

# NoRest conference

## Copenhagen 25.-26.10.2016



## Upcycling food industry co-streams: Food products and ingredients

Kaisu Honkapää, Riikka Juvonen, Katariina Rommi, Raija Lantto / VTT  
Ana Carvajal, Rasa Slizyte / SINTEF  
Randi Seljåsen / Nibio



**NIBIO**  
NORSK INSTITUTT FOR  
BIOØKONOMI



**SINTEF**



**Forskningsrådet**

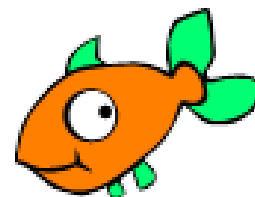
## Content of the presentation

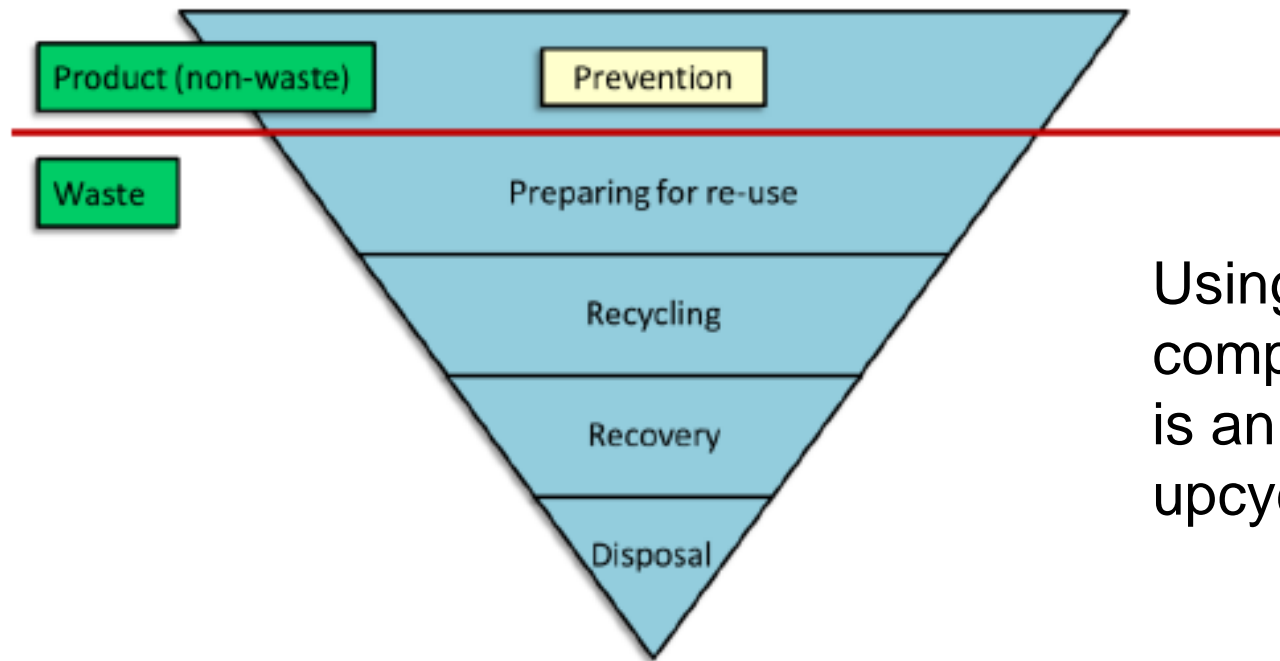
- Development of food products and ingredients in Cycle project
- Vegetable research cases
- Poultry research cases
- (Fish research cases presented earlier by Ana Carvajal / SINTEF)

## WP2 in Cycle: Resource-efficient bioprocessing technologies for food industry

**Aim:** To develop knowledge, technology and processes for better utilization of co-streams in the food industry with focus of food use

Case industries	Industrial partners	Research institutes
Vegetable	BAMA, Produsentpakkeriet	VTT Technical Research Centre of Finland Ltd, The Norwegian Institute of Bioeconomy Research (NIBIO)
Poultry	Norilia	SINTEF Fisheries and Aquaculture
Fish	Fjordlaks	SINTEF Fisheries and Aquaculture






Using co-streams as food components or ingredients is an efficient way of upcycling material.

