Scientific paper

Synthesis and Biological Activity of New Series of *N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(substituted Phenyl)-3-Chloro-4-Oxo-1-Azetidinecarboxamide

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Abstract

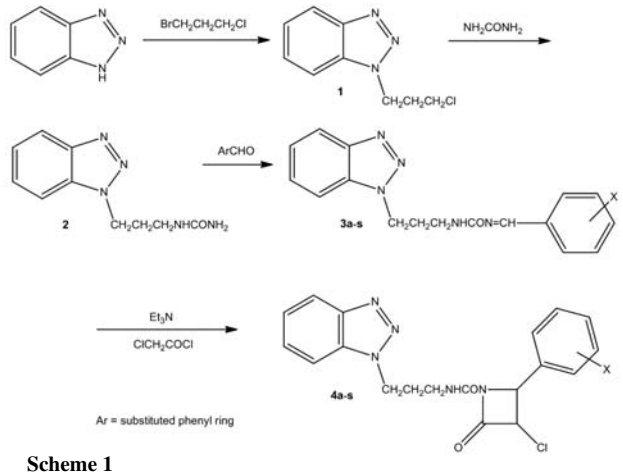
The synthesis of a new series of *N*-[3-(1*H*-1,2,3-benzotriazol-1-yl)propyl]-2-(4-substituted phenyl)-3-chloro-4-oxo-1-azetidinecarboxamides **4a–s** has been executed from 1,2,3-benzotriazole as a starting material by conventional method. Compounds **4a–s** were screened for their antibacterial, antifungal and antitubercular activities. Structures of all the synthesized compounds were confirmed by chemical and spectroscopic analyses such as IR, ^{1}H NMR, ^{13}C NMR and FAB mass spectroscopy.

Keyword: Synthesis, 1,2,3-benzotriazole, azetidinone, antimicrobial, antitubercular.

1. Introduction

Heterocyclic compounds have captured our attention for many reasons, mainly due to their biological activities. A wide variety of 2-oxoazetidine derivatives have been described for their chemotherapeutic importance. 2-Oxoazetidine and its derivatives possess various types of biological activities, such as antibacterial,[1–4] anticonvulsant,[5] analgesic, antitubercular,[6–8] antiinflammatory,[9] antifungal,[10–13] as synthetic precursors for amino acids,[14] to mediate cholesterol absorption,[15] for antiviral[16] and CNS[17] activity, etc. 2-Oxozetidines also serve as synthons for many biologically active compounds. Many antibiotics like penicillin and cephalosporin contain 2-oxoazetidine ring.

Benzotriazole derivatives have pharmaceutical importance possessing several remarkable biological activities, such as antibacterial,[11,18] antifungal,[1,19] antihistaminic, antiadrenergic and DNA cleavage,[20] antitubercular,[21] anticancer, antiemetic,[22] antitumor, antiinflammatory,[23,24] anticonvulsant,[25] as protein kinase inhibitors[26] and respiratory syndrome protease inactivators,[27] analgesic,[28] antiviral[29] etc. The biological activities of both 2-oxoazetidine and 1,2,3-benzotriazole aroused our interest in the synthesis of 2-oxoazetidine derivatives of 1,2,3-benzotriazole. 2-Oxoazetidine derivatives were synthesized in four steps shown in Scheme **1**. All synthesized compounds were screened against some selected bacteria and fungi for their antimicrobial activity and antitubercular activity screened against *Mycobacterium tuberculosis* using H37Rv strain. The structures of all the newly synthesized compounds were confirmed by elemental analysis, IR, ^{1}H and ^{13}C NMR and FAB mass spectroscopy.



Scheme 1

Comp.	X	Comp.	X	Comp.	X
3a, **4a**	H	**3h**, **4h**	4-NO_2	**3o**, **4o**	3-CH_3
3b, **4b**	4-Cl	**3i**, **4i**	3-NO_2	**3p**, **4p**	2-CH_3
3c, **4c**	3-Cl	**3j**, **4j**	2-NO_2	**3q**, **4q**	4-OH
3d, **4d**	2-Cl	**3k**, **4k**	4-OCH_3	**3r**, **4r**	3-OH
3e, **4e**	4-Br	**3l**, **4l**	3-OCH_3	**3s**, **4s**	2-OH
3f, **4f**	3-Br	**3m**, **4m**	2-OCH_3		
3g, **4g**	2-Br	**3n**, **4n**	4-CH_3		

Scheme 1. The synthesis of compounds **1**, **2**, **3a**–**s** and **4a**–**s**.

2. Results and Discussion

N-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(substituted phenyl)-3-chloro-4-oxo-1-azetidinecarboxamides **4a**–**s** were synthesized in four steps (Scheme 1): 1,2,3-benzotriazole on reaction with $Cl(CH_2)_3Br$ at room temperature afforded 1-(3-chloropropyl)-1*H*-1,2,3-benzotriazole (**1**). IR spectrum of **1** displayed absorption at 1235 and 749 cm^{-1} for N–CH_2 and C–Cl, respectively, clearly indicating the disappearance of NH absorption 3445 cm^{-1} of 1,2,3 benzotriazole. The compound **1** on reaction with urea at room temperature yielded *N*-[3-(1*H*-1,2,3-benzotriazol-1-yl)propyl]urea (**2**). IR spectrum of **2** showed absorption for CO at 1658 cm^{-1} while absorption of C–Cl has disappeared. The ^1H NMR spectrum of **2** displayed a signal for CH_2-N at δ 3.30 ppm and in its ^{13}C NMR spectrum a signal for CO group at δ 163.3 ppm. The compound **2** on further reaction with several substituted aromatic aldehydes produced **3a**–**s**, for them a characteristic absorption for Schiff base (N=CH) in IR spectrum appeared at 1544–1572 cm^{-1} and in the ^1H and ^{13}C NMR spectrum a signal appeared in the range of δ 7.86–8.12 and 145.2–155.9 ppm, respectively. In the ^1H NMR spectrum of **2** a broad signal for NH_2 (previously at δ 5.96 ppm) has disappeared. The compounds **3a**–**s** on treatment with $ClCH_2COCl$ in the presence of Et_3N furnished final products **4a**–**s**. In the IR spectrum of **4a**–**s** carbonyl group of β-lactam ring showed characteristic absorption in the range of 1732–1765 cm^{-1} and ^1H NMR spectrum of **4a**–**s** showed two doublets for NCH and CHCl in the range of δ 5.15–5.54 and 4.45–4.66 ppm, respectively. However, the ^{13}C NMR spectrum of **4a**–**s** displayed three signal for NCH, CHCl and cyclic CO in the range of δ 58.8–68.8, 47–54.9 and 166–175 ppm, respectively. The IR absorption, ^1H and ^{13}C NMR signal of N=CH have disappeared.

3. Pharmacological Results and Discussion

The results of the antimicrobial (antibacterial, antifungal and antitubercular) activities are summarized in Tables 1, 2 and 3. The results of the antimicrobial screening data revealed that all the compounds **4a**–**s** showed considerable and varied activity against the selected microorganisms. The new series of **4a**–**s** prepared was screened for their antibacterial and antifungal activity against some selected bacteria and fungi and antitubercular activity against *M. tuberculosis* (H37Rv strain). The investigation of antimicrobial data revealed that the compounds **4b**, **4d**–**f**, **4h**–**j** displayed high activity, the compounds **4c**, **4g** and **4r** showed moderate activity and the rest of the compounds showed less activity against all the strains compared with standard drugs.

4. Conclusion

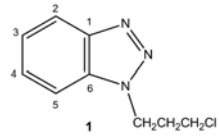
The research study reports the successful synthesis of a new series of **4a**–**s**. Biological testing of the newly synthesized systems bearing azetidinone moiety revealed that all the compounds tested showed moderate to good antibacterial, antifungal and antitubercular activities against selected microbial strains.

5. Experimental

Melting points were determined in open glass capillaries and are uncorrected. Progress of reaction was monitored by silica gel-G coated TLC plates using MeOH:$CHCl_3$ system (1:9). The spot was visualized by exposing dry plate at iodine vapours chamber. IR spectra were recorded as KBr discs on Schimadzu 8201 PC FTIR spectrophotometer (ν_{max} in cm^{-1}); ^1H and ^{13}C NMR spectra were measured on a Bruker DRX-300 spectrometer in $CDCl_3$ at 300 and 75 MHz, respectively using TMS as the internal standard. All chemical shifts are reported on δ scale. The FAB mass spectra were recorded on a Jeol SX-102 mass spectrometer. Elemental analyses were performed on a Carlo Erba 1108 analyzer providing satisfactory results. For column chromatographic purification of the products Merck silica Gel 60 (230–400 Mesh) was used. The reagent grade chemicals were purchased from the commercial sources and further purified before use.

