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Data Article

Generic mitigating and promoting effect of zeolite on anaerobic digestion: Physicochemical and metataxonomic data

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A B S T R A C T

This article provides comprehensive data on degradation performance and microbial dynamics derived from a set of 24 lab-scale batch anaerobic digesters involving various types of inhibitors and the addition of zeolite as a support material. In the first series of 12 digesters, three inhibitors were investigated at the following concentrations: 20 g/L of sodium chloride, 400 mg/L of erythromycin, and 5 mg/L of S-metolachlor. Each inhibitor was tested in triplicate, along with a control condition without inhibition. A parallel series was set up identically, except that 15 g/L of zeolite was introduced into each digester to mitigate the inhibition and promote the degradation process. The provided data comprises information regarding the experimental setup, monitoring measurements that assess the degradation performance (production, composition, and apparent isotopic factor of biogas, pH, dissolved inorganic and organic carbon and volatile fatty acids concentrations), microbial samples information, and 16S rRNA gene sequencing data that decipher changes in microbial structure. This datapaper is associated with research article [1] and presents both the sequencing data and the associated physicochemical data in a structured table format. The sequencing data were generated using the Ion Torrent PGM sequencer and have been deposited in the

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European Nucleotide Archive (ENA) database at EMBL-EBI under accession number PRJEB65129 (https://www.ebi.ac.uk/ena/browser/view/PRJEB65129), with sample accession numbers ranging from ERS16257742 to ERS16257691 [2]. The data serves as a valuable resource for comparisons with data from other studies on lab-scale batch anaerobic digesters, particularly those utilizing zeolite as a support material or involving inhibition caused by similar types of inhibitors (salts, antibiotics, or pesticides).

Specifications Table

Subject	Environmental Genomics and Metagenomics.
Specific subject area	Microbial ecology of anaerobic digestion.
Type of data	Table, Figure, Raw sequencing data
Data collection	Gas pressure in the digesters was measured using a differential manometer (Digitron 2082P, Margam, UK) to calculate gas production. Gas composition was analyzed by micro gas chromatography (CP4900, Varian, Palo Alto, USA). Isotopic fractionation of methane and carbon dioxide (δ13CH4 and δ13CO2) was measured using a Trace Gas Chromatograph Ultra coupled to an isotope ratio mass spectrometer Delta V Plus through a combustion machine GC III (Thermo Scientific) to calculate the apparent isotopic factor (αapp) following the description in [3]. Dissolved inorganic and organic carbon (DIC and DOC) were measured using a TOC-L CPN analyzer (Shimadzu) following the French standard NF EN 1484. Volatile fatty acids (VFAs) were measured using ionic chromatography (ICS 5000+, Thermo Fisher Scientific) equipped with an IonPAc ICE-AS1 column (9 mm 250 mm) as described in [3]. pH of the liquid samples was measured with a pH meter (HANNA). DNA sequencing was performed on Ion Torrent Personal Genome Machine according to the manufacturer's instructions and following the procedure described in [4].
Data source location	INRAE, Antony, France.
Data accessibility	**Data are available with the article. The sequencing data have been deposited in ENA at EMBL-EBI under accession number PRJEB65129** (https://www.ebi.ac.uk/ena/browser/view/PRJEB65129) **with sample accession numbers ranging from ERS16257742 to ERS16257691.** Repository name: ENA Data identification number: PRJEB65129 Direct URL to data: https://www.ebi.ac.uk/ena/browser/view/PRJEB65129
Related research article	Wang, X., Dürr, V., Guenne, A., Mazéas, L., Chapleur, O. 2024. Generic role of zeolite in enhancing anaerobic digestion and mitigating diverse inhibitions: Insights from degradation performance and microbial characteristics. Journal of Environmental Management, 356, 120,676. 10.1016/j.jenvman.2024.120676

Value of the Data

- The presented data provide connections between anaerobic digester performance (biogas production, dissolved inorganic/organic carbon and volatile fatty acids accumulation, methanogenesis pathway), inhibition types (salts, pesticides, antibiotics), zeolite addition as a support material, and microbial community structure at different time points. All data can serve as a valuable resource for comparative analysis with other studies on lab-scale batch anaerobic digesters utilizing zeolite or investigating similar inhibitors. The 16S rRNA sequencing data are particularly useful for identifying microbial characteristics influenced by zeolite and different types of inhibition. Access to the sequencing data and associated metadata allows researchers to conduct new studies. The data can also be helpful for exploring relationships between zeolite and specific microbial functions.

- We present comprehensive information on anaerobic digestion performance and microbial structure characteristics in the presence of erythromycin and S-metolachlor (a typical antibiotic and pesticide, respectively), the influence of which has been limited studied but is of increasing interest in anaerobic digestion. The use of zeolite to mitigate their inhibition is also a novel research focus.
- All 8 tested conditions were designed in triplicate in the same experimental system, with identical inoculum and substrate, at a constant mesophilic temperature. The selected samples for sequencing were highly representative to reflect microbial structure changes in the different conditions

This data can be related to previous data from our group on AD inhibition by different inhibitors and mitigation using zeolite or other support materials, conducted under similar experimental conditions and measuring similar parameters [5–7]. Our previous studies investigated the influence of different concentrations of ammonia and phenol, the impact of various support media on the inhibition, and the effects of different co-inhibitors on AD. This paper provides additional knowledge by specifically analyzing the effect of zeolite on a wide range of inhibitors.

1. Background

Zeolite is an aluminosilicate mineral with favorable physicochemical properties. It has been demonstrated to mitigate the inhibition in anaerobic digestion caused by several inhibitors, such as long-chain fatty acids, ammonia, and phenolic compounds [8–10]. We verified the broad applicability of zeolite's mitigating effect on other types of inhibitors found in anaerobic digestion, including sodium chloride, erythromycin, and S-metolachlor, from aspects of anaerobic digestion performance and microbial structure changes. The data article adds value to the related research article by providing detailed raw degradation performance data and sequencing data, which enhances data transparency, reproducibility, and accessibility while allowing other researchers to treat the data as a reference.

2. Data Description

The experimental design of this study is depicted in Fig. 1. A total of 24 batch anaerobic digesters were set up and divided into two series. Within each series, the 3 inhibitors were examined in triplicate alongside a control condition without inhibitors. One of the series included the addition of zeolite to evaluate its potential in mitigating the inhibition and promoting the anaerobic digestion process. The nomenclature of the digesters, the type of inhibitor added, the presence of zeolite, the number of replicates, and the selected dates for 16S rRNA sequencing and associated sample names are presented in Table 1. Tables 2–4 present the cumulative total biogas, methane, and carbon dioxide production data over time for each digester, while Fig. 2 provides a graphical representation of the production curves using the mean values of the triplicates for each condition. Table 5 displays the apparent isotope factor (αapp) of the biogas over time calculated from the isotopic fractionation of methane and carbon dioxide (δ13CH4 and δ13CO2), serving as an indicator of the methanogenic pathways. This data is also illustrated in Fig. 3 using the mean values of the triplicates for each condition. As noted by the horizontal lines in the figure, αapp greater than 1.065 implies the hydrogenotrophic pathway as the dominant methanogenesis pathway, while αapp less than 1.055 indicates acetoclastic methanogenesis as the prominent pathway [11]. Tables 6 and 7 depict the concentration of dissolved inorganic and organic carbon (DIC and DOC) over time in each digester, with Fig. 4 presenting these datasets using the mean values of the triplicates. The pH values are recorded in Table 8 and illustrated

Table 1
Experimental setup information and dates and sample names used for 16S rRNA gene sequencing.

Name of digester	Type of inhibitor	Zeolite addition	Replicate	Dates used for 16S rRNA sequencing and associated sample names						
				Day 0	Day 6	Day 13	Day 20	Day 34	Day 41	Day 55
0_a	No inhibitor	No	a				0_a_D20	0_a_D34		
0_b	No inhibitor	No	b				0_b_D20	0_b_D34		
0_c	No inhibitor	No	c				0_c_D20	0_c_D34		
Na_a	Sodium chloride	No	a				Na_a_D20			Na_a_D55
Na_b	Sodium chloride	No	b	Inoculum_3			Na_b_D20			Na_b_D55
Na_c	Sodium chloride	No	c				Na_c_D20			Na_c_D55
ERY_a	Erythromycin	No	a				E_a_D20			E_a_D55
ERY_b	Erythromycin	No	b				E_b_D20			E_b_D55
ERY_c	Erythromycin	No	c				E_c_D20	E_c_D34		
MET_a	S-metolachlor	No	a	Inoculum_4			M_a_D20	M_a_D34		
MET_b	S-metolachlor	No	b				M_b_D20	M_b_D34		
MET_c	S-metolachlor	No	c				M_c_D20		M_c_D41	
0z_a	No inhibitor	Yes	a		0z_a_D6		0z_a_D20			
0z_b	No inhibitor	Yes	b		0z_b_D6		0z_b_D20			
0z_c	No inhibitor	Yes	c	Inoculum_1	0z_c_D6		0z_c_D20			
Naz_a	Sodium chloride	Yes	a			Naz_a_D13	Naz_a_D20			
Naz_b	Sodium chloride	Yes	b	Inoculum_2		Naz_b_D13	Naz_b_D20			
Naz_c	Sodium chloride	Yes	c			Naz_c_D13	Naz_c_D20			
ERYz_a	Erythromycin	Yes	a		Ez_a_D6		Ez_a_D20			
ERYz_b	Erythromycin	Yes	b		Ez_b_D6		Ez_b_D20			
ERYz_c	Erythromycin	Yes	c		Ez_c_D6		Ez_c_D20			
METz_a	S-metolachlor	Yes	a		Mz_a_D6		Mz_a_D20			
METz_b	S-metolachlor	Yes	b		Mz_b_D6		Mz_b_D20			
METz_c	S-metolachlor	Yes	c		Mz_c_D6		Mz_c_D20			

Table 2
Cumulative biogas production in each digester (mL).

