Supporting information

Novel Cyano- and Amidino- Benzothiazole Derivatives: Synthesis, Antitumor Evaluation, X-ray and QSAR Analysis

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Contents:

1. Experimental and spectroscopic data for cyano derivatives **1-6** and **11-17**:

2-Amino-6-cyanobenzothiazole (1) was prepared by slightly changed conventional procedure[1] and recrystallized from EtOH to give physical constants in accord with literature values, yield: 60 %; mp = 216 - 218 °C (lit.[2] mp = 217 - 218 °C). The ^{1}H and ^{13}C NMR spectra are in accordance with literature data.

2-Bromo-6-cyanobenzothiazole (2) was prepared by a modified preparation procedure[3] in a solution of $CuBr_2$ (2.548 g, 1.14×10^{-2} mol) in dry acetonitrile (30 ml) *t*-butil nitrite was added (1.35 g, 1.14×10^{-2} mol). The reaction mixture was stirred for 10 minutes at room

temperature. After 10 minutes 2-amino-6-cyanobenzothiazole (1 g, 5.7×10^{-3} mol) was added in portions at 60 °C. The reaction mixture was left to stir at 60 °C for 30 minutes, and then an additional amount of *t*-butil nitrite (1.35 g, 1.14×10^{-2} mol) was added. After 1.5 h of stirring at room temperature the reaction mixture was poured on water (400 ml) and the precipitate was filtered off. The crude product was recrystallized from methanol (50 ml) and 1.24 g of 2-bromo-6-cyano-benzothiazole was obtained (87.4 %) as beige powder; mp = 180 - 182 °C; IR (KBr) (ν_{max}/cm^{-1}): 3417, 2229 (C≡N), 1596; ^{1}H NMR (DMSO) (δ/ppm): 8.71 (s, 1H), 8.17 (d, 1H, J = 7.9 Hz), 7.96 (d, 1H, J = 7.77 Hz); ^{13}C NMR (DMSO) (δ/ppm): 154.25, 145.16, 137.51, 130.12, 127.36, 123.19, 118.45. Anal. ($C_8H_3BrN_2S$) C, H, N.

General method for the synthesis of cyano substituted benzothiazol-2-yl benzamides (3-6): The reaction mixture of appropriate benzoyl chloride, corresponding 2-aminobenzazole derivative and Et_3N in equimolar amounts in dry toluene was refluxed for 4 - 5 h. After cooling, the crude product was filtered off, washed with water and recrystallized from MeOH.

***N*-(6-Cyanobenzothiazol-2-yl)benzamide (3):** White powder was isolated (1.06 g, 66.3 %); mp > 300 °C; IR (KBr) (ν_{max}/cm^{-1}): 2704, 2227 (C≡N), 1694 (C=O); ^{1}H NMR (DMSO) (δ/ppm): 13.21 (s, 1H, NH), 8.45 (s, 1H), 8.15 (d, 2H, J = 8.53 Hz), 7.91 (d, 1H, J = 8.43 Hz), 7.86 (dd, 1H, J_1 = 8.43 Hz, J_2 = 1.60 Hz), 7.72-7.54 (m, 3H); ^{13}C NMR (DMSO) (δ/ppm): 166.76, 163.1, 152.14, 133.67, 132.76, 131.90, 130.11, 129.18, 128.93, 127.54, 121.61, 119.67, 105.91; Anal. ($C_{15}H_9N_3OS$) C, H, N.

2-Chloro-*N*-(6-cyanobenzothiazol-2-yl)benzamide (4) was prepared by a conventional procedure and recrystallized from MeOH to give physical constants in accordance with literature values, yield: 72.6 %; mp = 226 - 229°C °C (lit.[4] mp = 227 - 229°C). The ^{1}H and ^{13}C NMR spectra are in accordance with literature data.

