Raw material effects and novel control- and optimisation strategies in agri-food valorization

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Nofima – Norwegian institute of Food, Fisheries and Aquaculture research

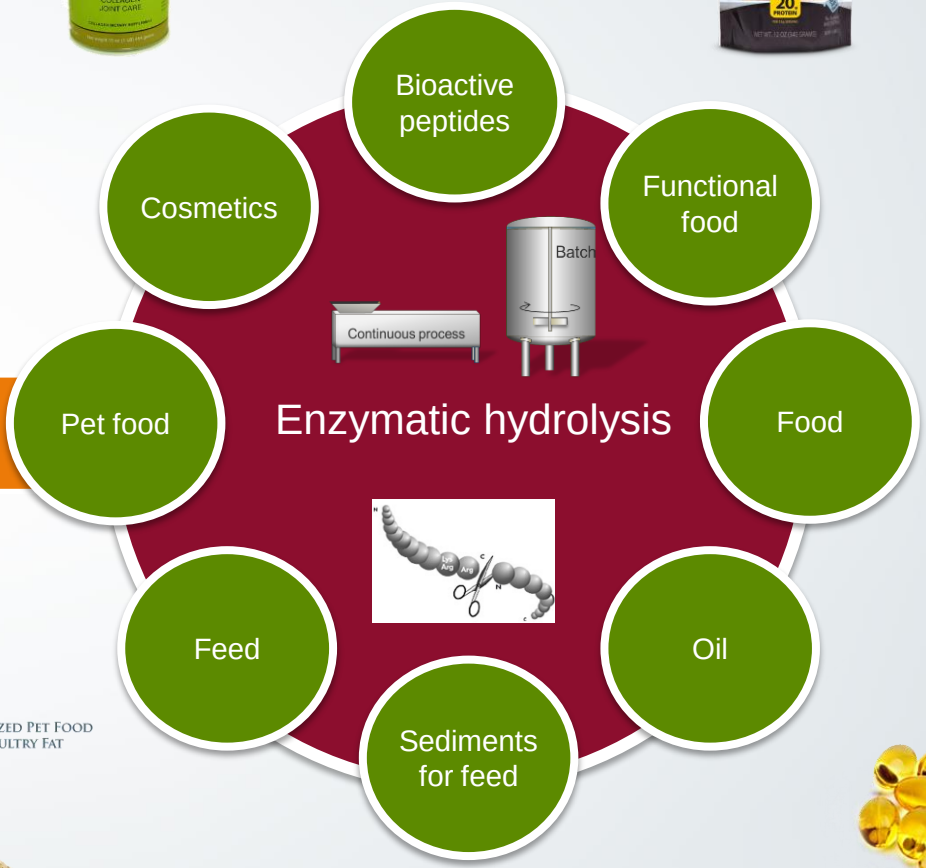
Enzymatic protein hydrolysis in agri-food valorization

Lipids

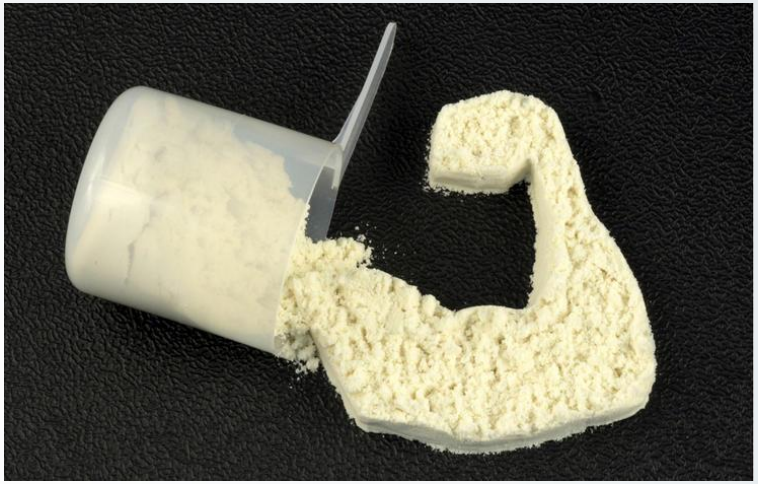
Protein hydrolysate

Unsoluble proteins / sediments

Enzymatic protein hydrolysis in agri-food valorization

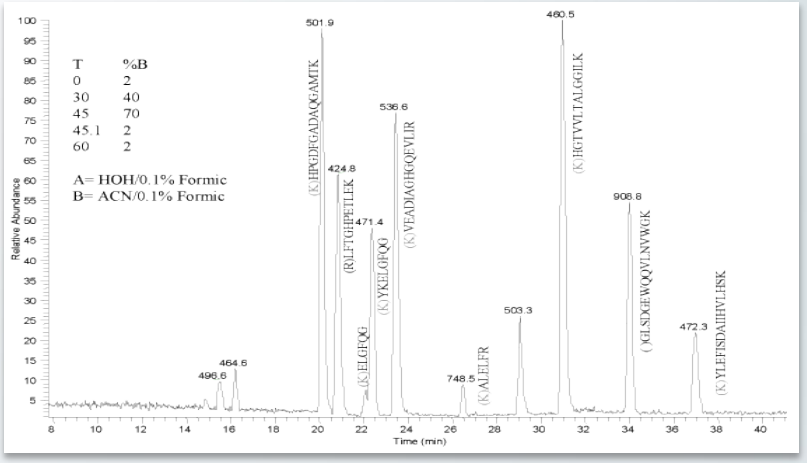


Enzymatic hydrolysis (the simple case)



Single protein digestion:
-Myoglobin (trypsin)

