The research project CYCLE aims on achieving total utilisation of raw materials from fish, chicken and vegetables with cycle thinking and sustainable technological solutions for an efficient and profitably food industry. CYCLE - industry partner Norilia is responsible for development and sales of co-streams from Nortura slaughterhouses. Some of the co-streams are further processed. Chicken co-streams are fully exploited, but there is still potential to increase value by up-cycling, i.e. by processing the material for new applications in high-value-markets.

**Feather meal**

Pressure cooking increases the digestibility of feather keratin, but limits the availability of some amino acids. CYCLE researchers worked on improving the hydrolysis process.
- Autoclaving, NaOH and Na₂SO₃ improved digestibility, but the tested enzymes had no effect
- Solubilised and residual fractions differed in pepsin digestibility and amino acid composition

**Enzymatic hydrolysis**

Enzymatic hydrolysis, originally developed for fish co-streams, was adapted for use with poultry bones.
- For food applications, oil and dried hydrolysates were derived (photos)
- Chicken oil had low oxidation and hydrolysates values, but thermally separated oil had better quality than oil after enzymatic hydrolysis (Tveit 2014)

**HTC**

The residues from enzymatic hydrolysates of poultry bones were treated with hydrothermal carbonization (HTC 190-210°C, <50 bar in aqueous suspension).
- Distribution of the P and N between the liquid and solid phase can be controlled by adjusting process temperature and pH
- HTC yielded between 43 and 65% biochar
- The solid fraction can be utilised as feed ingredient, soil amendment, fertilizer or energy source (photo)
- Nutrients can be recovered from the liquid fraction

**REFERENCES**

Carvajal, A.K. et al. 2016. Improved utilisation of raw materials in the supply chain for food with a bio-economical perspective (2013-2016) was funded by the Norwegian Research Council and is supervised by SINTEF Fisheries and Aquaculture.

Nortura SA is a cooperative owned by 19,000 farmers. Nortura-owned Norilia AS is responsible for development and sales of co-streams from slaughtering of beef, pork, lamb and poultry at the Nortura slaughterhouses.

**Upcycling**

Norilia is planning to invest in a hydrolysis plant for poultry bones in Hærland. A separate plant for hydrolysis for category 3 material is an option. Further development and implementation of CYCLE research may significantly improve resource utilisation and improve environmental sustainability in the chicken value chain by up-cycling co-streams and thereby improving the profitability for Nortura/Norilia.

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**CYCLE industry partner**

**Nortura / Norilia**

Photo: Adler S., NIBIO

Robot

Automated concepts have been developed for an efficient and precise sorting of raw materials and co-streams.
- The Gribbot (photo) is successful in both scraping the carcasses and harvesting the fillet including the tendons. The entire procedure takes 4-75 seconds (Miskini et al. 2016)

Online analysis

CYCLE researchers have developed VIS, NIR and X-ray based sensor systems for quality differentiation of raw materials and co-streams.
- Mapping of fat and protein in poultry bones (photo)
- Collected data can be used to steer hydrolysis of the material

Photo: NIBIO

CYCLE researchers worked on improving the digestion and amino acid composition of poultry bones more efficiently. Themapping of the P and N between the liquid and solid streams yielded more efficient digestion and amino acid composition of poultry bones. The mapping of the P and N between the liquid and solid streams yielded more efficient digestion and amino acid composition of poultry bones.

Photo: Adler S., NIBIO

Photo: NIBIO

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