The waste management hierarchy of the EU (EC, 2008)

## Cycle WP2: Resource-efficient bioprocessing technologies for food industry

### Vegetable case studies:

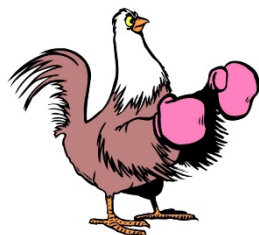
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- Enzyme-aided peeling of potatoes and vegetables
  - Films from potato peels
  - Smoothie recipes based on vegetable co-streams
  - Fermentation of vegetable co-streams with multifunctional starter cultures
    - vitamin B<sub>12</sub> enrichment
    - probiotic fermentations
  - Extruded snack product with vegetable co-stream and added protein

### Fish case studies:

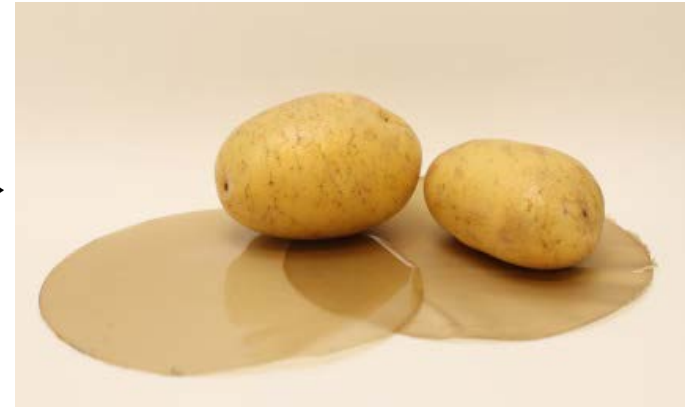
- Shelf-life of mackerell rest raw materials – effect of quality on oil and protein products
- Enzymatic hydrolysis of cod heads – effect of freezing and thawing on the quality of protein hydrolysates
- Pilot scale production of protein hydrolysates from cod heads and mixed cod rest raw materials

### Poultry case studies:

- Enzymatic hydrolysis of co-products from deboned chicken meat
- Effect of enzyme type and hydrolysis time on yield and composition of oil and protein fractions
- Antioxidative properties of chicken protein hydrolysates
- Chicken oil quality and stability

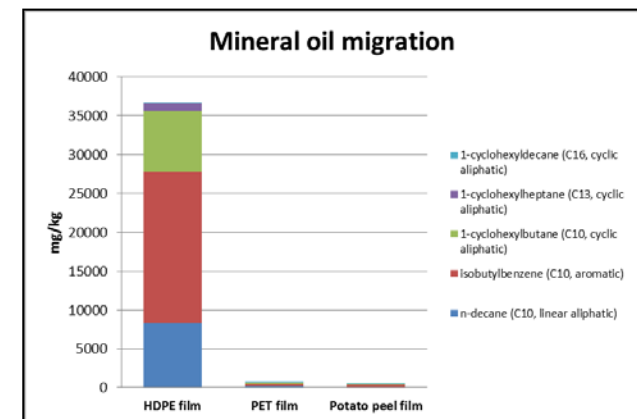


- **Aim:** to evaluate film forming properties of potato peel mass
- **Experimental:** Industrially peeled potato peels → wet-milling/enzymatic hydrolysis of starch → possible fractionation → high-pressure homogenization (HPH) +/- heat treatment → glycerol addition → film casting → analyses




### Results:

- Potato peel materials had good film-forming properties.
- Potato-based edible films had excellent oxygen barrier properties at low relative humidity and were totally impermeable to grease. Water vapour barrier properties were similar to starch films.
- Film-forming ability retained also after enzymatic starch removal → resulted in films with better mechanical properties compared to the other films



