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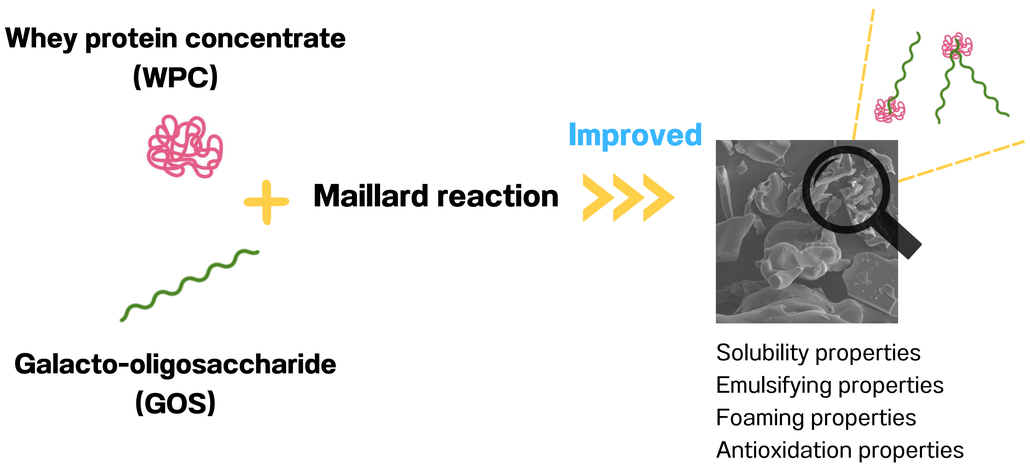
Structural characteristics and functionality of whey protein concentrate via wet-heating conjugation with galacto-oligosaccharide

Nareekan Chaiwong [1,*] and Yuthana Phimolsiripol [1,2]

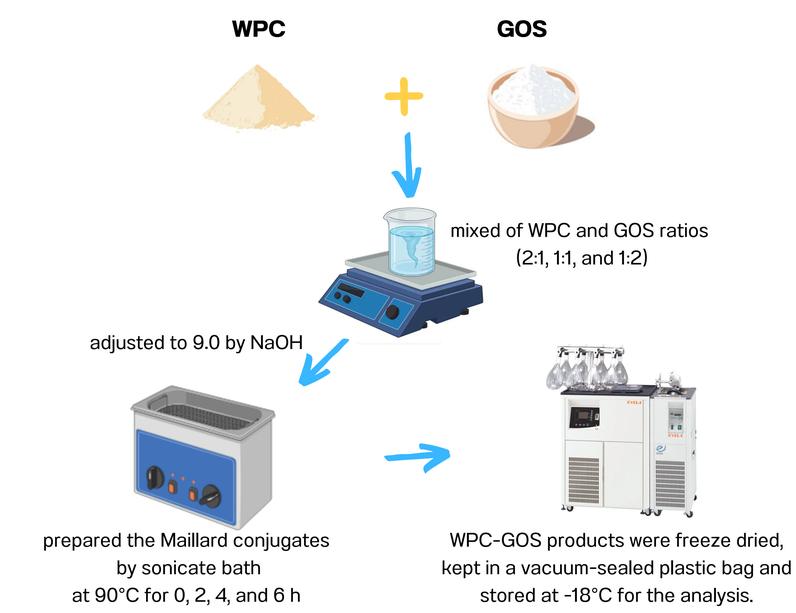
[1] Faculty of Agro-Industry, Chiang Mai University, Chiang Mai 50100, Thailand
[2] Center of Excellence in Agro Bio-Circular-Green Industry, Chiang Mai University, Chiang Mai 50100, Thailand; yuthana.p@cmu.ac.th
*Correspondence: nareekan_c@cmu.ac.th

RATIONAL

- The products formed by glycosylation of food proteins with carbohydrates via the Maillard reaction, also known as conjugates.
- The Maillard reaction uses the covalent bond between a group of a reducing carbohydrates and an amino group of a protein.
- An effective way to enhance the functionality of food proteins.



METHODOLOGY



The assays carried out included color development, SDS-PAGE, FTIR, microstructure analysis, and evaluation of the functionality of the resulting products.

RESULTS

• Characterization of WPC-GOS conjugation

The color was significantly ($p < 0.05$) changed as heating time increased, taking as reference the characteristics of the control sample (Figure 1).

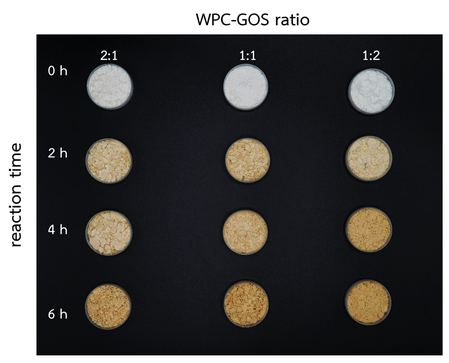


Figure 1. The visual appearance of WPC-GOS with different ratio and reaction time.

The difference in absorption peaks of WPC-GOS conjugates had changed by the reaction time (Figure 2a) and the loss in the identity of the bands was caused by transformations (Figure 2b).

