# Synthesis and Antimicrobial Activity of 2-(4-(Hydroxyalkyl)-1*H*-1,2,3-triazol-1-yl)-*N*-substituted propanamides

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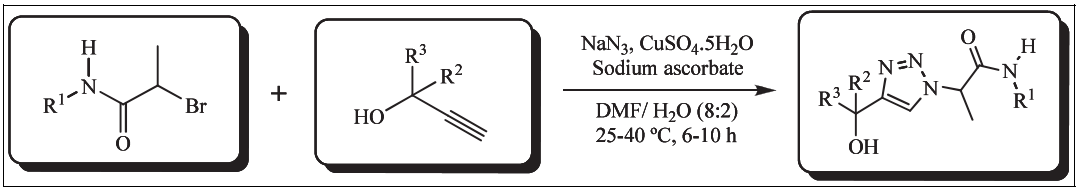


A series of 21 2-(4-(hydroxyalkyl)-1*H*-1,2,3-triazol-1-yl)-*N*-substituted propanamides (1,4-disubstituted 1,2,3-triazoles having amide linkage and hydroxyl group) have been synthesized from click reaction between terminal alkyne and 2-azido-*N*-substituted propanamide (generated *in situ* from reaction of 2-bromo-*N*-substituted propanamide and sodium azide) and characterized by FTIR, $^{1}$H NMR, $^{13}$C NMR spectroscopy, and HRMS. All the newly synthesized triazoles were tested *in vitro* for antimicrobial activity against four bacterial cultures – *Escherichia coli*, *Enterobacter aerogenes*, *Klebsiella pneumoniae*, and *Staphylococcus aureus* – and two fungal cultures – *Candida albicans* and *Aspergillus niger*. The synthesized 1,4-disubstituted 1,2,3-triazoles displayed moderate to good antimicrobial potential against the tested strains.

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## INTRODUCTION

In spite of significant progress in treatment of infectious diseases caused by bacteria and fungi still it remains a major world health problem owing to increasing resistance of microbes against the existing drugs. Owing to this, there is continuous requirement for antimicrobial having wide spectrum application. This leads to a challenging task for chemist to synthesize new molecule with excellent activity. Different heterocyclic compounds containing nitrogen heteroatom have been explored for development of microbicidal. In this sequence, five membered heterocyclic ring systems like triazole gained appreciable attention due to wide range of biological activities [1,2]. Triazoles have been reported to exhibit broad biological spectrum as anticancer [3,4], anti-HIV [5], antitubercular [6,7], antioxidant [8,9], antitrypanosomal [10], antimicrobial [11–15], anti-convulsant [16], antimalarial [17,18], antihistamines [19], antitumor [20], immune potentiators [21], antiviral [22,23], anti-inflammatory and [24,25], agents. In addition to aforementioned medicinal value, several members of the 1,2,3-triazoles family also show interesting industrial applications in form of corrosion inhibitions [26], dyes [27], and optical brightners [28].

Several methods have been reported for preparation of substituted 1,2,3-triazoles [29], but the thermal cycloaddition reaction of azides with alkynes discovered by Huisgen [30] has received considerable attention, which later modified by copper (I)-catalyst [31,32]. The Cu(I)-catalyzed azide-alkyne cycloaddition is one of the prime click reactions, which has been used extensively for the synthesis of 1,4-disubstituted 1,2,3-triazoles with high regioselectivity and yield under normal reaction condition. Click chemistry provides an efficient method for the construction of the triazole ring with diversified groups that can be explored as drug entities.

Keeping in view the wide ranging importance of triazoles, we herein reported the synthesis and antimicrobial properties of amide linked 1,4-disubstituted 1,2,3-triazoles. The synthesis was carried out from reaction of terminal alkynes, 2-bromo-*N*-substituted propanamide, and sodium azide in dimethylformamide/aqueous system in the presence of Cu(I) catalyst. To the best of our knowledge, all the synthesized compounds are new. The synthesized triazoles were characterized by spectroscopic techniques such as FT-IR, $^{1}$H NMR, $^{13}$C NMR, HRMS, and evaluated for antimicrobial potential against *Escherichia coli*, *Enterobacter aerogenes*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Candida albicans*, and *Aspergillus niger*.

## RESULTS AND DISCUSSION

**Chemistry.** The starting reactants 2-bromo-*N*-substituted propanamide (**3a**–**3g**) were synthesized from reaction of 2-bromopropanoyl bromide (**2**) and aromatic amines (**1a**–**1g**) in dichloromethane using potassium carbonate as base. 1,4-Disubstituted 1,2,3-triazoles (**5a**–**5u**) were synthesized by reacting 2-azido-*N*-substituted propanamide

with terminal alkyne dimethylformamide : water in the presence of copper sulfate pentahydrate and sodium ascorbate with stirring of 6–10 h at 25–40°C. (Scheme 1).

The structures of synthesized compounds (**5a**–**5u**) were confirmed by FTIR, $^1$H NMR, $^{13}$C NMR spectroscopy, and HRMS. In IR spectra compounds, characteristic absorption band displayed in region 3398–3370 owing to O–H stretching, 3296–3259 $cm^{-1}$, and 1708–1664 $cm^{-1}$ owing to N–H and C═O stretching of amide respectively, at 3163–3132 $cm^{-1}$ owing to C–H stretching of triazole ring.

$^1$H spectra of compounds displayed two characteristic singlet in the region δ 10.37–11.09 and δ 7.95–8.16 owing to N–H proton and triazolyl proton, respectively. Aromatic protons appeared in the range of δ 6.89–8.25, and a single proton attached to $N_1$ of triazoles appeared as quartet at δ 5.20–5.82. In $^{13}$C spectra, a characteristic signal of C═O appeared in range of δ 167.2–168.8, while C-4 of triazoles ring resonated in region δ 148.3–156.2. HRMS results of compounds showed good agreement with expected values.