***N*-(6-Cyanobenzothiazol-2-yl)-4-fluorobenzamide (5)**: White powder was isolated (1.43 g, 76.3 %); mp > 300 °C; IR (KBr) (ν_{max}/cm^{-1}): 3286, 2226 (C≡N), 1668 (C=O); ^{1}H NMR (DMSO) (δ/ppm): 13.20 (s, 1H, NH), 8.58 (s, 1H), 8.24-8.19 (m, 2H), 7.89 (d, 1H, *J* = 8.4 Hz), 7.83 (d, 1H, *J* = 8.4 Hz), 7.45-7.35 (m, 2H); ^{13}C NMR (DMSO) (δ/ppm): 165.87, 165.57 164.20, 162.80, 132.40, 131.28, 129.48, 128.41, 126.69, 120.89, 118.86, 115.63, 105.79; Anal. ($C_{15}H_8FN_3OS$) C, H, N.

4-Cyano-*N*-(benzothiazol-2-yl)benzamide (**6**) was prepared by a conventional procedure and recrystallized from MeOH to give physical constants in accordance with literature values, yield: 72.6 %; mp = 274 - 276 °C (lit.[4] mp = 274 - 276 °C). The ^{1}H and ^{13}C NMR spectra are in accordance with literature data.

General method for the synthesis of 2-(hetero)arylamino-benzothiazole cyano derivatives (11-17): In the solution of appropriate amine (6.3×10^{-3} mol) in dry THF (20 ml), NaH (0.25 g; 6.3×10^{-3} mol, ω = 0.6) was added. The reaction mixture was stirred for 30 minutes at 50 - 60 °C. After 30 minutes 2-bromo-6-cyanobenzothiazole (0.5 g, 2.09×10^{-3} mol) was added and the reaction mixture was left to stir for 4 hours. The reaction mixture was evaporated to dryness under reduced pressure. Crude product was recrystallized from methanol.

6-Cyano-2-(*N*-(4-cyanophenyl)amino)benzothiazole (11): Beige powder was isolated (0.35 g, 63 %); mp > 300 °C; IR (KBr) (ν_{max}/cm^{-1}): 3128, 2221 (C≡N), 1600; ^{1}H NMR (DMSO) (δ/ppm): 11.33 (s, 1H, NH), 8.41 (s, 1H), 7.97 (d, 2H, *J* = 8.73 Hz), 7.85 (d, 2H, *J* = 8.73 Hz), 7.78 (d, 2H, *J* = 7.62 Hz); ^{13}C NMR (DMSO) (δ/ppm): 166.54, 157.1, 145.93, 135.77, 133.29, 132.18, 122.40, 121.40, 121.37, 120.39, 115.61, 106.79, 106.33; MS *m/z*: 277 (M^{+}+1; 100%); Anal. ($C_{15}H_8N_4S$) C, H, N.

6-Cyano-2-(*N*-(3-methylpyridin-2-yl)amino)benzothiazole (12): Beige powder was isolated (0.51 g, 91.7 %); mp = 240 - 243 °C; IR (KBr) (ν_{max}/cm^{-1}): 2923, 2226 (C≡N), 1634; ^{1}H NMR (DMSO) (δ/ppm): 11.20 (s, 1H, NH), 8.46 (s, 1H), 8.26 (d, 1H, J = 4.68 Hz), 7.78-7.73 (m, 2H), 7.65 (d, 1H, J = 7.29 Hz), 7.05 (dd, 1H, J_1 = 7.00 Hz, J_2 = 5.19 Hz), 2.39 (s, 3H, CH$_3$); ^{13}C NMR (DMSO) (δ/ppm): 162.97, 152.01, 148.61, 142.73, 138.77, 128.85, 125.56, 119.81, 119.01, 118.86, 117.38, 106.16, 102.89, 16.14; MS *m/z*: 267 (M^++1, 100%); Anal. ($C_{14}H_{10}N_4S$) C, H, N.

