Unravelling the contrasting phase behavior of wheat gliadins: how to store storage proteins.

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Wheat gliadins serve as storage proteins in wheat seed and constitute a source of carbon, nitrogen and sulfur for the development of the plant. They have to be efficiently stored and dehydrated during seed development undergoing number of physical transitions towards a glassy state. We investigate structural transitions that occur upon increasing concentration in purified protein systems. We do so by combining osmotic compression and a multi-scale structural characterization [1]. We evidence three thermodynamical regimes corresponding to several structuring regimes as shown in the Figure below. First, for $\Phi < 0.03$, gliadins behave as repulsive colloids, with a positive second virial coefficient, arising presumably from their surface charge density and/or their steric repulsion. No intermolecular interaction was detected by FT-IR, suggesting that proteins form a stable dispersion. In the second regime, the system becomes more easily compressible, i.e., less repulsive and/or more attractive. It is associated with the disappearance of β-sheet intramolecular structures of the proteins in favor of random coils/α-helix and intermolecular β-sheet interactions.This coincides with the appearance of elasticity and the increase of the apparent viscosity. Finally, in the last regime, for $\Phi > 0.16$, FT-IR spectra show that proteins are strongly interacting via intermolecular interactions. A correlation peak develops in SAXS, revealing a global order in the dispersion. Interestingly, the osmotic pressure applied to extract the solvent is higher than expected from a hard-sphere-like protein and we highlighted a liquid-like state at very high concentration (>450 g L−1) which is in contrast with most proteins that form gel or glass at such concentration. Our study suggests the presence of supramolecular assemblies that prevent percolation and questions the role of hydration force in this specific behavior. From a biological perspective, these assemblies would prevent the formation of a gel or protein crystals in order to keep the proteins mobile at the germination time. This liquid-like behavior, despite of high concentrations and strong attraction, can be seen as a strategy for wheat seeds to store as much amino-acids as possible while being easily dispensable when needed.

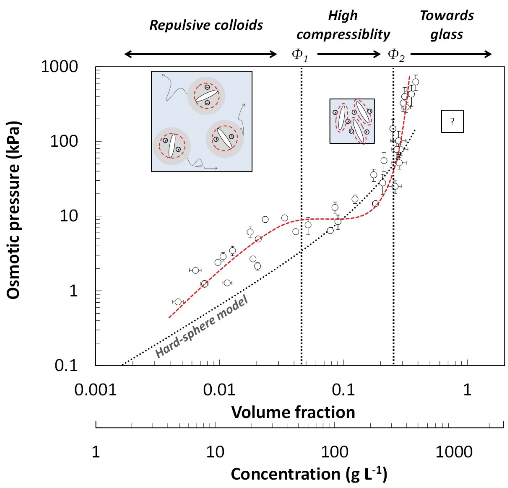

Figure 1 Osmotic pressure of wheat gliadin dispersions at 20 °C after 4 weeks of equilibration. Dashed black line stands for the prediction of an equivalent hard-sphere and red dashed line stands for guide to the eye.

[1] Boire A, Menut P, Morel M-H, Sanchez C., *J Phys Chem B*, **119**, 5412 (2015).