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# Swelling of dry heated whey protein microparticles in different physicochemical conditions

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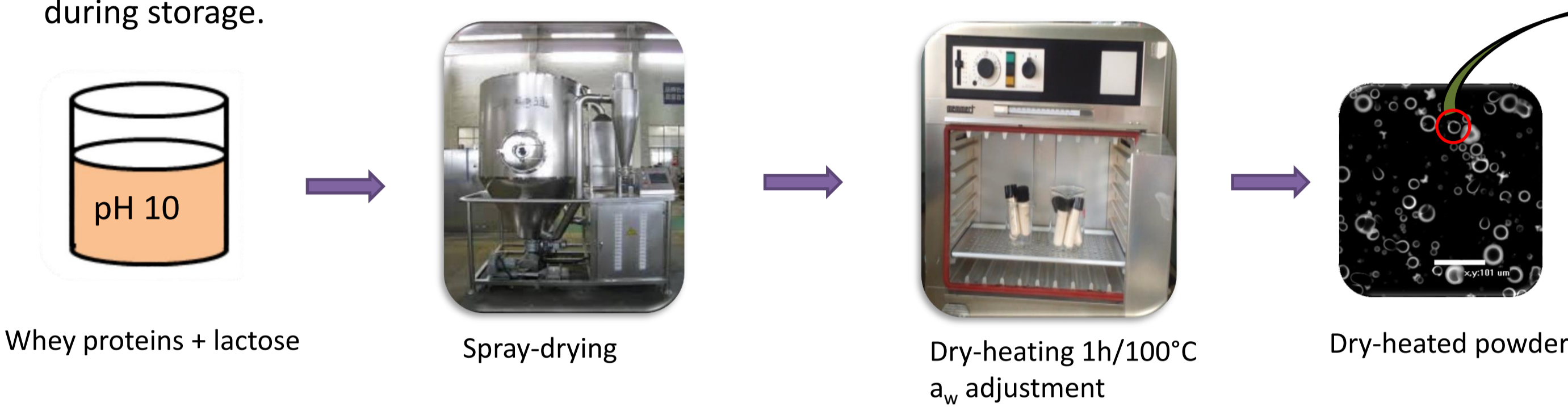


## Context

This study was conducted in order to promote innovation and new product development in the dairy industry with 100% dairy ingredients. Whey protein microparticles (PMI) produced by dry heating are studied for texturizing properties in food matrices. The production process consists of mixing whey proteins and lactose at an alkaline pH value, drying the solution and dry-heating the powder. We investigate the functional or swelling properties of these PMI by measuring the amount of water entrapped (WE) in microparticles and viscosity ( $\eta$ ) of their suspensions prepared in different physicochemical conditions. The results of the study allowed defining the best ranges of conditions to use these PMI for food applications.

## Method

- The whey protein solution at 100 g/kg with 0.5 g lactose/10 g whey proteins is adjusted at pH 10 and spray-dried at a final water activity ( $a_w$ ) of 0.45. Powder is then dry-heated for 1 h at 100°C for the cross-link building via the Maillard reaction [1]. Powder is then adjusted at  $a_w < 0.2$  to increase the powder stability during storage.



These PMI could be high-viscosity ingredients because they entrap large amounts of water:

- ✓ High porosity of the powder  $\Rightarrow$  high water entrapped
- ✓ Swelling of particles in the aqueous phase  $\Rightarrow$  high water entrapped

At pH 6.5, PMI entrap 20 g water/g dry PMI and lead to high-viscosity suspensions [2]

- Water entrapment (WE): suspension, centrifugation at 10000 g/15 min/20°C, weight of pellet (wet and after drying)
- Viscosity measurement: suspension at strain rate 0.1-1000 s<sup>-1</sup> (MCR301, cone-plate):  $\eta_0$  or viscosity at low strain rate

## Results

### pH



Fig. 1: Water entrapment (WE) in PMI = f(pH). Powder suspension at 10 g/kg.

