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The contribution of wheat starch and wheat gluten to structure formation during deep-fat frying:

An objective tool to tailor fried food matrices of higher quality and nutrition?

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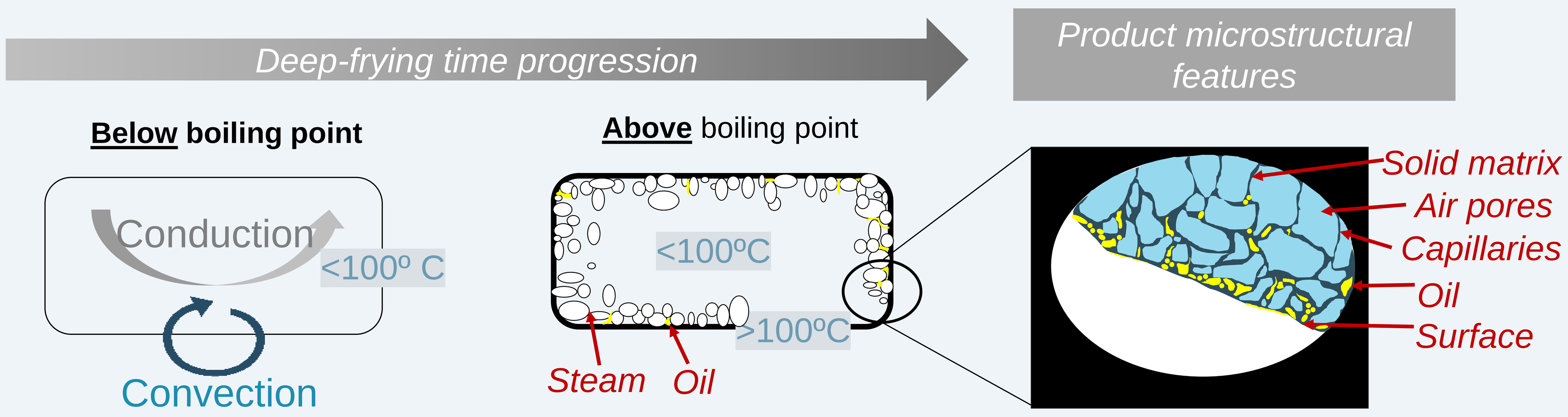
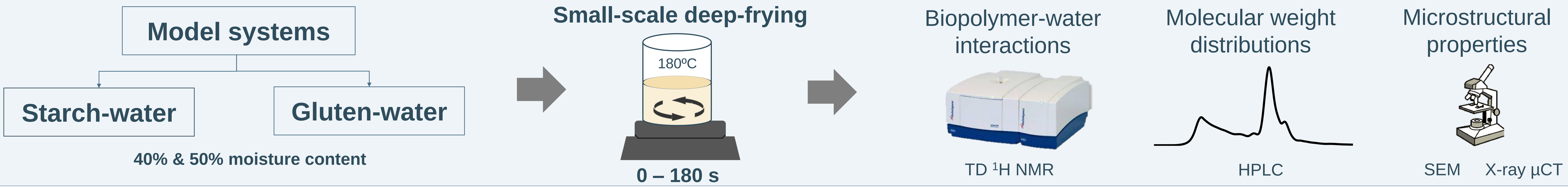
Research context

- Deep-fat frying is a popular cooking method across the world, commonly applied to various wheat-based food materials.
- This complex process involves heat exchange and the simultaneous transfer of oil and water. These contribute to unique textural and sensorial properties.
- Starch and gluten, the main constituents of wheat flour, are expected to contribute to deep-frying-induced structure formation.



Research question: **What contribution do starch and gluten constituents have to the formation of a porous matrix and water loss/oil uptake dynamics of deep-fried wheat-based foods?**

