CHEMISTRY
A EUROPEAN JOURNAL

Supporting Information

© Copyright Wiley-VCH Verlag GmbH & Co. KGaA, 69451 Weinheim, 2008

TEMPO/HCl/$NaNO_2$ Catalyst: The Transition-Metal-Free Approach to Efficient Aerobic Oxidation of Alcohols into the Aldehydes and Ketones under Mild Conditions

Xinliang Wang,[a] Renhua Liu,[b] Yu jin,[a] and Xinmiao Liang*[a,b]

[a] X. Wang, Y. Jin, X. Liang Dalian Institute of Chemical Physics, Chinese Academy of Sciences, 457 Zhongshan Road, Dalian 116023, P. R. China, Fax: (+86) 411-8437-9539.
[b] R. Liu, X. Liang School of Pharmacy, East China University of Science and Technology, 30 Meilong Road, Shanghai 200237, P. R. China, Fax: (+86) 21-6425-1830.

*To whom correspondence should be address.
email***:*** Xinmiao Liang (liangxm@dicp.ac.cn)

LIST of SUPPORTING INFORMATION

Experimental Section

General Equipment and Material All experiments were carried out in a open long-necked round-bottom flask (50 mL). ^{1}H NMR and ^{13}C NMR spectrum was recorded on a Varian DRX 400 using $CDCl_3$ as the solvent with TMS as an internal reference. GC analysis of determination of conversions and selectivities was performed on an Agilent 6890N. GC-MS was performed on Agilent 6890N GC / 5973 MS detector. Benzyl alcohol, 3-phenoxybenzyl alcohol, 2-ethyl hexanol, cyclopropyl carbinol, 2-phenylethanol, cyclohexanol, 3-methyl-2-buten-1-ol, 3-methoxyl-2-propanol and ethyl lactate were domestic commercial reagents, directly used for oxidation without further purification. TEMPO, 2-methylbenzyl alcohol, 3-methylbenzyl alcohol, 4-methylbenzyl alcohol, 2-chlorobenzyl alcohol, 3-chlorobenzyl alcohol, 4-chlorobenzyl alcohol, 4-flourobenzyl alcohol, 3,5-difluorobenzyl alcohol, 3,5-bis(triflouromethyl)benzyl alcohol, 4-methoxylbenzyl alcohol, methyl 4-(hydroxymethyl) benzoate, 4-nitrobenzyl alcohol, 1-phenylethanol, 1-phenyl-1-propanol, 1-indanol, benzhydrol, 1-octanol, 2-octanol, 3-octanol, cyclohexyl carbinol, 4-(methylthio)benzyl alcohol, 2-thienyl methanol, 3-pyridyl methanol, cinnamyl alcohol, 3-buten-2-ol, thioanisole and diethyl sulfide were purchased from Acros, directly used for oxidation without further purification. Acetonitrle (HPLC grade) were purchased from Merck. Other Halogen-containing compounds and solvents were purchased from Tianji Kermel Chemical Reagents Co. Ltd., directly used for oxidation without further purification.
(E)-4-phenyl-3-buten-2-ol were prepared according to the literature procedure (*1*).

General procedure for preparation of TEMPO-catalyzed aerobic oxidation: **Method A:** The oxidation of alcohols was carried out under air in a 50 ml long-necked round-bottom flask equipped with a magnetic stirrer. The alcohol substrate (5.0 mmol) and TEMPO (0.15 mmol) were dissolved in 8 ml dichloromethane. Conc. Hydrochloric acid (0.50 mmol) was added followed by $NaNO_2$ (0.25 mmol). **Method B:** The oxidation of alcohols was carried out under air in a 50 ml long-necked round-bottom flask equipped with a magnetic stirrer. The alcohol substrate (5.0 mmol) and TEMPO (0.25 mmol) were dissolved in 8 ml dichloromethane. Conc. Hydrochloric acid (0.50 mmol) was added followed by $NaNO_2$ (0.25 mmol). The resulting mixture was stirred at room temperature and ambient pressure. **Method C:** The oxidation of alcohols was carried out under air in a 50 ml long-necked round-bottom flask equipped with a magnetic stirrer. The alcohol substrate (5.0 mmol) and TEMPO (0.25 mmol) were dissolved in 8 ml dichloromethane. Conc. Hydrochloric acid (0.80 mmol) was added followed by $NaNO_2$ (0.40 mmol). **Method D:** The oxidation of alcohols was carried out under air in a 50 ml long-necked round-bottom flask equipped with a magnetic stirrer. The alcohol substrate (5.0 mmol) and TEMPO (0.40 mmol) were dissolved in 8 ml dichloromethane. Conc. Hydrochloric acid (0.80 mmol) was added followed by $NaNO_2$ (0.40 mmol).

General procedure for TEMPO-catalyzed aerobic oxidation: The resulting mixture was stirred at room temperature and ambient pressure.The conversion and selectivity of the reaction was detected by GC without any purification. When GC showed the reaction to be complete, the liquid in the flask was transferred into a separation funnel, carefully washed the flask with CH_2Cl_2, The combined organic layers were washed with aqueous 20 w.t.% $Na_2S_2O_3$ and saturated $NaHCO_3$ solution to remove the residual oxidants and TEMPO (*2*). The organic layer was dried over anhydrous Na_2SO_4 and concentrated to dryness. The yield was calculated on the basis of 5.0 mmol of substrate. Because the selectivities in most reactions were more than 99%, The ^{1}H and ^{13}C NMR spectra was recorded using isolated product directly. See the attached NMR spectra.

ESI-MS Detection: The control experiment and the monitoring experiment of the reacting solutions were performed on an Agilent 1100 Series MSD Trap XCT (USA). ESI mass spectra were acquired in the positive ions mode. Nitrogen was used as the nebulizing gas at 15 psi and as drying gas at a flow rate of 5 L·min^{-1} and at a temperature of 300 ^{o}C. Full-scan mode was used in the range of *m/z* 100–200 and only first-stage MS spectra were obtained.

After some study, we selected MeCN as the reaction solvent and the best solvent for diluting the sample taken from the reaction mixture. We also fixed the standard procedure for MS detection: 3 μL of the sample was taken from the reaction mixture stirred at room temperature in an open air atmosphere and was diluted with 1000 μL of MeCN. Then, a syringe pump was used to introduce the diluted sample into the ESI source at the rate of 5 $\mu L \cdot min^{-1}$ with a CapExit voltage of 102.7 V for the MS detection.

General GC conditions: HP-5 column, 30m x 0.32mm (id); FID detector, 250 ^oC; injection: 250 ^oC; carrier gas: nitrogen; carrier gas rate: 1.2 mL / min; area normalization. Benzyl alcohol, 2-methylbenzyl alcohol, 3-methylbenzyl alcohol, 4-methylbenzyl alcohol, 2-chlorobenzyl alcohol, 3-chlorobenzyl alcohol, 4-chlorobenzyl alcohol, 4-flourobenzyl alcohol, 3,5-difluorobenzyl alcohol, 3,5-bis(triflouromethyl)benzyl alcohol, 4-methoxyl-benzyl alcohol, methyl 4-(hydroxymethyl) benzoate, 4-nitrobenzyl alcohol, 3-phenoxy-benzyl alcohol, 2-phenylethanol, 1-phenylethanol, 1-phenyl-1-propanol, 1-indanol, 1-octanol, 2-octanol, 3-octanol, benzhydrol, 4-(methylthio)benzyl alcohol, 2-thienyl methanol, 3-pyridyl methanol, cinnamyl alcohol, (E)-4-phenyl-3-buten-2-ol and their corresponding carbonyl compounds were detected under a condition as: column temperature: 80 ^oC for 5 minutes, raising to 250 ^oC in a rate of 10 ^oC / min, holding at 250 ^oC for 8 min. TEMPO and thioanisole were also detected under this condition, and its corresponding peak areas were deleted in the GC diagrams.

2-Ethyl hexanol, cyclohexyl carbinol, cyclopropyl carbinol, cyclohexanol, 3-methyl-2-buten-1-ol, 3-methoxyl-2-propanol, ethyl lactate and their corresponding carbonyl compounds were performed under a condition as: 50 ^oC for 5 minutes, raising to 250 ^oC in a rate of 10 ^oC / min, holding at 250 ^oC for 5 min. TEMPO and diethyl sulfide were also detected under this condition, and its corresponding peak areas were deleted in the GC diagrams.

Reference:

1. Onaran, M. B.; Seto, C. T. *J. Org. Chem.* **2003**, *68*, 8136.
2. de Nooy, A. E. J.; Besemer, A. C.; van Bekkum, H. *Synthesis*, **1996**, 1153.

Optimization procedure of aerobic oxidation: For our initial experiments of aerobic alcohol oxidation, we chose benzyl alcohol as a test substrate to optimize the reaction conditions (Table 1). Primary results in Table 1 showed that TEMPO catalyzed aerobic benzyl alcohol oxidation with only HCl as the co-catalyst, about 1.9% of benzyl alcohol converted to benzaldehyde without any benzyl chloride at room temperature and ambient pressure for 10 hour (entry 1). Using $NaNO_2$ only as the co-catalyst showed no oxidation (entry 2). We then used HCl (8 mol%) together with $NaNO_2$ (4 mol%) as co-catalyst, a 89.6% conversion of benzyl alcohol with 99.1% of selectivity was obtained for 10 hour (entry 3). Prolonging the reaction time to 11.5 hour showed a complete conversion with 100% of selectivity (entry 4). Synchronously increasing the amount of HCl (from 10 mol% to 16 mol%) and $NaNO_2$ (from 5 mol% to 8 mol%), the same result was obtained at the cost of 10 hour (entry 5), 9.6 hour (entry 6), 9.0 hour (entry 7) and 8.5 hour (entry 8). Then we chose 10 hour as our further reaction time for other condition screening. When keeping 10 mol% of HCl and reducing the amount of $NaNO_2$ from 5 mol% to 3.3 or 2.5 mol% (entries 9-10), the slower conversions in high selectivities was observed, while tried to and reduce the amount of HCl from 10 mol% to 5 or 2.5 mol% with 5 mol% of $NaNO_2$ (entries 11-12), it resulted in the significant decreasing of conversion in low selectivities. In addition, further reducing the amount of TEMPO from 3 mol% to 2 or 1 mol% with 10 mol% HCl and 5 mol% $NaNO_2$ (entries 13-14), incomplete conversions in high selectivities were also observed. Therefore, an optimal reaction condition for benzyl alcohol was as follows: 3 mol% of TEMPO / 10 mol% of HCl/ 5 mol% of $NaNO_2$ as catalyst with ambient pressure air as the terminal oxidant at room temperature. While, for the less active alcohols, the reaction condition was tuned by adding more TEMPO/HCl/$NaNO_2$ to improve the reaction rate.

Table 1. Optimization of TEMPO-Catalyzed Oxidation of Benzyl Alcohol[a]

Entry	TEMPO (% mol)	HCl (% mol)	$NaNO_2$ (% mol)	Time (h)	Conversion (%)	Selectivity of aldehyde (%)
1	3	8	-	10	1.9	100
2	3	-	4	10	0.5	100
3	3	8	4	10	89.7	99.1
4	3	8	4	11.5	100	100
5	3	10	5	10	100	100
6	3	12	6	9.6	100	100
7	3	14	7	9.0	100	100
8	3	16	8	8.5	100	100
9	3	10	3.3	10	67.4	99.0
10	3	10	2.5	10	40.5	99.0
11	3	5	5	10	10.8	78.7
12	3	2.5	5	10	7.6	89.5
13	2	10	5	10	81.8	97.9
14	1	10	5	10	39.5	95.9

[a] The reaction was carried out with benzyl alcohol (5.0 mmol), a specific amount of TEMPO in dichloromethane (8 mL) and air, ambient temperature. The conversions and selectivities were performed on GC (area normalization).

Table 2. Screening Solvents for Catalytic Aerobic Oxidation of Benzyl Alcohol[a]

Entry	Solvent	Time (h)	Conv. (%)	Select. (%)
1	CH_2Cl_2	10	100	100
2	$CHCl_3$	10	63.4	98.9
3	CCl_4	10	26.7	97.4
4	$ClCH_2CH_2Cl$	10	99.4	99.6
5	CF_3CH_2OH	10	20.4	98.0
6	PhF	8	99.6	100
7	PhCl	10	57.5	94.3
8	PhMe	10	37.8	96.4
9	$PhCF_3$	10	54.1	100
10	HOAc	9	100	97.9
11	EtOAc	12	98.2	93.6
12	MeCN	11	99.6	100
13	*t*-BuOH	10	11.8	97.4
14	Me_2CO	10	2.1	91.3
15	THF	10	17.7	100

[a] Aerobic oxidation conditions are follows: alcohol (5.0 mmol), TEMPO (0.15 mmol), $NaNO_2$ (0.25 mmol), HCl (0.50 mmol), solvent (8.0 mL), air, ambient temperature. Conversions and selectivities are based on the gas chromatography (GC) with area normalization.

Characterization Data

Benzaldehyde (100-52-7). ^{1}H NMR (400MHz, $CDCl_3$) d 7.47 (t, 2H), 7.57 (t, 1H), 7.83 (m, J = 7.2 Hz , 2H), 9.96 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 125.6, 126.2, 131.0, 132.9, 188.9.

2-Methylbenzaldehyde (529-20-4). ^{1}H NMR (400MHz, $CDCl_3$) d 2.65 (s, 3H), 7.27 (d, J = 7.4 Hz, 1H), 7.34 (t, J = 7.4 Hz, 1H), 7.45 (t, J = 7.4 Hz, 1H), 7.77 (d, J = 7.4 Hz, 1H), 10.24 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 17.5, 124.3, 129.7, 130.0, 131.6, 132.0, 138.4, 190.7.

3-Methylbenzaldehyde (620-23-5). ^{1}H NMR (400MHz, $CDCl_3$) d 2.37 (s, 3H), 7.37 (s, 2H), 7.62 (s, 1H), 9.93 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 18.1, 124.1, 125.8, 126.9, 132.2, 133.4, 135.7, 189.4.

4-Methylbenzaldehyde (104-87-0). ^{1}H NMR (400MHz, $CDCl_3$) d 2.38 (s, 3H), 7.27 (d, J = 7.5 Hz, 2H), 7.72 (d, J = 7.5 Hz, 2H), 9.91 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d18.7, 126.7, 126.8, 131.2, 142.4, 188.9.

2-Chlorobenzaldehyde (89-98-5). ^{1}H NMR (400MHz, $CDCl_3$) d 7.37 (m, 1H), 7.42 (m, 1H), 7.52 (m, 1H), 7.88 (m, 1H), 10.4 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 127.3, 129.3, 130.3, 132.4, 135.2, 137.9, 189.7.

3-Chlorobenzaldehyde (587-04-2). ^{1}H NMR (400MHz, $CDCl_3$) d 7.46 (d, J = 6.5 Hz, 1H), 7.54 (d, J = 7.0 Hz, 1H), 7.73 (d, J = 6.5 Hz, 1H), 7.78 (s, 1H), 9.94 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 127.9, 129.1, 130.3, 134.2, 135.3, 137.7, 190.7.

4-Chlorobenzaldehyde (104-88-1). ^{1}H NMR (400MHz, $CDCl_3$) d 7.29-7.52 (m, 2H), 7.81-7.84 (m, 2H), 9.99 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 141.1, 134.9, 131.1, 129.6, 191.0.

4-Fluorobenzaldehyde (459-57-4). ^{1}H NMR (400MHz, $CDCl_3$) d 7.19-7.24 (m, 2H), 7.90-7.94 (m, J = 5.8 Hz, 2H), 9.97 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 115.8, 116.1, 131.8, 132.6, 164.8, 167.4, 190.2.

3,5-Difluorobenzaldehyde (32085-88-4). ^{1}H NMR (400MHz, $CDCl_3$) d 8.15 (s, 1H), 8.36 (s, J = 5.8 Hz,2H), 10.2 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 118.6, 134.9, 131.1, 129.6, 189.0.

3,5-Bis(trifluoromethyl) benzaldehyde (401-95-6). ^{1}H NMR (400MHz, $CDCl_3$) d 7.09 (t, J = 8.4Hz, 1H), 7.41 (d, J = 4.4Hz, 2H), 9.96 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 109.7, 109.9, 110.2, 112.3, 112.5, 139.3, 162.2, 164.7, 189.7.

4-Methoxybenzaldehyde (123-11-5). ^{1}H NMR (400MHz, $CDCl_3$) d 3.92 (s, 3H), 7.05 (d, J = 8.4 Hz, 2H), 7.88 (d, J = 8.4 Hz, 2H), 9.93 (s, 1H); ^{13}C NMR (100MHz,

$CDCl_3$) d 55.5, 114.2, 129.7, 131.8, 164.4, 190.6.

4-Nitrobenzaldehyde (555-16-8). ^{1}H NMR (400MHz, $CDCl_3$) d 8.13 (d, J = 8.0 Hz, 2H), 8.41 (d, J = 8.0 Hz, 2H), 10.2 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 124.4, 130.6, 140.2, 151.2, 190.6.

4-Methoxycarbonylbenzaldehyde (157-08-0). ^{1}H NMR (400MHz, $CDCl_3$) d 2.38 (s, 3H), 7.93 (d, J = 6.4 Hz, 1H), 8.16 (d, J = 6.4 Hz, 1H), 10.1 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 49.6, 126.4, 126.8, 127.0, 131.8, 136.0, 162.7, 188.6.

3-Phenoxybenzaldehyde (39515-51-0). ^{1}H NMR (400MHz, $CDCl_3$) d 7.02 (d, J = 8.0 Hz, 2H), 7.12-7.16 (m, 1H), 7.26 (dd, J = 8.2, 2.2 Hz, 1H), 7.33-7.37 (m, 2H), 7.44-7.48 (m, 2H), 7.57 (d, J = 7.6 Hz, 1H), 9.92 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 117.8, 119.2, 123.9, 124.2, 124.4, 129.8, 130.2, 137.7, 155.87, 158.0, 191.3.

Acetophenone (98-86-2). ^{1}H NMR (400MHz, $CDCl_3$) d 2.55 (s, 3H), 7.39-7.52 (m, 3H), 7.94 (m, 2H); ^{13}C NMR (100MHz, $CDCl_3$) d 26.4 , 128.2, 128.4, 133.0, 137.0, 198.0.

Propiophenone (93-55-0). ^{1}H NMR (400MHz, $CDCl_3$) d 1.21 (t, J = 7.2 Hz, 3H), 2.98 (q, J = 7.2 Hz, 2H), 7.51-7.53-7.52 (m, 1H), 7.94-7.96 (m, 2H); ^{13}C NMR (100MHz, $CDCl_3$) d 8.19, 31.7, 127.9, 128.5, 132.8, 136.8, 200.7.

1-Indanone (83-33-0). ^{1}H NMR (400MHz, $CDCl_3$) d 2.66-2.69 (m, 2H), 3.14 (t, J = 6.0 Hz, 2H), 7.37 (dd, J = 7.6, 0.8 Hz, 1H), 7.47 (d, J = 7.6, 0.8 Hz, 1H), 7.58 (dd, J = 7.6, 1.0 Hz, 1H), 7.75 (d, J = 7.6 Hz, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 25.8 , 36.3, 123.7, 126.8, 127.0, 127.3, 134.6, 155.2, 207.1.

Benzophenone (91-01-0). ^{1}H NMR (400MHz, $CDCl_3$) d 7.43-7.48 (m, 4H), 7.54-7.55 (m, 2H), 7.78-7.80 (m, 4H); ^{13}C NMR (100MHz, $CDCl_3$) d 128.4, 128.6, 130.4, 132.7, 196.8.

Octanal (124-13-0). ^{1}H NMR (400MHz, $CDCl_3$) d 0.88 (t, J = 6.4 Hz, 3H), 1.28-1.31 (m, 8H), 1.63 (s, 2H), 2.42 (t, J =6.8 Hz, 2H), 9.76 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 10.6, 18.6, 19.1, 25.5, 25.6, 28.2, 40.5, 199.4.

2-Ethylhexanal (123-05-7). ^{1}H NMR (400MHz, $CDCl_3$) d 1.10-1.12 (m, 4H), 1.27-1.35 (m, 4H), 1.44-1.54 (m, 2H), 1.61-1.68 (m, 2H), 9.56 (d, J = 2.8 Hz, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 9.4, 11.8, 19.8, 20.7, 26.0, 27.1, 51.3, 203.6.

Cyclohexanecarboxaldehyde (2043-61-0). ^{1}H NMR (400MHz, $CDCl_3$) d1.24-1.91(m, 10H), 1.83-1.89 (m, 1H), 2.24 (s, 1H), 9.62 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 24.1, 25.0, 49.0, 204.1.

Cyclopropanecarboxaldehyde (1489-69-6). ^{1}H NMR (400MHz, $CDCl_3$) d 0.88-0.93 (m, 6H), 1.27-1.35 (m, 4H), 1.83-1.89 (m, 1H), 8.92 (d, J = 6.0 Hz, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 7.4, 22.8, 201.6.

2-Octanone (111-13-7). ^{1}H NMR (400MHz, $CDCl_3$) d 0.88 (t, J = 6.8 Hz, 3H), 1.28-1.31 (m, 6H), 1.56 (m, 2H), 2.13 (s, 3H), 2.43 (t, J = 7.4 Hz, 2H); ^{13}C NMR (100MHz, $CDCl_3$) d 13.8, 22.2, 23.7, 28.8, 29.6, 31.2, 33.9, 209.3.

3-Octanone (106-68-3). ^{1}H NMR (400MHz, $CDCl_3$) d 0.89 (t, J = 6.8 Hz, 3H), 1.05 (t, J = 7.3 Hz, 3H), 1.26-1.33(m, 4H), 1.58 (m, 2H), 2.38-2.45 (m, 4H); ^{13}C NMR (100MHz, $CDCl_3$) d 7.8, 13.9, 22.5, 23.6, 31.5, 35.8, 42.4, 211.8.

Cylcohexanone (108-94-0). ^{1}H NMR (400MHz, $CDCl_3$) d 1.71-1.76 (m, 2H), 1.83-1.90 (m, 4H), 2.32-2.36 (m, 4H); ^{13}C NMR (100MHz, $CDCl_3$) d 24.9, 26.8, 26.9, 41.8, 211.8.

4-(Methylthio)benzaldehyde (3446-89-7). ^{1}H NMR (400MHz, $CDCl_3$) d 2.52 (s, 1H), 7.30 (d, J = 8.4 Hz, 2H), 7.76 (d, J = 8.4 Hz, 2H), 9.91 (s, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 14.7, 125.3, 130.1, 133.1, 148.0, 191.3.

2-Thiophenecarboxaldehyde (98-03-3). ^{1}H NMR (400MHz, $CDCl_3$) d 7.22 (m, 1H), 7.78-7.81 (m, 2H), 9.94 (d, J = 12.8 Hz, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 128.3, 133.7, 136.5, 143.7, 183.0.

***trans*-Cinnamaldehyde (14371-10-9).** ^{1}H NMR (400MHz, $CDCl_3$) d 6.73 (q, J = 7.6 Hz, 1H), 7.42-7.45 (m, 4H), 7.49-7.57 (m, 2H), 9.71 (d, J = 7.6 Hz, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 128.2, 128.4, 128.7, 128.9, 131.1, 133.8, 152.6, 193.6.

***trans*-4-Phenyl-3-buten-2-ol (36004-04-3).** ^{1}H NMR (400MHz, $CDCl_3$) d 1.34 (d, J = 6.4 Hz, 1H), 2.41(s, 1H), 4.41-4.47(m, 1H), 6.24 (d, J = 16.0, 6.4 Hz, 1H), 6.52 (d, J = 16.0 Hz, 1H), 7.21 (t, J = 2.4 Hz, 1H), 7.22-7.33 (m, 2H), 7.35 (d, J = 1.6 Hz, 2H); ^{13}C NMR (100MHz, $CDCl_3$) d 23.5, 68.9, 126.6, 127.7, 128.7, 129.4, 133.8, 136.9.

***trans*-4-Phenyl-3-buten-2-one (1896-62-4).** ^{1}H NMR (400MHz, $CDCl_3$) d 2.34 (s, 1H), 6.68 (d, J = 16.4 Hz, 1H), 7.29-7.36 (m, 3H), 7.46-7.50 (m, 3H); ^{13}C NMR (100MHz, $CDCl_3$) d 27.2, 126.8, 128.0, 128.8, 130.3, 134.2, 143.2, 198.0.

3-Methyl-2-butenal (107-86-8). ^{1}H NMR (400MHz, $CDCl_3$) d 1.99 (s, 3H), 2.18 (s, 3H), 5.87(d, J = 8.0 Hz, 1H), 9.95 (d, J = 8.0 Hz, 1H); ^{13}C NMR (100MHz, $CDCl_3$) d 16.3, 27.1, 127.8, 160.5, 190.8.

3-Methoxyacetone (5878-19-3). ^{1}H NMR (400MHz, $CDCl_3$) d2.14 (s, 3H), 3.42 (s, 3H), 4.04 (s, 2H), ^{13}C NMR (100MHz, $CDCl_3$) d 25.8, 58.8, 126.8, 77.5, 206.2.

Figure List

Figure 23: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HOAc and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 24: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of TsOH and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 25: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of $MeSO_3H$ and 5mol % of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 26: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of CF_3CO_2H and 5mol % of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 27: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of H_3PO_4 and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 28 : GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of H_2SO_4 and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 29: GC diagram of oxidation of benzyl alcohol for 13 h, 3 mol% of TEMPO, 5 mol% of H_2SO_4, 10 mol% NaCl and 5 mol % of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 30: GC diagram of oxidation of benzyl alcohol for 14 h, 3 mol% of TEMPO, 5 mol% of H_2SO_4, 10 mol% $BnNMe_3Cl$ and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 31: GC diagram of oxidation of benzyl alcohol for 17 h, 3 mol% of TEMPO, 10 mol% of H_3PO_4, 10 mol% NaCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 32: GC diagram of oxidation of benzyl alcohol for 17 h, 3 mol% of TEMPO, 10 mol% of HBF_4, 10 mol% NaCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 33: GC diagram of oxidation of benzyl alcohol for 16 h, 3 mol% of TEMPO, 10 mol% of $MeSO_3H$, 10 mol% NaCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 34: GC diagram of oxidation of benzyl alcohol for 17 h, 3 mol% of TEMPO, 10 mol% of CF_3CO_2H, 10 mol% NaCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.

Figure 35-Figure 49: Screening solvents for catalytic aerobic oxidation of benzyl alcohol.

Figure 35: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 36: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in chloroform ($CHCl_3$).
Figure 37: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in carbon tetrachloride (CCl_4).
Figure 38: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in 1,2-dichloromethane ($ClCH_2CH_2Cl$).
Figure 39: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol % of HCl and 5 mol % of $NaNO_2$ as catalyst in 2,2,2-trifluoroethanol (CF_3CH_2OH).
Figure 40: GC diagram of oxidation of benzyl alcohol for 8.0 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in fluorobenzene (PhF).
Figure 41: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in chlorobenzene (PhCl).
Figure 42: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in toluene (PhMe).
Figure 43: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in a,a,a-trifluorotoluene ($PhCF_3$).
Figure 44: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10

mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in acetic acid (HOAc).
Figure 45: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5mol% of $NaNO_2$ as catalyst in ethyl acetate (EtOAc).
Figure 46 : GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in acetonitrle (MeCN).
Figure 47: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in *tert*-butanol (*t*-BuOH).
Figure 48: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol % of HCl and 5 mol % of $NaNO_2$ as catalyst in acetone (Me_2CO).
Figure 49: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in tetrahydrofuran (THF).

Figure 50 - Figure 65: Optimization of TEMPO-catalyzed oxidation of benzyl alcohol.

Figure 50: GC diagram of benzyl alcohol in CH_2Cl_2.
Figure 51: GC diagram of TEMPO in CH_2Cl_2.
Figure 52: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO and 8 mol% of HCl as catalyst in CH_2Cl_2.
Figure 53: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO and 4 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 54: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 8 mol% of HCl and 4 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 55: GC diagram of oxidation of benzyl alcohol for 11.5 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 56: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 57: GC diagram of oxidation of benzyl alcohol for 9.6 h, 3 mol% of TEMPO, 12 mol% of HCl and 6 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 58: GC diagram of oxidation of benzyl alcohol for 9.0 h, 3 mol% of TEMPO, 14 mol% of HCl and 7 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 59: GC diagram of oxidation of benzyl alcohol for 8.5 h, 3 mol% of TEMPO, 16 mol% of HCl and 8 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 60: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 3.3 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 61: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 2.5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 62: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 5 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 63: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 2.5 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 64: GC diagram of oxidation of benzyl alcohol for 10 h, 2 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.
Figure 65: GC diagram of oxidation of benzyl alcohol for 10 h, 1 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.

Figure 66 - Figure 139: Catalytic aerobic oxidation of alcohols by TEMPO/HCl/$NaNO_2$.

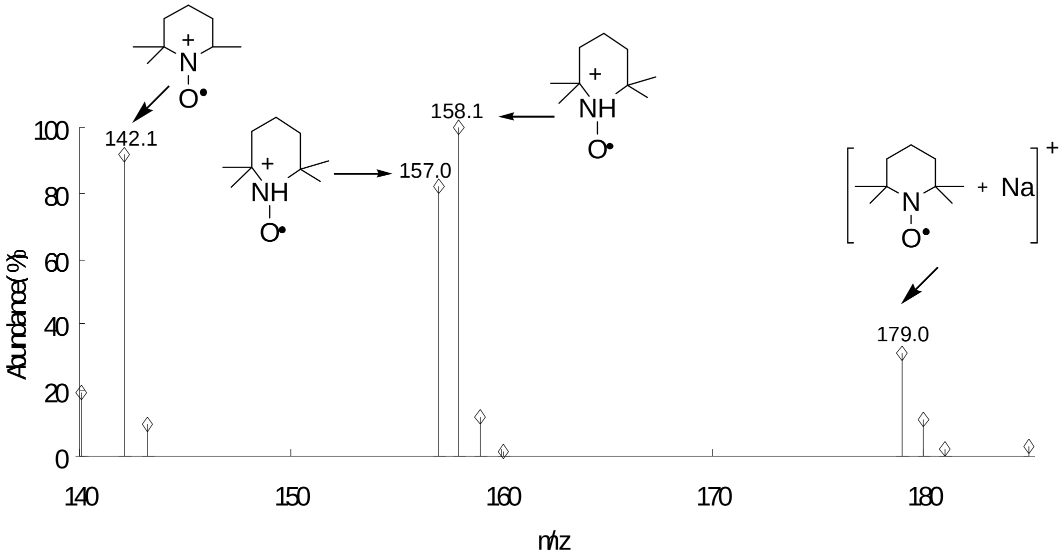


Figure S1 : ESI mass spectrum of the solution of TEMPO in acetonitrile.

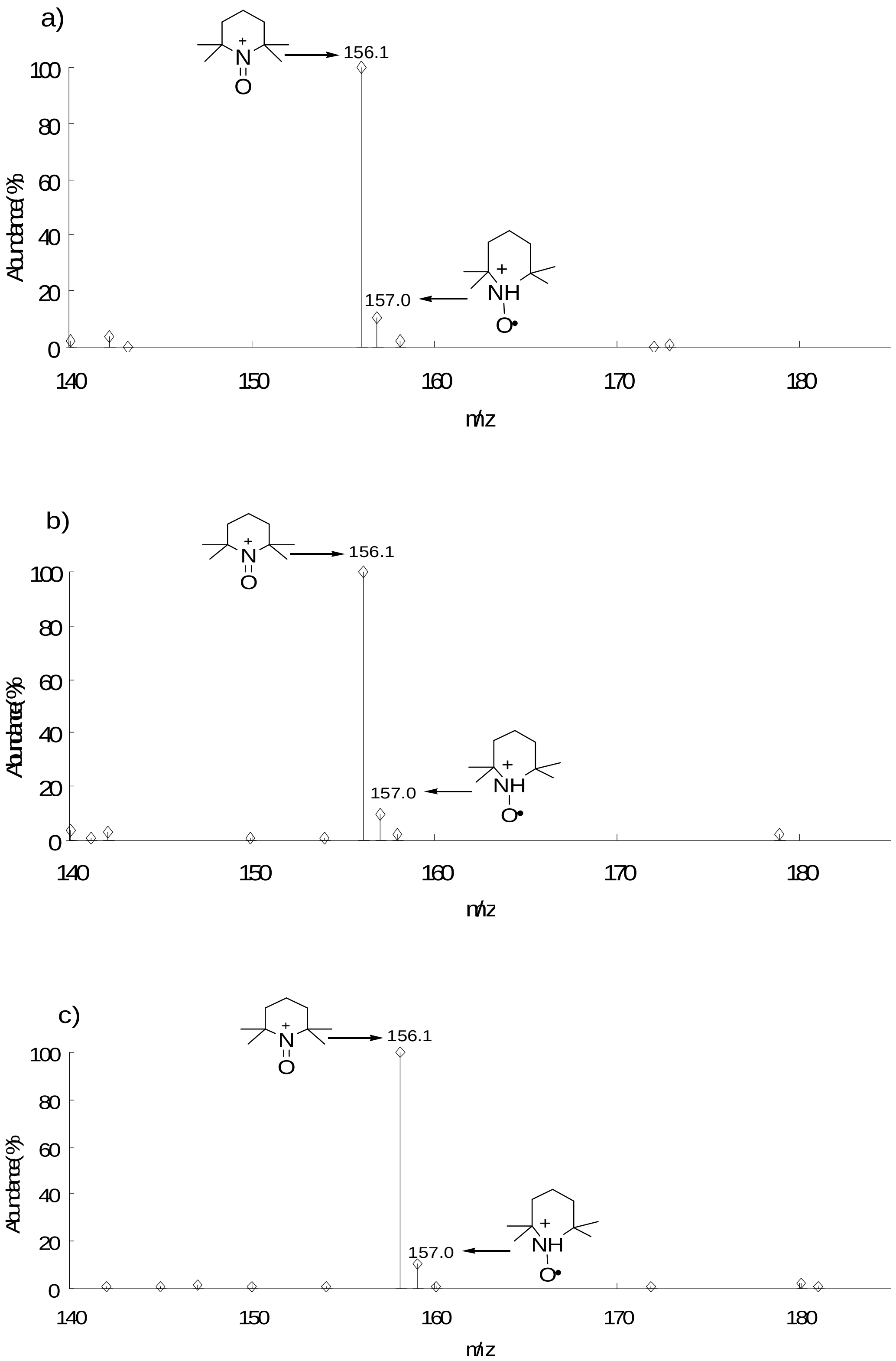
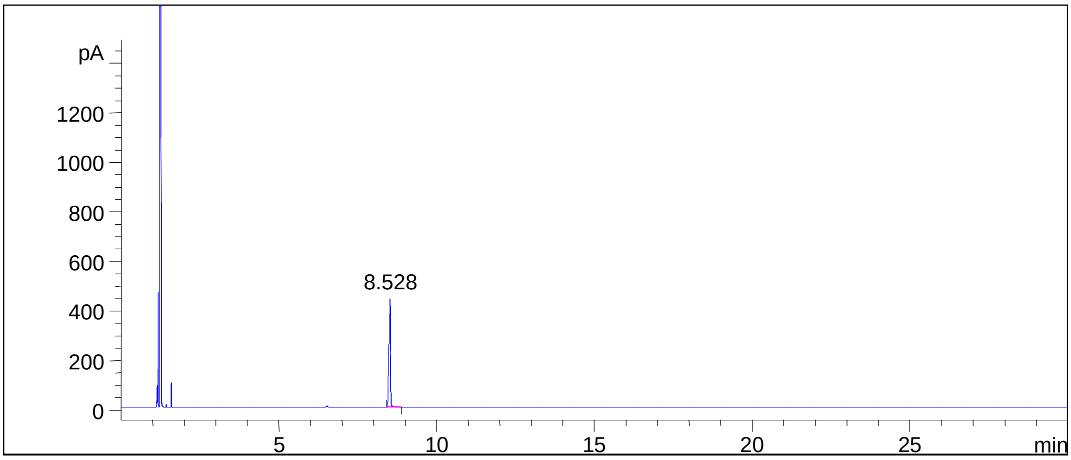
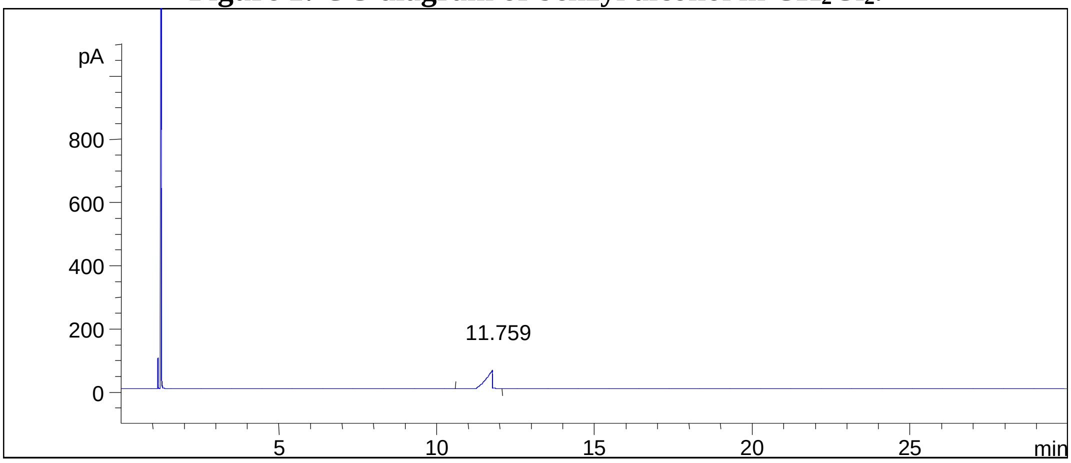


Figure S2 : ESI mass spectra of the reaction solution of TEMPO/HCl/NaNO$_2$ catalyzed aerobic oxidation in acetonitrile. ESI(+)-MS carried out with the standard procedure for MS detection for the sample taken from the reaction mixture of benzyl alcohol (2.0 mmol), TEMPO (0.06 mmol), HCl (0.20 mmol), NaNO$_2$ (0.10 mmol) in MeCN (5 mL) stirred at room temperature in an open air atmosphere at the reaction time of a) 6 h, b) 12 h (complete conversion), and c) 24 h.



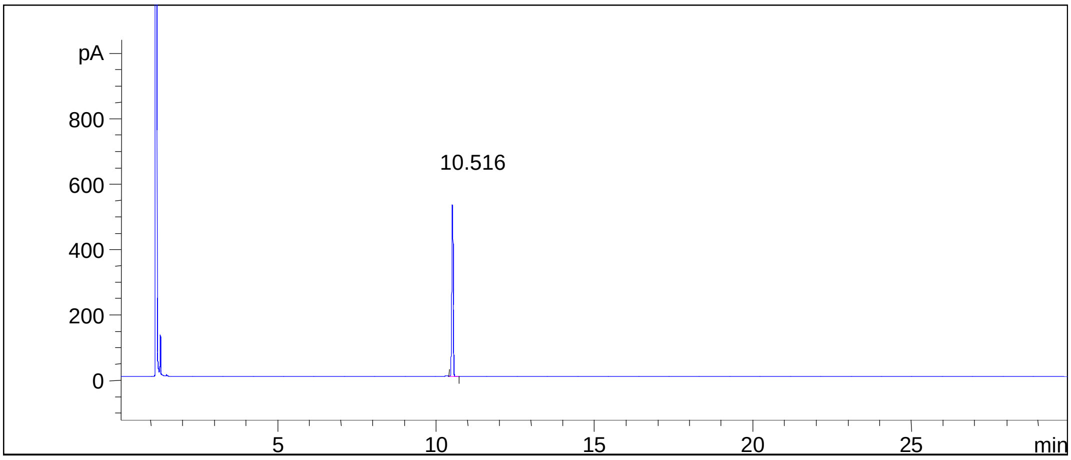
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	8.528	1549.2	438.5	0.0467	100.000	2.254
	Totals:	1549.2	438.5		100.000	

Figure 1: GC diagram of benzyl alcohol in CH_2Cl_2.



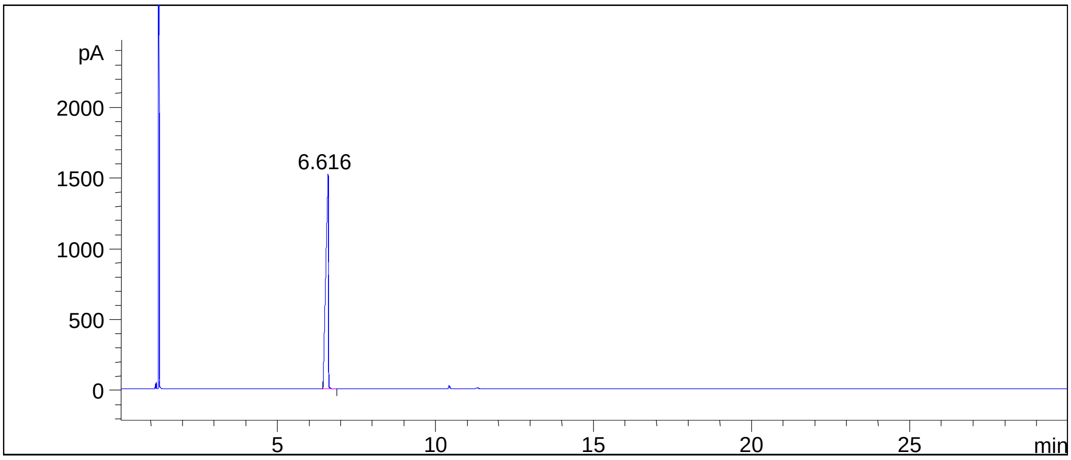
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	11.759	803.2	58.4	0. 2290	100.000	24.6
	Totals:	803.2	58.4		100.000	

Figure 2: GC diagram of benzoic acid in CH_2Cl_2.



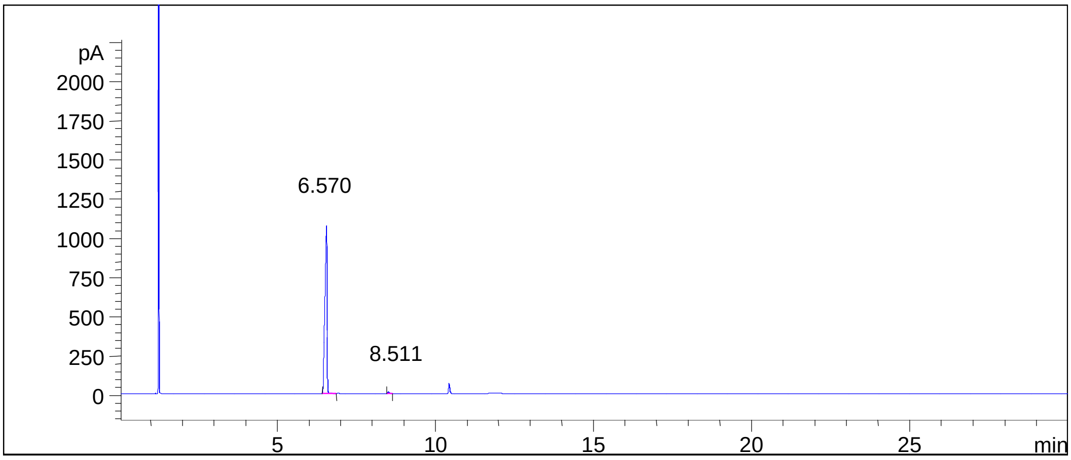
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	10.516	1559.1	526.6	0.0425	100.000	1.469
	Totals:	1559.1	526.6		100.000	

Figure 3: GC diagram of TEMPO in CH_2Cl_2.



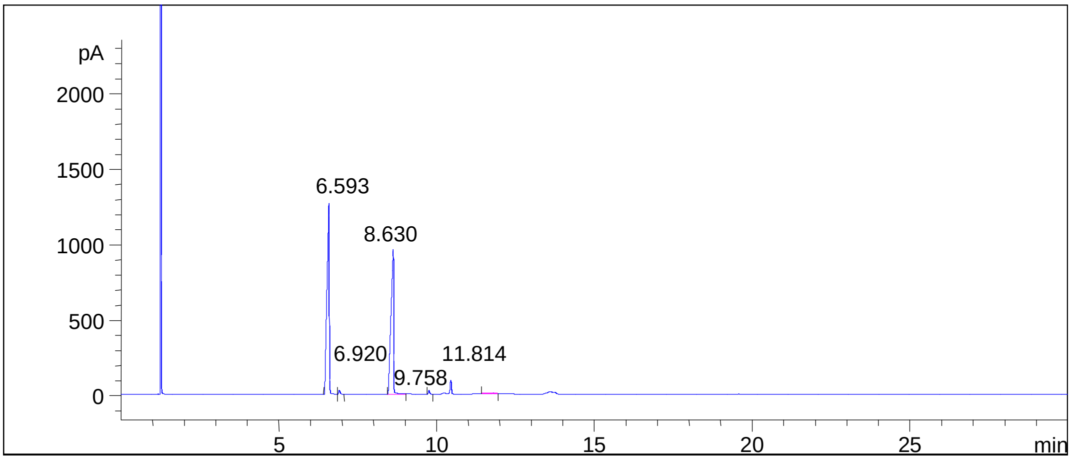
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.616	8627.6	1517.4	0.0721	100.000	5.956
	Totals:	8627.6	1517.4		100.000	

Figure 4: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 5mol% of Br_2 and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



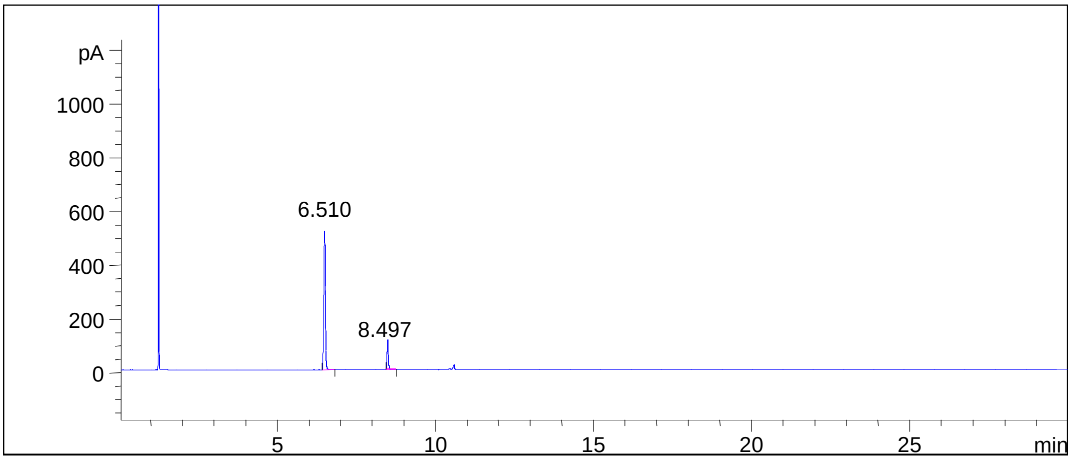
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.570	5052.4	1069.1	0.0619	99.245	3.683
2	8.511	38.4	12.2	0.0455	0.755	0.512
	Totals:	5090.8	1081.3		100.000	

Figure 5: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 5mol% of Bu_4NBr_3 and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



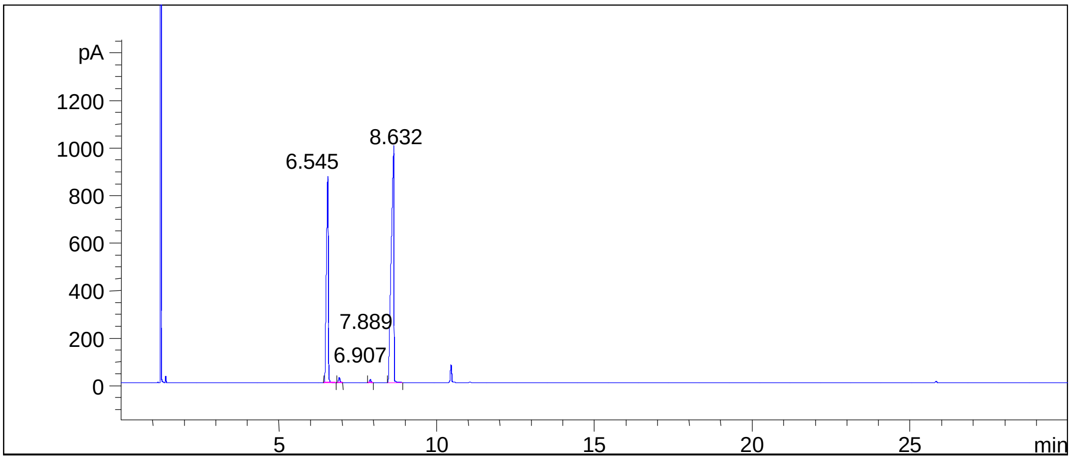
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.593	6515.3	1264.4	0.0666	53.153	4.612
2	6.920	81.8	25.0	0.0489	0.677	0.699
3	8.630	5518.1	960.5	0.0720	45.018	6.028
4	9.758	64.0	23.2	0.0430	0.522	0.892
5	11.814	78.3	5.3	0.1754	0.639	6.546
	Totals:	5090.8	2278.4		100.000	

Figure 6: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 5mol% of DBDMH and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



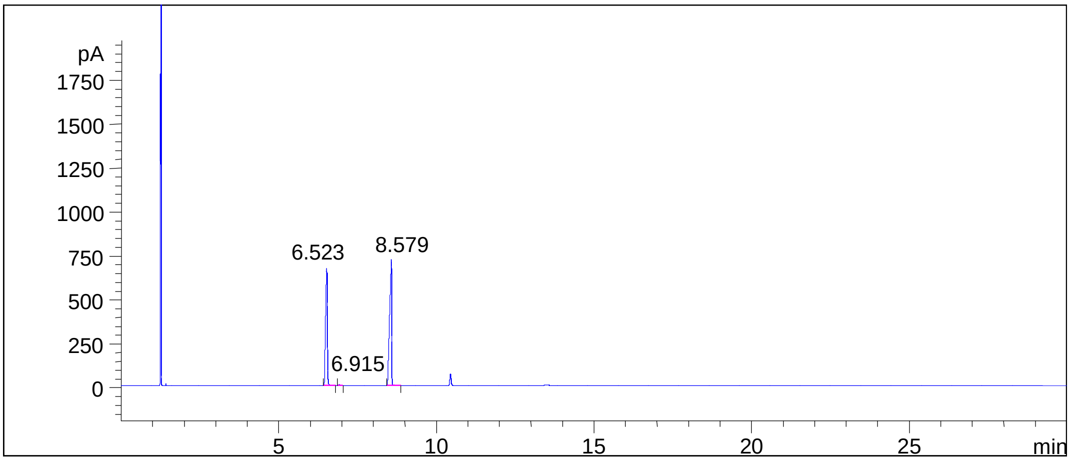
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.510	1784.0	517.1	0.0512	84.938	1.365
2	8.497	316.4	111.1	0.0437	15.062	0.784
	Totals:	5090.8	2278.4		100.000	

Figure 7: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of NBS and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



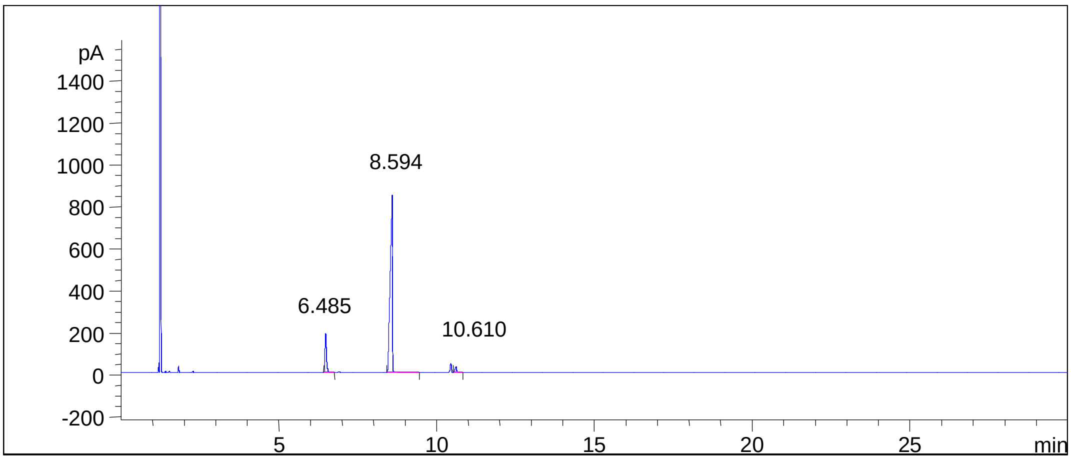
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.545	3680.9	868.4	0.0565	37.682	2.516
2	6.907	74.8	22.6	0.0508	0.781	0.753
3	7.889	43.8	14.2	0.0477	0.457	0.884
4	8.632	5850.0	997.1	0.0722	61.081	7.968
	Totals:	9649.5	1902.3		100.000	

Figure 8: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 5 mol% of TCCA and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



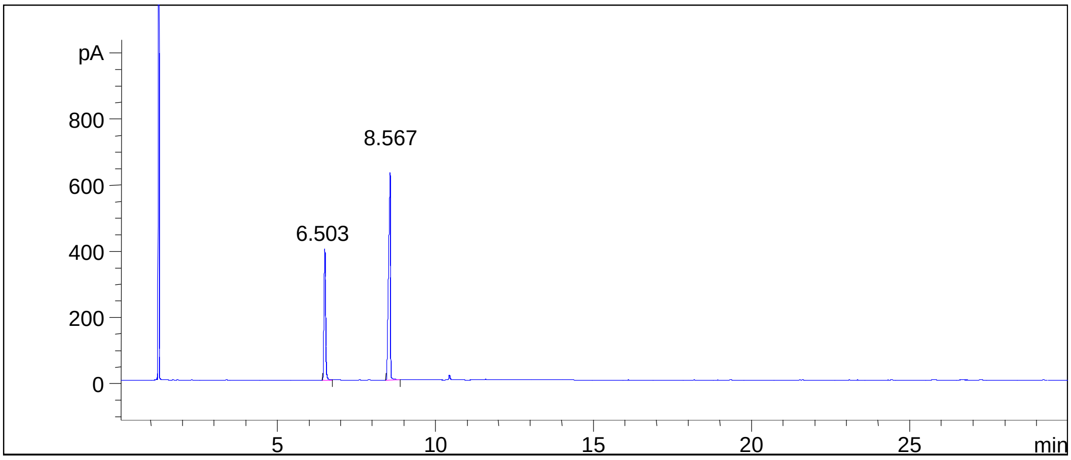
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.523	2585.0	669.2	0.0528	43.631	1.842
2	6.915	23.0	7.0	0.0464	0.388	0.811
3	8.579	3316.6	717.8	0.0589	55.980	4.073
	Totals:	5924.6	1394.0		100.000	

Figure 9: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 5 mol% of DCDMH and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



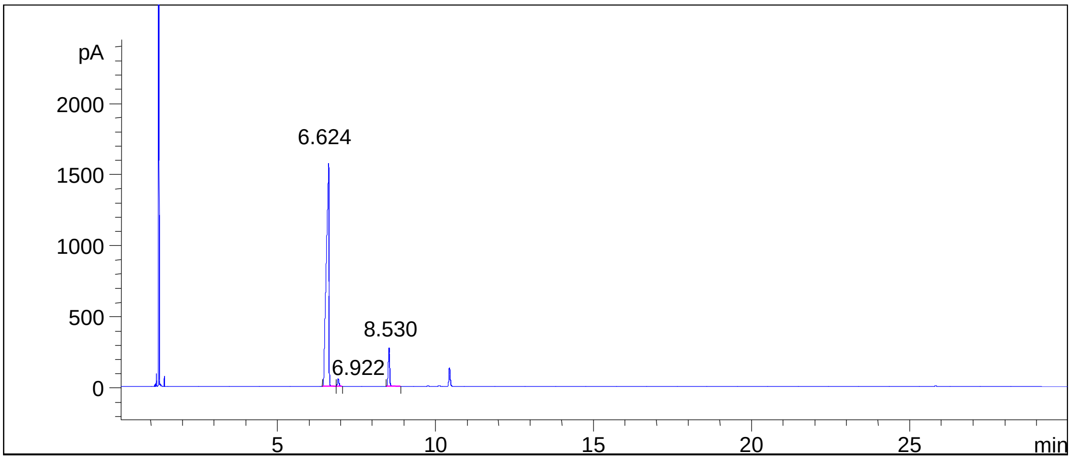
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.485	3680.9	868.4	0.0565	37.682	2.516
2	8.594	74.8	22.6	0.0508	0.781	0.753
3	10.610	43.8	14.2	0.0477	0.457	0.884
	Totals:	9649.5	1902.3		100.000	

Figure 10: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 5 mol% of NCS and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



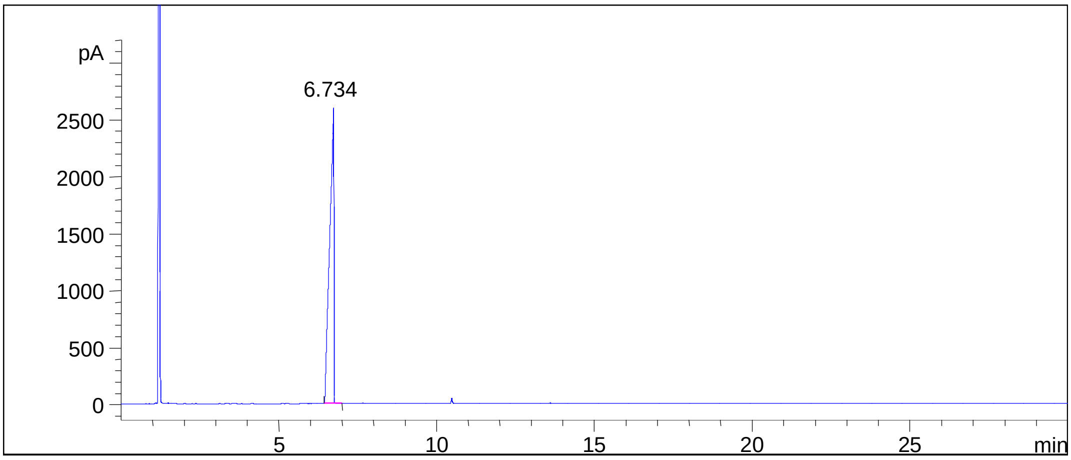
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.503	1391.7	397.3	0.0511	33.953	2.516
2	8.567	2707.2	626.9	0.0554	66.047	0.753
	Totals:	4098.9	1024.2		100.000	

Figure 11: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 5 mol% of I_2 and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



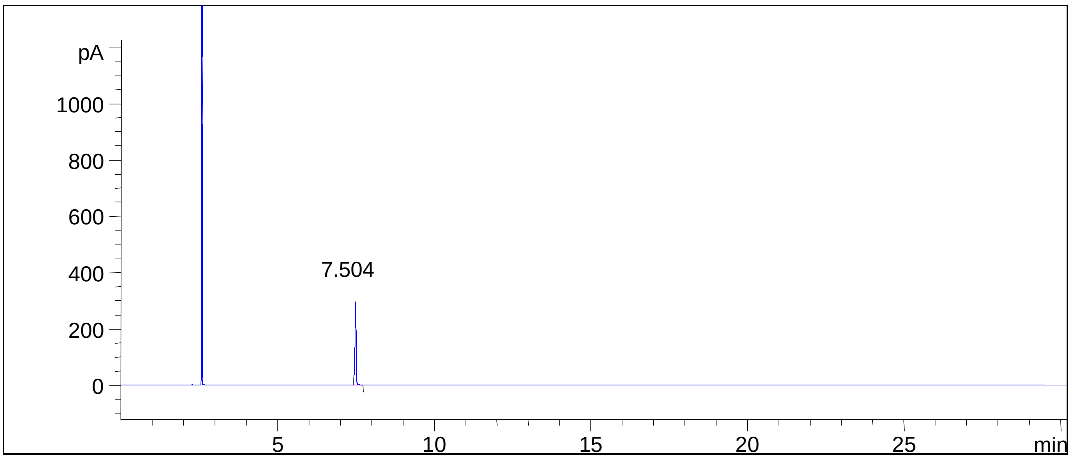
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.624	9296.2	1567.1	0.0757	90.336	6.077
2	6.922	198.7	53.0	0.0471	1.639	0.731
3	8.530	825.9	271.4	0.0428	8.025	1.262
	Totals:	10320.8	1891.5		100.000	

Figure 12: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HBr and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



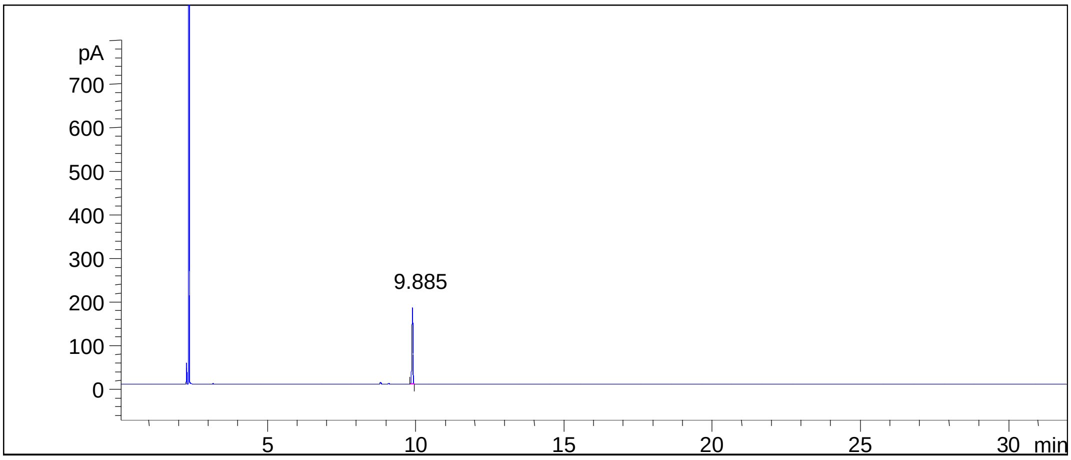
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.734	23741.0	2593.5	0.1108	100.000	15.867
	Totals:	23741.0	2593.5		100.000	

Figure 13 : GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



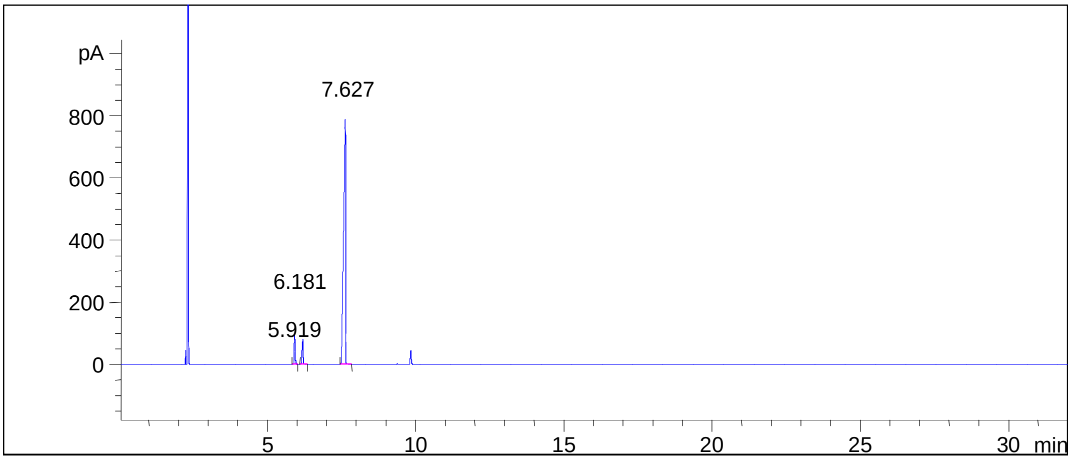
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	7.504	806.4	295.1	0.0384	100.00	1.867
	Totals:	806.4	295.1		100.000	

Figure 14: GC diagram of benzyl alcohol in CH_2Cl_2.



