Analysesystemer for fremtidens proteiningrediensproduksjon

JOSIPA MATIC

FORSKER

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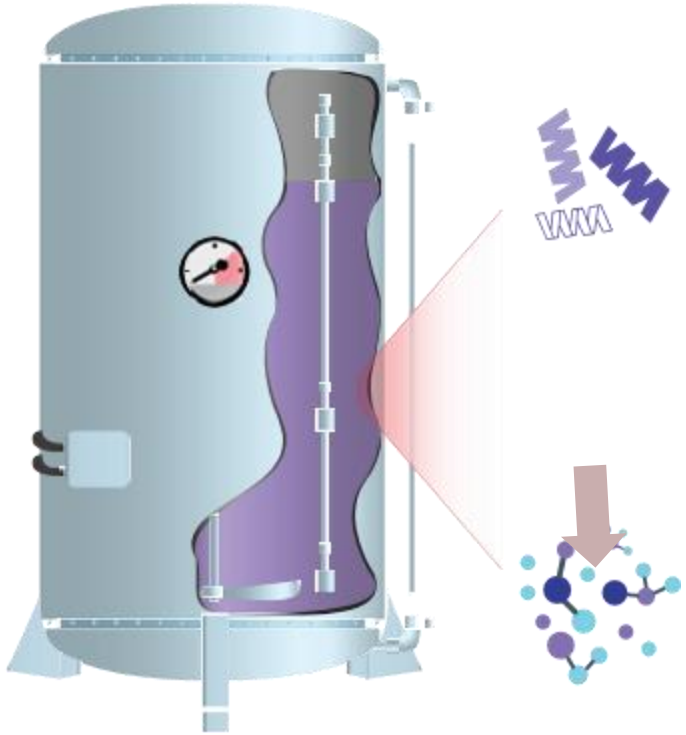
Nofima – Norwegian Institute of Food, Fisheries and Aquaculture Research, Ås, Norway

Enzymatic Protein Hydrolysis



A scalable biotechnological solution for recovery of valuable ingredients in protein rich biomasses

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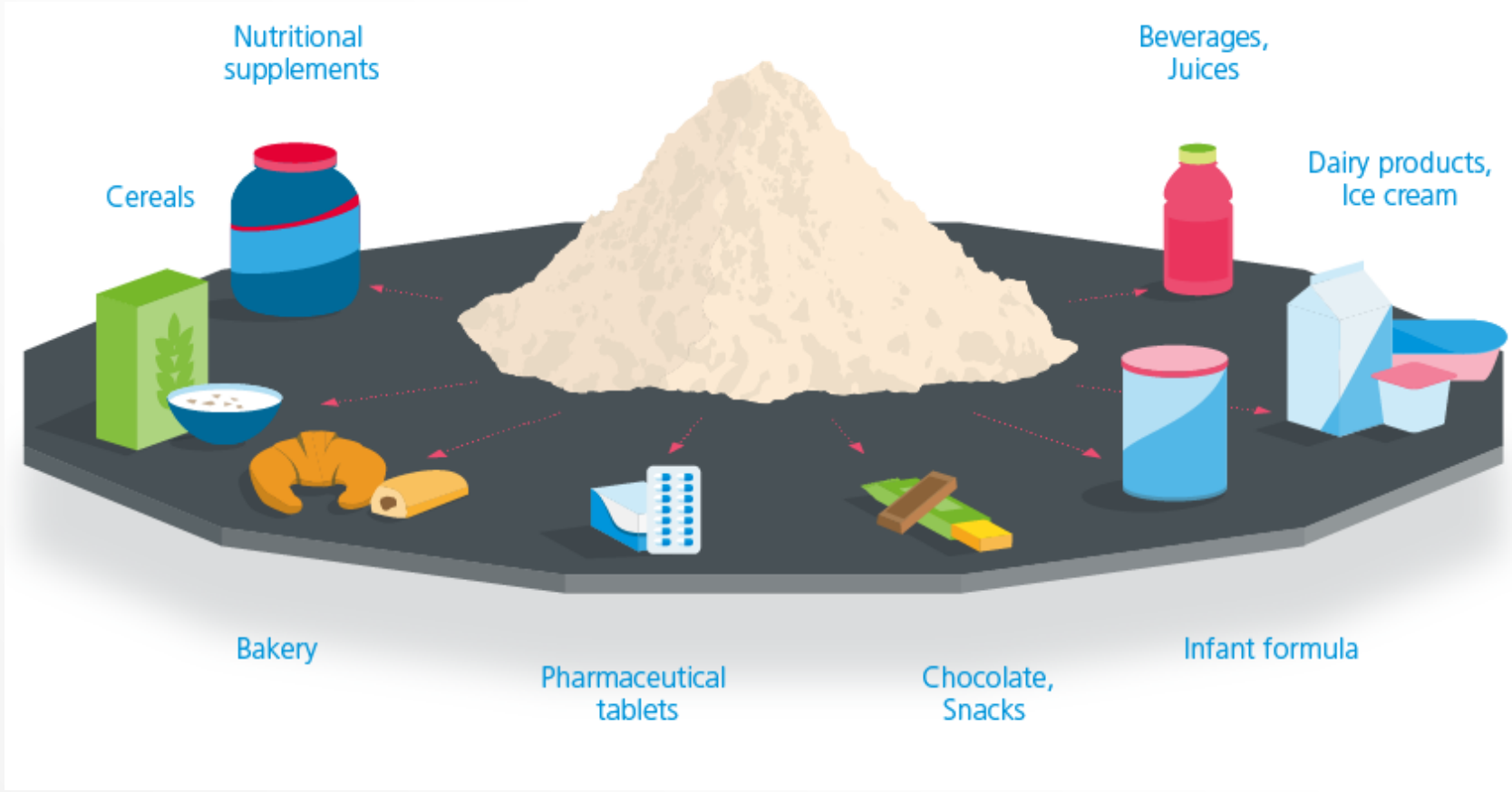
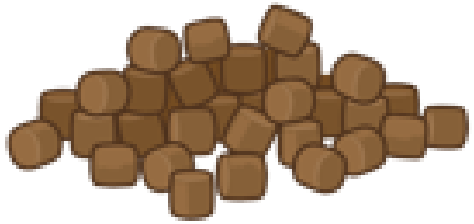
Application areas





