SINTEF

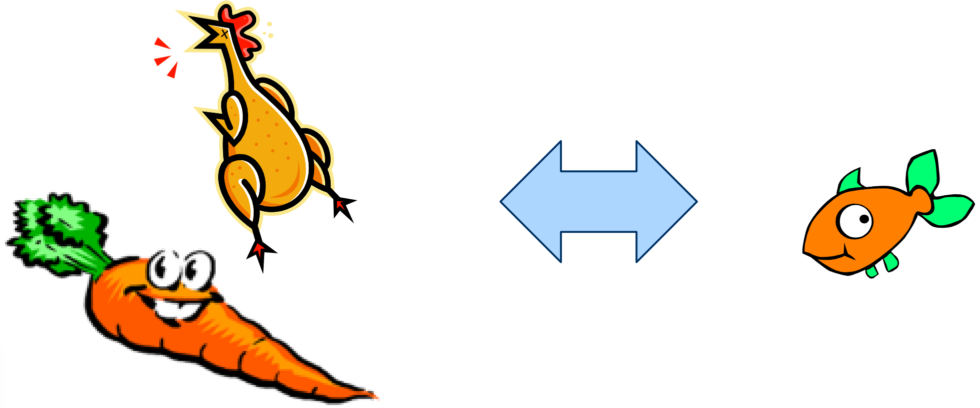
UPCYCLING CO-STREAMS FROM THE VEGETABLE AND POULTRY SUPPLY CHAIN – POSSIBILITIES FOR NEW INGREDIENTS AND FOOD PRODUCTS

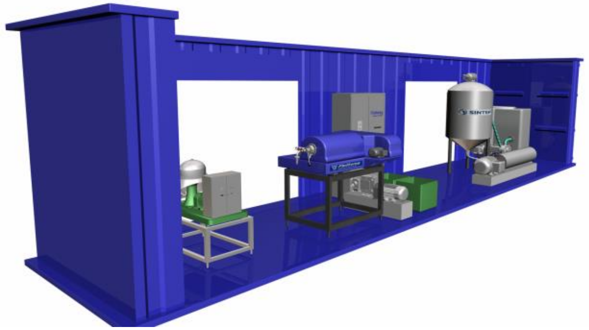
Rasa Slizyte

SINTEF Fisheries and Aquaculture

Industrial ⟷ lab processing

Equipment for hydrolysis optimisation
From 0.2 L up till 5 L





Equipment for process optimisation and up-scaling
Container plant: 500-100kg/h

Industry

CYCLE

Forskningsrådet

2013-2016

Total utilization of raw materials in the supply chain for food with a bio-economical perspective

WP4
Food safety and logistics

WP1
Quality differentiation

WP2
Bio-processing of loss

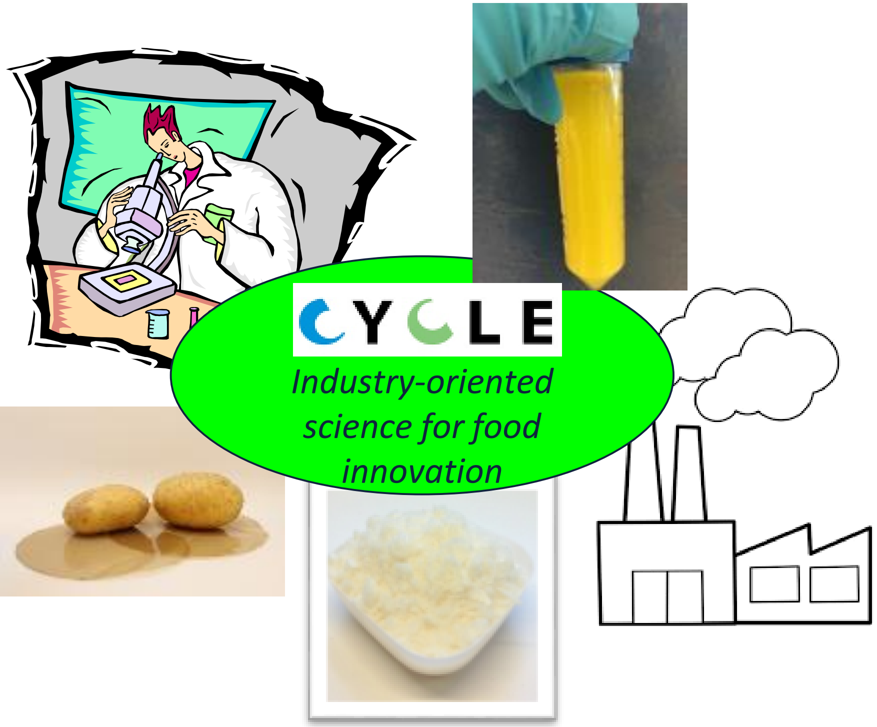
WP3
Processing of waste

WP5: Socio-economy: Market and consumer

WP6: Dissemination and demonstration

WP7: Management

Prevention of obesity related disorders in pets by bioactive compounds from chicken by-products

