

Recovery of Lipids from sewage sludge for biodiesel production



Silvia Venditti
University of Luxembourg

30th September 2021 Aquarama

FOG in municipal wastewater

- Lipids (fat, oil, grease – FOG) are present in relevant concentrations in municipal wastewater (30 % of COD): 45 % of the lipids comes from faeces while 55 % from kitchen waste;
- Lipids are present in both liquid and particulate forms;
- Most common lipids are: C18:1 (Oleic acid), C16:0 (palmitic acid), C18:2 (linoleic acid) all known to be favourable for the production of biodiesel;
- The distribution of LCFAs in wastewater varies from 20 to 500 mg/l with an average value of 150 mg/l;
- **35 to 50 g/inhabitant** per day of lipids occurs in sewage sludge;
- Potential annual market supply **3 – 414 10⁴ tons** of extractable biodiesel from wastewater;

Potential

- Particulate lipids: are removed in the sand and fat trap and then disposed at high costs for the operators;
- Dissolved lipids: are used from activated sludge bacteria;

Two possibilities:

- 1) In large WWTPs (> 20.000 PE) activated sludge is digested and biogas is produced → Energy production
- 2) In other wastewater treatment plants, sludge with accumulating lipids is disposed → valuable resources are lost

→ Lipids are not used at their potential

Where we can go

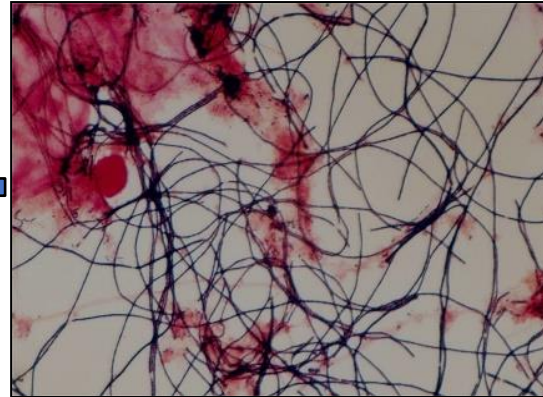
Overall potential:

- 50 g/ inhabitant x d: 18 kg lipids/inhabitant x a
- In NW-Europe around 250 million people are connected to municipal sewage treatment plants
- Total load of lipids in the inflow of municipal wastewater treatment plants: 4.5 million tons per year in total
- In addition: industrial wastewater treatment plants

→ **Impressive potential for biodiesel production from wastewater**



Background



*Bulking and foaming
Is a common **PROBLEM**
in municipal WWTPs*

*Microthrix Parvicella is
known to be responsible for
foaming and bulking*

*Microthrix Parvicella can
accumulate long chain
fatty acids (LCFAs) that
can be harvested for
biodiesel production
OPPORTUNITY*

**Selection of Microthrix Parvicella as a lipid
accumulator in municipal WWTP for the
production of biodiesel**

Main goals of the work

- to investigate the main factors affecting *Microthrix parvicella* growth in WWTPs (lab scale-University of Luxembourg);
- to develop a technology able to select *M. parvicella* (from lab to pilot scale-University of Luxembourg);
- to investigate the ability of *M. parvicella* in accumulating lipids (from lab to pilot scale-University of Luxembourg);
- to characterize the accumulated lipids by *M. parvicella* and their potential (University of Luxembourg-REMONDIS);
- to set up a pilot scale reactor for the selection of *M. parvicella* in a full scale WWTP with the ultimate scope of producing biodiesel (University of Luxembourg-SIVOM);
- to investigate effects of *M. parvicella* selection on conventional treatment.