Barriers:
Large variations in raw material and product quality

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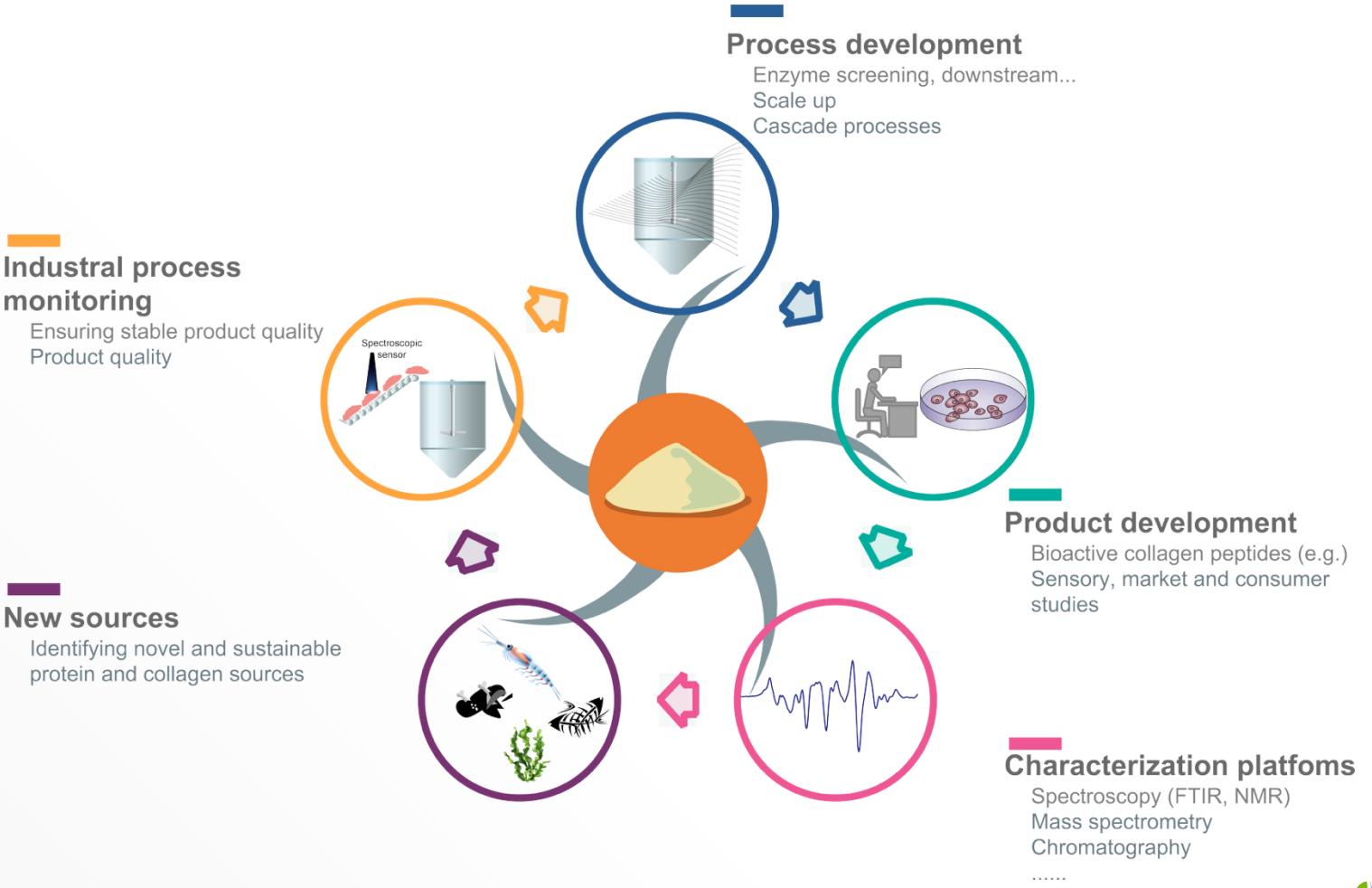
Overview of Nofima's activities on EPH

A summary of enabling technologies for process and product development



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Overview of Nofima's activities on EPH