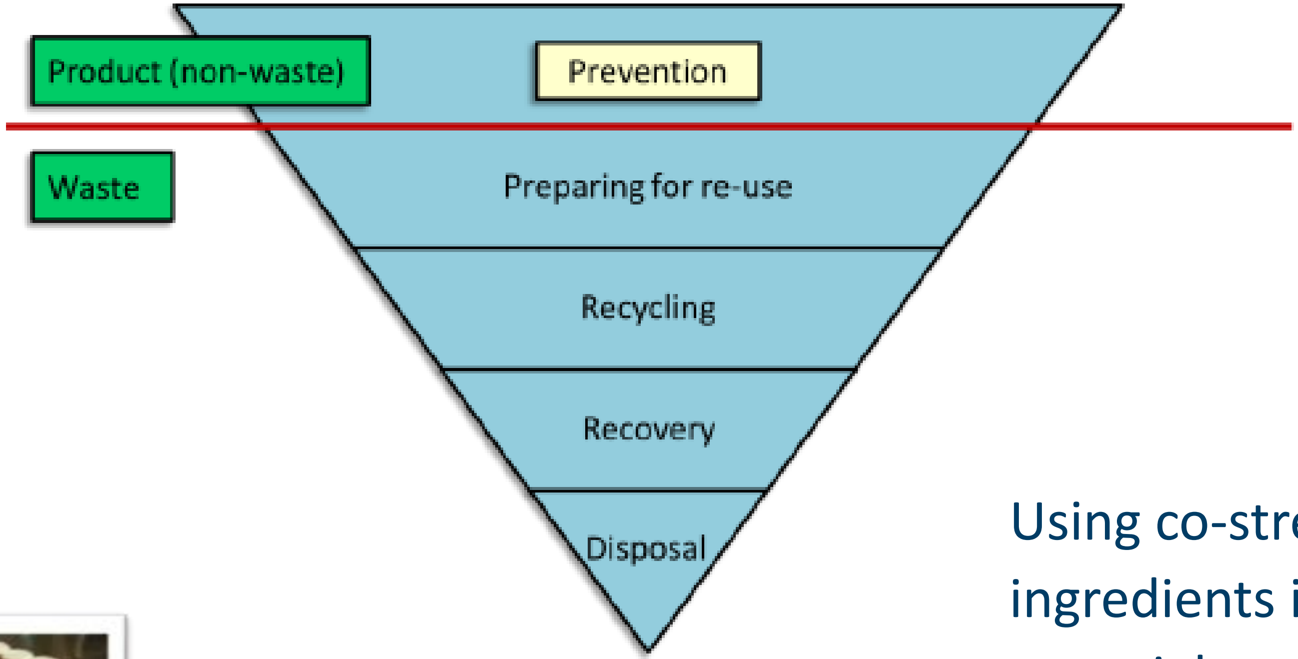


Bio-economic utilization of laying hens for food and feed (HØNE – helhetlig bioøkonomisk utnyttelse av verpehøne)

SOILFILM – development of biodegradable mulch film formulations from co-streams of food industry, to protect crops against the growth of weeds

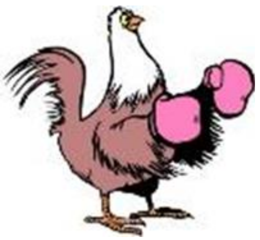
From loss to value added products – ensiling of rejected / defected potatoes and carrots

Upcycling food grade co-streams



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

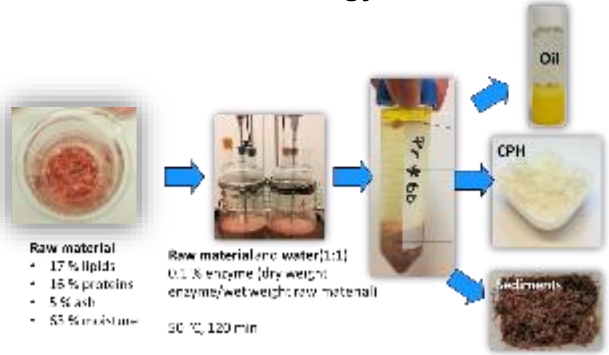
Using co-streams as food components or ingredients is an efficient way of upcycling material.



