Direct Synthesis of 1,3-Diketones by Rh-catalyzed Reductive α-Acylation of Enones

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General Information:

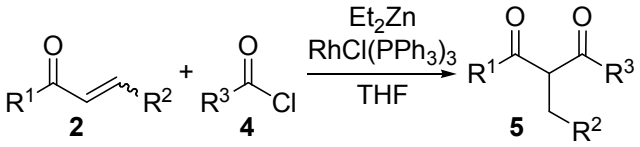
^{1}H NMR and ^{13}C NMR spectra were recorded on JNM-GX400 and JEOL-ECA-600SN spectrometers. ^{19}F NMR spectrum was recorded on Hitachi FT-NMR R-90H spectrometer. Chemical shifts of ^{1}H NMR and ^{13}C NMR are reported in ppm from tetramethylsilane (TMS) as an internal standard. Chemical shifts of ^{19}F NMR are reported in ppm from benzotrifluoride (BTF) as an internal standard. All data are reported as follows: chemical shifts, relative integration value, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, br = broad, m = multiplet), coupling constants (Hz). Mass spectra were obtained on JEOL JMS-700T spectrometer. IR spectra were recorded on Hitachi 270-30 Infrared spectrophotometer. Melting points were measured on Yanagimoto micro melting point apparatus MP-S3. Analytical gas-liquid chromatography (GLC) was carried out on Hitachi 263-50 gas chromatograph (column; 5% SE-30 3 mm x 2 m, carrier; N_2 at 30 ml/min). Peak areas were calculated on Hitachi D-2500 Chromato-Integrator.

Experimental Section:

Materials

Tetrahydrofuran (THF) was distilled over benzophenone ketyl sodium just before use. All commercially available acid chlorides were distilled just before use. Other commercially available reagents were used without further purification. All experiments were carried out under argon atmosphere in flame-dried glassware using standard inert techniques for introducing reagents and solvents unless otherwise noted.

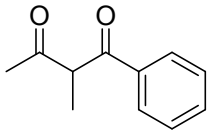
Typical procedure for reductive α-acylation reaction.



α,β-Unsaturated ketone (**2**; 4 mmol) and acid chloride (**4**; 2 mmol) were added to a solution of $RhCl(PPh_3)_3$ (2 mol%) in THF (5 mL) at 0 °C. Then 1.0 M Et_2Zn in hexane (3 mmol) was gradually added to the mixture at 0 °C, and was stirred at same temperature for the reaction time shown in Table 2. The mixture was quenched with 10% HCl, and extracted with AcOEt. The AcOEt layer was washed with sat. NaCl and dried over $MgSO_4$. The solvent was removed *in vacuo* and the residue was purified by column chromatography to give the corresponding 1,3-diketone (**5**).

Spectroscopic Data:

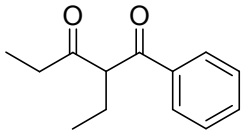
2-Methyl-1-phenylbutane-1,3-dione (5a)[1]



The title product (**5a**) was purified by column chromatography (AcOEt : hexane = 1:9) and was obtained in 62% yield (216.8 mg).

A colorless oil; ^{1}H NMR ($CDCl_3$) δ: 1.46 (3H, d, J = 7.0 Hz), 2.17 (3H, s), 4.50 (1H, q, J = 7.0 Hz), 7.50 (2H, m), 7.61 (1H, m), 7.98 (2H, m); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 13.62, 27.90, 56.77, 128.61, 128.80, 133.62, 135.83, 197.20, 204.94; MS *m*/*z*: 176 (M^+); HRMS Calcd. for $C_{11}H_{12}O_2$: 176.084 (M^+), Found: 176.084; IR (neat) cm^{-1}: 3072, 2992, 2944, 1726, 1678.

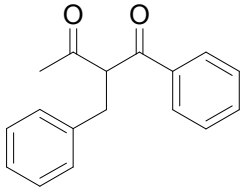
2-Ethyl-1-phenylpentane-1,3-dione (5c)



The title product (**5c**) was purified by column chromatography (AcOEt : hexane = 1:9) and was obtained in 79% yield (321.4 mg).

A colorless oil; ^{1}H NMR ($CDCl_3$) δ: 0.94 (3H, t, J = 7.3 Hz), 1.00 (3H, t, J = 7.4 Hz), 2.04 (2H, m), 2.47 (2H, m), 4.39 (1H, t, J = 7.1 Hz), 7.48 (2H, m), 7.60 (1H, m), 7.99 (2H, m); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 7.65, 12.30, 22.52, 34.01, 64.17, 128.55, 128.77, 133.52, 136.57, 196.52, 206.72; MS *m*/*z*: 204 (M^+); HRMS Calcd. for $C_{13}H_{16}O_2$: 204.115 (M^+), Found: 204.114; IR (neat) cm^{-1}: 2980, 2944, 1726, 1682.

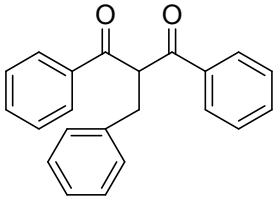
2-Benzyl-1-phenylbutane-1,3-dione (5d)[2]



The title product (**5d**) was purified by column chromatography (AcOEt : hexane = 1:9) and was obtained in 64% yield (321.0 mg).

A colorless oil; ^{1}H NMR ($CDCl_3$) δ: 2.13 (3H, s), 3.32 (2H, m), 4.80 (1H, t, J = 7.2 Hz), 7.16-7.27 (5H, m), 7.45 (2H, m), 7.57 (1H, m), 7.92 (2H, m); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 28.58, 34.75, 64.78, 126.58, 128.55, 128.61, 128.69, 128.74, 133.63, 136.30, 138.27, 195.62, 203.14; MS *m*/*z*: 252 (M^+); HRMS Calcd. for $C_{17}H_{16}O_2$: 252.115 (M^+), Found: 252.115; IR (neat) cm^{-1}: 3068, 3036, 2928, 1722, 1684.

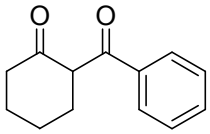
2-Benzyl-1,3-diphenylpropane-1,3-dione (5e)[2]



The title product (**5e**) was purified by column chromatography (AcOEt : hexane = 1:9) and was obtained in 74% yield (468.2 mg).

Colorless crystals; M.p. 105.0-106.0 °C; ^{1}H NMR ($CDCl_3$) δ: 3.45 (2H, d, J = 6.7 Hz), 5.52 (1H, t, J = 6.7 Hz), 7.14-7.26 (5H, m), 7.40 (4H, m), 7.53 (2H, m), 7.89 (4H, m); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 35.16, 58.91, 126.52, 128.50, 128.73, 128.88, 133.41, 135.82, 138.94, 195.25; MS m/z : 314 (M^+); HRMS Calcd. for $C_{22}H_{18}O_2$: 314.131 (M^+), Found: 314.132; IR (KBr) cm^{-1}: 1698, 1668.

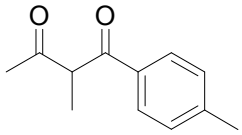
2-Benzoylcyclohexanone (5g) and its tautomer[3]



The title product (**5g**) was purified by column chromatography (AcOEt : hexane = 1:9) and was obtained in 81% yield (327.2 mg) as a mixture of the tatotmers.

A colorless oil; ^{1}H NMR ($CDCl_3$) δ: 1.58-1.64 (1H, m), 1.71-1.81 (1.5H m), 1.87-2.05 (1.5H, m), 2.07-2.15 (0.5H, m), 2.28-2.36 (0.5H, m), 2.39-2.42 (1H, m), 2.47-2.61 (2H, m), 4.38 (0.6H, m), 7.40-7.48 (2.5H, m), 7.52-7.58 (1.5H, m), 7.89-7.91 (1H, m), 16.76 (0.4H, s); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 21.84, 23.06, 23.42, 26.44, 27.27, 29.97, 32.66, 42.24, 58.75, 107.00, 127.47, 127.98, 128.39, 128.55, 130.30, 133.17, 136.40, 137.34, 189.38, 191.26, 197.40, 208.49; MS m/z : 202 (M^+); HRMS Calcd. for $C_{13}H_{14}O_2$: 202.099 (M^+), Found: 202.100; IR (neat) cm^{-1}: 2936, 2864, 1712, 1676, 1602, 1584.

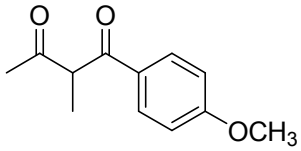
2-Methyl-1-*p*-tolylbutane-1,3-dione (5h)



The title product (**5h**) was purified by column chromatography (AcOEt : hexane = 1:9) and was obtained in 57% yield (215.0 mg).

A colorless oil; ^{1}H NMR ($CDCl_3$) δ: 1.44 (3H, d, J = 7.0 Hz), 2.15 (3H, s), 2.42 (3H, s), 4.47 (1H, q, J = 7.0 Hz), 7.29 (2H, m), 7.88 (2H, m); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 13.62, 21.65, 27.83, 56.69, 128.74, 129.48, 133.36, 144.60, 196.80, 205.10; MS m/z: 190 (M^+); HRMS Calcd. for $C_{12}H_{14}O_2$: 190.099 (M^+), Found: 190.100; IR (neat) cm^{-1}: 2988, 2940, 1724, 1676.

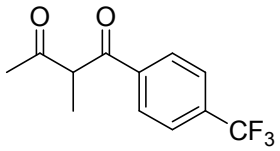
1-(4-Methoxyphenyl)-2-methylbutane-1,3-dione (5i)[4]



The title product (**5i**) was purified by column chromatography (AcOEt : hexane = 1:9) and was obtained in 51% yield (210.4 mg).