A summary of enabling technologies for process and product development

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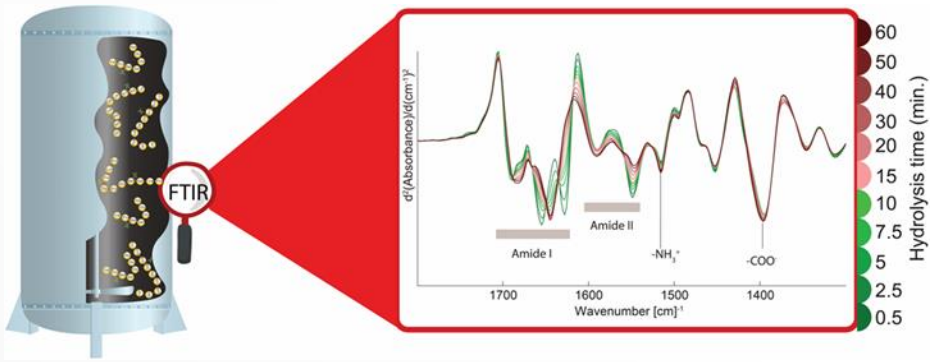
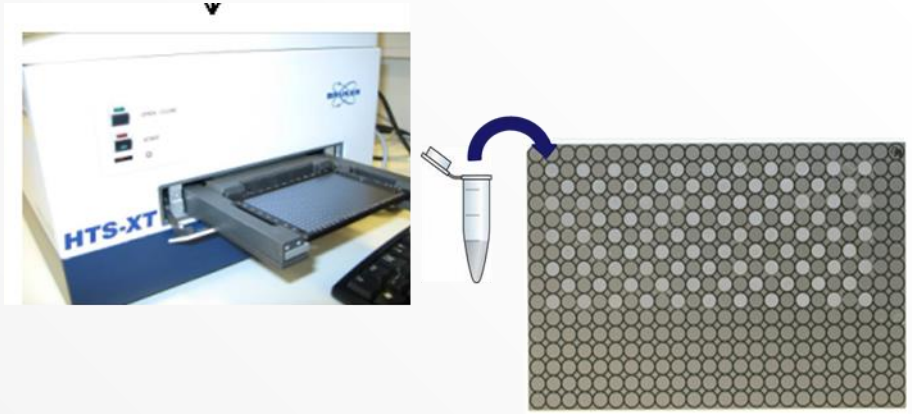
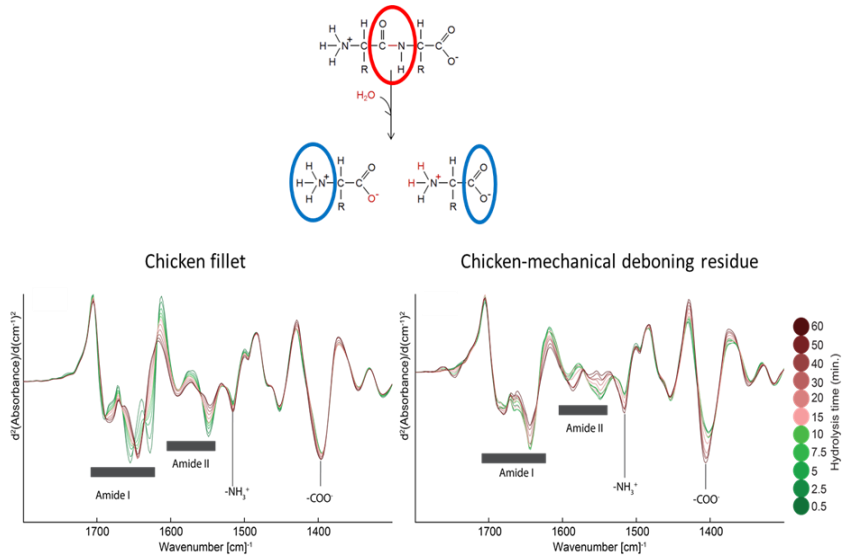
Product characterisation – FTIR spectroscopy







Product features

- Average molecular weights
- Peptide size fractions
- Collagen contents
- Product fingerprinting / benchmarking

Wubshet, S.G., et al., FTIR as a rapid tool for monitoring molecular weight distribution during enzymatic protein hydrolysis of food processing by-products. Analytical Methods, 2017, 9(29), 4247-4254.

Kristoffersen, K.A. et al., Average molecular weight, degree of hydrolysis and dry-film FTIR fingerprint of milk protein hydrolysates: Intercorrelation and application in process monitoring, Food Chemistry 2020, 310, 125800.

Måge, I. et al., Fourier-transform infrared (FTIR) fingerprinting for quality assessment of protein hydrolysates, LWT – Food Science and Technology, 152 (2021), 112339.

Kristoffersen, K.A. et al., FTIR-based prediction of collagen content in protein hydrolysates, accepted for publication, Spectrochimica Acta Part A, 2023.

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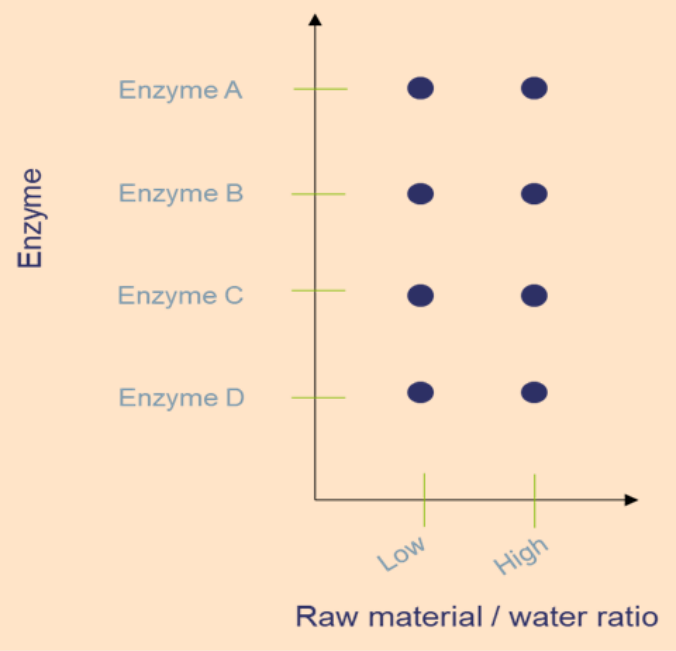
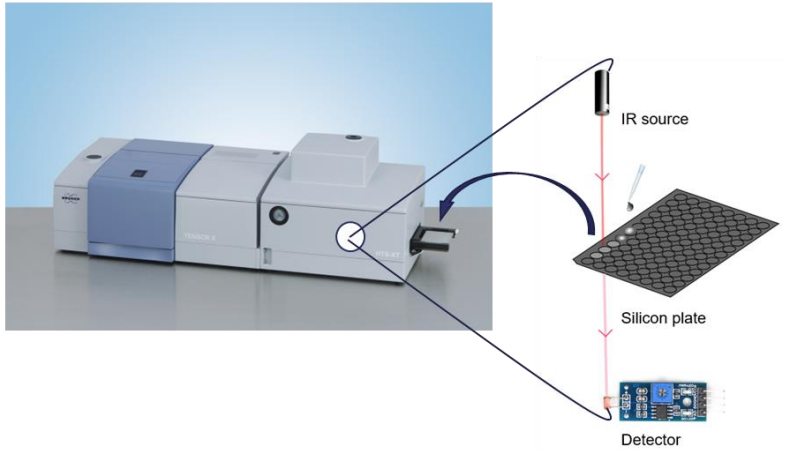
Characterisation of an industrial hydrolysis process (BIOCO) using FTIR spectroscopy