The Enzymatic Hydrolysis:
Value-adding by biorefining

New factory is planned for enzymatic hydrolysis of chicken bones

Production of high quality hydolysate, oil and sediments by use of new technology

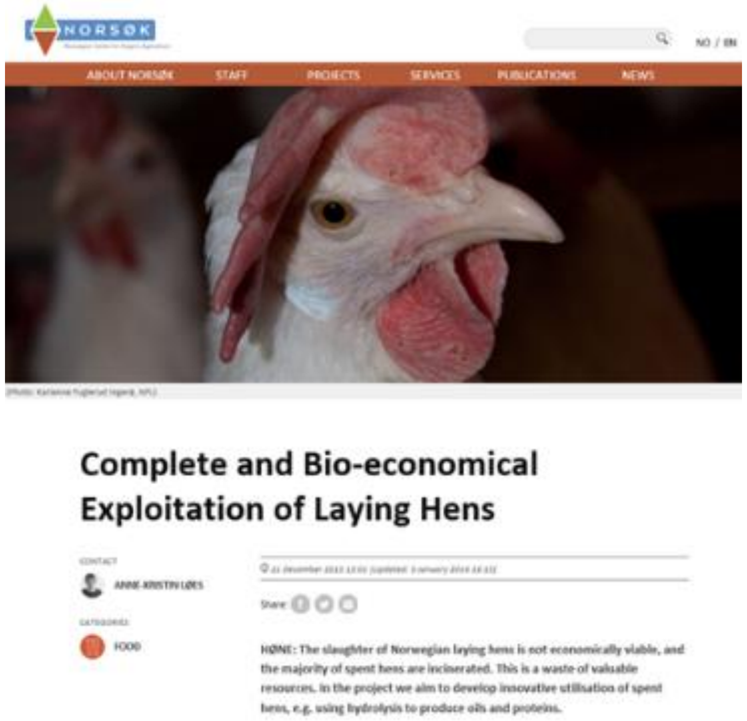


New ingredients to high-value markets

Work in Cycle based on Norilia raw materials:

- Quality - differentiation in raw-material by use of sensor-systems
- Lab-scale tests of enzymatic hydrolysis by use of different enzymes
- Characterization of hydrolysate
- Analyses of chicken-oil

Laying hens cannot be destroyed!



NORSØK

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ABOUT NORSØK STAFF PROJECTS SERVICES PUBLICATIONS NEWS

Complete and Bio-economical Exploitation of Laying Hens

CONTACT

ANNE-KRISTIN LØES

CATEGORIES

FOOD

Share

HØNE: The slaughter of Norwegian laying hens is not economically viable, and the majority of spent hens are incinerated. This is a waste of valuable resources. In the project we aim to develop innovative utilisation of spent hens, e.g. using hydrolysis to produce oils and proteins.

Utrangerte verpehøner

Store forskjeller i utnyttelsen i Norge, Sverige og Danmark

I Norge gasses nå mange flokker med CO_2 i huset, etter endt verpeperiode. Foto: KFI

Av Anne-Kristin Løes, NIBIO

Kylling er blitt en sterk konkurrent til hønsekjøtt, og norske forbrukere får knapt tak i råvarer til hønsefrikassé. Over kjølen slakter svenskene over 2 millioner høner i året til mat, men mye av dette eksporteres til Afrika. Danske høner brukes til pelsdyrfôr, mens flertallet av norske høner kjøres til forbrenning i Hamar. HØNE-prosjektet, ledet av Sintef, prøver å endre på situasjonen. I denne artikkelen drøfter vi forskjellene mellom Norge og nabolandene på dette området.

Eggproduksjon i Norge

I Norge har vi ca. 2 millioner høneplasser i konvensjonelle frittgående systemer, 1,3 millioner i konvensjonelle bursystem, og 127.200 plasser i økologiske systemer (Animalia 2014). Hønene starter oppverping ved ca. 19 ukers alder og står i full produksjon i 58 uker. Etter å ha verpet omtrent 340-350 egg er det takk og farvel, og bonden gjør huset klart for nytt innsett. Hver nordmann spiser ca. 200 egg, 12,6 kg hvert år, og legger altså beslag på omtrent en halv høne. Norsk eggproduksjon er innrettet mot å dekke innenlands eggforbruk, og det er for tida en viss overkapasitet i bransjen som gjør det nødvendig å avlive en del høner før de er ferdige med eggleggingsperioden. Det skjer gjennom «frivillig førtidsslakting», der bonden får betalt ca. 8 kr per kg egg som erstatning for anslått tapt produksjon. Disse pengene tas fra omsetningsavgiften på 1 kr per kg egg, som alle eggprodusenter må betale.

Gjennom handelsavtaler har Norge åpnet for import fra EU av 1.295 tonn egg («skallegg») årlig med redusert toll, og 290 tonn uten toll. Dette utgjør omlag 2,5 % av den norske produksjonen, som var på 60.454 tonn i 2014 (Nortura 2015). I praksis er likevel importen betydelig lavere enn

Få til slakt

Hvert år er det altså rundt regnet 3,5 millioner verpehøner som avlives i Norge. Anvendelsesmulighetene påvirker valg av avlivningsmetode. Moderne eggleggingsraser av høns har liten kjøttfylde, høye slaktekostnader per kg slakt, og med stadig lavere priser på slaktekylling og skjerpet konkurranse om plassen i frysediskene har salget av slaktede utrangerte høns over tid blitt kraftig redusert. Etter hvert har det også blitt svært vanskelig for potensielle kunder å finne slaktet høne i matbutikkene.