A colorless oil; ^{1}H NMR ($CDCl_3$) δ: 1.44 (3H, d, *J* = 7.0 Hz), 2.14 (3H, s), 3.88 (3H, s), 4.43 (1H, q, *J* = 7.0 Hz), 6.96 (2H, m), 7.97 (2H, m); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 13.68, 27.64, 55.52, 56.70, 113.98, 128.89, 131.03, 163.88, 195.54, 205.31; MS *m*/*z*: 206 (M^+); HRMS Calcd. for $C_{12}H_{14}O_3$: 206.094 (M^+), Found: 206.094; IR (neat) cm^{-1}: 2980, 2940, 1724, 1670, 1600, 1264.

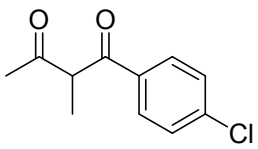
1-[4-(Trifluoromethyl)phenyl]-2-methylbutane-1,3-dione (5j) and its tautomer



The title product (**5a**) was purified by column chromatography (AcOEt : hexane = 1:9) and was obtained in 74% yield (361.0 mg) as a mixture of the tautomers.

Colorless crystals; M.p. 48.0-50.0 °C; ^{1}H NMR ($CDCl_3$) δ: 1.49 (2.55H, d, *J* = 7.0 Hz), 1.92 (0.45H, s), 2.19 (2.55H, s), 2.29 (0.45H, s), 4.49 (0.85H, q, *J* = 7.0 Hz), 7.62 (0.3H, m), 7.70 (0.3H, m), 7.76 (1.7H, m), 8.08 (1.7H, m), 16.5 (0.15H, s); ^{13}C NMR (150 MHz, $CDCl_3$) δ: 13.48, 14.34, 25.87, 27.85, 57.25, 105.23, 123.49 (q, *J* = 272.3 Hz), 123.80 (q, *J* = 272.3 Hz), 125.25 (q, *J* = 4.2 Hz), 125.98 (q, *J* = 4.2 Hz), 128.56, 129.04, 131.87 (q, *J* = 32.8 Hz), 134.93 (q, *J* = 32.8 Hz), 138.68, 139.62, 179.34, 196.32, 199.67, 204.60;^{19}F NMR (90 MHz, $CDCl_3$) δ: –0.51 (3F, s); MS *m*/*z*: 244 (M^+); HRMS Calcd. for $C_{12}H_{11}F_3O_2$: 244.071 (M^+), Found: 244.071; IR (KBr) cm^{-1}: 1716, 1692, 1336, 1170, 1112.

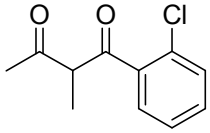
1-(4-Chlorophenyl)-2-methylbutane-1,3-dione (5k)



The title product (**5k**) was purified by column chromatography (AcOEt : hexane = 1:9) and was obtained in 70% yield (295.3 mg).

A colorless oil; ^{1}H NMR ($CDCl_3$) δ: 1.46 (3H, d, *J* = 7.0 Hz), 2.16 (3H, s), 4.44 (1H, q, *J* = 7.0 Hz), 7.46 (2H, m), 7.92 (2H, m); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 13.54, 27.75, 56.91, 129.13, 130.01, 134.16, 140.18, 195.86, 204.70; MS *m*/*z*: 210 (M^+); HRMS Calcd. for $C_{11}H_{11}O_2Cl$: 210.05 (M^+), Found: 210.04; IR (neat) cm^{-1}: 2992, 2940, 1728, 1686, 1592.

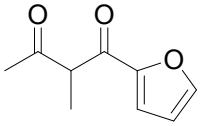
1-(2-Chlorophenyl)-2-methylbutane-1,3-dione (5l) and its tautomer



The title product (**5l**) was purified by column chromatography (AcOEt : hexane = 1:9) and was obtained in 57% yield (242.2 mg) as a mixture of the tautomers.

A colorless oil; ^{1}H NMR ($CDCl_3$) δ: 1.42 (0.75H, d, *J* = 7.2 Hz), 1.69 (2.25H, s), 2.23 (0.75H, s), 2.26 (2.25H, s), 4.48 (0.25H, q, *J* = 7.2 Hz), 7.28-7.46 (5H, m), 16.20 (0.75H, s); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 13.15, 13.42, 25.41, 28.92, 59.94, 106.41, 126.78, 127.03, 128.70, 129.36, 129.62, 130.38, 130.43, 131.24, 132.02, 135.51, 138.47, 180.19, 197.84, 200.33, 204.28; MS *m*/*z*: 210 (M^+); HRMS Calcd. for $C_{11}H_{11}O_2Cl$: 210.05 (M^+), Found: 210.04; IR (neat) cm^{-1}: 2932, 1728, 1696.

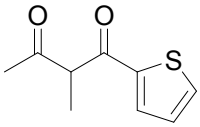
1-(Furan-2-yl)-2-methylbutane-1,3-dione (5m)



The title product (**5m**) was purified by column chromatography (AcOEt : hexane = 2:3) and was obtained in 66% yield (217.9 mg).

A colorless oil; ^{1}H NMR ($CDCl_3$) δ: 1.43 (3H, d, *J* = 7.0 Hz), 2.21 (3H, s), 4.28 (1H, q, *J* = 7.0 Hz), 6.58 (1H, m), 7.29 (1H, m), 7.62 (1H, m); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 12.85, 28.26, 56.87, 112.66, 118.46, 146.91, 151.81, 185.61, 204.26; MS *m*/*z*: 166 (M^+); HRMS Calcd. for $C_9H_{10}O_3$: 166.06 (M^+), Found: 166.06; IR (neat) cm^{-1}: 3144, 2992, 2944, 1728, 1670.

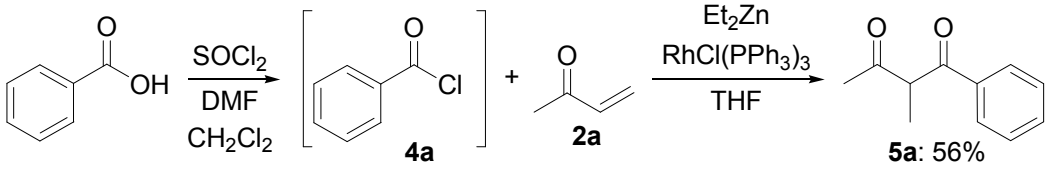
2-Methyl-1-(thiophen-2-yl)butane-1,3-dione (5n)



The title product (**5n**) was purified by column chromatography (AcOEt : hexane = 2:3) and was obtained in 55% yield (200.6 mg).

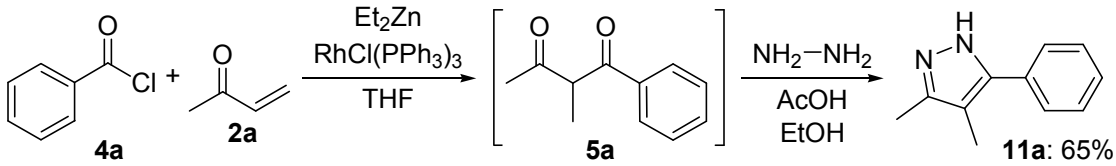
A colorless oil; ^{1}H NMR ($CDCl_3$) δ: 1.48 (3H, d, *J* = 7.1 Hz), 2.19 (3H, s), 4.32 (1H, q, *J* = 7.1 Hz), 7.17 (1H, m), 7.72 (1H, m), 7.79 (1H, m); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 13.67, 27.62, 58.26, 128.41, 133.17, 134.93, 143.19, 189.58, 204.27; MS *m*/*z*: 182 (M^+); HRMS Calcd. for $C_9H_{10}O_2S$: 182.04 (M^+), Found: 182.03; IR (neat) cm^{-1}: 3108, 2992, 2940, 1726, 1664.

Typical procedure for one-pot synthesis of a 1,3-diketone.



To a solution of benzoic acid (2 mmol) of CH_2Cl_2 (5 mL) was added $SOCl_2$ (2.6 mmol) and DMF (2 drops) at room temperature, and was stirred for 20h. The solvent was removed *in vacuo*, then $RhCl(PPh_3)_3$ (2 mol%) and THF (5 mL) were added to the residue. Methyl vinyl ketone (4 mmol) was added to the THF solution at 0 °C, then 1.0 M Et_2Zn in hexane (3 mmol) was gradually added to the mixture. The mixture was stirred at the same temperature for 1h, then it was quenched with 10% HCl, and extracted with AcOEt. The AcOEt layer was washed with sat. NaCl and dried over $MgSO_4$. The solvent was removed *in vacuo* and the residue was purified by column chromatography to give **5a** (197.1 mg, 56%).

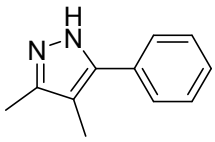
Typical procedure for one-pot synthesis of a pyrazole.



Methyl vinyl ketone (**2a**, 4 mmol) and benzoyl chloride (**4a**, 2 mmol) were added to a solution of $RhCl(PPh_3)_3$ (2 mol%) in THF (5 mL) at 0 °C. Then 1.0 M Et_2Zn in hexane (3 mmol) was gradually added to the mixture at 0 °C, and was stirred at the same temperature for 1h. AcOH (2mL), EtOH (10mL) and hydrazine monohydrate (20 mmol) were added to the mixture, and it was stirred at room temperature for 1h. The mixture was quenched with 10% NaOH, and extracted with AcOEt. The AcOEt layer was washed with sat. NaCl and dried over $MgSO_4$. The solvent was removed *in vacuo* and the residue was purified by column chromatography (AcOEt : hexane = 2:3) to give the pyrazole (**11a**; 224.4 mg, 65%).