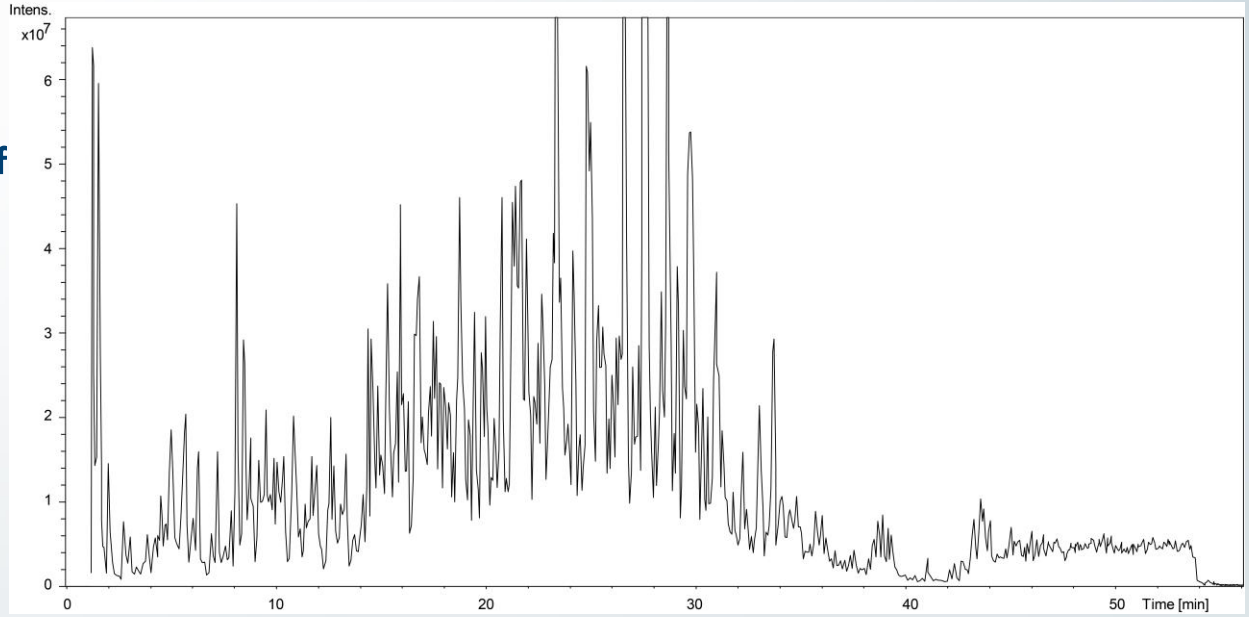
LCMS Chromatogram



http://www.ionsource.com

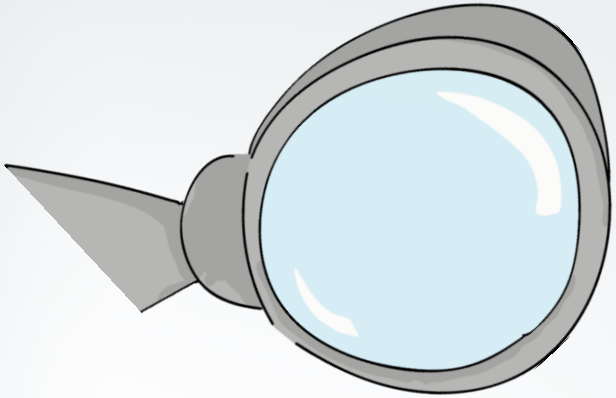
Enzymatic hydrolysis (the real case)

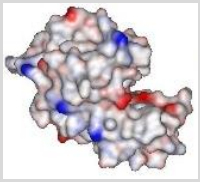
LCMS chromatogram of Hydrolysate from MDC



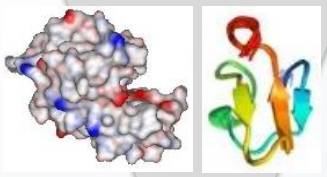
Wubshet, S. G. et al. *Unpublished data,* **2016**

Bioanalytics and protein characterisation

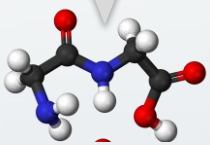




Degree of hydrolysis – OPA / TNBS etc.