Omlag 5 % av hønene har blitt slaktet og solgt til konsum. Dette er fortrinnsvis hel høne uten fjær, hode, bein og innvoller, pakket i pose og distribuert frossen. Det er et teknisk problem at høner og kyllinger ikke har samme størrelse, slik at slaktemaskinene må stilles om for hønseslakting. Kjøttkontrollen på høns er også mer tidkrevende, og slaktehastigheten må være lavere enn på slaktekylling. Derfor er det for de meste mindre, private fjørfeslakterier som Ytterøykylling i Nord-Trøndelag og Gårdsand i Vestfold som har mulighet til å ta imot utrangerte verpehøns til slakt.

Gårdsand AS slaktet økologiske verpehøns til Forsvaret i et prøveprosjekt i samarbeid med Toten eggpakkeri, Nofima og Norgesgruppen i 2013. Hønene ble levert ferdig kokt i poser, men det ble for arbeidskrevende i norske militære kantiner å dele kjøttet fra beina. Toten eggpakkeri har fortsatt satsingen på kokt hønsekjøtt pakket som sous-vide, og leverer til storkjøkken og arrangement (Mat og drikke 2014; Toten Egg 2014).

Bra dyrevelferd, men dårlig ressursbruk

Å kvitte seg med høner som skal avlives er blitt en betydelig kostnad for bonden, med utgifter på 5-6 kr per dyr som destrueres. Levendevekta er om lag 1,6 kg (Prior 2015). Ved leveranse til slakt må bonden vanligvis dekke transportkostnader, og får ingen betaling for dyra. Ved avlivning står valget mellom gassing i container, gassing i hus og tradisjonell

I Trondheim koker de olje av avdankede verpehøns for å utnytte næringsstoffene til lønnsomme kosttilskudd. – Det lukter hønsesuppe, men vi har ennå et stykke frem for å få riktig smak, sier forskningsleder Ana Carvajal ved SINTEF Fiskeri og akvakultur. (Foto: Anne Lise Stranden, forskning.no)

Skal redde høns fra å ende som betong

Over tre millioner avdankede verpehøns blir gasset og kastet hvert år, eller de ender som bindemiddel i betong. Men kanskje kan de brukes på flere områder, som for eksempel som proteinshake?

Anne Lise Stranden
journalist

1.6 2016 04:00

- Verpehøns kan bli til mat, kosttilskudd og gjødsel

NATIONEN

NATIONEN

Nationen 20. aug 795 ord

Forfatter: Hanad Ali

Technological solutions used for screening

	Temperature	Time	pH
Thermal	>90ºC	15 min	5.3-5.8
Enzymatic hydrolyse	50ºC + >90ºC	60 min + 10 min	5.3-5.8
Ensiling	40ºC + >90ºC	24 hours + 10 min	2.9-3.8

Enzymatic hydrolysis of hens and co-products from deboned chicken meat

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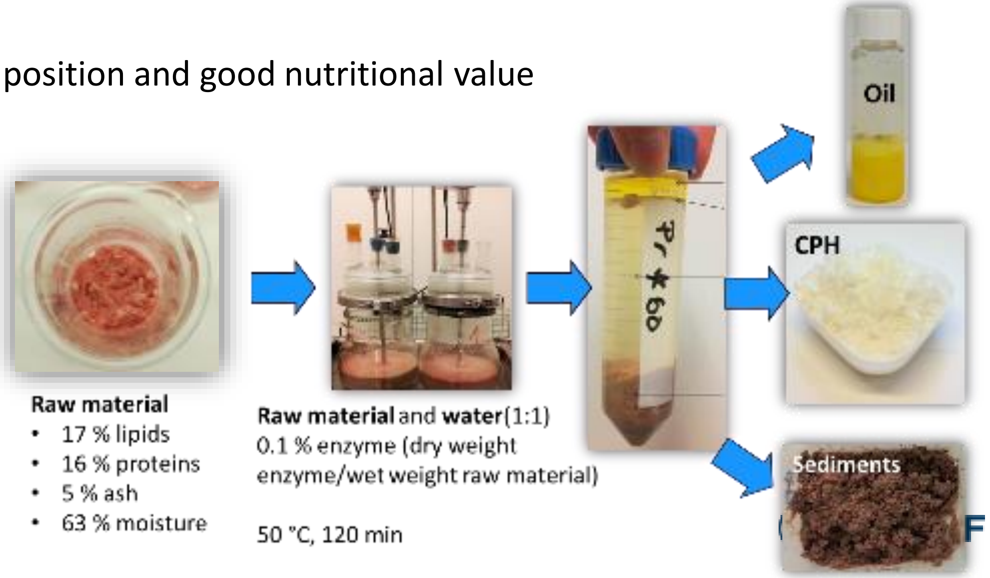
- **Aim:** Use enzymatic hydrolysis as technology for valorisation of chicken rest raw materials. Study the effect of enzyme type and hydrolysis time on the composition, properties and quality of produced products
- **Experimental:** Enzymatic hydrolysis: Mixture of minced raw material and water (1:1), 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 , Papain and Bromelain ⟶ 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

