Development of System for Waterless Collection of Human Excreta by Application of Lactic Acid Fermentation Process in Terra Preta Sanitation System

4th International Dry Toilet Conference
22 - 25 August, 2012
University of Tampere

Asrat Yemaneh
yemaneh@tuhh.de

TUHH
Hamburg University of Technology
Department of Telecommunications

aww
Institute of Wastewater Management
and Water Protection

Outline

- Background
- Objectives
- Materials and Methods
- Results and Discussion
- Conclusions

Background

- 2.5 billion people worldwide are without access to improved sanitation
- Very rapid increase in urbanization, specially in developing countries, means urban sanitation will become increasingly a challenge
- Conventional sanitation systems are not sustainable solutions

➢ High water consumption, highly capital intensive, nutrients and pathogens are released to the environment causing pollution, not efficient to recover and recycle nutrients

- Sustainable sanitation approach - more than two decades since introduced
- Still works remain to be done to have widely accepted and standardized system specially in urban system

Consideration for further development,

- Cheap and comfortable toilet units suiting to varying settlement conditions
- Hygienization of excreta at the source during collection
- Designing collection systems and further treatments to minimize losses of organic matter and nutrients, and also to maximize resource recycling

Mis-used UDDT – Arba Minch

Unused UDDT – Arba Minch

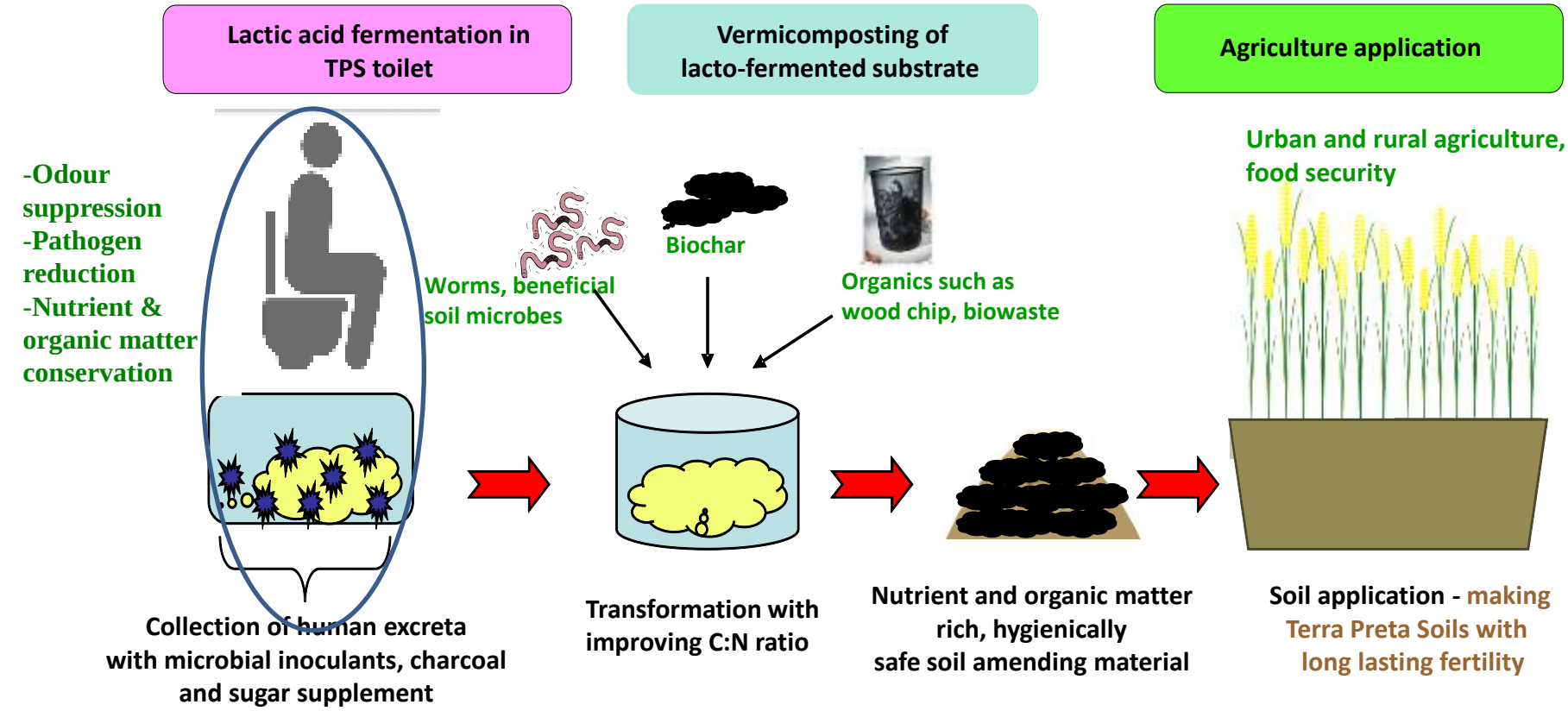
Terra Preta Sanitation (TPS) system

- A concept in sustainable sanitation approach developed based on ancient Amazonian practices which led to the development of ‘Terra Preta’ soils

  - Composed of charcoal (biochar) and composted organics such as excreta and other bio-wastes

- TPS aims in treating and transforming human excreta and other biowastes, to pathogen free humus which is rich in nutrients and organic matter

Terra Preta Soil in Amazon basin (Ulf Rakelmann)



Waterless or low-flush system with filtration

Pathogen free, nutrient and organic matter rich soil amending material

Objectives

- Study the suitability of LAF process as a method for collection and treatment of human excreta in dry toilets
- Specifically effect on:
  - Odour
  - Faecal pathogens
  - Organic matter
- Investigations are conducted to identify suitable lactic acid bacteria inoculants, level of sugar supplement, suitable mode of collection for efficient lactic acid fermentation process

Materials and Methods

- Excreta collected in experimental toilet at TUHH
- Microbial inoculants
- Sugar supplement
- 1L anaerobic fermentation reactors

Considerations:

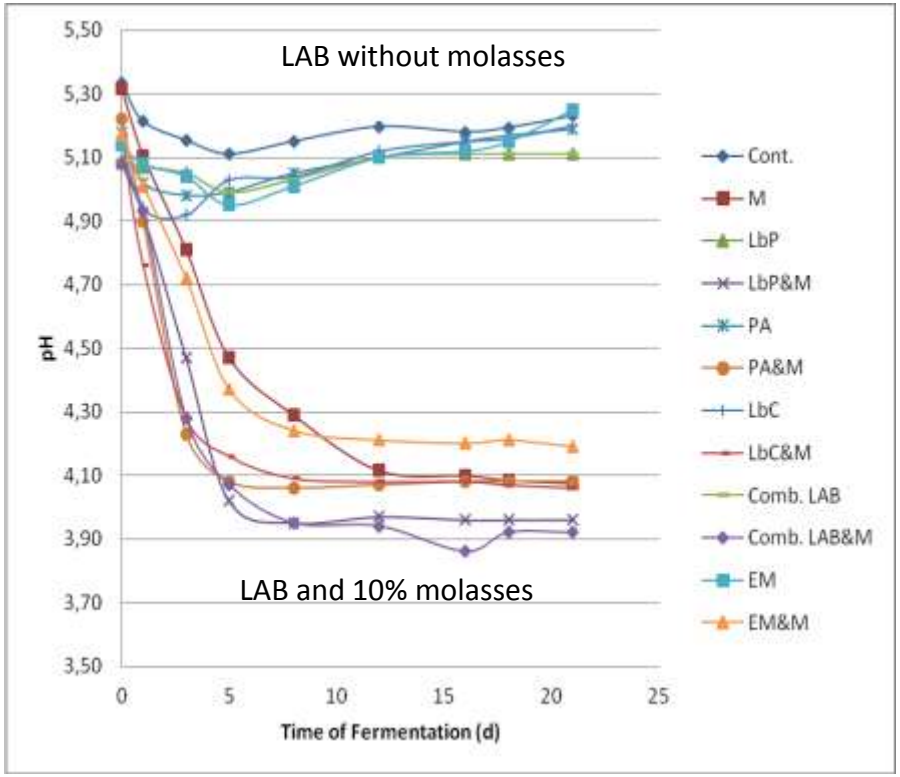
- Batch laboratory-scale fermentation experiments lasting three weeks
- Different collection modes
- Different LAB inoculants
- Sugar supplement variations

