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Impact of solid lipid nanoparticles on protein gel properties and their behavior during gel preparation

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Nanoparticles show great potential as carriers of active substances enhancing the functionality of foods. Furthermore, they can modify food structure related properties such as firmness or syneresis of gels [1]. Their effect on these gel properties depends on the surface properties, size, shape and number of the particles, among others [2]. Besides the impact of solid lipid nanoparticles (SLN) on protein gel properties, we investigated the change in SLN size after heating in the presence of β-lactoglobulin (BLG). By using SLN, we aimed to improve gel properties like syneresis and gel strength.

SLN were prepared by ultrasound assisted hot emulsification and were stabilized by sucrose palmitate, soy lecithin and Tween 20 as described in [3]. In addition, Tween 20 was exchanged by BLG to modify possible interactions between SLN and the protein. SLN stabilized by BLG (B-SLN) or Tween 20 (T-SLN) were added to the BLG-solution before the heat denaturation of the protein at varying concentrations (0.25 to 2.5 wt.-%). Gelling of the protein was induced by decreasing the pH value. Samples were characterized before and after gelling. The characterization of the gels included syneresis, network structure and mechanical properties.

After the heat treatment, the T-SLN – BLG - dispersion had a bimodal shape with one particle fraction being larger than the initial SLN and the other fraction being substantially smaller. This is interpreted as the presence of small protein aggregates (approx. 50 nm) and large coalesced SLN particles (approx. 300 nm). T-SLN did not affect the Young's modulus. Furthermore, in all samples containing T-SLN, particles were present in the syneresis water, i.e. they were washed out from the gel.

If SLN were prepared with BLG instead of Tween 20, they did not coalesce during the heat treatment and the particle size distribution was monomodal (approx. 155 nm). All SLN-filled gels showed fine stranded network morphology. The addition of B-SLN increased the Young's modulus of the gels compared to the control. B-SLN caused many ramifications within the gel and no particles were detected in the syneresis water.

The results indicate the integration of B-SLN in the network and their function as bound particles. T-SLN did coalesce during the heat treatment, did not participate in the gel network and did not alter the gel properties.

Hence, by the choice of emulsifier, SLN can be used to modify gel properties in a targeted way. This study will help in better understanding the behavior of nanoparticles during gel network formation which is important if SLN are to be used as carriers of bioactive substances in complex food systems.

1. Pérez-Esteve E, Oliver L, García L, Nieuwland M, De Jongh HHJ, Martínez-Máñez R, Barat JM. Incorporation of mesoporous silica particles in gelatine gels: Effect of particle type and surface modification on physical properties. Langmuir. 2014;30:6970-9.
2. Gravelle, A. J., Barbut, S. & Marangoni, A. G. Influence of particle size and interfacial interactions on the physical and mechanical properties of particle-filled myofibrillar protein gels. *RSC Advances* **5**, 60723-60735, doi:10.1039/C5RA07254A (2015).
3. Oehlke K, Behsnilian D, Mayer-Miebach E, Weidler PG, Greiner R. Edible solid lipid nanoparticles (SLN) as carrier system for antioxidants of different lipophilicity. PLOS ONE. 2017;12:e0171662.