Day	0_a	0_b	0_c	Na_a	Na_b	Na_c	Ery_a	Ery_b	Ery_c	Met_a	Met_b	Met_c	0z_a	0z_b	0z_c	Naz_a	Naz_b	Naz_c	Eryz_a	Eryz_b	Eryz_c	Metz_a	Metz_b	Metz_c
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	70.663	66.99	69.785	13.778	14.285	17.642	27.037	26.594	20.385	53.249	63.834	69.225	73.54	76.287	75.03	32.793	31.664	29.209	73.648	56.156	68.261	76.257	81.455	78.251
4	194.377	198.782	193.21	132.587	132.113	139.826	136.989	198.028	159.996	168.192	187.836	181.168	264.564	259.031	248.253	181.665	186.797	185.265	208.614	205.663	123.973	259.577	244.955	265.784
5	236.384	242.665	229.158	177.912	175.678	183.767	175.275	253.595	190.925	206.103	229.064	225.425	357.926	354.672	329.411	236.511	249.894	244.958	273.154	269.857	180.319	353.113	327.296	377.121
6	260.388	272.958	256.423	206.331	200.779	210.223	205.338	283.456	219.689	238.964	257.685	256.094	464.358	450.747	416.08	289.684	305.779	297.006	334.289	338.234	238.887	447.601	407.012	488.544
7	278.846	293.922	274.855	229.464	224.728	228.805	228.035	305.177	242.836	261.422	274.827	272.759	583.73	555.366	520.709	336.06	353.337	340.84	405.579	414.672	308.153	550.934	490.585	609.222
8	290.479	308.367	288.175	240.061	231.951	236.176	238.307	316.366	258.08	275.808	287.851	284.451	695.946	655.682	625.347	407.427	421.33	403.77	473.364	484.499	375.938	651.931	561.449	730.91
11	344.382	365.674	344.712	283.87	270.135	282.264	279.955	360.204	320.567	330.51	337.521	325.034	1076.52	980.548	967.974	608.74	613.556	579.065	730.327	768.369	640.656	959.895	802.812	1066.373
12	374.278	400.158	375.201	308.202	292.928	306.744	304.405	385.602	356.946	365.705	367.418	351.349	1252.436	1146.311	1140.367	711.602	714.879	687.255	865.779	926.554	790.553	1113.641	932.581	1248.565
13	389.967	417.12	389.113	323.15	302.193	316.689	311.42	394.097	383.024	385.123	381.744	359.844	1457.006	1333.594	1330.758	828.939	820.316	793.965	1021.892	1103.033	956.287	1281.091	1080.258	1437.771
14	432.703	458.585	427.518	341.769	314.185	328.115	323.446	404.653	435.284	428.854	399.126	370.417	1652.108	1520.907	1513.05	947.945	924.853	899.117	1187.137	1284.199	1132.996	1449.635	1239.484	1625.118
15	497.504	479.709	445.728	357.457	317.311	341.214	329.699	410.207	462.629	457.747	415.181	378.733	1794.51	1718.667	1706.44	1077.904	1045.827	1016.602	1356.156	1460.927	1320.71	1633.859	1425.62	1780.934
18	602.818	592.155	538.72	404.348	355.674	381.609	371.339	447.628	582.967	594.413	510.813	435.821	1987.384	1966.444	1980.409	1459.099	1414.792	1389.906	1685.968	1760.42	1641.236	1884.276	1768.878	1984.947
19	665.734	661.869	594.776	429.963	383.201	391.352	400.384	475.49	662.514	677.906	564.836	469.266	2035.277	2045.141	2072.46	1602.017	1566.724	1542.627	1790.16	1856.629	1754.897	1975.387	1881.841	2063.735
20	736.935	742.661	661.304	442.649	391.881	398.18	417.865	495.187	755.294	772.689	629.178	485.473	2076.522	2098.132	2131.704	1707.088	1694.284	1672.798	1866.976	1928.377	1840.059	2042.157	1968.824	2116.514
21	812.233	826.181	727.264	457.794	406.998	415.07	445.046	520.509	848.552	867.23	695.79	509.125	2104.256	2139.919	2177.536	1788.798	1792.757	1776.614	1936.219	1988.227	1912.701	2104.363	2048.922	2163.242
22	903.634	921.345	807.811	463.858	409.3	430.154	472.663	544.953	949.625	969.236	772.139	544.205	2108.267	2164.021	2204.375	1843.875	1863.01	1852.216	1993.535	2034.845	1971.261	2148.182	2110.064	2190.952
25	1143.534	1183.761	1033.717	523.569	453.647	477.362	523.012	582.645	1206.008	1265.644	971.641	627.645	2122.449	2205.414	2269.124	1932.26	1973.133	1962.059	2092.026	2114.335	2077.403	2200.242	2218.538	2215.583
26	1263.702	1306.479	1147.447	546.396	476.91	501.962	553.583	608.426	1320.018	1393.959	1069.573	672.677	2145.089	2225.287	2291.142	1967.029	2011.385	2003.888	2135.192	2145.559	2120.631	2226.335	2250.291	2241.893
27	1390.774	1440.984	1265.096	559.799	487.763	513.904	571.123	619.342	1423.765	1527.562	1179.416	724.084	2151.713	2232.999	2298.731	1984.164	2033.03	2023.48	2153.79	2158.372	2139.508	2236.628	2262.326	2251.378
28	1508.284	1564.072	1378.317	588.091	512.79	543.386	605.77	644.55	1513.978	1646.538	1293.395	781.866	2161.48	2240.356	2305.007	2013.401	2068.119	2060.944	2186.707	2184.457	2173.509	2245.226	2270.542	2260.37
29	1627.526	1690.225	1501.953	601.308	523.746	554.31	623.988	655.665	1592.358	1750.652	1424.262	839.449	2167.881	2244.56	2309.752	2022.988	2077.705	2071.199	2196.197	2190.285	2182.873	2251.659	2272.803	2266.387
32	1918.177	1958.487	1836.205	663.541	577.061	611.765	701.603	708.438	1774.405	1907.443	1776.254	978.341	2198.36	2275.772	2344.085	2071.971	2122.517	2120.214	2236.486	2233.249	2225.455	2290.515	2306.722	2300.945
33	1992.575	2006.928	1942.739	696.855	602.38	643.709	747.593	739.841	1854.727	1948.464	1878.584	1052.835	2203.297	2280.04	2349.85	2097.004	2145.352	2145.215	2258.525	2256.817	2246.57	2296.693	2314.748	2307.633
34	2035.38	2041.261	2009.654	733.735	627.796	679.507	799.251	771.307	1919.062	1980.854	1945.848	1139.018	2228.776	2303.799	2372.494	2111.368	2157.104	2159.101	2265.437	2270.194	2256.539	2321.058	2338.953	2333.494
35	2071.33	2078.288	2055.792	764.165	646.811	708.653	856.286	808.518	1975.803	2003.654	1984.639	1240.641	2239.954	2316.687	2384.685	2126.846	2171.391	2176.282	2273.284	2282.395	2267.247	2333.019	2350.564	2347.537
36	2095.127	2097.521	2085.978	791.319	661.578	733.655	884.81	829.838	2001.132	2030.123	2012.054	1361.254	2242.431	2322.164	2389.347	2133.04	2179.018	2186.094	2277.424	2291.783	2275.461	2337.224	2353.758	2349.558
39	2171.863	2166.629	2155.379	912.486	737.238	840.642	1053.765	936.368	2092.113	2094.472	2084.65	1739.034	2251.722	2331.389	2400.299	2161.922	2212.627	2221.365	2304.09	2277.407	2287.197	2352.284	2366.113	2358.131
41	2210.165	2216.569	2214.708	1019.115	806.412	929.602	1207.661	1044.626	2148.605	2127.591	2137.654	1937.915	2256.057	2337.191	2405.059	2169.648	2220.092	2229.123	2321.367	2286.079	2305.191	2360.466	2371.557	2362.956
42	2233.309	2241.78	2251.816	1084.045	853.364	988.717	1306.88	1118.466	2178.301	2141.678	2170.964	1999.747	2263.78	2345.104	2411.169	2175.028	2226.032	2234.878	2352.308	2291.467	2334.573	2369.802	2380.413	2371.757
43	2237.744	2246.549	2268.623	1172.649	907.954	1063.149	1395.317	1213.873	2205.712	2162.653	2175.533	2039.164	2266.881	2350.506	2414.67	2174.994	2225.299	2234.378	2360.511	2291.6	2343.676	2375.204	2384.181	2374.758
46	2248.515	2258.287	2301.837	1389.608	1048.847	1269.369	1562.822	1421.294	2233.958	2181.494	2187.038	2088.652	2296.06	2381.953	2445.217	2199.371	2247.341	2258.054	2398.56	2321.48	2382.193	2409.619	2415.895	2407.705
47	2251.917	2262.889	2307.04	1486.015	1122.545	1369.712	1642.222	1520.936	2259.435	2204.338	2207.446	2115.23	2299.728	2386.555	2449.118	2202.873	2250.843	2261.589	2404.463	2327.949	2387.428	2413.654	2420.33	2411.674
48	2256.952	2270.092	2312.475	1572.519	1197.477	1465.319	1712.752	1610.374	2270.54	2213.508	2216.083	2130.503	2303.43	2391.257	2453.487	2208.075	2255.278	2265.724	2409.699	2332.918	2393.131	2418.59	2424.898	2415.375
49	2279.045	2292.608	2332.829	1640.118	1267.935	1544.193	1771.897	1684.782	2294.985	2222.722	2227.324	2143.674	2309.462	2397.686	2457.779	2211.724	2260.546	2270.537	2414.049	2336.304	2398.546	2425.239	2430.686	2422.811
53	2301.992	2314.975	2360.515	1814.455	1530.037	1745.739	1924.958	1867.814	2328.877	2261.729	2266.638	2237.031	2319.827	2412.586	2469.679	2221.544	2268.081	2279.777	2426.153	2342.066	2418.288	2438.844	2442.45	2433.722
54	2305.129	2317.362	2364.164	1874.398	1619.848	1814.956	1986.367	1940.133	2356.257	2265.786	2270.218	2271.708	2321.362	2414.393	2470.429	2221.987	2269.547	2281.891	2428.915	2343.6	2443.111	2440.583	2443.814	2435.598
55	2322.007	2333.694	2382.678	1918.519	1686.746	1867.261	2029.363	1994.245	2365.838	2289.483	2291.188	2284.153	2342.536	2434.34	2492.285	2221.885	2269.991	2282.88	2450.396	2344.419	2449.044	2465.576	2411.115	2459.84
56	2327.565	2339.491	2389.395	1955.894	1745.148	1912.42	2073.404	2050.487	2393.897	2298.621	2296.848	2303.418	2347.684	2440.852	2498.491	2240.195	2287.21	2300.645	2455.988	2346.567	2453.442	2471.815	2417.252	2465.194
57	2331.963	2344.196	2394.68	1984.05	1794.072	1949.915	2109.122	2098.226	2401.145	2306.634	2301.28	2308.396	2350.753	2444.535	2502.514	2245.139	2290.585	2304.6	2459.807	2348.374	2456.408	2475.805	2421.105	2468.535
60	2341.101	2354.05	2405.046	2032.033	1914.013	2019.224	2156.094	2171.264	2431.148	2337.628	2327.808	2335.776	2354.129	2448.831	2508.174	2249.844	2294.404	2308.828	2484.766	2375.344	2482.902	2479.59	2425.913	2472.934
61	NA	NA	NA	2053.011	1955.794	2043.616	2190.104	2212.139	2459.478	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
62	NA	NA	NA	2063.674	1993.602	2057.276	2221.989	2254.86	2474.775	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2479.048	2425.051	2472.151
63	NA	NA	NA	2076.727	2020.825	2068.983	2238.215	2279.145	2486.962	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
64	NA	NA	2449.384	2084.095	2032.038	2070.798	2244.907	2292.031	2494.472	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
67	2392.014	2403.421	2482.801	2116.523	2065.604	2103.155	2292.107	2360.73	2537.045	2378.862	2377.774	2380.919	2384.15	2486.033	2538.04	2272.543	2316.612	2331.063	2510.1	2455.2	2519.697	NA	NA	NA
68	NA	NA	NA	2139.589	2087.46	2128.285	2321.615	2394.475	2563.421	2403.574	2404.68	2406.314	NA	NA	NA	NA	NA	NA	2510.244	2455.812	2520.848	2479.318	2425.382	2472.442
69	NA	NA	NA	2144.821	2092.479	2136.793	2330.835	2410.172	2570.148	2407.926	2410.076	2410.271	NA	NA	NA	NA	NA	NA				NA	NA	NA
71	NA	NA	NA	2159.202	2105.436	2152.633	2344.646	2431.103	2578.976	2415.228	2417.306	2416.853	NA	NA	NA	NA	NA	NA	2513.697	2461.423	2526.999	NA	NA	NA
74	NA	NA	NA	2184.226	2120.35	2172.353	2379.707	2479.94	2611.439	2420.947	2424.751	2422.429	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
75	NA	NA	NA	2194.869	2127.149	2181.358	2384.264	2486.917	2614.928	2422.494	2426.55	2423.975	NA	NA	NA	2280.025	2322.943	2337.933	NA	NA	NA	NA	NA	NA
78	NA	NA	NA	2243.279	2163.635	2231.157	2400.033	2507.313	2623.293	2426.99	2431.982	2429.191	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 3
Cumulative methane production in each digester (mg of C).

