Indian Journal of Chemistry
Vol. 47B, March 2008, pp. 463-469

Synthesis of some new 5-[2-{(1,2,3-benzotriazole)-1- yl-methyl}- 1′-(4′-substituted aryl-3′-chloro-2′-oxo azetidine)]-amino-1,3,4-thiadiazoles: Antifungal and antibacterial agents

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Received 22 June 2007; accepted (revised) 3 January 2008

As a part of systematic investigation of synthesis and biological activity, several new 5-[2-(1,2,3-benzotriazole)-1-yl-methyl]-arylidene hydrazino-1,3,4-thiadiazoles **7** and 5-[2-{(1,2,3-benzotriazole)-1-yl-methyl}-1′-(4′-substituted aryl-3′-chloro-2′-oxo-azetidine]-amino-1,3,4-thiadiazoles **8** have been synthesized from 5-[2-(1,2,3-benzotriazole)-1-yl-methyl]-5-hydrazino-1,3,4-thiadiazoles **6** using 1,2,3-benzotriazole as the starting material. All the synthesized products are evaluated for their antifungal activity against *Aspergillus niger, Aspergillus flavus, Fusarium oxisporum* and *Trichoderma viride* and antibacterial activity against *Bacilus subtilis, Escherichia coli, Klebsiella pneumoneae* and S*taphylococcus aureus*. The structure of all the synthesized compounds have been determined by spectral and chemical methods.

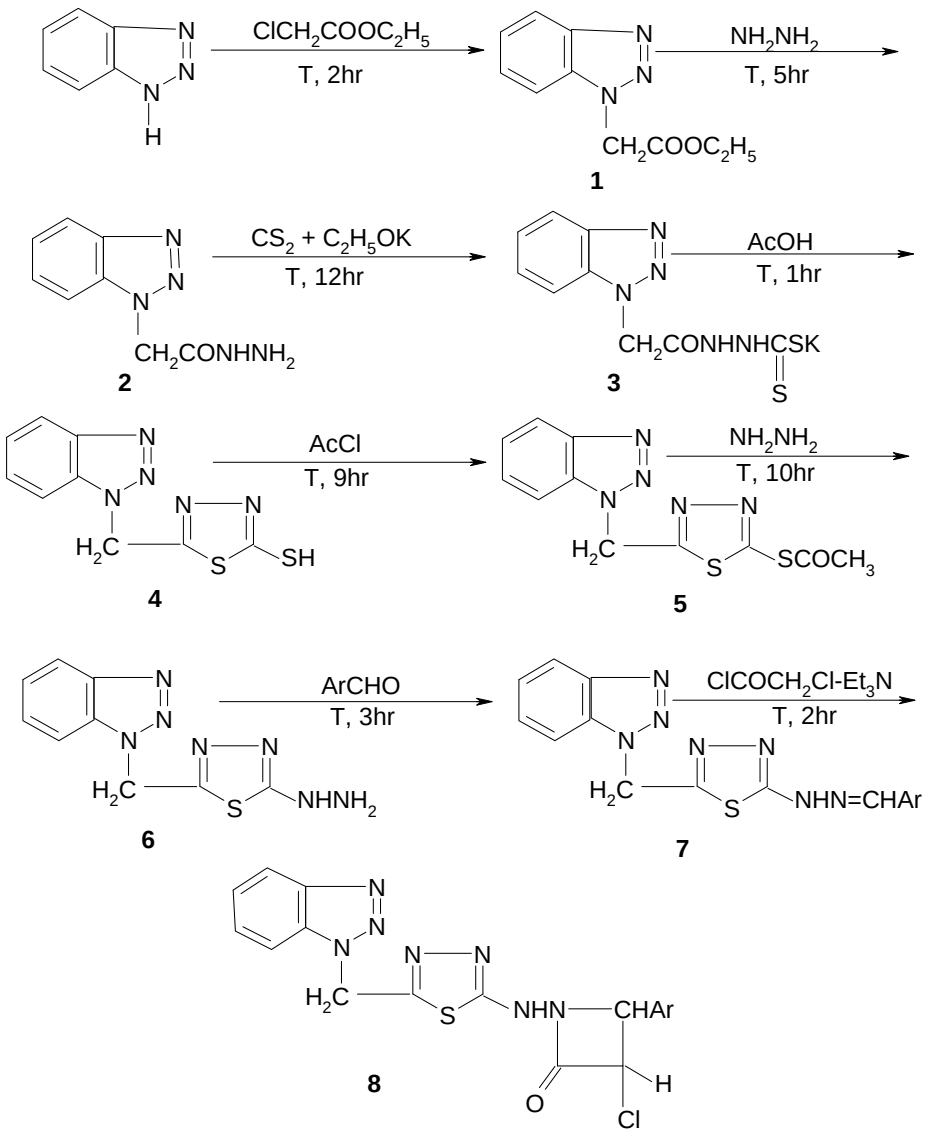
Keywords: Benzotriazole, thiadiazoles, antifungal, antibacterial

