AQUAPONIC SLUDGE DIGESTION FOR ORGANIC REDUCTION AND NUTRIENTS MINERALISATION IN UASB REACTORS

by Boris Delaide

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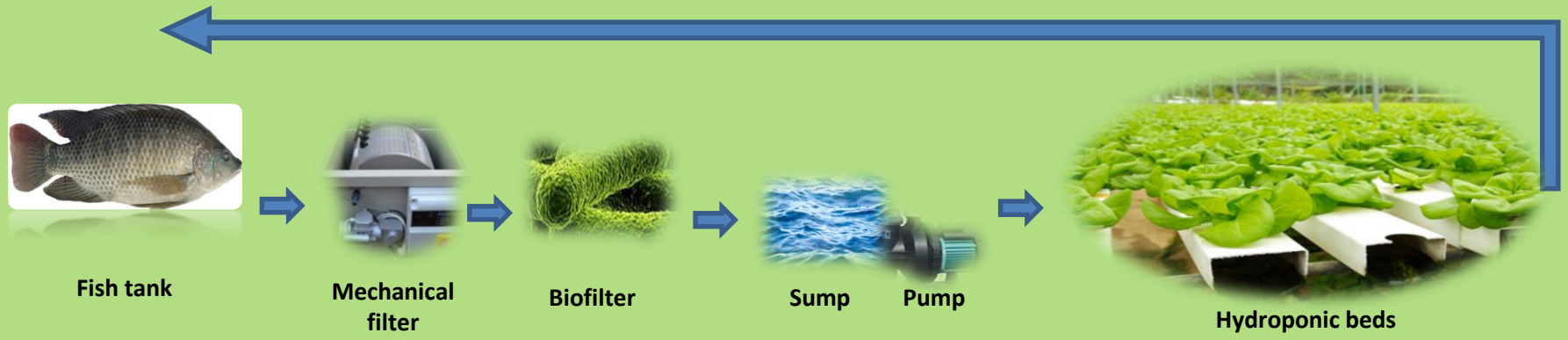
LIÈGE université
Gembloux
Agro-Bio Tech

Introduction

Formula → Aerobic vs Anaerobic → UASB performances → UASB effluents → Perspectives

One loop aquaponics



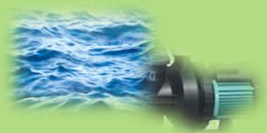
Introduction

Low concentration of mineral elements in solution

Fish tank

Mechanical filter

Biofilter



Sump Pump

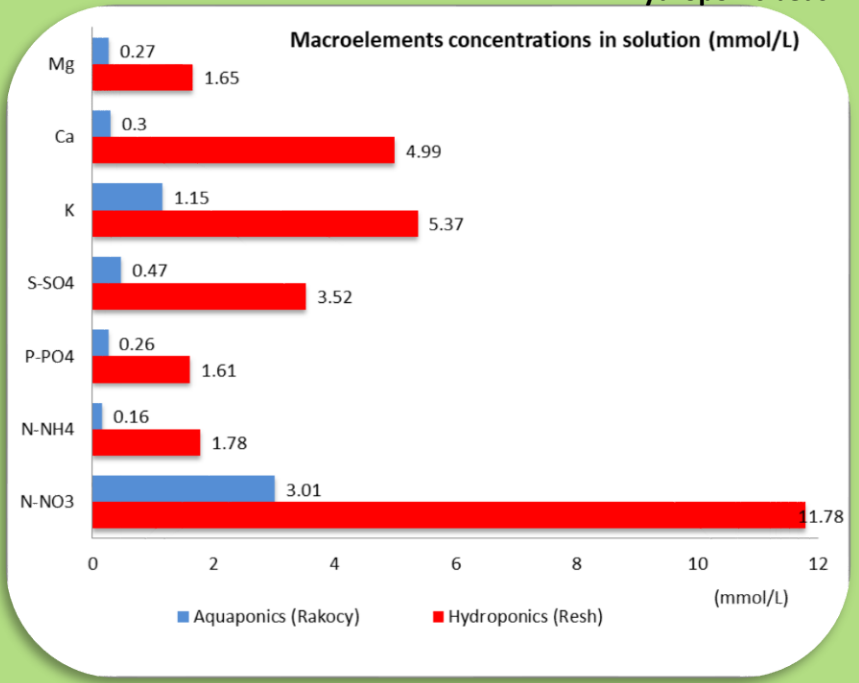
Hydroponic beds

- Macroelements:

N, P, K, Ca, Mg, S

- Microelements:

Fe, B, Cu, Zn, Mn, Mo



Introduction

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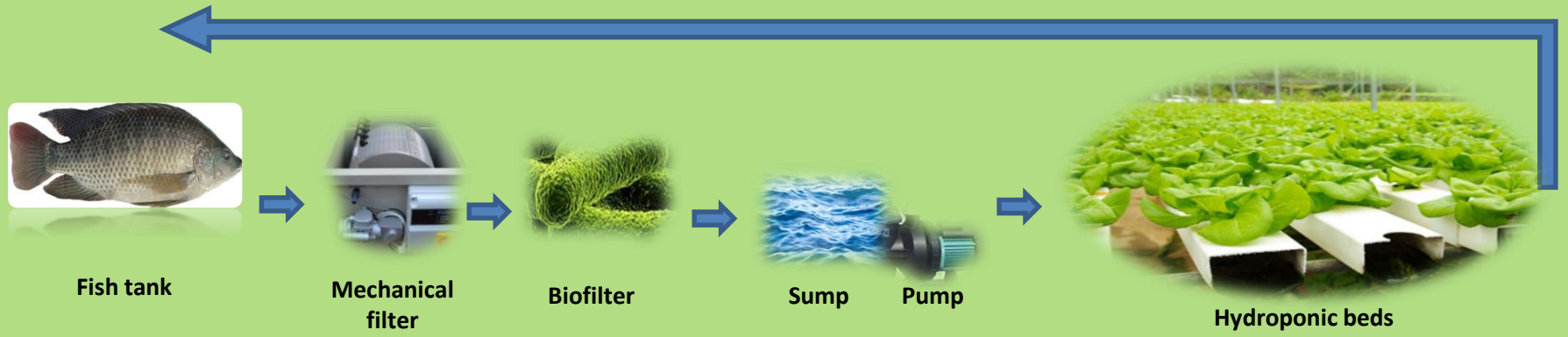
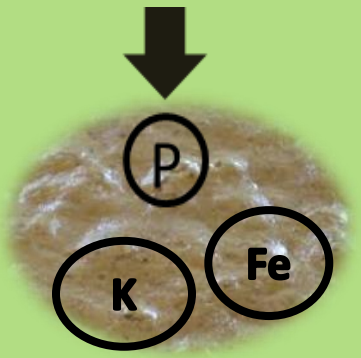
Nutrients lost by sludge spillage