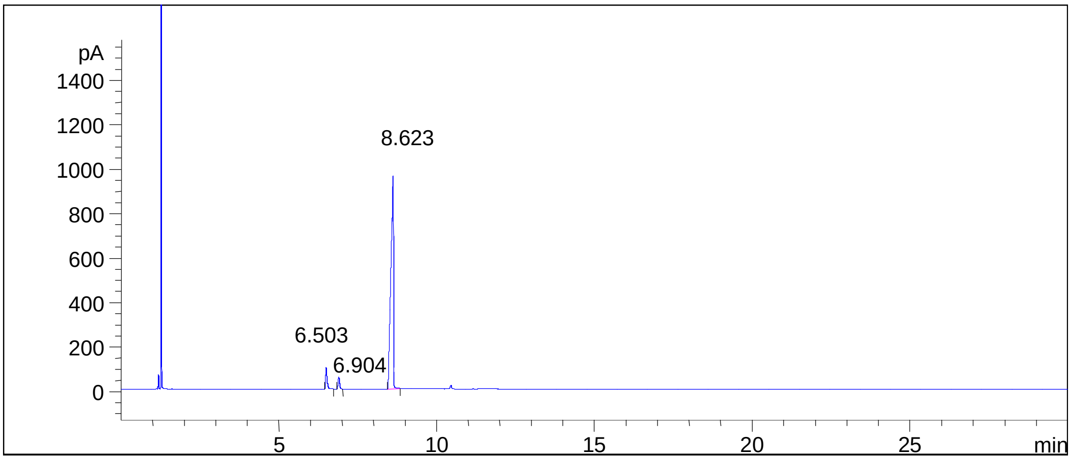
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	9.885	424.2	174.9	0.0373	100.00	1.147
	Totals:	424.2	174.9		100.000	

Figure 15: GC diagram of TEMPO in CH_2Cl_2.



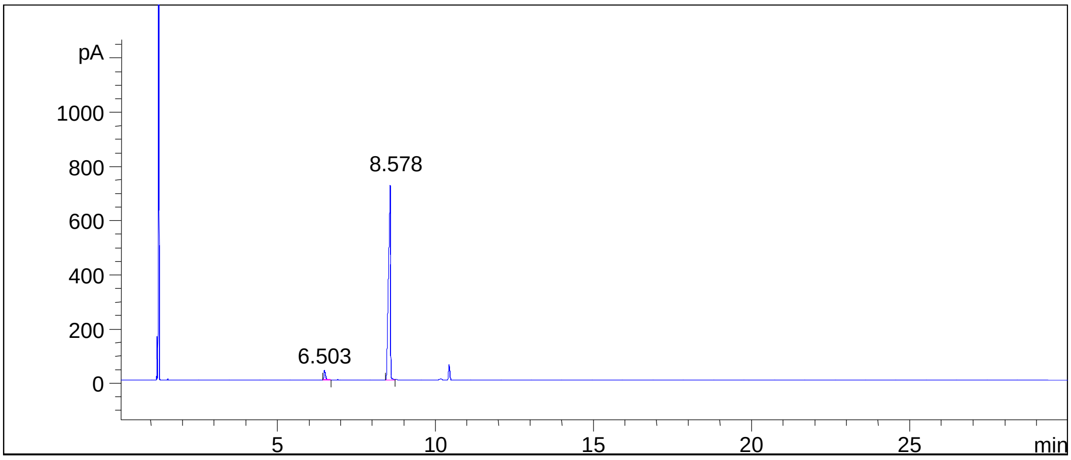
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.919	223.1	95.2	0.0368	5.442	1.011
2	6.181	195.4	79.3	0.0378	4.765	0.920
3	7.627	3681.6	788.9	0.0594	89.793	6.542
	Totals:	4100.1	963.4		100.000	

Figure 16 : GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HF and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



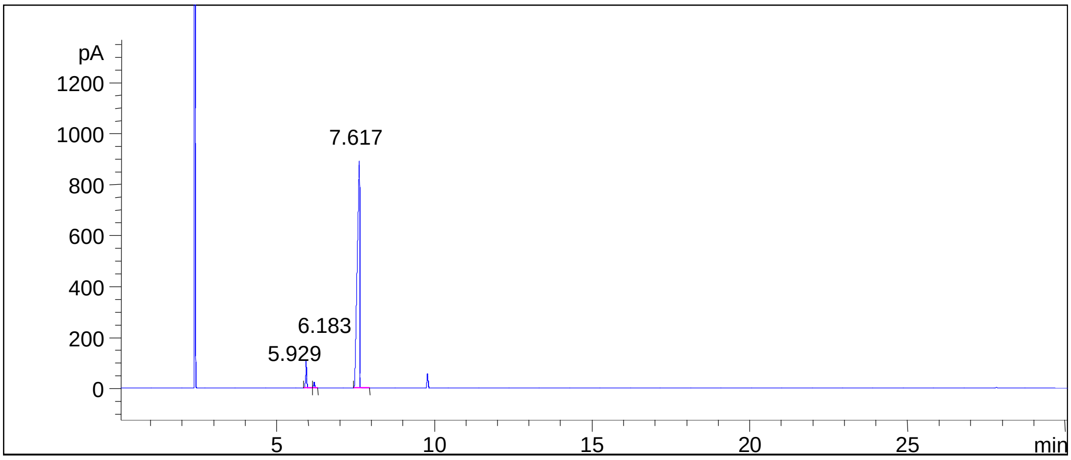
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.503	320.3	96.2	0.0504	5.358	0.517
2	6.904	176.3	53.4	0.0485	2.949	0.741
3	8.623	5481.3	955.4	0.0687	91.693	5.027
	Totals:	5977.9	1105.0		100.000	

Figure 17: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HBF_4 and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



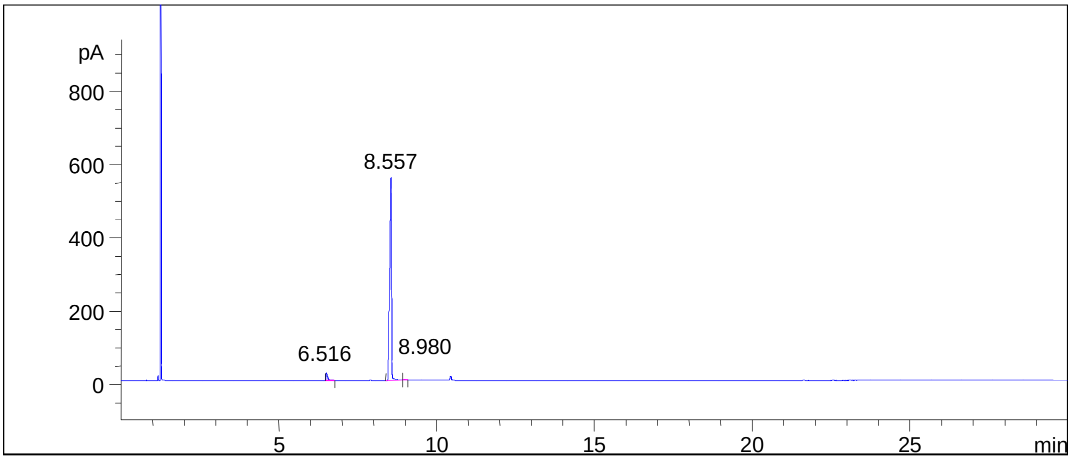
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.503	125.7	36.9	0.0485	3.718	0.496
2	8.758	3255.6	719.8	0.0583	96.282	2.680
	Totals:	3381.3	756.7		100.000	

Figure 18 : GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HNO_3 and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



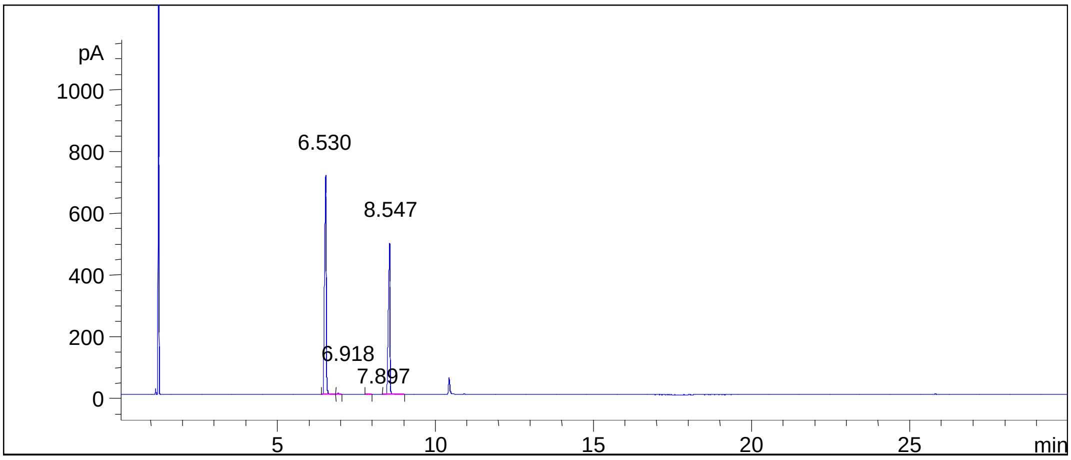
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.929	260.9	106.9	0.0380	5.277	0.940
2	6.183	59.5	24.4	0.0380	1.203	0.910
3	7.617	4624.0	891.6	0.0640	93.520	7.634
	Totals:	4944.4	1022.9		100.000	

Figure 19: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HNO_3 as catalyst in CH_2Cl_2.



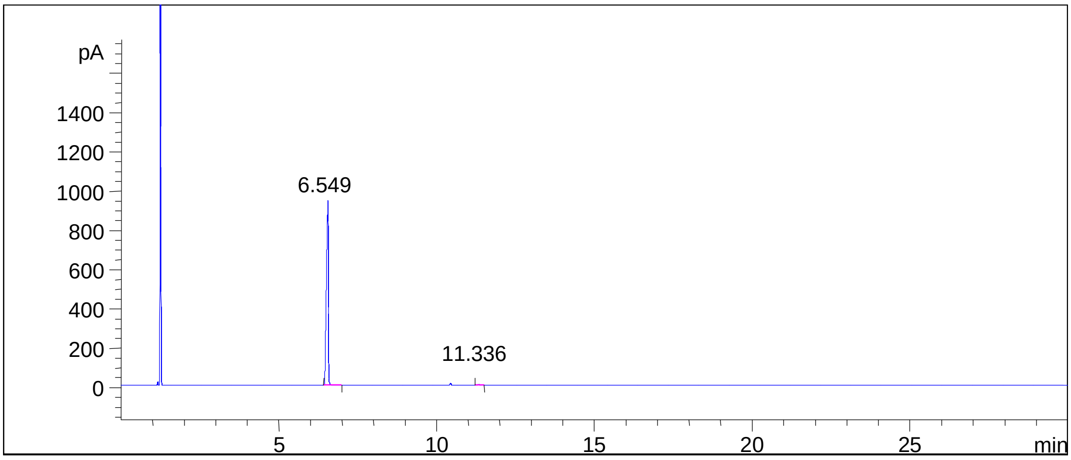
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.516	71.3	20.7	0.0507	3.049	0.496
2	8.557	2254.1	554.7	0.0544	96.380	2.680
3	8.980	13.4	3.2	0.0588	0.571	0.559
	Totals:	2338.8	578.6		100.000	

Figure 20 : GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_3$ as catalyst in CH_2Cl_2.



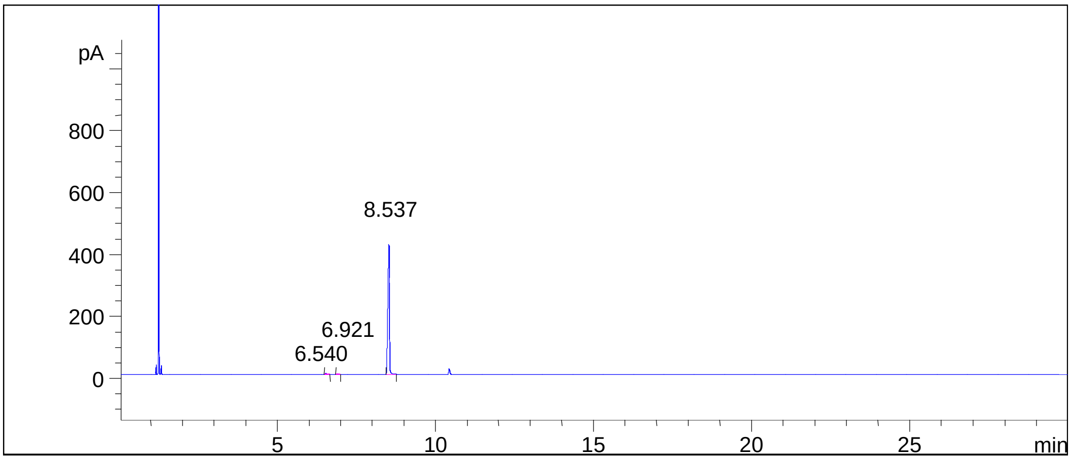
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.530	2686.4	711.5	0.0531	58.868	1.919
2	6.918	18.4	5.3	0.0531	0.403	0.805
3	7.897	10.3	3.3	0.0484	0.227	0.912
4	8.547	1848.3	491.8	0.0498	40.502	2.397
	Totals:	4563.4	1211.9		100.000	

Figure 21 : GC diagram of oxidation of benzyl alcohol for 19 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_3$ as catalyst in CH_2Cl_2.



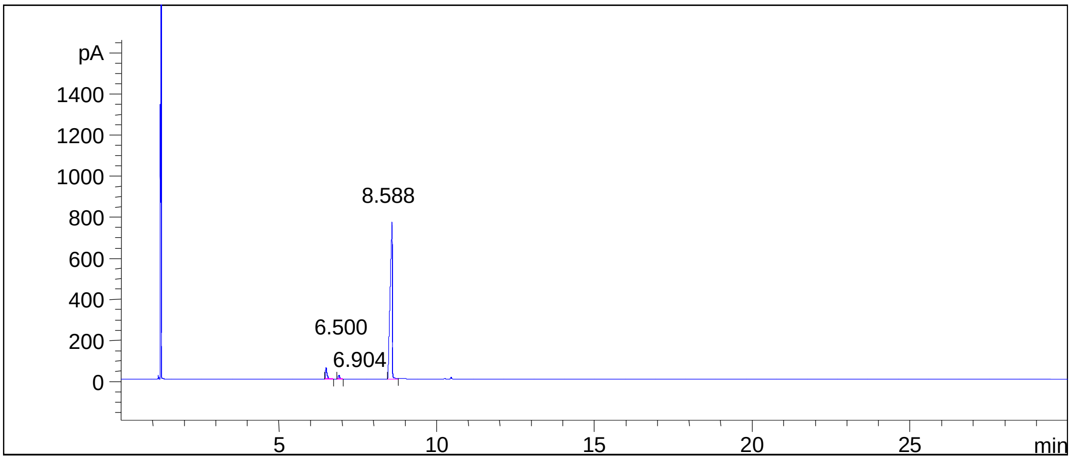
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.549	4043.6	939.4	0.0577	99.499	2.807
2	11.368	22.4	4.6	0.0644	0.551	1.505
	Totals:	4066.0	944.0		100.000	

Figure 22: GC diagram of oxidation of benzyl alcohol for 25 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_3$ as catalyst in CH_2Cl_2.



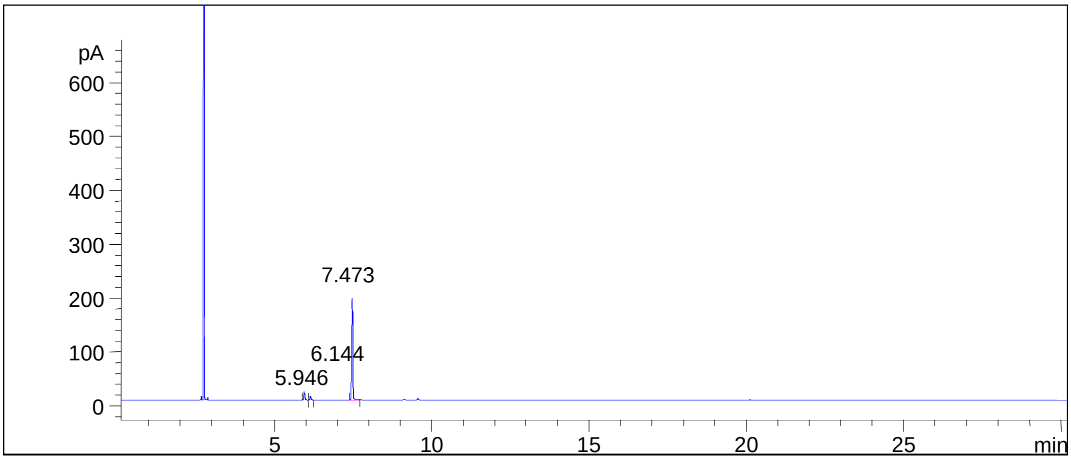
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.540	15.0	4.3	0.0469	0.999	0.510
2	6.921	6.9	2.1	0.0401	0.457	0.826
3	8.537	1483.3	420.6	0.0474	98.544	2.125
	Totals:	1505.2	427.0		100.000	

Figure 23: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HOAc and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



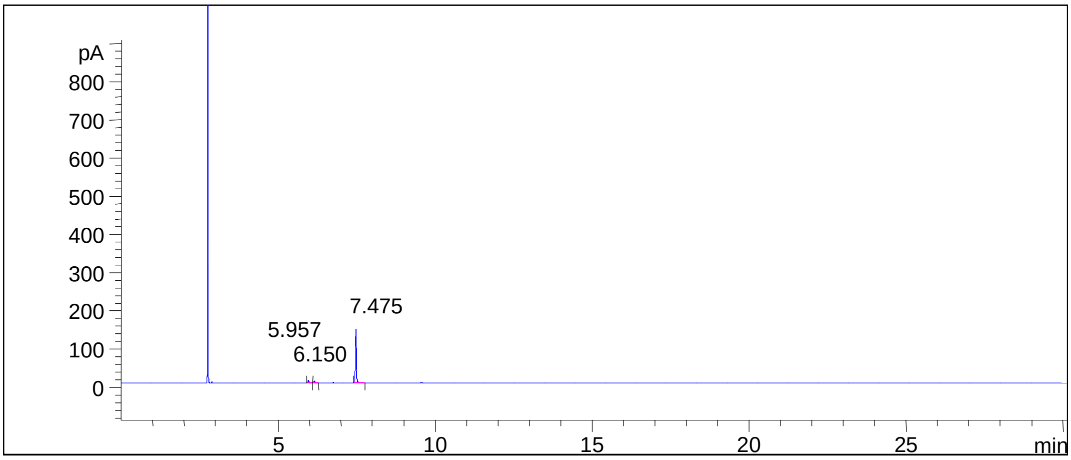
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.500	191.9	57.2	0.0491	4.936	0.518
2	6.904	61.0	18.5	0.0444	1.569	0.703
3	8.588	3634.4	763.4	0.0605	93.496	5.054
	Totals:	3887.3	839.1		100.000	

Figure 24: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of TsOH and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



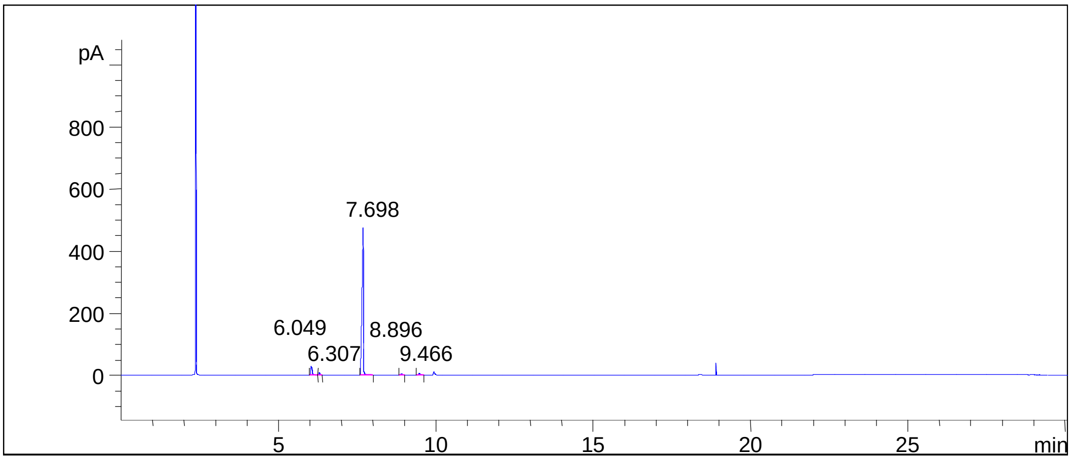
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.946	33.3	14.7	0.0355	6.747	0.496
2	6.144	61.0	7.1	0.0349	3.253	2.680
3	7.473	443.9	188.7	0.0359	90.000	0.559
	Totals:	538.2	210.5		100.000	

Figure 25: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of $MeSO_3H$ and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



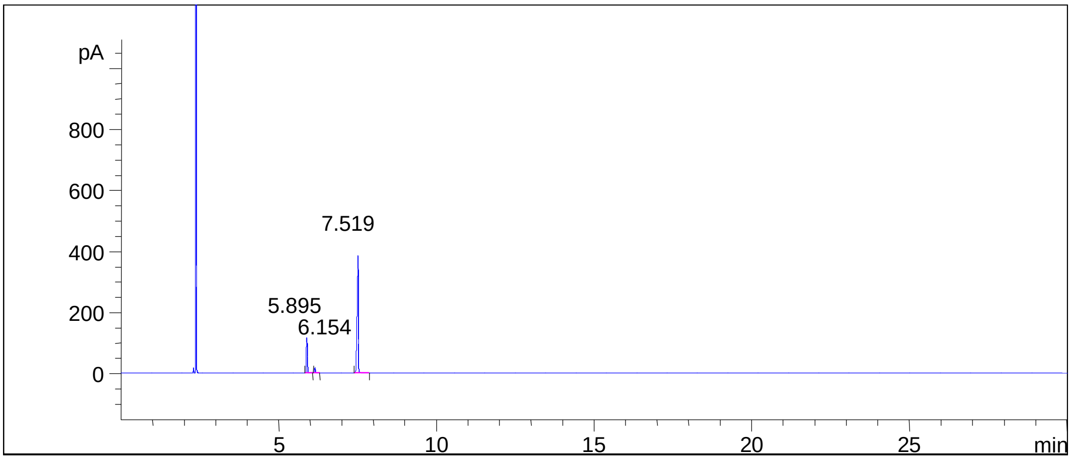
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.957	14.8	6.4	0.0348	4.202	0.663
2	6.150	12.3	5.5	0.0337	3.478	0.837
3	7.475	325.6	142.1	0.0365	92.320	1.064
	Totals:	538.2	154.0		100.000	

Figure 26: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of CF_3CO_2H and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



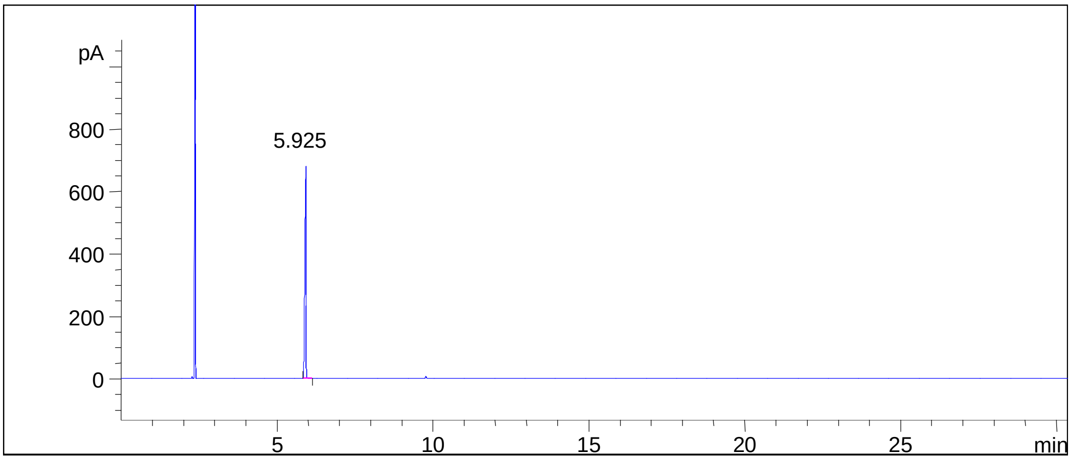
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.049	80.3	29.1	0.0412	4.682	
2	6.307	19.6	8.3	0.0356	1.142	
3	7.475	1580.9	474.0	0.0439	92.140	
4	8.896	15.5	4.6	0.0452	0.906	
5	9.466	19.4	5.6	0.0467	1.130	
	Totals:	1855.7	521.6		100.000	

Figure 27: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of H_3PO_4 and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



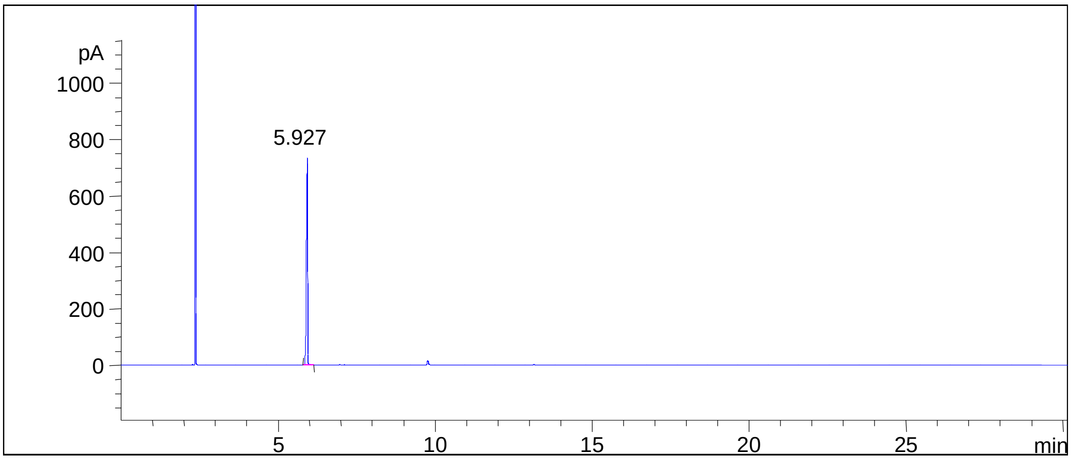
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.895	263.6	117.4	0.0354	18.426	0.894
2	6.154	41.1	17.4	0.0365	2.873	0.943
3	7.519	1126.0	383.8	0.0400	78.702	2.606
	Totals:	1403.7	518.6		100.000	

Figure 28 : GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of H_2SO_4 and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



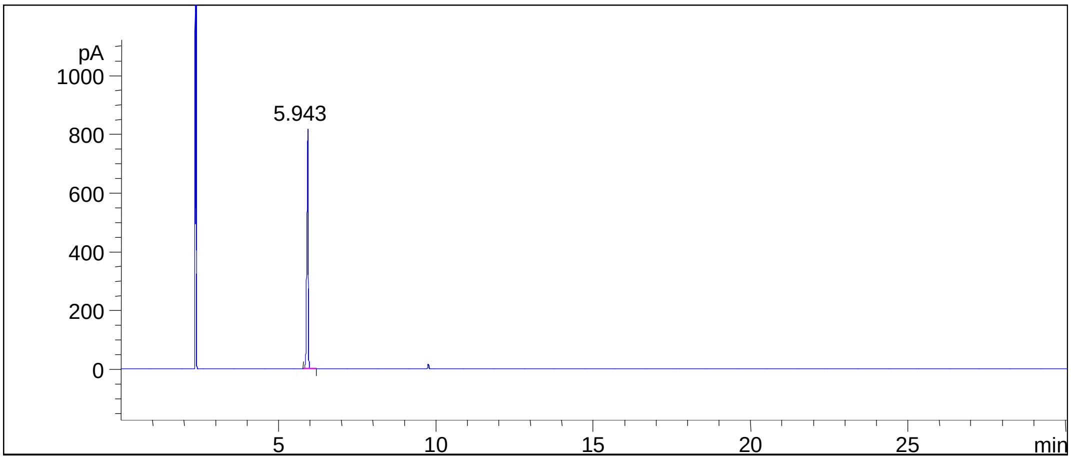
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.925	1819.3	680.2	0.0390	100.000	0.894
	Totals:	1819.3	680.2		100.000	

Figure 29: GC diagram of oxidation of benzyl alcohol for 13 h, 3 mol% of TEMPO, 5 mol% of H_2SO_4, 10 mol% NaCl and 5 mol % of $NaNO_2$ as catalyst in CH_2Cl_2.



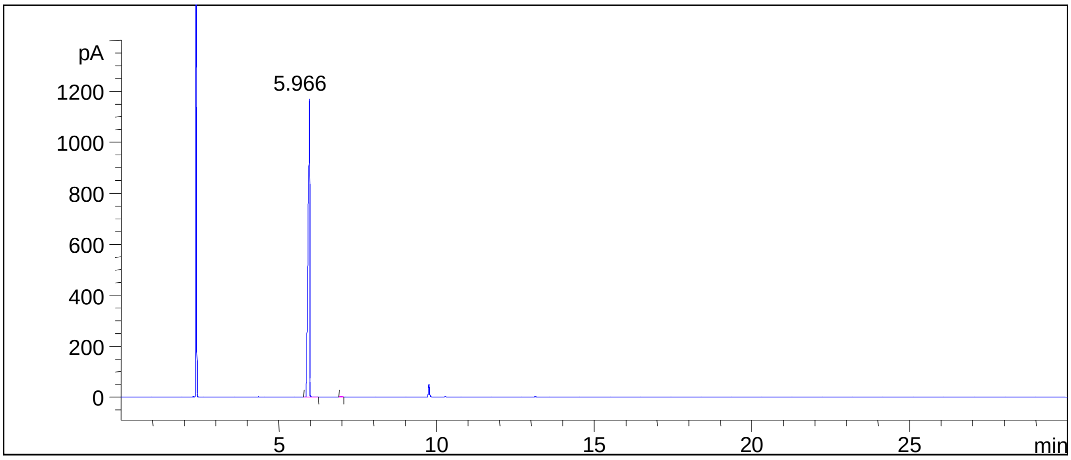
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.927	2127.0	735.1	0.0403	100.000	2.781
	Totals:	2127.0	735.1		100.000	

Figure 30: GC diagram of oxidation of benzyl alcohol for 14 h, 3 mol% of TEMPO, 5 mol% of H_2SO_4, 10 mol% $BnNMe_3Cl$ and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



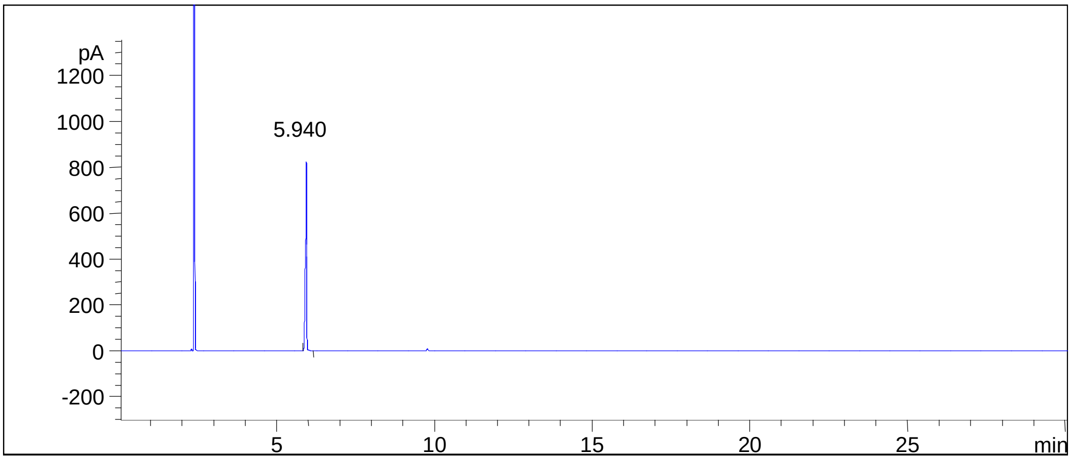
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.943	2585.5	816.8	0.0454	100.000	3.269
	Totals:	2585.5	816.8		100.000	

Figure 31: GC diagram of oxidation of benzyl alcohol for 17 h, 3 mol% of TEMPO, 10 mol% of H_3PO_4, 10 mol% NaCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



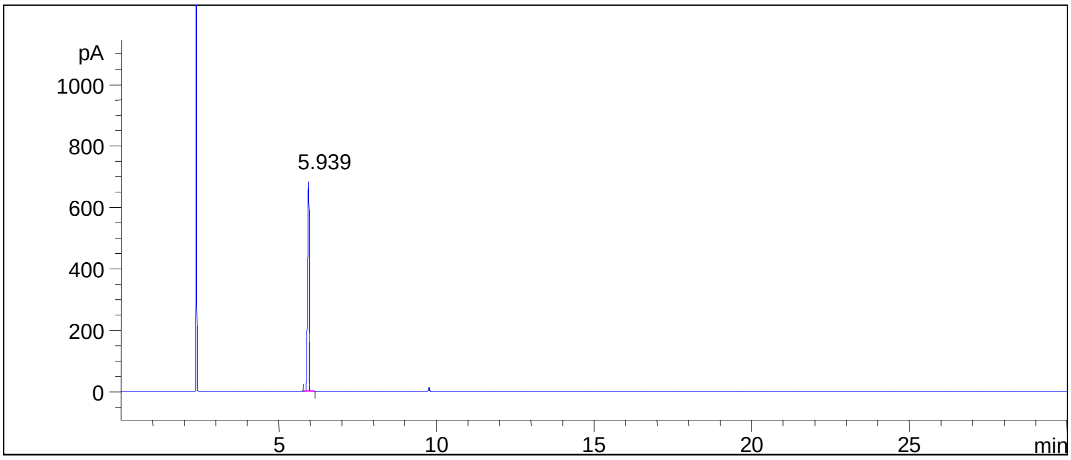
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.966	4124.8	1166.8	0.0492	100.000	4.601
	Totals:	4124.8	1166.8		100.000	

Figure 32: GC diagram of oxidation of benzyl alcohol for 17 h, 3 mol% of TEMPO, 10 mol% of HBF_4, 10 mol% NaCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



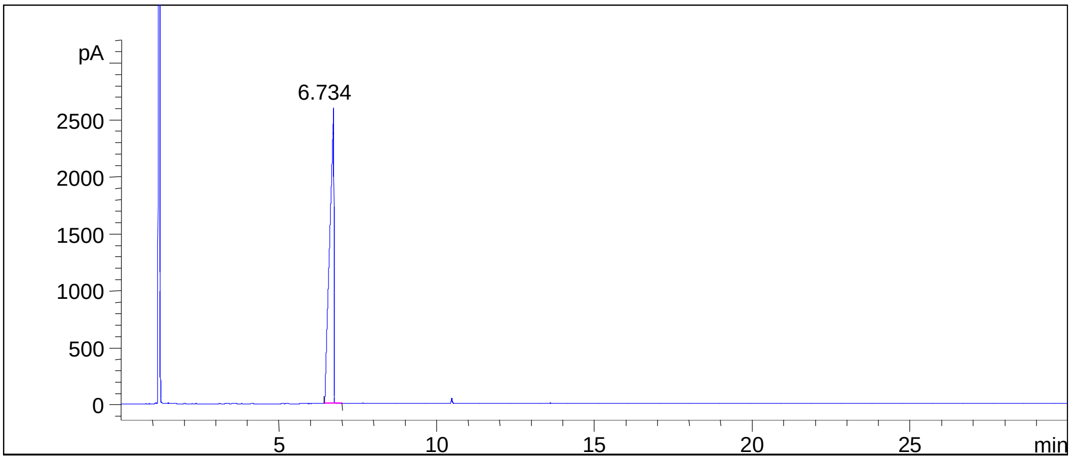
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.940	2409.9	821.9	0.0412	100.000	2.970
	Totals:	2409.9	821.9		100.000	

Figure 33: GC diagram of oxidation of benzyl alcohol for 16 h, 3 mol% of TEMPO, 10 mol % of $MeSO_3H$, 10 mol% NaCl and 5 mol % of $NaNO_2$ as catalyst in CH_2Cl_2.



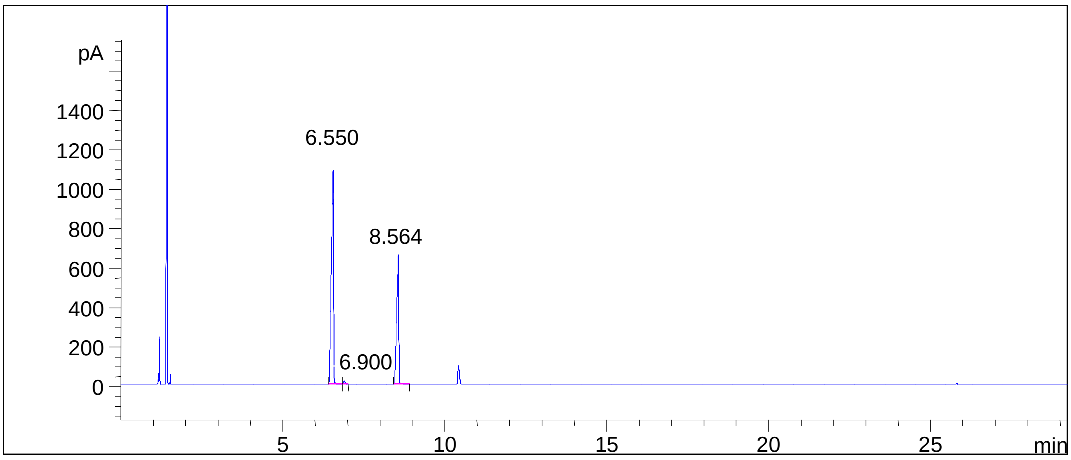
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.939	193.3	681.6	0.0402	100.000	2.526
	Totals:	193.3	681.6		100.000	

Figure 34: GC diagram of oxidation of benzyl alcohol for 17 h, 3 mol% of TEMPO, 10 mol% of CF_3CO_2H, 10 mol% NaCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



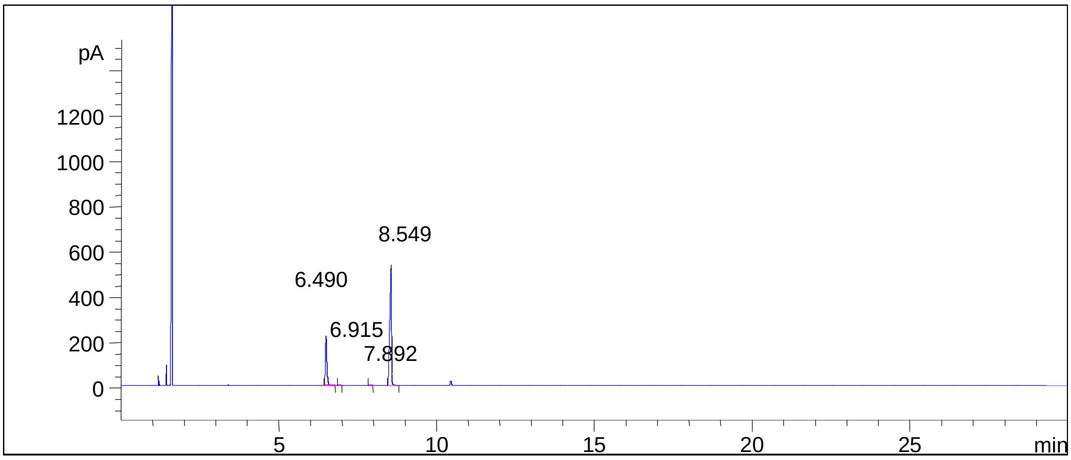
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.734	23741.0	2593.5	0.1108	100.000	15.867
	Totals:	23741.0	2593.5		100.000	

Figure 35: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



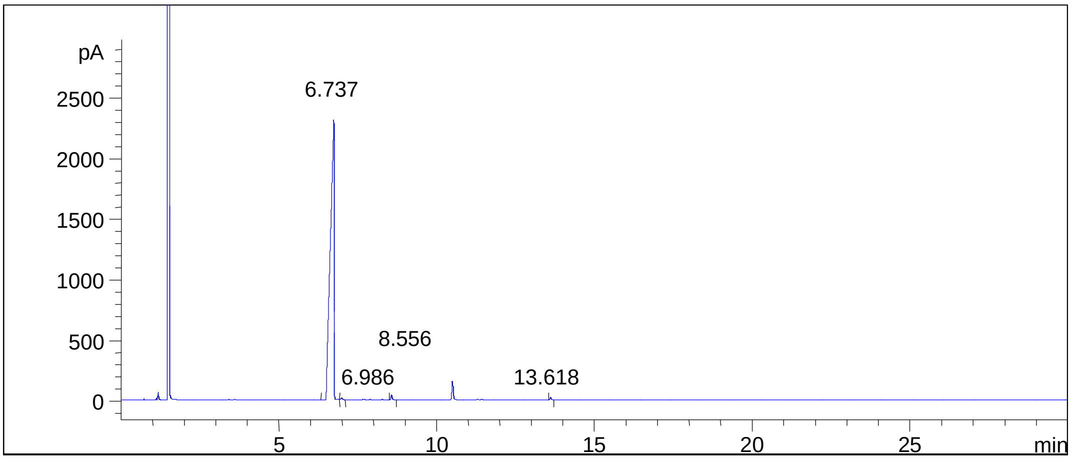
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.550	5131.2	1083.4	0.0633	62.653	3.840
2	6.900	65.1	19.1	0.0497	0.794	0.818
3	8.564	2993.6	658.8	0.0590	36.553	3.842
	Totals:	8189.9	1761.3		100.000	

Figure 36: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in chloroform ($CHCl_3$).



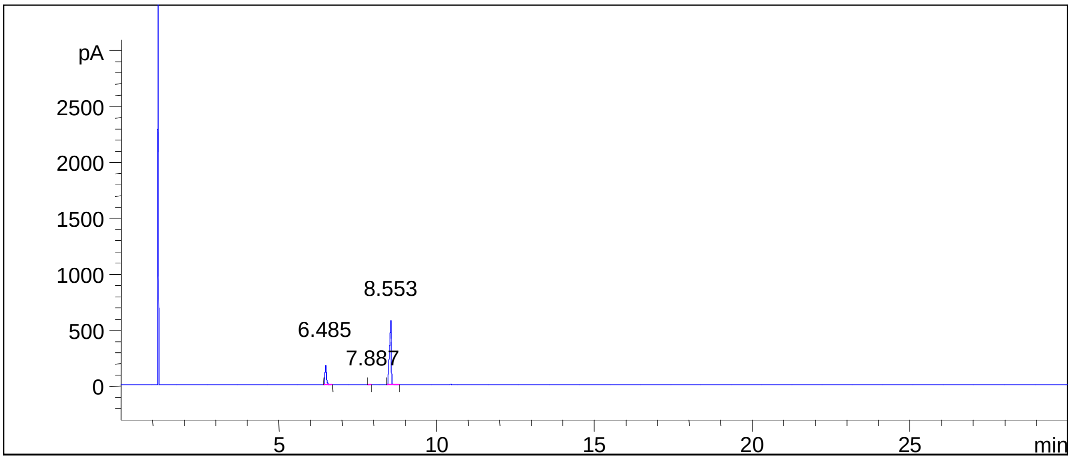
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.490	743.3	220.4	0.0528	25.985	0.687
2	6.915	10.6	3.1	0.0411	0.370	0.942
3	7.892	9.2	2.9	0.0405	0.323	1.013
4	8.549	2097.4	513.6	0.0515	73.323	3.140
	Totals:	2860.5	740.0		100.000	

Figure 37: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in carbon tetrachloride (CCl_4).



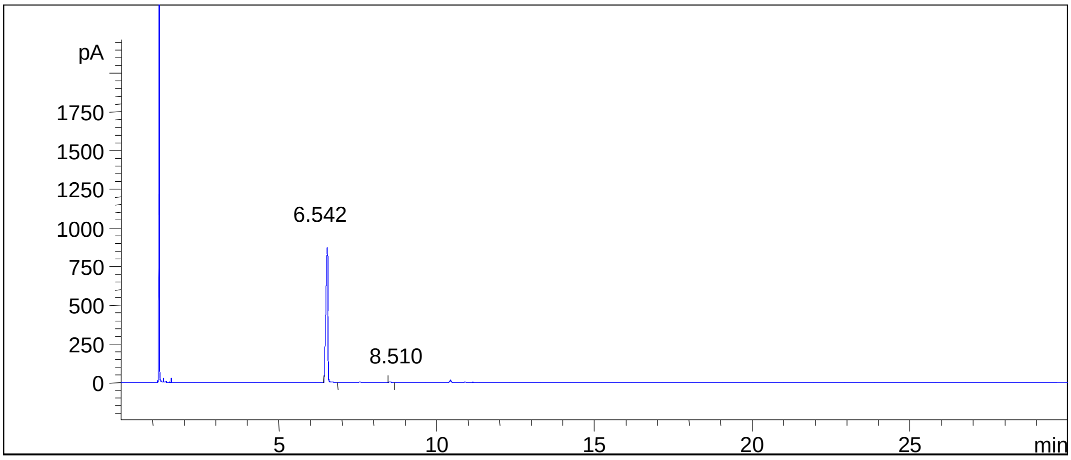
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.737	18993.9	2307.1	0.1018	98.871	10.793
2	6.966	56.6	15.9	0.0504	0.295	0.762
3	8.556	112.8	38.6	0.0426	0.587	0.586
4	13.616	47.5	18.3	0.0398	0.247	0.805
	Totals:	19210.8	2379.9		100.000	

Figure 38: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in 1,2-dichloromethane ($ClCH_2CH_2Cl$).



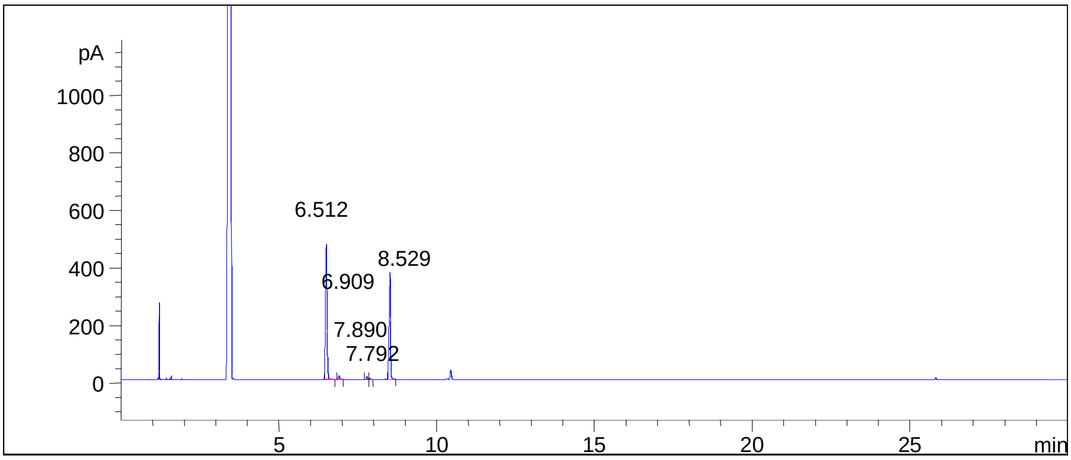
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.485	576.1	174.9	0.0497	19.997	0.618
2	7.887	10.5	3.3	0.0393	0.365	0.888
3	8.553	2294.5	577.2	0.0531	79.638	3.103
	Totals:	2881.1	755.4		100.000	

Figure 39: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol % of HCl and 5 mol % of $NaNO_2$ as catalyst in 2,2,2-trifluoroethanol (CF_3CH_2OH).



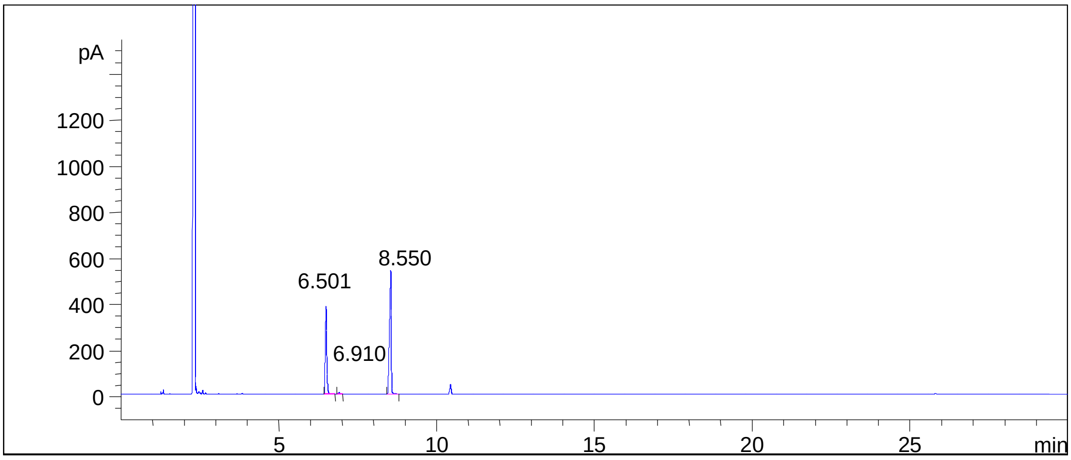
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.542	3798.6	874.2	0.0574	99.615	2.810
2	8.510	14.7	4.6	0.0456	0.385	0.534
	Totals:	3804.3	878.8		100.000	

Figure 40: GC diagram of oxidation of benzyl alcohol for 8.0 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in fluorobenzene (PhF).



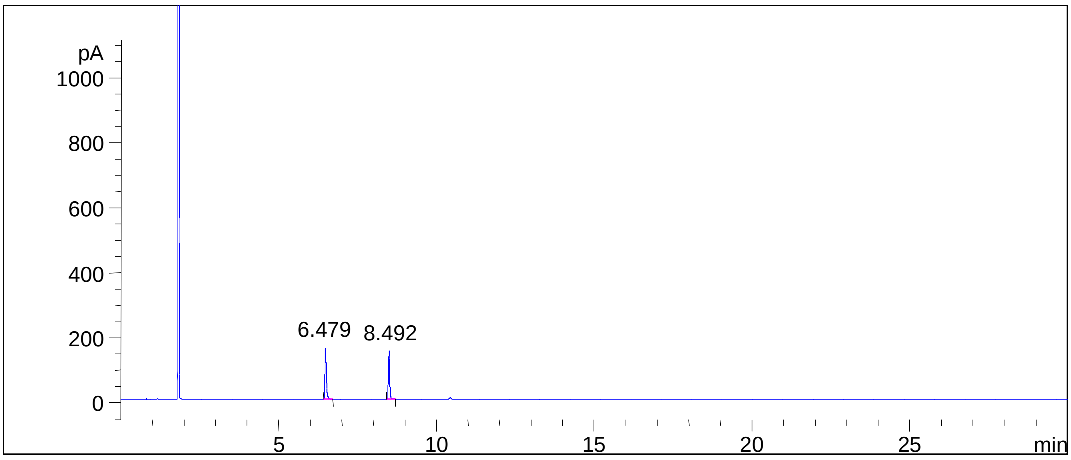
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.512	1603.0	470.9	0.0497	54.488	1.250
2	6.909	45.5	13.6	0.0497	1.546	0.793
3	7.792	32.2	10.9	0.0467	1.094	0.854
4	7.890	19.0	6.2	0.0409	0.646	0.902
5	8.553	1242.3	372.4	0.0462	42.226	1.918
	Totals:	2942.0	874.0		100.000	

Figure 41: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in chlorobenzene (PhCl).



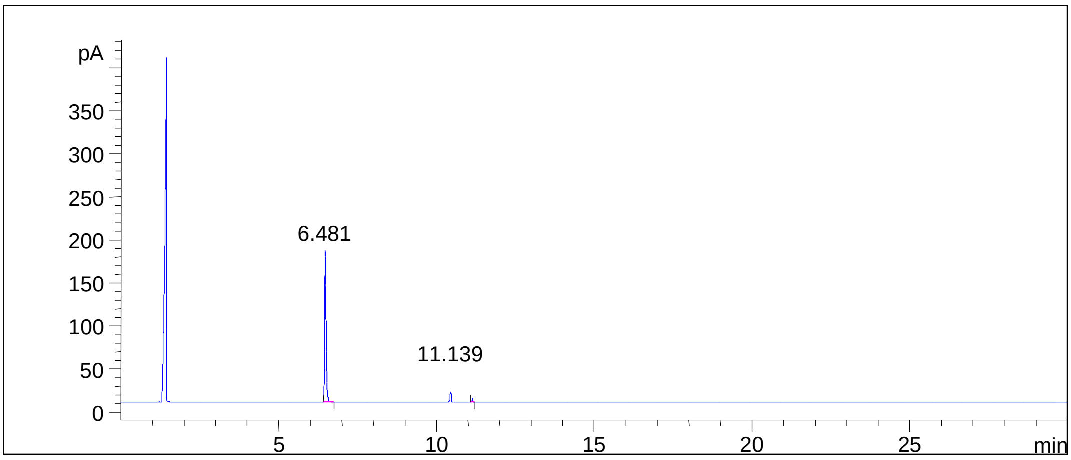
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.501	1286.2	381.2	0.0491	37.421	0.917
2	6.910	24.5	7.5	0.0464	0.713	0.775
3	8.550	2126.5	536.8	0.0527	61.866	2.569
	Totals:	3437.2	925.5		100.000	

Figure 42: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in toluene (PhMe).



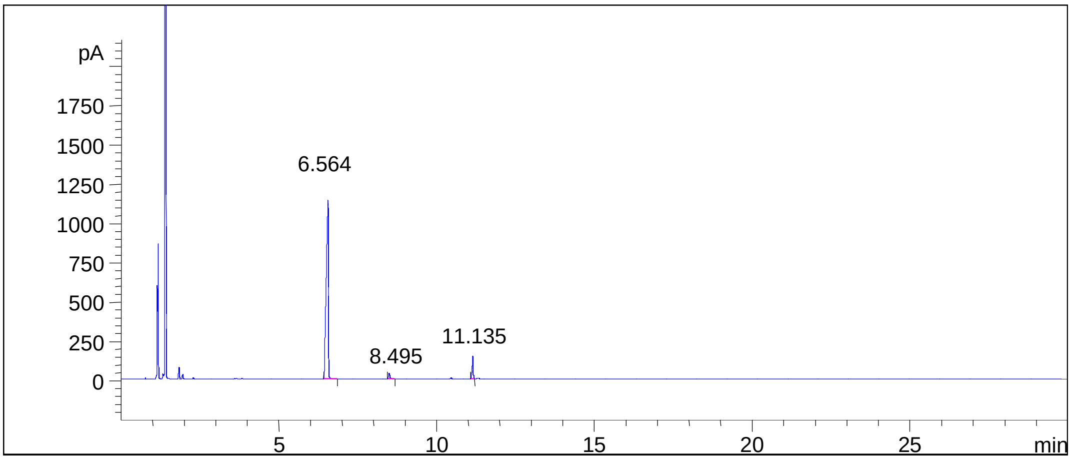
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.479	519.3	155.6	0.0509	54.141	0.917
2	8.492	439.7	150.9	0.0417	45.859	0.775
	Totals:	959.0	306.5		100.000	

Figure 43: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in a,a,a-trifluorotoluene ($PhCF_3$).



