Kinetics and phase composition of phase-separating carrageenan-milk protein mixtures from T_2-measurements

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In many food products, various types of carrageenan (marine polysaccharide) are frequently used as thickening, gelling or stabilising agents. In dairy products, the functionality of the carrageenan is usually related to interactions of the carrageenan molecules with milk proteins.[1,2]. Depending on the conditions, aggregative or segregative interactions may occur (bridging or depletion flocculation), leading to phase separation. The resulting phase-separated system may be kinetically trapped in a microscopically demixed network (gelation) or it may progress to bulk phase separation. To optimally use carrageenan in food formulation it is necessary to know the mechanisms of interactions and the phase diagrams of milk protein-carrageenan mixtures in detail.

We have investigated the phase behaviour of mixtures of milk proteins and various types of carrageenan (κ-, ι-, and κ/ι-hybrid) using ^{1}H T_2-measurements at low field (23.5 MHz). Since transversal relaxation times of water in such systems are particularly sensitive to protein concentrations, it proved possible to distinguish between protein-enriched and protein-depleted (micro-) domains. Multi-exponential fitting of the CPMG echo decay curves (either to discrete T_2-values or to T_2-distributions) allowed fair quantification of the phase volumes as well as the protein concentrations of the different phases in the phase-separated mixtures.

Since the CPMG-experiment is very quick, it was also possible to monitor the development of phase separation in time, which allowed the study of phase separation in a very early stage (only several minutes after mixing), long before macroscopic phase separation could be observed.

References:

1. Schorsch, C., Jones, M. G., and Norton, I. T. (2000). *Food Hydrocoll.*, 14 347-358.
2. Spagnuolo, P. A., Dalgleish, D. G., Goff, H. D., and Morris, E. R. (2005). *Food Hydrocoll.*, 19 371-377.