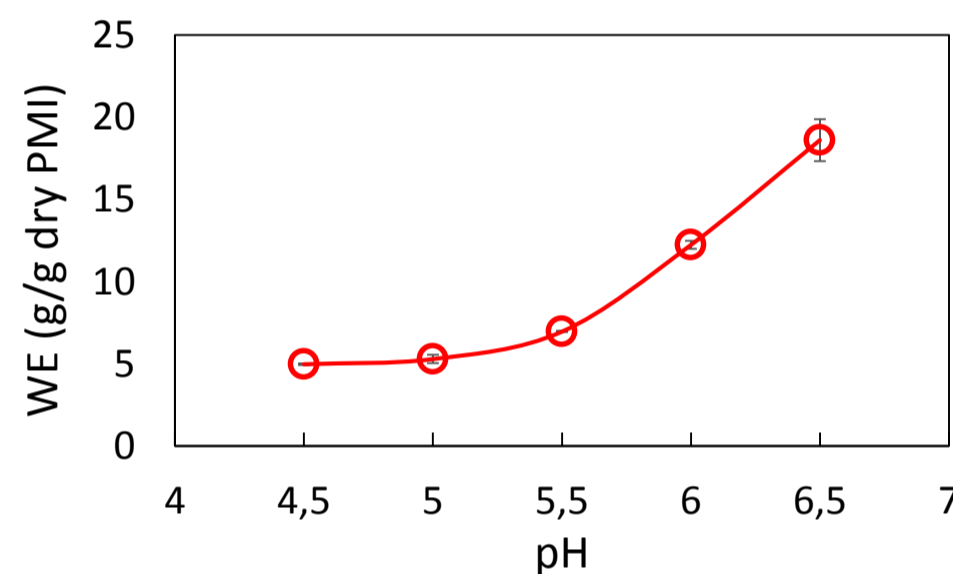
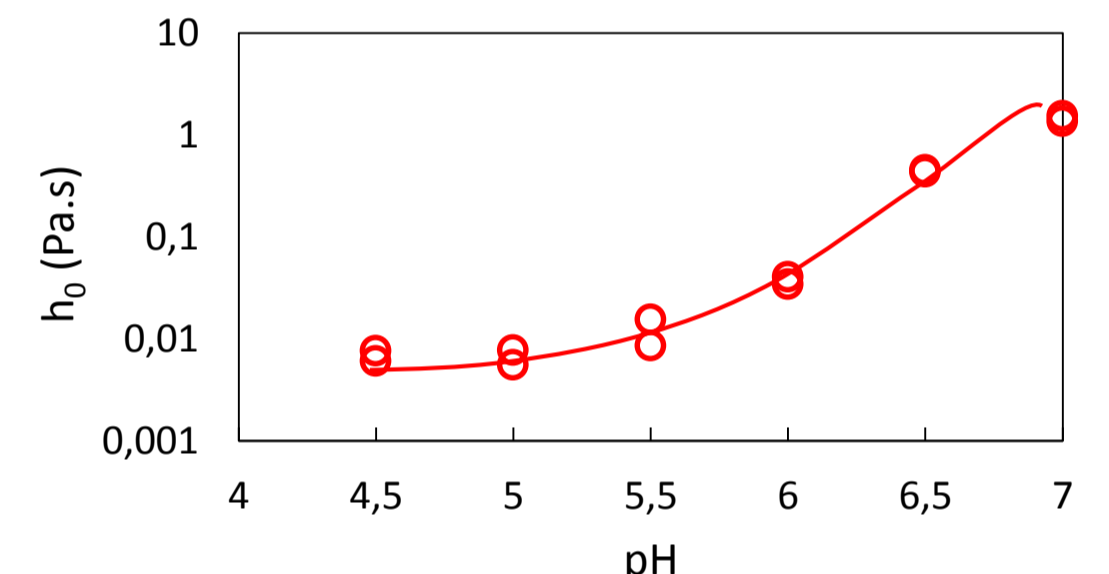


Fig. 2:  $\eta_0$  of suspensions = f(pH). Powder suspension at 80 g/kg PMI.



### Addition of NaCl



Fig. 3: WE in PMI = f(NaCl). Powder suspension at 10 g/kg.