Industrial design – 1 enzyme per week



Industrial sampling – 463 samples

FTIR analysis and modelling



Dry film FTIR analysis of protein hydrolysate samples

- Enzyme type
- Raw material composition (chicken / turkey)
- Raw material / water ratio

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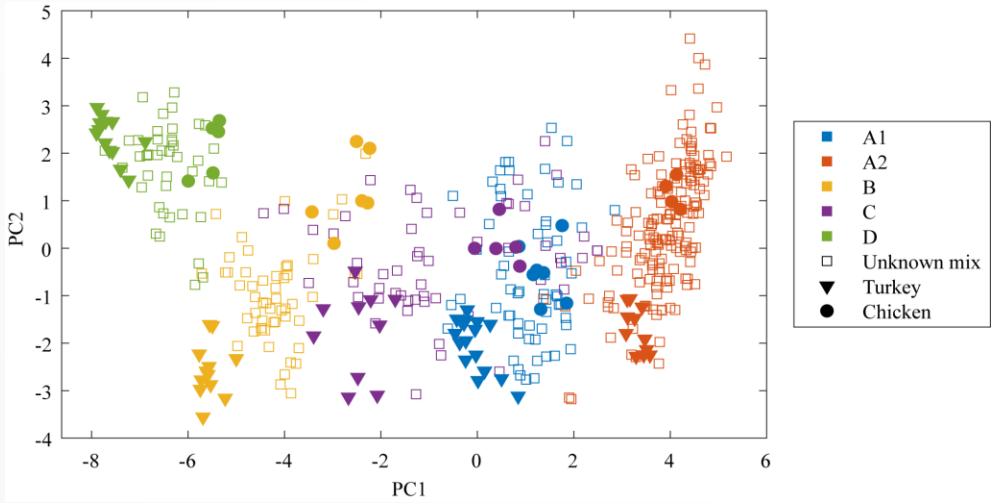
Kafle, B. et al., From laboratory to industrial use: Understanding process variations during enzymatic protein hydrolysis with dry-film Fourier-transform Infrared spectroscopy, Food Control, 2023, 164(3), 110577.

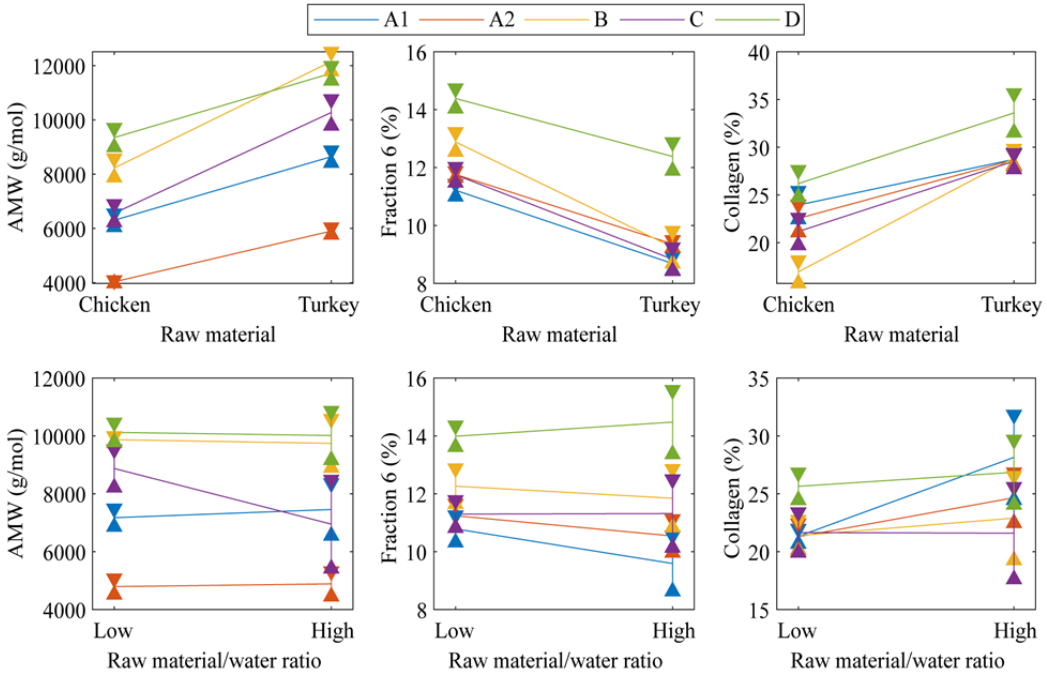
FTIR reveal qualitative and quantitative features of the industrial process

Qualitative analysis



The FTIR spectra reveal qualitative information on how product qualities (e.g., distributions and collagen contents) are affected by enzyme type and raw material variations

Quantitative analysis



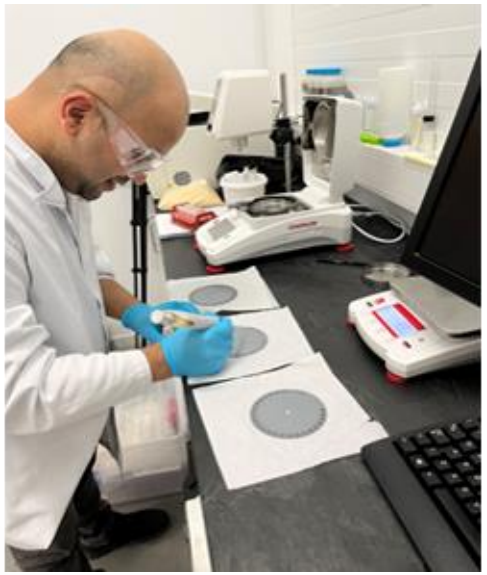
FTIR spectra were used to predict size distributions and collagen contents of all samples.

