ELECTRONIC SUPPLEMENTARY INFORMATIONS

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REPRESENTATION OF IMPROVED SYNTHESIS OF DAPG (S1)

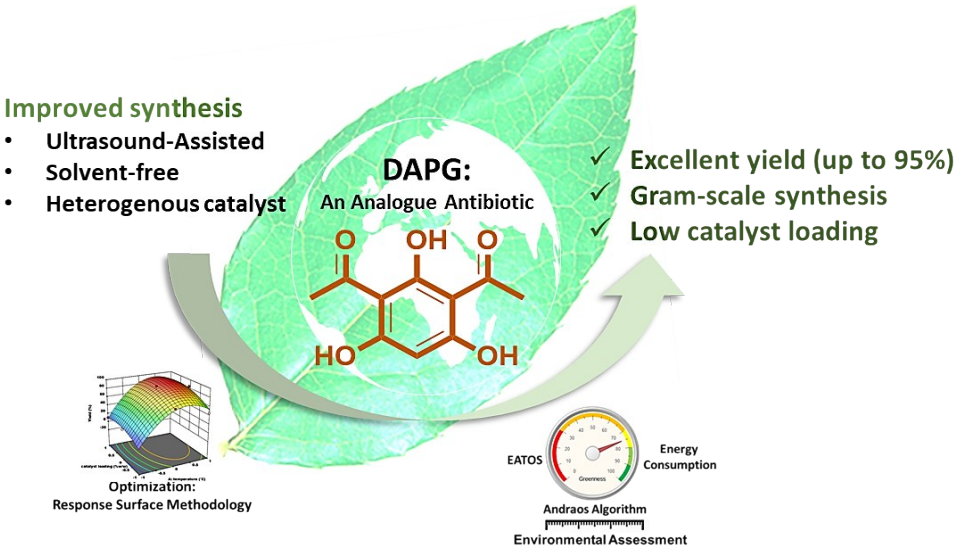


FIGURE S1. Representation of improved synthesis of DAPG

CHARACTERISATION DATA OF CATALYST (S2)

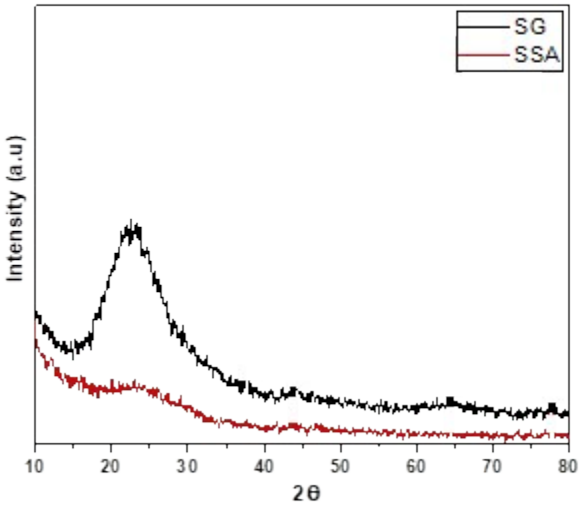


FIGURE S2. XRD spectra of silica gel (SG) and silica sulphuric acid (SSA)