### Possible product applications:

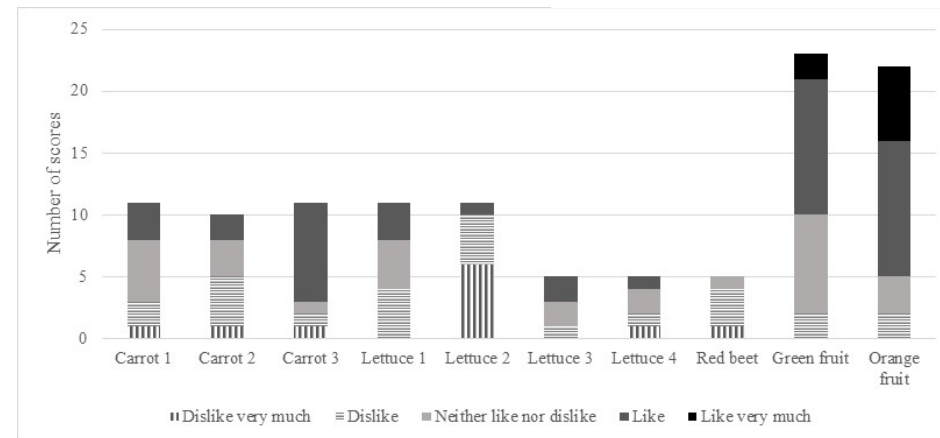
- Edible film → hygienic quality of peels a challenge
- Effective mineral oil barrier coating in recycled cardboard packaging, e.g. in disposable plates ("potato chips packed in potato peel")
- Mulch film protecting plants from weeds etc.

Higher  
  
 Lower

Value



- **Aim:** to utilize industrial vegetable co-streams as innovative food products
- **Case application:** smoothie
- **Materials tested:** carrot, lettuce, Swedish turnip, red beets and spinach
- **Results:** mixtures developed varied in sensory properties and how they were liked by the consumers. Some of the mixture were very promising.
- **Conclusions:**
  - Industrial co-streams currently forwarded to feed use could be utilised more directly as components in food products
  - The results from the studies has stimulated industry to investigate raw material utilization and product development of fermented products.

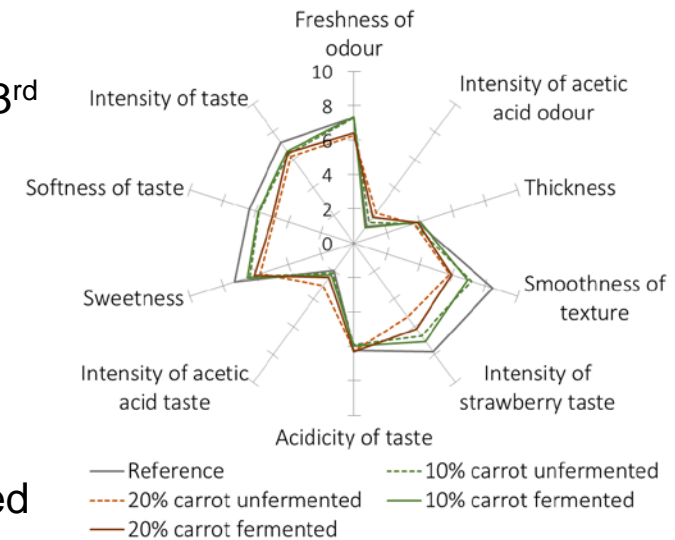


# CYLE Vegetable co-streams as production media and carriers of probiotic bacteria

**Aim:** to explore feasibility of edible vegetable and fruit co-streams as production media and carriers of probiotic bacteria.

**Experimental:** Enrichment of probiotic bacteria in co-streams

- Real industrial vegetable co-streams: 2<sup>nd</sup> grade carrots and Swedish turnip, cabbage outer leaves, apple press cake and 3<sup>rd</sup> grade tomatoes and cucumbers
- Two probiotic strains: *Lactobacillus rhamnosus* VTT E-97800 and *Bifidobacterium animalis* ssp. *lactis* VTT E-12010 (Bp-12)
- Most co-streams suitable for enrichment of *L. rhamnosus*, *B. animalis* more demanding
- High cell numbers reached after 12-16 h fermentation
- Food application case study: 10-20 % probiotic ferments added into commercial smoothie base
  - Sensory profiling indicated that 10-20% addition level is feasible, depending on the co-stream and the product base
  - At 10% addition level, the consumption of 10-100g of the product would deliver a recommended daily dose of ca.  $10^9$  CFU.