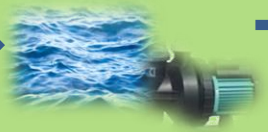
Sludge

Sludge digestion for mineral elements recovery

Fish tank

Mechanical filter

Biofilter



Sump Pump

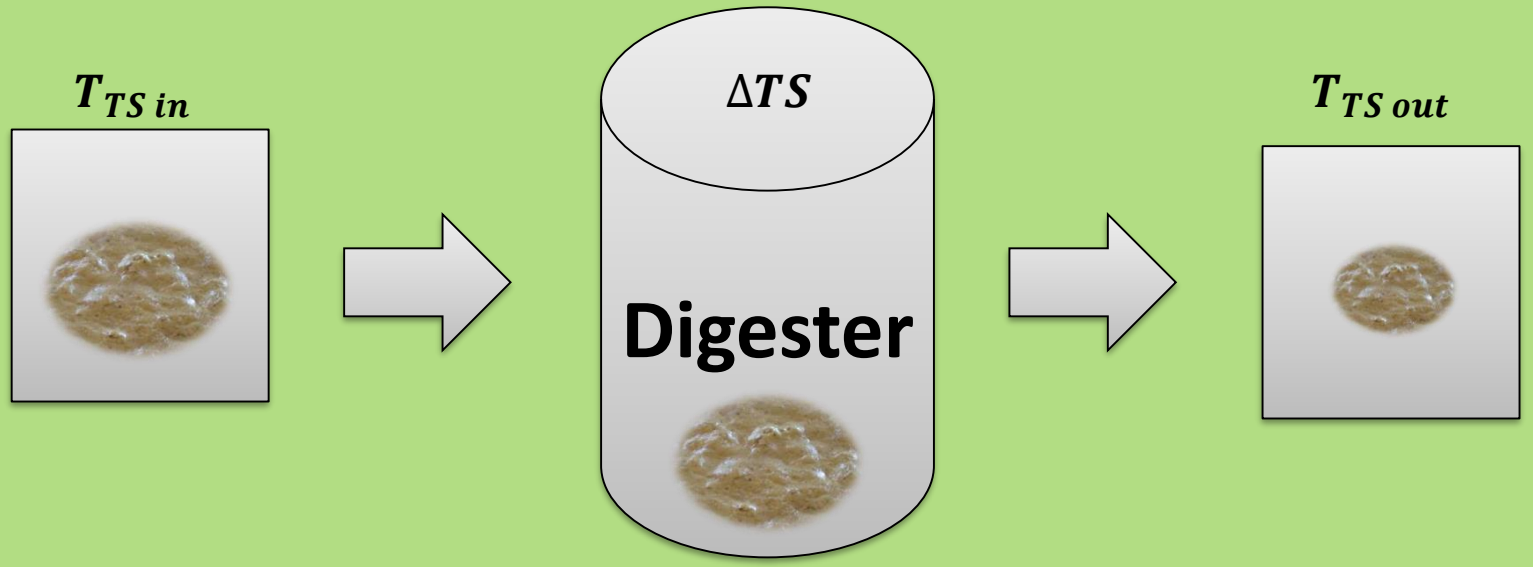
Hydroponic beds

Sludge

Digestion in bioreactor

Macro and microelements mineralised

Formula used for COD – TS reduction:

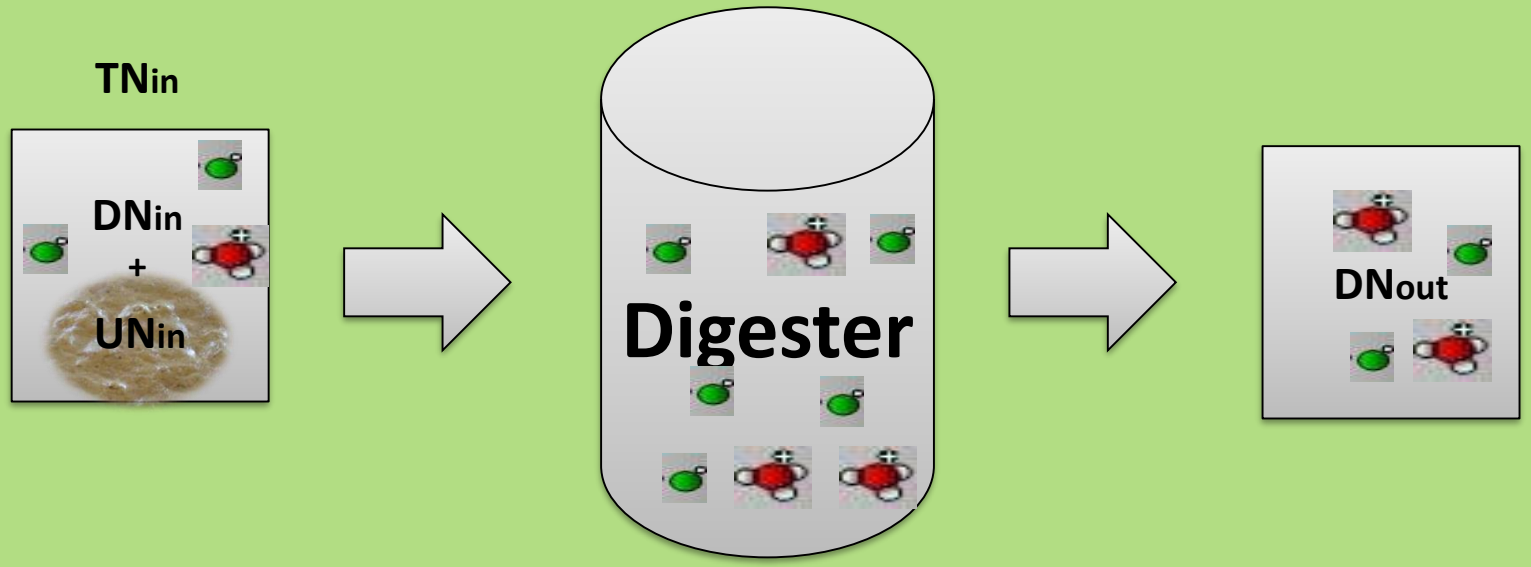


$$\eta_{TS} = 1 - \frac{\Delta TS + T_{TS\ out}}{T_{TS\ in}}$$

where ΔTS is the TS inside the reactor at the end of the experiment minus the TS inside the reactor at the beginning of the experiment, $T_{TS\ out}$ is the total TS outflow and $T_{TS\ in}$ is the total TS inflow.