Heterocycles bearing thaizole, sulphur and nitrogen moieties constitute the core structure of a number of pharmacologically and biologically active interesting compounds. The efficiency of azoles as chemo-therapeutic agent is well established[1,2]. Various derivatives of 1,2,3-benzotriazole,1,3,4-thiadiazoles and 2-oxo-azetidines exhibit interesting pharmacological properties including antimicrobial[3-6], anti-cancer[7], analgesic[8,9], anticonvulsant[10], antiinflammatory[11-13] and CNS depressant[14]. It has also an important applications for the protection of human skin from harmful UV irradiation[15,16] and corrosion inhibitor[17]. The incorporation of thiadiazolo-2-oxo-azetidine in 1,2,3-benzotriazole framework through -NCH_2- and -NH as their bridging groups was used as the target for chemical modification. Looking at the importance of these compounds, the present work aims to synthesize and screen the antifungal and antibacterial activities of arylidinothiadiazole and 2′-oxo-azetidinothiadiazole derivatives of 1,2,3,-benzotriazole nuclei.

Benzotriazole on reaction with ethyl chloro-acetate gave ethyl-N^1-benzotriazoloacetate **1**, which on reaction with hydrazine hydrate afforded N^1-benzotriazoloacetyl hydrazine **2**. The compound **2** on treatment with carbon disulphide in the presence of C_2H_5OK yielded N^1benzotriazoloacetyl hydrazino potassium carbazate **3** which on further treatment with acetic acid afforded 5-[2-(1,2,3-benzotriazole)-1-yl-methyl]- mercapto-1,3,4-thiadiazole **4**. The compound **4** on reaction with AcCl in the presence of a diphenyl amine gave 5-[2-(1,2,3-benzotriazole)-1-yl-methyl]-5-S-acyl-1,3,4-thiadiazoles **5** which on reaction with hydrazine hydrate at RT afforded 5-[2-(1, 2, 3-benzotriazole)-1-yl-methyl]-5-hydrozino-1,3,4-thiadiazole **6.** The compound **6** on reaction with various aromatic aldehydes yielded 5-[2-(1,2,3-benzo-triazole)-1-yl-methyl]-arylidene hydrazino-1,3,4-thiadiazole **7** which on further treatment with chloroacetyl chloride in the presence of Et_3N afforded 5-[2-{(1, 2, 3-benzotriazole)-1-yl-methyl}-1′-(4′-substituted aryl-3′-chloro-2′-oxo-azetidine)]-amino-1,3,4-thiadiazoles **8** (**Scheme I**).

Experimental Section

Melting points were taken in an open capillary tube. IR spectra (KBr) were recorded on a Shimadzu 8201 PC spectrophotometer and ^{1}H NMR spectra in $CDCl_3$ at 300 MHz on a Bruker DRX 300 spectrophotometer using TMS as an internal standard



Ar = Substituted aryl; T = reflux temp., 95-100ºC

Scheme I

(Chemical shift in δ, ppm). The mass spectra were recorded on a Jeol SX-102 (FAB) spectrometer.