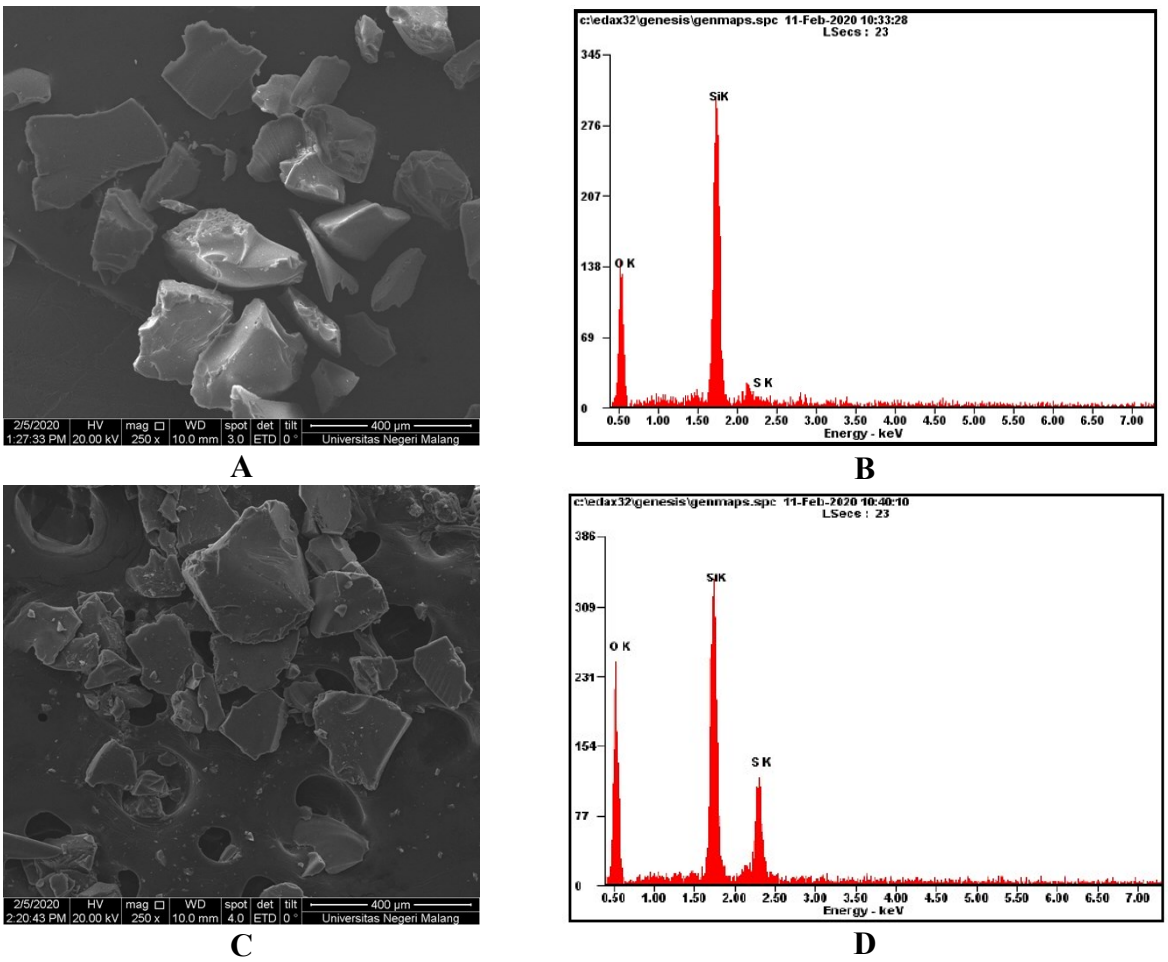


FIGURE S3. (a) SEM image of silica gel (SG)**, (b)** EDS spectrum of silica gel (SG)**, (c)** SEM image of silica sulphuric acid (SSA)**, (d)** EDS spectrum of silica gel (SG)

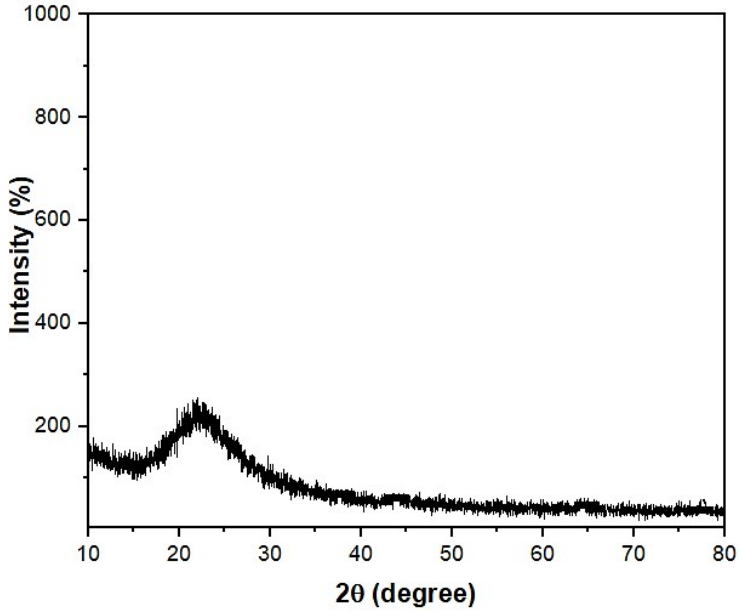


Figure S4. XRD spectra of recycle silica sulphuric acid (rSSA)

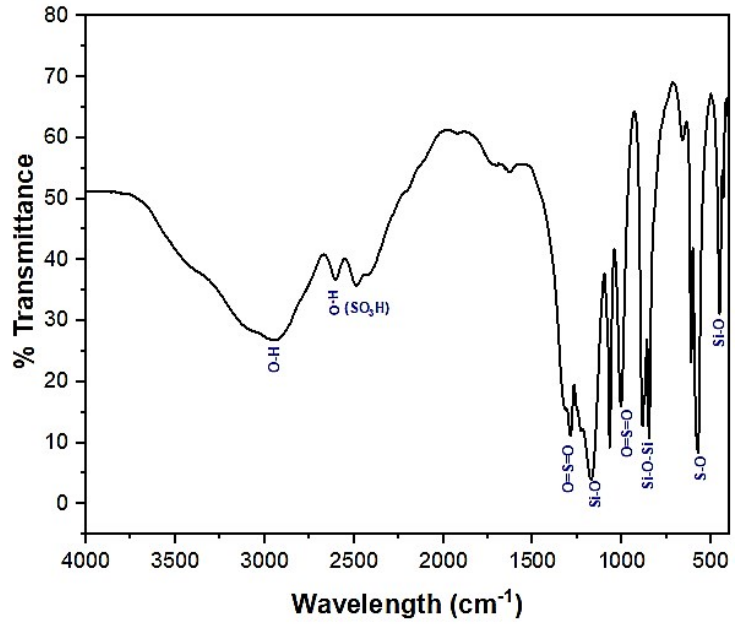


Figure S5. FTIR spectra of recycle silica sulphuric acid (rSSA)

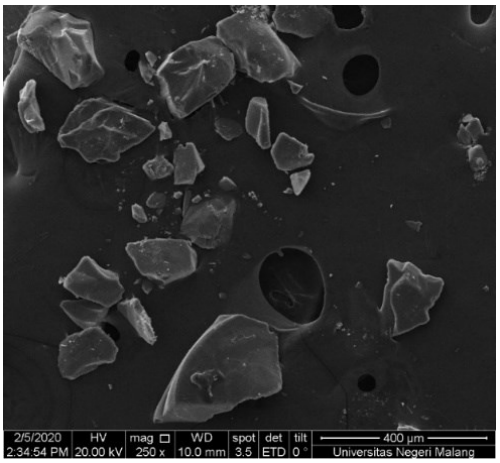
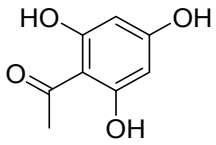
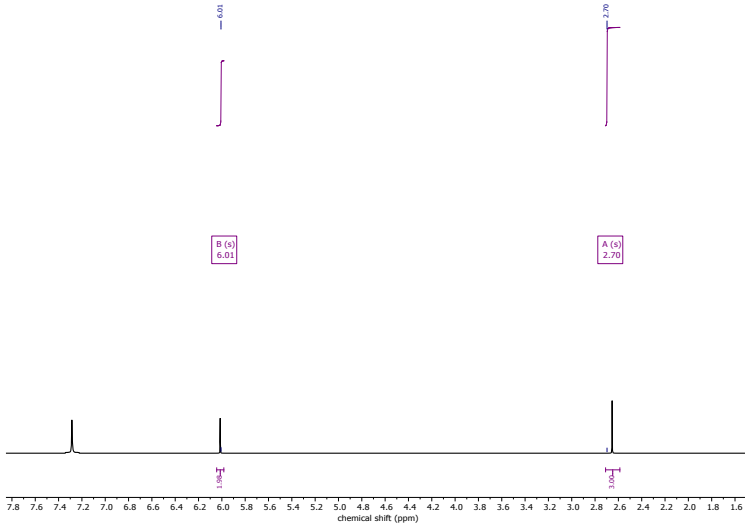