Synthesis of the 1-(3-chloropropyl)-1*H*-1,2,3-benzotriazole (1)

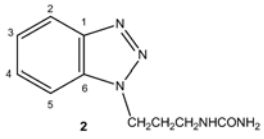
A mixture of 1,2,3-benzotriazole and 1-bromo-3-chloropropane (1:1 mol) was dissolved in methanol at room temperature. The reaction mixture was continuously stirred on a magnetic stirrer for about 360 min. The product was filtered and purified with column chromatography and recrystallized from ethanol at room temperature to yield **1.**



1-(3-chloropropyl)-1*H*-1,2,3-benzotriazole. Yield: 60%; mp 77–79 °C; IR ν 749 (C–Cl), 1235 (N–CH_2), 1563 (C=C), 3020, 2836 (CH) cm^{-1}. ^1H NMR δ 2.13 (m, 2H, $CH_2CH_2CH_2$), 3.49 (t, 2H, *J* = 7.5 Hz, $CH_2CH_2CH_2$-Cl), 4.17 (t, 2H, *J* = 7.5 Hz, N-$CH_2CH_2CH_2$), 7.29–7.96 (m, 4H, ArH). ^{13}C NMR δ 36.2 ($CH_2CH_2CH_2$), 43.7 ($CH_2CH_2CH_2$-Cl), 49.3 (N-$CH_2CH_2CH_2$), 118.5 (C-2), 120.2 (C-5), 128.4 (C-3), 128.9 (C-4), 145.5 (C-6), 147.9 (C-1). Anal. Calcd for $C_9H_{10}N_3Cl$: C, 55.25; H, 5.15; N, 21.47. Found: C, 55.21; H, 5.13; N, 21.41; MS-FAB: 195 (M^+).

Synthesis of the *N*-[3-(1*H*-1,2,3-benzotriazol-1-yl)propyl]urea (2)

A mixture of **1** and urea (1:1 mole) was dissolved in methanol at room temperature. The reaction mixture was continuously stirred on a magnetic stirrer for about 270 min. The product was filtered and purified with a column chromatography and recrystallized from ethanol at room temperature to yield **2**.

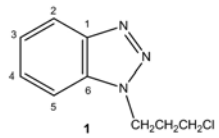


2

Yield: 71%; mp 60–63 °C; IR ν 1234 (C–NH), 1658 (CO), 3340 (NH), 3415 (NH_2) cm^{-1}. ^1H NMR δ 2.17 (m, 2H, $CH_2CH_2CH_2$), 3.30 (t, 2H, *J* = 7.4 Hz, $CH_2CH_2CH_2$ NH), 4.12 (t, 2H, *J* = 7.4 Hz, N-$CH_2CH_2CH_2$), 5.64 (s, 1H, NH), 5.96 (s, 2H, NH_2), 6.80–7.70 (m, 4H, ArH). ^{13}C NMR δ 39.5 ($CH_2CH_2CH_2$), 47.2 ($CH_2CH_2CH_2$-NH), 48.2 (N-$CH_2CH_2CH_2$), 117.6 (C-2), 121.3 (C-5), 127.8 (C-3), 128.2 (C-4), 144.7 (C-6), 146.7 (C-1), 163.3 (CO). Anal. Calcd for $C_{10}H_{13}N_5O$: C, 54.78; H, 5.97; N, 31.94. Found: C, 54.79; H, 5.90; N, 31.88; MS-FAB: 219 (M^+).

Synthesis of 3a–s

A mixture of compound **2** and appropriate substituted benzaldehydes (1:1 mole) was dissolved in methanol at room temperature and allowed to react. The reaction mixture was first continuously stirred on a magnetic stirrer for about 120–180 min then refluxed on a steam bath for about 90–135 min. The products were filtered and cooled at room temperature. The filtered products were purified with a column chromatography and recrystallized from ethanol at room temperature to yield **3a–s**.



1

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(phenyl)methylidene]urea (3a).** Yield: 58%; mp 70–72 °C; IR ν 1553 (N=CH), 1662 (CO), 3360 (NH) cm^{-1}. ^1H NMR δ 2.06 (m, 2H, $CH_2CH_2CH_2$), 3.36 (t, 2H, *J* = 7.4 Hz, $CH_2CH_2CH_2$-NH), 4.15 (t, 2H, *J* = 7.4 Hz, N-$CH_2CH_2CH_2$), 5.79 (s, 1H, NH), 7.40–7.74 (m, 9H, ArH), 7.85 (s, 1H, N=CH). ^{13}C NMR δ 38.4 ($CH_2CH_2CH_2$), 45.3 ($CH_2CH_2CH_2$-NH), 51.3 (N-$CH_2CH_2CH_2$), 115.3 (C-2), 120.0 (C-5), 125.8 (C-3), 126.3 (C-8, C-12), 127.5 (C-9, C-11), 128.5 (C-4), 129.2 (C-10), 131.2 (C-7), 136.2 (C-6), 145.2 (N=CH), 146.1 (C-1), 149.3 (12C, Ar), 162.6 (CO). Anal. Calcd for $C_{17}H_{17}N_5O$: C, 66.43; H, 5.57; N, 22.78. Found: C, 66.40; H, 5.48; N, 22.72. MS-FAB: 307 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(4-chloroophenyl)methylidene]urea (3b).** Yield: 66%; mp 81–82 °C; IR ν 740 (C–Cl), 1566 (N=CH), 1675 (CO), 3372 (NH) cm^{-1}. ^1H NMR δ 2.28 (m, 2H, $CH_2CH_2CH_2$), 3.36 (t, 2H, *J* = 7.4 Hz, $CH_2CH_2CH_2$-NH), 4.28 (t, 2H, *J* = 7.4 Hz, N-$CH_2CH_2CH_2$), 5.76 (s, 1H, NH), 7.32–7.81 (m, 8H, ArH), 7.92 (s, 1H, N=CH). ^{13}C NMR δ 38.9 ($CH_2CH_2CH_2$), 44.5 ($CH_2CH_2CH_2$-NH), 47.3 (N-$CH_2CH_2CH_2$), 112.5 (C-2), 121.0 (C-5), 125.4 (C-3), 127.7 (C-8, C-12), 128.8 (C-4), 129.2 (C-9, C-11), 132.3 (C-6), 135.5 (C-10), 137.8 (C-7), 144.1 (C-1), 152.6 (N=CH), 163.5 (CO). Anal. Calcd for $C_{17}H_{16}N_5OCl$: C, 59.73; H, 4.71; N, 20.48. Found: C, 59.62; H, 4.62; N, 20.35. MS-FAB: 341 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(3-chlorophenyl)methylidene]urea (3c).** Yield: 67%; mp 76–78 °C; IR ν 735 (C–Cl), 1559 (N=CH), 1673 (CO), 3363 (NH) cm^{-1}. ^1H NMR δ 2.27 (m, 2H, $CH_2CH_2CH_2$), 3.37 (t, 2H, *J* = 7.4 Hz, $CH_2CH_2CH_2$-NH), 4.25 (t, 2H, *J* = 7.4 Hz, N-$CH_2CH_2CH_2$), 5.79 (s, 1H, NH), 7.10–7.90 (m, 8H, ArH), 7.98 (s, 1H, N=CH). ^{13}C NMR δ 38.5 ($CH_2CH_2CH_2$), 43.7 ($CH_2CH_2CH_2$-NH), 52.2 (N-$CH_2CH_2CH_2$), 113.3 (C-2), 120.5 (C-5), 125.3 (C-3), 126.4 (C-8), 127.7 (C-12), 128.3 (C-4), 129.4 (C-10), 131.2 (C-11), 132.7 (C-6), 135.6 (C-9), 139.2 (C-7), 146.1 (C-1), 150.7 (N=CH), 162.9 (CO). Anal. Calcd for $C_{17}H_{16}N_5OCl$: C, 59.73; H, 4.71; N, 20.48. Found: C, 59.63; H, 4.62; N, 20.44. MS-FAB: 341 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(2-chlorophenyl)methylidene]urea (3d).**