**Antimicrobial activity.** Synthesized triazoles (**5a**–**5u**) were evaluated *in vitro* antibacterial activity against Gram-negative bacteria – *E. coli*, *E. aerogenes*, *K. pneumoniae*, and Gram-positive bacteria – *S. aureus* by the standard serial dilution method [33]. Results were compared with the standard drug Norfloxacin in term of minimum inhibitory concentration (MIC, μmol/mL; Table 1).

The synthesized compounds showed moderate to good antibacterial activity. Compounds **5k**, **5r**, and **5t** (MIC, 0.0707, 0.0680, and 0.0375 μmol/mL, respectively) showed appreciable activity against bacteria *E. coli*, *E. aerogenes*, and *K. pneumoniae.* In case of *S. aureus*, compounds **5d**, **5 k**, **5r**, **5t**, and **5u** (MIC, 0.0768, 0.0707, 0.0680, 0.0749 and 0.0738 μmol/mL respectively) displayed potent activity compared to standard.

The aforementioned result revealed that the presence of electron-withdrawing group Br and $NO_2$ at phenyl ring improved the antibacterial activity against *E. coli*, *E. aerogenes*, *K. pneumoniae*, and *S. aureus*.

Over all, above data of activity revealed that presence of alkyl group on carbon having free hydroxyl group increases the antibacterial activity.

All the synthesized triazoles (**5a**–**5u**) were also screened for antifungal activity against *C. albicans* and *A. niger*. Fluconazole was used as reference compound, and the results were recorded in terms of MIC in μmol/mL. (Table 2).

Results of antifungal data revealed that triazoles exhibited moderate to good activity. Compounds **5k**, **5r**, and **5t** (MIC 0.0707, 0.0340 and 0.0375 μmol/mL respectively) displayed potent fungicidal activity against *C. albicans*.

In case of *A. niger*, compounds **5d**, **5 k**, **5r**, and **5 t** (MIC 0.0384, 0.0353, 0.0340 and 0.0375 μmol/mL respectively) showed good activity.

As evident from the activity data, all the tested compounds with Br and $NO_2$ group on phenyl ring showed good inhibitory activity against both the strains.

The presence of the alkyl group on carbon having free hydroxyl group improved the antifungal activity against *C. albicans* and *A. niger.*

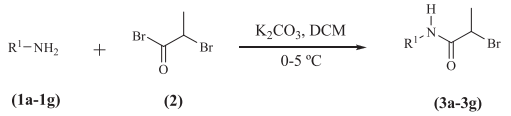
## EXPERIMENTAL

All chemicals used in the synthesis were purchased from Alfa-Aesar, Sigma-Aldrich and used without purification. Thin layer chromatography was used to monitor the progress of the reactions using n-Hexane, ethyl acetate, and chloroform in different ratio as mobile phase. Melting points were determined by open capillary method and were uncorrected. IR spectra were recorded on a Shimazdu IR Affinity-I FT-IR spectrophotometer using KBr powder, and the values are expressed in $cm^{-1}$. The $^1$H and $^{13}$C NMR spectra of the synthesized compounds were recorded at 400 and 100 MHz, respectively, using Bruker Avance II 400 MHz NMR spectrometer in DMSO-$d_6$ solvent, and the chemical shifts were expressed in δ, while coupling constants (*J*) in Hz. Splitting patterns were indicated as s: singlet, brs: broad singlet, d: doublet, t: triplet, q: quartet, m: multiplet. HRMS were obtained on Waters Micromass Q-Tof Micro (ESI) spectrophotometer.

**General procedure for synthesis of 1,4-disubstituted 1,2,3-triazoles (5a–5u).** For the synthesis of target compounds, the starting reactants 2-bromo-*N*-substituted propanamide (**3a**–**3g**) were synthesized by dropwise addition of 2-bromopropanoyl bromide (1.2 mmol) to aromatic amines (**1a**–**1g**) (1.0 mmol) in the presence of potassium carbonate (1.5 mmol) using dichloromethane as solvent at 0–5°C for 15–20 min, and after the completion of reaction, ice cold water was added to the reaction mixture and the resulting solid was filtered and dried.

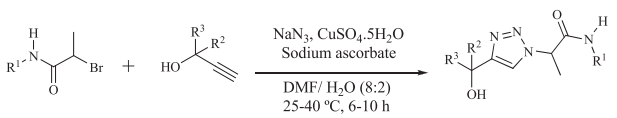
To synthesize the desired triazoles (**5a**–**5u**) 2-bromo-*N*-substituted propanamide (**3a**–**3g**) were stirred with aqueous sodium azide (3.0 mmol) in dimethylformamide for 30 min at 25–40°C. In the aforementioned mixture terminal alkyne (**4a**–**4c**), aqueous copper sulfate pentahydrate (0.1 mmol) and sodium ascorbate (0.4 mmol) were added, and stirring was continued for 6–10 h at same temperature. After the completion of reaction, as indicated by TLC, ice cold water was added to the reaction mixture, and then filtered the precipitated solid and washed with aqueous ammonia solution followed by water. The solid product was recrystallized with ethyl acetate to get pure product.

**Scheme 1.** Synthesis of amide linked 1,4-disubstituted 1,2,3-triazoles (**5a**–**5u**).




(1a-1g) (2) (3a-3g)

**R1** = $C_6H_5$-, 4-$FC_6H_4$-, 4-$ClC_6H_4$-, 4-$BrC_6H_4$-, 4-$CH_3OC_6H_4$-, 4-$NO_2C_6H_4$-, α–$C_{10}H_7$-




(3a-3g) (4a-4c) (5a-5u)

