Total Synthesis of Aristolactams via One-Pot Suzuki-Miyaura Coupling/Aldol Condensation Cascade Reaction

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SUPPORTING INFORMATION

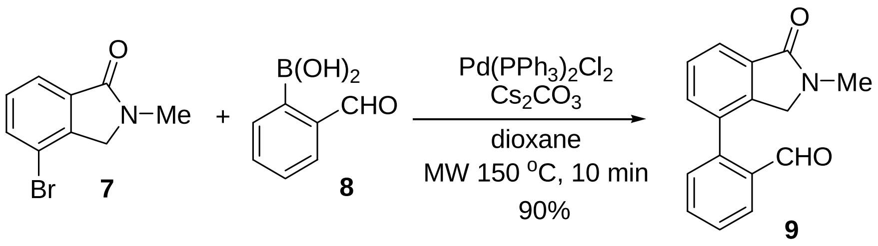
Experimental details and spectroscopic data for compounds **1-5**, **9-16**, **24-30**, and **34-35**. This material is available free of charge via the Internet at http://pubs.acs.org

☞ General

All microwave reactions were conducted in oven-dried microwave glassware by using Biotage Initiator EXP^{TM} microwave reactor under an atmosphere of dry nitrogen. All solvents were purified before use unless otherwise indicated. Toluene was distilled from CaH_2. 2-Formylphenylboronic acids (**8** and **17-23**) were purchased from Aldrich and Frontier Scientific, Inc. and used without further purification.

Analytical thin layer chromatography (TLC) was performed on Kieselgel 60 F_{254} glass plates precoated with a 0.2 mm thickness of silica gel. The TLC plates were visualized by shortwave (254 nm) or longwave (360 nm) UV light, potassium permanganate or ceric ammonium molybdate stain. Flash chromatography on Kieselgel 60 (230400 mesh) silica gel was performed using a CombiFlash Companion system. Preparative HPLC normal phase separations were performed using a Shimadzu HPLC system composed of two LC-8A pumps, a CTO-10A column oven and injector, a SPD-10A detector, and a SCL-10A system controller.

FT-IR spectra were recorded as neat samples using a Travel IR Portable spectrometer. Melting points were determined on a Uni-Melt capillary melting point apparatus and are uncorrected. GC/MS spectra were measured on a Shimadzu spectrometer. ^{1}H NMR and spectra were obtained at 300 MHz on a Varian Gemini 300 instrument using $CDCl_3$ as solvent. ^{1}H NMR assignment abbreviations are the following: singlet (s), doublet (d), triplet (t), quartet (q), broad singlet (bs), doublet of doublets (dd), doublet of triplets (dt), and multiplet (m). ^{13}C NMR spectra were measured at 75.5 MHz or 125 MHz using $CDCl_3$ as an internal reference.



2-(2-Methyl-1-oxoisoindolin-4-yl)benzaldehyde (9). To a thick-well borosilicate glass vial (3 mL) was added isoindolinone **7**[1] (60 mg, 0.26 mmol), boronic acid **8** (48 mg, 0.32 mmol), $Pd(PPh_3)_2Cl_2$ (7.7 mg, 4 mol %), and Cs_2CO_3 (259 mg, 0.79 mmol) sequentially. The mixture was suspended in dioxane (3 mL). Then, the reaction vial was sealed and placed into a microwave reactor and irradiated at 150 ℃

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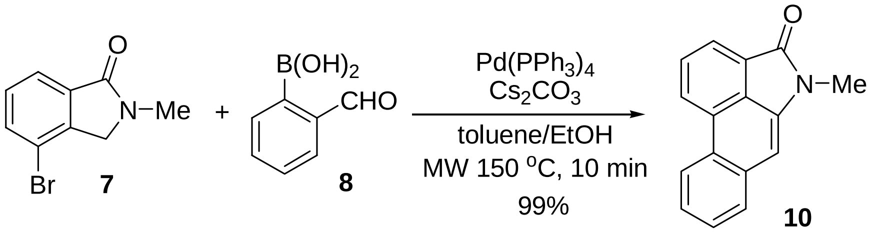
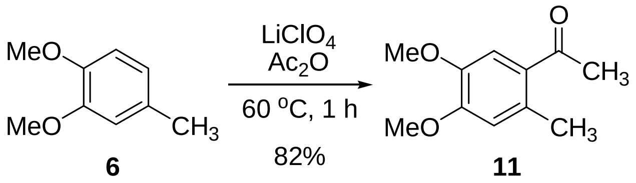
[1] Curtin, M. L.; Davidsen, S. K.; Frey, R. R.; Heyman, H. R.; Holms, J. H.; Michaelides, M.; Steinman, D. H. PCT Int. Appl. (2004), WO 2004108672.

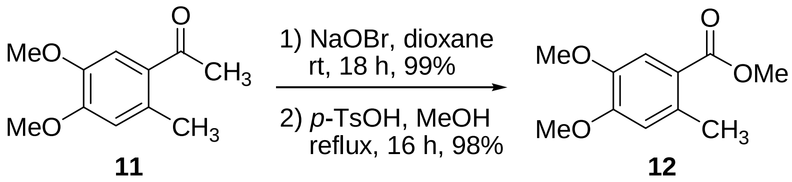
for 10 min. After being cooled to room temperature, the mixture was diluted with EtOAc and filtered through a short Celite pad. The solution was concentrated *in vacuo* and the residue was purified by silica gel flash column chromatography (20% EtOAc/hexanes) to afford biphenyl **9** (62 mg) in 90% yield as a gray solid: mp 152 ℃; ^{1}H NMR (300 MHz, $CDCl_3$) δ 9.84 (s, 1H), 8.08 (dd, 1H, *J* = 7.6, 1.0 Hz), 7.93 (dd, 1H, *J* = 7.5, 0.8 Hz), 7.73-7.67 (m, 1H), 7.59 (t, 2H, *J* = 7.6 Hz), 7.46-7.39 (m, 2H), 4.16 (s, 2H), 3.16 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 191.5, 168.3, 142.1, 140.2, 134.2, 133.8, 133.4, 133.3, 132.8, 130.5, 129.0, 128.6, 128.4, 123.8, 51.7, 29.6; IR (neat) 3305, 1691, 1644, 1254 cm^{-1}; MS (EI) *m/z* 250 (M$^+$, 43), 233 (34), 222 (17), 204 (23), 193 (100), 178 (10), 164 (73), 151 (71); HRMS (EI) calcd for $C_{16}H_{13}NO_2$ [M$^+$] 251.0946, found 251.0955.



5-Methyldibenzo[*cd,f*]indol-4(5*H*)-one (10). To a thick-well borosilicate glass vial (3 mL) was added isoindolinone **7**[1] (60 mg, 0.26 mmol), boronic acid **8** (48 mg, 0.32 mmol), $Pd(PPh_3)_4$ (12 mg, 4 mol %), and Cs_2CO_3 (259 mg, 0.79 mmol) sequentially. The mixture was suspended in toluene/EtOH (2 mL/1 mL). Then, the reaction vial was sealed and placed into a microwave reactor and irradiated at 150 ℃ for 10 min (Usually, an average microwave power ranged from 60W to 80W and an internal pressure was 6-8 bars). After being cooled to room temperature, the mixture was diluted with EtOAc and filtered through a short Celite pad. The solution was concentrated *in vacuo* and the residue was purified by silica gel flash column chromatography (20% EtOAc/hexanes) to afford phenanthrene lactam **10** (60 mg) in 99% yield as a yellowish green solid: mp 176 ℃; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.60 (d, 1H, *J* = 7.9 Hz), 8.55-8.52 (m, 1H), 8.10 (d, 1H, *J* = 6.8 Hz), 7.89-7.81 (m, 2H), 7.62-7.55 (m, 2H), 7.11 (s, 1H), 3.52 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.2, 137.1, 134.0, 129.4, 129.0, 127.8, 126.9, 126.8, 126.5, 126.3, 125.8, 125.5, 123.6, 123.4, 105.0, 26.2; IR (neat) 3272, 1631, 1548, 1320 cm^{-1}; MS (EI) *m/z* 233 (M$^+$, 62), 215 (16), 203 (60), 187 (5), 175 (32), 162 (14), 150 (38); HRMS (EI) calcd for $C_{16}H_{11}NO$ [M$^+$] 233.0841, found 233.0843.



1-(4,5-Dimethoxy-2-methylphenyl)ethanone (11). To a suspension of $LiClO_4$ (34.5 g, 328 mmol) in Ac_2O (18.2 mL, 197 mmol) at 60 ℃ was added 3,4-dimethoxytoluene **6** (23.7 mL, 164 mmol) dropwise. After being stirred for 1 h, the mixture was cooled to rt, quenched with saturated aq. $NaHCO_3$ solution, and extracted with CH_2Cl_2 (3 × 100 mL). The combined organic extracts were dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The residue was purified by silica gel flash column chromatography (20% EtOAc/hexanes) to give acetophenone **11** (26.1 g) in 82% yield: ^{1}H NMR (300MHz, $CDCl_3$) δ 7.26 (s, 1H), 6.71 (s, 1H), 3.93 (s, 3H), 3.91 (s, 3H), 2.57 (s, 3H), 2.53 (s, 3H).



Methyl 4,5-dimethoxy-2-methylbenzoate (12). A solution of sodium hypobromite was prepared *in situ* by mixing of NaOH (32.4 g, 816 mmol) and Br_2 (11.1 mL, 218 mmol) in H_2O (154 mL) at 0 ^{o}C. To the above solution was added a solution of acetophenone **11** (10.0 g, 52 mmol) in dioxane (100 mL) over 30 min and reaction temperature was allowed to increase to rt. After 1 h, the mixture was treated with saturated aq. $NaHSO_3$ (1.2 L) and stirred for 18 h at rt. A half of solvents were removed under reduced pressure. The resulting solution was acidified to pH = 1~2 with conc. HCl to give a crystalline precipitate. Then solid was collected by filtration while rinsing with H_2O and dried *in vacuo* to give the corresponding benzoic acid: ^{1}H NMR (300MHz, $CDCl_3$) δ 7.59 (s, 1H), 6.72 (s, 1H), 3.93 (s, 3H), 3.91 (s, 3H), 3.75 (s, 1H).

The resulting benzoic acid was dissolved in MeOH (100 mL) and *p*-TsOH (15.2 g, 800 mmol) added. The mixture was refluxed for 16 h and solvents were removed under reduced pressure. The residue was diluted with diethyl ether, washed with saturated aq. $NaHCO_3$ solution and brine, dried over $MgSO_4$, and concentrated *in vacuo*. The residue was purified by silica gel flash column chromatography (30% EtOAc/hexanes) to give benzoate **12**[2] (10.6 g) in 98% yield as a white solid: ^{1}H NMR (300MHz, $CDCl_3$) δ 7.48 (s, 1H), 6.70 (s, 1H), 3.92 (s, 3H), 3.90 (s, 3H), 3.87 (s, 3H), 2.58 (s, 3H).

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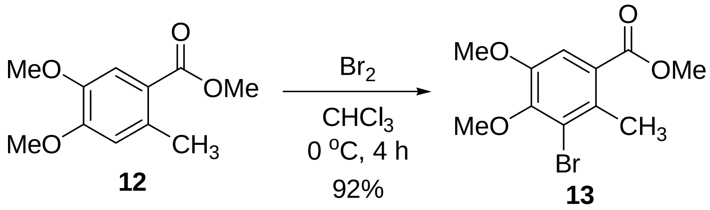
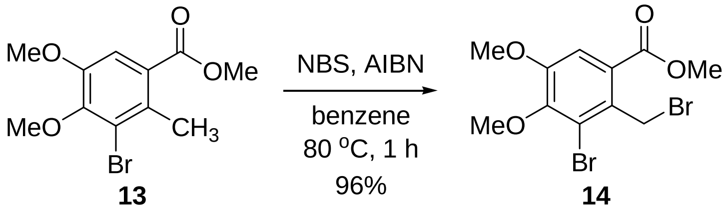
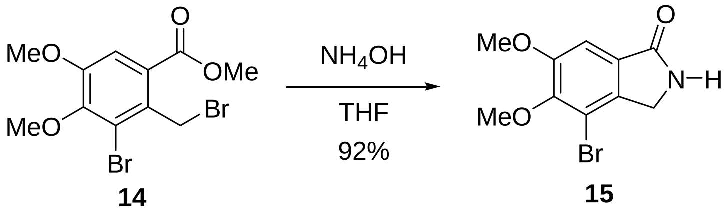
[2] Grethe, G.; Lee, H. L.; Uskokovic, M.; Brossi, A. *J. Org. Chem.* **1968**, *33*, 494–503.



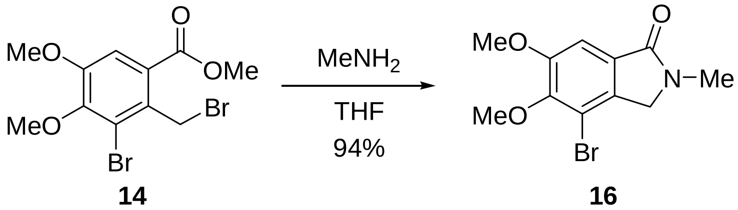
Methyl 3-bromo-4,5-dimethoxy-2-methylbenzoate (13). To a solution of methyl 4,5-dimethoxy-2-methylbenzoate **12** (11.3 g, 53.8 mmol) in 150 mL of $CHCl_3$ at 0 ℃ was added bromine (2.8 mL, 53.8 mmol) dropwise over 30 min. The mixture was stirred at 0 ℃ for 4 h and quenched with saturated aqueous $Na_2S_2O_3$ solution (100 mL). The resulting two phases were separated and the aqueous layer was extracted with EtOAc (2 × 50 mL). The combined organic layers were washed with brine, dried over $MgSO_4$, and concentrated *in vacuo*. The residue was purified by silica gel column chromatography (10% EtOAc/hexanes) to provide benzoate **13** (14.3 g) in 92% yield as a white solid: mp 66 ℃; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.36 (s, 1H), 3.90 (s, 6H), 3.89 (s, 3H), 2.61 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 167.5, 150.6, 149.3, 132.7, 126.8, 122.8, 113.3, 60.4, 56.1, 52.2, 20.3; IR (neat) 2952, 1719, 1485, 1427, 1321, 1249, 1205, 1162, 1012, 987.8, 775.3 cm^{-1}; MS (EI) *m/z* 288 (M^+, 93). 273 (16), 258 (51), 243 (19), 230 (66), 213 (44); HRMS (EI) calcd for $C_{11}H_{13}BrO_4$ [M^+] 287.9997, found 287.9991.



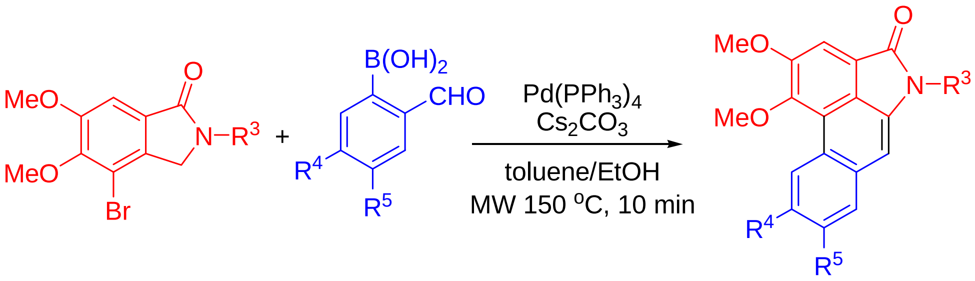
Methyl 3-bromo-2-bromomethyl-4,5-dimethoxybenzoate (14). To a solution of benzoate **13** (24.0 g, 86 mmol) in 200 mL of benzene was added *N*-bromosuccinimide (18.0 g, 103 mmol) and AIBN (1.4 g, 8.6 mmol). The mixture was stirred at reflux temperature for 6 h and cooled to 0 ℃. The precipitate was filtered off and the resulting solution was washed with saturated aqueous $Na_2S_2O_3$ solution (100 mL). The aqueous layer was extracted with Et_2O (2 × 50 mL). The combined organic extracts were washed with brine, dried over $MgSO_4$, and concentrated *in vacuo*. The residue was purified by silica gel column chromatography (10% EtOAc/hexanes) to provide 2-(bromomethyl)benzoate **14** (30.3 g) in 96% yield as a white solid: mp 126 ℃; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.49 (s, 1H), 5.16 (s, 2H), 3.96 (s, 3H), 3.93 (s, 3H), 3.92 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 166.1, 152.6, 149.8, 131.6, 126.4, 123.1, 114.0, 60.5, 56.2, 52.6, 31.1; IR (neat) 2947, 2843, 1716, 1585, 1485, 1423, 1321, 1256, 1203, 1161, 986, 876 cm^{-1}; MS (EI) *m/z* 365 (M^+, 47), 288 (100), 272 (4), 256 (21), 244 (8); HRMS (EI) calcd for $C_{11}H_{12}Br_2O_4$ [M^+] 365.9102, found 365.9108.



4-Bromo-5,6-dimethoxyisoindolin-1-one (15). To a solution of 2-(bromomethyl)benzoate **14** (368 mg, 1.0 mmol) in 5 mL of THF was added ammonium hydroxide (0.4 mL of 48 wt% in H_2O, 5.0 mmol). The mixture was stirred at room temperature for 2 d and THF was removed under reduced pressure. The residue was diluted with H_2O (10 mL) and extracted with EtOAc (3 × 10 mL). The combined organic layers were washed with brine, dried over $MgSO_4$, and concentrated *in vacuo*. The residue was purified by recrystallization (EtOAc/hexanes) to provide isoindolin-1-one **15** (248 mg) in 92% yield as a white solid: mp 205 ℃; ^{1}H NMR (300 MHz, DMSO–d_6) δ 8.67 (s, 1H), 7.29 (s, 1H), 4.19 (s, 2H), 3.89 (s, 1H), 3.79 (s, 1H); ^{13}C NMR (125 MHz, DMSO–d_6) δ 169.1, 153.8, 148.7, 136.8, 129.3, 112.2, 106.0, 60.3, 56.4, 45.1; IR (neat) 3212, 1717, 1670, 1478, 1318, 1081, 1029, 966, 855 cm^{-1}; MS (EI) *m/z* 270 (M$^+$, 47); HRMS (EI) calcd for $C_{10}H_{10}BrNO_3$ [M$^+$] 270.9844, found 270.9848.

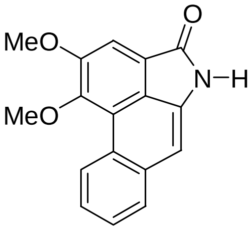


4-Bromo-5,6-dimethoxy-2-methylisoindolin-1-one (16). To a solution of 2-(bromomethyl)benzoate **14** (15.6 g, 40.5 mmol) in 100 mL of THF was added methylamine (17.5 mL of 40 wt% in H_2O, 202.5 mmol). The mixture was stirred at room temperature for 2 h and THF was removed under reduced pressure. The residue was diluted with H_2O (50 mL) and extracted with EtOAc (3 × 50 mL). The combined extracts were washed with brine, dried over $MgSO_4$, and concentrated *in vacuo*. The residue was purified by recrystallization (EtOAc/hexanes) to provide isoindolin-1-one **16** (10.9 g) in 94% yield as a white solid: mp 165 ℃; ^{1}H NMR (300MHz, $CDCl_3$) δ 7.31 (s, 1H), 4.21 (s, 2H), 3.93 (s, 3H), 3.91 (s, 3H), 3.20 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 167.9, 154.2, 149.3, 134.4, 129.3, 112.3, 105.9, 60.8, 56.4, 52.2, 29.5, 14.1; IR (neat) 2840, 1673, 1473, 1414, 1394, 1310, 1045, 1022, 984, 929, 757 cm^{-1}; MS (EI) *m/z* 284 (M$^+$, 95), 255 (100), 206 (42); HRMS (EI) calcd for $C_{11}H_{12}BrNO_3$ [M$^+$] 285.0001, found 284.9997.



Typical procedure for direct "one-pot" synthesis of phenanthrene lactams

To a thick-well borosilicate glass vial (3 mL) was added isoindolin-1-one **15** or **16** (0.5 mmol), boronic acid (0.6 mmol), $Pd(PPh_3)_4$ (4 mol %), and Cs_2CO_3 (1.5 mmol) sequentially. The mixture was suspended in toluene/EtOH (2 mL/1 mL). Then, the reaction vial was sealed and placed into a microwave reactor and irradiated at 150 °C for 10 min (Usually, the average microwave power ranged from 60 to 80 W and the internal pressure was 6–8 bars). After being cooled to room temperature, the mixture was diluted with EtOAc and filtered through a short Celite pad. The solution was concentrated *in vacuo*, and the residue was purified by silica gel flash column chromatography (EtOAc/hexanes) to afford a phenanthrene lactam product.



Aristolactam BII (**1**)

Aristolactam BII (Cepharanone B, 1). Yield 81%, light yellow solid, mp 254 ℃ (lit.[3] 249–251 ℃); ^{1}H NMR (300 MHz, DMSO–d_6) δ 10.84 (s, 1H), 9.11 (d, 2H, $J = 8.9$ Hz), 7.94 (d, 1H, $J = 7.9$ Hz), 7.85 (s, 1H), 7.58-7.54 (m, 2H), 7.13 (s, 1H), 4.03 (s, 3H), 4.02 (s, 3H); ^{13}C NMR (125 MHz, DMSO–d_6) δ 168.4, 154.2, 150.3, 135.1, 134.8, 129.0, 127.5, 126.8, 125.9, 125.5, 123.3, 121.5, 119.9, 109.9, 104.6, 59.9, 56.9; IR (neat) 3453, 2411, 2277, 1703, 1317, 1255, 1136, 772, 432 cm^{-1}; MS (EI) *m/z* 279 (M^+, 100), 264 (18), 236 (23), 221 (14), 218 (12), 209 (17), 193 (21), 181 (25); HRMS (EI) calcd for $C_{17}H_{13}NO_3$ [M^+] 279.0895, found 279.0892.

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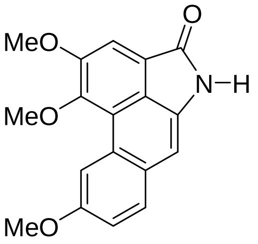
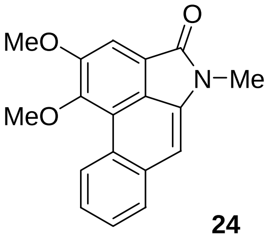
[3] Castedo, L.; Guitian, E.; Saa, J. M.; Suau, R. *Heterocycles* **1982**, *19*, 279–280.



Aristolactam BIII (**2**)

Aristolactam BIII (2). Yield 83%, yellow solid, mp 227 ℃ (lit.[4] 225 ℃); ^{1}H NMR (300 MHz, DMSO–d_6) δ 10.75 (s, 1H), 8.64 (d, 1H, J = 2.1 Hz), 7.87 (d, 1H, J = 8.8 Hz), 7.83 (s, 1H), 7.24 (dd, 1H, J = 8.7, 2,5 Hz), 7.08 (s, 1H), 4.04 (s, 3H), 4.03 (s, 3H), 3.90 (s, 3H); ^{13}C NMR (125 MHz, DMSO–d_6) δ 168.1, 157.0, 153.9, 150.3, 133.1, 130.0, 128.7, 127.0, 123.4, 121.6, 119.6, 116.1, 110.0, 109.4, 104.5, 59.9, 56.9, 55.1; IR (neat) 2359, 1697, 1503, 1374, 1267, 783, 759 cm^{-1}; MS (EI) *m/z* 309 (M$^+$, 100), 294 (22), 279 (5), 266 (18), 251 (17), 238 (12), 223 (10), 195 (7), 180 (13); HRMS (EI) calcd for $C_{18}H_{15}NO_4$ [M$^+$] 309.1001, found 309.0998.



24

1,2-Dimethoxy-5-methyldibenzo[*cd,f*]indol-4-(5*H*)-one (24). Yield 86%, yellowish green solid, mp 189 ℃ (lit.[5] 193–194 ℃); ^{1}H NMR (300 MHz, $CDCl_3$) δ 9.24-9.21 (m, 1H), 7.85-7.82 (m, 1H), 7.79 (s, 1H), 7.58-7.55 (m, 1H), 7.00 (s, 1H), 4.11 (s, 3H), 4.07 (s, 3H), 3.49 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 167.9, 154.3, 151.0, 137.1, 134.7, 128.9, 127.5, 127.4, 127.1, 125.7, 122.9, 121.2, 120.5, 109.4, 103.9, 60.2, 56.8, 26.2; IR (neat) 1697, 1647, 1456, 1399, 1315, 1232, 1117, 1017, 752 cm^{-1}; MS (EI) *m/z* 293.0 (M$^+$, 100) 278.0 (12), 250.0 (27), 235.0 (11), 222.0 (9); HRMS (EI) calcd for $C_{18}H_{15}NO_4$ [M$^+$] 293.1052, found 293.1046.