**Conclusion:** Vegetable co-streams are promising production and carrier media for probiotic lactobacilli and bifidobacteria.

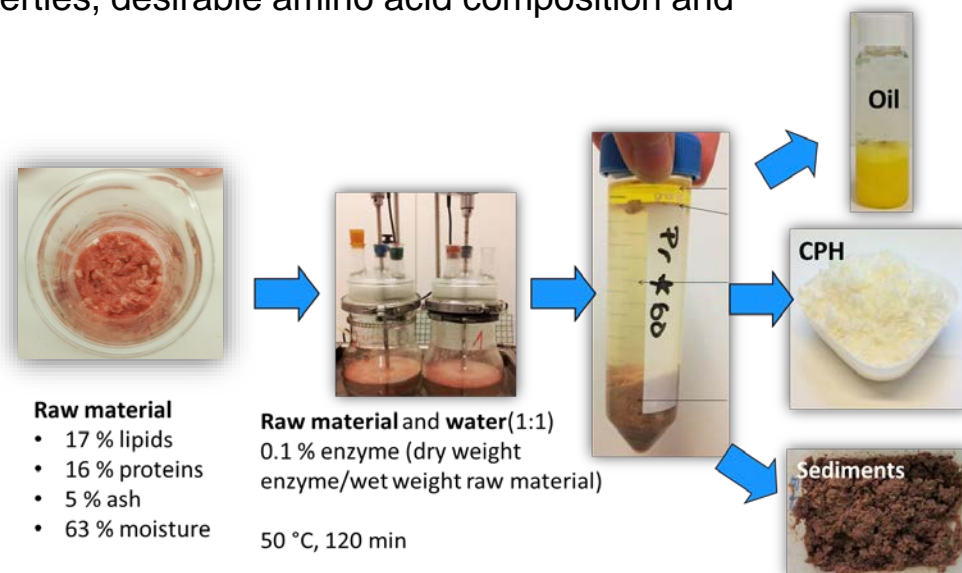
More results: Poster presentation Hyrkkänen *et al*



- Currently used mainly as feed -> good use from the sustainability view point (no material is wasted, stays in the food chain), but of no or low economic value to vegetable industry
- Low protein content in most of the co-streams -> less ambition / need to take it into direct food use
- 2<sup>nd</sup> class vegetables and many other co-streams are food grade raw materials, but:
  - more sophisticated identification, quality differentiation and sorting procedures needed to direct the co-streams efficiently to food uses
  - logistic challenge to use them as raw material in other food factories (as raw materials for ready-to-eat products, alcohol, potato flour, etc.)
  - microbiological safety needs to be ensured
- Interest to extract/enrich valuable components like flavonoids, carotenoids, sugars, starch, protein, fiber, from vegetables?
  - Lot of research already done and technologies developed
  - Investments in production facilities needed
  - To make investments feasible, large amounts of co-streams is needed
    - Norwegian vegetable industry is located in relatively small units around the country, which makes the profitability of co-stream valorization uncertain