**4a:** $R^2$ = H, $R^3$ = H
**4b:** $R^2$= $CH_3$-, $R^3$ = $CH_3$-
**4c:** $R^2$ = $CH_3$-, $R^3$ = $C_2H_5$-

| Compound | $R^1$ | $R^2$ | $R^3$ |
|---|---|---|---|
| **5a** | $C_6H_5$ | H | H |
| **5b** | 4-$FC_6H_4$ | H | H |
| **5c** | 4-$ClC_6H_4$ | H | H |
| **5d** | 4-$BrC_6H_4$ | H | H |
| **5e** | 4-$CH_3OC_6H_4$ | H | H |
| **5f** | 4-$NO_2C_6H_4$ | H | H |
| **5g** | α-$C_{10}H_7$ | H | H |
| **5h** | $C_6H_5$ | $CH_3$ | $CH_3$ |
| **5i** | 4-$FC_6H_4$ | $CH_3$ | $CH_3$ |
| **5j** | 4-$ClC_6H_4$ | $CH_3$ | $CH_3$ |
| **5k** | 4-$BrC_6H_4$ | $CH_3$ | $CH_3$ |
| **5l** | 4-$CH_3OC_6H_4$ | $CH_3$ | $CH_3$ |
| **5m** | 4-$NO_2C_6H_4$ | $CH_3$ | $CH_3$ |
| **5n** | α-$C_{10}H_7$ | $CH_3$ | $CH_3$ |
| **5o** | $C_6H_5$ | $CH_3$ | $C_2H_5$ |
| **5p** | 4-$FC_6H_4$ | $CH_3$ | $C_2H_5$ |
| **5q** | 4-$ClC_6H_4$ | $CH_3$ | $C_2H_5$ |
| **5r** | 4-$BrC_6H_4$ | $CH_3$ | $C_2H_5$ |
| **5s** | 4-$CH_3OC_6H_4$ | $CH_3$ | $C_2H_5$ |
| **5t** | 4-$NO_2C_6H_4$ | $CH_3$ | $C_2H_5$ |
| **5u** | α-$C_{10}H_7$ | $CH_3$ | $C_2H_5$ |

**Table 1**

Antibacterial activity of 1,4-disubstituted 1,2,3-triazoles (**5a**–**5u**) (MIC in μmol/mL).

| Compound | *Escherichia coli* (MTCC 443) | *Enterobacter aerogenes* (NCDC 106) | *Klebsiella pneumoniae* (NCDC 138) | *Staphylococcus aureus* (MTCC 3160) |
|---|---|---|---|---|
| **5a** | 0.2030 | 0.1015 | 0.1015 | 0.2030 |
| **5b** | 0.0946 | 0.1892 | 0.0946 | 0.1892 |
| **5c** | 0.0890 | 0.0890 | 0.1781 | 0.1781 |
| **5d** | 0.0768 | 0.0768 | 0.0768 | 0.0768 |
| **5e** | 0.0904 | 0.0904 | 0.1809 | 0.1809 |
| **5f** | 0.0858 | 0.0858 | 0.0858 | 0.1716 |
| **5g** | 0.0843 | 0.0843 | 0.0843 | 0.0843 |
| **5h** | 0.0911 | 0.0911 | 0.0911 | 0.0911 |
| **5i** | 0.0855 | 0.0855 | 0.0855 | 0.0855 |
| **5j** | 0.0809 | 0.0809 | 0.1619 | 0.1619 |
| **5k** | 0.0707 | 0.0707 | 0.0707 | 0.0707 |
| **5l** | 0.0821 | 0.1642 | 0.1642 | 0.1642 |
| **5m** | 0.0782 | 0.0782 | 0.0782 | 0.1564 |
| **5n** | 0.0770 | 0.0770 | 0.1541 | 0.1541 |
| **5o** | 0.0867 | 0.0867 | 0.0867 | 0.0867 |
| **5p** | 0.0816 | 0.0816 | 0.0816 | 0.0816 |
| **5q** | 0.0774 | 0.0774 | 0.1548 | 0.1548 |
| **5r** | 0.0680 | 0.0680 | 0.0680 | 0.0680 |
| **5s** | 0.0785 | 0.0785 | 0.1570 | 0.1570 |
| **5t** | 0.0375 | 0.0375 | 0.0375 | 0.0749 |
| **5u** | 0.0738 | 0.0738 | 0.0738 | 0.0738 |
| Norfloxacin | 0.0391 | 0.0391 | 0.0391 | 0.0783 |

**Table 2**

Antifungal activity of 1,4-disubstituted 1,2,3-triazoles (**5a**–**5u**) (MIC in μmol/mL).

| Compound | *Candida albicans* (MTCC 227) | *Aspergillus niger* (MTCC 282) |
|---|---|---|
| **5a** | 0.1015 | 0.1015 |
| **5b** | 0.0946 | 0.0946 |
| **5c** | 0.0890 | 0.0890 |
| **5d** | 0.0768 | 0.0384 |
| **5e** | 0.0904 | 0.0904 |
| **5f** | 0.0858 | 0.0858 |
| **5g** | 0.0843 | 0.0843 |
| **5h** | 0.0911 | 0.0911 |
| **5i** | 0.0855 | 0.0427 |
| **5j** | 0.0809 | 0.0809 |
| **5k** | 0.0707 | 0.0353 |
| **5l** | 0.0821 | 0.0821 |
| **5m** | 0.0782 | 0.0782 |
| **5n** | 0.0770 | 0.0770 |
| **5o** | 0.0867 | 0.0433 |
| **5p** | 0.0816 | 0.0408 |
| **5q** | 0.0774 | 0.0774 |
| **5r** | 0.0340 | 0.0340 |
| **5s** | 0.0785 | 0.0785 |
| **5t** | 0.0375 | 0.0375 |
| **5u** | 0.0738 | 0.0738 |
| Fluconazole | 0.0408 | 0.0102 |

**Characterization of synthesized 1,4-disubstituted 1,2,3-triazoles.** ***2-(4-(Hydroxymethyl)-1H-1,2,3-triazol-1-yl)-N-phenylpropanamide (5a).*** Appearance: white solid; yield: 89%; mp 128–130°C. IR spectrum, ν, $cm^{-1}$: 3381 (O–H str.), 3259 (N–H str.), 3142 (C–H str. triazole), 3084 (C–H str. aromatic ring), 2968 (C–H str., aliphatic), 1695 (C═O str. amide), 1548, 1448 (C═C str., aromatic ring). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm: 1.78 d (3H, $J$ = 8 Hz), 4.55 d (2H, $OCH_2$, $J$ = 8 Hz), 5.22 t (1H, OH, $J$ = 8 Hz), 5.55 q (1H, $J$ = 8 Hz), 7.10 t (1H, Ar–H, $J$ = 8 Hz), 7.34 t (2H, Ar–H, $J$ = 8 Hz), 7.60 d (2H, Ar–H, $J$ = 8 Hz), 8.12 s (1H, C–H triazole), 10.50 s (1H, N–H amide). $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 18.3, 55.5, 59.2, 119.9, 122.4 ($C_5$ triazole), 124.4, 129.3, 138.8, 148.3 ($C_4$ triazole), 167.7 (C = O). Found, *m/z*: 247.1189 $[M + H]^+$ $C_{12}H_{14}N_4O_2$ Calculated, *m/z*: 247.1117.