Ethyl-N[1]-Benzotriazoloacetate 1. Ethyl chloroacetate (0.12 mole) was added to a solution of 1,2,3,-benzotriazole in MeOH (50 mL, ref. 1) and the reaction-mixture was refluxed on a water-bath about 2 hr. The solvent was removed *in vacuo* and the residue was purified over the column of silica gel using $CHCl_3$ as an eluent. The product was crystallized from chloroform to give **1**, yield 87%, m.p. 130-32°C. Anal. Calcd. for $C_{10}H_{11}N_3O_2$: C, 58.53; H, 5.36; N, 20.48. Found: C, 58.50; H, 5.32; N, 20.42%. IR (KBr): 3253, 3076, 2958, 2801, 1595, 1472, 1361, 1000, 941, 868, 740 (1,2,3,-benzotriazole nucleus), 1715 (>C=O of ester), 2828, 1468, 1204 (N-CH_2), 2896, 2873, 1434, 698 (CH_2 and CH_3) cm^{-1}; ^1H NMR ($CDCl_3$): 1.22 (t, 3H, *J*=7Hz, $COOCH_2CH_3$), 3.63 (s, 2H, N-CH_2), 4.12 (q, 2H, *J*=7Hz, $COOCH_2CH_3$), 7.23-7.87 (m, 4H, Ar-H); MS: *m/z* 205 (M^+).

N[1]-Benzotriazoloacetyl hydrazine 2. A mixture of compound **1** (0.063 mole) and hydrazine hydrate (0.063 mole) was refluxed on a water-bath in MeOH (50 mL, ref. 1) for about 5 hr, cooled and filtered to get a product which was purified over the column of silica gel and eluted with $CHCl_3$. The product was crystallized

from $CHCl_3$ to give compound **2**, yield 85%, m.p.176-77°C. Anal. Calcd. for $C_8H_9N_5O$: C, 50.26; H, 4.71; N, 36.64. Found: C, 50.22; H, 4.69; N, 36.59%. IR (KBr): 3256, 3079, 2956, 2804, 1594, 1470, 1360, 998, 940, 869, 743 (1,2,3,-benzotriazole nucleus), 1206 (N-CH_2), 3375, 3326 (-$NHNH_2$), 1675 (>C=O amido carboxyl), 2828, 1470, 1210 (>N-CH_2) cm^{-1}, ^1H NMR ($CDCl_3$): 3.67 (s, 2H, -NH_2), 3.65 (s, 2H, N-CH_2), 8.13 (s, 1H, CONH), 7.30-7.81 (m, 4H, Ar-H); MS: *m/z* 199(M^+).

N^1-Benzotriazoloacetyl hydrazino-K-carbazate 3. A mixture of compound **2** (0.054 mole) and KOH in absolute ethanol (30 mL, ref. 18,19) was treated with carbon disulphide (0.054 mole). The mixture was diluted with methanol (100 mL) and refluxed for about 12 hr. The separated solid was filtered, dried *in vacuo* and purified over column of silica gel, eluted with C_6H_6 : $CHCl_3$, (2:8 v/v) mixture to give **3** which was crystallized with $CHCl_3$ yield 84%, m.p. 173-74°C. Anal. Calcd. for $C_{10}H_8N_5COS_2K$: C, 37.89; H, 2.80; N, 24.56. Found: C, 37.83; H, 2.79; N, 24.49%. IR (KBr): 3250, 3076, 2355, 2803, 1589, 1471, 1593, 939, 868, 742 (1,2,3,-benzotriazole nucleus), 2826, 1473, 1211 (>N-CH_2), 1672 (>C=O amido carbonyl), 3372, 3328 (-NH) cm^{-1}; ^1H NMR ($CDCl_3$): 3.64 (s, 2H, N-CH_2), 8.12 (s, 1H, CONH), 7.89 (s,1H,-NH),7.29-7.80 (m, 4H, Ar-H); MS: *m/z* 285 (M^+).