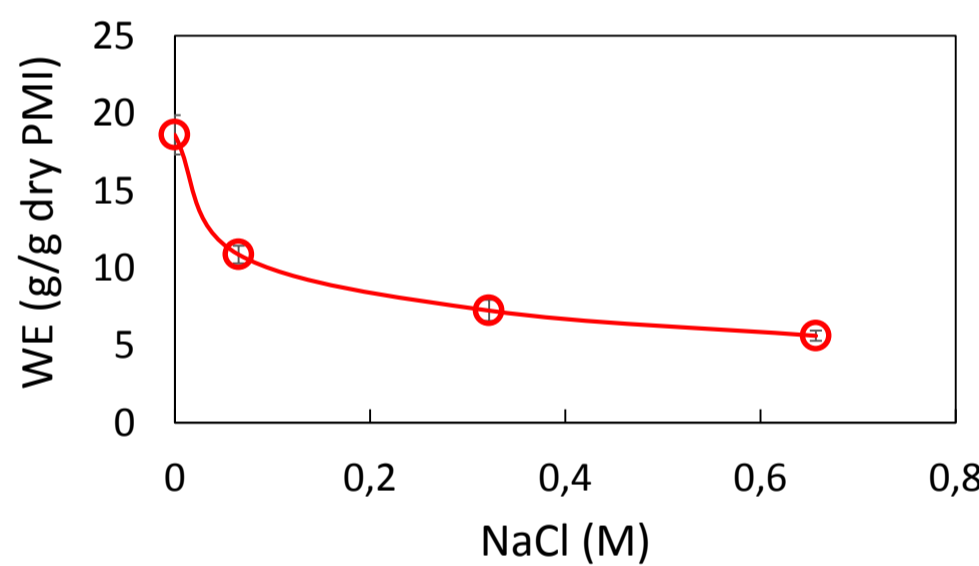
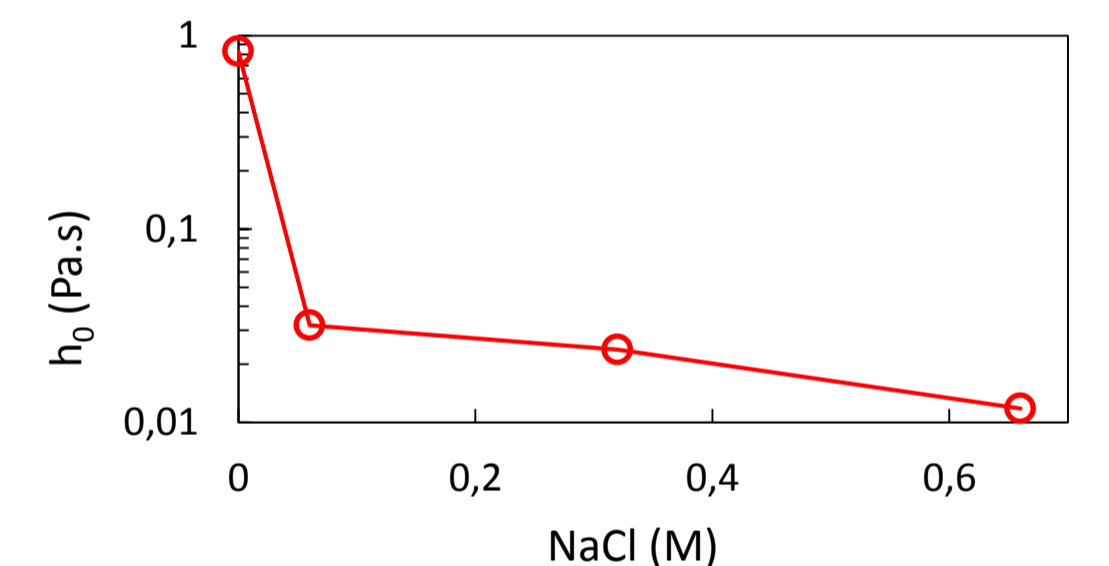


Fig. 4:  $\eta_0$  of suspensions = f(NaCl). Powder suspension at 80 g/kg PMI.



### Addition of micellar-enriched milk protein concentrate (Mic cas)



Fig. 5: WE in PMI = f(Mic cas) Powder suspension 10 g/kg + 0-50 g/kg Mic cas In black = theoretical, i.e. sum of each constituent according to their proportion.