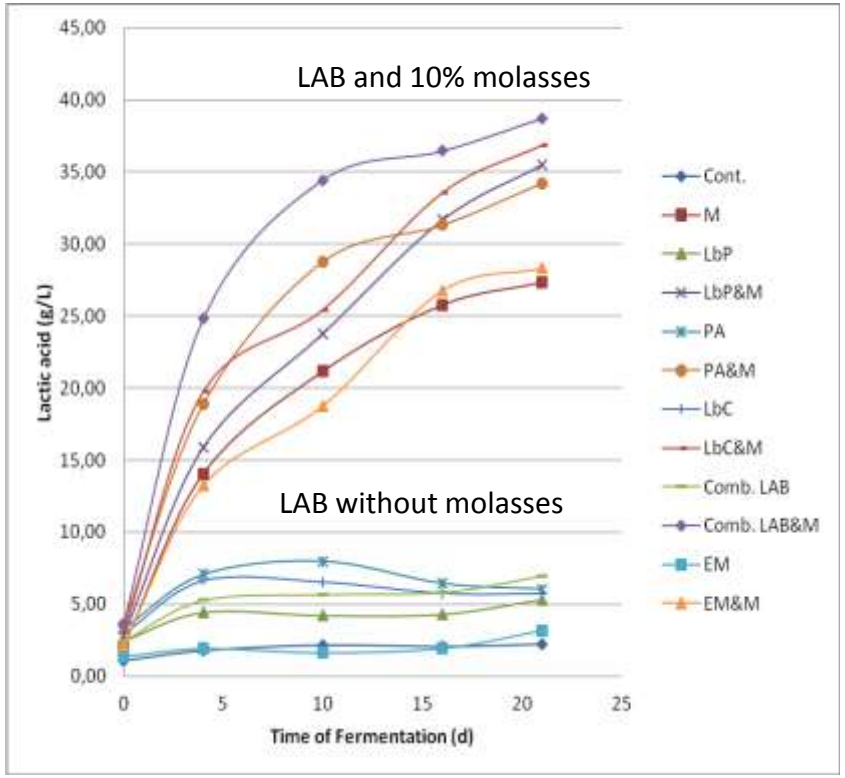
TUHH
Hamburg University of Technology
Department of Telecommunications

aww
Institute of Wastewater Management
and Water Protection

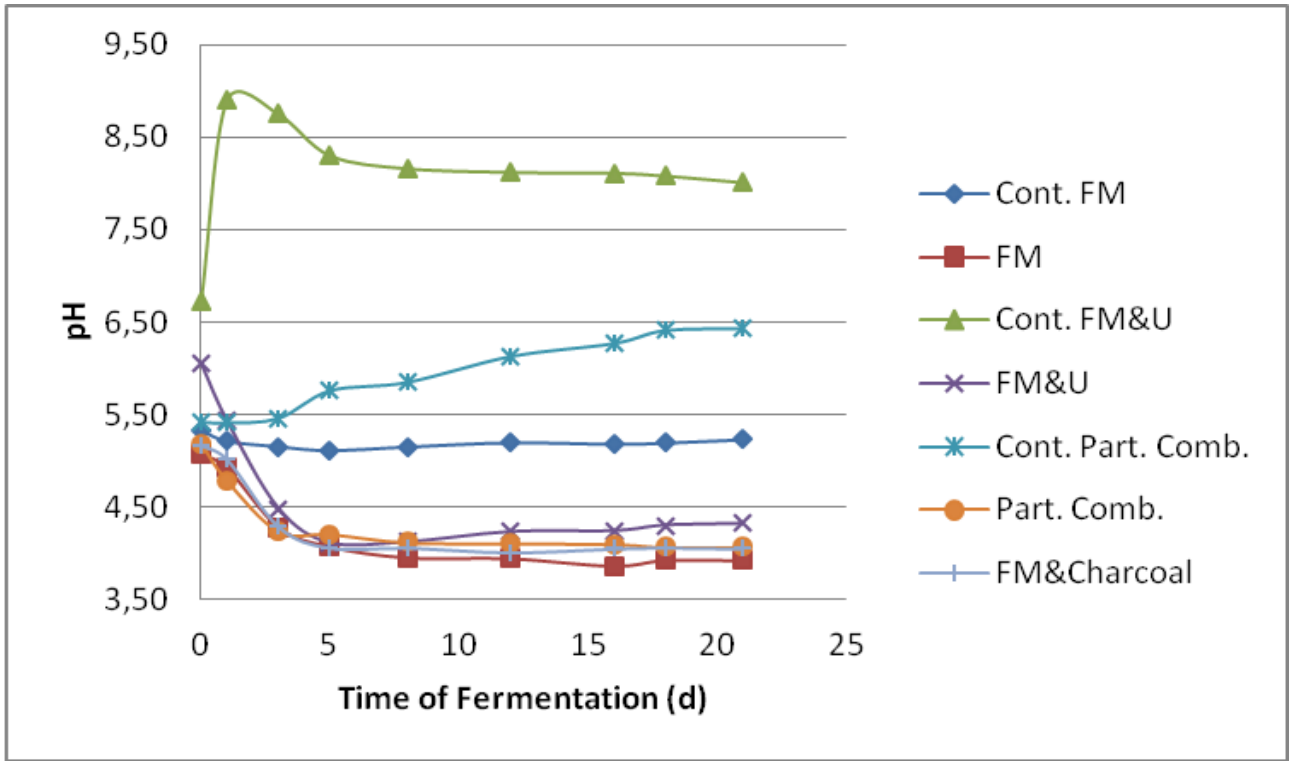
- The efficiency of the system is evaluated by measuring: pH, lactic acid (LA), volatile fatty acids (VFAs), total titrable acidity (TTA), dry matter (DM), volatile solids (VS), E-Coli and subjective sensory odour evaluation