5-[2-(1,2,3-Benzotriazole)-1-yl-methyl] marcapto-1,3,4-thiadiazoles 4. A mixture of compound **3** (0.026 mole) and acetic acid (0.026 mole) in methanol (50 mL, ref. 19) was refluxed for about 1 hr. On cooling, a solid was separated out, filtered, purified over the column of silica gel, eluted with $CHCl_3$ and recrystallized from $CHCl_3$ to afford compound **4**, yield 82%, m.p. 172-73°C. Anal. Calcd. for $C_9H_7N_5S_2$: C,43.37; H, 2.81; N, 28.11. Found: C, 43.34; H, 2.79; N, 28.10%. IR (KBr): 3251, 3075, 2953, 2800, 1594, 1470, 1360, 998, 938, 867, 741 (1,2,3,-benzotriazole nucleus), 2827, 1475, 1210 (>N-CH_2), 1600, 1445, 1312, 1175 and 690 (thiadiazole nucleus), 2585 (-SH) cm^{-1}; ^1H NMR ($CDCl_3$): 3.61 (s, 2H, >N-CH_2), 7.30-7.80 (m, 4H, Ar-H), and 4.10 (1H, -SH); MS: *m/z* 249 M^+).

5-[2-(1,2,3-Benzotriazole)-1-yl-methyl]-5-S-acyl-1,3,4-thiadiazoles 5. The compound **4** (0.004 mole) in methanol (50 mL, ref. 19) was treated with acetyl chloride (0.04 mole) in the presence of diphenyl amine (0.004 mole) was refluxed on a water-bath for about 9 hr. The solvent was removed, purified over the column of silica gel, eluted with $CHCl_3$ and recrystallized from chloroform - ethyl acetate to give compound **5**, yield 78%, m.p. 154-62°C. Anal. Calcd. for $C_{11}H_9N_5OS$: C, 45.36; H, 3.09; N, 24.05. Found: C, 45.32; H, 3.08; N, 23.98%. IR (KBr): 3252, 3073, 2952, 2801, 1591, 1468, 1361, 996, 936, 865, 740 (1,2,3,-benzotriazole nucleus), 2825, 1472, 1209 (>N-CH_2), 1601, 1443, 1310, 1172 and 689 (thiadiazole nucleus), 696 and 598 (C-S-C) cm^{-1}; ^1H NMR ($CDCl_3$): 3.69 (s 2H, >NCH_2), 7.32-7.83, (m, 4H, Ar-H) and 2.50 (s, 3H, -$COCH_3$); MS: *m/z* 291 (M^+).

5-[2-(1,2,3-Benzotriazole)-1-yl-methyl]-5-hydrazino-1,3,4-thiadiazoles 6. The compound **5** (0.01 mole) and hydrazine hydrate (0.01 mole) in methanol (50 mL, ref. 19) was stirred for about 10 hr at RT and the mixture was kept for about 72 hr at RT. The solid thus obtained was separated, purified over the column of silica gel, eluted with $CHCl_3$ and the product was recrystallized from $CHCl_3$ to give compound **6**; yield 68%, m.p. 160-61°C. Anal. Calcd. for $C_9H_9N_7S$: C, 43.72; H, 3.64; N, 39.69. Found: C, 43.70; H, 3.61; N, 39.62%. IR (KBr): 3250, 3071, 2951, 2800, 1593, 1471, 1360, 996, 937, 862, 741 (1,2,3,-benzotriazole nucleus), 2826, 1472, 1211 (>N-CH_2), 1600, 1446, 1311, 1170 and 691 (thiadiazole nucleus), 3374 and 3324 ($NHNH_2$) cm^{-1}; ^1H NMR ($CDCl_3$): 3.66 (s, 2H, -NH_2), 8.82 (s, 1H. -NH), 4.53 (s, 2H, >N-CH_2), 7.31-7.80 (m, 4H, Ar-H); MS: *m/z* 247 (M^+).

