

Hydrogen production from biomass and organic waste using dark fermentation. An analysis of the effect of operating parameters on process performance in literature studies

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Supplementary material

Table S1. The list of all the studies considered, with the operational parameters investigated, and analysed process parameters. CN: continuous, BA: batch.

Waste composition	Operating parameters							Process performance parameters			References
	tCOD (g COD l ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Sugar factory wastewater	31.85	CN	0.50	60	6.80	No	Yes	4.98	396.60	64.00	[1]
	31.90		1.00					2.72	216.40	64.00	
	31.90		2.00					1.28	101.60	64.00	
	31.80		3.00					0.85	67.80	64.00	
Soluble condensed molasses	40.00	CN	1.00	35	5.50	Yes	Yes	1.20	60.00	35.20	[2]
			0.50					3.06	306.00	47.00	
			0.33					2.52	378.00	47.70	
			0.25					2.97	594.00	47.80	
			0.17					2.21	664.00	50.20	
			0.13					1.95	780.00	51.70	
Molasses from a Local sugar refining industry	2.47	CN	0.48	35	4.50	No	No	0.65	4.22	50.00	[3]

Waste composition	Operating parameters							Process performance parameters			References
	tCOD (g COD l ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Molasses – Local sugar refining industry	5.47	CN	0.44	35	4.50	No	No	5.98	93.48	49.00	[3]
	5.21		0.33					6.45	126.06	52.00	
	5.47		0.25					6.62	181.08	52.00	
	6.08	CN	0.17	35	4.50	No	No	8.00	364.82	52.00	
	6.25							7.04	330.10	52.00	
	8.33							6.44	402.21	52.00	
	9.72							5.267	384.05	52.00	
	11.63							5.88	513.19	52.00	
	13.02							4.52	441.28	52.00	
	14.41							0.04	4.67	52.00	
Rice winery wastewaters	34.00	CN	0.08	35	5.50	No	Yes	1.16	590.90	61.00	[4]
			0.25					1.20	203.76	61.00	
			0.50					1.33	113.20	61.00	
			1.00					1.42	60.56	61.00	
	14.00	CN	0.08	35	5.50	No	Yes	1.27	265.69	61.00	
	25.00							1.21	454.46	61.00	
	36.00							1.20	647.24	61.00	
	34.00	CN	0.08	35	4.50	No	Yes	0.92	48.65	61.00	
								0.99	502.61	61.00	
								1.17	597.70	61.00	
								1.00	509.40	61.00	
	34.00	CN	0.08	20	6.00	No	Yes	0.92	468.65	61.00	
								1.05	536.57	61.00	
								1.17	597.70	61.00	
								1.00	509.40	61.00	
Glucose	21.17	CN	2.00	35	5.70	No	Yes	5.03	66.60	48.80	[5]
			1.50					8.18	143.60	49.30	

Waste composition	Operating parameters							Process performance parameters			References
	tCOD (g COD l ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre- treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Glucose	21.17	CN	1.00	35	5.70	No	Yes	7.86	208.00	44.20	[5]
			0.50					13.83	732.00	45.30	
			0.25					13.43	1422.00	43.10	
Glucose	21.17	CN	2.00	35	6.40	No	No	7.07	93.60	53.30	
			1.50					8.33	146.20	51.70	
			1.00					9.52	252.00	49.40	
			0.50					13.38	708.00	46.60	
			0.25					10.84	1148.00	43.80	
Glucose	53.35	BA	8.00	55	7.00	No	No	5.55	46.23	-	
	5.34	CN	0.33	30	6.70			18.22	7.59	-	[6]
	10.67		0.33					15.84	13.21	-	[7]
Starch	5.20	BA	8.33	55	5.00	No	Yes	0.39	0.30	60.00	
					6.00			0.97	0.75	60.00	
					7.00			0.70	0.55	60.00	
					8.00			0.63	0.49	60.00	
					9.00			0.52	0.40	60.00	
	10.40	BA	8.33	55	6.00	No	Yes	0.70	1.10	60.00	
	20.68							0.52	1.60	60.00	
	31.08							0.42	1.96	60.00	
	41.36							0.25	1.57	60.00	
	5.20	BA	8.33	37	7.00	No	Yes	0.49	0.39	60.00	
				55				0.82	0.64	60.00	
Coffee drink manufacturing wastewater	20.00	CN	0.50	35	8.00	No	Yes	1.34	66.75	-	[9]
			0.33					2.67	199.875	-	