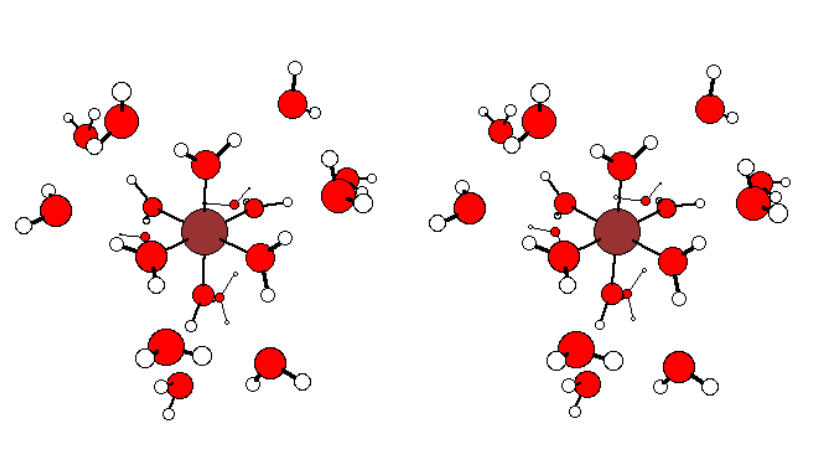


Size distributions – size exclusion chromatography



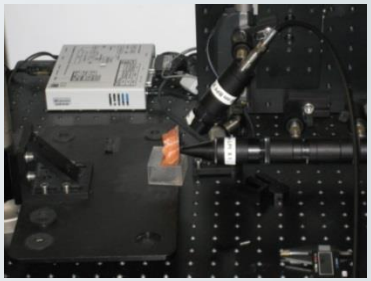
Detailed characterization – LCMS / NMR

Rapid and non-destructive spectroscopic measurements



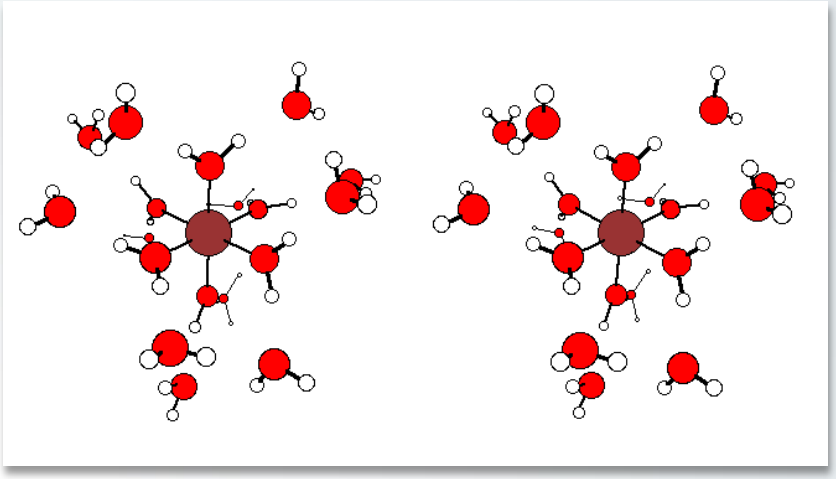
NIR spectroscopy

FTIR spectroscopy

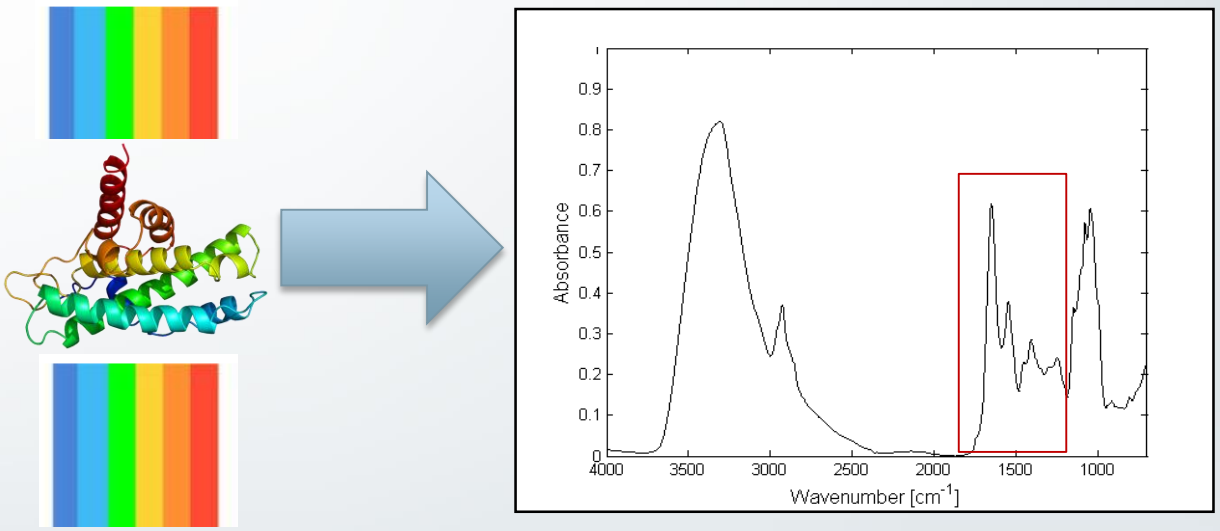


Raman spectroscopy

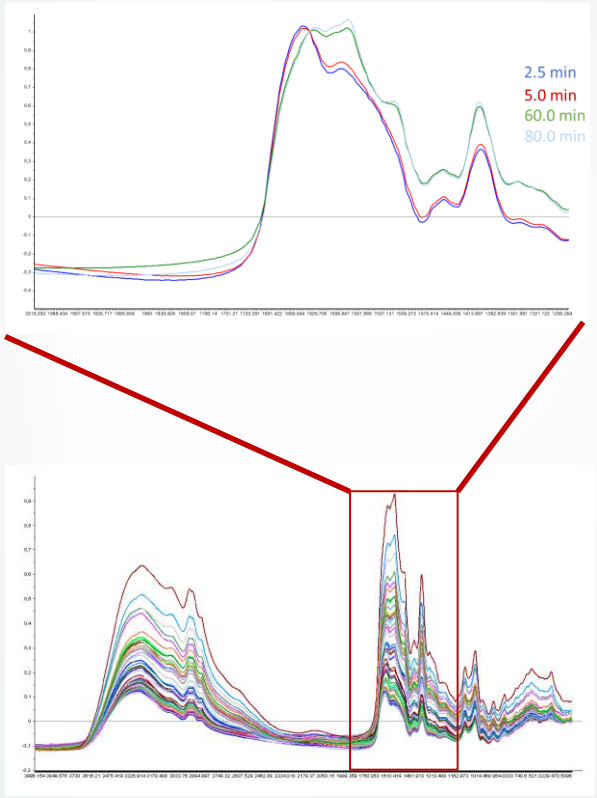
FTIR provides a biochemical fingerprint



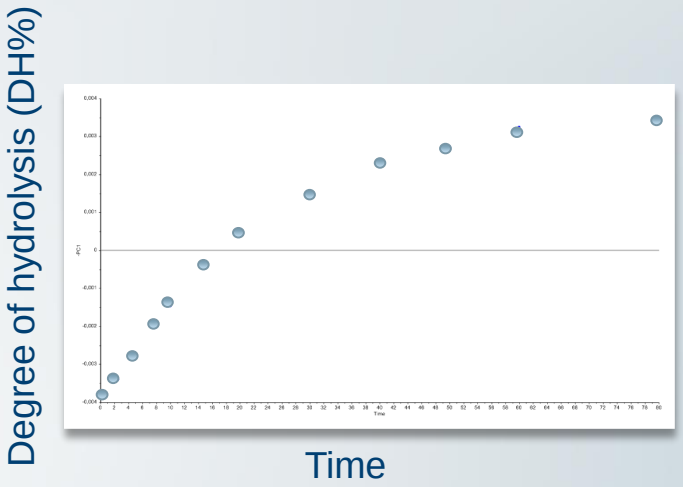
Qualitative and quantitative information on protein structure



FTIR for monitoring enzymatic protein hydrolysis

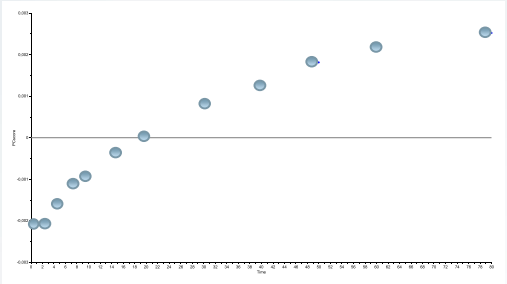


FTIR spectra

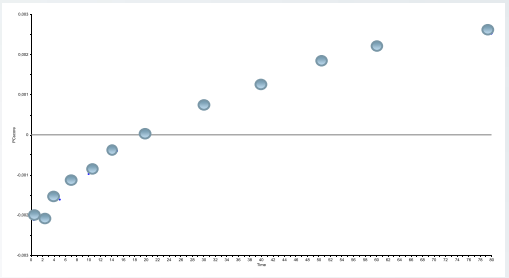


Average protein size estimation / Degree of Hydrolysis (DH%)

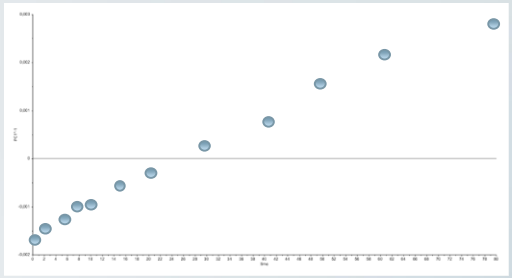
FTIR for monitoring enzymatic protein hydrolysis



