

[Supplementary Material]

Primary Products from Fast Co-Pyrolysis of Palm Kernel Shell and Sawdust

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Table S1. Product distribution of fast pyrolysis of individual and co-pyrolysed biomass blends at 600°C and 5 s.

	Chemical Compounds	Individual biomass			Two biomass blend			Three biomass blend		
*RT	Phenols	PKS	MAH	IRO	PKS:MAH-1:1	PKS:IRO-1:1	MAH:IRO-1:1	PKS:MAH:IRO-1:1:1	PKS:MAH:IRO-1:2:2	PKS:MAH:IRO-2:1:1
5.83	Phenol	2.59	0.32	0.12	2.46	2.67	0.12	1.17	1.21	2.85
5.94	4-Ethylphenol	0	0	0.21		0	0.3	0.18	0.25	0
7.13	2-Methylphenol	0.17	0.18	0.07	0.26	0.28	0.2	0.22	0.18	0.37
7.54	4-Methylphenol	0.22	0.12	0.17	0.14	0.19	0.11	0.16	0.15	0.23
7.7	2-Methoxyphenol	0.65	0.46	0.68	0.71	0.9	0.71	0.79	0.67	0.87
8.79	2,5-Dimethylphenol	0.16	0.14	0.34	0.07	0.07	0.08	0.35	0.09	0.08
9.23	4-Ethyl-1,3-benzenediol	0	0.24	0.41	0.16	0.11	0.24	0.33	0.13	0.26
9.52	4-Methyl-2-methoxyphenol	0.68	0.16	0.35	0.65	0.89	0.39	0.67	0.54	0.99
9.97	1,2-Benzenediol	0.87	0.43	0.33	0.52	0.5	0.45	0.34	0.47	0.82
10.83	3-Methoxy-1,2-benzenediol	0	0.36	0.27	0	0	0	0.34	0.38	0.39
10.96	4-Ethyl-2-methoxyphenol	0.61	0.36	0.25	0.53	0.53	0.39	0.25	0.18	0.43
11.69	4-Vinyl-2-methoxyphenol	1.15	0.55	1.12	0.98	1.14	0.92	1.33	0.78	1.21
12.27	2,6-Dimethoxyphenol	1.03	0.84	1	1.06	1.03	1.14	1.22	0.85	1.33
12.39	3-(2-Propenyl)-2-methoxyphenol	0.09	0	0	0.06	0.06	0.07	0.07	0.07	0.1
12.48	2,4-Dimethoxyphenol	0.22	0.33	0.2	0.15	0.17	0.18	0.1	0.16	0.23
13.12	4-(1-propenyl)- 2-methoxyphenol	0.15	0.07	0.1	0.11	0.12	0.12	0.1	0.09	0.15
13.21	Vanillin	0.31	0.18	0.23	0.19	0.24	0.21	0.27	0.18	0.29
13.77	4-Methoxy-3-(methoxymethyl)phenol	0.68	0.33	0.45	0.78	0.89	0.59	0.64	0.4	1.17
13.84	4-(1-propenyl)- 2-methoxyphenol	0.63	0.37	0.58	0.46	0.54	0.46	0.59	0.33	0.47
14.07	4-Propyl-2-methoxyphenol	0.15	0.1	0.17	0.1	0.09	0.16	0.13	0.12	0.11
14.53	1-(4-Hydroxy-3-methoxyphenyl)-ethanone	0.19	0.17	0.14	0.2	0.23	0.12	0.18	0.19	0.18
14.91	5-tert-Butylpyrogallol	0.18	0.07	0.08	0.08	0.08	0.1	0.13	0.14	0.11
15.13	4-Hydroxy-3-methoxyphenylpropan-2-one	0.23	0.2	0.19	0.19	0.17	0.06	0.2	0.2	0.19
15.59	3-tert-Butyl-4-hydroxyanisole	0.51	0.49	0.99	0.68	0.61	0.74	1.16	0.63	0.95