ANOVA analysis of predictions show clear effects of raw material and enzyme variations

ANOVA analysis of predictions show no effect of raw material / water ratios

Kafle, B. et al., From laboratory to industrial use: Understanding process variations during enzymatic protein hydrolysis with dry-film Fourier-transform Infrared spectroscopy, Food Control, 2023, 164(3), 110577.

A portable protein characterization system for industrial use (Bumble Bee)



Industrial trouble shooting
Process development
Product testing

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Kafle, B. et al., A portable dry film FTIR instrument for industrial food and bioprocess applications, Analytical Methods, 2024, 16(26).

Smart Sensing Platform for Protein and Peptide Analysis

SmartSense 4Proteins

Guts

Offcuts

biomega

Enzymatic Protein Hydrolysis

Oil phase

Water phase

Solid

Proteins & Peptides

Sample analysis

Tunable laser spectrometer

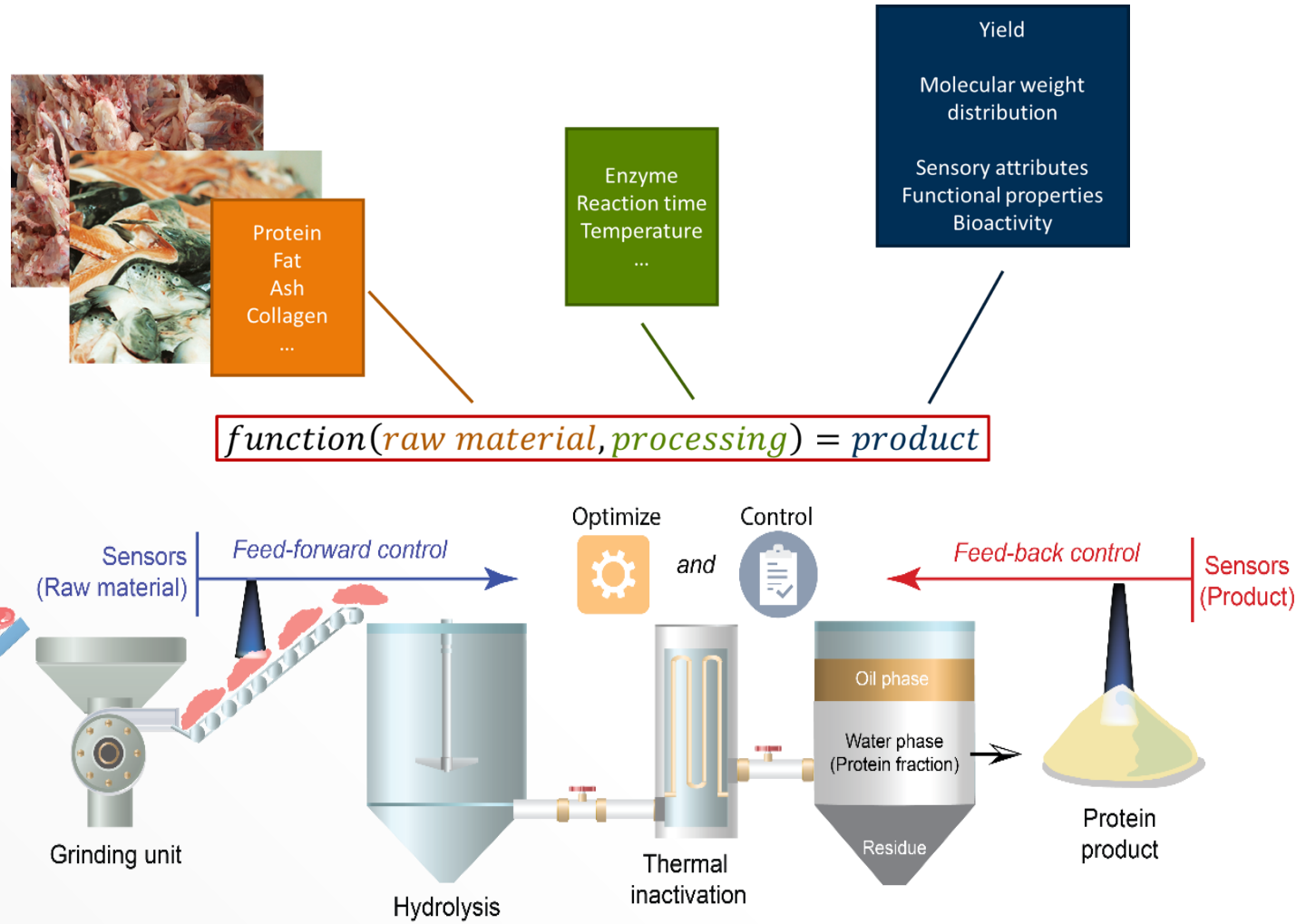
Objective

- Raw materials optimization
- Process monitoring
- Product quality control

NFR 353091

biomega Nofima Justervesenet NORSUS Norsk institutt for bærekraftsforskning universität ulm NMBU Norges miljø- og biovitenskapelige universitet

Spectroscopic process optimization?