Formula

Formula used for elements mineralisation:



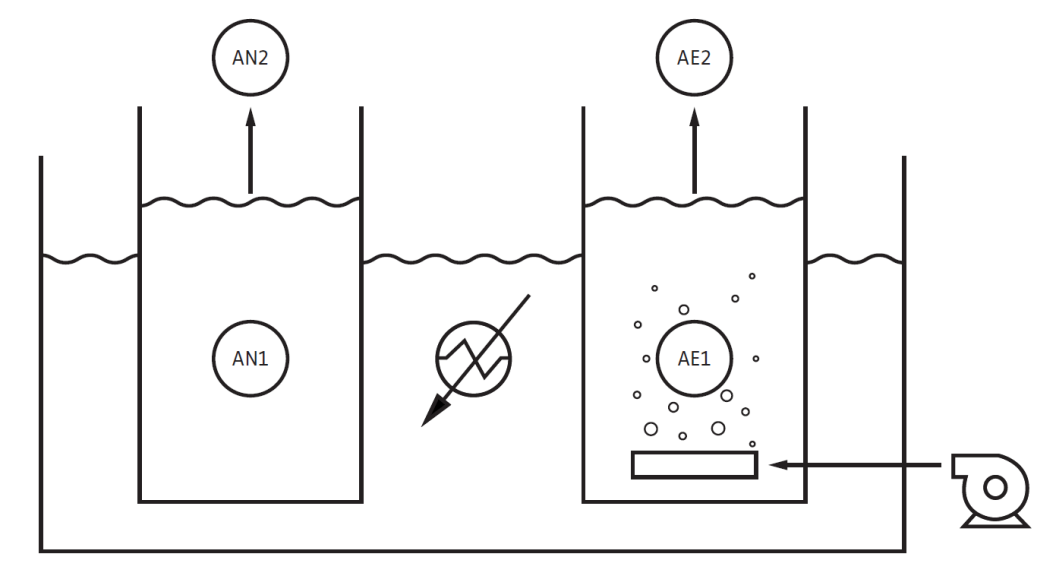
$$NR = \frac{DN_{out} - DN_{in}}{TN_{in} - DN_{in}}$$

Where NR is the nutrient recovery at the end of the experiment in percent, DN_{out} is the total mass of dissolved nutrient in the outflow, DN_{in} the total mass of dissolved nutrient in the inflow , and TN_{in} the total mass of dissolved plus undissolved nutrients in the inflow.

Aerobic vs Anaerobic

Aerobic vs Anaerobic sludge digestion in simple reactors

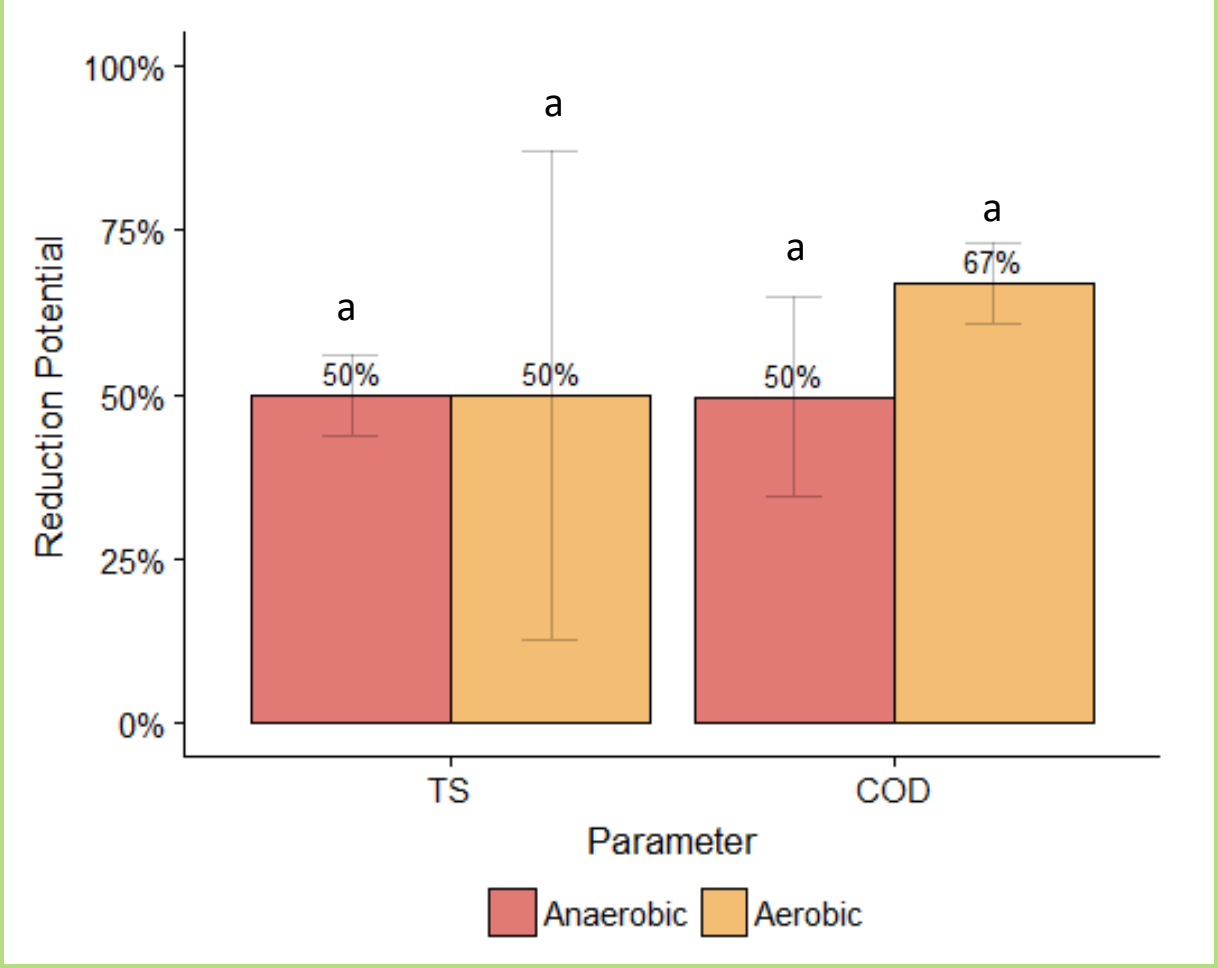
ZHAW[1], ULg[2] and WUR[3]



[1] ZHAW Life Sciences und Facility Management, Grüentalstrasse 14, Postfach, 8820 Wädenswil
[2] Integrated and Urban Plant Pathology Laboratory, Université de Liège, Avenue Maréchal Juin 13, 5030 Gembloux, Belgium
[3]Wageningen University, Wageningen Institute of Animal Sciences, Aquaculture and Fisheries Group, P.O. Box 338, 6700 AH Wageningen, The Netherlands

