Effects of structural and chemical changes of soy proteins during thermal processing on proteolysis

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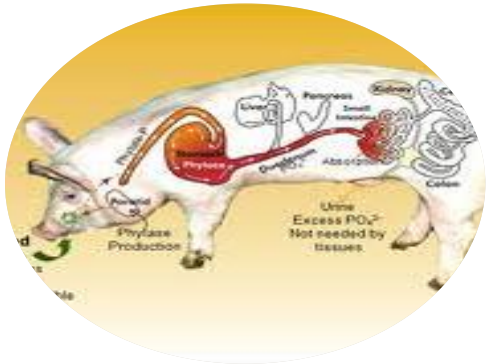

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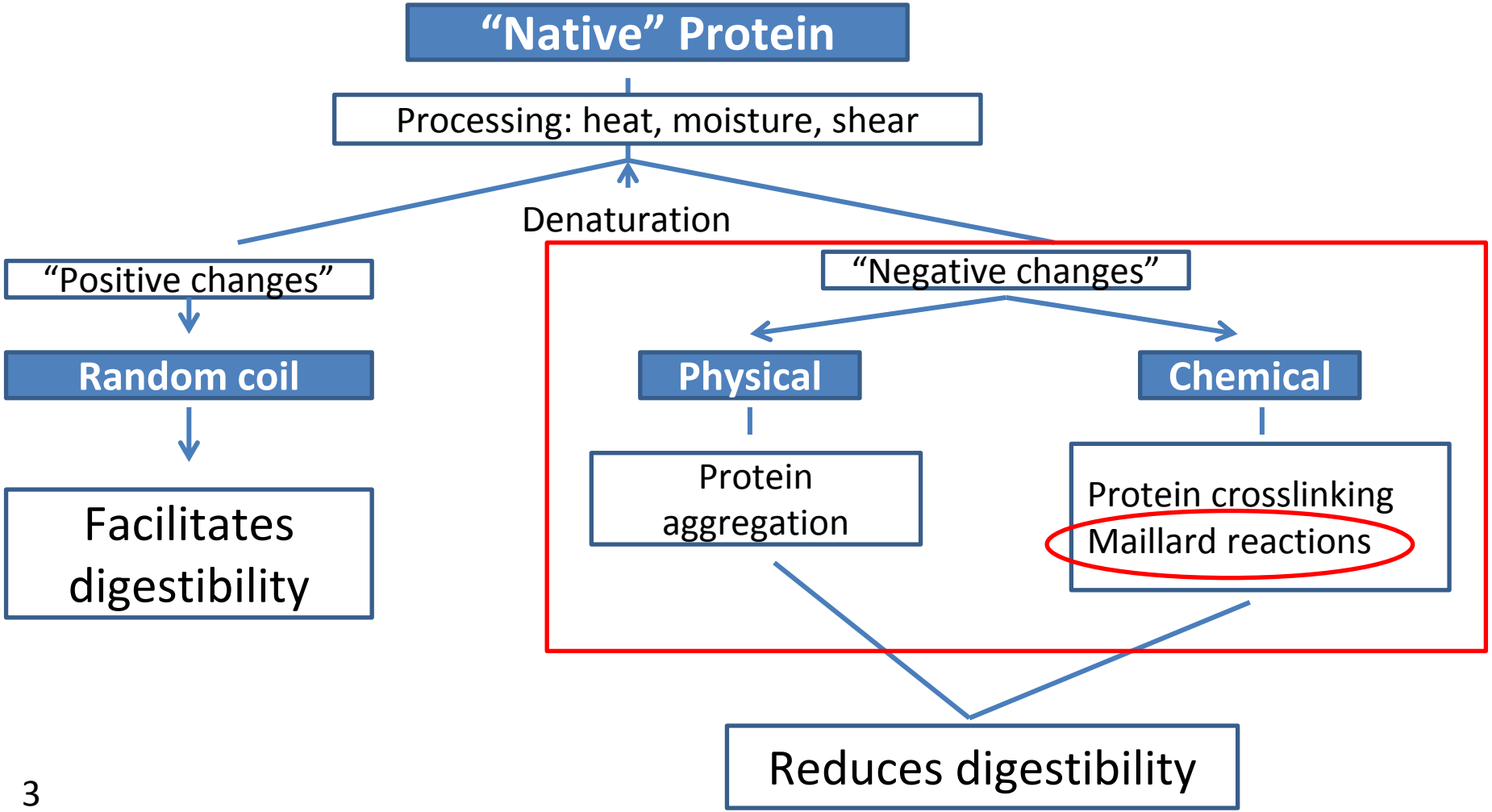
Why processing of ingredients/diets?