15.79	4-(3-hydroxy-1-propenyl)-2-methoxyphenol	0.36	0.53	0.26	0.14	0.22	0.15	0.39	0.2	0.24
15.87	3-Hydroxy-4-methoxybenzaldehyde	0	0	0				0.4	0.29	0.32
16.07	4-(2-Propenyl)-2,6-dimethoxyphenol	0.6	0.47	0.31	0.34	0.52	0.26	0.33	0.31	0.44
16.03	4-(2-Propenyl)-2,6-dimethoxyphenol	0	0	0	0.12	0.33	0.1	0.22	0.12	0.17
16.77	4-(2-Propenyl)-2,6-dimethoxyphenol	0.23	0.12	0.12	0.1	0.12	0.1	0	0	0
17.07	4-Hydroxy-3,5-dimethoxybenzaldehyde	0	0.24	0.19	0.09	0.11	0.23	0.37	0.12	0.15
17.57	4-(2-Propenyl)-2,6-dimethoxyphenol	0.68	0.42	0.62	0.63	0.57	0.56	0.7	0.46	0.66
18.05	2,3,4-Trimethoxybenzaldehyde	0	0.09	0.12	0.08	0.08	0.15	0.15	0.08	0.1
18.13	4-Hydroxy-2-methoxycinnamaldehyde	0	0	0.36		0	0.1	0.25	0	0
18.45	4-Hydroxy-3-methoxybenzeneacetic acid	0.34	0.15	0	0.11	0.1	0.11	0.13	0.08	0.16
	Total Phenols	13.69	8.49	10.44	12.16	13.59	9.63	13.82	10.04	16.03
	Ketones									
2.35	1-Hydroxy-2-propanone	3.44	5.2	5.91	5.7	4.93	5.31	4.36	4.48	4.68
2.54	2-Pentanone	0.83	0.88	0.85	0.91	0.94	1.04	0.88	0.84	0.86
3.21	2,3-Pentanedione	1.22	2.14	2.01	1.37	1.54	2.33	2.31	1.51	1.77
4.21	2,6-Dimethyl-1,5-heptadiene	0	0	0.14				0.34	0.42	0.31
4.4	2-Cyclopentene-1,4-dione	0	0.44	0.64	0	0.6	0.59	0.31	0.31	0.34
4.71	2-Methyl-2-cyclopentenone	0.95	0.32	0.24	0	0	0	0.26	0.25	0
5.1	2-Hydroxycyclopent-2-en-1-one	0	0.84	0.92	1.45	1.46	0.99	1.14	1.37	1.33
5.54	3-Methylcyclopentanediol	0	0	0				0.2	0.36	0.5
6.4	4-Hydroxy-5,6-dihydro-2H-pyran-2-one	3.24	1.03	0.93	2.32	2.22	1.35	0.97	1.4	2.66
6.36	3,4-Dihydro-2-methoxy-2H-pyran	0	0	0				1.13	0.67	0.66
6.79	2-Hydroxy-3-methyl-2-cyclopentenone	0.25	0.36	0.54	0.26	0.62	0.51			
8.34	3-Ethyl-2-hydroxy-2-cyclopenten-1-one	0	0	0.43	0.15	0.1	0.32	0.32	0.14	0.2
9.89	2-Methyl-3,5-dihydroxy-4H-pyran-4-one	0	0.47	0.52	0	0	0	0.11		
	Total Ketones	9.93	11.68	13.12	12.17	12.42	12.44	12.33	11.76	13.3
	Aldehydes									
1.81	Acetaldehyde	16.72	17.94	18.28	11.68	13.65	12.69	12.28	12.46	12.19

