Synthesis of 2-aminobenzothiazole substituted indole via DBU catalyzed addition of indole and benzothiazolimine

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Supporting Information

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1. General Information

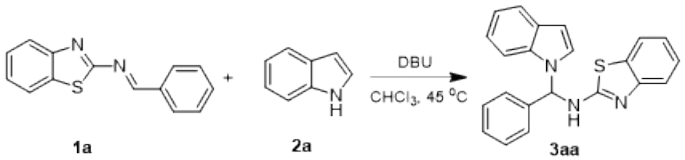
Chemicals were purchased from commercial suppliers and used without further purification unless otherwise stated. Reactions were monitored by TLC and visualized with ultraviolet light. Flash column chromatography was performed on silica gels (300-400 mesh) eluting with ethyl acetate, dichloromethane and petroleum ether. ^{1}H NMR and ^{13}C NMR spectra were recorded on Bruker Avance (400MHz for ^{1}H NMR, 100MHz and for ^{13}C NMR) instruments. Data for ^{1}H NMR are reported as chemical shift (ppm, tetramethylsilane as the internal standard), integration, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), coupling constant (Hz). Data for ^{13}C NMR are reported as chemical shift. Flash column chromatography was carried out using silica gel eluting with ethyl acetate and petroleum ether. High-resolution mass spectra (HRMS) analyses were obtained with the Bruker Solari X 70 Fourier-transform mass spectrometer. Reactions were monitored by TLC and visualized with ultraviolet light. Melting points were recorded on a Buchi Melting Point B-545.

2. Experimental Procedures

2.1. Typical Procedure for the Synthesis of benzothiazolimines 1.

Benzothiazolimines[1] were prepared as reported procedures. Unless otherwise noted, materials were purchased from commercial suppliers and used without further purification.

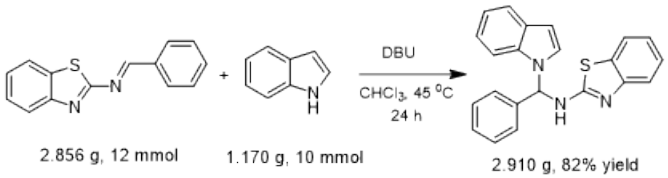
2.2. General procedure for the synthesis of 3



1a 2a 3aa

To a reaction tube equipped (15.0 mL) with a stirrer were added **1a** (28.6 mg, 0.12 mmol), **2a** (11.7 mg, 0.1 mmol), 1.0 equiv. DBU and $CHCl_3$ (1.0 mL). The tube was then sealed, and the mixture was stirred at 45 °C under air until the reaction was completed. The mixture was evaporated and purified by silica gel column chromatography using petroleum ether/ethyl acetate (15/1-10/1) as eluent to afford **3aa** (30.2 mg). Other products were obtained in a similar manner.

2.3. Scale-up preparation and representative transformation of product 3a



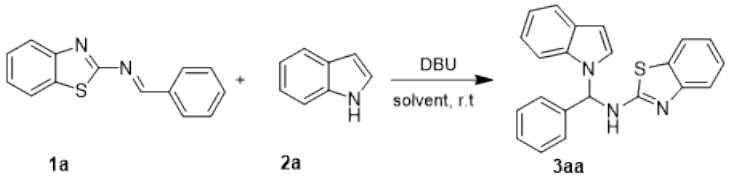
A solution of benzothiazolimine **1a** (2.856 g, 12.0 mmol, 1.2 equiv.), indol **2a** (1.170 g, 10 mmol, 1.0 equiv.), 1.0 equiv. DBU and $CHCl_3$ (1.0 mL). The tube was stirred at 45 °C. After indol **2a** was consumed monitored by TLC, the solvent was evaporated and the mixture was directly purified by column chromatography on silica gel eluting with petroleum ether/ethyl acetate to afford product **3aa**.

Reference

[1] Q.-J. Ni, X.-X. Song, J.-W. Xiong, G. Raabe, and D. Enders. *Chem. Commun*., 2015, 51, 1263.

3. Preliminary reaction condition optimization for Mannich reaction

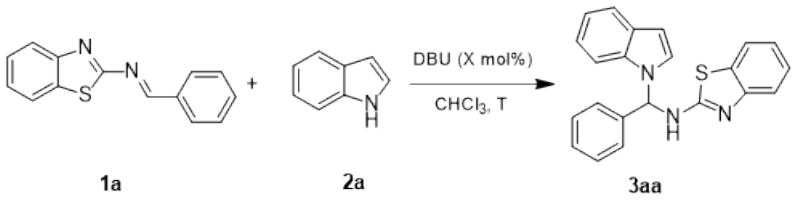
Table S1 Screenings of solvent[a]



Entry[a]	Solvent	Time (h)	Yield[b] (%)
1	CH_2Cl_2	48	60
2	$CHCl_3$	48	64
3	DCE	48	40
4	MeCN	44	44
5	DMF	72	nd[c]
6	DMSO	72	nd[c]
7	CH_3OH	72	nd[c]
8	Toluene	168	35
9	THF	168	44
10	EA	168	40
11	MTBE	72	38
12	1,4-Dioxane	72	52
13	Hexane	168	nd[c]
14	H_2O	168	nr[d]

[a]Unless otherwise specified, the reaction was performed with 0.15mmol **1a**, 0.1 mmol **2a** and 20 mol% catalyst in 1.0 mL solvent at room temperature. [b]Isolated yields. [c]No determined. [d]No reaction

Table S2 Further Optimization of Reaction Conditions[a]



1a 2a 3aa

Entry[a]	**1a:2a**	T/°C	X	T/h	Yield[b] (%)
1	1.5:1	r.t	20	48	64
2	1.5:1	r.t	50	48	67
3	1.5:1	r.t	100	48	80
4	1.5:1	r.t	150	48	80
5	1.5:1	r.t	200	48	78
6	1:1	r.t	100	48	72
7	1.2:1	r.t	100	48	80
8	2.0:1	r.t	100	48	78
9	1.2:1	r.t	100	48	76
10	1.2:1	r.t	100	48	80
11	1.2:1	45	100	24	85
12	1.2:1	reflux	100	16	81

[a]Unless otherwise specified, the reaction was performed with 0.15mmol **1a**, 0.1 mmol **2a** and 20 mol% catalyst in 1.0 mL $CHCl_3$ at room temperature. [b]Isolated yields.

4. Crystallographic Information for 2-aminobenzothiazole 3ia (CCDC 2301432)

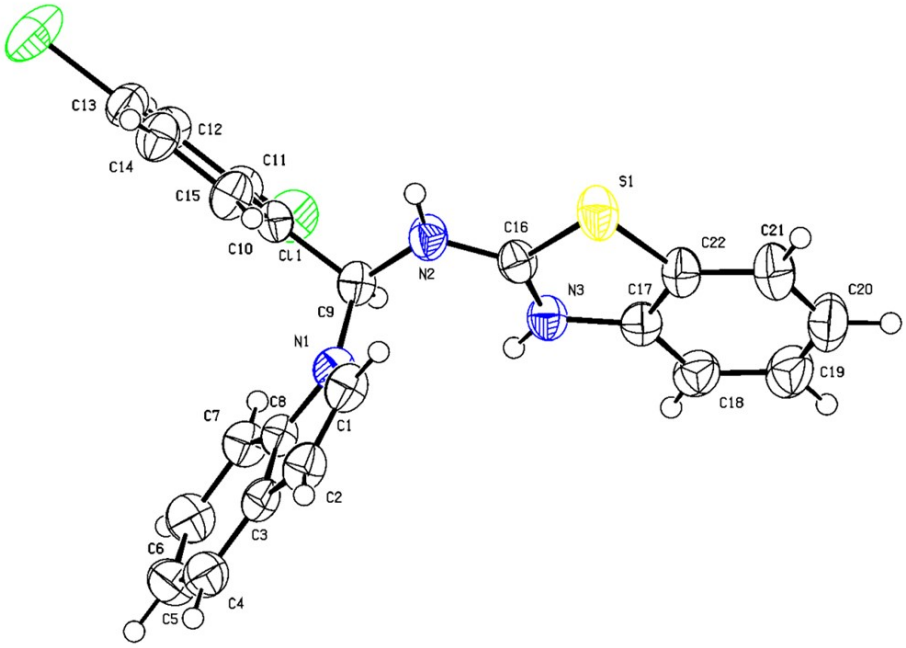


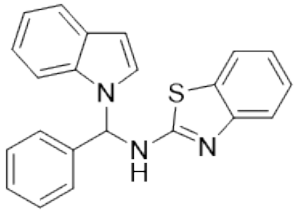
Figure S1. ORTEP plot of compound **3ia**
Thermal ellipsoids are drawn at 30% probability level.

Table S3 Important crystal data of compound **3ia**

Empirical formula	$C_{22}H_{16}Cl_2N_3S$
Formula weight	425.34
Temperature/K	293(2)
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	8.5113(9)
b/Å	22.4784(19)
c/Å	10.1545(9)
α/°	90
β/°	99.787(9)
γ/°	90
Volume/Å^3	1914.5(3)
Z	4
ρ_{calc}g/cm^3	1.476
μ/mm^{-1}	0.462
F(000)	876.0
Crystal size/mm^3	0.16× 0.1 × 0.08
Radiation	Mo Kα (λ = 0.71073)
2Θ range for data collection/°	4.456 to 61.108
Index ranges	$-12 \leq h \leq 11$, $-32 \leq k \leq 31$, $-14 \leq l \leq 14$
Reflections collected	27664
Independent reflections	5687 [R_{int} = 0.0553, R_{sigma} = 0.0544]
Data/restraints/parameters	5687/0/253
Goodness-of-fit on F^2	1.029
Final R indexes [I>=2σ (I)]	R_1 = 0.0506, wR_2 = 0.1063
Final R indexes [all data]	R_1 = 0.1013, wR_2 = 0.1234
Largest diff. peak/hole / e Å^{-3}	0.24/-0.53

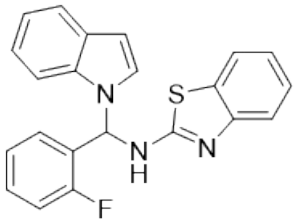
5. ^{1}H and ^{13}C NMR data for all compound

***N*-((1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3aa）**



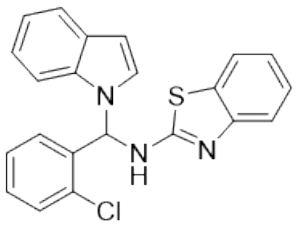
The target product **3aa** (30.2 mg, 85%) was synthesized as a white solid, mp: 164.0~165.1 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.49 (d, J = 8.2 Hz, 1H), 7.73 (d, J = 7.8 Hz, 1H), 7.66 (d, J = 8.2 Hz, 1H), 7.56 (d, J = 7.9 Hz, 2H), 7.48 (d, J = 3.2 Hz, 1H), 7.43 (d, J = 8.0 Hz, 1H), 7.4~7.29 (m, 5H), 7.24 (t, J = 7.3 Hz, 1H), 7.10 (dd, J = 16.0, 7.8 Hz, 2H), 7.06~6.98 (m, 1H), 6.52 (d, J = 3.2 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 164.8, 151.7, 138.4, 135.2, 130.6, 128.7, 128.6, 128.4, 126.4, 126.1, 125.7, 121.8, 121.4, 121.2, 120.6, 119.6, 118.8, 110.8, 101.7, 67.3. HRMS (ESI) *m/z* calcd for $C_{22}H_{18}N_3S^+$ $(M+H)^+$ 356.1216, found 356.1218.

***N*-((2-fluorophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3ba）**



The target product **3ba** (30.6 mg, 82%) was synthesized as a white solid, mp: 168.2~169.3 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.56 (d, J = 7.9 Hz, 1H), 7.83 (d, J = 7.9 Hz, 1H), 7.74 (d, J = 7.5 Hz, 1H), 7.58 (d, J = 7.8 Hz, 1H), 7.52 (d, J = 8.2 Hz, 1H), 7.49~7.39 (m, 3H), 7.35~7.28 (m, 1H), 7.28~7.20 (m, 3H), 7.14 (t, J = 7.3 Hz, 1H, 7.09 (d, J = 7.8 Hz, 1H), 7.05 (d, J = 7.2 Hz, 1H), 6.53 (d, J = 3.0 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 164.3, 151.5, 135.0, 131.0 (d, $J_{C\text{-}F}$ = 8.3 Hz), 130.6, 128.6, 127.6, 125.7 (d, $J_{C\text{-}F}$ = 15.2 Hz), 125.4 (d, $J_{C\text{-}F}$ = 13.2 Hz), 124.8 (d, $J_{C\text{-}F}$ = 3.4 Hz), 121.8 (d, $J_{C\text{-}F}$ = 16.2 Hz), 121.2, 120.7, 119.8, 118.9, 116.0, 115.8, 110.2, 102.0, 62.0 (d, $J_{C\text{-}F}$ = 3.9 Hz). HRMS (ESI) *m/z* calcd for $C_{22}H_{16}FN_3SNa^+$ $(M+Na)^+$ 396.0941, found 396.0944.

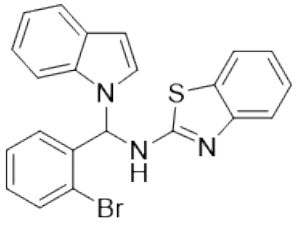
***N*-((2-chlorophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3ca）**



The target product **3ca** (31.5 mg, 81%) was synthesized as a white solid, mp: 156.1~157.5 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.51 (d, J = 7.0 Hz, 1H), 7.81 (d, J = 7.6 Hz, 1H), 7.74 (d, J = 7.8 Hz, 1H), 7.59 (d, J = 8.0 Hz, 2H), 7.43 (ddd, J = 10.6, 9.2, 6.0 Hz, 3H), 7.37 (d, J = 7.6 Hz, 1H), 7.31 (d, J = 3.3 Hz, 1H), 7.25 (t, J = 7.4 Hz, 1H), 7.19 (d, J = 7.0 Hz, 1H), 7.17~7.08 (m, 2H), 7.06 (d, J = 7.0 Hz, 1H), 6.54 (d, J = 3.1 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 164.3, 151.6, 135.5, 133.6, 130.6, 130.0, 128.1, 127.7, 127.6, 125.7, 125.5, 121.9, 121.8, 121.2, 120.8, 119.9, 119.0,

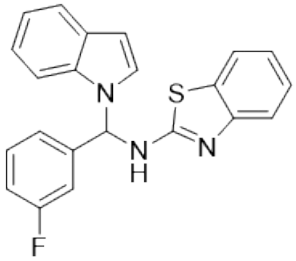
110.1, 102.0, 64.8. HRMS (ESI) *m/z* calcd for $C_{22}H_{16}ClN_3SNa^+$ $(M+Na)^+$ 412.06457, found 412.06461.

***N*-((2-bromophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3da）**



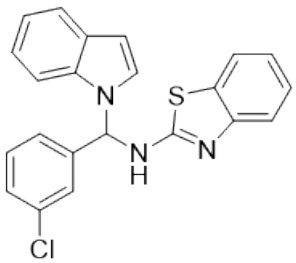
The target product **3da** (34.3 mg, 79%) was synthesized as a white solid, mp: 171.3~173.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.48 (d, J = 7.0 Hz, 1H), 7.74 (dd, J = 17.1, 7.6 Hz, 2H), 7.60 (d J = 8.0, 1H), 7.47 (d, J = 6.3 Hz, 1H), 7.44 (s, 1H), 7.37 (dd, J = 9.4, 4.9 Hz, 3H), 7.29 (d, J = 3.3 Hz, 1H), 7.24 (t, J = 7.2 Hz, 1H),7.18~7.12 (m, 2H), 7.10 (d, J = 7.1 Hz, 1H), 7.06 (d, J = 6.7 Hz, 1H), 6.54 (d, J = 3.1 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 164.3, 151.7, 137.0, 135.2, 133.3, 130.8, 130.6, 128.0, 128.2, 127.8, 125.7, 125.4, 123.0, 121.9, 121.2, 120.8, 119.9, 119.0, 110.1, 102.0, 67.1. HRMS (ESI) *m/z* calcd for $C_{22}H_{16}BrN_3SNa^+$ $(M+Na)^+$ 456.0141, found 456.0140.

***N*-((3-fluorophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3ea）**



The target product **3ea** (28.0 mg, 75%) was synthesized as a white solid, mp: 192.3~193.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.52 (d, J = 8.1 Hz, 1H), 7.72 (dd, J = 17.2, 8.0 Hz, 2H), 7.58 (dd, J = 10.7, 8.3 Hz, 2H), 7.51 (d, J = 3.2 Hz, 1H), 7.48~7.40 (m, 2H), 7.25 (t, J = 5.8 Hz, 1H), 7.22 (d, J = 9.5 Hz, 1H), 7.19~7.13 (m, 3H), 7.11 (d, J = 5.2 Hz, 1H), 7.06 (dd, J = 13.7, 6.3 Hz, 2H), 6.53 (d, J = 3.2 Hz, 1H).^{13}C NMR (100 MHz, DMSO-d_6) δ 164.6, 162.2 (d, $J_{C\text{-}F}$ = 244.3 Hz), 151.6, 141.2 (d, $J_{C\text{-}F}$ = 7.0 Hz), 135.1, 130.8 (d, $J_{C\text{-}F}$ = 8.3 Hz), 130.7, 128.6, 126.0, 125.7, 122.6, 121.9, 121.4, 121.2 (d, $J_{C\text{-}F}$ = 12.0 Hz), 119.7, 118.9, 115.40 (d, $J_{C\text{-}F}$ = 21.0 Hz), 113.47 (d, $J_{C\text{-}F}$ = 22.8 Hz), 110.8, 101.9, 66.8. HRMS (ESI) *m/z* calcd for $C_{22}H_{16}FN_3SNa^+$ $(M+Na)^+$ 396.09412, found 396.09421.

