Whey microparticles as a tool to change the caloric content of dairy products

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Objective

- **Increasing the water binding capacity (WBC)** of whey protein microparticles (MPs) to potentially reduce the caloric content of dairy products
- Investigating the role of water in the MPs and between the MPs in the WBC as calculated from a pellet of MPs

Conclusions

- Dithiothreitol increased the WBC of MPs from **6 to 9 g water / g protein**
- The WBC of the DTT MPs increased due to
  - an increase in swelling
  - and an **increase in the amount of water between the MPs**

Results

Effect of a reduced crosslink density on the water binding capacity of MPs

One way to increase the swelling of MPs would be **decreasing their crosslink density**. To change the crosslink density of MPs, MPs were incubated in a dithiothreitol (DTT) solution. DTT broke down disulphide bridges into sulfhydryl groups (Figure 1). A reduction in the crosslink density of MPs resulted in an **increase of the WBC of the MPs** (Figure 2).

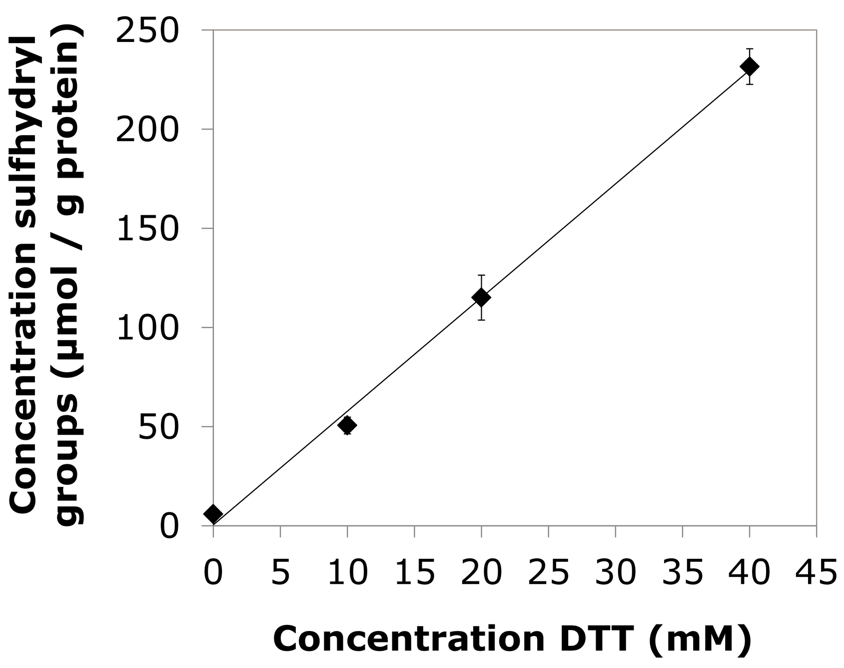

Figure 1. The concentration of sulfhydryl groups (μmol / g protein) present in the standard microparticles (MPs) (0mM) and MPs incubated in solutions with various amounts of dithiothreitol (DTT). The bars show the standard deviation. The line guides the eye.