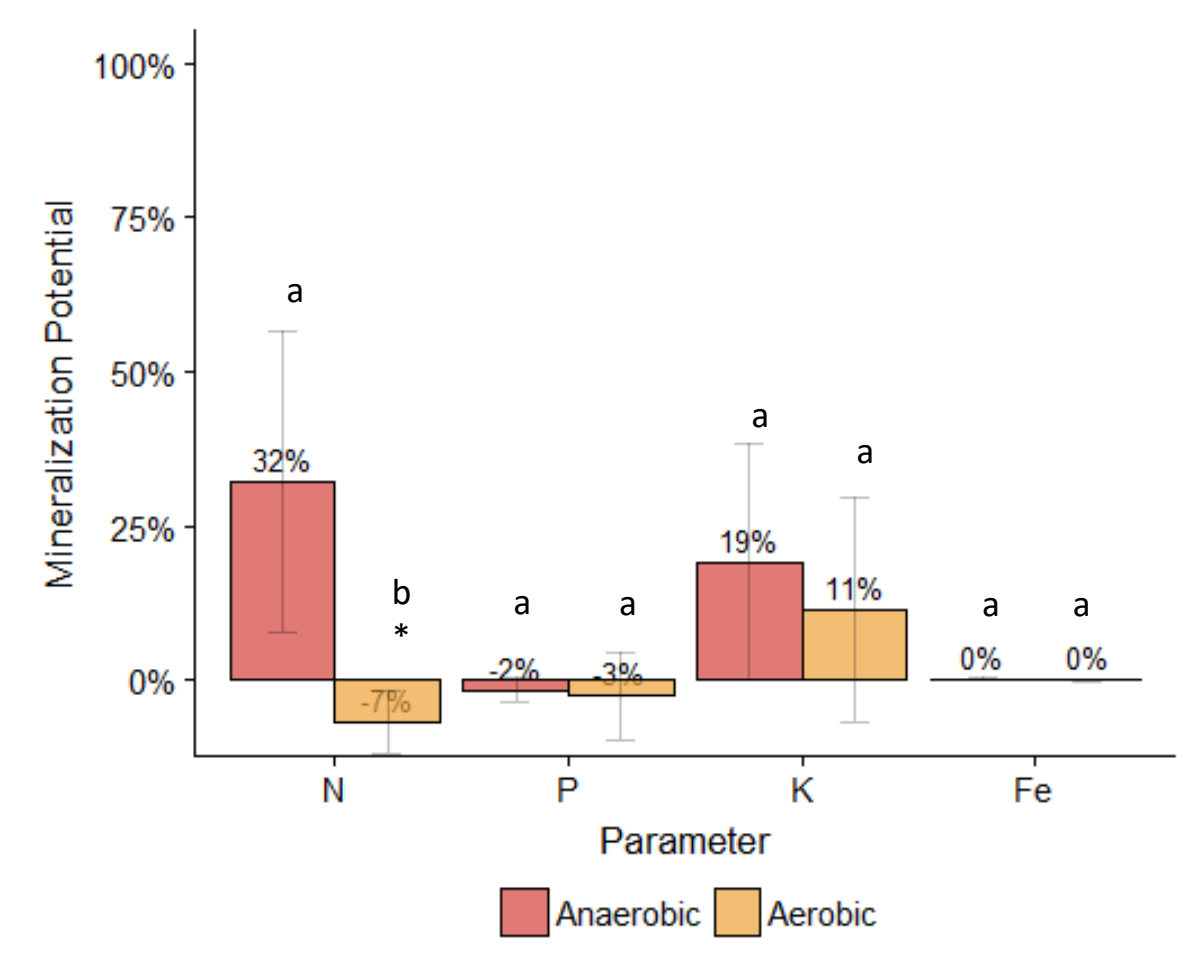
Aerobic vs Anaerobic

Anaerobic vs Aerobic sludge digestion in simple reactors

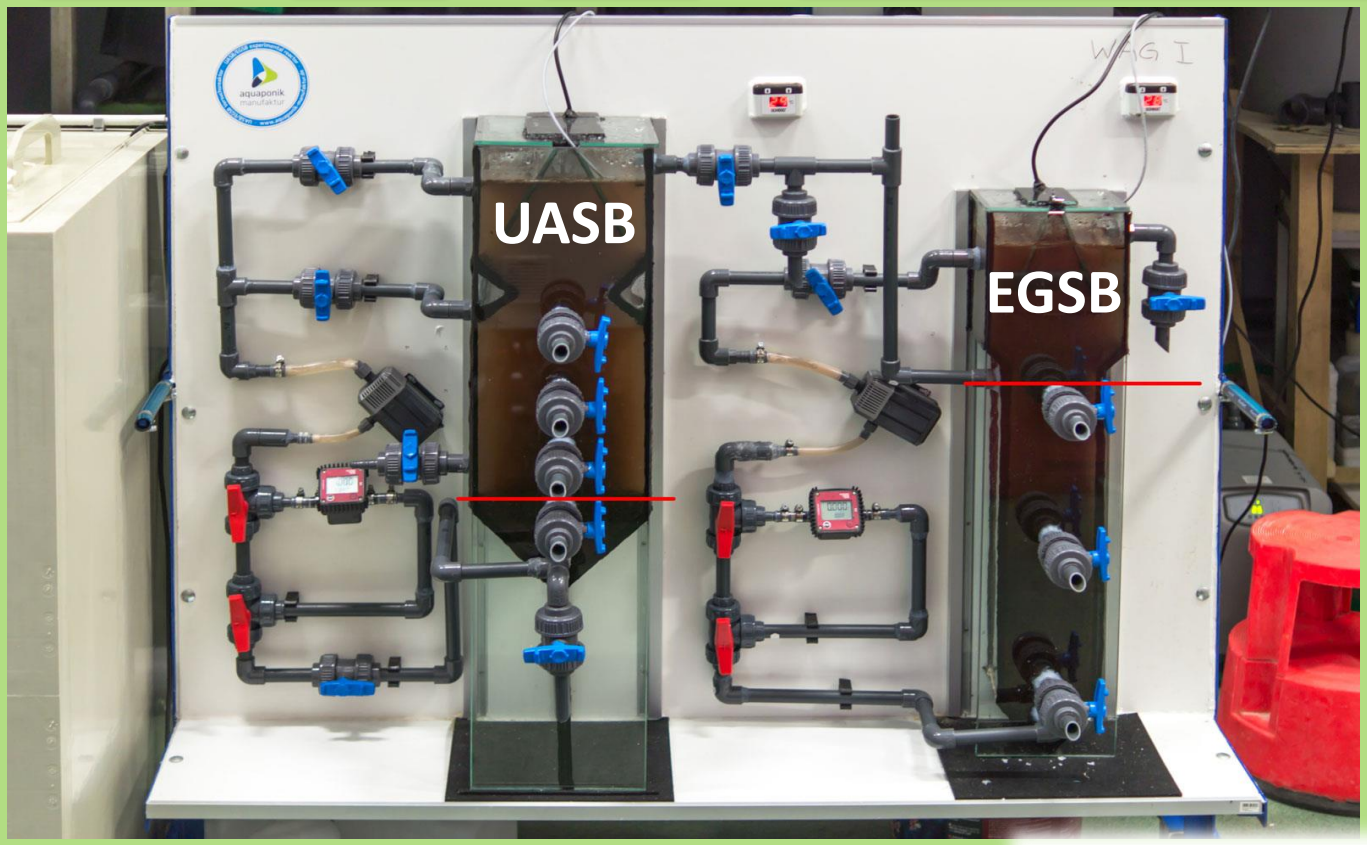


Aerobic vs Anaerobic

Anaerobic vs Aerobic elements mineralisation performances



UASB performances