6-Cyano-2-(*N*-(4-methylpyridin-2-yl)amino)benzothiazole (13): Beige powder was isolated (0.52 g, 93 %); mp = 295 - 298 °C; IR (KBr) (ν_{max}/cm^{-1}): 2950, 2221 (C≡N), 1620; ^{1}H NMR (DMSO) (δ/ppm): 11.93 (s, 1H, NH), 8.44 (s, 1H), 8.25 (d, 1H, J = 5.13 Hz), 7.75 (d, 1H, J = 8.43 Hz), 7.7 (d, 1H, J = 8.37 Hz), 6.98 (s, 1H), 6.93 (d, 1H, J = 5.16 Hz), 2.32 (s, 3H, CH$_3$); ^{13}C NMR (DMSO) (δ/ppm): 163.10, 152.82, 151.06, 149.39, 146.12, 132.53, 129.40, 126.07, 119.57, 119.44, 118.97, 111.50, 103.29, 20.69; MS *m/z*: 267 (M^++1; 100%); Anal. ($C_{14}H_{10}N_4S$) C, H, N.

6-Cyano-2-(*N*-(5-methylpyridin-2-yl)amino)benzothiazole (14): Beige powder was isolated (0.543 g, 97.3 %); mp = 283 – 285 °C; IR (KBr) (ν_{max}/cm^{-1}): 3409, 2952, 2218 (C≡N), 1627; ^{1}H NMR (DMSO) (δ/ppm): 11.87 (s, 1H, NH), 8.43 (s, 1H), 8.21 (s, 1H), 7.76-7.62 (m, 3H), 7.10 (d, 1H, J = 8.37 Hz), 2.26 (s, 3H, CH$_3$); ^{13}C NMR (DMSO) (δ/ppm): 165.22, 155.12, 151.1, 148.11, 141.54, 134.6, 131.64, 128.79, 128.29, 121.83, 121.55, 113.39, 105.33, 19.42; MS *m/z*: 267 (M^++1; 100%); Anal. ($C_{14}H_{10}N_4S$) C, H, N.

6-Cyano-2-(*N*-(6-methylpyridin-2-yl)amino)benzothiazole (15): Beige powder was isolated (0.523 g, 96.8 %); mp. = 289 - 291 °C; IR (KBr) (ν_{max}/cm^{-1}): 3414, 2222 (C≡N), 1628; ^{1}H NMR (DMSO) (δ/ppm): 11.92 (s, 1H, NH), 8.46 (s, 1H), 7.77-7.66 (m, 3H), 6.98 (d, 1H, J = 8.13 Hz), 6.93 (d, 1H, J = 7.38 Hz), 2.53 (s, 3H, CH$_3$); ^{13}C NMR (DMSO) (δ/ppm):

163.43, 155.93, 153.26, 150.66, 139.29, 133.04, 129.93, 126.57, 120.13, 119.93, 117.17, 108.83, 103.76, 23.83; MS *m/z*: 267 (M^++1; 100%); Anal. ($C_{14}H_{10}N_4S$) C, H, N.

6-Cyano-2-(*N*-(5-chloropyridin-2-yl)amino)benzothiazole (16): Beige powder was isolated (0.521 g, 87 %); mp > 300 °C; IR (KBr) (ν_{max}/cm^{-1}): 3078, 2227 (C≡N), 1591; ^{1}H NMR (DMSO) (δ/ppm): 12.12 (s, 1H, NH), 8.47 (s, 1H), 8.43 (d, 1H, J_2 = 1.95 Hz), 7.92 (dd, 1H, J_1 = 8.55 Hz, J_2 = 1.89 Hz); 7.75 (s, 2H), 7.23 (d, 1H, J = 8.79 Hz); ^{13}C NMR (DMSO) (δ/ppm): 162.76, 152.73, 149.73, 144.72, 138.46, 132.32, 129.52, 126.22, 123.77, 119.73, 119.45, 113.04, 113.68; MS *m/z*: 287 (M^+; 100%); Anal. ($C_{13}H_7ClN_4S$) C, H, N.

