Supplementary Information

$Cu(OAc)_2$-catalyzed remote benzylic $C(sp^3)$–H oxyfunctionalization for C=O formation directed by the hindered *para*-hydroxyl group with ambient air as terminal oxidant under ligand- and additive-free conditions

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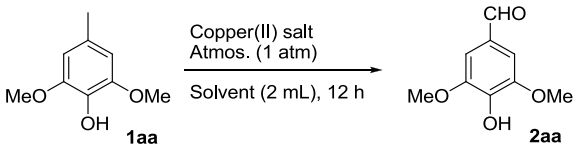
1. General Information

All solvents and reagents were purchased from commercial suppliers and used without further purification. All reactions were carried out in oven-dried glassware and monitored by thin layer chromatography (TLC, pre-coated silica gel plates containing HF_{254}). Reaction products were purified by silica gel chromatography (300–400 mesh). Melting points were determined using an open capillaries and uncorrected. NMR spectra were determined on Bruker AV400 in $CDCl_3$ or DMSO-d_6, with TMS as internal standard for ^{1}H NMR (400 MHz) and ^{13}C NMR (100 MHz), respectively. HRMS were carried out on a QSTAR Pulsar I LC/TOF MS mass spectrometer or a Micromass GCTTM gas chromatograph-mass spectrometer.

2. General Procedures and Characterization Data of Compounds

2.1 Optimizing the reaction conditions (comprehensive experiments for Table 1 in the text).

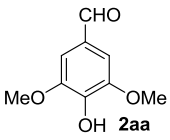
Table S1. Copper(II)-catalyzed oxidation of **1aa** to **2aa**.[a]



Entry	Cu(II) salt (*n* mol%)	Atmos.	T [°C]	Solvent	Yield [%][b]
1	$CuCl_2$ (3)	O_2	25	MeOH	trace
2	$CuCl_2$ (3)	O_2	50	MeOH	trace
3	$CuCl_2$ (3)	O_2	75	MeOH	trace
4	$CuBr_2$ (3)	O_2	75	MeOH	trace
5	CuF_2 (3)	O_2	75	MeOH	trace
6	$CuSO_4$ (3)	O_2	75	MeOH	0
7	$Cu(NO_3)_2$ (3)	O_2	75	MeOH	0
8	Cupric tartrate (3)	O_2	75	MeOH	0
9	Cupric citrate (3)	O_2	75	MeOH	0
10	Cupric acetylacetonate (3)	O_2	75	MeOH	0
11	$Cu(AcO)_2$ (3)	O_2	75	MeOH	79
12	$Cu(AcO)_2$ (3)	O_2	50	MeOH	79
13	$Cu(AcO)_2$ (3)	O_2	40	MeOH	53
14	$Cu(AcO)_2$ (3)	O_2	50	EtOH	78
15	$Cu(AcO)_2$ (3)	O_2	50	*n*-PrOH	71
16	$Cu(AcO)_2$ (3)	O_2	50	*i*-PrOH	76
17	$Cu(AcO)_2$ (3)	O_2	50	*n*-BuOH	68
18	$Cu(AcO)_2$ (3)	O_2	50	*t*-BuOH	74
19	$Cu(AcO)_2$ (3)	O_2	50	ethylene glycol (EG)	92
20	$Cu(AcO)_2$ (3)	O_2	50	THF	0
21	$Cu(AcO)_2$ (3)	O_2	50	CH_3CN	0
22	$Cu(AcO)_2$ (3)	O_2	50	DMF	0
23	$Cu(AcO)_2$ (3)	O_2	50	CH_2Cl_2	0
24	$Cu(AcO)_2$ (3)	air	50	EG	92
25	$Cu(AcO)_2$ (2)	air	50	EG	92
26	**$Cu(AcO)_2$ (1)**	**air**	**50**	**EG**	**92**
27	$Cu(AcO)_2$ (0. 5)	air	50	EG	69
28	$Cu(AcO)_2$ (3)	argon	50	EG	trace
29	$Cu(AcO)_2 \cdot H_2O$ (1)	air	50	EG	92

[a]Reaction conditions: **1aa** (1.0 mmol), copper(II) salt (*n* mol%), solvent (2 mL), atmos. (1 atm), 12 h. [b]Isolated yield. [c]Reaction time: 24 h.

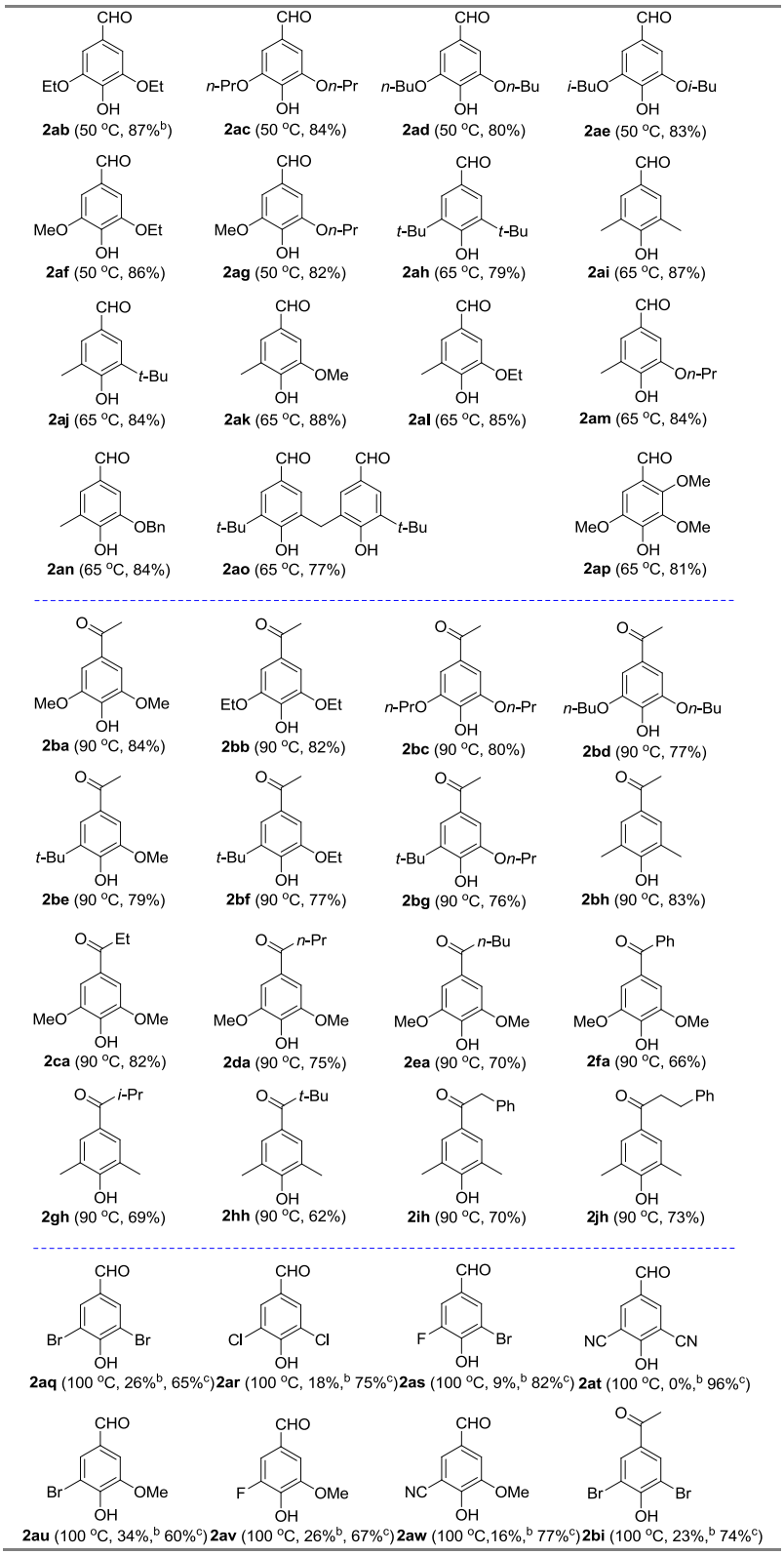
General procedure: a mixture of **1aa** (1.0 mmol, 168.2 mg) and specified copper(II) salt (*n* mol%) in solvent (2 mL) was stirred at specified reaction temperature under corresponding atmosphere for 12 h. Hydrochloric acid (4 mL, 2%) and methyl *tert*-butyl ether (MTBE, 4 mL) were added to the reaction mixture successively. The MTBE phase was separated, and the aqueous phase was further extracted with MTBE (4 mL × 2). The combined organic layers were dried over anhydrous sodium sulfate and concentrated in vacuo to give a residue, which was purified by column chromatography on silica gel (eluents: petroleum ether/ethyl acetate 5:1) to provide the desired product **2aa**.



2aa

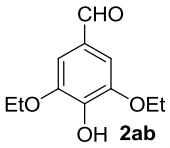
3,5-Dimethoxy-4-hydroxybenzaldehyde (2aa):[1] yellow solid, 167.6 mg (the best yield of 92%), m.p. 108–110 °C (lit[1] m.p. 110–111 °C); ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.81 (br s, 1H), 7.15 (s, 2H), 6.10 (br s, 1H), 3.97 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 190.8, 147.4 (2C), 140.8, 128.4, 106.7 (2C), 56.5 (2C); HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_9H_{11}O_4$ 183.0657, found 183.0635.

2.2 General procedure for the $Cu(OAc)_2$-catalyzed oxidation of 2,6-disubstituted 4-cresols and 4-alkylphenols 1 (Scheme 3 in the text).

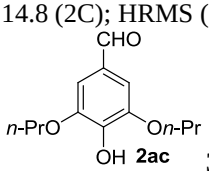


Scheme 3. Scope of **1** for $Cu(OAc)_2$-catalyzed oxidation. [a]Reaction conditions: **1** (1.0 mmol), $Cu(OAc)_2$ (0.01 mmol), EG (2 mL), ambient air, 12 h. [b]Isolated yield for the oxidation product. [c]Recovery for the starting material.

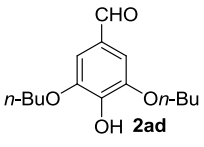
General procedure: a mixture of substrate **1** (1.0 mmol) and $Cu(OAc)_2$ (0.01 mmol, 1.8 mg) in EG (2 mL) was stirred at specified temperature under ambient air for 12 h. Hydrochloric acid (4 mL, 2%) and MTBE (4 mL) were added to the reaction mixture successively. The MTBE phase was separated, and the aqueous phase was further extracted with MTBE (4 mL × 2). The combined organic layers were dried over anhydrous sodium sulfate and concentrated in vacuo to give a residue, which was purified by column chromatography on silica gel (eluents: petroleum ether/ethyl acetate 5:1) to provide the corresponding product **2**.



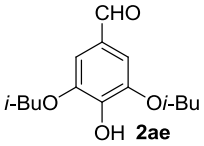
2ab **3,5-Diethoxy-4-hydroxybenzaldehyde (2ab)**: yellow solid, 182.9 mg (87% yield), m.p. 116–118 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.79 (br s, 1H), 7.12 (s, 2H), 6.07 (br s, 1H), 4.20 (q, J = 7.2 Hz, 4H), 1.49 (t, J = 7.2 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 190.9, 146.6 (2C), 141.2, 128.3, 107.6 (2C), 65.1 (2C), 14.8 (2C); HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_{11}H_{15}O_4$ 211.0970, found 211.0962.



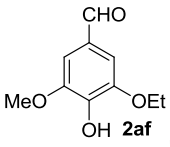
2ac **3,5-Dipropoxy-4-hydroxybenzaldehyde (2ac)**: yellow solid, 200.2 mg (84% yield), m.p. 64–66 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.79 (br s, 1H), 7.12 (s, 2H), 6.05 (br s, 1H), 4.09 (t, J = 7.2 Hz, 4H), 1.89 (sext, J = 7.2 Hz, 4H), 1.06 (t, J = 7.2 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 190.9, 146.8 (2C), 141.4, 128.3, 107.7 (2C), 71.0 (2C), 22.5 (2C), 14.8 (2C); HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_{13}H_{19}O_4$ 239.1283, found 239.1282.



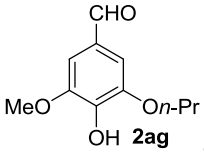
2ad **3,5-Dibutoxy-4-hydroxybenzaldehyde (2ad)**: yellow solid, 213.1 mg (80% yield), m.p. 90–92 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.77 (br s, 1H), 7.11 (s, 2H), 6.16 (br s, 1H), 4.10 (t, J = 7.2 Hz, 4H), 1.81 (quint, J = 7.2 Hz, 4H), 1.48 (sext, J = 7.2 Hz, 4H), 0.96 (t, J = 7.2 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 189.8, 149.0 (2C), 147.0, 130.0, 108.7 (2C), 69.8 (2C), 28.0 (2C), 22.4 (2C), 14.0 (2C); HRMS (ESI): *m/z* [M–H$^+$] calcd. for $C_{15}H_{21}O_4$ 265.1440, found 265.1446.



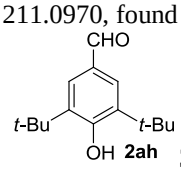
2ae **3,5-Diisobutoxy4-hydroxybenzaldehyde (2ae)**: yellow solid, 221.0 mg (83% yield), m.p. 58–60 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.79 (br s, 1H), 7.11 (s, 2H), 6.03 (br s, 1H), 3.88 (d, J = 6.8 Hz, 4H), 2.17 (heptet, J = 6.8 Hz, 2H), 1.05 (d, J = 6.8 Hz, 12H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 189.9, 145.8 (2C), 140.4, 127.2, 106.7 (2C), 74.8 (2C), 27.1 (2C), 18.2 (4C); HRMS (ESI): *m/z* [M–H$^+$] calcd. for $C_{15}H_{21}O_4$ 265.1440, found 265.1436.



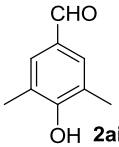
2af **3-Ethoxy-4-hydroxy-5-methoxybenzaldehyde (2af)**: yellow solid, 168.7 mg (86% yield), m.p. 72–74 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.80 (br s, 1H), 7.13 (d, J = 1.6 Hz, 2H), 6.10 (br s, 1H), 4.21 (t, J = 6.8 Hz, 2H), 3.97 (s, 3H), 1.49 (t, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 190.9, 147.4, 146.5, 141.0, 128.3, 107.6, 106.6, 65.1, 56.4, 14.8; HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_{10}H_{13}O_4$ 197.0814, found 197.0804.



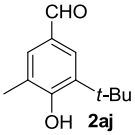
2ag **4-Hydroxy-3-methoxy-5-*n*-propoxybenzaldehyde (2ag)**: yellow solid, 172.4 mg (82% yield), m.p. 84–86 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.80 (br s, 1H), 7.14 (s, 2H), 6.06 (br s, 1H), 4.09 (t, J = 6.8 Hz, 2H), 3.97 (s, 3H), 1.88 (sext, J = 6.8 Hz, 2H), 1.06 (t, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 189.9, 146.4, 145.6, 140.0, 127.3, 106.6, 105.6, 70.0, 55.4, 21.4, 9.4; HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_{11}H_{15}O_4$ 211.0970, found 211.0962.



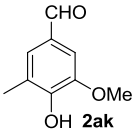
2ah **3,5-Di-*tert*-butyl-4-hydroxybenzaldehyde (2ah)**:[1,2] white solid, 185.1 mg (79% yield), m.p. 188–190 °C (lit[2] m.p. 190–191 °C); ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.85 (br s, 1H), 7.73 (s, 2H), 5.85 (br s, 1H), 1.48 (s, 18H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 191.9, 159.7 (2C), 136.5, 128.7, 127.7 (2C), 34.4 (2C), 30.1 (6C); HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_{15}H_{23}O_2$ 235.1698, found 235.1693.



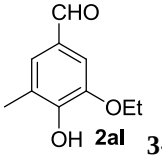
2ai **3,5-Dimethyl-4-hydroxybenzaldehyde (2ai)**:[1,3] white solid, 130.6 mg (87% yield), m.p. 112–114 °C (lit[3] m.p. 113–114 °C); ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.81 (br s, 1H), 7.54 (s, 2H), 5.46 (br s, 1H), 2.31 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 191.5, 158.1 (2C), 131.0, 129.3, 123.7 (2C), 15.8 (2C); HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_9H_{11}O_2$ 151.0759, found 151.0750.



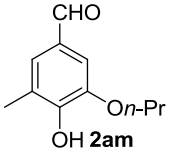
2aj **3-*tert*-Butyl-4-hydroxy-5-methylbenzaldehyde (2aj)**:[4] white solid, 161.5 mg (84% yield), m.p. 148–150 °C (lit[4] m.p. 152–153 °C); ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.83 (br s, 1H), 7.71 (s, 1H), 7.70 (s, 1H), 5.49 (br s, 1H), 2.32 (s, 3H), 1.44 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 191.7, 158.6, 153.6, 136.4, 130.8, 128.0, 123.8, 34.7, 29.5 (3C), 15.9; HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_{12}H_{17}O_2$ 193.1229, found 193.1234.



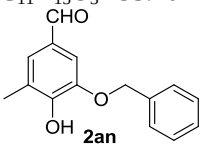
2ak **4-Hydroxy-3-methoxy-5-methylbenzaldehyde (2ak)**: white solid, 146.2 mg (88% yield), m.p. 98–100 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.80 (br s, 1H), 7.30 (s, 1H), 7.28 (s, 1H), 6.24 (br s, 1H), 3.96 (s, 3H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 191.2, 149.8, 146.7, 128.9, 128.8, 124.0, 106.7, 56.2, 15.3; HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_9H_{11}O_3$ 167.0708, found 167.0706.



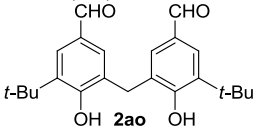
2al **3-Ethoxy-4-hydroxy-5-methylbenzaldehyde (2al)**: white solid, 153.2 mg (85% yield), m.p. 86–88 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.78 (br s, 1H), 7.29 (s, 1H), 7.26 (s, 1H), 6.34 (br s, 1H), 4.19 (q, *J* = 6.8 Hz, 2H), 2.32 (s, 3H), 1.47 (t, *J* = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 191.3, 149.9, 146.0, 128.74, 128.70, 124.0, 107.5, 64.8, 15.4, 14.8; HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_{10}H_{13}O_3$ 181.0865, found 181.0862.



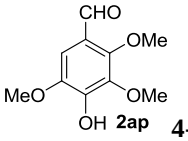
2am **4-Hydroxy-3-methyl-5-propoxybenzaldehyde (2am)**: white solid, 163.2 mg (84% yield), m.p. 110–112 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.79 (br s, 1H), 7.29 (s, 1H), 7.27 (s, 1H), 6.33 (br s, 1H), 4.08 (t, *J* = 6.8 Hz, 2H), 2.32 (s, 3H), 1.87 (sext, *J* = 6.8 Hz, 2H), 1.06 (t, *J* = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 191.3, 149.9, 146.1, 128.8, 128.7, 124.0, 107.5, 70.7, 22.4, 15.4, 10.5; HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_{11}H_{15}O_3$ 195.1021, found 195.1020.



2an **3-(Benzyloxy)-4-hydroxy-5-methylbenzaldehyde (2an)**: white solid, 203.5 mg (84% yield), m.p. 118–120 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.71 (br s, 1H), 7.40-7.18 (m, 7H), 6.24 (br s, 1H), 5.09 (s, 2H), 2.25 (s, 3H) ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 191.2, 149.9, 145.9, 135.6, 128.9, 128.85 (2C), 128.8, 128.7, 128.1 (2C), 124.4, 108.1, 71.3, 15.4; HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_{15}H_{15}O_3$ 243.1021, found 243.1012.

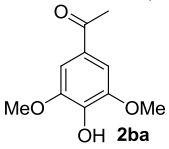


2ao **5,5'-Methylenebis(3-*tert*-butyl-4-hydroxybenzaldehyde) (2ao)**: yellow solid, 283.7 mg (77% yield), m.p. 184–186 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.85 (br s, 2H), 7.75 (d, *J* = 2.0 Hz, 2H), 7.70 (d, *J* = 2.0 Hz, 2H), 6.73 (br s, 2H), 4.06 (s, 2H), 1.45 (s, 18H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 191.3 (2C), 157.5 (2C), 136.9 (2C), 131.0 (2C), 129.9 (2C), 128.2 (2C), 127.1 (2C), 34.5 (2C), 30.9, 29.8 (6C); HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_{23}H_{29}O_4$ 369.2066, found 369.2045.



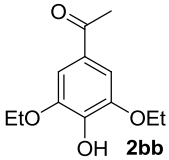
2ap

4-Hydroxy-2,3,5-trimethoxybenzaldehyde (2ap): white solid, 171.9 mg (81% yield), m.p. 112–114 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 10.25 (br s, 1H), 7.12 (s, 1H), 6.17 (br s, 1H), 3.98 (s, 3H), 3.97 (s, 3H), 3.91 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 188.4, 152.5, 145.9, 144.2, 139.9, 121.0, 103.2, 62.8, 61.0, 56.4; HRMS (ESI): *m/z* [M+H$^+$] calcd. for $C_{10}H_{13}O_5$ 213.0763, found 213.0760.



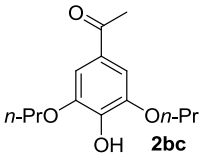
2ba

1-(4-Hydroxy-3,5-dimethoxyphenyl)ethanone (2ba):[5] yellow solid, 164.8 mg (84% yield), m.p. 122–124 °C (lit[5] m.p. 121–122 °C); ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.26 (d, *J* = 4.0 Hz, 2H), 5.95 (br s, 1H), 3.96 (s, 6H), 2.58 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 197.1, 147.4 (2C), 140.4, 129.5, 106.5 (2C), 57.1 (2C), 26.8; HRMS (EI): *m/z* [M$^+$] calcd. for $C_{10}H_{12}O_4$ 196.0736, found 196.0737.



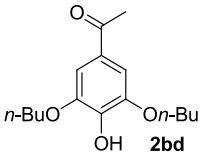
2bb

1-(3,5-Diethoxy-4-hydroxyphenyl)ethanone (2bb): yellow solid, 183.9 mg (82% yield), m.p. 117–119 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.15 (s, 2H), 6.02 (br s, 1H), 4.10 (q, *J* = 6.8, 4H), 2.48 (s, 3H), 1.40 (t, *J* = 6.8 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 197.3, 146.7 (2C), 141.1, 129.4, 107.7 (2C), 65.8 (2C), 26.9, 15.5 (2C); HRMS (EI): *m/z* [M$^+$] calcd. for $C_{12}H_{16}O_4$ 224.1049, found 224.1047.



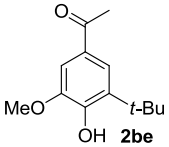
2bc

1-(4-Hydroxy-3,5-di-*n*-propoxyphenyl)ethanone (2bc): white solid, 201.0 mg (80% yield), m.p. 98–100 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.23 (s, 2H), 5.93 (br s, 1H), 4.07 (t, *J* = 6.8 Hz, 4H), 2.55 (s, 3H), 1.88 (m, 4H), 1.06 (t, *J* = 7.2 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 196.7, 146.2 (2C), 140.4, 128.7, 107.0 (2C), 71.1 (2C), 26.3, 22.5 (2C), 10.4 (2C); HRMS (EI): *m/z* [M$^+$] calcd. for $C_{14}H_{20}O_4$ 252.1362, found 252.1361.



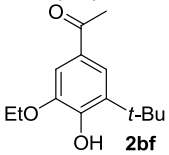
2bd

1-(3,5-Di-*n*-butoxy-4-hydroxyphenyl)ethanone (2bd): white solid, 215.9 mg (77% yield), m.p. 90–92 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.23 (s, 2H), 5.93 (br s, 1H), 4.11 (t, *J* = 6.8 Hz, 4H), 2.55 (s, 3H), 1.83 (m, 4H), 1.52 (m, 4H), 0.99 (t, *J* = 7.2 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 197.3, 146.8 (2C), 141.1, 129.3, 107.6 (2C), 70.0 (2C), 31.9 (2C), 26.9, 19.8 (2C), 14.4 (2C); HRMS (EI): *m/z* [M$^+$] calcd. for $C_{16}H_{24}O_4$ 280.1675, found 280.1676.



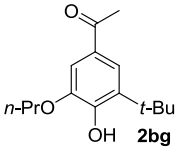
2be

1-(3-*tert*-butyl-4-hydroxy-5-methoxyphenyl)ethanone (2be): yellow solid, 175.6 mg (79% yield), m.p. 82–84 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.58 (s, 1H), 7.43 (s, 1H), 6.47 (br s, 1H), 3.95 (s, 3H), 2.57 (s, 3H), 1.43 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 197.7, 149.7, 147.3, 135.5, 129.3, 122.1, 108.3, 56.9, 35.3, 29.8 (3C), 26.7; HRMS (EI): *m/z* [M$^+$] calcd. for $C_{13}H_{18}O_3$ 222.1256, found 222.1254.

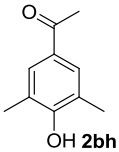


2bf

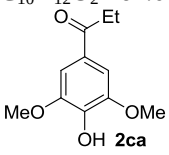
1-(3-*tert*-Butyl-5-ethoxy-4-hydroxyphenyl)ethanone (2bf): white solid, 181.9 mg (77% yield), m.p. 80–82 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.57 (s, 1H), 7.41 (s, 1H), 6.54 (br s, 1H), 4.18 (q, *J* = 6.8 Hz, 2H), 2.56 (s, 3H), 1.47 (t, *J* = 6.8 Hz, 3H), 1.43 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 197.2, 149.1, 145.9, 134.8, 128.6, 121.3, 108.5, 64.9, 34.7, 29.2 (3C), 26.2, 14.8; HRMS (EI): *m/z* [M$^+$] calcd. for $C_{14}H_{20}O_3$ 236.1412, found 236.1414.



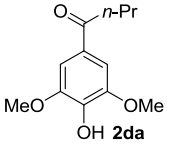
2bg **1-(3-*tert*-Butyl-4-hydroxy-5-*n*-propoxyphenyl)ethanone (2bg)**: yellow solid, 190.2 mg (76% yield), m.p. 78–80 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.59 (s, 1H), 7.43 (s, 1H), 6.57 (br s, 1H), 4.09 (t, J = 6.8 Hz, 2H), 2.58 (s, 3H), 1.89 (sext, J = 6.8 Hz, 2H), 1.46 (s, 9H), 1.09 (t, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 197.2, 149.1, 146.0, 134.8, 128.6, 121.3, 108.5, 70.8, 34.7, 29.2 (3C), 26.2, 22.5, 10.5; HRMS (EI): *m/z* [M^+] calcd. for $C_{15}H_{22}O_3$ 250.1569, found 250.1570.



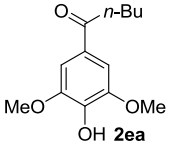
2bh **1-(4-Hydroxy-3,5-dimethylphenyl)ethanone (2bh)**: yellow solid, 136.3 mg (83% yield), m.p. 157–159 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.64 (s, 2H), 5.43 (br s, 1H), 2.54 (s, 3H), 2.30 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 197.6, 157.0, 129.6 (3C), 123.1 (2C), 26.3, 16.0 (2C); HRMS (EI): *m/z* [M^+] calcd. for $C_{10}H_{12}O_2$ 164.0837, found 164.0838.



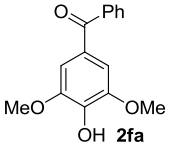
2ca **1-(4-Hydroxy-3,5-dimethoxyphenyl)propan-1-one (2ca)**:[6] white solid, 172.4 mg (82% yield), m.p. 109–111 °C (lit[6] m.p. 109–110 °C); ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.26 (s, 2H), 6.09 (br s, 1H), 3.95 (s, 6H), 2.97 (q, J = 7.2 Hz, 2H), 1.22 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 199.3, 146.8 (2C), 139.5, 128.5, 105.4 (2C), 56.4 (2C), 31.3, 8.5; HRMS (EI): *m/z* [M^+] calcd. for $C_{11}H_{14}O_4$ 210.0892, found 210.0893.



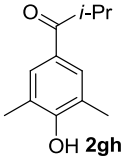
2da **1-(4-Hydroxy-3,5-dimethoxyphenyl)butan-1-one (2da)**: yellow solid, 168.2 mg (75% yield), m.p. 89–91 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.26 (s, 2H), 5.93 (br s, 1H), 3.96 (s, 6H), 2.91 (t, J = 7.2 Hz, 2H), 1.78 (sext, J = 7.2 Hz, 2H), 1.01 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 198.9, 146.7 (2C), 139.5, 128.7, 105.4 (2C), 56.5 (2C), 40.1, 18.0, 13.9; HRMS (EI): *m/z* [M^+] calcd. for $C_{12}H_{16}O_4$ 224.1049, found 224.1047.



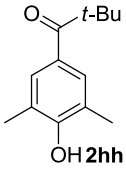
2ea **1-(4-Hydroxy-3,5-dimethoxyphenyl)pentan-1-one (2ea)**: yellow solid, 166.8 mg (70% yield), m.p. 76–78 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.26 (s, 2H), 5.93 (br s, 1H), 3.96 (s, 6H), 2.92 (t, J = 7.6 Hz, 2H), 1.71 (sext, J = 7.6 Hz, 2H), 1.42 (sext, J = 7.6 Hz, 2H), 0.96 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 199.0, 146.7 (2C), 139.5, 128.7, 105.5 (2C), 56.5 (2C), 37.9, 26.8, 22.5, 14.0; HRMS (ESI): *m/z* [M+H^+] calcd. for $C_{13}H_{19}O_4$ 239.1283, found 239.1277.



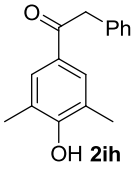
2fa **(4-Hydroxy-3,5-dimethoxyphenyl)(phenyl)methanone (2fa)**: yellow solid, 170.5 mg (66% yield), m.p. 124–126 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.77 (d, J = 8.0 Hz, 2H), 7.59 (t, J = 7.2 Hz, 1H), 7.49 (t, J = 7.2 Hz, 2H), 7.13 (s, 2H), 5.98 (br s, 1H), 3.92 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 195.5, 146.6 (2C), 139.4, 138.2, 132.0, 129.7 (2C), 128.6, 128.2 (2C), 107.8 (2C), 56.5 (2C); HRMS (EI): *m/z* [M^+] calcd. for $C_{15}H_{14}O_4$ 258.0892, found 258.0896.



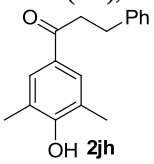
2gh **1-(4-Hydroxy-3,5-dimethylphenyl)-2-methylpropan-1-one (2gh)**: pale yellow solid, 132.7 mg (69% yield), m.p. 104–106 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.65 (s, 2H), 5.24 (br s, 1H), 3.52 (heptet, J = 6.8 Hz, 1H), 2.29 (s, 6H), 1.19 (d, J = 6.8 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 203.9, 156.8, 129.5 (2C), 128.5 (2C), 123.1, 34.8, 19.4 (2C), 16.0 (2C); HRMS (EI): *m/z* [M^+] calcd. for $C_{12}H_{16}O_2$ 192.1150, found 192.1151.



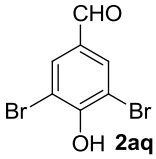
2hh **1-(4-Hydroxy-3,5-dimethylphenyl)-2,2-dimethylpropan-1-one (2hh)**: yellow oil, 127.9 mg (62% yield); ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.51 (s, 2H), 5.30 (br s, 1H), 2.27 (s, 6H), 1.36 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 207.3, 155.2, 129.8 (4C), 122.5, 44.0, 28.5 (3C), 16.0 (2C); HRMS (EI): *m/z* [M^+] calcd. for $C_{13}H_{18}O_2$ 206.1307, found 206.1304.



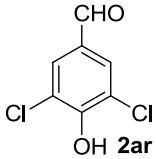
2ih **1-(4-Hydroxy-3,5-dimethylphenyl)-2-phenylethanone (2ih)**: white solid, 168.2 mg (70% yield), m.p. 110–112 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.69 (s, 2H), 7.37–7.19 (m, 5H), 5.23 (br s, 1H), 4.22 (s, 2H), 2.27 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 197.1, 157.1, 135.1, 130.0 (2C), 129.4 (2C), 129.0, 128.6 (2C), 126.7 (2C), 123.2, 45.1, 16.0 (2C); HRMS (EI): *m/z* [M^+] calcd. for $C_{16}H_{16}O_2$ 240.1150, found 240.1149.



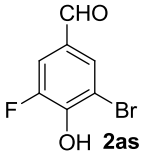
2jh **1-(4-Hydroxy-3,5-dimethylphenyl)-3-phenylpropan-1-one (2jh)**: white solid, 185.6 mg (73% yield), m.p. 99–101 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.64 (s, 2H), 7.32–7.18 (m, 5H), 5.25 (br s, 1H), 3.24 (t, *J* = 7.2 Hz, 2H), 3.04 (t, *J* = 7.2 Hz, 2H), 2.27 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 198.6, 156.9, 141.5, 129.4 (2C), 129.3, 128.5 (2C), 128.4 (2C), 126.1 (2C), 123.1, 40.1, 30.5, 16.0 (2C); HRMS (EI): *m/z* [M^+] calcd. for $C_{17}H_{18}O_2$ 254.1307, found 254.1309.



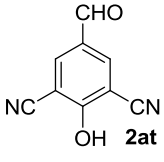
2aq **3,5-Dibromo-4-hydroxybenzaldehyde (2aq)**:[8] white solid, 72.8 mg (26% yield), m.p. 182–184 °C (lit[8] m.p. 183 °C); ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.80 (br s, 1H), 8.00 (s, 2H), 6.40 (br s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 188.2, 154.4, 133.7 (2C), 131.3, 110.7 (2C); HRMS (ESI): *m/z* [M–H^+] calcd. for $C_7H_3Br_2O_2$ 276.8500, found 276.8490. Recovery of the starting material: 172.2 mg (65%).



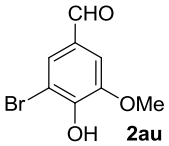
2ar **3,5-Dichloro-4-hydroxybenzaldehyde (2ar)**: white solid, 34.4 mg (18% yield), m.p. 160–162 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.82 (s, 1H), 7.83 (s, 2H), 6.43 (br s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 188.5, 152.9, 130.1 (2C), 129.8 (2C), 122.2; HRMS (ESI): *m/z* [M–H^+] calcd. for $C_7H_3Cl_2O_2$ 188.9510, found 188.9502. Recovery of the starting material: 132.8 mg (75%).



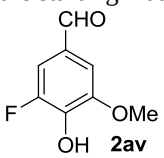
2as **3-Bromo-5-fluoro-4-hydroxybenzaldehyde (2as)**: white solid, 19.7 mg (9% yield), m.p. 138–140 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.74 (d, *J* = 2.0 Hz, 1H), 7.78 (t, *J* = 1.6 Hz, 1H), 7.54 (dd, *J* = 9.6, 2.0 Hz, 1H), 6.33 (br s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 188.7, 151.1 (d, *J* = 247.3), 147.2 (d, *J* = 15.0), 130.6 (d, *J* = 2.7), 130.0 (d, *J* = 5.4), 115.6 (d, *J* = 18.8), 111.4 (d, *J* = 1.4); HRMS (ESI): *m/z* [M–H^+] calcd. for $C_7H_3BrFO_2$ 216.9300, found 216.9281. Recovery of the starting material: 179.6 mg (82%).



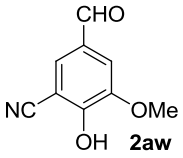
2at The substrate failed to undergo the oxidation. Recovery of the starting material: 151.8 mg (96%).



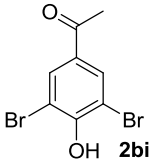
2au **3-Bromo-4-hydroxy-5-methoxybenzaldehyde (2au)**:[8] white solid, 78.6 mg (34% yield), m.p. 162–164 °C (lit[8] m.p. 163–166 °C); ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.79 (br s, 1H), 7.64 (d, J = 1.6 Hz, 1H), 7.36 (d, J = 1.6 Hz, 1H), 6.50 (br s, 1H), 3.99 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 189.8, 148.9, 147.7, 130.2, 130.0, 108.2, 108.0, 56.6; HRMS (ESI): m/z [M–H$^+$] calcd. for $C_8H_6BrO_3$ 228.9500, found 228.9473. Recovery of the starting material: 130.2 mg (60%).



2av **3-Fluoro-4-hydroxy-5-methoxybenzaldehyde (2av)**: white solid, 44.2 mg (26% yield), m.p. 116–118 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.81 (s, 1H), 7.33–7.25 (m, 2H), 5.98 (br s, 1H), 4.00 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 190.0 (d, J = 2.3), 150.4 (d, J = 243.8), 148.7 (d, J = 5.3), 140.0 (d, J = 13.5), 128.1 (d, J = 6.3), 113.0 (d, J = 18.5), 106.0 (d, J = 1.7), 56.7; HRMS (ESI): m/z [M+H$^+$] calcd. for $C_8H_8FO_3$ 171.0457, found 171.0447. Recovery of the starting material: 104.6 mg (67%).



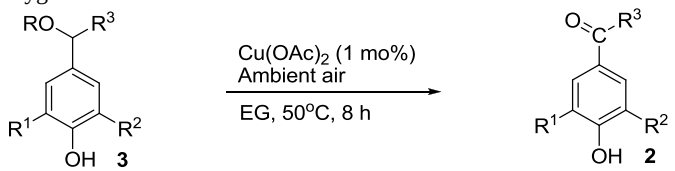
2aw **5-Formyl-2-hydroxy-3-methoxybenzonitrile (2aw)**: white solid, 28.3 mg (16% yield), m.p. 196–198 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.84 (s, 1H), 7.66 (s, 1H), 7.58 (s, 1H), 6.90 (br s, 1H), 4.04 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6, ppm): δ 190.6, 156.1, 148.9, 129.6, 129.2, 116.3, 113.6, 99.7, 56.8; HRMS (EI): m/z [M$^+$] calcd. for $C_9H_7NO_3$ 177.0426, found 177.0424. Recovery of the starting material: 125.6 mg (77%).

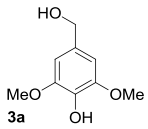
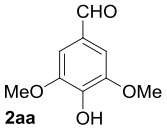


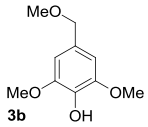
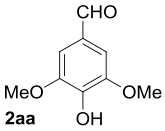
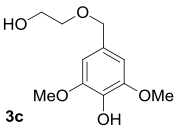
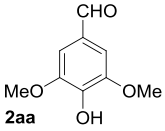
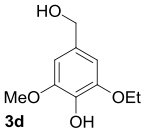
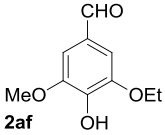
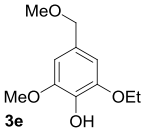
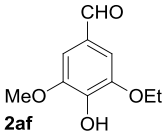
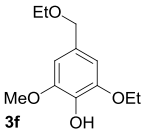
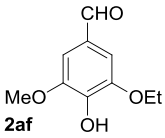
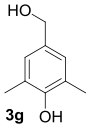
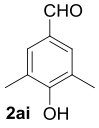
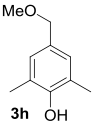
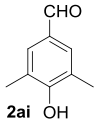
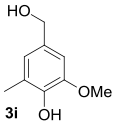
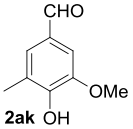
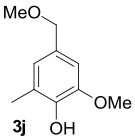
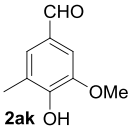
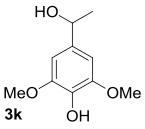
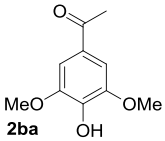
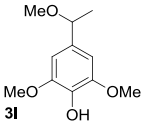
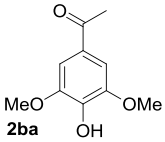
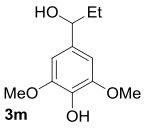
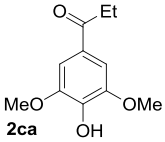
2bi **1-(3,5-Dibromo-4-hydroxyphenyl)ethanone (2bi)**: white solid, 67.6 mg (23% yield), m.p. 185–187 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 8.08 (s, 2H), 6.33 (br s, 1H), 2.56 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 194.3, 153.3, 132.6 (2C), 131.9, 110.1 (2C), 26.3; HRMS (ESI): m/z [M+H$^+$] calcd. for $C_8H_7Br_2O_2$ 292.8813, found 292.8817. Recovery of the starting material: 207.2 mg (74%).

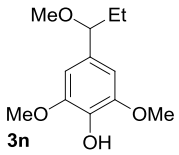
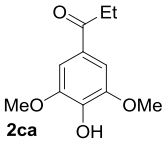
2.3 General procedure for the Cu(AcO)$_2$-catalyzed oxidation of 4-hydroxybenzyl alcohols and 4-hydroxybenzyl ethers 3 (Table 2 in the text).

Table 2. Cu(OAc)$_2$-catalyzed oxygenation of **3**.[a]



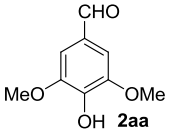
Entry	Substrate **3**	Product **2**	Yield (%)[b]
1	 **3a**	 **2aa**	96

2	 **3b**	 **2aa**	86
3	 **3c**	 **2aa**	94
4	 **3d**	 **2af**	93
5	 **3e**	 **2af**	84
6	 **3f**	 **2af**	82
7	 **3g**	 **2ai**	92
8	 **3h**	 **2ai**	85
9	 **3i**	 **2ak**	93
10	 **3j**	 **2ak**	87
11	 **3k**	 **2ba**	91
12	 **3l**	 **2ba**	83
13	 **3m**	 **2ca**	90

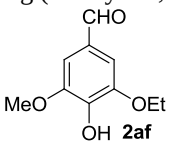
14	 **3n**		 **2ca**	81

[a] Reaction conditions: **3** (1.0 mmol), $Cu(OAc)_2$ (0.01 mmol), EG (2 mL), ambient air, 50 °C for 8 h. [b] Isolated yield.

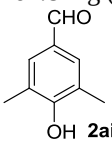
General procedure: a mixture of substrate **3** (1.0 mmol) and $Cu(AcO)_2$ (0.01 mmol, 1.8 mg) in EG (2 mL) was stirred at 50 °C under ambient air for 8 h. Hydrochloric acid (4 mL, 2%) and MTBE (4 mL) were added to the reaction mixture successively. The MTBE phase was separated, and the aqueous phase was further extracted with MTBE (4 mL × 2). The combined organic layers were dried over anhydrous sodium sulfate and concentrated in vacuo to give a residue, which was purified by column chromatography on silica gel (eluents: petroleum ether/ethyl acetate 5:1) to provide the corresponding product **2**.

 **2aa**

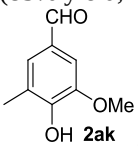
3,5-Dimethoxy4-hydroxybenzaldehyde (2aa):[1] yellow solid, 174.9 mg (96% yield, from **3a**); 156.7 mg (86% yield, from **3b**); 171.2 mg (94% yield, from **3c**). The spectral data see 2.1 section.

 **2af**

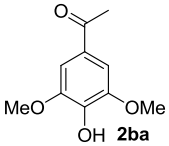
3-Ethoxy-4-hydroxy-5-methoxybenzaldehyde (2af): yellow solid, 182.5 mg (93% yield, from **3d**); 164.8 mg (84% yield, from **3e**); 160.9 mg (82% yield, from **3f**). The spectral data see 2.2 section.

 **2ai**

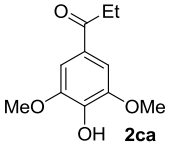
3,5-dimethyl-4-hydroxybenzaldehyde (2ai):[1,3] white solid, 138.2 mg (92% yield, from **3g**); 127.6 mg (85% yield, from **3h**). The spectral data see 2.2 section.

 **2ak**

4-Hydroxy-3-methoxy-5-methylbenzaldehyde (2ak): white solid, 154.5 mg (93% yield, from **3i**); 144.6 mg (87% yield, from **3j**). The spectral data see 2.2 section.

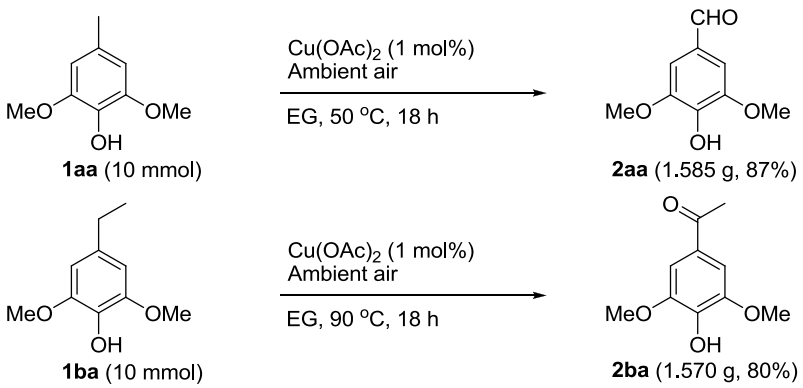
 **2ba**

1-(4-Hydroxy-3,5-dimethoxyphenyl)ethanone (2ba): yellow solid, 178.5 mg (91% yield, from **3k**); 162.8 mg (83% yield, from **3l**). The spectral data see 2.2 section.

 **2ca**

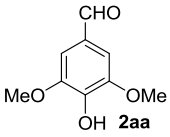
1-(4-Hydroxy-3,5-dimethoxyphenyl)propan-1-one (2ca): white solid, 189.2 mg (90% yield, from **3m**); 170.3 mg (81% yield, from **3n**). The spectral data see 2.2 section.

2.4 The gram-scale oxidations of 1aa and 1ba (Scheme 4 in the text).

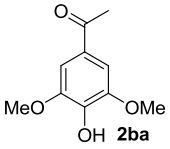


Scheme 4. Experiments on a gram-scale.

General procedure: a mixture of substrate **1aa** or **1ba** (10 mmol) and $Cu(AcO)_2$ (0.1 mmol, 18 mg) in EG (8 mL) was stirred at 50 °C under ambient air for 18 h. Hydrochloric acid (15 mL, 2%) and MTBE (15 mL) were added to the reaction mixture successively. The MTBE phase was separated, and the aqueous phase was further extracted with MTBE (15 mL × 2). The combined organic layers were dried over anhydrous sodium sulfate and concentrated in vacuo to give a residue, which was purified by column chromatography on silica gel (eluents: petroleum ether/ethyl acetate 5:1) to provide the corresponding product **2**.

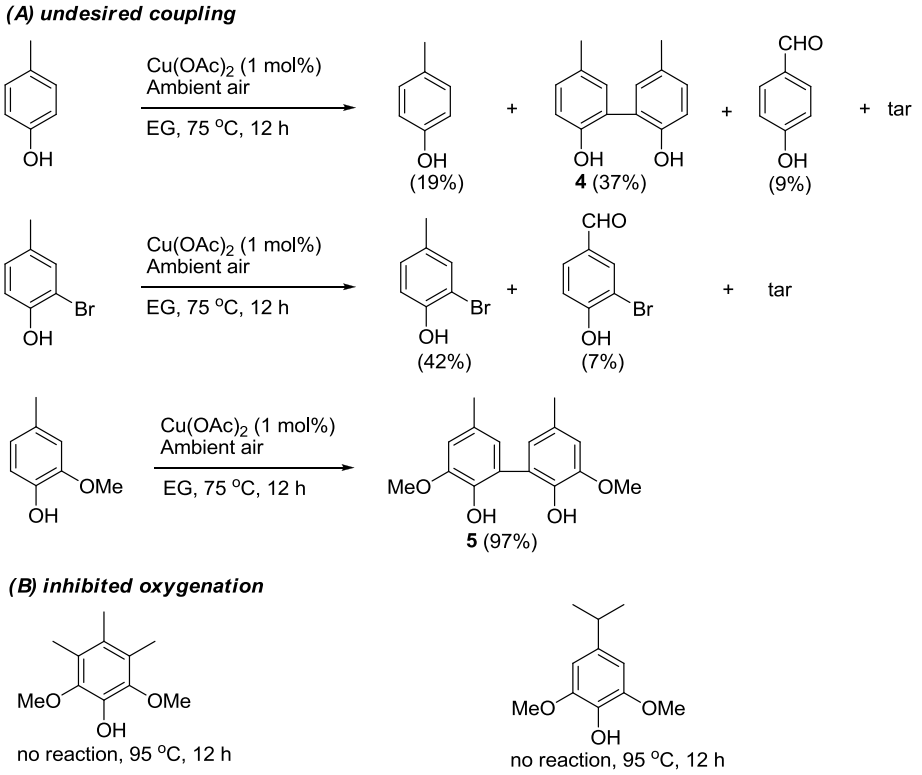


3,5-Dimethoxy-4-hydroxybenzaldehyde (2aa):[1] yellow solid, 1.585 g (87% yield).



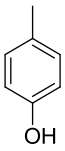
1-(4-Hydroxy-3,5-dimethoxyphenyl)ethanone (2ba):[5] yellow solid, 1.570 g (80% yield).

2.5 Limitations of Cu(OAc)2-catalyzed oxygenation (Scheme 5 in the text).

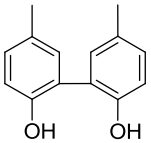


Scheme 5. Limitations of Cu(OAc)2-catalyzed oxygenation due to (*A*) undesired coupling or (*B*) inhibited oxygenation.

Procedure for Scheme 5(*A*): a mixture of substrate (1.0 mmol) and $Cu(AcO)_2$ (0.01 mmol, 1.8 mg) in EG (2 mL) was stirred at 75 °C under ambient air for 12 h. Hydrochloric acid (4 mL, 2%) and MTBE (4 mL) were added to the reaction mixture successively. The MTBE phase was separated, and the aqueous phase was further extracted with MTBE (4 mL × 2). The combined organic layers were dried over anhydrous sodium sulfate and concentrated in vacuo to give a residue, which was purified by column chromatography on silica gel (eluents: petroleum ether/ethyl acetate 5:1) to provide the corresponding products.

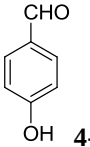


Recovery of the starting material: 20.5 mg (19%).

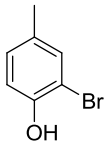


4

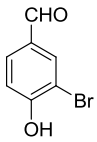
5,5'-Dimethylbiphenyl-2,2'-diol (4): white solid, 79.3 mg (37% yield), m.p. 148–150 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 7.11 (dd, J = 8.0, 1.6 Hz, 2H), 7.06 (d, J = 1.6 Hz, 2H), 6.92 (d, J = 8.0 Hz, 2H), 5.43 (br s, 2H), 2.32 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 150.6 (2C), 131.6 (2C), 130.8 (2C), 130.3 (2C), 123.7 (2C), 116.5 (2C), 20.5 (2C); HRMS (EI): *m/z* [M^+] calcd. for $C_{14}H_{14}O_2$ 214.0994, found 214.0992.



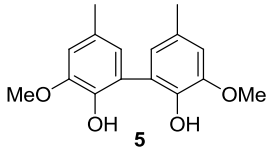
4-Hydroxybenzaldehyde: yellow solid, 11.0 mg (9% yield), m.p. 116–118 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.87 (br s, 1H), 7.83 (d, J = 8.8 Hz, 2H), 7.98 (d, J = 8.8 Hz, 2H), 6.29 (br s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 191.2, 161.5, 132.5 (2C), 129.9, 116.0 (2C); HRMS (EI): *m/z* [M^+] calcd. for $C_7H_6O_2$ 122.0368, found 122.0367.



Recovery of the starting material: 78.6 mg (42%).



3-Bromo-4-hydroxybenzaldehyde: white solid, 14.1 mg (7% yield), m.p. 130–132 °C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 9.83 (br s, 1H), 8.04 (s, 1H), 7.77 (d, J = 8.4 Hz, 1H), 7.15 (d, J = 8.0 Hz, 1H), 6.43 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 192.7, 151.8, 132.9, 130.3, 128.1, 127.5, 127.4; HRMS (ESI): m/z [M-H$^+$] calcd. for $C_7H_4BrO_2$ 198.9395, found 198.9359.

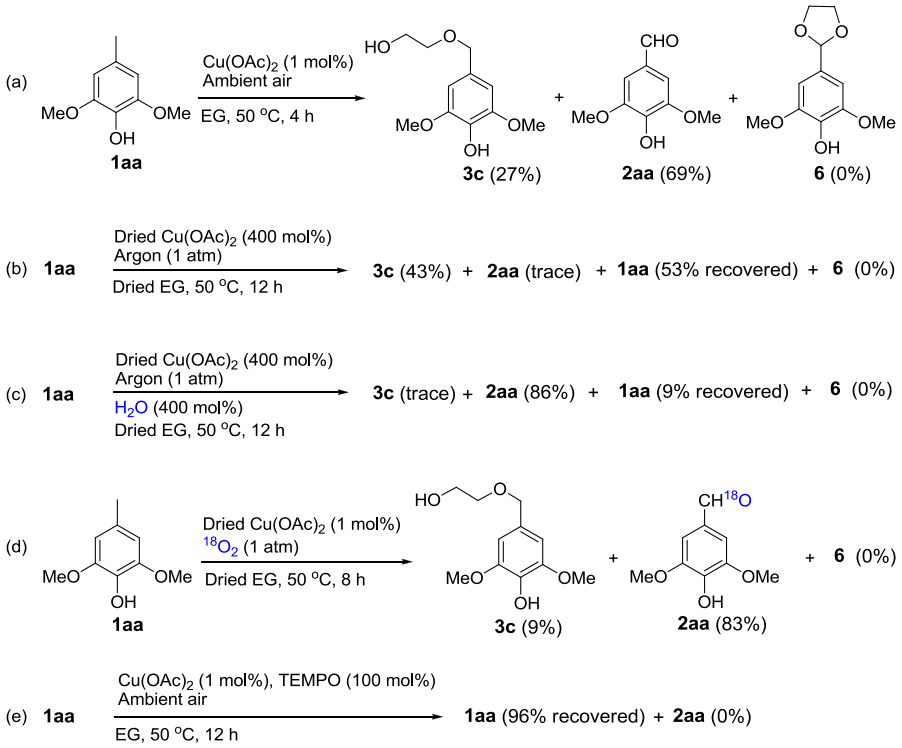


5

3,3'-Dimethoxy-5,5'-dimethylbiphenyl-2,2'-diol (5):[7] brown solid, 133.0 mg (97% yield), m.p. 132–134 °C (lit[7] m.p. 133–135 °C); ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 6.73 (s, 2H), 6.72 (s, 2H), 5.96 (br s, 2H), 3.91 (s, 6H), 2.33 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 147.1 (2C), 140.3 (2C), 129.6 (2C), 124.4 (2C), 123.4 (2C), 111.3 (2C), 56.0 (2C), 21.2 (2C); HRMS (ESI): m/z [M+H$^+$] calcd. for $C_{16}H_{19}O_4$ 275.1283, found 275.1283.

Procedure for Scheme 5(*B*): a mixture of corresponding substrate (1.0 mmol) and $Cu(AcO)_2$ (0.01 mmol, 1.8 mg) in EG (2 mL) was stirred at 95 °C under ambient air. No reaction occurred after 12 h monitored by TLC.

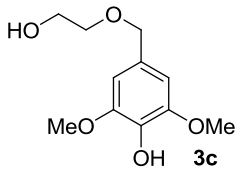
2.5 Mechanistic studies (Scheme 6 in the text).