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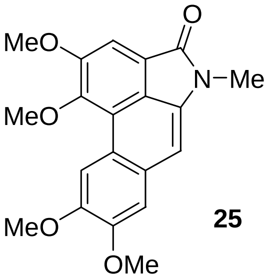
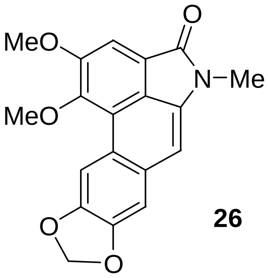
[4] Crohare, R.; Priestap, H. A.; Farina, M.; Cedola, M.; Ruveda, E. A. *Phytochemistry* **1974**, *13*, 1957–1962.

[5] Rao, K. V.; Reddy, G. C. S. *J. Nat. Prod.* **1990**, *53*, 309–312.



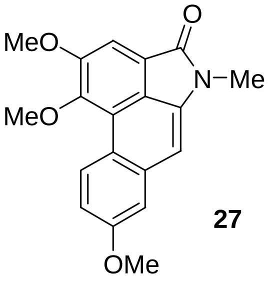
25

1,2,8,9-Tetramethoxy-5-methyldibenzo[*cd,f*]indol-4-(5*H*)-one (25). Yield 86%, yellow solid, mp 218 ℃ (lit.[6] 216–217 ℃); ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.70 (s, 1m), 7.68 (s, 1H), 7.15 (s, 1H), 6.81 (s, 1H), 4.09 (s, 3H), 4.07 (s, 3H), 4.03 (s, 3H), 4.02 (s, 3H), 3.41 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.7, 153.8, 149.9, 149.0, 147.6, 135.9, 129.6, 121.8, 121.4, 120.8, 120.1, 109.3, 108.8, 108.6, 103.4, 60.2, 56.8, 55.8, 26.2; IR (neat) 2360, 2341, 1690, 1504, 1401, 1250, 1107, 1024, 668 cm^{-1}; MS (EI) *m/z* 353 (M^+, 100), 338 (24), 309 (6), 294 (8), 279 (11), 251 (3); HRMS (EI) calcd for $C_{20}H_{19}NO_5$ [M^+] 353.1263, found 353.1275.



26

Aristolactam (26). Yield 80%, yellow solid, mp 261 ℃; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.69 (s, 1H), 7.78 (s, 1H), 7.22 (s, 1H), 6.91 (s, 1H), 6.12 (s, 2H), 4.09 (s, 3H), 4.06 (s, 3H), 3.47 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 167.8, 153.9, 150.4, 147.6, 146.7, 136.2, 131.1, 122.2, 121.9, 121.4, 120.5, 109.3, 106.9, 106.2, 104.1, 101.4, 60.3, 56.9, 26.3; IR (neat) 3453, 2359, 1700, 1476, 1236, 1075, 772, 431 cm^{-1}; MS (EI) *m/z* 337 (M^+, 47), 288 (100), 272 (4), 256 (21), 244 (8); HRMS (EI) calcd for $C_{19}H_{15}NO_5$ [M^+] 337.0950, found 337.0941.



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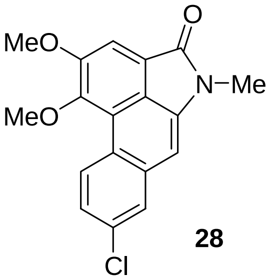
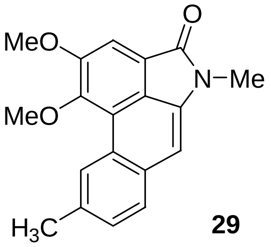
[6] Castedo, L.; Suau, R.; Mouriño, A. *Tetrahedron Lett.* **1976**, *6*, 501–502.

1,2,8-Trimethoxy-5-methyldibenzo[*cd,f*]indol-4-(5*H*)-one (27). Yield 87%, yellow solid, mp 216 ℃; ^{1}H NMR (300MHz, $CDCl_3$) δ 9.12 (d, 1H, *J* = 9.0 Hz), 7.73 (s, 1H), 7.26 (d, 1H, *J* = 2.8 Hz), 7.15 (dd, 1H, *J* = 9.0, 2.7 Hz), 6.94 (s, 1H), 4.09 (s, 3H), 4.06 (s, 3H), 3.96 (s, 3H), 3.48 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.9, 158.5, 154.2, 150.0, 137.5, 136.4, 128.7, 122.0, 121.1, 120.8, 120.5, 114.2, 110.8, 108.3, 103.5, 60.1, 56.7, 55.6, 26.1; IR (neat) 2937, 2838, 1698, 1401, 1228, 1110, 1016, 867, 830 cm^{-1}; MS (EI) *m/z* 323 (M^{+}, 100), 309 (12), 308 (68), 279 (51), 265 (65), 252 (17), 249 (16), 237 (17), 208 (22), 193 (12); HRMS (EI) calcd for $C_{19}H_{17}NO_4$ [M^{+}] 323.1158, found 323.1158.



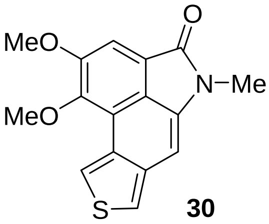
28

8-Chloro-1,2-dimethoxy-5-methyldibenzo[*cd,f*]indol-4-(5*H*)-one (28). Yield 86%, light yellow solid, mp 210 ℃; ^{1}H NMR (300MHz, $CDCl_3$) δ 9.14 (d, 1H, *J* = 8.8 Hz), 7.80 (s, 2H), 7.50 (dd, 1H, *J* = 8.8, 2.1 Hz), 6.90 (s, 1H), 4.10 (s, 3H), 4.07 (s, 3H), 3.48 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.9, 154.5, 150.8, 138.2, 136.2, 133.2, 128.9, 127.9, 125.9, 125.3, 122.8, 121.2, 120.1, 109.7, 102.5, 60.4, 56.9, 26.4; IR (neat) 2935, 1685, 1646, 1446, 1316, 1232, 1017, 823, 758 cm^{-1}; MS (EI) *m/z* 327 (M^{+}, 100), 311 (28), 283 (14), 277 (35), 268 (13), 249 (81), 215 (10), 212 (27), 178 (14); HRMS (EI) calcd for $C_{18}H_{14}ClNO_3$ [M^{+}] 327.0662, found 327.0660.



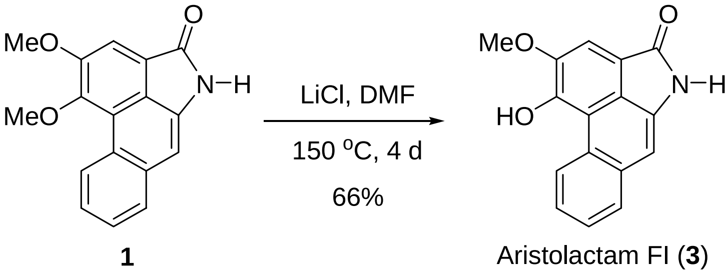
29

1,2-Dimethoxy-5,9-dimethyldibenzo[*cd,f*]indol-4-(5*H*)-one (29). Yield 81%, yellow solid, mp 200 ℃; ^{1}H NMR (300MHz, $CDCl_3$) δ 9.03 (s, 1H), 7.79 (s, 1H), 7.73 (d, 1H, *J* = 8.1 Hz), 7.41 (dd, 1H, *J* = 8.1, 1.2 Hz), 6.98 (s, 1H), 4.11 (s, 3H), 4.06 (s, 3H), 3.48 (s, 3H), 2.59 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.9, 154.2, 151.0, 136.4, 135.5, 132.4, 128.9, 128.8, 127.6, 127.2, 123.0, 121.3, 120.4, 109.4, 104.1, 60.3, 56.9, 26.3, 22.1; IR (neat) 2935, 1693, 1645, 1395, 1114, 1025, 956, 844 cm^{-1}; MS (EI) *m/z* 307 (M^{+}, 100), 292 (12), 277 (10), 264 (37), 249 (51), 236 (10) 193 (19), 192 (15); HRMS (EI) calcd for $C_{19}H_{17}NO_3$ [M^+] 307.1208, found 307.1202.



30

1,2-Dimethoxy-5-methylbenzo[*cd*]thieno[3,4-*f*]indol-4(5*H*)-one (30). Yield 35%, brown solid, mp 188 ℃; ^{1}H NMR (300MHz, $CDCl_3$) δ 8.45 (dd, 1H, *J* = 3.1, 0.7 Hz), 7.58 (s, 1H), 7.51 (d, 1H, *J* = 3.1 Hz), 6.80 (s, 1H), 4.13 (s, 3H), 4.03 (s, 3H), 3.43 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 168.0, 154.2, 149.0, 138.3, 136.6, 129.9, 124.3, 121.9, 121.3, 118.5, 117.6, 107.4, 98.5, 60.2, 56.7, 26.3; IR (neat) 3100, 2994, 2931, 1689, 1386, 1311, 1131, 1017, 955, 815, 755 cm^{-1}; MS (EI) *m/z* 299 (M^+, 100), 284 (26), 256 (42), 241 (36), 239 (14), 186 (14), 185 (35), 183 (12); HRMS (EI) calcd for $C_{16}H_{13}NO_3S$ [M^+] 299.0616, found 299.0613.



Aristolactam FI (Piperolactam A, 3). To a solution of cepharanone B **1** (279 mg, 1.0 mmol) in 3 mL of DMF was added lithium chloride (420 mg, 10.0 mmol). The mixture was stirred at 150 ℃ for 4 d and cooled to room temperature. The reaction mixture was diluted with H_2O (5 mL) and extracted with EtOAc (3 × 10 mL). The combined organic layers were washed with H_2O and brine, dried over $MgSO_4$, and concentrated *in vacuo*. The residue was purified by silica gel column chromatography (50% EtOAc/hexanes) to provide piperolactam **3** (175 mg) in 66% yield as a yellow solid: mp 234-235 ℃ (lit.[7] 303–306 ℃); ^{1}H NMR (300 MHz, DMSO–d_6) δ 10.65 (s, 1H), 9.26-9.23 (m, 1H), 7.93-7.90 (m, 1H), 7.75 (s, 1H), 7.55-7.50 (m, 2H), 7.11 (s, 1H), 4.03 (s, 3H); ^{13}C NMR (125 MHz, DMSO–d_6) δ 168.8, 149.3, 148.2, 135.1, 134.1, 128.6, 127.4, 126.6, 126.5, 124.9, 124.3, 115.9, 114.4, 108.5, 104.3, 57.1; IR (neat) 3482, 2361, 1684, 1375, 1241, 772, 443 cm^{-1}; MS (EI) *m/z* 265.1 (M^+, 100), 250 (54),

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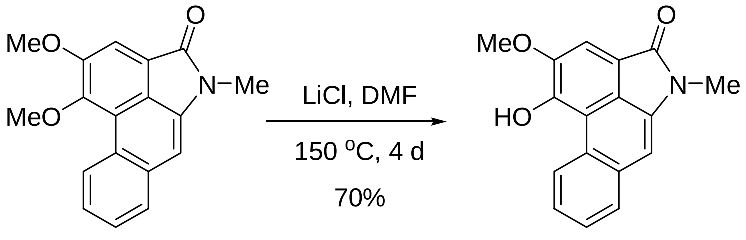
[7] Desai, S. J.; Prabhu, B. R.; Mulchandani, N. B. *Phytochemistry* **1988**, *27*, 1511–1515.

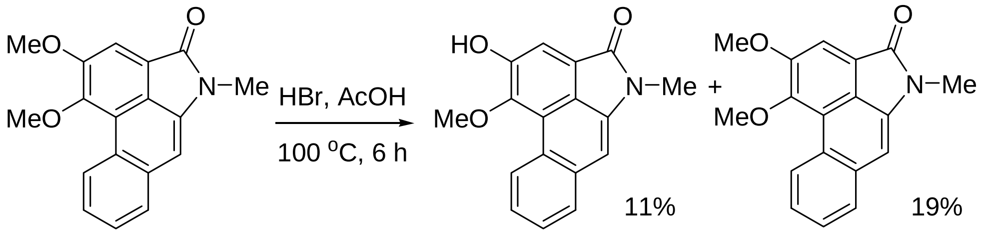
222 (35), 193 (4), 166 (37), 150 (6), 139 (25), 132 (8); HRMS (EI) calcd for $C_{16}H_{11}NO_3$ $[M^+]$ 265.0739, found 265.0737.



24

N-Methyl piperolactam (**4**)

***N*-Methyl piperolactam A (4)**. To a solution of aristolactam **24** (293 mg, 1.0 mmol) in 3 mL of DMF was added lithium chloride (420 mg, 10.0 mmol). The mixture was stirred at 150 ℃ for 4 d and cooled to room temperature. The reaction mixture was diluted with H_2O (5 mL) and extracted with EtOAc (3 × 10 mL). The combined organic layers were washed with H_2O and brine, dried over $MgSO_4$, and concentrated *in vacuo*. The residue was purified by silica gel column chromatography (50% EtOAc/hexanes) to provide aristolactam **4** (196 mg) in 70% yield as a gray solid: mp 201 ℃ (lit.[8] 205–207 ℃); ^{1}H NMR (300 MHz, DMSO–d_6) δ 10.69 (s, 1H), 9.26-9.21 (m, 1H), 7.94-7.91 (m, 1H), 7.78 (s, 1H) 7.56-7.50 (m, 2H), 7.29 (s, 1H), 4.02 (s, 3H), 3.38 (s, 3H); ^{13}C NMR (125 MHz, DMSO–d_6) 167.2, 149.4, 148.2, 136.7, 133.9, 128.8, 127.5, 126.9, 126.8, 125.2, 122.9, 115.1, 114.2, 108.7, 103.9, 57.2, 26.1; IR (neat) 2991, 2927, 1694, 1642, 1445, 1396, 1314, 1117, 1012, 822.9 cm^{-1}; MS (EI) *m/z* 279 (M^+, 100) 264 (48), 236 (18), 180 (10); HRMS (EI) calcd for $C_{17}H_{13}NO_3$ $[M^+]$ 279.0895, found 279.0891.



24

Sauristolactam (**5**)

4

Sauristolactam (5). To a solution of aristolactam **24** (124 mg, 0.42 mmol) in 3 mL of glacial acetic acid was added hydrobromic acid (47 μL, 0.42 mmol). The mixture was stirred at 100 ℃ for 6 h and cooled to room temperature. The reaction mixture was diluted with H_2O (5 mL) and extracted with EtOAc (3 × 10 mL). The combined organic layers were washed with saturated aqueous $NaHCO_3$ solution and brine, dried over $MgSO_4$, and concentrated *in vacuo*. The residue was purified by preparative HPLC (20%

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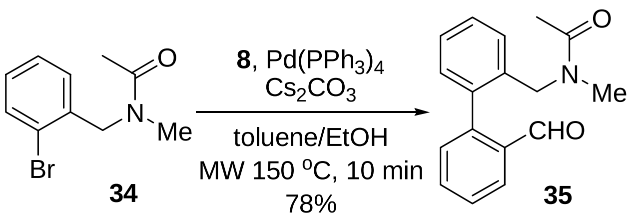
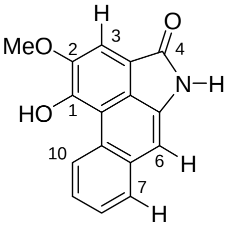
[8] Ruangrungsi, N.; Prathanturarug, S.; Lange, G. L.; Organ, M. G. *Phytochemistry* **1992**, *31*, 2397–2400.

H_2O/CH_3CN, C18 column, 30 × 150 mm, 20 mL/min) to provide aristolactam **4** (22 mg, 19% yield, retention time = 6.09 min) and sauristolactam **5** (13 mg, 11% yield, retention time = 7.28 min) as a yellow solid: mp 276 ℃ (lit.[5] >290 ℃); ^{1}H NMR (300 MHz, DMSO–d_6) δ 10.36 (s, 1H), 9.11 (dd, 1H, *J* = 7.5, 1.8 Hz), 7.94 (dd, 1H, *J* = 8.1, 1.7 Hz), 7.63 (s, 1H), 7.60-7.54 (m, 2H), 7.30 (s, 1H), 4.01 (s, 3H), 3.38 (s, 3H); ^{13}C NMR (125 MHz, DMSO–d_6) δ 167.2, 149.7, 148.2, 136.7, 133.9, 128.7, 127.5, 127.0, 126.7, 125.2, 123.0, 114.8, 114.3, 108.7, 103.8, 57.2, 26.0; IR (neat) 2359, 1645, 1219, 772, 432 cm^{-1}; MS (EI) *m/z* 279 (M^+, 100), 264 (35), 236 (15), 180 (6); HRMS (EI) calcd for $C_{17}H_{13}NO_3$ [M^+] 279.0895, found 279.0895.

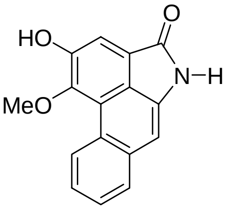


***N*-((2'-Formylbiphenyl-2-yl)methyl)-*N*-methylacetamide (35).** To a thick-well borosilicate glass vial (3 mL) was added acetamide **34** (64 mg, 0.27 mmol), boronic acid **8** (48 mg, 0.34 mmol), $Pd(PPh_3)_4$ (12 mg, 4 mol %), and Cs_2CO_3 (259 mg, 0.79 mmol) sequentially. The mixture was suspended in toluene/EtOH (2 mL/1 mL). Then, the reaction vial was sealed and placed into a microwave reactor and irradiated at 150 °C for 10 min (the average microwave power ranged from 60 to 80 W and the internal pressure was 6–8 bars). After being cooled to room temperature, the mixture was diluted with EtOAc and filtered through a short Celite pad. The solution was concentrated *in vacuo*, and the residue was purified by silica gel flash column chromatography (50% EtOAc/hexanes) to afford biphenyl **35** (55 mg) in 78% yield as a white solid: ^{1}H NMR (300 MHz, $CDCl_3$) δ 9.79 (s, 0.6H), 9.77 (s, 0.4H), 8.04-8.01 (m, 1H), 7.71-7.62 (m, 1H) 7.61-7.49 (m, 1H), 7.48-7.36 (m, 1H), 7.35-7.22 (m, 4H), 4.40 (ABq, 1.2H, *J* = 15.3 Hz), 4.21 (ABq, 0.8H, *J* = 17.1 Hz), 2.82 (s, 1.2H), 2.74 (s, 1.8H), 2.01 (s, 1.8H), 1.88 (s, 1.2H).

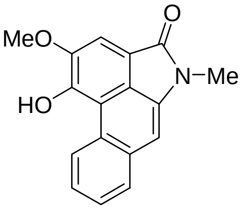
Table S1. Comparison of ^{1}H NMR Chemical Shifts of Aristolactams



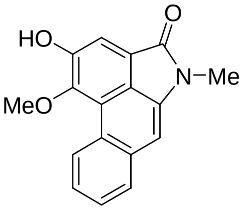
Aristolactam FI (**3**)



Aristolactam AII (**31**)



N-Methyl piperolactam (**4**)



Sauristolactam (**5**)

Compounds	H-3	H-6	H-7	H-8, H-9	H-10	OMe	N-H
3	7.75	7.11	7.92	7.53	9.25	4.03	10.65
3 (lit.)[7]	7.62	7.10	7.95	7.58	9.12	4.02	10.81
3 (lit.)[9]	8.09	7.48	7.92	7.65	9.45	4.05	-
31 (lit.)[10]	7.62	7.08	7.93	7.54	9.13	4.03	10.77
4	7.78	7.29	7.93	7.55	9.25	4.02	-
5	7.63	7.30	7.94	7.58	9.11	4.01	-

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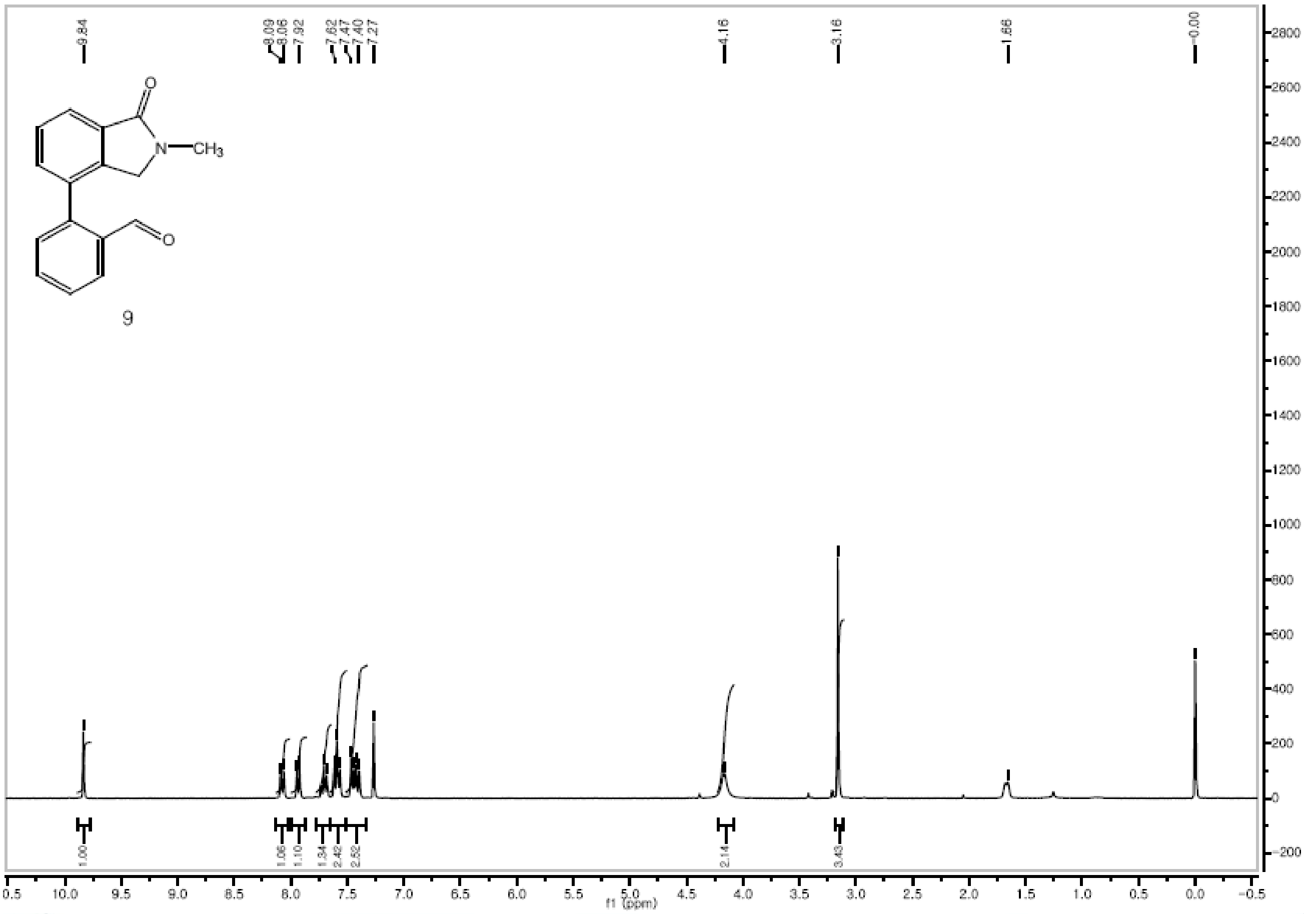
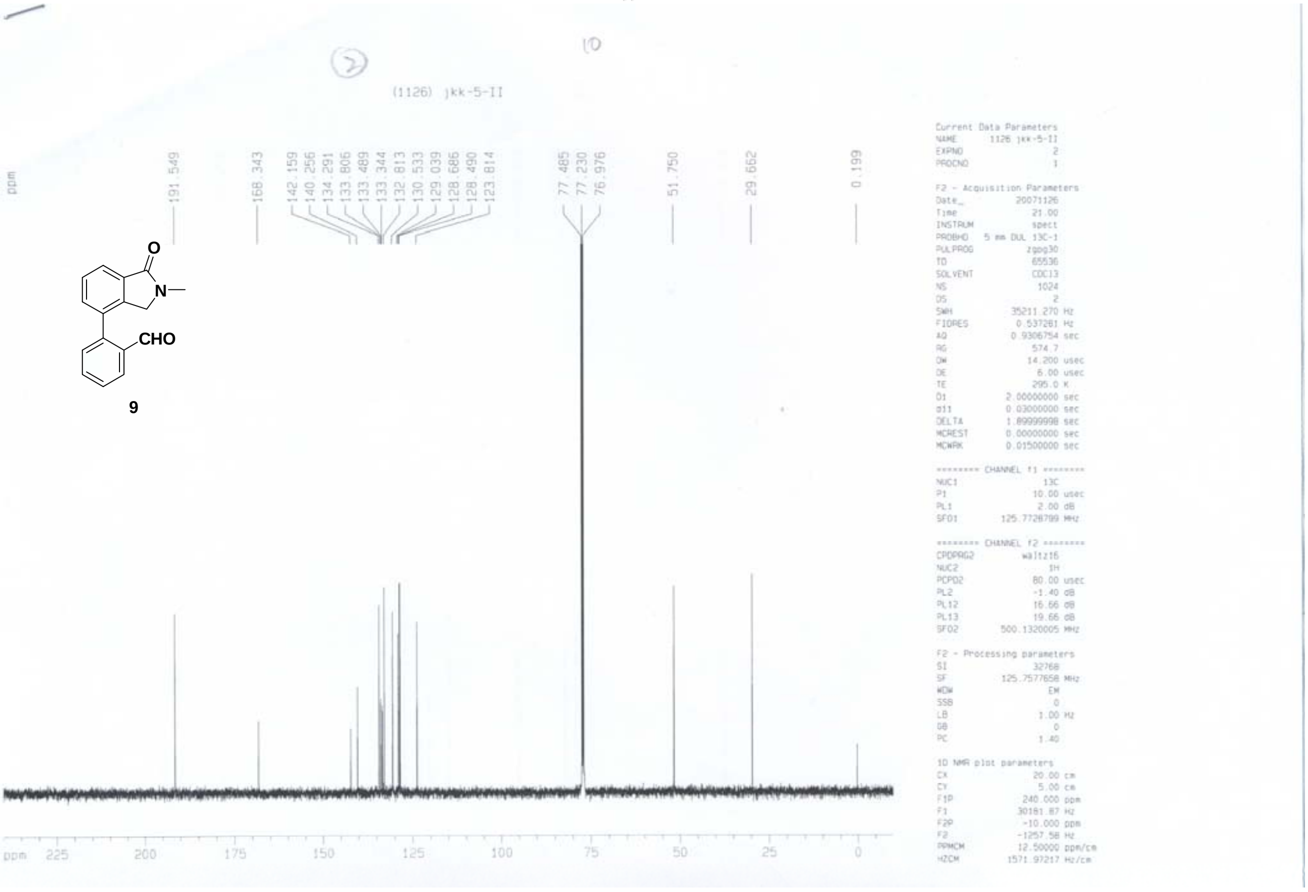
[9] Sun, N.-J.; Antoun, M.; Chang, C.-J.; Cassady, J. M. *J. Nat. Prod.* **1987**, *50*, 843–846.

