

Background

Acidogenic fermentation (acidogenesis) is an intermediate stage of anaerobic digestion, where volatile fatty acids (VFA) with a low carbon number ($C_2 - C_6$) are produced.

VFA can be used as platform chemicals for “green” chemistry, e.g., for biodegradable solvents, bioplastics (i.e., polyhydroxyalkanoates) and biofuels, or as substrate for biological nutrient removal in wastewater.

Main challenge

Obtaining the desired specific product despite the complex composition of the substrate and the inoculum (natural, mixed microbial consortia)

Experimental conditions

Substrate	pH	substrate : inoculum* COD ratio	Total initial concentration (C_{in}) g_COD/kg_ML	Temperature	Duration	Working volume	Fermentation type
chicory roots	4.5 / 5.5 / 7 (adjusted daily)	3:1	26.6 / 53.3 / 80	35 °C	15 days	100ml	batch (in duplicates)

* inoculum: mix of acidogenic slurry and methanogenic effluent (mass ratio 3:1, respectively) from a two-stage anaerobic digestion pilot plant (Greenwatt, Belgium)

Analysis

- Substrate & inoculum characterisation**
- Gas phase sampling (daily)**
Biogas production → Manometric method
Biogas composition → GC - TCD
- Mixed liquor sampling (days 0, 1, 2, 3, 7, 10, 15)**
Centrifugation
Liquid phase → COD, Metabolite concentration (GC - FID)
Solid phase → Microbial communities (...planned)

COD: Chemical Oxygen Demand; ML: Mixed Liquor; TS: Total Solids; VS: Volatile solids, GC: Gas Chromatography; TCD: Thermal Conductivity Detector; FID: Flame Ionization Detector

Results

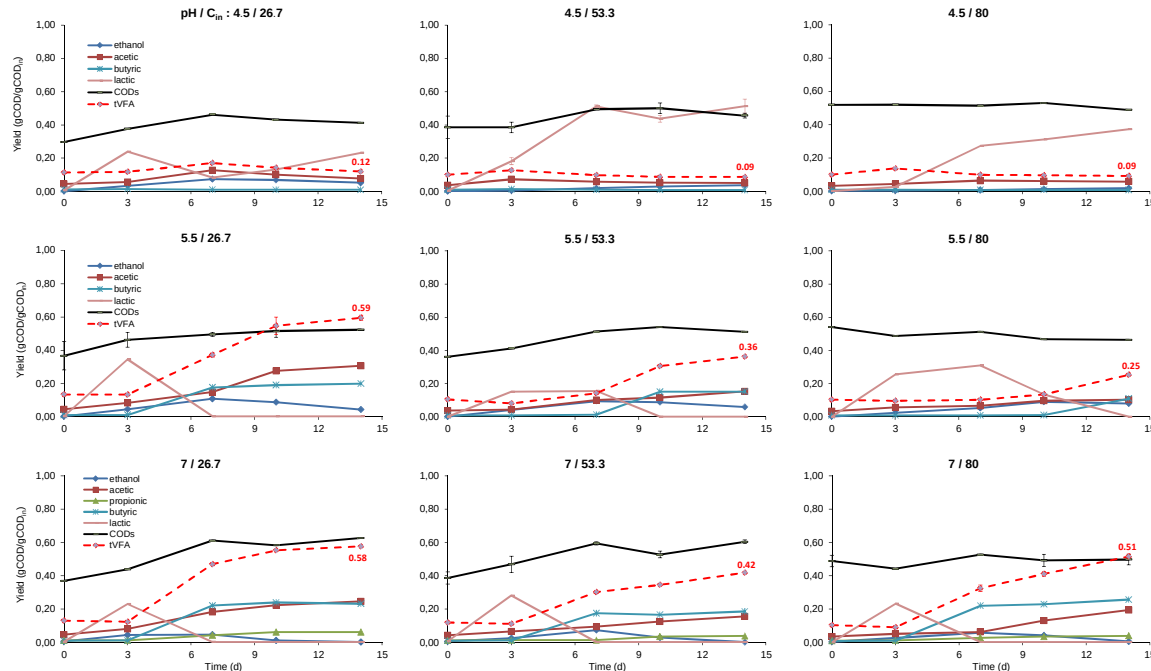


Fig. 1: Yields of conversion of the initial COD into metabolites (gCOD/gCOD_{in}) for the different conditions tested

Table 1: Characterisation of substrate and inoculum

	COD (g_COD/g_FM*)	TS (%_FM)	VS (%_TS)
Chicory roots	0.151	12.8	92.7
Acidogenic slurry	0.057	3.2	73.2
Methanogenic effluent	0.003	0.6	36.5

* FM: Fresh Matter

Table 2: Concentration of tVFA* (g_COD/kg_ML)

C_{in}	26.7	53.3	80
pH 4.5	4.5	6.7	10.8
pH 5.5	15.9	19.3	20.2
pH 7	15.3	22.3	41.1

* tVFA: total VFA

Conclusions

- tVFA yields up to 59 % C_{in} and concentrations up to 41g_COD/kg_ML
- Higher C_{in} → higher tVFA concentration ; Lower C_{in} → higher tVFA yield
- A near neutral pH is favourable for acidogenesis
- Butyric and acetic are the predominant VFA, lactic acid is significant at acidic conditions
- No methane detected → no unwanted consumption of VFA

Objectives

- To determine the acidogenic potential (i.e. conversion yield of substrate into VFA) of an agro-industrial residue (forced chicory roots)
- To master the experimental conditions (e.g. pH, initial concentration) in order to obtain the desired fermentation profile for a targeted production of VFA

Outlook - Perspectives

- Acidogenic fermentation offers an alternative pathway for the valorisation of agro-industrial residues
- Comparison between the metabolic and microbial profile will provide valuable information towards selective production of VFA.