Yield: 66%; mp 80–81 °C; IR ν 734 (C-Cl), 1567 (N=CH), 1672 (CO), 3371 (NH) cm^{-1}. ^1H NMR δ 2.22 (m, 2H, $CH_2CH_2CH_2$), 3.31 (t, 2H, *J* = 7.4 Hz, $CH_2CH_2CH_2$-NH), 4.24 (t, 2H, *J* = 7.4 Hz, N-$CH_2CH_2CH_2$), 5.73 (s, 1H, NH), 7.20–7.90 (m, 8H, Ar-H), 8.07 (s, 1H N=CH). ^{13}C NMR δ 38.7 ($CH_2CH_2CH_2$), 44.2 ($CH_2CH_2CH_2$-NH), 50.1 (N-$CH_2CH_2CH_2$), 113.4 (C-2), 118.3 (C-5), 125.8 (C-3), 126.7, 127.4 (C-11), 128.2 (C-4), 129.2 (C-9), 130.2 (C-12), 133.2 (C-6), 133.8 (C-8), 138.2 (C-7), 147.2 (C-1), 151.6 (N=CH), 161.0 (CO). Anal. Calcd for $C_{17}H_{16}N_5OCl$: C, 59.73; H, 4.71; N, 20.48. Found: C, 59.65; H, 4.70; N, 20.40. MS-FAB: 341 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(4-bromophenyl)methylidene]urea (3e).** Yield: 65%; mp 78–79 °C; IR ν 636 (C–Br), 1560 (N=CH), 1667 (CO), 3374 (NH) cm^{-1}. ^1H NMR δ 2.27 (m, 2H, $CH_2CH_2CH_2$), 3.30 (t, 2H, *J* = 7.5 Hz, $CH_2CH_2CH_2$-NH), 4.29 (t, 2H, *J* = 7.5 Hz, N-$CH_2CH_2CH_2$), 5.77 (s, 1H, NH), 7.41–7.69 (m, 8H, ArH), 7.97 (s, 1H, N=CH). ^{13}C NMR δ 36.2 ($CH_2CH_2CH_2$), 44.3 ($CH_2CH_2CH_2$-NH), 50.3 (N-$CH_2CH_2CH_2$), 114.1 (C-2), 121.3 (C-5), 123.2 (C-10), 125.1 (C-3), 128.4 (C-8, C-12), 129.3 (C-4), 132.4 (C-9, C-11), 134.5 (C-6), 136.9 (C-7), 148.2 (C-1), 152.7 (N=CH), 163.8 (CO). Anal. Calcd for $C_{17}H_{16}N_5OBr$: C, 52.86; H, 4.17; N, 18.13. Found: C, 52.82; H, 4.13; N, 18.07. MS-FAB: 386 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(3-bromophenyl)methylidene]urea (3f).** Yield: 64%; mp 80–81 °C; IR ν 643 (C–Br), 1568 (N=CH), 1664 (CO), 3366 (NH) cm^{-1}. ^1H NMR δ 2.24 (m, 2H, $CH_2CH_2CH_2$), 3.37 (t, 2H, *J* = 7.6 Hz, $CH_2CH_2CH_2$–NH), 4.30 (t, 2H, *J* = 7.6 Hz, N-$CH_2CH_2CH_2$), 5.73 (s, 1H, NH), 7.23–7.90 (m, 8H, ArH), 7.98 (s, 1H, N=CH). ^{13}C NMR δ 36.5 ($CH_2CH_2CH_2$), 44.74 ($CH_2CH_2CH_2$-NH), 48.4 ($NCH_2CH_2CH_2$), 114.2 (C-2), 119.6 (C-5), 123.8 (C-9), 125.5 (C-3), 126.8 (C-12), 128.4 (C-4), 129.5 (C-8), 131.6 (C-11), 132.4 (C-10), 134.6 (C-6), 139.1 (C-7), 146.3 (C-1), 152.6 (N=CH), 162.5 (CO). Anal. Calcd for $C_{17}H_{16}N_5OBr$: C, 52.86; H, 4.17; N, 18.13. Found: C, 52.76; H, 4.10; N, 18.05. MS-FAB: 386 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(2-bromophenyl)methylidene]urea (3g).** Yield: 62%; mp 74–75 °C; IR ν 638 (C–Br), 1559 (N=CH), 1666 (CO), 3368 (NH) cm^{-1}. ^1H NMR δ 2.26 (m, 2H, $CH_2CH_2CH_2$), 3.32 (t, 2H, *J* = 7.6 Hz, $CH_2CH_2CH_2$-NH), 4.22 (t, 2H, *J* = 7.6 Hz, N-$CH_2CH_2CH_2$), 5.72 (s, 1H, NH), 7.31–7.63 (m, 8H, ArH), 8.02 (s, 1H, N=CH). ^{13}C NMR δ 38.5 ($CH_2CH_2CH_2$), 44.5 ($CH_2CH_2CH_2$-NH), 51.4 (N-$CH_2CH_2CH_2$), 115.4 (C-2), 121.5 (C-5), 121.7 (C-8), 124.2 (C-3), 128.3 (C-11), 129.4 (C-4), 130.5 (C-12), 131.4 (C-10), 133.9 (C-9), 134.2 (C-6), 142.3 (C-7), 149.7 (C-1), 152.8 (N=CH), 161.9 (CO). Anal. Calcd for $C_{17}H_{16}N_5OBr$: C, 52.86; H, 4.17; N, 18.13. Found: C, 52.80; H, 4.08; N, 18.12. MS-FAB: 386 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(4-nitrophenyl)methylidene]urea (3h).** Yield: 66%; mp 73–74 °C; IR ν 847 (C–NH), 1530 (N=O), 1568 (N=CH), 1668 (CO), 3358 (NH) cm^{-1}. ^1H NMR δ 2.24 (m, 2H, $CH_2CH_2CH_2$), 3.28 (t, 2H, *J* = 7.6 Hz, $CH_2CH_2CH_2$-NH), 4.24 (t, 2H, *J* = 7.6 Hz, N-$CH_2CH_2CH_2$), 5.81 (s, 1H, NH), 7.32–7.91 (m, 8H, ArH), 8.10 (s, 1H, N=CH). ^{13}C NMR δ 40.1 ($CH_2CH_2CH_2$), 45.7 ($CH_2CH_2CH_2$-NH), 50.8 ($NCH_2CH_2CH_2$), 110.2 (C-2), 120.4 (C-5), 123.4 (C-9, C-11), 125.2 (C-3), 128.4 (C-4), 130.3 (C-8, C-12), 133.6 (C-6), 138.2 (C-7), 144.3 (C-1), 149.5 (C-10), 155.9 (N=CH), 162.3 (CO). Anal. Calcd for $C_{17}H_{16}N_6O_3$: C, 57.94; H, 4.57; N, 23.85. Found: C, 57.81; H, 4.51; N, 23.73. MS-FAB: 352 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(3-nitrophenyl)methylidene]urea (3i).** Yield: 63%; mp 70–71 °C; IR ν 840 (C–NH), 1528 (N=O), 1572 (N=CH), 1665 (CO), 3351 (NH) cm^{-1}. ^1H NMR δ 2.26 (m, 2H, $CH_2CH_2CH_2$), 3.20 (t, 2H, *J* = 7.6 Hz, $CH_2CH_2CH_2$-NH), 4.22 (t, 2H, *J* = 7.6 Hz, N-$CH_2CH_2CH_2$), 5.83 (s, 1H, NH), 7.21–7.86 (m, 8H, ArH), 8.07 (s, 1H, N=CH). ^{13}C NMR δ 39.7 ($CH_2CH_2CH_2$), 44.2 ($CH_2CH_2CH_2$-NH), 49.4 (N-$CH_2CH_2CH_2$), 111.2 (C-2), 119.5 (C-5), 121.5 (C-8), 124.2 (C-10), 125.4 (C-3), 129.3 (C-4), 129.9 (C-11), 133.5 (C-6), 133.9 (C-12), 139.8 (C-7), 146.9 (C-1), 149.6 (C-9), 154.3 (N=CH), 160.2 (CO). Anal. Calcd for $C_{17}H_{16}N_6O_3$: C, 57.94; H, 4.57; N, 23.85. Found: C, 57.80; H, 4.55; N; 23.60. MS-FAB: 352 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(2-nitrophenyl)methylidene]urea (3j).** Yield: 62%; mp 73–75 °C; IR ν 841 (C-NH), 1533 (N=O), 1572 (N=CH), 1664 (CO), 3350 (NH) cm^{-1}. ^1H NMR δ 2.17 (m, 2H, $CH_2CH_2CH_2$), 3.35 (t, 2H, *J* = 7.6 Hz, $CH_2CH_2CH_2$-NH), 4.18 (t, 2H, *J* = 7.6 Hz, N-$CH_2CH_2CH_2$), 5.87 (s, 1H, NH), 7.26–7.99 (m, 8H, ArH), 8.12 (s, 1H, N=CH). ^{13}C NMR δ 40.2 ($CH_2CH_2CH_2$), 45.1 ($CH_2CH_2CH_2$-NH), 48.9 ($NCH_2CH_2CH_2$), 110.6 (C-2), 120.5 (C-5), 123.6 (C-9), 125.2 (C-3), 127.3 (C-12), 129.1 (C-4), 130.4 (C-10), 132.9 (C-6), 134.2 (C-7), 135.6 (C-11), 145.3 (C-1), 146.2 (C-8), 155.4 (N=CH), 162.2 (CO). Anal. Calcd for $C_{17}H_{16}N_6O_3$: C, 57.94; H, 4.57; N, 23.85. Found: C, 57.90; H, 4.40; N, 23.75. MS-FAB: 352 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(4-methoxyphenyl)methylidene]urea (3k).** Yield: 61%; mp 68–69 °C; IR ν 1561 (N=CH), 2947 (OCH_3), 3351 (NH) cm^{-1}. ^1H NMR δ 2.15 (m, 2H, $CH_2CH_2CH_2$), 3.28 (t, 2H, *J* = 7.6 Hz, $CH_2CH_2CH_2$-NH), 3.47 (s, 3H, OCH_3), 4.16 (t, 2H, *J* = 7.6 Hz, $NCH_2CH_2CH_2$), 5.78 (s, 1H, NH), 7.34–7.52 (m, 8H, ArH), 7.88 (s, 1H, N=CH). ^{13}C NMR δ 37.2 ($CH_2CH_2CH_2$), 42.6 ($CH_2CH_2CH_2$-NH), 47.2 (N-CH_2CH_2 CH_2), 51.7 (OCH_3), 111.3 (C-2), 114.5 (C-9, C-11), 119.6 (C-5), 122.9 (C-3), 128.2 (C-8, C-12), 130.0 (C-4), 131.1 (C-7), 132.8 (C-6), 148.6 (C-1), 154.2 (N=CH), 159.6 (C-10), 161.5 (CO). Anal. Calcd for $C_{18}H_{19}N_5O_2$: C, 64.08; H, 5.67; N, 20.75. Found: C, 63.96; H, 5.56; N, 20.65. MS-FAB: 337 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(3-methoxyphenyl)methylidene]urea (3l).** Yield: 62%; mp 67–68 °C; IR ν 1559 (N=CH), 2942 (OCH_3), 3355 (NH) cm^{-1}. ^1H NMR δ 2.17 (m, 2H, $CH_2CH_2CH_2$), 3.30 (t, 2H, *J* = 7.6 Hz, $CH_2CH_2CH_2$-NH), 3.61 (s, 3H, OCH_3), 4.18 (t, 2H, *J* = 7.6 Hz, N-$CH_2CH_2CH_2$), 5.69 (s, 1H NH), 7.41–7.82 (m, 8H, ArH), 7.96 (s, 1H, N=CH). ^{13}C NMR δ