6-Cyano-2-(*N*-(pyrimidin-2-yl)amino)benzothiazole (17): Beige powder was isolated (0.497 g, 93.8 %); mp > 300 °C; IR (KBr) (ν_{max}/cm^{-1}): 2911, 2222 (C≡N), 1614; ^{1}H NMR (DMSO) (δ/ppm): 12.43 (s, 1H, NH), 8.74 (d, 2H, J = 4.83 Hz), 8.50 (s, 1H), 7.78 (d, 2H, J = 0.87 Hz), 7.19 (t, 1H, J = 4.83 Hz).; ^{13}C NMR (DMSO) (δ/ppm): 163.72, 158.73, 157.15, 153.23, 133.21, 130.01, 126.81, 120.61, 119.94, 115.88, 104.45; MS *m/z*: 254 (M^++1; 100%); Anal. ($C_{12}H_7N_5S$) C, H, N.

References

1. Ćaleta, I.; Cetina, M.; Hergold-Brundić, A.; Nagl, A.; Karminski-Zamola, G. Synthesis and crystal structure determination of 6-(*N*-isopropyl)amidino-2-methylbenzothiazole hydrochloride monohydrate and 2-(amino-6-(*N*-isopropyl)amidinobenzothiazole hydrochloride. *Struct. Chem.* **2003**, *14*, 585-592.

2. Sawhney, S. N.; Boykin, D. W. Transmission of Substitutent Effects in Heterocyclic Systems by Carcon-13 Nuclear Magnetic Resonance. Benzothiazoles. *J. Org. Chem.* **1979**, *44*, 1136-1142.

3. Porcari, A. R.; Devivar, R. V.; Kucera, L. S.; Drach, J. C.; Townsend, L. B. Synthesis, and Antiviral Evaluations of 1-(Substituted benzyl)-2-substituted-5,6-dichlorobenzimidazoles

as Nonnucleoside Analogues of 2,5,6-Trichloro-1-(β-D-ribofuranosyl)benzimidazole. *J. Med. Chem.* **1998,** *41*, 1252-1262.

4. Ćaleta, I.; Cinčić, D.; Karminski-Zamola, G.; Kaitner, B. The synthesis and structure of two novel N-(benzothiazol-2-yl)benzamides. *J. Chem. Chrystallogr.* **2008**, *38*, 775-780.

2. Elemental Analysis

Compound	**Elemental Analysis**		
		calcd. (%)	**found (%)**
2	C	40.19	40.20
	H	1.26	1.27
	N	11.72	11.70
3	C	64.50	64.68
	H	3.25	3.06
	N	15.04	15.32
5	C	60.59	60.65
	H	2.71	2.67
	N	14.14	14.19
7	C	57.67	57.78
	H	5.11	5.14
	N	14.94	14.81
8	**C**	52.81	52.66
	H	4.43	4.41
	N	13.69	13.74
9	**C**	55.03	55.11
	H	4.62	4.55
	N	14.26	14.17
11	C	65.20	65.15
	H	2.92	2.99
	N	20.28	20.38
12	C	63.14	63.27
	H	3.78	3.83
	N	21.04	20.95
13	C	63.14	63.06
	H	3.78	3.64
	N	21.04	21.17
14	C	63.14	63.02
	H	3.78	3.68
	N	21.04	20.93
15	C	63.14	63.18
	H	3.78	3.81
	N	21.04	21.07
16	C	54.45	54.58
	H	2.46	2.39
	N	19.54	19.61

17	C	56.90	56.88
	H	2.79	2.75
	N	27.66	27.72
18	C	53.96	53.87
	H	6.04	5.95
	N	17.98	17.86
19	C	51.26	51.22
	H	5.31	5.34
	N	17.58	17.63
20	C	51.26	51.19
	H	5.31	5.24
	N	17.58	17.46
21	C	51.26	51.33
	H	5.31	5.27
	N	17.58	17.49
22	C	51.26	51.41
	H	5.31	5.19
	N	17.58	17.65
23	C	45.89	45.97
	H	4.33	4.24
	N	16.72	16.81
24	C	46.75	46.97
	H	4.71	4.83
	N	21.81	21.54
25	C	52.42	52.32
	H	4.63	4.70
	N	19.30	19.18
26	C	50.27	50.25
	H	4.48	4.39
	N	18.32	18.38
27	C	50.27	50.34
	H	4.48	4.42
	N	18.32	18.30
28	C	50.27	50.32
	H	4.48	4.51
	N	18.32	18.35
29	C	50.27	50.20
	H	4.48	4.45
	N	18.32	18.29
30	C	44.73	44.81
	H	3.50	3.54
	N	17.39	17.32
31	C	45.53	45.57
	H	3.82	3.79
	N	22.76	22.81

3.