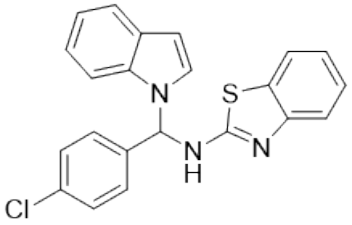
***N*-((3-chlorophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3fa）**



The target product **3fa** (30.0mg, 77%) was synthesized as a white solid, mp: 164.3~166.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.52 (d, J = 8.2 Hz, 1H), 7.72 (dd, J = 11.9, 8.1 Hz, 2H), 7.59 (dd, J = 11.1, 8.2 Hz, 2H), 7.51 (d, J = 3.3 Hz, 1H), 7.48~7.38 (m, 4H), 7.28 (dd, J = 5.3, 4.3 Hz, 1H),

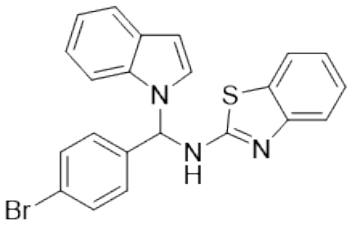
7.26~7.22 (m, 1H), 7.14 (t, *J* = 7.6 Hz, 1H), 7.07 (dt, *J* = 15.2, 7.4 Hz, 2H), 6.54 (d, *J* = 3.1 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 164.6, 151.6, 140.8, 135.1, 133.4, 130.6, 128.6, 126.4, 126.0, 125.7, 125.3, 121.9, 121.6, 121.2, 120.7, 119.7, 118.9, 110.8, 102.0, 66.7. HRMS (ESI) *m/z* calcd for $C_{16}H_{13}FN_2OS_2Na^+$ $(M+Na)^+$ 355.0345, found 355.0345.

***N*-((4-chlorophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3ga）**



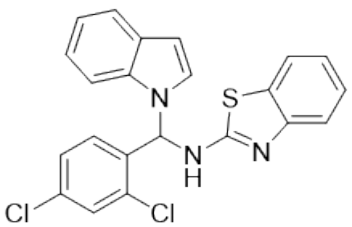
The target product **3ga** (31.5mg, 81%) was synthesized as a white solid, mp: 208.2~209.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.50 (d, *J* = 8.0 Hz, 1H), 7.73 (d, *J* = 7.7 Hz, 1H), 7.67 (d, *J* = 7.9 Hz, 1H), 7.56 (d, *J* = 7.9 Hz, 2H), 7.47 (d, *J* = 8.7 Hz, 3H), 7.43 (d, *J* = 8.1 Hz, 1H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.24 (t, *J* = 7.5 Hz, 1H), 7.11 (dd, *J* = 17.2, 8.0 Hz, 2H), 7.07~7.01 (m, 1H), 6.53 (d, *J* = 1.9 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 164.7, 151.6, 137.4, 135.0, 133.2, 130.6, 128.7, 128.4 126.1, 125.7, 121.8, 121.5, 121.2, 120.6, 119.7, 118.9, 110.8, 101.9, 66.8. HRMS (ESI) *m/z* calcd for $C_{22}H_{16}ClN_3SNa^+$ $(M+Na)^+$ 412.06457, found 412.06476.

***N*-((4-bromophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3ha）**



The target product **3ha** (34.6 mg, 80%) was synthesized as a white solid, mp: 183.3~185.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.50 (d, *J* = 7.7 Hz, 1H), 7.74 (d, *J* = 7.9 Hz, 1H), 7.63~7.54 (m, 4H), 7.51~7.46 (m, 1H), 7.41 (dd, *J* = 17.4, 10.1 Hz, 1H), 7.36~7.32 (m, 1H), 7.26 (d, *J* = 8.0 Hz, 3H), 7.08 (dd, *J* = 9.8, 5.2 Hz, 2H), 7.04 (d, *J* = 8.8 Hz, 1H), 6.53 (d, *J* = 2.9 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 165.1, 152.1, 138.3, 135.5, 134.1, 132.8, 132.2, 131.1, 129.2, 127.2, 126.2, 125.7, 122.0, 121.7 121.2, 120.4, 119.3, 111.3, 102.4, 67.3. HRMS (ESI) *m/z* calcd for $C_{22}H_{16}BrN_3SNa^+$ $(M+Na)^+$ 456.0140, found 456.0139.

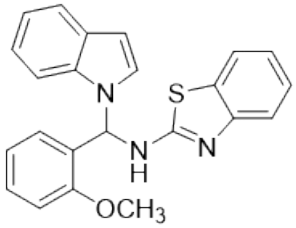
***N*-((2,4-dichlorophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3ia）**



The target product **3ia** (28.4 mg, 67%) was synthesized as a white solid, mp: 183.3~185.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.51 (d, *J* = 6.7 Hz, 1H), 7.80~7.71 (m, 3H), 7.60 (d, *J* = 7.9 Hz, 1H), 7.54~7.45 (m, 3H), 7.42 (d, *J* = 8.3 Hz, 1H), 7.33 (d, *J* = 3.0 Hz, 1H), 7.25 (t, *J* = 7.7 Hz, 1H), 7.16 (t, *J* = 9.3 Hz, 2H), 7.10 (d, *J* = 7.0 Hz, 1H), 7.07 (d, *J* = 6.9 Hz, 1H), 6.55 (d, *J* = 3.2 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 164.2, 151.6, 135.1, 134.6, 134.4, 133.6, 130.6, 129.5, 129.0,

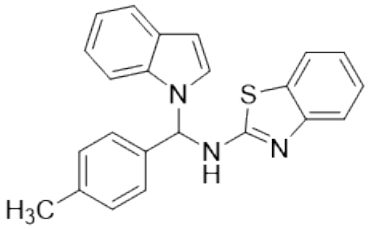
128.7, 127.9, 125.8, 125.5, 121.9, 121.3, 120.9, 119.0, 110.1, 102.2, 64.5. HRMS (ESI) *m/z* calcd for $C_{22}H_{15}Cl2N_3SNa^+$ $(M+Na)^+$ 446.0256, found 446.0251.

***N*-((1*H*-indol-1-yl)(2-methoxyphenyl)methyl)benzo[*d*]thiazol-2-amine（3ja）**



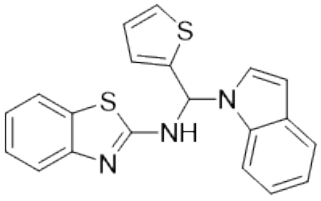
The target product **3ja** (34.7 mg, 90%) was synthesized as a white solid, mp: 183.3~185.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.37 (d, J = 8.1 Hz, 1H), 7.81 (d, J = 8.1 Hz, 1H), 7.72 (d, J = 7.7 Hz, 1H), 7.55 (d, J = 7.8 Hz, 1H), 7.45 (t, J = 7.3 Hz, 2H), 7.41~7.35 (m, 1H), 7.32 (d, J = 3.3 Hz, 1H), 7.23 (t, J = 7.7 Hz, 2H), 7.1~7.08 (m, 2H), 7.04 (dd, J = 14.7, 7.2 Hz, 2H), 6.97 (t, J = 7.5 Hz, 1H), 6.46 (d, J = 3.2 Hz, 1H), 3.81 (s, 3H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 165.0, 156.9, 152.2, 135.6, 131.0, 130.7, 129.1, 127.2, 126.4, 126.2, 126.0, 122.2, 121.9, 121.7, 121.1, 120.9, 120.0, 119.3, 112.0, 110.8, 101.7, 62.7, 56.3. HRMS (ESI) *m/z* calcd for $C_{23}H_{19}N_3OSNa^+$ $(M+Na)^+$ 408.1141, found 408.1142.

***N*-((1*H*-indol-1-yl)(p-tolyl)methyl)benzo[*d*]thiazol-2-amine（3ka）**



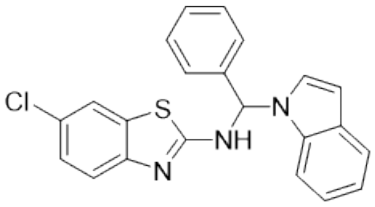
The target product **3ka** (32.1 mg, 87%) was synthesized as a white solid, mp: 183.3~185.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.45 (d, J = 8.2 Hz, 1H), 7.72 (d, J = 7.8 Hz, 1H), 7.61 (d, J = 8.1 Hz, 1H), 7.54 (dd, J = 11.6, 5.6 Hz, 2H), 7.46 (d, J = 3.2 Hz, 1H), 7.42 (t, J = 8.1 Hz, 2H), 7.23 (d, J = 2.7 Hz, 1H), 7.20 (d, J = 2.9 Hz, 4H), 7.13~7.08 (m, 2H), 7.08~6.99 (m, 1H), 6.50 (d, J = 3.1 Hz, 1H), 2.28 (s, 3H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 164.7, 151.7, 137.8, 135.4, 135.1, 130.6, 130.2, 129.8, 129.2, 128.6, 126.4, 126.1, 125.7, 125.1, 121.7, 121.3, 120.6, 119.5, 118.7, 110.8, 101.5, 67.2, 20.6. HRMS (ESI) *m/z* calcd for $C_{23}H_{19}N_3SNa^+$ $(M+Na)^+$ 392.1192, found 392.1191.

***N*-((1*H*-indol-1-yl)(thiophen-2-yl)methyl)benzo[*d*]thiazol-2-amine（3la）**



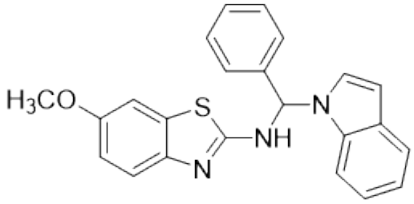
The target product **3la** (20.9 mg, 58%) was synthesized as a white solid, mp: 205.5~206.8 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.65 (d, J = 8.3 Hz, 1H), 7.91 (dd, J = 13.6, 8.3 Hz, 1H), 7.74 (d, J = 7.7 Hz, 1H), 7.66 (d, J = 8.2 Hz, 1H), 7.61~7.49 (m, 3H), 7.45 (d, J = 7.9 Hz, 1H), 7.26 (t, J = 7.6 Hz, 1H), 7.15 (t, J = 7.4 Hz, 1H), 7.12~7.01 (m, 3H), 7.01~6.96 (m, 1H), 6.53 (d, J = 3.1 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 171.5, 160.5, 151.8, 142.4, 138.8, 135.8, 135.5, 129.7, 129.1, 127.5, 127.2, 126.5, 125.6, 122.4, 121.7, 120.5, 119.3, 111.8, 101.4, 64.5. HRMS (ESI) *m/z* calcd for $C_{20}H_{15}N_3S_2Na^+$ $(M+Na)^+$ 384.0600, found 384.0600.

***N*-((1*H*-indol-1-yl)(phenyl)methyl)-6-chlorobenzo[*d*]thiazol-2-amine（3ma）**



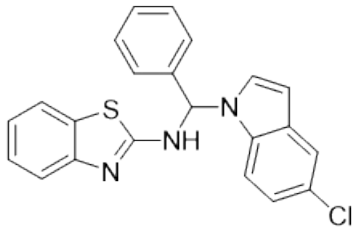
The target product **3ma** (27.2 mg, 70%) was synthesized as a white solid, mp: 178.5~179.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.62 (d, J = 8.0 Hz, 1H), 7.88 (d, J = 2.1 Hz, 1H), 7.64 (d, J = 7.6 Hz, 1H), 7.60~7.52 (m, 2H), 7.48 (d, J = 3.2 Hz, 1H), 7.44~7.36 (m, 4H), 7.32 (d, J = 7.9 Hz, 2H), 7.26 (dd, J = 8.6, 2.2 Hz, 1H), 7.12 (t, J = 7.7 Hz, 1H), 7.05 (t, J = 7.4 Hz, 1H), 6.53 (d, J = 3.0 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 165.9, 151.1, 138.7, 135.6, 132.8, 129.2, 129.0, 126.9, 126.5, 126.4, 126.1, 122.0, 121.4, 121.1, 120.2, 120.1, 111.3, 102.2, 67.8. HRMS (ESI) *m/z* calcd for $C_{22}H_{16}ClN_3SNa^+$ $(M+Na)^+$ 412.0646, found 412.0648.

***N*-((1*H*-indol-1-yl)(phenyl)methyl)-6-methoxybenzo[*d*]thiazol-2-amine（3na）**



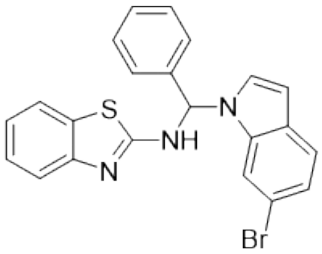
The target product **3na** (31.6 mg, 82%) was synthesized as a white solid, mp: 178.5~179.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.28 (d, J = 8.2 Hz, 1H), 7.68~7.64 (m, 1H), 7.55 (t, J = 8.4 Hz, 3H), 7.49 (d, J = 3.1 Hz, 1H), 7.39 (s, 1H), 7.36 (d, J = 2.7 Hz, 2H), 7.33~7.30 (m, 2H), 7.12~7.07 (m, 1H), 7.06~6.96 (m, 2H), 6.84 (dd, J = 8.8, 2.5 Hz, 1H), 6.51 (d, J = 3.0 Hz, 1H), 3.73 (s, 3H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 166.2, 154.9, 138.5, 135.1, 131.7, 129.9, 129.1, 128.5, 126.4, 126.0, 123.3, 121.4, 120.8, 120.6, 120.0, 119.5, 119.2, 113.3, 110.8, 101.6, 67.4, 55.5. HRMS (ESI) *m/z* calcd for $C_{23}H_{19}N_3OSNa^+$ $(M+Na)^+$ 408.1141, found 408.1141.

***N*-((5-chloro-1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3ab）**



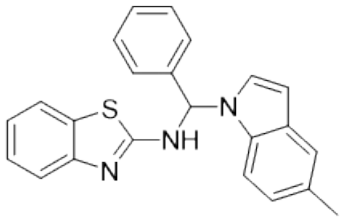
The target product **3ab** (25.3 mg, 65%) was synthesized as a white solid, mp: 188.0~189.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.53 (d, J = 8.1 Hz, 1H), 7.75 (d, J = 7.8 Hz, 1H), 7.66 (d, J = 8.2 Hz, 1H), 7.62 (d, J = 8.7 Hz, 2H), 7.59 (d, J = 3.2 Hz, 1H), 7.39 (dt, J = 13.7, 5.8 Hz, 4H), 7.31 (d, J = 7.0 Hz, 2H), 7.25 (t, J = 7.6 Hz, 1H), 7.14 (dd, J = 8.8, 1.8 Hz, 1H), 7.09 (t, J = 7.7 Hz, 1H), 6.53 (d, J = 3.1 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 165.1, 152.3, 138.5, 134.0, 130.6, 130.3, 129.7, 129.2, 129.1, 128.4, 126.9, 126.2, 124.8, 122.4, 121.9, 121.8, 120.3, 119.3, 112.9, 101.9, 68.0. HRMS (ESI) *m/z* calcd for $C_{22}H_{16}ClN_3SNa^+$ $(M+Na)^+$ 412.0646, found 412.0647.

***N*-((6-bromo-1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3ac）**



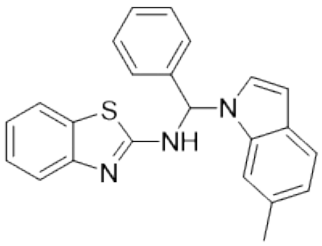
The target product **3ac** (23.8 mg, 55%) was synthesized as a white solid, mp: 188.0~189.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.52 (d, J = 8.1 Hz, 1H), 7.90 (s, 1H), 7.74 (d, J = 7.8 Hz, 1H), 7.68 (d, J = 8.1 Hz, 1H), 7.56 (d, J = 3.2 Hz, 1H), 7.52 (d, J = 8.4 Hz, 1H), 7.47~7.36 (m, 4H), 7.32 (d, J = 7.0 Hz, 2H), 7.25 (t, J = 7.6 Hz, 1H), 7.17 (d, J = 8.4 Hz), 7.08 (t, J = 7.5 Hz, 1H), 6.55 (d, J = 3.1 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 164.7, 151.6, 138.0, 135.9, 130.7, 128.7, 128.6, 127.7, 127.3, 126.4, 125.7, 122.5, 122.5, 122.3, 121.9, 121.2, 118.8, 114.4, 113.8, 102.0, 67.5. HRMS (ESI) *m/z* calcd for $C_{22}H_{16}BrN_3SNa^+$ $(M+Na)^+$ 456.0141, found 456.0140.

