Microstructure of whey protein gels influences *in vitro* gastric protein digestion after oral processing

Dan Liu[a], Anja E. M. Janssen[b], Paul A. M. Smeets[a], Markus Stieger[a]
[a] Division of Human Nutrition & Health, [b] Food Process Engineering group, Wageningen University & Research, The Netherlands

Introduction

- Gastric protein digestion can be influenced by food structure.
- Porous, homogeneous microstructure benefits the protein hydrolysis of soy protein gels.
- Whey protein gels with higher Young's modulus and smaller total surface area are more resistant to digestion, whereas these effect can be influenced by gel microstructure.
- Oral processing plays an essential role during food consumption. During oral processing, the macrostructure of solid foods is broken down and lubricated by saliva.
- Little is known about the influence of microstructure and mechanical properties of whey protein gels on digestion after oral processing.

Objective

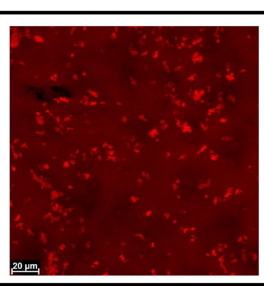
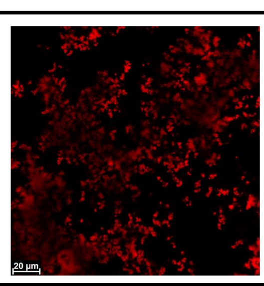
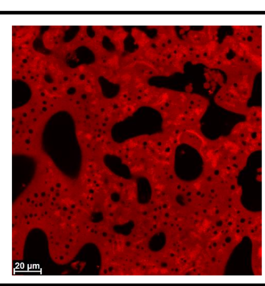
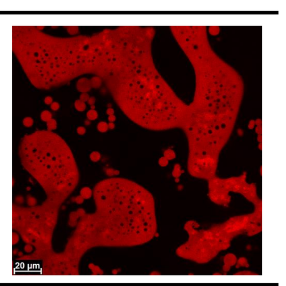
Understanding the influence of microstructure and mechanical properties of whey protein gels on *in vitro* gastric digestion after oral processing.

Methods

- Whey protein isolate (10 wt%) was mixed with κ-carrageenan (0-0.3 wt%) at different ionic strength (50-250 mM NaCl) to obtain heat-induced gels.
- Gel boli at the moment of swallowing were pooled from 14 healthy adults and characterized for number and size of bolus fragments by using image analysis.
- Static *in vitro* gastric digestion of gels before mastication and expectorated gel boli after mastication were conducted following the INFOGEST 2.0 protocol with minor modifications.
- Ovalbumin was used to simulate pepsin to measure the partition coefficient of pepsin between gel surface and simulated gastric fluid.

Results

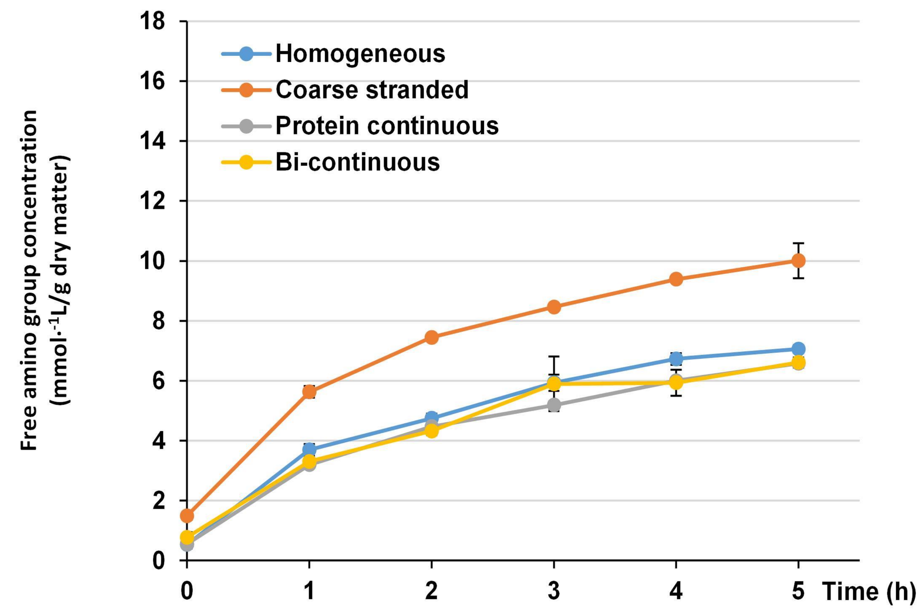
- **Microstructure and mechanical properties**