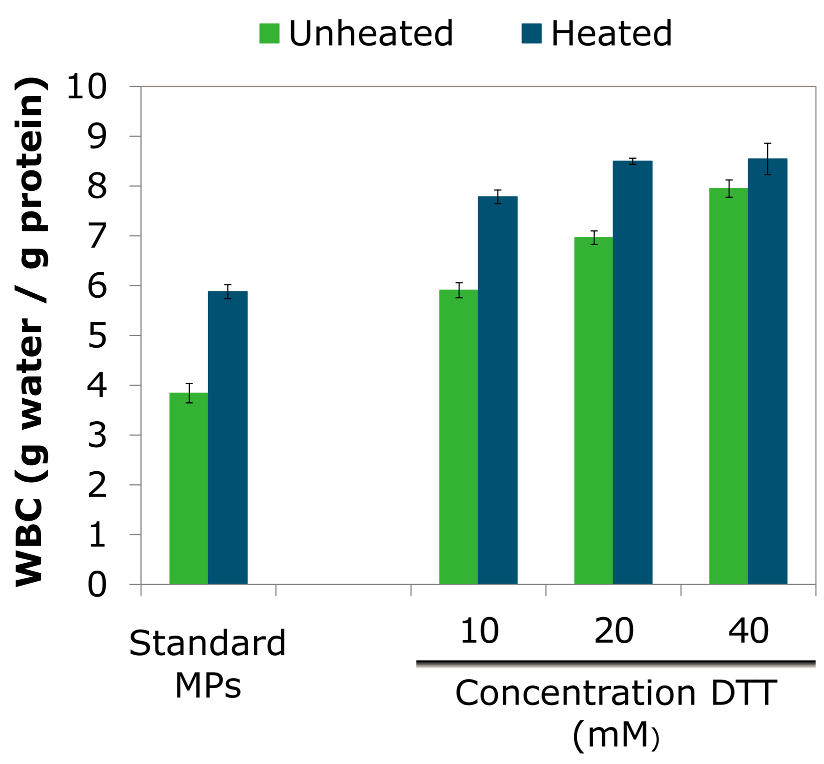

Figure 2. The water binding capacity (WBC) of the unheated and heated pellets of standard microparticles (MPs) and MPs incubated in dithiothreitol (DTT). The bars show the standard deviation.

decreased crosslink density → increased WBC

Is the WBC a function of the swelling of the MPs and/or the amount of water between the MPS?

The pellets made of the MPs during the WBC experiment (Figure 3) contained both **swollen MPs** (1) and **water between the MPs** (2). That made it uncertain if the MPs were able to swell more, or more water between the MPs was present.

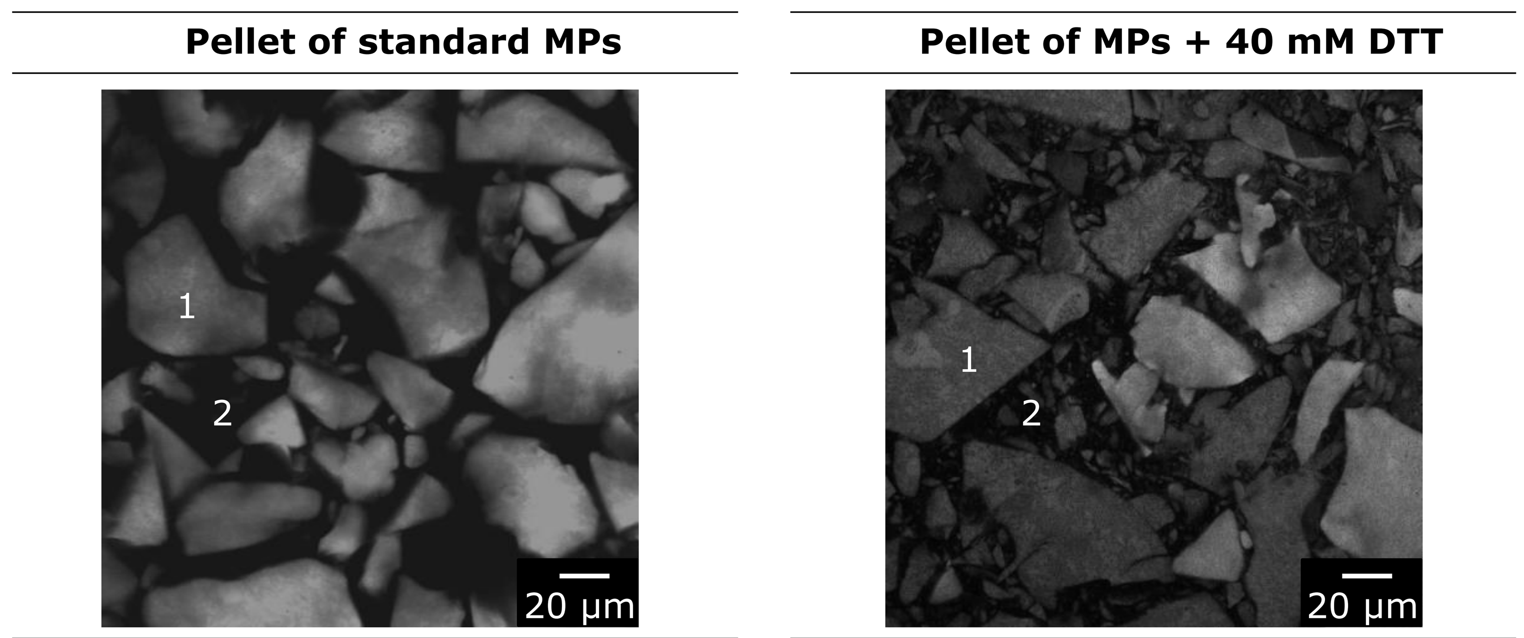

Figure 3. Microscopic pictures of the unheated pellets of standard microparticles (MPs) and MPs incubated in dithiothreitol (DTT) containing swollen MPs (1) and water between the MPs (2).