X-ray crystal structure analysis of 6-cyano-2-(*N*-(6-methylpyridin-2-yl)amino)benzothiazole **15**

Data were collected on Oxford Diffraction Xcalibur2 diffractometer with Sapphire 3 CCD detector at ambient temperature and controlled by the program CrysAlis Software system, Version 1.4, 2004. Data reduction has been applied by the same program. The data have been corrected for Lorentz-polarization, but not for absorption effects.

The structures were solved by direct methods. Refinement procedure by full-matrix least squares methods based on F^2 values against all reflections included anisotropic displacement parameters for all non-H atoms. The positions of hydrogen atoms belonging to the phenyl Csp^2 and methyl Csp^3 atoms were geometrically optimized applying the riding model [Csp^2-H, Csp^3-H, 0.93 and 0.96 Å, respectively; U_{iso}(H) = 1.2 (for Csp^2 and 1.5 for Csp^3 Ueq(C)]. The hydrogen atom belonging to the nitrogen N atom has been found in the electron-density Fourier maps and refined freely [N2- H2N = 0.84(3)Å; U_{iso}(H) = 0.046(6)].

Calculations were performed with SHELXS97 and SHELXL97. The molecular graphics were done using ORTEP-3 and PLATON programmes.

4. **Selected crystallographic data**

Table S1. General and crystal data and summary of intensity data collection and structure refinement for compound **15**.

Compound	**15**
Formula	$C_{14}H_{10}N_4S$
M_r	266.33
Crystal system, colour and habit	Monoclinic, yellow prism
Space group	*C* 2/*c* (No. 15)
Crystal dimensions (mm)	0.42 × 0.37 × 0.20
Unit cell parameters:	
a (Å)	27.145(3)
b (Å)	7.1711(7)
c (Å)	13.5866(12)
β/°	105.246(8)
V (Å^3)	2551.7(4)
Z	8
D_c (gcm^{-3})	1.387
μ (mm^{-1})	0.244
F(000)	1104
θ range for data collection (^{o})	4 - 27
h,*k*,*l* range	-34 to 31 ; -9 to 9 ; -17 to 17
Scan type	ω and φ
No. measured reflections	13877,
No. independent reflections (R_{int})	2756, 0.042
No. refined parameters	177
No. observed reflections, $I \geq 2\sigma(I)$	2535
g_1, g_2 in w	0.0823, 2.3308
R, w*R* [$I \geq 2\sigma(I)$]	0.0516, 0.1466
R, w*R* [all data]	0.0559, 0.1406
Goodness of fit on F^2, *S*	1.04

Max., min. electron density (e $Å^{-3}$)	0.28, -0.23
Maximum Δ/σ	0.001

Table S2 – Final Coordinates and Equivalent Isotropic Displacement Parameters of the non-Hydrogen atoms for: 1
R = 0.05

Atom	x	y	z	U(eq) [Ang^2]
S1	0.04881(2)	0.78565(7)	0.50535(3)	0.0385(2)
N1	0.05768(6)	0.8264(2)	0.70068(11)	0.0398(5)
N2	-0.02489(7)	0.7540(2)	0.60828(12)	0.0402(5)
N3	-0.05078(7)	0.7159(2)	0.43321(12)	0.0386(5)
N4	0.28461(10)	0.9348(6)	0.5937(2)	0.1107(15)
C1	0.02488(7)	0.7891(2)	0.61306(13)	0.0346(5)
C2	0.10573(8)	0.8556(3)	0.68687(14)	0.0394(6)
C3	0.14998(8)	0.8991(3)	0.76319(15)	0.0508(7)
C4	0.19548(9)	0.9205(4)	0.73804(17)	0.0571(7)
C5	0.19793(8)	0.8986(4)	0.63695(17)	0.0539(7)
C6	0.15419(8)	0.8575(3)	0.55961(16)	0.0470(6)
C7	0.10868(8)	0.8373(3)	0.58543(14)	0.0394(5)
C8	-0.06338(8)	0.7107(2)	0.52107(14)	0.0361(5)
C9	-0.11182(8)	0.6640(3)	0.52972(15)	0.0422(6)
C10	-0.14851(9)	0.6249(3)	0.44150(17)	0.0511(7)
C11	-0.13620(9)	0.6313(3)	0.34909(17)	0.0531(7)
C12	-0.08734(9)	0.6762(3)	0.34726(15)	0.0445(6)
C13	-0.07127(11)	0.6826(4)	0.24974(16)	0.0587(8)
C14	0.24604(10)	0.9190(5)	0.6123(2)	0.0727(9)