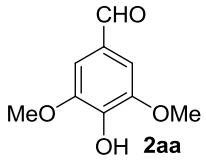
Scheme 6. Mechanistic studies.

Procedure for Scheme 6(a): a mixture of substrate **1aa** (1.0 mmol, 168.2 mg) and $Cu(AcO)_2$ (0.01 mmol, 1.8 mg) in EG (2 mL) was stirred at 50 °C under ambient air for 4 h. Hydrochloric acid (5.0 mL, 2%) and MTBE (4 mL) were added to the reaction mixture successively. The MTBE phase was separated, and the aqueous phase was further extracted with MTBE (4 mL × 2). The combined organic layers were dried over anhydrous

sodium sulfate and concentrated in vacuo to give a residue, which was purified by column chromatography on silica gel (eluents: petroleum ether/ethyl acetate 5:1) to provide intermediate **3c** and product **2aa**.

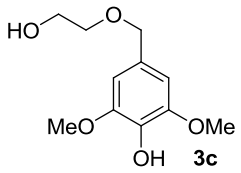


3c **4-((2-Hydroxyethoxy)methyl)-2,6-dimethoxyphenol (3c)**: yellow solid, 61.6 mg (27% yield), m.p. 78–80 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ 6.58 (s, 2H), 5.52 (br s, 1H), 4.48 (s, 2H), 3.90 (s, 6H), 3.77 (t, J = 4.4 Hz, 2H), 3.60 (t, J = 4.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ 147.0 (2C), 134.3, 128.9, 104.7 (2C), 73.7, 71.2, 61.9, 56.3 (2C); HRMS (ESI): m/z [M+Na^{+}] calcd. for $C_{11}H_{16}O_5Na$ 251.0895, found 251.0894.



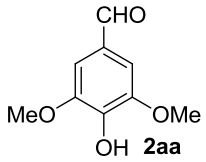
2aa **3,5-Dimethoxy4-hydroxybenzaldehyde (2aa)**:[1] yellow solid, 125.7 mg (69% yield). The spectral data see 2.1 section.

Procedure for Scheme 6(b): a mixture of substrate **1aa** (1.0 mmol) and dried $Cu(AcO)_2$ (dried in a vacuum oven at 60 ^{o}C for 10 h, 4.0 mmol, 726.5 mg) in dried EG (15 mL, dried over 4 A molecular sieve for 24 h) was stirred at 50 ^{o}C under argon atmosphere for 12 h. Hydrochloric acid (10 mL, 1%) and MTBE (10 mL) were added to the reaction mixture successively. The MTBE phase was separated, and the aqueous phase was further extracted with MTBE (10 mL × 2). The combined organic layers were dried over anhydrous sodium sulfate and concentrated in vacuo to give a residue, which was purified by column chromatography on silica gel (eluents: petroleum ether/ethyl acetate 5:1) to provide intermediate **3c** and the desired **2aa**.



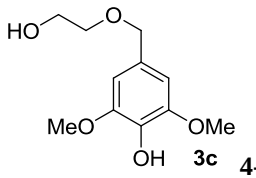
3c **4-((2-Hydroxyethoxy)methyl)-2,6-dimethoxyphenol (3c)**: yellow solid, 98.1 mg (43% yield). The spectral data see 2.5 section.

Procedure for Scheme 6(c): a mixture of substrate **1aa** (1.0 mmol) and dried $Cu(AcO)_2$ (4.0 mmol, 726.5 mg, dried in a vacuum oven at 60 ^{o}C for 10 h) and H_2O (4.0 mmol, 72 mg) in dried EG (15 mL, dried over 4 A molecular sieve for 24 h,) was stirred at 50 ^{o}C under argon atmosphere for 12 h. Hydrochloric acid (10 mL, 1%) and MTBE (10 mL) were added to the reaction mixture successively. The MTBE phase was separated, and the aqueous phase was further extracted with MTBE (10 mL × 2). The combined organic layers were dried over anhydrous sodium sulfate and concentrated in vacuo to give a residue, which was purified by column chromatography on silica gel (eluents: petroleum ether/ethyl acetate 5:1) to provide intermediate **3c** and the desired **2aa**.

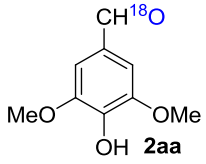


2aa **3,5-Dimethoxy4-hydroxybenzaldehyde (2aa)**:[1] yellow solid, 154.8 mg (85% yield). The spectral data see 2.1 section.

Procedure for Scheme 6(d): a mixture of substrate **1aa** (1.0 mmol, 168.2 mg) and dried $Cu(AcO)_2$ (0.01 mmol, 1.8 mg, dried in a vacuum oven at 60 ^{o}C for 10 h) in dried EG (2 mL, dried over 4 A molecular sieve for 24 h) was stirred at 50 ^{o}C under $^{18}O_2$ for 8 h. Hydrochloric acid (4 mL, 2%) and MTBE (4 mL) were added to the reaction mixture successively. The MTBE phase was separated, and the aqueous phase was further extracted with MTBE (4 mL × 2). The combined organic layers were dried over anhydrous sodium sulfate and concentrated in vacuo to give a residue, which was purified by column chromatography on silica gel (eluents: petroleum ether/ethyl acetate 5:1).

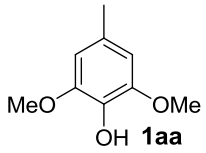


4-((2-Hydroxyethoxy)methyl)-2,6-dimethoxyphenol (3c): yellow solid, 20.5 mg (9% yield). HRMS (EI): *m/z* [M^+] calcd. for $C_{11}H_{16}O_5$ 228.0998, found 228.0997 (herein HRMS determined again for the mechanistic studies). Other spectral data see 2.5 section.



3,5-Dimethoxy-4-hydroxybenzaldehyde (2aa):[1] yellow solid, 152.9 mg (83% yield), HRMS (EI): *m/z* [M^+] calcd. for $C_9H_{10}{}^{16}O_3{}^{18}O$ 184.0622, found 184.0623. Other spectral data see 2.1 section.

Procedure for Scheme 6(e): a mixture of substrate **1aa** (1.0 mmol, 168.2 mg), $Cu(AcO)_2$ (0.01 mmol, 1.8 mg) and TEMPO (1.0 mmol, 156.3 mg) in EG (2 mL) was stirred at 50 ^oC under ambient air for 4 h. Hydrochloric acid (4 mL, 2%) and MTBE (4 mL) were added to the reaction mixture successively. The MTBE phase was separated, and the aqueous phase was further extracted with MTBE (4 mL × 2). The combined organic layers were dried over anhydrous sodium sulfate and concentrated in vacuo to give a residue, which was purified by column chromatography on silica gel (eluents: petroleum ether/ethyl acetate 5:1) to recover **1aa**.

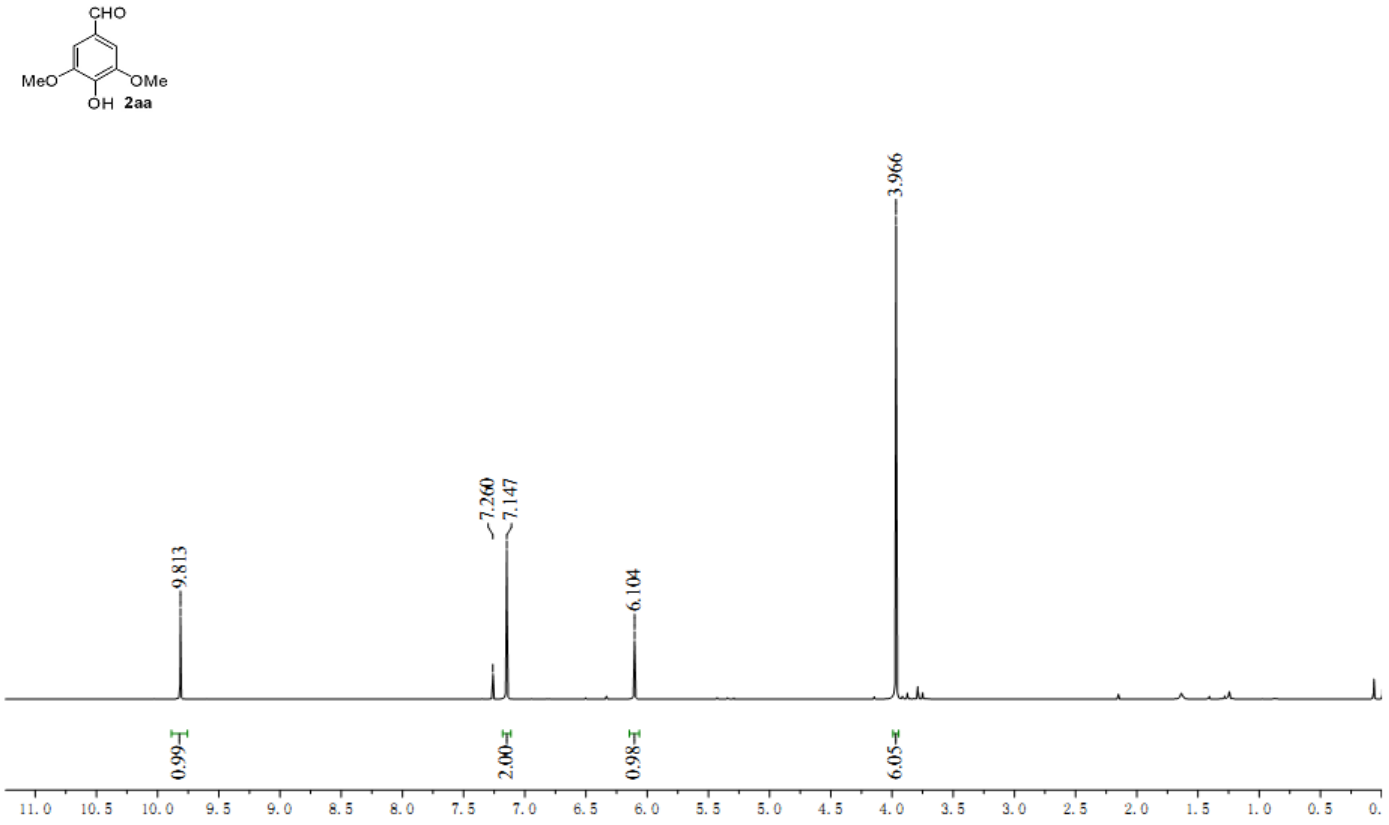


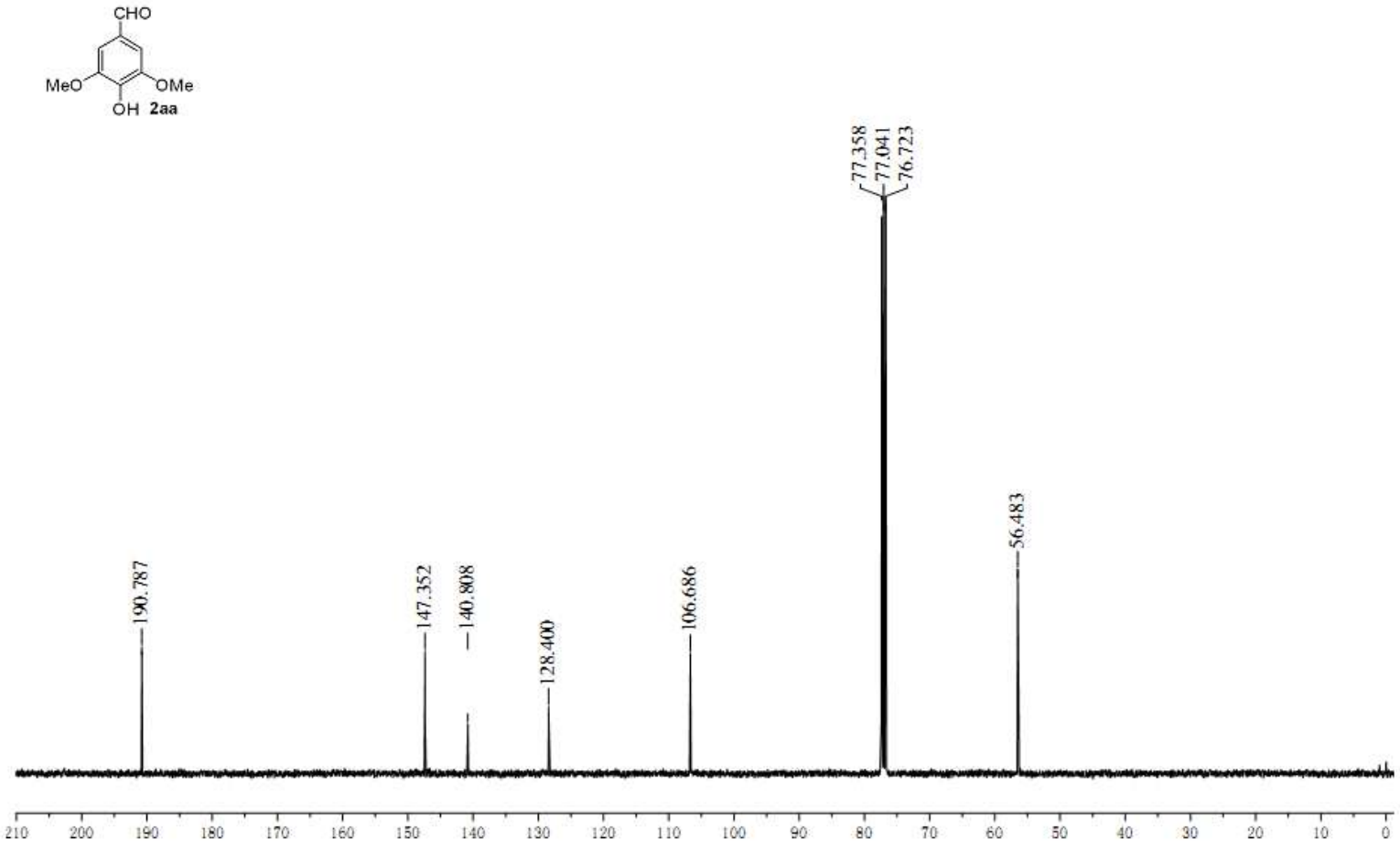
2,6-dimethoxy-4-methylphenol (1aa): recovery, 161.5 mg (96%).

3. References

[1] W. Baik, H. J. Lee, J. M. Jang, S. Koo and B. H. Kim, *J. Org. Chem*., 2000, **65**, 108.
[2] W. Li, H. Li, Y. Li and Z. Hou, *Angew. Chem. Int. Ed*., 2006, **45**, 7609 (see supporting information therein).
[3] S. L. Goldstein and E. McNelis, *J. Org. Chem*., 1984, **49**, 1613.
[4] H. Van der Goot, J. C. Eriks, P. J. Van Rhjin-Van der Schaar, O. P. Zuiderveld and W. T. Nauta, *Eur. J. Med. Chem.*, 1978, **13**, 425.
[5] J. M. Pepper and H. Hibbert, *J. Am. Chem. Soc*., 1948, **70**, 67.
[6] I. A. Pearl, *J. Org. Chem*., 1957, **22**, 1229.
[7] A. Alexakis, D. Polet, S. Rosset and S. March, *J. Org. Chem*., 2004, **69**, 5660.
[8] L. Kumar, T. Mahajan and D. D. Agarwal, *Green Chem*., 2011, **13**, 2187.

4. Copies of Spectra for All Compounds





Elemental Composition Report

Single Mass Analysis

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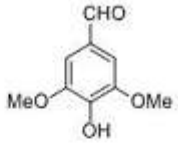
Element prediction: Off
Number of isotope peaks used for i-FIT = 2



Monoisotopic Mass, Even Electron Ions
15 formula(e) evaluated with 8 results within limits (up to 1 closest results for each mass)
Elements Used:
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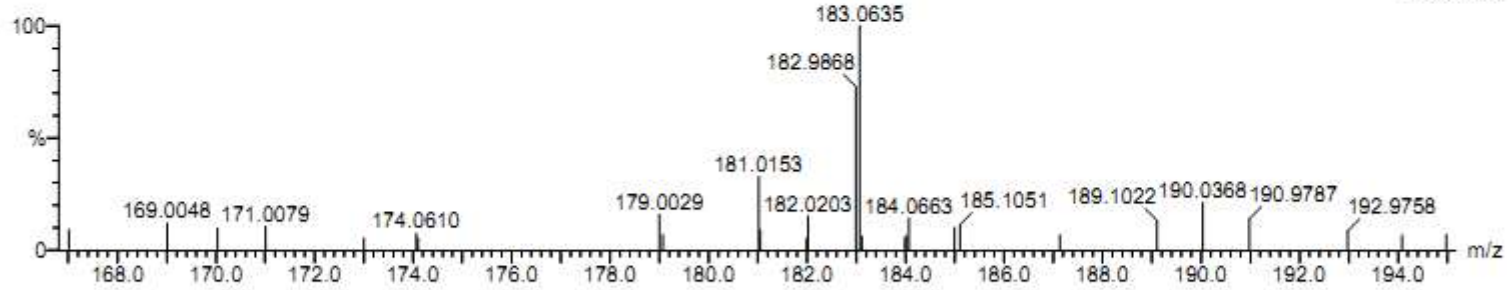
YF-JI ECUST institute of Fine Chem 02-Jan-2013 20:20:35

JYF-JA-01 1 (0.128) Cm (1:2) 1: TOF MS ES+ 5.38e+002



Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
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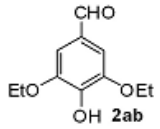
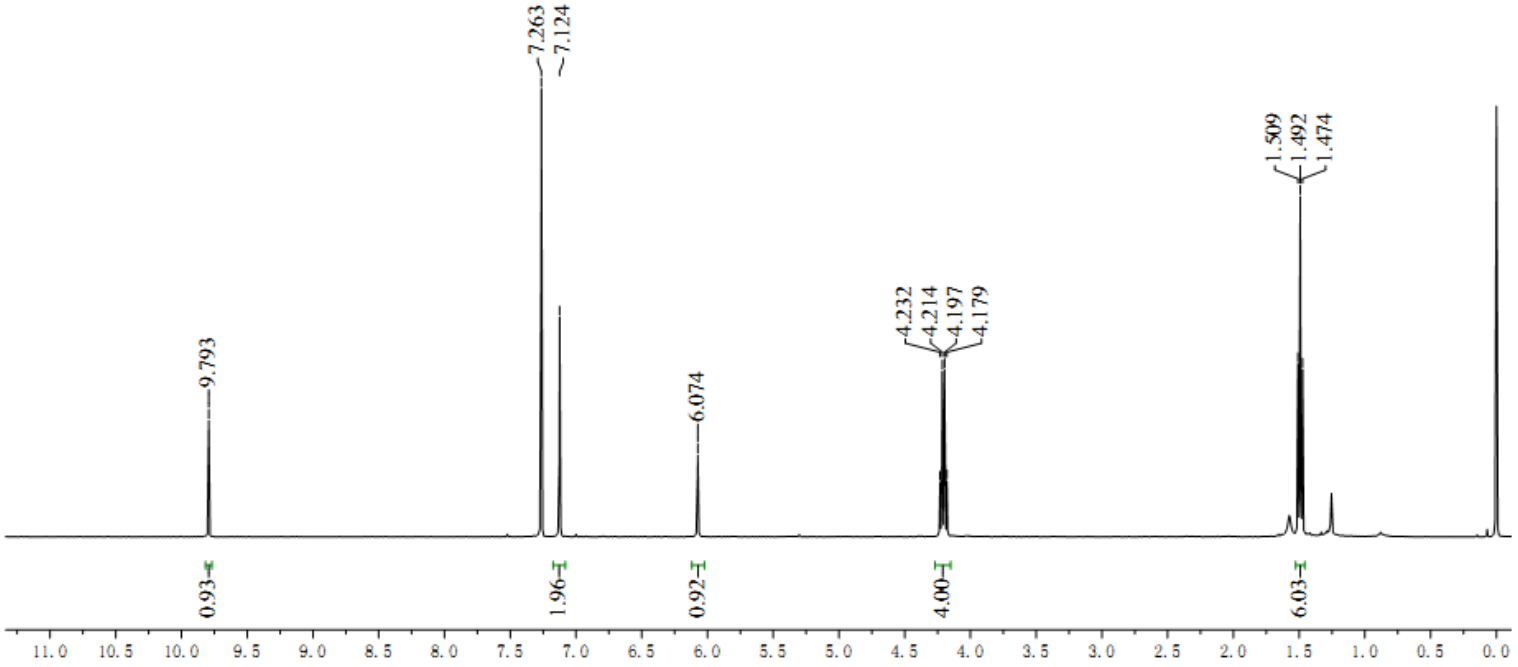
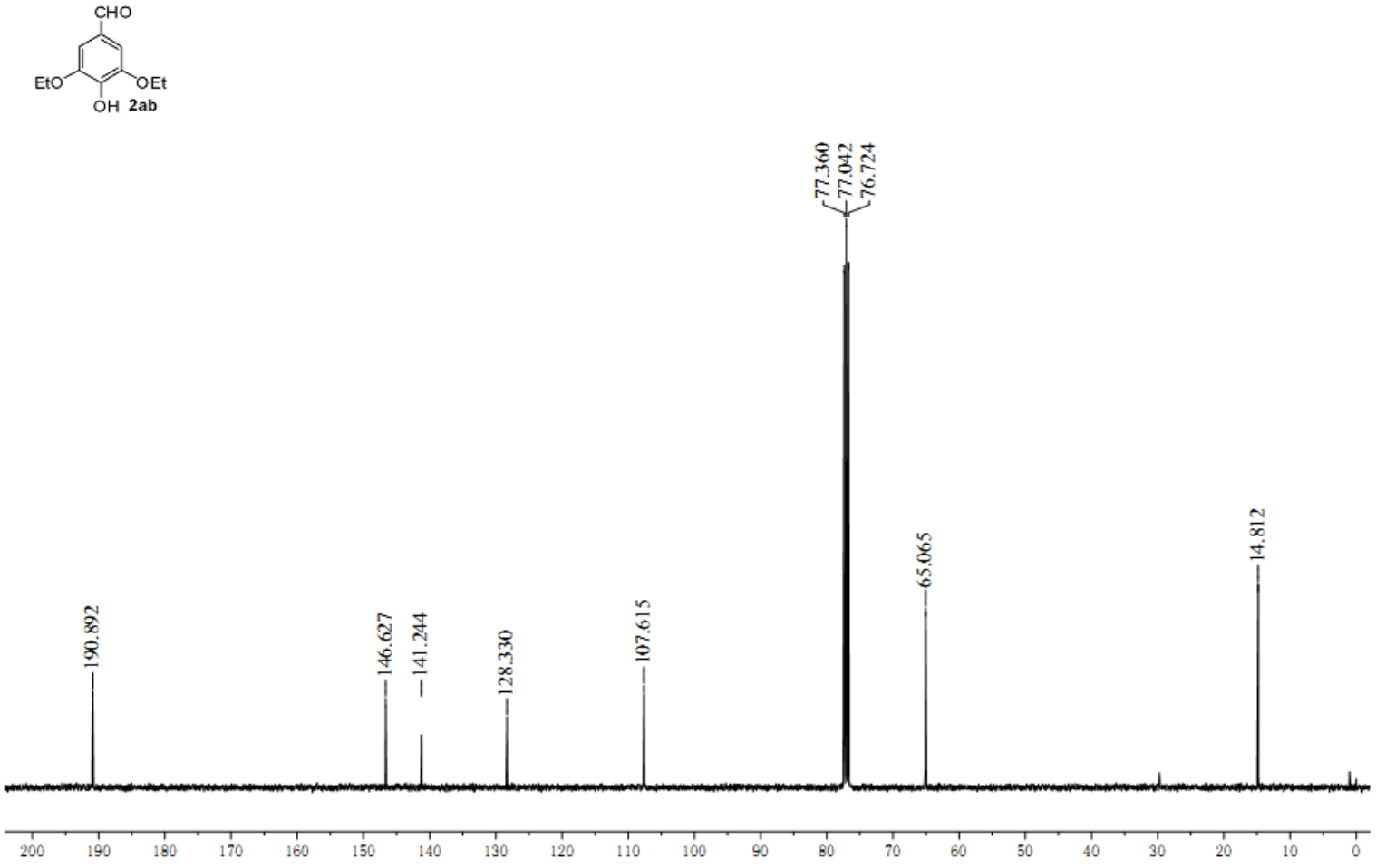


2ab





Elemental Composition Report

Single Mass Analysis

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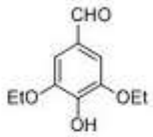
Element prediction: Off
Number of isotope peaks used for i-FIT = 2



Monoisotopic Mass, Even Electron Ions
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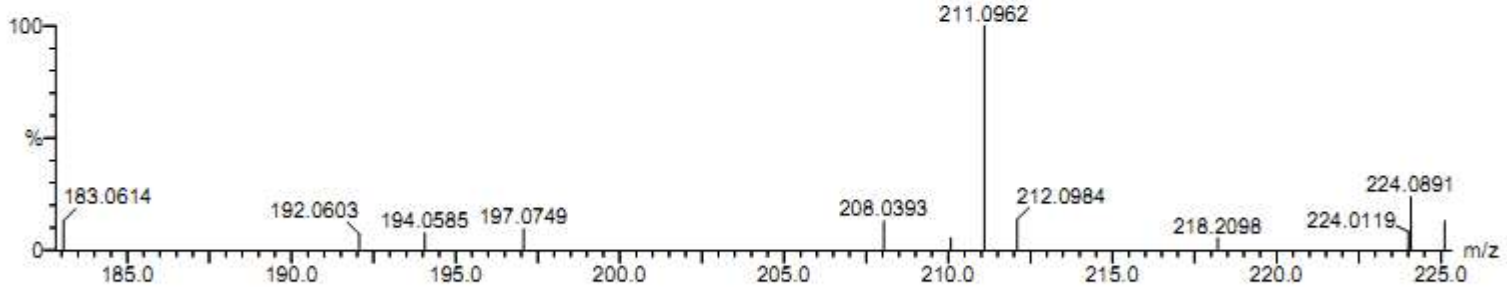

Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
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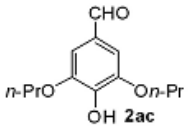

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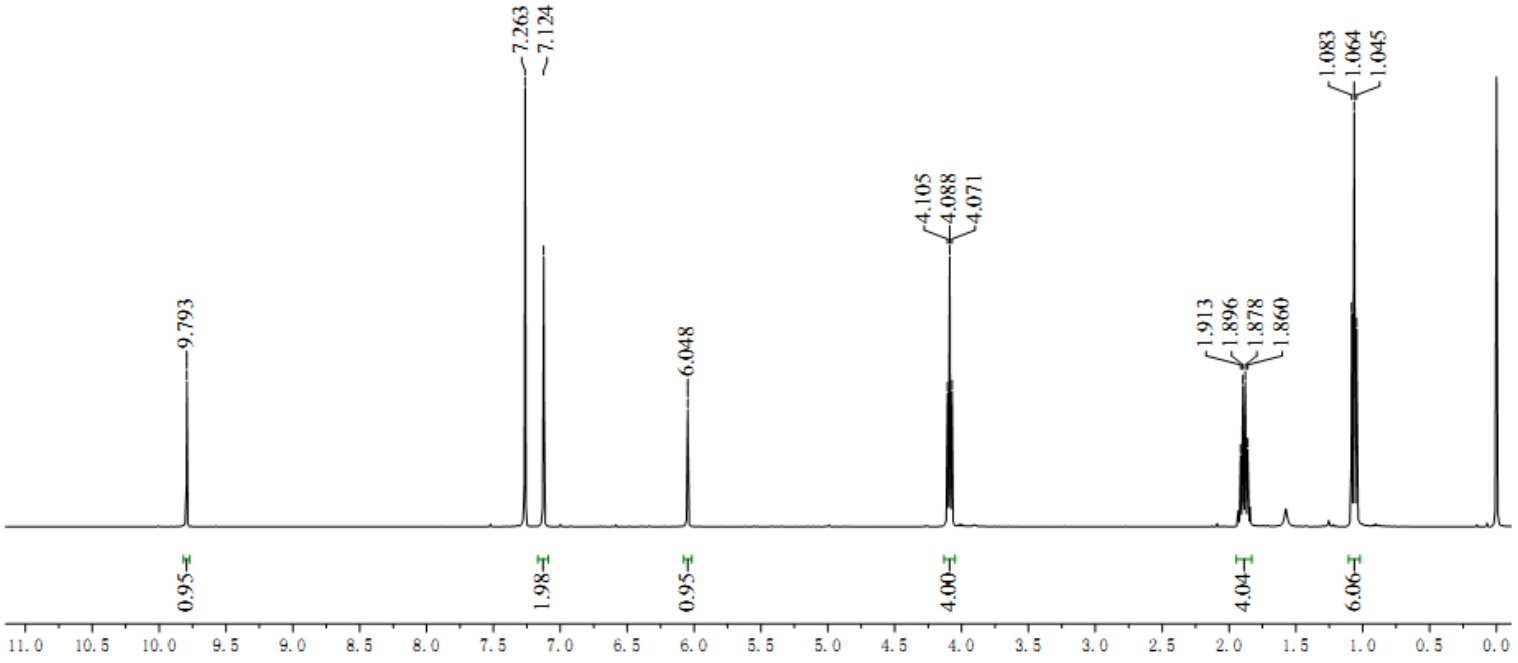
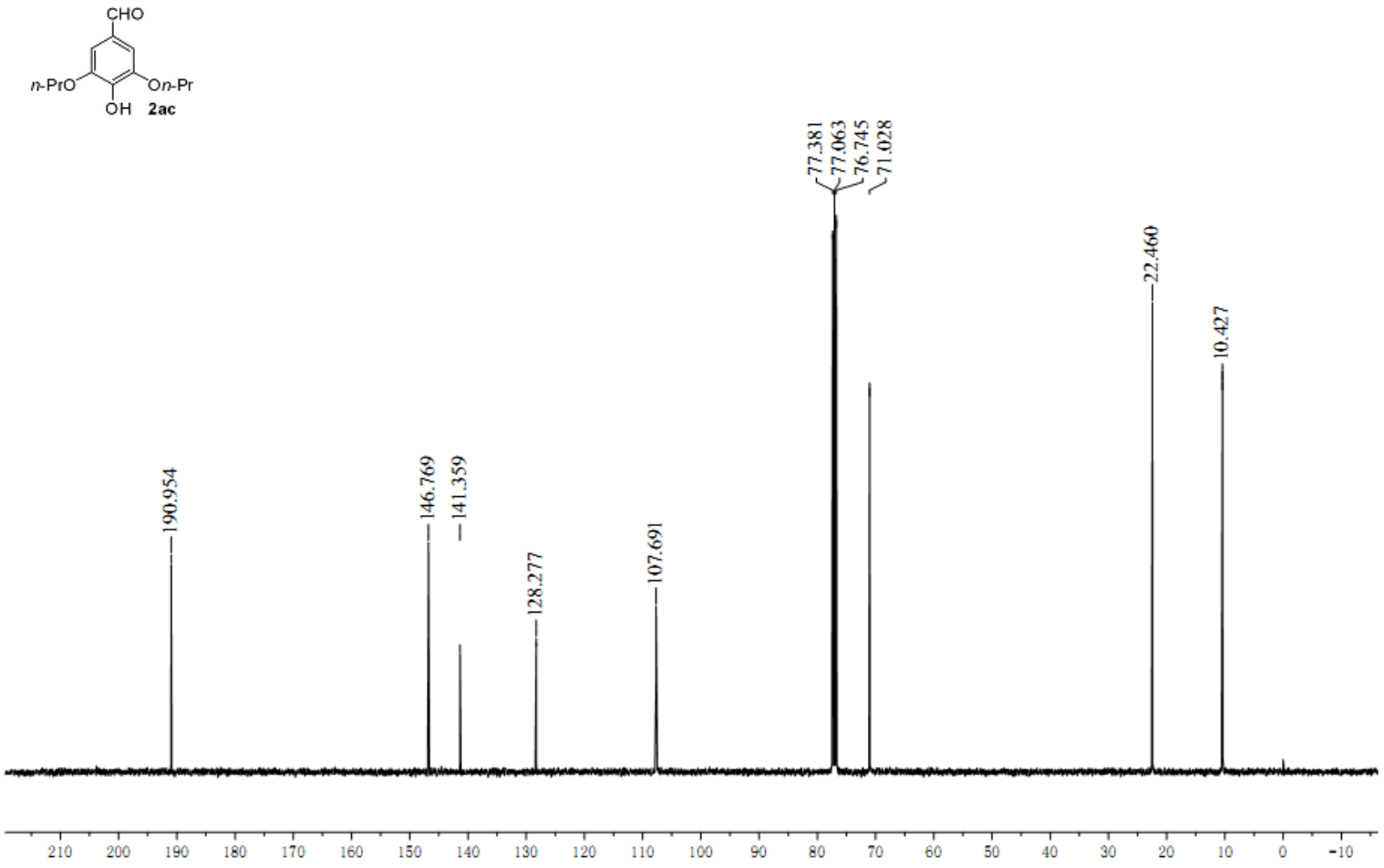
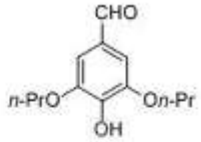




Elemental Composition Report



Single Mass Analysis

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Element prediction: Off
Number of isotope peaks used for i-FIT = 2

Monoisotopic Mass, Even Electron Ions
18 formula(e) evaluated with 10 results within limits (up to 1 closest results for each mass)
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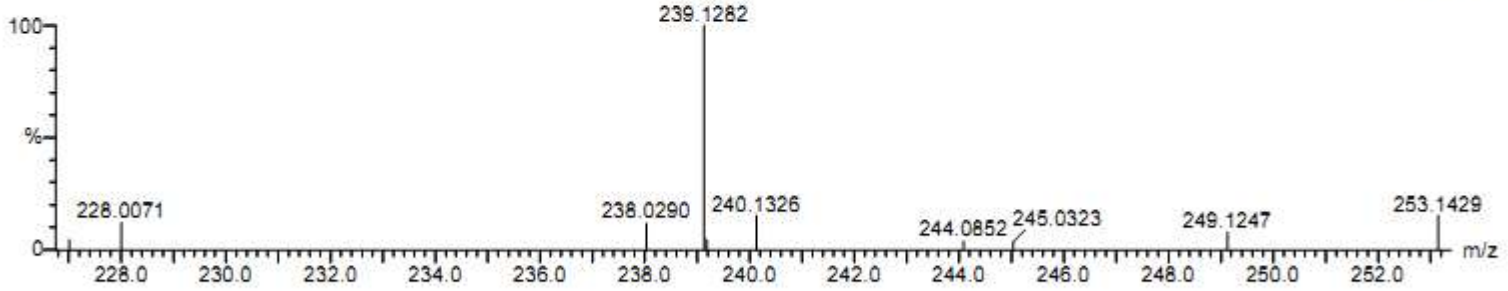

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Maximum:		100.0	50.0	100.0			
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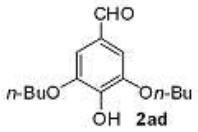
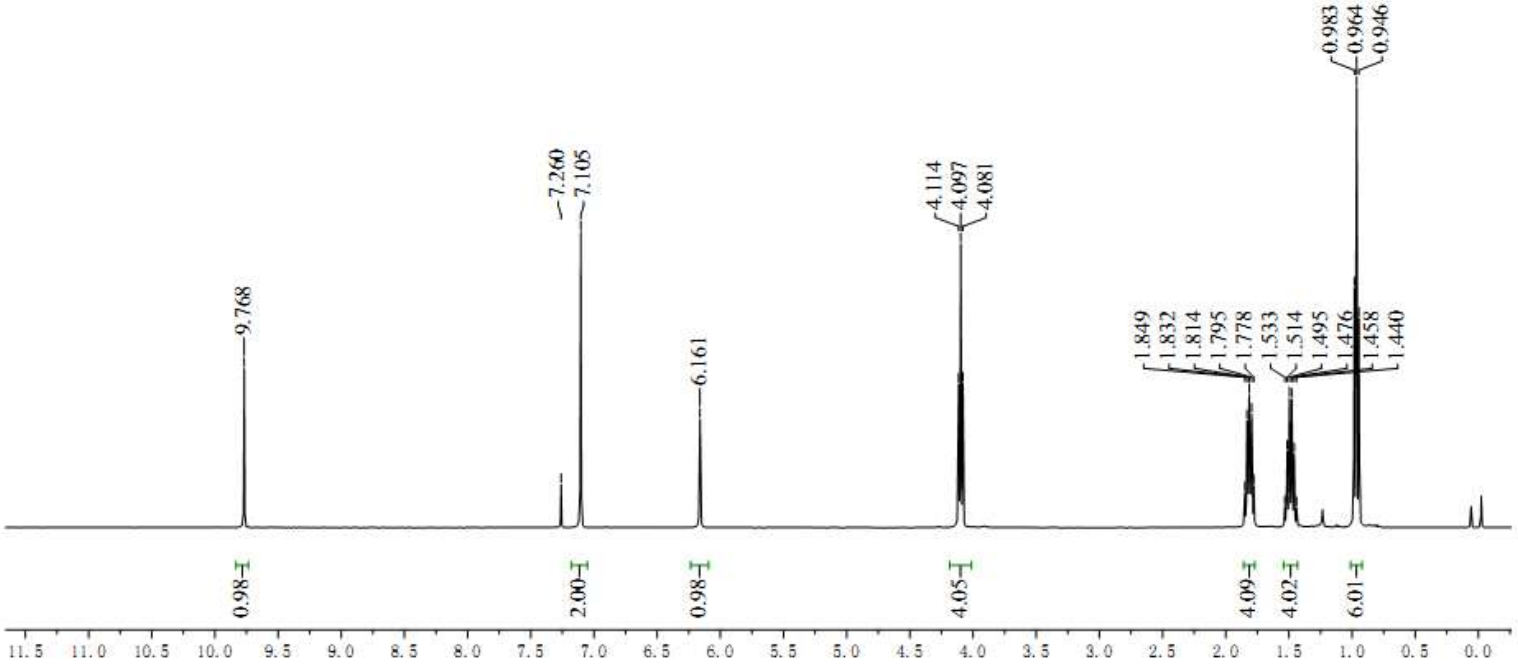
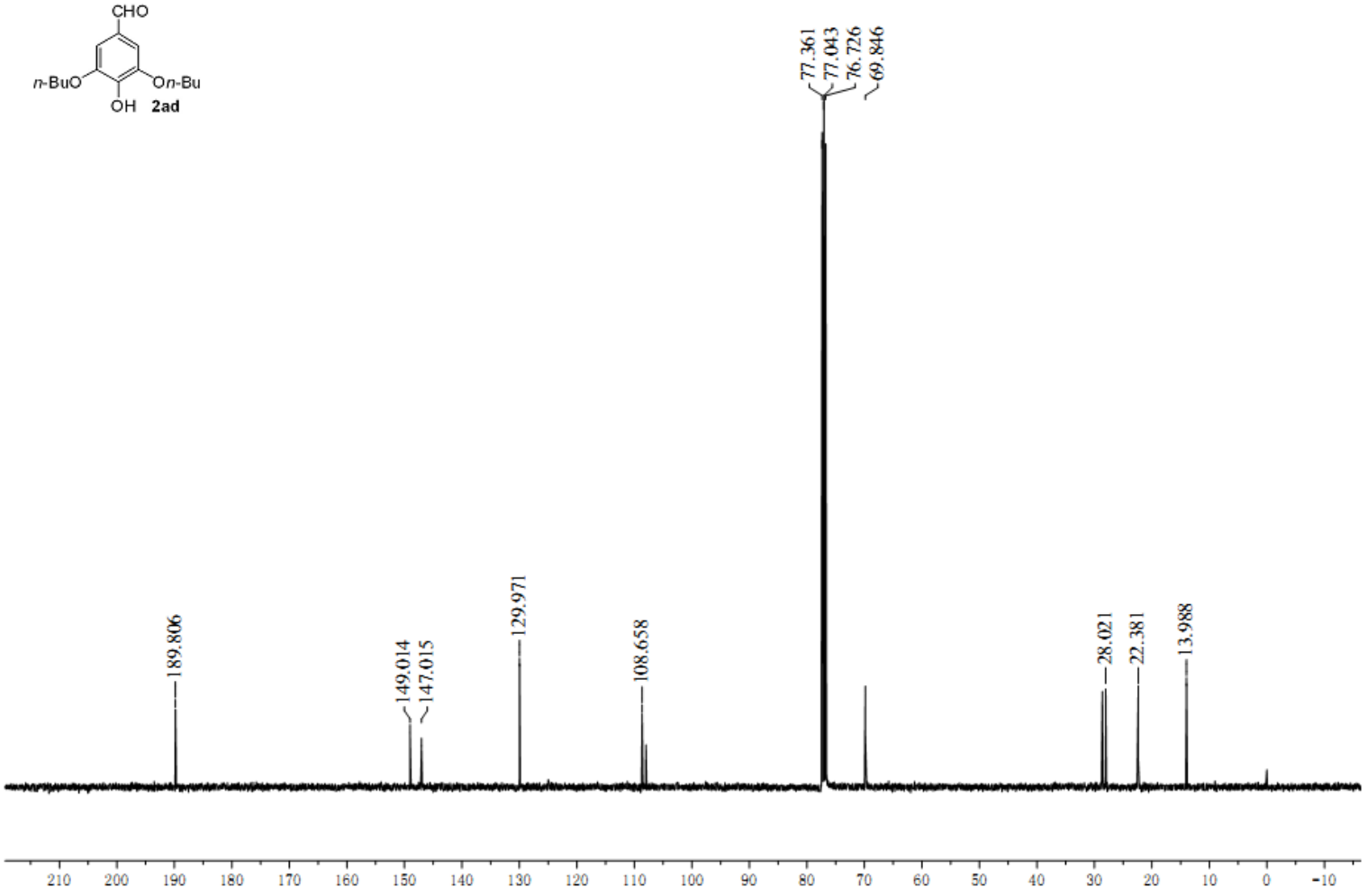


2ad





Elemental Composition Report

Single Mass Analysis

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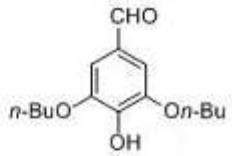

Monoisotopic Mass, Even Electron Ions
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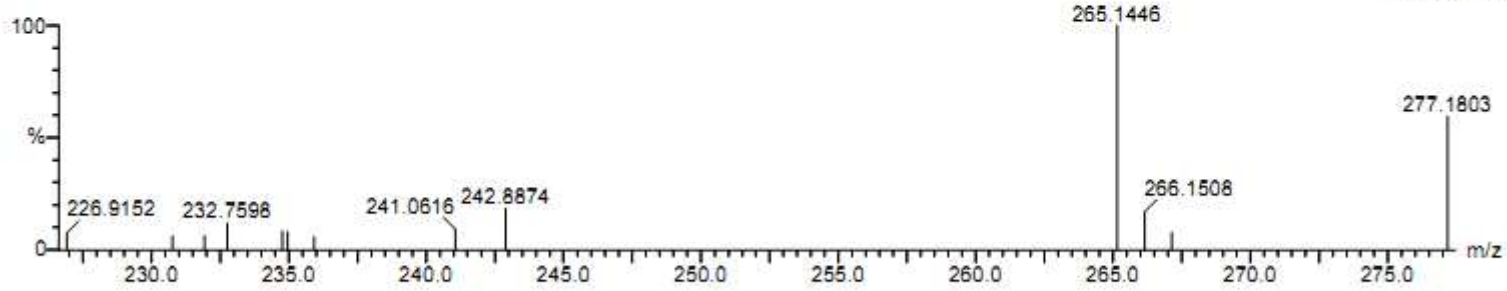

Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
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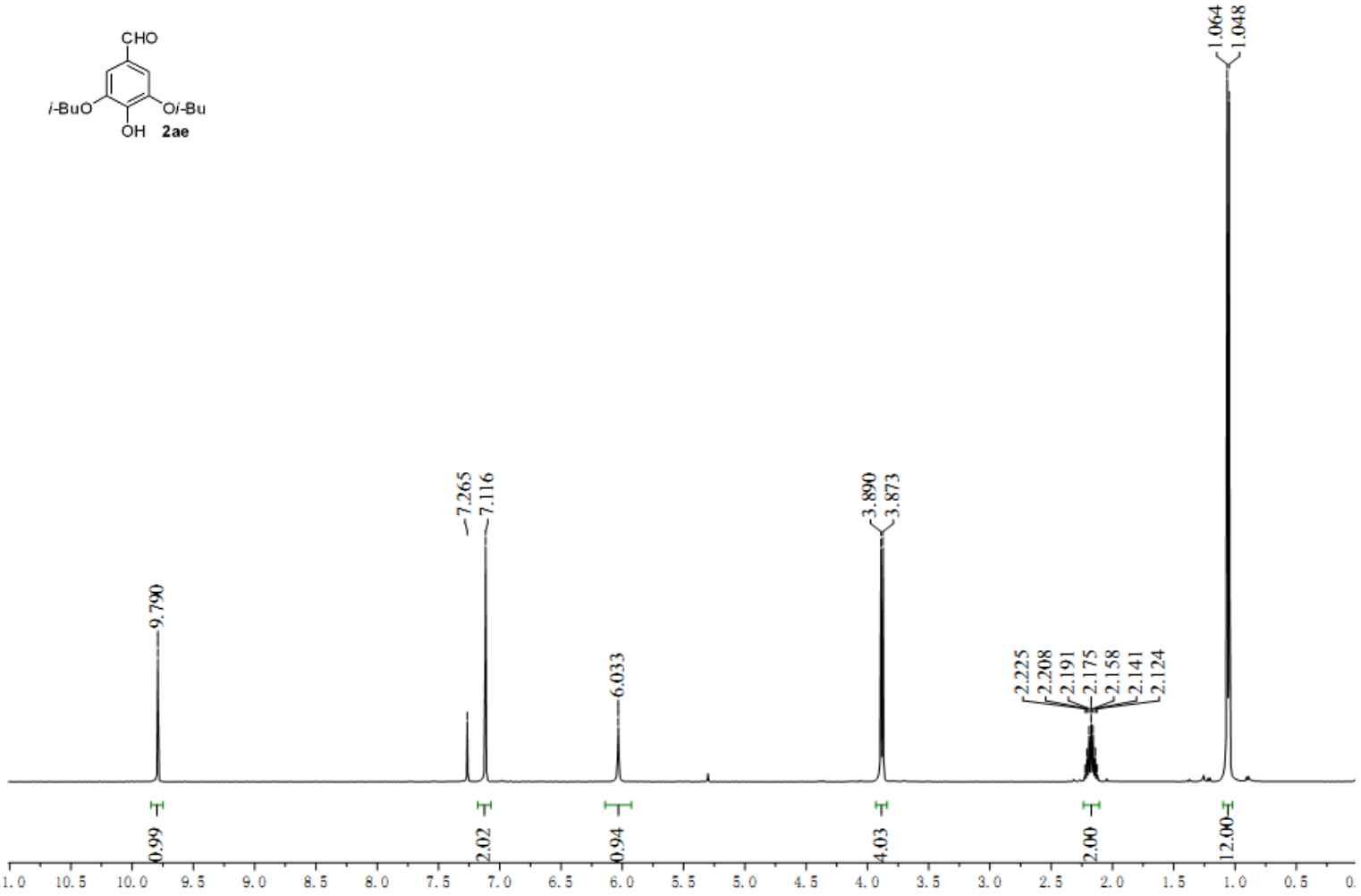

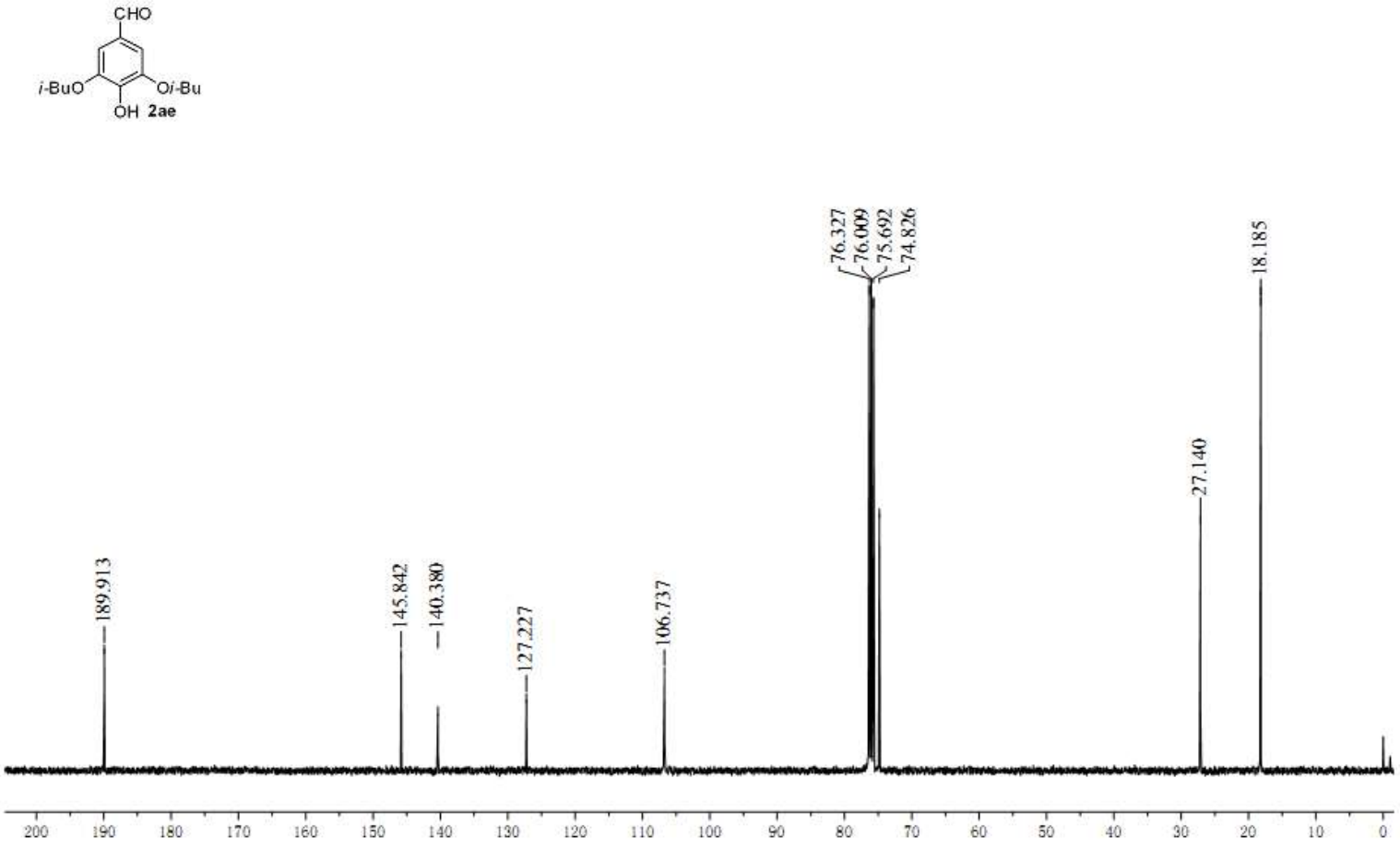

Elemental Composition Report

Single Mass Analysis

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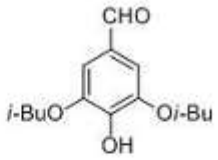
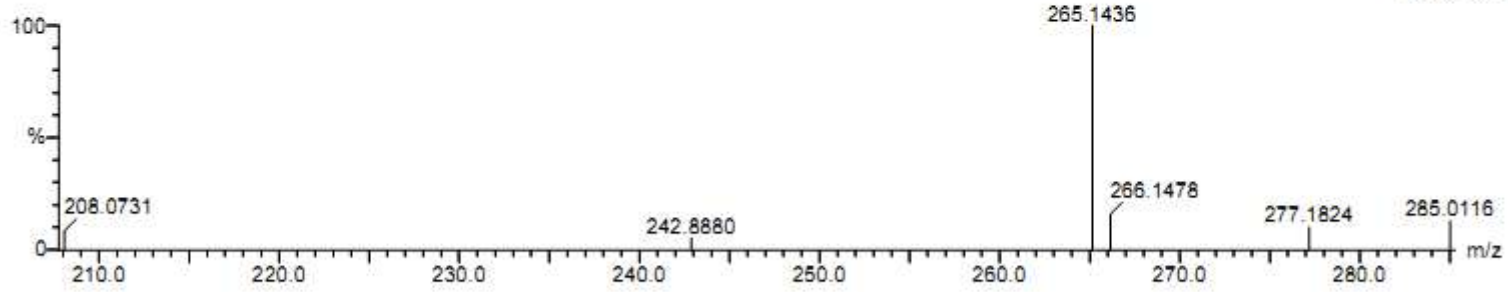


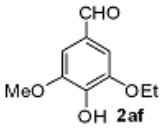
Monoisotopic Mass, Even Electron Ions
30 formula(e) evaluated with 17 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8

YF-JI ECUST institute of Fine Chem 02-Jan-2013 20:42:48

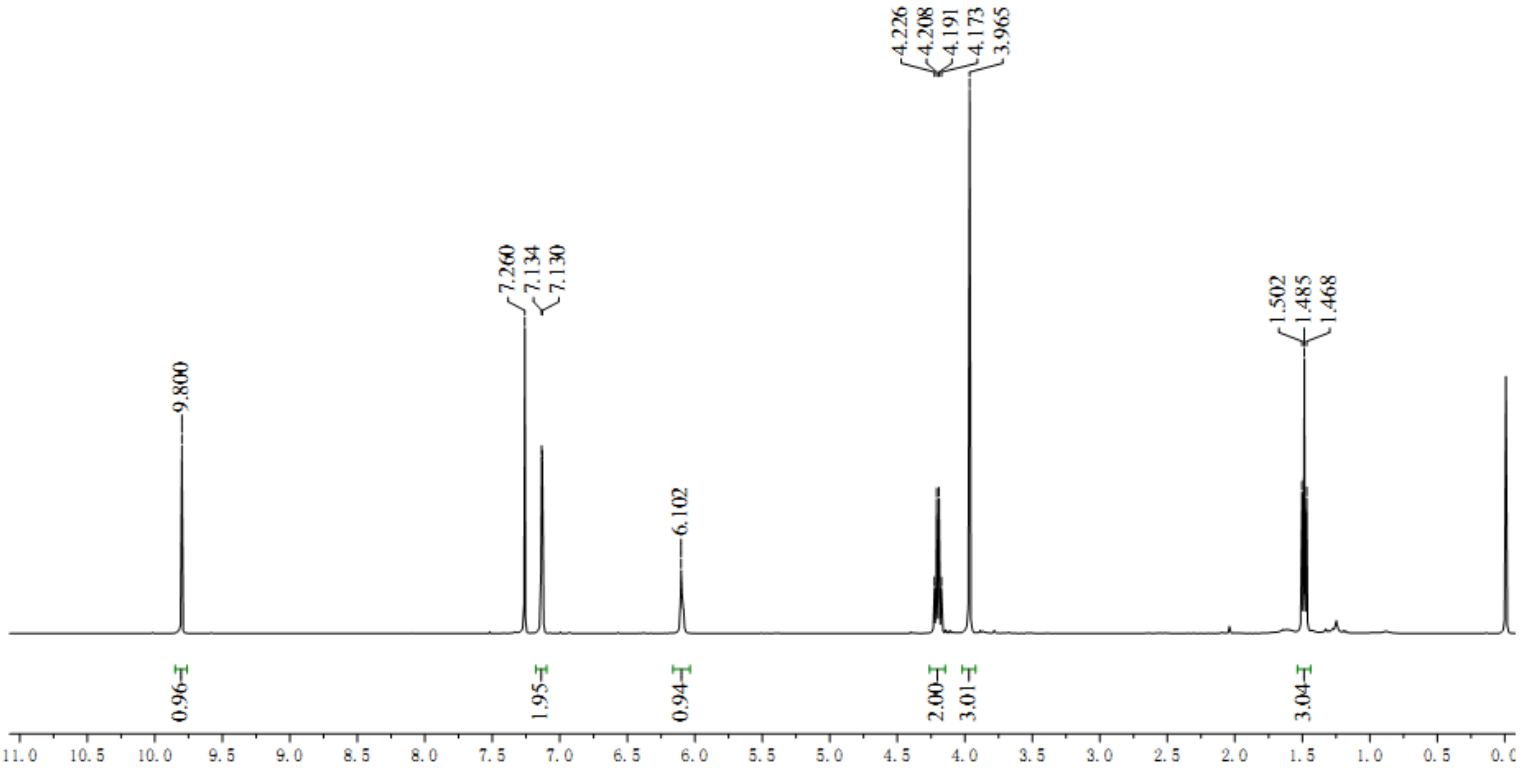
JYF-JA-05 9 (0.394) Cm (8:12) 2: TOF MS ES- 3.48e+003