37.7 ($CH_2CH_2CH_2$), 42.9 ($CH_2CH_2CH_2$-NH), 47.7 (N-$CH_2CH_2CH_2$), 54.7 (OCH_3), 110.2 (C-2), 114.1 (C-8), 115.4 (C-10), 117.2 (C-12), 119.5 (C-5), 125.3 (C-3), 128.7 (C-11), 129.6 (C-4), 133.4 (C-6), 140.4 (C-7), 146.5 (C-1), 153.7 (N=CH), 160.7 (C-9), 161.9 (CO). Anal. Calcd for $C_{18}H_{19}N_5O_2$: C, 64.08; H, 5.67; N, 20.75. Found: C, 63.98; H, 5.64; N, 20.62. MS-FAB: 337 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(2-methoxyphenyl)methylidene]urea (3m).** Yield: 64%; mp 62–64 °C; IR ν 1558 (N=CH), 2945 (OCH_3), 3361 (NH) cm^{-1}. ^1H NMR δ 2.12 (m, 2H, $CH_2CH_2CH_2$), 3.32 (t, 2H, *J* = 7.6 Hz, $CH_2CH_2CH_2$-NH), 3.67 (s, 3H, OCH_3), 4.16 (t, 2H, *J* = 7.6 Hz, N-$CH_2CH_2CH_2$), 5.74 (s, 1H, NH), 7.22–7.72 (m, 8H, ArH), 7.86 (s, 1H, N=CH). ^{13}C NMR δ 38.3 ($CH_2CH_2CH_2$), 43.2 ($CH_2CH_2CH_2$-NH), 48.1 (N-$CH_2CH_2CH_2$), 53.7 (OCH_3), 113.2 (C-2), 118.4 (C-5), 123.5 (C-3), 126.7 (C-9), 127.7 (C-8), 128.6 (C-10), 129.6 (C-4), 130.9 (C-11), 132.5 (C-6), 135.9 (C-12), 138.8 (C-7), 147.4 (C-1), 151.0 (N=CH), 158.1 (CO). Anal. Calcd for $C_{18}H_{19}N_5O_2$: C, 64.08; H, 5.67; N, 20.75. Found: C, 63.90; H, 5.57; N, 20.61. MS-FAB: 337 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(4-methylphenyl)methylidene]urea (3n).** Yield: 60%; mp 57–58 °C; IR ν 1548 (N=CH), 2917 (CH_3), 3342 (NH) cm^{-1}. ^1H NMR δ 2.11 (m, 2H, $CH_2CH_2CH_2$), 2.64 (s, 3H, CH_3), 3.22 (t, 2H, *J* = 7.4 Hz, $CH_2CH_2CH_2$-NH), 4.03 (t, 2H, *J* = 7.4 Hz, N-$CH_2CH_2CH_2$), 5.67 (s, 1H, NH), 7.39–7.79 (m, 8H, ArH), 7.89 (s, 1H, N=CH). ^{13}C NMR δ 24.9 (CH_3), 36.6 ($CH_2CH_2CH_2$), 42.6 ($CH_2CH_2CH_2$-NH), 46.8 (N-$CH_2CH_2CH_2$), 113.2 (C-2), 120.3 (C-5), 124.5 (C-3), 126.4 (C-8, C-12), 128.6 (C-4), 129.9 (C-9, C-11), 132.7 (C-6), 134.7 (C-7), 137.6 (C-10), 146.3 (C-1), 151.2 (N=CH), 159.8 (CO). Anal. Calcd for $C_{18}H_{19}N_5O$: C, 67.27; H, 5.95; N, 21.79. Found: C, 67.18; H, 5.90; N, 21.72. MS-FAB: 321 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(3-methylphenyl)methylidene]urea (3o).** Yield: 61%; mp 54–56 °C; IR ν 1544 (N=CH), 2923 (CH_3), 3345 (NH) cm^{-1}. ^1H NMR δ 4.05 (m, 2H, $CH_2CH_2CH_2$), 2.58 (s, 3H, CH_3), 3.17 (t, 2H, *J* = 7.5 Hz, $CH_2CH_2CH_2$-NH), 4.05 (t, 2H, *J* = 7.5 Hz, N-$CH_2CH_2CH_2$), 5.78 (s, 1H, NH), 7.31–7.84 (m, 8H, ArH), 7.91 (s, 1H, N=CH). ^{13}C NMR δ 22.4 (CH_3), 36.5 ($CH_2CH_2CH_2$), 42.5 ($CH_2CH_2CH_2$-NH), 45.8 (N-$CH_2CH_2CH_2$), 112.4 (C-2), 121.5 (C-5), 125.2 (C-12), 126.6 (C-3), 127.1 (C-8), 128.2 (C-4), 129.2 (C-11), 130.6 (C-10), 132.4 (C-6), 137.5 (C-7), 139.5 (C-9), 147.5 (C-1), 152.0 (N=CH), 160.8 (CO). Anal. Calcd for $C_{18}H_{19}N_5O$: C, 67.27; H, 5.95; N, 21.79. Found: C, 67.11; H, 5.88; N, 21.76. MS-FAB: 321 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(2-methylphenyl)methylidene]urea (3p).** Yield: 62%; mp 52–54 °C; IR ν 1553 (N=CH), 2908 (CH_3), 3341 (NH) cm^{-1}. ^1H NMR δ 2.08 (m, 2H, $CH_2CH_2CH_2$), 2.60 (s, 3H, CH_3), 3.22 (t, 2H, *J* = 7.4 Hz, $CH_2CH_2CH_2$-NH), 4.00 (t, 2H, *J* = 7.4 Hz, N-$CH_2CH_2CH_2$), 5.72 (s, 1H, NH), 7.34–7.76 (m, 8H, ArH), 7.88 (s, 1H, N=CH). ^{13}C NMR δ 21.9 (CH_3), 38.7 ($CH_2CH_2CH_2$), 43.4 ($CH_2CH_2CH_2$-NH), 45.7 (N-$CH_2CH_2CH_2$), 113.3 (C-2), 120.5 (C-5), 124.5 (C-3), 126.1 (C-9), 126.8 (C-8), 128.9 (C-4), 129.7 (C-10), 130.3 (C-11), 133.6 (C-6), 136.5 (C-12), 138.6 (C-7), 145.5 (C-1), 154.0 (N=CH), 159.2 (CO). Anal. Calcd for $C_{18}H_{19}N_5O$: C, 67.27; H, 5.95; N, 21.79. Found: C, 67.21; H, 5.89; N, 21.70. MS-FAB: 321 (M^+).

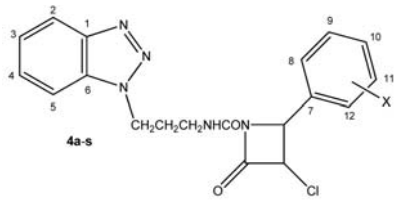
***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(4-hydroxyphenyl)methylidene]urea (3q).** Yield: 64%; mp 72–73 °C; IR ν 1557 (N=CH), 3385 (NH), 3472 (OH) cm^{-1}. ^1H NMR δ 2.22 (m, 2H, $CH_2CH_2CH_2$), 3.36 (t, 2H, *J* = 7.7 Hz, $CH_2CH_2CH_2$-NH), 4.15 (s, 1H, OH), 4.17 (t, 2H, *J* = 7.7 Hz, N-$CH_2CH_2CH_2$), 5.84 (s, 1H, NH), 7.32–7.79 (m, 8H, ArH), 8.07 (s, 1H, N=CH). ^{13}C NMR δ 39.9 ($CH_2CH_2CH_2$), 45.7 ($CH_2CH_2CH_2$-NH), 50.4 (N-$CH_2CH_2CH_2$), 111.3 (C-2), 118.9 (C-9, C-11), 120.7 (C-5), 124.3 (C-3), 127.9 (C-8, C-12), 128.4 (C-4), 130.8 (C-7), 132.2 (C-6), 147.1 (C-1), 153.3 (N=CH), 154.6 (C-10), 163.7 (CO). Anal. Calcd for $C_{17}H_{17}N_5O_2$: C, 63.14; H, 5.29; N, 21.65. Found: C, 63.07; H, 5.22; N, 21.50. MS-FAB: 323 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(3-hydroxyphenyl)methylidene]urea (3r).** Yield: 60%; mp 70–72 °C; IR ν 1561 (N=CH), 3379 (NH), 3464 (OH) cm^{-1}. ^1H NMR δ 2.18 (m, 2H, $CH_2CH_2CH_2$), 3.39 (t, 2H, *J* = 7.6 Hz, $CH_2CH_2CH_2$-NH), 4.24 (s, 1H, OH), 4.25 (t, 2H, *J* = 7.6 Hz, N-$CH_2CH_2CH_2$), 5.89 (s, 1H, NH), 7.36–7.74 (m, 8H, ArH), 8.01 (s, 1H, N=CH). ^{13}C NMR δ 39.9 ($CH_2CH_2CH_2$), 44.7 ($CH_2CH_2CH_2$-NH), 49.7 (N-$CH_2CH_2CH_2$), 112.6 (C-2), 114.2 (C-8), 116.3 (C-4), 119.5 (C-12), 120.6 (C-5), 125.4 (C-3), 128.4 (C-4), 130.8 (C-11), 132.4 (C-6), 139.3 (C-7), 146.4 (C-1), 151.4 (N=CH), 155.6 (C-9), 160.7 (CO). Anal. Calcd for $C_{17}H_{17}N_5O_2$: C, 63.14; H, 5.29; N, 21.65. Found: C, 63.11; H, 5.18; N, 21.58. MS-FAB: 323 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-*N*'-[(2-hydroxyphenyl)methylidene]urea (3s).** Yield: 62%; mp 68–69 °C; IR ν 1565 (N=CH), 3381 (NH), 3460 (OH) cm^{-1}. ^1H NMR δ 2.28 (m, 2H, $CH_2CH_2CH_2$), 3.33 (t, 2H, *J* = 7.7 Hz, $CH_2CH_2CH_2$-NH), 4.36 (s, 1H, OH), 4.21 (t, 2H, *J* = 7.7 Hz, N-$CH_2CH_2CH_2$), 5.86 (s, 1H, NH), 7.25–7.69 (m, 8H, ArH), 7.97 (s, 1H, N=CH). ^{13}C NMR δ 38.4 ($CH_2CH_2CH_2$), 43.5 ($CH_2CH_2CH_2$-NH), 49.2 (N-$CH_2CH_2CH_2$), 114.2 (C-2), 116.5 (C-9), 120.7 (C-5), 122.7 (C-11), 125.9 (C-3), 126.4 (C-7), 128.8 (C-12), 129.5 (C-4), 130.3 (C-10), 132.9 (C-6), 147.8 (C-1), 151.7 (N=CH), 154.2 (C-8), 161.1 (CO). Anal. Calcd for $C_{17}H_{17}N_5O_2$: C, 63.14; H, 5.29; N, 21.65. Found: C, 63.09; H, 5.23; N, 21.57. MS-FAB: 323 (M^+).