Day	0_a	0_b	0_c	Na_a	Na_b	Na_c	Ery_a	Ery_b	Ery_c	Met_a	Met_b	Met_c	Oz_a	Oz_b	Oz_c	Naz_a	Naz_b	Naz_c	Eryz_a	Eryz_b	Eryz_c	Metz_a	Metz_b	Metz_c
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	16.084	1.767	0.169	0.504	0.31	0.363	4.262	1.682	1.084	2.076	2.078	0.781	1.193	1.4	0.185	0.475	0.53	0.521	0.438	0.703	NA	0.567	0.636	0.408
4	NA	13.228	1.195	2.07	1.888	4.212	5.35	16.659	1.486	3.673	3.366	3.052	8.11	21.184	2.736	4.596	3.783	2.323	7.221	15.65	2.204	5.133	4.841	4.353
5	5.563	16.445	NA	2.419	2.178	NA	NA	21.701	NA	3.978	3.53	NA	NA	41.812	NA	5.417	6.222	3.75	9.899	23.254	NA	10.11	7.322	5.064
6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	56.422	1.891	NA	NA	NA	28.381	32.684	1.406	11.136	10.419	16.385
7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	14.672	87.043	NA	11.987	12.03	7.321	33.819	45.066	26.744	16.913	13.905	NA
8	15.614	19.675	11.521	8.324	8.456	9.012	12.2	24.908	14.637	13.582	14.327	10.691	93.27	114.962	73.628	34.12	38.013	31.848	57.804	62.909	41.992	85.402	58.68	97.962
11	23.827	28.166	21.576	15.88	11.796	12.626	13.785	28.22	20.944	22.09	18.647	12.864	233.109	241.824	211.489	104.386	102.392	90.265	133.17	170.755	137.801	203.864	143.146	235.944
12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	298.947	297.224	263.809	134.148	127.629	118.289	178.082	216.105	179.502	250.138	182.664	294.913
13	30.65	36.522	29.426	NA	NA	NA	NA	NA	33.353	31.772	NA	NA	377.276	366.529	331.139	176.506	162.589	152.122	230.46	276.369	234.356	311.278	233.953	363.869
14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	448.748	437.385	398.792	218.684	198.013	187.339	287.735	339.689	294.36	372.906	290.764	431.916
15	42.781	48.343	38.273	32.618	22.493	NA	20.969	35.595	60.421	51.52	36.338	25.585	501.287	513.818	480.254	252.788	244.438	231.192	350.984	404.944	363.311	441.908	363.231	490.333
18	67.722	83.435	59.954	36.985	23.642	NA	25.869	41.029	96.869	95.613	56.574	30.654	580.864	613.982	597.77	422.468	400.641	393.086	484.01	529.205	494.881	545.669	503.643	575.721
19	81.575	96.529	72.869	NA	NA	NA	NA	NA	118.091	116.528	66.802	NA	589.125	637.358	624.259	462.039	442.868	435.594	513.224	555.781	525.213	571.245	535.803	598.08
20	100.304	120.103	89.745	NA	NA	NA	NA	NA	145.635	144.34	80.552	NA	602.815	656.335	646.279	503.323	492.06	487.672	543.816	600.998	560.915	599.489	573.421	619.494
21	122.051	146.406	108.071	NA	NA	NA	41.582	55.666	NA	173.939	98.397	47.464	NA	NA	NA	529.979	526.079	523.849	566.977	605.865	586.574	620.388	603.476	636.345
22	147.881	177.532	132.586	50.493	33.042	33.705	45.152	NA	196.483	208.054	120.674	52.855	NA	679.056	672.237	548.798	550.693	550.114	586.753	631.738	606.625	637.635	624.199	NA
25	247.47	286.043	222.083	63.029	40.819	44.292	52.487	69.327	303.326	336.53	197.517	73.219	617.141	691.584	694.708	586.987	598.894	597.225	631.626	658.902	654.797	654.075	673.868	654.248
26	284.59	324.235	253.683	NA	NA	NA	NA	NA	336.928	381.283	224.768	84.229	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
27	331.395	374.232	294.108	71.268	47.315	53.814	64.268	75.281	372.537	432.861	261.19	95.045	NA	NA	NA	598.441	617.999	613.861	653.78	673.011	675.91	NA	NA	NA
28	376.555	421.987	334.761	NA	NA	NA	NA	NA	406.192	482.767	305.218	111.109	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
29	427.828	477.844	386.506	80.715	55.104	61.954	75.308	81.116	434.536	527.041	358.776	126.719	629.978	701.317	703.686	606.886	629.374	632.344	662.699	695.252	688.805	683.123	689.772	686.287
32	572.944	588.032	537.727	94.869	64.885	74.179	97.215	92.629	516.61	598.347	522.922	176.833	NA	NA	NA	628.244	647.549	648.734	678.994	704.776	706.029	NA	NA	NA
33	591.764	604.763	577.808	103.53	71.246	81.247	108.897	100.639	543.39	613.223	556.534	194.141	641.717	711.577	719.16	NA	NA	NA	NA	NA	NA	687.45	701.502	NA
34	606.824	619.134	604.646	NA	NA	NA	124.314	105.849	564.453	NA	588.325	224.247	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35	NA	NA	NA	NA	NA	NA	NA	NA	NA	627.462	601.522	261.537	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
36	628.7	638.51	633.844	137.903	87.413	112.516	155.124	121.536	600.906	NA	NA	311.616	NA	NA	NA	653.801	669.694	676.323	NA	722.653	NA	NA	NA	NA
39	666.172	670.301	659.796	181.194	113.507	149.949	221.328	159.169	637.511	669.841	647.384	494.332	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
41	676.394	688.765	684.338	218.272	133.223	178.137	276.481	193.689	657.646	NA	665.082	579.207	NA	NA	NA	NA	NA	NA	712.814	NA	NA	NA	NA	NA
42	NA	NA	NA	239.6	146.859	194.779	308.079	217.028	666.336	683.609	NA	596.931	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
43	NA	NA	699.479	271.032	164.425	220.895	341.436	251.394	NA	NA	NA	NA	663.203	738.969	741.541	665.144	685.648	694.811	722.383	741.041	720.969	716.872	726.337	709.38
46	NA	NA	NA	366.499	221.32	307.377	414.34	340.334	688.796	694.441	675.149	635.708	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
47	NA	NA	NA	394.811	242.493	339.942	441.471	372.065	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
48	693.409	710.165	717.568	426.419	266.047	373.741	465.06	403.171	701.966	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
49	NA	NA	NA	450.583	290.641	402.668	490.21	432.102	NA	709.217	691.662	655.086	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
53	NA	NA	NA	540.445	413.735	501.013	564.203	518.017	726.092	NA	NA	696.214	NA	NA	NA	NA	NA	NA	NA	NA	752.604	NA	NA	NA
54	714.587	727.651	742.583	550.9	437.114	522.392	578.194	536.738	NA	729.273	711.675	NA	681.109	760.496	774.143	NA	NA	NA	752.777	NA	NA	737.882	745.628	729.936
55	NA	NA	NA	570.581	464.734	540.169	596.11	557.677	738.704	NA	NA	709.172	NA	NA	NA	683.218	701.352	711.132	NA	NA	NA	NA	NA	NA
56	NA	NA	NA	576.353	483.003	552.267	610.567	577.971	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
57	NA	NA	NA	596.071	503.513	566.975	NA	NA	NA	745.791	714.023	NA	NA	NA	NA	NA	NA	NA	756.702	764.221	763.708	NA	NA	NA
60	NA	NA	NA	613.487	567.868	604.975	650.504	637.811	766.327	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
61	NA	NA	NA	NA	576.698	NA	657.34	650.636	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
62	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
63	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
64	NA	NA	NA	628.768	612.292	623.003	679.351	681.334	788.061	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
67	743.204	756.05	769.278	648.919	617.842	632.685	694.144	709.2	801.427	765.335	745.712	742.489	702.313	782.835	781.948	NA	NA	NA	NA	NA	NA	766.835	767.332	751.956
68	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
69	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
71	NA	NA	NA	NA	NA	NA	715.345	735.574	816.498	NA	NA	NA	NA	NA	NA	NA	NA	NA	773.795	783.938	786.347	NA	NA	NA
74	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
75	NA	NA	NA	686.884	647.323	672.72	NA	NA	NA	NA	NA	NA	NA	NA	NA	694.238	715.558	723.549	NA	NA	NA	NA	NA	NA
78	NA	NA	NA	NA	663.497	692.607	740.181	771.247	832.589	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 4
Cumulative carbon dioxide production in each digester (mg of C).