[10] Priestap, H. A. *Phytochemistry* **1985**, *24*, 849–852.



9



9

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DE                 6.00 usec
TE                295.0 K
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d11          0.03000000 sec
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MCWRK        0.01500000 sec

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1D NMR plot parameters
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F1             30181.87 Hz
F2P             -10.000 ppm
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PPMCM          12.50000 ppm/cm
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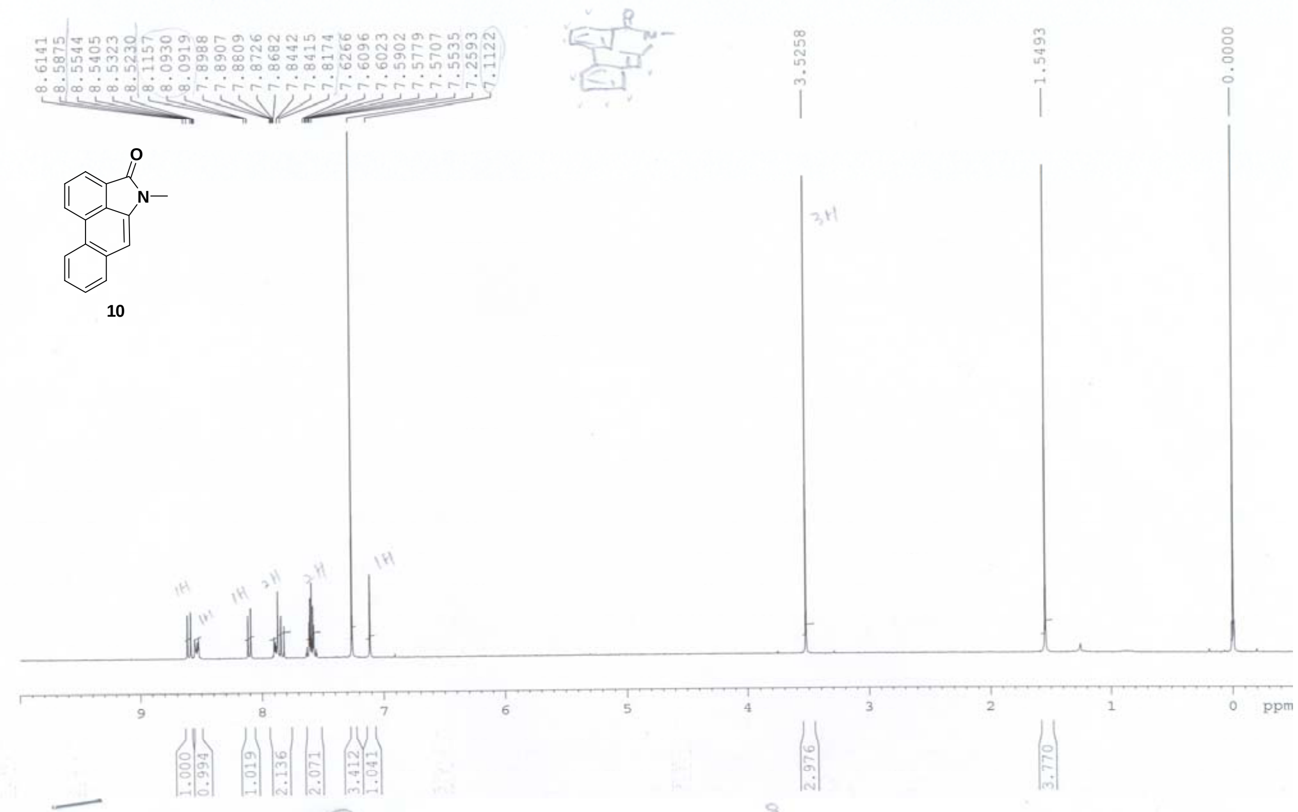
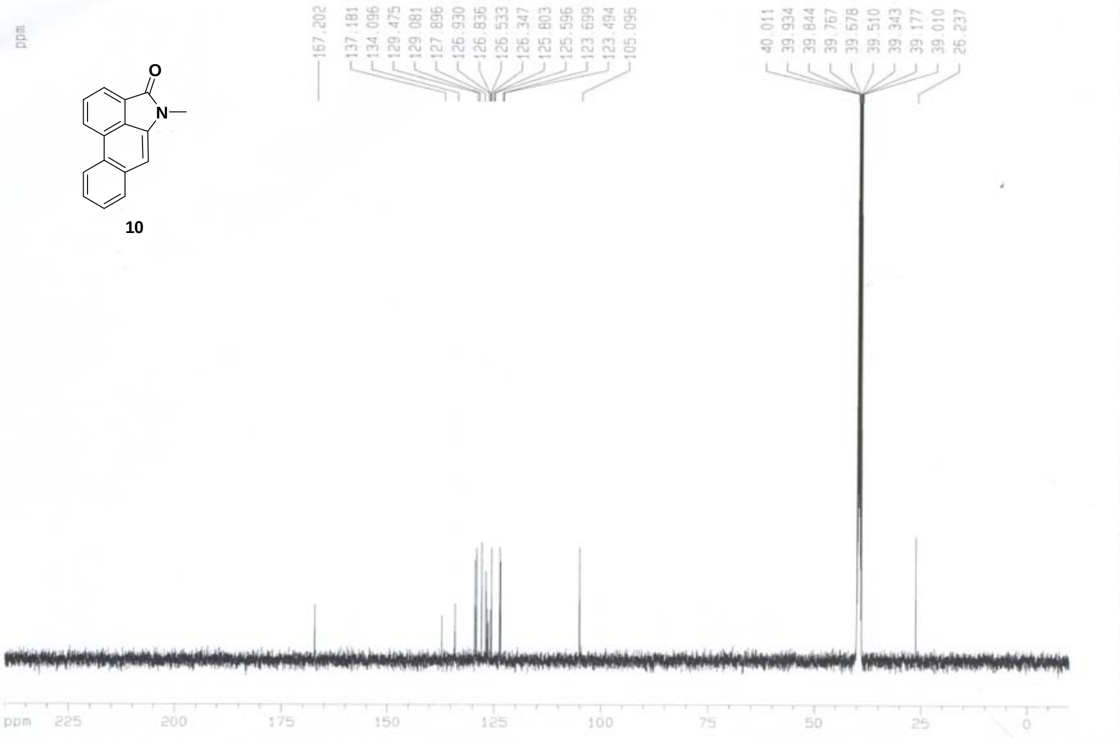
jkk5-3 ② 10



① 9

(1126) jkk-5-I



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1D NMR plot parameters
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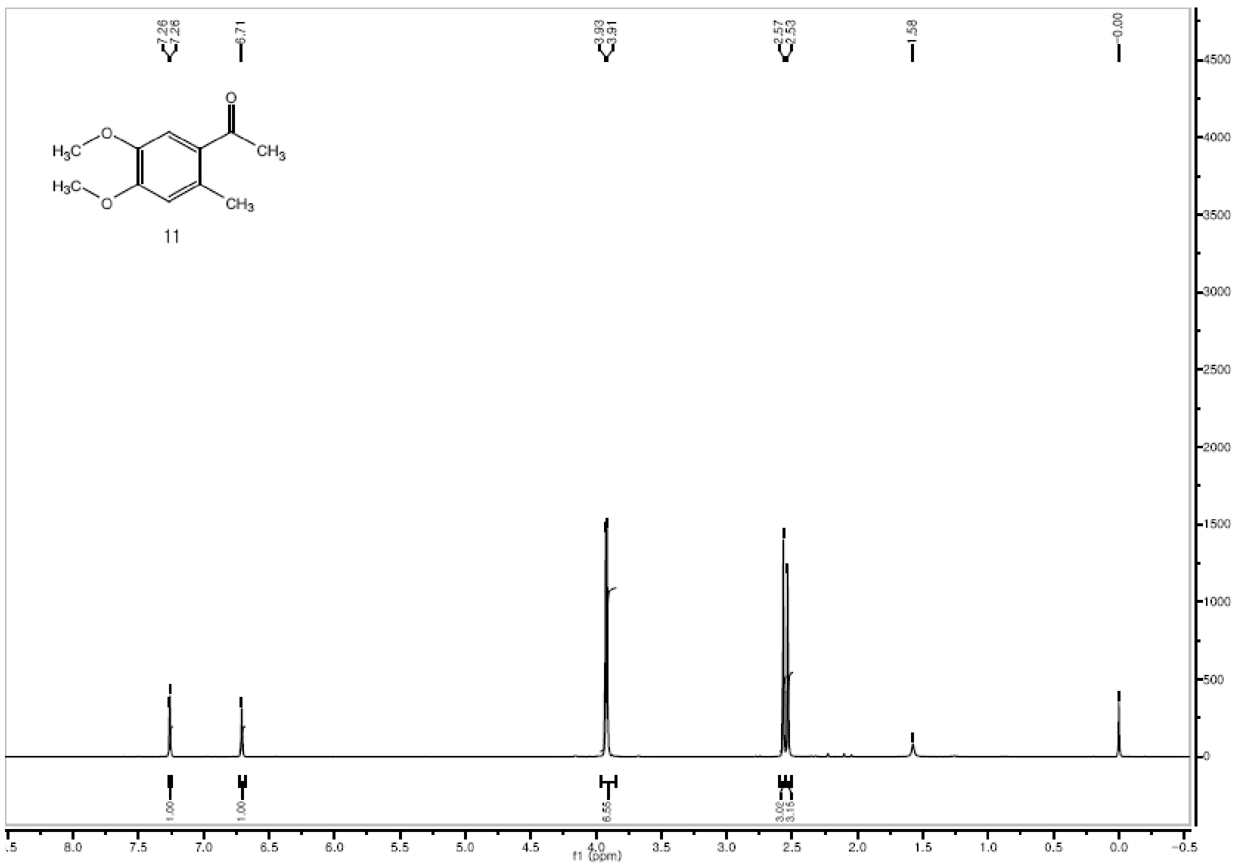
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CH_3
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1.00
1.00
6.55
3.02
3.15
4500
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1000
500
0
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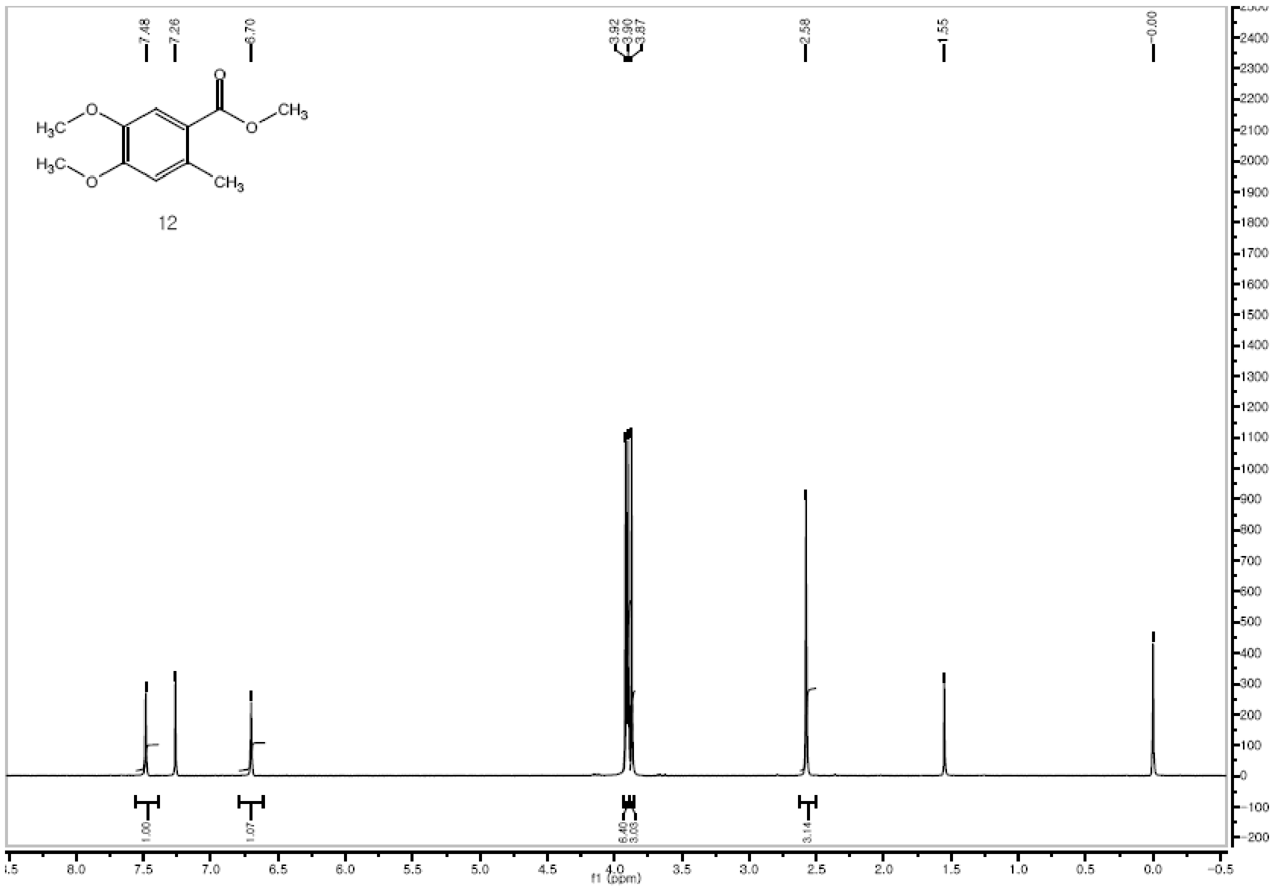
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400
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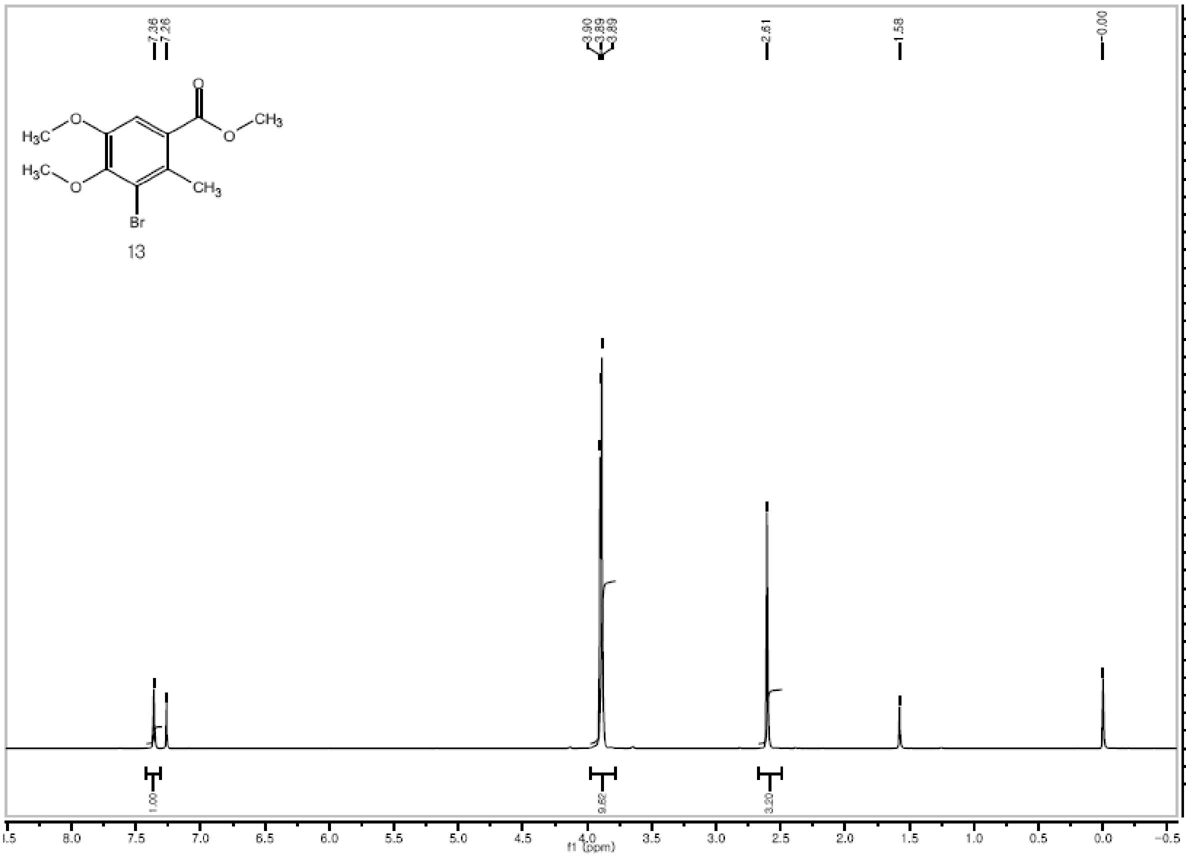
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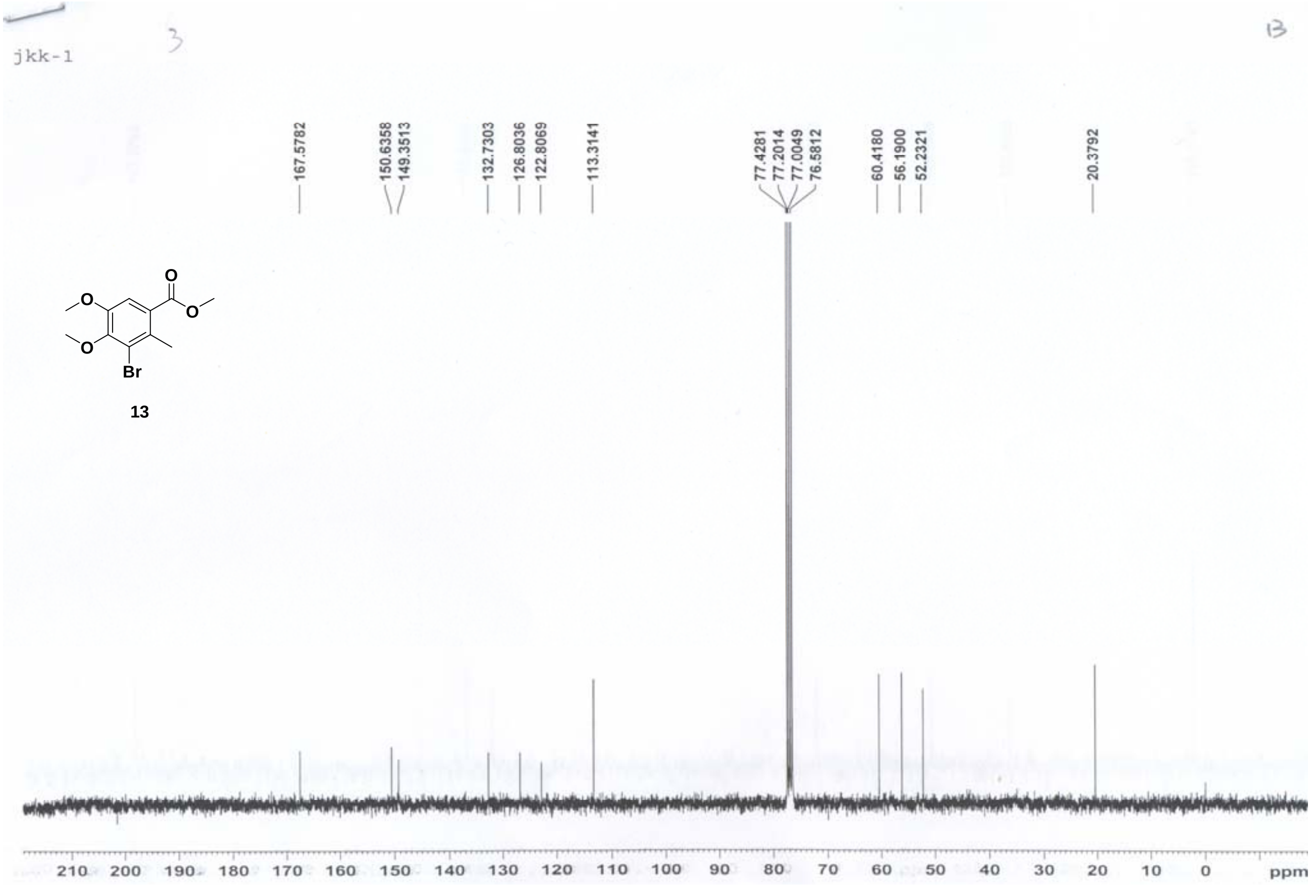
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13
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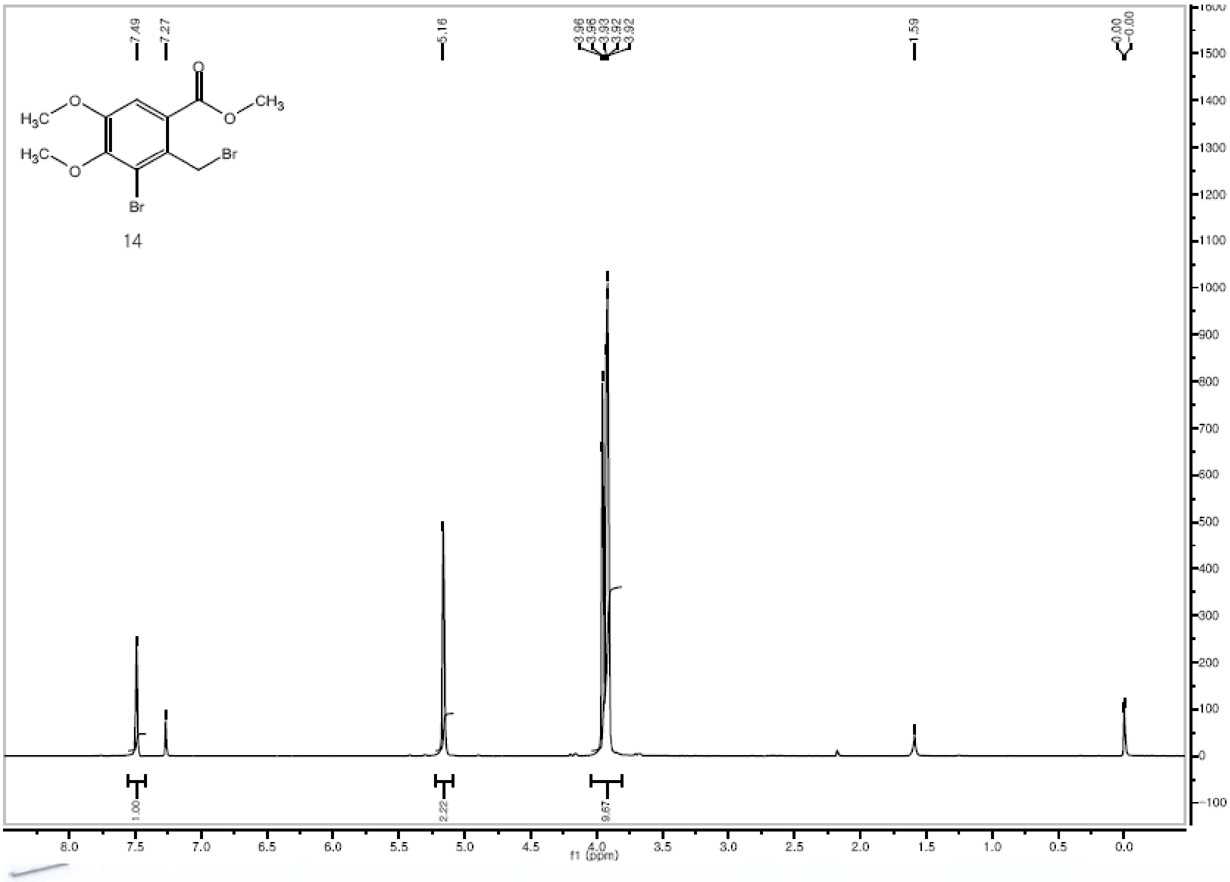
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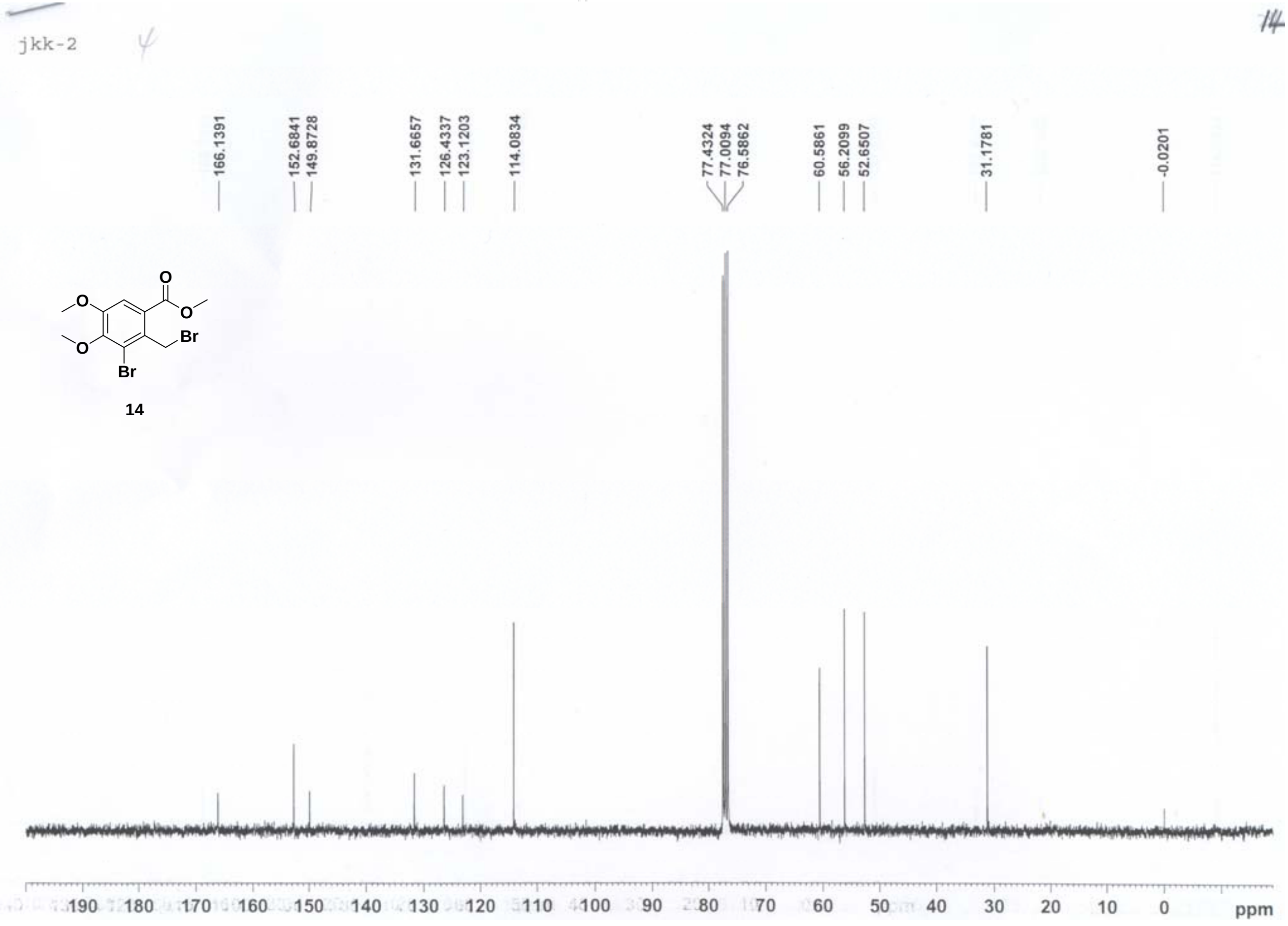
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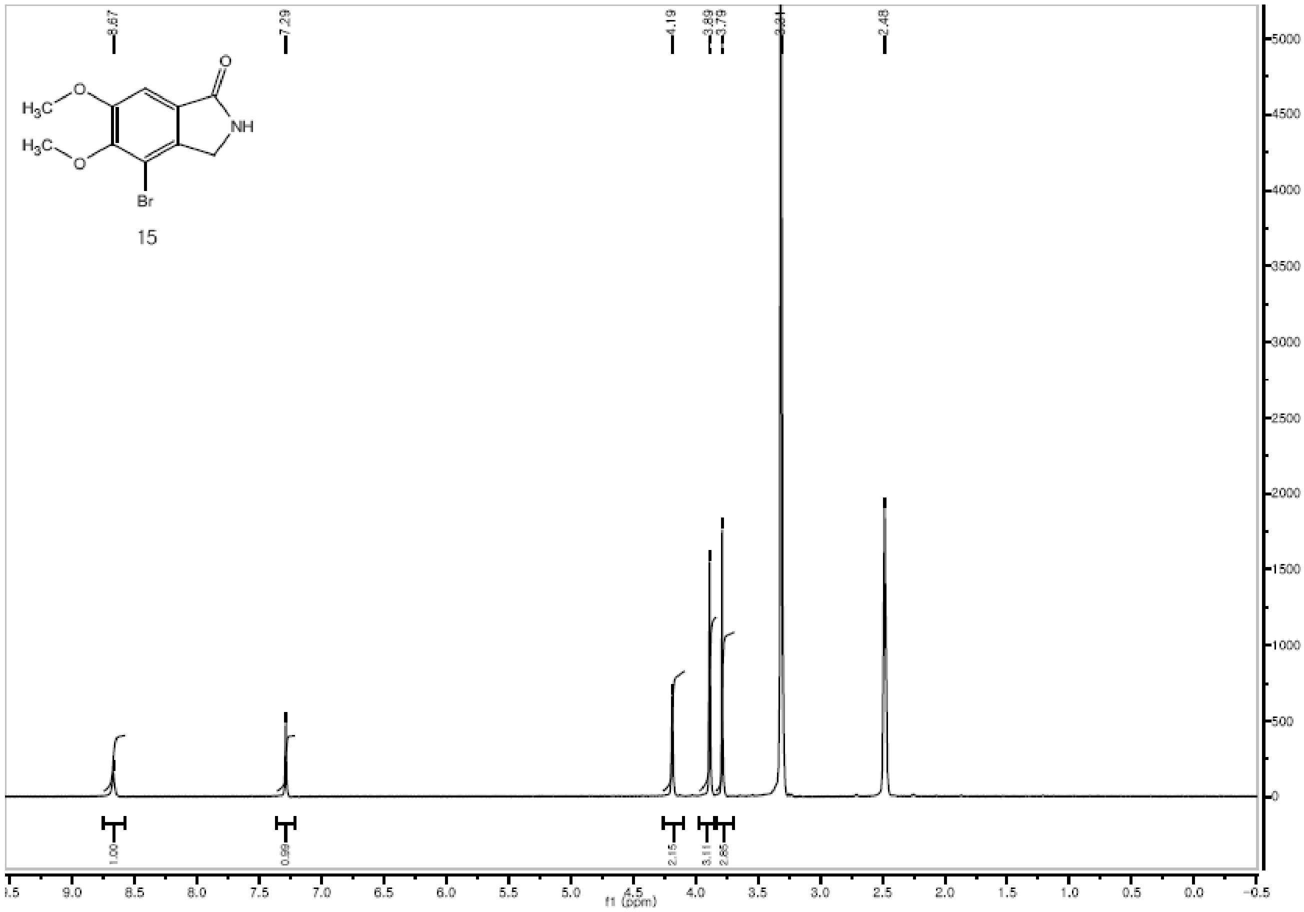
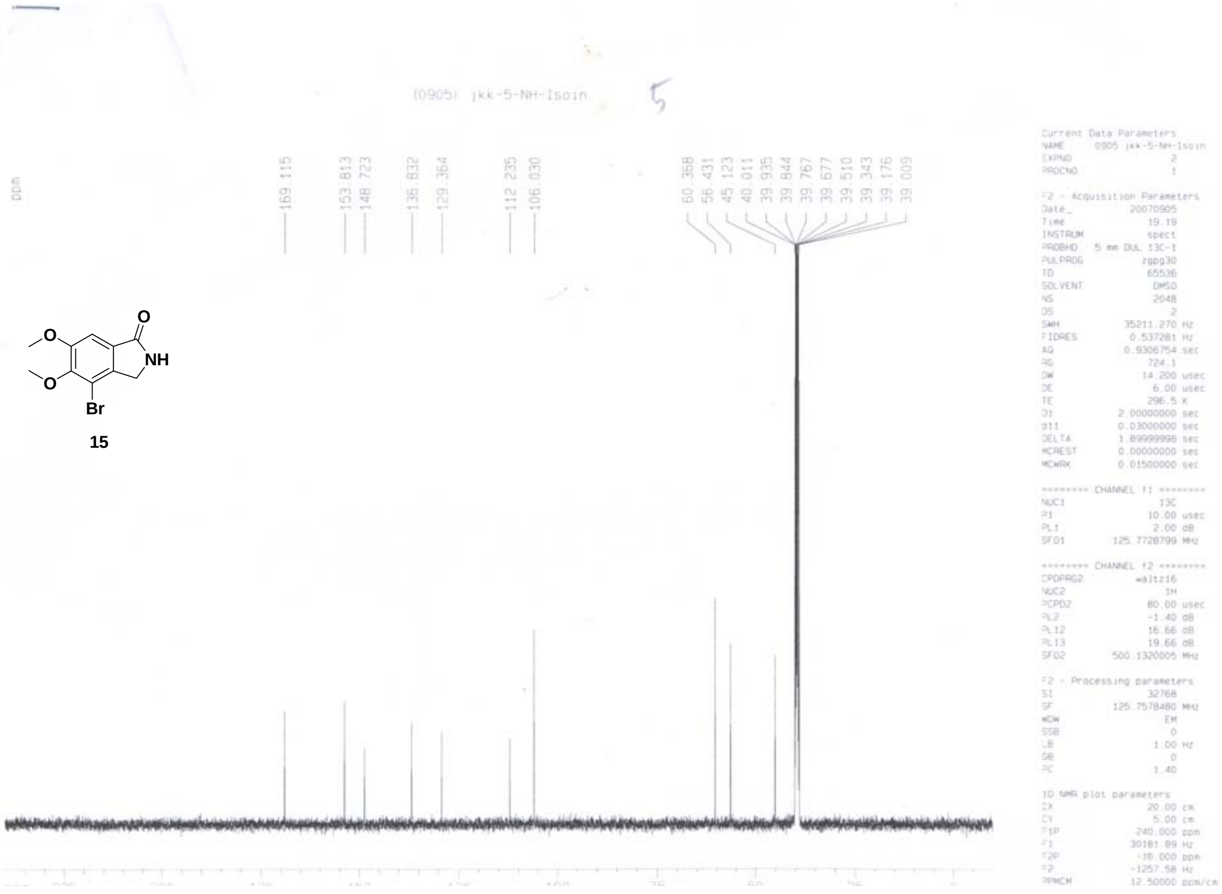
149.8728
131.6657
126.4337
123.1203
114.0834
77.4324
77.0094
76.5862
60.5861
56.2099
52.6507
31.1781
-0.0201
O
O
O
O
Br
Br
14
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm