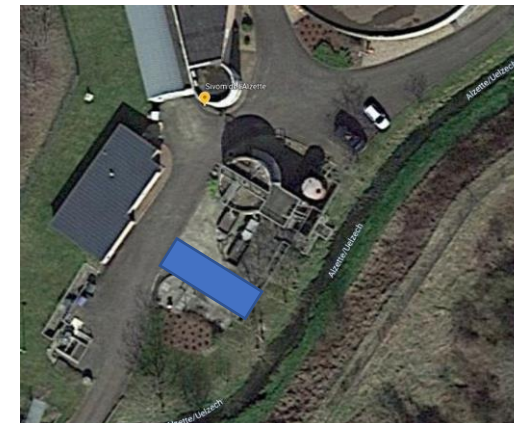
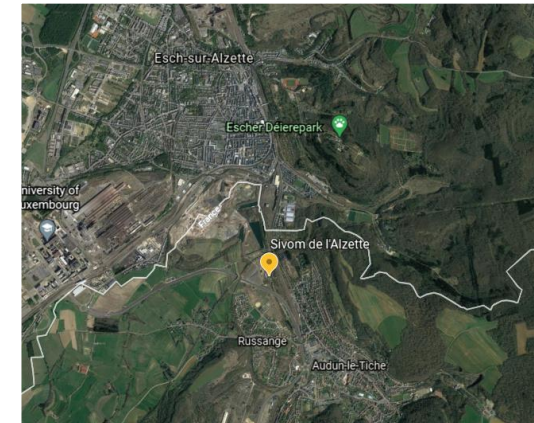
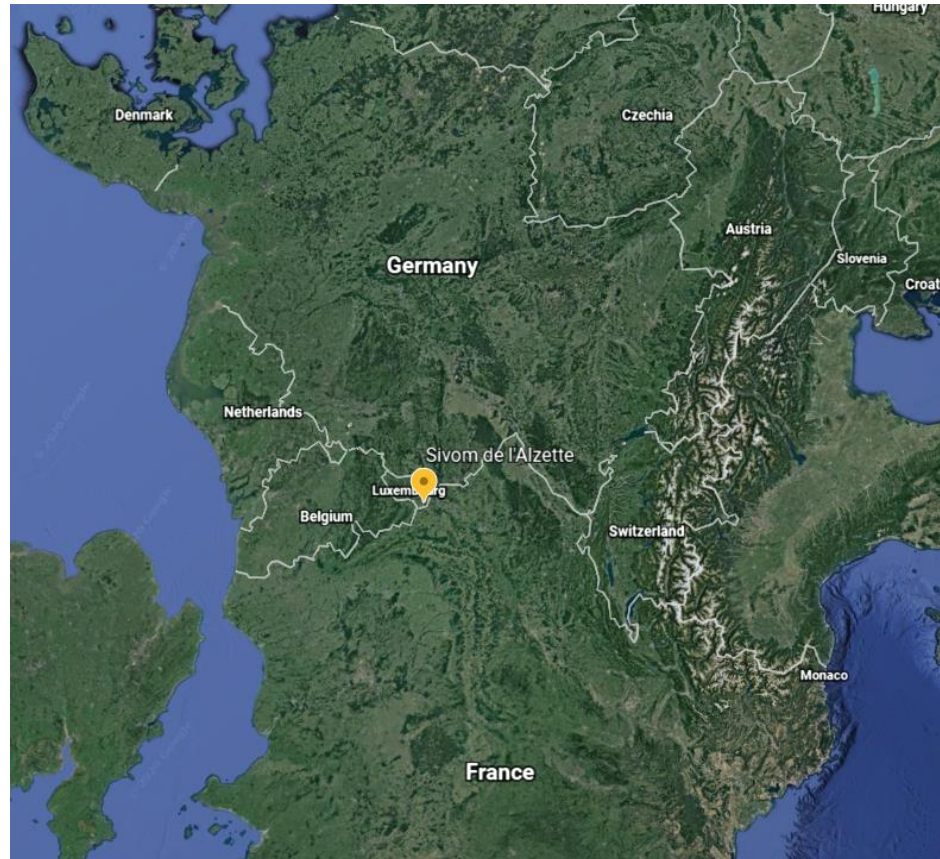