Synthesis of 4a–s

A mixture of **3a**–**s** and chloroacetyl chloride in the presence of Et_3N (1:1:1 mole) was dissolved in methanol at room temperature and allowed to react. The reaction mixture was first continuously stirred on a magnetic stirrer for about 135–180 min, then refluxed on a steam bath for about 90–150 min. The products were filtered and cooled at room temperature. The filtered products were purified with a column chromatography and recrystallized from ethanol at room temperature to yield compounds **4a**–**s**.



4a-s

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-phenyl-3-chloro-4-oxo-1-azetidinecarboxamide (4a).** Yield: 68%; mp 78–79 °C; IR ν 1329 (C–NH), 1732 (CO cyclic), 2908 (CH–Cl) cm^{-1}. ^1H NMR δ 2.10 (m, 2H, $CH_2CH_2CH_2$), 3.28 (t, 2H, *J* = 7.5 Hz, $CH_2CH_2CH_2$-NH), 4.11 (t, 2H, *J* = 7.5 Hz, N-$CH_2CH_2CH_2$), 4.48 (d, *J* = 5.0 Hz, 1H, CH-Cl), 5.17 (d, *J* = 5.0 Hz, 1H, N-CH), 5.60 (s, 1H, NH), 6.85–7.72 (m, 9H, ArH). ^{13}C NMR δ 34.4 ($CH_2CH_2CH_2$), 40.5 ($CH_2CH_2CH_2$-NH), 47.2 (N-$CH_2CH_2CH_2$), 54.9 (CH-Cl), 62.7 (N-CH), 110.3 (C-2), 118.9 (C-5), 125.7 (C-3), 126.4 (C-8, C-12), 128.4 (C-4), 129.8 (C-10), 130.1 (C-9, C-11), 132.6 (C-6), 136.4 (C-7), 145.9 (C-1), 161.1 (CO), 168.7 (CO cyclic). Anal. Calcd for $C_{19}H_{18}N_5O_2Cl$: C, 59.45; H, 4.72; N, 18.24. Found: C, 59.38; H, 4.61; N, 18.15. MS-FAB: 383 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(4-chlorophenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4b).** Yield: 64%; mp 85–87 °C; IR ν 765 (C–Cl), 1337 (C–NH), 1752 (CO cyclic), 2915 (CH–Cl) cm^{-1}. ^1H NMR δ 2.17 (m, 2H, $CH_2CH_2CH_2$), 3.30 (t, 2H, *J* = 7.6 Hz, $CH_2CH_2CH_2$-NH), 4.12 (t, 2H, *J* = 7.6 Hz, N-$CH_2CH_2CH_2$), 4.65 (d, 1H, *J* = 5.1 Hz, CH-Cl), 5.39 (d, 1H, *J* = 5.1 Hz, N-CH), 5.64 (s, 1H, NH), 6.86–7.75 (m, 8H, ArH). ^{13}C NMR δ 38.2 ($CH_2CH_2CH_2$), 42.5 ($CH_2CH_2CH_2$-NH), 49.3 (N-$CH_2CH_2CH_2$), 53.7 (CH-Cl), 63.6 (N-CH), 116.2 (C-2), 120.9 (C-5), 123.7 (C-3), 127.7 (C-8, C-12), 128.6 (C-4), 129.4 (C-9, C-11), 132.8 (C-6), 135.5 (C-10), 136.7 (C-7), 146.9 (C-1), 164.1 (CO), 174.5 (CO cyclic). Anal. Calcd for $C_{19}H_{17}N_5O_2Cl_2$: C, 54.55; H, 4.14; N, 16.74. Found: C, 54.48; H, 4.10; N, 16.60. MS-FAB: 418 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(3-chlorophenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4c).** Yield: 65%; mp 82–84 °C; IR ν 776 (C–Cl), 1333 (C–NH), 1754 (CO cyclic), 2920 (CH–Cl) cm^{-1}. ^1H NMR δ 2.15 (m, 2H, $CH_2CH_2CH_2$), 3.33 (t, 2H, *J* = 7.5 Hz, $CH_2CH_2CH_2$-NH), 4.15 (t, 2H, *J* = 7.5 Hz, N-$CH_2CH_2CH_2$), 4.63 (d, 1H, *J* = 5.1 Hz, CH-Cl), 5.34 (d, 1H, *J* = 5.1 Hz, N-CH), 5.64 (s, 1H, NH), 6.79–7.64 (m, 8H, ArH). ^{13}C NMR δ 37.4 ($CH_2CH_2CH_2$), 42.9 ($CH_2CH_2CH_2$-NH), 49.3 (N-$CH_2CH_2CH_2$), 55.8 (CH-Cl), 65.7 (N-CH), 114.2 (C-2), 118.4 (C-5), 124.3 (C-3), 126.7 (C-8), 128.3 (C-12), 129.1 (C-4), 129.9 (C-10), 131.4 (C-11), 134.4 (C-6), 135.3 (C-9), 138.1 (C-7), 147.9 (C-1), 164.3 (CO), 171.2 (CO cyclic). Anal. Calcd for $C_{19}H_{17}N_5O_2Cl_2$: C, 54.55 H, 4.14; N, 16.74. Found: C, 54.47; H, 4.08; N, 16.58. MS-FAB: 418 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(2-chlorophenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4d).** Yield: 66%; mp 80–81 °C; IR ν 773 (C–Cl), 1334 (C–NH), 1751 (CO cyclic), 2917 (CH–Cl) cm^{-1}. ^1H NMR δ 2.13 (m, 2H, $CH_2CH_2CH_2$), 3.28 (t, 2H, *J* = 7.6 Hz, $CH_2CH_2CH_2$-NH), 4.14 (t, 2H, *J* = 7.6 Hz, N-$CH_2CH_2CH_2$), 4.62 (d, 1H, *J* = 5.1 Hz, CH-Cl), 5.33 (d, 1H, *J* = 5.1 Hz, N-CH), 5.68 (s, 1H, NH), 6.81–7.62 (m, 8H, ArH). ^{13}C NMR δ 37.9 ($CH_2CH_2CH_2$), 43.1 ($CH_2CH_2CH_2$-NH), 48.7 (N-$CH_2CH_2CH_2$), 55.2 (CH-Cl), 64.6 (N-CH), 114.5 (C-2), 119.9 (C-5), 124.7 (C-3), 127.6 (C-11), 128.9 (C-4), 129.4 (C-9), 130.4 (C-10), 132.2 (C-12), 133.3 (C-6), 135.1 (C-8), 137.9 (C-7), 147.4 (C-1), 163.6 (CO), 173.7 (CO cyclic). Anal. Calcd for $C_{19}H_{17}N_5O_2Cl_2$: C, 54.55; H, 4.14; N, 16.74. Found: C, 54.48; H, 4.05; N, 16.70. MS-FAB: 418 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(4-bromophenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4e).** Yield: 61%; mp 78–80 °C; IR ν 578 (C-Br), 1310 (C-NH), 1741 (CO cyclic), 2892 (CH-Cl) cm^{-1}. ^1H NMR δ 2.15 (m, 2H, $CH_2CH_2CH_2$), 3.25 (t, 2H, *J* = 7.6 Hz, $CH_2CH_2CH_2$-NH), 4.20 (t, 2H, *J* = 7.6 Hz, N-$CH_2CH_2CH_2$), 4.63 (d, 1H, *J* = 5.2 Hz, CH-Cl), 5.44 (d, 1H, *J* = 5.2 Hz, N-CH), 5.70 (s, 1H, NH), 7.37–7.95 (m, 8H, ArH). ^{13}C NMR δ 38.8 ($CH_2CH_2CH_2$), 43.2 ($CH_2CH_2CH_2$-NH), 49.6 (N-$CH_2CH_2CH_2$), 47.3 (CH-Cl), 59.7 (N-CH), 112.4 (C-2), 119.4 (C-5), 123.9 (C-10), 124.5 (C-3), 128.6 (C-4), 130.8 (C-8, C-12), 131.4 (C-9, C-11), 132.6 (C-6), 136.5 (C-7), 147.9 (C-1), 164.2 (CO), 172.3 (CO cyclic). Anal. Calcd for $C_{19}H_{17}N_5O_2BrCl$: C, 49.31; H, 3.70; N, 15.13. Found: C, 49.19; H, 3.65; N, 15.05. MS-FAB: 462 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(3-bromophenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4f).** Yield: 64%; mp 81–82 °C; IR ν 572 (C–Br), 1319 (C–NH), 1747 (CO cyclic), 2895 (CH–Cl) cm^{-1}. ^1H NMR δ 2.20 (m, 2H, $CH_2CH_2CH_2$), 3.35 (t, 2H, *J* = 7.7 Hz, $CH_2CH_2CH_2$-NH), 4.21 (t, 2H, *J* = 7.7 Hz, N-$CH_2CH_2CH_2$), 5.38 (d, 1H, *J* = 5.2 Hz, N-CH), 5.57 (d, 1H, *J* = 5.2 Hz, CH-Cl), 5.72 (s, 1H, NH), 7.31–7.92 (m, 8H, ArH). ^{13}C NMR δ 37.8 ($CH_2CH_2CH_2$), 42.8 ($CH_2CH_2CH_2$-NH), 48.6 (CH-Cl), 49.2 (N-$CH_2CH_2CH_2$),

