Electronic Supplementary Information (ESI)

Synthesis and antitumor activity of aza-brazilan derivatives containing imidazolium salt pharmacophore

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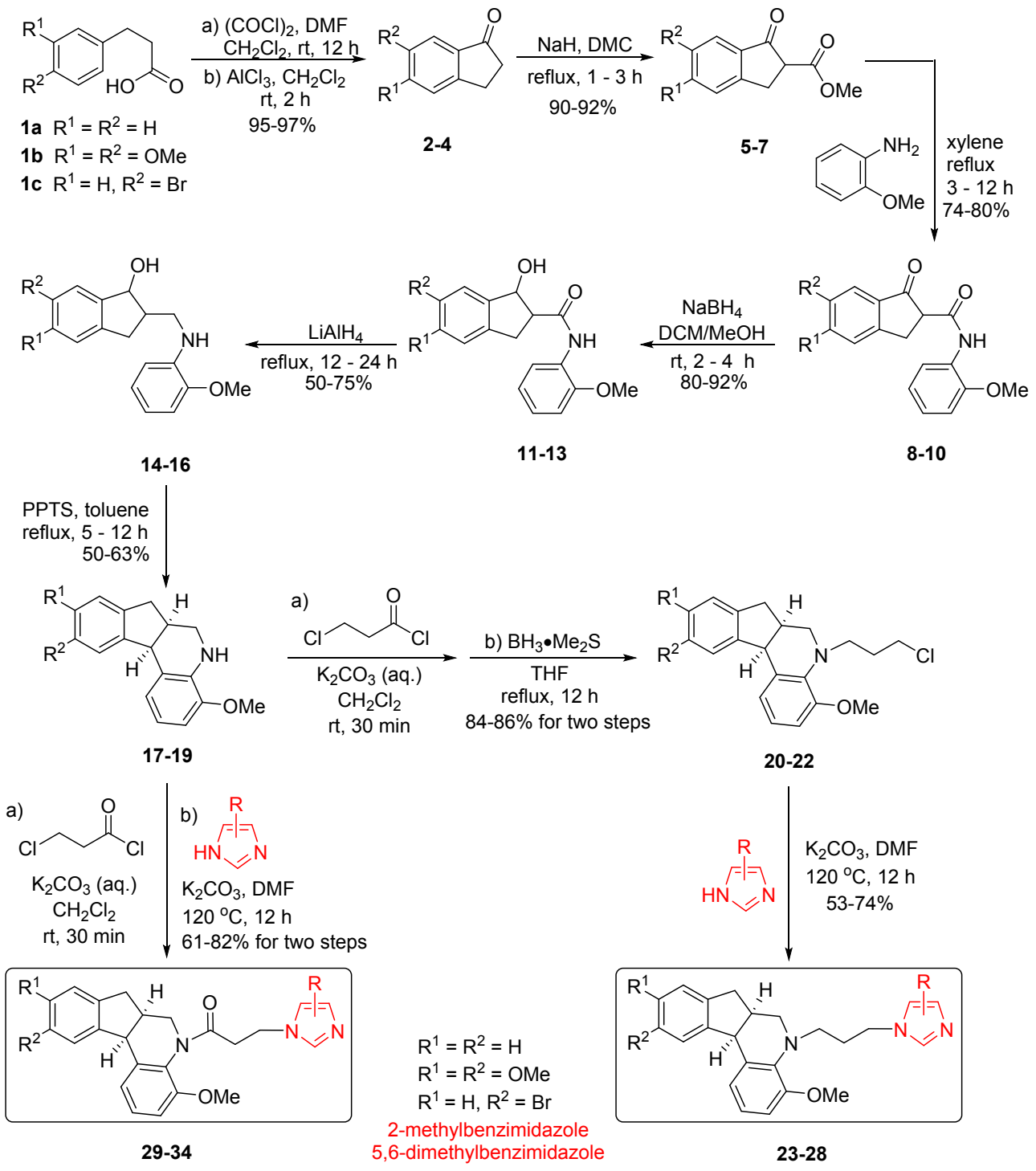
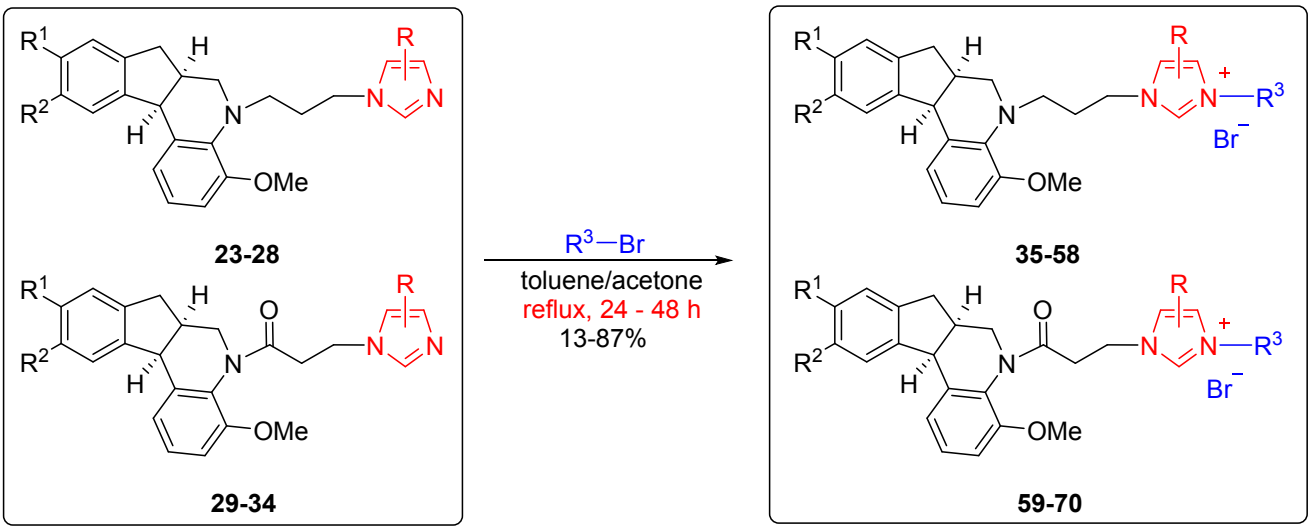
1. General Experimental

Melting points were obtained on a XT-4 melting-point apparatus and were uncorrected. Proton nuclear magnetic resonance (^{1}H-NMR) spectra were recorded on a Bruker Avance 300 or Bruker DRX 400 spectrometer at 300 or 400 MHz. Carbon-13 nuclear magnetic resonance (^{13}C-NMR) was recorded on Bruker DRX 400 spectrometer at 100 MHz. Chemical shifts are reported as δ values in parts per million (ppm) relative to tetramethylsilane (TMS) for all recorded NMR spectra. Low-resolution Mass spectra were recorded on a VG Auto Spec-3000 magnetic sector MS spectrometer. High Resolution Mass spectra were taken on AB QSTAR Pulsar mass spectrometer.Silica gel (200-300 mesh) for column chromatography and silica GF_{254} for TLC were produced by Qingdao Marine Chemical Company (China). All air- or moisture-sensitive reactions were conducted under an argon atmosphere. Starting materials and reagents used in reactions were obtained commercially from Acros, Aldrich, Fluka and were used without purification, unless otherwise indicated.

2. Experimental Procedures and Analytical Data





$R^1 = R^2 = H$
$R^1 = R^2 = OMe$
$R^1 = H, R^2 = Br$

2-methylbenzimidazole
5,6-dimethylbenzimidazole
R^3 = alkyl, phenacyl

Synthesis of hybrid compounds **23-70**

Entry	Compound No.	R^1	R^2	Imidazole ring	R^3	Molecular formula	Yields (%)
1	**23**	H	H	2-Methylbenzimidazole	-	$C_{28}H_{29}N_3O$	74
2	**24**	H	H	5,6-Dimethylbenzimidazole	-	$C_{29}H_{31}N_3O$	66
3	**25**	OMe	OMe	2-Methylbenzimidazole	-	$C_{30}H_{33}N_3O_3$	74
4	**26**	OMe	OMe	5,6-Dimethylbenzimidazole	-	$C_{31}H_{35}N_3O_3$	53
5	**27**	H	Br	2-Methylbenzimidazole	-	$C_{28}H_{28}BrN_3O$	69
6	**28**	H	Br	5,6-Dimethylbenzimidazole	-	$C_{29}H_{30}BrN_3O$	71
7	**29**	H	H	2-Methylbenzimidazole	-	$C_{28}H_{27}N_3O_2$	64
8	**30**	H	H	5,6-Dimethylbenzimidazole	-	$C_{29}H_{29}N_3O_2$	61
9	**31**	OMe	OMe	2-Methylbenzimidazole	-	$C_{30}H_{31}N_3O_4$	82
10	**32**	OMe	OMe	5,6-Dimethylbenzimidazole	-	$C_{31}H_{33}N_3O_4$	81
11	**33**	H	Br	2-Methylbenzimidazole	-	$C_{28}H_{26}BrN_3O_2$	69
12	**34**	H	Br	5,6-Dimethylbenzimidazole	-	$C_{29}H_{28}BrN_3O_2$	71
13	**35**	H	H	2-Methylbenzimidazole	4-Methylbenzyl	$C_{36}H_{38}BrN_3O$	66
14	**36**	H	H	2-Methylbenzimidazole	2-Naphthylmethyl	$C_{39}H_{38}BrN_3O$	81
15	**37**	H	H	2-Methylbenzimidazole	4-Methoxyphenacyl	$C_{37}H_{38}BrN_3O_3$	84

17	**38**	H	H	2-Methylbenzimidazole	2-Naphthylacyl	$C_{40}H_{38}BrN_3O_2$	58
18	**39**	H	H	5,6-Dimethylbenzimidazole	4-Methylbenzyl	$C_{36}H_{40}BrN_3O$	63
19	**40**	H	H	5,6-Dimethylbenzimidazole	2-Naphthylmethyl	$C_{40}H_{40}BrN_3O$	87
20	**41**	H	H	5,6-Dimethylbenzimidazole	4-Methoxyphenacyl	$C_{38}H_{40}BrN_3O_3$	80
21	**42**	H	H	5,6-Dimethylbenzimidazole	2-Naphthylacyl	$C_{41}H_{40}BrN_3O_2$	71
22	**43**	OMe	OMe	2-Methylbenzimidazole	4-Methylbenzyl	$C_{38}H_{42}BrN_3O_4$	65
23	**44**	OMe	OMe	2-Methylbenzimidazole	2-Naphthylmethyl	$C_{42}H_{42}BrN_3O_3$	76
24	**45**	OMe	OMe	2-Methylbenzimidazole	4-Methoxyphenacyl	$C_{39}H_{42}BrN_3O_5$	68
25	**46**	OMe	OMe	2-Methylbenzimidazole	2-Naphthylacyl	$C_{42}H_{42}BrN_3O_4$	86
26	**47**	OMe	OMe	5,6-Dimethylbenzimidazole	4-Methylbenzyl	$C_{39}H_{44}BrN_3O_3$	74
27	**48**	OMe	OMe	5,6-Dimethylbenzimidazole	2-Naphthylmethyl	$C_{42}H_{44}BrN_3O_3$	52
28	**49**	OMe	OMe	5,6-Dimethylbenzimidazole	4-Methoxyphenacyl	$C_{40}H_{44}BrN_3O_5$	63
29	**50**	OMe	OMe	5,6-Dimethylbenzimidazole	2-Naphthylacyl	$C_{43}H_{44}BrN_3O_4$	71
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31	**52**	H	Br	2-Methylbenzimidazole	2-Naphthylmethyl	$C_{39}H_{37}Br_2N_3O$	49
32	**53**	H	Br	2-Methylbenzimidazole	4-Methoxyphenacyl	$C_{37}H_{37}Br_2N_3O_3$	67
33	**54**	H	Br	2-Methylbenzimidazole	2-Naphthylacyl	$C_{40}H_{37}Br_2N_3O_2$	80
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39	**60**	H	H	2-Methylbenzimidazole	2-Naphthylmethyl	$C_{39}H_{36}BrN_3O_2$	27
40	**61**	H	H	2-Methylbenzimidazole	4-Methoxyphenacyl	$C_{37}H_{36}BrN_3O_4$	33
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42	**63**	H	H	5,6-Dimethylbenzimidazole	2-Naphthylmethyl	$C_{40}H_{38}BrN_3O_2$	16
43	**64**	H	H	5,6-Dimethylbenzimidazole	4-Methoxyphenacyl	$C_{38}H_{38}BrN_3O_4$	17
44	**65**	H	H	5,6-Dimethylbenzimidazole	2-Naphthylacyl	$C_{41}H_{38}BrN_3O_3$	13
45	**66**	OMe	OMe	2-Methylbenzimidazole	4-Methoxyphenacyl	$C_{39}H_{40}BrN_3O_6$	21
46	**67**	OMe	OMe	2-Methylbenzimidazole	2-Naphthylacyl	$C_{42}H_{40}BrN_3O_5$	20

47	**68**	H	Br	2-Methylbenzimidazole	2-Naphthylacyl	$C_{40}H_{35}Br_2N_3O_3$	45
48	**69**	H	Br	5,6-Dimethylbenzimidazole	2-Naphthylmethyl	$C_{40}H_{37}Br_2N_3O_2$	27
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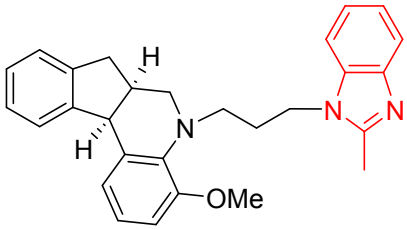

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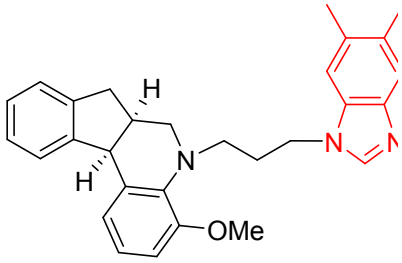

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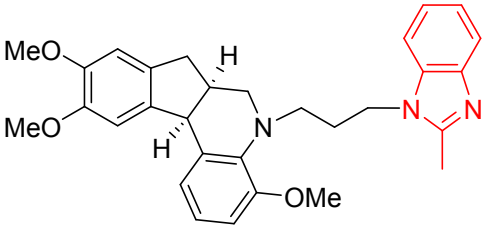

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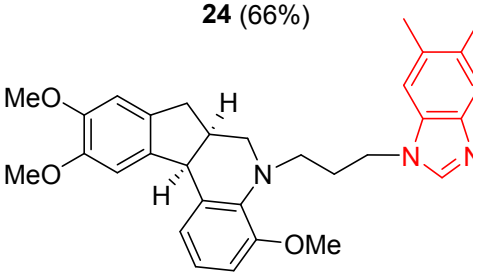

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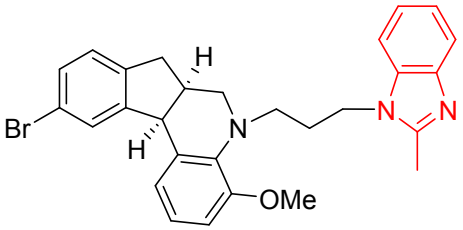

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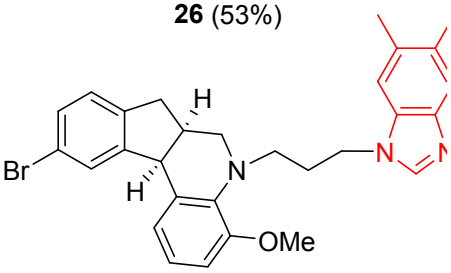

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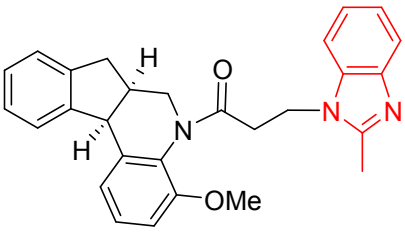

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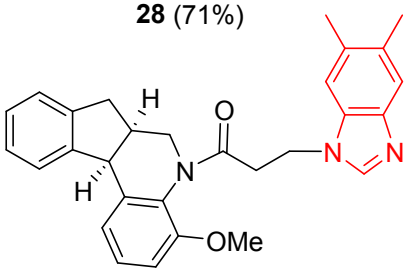

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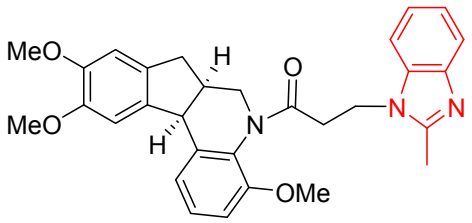

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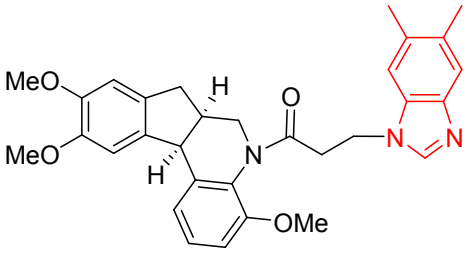

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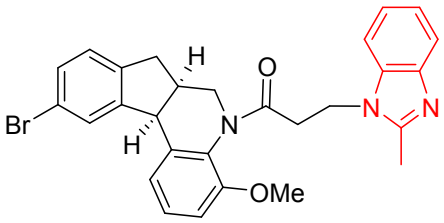

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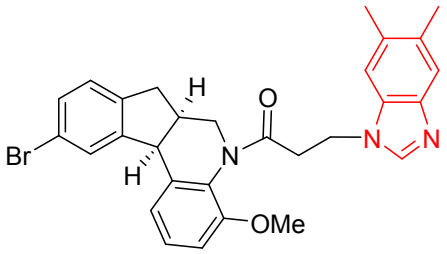

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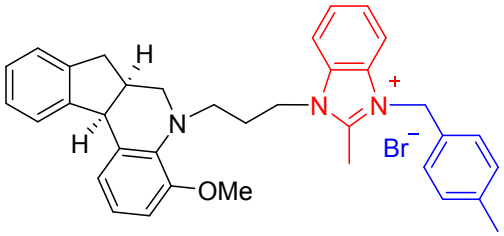

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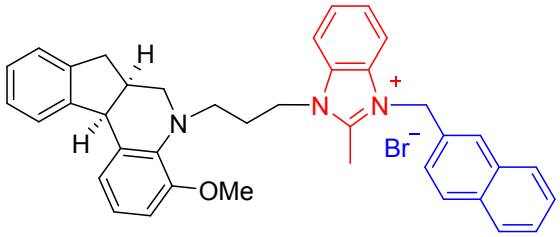

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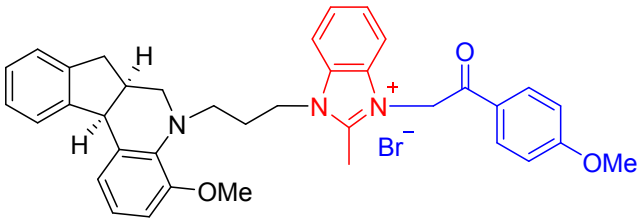

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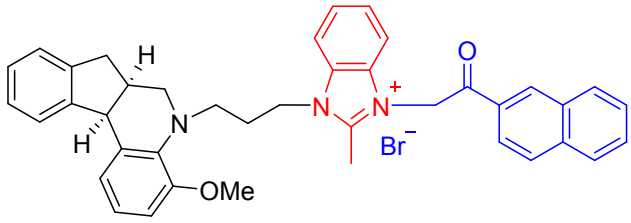

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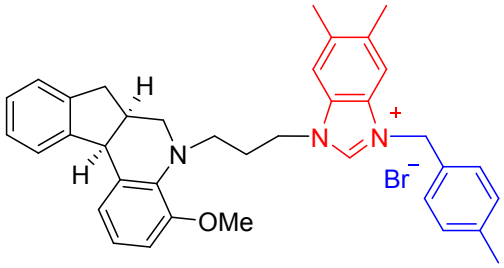

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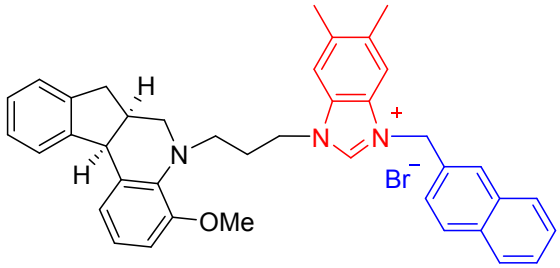

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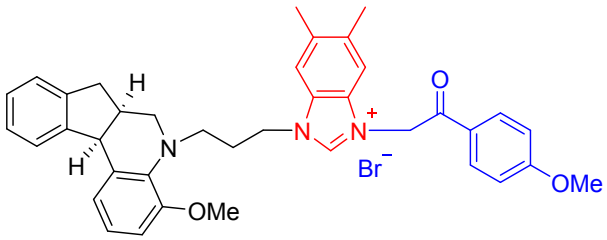

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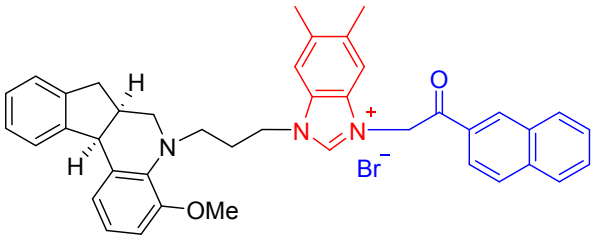

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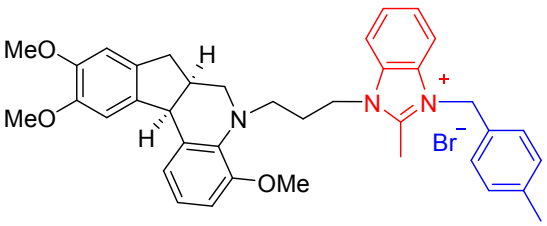

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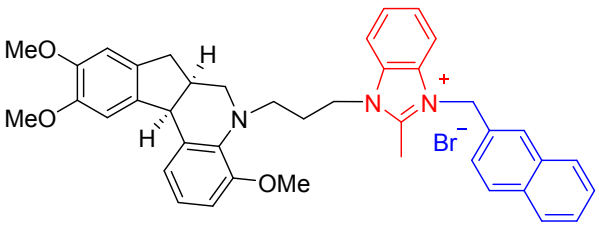

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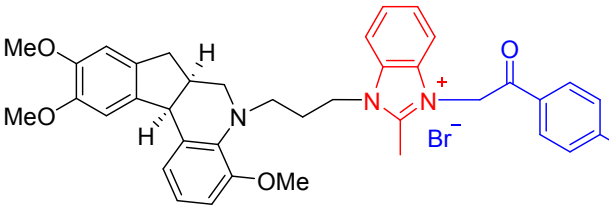

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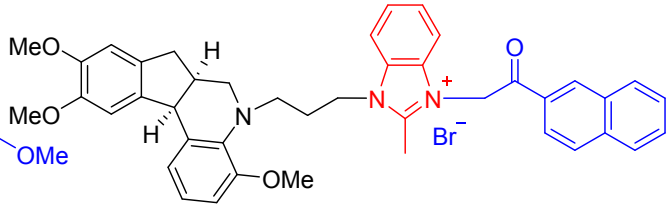

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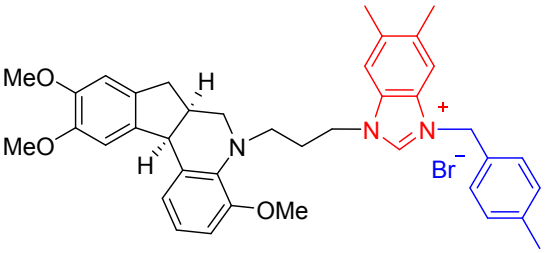

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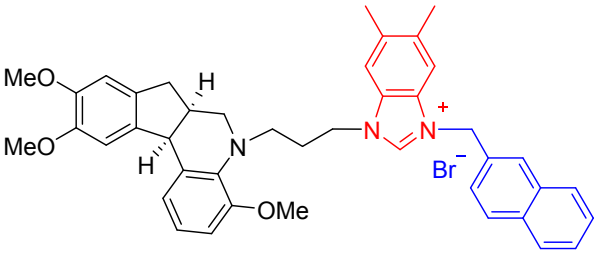

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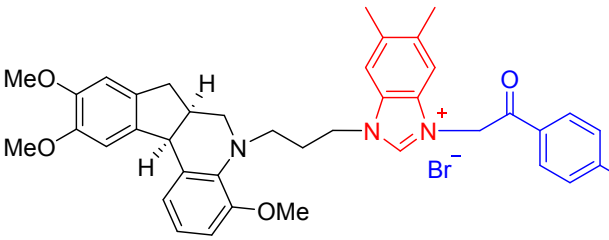

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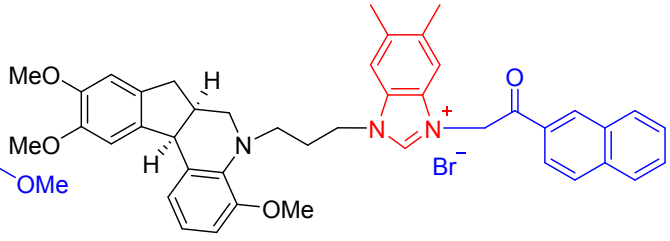

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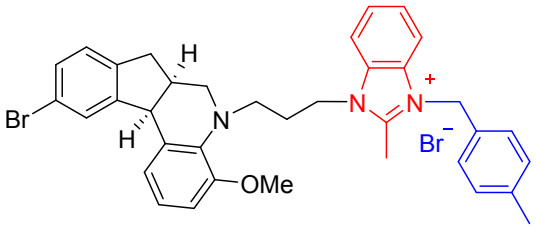

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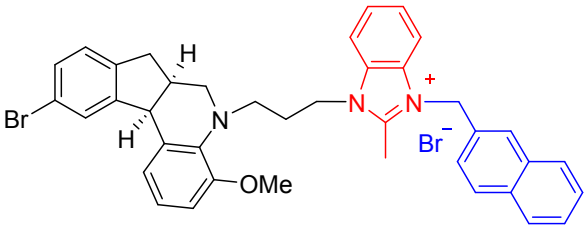

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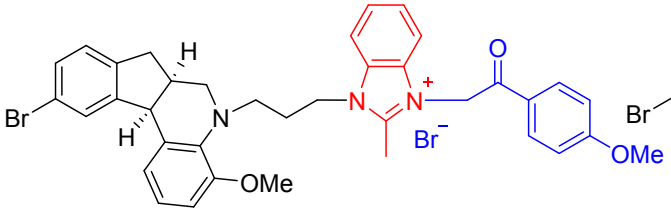

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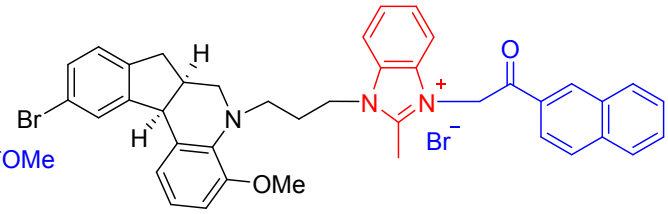

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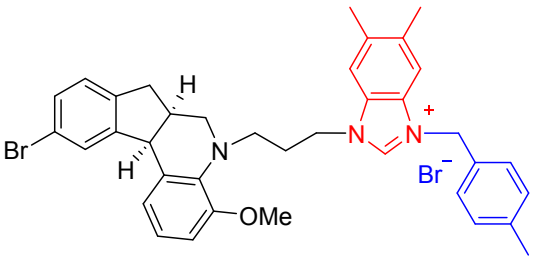

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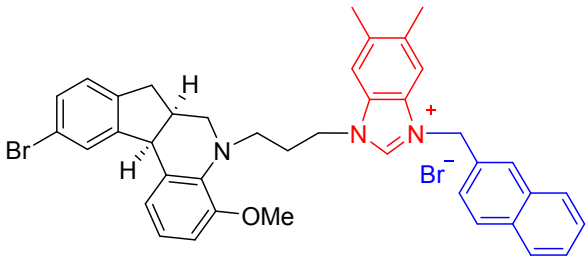

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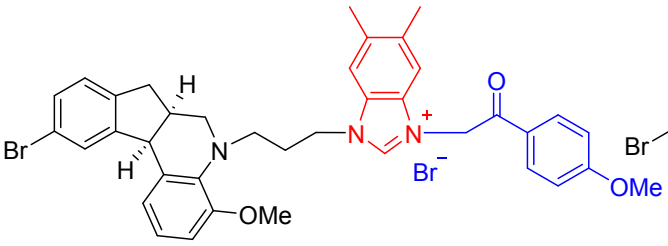

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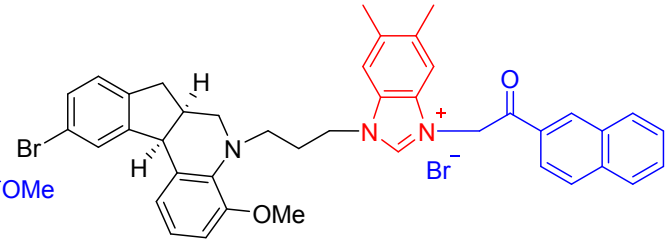

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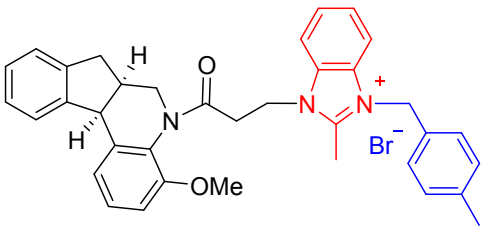
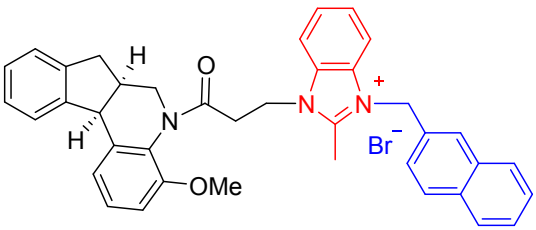
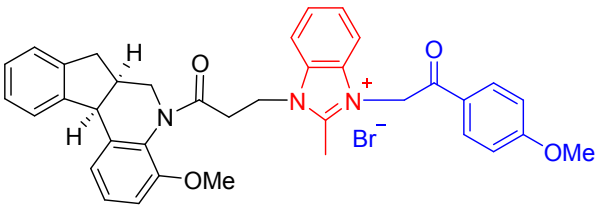


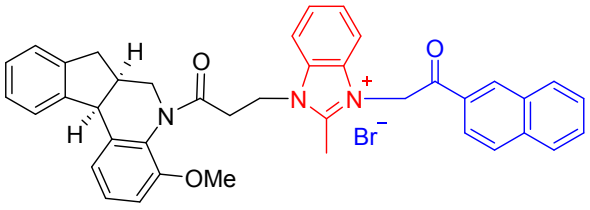
59 (28%)



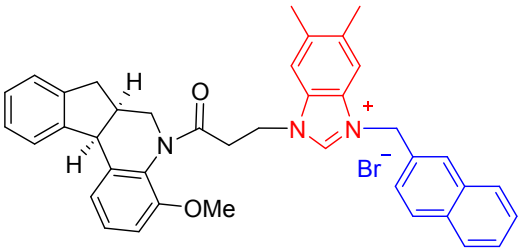
60 (27%)



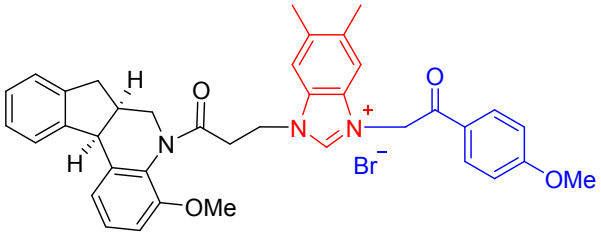
61 (33%)



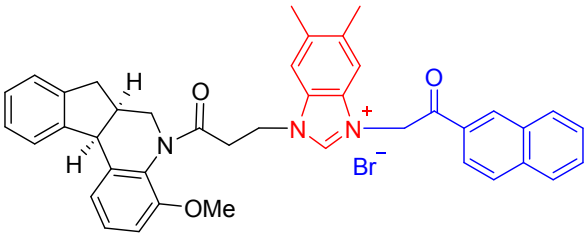
62 (34%)



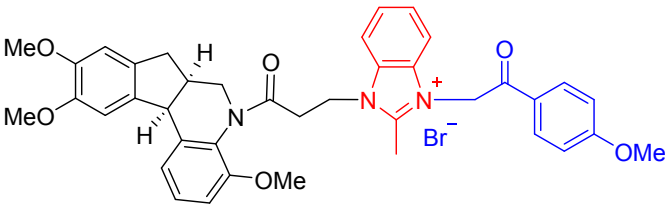
63 (16%)



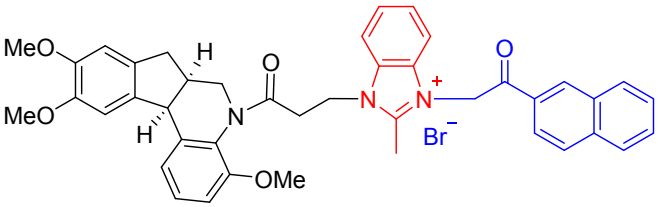
64 (17%)



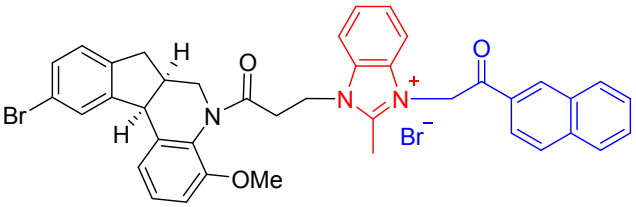
65 (13%)



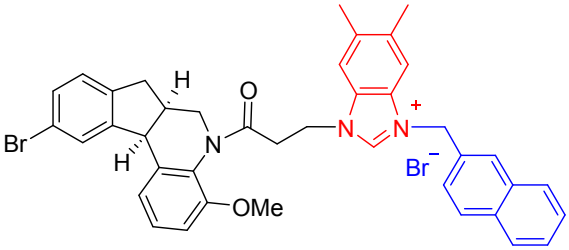
66 (21%)



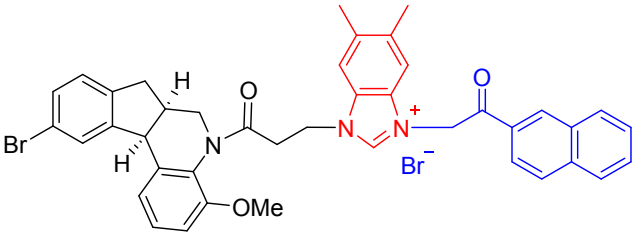
67 (20%)



68 (45%)

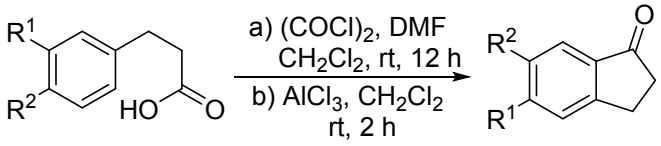


69 (27%)



70 (24%)

2.1 Synthesis of compound 2-4

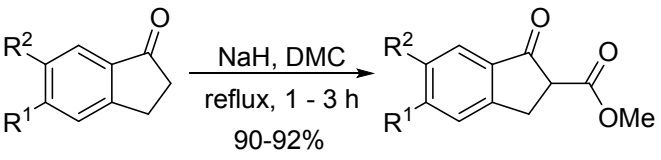


1a $R^1 = R^2 = H$
1b $R^1 = R^2 = OMe$
1c $R^1 = H$, $R^2 = Br$

2-4

A solution of derivatives of phenylpropionic acid (0.10 mol) in dry dichloromethane (300 mL), N,N-dimethylformamide (0.5 ml) and oxalyl chloride (21 mL, 0.25 mol) were stirred at room temperature for 12 h. The reaction mixture was concentrated by rotary evaporation. A solution of crude in anhydrous dichloromethane (300 mL) was cooled with an ice bath to 0 °C and a powder of $AlCl_3$ (16 g, 0.12 mol) was added portionwise over 30 min. The reaction was then stirred at room temperature for 2 h and cooled to 0 °C. Ice-water (130 mL) was added slowly in reaction medium to quench the excess $AlCl_3$. The layers were separated, and the aqueous phase was extracted with CH_2Cl_2 (3 × 100 mL). The combined organic phases were dried over Na_2SO_4, filtered and concentrated by rotary evaporation. And the target compound **2-4** was recrystallized from ethyl acetate and obtained as yellow powder in 95% -97% yields. The ^1H and $^{13}C\{^1H\}$ NMR data for compound **3** matched the literature data. [1]

2.2 Synthesis of compound 5-7

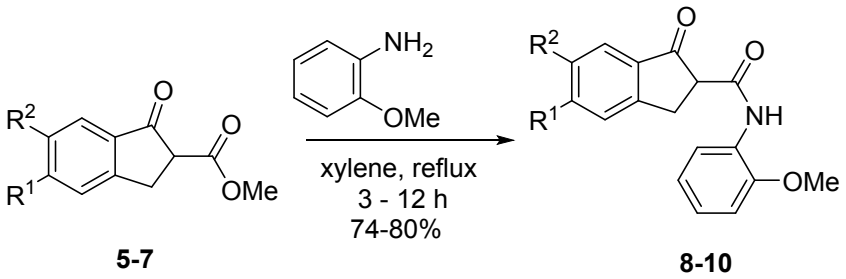


2-4 **5-7**

NaH (6 g, 0.15 mol, 60% in mineral oil) was added slowly to the solution of **2-4** (0.05 mol) in dimethylcarbonate (50 mL), and the suspension was refluxed at 90 °C for 1-3 h. The resulting solid was cooled to 0 °C with an ice bath. After cooling, 3 mol/L HCl was added carefully to neutral. The aqueous layer was extracted with CH_2Cl_2 (3 × 80 mL). The combined organic extracts were dried over Na_2SO_4 and concentrated. The desired product **5-7** (pale yellow powder, 90%-92% yields) was obtained by

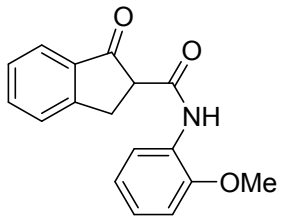
recrystallization from ethyl acetate. The ^{1}H and $^{13}C\{^{1}H\}$ NMR data for compound **5, 6** matched the literature data. [1-2]

2.3 Synthesis of compound 8-10



5-7 **8-10**

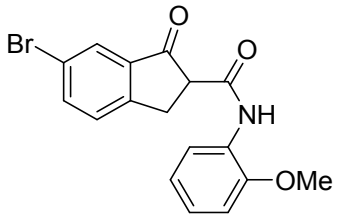
To a mixture of compound **5-7** (1.00 mmol) and 2-methoxyaniline (246 mg, 2.00 mmol) in xylene were refluxed under nitrogen for 3-12 h. The reaction progress was monitored by TLC. The solvent was evaporated under reduced pressure and the crude product was purified by flash column chromatography on silica gel (eluted with petroleum ether:ethyl acetate = 2:1) to give **8-10** as yellow powder in 74%-80% yields. The ^{1}H and $^{13}C\{^{1}H\}$ NMR data for compound **9** matched the literature data.[3]



8

N-(2-methoxyphenyl)-1-oxo-2,3-dihydro-1*H*-indene-2-carboxamide

Yield 76%; yellow powder; m.p. = 131-133 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 9.63 (s, 1H), 8.34 (d, *J* = 8.1 Hz, 1H), 7.80 (d, *J* = 7.8 Hz, 1H), 7.65 (t, *J* = 7.8 Hz, 1H), 7.54 (d, *J* = 7.8 Hz, 1H), 7.40 (t, *J* = 7.5 Hz, 1H), 7.05 (t, *J* = 7.8 Hz, 1H), 6.97-6.90 (m, 2H), 3.98 (s, 3H), 3.92-3.84 (m, 1H), 3.81-3.78 (m, 1H), 3.43 (dd, *J* = 17.4, 7.8 Hz, 1H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$) δ 203.2, 164.4, 154.3, 148.6, 136.0, 135.5, 127.8, 126.9, 124.6, 124.0, 121.1, 120.0, 110.4, 56.1, 54.1, 28.7 ppm; IR (KBr) ν: 3414, 1698, 1681, 1602, 1526, 1484, 1460, 1431, 1249, 1119, 1026, 753 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{17}H_{16}NO_3$ $[M+H]^+$ 282.1125, found 282.1126.

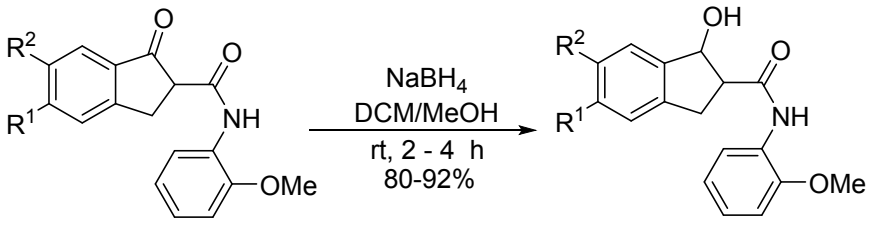


6-bromo-*N*-(2-methoxyphenyl)-1-oxo-2,3-dihydro-1*H*-indene-2-carboxamide

10

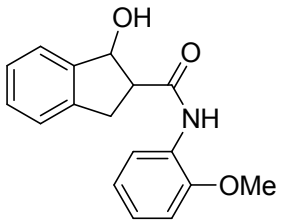
Yield 74%; yellow powder; m.p. = 186-188 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.50 (s, 1H), 8.31 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.91 (d, *J* = 2.0 Hz, 1H), 7.74 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.43 (d, *J* = 8.4 Hz, 1H), 7.08-7.04 (m, 1H), 6.96-6.90 (m, 2H), 3.97 (s, 3H), 3.84-3.79 (m, 2H), 3.36 (dd, *J* = 18.4, 8.8 Hz, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 201.8, 163.8, 152.8, 148.6, 138.7, 137.3, 128.4, 127.7, 127.5, 124.2, 122.0, 121.1, 120.0, 110.3, 56.1, 54.4, 28.4 ppm; IR (KBr) ν: 3382, 3055, 2963, 2879, 1704, 1675, 1530, 1460, 1250, 1187, 1120, 1025, 786, 768, 694, 653, 465 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{17}H_{15}BrNO_3$ $[M+H]^+$ 360.0230, found 360.0228.

2.4 Synthesis of compound 11-13



8-10 **11-13**

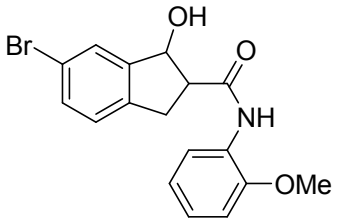
The compound **8-10** (0.20 mmol) was dissolved in dry dichloromethane (3 mL) and methanol (0.3 mL). $NaBH_4$ (23 mg, 0.60 mmol) was added portionwise at 0 °C and the mixture was stirred at room temperature for 2-4 h. A staturated solution of NH_4Cl was added. The layers were separated and the aqueous layer was extracted with dichloromethane (3 × 15 mL). The combined organic layers were washed with brine, dried over Na_2SO_4 and concentrated. The desired product was obtained by flash column chromatography on silica gel (eluted with petroleum ether:ethyl acetate = 2:1) to give **11-13** as yellow powder or yellow oil in 80%-92% yields. The ^{1}H and ^{13}C{^{1}H} NMR data for compound **12** matched the literature data.[3]



11

1-hydroxy-*N*-(2-methoxyphenyl)-2,3-dihydro-1*H*-indene-2-carboxamide

Yield 80%; yellow powder; m.p. = 117-119 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.46 (s, 1H), 8.39 (dd, *J* = 8.1, 1.8 Hz, 1H), 7.38-7.34 (m, 1H), 7.29-7.21 (m, 2H), 7.05 (td, *J* = 7.8, 1.8 Hz, 1H), 6.95 (td, *J* = 7.8, 1.5 Hz, 1H), 6.88 (dd, *J* = 7.8, 1.5 Hz, 1H), 5.43 (t, *J* = 6.9 Hz, 1H), 3.87 (s, 3H), 3.25-3.19 (m, 2H), 3.16-3.10 (m, 1H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$) δ 171.4, 148.1, 143.2, 140.1, 128.5, 127.7, 127.1, 124.9, 123.9, 123.7, 121.1, 112.0, 110.1, 79.0, 57.2, 55.8, 32.2 ppm; IR (KBr) ν:3395, 2932, 2837, 1679, 1652, 1521, 1435, 1286, 1253, 1049, 1032, 748, 632 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{17}H_{18}NO_3$ $[M+H]^+$ 284.1281, found 284.1281.

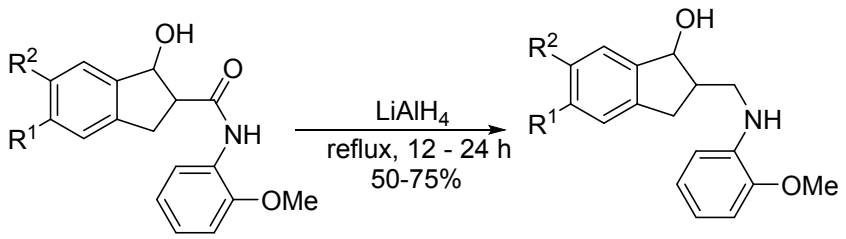


13

6-bromo-1-hydroxy-*N*-(2-methoxyphenyl)-2,3-dihydro-1*H*-indene-2-carboxamide

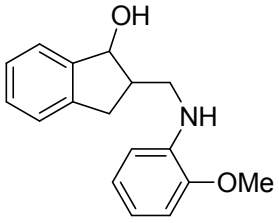
Yield 80%; yellow powder; m.p. = 195-197 °C; ^{1}H NMR (300 MHz, DMSO-d_6) δ 9.22 (s, 1H), 8.15-8.12 (m, 1H), 7.45-7.39 (m, 2H), 7.20 (d, *J* = 7.8 Hz, 1H), 7.08-7.04 (m, 2H), 6.95-6.89 (m, 1H), 6.12 (d, *J* = 6.6 Hz, 1H), 5.28 (t, *J* = 7.2 Hz, 1H), 3.85 (s, 3H), 3.33 (t, *J* = 9.0 Hz, 1H), 3.10 (dd, *J* = 15.9, 8.4 Hz, 1H), 2.90 (dd, *J* = 15.9, 9.6 Hz, 1H) ppm; ^{13}C NMR (75 MHz, DMSO-d_6) δ 171.4, 149.0, 148.0, 139.4, 130.4, 127.5, 126.7, 124.1, 121.0, 120.3, 119.5, 111.1, 77.0, 55.8, 55.6, 32.6 ppm; IR (KBr) ν: 3424, 1663, 1607, 1542, 1491, 1464, 1436, 1261, 1246, 1116, 1030, 747 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{17}H_{17}BrNO_3$ $[M+H]^+$ 362.0386, found 362.0386.

2.5 Synthesis of compound 14-16



11-13 **14-16**

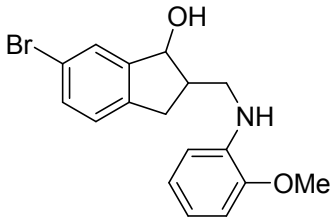
To a solution of compound **11-13** (2.91 mmol) in dry THF (15 mL) was added slowly lithium alminum hydride (331 mg, 8.73 mmol) at an ice bath. The solution was warmed to room temperature and stirred for 1 h and the mixture was refluxed under nitrogen for 12-24 h. After cooling at 0 °C, it was quenched with staturated solution of Na_2SO_4 and filtered. The resulting mixture was extracted with EtOAc, and the organic layer was washed with brine, dried over Na_2SO_4, and concentrated. The desired product was obtained by flash column chromatography on silica gel (eluted with petroleum ether:ethyl acetate = 5:1→1:1) to give **14-16** as yellow powder or yellow oil in 50%-75% yields. The ^{1}H and ^{13}C{^{1}H} NMR data for compound **15** matched the literature data.[3]



14

2-(((2-methoxyphenyl)amino)methyl)-2,3-dihydro-1*H*-inden-1-ol

Yield 60%; yellow powder; m.p. = 93-95 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.27-7.24 (m, 1H), 7.16-7.11 (m, 3H), 6.79 (td, *J* = 7.5, 1.5 Hz, 1H), 6.67 (dd, *J* = 7.8, 1.5 Hz, 1H), 6.62-6.55 (m, 2H), 4.91 (d, *J* = 6.6 Hz, 1H), 3.73 (s, 3H), 3.26-3.24 (m, 2H), 3.04 (dd, *J* = 15.0, 7.2 Hz, 1H), 2.56-2.41 (m, 2H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$) δ 147.0, 144.6, 141.3, 138.3, 128.3, 127.0, 124.9, 124.0, 121.4, 116.8, 110.1, 109.6, 80.4, 55.5, 50.1, 47.3, 34.4 ppm; IR (KBr) ν: 3320, 3254, 2929, 2833, 1599, 1509, 1456, 1274, 1248, 1132, 1049, 1033, 740 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{17}H_{20}NO_2$ $[M+H]^+$ 270.1489, found 270.1489.

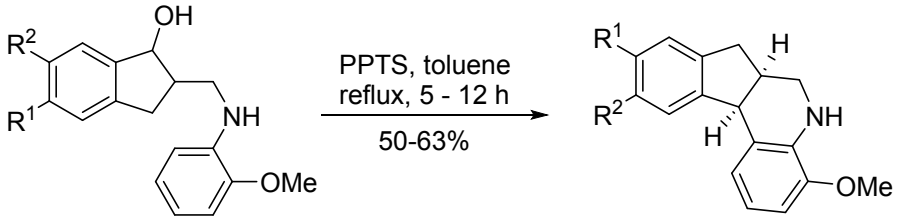


16

6-bromo-2-(((2-methoxyphenyl)amino)methyl)-
2,3-dihydro-1*H*-inden-1-ol

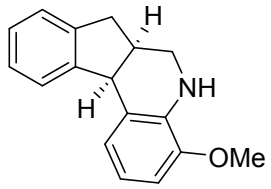
Yield 75%; yellow oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.35 (d, *J* = 1.8 Hz, 1H), 7.24 (dd, *J* = 7.8, 1.8 Hz, 1H), 6.96 (d, *J* = 8.1 Hz, 1H), 6.79 (td, *J* = 7.5, 1.8 Hz, 1H), 6.69-6.54 (m, 3H), 4.86 (d, *J* = 6.6 Hz, 1H), 3.73 (s, 3H), 3.25 (d, *J* = 6.3 Hz, 2H), 3.02-2.92 (m, 1H), 2.47-2.43 (m, 2H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$) δ 147.0, 146.9, 140.1, 138.1, 131.2, 127.3, 126.4, 121.4, 120.6, 117.1, 110.3, 109.6, 79.9, 55.5, 50.4, 47.1, 34.0 ppm; IR (KBr) ν: 3413, 2936, 2834, 1602, 1512, 1470, 1455, 1249, 1222, 1028, 739 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{17}H_{19}BrNO_2$ $[M+H]^+$ 348.0594, found 348.0594.

2.6 Synthesis of compound 17-19



14-16 **17-19**

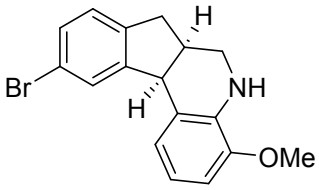
To a mixture of compound **14-16** (3.04 mmol) and PPTS (917 mg, 3.65 mmol) in dry toluene were refluxed under nitrogen for 5-12 h. The reaction progress was monitored by TLC. The solvent was evaporated under reduced pressure and the crude product was purified by flash column chromatography on silica gel (eluted with petroleum ether:ethyl acetate = 8:1→5:1) to give **17-19** as yellow powder in 50%-63% yields. The ^{1}H and ^{13}C{^{1}H} NMR data for compound **18** matched the literature data.[3]



(6a*R*,11b*R*)-4-methoxy-6,6a,7,11b-tetra hydro-5*H*-indeno[2,1-*c*]quinoline

17

Yield 63%; yellow powder; m.p. = 92-94 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.29-7.26 (m, 1H), 7.17-7.14 (m, 1H), 7.07-7.04 (m, 2H), 6.96 (dd, *J* = 7.5, 1.5 Hz, 1H), 6.67 (t, *J* = 7.8 Hz, 1H), 6.59 (dd, *J* = 7.8, 1.5 Hz, 1H), 4.24 (d, *J* = 6.3 Hz, 1H), 3.74 (s, 3H), 3.19-3.11 (m, 2H), 2.82-2.61 (m, 3H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$) δ 146.9, 146.8, 141.6, 134.9, 126.6, 126.4, 125.4, 124.7, 122.9, 122.4, 116.5, 107.7, 55.5, 45.6, 42.8, 37.2, 36.2 ppm; IR (KBr) ν: 3416, 3379, 2994, 2806, 1610, 1492, 1257, 1196, 1093, 736 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{17}H_{18}NO$ $[M+H]^+$ 252.1383, found 252.1384.

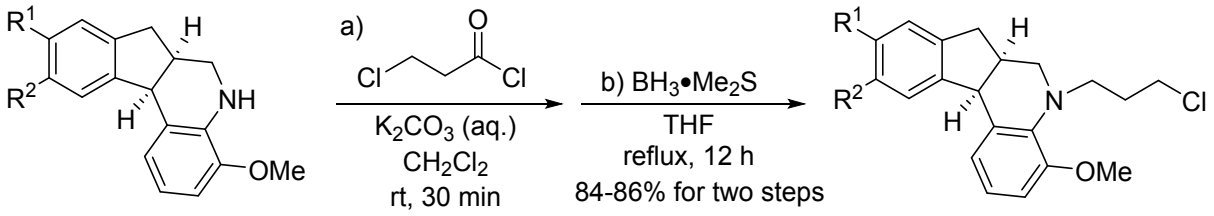


10-bromo-4-methoxy-6,6a,7,11b-tetr ahydro-5*H*-indeno[2,1-*c*]quinoline

19

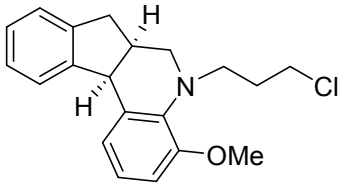
Yield 50%; yellow powder; m.p. = 153-155 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 (s, 1H), 7.18-7.16 (m, 1H), 7.01 (d, *J* = 7.6 Hz, 1H), 6.91-6.89 (m, 1H), 6.70-6.66 (m, 1H), 6.61 (dd, *J* = 8.0, 1.6 Hz, 1H), 4.22 (d, *J* = 6.4 Hz, 1H), 3.75 (s, 3H), 3.15 (dd, *J* = 10.0, 4.4 Hz, 1H), 3.08 (dd, *J* = 16.0, 6.8 Hz, 1H), 2.82-2.73 (m, 1H), 2.70 (t, *J* = 9.2 Hz, 1H), 2.57 (dd, *J* = 15.6, 2.0 Hz, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.4, 146.8, 140.6, 134.8, 129.7, 128.0, 126.9, 122.7, 121.4, 120.2, 116.8, 107.9, 55.6, 45.7, 42.7, 37.5, 35.8 ppm; IR (KBr) ν: 3430, 2931, 2836, 1586, 1499, 1277, 1197, 1174, 1105, 1092, 750 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{17}H_{17}BrNO$ $[M+H]^+$ 330.0488, found 330.0487.

2.7 Synthesis of compound 20-22



17-19 **20-22**

To a solution of compound **17-19** (0.96 mmol) and 0.5 mol/L potassium carbonate aqueous solution (6 ml, 3.00 mmol) in dichloromethane (10 mL) was added slowly 3-chloropropionyl chloride (367 mg, 2.89 mmol) at an ice bath. The solution was warmed to room temperature and stirred for 30 min. After cooling at 0 °C, it was quenched with H_2O. The resulting mixture was extracted with dichloromethane, and the organic layer was washed with brine, dried over Na_2SO_4, and concentrated. The obtained product was used without any further purification. A mixture of the previous compound (0.96 mmol) in dry THF (10 mL) was stirred under nitrogen and added slowly BH_3•Me_2S (547 ul, 5.76 mmol) at an ice salt bath. The solution was warmed to room temperature and the mixture was refluxed for 12 h. After cooling at 0 °C, it was quenched with staturated solution of Na_2CO_3. The resulting mixture was extracted with EtOAc, and the organic layer was washed with brine, dried over Na_2SO_4, and concentrated. The desired product was obtained by flash column chromatography on silica gel (eluted with petroleum ether:ethyl acetate = 15:1→10:1) to give **20-22** as yellow powder in 84%-86% yields.

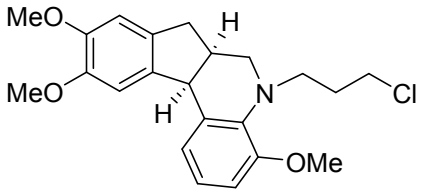


20

5-(3-chloropropyl)-4-methoxy-6,6a,7,11 b-tetrahydro-5*H*-indeno[2,1-*c*]quinoline

Yield 84%; yellow powder; m.p. = 114-116 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.28-7.25 (m, 1H), 7.16-7.14 (m, 1H), 7.06-7.00 (m, 3H), 6.93 (t, *J* = 7.8 Hz, 1H), 6.68 (dd, *J* = 7.8, 1.5 Hz, 1H), 4.23 (d, *J* = 6.0 Hz, 1H), 3.75 (s, 3H), 3.60 (t, *J* = 6.6 Hz, 2H), 3.28-3.20 (m, 1H), 3.17-3.10 (m, 1H), 3.04-2.95 (m, 1H), 2.89 (dd, *J* = 13.2, 3.3 Hz, 1H), 2.72-2.61 (m, 1H), 2.54-2.45 (m, 2H), 2.19-2.07 (m, 1H), 2.02-1.89 (m, 1H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$) δ 152.0, 145.4, 141.4, 137.5, 129.0, 126.7, 126.4, 125.3, 124.6, 123.2, 121.1, 109.1, 55.4, 52.3, 49.4, 46.5, 43.5, 36.1, 32.7, 31.3 ppm; IR (KBr) ν: 3448, 2962, 2852, 1577, 1476, 1462, 1262,

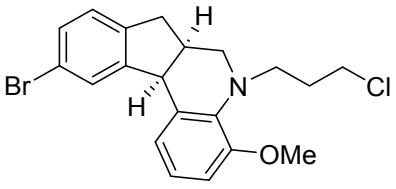
1220, 1111, 1090, 1026, 804, 766, 749, 740, 719 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{20}H_{23}ClNO$ $[M+H]^+$ 328.1463, found 328.1463.