***N*-((5-methyl-1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3ae）**



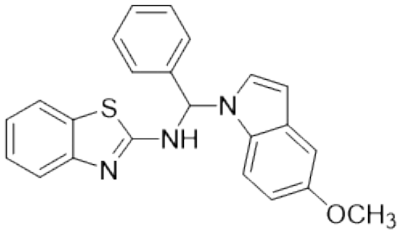
The target product **3ae** (28.8 mg, 78%) was synthesized as a white solid, mp: 188.0~189.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.45 (d, J = 8.1 Hz, 1H), 7.71 (t, J = 7.1 Hz, 1H), 7.60 (t, J = 7.1 Hz, 1H), 7.53 (t, J = 7.6 Hz, 1H), 7.43 (dd, J = 12.5, 4.1 Hz, 4H), 7.38 (d, J = 7.5 Hz, 2H), 7.30 (dd, J = 14.8, 7.1 Hz, 2H), 7.26 (s, 1H), 7.07 (t, J = 7.5 Hz, 1H), 6.91 (dd, J = 8.1 Hz, 1H), 6.41 (d, J = 3.1 Hz, 1H), 2.36 (s, 3H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 164.2, 151.4, 138.5, 134.5, 133.5, 130.1, 129.0, 128.6, 126.4, 125.8, 125.2, 122.8, 122.5, 122.3, 120.3, 119.5, 110.5, 101.1, 67.4, 21.2. HRMS (ESI) *m/z* calcd for $C_{23}H_{19}N_3SNa^+$ $(M+Na)^+$ 392.1192, found 392.1193.

***N*-((6-methyl-1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3af）**



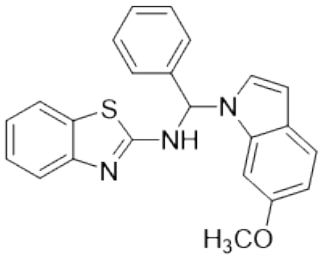
The target product **3af** (28.4 mg, 77%) was synthesized as a white solid, mp: 188.0~189.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.46 (d, J = 8.2 Hz, 1H), 7.73 (d, J = 7.7 Hz, 1H), 7.61 (d, J = 8.2 Hz, 1H), 7.44 (s, 1H), 7.42 (s, 1H), 7.41~7.33 (m, 5H), 7.30 (d, J = 7.0 Hz, 2H), 7.24 (t, J = 7.5 Hz, 1H), 7.07 (t, J = 7.4 Hz, 1H), 6.87 (d, J = 7.9 Hz, 1H), 6.45 (d, J = 2.7 Hz, 1H), 2.37 (s, 3H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 164.8, 151.7, 138.5, 135.6, 130.7, 130.5, 128.6, 128.4, 126.4, 126.0, 125.3, 121.7, 121.3, 121.2, 120.3, 118.8, 110.5, 101.6, 67.2, 21.6. HRMS (ESI) *m/z* calcd for $C_{23}H_{19}N_3SNa^+$ $(M+Na)^+$ 392.1192, found 392.1192.

***N*-((5-methoxy-1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3ag）**



The target product **3ag** (33.3 mg, 85%) was synthesized as a white solid, mp: 188.0~189.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.48 (d, J = 8.3 Hz, 1H), 7.77~7.72 (m, 1H), 7.59 (d, J = 8.2 Hz, 1H), 7.48~7.43 (m, 2H), 7.42 (s, 1H), 7.41~7.35 (m, 3H), 7.33~7.26 (m, 2H), 7.26~7.22 (m, 1H), 7.12~7.05 (m, 2H), 6.76 (dd, J = 8.9, 2.4 Hz, 1H), 6.43 (d, J = 3.1 Hz, 1H), 3.74 (s, 3H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 165.2, 154.2, 152.2, 138.9, 131.1, 130.8, 129.6, 129.1, 128.9, 127.2, 126.9, 126.2, 122.3, 121.7, 119.3, 112.0, 111.9, 102.9, 101.8, 67.9, 55.8. HRMS (ESI) *m/z* calcd for $C_{23}H_{19}N_3OSNa^+$ $(M+Na)^+$ 408.1141, found 408.1141.

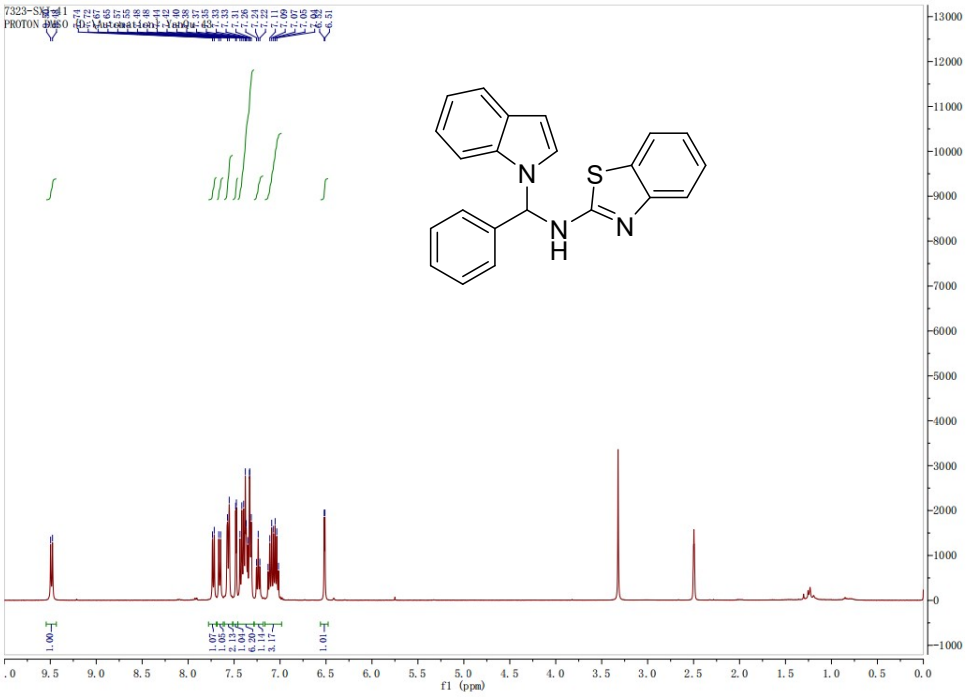
***N*-((6-methoxy-1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3ah）**



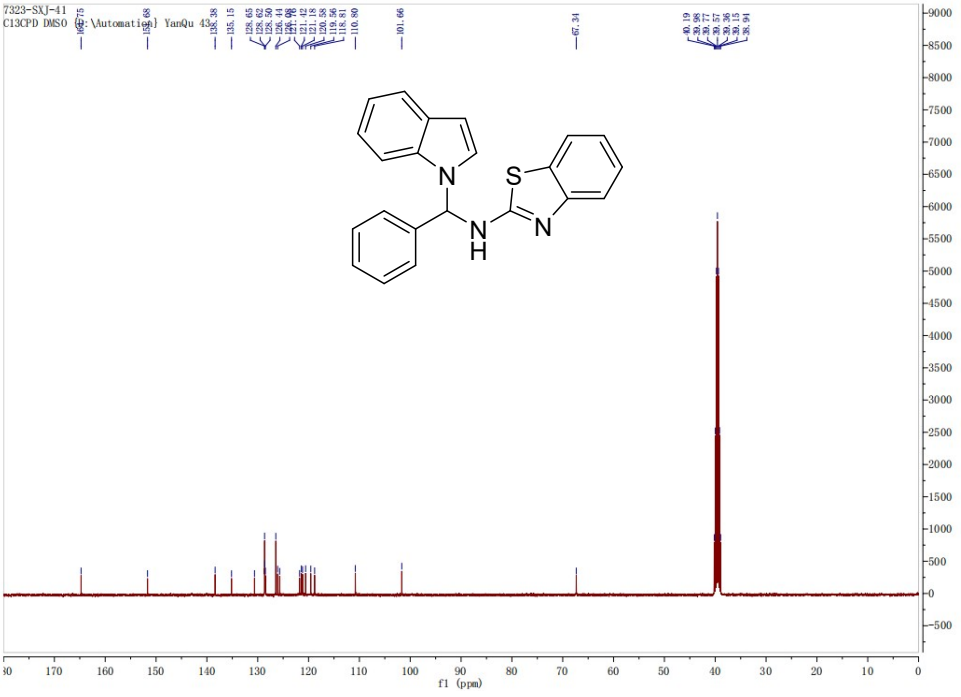
The target product **3ah** (33.3 mg, 85%) was synthesized as a white solid, mp: 188.0~189.0 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.49 (d, J = 8.4 Hz, 1H), 7.74 (d, J = 7.2 Hz, 1H), 7.64 (d, J = 8.4 Hz, 1H), 7.45 (d, J = 2.7 Hz, 1H), 7.44~7.38 (m, 4H), 7.36 (t, J = 5.8 Hz, 3H), 7.29 (t, J = 3.3 Hz, 1H), 7.28~7.22 (m, 1H), 7.18 (d, J = 1.8 Hz, 1H), 7.12~7.05 (m, 1H), 6.70 (dd, J = 8.6, 2.2 Hz, 1H), 6.42 (d, J = 3.2 Hz, 1H), 3.72 (s, 3H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 165.4, 156.1, 138.8, 136.5, 131.1, 129.1, 127.0, 126.2, 125.3, 122.2, 122.0, 121.7, 121.6 119.2, 109.9, 102.2, 95.2, 67.6, 55.8. HRMS (ESI) *m/z* calcd for $C_{23}H_{19}N_3OSNa^+$ $(M+Na)^+$ 408.1141, found 408.1141.

6. ^{1}H and ^{13}C NMR spectra for all compounds

***N*-((1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3aa）**

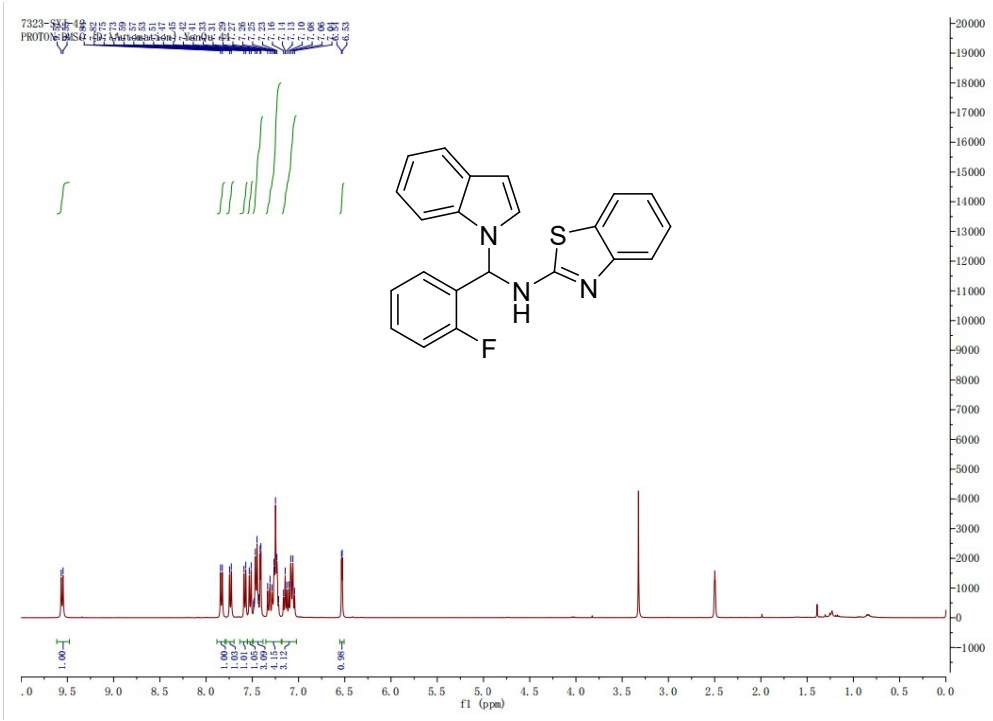


^{1}H NMR (400 MHz, DMSO-d_6)

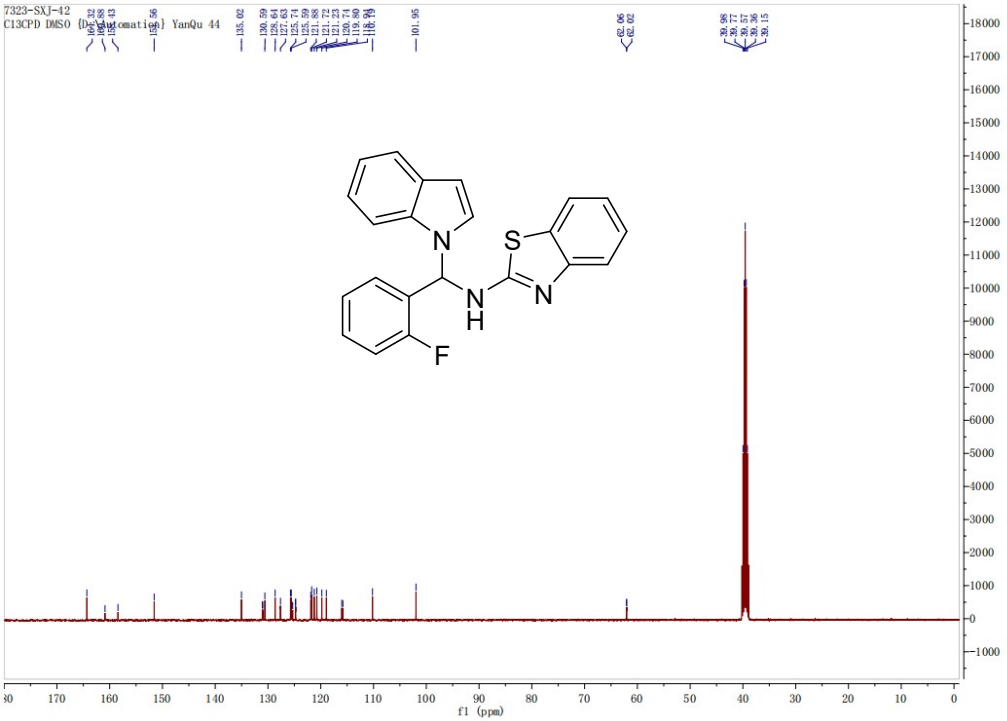


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((2-fluorophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3ba）**

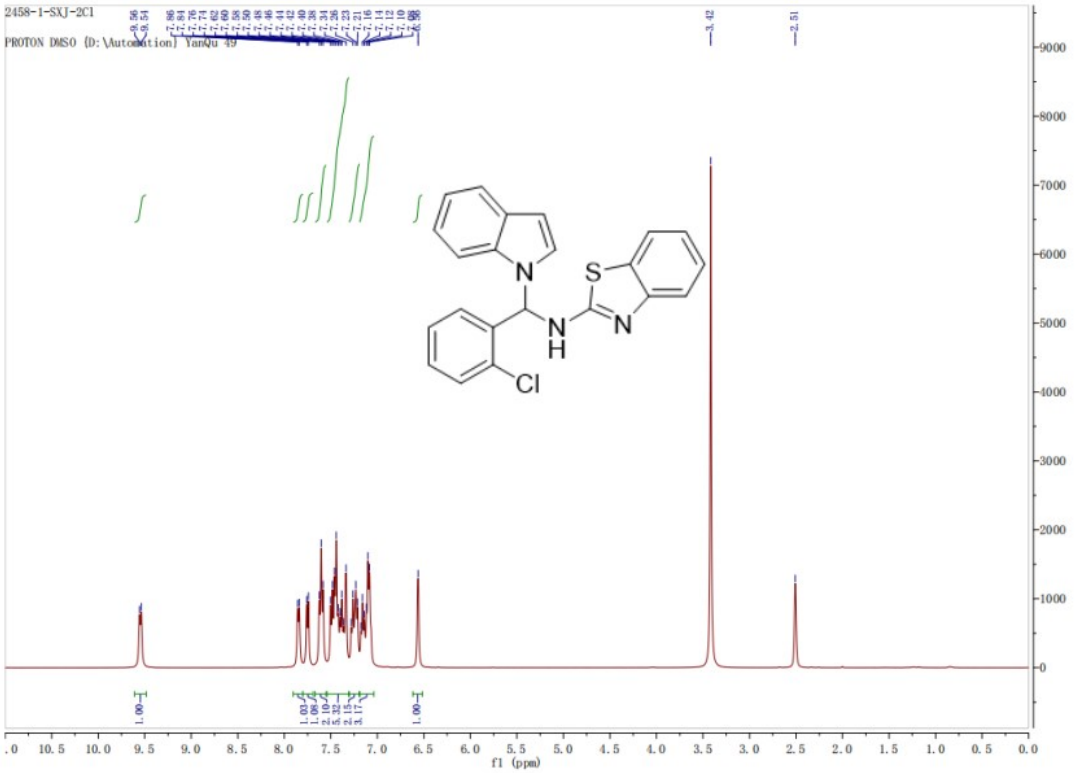


^{1}H NMR (400 MHz, DMSO-d_6)