Måge, I. et al, The role of biospectroscopy and chemometrics as enabling technologies for upcycling of raw materialsfrom the food industry, Analytica Chimica Acta 2023, 1284(1), 342005.

Raw material variation (Biomega and Bioco)

Inline near-Infrared spectroscopy (Biomega)

- Fat content
- Water content
- Protein content

Inline Raman spectroscopy (Bioco)

- Fat content
- Protein content
- Ash content
- Collagen content

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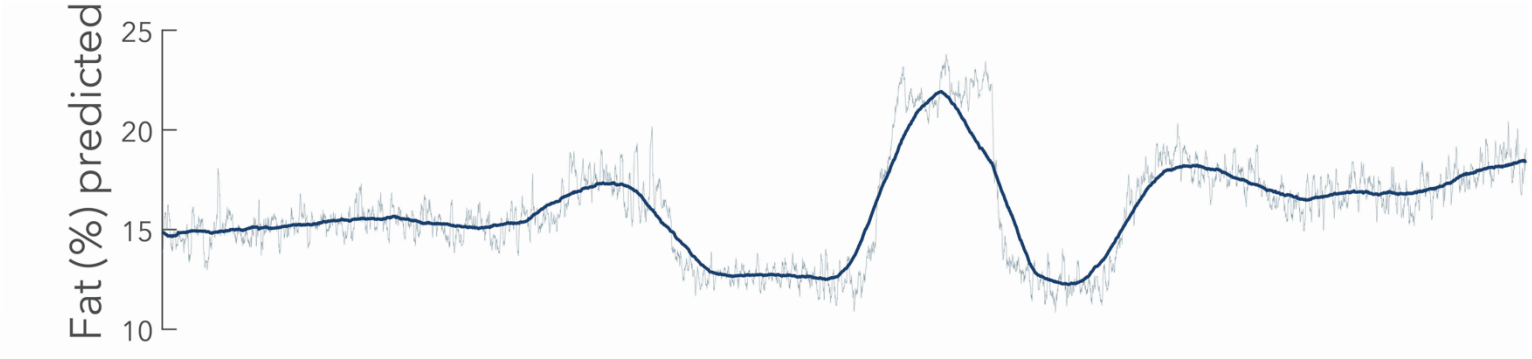
Lintvedt, T.A., Andersen, P.V., Afseth, N.K., and Wold, J.P., In-line Raman spectroscopy for characterization of an industrial poultry raw material stream, Talanta, 2023, 266(17), 125079.

Raw material variations impacts product at industrial scale (Bioco)

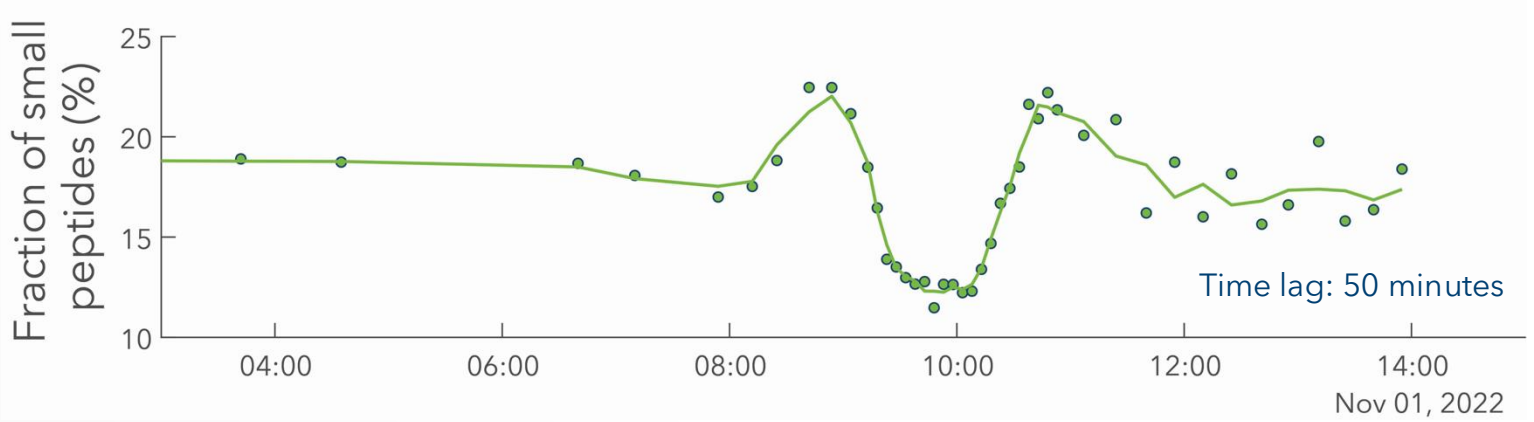
NIR predicted fat contents

Raw material
Predicted fat content (NIRS)



SEC predicted hydrolysate quality

Corresponding product samples
Fraction of product hydrolysate with molecular weight below 700 g/mol (SEC)



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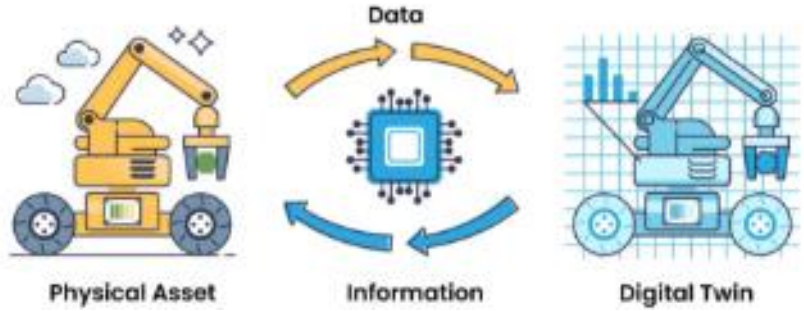
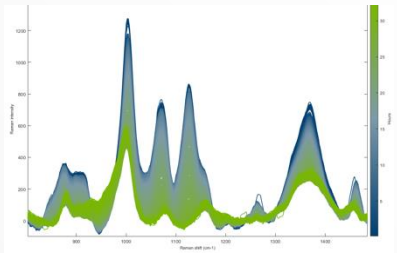
Måge, I. et al, The role of biospectroscopy and chemometrics as enabling technologies for upcycling of raw materialsfrom the food industry, Analytica Chimica Acta 2023, 1284(1), 342005.

