

Catalytic Hydrothermal Liquefaction of *Scenedesmus* sp. Biomass Integrated with Dark-Fermentation: Bio-crude and Low-Carbon Fuels Production in Biorefinery Approach

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Supplementary Information

S Table 1: GC-MS product profile of H-HTL and N-HTL Bio-oil

RT (min)	Compound	Control	NaOH	K ₂ CO ₃	Ru/C	MoS ₂	Pt/C	Control	NaOH	K ₂ CO ₃	Ru/C	MoS ₂	Pt/C
		Nitrogen Atmosphere						Hydrogen Atmosphere					
7.97	2- Furancarboxaldehyde	5.21		1.27				8.336		1.27			
14.42	Nonane				1.06				2.5	6.1	4.6	1.6	3.6
14.58	Tetradecane	1.4				0.52					2.1	0.52	
14.67	Phenol	1.73				0.89		2.595		2.3		0.89	
14.85	Benzoic acid		2.11		2.42	3.43	1.72		2.11	1.2	2.42	3.43	1.72
14.96	Heptacosane		1.03			0.92			1.03			0.92	
15.27	Dodecanoic acid		0.95		2.29	1.4	0.95		0.95		2.29	1.4	0.95
15.66	Hexadecane	2.93			2.58	2.04		4.395	6.2	6.6	2.58	2.04	2.8
15.85	pentadecane	2.2				0.57		2.2				0.57	
16.79	Heptadecane	1.65	0.72	0.42	0.88	1.07	0.59	1.65	0.72	0.42	0.88	1.07	0.59

17.07	Hexadecene	0.82			5.01			0.82			5.01		
17.13	Diethyl Phthalate	3.36		0.29	0.87		2.92	3.36		0.29	0.87		2.92
17.5	Tetradecanoic acid		4.56		5.72	3.32			4.56		5.72	3.32	
17.82	Octadecene		2.35		3.26	3.75	1.97	4.6	2.35		3.26	3.75	1.97
17.82	Octane	4.35						4.35					
17.88	Octadecane	4.17	0.63	0.25	2.74	1.51	0.68		0.63	0.25	2.74	1.51	0.68
18.28	Decane	0.85						0.85	2.6	6.2	9.1	8.3	4.6
18.37	Pentadecanone		1.23					6.1	1.23				
18.6	Cyclononasiloxane		4.92		2	0.66	4.75		8.2		2	0.66	4.75
18.85	Nonadecane	0.7				0.75	1.67	0.7				0.75	1.67
18.91	Triacontane					3.35		1.5				3.35	
19.19	Heneicosane		1.24	0.51		1.8			1.24	0.51		1.8	
19.85	Propenal	0.96						0.96	1.7	4.5	4.5	6.1	9.1
19.9	Cyclopentane					1.42						1.42	
20.66	Hexadecanoic acid	5.7	17.8		23.98	16.41	21.55	5.7	17.8		23.98	16.41	21.55

20.79	Heptadecanoic acid		2.03						2.03	7.6	4.9	9.1	6.3
21.32	Eicosane	3.52		1.03	2.9		0.39	3.52	4.3	1.03	2.9		0.39
21.48	Octadecanoic acid	2.52			5.91	2.7	5.71	2.52	4.6		5.91	2.7	5.71
21.6	Octacosane				1.1	1		1.6			1.1	1	
23.18	Docosane	1.1		0.48	3			1.1	2.6	0.48	4.6	4.9	5.2
33.84	Cyclohexanone						3.26						3.26

