Effect of Shear Treatment during Cooling on Structure Formation of a Pea Protein Isolate-Wheat Gluten blend in High Temperature Shear Cell

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Background

High temperature shear cell (HTSC) technology is used to study the structuring of plant-based materials into meat analogues. A fibrous structure is formed by processing a pea protein isolate-wheat gluten (PPI-WG) blend in the HTSC, when shearing is applied during heating. The effect of shear application during the HTSC process has previously only been researched during heating. However, shear application during cooling could be a manner to make the shear cell process more efficient and could help to better understand structure formation in the cooling die of the extruder.

Objective

This study aims to investigate the effect of shearing during cooling on the structure formation, by varying shear rate (i.e. 6.5~130 s^{-1}) and/or shearing time (i.e. 4~10 min).

Approach

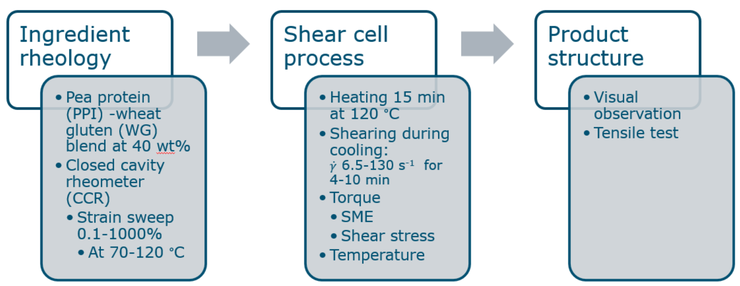

Figure 1. Schematic overview of the experimental approach.

Results – Macrostructure

- Fibrous structures could only be observed for the lowest shear rate conditions and are indicated with green checkmarks in Fig. 2.

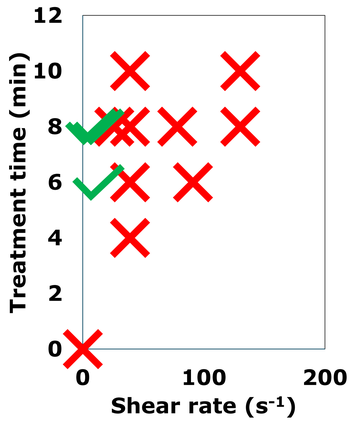

Figure 2. Overview of conditions at which fibrous structures were (not) formed.

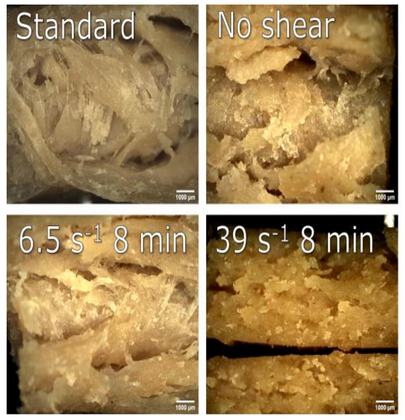

Figure 3. Smartzoom digital microscope pictures at 34x magnification.

Results – Rheology

- Viscosity increases with decreasing temperature.
- Shear thinning behaviour constant.
- Increased viscosity expected to result in droplet break-up during shearing.

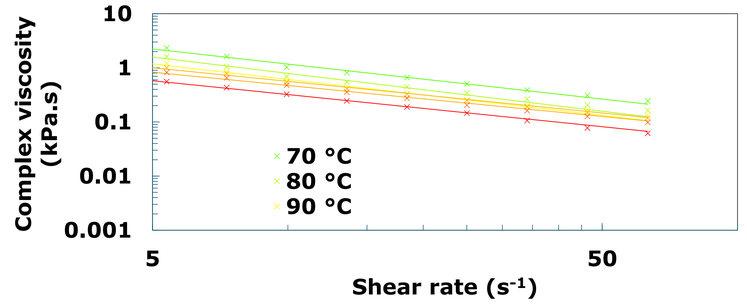

Figure 5. Complex viscosity 40 wt% PPI-WG gluten plotted against shear rates in the range relevant for HTSC processing (5-63 s^{-1}) at different temperatures. Lines represent fitted power law model for these data.

Results – Mechanical properties

- HTSC products could be divided into two clusters in the texture map:
  - Though fibrous structures
  - Mushy non-fibrous structures

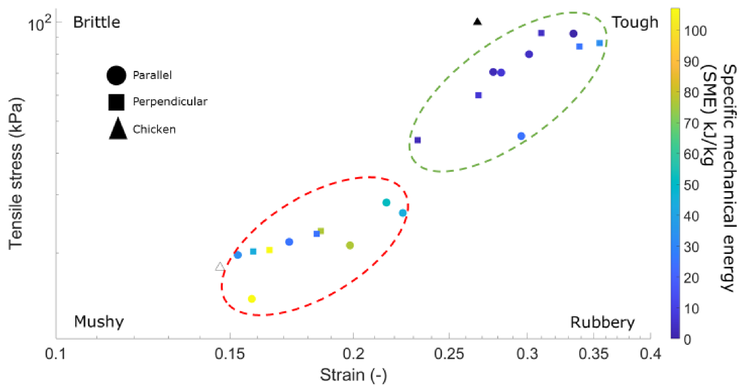

Figure 4. Texture map shear cell products with boiled chicken[1] as reference

Conclusions

- Only low shear rates suitable structuring during cooling as high shear rates lead to structural breakdown.
- A lower SME is required when structuring is performed during cooling.
- This process could be energy efficient alternative to standard shear cell treatment or extrusion.

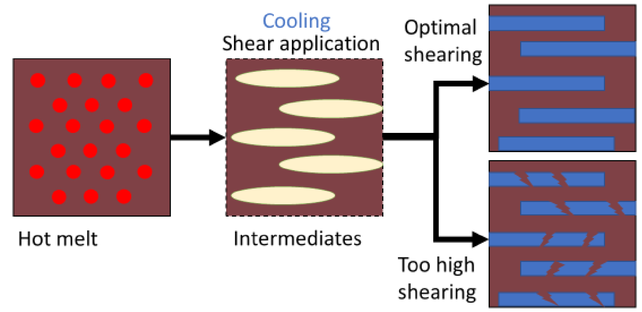

Figure 6. Hypothesized mechanism for structure formation during cooling.

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1 Schreuders et al. (2019). *J. of Food Eng., 261*(May), 32–39.