59.9 (N-CH), 109.2 (C-2), 118.9 (C-5), 123.7 (C-9), 124.7 (C-3), 125.6 (C-12), 128.4 (C-4), 129.8 (C-8), 132.5 (C-11), 133.4 (C-10), 134.5 (C-6), 140.3 (C-7), 145.6 (C-1), 163.7 (CO), 172.6 (CO cyclic). Anal. Calcd for $C_{19}H_{17}N_5O_2BrCl$: C, 49.31; H, 3.70; N, 15.13. Found: C, 49.24; H, 3.59; N, 15.07. MS-FAB: 462 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(2-bromophenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4g).** Yield: 65%; mp 77–78 °C IR ν 566 (C–Br), 1327 (C–NH), 1753 (CO cyclic), 2882 (CH–Cl) cm^{-1}. ^1H NMR δ 2.22 (m, 2H, $CH_2CH_2CH_2$), 3.38 (t, 2H, J = 7.6 Hz, $CH_2CH_2CH_2$-NH), 4.16 (t, 2H, J = 7.6 Hz, N-$CH_2CH_2CH_2$), 4.66 (d, 1H, J = 5.2 Hz, CH-Cl), 5.15 (d, 1H, J = 5.2 Hz, N-CH), 5.69 (s, 1H, NH), 7.27–7.84 (m, 8H, ArH). ^{13}C NMR δ 38.2 ($CH_2CH_2CH_2$), 43.0 ($CH_2CH_2CH_2$-NH), 47.8 (CH-Cl), 49.5 (N-$CH_2CH_2CH_2$), 58.8 (N-CH), 111.1 (C-2), 119.5 (C-5), 120.3 (C-8), 125.7 (C-3), 127.2 (C-11), 128.4 (C-4), 130.1 (C-12), 131.5 (C-10), 132.2 (C-6), 133.2 (C-9), 142.6 (C-7), 147.9 (C-1), 161.1 (CO), 172.5 (CO cyclic). Anal. Calcd for $C_{19}H_{17}N_5O_2BrCl$: C, 49.31; H, 3.70; N, 15.13. Found: C, 49.25; H, 3.43; N, 15.24. MS-FAB: 462 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(4-nitrophenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4h).** Yield: 63%; mp 81–83 °C; IR ν 868 (C–NO), 1352 (C–NH), 1540 (NO_2), 1745 (CO cyclic), 2923 (CH–Cl) cm^{-1}. ^1H NMR δ 2.26 (m, 2H, $CH_2CH_2CH_2$), 3.65 (t, 2H, J = 7.4 Hz, $CH_2CH_2CH_2$-NH), 4.20 (t, 2H, J = 7.4 Hz, N-$CH_2CH_2CH_2$), 5.44 (d, 1H, J = 5.3 Hz, N-CH), 4.59 (d, 1H, J = 5.3 Hz, CH-Cl), 5.72 (s, 1H, NH), 7.10–7.71 (m, 8H, ArH). ^{13}C NMR δ 37.8 ($CH_2CH_2CH_2$), 42.7 ($CH_2CH_2CH_2$-NH), 50.2 (N-$CH_2CH_2CH_2$), 51.0 (CH-Cl), 68.8 (N-CH), 112.2 (C-2), 118.5 (C-5), 122.6 (C-9, C-11), 124.8 (C-3), 127.9 (C-8, C-12), 128.3 (C-4), 132.4 (C-6), 139.8 (C-7), 145.9 (C-1), 147.9 (C-10), 163.7 (CO), 173.6 (CO cyclic). Anal. Calcd for $C_{19}H_{17}N_6O_4Cl$: C, 53.21; H, 3.99; N, 19.59. Found: C, 53.15; H, 3.79; N, 19.49. MS-FAB: 428 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(3-nitrophenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4i).** Yield: 64%; mp 79–81 °C; IR ν 864 (C–NO), 1358 (C–NH), 1542 (NO_2), 1749 (CO cyclic), 2916 (CH–Cl) cm^{-1}. ^1H NMR δ 2.28 (m, 2H, $CH_2CH_2CH_2$), 3.39 (t, 2H, J = 7.6 Hz, $CH_2CH_2CH_2$-NH), 4.19 (t, 2H, J = 7.6 Hz, N-$CH_2CH_2CH_2$), 4.47 (d, 1H, J = 5.2 Hz, CH-Cl), 5.45 (d, 1H, J = 5.2 Hz, N-CH), 5.74 (s, 1H, NH), 7.16–7.79 (m, 8H, ArH). ^{13}C NMR δ 38.9 ($CH_2CH_2CH_2$), 43.6 ($CH_2CH_2CH_2$-NH), 49.9 (N-$CH_2CH_2CH_2$), 51.3 (CH-Cl), 68.8 (N-CH), 113.3 (C-2), 118.9 (C-5), 122.7 (C-8), 124.8 (C-10), 125.9 (C-3), 128.8 (C-4), 129.4 (C-11), 132.6 (C-6), 132.9 (C-12), 139.7 (C-7), 146.9 (C-1), 147.9 (C-9), 163.1 (CO), 175.6 (CO cyclic). Anal. Calcd for $C_{19}H_{17}N_6O_4Cl$: C, 53.21, H, 3.99; N, 19.59. Found: C, 53.12; H, 3.87; N, 19.54. MS-FAB: 428 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(2-nitrophenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4j).** Yield: 62%; mp 80–82 °C; IR ν 869 (C–NO), 1355 (C–NH), 1542 (NO_2), 1747 (CO cyclic), 2917 (CH–Cl) cm^{-1}. ^1H NMR δ 2.17 (m, 2H, $CH_2CH_2CH_2$), 3.30 (t, 2H, J = 7.5 Hz, $CH_2CH_2CH_2$-NH), 4.12 (t, 2H, J = 7.5 Hz, N-$CH_2CH_2CH_2$), 4.45 (d, 1H, J = 5.3 Hz, CH-Cl), 5.54 (d, 1H, J = 5.3 Hz, N-CH), 5.64 (s, 1H, NH), 7.05–7.71 (m, 8H, ArH). ^{13}C NMR δ 38.4 ($CH_2CH_2CH_2$), 43.5 ($CH_2CH_2CH_2$-NH), 49.2 (N-$CH_2CH_2CH_2$), 54.6 (CH-Cl), 64.8 (N-CH), 112.4 (C-2), 117.4 (C-5), 122.5 (C-9), 123.8 (C-3), 127.6 (C-12), 128.6 (C-4), 130.8 (C-10), 132.9 (C-6), 133.5 (C-7), 135.3 (C-11), 145.7 (C-1), 146.5 (C-8), 161.1 (CO), 174.5 (CO cyclic). Anal. Calcd for $C_{19}H_{17}N_6O_4Cl$: C, 53.21; H, 3.99; N, 19.59. Found: C, 53.18; H, 3.90; N, 19.50. MS-FAB: 428 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(4-methoxyphenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4k).** Yield: 65%; mp 74–75 °C; IR ν 1165 (C–O), 1329 (N–C), 1738 (CO cyclic), 2891 (CH–Cl) cm^{-1}. ^1H NMR δ 2.10 (m, 2H, $CH_2CH_2CH_2$), 3.25 (t, 2H, J = 7.6 Hz, $CH_2CH_2CH_2$-NH), 3.67 (s, 3H, OCH_3), 4.10 (t, 2H, J = 7.6 Hz, N-$CH_2CH_2CH_2$), 4.45 (d, 1H, J = 5.1 Hz, CH-Cl), 5.30 (d, 1H, J = 5.1 Hz, N-CH), 5.55 (s, 1H, NH), 7.26–7.92 (m, 8H, ArH). ^{13}C NMR δ 34.4 ($CH_2CH_2CH_2$), 41.5 ($CH_2CH_2CH_2$-NH), 47.2 (N-$CH_2CH_2CH_2$), 49.4 (CH-Cl), 54.5 (OCH_3), 64.8 (N-CH), 112.3 (C-2), 114.4 (C-9, C-11), 120.1 (C-5), 124.8 (C-3), 126.9 (C-8, C-12), 128.5 (C-4), 131.7 (C-7), 132.4 (C-6), 145.3 (C-1), 159.8 (C-10), 162.6 (CO), 171.5 (CO cyclic). Anal. Calcd for $C_{20}H_{20}N_5O_3Cl$: C, 58.04; H, 4.87; N, 16.92. Found: C, 57.95; H, 4.78; N, 16.85. MS-FAB: 413 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(3-methoxyphenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4l).** Yield: 61%; mp 76–77 °C; IR ν 1168 (C–O), 1325 (N–C), 1732 (CO cyclic), 2895 (CH–Cl) cm^{-1}. ^1H NMR δ 2.09 (m, 2H, $CH_2CH_2CH_2$), 3.26 (t, 2H, J = 7.5 Hz, $CH_2CH_2CH_2$-NH), 3.59 (s, 3H, OCH_3), 4.06 (t, 2H, J = 7.5 Hz, N-$CH_2CH_2CH_2$), 4.49 (d, 1H, J = 5.1 Hz, CH-Cl), 5.27 (d, 1H, J = 5.1 Hz, N-CH), 5.59 (s, 1H, NH), 7.36–8.02 (m, 8H, ArH). ^{13}C NMR δ 35.9 ($CH_2CH_2CH_2$), 40.5 ($CH_2CH_2CH_2$-NH), 48.2 (N-$CH_2CH_2CH_2$), 49.8 (CH-Cl), 54.8 (OCH_3), 62.7 (N-CH), 112.4 (C-2), 113.2 (C-8), 115.6 (C-10), 120.2 (C-12), 123.6 (C-5), 124.5 (C-3), 127.5 (C-11), 128.4 (C-4), 132.6 (C-6), 138.4 (C-7), 147.5 (C-1), 159.6 (C-9), 160.4 (CO), 170.7 (CO cyclic). Anal. Calcd for $C_{20}H_{20}N_5O_3Cl$: C, 58.04; H, 4.87; N, 16.92. Found: C, 57.94; H, 4.72; N, 16.87. MS-FAB: 413 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(2-methoxyphenyl)-3-chloro-4-oxo-1-azetidinecarboxamide**