Materials and methods

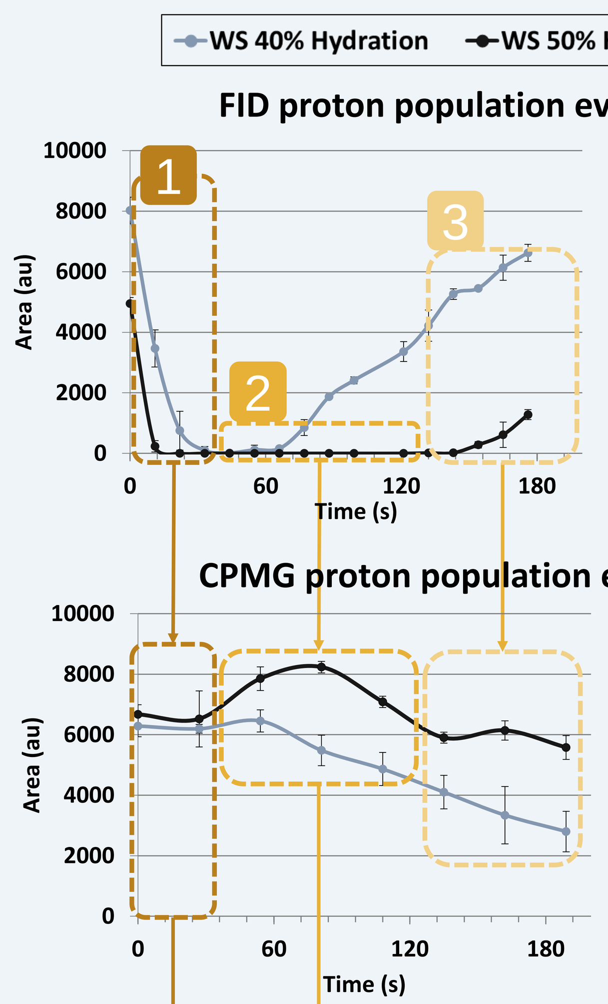


Results

WHEAT STARCH

Changes in the physical state of wheat starch (WS)

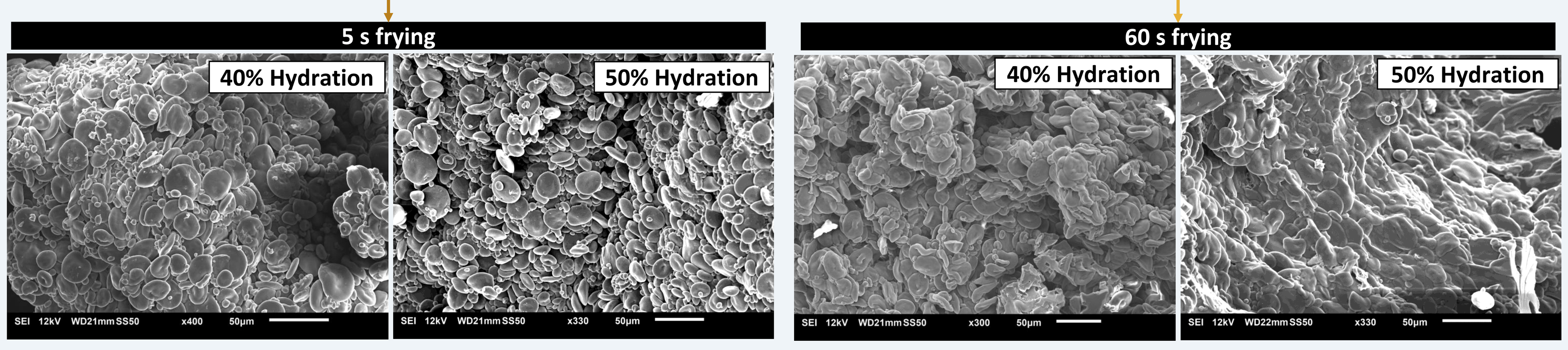
Temperature-controlled TD ^{1}H NMR may be used to evaluate proton dynamics [free induction decay (FID) and Carr-Purcell-Meiboom-Gill (CPMG)] during simulated deep-frying conditions at *ca.* 125° C.



FID: Representing rigid, fast-relaxing protons (*e.g.* crystalline amylopectin, amorphous starch in the glassy state).

CPMG: Representing slowly-relaxing protons such as those belonging to water domains (*e.g.* water interacting strongly or weakly with starch)

1. Loss of crystalline amylopectin due to starch gelatinization.
   - Starch granules cluster together thereby forming pores for oil to enter, however, starch granular integrity is maintained.
2. The increased interaction of previously crystalline starch chains with water.
   - Starch granules lose integrity, causing the microstructure to be predominantly characterized by a merged mass of starch granules.
3. Progressive increase of starch chains in the glassy state.