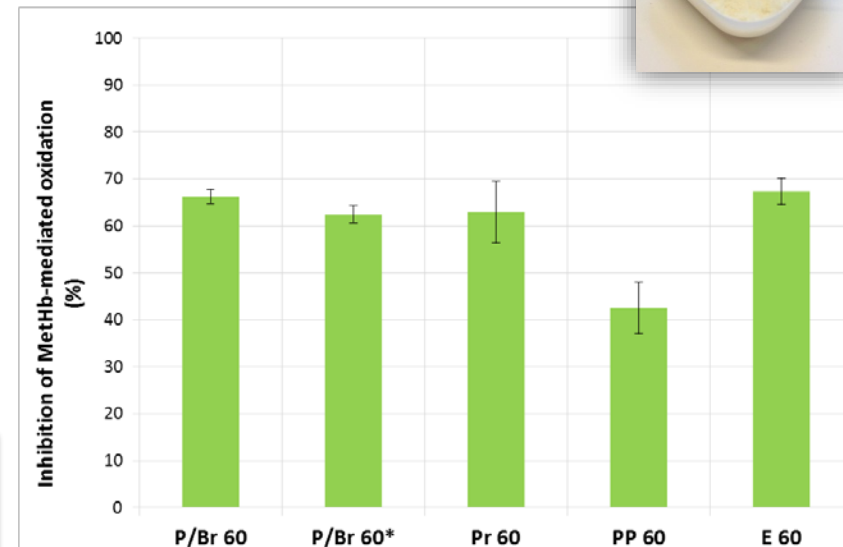
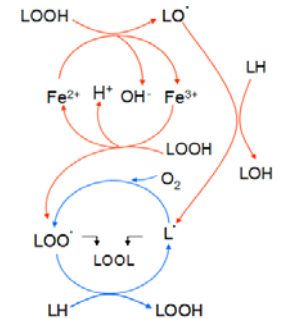
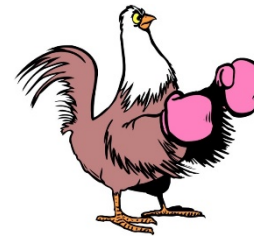
# Enzymatic hydrolysis of co-products from deboned chicken meat

- **Aim:** Use enzymatic hydrolysis as technology for valorisation of chicken rest raw materials. Study the effect of enzyme type and hydrolysis time on the composition, properties and quality of produced products
- **Experimental:** Enzymatic hydrolysis: Mixture of minced raw material and water (1:1), heated to 50 °C, addition of 0.1 % enzyme (of raw material), up to 120 min hydrolysis, Inactivation, Separation. Enzymes tested: Endogenous, Protamex, Corolase PP, Papain and Bromelain
- **Results and Conclusions:**
  - Protamex → highest hydrolysate yield
  - Hydrolysis time > 60 min gave no significant increase in hydrolysate yield
  - The protein hydrolysates had good sensory properties, desirable amino acid composition and good nutritional value
- **Possible product application:**
  - **Hydrolysates:** ingredient in food products as meat cakes, sausages, or as protein supplement
  - **Oil:** lipid source for pet-food and feed, but also possible ingredient in food products
  - **Sediments:** pet-food, feed



# Antioxidative properties of chicken protein hydrolysates

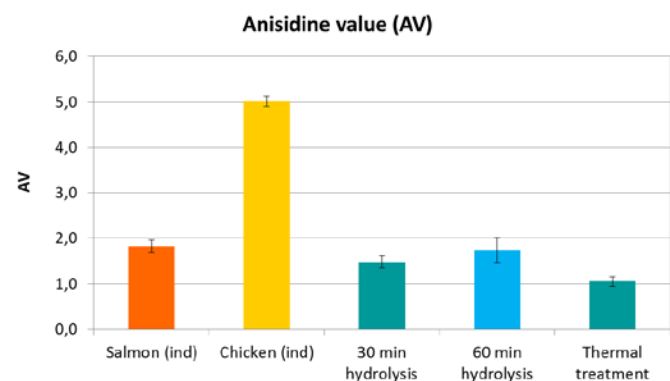
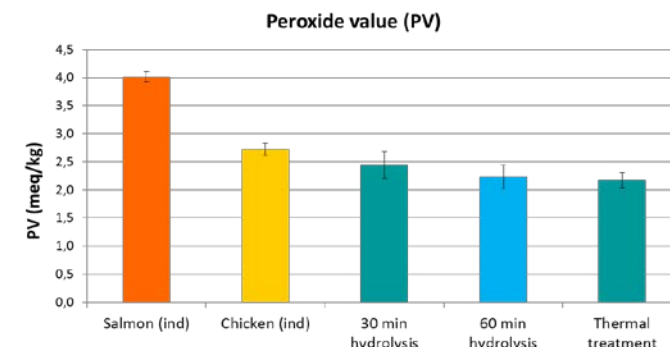
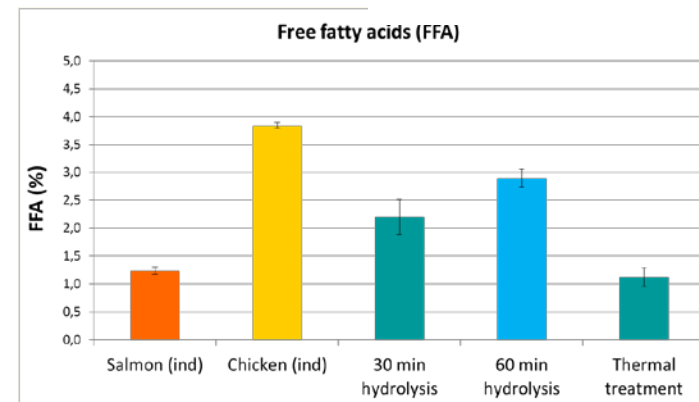
- **Aim:** Study if chicken protein hydrolysates can be used to inhibit lipid oxidation
- **Materials tested:** Chicken protein hydrolysates produced by different enzymes
- **Experimental:** Use of Oxygraph (measure of oxygen uptake) in order to study the effect of chicken protein hydrolysates in inhibiting iron and Hb-mediated lipid oxidation in cod roe liposome model system
- **Results and Conclusions:**
  - 42 – 67 % inhibition of Hb-mediated lipid oxidation
  - No significant difference in inhibition effect between hydrolysates produced by use of only endogenous enzymes, a mixture of Papain and Bromelain (P/Br) or Protamex
  - Lower inhibition effect in hydrolysates produced by Corolase PP