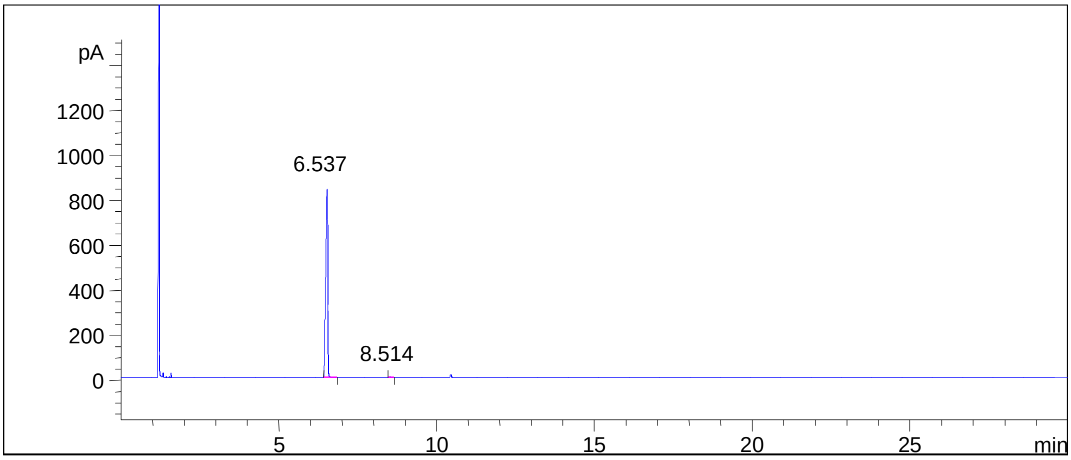
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.481	599.7	176.7	0.0496	97.902	0.682
2	11.139	12.9	4.7	0.0377	2.098	0.942
	Totals:	612.6	181.4		100.000	

Figure 44: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in acetic acid (HOAc).



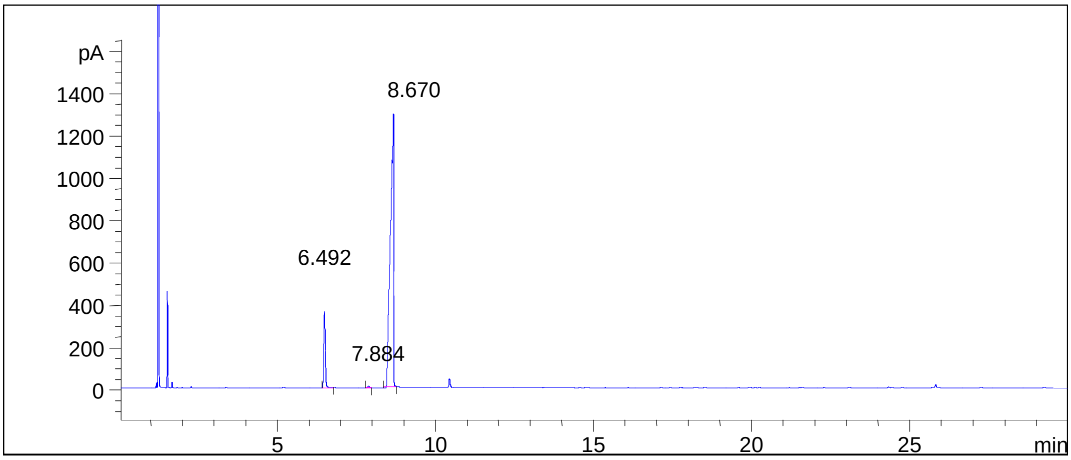
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.481	5473.2	1137.2	0.0627	91.801	4.008
2	8.495	114.1	36.8	0.0469	1.913	0.584
3	11.135	374.7	144.2	0.396	6.285	1.064
	Totals:	5962.1	1318.2		100.000	

Figure 45: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5mol% of $NaNO_2$ as catalyst in ethyl acetate (EtOAc).



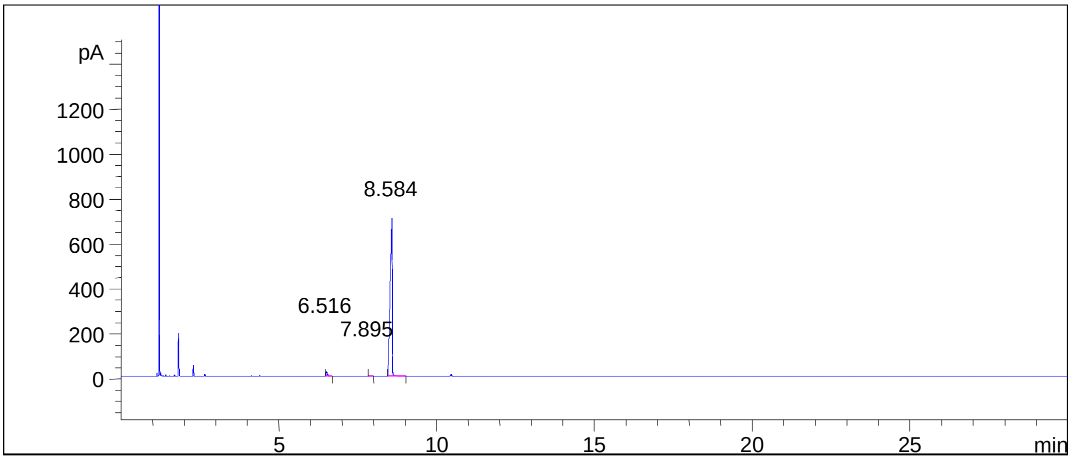
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.537	3643.7	838.6	0.0584	99.624	2.548
2	8.514	13.8	4.4	0.0442	0.376	0.560
	Totals:	3657.5	843.0		100.000	

Figure 46 : GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in acetonitrle (MeCN).



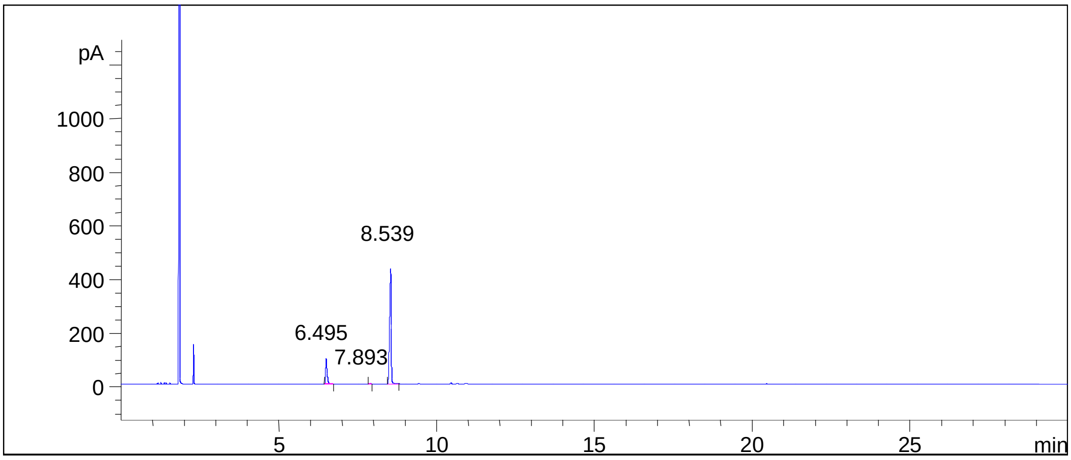
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.492	1200.9	358.9	0.0475	11.516	0.939
2	7.884	28.8	9.2	0.0476	0.276	0.875
3	8.670	9198.6	1290.1	0.1188	88.208	10.754
	Totals:	10428.3	1658.2		100.000	

Figure 47: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in *tert*-butanol (*t*-BuOH).



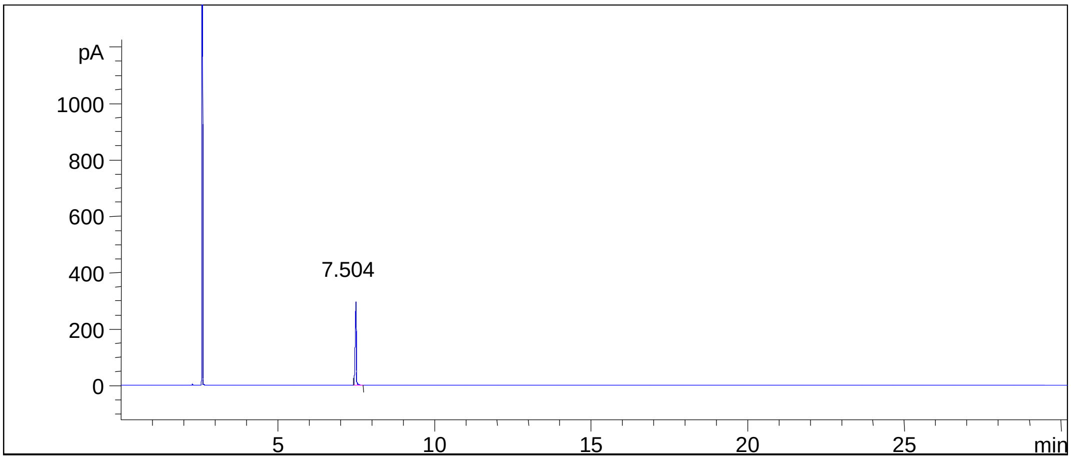
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.516	71.2	20.9	0.0507	2.127	0.481
2	7.895	7.0	2.2	0.0458	0.209	0.851
3	8.514	3270.6	702.9	0.0590	97.664	4.229
	Totals:	3348.8	726.0		100.000	

Figure 48: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol % of HCl and 5 mol % of $NaNO_2$ as catalyst in acetone (Me_2CO).



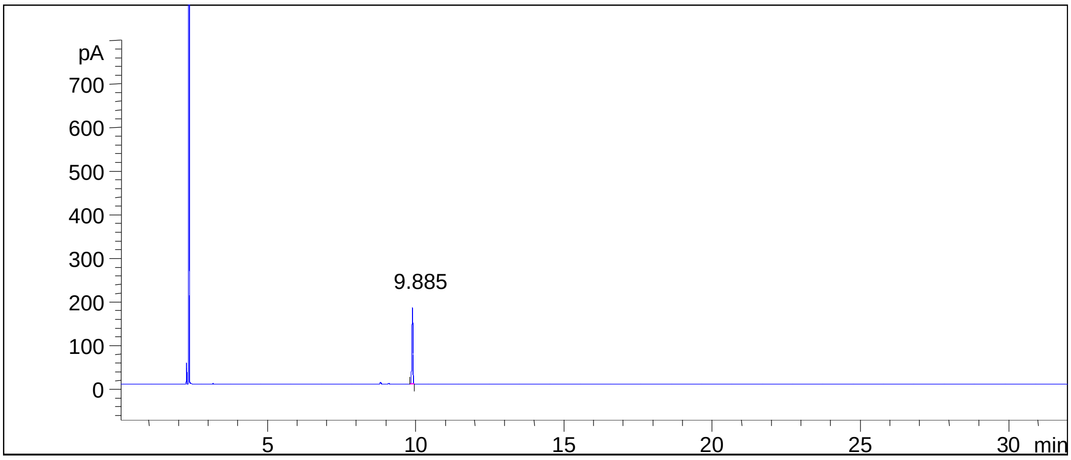
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.495	312.0	94.9	0.0496	16.867	0.580
2	7.893	8.2	2.6	0.0438	0.445	0.921
3	8.539	1529.6	429.7	0.0473	82.688	2.307
	Totals:	1849.8	527.2		100.000	

Figure 49: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in tetrahydrofuran (THF).



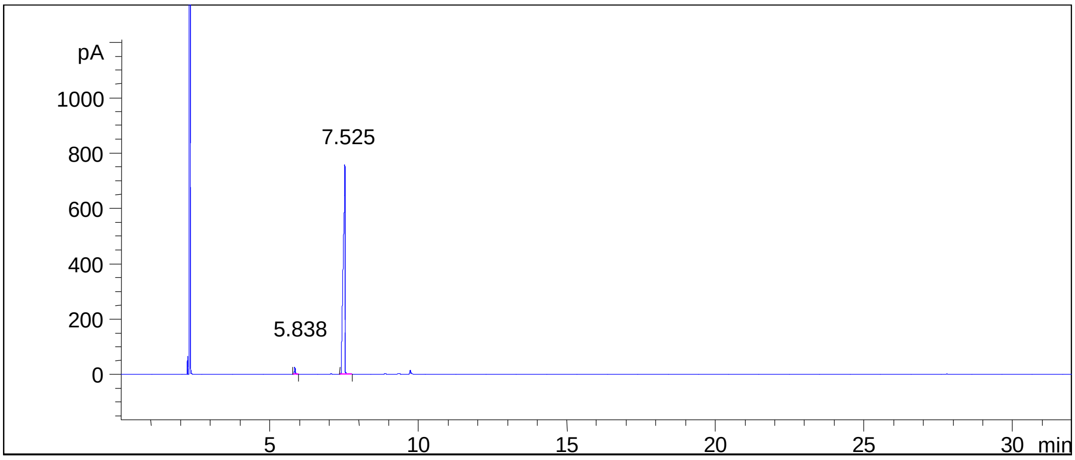
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	7.504	806.4	295.1	0.0384	100.00	1.867
	Totals:	806.4	295.1		100.000	

Figure 50: GC diagram of benzyl alcohol in CH_2Cl_2.



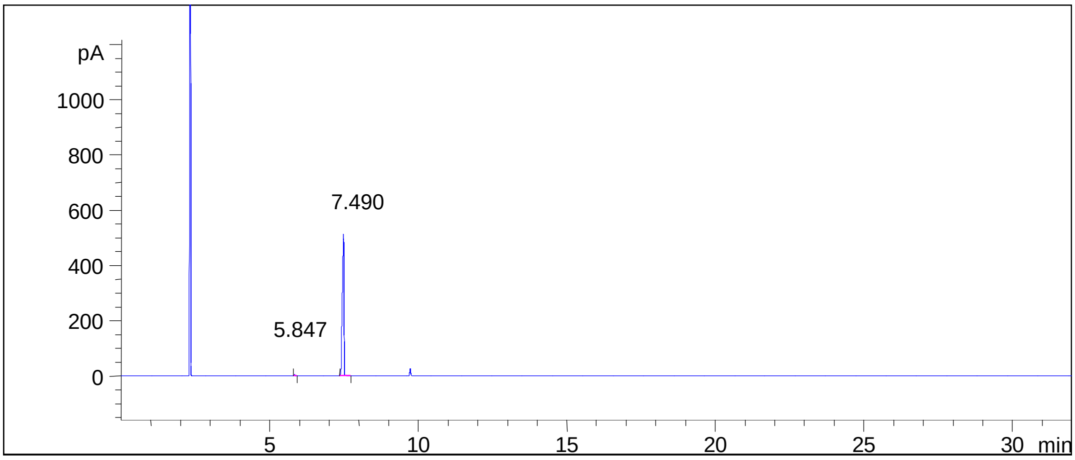
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	9.885	424.2	174.9	0.0373	100.00	1.147
	Totals:	424.2	174.9		100.000	

Figure 51: GC diagram of TEMPO in CH_2Cl_2.



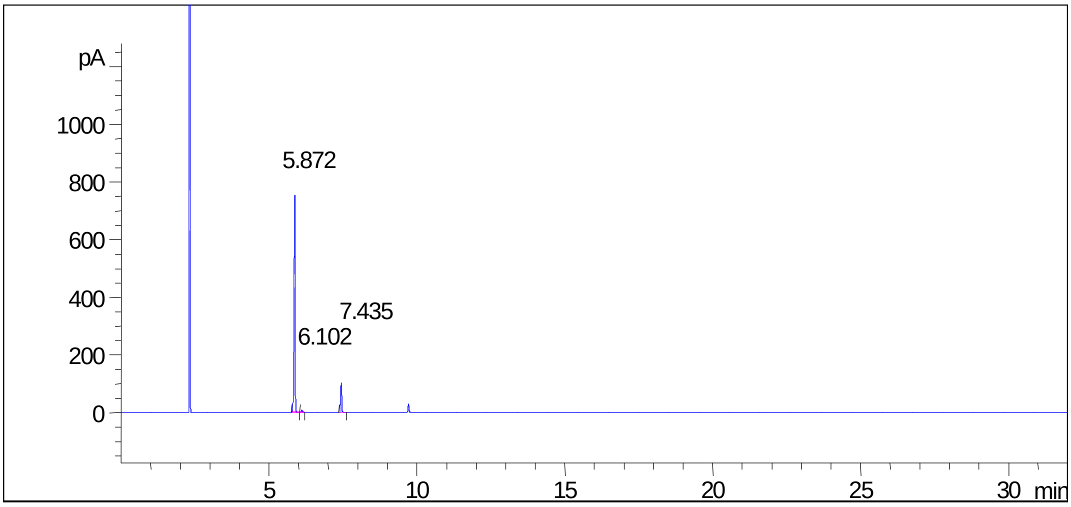
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.838	63.3	25.5	0.0346	1.863	0.854
2	7.525	3335.3	757.7	0.0548	98.147	6.458
	Totals:	3398.6	783.2		100.000	

Figure 52: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO and 8 mol% of HCl as catalyst in CH_2Cl_2.



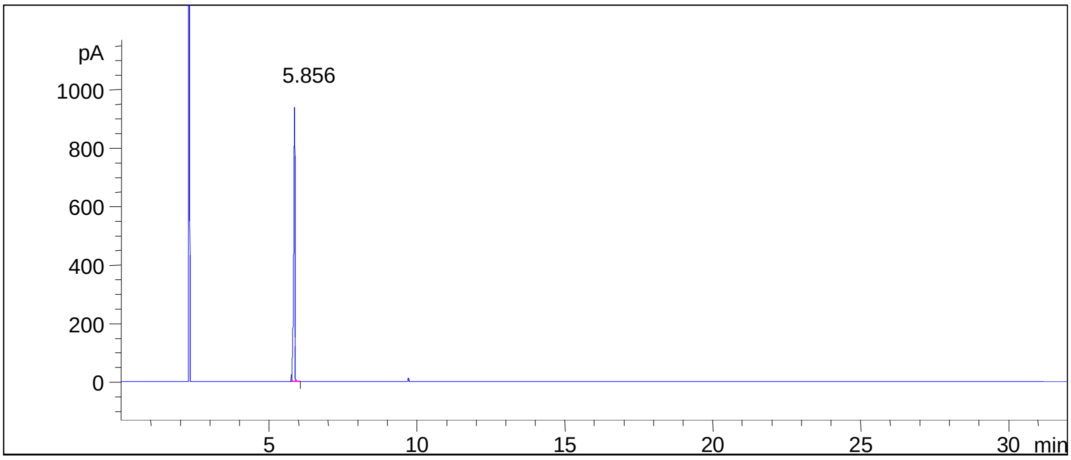
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.847	8.9	3.8	0.0364	0.474	0.845
2	7.490	1872.3	513.8	0.0475	99.526	3.902
	Totals:	1881.2	517.6		100.000	

Figure 53: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO and 4 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



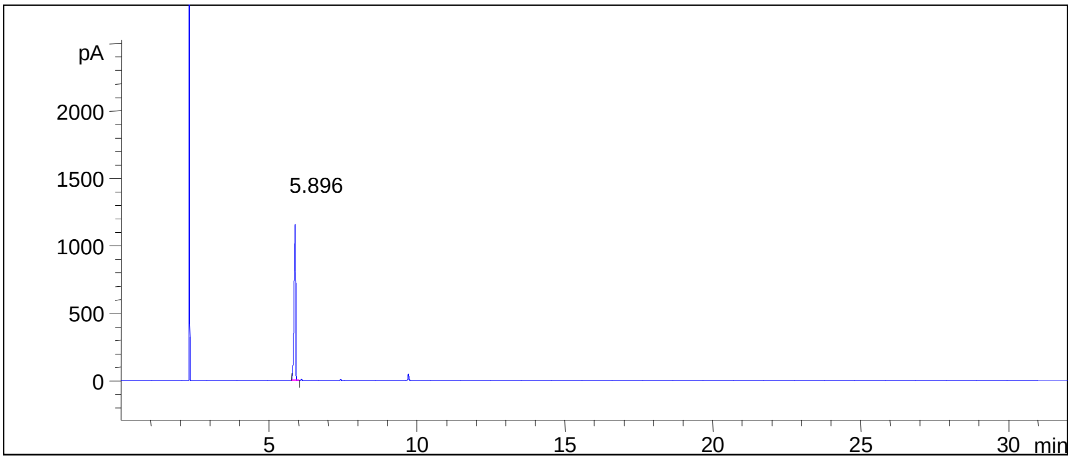
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.871	2988.8	751.6	0.0427	89.722	3.070
2	6.102	20.5	8.6	0.0363	0.802	0.876
3	7.435	242.8	102.5	0.0364	9.476	1.116
	Totals:	3252.1	862.7		100.000	

Figure 54: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 8 mol% of HCl and 4 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



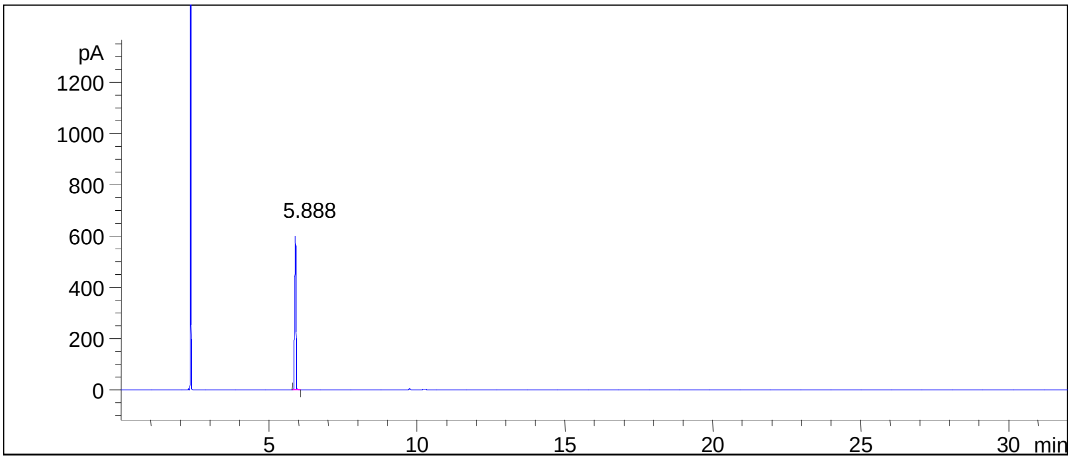
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.856	3206.8	938.4	0.0467	100.000	3.989
	Totals:	3206.8	938.4		100.000	

Figure 55: GC diagram of oxidation of benzyl alcohol for 11.5 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



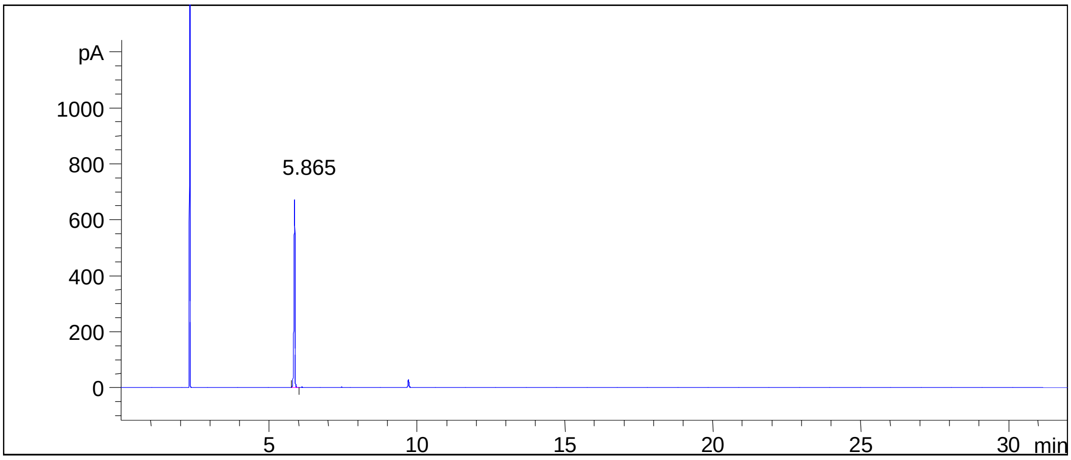
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.896	4138.1	1162.8	0.0465	100.000	4.890
	Totals:	4138.1	1162.8		100.000	

Figure 56: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



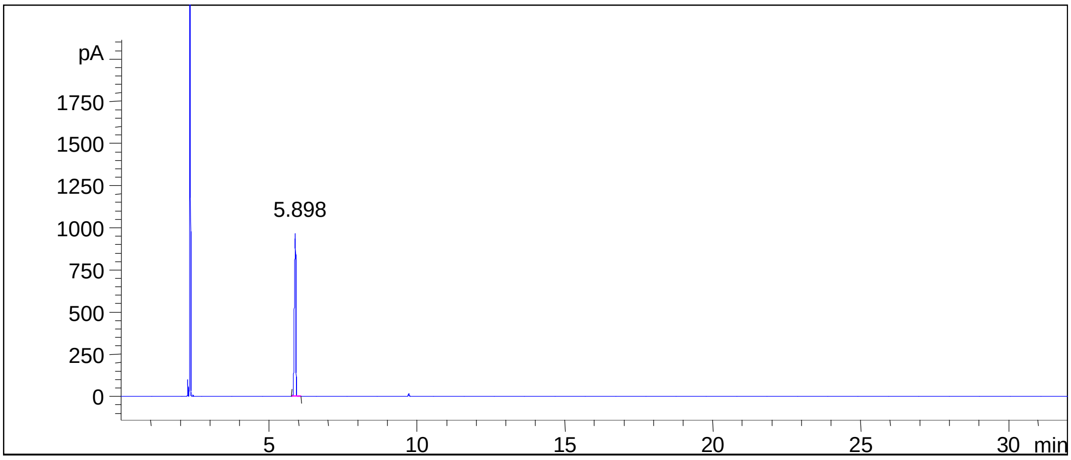
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.888	1576.0	599.6	0.0382	100.000	2.179
	Totals:	1576.0	599.6		100.000	

Figure 57: GC diagram of oxidation of benzyl alcohol for 9.6 h, 3 mol% of TEMPO, 12 mol% of HCl and 6 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



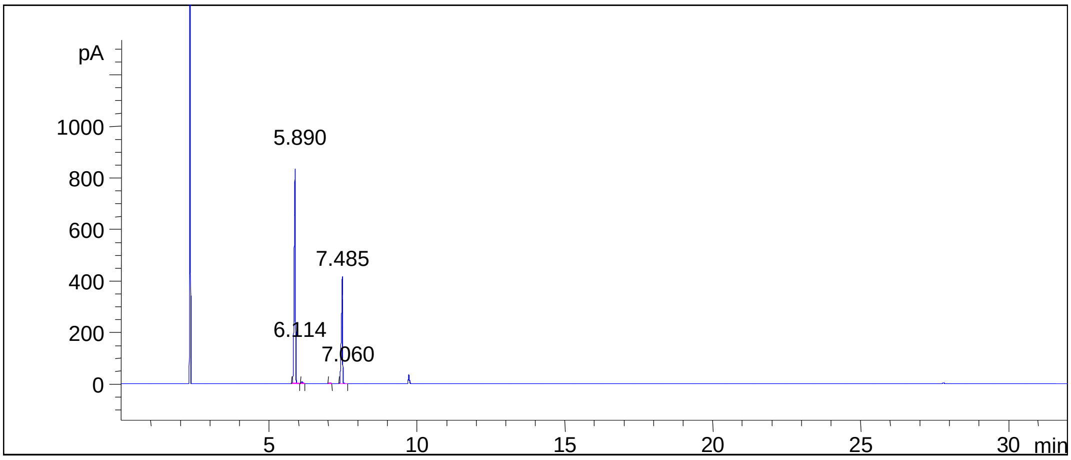
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.865	1923.5	671.2	0.0404	100.000	2.682
	Totals:	1923.5	671.2		100.000	

Figure 58: GC diagram of oxidation of benzyl alcohol for 9.0 h, 3 mol% of TEMPO, 14 mol% of HCl and 7 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



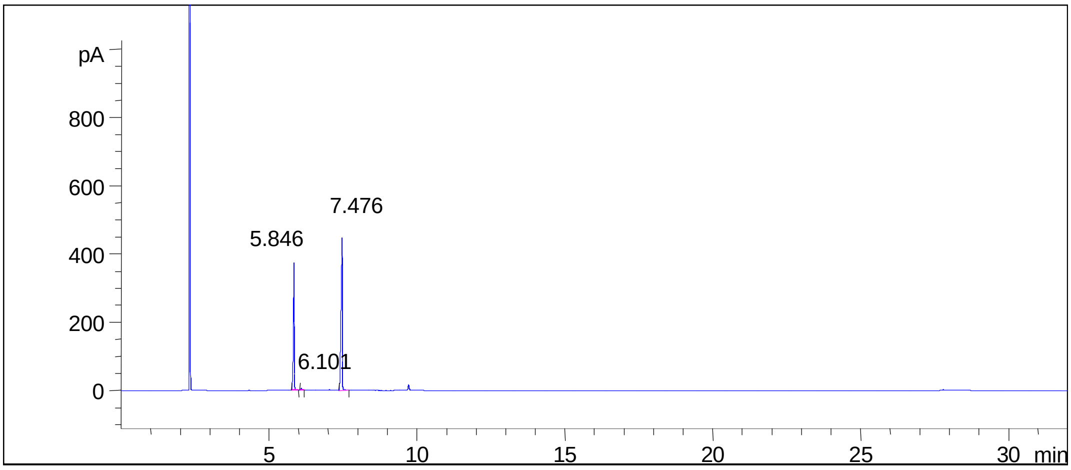
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.898	3047.7	965.5	0.0416	100.000	3.818
	Totals:	3047.7	965.5		100.000	

Figure 59: GC diagram of oxidation of benzyl alcohol for 8.5 h, 3 mol% of TEMPO, 16 mol% of HCl and 8 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



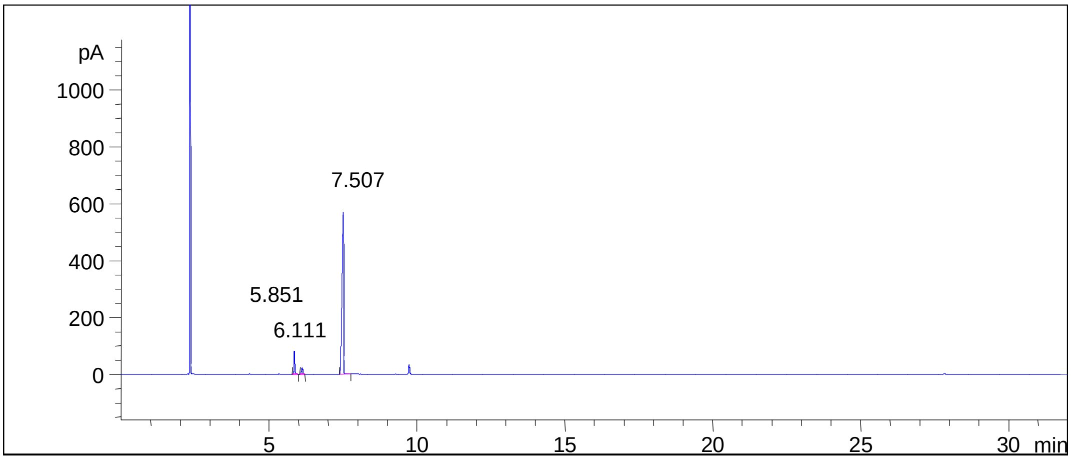
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.890	2636.9	833.5	0.0427	66.671	3.447
2	6.114	21.5	8.9	0.0357	0.543	0.845
3	7.060	8.4	3.4	0.0329	0.212	0.787
4	7.485	1288.3	415.3	0.0427	32.574	2.965
	Totals:	3955.1	1261.1		100.000	

Figure 60: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 3.3 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



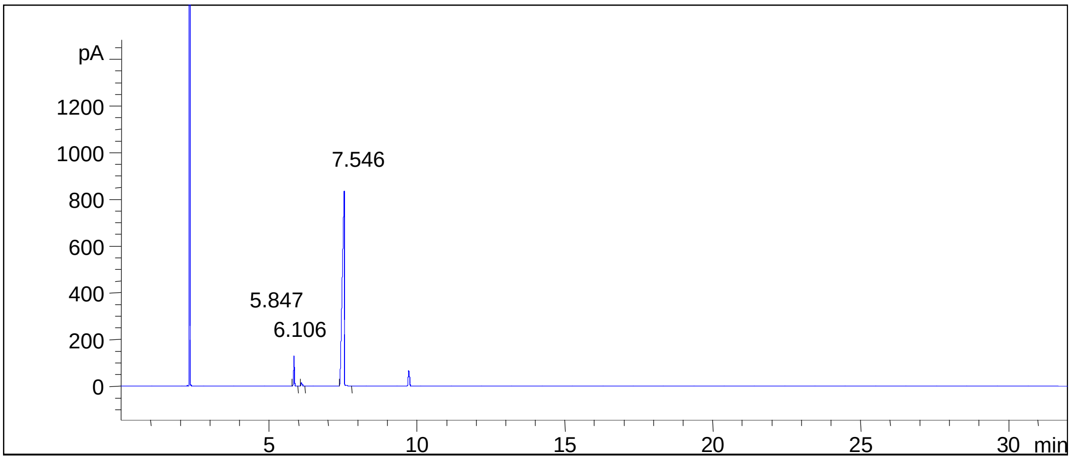
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.846	972.5	373.4	0.0406	40.087	1.566
2	6.101	11.8	4.7	0.0375	0.486	0.875
3	7.470	1441.6	446.4	0.0434	59.427	3.197
	Totals:	2425.9	824.5		100.000	

Figure 61: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 10 mol% of HCl and 2.5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



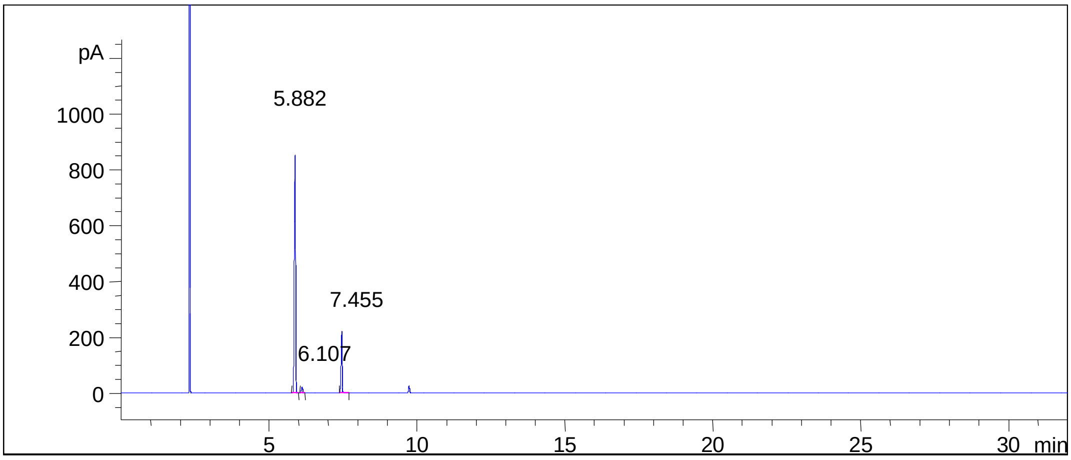
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.851	200.2	80.6	0.0387	8.537	0.914
2	6.111	52.0	20.7	0.0388	2.216	0.913
3	7.507	2093.3	569.8	0.0469	89.247	4.469
	Totals:	2345.5	671.1		100.000	

Figure 62: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 5 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



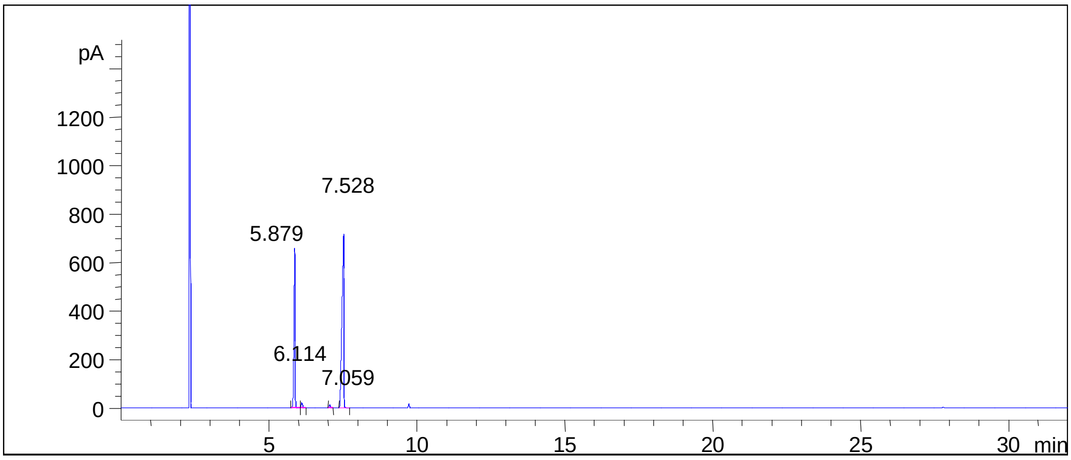
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.847	301.5	128.0	0.0365	6.790	0.961
2	6.106	33.9	14.1	0.0368	0.764	0.872
3	7.546	4104.7	834.3	0.0619	92.446	7.265
	Totals:	4440.1	976.7		100.000	

Figure 63: GC diagram of oxidation of benzyl alcohol for 10 h, 3 mol% of TEMPO, 2.5 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



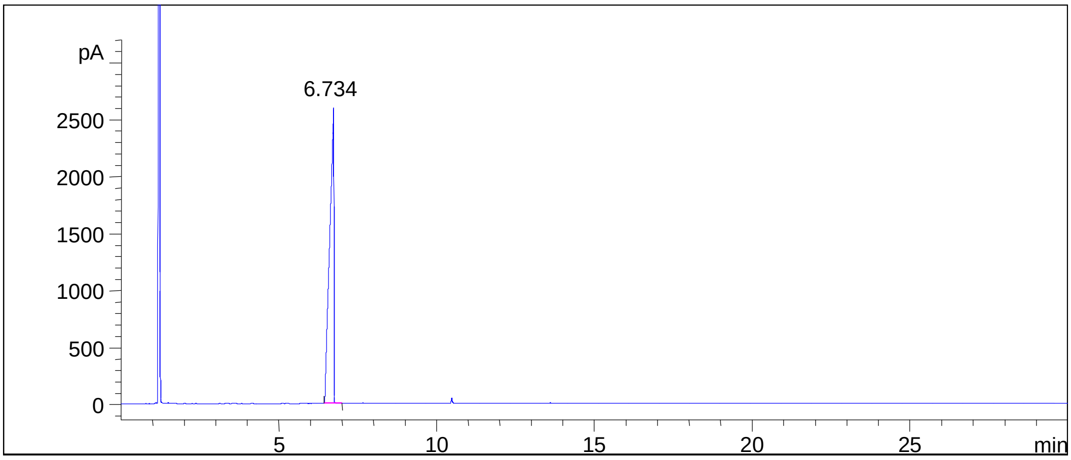
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.882	2499.3	853.3	0.0407	80.134	0.961
2	6.107	50.9	21.1	0.0369	1.631	0.872
3	7.455	568.7	221.0	0.0368	18.235	7.265
	Totals:	3118.9	1095.4		100.000	

Figure 64: GC diagram of oxidation of benzyl alcohol for 10 h, 2 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



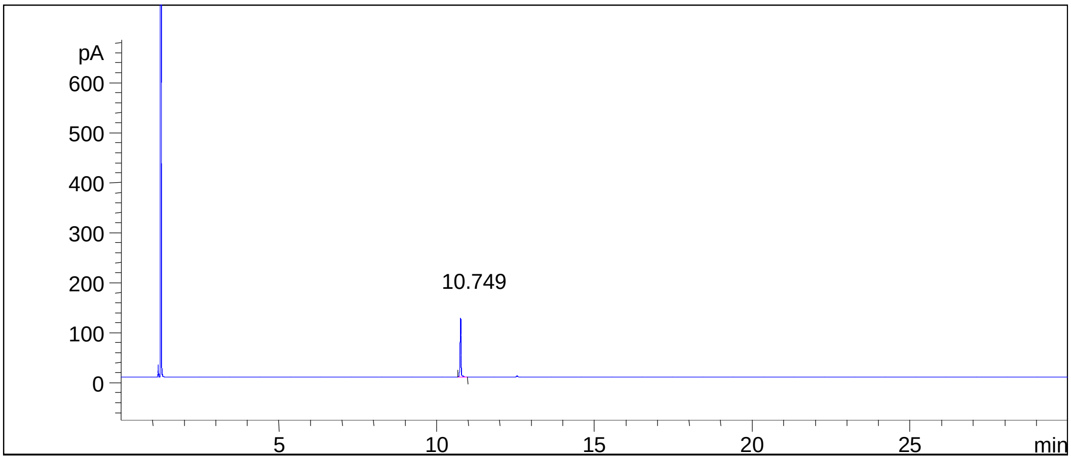
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.879	2016.0	659.3	0.0419	37.905	2.910
2	6.114	52.2	21.8	0.0367	0.982	0.913
3	7.059	32.2	12.8	0.0387	0.605	0.827
4	7.528	3218.1	715.5	0.0585	60.508	5.813
	Totals:	5318.5	1409.4		100.000	

Figure 65: GC diagram of oxidation of benzyl alcohol for 10 h, 1 mol% of TEMPO, 10 mol% of HCl and 5 mol% of $NaNO_2$ as catalyst in CH_2Cl_2.



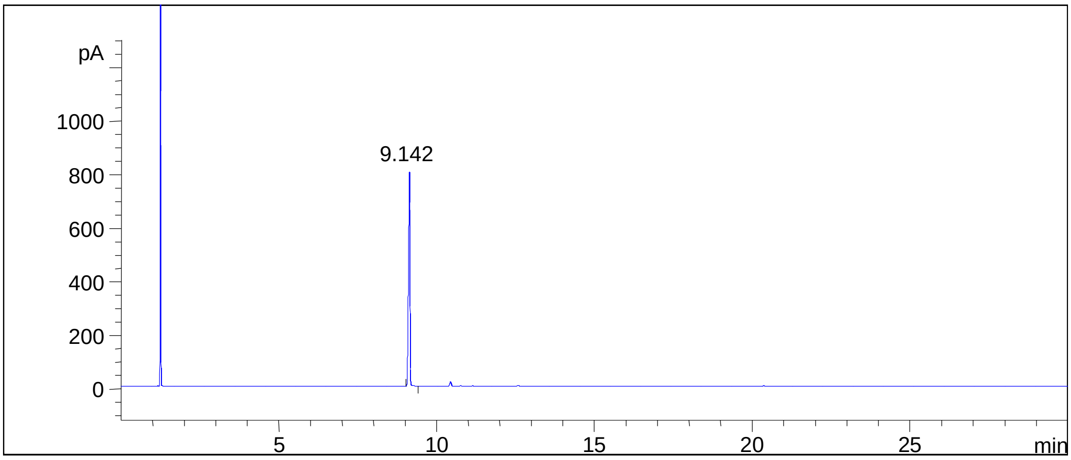
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.734	23741.0	2593.5	0.1108	100.000	15.867
	Totals:	23741.0	2593.5		100.000	

Figure 66: GC diagram of oxidation of benzyl alcohol with Method A for 10 h.



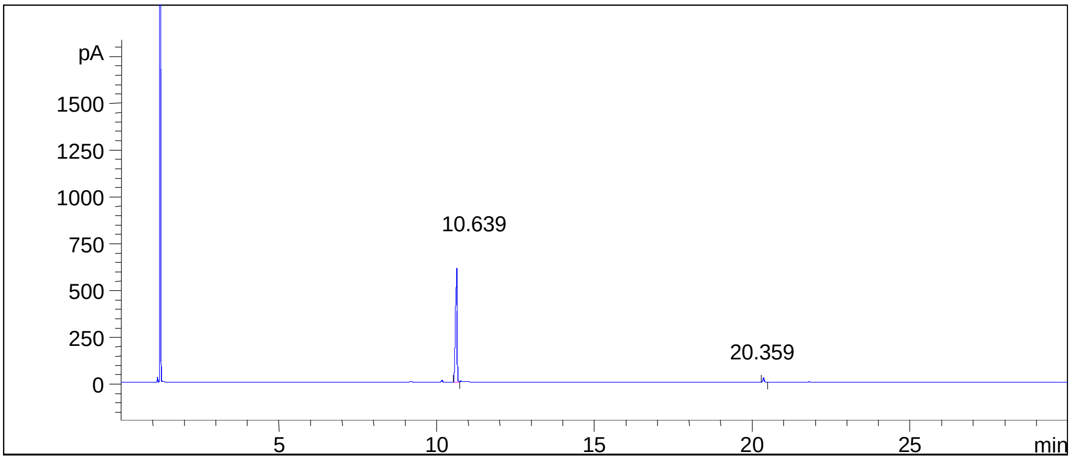
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	10.749	309.3	118.6	0.0399	100.000	0.981
	Totals:	309.3	118.6		100.000	

Figure 67: GC diagram of 2-methylbenzyl alcohol in CH_2Cl_2.



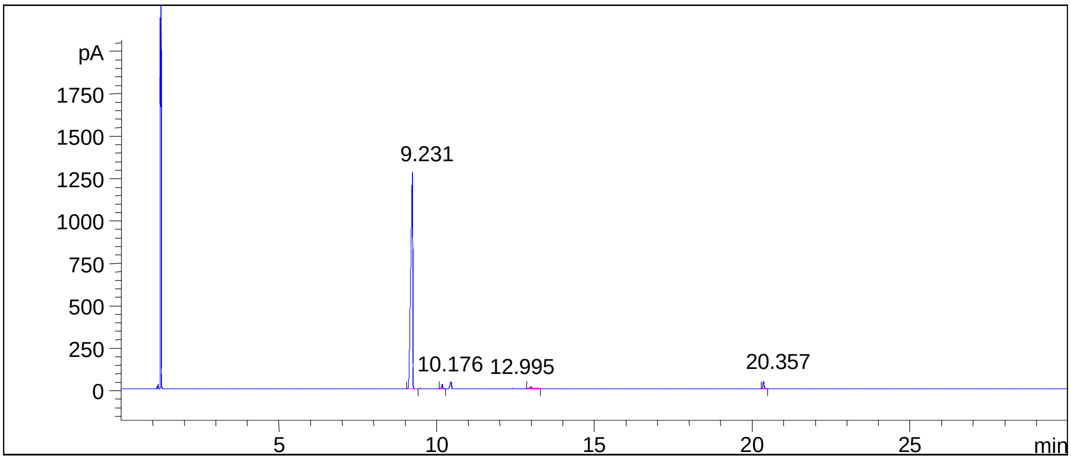
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	9.142	2631.7	799.8	0.0484	100.000	2.070
	Totals:	2631.7	799.8		100.000	

Figure 68: GC diagram of oxidation of 2-methylbenzyl alcohol with Method B for 10 h.



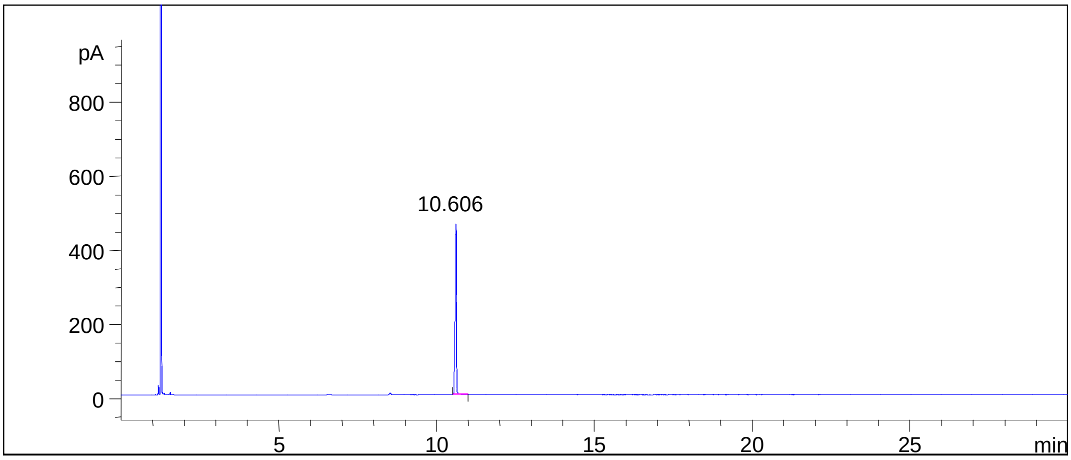
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	10.639	2168.7	608.0	0.0506	97.255	2.926
2	20.359	61.2	23.0		2.745	
	Totals:	2179.9	631.0		100.000	

Figure 69: GC diagram of 3-methylbenzyl alcohol in CH_2Cl_2.



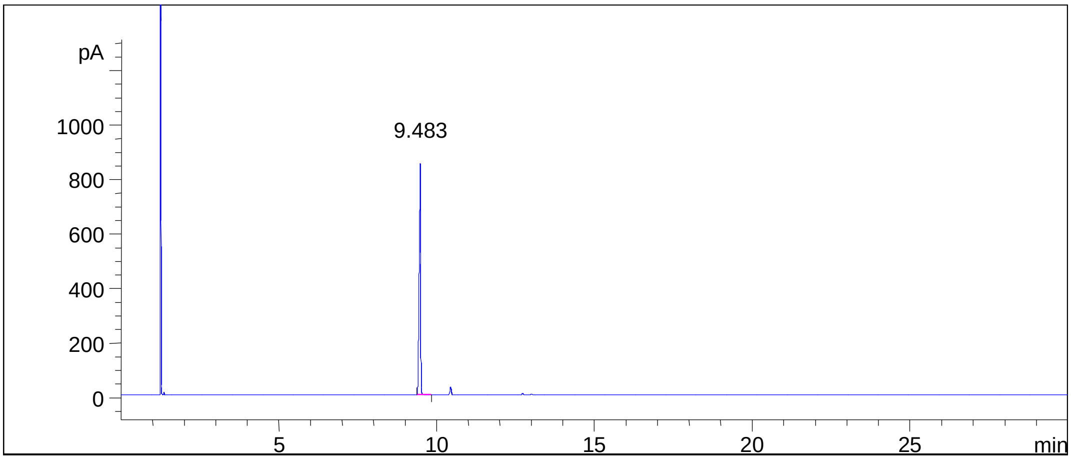
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	9.231	5432.1	1277.7	0.0558	95.566	4.137
2	10.176	74.2	25.8	0.0435	1.300	0.992
3	12.995	58.7	12.0	0.0624	1.030	2.310
4	20.357	120.1	43.8	0.0430	2.105	0.866
	Totals:	5685.1	1359.3		100.000	

Figure 70: GC diagram of oxidation of 3-methylbenzyl alcohol with Method B for 10 h.



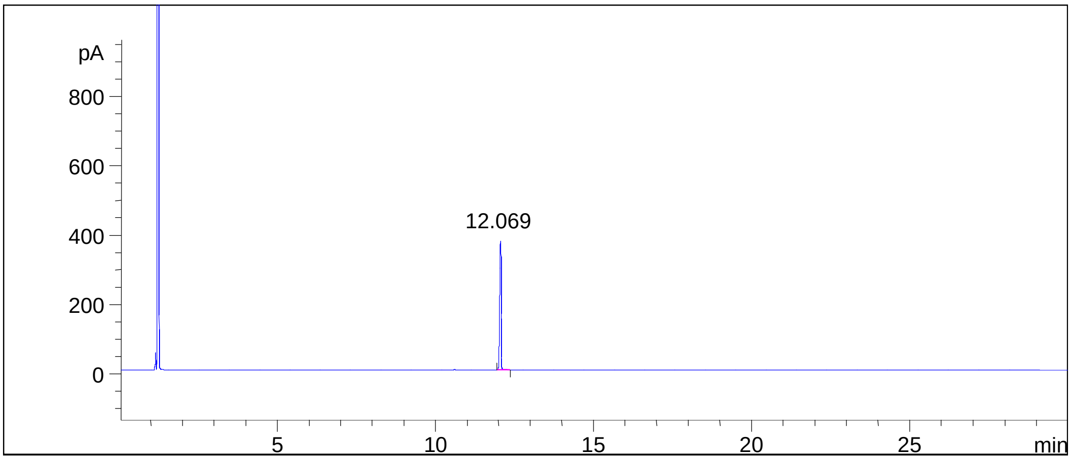
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	10.606	1413.5	460.9	0.0413	100.000	2.207
	Totals:	1413.5	460.9		100.000	

Figure 71: GC diagram of 4-methylbenzyl alcohol in CH_2Cl_2.



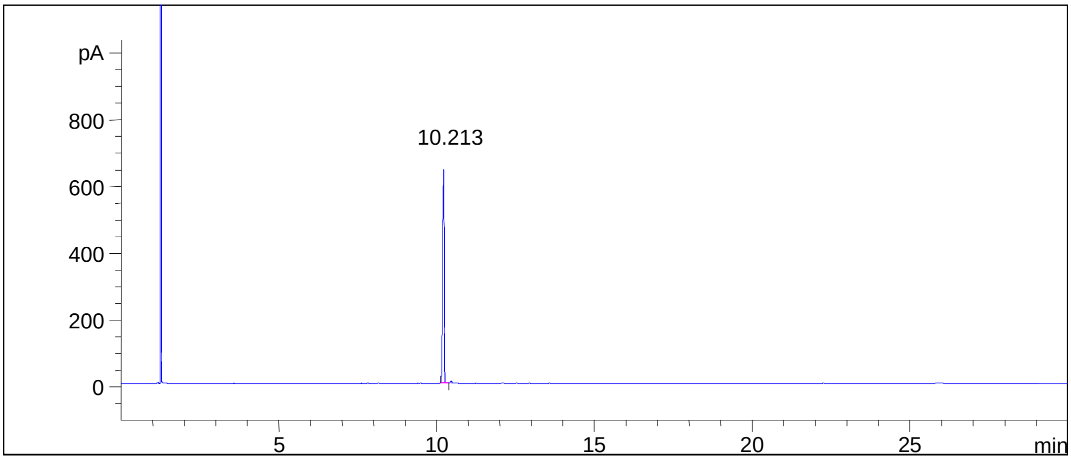
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	9.483	2843.2	849.9	0.0470	100.000	2.571
	Totals:	2843.2	849.9		100.000	

Figure 72: GC diagram of oxidation of 4-methylbenzyl alcohol with Method B for 16 h.



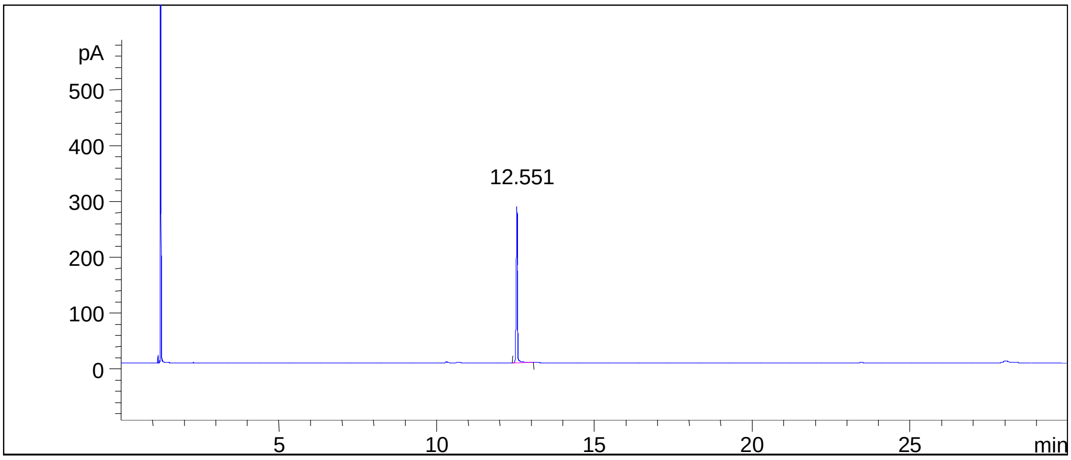
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	12.069	1016.9	370.7	0.0400	100.000	1.661
	Totals:	1016.9	370.7		100.000	

Figure 73 : GC diagram of 2-chlorobenzyl alcohol in CH_2Cl_2.



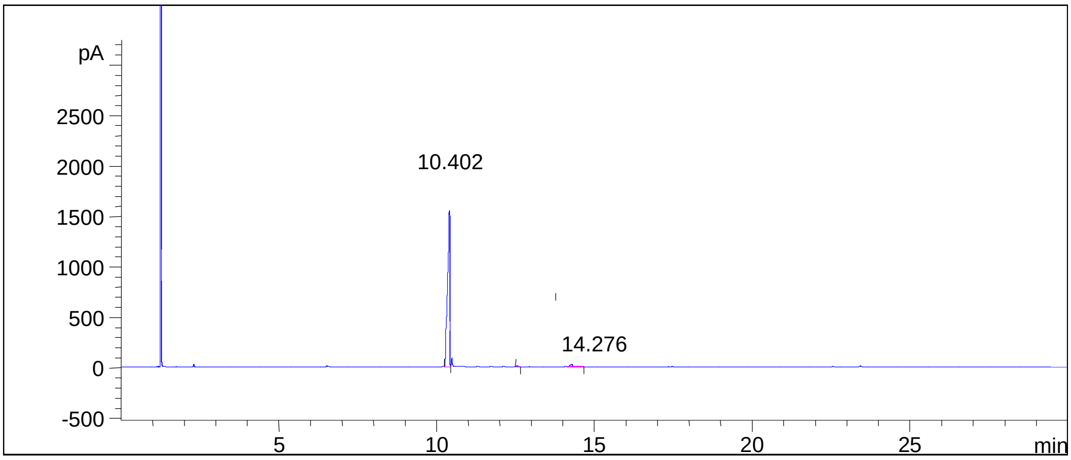
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	10.213	1986.9	640.7	0.0442	100.000	2.019
	Totals:	1986.9	640.7		100.000	

Figure 74: GC diagram of oxidation of 2-chlorobenzyl alcohol with Method A for 13 h.



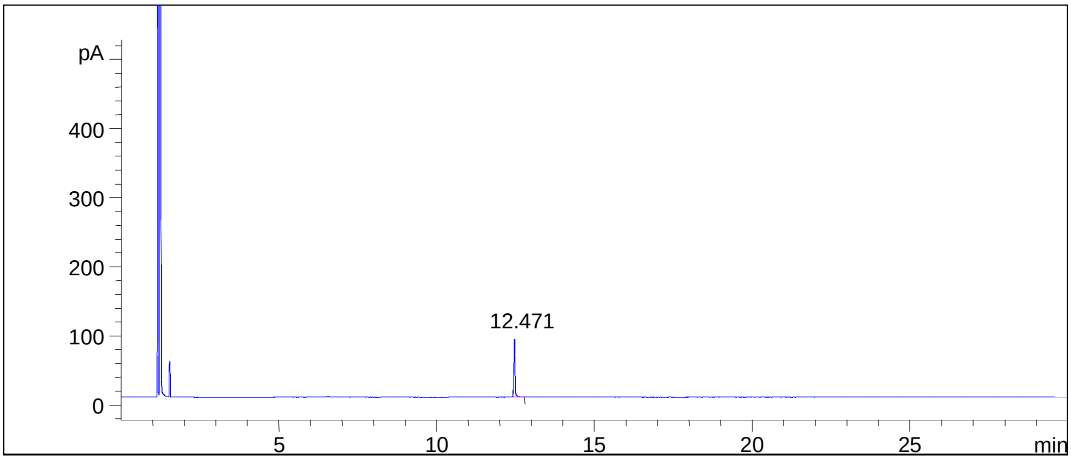
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	12.551	714..7	279.7	0.0399	100.000	1.290
	Totals:	714..7	279.7		100.000	

Figure 75 : GC diagram of 3-chlorobenzyl alcohol in CH_2Cl_2.