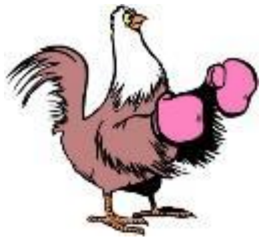
- **Possible product application:**
  - Hydrolysates: ingredient in food products as meat cakes, sausages, or as protein supplement
  - Oil: ingredient in food products, lipid source for pet-food and feed,
  - Sediments: pet-food, feed

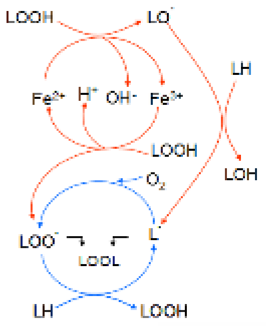


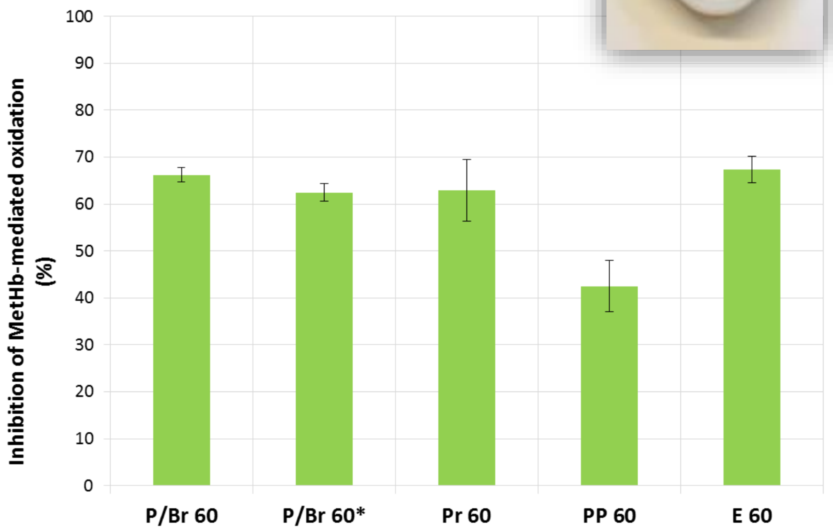
Antioxidative properties of chicken protein hydrolysates

SINTEF

- **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

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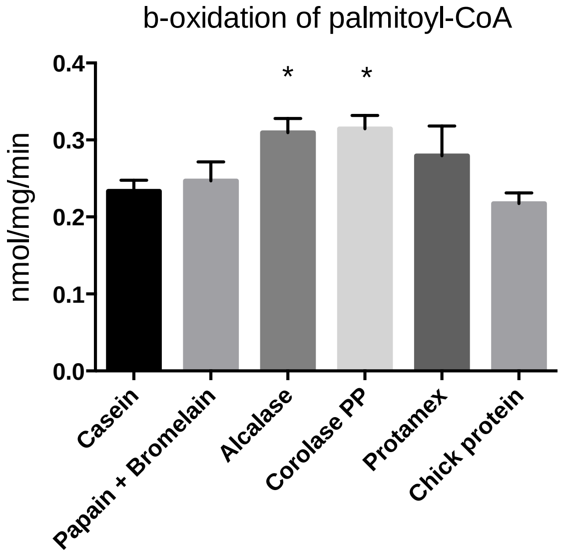
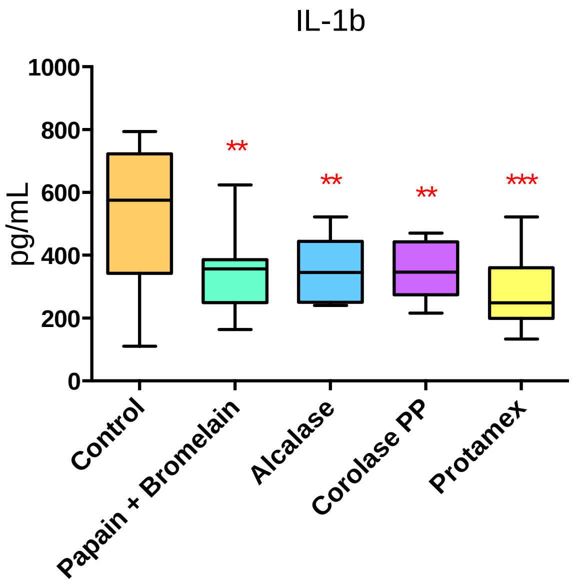
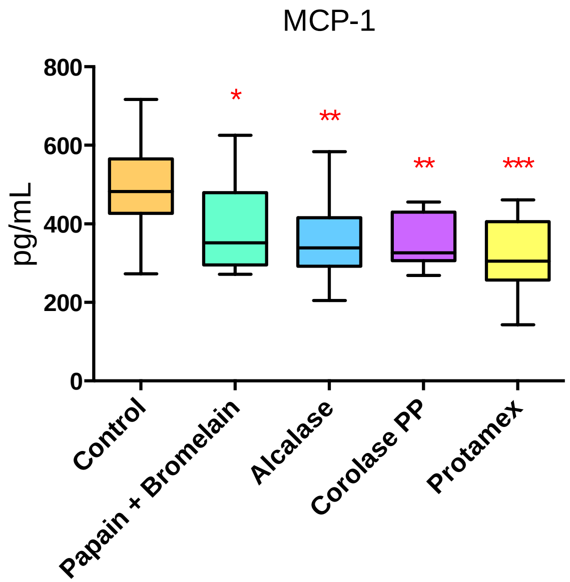
Bioactive peptides