- Manage physical characteristics
  - Oil extraction, feed production
- Improve safety
- Beneficial effects on animal performance
  - Feed intake, FCR
- Nutrient digestibility
  - Starch gelatinization
  - Protein?!
    - Depending on conditions (large variability)


"Native" Protein
Processing: heat, moisture, shear
Denaturation
"Positive changes"
Random coil
Facilitates digestibility
"Negative changes"
Physical
Chemical
Protein aggregation
Protein crosslinking
Maillard reactions
Reduces digestibility

Objective

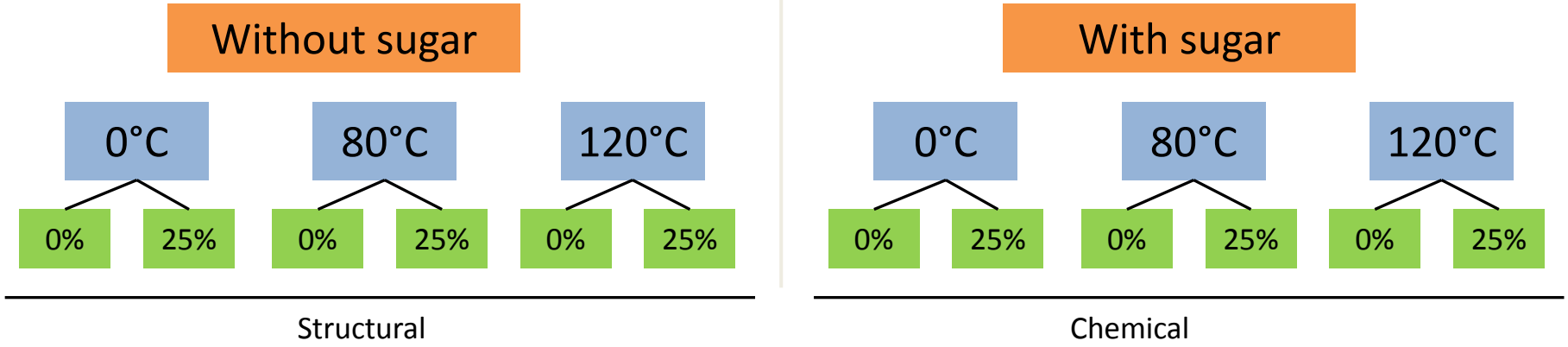
- To analyse the decisive factors for protein modifications during thermal processing and their influence on proteolysis

Hypothesis

- Modifications to the structure of proteins can be as severe to proteolysis as Maillard-damage to proteins

Experimental setup

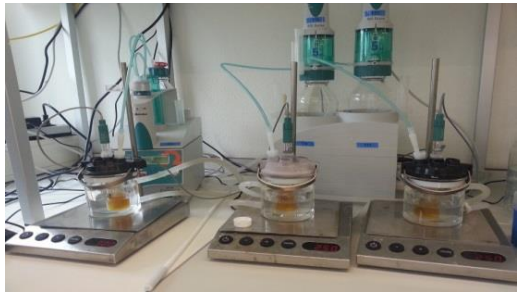
- Soy protein isolate – commercial origin
- Autoclaving for 30 minutes in sealed bags



- 12 treatments in total, 3 replicates/treatment
- Glucose added at 2:1 molar ratio glucose:Lys

What was analysed?