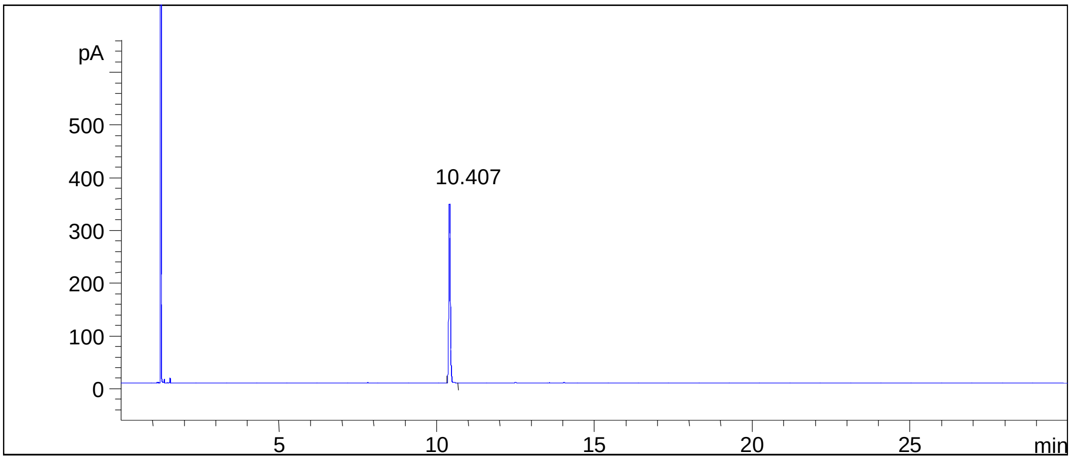
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	10.402	7770.4	1549.5	0.0645	98.174	5.937
2	14.276	144.6	25.2	0.0729	1.826	1.474
	Totals:	7915.0	1574.7		100.000	

Figure 76: GC diagram of oxidation of 3-chlorobenzyl alcohol with Method B for 10 h.



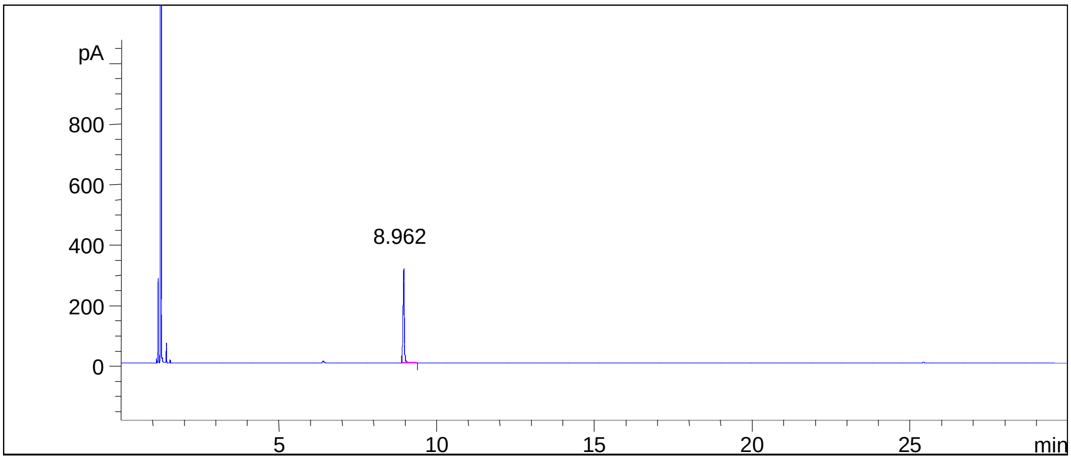
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	12.471	223.5	83.9	0.0401	100.000	0.887
	Totals:	223.5	83.9		100.000	

Figure 77 : GC diagram of 4-chlorobenzyl alcohol in CH_2Cl_2.



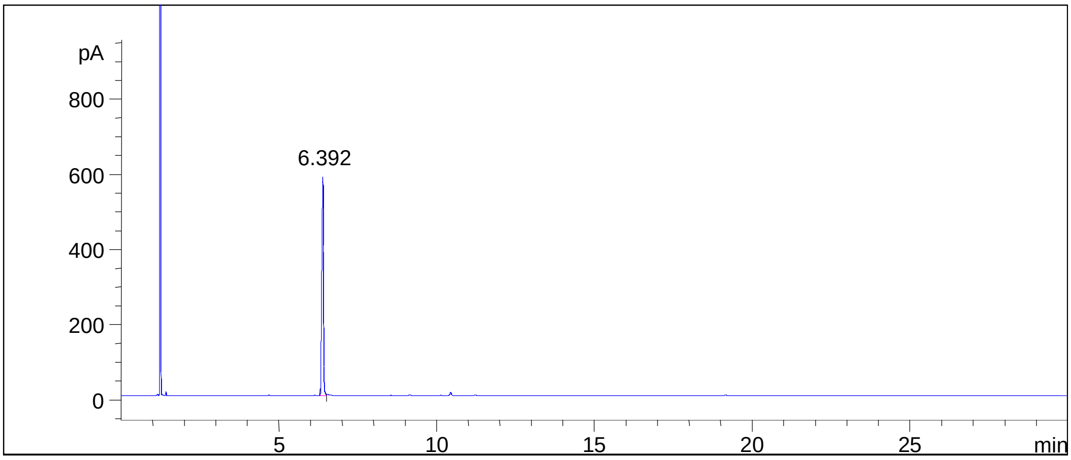
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	10.407	993.3	339.5	0.0441	100.000	1.096
	Totals:	993.3	339.5		100.000	

Figure 78: GC diagram of oxidation of 4-chlorobenzyl alcohol with Method A for 10 h.



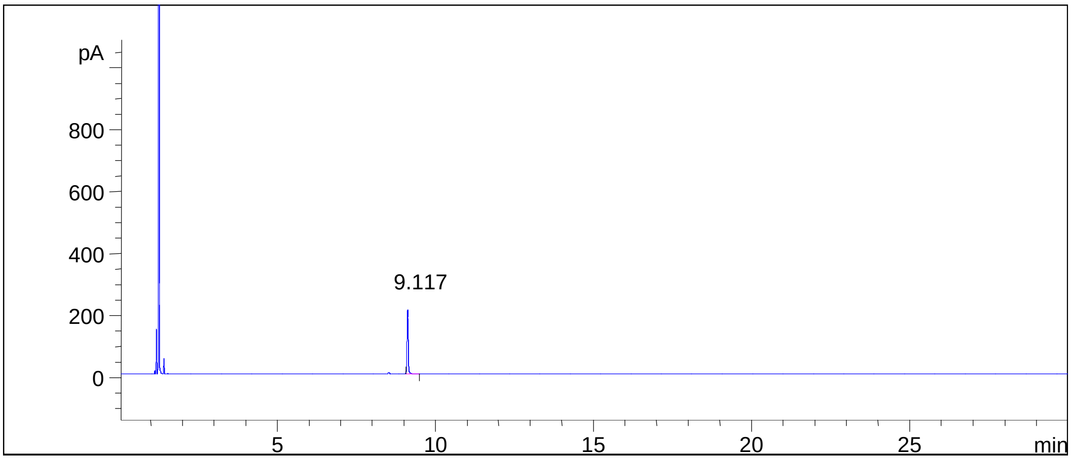
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	8.962	927.5	310.9	0.0433	100.000	1.258
	Totals:	927.5	310.9		100.000	

Figure 79 : GC diagram of 4-fluorobenzyl alcohol in CH_2Cl_2.



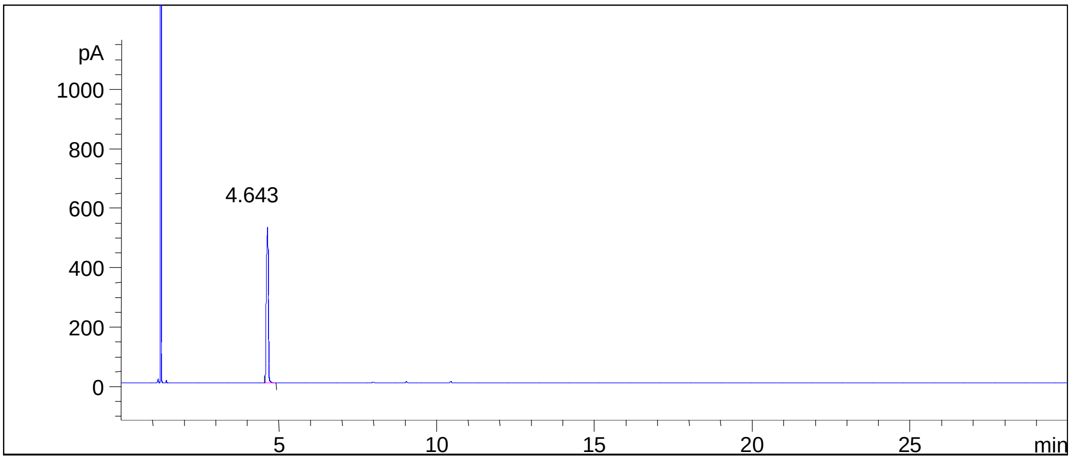
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.392	2166.0	581.0	0.0535	100.000	1.795
	Totals:	2166.0	581.0		100.000	

Figure 80: GC diagram of oxidation of 4-fluorobenzyl alcohol with Method A for 10 h.



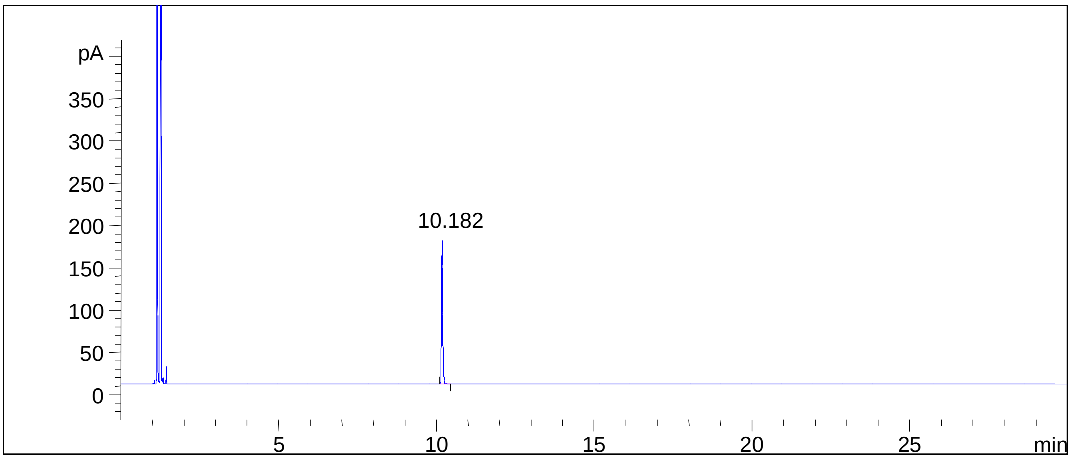
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	9.117	578.4	207.7	0.0425	100.000	0.949
	Totals:	578.4	207.7		100.000	

Figure 81 : GC diagram of 3,5-difluorobenzyl alcohol in CH_2Cl_2.



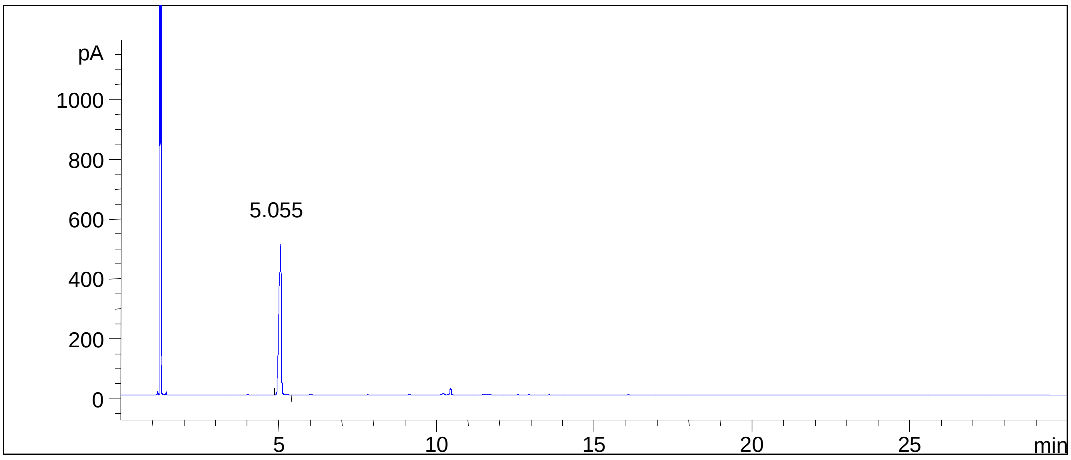
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	4.643	2076.8	523.2	0.0568	100.000	1.500
	Totals:	2076.8	523.2		100.000	

Figure 82: GC diagram of oxidation of 3,5-difluorobenzyl alcohol with Method A for 10 h.



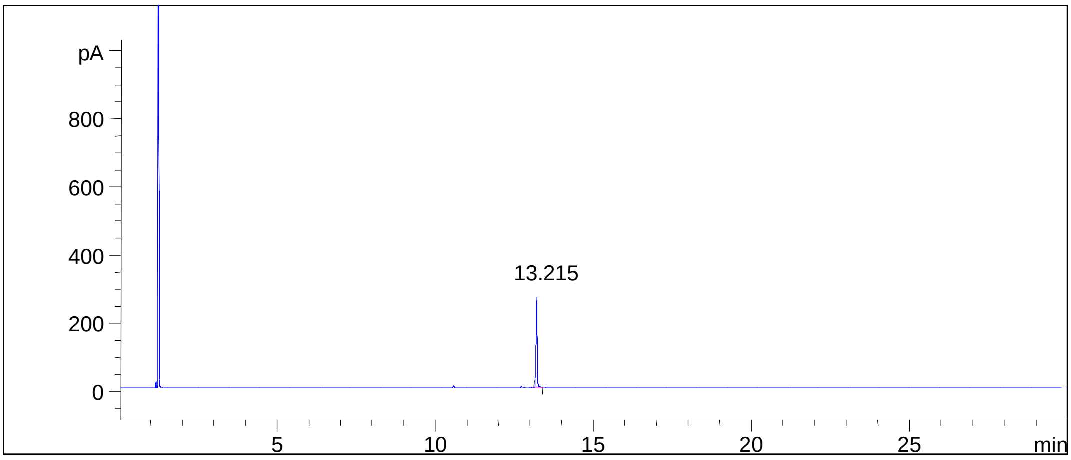
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	9.117	578.4	207.7	0.0425	100.000	0.949
	Totals:	578.4	207.7		100.000	

Figure 83 : GC diagram of 3,5-bis(trifluoromethyl)benzyl alcohol in CH_2Cl_2.



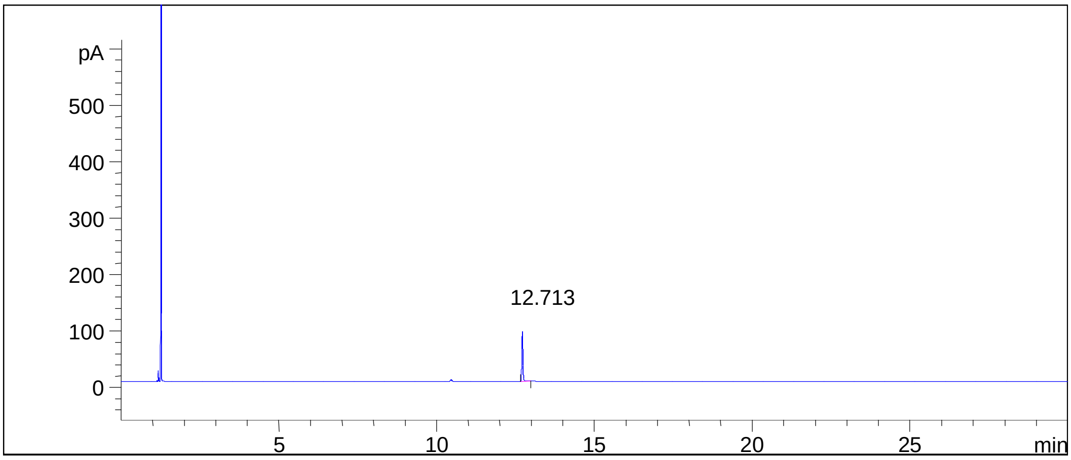
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.055	2646.3	503.3	0.0708	100.000	2.424
	Totals:	2646.3	503.3		100.000	

Figure 84 : GC diagram of oxidation of 3,5-bis(trifluoromethyl)benzyl alcohol with Method A for 12 h.



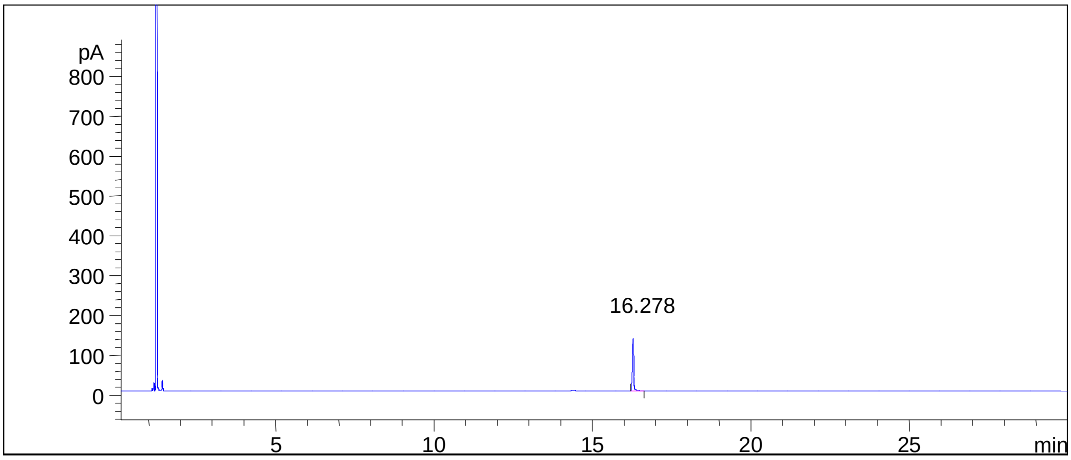
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	13.215	711.0	264.0	0.0404	100.000	1.526
	Totals:	711.0	264.0		100.000	

Figure 85 : GC diagram of 4-methoxybenzyl alcohol in CH_2Cl_2.



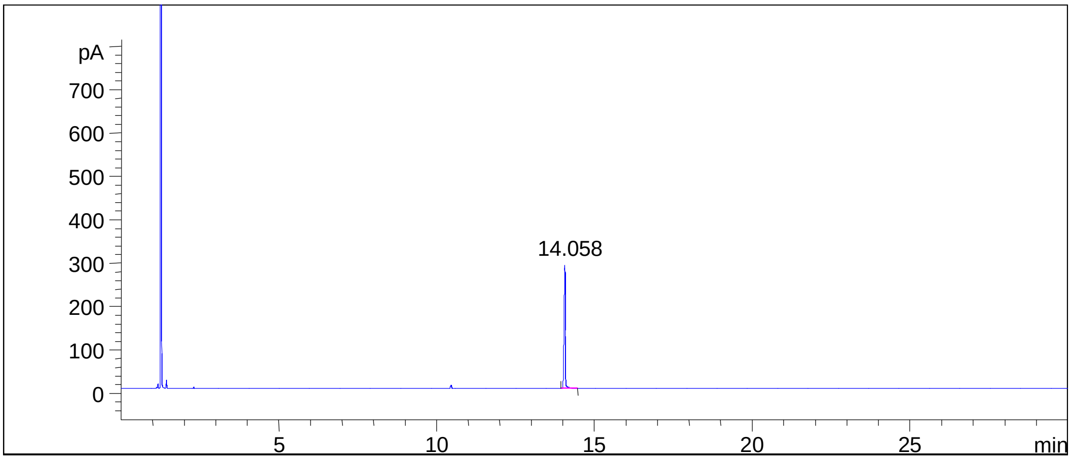
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	13.215	216.8	87.8	0.0383	100.000	0.930
	Totals:	216.8	87.8		100.000	

Figure 86 : GC diagram of oxidation of 4-methoxybenzyl alcohol with Method B for 15 h.



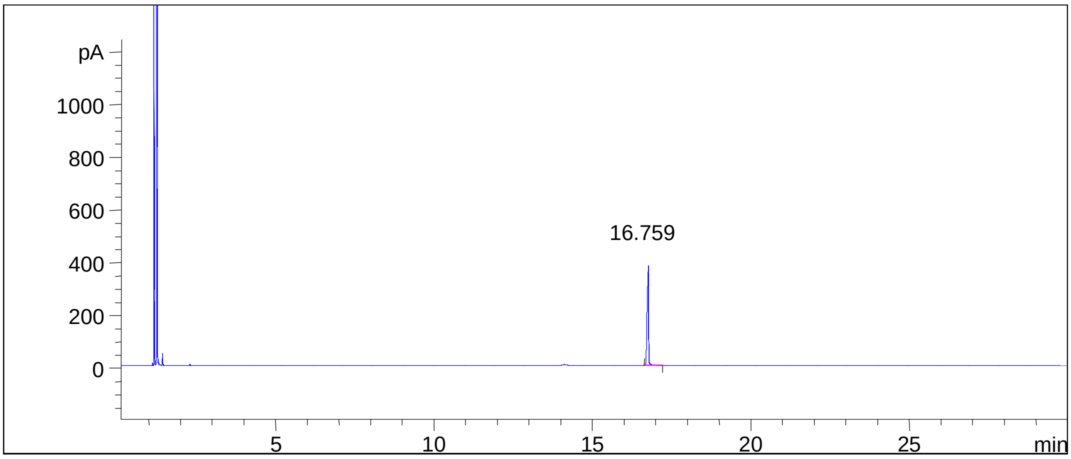
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	16.278	341.4	140.7	0.0363	100.000	1.418
	Totals:	341.4	140.7		100.000	

Figure 87 : GC diagram of methyl 4-(hydroxymethyl) benzoate in CH_2Cl_2.



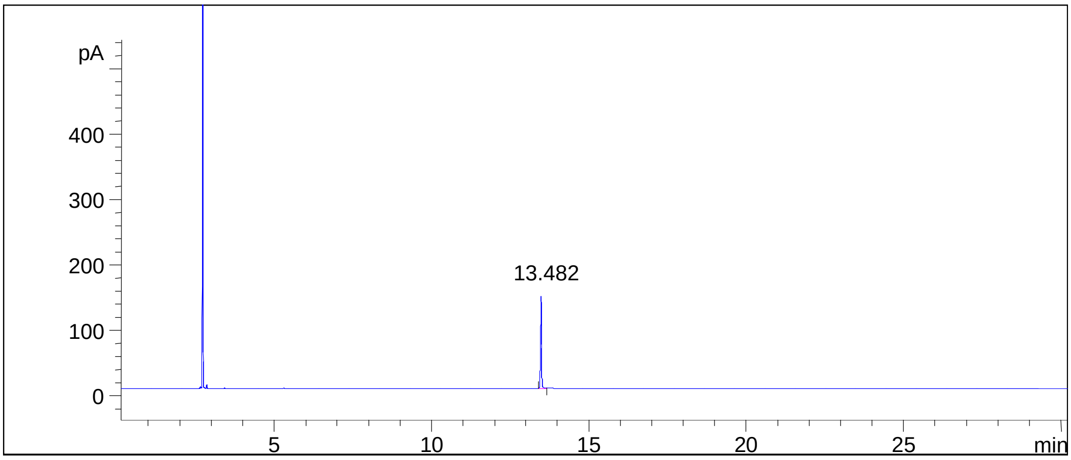
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	14.058	789.7	284.0	0.0399	100.000	1.580
	Totals:	789.7	284.0		100.000	

Figure 88 : GC diagram of oxidation of methyl 4-(hydroxymethyl) benzoate with Method B for 12 h.



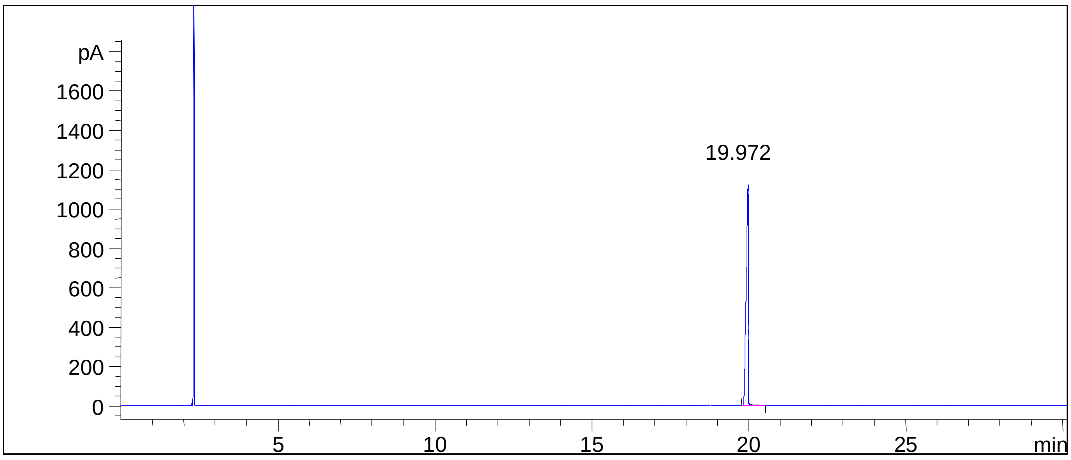
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	16.759	1215.0	377.6	0.0430	100.000	2.900
	Totals:	1215.0	377.6		100.000	

Figure 89 : GC diagram of 4-nitrobenzyl alcohol in CH_2Cl_2.



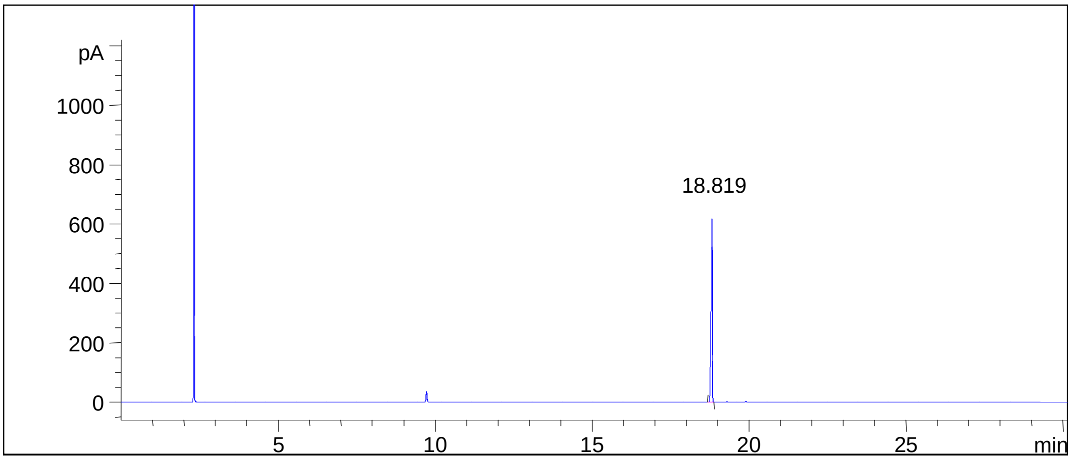
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	13.482	341.4	140.7	0.0363	100.000	1.418
	Totals:	341.4	140.7		100.000	

Figure 90 : GC diagram of oxidation of 4-nitrobenzyl alcohol with Method A for 13 h.



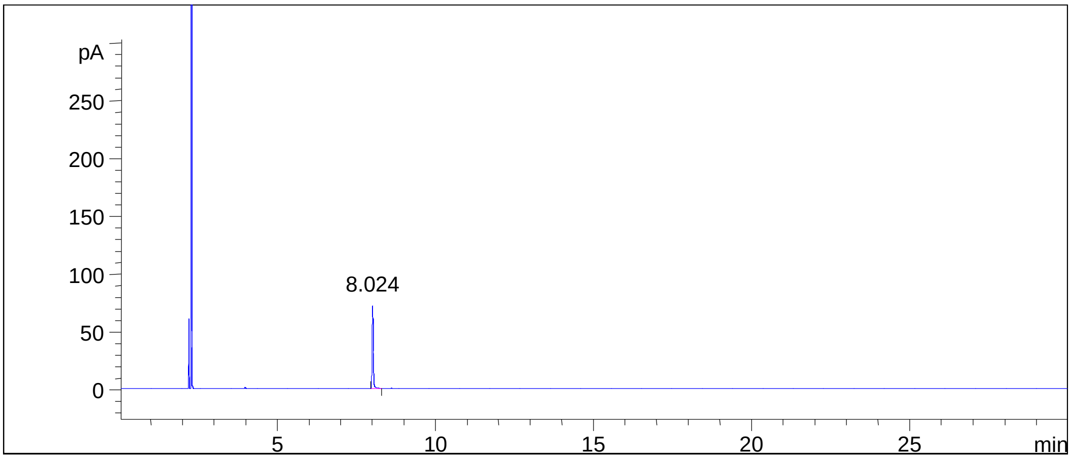
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	19.972	5366.7	1121.8	0.0623	100.000	4.485
	Totals:	5366.7	1121.8		100.000	

Figure 91 : GC diagram of 3-(phenoxyl)benzyl alcohol in CH_2Cl_2.



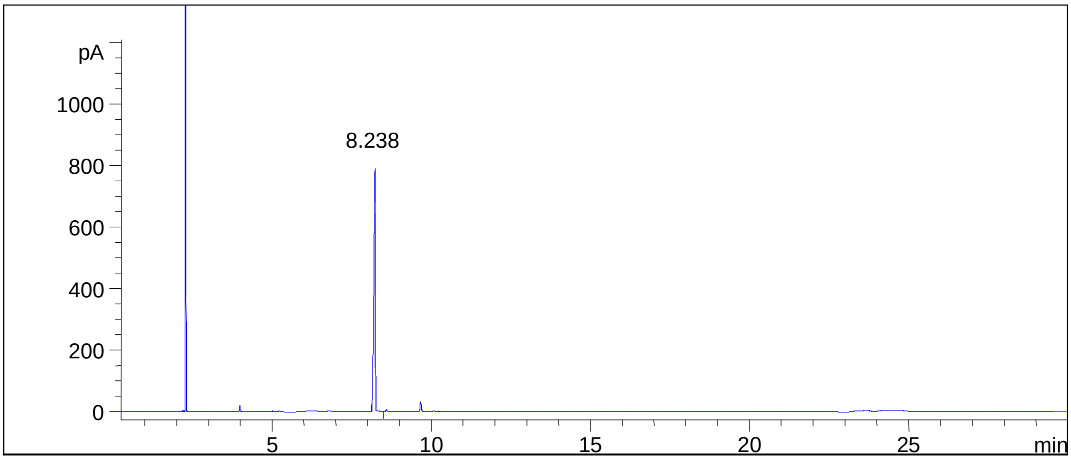
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	18.819	1806.4	616.9	0.0437	100.000	2.631
	Totals:	1806.4	616.9		100.000	

Figure 92 : GC diagram of oxidation of 3-(phenoxyl)benzyl alcohol with Method B for 11 h.



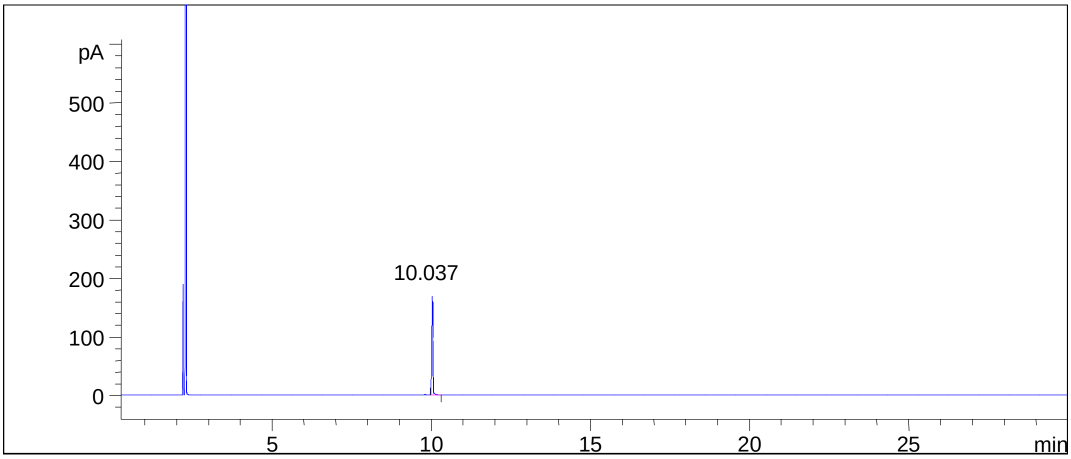
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	8.024	181.8	71.4	0.0392	100.000	0.877
	Totals:	181.8	71.4		100.000	

Figure 93 : GC diagram of 1-phenylethanol in CH_2Cl_2.



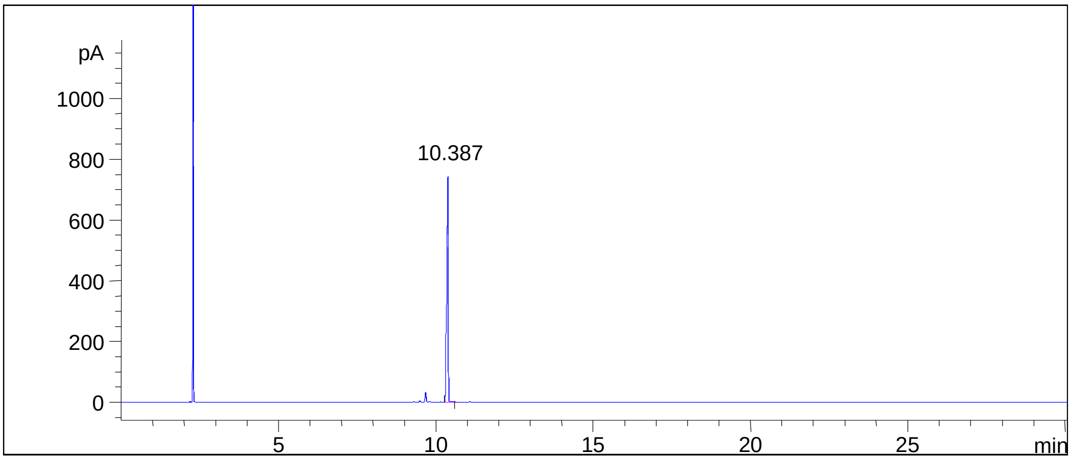
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	8.238	2614.0	789.0	0.0434	100.000	3.487
	Totals:	2614.0	789.0		100.000	

Figure 94 : GC diagram of oxidation of 1-phenylethanol with Method B for 12 h.



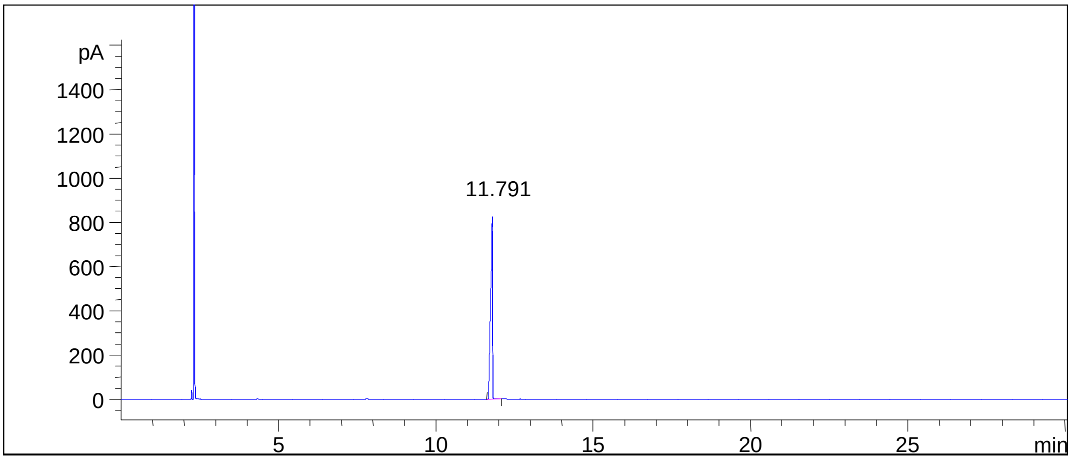
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	10.037	421.1	167.9	0.0388	100.000	1.176
	Totals:	421.1	167.9		100.000	

Figure 95 : GC diagram of 1-phenyl-1-propanol in CH_2Cl_2.



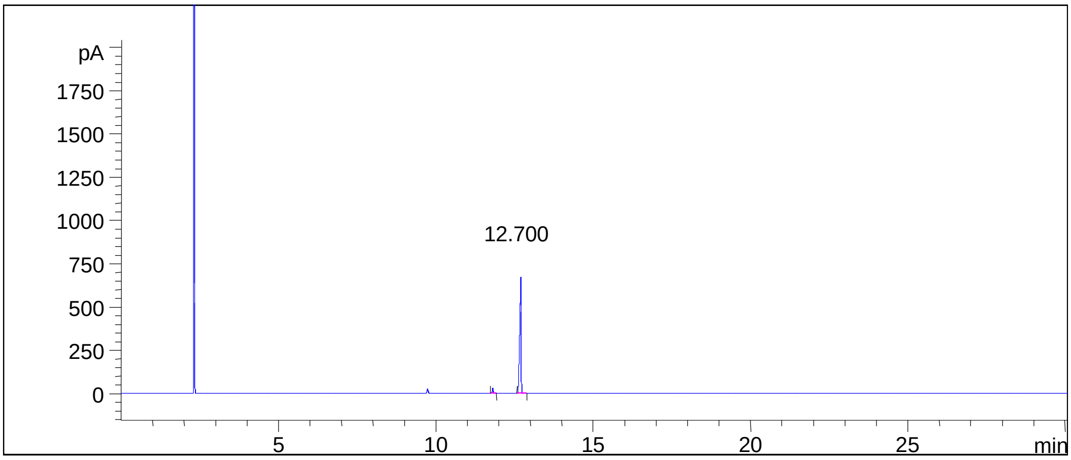
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	10.387	2335.9	740.9	0.04188	100.000	3.153
	Totals:	2335.9	740.9		100.000	

Figure 96 : GC diagram of oxidation of 1-phenyl-1-propanol with Method B for 12 h.



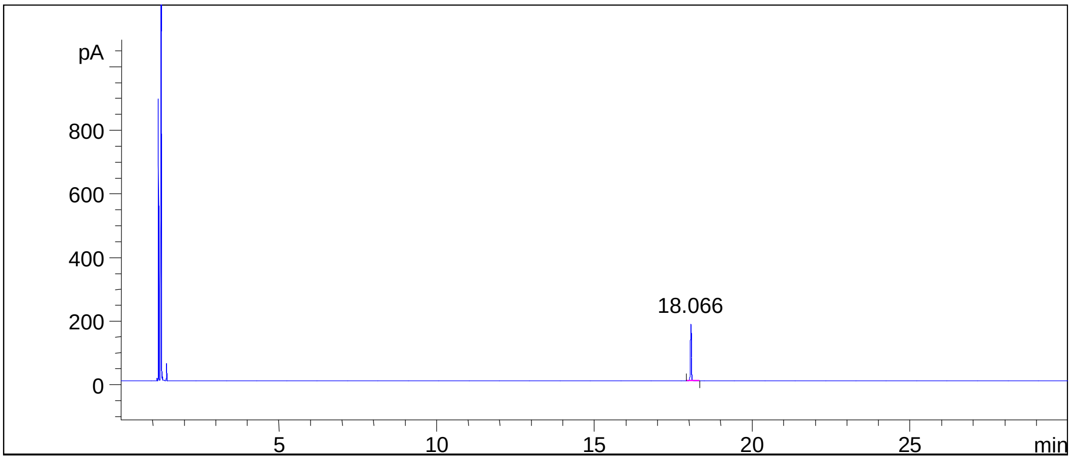
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	11.791	3552.3	822.0	0.0623	100.000	4.832
	Totals:	3552.3	822.0		100.000	

Figure 97 : GC diagram of 1-indanol in CH_2Cl_2.



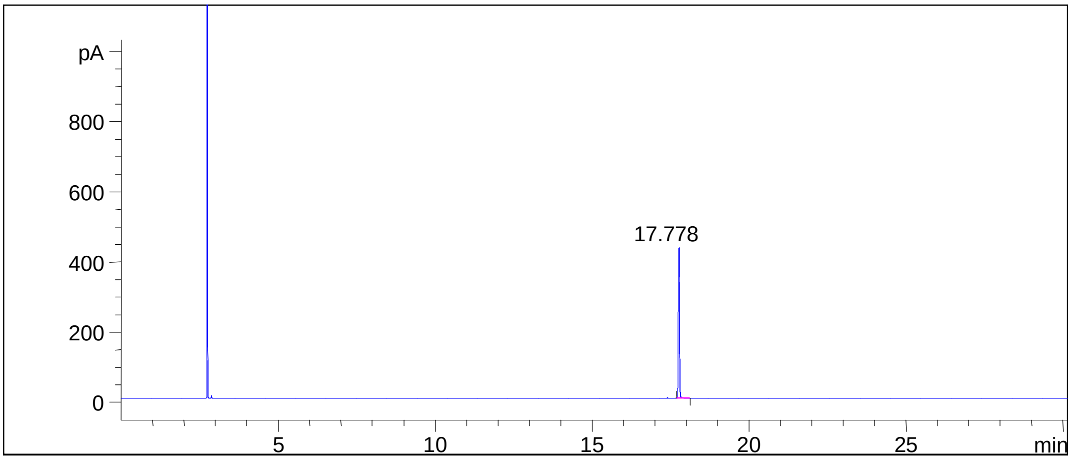
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	12.700	2238.9	671.8	0.0439	100.000	3.499
	Totals:	2238.9	671.8		100.000	

Figure 98 : GC diagram of oxidation of 1-indanol with Method B for 16 h.



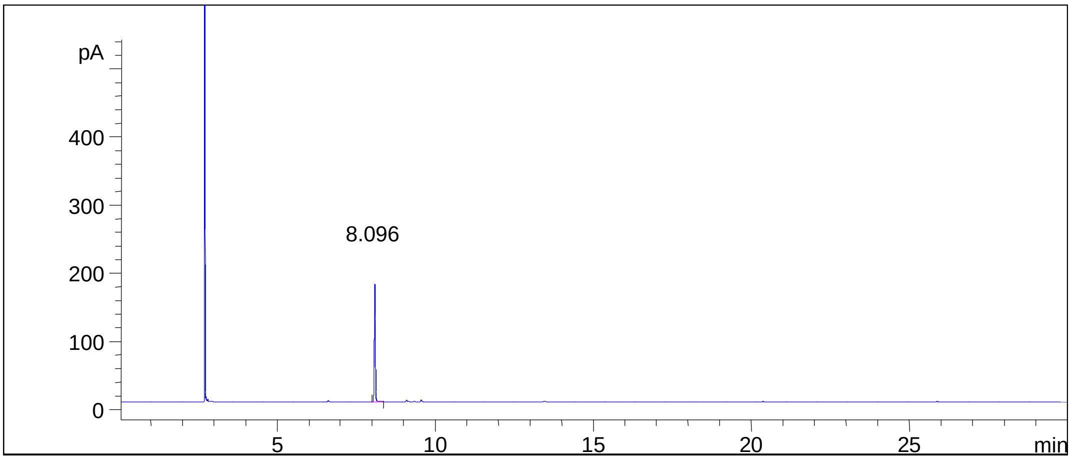
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	18.066	428.0	178.5	0.0350	100.000	1.232
	Totals:	428.0	178.5		100.000	

Figure 99 : GC diagram of benzhydrol in CH_2Cl_2.



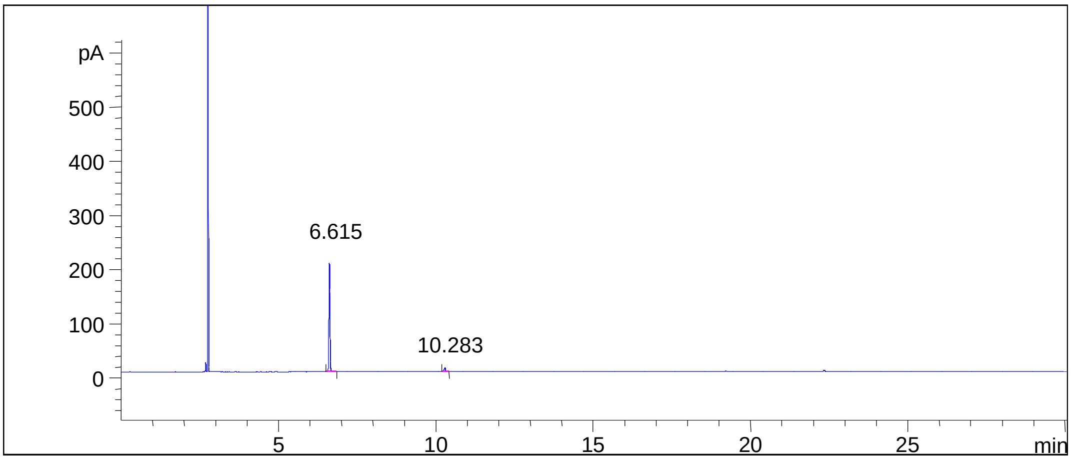
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	17.778	1108.3	429.6	0.0391	100.000	1.617
	Totals:	1108.3	429.6		100.000	

Figure 100 : GC diagram of oxidation of benzhydrol with Method B for 16 h.



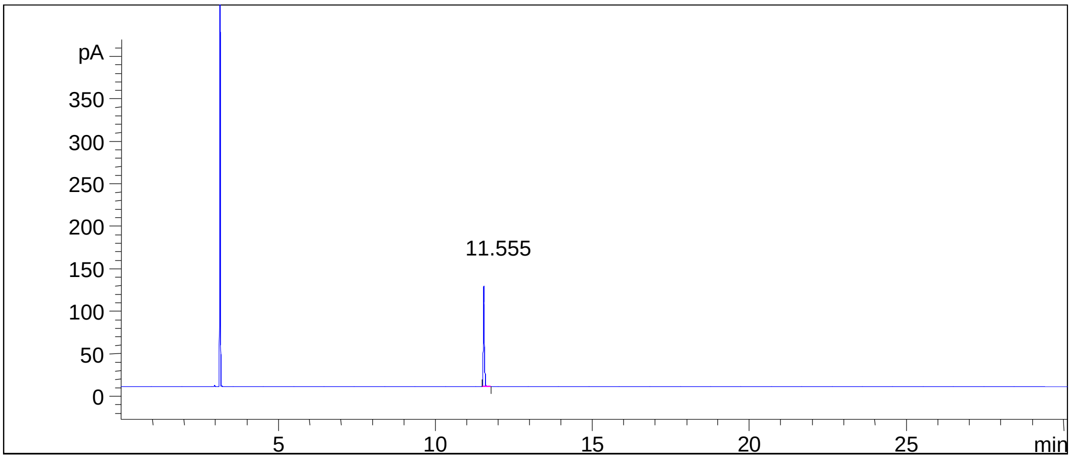
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	8.096	404.5	172.7	0.0358	100.000	1.118
	Totals:	404.5	172.7		100.000	

Figure 101 : GC diagram of 1-octanol in CH_2Cl_2.



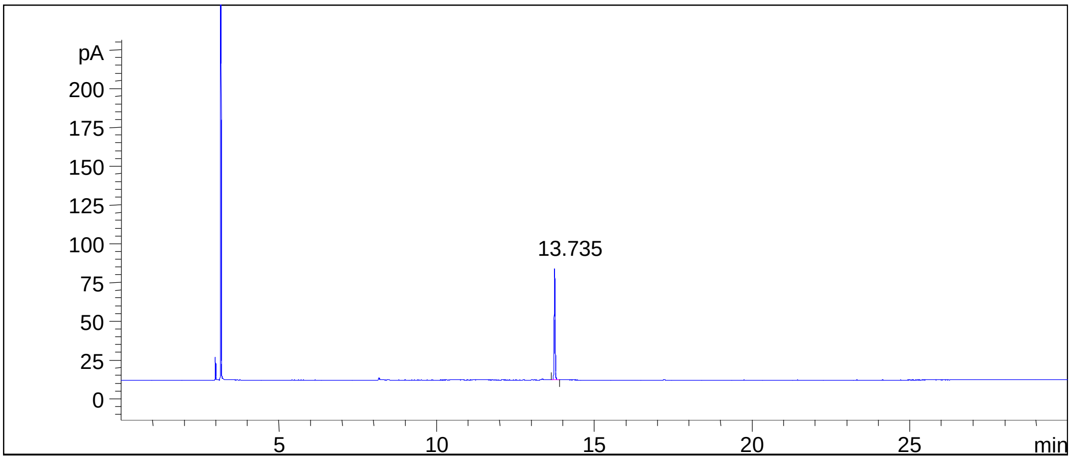
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.615	456.0	199.8	0.0361	94.801	0.0986
2	10.283	25.0	7.3	0.0509	5.193	1.766
	Totals:	481.0	207.1		100.000	

Figure 102 : GC diagram of oxidation of 1-octanol with Method D for 12 h.



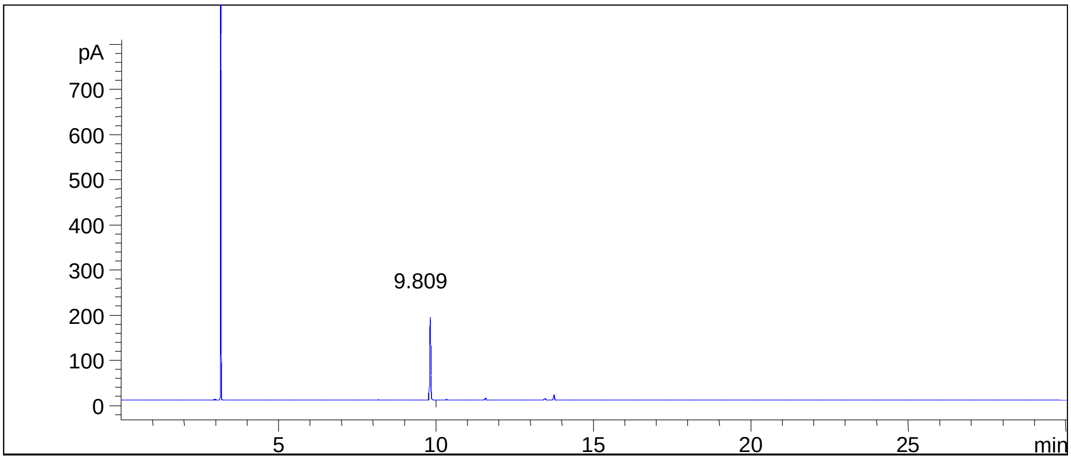
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	11.555	265.8	118.7	0.0351	100.000	0.9974
	Totals:	265.8	118.7		100.000	

Figure 103 : GC diagram of 2-ethyl hexanol in CH_2Cl_2.



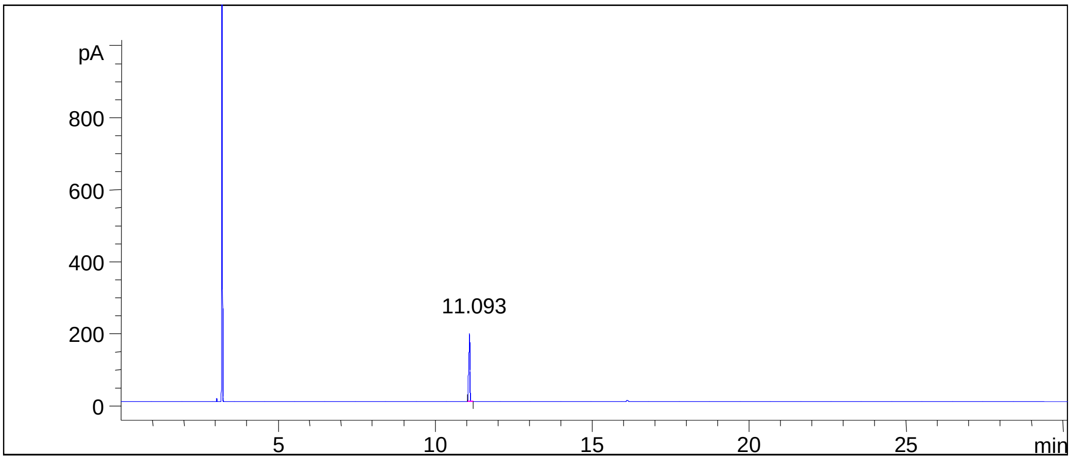
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	13.735	157.8	71.4	0.0343	100.000	0.912
	Totals:	157.8	71.4		100.000	

Figure 104 : GC diagram of TEMPO in CH_2Cl_2.



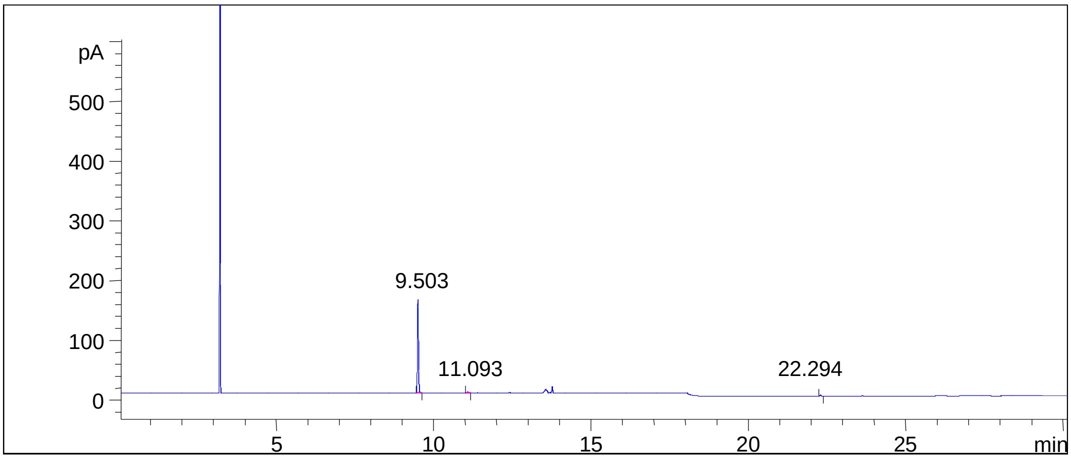
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	9.809	409.4	183.0	0.0351	100.000	0.0935
	Totals:	409.4	183.0		100.000	

Figure 105: GC diagram of oxidation of 2-ethyl hexanol with Method D for 17h.



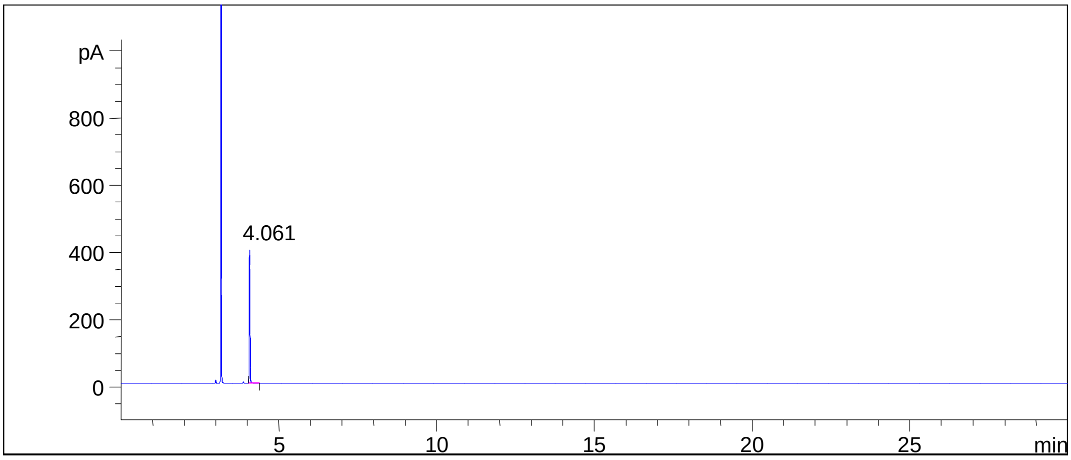
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	11.093	431.6	188.0	0.0348	100.000	1.175
	Totals:	431.6	188.0		100.000	

Figure 106: GC diagram of cyclohexyl carbinol in CH_2Cl_2.



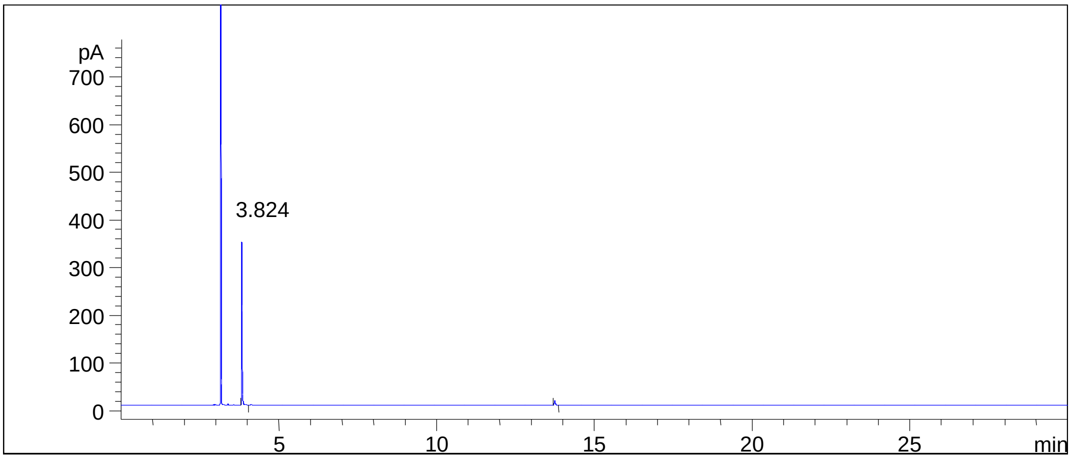
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	9.503	353.1	156.8	0.0328	96.849	0.868
2	11.093	6.7	2.7	0.0370	1.831	0.728
3	22.294	4.8	2.1	0.0357	1.320	0.979
	Totals:	364.6	161.6		100.000	

Figure 107: GC diagram of oxidation of cyclohexyl carbinol with Method D for 16 h.