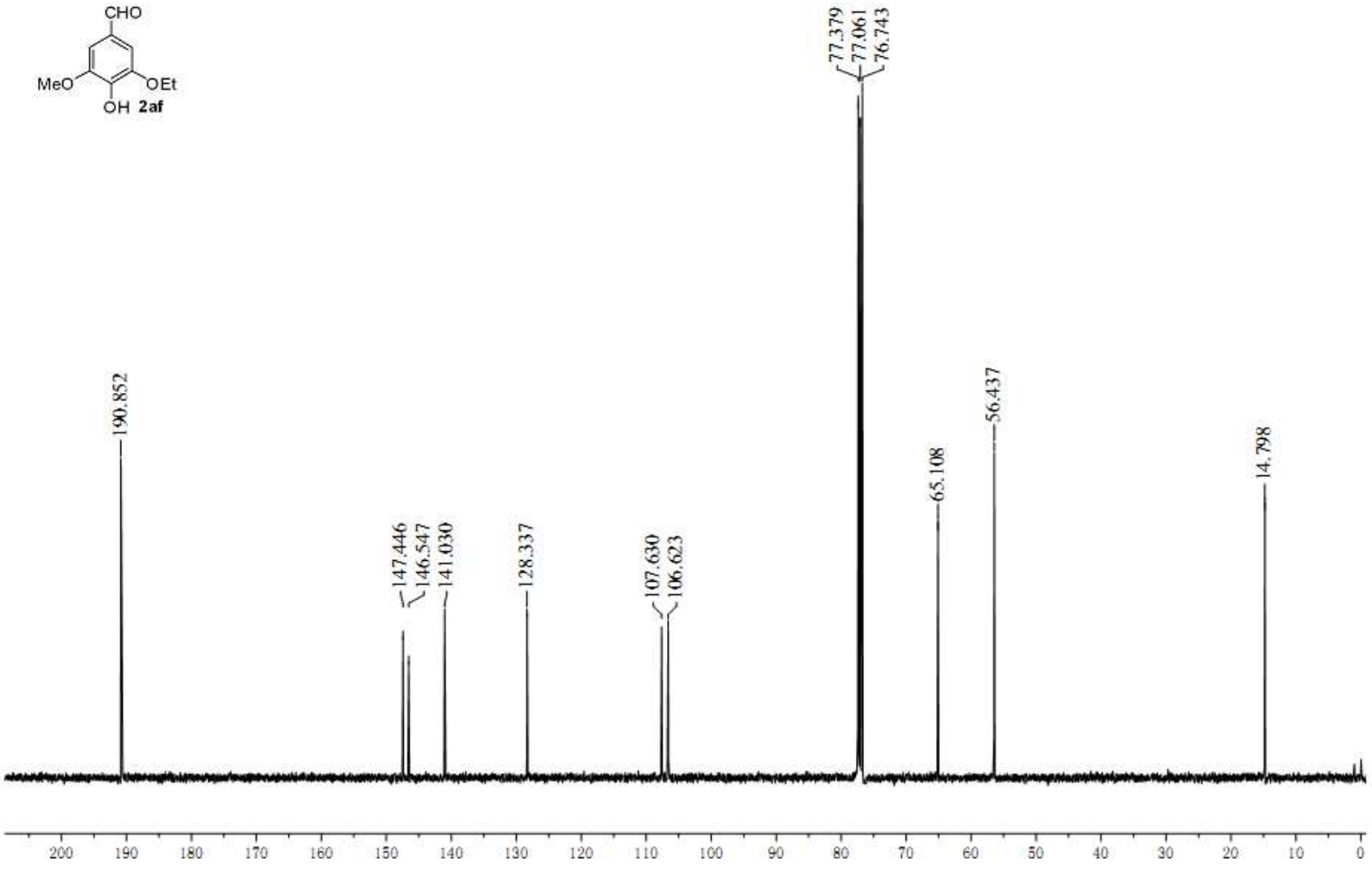


Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
265.1436	265.1440	-0.4	-1.5	5.5	7.5	0.0	C15 H21 O4

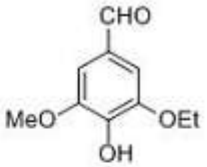


2af





Elemental Composition Report



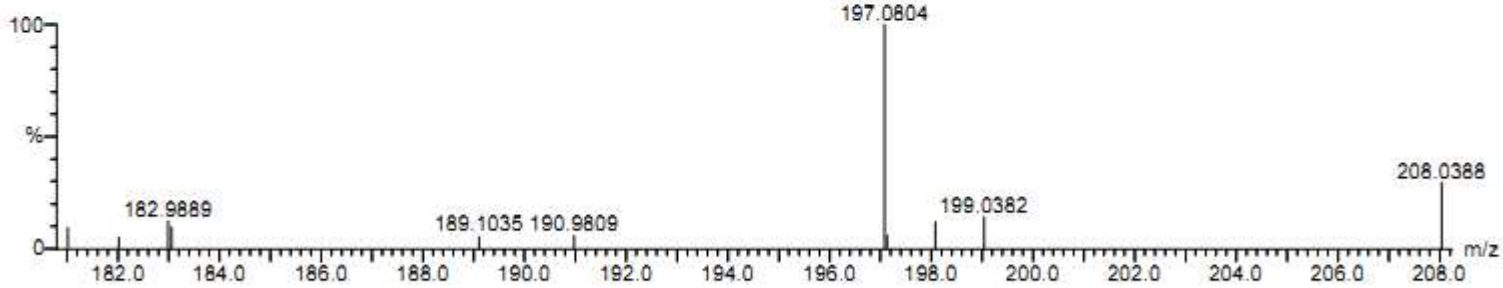
Single Mass Analysis

Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

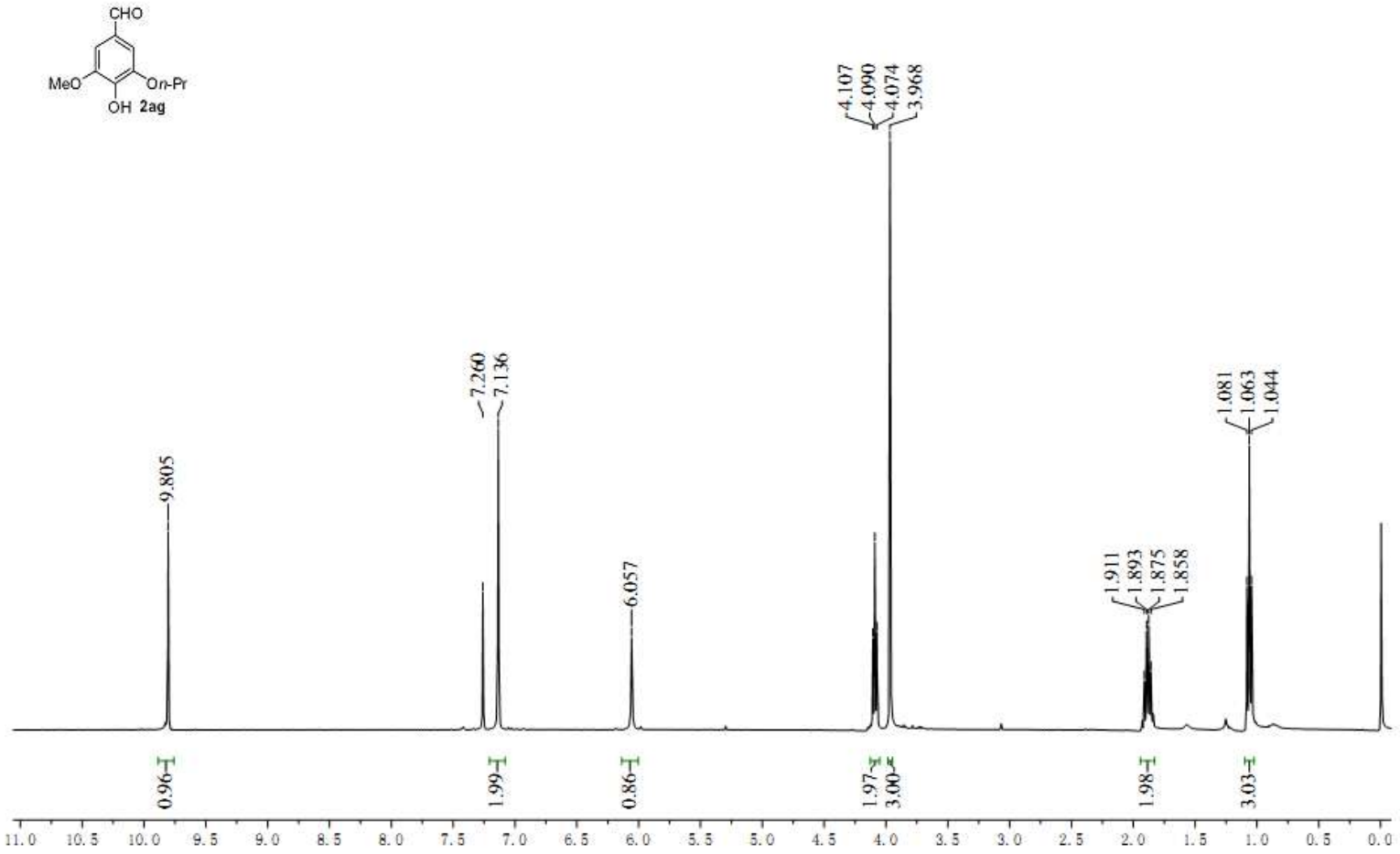
Monoisotopic Mass, Even Electron Ions
22 formula(e) evaluated with 16 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8

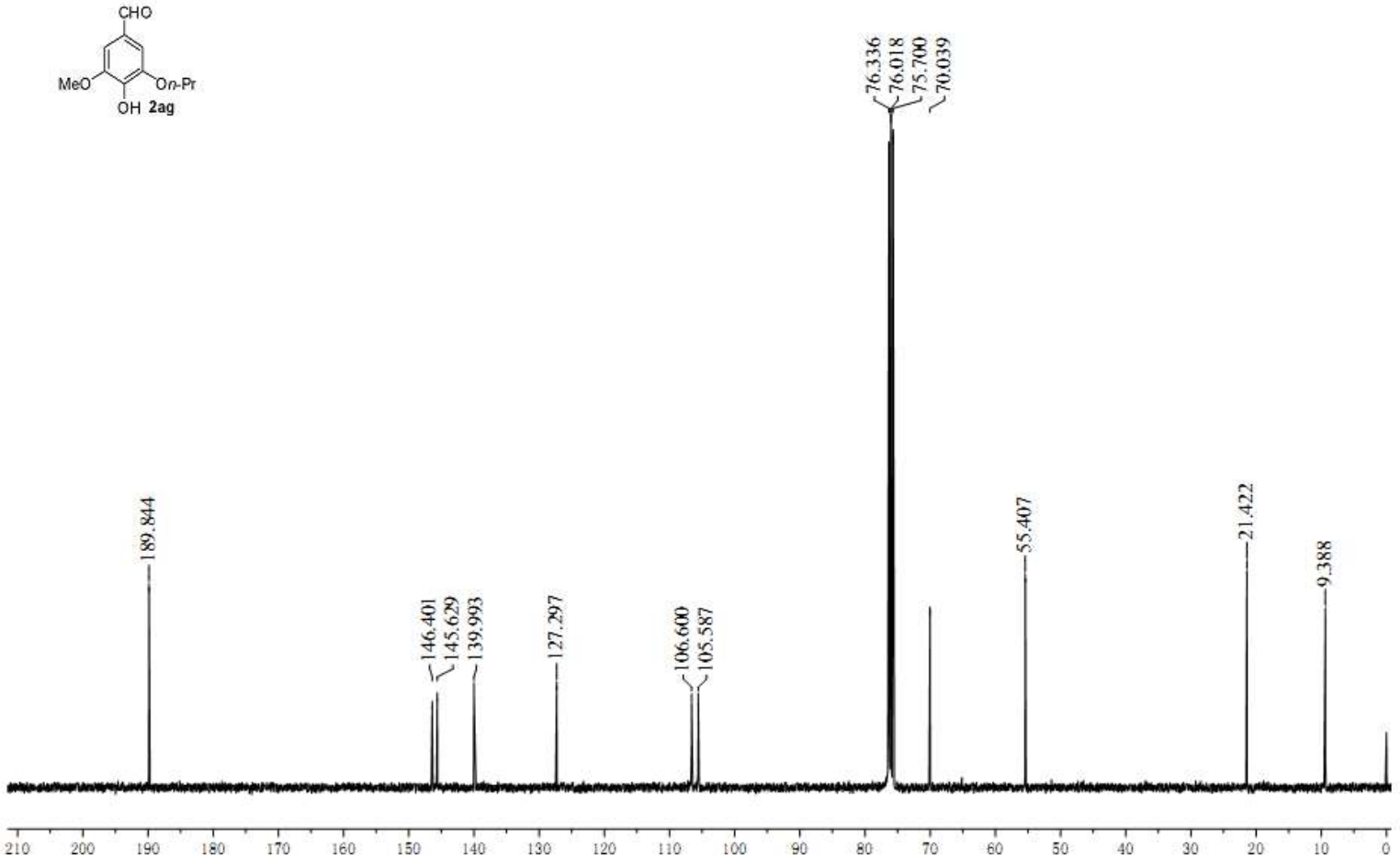
YF-JI ECUST institute of Fine Chem 02-Jan-2013 20:45:03

JYF-JA-06 6 (0.274) Cm (5:6) 1: TOF MS ES+ 1.40e+003



Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
197.0804	197.0814	-1.0	-5.1	4.5	14.0	0.0	C10 H13 O4

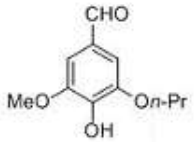




Elemental Composition Report

Single Mass Analysis

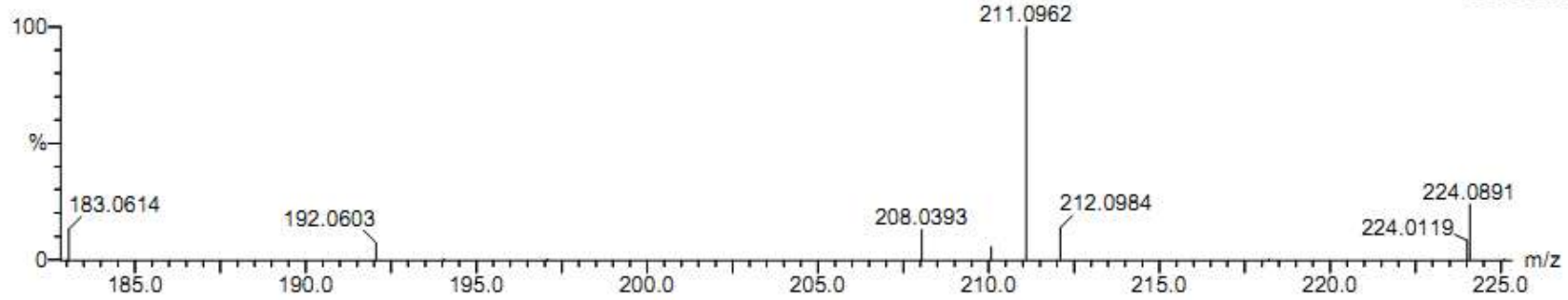
Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2



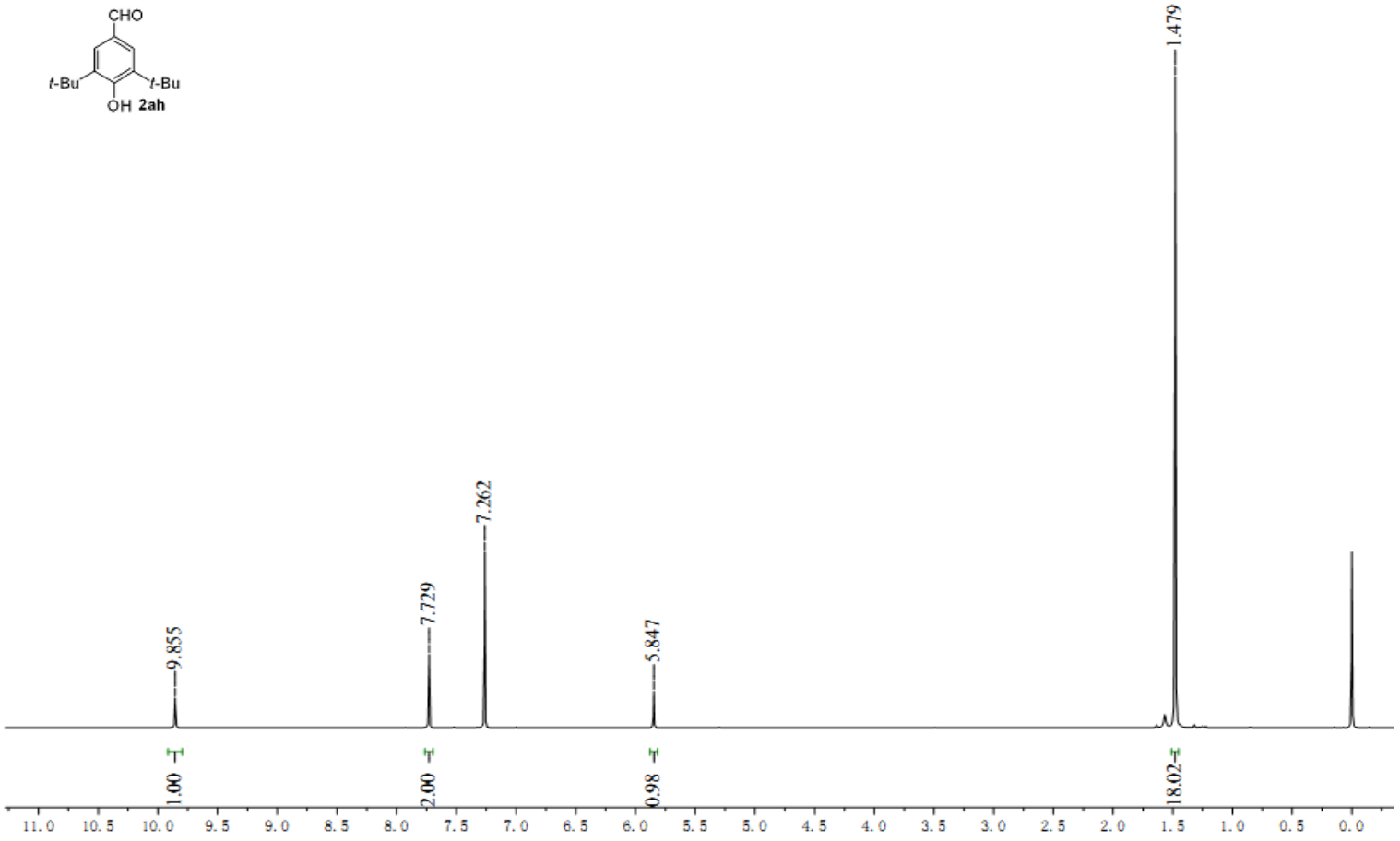
Monoisotopic Mass, Even Electron Ions
25 formula(e) evaluated with 16 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8

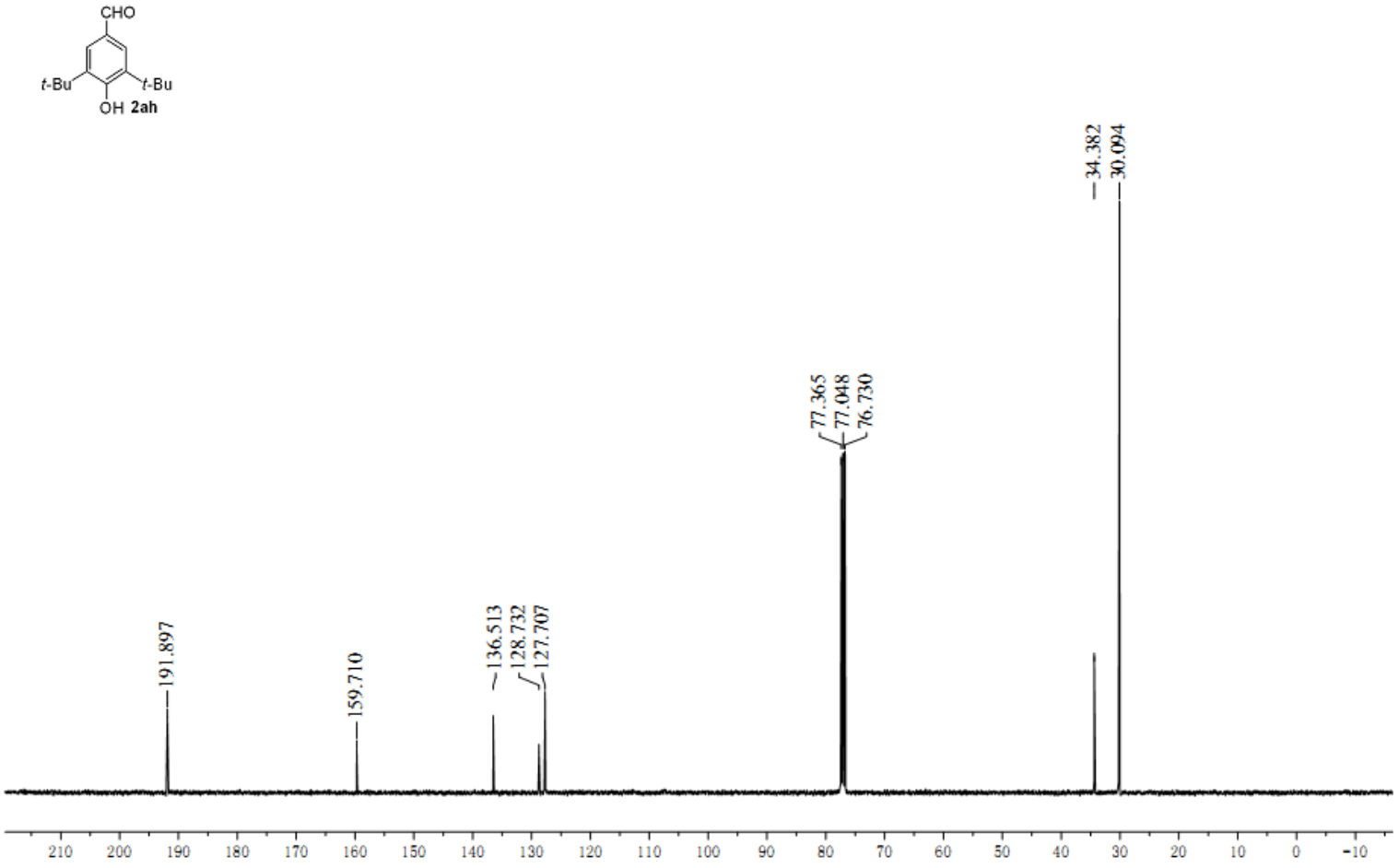
YF-JI ECUST institute of Fine Chem

JYF-JA-02 19 (0.668) Cm (19:20) 1: TOF MS ES+ 5.08e+002

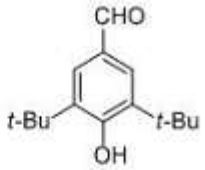


Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
211.0962	211.0970	-0.8	-3.8	4.5	5.5	0.0	C11 H15 O4





Elemental Composition Report



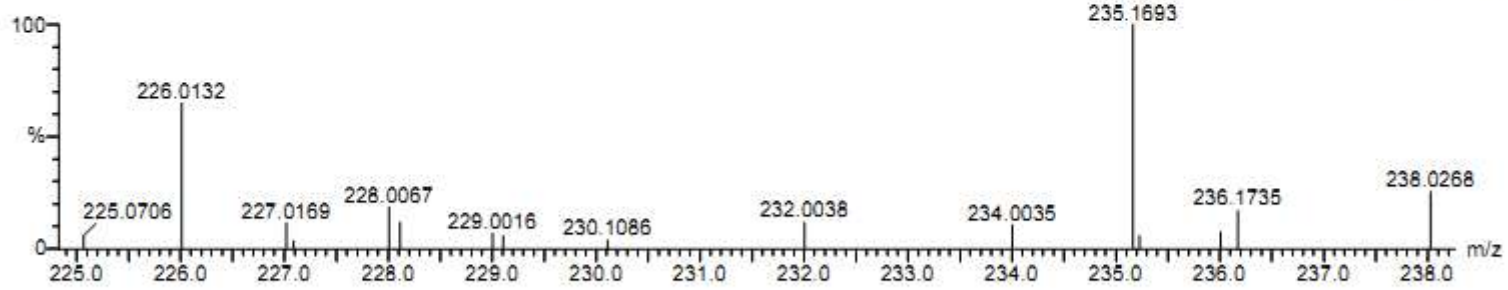
Single Mass Analysis

Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

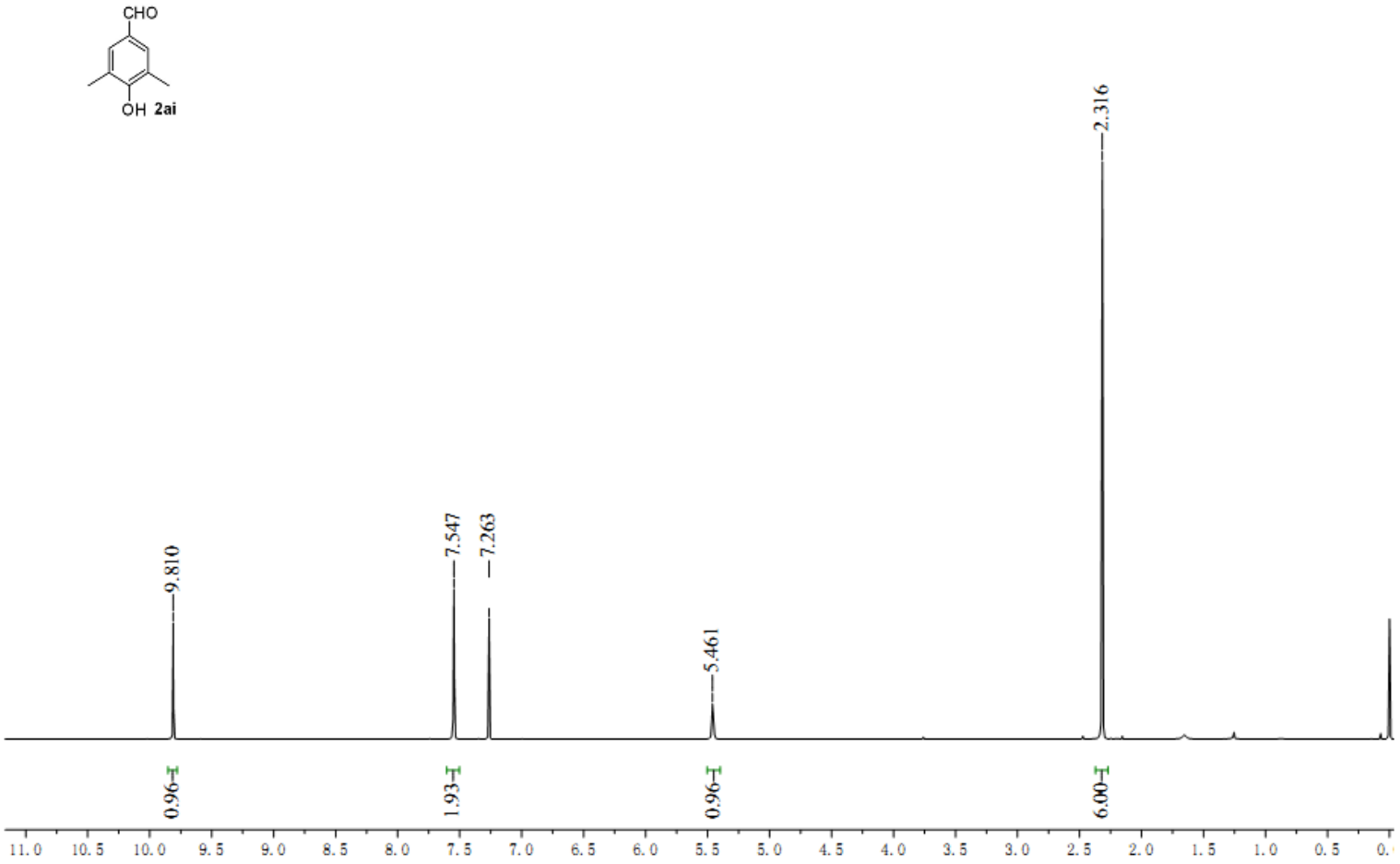
Monoisotopic Mass, Even Electron Ions
29 formula(e) evaluated with 13 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8

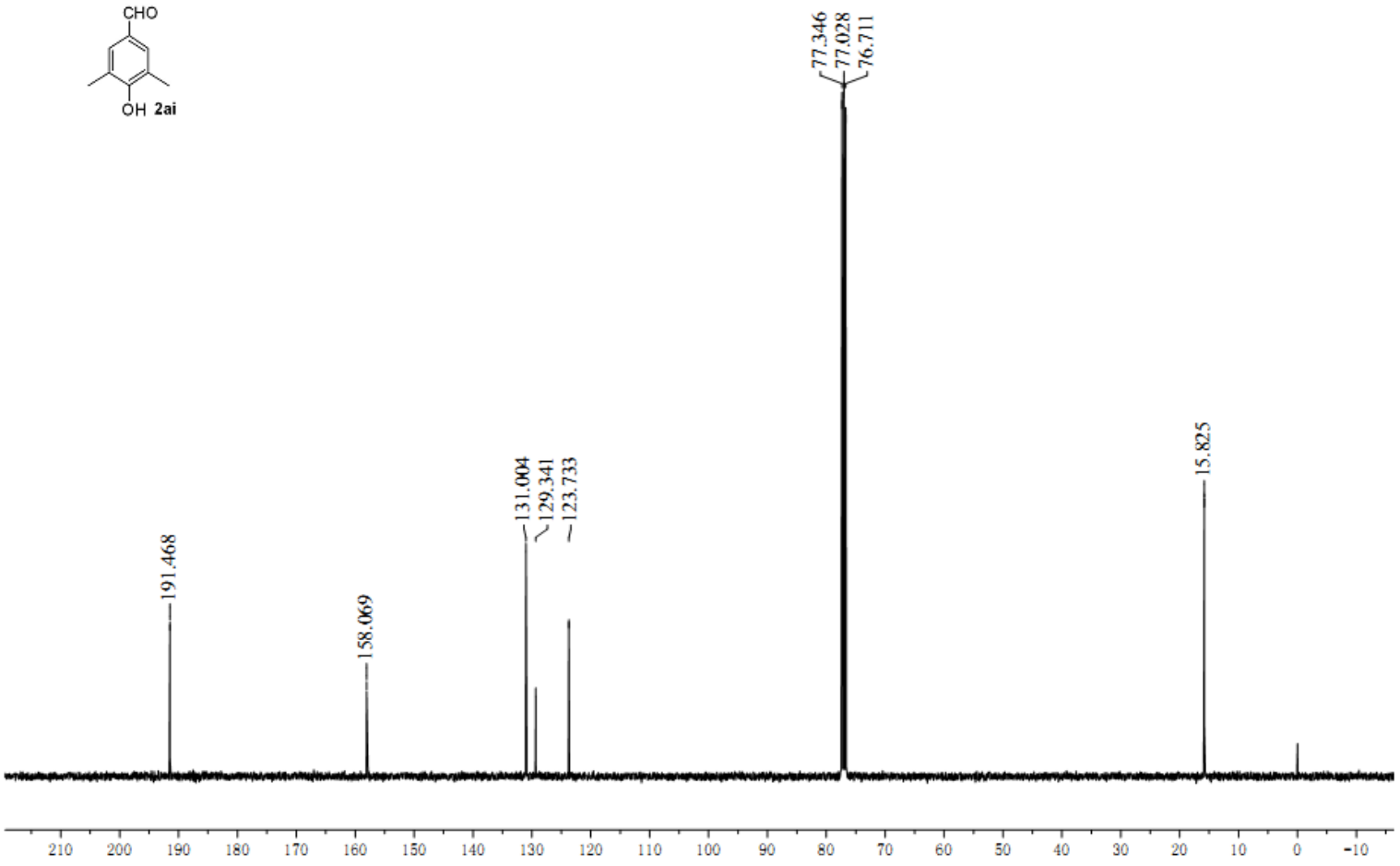
YF-JI ECUST institute of Fine Chem 02-Jan-2013 20:57:01

JYF-JA-09 8 (0.323) Cm (7:10) 1: TOF MS ES+ 9.47e+002



Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
235.1693	235.1698	-0.5	-2.1	4.5	22.1	0.0	C15 H23 O2

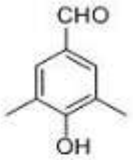




Elemental Composition Report

Single Mass Analysis

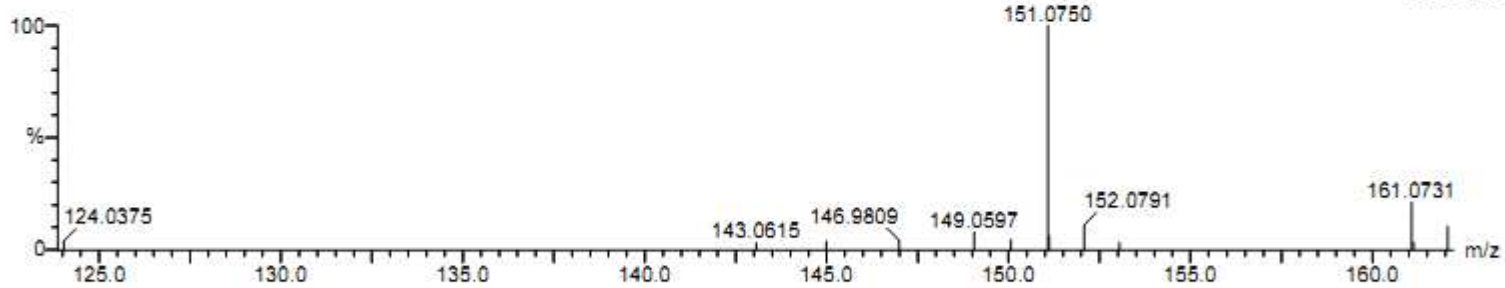
Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2



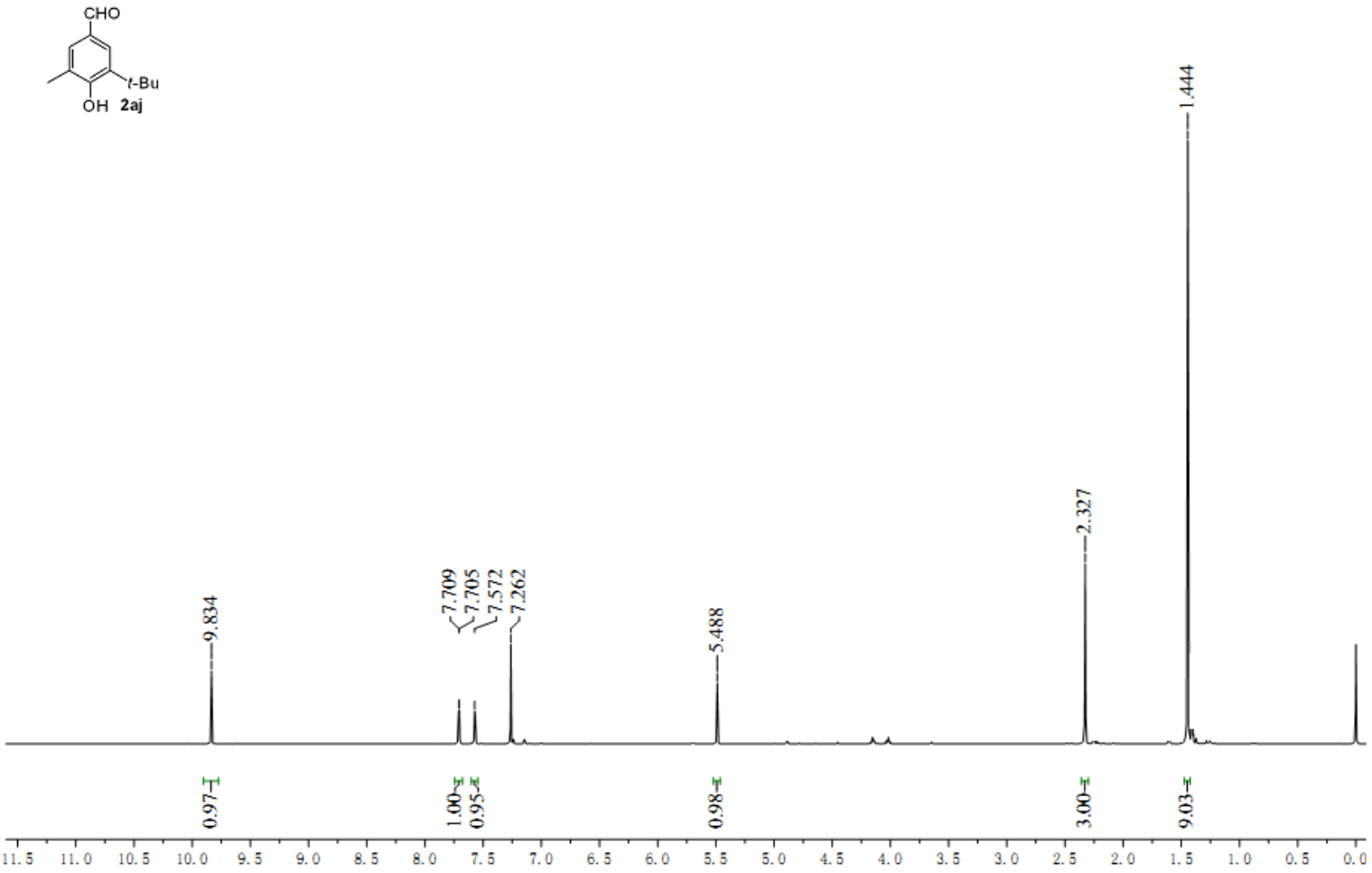
Monoisotopic Mass, Even Electron Ions
20 formula(e) evaluated with 12 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8

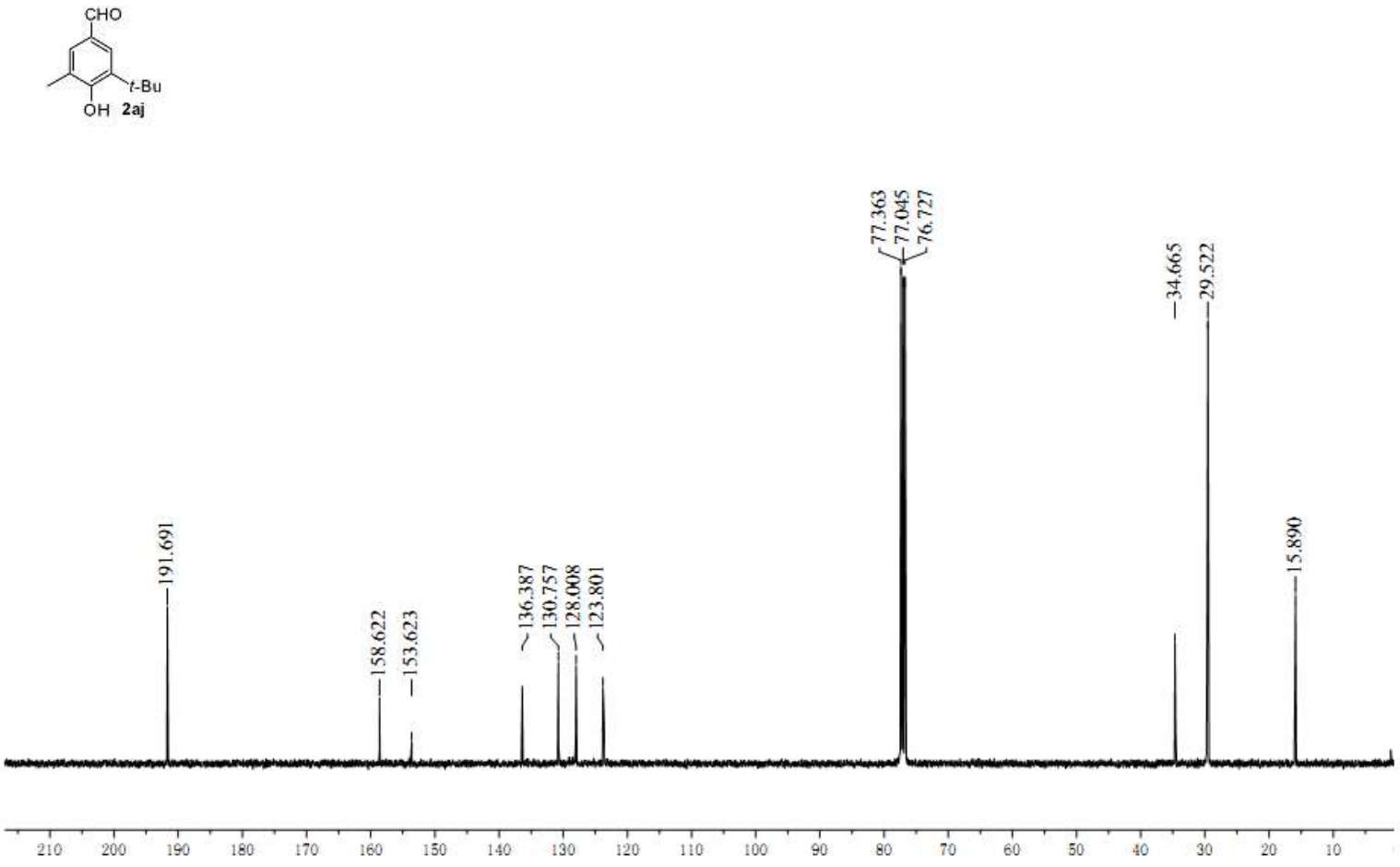
YF-JI ECUST institute of Fine Chem 02-Jan-2013 20:46:42

JYF-JA-08 33 (1.120) Cm (21:39) 1: TOF MS ES+ 1.23e+003

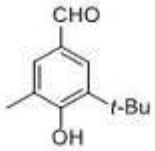


Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
151.0750	151.0759	-0.9	-6.0	4.5	13.7	0.0	C9 H11 O2





Elemental Composition Report



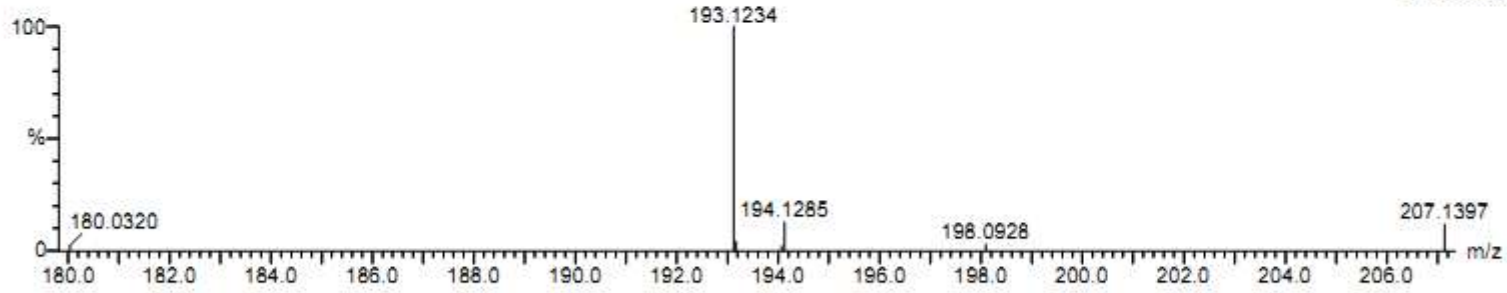
Single Mass Analysis

Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

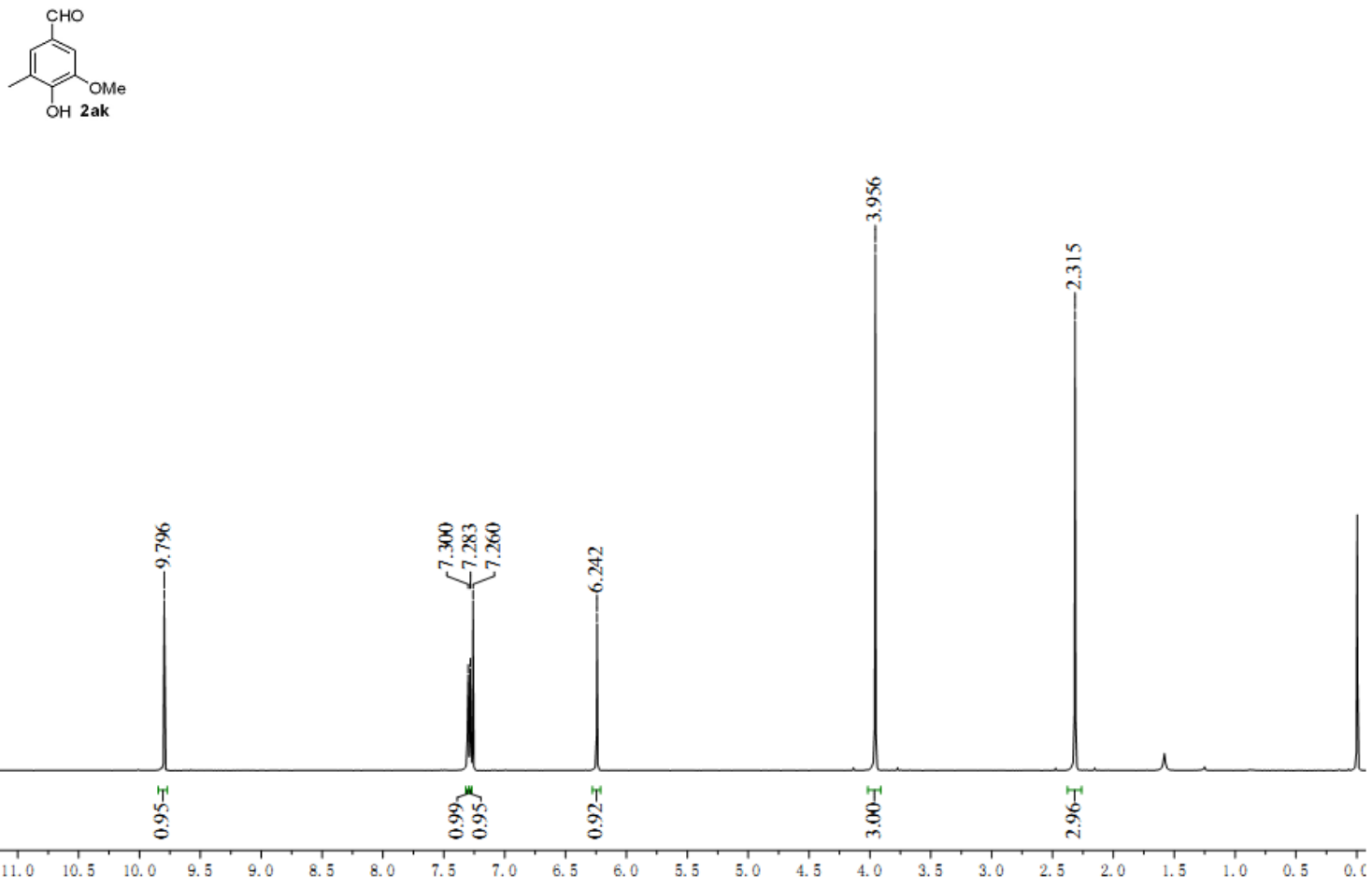
Monoisotopic Mass, Even Electron Ions
15 formula(e) evaluated with 10 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-37 H: 0-50 O: 0-4

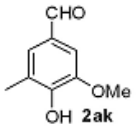
YF-JI ECUST institute of Fine Chem 02-Jan-2013 21:00:40

JYF-JA-10 10 (0.398) Cm (9:10) 1: TOF MS ES+ 2.05e+003



Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
193.1234	193.1229	0.5	2.6	4.5	24.0	0.0	C12 H17 O2





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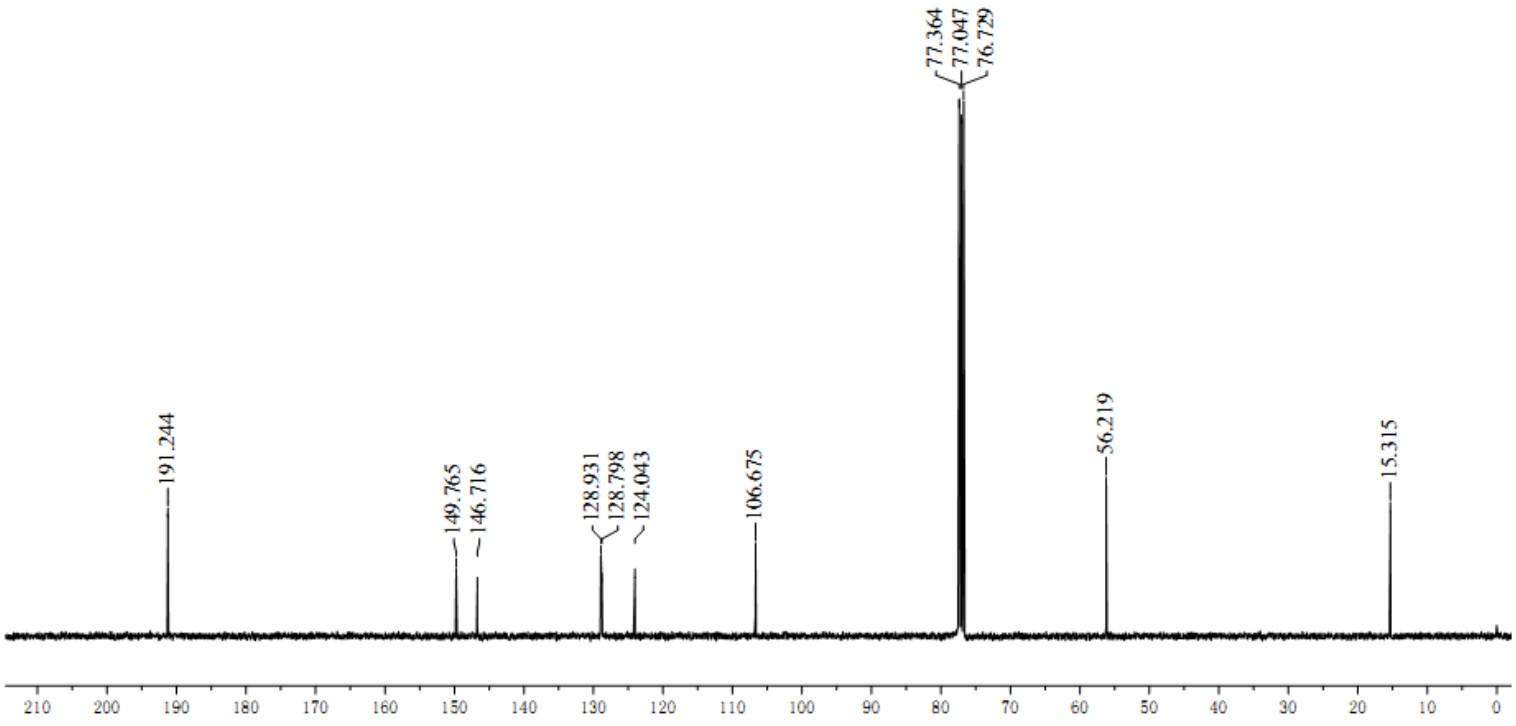
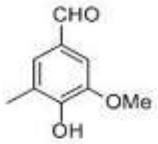