21

5-(3-chloropropyl)-4,9,10-trimethoxy-6,6a,7,11b-tetrahydro- 5*H*-indeno[2,1-*c*]quinoline

Yield 86%; yellow powder; m.p. = 113-115 °C; ^1H NMR (400 MHz, $CDCl_3$) δ 7.00-6.92 (m, 2H), 6.80 (s, 1H), 6.70-6.68 (m, 2H), 4.18 (d, *J* = 5.6 Hz, 1H), 3.77 (s, 6H), 3.72 (s, 3H), 3.61 (t, *J* = 6.8 Hz, 2H), 3.23-3.11 (m, 2H), 3.03-2.96 (m, 1H), 2.90 (dd, *J* = 13.2, 3.6 Hz, 1H), 2.69-2.62 (m, 1H), 2.54 (t, *J* = 12.8 Hz, 1H), 2.40 (d, *J* = 13.6 Hz, 1H), 2.20-2.09 (m, 1H), 2.02-1.93 (m, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.9, 147.2, 146.9, 136.4, 136.1, 131.9, 128.1, 121.7, 120.0, 107.9, 107.4, 107.1, 55.1, 55.0, 54.2, 51.2, 48.5, 45.2, 42.3, 34.9, 31.6, 30.5 ppm; IR (KBr) ν: 3439, 2991, 2919, 2830, 1576, 1501, 1475, 1459, 1473, 1301, 1276, 1260, 1223, 1200, 1184, 1168, 1080, 1026, 858, 747 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{22}H_{27}ClNO_3$ $[M+H]^+$ 388.1674, found 388.1674.



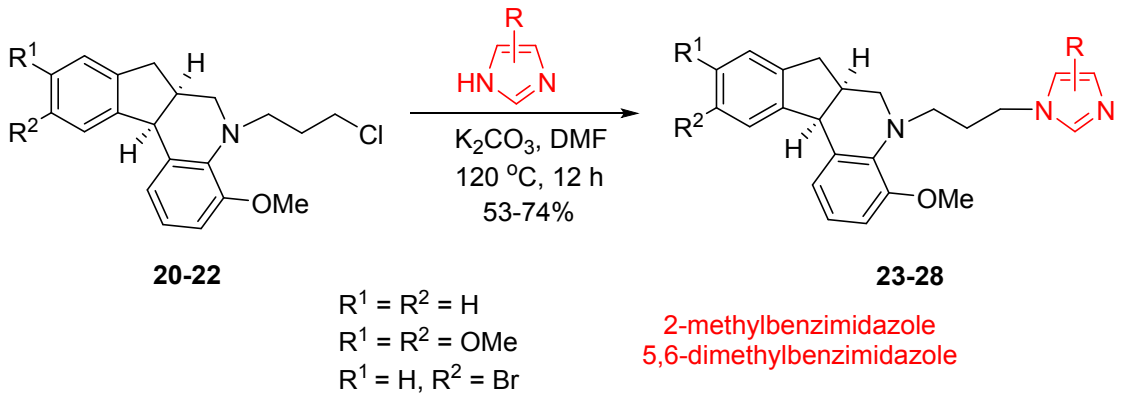
22

(6a*R*,11b*R*)-10-bromo-5-(3-chloropropyl)-4-me thoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinoline

Yield 86%; yellow powder; m.p. = 141-143 °C; ^1H NMR (400 MHz, $CDCl_3$) δ 7.35 (t, *J* = 1.7 Hz, 1H), 7.17 (dd, *J* = 7.6, 2.0 Hz, 1H), 7.01 (d, *J* = 8.0 Hz, 1H), 6.95 (d, *J* = 4.8 Hz, 2H), 6.70 (t, *J* = 4.8 Hz, 1H), 4.21 (d, *J* = 6.4 Hz, 1H), 3.76 (s, 3H), 3.60 (t, *J* = 6.8 Hz, 2H), 3.19-3.11 (m, 2H), 3.01-2.95 (m, 1H), 2.89 (dd, *J* = 13.6, 4.0 Hz, 1H), 2.70-2.62 (m, 1H), 2.51-2.41 (m, 2H), 2.19-2.08 (m, 1H), 2.00-1.90 (m, 1H) ppm; ^{13}C

NMR (100 MHz, $CDCl_3$) δ 152.0, 147.9, 140.4, 137.4, 129.7, 127.0, 127.8, 126.7, 122.9, 121.3, 120.2, 109.3, 55.4, 52.2, 49.3, 46.5, 43.3, 35.6, 32.6, 31.6 ppm; IR (KBr) ν: 3448, 2948, 2918, 1637, 1476, 1450, 1385, 1290, 1270, 1253, 1150, 815, 746 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{20}H_{22}BrClNO$ $[M+H]^+$ 406.0568, found 406.0570.

2.8 Synthesis of compound 23-28



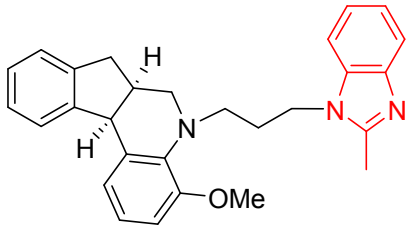
20-22

$R^1 = R^2 = H$
$R^1 = R^2 = OMe$
$R^1 = H, R^2 = Br$

23-28

2-methylbenzimidazole
5,6-dimethylbenzimidazole

To a mixture of compound **20-22** (0.44 mmol) and 2-methylbenzimidazole or 5,6-dimethylbenzimidazole (0.53 mmol) and K_2CO_3 (365 mg, 2.64 mmol) were stirred in DMF (20 ml) at 120 °C under nitrogen for 12 h. The reaction progress was monitored by TLC. After cooling to room temperature, the solvent was evaporated under reduced pressure and the crude product was purified by flash column chromatography on silica gel (eluted with CH_2Cl_2:MeOH:Et_3N = 500:1:5→300:1:3) to give **23-28** as white powder or colorless oil in 53-74% yields.



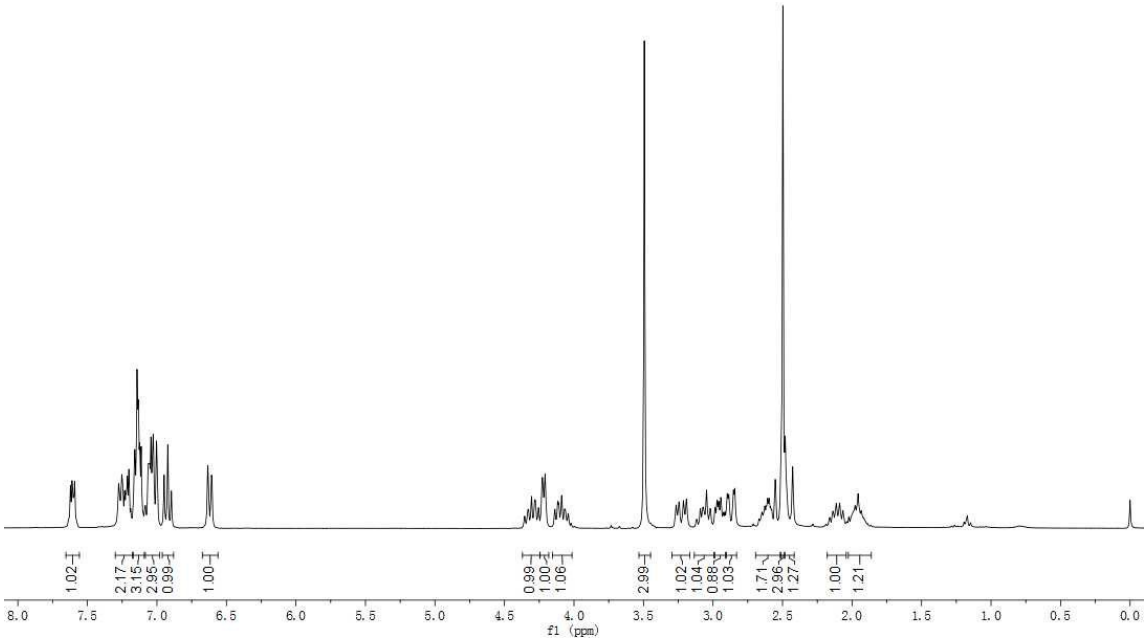
23

(6a*R*,11b*R*)-4-methoxy-5-(3-(2-methyl-1*H*-benzo[*d*]imidazol-1-yl)propyl)-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinoline

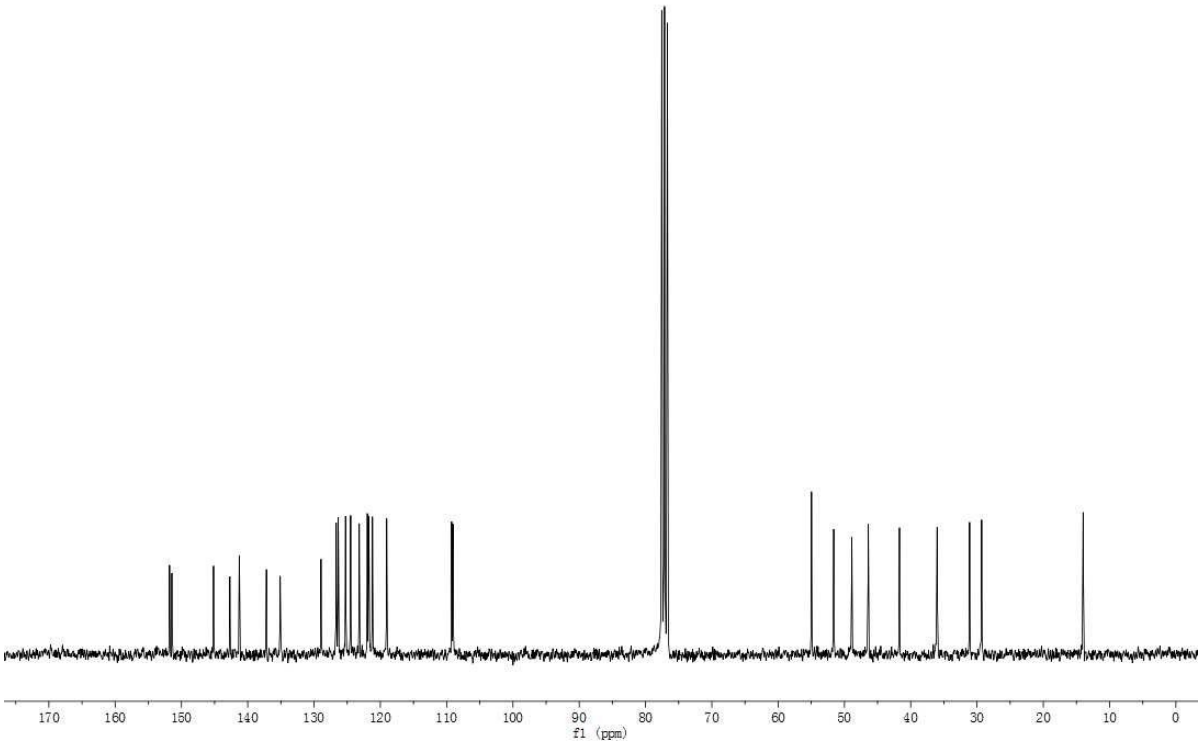
Yield 74%; colorless oil; ^1H NMR (300 MHz, $CDCl_3$) δ 7.62-7.59 (m, 1H), 7.27-7.20 (m, 2H), 7.16-7.11 (m, 3H), 7.06-6.70(m, 3H), 6.92 (t, *J* = 7.8 Hz, 1H), 6.62 (dd, *J* = 8.4, 1.5 Hz, 1H), 4.33-4.26 (m, 1H), 4.22 (d, *J* = 5.7 Hz, 1H), 4.14-4.02 (m, 1H), 3.49 (s, 3H), 3.23 (dd, *J* = 15.9, 6.3 Hz, 1H), 3.12-3.02 (m, 1H), 2.99-2.91 (m, 1H), 2.87 (dd, *J* = 13.2, 3.6 Hz, 1H), 2.65-2.55 (m, 2H), 2.50 (s, 3H), 2.45 (d, *J* = 15.9 Hz, 1H), 2.16-

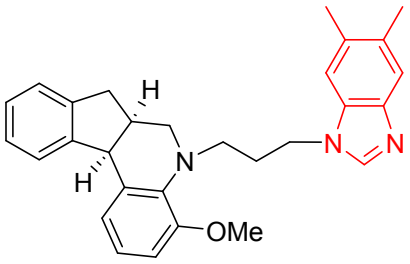
2.07 (m, 1H), 2.02-1.92 (m, 1H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$) δ 152.3, 151.9, 145.6, 143.2, 141.7, 137.6, 135.6, 129.4, 127.1, 126.8, 125.7, 124.9, 123.6, 122.4, 122.2, 121.6, 119.5, 109.7, 109.5, 55.4, 52.1, 49.3, 46.9, 42.2, 36.5, 31.6, 29.8, 14.5 ppm; IR (KBr) ν: 2932, 2838, 1576, 1517, 1477, 1457, 1266, 1217, 1156, 1092, 1078, 806, 743 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{28}H_{30}N_3O$ $[M+H]^+$ 424.2383, found 424.2384.

^{1}H NMR spectra (300 MHz, $CDCl_3$) of Compound 23



$^{13}C\{^{1}H\}$ NMR spectra (75 MHz, $CDCl_3$) of Compound 23



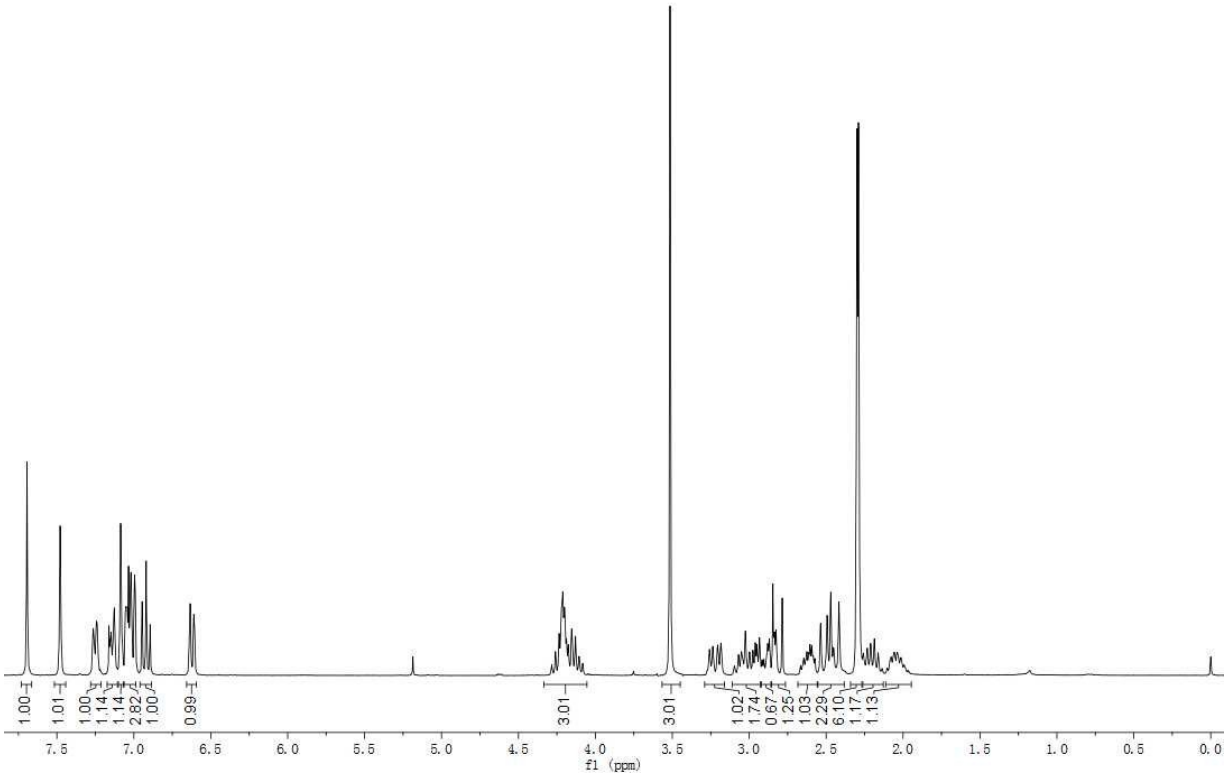


24

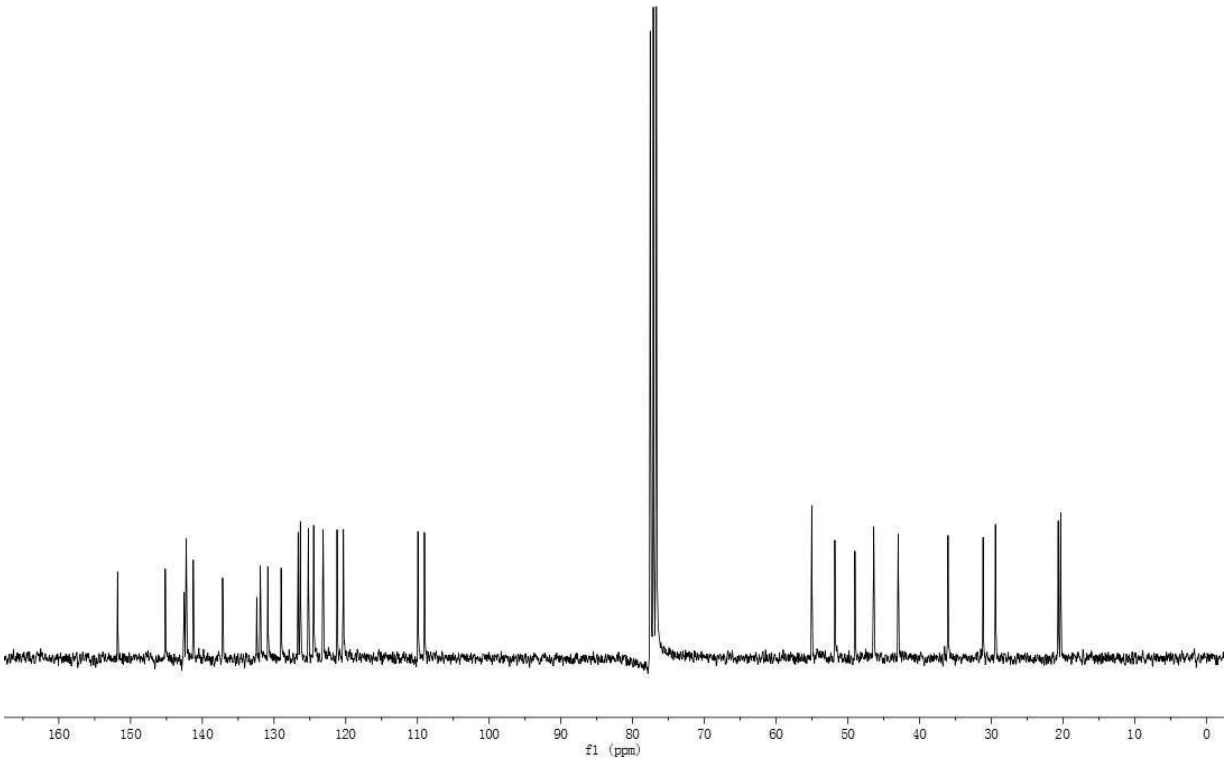
(6a*R*,11b*R*)-5-(3-(5,6-dimethyl-1*H*-benzo[*d*]imidazol-1-yl)propyl)-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinoline

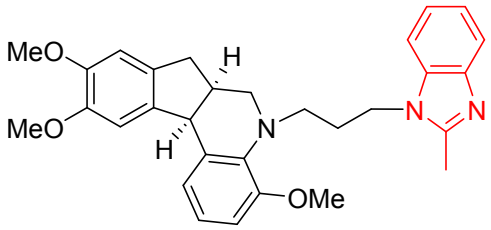
Yield 66%; colorless oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.69 (s, 1H), 7.48 (s, 1H), 7.26-7.24 (m, 1H), 7.16-7.13 (m, 1H), 7.09 (s, 1H), 7.06-6.99 (m, 3H), 6.92 (t, *J* = 7.8 Hz, 1H), 6.62 (dd, *J* = 8.1, 1.5 Hz, 1H), 4.28-4.08 (m, 3H), 3.51 (s, 3H), 3.22 (dd, *J* = 15.9, 6.3 Hz, 1H), 3.10-2.93 (m, 2H), 2.92-2.87 (m, 1H), 2.85-2.79 (m, 1H), 2.65-2.57(m, 1H), 2.54-2.42 (m, 2H), 2.29 (d, *J* = 3.0 Hz, 6H), 2.26-2.16 (m, 1H), 2.10-1.96 (m, 1H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$) δ 151.8, 145.2, 142.5, 142.2, 141.3, 137.2, 132.4, 131.9, 130.9, 129.0, 126.6, 126.3, 125.2, 124.5, 123.2, 121.2, 120.3, 109.9, 109.0, 55.0, 51.8, 49.0, 46.4, 43.0, 36.0, 31.1, 29.4, 20.7, 20.3 ppm; IR (KBr) ν: 2933, 2840, 1675, 1575, 1497, 1477, 1456, 1251, 1215, 1091, 1078, 806, 745 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{29}H_{32}N_3O$ $[M+H]^+$ 438.2540, found 438.2539.

^{1}H NMR spectra (300 MHz, $CDCl_3$) of Compound 24



^{13}C{^{1}H} NMR spectra (75MHz, $CDCl_3$) of Compound 24



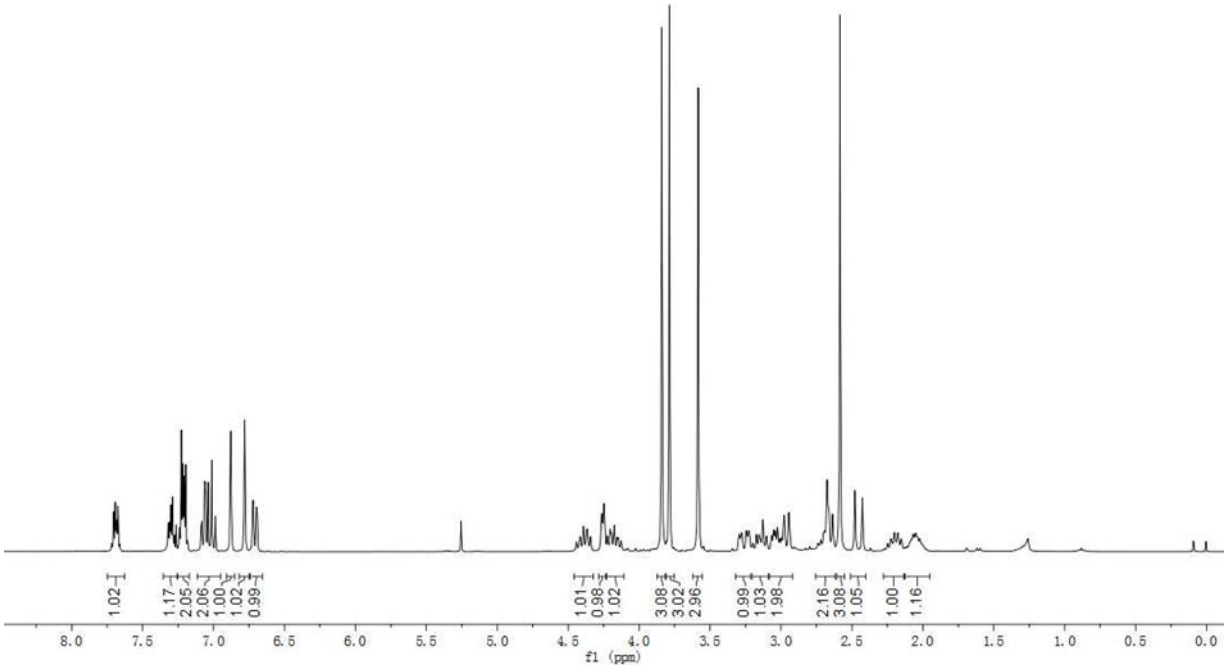


25

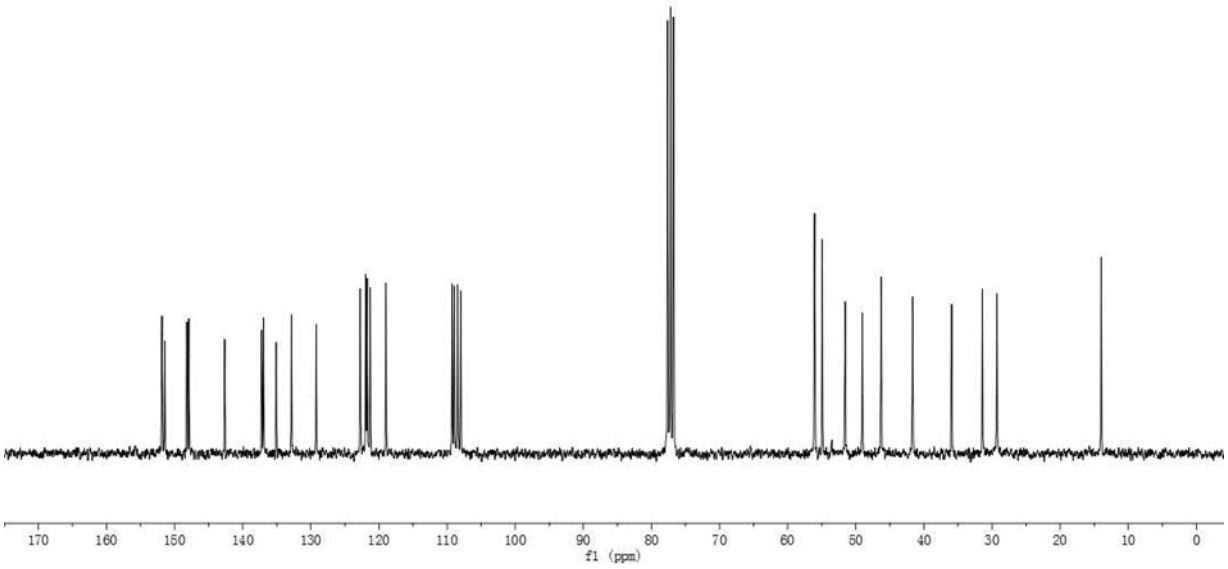
4,9,10-trimethoxy-5-(3-(2-methyl-1*H*-benzo[*d*]imidazol-1-yl)propyl)-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinoline

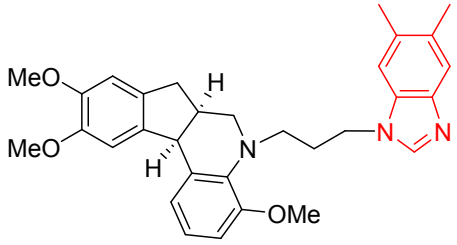
Yield 74%; white powder; m.p. = 158-160 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.75-7.63 (m, 1H), 7.35-7.26 (m, 1H), 7.25-7.17 (m, 2H), 7.11-6.95 (m, 2H), 6.88 (s, 1H), 6.78 (s, 1H), 6.71 (dd, *J* = 7.8, 1.5 Hz, 1H), 4.44-4.34 (m, 1H), 4.26 (d, *J* = 5.1 Hz, 1H), 4.22-4.12 (m, 1H), 3.84 (s, 3H), 3.79 (s, 3H), 3.58 (s, 3H), 3.26 (dd, *J* = 15.6, 5.7 Hz, 1H), 3.20-3.10 (m, 1H), 3.07-2.95 (m, 2H), 2.74-2.64 (m, 2H), 2.58 (s, 3H), 2.45 (d, *J* = 15.9 Hz, 1H), 2.27-2.15 (m, 1H), 2.11-2.01 (m, 1H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$) δ 151.9, 151.5, 148.2, 147.9, 142.6, 137.2, 137.0, 135.1, 132.9, 129.2, 122.7, 122.0, 121.7, 121.3, 119.0, 109.3, 109.0, 108.5, 108.0, 56.1, 56.0, 54.9, 51.6, 49.0, 46.3, 41.7, 35.9, 31.4, 29.3, 14.0 ppm; IR (KBr) ν: 3425, 2991, 2945, 2830, 1618, 1577, 1521, 1450, 1479, 1460, 1402, 1297, 1276, 1220, 1097, 1008, 1060, 1031, 859, 762, 746 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{30}H_{34}N_3O_3$ $[M+H]^+$ 484.2595, found 484.2594.

^{1}H NMR spectra (300 MHz, $CDCl_3$) of Compound 25



^{13}C{^{1}H} NMR spectra (75 MHz, $CDCl_3$) of Compound 25



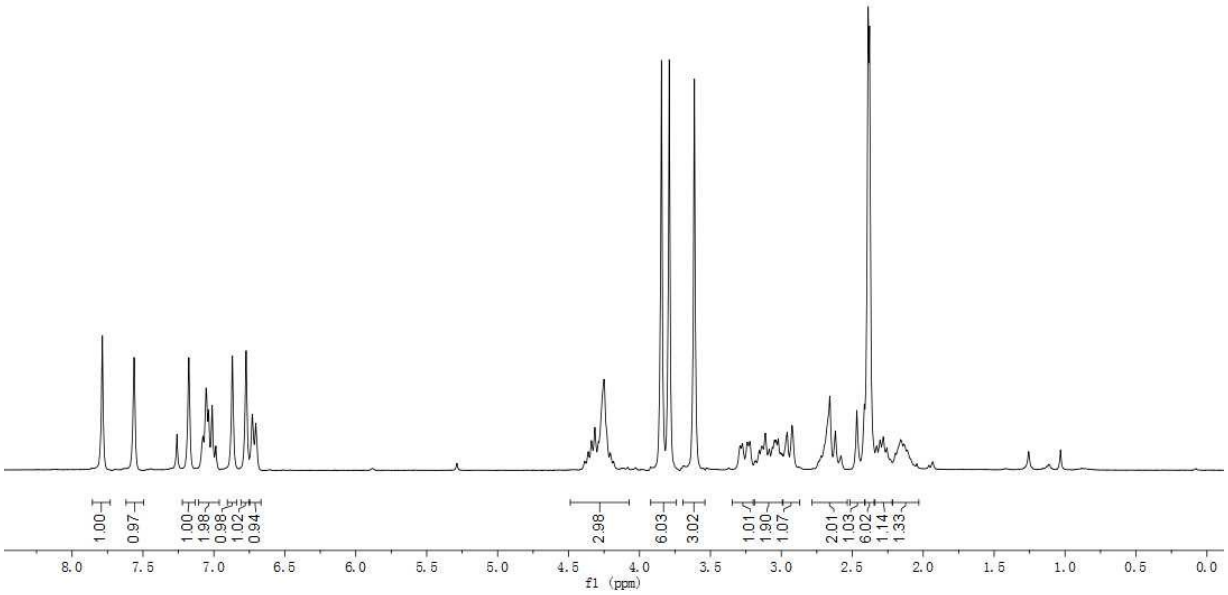


26

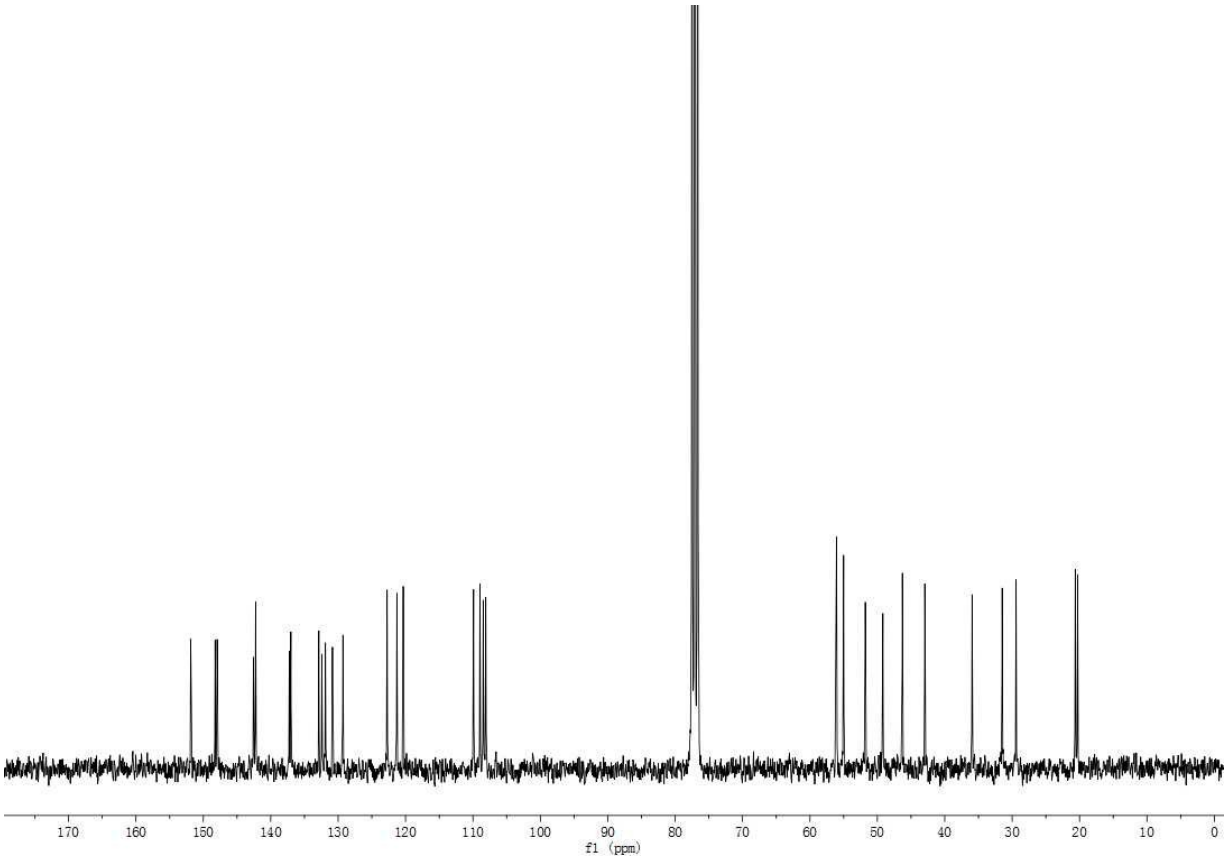
(6a*R*,11b*R*)-5-(3-(5,6-dimethyl-1*H*-benzo[*d*]imidazol-1-yl)propyl)-4,9,10-trimethoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinoline

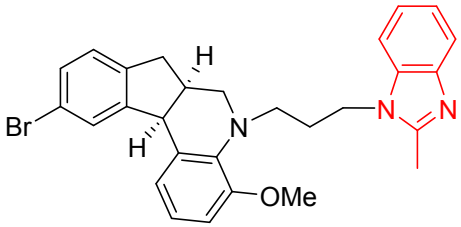
Yield 53%; white powder; m.p. = 170-172 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.79 (s, 1H), 7.56 (s, 1H), 7.18 (s, 1H), 7.08-6.99 (m, 2H), 6.87 (s, 1H), 6.77 (s, 1H), 6.72 (dd, *J* = 8.1, 1.8 Hz, 1H), 4.36-4.21 (m, 3H), 3.85 (s, 3H), 3.79 (s, 3H), 3.61 (s, 3H), 3.26 (dd, *J* = 15.9, 5.7 Hz, 1H), 3.16-3.00 (m, 2H), 2.94 (d, *J* = 10.5 Hz, 1H), 2.74-2.58 (m, 2H), 2.44 (d, *J* = 16.2 Hz, 1H), 2.39 (s, 3H), 2.38 (s, 3H), 2.33-2.56 (m, 1H), 2.20-2.11 (m, 1H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$) δ 152.0, 148.3, 148.0, 142.7, 142.3, 137.3, 137.1, 132.9, 132.5, 132.0, 131.0, 129.4, 122.8, 121.4, 120.4, 110.0, 109.0, 108.6, 108.2, 56.2, 56.1, 55.1, 51.9, 49.3, 46.4, 43.0, 36.0, 31.6, 29.5, 20.7, 20.4 ppm; IR (KBr) ν: 3442, 2996, 2949, 2917, 2855, 2831, 1576, 1500, 1480, 1463, 1387, 1222, 1083, 1063, 1034, 856, 745, 735 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{31}H_{36}N_3O_3$ $[M+H]^+$ 498.2751 , found 498.2751.

^{1}H NMR spectra (300 MHz, $CDCl_3$) of Compound 26



^{13}C{^{1}H} NMR spectra (75 MHz, $CDCl_3$) of Compound 26



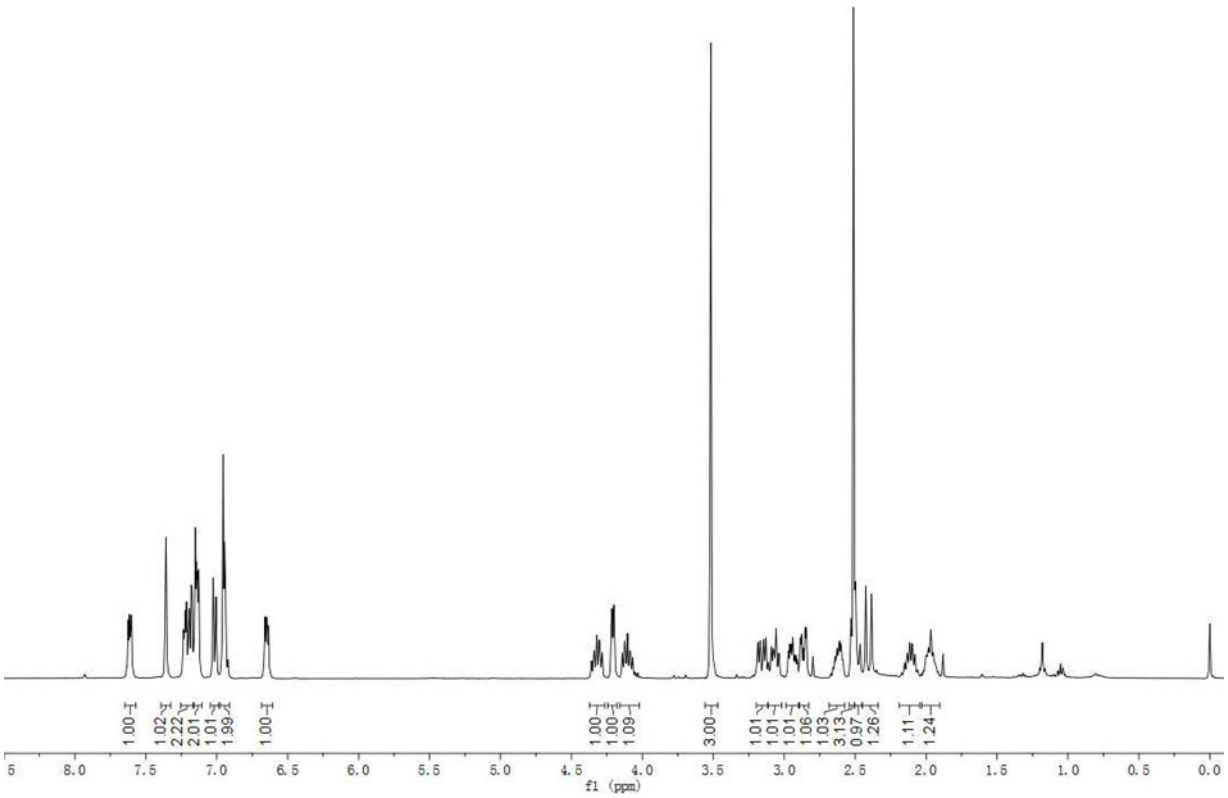


27

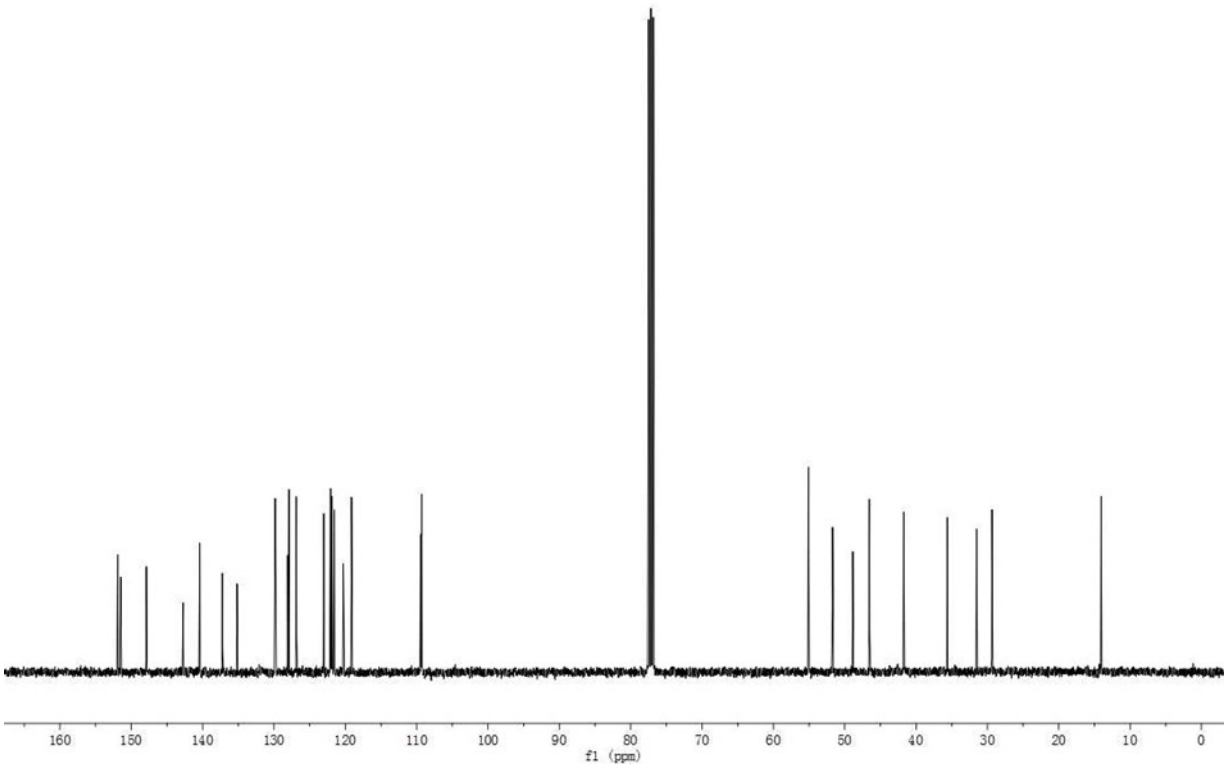
(6a*R*,11b*R*)-10-bromo-4-methoxy-5-(3-(2-methyl-1*H*-benzo[*d*]imidazol-1-yl)propyl)-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinoline

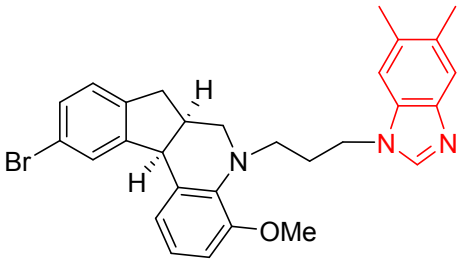
Yield 69%; colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63-7.59 (m, 1H), 7.36 (s, 1H), 7.24-7.17 (m, 2H), 7.15-7.13 (m, 2H), 7.02 (d, *J* = 8.0 Hz, 1H), 6.96-6.92 (m, 2H), 6.65 (dd, *J* = 6.0, 4.0 Hz, 1H), 4.36-4.28 (m, 1H), 4.21 (d, *J* = 6.0 Hz, 1H), 4.14-4.03 (m, 1H), 3.52 (s, 3H), 3.16 (dd, *J* = 16.0, 6.4 Hz, 1H), 3.11-3.04 (m, 1H), 2.97-2.91 (m, 1H), 2.89-2.85 (m, 1H), 2.66-2.59 (m, 1H), 2.51 (s, 3H), 2.48 (d, *J* = 12.8 Hz, 1H), 2.40 (d, *J* = 16.0 Hz, 1H), 2.17-2.06 (m, 1H), 2.02-1.92 (m, 1H) ppm; ^{13}C NMR (100MHz, $CDCl_3$) δ 151.9, 151.5, 147.9, 142.7, 140.4, 137.2, 135.2, 129.8, 128.1, 127.9, 126.9, 123.1, 122.1, 121.9, 121.5, 120.3, 119.1, 109.4, 109.3, 55.1, 51.7, 48.9, 46.5, 41.7, 35.6, 31.5, 29.4, 14.1 ppm; IR (KBr) ν: 2928, 2846, 1675, 1577, 1571, 1474, 1402, 1381, 1328, 1284, 1252, 1217, 1196, 1155, 1098, 1082, 1063, 747 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{28}H_{29}BrN_3O$ $[M+H]^+$ 502.1489, found 502.1489.

^{1}H NMR spectra (400 MHz, $CDCl_3$) of Compound 27



^{13}C{^{1}H} NMR spectra (100 MHz, $CDCl_3$) of Compound 27



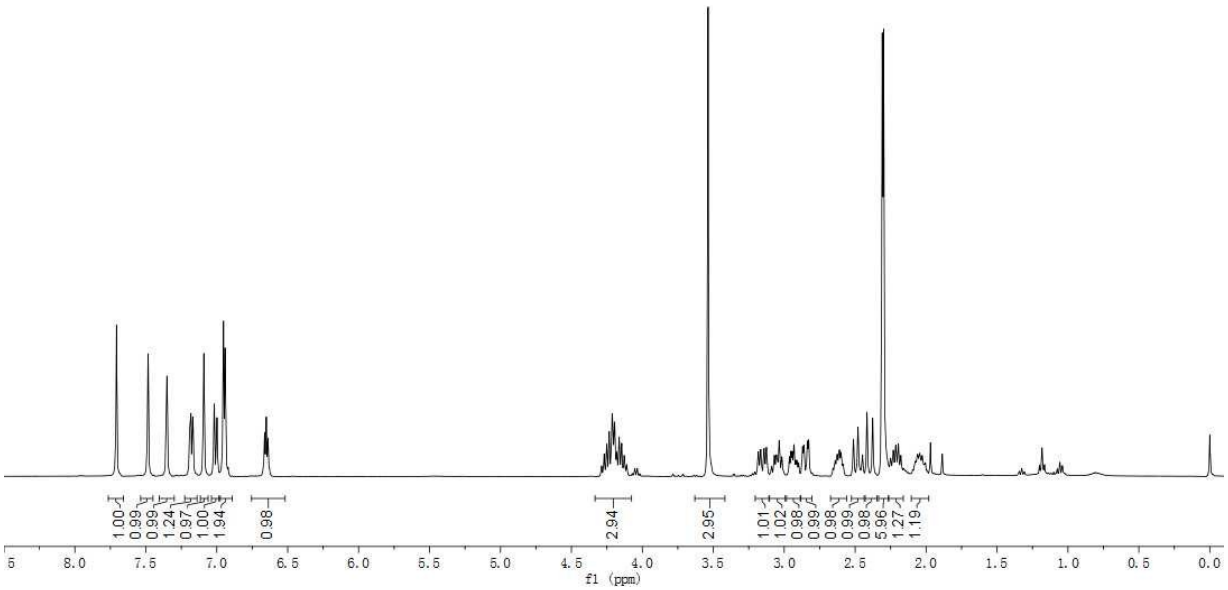


(6a*R*,11b*R*)-10-bromo-5-(3-(5,6-dimethyl-1*H*-benzo[*d*]imidazol-1-yl)propyl)-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinoline

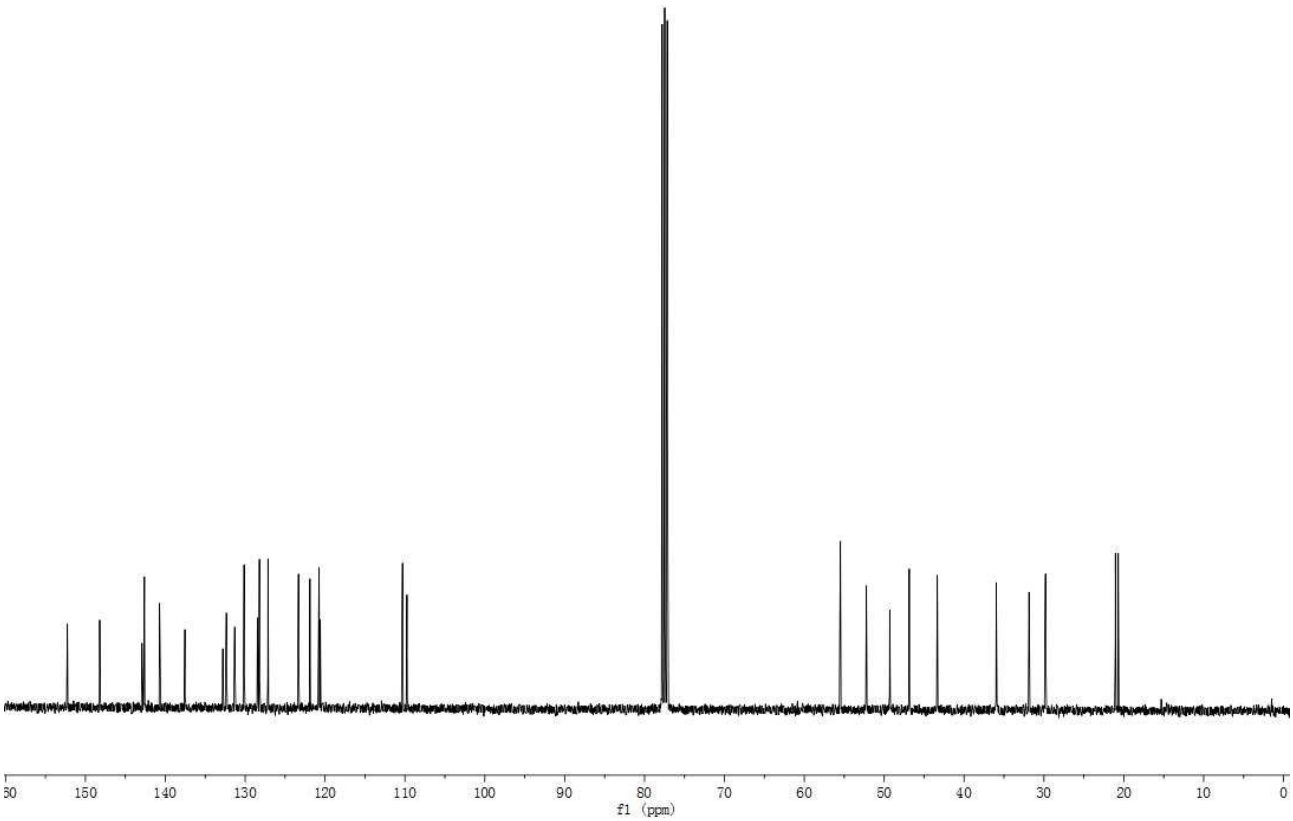
28

Yield 71%; colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (s, 1H), 7.48 (s, 1H), 7.35 (t, *J* = 1.6 Hz, 1H), 7.19-7.17 (m, 1H), 7.09 (s, 1H), 7.01 (d, *J* = 8.0 Hz, 1H), 6.95-6.94 (m, 2H), 6.66-6.64 (m, 1H), 4.29-4.11 (m, 3H), 3.54 (s, 3H), 3.15 (dd, *J* = 16.0, 6.8 Hz, 1H), 3.09-3.02 (m, 1H), 2.96-2.90 (m, 1H), 2.85 (dd, *J* = 13.6, 4.0 Hz, 1H), 2.66-2.50 (m, 1H), 2.48 (t, *J* = 13.2 Hz, 1H), 2.40 (d, *J* = 16.4 Hz, 1H), 2.30 (d, *J* = 3.6 Hz, 6H), 2.27-2.18 (m, 1H), 2.08-2.00 (m, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.3, 148.2, 142.9, 142.6, 140.7, 137.5, 132.8, 132.4, 131.3, 130.1, 128.5, 128.2, 127.1, 123.3, 121.9, 120.8, 120.6, 110.3, 109.7, 55.5, 52.2, 49.3, 46.9, 43.4, 36.0, 32.0, 29.8, 21.1, 20.7 ppm; IR (KBr) ν: 2933, 2853, 1676, 1577, 1497, 1474, 1451, 1384, 1326, 1252, 1217, 1169, 1098, 1082, 1030, 850, 819, 750 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{29}H_{31}BrN_3O$ $[M+H]^+$ 516.1645, found 516.1647.

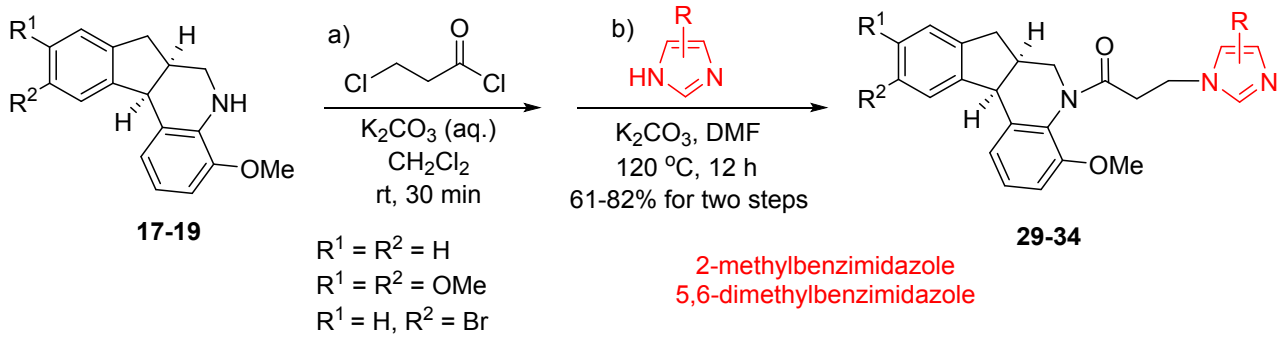
^{1}H NMR spectra (400 MHz, $CDCl_3$) of Compound 28



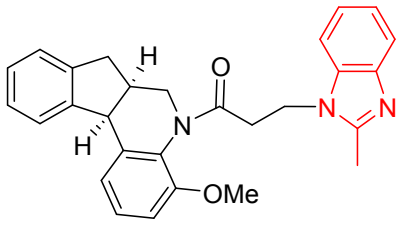
^{13}C{^{1}H} NMR spectra (100 MHz, $CDCl_3$) of Compound 28



2.9 Synthesis of compound 29-34



To a solution of compound **17-19** (0.96 mmol) and K_2CO_3 aqueous solution (0.5 M, 6 ml, 3.00 mmol) in CH_2Cl_2 (10 mL) was added slowly 3-chloropropionyl chloride (367 mg, 2.89 mmol) at an ice bath. The solution was warmed to room temperature and stirred for 30 min. After cooling at 0 °C, it was quenched with H_2O. The resulting mixture was extracted with CH_2Cl_2, and the organic layer was washed with brine, dried over Na_2SO_4, and concentrated. The obtained product was used without any further purification. A mixture of the previous product (0.44 mmol) and 2-methylbenzimidazole or 5,6-dimethylbenzimidazole (0.53 mmol) and K_2CO_3 (365 mg, 2.64 mmol) in dry DMF (5 ml) were stirred in DMF (20 ml) at 120 °C under nitrogen for 12 h. The reaction progress was monitored by TLC. The solvent was evaporated under reduced pressure and the crude product was purified by flash column chromatography on silica gel (eluted with CH_2Cl_2:MeOH:Et_3N = 500:1:5→300:1:3) to give **29-34** as white powder or colorless oil in 61-82% yields.