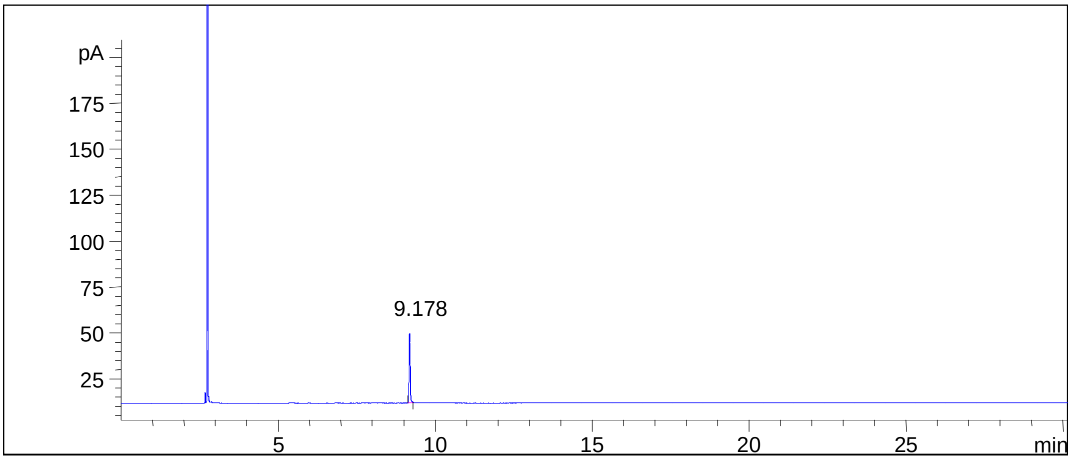
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	4.061	722.8	396.7	0.0298	100.000	0.0897
	Totals:	722.8	396.7		100.000	

Figure 108: GC diagram of cyclopropyl carbinol in CH_2Cl_2.



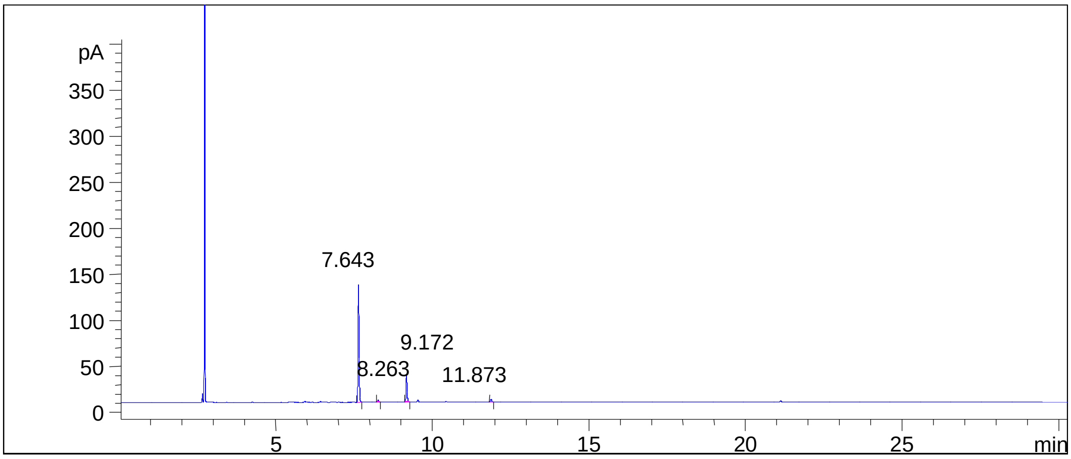
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	3.824	498.3	341.5	0.0230	100.000	0.0627
	Totals:	498.3	341.5		100.000	

Figure 109: GC diagram of oxidation of cyclopropyl carbinol with Method C for 15 h.



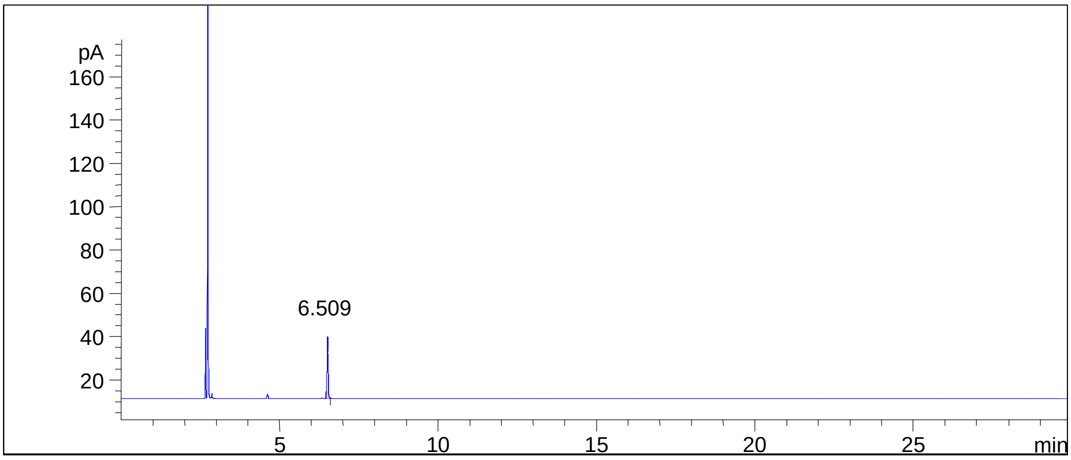
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	9.178	90.8	37.6	0.0305	100.000	0.737
	Totals:	90.8	37.6		100.000	

Figure 110 : GC diagram of 2-phenylethanol in CH_2Cl_2.



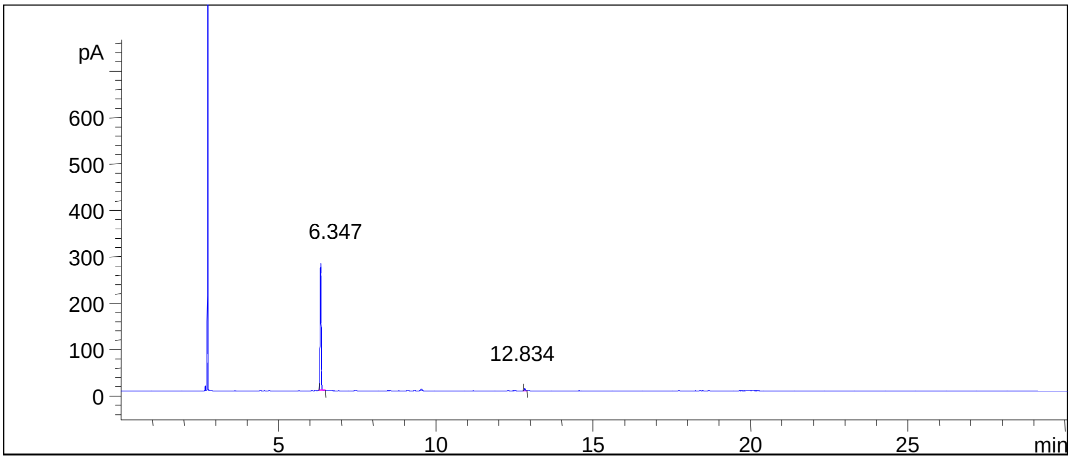
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	7.643	292.3	127.8	0.0354	77.573	0.961
2	8.263	5.5	2.3	0.0304	1.465	0.736
3	9.173	69.4	28.2	0.0362	18.417	0.815
4	11.873	9.6	3.4	0.0341	2.545	0.640
	Totals:	376.8	161.7		100.000	

Figure 111 : GC diagram of oxidation of 2-phenylethanol with Method D for 19 h.



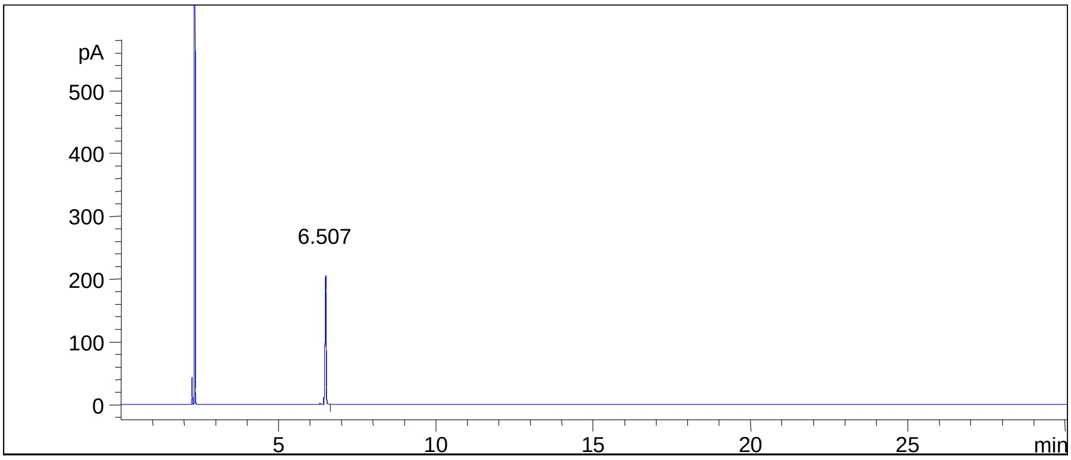
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.509	66.1	28.6	0.0354	100.000	0.803
	Totals:	66.1	28.6		100.000	

Figure 112 : GC diagram of 2-octanol in CH_2Cl_2.



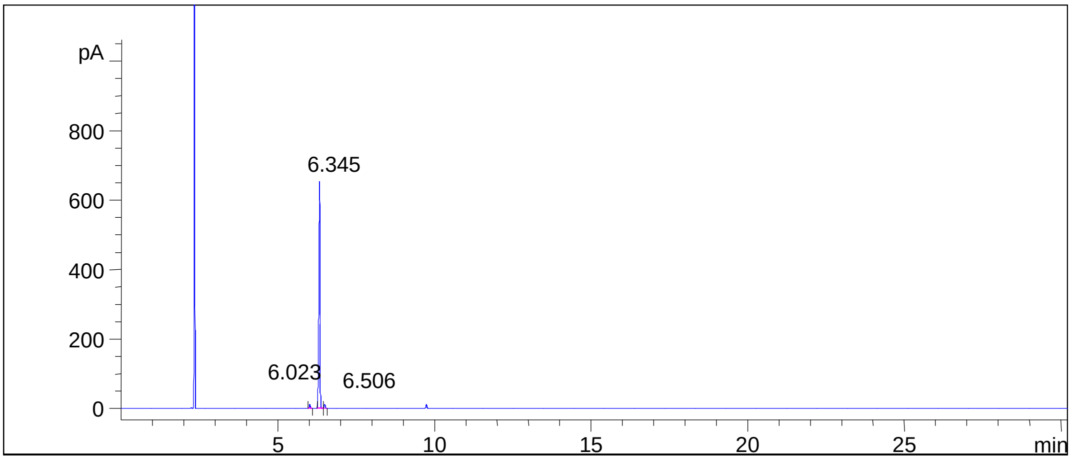
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.347	626.8	274.1	0.0354	98.238	1.084
2	12.834	11.2	4.9	0.0321	1.762	0.809
	Totals:	638.0	279.0		100.000	

Figure 113 : GC diagram of oxidation of 2-octanol with Method C for 17 h.



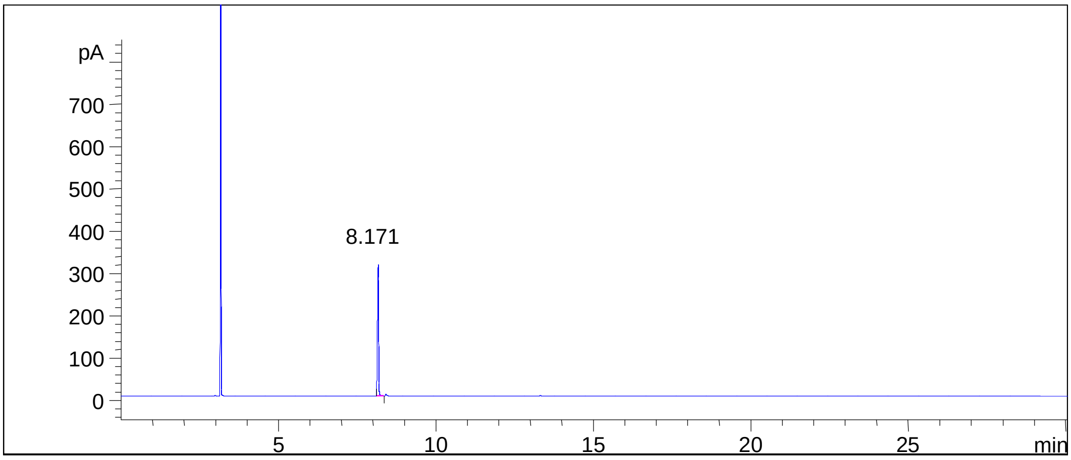
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.507	503.3	204.3	0.0372	100.000	1.249
	Totals:	503.3	204.3		100.000	

Figure 114 : GC diagram of 3-octanol in CH_2Cl_2.



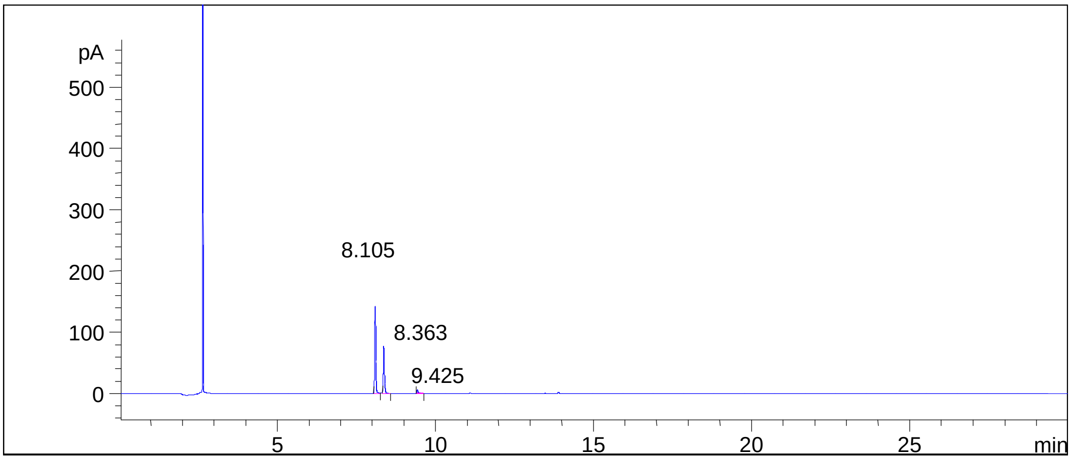
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.023	30.4	11.8	0.0385	1.641	0.958
2	6.345	1792.9	654.0	0.0390	96.878	2.013
3	6.506	27.4	11.2	0.0369	1.481	0.845
	Totals:				100.000	

Figure 115 : GC diagram of oxidation of 3-octanol with Method C for 27 h.



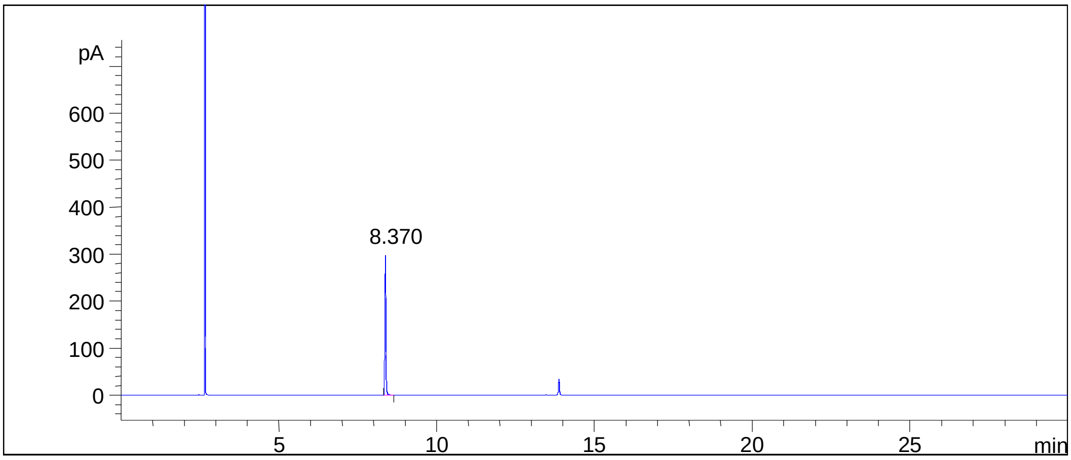
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	8.171	805.2	311.1	0.0362	100.000	1.610
	Totals:	805.2	311.1		100.000	

Figure 116 : GC diagram of cyclohexanol in CH_2Cl_2.



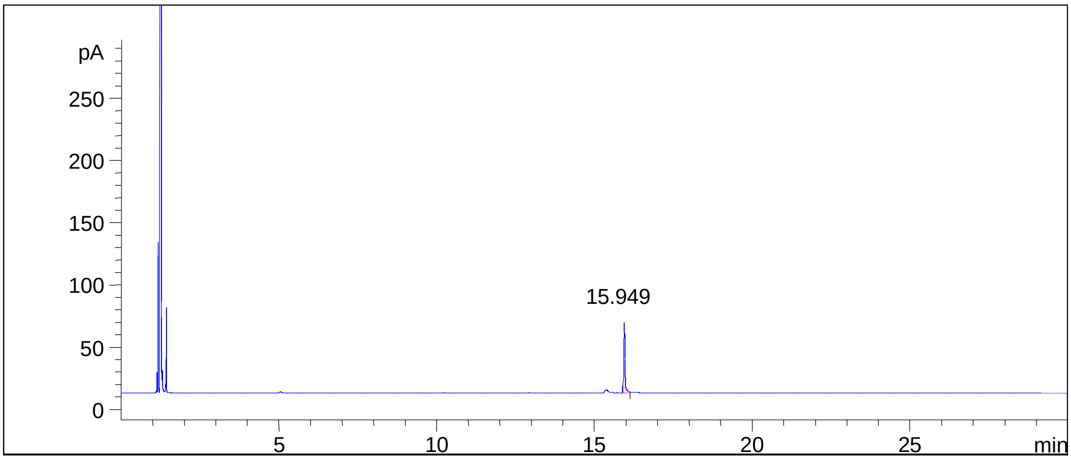
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	8.105	345.7	142.0	0.0384	62.733	0.974
2	8.363	186.5	77.0	0.0375	33.842	0.592
3	9.425	18.9	6.2	0.0429	3.425	0.324
	Totals:	551.1	255.2		100.000	

Figure 117 : GC diagram of oxidation of cyclohexanol with Method D for 24 h.



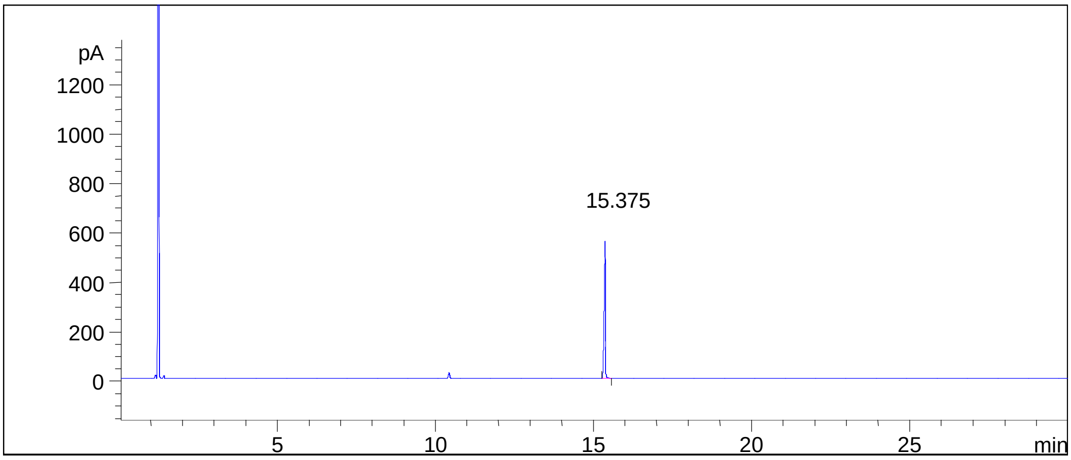
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	8.370	727.0	297.8	0.0362	100.000	1.107
	Totals:	727.0	297.8		100.000	

Figure 118 : GC diagram of oxidation of cyclohexanol in the presence of 16 mol % HBr instead of HCl with Method D for 16 h.



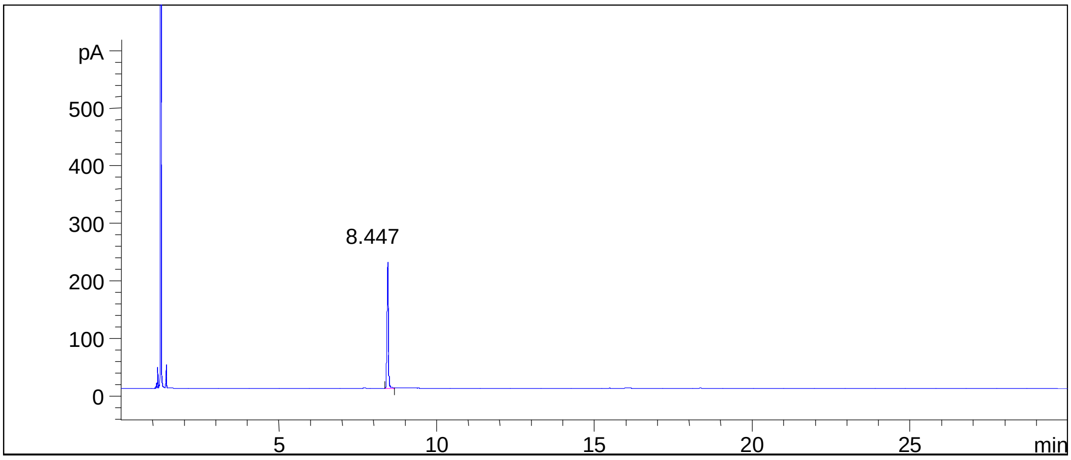
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	15.949	154.2	56.4	0.0386	100.000	0.824
	Totals:	154.2	56.4		100.000	

Figure 119: GC diagram of 4-(methylthio)benzyl alcohol in CH_2Cl_2.



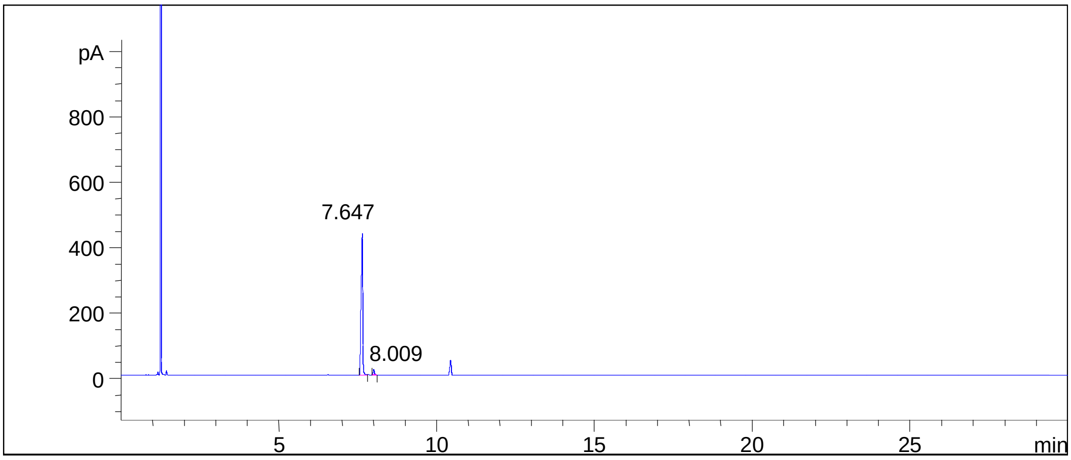
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	15.375	1660.7	555.9	0.0404	100.000	2.719
	Totals:	1660.7	555.9		100.000	

Figure 120 : GC diagram of oxidation of 4-(methylthio)benzyl alcohol with Method C for 11 h.



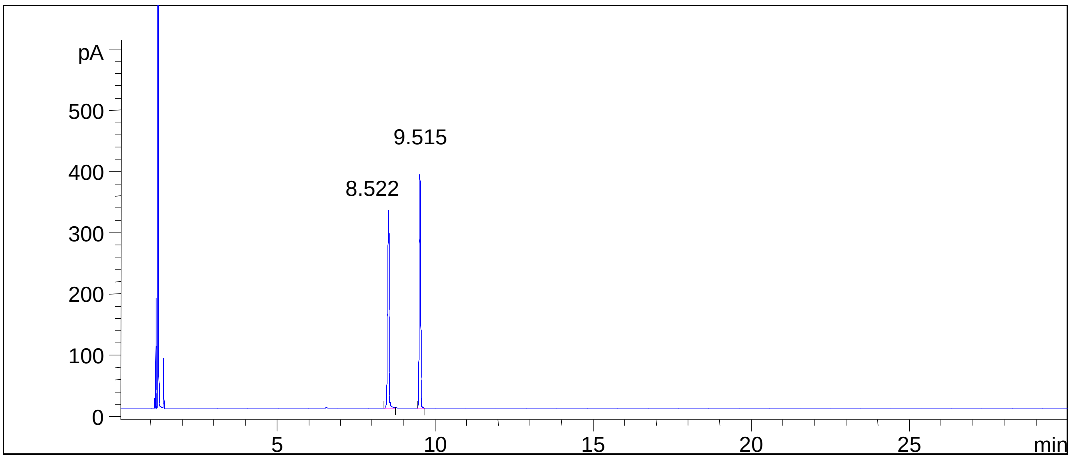
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	8.447	689.4	218.2	0.0449	100.000	1.431
	Totals:	689.4	218.2		100.000	

Figure 121 : GC diagram of 2-thienyl methanol in CH_2Cl_2.



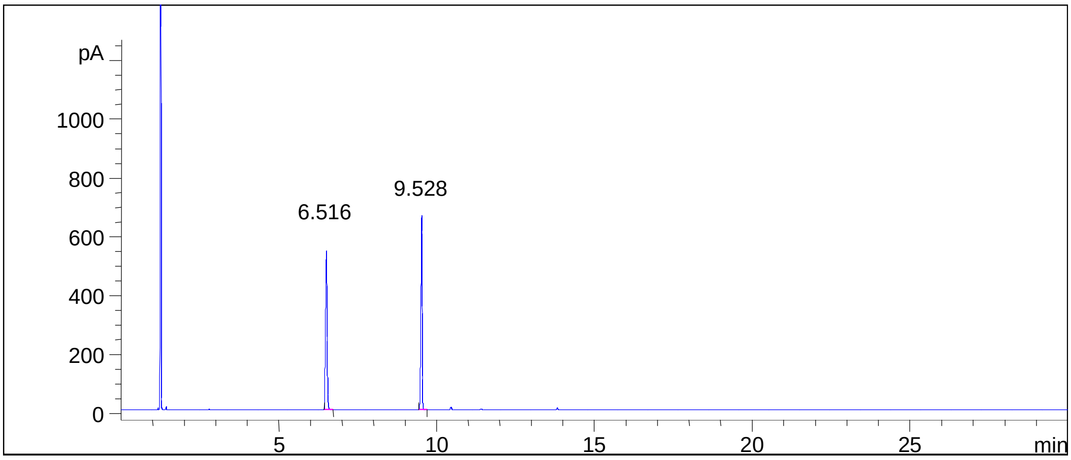
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	7.647	1579.5	433.0	0.0491	96.973	2.121
2	8.009	49.3	16.4	0.0393	3.021	0.729
	Totals:	1628.8	449.4		100.000	

Figure 122 : GC diagram of oxidation of 2-thienyl methanol with Method C for 12 h.



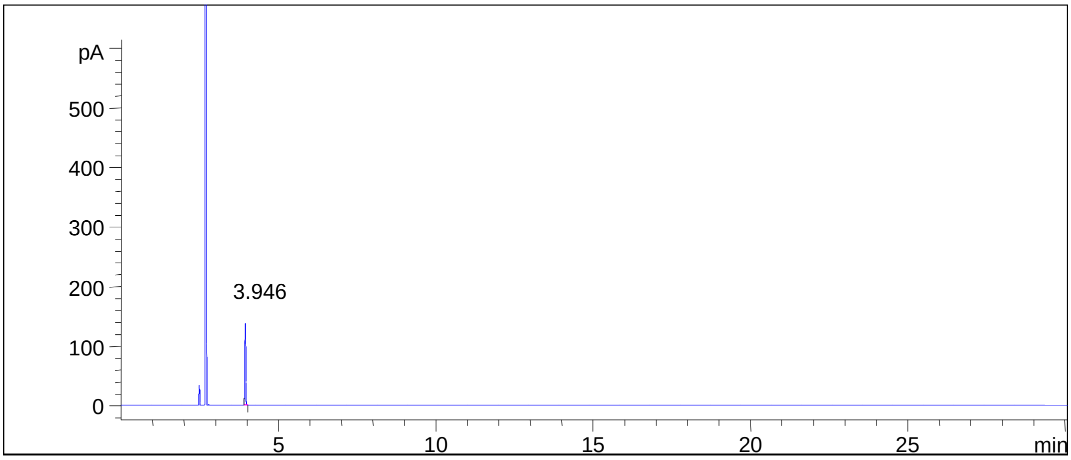
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	8.522	1020.5	323.3	0.0428	48.731	1.647
2	9.515	1073.6	381.5	0.0428	51.269	1.080
	Totals:	2094.1	704.8		100.000	

Figure 123 : GC diagram of benzyl alcohol and thioanisole in CH_2Cl_2.



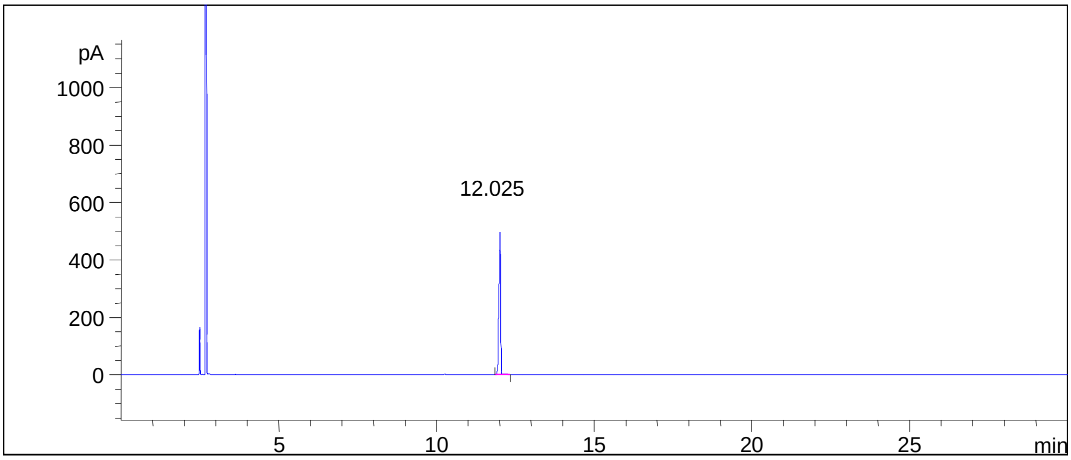
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.516	1935.4	541.3	0.0492	49.695	1.408
2	9.528	1959.1	660.3	0.0429	50.305	1.544
	Totals:	3894.5	1201.6		100.000	

Figure 124 : GC diagram of oxidation of benzyl alcohol and thioanisole with Method B for 13 h.



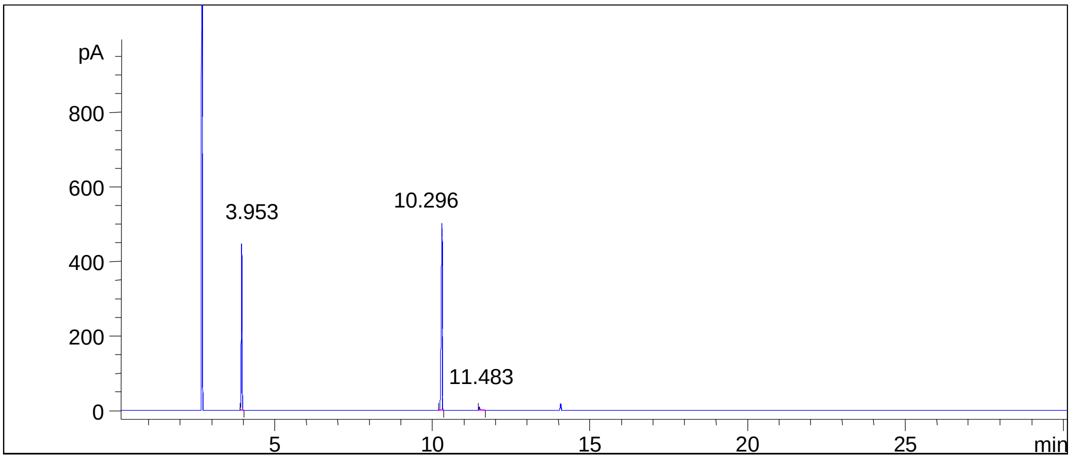
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	3.946	274.2	137.5	0.0318	100.000	1.056
	Totals:	274.2	137.5		100.000	

Figure 125 : GC diagram of diethyl sulfide in CH_2Cl_2.



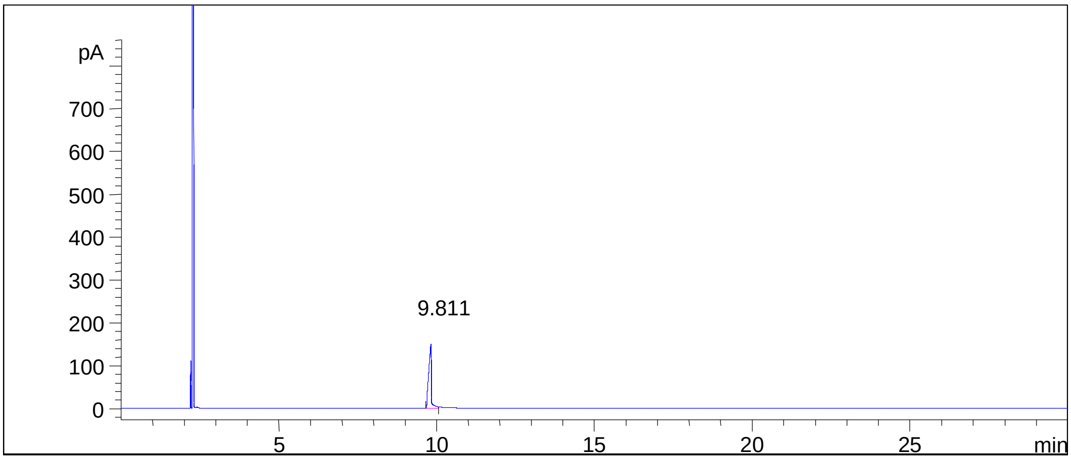
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	12.025	1744.5	493.6	0.0487	100.000	3.120
	Totals:	1744.5	493.6		100.000	

Figure 126 : GC diagram of benzyl alcohol in CH_2Cl_2.



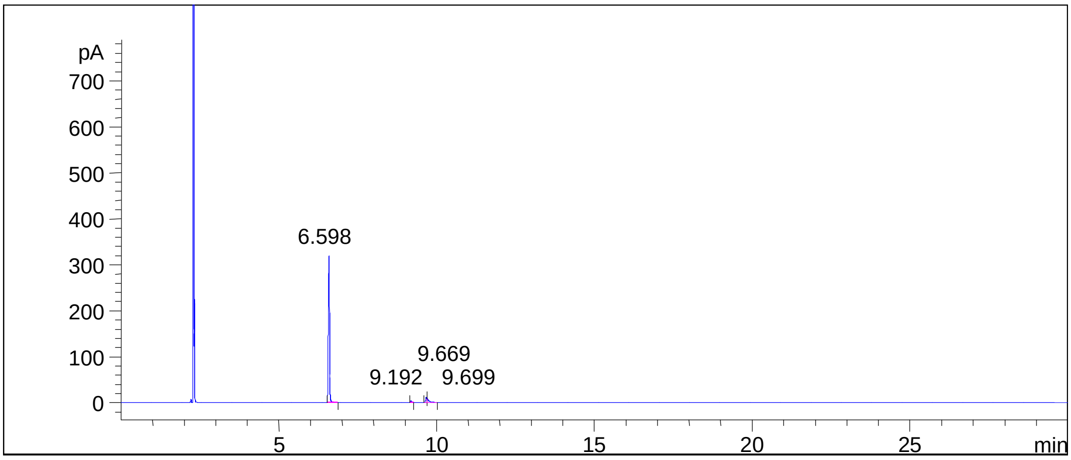
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	3.953	797.5	447.0	0.0273	37.656	1.149
2	10.296	1292.3	500.7	0.0369	61.020	1.921
3	11.483	28.0	9.8	0.0403	1.323	0.286
	Totals:				100.000	

Figure 127 : GC diagram of oxidation of benzyl alcohol and diethyl sulfide with Method B for 14 h.



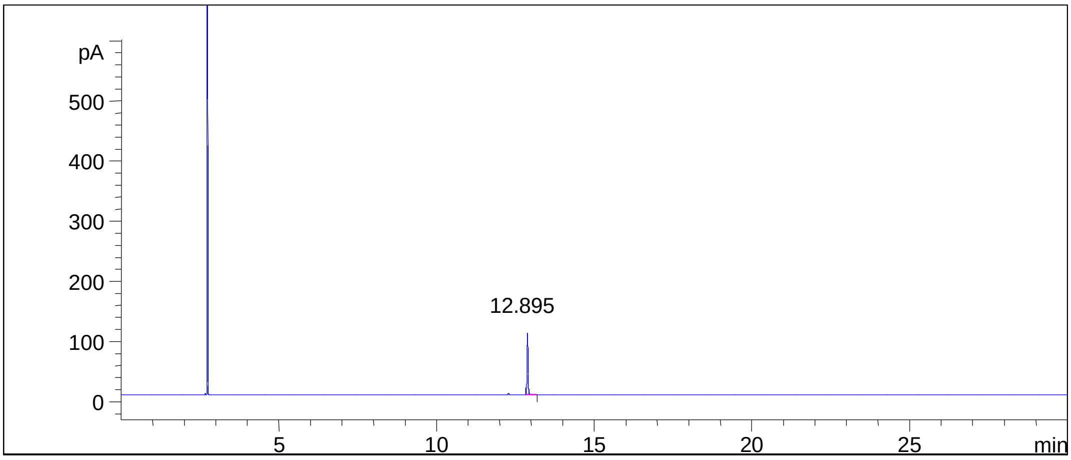
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	9.611	902.0	149.7	0.0748	100.000	3.196
	Totals:	902.0	149.7		100.000	

Figure 128: GC diagram of 3-pyridine methanol in CH_2Cl_2.



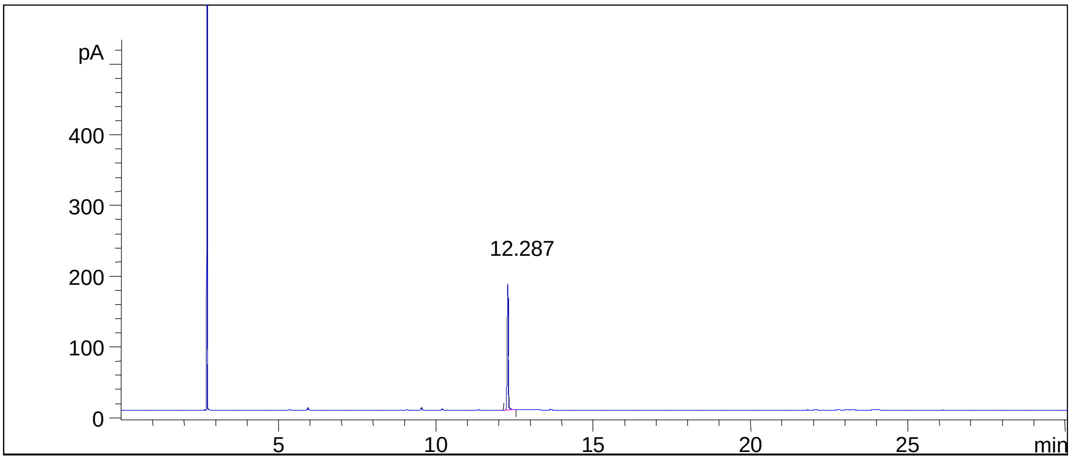
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.598	842.4	320.1	0.0364	91.125%	1.675
2	9.192	11.9	4.5	0.0384	1.288%	0.713
3	9.669	22.1	11.5	0.0303	2.390%	1.458
4	9.699	48.0	9.6	0.0630	5.197%	0.155
	Totals:	924.4	345.7		100.000	

Figure 129 : GC diagram of oxidation of 3-pyridine methanol with Method B for 24 h.



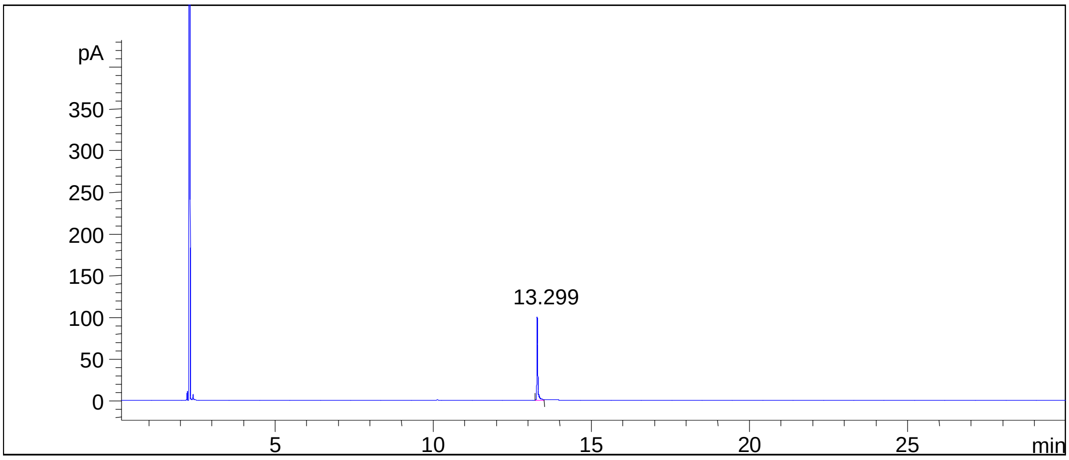
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	12.895	245.8	102.9	0.0364	100.000	1.082
	Totals:	245.8	102.9		100.000	

Figure 130 : GC diagram of cinnamyl alcohol in CH_2Cl_2.



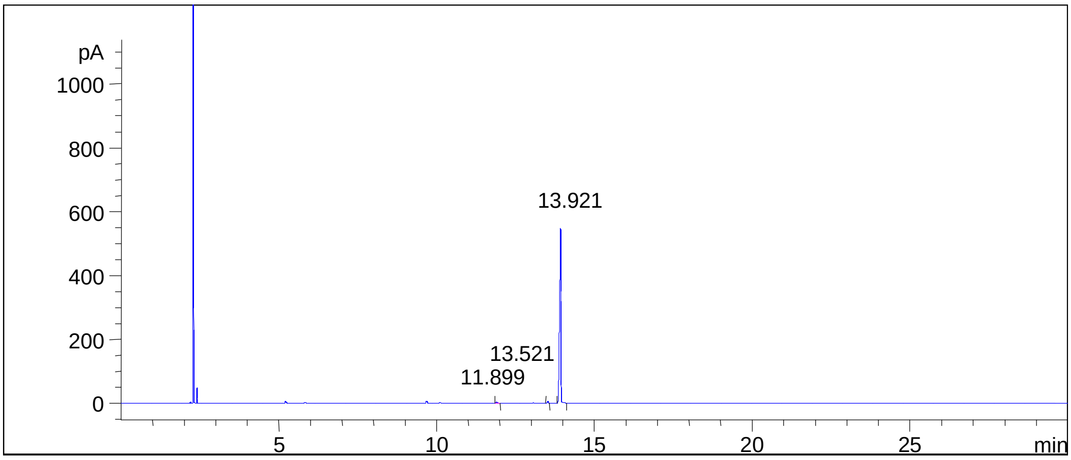
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	12.287	429.4	178.0	0.0371	100.000	1.205
	Totals:	429.4	178.0		100.000	

Figure 131 : GC diagram of cinnamyl alcohol with Method C for 12 h.



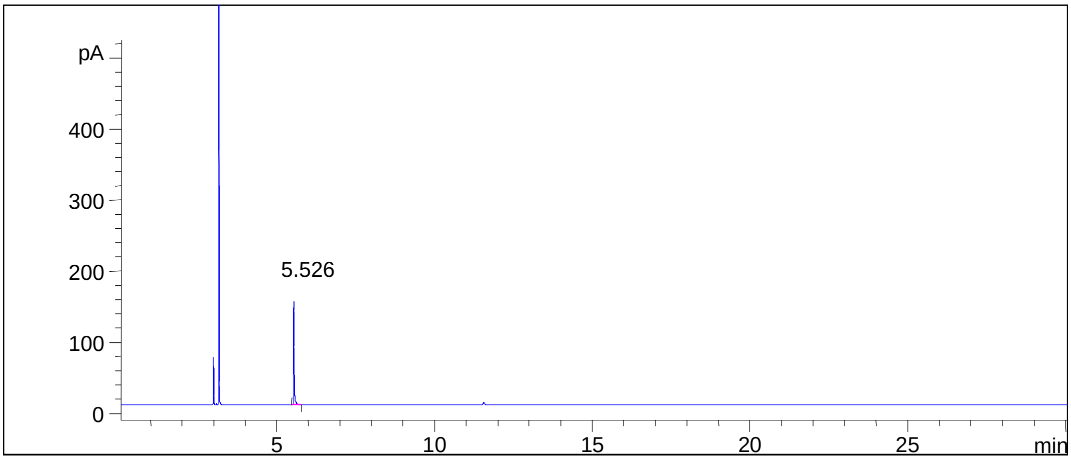
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	13.299	242.6	99.8	0.0354	100.000	0.829
	Totals:	242.6	99.8		100.000	

Figure 132 : GC diagram of (E)-4-phenyl-3-buten-2-ol.



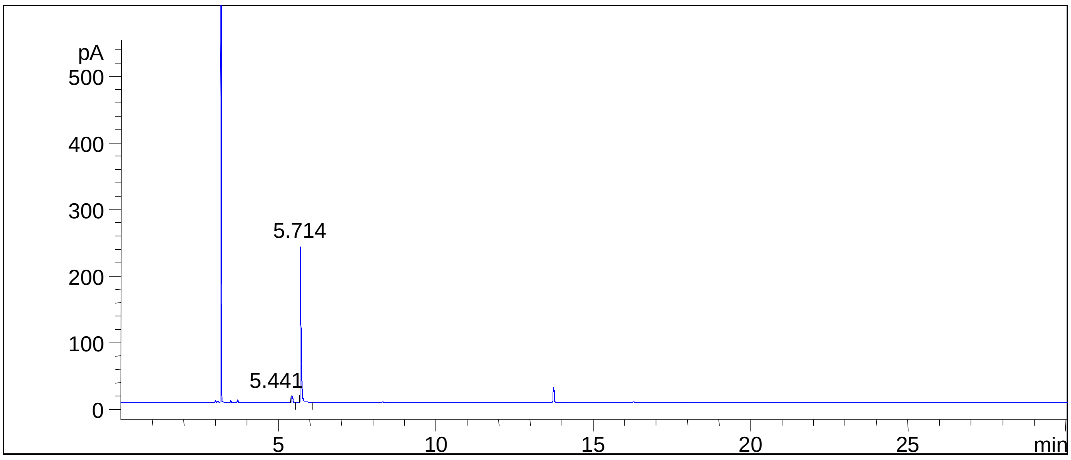
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	11.899	9.6	3.4	0.0395	0.597	0.685
2	13.521	13.3	5.7	0.0346	0.829	0.998
3	13.921	1586.9	548.2	0.0413	98.574	2.577
	Totals:	1609.8	557.3		100.000	

Figure 133 : GC diagram of oxidation of (E)-4-phenyl-3-buten-2-ol with Method D for 16 h.



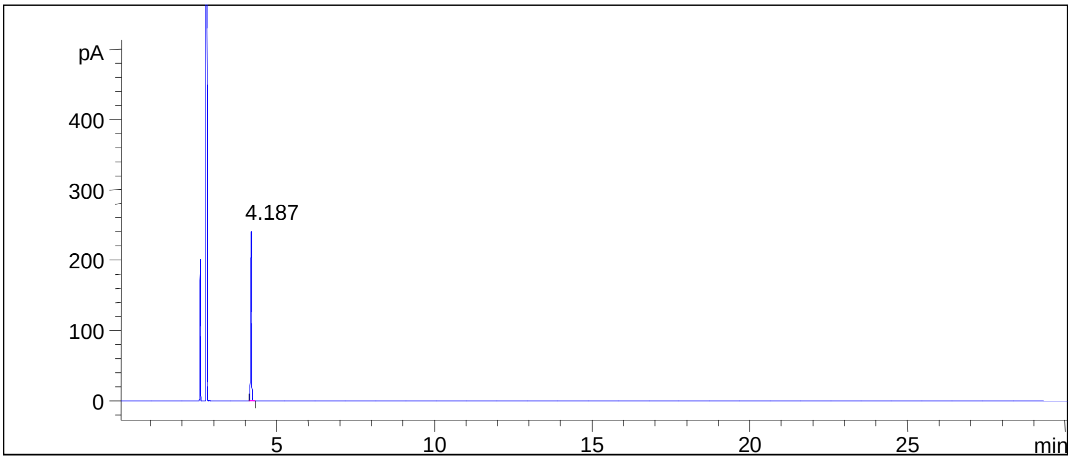
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.526	305.9	145.3	0.0326	100.000	0.495
	Totals:	305.9	145.3		100.000	

Figure 134 : GC diagram of 3-methyl-2-buten-1-ol in CH_2Cl_2.



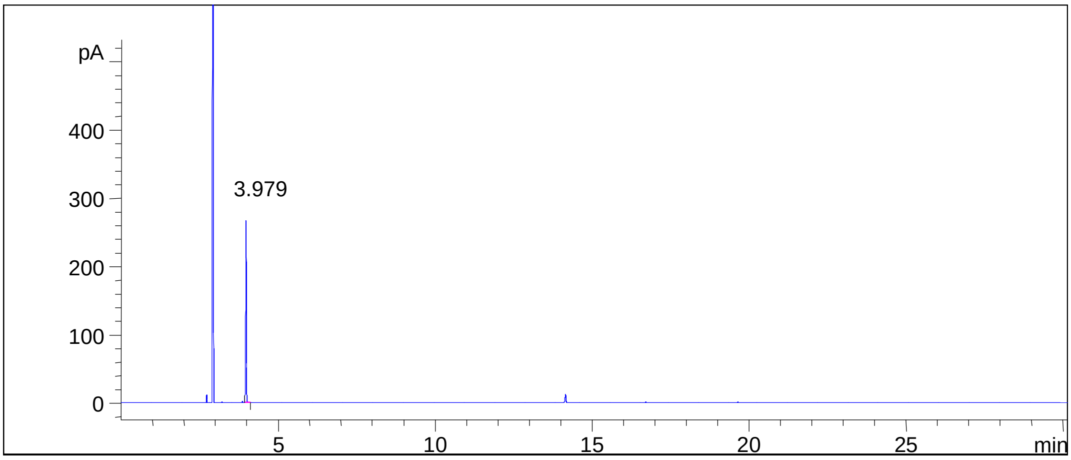
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	5.441	20.5	9.8	0.0325	3.875	0.844
2	5.714	509.4	232.9	0.0340	96.125	0.545
	Totals:	529.9	242.7		100.000	

Figure 135 : GC diagram of oxidation of 3-methyl-2-buten-1-ol with Method D for 32 h.



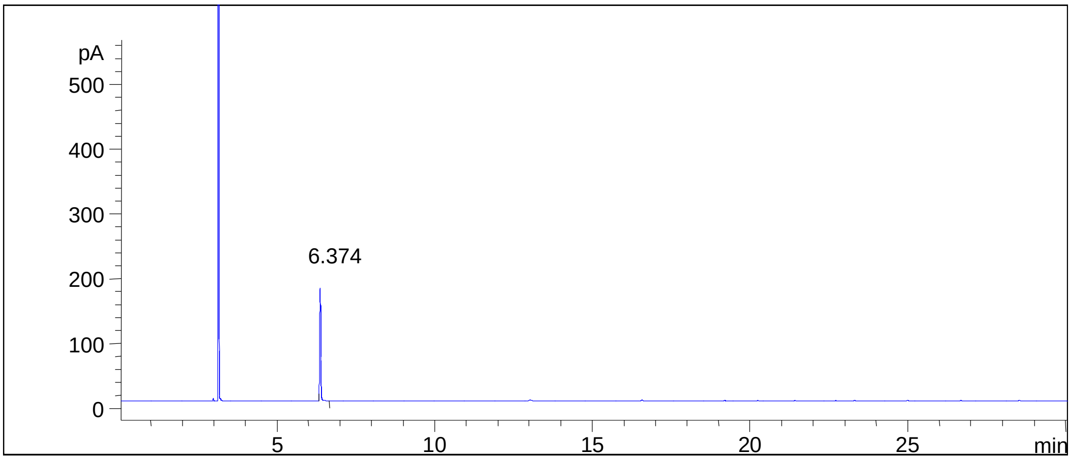
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	4.187	515.9	240.6	0.0360	100.000	2.053
	Totals:	515.9	240.6		100.000	

Figure 136 : GC diagram of 3-methoxyl-2-propanol in CH_2Cl_2.



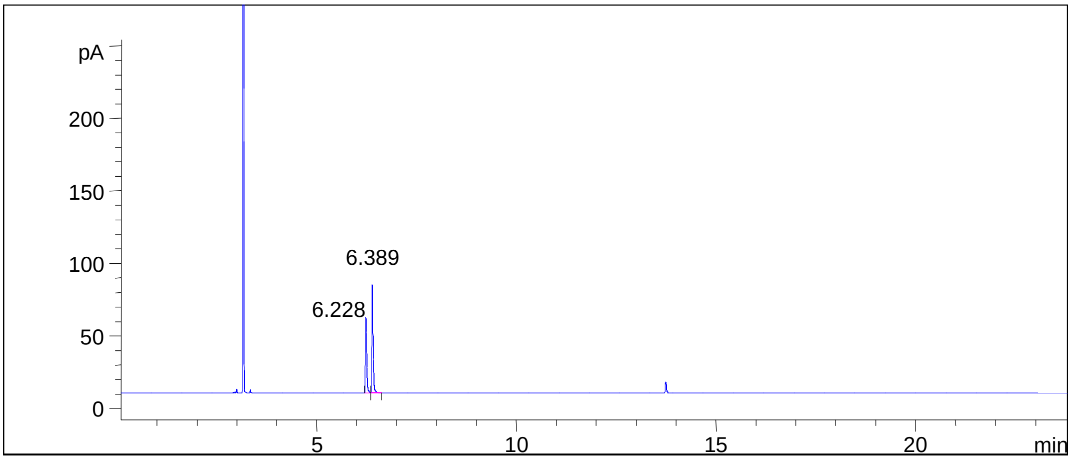
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	3.979	441.3	266.5	0.0253	100.000	1.216
	Totals:	441.3	266.5		100.000	

Figure 137 : GC diagram of oxidation of 3-methoxyl-2-propanol with Method D for 31 h.



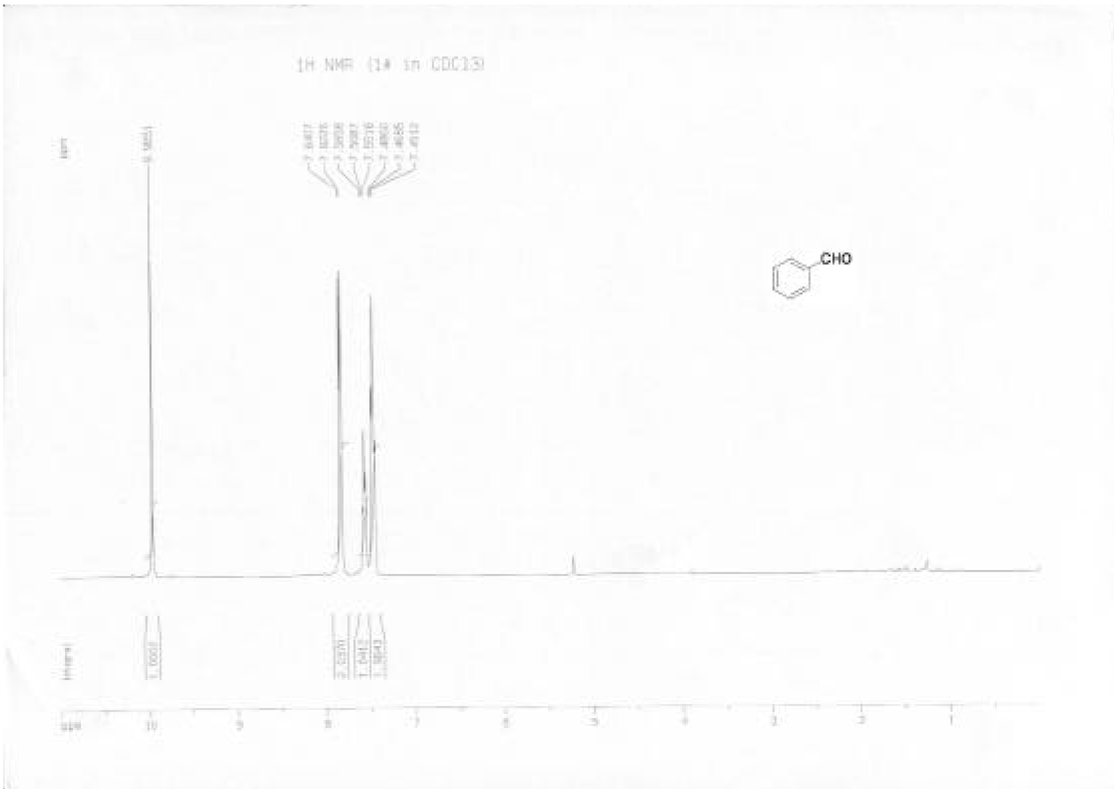
Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.374	411.0	174.1	0.0400	100.000	1.221
	Totals:	411.0	174.1		100.000	

Figure 138: GC diagram of ethyl lactate in CH_2Cl_2.



Peak	Ret. Time(min)	Area	Height	Width	Area(%)	Symmetry
1	6.228	112.9	52.0	0.0328	41.164	0.508
2	6.389	161.4	74.4	0.0333	58.836	0.581
	Totals:	274.3	126.4		100.000	

Figure 139 : GC diagram of oxidation of ethyl lactate with Method B for 29 h.