Lipid pilot

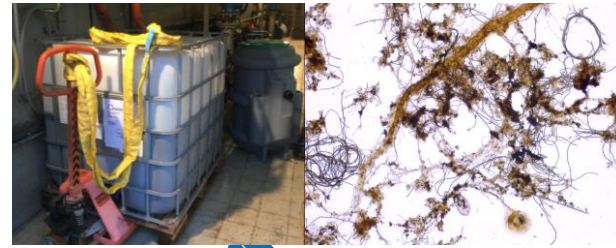
- Operate at up-scale “real conditions” using favourable operational parameters for *Microthrix parvicella* growth and lipid accumulation
- Test settleability of the sludge and recirculation
- Characterize long-chain fatty acids (LCFAs) being accumulated in the set of bioreactors
- Calculate mass balance and evaluate performance of the pilot
- Dispatch sludge samples to Animox (Germany) for development of the lipid extraction protocol
- Dispatch samples of the extracted lipids to the IRSA (Italy) for the transesterification to biodiesel and assessment of biodiesel quality (by Animox)
- Evaluate development of microbial community within the experimental time and in changing seasons at the sewage treatment plant (genomics,



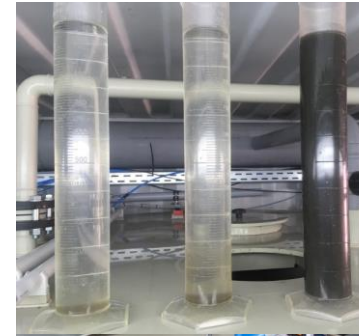
Lipid pilot at the WWTP in Audun-le-tiche



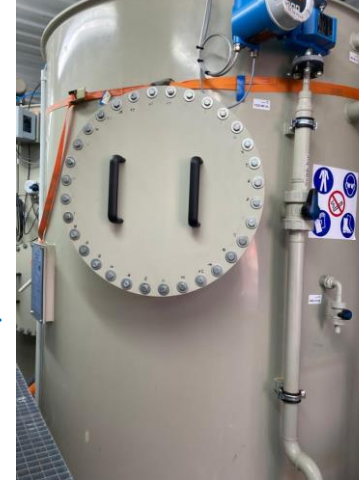
Scheme



Inoculation with surplus sludge (SIVOM)



Inlet water (after screen)



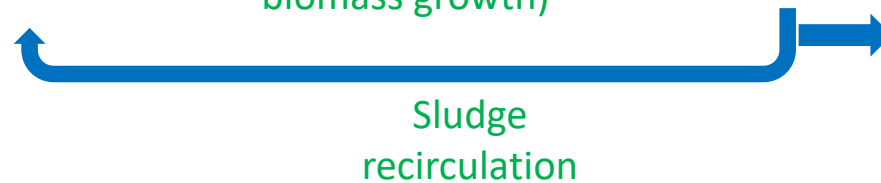
4 m³ Mixing tank (homogenization)

4 m³ Reactor 1 (anoxic, lipid accumulation)

4 m³ Reactor 2 (micro-aerobic, biomass growth)