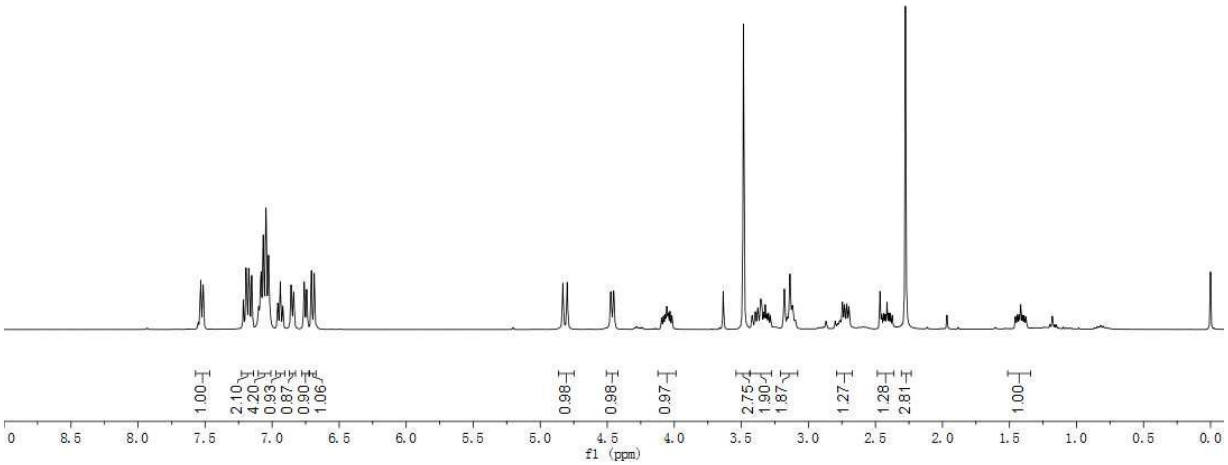
29

1-((6a*R*,11b*R*)-4-methoxy-6,6a,7,11b
-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)-3-(
2-methyl-1*H*-benzo[*d*]imidazol-1-yl)propan-1-one

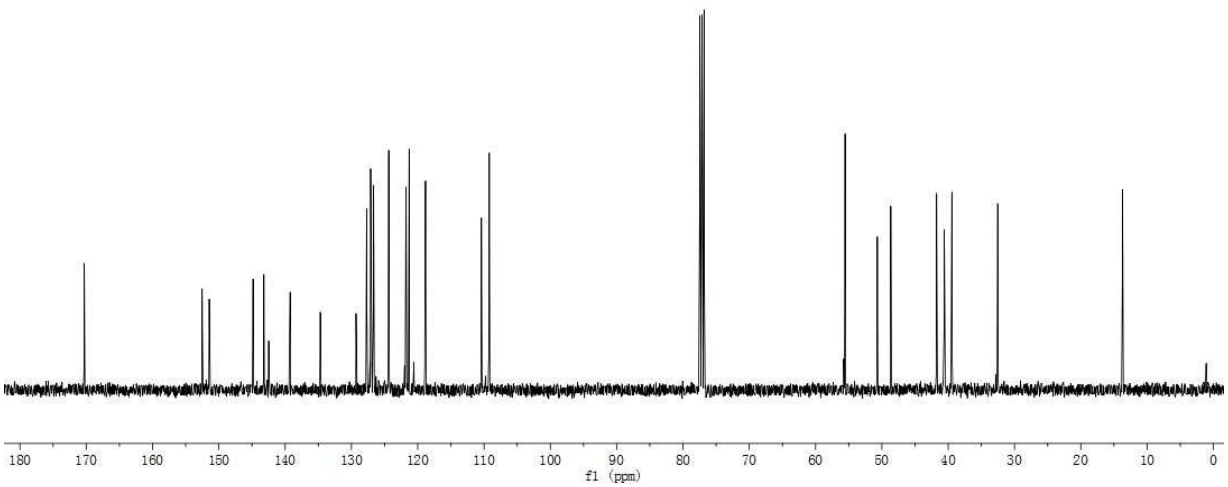
Yield 64%; white powder; m.p. = 171-173 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, *J* = 7.2 Hz, 1H), 7.22-7.15 (m, 2H), 7.10-7.02 (m, 4H), 6.94 (t, *J* = 7.2 Hz, 1H), 6.86-6.84 (m, 1H), 6.75 (d, *J* = 7.6 Hz, 1H), 6.70 (dd, *J* = 8.4, 1.2 Hz, 1H), 4.82 (d, *J* = 12.8 Hz, 1H), 4.46 (d, *J* = 8.8 Hz, 1H), 4.10-4.02 (m, 1H), 3.48 (s, 3H), 3.42-3.28 (m, 2H), 3.18-3.10 (m, 2H), 2.72 (dd, *J* = 13.2, 6.4 Hz, 1H), 2.47-2.39 (m, 1H), 2.27 (s, 3H), 1.46-

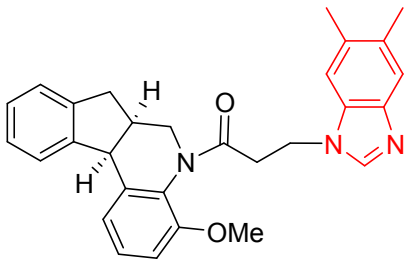
1.38 (m, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 152.5, 151.5, 144.8, 143.2, 142.5, 139.2, 134.7, 129.3, 127.7, 127.1, 126.7, 124.4, 124.3, 121.8, 121.7, 121.3, 118.8, 110.4, 109.2, 55.6, 50.7, 48.7, 41.8, 40.6, 39.4, 32.5, 13.7 ppm; IR (KBr) ν: 3439, 2942, 2839, 1639, 1485, 1457, 1400, 1328, 1280, 1267, 1098, 1060, 793, 768, 741, 569 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{28}H_{28}N_3O_2$ $[M+H]^+$ 438.2176, found 438.2176.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 29



$^{13}C\{^{1}H\}$ NMR spectra (100 MHz, DMSO-d_6) of Compound 29



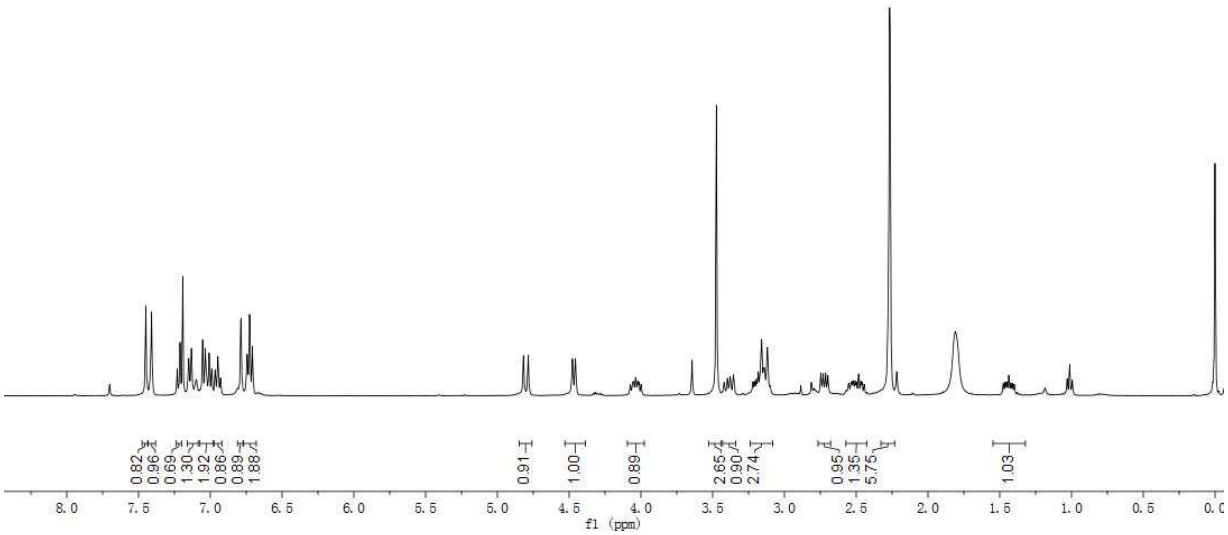


30

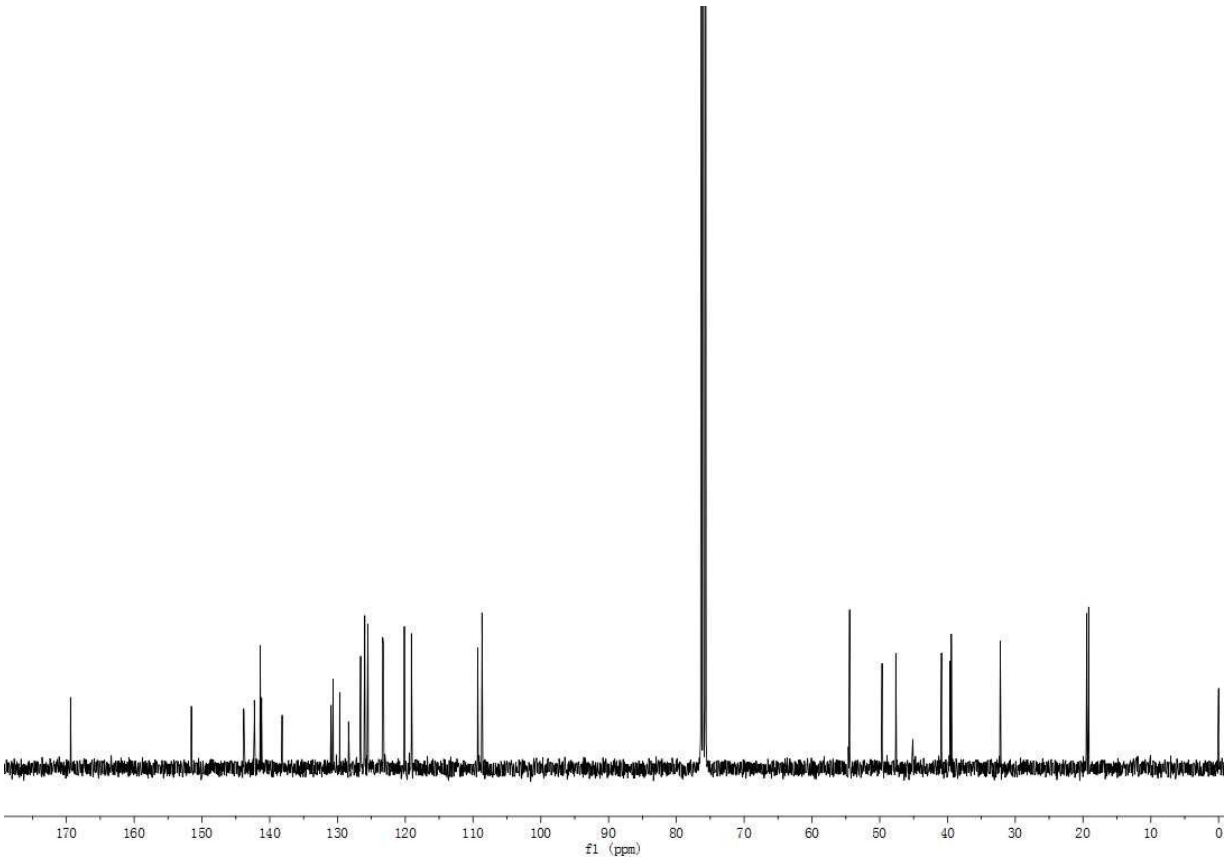
3-(5,6-dimethyl-1*H*-benzo[*d*]imidazol-1-yl)-1-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propan-1-one

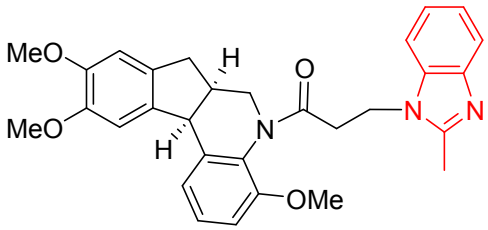
Yield 61%; white powder; m.p. = 97-99 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 (s, 1H), 7.41 (s, 1H), 7.22 (d, *J* = 8.0 Hz, 1H), 7.15-7.10 (m, 1H), 7.05-6.99 (m, 2H), 6.95 (t, *J* = 7.6 Hz, 1H), 6.79 (s, 1H), 6.73 (t, *J* = 6.8 Hz, 2H), 4.80 (d, *J* = 13.2 Hz, 1H), 4.47 (d, *J* = 8.4 Hz, 1H), 4.07-4.00 (m, 1H), 3.47 (s, 3H), 3.39 (dd, *J* = 16.8, 9.2 Hz, 1H), 3.21-3.12 (m, 3H), 2.72 (dd, *J* = 13.2, 6.4 Hz, 1H), 2.56-2.44 (m, 1H), 2.27 (d, *J* = 2.0 Hz, 6H), 1.48-1.40 (m, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.4, 151.6, 143.8, 142.3, 141.4, 141.2, 138.2, 131.0, 130.7, 129.7, 128.4, 126.6, 126.0, 125.5, 123.3, 123.2, 120.1, 119.1, 109.3, 108.7, 54.4, 49.7, 47.6, 40.9, 39.6, 39.4, 32.2, 19.5, 19.2 ppm; IR (KBr) ν: 3443, 2933, 1652, 1485, 1455, 1406, 1279, 1256, 1217, 1156, 1098, 746 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{29}H_{30}N_3O$ $[M+H]^+$ 452.2333, found 452.2333.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 30



$^{13}C\{^{1}H\}$ NMR spectra (100 MHz, DMSO-d_6) of Compound 30



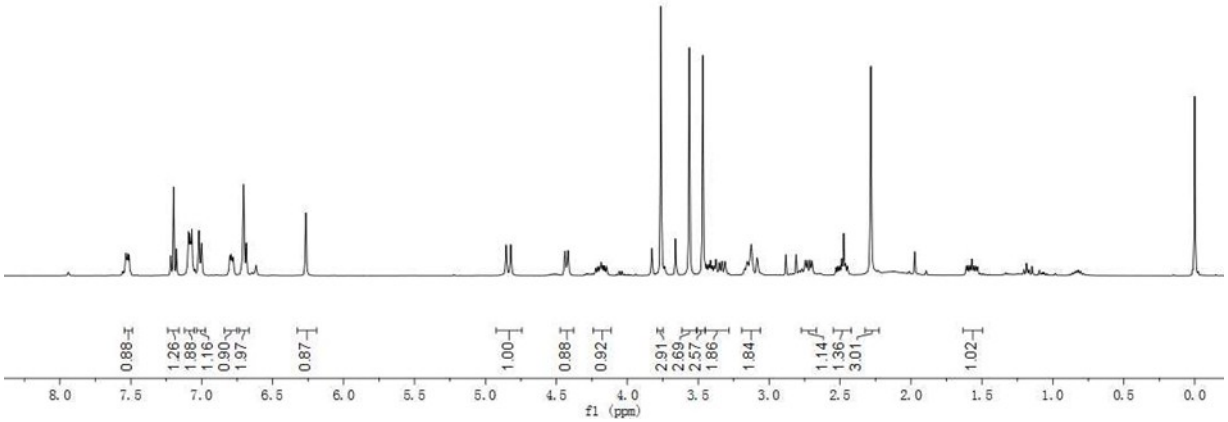


31

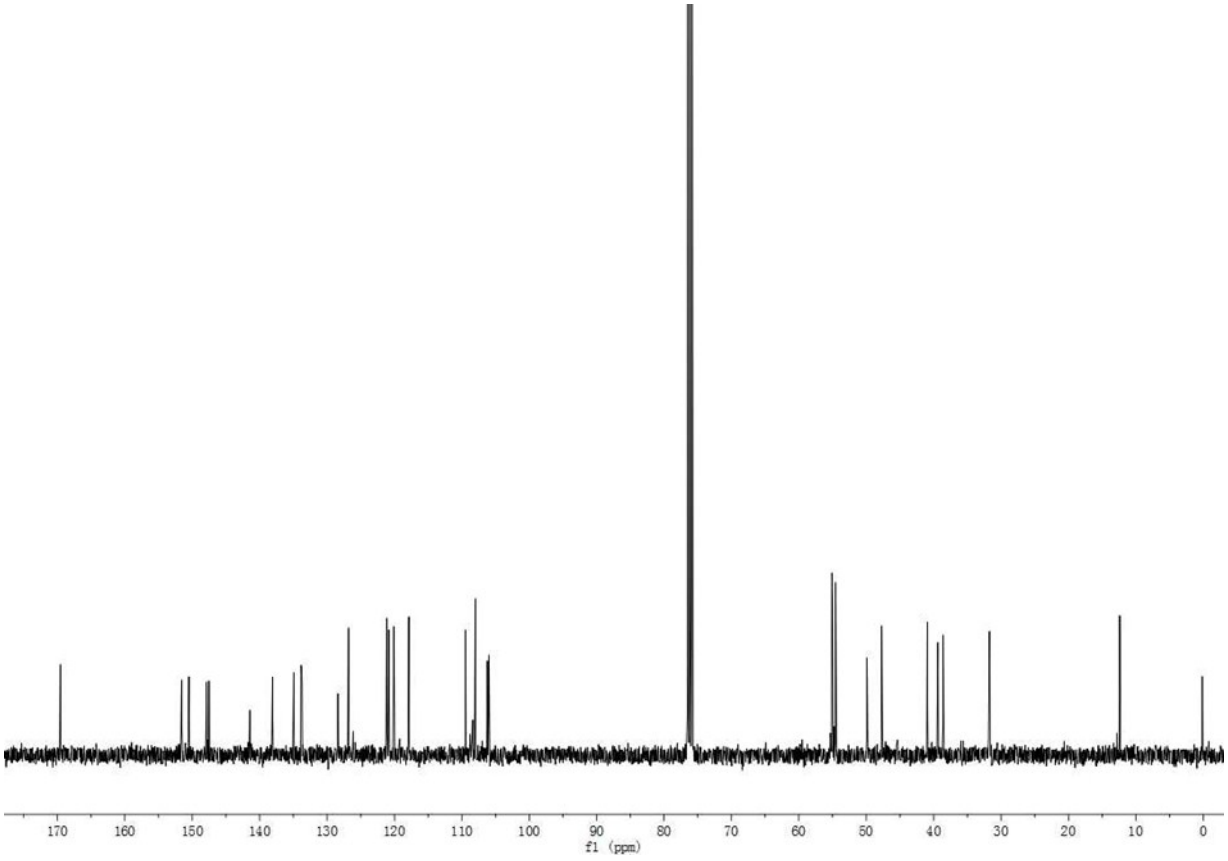
3-(2-methyl-1*H*-benzo[*d*]imidazol-1-yl)-1-((6a*R*,11b*R*)-4,9,10-trimethoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propan-1-one

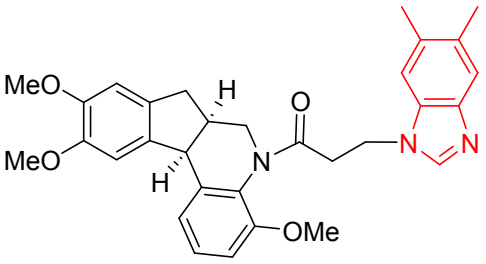
Yield 82%; colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54-7.51 (m, 1H), 7.22-7.18 (m, 1H), 7.09-7.07 (m, 2H), 7.02-7.00 (m, 1H), 6.80-6.78 (m, 1H), 6.72-6.69 (m, 2H), 6.26 (s, 1H), 4.83 (d, *J* = 13.2 Hz, 1H), 4.42 (d, *J* = 8.8 Hz, 1H), 4.22-4.15 (m, 1H), 3.76 (s, 3H), 3.56 (s, 3H), 3.46 (s, 3H), 3.44-3.31 (m, 2H), 3.18-3.08 (m, 2H), 2.71 (dd, *J* = 12.8, 5.6 Hz, 1H), 2.53-2.45 (m, 1H), 2.28 (s, 3H), 1.61-1.53 (m, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.4, 151.4, 150.3, 147.7, 147.4, 141.4, 138.0, 134.8, 133.7, 133.6, 128.3, 126.7, 121.0, 120.7, 120.0, 117.7, 109.3, 107.9, 106.1, 105.9, 55.0, 54.9, 54.4, 49.8, 47.6, 40.8, 39.2, 38.5, 31.6, 12.3 ppm; IR (KBr) ν: 2927, 2854, 1648, 1503, 1487, 1457, 1400, 1305, 1271, 1242, 1216, 1086, 750 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{30}H_{32}N_3O_4$ $[M+H]^+$ 498.2387, found 498.2387.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 31



$^{13}C\{^{1}H\}$ NMR spectra (100 MHz, DMSO-d_6) of Compound 31



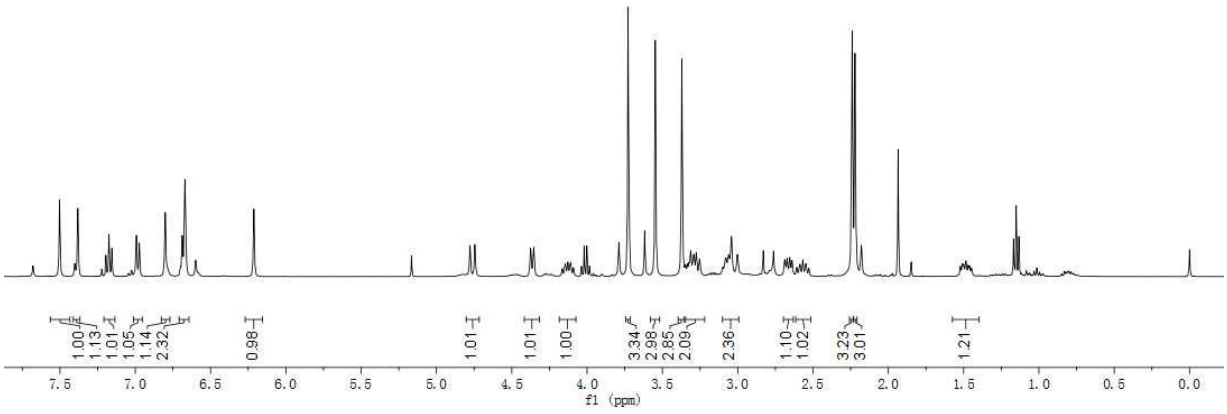


32

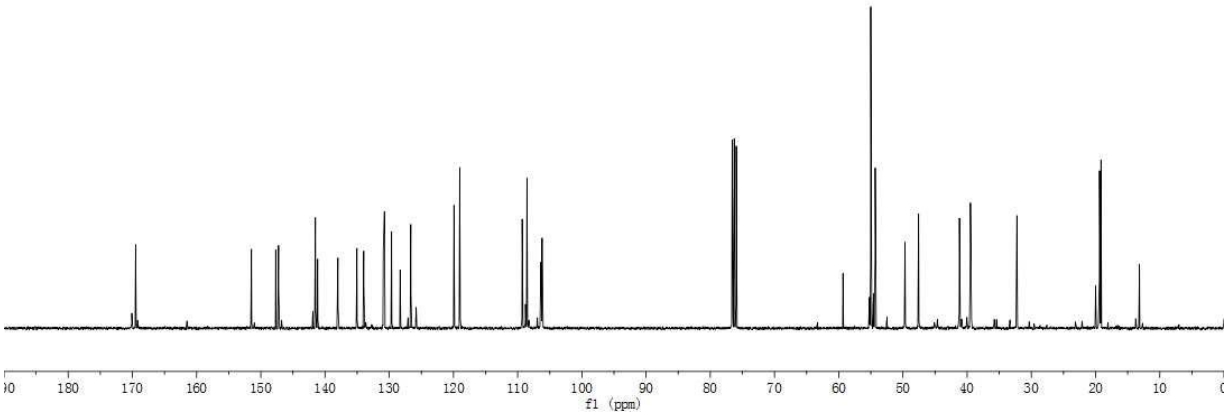
3-(5,6-dimethyl-1*H*-benzo[*d*]imidazol-1-yl)-1-((6a*R*,11b*S*)-4,9,10-trimethoxy-6a-methyl-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propan-1-one

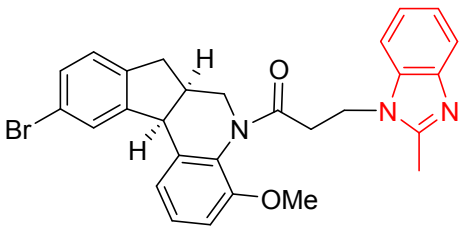
Yield 81%; white powder; m.p. = 167-169 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 (s, 1H), 7.38 (s, 1H), 7.17 (t, *J* = 8.0 Hz, 1H), 6.98 (dd, *J* = 7.6, 1.2 Hz, 1H), 6.80 (s, 1H), 6.71-6.64 (m, 2H), 6.21 (s, 1H), 4.76 (d, *J* = 12.8 Hz, 1H), 4.36 (d, *J* = 8.4 Hz, 1H), 4.18-4.07 (m, 1H), 3.73 (s, 3H), 3.55 (s, 3H), 3.37 (s, 3H), 3.35-3.22 (m, 2H), 3.10-2.99 (m, 2H), 2.66 (dd, *J* = 13.2, 6.4 Hz, 1H), 2.57 (m, 1H), 2.24 (s, 3H), 2.22 (s, 3H), 1.48 (m, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.5, 151.5, 147.68, 147.2, 141.5, 141.2, 138.0, 135.0, 134.0, 130.9, 130.8, 129.6, 128.3, 126.6, 119.9, 119.0, 109.3, 108.6, 106.4, 106.2, 55.0, 54.3, 49.7, 47.6, 41.2, 39.5, 39.4, 32.3, 19.4, 19.2 , 13.2 ppm; IR (KBr) ν: 3444, 2935, 1649, 1502, 1453, 1406, 1305, 1274, 1217, 1187, 1085, 996, 838, 756, 621, 434 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{31}H_{34}N_3O_4$ $[M+H]^+$ 512.2544, found 512.2544.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 32



$^{13}C\{^{1}H\}$ NMR spectra (100 MHz, DMSO-d_6) of Compound 32



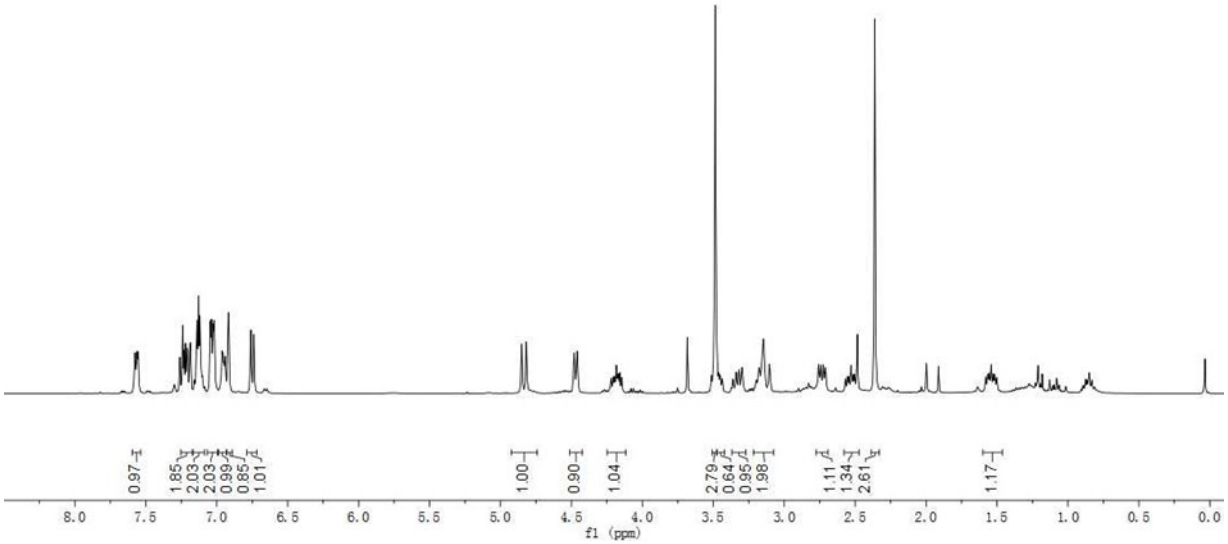


33

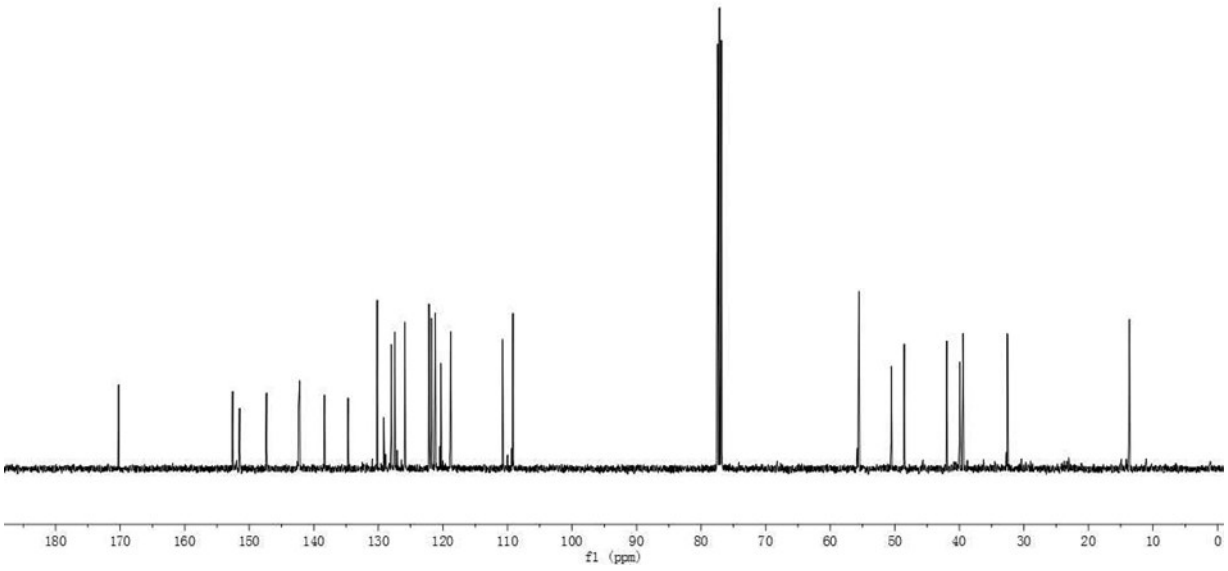
1-((6a*R*,11b*R*)-10-bromo-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)-3-(2-methyl-1*H*-benzo[*d*]imidazol-1-yl)propan-1-one

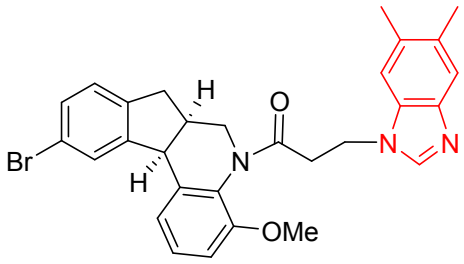
Yield 69%; colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58-7.56 (m, 1H), 7.26-7.19 (m, 2H), 7.14-7.11 (m, 2H), 7.05-7.02 (m, 2H), 6.96-6.91 (m, 1H), 6.92 (s, 1H), 6.75 (d, *J* = 8.4 Hz, 1H), 4.83 (d, *J* = 13.2 Hz, 1H), 4.47 (d, *J* = 8.4 Hz, 1H), 4.22-4.15 (m, 1H), 3.49 (s, 3H), 3.46-3.44 (m, 1H), 3.33 (dd, *J* = 16.8, 9.2 Hz, 1H), 3.20-3.10 (m, 2H), 2.73 (dd, *J* = 13.2, 6.0 Hz, 1H), 2.57-2.48 (m, 1H), 2.36 (s, 3H), 1.58-1.50 (m, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 152.6, 151.5, 147.3, 142.4, 142.2, 138.3, 134.7, 130.2, 129.2, 128.0, 127.5, 125.9, 122.2, 121.8, 121.2, 120.3, 118.8, 110.8, 109.1, 55.6, 50.5, 48.5, 41.9, 39.9, 39.4, 32.6, 13.6 ppm; IR (KBr) ν: 3504, 2933, 16717, 1655, 1589, 1486, 1473, 1458, 1400, 1310, 1272, 1089, 1064, 746, 660 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{28}H_{27}BrN_3O_2$ $[M+H]^+$ 516.1281, found 516.1283.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 33



$^{13}C\{^{1}H\}$ NMR spectra (100 MHz, DMSO-d_6) of Compound 33



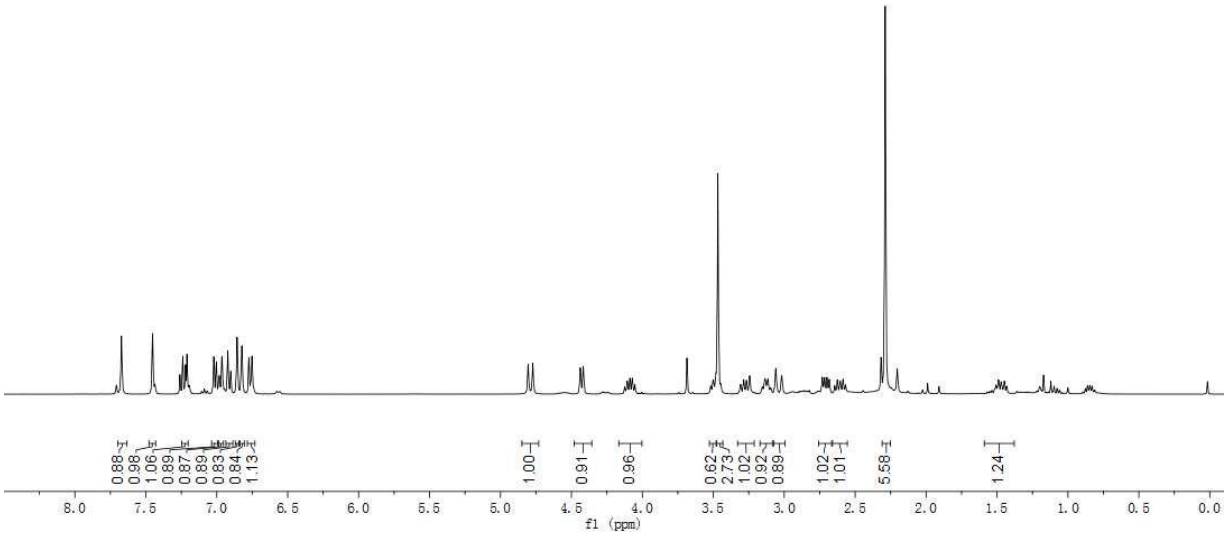


34

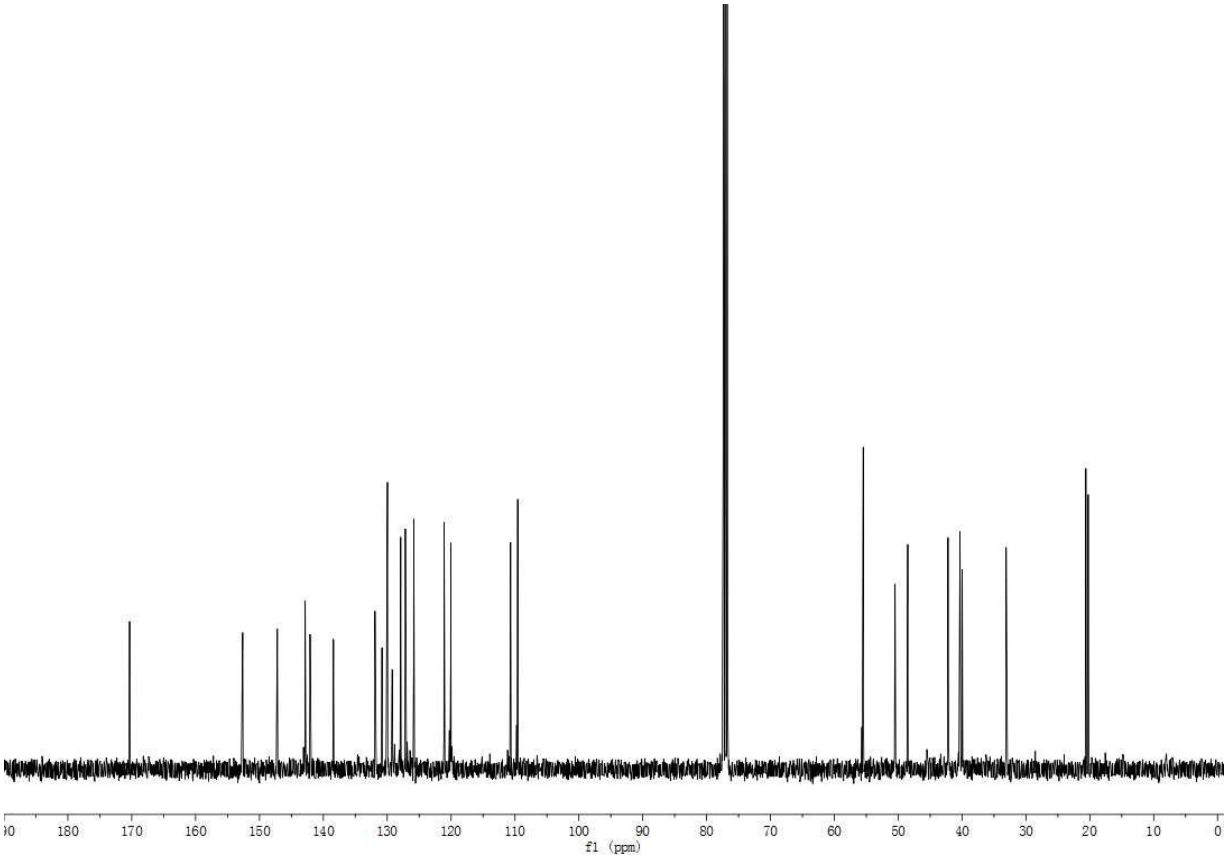
1-((6a*R*,11b*R*)-10-bromo-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)-3-(5,6-dimethyl-1*H*-benzo[*d*]imidazol-1-yl)propan-1-one

Yield 71%; colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (s, 1H), 7.45 (s, 1H), 7.26-7.21 (m, 1H), 7.01 (d, *J* = 7.6 Hz, 1H), 6.97 (d, *J* = 8.0 Hz, 1H), 6.91 (d, *J* = 8.0 Hz, 1H), 6.86 (s, 1H), 6.82 (s, 1H), 6.76 (d, *J* = 8.0 Hz, 1H), 4.79 (d, *J* = 13.2 Hz, 1H), 4.43 (d, *J* = 8.4 Hz, 1H), 4.12-4.05 (m, 1H), 3.52-3.48 (m, 1H), 3.47 (s, 3H), 3.28 (dd, *J* = 16.8, 9.2 Hz, 1H), 3.13 (dd, *J* = 8.4, 6.4 Hz, 1H), 3.06-3.02 (m, 1H), 2.71 (dd, *J* = 13.2, 6.4 Hz, 1H), 2.64-2.57 (m, 1H), 2.29 (s, 6H), 1.57-1.43 (m, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 152.6, 147.2, 142.8, 142.1, 138.4, 131.9, 131.9, 130.8, 130.0, 129.2, 127.9, 127.2, 125.9, 121.1, 120.1, 119.9, 110.7, 109.6, 55.5, 50.5, 48.5, 42.2, 40.3, 40.0, 33.1, 20.6, 20.3 ppm; IR (KBr) ν: 3440, 2936, 1654, 1589, 1487, 1474, 1404, 1310, 1274, 1254, 1216, 1175, 1086, 1062 , 841, 756, 621 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{29}H_{29}BrN_3O_2$ $[M+H]^+$ 530.1438, found 540.1440.

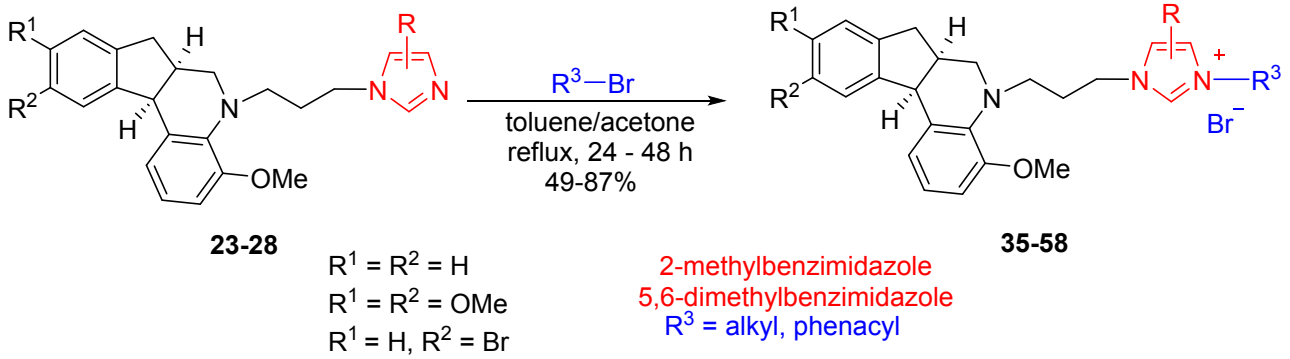
^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 34



$^{13}C\{^{1}H\}$ NMR spectra (100 MHz, DMSO-d_6) of Compound 34



2.10 Synthesis of compound 35-58



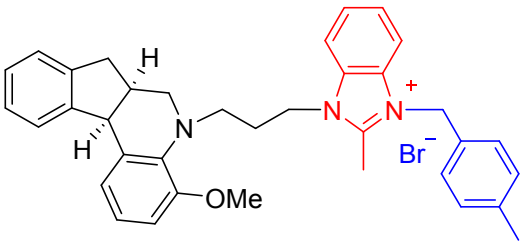
23-28

$R^1 = R^2 = H$
$R^1 = R^2 = OMe$
$R^1 = H, R^2 = Br$

2-methylbenzimidazole
5,6-dimethylbenzimidazole
R^3 = alkyl, phenacyl

35-58

A mixture of compound **23-28** (0.19 mmol) and the corresponding alkyl and phenacyl bromides (0.38 mmol) were stirred in acetone/toluene (1:1, 6 ml) in fluxing for 24-48 h. An insoluble substance was formed. After completion of the reaction as indicated by TLC, the precipitate was filtered through a small pad of Celite, and washed with ethyl acetate (3 × 30 ml), then dried to afford imidazolium salts **35-58** in 49-87% yields.

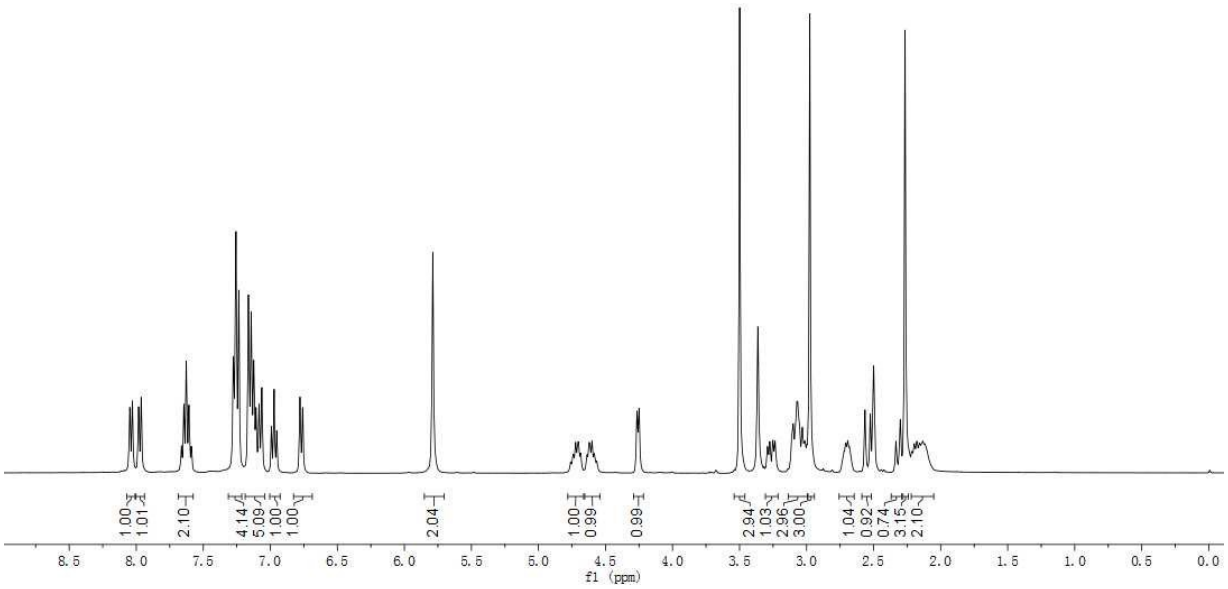


35

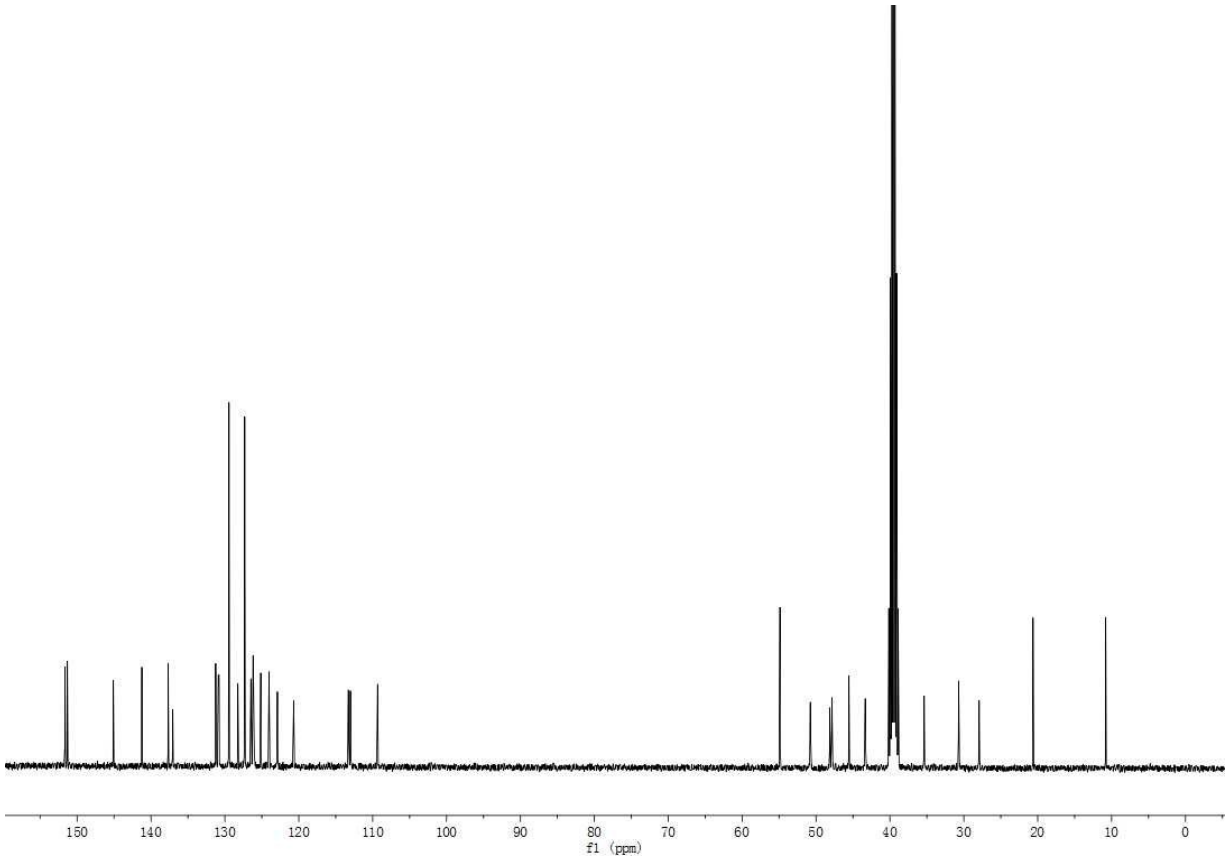
1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-2-methyl-3-(4-methylbenzyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

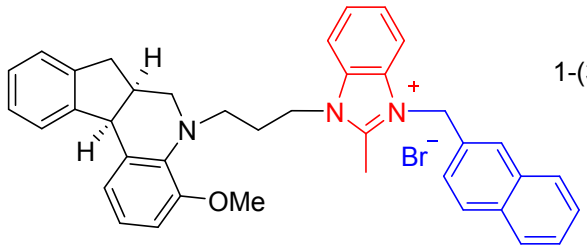
Yield 66%; yellow powder; m.p. = 198-200 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.05-8.03 (m, 1H), 7.98-7.96 (m, 1H), 7.68-7.59 (m, 2H), 7.28-7.24 (m, 4H), 7.16-7.06 (m, 5H), 6.97 (t, J = 7.6 Hz, 1H), 6.77 (d, J = 8.0 Hz, 1H), 5.79 (s, 2H), 4.76-4.69 (m, 1H), 4.64-4.56 (m, 1H), 4.26 (d, J = 6.0 Hz, 1H), 3.50 (s, 3H), 3.26 (dd, J = 16.0, 6.8 Hz, 1H), 3.11-3.03 (m, 3H), 2.98 (s, 3H), 2.74-2.67 (m, 1H), 2.54 (d, J = 16.0 Hz, 1H), 2.32 (d, J = 13.2 Hz, 1H), 2.27 (s, 3H), 2.22-2.11 (m, 2H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 151.6, 151.3, 145.1, 141.2, 137.7, 137.1, 131.2, 130.9, 130.8, 129.4, 128.2, 127.3, 126.5, 126.2, 126.2, 126.1, 125.1, 124.0, 122.9, 120.7, 113.3, 113.0, 109.3, 54.9, 50.8, 48.1, 47.9, 45.5, 43.3, 35.4, 30.7, 27.9, 20.6, 10.8 ppm; IR (KBr) ν: 3432, 2928, 1522, 1472, 1250, 1213, 1137, 1094, 1078, 778, 734, 730, 617 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{36}H_{38}N_3O$ $[M-Br]^+$ 528.3009, found 528.3009.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 35



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 35



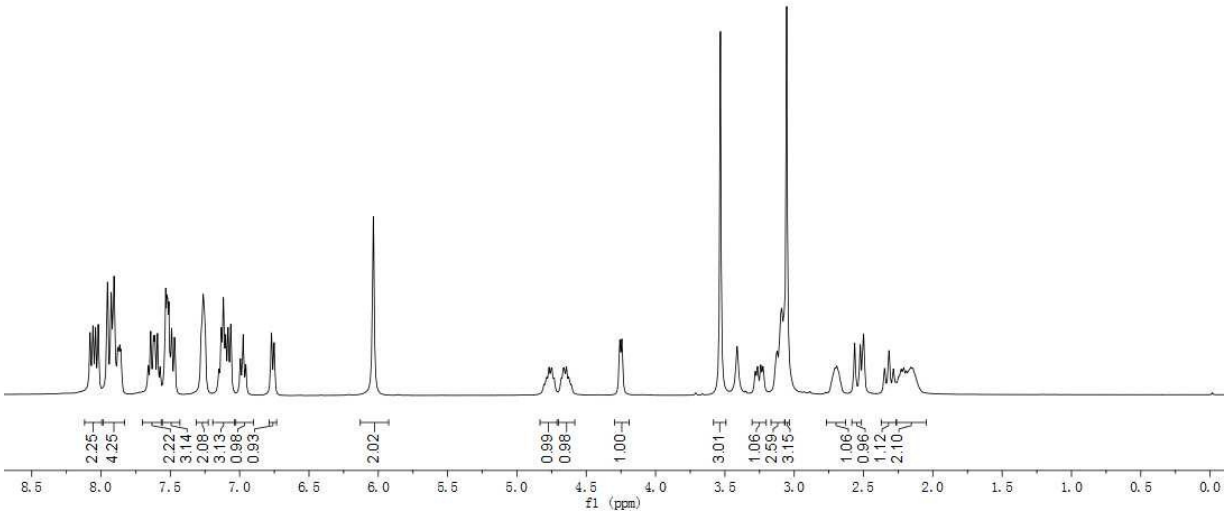


36

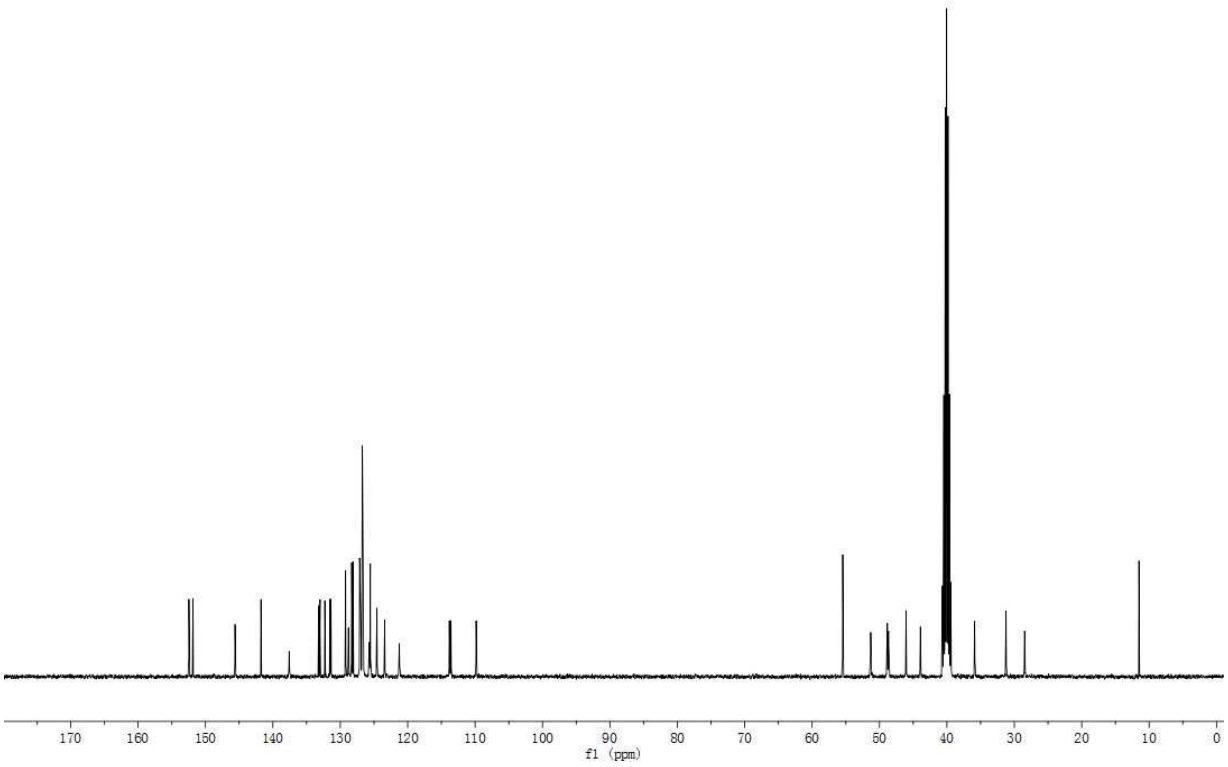
1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-2-methyl-3-(naphthalen-2-ylmethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

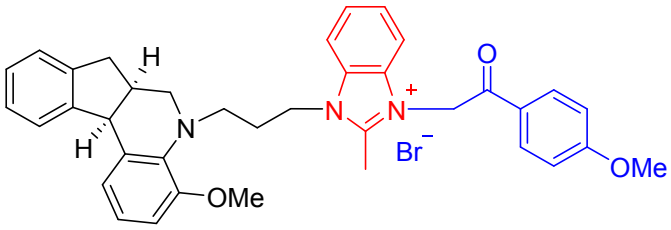
Yield 81%; yellow powder; m.p. = 263-265 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.05 (dd, J = 15.6, 8.4 Hz, 2H), 7.95-7.86 (m, 4H), 7.66-7.58 (m, 2H), 7.54-7.47 (m, 3H), 7.28-7.25 (m, 2H), 7.15-7.06 (m, 3H), 6.98 (t, J = 8.0 Hz, 1H), 6.76 (d, J = 8.0 Hz, 1H), 6.04 (s, 2H), 4.81-4.73 (m, 1H), 4.68-4.61 (m, 1H), 4.25 (d, J = 6.0 Hz, 1H), 3.53 (s, 3H), 3.25 (dd, J = 16.0, 6.8 Hz, 1H), 3.13-3.09 (m, 3H), 3.05 (s, 3H), 2.74-2.66 (m, 1H), 2.54 (d, J = 16.0 Hz, 1H), 2.32 (t, J = 12.8 Hz, 1H), 2.25-2.12 (m, 2H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 151.9, 151.3, 145.1, 141.2, 137.1, 132.7, 132.5, 131.8, 131.0, 130.9, 128.7, 128.3, 127.8, 127.6, 126.6, 126.5, 126.5, 126.2, 126.0, 125.1, 125.0, 124.0, 122.9, 120.7, 113.3, 113.1, 109.3, 54.9, 50.8, 48.3, 48.1, 45.5, 43.4, 35.4, 30.7, 28.0, 11.0 ppm; IR (KBr) ν: 3443, 3037, 2952, 2838, 1631, 1575, 1520, 1473, 1415, 1383, 1251, 1215, 1182, 1091, 1076, 805, 794, 737 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{39}H_{38}N_3O$ $[M\text{-}Br]^+$ 564.3009, found 564.3009.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 36



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 36



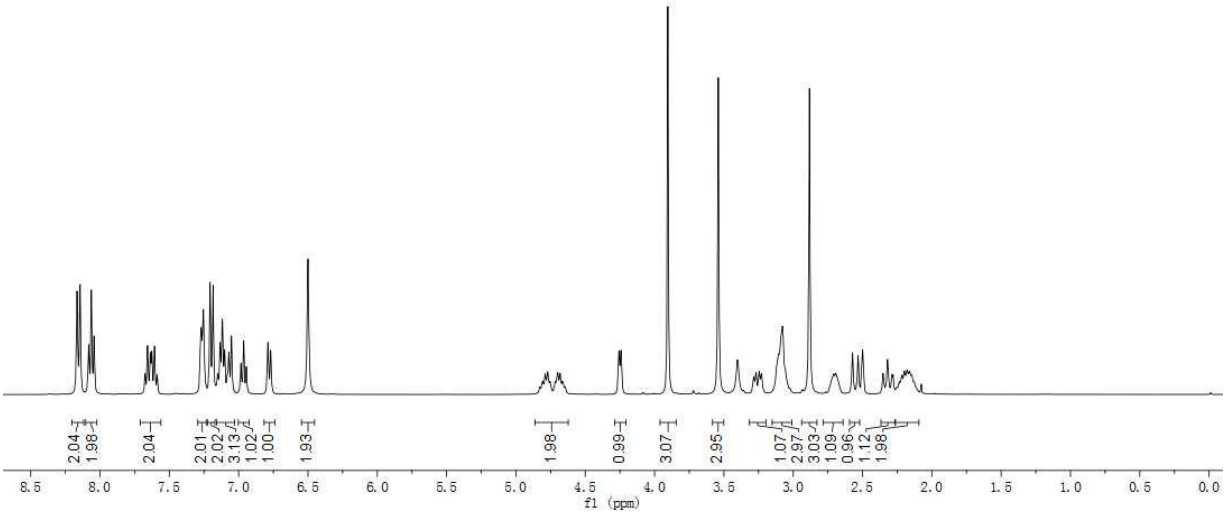


1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-3-(2-(4-methoxyphenyl)-2-oxoethyl)-2-methyl-1*H*-benzo[*d*]imidazol-3-ium bromide