2.09	Hydroxyacetaldehyde	33.47	42.32	42.15	33.13	27.89	47.7	39.93	34.07	24.43
	Total Aldehydes	50.19	60.26	60.43	44.82	41.54	60.39	52.2	46.52	36.62
	Acids									
2.22	Acetic acid	16.02	11.93	9.39	23.84	24.48	11.52	12.59	24.58	25.14
3.04	2-Methylpropanoic acid	1.99	2.2	2.27	2.22	2.51	2.06	2.21	2.24	2.27
15.94	4-Acetoxybenzoic acid	1.18	1.32	1.1	0.3	0.43	0.21		0.22	0.41
16.24	4-Hydroxybenzoic acid	0.55	0	0	0	0		0.13	0.89	0.79
20.88	Oleic Acid	1.65	0.09	0.07	0.65	0.74	0.08	0.86	0.29	0.96
22.92	n-Hexadecanoic acid	0.65	0.05	0.06	0.36	0.31	0.07	0.41	0.19	0.42
23.33	Dodecanoic acid	0.48	0.31	0.38	0.12	0.12	0.02	0.14	0.06	0.15
	Total Acid	22.52	15.91	13.27	27.49	28.58	13.97	16.33	28.47	30.15
	Sachharides									
8.31	Levogluconone	0	0	0.23		0	0.02	0.18	0.01	0.01
16.34	Levogluconan	0.8	0.84	0.13	0.53	0.72	0.66	1.43	0.32	0.8
	Total Sachharides	0.8	0.84	0.36	0.53	0.72	0.68	1.61	0.33	0.81
	Furans									
3.71	Furfural	1.54	0.98	1.43	1.88	2.11	1.82	1.53	1.84	1.88
4.05	2,5-Dimethyl-2,3-dihydrofuran	0.72	1	0.23	0.68	0.55	0.66	0.77	0.54	0.51
4.97	2(3H)-furanone	0	0.24	0	0		0	0.41	0.18	0.25
5.66	3-Butyldihydro-2(3H)-furanone	0.61	0.6	0.46	0.29	0.49	0.41	0.58	0.16	0.34
10.1	2,3-Dihydrobenzofuran	0	0	0.26		0	0	0.43	0	0
	Total Furans	2.87	2.82	2.38	2.85	3.16	2.89	3.72	2.72	2.98

Highlighted compounds refer to main chemical compounds formed in each group of compounds.

*RT. - Retention time (mins).

Product distribution is given in normalised response (count/μg sample).

Table S2. Comparison of the experimental and predicted results of the two-biomass pyrolysis blend

PKS_MAH_1:1	Response (count/μg sample)		STDEV	STDEV
Group of chemical compounds	Exp.	Pred.	Exp.	Pred.
Phenols	8794	6483	362	312
Ketones	9200	5946	1391	399
Aldehydes	33895	19157	8385	3703
Acids	20787	11097	1921	1296
Sachharides	425	470	24	126
Furans	2152	1650	194	262
	75253	44803		

PKS_IRO_1:1	Response (count/μg sample)		STDEV	STDEV
Group of chemical compounds	Exp.	Pred.	Exp.	Pred.
Phenols	10000	5974	481	303
Ketones	9139	5062	562	351
Aldehydes	30574	13714	2722	2278
Acids	21036	9299	4041	797
Sachharides	532	316	303	88
Furans	2325	1334	346	243
	73606	35699		

MAH_IRO_1:1	Response (count/μg sample)		STDEV	STDEV
Group of chemical compounds	Exp.	Pred.	Exp.	Pred.
Phenols	6345	3318	163	158
Ketones	8195	4377	613	352
Aldehydes	39790	21711	5910	3452
Acids	9205	5370	459	1107
Sachharides	435	237	262	92
Furans	1907	956	230	116
	65876	35970		

Table S3. Comparison of the experimental and predicted results of the three-biomass pyrolysis blend

PKS_MAH_IRO_1:1:1	Response (count/μg sample)		STDEV	STDEV
Group of chemical compounds	Exp.	Pred.	Exp.	Pred.
Phenols	5412	5870	184	308
Ketones	4996	5103	307	367
Aldehydes	20456	18194	2320	3205
Acids	6399	8028	178	1075
Sachharides	628	321	111	104
Furans	1458	1314	115	217
	39350	38829		

PKS_MAH_IRO_1:2:2	Response (count/μg sample)		STDEV	STDEV
Group of chemical compounds	Exp.	Pred.	Exp.	Pred.
Phenols	8125	5028	505	346
Ketones	9518	4797	531	464
Aldehydes	37647	19601	8026	4268
Acids	23035	6786	5076	1402
Sachharides	257	297	46	128
Furans	2330	1217	197	239
	80912	37725		

PKS_MAH_IRO_2:1:1	Response (count/μg sample)		STDEV	STDEV
Group of chemical compounds	Exp.	Pred.	Exp.	Pred.
Phenols	12382	6923	403	407
Ketones	10276	5484	801	433
Aldehydes	28287	16435	2365	3550
Acids	23285	9580	1816	1226
Sachharides	621	386	249	126
Furans	2385	1521	243	293
	77236	40329		