5-[2-(1,2,3-Benzotriazole)-1-yl-methyl]-arylidene-hydrazino-1,3,4-thiadiazoles 7a. The compound **6** (0.008 mole) and benzaldehyde (0.008 mole) with 2 mL gl. acetic acid in methanol (50 mL, ref. 2) were refluxed for about 3 hr on a water-bath and the solvent was removed under reduced pressure. The product so obtained was purified over the column of silica gel, eluted with $CHCl_3$ and the residue was recrystallized from ethanol to give **7a**; yield 58%, m.p. 175-76°C. Anal. Calcd. for $C_{16}H_{13}N_7S$: C, 57.31; H, 3.88; N, 29.25. Found: C, 57.29; H, 3.87; N, 29.22%. IR (KBr): 3249, 3170, 2953, 2802, 1591, 1470, 1359, 993, 935, 860, 742 (1,2,3,-benzotriazole nucleus), 2824, 1471, 1210 (>N-CH_2), 1601,1445,1312, 1171 and 690 (thiadiazole nucleus), 1603 (-N=CH) cm^{-1}; ^1H NMR ($CDCl_3$): 4.49 (s, 2H, >N-CH_2), 8.80 (s, 1H, -NH), 7.31-7.80 (m, 9H, Ar-H), 4.43 (s, 1H, N=CH), MS: *m/z* 335 (M^+).

Other compounds **7b-n** were synthesized similarly from compound **6** using different aromatic aldehydes. Physical characterization data are presented in **Table I**.

5-[2-{(1, 2, 3-Benzotriazole)-1-yl-methyl}-1′-(4′-substituted aryl -3′-chloro-2′-oxo azetidine)]-amino-1,3,4-thiadiazoles 8a. To a stirred