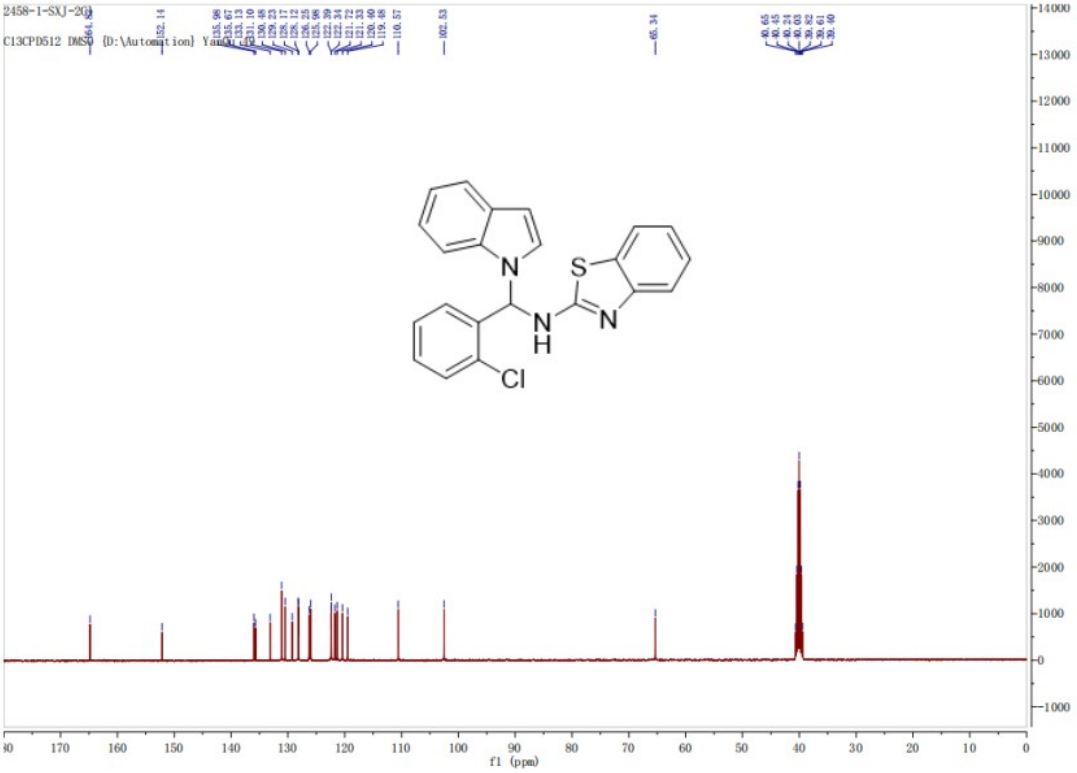


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((2-chlorophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3ca）**

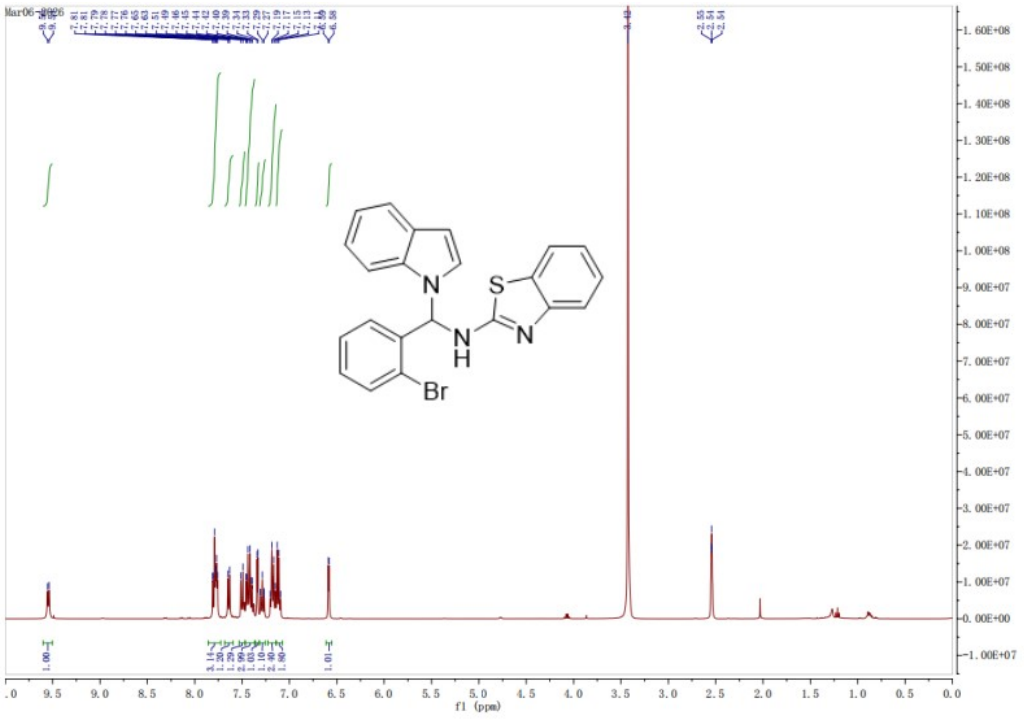


^{1}H NMR (400 MHz, DMSO-d_6)

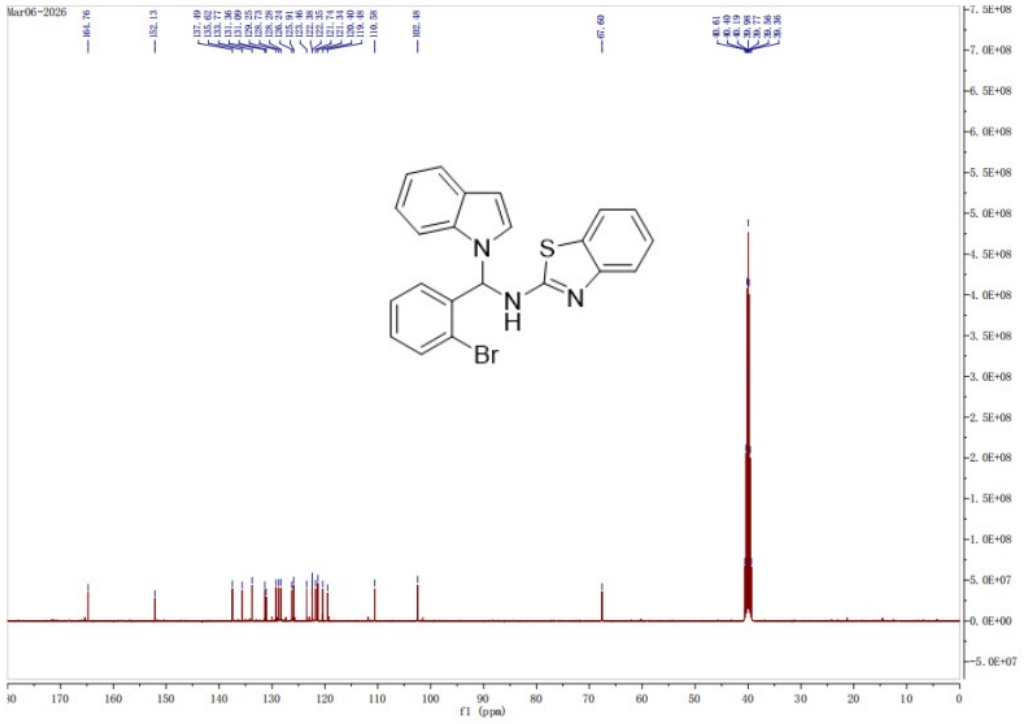


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((2-bromophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3da）**

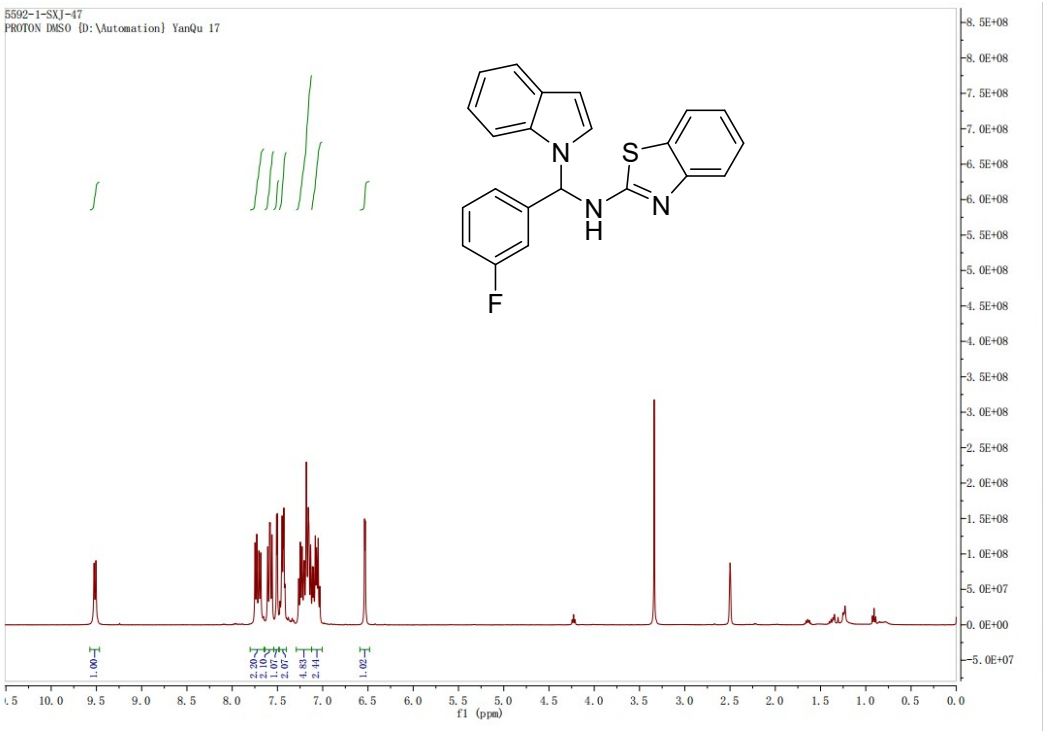


^{1}H NMR (400 MHz, DMSO-d_6)

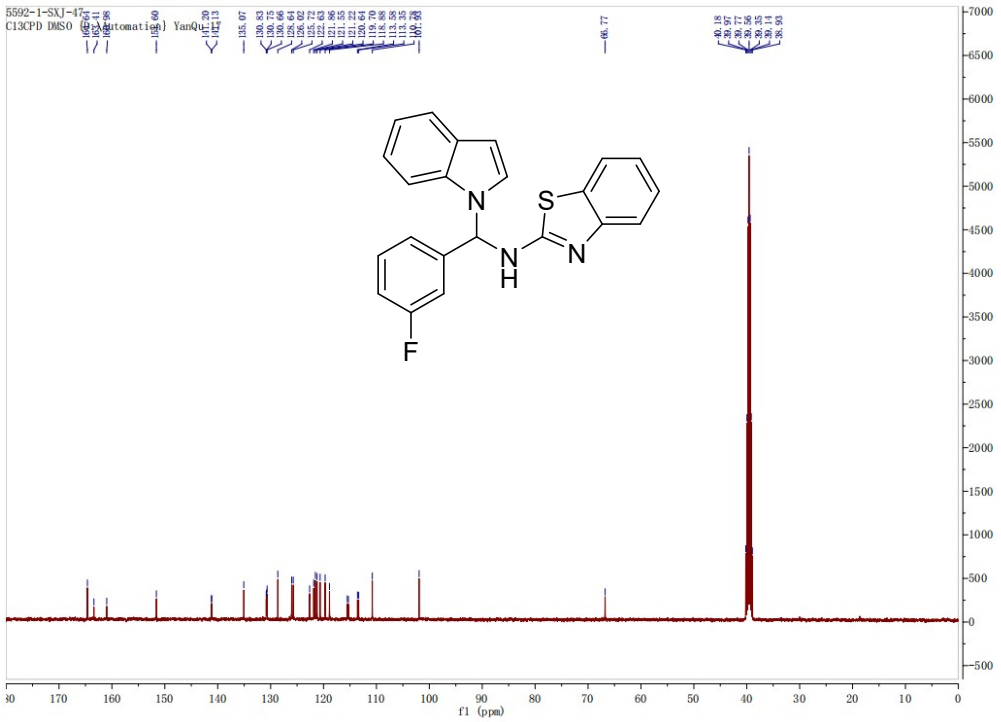


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((3-fluorophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3ea）**

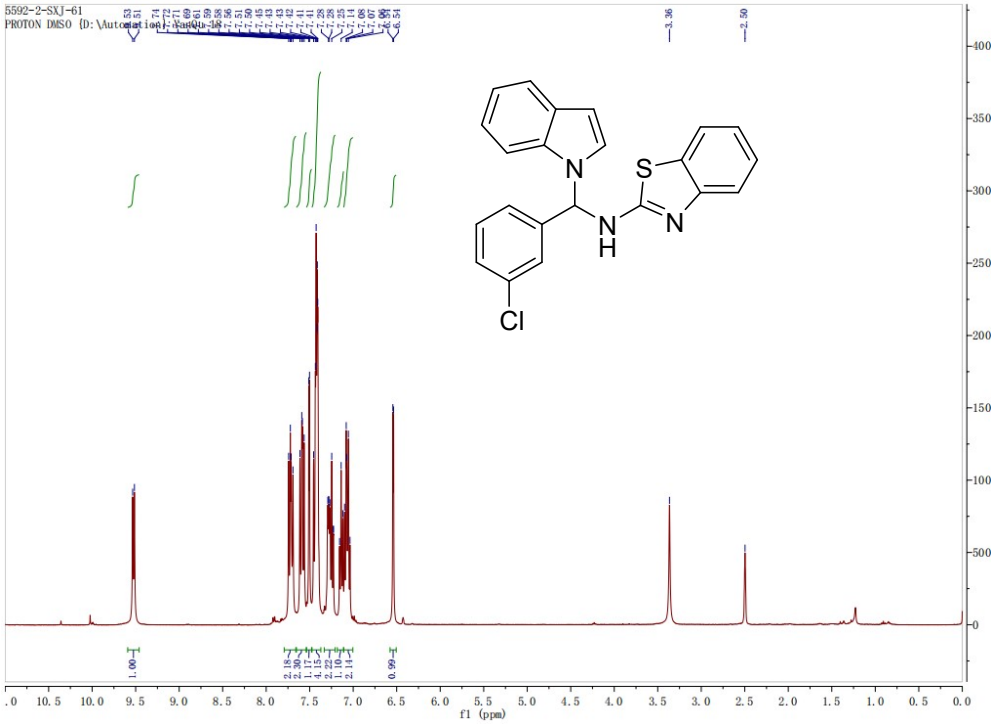


^{1}H NMR (400 MHz, DMSO-d_6)

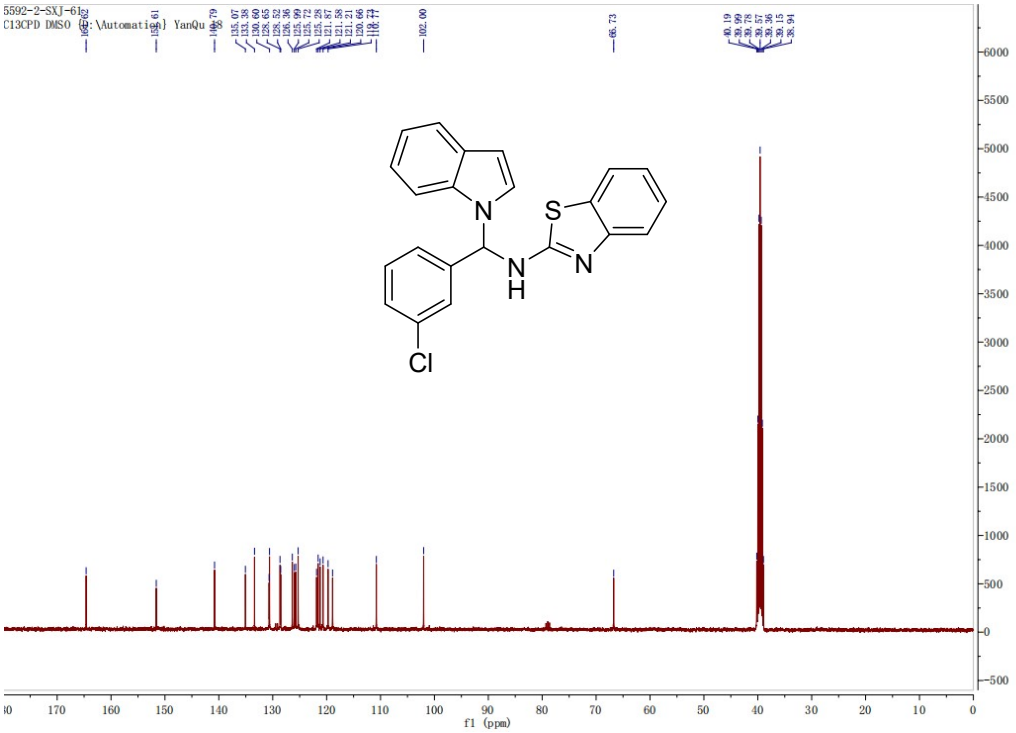


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((3-chlorophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3fa）**

