Controlling water binding properties of dairy proteins through micro-structuring

J.P.C.M. Peters, A.J. van der Goot, R.M. Boom

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Background

In the last decade the amount of obese people has increased considerably. Besides this, also the amount of health conscious people has increased. This resulted in a demand for healthier food. One way to decrease the caloric content is by increasing the water content of products. However, water addition leads to softer products or even syneresis. Since the consumer only accepts healthier products in case they are equally attractive, a manner has to be found to fulfil both conditions. Therefore it is important to control the ability of dairy proteins to hold water and to get to know how this can be changed. Micro-structuring seems an attractive option.

Objective

To determine how the characteristics of dairy proteins have to be changed so they hold more water, insight has to be obtained in the natural swelling ability of the dairy proteins. Whey protein isolate (WPI), homogeneous and microstructured gels of whey protein isolate (MPs), sodiumcaseinate (NaCas), calciumcaseinate (CaCas) and paracasein (ParaCas) were evaluated.

Results

The interaction of water with dairy proteins

The isotherm of the dairy proteins (Figure 1) shows that differences existed in the amount of water taken up by the dairy proteins when the aw was between 0.1-0.8. At higher aw (>0.8), only small differences between the various dairy proteins were found. Furthermore, the results show that the proteins were not able to take up the amount of water they would absorb in cheese.

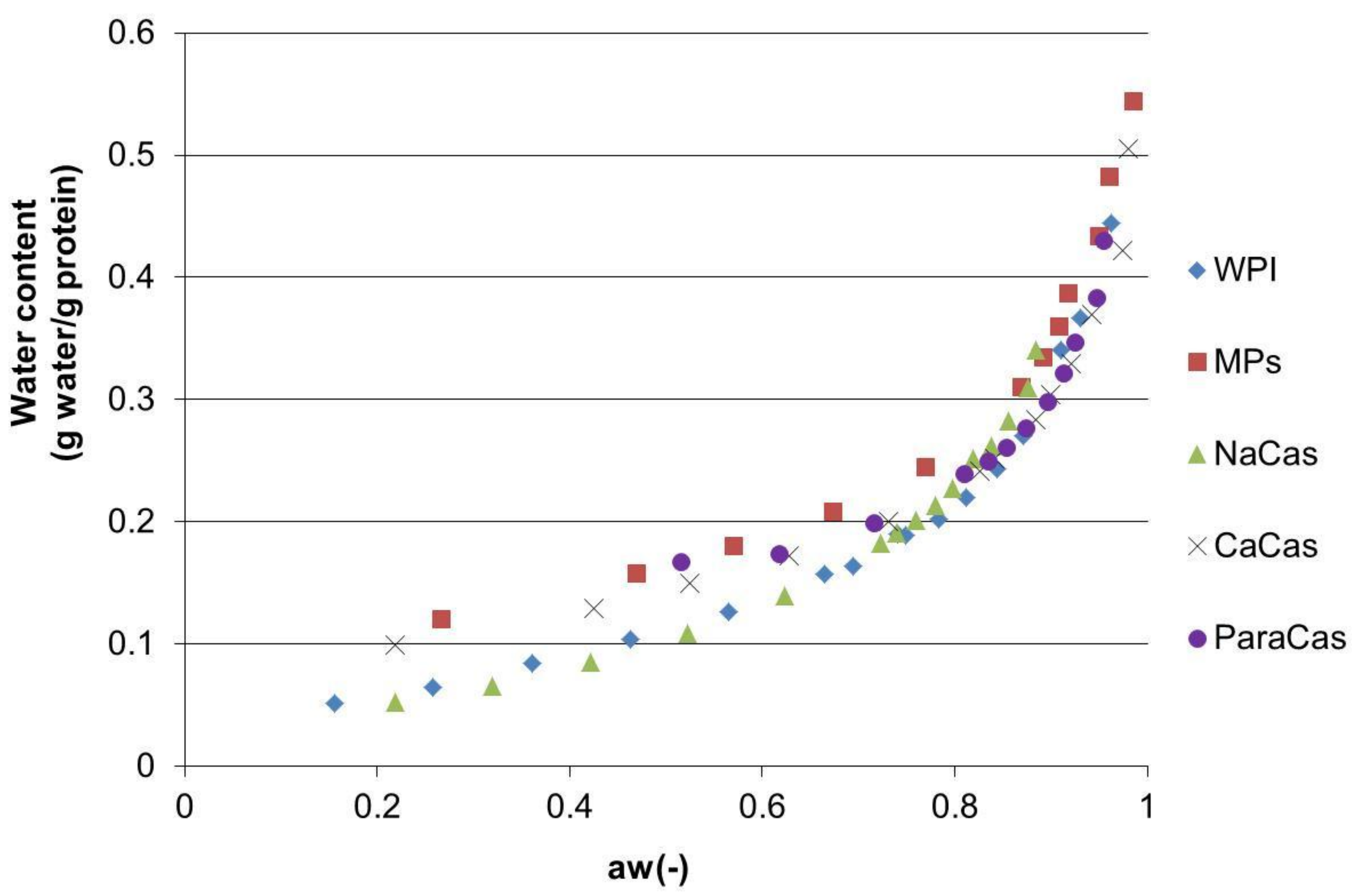


Figure 1. The isotherms of whey protein isolate (WPI), microstructured gels (MPs), sodiumcaseinate (NaCas), calciumcaseinate (CaCas) and paracasein (ParaCas).