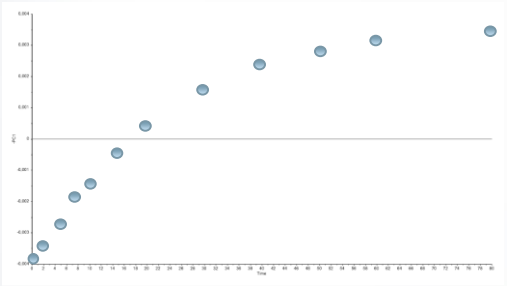
Chicken muscle



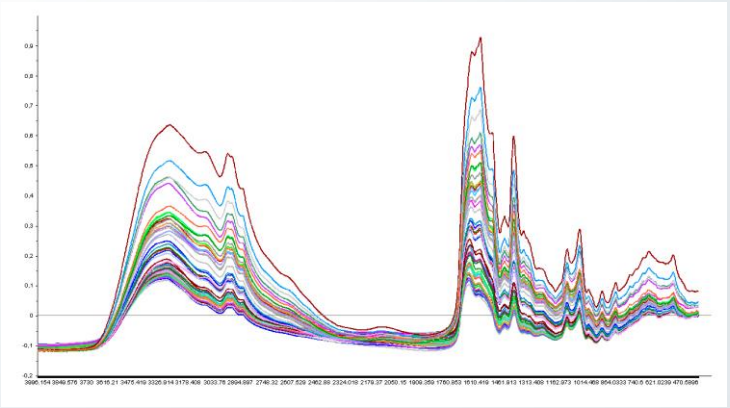
Salmon muscle



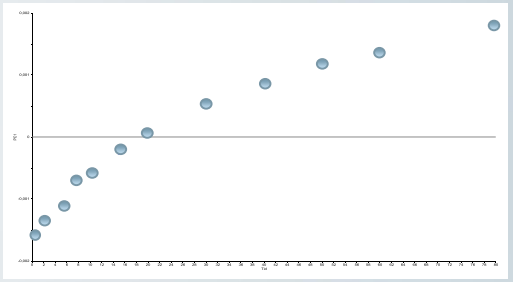
Salmon heads



Chicken by-products



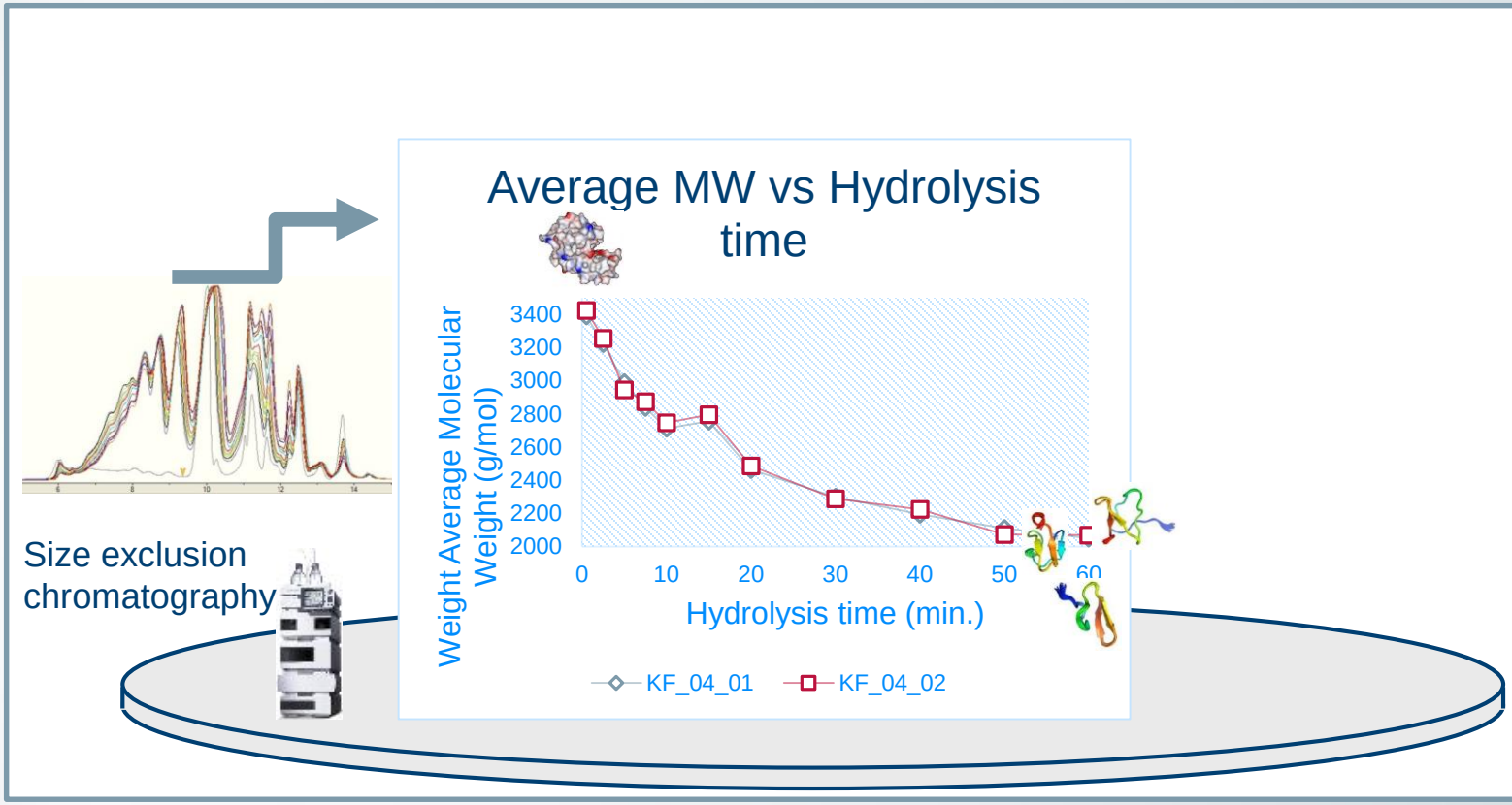
FTIR spectra - Chicken by-products



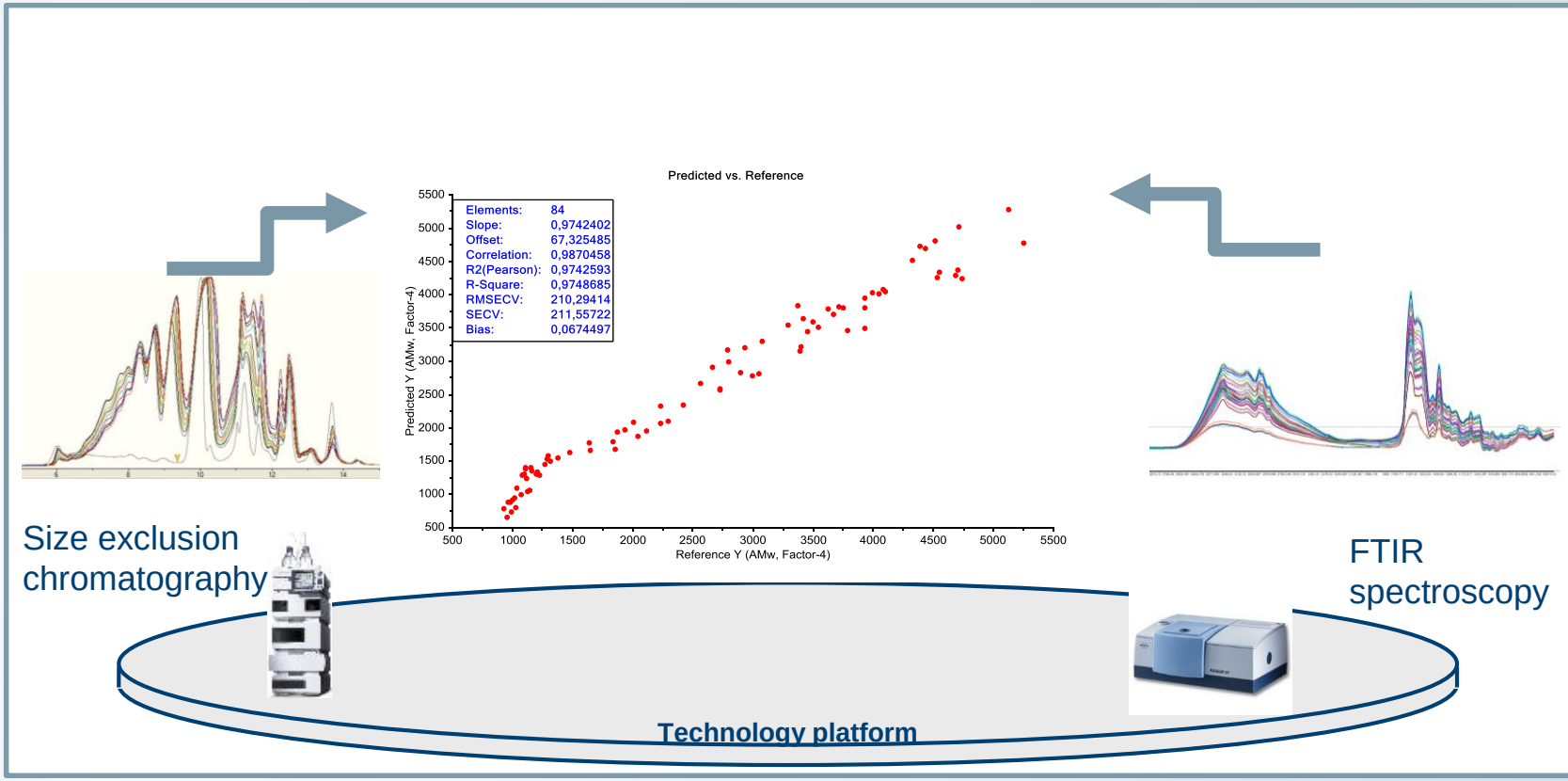
Salmon backs

Ref:
Böcker, U., Wubshet, S., Måge, I., Lindberg, D., and Afseth, N.K. Fourier-transform Infrared spectroscopy for qualitative characterization