Table I — Physical characterization data of compds **7b-n** and **8b-n**

Compd	Ar	Yield (%)	m.p. (°C)	Mol. Formula	Calcd (Found) %		
					C	H	N
7b	2-BrC_6H_4	63	172-73	$C_{16}H_{12}N_7SBr$	46.60 (46.58	2.91 2.89	23.78 23.76)
7c	3-BrC_6H_4	73	171-72	$C_{16}H_{12}N_7SBr$	46.60 (46.59	2.91 2.89	23.78 23.73)
7d	4-BrC_6H_4	63	170-73	$C_{16}H_{12}N_7SBr$	46.60 (46.57	2.91 2.85	23.78 23.75)
7e	2-ClC_6H_4	71	169-67	$C_{16}H_{12}N_7SCl$	51.96 (51.94	3.24 3.22	26.52 26.50)
7f	3-ClC_6H_4	70	168-69	$C_{16}H_{12}N_7SCl$	51.96 (51.92	3.24 3.21	26.52 26.49)
7g	4-ClC_6H_4	69	170-71	$C_{16}H_{12}N_7SCl$	51.96 (51.91	3.24 3.20	26.52 26.48)
7h	2-$NO_2C_6H_4$	73	172-74	$C_{16}H_{12}N_8O_2S$	50.52 (50.50	3.15 3.13	29.47 29.44)
7i	3-$NO_2C_6H_4$	71	173-75	$C_{16}H_{12}N_8O_2S$	50.52 (50.49	3.15 3.12	29.47 29.40)
7j	4-$NO_2C_6H_4$	72	174-76	$C_{16}H_{12}N_8O_2S$	50.52 (50.48	3.15 3.12	29.47 29.45)
7k	2-$OCH_3C_6H_4$	68	167-69	$C_{17}H_{15}N_7O_5$	58.45 (58.43	4.29 4.26	28.08 28.06)
7l	3-$OCH_3C_6H_4$	70	170-72	$C_{17}H_{15}N_7O_5$	58.45 (58.42	4.29 4.27	28.08 28.06)
7m	4-$OCH_3C_6H_4$	69	169-71	$C_{17}H_{15}N_7O_5$	58.45 (58.43	4.29 4.25	28.08 28.05)
7n	4,4'-$N(CH_3)_2C_6H_4$	58	173-74	$C_{18}H_{18}N_8S$	57.14 (57.11	4.76 4.74	29.62 29.60)
8b	2-BrC_6H_4	71	161-63	$C_{17}H_{13}ON_7SBrCl$	42.64 (42.62	2.71 2.69	20.48 20.46)
8c	3-BrC_6H_4	72	160-62	$C_{17}H_{13}ON_7SBrCl$	42.64 (42.61	2.71 2.69	20.48 20.47)
8d	4-BrC_6H_4	70	138-40	$C_{17}H_{13}ON_7SBrCl$	42.64 (42.63	2.71 2.70	20.48 20.45)
8e	2-ClC_6H_4	66	140-41	$C_{17}H_{13}ON_7SCl_2$	47.00 (47.00	2.99 2.96	22.58 22.56)
8f	3-ClC_6H_4	67	140-42	$C_{17}H_{13}ON_7SCl_2$	47.00 (47.00	2.99 2.97	22.58 22.57)
8g	4-ClC_6H_4	69	139-41	$C_{17}H_{13}ON_7SCl_2$	47.00 (47.00	2.99 2.98	22.58 22.58)
8h	2-$NO_2C_6H_4$	65	119-21	$C_{17}H_{13}O_3N_8SCl$	45.89 (45.87	2.92 2.90	25.19 25.16)
8i	3-$NO_2C_6H_4$	63	120-22	$C_{17}H_{13}O_3N_8SCl$	45.89 (45.86	2.92 2.91	25.19 25.17)
8j	4-$NO_2C_6H_4$	62	118-20	$C_{17}H_{13}O_3N_8SCl$	45.89 (45.87	2.92 2.90	25.19 25.16)
8k	2-$OCH_3C_6H_4$	78	136-38	$C_{18}H_{16}O_2N_7SCl$	50.29 (50.26	3.72 3.70	22.18 22.79)
8l	3-$OCH_3C_6H_4$	76	135-37	$C_{18}H_{16}O_2N_7SCl$	50.29 (50.29	3.72 3.70	22.81 22.79)
8m	4-$OCH_3C_6H_4$	79	131-33	$C_{18}H_{16}O_2N_7SCl$	50.29 (50.27	3.72 3.71	22.81 22.80)
8n	4,4'-$N(CH_3)_2C_6H_4$	70	129-31	$C_{20}H_{19}ON_8S$	57.27 (57.24	4.53 4.51	26.73 26.71)

Table II — Antifungal activity data of the compounds

Compd	*A. niger*		*A. flavus*		*F. oxisporum*		*T. viride*	
	100 ppm	500 ppm	100 ppm	500 ppm	100 ppm	500 ppm	100 ppm	500 ppm
1	+	++	-	-	+	++	++	++
2	+	++	+	+	+	+	-	+
3	++	++	+	+	-	-	+	+
4	+	+	-	+	+	+	-	+
5	-	+	-	-	-	+	+	+
6	-	-	+	++	-	+	+	+
7a	++	++	+	++	+	+	+	++
7b	++	++	+++	+++	+++	++++	+++	++++
7c	++	+++	++	+++	++	++	++	+++
7d	++	+++	+++	+++	+++	+++	++	++
7e	++	+++	++	++	+++	+++	+++	+++
7f	++	++	+	++	++	++	++	+++
7g	+	++	++	++	++	+++	+++	+++
7h	+	+++	-	+	+	++	+++	++
7i	+	++	++	++	++	++	++	+++
7j	++	++	-	+	+	+	+	++
7k	+	++	-	-	-	+	+	++
7l	+	+	+	-	+	+	-	-
7m	-	-	-	+	-	+	-	++
7n	+	+	+	++	+	++	+	+
8a	+	+	+	+	+	++	++	++
8b	++	++	++	+++	++	++	+++	+++
8c	++	+++	++	++	++	++	++	+++
8d	++	+++	++	++	++	+++	+++	+++
8e	++	++	-	+	+	++	++	++
8f	++	++	+	+	++	++	++	++
8g	+	+	+	++	+	+	+	+
8h	+	+	-	+	-	-	-	+
8i	+	+	+	+	-	+	+	+
8j	+	+	-	+	-	-	+	+
8k	-	-	+	+	+	+	+	+
8l	-	+	-	-	-	-	-	+
8m	-	-	+	+	+	+	-	+
8n	-	-	-	-	+	+	-	-
GF	+++	++++	+++	++++	++++	++++	+++	++++