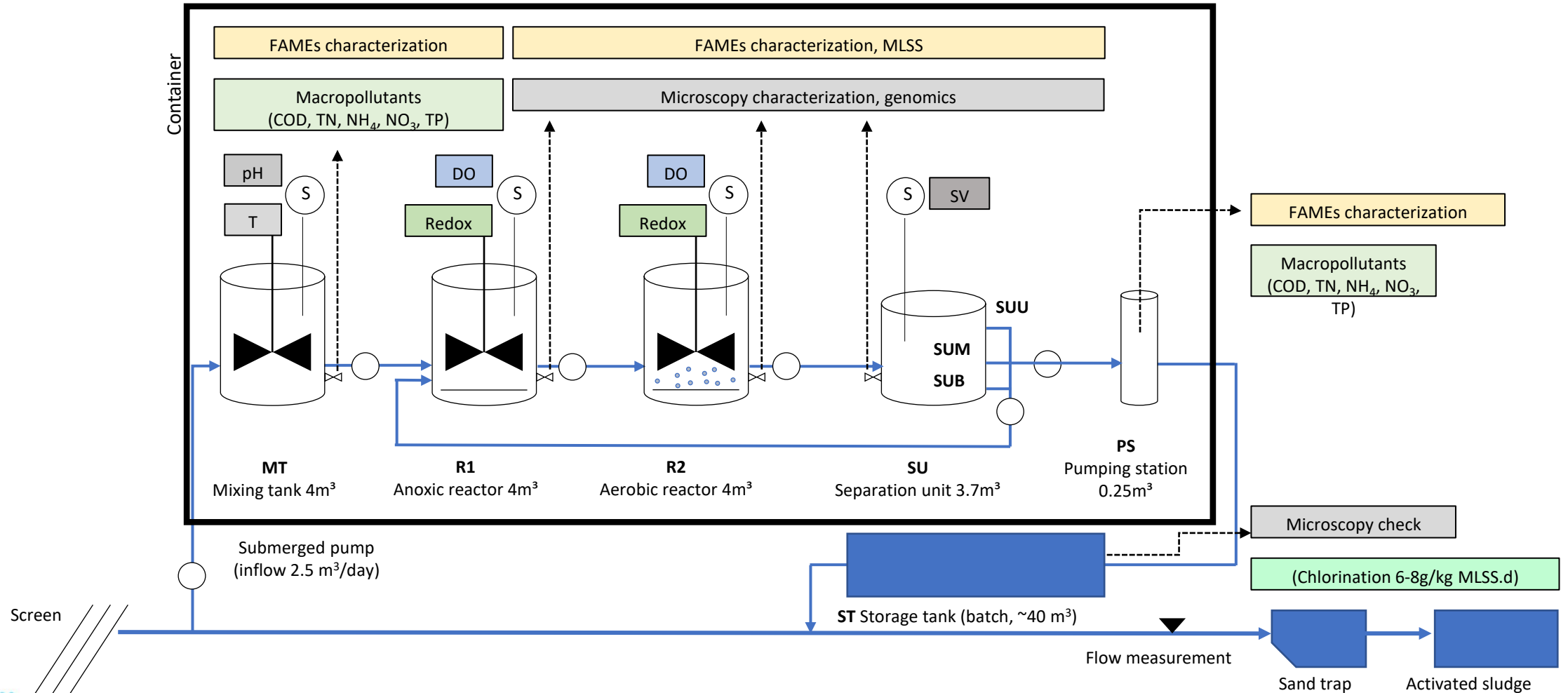
3.7 m³ Separation unit

Storage tank (effluent)



