Supplementary information for

Anaerobic digestion of food waste with unconventional co-substrates for stable biogas production at high organic loading rates

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Table S1: Components of mixed cafeteria food waste (CFW); n=4

Components	Mass fraction, %
Fruits and vegetables	59.4 ± 3.2
Meat	14.3 ± 3.8
Grains and cereals	23.0 ± 3.5

Table S2: Optimization to choose the ratio of CFW to co-substrates

Experiment	OLR [gVS/L d]	% CFW	% Co-Substrate	Methane FW/ Methane Co-Digestion
CFW+Manure	1.4	30	70	0.78
	1.4	50	50	0.76
	1.2	20	80	0.77
	1.4	70	30	1.35
CFW+Bread	1.4	90	10	1.30
	1.4	80	20	1.06
	1.4	70	30	1.15
CFW+paper	1.4	92	8	0.74
	1.4	85	15	0.64
	1.4	95	5	1.34

Table S3: Experimental design for feeding CFW and co-substrates at different OLRs. The mass of CFW and co-substrates are in grams. If the weights of substrate and cosubstrates do not sum to 60g, the remaining amount comes from water.

**OLR reduced to 3.5 $gVSL^{-1}d^{-1}$ due to the reactor failure at 4.4 $gVSL^{-1}d^{-1}$

	R1	R2		R3		R4		R5		R6		Test duration (d)
OLR, $gVSL^{-1}d^{-1}$	CFW (g)	CFW	AW	CFW	ED	CFW	WB	CFW	PN	CFW	CM	
1.4±0.2	11.6±0.3	9.2±0.4	30.6±0.8	11.5±0.1	48.3±6.1	8.4±0.23	1.5±0.1	9.6±0.1	0.5±0.0	10.1±0.0	4.1±0.4	25
2.8±0.1	23.2±0.1	19.2±0.2	42.1±1.4	23.1±0.2	37.6±0.7	15.1±0.1	2.4±0.2	11.3±0.3	1.1±0.0	19.6±0.2	8.2±0.1	21
4.4±0.1	36±0.1	34.4±0.7	26.1±0.9	36±0.0	24.1±0.1	23±0.2	3.8±0.0	17±0.3	1.7±0.0	29.8±0.8	13.6±0.8	14
5.5±0.1	**	45.2±0.2	15.6±0.4	46.2±0.2	14.5±0.5	29.8±0.4	5.0±0.0	21.6±0.4	2.0±0.0	38.2±0.1	18.3±0.3	10*

Table S4: Observed hydraulic retention times at different OLRs. Small variations in HRT are attributed to sample preparation error and volume losses during feeding and withdrawal.

	HRT (d)					
OLR, $gVSL^{-1}d^{-1}$	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**
1.4±0.2	31.7±0.4	31.3±0.4	31.5±0.4	32.8±0.5	32.4±1.2	32.1±0.7
2.8±0.1	33.4±0.4	33.3±0.7	33.2±0.4	32.7±0.7	32.2±0.8	33.5±0.3
4.4±0.1	29.7±0.3	29.5±1.0	29.9±0.1	29.6±0.4	30.9±0.4	29.5±1.2
5.5±0.1	NA	29.8±0.2	29.5±0.2	30.1±2.1	30.9±0.7	29.5±0.2

Table S5 - Digestate characteristics at OLR = 2.8 $gVSL^{-1}d^{-1}$

	R1	R2	R3	R4	R5	R6
TS, %	1.1	1.2	1.5	2.0	0.9	1.4
C:N ratio	6.2	3.0	4.0	4.5	8.0	5.2
Carbon, %	41	24.8	41.6	35.2	61.7	36.5
Nitrogen, %	7.6	8.3	10.4	7.8	7.7	7.0
Phosphorus, %	1.53	0.7	1.5	1.4	0.9	1.3
Potassium, %	3.44	6.7	4.0	2.1	2.5	3.1
Magnesium, %	0.6	0.6	0.9	0.6	0.4	0.8
Calcium, %	2.9	4.5	3.0	3.0	1.4	2.8
Sodium, %	2	3.3	3.3	2.1	1.2	1.7
Sulfur, %	1.1	0.6	1.6	0.9	0.5	0.7
Iron, %	1.8	0.6	1.2	1.1	0.4	0.5