influence lipid metabolism and inflammation parameters in vivo







•Chicken hydrolysates stimulate mitochondrial fatty acid oxidation leading to increased fat metabolism (measured in vivo)

•Especially effective were hydrolysate produced with Alcalase and Coralase PP - vs control

•Chicken hydrolysates reduced inflammations parameters, which are connected to overweight

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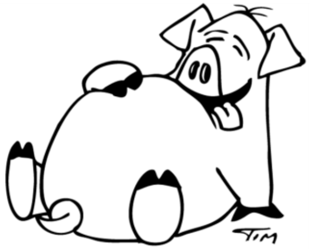
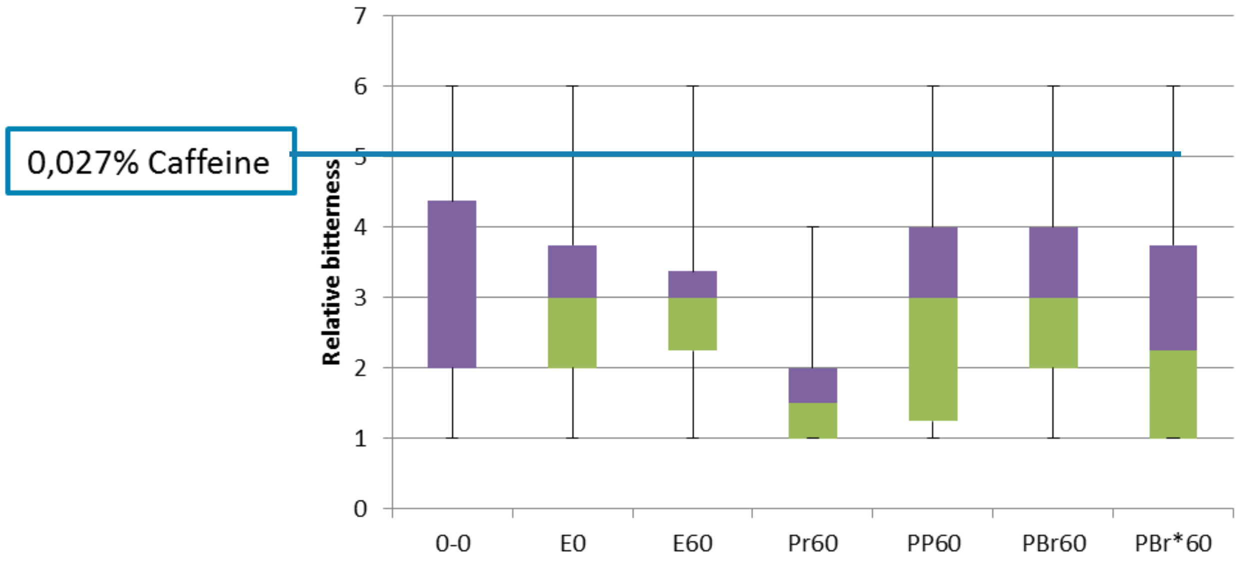
Chicken hydrolystaes in food products