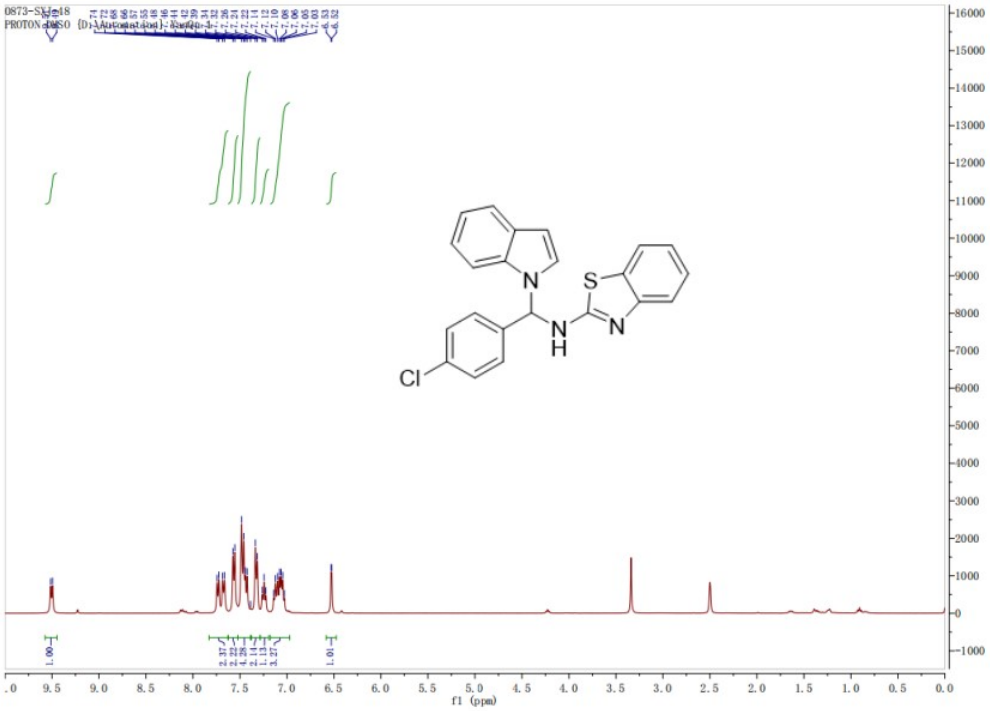


^{1}H NMR (400 MHz, DMSO-d_6)

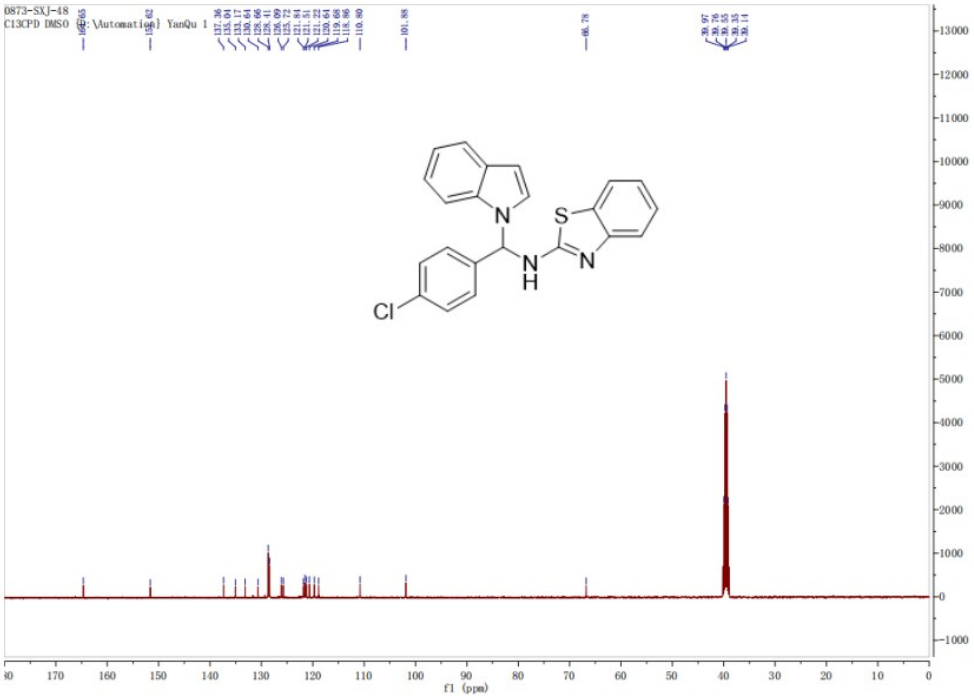


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((4-chlorophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3ga）**

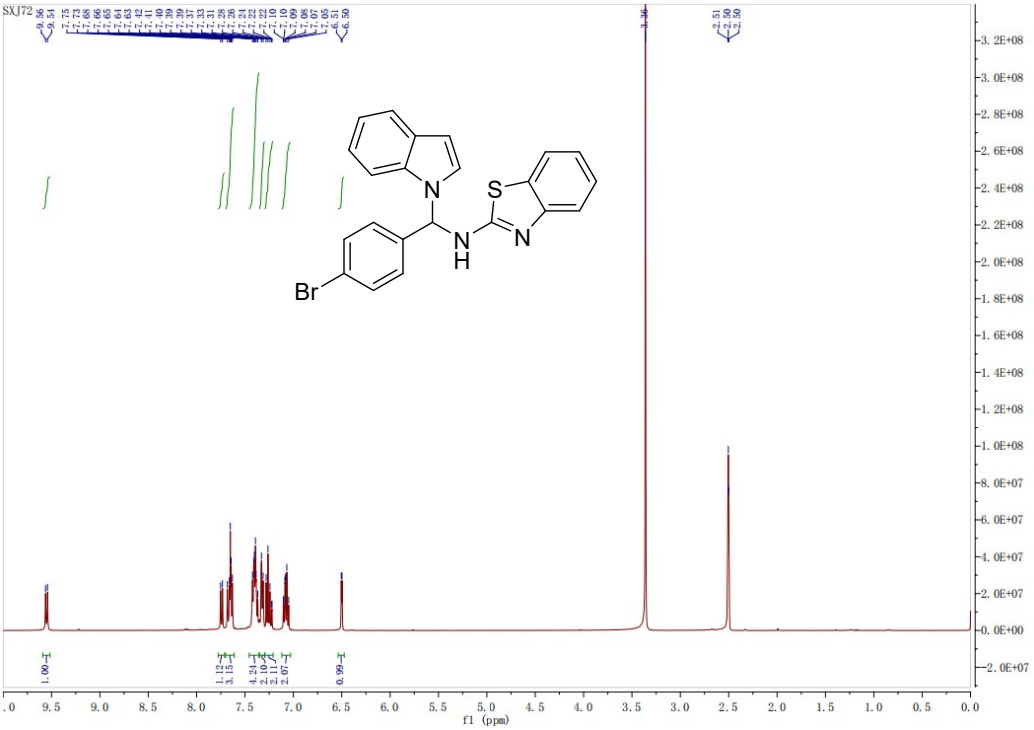


^{1}H NMR (400 MHz, DMSO-d_6)

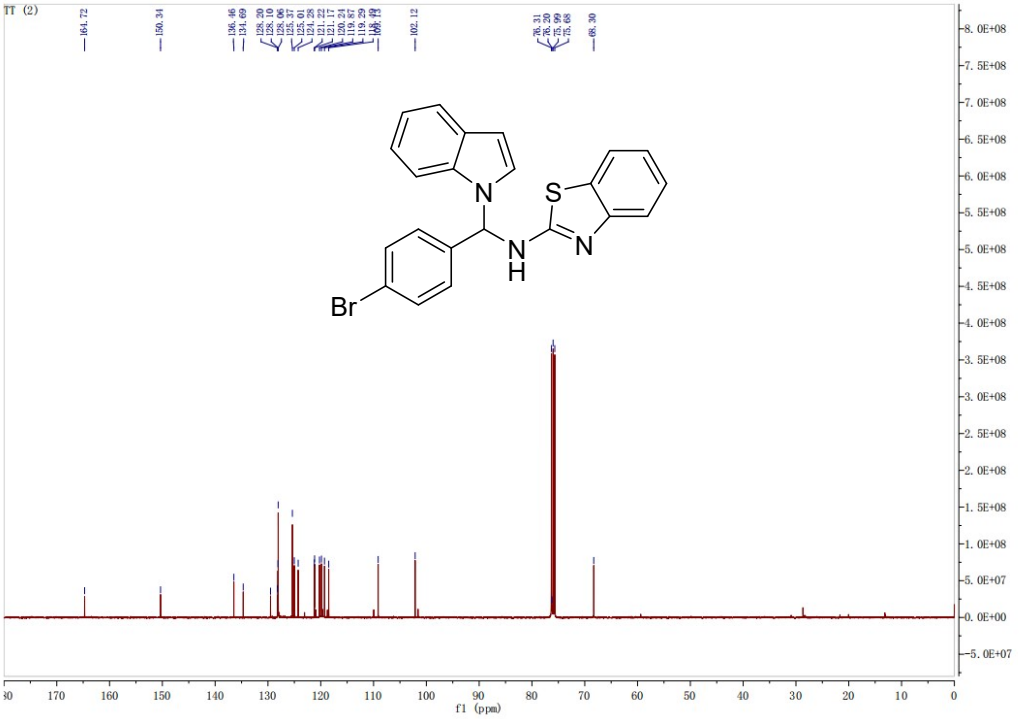


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((4-bromophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3ha）**

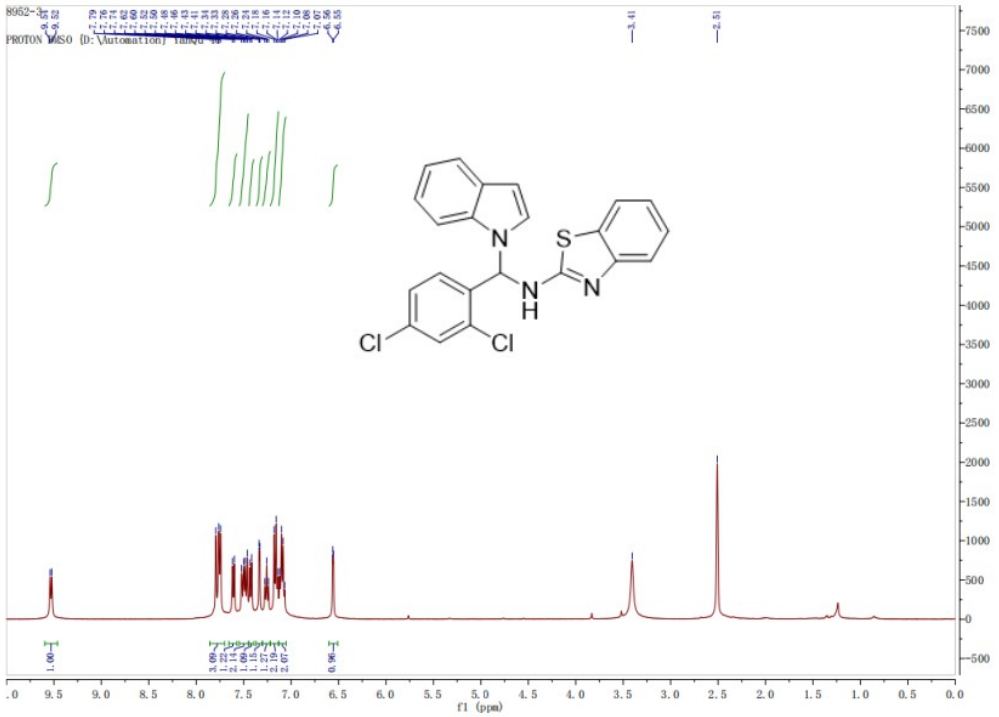


^{1}H NMR (400 MHz, DMSO-d_6)

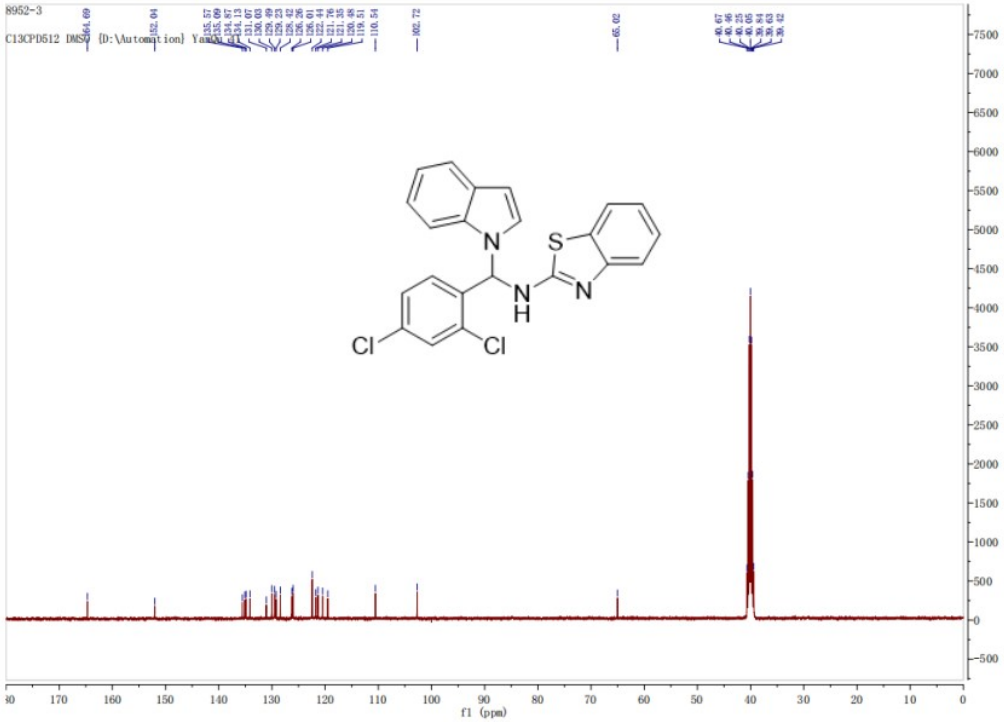


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((2,4-dichlorophenyl)(1*H*-indol-1-yl)methyl)benzo[*d*]thiazol-2-amine（3ia）**

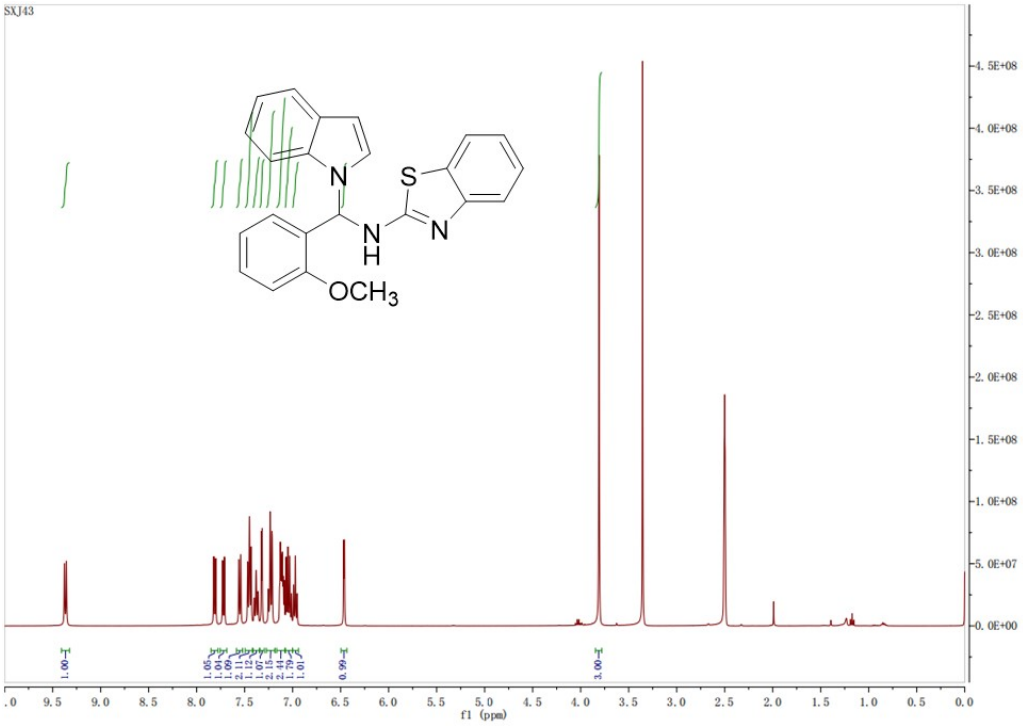


^{1}H NMR (400 MHz, DMSO-d_6)

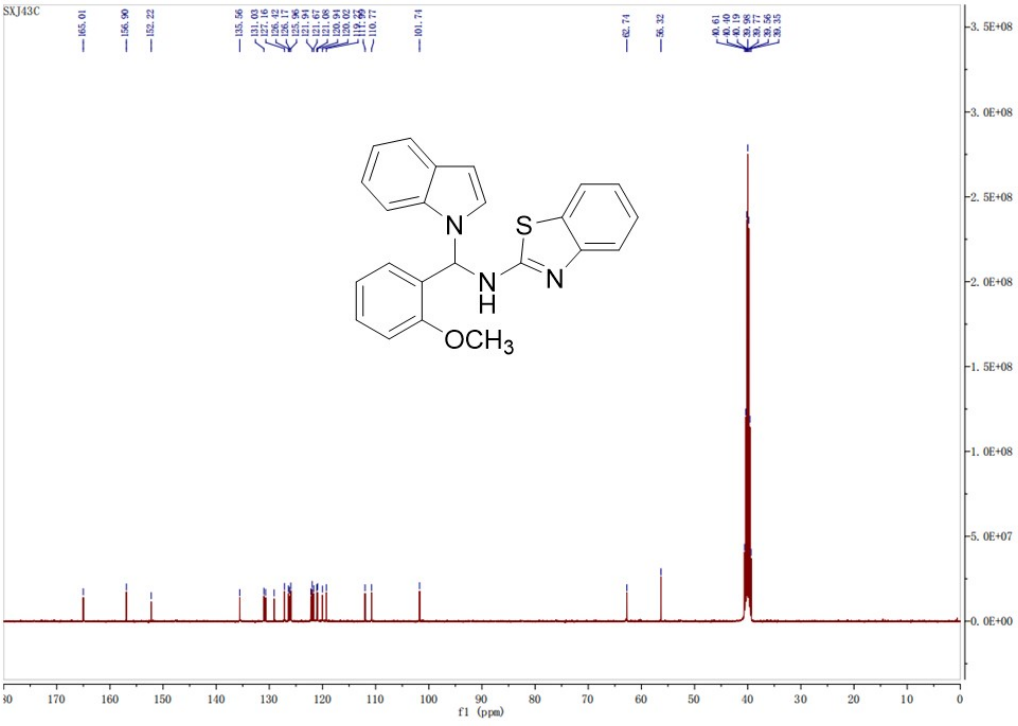


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((1*H*-indol-1-yl)(2-methoxyphenyl)methyl)benzo[*d*]thiazol-2-amine（3ja）**