Figure S6. SEM image of recycle silica sulphuric acid (rSSA)

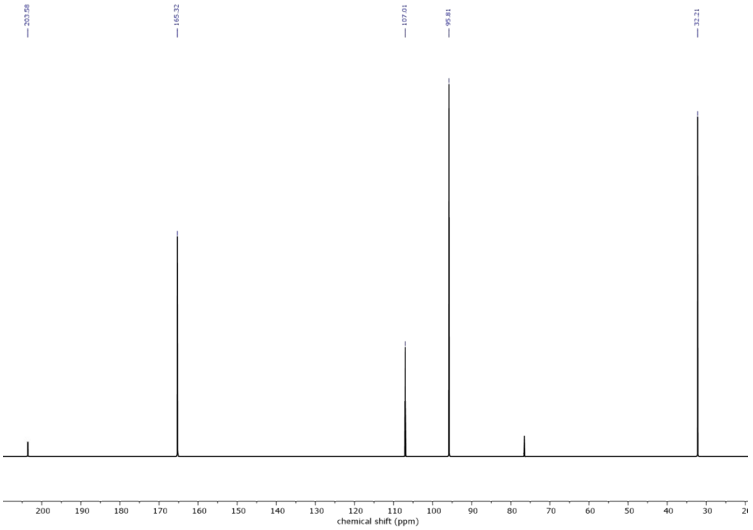
^{1}H NMR AND ^{13}C NMR SPECTRA (S3)

1-(2,4,6-trihydroxyphenyl)ethan-1-one (6a). ^{1}H NMR (CD_3Cl_3, 500 MHz) δ ppm: 6.01 (s, 1H, 2 x Ar**H**), 2.70 (s, 3H, C**H$_3$**). ^{13}C NMR (CD_3Cl_3, 125 MHz) δ ppm: 203.58, 165.32, 107.01, 95.81, 32.21. The data of ^{1}H NMR and ^{13}C NMR were agreed with the literature values[1].



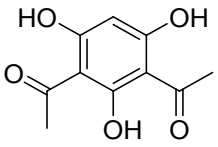


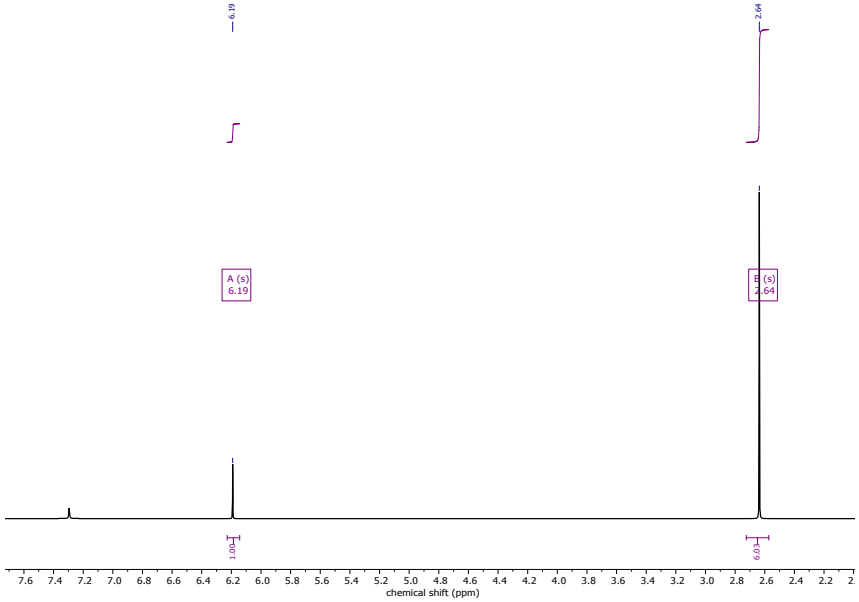
^{1}H NMR spectrum of 1-(2,4,6-trihydroxyphenyl)ethan-1-one



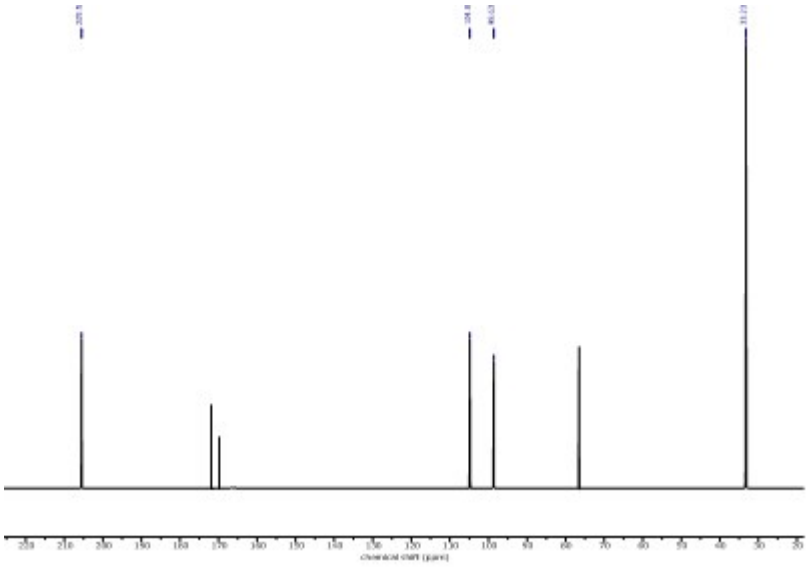
^{13}C NMR spectrum of 1-(2,4,6-trihydroxyphenyl)ethan-1-one

1,1'-(2,4,6-trihydroxy-1,3-phenylene)bis(ethan-1-one) (3). ^{1}H NMR (CD_3Cl_3, 500 MHz) δ ppm: 6.20 (s, 1H, Ar**H**), 2.63 (s, 6H, 2 x C**H**$_3$).^{13}C NMR (CD_3Cl_3, 125 MHz) δ ppm: 205.56, 173.56, 170.65, 104.83, 98.63, 33.23. The data of ^{1}H NMR and ^{13}C NMR were agreed with the literature values[1].