- All hydrolysates had very low bitterness



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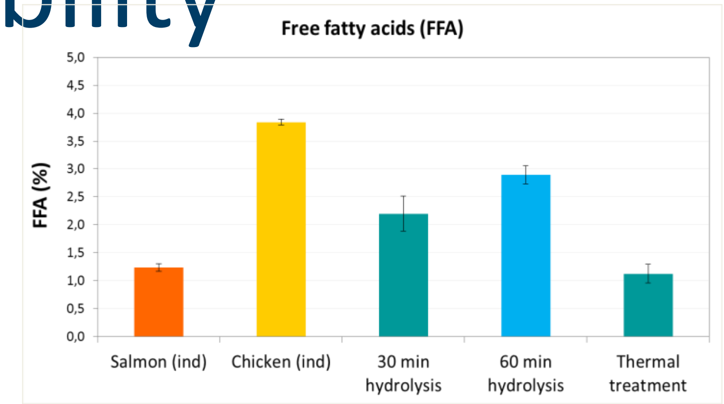
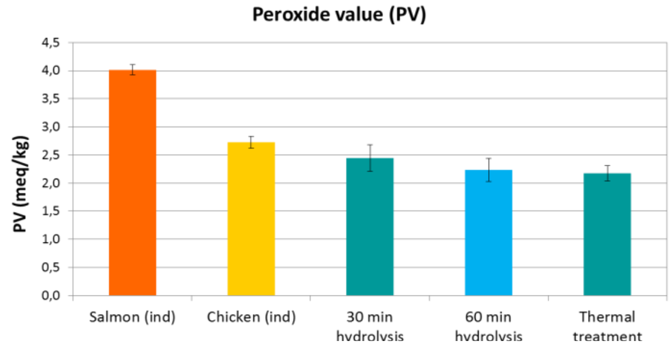
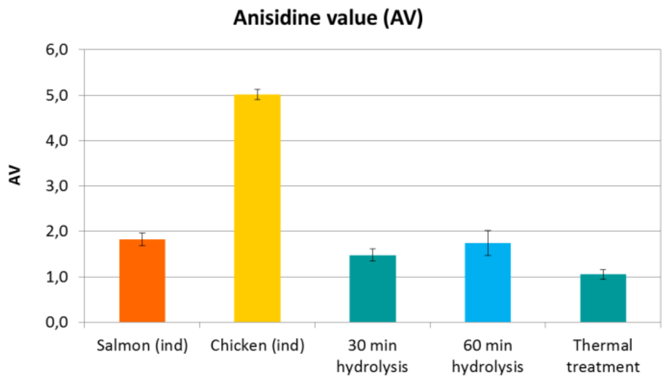
Chicken oil – quality and stability

- **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°C for 15 min, separation. Enzymatic hydrolysis: Mixture of minced raw material and water (1:1), 50 °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



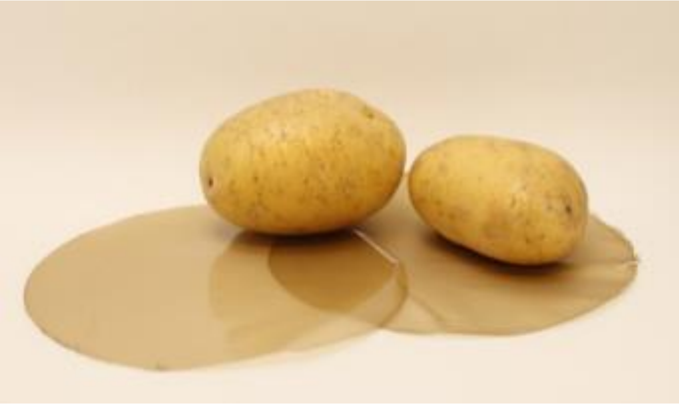


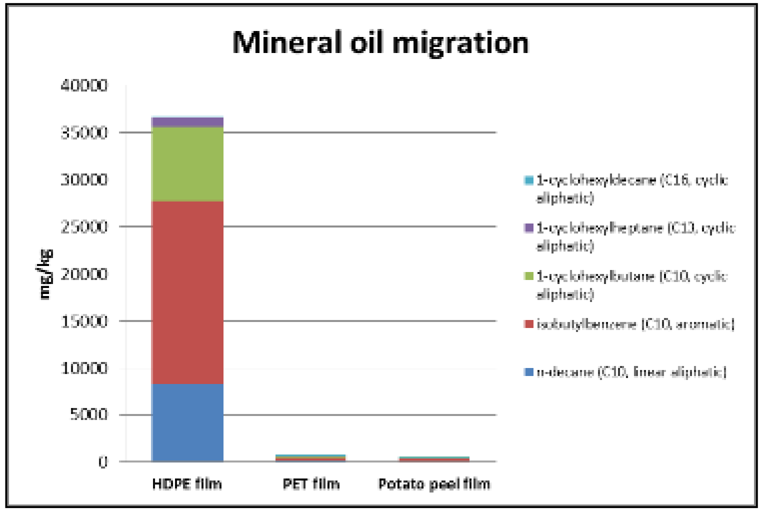


Co-products from deboning of chicken meat are good lipid source for feed and food

Films from potato peels

- **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.






Journal of Applied Polymer Science

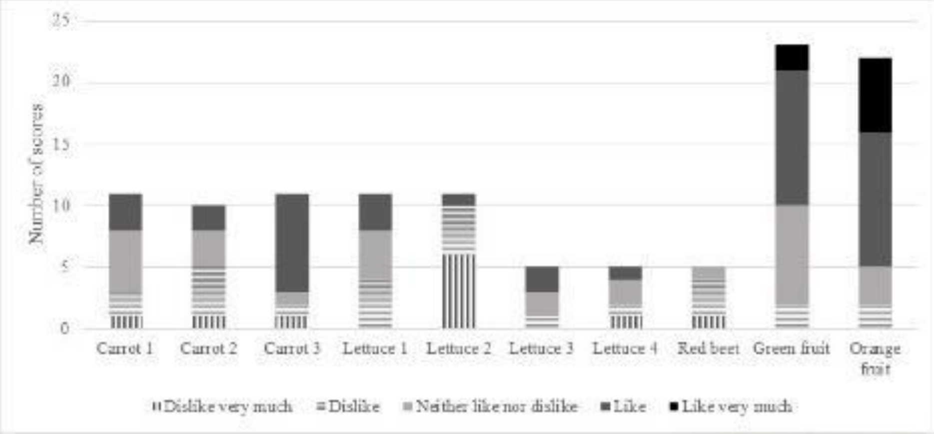
Potato peeling costreams as raw materials for biopolymer film preparation

