NORSØK

Norwegian Centre for Organic Agriculture

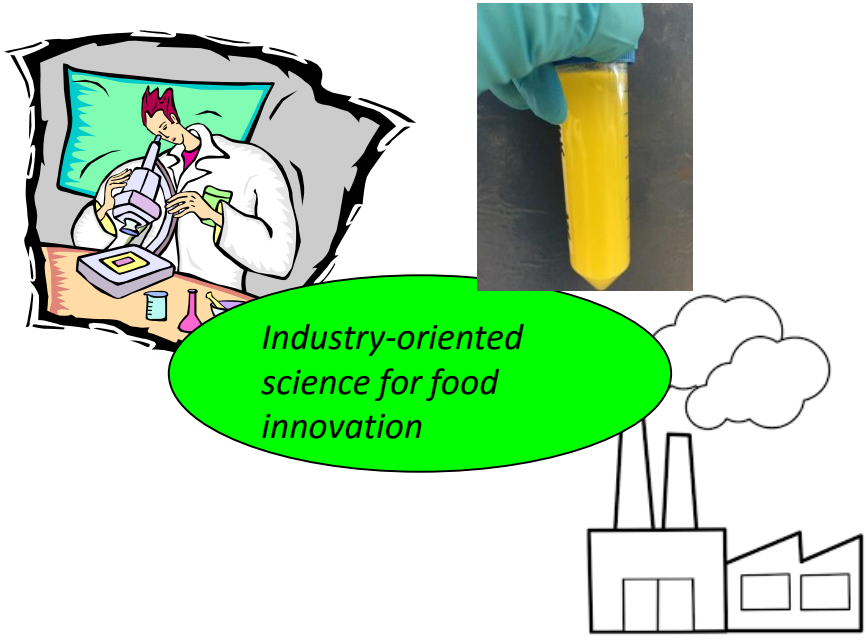
Upcycling food industry co-streams: Feed and fertilizer products

NoRest Conference, Copenhagen October 25, 2016

Anne-Kristin Løes, CYCLE WP3

CYCLE

CYCLE project (2013-16): Processing co-streams from ***food industry*** to design innovative food, feed and fertilizer products



BACKGROUND:

We throw away 50% of our food…..

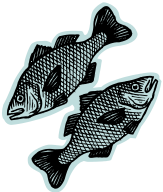
CYCLE aims at reducing food waste by increasing resource utilization in the food industry

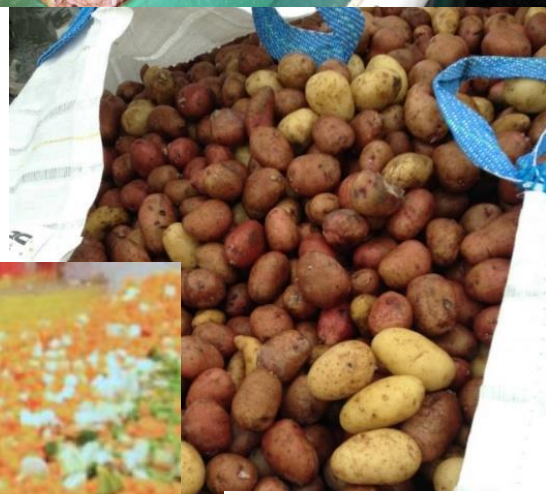
CYCLE

Chicken, vegs and fish

Scientists co-operate with industry partners in three important Norwegian food chains:

- Chicken
- Vegetables and potatoes
- White and pelagic fish

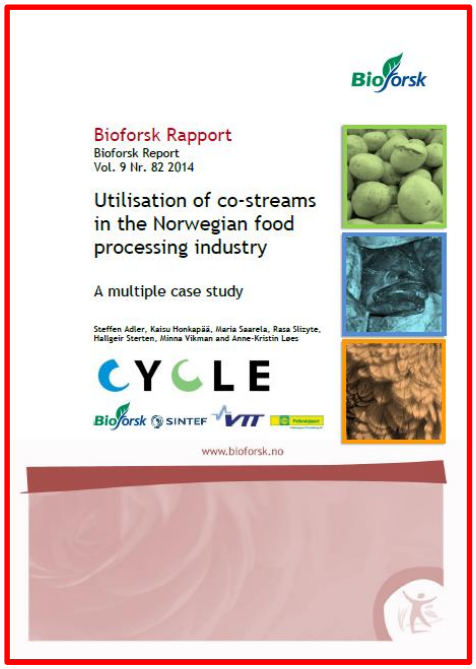




Residual terminology

- Waste: To be discarded; food waste has negative connotations
- Loss: Decrease in mass of edible food along food chain
- Co-streams: By-products or residual raw materials, resources for further utilisation