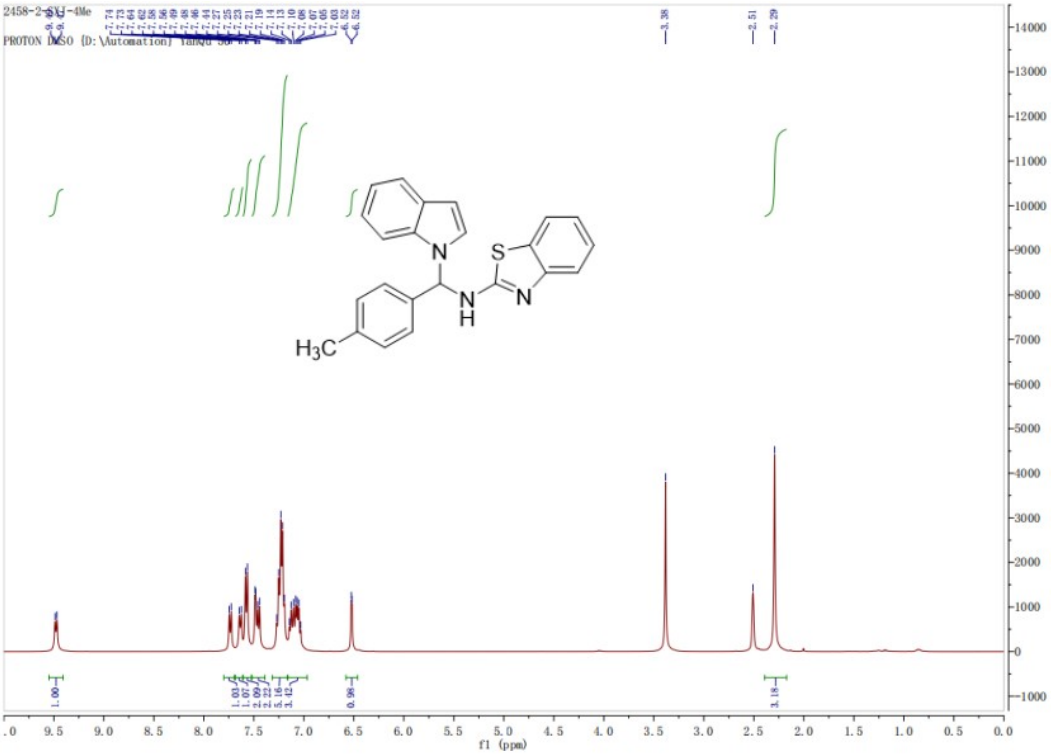


^{1}H NMR (400 MHz, DMSO-d_6)

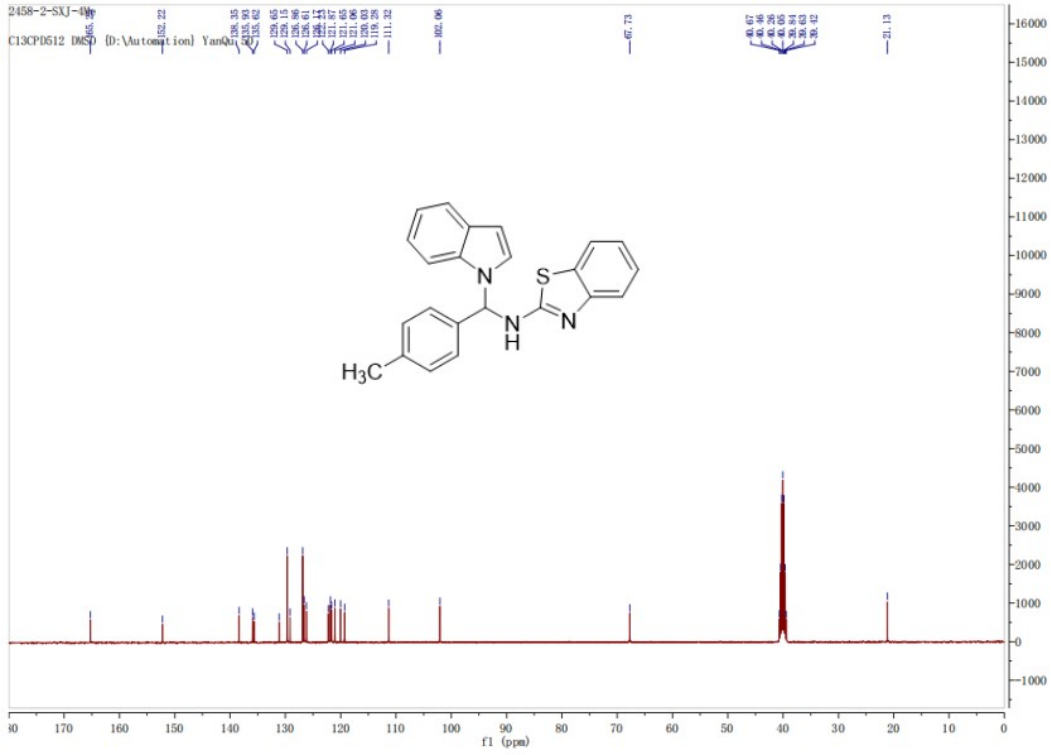


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((1*H*-indol-1-yl)(p-tolyl)methyl)benzo[*d*]thiazol-2-amine（3ka）**

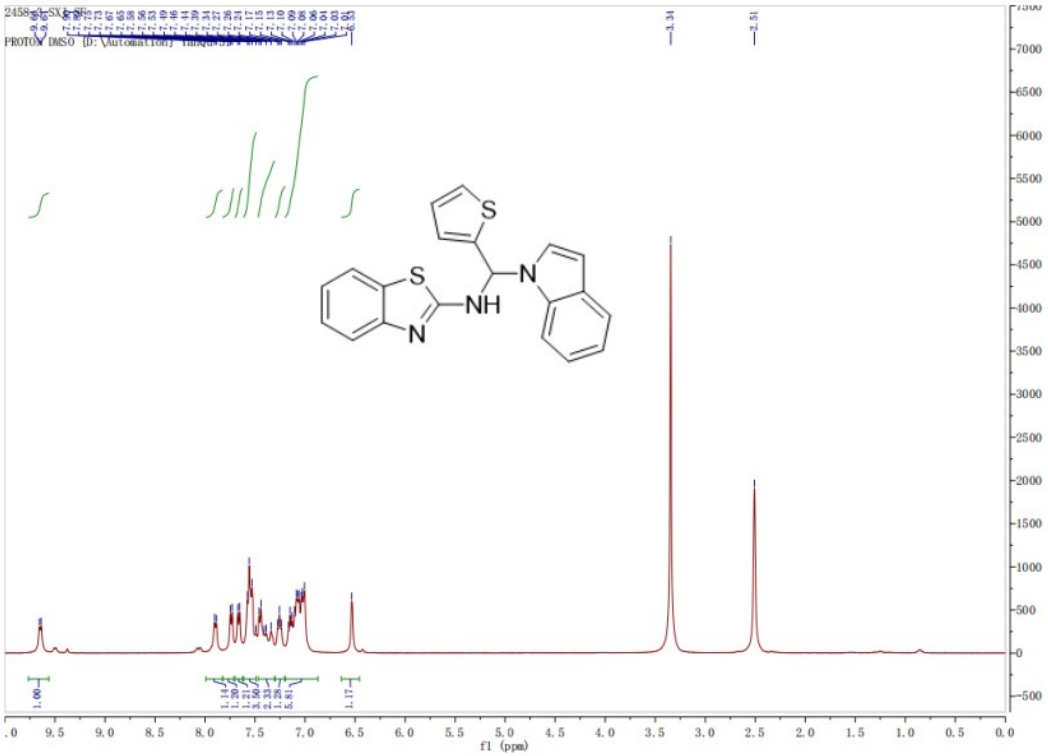


^{1}H NMR (400 MHz, DMSO-d_6)

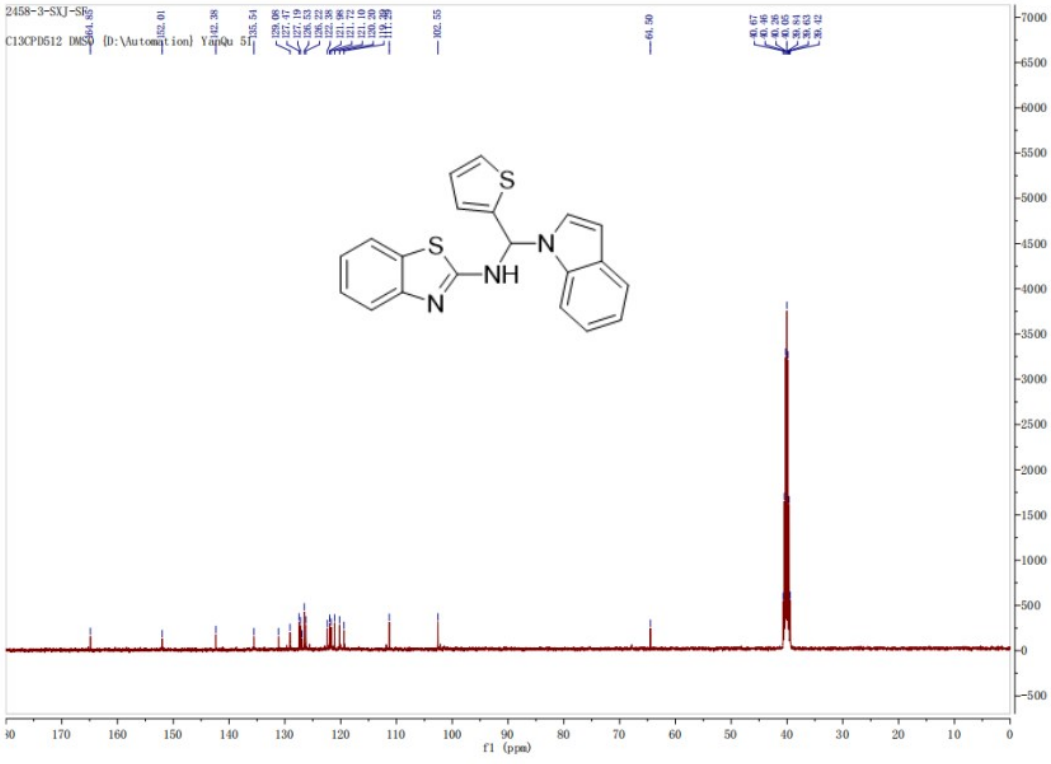


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((1*H*-indol-1-yl)(thiophen-2-yl)methyl)benzo[*d*]thiazol-2-amine（3la）**

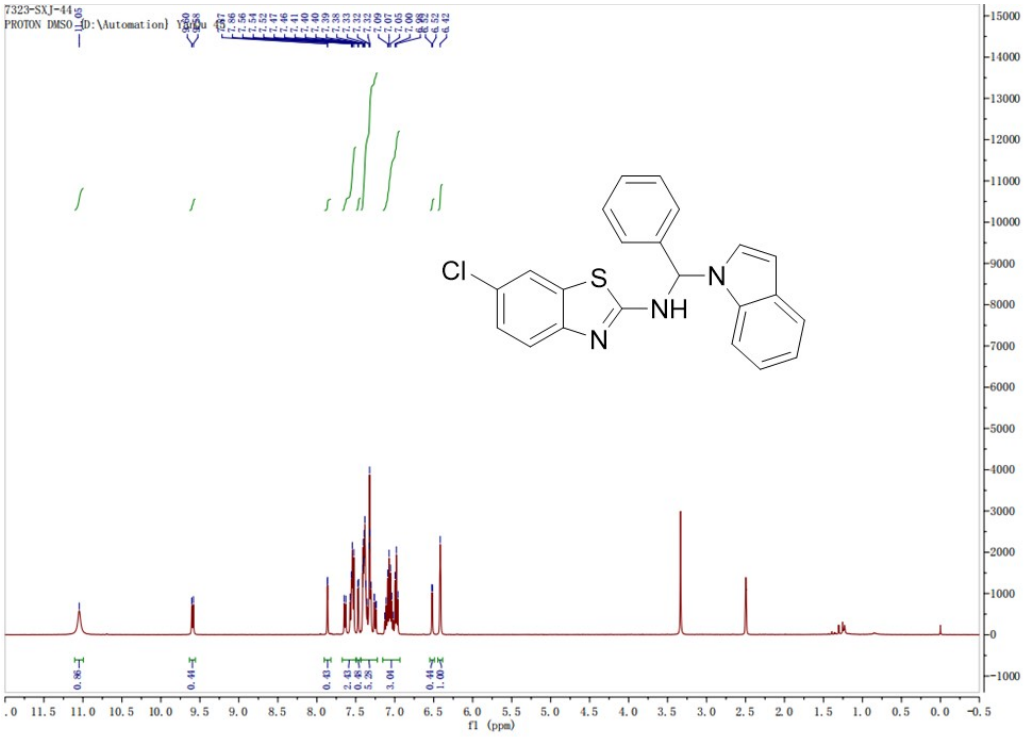


^{1}H NMR (400 MHz, DMSO-d_6)

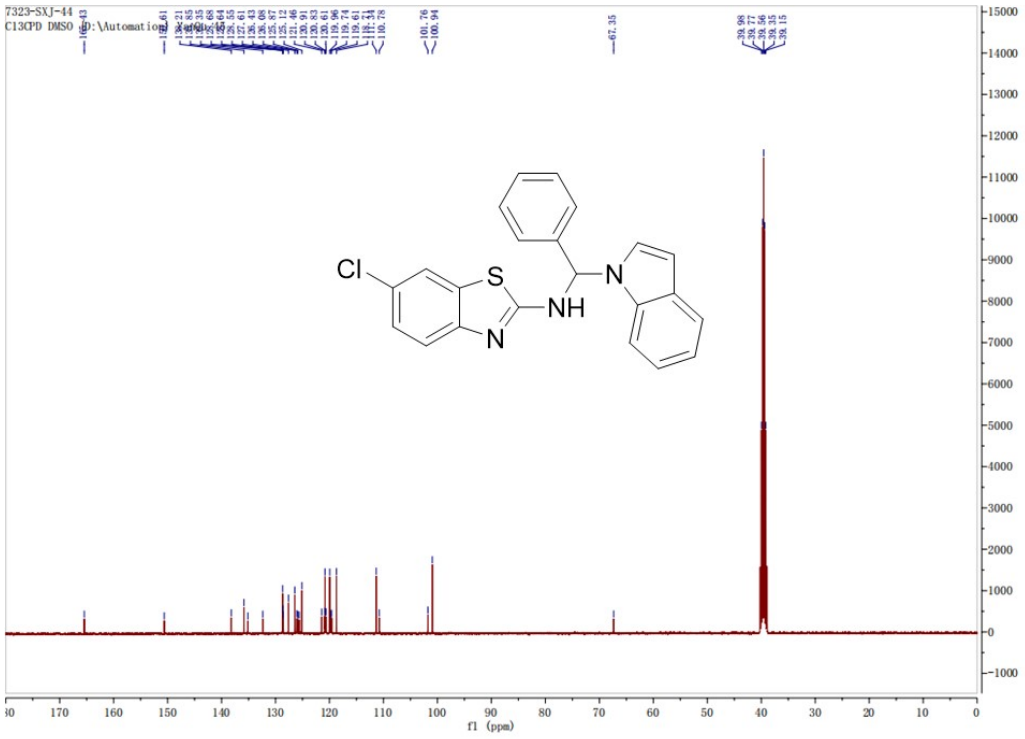


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((1*H*-indol-1-yl)(phenyl)methyl)-6-chlorobenzo[*d*]thiazol-2-amine（3ma）**