***N-(4-Fluorophenyl)-2-(4-(hydroxymethyl)-1H-1,2,3-triazol-1-yl)propanamide (5b).*** Appearance: white solid; yield: 92%; mp 118–120°C. IR spectrum, ν, $cm^{-1}$: 3378 (O–H str.), 3271 (N–H str.), 3143 (C–H str. triazole), 3069 (C–H str. aromatic ring), 2968 (C–H str., aliphatic), 1674 (C = O str. amide), 1554, 1458 (C = C str., aromatic ring). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm: 1.78 d (3H, $J$ = 8 Hz), 4.55 s (2H, $OCH_2$), 5.22 s (1H, OH), 5.53 q (1H, $J$ = 8 Hz), 7.18 t (2H, Ar–H, $J$ = 8 Hz), 7.62 t (2H, Ar–H, $J$ = 8 Hz), 8.12 s (1H, C–H triazole), 10.57 s (1H, N–H amide). $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 18.3, 55.5, 59.1, 115.9 d ($J$ = 30 Hz), 121.7 d ($J$ = 10 Hz), 122.4 ($C_5$ triazole), 135.2 d ($J$ = 10 Hz), 148.3 ($C_4$ triazole), 158.8 d ($J$ = 240), 167.7 (C═O). Found, *m/z*: 265.1095 $[M + H]^+$. $C_{12}H_{13}FN_4O_2$. Calculated, *m/z*: 265.1023.

***N-(4-Chlorophenyl)-2-(4-(hydroxymethyl)-1H-1,2,3-triazol-1-yl)propanamide (5c).*** Appearance: white solid; yield:

88%; mp 136–138°C. IR spectrum, ν, $cm^{-1}$: 3378 (O–H str.), 3261 (N–H str.), 3132 (C–H str. triazole), 3094 (C–H str. aromatic ring), 2968 (C–H str., aliphatic), 1664 (C═O str. amide), 1548, 1456 (C═C str., aromatic ring). $^1H$ NMR spectrum (DMSO-$d_6$), δ, ppm: 1.78 d (3H, $J$ = 8 Hz), 4.55 s (2H), 5.21 s (1H, OH), 5.54 q (1H, $J$ = 8 Hz), 7.40 d (2H, Ar–H, $J$ = 8 Hz), 7.62 d (2H, Ar–H, $J$ = 8 Hz), 8.12 s (1H, C–H triazole), 10.64 s (1H, N–H amide). $^{13}C$ NMR spectrum (DMSO-$d_6$), δ, ppm: 18.2, 55.5, 59.2, 121.5, 122.4 ($C_5$ triazole), 128.0, 129.3, 137.8, 148.3 ($C_4$ triazole), 167.9 (C═O). Found, $m/z$: 281.0800 ($^{35}Cl$), 283.0770 ($^{37}Cl$) $[M + H]^+$. $C_{12}H_{13}ClN_4O_2$. Calculated, $m/z$: 281.0727 ($^{35}Cl$), 283.0731 ($^{37}Cl$).

***N-(4-Bromophenyl)-2-(4-(hydroxymethyl)-1H-1,2,3-triazol-1-yl)propanamide (5d).*** Appearance: white solid; yield: 96%; mp 154–156°C. IR spectrum, ν, $cm^{-1}$: 3377 (O–H str.), 3275 (N–H str.), 3142 (C–H str. triazole), 3053 (C–H str. aromatic ring), 2951 (C–H str., aliphatic), 1666 (C = O str. amide), 1541, 1448 (C═C str., aromatic ring). $^1H$ NMR spectrum (DMSO-$d_6$), δ, ppm: 1.79 d (3H, $J$ = 8 Hz), 4.57 s (2H, $OCH_2$), 5.24 s (1H, OH), 5.55 q (1H, $J$ = 8 Hz), 7.59–7.50 m (4H, Ar–H), 8.13 s (1H, C–H triazole), 10.64 s (1H, N–H amide). $^{13}C$ NMR spectrum (DMSO-$d_6$), δ, ppm: 18.2, 55.5, 59.2, 116.1, 121.9, 122.4 ($C_5$ triazole), 132.2, 138.2, 148.3 ($C_4$ triazole), 167.9 (C═O). Found, $m/z$: 325.0298 ($^{79}Br$), 327.0274 ($^{81}Br$) $[M + H]^+$. $C_{12}H_{13}BrN_4O_2$. Calculated, $m/z$: 325.0222 ($^{79}Br$), 327.0201 ($^{81}Br$).

***2-(4-(Hydroxymethyl)-1H-1,2,3-triazol-1-yl)-N-(4-methoxyphenyl) propanamide (5e).*** Appearance: white solid; yield: 94%; mp 134–136°C. IR spectrum, ν, $cm^{-1}$: 3383 (O–H str.), 3275 (N–H str.), 3142 (C–H str. triazole), 3031 (C–H str. aromatic ring), 2954 (C–H str., aliphatic), 1662 (C═O str. amide), 1550, 1450 (C═C str., aromatic ring) 1243 (C–O asym. Str., ether), 1032 (C–O sym. Str., ether). $^1H$ NMR spectrum (DMSO-$d_6$), δ, ppm: 1.77 d (3H, $J$ = 8 Hz), 3.72 s (3H, $OCH_3$), 4.54 d (2H, $OCH_2$, $J$ = 8 Hz), 5.21 t (1H, OH, $J$ = 8 Hz), 5.51 q (1H, $J$ = 8 Hz), 6.90 d (2H, Ar–H, $J$ = 8 Hz), 7.51 d (2H, Ar–H, $J$ = 8 Hz), 8.10 s (1H, C–H triazole), 10.37 s (1H, N–H amide). $^{13}C$ NMR spectrum (DMSO-$d_6$), δ, ppm: 18.4, 55.5, 59.1, 114.4, 121.5, 122.3 ($C_5$ triazole), 131.9, 148.3 ($C_4$ triazole), 156.1, 167.2 (C═O). Found, $m/z$: 277.1293. $[M + H]^+$. $C_{13}H_{16}N_4O_3$. Calculated, $m/z$: 277.1222.