Further reading:



CYCLE team touring Norway June 2013; here at Norilia chicken slaughterhouse

CYCLE

NORSØK
Norwegian Centre for Organic Agriculture

Products studied in WP3

- Eggshell for liming
- Feathers for protein feed
- Left-over potatoes and vegetables for feed
- Residual soil/sludge for fertilizer after composting
- Bone residues for P, N fertilizer, hydrochar
- Digestate for hydrochar
- Seaweed for hydrochar

Feathers: Topic for Steffen Adler's CYCLE post-doc

NIBIO
NORSK INSTITUTT FOR BIOØKONOMI

NORSØK
Norwegian Centre for Organic Agriculture

CYCLE

Eggshell for liming

- 800 tons available annually at Norilia, Revetal
- Effect on soil pH comparable to traditional limestone (pH 6.1 → 6.3)
- Ca-AL in soil increased much more with eggshell (109 → 160 mg/100 g soil vs no change for traditional lime)
- Indicates higher bioavailability of minerals in eggshell
- Likely better to use for food or feed application than liming

8 g eggshell per egg

Field trial with Jon Erik Knotten, Re, Vestfold 2013

Nortura norilia Norsk Landbruksrådgiving

NORSØK Norwegian Centre for Organic Agriculture

CYCLE

Feathers for protein feed

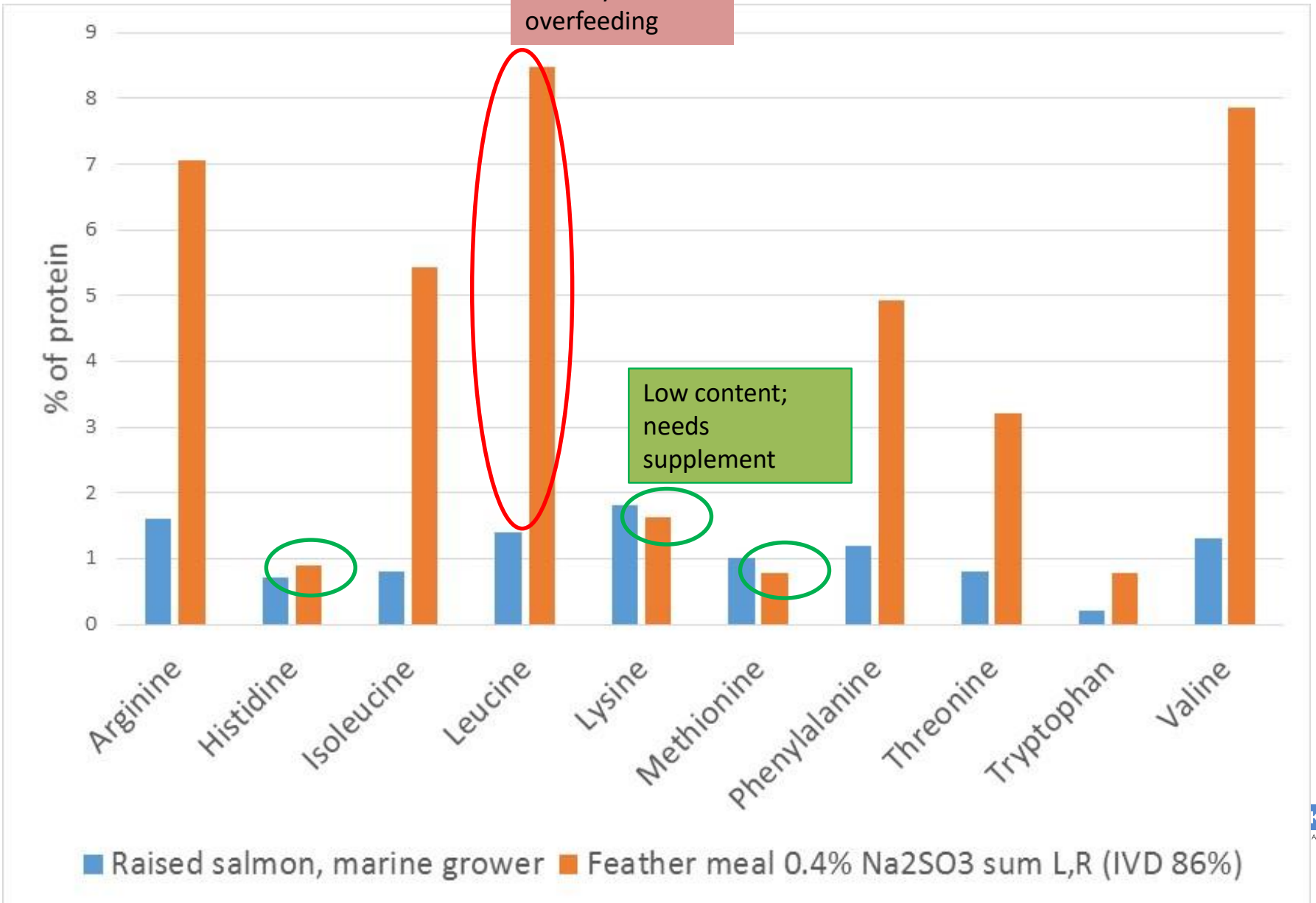
- Feathers cut, mixed with degrading enzymes, hydrolyzed with NaOH and Na_2SO_3
- Amounts of dissolved (L) and residual (R) proteins analyzed by freeze-drying
- In vitro pepsin digestibility (IVD) measured
- Amino acid composition analyzed