15



```
Current Data Parameters
NAME      0905 jkk-5-NH-Isoin
EXPNO                     2
PROCNO                    1

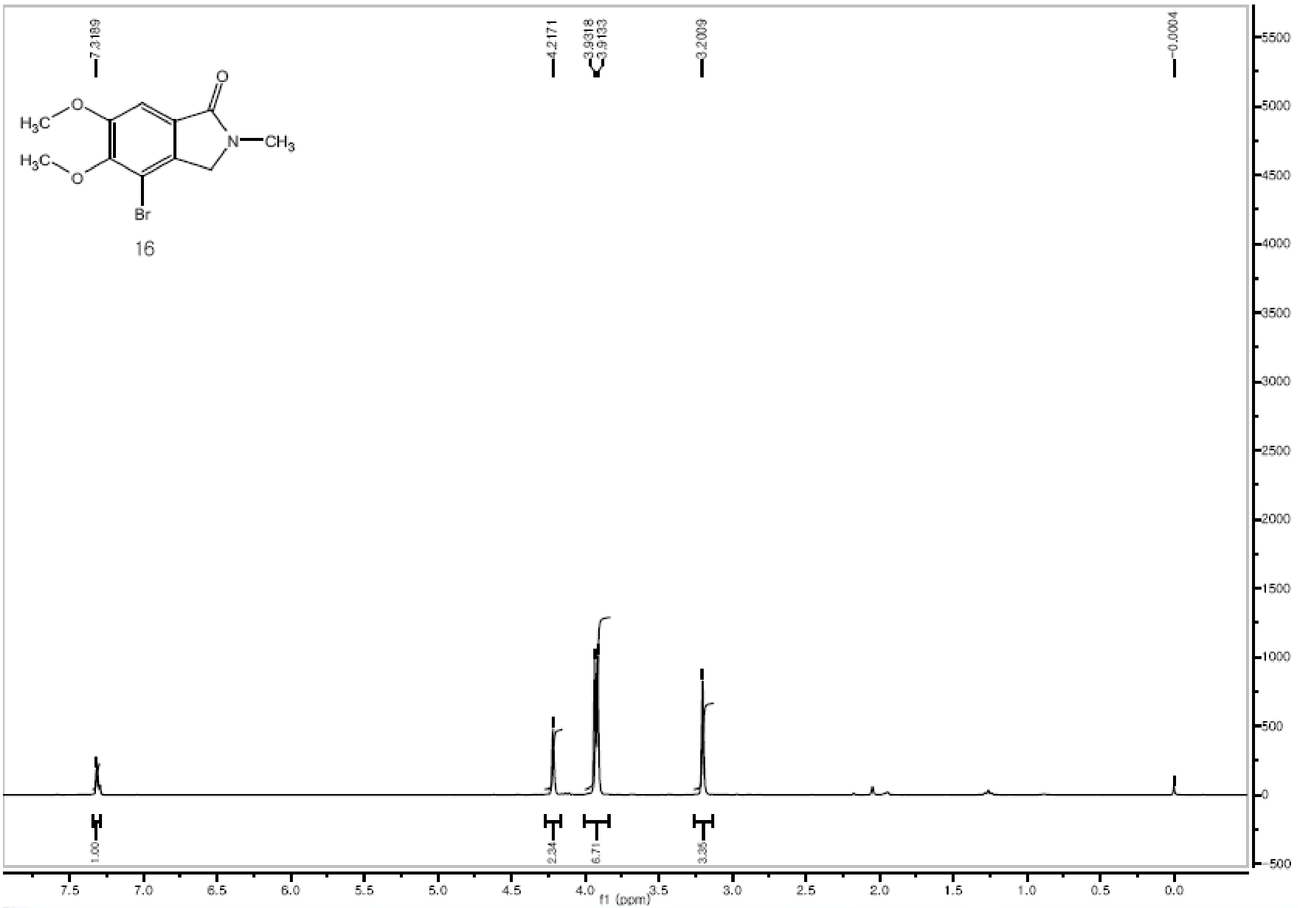
F2 - Acquisition Parameters
Date_             20070905
Time                 19.19
INSTRUM              spect
PROBHD   5 mm DUL 13C-1
PULPROG            zgpg30
TD                   65536
SOLVENT               DMSO
NS                    2048
DS                       2
SWH             35211.270 Hz
FIDRES           0.537281 Hz
AQ              0.9306754 sec
RG                   724.1
DW                  14.200 usec
DE                    6.00 usec
TE                   296.5 K
D1             2.00000000 sec
d11            0.03000000 sec
DELTA          1.89999998 sec
MCREST         0.00000000 sec
MCWRK          0.01500000 sec

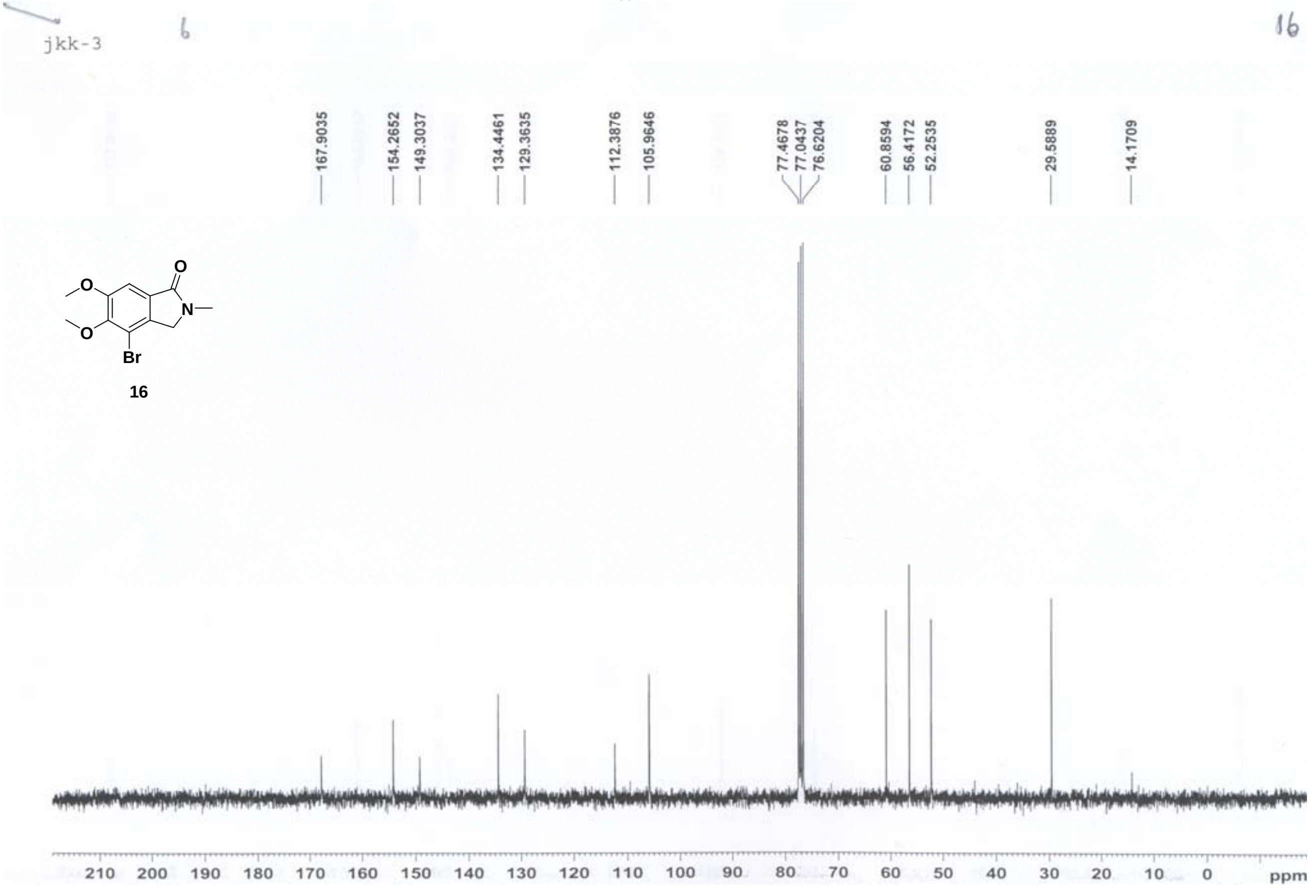
======== CHANNEL f1 ========
NUC1                   13C
P1                    10.00 usec
PL1                    2.00 dB
SFO1           125.7728799 MHz

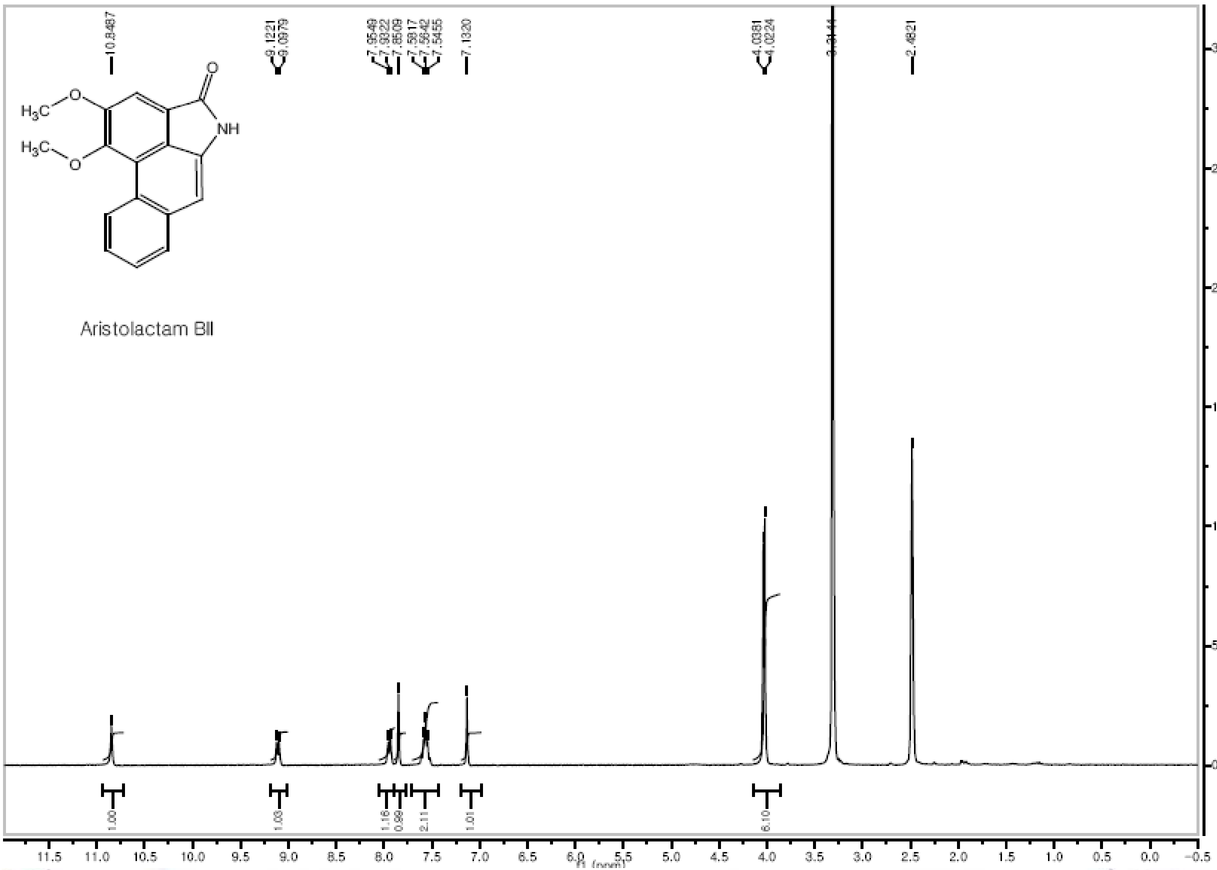
======== CHANNEL f2 ========
CPDPRG2            waltz16
NUC2                    1H
PCPD2                 80.00 usec
PL2                   -1.40 dB
PL12                  16.66 dB
PL13                  19.66 dB
SFO2           500.1320005 MHz

F2 - Processing parameters
SI                   32768
SF             125.7578480 MHz
WDW                     EM
SSB                      0
LB                    1.00 Hz
GB                       0
PC                    1.40

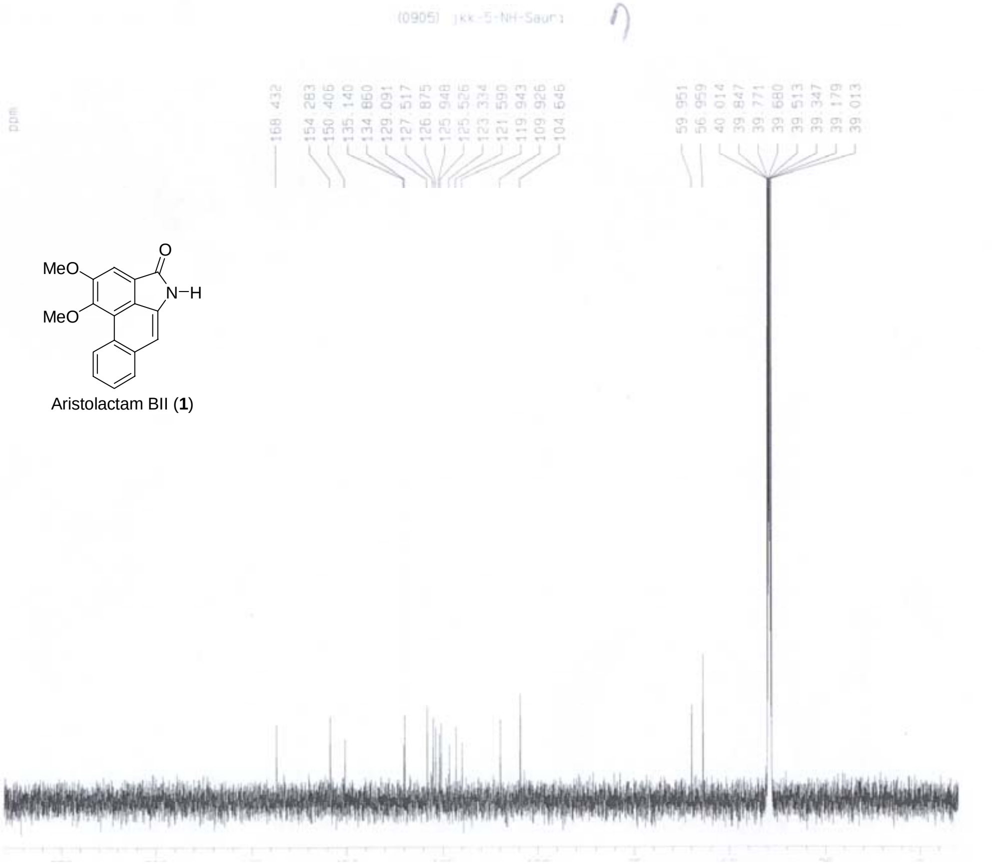
1D NMR plot parameters
CX                    20.00 cm
CY                     5.00 cm
F1P                 240.000 ppm
F1                 30181.89 Hz
F2P                 -10.000 ppm
F2                 -1257.58 Hz
PPMCM              12.50000 ppm/cm
```