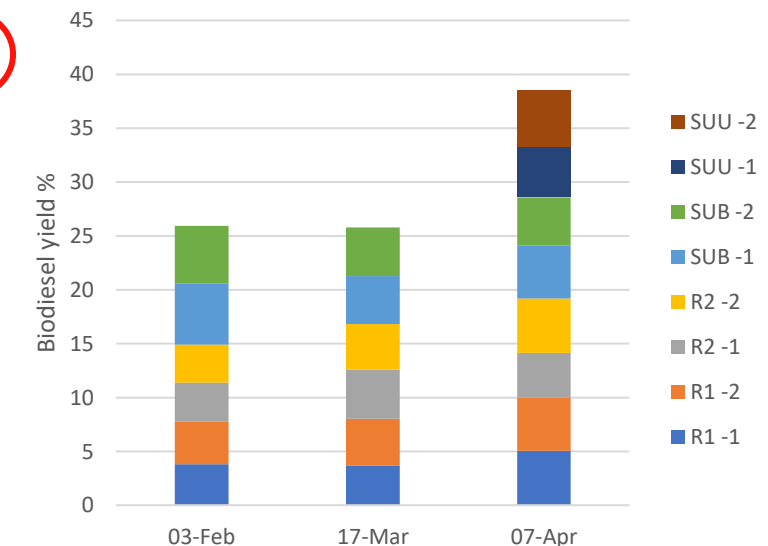
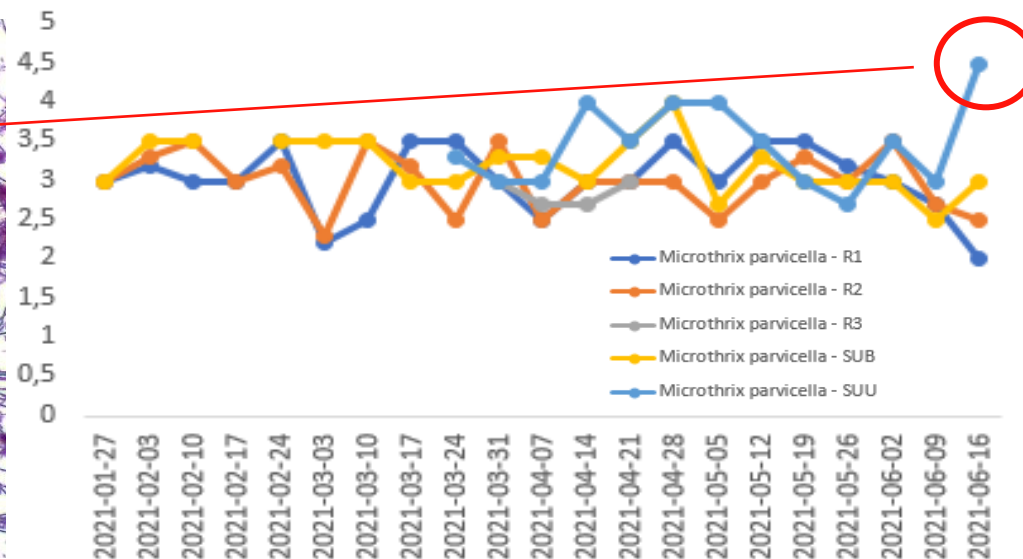
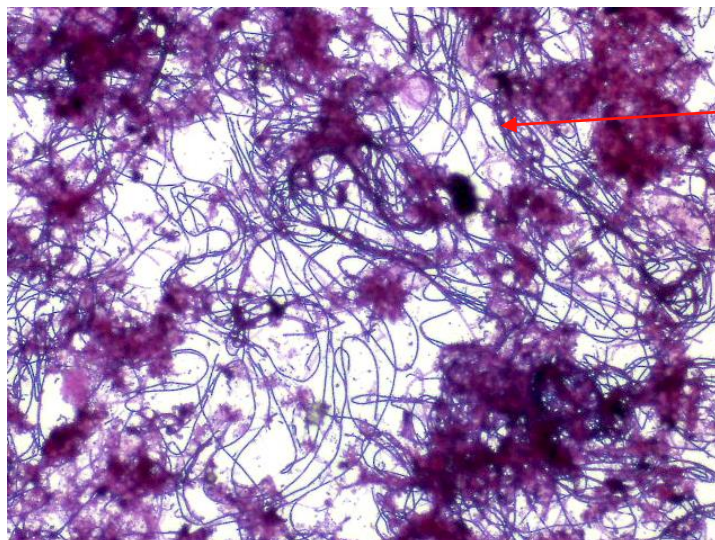
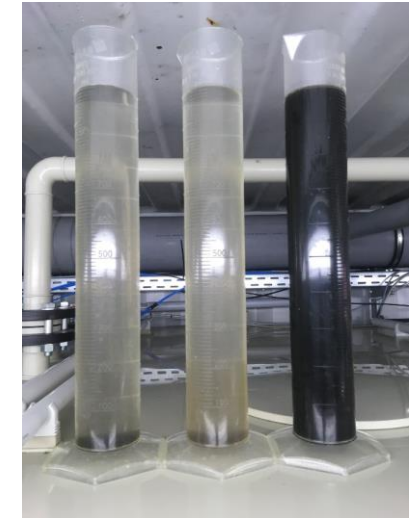
Surplus sludge (lipid enriched biomass)

