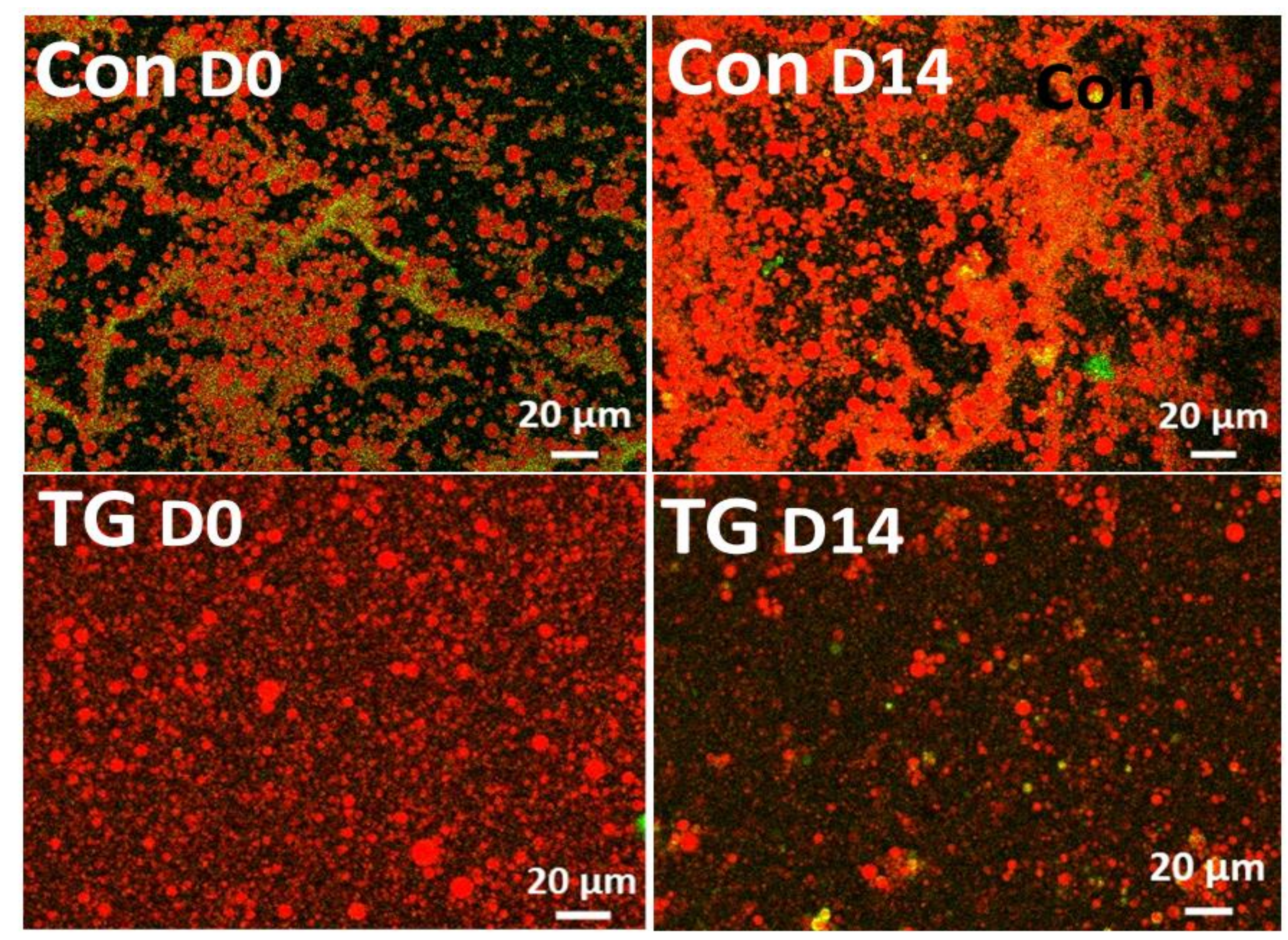

Figure 3. Confocal laser scanning microscopic (CLSM) images of the emulsions on D0 and D14.
Green indicates protein and red indicates oil.

> TG formed stable emulsions for 30 days with small droplets, while Con flocculated and showed creaming on D14.