(4m). Yield: 61%; mp 73–75 °C; IR ν 1162 (C–O), 1325 (N–C), 1738 (CO cyclic), 2885 (CH–Cl) cm^{-1}. ^1H NMR δ 2.12 (m, 2H, $CH_2CH_2CH_2$), 3.22 (t, 2H, *J* = 7.4 Hz, $CH_2CH_2CH_2$-NH), 3.52 (s, 3H, OCH_3), 4.05 (t, 2H, *J* = 7.4 Hz, N-$CH_2CH_2CH_2$), 4.47 (d, 1H, *J* = 5.1 Hz, CH-Cl), 5.39 (d, 1H, *J* = 5.1 Hz, N-CH), 5.60 (s, 1H, NH), 7.04–7.87 (m, 8H, ArH). ^{13}C NMR δ 35.3 ($CH_2CH_2CH_2$), 41.1 ($CH_2CH_2CH_2$-NH), 47.6 (N-$CH_2CH_2CH_2$), 47.5 (CH-Cl), 54.6 (OCH_3), 63.5 (N-CH), 112.4 (C-2), 115.4 (C-9), 121.3 (C-5), 121.8 (C-11), 123.8 (C-7), 124.5 (C-3), 127.5 (C-12), 128.4 (C-4), 129.9 (C-10), 132.4 (C-6), 147.8 (C-1), 157.4 (C-8), 160.1 (CO), 169.7 (CO cyclic). Anal. Calcd for $C_{20}H_{20}N_5O_3Cl$: C, 58.04; H, 4.87; N, 16.92. Found: C, 57.97; H, 4.82; N, 16.88. MS-FAB: 413 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(4-methylphenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4n).** Yield: 62%; mp 72–73 °C; IR ν 1330 (C–NH), 1742 (CO cyclic), 2889 (CH–Cl), 2927 (CH_3) cm^{-1}. ^1H NMR δ 2.07 (m, 2H, $CH_2CH_2CH_2$), 2.67 (s, 3H, CH_3), 3.19 (t, 2H, *J* = 7.5 Hz, $CH_2CH_2CH_2$-NH), 4.01 (t, 2H, *J* = 7.5 Hz, N-$CH_2CH_2CH_2$), 4.53 (d, 1H, *J* = 5.0 Hz, CH-Cl), 5.45 (d, 1H, *J* = 5.0 Hz, N-CH), 5.64 (s, 1H, NH), 7.28–7.98 (m, 8H, ArH). ^{13}C NMR δ 24.7 (CH_3), 38.4 ($CH_2CH_2CH_2$), 43.5 ($CH_2CH_2CH_2$-NH), 49.2 (N-$CH_2CH_2CH_2$), 52.7 (CH-Cl), 62.8 (N-CH), 110.4 (C-2), 118.9 (C-5), 125.7 (C-3), 127.7 (C-8, C-12), 128.5 (C-4), 129.5 (C-9, C-11), 133.5 (C-6), 134.8 (C-7), 138.6 (C-10), 146.4 (C-1), 161.1 (CO), 166.8 (CO cyclic). Anal. Calcd for $C_{20}H_{20}N_5O_2Cl$: C, 60.37; H, 5.06; N, 17.60. Found: C, 60.27; H, 4.97; N, 17.54. MS-FAB: 397 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(3-methylphenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4o).** Yield: 60%; mp 70–71 °C; IR ν 1324 (C–NH), 1748 (CO cyclic), 2894 (CH–Cl), 2929 (CH_3) cm^{-1}. ^1H NMR δ 2.02 (m, 2H, $CH_2CH_2CH_2$), 2.62 (s, 3H, CH_3), 3.15 (t, 2H, *J* = 7.5 Hz, $CH_2CH_2CH_2$-NH), 4.00 (t, 2H, *J* = 7.5 Hz, N-$CH_2CH_2CH_2$), 4.55 (d, 1H, *J* = 5.0 Hz, CH-Cl), 5.38 (d, 1H, *J* = 5.0 Hz, N-CH), 5.60 (s, 1H, NH), 7.18–7.84 (m, 8H, ArH). ^{13}C NMR δ 23.5 (CH_3), 33.4 ($CH_2CH_2CH_2$), 39.5 ($CH_2CH_2CH_2$-NH), 47.2 (N-$CH_2CH_2CH_2$), 51.0 (CH-Cl), 63.8 (N-CH), 110.5 (C-2), 118.2 (C-5), 122.7 (C-12), 123.3 (C-3), 126.5 (C-8), 128.7 (C-4), 129.3 (C-11), 129.9 (C-10), 132.2 (C-6), 137.6 (C-7), 139.1 (C-9), 147.9 (C-1), 159.8 (CO), 167.8 (CO cyclic). Anal. Calcd for $C_{20}H_{20}N_5O_2Cl$: C, 60.37; H, 5.06; N, 17.60. Found: C, 60.25; H, 4.95; N, 17.58. MS-FAB: 397 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(2-methylphenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4p).** Yield: 58%; mp 68–69 °C; IR ν 1325 (C–NH), 1749 (CO cyclic), 2876 (CH–Cl), 2917 (CH_3) cm^{-1}. ^1H NMR δ 2.03 (m, 2H, $CH_2CH_2CH_2$), 2.76 (s, 3H, CH_3), 3.10 (t, 2H, *J* = 7.4 Hz, $CH_2CH_2CH_2$-NH), 4.06 (t, 2H, *J* = 7.4 Hz, N-$CH_2CH_2CH_2$), 4.50 (d, 1H, *J* = 5.1 Hz, CH-Cl), 5.47 (d, 1H, *J* = 5.1 Hz, N-CH), 5.50 (s, 1H, NH), 7.21–8.09 (m, 8H, ArH). ^{13}C NMR δ 23.6 (CH_3), 35.7 ($CH_2CH_2CH_2$), 40.6 ($CH_2CH_2CH_2$-NH), 47.1 (N-$CH_2CH_2CH_2$), 50.9 (CH-Cl), 62.4 (N-CH), 109.4 (C-2), 118.7 (C-5), 124.3 (C-3), 125.7 (C-9), 126.5 (C-8), 127.4 (C-10), 128.5 (C-4), 129.8 (C-11), 132.8 (C-6), 137.4 (C-12), 138.4 (C-7), 145.4 (C-1), 161.4 (CO), 168.2 (CO cyclic). Anal. Calcd for $C_{20}H_{20}N_5O_2Cl$: C, 60.37; H, 5.06; N, 17.60. Found: C, 60.29; H, 4.90; N, 17.49. MS-FAB: 397 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(4-hydroxyphenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4q).** Yield: 60%; mp 78–79 °C; IR ν 1188 (C–O), 1358 (C–NH), 2914 (CH–Cl), 1758 (CO cyclic), 3467 (OH) cm^{-1}. ^1H NMR δ 2.27 (m, 2H, $CH_2CH_2CH_2$), 3.38 (t, 2H, *J* = 7.7 Hz, $CH_2CH_2CH_2$-NH), 4.19 (t, 2H, *J* = 7.7 Hz, N-$CH_2CH_2CH_2$), 4.26 (s, 1H, OH), 4.59 (d, 1H, *J* = 5.2 Hz, CH-Cl), 5.38 (d, 1H, *J* = 5.2 Hz, N-CH), 5.74 (s, 1H, NH), 7.09–8.10 (m, 8H, ArH). ^{13}C NMR δ 38.9 ($CH_2CH_2CH_2$), 43.8 ($CH_2CH_2CH_2$-NH), 50.2 (N-$CH_2CH_2CH_2$), 53.5 (CH-Cl), 63.9 (N-CH), 111.3 (C-2), 117.4 (C-9, C-11), 120.5 (C-5), 124.4 (C-3), 127.5 (C-8, C-12), 128.6 (C-4), 131.4 (C-7), 133.5 (C-6), 145.6 (C-1), 155.2 (C-10), 163.7 (CO), 172.4 (CO cyclic). Anal. Calcd for $C_{19}H_{18}N_5O_3Cl$: C, 57.07; H, 4.53; N, 17.51. Found: C, 56.91; H, 4.47; N, 17.45. MS-FAB: 399 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(3-hydroxyphenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4r).** Yield: 63%; mp 80–81 °C; IR ν 1185 (C–O), 1362 (C–NH), 1765 (CO cyclic), 2925 (CH–Cl), 3469 (OH) cm^{-1}. ^1H NMR δ 2.25 (m, 2H, $CH_2CH_2CH_2$), 3.40 (t, 2H, *J* = 7.7 Hz, $CH_2CH_2CH_2$-NH), 4.26 (t, 2H, *J* = 7.7 Hz, N-$CH_2CH_2CH_2$), 4.22 (s, 1H, OH), 4.58 (d, 1H, *J* = 5.2 Hz, CH-Cl), 5.45 (d, 1H, *J* = 5.2 Hz, N-CH), 5.74 (s, 1H, NH), 7.12–8.13 (m, 8H, ArH). ^{13}C NMR δ 37.8 ($CH_2CH_2CH_2$), 43.9 ($CH_2CH_2CH_2$-NH), 49.8 (N-$CH_2CH_2CH_2$), 51.2 (CH-Cl), 64.7 (N-CH), 111.9 (C-2), 113.6 (C-8), 116.6 (C-10), 118.6 (C-12), 120.5 (C-5), 124.6 (C-3), 128.7 (C-4), 130.9 (C-11), 132.7 (C-6), 139.9 (C-7), 146.8 (C-1), 156.3 (C-9), 165.7 (CO), 173.8 (CO cyclic). Anal. Calcd for $C_{19}H_{18}N_5O_3Cl$: C, 57.07; H, 4.53; N, 17.51. Found: C, 56.79; H, 4.35; N, 17.39. MS-FAB: 399 (M^+).