Results and Discussion

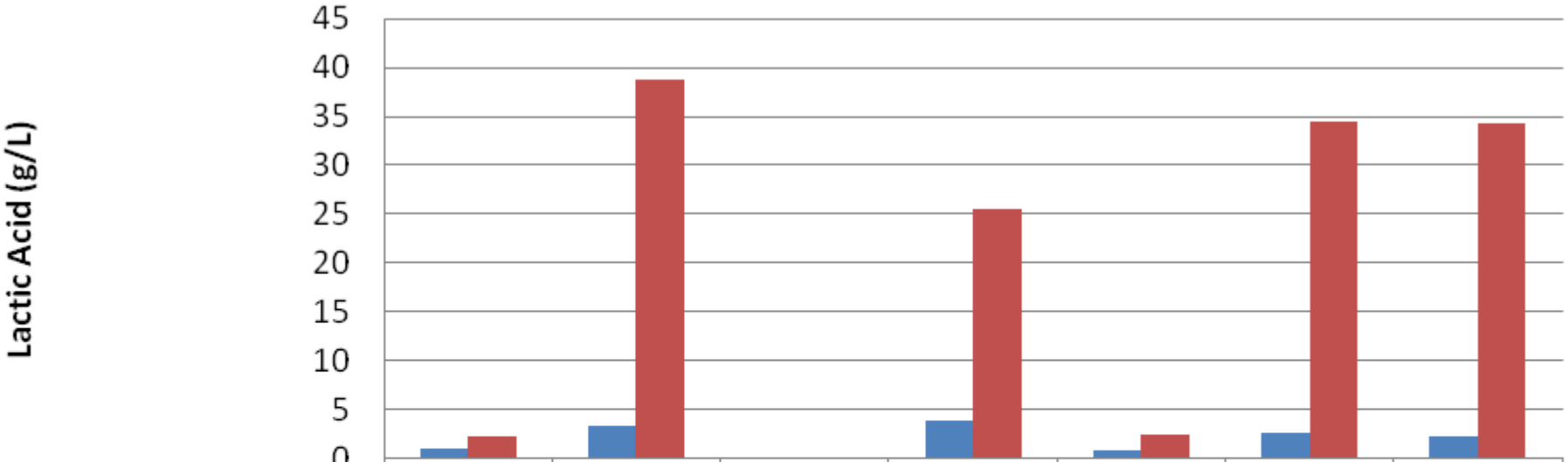




pH and LA during LAF experiments simulating separate collection of FM

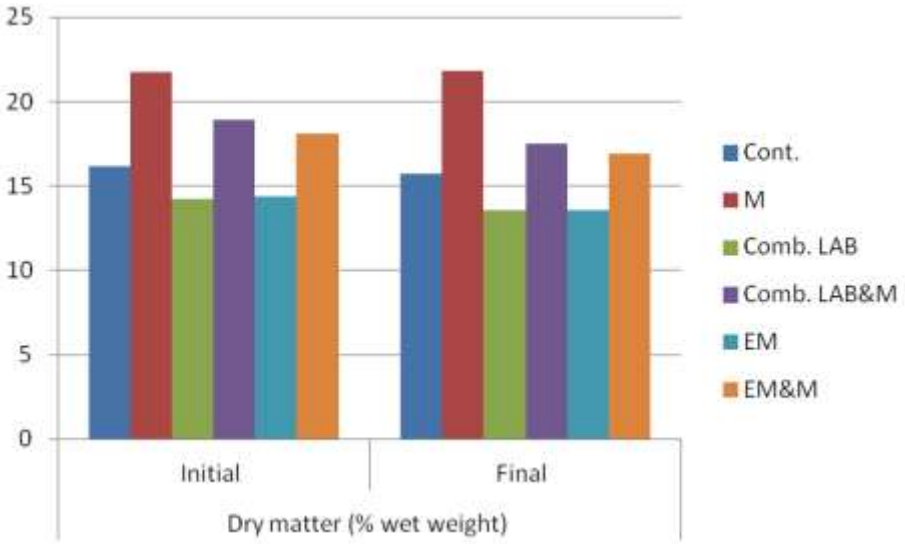


- pH during LAF experiments simulating different modes of human excreta collection