***2-(4-(Hydroxymethyl)-1H-1,2,3-triazol-1-yl)-N-(4-nitrophenyl) propanamide (5f).*** Appearance: yellow solid; yield: 89%; mp 178–180°C. IR spectrum, ν, $cm^{-1}$: 3378 (O–H str.), 3274 (N–H str.), 3159 (C–H str. triazole), 3088 (C–H str. aromatic ring), 2966 (C–H str., aliphatic), 1708 (C═O str. amide), 1554, 1458 (C═C str., aromatic ring), 1502 (N-O str., asym., $NO_2$), 1340 (N-O str., sym., $NO_2$). $^1H$ NMR spectrum (DMSO-$d_6$), δ, ppm: 1.82 d (3H, $J$ = 8 Hz), 4.55 d (2H, $OCH_2$, $J$ = 8 Hz), 5.23 t (1H, OH, $J$ = 8 Hz), 5.59 q (1H, $J$ = 8 Hz), 7.85 d (2H, Ar–H), 8.15 s (1H, C–H triazole), 8.25 d (2H, Ar–H), 11.08 s (1H, N–H amide). $^{13}C$ NMR spectrum (DMSO-$d_6$), δ, ppm ($J$, Hz): 18.1, 55.5, 59.3, 119.8, 122.6 ($C_5$ triazole), 125.5, 143.2, 144.9, 148.4 ($C_4$ triazole), 168.7 (C═O). Found, $m/z$: 292.1039 $[M + H]^+$. $C_{12}H_{13}N_5O_4$. Calculated, $m/z$: 292.0968.

***2-(4-(Hydroxymethyl)-1H-1,2,3-triazol-1-yl)-N-(naphthalen-1-yl)propanamide (5g).*** Appearance: white solid; yield: 93%; mp 140–142°C. IR spectrum, ν, $cm^{-1}$: 3381 (O–H str.), 3270 (N–H str.), 3142 (C–H str. triazole), 3051 (C–H str. aromatic ring), 2951 (C–H str., aliphatic), 1681 (C═O str. amide), 1554, 1454 (C═C str., aromatic ring). $^1H$ NMR spectrum (DMSO-$d_6$), δ, ppm: 1.89 d (3H, $J$ = 8 Hz), 4.56 s (2H, $OCH_2$), 5.22 s (1H, OH), 5.82 q (1H, $J$ = 8 Hz), 7.67–7.51 m (4H, Ar–H), 7.82 d (2H, Ar–H, $J$ = 8 Hz), 7.97 d (2H, Ar–H, $J$ = 8 Hz), 8.04 d (1H, Ar–H, $J$ = 8 Hz), 8.16 s (1H, C–H triazole), 10.47 s (1H, N–H amide). $^{13}C$ NMR spectrum (DMSO-$d_6$), δ, ppm: 18.6, 55.5, 58.9, 122.5 ($C_5$ triazole), 122.9, 126.0, 126.5, 126.6, 126.7, 128.3, 128.7, 133.1, 134.2, 148.3 ($C_4$ triazole), 168.7 (C═O). Found, $m/z$: 297.1347 $[M + H]^+$. $C_{16}H_{16}N_4O_2$. Calculated, $m/z$: 297.1273.

***2-(4-(2-Hydroxypropan-2-yl)-1H-1,2,3-triazol-1-yl)-N-phenylpropanamide (5h).*** Appearance: white solid; yield: 89%; mp 158–160°C. IR spectrum, ν, $cm^{-1}$: 3396 (O–H str.), 3286 (N–H str.), 3145 (C–H str. triazole), 3051 (C–H str. aromatic ring), 2960 (C–H str., aliphatic), 1678 (C═O str. amide), 1554, 1500, 1446 (C═C str., aromatic ring). $^1H$ NMR spectrum (DMSO-$d_6$), δ, ppm: 1.48 s (6H), 1.77 d (3H, $J$ = 8 Hz), 5.13 s (1H, OH), 5.53 q (1H, $J$ = 8 Hz), 7.10 t (1H, Ar–H, $J$ = 8 Hz), 7.34 t (2H, Ar–H, $J$ = 8 Hz), 7.60 d (2H, Ar–H, $J$ = 8 Hz), 8.00 s (1H, C–H triazole), 10.51 s (1H, N–H amide). $^{13}C$ NMR spectrum (DMSO-$d_6$), δ, ppm: 18.3, 31.2, 59.1, 67.5, 119.9 ($C_5$ triazole), 124.4, 129.3, 138.8, 156.1 ($C_4$ triazole), 167.8 (C═O). Found, $m/z$: 275.1502 $[M + H]^+$. $C_{14}H_{18}N_4O_2$. Calculated, $m/z$: 275.1430.