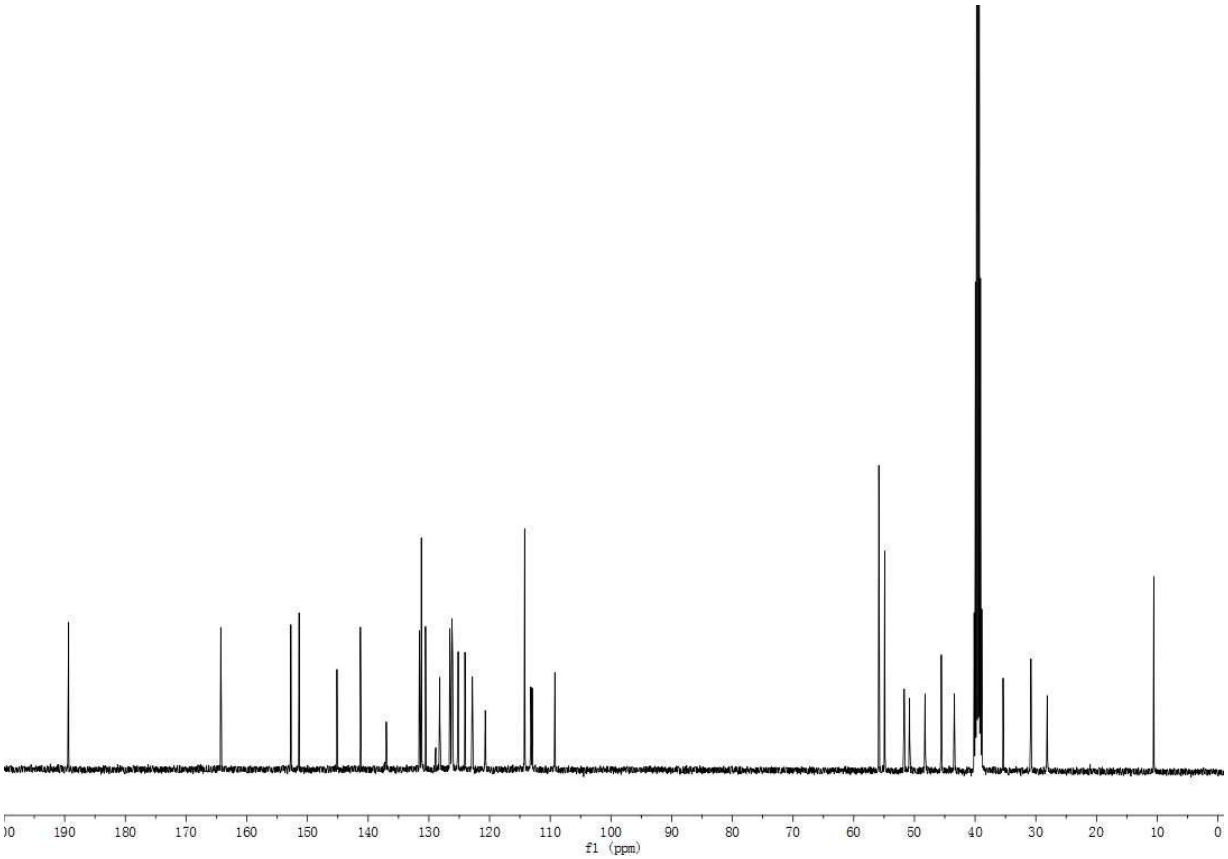
37

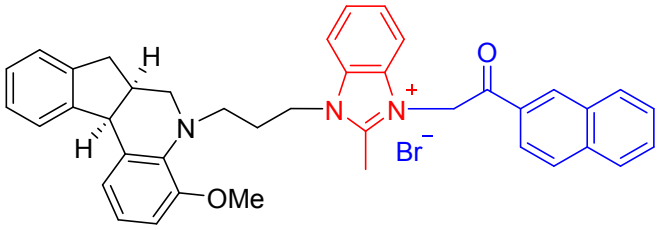
Yield 84%; yellow powder; m.p. = 250-252 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.15 (d, J = 8.8 Hz, 2H), 8.06 (t, J = 8.0 Hz, 2H), 7.71-7.56 (m, 2H), 7.30-7.23 (m, 2H), 7.20 (d, J = 8.4 Hz, 2H), 7.16-7.03 (m, 3H), 6.96 (t, J = 8.0 Hz, 1H), 6.78 (d, J = 8.0 Hz, 1H), 6.50 (s, 2H), 4.74 (m, 2H), 4.25 (d, J = 6.0 Hz, 1H), 3.90 (s, 3H), 3.54 (s, 3H), 3.26 (dd, J = 16.0, 6.8 Hz, 1H), 3.09 (m, 3H), 2.88 (s, 3H), 2.78-2.64 (m, 1H), 2.55 (d, J = 16.4 Hz, 1H), 2.37-2.27 (m, 1H), 2.26-2.09 (m, 2H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 189.4, 164.3, 152.7, 151.4, 145.1, 141.3, 137.0, 131.6, 131.2, 130.6, 128.2, 126.5, 126.5, 126.2, 126.2, 126.1, 125.2, 124.1, 122.8, 120.7, 114.2, 113.2, 113.0, 109.2, 55.9, 54.9, 51.7, 50.8, 48.2, 45.6, 43.4, 35.4, 30.8, 28.1, 10.6 ppm; IR (KBr) ν: 3441, 3040, 2939, 2839, 1674, 1601, 1575, 1529, 1512, 1475, 1423, 1385, 1353, 1320, 1244, 1182, 1142, 1092, 1079, 1024, 837, 806, 776, 741, 688, 581 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{37}H_{38}N_3O_3$ $[M\text{-}Br]^+$ 572.2909, found 572.2909.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 37



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 37



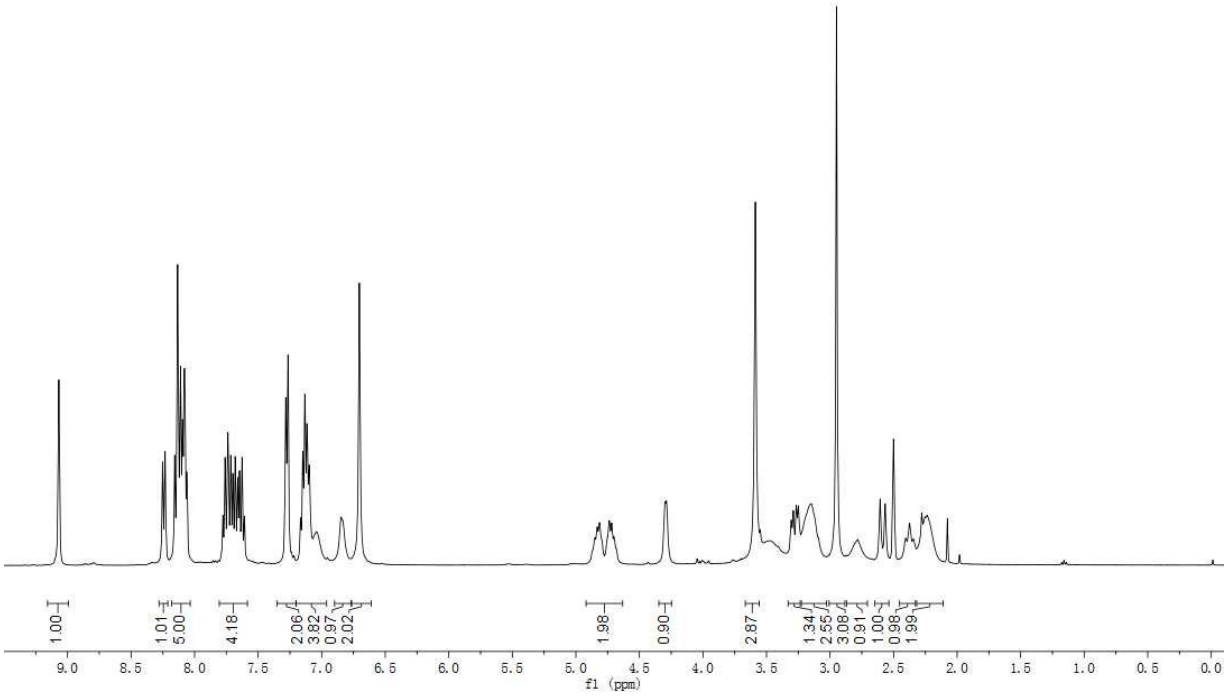


1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-2-methyl-3-(2-(naphthalen-2-yl)-2-oxoethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

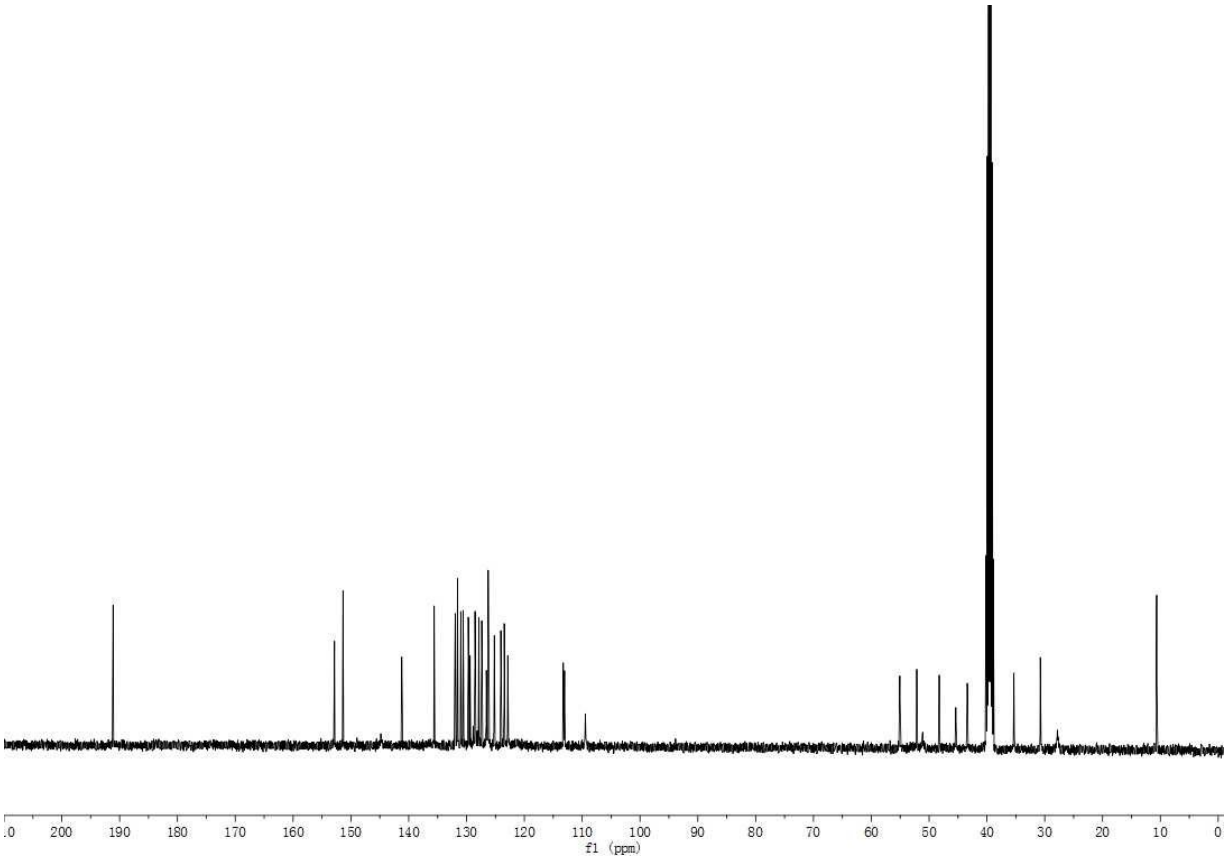
38

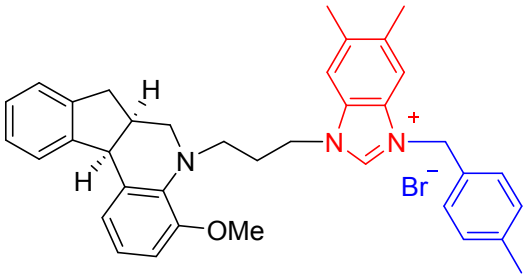
Yield 58%; yellow powder; m.p. = 206-208 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.07 (s, 1H), 8.24 (d, J = 8.0 Hz, 1H), 8.16-8.06 (m, 5H), 7.78-7.61 (m, 4H), 7.27 (d, J = 7.2 Hz, 2H), 7.17-7.04 (m, 4H), 6.84 (d, J = 7.6 Hz, 1H), 6.70 (s, 2H), 4.87-4.68 (m, 2H), 4.29 (d, J = 6.0 Hz, 1H), 3.59 (s, 3H), 3.47 (s, 1H), 3.28 (dd, J = 16.0, 6.8 Hz, 1H), 3.15 (s, 3H), 2.95 (s, 3H), 2.79 (s, 1H), 2.59 (d, J = 16.0 Hz, 1H), 2.37 (t, J = 12.8 Hz, 1H), 2.28-2.24 (m, 2H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 191.1, 152.8, 151.4, 141.2, 135.6, 132.0, 131.6, 131.5, 131.0, 130.6, 129.7, 129.4, 128.5, 127.9, 127.4, 126.6, 126.3, 126.1, 125.2, 124.1, 123.5, 122.9, 113.3, 113.1, 109.5, 55.1, 52.1, 48.3, 45.4, 43.4, 35.3, 30.8, 10.6 ppm; IR (KBr) ν: 3440, 2932, 1683, 1628, 1577, 1527, 1474, 1359, 1250, 1215, 1182, 1125, 1182, 1126, 1094, 1031, 746, 581cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{40}H_{38}N_3O_2$ $[M\text{-}Br]^+$ 592.2959, found 592.2959.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 38



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 38



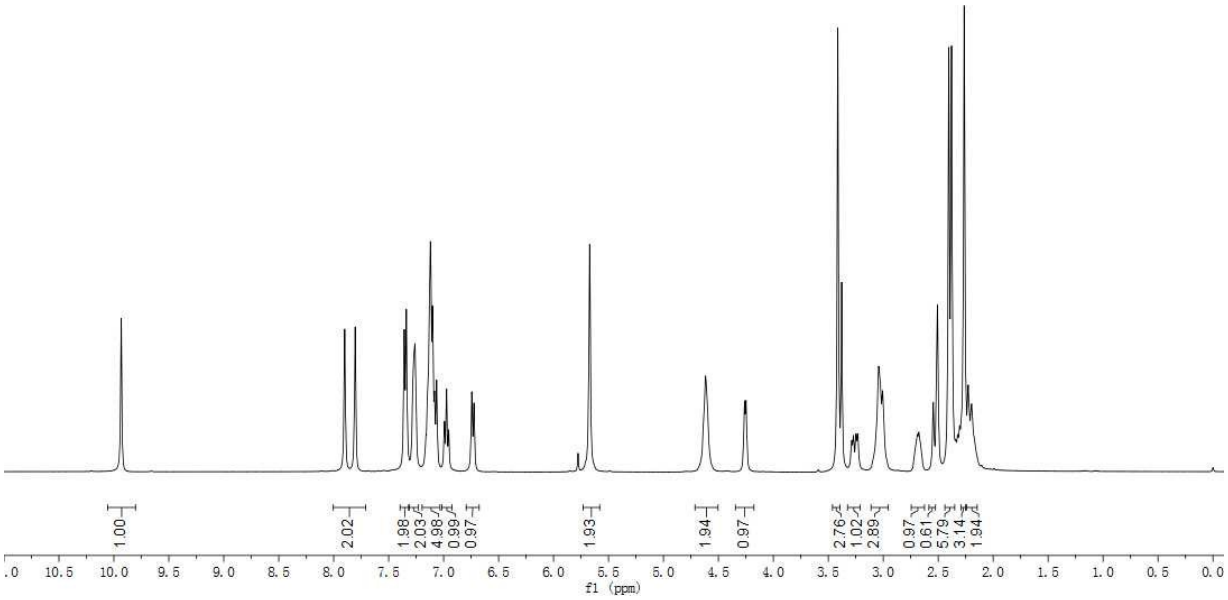


39

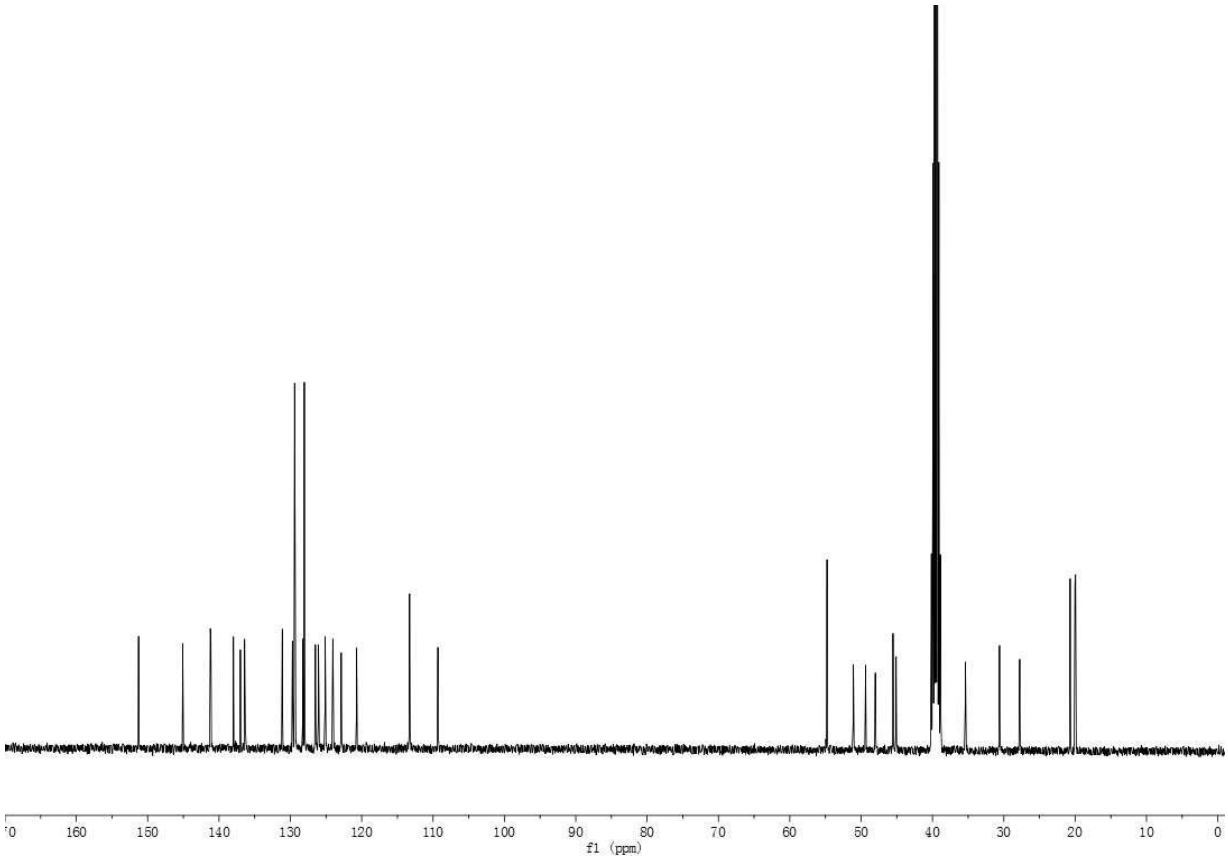
1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-5,6-dimethyl-3-(4-methylbenzyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

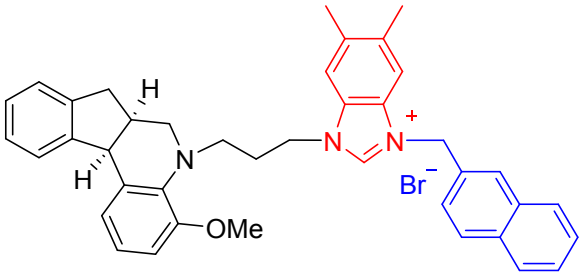
Yield 63%; yellow powder; m.p. = 228-230 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.93 (s, 1H), 7.90 (s, 1H), 7.81 (s, 1H), 7.35 (d, J = 7.6 Hz, 2H), 7.28-7.26 (m, 2H), 7.16-7.06 (m, 5H), 6.97 (t, J = 8.0 Hz, 1H), 6.73 (d, J = 8.0 Hz, 1H), 5.67 (s, 2H), 4.62-4.60 (m, 2H), 4.26 (d, J = 6.0 Hz, 1H), 3.41 (s, 3H), 3.26 (dd, J = 16.0, 6.8 Hz, 1H), 3.10-2.97 (m, 3H), 2.72-2.65 (m, 1H), 2.54 (s, 1H), 2.39 (d, J = 10.0 Hz, 6H), 2.26 (s, 3H), 2.23-2.19 (m, 2H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 151.3, 145.1, 141.2, 141.1, 138.0, 137.0, 136.4, 136.3, 131.1, 129.7, 129.4, 129.3, 128.3, 128.0, 126.5, 126.1, 125.1, 124.0, 122.9, 120.7, 113.3, 109.3, 54.8, 51.1, 49.4, 48.1, 45.5, 45.1, 35.4, 30.6, 27.8, 20.7, 20.0, 19.9 ppm; IR (KBr) ν: 3425, 2938, 1618, 1561, 1487, 1450, 1385, 1248, 1212, 1176, 1132, 1091, 1076, 741, 476 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{37}H_{40}N_3O$ $[M-Br]^+$ 542.3166, found 542.3168.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 39



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 39



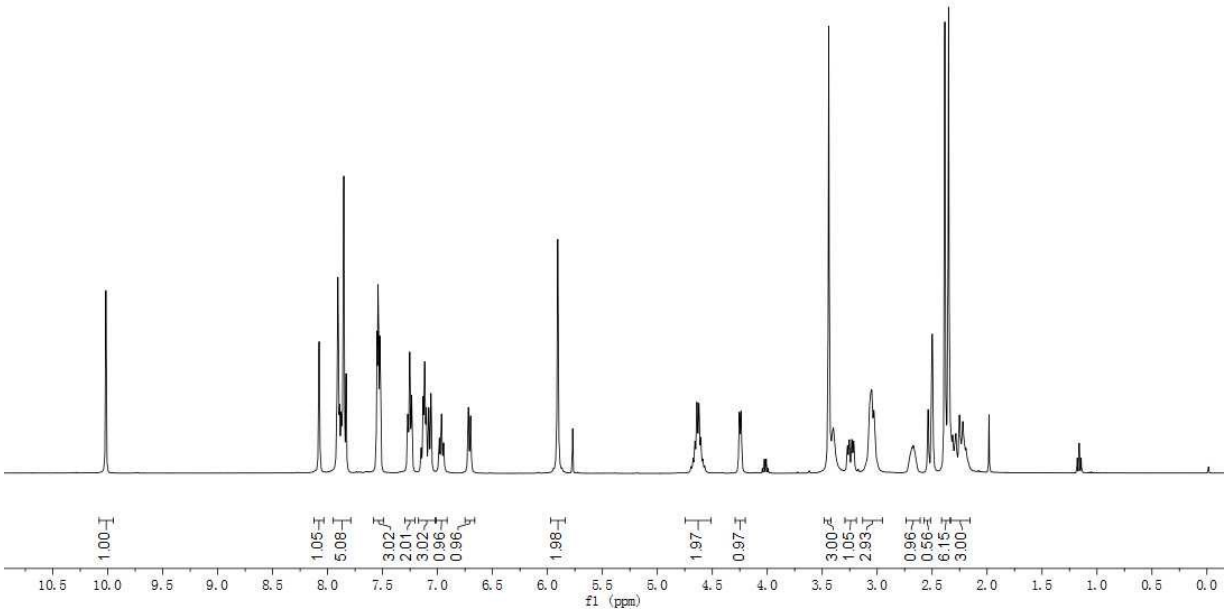


40

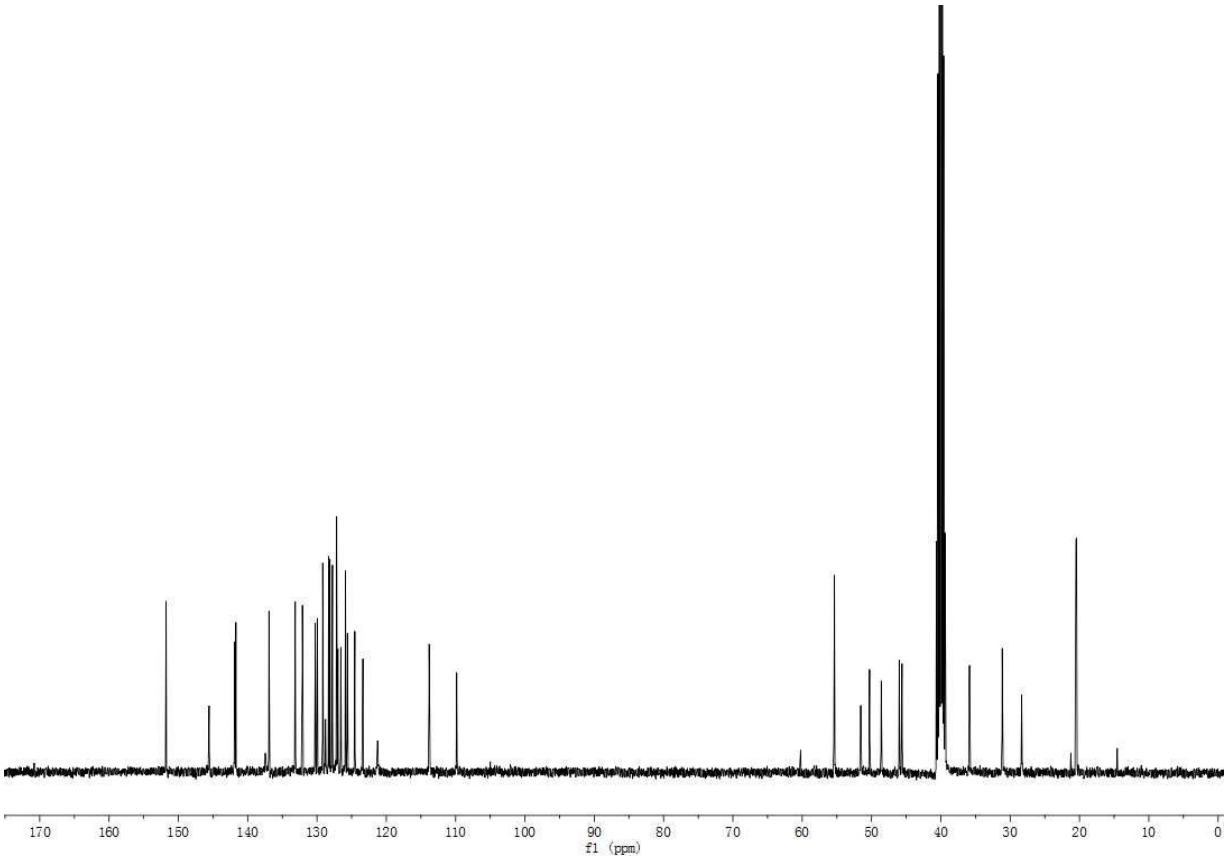
1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-5,6-dimethyl-3-(naphthalen-2-ylmethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

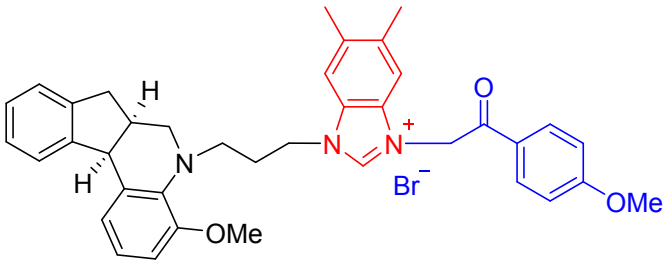
Yield 87%; yellow powder; m.p. = 201-203 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 10.02 (s, 1H), 8.08 (s, 1H), 7.91-7.83 (m, 5H), 7.55-7.52 (m, 3H), 7.25 (t, J = 7.2 Hz, 2H), 7.15-7.06 (m, 3H), 6.96 (t, J = 8.0 Hz, 1H), 6.71 (d, J = 8.0 Hz, 1H), 5.91 (s, 2H), 4.66-4.60 (m, 2H), 4.25 (d, J = 6.4 Hz, 1H), 3.44 (s, 3H), 3.24 (dd, J = 16.0, 6.4 Hz, 1H), 3.10-3.00 (m, 3H), 2.70-2.66 (m, 1H), 2.54 (s, 1H), 2.38 (s, 3H), 2.35(s, 3H), 2.34-2.19 (m, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 151.8, 145.6, 141.9, 141.7, 136.9, 136.9, 133.1, 133.1, 132.1, 130.2, 129.9, 129.2, 128.8, 128.3, 128.1, 127.8, 127.2, 127.1, 127.0, 126.6, 125.9, 125.6, 124.5, 123.4, 121.3, 113.8, 113.8, 109.8, 55.4, 51.6, 50.3, 48.6, 46.0, 45.6, 35.9, 31.2, 28.3, 20.5, 20.4 ppm; IR (KBr) ν: 3440, 3017, 2932, 1630, 1604, 1560, 1477, 1449, 1385, 1356, 1249, 1211, 1144, 1090, 737 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{40}H_{40}N_3O$ $[M\text{-}Br]^+$ 578.3166, found 578.3167.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 40



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 40



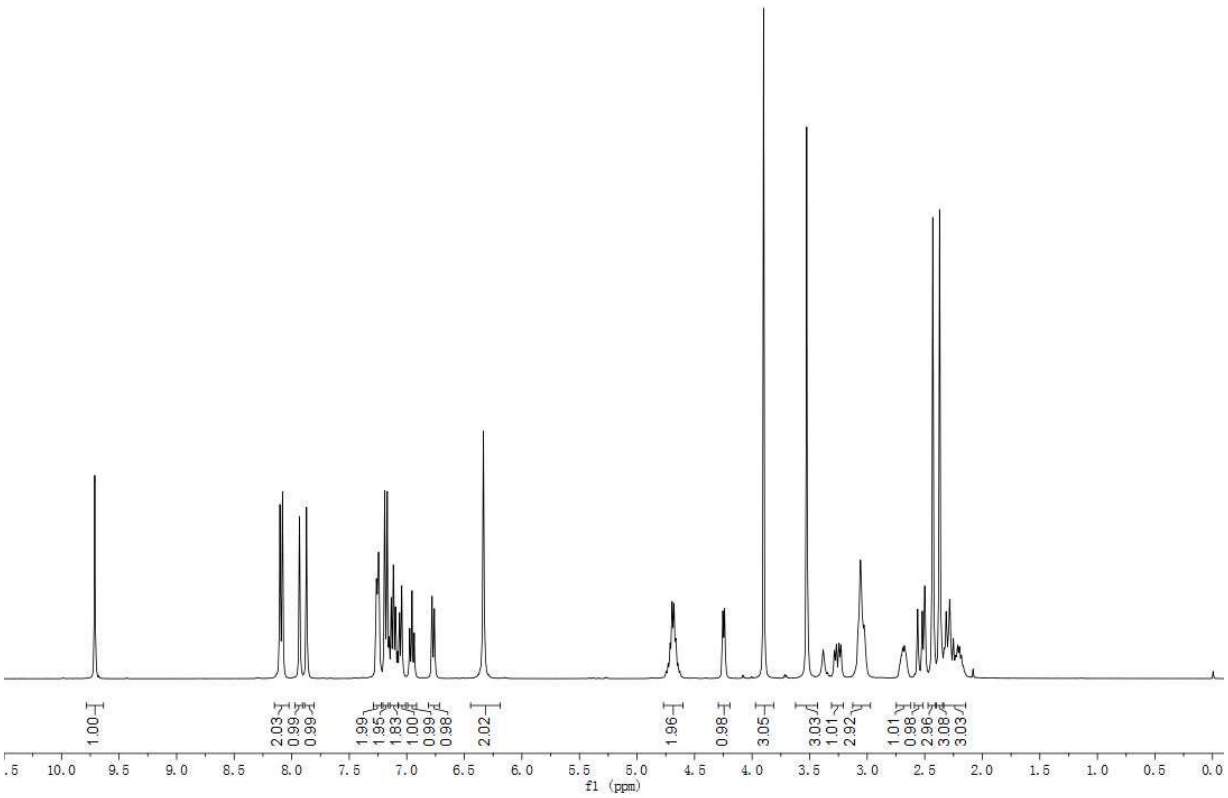


1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-3-(2-(4-methoxyphenyl)-2-oxoethyl)-5,6-dimethyl-1*H*-benzo[*d*]imidazol-3-ium bromide

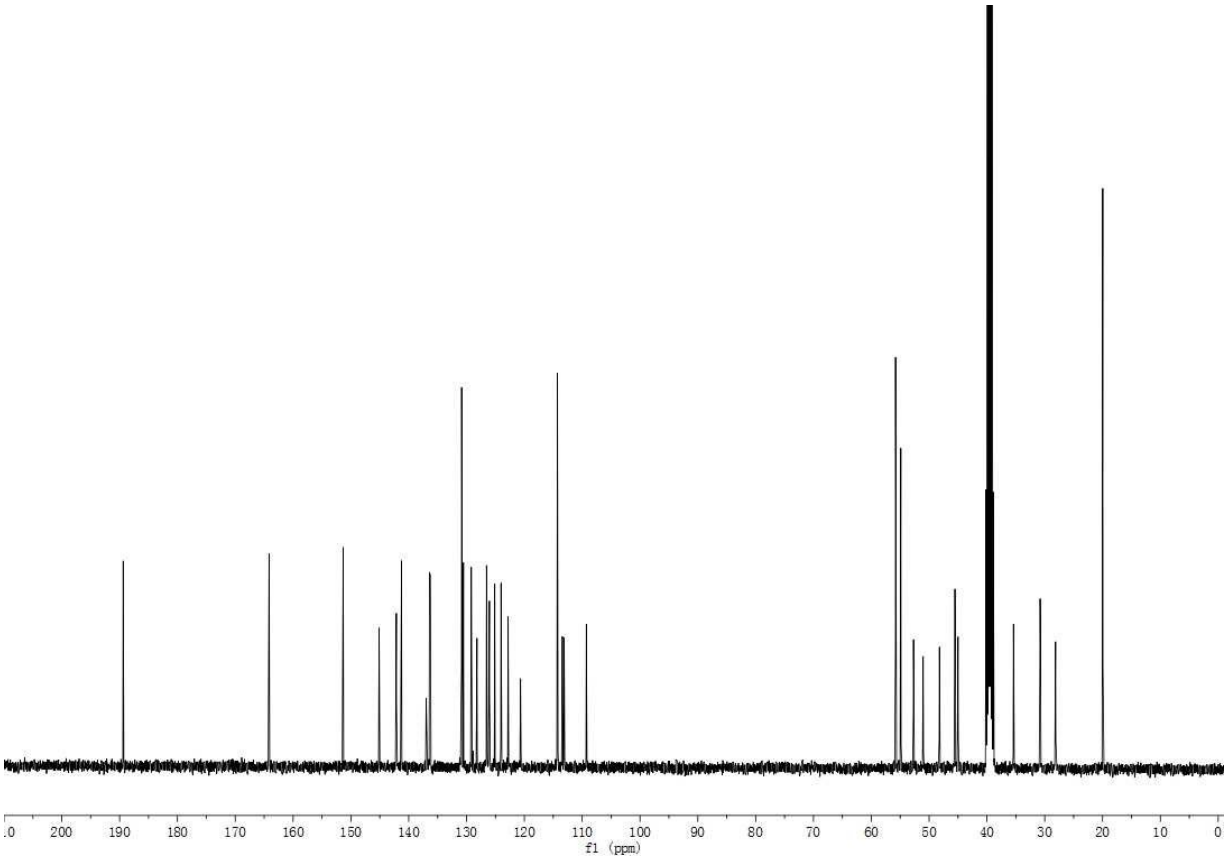
41

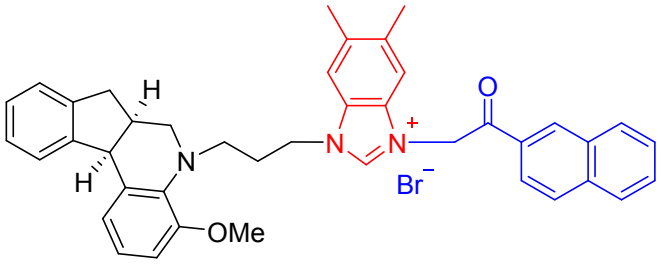
Yield 80%; yellow powder; m.p. = 189-191 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.71 (s, 1H), 8.09 (d, J = 4.8 Hz 2H), 7.93 (s, 1H), 7.87 (s, 1H), 7.27-7.24 (m, 2H), 7.19-7.15 (m, 2H), 7.14-7.10 (m, 2H), 7.05 (d, J = 7.6 Hz, 1H), 6.95 (t, J = 7.6 Hz, 1H), 6.77 (d, J = 7.6 Hz 1H), 6.33 (s, 2H), 4.75-4.63 (m, 2H), 4.25 (d, J = 6.4 Hz, 1H), 3.90 (s, 3H), 3.53 (s, 3H), 3.26 (dd, J = 16.0, 6.8 Hz, 1H), 3.08-3.02 (m, 3H), 2.72-2.65 (m, 1H), 2.54 (d, J = 16.0 Hz, 1H), 2.43 (s, 3H), 2.37 (s, 3H), 2.33-2.18 (m, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 189.4, 164.2, 151.3, 145.1, 142.1, 141.2, 137.0, 136.4, 136.3, 130.9, 130.5, 129.2, 128.2, 126.5, 126.5, 126.0, 125.1, 124.0, 122.8, 120.7, 114.3, 113.4, 113.1, 109.3, 55.8, 54.9, 52.7, 51.0, 48.2, 45.5, 45.0, 35.4, 30.8, 28.1, 20.0 ppm; IR (KBr) ν: 3439, 2930, 1686, 1654, 1617,1601, 1576, 1561, 1478, 1243, 1174, 790, 593, 505, 485 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{38}H_{40}N_3O_3$ $[M\text{-}Br]^+$ 586.3064, found 586.3061.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 41



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 41



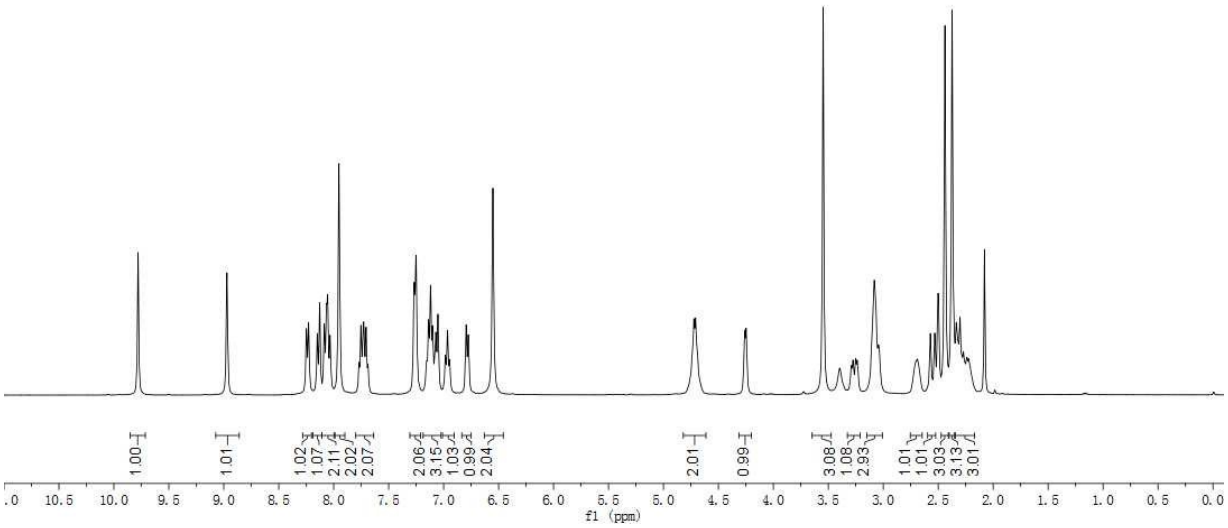


42

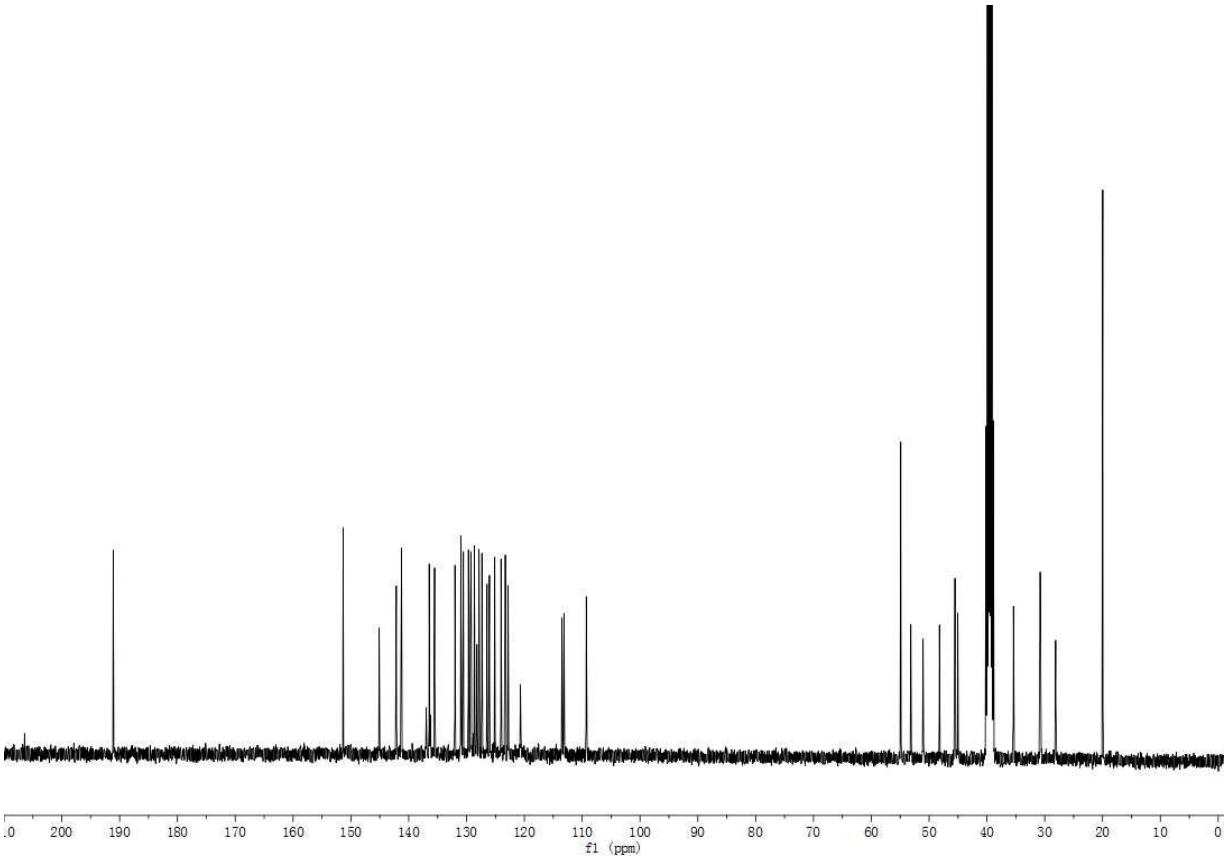
1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-5,6-dimethyl-3-(2-(naphthalen-2-yl)-2-oxoethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

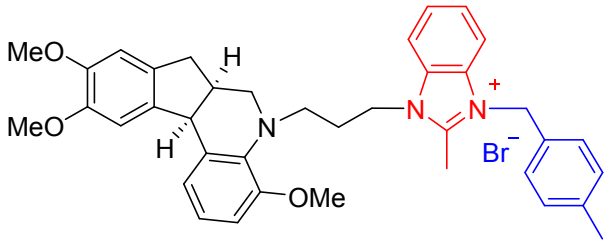
Yield 71%; yellow powder; m.p. = 244-246 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.78 (s, 1H), 8.97 (s, 1H), 8.24 (d, J = 8.0 Hz, 1H), 8.14 (d, J = 8.8 Hz, 1H), 8.06 (dd, J = 12.8, 8.0 Hz, 2H), 7.95 (s, 2H), 7.77-7.69 (m, 2H), 7.26 (d, J = 7.2 Hz, 2H), 7.16-7.05 (m, 3H), 6.97 (t, J = 8.0 Hz, 1H), 6.79 (d, 8Hz), 6.55 (s, 2H), 4.76-4.67 (m, 2H), 4.25 (d, J = 6.0 Hz, 1H), 3.55 (s, 3H), 3.26 (dd, J = 16.0, 6.8 Hz, 1H), 3.10-3.03 (m, 3H), 2.72-2.68 (m, 1H), 2.55 (d, J = 16.0 Hz, 1H), 2.44 (s, 3H), 2.37 (s, 3H), 2.34-2.19 (m, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 191.1, 151.3, 145.1, 142.2, 141.2, 137.0, 136.5, 136.3, 135.5, 132.0, 131.0, 130.9, 130.5, 129.7, 129.3, 129.2, 128.6, 128.2, 127.9, 127.4, 126.5, 126.0, 125.1, 124.0, 123.3, 122.8, 120.7, 113.5, 113.1, 109.3, 54.9, 53.2, 51.0, 48.2, 45.5, 45.0, 35.4, 30.8, 30.7, 28.1, 20.0 ppm; IR (KBr) ν: 3434, 2930, 1682, 1626, 1561, 1479, 1456, 1358, 1250, 1213, 1190, 1123, 1091, 739 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{41}H_{40}N_3O_2$ $[M\text{-}Br]^+$ 606.3115, found 606.3114.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 42



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 42



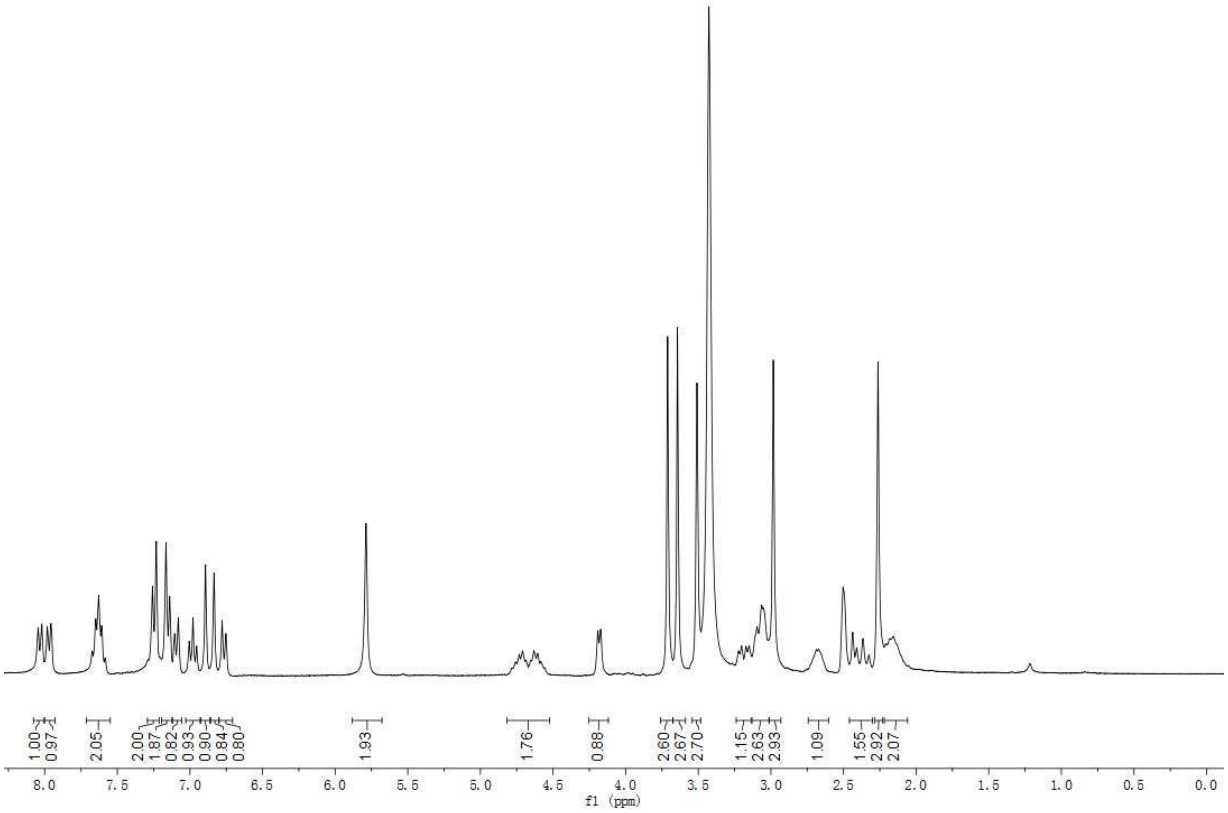


2-methyl-3-(4-methylbenzyl)-1-(3-(4,9,10-trimethoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

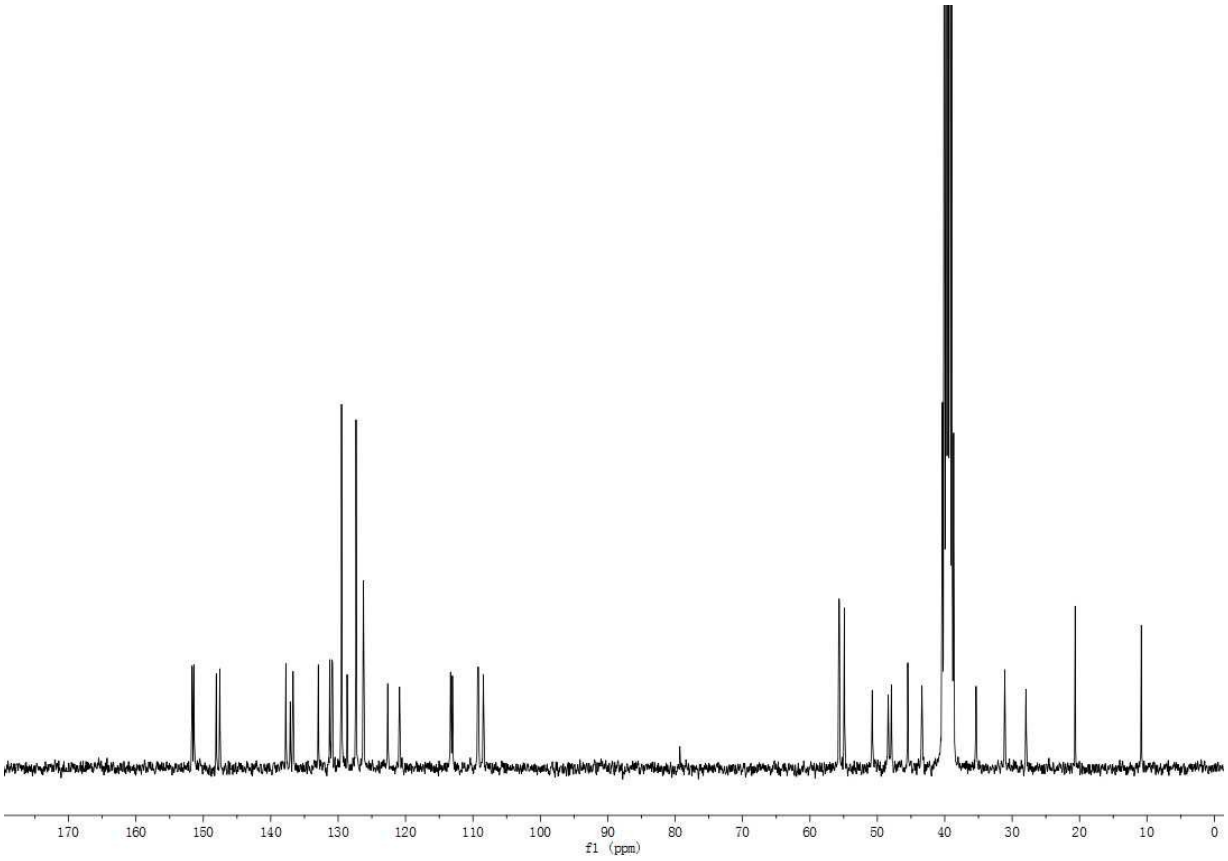
43

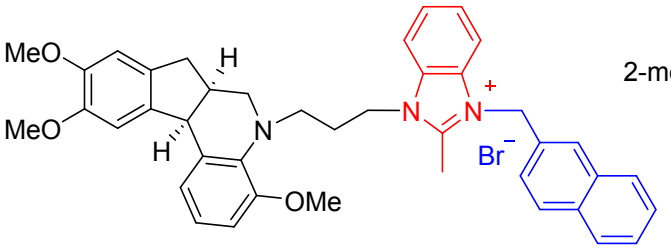
Yield 65%; yellow powder; m.p. = 182-184 °C; ^{1}H NMR (300 MHz, DMSO-d_6) δ 8.03 (d, J = 7.8 Hz 1H), 7.97 (d, J = 8.1 Hz 1H), 7.67-7.61 (m, 2H), 7.24 (d, J = 7.8 Hz, 2H), 7.15 (d, J = 7.8 Hz, 2H), 7.09 (d, J = 4.8 Hz, 1H), 6.98 (t, J = 7.8 Hz, 1H), 6.89 (s, 1H), 6.83 (s, 1H), 6.77 (d, J = 7.8 Hz, 1H), 5.79 (s, 2H), 4.78-4.56 (m, 2H), 4.18 (d, J = 6.0 Hz, 1H), 3.71 (s, 3H), 3.64 (s, 3H), 3.51 (s, 3H), 3.19 (dd, J = 15.6, 6.3 Hz, 1H), 3.10-3.04 (m, 3H), 2.98 (s, 3H), 2.74-2.63 (m, 1H), 2.38 (dd, J = 21.3, 8.4 Hz, 2H), 2.26 (s, 3H), 2.21-2.08 (m, 2H) ppm; ^{13}C NMR (75 MHz, DMSO-d_6) δ 151.7, 151.4, 148.1, 147.6, 137.8, 137.2, 136.7 132.9, 131.2, 130.9, 130.8, 129.5, 128.7, 127.3, 126.2, 122.6, 120.9, 113.3, 113.0, 109.3, 109.2, 108.5, 55.7, 55.6, 54.9, 50.8, 48.4, 47.9, 45.5, 43.4, 35.4, 31.1, 28.0, 20.7, 10.8 ppm; IR (KBr) ν: 3420, 2931, 1619, 1518, 1501, 1472, 1303, 1275, 1251, 1220, 1187, 1078, 1061, 753 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{38}H_{42}N_3O_4$ $[M\text{-}Br]^+$ 588.3221, found 588.3221.