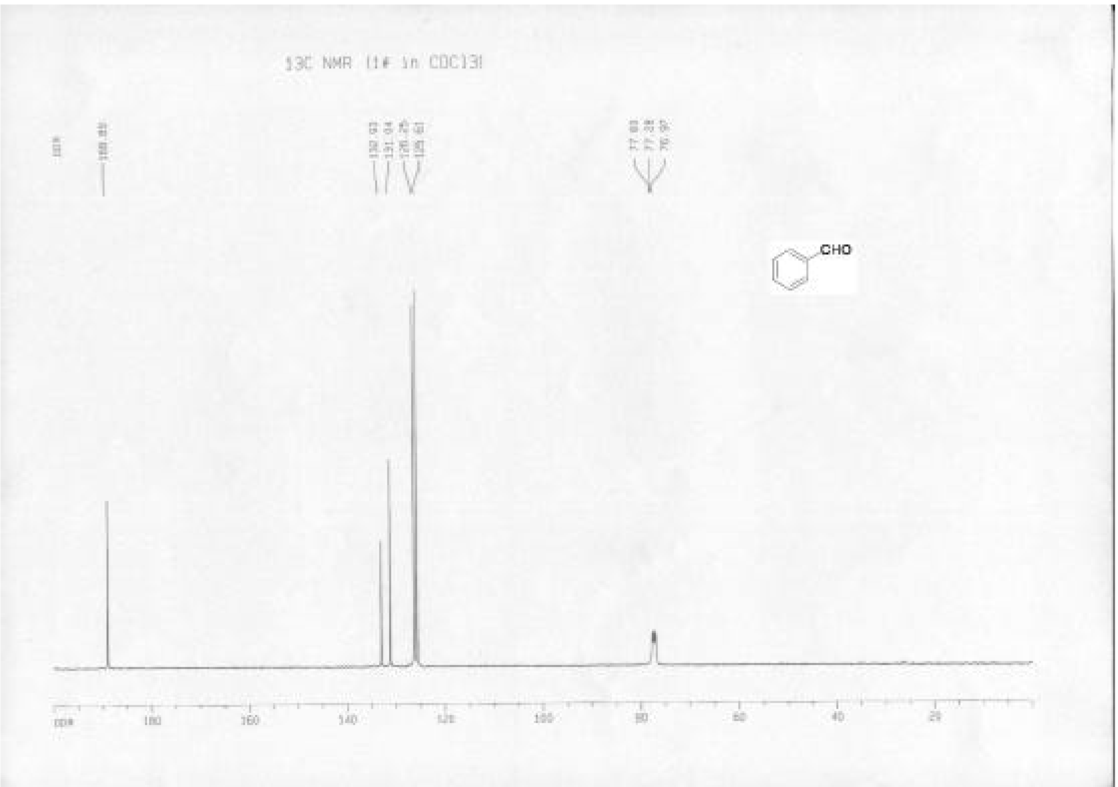
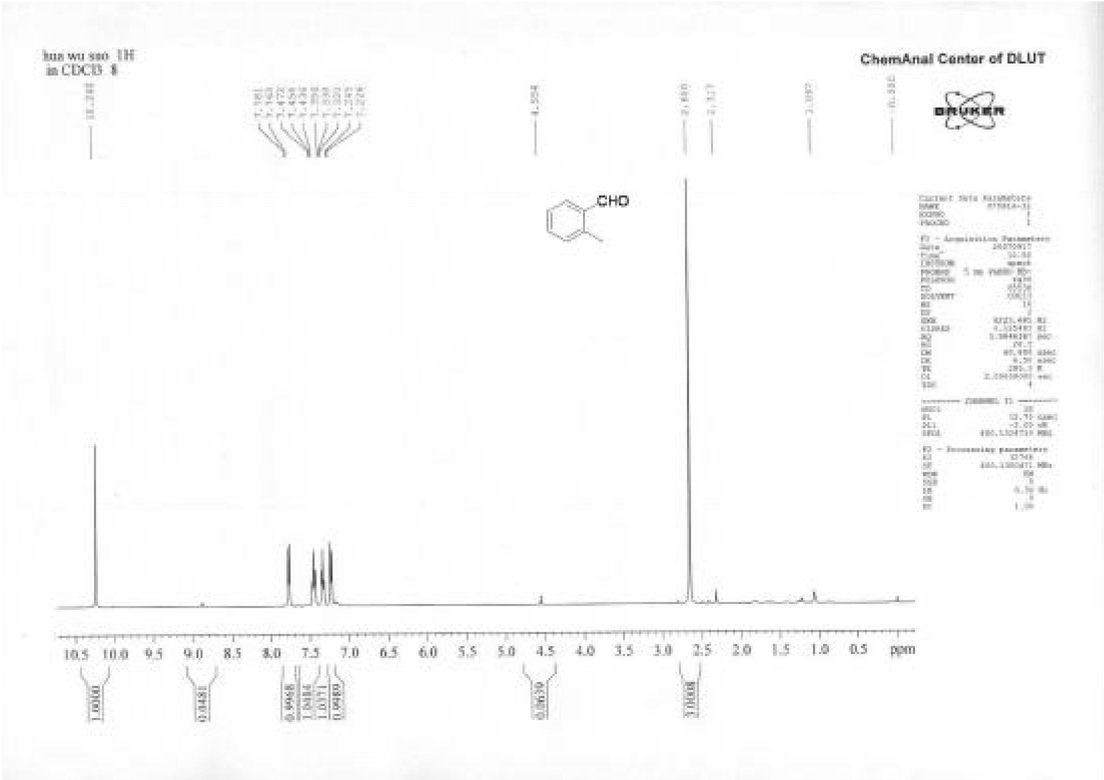


Figure 140: ^{1}H and ^{13}C NMR spectra of benzaldehyde.



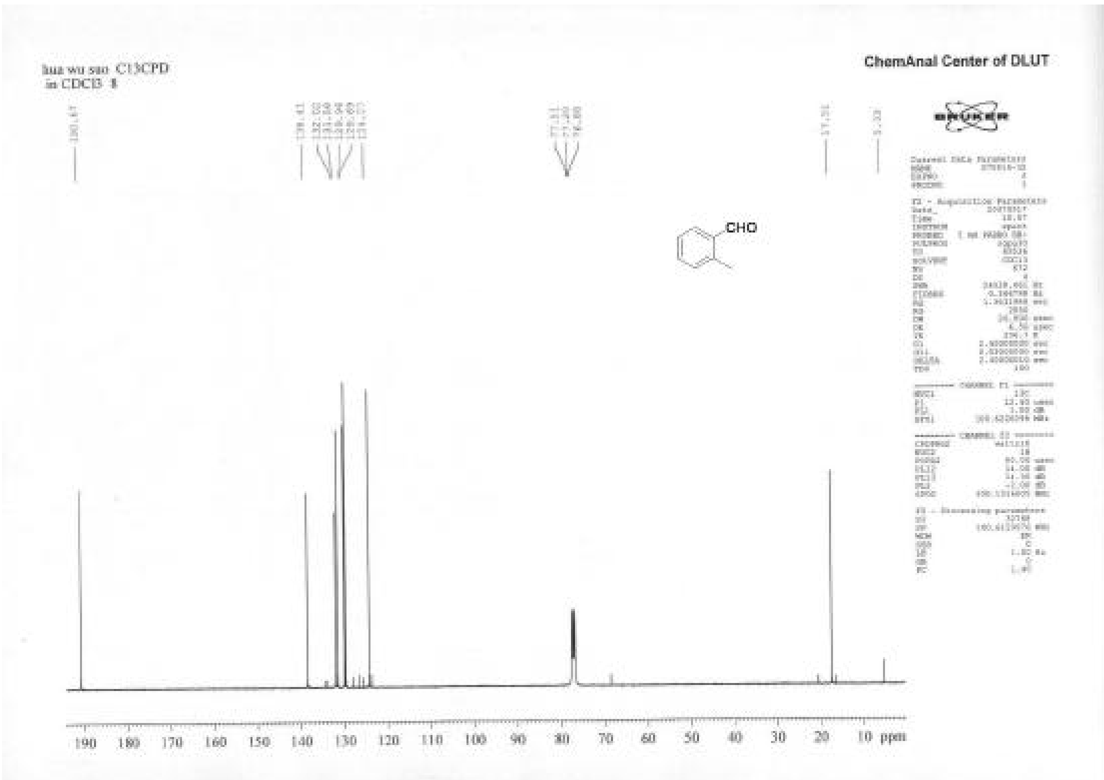
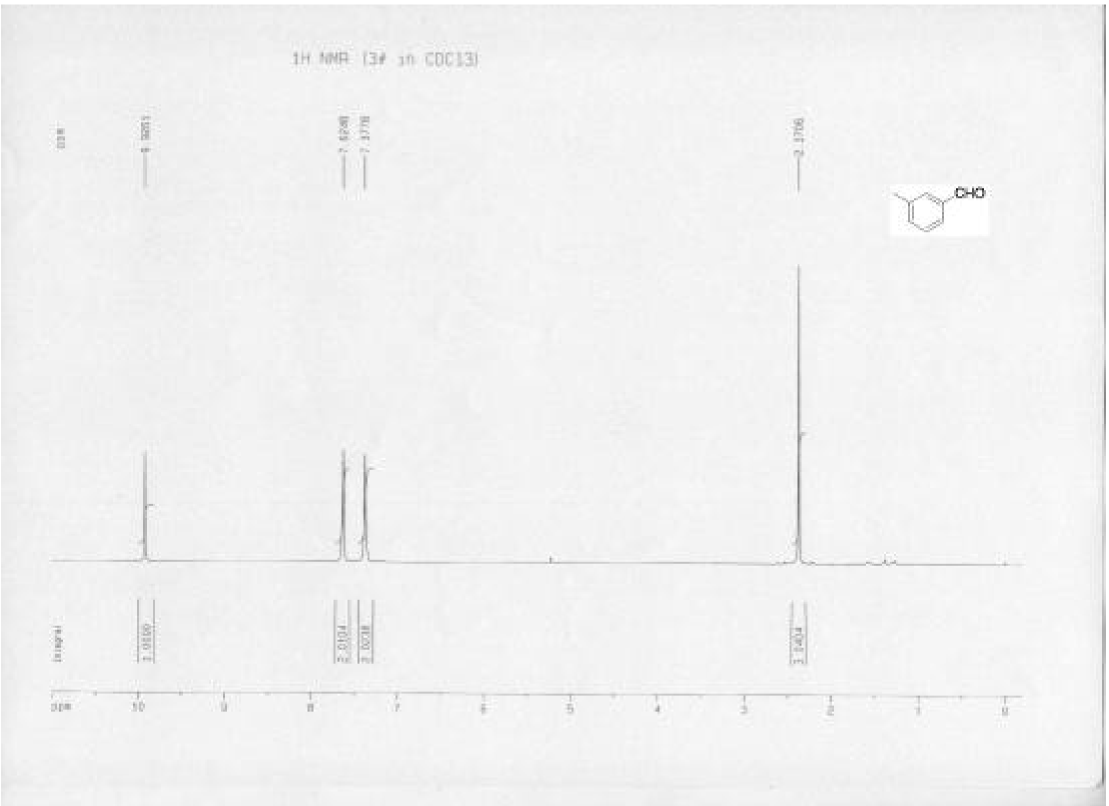


Figure 141: ^{1}H and ^{13}C NMR spectra of 2-methylbenzaldehyde.



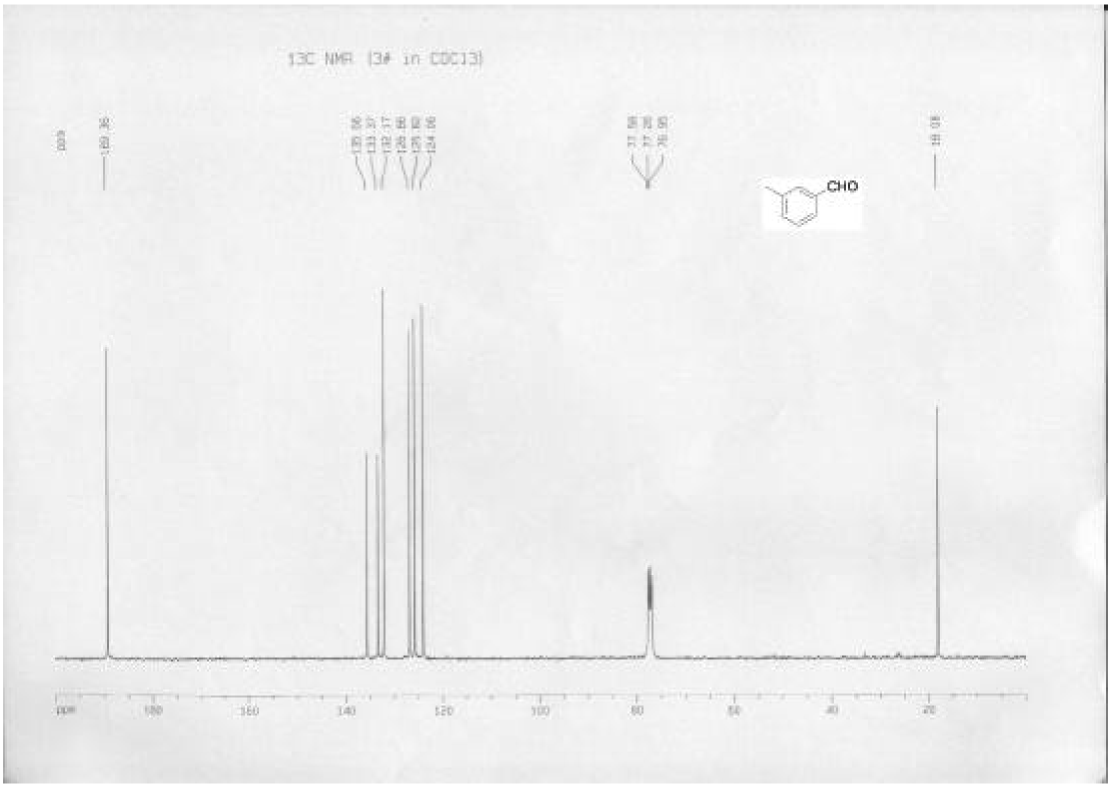
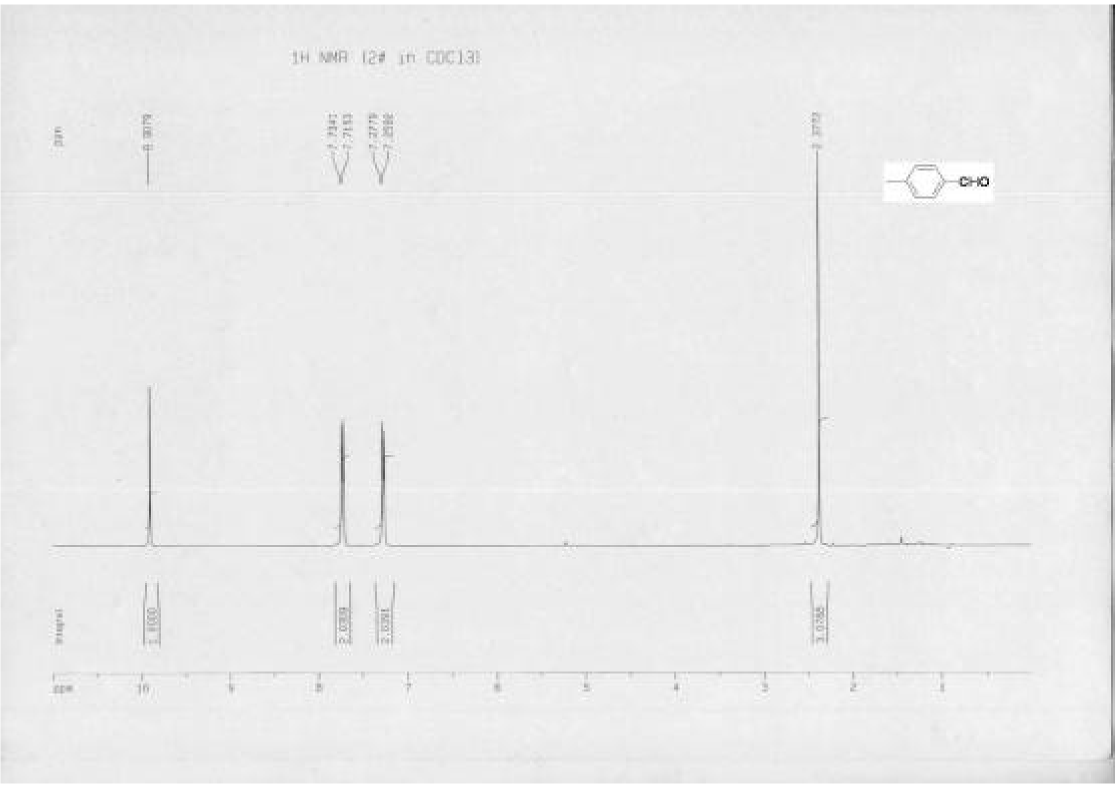


Figure 142: ^{1}H and ^{13}C NMR spectra of 3-methylbenzaldehyde.



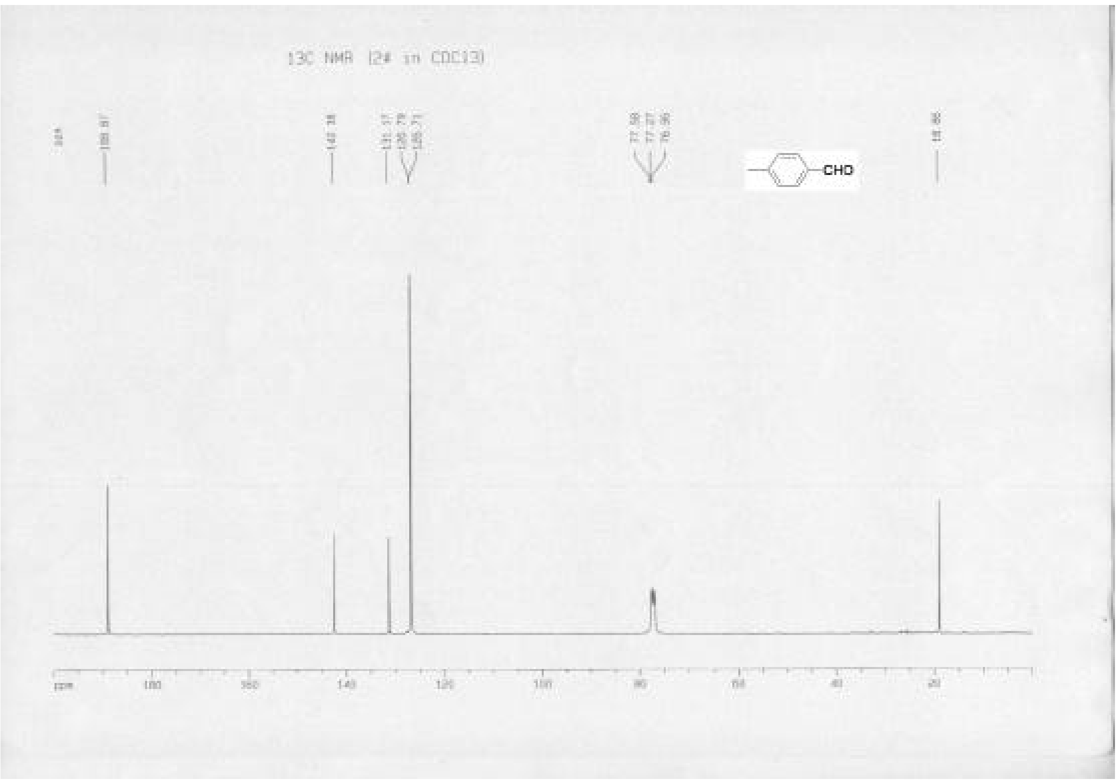
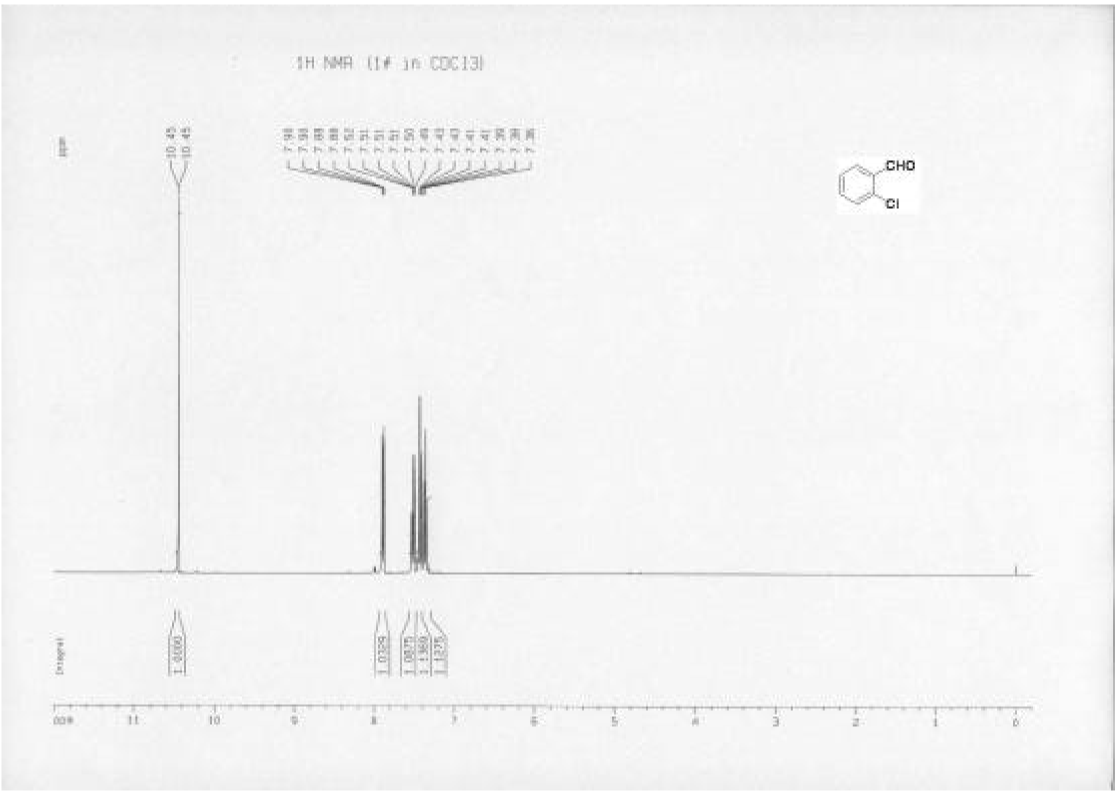


Figure 143: ^{1}H and ^{13}C NMR spectra of 4-methylbenzaldehyde.



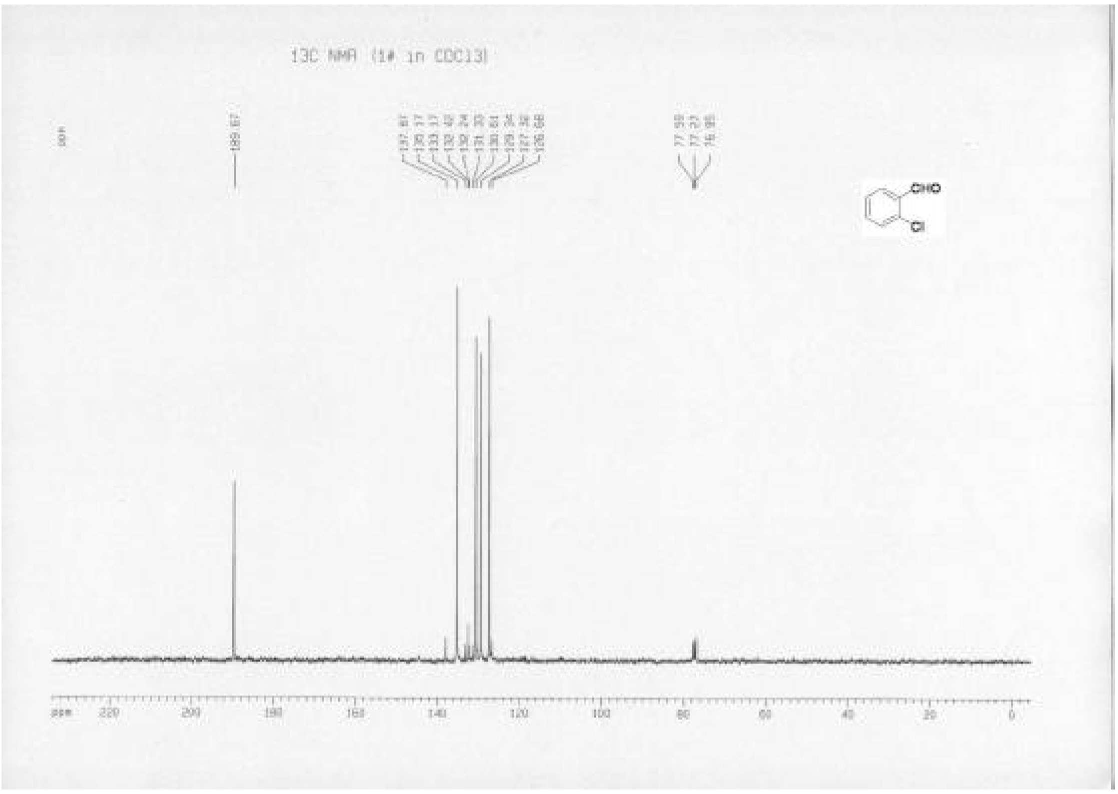
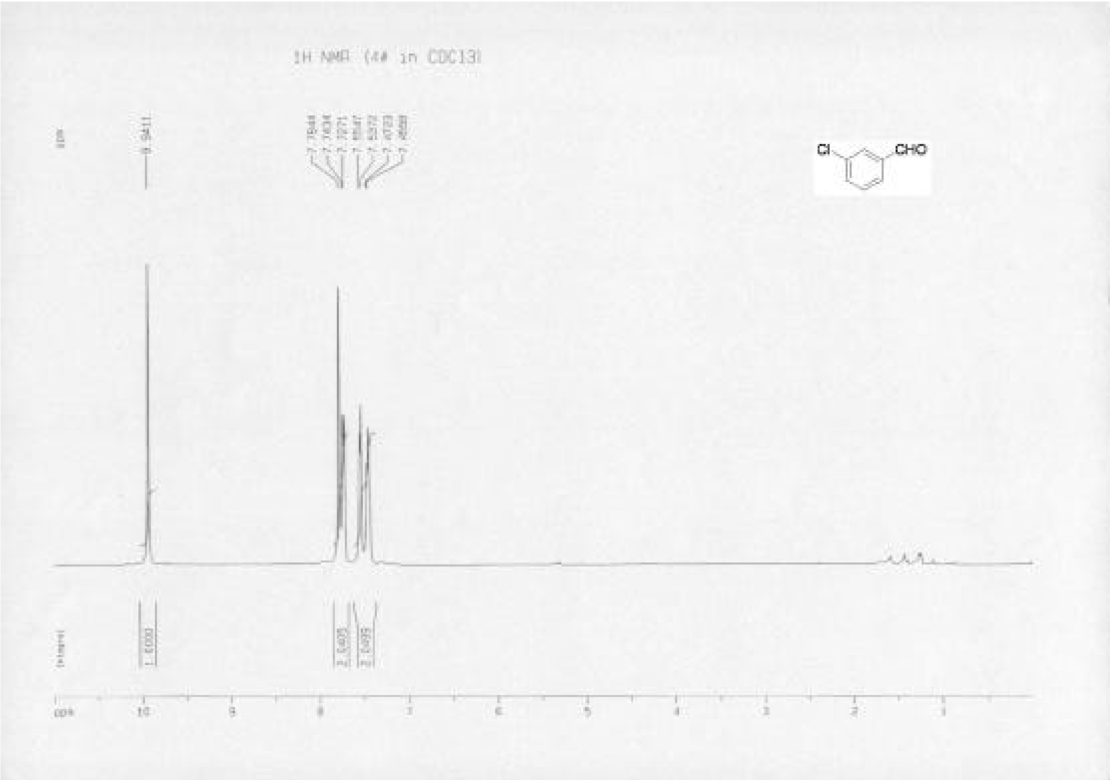


Figure 144: ^{1}H and ^{13}C NMR spectra of 2-chlorobenzaldehyde.



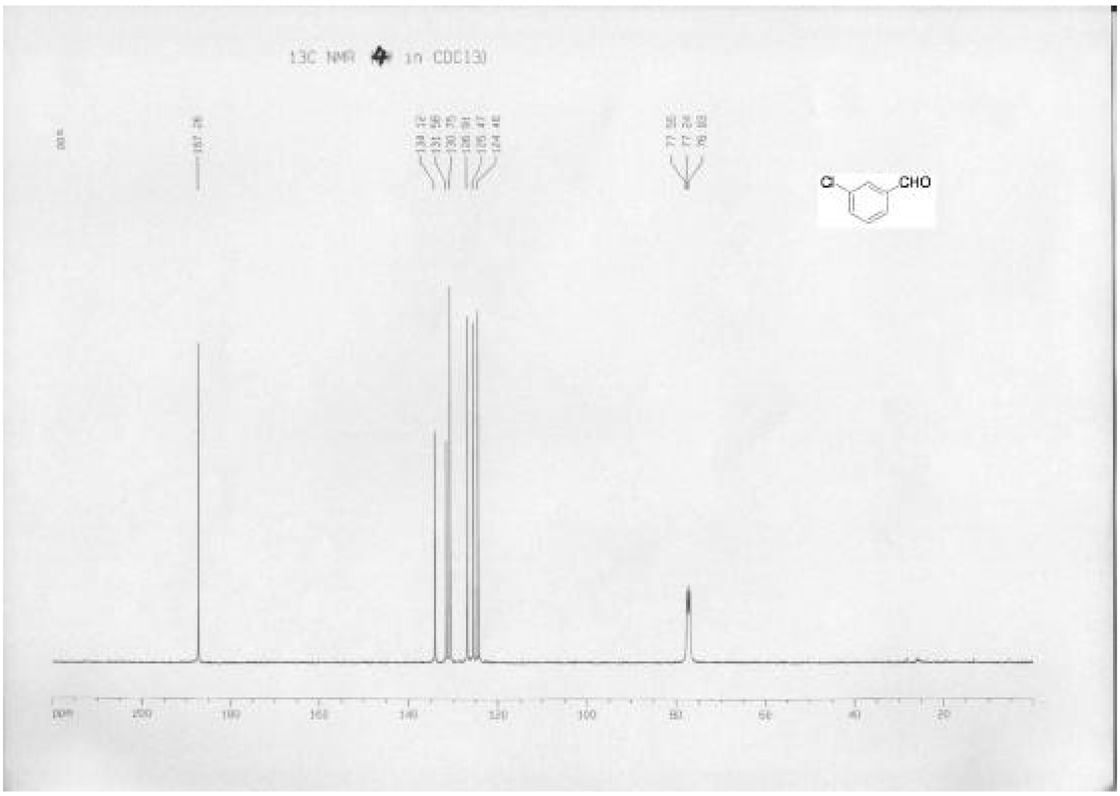
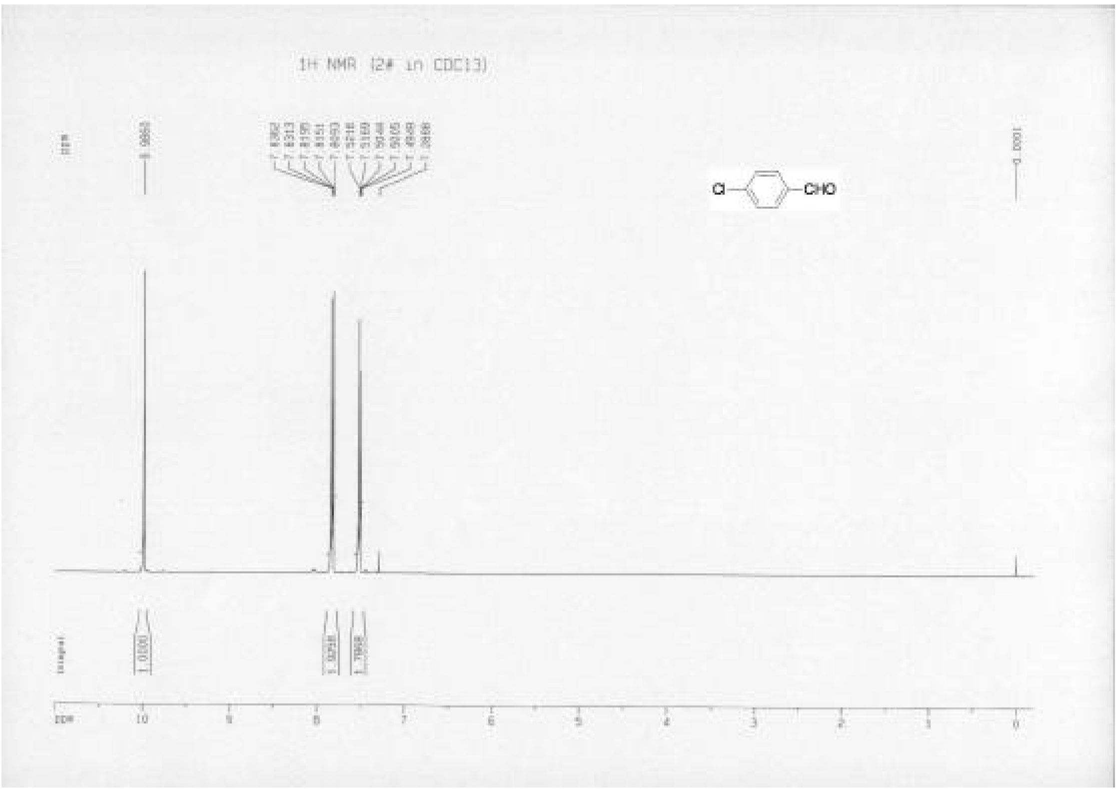


Figure 145: ^{1}H and ^{13}C NMR spectra of 3-chlorobenzaldehyde.



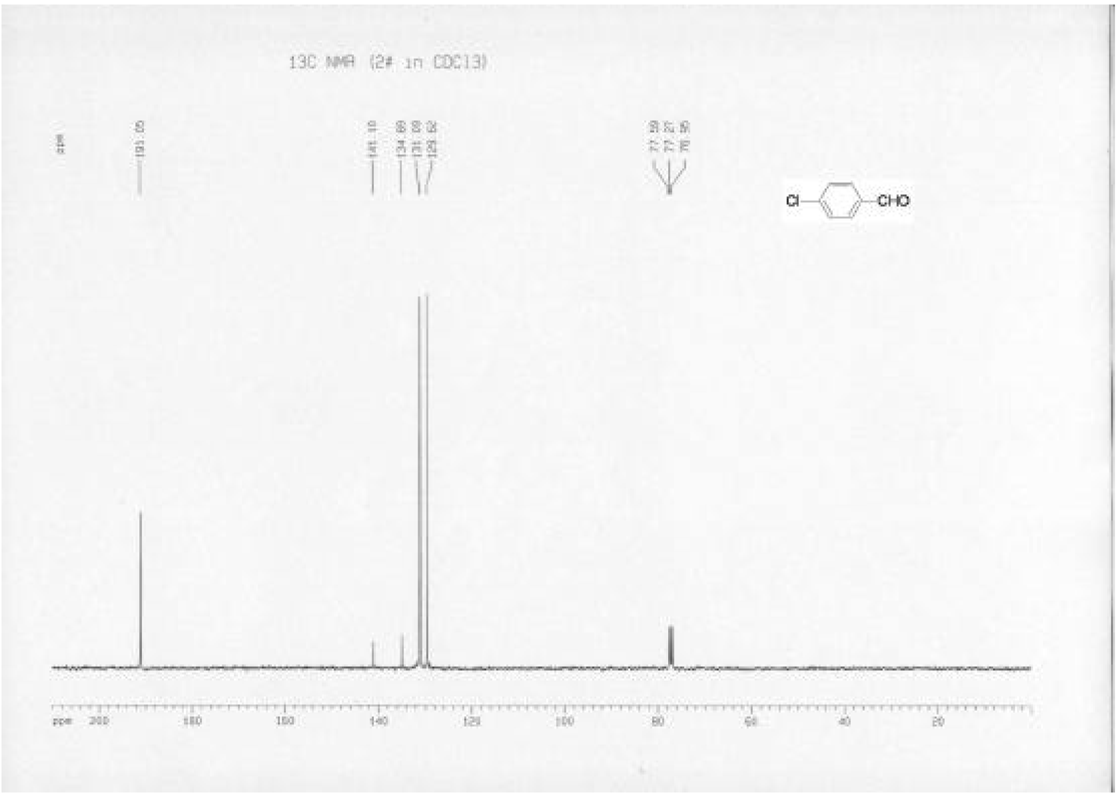
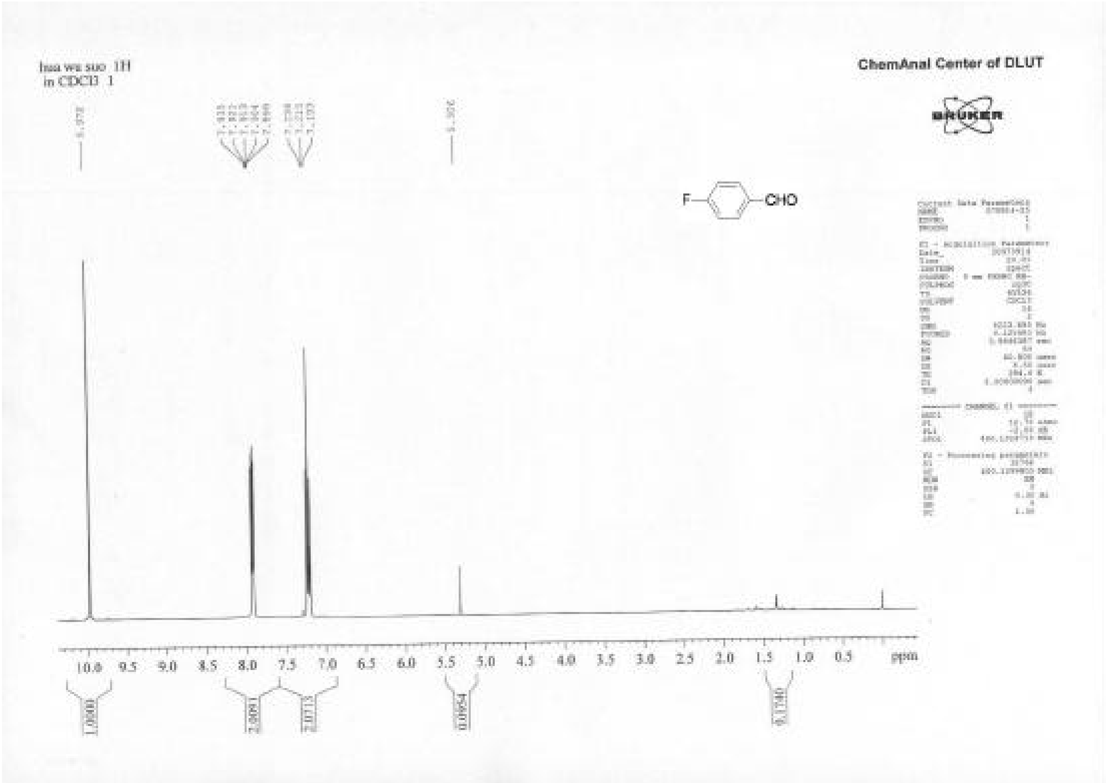


Figure 146: ^{1}H and ^{13}C NMR spectra of 4-chlorobenzaldehyde.



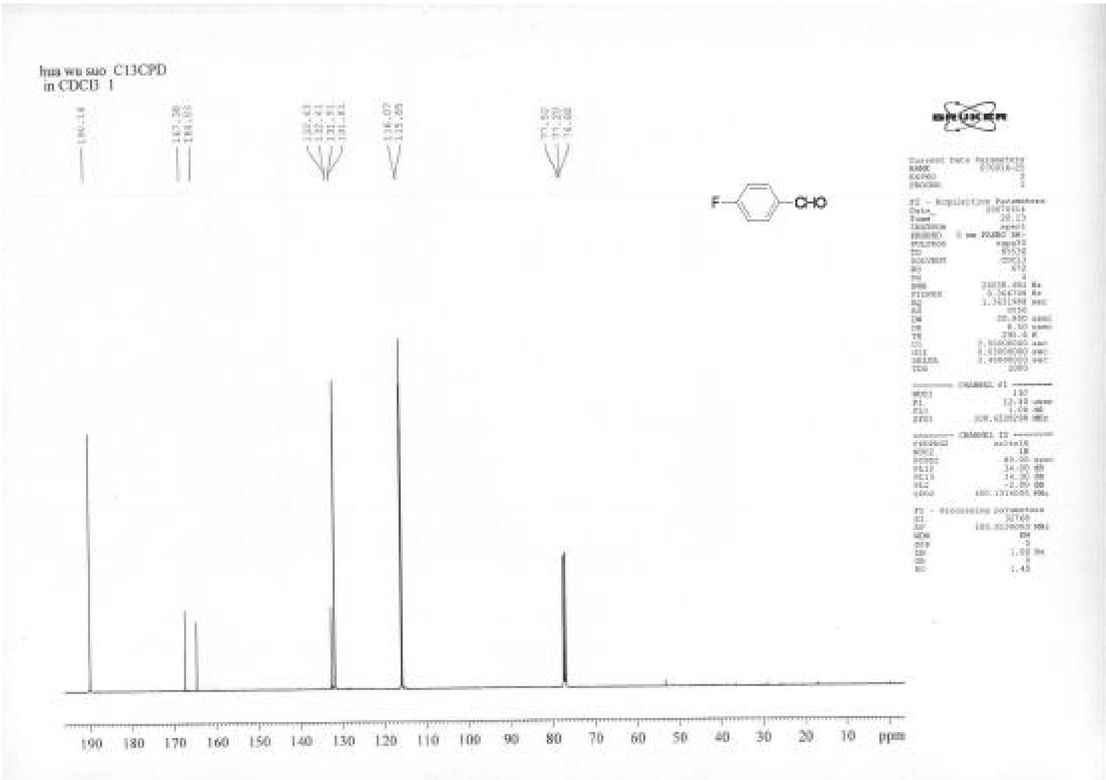
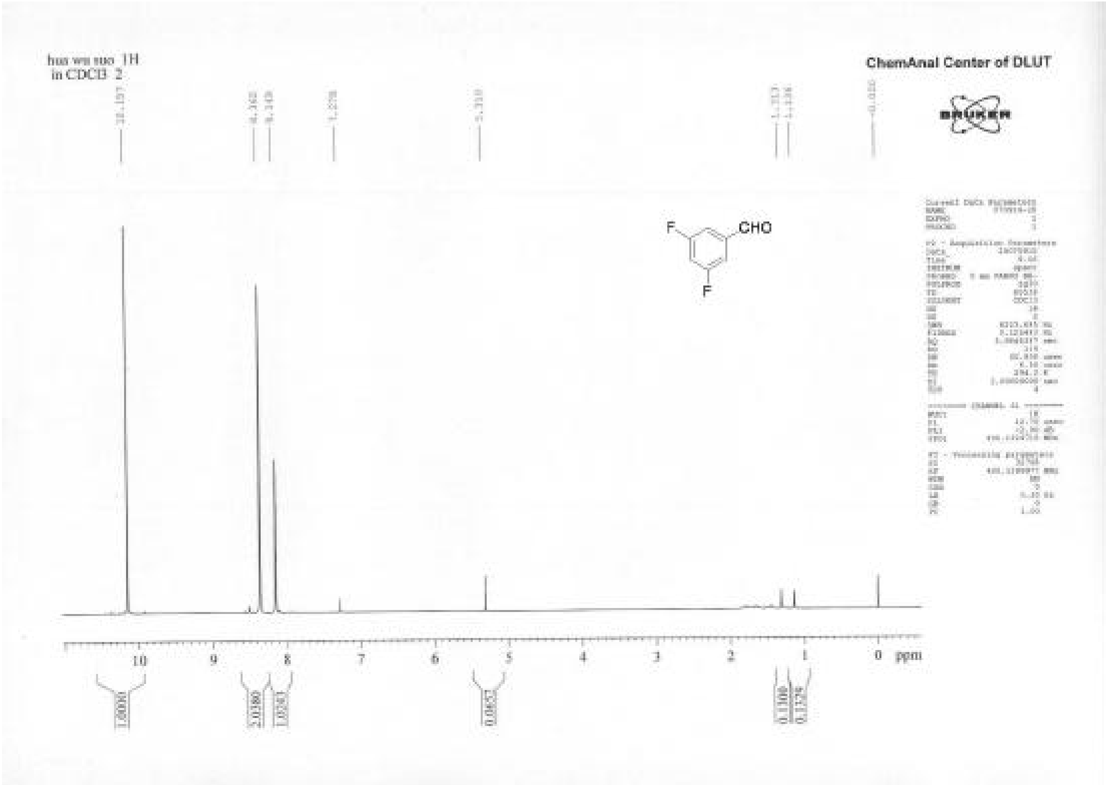


Figure 147: ^{1}H and ^{13}C NMR spectra of 4-fluorobenzaldehyde.



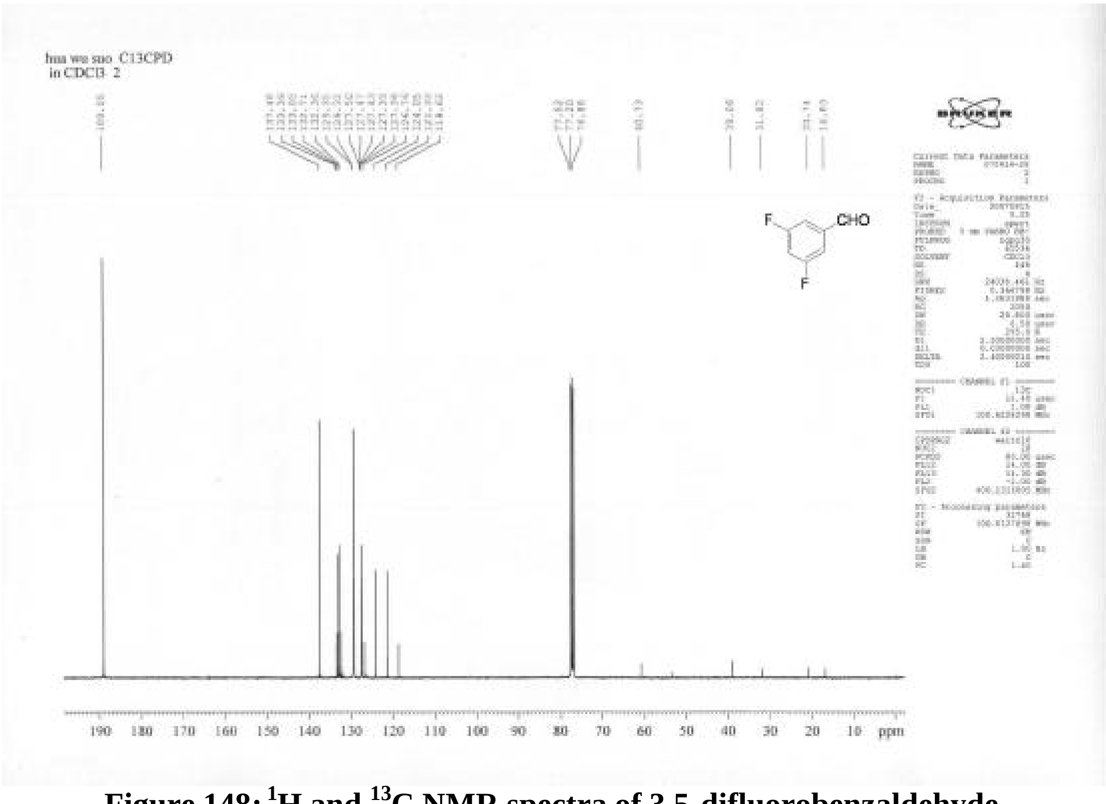
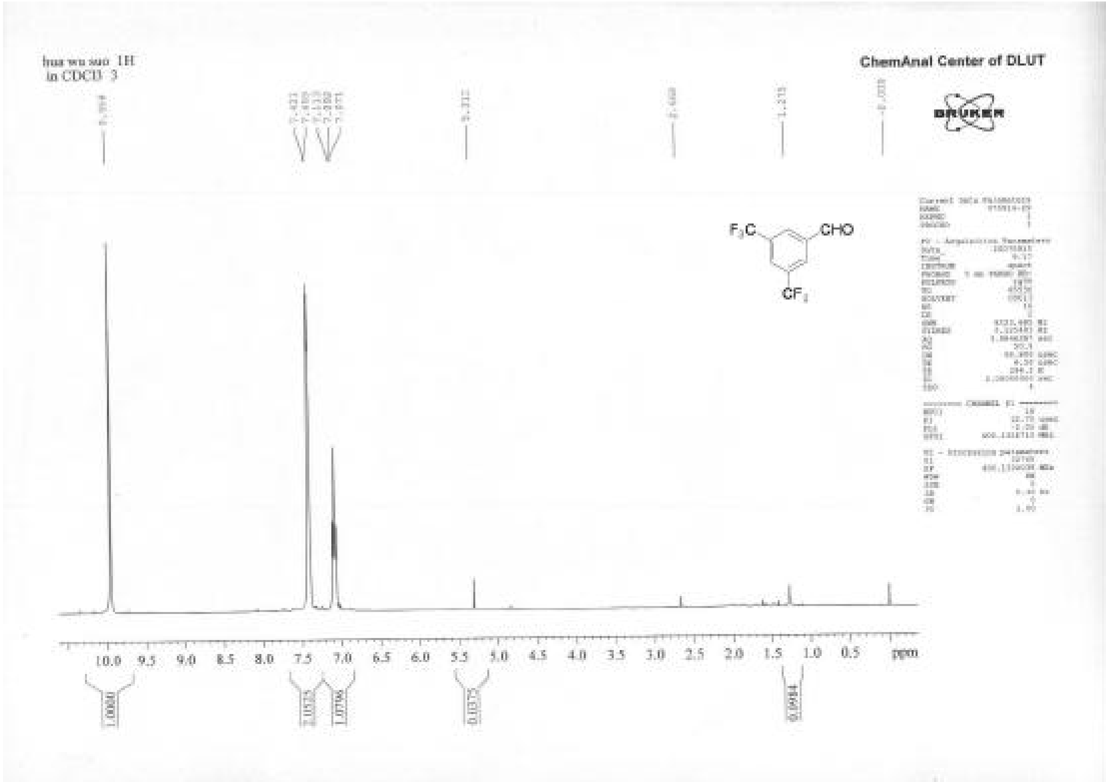


Figure 148: ^{1}H and ^{13}C NMR spectra of 3,5-difluorobenzaldehyde.



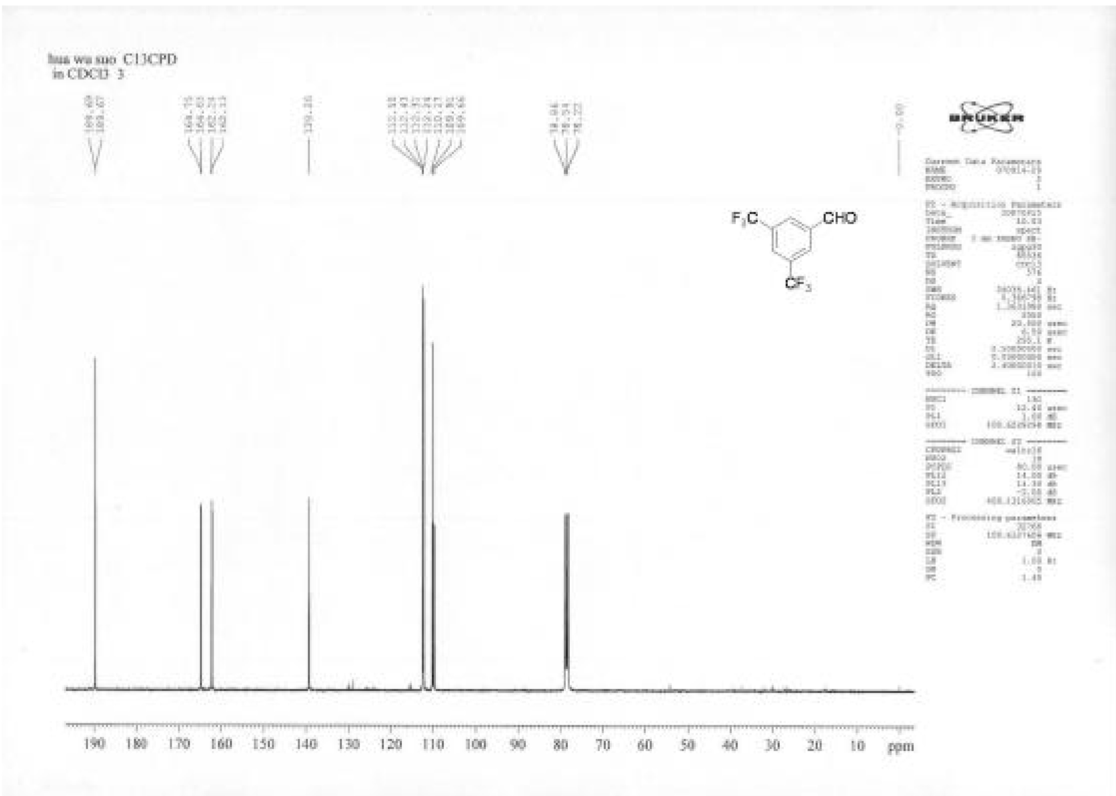
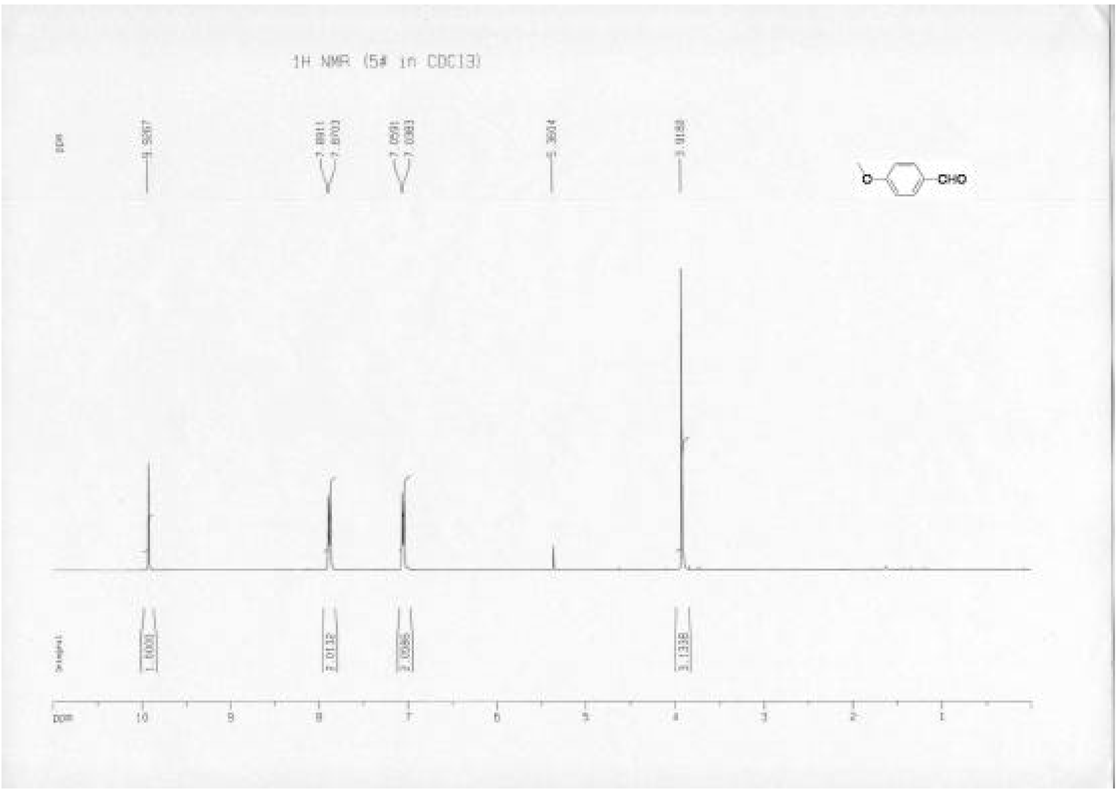


Figure 149: ^{1}H and ^{13}C NMR spectra of 3,5-bis(trifluoromethyl) benzaldehyde.



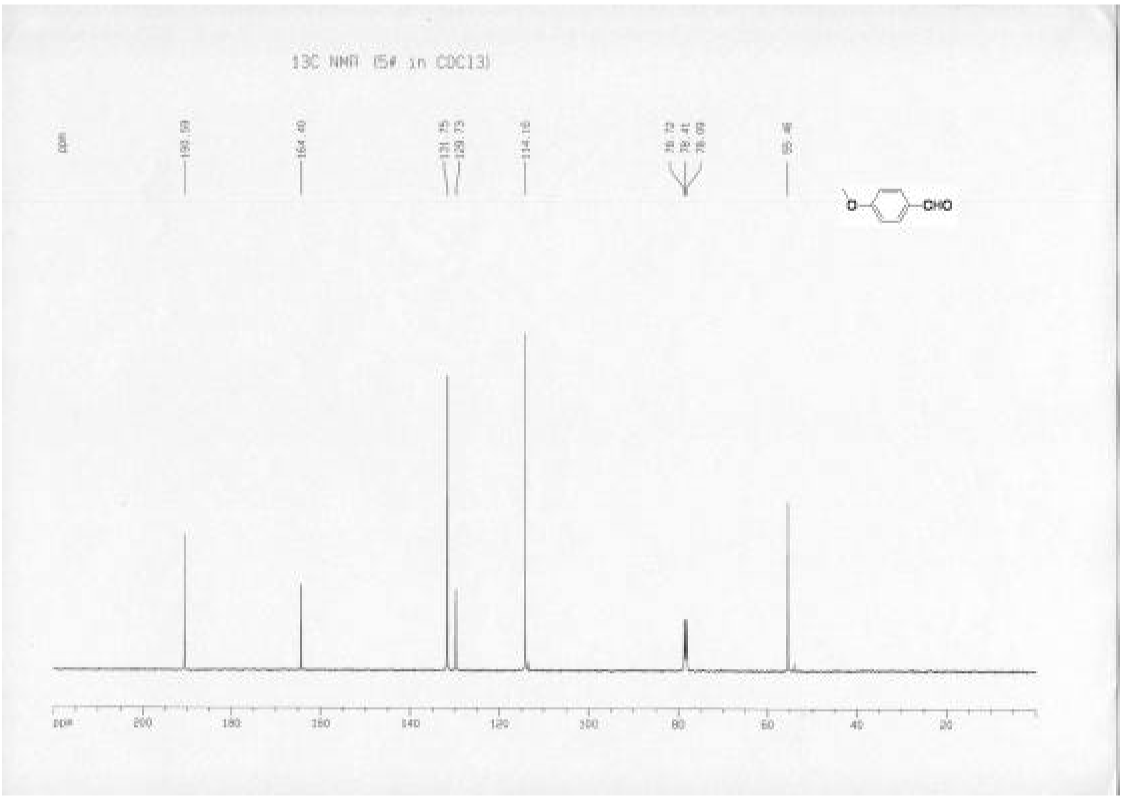
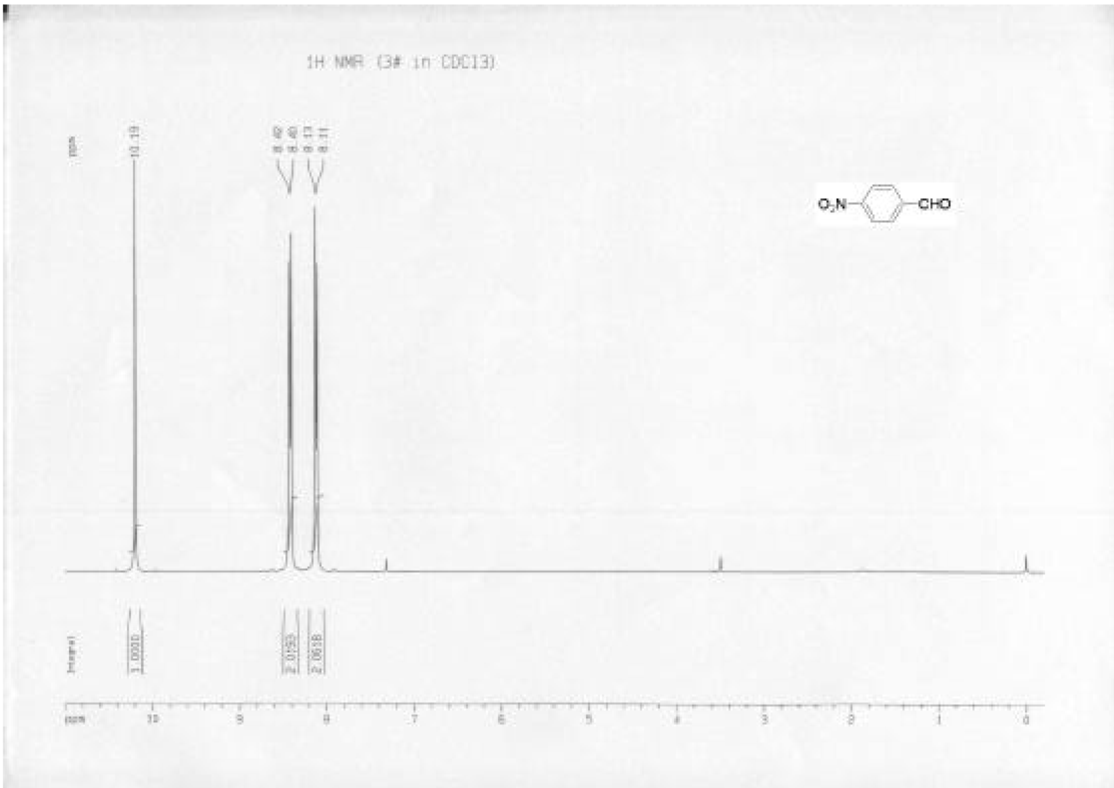


Figure 150: ¹H and ¹³C NMR spectra of 4-methoxybenzaldehyde.