Day	0_a	0_b	0_c	Na_a	Na_b	Na_c	Ery_a	Ery_b	Ery_c	Met_a	Met_b	Met_c	0z_a	0z_b	0z_c	Naz_a	Naz_b	Naz_c	Eryz_a	Eryz_b	Eryz_c	Metz_a	Metz_b	Metz_c
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	8.188	29.54	2.703	14.058	10.963	11.029	14.17	11.49	0.977	8.534	9.501	35.321	13.25	42.144	4.951	19.176	17.216	22.86	15.462	29.975	NA	13.024	12.802	12.003
4	12.403	105.968	8.54	41.054	29.972	79.49	52.938	100.113	9.471	43.779	39.608	49.268	66.587	127.839	13.195	62.866	52.409	44.103	66.534	98.905	16.016	64.861	55.445	61.638
5	22.931	118.197	NA	50.058	35.993	NA	NA	118.6	NA	47.053	40.028	NA	NA	154.667	NA	69.822	59.766	45.497	72.986	125.987	NA	81.733	64.526	65.246
6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	181.014	9.127	NA	NA	NA	88.974	149.713	8.753	NA	NA	68.37
7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	69.89	217.867	NA	86.994	64.003	47.433	126.333	163.16	87.53	110.5	86.922	88.659
8	71.411	120.951	66.177	72.362	92.946	103.251	95.054	132.849	79.573	99.12	99.382	104.559	164.974	240.575	98.723	138.265	129.803	121.919	146.038	179.36	111.395	153.879	138.889	149.002
11	103.017	148.27	99.795	99.829	101.61	114.067	99.942	143.255	85.465	125.41	109.785	108.291	183.157	261.094	140.365	173.074	186.041	152.254	174.53	219.055	152.388	189.632	168.327	183.618
12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	222.673	294.277	175.657	194.943	191.323	174.403	209.575	244.257	184.223	220.762	197.972	217.992
13	123.352	165.106	114.426	NA	NA	NA	NA	NA	115.973	139.627	NA	NA	251.154	321.06	206.015	212.757	211.746	194.996	235.437	277.894	212.86	244.485	221.052	244.725
14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	278.883	347.856	231.961	230.661	227.51	211.436	260.669	306.198	241.129	267.683	244.401	271.403
15	133.102	181.357	128.178	125.696	124.024	NA	124.66	161.203	151.771	149.232	140.288	137.809	299.469	372.744	255.898	235.974	244.733	228.741	284.376	330.161	267.977	290.008	268.414	292.965
18	161.02	206.208	151.222	137.537	133.701	NA	136.859	171.695	174.919	176.817	160.063	150.344	316.309	397.129	281.479	276.786	279.145	261.756	317.398	357.661	301.648	313.945	300.503	312.589
19	176.037	219.418	162.133	NA	NA	NA	NA	NA	188.571	193.608	170.466	NA	323.59	411.146	298.697	305.974	309.03	291.972	338.208	375.698	323.303	329.087	321.636	325.599
20	191.757	238.701	177.825	NA	NA	NA	NA	NA	206.458	211.746	185.342	NA	327.641	417.579	305.996	318.898	326.648	308.76	347.398	384.002	334.241	337.105	330.526	332.349
21	209.041	256.119	193.086	NA	NA	NA	155.487	192.891	224.386	229.581	200.666	168.014	NA	NA	NA	329.589	340.12	323.533	354.515	390.77	342.987	342.729	340.296	336.873
22	225.35	271.973	208.07	151.372	145.262	137.212	156.659	NA	241.004	247.044	217.703	174.711	NA	424.558	314.64	336.274	348.909	333.558	362.327	396.326	349.165	348.457	346.645	NA
25	259.047	312.425	239.039	166.066	159.126	150.724	168.396	208.167	269.168	274.249	245.928	199.733	334.837	429.808	321.756	345.608	359.429	344.104	371.282	404.213	359.395	352.864	356.948	344.739
26	286.582	333.726	265.18	NA	NA	NA	NA	NA	292.152	297.073	267.975	209.365	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
27	303.591	350.831	282.378	174	161.888	160.046	185.324	214.756	307.133	309.911	283.096	219.146	NA	NA	NA	350.885	367.002	352.915	380.234	409.965	367.792	NA	NA	NA
28	317.75	365.392	297.64	NA	NA	NA	NA	NA	319.978	321.761	299.919	233.878	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
29	329.278	377.442	311.326	180.024	173.916	167.41	198.091	224.09	327.569	329.985	312.511	245.345	341.482	435.574	327.166	355.992	372.227	357.792	383.467	413.257	372.985	360.537	364.428	352.018
32	343.676	383.925	325.919	192.078	185.873	179.965	215.263	238.17	342.308	340.668	329.049	266.675	NA	NA	NA	362.473	378.395	364.179	388.96	418.587	378.18	NA	NA	NA
33	354.234	395.417	344.369	197.841	190.164	183.364	222.581	245.333	355.112	344.28	343.578	280.761	346.52	440.614	332.352	NA	NA	NA	NA	NA	NA	366.475	371.142	358.052
34	358.499	400.231	350.863	NA	NA	NA	233.719	249.383	361.033	NA	349.835	297.929	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35	NA	NA	NA	NA	NA	NA	NA	NA	NA	353.491	352.932	312.951	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
36	364.636	406.336	358.144	217.363	202.797	203.675	249.089	266.099	370.002	NA	NA	324.125	NA	NA	NA	370.624	384.909	372.188	NA	424.714	NA	NA	NA	NA
39	372.436	413.58	364.939	234.239	217.069	219.833	270.764	284.551	376.633	362.691	362.722	343.347	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
41	374.335	417.596	371.312	251.406	228.232	235.376	292.534	302.186	383.451	NA	367.373	362.339	NA	NA	NA	NA	NA	NA	399.155	NA	NA	NA	NA	NA
42	NA	NA	NA	261.869	235.895	244.58	309.952	316.052	385.545	367.869	NA	372.487	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
43	NA	NA	375.278	276.374	247.197	258.576	322.827	332.163	NA	NA	NA	NA	356.174	452.258	343.552	375.032	389.849	378.19	402.9	430.726	382.36	379.772	381.817	369.454
46	NA	NA	NA	303.362	265.646	282.617	336.671	351.538	393.864	374.095	372.604	381.097	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
47	NA	NA	NA	317.022	280.291	299.141	349.199	368.989	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
48	382.58	427.063	381.185	328.182	293.332	313.628	356.38	380.506	395.755	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
49	NA	NA	NA	334.859	303.411	322.442	364.737	391.272	NA	377.167	378.106	386.885	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
53	NA	NA	NA	349.348	326.608	336.971	375.329	405.072	405.47	NA	NA	395.858	NA	NA	NA	NA	NA	NA	NA	NA	393.072	NA	NA	NA
54	391.644	434.316	392.064	354.249	341.831	346.898	381.301	414.294	NA	385.66	385.86	NA	364.209	461.669	352.361	NA	NA	NA	413.771	NA	NA	388.124	390.392	378.095
55	NA	NA	NA	360.613	349.959	350.838	387.548	421.88	408.617	NA	NA	399.712	NA	NA	NA	383.208	397.06	386.473	NA	NA	NA	NA	NA	NA
56	NA	NA	NA	361.005	355.268	355.469	391.567	429.596	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
57	NA	NA	NA	364.955	359.082	357.616	NA	NA	NA	393.534	385.867	NA	NA	NA	NA	NA	NA	NA	415.439	439.885	397.743	NA	NA	NA
60	NA	NA	NA	368.94	367.41	363.537	400.515	438.272	417.412	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
61	NA	NA	NA	NA	370.531	NA	402.532	442.519	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
62	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
63	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
64	NA	NA	394.758	373.165	378.525	368.469	410.115	452.358	423.783	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
67	402.029	444.579	403.773	379.252	378.666	371.781	413.8	459.609	428.064	400.074	398.968	413.326	373.608	473.307	361.945	NA	NA	NA	NA	NA	NA	404.304	400.241	387.686
68	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
69	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
71	NA	NA	NA	NA	NA	NA	419.54	466.147	432.631	NA	NA	NA	NA	NA	NA	NA	NA	NA	424.444	449.24	408.584	NA	NA	NA
74	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
75	NA	NA	NA	385.829	386.649	393.566	NA	NA	NA	NA	NA	NA	NA	NA	NA	389.665	403.126	391.901	NA	NA	NA	NA	NA	NA
78	NA	NA	NA	NA	391.341	NA	427.038	473.51	436.867	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5
Apparent isotopic factor (α_{app}) in each digester.