7.3189
4.2171
3.9318
3.9133
3.2009
-0.0004
H_3C
O
N
CH_3
Br
16
1.00
2.34
6.71
3.35
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500


jkk-3
6
16
167.9035
154.2652
149.3037
134.4461
129.3635
112.3876
105.9646
77.4678
77.0437
76.6204
60.8594
56.4172
52.2535
29.5889
14.1709
O
N
Br
16
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm



Aristolactam BII



```
Current Data Parameters
NAME      0905 jkk-5-NH-Saur1
EXPNO                   2
PROCNO                  1

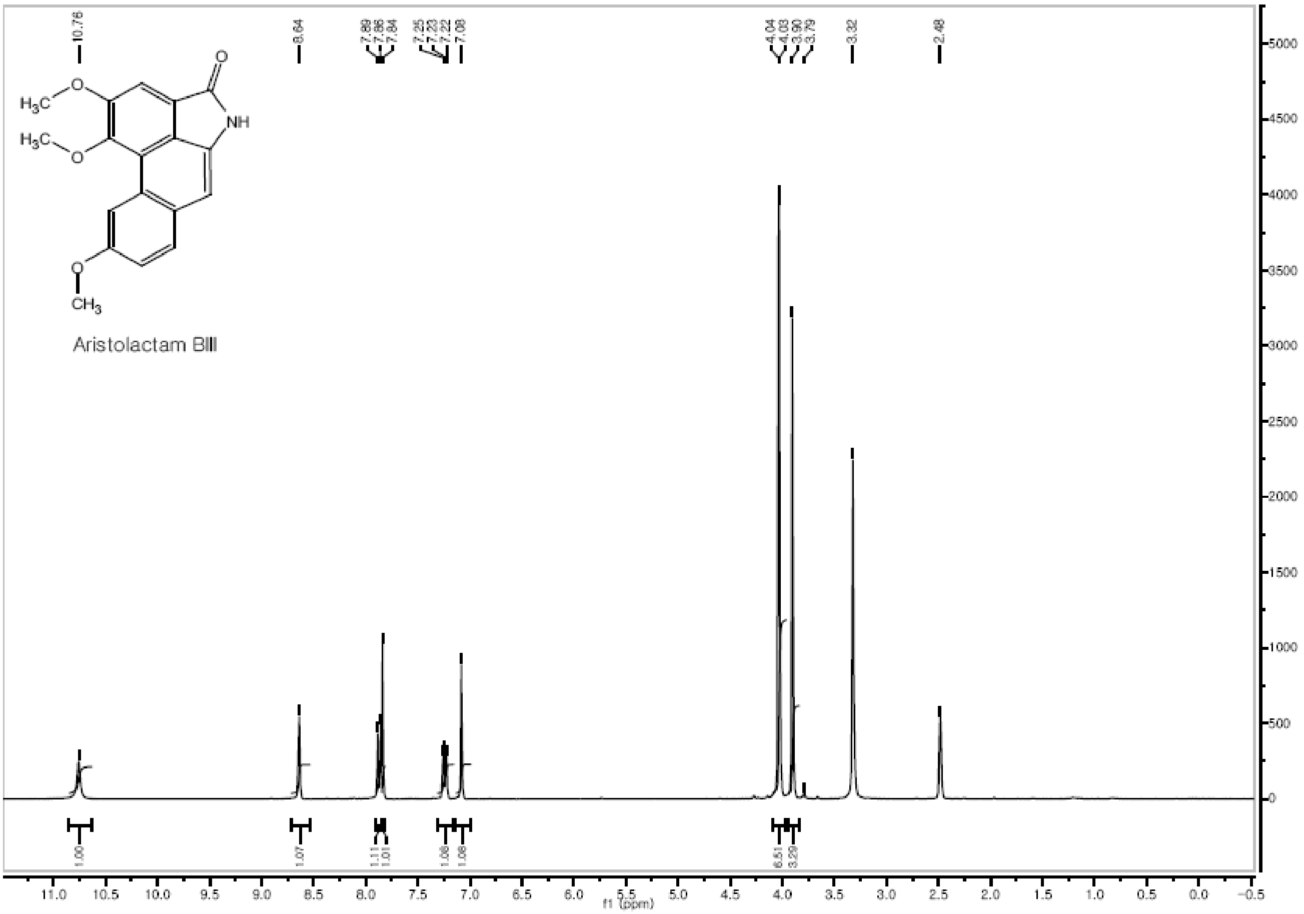
F2 - Acquisition Parameters
Date_            20070905
Time                20.59
INSTRUM             spect
PROBHD   5 mm DUL 13C-1
PULPROG           zgpg30
TD                 65536
SOLVENT             DMSO
NS                  1024
DS                     2
SWH            35211.270 Hz
FIDRES          0.537281 Hz
AQ             0.9306754 sec
RG                  1024
DW                14.200 usec
DE                  6.00 usec
TE                 296.5 K
D1            2.00000000 sec
d11           0.03000000 sec
DELTA         1.89999998 sec
MCREST        0.00000000 sec
MCWRK         0.01500000 sec

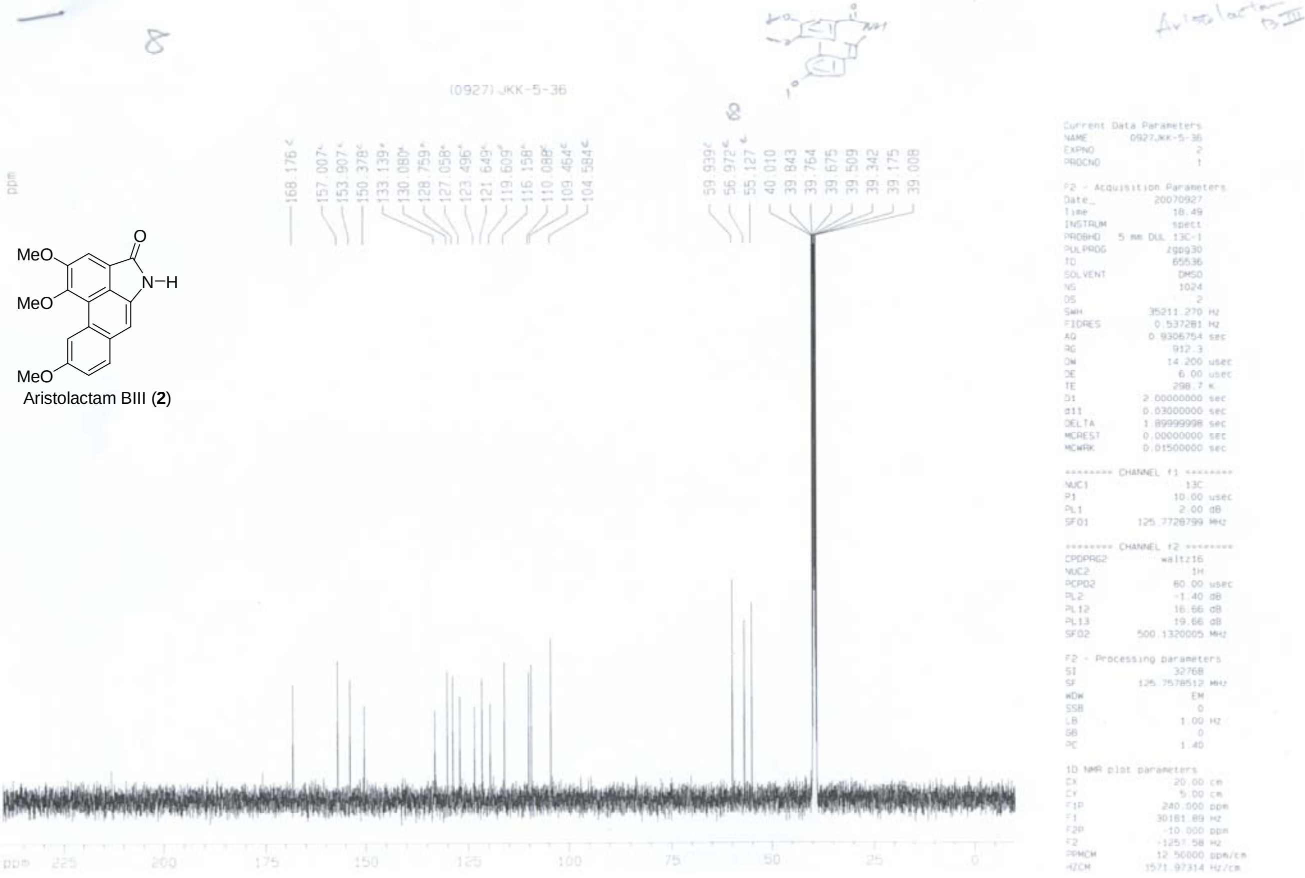
======== CHANNEL f1 ========
NUC1                 13C
P1                 10.00 usec
PL1                 2.00 dB
SFO1         125.7728799 MHz

======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2              80.00 usec
PL2                -1.40 dB
PL12               16.66 dB
PL13               19.66 dB
SFO2         500.1320005 MHz

F2 - Processing parameters
SI                 32768
SF           125.7578480 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40

1D NMR plot parameters
CX                 20.00 cm
CY                  3.00 cm
F1P              240.000 ppm
F1              30181.89 Hz
F2P              -10.000 ppm
F2              -1257.58 Hz
PPMCM           12.50000 ppm/cm
```





```
Current Data Parameters
NAME        0927JKK-5-36
EXPNO                  2
PROCNO                 1

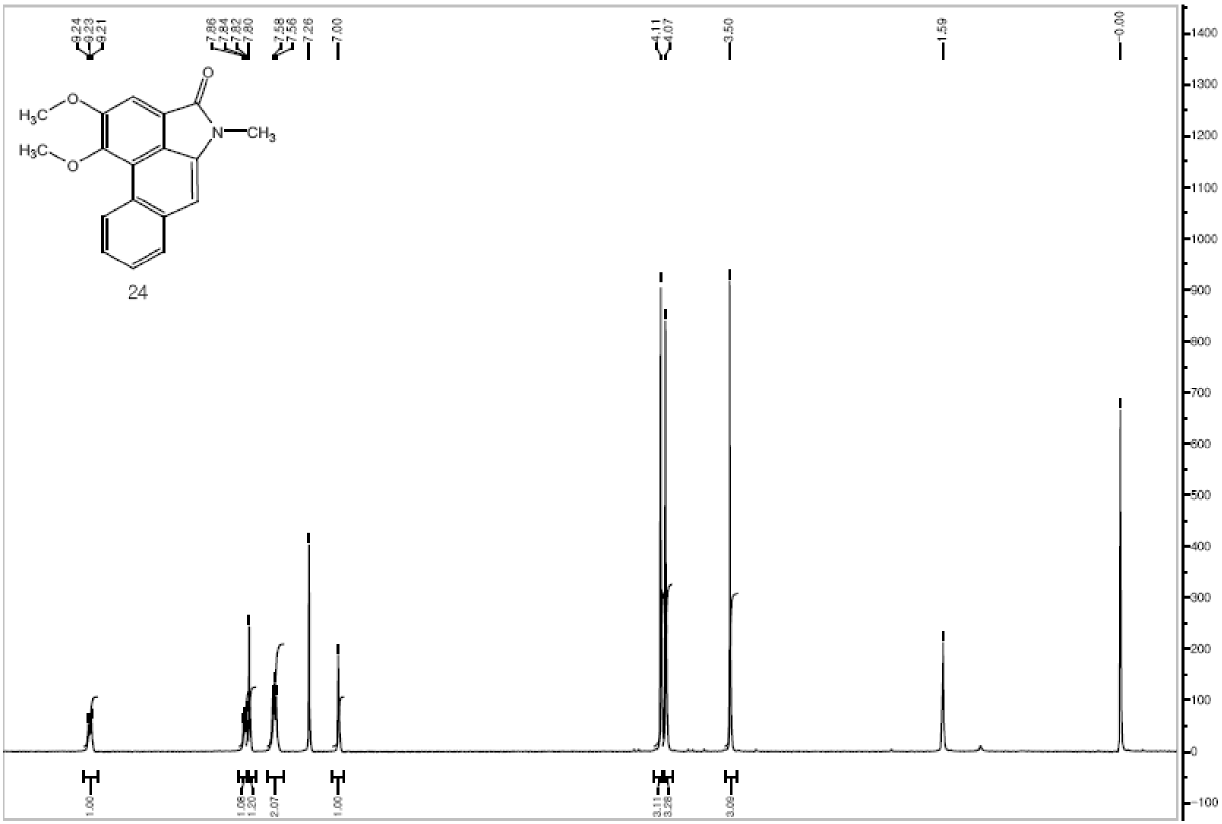
F2 - Acquisition Parameters
Date_           20070927
Time               18.49
INSTRUM            spect
PROBHD   5 mm DUL 13C-1
PULPROG          zgpg30
TD                65536
SOLVENT             DMSO
NS                  1024
DS                     2
SWH            35211.270 Hz
FIDRES          0.537281 Hz
AQ             0.9306754 sec
RG                 912.3
DW                14.200 usec
DE                  6.00 usec
TE                 298.7 K
D1            2.00000000 sec
d11           0.03000000 sec
DELTA         1.89999998 sec
MCREST        0.00000000 sec
MCWRK         0.01500000 sec

======== CHANNEL f1 ========
NUC1                 13C
P1                 10.00 usec
PL1                 2.00 dB
SFO1         125.7728799 MHz

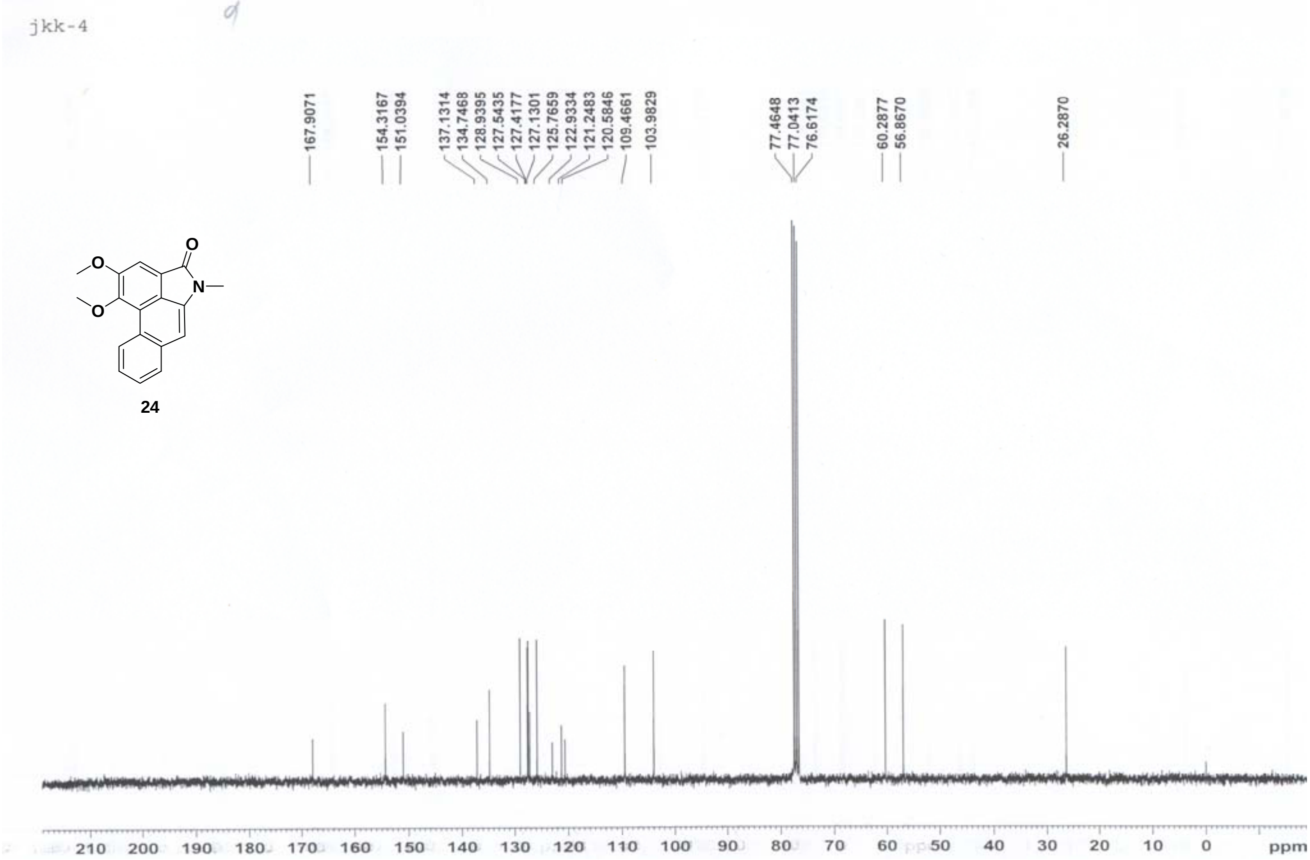
======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2              80.00 usec
PL2                -1.40 dB
PL12               16.66 dB
PL13               19.66 dB
SFO2         500.1320005 MHz

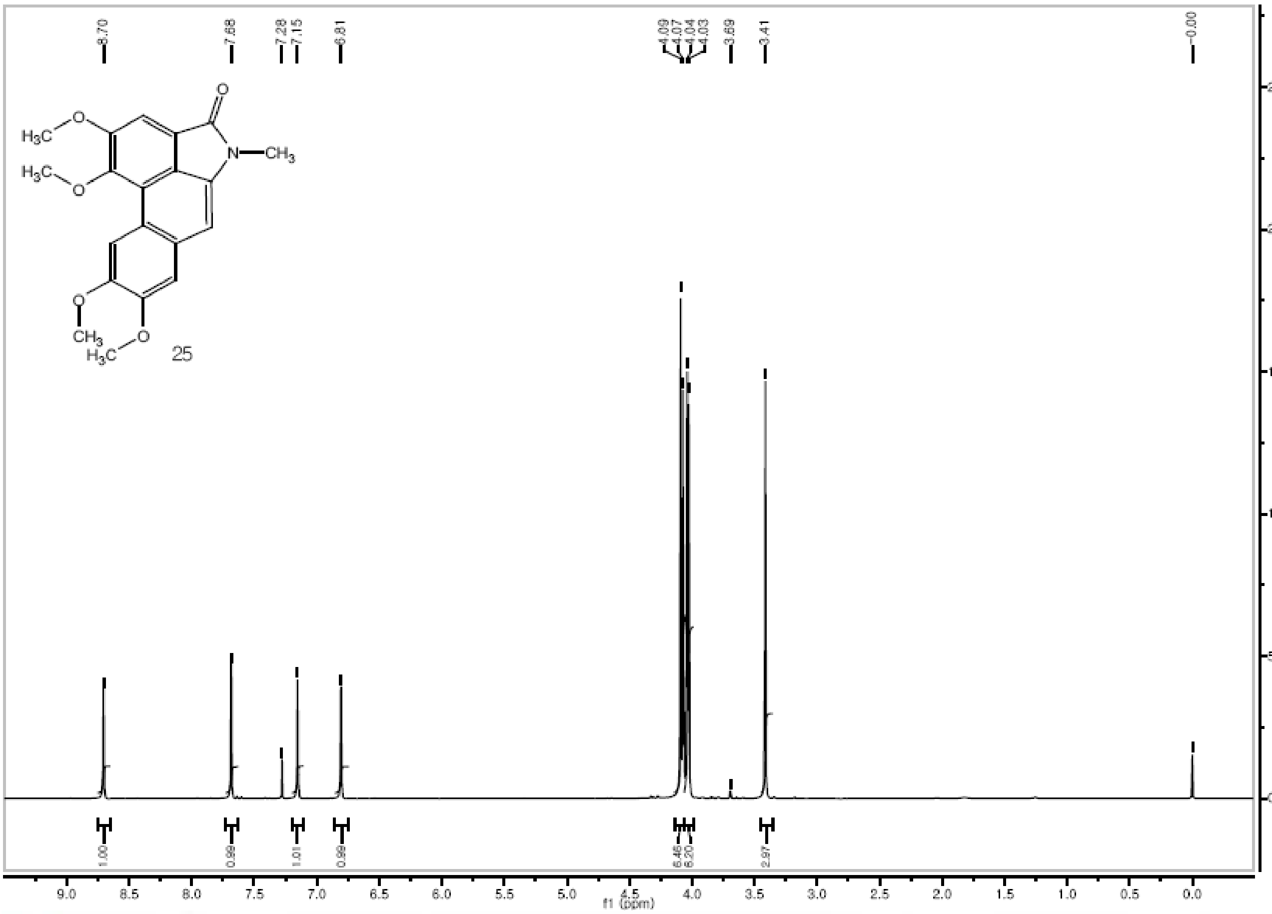
F2 - Processing parameters
SI                 32768
SF           125.7578512 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40

1D NMR plot parameters
CX                 20.00 cm
CY                  5.00 cm
F1P              240.000 ppm
F1              30181.89 Hz
F2P              -10.000 ppm
F2              -1257.58 Hz
PPMCM           12.50000 ppm/cm
HZCM          1571.97314 Hz/cm
```