Elemental Composition Report



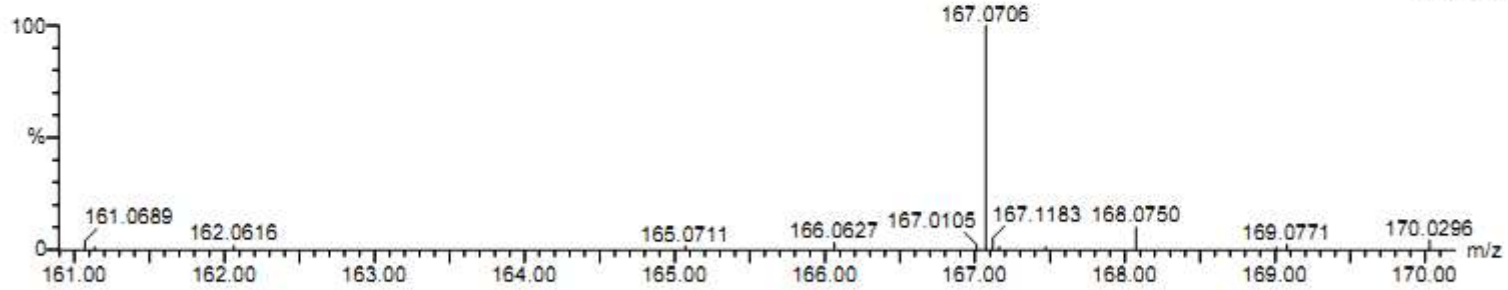
Single Mass Analysis

Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

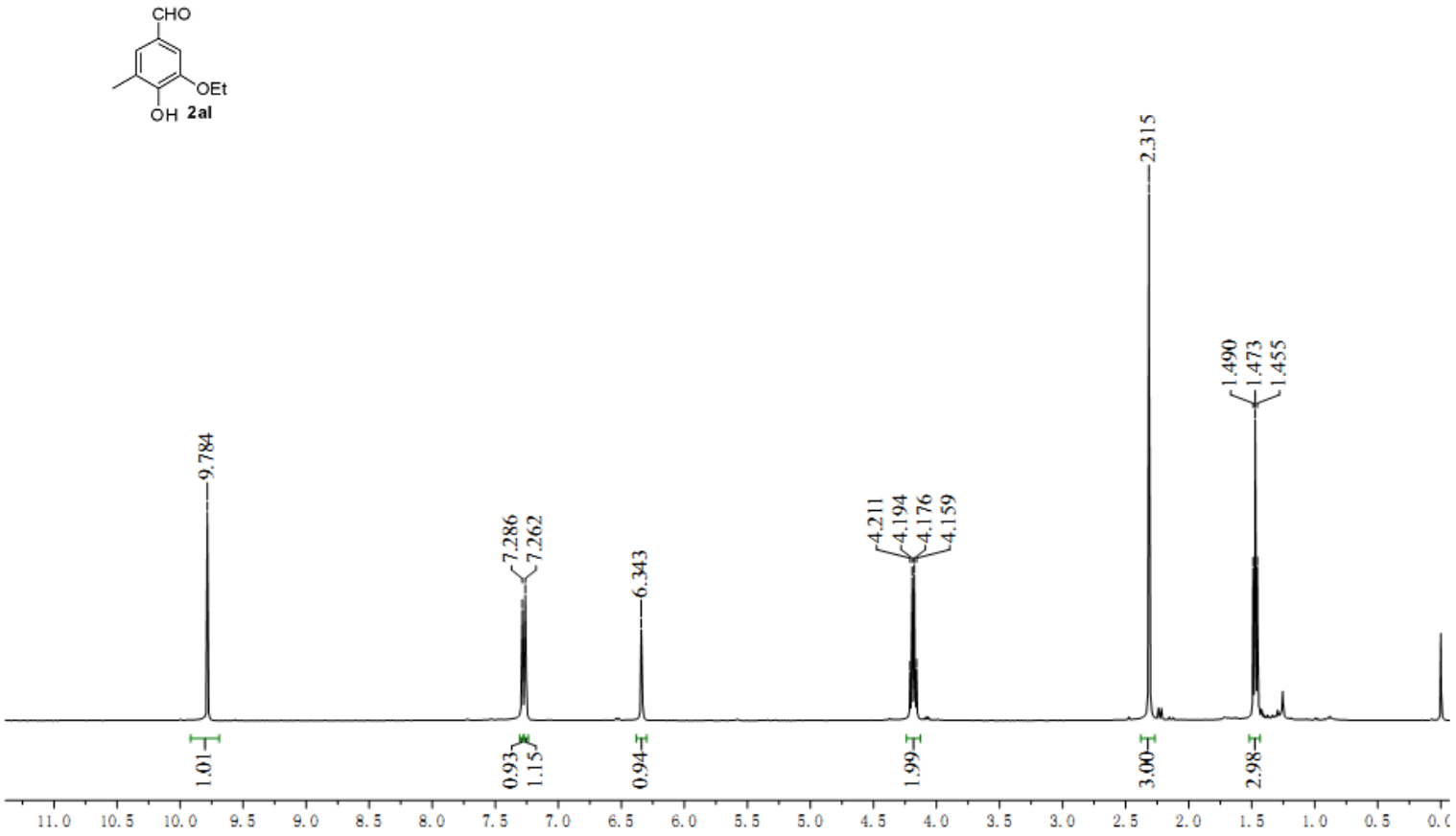
Monoisotopic Mass, Even Electron Ions
21 formula(e) evaluated with 13 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8

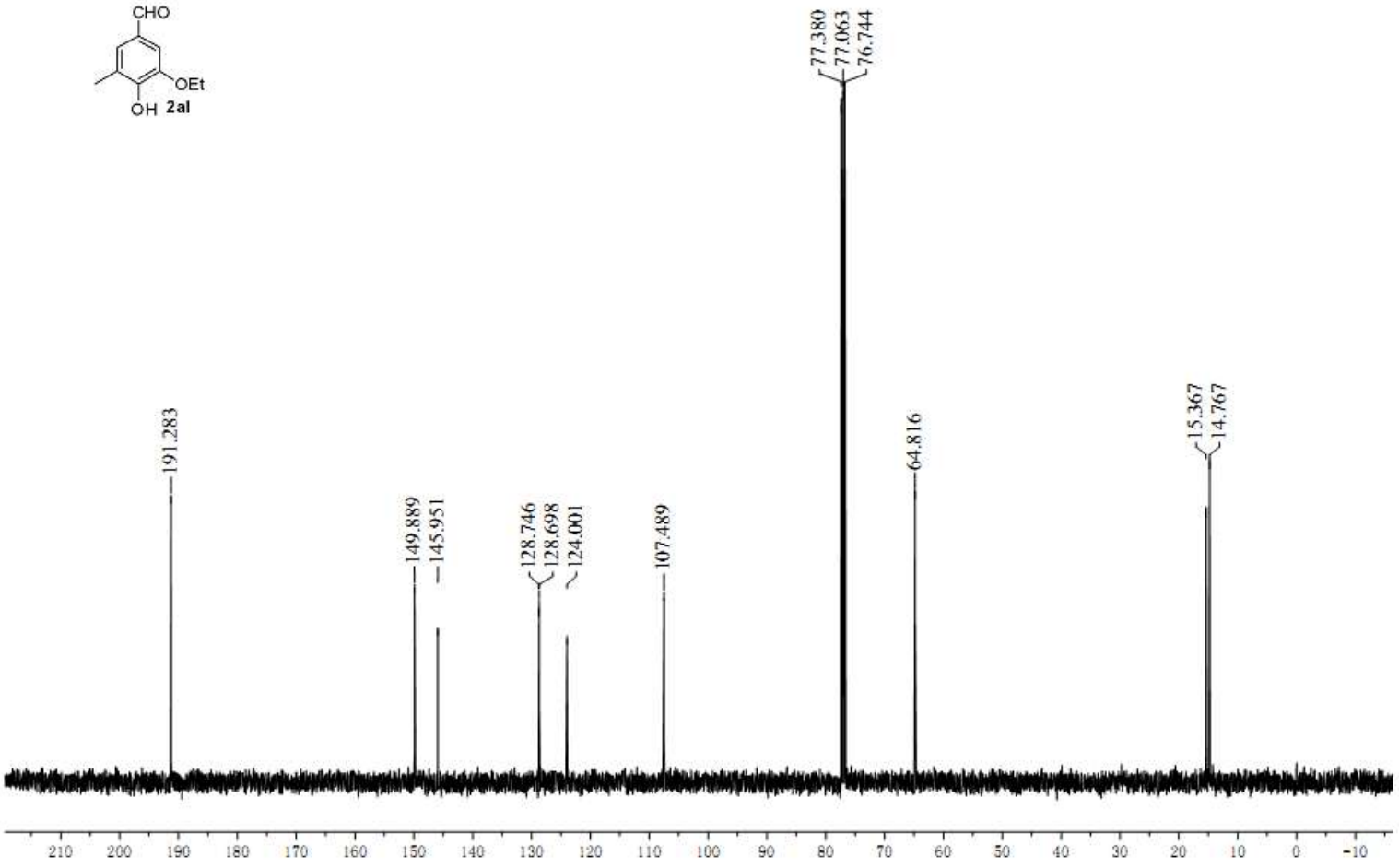
YF-JI ECUST institute of Fine Chem 02-Jan-2013 21:03:40

JYF-JA-11 18 (0.643) Cm (17:21) 1: TOF MS ES+ 1.63e+003

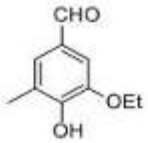


Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
167.0706	167.0708	-0.2	-1.2	4.5	26.7	0.0	C9 H11 O3





Elemental Composition Report



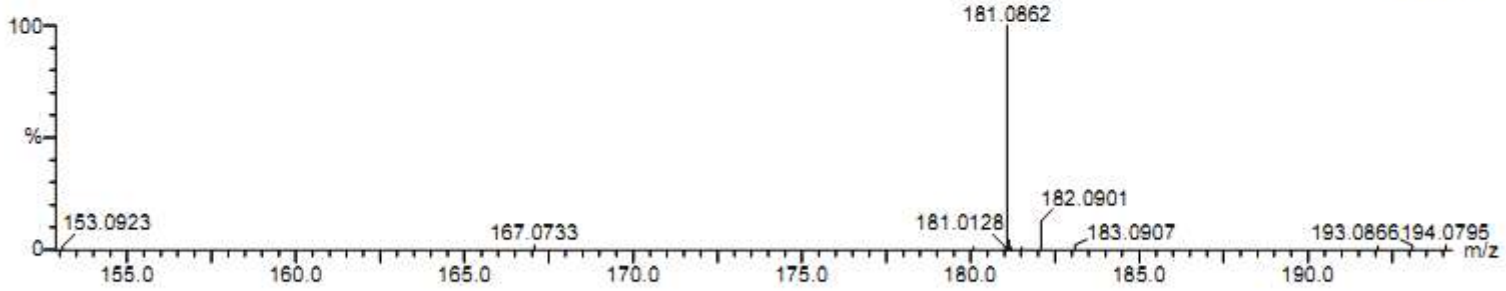
Single Mass Analysis

Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

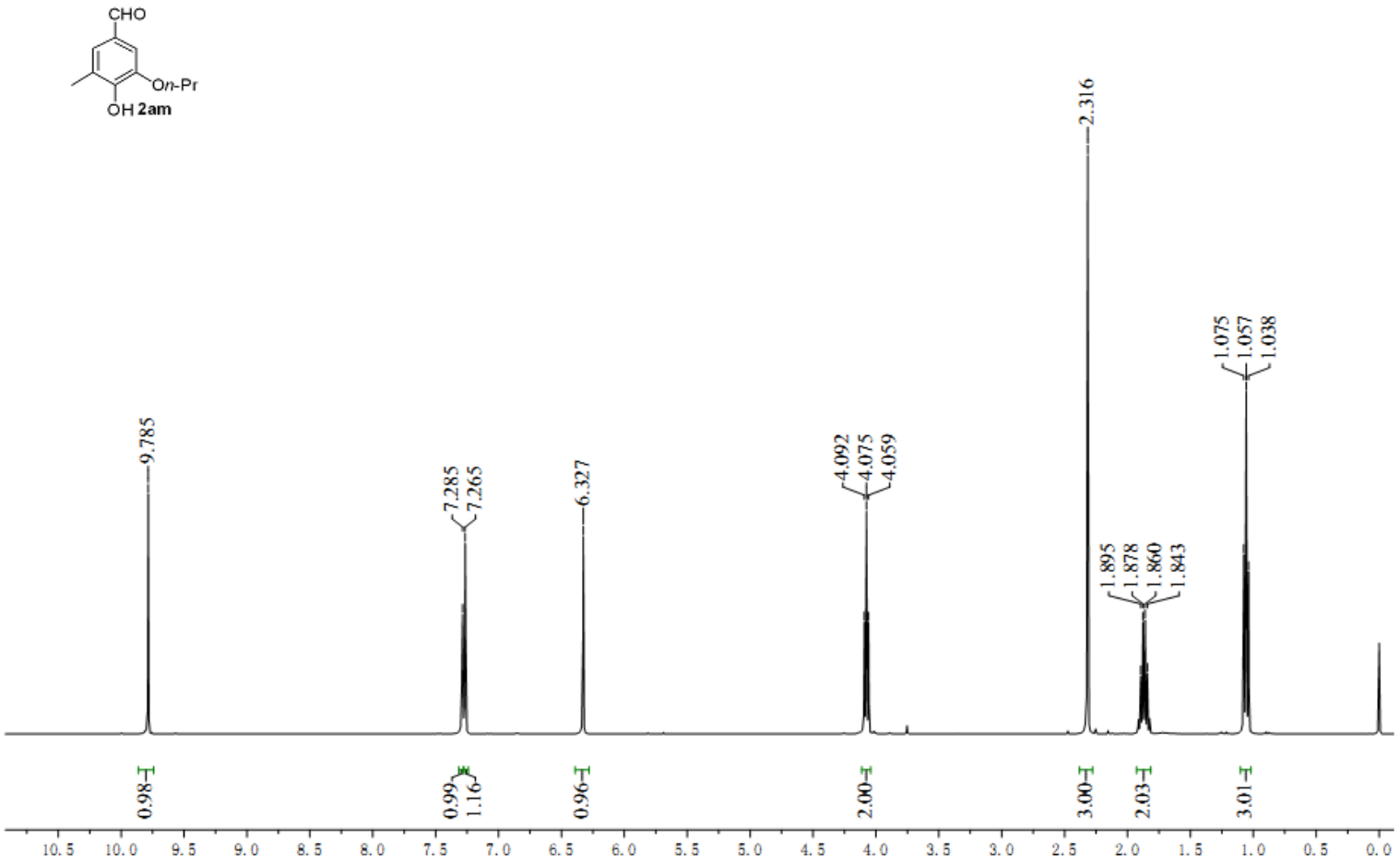
Monoisotopic Mass, Even Electron Ions
21 formula(e) evaluated with 15 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8

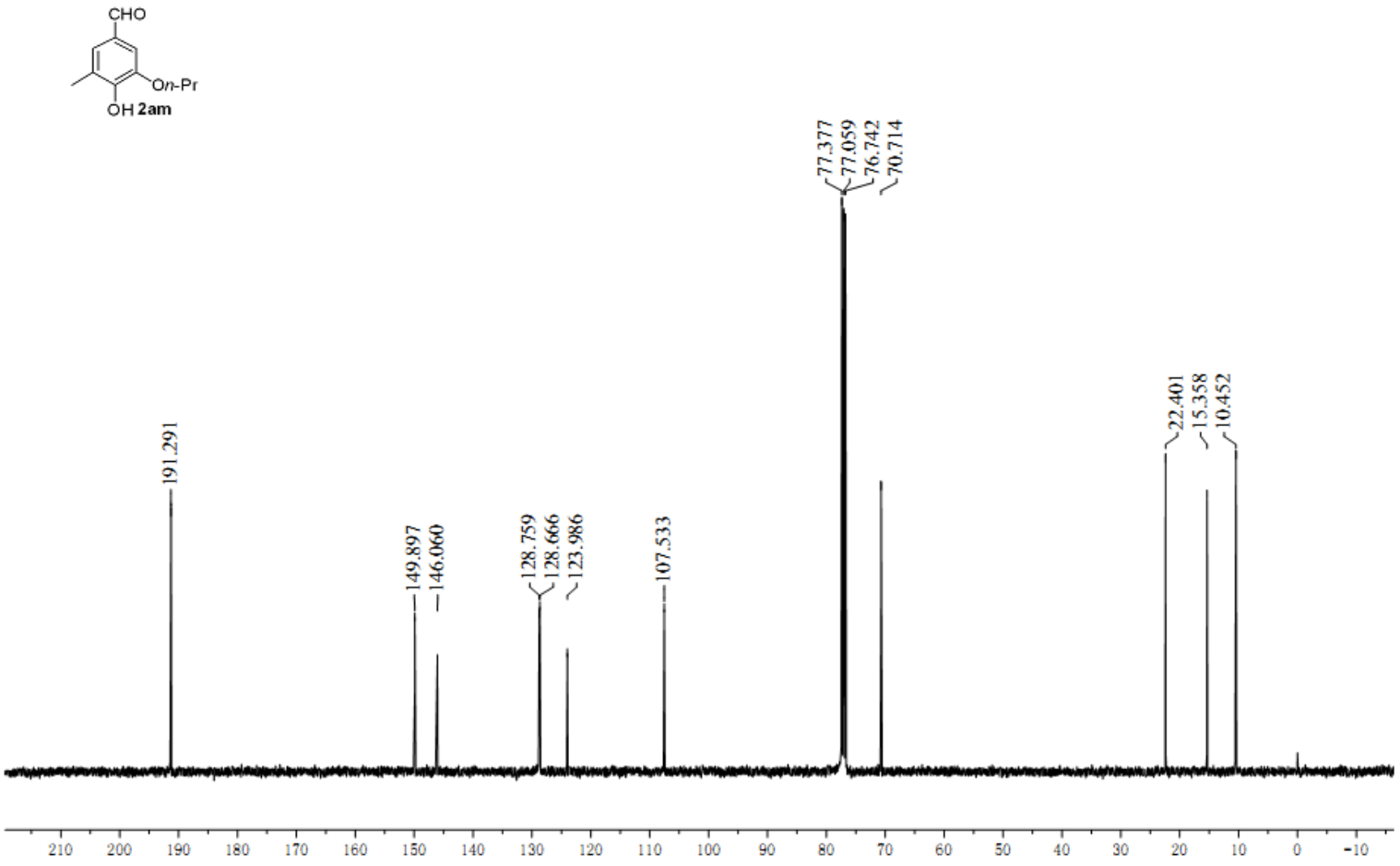
YF-JI ECUST institute of Fine Chem 02-Jan-2013 21:06:26

JYF-JA-12 15 (0.545) Cm (13:15) 1: TOF MS ES+ 2.62e+003

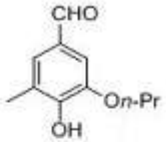


Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
181.0862	181.0865	-0.3	-1.7	4.5	28.7	0.0	C10 H13 O3





Elemental Composition Report



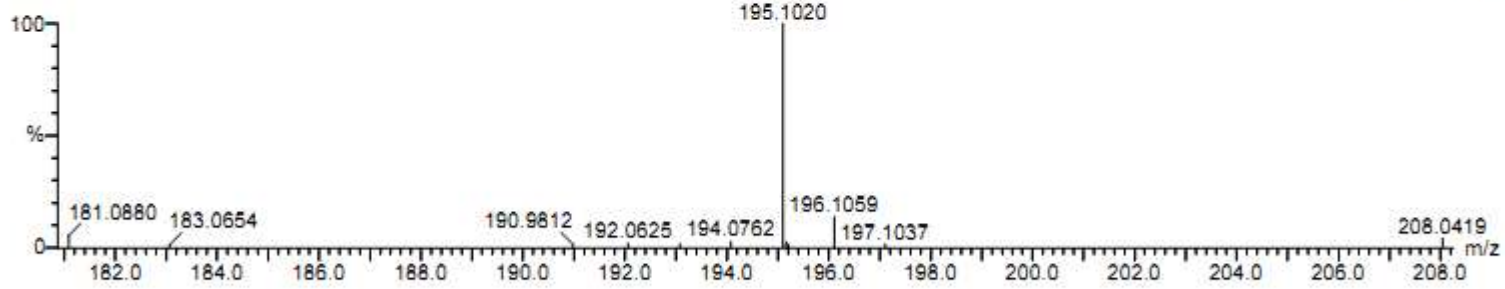
Single Mass Analysis

Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

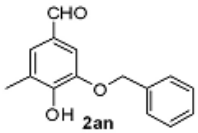
Monoisotopic Mass, Even Electron Ions
24 formula(e) evaluated with 15 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8

YF-JI ECUST institute of Fine Chem 02-Jan-2013 21:08:56

JYF-JA-13 12 (0.446) Cm (10:14) 1: TOF MS ES+ 3.72e+003



Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
195.1020	195.1021	-0.1	-0.5	4.5	23.3	0.0	C11 H15 O3



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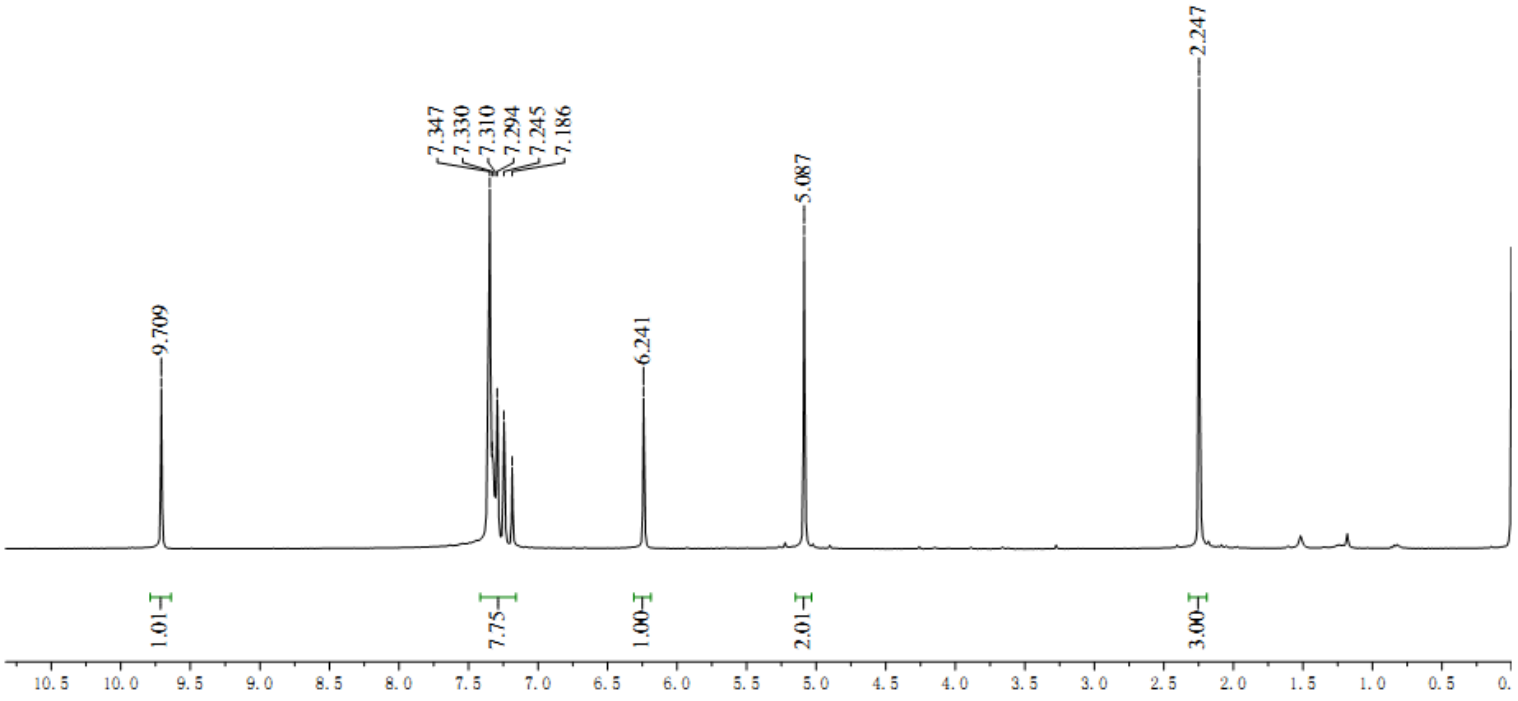
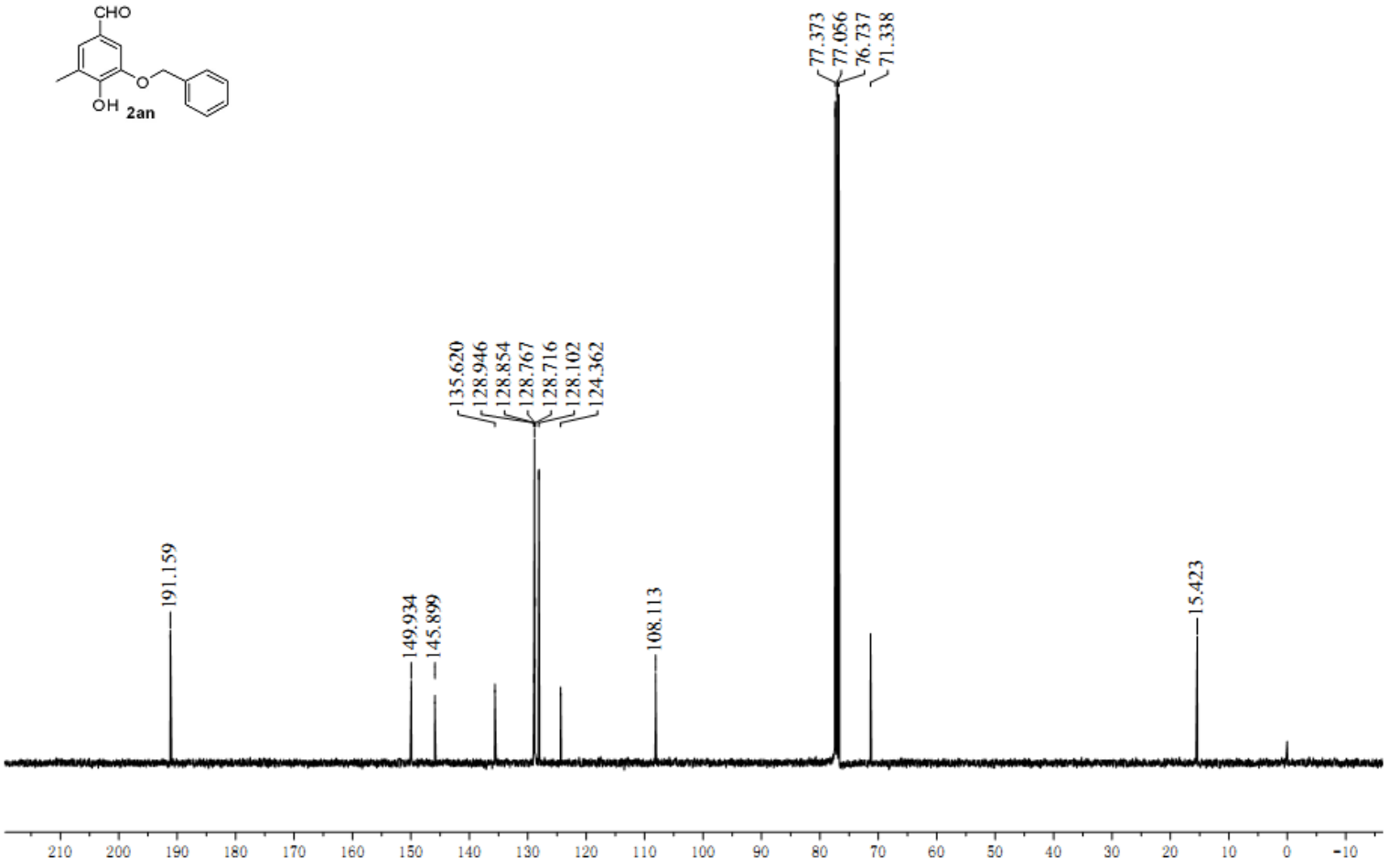
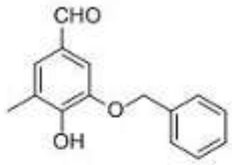




Elemental Composition Report



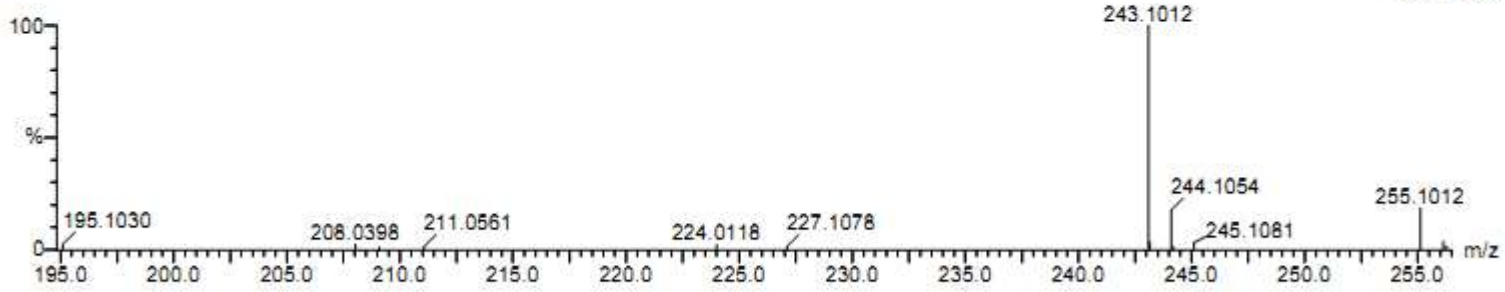
Single Mass Analysis

Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

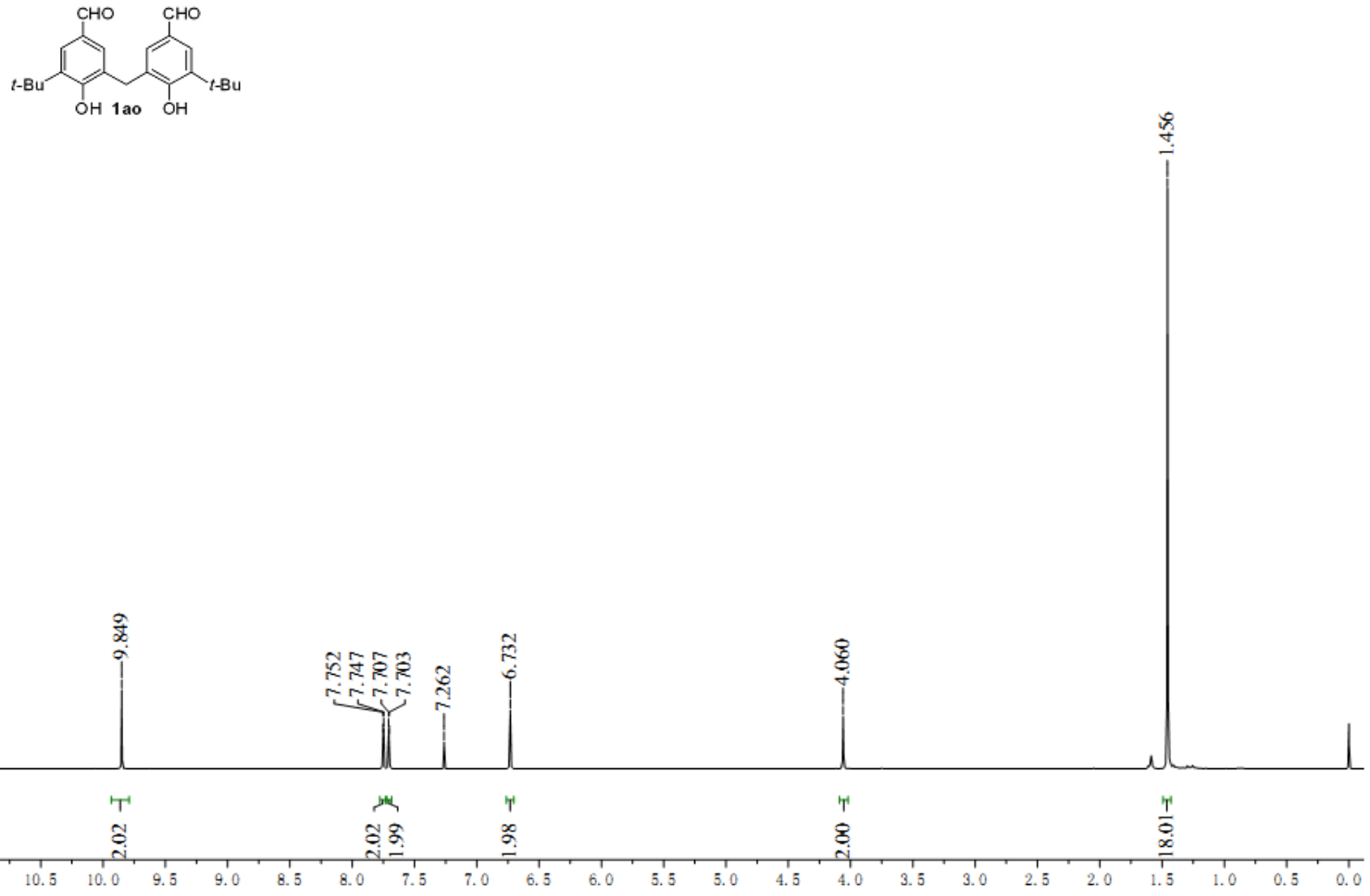
Monoisotopic Mass, Even Electron Ions
29 formula(e) evaluated with 18 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8

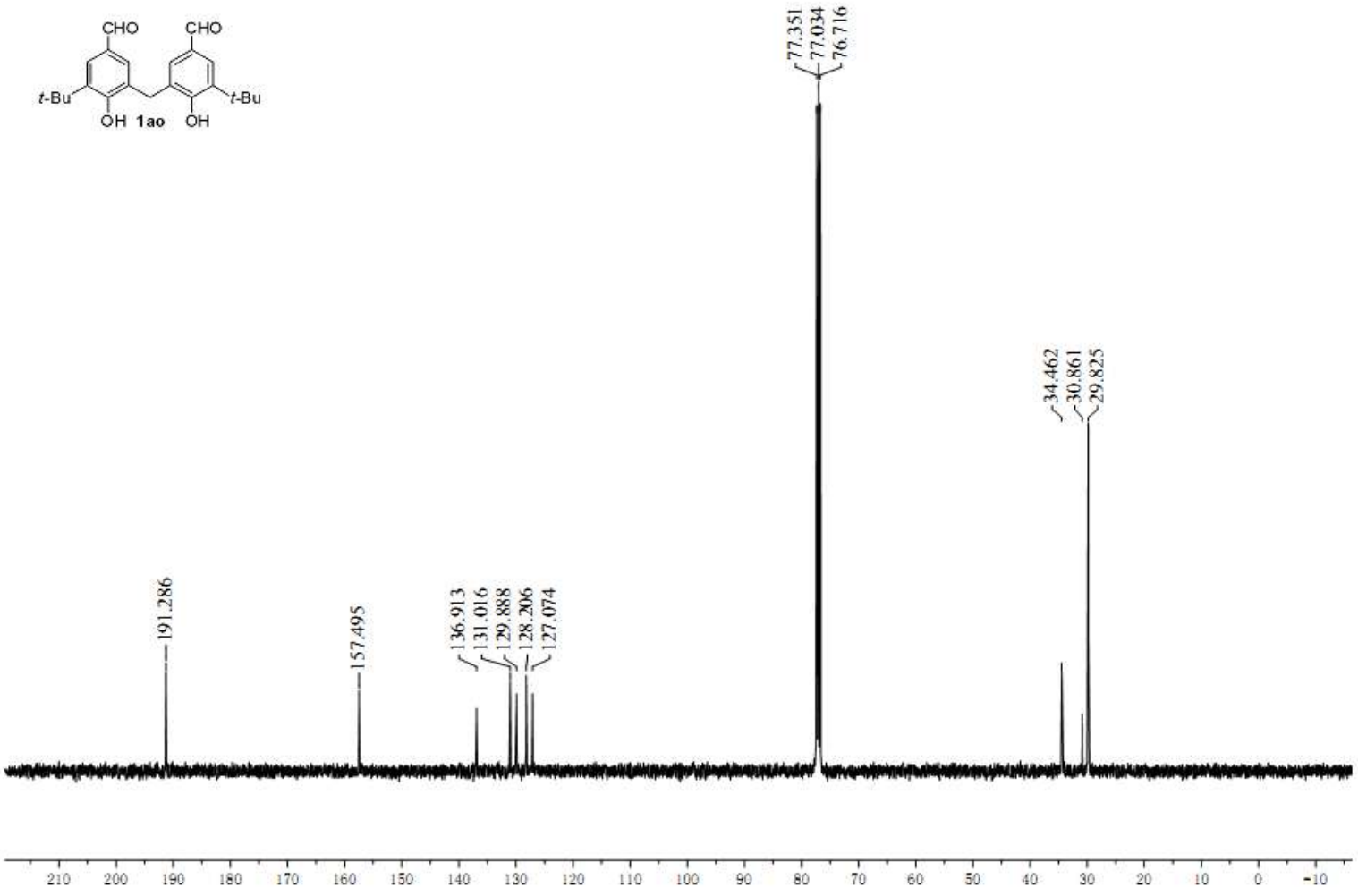
YF-JI ECUST institute of Fine Chem 02-Jan-2013 21:11:34

JYF-JA-14 22 (0.766) Cm (21:22) 1: TOF MS ES+ 3.57e+003

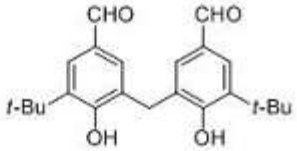


Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
243.1012	243.1021	-0.9	-3.7	8.5	23.7	0.0	C15 H15 O3





Elemental Composition Report



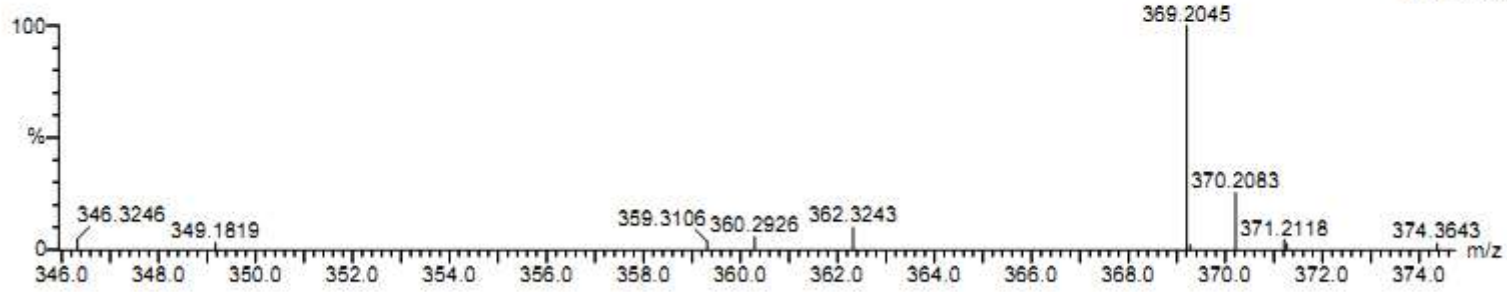
Single Mass Analysis

Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

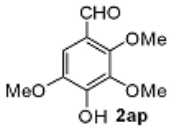
Monoisotopic Mass, Even Electron Ions
21 formula(e) evaluated with 11 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-37 H: 0-50 O: 0-4

YF-JI ECUST institute of Fine Chem 02-Jan-2013 21:16:46

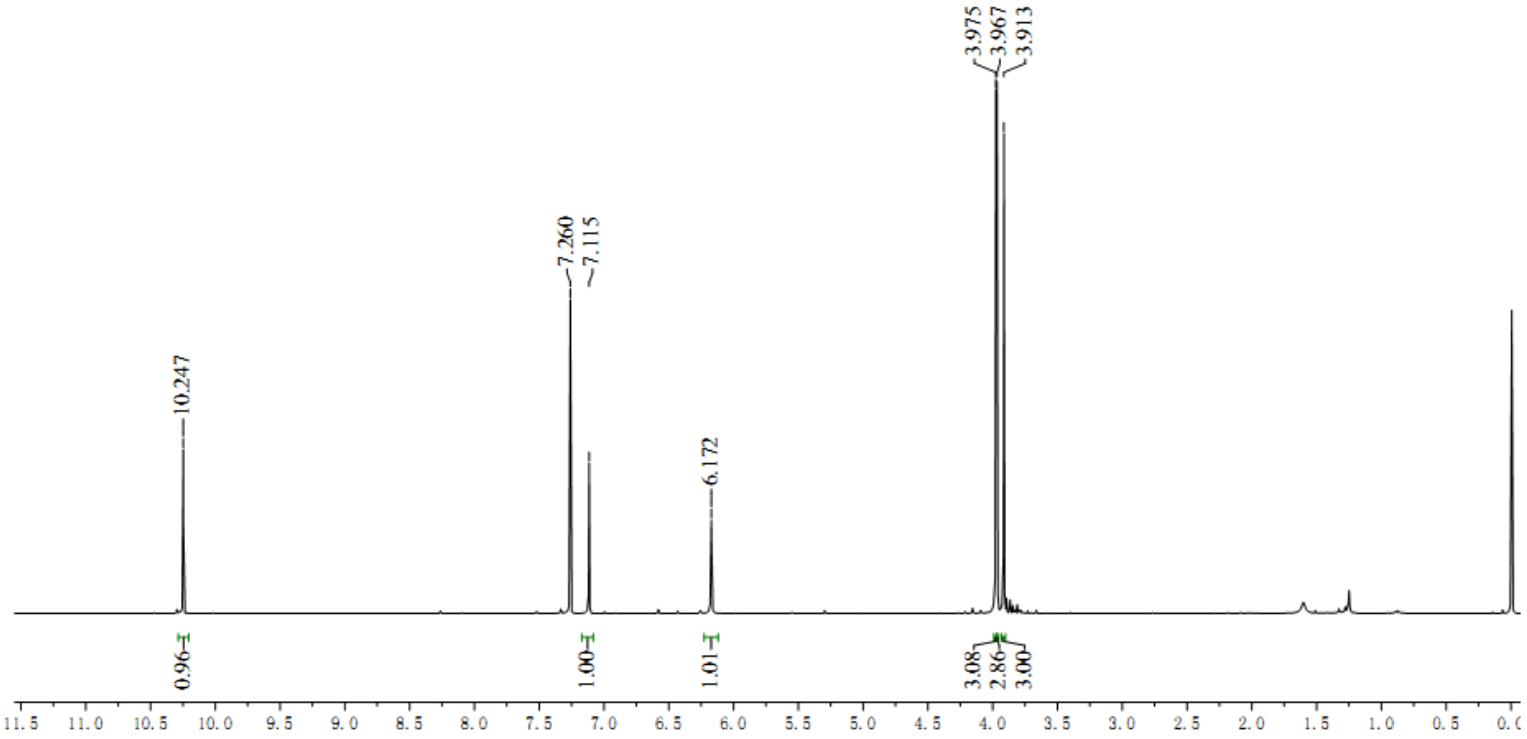
JYF-JA-17 7 (0.299) Cm (5:7) 1: TOF MS ES+ 3.00e+003

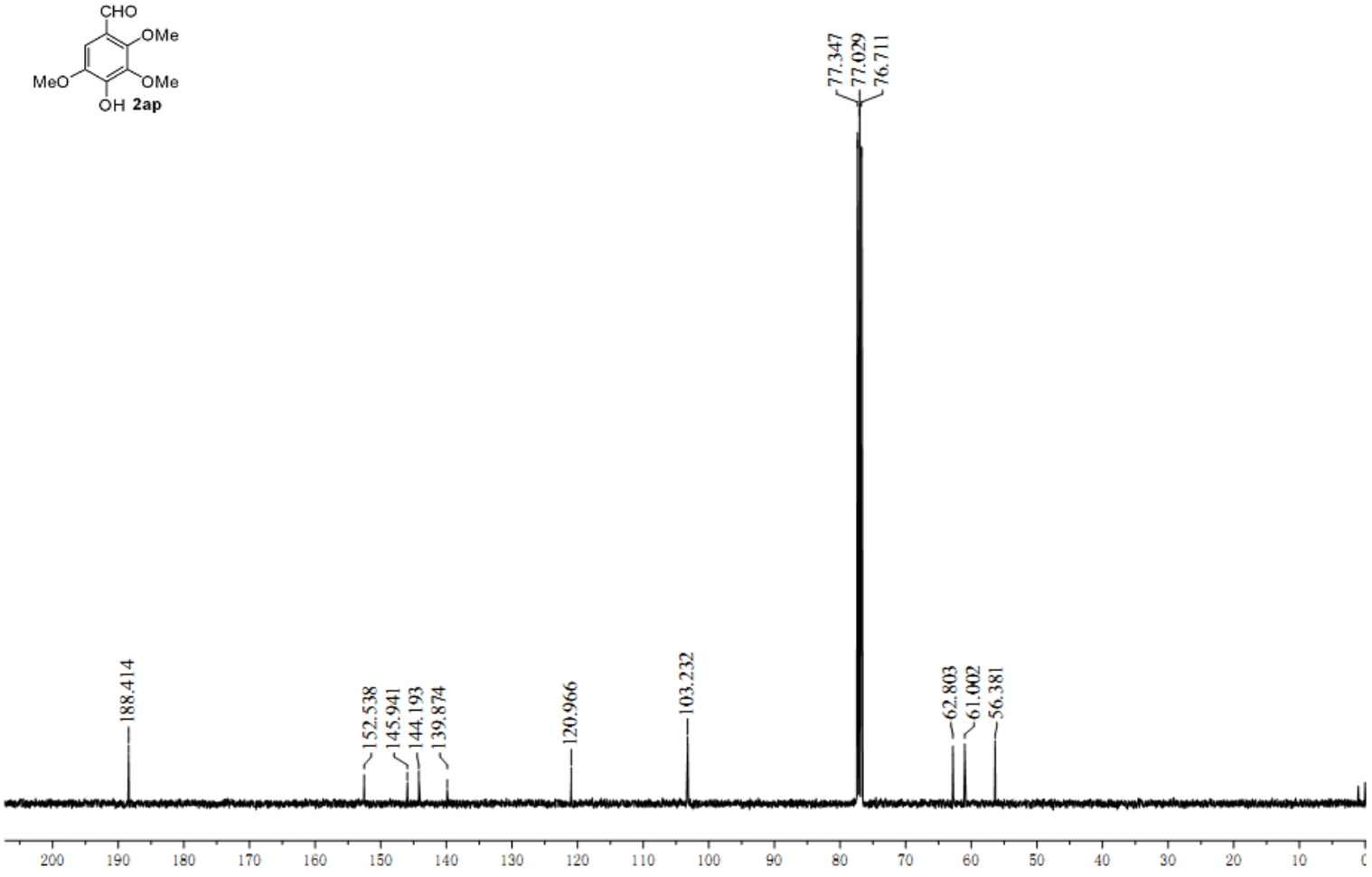


Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
369.2045	369.2066	-2.1	-5.7	9.5	14.8	0.0	C23 H29 O4



2ap

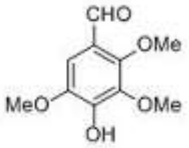




Elemental Composition Report

Single Mass Analysis

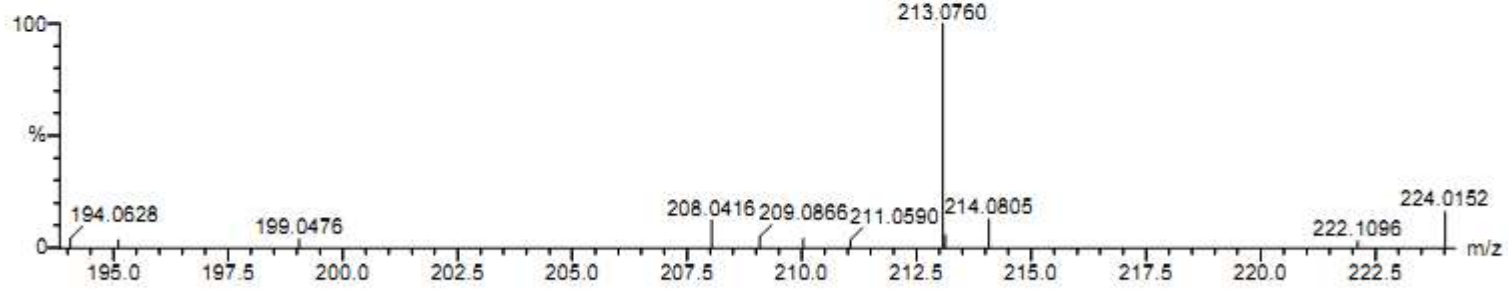
Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2



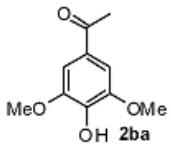
Monoisotopic Mass, Even Electron Ions
24 formula(e) evaluated with 17 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8

YF-JI ECUST institute of Fine Chem 02-Jan-2013 21:14:32

JYF-JA-16 6 (0.275) Cm (5:6) 1: TOF MS ES+ 1.00e+003



Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
213.0760	213.0763	-0.3	-1.4	4.5	14.1	0.0	C10 H13 O5



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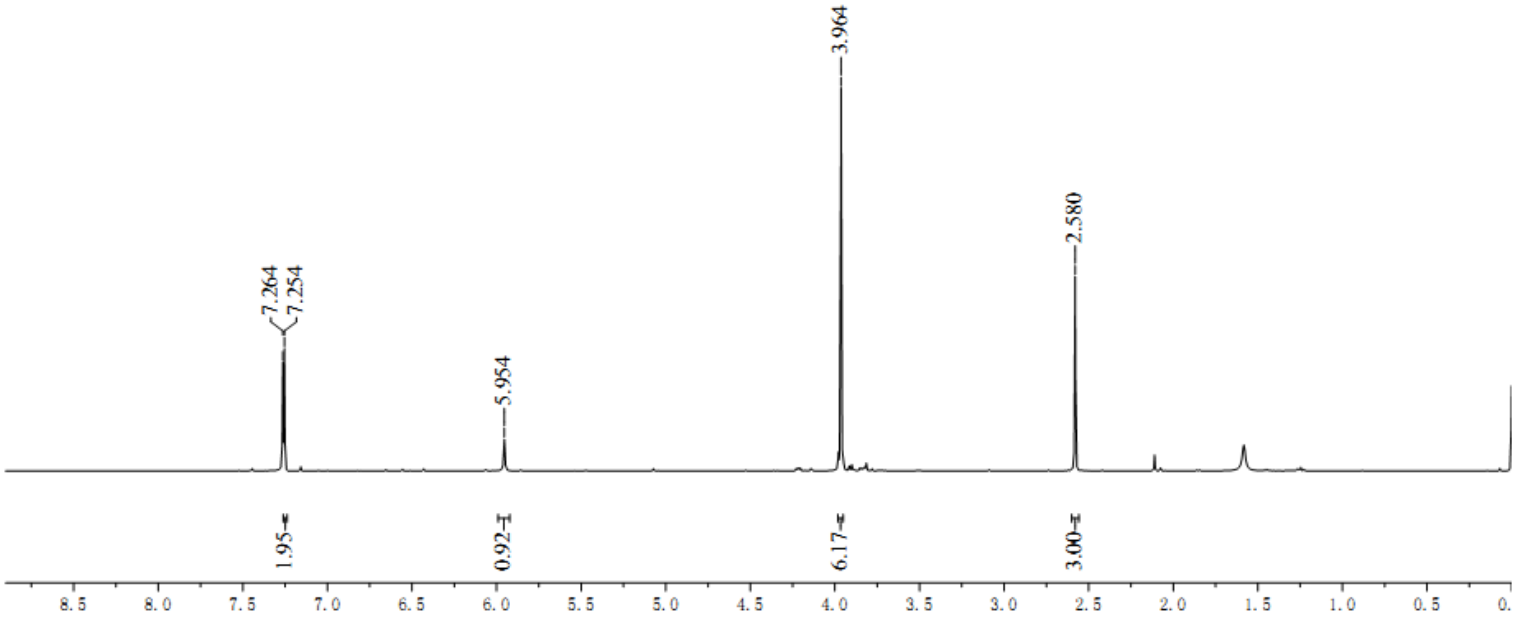
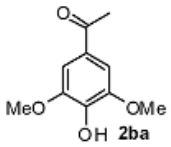
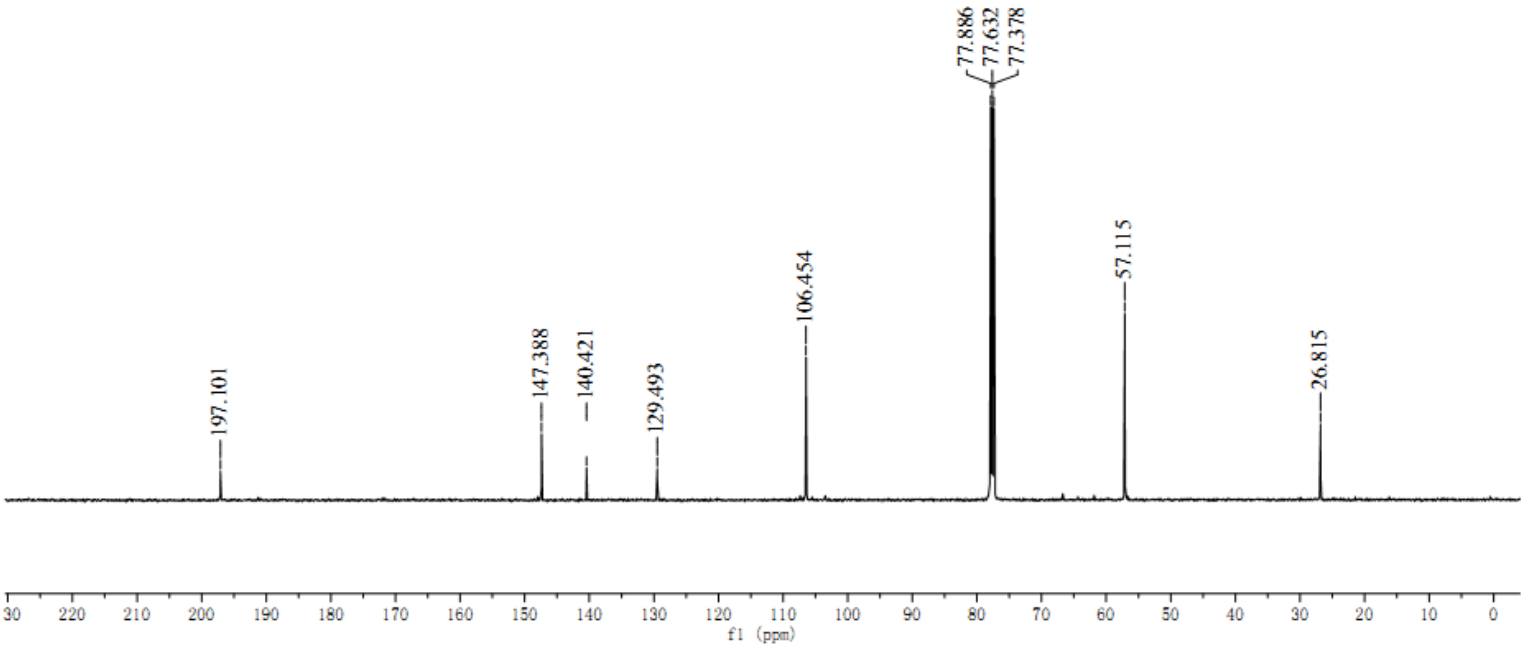
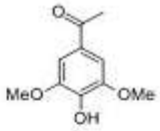




2ba



Elemental Composition Report



Single Mass Analysis

Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

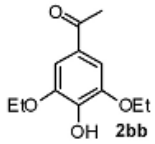
Monoisotopic Mass, Odd and Even Electron Ions

21 formula(e) evaluated with 5 results within limits (up to 50 closest results for each mass)

Elements Used:

C: 0-10 H: 0-12 O: 0-4

Minimum:					-1.5		
Maximum:		100.00	5.0	10.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
196.0737	51.69	196.0736	0.1	0.5	5.0	1	C10 H12 O4



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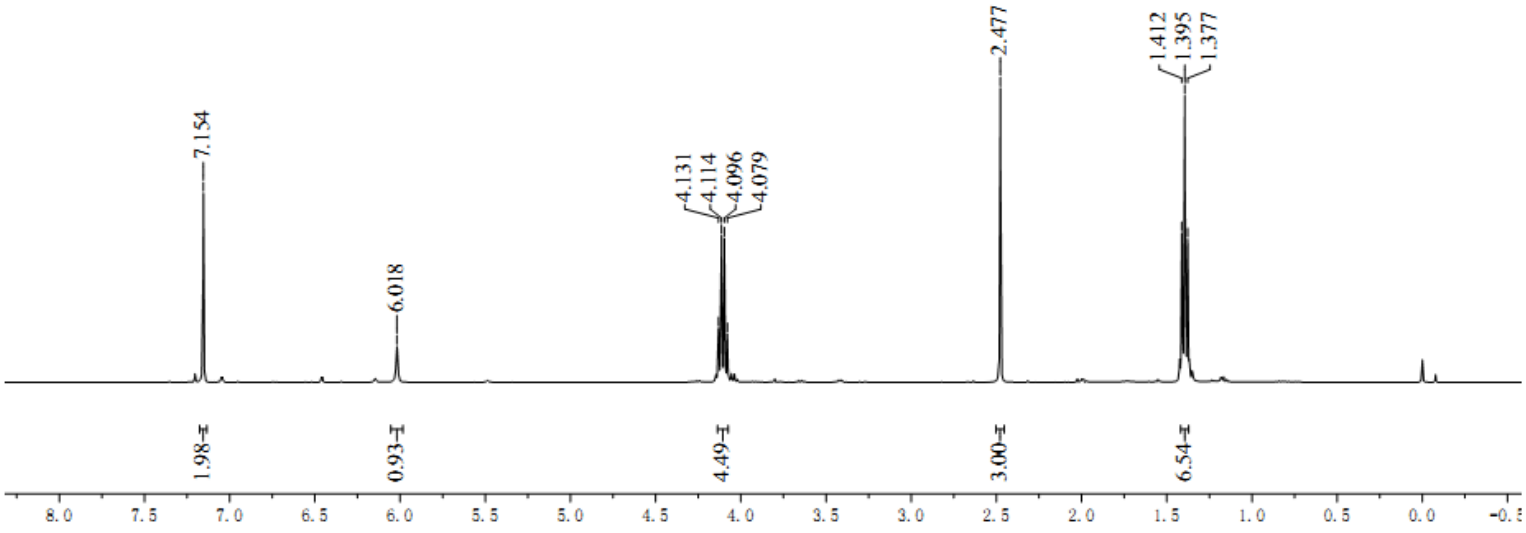