Day	0_a	0_b	0_c	Na_a	Na_b	Na_c	Ery_a	Ery_b	Ery_c	Met_a	Met_b	Met_c	0z_a	0z_b	0z_c	Naz_a	Naz_b	Naz_c	Eryz_a	Eryz_b	Eryz_c	Metz_a	Metz_b	Metz_c
14	1.075	1.072	1.072	1.063	1.068	1.068	1.072	1.068	1.075	1.076	1.077	1.075	1.038	1.042	1.041	1.041	1.045	1.046	1.052	1.048	1.051	1.044	1.05	1.041
21	1.075	1.068	1.072	1.066	1.073	1.075	1.081	1.078	1.065	1.066	1.079	1.083	1.038	1.033	1.029	1.031	NA	1.034	1.032	1.029	1.033	1.033	1.03	1.034
28	1.048	1.045	1.054	1.071	1.079	1.079	1.087	1.084	1.047	1.036	1.055	1.08	1.04	1.038	1.037	1.029	1.024	1.024	1.027	1.027	1.028	1.038	1.034	1.039
35	1.022	1.023	1.017	1.066	1.077	1.071	1.073	1.085	1.03	1.026	1.018	1.061	1.043	1.042	1.041	1.036	1.031	1.032	1.029	1.033	1.03	1.041	1.038	1.042
42	1.035	1.035	1.034	1.055	1.066	1.059	1.053	1.066	1.028	1.037	1.032	1.019	1.043	1.044	1.041	1.039	1.035	1.035	1.037	1.039	1.04	1.041	1.038	1.042
49	1.037	1.04	1.038	1.043	1.054	1.045	1.04	1.046	1.027	1.039	1.038	1.023	1.046	1.042	1.043	1.039	1.038	1.036	1.039	1.04	1.041	1.044	1.04	1.045

Table 6
Dissolved inorganic carbon (DIC) concentration in each digester (mgC/L).

Day	0_a	0_b	0_c	Na_a	Na_b	Na_c	Ery_a	Ery_b	Ery_c	Met_a	Met_b	Met_c	0z_a	0z_b	0z_c	Naz_a	Naz_b	Naz_c	Eryz_a	Eryz_b	Eryz_c	Metz_a	Metz_b	Metz_c
0	1659.2	1602.4	1513.6	1663.2	1690.8	1702.8	1700	1687.2	1702.4	1691.2	1680	1804	1674.4	1652.4	1686.4	1664.8	1678.4	1657.6	1674.4	1673.6	1682.4	1670.8	1724	1668.4
6	1306.8	1308.8	1312.8	1331.2	1329.6	1356.8	1388.4	1371.6	1353.2	1316.4	1314.4	1294.4	1362	1323.2	1320.8	1286.8	1306	1278.8	1324.4	1253.6	1360.8	1309.2	1294	1291.2
13	1294.8	1294.4	1301.6	1368.4	1380.4	1419.2	1383.2	1400.8	1495.6	1360.8	1337.2	1358.4	1624	1567.6	1568.4	1543.6	1503.6	1454.8	1447.2	1446.8	1384	1540	1358.8	1520.4
20	1223.6	1250	1242	1429.6	1407.6	1400.8	1368.8	1370.8	1352.8	1286.8	1255.2	1310.4	1787.2	1948.4	1784	1744.8	1746.4	1710	1691.2	1713.2	1568.4	1788.8	1726.4	1754.8
27	1255.2	1320.8	1220	1198.8	1190	1193.6	1122	1134.4	1360.8	1484.8	1152.4	1055.2	1714.8	1732	1754.4	2115.2	2374	1694.8	1972.8	1699.2	1717.6	1771.6	1828.4	1820.8
34	2055.6	1320	1220.4	1255.6	1233.2	1277.2	1187.6	1127.2	1710	1804.4	1670.8	1203.6	1812	1804	1906.8	1758.4	1725.2	1765.6	1662.4	1871.6	1955.6	1741.6	1754.8	1711.2
41	1686.4	1273.6	1289.6	1090	898.4	996.8	989.2	700.8	1513.6	1834.4	2014.8	1197.6	1340.8	1299.2	1496.4	1720.4	1660.4	1631.6	1495.6	1403.2	1257.6	1104	1398.4	1386.8
48	1448.8	1578.8	1863.2	1252	1085.2	1289.2	1242.4	1044.8	1585.2	1474	1237.2	1563.2	1268.4	1449.2	1600.8	1521.2	1424.4	1422.4	1241.6	1502	1101.6	1172.4	1143.6	1546.4

Table 7
Dissolved organic carbon (DOC) concentration in each digester (mgC/L).

Day	0_a	0_b	0_c	Na_a	Na_b	Na_c	Ery_a	Ery_b	Ery_c	Met_a	Met_b	Met_c	0z_a	0z_b	0z_c	Naz_a	Naz_b	Naz_c	Eryz_a	Eryz_b	Eryz_c	Metz_a	Metz_b	Metz_c
0	989.2	994.8	947.2	1004.4	1035.6	1016	1266.4	1359.2	1006	1282.8	1030	1091.6	1010.4	1063.2	1022.4	1005.6	1022	1026.8	1273.6	1229.6	1244	1004.4	915.6	1007.6
6	1235.2	1224.4	1256.8	1150.4	1180.8	1159.2	1393.6	1450.8	1364.8	1223.2	1220.8	1250.8	1043.6	1088.8	1122.8	1144.4	1142.4	1157.6	1376.8	1313.6	1340.4	1142.8	1165.6	1030
13	1343.6	1302.8	1357.6	1078	1122.8	1116.8	1402	1468	1688.8	1280.4	1259.6	1294	518.8	606.4	678.8	750.4	809.2	861.6	1059.2	998.4	1059.6	702	818	526
20	1402.8	1304	1337.2	1044.4	1087.2	1074.4	1389.2	1442.4	1377.2	1348.4	1406.4	1262.4	71.2	148.8	153.6	346.4	412.8	430.4	621.2	490	578.8	155.2	274.4	95.2
27	1205.2	1055.6	1275.6	1224	1303.6	1326	1652	1620.8	1186	768.4	1365.6	1566.4	56.4	55.2	60	189.6	1527.2	222	446.8	327.2	399.6	57.6	56.4	56
34	236.4	238	1567.6	1187.6	1284	1272	1697.6	1726.4	706.8	175.2	221.6	1407.2	33.2	38	43.6	93.6	107.6	112	335.2	279.6	359.2	41.2	36.8	28.4
41	69.2	58.8	94	1134.4	1156	1310.4	1443.6	1263.2	446	81.6	93.6	318.4	26.8	20.4	25.2	68.8	64	67.6	218	175.6	198.4	19.6	28.8	22
48	57.2	59.6	82.8	878.4	1276.4	1097.2	918.4	1180.4	362	48	45.6	205.2	20	21.6	25.6	56.4	45.6	55.6	147.6	158.8	142	18.4	17.2	22.4

Table 8
pH values in each digester.

