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The formation and deformation of protein structures with visco-elastic properties

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Introduction

People suffering from celiac disease—gluten intolerance—cannot enjoy the structural and functional properties gluten provides in many foodstuffs. Despite a lot of research on alternative gluten free cereals, no cereals with a structure equivalent to that of wheat have been found. Due to increasing intolerance for gluten, a need is raised for the production of breads without the gluten allergenic ingredients.

The low quality of gluten free wheat products is caused by the fact that gluten proteins are a major structure-builder, which can not be replaced without a detrimental effect on product quality. Only with a gluten protein analog—a biopolymer system with similar functional properties as the gluten-proteins matrix it is possible to make quality gluten free wheat products.

Aim

In this study, we investigate how a protein structure should be processed to obtain an aggregate that has comparable functionality as gluten. The formation of protein structures with comparable functionality as gluten particles may fill the gap of quality gluten free products.

Research

The gluten network is a very complex network, and the real structure is still unclear. Nevertheless, we think that we can consider the gluten network to be built up by protein particles (or aggregates) that interact with each other. The strength of those particles is governed by the chemical bonds and physical interactions at molecular scale. In this project, we try to mimic those gluten particles by aggregated formed with other proteins. To get insight in the necessary micro-aggregate properties, the effect of different types of micro-aggregates on the properties of the final protein structure is investigated.

Small micro-aggregates are formed by shearing a phase separating protein/carbohydrate solution. The phase separation of the solution causes proteins to concentrate in one phase, so the protein molecules prefer to cluster and form physically linked aggregates. Stirring will break the formed aggregates into droplets, leading to small protein beads. Variation in concentration, type of carbohydrate, shearing speed and temperature results in different protein aggregates. The effect of the variations of the protein aggregates on their ability to form a network is analysed. The network structure is visualized by microscopy and rheological properties of the formed network are measured.

Future research

When the effect of the protein type, size of the micro-aggregate and shape of the micro-aggregate is clarified, further research will focus on the influence of chemical bond formation. By chemical modification of the surface of the micro-aggregates, the effect of additional sulphide-groups or surface charge on the final protein structure will be analyzed.

Later we will investigate the effect of shearing and kneading on the protein network in the presence of starch particles and water. This is the first step to evaluate the potential of protein aggregates as gluten replacers.

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