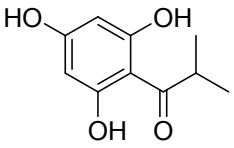


^{1}H NMR spectrum of 1,1'-(2,4,6-trihydroxy-1,3-phenylene)bis(ethan-1-one)

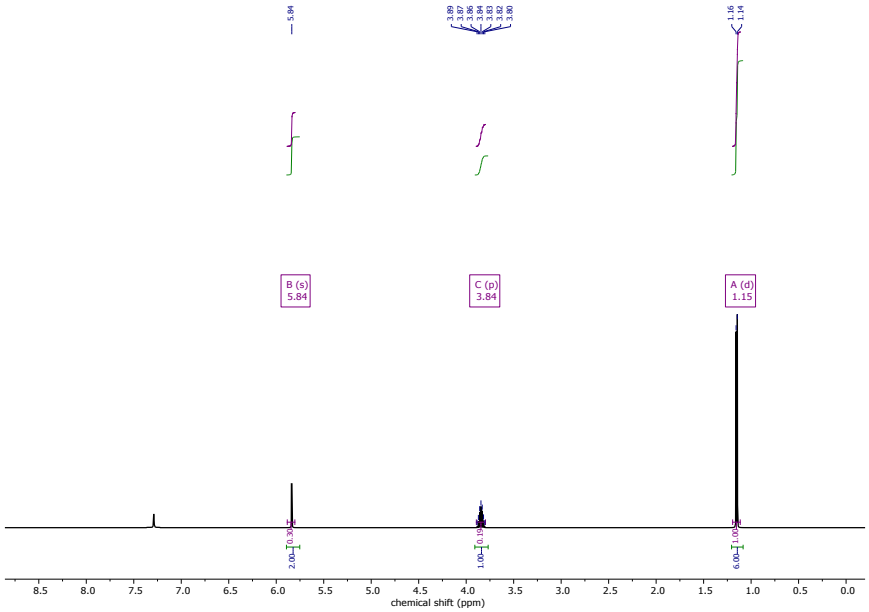


^{13}C NMR spectrum of 1,1'-(2,4,6-trihydroxy-1,3-phenylene)bis(ethan-1-one)

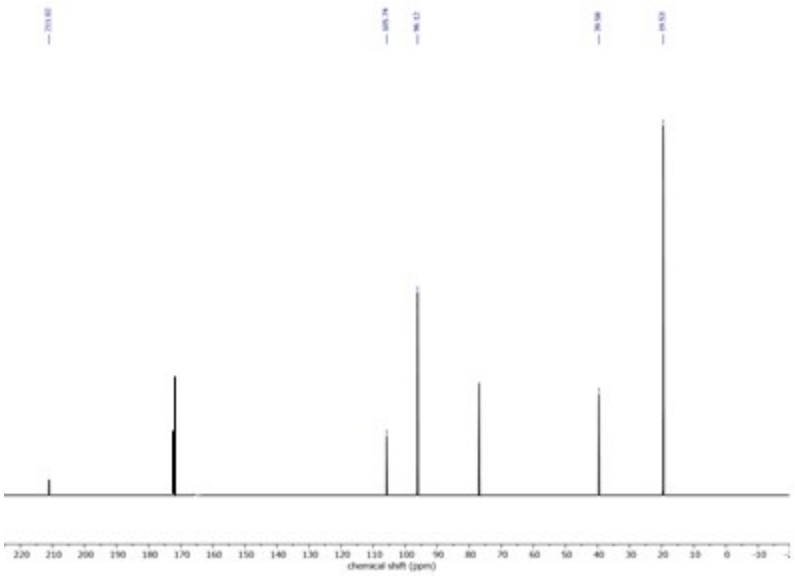
2-methyl-1-(2,4,6-trihydroxyphenyl)propan-1-one (6b). ^{1}H NMR (CD_3Cl_3, 500 MHz) δ ppm: 5.84 (s, 2H, 2 x Ar**H**), 3.84 (p, J = 5.4 Hz, 1H, -C**H**$(CH_3)_2$), 1.15 (d, J = 5.5 Hz, 6H, 2 x C**H**$_3$).^{13}C NMR (CD_3Cl_3, 125 MHz) δ ppm: 211.02, 172.70, 170.29,, 105.74, 96.12, 39.58, 19.53.



The data of ^{1}H NMR and ^{13}C NMR were agreed with the literature values[2–4].

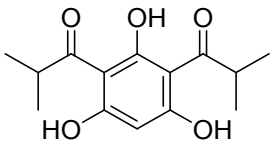


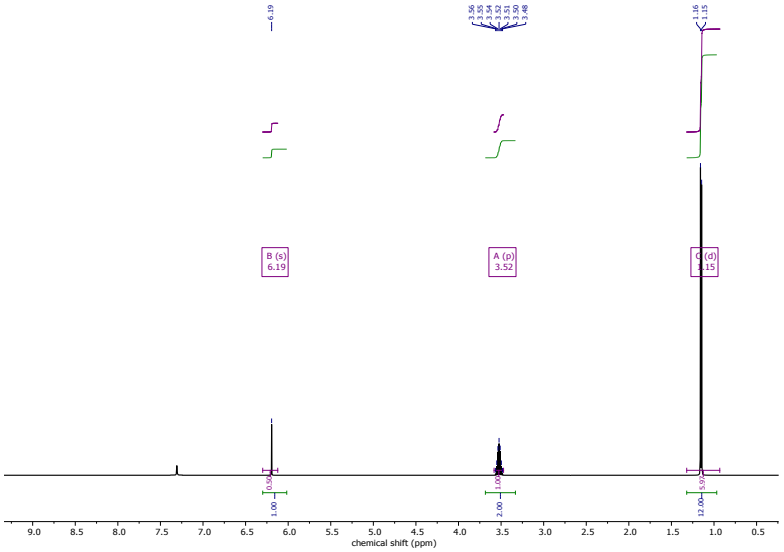
^{1}H NMR spectrum of 2-methyl-1-(2,4,6-trihydroxyphenyl)propan-1-one