^{1}H NMR spectra (300 MHz, DMSO-d_6) of Compound 43



^{13}C{^{1}H} NMR spectra (75 MHz, DMSO-d_6) of Compound 43



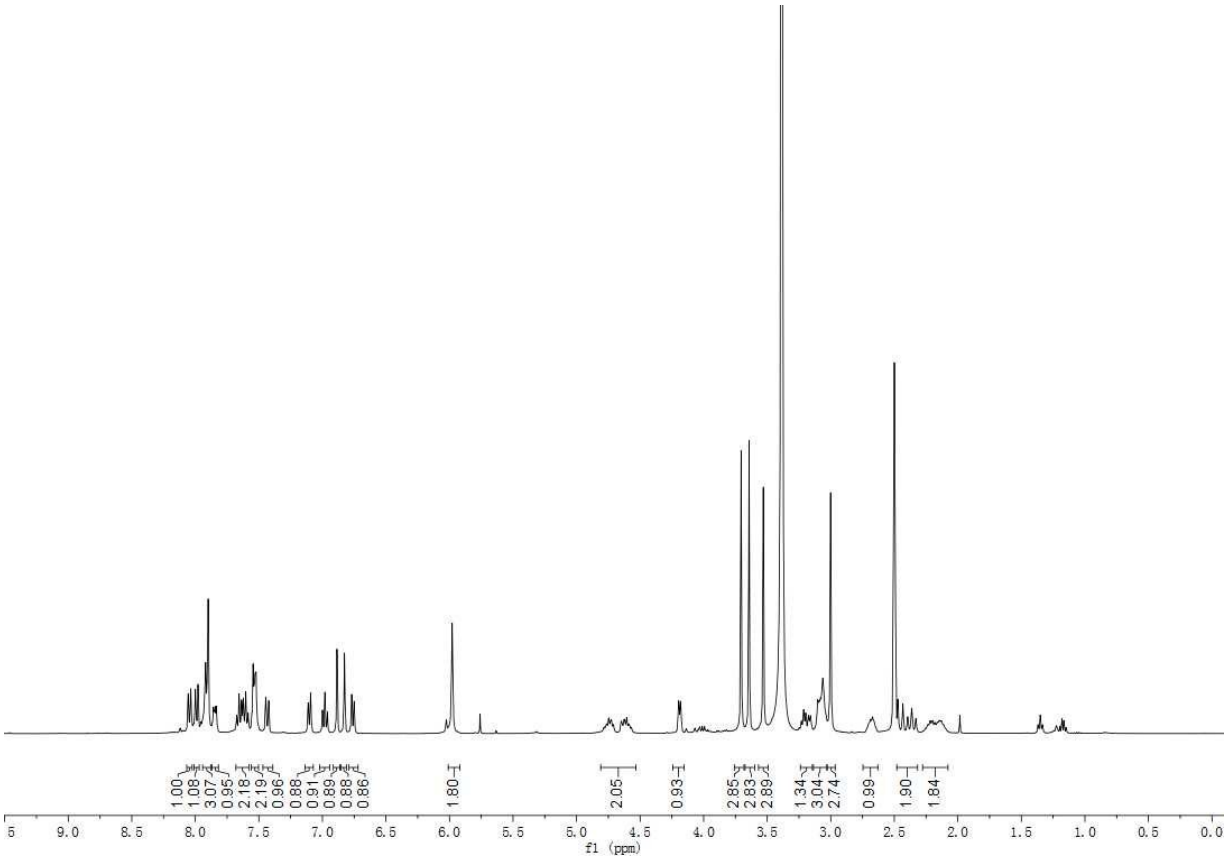


2-methyl-3-(naphthalen-2-ylmethyl)-1-(3-(4,9,10-trimethoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

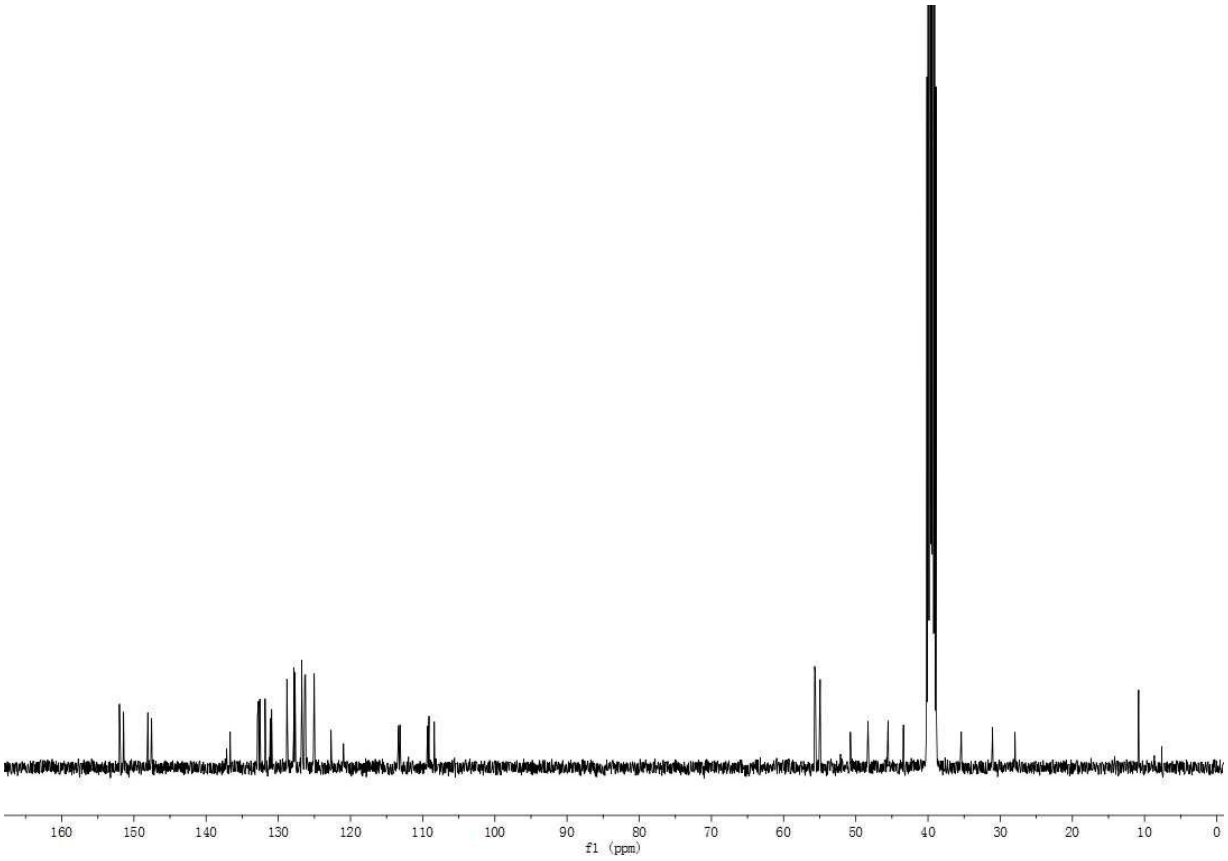
44

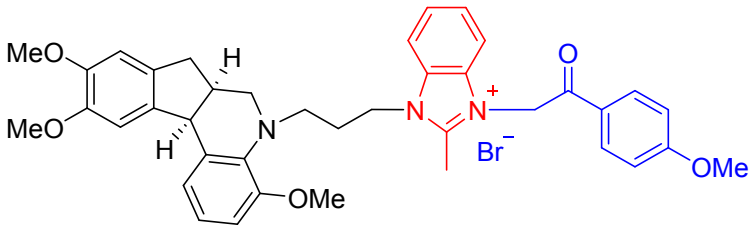
Yield 76%; yellow powder; m.p. = 227-229 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.05 (d, J = 8.0 Hz, 1H), 7.99 (d, J = 8.4 Hz, 1H), 7.91 (d, J = 7.6 Hz, 3H), 7.86-7.83 (m, 1H), 7.67-7.59 (m, 2H), 7.55-7.52 (m, 2H), 7.43 (dd, J = 1.6 Hz, 1H), 7.10 (d, J = 8.0 Hz, 1H), 6.98 (t, J = 8.0 Hz, 1H), 6.89 (s, 1H), 6.83 (s, 1H), 6.76 (d, J = 8.0 Hz, 1H), 5.98 (s, 2H), 4.79-4.57 (m, 2H), 4.19 (d, J = 6.0 Hz, 1H), 3.71 (s, 3H), 3.64 (s, 3H), 3.53 (s, 3H), 3.19 (dd, J = 15.6, 6.8 Hz, 1H), 3.10-3.04 (m, 3H), 3.00 (s, 3H), 2.70-2.64 (m, 1H), 2.47-2.33 (m, 2H), 2.24-2.11 (m, 2H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 152.0, 151.4, 148.1, 147.6, 137.2, 136.7, 132.9, 132.8, 132.6, 131.8, 131.1, 130.9, 128.8, 128.7, 127.9, 127.7, 126.8, 126.7, 126.3, 126.2, 125.0, 122.7, 121.0, 113.3, 113.1, 109.3, 109.1, 108.4, 55.7, 55.6, 54.9, 50.8, 48.3, 45.5, 43.4, 35.4, 31.1, 28.0, 10.8 ppm; IR (KBr) ν: 3358, 2932, 1701, 1602, 1576, 1501, 1473, 1302, 1218, 1078, 796, 744, 660, 474 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{41}H_{42}N_3O_3$ $[M\text{-}Br]^+$ 624.3221, found 624.3221.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 44



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 44



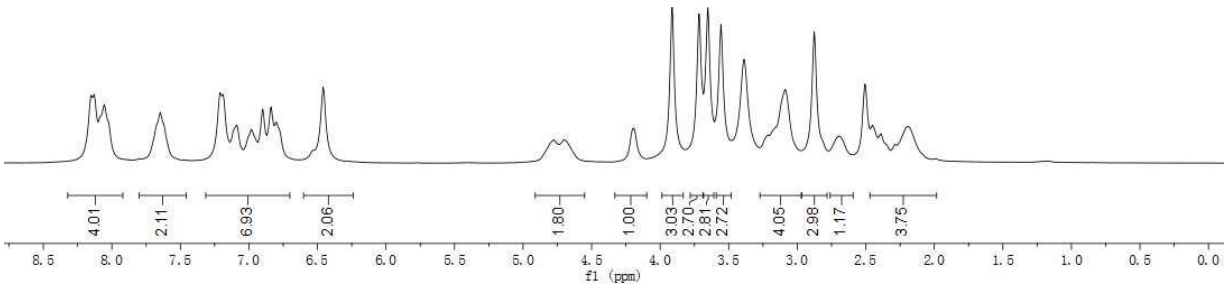


3-(2-(4-methoxyphenyl)-2-oxoethyl)-2-methyl-1-(3-(4,9,10-trimethoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

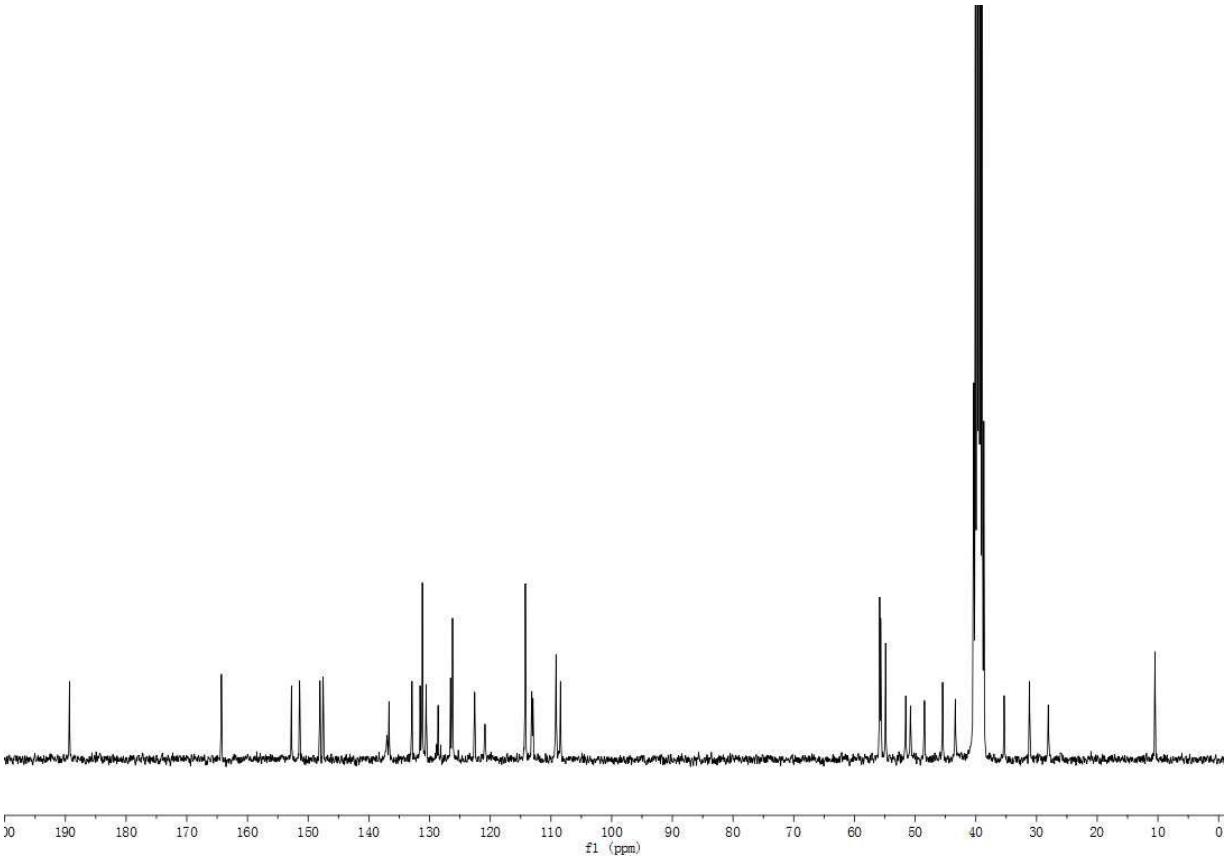
45

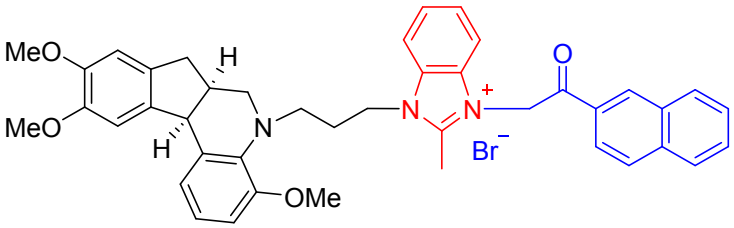
Yield 68%; yellow powder; m.p. = 233-235 °C; ^{1}H NMR (300 MHz, DMSO-d_6) δ 8.15-8.05 (m, 4H), 7.68-7.62 (m, 2H), 7.21-6.77 (m, 7H), 6.46 (s, 2H), 4.85-4.63 (m, 2H), 4.31-4.12 (m, 1H), 3.91 (s, 3H), 3.72 (s, 3H), 3.65 (s, 3H), 3.56 (s, 3H), 3.23-3.08 (m, 4H), 2.88 (s, 3H), 2.70-2.69 (m, 1H), 2.46-2.19 (m, 4H) ppm; ^{13}C NMR (75 MHz, DMSO-d_6) δ 189.3, 164.3, 152.8, 151.4, 148.1, 147.5, 137.0, 136.7, 132.9, 131.6, 131.2, 130.6, 128.6, 126.6, 126.2, 122.6, 120.9, 114.2, 113.2, 113.0, 109.2, 108.4, 55.9, 55.7, 55.6, 54.9, 51.6, 50.8, 48.5, 45.5, 43.4, 35.3, 31.2, 28.1, 10.5 ppm; IR (KBr) ν: 3433, 2939, 1674, 1602, 1575, 1502, 1474, 1304, 1246, 1224, 1186, 1078, 753, 581 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{39}H_{42}N_3O_5$ $[M-Br]^+$ 632.3119, found 632.3119.

^{1}H NMR spectra (300 MHz, DMSO-d_6) of Compound 45



^{13}C{^{1}H} NMR spectra (75 MHz, DMSO-d_6) of Compound 45



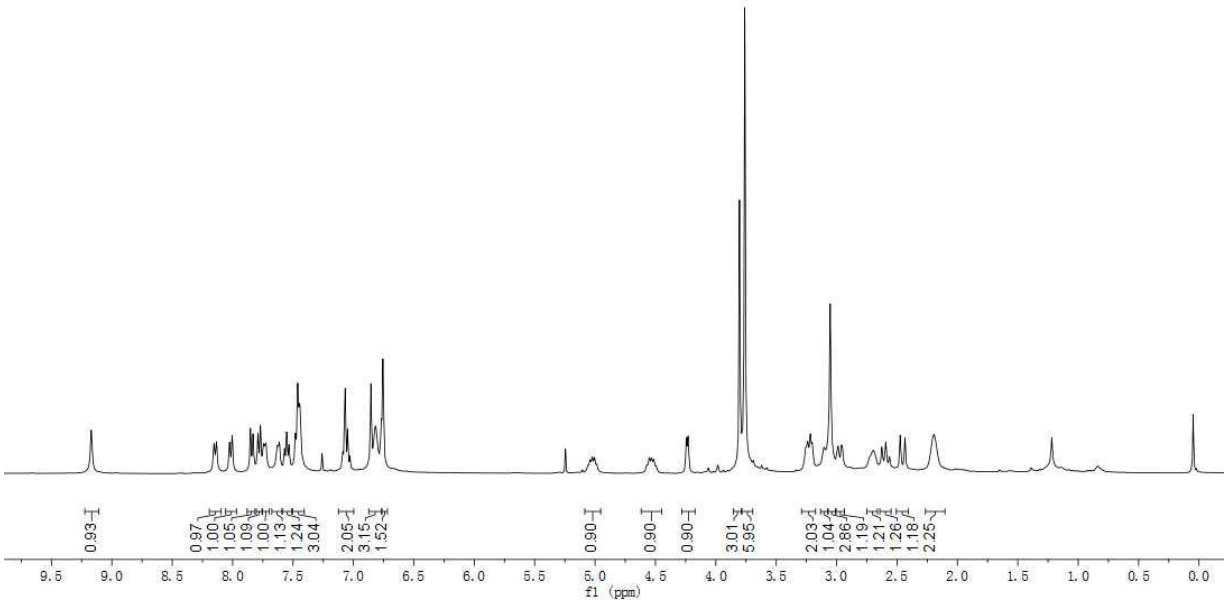


2-methyl-3-(2-(naphthalen-2-yl)-2-oxoethyl)-1-(3-(4,9,10-trimethoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

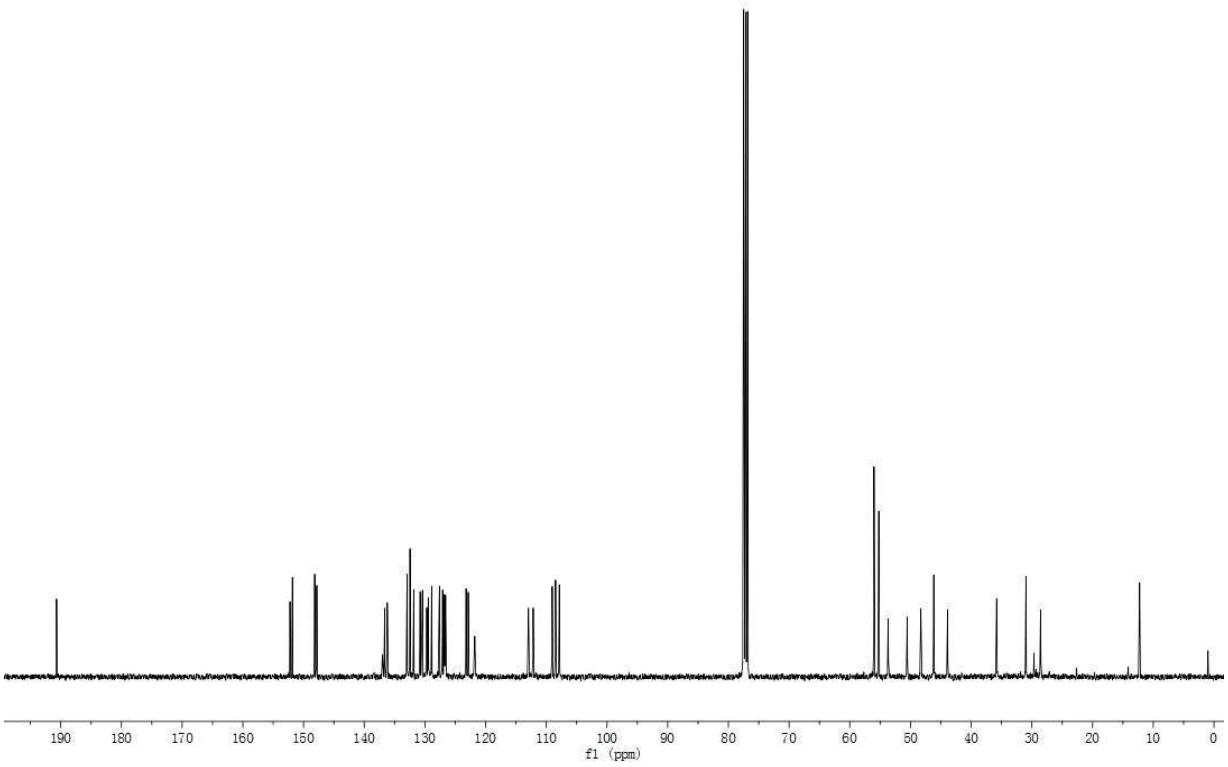
46

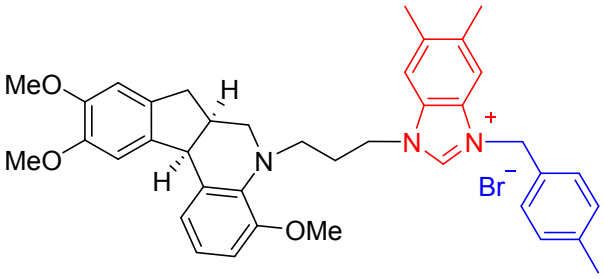
Yield 86%; yellow powder; m.p. = 213-215 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.17 (s, 1H), 8.14 (d, *J* = 8.4 Hz, 1H), 8.02 (d, *J* = 8.8 Hz, 1H), 7.84 (d, *J* = 8.8 Hz, 1H), 7.78 (d, *J* = 8.0 Hz, 1H), 7.73 (d, *J* = 7.2 Hz, 1H), 7.64-7.61 (m, 1H), 7.55 (t, *J* = 7.6 Hz, 1H), 7.48-7.44 (m, 3H), 7.09-7.03 (m, 2H), 6.86-6.77 (m, 3H), 6.76 (s, 2H), 5.03-4.99 (m, 1H), 4.53 (dt, *J* = 15.6, 8.1 Hz, 1H), 4.24 (d, *J* = 6.0 Hz, 1H), 3.80 (s, 3H), 3.76 (s, 6H), 3.26-3.20 (m, 2H), 3.11-3.09 (m, 1H), 3.05 (s, 3H), 2.97 (d, *J* = 11.6 Hz, 1H), 2.74-2.67 (m, 1H), 2.63-2.56 (m, 1H), 2.45 (d, *J* = 16.0 Hz, 1H), 2.23-2.12 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.7, 152.2, 151.8, 148.2, 147.8, 137.0, 136.6, 136.2, 132.9, 132.5, 131.8, 130.8, 130.5, 130.4, 129.7, 129.5, 128.9, 127.6, 127.1, 126.8, 126.6, 123.2, 122.9, 121.8, 112.9, 112.2, 109.0, 108.5, 107.9, 56.0, 56.0, 55.2, 53.7, 50.5, 48.3, 46.2, 43.9, 35.8, 31.0, 28.6, 12.2 ppm; IR (KBr) *v*: 3423, 2930, 2834, 1687, 1626, 1577, 1528, 1501, 1473, 1302, 1259, 1220, 1125, 1078, 1062, 1030, 751 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{42}H_{42}N_3O_4$ $[M\text{-}Br]^+$ 652.3170, found 652.3170.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 46



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 46



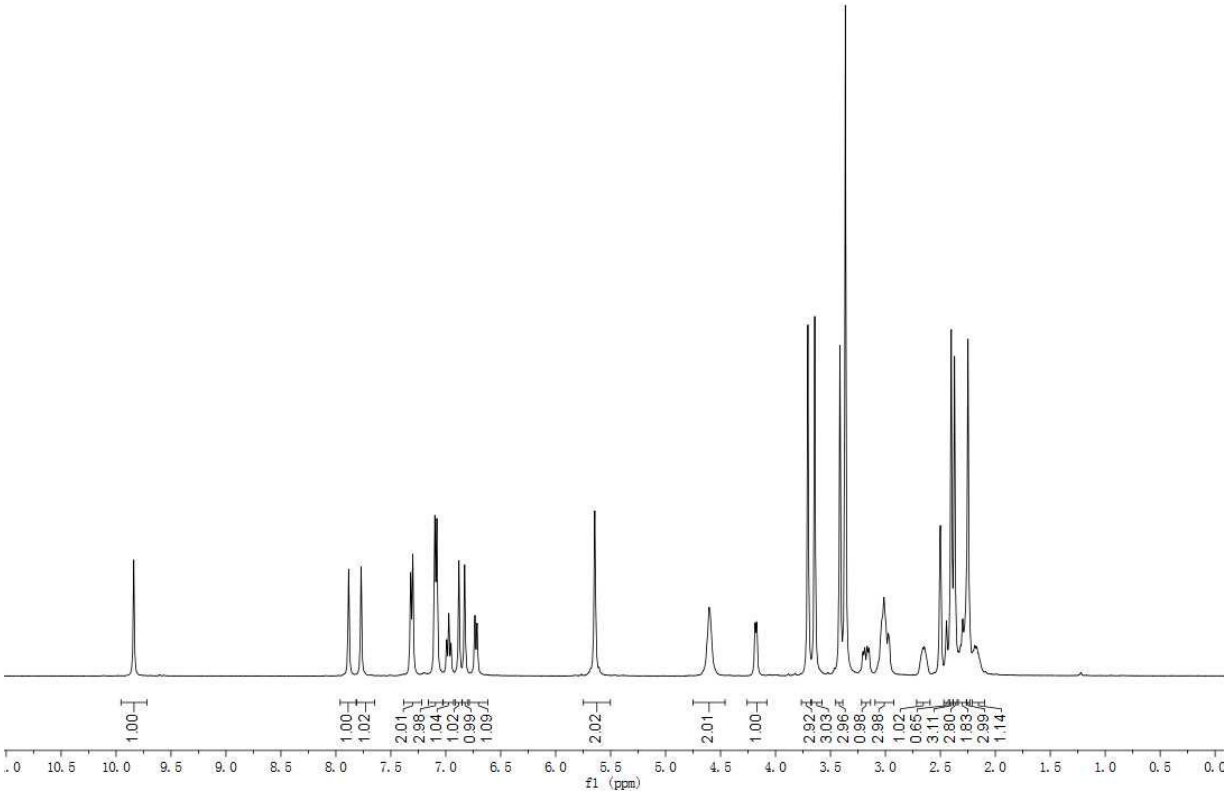


5,6-dimethyl-3-(4-methylbenzyl)-1-(3-(4,9,10-trimethoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

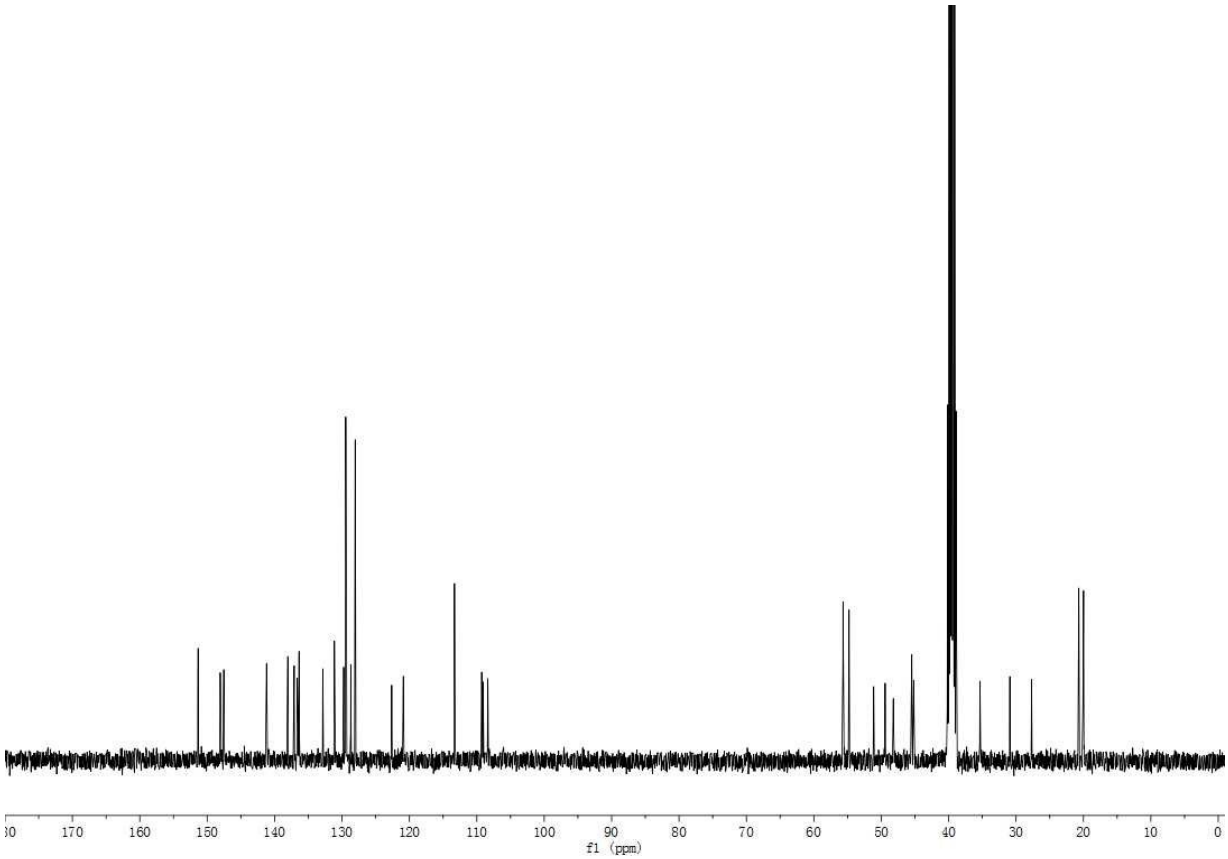
47

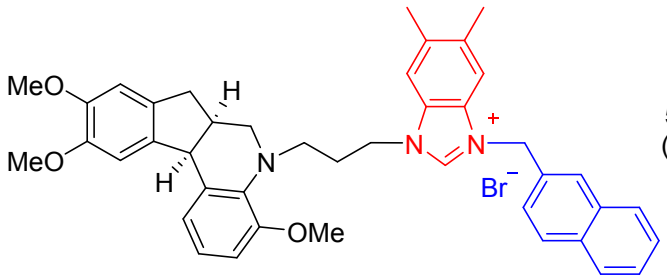
Yield 74%; yellow powder; m.p. = 176-178 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.84 (s, 1H), 7.88 (s, 1H), 7.77 (s, 1H), 7.31 (d, J = 7.6 Hz, 2H), 7.09 (d, J = 7.6 Hz, 3H), 6.97 (t, J = 8.0 Hz, 1H), 6.88 (s, 1H), 6.83 (s, 1H), 6.72 (d, J = 8.0 Hz, 1H), 5.64 (s, 2H), 4.60 (m, 2H), 4.18 (d, J = 6.0 Hz, 1H), 3.71 (s, 3H), 3.64 (s, 3H), 3.41 (s, 3H), 3.18 (dd, J = 15.6, 6.4 Hz, 1H), 3.00 (m, 3H), 2.72-2.59 (m, 1H), 2.45 (s, 1H), 2.40 (s, 3H), 2.37 (s, 3H), 2.34-2.26 (m, 2H), 2.25 (s, 3H), 2.18 (m, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 151.4, 148.1, 147.5, 141.2, 138.0, 137.1, 136.6, 136.5, 136.4, 132.9, 131.1, 129.8, 129.4, 129.3, 128.7, 128.0, 122.6, 120.9, 113.3, 109.3, 109.1, 108.4, 55.7, 55.6, 54.8, 51.1, 49.4, 48.2, 45.5, 45.2, 35.4, 30.9, 27.7, 20.7, 20.1, 20.0 ppm; IR (KBr) ν: 3443, 2935, 1630, 156, 1452, 1302, 1275, 1250, 1219, 1186, 1144, 1078, 1062, 1030, 758 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{39}H_{44}N_3O_3$ $[M\text{-}Br]^+$ 602.3377, found 602.3377.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 47



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 47



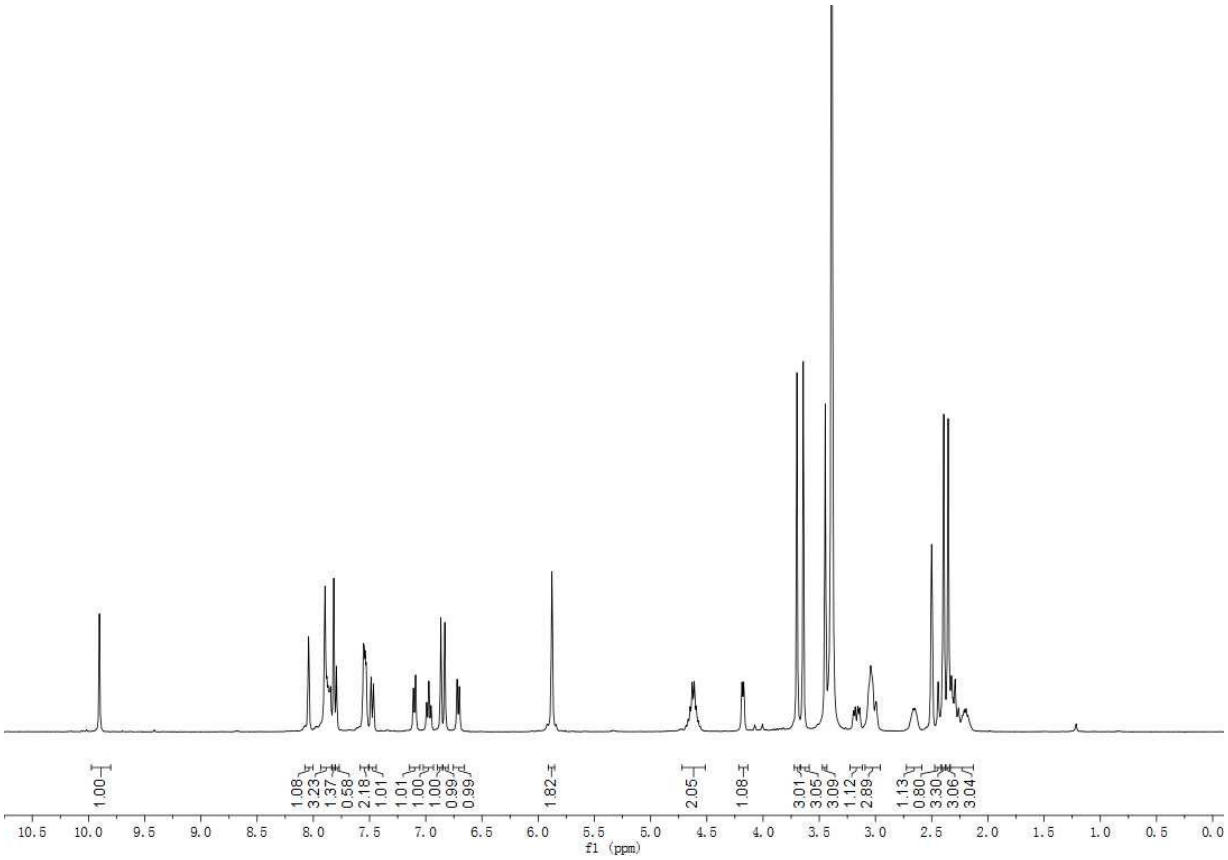


5,6-dimethyl-3-(naphthalen-2-ylmethyl)-1-(3-(4,9,10-trimethoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

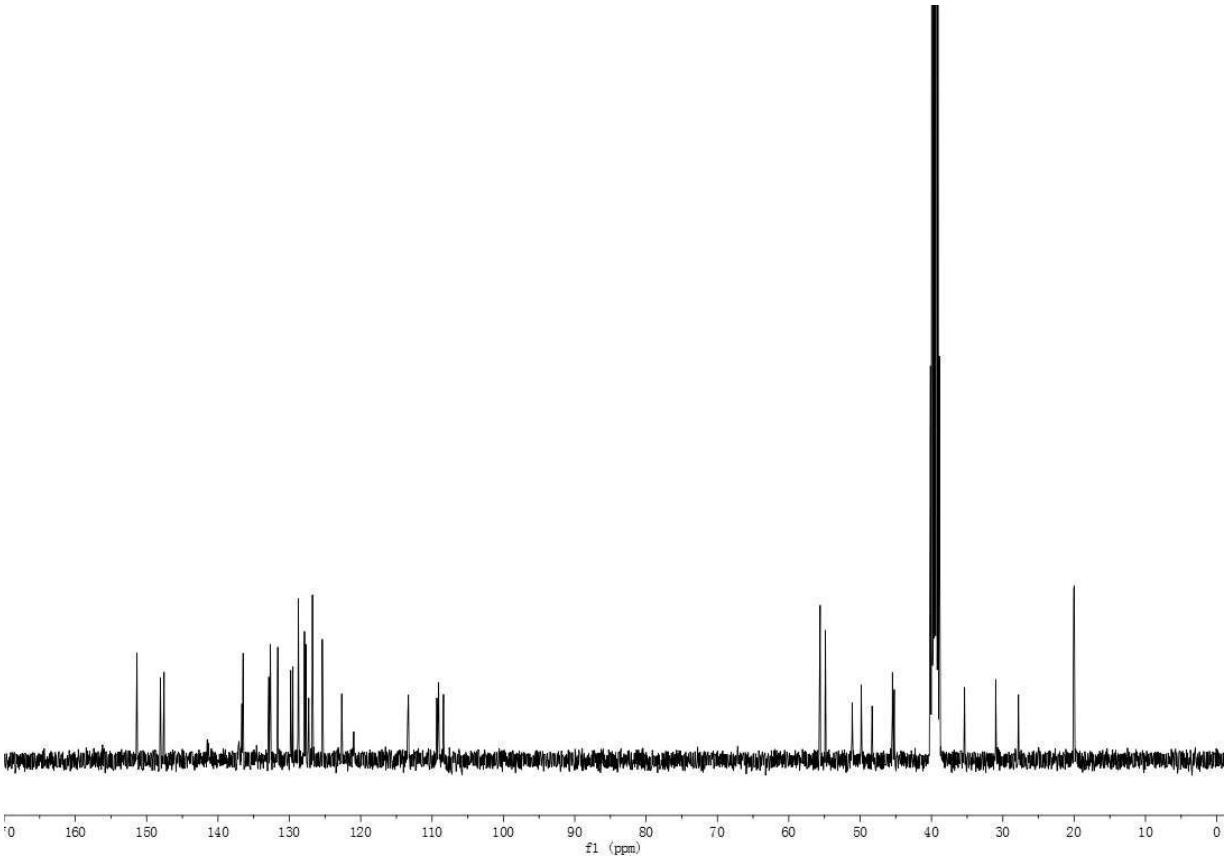
48

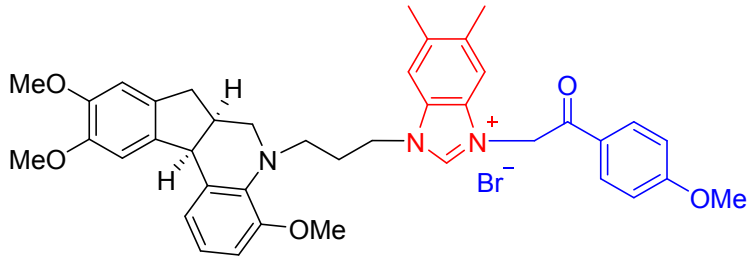
Yield 52%; yellow powder; m.p. = 179-181 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.90 (s, 1H), 8.04 (s, 1H), 7.90-7.85 (m, 3H), 7.82 (s, 1H), 7.79 (s, 1H), 7.56-7.52 (m, 2H), 7.48 (dd, *J* = 8.4 Hz, 1H), 7.10 (d, *J* = 7.6 Hz, 1H), 6.97 (t, *J* = 7.6 Hz, 1H), 6.87 (s, 1H), 6.83 (s, 1H), 6.71 (d, *J* = 8.0 Hz, 1H), 5.88 (s, 2H), 4.67-4.58 (m, 2H), 4.18 (d, *J* = 6.4 Hz, 1H), 3.70 (s, 3H), 3.64 (s, 3H), 3.45 (s, 3H), 3.17 (dd, *J* = 15.6, 6.8 Hz, 1H), 3.06-2.99 (m, 3H), 2.69-2.63 (m, 1H), 2.44 (s, 1H), 2.39 (s, 3H), 2.35 (s, 3H), 2.32-2.16 (m, 3H) ppm; 13C NMR (100 MHz, $CDCl_3$) δ 151.4, 148.1, 147.6, 136.7, 136.5, 136.5, 132.9, 132.7, 132.7, 131.6, 129.8, 129.5, 128.7, 127.9, 127.7, 127.3, 126.8, 125.4, 122.7, 121.0, 113.4, 113.3, 109.3, 109.1, 108.4, 55.7, 55.6, 54.9, 51.1, 49.9, 48.3, 45.5, 45.2, 35.4, 31.0, 27.8, 20.1, 20.0 ppm; IR (KBr) ν: 3415, 2930, 2845, 1637, 1618, 1577, 1561, 1501, 1475, 1461, 1301, 1253, 1219, 1198, 1184, 1124, 1075, 1061, 750, 611, 474, 430 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{42}H_{44}N_3O_3$ $[M-Br]^+$ 638.3377, found 638.3376.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 48



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 48



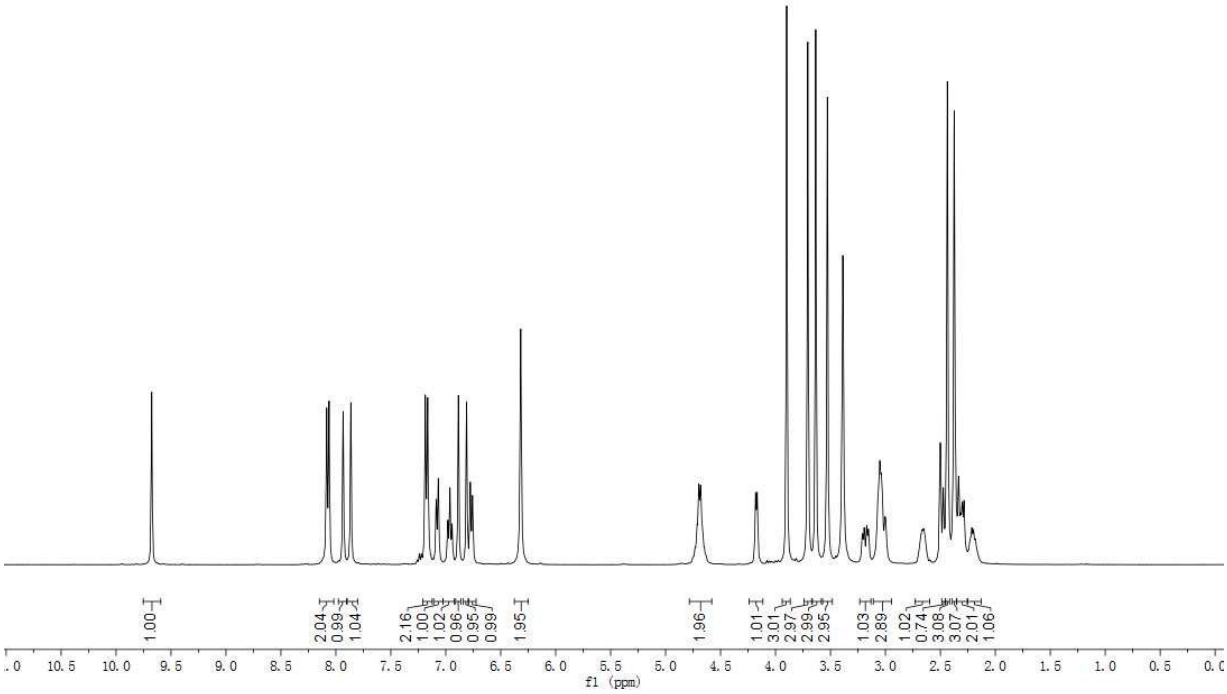


3-(2-(4-methoxyphenyl)-2-oxoethyl)-5,6-dimethyl-1-(3-(4,9,10-trimethoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

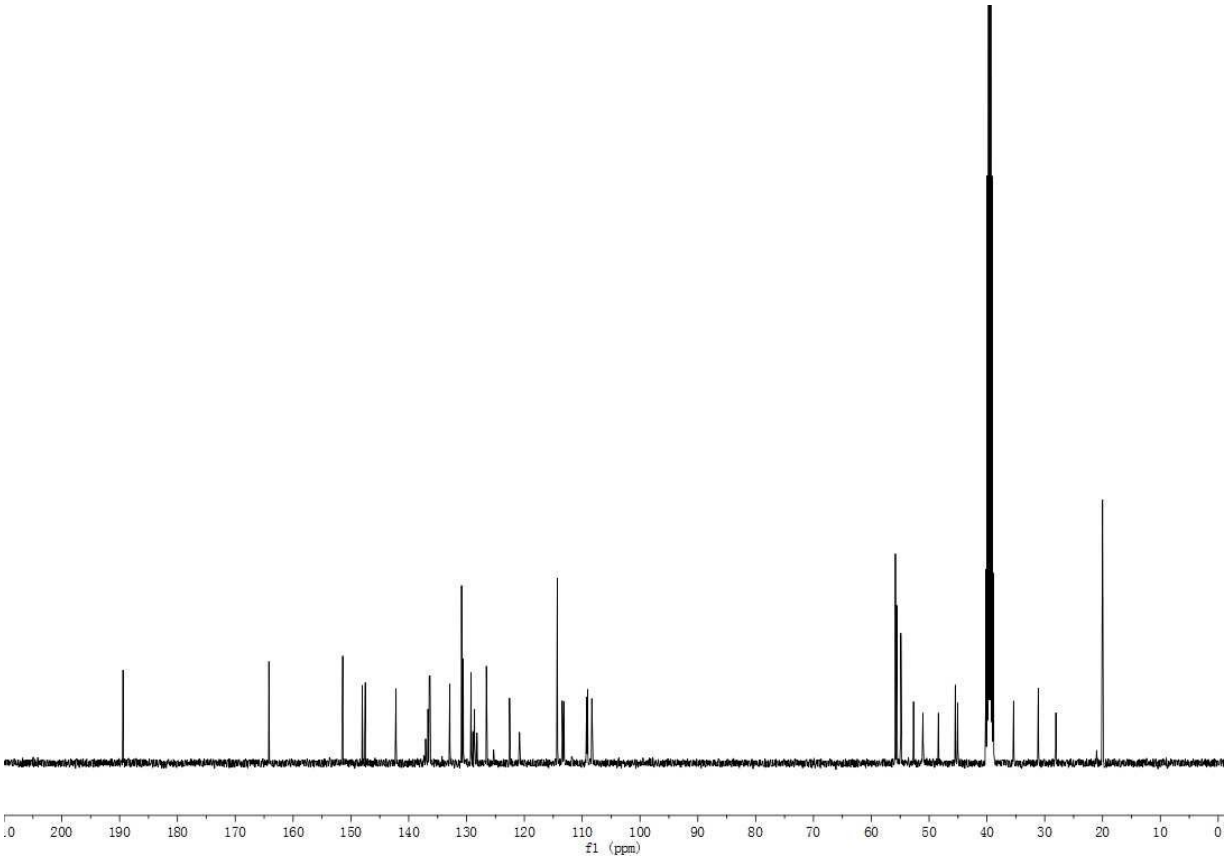
49

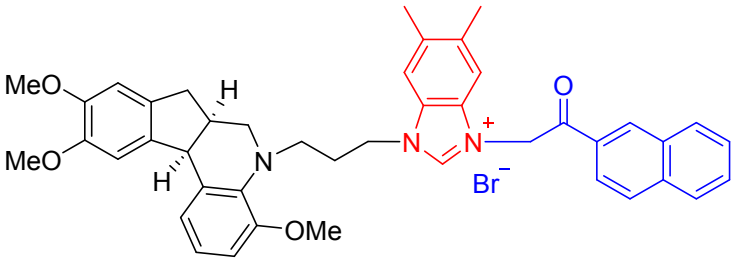
Yield 63%; yellow powder; m.p. = 234-236 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.68 (s, 1H), 8.07 (d, J = 8.4 Hz, 2H), 7.93 (s, 1H), 7.86 (s, 1H), 7.18 (d, J = 8.4 Hz, 2H), 7.08 (d, J = 7.6 Hz, 1H), 6.96 (t, J = 7.6 Hz, 1H), 6.89 (s, 1H), 6.81 (s, 1H), 6.77 (d, J = 8.0 Hz, 1H), 6.32 (s, 2H), 4.73-4.65 (m, 2H), 4.17 (d, J = 6.0 Hz, 1H), 3.90 (s, 3H), 3.71 (s, 3H), 3.63 (s, 3H), 3.53 (s, 3H), 3.18 (dd, J = 15.6, 6.8 Hz, 1H), 3.07-2.99 (m, 3H), 2.68-2.64 (m, 1H), 2.47 (s, 1H), 2.44 (s, 3H), 2.37 (s, 3H), 2.33-2.29 (m, 2H), 2.23-2.17 (m, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 189.4, 164.2, 151.4, 148.0, 147.5, 142.2, 137.1, 136.7, 136.5, 136.3, 132.9, 130.9, 130.6, 129.2, 128.6, 126.6, 122.6, 120.8, 114.3, 113.4, 113.2, 109.2, 109.1, 108.3, 55.8, 55.6, 55.6, 54.9, 52.7, 51.1, 48.4, 45.5, 45.0, 35.4, 31.1, 28.1, 20.0 ppm; IR (KBr) ν: 3425, 2935, 1685, 1601, 1572, 1502, 1454, 1304, 1245, 1222, 1180, 835, 750, 597 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{40}H_{44}N_3O_5$ [M-Br]$^{+}$ 646.3275, found 646.3276.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 49



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 49



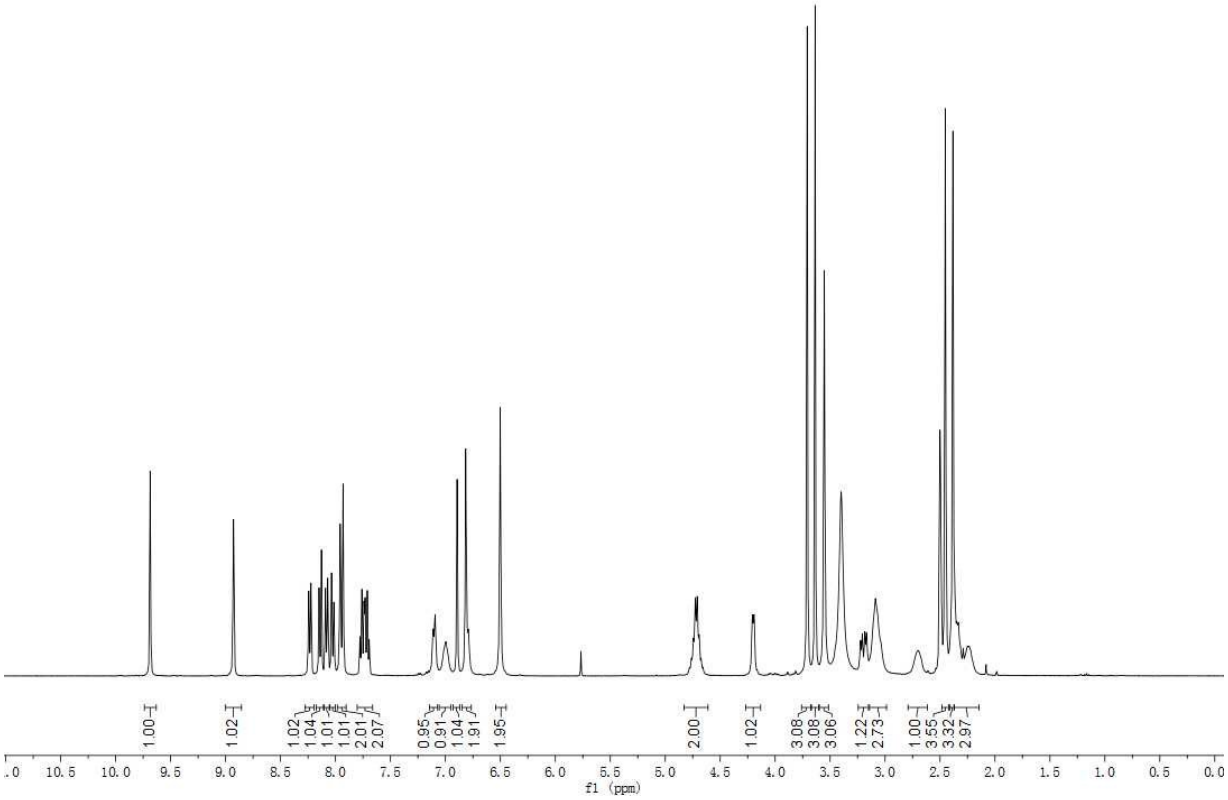


5,6-dimethyl-3-(2-(naphthalen-2-yl)-2-oxoethyl)-1-(3-(4,9,10-trimethoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

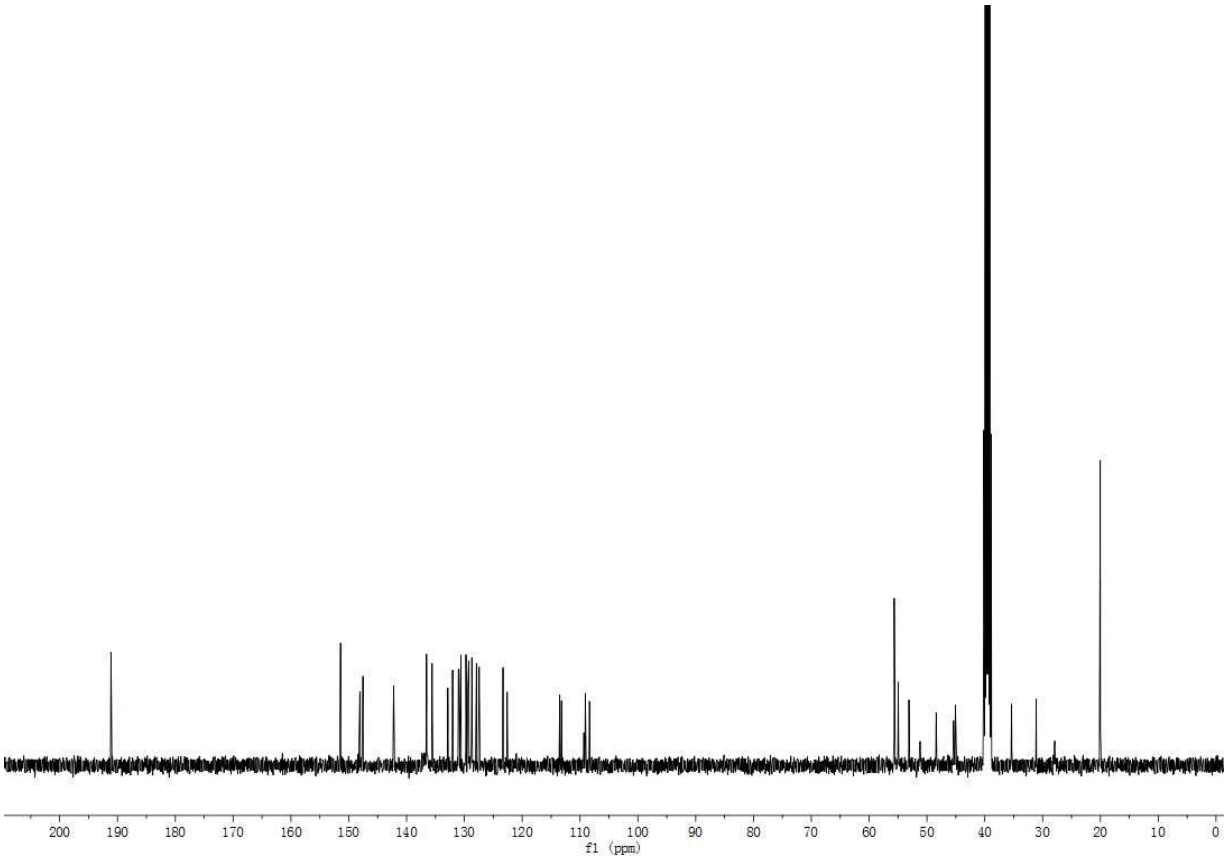
50

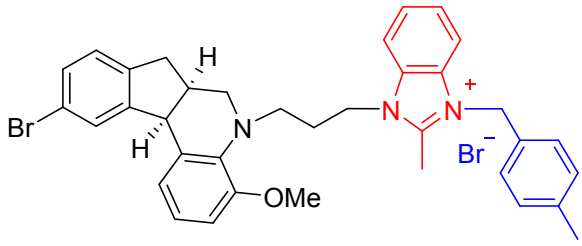
Yield 71%; yellow powder; m.p. = 234-236 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.69 (s, 1H), 8.93 (s, 1H), 8.23 (d, J = 8.0 Hz, 1H), 8.14 (d, J = 8.8 Hz, 1H), 8.08 (d, J = 8.0 Hz, 1H), 8.03 (d, J = 8.4 Hz, 1H), 7.94 (d, J = 10.4 Hz, 2H), 7.78-7.69 (m, 2H), 7.10 (d, J = 8.0 Hz, 1H), 7.00 (s, 1H), 6.89 (s, 1H), 6.80 (d, J = 10.0 Hz, 2H), 6.50 (s, 2H), 4.76-4.67 (m, 2H), 4.20 (d, J = 6.0 Hz, 1H), 3.71 (s, 3H), 3.64 (s, 3H), 3.55 (s, 3H), 3.20 (dd, J = 16.0, 6.8 Hz, 1H), 3.09-2.97 (m, 3H), 2.78-2.61 (m, 1H), 2.45 (s, 4H), 2.38 (s, 3H), 2.37-2.23 (m, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 191.1, 151.4, 148.1, 147.6, 142.2, 136.6, 136.4, 135.6, 132.9, 132.1, 131.0, 130.9, 130.6, 129.7, 129.4, 129.3, 128.7, 127.9, 127.4, 123.3, 122.6, 113.5, 113.2, 109.3, 109.1, 108.4, 55.7, 55.6, 55.0, 53.1, 51.2, 48.4, 45.4, 45.1, 35.4, 31.1, 27.9, 20.0 ppm; IR (KBr) ν: 3443, 2934, 1695, 1626, 1565, 1495, 1472, 1453, 1307, 1277, 1254, 1218, 1188, 1125, 1082, 754, 478 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{43}H_{44}N_3O_4$ $[M\text{-}Br]^+$ 666.3326, found 666.3326.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 50



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 50



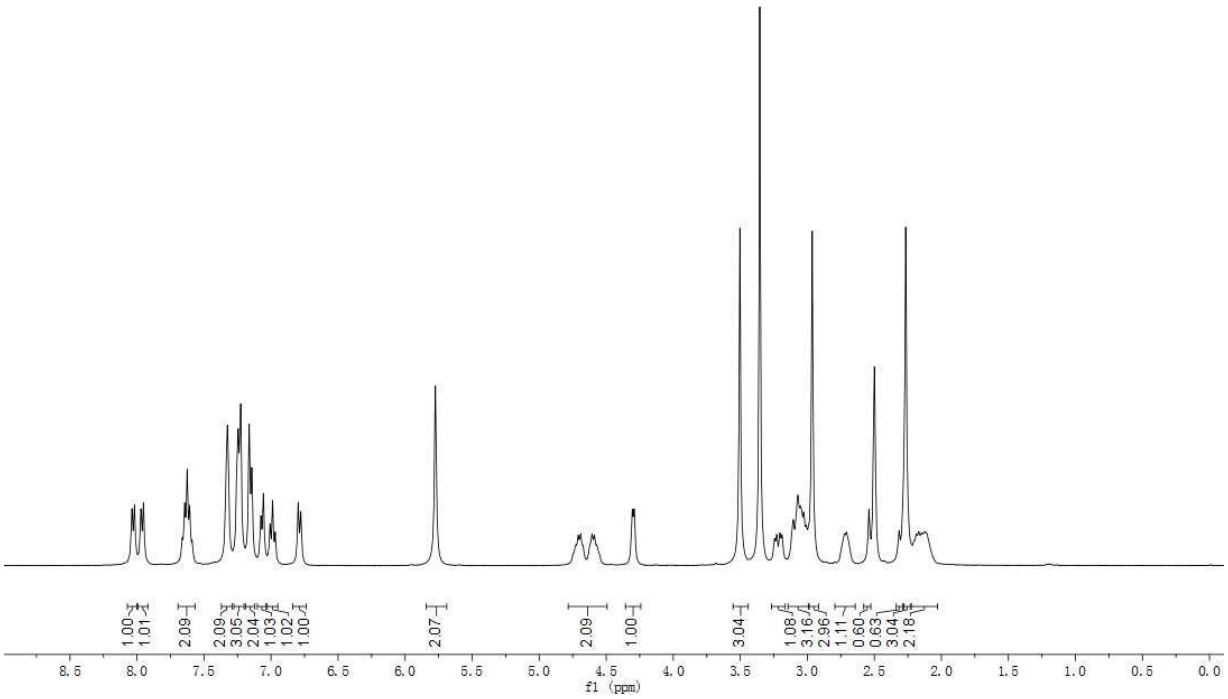


51

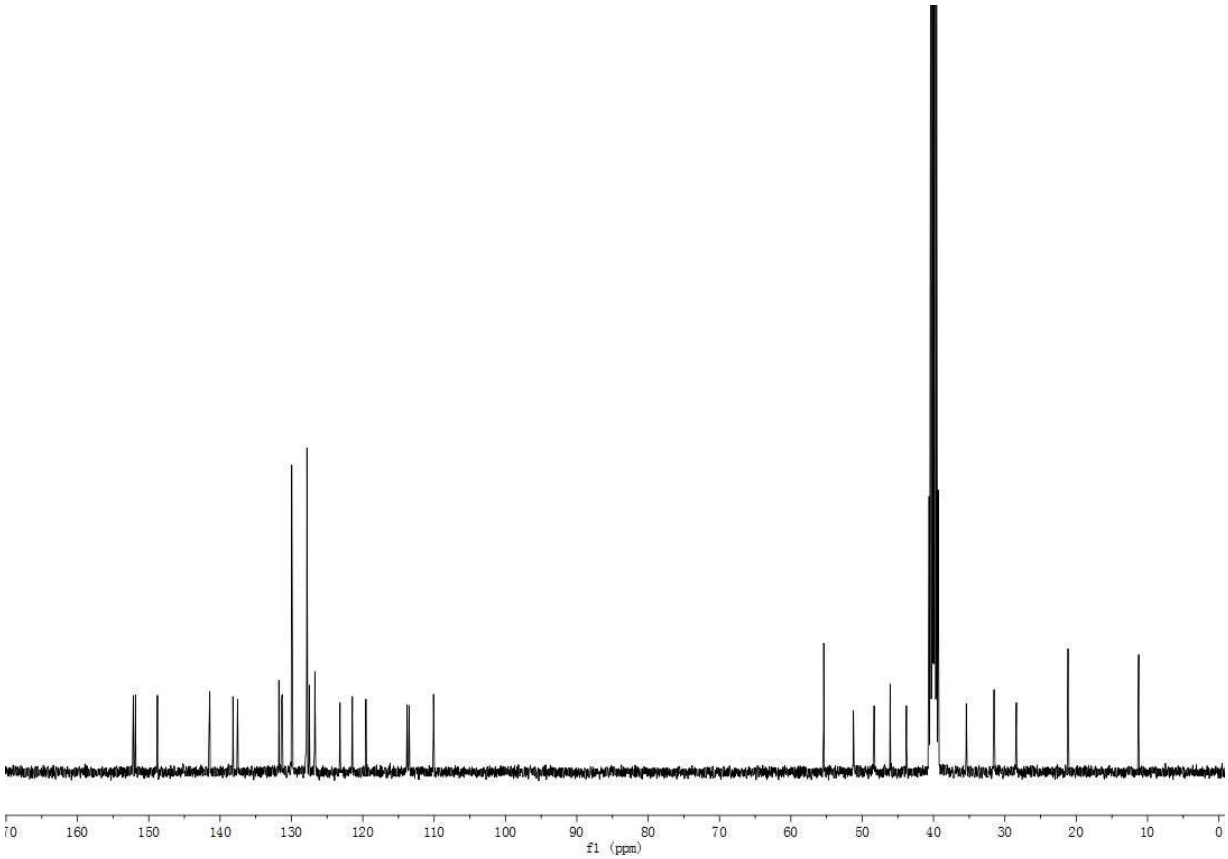
1-(3-((6a*R*,11b*R*)-10-bromo-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-2-methyl-3-(4-methylbenzyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

