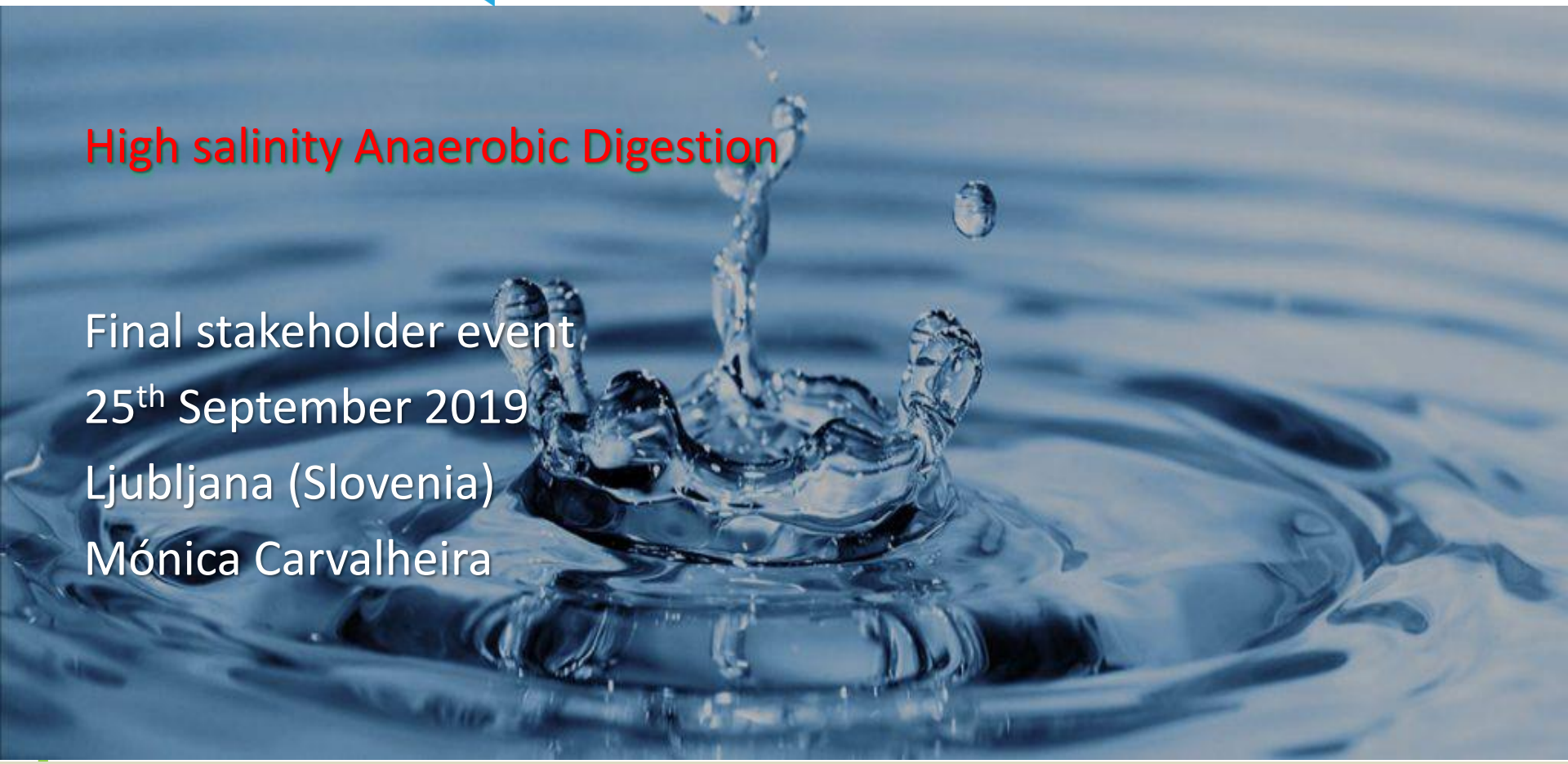
SaltGae

algae to treat saline wastewater



High salinity Anaerobic Digestion

Final stakeholder event

25th September 2019

Ljubljana (Slovenia)

Mónica Carvalheira

H2020-Water-1b-2015

This project has received funding from the European Union's Horizon 2020 Innovation Action programme WATER under grant agreement no 689785

Problem statement

Fig 1. Salted hides (KOTO, Slovenia)

Saline industrial wastewater (WW), such as leather pickling WW, are high organically polluted WW:

