

Supplementary Information

Co-digestion of microalgae with potato processing waste and glycerol: effect of glycerol addition on methane production and the microbial community

Yanghanzi Zhang^a*, Gary S. Caldwell^b, Philip T. Blythe^a,
Andrew M. Zealand^c, Shuo Li^a, Simon Edwards^a, Jin Xing^a, Paul Goodman^a, Paul
Whitworth^b, Paul J. Sallis^a

^a School of Engineering, Newcastle University, Cassie Building, Claremont Road, Newcastle upon Tyne, NE1 7RU, UK

^b School of Natural and Environmental Sciences, Newcastle University, Ridley Building, Claremont Road, Newcastle upon Tyne, NE1 7RU, UK

^c Department of Applied Sciences, Faculty of Health and Life Sciences, Northumbria University, Newcastle Upon Tyne NE1 8ST, UK

*corresponding author: yanghanzi.zhang@newcastle.ac.uk

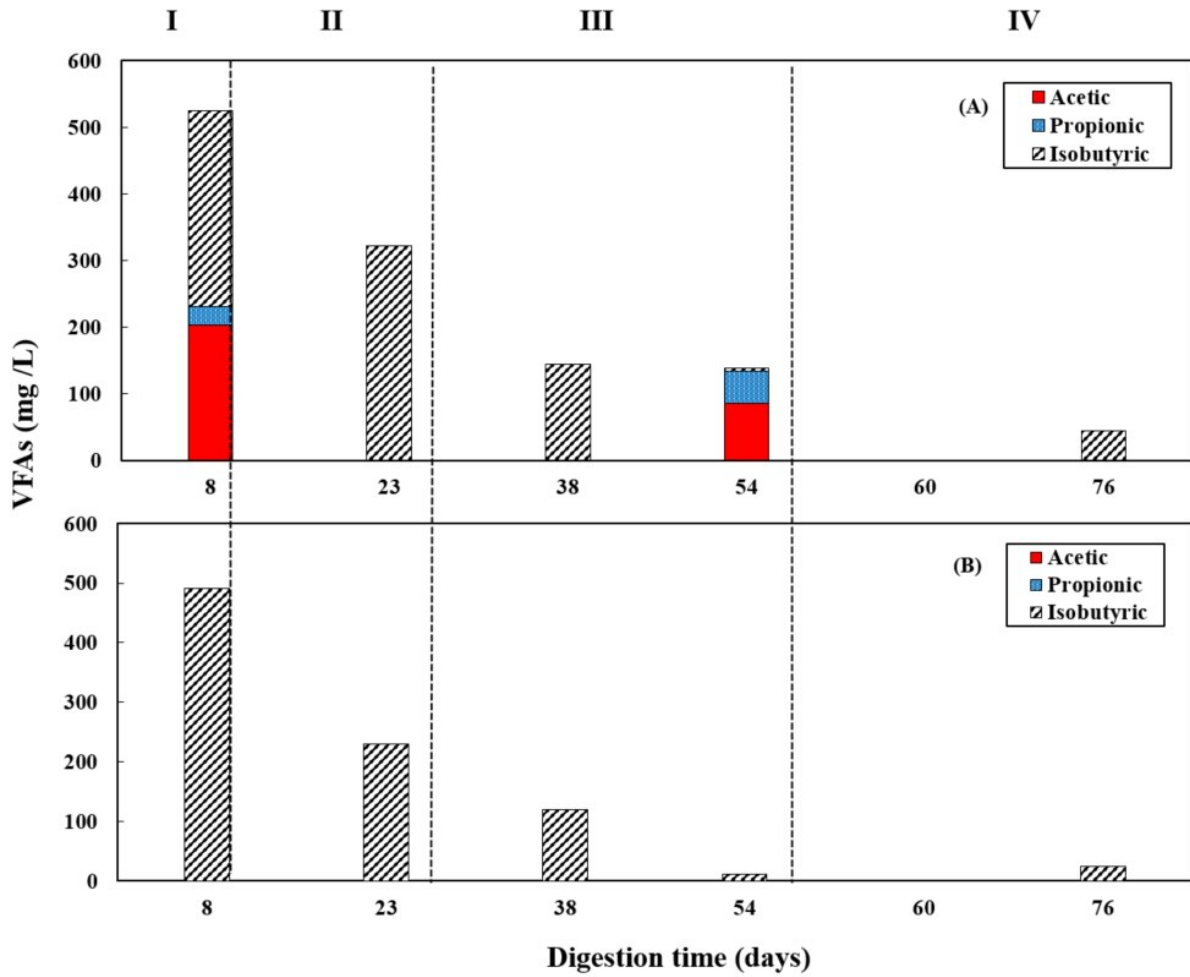


Figure S1. Concentrations of acetic, propionic and isobutyric acids in semi-continuous anaerobic co-digestion of *C. vulgaris* and potato discarded parts (PPW_{dp}) (A) with glycerol (C1) and (B) without glycerol (C2). Note: acetic and propionic acids below detection in all digester C2, and some C1 periods.