Spectroscopic Data:

3,4-Dimethyl-5-phenyl-1H-pyrazole (11a)

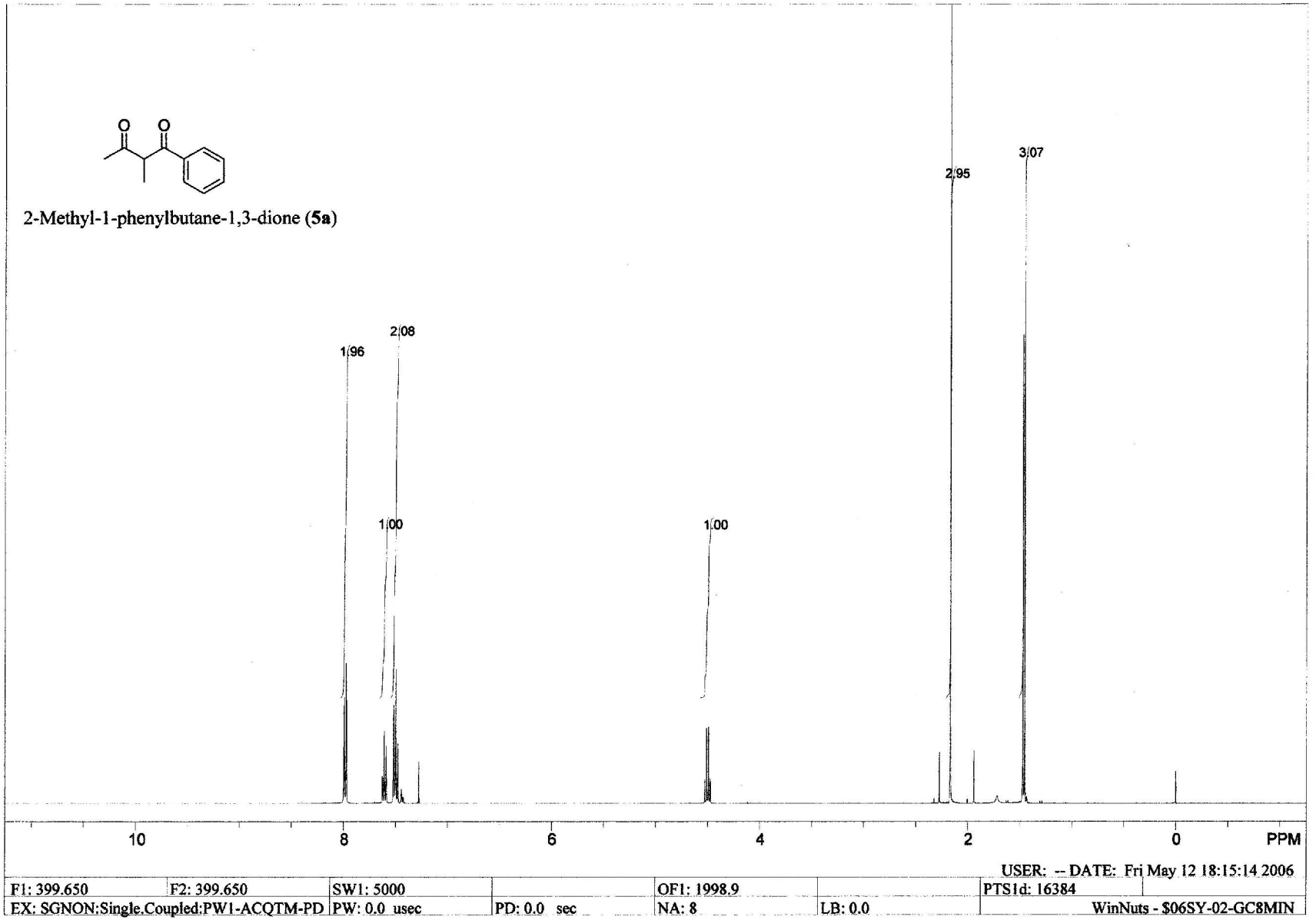


The title product (**11a**) was purified by column chromatography (AcOEt : hexane = 2:3) and was obtained in 65% yield (224.4 mg).

A colorless oil; ^1H NMR ($CDCl_3$) δ: 2.12 (3H, s), 2.18 (3H, s), 7.32 (1H, m), 7.39 (2H, m), 7.55 (2H, m), 10.57 (1H, brs); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 8.80, 10.57, 110.61, 127.43, 127.58, 128.51, 132.37, 142.68, 145.80; MS *m*/*z*: 172 (M^+); HRMS Calcd. for $C_{11}H_{12}N_2$: 172.100 (M^+), Found: 172.100; IR (neat) cm^{-1}: 2952, 1596, 1496, 1448, 770, 700.

References.