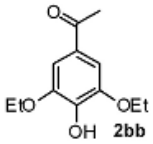

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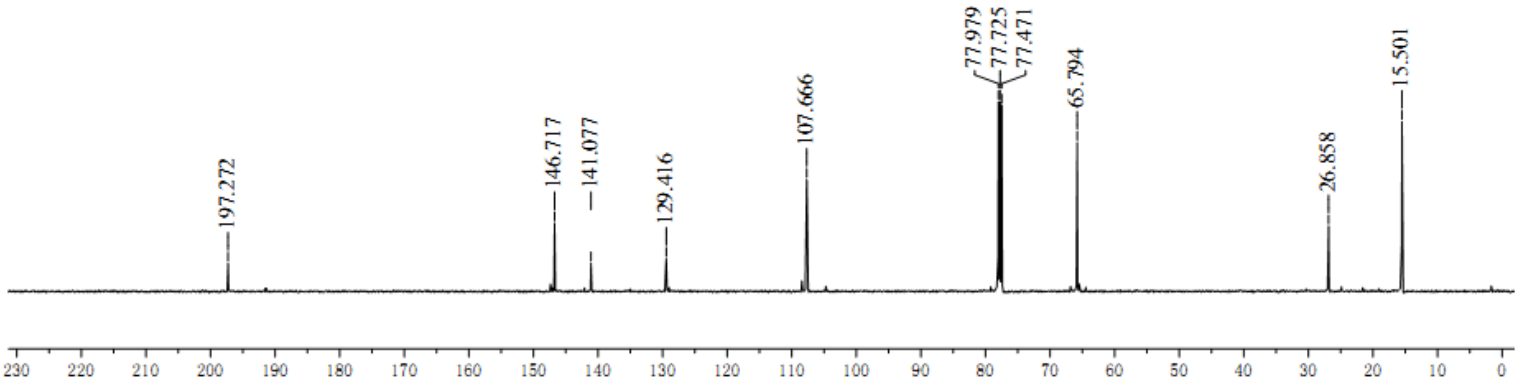
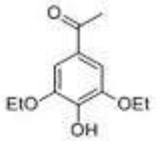


Elemental Composition Report



Single Mass Analysis

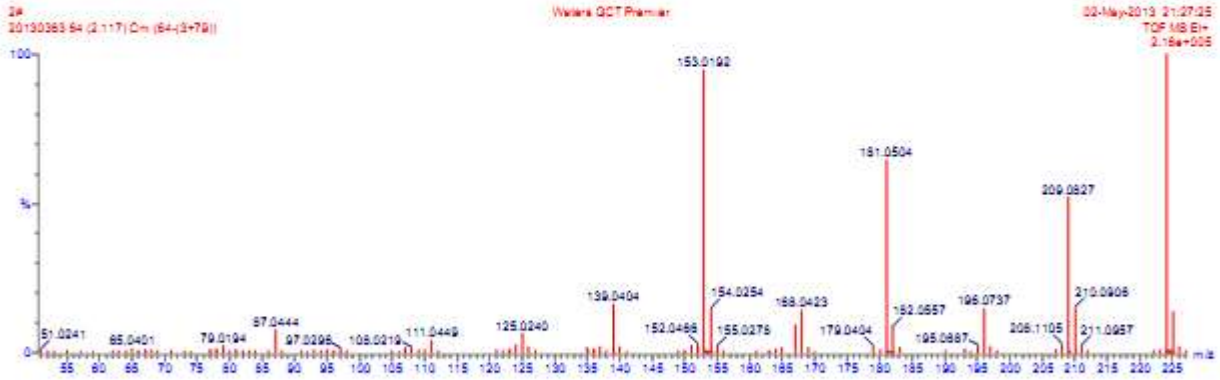
Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

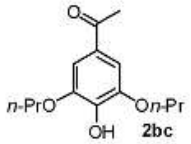
21 formula(e) evaluated with 5 results within limits (up to 50 closest results for each mass)

Elements Used:

C: 0-12 H: 0-16 O: 0-4



Minimum:					-1.5		
Maximum:		100.00	5.0	10.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
224.1047	100.00	224.1049	-0.2	-0.9	5.0	1	C12 H16 O4



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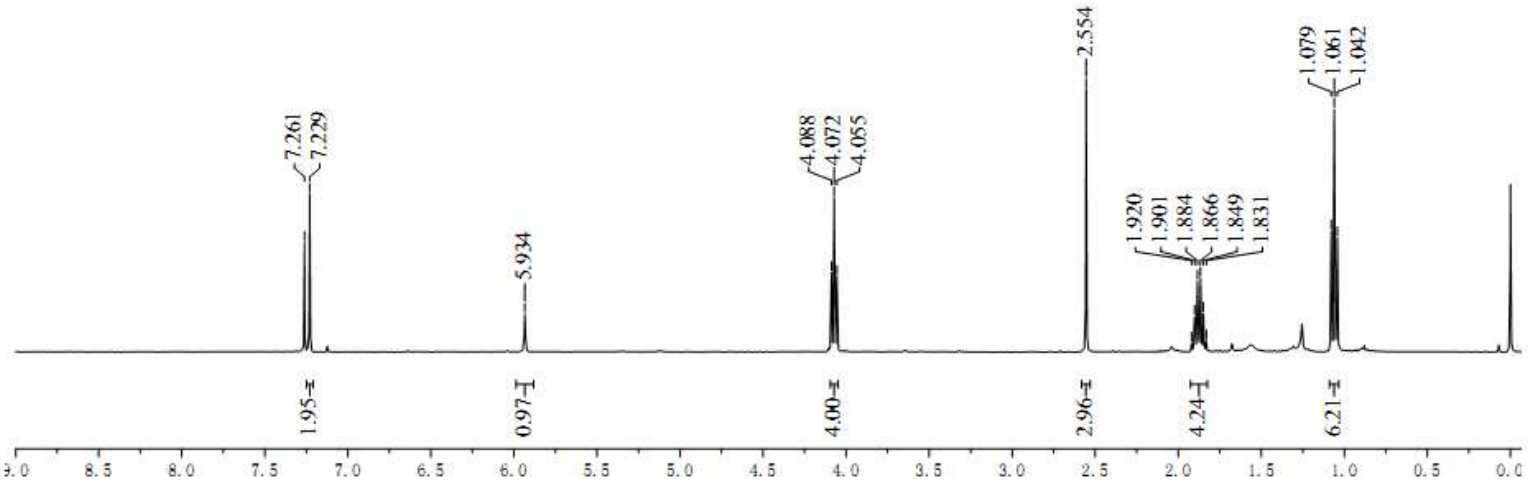

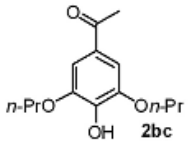

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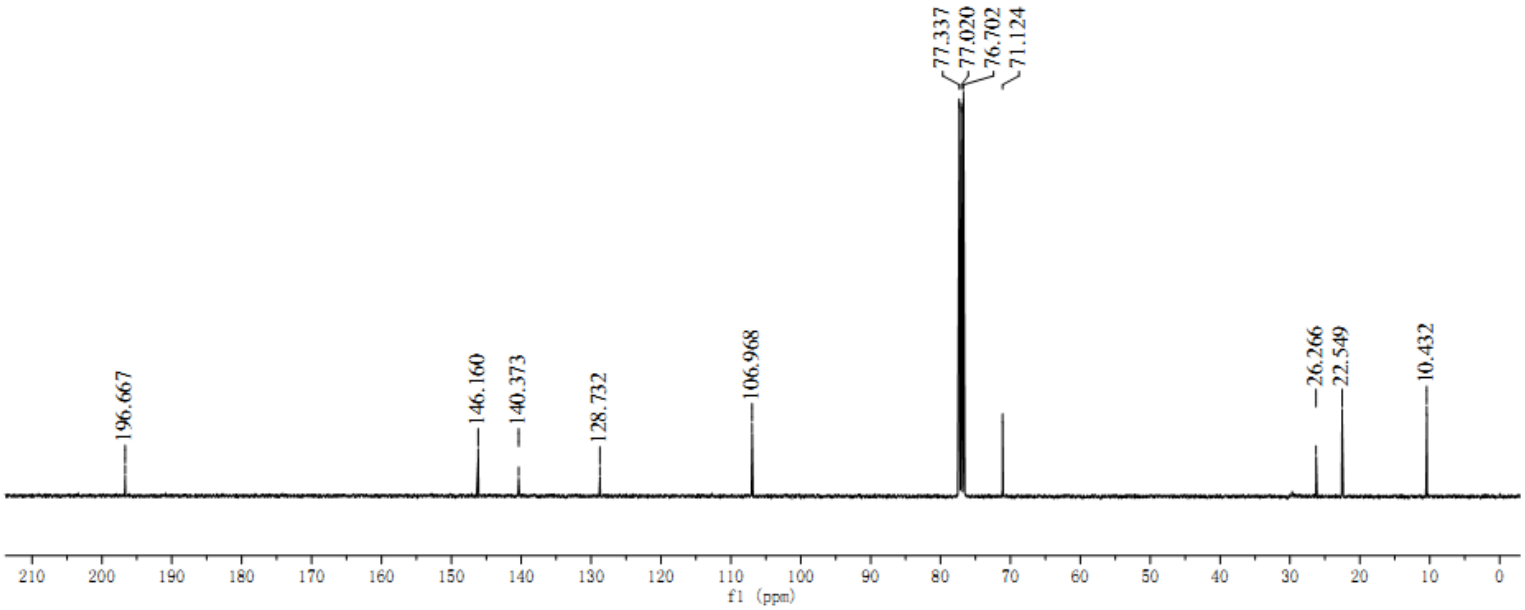
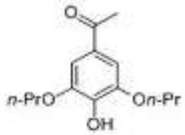


Elemental Composition Report



Single Mass Analysis

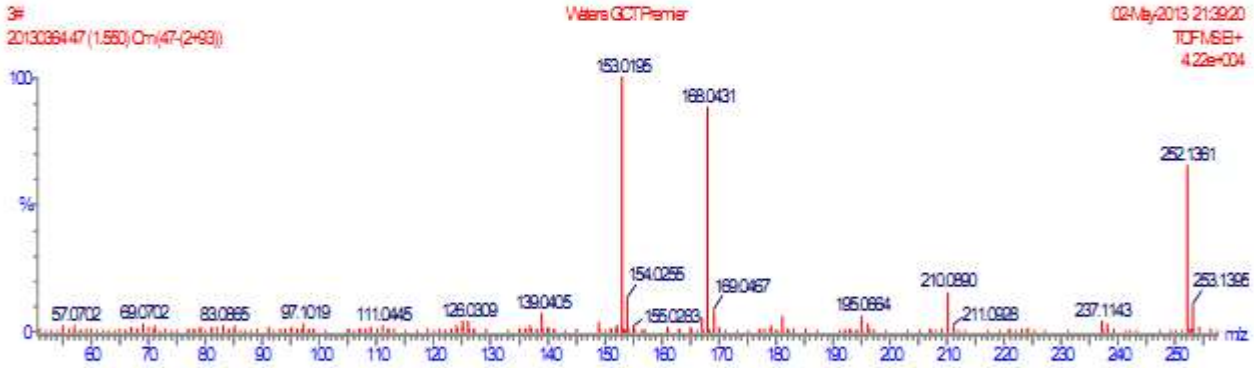
Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

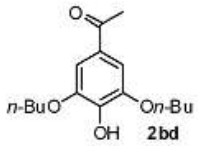
21 formula(e) evaluated with 5 results within limits (up to 50 closest results for each mass)

Elements Used:

C: 0-14 H: 0-20 O: 0-4



Minimum:					-1.5		
Maximum:		100.00	5.0	10.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
252.1361	65.18	252.1362	-0.1	-0.4	5.0	1	C14 H20 O4



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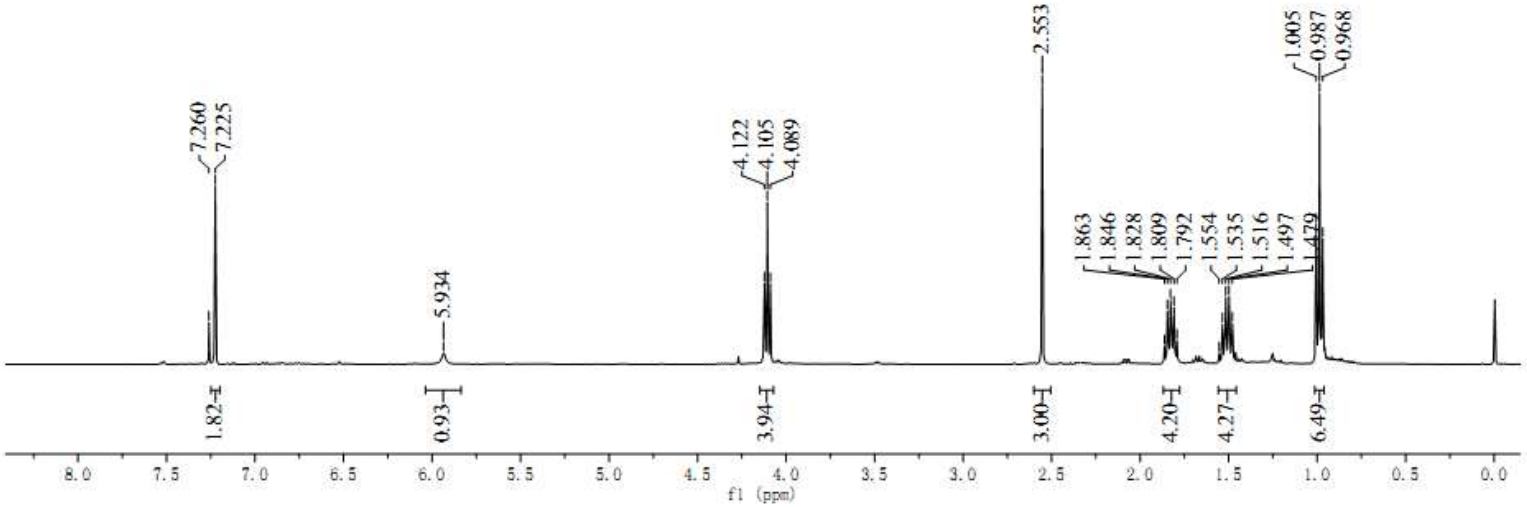

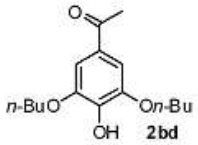

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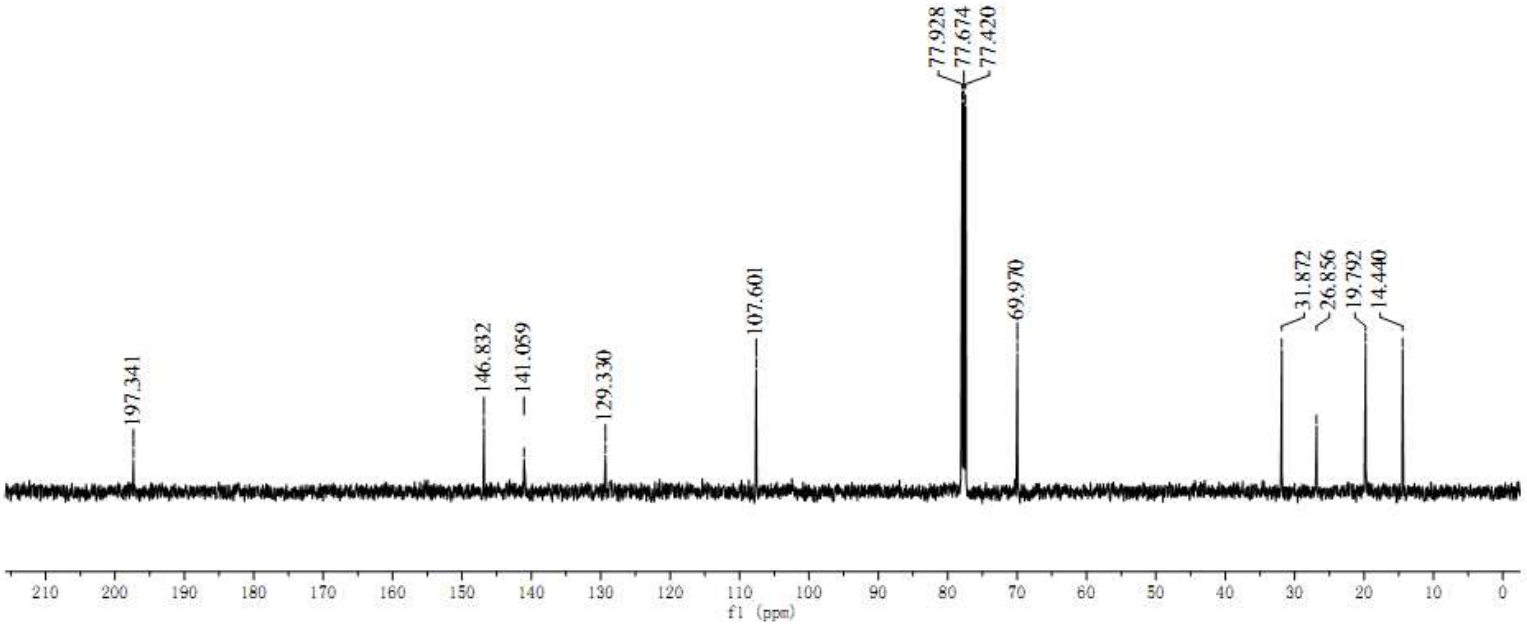
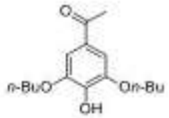


Elemental Composition Report



Single Mass Analysis

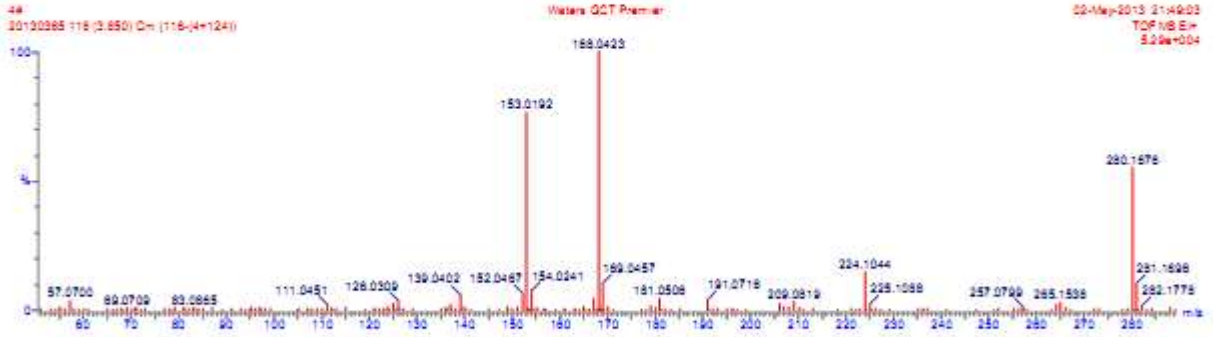
Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

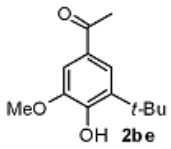
21 formula(e) evaluated with 5 results within limits (up to 50 closest results for each mass)

Elements Used:

C: 0-16 H: 0-24 O: 0-4



Minimum:						-1.5	
Maximum:		100.00	5.0	10.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
280.1676	55.00	280.1675	0.1	0.4	5.0	1	C16 H24 O4



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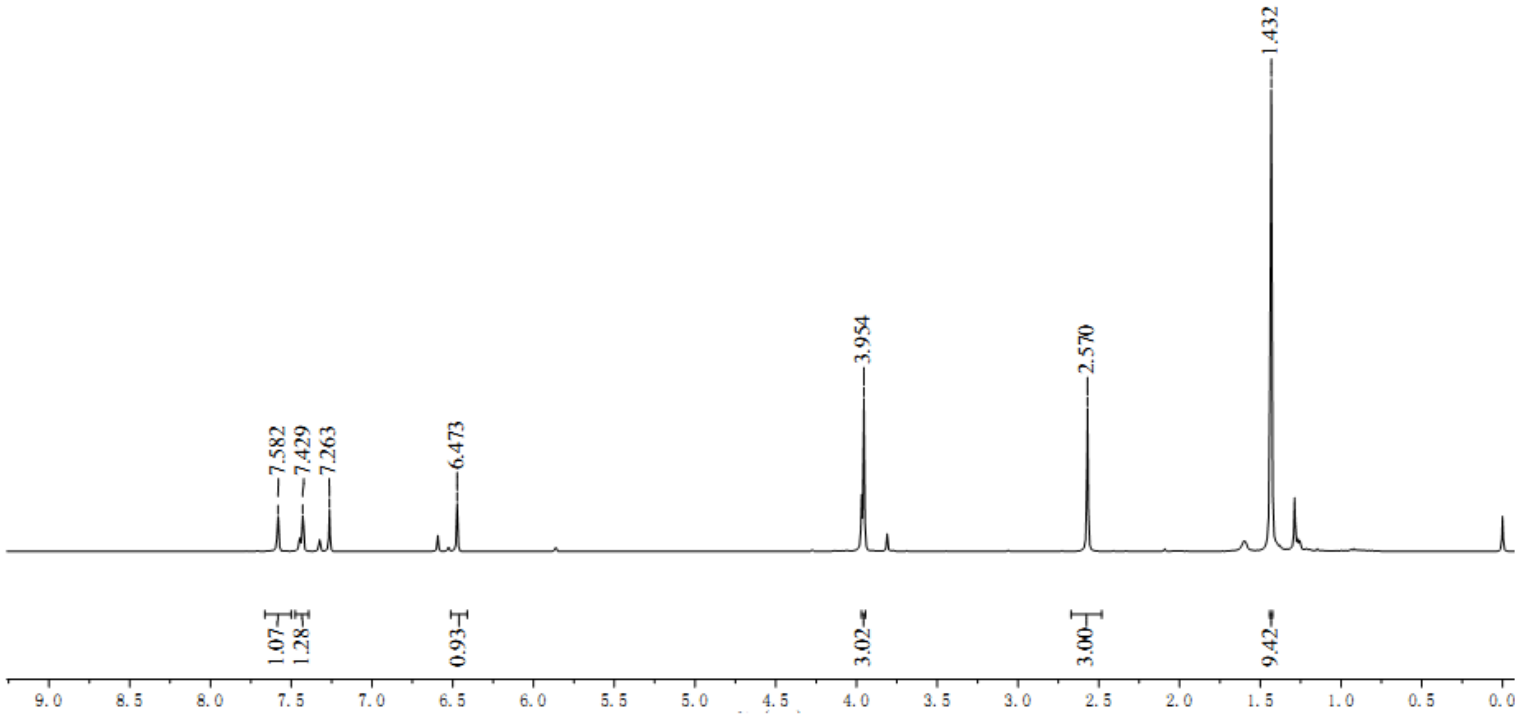

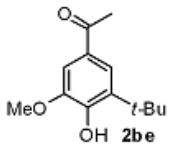

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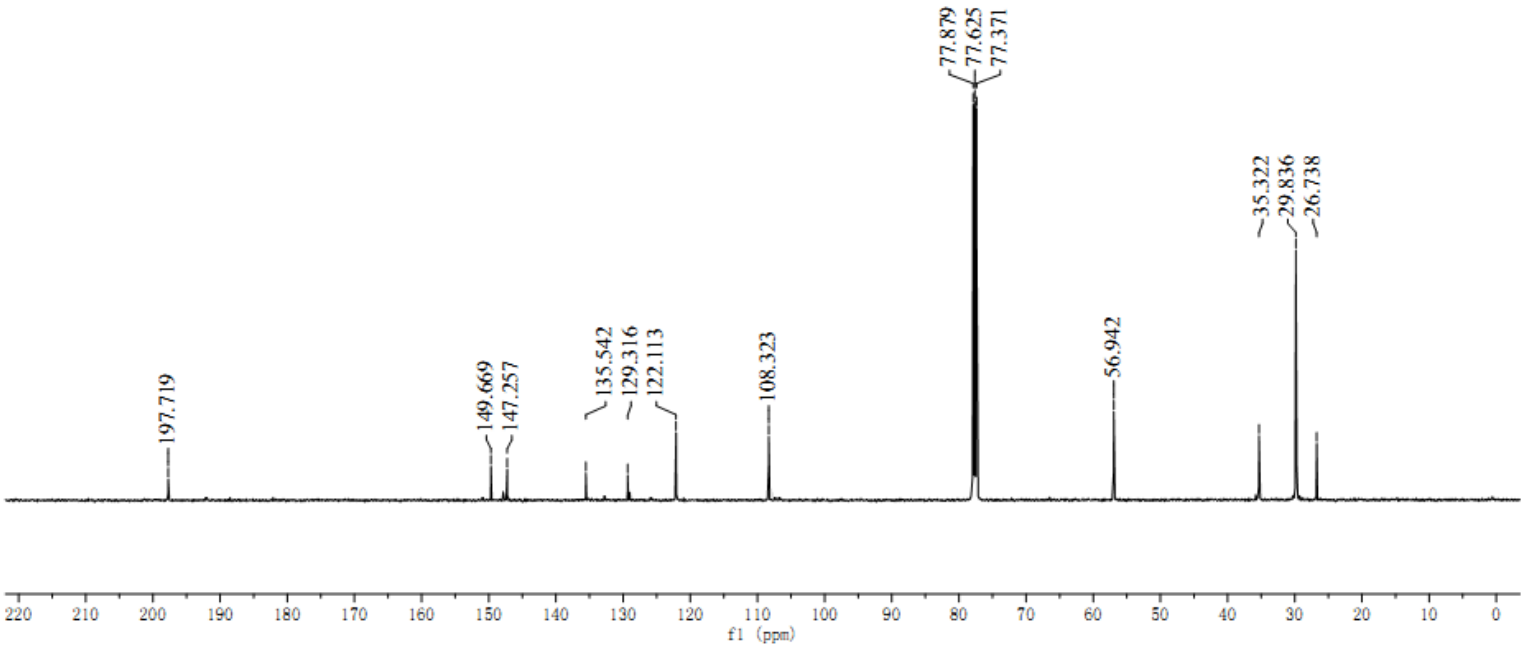
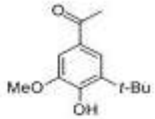


Elemental Composition Report



Single Mass Analysis

Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

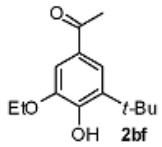
Monoisotopic Mass, Odd and Even Electron Ions

21 formula(e) evaluated with 5 results within limits (up to 50 closest results for each mass)

Elements Used:

C: 0-13 H: 0-18 O: 0-3

Minimum:					-1.5		
Maximum:		100.00	5.0	10.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
222.1254	32.66	222.1256	-0.2	-0.9	5.0	1	C13 H18 O3



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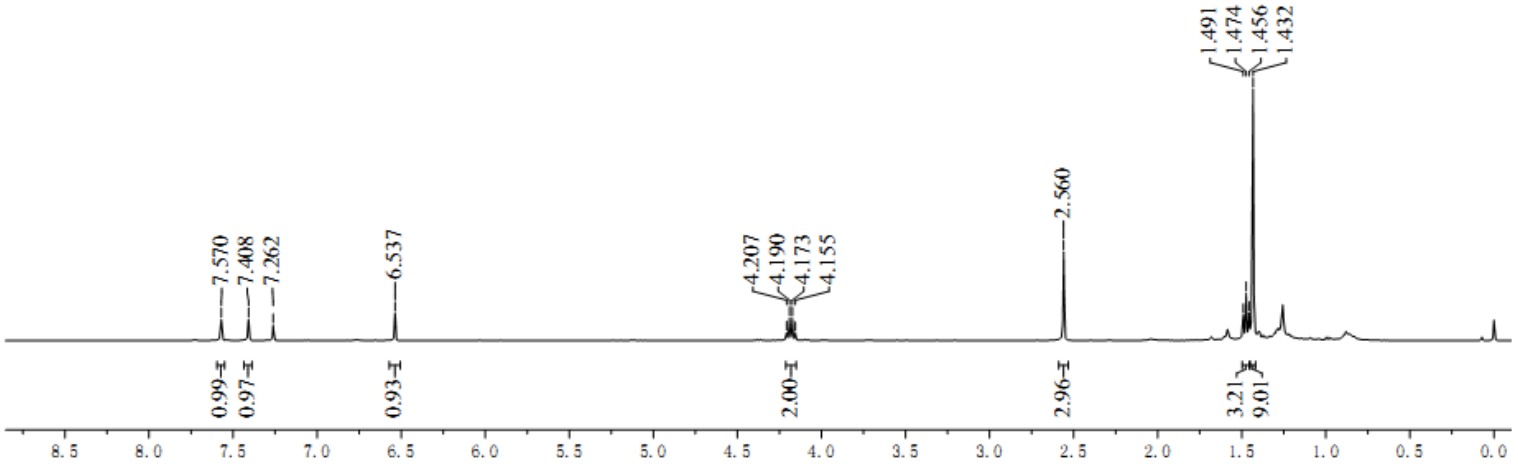

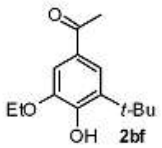

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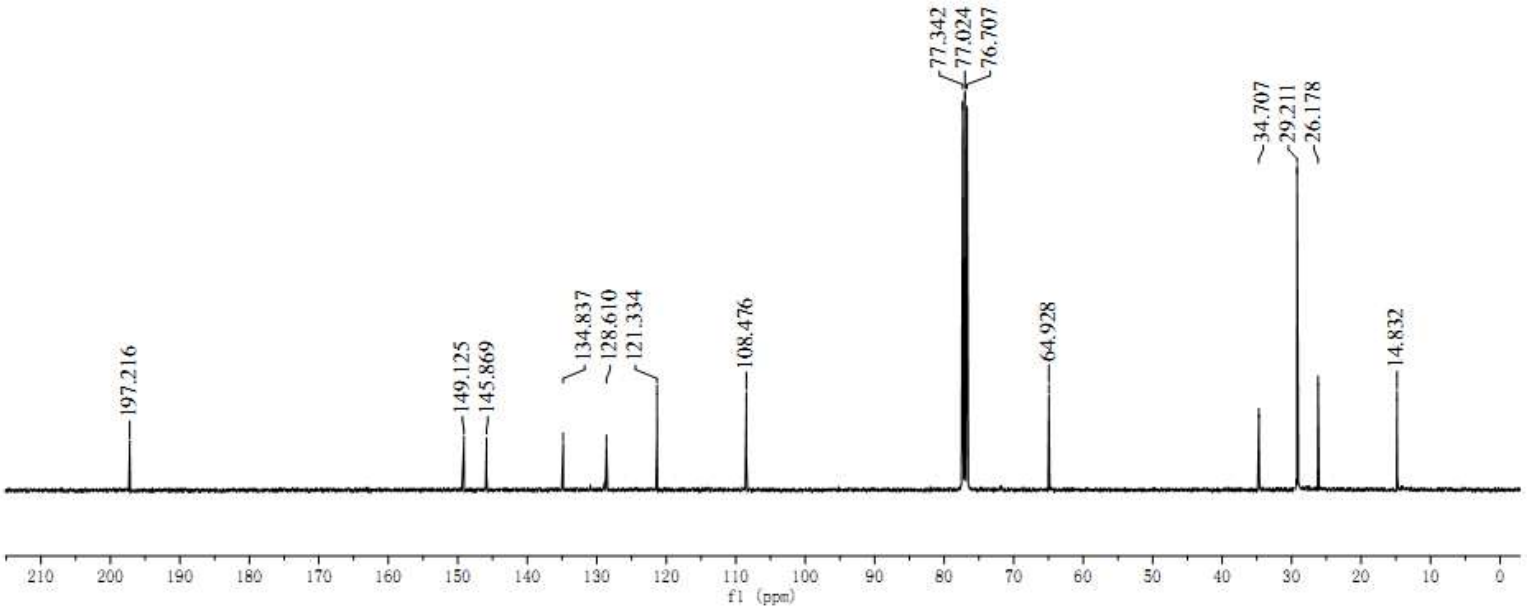
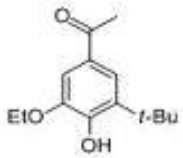


Elemental Composition Report



Single Mass Analysis

Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

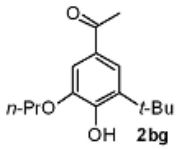
Monoisotopic Mass, Odd and Even Electron Ions

21 formula(e) evaluated with 5 results within limits (up to 50 closest results for each mass)

Elements Used:

C: 0-14 H: 0-20 O: 0-3

Minimum:					-1.5		
Maximum:		100.00	5.0	10.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
236.1414	43.88	236.1412	0.2	0.8	5.0	1	C14 H20 O3



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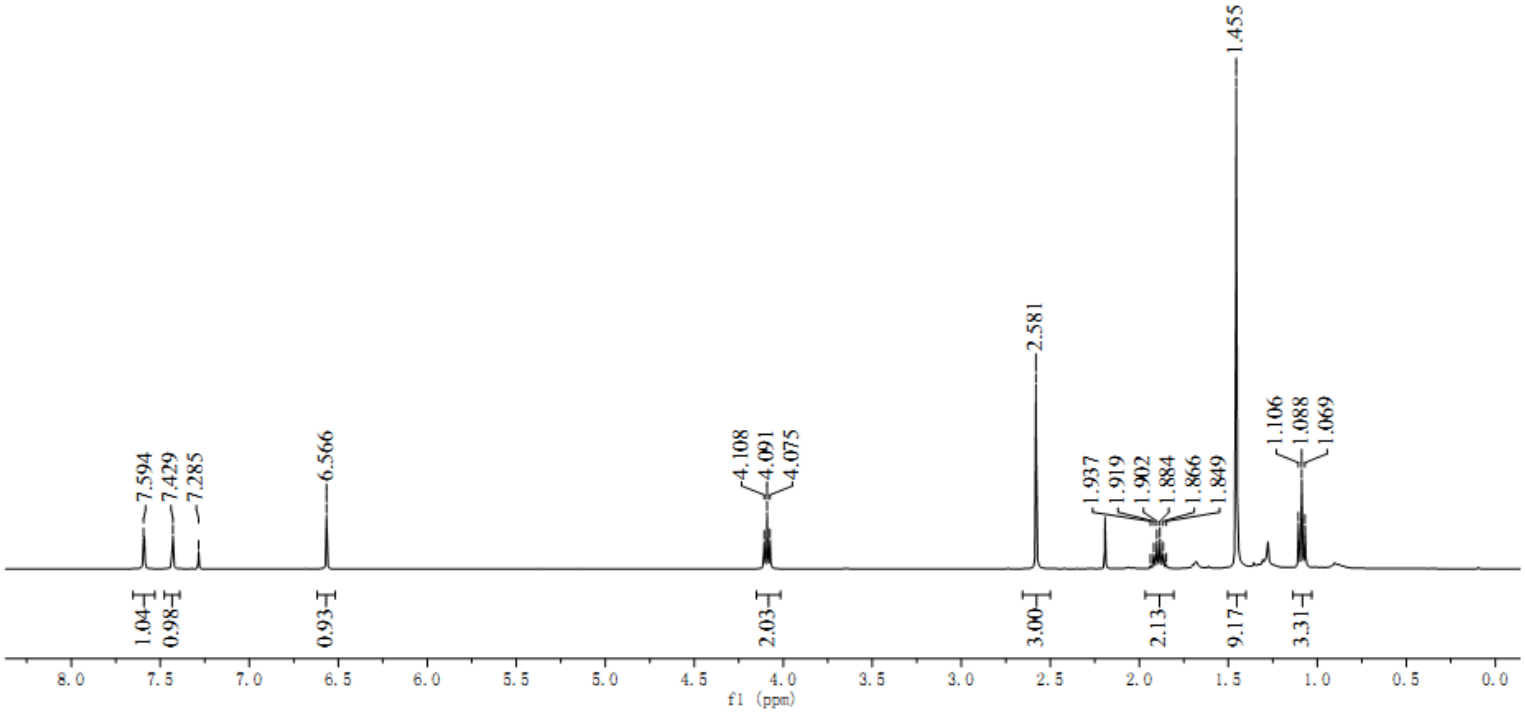

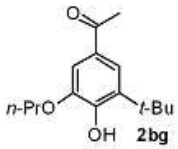

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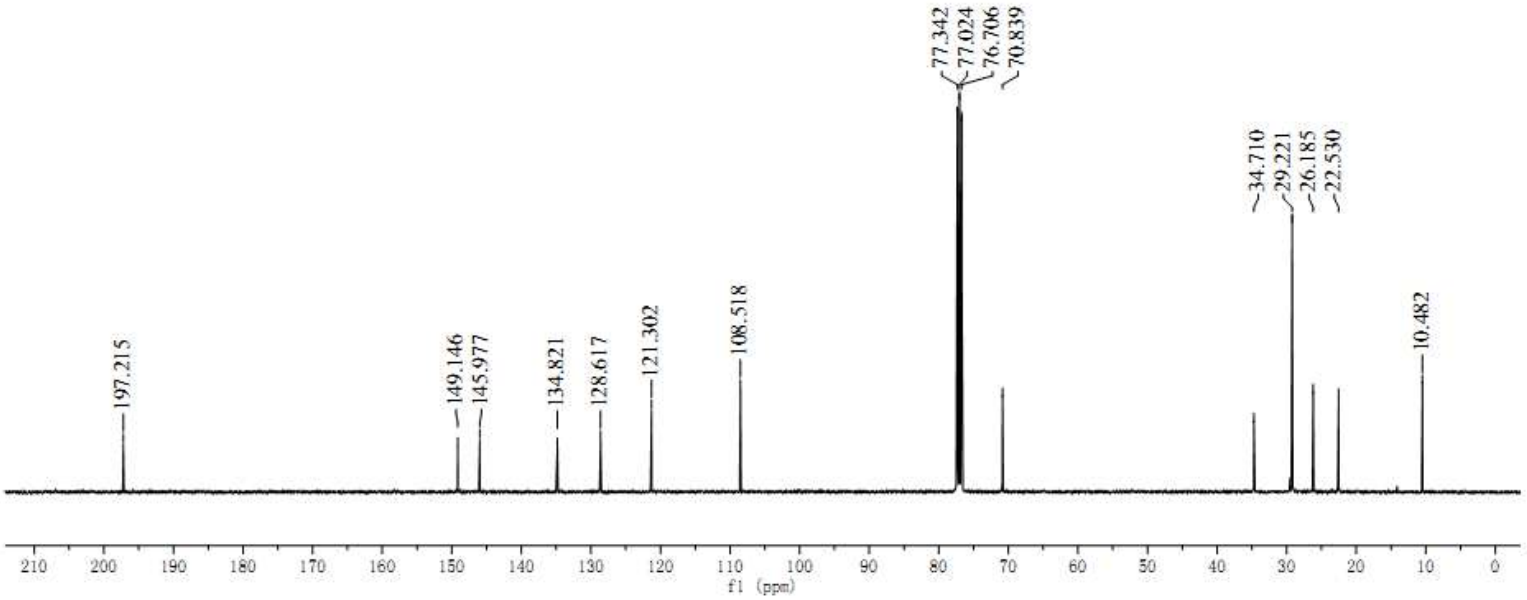
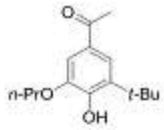


Elemental Composition Report



Single Mass Analysis

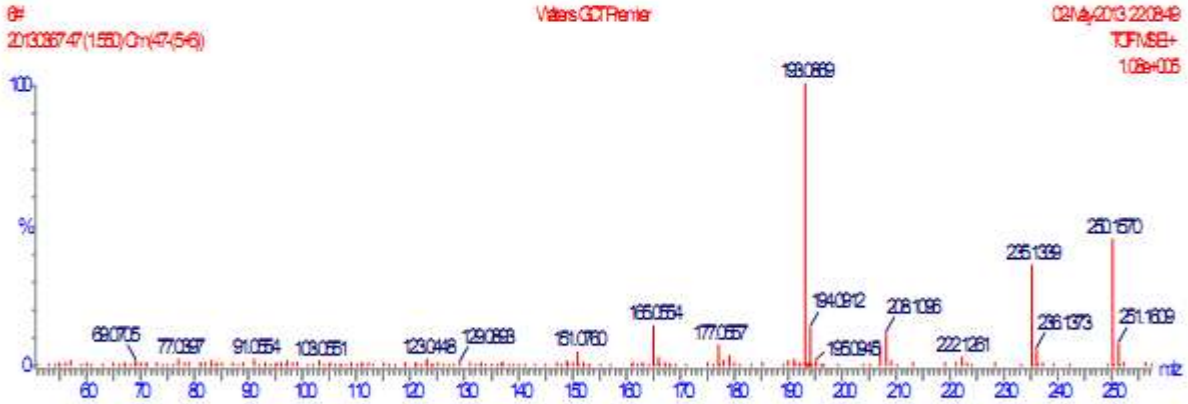
Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

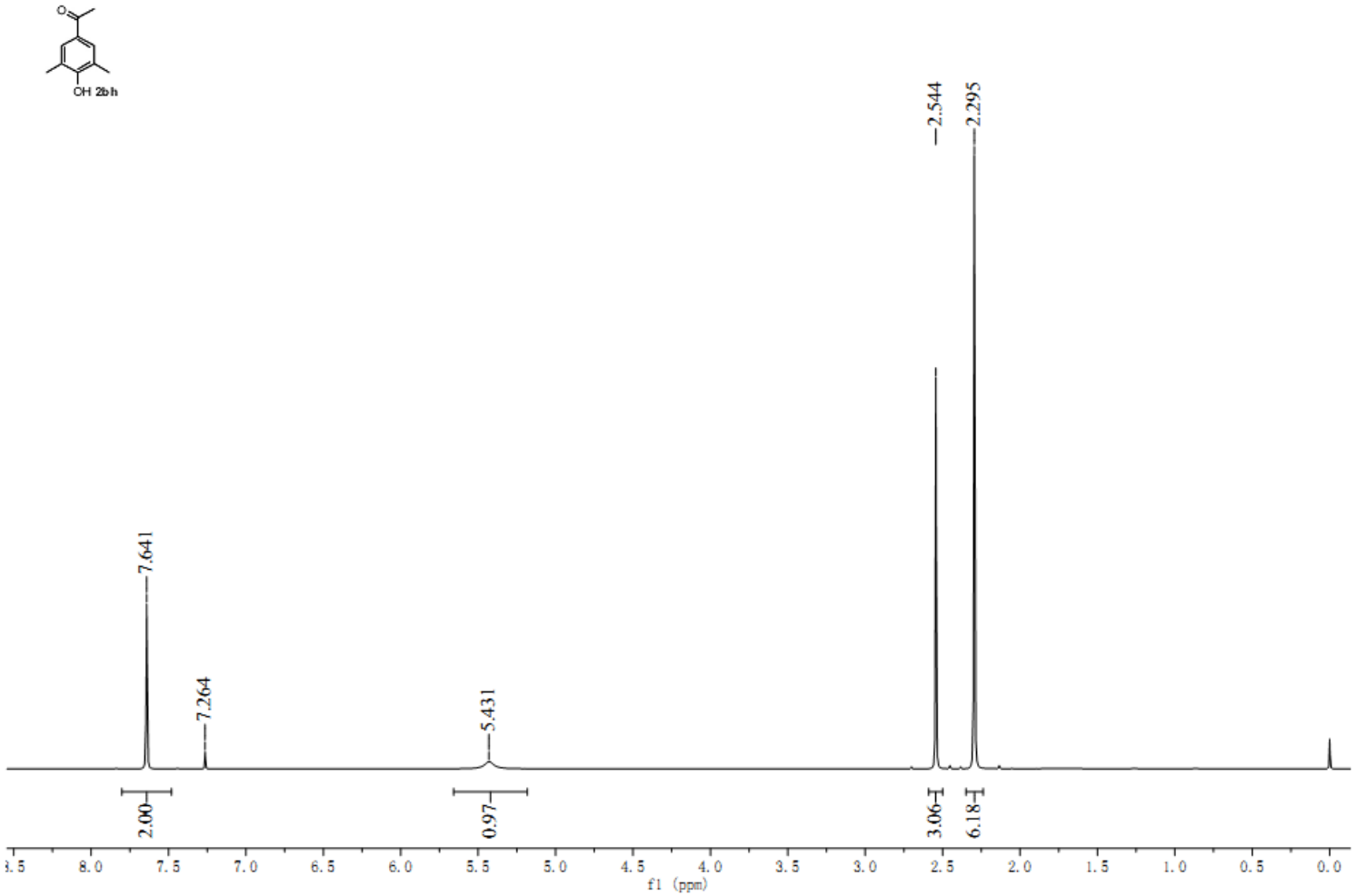
21 formula(e) evaluated with 5 results within limits (up to 50 closest results for each mass)

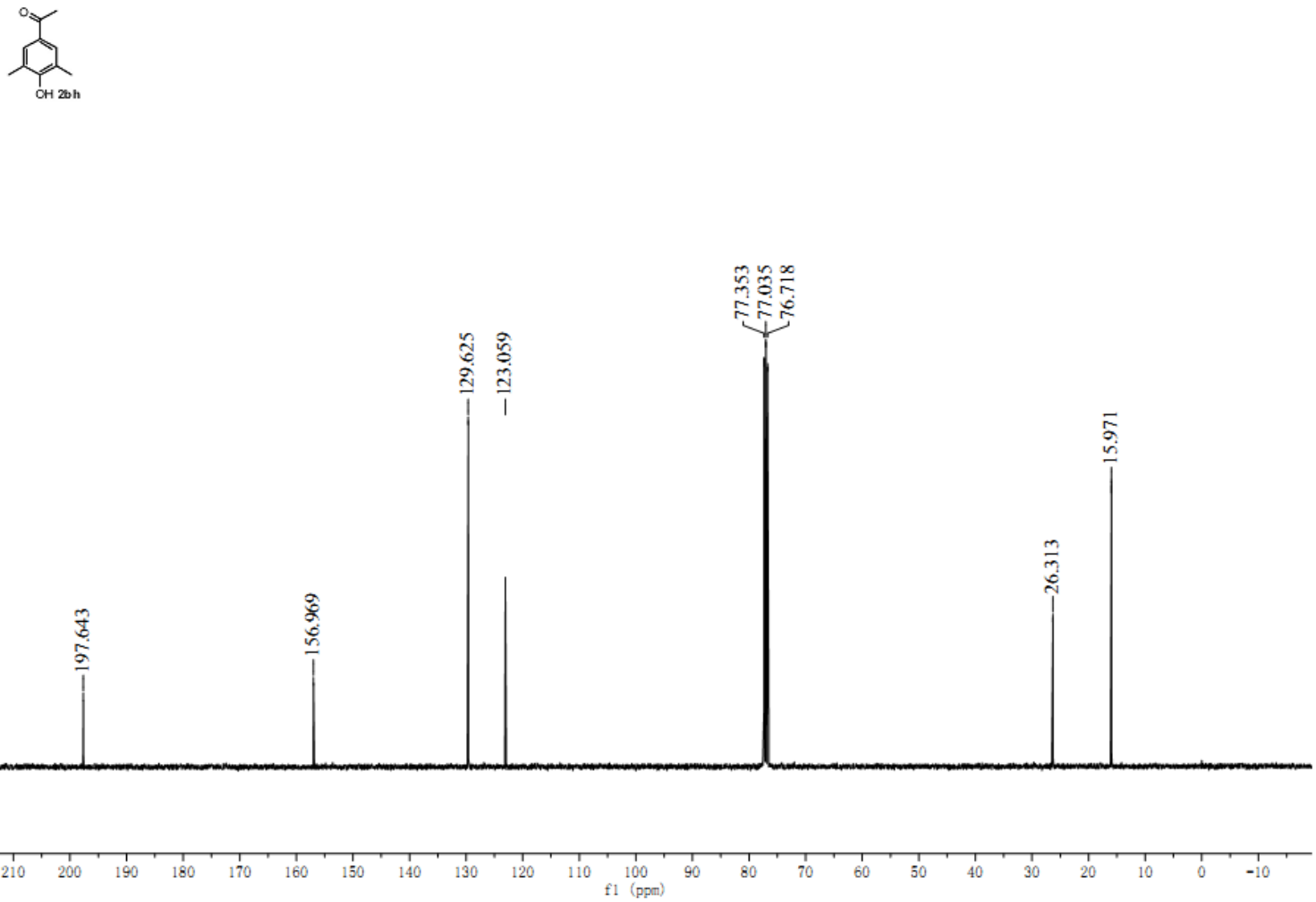
Elements Used:

C: 0-15 H: 0-22 O: 0-3

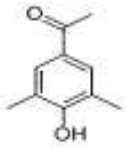


Minimum:					-1.5		
Maximum:		100.00	5.0	10.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
250.1570	44.79	250.1569	0.1	0.4	5.0	1	C15 H22 O3





Elemental Composition Report



Single Mass Analysis

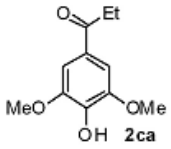
Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

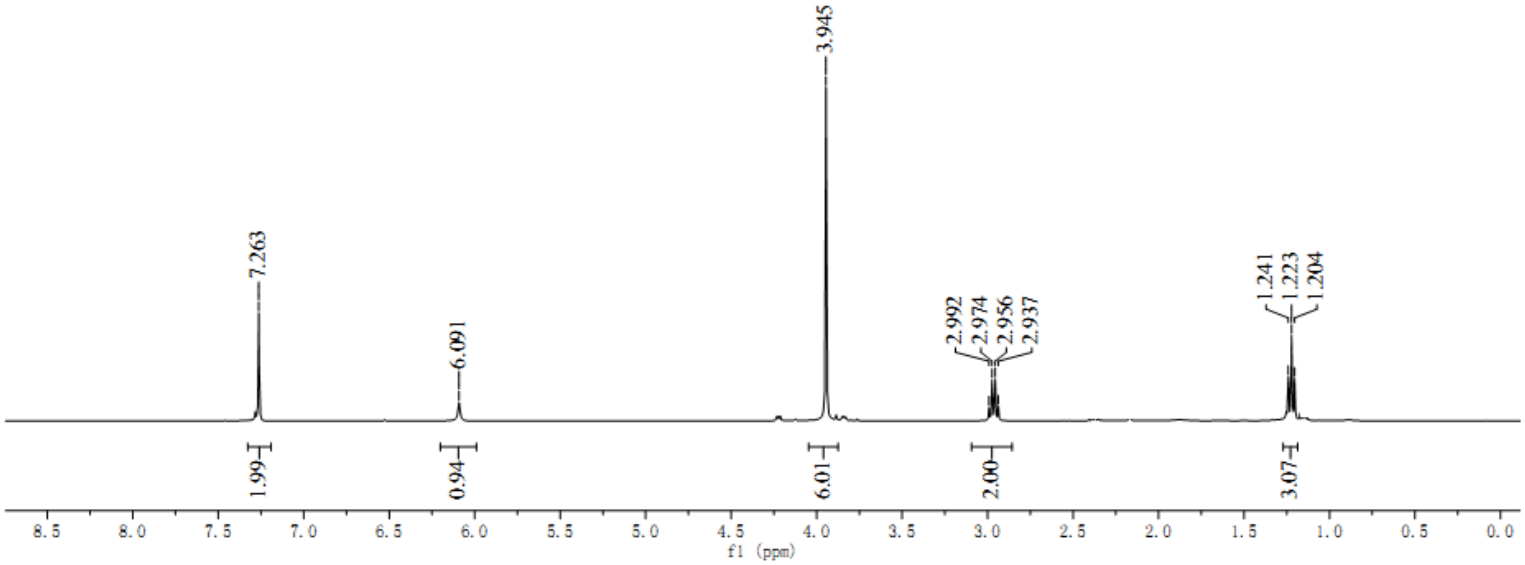
23 formula(e) evaluated with 6 results within limits (up to 50 closest results for each mass)
Elements Used:

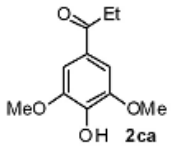
C: 0-10 H: 0-12 O: 0-2

Minimum:		3.00			-1.5		
Maximum:		100.00	5.0	5.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
164.0838	40.80	164.0837	0.1	0.4	5.0	1	C10 H12 O2

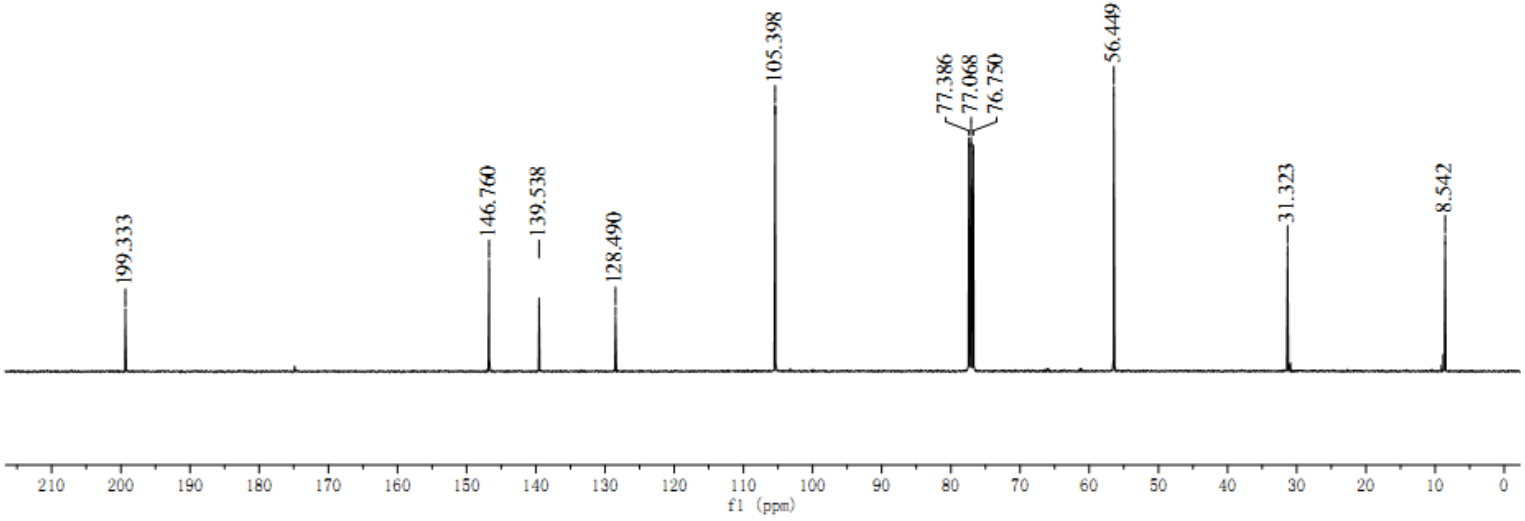


2ca

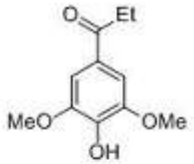




2ca



Elemental Composition Report



Single Mass Analysis

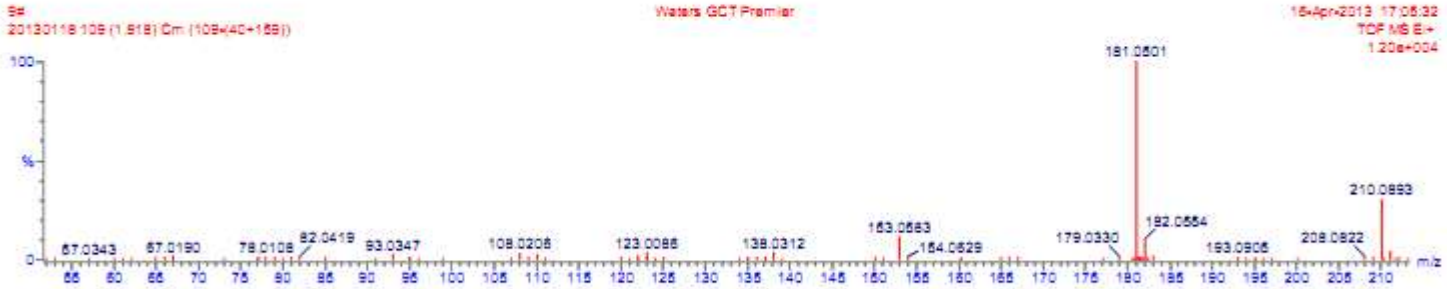
Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