of protein chain reductions in enzymatic hydrolysis, submitted manuscript.

Quantitative monitoring of enzymatic protein hydrolysis

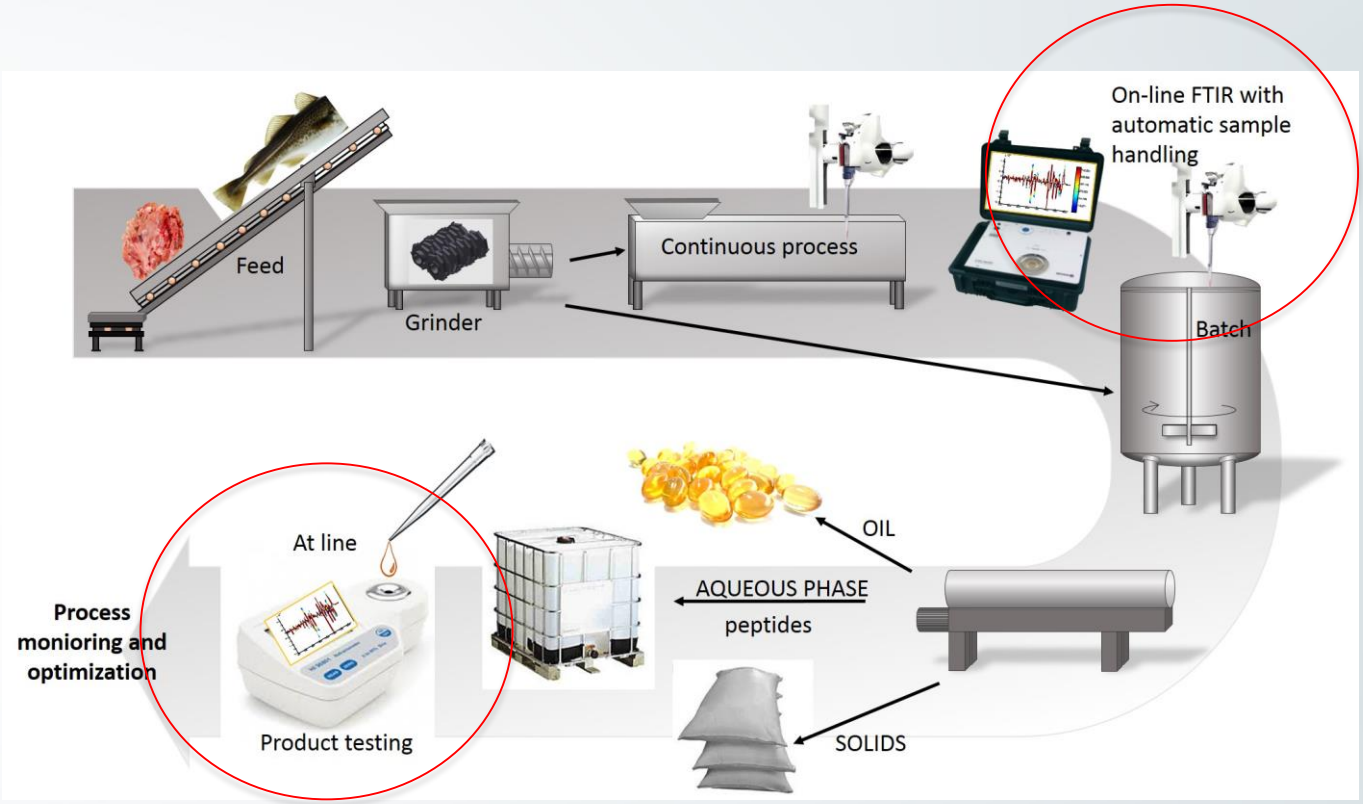


Quantitative monitoring of enzymatic protein hydrolysis



Refs:
Wubshet, S., Måge, I., Bocker, U., Lindberg, D., Knutsen, S.H., Rieder, A., Airado-Rodriguez, D. & Afseth, N.K.. FTIR as a rapid tool for monitoring enzymatic protein hydrolysis of food processing by-products, submitted manuscript.