U(eq) = 1/3 of the trace of the orthogonalized U Tensor

Table S3 – Hydrogen Atom Positions and Isotropic Displacement Parameters
for: 15
R = 0.05

Atom	x	y	z	U(iso) [Ang^2]
H2N	-0.0344(9)	0.771(3)	0.6616(19)	0.046(6)
H3	0.14860	0.91350	0.83040	0.0610
H4	0.22490	0.94970	0.78860	0.0690
H6	0.15570	0.84410	0.49240	0.0560
H9	-0.11900	0.65950	0.59290	0.0510
H10	-0.18150	0.59430	0.44380	0.0610
H11	-0.16080	0.60530	0.28870	0.0640
H13A	-0.04790	0.58250	0.24890	0.0880
H13B	-0.05490	0.79960	0.24500	0.0880
H13C	-0.10080	0.66990	0.19280	0.0880

The Temperature Factor has the Form of Exp(-T) Where
T = 8*(Pi**2)*U*(Sin(Theta)/Lambda)**2 for Isotropic Atoms

Table S4 – (An)isotropic Displacement Parameters for: 15
R = 0.05

Atom	U(1,1) or U	U(2,2)	U(3,3)	U(2,3)	U(1,3)	U(1,2)
S1	0.0456(3)	0.0440(3)	0.0283(3)	0.0007(2)	0.0141(2)	0.0017(2)
N1	0.0440(9)	0.0474(9)	0.0289(7)	0.0014(6)	0.0114(6)	0.0008(7)
N2	0.0440(9)	0.0515(9)	0.0279(8)	-0.0005(7)	0.0144(7)	-0.0004(7)
N3	0.0487(9)	0.0371(8)	0.0312(8)	0.0002(6)	0.0125(7)	-0.0003(7)
N4	0.0567(14)	0.207(4)	0.0731(16)	0.011(2)	0.0254(12)	-0.0205(19)
C1	0.0433(10)	0.0338(9)	0.0280(8)	0.0029(6)	0.0118(7)	0.0020(7)
C2	0.0449(10)	0.0407(10)	0.0342(9)	0.0063(8)	0.0135(8)	0.0042(8)
C3	0.0510(12)	0.0673(14)	0.0331(10)	0.0037(9)	0.0094(8)	-0.0038(10)
C4	0.0437(11)	0.0783(16)	0.0464(11)	0.0088(11)	0.0068(9)	-0.0055(11)
C5	0.0426(11)	0.0689(14)	0.0524(12)	0.0123(11)	0.0162(9)	0.0015(10)
C6	0.0500(11)	0.0534(12)	0.0414(10)	0.0082(9)	0.0188(9)	0.0028(9)
C7	0.0455(10)	0.0391(9)	0.0345(9)	0.0058(7)	0.0123(8)	0.0038(8)
C8	0.0445(10)	0.0318(9)	0.0323(9)	0.0028(6)	0.0108(8)	0.0020(7)
C9	0.0460(11)	0.0427(10)	0.0398(10)	0.0028(8)	0.0148(8)	-0.0003(8)
C10	0.0444(11)	0.0561(12)	0.0514(12)	0.0033(10)	0.0099(9)	-0.0059(10)
C11	0.0540(12)	0.0546(12)	0.0430(11)	-0.0001(10)	-0.0007(9)	-0.0087(10)
C12	0.0591(12)	0.0407(10)	0.0326(9)	-0.0012(8)	0.0099(9)	-0.0017(9)
C13	0.0753(16)	0.0664(14)	0.0344(11)	-0.0087(10)	0.0143(10)	-0.0034(12)
C14	0.0507(14)	0.114(2)	0.0537(13)	0.0093(15)	0.0145(11)	-0.0071(15)