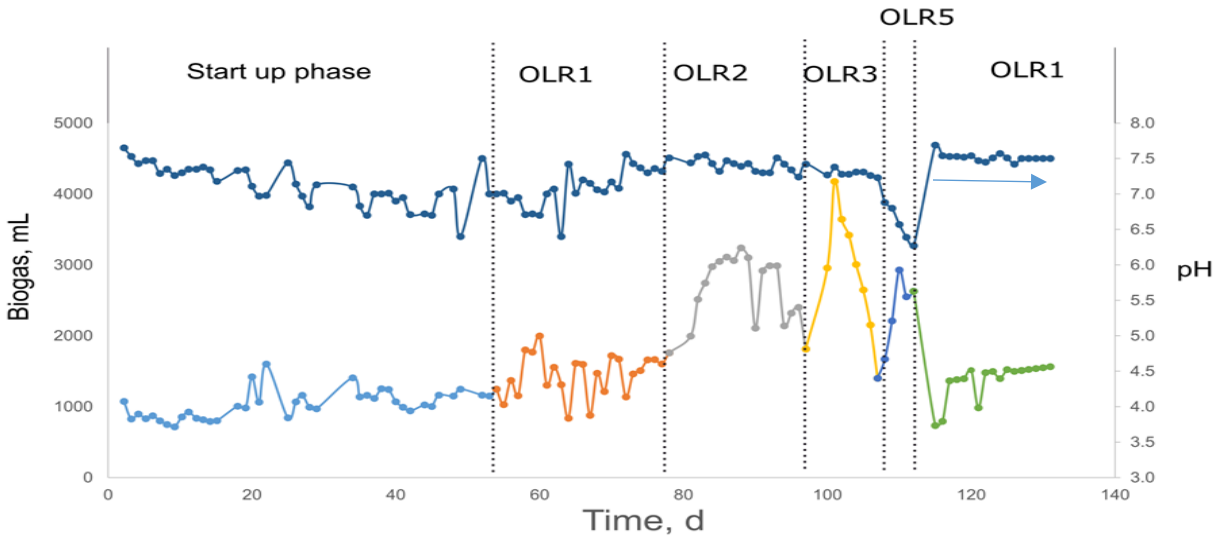

Figure S1 - Sample kinetics of cafeteria food waste (CFW) digestion

OLR1=1.4 $gVSL^{-1}d^{-1}$; OLR2= 2.8 $gVSL^{-1}d^{-1}$; OLR3=4.4 $gVSL^{-1}d^{-1}$; OLR4=5.5 $gVSL^{-1}d^{-1}$; OLR5=3.5 $gVSL^{-1}d^{-1}$; OLR4 is not shown as this OLR was not studied for CFW due to process instability observed at OLR3

Anaerobic digestion of food scraps with continuous mixing:

The start-up procedure for CSTRs was the same as for AMPTSII reactors. The CSTRs were continuously mixed at 60 rpm, and the temperature was maintained at 37^0C using an embedded control thermocouple. The CFW showed a 20% and 27% lower average daily methane at 1.4 and 2.8 $gVSL^{-1}d^{-1}$, respectively, when compared with R1. The alkalinity, volatile acids and total ammoniacal nitrogen were also significantly higher compared to R1. The average hydrogen sulfide levels were nine times lower than R1 with intermittent mixing. There is literature on the effect of mixing on the composition of biogas. However, the mechanism by which mixing would reduce the H_2S concentration is not clear. Continuous mixing is not recommended since it reduces biogas production.

However, In the case of excessive H_2S in the biogas, mixing continuously for a fixed time could help reducing H_2S levels. The parameters measured in this experiment are listed in Table S6.

Table S6 - Process monitoring during digestion of mixed cafeteria food waste (CFW) and vegetable waste (VW) with continuous mixing;

OLR1=1.4 $gVSL^{-1}d^{-1}$; OLR2= 2.8 $gVSL^{-1}d^{-1}$

	CFW		VW	
Parameters	**OLR1**	**OLR2**	**OLR1**	**OLR2**
pH	7.6±0.1	7.5±0.1	7.5±0.1	7.3±0.2
Avg. daily biogas, mL	1261±406	2241±384	1021±241	1402±296
Biogas methane, %	60±4	60±1	56±4	50±5
Biogas H_2S, ppm	18±7	101±32	33±37	381±175
Avg. daily methane, mL	746±193	1354±240	562±133	686±239
SMY, mL CH_4 gVS^{-1} d^{-1}	260±58	253±22	198±48	125±45
Total volatile acids, mg CH_3COOH L^{-1}	1089±514	886±168	1271±572	2197±1070
Total alkalinity, mg $CaCO_3$ L^{-1}	7300±1256	7410±1489	7471±1294	6230±356
Total ammoniacal nitrogen, mg NH_3-N L^{-1}	1840±56	1546±32	1624±29	1518±110