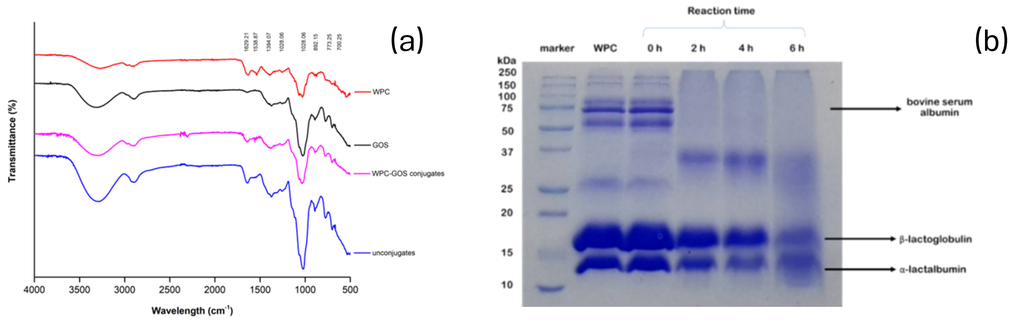


Figure 2. (a) FTIR and (b) SDS-PAGE profiles of WPC, GOS, WPC-GOS conjugates (ratio 1:1 after 4 h heating) and unconjugated.

• Protein functional properties

WPC-GOS conjugates showed better functional properties of protein than the control and mixtures of WPC-GOS (Table 1), and can improved the antioxidant properties of protein because of the high antioxidant activities of the reaction products (Figure 3).

Table 1. Functional properties of whey protein concentrate (WPC) and WPC conjugated with GOS after different ratio (WPC-GOS) and heating times.

Ratio (WPC-GOS)	Time (h)	Glycation degree (%)	EAI (m^2/g)	ESI (min)	Foaming capacity (%)	Foaming stability (%)
WPC		31.36 ± 0.46^{d}	14.14 ± 0.43^{c}	28.44 ± 0.58^{c}	32.50 ± 1.09^{e}	53.08 ± 1.21^{d}
1:1	0	31.79 ± 0.69^{d}	14.52 ± 0.38^{c}	29.94 ± 0.99^{c}	33.55 ± 1.09^{e}	52.85 ± 0.78^{d}
	2	38.42 ± 0.40^{c}	19.09 ± 0.43^{b}	40.47 ± 0.74^{b}	44.71 ± 1.13^{cd}	58.31 ± 1.00^{c}
	4	44.69 ± 0.64^{bc}	20.60 ± 0.33^{b}	48.94 ± 0.61^{a}	47.16 ± 1.06^{c}	65.28 ± 1.07^{b}
	6	47.99 ± 0.64^{b}	22.15 ± 0.61^{b}	50.91 ± 0.86^{a}	53.68 ± 1.05^{b}	67.98 ± 1.19^{b}
1:2	0	33.95 ± 0.48^{d}	15.59 ± 0.39^{c}	30.31 ± 0.58^{c}	35.13 ± 1.06^{e}	53.15 ± 1.04^{d}
	2	40.14 ± 0.47^{c}	19.22 ± 0.32^{b}	42.02 ± 0.98^{b}	49.30 ± 1.07^{c}	69.30 ± 1.18^{b}
	4	46.01 ± 0.34^{b}	20.70 ± 0.38^{b}	48.94 ± 0.82^{a}	54.87 ± 1.18^{b}	74.22 ± 1.13^{ab}
	6	51.74 ± 0.74^{a}	24.28 ± 0.45^{a}	52.09 ± 0.98^{a}	63.32 ± 1.05^{a}	77.87 ± 1.21^{a}

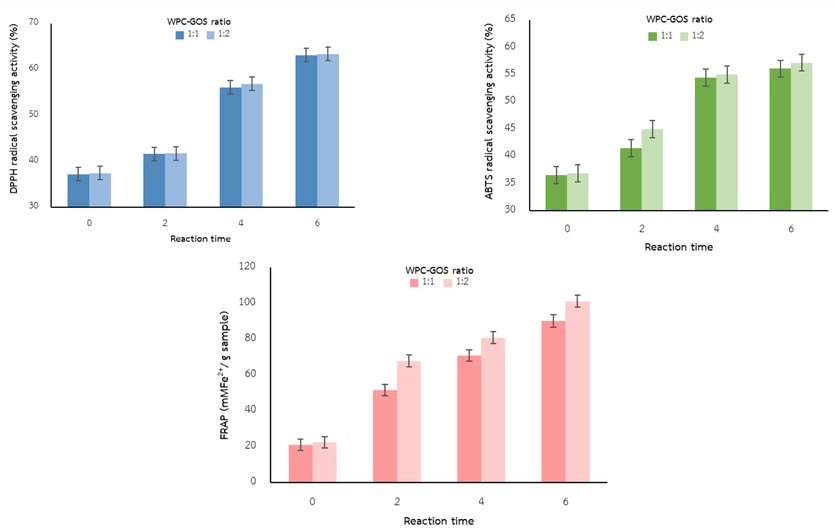


Figure 3. Antioxidant activities of WPC-GOS with different ratio and reaction time.

CONCLUSIONS

- The Maillard reaction led to a glycation degree of up to 30–35%.
- WPC-GOS ratios of 1:1 and 1:2 at 4-6 hours showed improvements in emulsification and foaming stability.
- Resulted in a significant 2-fold enhancement in antioxidative properties.
- This conjugation can be further advantageous in developing food ingredients and novel materials.

REFERENCES

Kan, X., Chen, G., Zhou, W., & Zeng, X. (2021). Application of protein-polysaccharide Maillard conjugates as emulsifiers: Source, preparation and functional properties. *Food Research International*, 150, 110740.

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