***N-(4-Fluorophenyl)-2-(4-(2-hydroxypropan-2-yl)-1H-1,2,3-triazol-1-yl)propanamide (5i).*** Appearance: white solid; yield: 88%; mp 198–200°C. IR spectrum, ν, $cm^{-1}$: 3396 (O–H str.), 3296 (N–H str.), 3163 (C–H str. triazole), 3078 (C–H str. aromatic ring), 2978 (C–H str., aliphatic), 1678 (C═O str. amide), 1558, 1454 (C═C str., aromatic ring). $^1H$ NMR spectrum (DMSO-$d_6$), δ, ppm: 1.48 s (6H), 1.77 d (3H, $J$ = 8 Hz), 5.13 s (1H, OH), 5.50 q (1H, $J$ = 8 Hz), 7.18 t (2H, Ar–H, $J$ = 8 Hz), 7.63 d (2H, Ar–H, $J$ = 8 Hz), 8.00 s (1H, C–H triazole), 10.57 s (1H, N–H amide). $^{13}C$ NMR spectrum (DMSO-$d_6$), δ, ppm: 18.3, 31.1, 59.1, 67.5, 115.9 d ($J$ = 30 Hz), 119.9 ($C_5$ triazole), 121.8 d ($J$ = 10 Hz), 135.2 d ($J$ = 10 Hz), 156.1 ($C_4$ triazole), 158.8 d ($J$ = 240 Hz), 167.7 (C═O). Found, *m/*

*z*: 293.1405 [M + H]$^+$. $C_{14}H_{17}FN_4O_2$. Calculated, *m/z*: 293.1336.

***N-(4-Chlorophenyl)-2-(4-(2-hydroxypropan-2-yl)-1H-1,2,3-triazol-1-yl)propanamide (5j).*** Appearance: white solid; yield: 85%; mp 198–200°C. IR spectrum, ν, cm$^{-1}$: 3387 (O–H str.), 3280 (N–H str.), 3145 (C–H str. triazole), 3051 (C–H str. aromatic ring), 2975 (C–H str., aliphatic), 1676 (C═O str. amide), 1548, 1454 (C═C str., aromatic ring). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm: 1.48 s (6H), 1.77 d (3H, *J* = 8 Hz), 5.13 s (1H, OH), 5.50 q (1H, *J* = 8 Hz), 7.40 d (2H, Ar–H, *J* = 12 Hz), 7.63 d (2H, Ar–H, *J* = 12 Hz), 8.00 s (1H, C–H triazole), 10.65 s (1H, N–H amide). $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 18.2, 31.1, 59.1, 67.5, 120.0 ($C_5$ triazole), 121.5, 128.0, 129.3, 137.8, 156.1 ($C_4$ triazole), 167.9 (C═O). Found, *m/z*: 309.1111 ($^{35}$Cl), 311.1084 ($^{37}$Cl). [M + H]$^+$. $C_{14}H_{17}ClN_4O_2$. Calculated, *m/z*: 309.1040 ($^{35}$Cl), 311.1044 ($^{37}$Cl).

***N-(4-Bromophenyl)-2-(4-(2-hydroxypropan-2-yl)-1H-1,2,3-triazol-1-yl)propanamide (5k).*** Appearance: white solid; yield: 94%; mp 202–204°C. IR spectrum, ν, cm$^{-1}$: 3381, 3282 (N–H str.), 3145 (C–H str. triazole), 3069 (C–H str. aromatic ring), 2978 (C–H str., aliphatic), 1676 (C═O str. amide), 1546, 1446 (C═C str., aromatic ring). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm: 1.47 s (6H), 1.77 d (3H, *J* = 8 Hz), 5.12 s (1H, OH), 5.50 q (1H, *J* = 8 Hz), 7.59–7.51 m (4H, Ar–H), 8.00 s (1H, C–H triazole), 10.64 s (1H, N–H amide). $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 18.2, 31.1, 59.1, 67.5, 116.1, 120.0 ($C_5$ triazole), 121.9, 132.2, 138.2, 156.1 ($C_4$ triazole), 167.9 (C═O). Found, *m/z*: 353.0611 ($^{79}$Br), 355.0583 ($^{81}$Br) [M + H]$^+$. $C_{14}H_{17}BrN_4O_2$. Calculated, *m/z*: 353.0535 ($^{79}$Br), 355.0514 ($^{81}$Br).

***2-(4-(2-Hydroxypropan-2-yl)-1H-1,2,3-triazol-1-yl)-N-(4-methoxyphenyl)propanamide (5l).*** Appearance: white solid; yield: 84%; mp 136–138°C. IR spectrum, ν, cm$^{-1}$: 3375 (O–H str.), 3296 (N–H str.), 3143 (C–H str. triazole), 3060 (C–H str. aromatic ring), 2981 (C–H str., aliphatic), 1666 (C═O str. amide), 1548, 1462 (C═C str., aromatic ring) 1243 (C–O asym. str., ether), 1032 (C–O sym. str., ether). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm: 1.48 s (6H), 1.76 d (3H, *J* = 8 Hz), 3.73 s (3H, $OCH_3$), 5.12 s (1H, OH), 5.50 q (1H, *J* = 8 Hz), 6.91 d (2H, Ar–H, *J* = 8 Hz), 7.52 d (2H, Ar–H, *J* = 8 Hz), 7.99 s (1H, C–H triazole), 10.37 s (1H, N–H amide). $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 18.4, 31.2, 55.6, 59.1, 67.5, 114.4, 119.9 ($C_5$ triazole), 121.4, 131.9, 156.1, 156.1 ($C_4$ triazole), 167.2 (C═O). Found, *m/z*: 305.1607 [M + H]$^+$. $C_{15}H_{20}N_4O_3$. Calculated, *m/z*: 305.1535.

***2-(4-(2-Hydroxypropan-2-yl)-1H-1,2,3-triazol-1-yl)-N-(4-nitrophenyl)propanamide (5m).*** Appearance: yellow solid; yield: 90%; mp 156–158°C. IR spectrum, ν, cm$^{-1}$: 3398 (O–H str.), 3273 (N–H str.), 3157 (C–H str. triazole), 3056 (C–H str. aromatic ring), 2970 (C–H str., aliphatic), 1699 (C═O str. amide), 1564, 1456 (C═C str., aromatic ring), 1516 (N–O str., asym., $NO_2$), 1342 (N–O str., sym., $NO_2$). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm: 1.48 s (6H), 1.81 d (3H, *J* = 8 Hz), 5.14 s (1H, OH), 5.57 q (1H, *J* = 8 Hz), 7.86 d (2H, Ar–H, *J* = 8 Hz), 8.03 s (1H, C–H triazole), 8.25 d (2H, Ar–H, *J* = 8 Hz), 11.09 s (1H, N–H amide). $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 18.1, 31.1, 59.2, 67.5, 119.8 ($C_5$ triazole), 120.2, 125.5, 143.2, 144.9, 156.2 ($C_4$ triazole), 168.8 (C═O). Found, *m/z*: 320.1352 [M + H]$^+$. $C_{14}H_{17}N_5O_4$. Calculated, *m/z*: 320.1281.