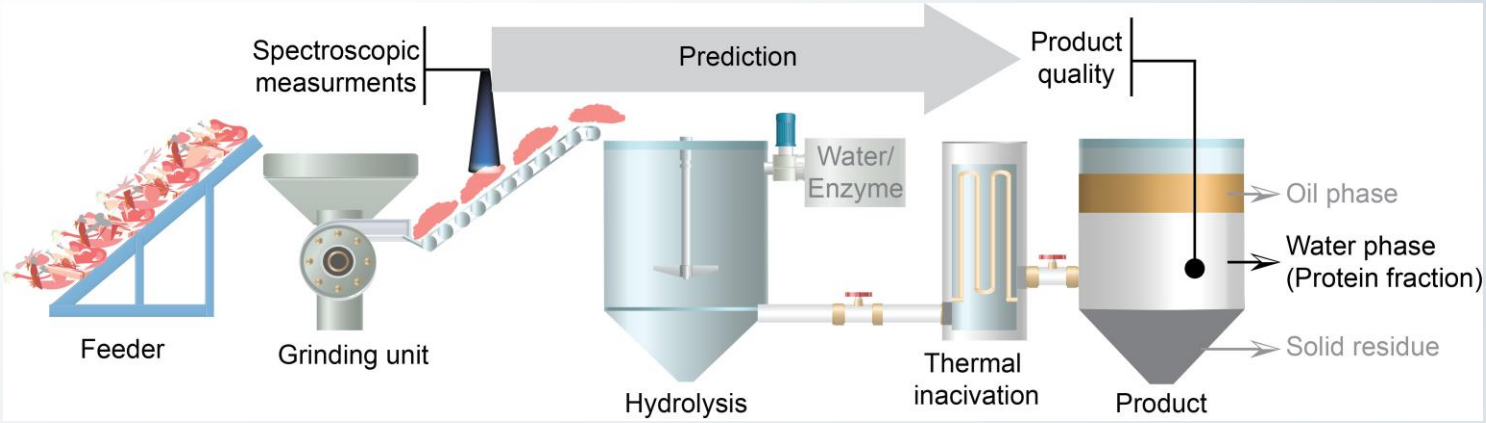
A spectroscopic platform for control and optimisation of biotech processes



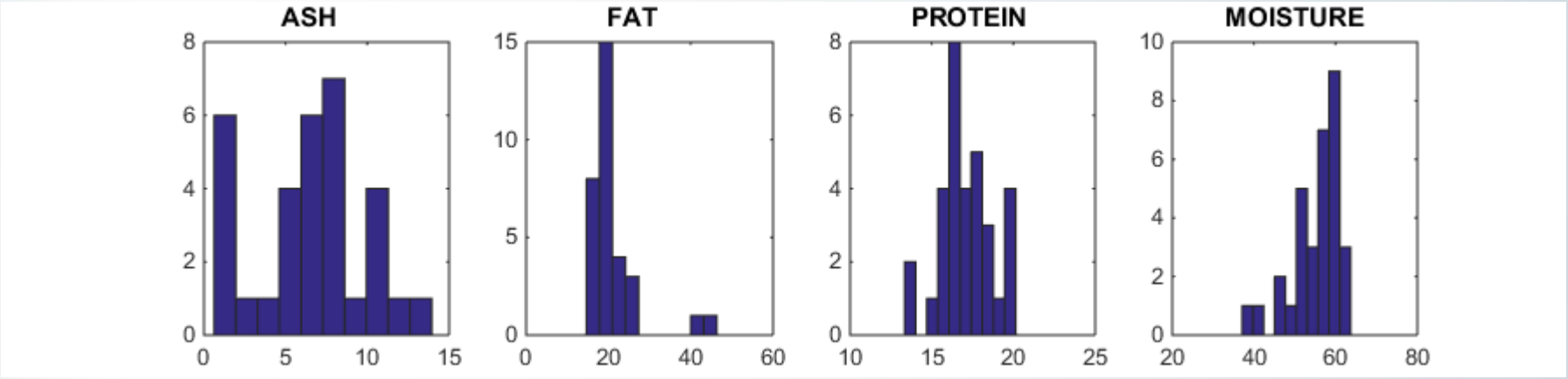
Projects:

- LiqIR – Project leader: Prediktor (2015 – 2017) - Funded by the Regional research fund "Oslofjordfondet", with Biomega, Nutrimar, VEAS, and SINTEF ICT

Prediction of hydrolysis outcome based on raw material analysis



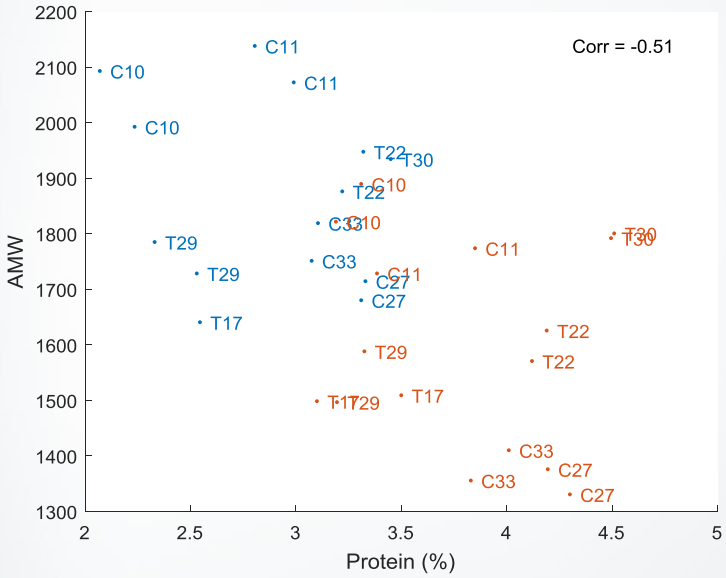
Prediction of hydrolysis outcome – the chicken and turkey case