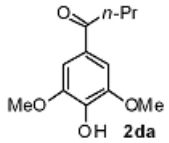
21 formula(e) evaluated with 5 results within limits (up to 50 closest results for each mass)

Elements Used:

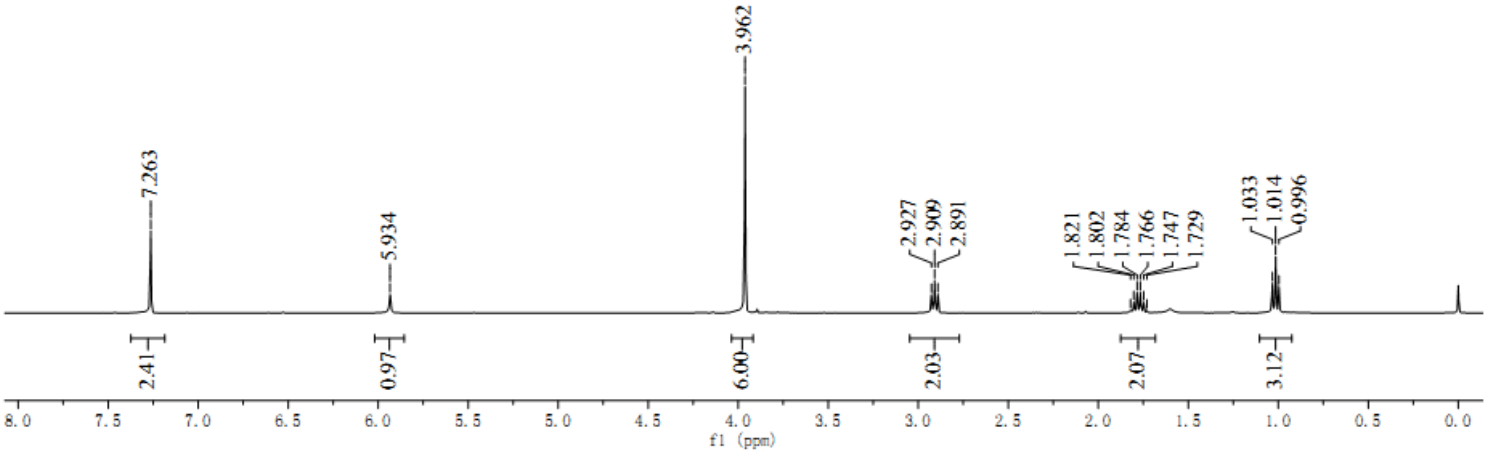
C: 0-11 H: 0-14 O: 0-4

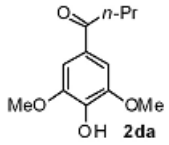


Minimum:					-1.5		
Maximum:		100.00	5.0	10.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
210.0893	29.89	210.0892	0.1	0.5	5.0	1	C11 H14 O4

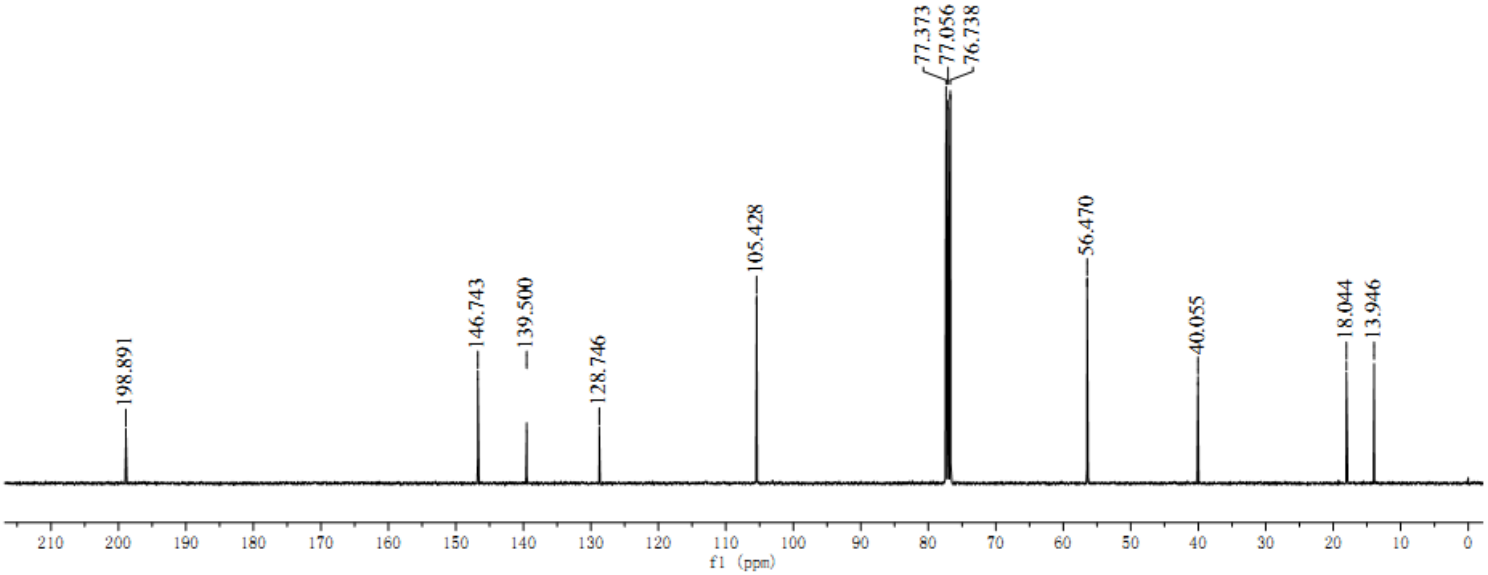


2da

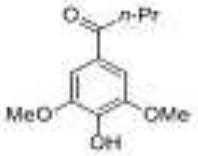




2da



Elemental Composition Report



Single Mass Analysis

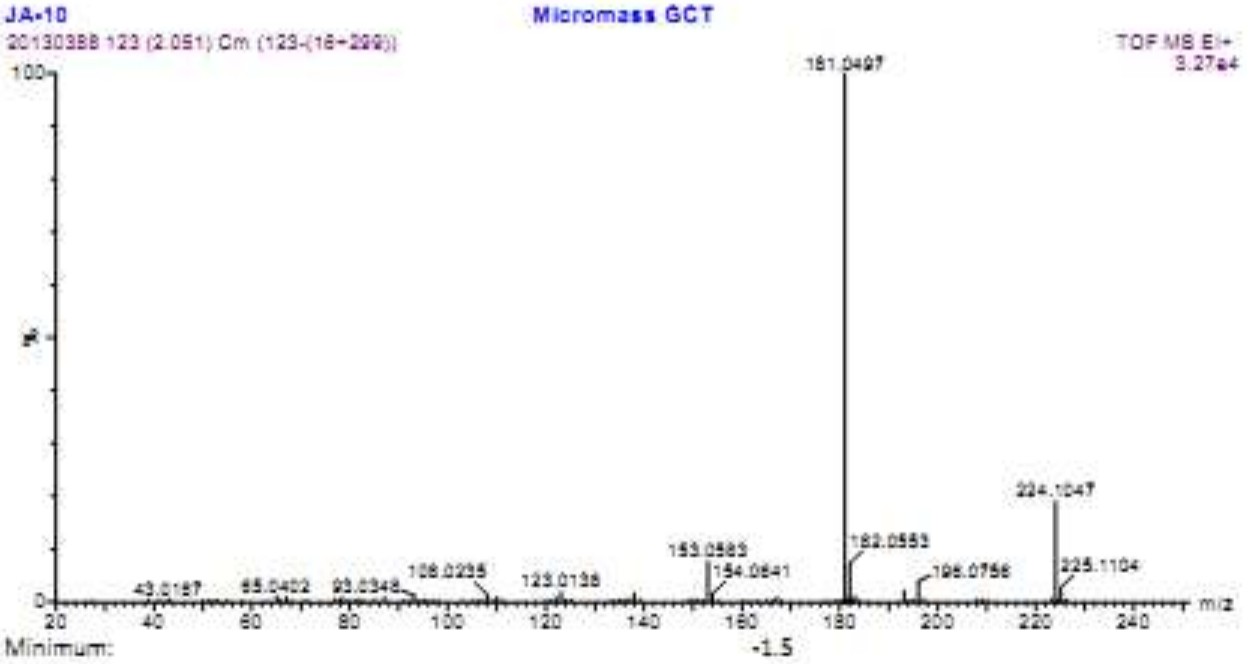
Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

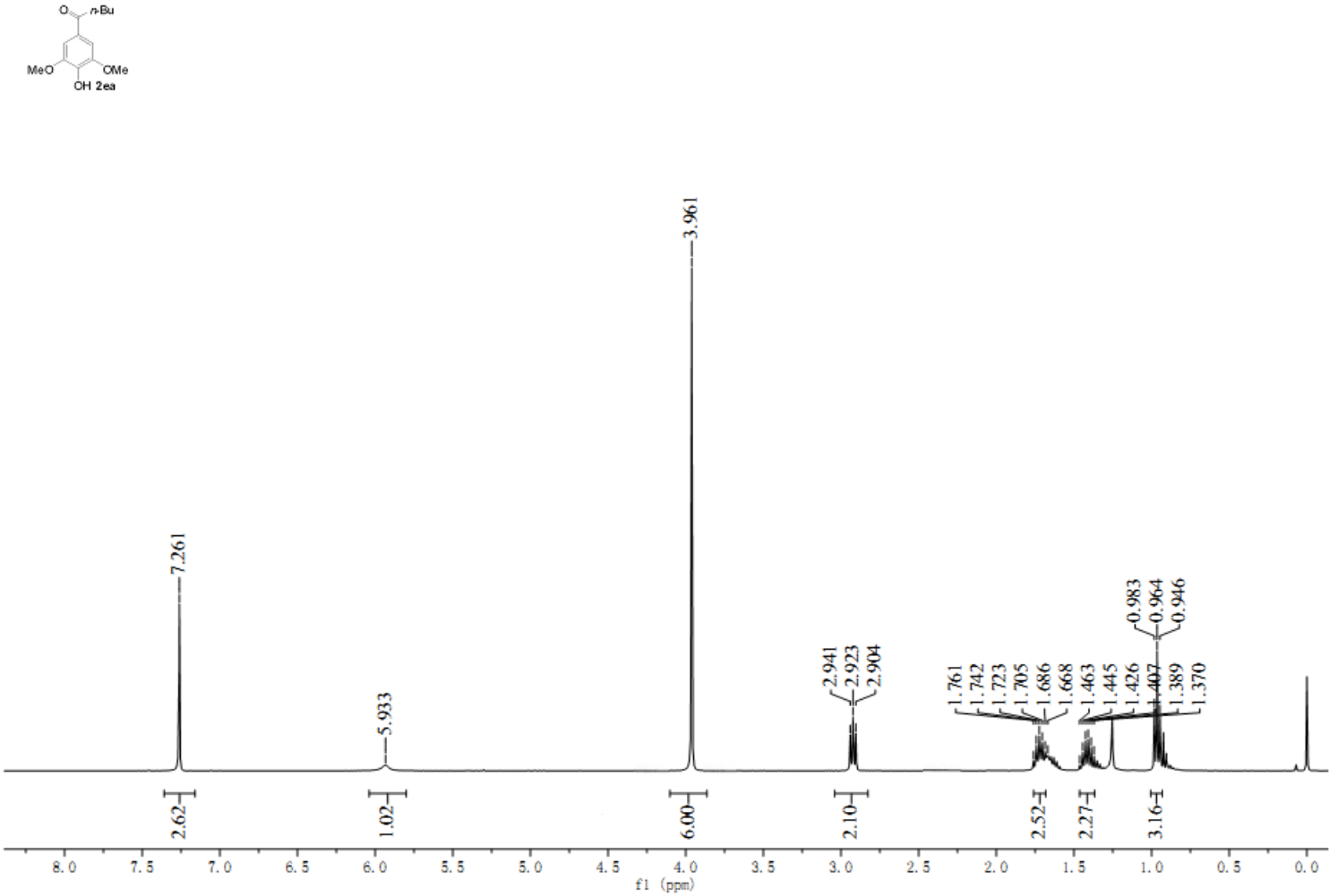
21 formula(e) evaluated with 5 results within limits (up to 50 closest results for each mass)

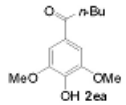
Elements Used:

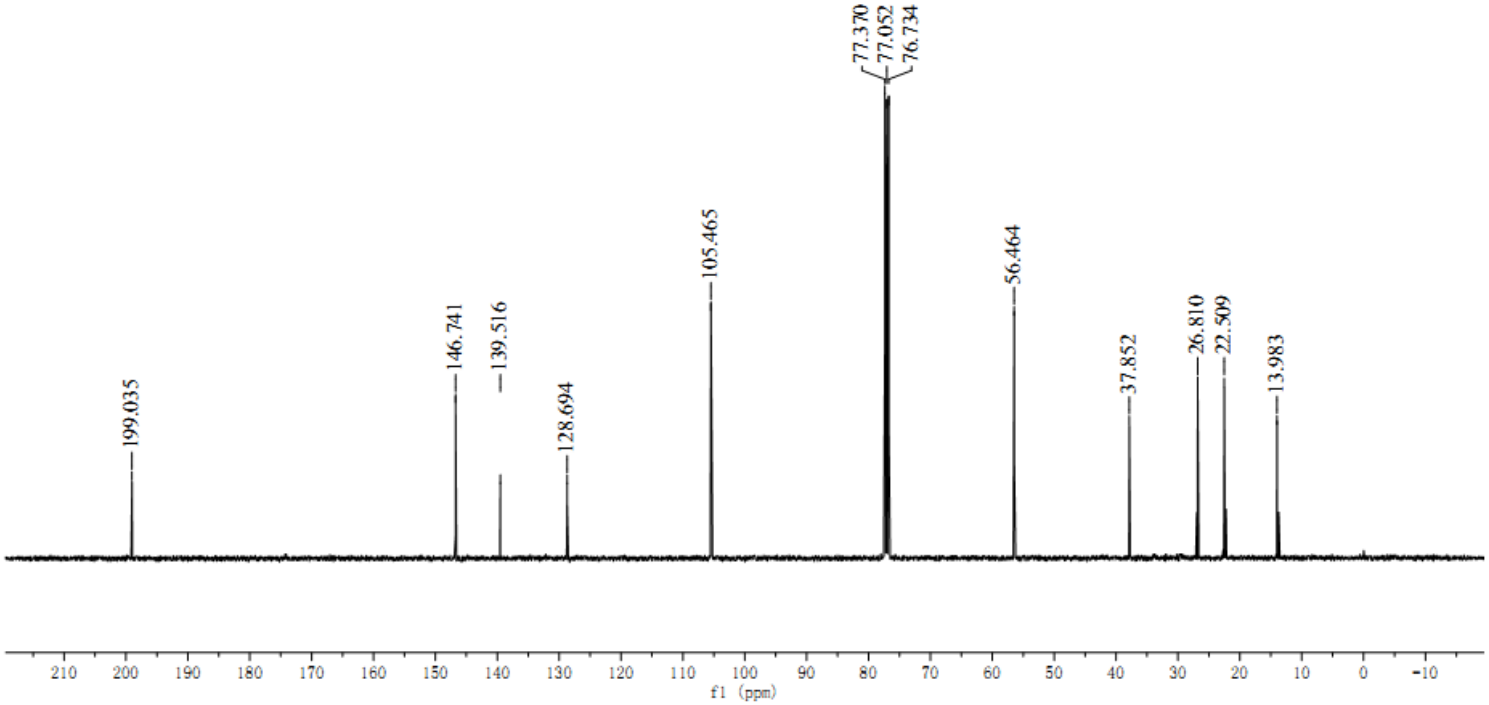
C: 0-12 H: 0-16 O: 0-4



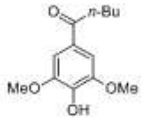
Minimum:					-1.5		
Maximum:		100.00	5.0	10.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
224.1047	18.94	224.1049	-0.2	-0.7	5.0	1	C12 H16 O4







Elemental Composition Report



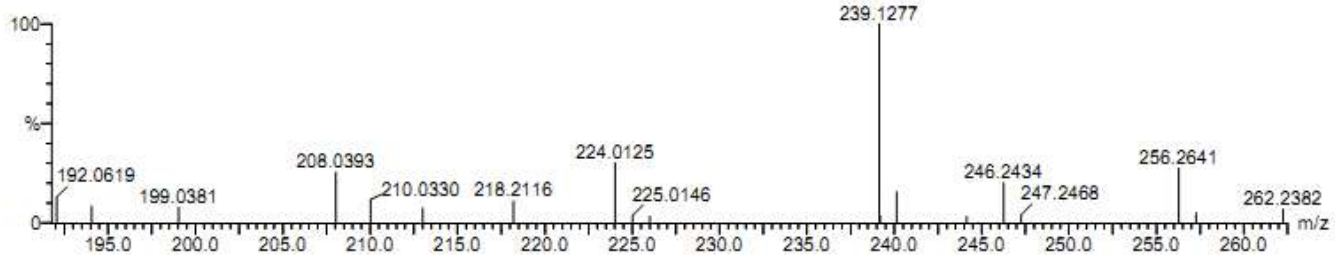
Single Mass Analysis

Tolerance = 30.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

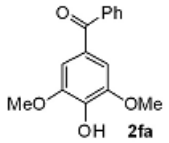
Monoisotopic Mass, Even Electron Ions
6 formula(e) evaluated with 1 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-13 H: 0-80 O: 0-4

YF-JI ECUST institute of Fine Chem 15-Sep-2013 16:18:12

JYF-JG-4 36 (0.311) Cm (30:37) 1: TOF MS ES+ 1.14e+004



Minimum:				-1.5			
Maximum:		30.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
239.1277	239.1283	-0.6	-2.5	4.5	18.7	0.0	C13 H19 O4



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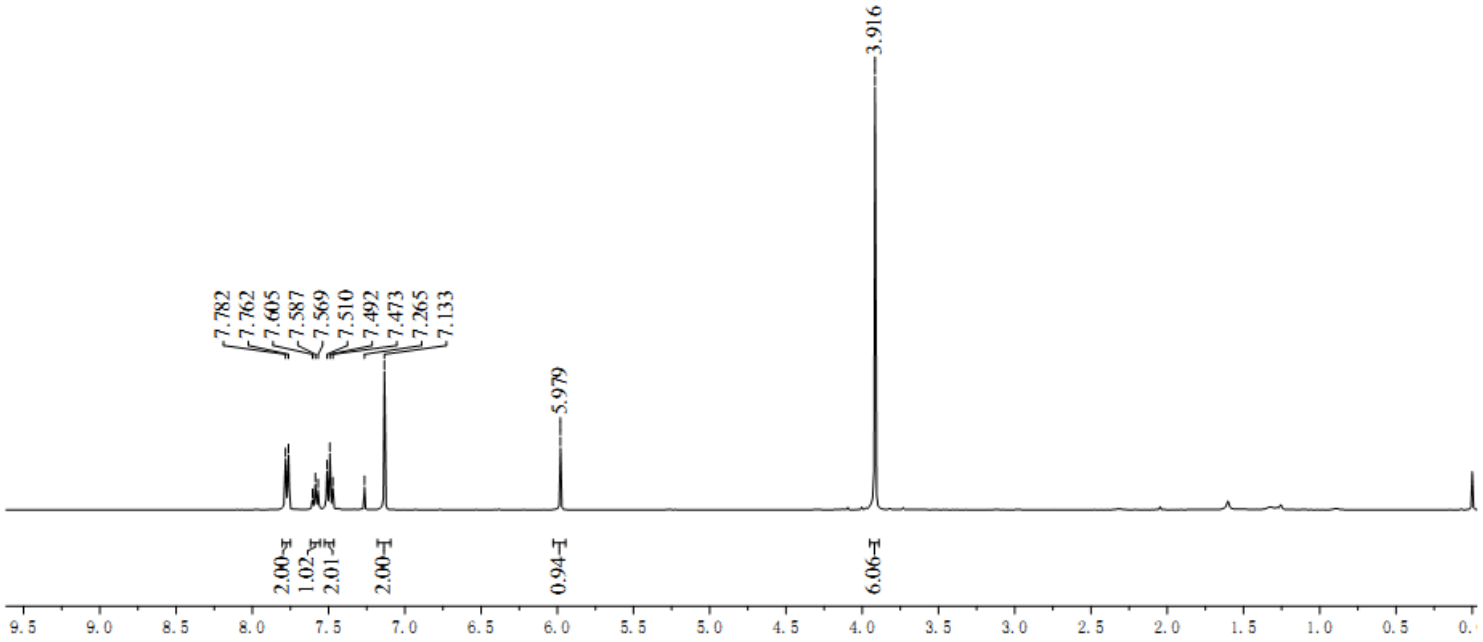

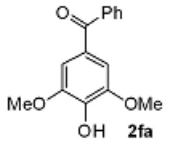

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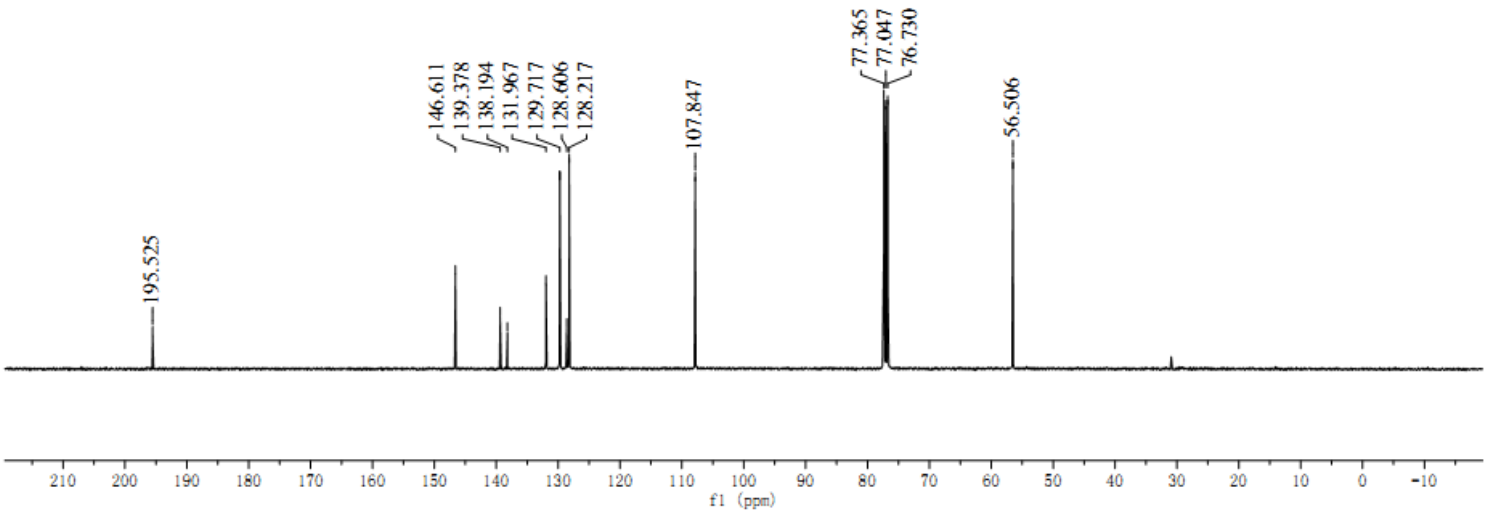
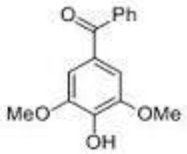


Elemental Composition Report



Single Mass Analysis

Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

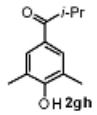
Monoisotopic Mass, Odd and Even Electron Ions

21 formula(e) evaluated with 5 results within limits (up to 50 closest results for each mass)

Elements Used:

C: 0-15 H: 0-14 O: 0-4

Minimum:					-1.5		
Maximum:		100.00	5.0	10.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
258.0896	88.21	258.0892	0.4	1.5	9.0	1	C15 H14 O4



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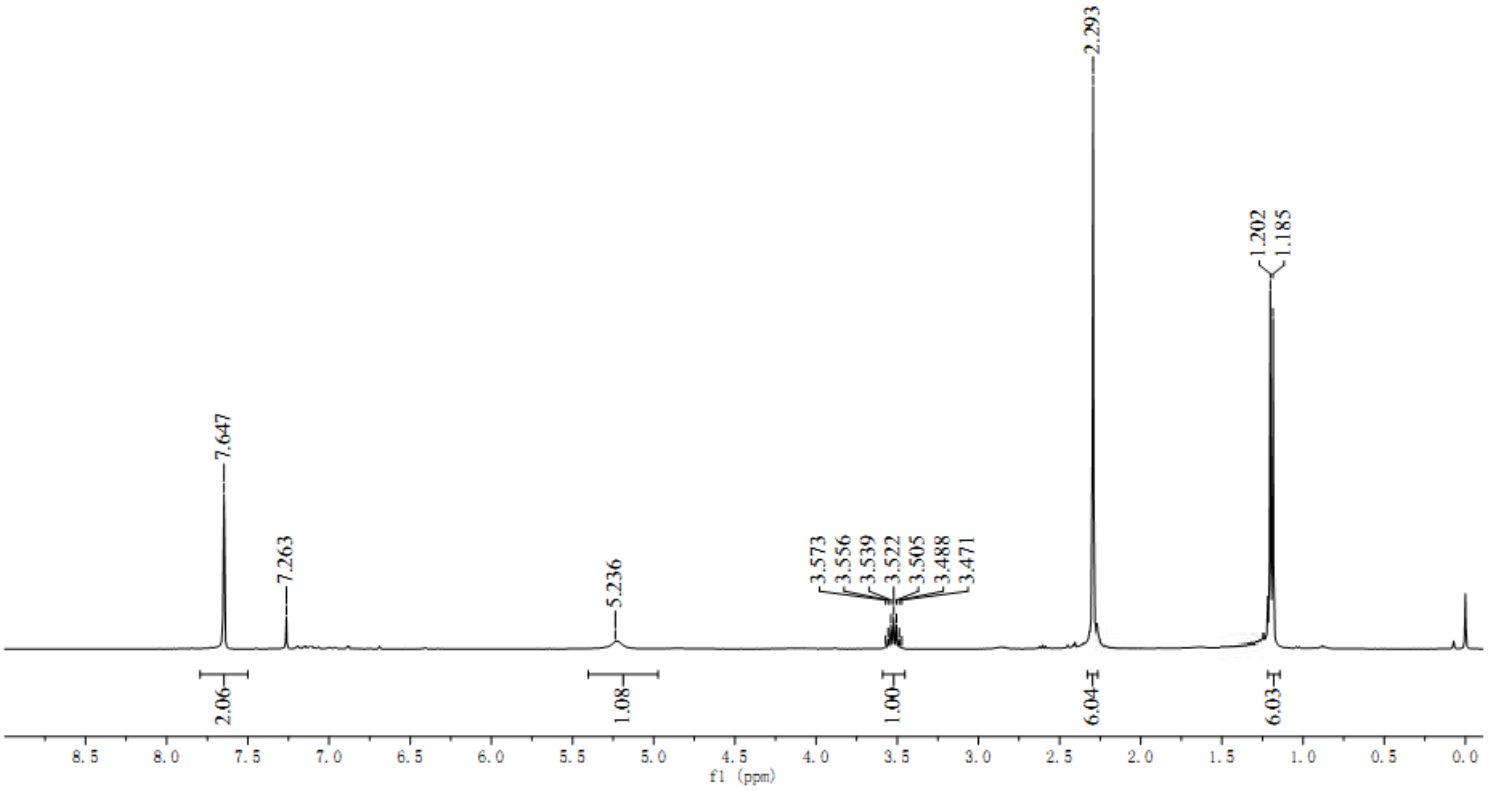

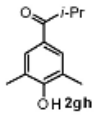

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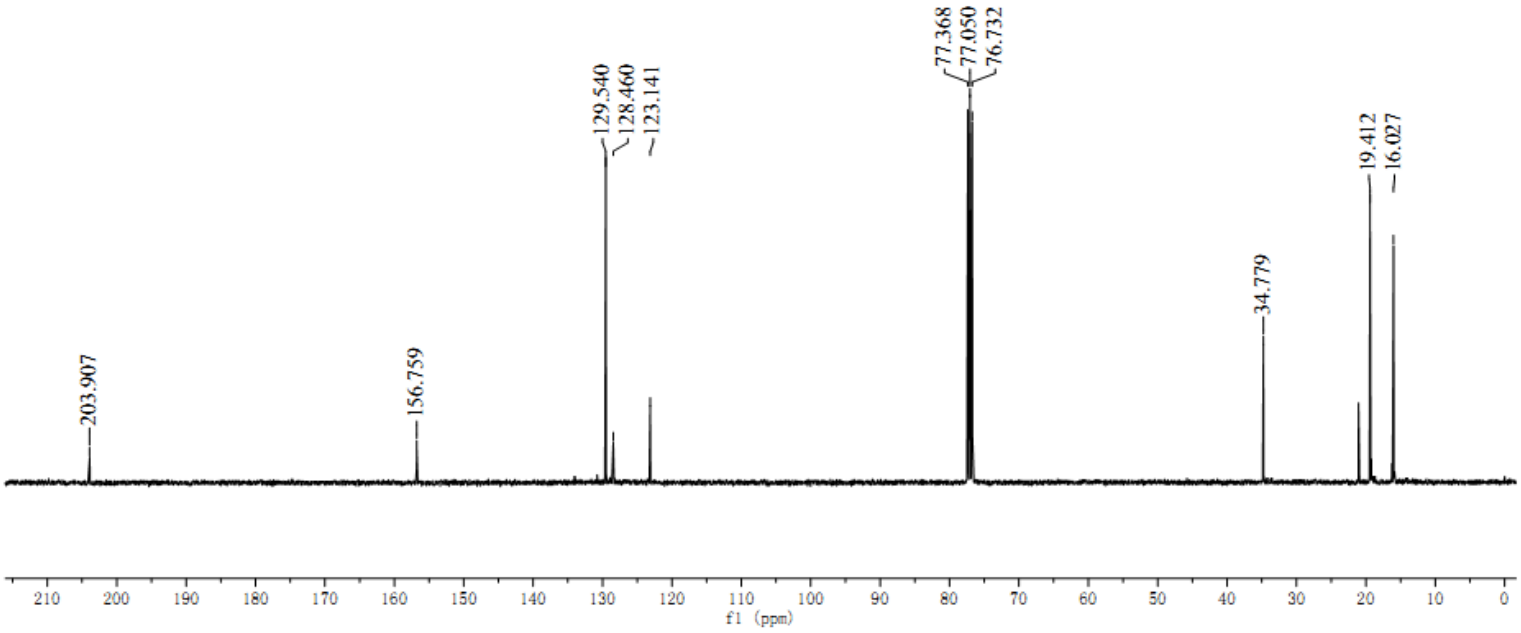
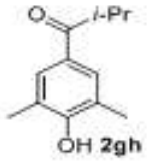


Elemental Composition Report



2gh

Single Mass Analysis

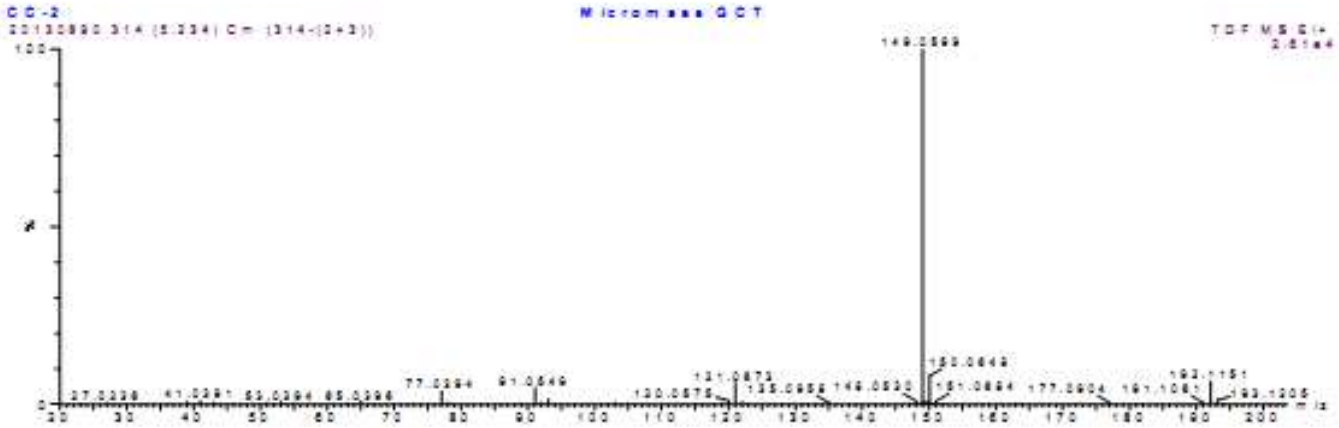
Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

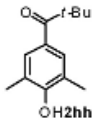
18 formula(e) evaluated with 7 results within limits (up to 50 closest results for each mass)

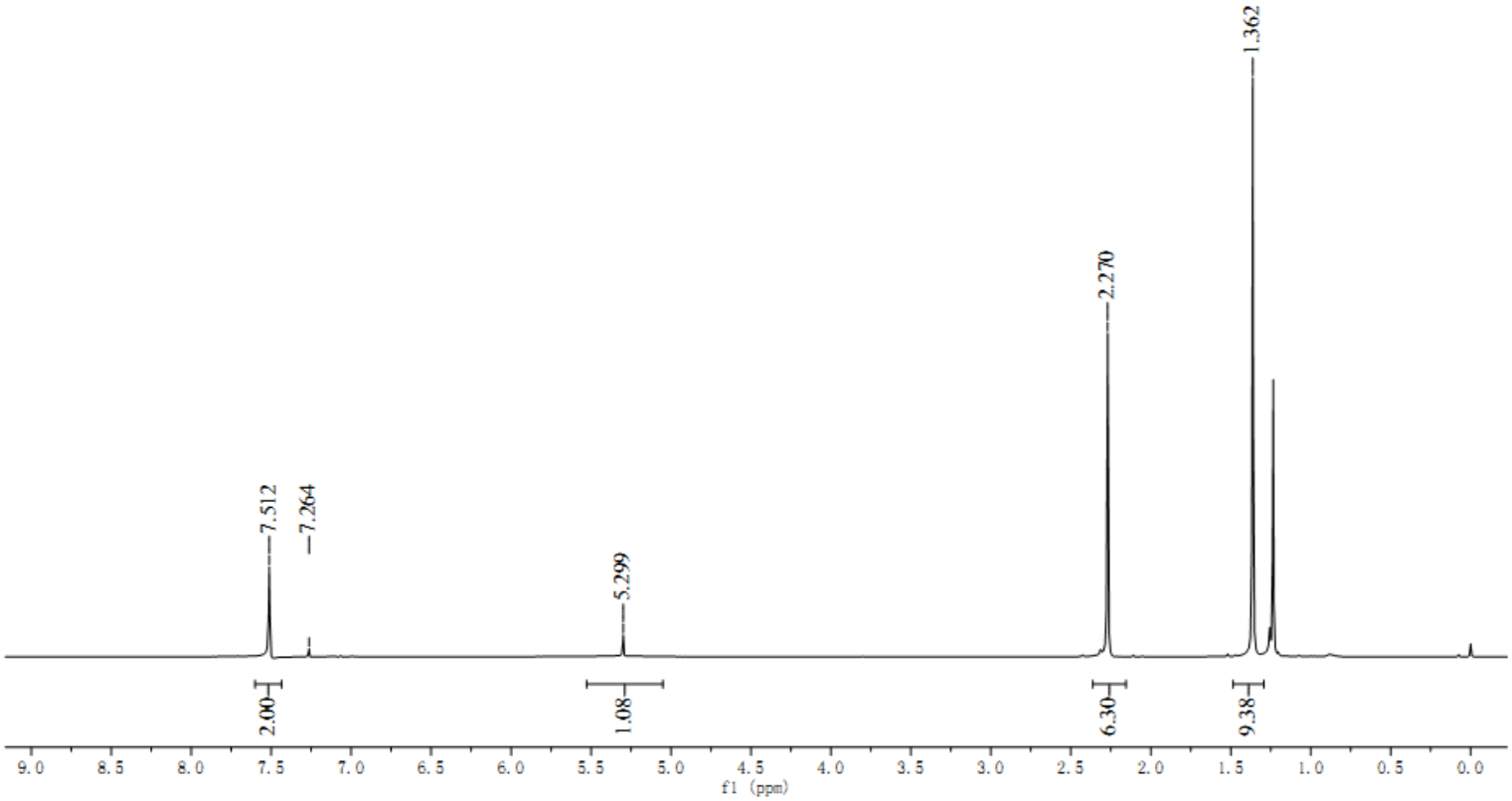
Elements Used:

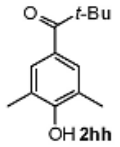
C: 0-12 H: 0-16 O: 0-2



Minimum:		3.00			-1.5		
Maximum:		100.00	5.0	5.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
192.1151	6.35	192.1150	0.1	0.4	5.0	1	C12 H16 O2







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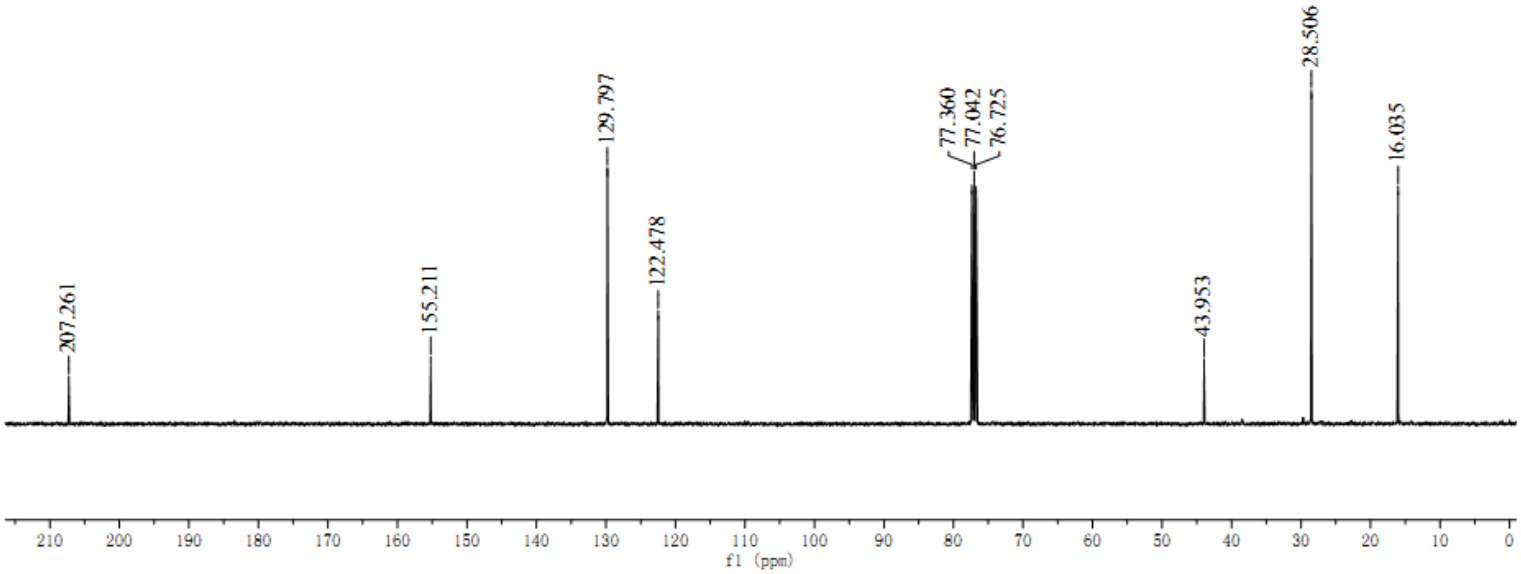
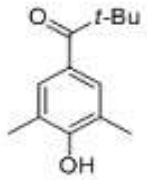


Elemental Composition Report



Single Mass Analysis

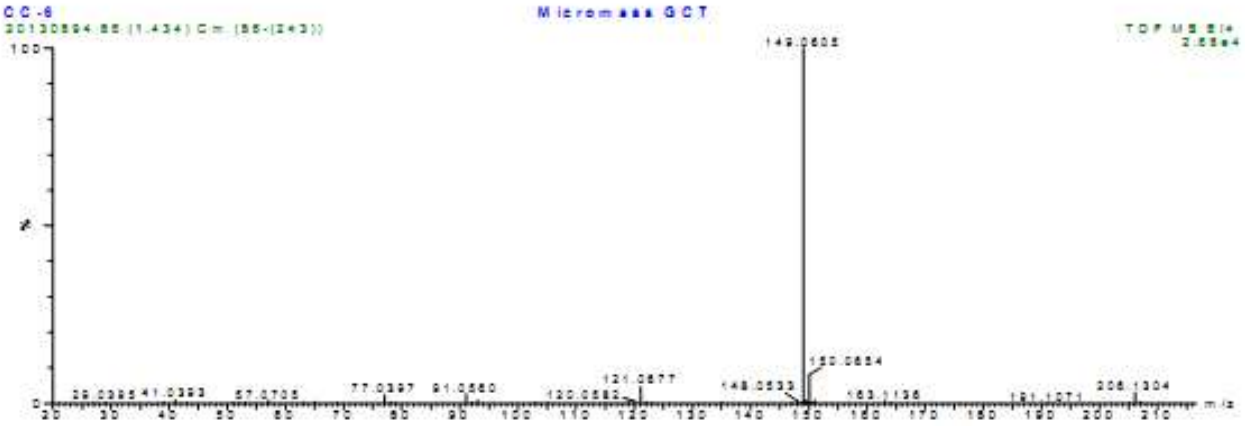
Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

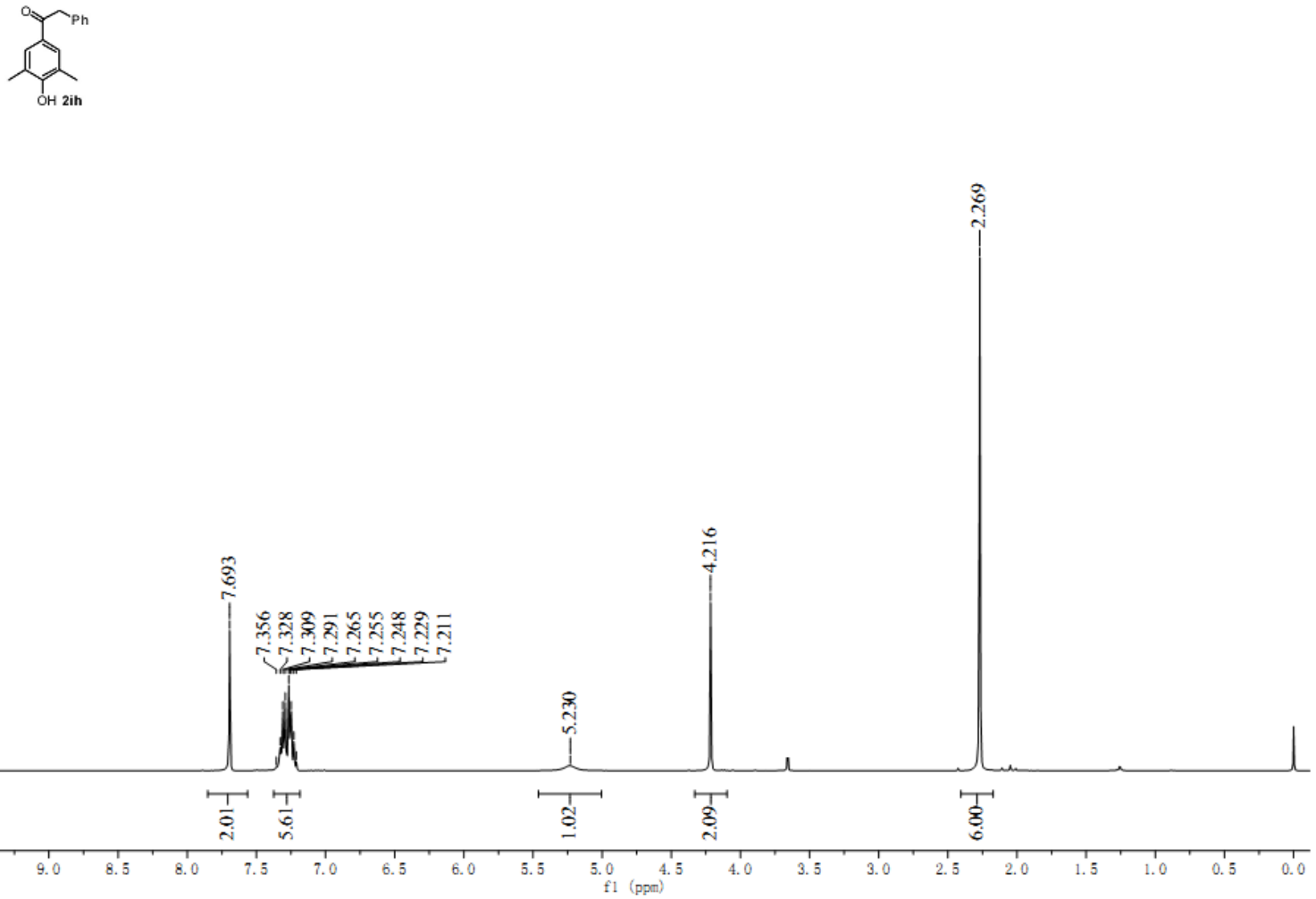
27 formula(e) evaluated with 6 results within limits (up to 50 closest results for each mass)

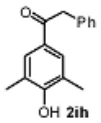
Elements Used:

C: 0-13 H: 0-18 O: 0-2



Minimum:		3.00			-1.5	
Maximum:		100.00	5.0	5.0	50.0	
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
206.1304	3.12	206.1307	-0.3	-1.4	5.0	1	C13 H18 O2





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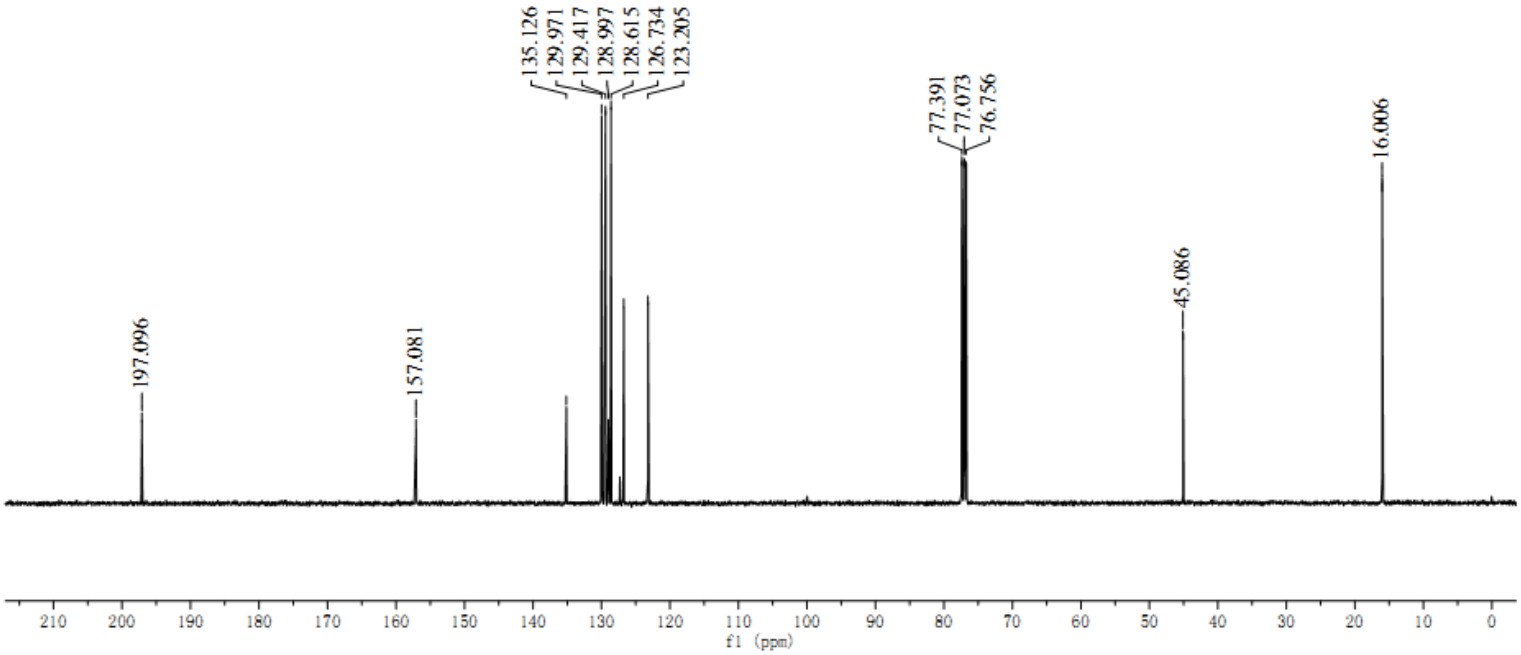
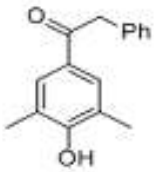


Elemental Composition Report



Single Mass Analysis

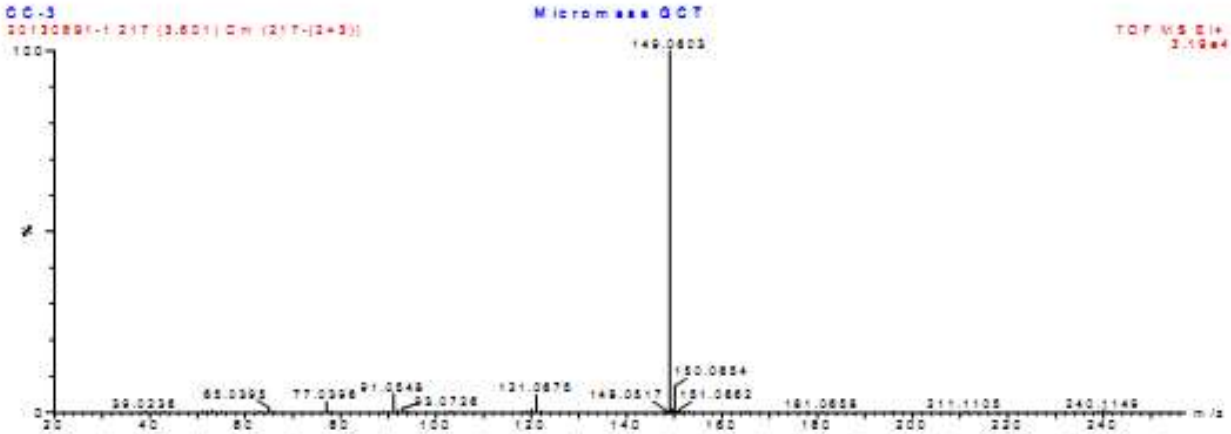
Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

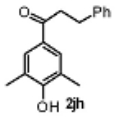
54 formula(e) evaluated with 10 results within limits (up to 50 closest results for each mass)

Elements Used:

C: 0-16 H: 0-16 O: 0-2



Minimum:		3.00			-1.5		
Maximum:		100.00	5.0	5.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
240.1149	0.64	240.1150	-0.1	-0.5	9.0	1	C16 H16 O2



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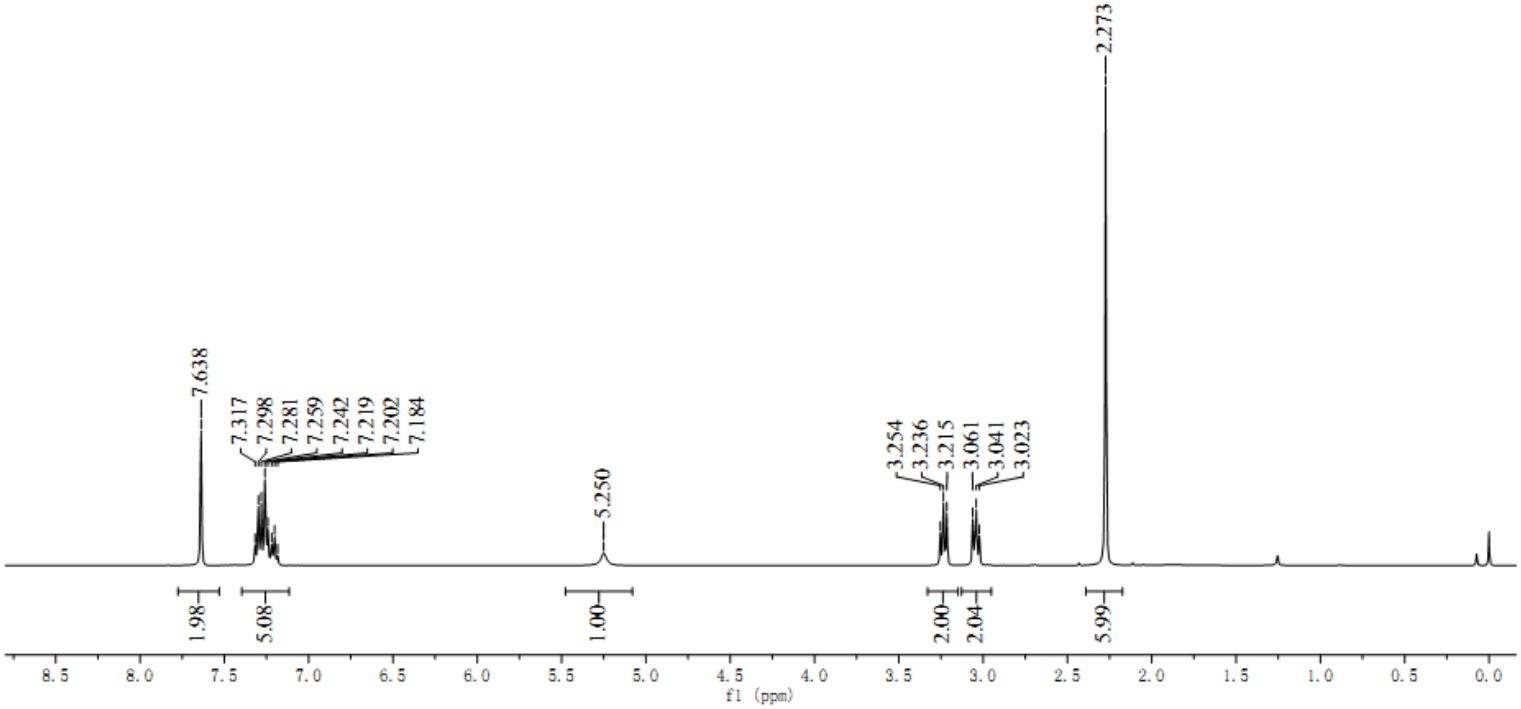