GF=Griseofulvin, inhibition diameter in mm; (-) 5; (+) 5-11; (++) 11-15, (+++) 15-19; (++++) 19-24.

solution of the compound **7a** (0.002 mole) and triethyl amine (0.002 mole) in methanol (50 mL, ref. 2, 0.002 mole) chloro acetyl chloride was added dropwise at ice-cooled condition. The reaction-mixture was stirred for about 4 hr and the separated amine hydrochloride was filtered off. The filtrate was refluxed for about 2 hr, concentrated at reduced pressure and the separated solid was purified over the column of silica gel, eluted with $CHCl_3$ and recrystallized from chloroform to get compound **8a**, yield 71%, m.p. 179-80°C. Anal. Calcd. for $C_{18}H_{14}ON_7SCl$: C, 52.49; H, 3.40; N, 23.84. Found: C, 52.47; H, 3.38; N, 23.79%. IR (KBr): 3248, 3169, 2952, 2801, 1592, 1469, 1361, 991, 932, 859, 740 (1,2,3,-benzotriazole nucleus), 2823, 1470, 1209 (>N-CH_2), 1600, 1443, 1310, 1169 and 689 (thiadiazole nucleus), 1760 (β-lactam), 760

Table III — Antibacterial activity data of the compounds

Compd	*B. substilis*		*E. coli*		*K.pneumoneae*		*S.aureus*	
	50 ppm	100 ppm	50 ppm	100 ppm	50 ppm	100 ppm	50 ppm	100 ppm
1	+	+	+	+	-	+	++	++
2	++	++	-	+	-	-	++	++
3	+	++	-	-	-	-	+	++
4	++	++	+	+	+	+	-	-
5	+	+	+	++	+	++	+	++
6	++	++	+	+	+	++	+	++
7a	+++	+++	++	++	+	+	++	++
7b	+++	+++	++	++	++	++	++	++
7c	++	+++	+++	+++	+++	+++	++	++
7d	++	++	++	+++	++	+++	+++	+++
7e	++	++	++	++	++	+++	+	+++
7f	+	+	+	++	+	++	+	++
7g	++	++	+	++	+	+	++	++
7h	+	++	-	+	+	+	+	++
7i	+	++	-	-	-	-	+	++
7j	-	+	+	+	-	+	+	++
7k	+	++	-	+	+	+	+	+
7l	-	-	-	+	+	++	-	-
7m	+	+	+	+	-	+	-	+
7n	-	-	+	+	+	+	++	++
8a	+	+	+	+	+	++	+	+
8b	++	++	+	++	+	+	+	+
8c	+++	+++	++	++	++	++	++	+++
8d	++	+++	+++	+++	+++	+++	++	++
8e	++	++	++	+++	+++	+++	++	++
8f	+	++	+	++	++	++	+	++
8g	++	++	+	++	++	++	+++	+++
8h	+	+	-	-	-	+	+	+
8i	++	++	-	+	+	+	+	++
8j	-	-	-	+	+	+	-	-
8k	+	+	-	-	-	+	+	+
8l	-	-	-	-	+	+	-	-
8m	-	+	+	+	-	+	+	+
8n	-	+	+	+	-	-	+	+
SM	+++	++++	+++	++++	+++	++++	+++	++++

SM=Streptomycin, inhibition diameter in mm; (-) 4; (+) 5-11; (++) 11-17, (+++) 17-23; (++++) 23-29.