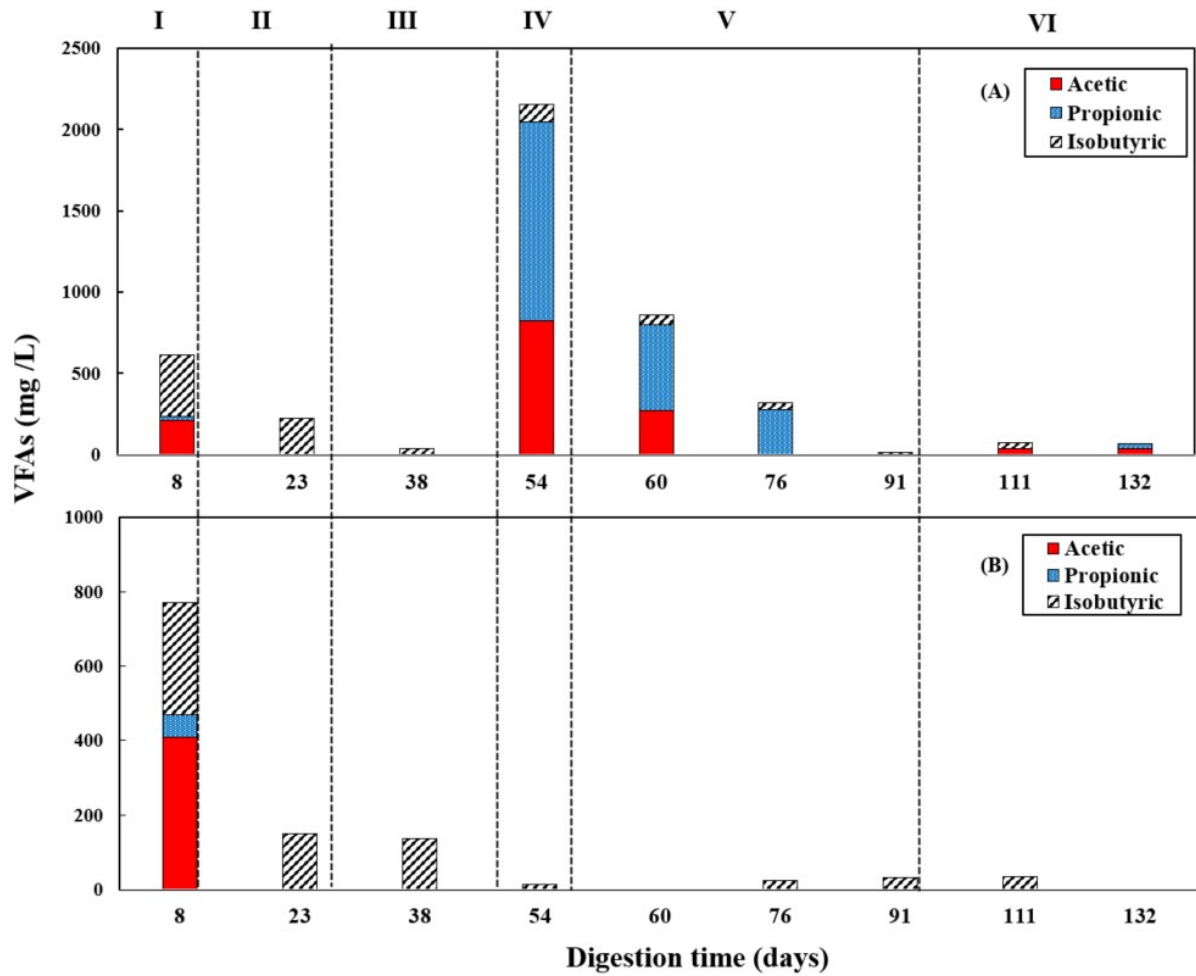


Figure S2. Concentrations of acetic, propionic and isobutyric acids in semi-continuous anaerobic co-digestion of *C. vulgaris* and potato peel (PPW_p) (A) with glycerol, digester C3 and (B) without glycerol, digester C4. Note: acetic and propionic acids below detection in some periods of digesters C3 and C4.