Waste composition	Operating parameters							Process performance parameters			References
	tCOD (g COD l ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Coffee drink manufacturing wastewater	20.00	CN	0.25	35	8.00	No	Yes	1.67	166.50	-	[9]
			0.33		5.50			1.75	131.25	-	
			0.25					10.75	1074.50	-	
			0.17					8.00	1199.25	-	
			0.25					10.83	1083.00	-	
Sucrose-rich synthetic wastewater	4.06	CN	0.54	39	3.40	No	No	12.36	115.68	-	[10]
					3.80			17.15	160.54	-	
					4.20			29.00	271.49	-	
					4.80			21.94	205.40	-	
					5.30			20.67	193.59	-	
					5.70			20.67	193.59	-	
					6.30			18.15	169.98	-	
								11.10	98.70	56.60	
	5.33	CN	0.75	38	4.50	No	Yes	8.62	241.86	-	[11]
	22.43		1.00	35	6.70			13.01	440.32	-	
	22.56		0.83					12.83	545.74	-	
	22.69		0.67					7.45	421.7	-	
	22.63		0.50					5.04	341.08	-	
	22.56		0.42					2.64	223.26	42.40	
			0.33					1.70	192.24	-	
	22.63		0.25					0.22	37.20	-	
	5.33	CN	0.75	38	4.40	No	No	11.90	98.42	-	[13]
	8.00							9.16	110.86	-	
	10.67							8.74	139.23	-	
	19.65							8.74	252.82	-	

Waste composition	Operating parameters							Process performance parameters			References
	tCOD (g COD l ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Sucrose-rich synthetic wastewater	22.45	CN	0.75	38	4.40	No	No	8.57	284.33	-	[13]
	28.07							8.74	356.92	-	
	10.67		0.13					4.08	93.72	-	
			0.25					6.16	103.70	-	
			0.42					7.74	139.44	-	
			0.58					8.41	259.70	-	
			0.92					8.24	285.80	-	
			1.25					6.58	363.76	-	
Bean curd manufacturing process – Municipal waste	12.25	CN	0.42	35	5.00	No	No	2.70	99.17	-	[14]
Rice bran – Municipal waste	8.82							8.25	218.21	68.00	
Wheat bran – Municipal waste	10.65							9.82	313.70	72.00	
Glucose	4.85										
Oat straw hydrolysate	1.20	CN	1.00	28	5.50	Yes	Yes	20.56	2.77	20.60	[15]
	4.32							11.82	2.05	9.50	
	14.88							15.56	2.70	15.60	
								9.91	14.86	-	
								4.13	22.29	47.00	
								1.199	22.29	47.00	
	35.04		0.50					0.59	52.02	36.50	[16]
	34.98		0.25					0.25	44.59	-	

Waste composition	Operating parameters							Process performance parameters			References
	tCOD (g COD ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Diluted molasses	5.00	BA	55.00	35	4.40	No	No	8.22	0.93	54.00	[17]
Molasses	20.00	BA	3.00	35	3.00			3.16	26.36	-	[18]
					4.00			2.30	19.18	-	
					5.00			1.34	11.17	-	
					6.81			0.53	4.38	-	
					10.00			1.83	15.26	-	
					11.00			0.38	3.16	-	
					12.00			0.78	6.49	-	
Starch	4.52	CN	0.17	30	4.50	No	No	4.95	16.78	40.97	[19]
	9.04		0.33					4.31	14.60	50.17	
	18.08		0.67					3.21	10.90	41.86	
	9.04							4.89	8.28	56.99	
	4.52		0.33					7.07	11.99	60.55	
	2.26		0.17					4.95	8.39	34.45	
			0.33					4.89	4.14	54.62	
	4.52		0.67					6.04	5.12	50.47	
	2.26							5.53	2.34	49.28	
	3.39		1.00					6.04	2.56	47.20	
Waste sludge	19.50	BA	0.67	35	7.90	No	Yes	5.93	216.75	-	[20]
						Yes	Yes	6.67	243.84	-	
								5.55	202.88	-	
								5.96	218.02	-	