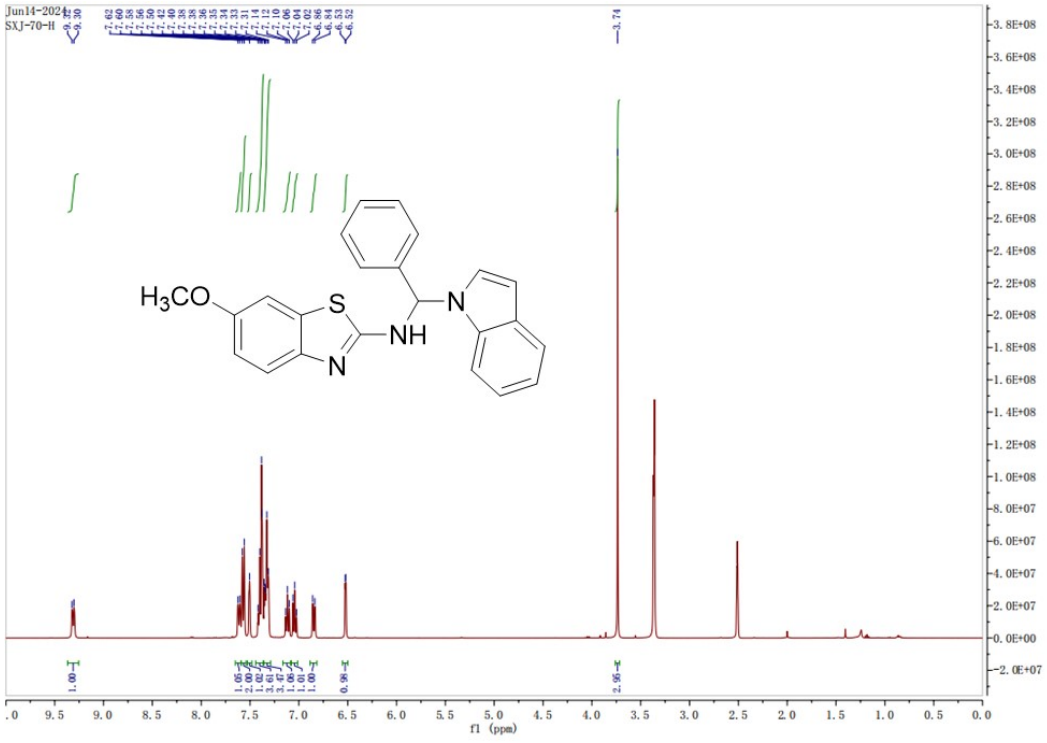


^{1}H NMR (400 MHz, DMSO-d_6)

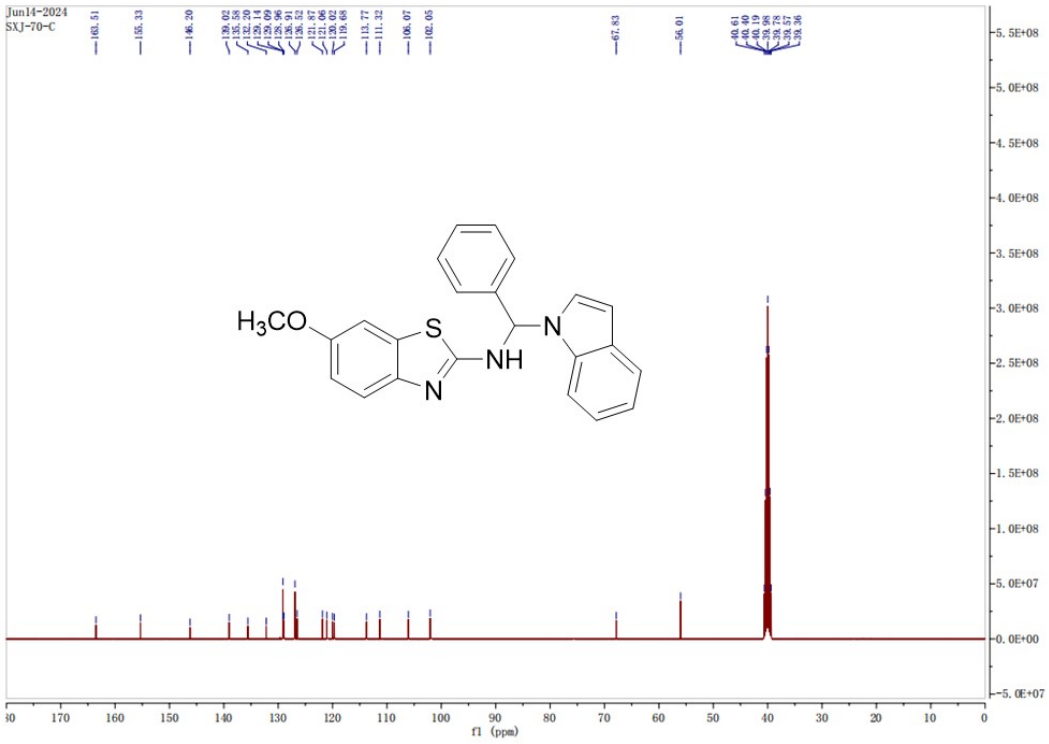


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((1*H*-indol-1-yl)(phenyl)methyl)-6-methoxybenzo[*d*]thiazol-2-amine（3na）**

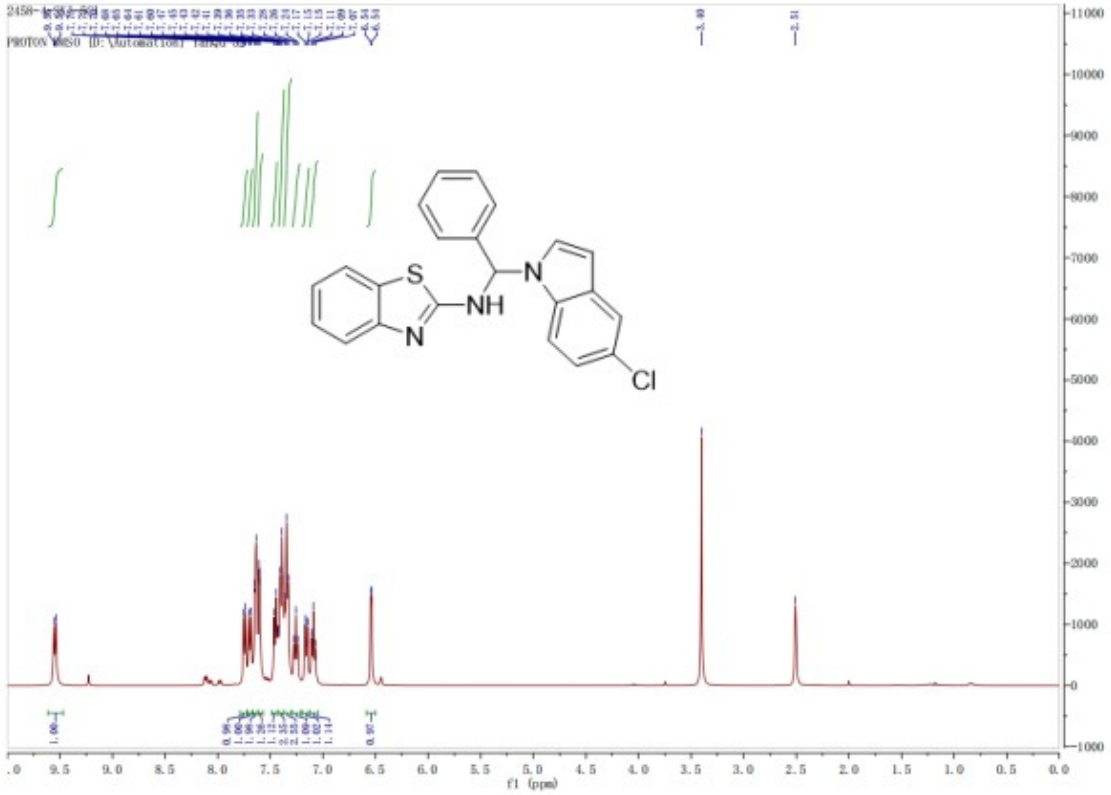


^{1}H NMR (400 MHz, DMSO-d_6)

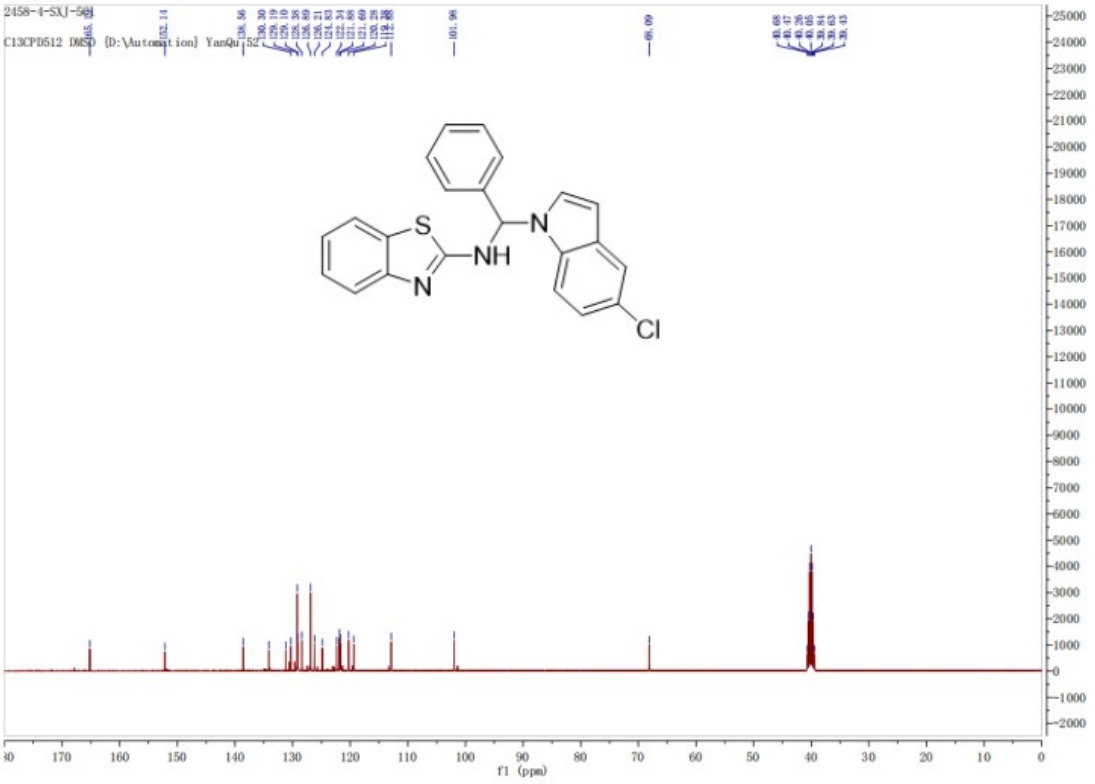


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((5-chloro-1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3ab）**

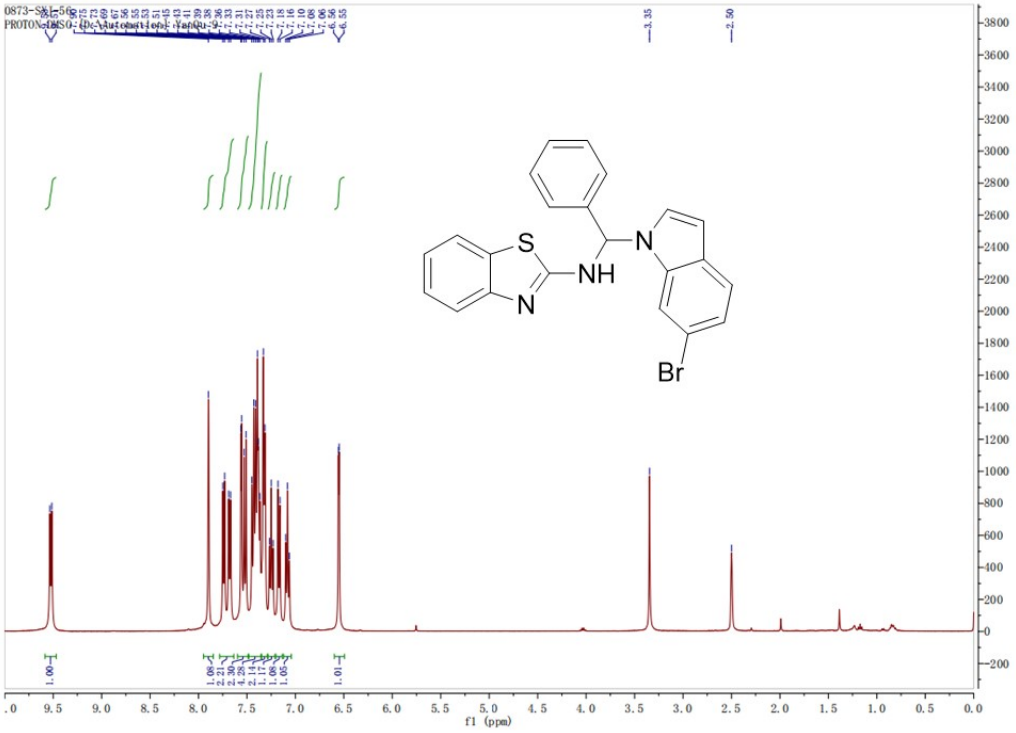


^{1}H NMR (400 MHz, DMSO-d_6)

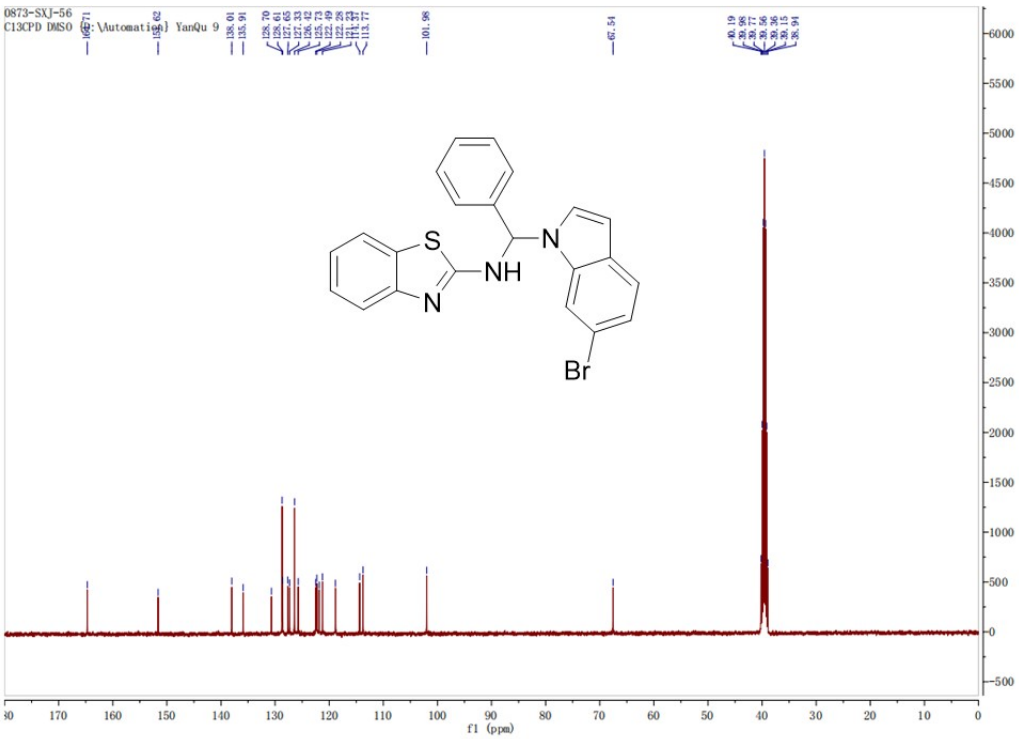


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((6-bromo-1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3ac）**

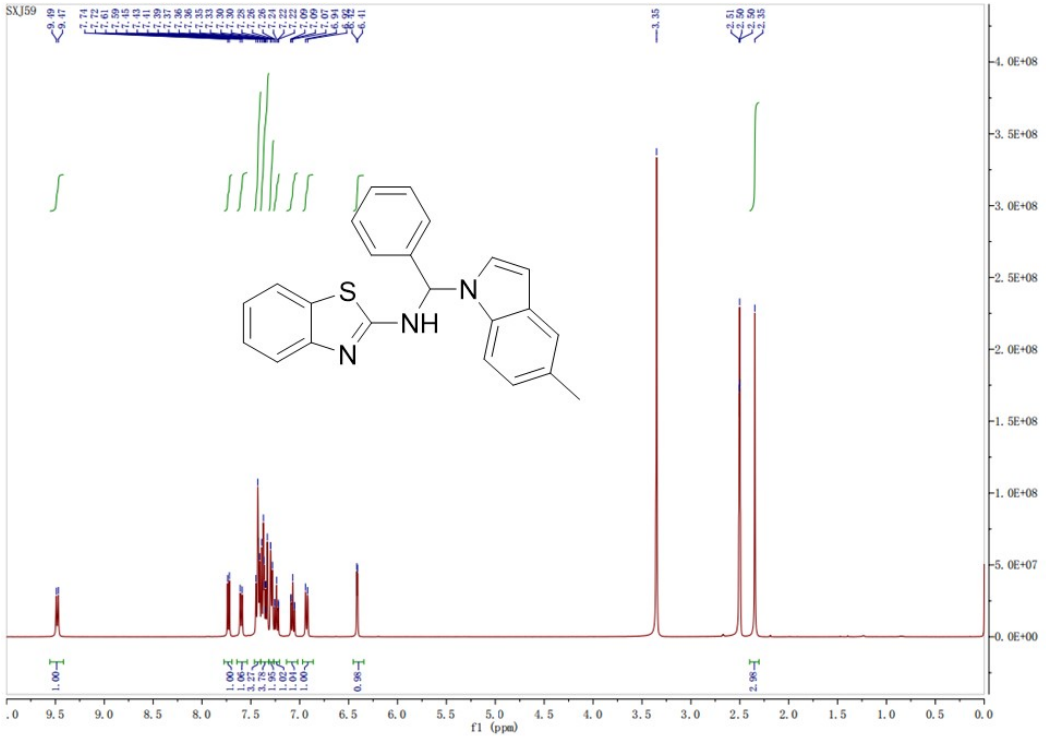


^{1}H NMR (400 MHz, DMSO-d_6)