An EPH digital twin?



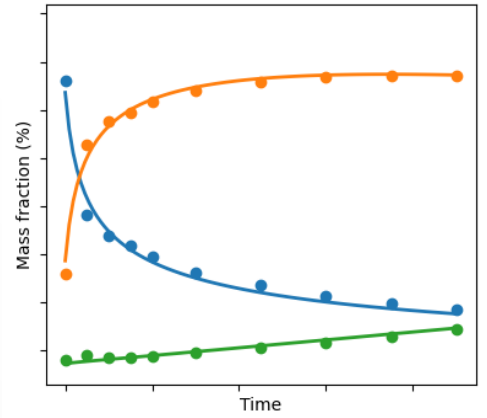
Sensor data



$$\frac{dF_1}{dt} = -k_1 F_1^{n_1}$$

$$\frac{dF_2}{dt} = \alpha\left(k_1 F_1^{n_1}\right) - k_2 F_2^{n_2}$$

$$\frac{dF_3}{dt} = (1-\alpha)\left(k_1 F_1^{n_1}\right) + k_2 F_2^{n_2}$$



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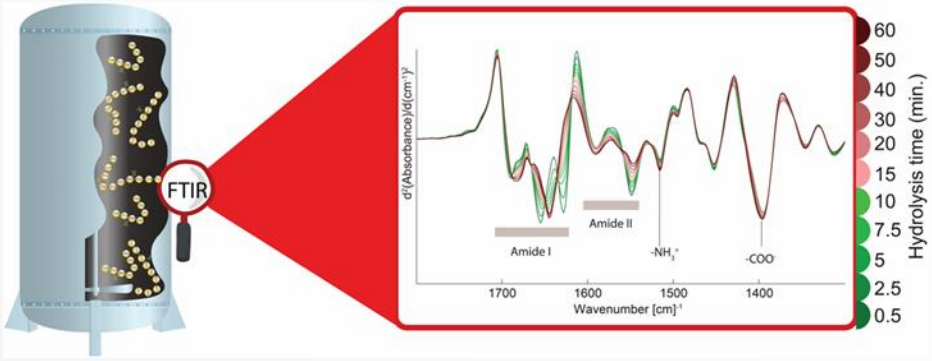
Outlook

- We are developing analytical solutions that are relevant for protein ingredient producers

- We are currently developing optimisation approaches based on these and other analytical solution
  - Our next target is industrial optimisation of enzyme dosaging

- Laboratory and industrial analytics enable process understanding, optimisation possibilities and the possibility to develop new processes and products



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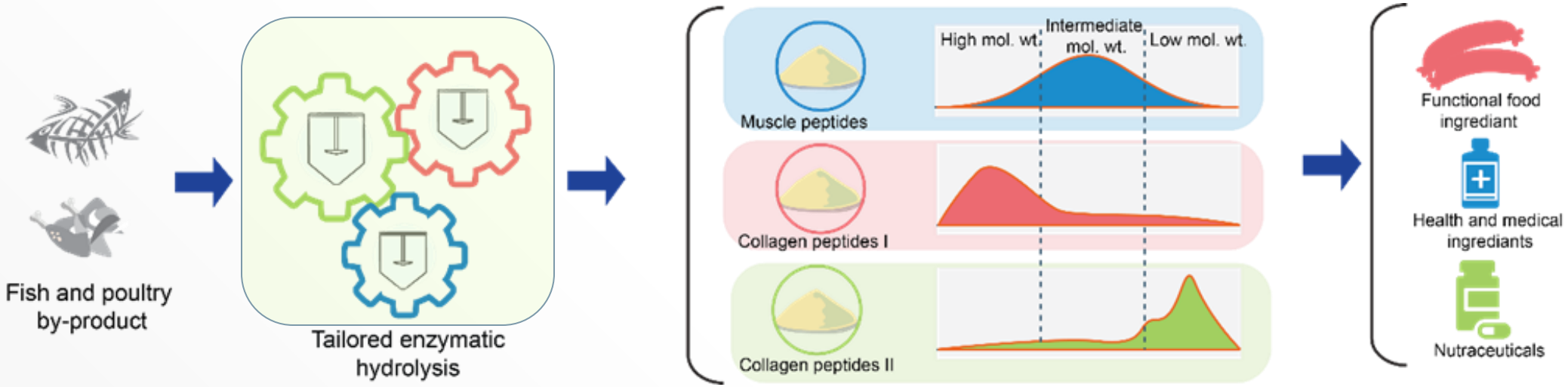
Tailor-making specialized collagen peptides for high-end markets using by-products from the Norwegian poultry and salmon industry – SPECtaCOLL