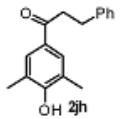

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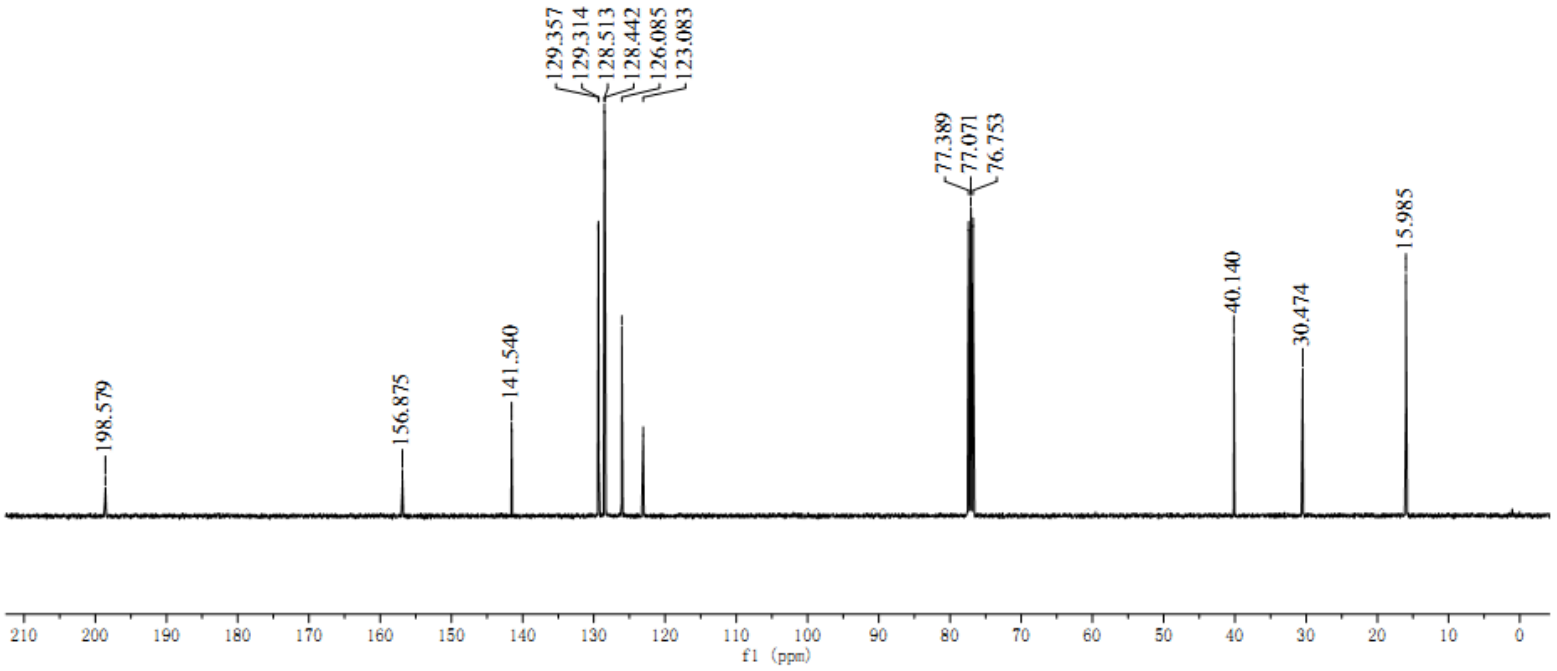
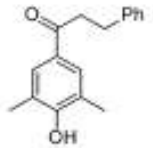


Elemental Composition Report



Single Mass Analysis

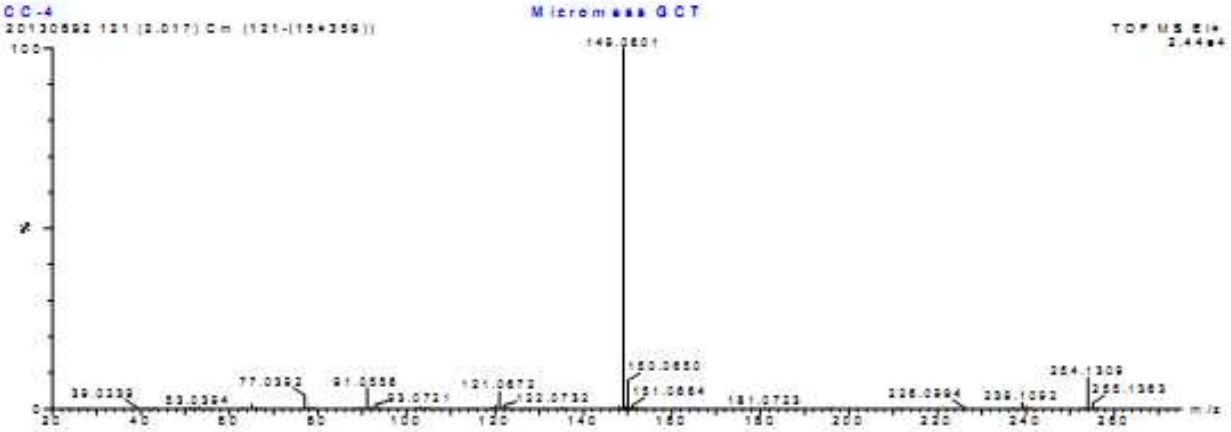
Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

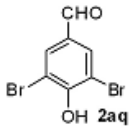
27 formula(e) evaluated with 6 results within limits (up to 50 closest results for each mass)

Elements Used:

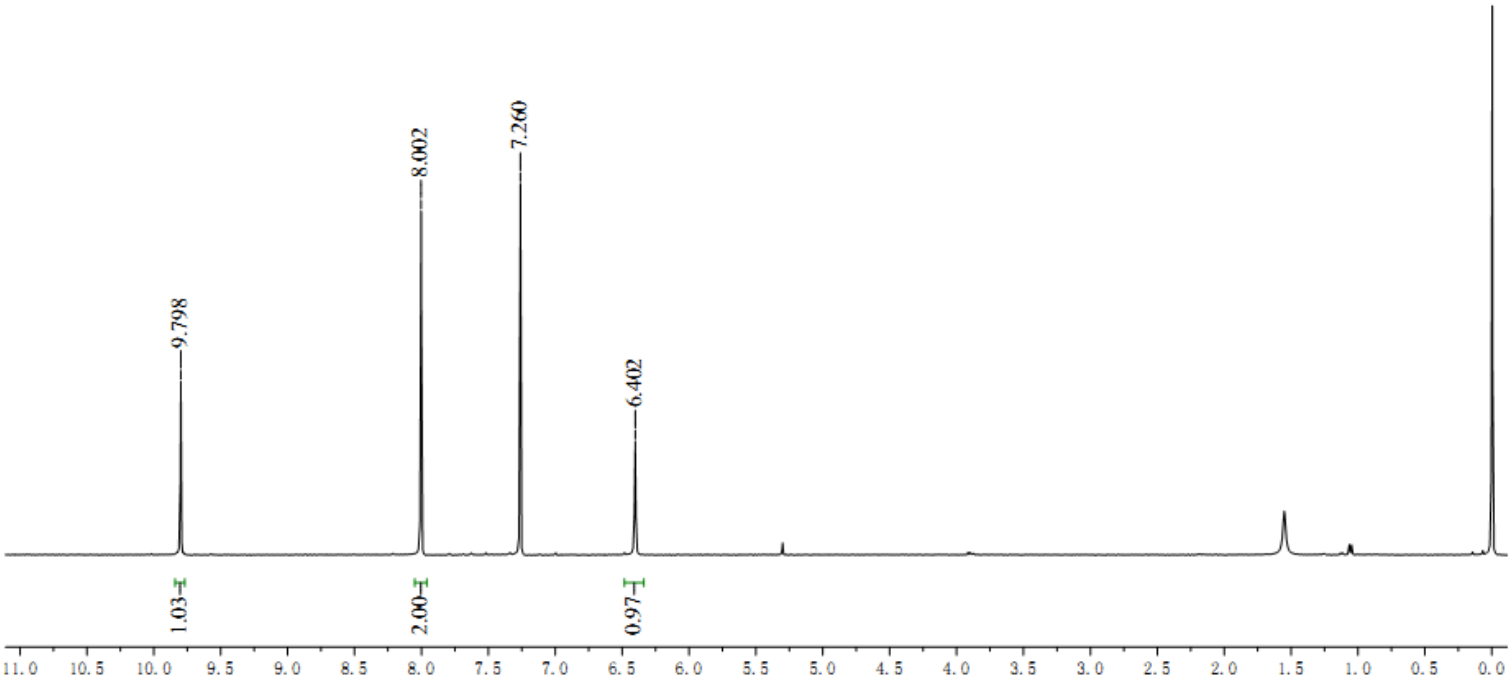
C: 0-17 H: 0-18 O: 0-2

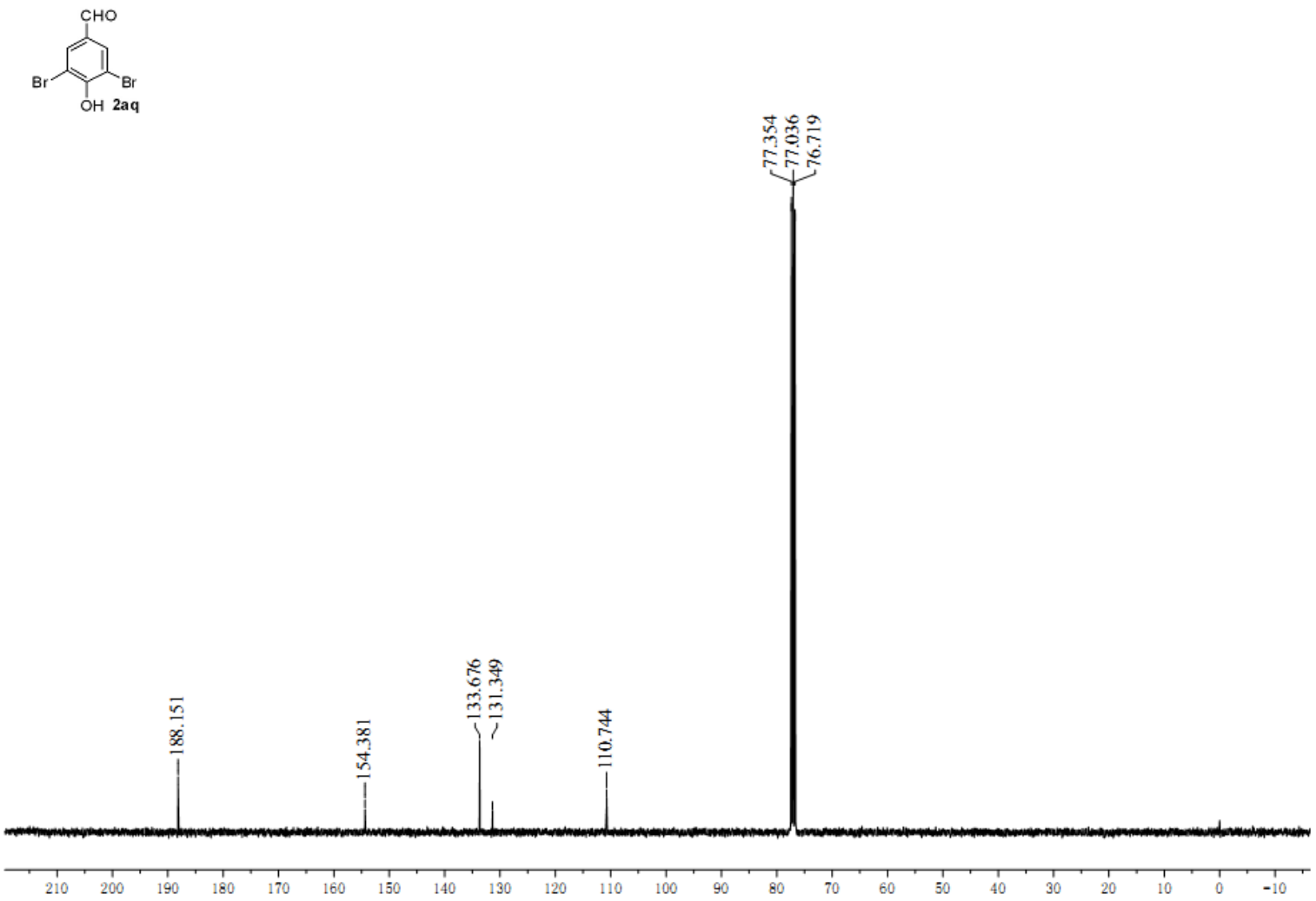


Minimum:		3.00			-1.5	
Maximum:		100.00	5.0	5.0	50.0	
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
254.1309	8.68	254.1307	0.2	0.9	9.0	1	C17 H18 O2



2aq

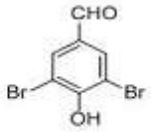




Elemental Composition Report

Single Mass Analysis

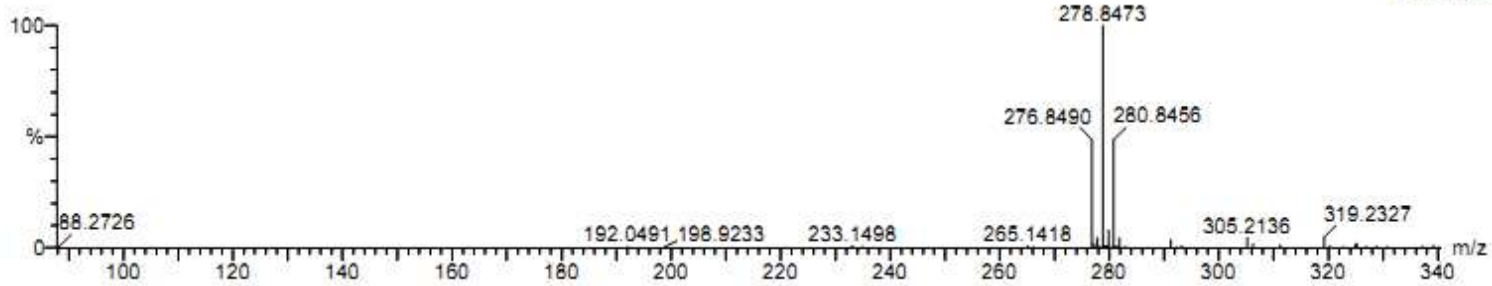
Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2



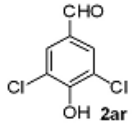
Monoisotopic Mass, Even Electron Ions
67 formula(e) evaluated with 11 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8 Br: 0-2

YF-JI ECUST institute of Fine Chem 02-Jan-2013 21:43:39

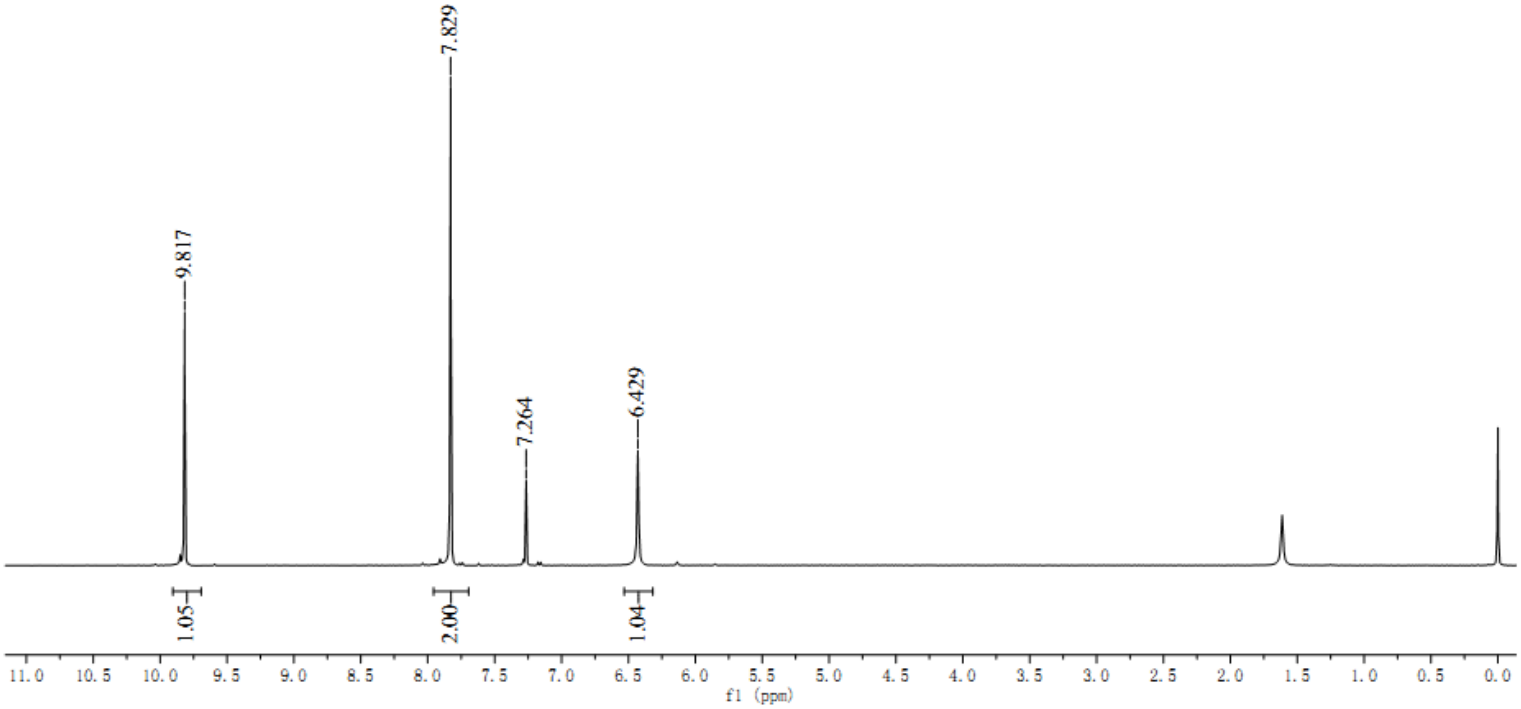
JYF-JA-101 22 (0.787) Cm (21:22) 2: TOF MS ES- 1.80e+003

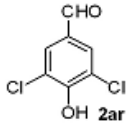


Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
276.8490	276.8500	-1.0	-3.6	5.5	26.5	0.0	C7 H3 O2 Br2

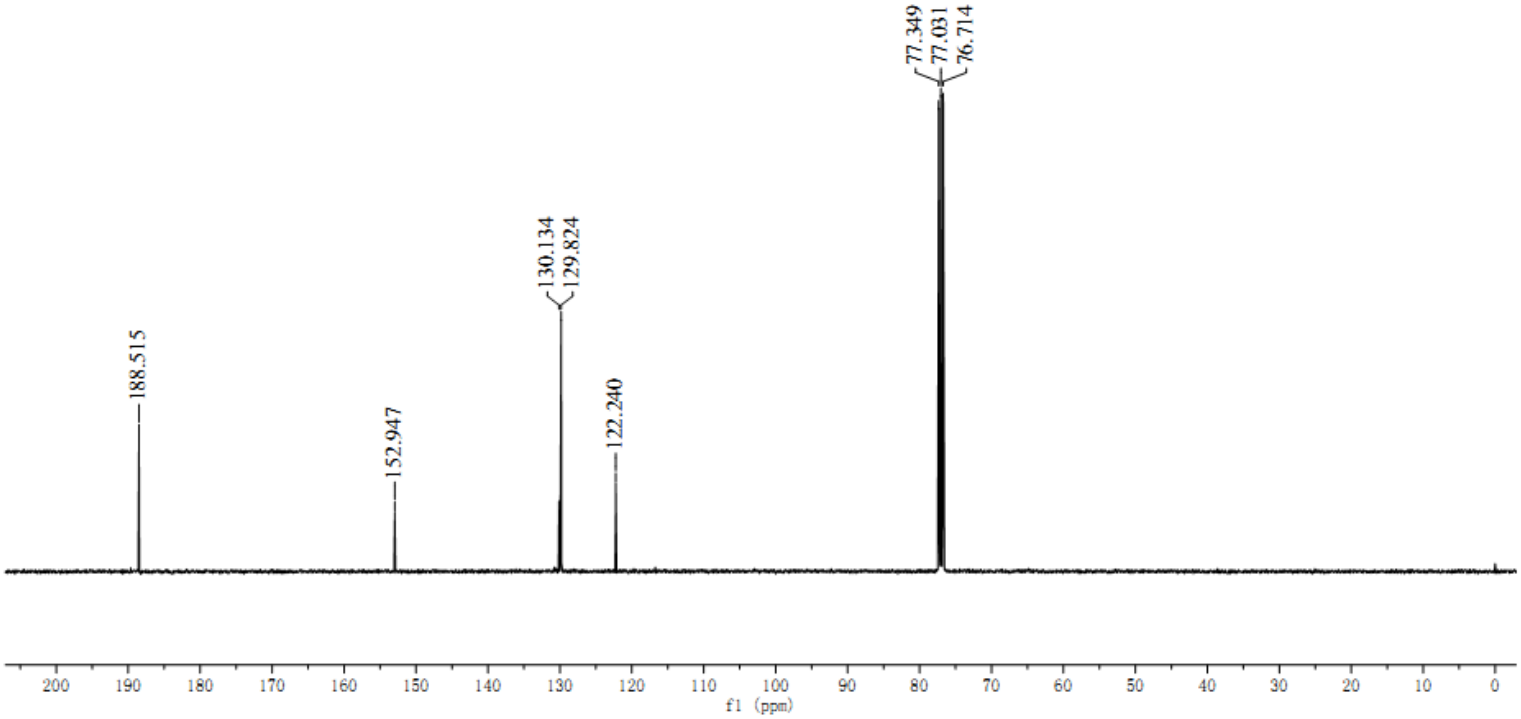


2ar

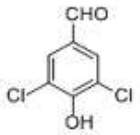




2ar



Elemental Composition Report



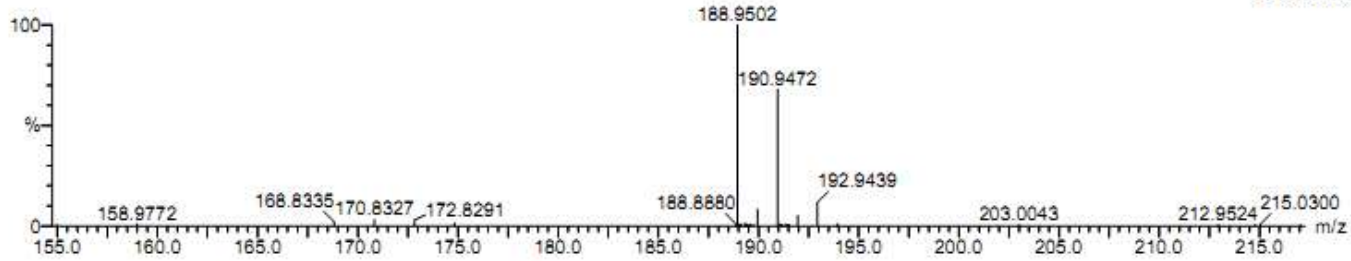
Single Mass Analysis

Tolerance = 30.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

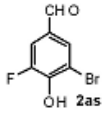
Monoisotopic Mass, Even Electron Ions
48 formula(e) evaluated with 7 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-35 H: 0-80 O: 0-5 Cl: 0-3

JI-YF ECUST institute of Fine Chem 16-Sep-2013 15:42:29

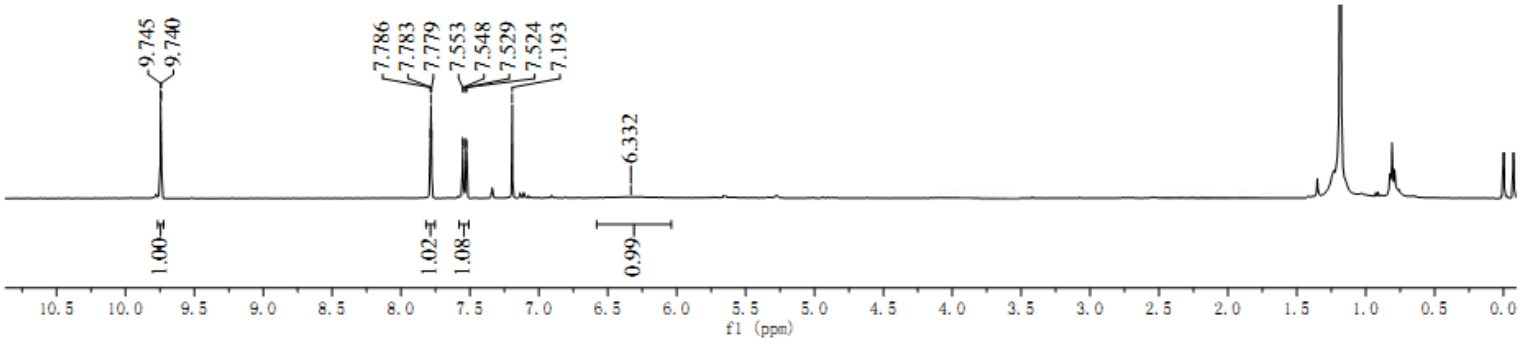
JYF-DJL-11 69 (2.237) Cm (69:72) 2: TOF MS ES- 5.79e+003

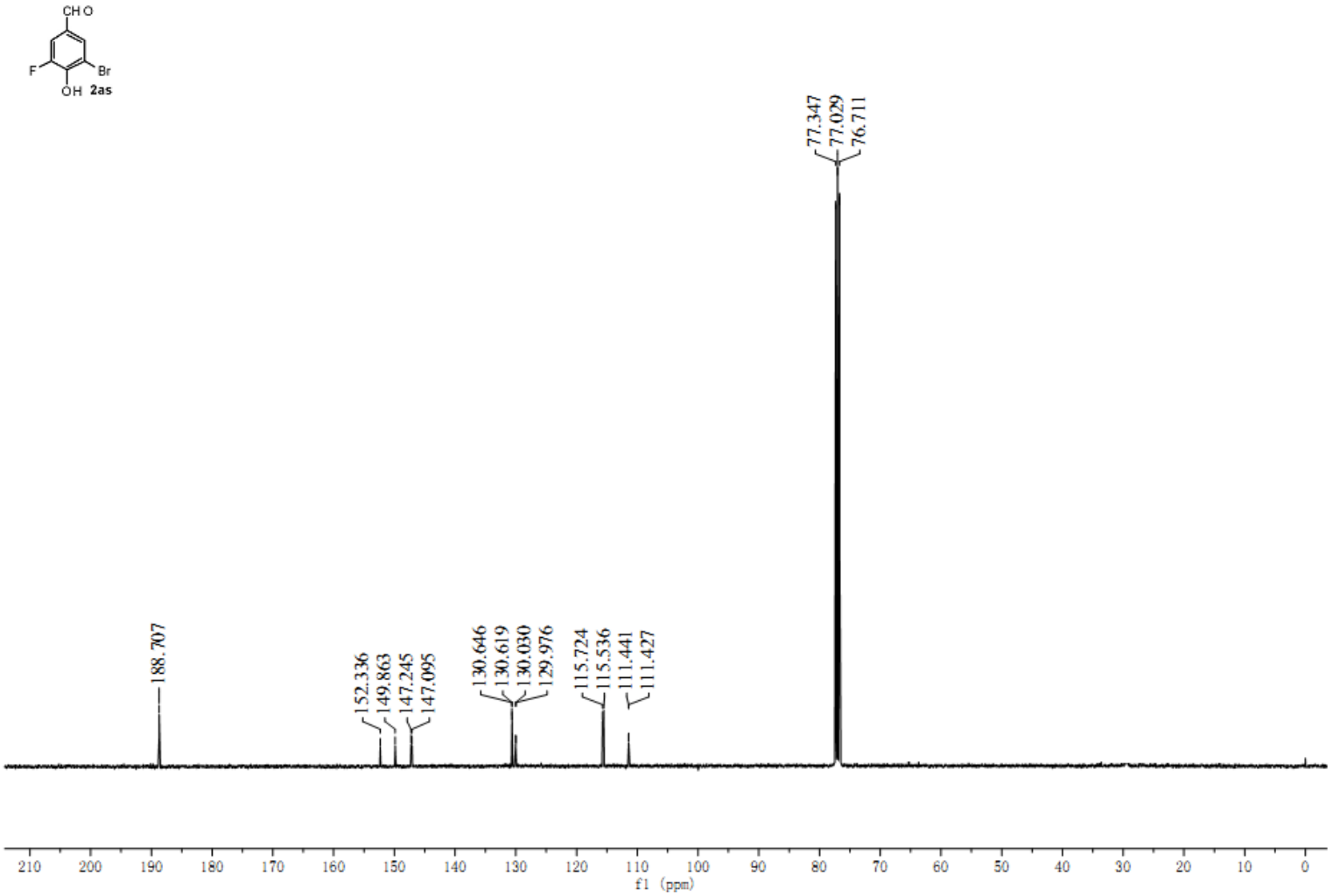


Minimum:				-1.5			
Maximum:		30.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
188.9502	188.9510	-0.8	-4.2	5.5	73.2	0.0	C7 H3 O2 Cl2



2as





Elemental Composition Report

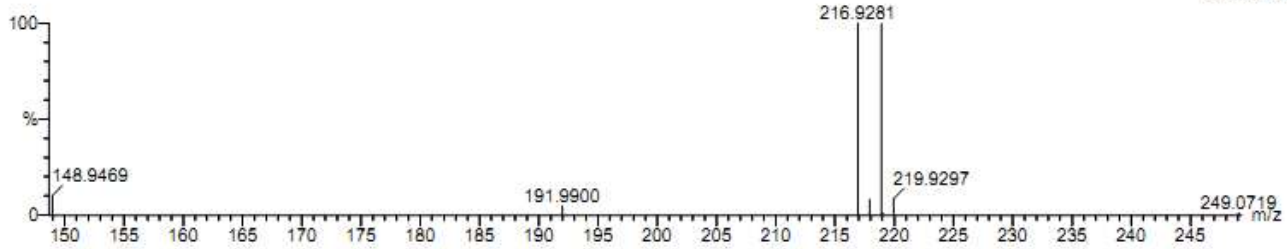
Single Mass Analysis

Tolerance = 30.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

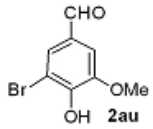
Monoisotopic Mass, Even Electron Ions
27 formula(e) evaluated with 4 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-7 H: 0-80 O: 0-2 Br: 0-1 F: 0-3

YF-JI ECUST institute of Fine Chem 15-Sep-2013 15:39:01

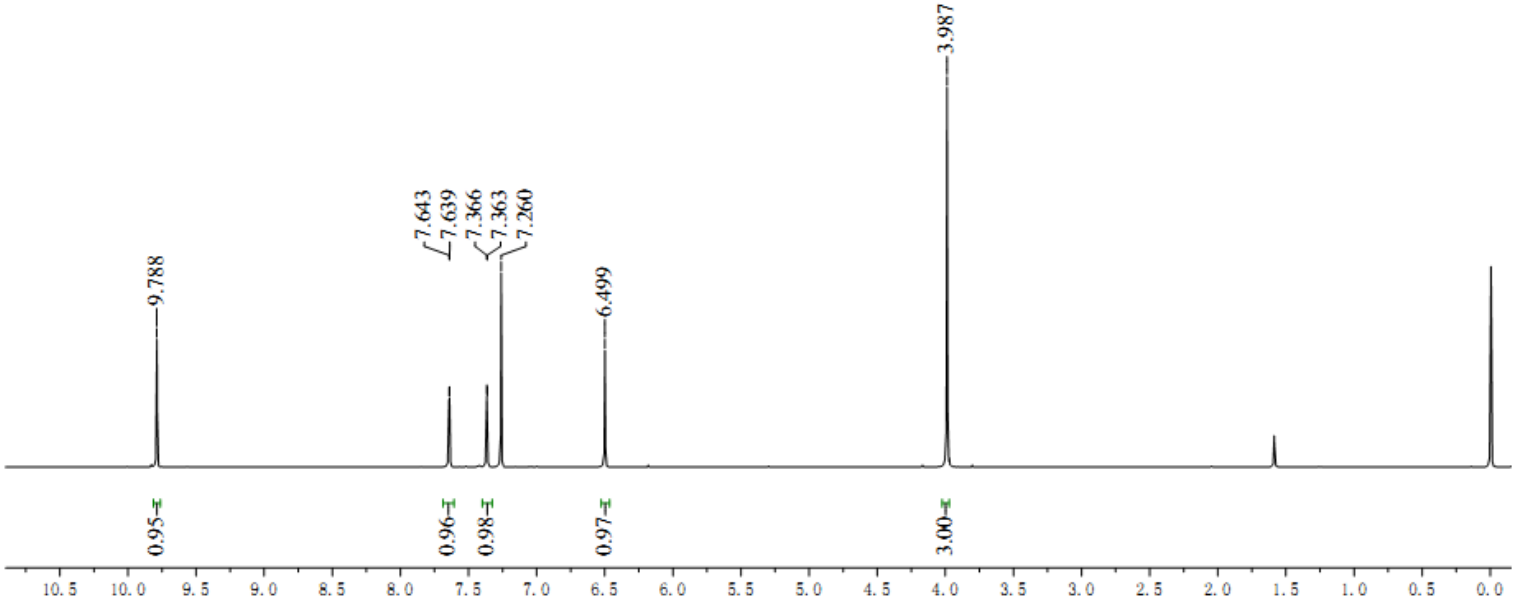
JYF-JG-1 189 (1.311) Cm (184:196) 1: TOF MS ES- 1.26e+004

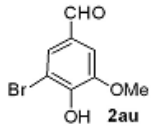


Minimum:				-1.5			
Maximum:		30.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
216.9281	216.9300	-1.9	-8.8	5.5	5.8	0.0	C7 H3 O2 Br F

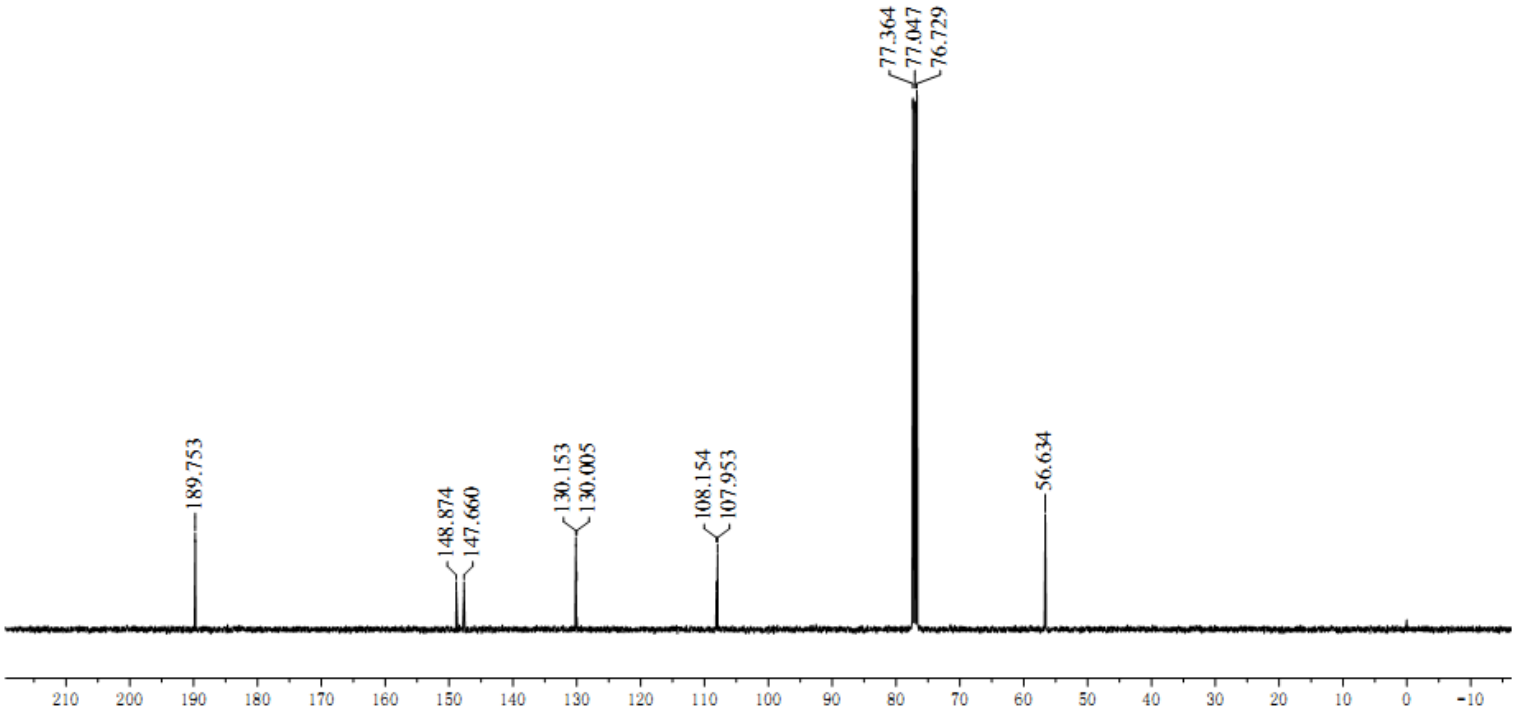


2au





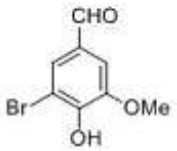
2au



Elemental Composition Report

Single Mass Analysis

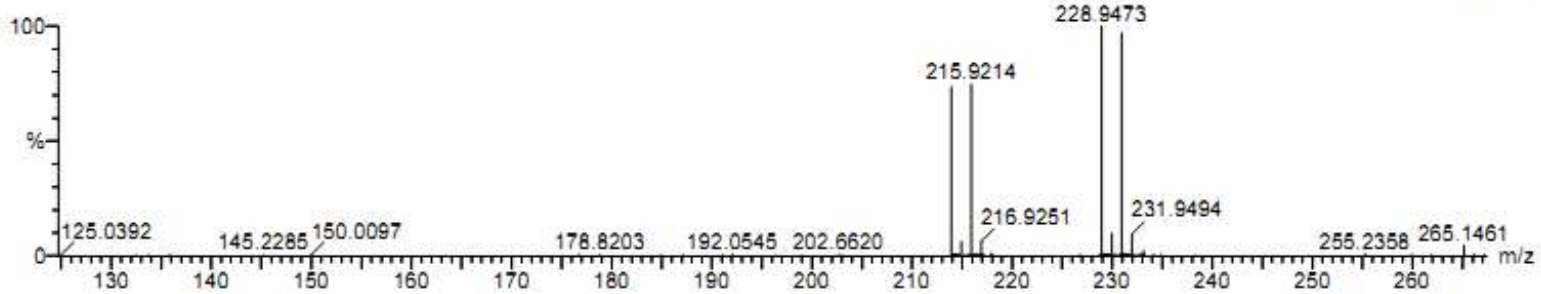
Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2



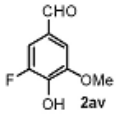
Monoisotopic Mass, Even Electron Ions
50 formula(e) evaluated with 21 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8 Br: 0-2

YF-JI ECUST institute of Fine Chem 02-Jan-2013 21:47:30

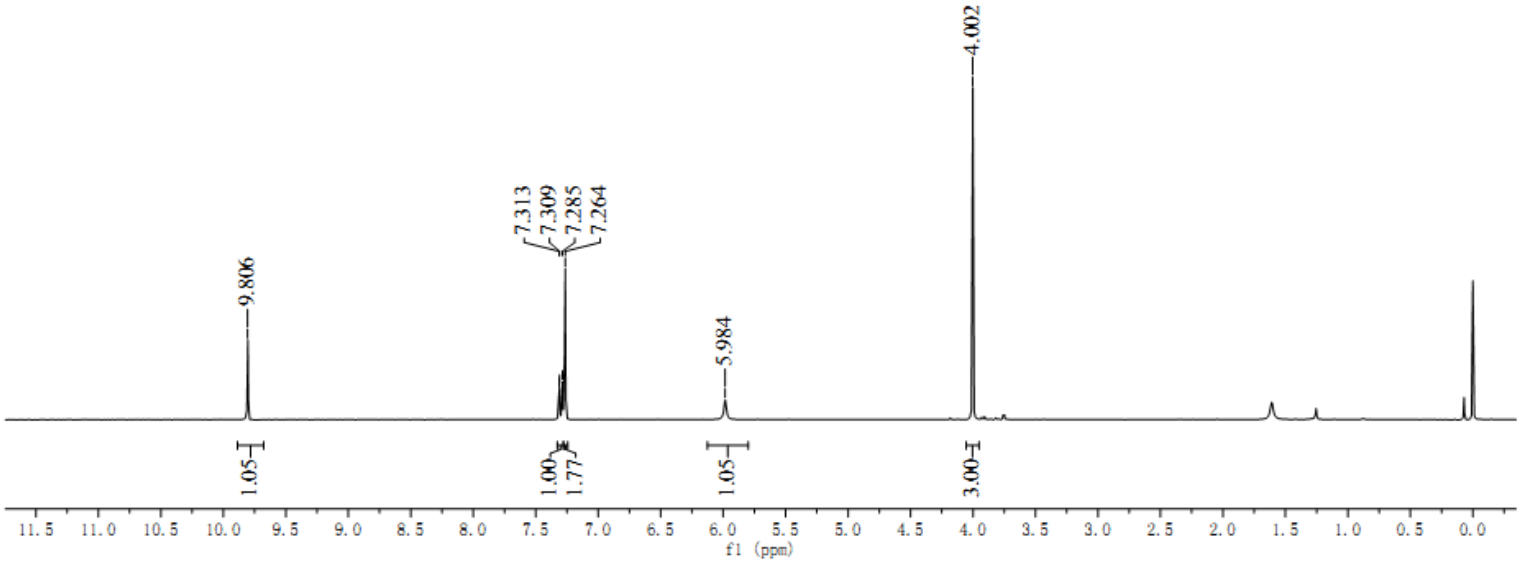
JYF-JA-102 47 (1.550) Cm (41:47) 2: TOF MS ES- 5.51e+003

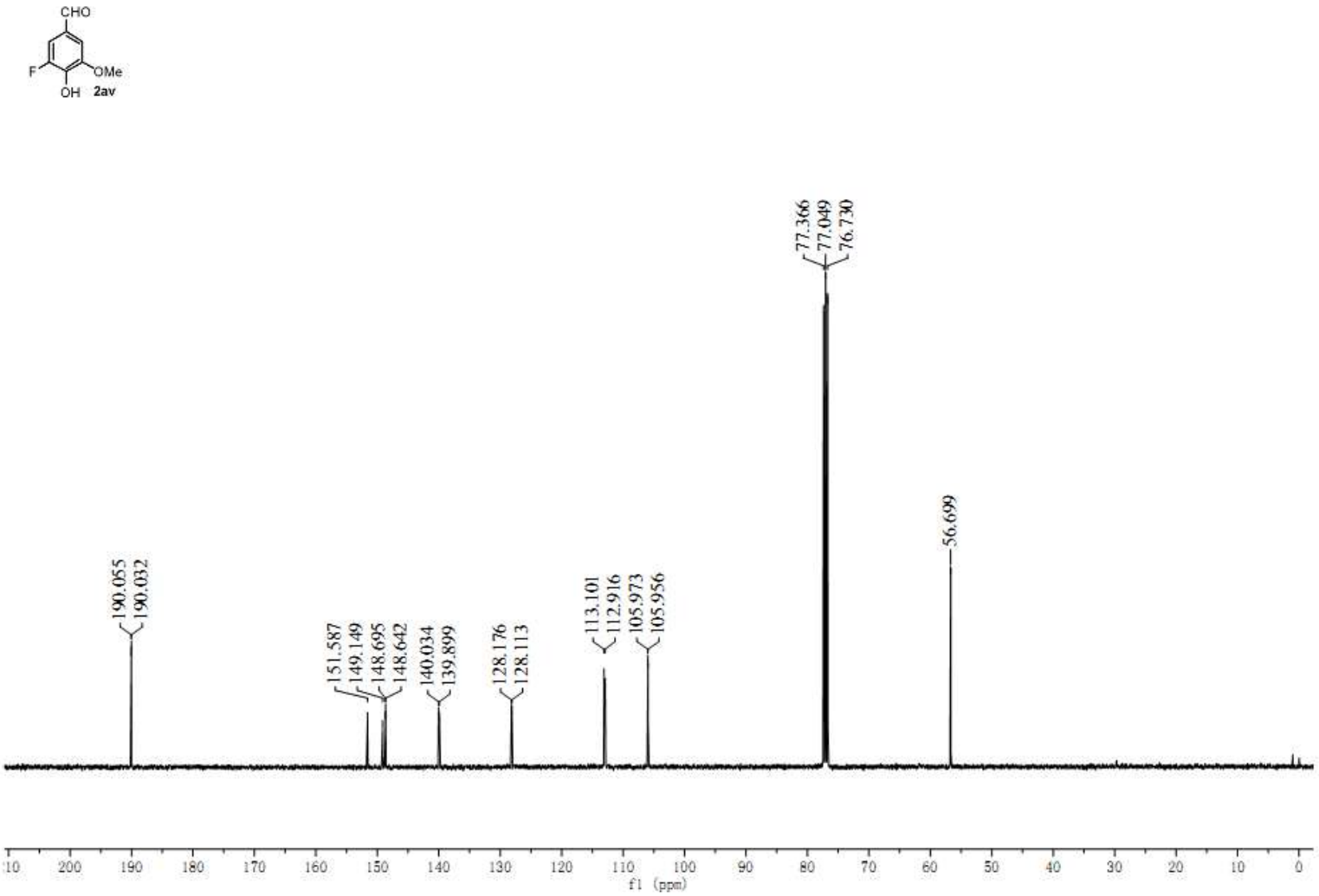


Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
228.9473	228.9500	-2.7	-11.8	5.5	114.0	0.0	C8 H6 O3 Br

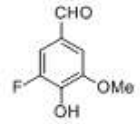


2av





Elemental Composition Report



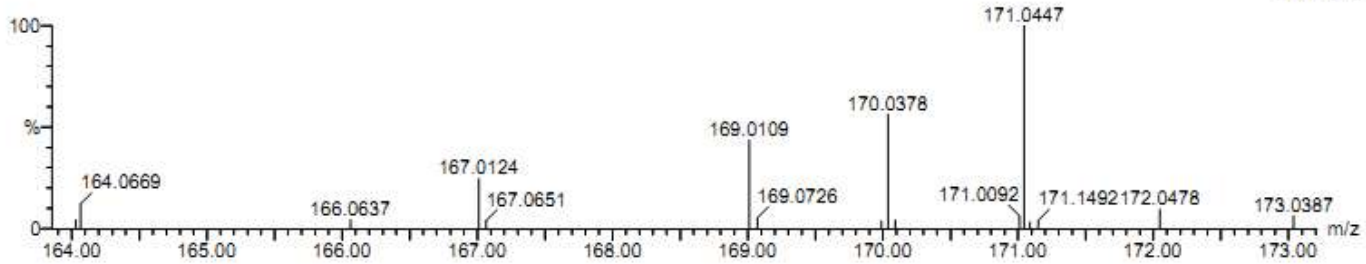
Single Mass Analysis

Tolerance = 30.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

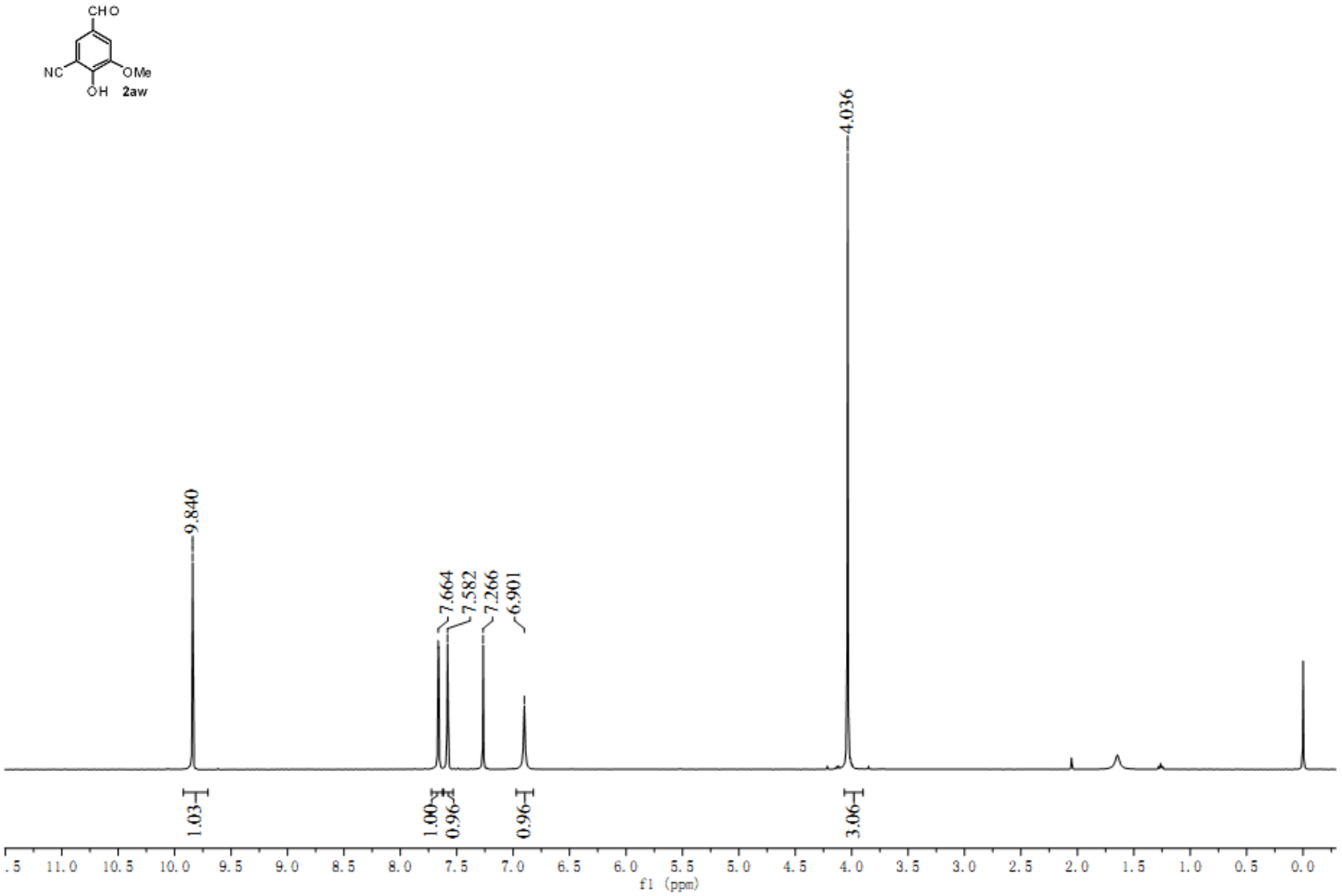
Monoisotopic Mass, Even Electron Ions
20 formula(e) evaluated with 4 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-8 H: 0-80 O: 0-3 F: 0-3

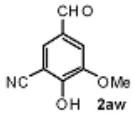
YF-JI ECUST institute of Fine Chem 15-Sep-2013 15:53:36

JYF-JG-2 55 (0.426) Cm (52:62) 1: TOF MS ES+ 1.86e+003

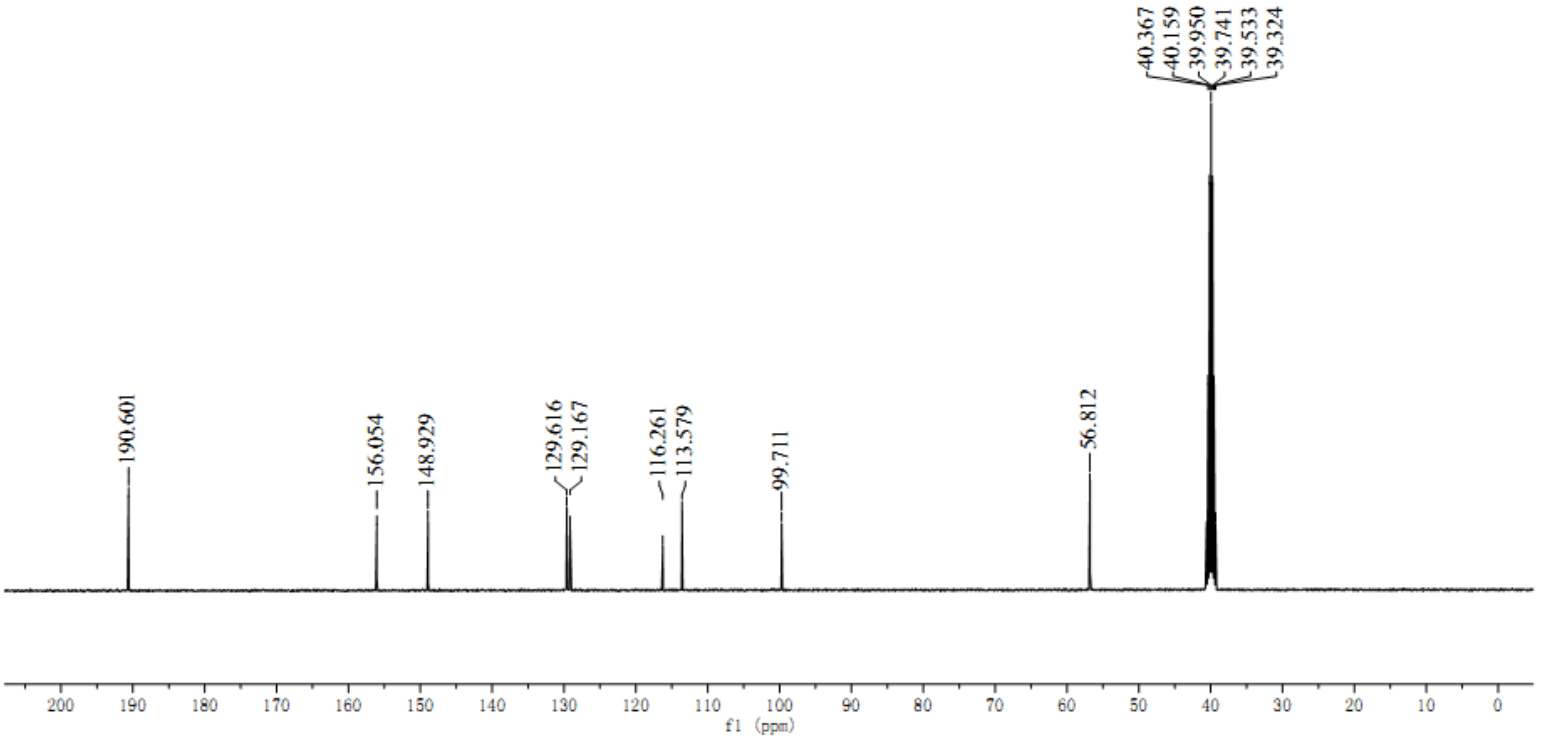


Minimum:				-1.5			
Maximum:		30.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
171.0447	171.0457	-1.0	-5.8	4.5	21.5	0.0	C8 H8 O3 F