	Homogeneous gel	Coarse stranded gel	Protein continuous gel	Bi-continuous gel
Young's modulus (kPa)	41	28	48	51
Fracture stress (kPa)	59	26	70	28
Microstructure				

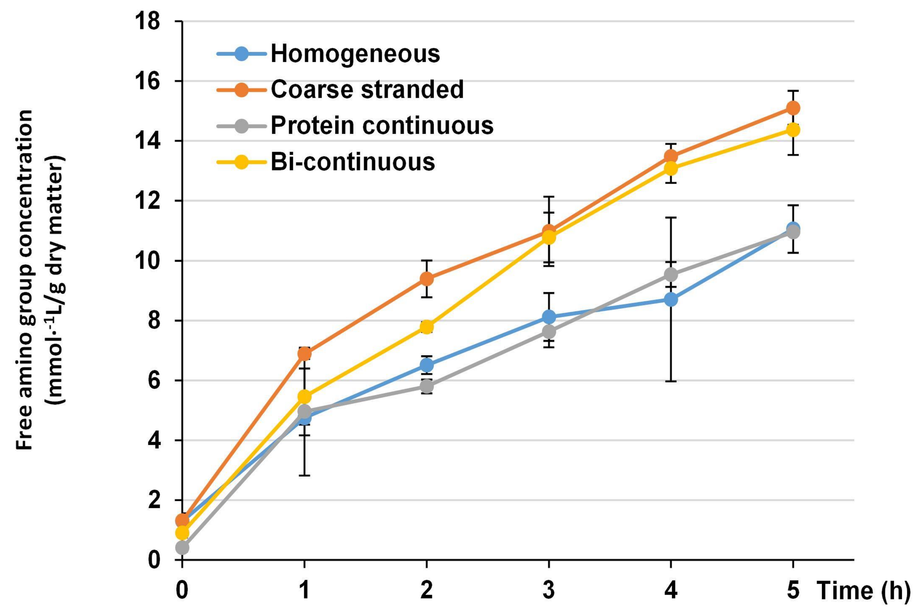
- **Bolus properties**

	Homogeneous gel	Coarse stranded gel	Protein continuous gel	Bi-continuous gel
particle number (no./g bolus)	904	5210	324	605
mean particle size (mm²)	1.22	0.38	2.84	1.64
estimated total surface area (mm²)	6710	14900	5910	6420