1. Dalgaard, L.; Jensen, L.; Lawesson, S. -O. *Tetrahedron* **1974**, *30*, 93-104.
2. Rueping, M.; Nachtsheim, B. J.; Kuenkel, A. *Org. Lett.* **2007**, *9*, 825-828.
3. Nishimura, Y., Miyake, Y., Amemiya, R., Yamaguchi, M. *Org. Lett.* **2006**, *8*, 5077-5080.
4. Davis, B. R.; Hinds, M. G.; Ting, P. P. C. *Aust. J. Chem.* **1992**, *45*, 865-875.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1.00
2.95
3.07
10
8
6
4
2
0
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OF1: 1998.9
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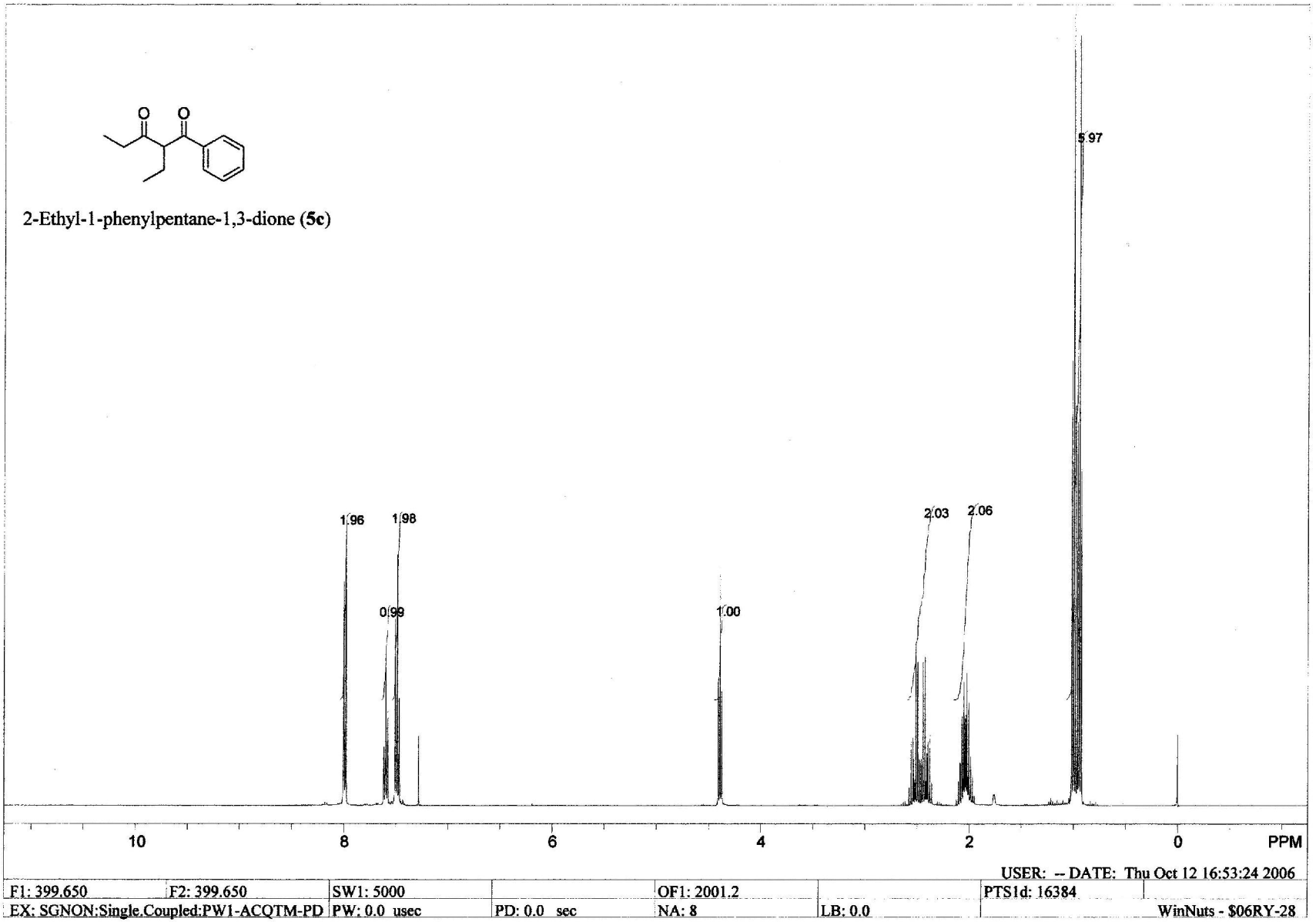