Operating parameters								Process performance parameters			References									
Waste composition	tCOD (g COD-1)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)										
Corn starch	20.00	CN	0.75	35	5.30	Yes	Yes	3.56	118.64	60.00	[21]									
			0.63					5.44	217.50	60.00										
			0.50					7.12	355.92	60.00										
			0.38					5.34	355.92	65.00										
			0.25					3.95	395.46	65.00										
			0.17					2.11	316.37	50.00										
Raw starch	20.00	BA	40.00	37	7.50	Yes	Yes	1.67	1.042	-	[22]									
Starch	26.70						No	1.87	1.56	-										
hydrolysate	29.10	CN	0.50	37	5.80	Yes	Yes	16.90	48.27	50.00										
			0.25					13.68	78.17	50.00										
			0.17					11.74	100.66	50.00										
			0.08					12.40	212.56	50.00										
Corn	3.00 5.00 10.00 25.00 50.00 3.00 5.00 10.00 25.00 50.00	BA	3.13	35	5.50	Yes	Yes	13.94	16.73	-	[23]									
								20.34	40.69	-										
								18.06	72.25	-										
								18.13	181.25	-										
								16.10	321.94	-										
								17.43	20.91	-										
								18.32	36.63	-										
								7.29	29.15	-										
								7.29	72.88	-										
								16.10	321.94	-										
								Sugarcane	20.00	BA		2.50	37	5.50	Yes	Yes	13.70	137.05	45.00	[24]
																	6.00	95.85	45.00	
																	6.50	86.35	45.00	
																	7.00	84.76	45.00	
																	8.00	59.41	44.00	

Operating parameters								Process performance parameters			References
Waste composition	tCOD (g COD ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Sugarcane	1.50	BA	2.50	37	5.50	Yes	Yes	11.57	8.67	43.00	[24]
	2.50										
	5.00										
	10.00										
	20.00										
	40.00										
Glucose	5.34	BA	1.25		5.00	Yes	Yes	16.70	89.09	-	[25]
	0.96										
Sorghum extract	3.20	BA	0.50		5.00	Yes	Yes	19.96	159.75	-	
	3.20		0.50					4.76	38.06	-	
Sorghum stalks								5.74	45.93	-	
Sorghum residues								4.72	37.76	-	
D-Glucose	5.34	BA	3.00		5.00	Yes	Yes	21.86	48.60	-	
Cellobiose								23.33	51.86	-	
D-xylose								19.68	43.74	-	
L-arabinose								19.96	44.38	-	
D-arabinose								13.69	30.43	-	
Glucose +Biomass	23.47	CN	1.75		5.00	Yes	Yes	9.00	88.03	50.00	

Waste composition	Operating parameters							Process performance parameters			References
	tCOD (g COD ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Glucose +Biomass	23.47	CN	1.50	37	5.00	Yes	Yes	4.00	39.12	39.00	[25]
			1.00					5.00	48.90	42.00	
Pre-treated vinegar	29.80	BA	1.00	37	6.00			4.00	149.04	62.00	[26]
								3.00	111.63	58.00	
								3.42	127.24	57.00	
Hydrolysed waste ground wheat	4.41	BA	3.96	37	6.50	Yes	Yes	8.71	12.13	-	[27]
	8.59							4.92	13.34	-	
	11.30							5.36	19.12	-	
	16.95							3.72	19.90	-	
	24.86							2.26	17.74	-	
	31.19	BA				Yes	Yes	8.71	85.82	-	
	7.80		2.92	37	6.50			12.04	40.24	-	
	8.14							9.19	32.04	-	
	8.25							8.71	30.81	-	
	8.59							9.03	33.24	-	
	8.36							11.57	41.45	-	
	8.02							9.74	33.50	-	
Brewery plant wastewater	22.60	BA	1.38	35	5.5	No	Yes	6.63	136.12	53.39	[28]
	33.90		1.13					8.27	311.60	52.91	
	45.20		0.96					7.68	452.59	56.59	
	67.80		1.13					9.92	747.32	51.93	
	113.00		3.04					5.76	267.62	54.80	