- Degree of hydrolysis – pH-STAT method (Pedersen and Eggum, 1983)
  - Trypsin, chymotrypsin, peptidase
  - Hydrolysis 10 min, pH 8
    - $DH\ (\%) = \frac{Peptide\ bonds\ cleaved}{Total\ number\ of\ peptide\ bonds}$



- Solubility
  - Water (PDI)
  - 0.2% KOH (NSI)

Statistical analysis

- GLM, SAS
- Model
  - Temperature, Moisture, Sugar + Interactions

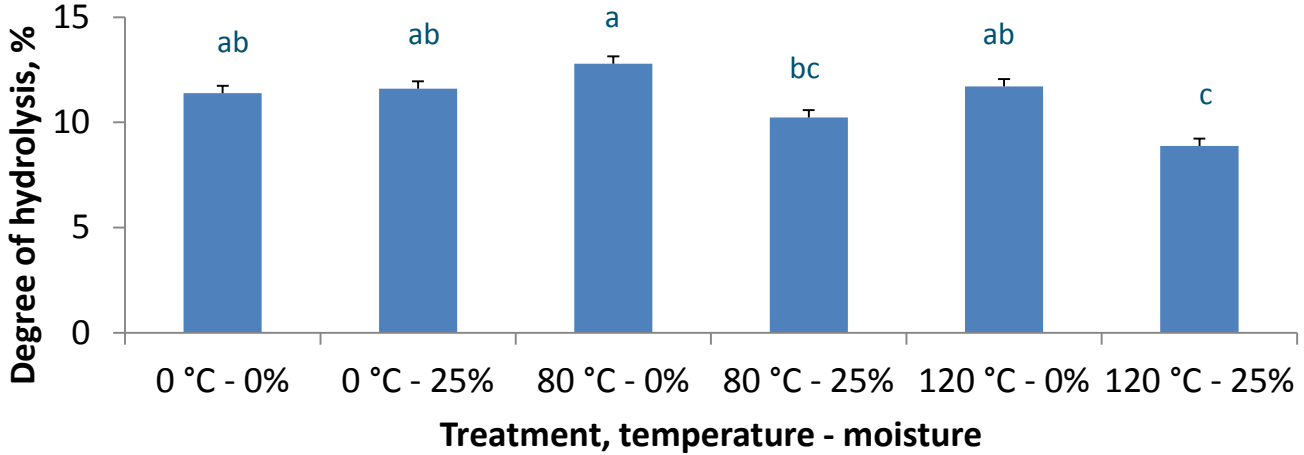
Rate of hydrolysis - *k*

$$DH = \frac{\ln(k \times t + 1)}{b}$$

- Proc MODEL, SAS
- *k* – rate of hydrolysis, *b* – fitting parameter (Butré et al. 2012)