Chicken protein hydrolysates have antioxidative properties and can be used to reduce oxidation in food products

# Chicken oil – quality and stability

- **Aim:** Study the quality and stability of chicken oil – use as an ingredient in feed and food
- **Materials tested:** Oil produced from co-products from deboned chicken meat by thermal treatment and enzymatic hydrolysis
- **Experimental:** Thermal treatment: Mincing of raw material, cooked at  $> 90^{\circ}\text{C}$  for 15 min, separation. Enzymatic hydrolysis: Mixture of minced raw material and water (1:1),  $50^{\circ}\text{C}$ , 0.1 % Papain and Bromelain, 1 hour hydrolysis, Inactivation, Separation
- **Results and Conclusions:**
  - The produced chicken oil have a low oxidation status (low PV and AV) and high stability compared to industrial used oils
  - Thermal treatment resulted in an oil with lower oxidation status compared to enzymatic hydrolysis
  - Low FFA values indicates a high quality raw material



Co-products from deboning of chicken meat are good lipid source for feed and food

**Thank you for your attention!**  
**And thank you to:**

**VTT team:**

Hanna-Leena Alakomi, Riitta Alander, Ulla Holopainen, Kaisu Honkapää, Linda Hyrkkänen, Riikka Juvonen, Panu Lahtinen, Raija Lantto, Riitta Pasanen, Jenni Rahikainen, Katariina Rommi, Jari Vartiainen

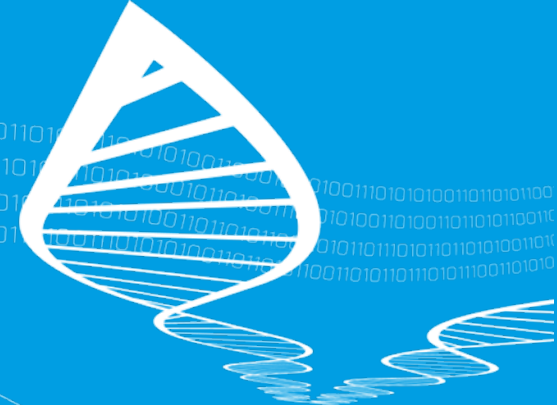
**SINTEF team:**

Ana Carvajal, Rasa Slizyte

**NIBIO team:**

Randi Seljåsen

**SINTEF Fisheries and Agriculture for coordination**  
**The Research Council of Norway for financial support**



# TECHNOLOGY FOR BUSINESS