Operating parameters								Process performance parameters			References
Waste composition	tCOD (g COD ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Brewery plant wastewater	22.60	BA	1.17	35	5	No	Yes	5.47	132.41	52.53	[28]
			0.96		5.50			15.35	452.59	56.59	
			1.00		6.00			7.99	225.78	53.90	
			0.83		6.50			3.89	131.90	30.33	
			7.00					0.11	3.57	12.50	
Medium containing sucrose	8.42	BA	5.00	35	5.50	No	No	5.72	12.04	-	[29]
					3.00			6.85	14.41	-	
					10.00			3.18	6.70	-	
					5.50			10.70	22.50	-	
	8.42	BA	5.00	35	5.50	No	Yes	11.67	24.55	-	
								12.46	26.22	-	
								11.43	24.04	-	
	8.42	BA	5.00	35	5.50	No	No	7.03	14.78	-	
								8.22	17.30	-	
								13.53	28.45	-	
								8.22	17.30	-	
								8.04	16.92	-	
								5.33	11.20	-	
								10.08	21.20	-	
	2.81	BA	5.00	35	5.50	No	No	16.35	11.47	-	
	5.61							16.35	22.94	-	

Operating parameters								Process performance parameters			References
Waste composition	tCOD (g COD ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Lactate wastewater	21.50	BA	2.92	35	6.50	No	Yes	1.27	11.68	39.72	[30]
					7.50			1.90	17.52	39.72	
			8.33	45	8.50			1.11	10.22	30.84	
					6.50			3.96	12.77	50.93	
					7.50			13.47	43.43	53.27	
					8.50			12.20	39.34	70.56	
Sucrose	168.30	BA	6.67	37	4.50	No	Yes	13.29	419.41	4000	[31]
					5.00			12.17	383.94	40.00	
					5.50			11.51	363.06	40.00	
					6.00			10.66	336.33	40.00	
					6.50			9.16	289.18	40.00	
					Starch			11.30			
5.00	6.92	14.66	40.00								
5.50	6.34	13.43	40.00								
6.00	5.81	12.32	40.00								
6.50	3.99	8.46	40.00								
Citric acid wastewater	18.00	CN	48.00	37		7.00	No				No
			32.00		4.75			490.00	67.17		
			24.00		5.70			560.00	63.16		
			12.00		6.65			690.00	65.91		
			10.00		3.88			490.00	65.91		
			8.00		3.49			330.00	67.17		

Operating parameters								Process performance parameters			References
Waste composition	tCOD (g COD-1)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Condensed molasses	40.00	CN	12.00	35	5.50	No	Yes	10.41	800.00	-	[33]
			8.00					6.63	800.00	-	
			6.00		5.50	No	Yes	6.17	600.00	-	
			4.00					4.74	400.00	-	
			3.00					4.28	300.00	-	
Cellulose cellobiose	5.92	BA	2.50	60	5.60	No	Yes	14.26	42.21	-	[34]
Sucrose	22.44		0.67		6.25			21.01	20.00	-	[35]
Glucose	11.30	BA	0.83	35	6.50	No	Yes	4.83	81.91	-	[36]
Waste potato starch	11.30							8.79	149.05	-	
Molasses	25.43							9.66	368.59	-	
Glucose	11.30							4.04	68.48	-	
Cellulose	118.40	BA	6.67	80	7.50	Yes	No	14.00	310.70	6.1	[37]
								10.74	238.40	22.7	
								8.36	185.64	24.9	
								10.74	238.40	36.1	
								19.36	429.89	36.1	
Distillery effluent	101.00	BA	1.67	37	7.00	No	Yes	1.75	356.67	-	[38]
	10.67							10.30	82.80	-	
								11.80	166.00	-	
								12.83	179.40	-	

