Microbes in waste management make our blue planet greener

Heribert Insam
Univ. of Innsbruck, Austria

The superchallenges of the 21\textsuperscript{st} century

(W. Verstraete ®)

1. Increase of atmospheric \( \text{CO}_2 \)  
   \( \rightarrow \) Global Warming

2. Energy crisis

3. Sustainable use of resources (water, soil, phosphorus, etc. etc.)
Microbial Resource Management

• Biomethanisation
  (Pretreatment, microbiota, modelling)
• Advanced products
  (Lactate, protein)
• Wastewater treatment
  (DEMON®️, co-fermentation)
• Soil effects
  (biomass ashes, digestates)
Microbial Resource Management

- **Biomethanisation** (Pretreatment, microbiota, modelling)
- Advanced products (Lactate, protein)
- Wastewater treatment (DEMON®, co-fermentation)
- Soil effects (biomass ashes, digestates)
Pretreatment strategies for lignocellulosic wastes

Cellulosomes
Rumen fluid
>30% increase in CH4

Dr. Podmirscheg
Neocallimastix
Neocallimastigomycota – culture collection
**Neocallimastix frontalis**, a- b: Mycelium and sporangia in different growth stages up to containing zoospores (light micr.). c: Sporangia stained with Calcofluor white. d: Sporangia stained with DAPI, nuclei visible in the sporangia and the mycelium. (Leis
60 plants world-wide

Thermo-Gas-Lift + Swip-swap technology

BIO-2-GAS
Microbial Resource Management

• Biomethanisation
  (Pretreatment, microbiota, modelling)
• Advanced products
  (Lactate, protein)
• Wastewater treatment
  (DEMON®, co-fermentation)
• Soil effects
  (biomass ashes, digestates)
Valorisation of Biowaste – lactic acid

5g $C_{\text{lactic acid}}$ g$^{-1}$C h$^{-1}$ and a concentration > 30gL$^{-1}$

high biogas potential of the remaining sludge

Probst et al. (2015) (a) A closed loop for municipal organic solid waste by lactic acid fermentation. (b) End-product inhibition and acidification limit biowaste fermentation efficiency; both in  Bioresource Technology
Protein from Black Soldier Fly

Growth rates of larvae (weight)

**Larvae**
- >40% Protein
- >30% Fat

**Pupae**

- 100% hen fodder
- 1/3 digester sludge, 2/3 hen fodder
- 1/2 digester sludge, 1/2 hen fodder
- 2/3 digester sludge, 1/3 hen fodder
- 100% digester sludge
- Organic solid waste

Andreas Walter
Microbial Resource Management

• Biomethanisation
  (Pretreatment, microbiota, modelling)
• Advanced products
  (Lactate, protein)
• Wastewater treatment
  (DEMON®, co-fermentation)
• Soil effects
  (biomass ashes, digestates)
Abwasserreinigung
Filtratwasserbehandlung

Christian Ebner alpS GmbH, Innsbruck.

Kooperation mit ARA Zirl, Inst. f. Infrastruktur

Working Group Microbial Ecology
Anaerobic ammonia oxidation

- Saves energy in WWT
- WWTP turned to powerplant

More than 70 DEMON® - plants worldwide

Foto: Pümpel
Co-fermentation of Wastewater sludge + OFMSW (biowaste)

Priming effect:
30% increase in methane production
25% decrease in residual anaerobic sludge

Insam and Markt (2016) Water Research
Microbial Resource Management

• **Biomethanisation**
  (Pretreatment, microbiota, modelling)
• **Advanced products**
  (Lactate, protein)
• **Wastewater treatment**
  (DEMON®, co-fermentation)
• **Soil effects**
  (biomass ashes, digestates)
Effects of anaerobic sludge and biomass ashes
Biogas slurry:
- Higher nutrient availability
- Reduced pathogens

Biomass ashes:
- Recovery of phosphate
- Lime replacement
- Micronutrient supply

Insam et al. 2015 Soil Biology and Biochemistry 84
Fernandez et al. 2015 Science of The Total Environment 511
Human Welfare and Ecological Footprints compared

Data sourced from:
Global Footprint Network
2008 report (2005 data)
UN Human Development Index 2007/08
Thank you for your attention