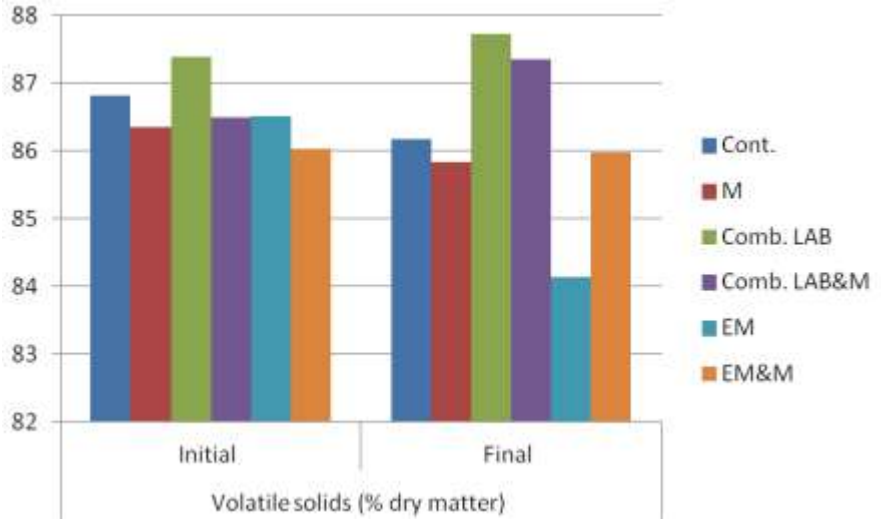


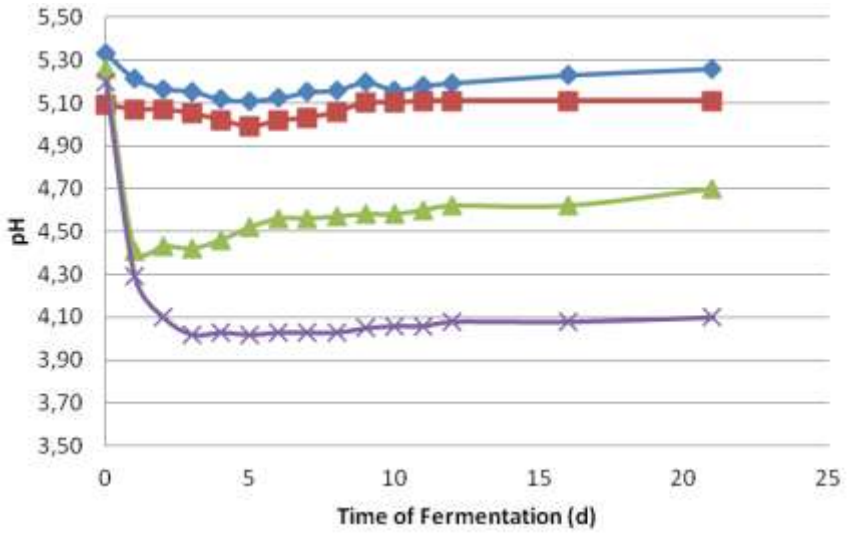
	Cont. FM	FM	Cont. FM&U	FM&U	Cont. Part. Comb.	Part. Comb.	FM&Char coal
Lactic acid (g/L) Initial	1,07	3,38	0,01	3,84	0,85	2,66	2,34
Lactic acid (g/L) Final	2,24	38,73	0	25,56	2,45	34,47	34,35