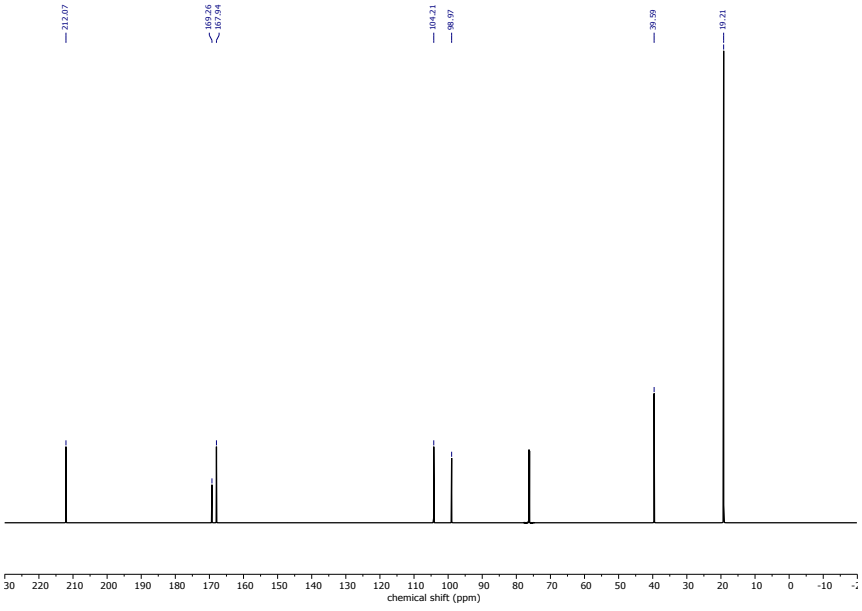
^{13}C NMR spectrum of 2-methyl-1-(2,4,6-trihydroxyphenyl)propan-1-one

1,1'-(2,4,6-trihydroxy-1,3-phenylene)bis(2-methylpropan-1-one) (5a). ^{1}H NMR (CD_3Cl_3, 500 MHz) δ ppm: 6.19 (s, 1H, Ar**H**), 3.52 (p, J = 5.4 Hz, 2H, 2 x -C**H**$(CH_3)_2$), 1.15 (d, J = 5.4 Hz, 12H, 4 x C**H**$_3$).^{13}C NMR (CD_3Cl_3, 500 125) δ ppm: δ 212.07, 170, 168, 104.21, 98.97, 39.59, 19.21. The data of ^{1}H NMR and ^{13}C NMR were agreed with the literature values[2].



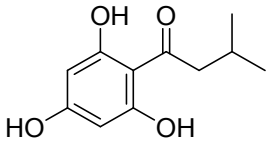


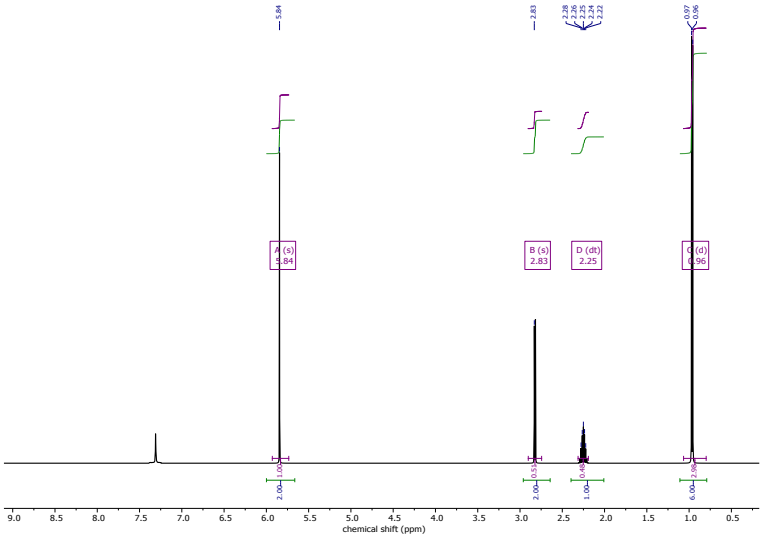
^{1}H NMR spectrum of 1,1'-(2,4,6-trihydroxy-1,3-phenylene)bis(2-methylpropan-1-one)



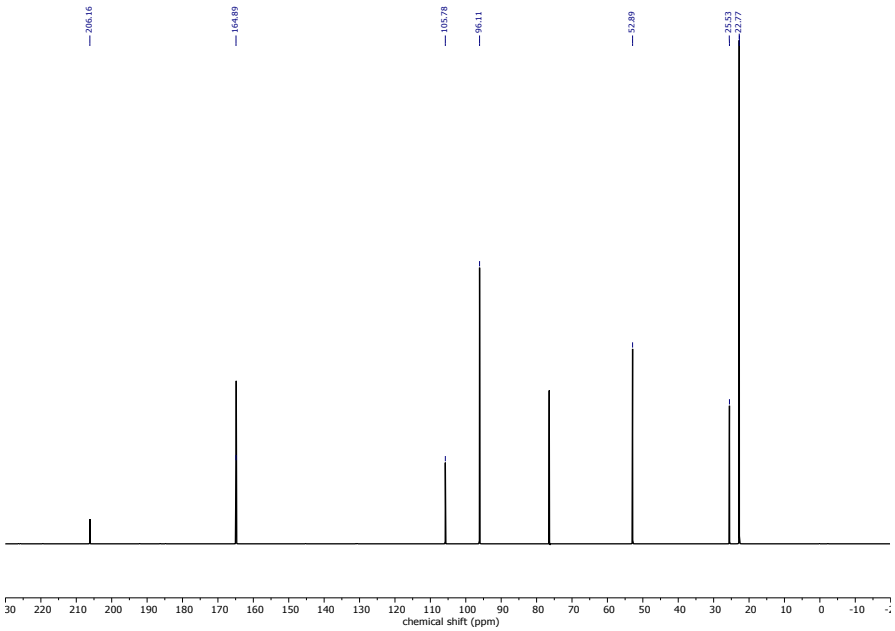
^{13}C NMR spectrum of 1,1'-(2,4,6-trihydroxy-1,3-phenylene)bis(2-methylpropan-1-one)