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The Temperature Factor has the Form of Exp(-T) Where
T = 8*(Pi**2)*U*(Sin(Theta)/Lambda)**2 for Isotropic Atoms
T = 2*(Pi**2)*Sumij(h(i)*h(j)*U(i,j)*Astar(i)*Astar(j)), for Anisotropic Atoms. Astar(i) are Reciprocal Axial Lengths and h(i) are the Reflection Indices.

Table S5 – Bond Distances (Angstrom)for: 15
R = 0.05

S1	–C1	1.7505(19)	C6	–C7	1.378(3)
S1	–C7	1.741(2)	C8	–C9	1.392(3)
N1	–C1	1.313(2)	C9	–C10	1.371(3)
N1	–C2	1.382(3)	C10	–C11	1.382(3)
N2	–C1	1.359(3)	C11	–C12	1.371(4)
N2	–C8	1.393(3)	C12	–C13	1.501(3)
N3	–C8	1.326(3)	C3	–H3	0.9300
N3	–C12	1.349(3)	C4	–H4	0.9300
N4	–C14	1.145(4)	C6	–H6	0.9300
N2	–H2N	0.84(3)	C9	–H9	0.9300
C2	–C3	1.400(3)	C10	–H10	0.9300
C2	–C7	1.408(3)	C11	–H11	0.9300
C3	–C4	1.374(3)	C13	–H13A	0.9600
C4	–C5	1.401(3)	C13	–H13B	0.9600
C5	–C6	1.395(3)	C13	–H13C	0.9600
C5	–C14	1.438(4)			

Table S6 – Bond Angles (Degrees) for: 15
R = 0.05

C1	–S1	–C7	88.01(9)	C9	–C10	–C11	119.6(2)
C1	–N1	–C2	110.31(15)	C10	–C11	–C12	119.4(2)
C1	–N2	–C8	126.57(17)	N3	–C12	–C11	121.9(2)
C8	–N3	–C12	117.9(2)	N3	–C12	–C13	116.1(2)
C1	–N2	–H2N	117.3(17)	C11	–C12	–C13	122.0(2)
C8	–N2	–H2N	115.7(17)	N4	–C14	–C5	179.3(3)
N1	–C1	–N2	120.64(16)	C2	–C3	–H3	120.00
S1	–C1	–N1	116.65(15)	C4	–C3	–H3	120.00
S1	–C1	–N2	122.70(13)	C3	–C4	–H4	120.00
C3	–C2	–C7	119.2(2)	C5	–C4	–H4	120.00
N1	–C2	–C3	126.15(17)	C5	–C6	–H6	121.00
N1	–C2	–C7	114.69(18)	C7	–C6	–H6	121.00
C2	–C3	–C4	119.53(19)	C8	–C9	–H9	121.00
C3	–C4	–C5	120.6(2)	C10	–C9	–H9	121.00
C4	–C5	–C14	119.8(2)	C9	–C10	–H10	120.00
C4	–C5	–C6	120.8(2)	C11	–C10	–H10	120.00
C6	–C5	–C14	119.4(2)	C10	–C11	–H11	120.00
C5	–C6	–C7	118.24(19)	C12	–C11	–H11	120.00
S1	–C7	–C6	127.97(15)	C12	–C13	–H13A	110.00

C2	-C7	-C6	121.68(19)	C12	-C13	-H13B
109.00						
S1	-C7	-C2	110.34(16)	C12	-C13	-H13C
109.00						
N3	-C8	-C9	123.78(18)	H13A	-C13	-H13B
110.00						
N2	-C8	-N3	116.50(19)	H13A	-C13	-H13C
109.00						
N2	-C8	-C9	119.72(18)	H13B	-C13	-H13C
109.00						
C8	-C9	-C10	117.44(19)			