Table S1. Performance of digesters co-digesting *C. vulgaris* and PPW_{dp} with or without glycerol during different experimental stages.

	Digester C1		Digester C2	
	Period III (day 24-56)	Period IV (day 57-76)	Period III (day 24-56)	Period IV (day 57-76)
OLR (g COD/L/d)	1.20	0.70	0.60	0.60
Process stability				
pH	6.94 ± 0.01 ^a	6.75 ± 0.01	7.05 ± 0.01	6.81 ± 0.06
Total Alkalinity (g/L)	2.06 ± 0.02	1.45 ± 0.25	2.80 ± 0.04	1.86 ± 0.02
Total VFAs (g/L)	0.93 ± 0.11	0.56 ± 0.06	0.31 ± 0.06	0.35 ± 0.01
NH ⁺ ₄ -N (g/L)	0.34 ± 0.01	0.32 ± 0.01	0.53 ± 0.02	0.35 ± 0.04
FAN (mg/L)	3.86 ± 0.21	2.35 ± 0.21	7.56 ± 0.60	2.86 ± 0.73
Digester effluent				
TS (g/L)	8.09 ± 0.19	5.67 ± 0.01	6.79 ± 0.35	4.70 ± 0.39
VS (g/L)	5.36 ± 0.05	3.81 ± 0.01	4.18 ± 0.32	2.77 ± 0.37
COD _t (g/L)	6.86 ± 0.06	6.04 ± 0.06	5.84 ± 0.01	4.43 ± 0.08
COD _s (g/L)	1.49 ± 0.02	1.01 ± 0.05	1.25 ± 0.04	0.72 ± 0.06
VS _{removal} (%)	49 ± 7	64 ± 5	57 ± 1	71 ± 1
COD _{removal} (%)	59 ± 7	64 ± 6	69 ± 2	77 ± 2
Methane production				
Volumetric CH ₄ yield (L/L/d)	0.59 ± 0.08	0.51 ± 0.05	0.19 ± 0.02	0.19 ± 0.03
Specific CH ₄ yield (L/g COD _{added})	0.49 ± 0.07	0.73 ± 0.07	0.32 ± 0.03	0.32 ± 0.05

^a Mean ± SD, n = 2.

Table S2. Performance of digesters co-digesting *C. vulgaris* and PPW_p with or without glycerol during the different experimental stages.

	Digester C3		Digester C4	
	Period III (day 24-45)	Period VI (day 95-132)	Period III (day 24-45)	Period VI (day 95-132)
OLR (g COD/L/d)	1.12	0.60	0.50	0.50
Process stability				
pH	7.18 ± 0.01 ^a	6.80 ± 0.01	7.16 ± 0.01	6.65 ± 0.01
Total Alkalinity (g/L)	3.10 ± 0.14	1.10 ± 0.01	3.39 ± 0.02	1.30 ± 0.01
Total VFAs (g/L)	0.70 ± 0.02	0.18 ± 0.01	0.39 ± 0.06	0.18 ± 0.01
NH ₄ ⁺ -N (g/L)	0.53 ± 0.01	0.16 ± 0.01	0.57 ± 0.02	0.18 ± 0.04
FAN (mg/L)	10.4 ± 0.23	1.28 ± 0.03	10.5 ± 0.16	1.07 ± 0.04
Digester effluent				
TS (g/L)	8.75 ± 0.05	4.51 ± 0.01	7.22 ± 0.03	4.02 ± 0.01
VS (g/L)	5.70 ± 0.15	3.30 ± 0.01	4.34 ± 0.09	2.85 ± 0.01
COD _t (g/L)	10.7 ± 0.43	4.88 ± 0.01	7.67 ± 0.42	4.10 ± 0.01
COD _s (g/L)	3.02 ± 1.91	0.88 ± 0.01	1.07 ± 0.01	0.41 ± 0.02
VS _{removal} (%)	48 ± 6	70 ± 3	56 ± 1	71 ± 1
COD _{removal} (%)	50 ± 5	77 ± 1	58 ± 5	78 ± 2
Methane production				
Volumetric CH ₄ yield (L/L/d)	0.60 ± 0.05	0.33 ± 0.02	0.15 ± 0.02	0.17 ± 0.03
Specific CH ₄ yield (L/g COD _{added})	0.54 ± 0.04	0.55 ± 0.03	0.31 ± 0.04	0.34 ± 0.06

^a Mean ± SD, n = 2.