3-methyl-1-(2,4,6-trihydroxyphenyl)butan-1-one (6c). ^{1}H NMR (CD_3Cl_3, 500 MHz) δ ppm: 5.83 (s, 2H, 2 x Ar**H**), 2.83 (d, 2H, -C**H**$_2$-CH<), 2.25 (dt, J = 11.0, 5.5 Hz, 1H, -C**H**$(CH_3)_2$), 0.95 (d, J = 5.4 Hz, 12H, 4x C**H**$_3$).^{13}C NMR (CD_3Cl_3, 125 MHz) δ ppm: 206.16, 164.5, 165.7, 105.78, 96.11, 52.89, 25.53, 22.77. The data of ^{1}H NMR and ^{13}C NMR were agreed with the literature values[2].



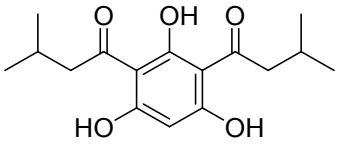


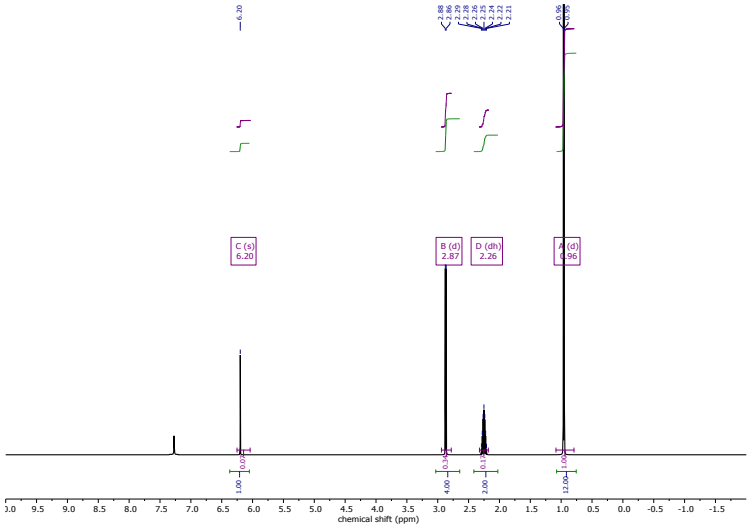
^{1}H NMR spectrum of 3-methyl-1-(2,4,6-trihydroxyphenyl)butan-1-one



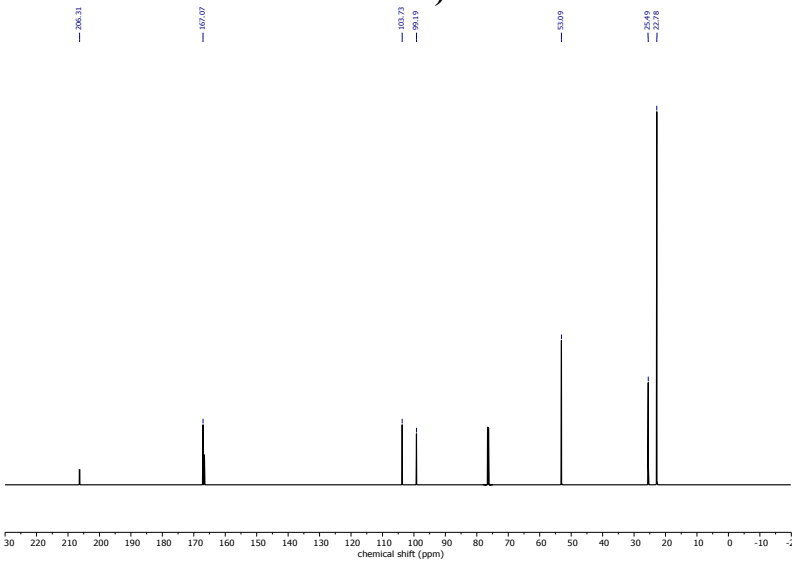
^{13}C NMR spectrum of 3-methyl-1-(2,4,6-trihydroxyphenyl)butan-1-one

1,1'-(2,4,6-trihydroxy-1,3-phenylene)bis(3-methylbutan-1-one) (5b). ^{1}H NMR (CD_3Cl_3, 500 MHz) δ ppm: : 6.20 (s, 1H, Ar**H**), 2.9 (d, J = 5.6 Hz, 4H, 2 x -C**H$_2$**-CH(CH_3)$_2$), 2.26 (dh, J = 11.0, 5.5 Hz, 2H, 2 x CH_2-C**H**(CH_3)$_2$), 0.97 (d, J = 5.4 Hz, 12H, 4x C**H$_3$**). ^{13}C NMR (CD_3Cl_3, 125 MHz) δ ppm: 205.98, 167.07, 103.73, 99.19, 53.09, 24.94, 22.81. The data of ^{1}H NMR and ^{13}C NMR were agreed with the literature values[2].