Day	0_a	0_b	0_c	Na_a	Na_b	Na_c	Ery_a	Ery_b	Ery_c	Met_a	Met_b	Met_c	0z_a	0z_b	0z_c	Naz_a	Naz_b	Naz_c	Eryz_a	Eryz_b	Eryz_c	Metz_a	Metz_b	Metz_c
0	8.2	8.2	8.2	8.2	8.3	8.2	8	8.1	8	8.3	8.3	8.3	7.9	8.2	7.5	8.2	8.2	8	8	8.1	8.1	8.3	8.2	8.2
6	7.4	7.3	7.3	7.2	7.2	7.2	7.2	7.3	7.3	7.2	7.2	7.2	7.1	7.1	7.1	7	7	7	7.2	7.2	7.2	7.1	7.2	7.2
13	7.2	7.2	7.2	7.1	7.1	7.2	7.2	7.2	7.2	7.2	7.2	7.1	7.5	7.4	7.4	7.2	7.1	7.1	7.4	7.3	7.3	7.4	7.2	7.4
20	7	7.1	7.1	6.9	6.9	6.9	7.1	7.1	7.1	7.1	7	7.1	7.5	7.5	7.5	7.3	7.2	7.3	7.5	7.5	7.5	7.5	7.5	7.5
27	7.3	7.4	7.3	7	7	7	7.2	7.2	7.4	7.5	7.3	7.1	7.6	7.6	7.7	7.4	7.4	7.4	7.7	7.7	7.7	7.7	7.7	7.6
34	7.8	7.8	7.8	7	7	7.1	7.3	7.2	7.8	7.8	7.8	7.3	7.7	7.8	7.7	7.4	7.5	7.5	7.8	7.8	7.8	7.7	7.7	7.7
41	7.7	7.8	7.8	7.2	7.1	7.1	7.4	7.2	7.7	7.8	7.9	7.7	7.7	7.7	7.8	7.5	7.5	7.5	7.8	7.8	7.8	7.7	7.7	7.7
48	7.7	7.9	7.9	7.5	7.3	7.3	7.7	7.5	7.9	7.8	7.9	7.8	7.8	7.7	7.7	7.7	7.7	7.6	7.8	7.9	7.8	7.7	7.7	7.7

in Fig. 5 using the mean values of the triplicates. Tables 9–11, and 12 provide data on the accumulation of acetic acid, propionic acid, butyric acid, and total volatile fatty acids (VFAs) over time in each digester, and Fig. 6 visually represents these datasets with the mean values of the triplicates.

The sequencing data has been deposited in the form of fastq.gz files in the European Nucleotide Archive. These files contain 16S rRNA gene sequencing data generated using the Ion Torrent PGM platform. The sequencing data captures information from two time points for each digester. The first time point corresponds to the peak of VFAs accumulation, focusing on the hydrolysis and acidogenesis processes (referred to as early degradation stage in the related research article). The second time point corresponds to the peak of biogas production, aiming at

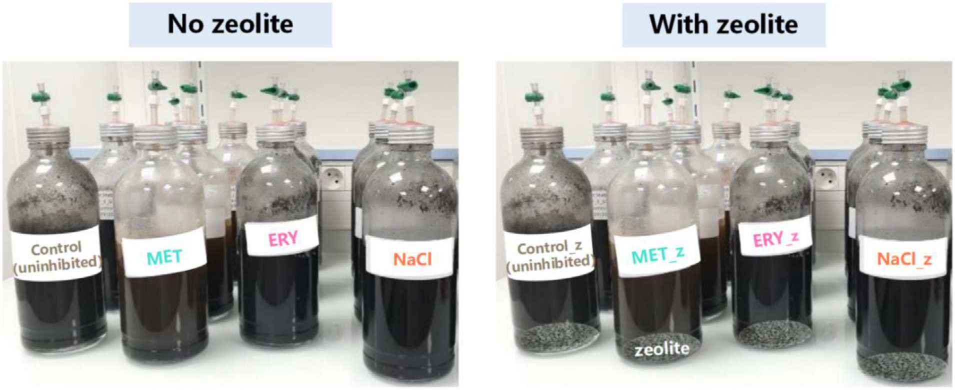

Fig. 1. Experimental design.

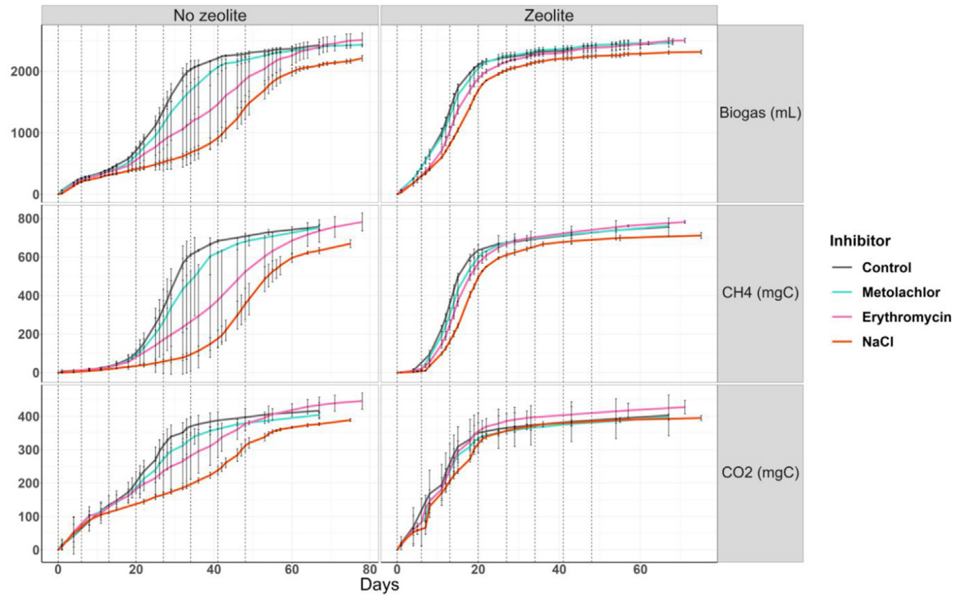

Fig. 2. Cumulative total biogas, CH_4, and CO_2 production (mg of C) over time (number of days) for different conditions. The data used are mean values of the triplicate digesters, and standard deviations are indicated with error bars. Vertical lines represent the sampling dates.

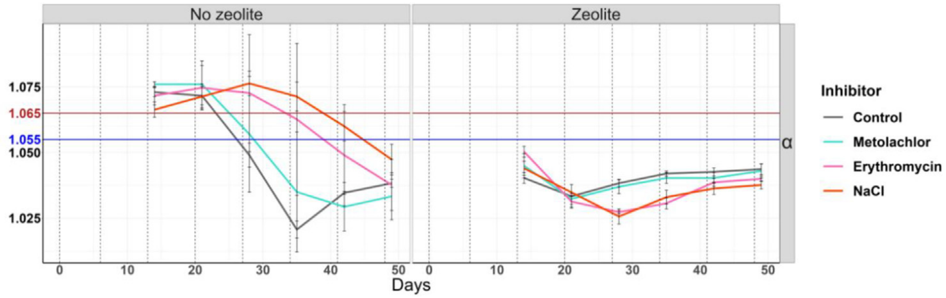

Fig. 3. Apparent isotope factor (α_{app}) of the biogas over time (number of days) for different conditions. α_{app} is an indicator of the methanogenic pathway. It is commonly assumed that α_{app} greater than 1.065 implies the hydrogenotrophic pathway as the dominant methanogenesis pathway, while α_{app} less than 1.055 indicates acetoclastic methanogenesis as the prominent pathway [6]. The horizontal red and blue lines denote the thresholds for hydrogenotrophic and acetoclastic methanogenesis, respectively. The data used are mean values of the triplicate digesters, and standard deviations are indicated with error bars. Vertical lines represent the sampling dates.