(C-Cl) cm^{-1}; ^1H NMR ($CDCl_3$): 5.18 (d, J = 5 Hz, 1H, -CHCl), 4.49 (s, 2H, $>NCH_2$), 8.78 (s, 1H, -NH), 4.12 (d, J = 5 Hz, 1H, -NCH-Ar), 7.14-7.85 (m, 9H, Ar-H), MS: *m/z* 411 (M^+).

Other compounds **8b-n** were synthesized similarly from **7b-n** respectively. Physical characterization data are presented in **Table I**.

Biological Activity

The compounds were screened for their antifungal activity (**Table II**) against *A. niger*, *A. flavus*, *F. oxisporum* and *T. viride* by paper disc technique at two concentrations (100 and 500 ppm) and antibacterial activity (**Table III**) against *B. subtilis*, *E. coli*, *K. pheumoneae* and *S. aureus* at two con-

centrations (50 and 100 ppm) by filler paper disc techniques. A commercial fungicide griseofulvin and antibacterial streptomycin were also screened under the similar conditions for comparison of the activity for synthesized compounds.

Acknowledgement

The authors are thankful to SAIF, CDRI, Lucknow for providing the spectral and analytical data of the compounds. The authors are also thankful to the Heads, Department of Biotechnology for anti-microbial activity and Department of Chemistry, Dr. H.S. Gour University, Sagar for providing the laboratory facilities.

References

1 Asati K C, Srivastava S K & Srivastava S D, *Indian J Chem,* 45B, **2006**, 526.
2 Yadav R, Srivastava S, Srivastava S K & Srivastava S D, *Chemistry An Indian J*, 1, **2003**, 95.
3 EI-khawas S M & Habib N S, *J Heterocyclic Chem*, 26, **1989**, 177.
4 Rao S & Mitra A S, *Indian J Chem*, 15B, **1977**, 1062.
5 Guru S, Yadav R, Srivastava Soumya, Srivastava S K & Srivastava S D, *J Indian Chem Soc*, 83, **2006**, 1236.
6 Rawat T R & Srivastava S D, *Indian J Chem*, 38B, **1999**, 623.
7 Sanghee Kim, Minjae Cho, Taeho Lee, Sukjin Lee, Hye-Young Min & Sang Kook Lee, *Bioorg Med Chem Letters*, 17, **2007**, 4584.
8 Srivastava S K, Yadav R & Srivastava S D, *J Indian Chem Soc*, 81, **2004**, 342.
9 Guru N & Srivastava S D, *J Sci Ind Res*, 60, **2001**, 601.
10 Desai N C, Shukla H K & Thaker K A, *J Indian Chem Soc*, 61, **1984**, 239.
11 Purohit M & Srivastava S K, *Indian J Pharm Sci*, 53, **1991**, 12.
12 Zhu L, Lang H, Denisko O, Wang Z & Katritzky A R, *Tetrahedron*, 51, **1995**,13271.
13 Upadhya R, Srivastava S D & Srivastava S K, *J Indian Council Chem*, 9, **1993**, 36.
14 Dutta M M & Kataky J C S, *J Indian Chem Soc*, 69, **1992**, 599.
15 Abbond K A, Katritzky A R, Rachwal B & Rachwal S, *J Org Chem*, 61, **1996**, 3117.
16 Zhang G, Qi M, Xie L & Katritzky A R, *Tetrahedron Lett*, 38, **1997**, 6959.
17 Ware G W, *The Pesticidal Book*, (Freeman Company, San Francisco), *Chem Abstr*, 82, **1978**, 81.
18 Laddi U V, Desai S R, Samannavar V S, Bennur R S & Bennur S C, *Indian J Chem*, 37B, **1998**, 461.
19 Himatkumar Patel V, Fernndes P S & Vyas Kavita A, *Indian J Chem*, 29B, **1990**, 135.