With the Flory-Rehner equation the polymer-solvent interaction parameter (χ) was calculated from the results of the isotherms. Therefore the following formula were used:

$$aw = e^{[ln(1-\varphi_1)+\varphi_1+\chi*\varphi_1{}^2]}$$

and

$$\chi = \chi_0 + (\chi_1 - \chi_0) * \varphi_1{}^2$$

with φ_1 as the polymer volume fraction, χ_0 as the polymer-solvent interaction parameter of the material in a diluted system (=0.5) and χ_1 as the polymer-solvent interaction parameter of the dry material.

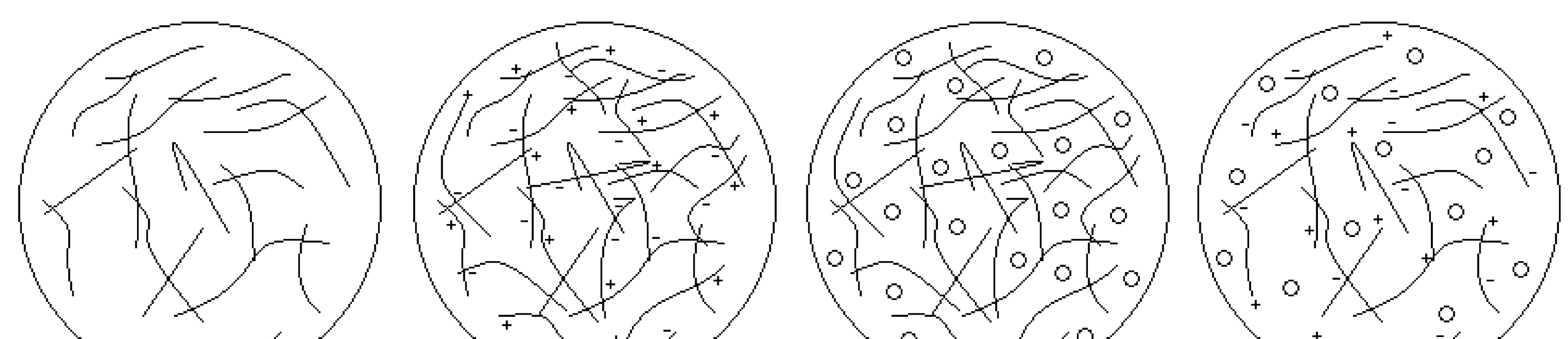
The results of the calculations (Table 1) show that NaCas was the most hydrophobic dairy protein while the MPs were the most hydrophilic. This is in contrast to what was found during the WHC experiments were NaCas and WPI dissolved (Table 1), which only can happen when they are hydrophilic or from hydrophilic microstructures. Also the MPs did not show the highest WHC.

Table 1. The water holding capacity (WHC) (g water/g protein) and the polymer-interaction parameter (χ) of whey protein isolate (WPI), microstructured gels (MPs), sodiumcaseinate (NaCas), calciumcaseinate (CaCas) and paracasein (ParaCas).

	WHC (g water/g protein)	χ_1
WPI	Dissolved	0.93
MPs	3.78 ± 0.08	0.57
NaCas	Dissolved	0.95
CaCas	5.27 ± 0.19	0.68
ParaCas	2.46 ± 0.01	0.67

The possibilities to change the WHC of dairy proteins

From the experiments it could be concluded that dairy proteins naturally do not absorb a lot of water. A possibility to change this is by altering their microstructure. Comparing the characteristics of the dairy proteins to the properties of superabsorbers it was concluded that the following changes within the structures probably will lead to an increased WHC:



Decreased crosslink density — *Addition of hydrophilic groups* — *Introducing pores* — *Combination of changes: superabsorber*

Conclusions

- Dairy proteins naturally do not absorb a lot of water
- Modification of the proteins could cause an increase in their swell ability when
  - The crosslink density is reduced and/or
  - The molecular weight is increased and/or
  - Pores are introduced

Jorien P..C.M. Peters
Bomenweg 2
P.O. Box 8129, 6700 EV Wageningen
Contact: jorien.peters@wur.nl
www.foodstructuring.wur.nl