Swelling experiments performed suggest that DTT had only clearly enhanced the swelling of the unheated MPs (Table 1). Isotherms even imply that the swelling of the MPs was hardly changed with DTT (Figure 4). As a consequence, the **amount of water between the MPs** should have been changed. The importance of this fraction can be seen in Table 1.

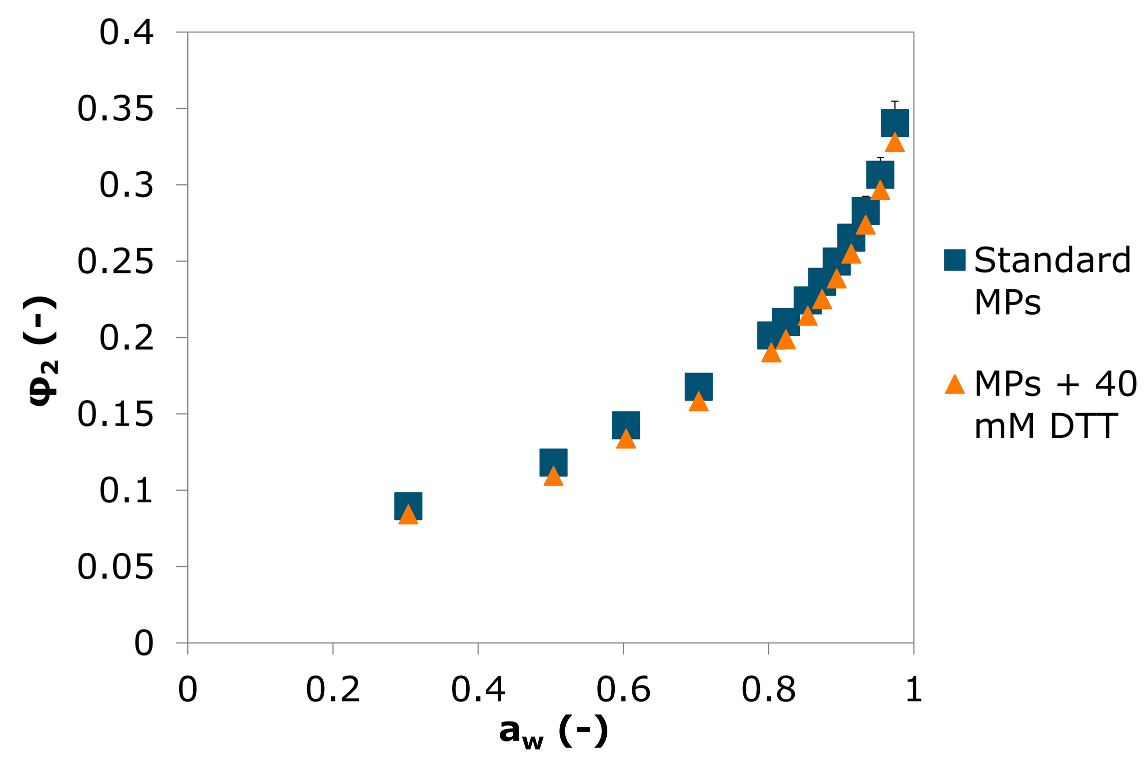

Figure 4. The isotherms of standard MPs (□) and MPs incubated in 40 mM dithiothreitol (DTT) (Δ), in which φ_2 is the volume fraction of water and a_w the water activity. The bars show the standard deviation.

WBC = swelling MPs + water between the MPs

Table 1. The average diameter $d_{4,3}$ (μm) of the dry, hydrated, and hydrated and heated standard microparticles (MPs) and MPs incubated in 40 mM dithiothreitol (DTT), the calculated swelling of only the MPs (g water / g particle), and the calculated ratio water in the MPs and between the MPs in the pellet obtained during the water binding capacity (WBC) experiment.

	Average diameter (μm) (d_{43})			Swelling (g water / g particles)		water in MPs : water between MPs	
	Dry	Hydrated	Hydrated and heated	Hydrated	Hydrated and heated	Hydrated	Hydrated and heated
Standard MPs	88 (5)	114 (7)	124 (6)	0.9	1.4	1.0 : 3.2	1.0 : 3.3
MPs + 40 mM DTT	73 (4)	122 (2)	111 (4)	2.8	1.9	1.0 : 1.7	1.0 : 3.3

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