WinNuts - $06SY-02-GC8MIN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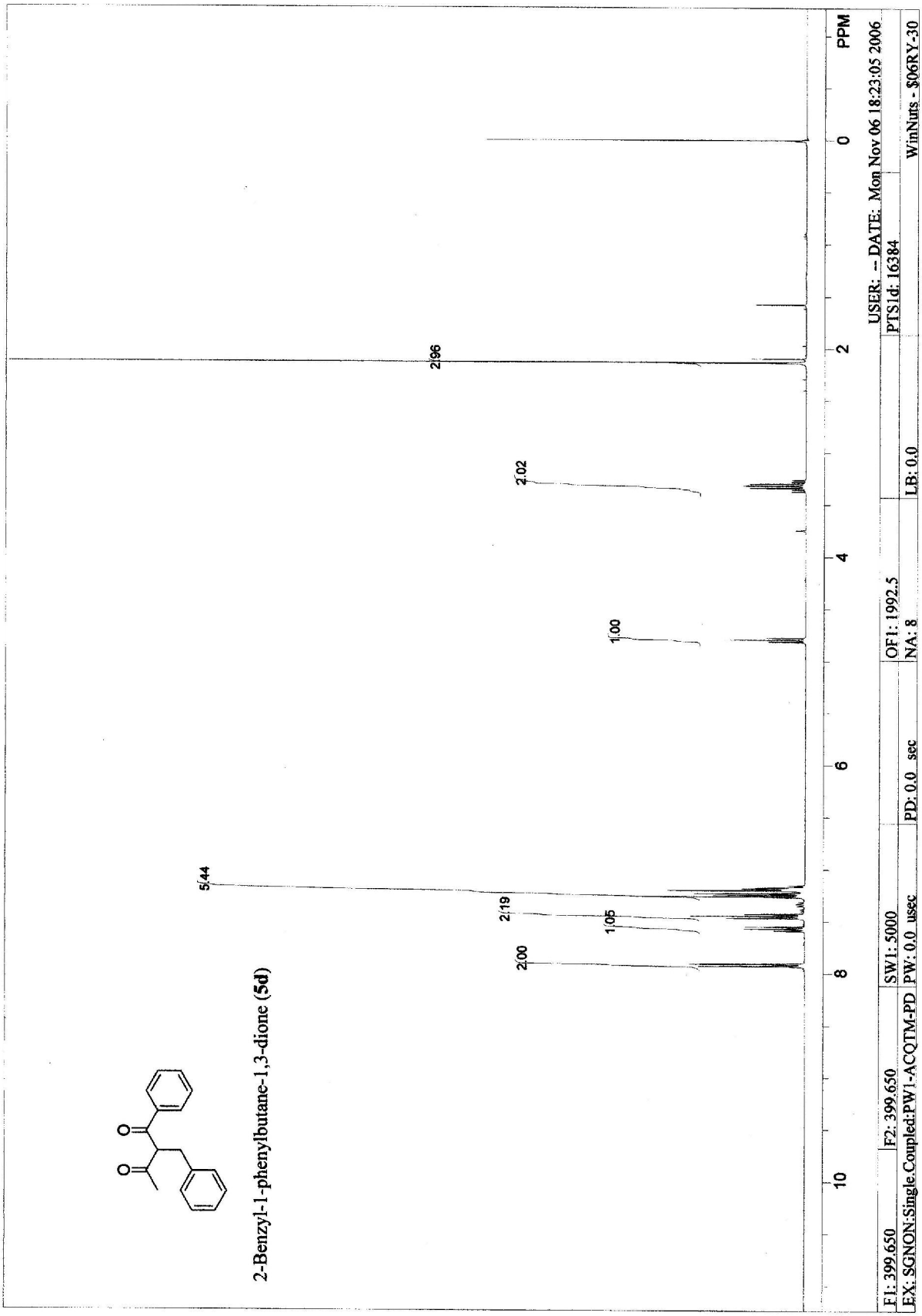
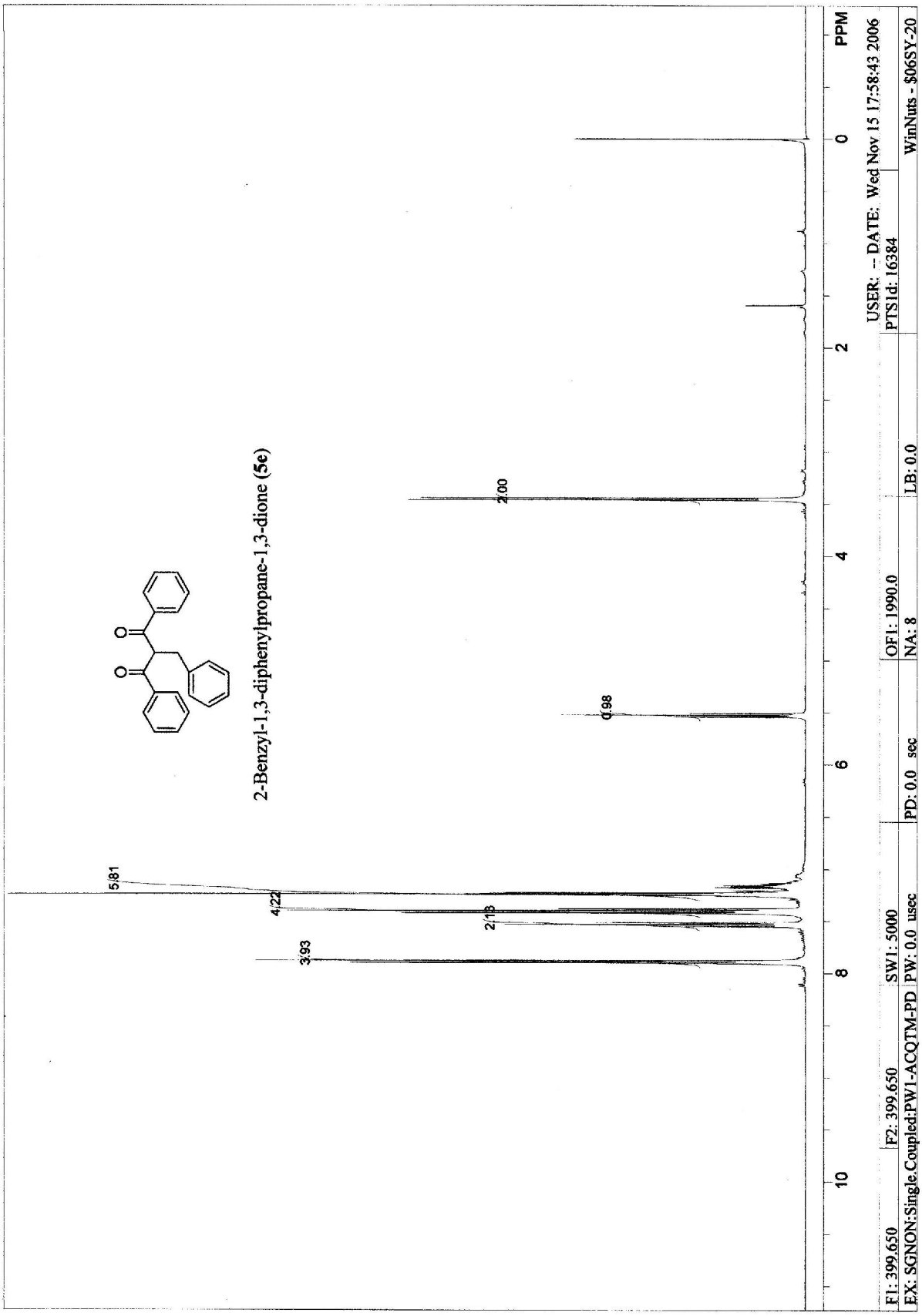
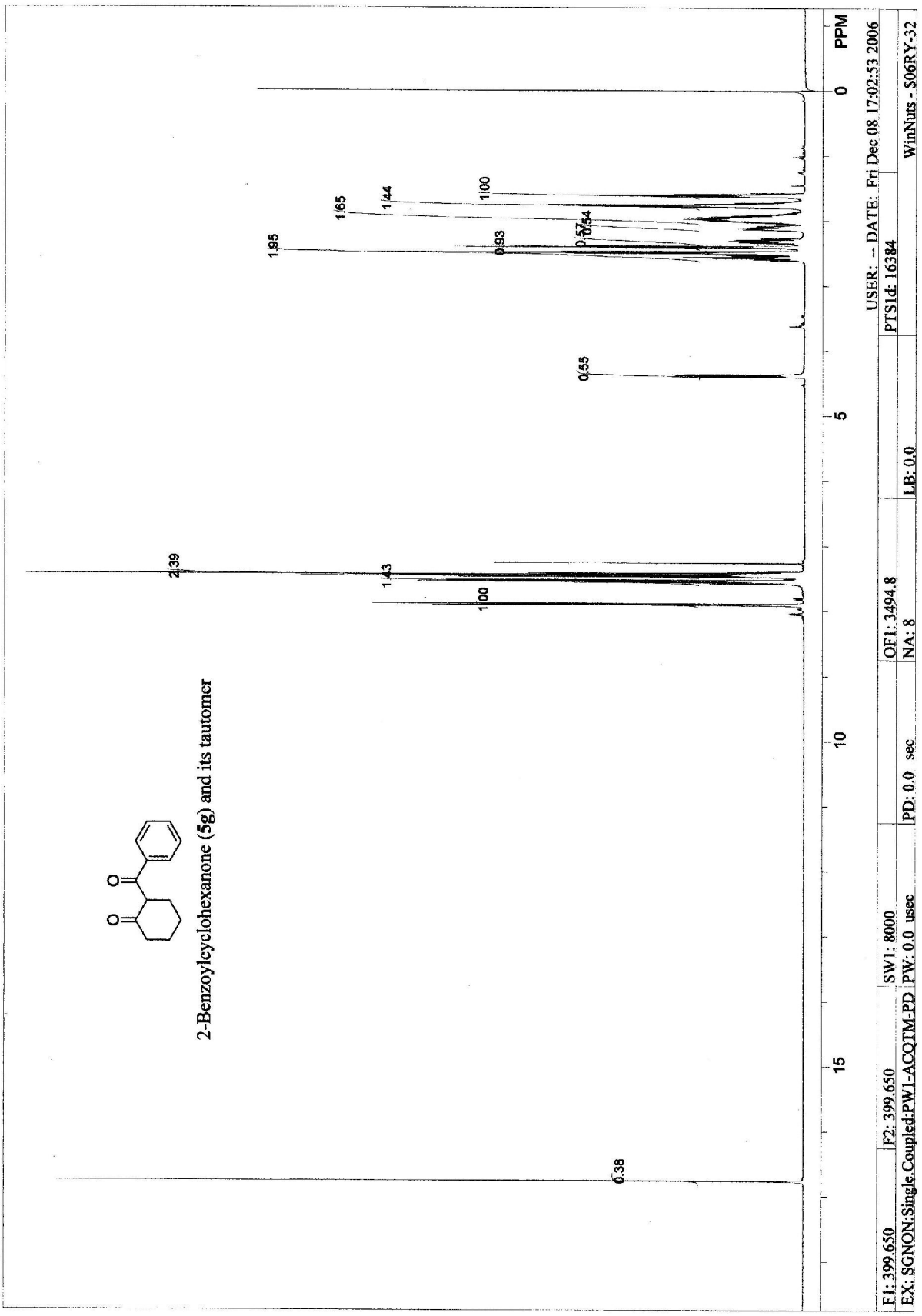
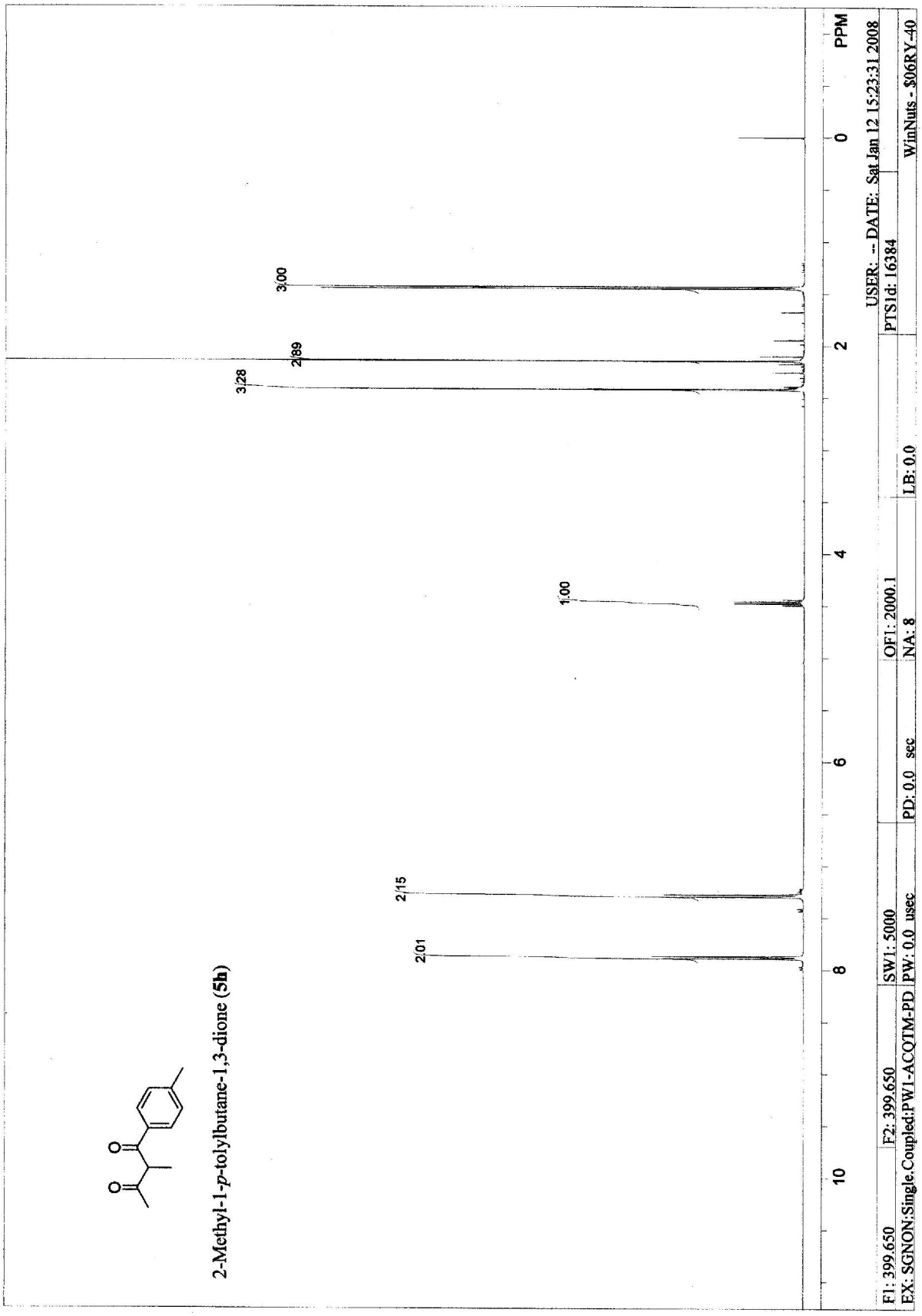
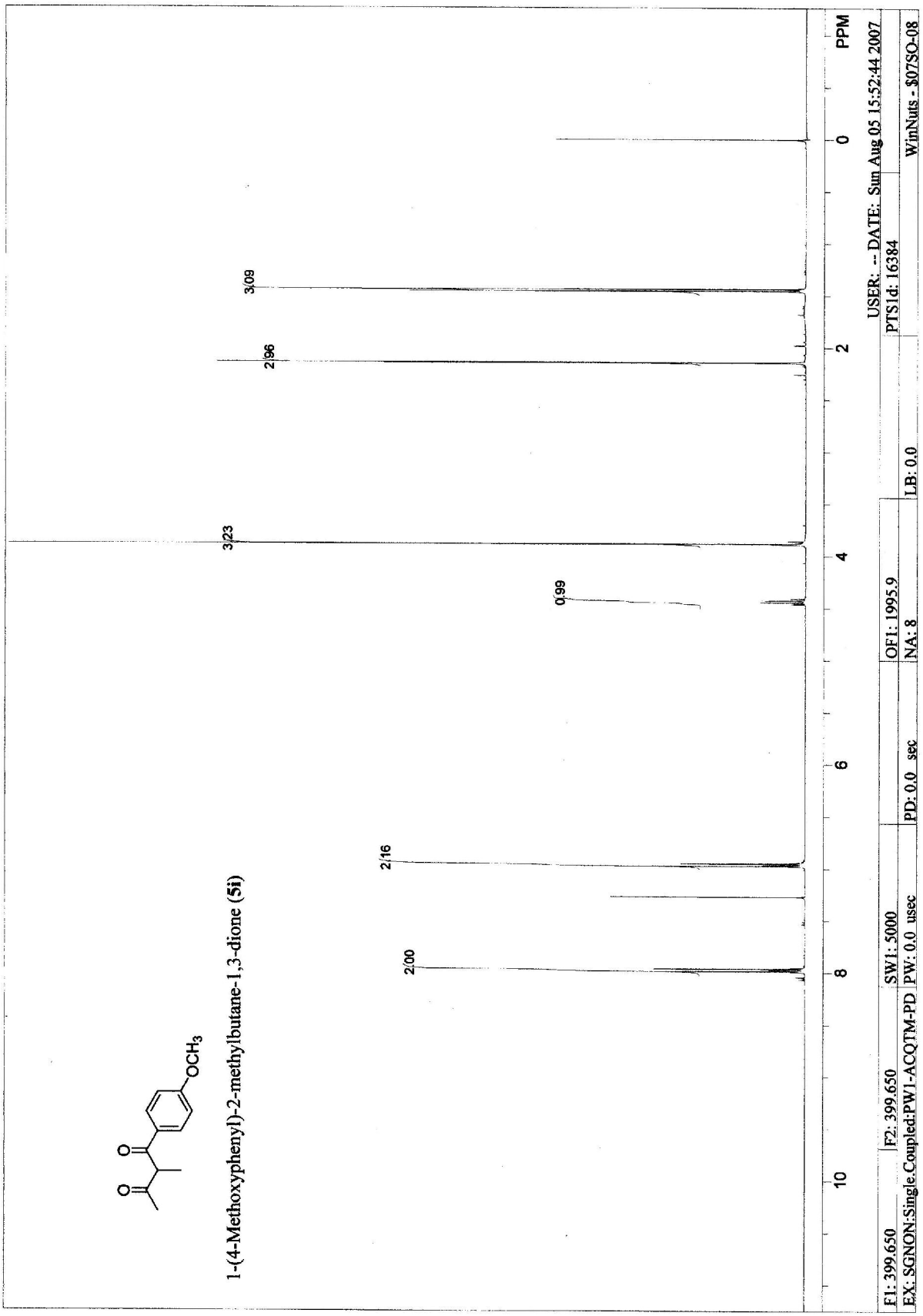
1.00
2.03
2.06
5.97
10
8
6
4
2
0
PPM
USER: -- DATE: Thu Oct 12 16:53:24 2006
F1: 399.650
F2: 399.650
SW1: 5000
OF1: 2001.2
PTS1d: 16384
EX: SGNON:Single.Coupled:PW1-ACQTM-PD
PW: 0.0 usec
PD: 0.0 sec
NA: 8
LB: 0.0
WinNuts - $06RY-28