Operating parameters								Process performance parameters			References
Waste composition	tCOD (gCOD l ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Distillery effluent	10.67	BA	1.00	37	7.00	No	Yes	13.07	184.00	-	[38]
Rice slurry	5.86	BA	16.67	37	4.00	No	Yes	9.76	5.50	-	[39]
					4.50			15.92	8.98	-	
					5.00			15.46	8.70	-	
					5.50			13.81	7.79	-	
					6.00			12.15	6.91	-	
					6.50			10.26	5.81	-	
					7.00			7.36	4.15	-	
					4.50			15.92	10.87	-	
	5.86	BA	16.67	55	4.50	No	Yes	9.13	6.60	-	
	2.86	BA	16.67	37	4.50	No	Yes	12.79	3.61	-	
	5.86							15.92	8.98	-	
	8.84							11.23	9.49	-	
	11.72							8.10	9.14	-	
	14.70							7.23	10.21	-	
	23.54							7.09	16.02	-	
Wheat starch	8.48	CN	0.75	35	4.50	Yes	Yes	1.79	25.31	-	[40]
Wheat starch co-product		BA	1.67					1.60	10.19	-	
Lactose	5.62	BA	2.08	37	7.50	Yes	Yes	15.01	451.20	50	[41]
Cheese whey protein	17.40				6.00			12.93	388.80	50	
Glucose	5.34	BA	2.08	37	7.50	Yes	Yes	11.57	37.02	50	

Operating parameters								Process performance parameters			References
Waste composition	tCOD (g COD ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Wastewater sludge	27.00	BA	4.17	35	6.00	No	Yes	1.04	8.42	-	[42]
	26.20				6.00	Yes		1.36	10.69	-	
	24.00				4.00	Yes		1.28	9.22	-	
	25.20				6.00			0.48	3.63	-	
	30.00							2.72	24.48	-	
	25.60							3.60	27.65	-	
Sucrose-containing wastewater	5.48	CN	4.78	26	5.50	No	No	12.19	17.47	67.35	[43]
	8.07		7.25					12.77	17.77	64.29	
	11.94		10.72					13.35	18.60	64.29	
	16.31		14.49					15.68	22.05	65.31	
	20.36		18.16					13.93	19.53	63.27	
	34.06		30.29					10.45	14.69	57.14	
Soybean straw	10.00	BA	2.92	35	7.00	No	Yes	0.39	1.68	-	[44]
						Yes		0.73	3.12	-	
								1.05	4.52	-	
								1.42	6.10	-	
								2.01	8.61	-	
								1.72	7.37	-	
	10.00	BA	2.29	35	7.00	No	Yes	0.23	1.26	-	
						Yes		0.44	2.41	-	
								0.42	2.30	-	
								0.32	1.75	-	
								0.28	1.52	-	
								0.13	0.72	-	

Operating parameters								Process performance parameters			References
Waste composition	tCOD (g COD ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Soybean straw	12.50	BA	1.54	35	7.00	Yes	Yes	0.07	0.75	-	
	11.13							0.12	1.08	-	
	10.00							0.19	1.53	-	
	10.38							0.26	2.20	-	
	10.00							0.59	4.78	-	
	9.88							0.97	7.76	-	
	8.50							0.76	5.24	-	
	10.50	BA	1.79	35	7.00	Yes	Yes	0.33	2.39	-	
	10.38							0.41	2.96	-	
								0.48	3.47	-	
	10.50							0.29	2.12	-	
	10.63							0.03	0.23	-	
	10.13							1.73	12.21	-	
	10.00							0.73	5.11	-	
								0.04	0.30	-	
								0.04	0.28	-	
								0.05	0.37	-	
Synthetic wastewater	21.34	BA	1.25	35	6.20	No	No	10.55	225.15	0.00	[45]
							Yes	15.66	334.24	55.00	
								16.11	343.89	51.00	
								12.19	260.09	61.00	
								10.00	213.45	56.00	