ULg: one set
WUR: two sets

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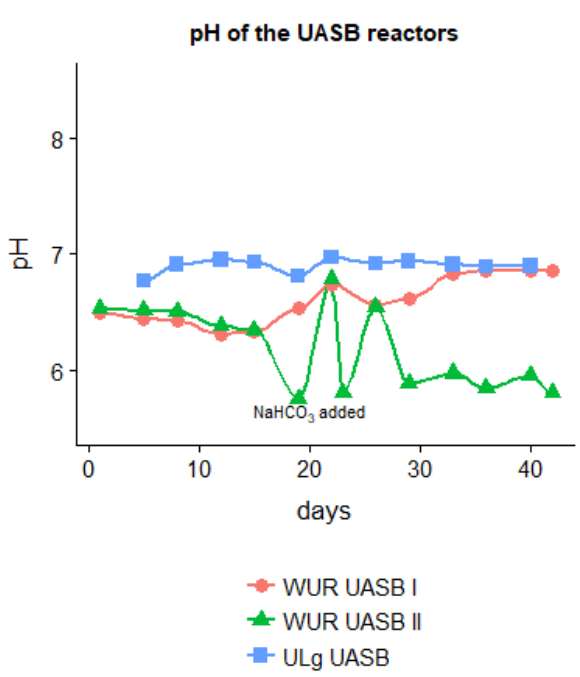
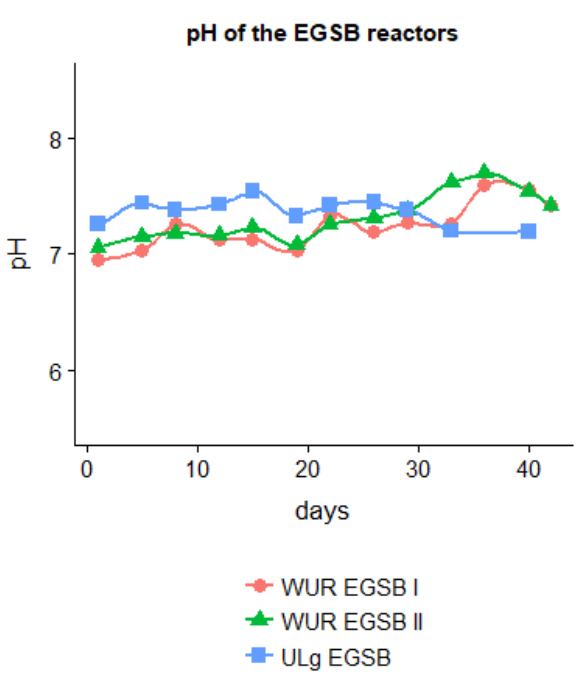
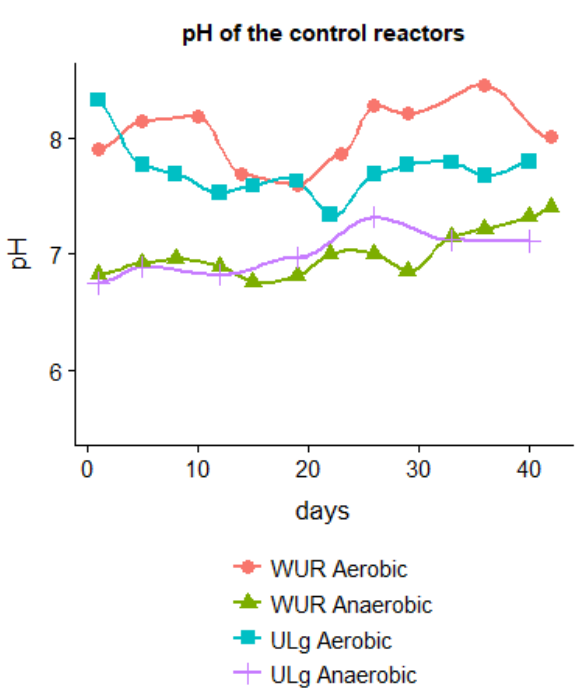
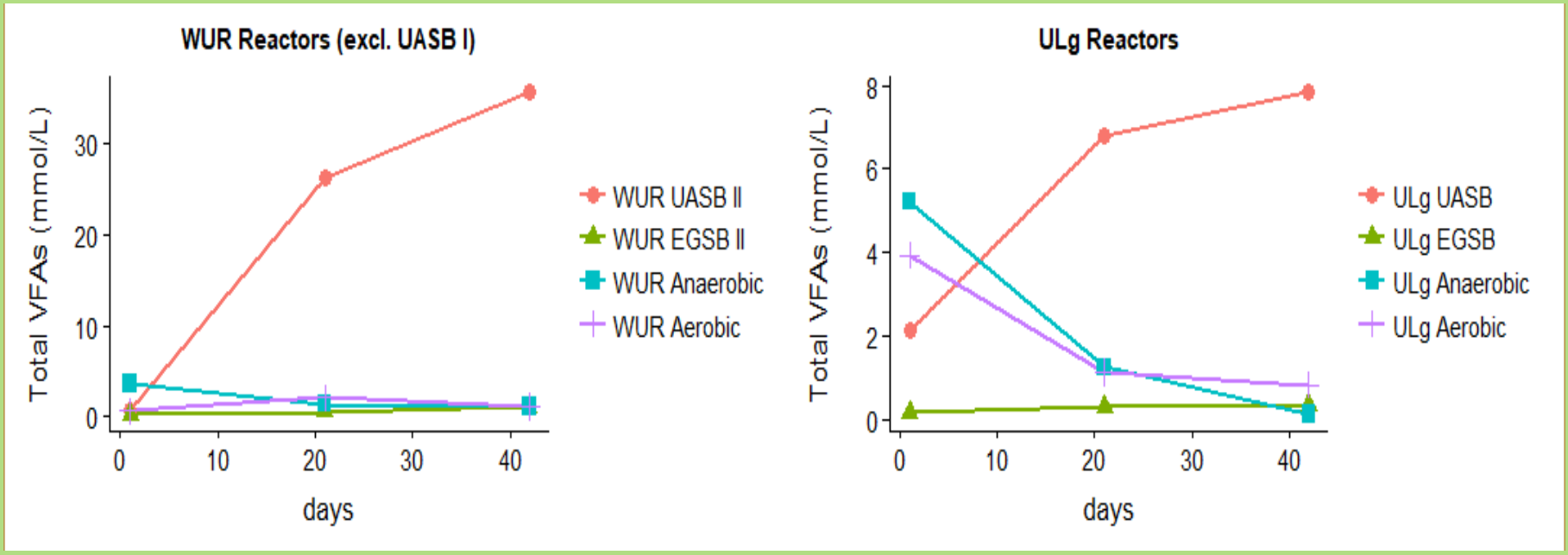
pH in reactors