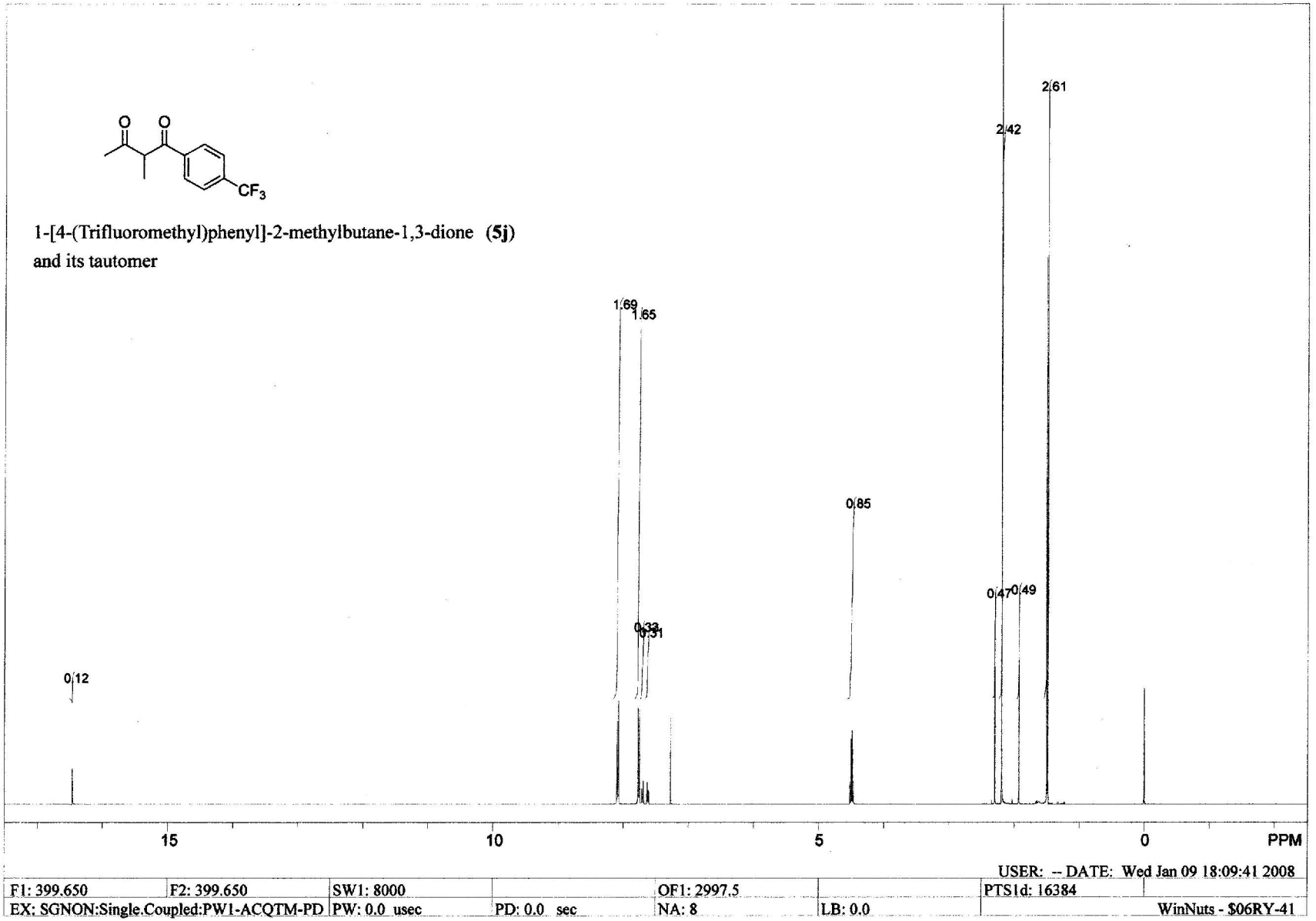

2-Benzyl-1-phenylbutane-1,3-dione (5d)
5.44
2.19
1.05
2.00
2.96
2.02
1.00
PPM
USER: -- DATE: Mon Nov 06 18:23:05 2006
F1: 399.650
F2: 399.650
SW1: 5000
OF1: 1992.5
PTS1d: 16384
EX: SGNON:Single.Coupled:PW1-ACQTM-PD
PW: 0.0 usec
PD: 0.0 sec
NA: 8
LB: 0.0
WinNurs - $06RY-30

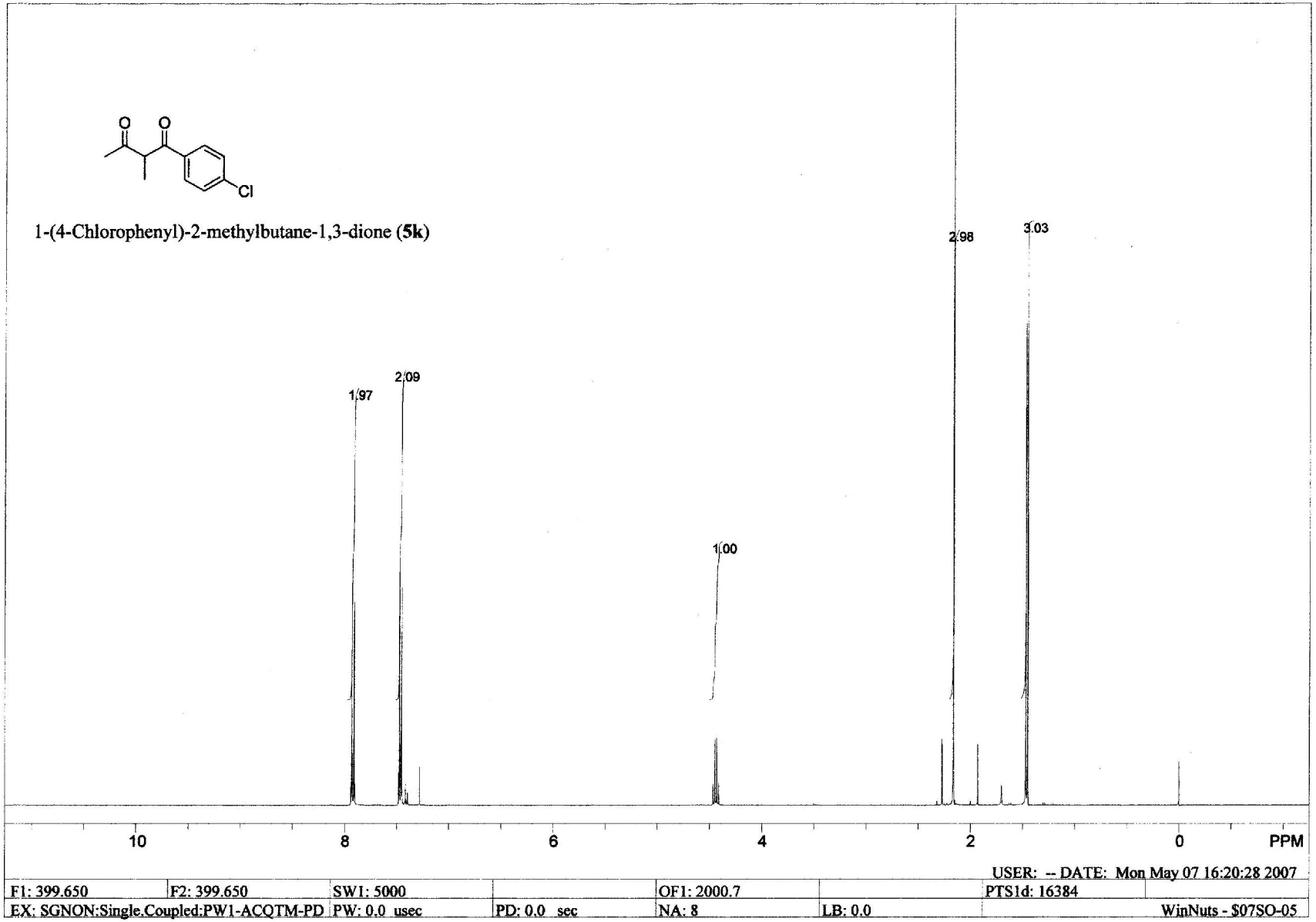

2-Benzyl-1,3-diphenylpropane-1,3-dione (5e)
5.81
4.22
3.93
2.13
2.00
0.98
10
8
6
4
2
0
PPM
F1: 399.650
F2: 399.650
SW1: 5000
OF1: 1990.0
USER: -- DATE: Wed Nov 15 17:58:43 2006
EX: SGNON:Single.Coupled:PW1-ACQTM-PD
PW: 0.0 usec
PD: 0.0 sec
NA: 8
LB: 0.0
PTS1d: 16384
WinNuts - S06SY-20