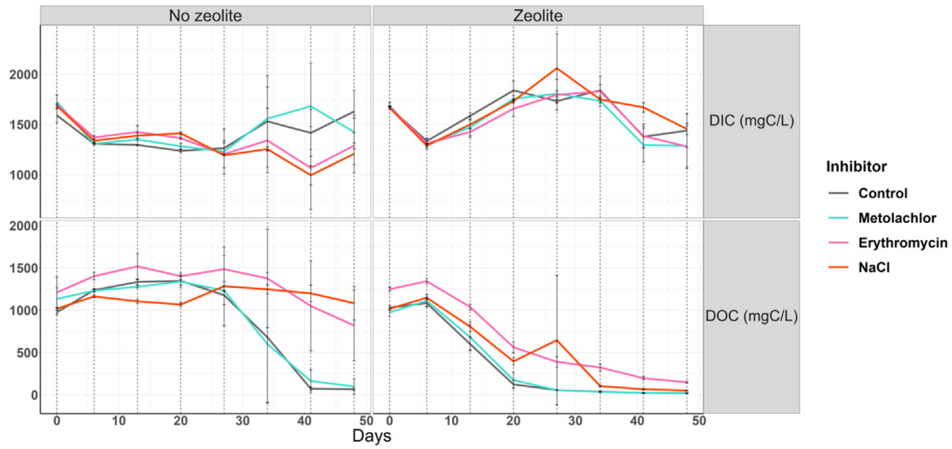

Fig. 4. Dissolved inorganic and organic carbon (DIC and DOC) concentrations (mg of C/L) over time (number of days) for different conditions. The data used are mean values of the triplicate digesters, and standard deviations are indicated with error bars. Vertical lines represent the sampling dates.

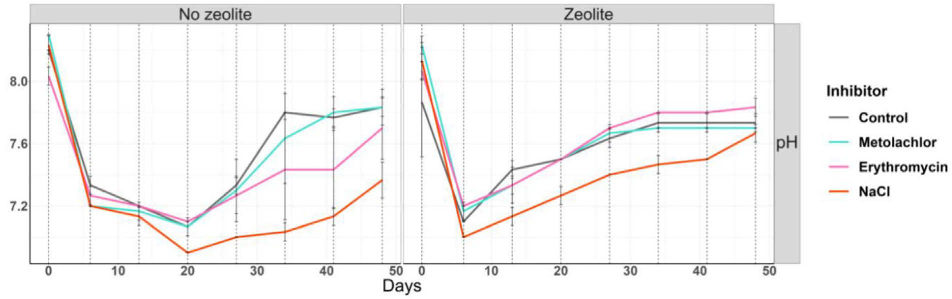

Fig. 5. pH values over time (number of days) for different conditions. The data used are mean values of the triplicate digesters, and standard deviations are indicated with error bars. Vertical lines represent the sampling dates.

Table 9
Acetic acid concentration in each digester (mgC/L).

Day	0_a	0_b	0_c	Na_a	Na_b	Na_c	Ery_a	Ery_b	Ery_c	Met_a	Met_b	Met_c	0z_a	0z_b	0z_c	Naz_a	Naz_b	Naz_c	Eryz_a	Eryz_b	Eryz_c	Metz_a	Metz_b	Metz_c
0	27.2	27.3	28.4	88.5	53.1	44.1	26.1	28.4	26.4	26.6	55.1	57.1	48.6	41.5	43.7	31	67.6	36.6	28.6	27	30.8	49.4	49.7	23.4
6	414.8	446.5	446.5	4.6	36.9	20.7	421.5	335	369.5	444.7	417.3	396.4	402.9	377.3	406.1	46.4	81	10.1	342.5	410.3	352.2	422.2	486.9	508.6
13	701.7	717.2	742.6	548.1	563.2	540.7	504.8	499.2	554.2	781.7	737.7	701.9	257.1	337.7	386.8	424.3	502.3	523.3	569.2	538.1	576.5	416.1	541.6	288.4
20	1052.4	974.6	975.6	660.7	657.5	635.1	772.7	750.3	913.8	948.4	1058.7	888.7	0	0	0	109.2	193.6	211.8	218.9	99	220.7	9.7	80.9	0
27	886	738	966	868	914	940	1038	996	686	464	1068	1228	0	0	0	0	23.4	21.8	46.8	7.5	33.6	0	0	0
34	7	6.7	15.6	928	1076	966	1146	1126	200	0	6.7	1202	0	0	0	0	0	0	0	0	5.6	0	0	0
41	6	4.9	6.1	812.6	754.8	782.1	288.6	607.1	61.2	2.3	3.6	45.7	3.7	2.2	2.3	3.5	3.4	4.3	13.3	1.4	7.2	2.9	2.9	3.2
48	4.2	5.4	5	337.5	723.8	423.8	243.8	207.9	37	2	3.2	4.3	1.3	1.9	1.8	5	4.8	3.6	2.6	1.3	3	1.8	1.3	2

Table 10
Propionic acid concentration in each digester (mgC/L).

Day	0_a	0_b	0_c	Na_a	Na_b	Na_c	Ery_a	Ery_b	Ery_c	Met_a	Met_b	Met_c	0z_a	0z_b	0z_c	Naz_a	Naz_b	Naz_c	Eryz_a	Eryz_b	Eryz_c	Metz_a	Metz_b	Metz_c
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	53.6	79.9	75.3	0	6.3	0	85.7	52.1	54.6	63.1	50.4	51.4	81.1	67.5	74.5	0	0	0	79.1	66.6	70.3	70.5	87	100.3
13	101.6	104.1	104.9	76.2	82.5	91.5	112.8	120.9	94.4	95.8	99.6	94.9	107.1	111.8	118.1	72.4	75.2	89	105.7	80.6	120.7	103.9	96	110.9
20	110.3	110.1	97.7	82.7	83.5	65.5	121.8	126.7	112.1	73.9	99.3	70.3	0	10	45	84	89.6	82.8	106	82.8	112.8	22.6	79.2	0
27	133.1	133.3	132.6	91.5	98	109.2	183.9	193.4	121.9	127.9	130.1	123.8	0	0	0	76.1	98.8	98.5	120.4	100.2	111.4	0	0	0
34	102.2	101.4	100.2	89.3	153.5	83.7	195.1	121.1	90.2	64.2	102.6	120.2	0	0	0	0	0	0	36.2	0	102.4	0	0	0
41	0	0	20.3	143.8	117.8	142.9	64	112.4	94.8	0.5	0	71.5	0.6	0.6	0.7	0	0	0	21.6	0	16.7	0.6	0.6	0.7
48	0	0	0	98.3	133.7	115.8	98.5	58.9	117.1	0.5	0.6	82.8	0.6	0.6	0.7	0	0	0	0	0	0.7	0.6	0.6	0.6

Table 11
Butyric acid concentration in each digester (mgC/L).

Day	0_a	0_b	Na_a	0_c	Na_b	Na_c	Ery_a	Ery_b	Ery_c	Met_a	Met_b	Met_c	0z_a	0z_b	0z_c	Naz_a	Naz_b	Naz_c	Eryz_a	Eryz_b	Eryz_c	Metz_a	Metz_b	Metz_c
0	0	0	0	0	0	0	0	0	0	0	87.6	95.4	128.1	100	122.2	123.2	129.1	129.7	0	0	0	122.3	133.8	184.6
6	0	167	109.9	257.9	0	0	403.8	448.6	384.7	0	20.7	45.1	152.7	56.5	118.4	0	0	0	414.8	378.8	380.2	159.4	0	269.3
13	243.4	257.7	306.7	315.9	342.4	325.4	407.9	435.8	336.6	197.8	257.5	337.6	0	0	0	113.5	122.4	127	66.1	73.4	68.1	0	0	0
20	84.3	102	112.3	196	247.8	188.4	214.9	248.9	107.1	81.6	99.7	75.8	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	21	60	60	62.2	26.4	25.2	0	0	25	38	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	51.8	53.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	7.6	29.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 12
Total volatile fatty acids (VFAs) concentration in each digester (mgC/L).

Day	0_a	0_b	0_c	Na_a	Na_b	Na_c	Ery_a	Ery_b	Ery_c	Met_a	Met_b	Met_c	0z_a	0z_b	0z_c	Naz_a	Naz_b	Naz_c	Eryz_a	Eryz_b	Eryz_c	Metz_a	Metz_b	Metz_c
0	125.4	103.8	110.8	148.1	75.5	67.1	123.7	135.1	72.9	127.9	190.4	209.5	230.5	180.7	214.7	154.2	196.7	166.3	148.7	127.8	142.6	186.3	201	225.3
6	483.4	707.7	643.6	262.5	51.2	30.8	935.8	846.6	823.3	520.2	488.5	499.4	645.7	501.3	599	46.4	81	10.1	862.7	864.7	802.6	652.1	573.9	878.2
13	1066.2	1100.7	1175.5	951.6	999	969.5	1061.7	1099	997.2	1102.2	1120.6	1154.4	371.9	456.4	512.8	632.6	724.1	762.9	750.7	709.6	774.5	520	637.6	399.4
20	1247.1	1192.6	1197.1	960.1	1013.5	899.2	1160.8	1184.8	1141.3	1110.7	1264	1047.7	0	10	45	193.1	290.4	302.1	324.9	181.8	333.5	32.3	160.1	0
27	1019.1	871.3	1119.6	1045	1102.5	1124.9	1282.4	1254	807.9	591.9	1223.1	1389.8	0	0	0	76.1	122.2	120.3	167.2	107.7	145	0	0	0
34	109.2	108.1	115.8	1017.3	1229.5	1049.7	1399.7	1312.6	290.2	64.2	109.4	1322.2	0	0	0	0	0	0	36.2	0	108	0	0	0
41	6	4.9	26.5	958.8	875	927.7	362.5	754.4	156.3	3.1	4	117.6	4.4	2.8	3	3.5	3.4	4.3	35.2	1.4	24.3	3.5	3.5	4.2
48	4.5	5.7	5.4	435.8	857.4	541	342.3	268.3	154.4	2.6	4.1	87.5	2.2	2.8	2.8	5	4.8	3.6	2.9	1.5	4	2.4	1.9	2.6

