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TOWARDS SULFIDE RESISTANT BIOPRODUCTION; UNDERSTANDING SULFIDE TOXICITY DURING HOMOACETOGENIC FERMENTATION

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Sulfide (H_2S) contained in waste gases could induce toxicity, limiting bioproduction

- Gas streams containing H_2/CO_2 can be converted to commodity chemicals through homoacetogenic fermentation (Patil et al., 2015).
- Traces of H_2S in the waste gas steams (biogas, waste geothermal gas streams) impact the bioproduction.
- Extend of inhibition will be determined by the operational pH (Chen et al., 2015).

q_{Ac} decreases with increasing [TDS] and decreasing pH

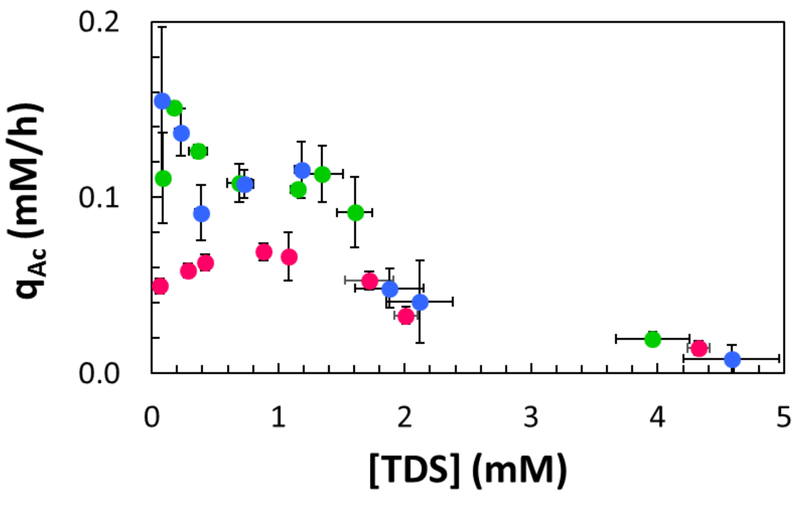

Fig. 1. Total acetate production rate (q_{Ac}) (mM/h) plotted against initial total dissolved sulfide concentration ([TDS]) (mM), for the different pH levels (for n=3 biological replicates).

● pH 5, ● pH 6, ● pH 7

ΔOD_{600} response drops with increasing [TDS]

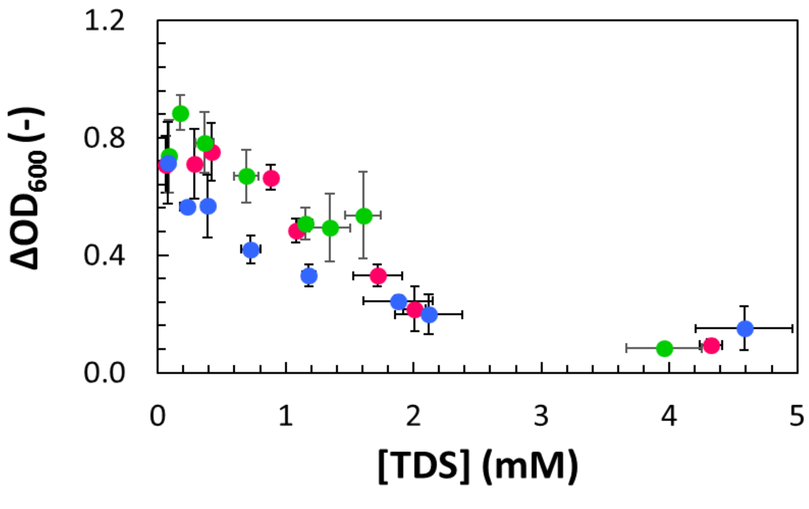

Fig. 2. Delta OD (ΔOD_{600}) plotted against initial total dissolved sulfide concentration ([TDS]) (mM), for the different pH levels (for n=3 biological replicates).

Cell growth is inhibited at [TDS] ± 4.3 mM

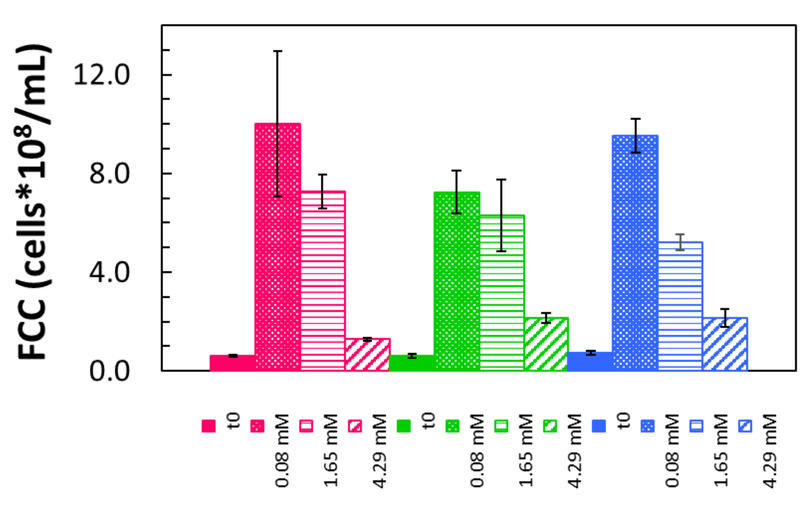

Fig. 3. Flow cytometric counts (FCC) (Cell numbers/ml) at t=0 and t=13 d, for the different pH levels and critical TDS concentrations: 0.08 mM, 1.65 mM and 4.29 mM TDS (for n=3 biological replicates).