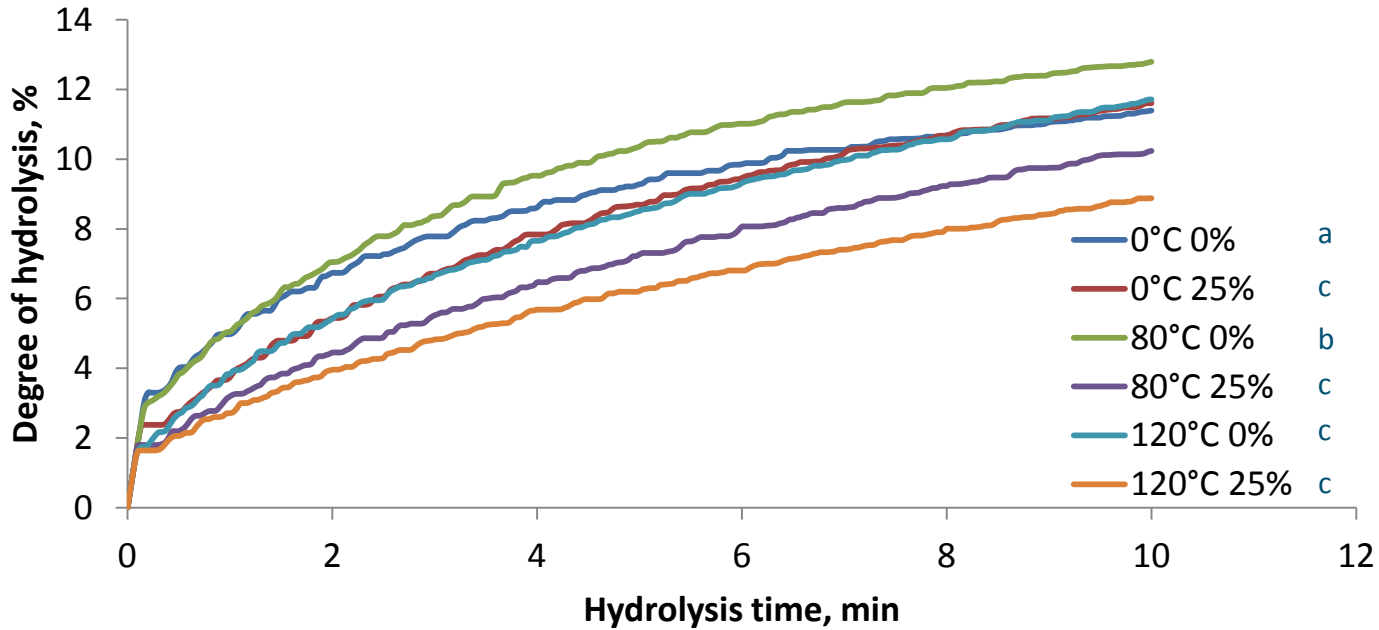
Degree of hydrolysis – 10 min

- Model, $P < 0.001$, $R^2 = 0.78$
  - Temperature, $P = 0.002$
  - Moisture, $P < 0.001$
  - Temperature*Moisture, $P < 0.001$
  - Temperature*Sugar, $P = 0.07$