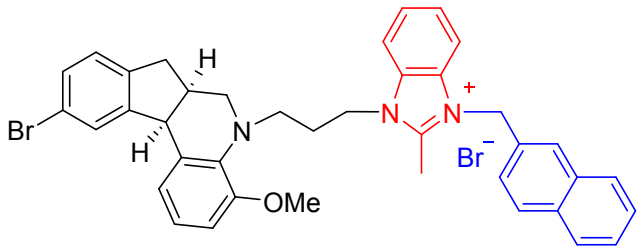
Yield 53%; yellow powder; m.p. = 248-250 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.03 (d, J = 8.0 Hz, 1H), 7.96 (d, J = 8.0 Hz, 1H), 7.66-7.59 (m, 2H), 7.34-7.32 (m, 2H), 7.26-7.23 (m, 3H), 7.15 (d, J = 8.0 Hz, 2H), 7.07 (d, J = 7.6 Hz, 1H), 6.99 (t, J = 8.0 Hz, 1H), 6.79 (d, J = 7.6 Hz, 1H), 5.77 (s, 2H), 4.73-4.57 (m, 2H), 4.30 (d, J = 6.4 Hz, 1H), 3.50 (s, 3H), 3.22 (dd, J = 16.4, 6.8 Hz, 1H), 3.11-3.01 (m, 3H), 2.96 (s, 3H), 2.72 (m, 1H), 2.54 (m, 1H), 2.32 (s, 1H), 2.75-2.68 (s, 3H), 2.21-2.11 (m, 2H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 151.7, 151.4, 148.3, 141.0, 137.7, 137.1, 131.3, 130.9, 130.8, 129.5, 129.4, 127.5, 127.4, 127.4, 127.0, 126.5, 126.2, 122.7, 121.0, 119.1, 113.3, 113.0, 109.6, 54.9, 50.8, 47.9, 47.9, 45.6, 43.3, 34.9, 31.0, 27.9, 20.8, 10.8 ppm; IR (KBr) ν: 3423, 2933, 1618, 1577, 1473, 1414, 1388, 1365, 1252, 1213, 1138, 1099, 1080, 792, 777, 745, 473 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{36}H_{37}BrN_3O$ $[M\text{-}Br]^+$ 606.2115, found 606.2115.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 51



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 51



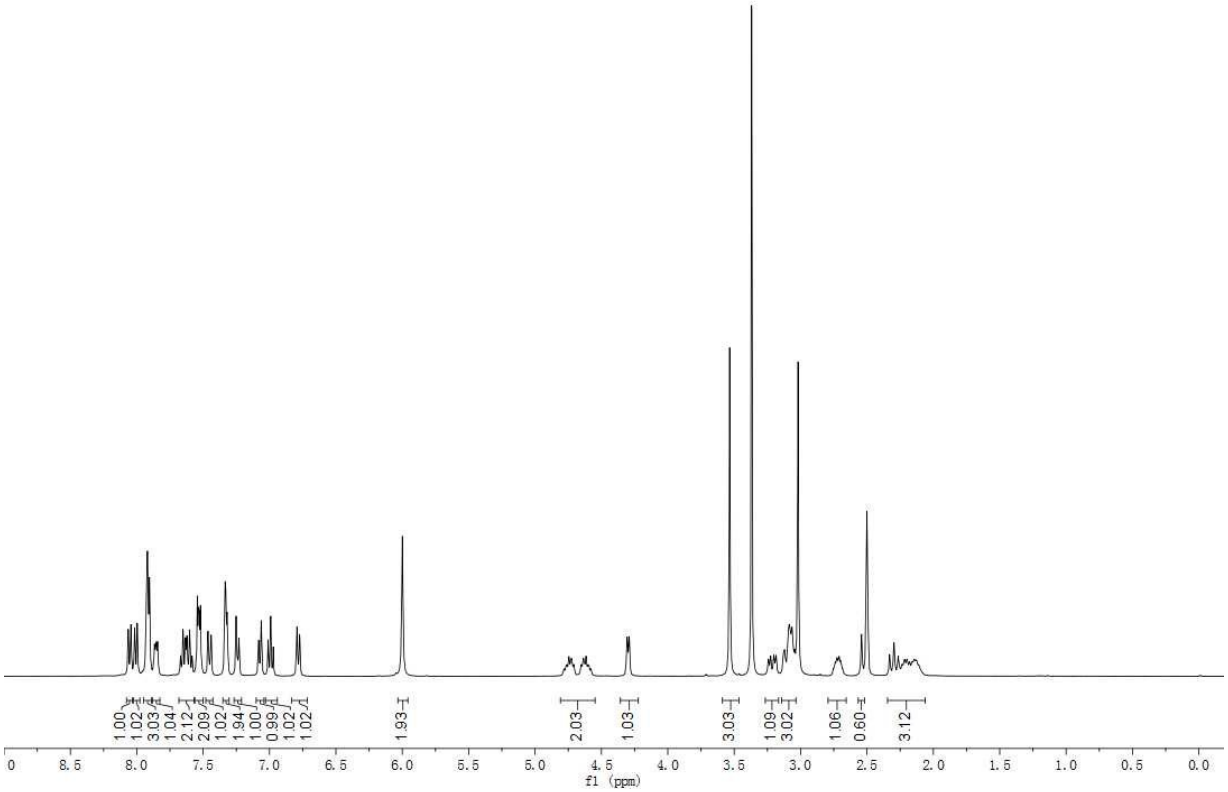


52

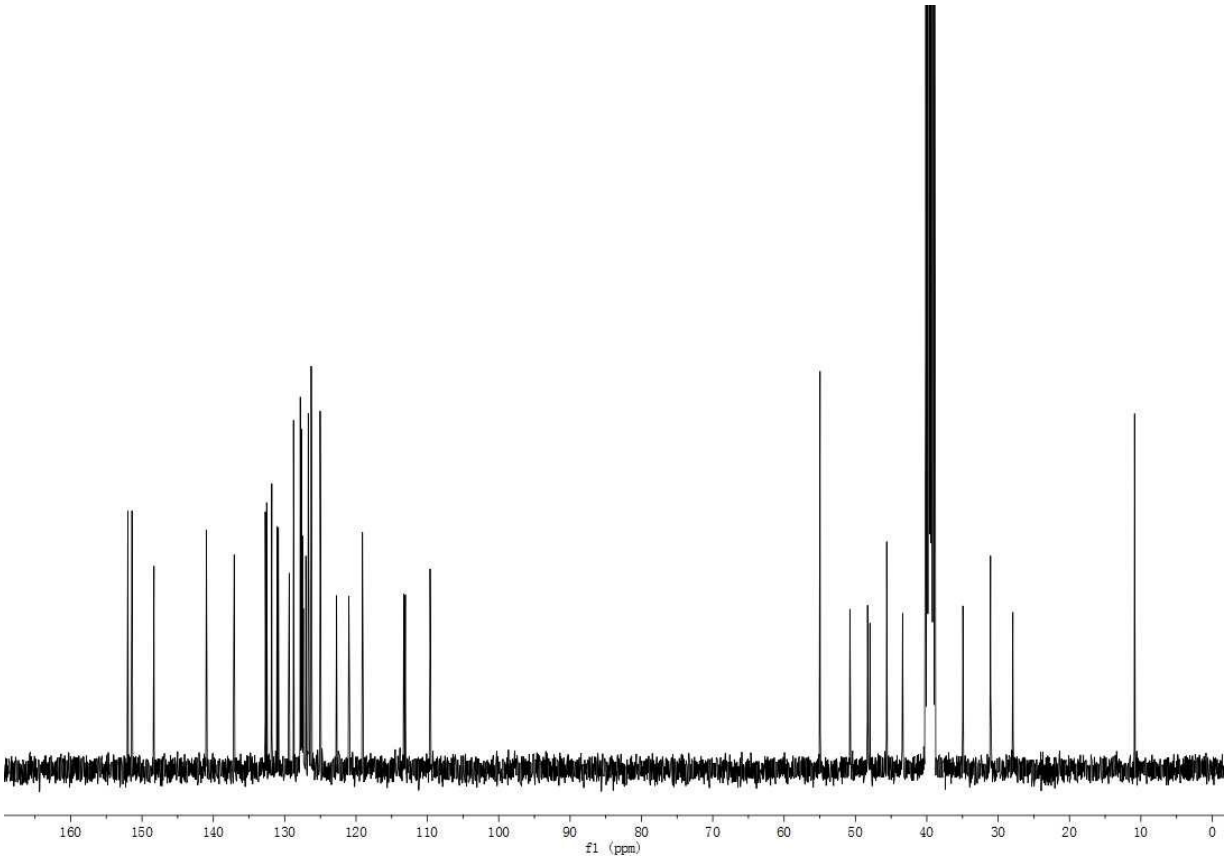
1-(3-((6a*R*,11b*R*)-10-bromo-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-2-methyl-3-(naphthalen-2-ylmethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

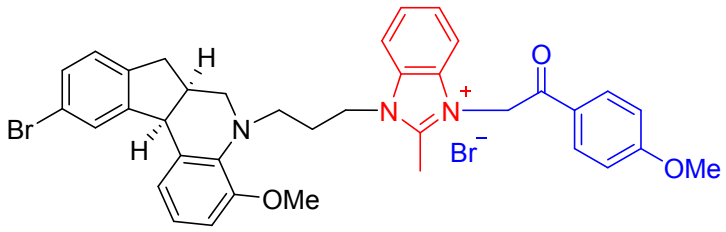
Yield 49%; yellow powder; m.p. = 272-274 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.05 (d, J = 8.0 Hz, 1H), 8.01 (d, J = 8.0 Hz, 1H), 7.93-7.90 (m, 3H), 7.87-7.84 (m, 1H), 7.67-7.58 (m, 2H), 7.55-7.51 (m, 2H), 7.45 (d, J = 9.4 Hz, 1H), 7.34-7.32 (m, 2H), 7.24 (d, J = 8.0 Hz, 1H), 7.07 (d, J = 7.6 Hz, 1H), 6.99 (t, J = 7.6 Hz, 1H), 6.78 (d, J = 7.6 Hz, 1H), 6.00 (s, 2H), 4.78-4.58 (m, 2H), 4.30 (d, J = 6.4 Hz, 1H), 3.53 (s, 3H), 3.21 (dd, J = 16.0, 6.4 Hz, 1H), 3.13-3.04 (m, 3H), 2.74-2.69 (m, 1H), 2.54 (s, 1H), 2.33-2.11 (m, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 152.0, 151.4, 148.3, 141.0, 137.1, 132.7, 132.5, 131.8, 131.1, 130.9, 129.4, 128.8, 127.8, 127.7, 127.5, 127.4, 127.0, 126.7, 126.6, 126.3, 126.2, 125.0, 122.7, 121.0, 119.1, 113.3, 113.1, 109.6, 55.0, 50.8, 48.3, 48.0, 45.6, 43.4, 34.9, 31.1, 27.9, 10.9 ppm; IR (KBr) ν: 3441, 2950, 1630, 1577, 1522, 1473, 1388, 1251, 1215, 1144, 1097, 1079, 1060, 794, 745 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{39}H_{37}BrN_3O$ $[M\text{-}Br]^+$ 642.2115, found 642.2115.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 52



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 52



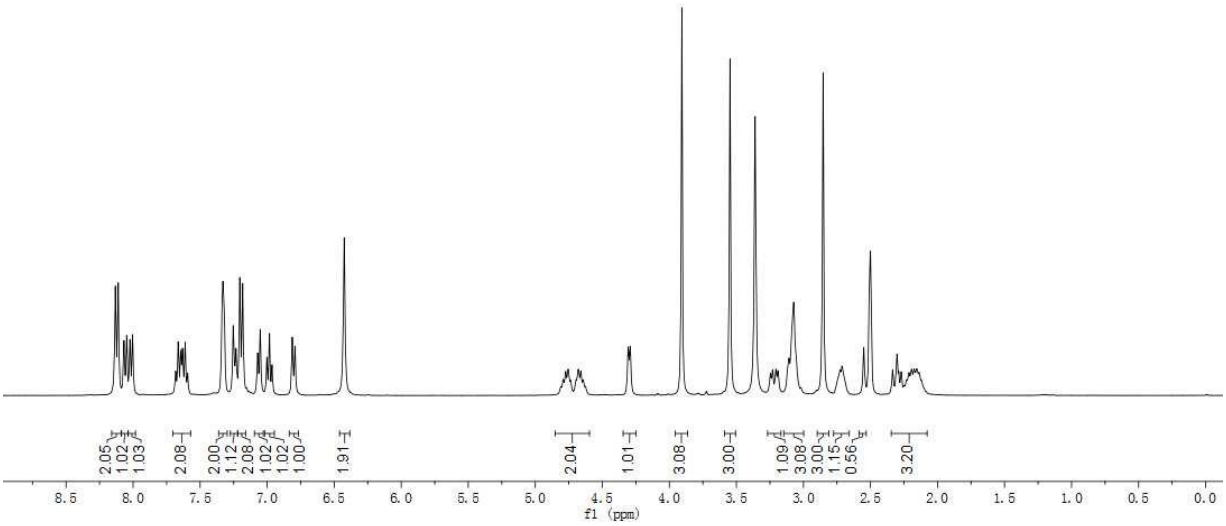


1-(3-(10-bromo-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-3-(2-(4-methoxyphenyl)-2-oxoethyl)-2-methyl-1*H*-benzo[*d*]imidazol-3-ium bromide

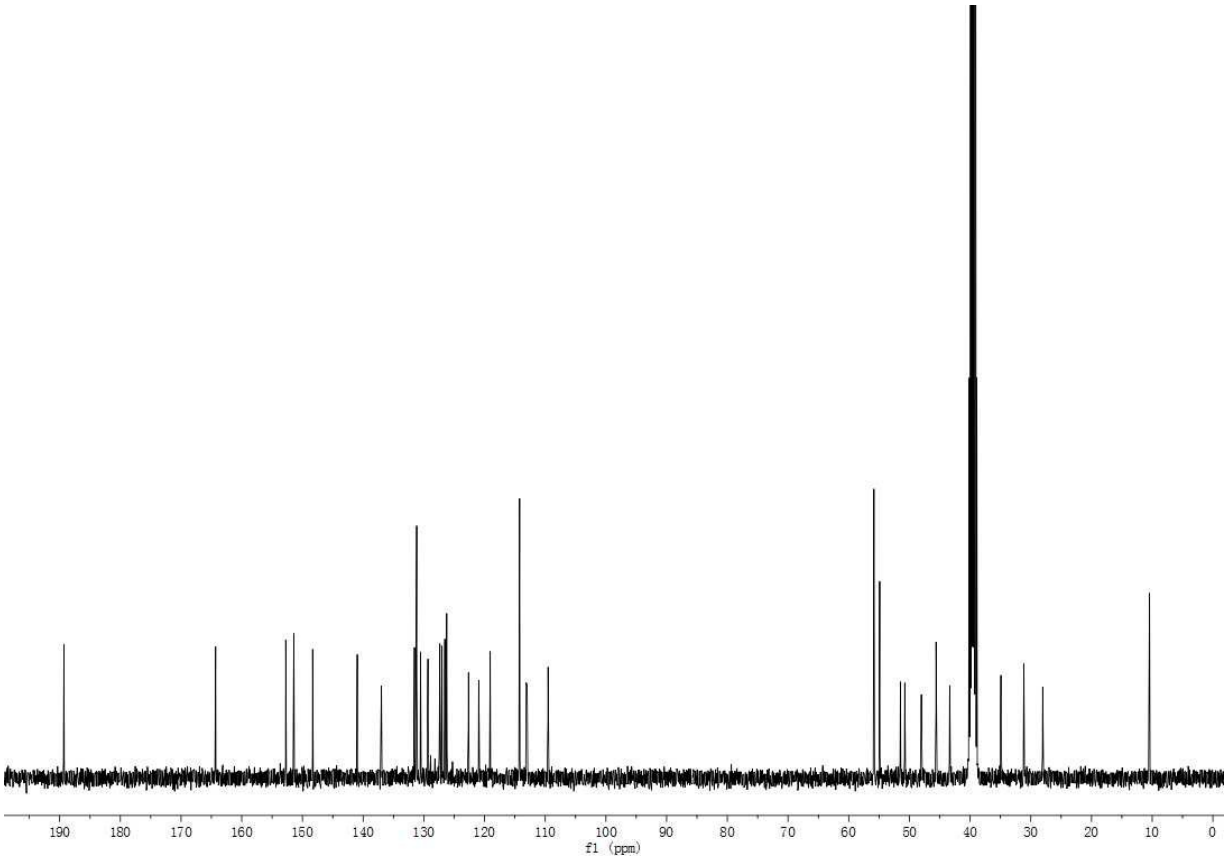
53

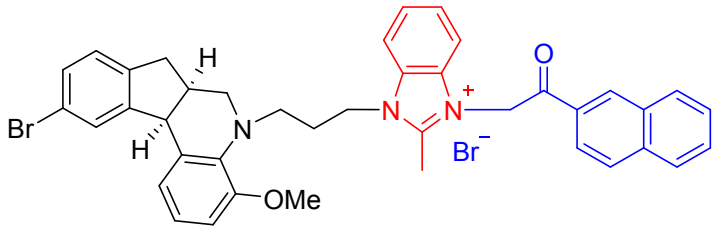
Yield 67%; yellow powder; m.p. = 268-270 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.12 (d, J = 8.4 Hz, 2H), 8.06 (d, J = 8.0 Hz, 1H), 8.01 (d, J = 8.4 Hz, 1H), 7.68-7.59 (m, 2H), 7.34-7.32 (m, 2H), 7.24 (d, J = 8.4 Hz, 1H), 7.19 (d, J = 8.4 Hz, 2H), 7.06 (d, J = 7.6 Hz, 1H), 6.98 (t, J = 7.6 Hz, 1H), 6.80 (d, J = 8.0 Hz, 1H), 6.43 (s, 2H), 4.79-4.64 (m, 2H), 4.30 (d, J = 6.0 Hz, 1H), 3.91 (s, 3H), 3.55 (s, 3H), 3.22 (dd, J = 16.4, 6.8 Hz, 1H), 3.12-3.05 (m, 3H), 2.85 (s, 3H), 2.76-2.68 (m, 1H), 2.55 (s, 1H), 2.34-2.12 (m, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 189.3, 164.3, 152.8, 151.4, 148.3, 141.0, 137.0, 131.5, 131.2, 130.5, 129.3, 127.4, 127.4, 127.0, 126.5, 126.2, 122.6, 121.0, 119.1, 114.2, 113.1, 113.0, 109.5, 55.8, 54.9, 51.5, 50.8, 48.0, 45.6, 43.4, 34.9, 31.1, 28.0, 10.4 ppm; IR (KBr) ν: 3432, 2940, 2838, 1673, 1601, 1575, 1529, 1512, 1475, 1424, 1353, 1321, 1245, 1182, 1099, 1027, 773, 750, 581, 506 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{37}H_{37}BrN_3O_3$ $[M-Br]^+$ 650.2013, found 650.2011.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 53



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 53



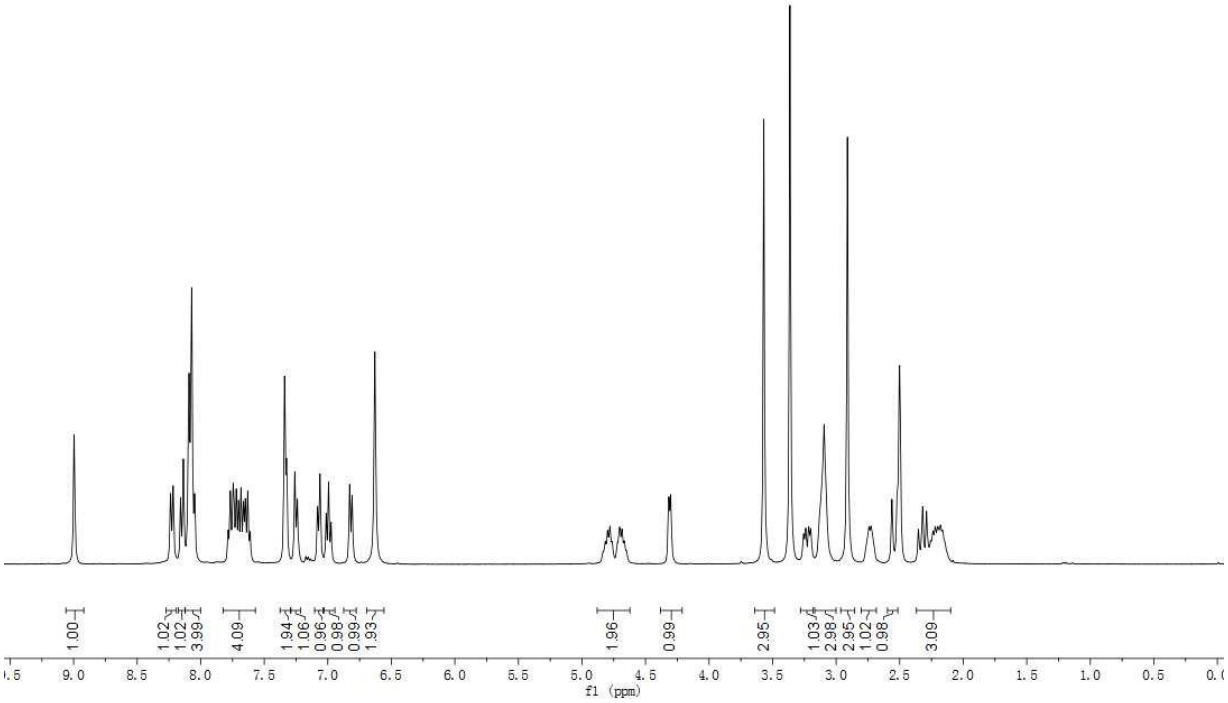


1-(3-((6a*R*,11b*R*)-10-bromo-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-2-methyl-3-(2-(naphthalen-2-yl)-2-oxoethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

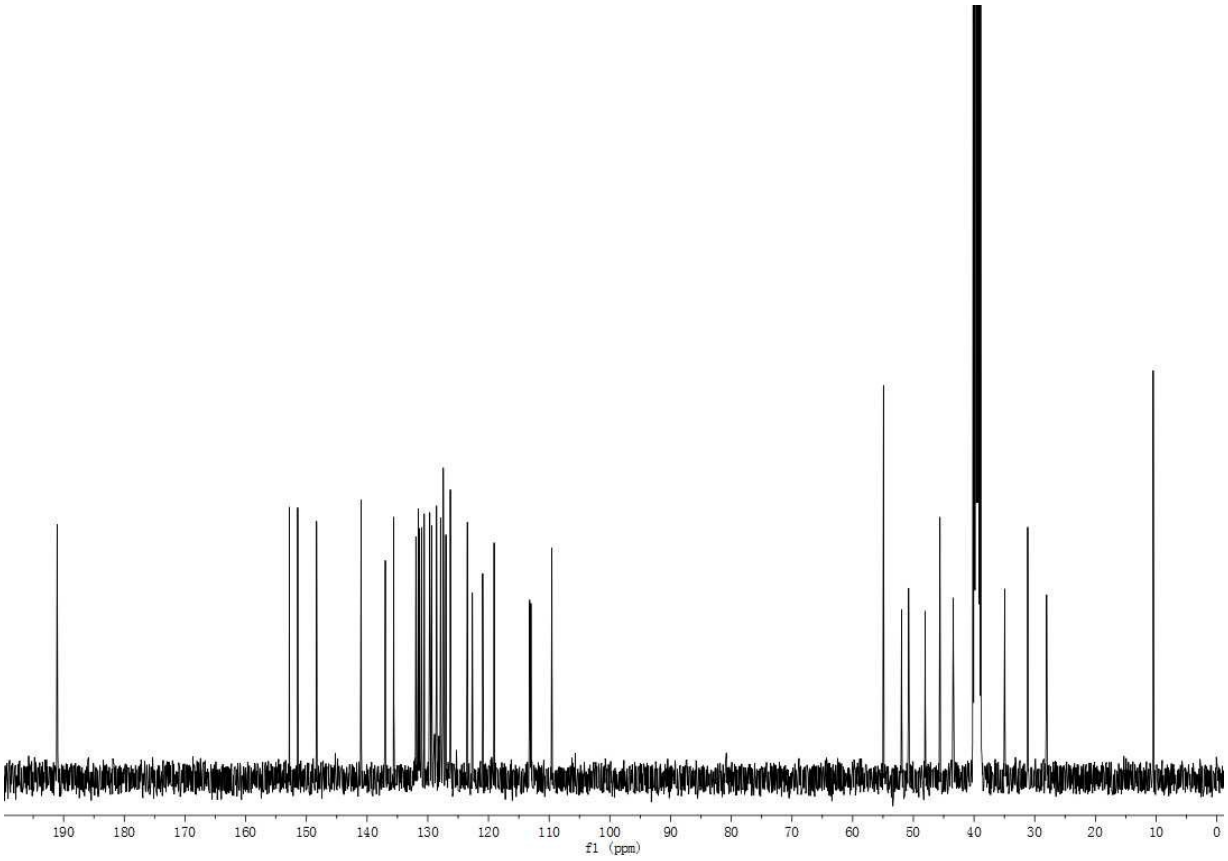
54

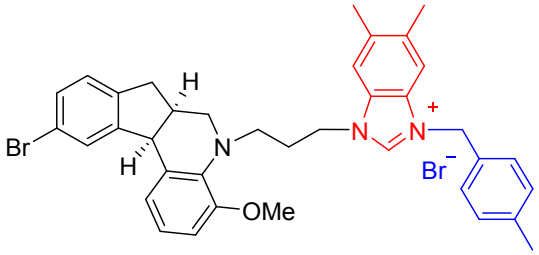
Yield 80%; yellow powder; m.p. = 231-233 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.00 (s, 1H), 8.23 (d, J = 8.0 Hz, 1H), 8.15 (d, J = 8.8 Hz, 1H), 8.09-8.05 (m, 4H), 7.77-7.63 (m, 4H), 7.33 (d, J = 6.8 Hz, 2H), 7.25 (d, J = 8.4 Hz, 1H), 7.07 (d, J = 7.6 Hz, 1H), 6.99 (t, J = 8.0 Hz, 1H), 6.82 (d, J = 8.0 Hz, 1H), 6.63 (s, 2H), 4.84-4.65 (m, 2H), 4.31 (d, J = 6.0 Hz, 1H), 3.57 (s, 3H), 3.23 (dd, J = 16.0, 6.8 Hz, 1H), 3.13-3.08 (m, 3H), 2.91 (s, 3H), 2.77-2.70 (m, 1H), 2.54 (d, J = 16.8 Hz, 1H), 2.35-2.13 (m, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6)) δ 191.1, 152.8, 151.4, 148.3, 141.0, 137.0, 135.6, 132.0, 131.6, 131.4, 131.0, 130.6, 129.7, 129.4, 129.3, 128.6, 127.9, 127.5, 127.4, 127.4, 127.0, 126.3, 123.5, 122.7, 121.0, 119.1, 113.2, 113.0, 109.6, 54.9, 51.9, 50.8, 48.1, 45.6, 43.4, 34.9, 31.2, 28.1, 10.5 ppm; IR (KBr) ν: 3432, 2934, 1675, 1628, 1596, 1578, 1562, 1476, 1358, 1255, 1191, 1124, 1080, 746, 475 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{40}H_{37}BrN_3O_2$ $[M-Br]^+$ 670.2064, found 670.2065.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 54



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 54



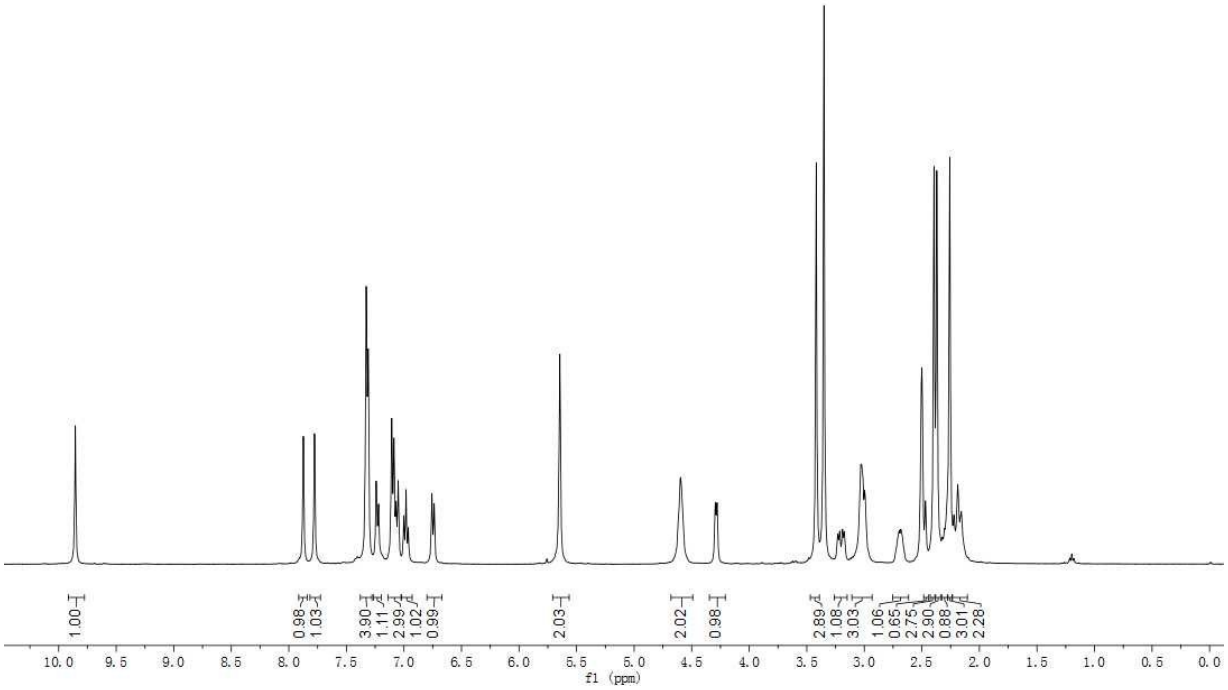


55

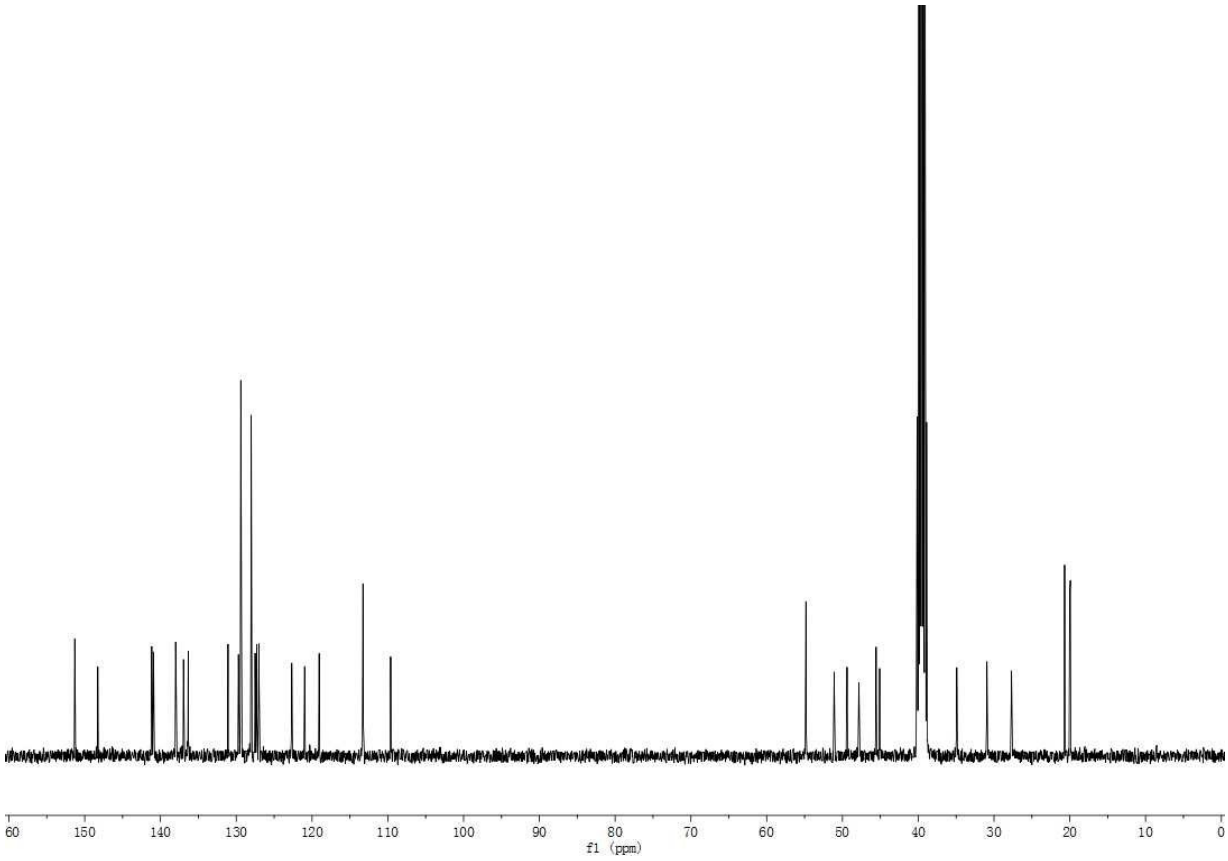
1-(3-((6a*R*,11b*R*)-10-bromo-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-5,6-dimethyl-3-(4-methylbenzyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

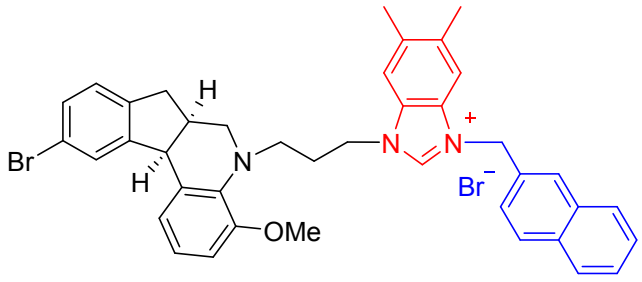
Yield 69%; yellow powder; m.p. = 177-179 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.86 (s, 1H), 7.87 (s, 1H), 7.78 (s, 1H), 7.32 (d, J = 6.8 Hz, 4H), 7.23 (d, J = 8.4 Hz, 1H), 7.11-7.05 (m, 3H), 6.98 (t, J = 7.6 Hz, 1H), 6.75 (d, J = 8.0 Hz, 1H), 5.65 (s, 2H), 4.62-4.58 (m, 2H), 4.29 (d, J = 6.0 Hz, 1H), 3.42 (s, 3H), 3.20 (dd, J = 16.4, 7.2 Hz, 1H), 3.04-2.99 (m, 3H), 2.71-2.67 (m, 1H), 2.47 (s, 1H), 2.39 (s, 3H), 2.37 (s, 3H), 2.33-2.27 (m, 1H), 2.26 (s, 3H), 2.22-2.16 (m, 2H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 151.3, 148.3, 141.2, 140.9, 138.0, 137.0, 136.4, 136.3, 131.1, 129.7, 129.4, 129.3, 129.3, 128.0, 127.5, 127.3, 127.0, 122.8, 121.0, 119.1, 113.3, 109.6, 54.8, 51.1, 49.4, 47.8, 45.6, 45.1, 34.9, 30.9, 27.7, 20.7, 20.0, 19.9 ppm; IR (KBr) ν: 3440, 2934, 1629, 1560, 1517, 1475, 1454, 1357, 1251, 1214, 1179, 1146, 1097, 1080, 850, 817, 758, 743, 476 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{37}H_{39}BrN_3O$ $[M\text{-}Br]^+$ 620.2271, found 620.2271.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 55



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 55



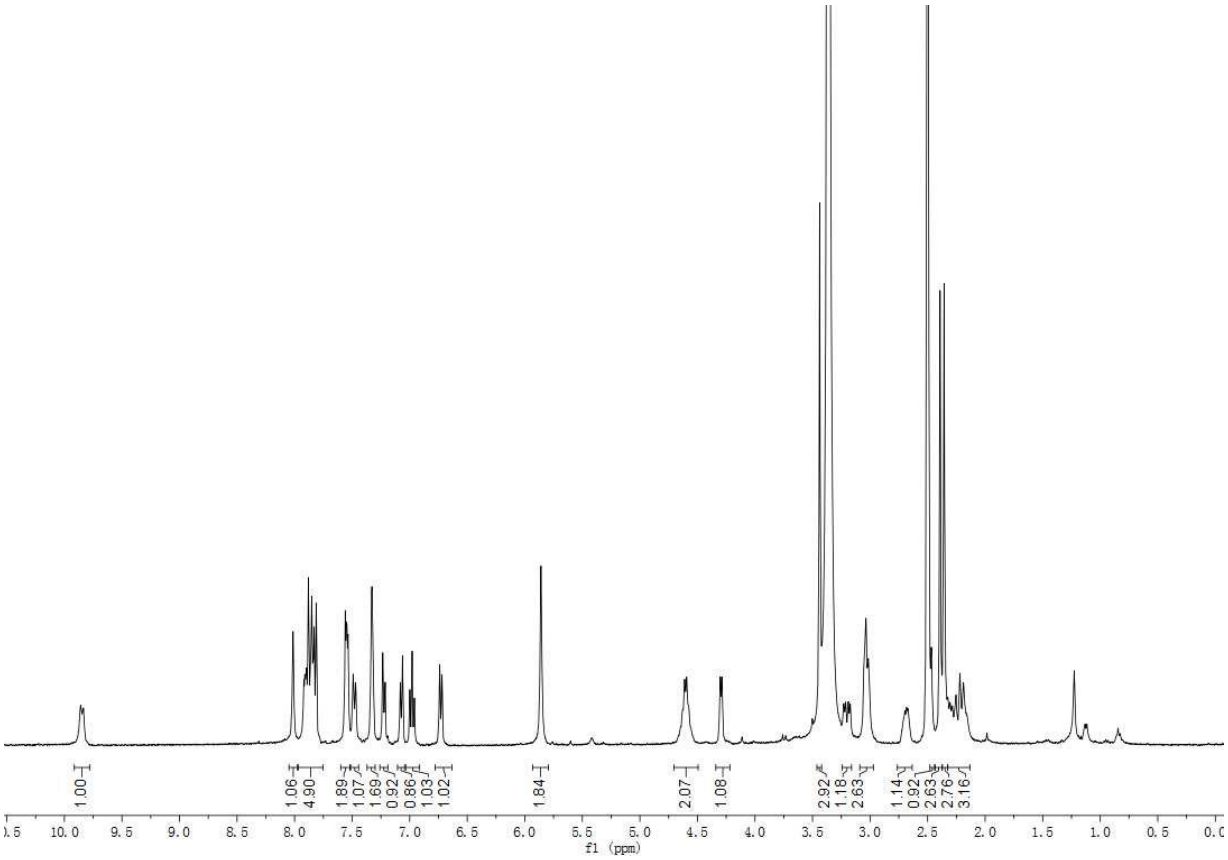


56

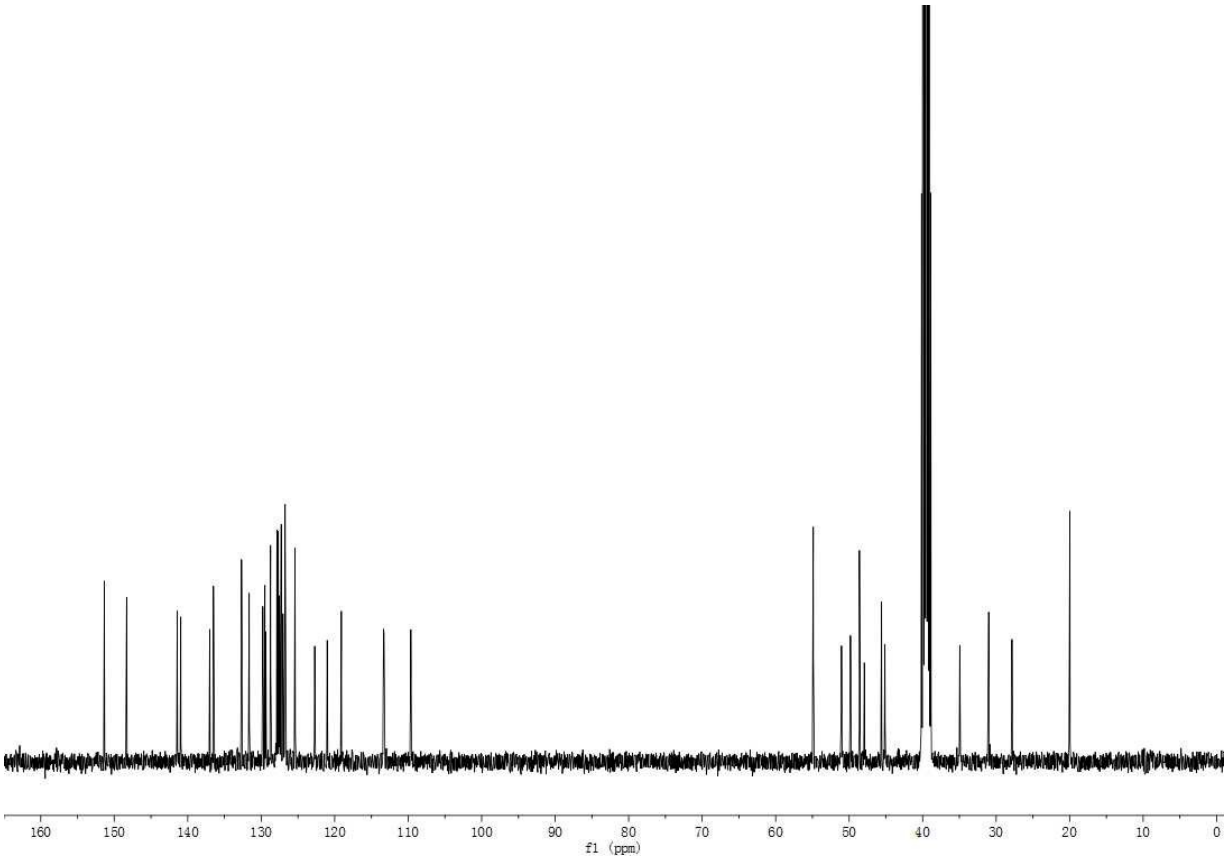
1-(3-((6a*R*,11b*R*)-10-bromo-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-5,6-dimethyl-3-(naphthalen-2-ylmethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

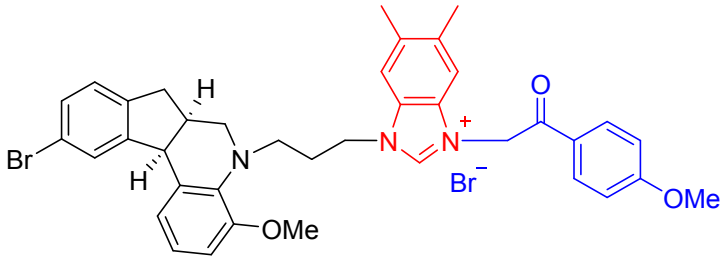
Yield 56%; yellow powder; m.p. = 139-141 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.85 (d, J = 10.4 Hz, 1H), 8.01 (s, 1H), 7.92-7.81 (m, 5H), 7.57-7.54 (m, 2H), 7.48 (d, J = 8.4 Hz, 1H), 7.33-7.32 (m, 2H), 7.22 (d, J = 8.4 Hz, 1H), 7.07 (d, J = 7.6 Hz, 1H), 6.98 (t, J = 7.6 Hz, 1H), 6.73 (d, J = 8.0 Hz, 1H), 5.86 (s, 2H), 4.61-4.57 (m, 2H), 4.29 (d, J = 6.0 Hz, 1H), 3.44 (s, 3H), 3.20 (dd, J = 16.0, 6.4 Hz, 1H), 3.05-3.00 (m, 3H), 2.70-2.67 (m, 1H), 2.47 (s, 1H), 2.39 (s, 3H), 2.36 (s, 3H), 2.33-2.16 (m, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 151.3, 148.3, 141.4, 140.9, 137.0, 136.5, 136.5, 132.7, 132.7, 131.6, 129.8, 129.5, 129.4, 128.7, 127.9, 127.7, 127.5, 127.4, 127.3, 127.0, 126.8, 125.4, 122.7, 121.0, 119.1, 113.4, 113.3, 109.6, 54.9, 51.0, 49.8, 47.9, 45.6, 45.1, 34.9, 31.0, 27.9, 20.1, 20.0 ppm; IR (KBr) ν: 3422, 2925, 2852, 1618, 1561, 1474, 1384, 1251, 1130, 637, 616, 480 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{40}H_{39}BrN_3O$ $[M\text{-}Br]^+$ 656.2271, found 656.2269.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 56



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 56



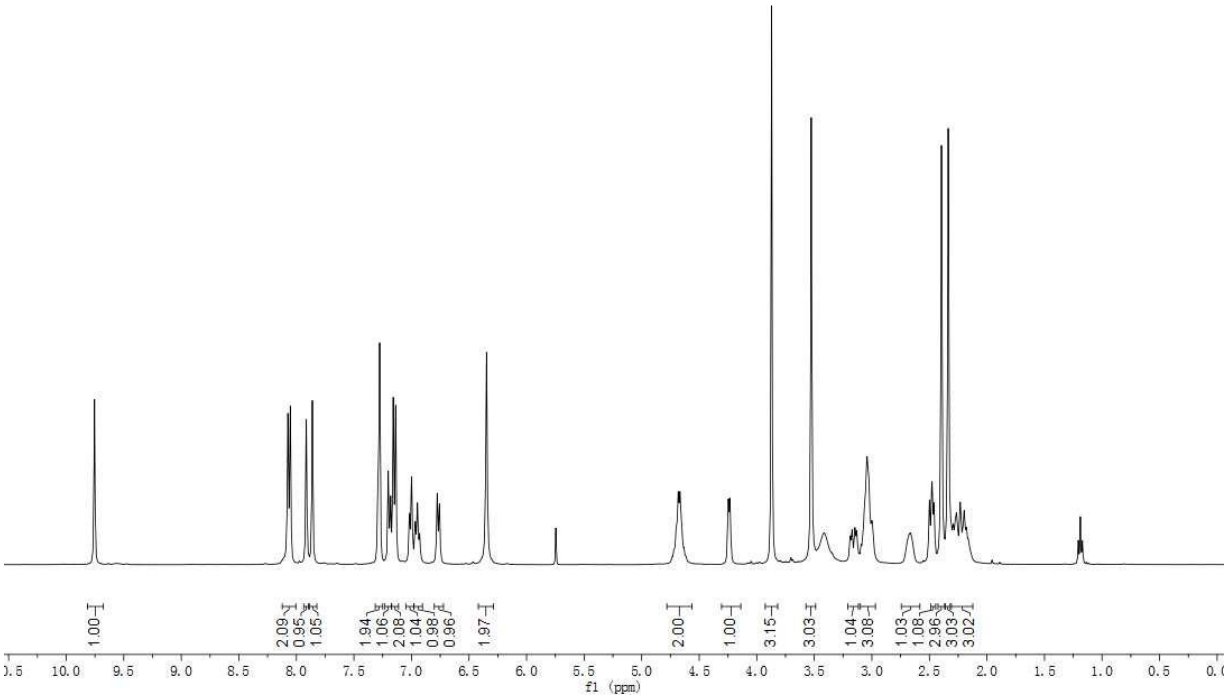


1-(3-((6a*R*,11b*R*)-10-bromo-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-3-(2-(4-methoxyphenyl)-2-oxoethyl)-5,6-dimethyl-1*H*-benzo[*d*]imidazol-3-ium bromide

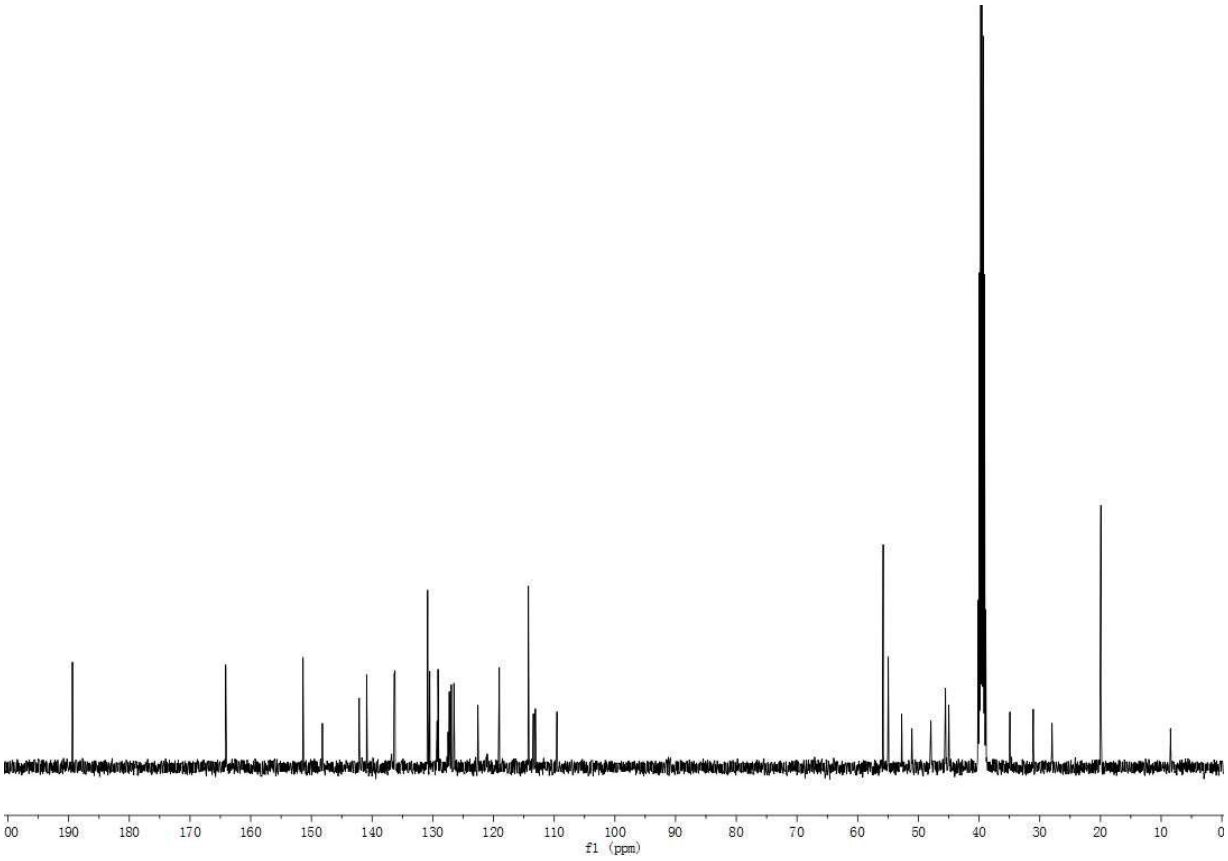
57

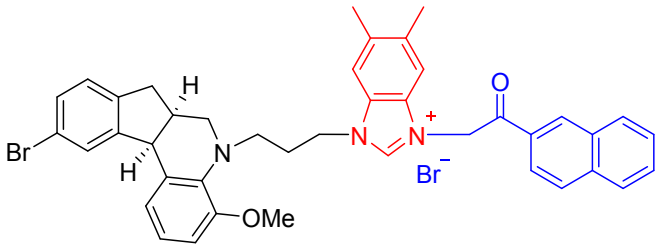
Yield 69%; yellow powder; m.p. = 171-173 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.75 (s, 1H), 8.06 (d, J = 7.6 Hz, 2H), 7.91 (s, 1H), 7.86 (s, 1H), 7.29-7.78 (m, 2H), 7.19 (d, J = 8.4 Hz, 1H), 7.15 (d, J = 8.8 Hz, 2H), 7.01 (d, J = 7.6 Hz, 1H), 6.95 (t, J = 7.6 Hz 1H), 6.77 (d, J = 8.0 Hz, 1H), 6.35 (s, 2H), 4.70-4.65 (m, 2H), 4.24 (d, J = 6.0 Hz, 1H), 3.87 (s, 3H), 3.53 (s, 3H), 3.16 (dd, J = 16.4, 6.8 Hz, 1H), 3.09-2.99 (m, 3H), 2.71-2.63 (m, 1H), 2.47 (d, J = 7.2 Hz, 1H), 2.40 (s, 3H), 2.34 (s, 3H), 2.32-2.15 (m, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 189.4, 164.1, 151.4, 148.2, 142.1, 140.9, 136.4, 136.2, 130.9, 130.5, 129.3, 129.2, 127.5, 127.3, 127.0, 126.5, 122.6, 119.0, 114.35, 113.4, 113.1, 109.6, 55.8, 55.0, 52.8, 51.1, 47.9, 45.5, 45.0, 34.9, 31.1, 28.0, 19.9 ppm; IR (KBr) ν: 3439, 2935, 1686, 1601, 1572, 1513, 1475, 1352, 1315, 1243, 1173, 1143, 1142, 1099, 1081, 1029 ,840, 597 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{38}H_{39}BrN_3O_3$ $[M\text{-}Br]^+$ 664.2169, found 664.2170.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 57



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 57



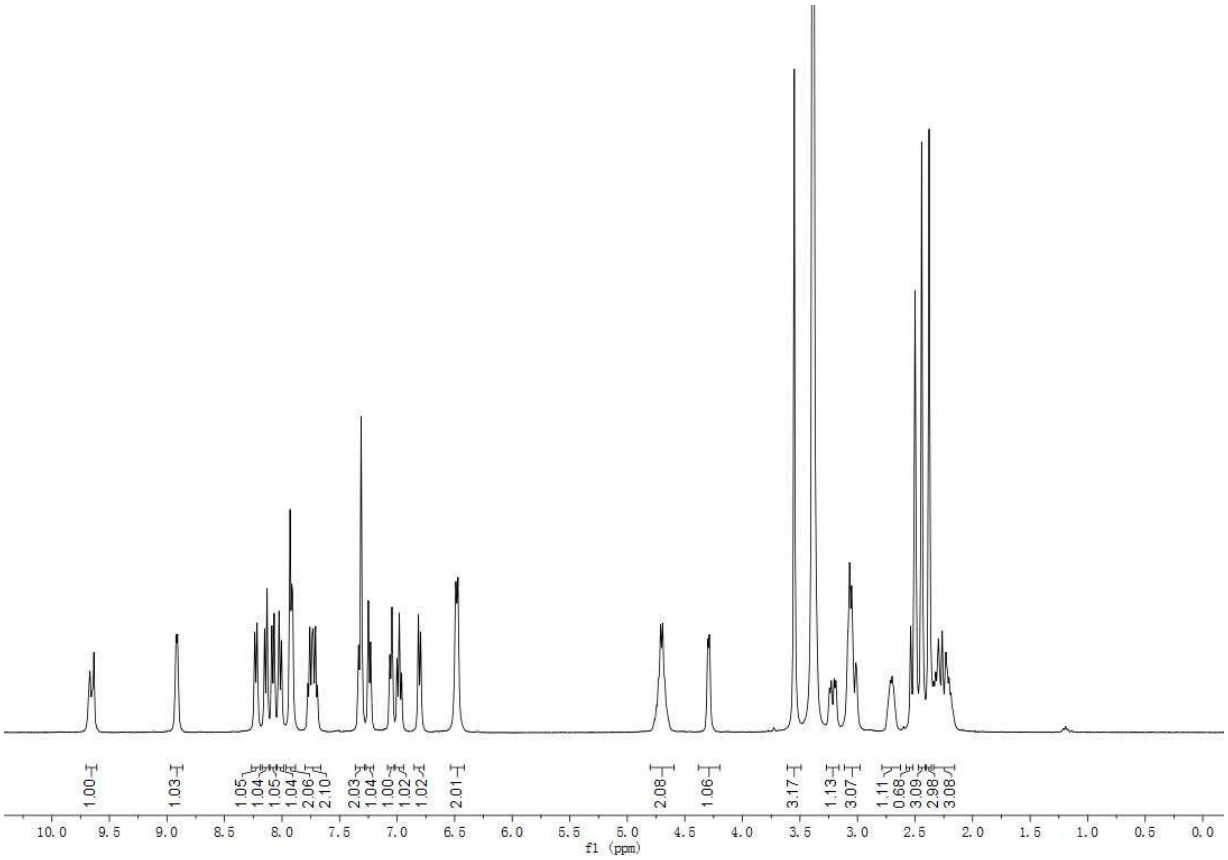


1-(3-((6a*R*,11b*R*)-10-bromo-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-5,6-dimethyl-3-(2-(naphthalen-2-yl)-2-oxoethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

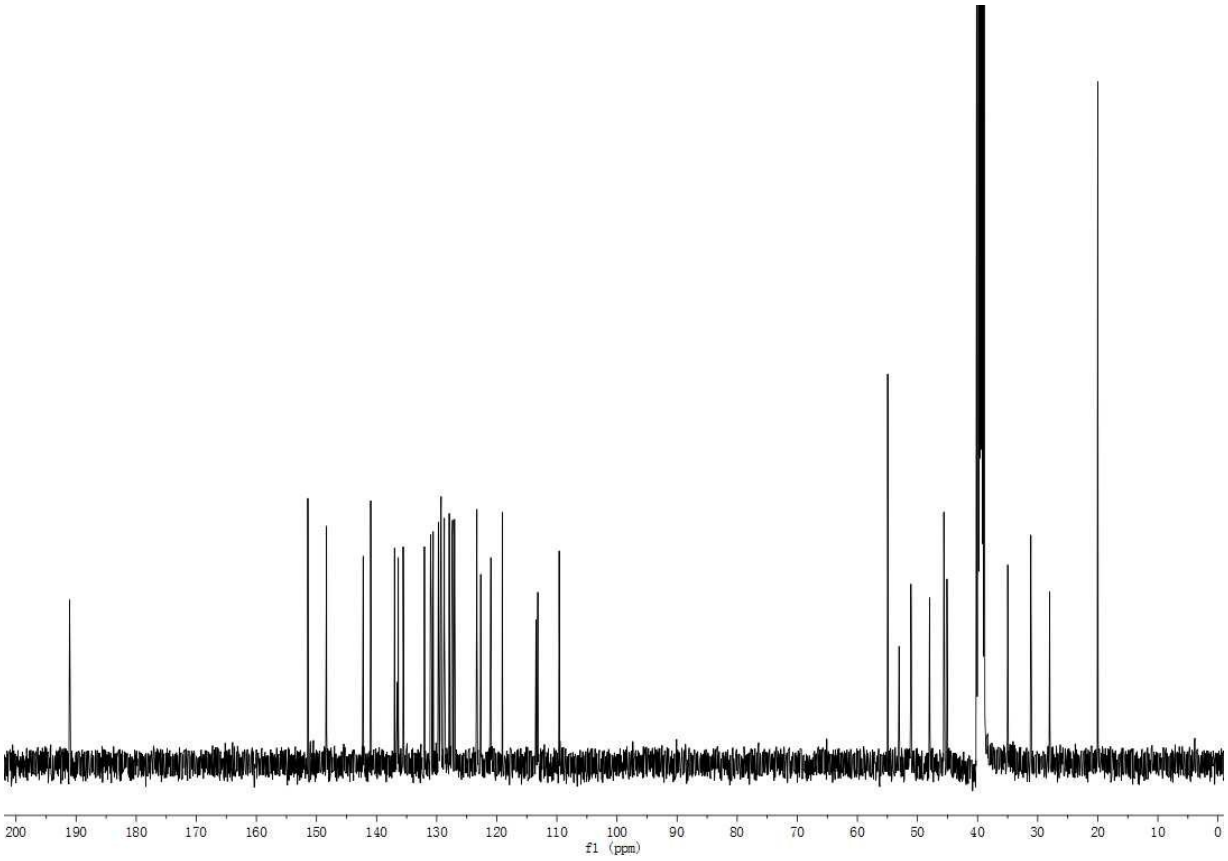
58

Yield 68%; yellow powder; m.p. = 176-178 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.68-9.64 (m, 1H), 8.91 (d, J = 5.6 Hz, 1H), 8.23 (d, J = 8.0 Hz, 1H), 8.14 (d, J = 8.8 Hz, 1H), 8.08 (d, J = 8.0 Hz, 1H), 8.02 (d, J = 8.4 Hz, 1H), 7.93-7.91 (m, 2H), 7.76-7.71 (m, 2H), 7.34-7.31 (m, 2H), 7.24 (d, J = 8.0 Hz, 1H), 7.05 (d, J = 7.6 Hz, 1H), 6.98 (t, J = 8.0 Hz, 1H), 6.81 (d, J = 8.0 Hz, 1H), 6.48 (d, J = 7.6 Hz, 2H), 4.73-4.68 (m, 2H), 4.29 (d, J = 6.0 Hz, 1H), 3.55 (s, 3H), 3.22 (dd, J = 16.4, 6.4 Hz, 1H), 3.09-3.00 (m, 3H), 2.74-2.67 (m, 1H), 2.54 (s, 1H), 2.44 (s, 3H), 2.38 (s, 3H), 2.34-2.17 (m, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 191.1, 151.4, 148.3, 142.2, 141.0, 137.0, 136.5, 136.4, 135.6, 132.0, 131.0, 130.9, 130.9, 130.6, 129.7, 129.4, 129.3, 129.3, 128.7, 127.9, 127.5, 127.4, 127.4, 127.0, 123.3, 122.7, 121.0, 119.1, 113.5, 113.2, 109.6, 55.0, 53.1, 51.1, 48.0, 45.6, 45.1, 35.0, 31.1, 28.0, 20.0 ppm; IR (KBr) ν: 3419, 2934, 1693, 1627, 1567, 1474, 1362, 1253, 1216, 1126, 638, 616 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{41}H_{39}BrN_3O_2$ $[M\text{-}Br]^+$ 684.2220, found 684.2222.