- high COD content
- high concentration of salt

Need to be treat to avoid the soil and water contamination

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Saline wastewater treatment

Conventional biological treatment inhibited by salt

Physicochemical processes as alternative

High cost

More economical and feasible alternative

Two-phase Anaerobic Digestion
&
Granular sludge

Advantage

Wastewater treatment & Biogas production

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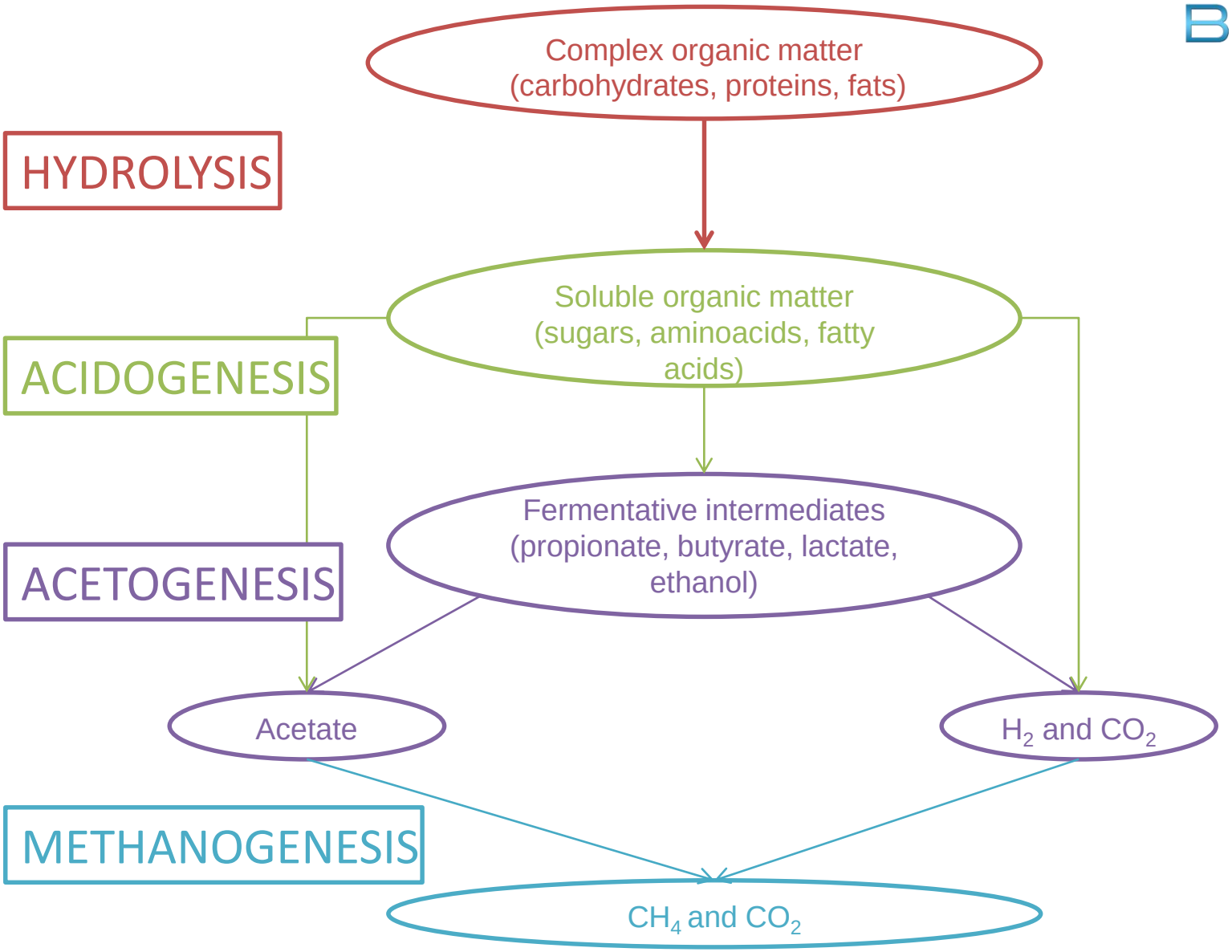
Anaerobic Digestion



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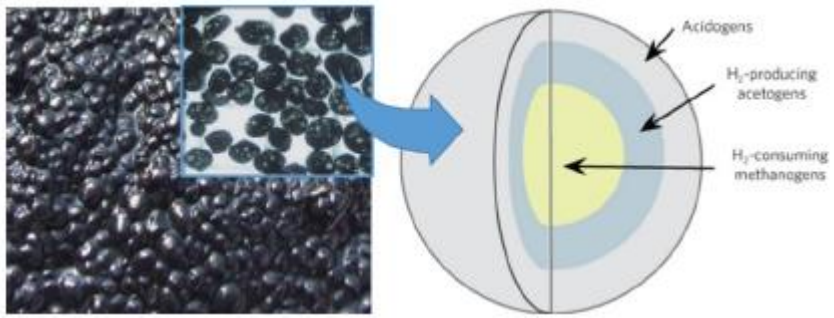
2-phase anaerobic granular sludge process