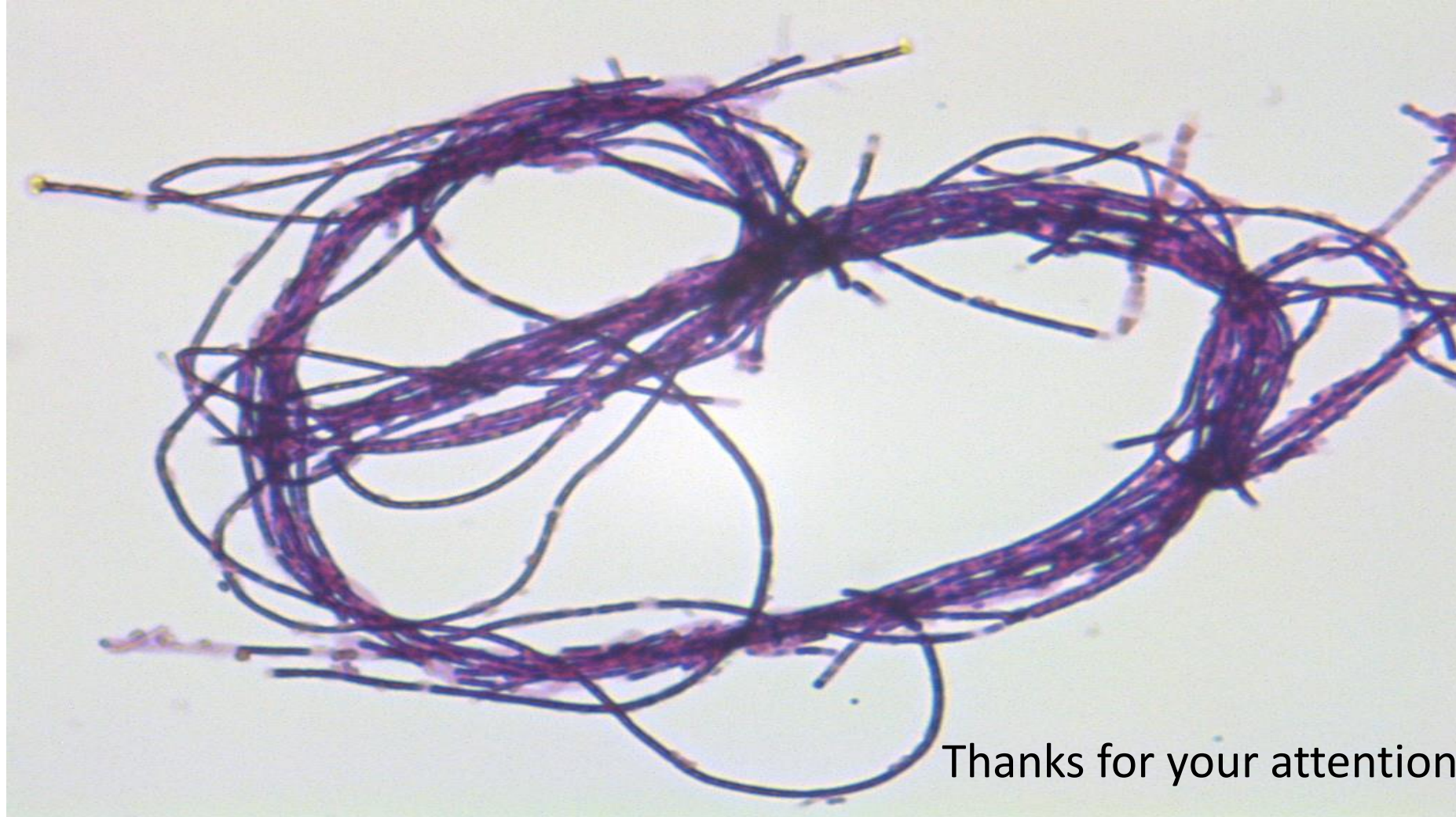
Sampling design



Results so far

- Optimum conditions for *Microthrix* growth and lipid accumulation are maintained (FI 2.5-4)
- Biodiesel yield 4-5.3% (53 mg FAME/g of dry solid) with ~84% transesterification efficiency
- Challenges of the technology
 - Inlet sewage water poor in LCFAs (32-35 mg/l) – specific challenge at WWTP SIVOM (average BOD 93.5 mg/l)
 - Separation of sludge
 - Influence of all parameters in separate tanks
 - Slow growing bacterium
 - Not to carry *Microthrix parvicella* in the following treatment steps





Thanks for your attention