Thermophilic anaerobic digestion of cattle manure and improving the hydrolysis yield

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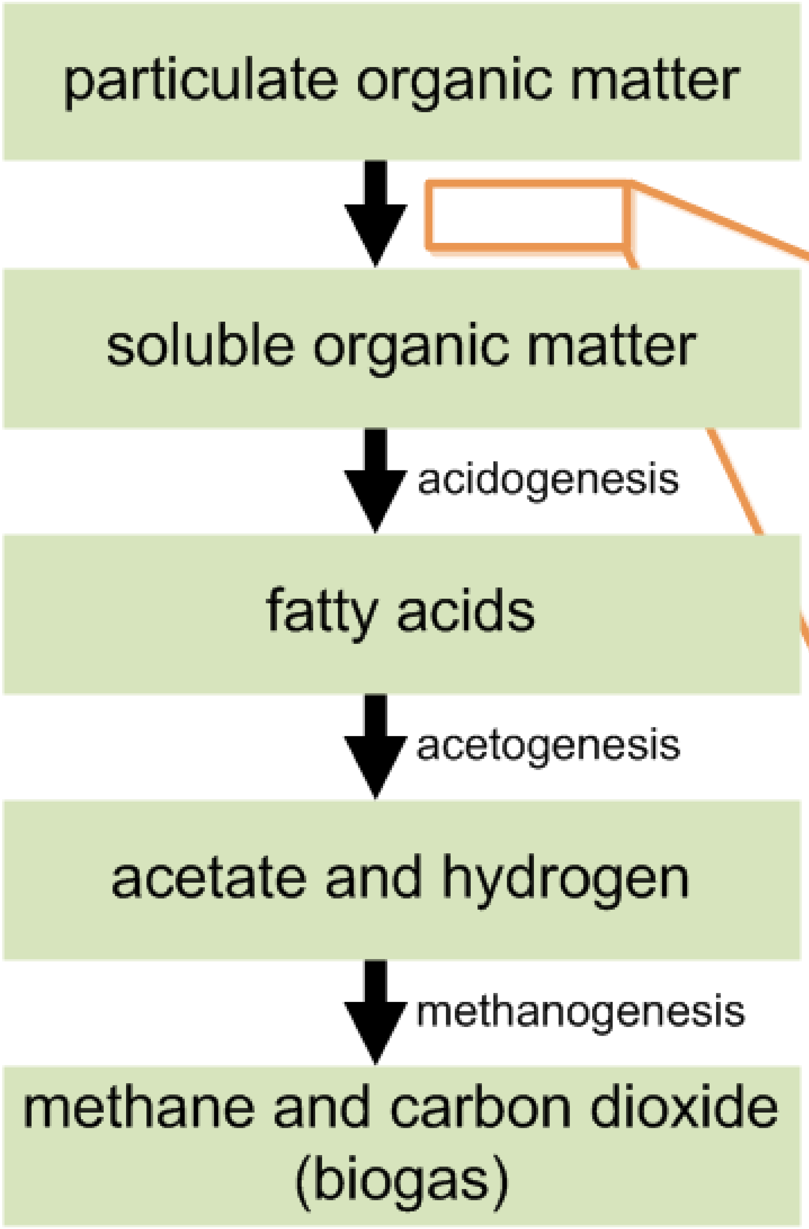
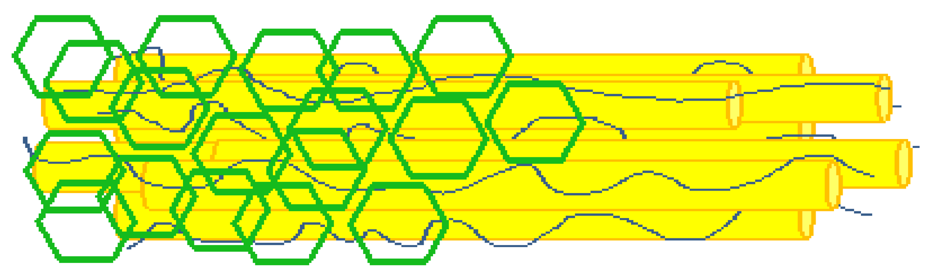
Research objectives

- Optimization of thermophilic anaerobic digestion of cattle manure
- Increase the biogas production based on a deeper understanding of the microbial metabolism



Is hydrolysis of lignocellulosic material (rate-)limiting?



Research directions

- Characterize the substrate and the changes it undergoes during thermophilic anaerobic digestion:
  - What fraction of the lignocellulosic material is hydrolysed?
  - What are the ratios cellulose : hemicellulose : lignin before and after digestion?
- Does lignin inhibit cellulase activity?
- Can organisms producing hydrolytic enzymes, and thereby their enzyme excretion, be stimulated by:
  - adjusting micro and macro nutrient availability[4]
  - addition of other substrates
  - selection of process conditions
- Can hydrolysis be enhanced by addition of enzymes?

Background

- Due to global warming and the depletion of fossil fuels, there is a trend towards renewable energy sources, such as solar power, bio-ethanol and biogas
- Anaerobic digestion is an established technology for:
  - waste management
  - energy recovery as biogas [1, 2]
- Although a proven technology, research is required to increase biogas yields and productivity
- Hydrolysis of lignocellulosic material is expected to be the (rate-)limiting step [3]

Expected outcome

- Hydrolysis of lignocellulosic material is (rate-)limiting
- Increased biogas yield and productivity as a result of an improved insight in the microbial community, esp. the organisms responsible for hydrolysis of lignocellulosic material

Figure 1: Dairy cow stable with saw dust bedding material.

1. Seghezzo, L., Zeeman, G., Van Lier, J. B., Hamelers, H. V. M., Lettinga, G. (1998) A review: the anaerobic treatment of sewage in UASB and EGSB reactors. Bioresource Technology. 65 (3), 175 – 190.
2. Ward, A. J., Hobbs, P. J., Holliman, P. J., Jones, D. L. (2008) Optimisation of the anaerobic digestion of agricultural resources. Bioresource Technology. 99 (17), 7928-7940.
3. Angelidaki, I. and Ahring, B.K. (2000) Methods for increasing the biogas potential from the recalcitrant organic matter contained in manure. Water Science and Technology. 41 (3), 189-94.
4. Demirel, B. and Scherer, P. (2011) Trace element requirements of agricultural biogas digesters during biological conversion of renewable biomass to methane. Biomass & Bioenergy. 35 (3), 992-998.

Figure 2: Thermophilic anaerobic digester (Sävsjö); source of inoculum and substrate for the present research.

Process steps

1. Storage (3 d at ambient temperature; not in picture)
2. Hygienization (1 h at 70 °C; not in picture)
3. Anaerobic digestion in a continuously fed stirred tank reactor (25 d at 52 °C)
4. Post-digestion/storage (46 °C)
5. Biogas upgrading to automotive fuel.

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