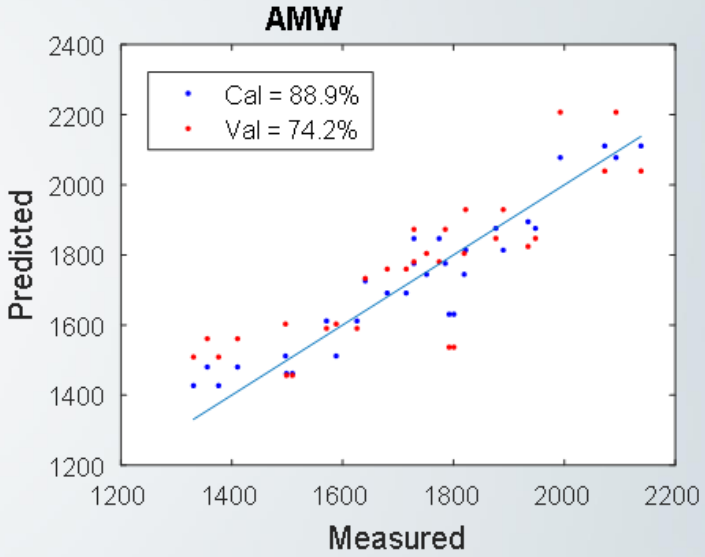


32 samples of chicken and turkey rest raw materials were collected at Nortura Hærland, spanning variation in chemical composition

End-product quality prediction

By-product-characterisation (spectroscopy) + processing conditions:

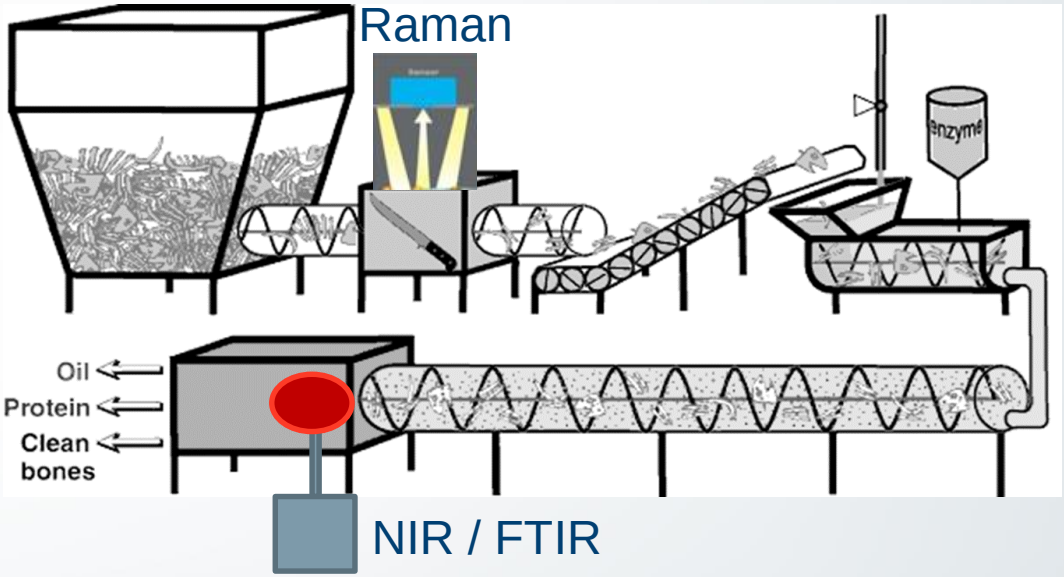




(AMV = Average molecular weight measured by SEC)

Future protein hydrolysis – raw material variation can be handled using spectroscopy

Raw material properties
measured by spectroscopy



Process settings
- Hydrolysis time

End-product quality
Protein yield
Average Molecular Weight

Refs:
Wubshet, S. et al., Spectroscopic process monitoring in enzymatic protein hydrolysis of byproducts: A strategy for stable product quality, manuscript.

Future agri-food valorisation

Sensory, consumer and market

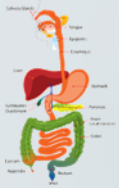

Paula Tomasco

Themis Altintzoglou

Industry-scale processing


Ragnhild Whitaker

Åge Oterhals



In vitro digestion and bioactivity


Bente Kirkhus

Sissel Rønning

Grain utilisation

Stefan Sahlstrøm

Fruits, berries and vegetables

Grethe Iren Borge

Raw materials quality


Eva Veiseth

Rune Rødbotten

Fermentation


Lars Axelsson

Dimi Tsimorotas

Lipid utilisation

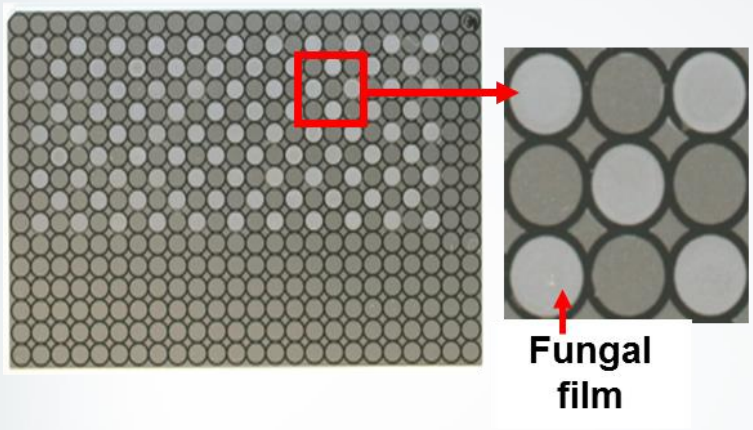
John-Erik Haugen

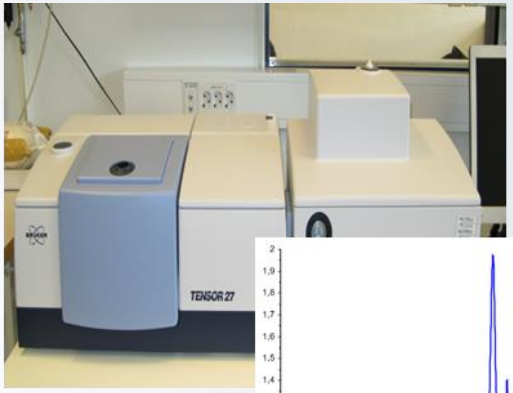
Sediment utilisation

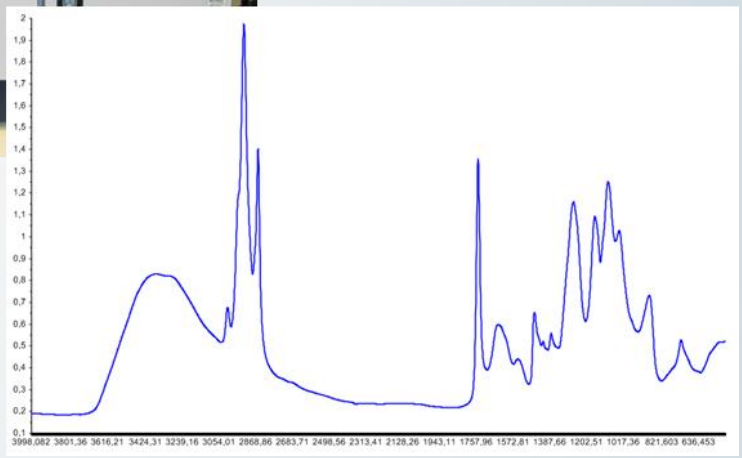

Sissel Albrigtsen

Tone Aspevik

Identification, optimization and screening of microbial oils grown on agrifood rest raw materials