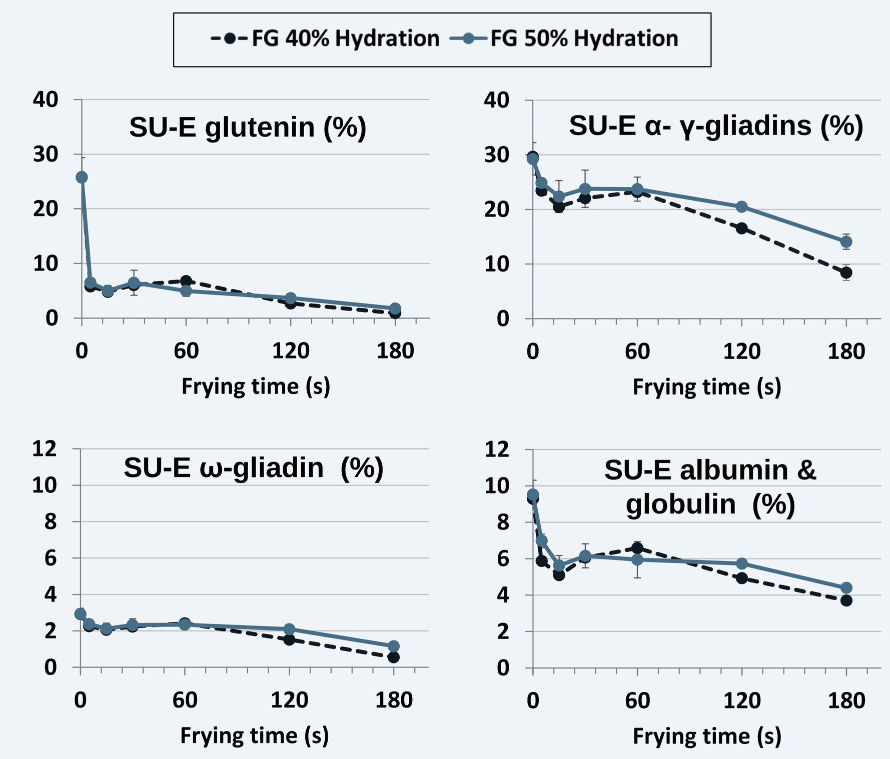
WHEAT GLUTEN

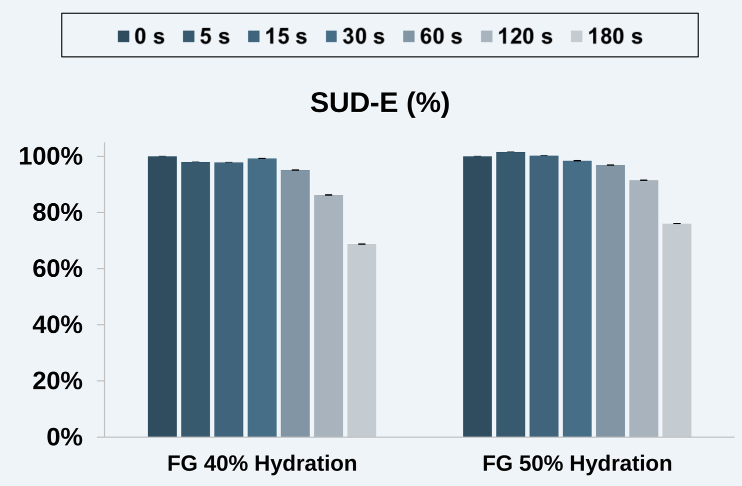
1. Non-covalent interactions

Extractability of fried gluten (FG) protein in media containing urea (2.0M) and 2% (w/v) SDS – (SU-E)

2. Covalent Linkages

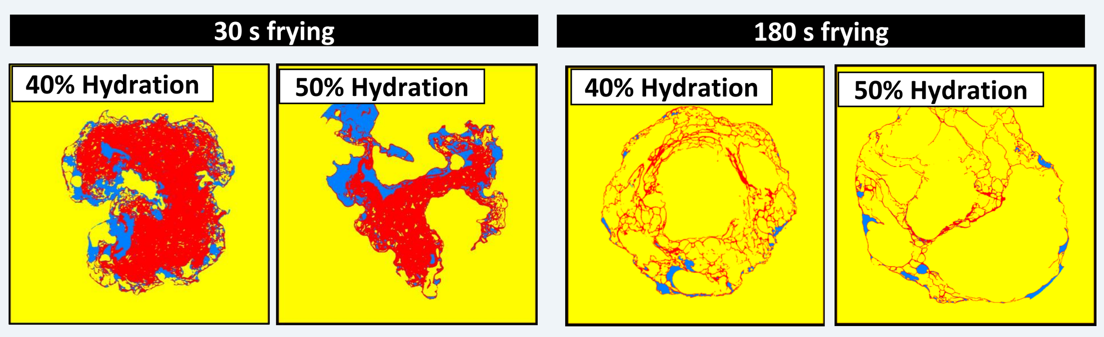
Protein extractability in media containing urea (2.0M), 2% SDS, and 1% DTT – (SUD-E)





- Non-covalent interactions contribute to the gluten network based on a decrease in SU-E.
- SU-E α-γ-gliadins are incorporated into the gluten network with longer deep-frying (60-180 s).
- Covalent reactions are dominated by disulfide bonds. However, non-disulfide bonds contribute to the gluten network (decrease in SUD-E) after 60 s of frying.
- Substantial expansion occurs later in the frying process.

3. Microstructural properties



Air (yellow) Protein (red) Oil (blue)

Conclusions

1 Wheat starch immediately gelatinizes upon deep-frying and the gluten network formed is dominated by non-covalent interactions.

2 Wheat starch (and presumably wheat gluten) progressively enter(s) into the glassy state during deep-frying depending on the initial moisture present in the system.

3 Non-disulfide cross-links contribute to the gluten network with longer deep-frying times.

Abbreviations: sodium dodecyl sulfate (SDS); dithiothreitol (DTT)