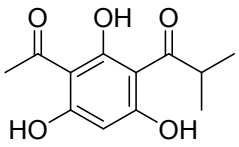


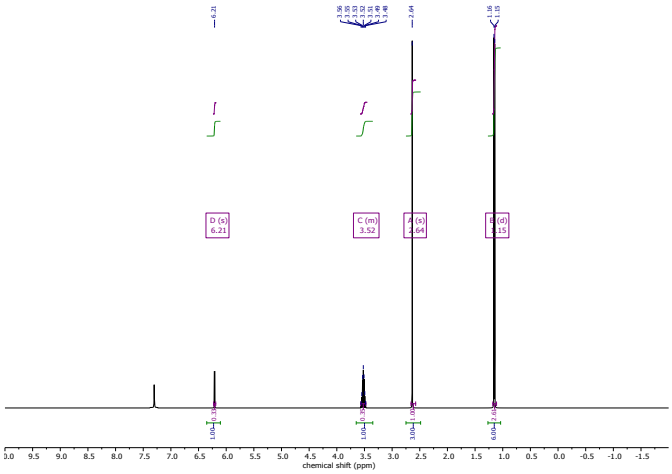
^{1}H NMR spectrum of 1,1'-(2,4,6-trihydroxy-1,3-phenylene)bis(3-methylbutan-1-one)



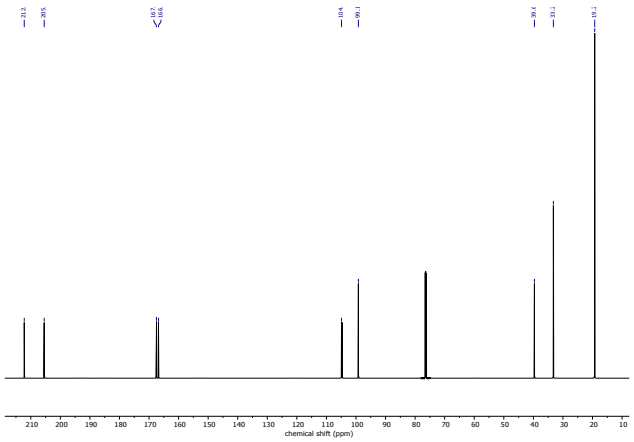
^{13}C NMR spectrum of 1,1'-(2,4,6-trihydroxy-1,3-phenylene)bis(3-methylbutan-1-one)

1-(3-acetyl-2,4,6-trihydroxyphenyl)-2-methylpropan-1-one (7a). ^{1}H NMR (CD_3Cl_3, 500 MHz) δ ppm: 6.21(s, 1H, Ar**H**), 3.57 – 3.47 (m, 1H, -C**H**$(CH_3)_2$), 2.64 (s, 3H, C**H$_3$**), 1.15 (d, J = 5.4 Hz, 6H, 2 x C**H$_3$**). ^{13}C NMR (CD_3Cl_3, 125 MHz) δ ppm: 212.20, 205.45, 167.51, 166.80, 104.89, 99.18, 39.65, 33.23, 19.26.



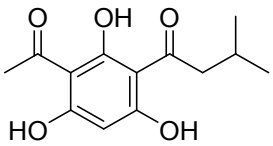


^{1}H NMR spectrum of 1-(3-acetyl-2,4,6-trihydroxyphenyl)-2-methylpropan-1-one

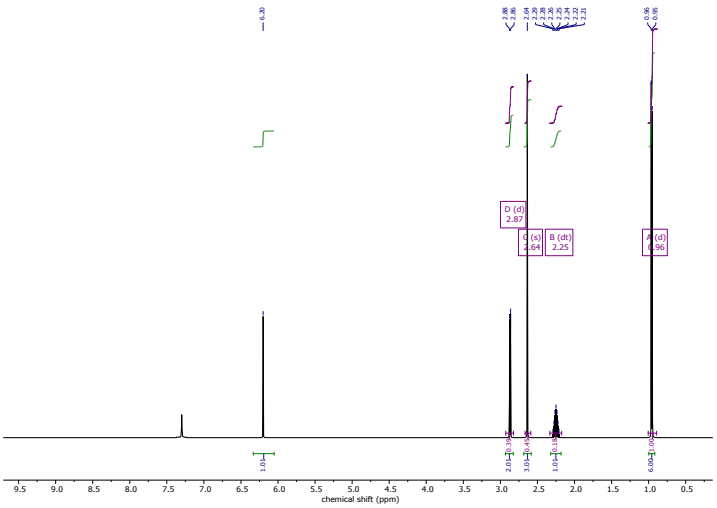


^{13}C NMR spectrum of 1-(3-acetyl-2,4,6-trihydroxyphenyl)-2-methylpropan-1-one

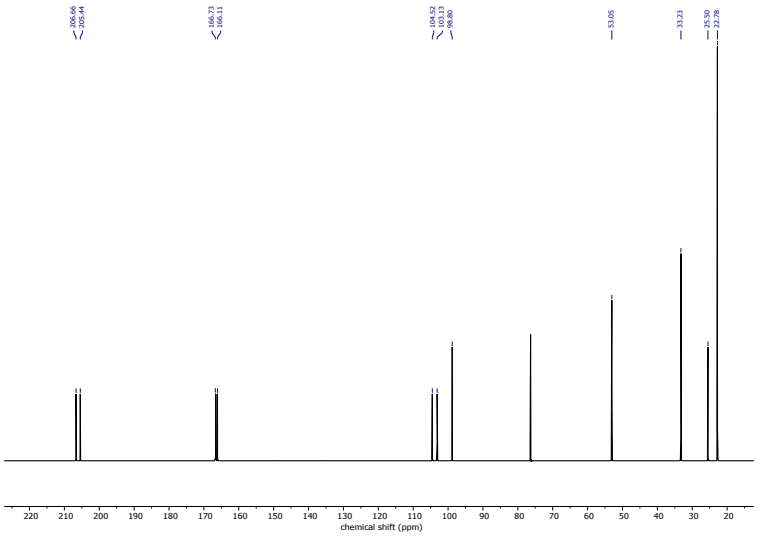
1-(3-acetyl-2,4,6-trihydroxyphenyl)-3-methylbutan-1-one (7b). ^{1}H NMR (CD_3Cl_3, 500 MHz) δ ppm: 6.2 (s, 1H, Ar**H**), 2.87 (d, J = 5.6 Hz, -C**H$_2$**-CH$(CH_3)_2$), 2.64(s, 3H, C**H$_3$**), 2.25 (dt, J = 11.0, 5.5 Hz, 1H, CH_2-C**H**$(CH_3)_2$), 0.96 (d, J = 5.5 Hz, 6H, 2 x C**H$_3$**). ^{13}C NMR (CD_3Cl_3, 125 MHz) δ ppm: 206.66, 205.44, 166.73, 166.11, 104.52,