***N*-[3-(1*H*-1,2,3-Benzotriazol-1-yl)propyl]-2-(2-hydroxyphenyl)-3-chloro-4-oxo-1-azetidinecarboxamide (4s).** Yield: 61%; mp 77–78 °C; IR ν 1186 (C–O), 1359 (C–NH), 1755 (CO cyclic), 2917 (CH–Cl), 3459 (OH) cm^{-1}. ^1H NMR δ 2.26 (m, 2H, $CH_2CH_2CH_2$), 3.32 (t, 2H, *J* = 7.7 Hz, $CH_2CH_2CH_2$-NH), 4.22 (t, 2H, *J* = 7.7 Hz, N-$CH_2CH_2CH_2$), 4.25 (s, 1H, OH), 4.62 (d, 1H, *J* = 5.2 Hz, CH-Cl), 5.51 (d, 1H, *J* = 5.2 Hz, N-CH), 5.76 (s, 1H,

NH), 7.19–8.21 (m, 8H, ArH). ^{13}C NMR δ 38.9 ($CH_2CH_2CH_2$), 43.1 ($CH_2CH_2CH_2$-NH), 49.6 (N-$CH_2CH_2CH_2$), 54.5 (CH-Cl), 63.6 (N-CH), 113.7 (C-2), 114.8 (C-9), 120.5 (C-5), 122.6 (C-11), 124.5 (C-3), 125.6 (C-7), 127.8 (C-12), 128.5 (C-4), 130.6 (C-10), 133.5 (C-6), 146.6 (C-1), 154.6 (C-8), 163.6 (CO), 173.2 (CO cyclic). Anal. Calcd for $C_{19}H_{18}N_5O_3Cl$: C, 57.07; H, 4.53; N, 17.51. Found: C, 56.81; H, 4.46; N, 17.43. MS-FAB: 399 (M^+).

6. Pharmacological Experimental Section

The synthesized compounds were screened against some selected microorganisms and determined their percentage inhibition zones. The percentage inhibition zone values were determined using the filter paper disc diffusion method and the concentrations have been used in ppm. All the final synthesized compounds **4a–s** have been screened in vitro for their antibacterial activity against *Bacillus subtilis, Escherichia coli* and *Staphylococcus aureus* and antifungal activity against *Aspergillus niger, Aspergillus flavus, Candida albicans*. Streptomycin and griseofulvin were used as standards for antibacterial and antifungal activity, respectively, and also screened under the similar conditions for comparison. The antitubercular activity was screened against the *M. tuberculosis.* For the antitubercular activity isoniazid and rifampicin were used as standards and also screened under the similar conditions for comparison.

6. 1. Antibacterial Activity

The antibacterial activity of compounds **4a–s** has been assayed in vitro at two concentrations (50 and 100 ppm) against *B. subtilis*, *E. coli* and *S. aureus.* The percentage inhibition zones of the compounds **4a–s** were determined by the filter paper disc diffusion method. Streptomycin used as standard showed 100% inhibition at both above concentrations. The percentage inhibition zones of the tested compounds are given in Table 1.

Table 1. In vitro antibacterial activity of compounds **4a–s** and their inhibition zone (%).

Comp.	*B. subtilis*		*E. coli*		*S. aureus*	
	50 ppm	100 ppm	50 ppm	100 ppm	50 ppm	100 ppm
4a	35	52	29	42	32	47
4b	47	78	53	75	42	65
4c	40	65	48	59	42	64
4d	64	76	61	76	47	62
4e	58	72	57	69	54	70
4f	55	77	54	66	55	70
4g	62	76	60	68	58	78
4h	26	62	67	82	64	82
4i	24	71	56	78	62	80
4j	27	73	54	79	70	86
4k	38	55	40	52	32	45
4l	50	60	41	56	30	42
4m	48	58	43	53	30	48
4n	47	55	38	52	31	44
4o	40	52	32	48	29	48
4p	41	54	35	50	38	48
4q	44	62	45	64	41	59
4r	48	68	48	66	40	62
4s	40	62	43	60	46	62

Streptomycin used as standard showed 100% inhibition at both 50 and 100 ppm.

6. 2. Antifungal Activity

The antifungal activity of compounds **4a–s** has been assayed in vitro at two concentrations (50 and 100 ppm) against *A. niger*, *A. flavus* and *C. albicans.* The percentage inhibition zones of the compounds **4a–s** were determined by the using filter paper disc diffusion method. Griseofulvin used as standard showed 100% inhibition at both above concentrations. The percentage inhibition zones of the tested compounds are given in Table 2.

Table 2. In vitro antifungal activity of compounds **4a–s** and their inhibition zone (%).

Comp.	*A. niger*		*A. flavus*		*C. albicans*	
	50 ppm	100 ppm	50 ppm	100 ppm	50 ppm	100 ppm
4a	38	50	40	50	30	49
4b	50	68	58	70	45	63
4c	43	65	40	65	42	62
4d	58	76	48	73	50	70
4e	50	72	59	71	51	66
4f	50	77	50	67	58	65
4g	45	76	44	56	50	62
4h	60	82	53	78	54	69
4i	61	81	54	75	52	70
4j	60	86	55	72	50	72
4k	40	54	30	44	38	47
4l	45	52	30	48	45	52
4m	40	59	31	46	38	48
4n	39	48	24	38	29	44
4o	30	45	25	34	28	40
4p	33	48	27	32	28	38
4q	36	52	33	54	36	49
4r	42	59	41	58	54	62
4s	40	52	43	50	46	52

Griseofulvin used as standard showed 100% inhibition at both 50 and 100 ppm.

6. 3. Antitubercular Activity

The synthesized compounds **4a–s** were screened against *M. tuberculosis* using L. J. medium (conventional)

method at two concentration (50 and 100 ppm) against *M. tuberculosis* H37Rv strain. The results are shown in Table 3. The standard antitubercular drugs isoniazid and rifampicin were taken as standards showing 100% inhibition at both above concentrations.

Table 3. Antitubercular percentage inhibition activity at 50 μg/mL concentration.

Comp.	% activity	Comp.	% activity	Comp.	% activity	Comp.	% activity	Comp.	% activity
4a	59	**4e**	85	**4i**	79	**4m**	63	**4q**	55
4b	78	**4f**	80	**4j**	80	**4n**	60	**4r**	75
4c	82	**4g**	76	**4k**	72	**4o**	55	**4s**	60
4d	84	**4h**	80	**4l**	70	**4p**	52		

Isoniazid and rifampicin were used as standard showed 100% inhibition at both 50 and 100 ppm.

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Povzetek

Za klasično sintezo nove serije N-[3-(1H-1,2,3-benzotriazol-1-il)propil]-2-(4-substituiranih fenil)-3-kloro-4-okso-1-azetidinekarboksamidov **4a-s** smo kot izhodno spojino uporabili 1,2,3-benzotriazol. Spojinam **4a-s** smo določili delovanje proti bakterijam, glivam in tuberkulozi. Strukture pripravljenih spojin smo potrdili s kemijsko analizo in spektroskopskimi metodami kot so IR, 1H NMR, 13C NMR ter FAB masno spektroskopijo.