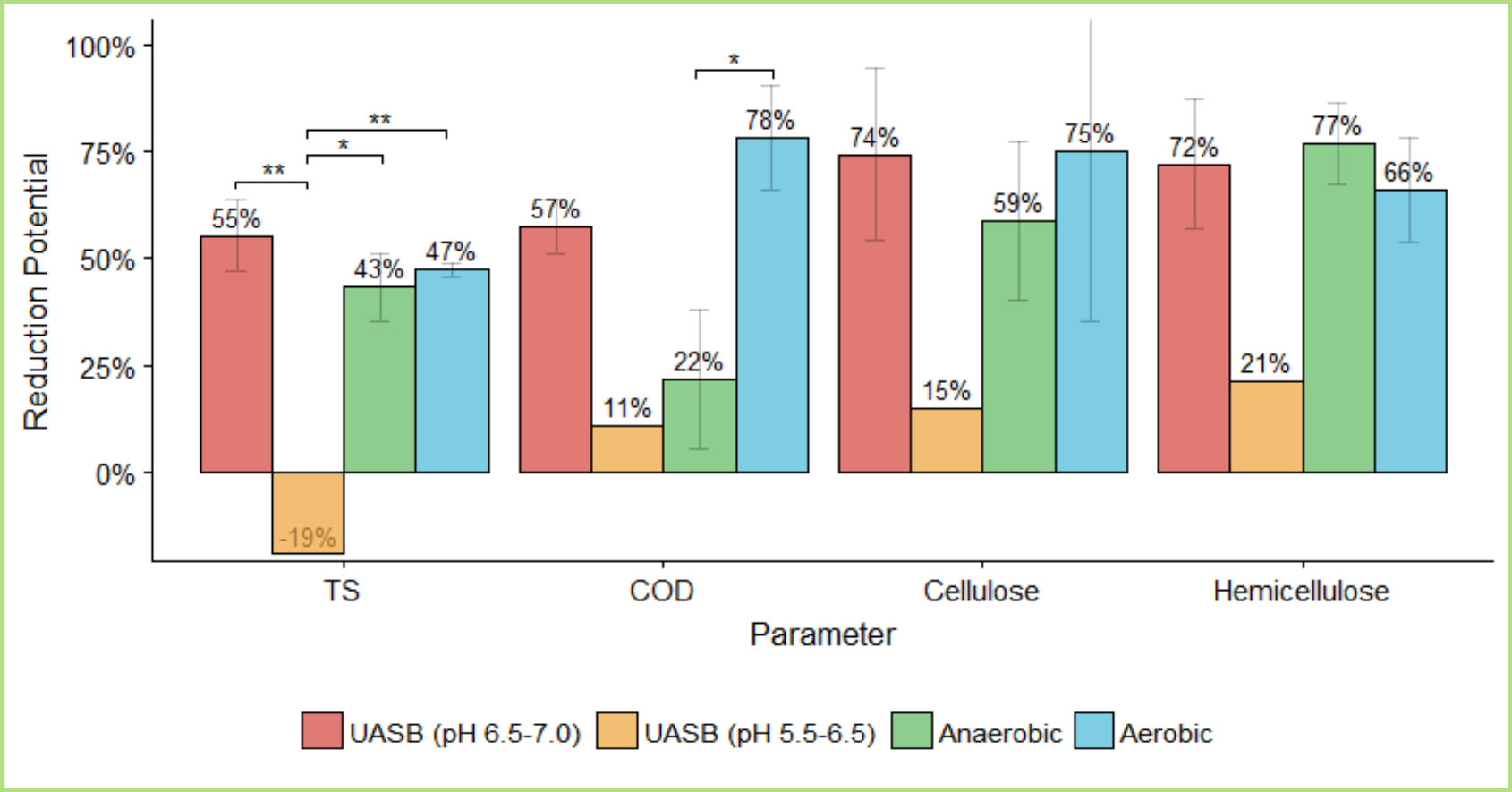




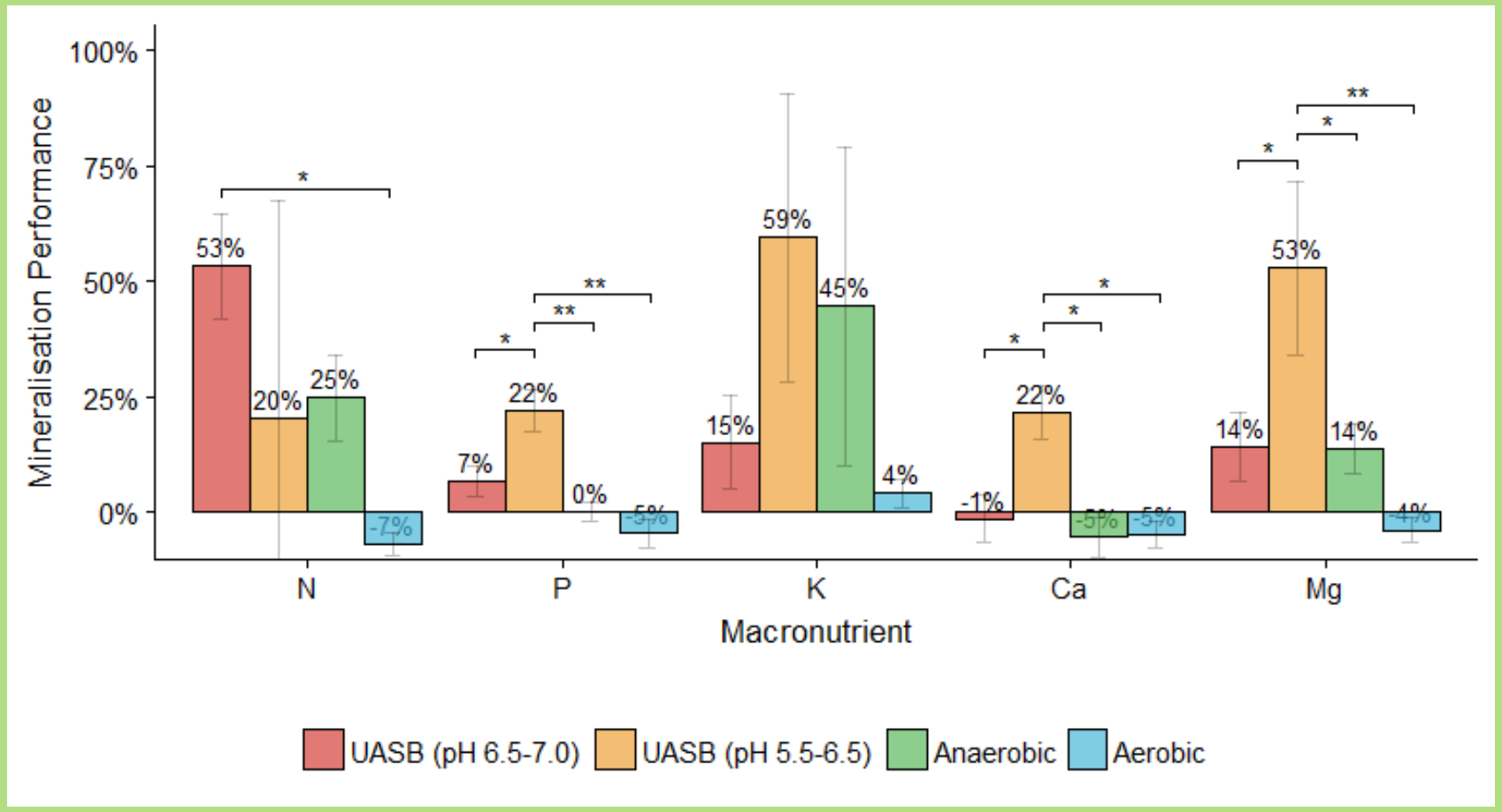
VFA in reactors



Sludge organic reduction performances

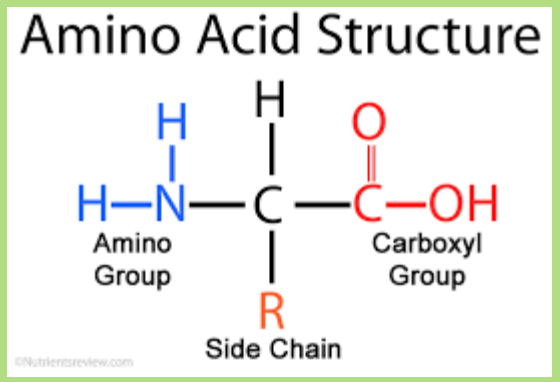


Sludge reduction and mineralisation performances