103.13, 98.80, 53.05, 33.23, 25.50, 22.78



^{1}H NMR spectrum of 1-(3-acetyl-2,4,6-trihydroxyphenyl)-3-methylbutan-1-one



^{13}C NMR spectrum of 1-(3-acetyl-2,4,6-trihydroxyphenyl)-3-methylbutan-1-one

EATOS RESULTS (S4)

Table S1. S^{-1}, EI_{in}, E, and EI_{out} measured for synthesis A

Synthesis A	S^{-1}	EI_{in}	E	EI_{out}
Total	3.43	13.71	2.43	5.72
Catalyst				
MSA	1.46	5.84	1.46	1.46
Substrates				
Phloroglucinol	0.64	3.19		
Acetic anhydride	1.03	3.617		1.37
By-products				
Coupled products				
Acetic acid			0.57	2.57

Table S2. S^{-1}, EI_{in}, E, and EI_{out} measured for synthesis B

Synthesis B	S^{-1}	EI_{in}	E	EI_{out}
Total	108	419.86	107	16.6
Solvent				
dioxane	89.10	356.39	89.10	89.10
Catalyst				
Boron trifluoride	9	35.93	9	9
Substrates				
Phloroglucinol	1.1	5.45		
Acetic anhydride	8.8	22.08	7.06	31.79
By-products			1.29	4..07
Coupled products				
Acetic acid			0.57	2.57

Table S3. S^{-1}, EI_{in}, E, and EI_{out} measured for synthesis C

Synthesis A	S^{-1}	EI_{in}	E	EI_{out}
Total	12.14	22.87	11.14	16.6
Catalyst				
MSA	9.22	9.22	9.22	9.22
Substrates				
Phloroglucinol	0.97	4.83		
Acetic anhydride	1.96	8.81	0.39	1.76
By-products			0.96	3.05
Coupled products				
Acetic acid			0.57	2.57

Table S4. S^{-1}, EI_{in}, E, and EI_{out} measured for synthesis D

Synthesis A	S^{-1}	EI_{in}	E	EI_{out}
Total	3.43	5.6	0.76	2.57
Catalyst				
NHZMOR	1.46	0.1	0.1	0.1
Substrates				
Phloroglucinol	0.64	1.9		0.04
Acetic anhydride	1.03	3.6		
By-products			0.08	0.45
Coupled products				
MAPG			0.4	1.8
Water			0.18	0.17

Table S5. S^{-1}, EI_{in}, E, and EI_{out} measured for synthesis E

Synthesis A	S^{-1}	EI_{in}	E	EI_{out}
Total	3.43	5.25	0.61	2.05
Catalyst				
SSA	1.46	0.03	0.03	0.03
Substrates				
Phloroglucinol	0.64	1.8	0.006	0.04
Acetic anhydride	1.03	3.4		1.37
By-products				
Coupled products				
MAPG			0.4	1.8
water			0.17	0.17

ANDRAOS ALGORITHM RESULTS (S5)

Table S6. Comparison of Raw Material Footprint for Syntheses A−E According to the Andraos Algorithm

	A	B	C	D	Present
AE	0.424	0.182	0.633	0.633	0.633
Rxn Yield	0.881	0.300	0.600	0.942	0.947
1/SF	0.391	0.111	0.617	0.617	0.617
MRP	0.904	0.207	0.053	0.867	1.000
RME	0.132	0.001	0.012	0.319	0.370

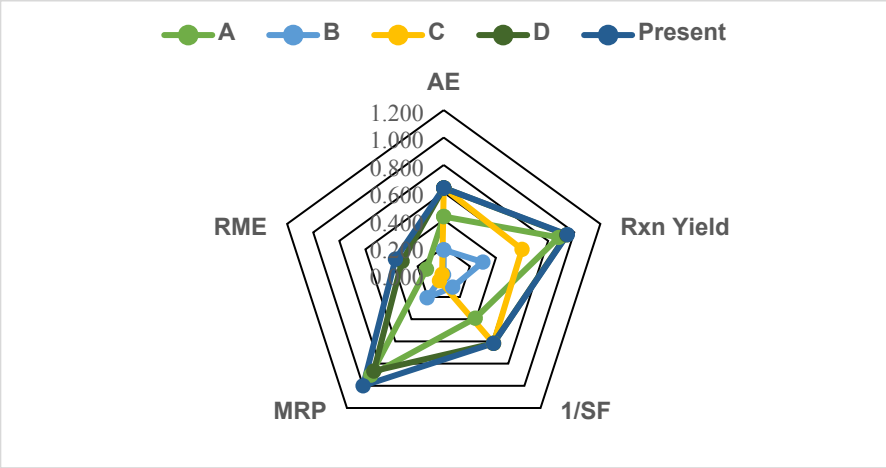
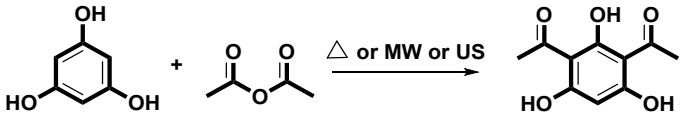


Figure S7. Comparison of the raw material footprint for synthetic routes A, B, C, D and E to DAPG

ENERGY CALCULATION RESULTS (S6)

Table S7. Comparison of the energy consumed by oil bath (Δ), microwave (MW) and ultrasound (US) heating for the Friedel-Crafts acylation between phloroglucinol and acetic anhydride.



Entry	Heating method	mmol	Yield (%)	P (kW)	t (h)	E (kWh)	E (kWh/mol)
A	MW	1	88	0.7	0.02	0.01	13.26
B	Oil bath	1	30	1.44	0.5	0.72	2400
C	Oil bath	2.5	60	1.44	2	2.88	12000
D	Oil bath	1	95	1.44	0.5	0.72	757.89
E	US	1	95	0.16	0.33	0.05	56.14

REFERENCES (S7)

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