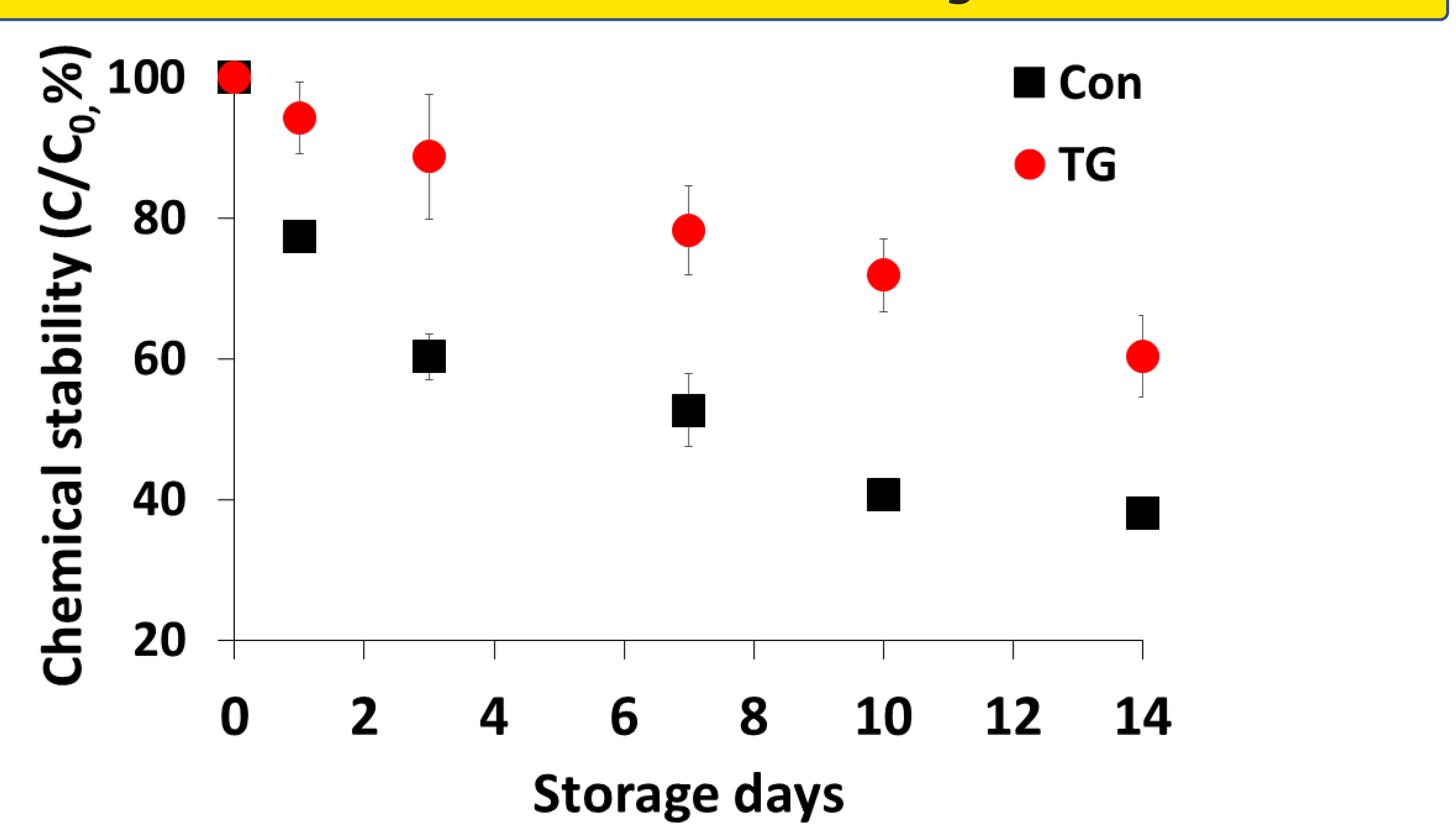

Figure 4. Chemical stability of β-carotene during 14 days of storage.

C and C_0 indicate the concentration of the compound at a specific time and just after preparation, respectively.

> TG protected β-carotene with high EE of 92% and prevented β-carotene from chemical degradation for 14 days.

Conclusion

- **Enzymatic cross-linking** between pea and whey proteins formed rigid protein network and **improved the emulsion stability** and **encapsulation properties** of β-carotene.
- A novel strategy was proposed to **replace more than half dairy protein with plant protein** for encapsulating lipophilic bioactive compounds with potential applications in the **beverage and powder production**.

References

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[2] Kim, W., Wang, Y., & Selomulya, C. (2022). *Journal of Food Engineering*, *321*, 110978.

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