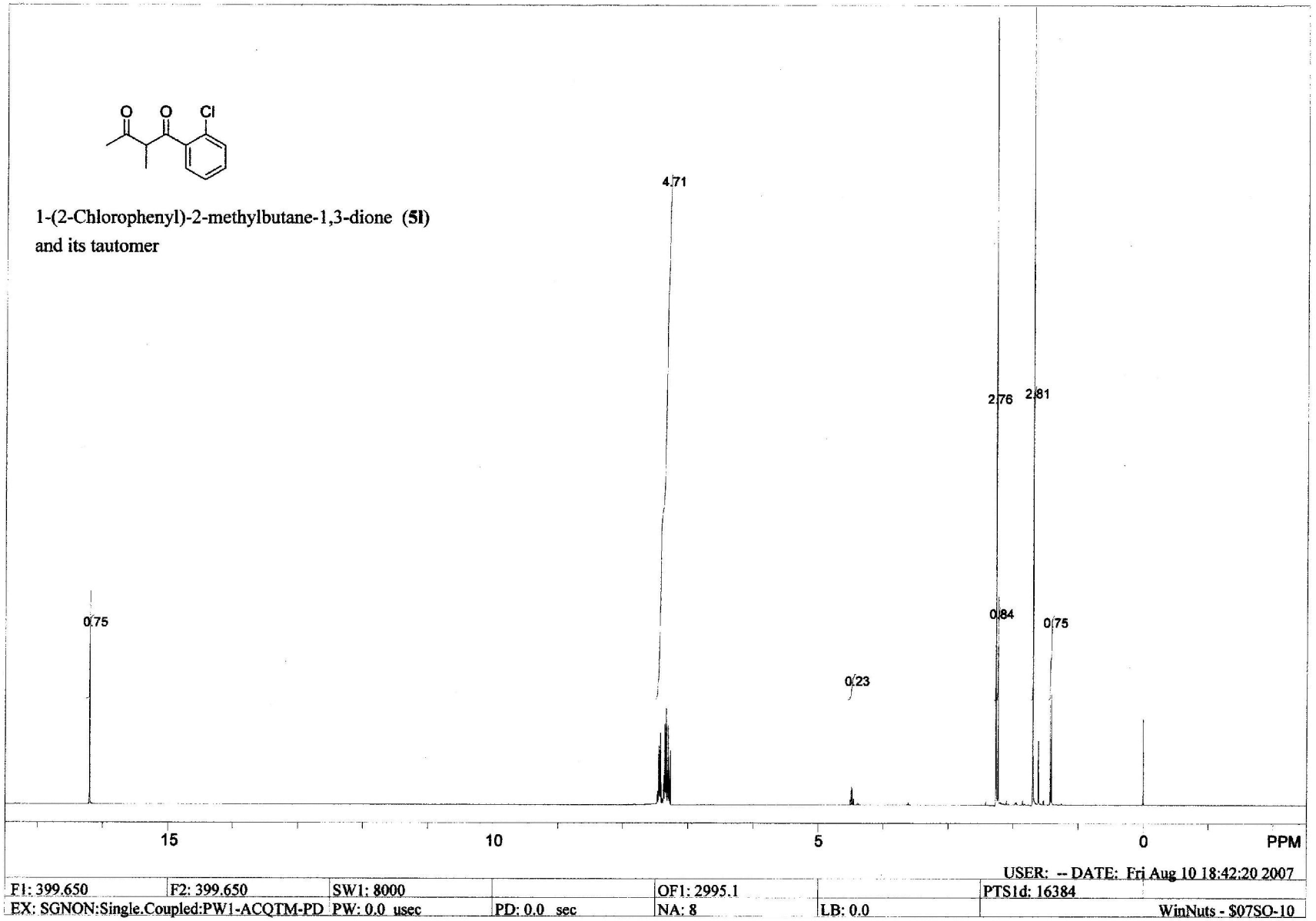

2-Benzoylcyclohexanone (5g) and its tautomer
O
O
2.39
1.43
1.00
0.38
1.95
1.65
1.44
1.00
0.93
0.57
0.54
0.55
15
10
5
0 PPM
F1: 399.650
F2: 399.650
SW1: 8000
OF1: 3494.8
PTS1d: 16384
USER: -- DATE: Fri Dec 08 17:02:53 2006
EX: SGNON:Single.Coupled:PW1-ACQTM-PD
PW: 0.0 usec
PD: 0.0 sec
NA: 8
LB: 0.0
WinNuts - S06RY-32

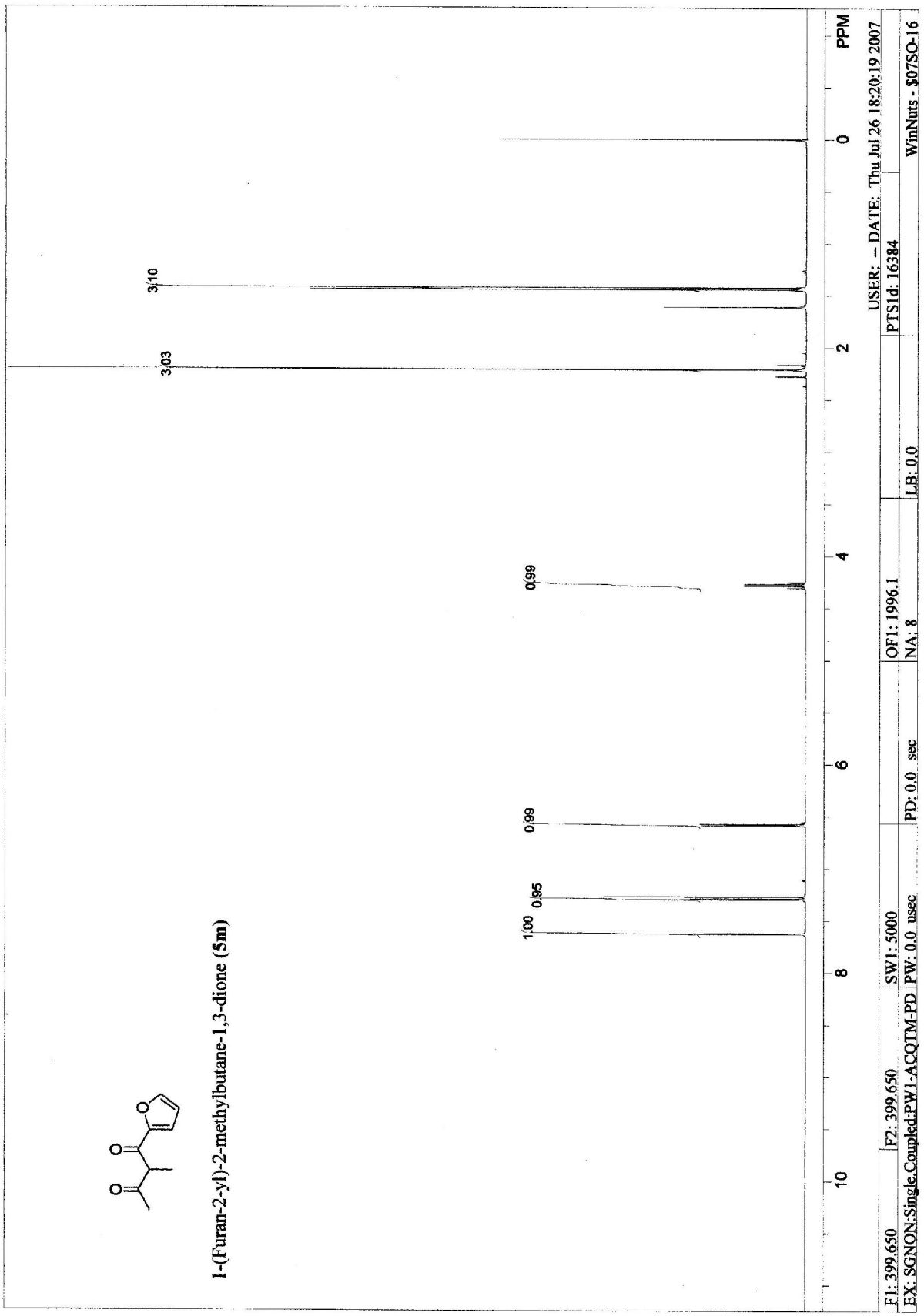

2-Methyl-1-*p*-tolylbutane-1,3-dione (**5h**)
3.00
2.89
3.28
1.00
2.15
2.01
PPM
F1: 399.650
F2: 399.650
SW1: 5000
OF1: 2000.1
PTS1d: 16384
EX: SGNON:Single.Coupled:PW1-ACQTM-PD
PW: 0.0 usec
PD: 0.0 sec
NA: 8
LB: 0.0
USER: -- DATE: Sat Jan 12 15:23:31 2008
WinNuts - \$06RY-40