Operating parameters								Process performance parameters			References							
Waste composition	tCOD (g COD ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)								
Synthetic wastewater	21.34	BA	1.25	35	6.20	No	Yes	9.68	206.49	60.00	[45]							
								9.96	212.50	56.00								
							No	14.63	312.11	46.00								
								15.41	328.87	47.00								
							Yes	15.023	320.64	50.00								
								14.13	301.51	67.00								
								13.85	295.66	61.00								
								14.37	306.57	62.00								
Sugarcane bagasse	10.67	BA	13.75	37	4.50	Yes	Yes	0.77	0.75	-	[46]							
								5.00	0.92	0.89		-						
								5.50	0.90	0.87		-						
								6.00	0.89	0.87		-						
								6.50	2.34	2.27		-						
								7.00	0.85	0.83		-						
								8.00	1.24	1.20		-						
								9.00	2.03	1.96		-						
	6.46	BA	13.75	37	6.50	Yes	Yes	5.43	3.19	-								
	11.70							6.03	6.41	-								
	27.54							2.05	5.12	-								
	36.45							1.50	4.96	-								
	47.18							0.72	3.08	-								
	59.20							2.54	69.40	-								
	Poplar leaves							33.60	BA	10.00	55	6.50	Yes	No	0.28	1.18	-	[48]
	Rice straw												No	Yes	0.38	1.58	-	

Operating parameters								Process performance parameters			References
Waste composition	tCOD (g COD ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Rice straw	33.60	BA	10.00	55	6.50	No	No	0.06	0.245	-	[48]
							Yes	0.26	1.11	-	
							No	0.09	0.38	-	
							Yes	0.12	0.49	-	
								0.38	1.58	-	
	67.20 100.80 134.40 100.80	BA	10.00	55	6.50	No	Yes	1.50	12.56	-	
								1.32	16.57	-	
								0.90	15.06	-	
								0.46	0.51	64.00	
								0.37	0.55	45.00	
Sucrose	10.67 21.34	CN	12.00	35	5.20	No	Yes	11.95	13.29	60.10	[49]
								10.88	24.18	57.70	
Food waste	27.00	BA	3.33	30	5.20	No	Yes	9.05	91.67	-	[50]
Food waste and sewage sludge	56.10		2.08	35	6.00			8.41	283.13	-	[51]
Organic fraction of municipal solid waste	10.40 19.67	BA	2.08	37	7.00	No	Yes	4.69	29.29	55.10	[52]
								3.86	45.53	46.80	

Operating parameters								Process performance parameters			References
Waste composition	tCOD (g COD ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Organic fraction of municipal solid waste	13.80	BA	2.08	37	7.00	No	Yes	5.23	43.34	45.60	[52]
	30.13							0.22	4.056	-	
	66.80							0.34	13.68	-	
	25.33							0.26	3.90	-	
	74.00							0.25	11.02	-	
	116.00	BA	7.00	37	5.50	No	Yes	2.90	60.14	70.00	[53]
	117.00							2.28	47.58	55.00	
	48.00							2.62	22.44	65.00	
Food waste and sewage sludge	52.00	BA	3.00	35	6.00	No	Yes	2.30	49.83	-	[54]
	54.50						No	2.00	45.42	-	
	56.50							0.90	21.19	-	
	31.50						Yes	4.00	52.50	-	
	32.50						No	3.80	51.46	-	
	34.00							2.20	31.17	-	
	35.00						Yes	0.20	2.92	-	
	21.00						No	4.10	35.88	-	
	22.00							3.50	32.08	-	
	22.50							2.90	27.19	-	
	23.50						Yes	0.60	5.88	-	
	24.50						No	0.10	1.02	-	
	16.50							2.60	16.79	-	
	16.50							2.40	16.50	-	

Waste composition	Operating parameters							Process performance parameters			References
	tCOD (g COD ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Food waste and sewage sludge	17.00	BA	3.00	35	6.00	No	No	2.40	16.50	-	[54]
	17.50						Yes	0.60	4.38	-	
	18.50						No	0.10	0.77	-	
	10.50							2.60	11.38	-	
	11.00							2.30	10.54	-	
	11.50							1.50	7.19	-	
	11.50						Yes	0.60	2.88	-	
	12.00						No	0.10	0.50	-	
	5.00							2.50	5.21	-	
	5.50							1.30	2.98	-	
	5.50							0.20	0.46	-	
	0.30						No	2.84	1.02	-	
Sucrose	0.60	BA	1.04	36	5.50	No	No	7.06	5.09	-	[55]
	1.10							9.21	12.15	-	
	2.20							12.74	33.63	-	
	4.50							14.76	79.69	-	
	9.00							11.48	123.97	-	
	17.90							5.61	120.57	-	
	2.00							7.38	17.71	-	
	4.00							7.51	36.03	-	
	8.00							7.19	69.02	-	
	16.00							5.87	112.62	-	