UASB performances

- **N mineralisation**: protein degradation

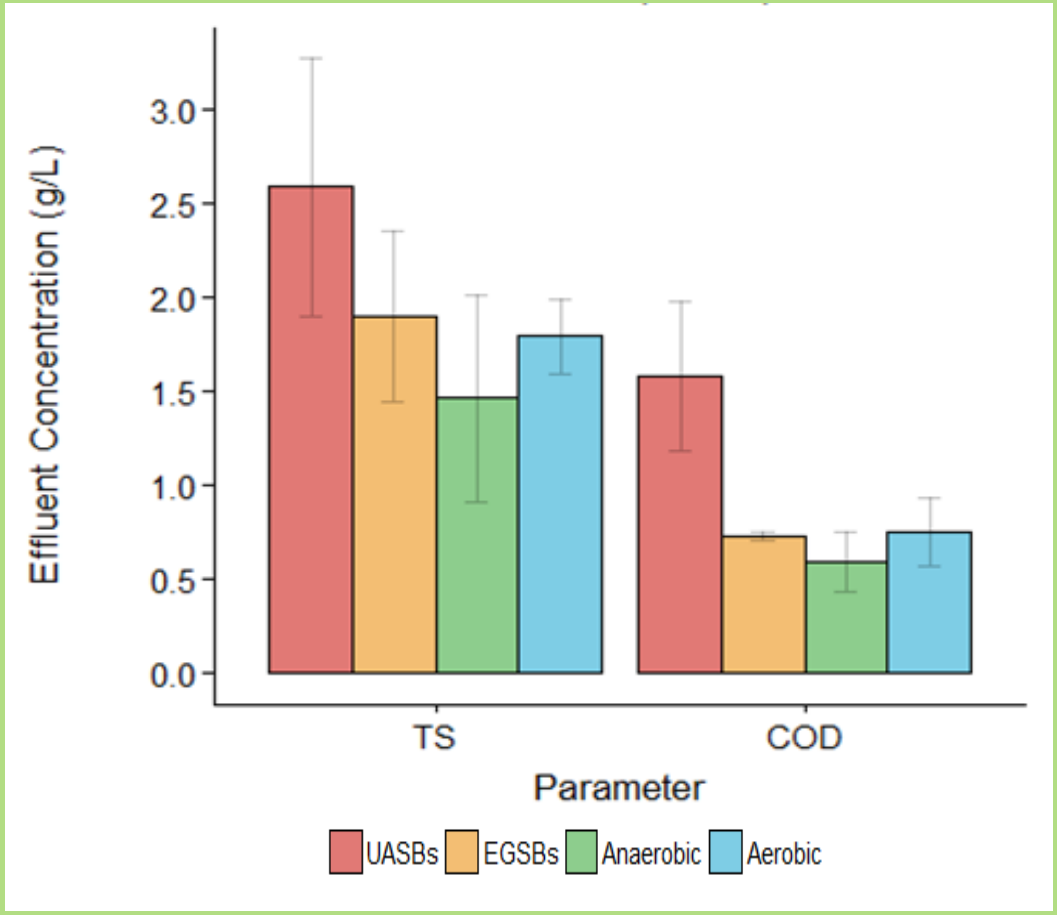


NH_4^+

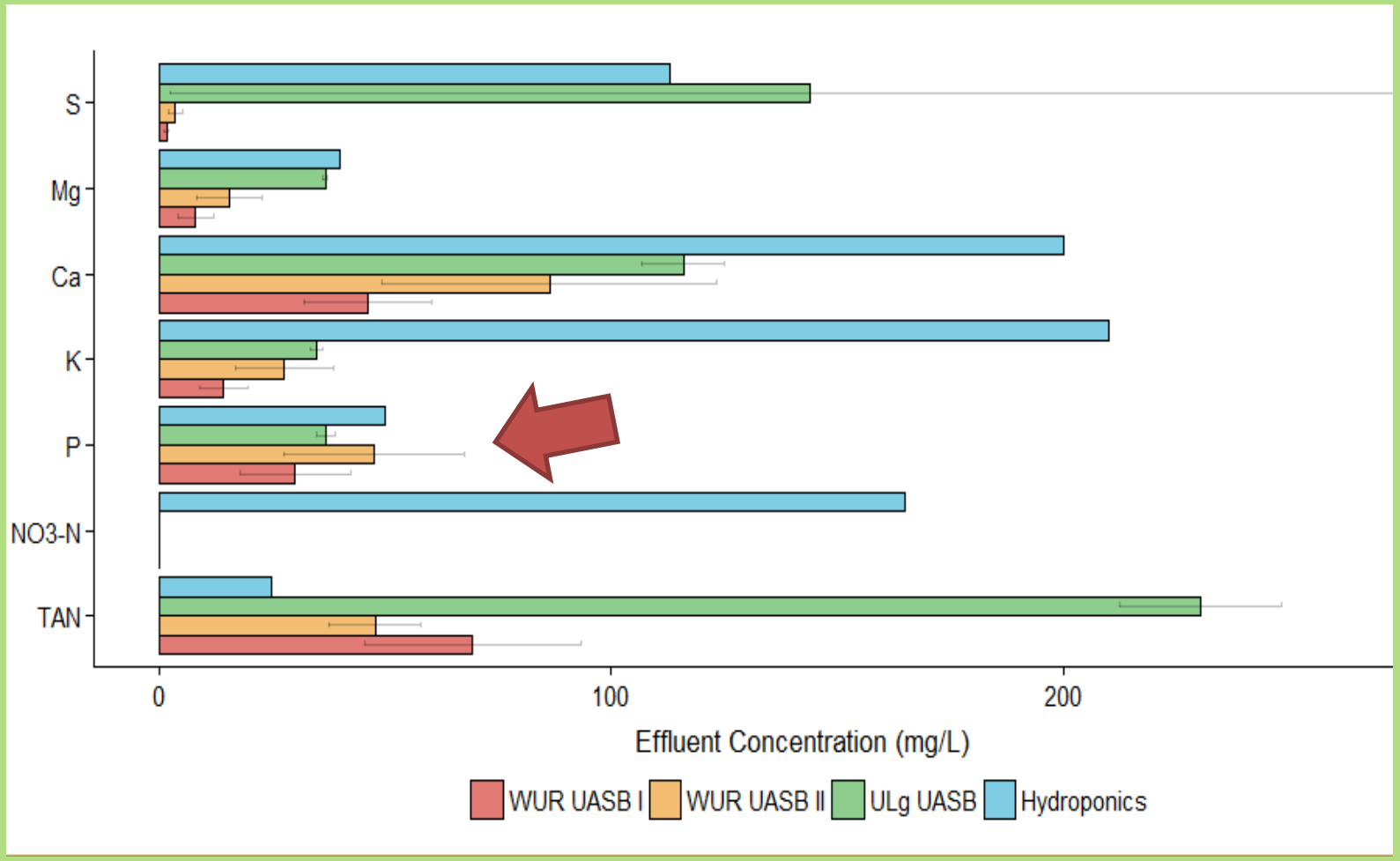
- **P, K, Ca, Mg mineralisation**: solubilisation low pH of precipitated minerals