Katariina Rommi, Jenni Rahikainen, Jari Vartiainen, Ulla Holopainen, Panu Lahtinen, Kaisu Honkapää, Raija Lantto
VTT Technical Research Centre of Finland Ltd., P.O. Box 1000, FI-02044 VTT, Espoo, Finland
Correspondence to: K. Rommi (E-mail: katariina.rommi@vtt.fi)

Smoothies from vegetable co-streams

- **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.



NIBIO
NORSK INSTITUTT FOR BIOØKONOMI

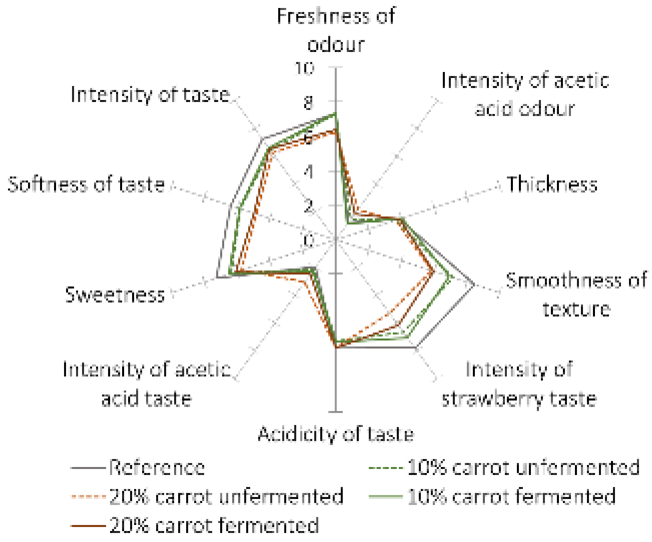
SINTEF

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: 2nd grade carrots and Swedish turnip, cabbage outer leaves, apple press cake and 3rd 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.

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From loss to value added products – ensiling of rejected / defected potatoes and carrots

Aim:

How with the help of ensiling and probiotic bacterial cultures turn potatoes an carrots into healthy feed


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journal homepage: www.elsevier.com/locate/smallrumres

ELSEVIER

The influence of ensiling potato hash waste with enzyme/bacterial inoculant mixtures on the fermentation characteristics, aerobic stability and nutrient digestion of the resultant silages by rams

B.D. Nkosi[a,c,*], R. Meeske[b], T. Langa[a], M.D. Motiang[a], T.F. Mutavhatsindi[a], R.S. Thomas[a], I.B. Groenewald[c], J.J. Baloyi[d]

[a] Division for Animal Nutrition: Animal Production Institute, P/Bag x 2, Irene, 0062, South Africa
[b] Directorate: Animal Sciences, Department of Agriculture Western Cape, Outeniqua Research Farm, P.O. Box 249, George 6530, South Africa
[c] Centre for Sustainable Agriculture, University of the Free State, P.O. Box 339, Bloemfontein 9300, South Africa
[d] University of Venda, School of Agriculture, Department of Animal Science, P.O. Box X5050, Thohoyandou, 0950, South Africa

Pre test

Start 19th July:

22nd July:

1st August:

End 5th August:

Main test with probiotic bacterial cultures

- Ensiling may improve feed value and extend shelf life
- Probiotic bacteria can have beneficial effects on gut health in e.g. pigs and calves
- Potatoes and carrots together other raw materials including cereal products, hay and fish hydrolysate
- Studies of pH, runoff, bacteria survival, palatability and oxidative stability

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Challenges in developing new uses for vegetable co-streams - some thoughts

- 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
- 2nd 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

Message to take home

- Food quality co-streams can and should be utilized for food or high-quality feed products
- Industrial concepts applied on new raw materials (food co-streams) may reveal completely new products and applications
- We need and can reduce food loss and stop producing waste!

Thank you all and projects partners:

SINTEF team:

Ana Carvajal, Rasa Slizyte, Kirsti Greiff, Guro Møen Tveit

VTT team:

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NIBIO team:

Steffen Adler, Randi Seljåsen

UiB team:

Rolf Kristian Berge, Bodil Bjorndal

NORSØK team:

Anne-Kristin Løes

JÅRDÅREN EGGENETTVERK

Teknologi for et bedre samfunn