***2-(4-(2-Hydroxypropan-2-yl)-1H-1,2,3-triazol-1-yl)-N-(naphthalen-1-yl)propanamide (5n).*** Appearance: white solid; yield: 87%; mp 90–92°C. IR spectrum, ν, cm$^{-1}$: 3381 (O–H str.), 3278 (N–H str.), 3142 (C–H str. triazole), 3057 (C–H str. aromatic ring), 2980 (C–H str., aliphatic), 1672 (C═O str. amide), 1541, 1456 (C═C str., aromatic ring). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm: 1.50 s (6H), 1.89 d (3H, *J* = 8 Hz), 5.16 s (1H, OH), 5.82 q (1H, *J* = 8 Hz), 7.69–7.51 m (4H, Ar–H), 7.82 d (1H, Ar–H, *J* = 8 Hz), 8.07–7.96 m (3H, 2Ar–H, C–H triazole), 10.47 s (1H, N–H amide). $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 18.6, 31.2, 58.9, 67.6, 120.1 ($C_5$ triazole), 122.5, 122.9, 126.0, 126.5, 126.6, 126.7, 128.3, 128.7, 133.0, 134.2, 156.1 ($C_4$ triazole), 168.8 (C═O). Found, *m/z*: 325.1657 [M + H]$^+$. $C_{18}H_{20}N_4O_2$. Calculated, *m/z*: 325.1586.

***2-(4-(2-Hydroxybutan-2-yl)-1H-1,2,3-triazol-1-yl)-N-phenylpropanamide (5o).*** Appearance: white solid; yield: 86%; mp 118–120°C. IR spectrum, ν, cm$^{-1}$: 3393 (O–H str.), 3286 (N–H str.), 3163 (C–H str. triazole), 3055 (C–H str. aromatic ring), 2978 (C–H str., aliphatic), 1680 (C═O str. amide), 1546, 1450 (C═C str., aromatic ring). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm: 0.76 t (3H, *J* = 8 Hz), 1.44 s (3H), 1.78–1.72 m (5H), 4.98 s (1H, OH), 5.53 q (1H, *J* = 8 Hz), 7.10 t (1H, Ar–H, *J* = 8 Hz), 7.34 t (2H, Ar–H, *J* = 8 Hz), 7.60 d (2H, Ar–H, *J* = 8 Hz), 7.97 s (1H, C–H triazole), 10.50 s (1H, N–H amide). $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 8.8, 18.3, 28.6, 35.9, 59.1, 70.2, 119.9, 120.7 ($C_5$ triazole), 124.4, 129.3, 138.8, 155.1 ($C_4$ triazole), 167.8 (C═O). Found, *m/z*: 289.1657 [M + H]$^+$. $C_{15}H_{20}N_4O_2$. Calculated, *m/z*: 289.1586.

***N-(4-Fluorophenyl)-2-(4-(2-hydroxybutan-2-yl)-1H-1,2,3-triazol-1-yl)propanamide (5p).*** Appearance: white solid; yield: 93%; mp 140–142°C. IR spectrum, ν, cm$^{-1}$: 3391 (O–H str.), 3283 (N–H str.), 3157 (C–H str. triazole), 3062 (C–H str. aromatic ring), 2974 (C–H str., aliphatic), 1680 (C═O str. amide), 1552, 1454 (C═C str., aromatic ring). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm: 0.75 t (3H, *J* = 8 Hz). 1.44 s (3H), 1.78–1.72 m (5H), 4.98 s (1H, OH), 5.51 q (1H, *J* = 8 Hz), 7.18 t (2H, Ar–H, *J* = 8 Hz), 7.63 t (2H, Ar–H, *J* = 8 Hz), 7.96 s (1H, C–H

triazole), 10.57 s (1H, N–H amide). $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 8.8, 18.3, 28.6, 35.9, 59.1, 70.3, 115.9 d ($J$ = 30 Hz), 120.7 ($C_5$ triazole), 121.8 d ($J$ = 10 Hz), 135.2 d ($J$ = 10 Hz), 155.1 ($C_4$ triazole), 158.8 d ($J$ = 240), 167.7 (C═O). Found, *m/z*: 307.1562 $[M + H]^+$. $C_{15}H_{19}FN_4O_2$. Calculated, *m/z*: 307.1492.

***N-(4-Chlorophenyl)-2-(4-(2-hydroxybutan-2-yl)-1H-1,2,3-triazol-1-yl)propanamide (5q).*** Appearance: white solid; yield: 90%; mp 162–164°C. IR spectrum, ν, $cm^{-1}$: 3378 (O–H str.), 3286 (N–H str.), 3140 (C–H str. triazole), 3062 (C–H str. aromatic ring), 2978 (C–H str., aliphatic), 1680 (C═O str. amide), 1546, 1450 (C═C str., aromatic ring). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm ($J$, Hz): 0.75 t (3H, $J$ = 8 Hz), 1.44 s (3H), 1.79–1.72 m (5H), 4.98 s (1H, OH), 5.51 q (1H, $J$ = 8 Hz), 7.40 d (2H, Ar–H, $J$ = 12 Hz), 7.63 d (2H, Ar–H, $J$ = 12 Hz), 7.97 s (1H, C–H triazole), 10.64 s (1H, N–H amide). $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 8.8, 18.2, 28.6, 35.9, 59.1, 70.2, 120.7 ($C_5$ triazole), 121.5, 128.0, 129.3, 137.8, 155.1 ($C_4$ triazole), 167.9 (C═O). Found, *m/z*: 323.1267 ($^{35}$Cl), 325.1237 ($^{37}$Cl) $[M + H]^+$. $C_{15}H_{19}ClN_4O_2$. Calculated, *m/z*: 323.1197 ($^{35}$Cl), 325.1201 ($^{37}$Cl).>