- ***In vitro* gastric digestion before and after oral processing**

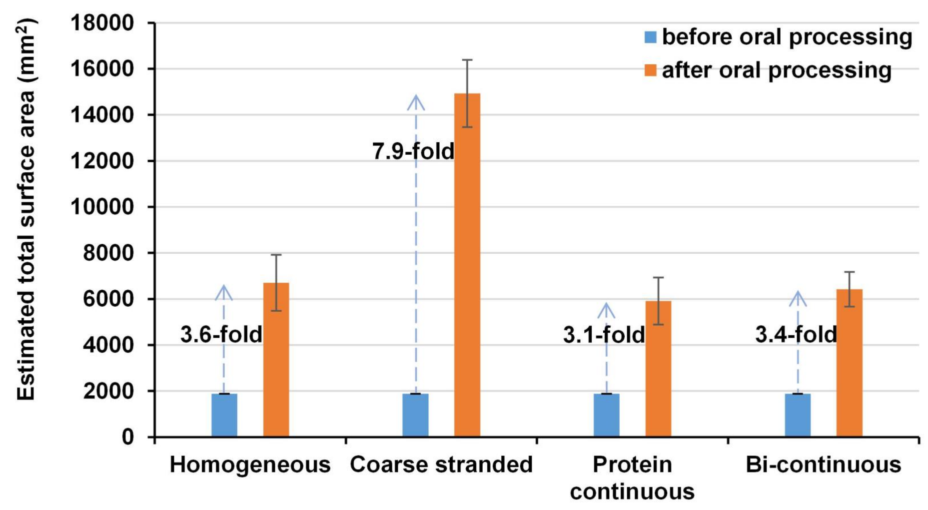


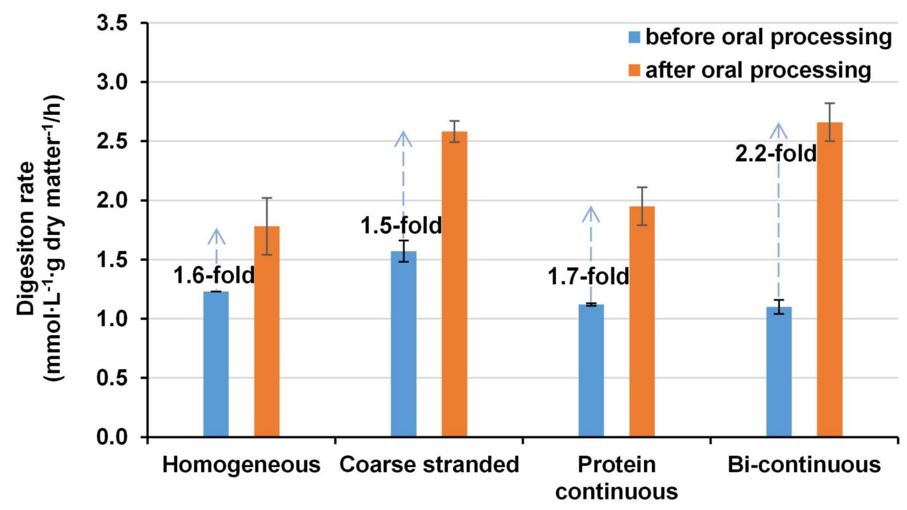
(a) before oral processing



(b) after oral processing

- **Relative change in total surface area and digestion rate after oral processing**

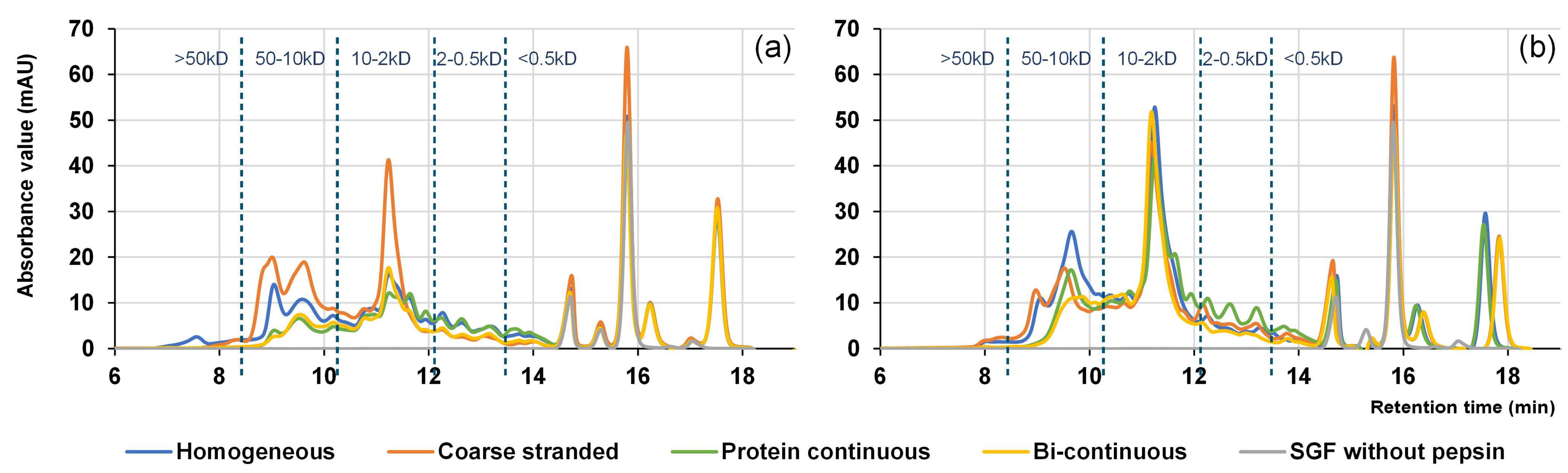




- **The partition coefficient of simulated pepsin at gel-SGF interface**

	Homogeneous gel	Coarse stranded gel	Protein continuous gel	Bi-continuous gel
Partition coefficient	6.5	5.2	5.5	8.7

- **Whey protein leaking from gels to SGF**



HP-SEC absorbance profile of the SGF of the gels digested under control condition (without pepsin) (a) before and (b) after oral processing.

Conclusions

- After oral processing, the increase in *in vitro* gastric protein digestion rate of bi-continuous gels was significantly higher than protein continuous, coarse stranded and homogeneous gels.
- Modification of food microstructure could be a new direction to develop products aimed to consumers which have high protein demand.

Acknowledgements

The authors thank the support from China Scholarship Council.

Dan Liu
Contact: dan1.liu@wur.nl