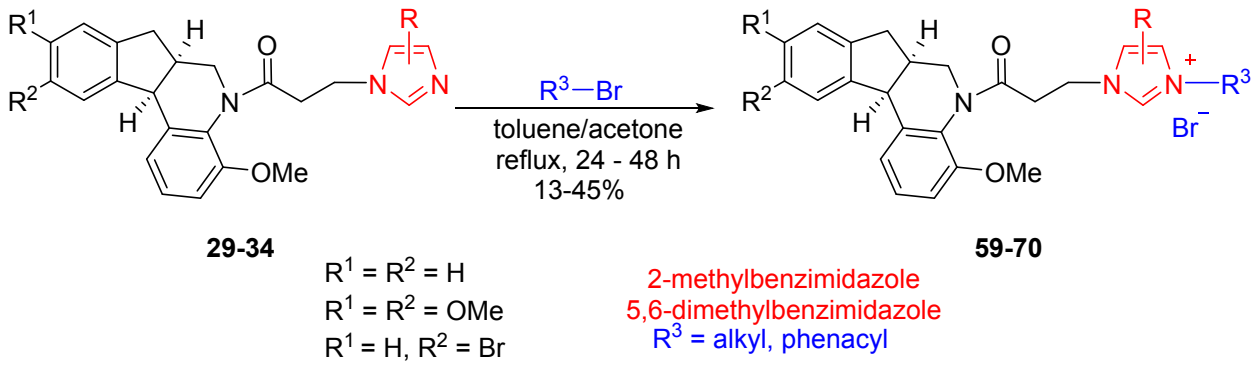
^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 58



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 58



2.11 Synthesis of compound 59-70

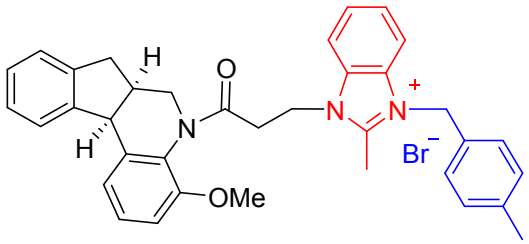


29-34 **59-70**

$R^1 = R^2 = H$
$R^1 = R^2 = OMe$
$R^1 = H, R^2 = Br$

2-methylbenzimidazole
5,6-dimethylbenzimidazole
R^3 = alkyl, phenacyl

A mixture of compound **29-34** (0.19 mmol) and the corresponding alkyl and phenacyl bromides (0.38 mmol) were stirred in acetone/toluene (1:1, 6 ml) in fluxing for 24-48 h. An insoluble substance was formed. After completion of the reaction as indicated by TLC, the precipitate was filtered through a small pad of Celite, and washed with ethyl acetate (3 × 30 ml), then dried to afford imidazolium salts **59-70** in 13-45% yields.

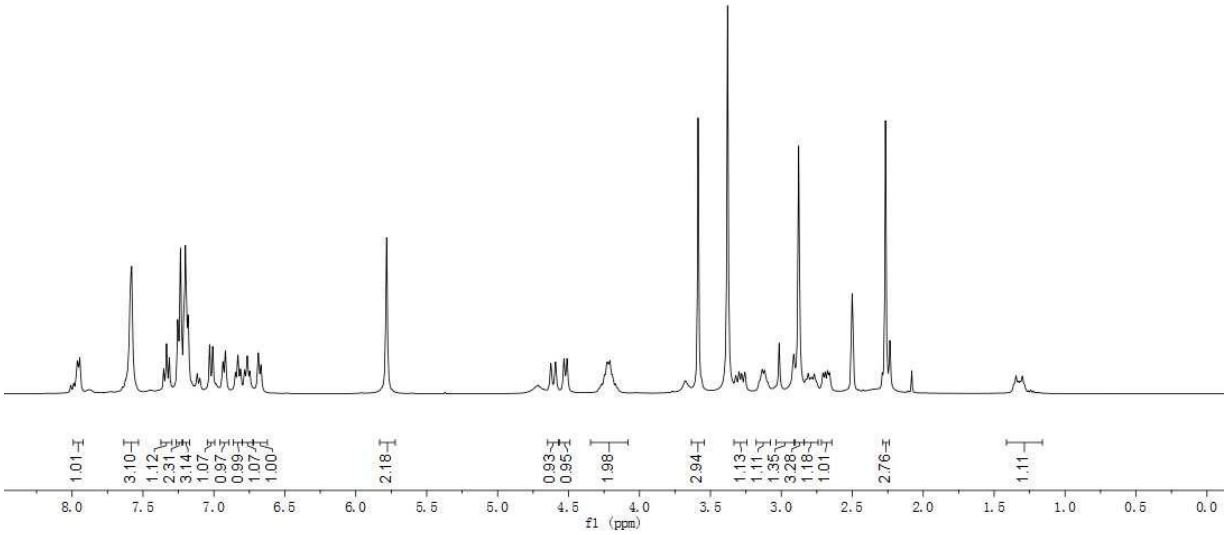


59

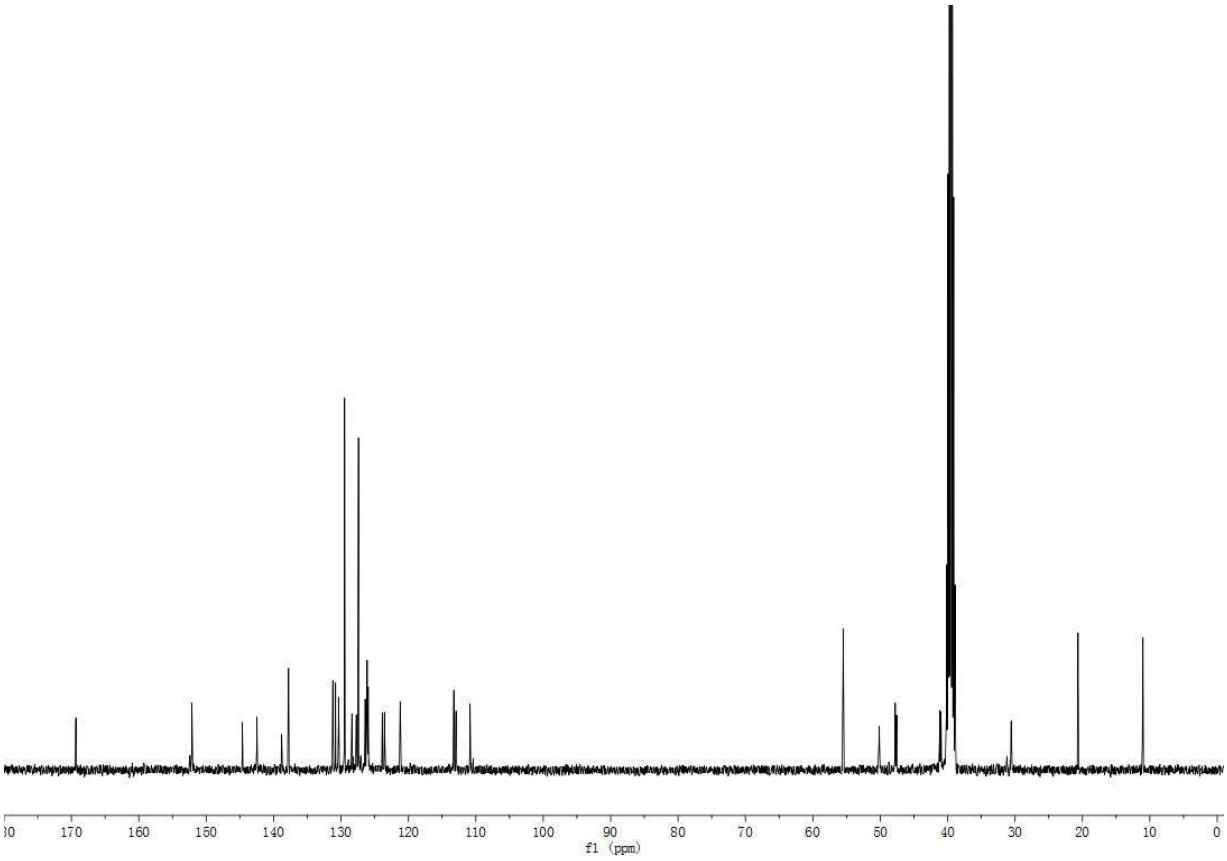
1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)-3-oxopropyl)-2-methyl-3-(4-methylbenzyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

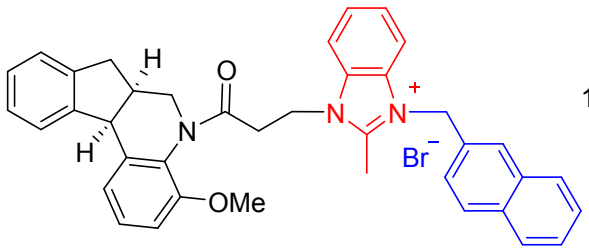
Yield 28%; white powder; m.p. = 281-283 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.95 (d, J = 6.4 Hz, 1H), 7.59-7.58 (m, 3H), 7.33 (t, J = 8.0 Hz, 1H), 7.26-7.24 (m, 2H), 7.21-7.18 (m, 3H), 7.02 (d, J = 8.4 Hz, 1H), 6.93 (d, J = 7.6 Hz, 1H), 6.83 (t, J = 7.2 Hz, 1H), 6.76 (t, J = 7.6 Hz, 1H), 6.68 (d, J = 7.6 Hz, 1H), 5.78 (s, 2H), 4.61 (d, J = 12.8 Hz, 1H), 4.52 (d, J = 8.4 Hz, 1H), 4.28-4.15 (m, 2H), 3.59 (s, 3H), 3.29 (dd, J = 16.4, 9.2 Hz, 1H), 3.16-3.10 (m, 1H), 3.02 (s, 1H), 2.88 (s, 3H), 2.83-2.75 (m, 1H), 2.68 (dd, J = 13.2, 6.0 Hz, 1H), 2.27 (s, 3H), 1.36-1.22 (m, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 169.3, 152.1, 152.1, 144.6, 142.5, 138.8, 137.8, 131.2, 130.8, 130.4, 129.5, 128.4, 127.7, 127.4, 126.4, 126.2, 126.1, 126.1, 126.0, 123.9, 123.6, 121.2, 113.3, 112.9, 110.9, 55.5, 50.2, 47.8, 47.6, 41.2, 41.0, 39.7, 30.6, 20.7, 11.0 ppm; IR (KBr) ν: 3432, 3036, 2944, 1661, 1578, 1510, 1486, 1474, 1448, 1411, 1280, 1177, 1095, 1080, 778, 748, 556 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{36}H_{36}N_3O_2$ $[M\text{-}Br]^+$ 542.2802, found 542.2801.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 59



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 59



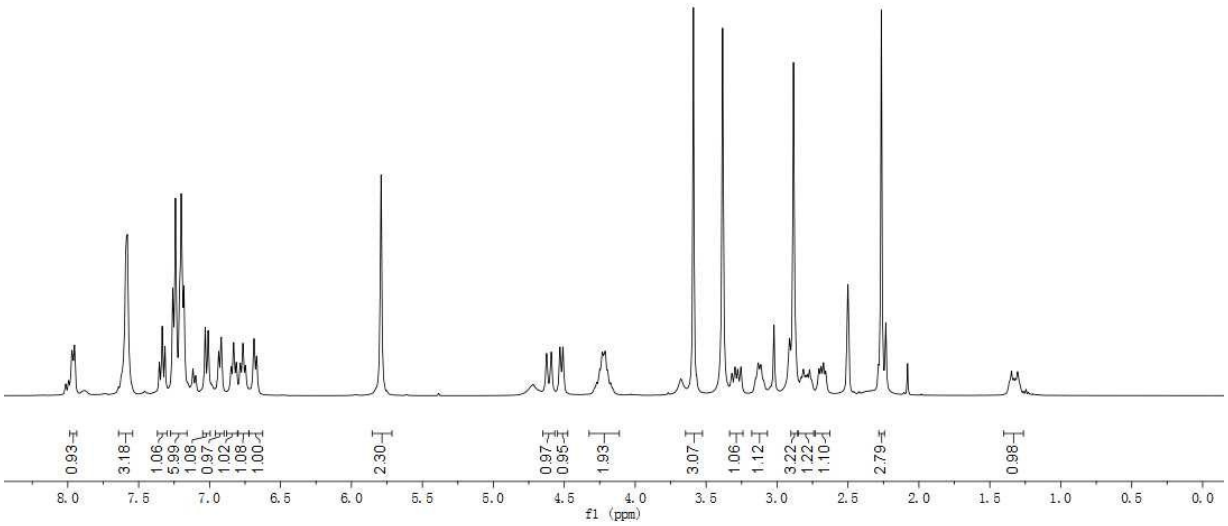


60

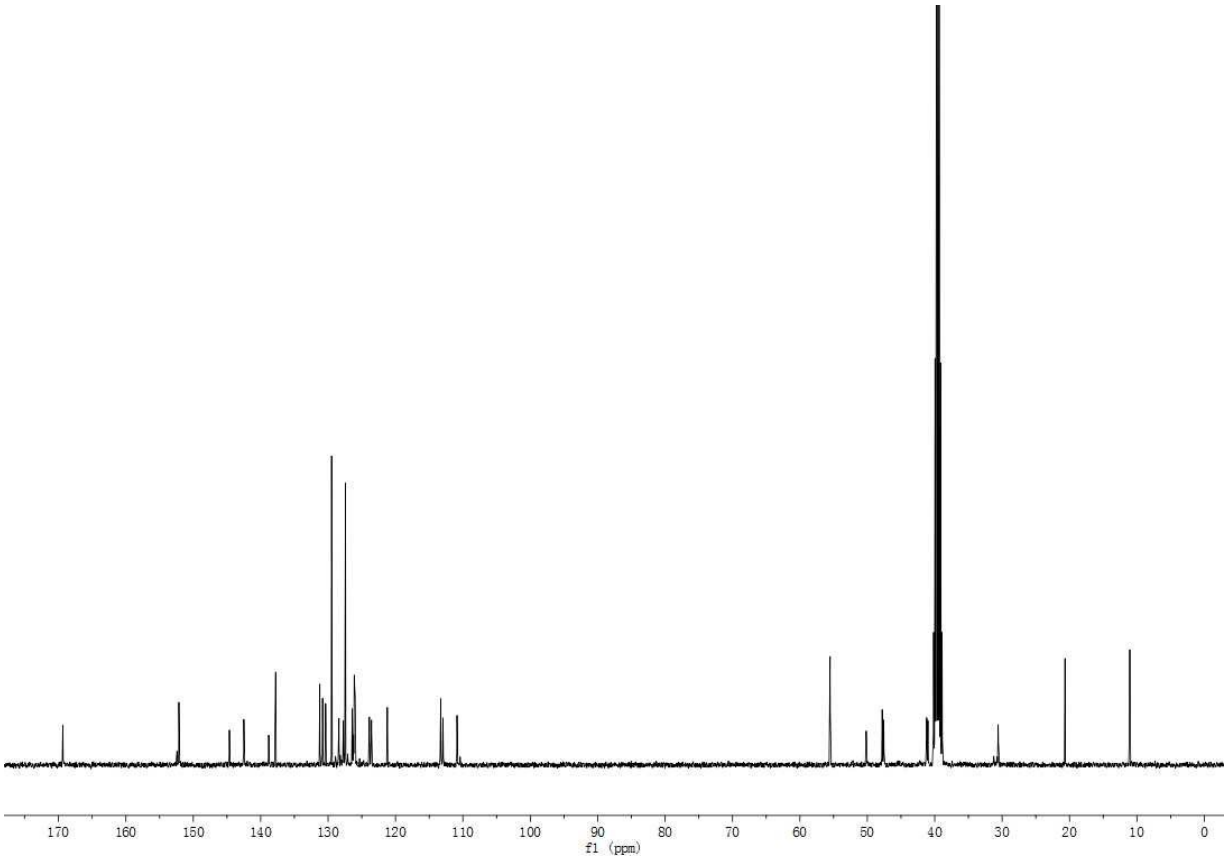
1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)-3-oxopropyl)-2-methyl-3-(naphthalen-2-ylmethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

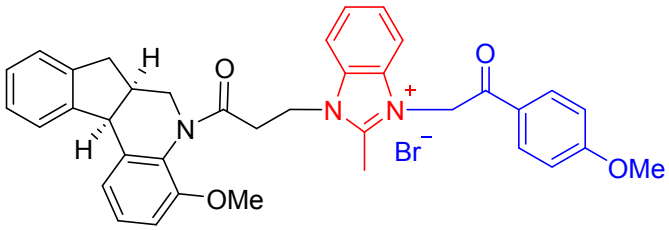
Yield 27%; white powder; m.p. = 232-234 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.96 (d, J = 6.8, 1H), 7.59-7.58 (m, 3H), 7.33 (t, J = 8.0 Hz, 1H), 7.26-7.18 (m, 6H), 7.02 (d, J = 8.4 Hz, 1H), 6.93 (d, J = 7.2 Hz, 1H), 6.83 (t, J = 7.2 Hz, 1H), 6.77 (t, J = 7.6 Hz, 1H), 6.68 (d, J = 7.6 Hz, 1H), 5.79 (s, 2H), 4.61 (d, J = 12.8 Hz, 1H), 4.52 (d, J = 8.4 Hz, 1H), 4.27-4.17 (m, 2H), 3.59 (s, 3H), 3.29 (dd, J = 16.8, 9.2 Hz, 1H), 3.15-3.09 (m, 1H), 2.88 (s, 3H), 2.83-2.76 (m, 1H), 2.68 (dd, J = 13.2, 6.4 Hz, 1H), 2.26 (s, 3H), 1.36-1.29 (m, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 169.3, 152.1, 152.1, 144.7, 142.5, 138.8, 137.8, 131.2, 130.8, 130.4, 129.5, 128.4, 127.7, 127.4, 126.4, 126.2, 126.1, 126.1, 126.0, 123.9, 123.6, 121.2, 113.3, 113.0, 110.9, 55.5, 50.2, 47.8, 47.6, 41.2, 41.1, 39.7, 30.6, 20.8, 11.1 ppm; IR (KBr) ν: 3432, 3030, 2934, 1651, 1523, 1474, 1407, 1356, 1276, 1174, 1092, 785, 749 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{39}H_{36}N_3O_2$ $[M\text{-}Br]^+$ 578.2802, found 578.2802.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 60



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 60



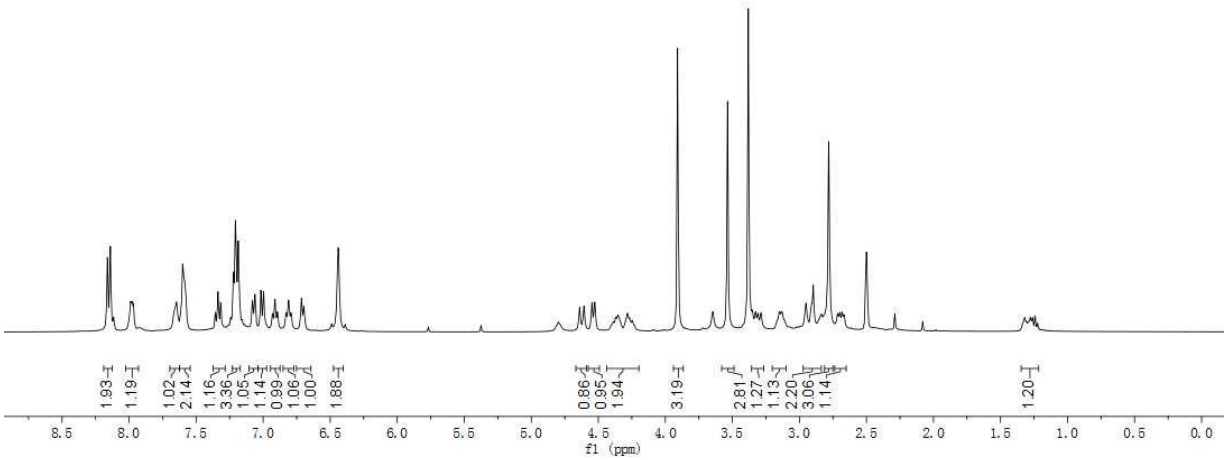


61

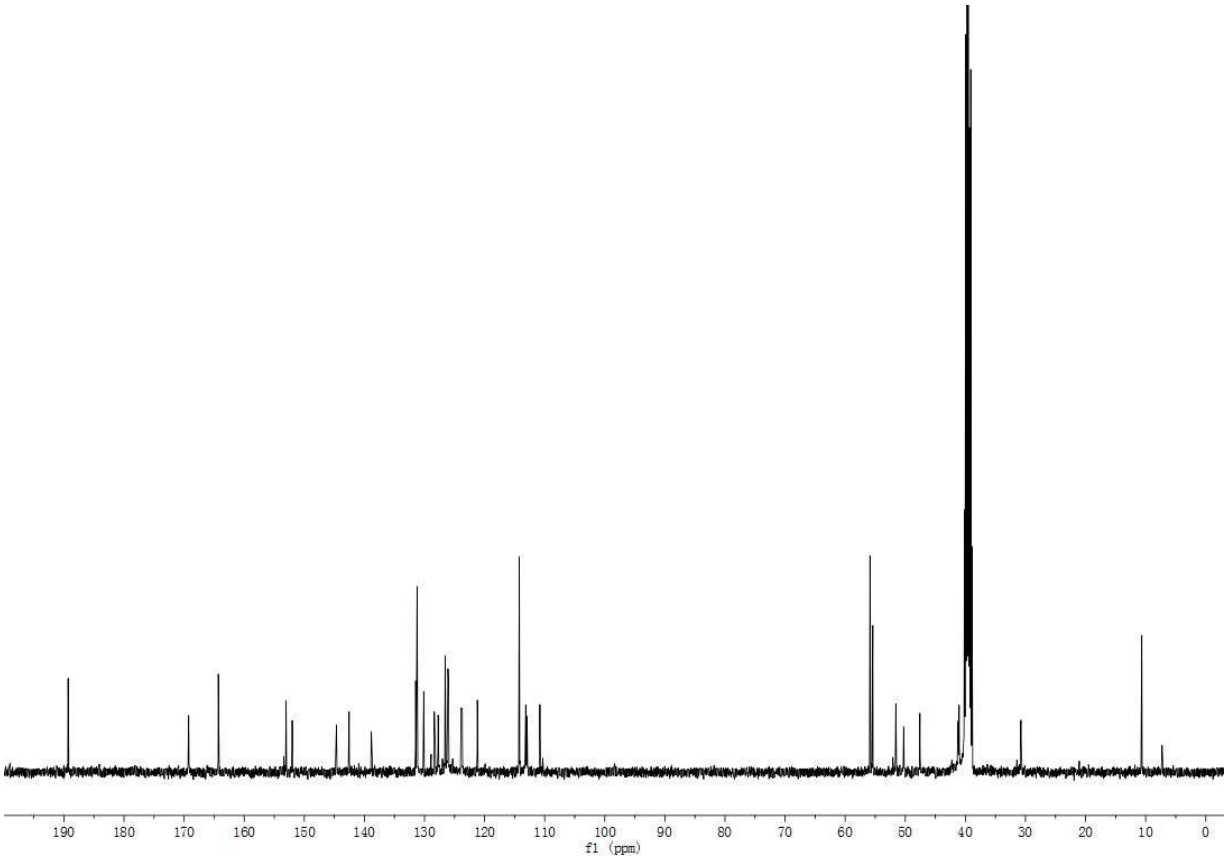
1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)-3-oxopropyl)-3-(2-(4-methoxyphenyl)-2-oxoethyl)-2-methyl-1*H*-benzo[*d*]imidazol-3-ium bromide

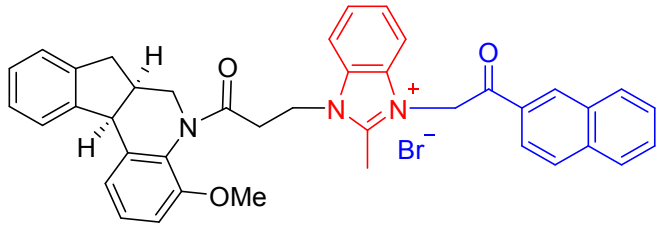
Yield 33%; white powder; m.p. = 234-236 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.15 (d, J = 8.8 Hz, 2H), 8.00-7.97 (m, 1H), 7.67-7.65 (m, 1H), 7.61-7.58 (m, 2H), 7.34 (t, J = 8.0 Hz, 1H), 7.24-7.16 (m, 3H), 7.07 (d, J = 7.6 Hz, 1H), 7.01 (d, J = 8.4 Hz, 1H), 6.91 (t, J = 7.6 Hz, 1H), 6.81 (t, J = 7.6 Hz, 1H), 6.70 (d, J = 7.6 Hz, 1H), 6.44 (s, 2H), 4.62 (d, J = 13.2 Hz, 1H), 4.54 (d, J = 8.8 Hz, 1H), 4.39-4.29 (m, 2H), 3.91 (s, 3H), 3.54 (s, 3H), 3.36-3.29 (m, 1H), 3.17-3.11 (m, 1H), 2.95-2.62 (m, 2H), 2.78 (s, 3H), 2.69 (dd, J = 13.2, 6.0 Hz, 1H), 1.34-1.22 (m, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 189.3, 169.2, 164.3, 153.0, 152.0, 144.7, 142.5, 138.9, 131.5, 131.2, 130.1, 128.4, 127.7, 126.6, 126.5, 126.2, 126.2, 126.1, 126.0, 123.9, 123.7, 121.2, 114.2, 113.2, 112.9, 110.8, 55.9, 55.4, 51.6, 50.3, 47.6, 41.2, 41.0, 39.7, 30.8, 10.7 ppm; IR (KBr) ν: 3432, 2934, 1686, 1639, 1601, 1575, 1513, 1477, 1417, 1261, 1241, 1181, 1078, 986, 840, 765, 587 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{37}H_{36}N_3O_4$ $[M\text{-}Br]^+$ 586.2700, found 586.2701.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 61



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 61



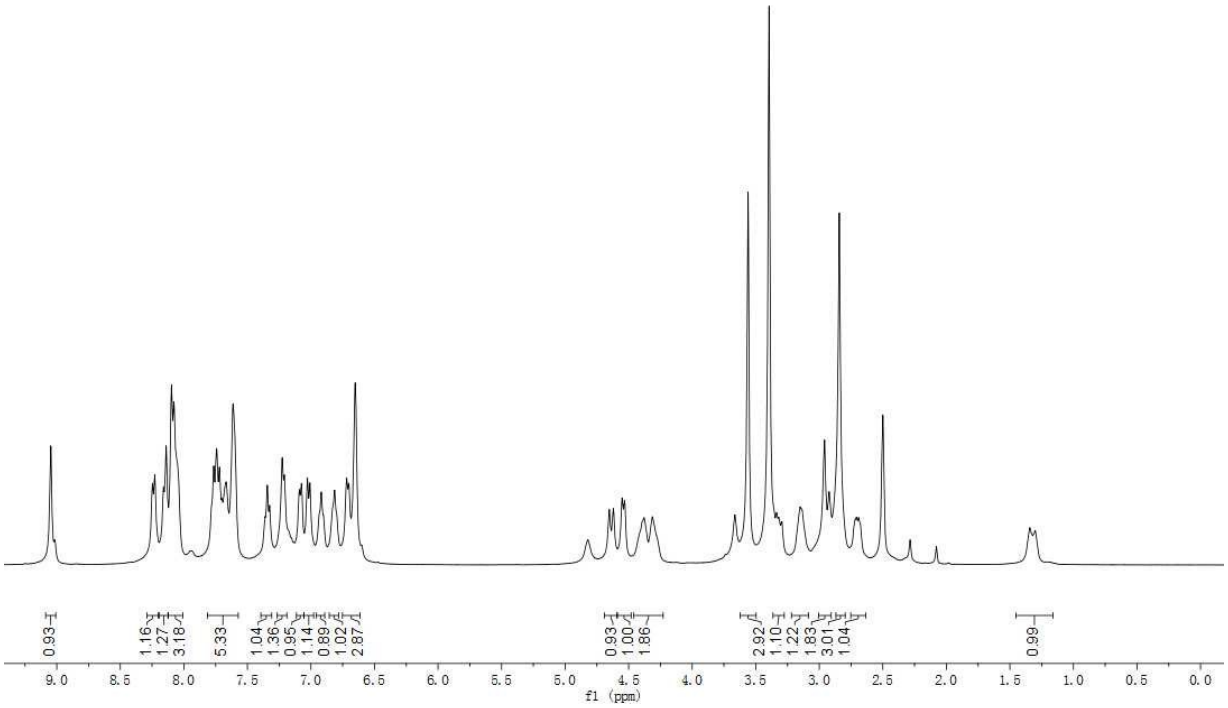


62

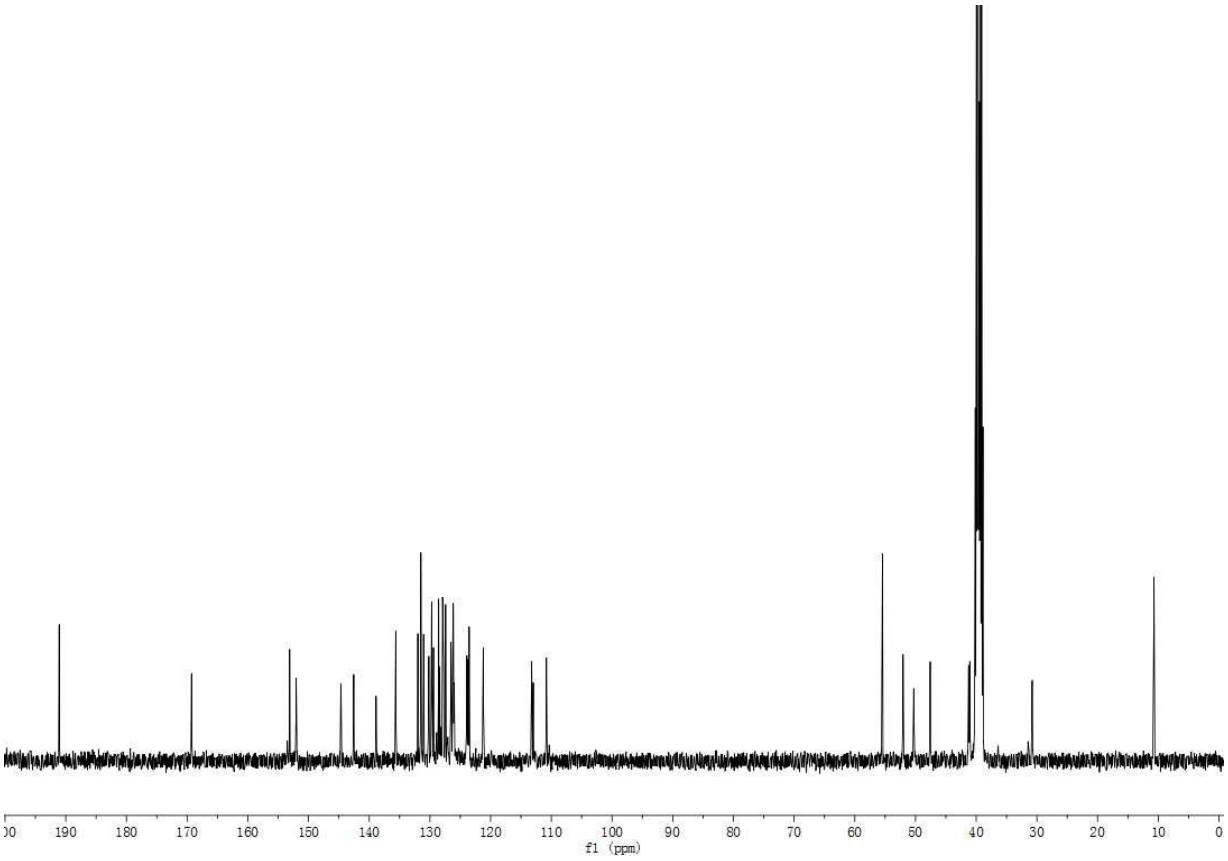
1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)-3-oxopropyl)-2-methyl-3-(2-(naphthalen-2-yl)-2-oxoethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

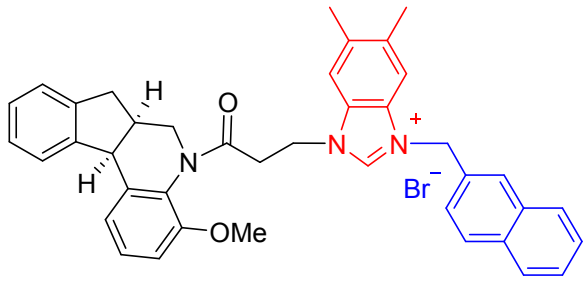
Yield 34%; white powder; m.p. = 181-183 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.05 (s, 1H), 8.24 (d, J = 8.0 Hz, 1H), 8.15 (d, J = 8.8 Hz, 1H), 8.10-8.04 (m, 3H), 7.78-7.60 (m, 5H), 7.36-7.32 (m, 1H), 7.22 (d, J = 7.6 Hz, 1H), 7.08 (d, J = 7.2 Hz, 1H), 7.02 (d, J = 8.4 Hz, 1H), 6.94-6.90 (m, 1H), 6.83-6.80 (m, 1H), 6.71 (d, J = 7.6 Hz, 1H), 6.65 (s, 2H), 4.64 (d, J = 12.8 Hz, 1H), 4.54 (d, J = 8.4 Hz, 1H), 4.43-4.26 (m, 2H), 3.56 (s, 3H), 3.37-3.29 (m, 1H), 3.17-3.11 (m, 1H), 2.94 (d, J = 15.2 Hz, 2H), 2.84 (s, 3H), 2.70 (dd, J = 13.2, 6.0 Hz, 1H), 1.36-1.28 (m, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 191.1, 169.3, 153.1, 152.0, 144.7, 142.6, 138.9, 135.6, 132.0, 131.5, 131.0, 130.2, 129.7, 129.4, 128.6, 128.4, 127.9, 127.8, 127.4, 126.5, 126.2, 126.1, 126.0, 123.9, 123.7, 123.5, 121.2, 113.2, 113.0, 110.8, 55.4, 52.1, 50.3, 47.6, 41.2, 41.1, 39.7, 30.8, 10.7 ppm; IR (KBr) ν: 3432, 2940, 1691, 1649, 1527, 1474, 1412, 1357, 1192, 1064, 823, 795, 751, 580, 476 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{40}H_{36}N_3O_3$ $[M-Br]^+$ 606.2751, found 606.2751.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 62



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 62



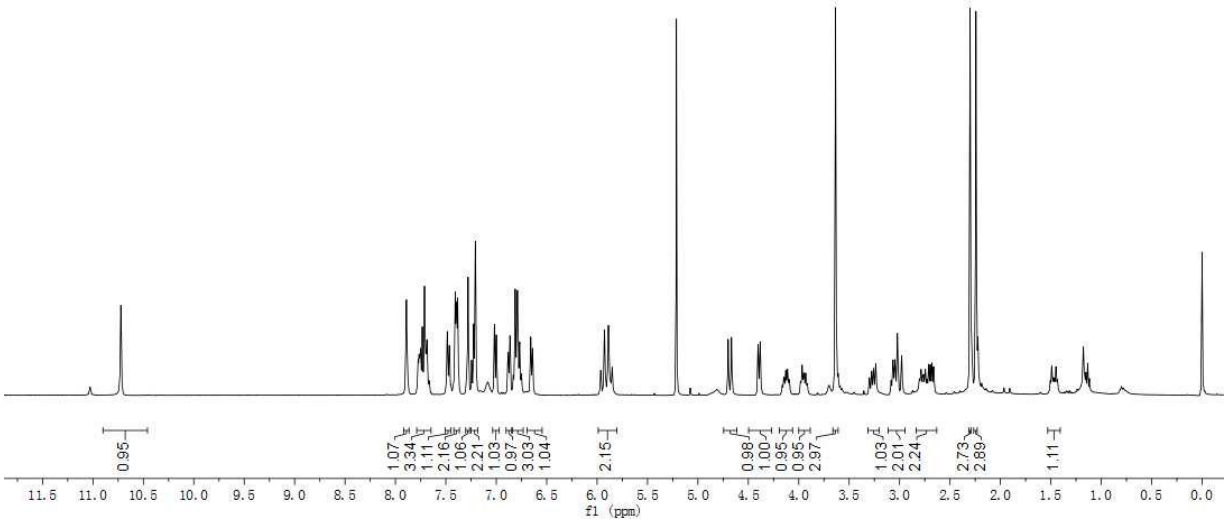


63

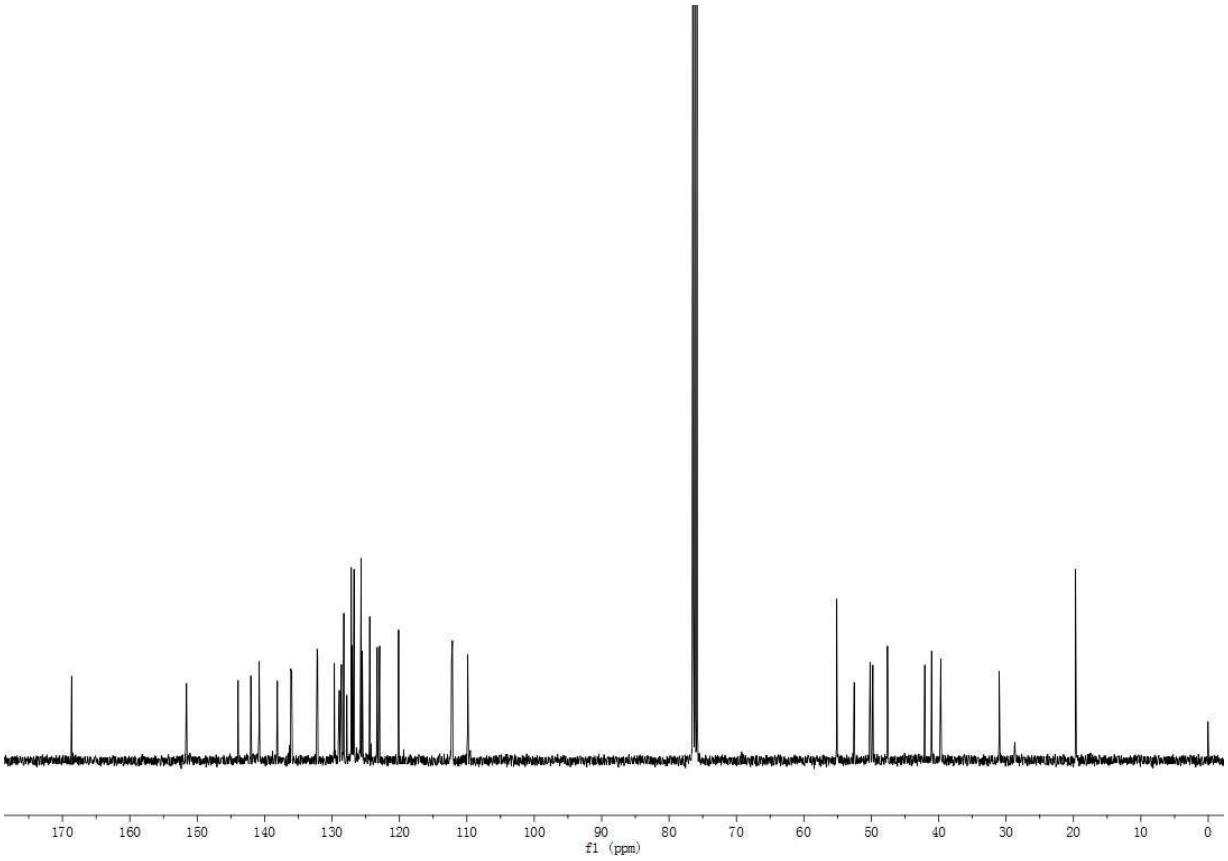
1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)-3-oxopropyl)-5,6-dimethyl-3-(naphthalen-2-ylmethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

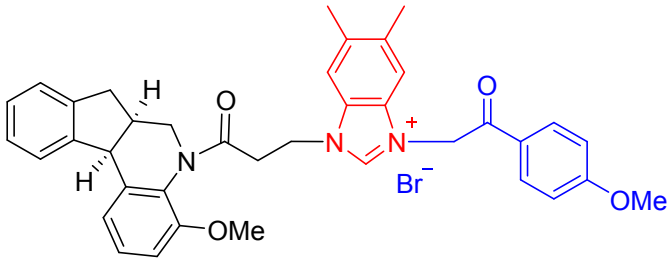
Yield 16%; white powder; m.p. = 246-248 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.72 (s, 1H), 7.89 (s, 1H), 7.78-7.67 (m, 3H), 7.48 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.40 (dd, *J* = 6.4, 3.2 Hz, 2H), 7.28 (s, 1H), 7.25-7.21 (m, 2H), 7.09 (d, *J* = 7.2 Hz, 1H), 6.87 (d, *J* = 7.2 Hz, 1H), 6.83-6.75 (m, 3H), 6.65 (d, *J* = 7.2 Hz, 1H), 5.96-5.85 (m, 2H), 4.68 (d, *J* = 12.8 Hz, 1H), 4.39 (d, *J* = 8.0 Hz, 1H), 4.18-4.09 (m, 1H), 3.98-3.92 (m, 1H), 3.64 (s, 3H), 3.27 (dd, *J* = 16.4, 8.8 Hz, 1H), 3.09-2.98 (m, 2H), 2.80-2.66 (m, 2H), 2.30 (s, 3H), 2.24 (s, 3H), 1.51-1.43 (m, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.6, 151.6, 143.9, 142.0, 140.8, 138.1, 136.1, 136.0, 132.2, 132.1, 129.7, 128.9, 128.6, 128.3, 127.8, 127.2, 127.0, 126.8, 126.7, 125.8, 125.7, 125.5, 124.4, 123.3, 122.9, 120.1, 112.3, 112.1, 109.8, 55.1, 50.2, 49.8, 47.6, 42.1, 41.1, 39.7, 31.0, 19.7, 19.6 ppm; IR (KBr) ν: 3375, 3011, 2931, 2456, 1652, 1588, 1560, 1510, 1486, 1455, 1413, 1218, 1098, 792, 769, 660, 476 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{40}H_{38}N_3O_2$ $[M-Br]^+$ 592.2959, found 592.2958.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 63



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 63



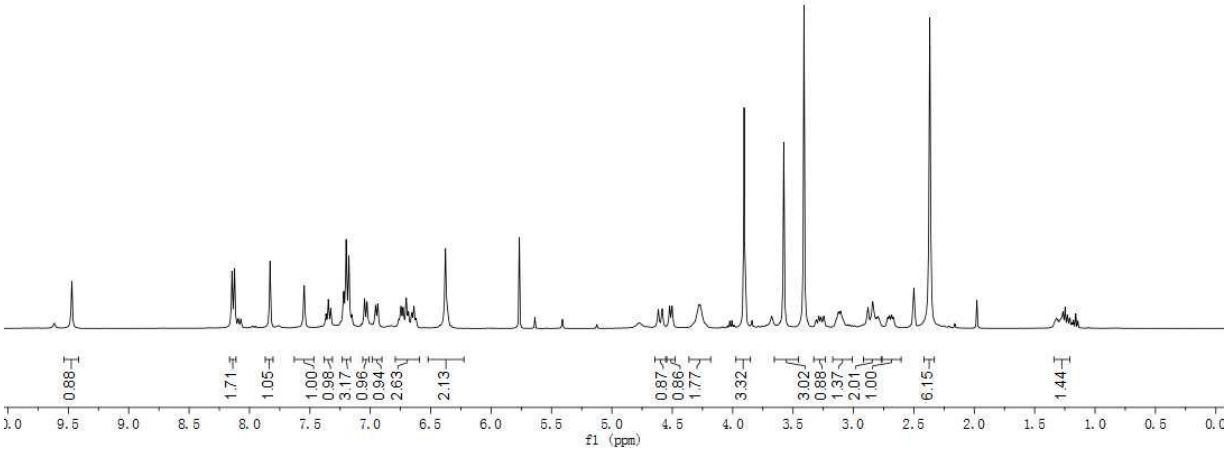


1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)-3-oxopropyl)-3-(2-(4-methoxyphenyl)-2-oxoethyl)-5,6-dimethyl-1*H*-benzo[*d*]imidazol-3-ium bromide

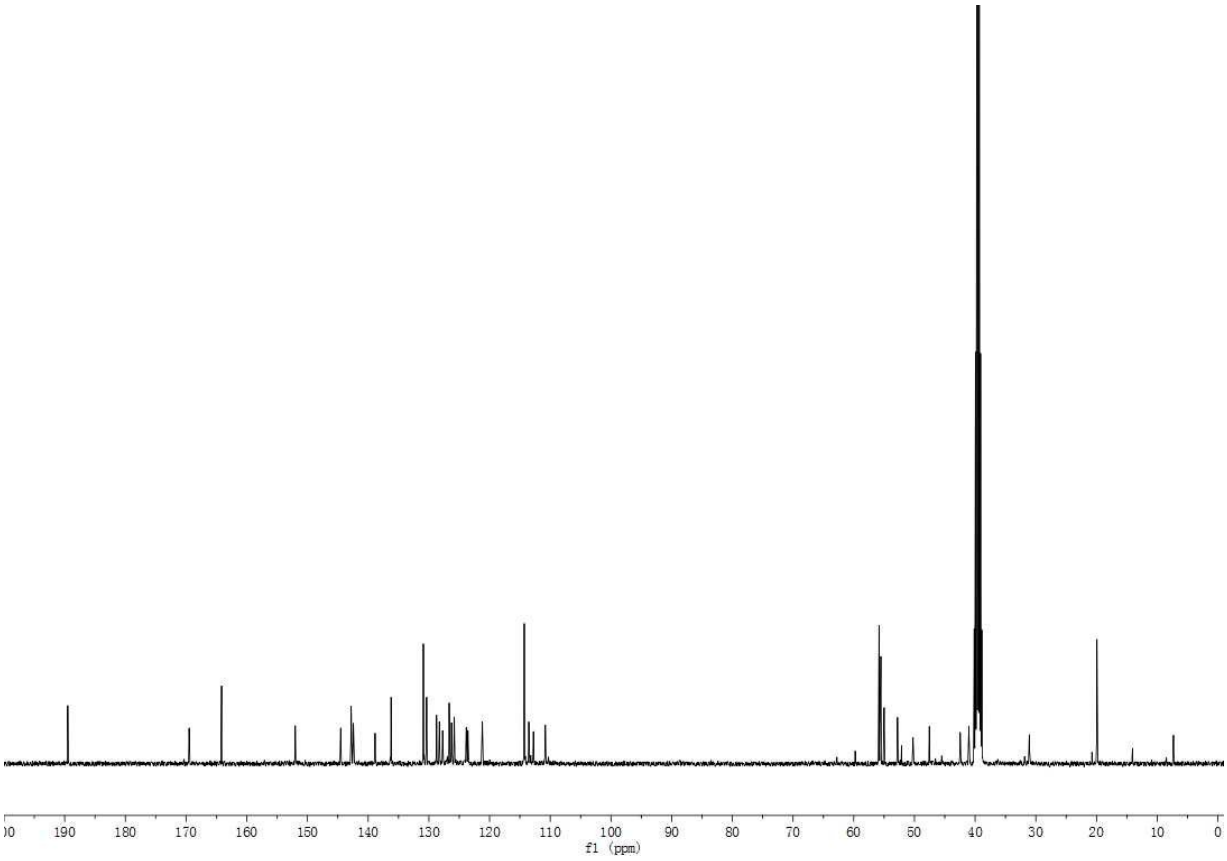
64

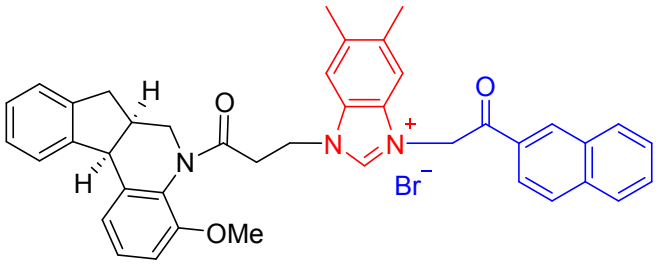
Yield 17%; white powder; m.p. = 177-179 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.47 (s, 1H), 8.13 (d, J = 8.4 Hz, 2H), 7.83 (s, 1H), 7.55 (s, 1H), 7.35 (t, J = 7.6 Hz, 1H), 7.22-7.15 (m, 3H), 7.04 (d, J = 8.0 Hz, 1H), 6.95 (d, J = 7.6 Hz, 1H), 6.77-6.62 (m, 3H), 6.38 (s, 2H), 4.60 (d, J = 13.2 Hz, 1H), 4.51 (d, J = 8.4 Hz, 1H), 4.32-4.25 (m, 2H), 3.91 (s, 3H), 3.58 (s, 3H), 3.28 (dd, J = 16.8, 9.2 Hz, 1H), 3.15-3.09 (m, 1H), 2.88-2.78 (m, 2H), 2.69 (dd, J = 13.2, 6.4 Hz, 1H), 2.37 (s, 6H), 1.34-1.20 (m, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 189.5, 169.5, 164.2, 152.0, 144.5, 142.8, 142.4, 138.9, 136.2, 136.2, 130.9, 130.4, 128.7, 128.3, 127.7, 126.7, 126.3, 125.8, 123.8, 123.6, 121.2, 114.3, 113.5, 112.8, 110.8, 55.8, 55.5, 55.0, 52.8, 50.2, 47.5, 42.5, 41.0, 40.2, 31.1, 19.9, 19.9 ppm; IR (KBr) ν: 3019, 2934, 2841, 1688, 1652, 1601, 1564, 1486, 1455, 1414, 1261, 1242, 1173, 1097, 1024, 750, 601 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{40}H_{38}N_3O_2$ $[M\text{-}Br]^+$ 600.2857, found . 600.2857.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 64



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 64



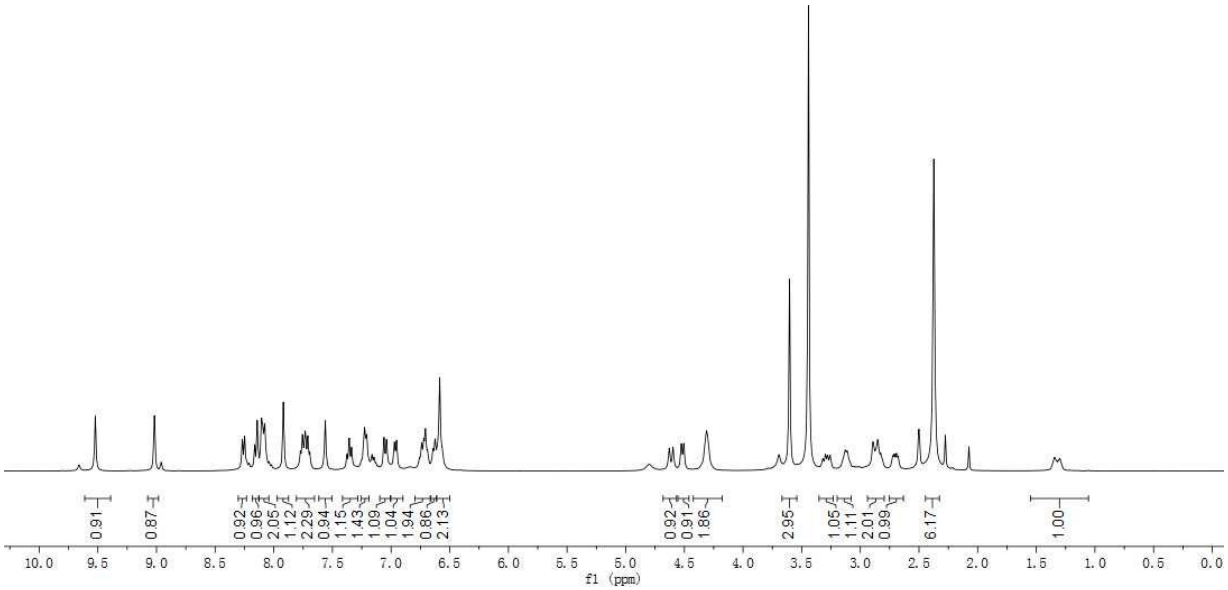


65

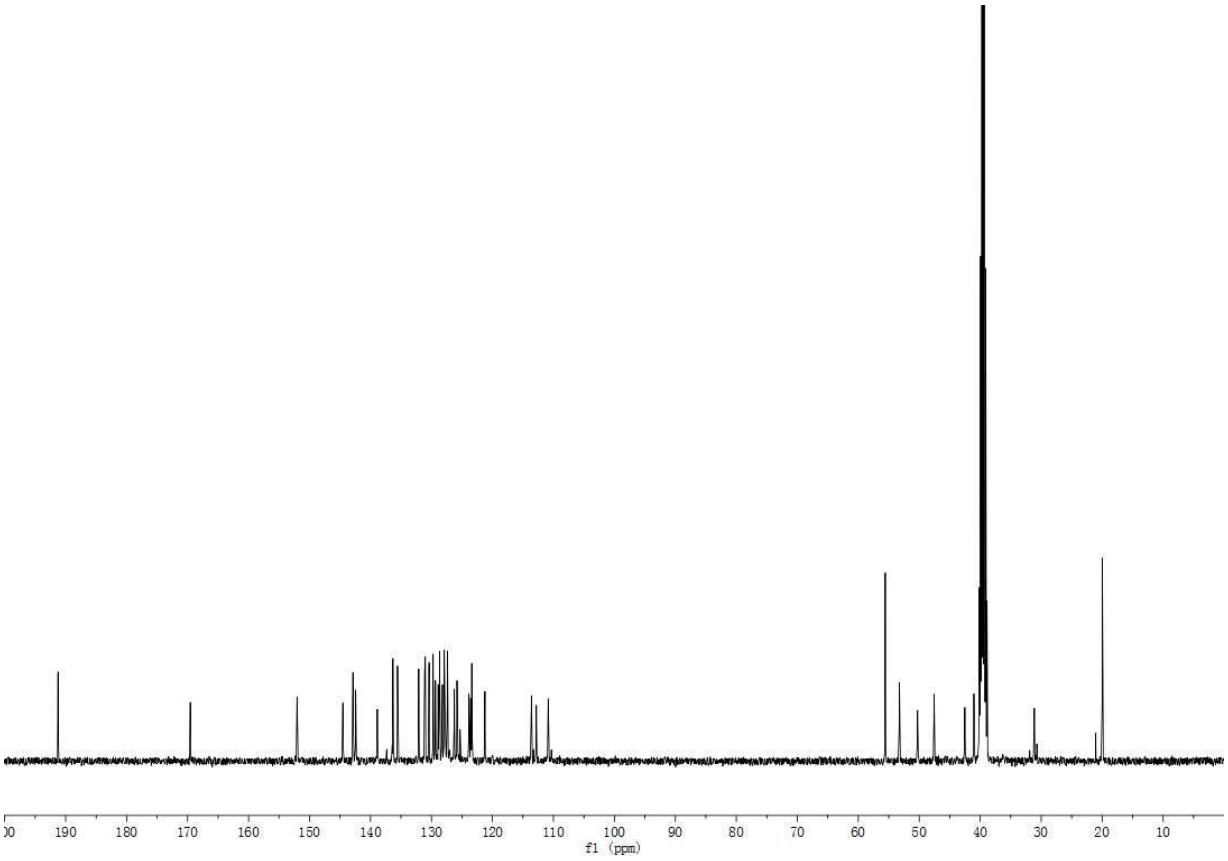
1-(3-(4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)-3-oxopropyl)-5,6-dimethyl-3-(2-(naphthalen-2-yl)-2-oxoethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