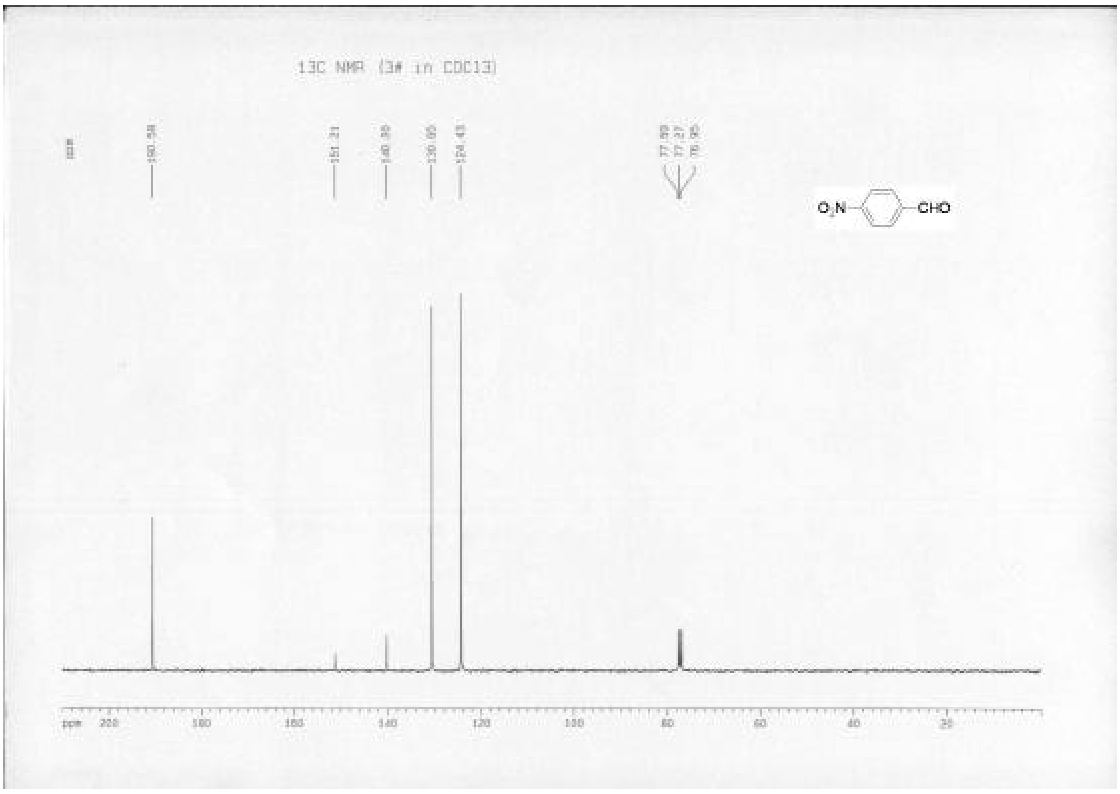
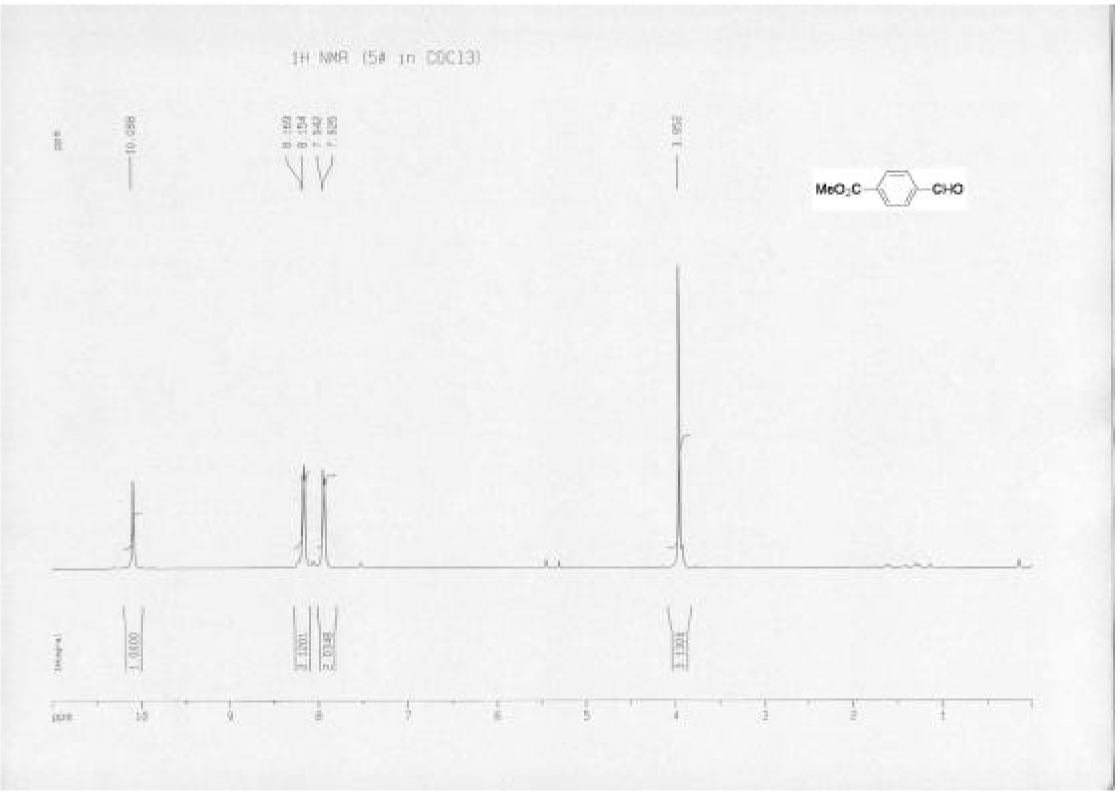


Figure 151: ^{1}H and ^{13}C NMR spectra of 4-nitrobenzaldehyde.



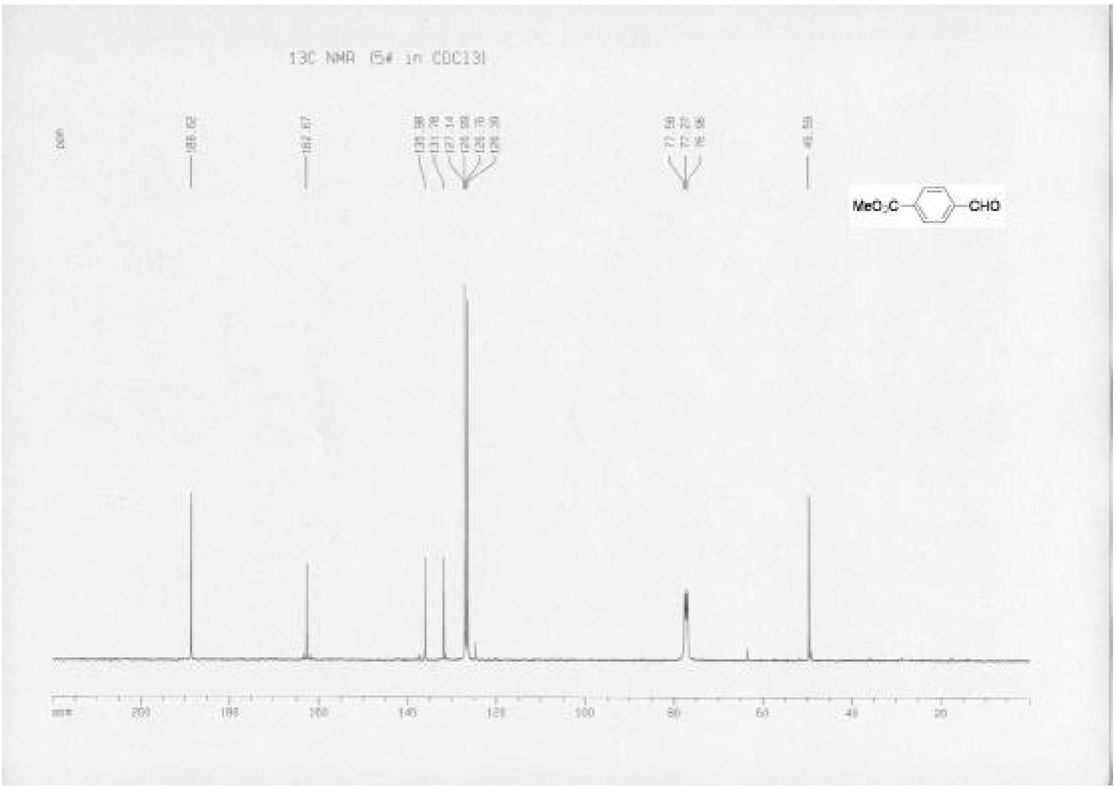
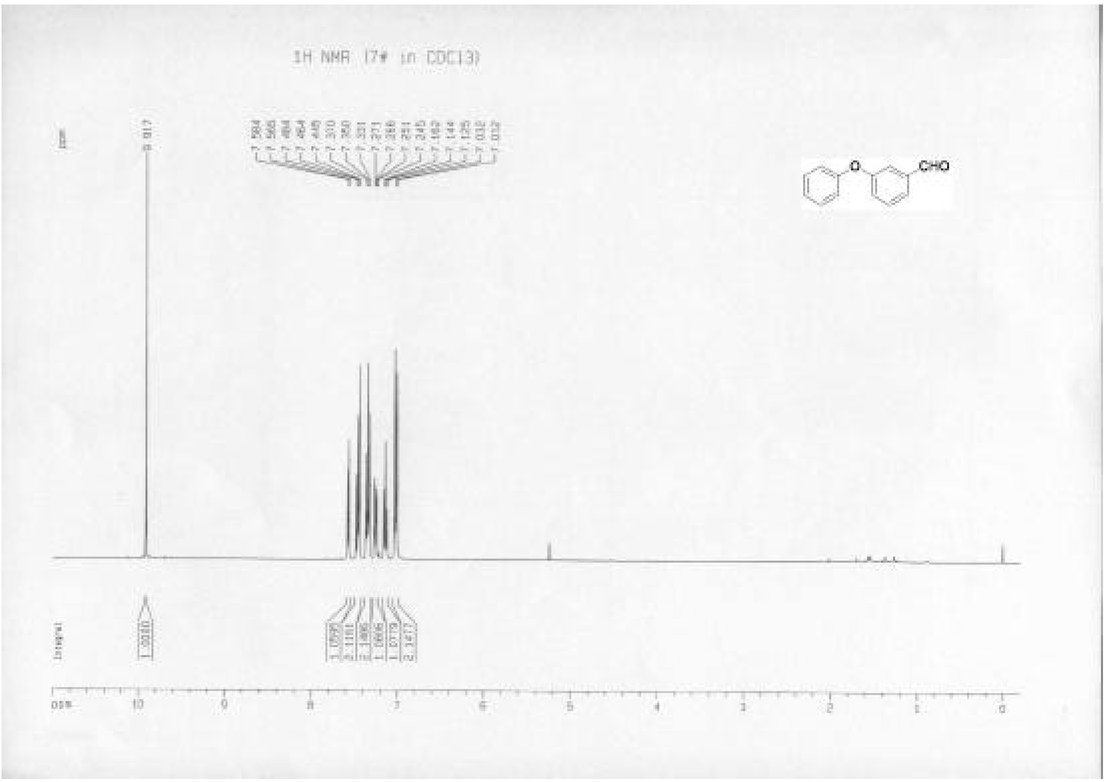


Figure 152: ^{1}H and ^{13}C NMR spectra of methyl 4-formylbenzoate.



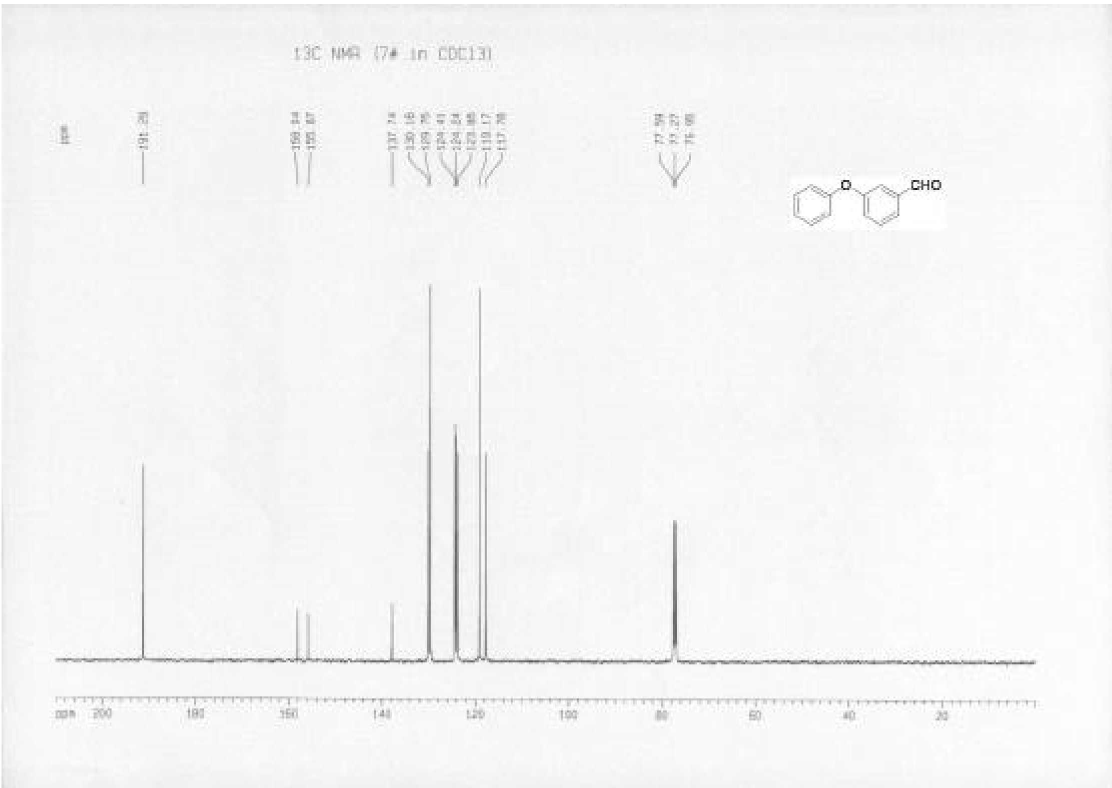
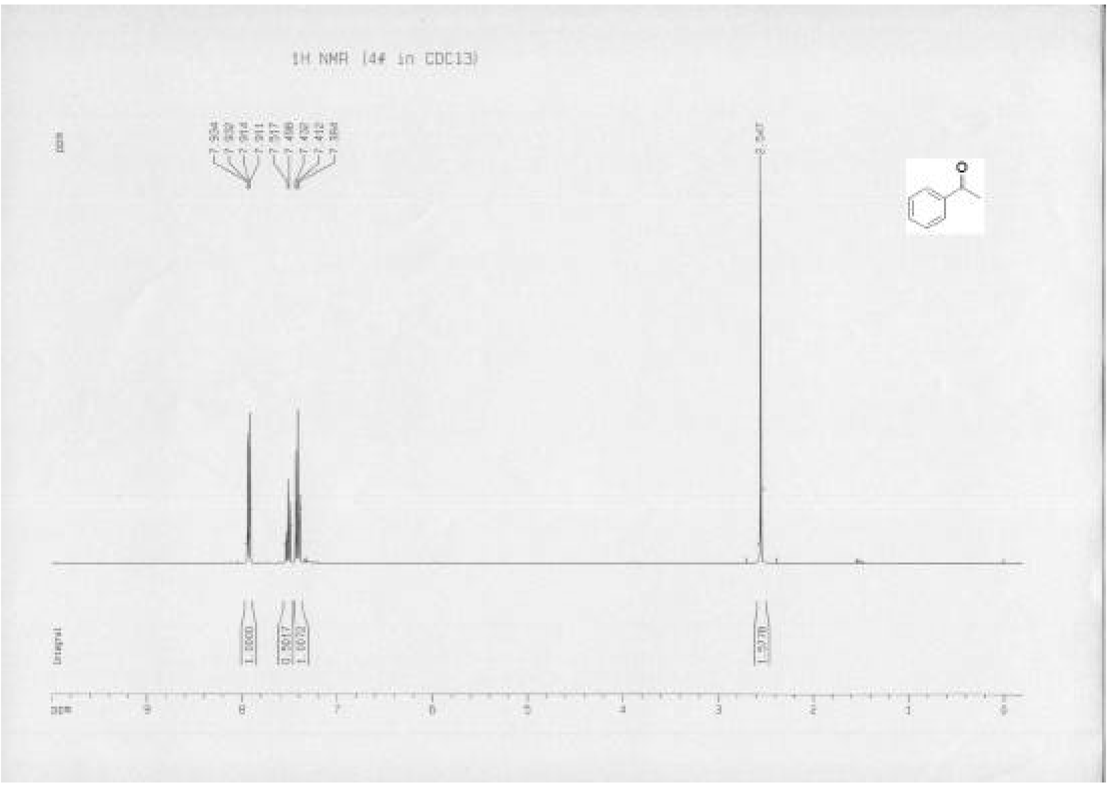


Figure 153: ^{1}H and ^{13}C NMR spectra of 3-phenoxybenzaldehyde.



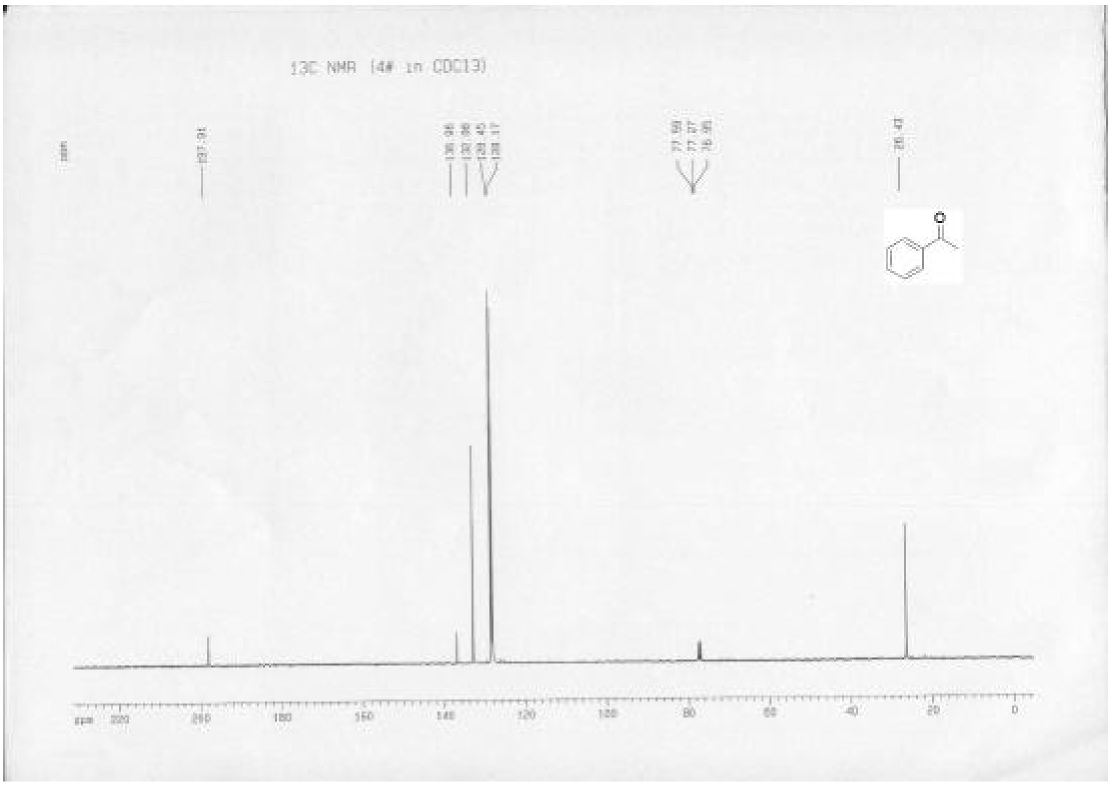
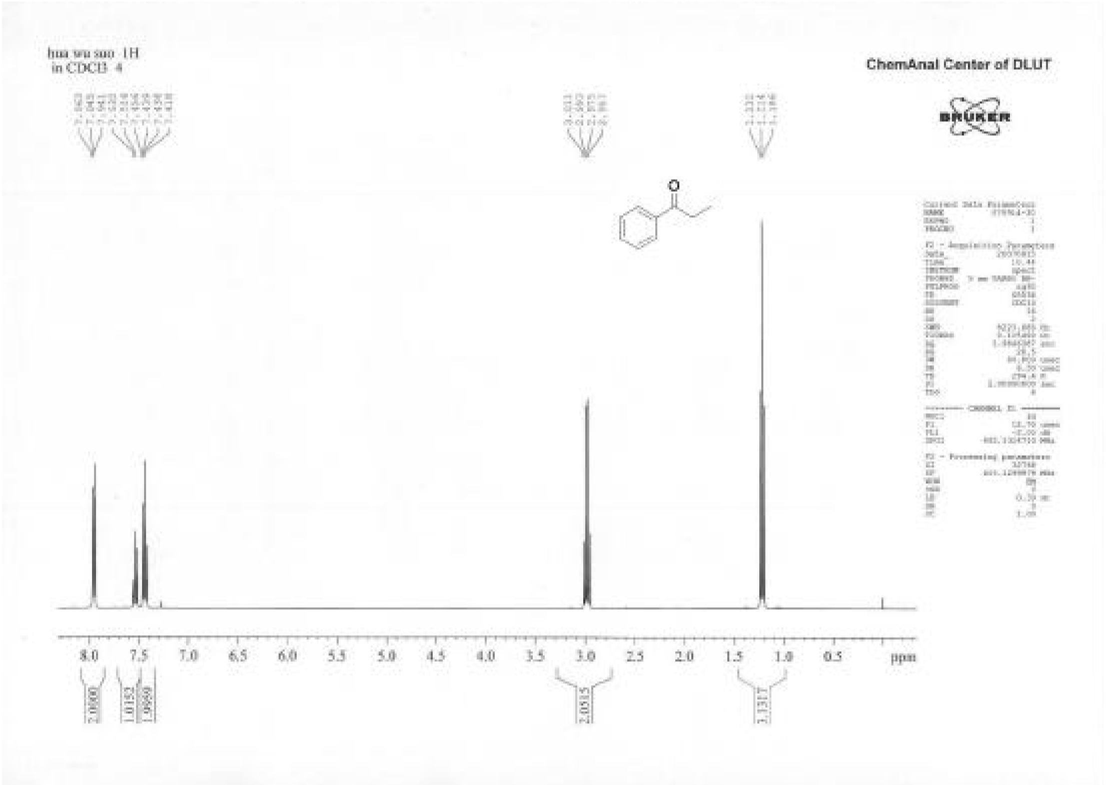


Figure 154: ^{1}H and ^{13}C NMR spectra of acetophenone.



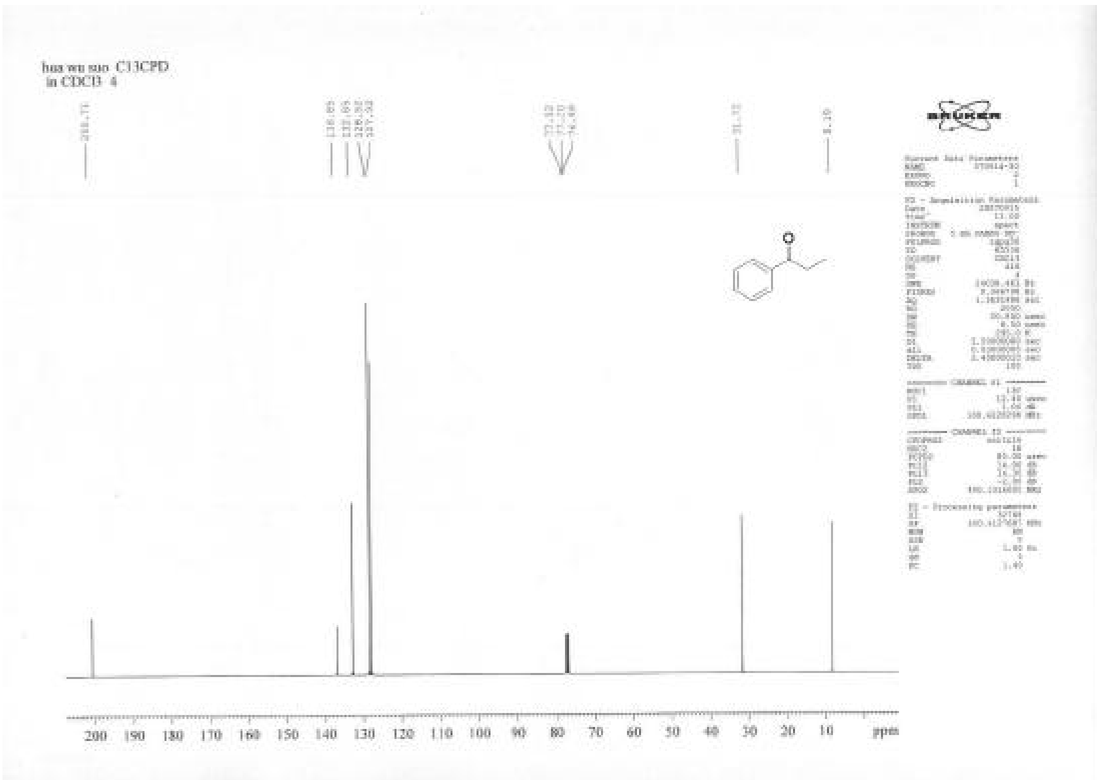
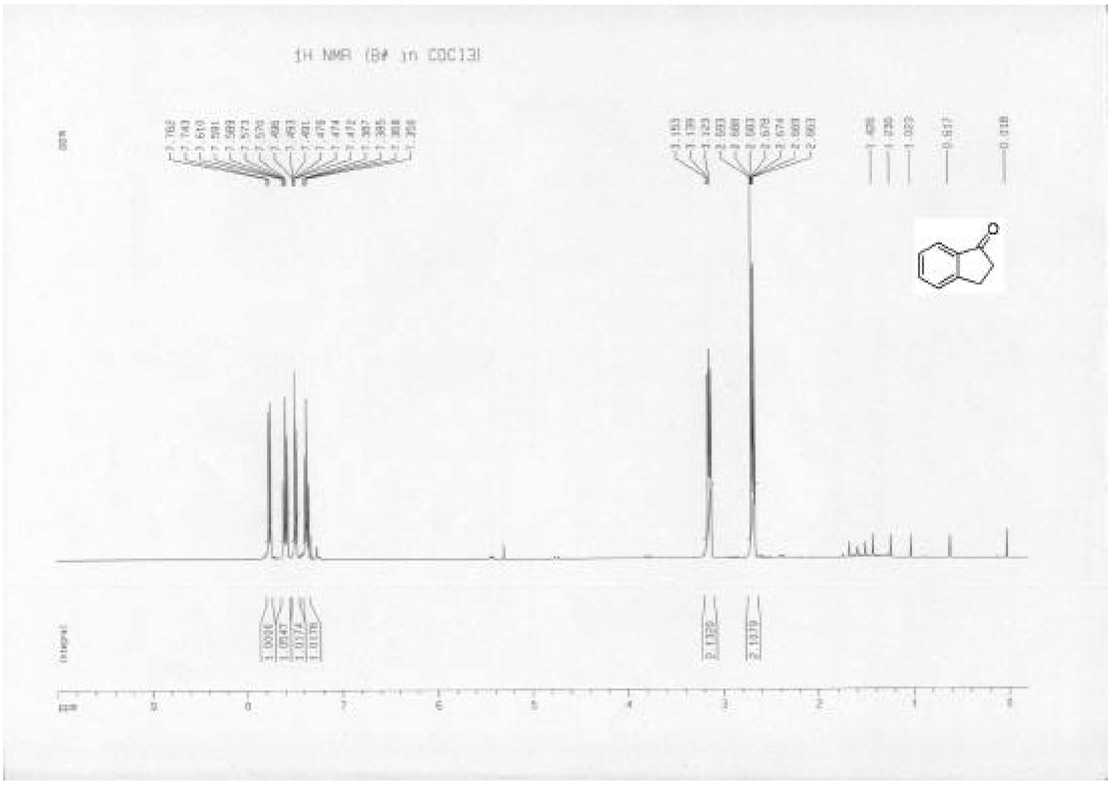


Figure 155: ^{1}H and ^{13}C NMR spectra of propiophenone.



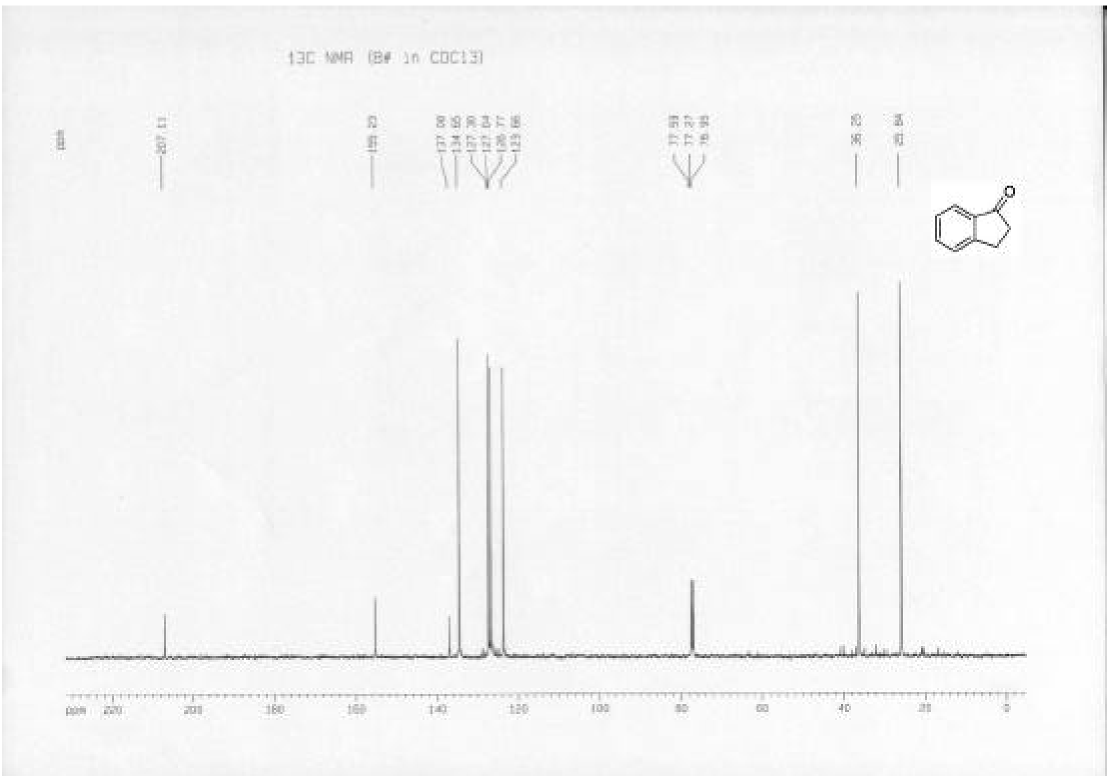
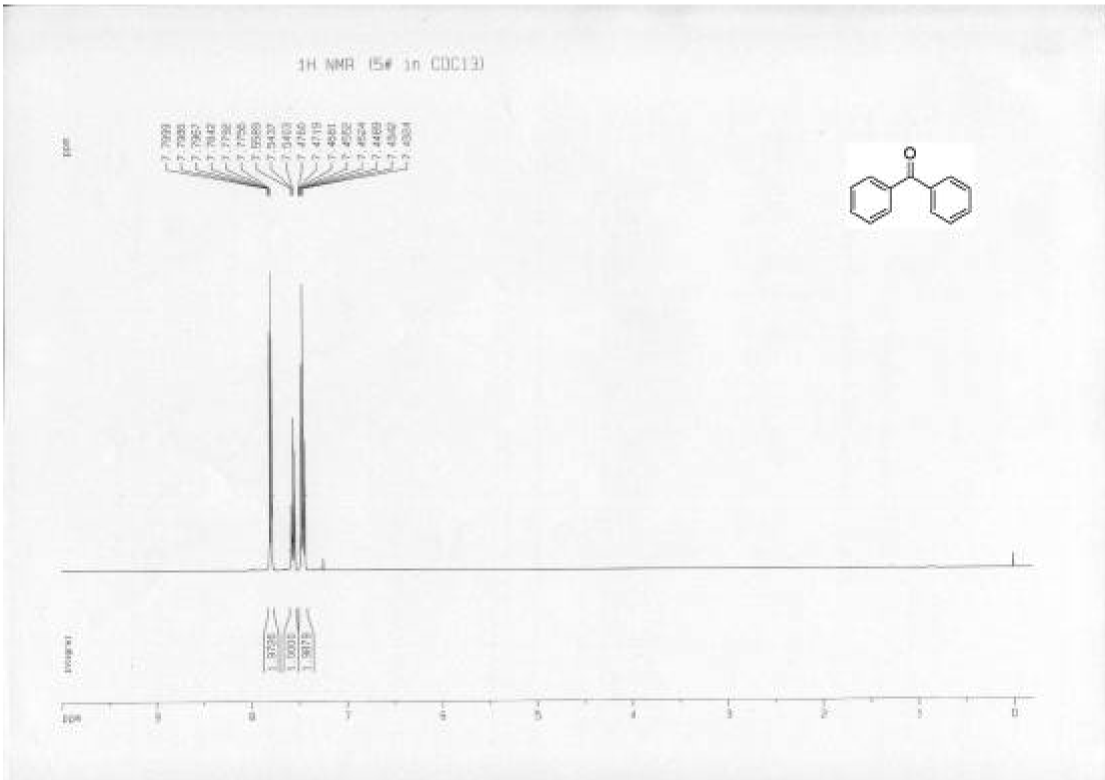


Figure 156: ^{1}H and ^{13}C NMR spectra of 1-indanone.



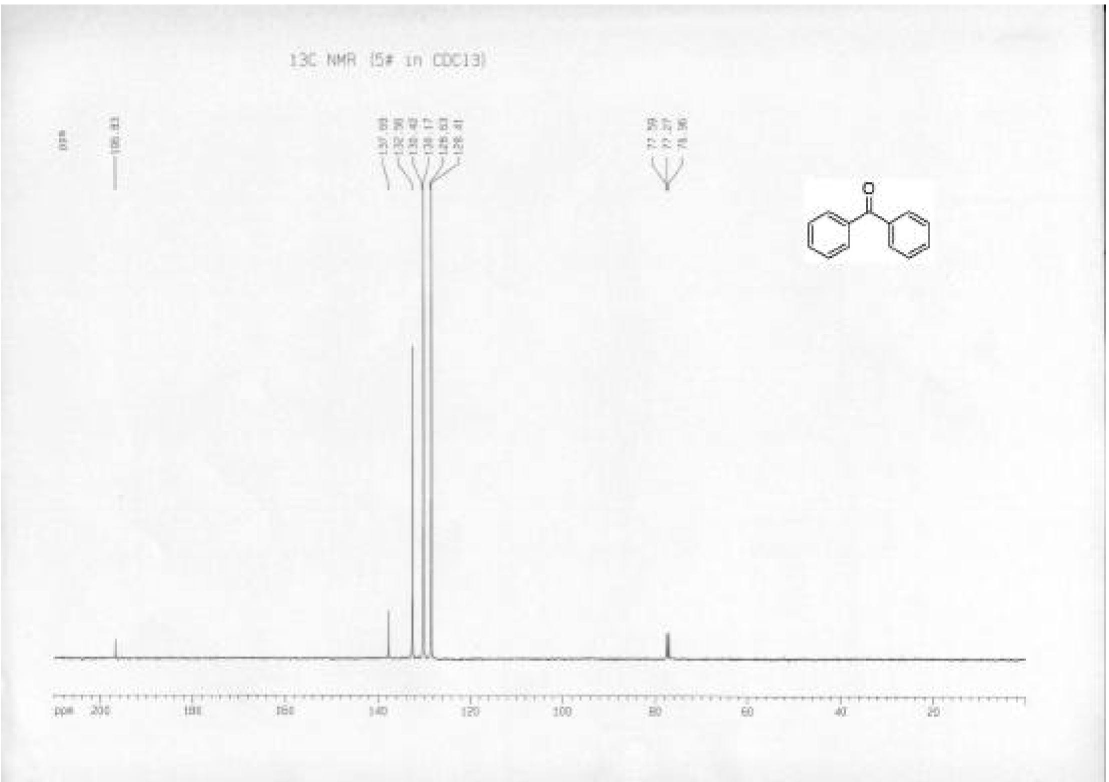
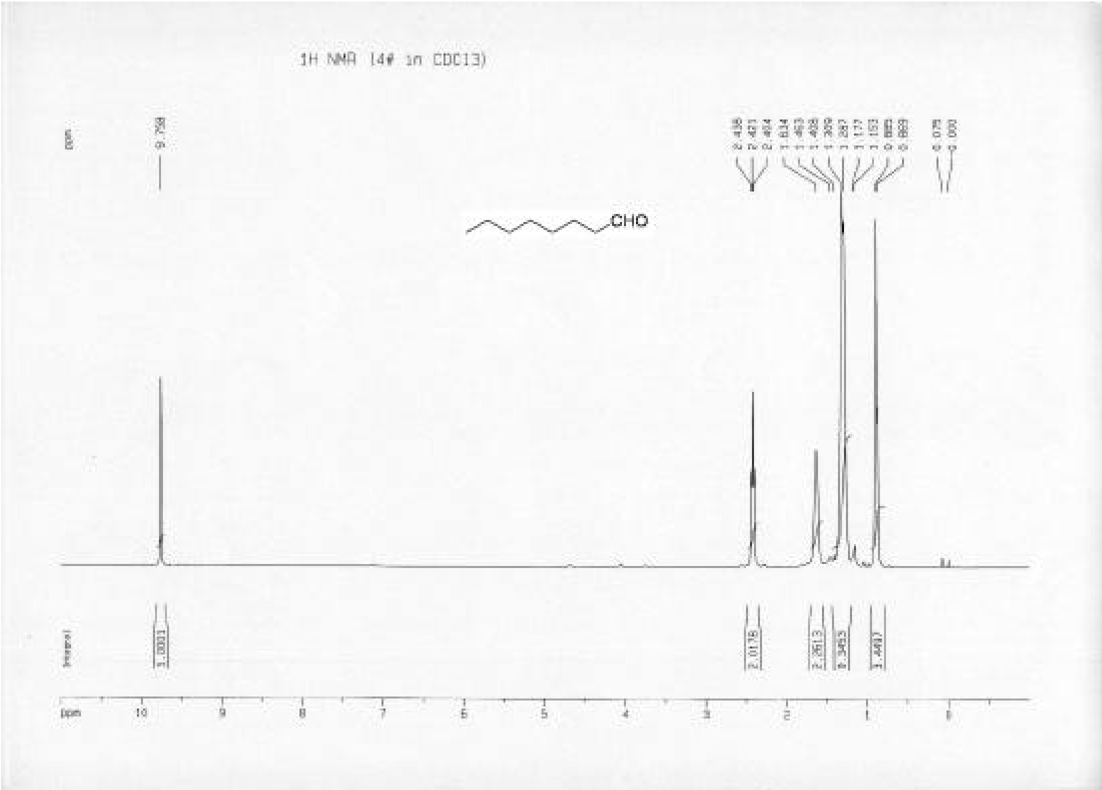


Figure 157: ^{1}H and ^{13}C NMR spectra of benzophenone.



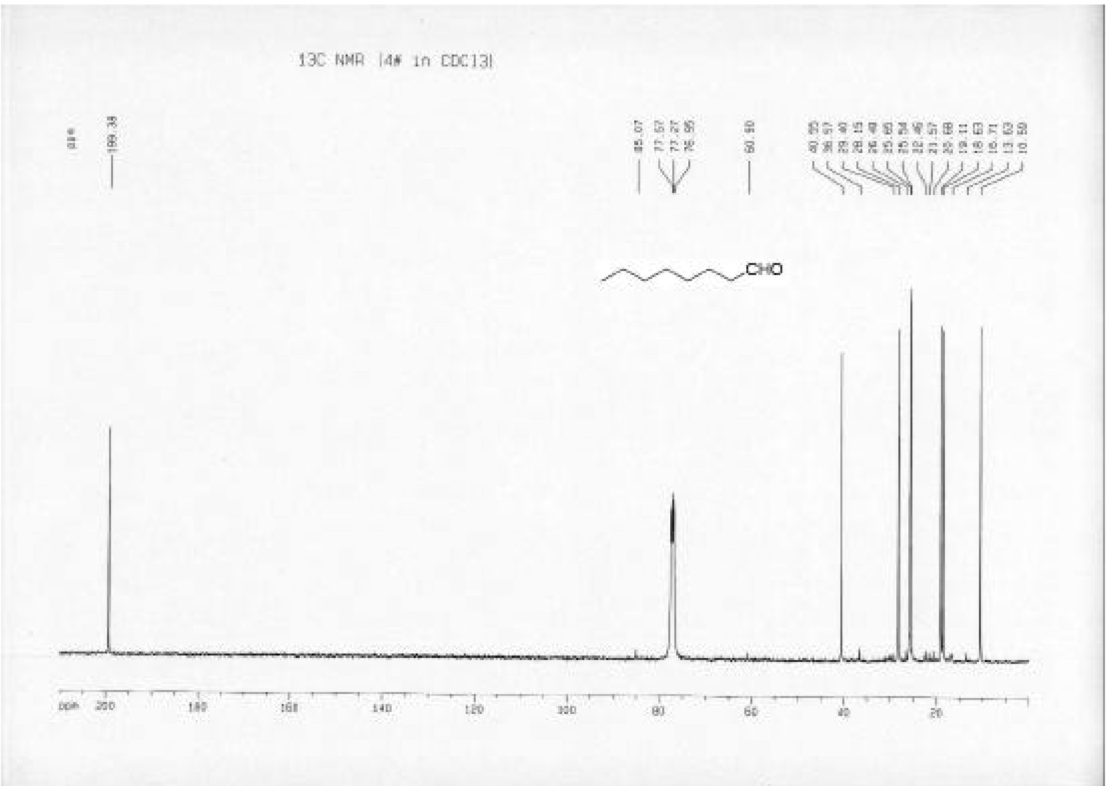
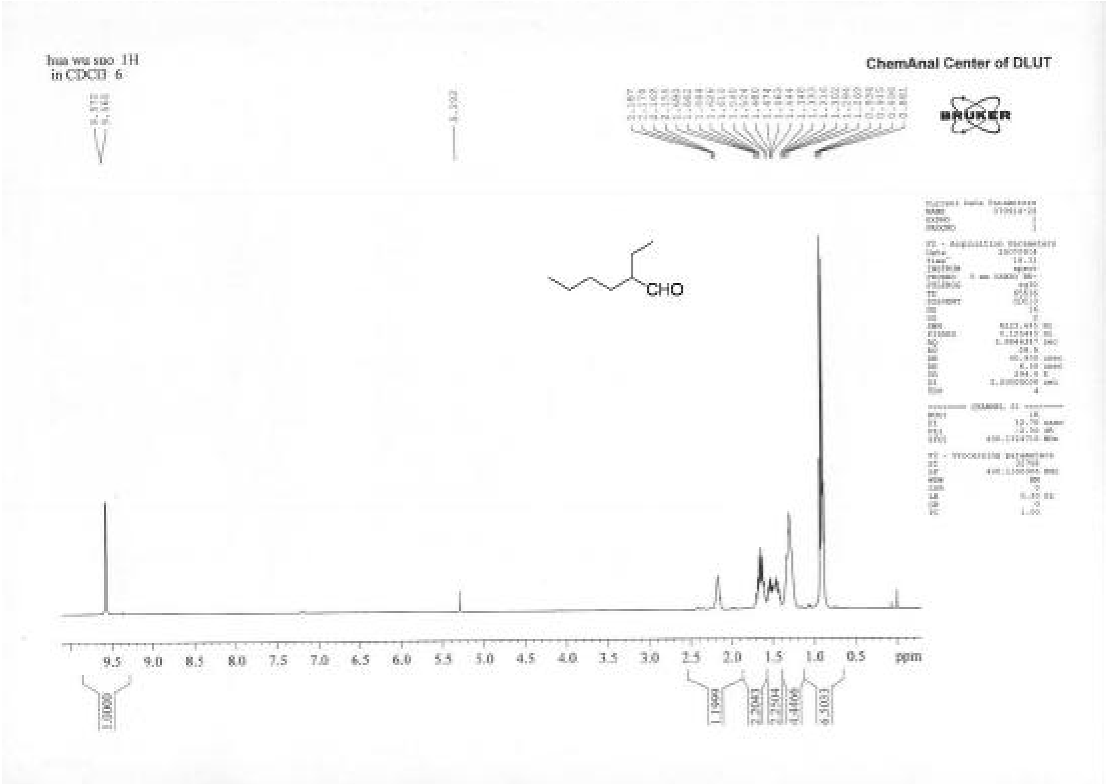


Figure 158: ^{1}H and ^{13}C NMR spectra of octanal.



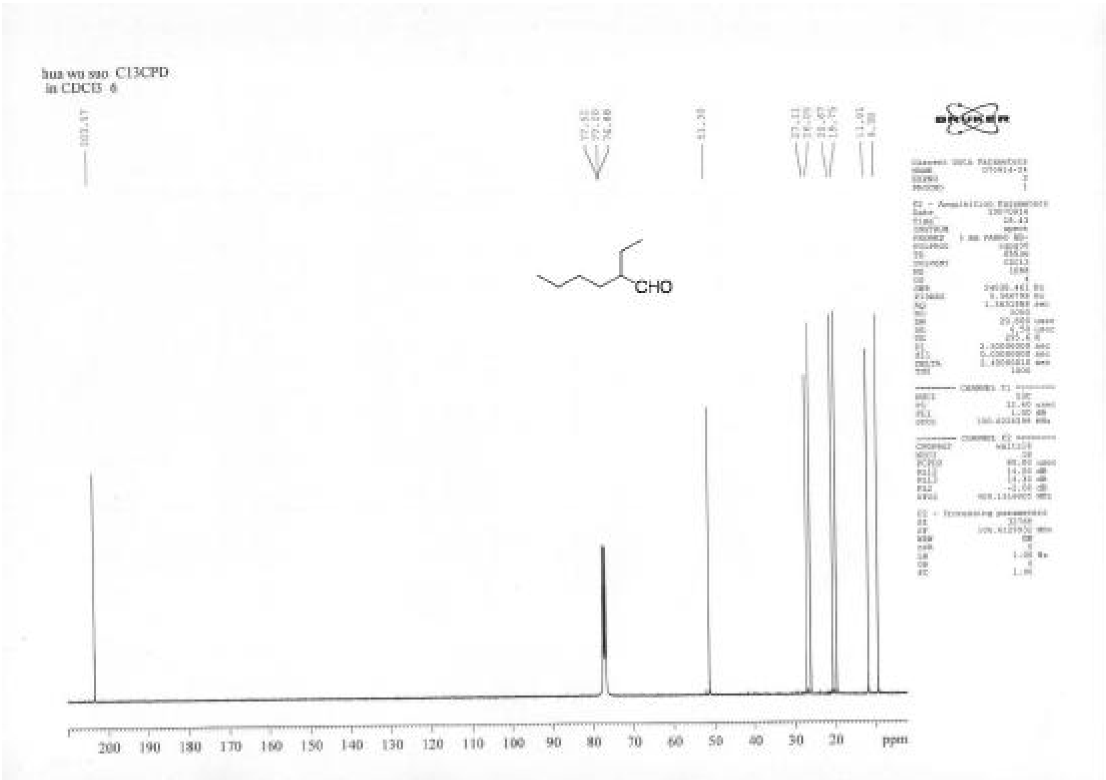
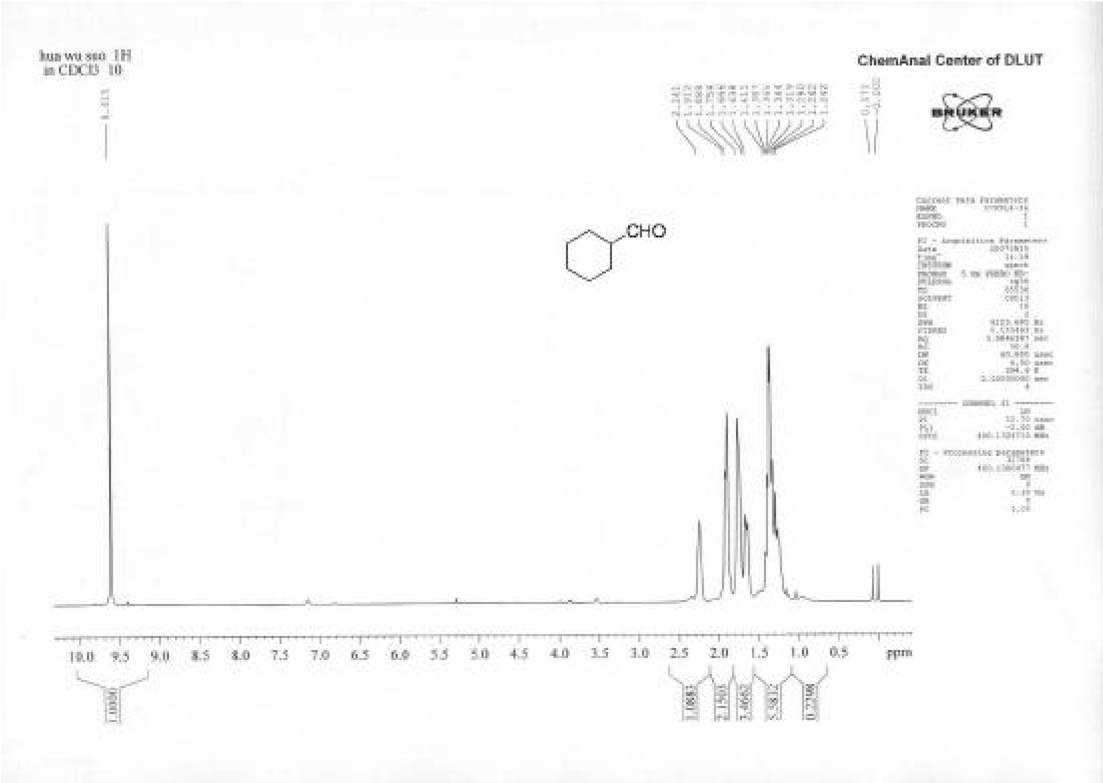


Figure 159: ^{1}H and ^{13}C NMR spectra of 2-ethylhexanal.



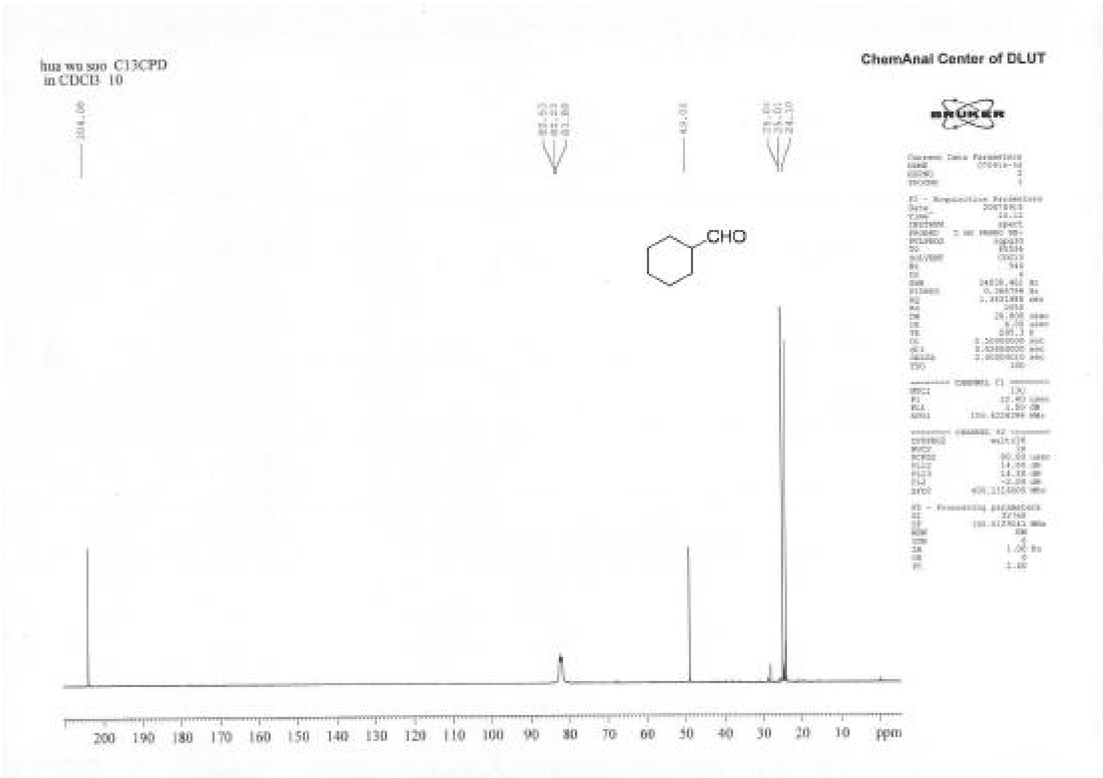
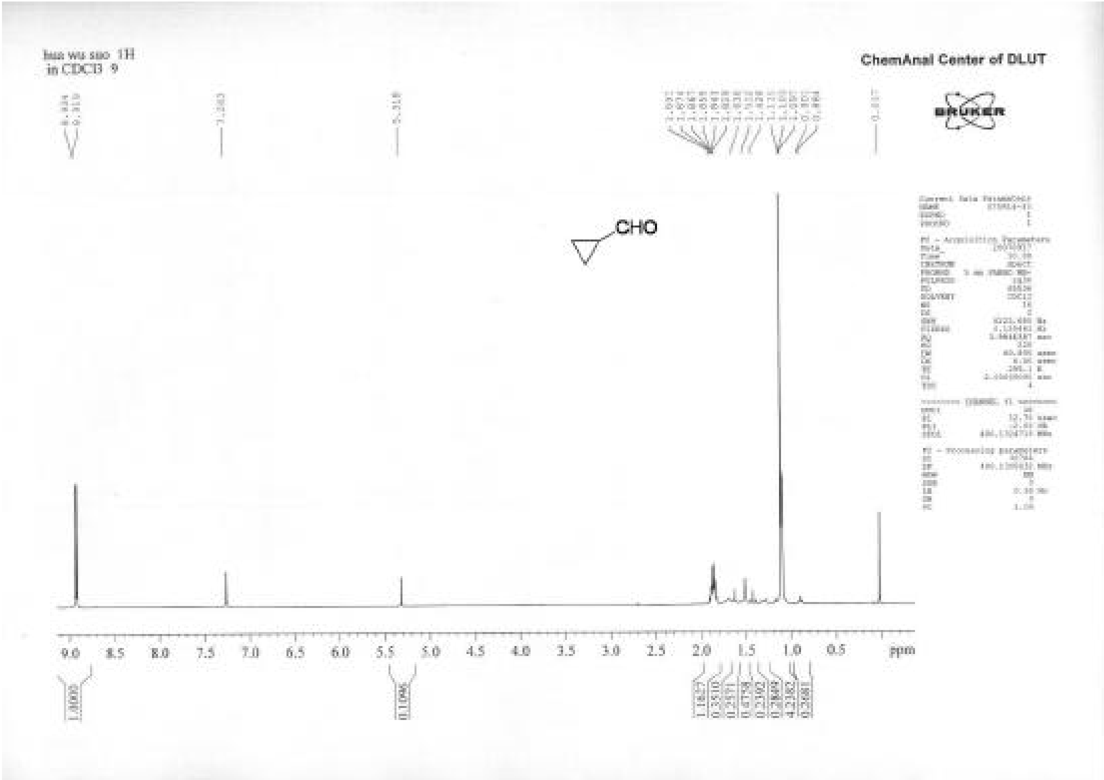


Figure 160: ^{1}H and ^{13}C NMR spectra of cyclohexanecarboxaldehyde.