9.24
9.23
9.21
7.86
7.84
7.82
7.80
7.58
7.56
7.26
7.00
4.11
4.07
3.50
1.59
0.00
H_3C
O
H_3C
O
O
N
CH_3
24
1.00
1.08
1.20
2.07
1.00
3.11
3.28
3.09
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

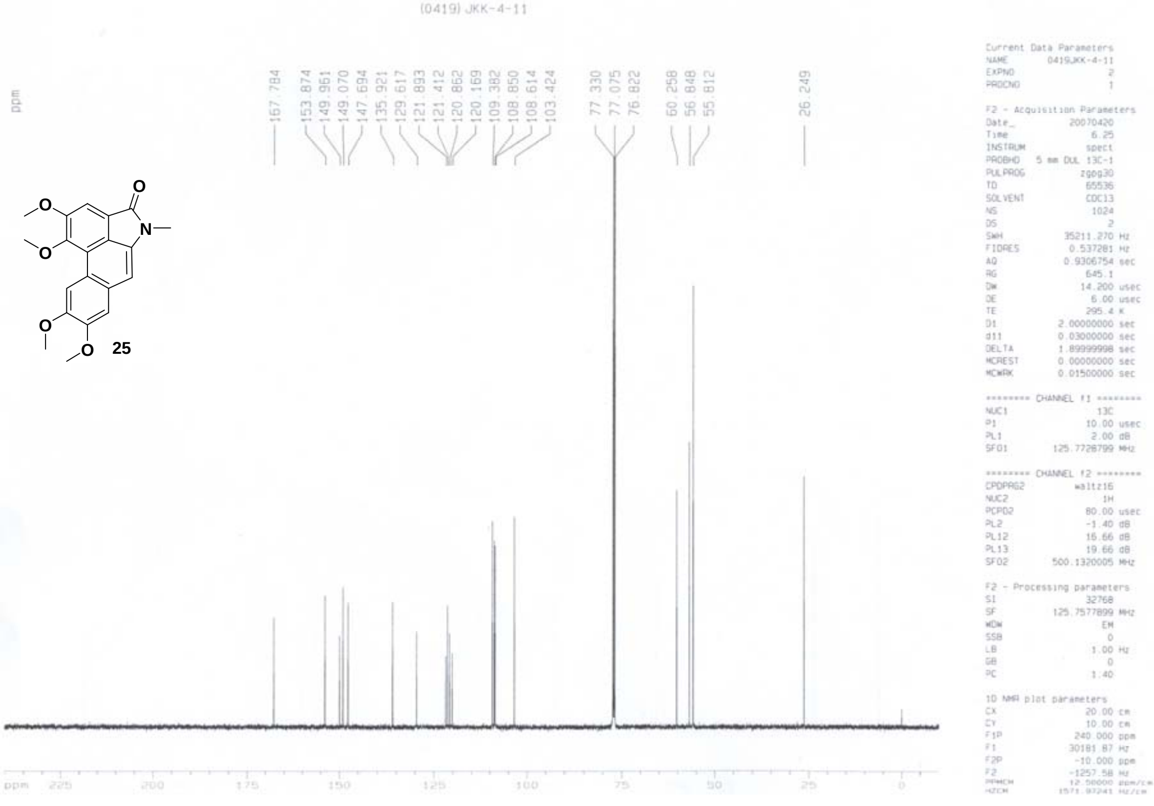
24


jkk-4
167.9071
154.3167
151.0394
137.1314
134.7468
128.9395
127.5435
127.4177
127.1301
125.7659
122.9334
121.2483
120.5846
109.4661
103.9829
77.4648
77.0413
76.6174
60.2877
56.8670
26.2870
O
O
O
N
24
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm



10

25



```
Current Data Parameters
NAME        0419JKK-4-11
EXPNO                  2
PROCNO                 1

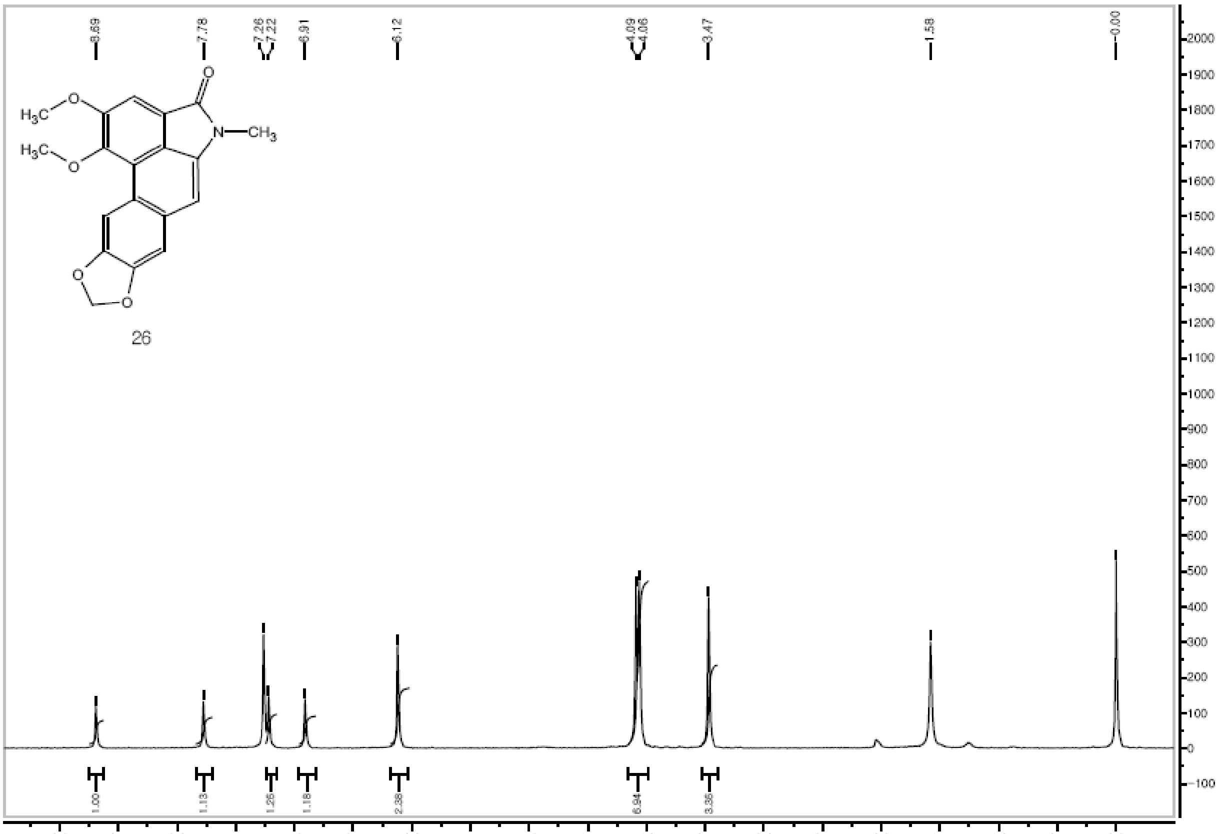
F2 - Acquisition Parameters
Date_           20070420
Time                6.25
INSTRUM            spect
PROBHD   5 mm DUL 13C-1
PULPROG          zgpg30
TD                 65536
SOLVENT            CDCl3
NS                  1024
DS                     2
SWH           35211.270 Hz
FIDRES         0.537281 Hz
AQ            0.9306754 sec
RG                 645.1
DW                14.200 usec
DE                  6.00 usec
TE                 295.4 K
D1            2.00000000 sec
d11           0.03000000 sec
DELTA         1.89999998 sec
MCREST        0.00000000 sec
MCWRK         0.01500000 sec

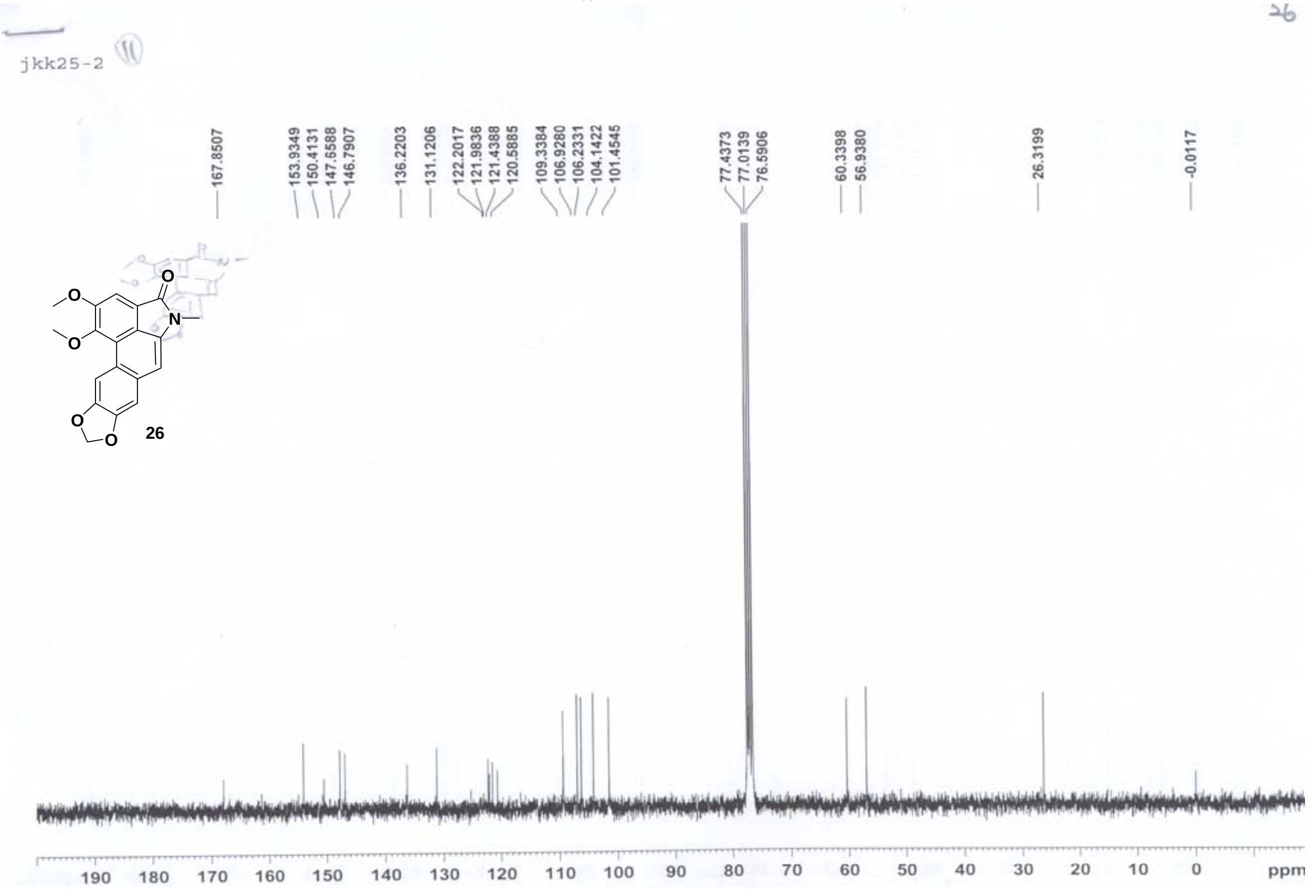
======== CHANNEL f1 ========
NUC1                 13C
P1                 10.00 usec
PL1                 2.00 dB
SFO1         125.7728799 MHz

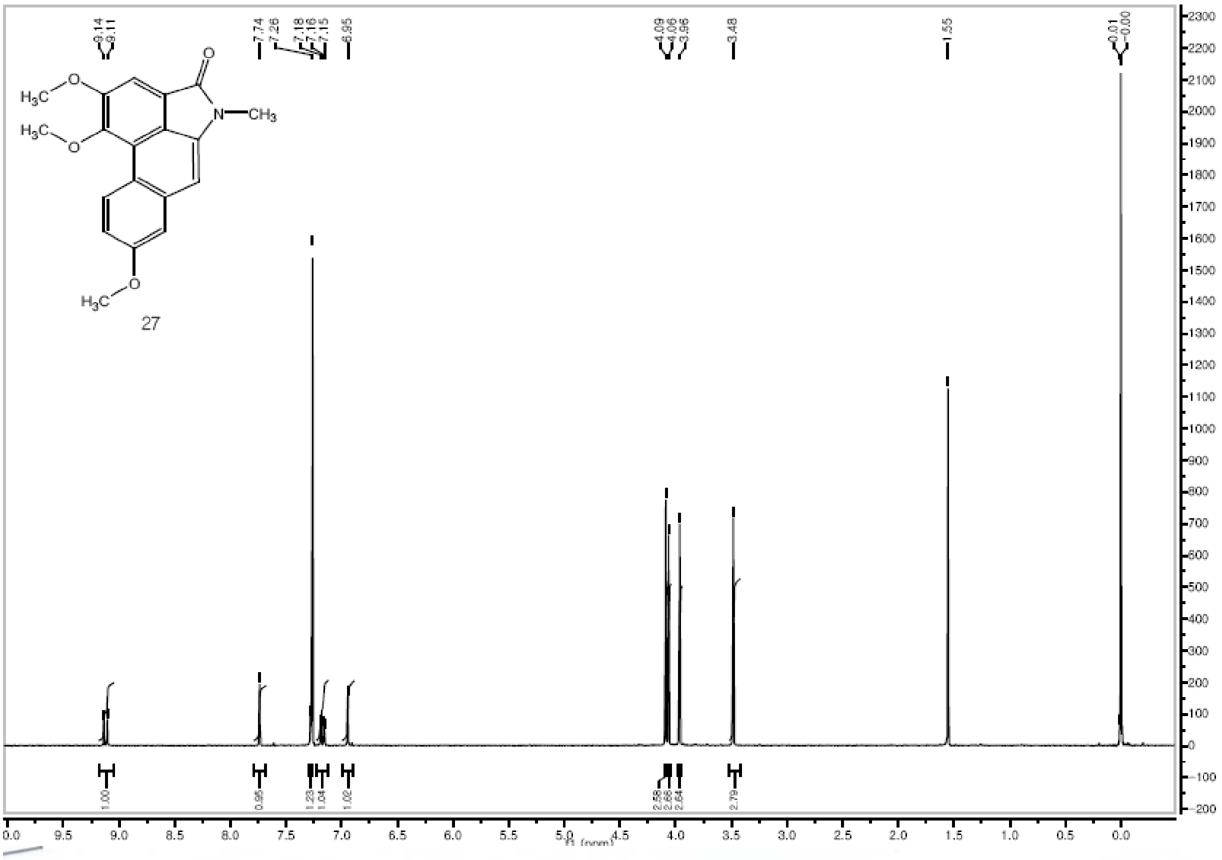
======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2              80.00 usec
PL2                -1.40 dB
PL12               16.66 dB
PL13               19.66 dB
SFO2         500.1320005 MHz

F2 - Processing parameters
SI                 32768
SF           125.7577899 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40

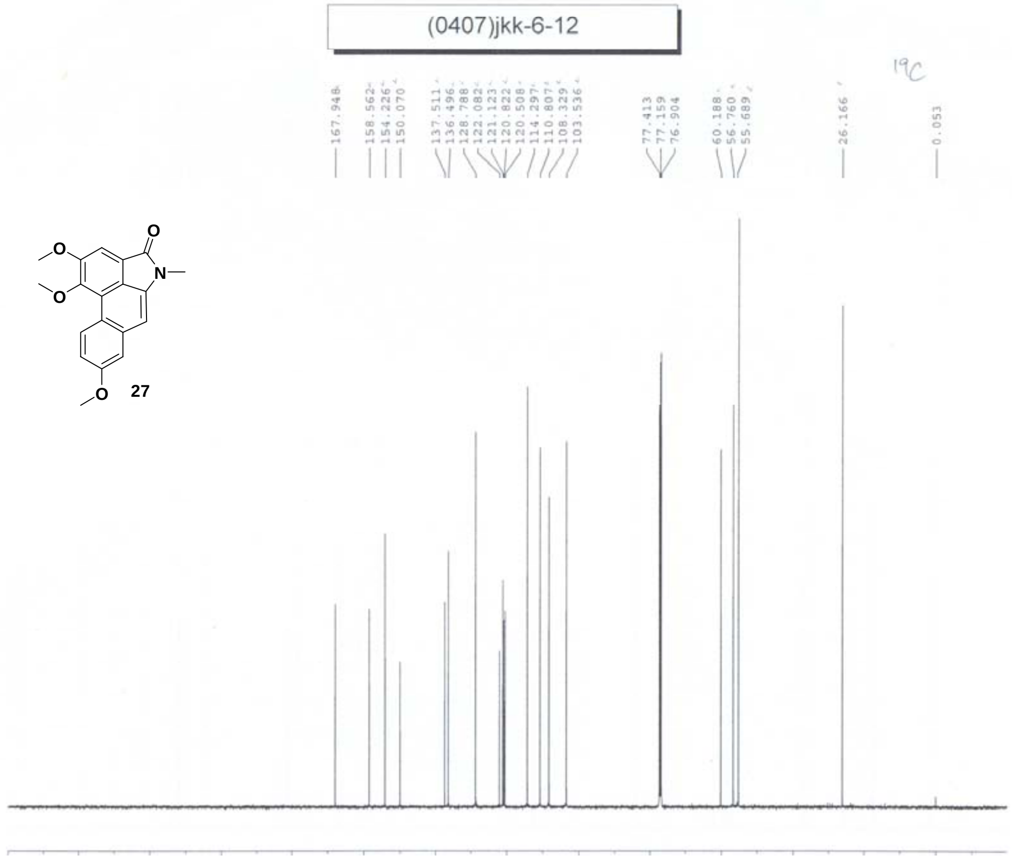
1D NMR plot parameters
CX                 20.00 cm
CY                 10.00 cm
F1P              240.000 ppm
F1              30181.87 Hz
F2P              -10.000 ppm
F2              -1257.58 Hz
PPMCM           12.50000 ppm/cm
HZCM          1571.97241 Hz/cm
```


8.69
7.78
7.26
7.22
6.91
6.12
4.09
4.06
3.47
1.58
0.00
H_3C
O
H_3C
O
N
CH_3
O
O
26
1.00
1.13
1.26
1.18
2.38
6.94
3.35
f1 (ppm)
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
2000 1900 1800 1700 1600 1500 1400 1300 1200 1100 1000 900 800 700 600 500 400 300 200 100 0 -100


26
jkk25-2
167.8507
153.9349
150.4131
147.6588
146.7907
136.2203
131.1206
122.2017
121.9836
121.4388
120.5885
109.3384
106.9280
106.2331
104.1422
101.4545
77.4373
77.0139
76.5906
60.3398
56.9380
26.3199
-0.0117
O
N
O
O
O
O
26
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm



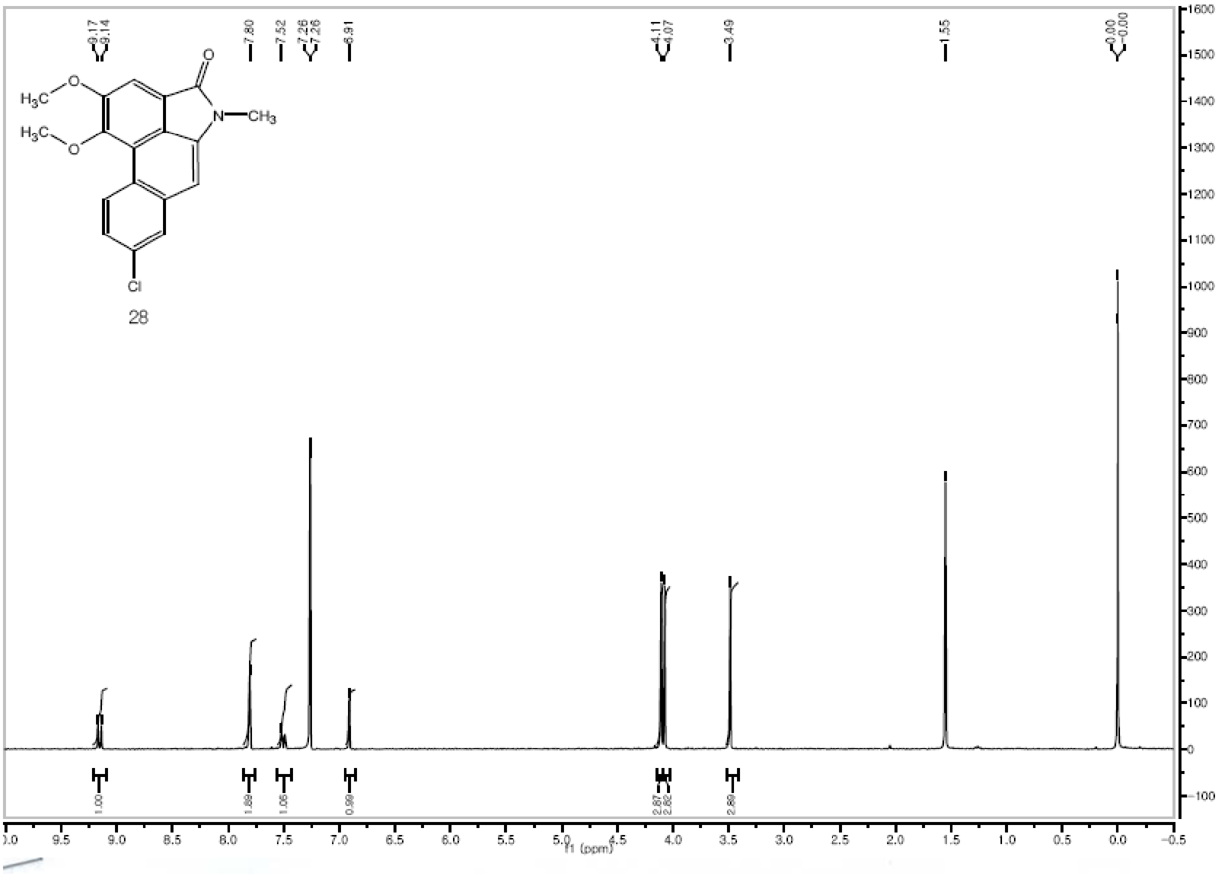
27



```
NAME       (0407)jkk-6-12
EXPNO                    2
PROCNO                   1
Date_             20080407
Time                 20.25
INSTRUM              spect
PROBHD     5 mm DUL 13C-1
PULPROG             zgpg30
TD                   65536
SOLVENT              CDCl3
NS                    1024
DS                       2
SWH             35211.270 Hz
FIDRES           0.537281 Hz
AQ              0.9306754 sec
RG                     512
DW                  14.200 usec
DE                    6.00 usec
TE                   296.3 K
D1              2.00000000 sec
D11             0.03000000 sec
TD0                      1

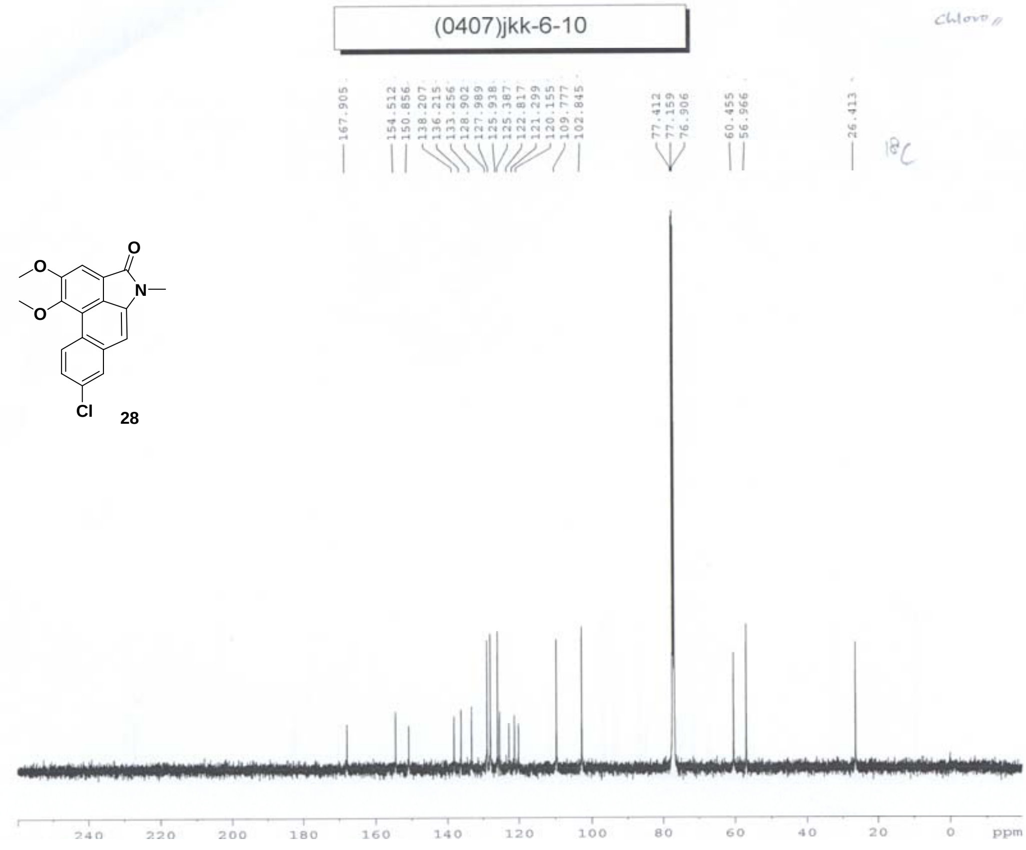
======== CHANNEL f1 ========
NUC1                   13C
P1                    8.00 usec
PL1                   1.40 dB
PL1W           70.60439301 W
SFO1          125.7728799 MHz

======== CHANNEL f2 ========
CPDPRG2            waltz16
NUC2                    1H
PCPD2               100.00 usec
PL2                  -1.90 dB
PL12                 16.00 dB
PL13                 19.00 dB
PL2W           27.23316002 W
PL12W           0.44167015 W
PL13W           0.22135943 W
SFO2          500.1320005 MHz
SI                   32768
SF            125.7577836 MHz
WDW                     EM
SSB                      0
LB                    1.00 Hz
GB                       0
PC                    1.40
```