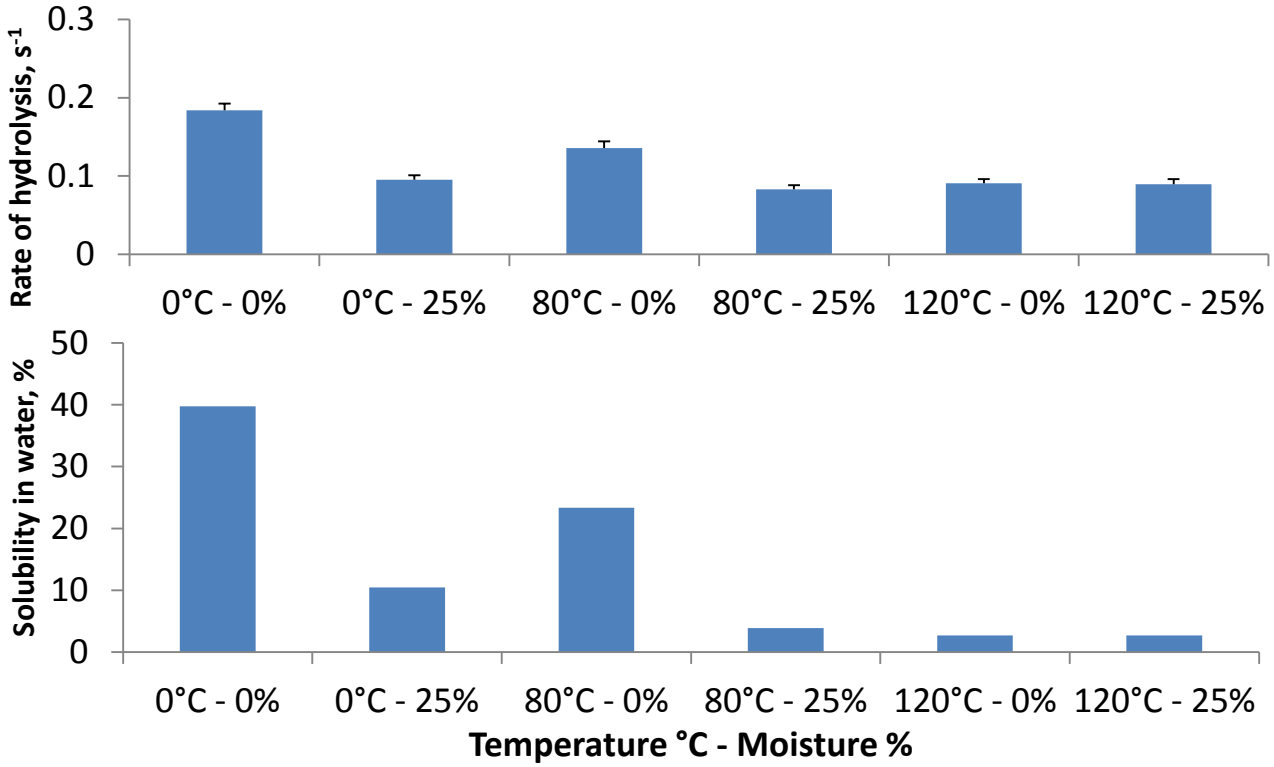


Rate of hydrolysis, *k*

- Model, $P < 0.001$, $R^2 = 0.98$
  - Temperature, $P < 0.001$
  - Moisture, $P < 0.001$
  - Temperature*Moisture, $P < 0.001$

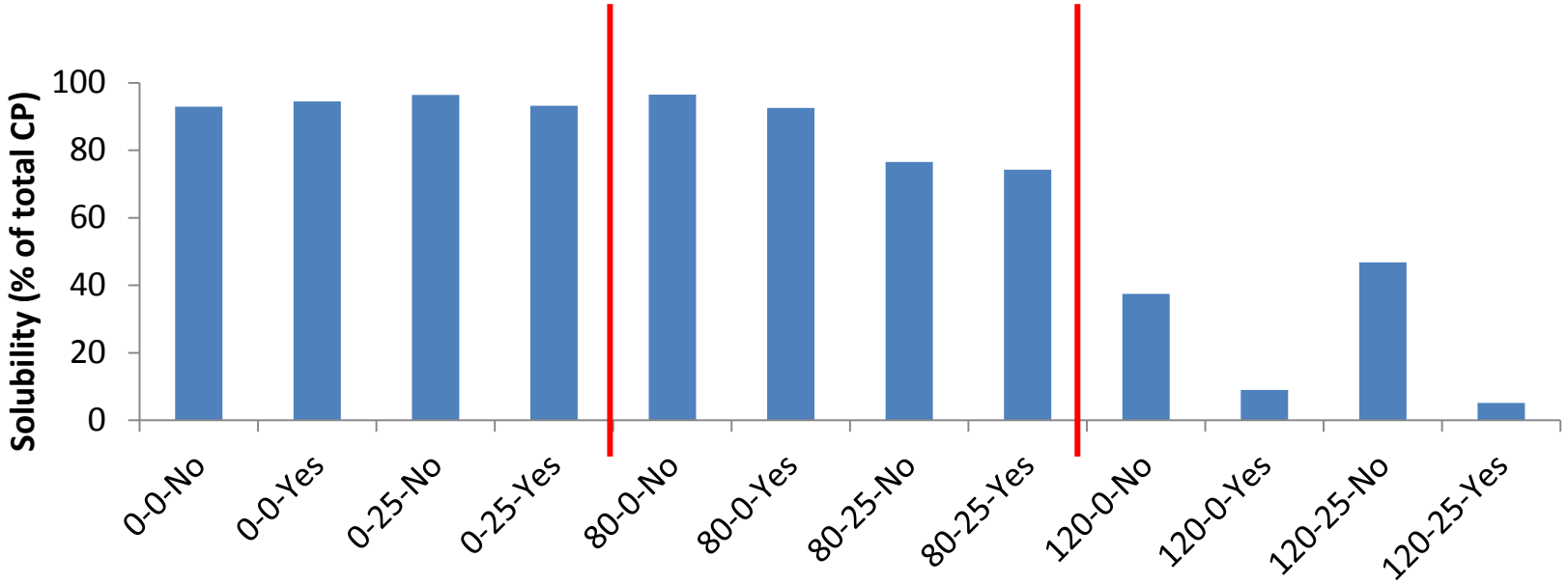


Solubility in water and rate of hydrolysis



Solubility in 0.2% KOH (NSI)