2-phase anaerobic digestion

- Acidogenic and methanogenic organisms have different pH requirements, growth kinetics, and resistance to environmental stresses
- Separate phases increases stability, higher OLR, higher biogas production rate, and BOD removal efficiency

Granular sludge

- More robust, shielding inner cells from high salinity effect



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Two-phase AD

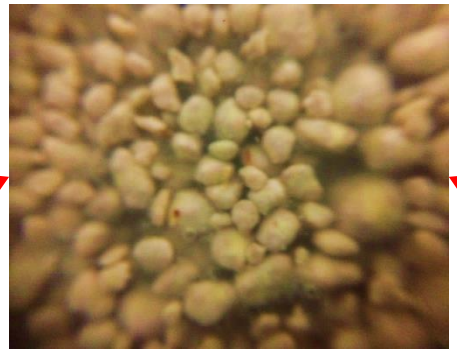
Acidogenic phase

Methanogenic phase

Biogas (CH_4 & CO_2)

VFAs & Ethanol

Wastewater



Anaerobic Granules

Treated Effluent

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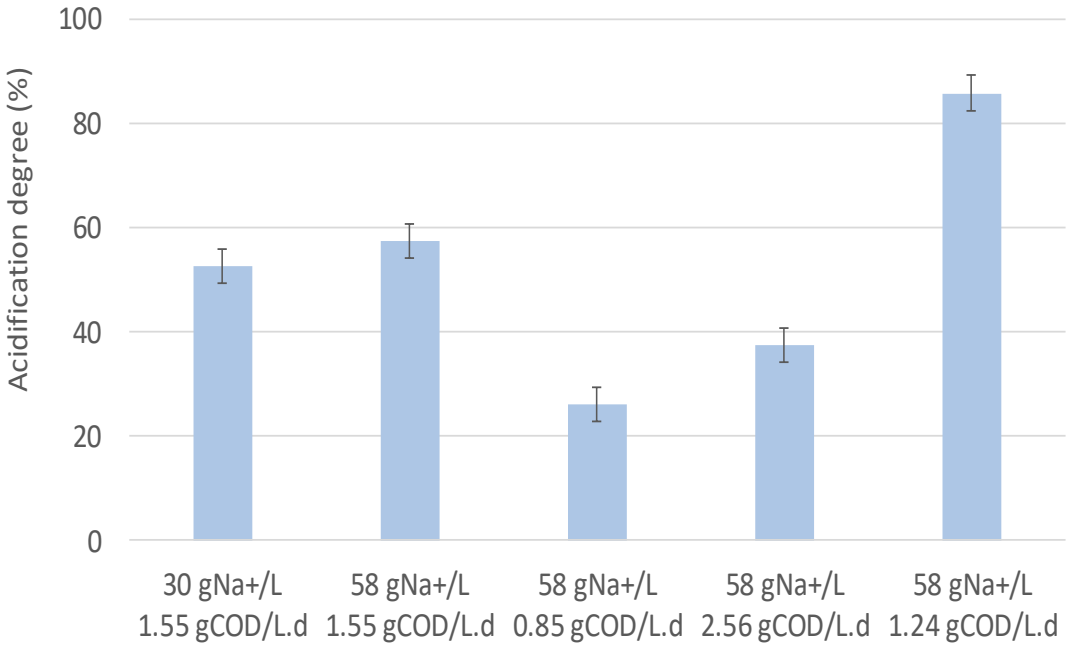
Acidogenic reactor performance



- Operational conditions affect the acidification degree and the profile of the fermentation products.
- Acidification degree up to 80.7±19.2% was obtained with sodium concentrations of 58 g Na+/L at OLR of 1.24 gCOD/L.d and pH of 6.5.

Such a high salinity was never reported in acidogenic UASB bioreactors.