28

Chloro

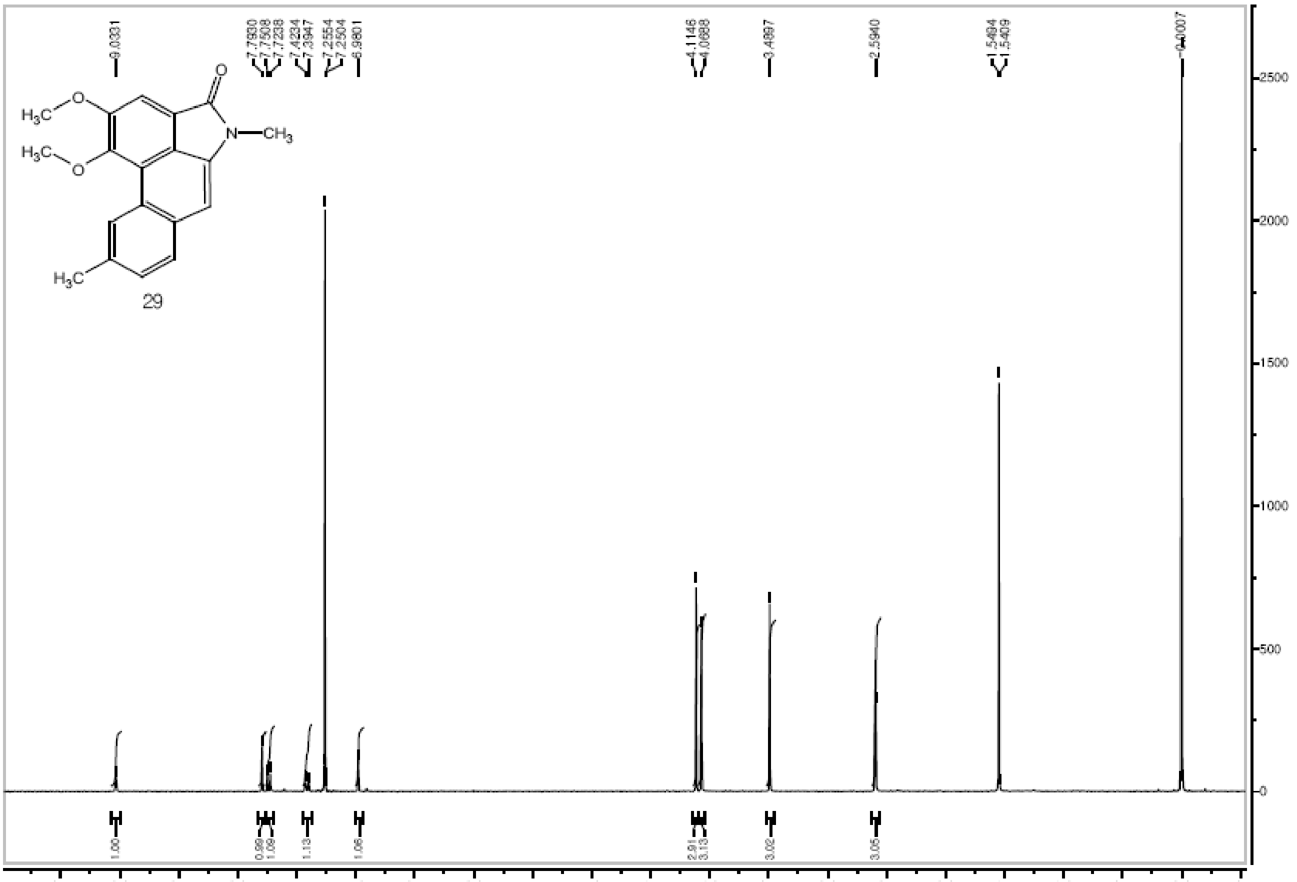


^{13}C

```
NAME       (0407)jkk-6-10
EXPNO                   2
PROCNO                  1
Date_            20080407
Time                18.33
INSTRUM             spect
PROBHD   5 mm DUL 13C-1
PULPROG            zgpg30
TD                  65536
SOLVENT             CDCl3
NS                   1024
DS                      2
SWH            35211.270 Hz
FIDRES          0.537281 Hz
AQ             0.9306754 sec
RG                    512
DW                 14.200 usec
DE                   6.00 usec
TE                  296.5 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                     1

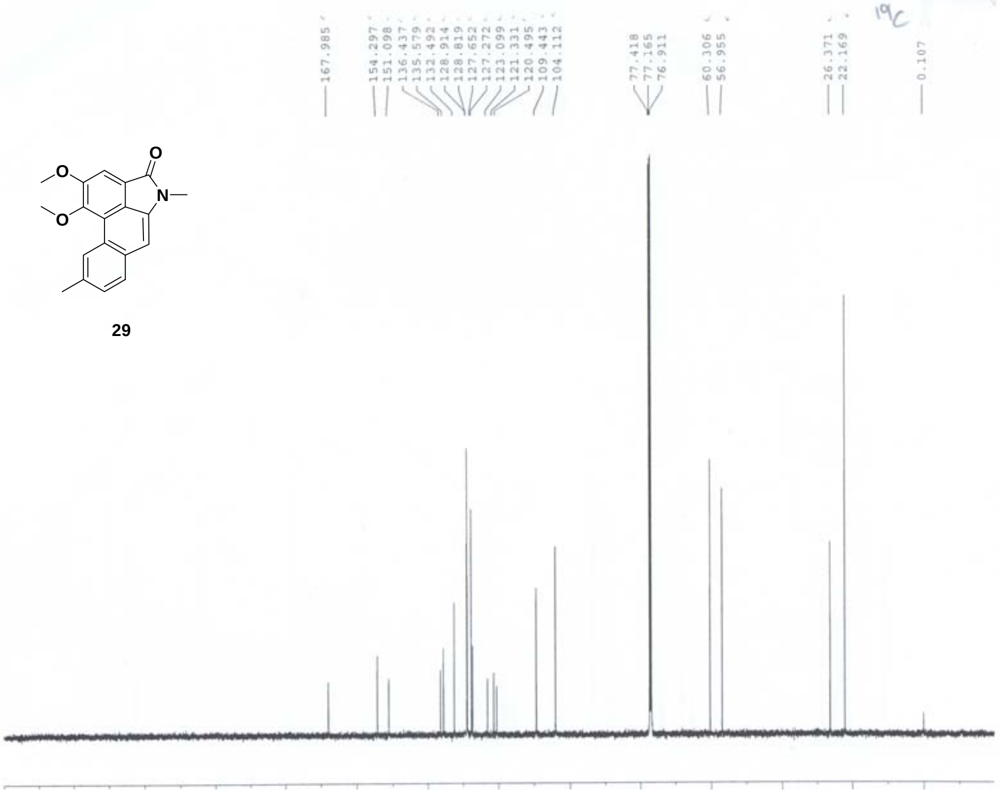
======== CHANNEL f1 ========
NUC1                  13C
P1                   8.00 usec
PL1                  1.40 dB
PL1W          70.60439301 W
SFO1          125.7728799 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                   1H
PCPD2              100.00 usec
PL2                 -1.90 dB
PL12                16.00 dB
PL13                19.00 dB
PL2W          27.23316002 W
PL12W          0.44167015 W
PL13W          0.22135943 W
SFO2          500.1320005 MHz
SI                  32768
SF            125.7577737 MHz
WDW                    EM
SSB                     0
LB                   1.00 Hz
GB                      0
PC                   1.40
```



29

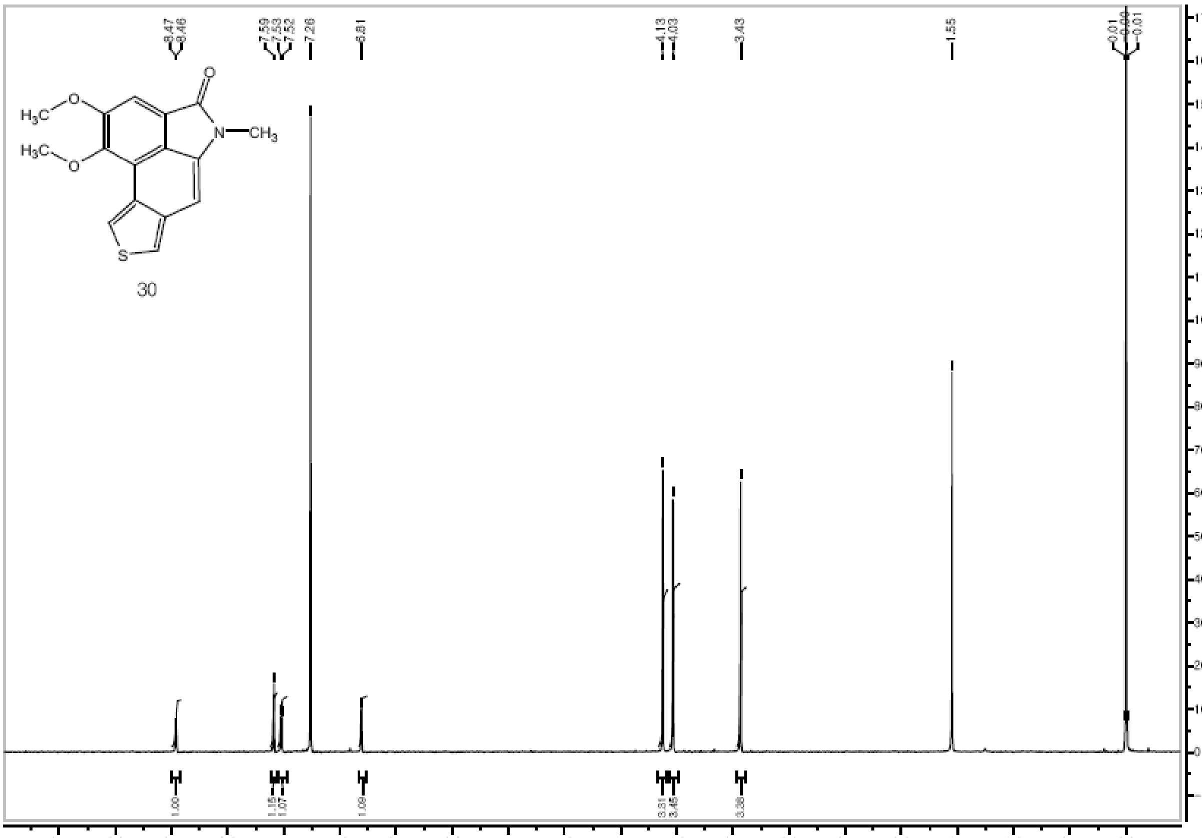
(0407)jkk-6-11



NAME (0407)jkk-6-11
EXPNO 2
PROCNO 1
Date_ 20080407
Time 19.28
INSTRUM spect
PROBHD 5 mm DUL 13C-1
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 1024
DS 2
SWH 35211.270 Hz
FIDRES 0.537281 Hz
AQ 0.9306754 sec
RG 512
DW 14.200 usec
DE 6.00 usec
TE 296.4 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

======== CHANNEL f1 ========
NUC1 13C
P1 8.00 usec
PL1 1.40 dB
PL1W 70.60439301 W
SFO1 125.7728799 MHz

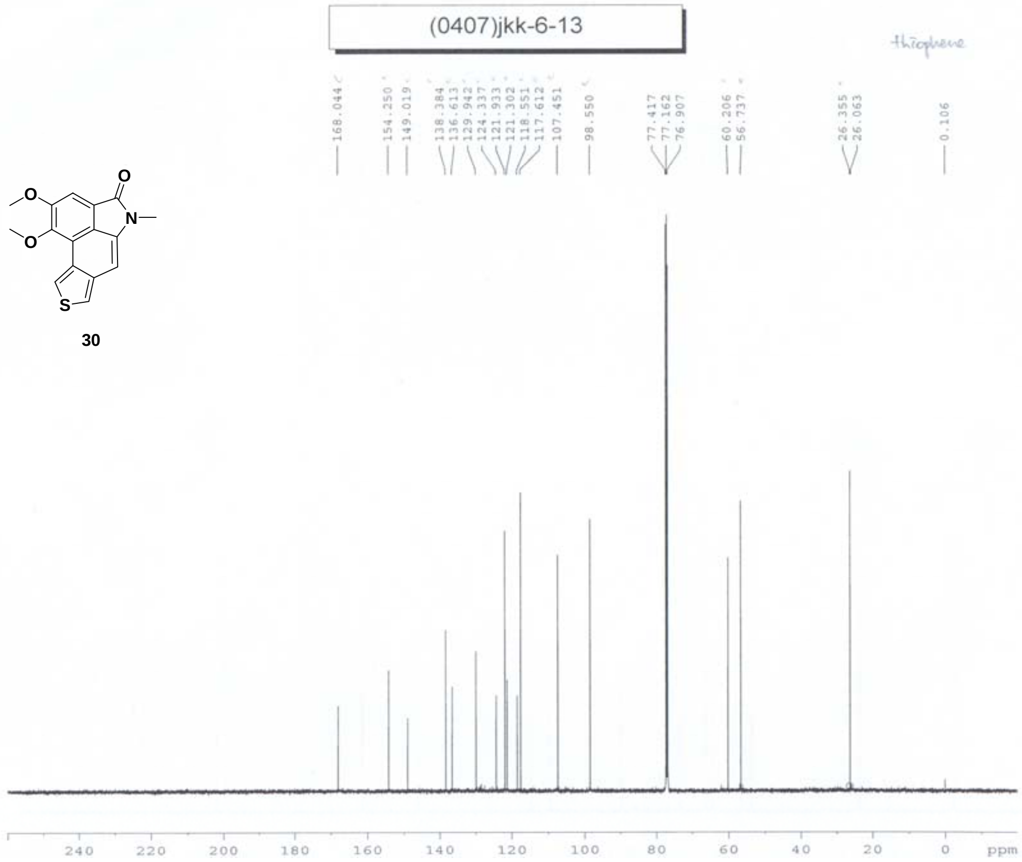
======== CHANNEL f2 ========
CPDPRG2 waltz16
NUC2 1H
PCPD2 100.00 usec
PL2 -1.90 dB
PL12 16.00 dB
PL13 19.00 dB
PL2W 27.23316002 W
PL12W 0.44167015 W
PL13W 0.22135943 W
SFO2 500.1320005 MHz
SI 32768
SF 125.7577771 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40



30

3c

thiophene

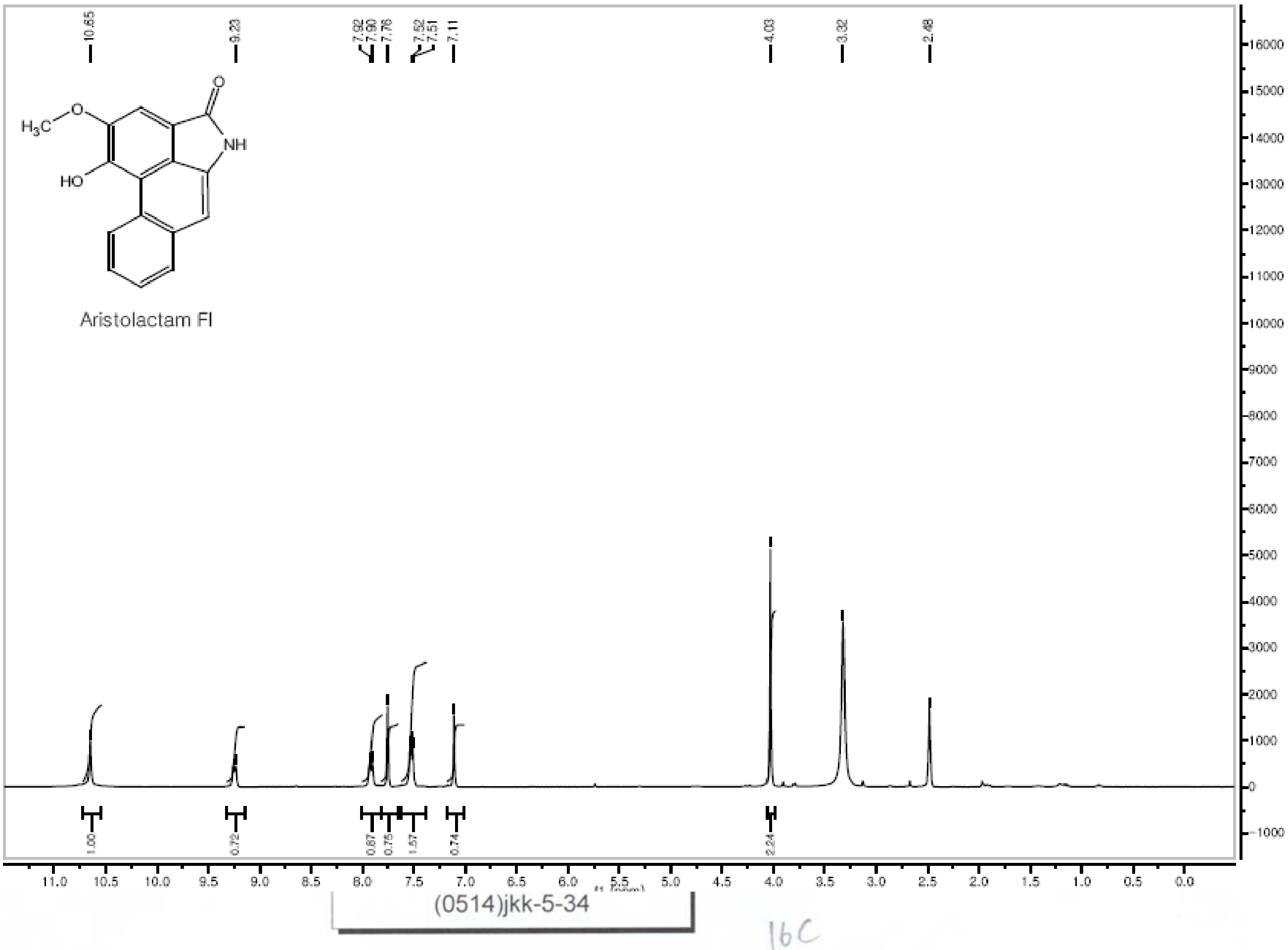


30

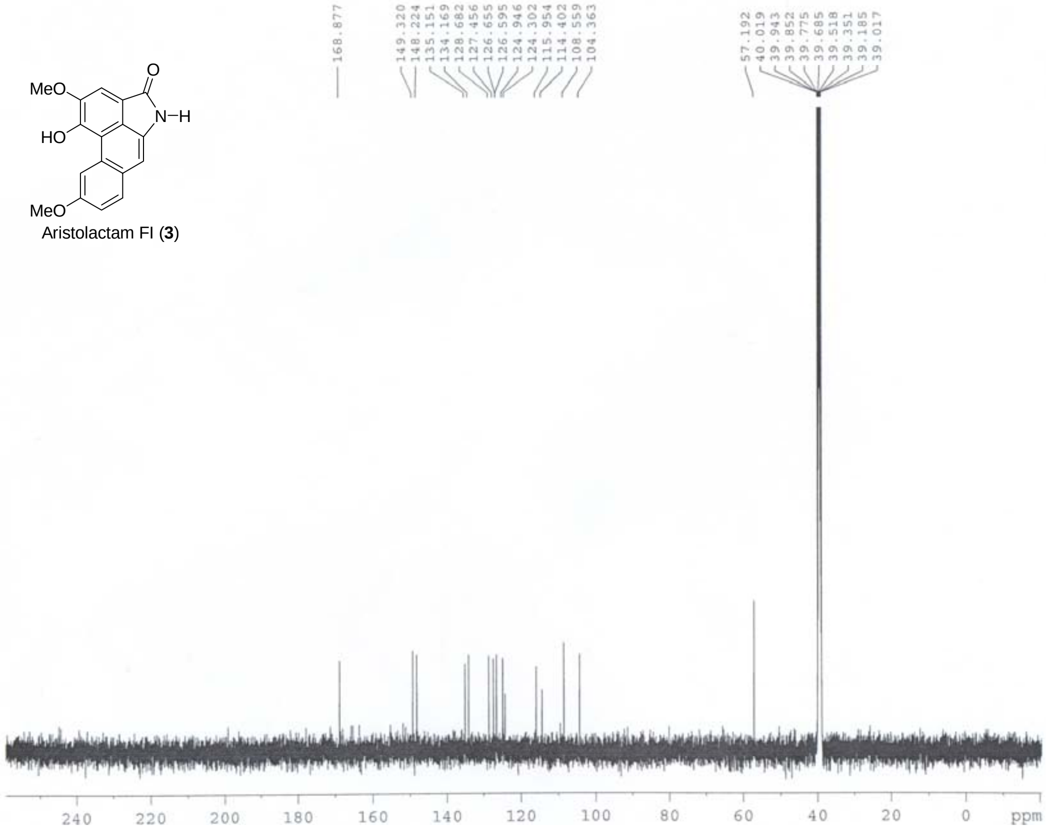
```
NAME        (0407)jkk-6-13
EXPNO                    2
PROCNO                   1
Date_             20080407
Time                 21.22
INSTRUM              spect
PROBHD   5 mm DUL 13C-1
PULPROG            zgpg30
TD                  65536
SOLVENT             CDCl3
NS                   1024
DS                      2
SWH            35211.270 Hz
FIDRES          0.537281 Hz
AQ             0.9306754 sec
RG                    512
DW                 14.200 usec
DE                   6.00 usec
TE                  296.5 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                  13C
P1                   8.00 usec
PL1                  1.40 dB
PL1W          70.60439301 W
SFO1         125.7728799 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                   1H
PCPD2              100.00 usec
PL2                 -1.90 dB
PL12                16.00 dB
PL13                19.00 dB
PL2W          27.23316002 W
PL12W          0.44167015 W
PL13W          0.22135943 W
SFO2         500.1320005 MHz
SI                  32768
SF           125.7577772 MHz
WDW                    EM
SSB                     0
LB                   1.00 Hz
GB                      0
PC                   1.40
```