- Temperature*Moisture*Sugar – $P = 0.01$ ($R^2 = 0.99$)



Conclusions

- Temperature and moisture content during autoclaving were the factors with largest influence on extent and rate of proteolysis
- Solubility in KOH was affected by structural and chemical modifications to proteins
- Structural modifications more relevant than Maillard reactions for proteolysis under the conditions of this experiment
- Further characterization
  - Early/advanced MRP: furosine, CML (+LAL)

Acknowledgments

- Sponsors

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Take home message

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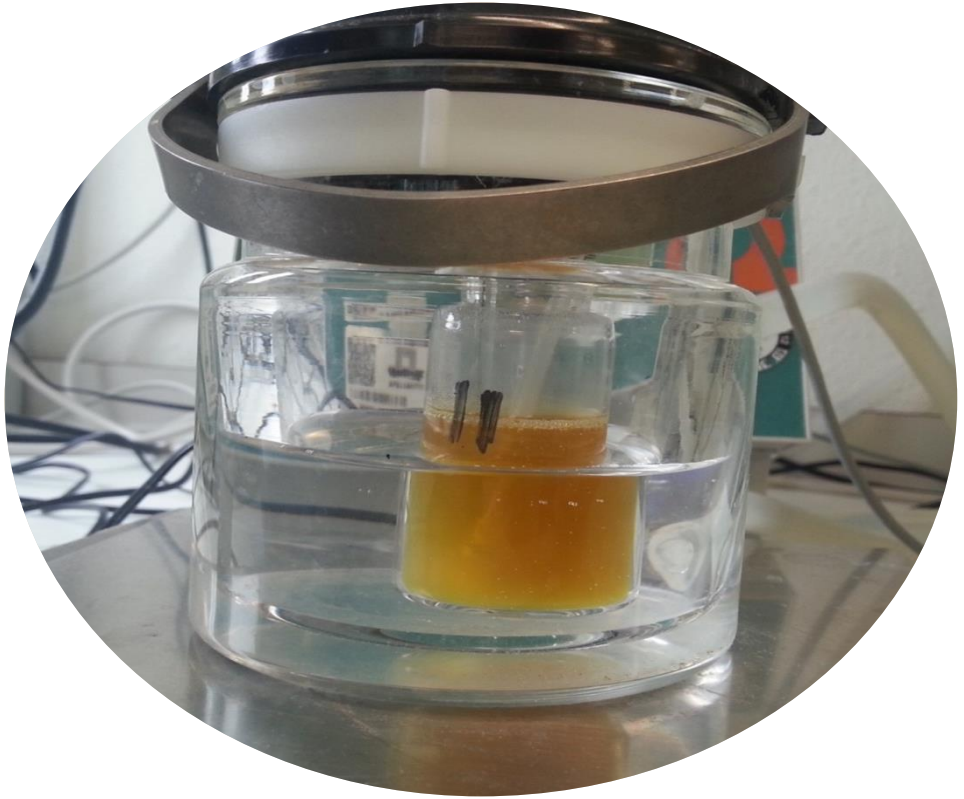
Reduction on extent and rate of proteolysis seems largely affected by structural changes to proteins

Thanks for your attention



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Correlations

	NSI	PDI
DH	r = 0.51 P-value = 0.002	r = 0.41 P-value = 0.01
k	r = 0.52 P-value = 0.001	r = 0.97 P-value <0.001

- Solubility does not seem to explain much of variation in DH, but PDI explains a lot of variation in rate of hydrolysis