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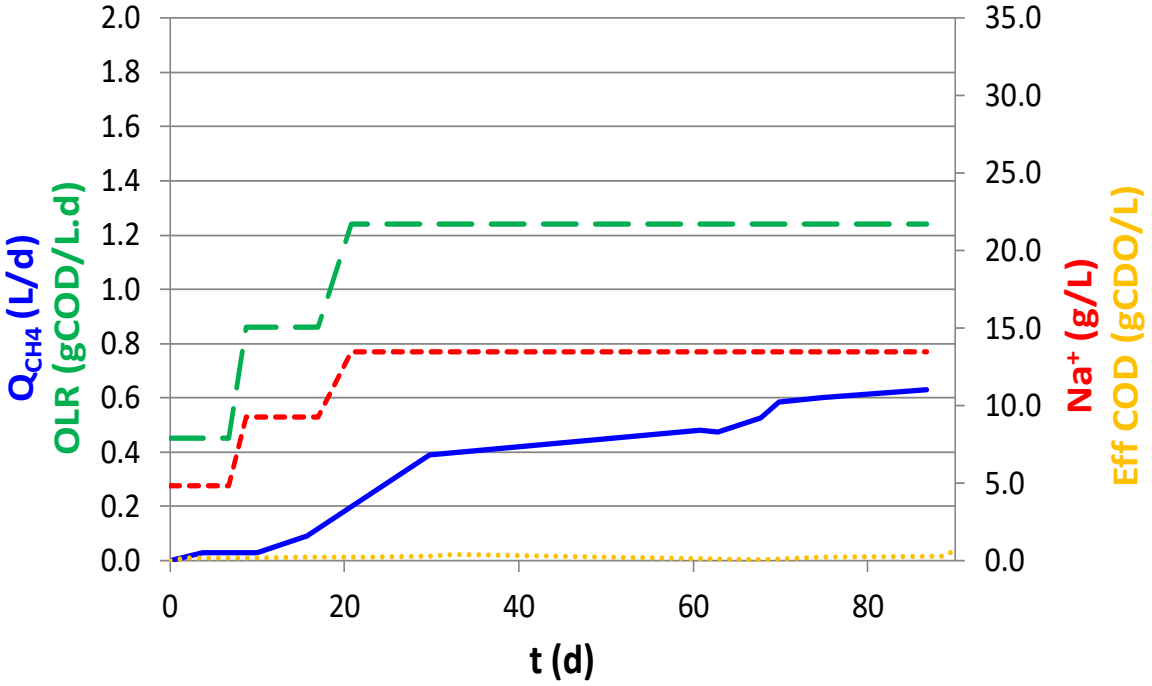
Methanogenic reactor performance



- **Slow adaptation** of the methanogenic community to salinity is needed.
- Methanogenic activity was still detected at levels of **14 gNa^+/L**

It is possible to produce 0.6L_{biogas}/day with a methane productivity of 0.23 L_{CH4}/L.day in a lab scale reactor (2.2 L).

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Take home message

- The two phase AD system is **robust** and can **operate efficiently** under dynamic feeding of saline wastewaters with no apparent destruction of granules.
  - » Anaerobic granules were able to withstand with salinities up to 58 gNa^+/L and 14 gNa^+/L in acidogenesis and methanogenesis stages, respectively.
  - » The phase separation allowed to obtain high acidification degree in the 1^{st} stage.
  - » $0.6L_{biogas}$/day with a methane productivity of 0.23 L_{CH4}/L.day was produced with a 2.2L 2^{nd} stage reactor.

This system can be used to treat saline wastewater and produce biogas (energy source), adding a new value to the wastewater.

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Slovenian demo site in industrial environment

Salted hides – wastewater source

AD1 acidogenic reactor

AD2 methanogenic reactor

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Slovenian demo site in industrial environment

- Continuous operation of AD system in industrial environment was **reached**.
  - » Successful adaptation of microbial culture in the granules to high salinity (in AD1 up to 38.7 g Na^+/L in AD2 up to 25.1 g Na^+/L.
  - » Biogas production varies, between 0 - 380 L/h in stable operation up to **9.31 m^3Biogas/d** can be produced in two phase AD (reactor volume 1.8 m^3, working volume 1,.52 m^3) at inflow to AD1 346.56 L/day of saline wastewater.
  - » **9.3 m^3 CH4/ m^3** wastewater (maximally **23.4 m^3 CH4/ m^3** wastewater)

The implementation in industrial environment was successfully achieved

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Slovenian demo site output

With a constant inflow and stable process temperature (30 ^{o}C) we can estimate that

*at inflow of **1 m³ WW 9 m³ biogas** can be produced and 9 kWh$_e$ electricity at CH$_4$ content > 85%.*

*contribution to **electric energy** = 9.08 kWh/day, maximally 68.4 kWh/day per 1 m³ of wastewater*

*contribution to **thermal energy** = 18.15 kWh/day, maximally 136.8 kWh/day per 1 m³ of wastewater*

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Thank you for the attention

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