Upcycling food industry co-streams: Feed and fertilizer products

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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
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
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
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
Feathers for protein feed

- Feathers cut, mixed with degrading enzymes, hydrolyzed with NaOH and Na$_2$SO$_3$
- Amounts of dissolved (L) and residual (R) proteins analyzed by freeze-drying
- In vitro pepsin digestibility (IVD) measured
- Amino acid composition analyzed

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

- Toxic by overfeeding
- Low content; needs supplement
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
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
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

Cysts from potato nematode

Colorado beetle

Compost reactor

High temp (55 °C) in decomposing horse manure
Bone residues for P, N fertilizer: Hydrochar

- De-meat ed 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
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
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