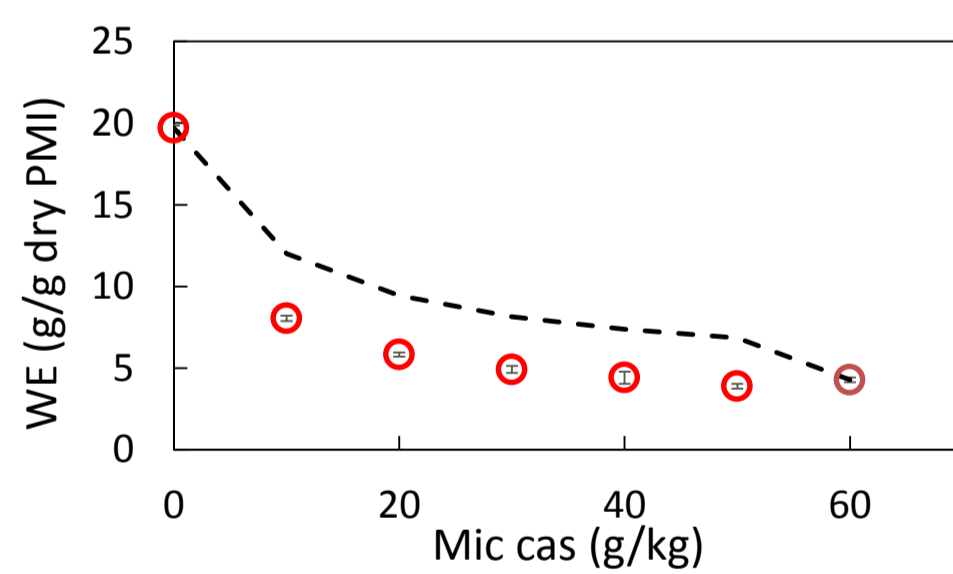
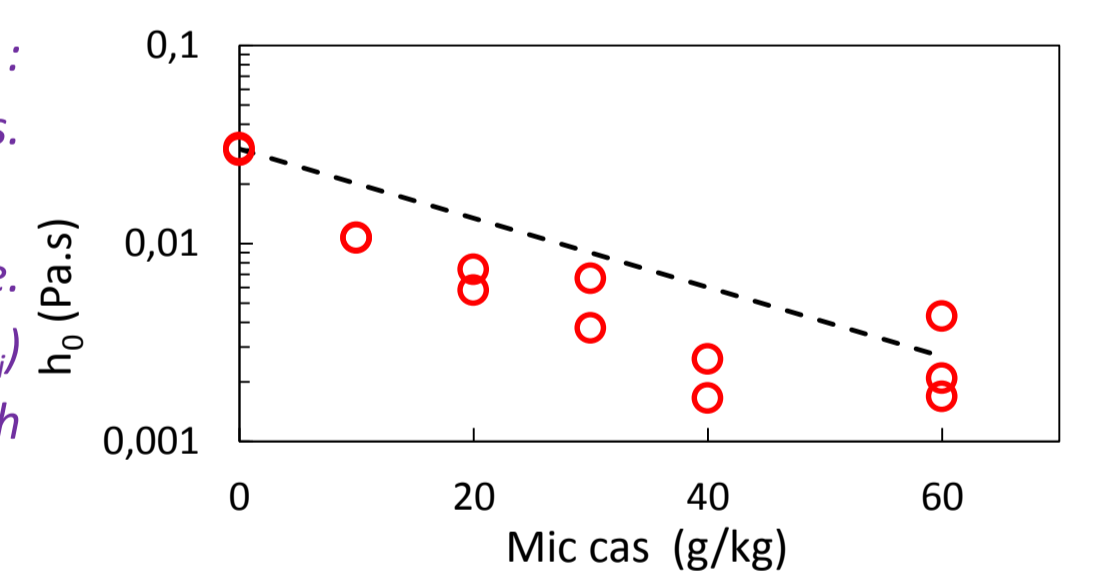


Fig. 6:  $\eta_0$  of suspensions = f(Mic cas) : 0-60 g/kg PMI + 60-0 g/kg Mic cas. Total protein concentration: 60 g/kg. In black = theoretical i.e.  $\log(\eta_{mixture}) = \sum(\phi_i \times \log(\eta_i))$  ( $\phi_i$ , volume fraction of each constituent).



### Addition of sodium caseinate (Na cas)



Fig. 7: WE in PMI = f(Na cas) Powder suspension 10 g/kg + 0-50 g/kg Na cas In black = theoretical, i.e. sum of each constituent according to their proportion.