NIBIO
NORSK INSTITUTT FOR BIOØKONOMI

Nortura norilia FK VTT SINTEF NORSØK Norwegian Centre for Organic Agriculture

CYCLE

Essential amino acid requirement for salmon vs. content in feather meal



Left-over potatoes and vegetables for feed

- First step: Potatoes compressed in round bales as silage, with beet pulp
- Good quality feed analyses after 12 weeks
- Challenging, but possible to make compressed potatoes stick together

PRODUSENT PAKKERIET Trøndelag AS

Orkel

NIBIO NORSK INSTITUTT FOR BIOØKONOMI

VTT

SINTEF

NORSØK Norwegian Centre for Organic Agriculture

CYCLE

Left-over potatoes and vegetables for feed

- Second step: Spin-off project SOCAPRO (RFF MIDT)
- Ensiling may improve feed value and extend shelf life
- Potatoes (2) and carrots (3), with wheat bran (4) and hay (5)
- Probiotic bacteria can have beneficial effects on gut health in e.g. pigs and calves
- Studies of pH, runoff, bacteria survival, palatability

PRODUSENT PAKKERIET Trøndelag AS

Orkel

NIBIO NORSK INSTITUTT FOR BIOØKONOMI

VTT

SINTEF

NORSØK Norwegian Centre for Organic Agriculture

CYCLE

Residual soil/sludge for fertilizer after composting

- Out-sorted potatoes and residual soil are currently deposited for plant safety reasons
- Better option: Reactor-composting for cheap sanitation?
- To be studied at Skjetlein in cooperation with GGE
- Two proposals for spin-off projects; no funding

Colorado beetle

Compost reactor

High temp (55 °C) in decomposing horse manure

Cysts from potato nematode

SINTEF

CYCLE

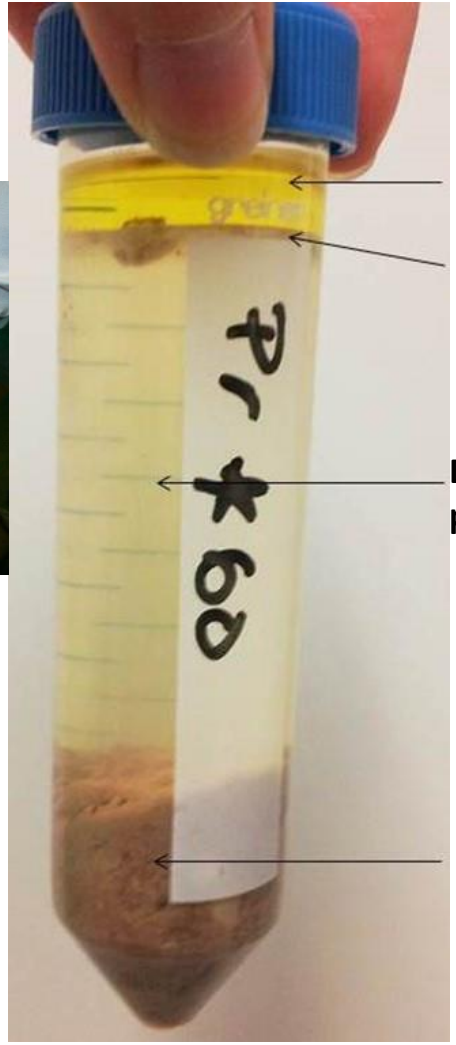
SKJETLEIN VIDEREGÅENDE SKOLE

GGE GLOBAL GREEN ENERGY AS

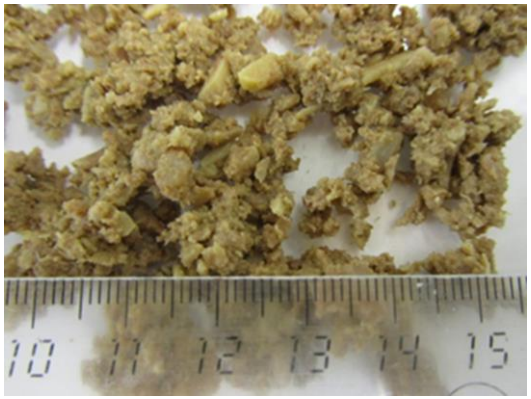
NORSØK Norwegian Centre for Organic Agriculture