16C

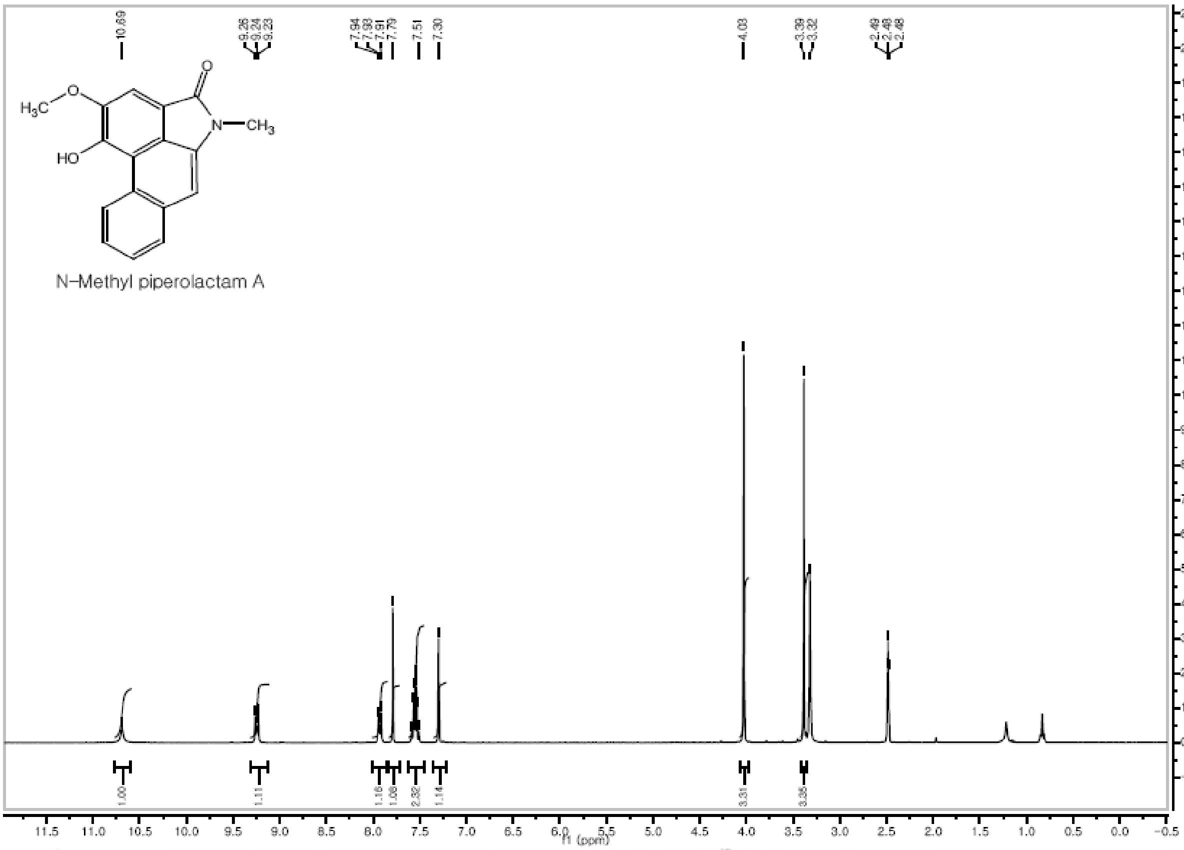


Aristolactam FI (**3**)

```
NAME       (0514)jkk-5-34
EXPNO                   2
PROCNO                  1
Date_            20080514
Time                16.56
INSTRUM             spect
PROBHD   5 mm DUL 13C-1
PULPROG           zgpg30
TD                 65536
SOLVENT             DMSO
NS                  1024
DS                     2
SWH          35211.270 Hz
FIDRES        0.537281 Hz
AQ           0.9306754 sec
RG                 812.7
DW                14.200 use
DE                  6.00 use
TE                 299.4 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

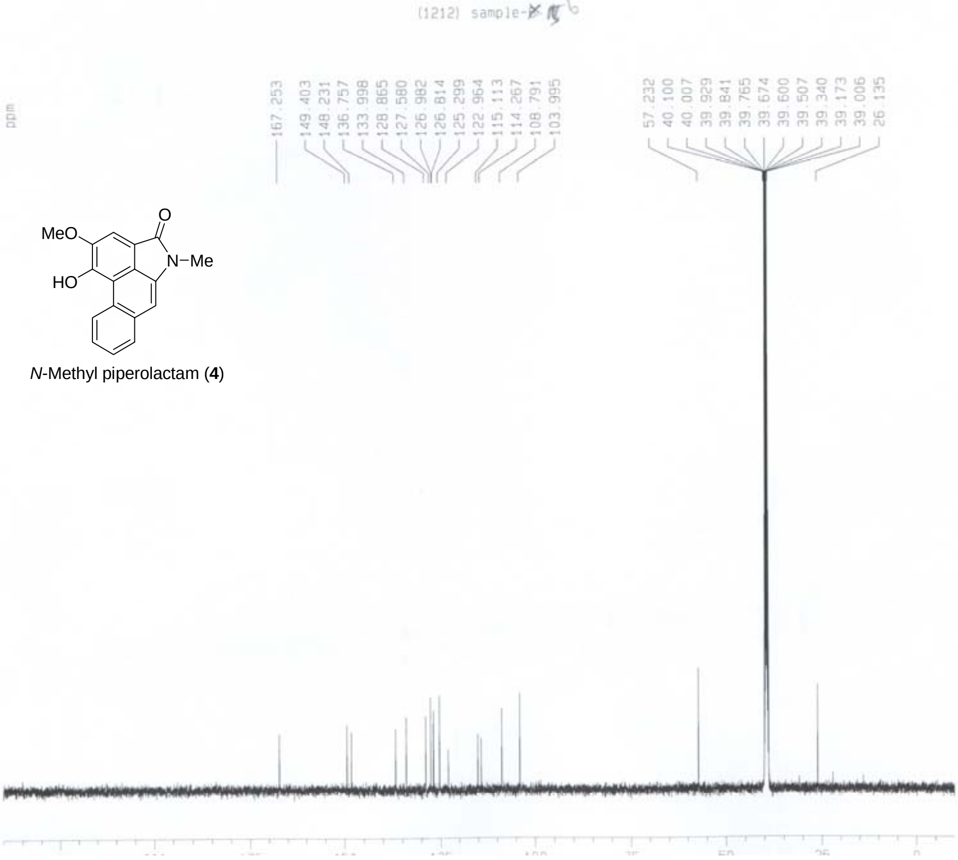
======== CHANNEL f1 ========
NUC1                 13C
P1                  8.00 use
PL1                 1.40 dB
PL1W         70.60439301 W
SFO1         125.7728799 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                  1H
PCPD2             100.00 use
PL2                -1.90 dB
PL12               16.00 dB
PL13               19.00 dB
PL2W         27.23316002 W
PL12W         0.44167015 W
PL13W         0.22135943 W
SFO2         500.1320005 MHz
SI                 32768
SF           125.7578505 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```



N−Methyl piperolactam A

N-methyl piperolactam



N-Methyl piperolactam (**4**)

```
Current Data Parameters
NAME             sample-6
EXPNO                   2
PROCNO                  1

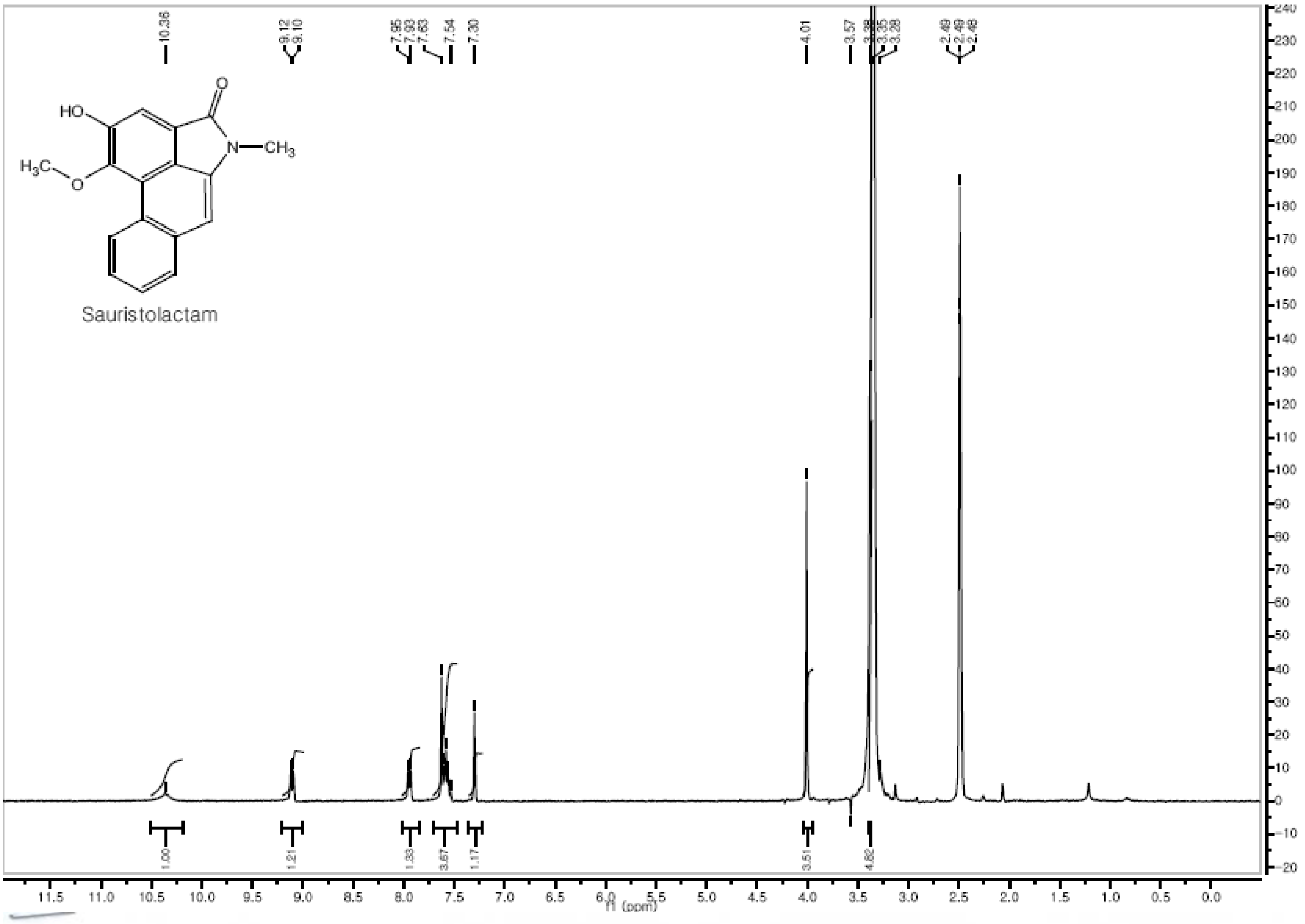
F2 - Acquisition Parameters
Date_            20071212
Time                 9.52
INSTRUM   .         spect
PROBHD   5 mm DUL 13C-1
PULPROG              zgpg
TD                  65536
SOLVENT              DMSO
NS                   1024
DS                      2
SWH            35211.270 Hz
FIDRES          0.537281 Hz
AQ             0.9306754 sec
RG                   1024
DW                 14.200 usec
DE                   6.00 usec
TE                  293.1 K
D1             2.00000000 sec
d11            0.03000000 sec
DELTA          1.89999998 sec
MCREST         0.00000000 sec
MCWRK          0.01500000 sec

======== CHANNEL f1 ========
NUC1                  13C
P1                   7.50 usec
PL1                  1.00 dB
SFO1          125.7728799 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                   1H
PCPD2               80.00 usec
PL2                 -1.40 dB
PL12                16.66 dB
PL13                25.00 dB
SFO2          500.1320005 MHz

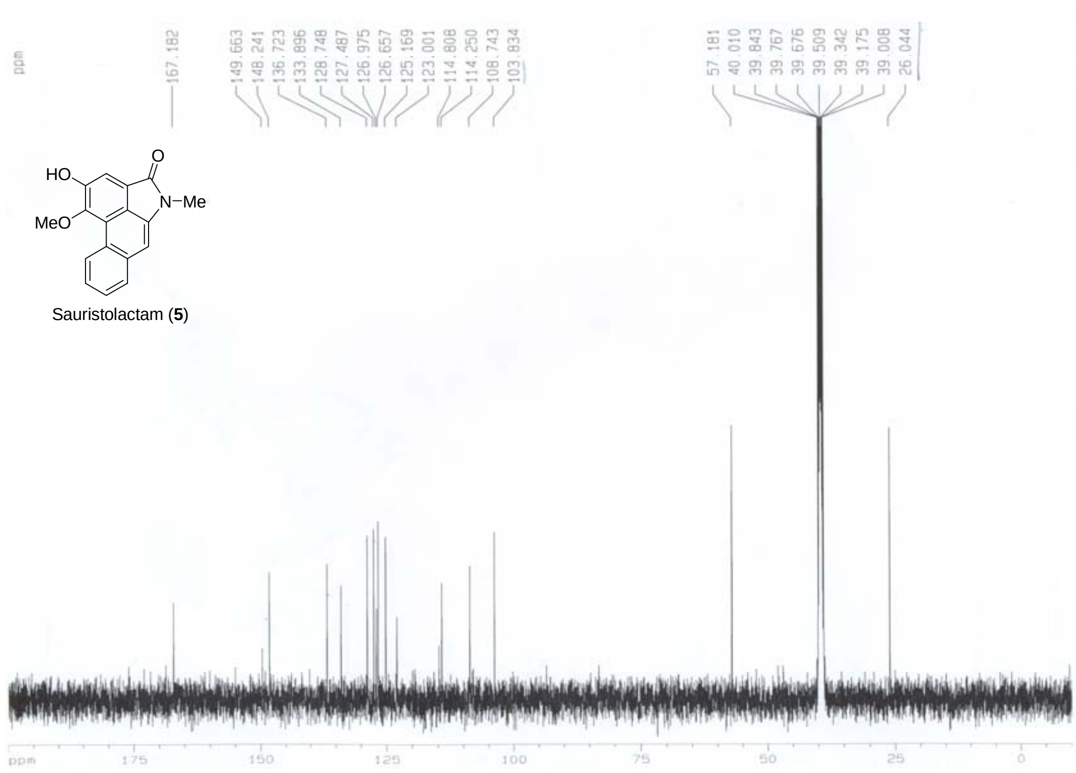
F2 - Processing parameters
SI                  32768
SF            125.7578426 MHz
WDW                    EM
SSB                     0
LB                   1.00 Hz
GB                      0
PC                   1.40

1D NMR plot parameters
CX                  20.00 cm
CY                  40.00 cm
F1P               240.000 ppm
F1               30181.88 Hz
F2P               -10.000 ppm
F2               -1257.58 Hz
PPMCM            12.50000 ppm/cm
```



13

(0925) NHT-1-160-2



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Current Data Parameters
NAME      0925NHT-1-160-2
EXPNO                   2
PROCNO                  1

F2 - Acquisition Parameters
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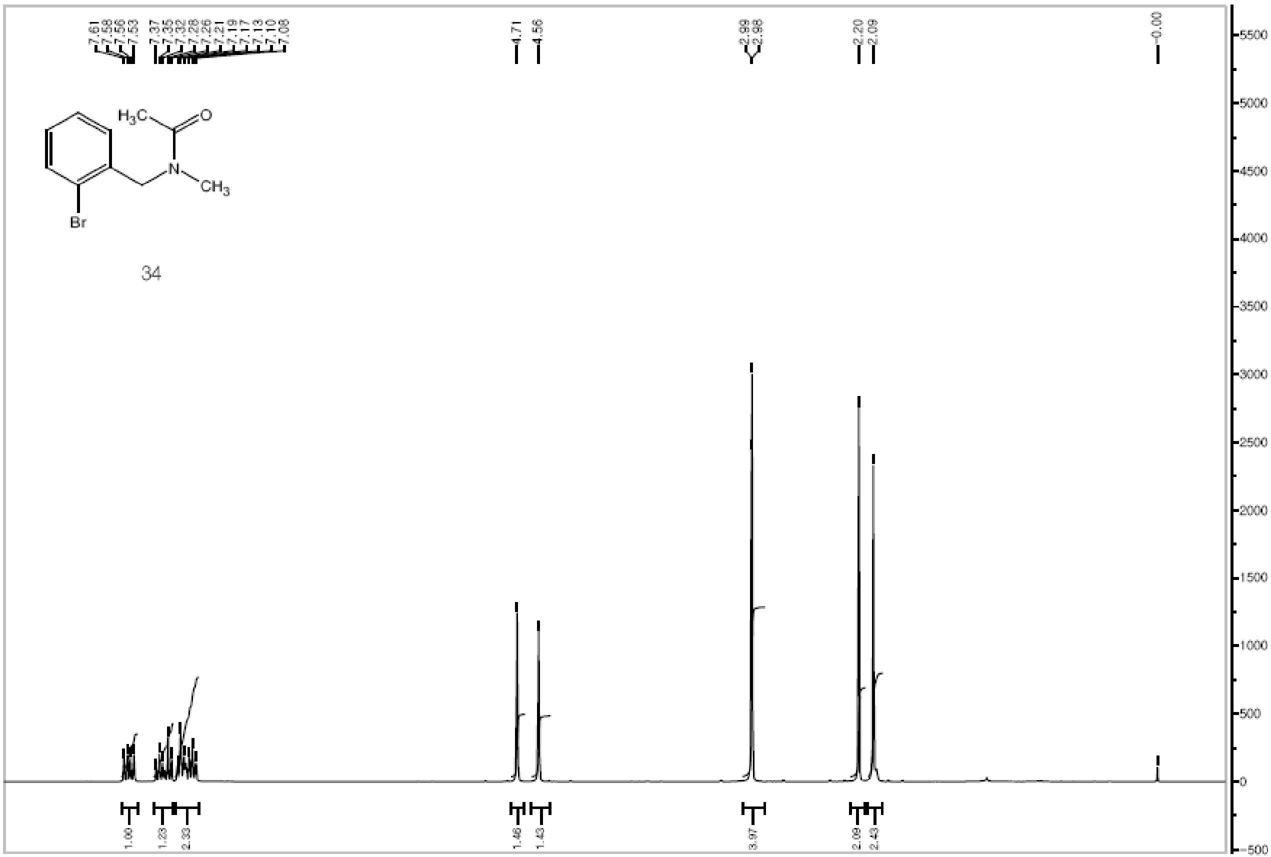
Time                8.46
INSTRUM            spect
PROBHD   5 mm DUL 13C-1
PULPROG           zgpg30
TD                 65536
SOLVENT             DMSO
NS                  1024
DS                     2
SWH           35211.270 Hz
FIDRES         0.537281 Hz
AQ            0.9306754 sec
RG                 912.3
DW                14.200 usec
DE                  6.00 usec
TE                 299.6 K
D1            2.00000000 sec
d11           0.03000000 sec
DELTA         1.89999998 sec
MCREST        0.00000000 sec
MCWRK         0.01500000 sec

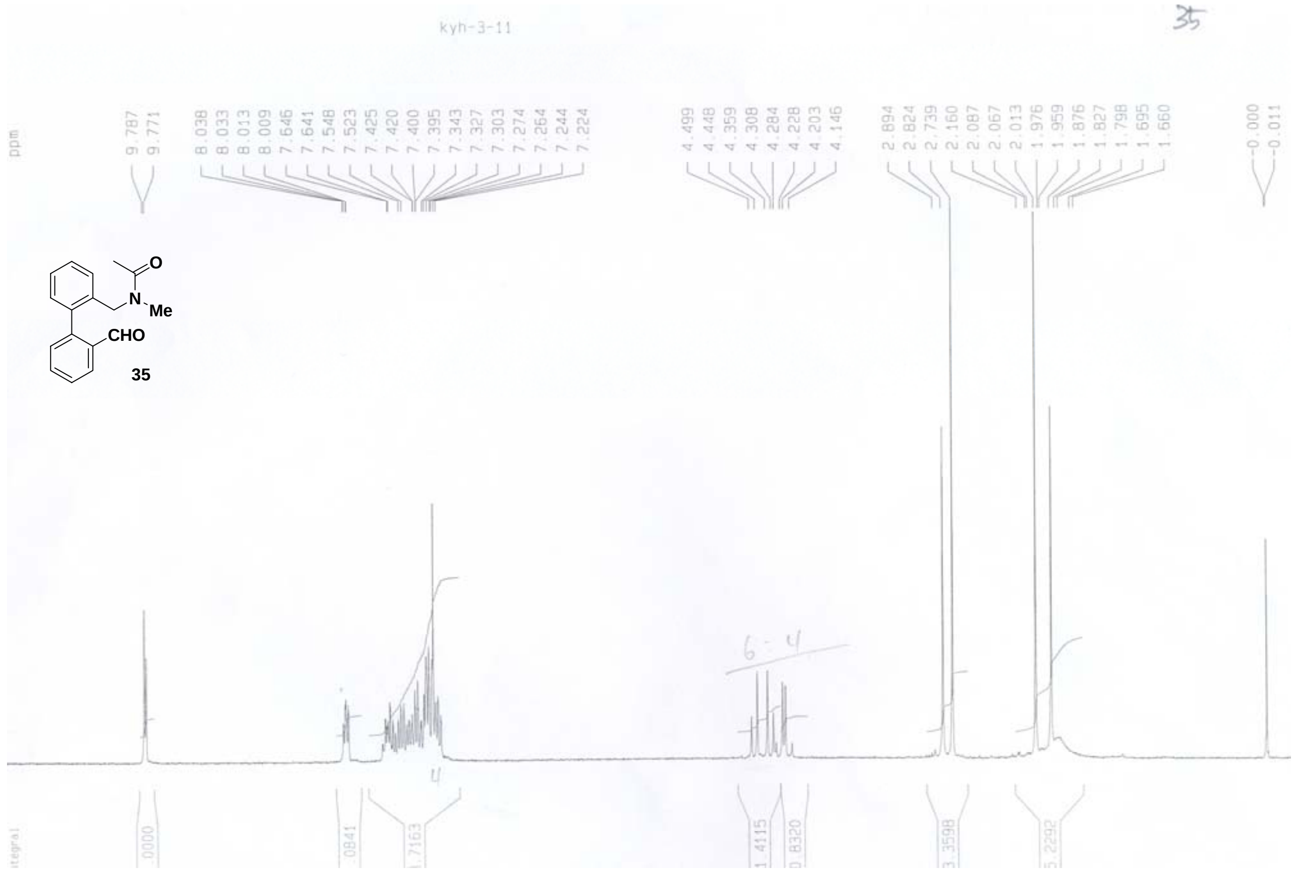
======== CHANNEL f1 ========
NUC1                 13C
P1                 10.00 usec
PL1                 2.00 dB
SFO1         125.7728799 MHz

======== CHANNEL f2 ========
CPDPRG2         waltz16
NUC2                  1H
PCPD2              80.00 usec
PL2                -1.40 dB
PL12               16.66 dB
PL13               19.66 dB
SFO2         500.1320005 MHz

F2 - Processing parameters
SI                 32768
SF           125.7578512 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40

1D NMR plot parameters
CX                 20.00 cm
CY                  6.00 cm
F1P              200.000 ppm
F1              25151.57 Hz
F2P              -10.000 ppm
F2              -1257.58 Hz
PPMCM           10.50000 ppm/cm
HZCM          1320.45740 Hz/cm
```


7.61
7.58
7.56
7.53
7.37
7.35
7.32
7.28
7.26
7.21
7.19
7.17
7.13
7.10
7.08
4.71
4.56
2.99
2.98
2.20
2.09
-0.00
H_3C
O
N
CH_3
Br
34
1.00
1.23
2.33
1.46
1.43
3.97
2.09
2.43
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
f1 (ppm)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500


kyh-3-11
35
ppm
9.787
9.771
8.038
8.033
8.013
8.009
7.646
7.641
7.548
7.523
7.425
7.420
7.400
7.395
7.343
7.327
7.303
7.274
7.254
7.244
7.224
4.499
4.448
4.359
4.308
4.284
4.228
4.203
4.146
2.894
2.824
2.739
2.160
2.087
2.067
2.013
1.976
1.959
1.876
1.827
1.798
1.695
1.660
-0.000
-0.011
O
N
Me
CHO
35
6 : 4
4
ntegral
0000
0841
7163
1.4115
0.8320
3.3598
5.2292