S Table 2: N₂-HRMS product profile HTL-AF

	Compound	Mg/L	Molar Mass	Formula
Control	Cellobiose	80	342	C ₁₂ H ₂₂ O ₁₁
	Butyrolactone	22.5	86.08	C ₄ H ₆ O ₂
	Fructose	162	180	C ₆ H ₁₂ O ₆
	HMF	30	126.11	C ₆ H ₆ O ₃
	Xylose	122.5	150	C ₅ H ₁₀ O ₅
NaOH	1,6 Anhydrous glucose	17	164	C ₆ H ₁₁ O ₅
	Cellobiose	69.5	342	C ₁₂ H ₂₂ O ₁₁
	Fructose	425	180	C ₆ H ₁₂ O ₆
	Levulinic acid	18.5	116	C ₅ H ₈ O ₃
	Levoglucosenone	24.5	126	C ₆ H ₆ O ₃
	Butyrolactone	40.5	86.08	C ₄ H ₆ O ₂
	Xylose	205	150	C ₅ H ₁₀ O ₅
K₂CO₃	Cellobiose	21.5	342	C ₁₂ H ₂₂ O ₁₁
	Fructose	234	180	C ₆ H ₁₂ O ₆
	Levulinic acid	47.5	116	C ₅ H ₈ O ₃
	Furfurol	48	96.08	C ₅ H ₄ O ₂
	Xylose	219	150	C ₅ H ₁₀ O ₅
MoS₂	Cellobiose	73	342	C ₁₂ H ₂₂ O ₁₁
	Fructose	38	180	C ₆ H ₁₂ O ₆
	Butyrolactone	78	86.08	C ₄ H ₆ O ₂

	Levulinic acid	33.5	116	C ₅ H ₈ O ₃
	angalic lactone	30.5	98.1	C ₅ H ₆ O ₂
	Xylose	260.5	150	C ₅ H ₁₀ O ₅
Ru/C	1,6 Anhydrous glucose	43	164	C ₆ H ₁₁ O ₅
	Fructose	365	180	C ₆ H ₁₂ O ₆
	Levoglucosenone	86	126	C ₆ H ₆ O ₃
	Butyrolactone	125	86.08	C ₄ H ₆ O ₂
	angalic lactone	12.5	98.1	C ₅ H ₆ O ₂
	Lactic acid	25	90.08	C ₃ H ₆ O ₃
	Xylose	213	150	C ₅ H ₁₀ O ₅
	Furfurol	124	96.08	C ₅ H ₄ O ₂
	Cellobiose	72.5	342	C ₁₂ H ₂₂ O ₁₁
Pt/C	1,6 Anhydrous glucose	145	164	C ₆ H ₁₁ O ₅
	Fructose	335.5	180	C ₆ H ₁₂ O ₆
	Levulinic acid	30	116	C ₅ H ₈ O ₃
	Butyrolactone	28	86.08	C ₄ H ₆ O ₂
	Furfurol	48	96.08	C ₅ H ₄ O ₂
	angalic lactone	63.5	98.1	C ₅ H ₆ O ₂
	Xylose	74.5	150	C ₅ H ₁₀ O ₅

S Table 3: H₂- HRMS product profile HTL-AF

	Compound	Mg/L	Mass	Formula
Control	Cellobiose	61	342	C ₁₂ H ₂₁ O ₁₁
	Fructose	160	180	C ₆ H ₁₁ O ₆
	HMF	45	126	C ₆ H ₆ O ₃
NaOH	1,6 Anhydrous glucose	37	164	C ₆ H ₁₁ O ₅
	Cellobiose	26	342	C ₁₂ H ₂₁ O ₁₁
	Fructose	34	180	C ₆ H ₁₁ O ₆
	Levenoic acid	139	116	C ₅ H ₇ O ₃
	Levoglucofenone	850	128	C ₆ H ₇ O ₃
	Xylose	60	150	C ₅ H ₉ O ₅
K₂CO₃	Cellobiose	25	342	C ₁₂ H ₂₁ O ₁₁
	Fructose	50	180	C ₆ H ₁₁ O ₆
	Levenoic acid	43	116	C ₅ H ₇ O ₃
	Xylose	60	150	C ₅ H ₉ O ₅
MoS₂	Cellobiose	250	342	C ₁₂ H ₂₁ O ₁₁
	Fructose	95	180	C ₆ H ₁₁ O ₆
	Levenoic acid	96	116	C ₅ H ₇ O ₃
	Xylose	67	150	C ₅ H ₉ O ₅
Ru/C	1,6 Anhydrous glucose	76	164	C ₆ H ₁₁ O ₅
	Fructose	156	180	C ₆ H ₁₁ O ₆
	Levoglucofenone	730	128	C ₆ H ₇ O ₃

	Cellobiose	426	342	$C_{12}H_{21}O_{11}$
Pt/C	1,6 Anhydrous glucose	49	164	$C_6H_{11}O_5$
	Fructose	56	180	$C_6H_{11}O_6$
	Levenoic acid	96	116	$C_5H_7O_3$
	Xylose	81	150	$C_5H_9O_5$