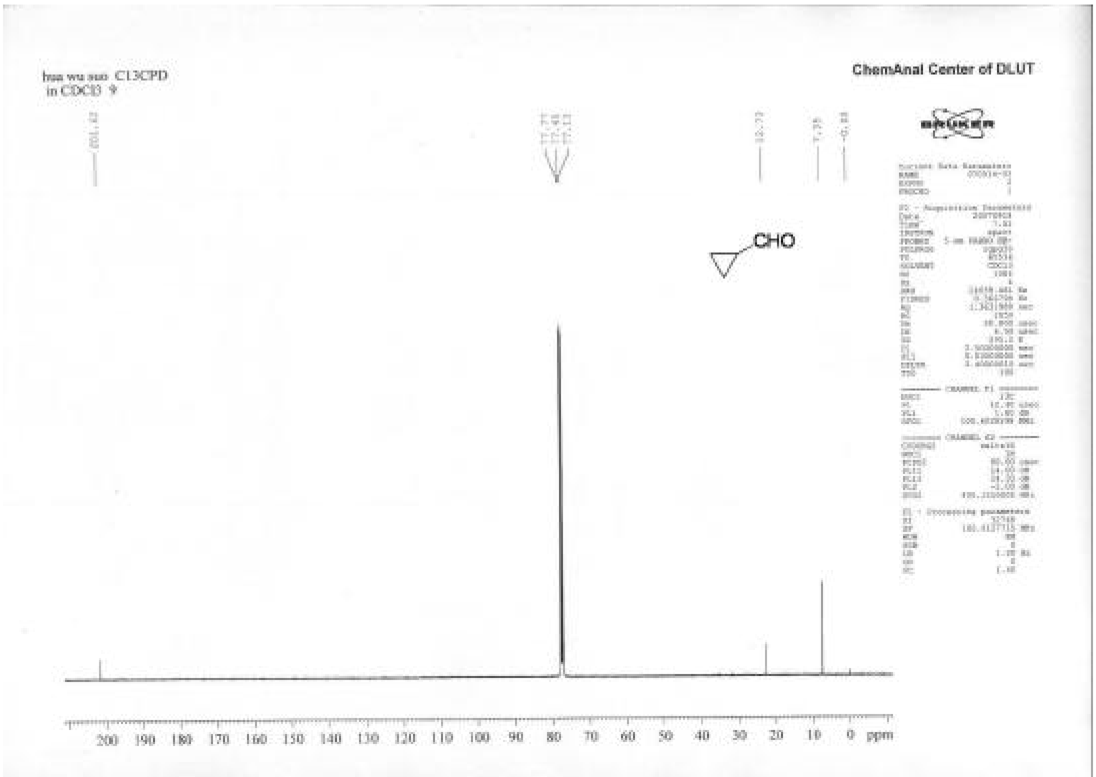
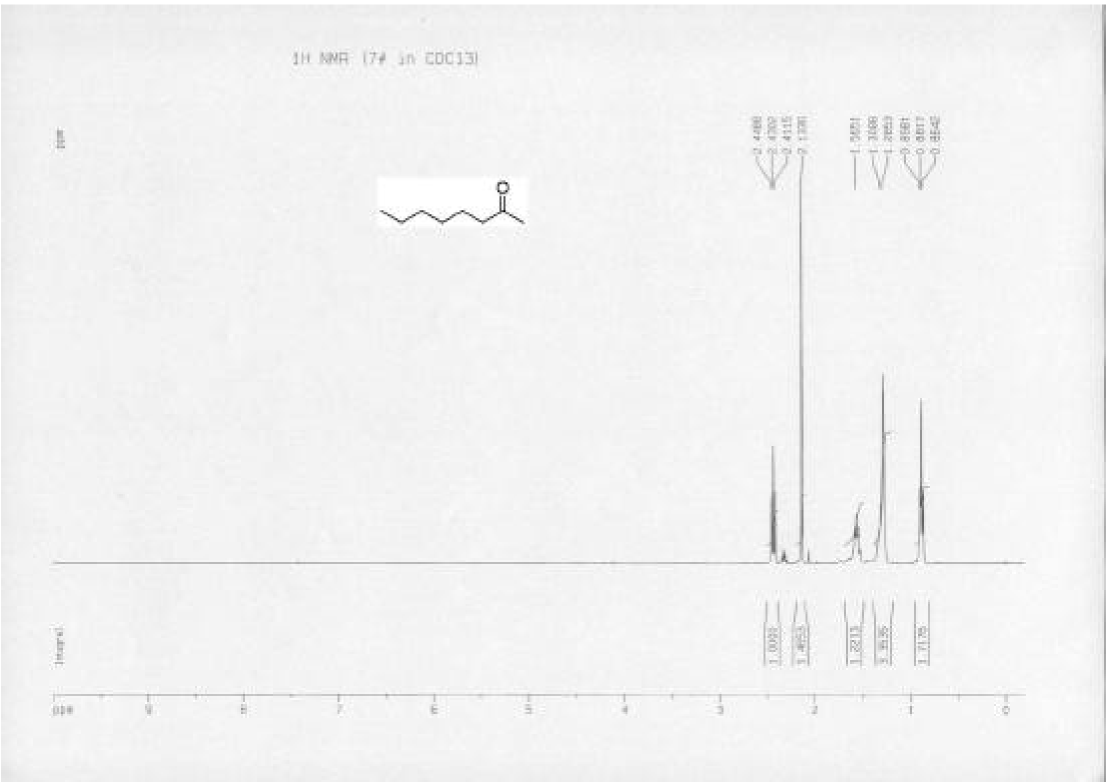


Figure 161: of ^{1}H and ^{13}C NMR spectra of cyclopropanecarboxaldehyde.



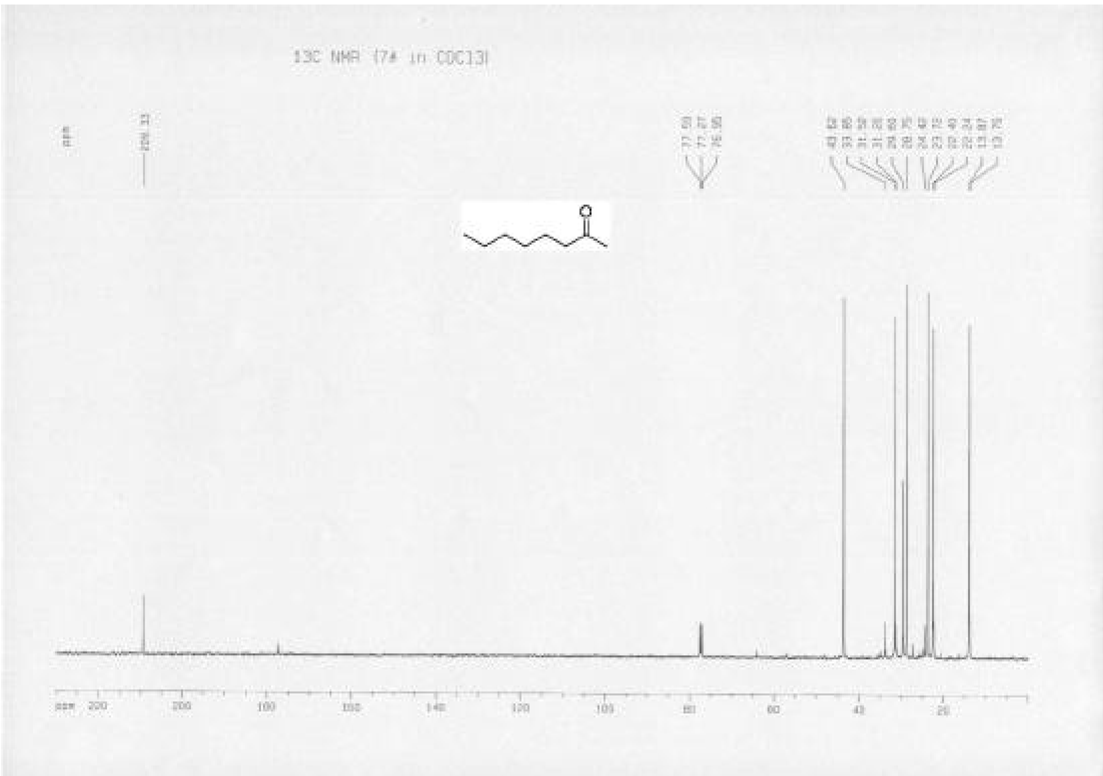
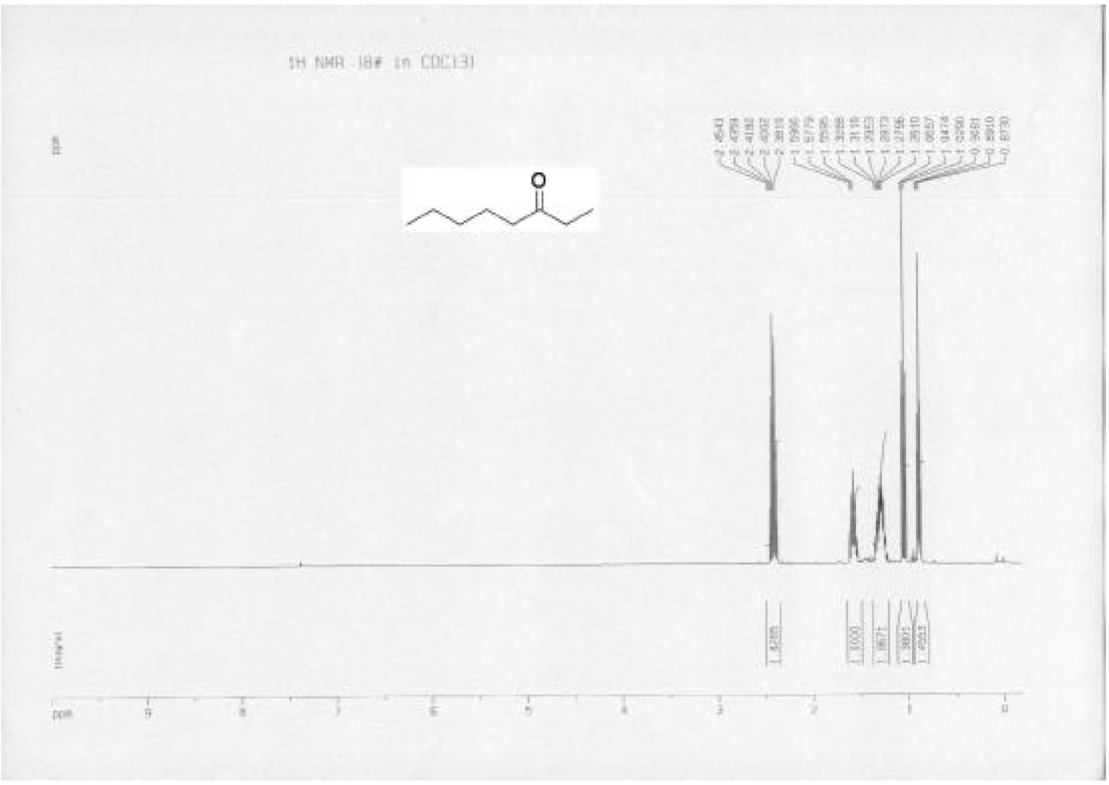


Figure 162: ^{1}H and ^{13}C NMR spectra of 2-octanone.



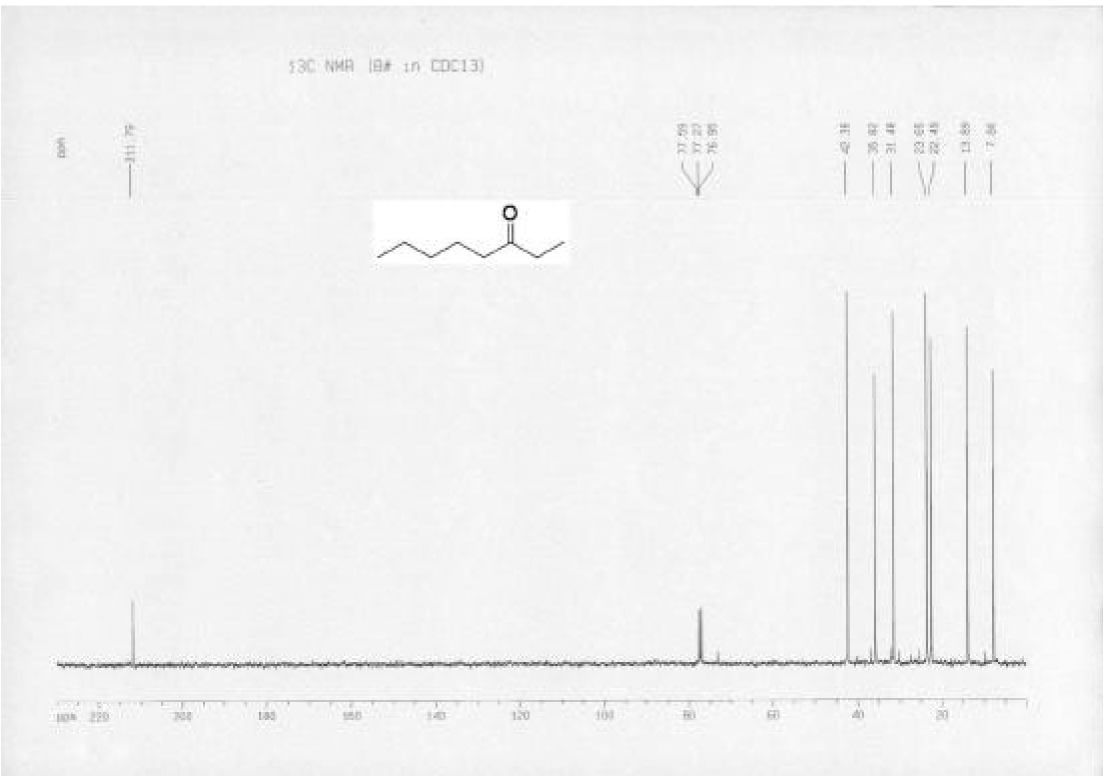
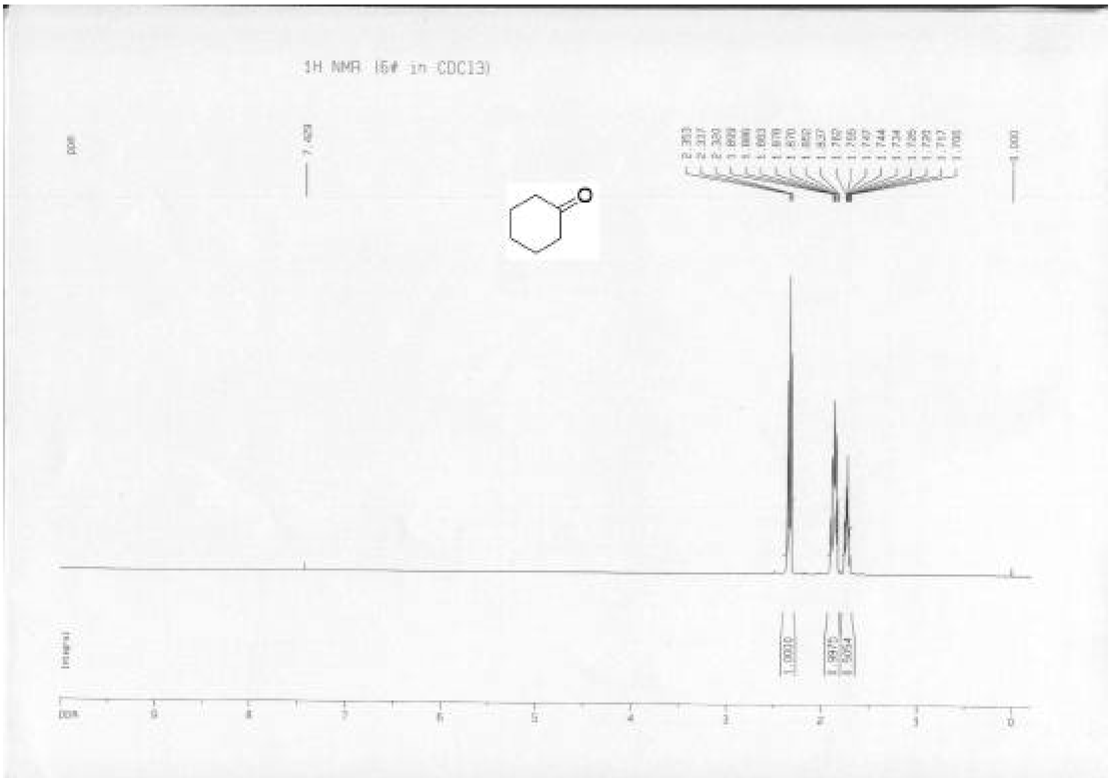


Figure 163: ^{1}H and ^{13}C NMR spectra of 3-octanone.



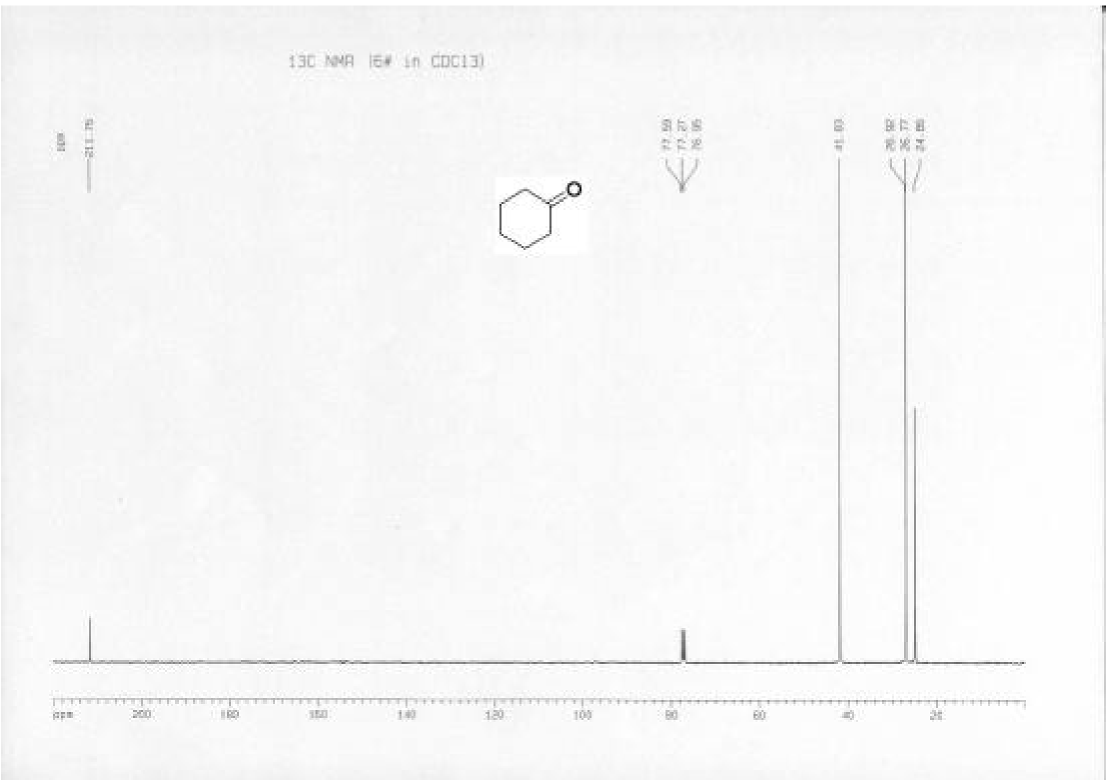
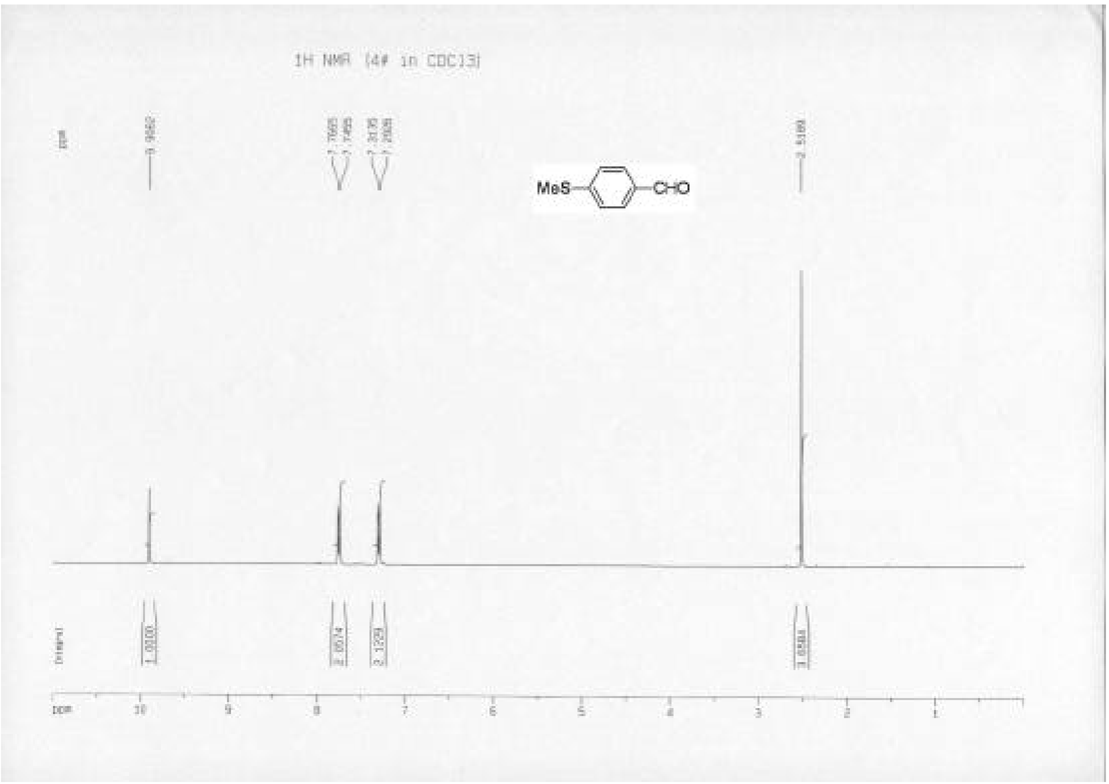


Figure 164: ^{1}H and ^{13}C NMR spectra of cylcohexanone.



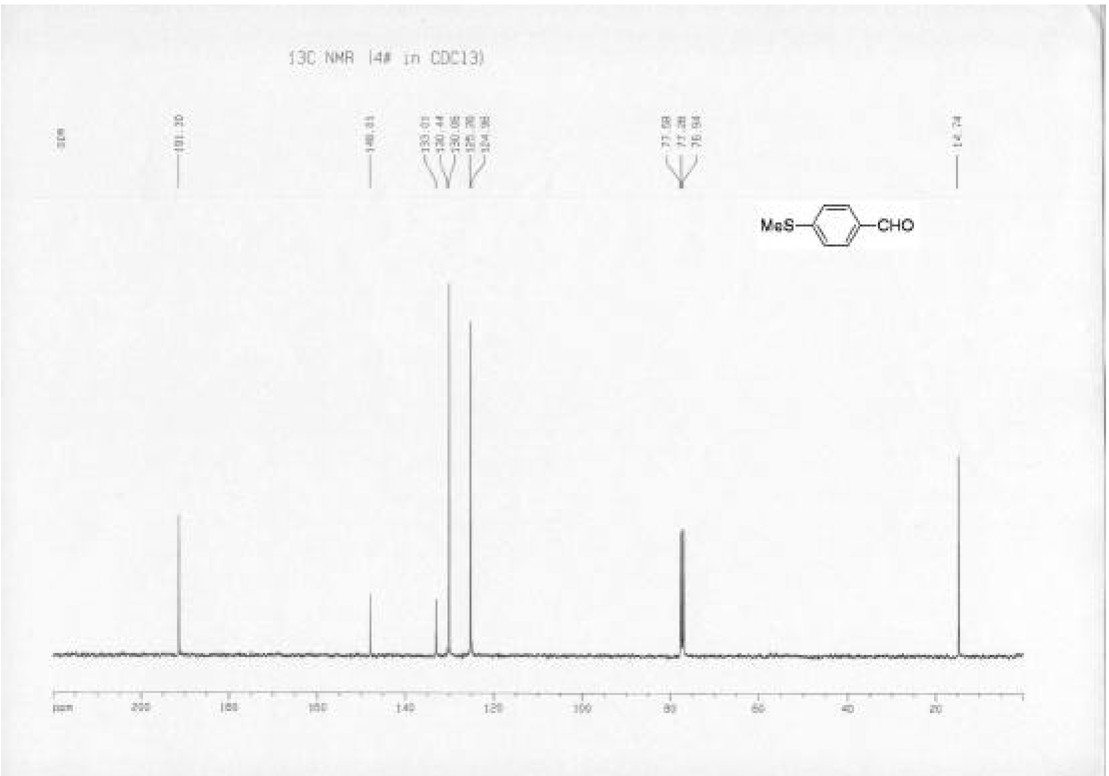
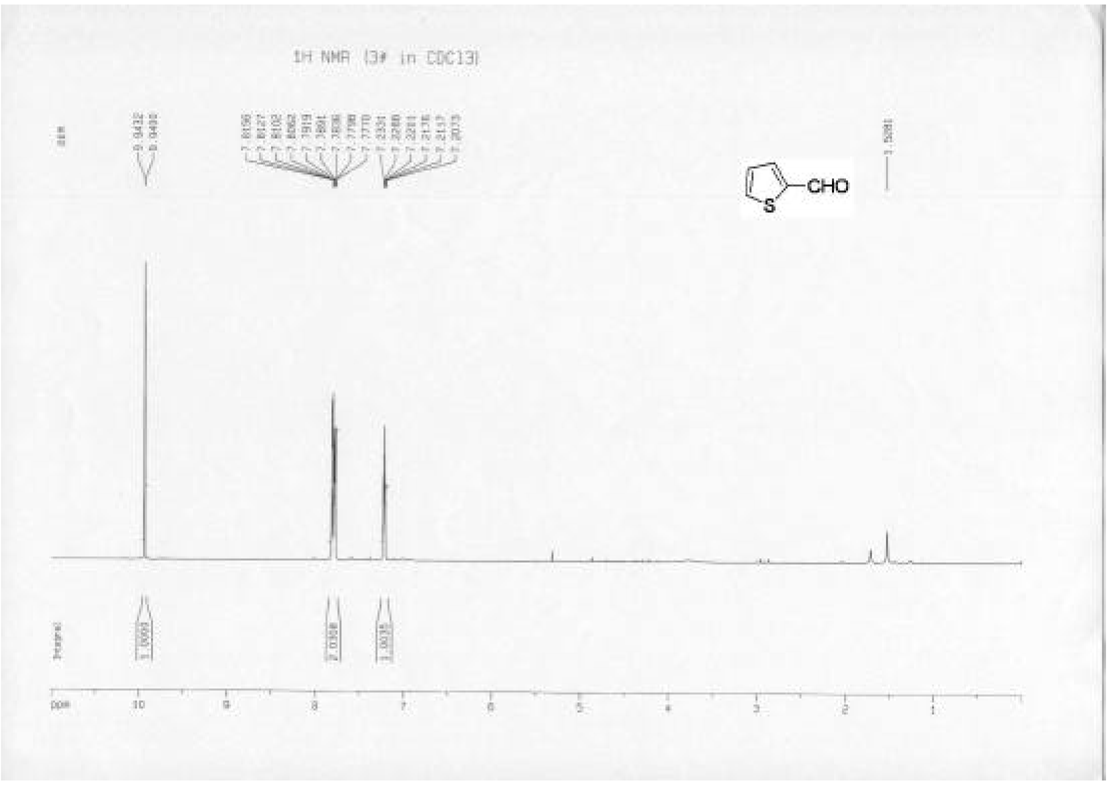


Figure 165: ^{1}H and ^{13}C NMR spectra of 4-(methylthio)benzaldehyde.



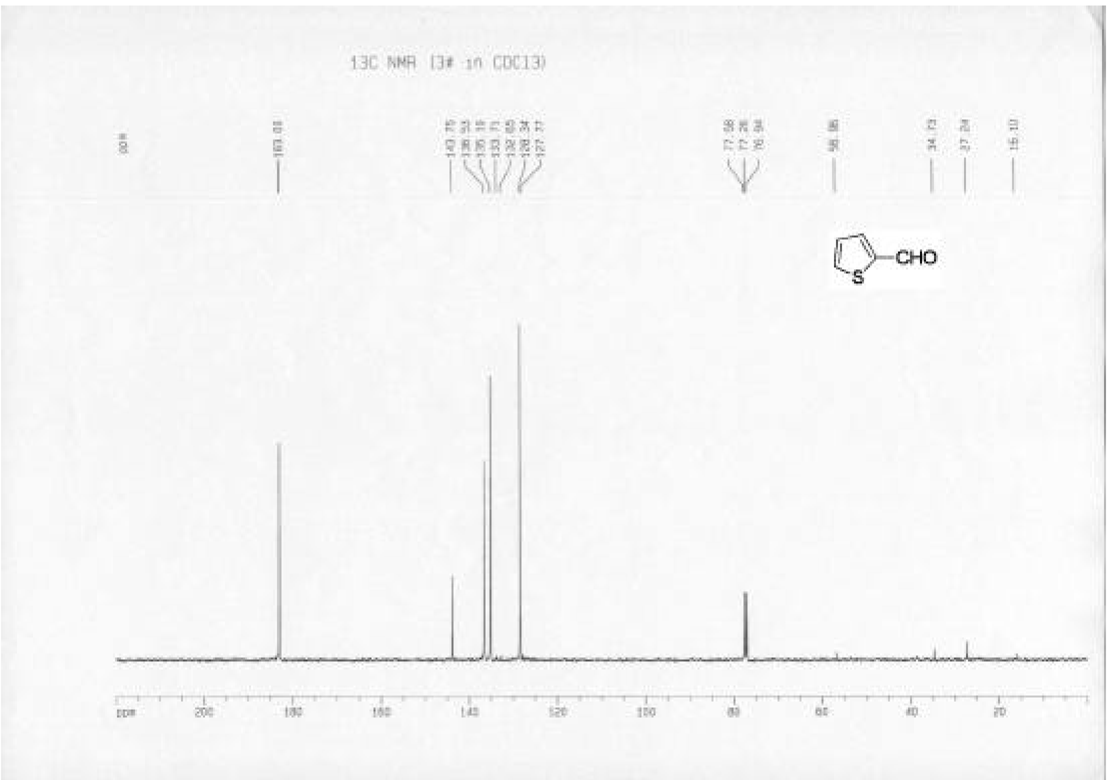
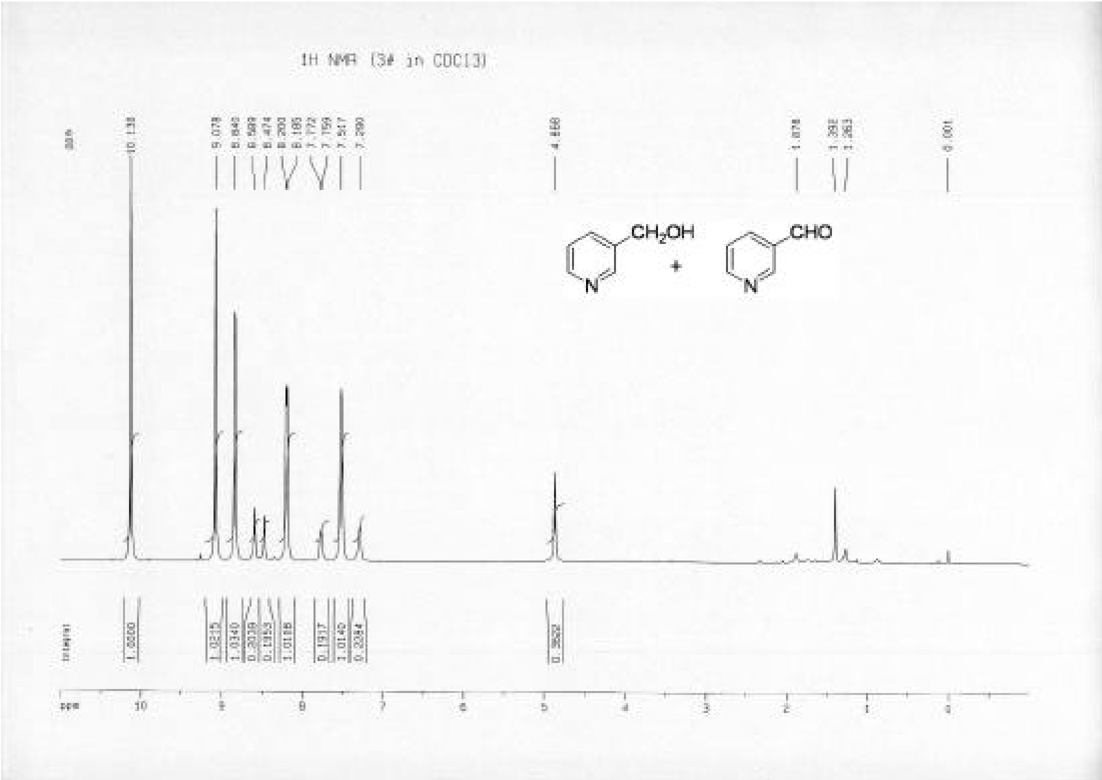


Figure 166: ^{1}H and ^{13}C NMR spectra of 2-thiophenecarboxaldehyde.



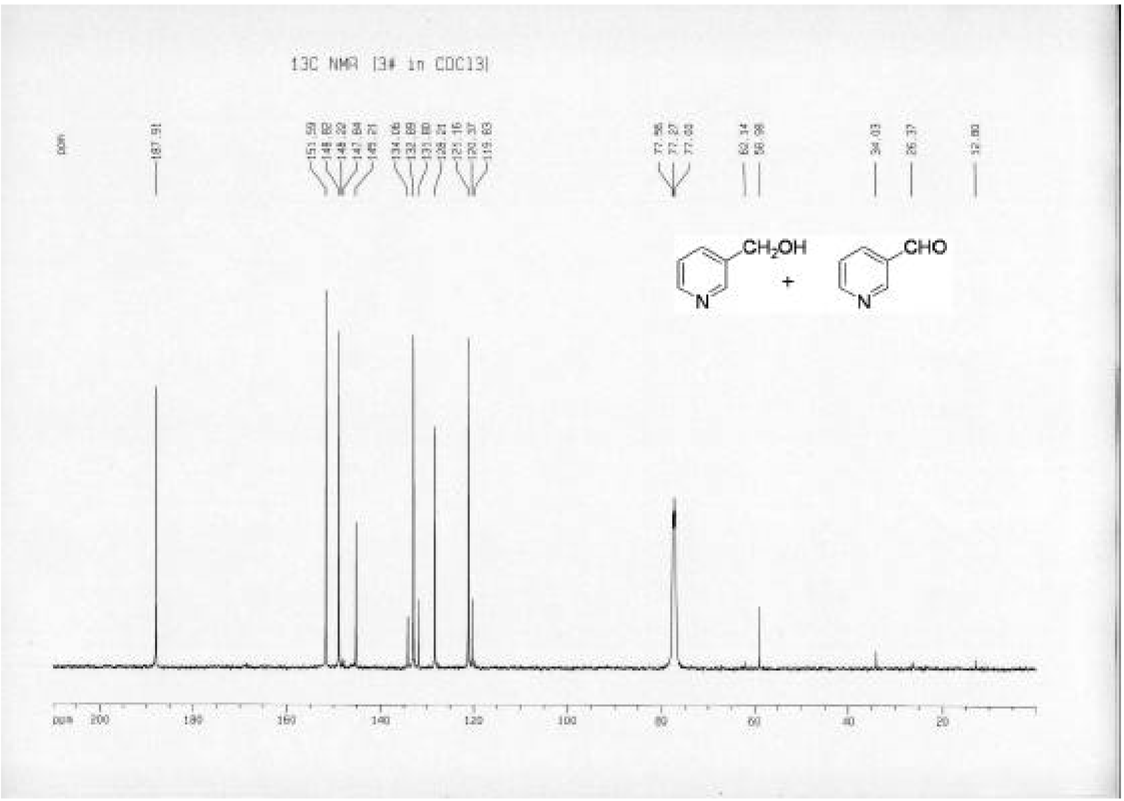
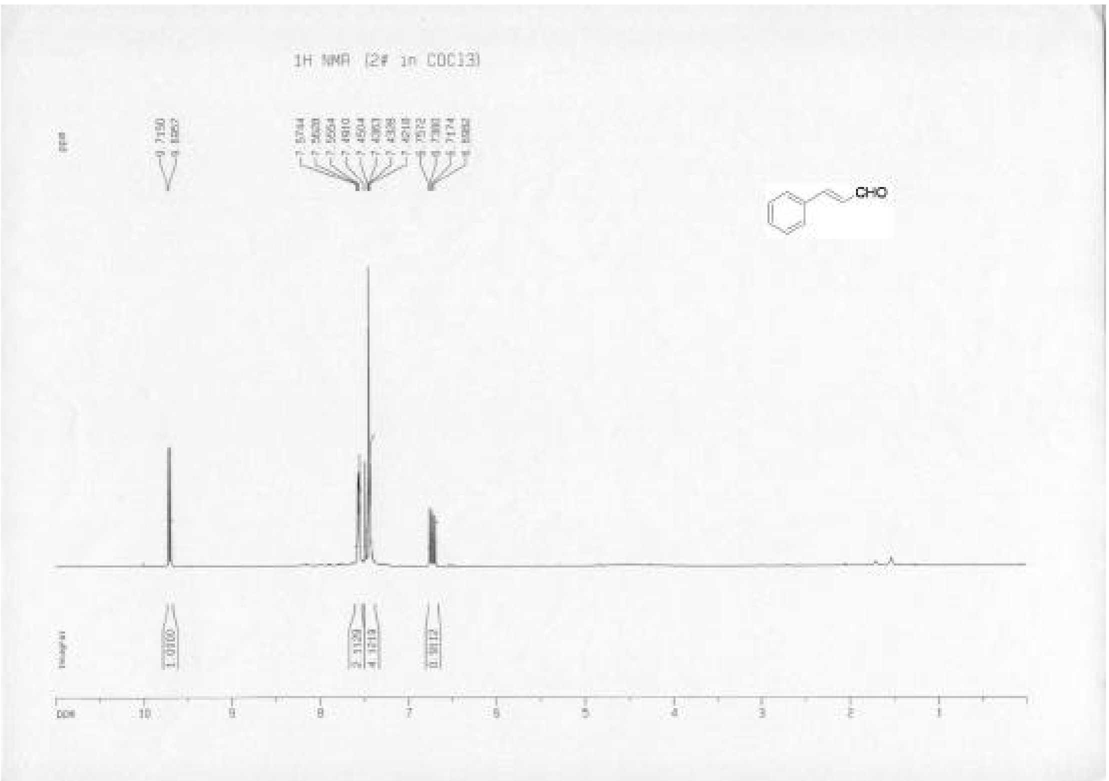


Figure 167: ^{1}H and ^{13}C NMR spectra of the mixture of 3-pyridinecarboxaldehyde and 3-pyridyl methanol.



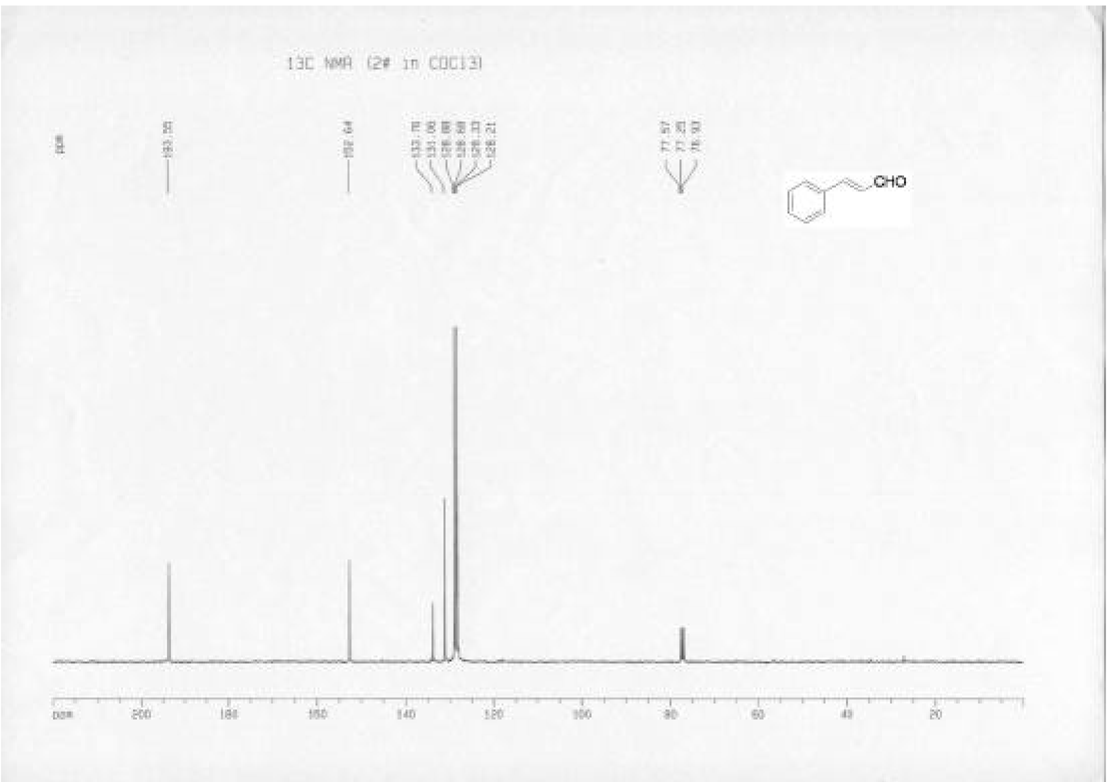
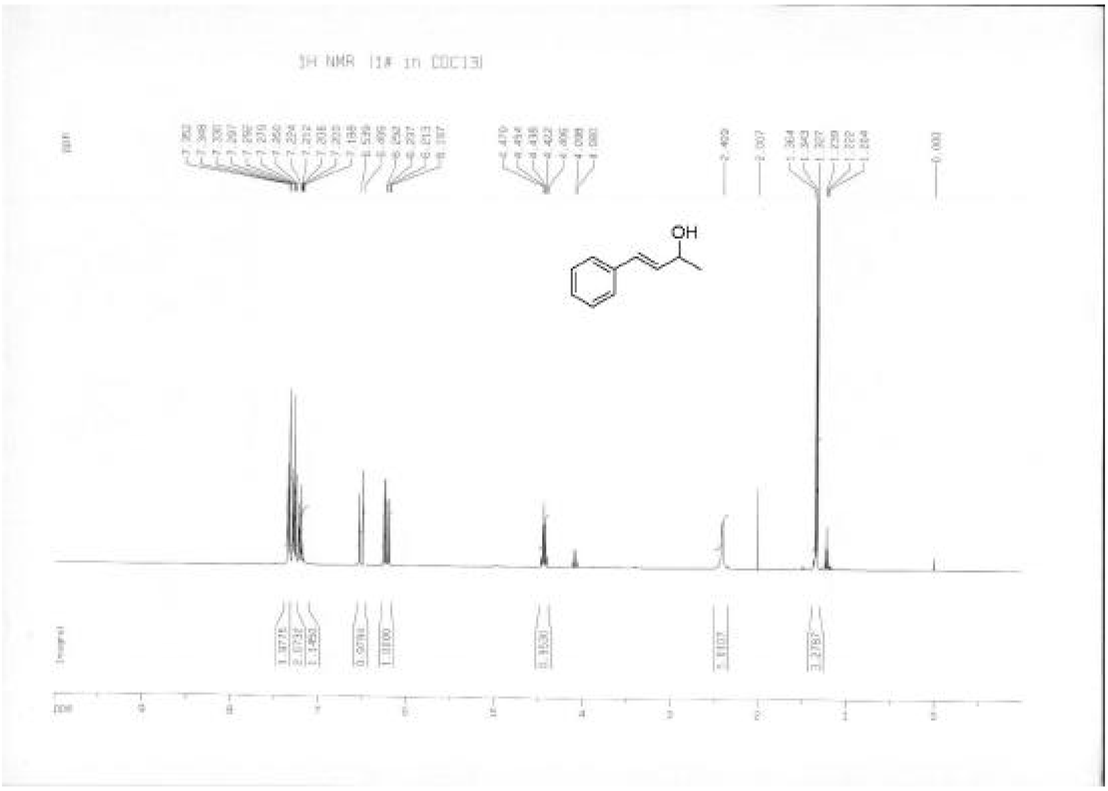


Figure 168: ^{1}H and ^{13}C NMR spectra of *trans*-cinnamaldehyde.



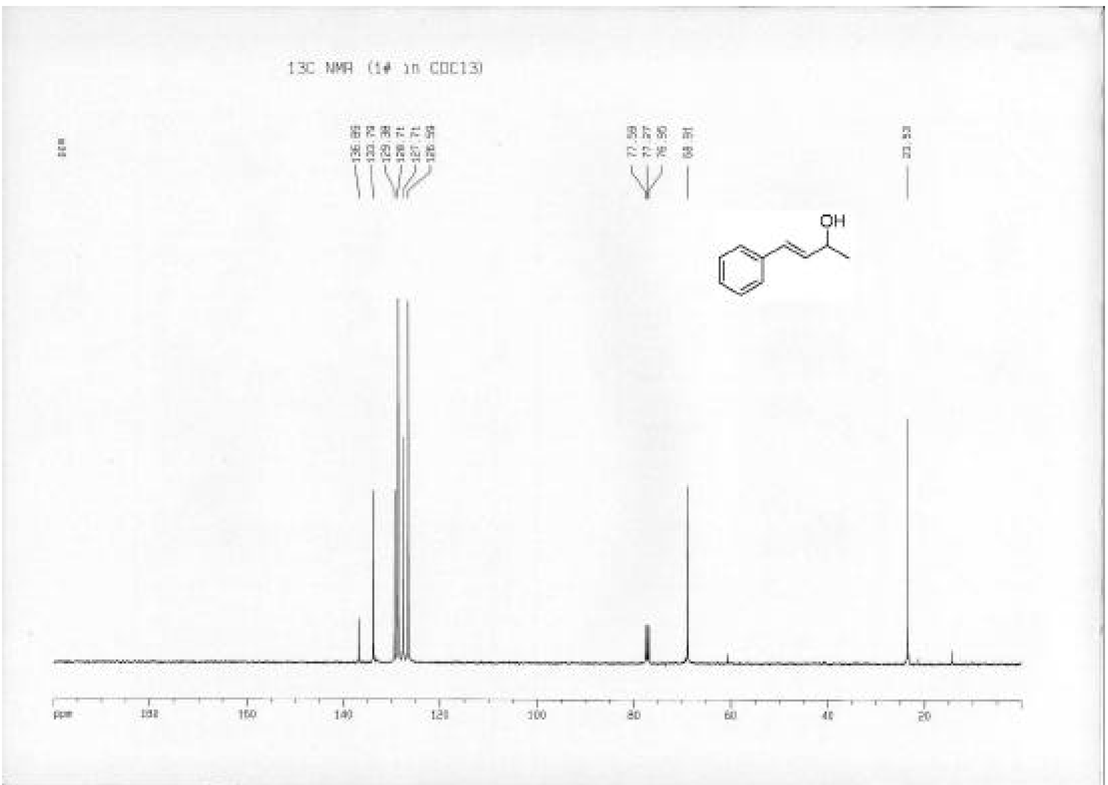
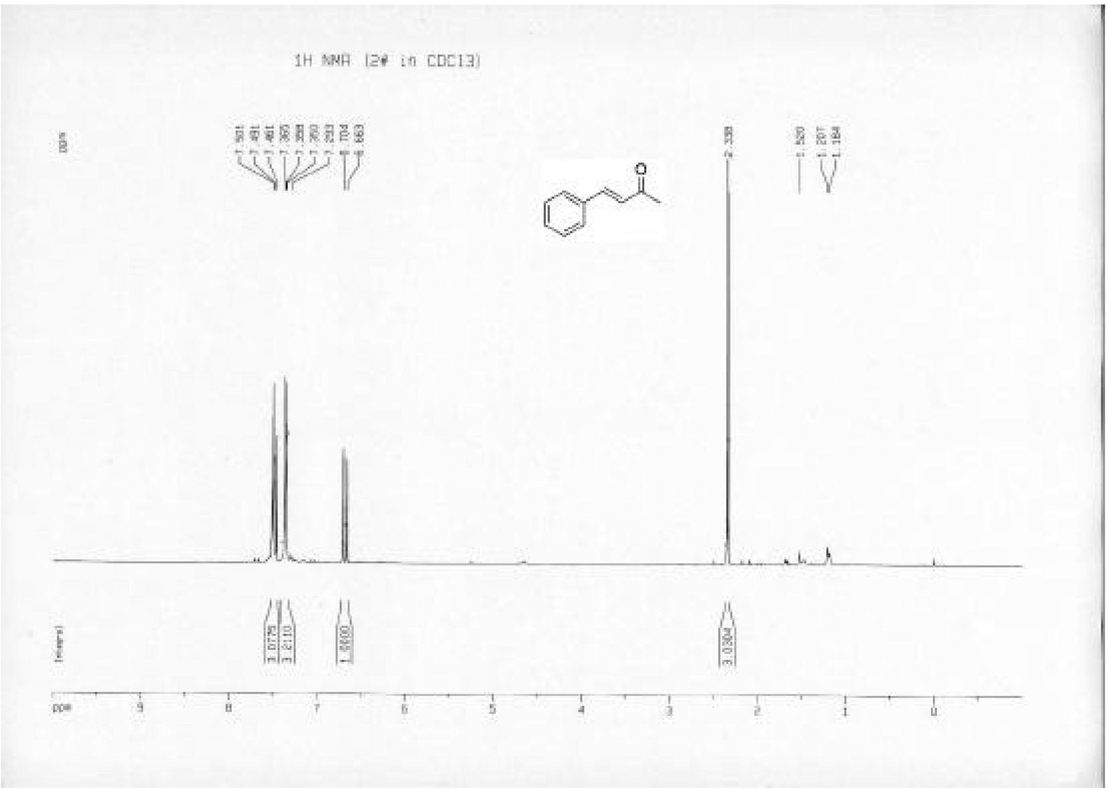


Figure 169: ^{1}H and ^{13}C NMR spectra of (E)-4-phenyl-3-buten-2-ol.



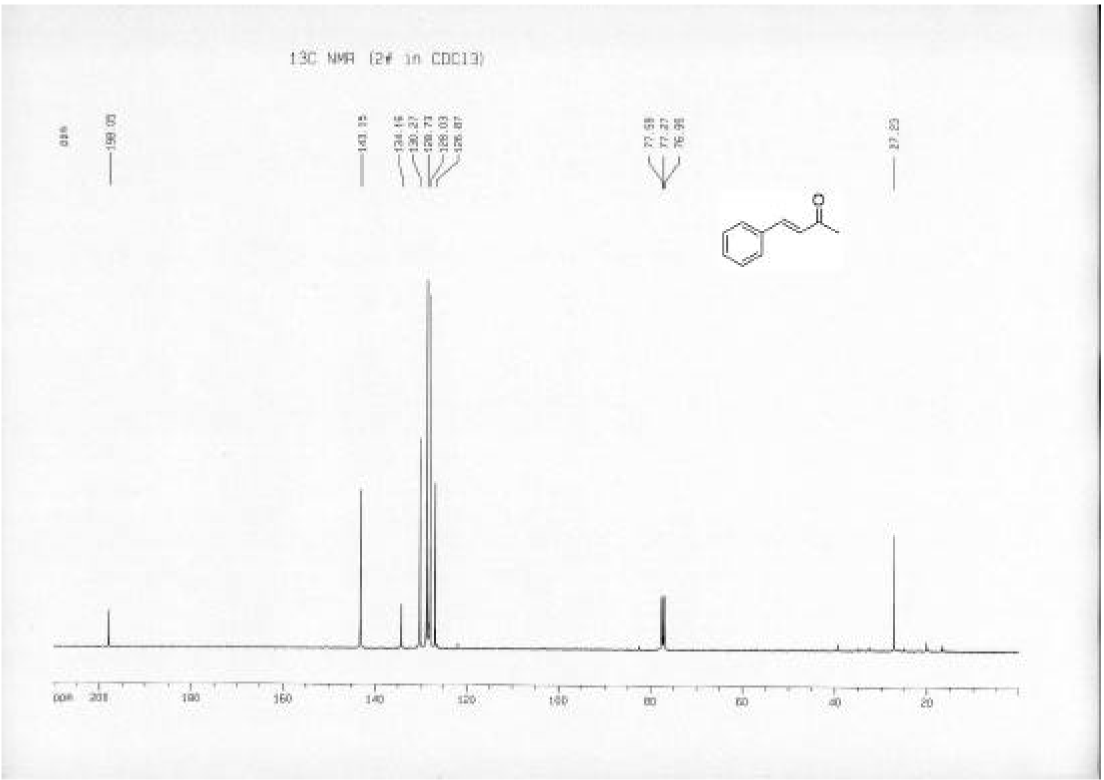
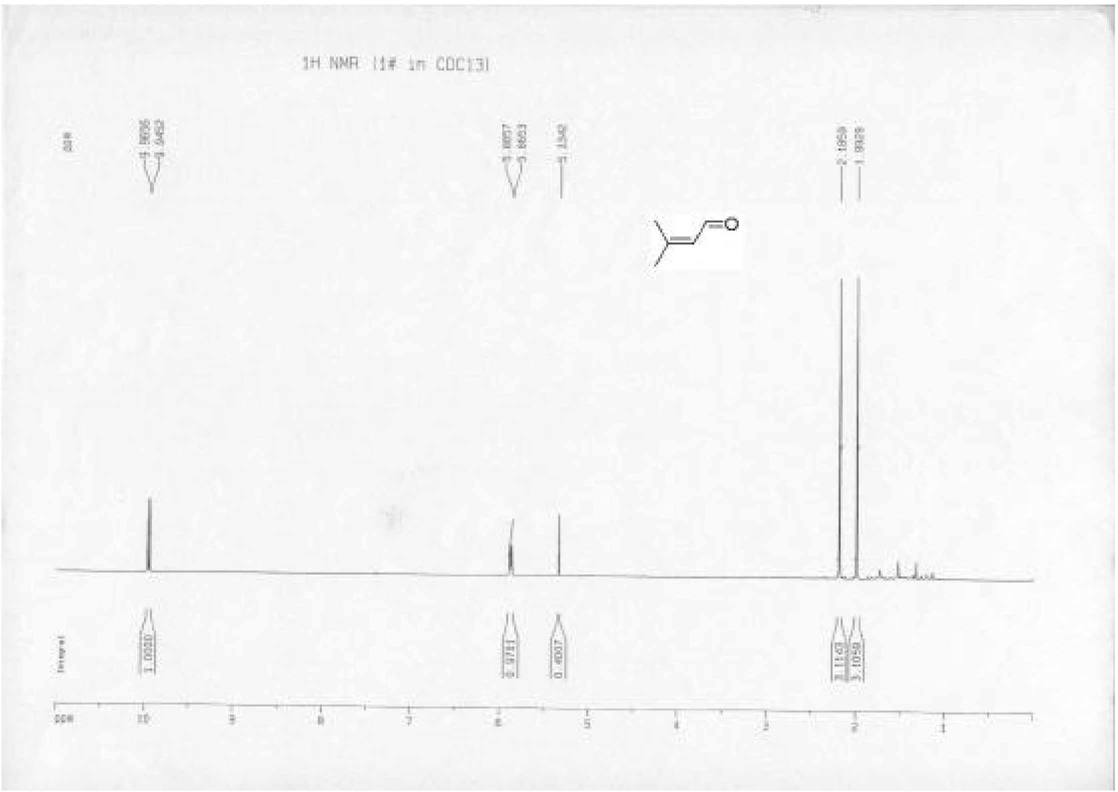


Figure 170: ^{1}H and ^{13}C NMR spectra of (E)-4-phenyl-3-buten-2-one.



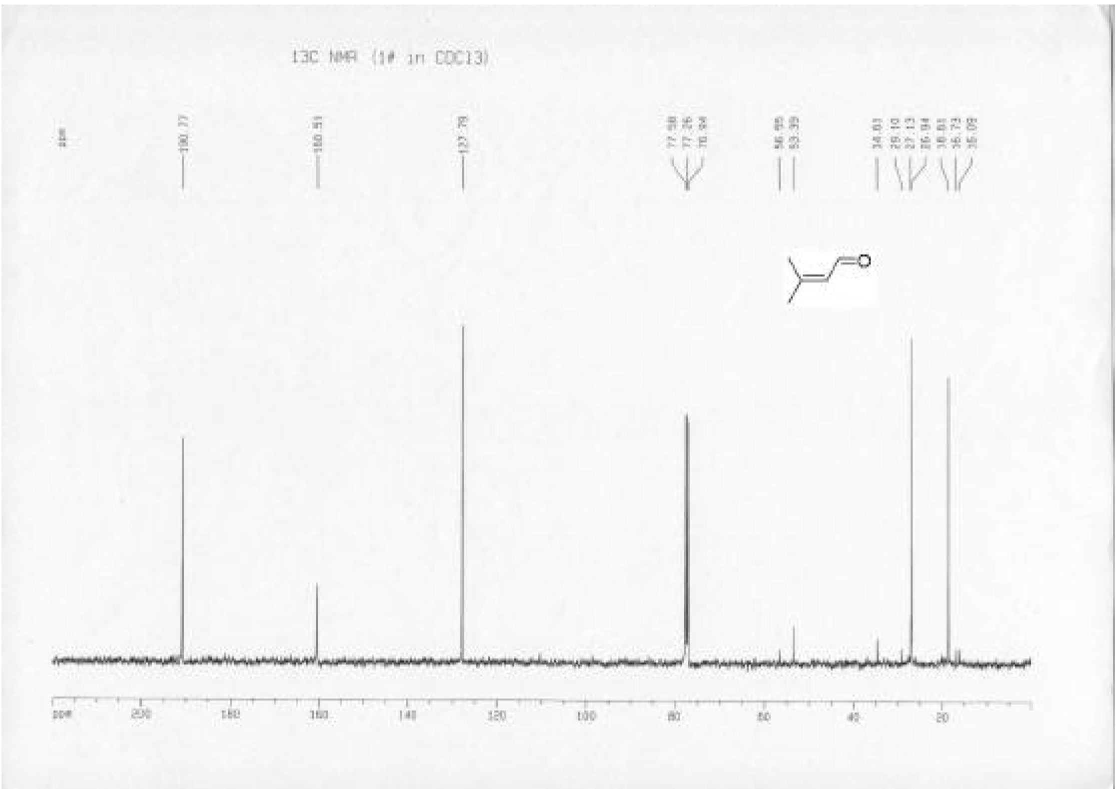


Figure 171: ^{1}H and ^{13}C NMR spectra of 3-methyl-2-butenal.

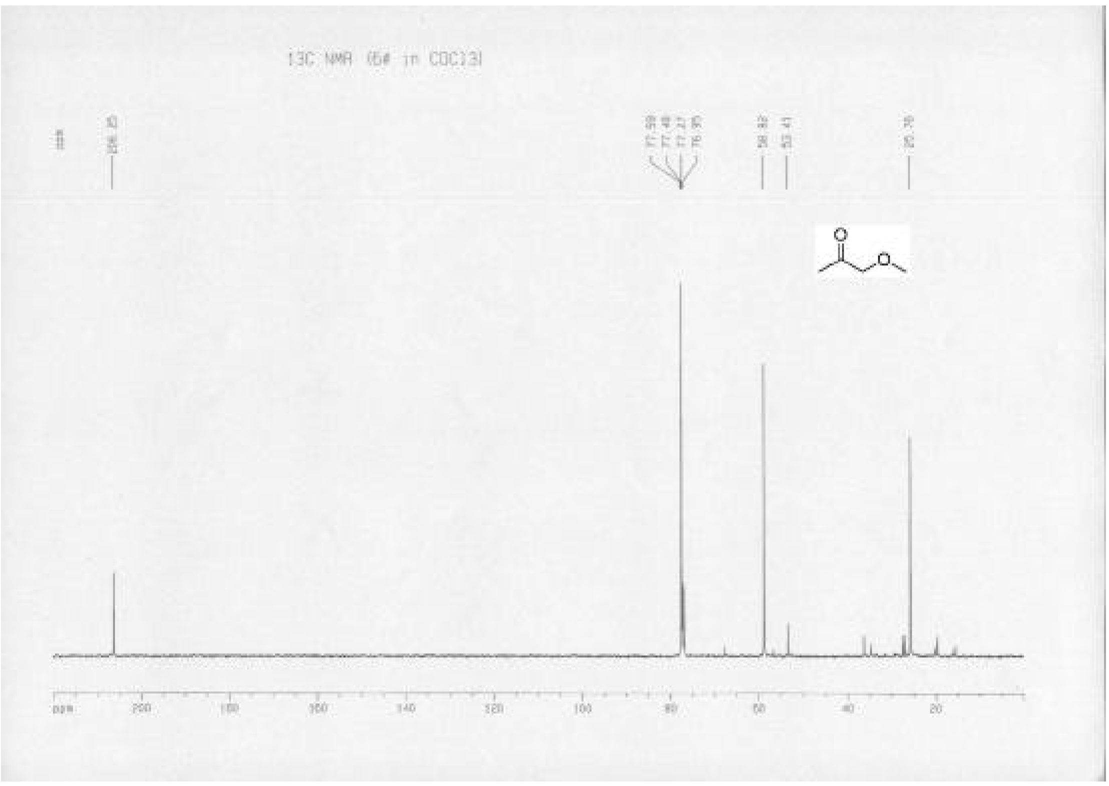


Figure 172: ^{1}H and ^{13}C NMR spectra of methoxyacetone.