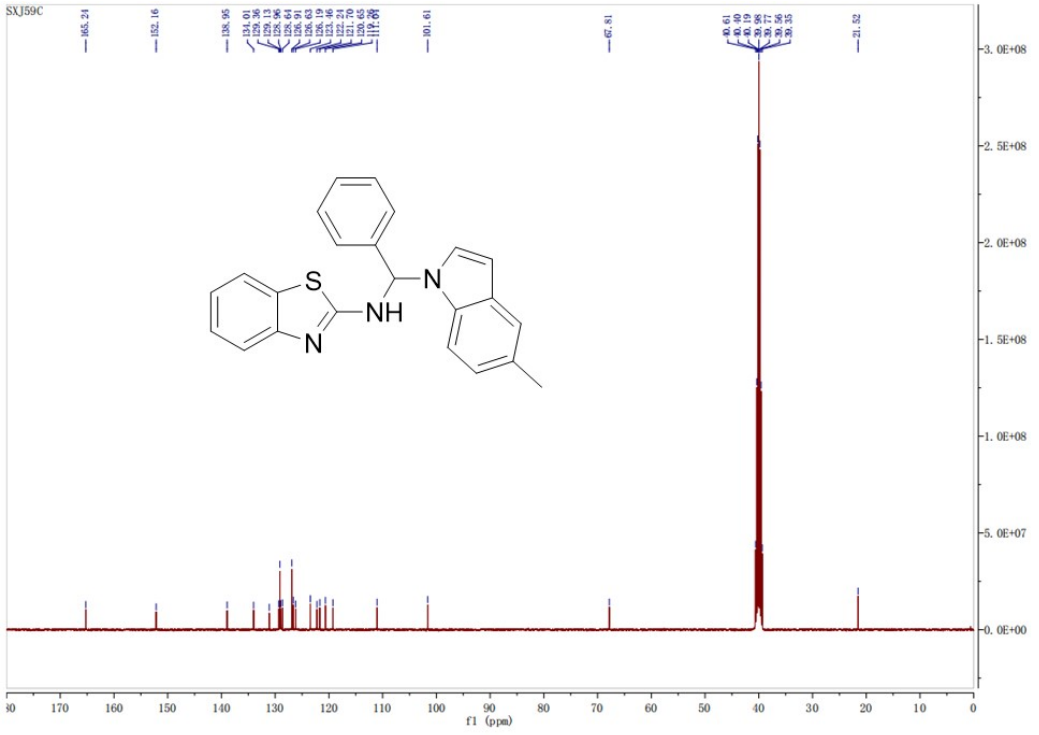


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((5-methyl-1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3ae）**

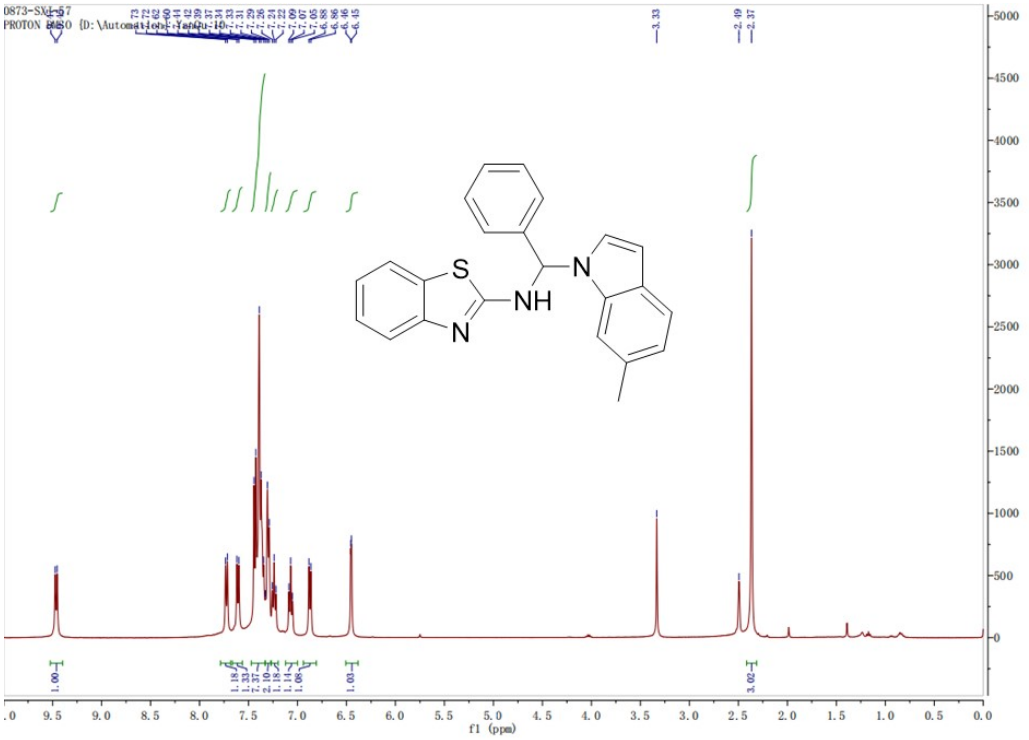


^{1}H NMR (400 MHz, DMSO-d_6)

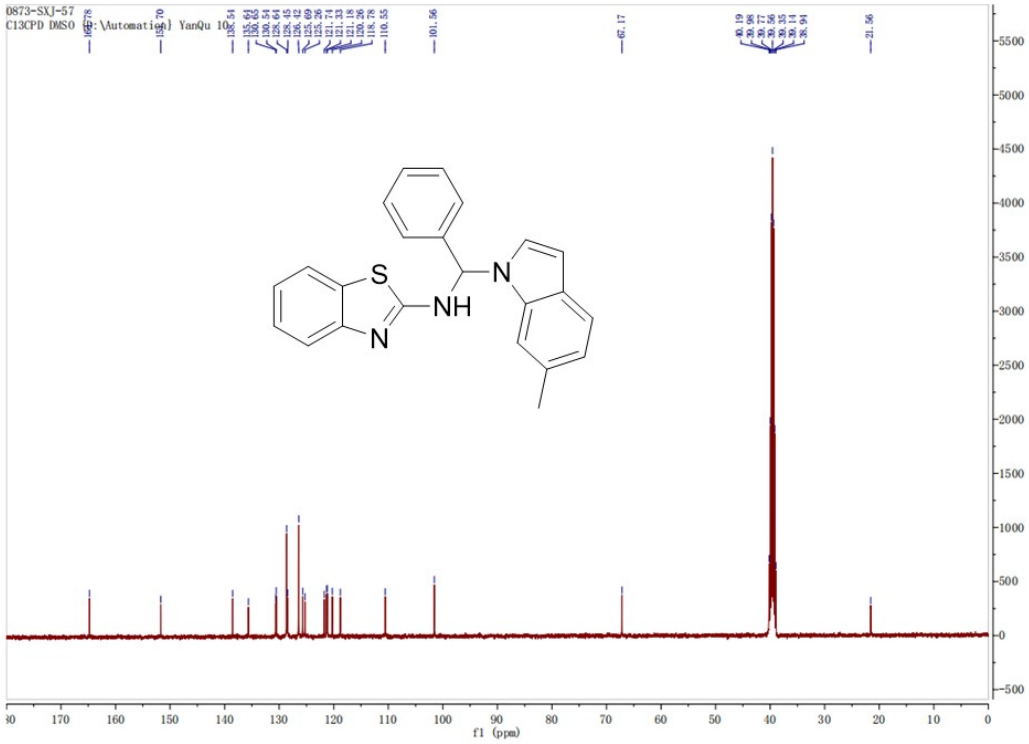


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((6-methyl-1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3af）**

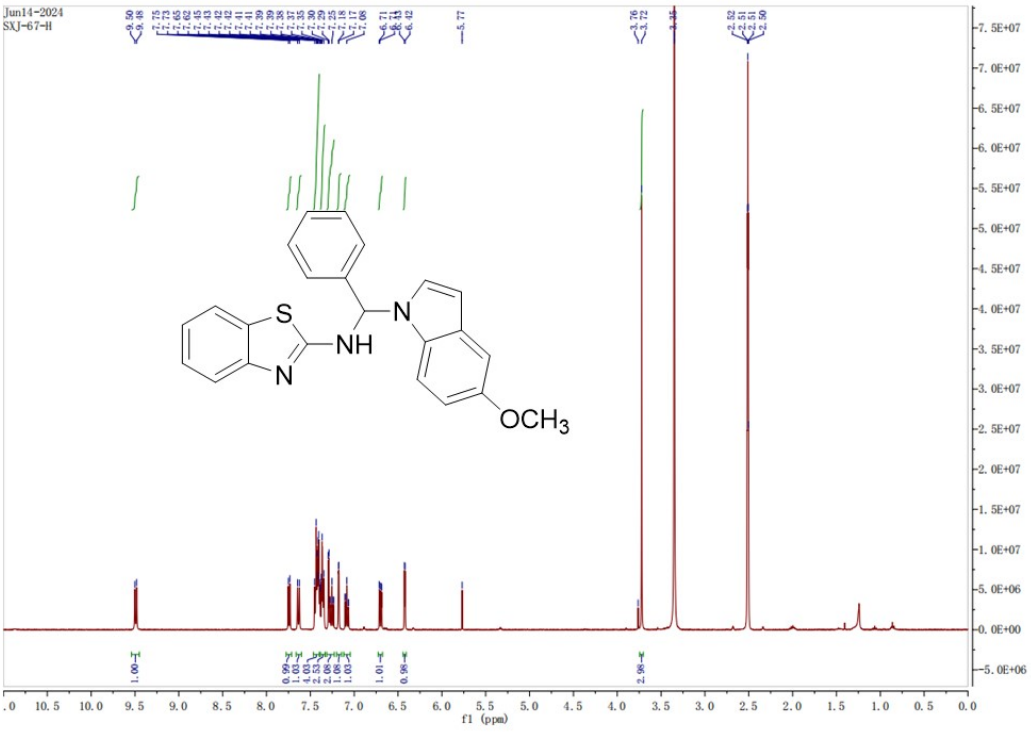


^{1}H NMR (400 MHz, DMSO-d_6)

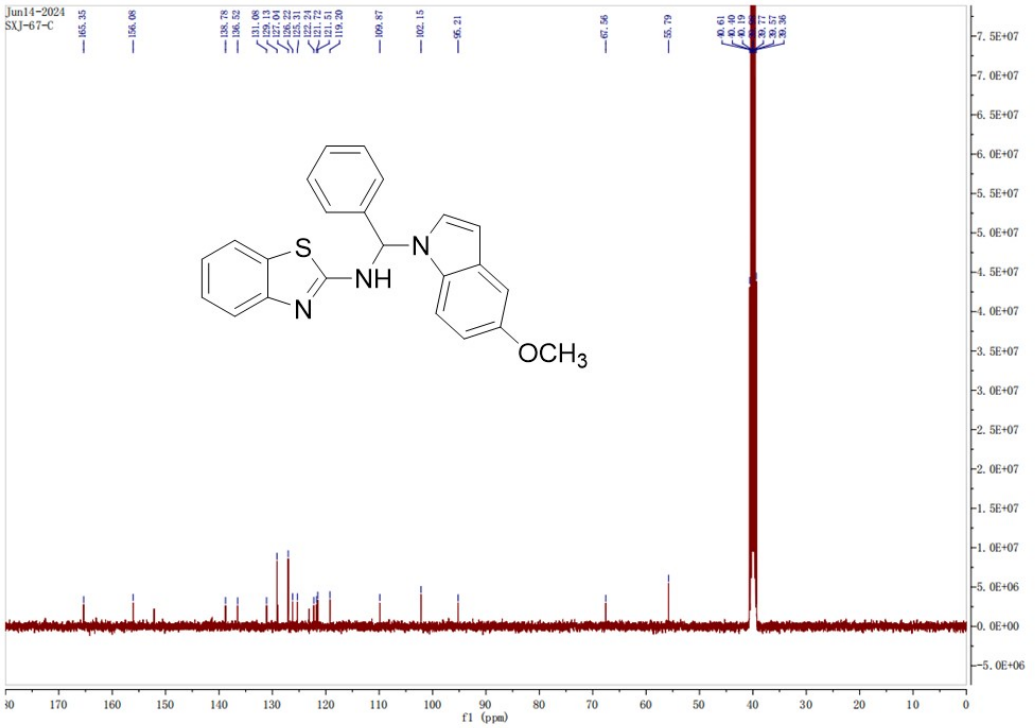


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((5-methoxy-1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3ag）**

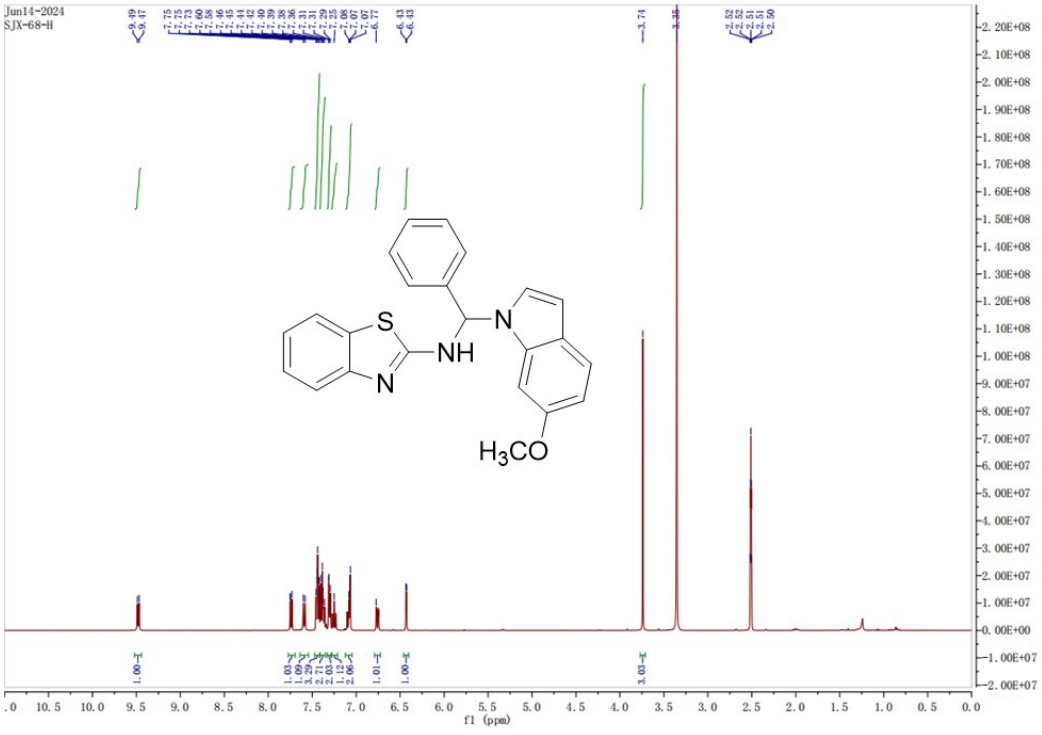


^{1}H NMR (400 MHz, DMSO-d_6)

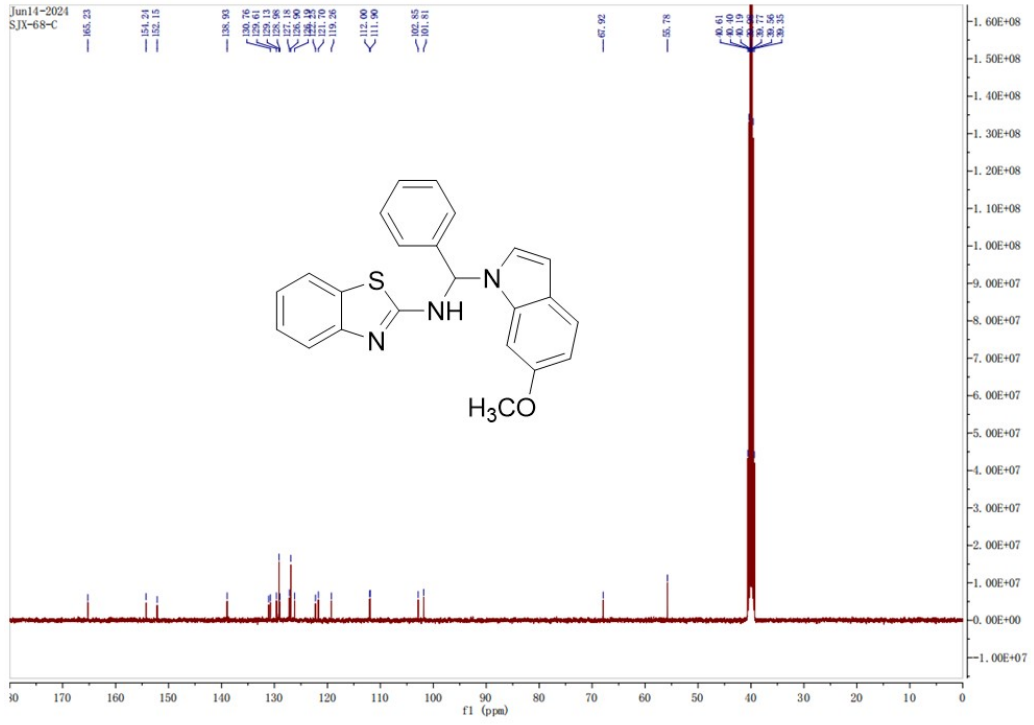


^{13}C NMR (100 MHz, DMSO-d_6)

***N*-((6-methoxy-1*H*-indol-1-yl)(phenyl)methyl)benzo[*d*]thiazol-2-amine（3ah）**



^{1}H NMR (400 MHz, DMSO-d_6)



^{13}C NMR (100 MHz, DMSO-d_6)