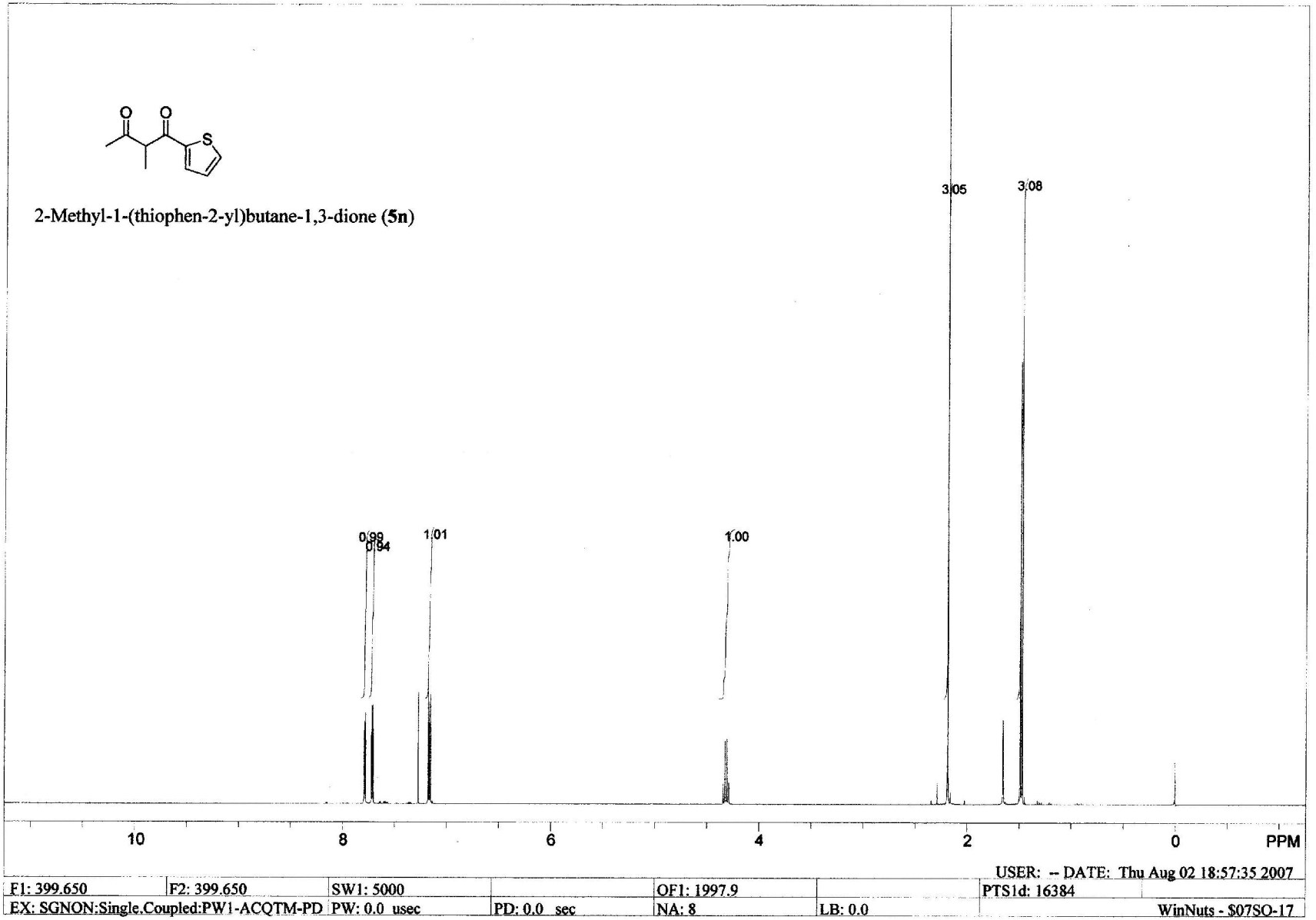

1-(4-Methoxyphenyl)-2-methylbutane-1,3-dione (5i)
OCH3
O
O
3.23
2.96
3.09
0.99
2.16
2.00
10
8
6
4
2
0
PPM
F1: 399.650
F2: 399.650
SW1: 5000
OF1: 1995.9
PTS1d: 16384
USER: -- DATE: Sun Aug 05 15:52:44 2007
EX: SGNON:Single.Coupled:PW1-ACQTM-PD
PW: 0.0 usec
PD: 0.0 sec
NA: 8
LB: 0.0
WinNuts - $07SO-08

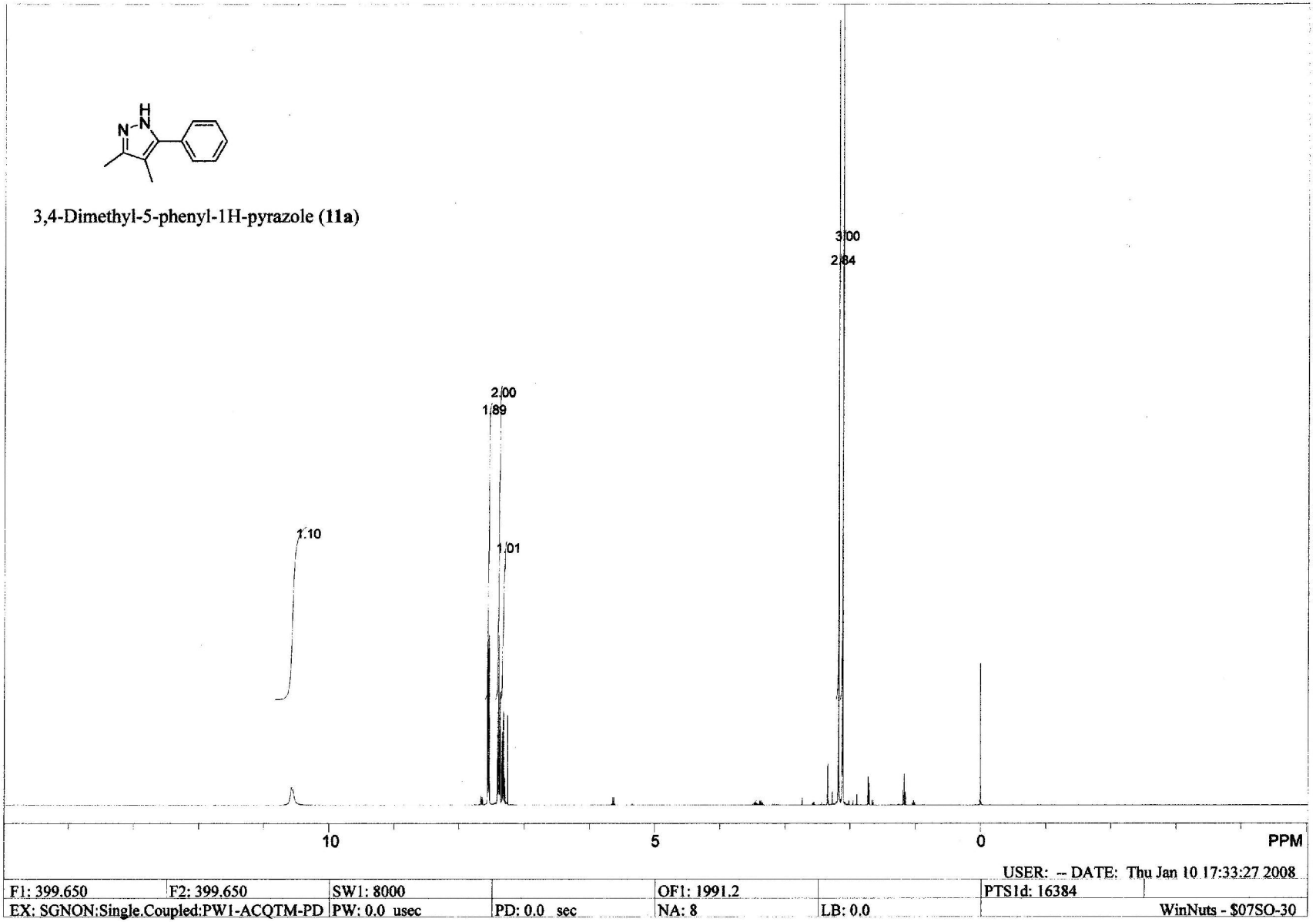

O
O
CF3
1-[4-(Trifluoromethyl)phenyl]-2-methylbutane-1,3-dione (5j)
and its tautomer
2.61
2.42
1.69
1.65
0.85
0.47
0.49
0.33
0.31
0.12
15
10
5
0
PPM
USER: -- DATE: Wed Jan 09 18:09:41 2008
F1: 399.650
F2: 399.650
SW1: 8000
OF1: 2997.5
PTS1d: 16384
EX: SGNON:Single.Coupled:PW1-ACQTM-PD
PW: 0.0 usec
PD: 0.0 sec
NA: 8
LB: 0.0
WinNuts - $06RY-41


1-(4-Chlorophenyl)-2-methylbutane-1,3-dione (5k)
1.97
2.09
1.00
2.98
3.03
10
8
6
4
2
0
PPM
USER: -- DATE: Mon May 07 16:20:28 2007
F1: 399.650
F2: 399.650
SW1: 5000
OF1: 2000.7
PTS1d: 16384
EX: SGNON:Single.Coupled:PW1-ACQTM-PD
PW: 0.0 usec
PD: 0.0 sec
NA: 8
LB: 0.0
WinNuts - S07SO-05


O
O
Cl
1-(2-Chlorophenyl)-2-methylbutane-1,3-dione (5l)
and its tautomer
4.71
2.76
2.81
0.75
0.84
0.75
0.23
15
10
5
0
PPM
USER: -- DATE: Fri Aug 10 18:42:20 2007
F1: 399.650
F2: 399.650
SW1: 8000
OF1: 2995.1
PTS1d: 16384
EX: SGNON:Single.Coupled:PW1-ACQTM-PD
PW: 0.0 usec
PD: 0.0 sec
NA: 8
LB: 0.0
WinNuts - $07SO-10


1-(Furan-2-yl)-2-methylbutane-1,3-dione (5m)
3.10
3.03
0.99
0.99
0.95
1.00
PPM
F1: 399.650
F2: 399.650
SW1: 5000
OF1: 1996.1
PTS1d: 16384
USER: -- DATE: Thu Jul 26 18:20:19 2007
EX: SGNON:Single.Coupled:PW1-ACQTM-PD
PW: 0.0 usec
PD: 0.0 sec
NA: 8
LB: 0.0
WinNuts - $07SO-16


2-Methyl-1-(thiophen-2-yl)butane-1,3-dione (5n)
3.05
3.08
0.99
0.94
1.01
1.00
10
8
6
4
2
0
PPM
USER: -- DATE: Thu Aug 02 18:57:35 2007
F1: 399.650
F2: 399.650
SW1: 5000
OF1: 1997.9
PTS1d: 16384
EX: SGNON:Single.Coupled:PW1-ACQTM-PD
PW: 0.0 usec
PD: 0.0 sec
NA: 8
LB: 0.0
WinNuts - S07SO-17


3,4-Dimethyl-5-phenyl-1H-pyrazole (11a)
3.00
2.84
2.00
1.89
1.10
1.01
10
5
0
PPM
USER: -- DATE: Thu Jan 10 17:33:27 2008
F1: 399.650
F2: 399.650
SW1: 8000
OF1: 1991.2
PTS1d: 16384
EX: SGNON:Single.Coupled:PW1-ACQTM-PD
PW: 0.0 usec
PD: 0.0 sec
NA: 8
LB: 0.0
WinNuts - $07SO-30