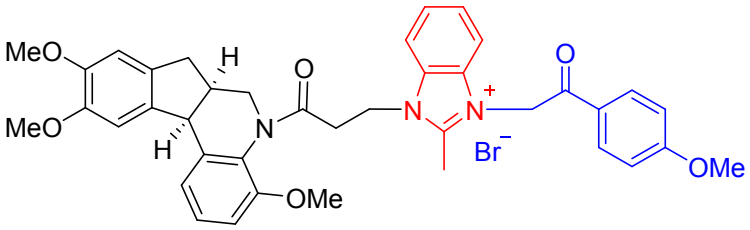
Yield 13%; white powder; m.p. = 207-209 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.52 (s, 1H), 9.02 (s, 1H), 8.26 (d, J = 8.0 Hz, 1H), 8.15 (d, J = 8.8 Hz, 1H), 8.10-8.08 (m, 2H), 7.92 (s, 1H), 7.77-7.69 (m, 2H), 7.56 (s, 1H), 7.36 (t, J = 7.6 Hz, 1H), 7.23-7.21 (m, 1H), 7.05 (d, J = 8.4 Hz, 1H), 6.96 (d, J = 7.6 Hz, 1H), 6.76-6.69 (m, 2H), 6.64-6.56 (m, 1H), 6.59 (s, 2H), 4.61 (d, J = 13.2 Hz, 1H), 4.52 (d, J = 8.4 Hz, 1H), 4.35-4.29 (m, 2H), 3.60 (s, 3H), 3.29 (dd, J = 16.8, 9.2 Hz, 1H), 3.15-3.09 (m, 1H), 2.89-2.81 (m, 2H), 2.70 (dd, J = 13.2, 6.0 Hz, 1H), 2.37 (s, 6H), 1.36-1.29 (m, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 191.2, 169.6, 152.0, 144.5, 142.9, 142.4, 138.9, 136.3, 136.3, 135.6, 132.1, 131.1, 131.0, 130.4, 129.7, 129.4, 128.9, 128.9, 128.8, 128.7, 128.3, 128.2, 127.9, 127.8, 127.4, 126.3, 125.8, 125.3, 123.9, 123.6, 123.4, 121.2, 113.6, 112.8, 110.9, 55.6, 53.3, 50.3, 47.6, 42.5, 41.0, 39.7, 31.1, 20.0, 20.0 ppm; IR (KBr) ν: 3428, 2938, 1695, 1643, 1561, 1487, 1454, 1412, 1279, 1259, 1222, 1179, 1124, 1096, 749 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{41}H_{38}N_3O_3$ $[M-Br]^+$ 620.2908, found 620.2910.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 65



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 65



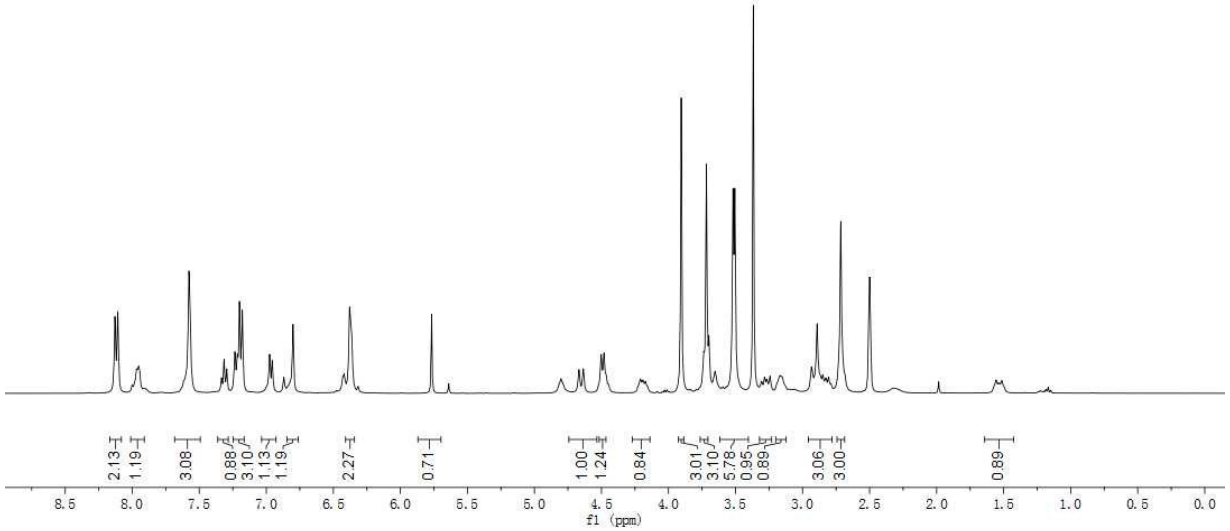


3-(2-(4-methoxyphenyl)-2-oxoethyl)-2-methyl-1-(3-oxo-3-(4,9,10-trimethoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

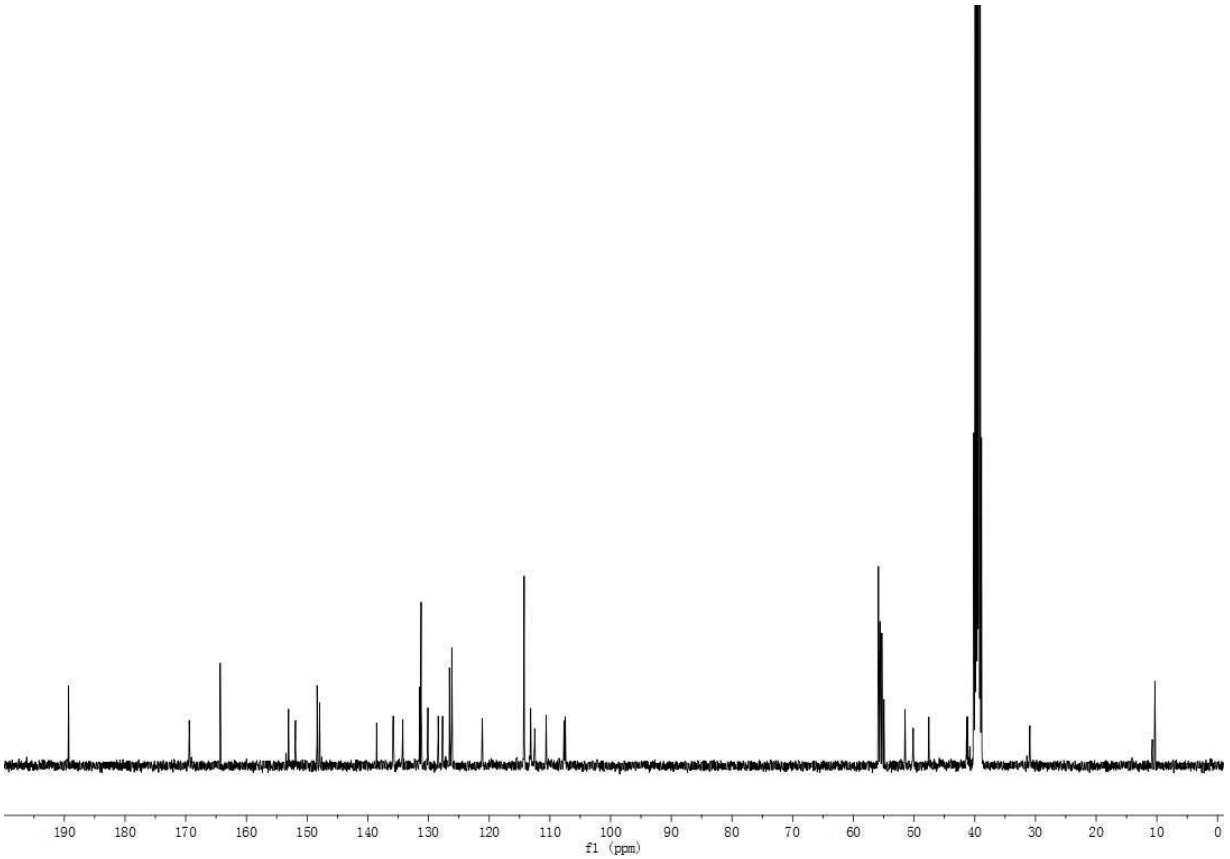
66

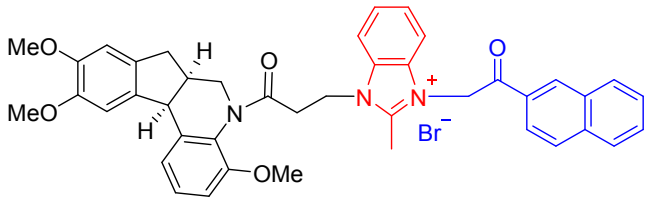
Yield 21%; yellow powder; m.p. = 193-195 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.12 (d, J = 8.4 Hz, 2H), 8.00-7.90 (m, 1H), 7.57 (d, J = 3.4 Hz, 3H), 7.31 (t, J = 7.6 Hz, 1H), 7.24-7.18 (m, 3H), 6.97 (d, J = 8.4 Hz, 1H), 6.80 (s, 1H), 6.38-6.36 (m, 2H), 5.77 (s, 1H), 4.65 (d, J = 13.2 Hz, 1H), 4.52-4.46 (m, 1H), 4.23-4.16 (m, 1H), 3.91 (s, 3H), 3.72 (s, 3H), 3.51 (d, J = 5.5 Hz, 6H), 3.27 (dd, J = 16.0, 9.2 Hz, 1H), 3.19-3.15 (m, 1H), 2.93-2.79 (m, 3H), 2.71 (s, 3H), 1.57-1.50 (m, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 189.3, 169.4, 164.3, 153.1, 151.9, 148.4, 147.9, 138.6, 135.8, 134.2, 131.4, 131.2, 130.1, 128.4, 127.7, 126.6, 126.2, 121.1, 114.2, 113.2, 112.5, 110.6, 107.6, 107.5, 55.9, 55.6, 55.6, 55.3, 51.5, 50.1, 47.6, 41.3, 41.2, 39.7, 30.9, 10.3 ppm; IR (KBr) ν: 3424, 2935, 2112, 1644, 1601, 1503, 1474, 1410, 1242, 1080, 836, 755, 637, 615 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{40}H_{37}N_3O_2$ $[M-Br]^+$ 670.2064, found 670.2064.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 66



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 66



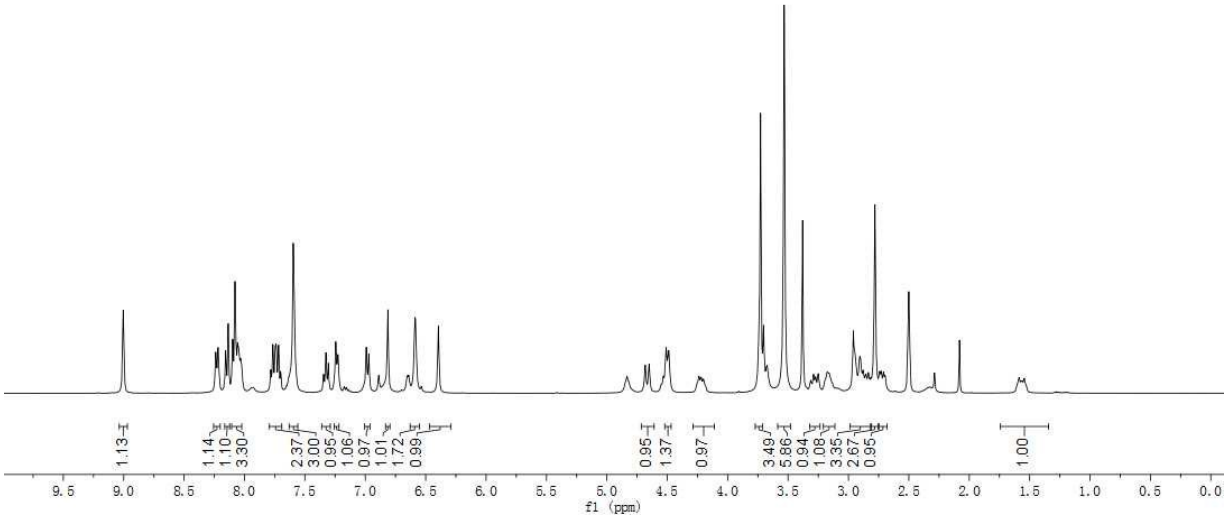


2-methyl-3-(2-(naphthalen-2-yl)-2-oxoethyl)-1-(3-oxo-3-(4,9,10-trimethoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)propyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

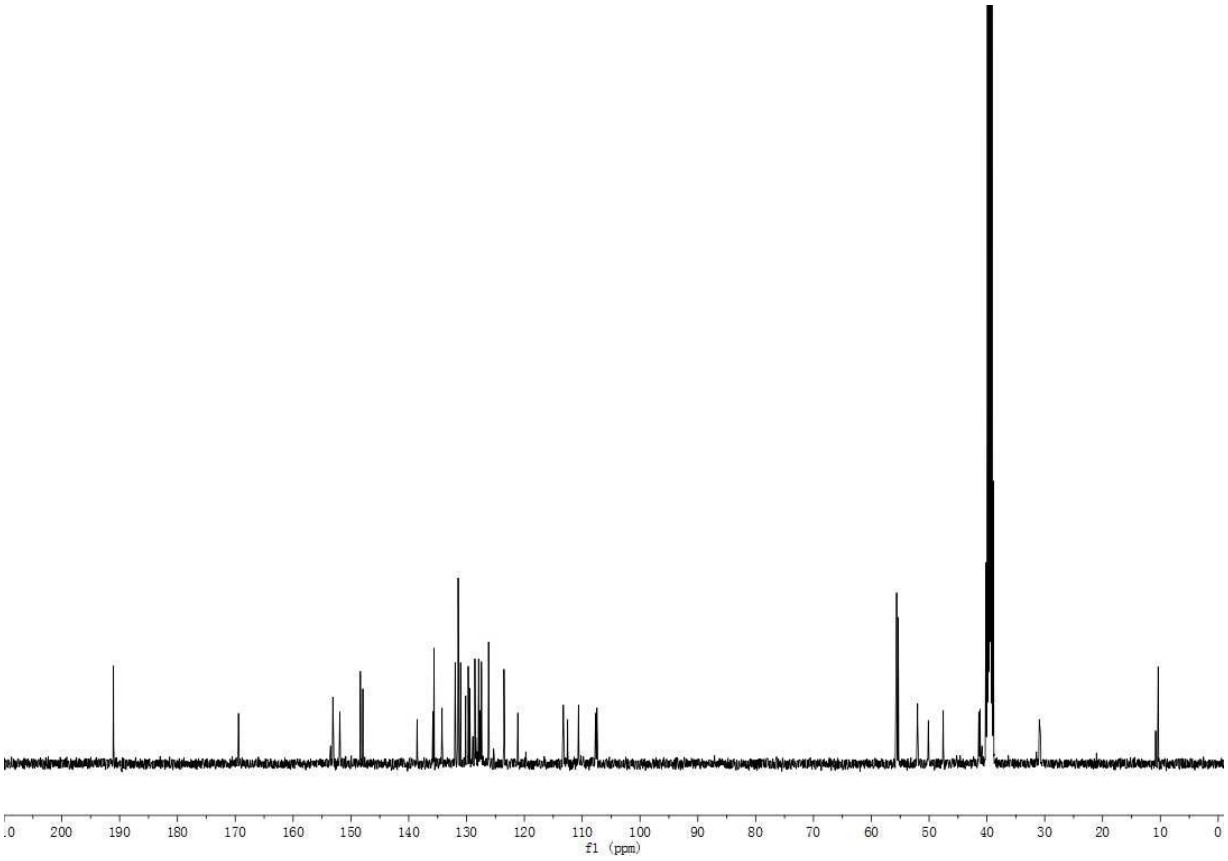
67

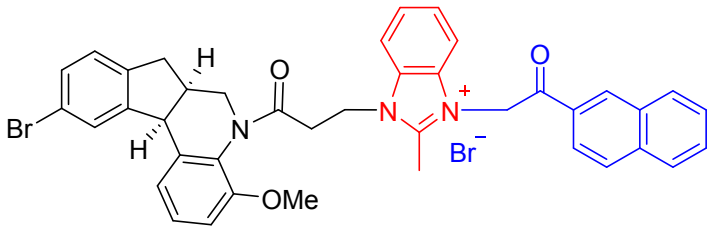
Yield 20%; yellow powder; m.p. = 191-193 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.00 (s, 1H), 8.23 (d, J = 7.6 Hz, 1H), 8.15 (d, J = 8.8 Hz, 1H), 8.10-8.03 (m, 3H), 7.78-7.70 (m, 2H), 7.59 (s, 3H), 7.33 (t, J = 8.0 Hz, 1H), 7.24 (d, J = 7.2 Hz, 1H), 6.98 (d, J = 8.4 Hz, 1H), 6.81 (s, 1H), 6.59 (d, J = 2.8 Hz, 2H), 6.39 (s, 1H), 4.67 (d, J = 13.2 Hz, 1H), 4.55-4.49 (m, 1H), 4.25-4.18 (m, 1H), 3.73 (s, 3H), 3.53 (s, 6H), 3.28 (dd, J = 16.4, 9.6 Hz, 1H), 3.20-3.14 (m, 1H), 2.96-2.82 (m, 3H), 2.78 (s, 3H), 2.72 (dd, J = 12.8, 5.6 Hz, 1H), 1.60-1.53 (m, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 191.1, 169.4, 153.1, 151.9, 148.4, 147.9, 138.6, 135.8, 135.6, 134.2, 132.0, 131.5, 131.0, 130.1, 129.7, 129.4, 128.6, 128.4, 127.9, 127.7, 127.4, 126.2, 123.5, 121.1, 113.2, 112.5, 110.6, 107.8, 107.5, 55.6, 55.6, 55.3, 52.0, 50.1, 47.6, 41.4, 41.2, 39.9, 30.9, 10.4 ppm; IR (KBr) ν: 3432, 2933, 1687, 1648, 1502, 1474, 1409, 1359, 1304, 1218, 1181, 1125, 1090, 752, 615, 479 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{42}H_{40}N_3O_5$ $[M\text{-}Br]^+$ 666.2962, found 666.2962.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 67



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 67



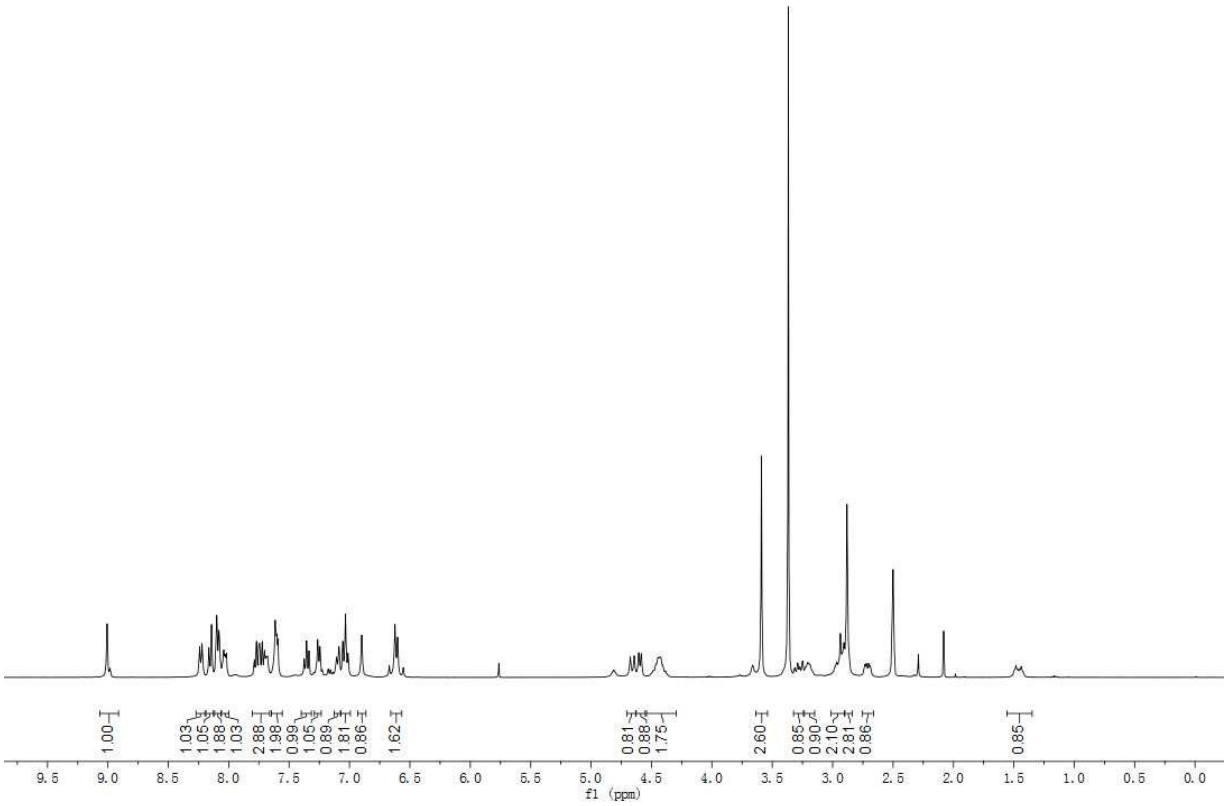


1-(3-((6a*R*,11b*R*)-10-bromo-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)-3-oxopropyl)-2-methyl-3-(2-(naphthalen-2-yl)-2-oxoethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

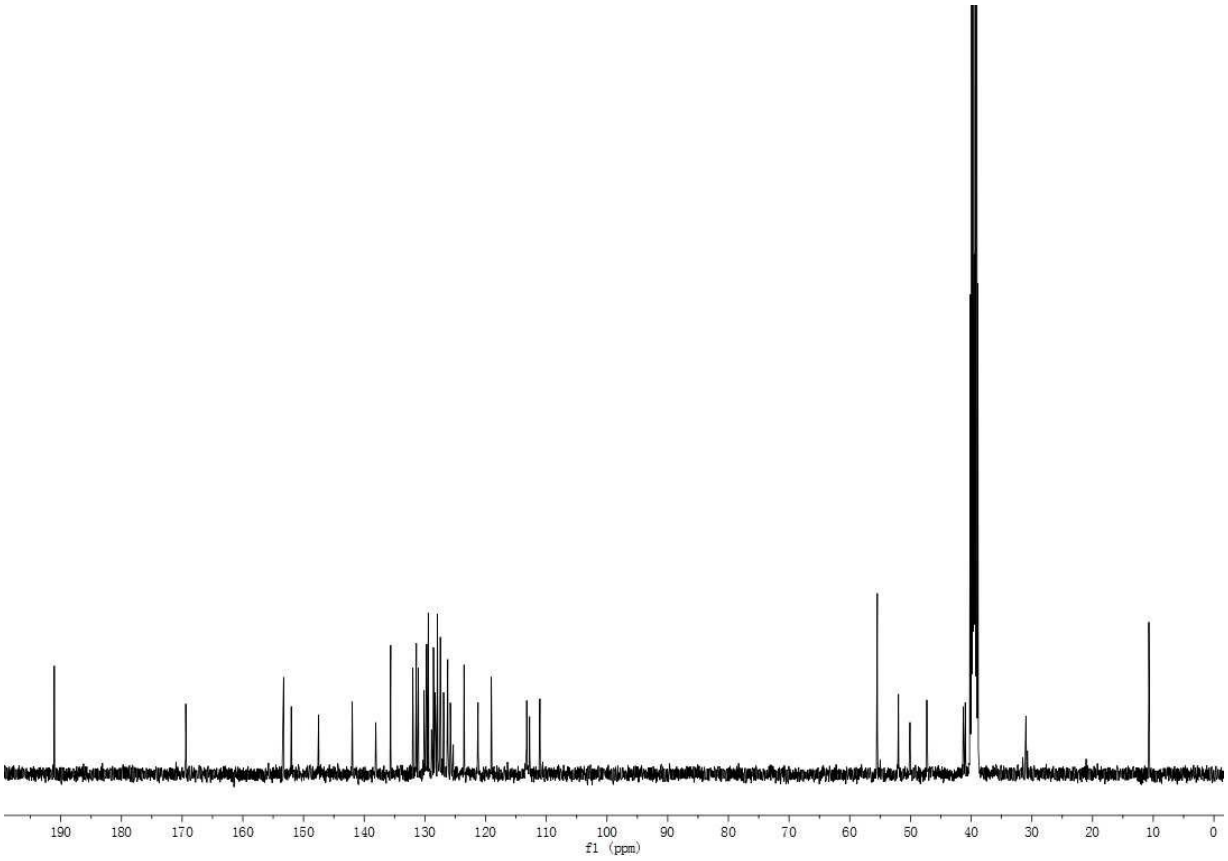
68

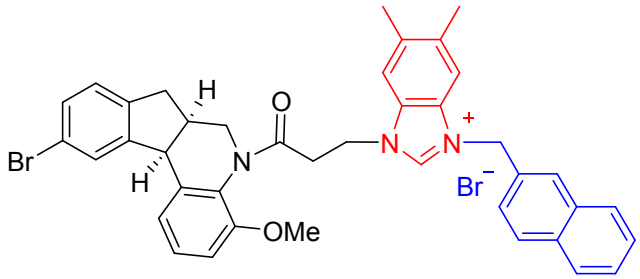
Yield 45%; white powder; m.p. = 266-268 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.01 (s, 1H), 8.23 (d, J = 8.0 Hz, 1H), 8.15 (d, J = 8.4 Hz, 1H), 8.10-9.07 (m, 2H), 8.05-8.02 (m, 1H), 7.79-7.67 (m, 3H), 7.63-7.58 (m, 2H), 7.36 (t, J = 8.0 Hz, 1H), 7.25 (d, J = 7.2 Hz, 1H), 7.11-7.09 (m, 1H), 7.03 (t, J = 8.8 Hz, 2H), 6.90 (s, 1H), 6.61 (d, J = 9.2 Hz, 2H), 4.66 (d, J = 12.8 Hz, 1H), 4.60 (d, J = 8.8 Hz, 1H), 4.49-4.38 (m, 2H), 3.59 (s, 3H), 3.28 (dd, J = 16.8, 9.6 Hz, 1H), 3.23-3.19 (m, 1H), 2.97-2.90 (m, 2H), 2.88 (s, 3H), 2.71 (dd, J = 13.2, 6.0 Hz, 1H), 1.48-1.44 (m, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 191.0, 169.4, 153.3, 152.0, 147.5, 142.0, 138.1, 135.6, 132.0, 131.4, 131.4, 131.1, 130.1, 129.7, 129.5, 128.6, 128.3, 127.9, 127.5, 126.9, 126.3, 126.2, 125.8, 123.6, 121.2, 119.1, 113.2, 112.8, 111.1, 55.5, 52.0, 50.1, 47.3, 41.3, 41.0, 39.4, 31.0, 10.7 ppm; IR (KBr) ν: 3440, 2946, 1698, 1648, 1589, 1526, 1474, 1418, 1406, 1358, 1289, 1277, 1249, 1217, 1178, 1123,1103, 1083, 1064, 832, 752, 578, 481 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{40}H_{35}BrN_3O_3$ $[M\text{-}Br]^+$ 684.1856, found 684.1856.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 68



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 68



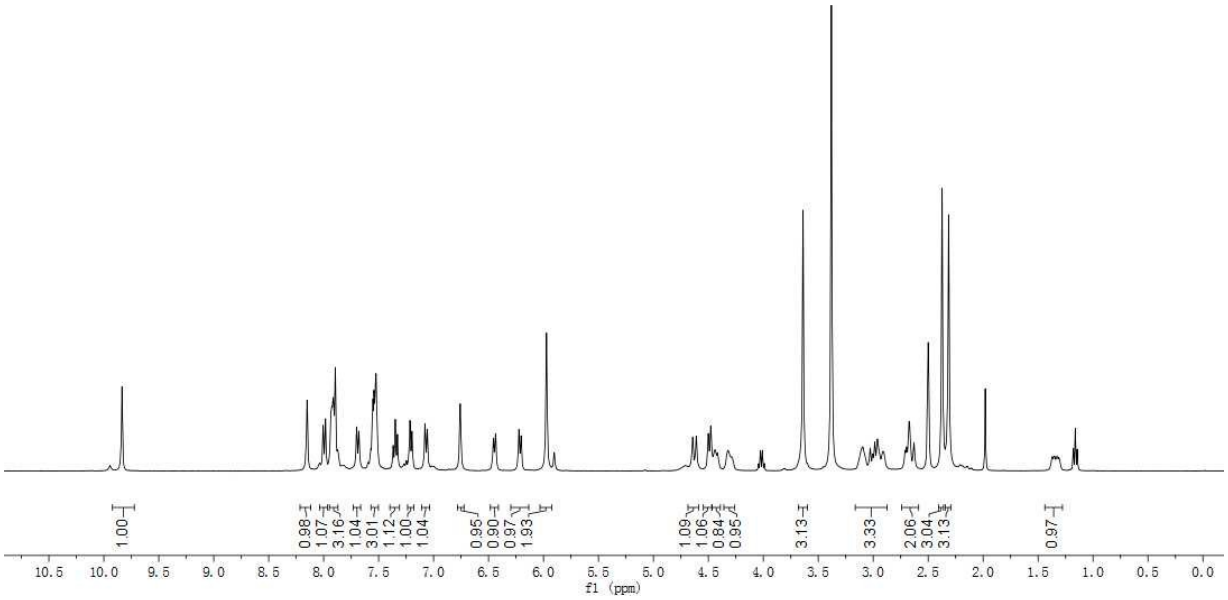


69

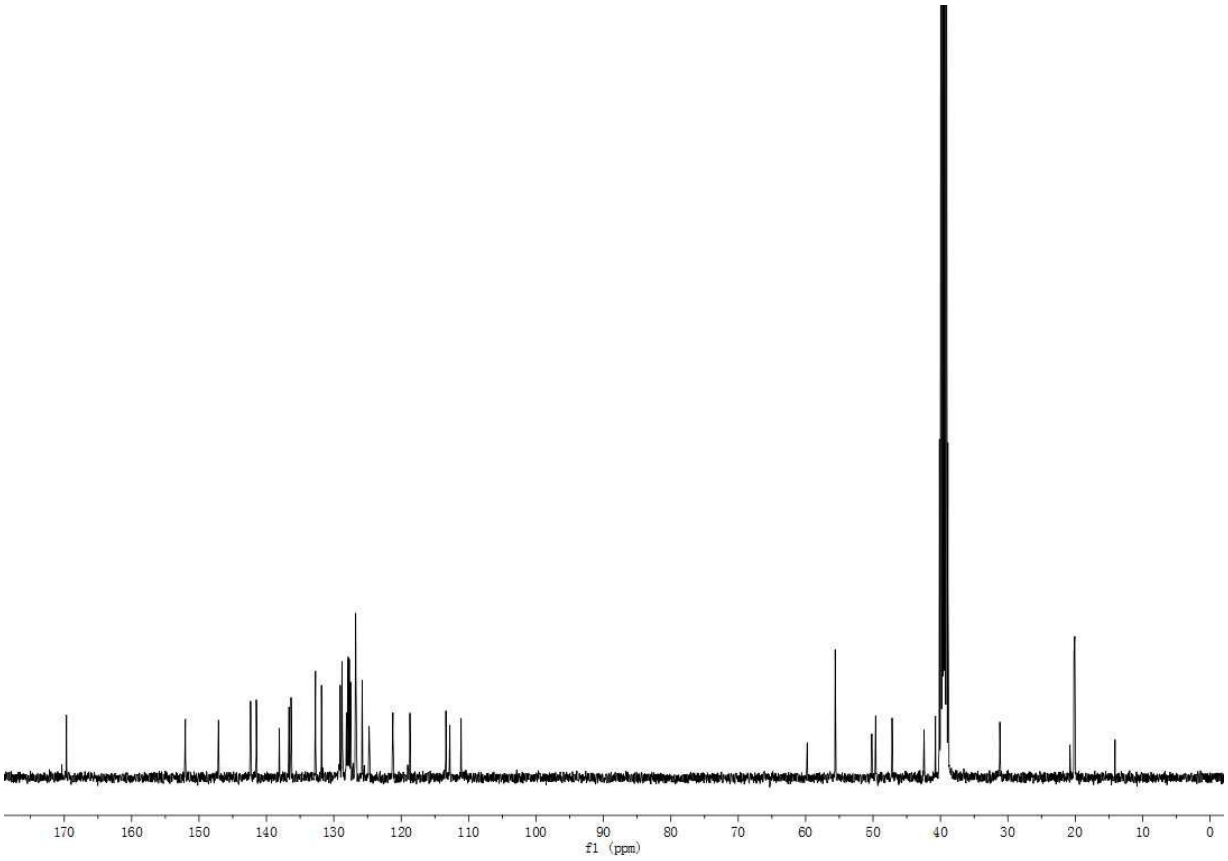
1-(3-((6a*R*,11b*R*)-10-bromo-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)-3-oxopropyl)-5,6-dimethyl-3-(naphthalen-2-ylmethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

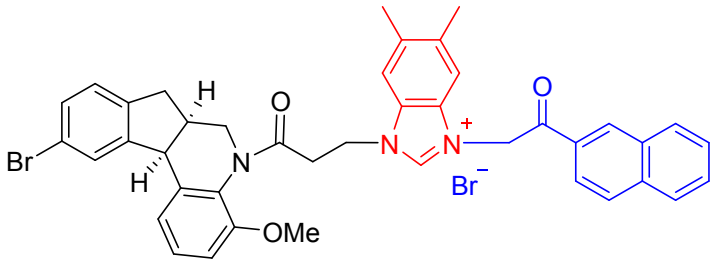
Yield 27%; white powder; m.p. = 201-203 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.83 (s, 1H), 8.15 (s, 1H), 7.99 (d, J = 8.4 Hz, 1H), 7.94-7.87 (m, 3H), 7.70-7.68 (m, 1H), 7.56-7.52 (m, 3H), 7.35 (t, J = 8.0 Hz, 1H), 7.21 (d, J = 7.6 Hz, 1H), 7.07 (d, J = 8.4 Hz, 1H), 6.76 (s, 1H), 6.45 (d, J = 8.0 Hz, 1H), 6.21 (d, J = 8.0 Hz, 1H), 5.97 (s, 2H), 4.63 (d, J = 13.2 Hz, 1H), 4.49 (d, J = 9.2 Hz, 1H), 4.44-4.41 (m, 1H), 4.34-4.27 (m, 1H), 3.64 (s, 3H), 3.13-2.90 (m, 3H), 2.71-2.63 (m, 2H), 2.37 (s, 3H), 2.31 (s, 3H), 1.38-1.30 (m, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 169.7, 152.0, 147.1, 142.4, 141.5, 138.1, 136.7, 136.4, 132.7, 132.7, 131.8, 129.2, 129.1, 128.8, 128.7, 128.1, 128.0, 127.9, 127.7, 127.5, 126.8, 126.7, 125.8, 124.8, 121.2, 118.7, 113.4, 112.8, 111. 1, 59.8, 55.6, 50.2, 49.6, 47.2, 42.4, 40.7, 39.3, 31.2, 20.2, 20.0 ppm; IR (KBr) ν: 3424, 2938, 1648, 1590, 1560, 1484, 1451, 1408, 1274, 1255, 1174, 1085, 1064, 758 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{40}H_{35}BrN_3O_3$ $[M\text{-}Br]^+$ 670.2064, found 670.2064.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 69



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 69



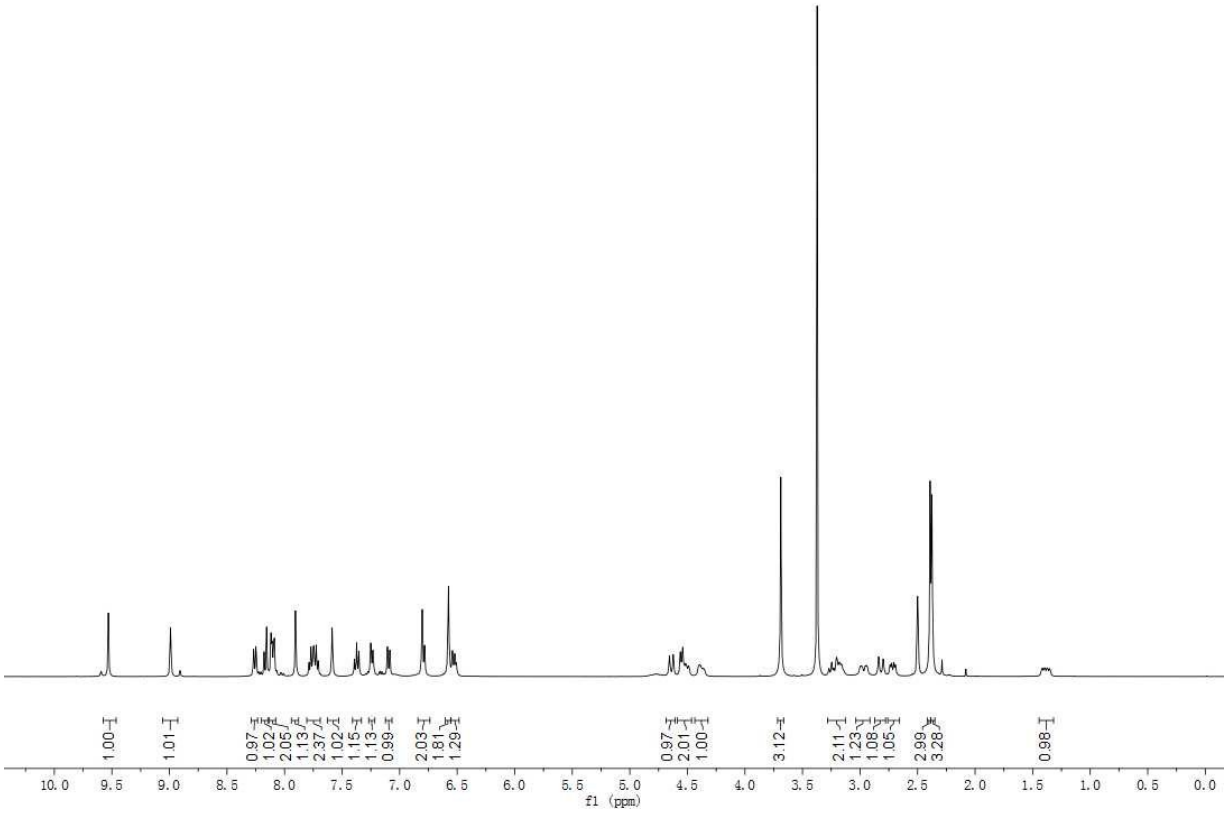


1-(3-((6a*R*,11b*R*)-10-bromo-4-methoxy-6,6a,7,11b-tetrahydro-5*H*-indeno[2,1-*c*]quinolin-5-yl)-3-oxopropyl)-5,6-dimethyl-3-(2-(naphthalen-2-yl)-2-oxoethyl)-1*H*-benzo[*d*]imidazol-3-ium bromide

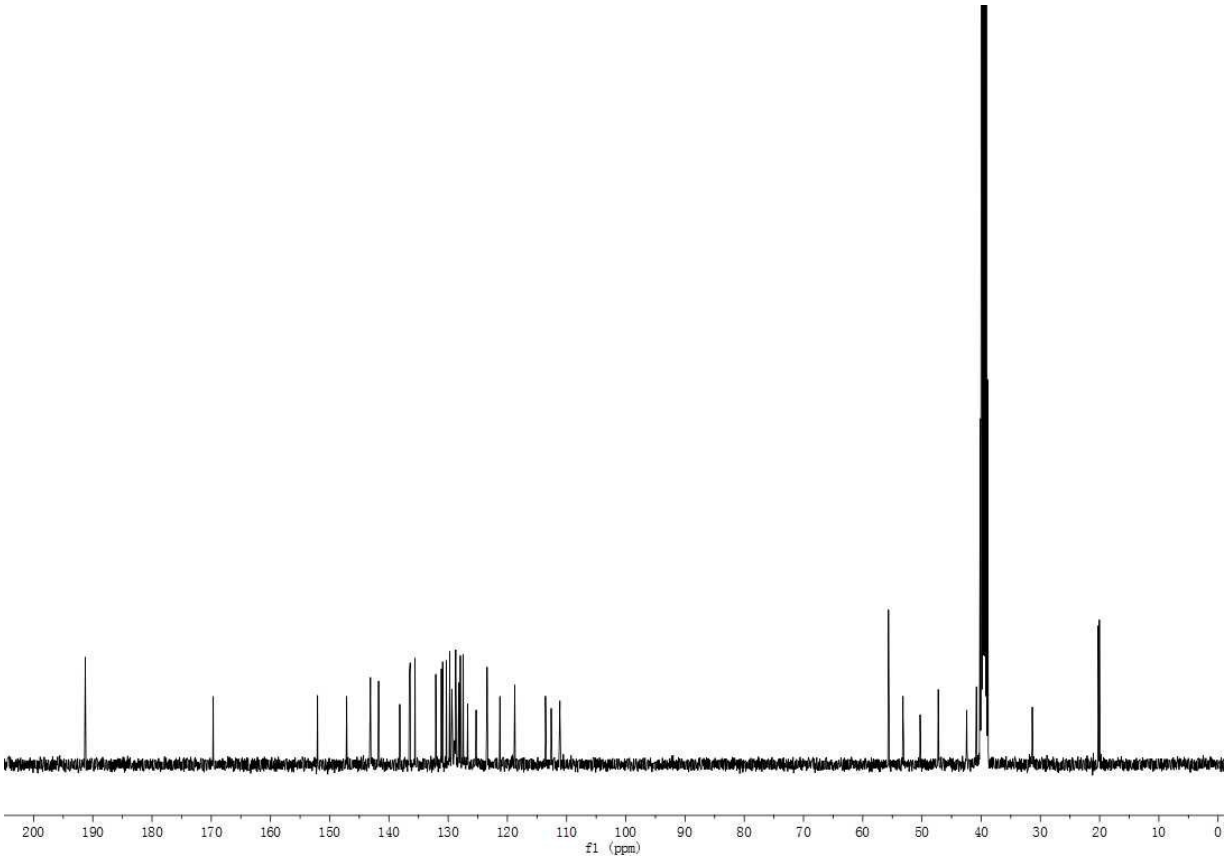
70

Yield 24%; white powder; m.p. = 213-215 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.53 (s, 1H), 8.99 (d, J = 1.7 Hz, 1H), 8.27-8.25 (m, 1H), 8.17 (d, J = 8.8 Hz, 1H), 8.12-8.09 (m, 2H), 7.91 (s, 1H), 7.79-7.71 (m, 2H), 7.59 (s, 1H), 7.37 (t, J = 7.6 Hz, 1H), 7.24 (d, J = 7.6 Hz, 1H), 7.10 (d, J = 8.0 Hz, 1H), 6.79 (d, J = 8.4 Hz, 2H), 6.58 (s, 2H), 6.54-6.51 (m, 1H), 4.64 (d, J = 13.2 Hz, 1H), 4.56-4.48 (m, 2H), 4.41-4.35 (m, 1H), 3.69 (s, 3H), 3.27-3.14 (m, 2H), 3.00-2.93 (m, 1H), 2.82 (d, J = 16.0 Hz, 1H), 2.72 (dd, J = 12.8, 5.6 Hz, 1H), 2.39 (s, 3H), 2.38 (s, 3H), 1.42-1.35 (m, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6) δ 191.3, 169.7, 152.1, 147.1, 143.1, 141.8, 138.2, 136.6, 136.4, 135.6, 132.1, 131.2, 130.9, 130.3, 129.7, 129.4, 128.9, 128.8, 128.7, 128.2, 128.0, 127.9, 127.5, 126.7, 125.3, 123.4, 121.3, 118.8, 113.6, 112.6, 111.1, 55.7, 53.2, 50.3, 47.3, 42.4, 40.8, 39.4, 31.4, 20.2, 20.0 ppm; IR (KBr) ν: 3424, 2938, 1691, 1653, 1591, 1559, 1489, 1453, 1410, 1277, 1259, 1220, 1179, 1123, 1105, 1086, 828, 754, 481 cm^{-1}; HRMS (ESI-TOF) *m/z* Calcd for $C_{40}H_{35}BrN_3O_3$ $[M\text{-}Br]^+$ 698.2013, found 698.2014.

^{1}H NMR spectra (400 MHz, DMSO-d_6) of Compound 70



^{13}C{^{1}H} NMR spectra (100 MHz, DMSO-d_6) of Compound 70



3. Biological Assay Procedures and Results

3.1 Cytotoxicity assay

The assay was in five kinds of cell lines (SMMC-7721, A549, MCF-7 and SW480). Cells were cultured at 37 ^{o}C under a humidified atmosphere of 5% CO_2 in RPMI 1640 medium supplemented with 10% fetal serum and dispersed in replicate 96-well plates. Compounds were then added. After 48 h exposure to the compounds, cells viability were determined by the [3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl-tetrazoliumbromide] (MTS) cytotoxicity assay by measuring the absorbance at 570 nm with a microplate spectrophotometer. Each test was performed in triplicate.

3.2 Cytotoxic activities of hybrid compounds 23-70 invitro[b] (IC_{50}, μM[a])

Entry	Compound No.	SMMC-7721	A-549	MCF-7	SW480
1	**23-34**	>20	>20	>20	>20
2	**35**	1.80 ± 0.24	4.25 ± 0.32	1.47 ± 0.17	1.66 ± 0.18
3	**36**	2.06 ± 0.37	5.74 ± 0.39	1.02 ± 0.03	2.16 ± 0.51
4	**37**	1.32 ± 0.14	3.65 ± 1.56	0.40 ± 0.25	1.27 ± 0.17
5	**38**	2.01 ± 0.19	5.32 ± 0.15	1.36 ± 0.17	1.80 ± 0.16
6	**39**	0.66 ± 0.11	1.51 ± 0.07	0.67 ± 0.10	0.56 ± 0.08
7	**40**	0.85 ± 0.17	1.51 ± 0.18	0.91 ± 0.27	0.93 ± 0.32
8	**41**	1.42 ± 0.14	1.40 ± 0.10	1.26 ± 0.13	1.73 ± 0.06
9	**42**	1.09 ± 0.11	1.47 ± 0.06	0.91 ± 0.15	1.46 ± 0.19
10	**43**	6.49 ± 0.76	14.40 ± 2.16	5.54 ± 1.06	3.51 ± 0.59
11	**44**	1.13 ± 0.08	1.53 ± 0.15	1.07 ± 0.06	1.50 ± 0.03
12	**45**	5.36 ± 1.12	14.42 ± 0.37	3.36 ± 0.45	2.34 ± 0.61
13	**46**	5.46 ± 0.50	8.26 ± 0.84	2.16 ± 0.21	2.06 ± 0.25
14	**47**	1.71 ± 0.35	4.83 ± 0.35	2.00 ± 0.01	2.00 ± 0.09
15	**48**	1.82 ± 0.41	5.83 ± 0.78	1.49 ± 0.07	1.62 ± 0.16
16	**49**	4.50 ± 0.50	8.27 ± 0.17	2.14 ± 0.19	1.80 ± 0.29
17	**50**	1.71 ± 0.04	4.91 ± 0.51	1.12 ± 0.14	1.38 ± 0.12
18	**51**	0.98 ± 0.29	1.42 ± 0.45	1.08 ± 0.28	1.62 ± 0.43
19	**52**	1.08 ± 0.26	1.89 ± 0.47	0.92 ± 0.01	1.28 ± 0.05

20	**53**	0.93 ± 0.05	1.22 ± 0.08	1.01 ± 0.12	1.24 ± 0.06
21	**54**	1.12 ± 0.09	1.61 ± 0.23	0.95 ± 0.10	1.26 ± 0.06
22	**55**	0.52 ± 0.06	1.30 ± 0.01	0.68 ± 0.14	0.75± 0.01
23	**56**	2.16 ± 0.74	5.62 ± 0.76	0.84 ± 0.78	3.92 ± 0.64
24	**57**	0.89 ± 0.02	1.53 ± 0.11	0.35 ± 0.13	1.40 ± 0.18
25	**58**	1.35 ± 0.16	3.48 ± 1.00	1.58 ± 0.15	4.26 ± 0.67
26	**59**	2.04 ± 0.57	6.27 ± 0.42	1.57 ± 0.38	1.57 ± 0.24
27	**60**	1.45 ± 0.32	3.68 ± 0.62	0.96 ± 0.20	0.77 ± 0.19
28	**61**	4.62 ± 0.73	10.61 ± 0.91	3.12 ± 0.71	2.65 ± 0.38
29	**62**	1.51 ± 0.11	4.71 ± 0.26	1.46 ± 0.06	1.44 ± 0.03
30	**63**	1.03 ± 0.15	2.58 ± 0.24	0.93 ± 0.14	0.97 ± 0.21
31	**64**	3.16 ± 1.72	7.53 ± 0.98	2.54 ± 0.81	0.80 ± 0.32
32	**65**	1.12 ± 0.23	1.99 ± 0.14	1.01 ± 0.25	1.35 ± 0.28
33	**66**	>20	>20	>20	15.40 ± 2.36
34	**67**	6.53 ± 0.72	9.29 ± 1.12	4.67 ± 0.20	3.79 ± 1.38
35	**68**	1.58 ± 0.20	2.63 ± 0.49	1.43 ± 0.20	1.75 ± 0.19
36	**69**	1.09 ± 0.01	1.45 ± 0.07	1.05 ± 0.10	1.05 ± 0.17
37	**70**	1.00 ± 0.08	1.11 ± 0.05	1.22 ± 0.16	1.83 ± 0.10
38	DDP	9.25 ± 0.39	5.55 ± 0.30	19.56 ± 0.49	6.84 ± 0.10

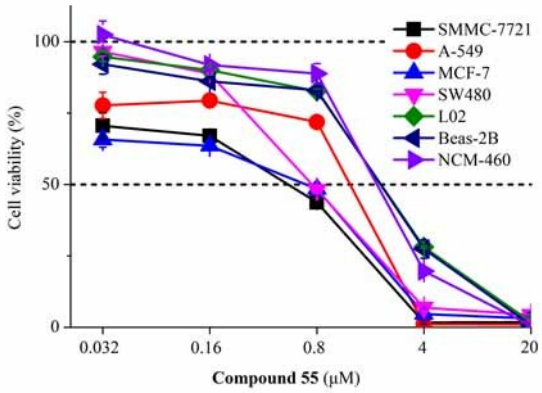
[a] Cytotoxicity as IC_{50} for each cell line, is the concentration of compound which reduced by 50% the optical density of treated cells with respect to untreated cells using the MTS assay.

[b] Data represent the mean values of three independent determinations.

3.3 Imidazolium salt 55 induced G0/G1 phase arrest and apoptosis in cancer cells

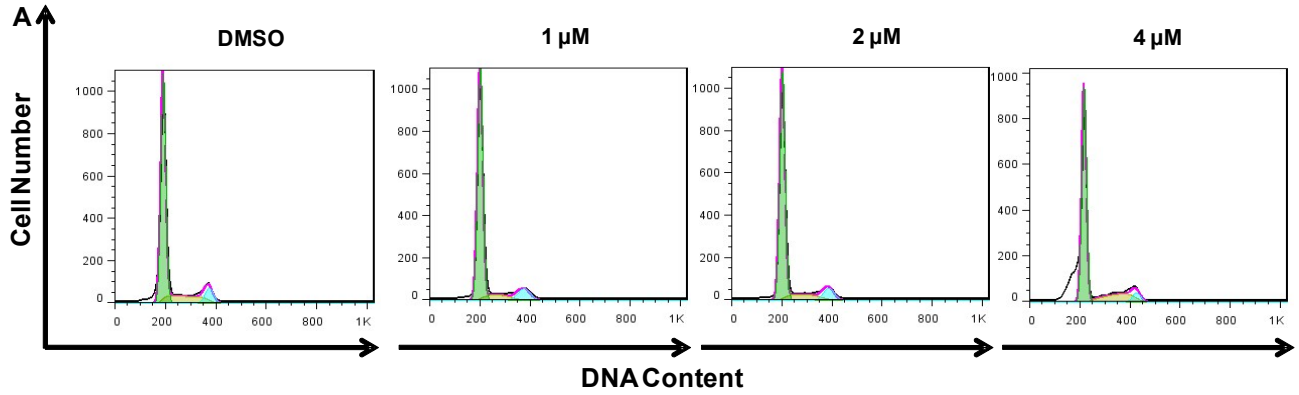
To determine the proliferation selectivity of compound **55**, the IC_{50} of compound **55** on three normal cell lines (normal human liver cell line L02, normal human lung cell line Beas-2B and normal human colon cell line NCM-460) were detected. As shown in Fig 1, compound **55** inhibited the growth of human cancer cells with moderate selectivity, compared with the corresponding normal human cell lines. To determine whether the proliferation inhibitory effect of aza-brazilan-imidazolium salt **55** caused by cell cycle arrest, propidium iodide (PI) staining and flow cytometry analysis of cells was performed in SMMC-7721 cells treated with

indicated concentrations of imidazolium salt **55** (1, 2, 4 μM). As shown in Fig. 2, the results suggested that imidazolium salt **55** may induce G0/G1 phase arrest in the cell cycle, and a sub-G1 peak (apoptotic peak) appeared when the concentration was at 4 μM.



Cell lines	55 (IC_{50} ± SD, μM)
SMMC-7721	0.52 ± 0.06
A-549	1.30 ± 0.01
MCF-7	0.68 ± 0.14
SW480	0.75 ± 0.01
L02	2.10 ± 0.04
Beas-2B	2.09 ± 0.14
NCM-460	1.97 ± 0.04

Fig. 1 The proliferation selectivity of imidazolium salt **55** against human cancer cells and normal human cell lines.



B	Cells (%)			
Treatment	sub-G1	G0/G1	S	G2/M
DMSO	4.03±0.47	72.17±1.0	14.733±1.29	8.21±0.38
Compound **55** (1 μM)	1.32±0.14	80.32±0.25	10.18±1.67	7.64±1.56
Compound **55** (2 μM)	1.21±0.18	80.22±0.89	9.27±1.69	9.16±0.93
Compound **55** (4 μM)	18.65±0.43	62.54±0.53	12.76±1.69	5.98±1.11

Fig. 2 Imidazolium salt **55** induced G0/G1 phase arrest in SMMC-7721 cells. (A) Cells were treated with 1, 2 and 4 μM of compound **55** for 24 h. Cell cycle was determined by PI staining and cell cytometry. (B) The

percentages of cells in different phases were quantified. At least three independent experiments were performed and data of one representative experiment was shown.

Aza-brazilan-imidazolium salt **55** induced cell apoptosis was determined with Annexin V-FITC/PI double-labeled cell cytometry. As shown in Fig. 3, after treatment of cells with imidazolium salt **55** at 0.5, 1, 2, 4 and 8 μM for 48 h, cell apoptosis in SMMC-7721 cells remarkably elevated to 8.97%, 15.13%, 16.22%, 77.72% and 81.56%, respectively. The data suggested that illustrated that steroidal imidazolium salt **55** inhibited cell proliferation through induction of G0/G1 cell cycle arrest and apoptosis of the SMMC-7721 cells.

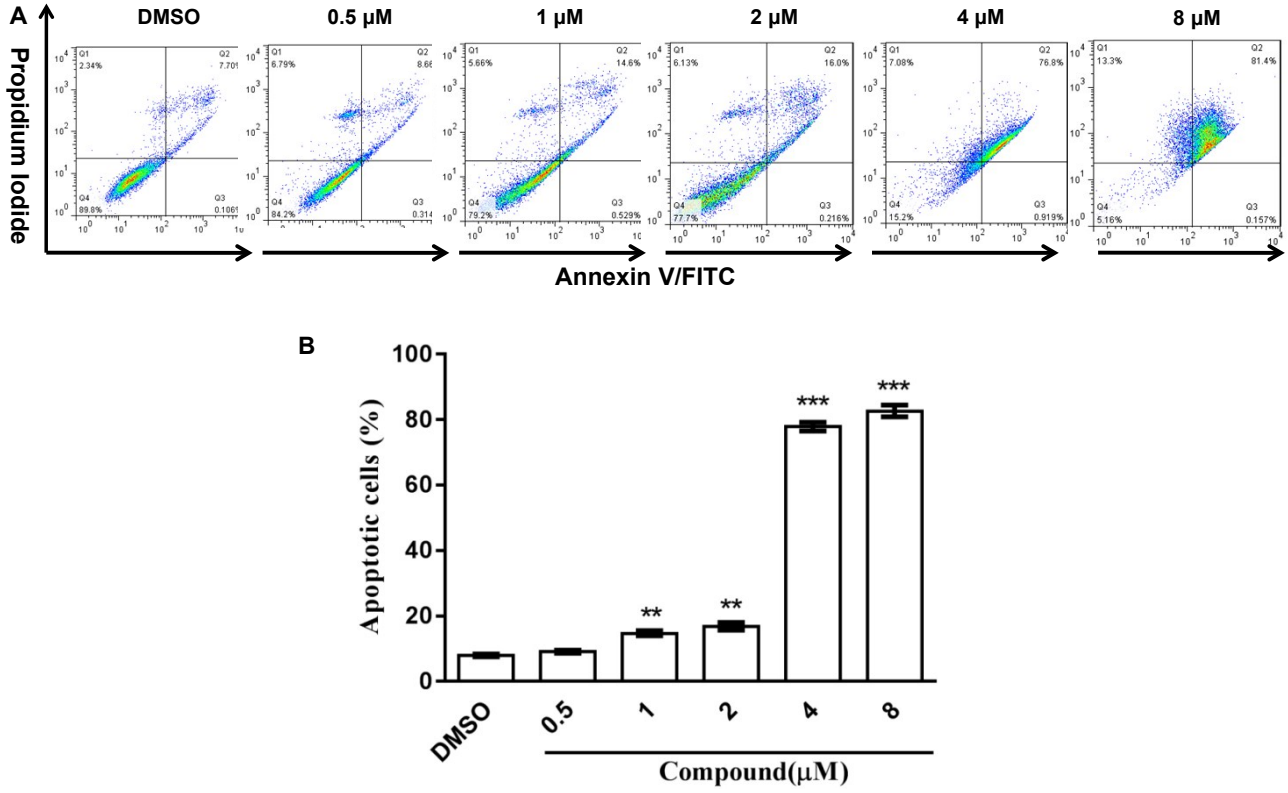


Fig. 3 Imidazolium salt **55** caused apoptosis of SMMC-7721 cells. (A) Cells were treated with 0.5, 1, 2, 4 and 8 μM imidazolium salt **55** for 48 h. Cell apoptosis was determined by Annexin V-FITC/PI double-staining assay. (B) The quantification of cell apoptosis. Four independent experiments were performed and data of one representative experiment was shown. The significance was determined by Student's t test (**$p < 0.01$ and ***$p < 0.001$ vs. DMSO).

4. References

1. Pan, C. X.; Zeng, X. H.; Guan, Y. F.; Jiang, X. L.; Li, L.; Zhang, H.B. *Synlett* **2011**, 425.
2. K. V. Emelen; T. D. Wit; F. Compernolle; *Org. Lett*. **2000**, 2, 3083-3086.
3. Wang, X. Q.; L, Y.; Yang, X. D.; Zhang, H. B. *Chin. J. Org. Chem*. **2015**, 35(6):1276-1285.