- Struvite: $(NH_4)Mg(PO_4)\ 6(H_2O)$
- Calcium phosphate, Hydroxyapatite: $Ca_5(PO_4)_3(OH)$

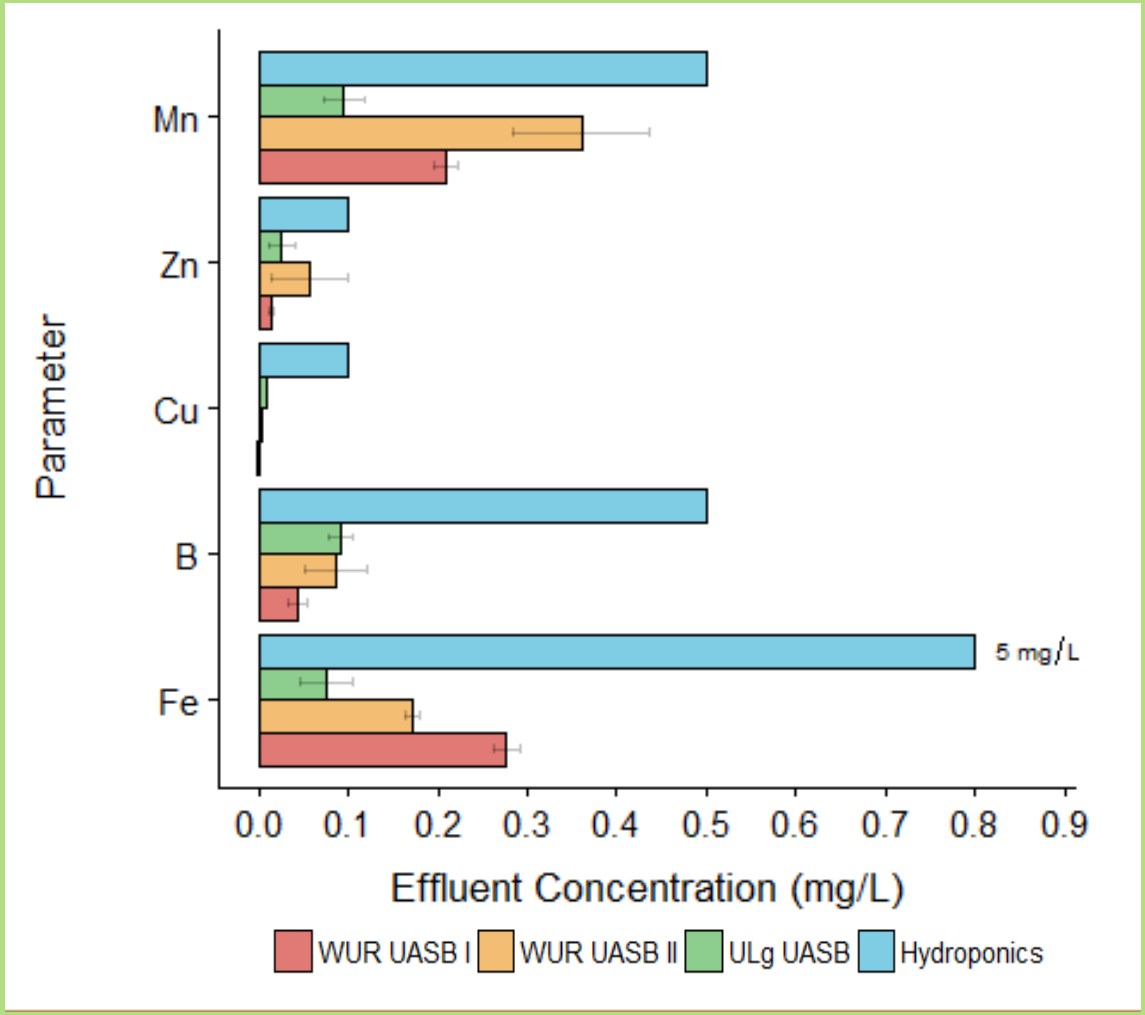
TS and COD in effluents comparison



Macroelements in UASB effluents compared to hydroponics

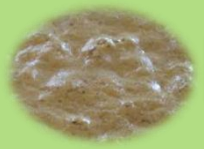


Microelements in UASB effluents compared to hydroponics



Two-step digestion + post-treatment?

Fresh sludge



UASB

- pH 6.5 – 7.5
- Organic reduction
- N mineralisation
- Biogas

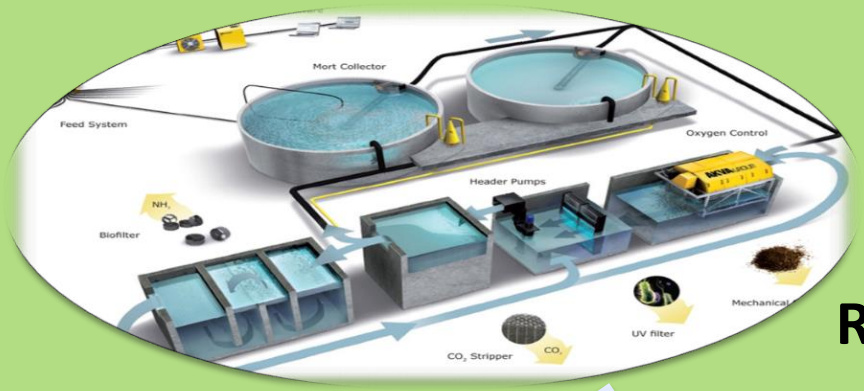
Acid reactor

- pH 4.5 to 5.5
- Macro and microelements mineralisation

Post-treatment

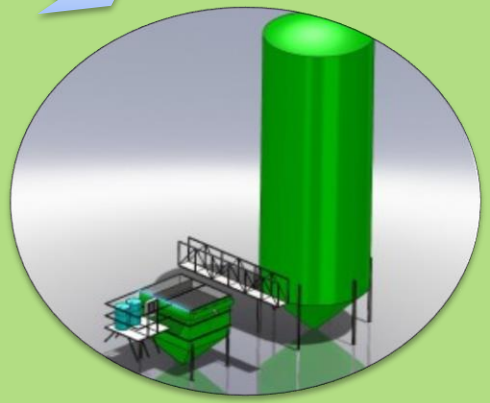
?

Decoupled AquaPonic System: DAPS



RAS

Hydroponics



UASB + Sludge mineralisation

Thank you for your attention!