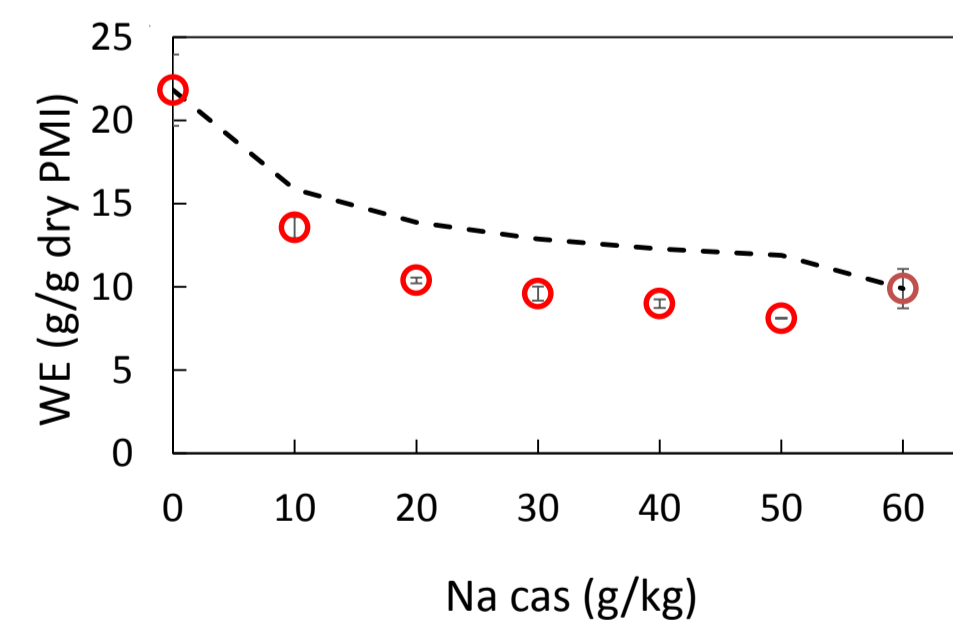
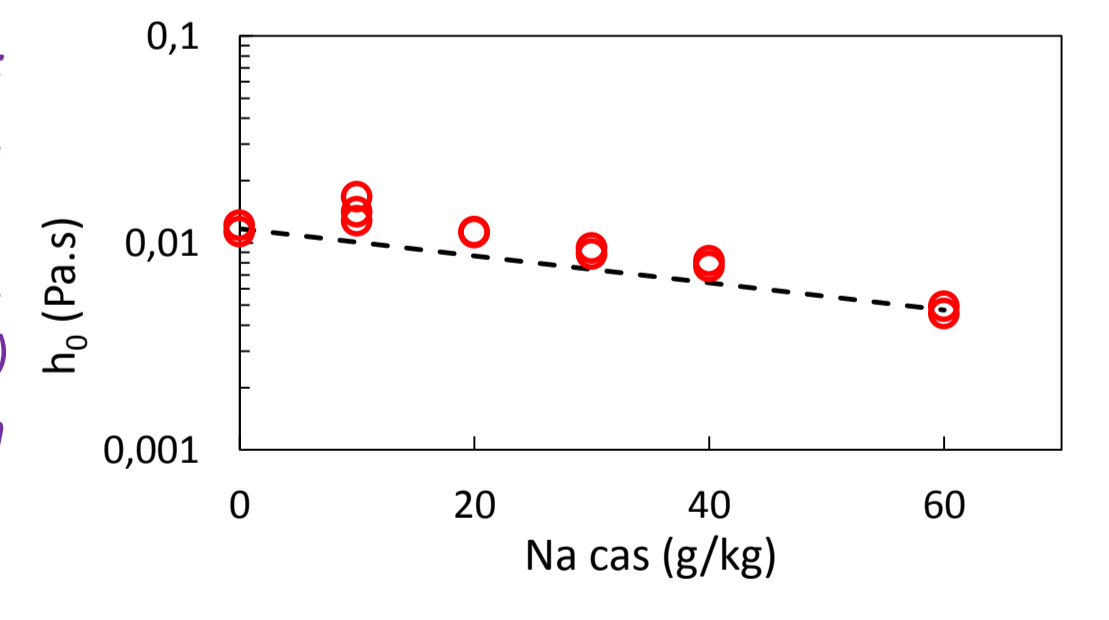


Fig. 8:  $\eta_0$  of suspensions = f(Na cas) : 0-60 g/kg PMI + 60-0 g/kg Na cas. Total protein concentration: 60 g/kg. In black = theoretical i.e.  $\log(\eta_{mixture}) = \sum(\phi_i \times \log(\eta_i))$  ( $\phi_i$ , volume fraction of each constituent).



## Conclusions and perspectives

The best physicochemical conditions for using PMI in food formulation:

- ✓ Neutral pH value (pH 6.5-7.0)
- ✓ Low salt content
- ✓ With casein more as sodium salt than micellar casein

Swelling of PMI could be due to the negative charges of whey proteins that leads to expanded proteins in the microparticles. Increasing the salt concentration or decreasing the pH  $\Rightarrow$  decrease of negative charges  $\Rightarrow$  Lower swelling of PMI

What effect of PMI on gel formation functionality?

[1] Famelart et al. 2018. WO2018185192 (A1) - Stabilized protein aggregate particles, and process for the preparation of said particles.  
 [2] Schong et al. 2018. Dry heating of whey proteins leads to formation of microspheres with useful functional properties. Food Res. Int. 113, 210-220.