Waste composition	Operating parameters							Process performance parameters			References
	tCOD (g COD ⁻¹)	Mode	RT (d)	T (°C)	pH	Substrate pre-treatment	Methanogens' inhibition	Hydrogen yield (% COD COD ⁻¹)	Hydrogen production rate (mg l ⁻¹ d ⁻¹)	Hydrogen content (% v/v)	
Sucrose	32.00	BA	1.04	36	5.50	No	No	3.53	135.62	-	[55]
	64.00							1.89	145.31	-	
	96.00							1.07	123.52	-	
	1.10							3.28	4.33	-	
	2.30							5.42	14.97	-	
	4.60							6.37	35.16	-	
	9.50							3.41	38.83	-	
	16.10							2.84	54.83	-	
	32.30							2.33	90.45	-	

Table S2. a. Kendall rank analysis between tCOD (continuous operational parameter) and the process performance parameters (hydrogen yield, production rate and content).

Parameters	z	p-value	Tau-b
Yield (% COD COD ⁻¹) and tCOD (g COD l ⁻¹)	-5.21	1.86 e-07	-0.17
Production rate (mg l ⁻¹ d ⁻¹) and tCOD (g COD l ⁻¹)	7.25	4.18 e-13	0.24
Content (% v/v) and tCOD (g COD l ⁻¹)	-0.14	0.88	- 0.01

Table S2. b. Kruskal Wallis analysis between categorial parameters (pH, substrate composition, temperature, operating mode, residence time, methanogen's inhibition, substrate pre-treatment) and process performance parameters (hydrogen yield, production rate and content).

Parameters	Yield (% COD COD ⁻¹)			Production rate (mg l ⁻¹ d ⁻¹)			Content (% v/v)		
	Chi-squared	df	p-value	Chi-squared	df	p-value	Chi-squared	df	p-value
pH	411.42	383	0.15	420.11	407	0.32	132.80	87	0.001
Substrate composition	413.31	383	0.14	421.99	407	0.29	118.55	87	0.01
Temperature (°C)	401.41	383	0.25	411.71	407	0.43	57.33	87	0.99
Operating mode	412.89	383	0.14	422	407	0.29	145.75	87	68.12 e-5
Residence time (d)	412.89	383	0.14	422	407	0.29	131.67	87	0.001
Methanogen's inhibition	411.63	383	0.15	422	407	0.29	101.67	87	0.13
Substrate pre-treatment	413.02	383	0.14	422	407	0.29	132.65	87	0.001

Table S3. R script (RStudio 4.1.2).

#Kendall-tau (Yield and tCOD)	<pre>library(readxl) tcod=Yieldfinal <- read_excel("FileLocation.xlsx", sheet = "tcod2") View(tcod) dftcod=as.data.frame(tcod) head(dftcod) ken1=cor.test(dftcod\$Y,dftcod\$tcod, method="kendall"): print(ken1)</pre>
#Kruskall-Wallis (Yield and pH)	<pre>library(readxl) ph=Yieldfinal <- read_excel("C:/Users/ritam/Desktop/Stat article/Yieldfinal.xlsx", sheet = "PH2") View(ph) dfph=as.data.frame(ph) head(dfph) kruskal.test(Category~Y, data = dfph)</pre>
#Yield multi-linear regression	<pre>library(readxl) Group1=Yieldfinal <- read_excel("C:/Users/ritam/Desktop/Stat article/Yieldfinal.xlsx", sheet = "Signif") View(Group1) dfgroup1=as.data.frame(Group1) head(dfgroup1) d.fit=glm(Y~.,data = dfgroup1) summary(d.fit) coef(d.fit) corrplot(cor(dfgroup1[,1:6]),method = "ellipse")</pre>

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