Total dissolved sulfide [TDS] > 4.3 mM inhibits homoacetogenic fermentation

- The average IC_{50}, was calculated at 1.14 ± 0.04 mM TDS and 0.71 ± 0.06 mM H_2S_{aq}.
- The average inhibitory TDS and H_2S_{aq} concentrations were calculated at 4.29 ± 0.25 and 2.38 ± 0.35 mM, respectively.

Microbial community shifts with TDS concentration and sulfide speciation (pH shifts)

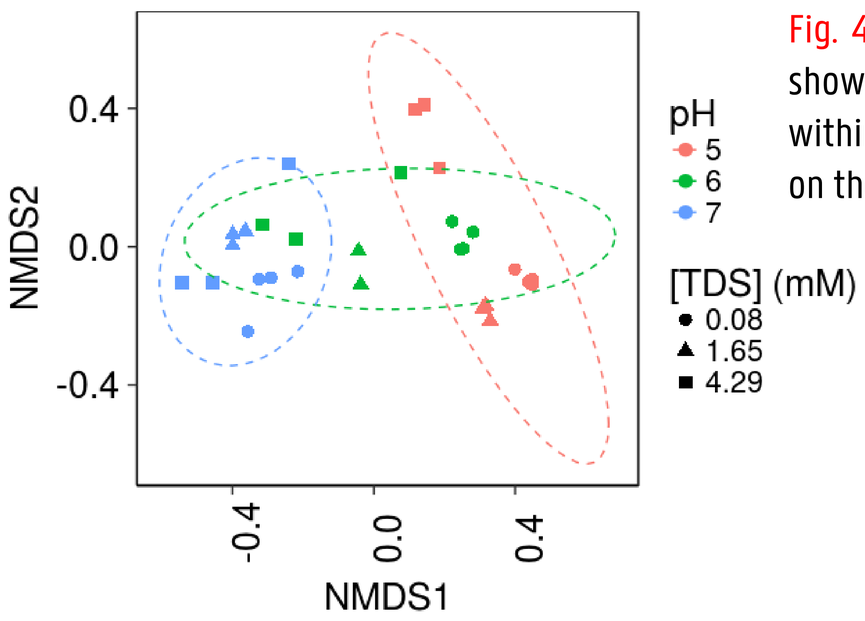

Fig. 4. β-diversity plot showing dissimilarity within samples, based on the pH.

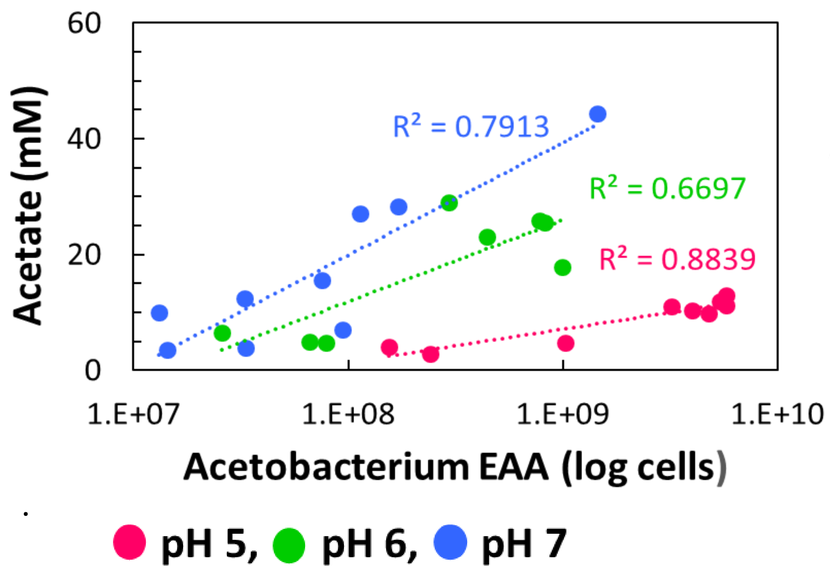

Fig. 5. Estimated absolute abundances (EAA) of Acetobacterium, plotted against the final acetate concentration achieved (mM), for the different pH levels.

● pH 5, ● pH 6, ● pH 7

Summary

- Sulfide concentrations 4.3 mM and higher, inhibit the bioproduction activity of homoacetogenic bacteria.
- Lower pH values decrease the activity of the bacteria but not necessarily their abundances.
- Long-term homoacetogenic fermentation should be investigated, from waste gas streams containing up to 1.5 mM (≈ 8700 ppmv) residual sulfide and controlled pH levels up to 6-7.

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References:
S. A. Patil, et al. Environmental Sci. Technol., vol. 49, pp. 8833 – 8843, 2015;CMET.
Y. Chen et al. Bioresour. Technol., vol. 99, pp. 4044–4064, 2008.