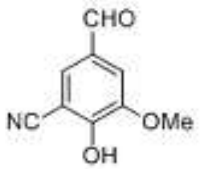




2aw



Elemental Composition Report



Single Mass Analysis

Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

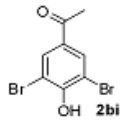
Monoisotopic Mass, Odd and Even Electron Ions

102 formula(e) evaluated with 22 results within limits (up to 50 closest results for each mass)

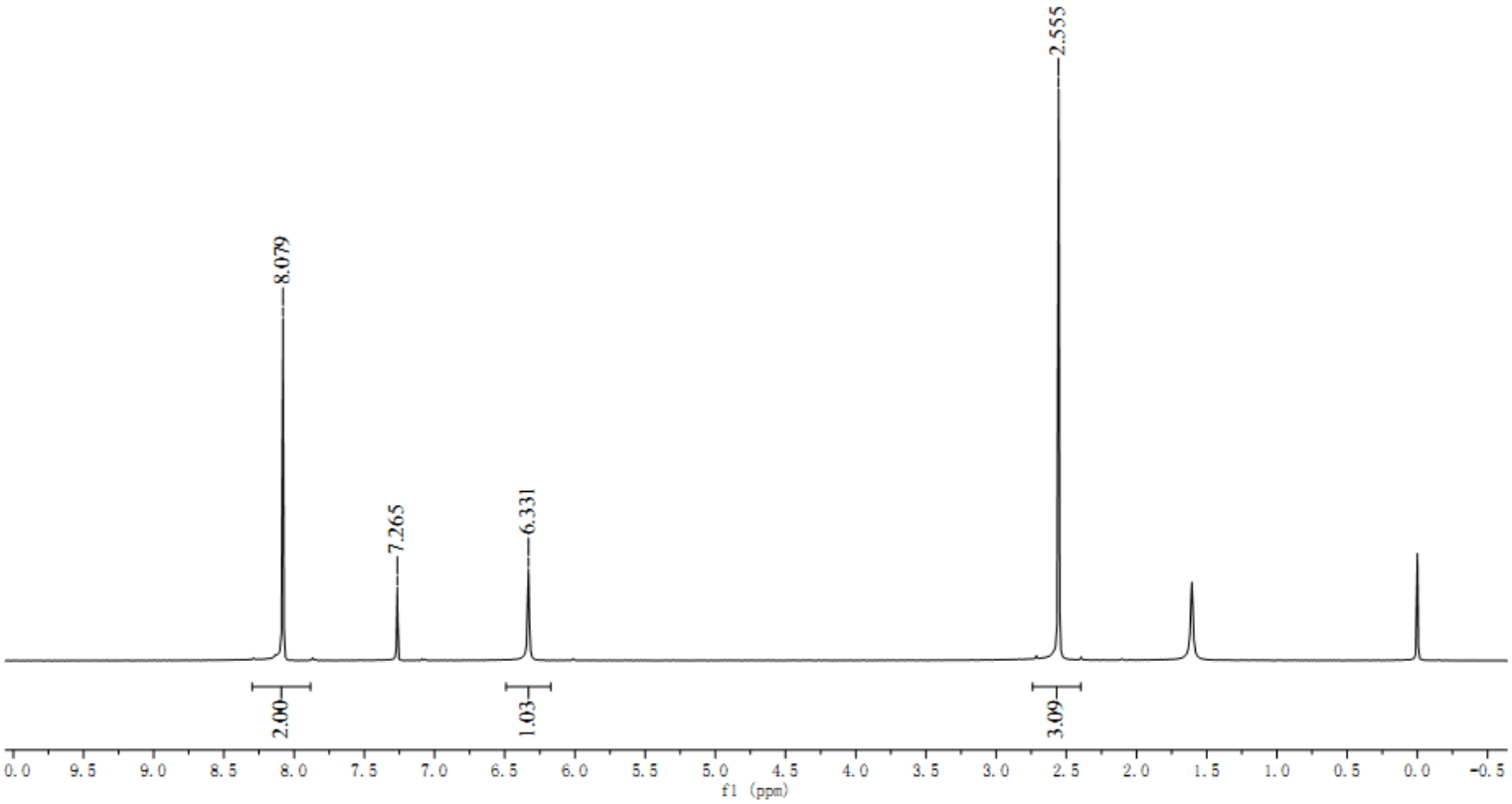
Elements Used:

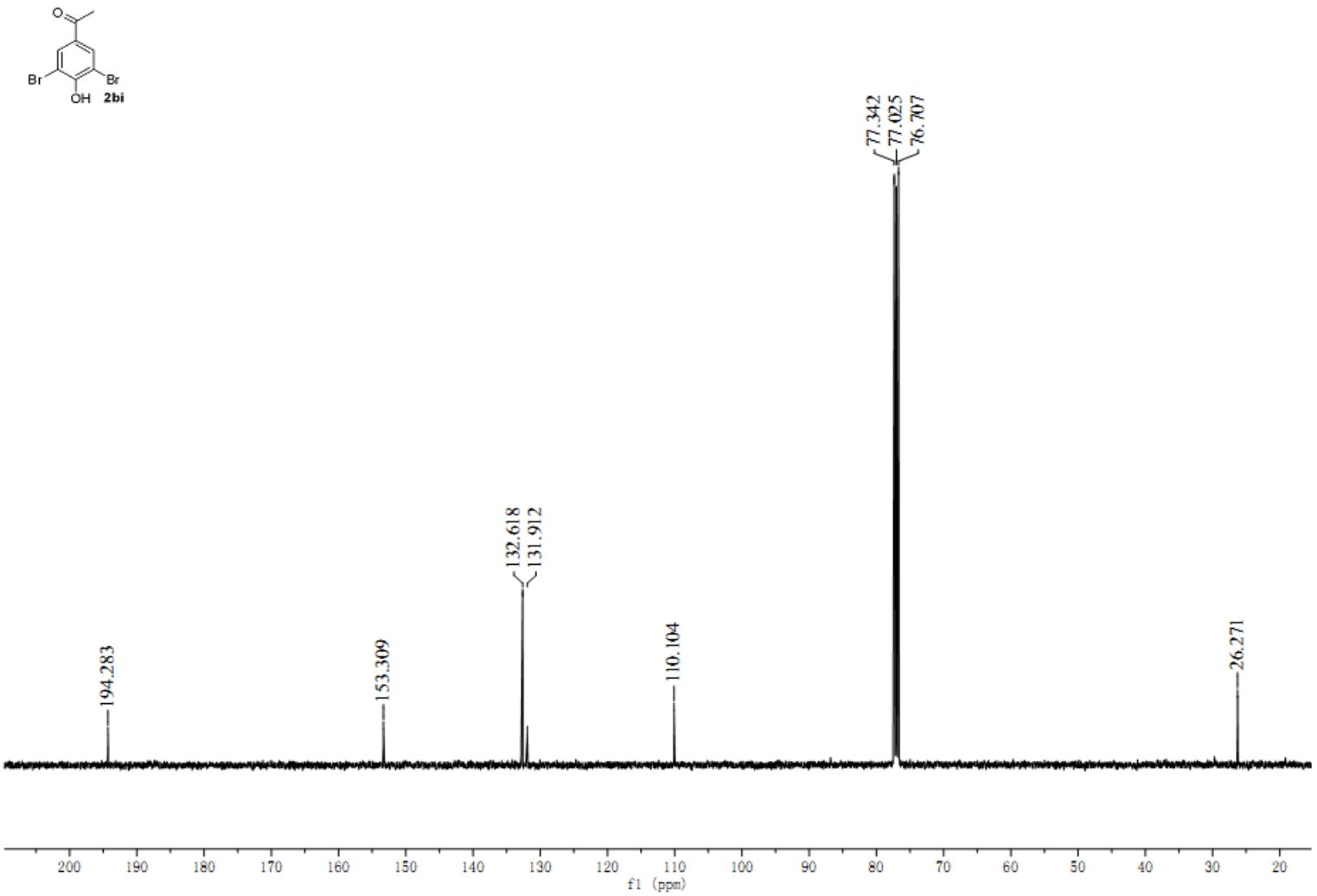
C: 0-9 H: 0-7 N: 0-1 O: 0-2

Minimum:		3.00			-1.5		
Maximum:		100.00	5.0	5.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
177.0424	100.00	177.0426	-0.2	-1.1	7.0	1	C9 H7 N O3

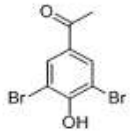


2bi





Elemental Composition Report



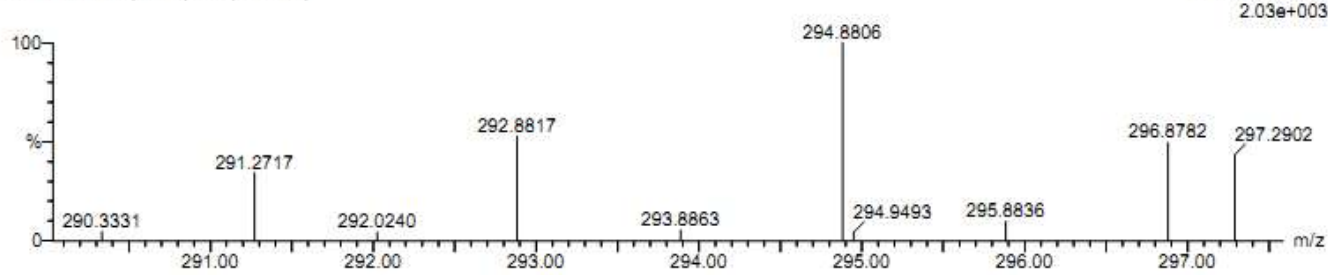
Single Mass Analysis

Tolerance = 30.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

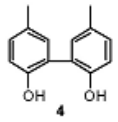
Monoisotopic Mass, Even Electron Ions
17 formula(e) evaluated with 1 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-10 H: 0-80 O: 0-3 Br: 0-2

YF-JI ECUST institute of Fine Chem 15-Sep-2013 15:59:47

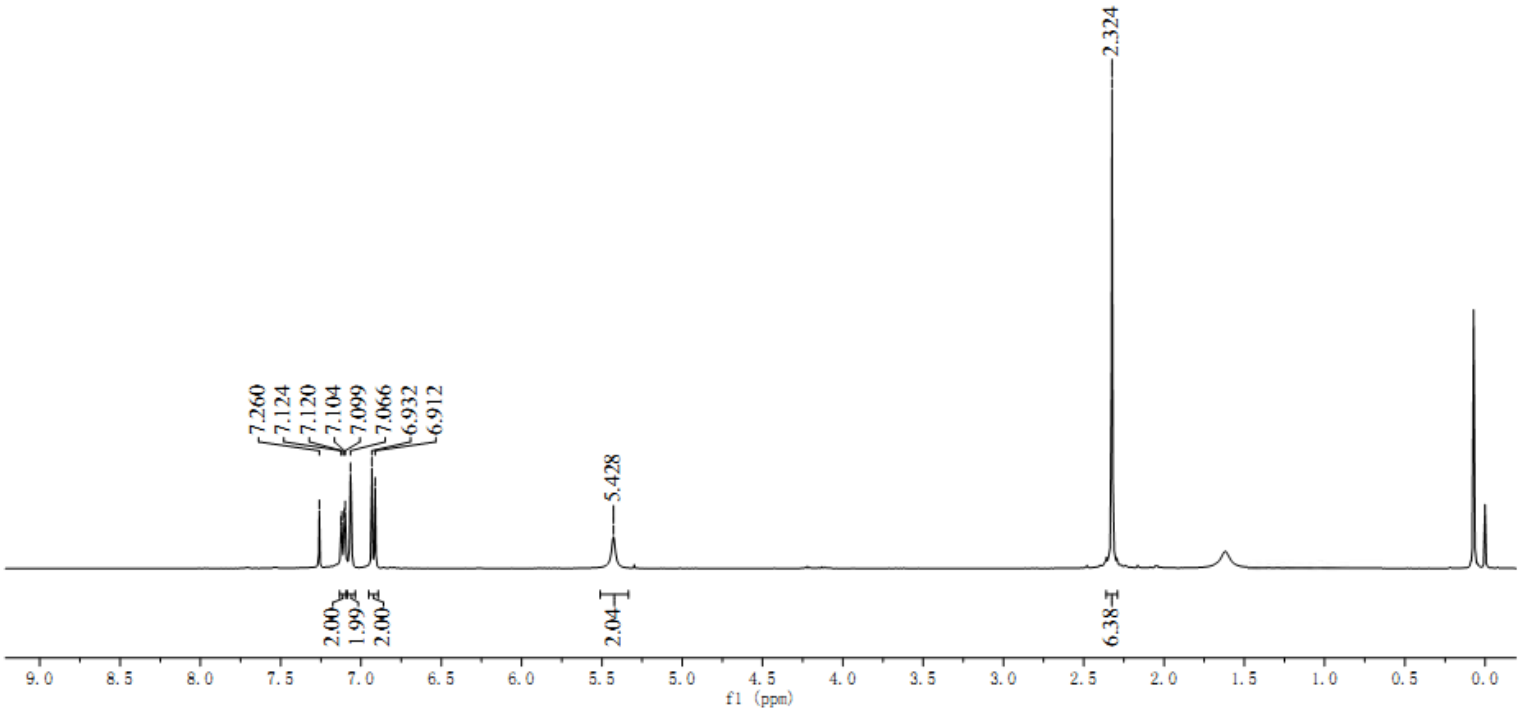
JYF-JG-3 109 (0.759) Cm (105:116) 1: TOF MS ES+ 2.03e+003

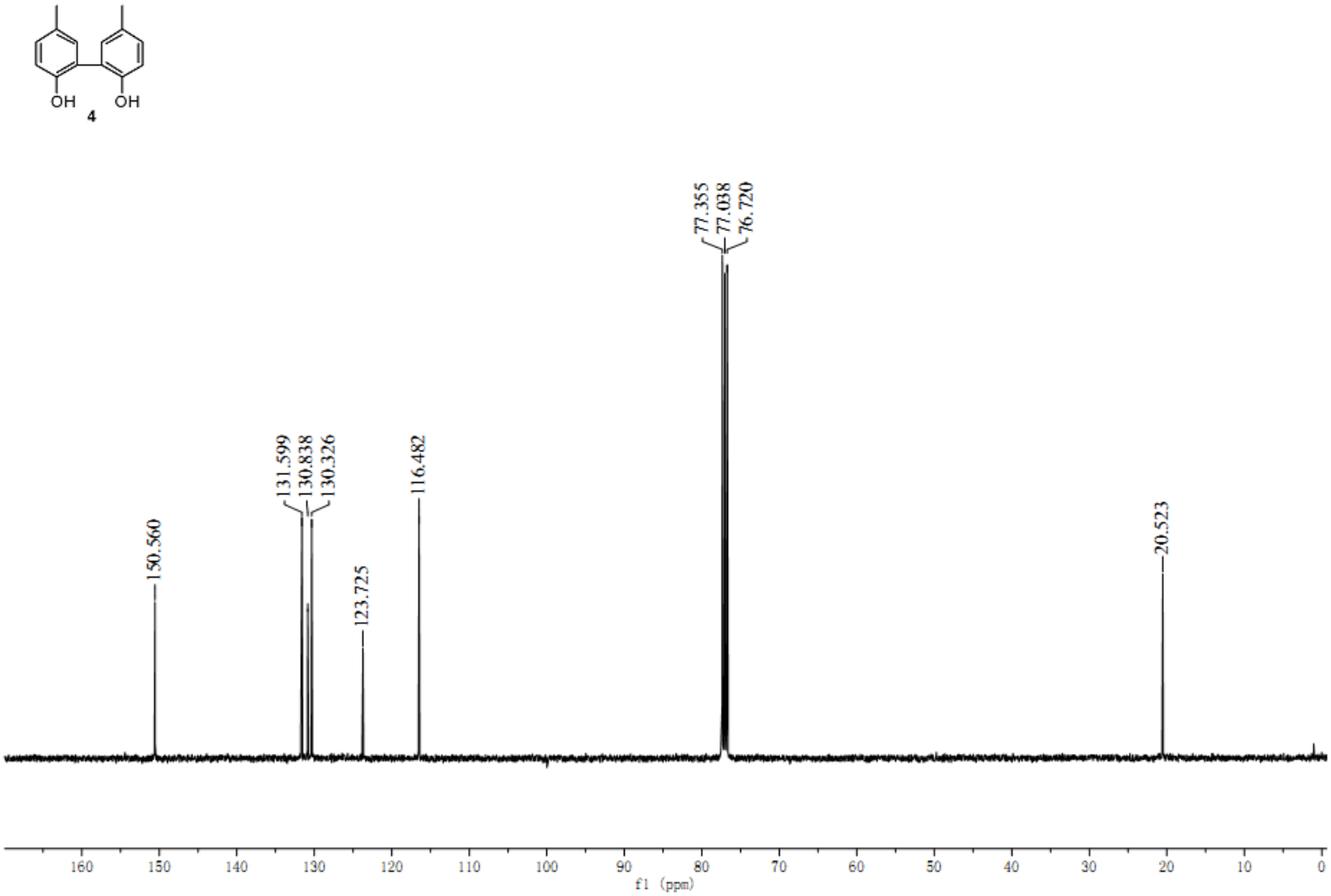


Minimum:				-1.5			
Maximum:		30.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
292.8817	292.8813	0.4	1.4	4.5	6.2	0.0	C8 H7 O2 Br2

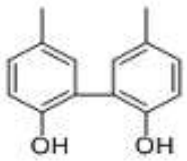


4





Elemental Composition Report



Single Mass Analysis

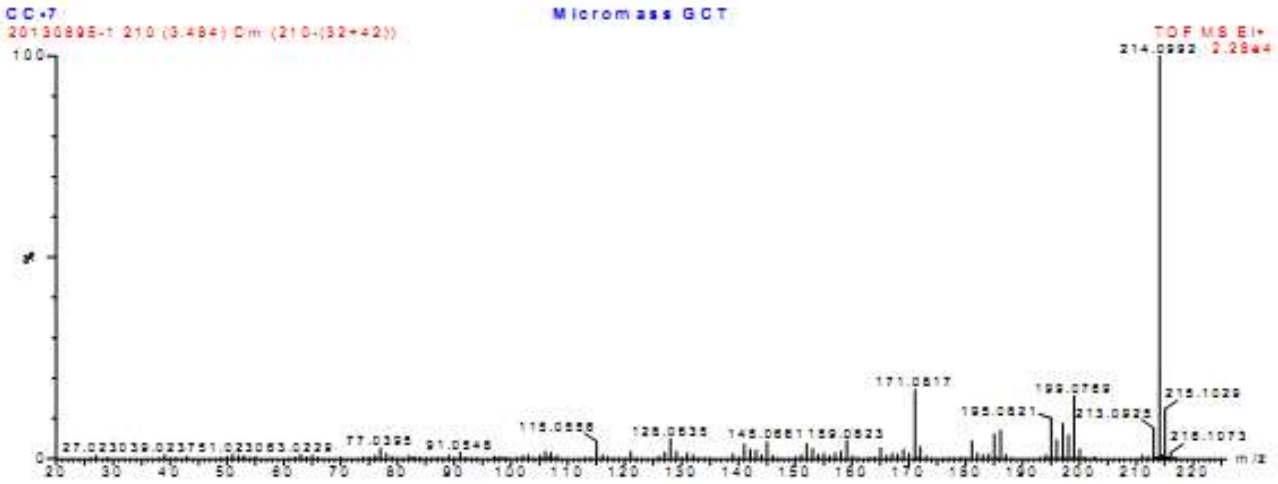
Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

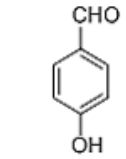
68 formula(e) evaluated with 20 results within limits (up to 50 closest results for each mass)

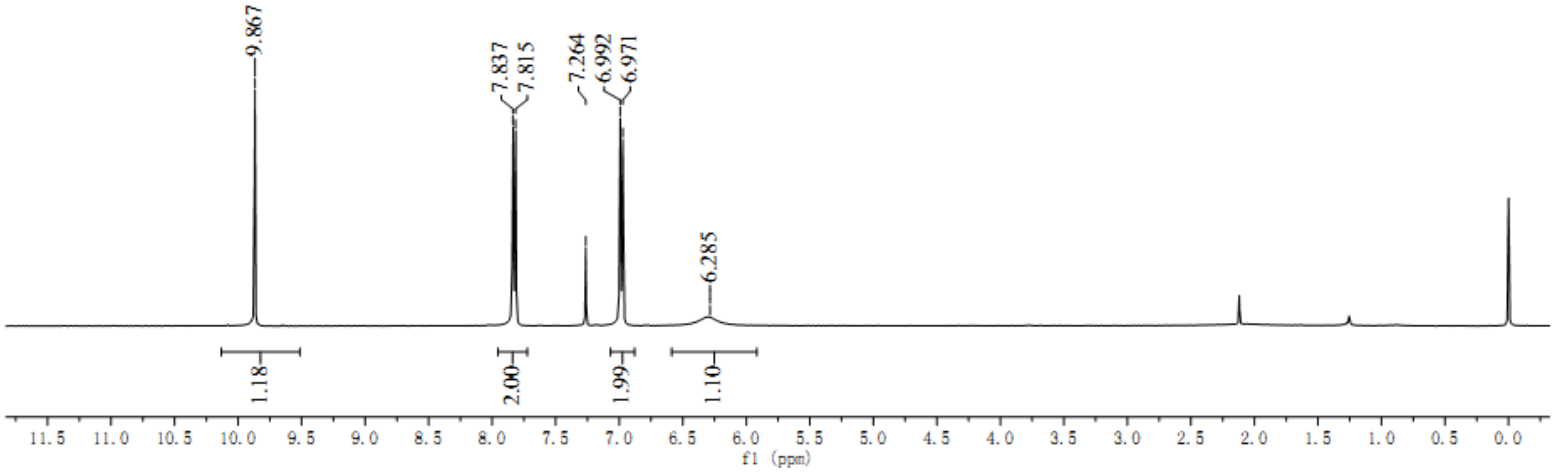
Elements Used:

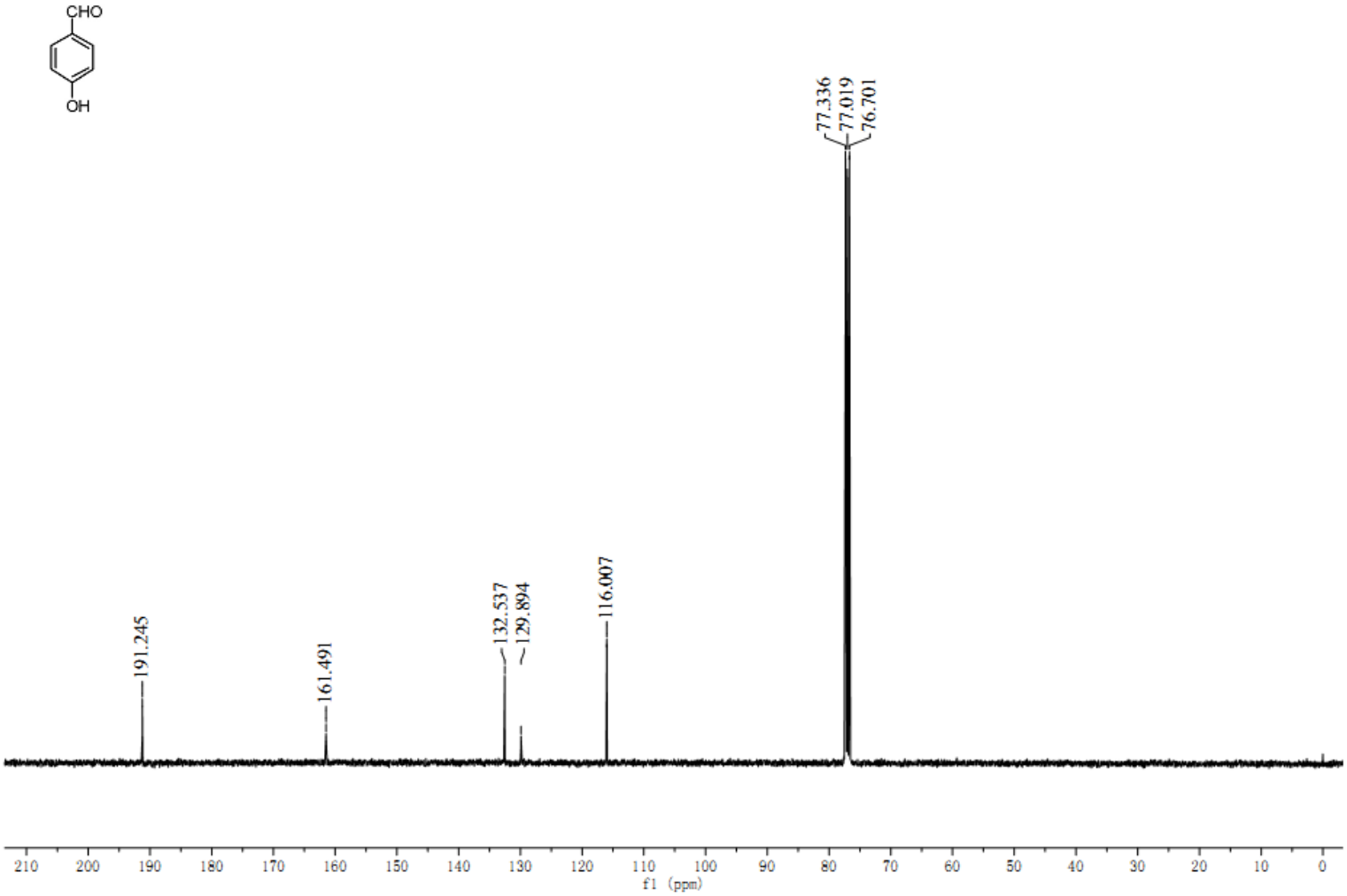
C: 0-14 H: 0-14 O: 0-2



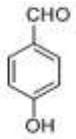
Minimum:		3.00			-1.5		
Maximum:		100.00	5.0	5.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
214.0992	100.00	214.0994	-0.2	-0.8	8.0	1	C14 H14 O2







Elemental Composition Report



Single Mass Analysis

Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

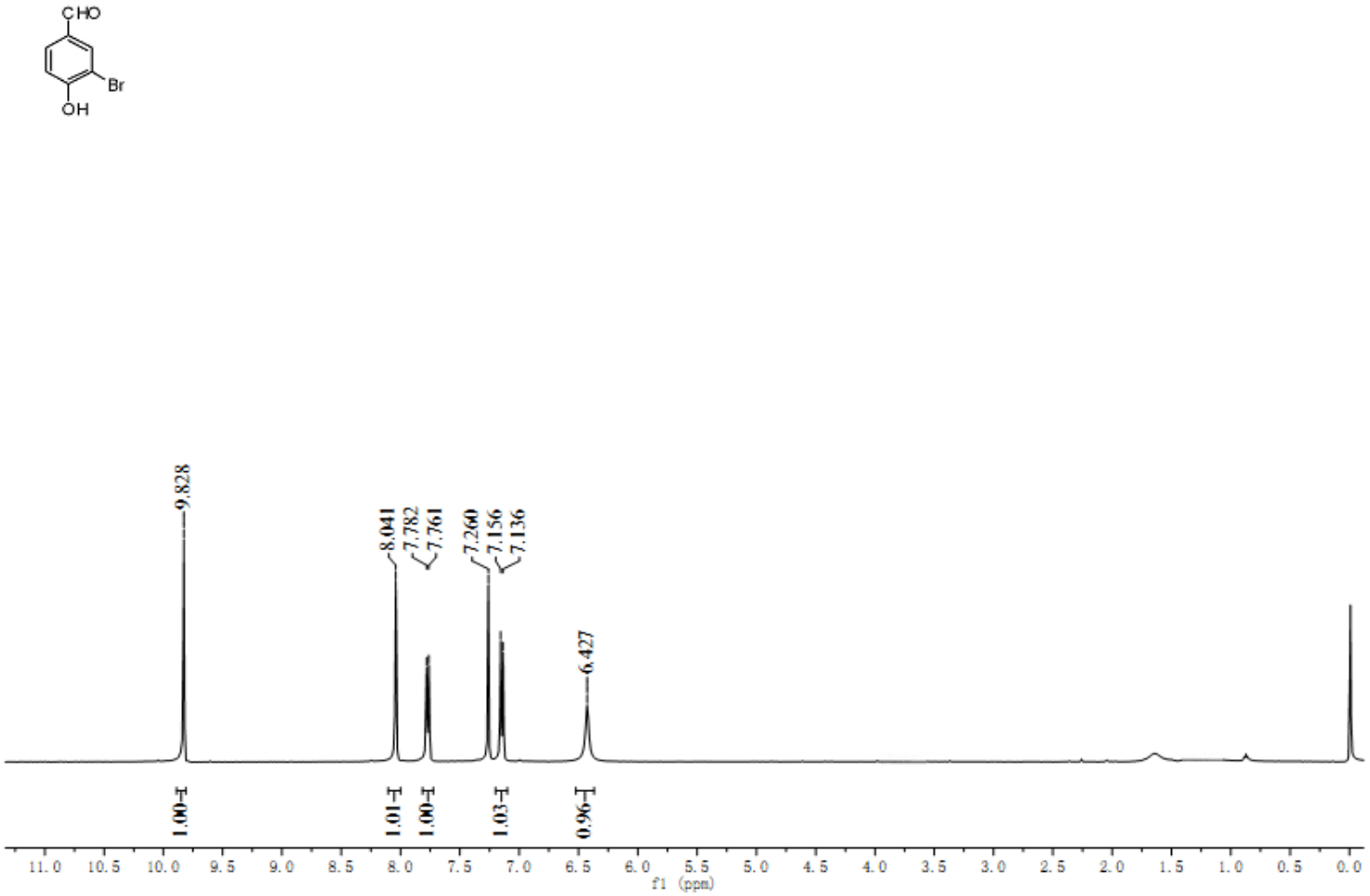
Monoisotopic Mass, Odd and Even Electron Ions

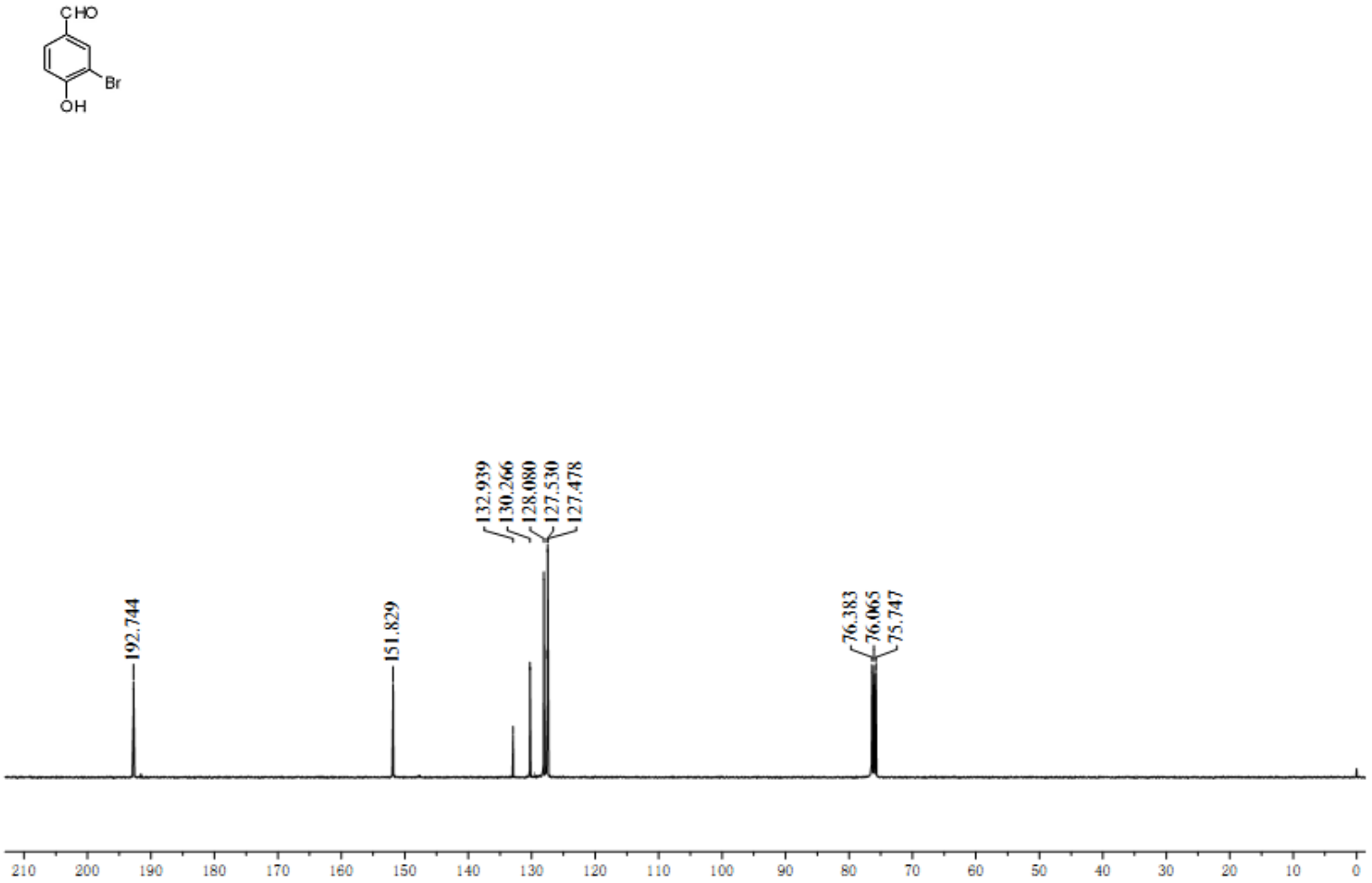
19 formula(e) evaluated with 9 results within limits (up to 50 closest results for each mass)

Elements Used:

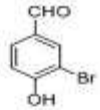
C: 0-7 H: 0-6 O: 0-2

Minimum:	3.00					-1.5	
Maximum:	100.00		5.0		10.0	50.0	
Mass	RA	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
122.0367	84.79	122.0368	-0.1	-0.8	5.0	3.5	C7 H6 O2





Elemental Composition Report



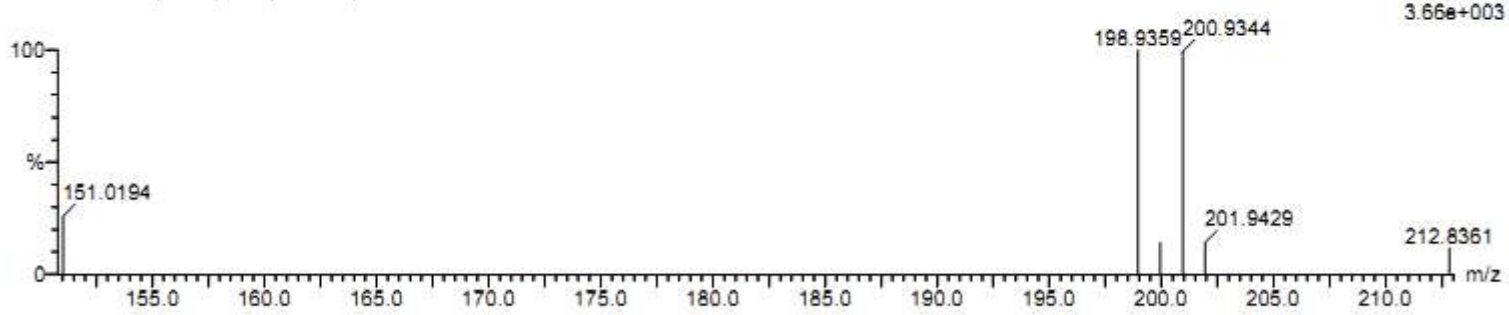
Single Mass Analysis

Tolerance = 30.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

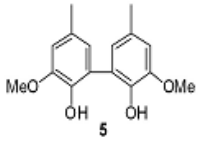
Monoisotopic Mass, Even Electron Ions
7 formula(e) evaluated with 1 results within limits (up to 1 best isotopic matches for each mass)
Elements Used:
C: 0-7 H: 0-5 O: 0-2 Br: 0-2

JI-YF ECUST institute of Fine Chem 12-May-2013 21:45:17

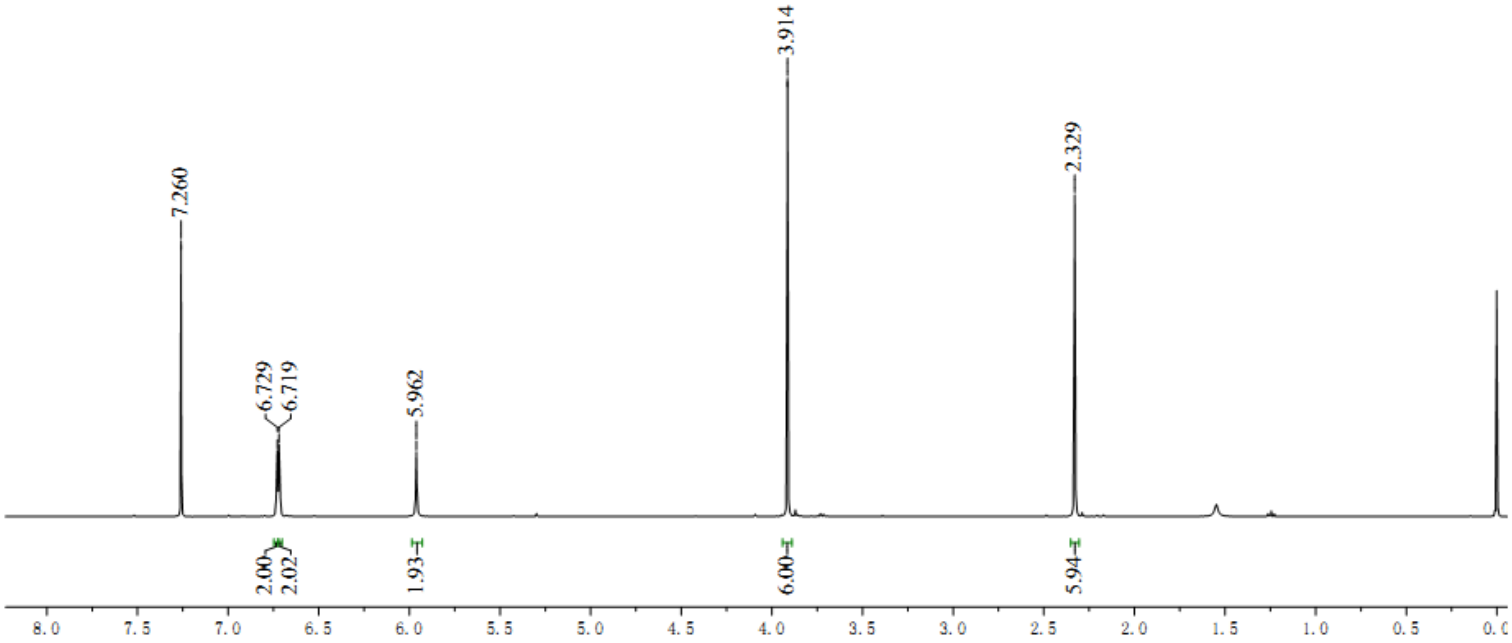
JYF-JA-19 255 (1.746) Cm (253:259) 1: TOF MS ES- 3.66e+003

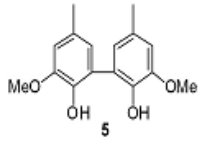


Minimum:				-1.5			
Maximum:		30.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
198.9359	198.9395	-3.6	-18.1	5.5	16.8	0.0	C7 H4 O2 Br

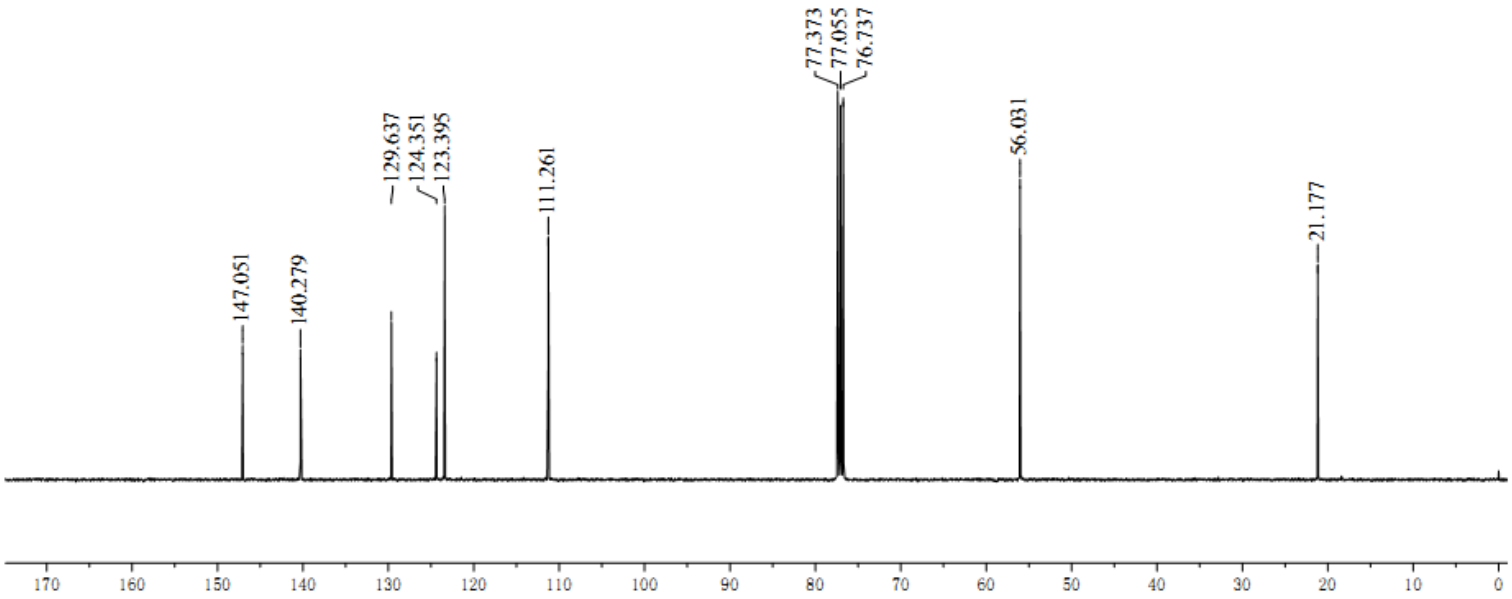


5





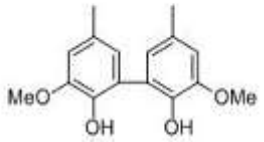
5



Elemental Composition Report

Single Mass Analysis

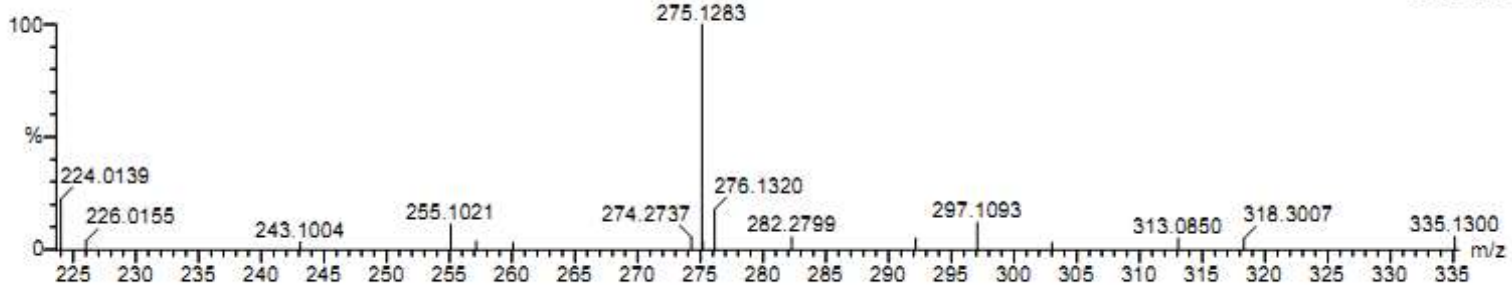
Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2



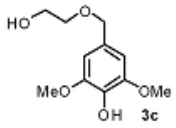
Monoisotopic Mass, Even Electron Ions
33 formula(e) evaluated with 17 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8

YF-JI ECUST institute of Fine Chem 02-Jan-2013 21:59:41

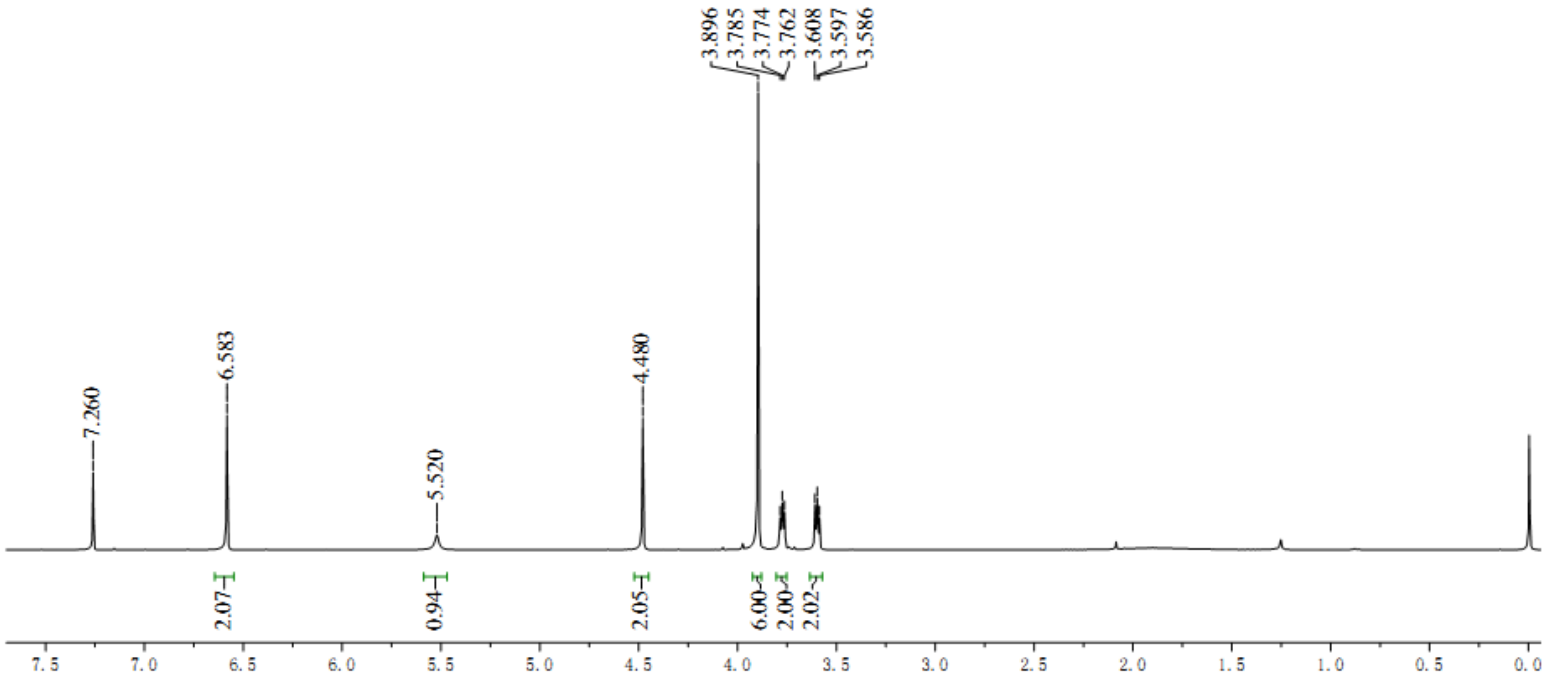
JYF-JA-105 16 (0.569) Cm (1:16) 1: TOF MS ES+ 9.57e+003

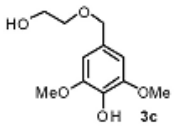


Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
275.1283	275.1283	0.0	0.0	7.5	18.4	0.0	C16 H19 O4

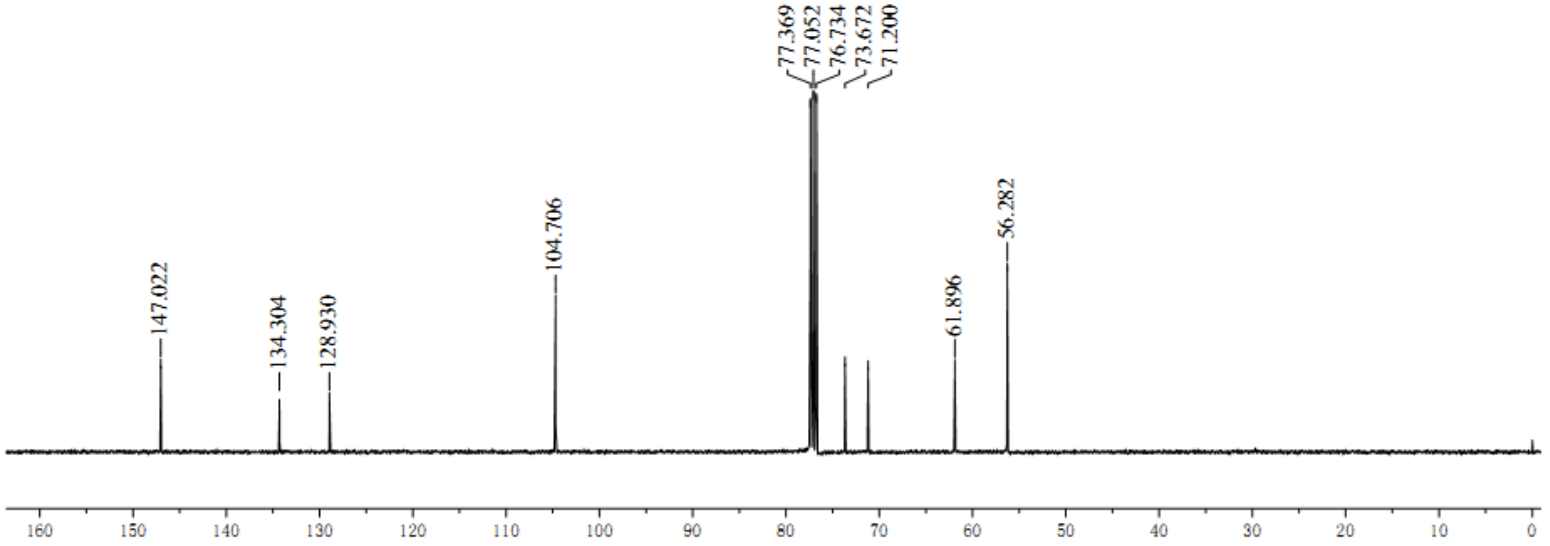


3c

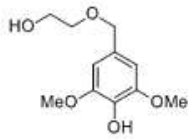




3c



Elemental Composition Report



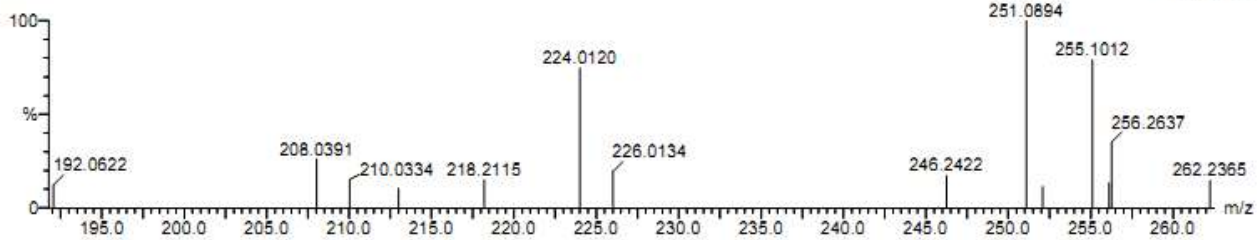
Single Mass Analysis

Tolerance = 100.0 mDa / DBE: min = -1.5, max = 100.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 2

Monoisotopic Mass, Even Electron Ions
56 formula(e) evaluated with 35 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-39 H: 0-60 O: 0-8 Na: 0-1

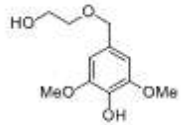
YF-JI ECUST institute of Fine Chem 02-Jan-2013 21:32:50

JYF-JA-21 14 (0.520) Cm (13:20) 1: TOF MS ES+ 2.95e+003



Minimum:				-1.5			
Maximum:		100.0	50.0	100.0			
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
251.0894	251.0895	-0.1	-0.4	3.5	8.4	0.0	C11 H16 O5 Na

Elemental Composition Report



Single Mass Analysis

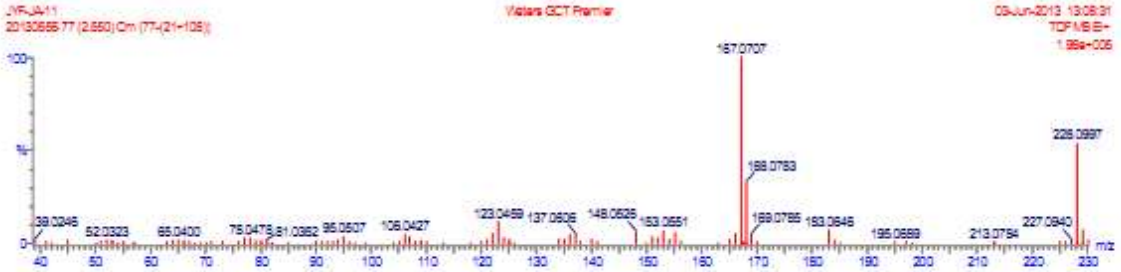
Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

138 formula(e) evaluated with 16 results within limits (up to 50 closest results for each mass)

Elements Used:

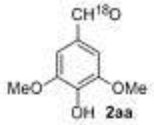
C: 0-11 H: 0-16 O: 0-5



Minimum:					-1.5		
Maximum:		100.00	5.0	10.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	Score	Formula
228.0997	53.31	228.0998	-0.1	-0.4	4.0	8.2	C11 H16 O5

Elemental Composition Report

Single Mass Analysis



2aa

Tolerance = 5.0 mDa / DBE: min = -1.5, max = 50.0

Monoisotopic Mass, Odd and Even Electron Ions

21 formula(e) evaluated with 5 results within limits (up to 50 closest results for each mass)

Elements Used:

C: 0-9 H: 0-10 16O: 0-4 18O: 0-1

Minimum:		2.00			-1.5		
Maximum:		100.00	7.1	10.0	50.0		
Mass	RA	Calc. Mass	mDa	PPM	DBE	i - FIT	Formula
182.0578	28.77	182.0579	-0.1	-0.5	5.0	245.6	C9 H10 16O4
184.0623	100.00	184.0622	0.1	0.5	5.0	1.5	C9 H10 16O3 18O