- optimized for extraction of different proteins

norilia

bioco

UiO : Universitetet i Oslo

HOFSETH BioCare

Forskningsmidlene for jordbruk og matindustri

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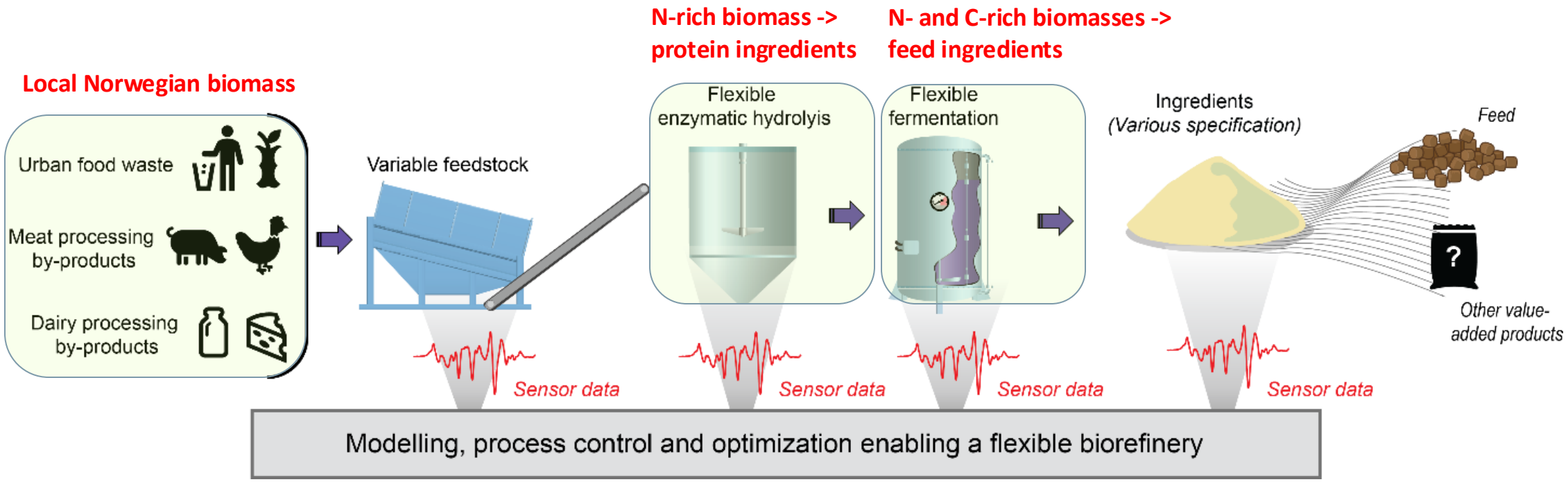
Flexible biorefineries for upcycling of local bioresources - Flexbio



Forskningsmidlene for jordbruk og matindustri

Nofima · NMBU Norges miljø- og biovitenskapelige universitet · NIBIO Norsk institutt for bioøkonomi · Akp · TINE · norilia · Norsk Kylling · Bruk fisken · Greentech Innovators · Chitofun Biotech · Land møter hav · NCE Heidner Biocluster · NCE Blue Legasea · NCE Seafood Innovation · Biotech North

Nutrients from category 2 fish for biorefinery application – Fish2Bio

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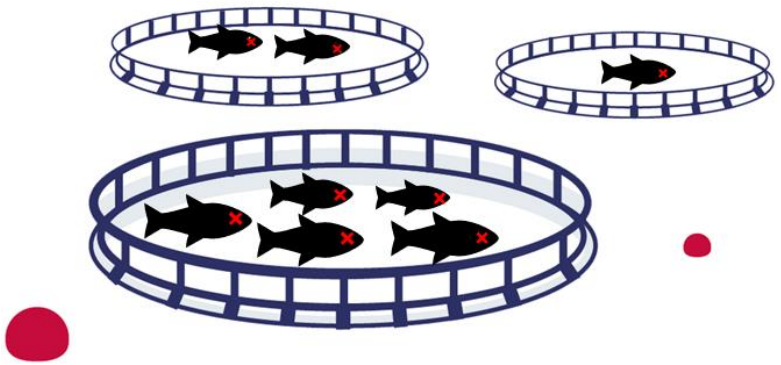
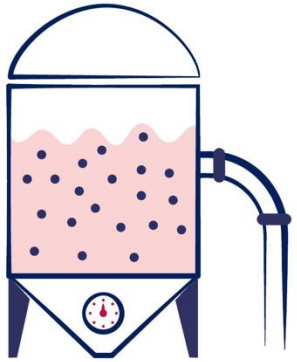
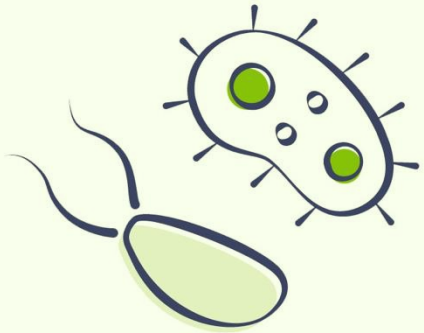
Category 2 salmon – nutrient rich biomass



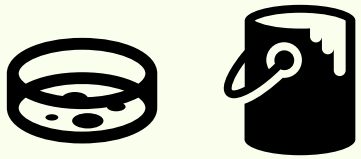
Enzymatic hydrolysis – protein, oil and residue



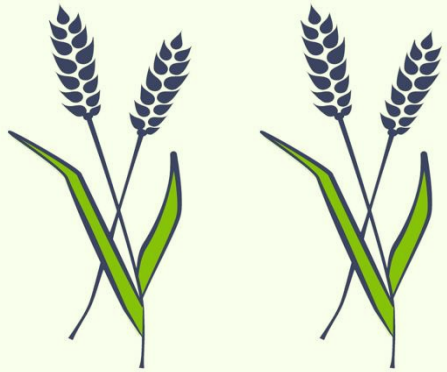
Protein – fermentation: production of platform chemicals (citric, gluconic acid..)



Oil – bio-based epoxy resins: collaboration with NordiCoats project (Research council of Norway, BIOTEK2021 program



Residue – fertilizers:



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FHF

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- The Research Council of Norway (projects «DigiFoods» and «SmartSense4Proteins»)

- FHF – Norwegian Seafood Research Fund (project «Fish2Bio»)

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Thank you for your attention!!!