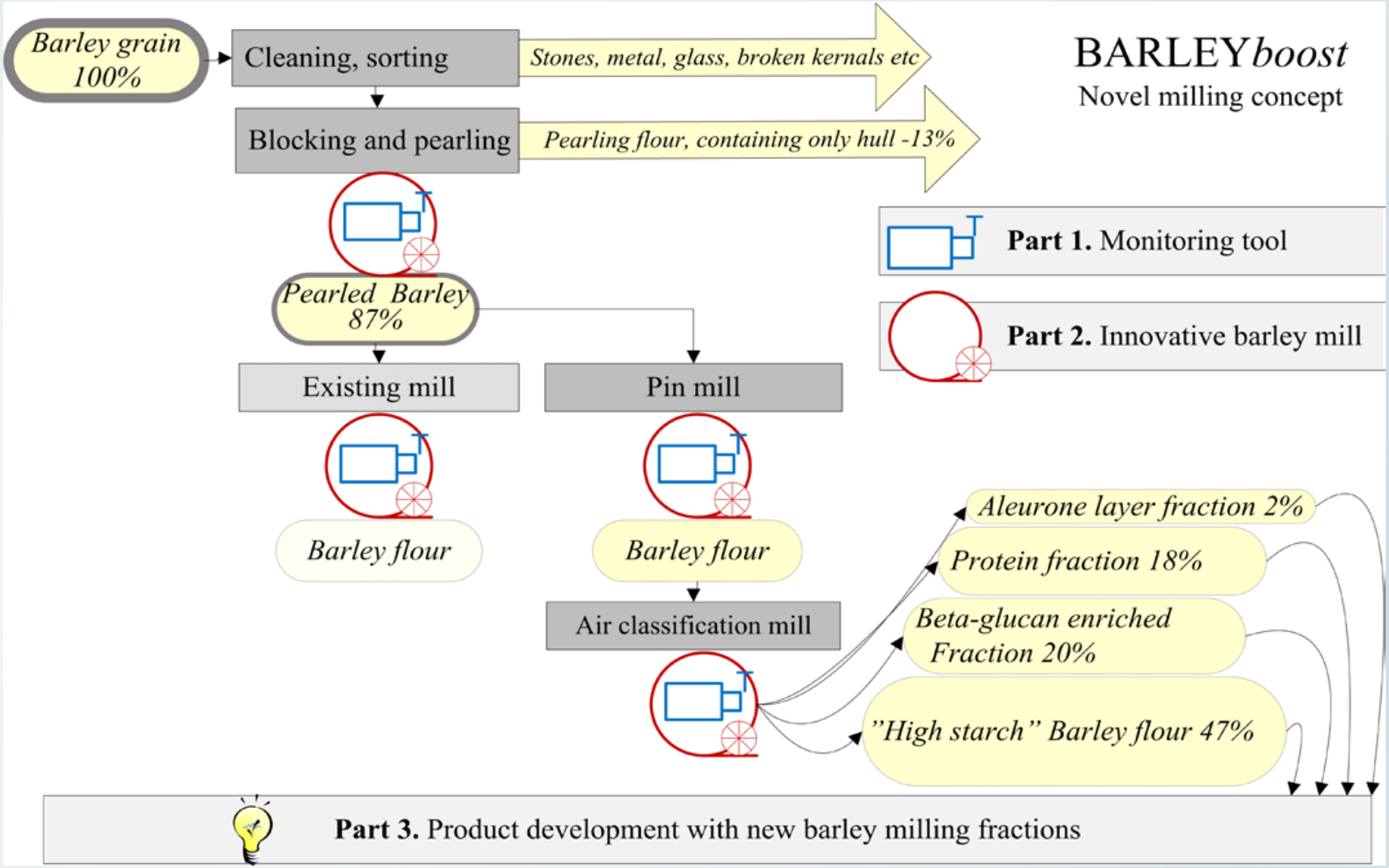
FTIR spectrum of *M. circinelloides* producing microbial oils

Interrest and SingleCellOil projects

Lars Axelsson

Dimi Tsimorotas

Ref:
Shapaval, Volha; Afseth, Nils Kristian; Vogt, Kjell Gjermund; Kohler, Achim. Fourier transform infrared spectroscopy for the prediction of fatty acid profiles in Mucor fungi grown in media with different carbon sources. *Microbial Cell Factories* 2014 ;Volume 13. p. 86



Stefan Sahlstrøm

Jens Petter Wold

Concluding remarks

- Controlling and handling rest raw material complexity and variation is essential for future valorisation

- Industrial analytical tools are key factors in producing protein products of defiend qualities (e.g. sensorial, functional or bioactive properties) for higher paying markets:
  - Flexible processing for dealing with rest raw material heterogeneity and variations (e.g. depending on season or pre-production steps)
  - Possibilities for real-time process adjustments

Sustainable use of rest raw materials through development of profitable industrial processes and products

Acknowledgements

- Industry collaboration:
  - Norilia, Nortura, Biomega and Nutrimar
- Research collaboration:
  - SINTEF FA, SINTEF ICT and NMBU
- Funding from The Norwegian Research Council, Oslofjordfondet, the foundation for Research levy on Agricultural Products, and EU:
  - «HydrolyseMonitor», led by Nofima
  - «Chickenlysis», led by Nortura
  - «LiqIR», led by Prediktor
  - «Cycle», led by Sintef FA
  - «Interrest», led by Nofima
  - «SingleCellOil», led by NMBU
  - «BarleyBoost», led by Nofima
  - «Multiblock», led by Nofima
  - «Food quality imaging», led by Nofima

Nofima centre of excellence

SPECTEC

Rapid and non-destructive measurements for process optimisation

Leader: Jens Petter Wold

PEPTEK

A characterisation and processing plattform for future protein production

Leader: Ragnhild Whitaker