LA concentration during LAF experiments simulating different modes of human excreta collection

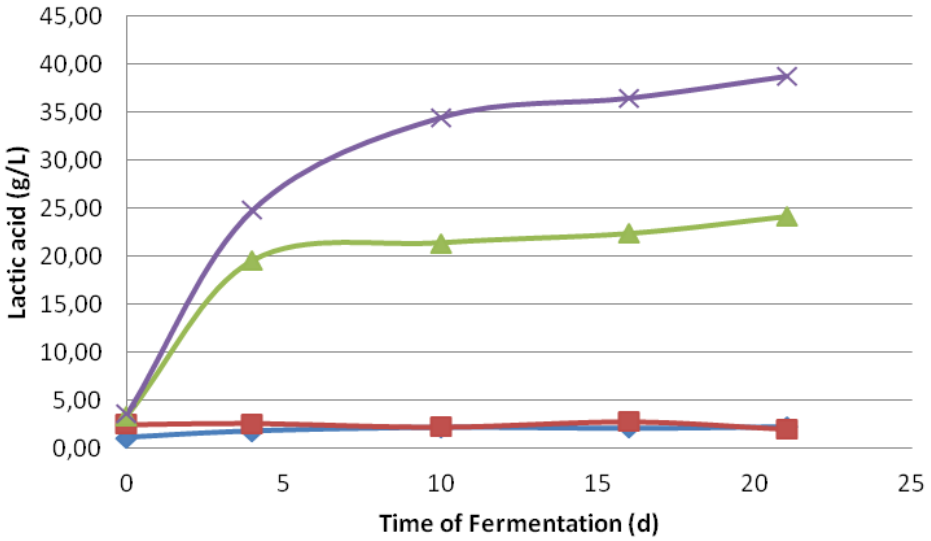


Relatively small dry matter and organic matter loss for treatments with LAB and molasses





pH and LA concentration during LAF experiments for separately collected FM for different level of sugar supplement



- Reduction of pH to around 4 and presence of more than 1.5% lactic acid in the fermentation system for sustained period is considered to help in eliminating faecal pathogens

- Achieved for more than 5% molasses supplement and for separate collection mode and for 10% molasses supplement for combined and partially combined collection modes

Treatment		Time of Fermentation (d)		
		0	5	21
Cont.		3.20E+06	2.60E+06	8.30E+04
LAB		3.10E+06	1.20E+06	6.50E+03
10%M		2.90E+06	3.70E+04	2.00E+02
5%M&LAB		2.30E+06	1.40E+02	Nil
10%M&LAB		1.80E+06	Nil	Nil

- *E-Coli* count (cfu/g) during LAF experiments for separately collected FM for different level of sugar supplement

Odour evaluation

- For experiments without additional molasses faecal odour is not suppressed

- For treatments with LAB or EM and 5-10 % molasses faecal odour is suppressed and replaced by acidic smell

- For treatments with LAB or EM, 10 % molasses and 10% charcoal produced odour free fermentation

Conclusions

- LAF can be applied, in suitably designed toilets, for collection of human excreta with efficient suppression of odors, achieving significant pathogen reduction during collection and also for conserving nutrients and organic matter for further recycling
- Supplementing human waste collection with easily degradable waste sugar sources necessary during collection – addition of 5% to 10% molasses is necessary
- Kitchen biowaste can also be source of sugar but need pre-processing as the carbohydrates in kitchen biowaste are not in their simple forms
- Combined and partially combined collection modes will allow implementation of toilets with only one inlet
- LAF can provide a new way for dry toilets and would facilitate large scale applications

Thank you for your attention!