Table S7 – Torsion Angles (Degrees) for: 15
R = 0.05

C7	-S1	-C1	-N1	0.50(14)
C7	-S1	-C1	-N2	-179.01(15)
C1	-S1	-C7	-C2	-0.81(16)
C1	-S1	-C7	-C6	178.5(2)
C2	-N1	-C1	-S1	0.00(19)
C2	-N1	-C1	-N2	179.51(15)
C1	-N1	-C2	-C3	179.76(19)
C1	-N1	-C2	-C7	-0.7(2)
C8	-N2	-C1	-S1	0.3(2)
C8	-N2	-C1	-N1	-179.23(15)
C1	-N2	-C8	-N3	-4.6(2)
C1	-N2	-C8	-C9	175.00(17)
C12	-N3	-C8	-N2	-179.45(16)
C12	-N3	-C8	-C9	1.0(3)
C8	-N3	-C12	-C11	-0.1(3)
C8	-N3	-C12	-C13	-179.62(18)
N1	-C2	-C3	-C4	178.7(2)
C7	-C2	-C3	-C4	-0.9(3)
N1	-C2	-C7	-S1	1.0(2)
N1	-C2	-C7	-C6	-178.32(19)
C3	-C2	-C7	-S1	-179.37(17)
C3	-C2	-C7	-C6	1.3(3)
C2	-C3	-C4	-C5	-0.2(4)
C3	-C4	-C5	-C6	1.0(4)
C3	-C4	-C5	-C14	-179.1(3)
C4	-C5	-C6	-C7	-0.6(4)
C14	-C5	-C6	-C7	179.5(3)
C5	-C6	-C7	-S1	-179.75(19)

Table S8 – Torsion Angles (Degrees) (continued) for: 15
R = 0.05

C5	–C6	–C7	–C2	–0.5(3)
N2	–C8	–C9	–C10	179.18(17)
N3	–C8	–C9	–C10	–1.3(3)
C8	–C9	–C10	–C11	0.6(3)
C9	–C10	–C11	–C12	0.2(3)
C10	–C11	–C12	–N3	–0.5(3)
C10	–C11	–C12	–C13	179.0(2)

Table S9 – Contact Distances(Angstrom) for: 15
R = 0.05

S1	.N3	2.670(2)	C1	.H2N_c	3.01(2)
S1	.C8_a	3.6096(16)	C2	.H13B_b	3.0900
S1	.C8_b	3.6612(16)	C3	.H9_c	2.8900
N1	.N2_c	3.002(2)	C9	.H3_c	2.9700
N2	.N1_c	3.002(2)	C14	.H11_e	3.0000
N3	.S1	2.670(2)	H2N	.H9	2.3800
N4	.C10_d	3.377(4)	H2N	.N1_c	2.16(2)
N1	.H2N_c	2.16(2)	H2N	.C1_c	3.01(2)
N1	.H13B_b	2.7900	H3	.C9_c	2.9700
N4	.H10_d	2.7000	H3	.H9_c	2.3400
N4	.H11_e	2.6900	H9	.H2N	2.3800
C2	.C12_b	3.408(3)	H9	.C3_c	2.8900
C6	.C10_a	3.463(3)	H9	.H3_c	2.3400
C7	.C11_a	3.506(3)	H10	.N4_f	2.7000
C7	.C10_a	3.535(3)	H11	.H13C	2.3800
C8	.S1_a	3.6096(16)	H11	.N4_g	2.6900
C8	.S1_b	3.6612(16)	H11	.C14_g	3.0000
C10	.C6_a	3.463(3)	H13A	.H13A_h	2.5900
C10	.C7_a	3.535(3)	H13B	.N1_b	2.7900
C10	.N4_f	3.377(4)	H13B	.C2_b	3.0900
C11	.C7_a	3.506(3)	H13C	.H11	2.3800
C12	.C2_b	3.408(3)			