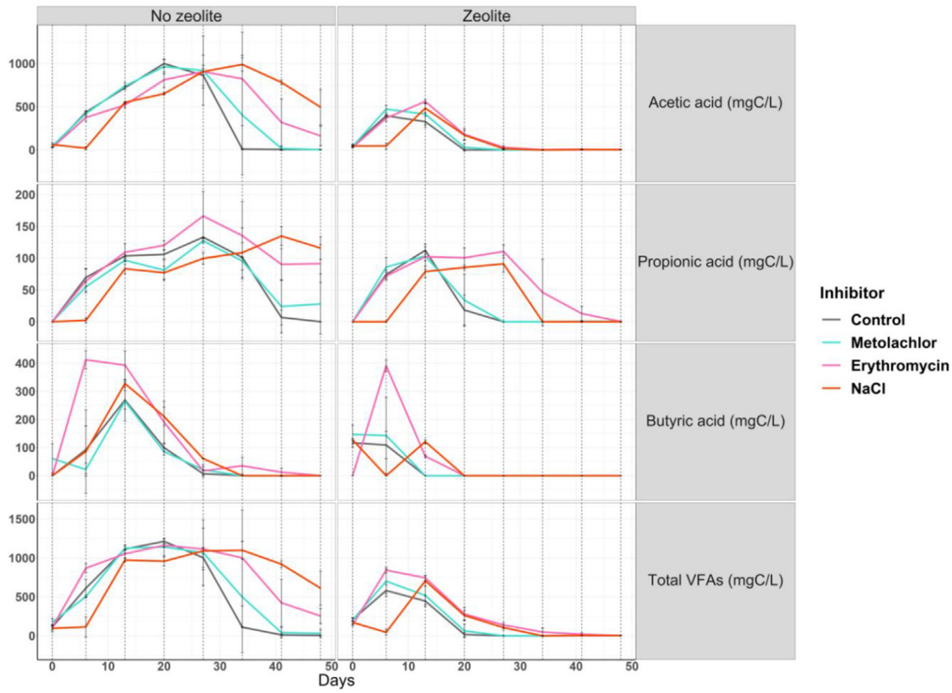

Fig. 6. Acetic acid, propionic acid, butyric acid, and total volatile fatty acids concentrations (mg of C/L) over time (number of days) for different conditions. The data used are mean values of the triplicate digesters, and standard deviations are indicated with error bars. Vertical lines represent the sampling dates.

the methanogenesis process (referred to as late degradation stage in the related research article). In addition, 4 samples taken on day 0 were analyzed to characterize the initial microbial community (inoculum). Details are provided in Table 1.

3. Experimental Design, Materials and Methods

3.1. Experimental design and sampling

The batch anaerobic digesters used in the study were 1 L glass bottles with a working volume of 700 mL. Each bottle was inoculated with 5.7 g of methanogenic sludge and fed 12.7 g of food waste, reaching a substrate-to-inoculum ratio of 7.9 g COD/1.8 g COD. This ratio was chosen to prevent excessive gas production that might lead to the rupture of the bottles. The inoculum came from a 60 L laboratory anaerobic bioreactor regularly fed with food waste at 35 °C and was centrifuged at 10,000 g for 10 min before use. The food waste was obtained from the institute's restaurant containing 0.45 g COD/g. All food waste was finely ground using a grinder and stored at −20 °C before use. In the first series of 12 digesters, 20 g/L of sodium chloride (Acros Organics), 400 mg/L of erythromycin (Acros Organics), and 5 mg/L of S-metolachlor (Honeywell) were added in triplicate, with three control digesters without any inhibitors. A second series of another 12 digesters was set up precisely as the first, but 15 g/L of zeolite (Siliz 24®, Somez company, France) was introduced as a support material, directly in the batch digesters. All digesters were sealed with rubber septa and caps. A short, flexible tube was inserted into the hole at the center of the rubber septum, above which was controlled by a valve that switched to open and close to collect the produced biogas. All digesters were incubated in the dark at 35 °C without agitation.

8 mL of liquid samples were collected from each digester weekly using a syringe of 10 mL through the septa. The samples were distributed into 2 mL Eppendorf tubes and centrifuged at 10,000 g for 10 min at 4 °C. The supernatant and pellet samples were stored at −20 °C before analyses. 7 mL of gas samples were taken every week from the headspace using a glass syringe and stored in vacuum tubes (BD Vacutainer dry tubes) at room temperature before the isotopic composition analysis.

3.2. Biodegradation performance monitoring

Gas production and composition were measured using a differential manometer (Digitron 2082P, Margam, UK) and a micro gas chromatograph (CP4900, Varian, Palo Alto, USA) respectively, as described in [3]. Volatile fatty acid concentrations were quantified using ionic chromatography (ICS 5000+, Thermo Fisher Scientific) with an IonPAC ICE-AS1 column, as described in [3]. Dissolved organic and inorganic carbon (DOC and DIC) were measured according to the French standard NF EN 1484 using a TOC-L CPN analyzer (Shimadzu). Isotopic fractionation of methane and carbon dioxide (δ13CH4 and δ13CO2) was measured with a Trace Gas Chromatograph Ultra (Thermo Scientific) connected to a Delta V Plus isotope ratio mass spectrometer (Thermo Scientific) via a combustion interface GC III (Thermo Scientific), to calculate apparent isotopic fractionation as described in [3].

3.3. DNA extraction, amplification and sequencing

The total DNA was extracted from the pellet samples using the DNeasy PowerSoilPro Isolation Kit (QIAGEN) with the QIAcube Instrument following the manufacturer's instructions. The concentration of extracted DNA was quantified with Qubit 2.0 fluorometer using dsDNA kit (Invitrogen), and the purity was checked with Epoch 2 Microplate Spectrophotometer (Agilent BioTek).

The extracted DNA was used to amplify the V4-V5 hypervariable region of the 16S rRNA genes of bacterial and archaeal populations. Briefly, the IonAmplicon Library Preparation (FusionMethod) Protocol, Revision C, was employed [4]. Amplicons were prepared using primers 515F (5′-GTGYCAGCMGCCGCGGTA-3′) and 928R (5′-CCCCGYCAATTCMTTTRAGT-3′). The forward primer was modified by adding a PGM sequencing adaptor (adaptor A: 5′-CCATCTCATCCCTGCGTGTCTCCGACTCAG-3′) and a barcode (5′-adaptor A-Barcode-515F-3′). The reverse primer was modified with the addition of a PGM sequencing adaptor (adaptor trP1: 5′-CCTCTCTATGGGCAGTCGGTGAT-3′) (5′-adaptor trP1-928R-3′). The V4-V5 region was amplified following the Platinum Pfx protocol (Life Technologies). PCR products were cleaned using the Agencourt AMPure XP magnetic beads purification system (Beckman Coulter). Automated electrophoresis (2200 TapeStation with D1000 ScreenTape, Agilent Technologies) was incorporated to verify the quantity and size of the amplicons. All libraries were pre-diluted to 500 pM in molecular-grade water and pooled equimolarly. The pooled library was then diluted to 26 pM and processed on the Ion OneTouch 2 Instrument using the Ion PGM Hi-Q View OT2 Kit to prepare template-positive Ion Sphere Particles (ISPs) containing clonally amplified DNA by emulsion PCR. These templated ISPs were quantified and enriched on the Ion OneTouch ES according to the manufacturer's instructions.

Sequencing was performed on Ion Torrent PGM (Life Technologies) using Ion 316 V2 chips and the Ion PGM Hi-Q View Sequencing Kit following the manufacturer's instructions.

3.4. Sequence read processing

Upon completion of sequencing, the sequencing instrument generated DAT files containing the raw traces of electrical signals. These raw traces were converted into single numeric values for each flow per well, resulting in 1.wells files. The information in the 1.wells files was then transformed into a sequence of bases using the BaseCaller, producing unaligned BAM (Binary Sequence Alignment/Map) files. The BAM files were subsequently converted to FASTQ format using the FileExporter plugin. Finally, the data were processed with Torrent Suite software to filter out low-quality and polyclonal sequence reads, ultimately yielding high-quality data in FASTQ format.

Limitations

The outcomes are influenced by the type of sludge used to inoculate the digesters and may vary if a different inoculum is employed. Likewise, the composition of the waste introduced into the digesters also affects the results.

Ethics Statement

The authors have read and follow the ethical requirements for publication in Data in Brief and confirm that the current work does not involve human subjects, animal experiments, or any data collected from social media platforms.

Data availability

16S rRNA gene sequencing data (Original data) (ENA).

CRediT Author Statement

Xiaoqing Wang: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Visualization, Writing – original draft; **Vincent Dürr:** Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Validation; **Angéline Guenne:** Investigation, Data curation; **Nadine Derlet:** Investigation, Data curation; **Chrystelle Bureau:** Investigation, Data curation; **Elodie Gittard:** Investigation, Data curation; **Laurent Mazéas:** Supervision; **Olivier Chapleur:** Conceptualization, Methodology, Writing – review & editing, Supervision, Project administration, Funding acquisition.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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