Bone residues for P, N fertilizer: Hydrochar

- De-meated chicken bones (from mechanical deboning of meat) were ground for hydrolyzation of oil and proteins
- Sediment rich in C, N and P, high content of minerals
- Hydrothermal carbonization (HTC) can be used to produce stable liquid and solid phase (hydrochar)
- A chemical process simulating natural coal formation
- “Pressure boiling” of aqueous organic substrates at moderate temperatures: 180-250 °C, 14-200 bars

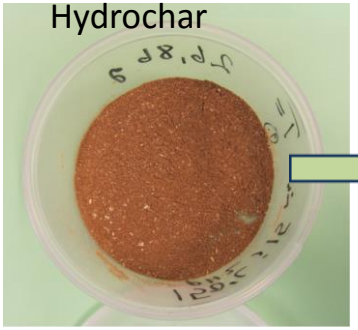


HTC of chicken co-streams



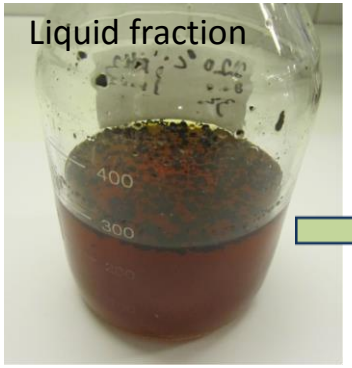
Sediment after hydrolysis

Reactor for hydrothermal carbonization



Hydrochar

Fertilizer, soil amendment

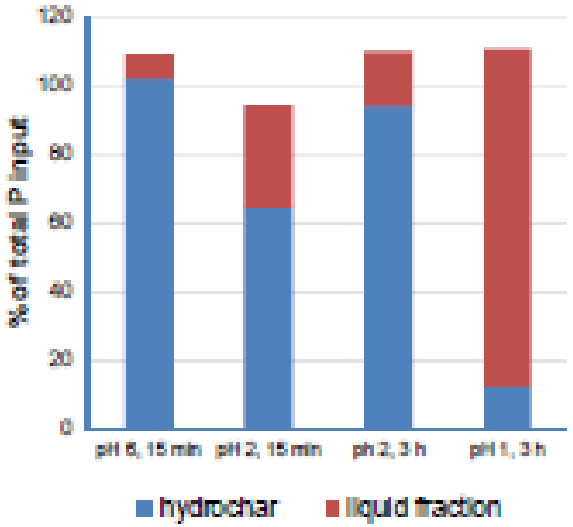


Liquid fraction

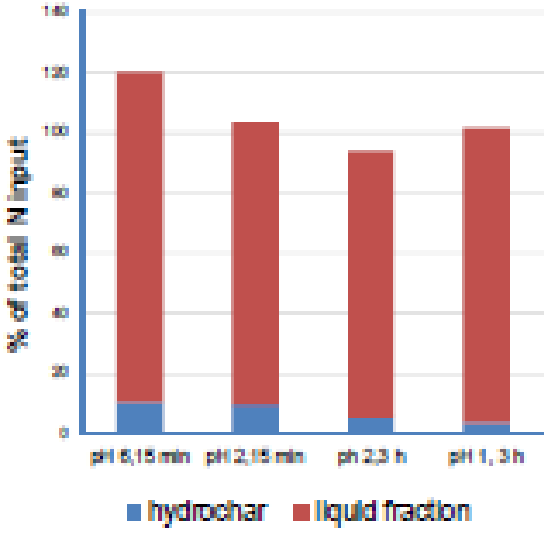
Nutrient (P,N) recovery from liquid fraction – more research needed

The distribution of nutrients in hydrochar and liquid can be controlled by processing conditions (time, temperature, pressure, pH)

Distribution of P and N in hydrochars and liquid with different processing pH



P in hydrochar unless dissolved in acid at pH 1



N in liquid

Thanks to all contributors, co-authors and the funding body:

Steffen Adler, NIBIO
John Ingar Øverland, Norwegian Agricultural Extension Service
Rasa Slizyte, SINTEF
Judit Sandquist, SINTEF
Kaisu Honkapää, VTT
Minna Vikmann, VTT
Hanne Wikberg, VTT
Astrid Oberson, ETH
Gregor Mayer, ETH