***N-(4-Bromophenyl)-2-(4-(2-hydroxybutan-2-yl)-1H-1,2,3-triazol-1-yl)propanamide (5r).*** Appearance: white solid; yield: 89%; mp 172–174°C. IR spectrum, ν, $cm^{-1}$: 3370 (O–H str.), 3282 (N–H str.), 3152 (C–H str. triazole), 3082 (C–H str. aromatic ring), 2976 (C–H str., aliphatic), 1672 (C═O str. amide), 1546, 1450 (C═C str., aromatic ring). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm: 0.75 t (3H, $J$ = 8 Hz), 1.44 s (3H), 1.78–1.72 m (5H), 4.98 s (1H, OH), 5.51 q (1H, $J$ = 8 Hz), 7.59–7.51 m (4H, Ar–H), 7.97 s (1H, C–H triazole), 10.63 s (1H, N–H amide). $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 8.8, 18.2, 28.6, 35.9, 59.1, 70.2, 116.1, 120.7 ($C_5$ triazole), 121.9, 132.2, 138.2, 155.1 ($C_4$ triazole), 168.0 (C═O). Found, *m/z*: 367.0770 ($^{79}$Br), 369.0738 ($^{81}$Br). $[M + H]^+$. $C_{15}H_{19}BrN_4O_2$. Calculated, *m/z*: 367.0691 ($^{79}$Br), 369.0671 ($^{81}$Br).

***2-(4-(2-Hydroxybutan-2-yl)-1H-1,2,3-triazol-1-yl)-N-(4-methoxyphenyl)propanamide (5s).*** Appearance: white solid; yield: 86%; mp 110–112°C. IR spectrum, ν, $cm^{-1}$: 3370 (O–H str.), 3286 (N–H str.), 3140 (C–H str. triazole), 3062 (C–H str. aromatic ring), 2972 (C–H str., aliphatic), 1676 (C═O str. amide), 1546, 1458 (C═C str., aromatic ring) 1243 (C–O asym. str., ether), 1034 (C–O sym. str., ether). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm: 0.75 t (3H, $J$ = 8 Hz), 1.44 s (3H), 1.77–1.72 m (5H), 3.72 s (3H, $OCH_3$), 4.97 s (1H, OH), 5.49 q (1H, $J$ = 8 Hz), 6.90 d (2H, Ar–H, $J$ = 8 Hz), 7.51 d (2H, Ar–H, $J$ = 8 Hz), 7.95 s (1H, C–H triazole), 10.37 s (1H, N–H amide). $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 8.8, 18.4, 28.6, 35.9, 55.6, 59.1, 70.2, 114.4, 120.6 ($C_5$ triazole), 121.4, 131.9, 155.1 ($C_4$ triazole), 156.1, 167.3 (C═O). Found, *m/z*: 319.1762 $[M + H]^+$. $C_{16}H_{22}N_4O_3$. Calculated, *m/z*: 319.1692.

***2-(4-(2-Hydroxybutan-2-yl)-1H-1,2,3-triazol-1-yl)-N-(4-nitrophenyl)propanamide (5t).*** Appearance: yellow solid; yield: 90%; mp 128–130°C. IR spectrum, ν, $cm^{-1}$: 3390 (O–H str.), 3276 (N–H str.), 3151 (C–H str. triazole), 3086 (C–H str. aromatic ring), 2970 (C–H str., aliphatic), 1697 (C═O str. amide), 1586, 1458 (C═C str., aromatic ring), 1502 (N–O str., asym., $NO_2$), 1338 (N–O str., sym., $NO_2$). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm: 0.75 t (3H, $J$ = 8 Hz), 1.44 s (3H), 1.82–1.72 m (5H), 4.98 s (1H, OH), 5.57 q (1H, $J$ = 8 Hz), 7.86 d (2H, Ar–H, $J$ = 8 Hz), 8.00 s (1H, C–H triazole), 8.25 d (2H, Ar–H, $J$ = 8 Hz), 11.09 s (1H, N–H amide). $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 8.8, 18.1, 28.6, 35.9, 59.2, 70.2, 119.8, 120.9 ($C_5$ triazole), 125.5, 143.2, 144.9, 155.2 ($C_4$ triazole), 168.8 (C═O). Found, *m/z*: 334.1505 $[M + H]^+$. $C_{15}H_{19}N_5O_4$. Calculated, *m/z*: 334.1437.

***2-(4-(2-Hydroxybutan-2-yl)-1H-1,2,3-triazol-1-yl)-N-(naphthalen-1-yl)propanamide (5u).*** Appearance: white solid; yield: 94%; mp 106–108°C. IR spectrum, ν, $cm^{-1}$: 3378 (O–H str.), 3269 (N–H str.), 3152 (C–H str. triazole), 3055 (C–H str. aromatic ring), 2970 (C–H str., aliphatic), 1674 (C═O str. amide), 1541, 1456 (C═C str., aromatic ring). $^1$H NMR spectrum (DMSO-$d_6$), δ, ppm: 0.75 t (3H, $J$ = 8 Hz). 1.46 s (3H), 1.90–1.74 m (5H), 4.98 s (1H, OH), 5.82 q (1H, $J$ = 8 Hz), 8.02 m (8H, 7Ar–H, C–H triazole), 10.45 s (1H, N–H amide), $^{13}$C NMR spectrum (DMSO-$d_6$), δ, ppm: 8.8, 18.5, 28.7, 36.0, 58.9, 70.3, 120.9 ($C_5$ triazole), 122.5, 122.9, 126.0, 126.5, 126.6, 126.7, 128.3, 128.7, 133.1, 134.2, 155.1 ($C_4$ triazole), 168.7 (C═O). Found, *m/z*: 339.1813 $[M + H]^+$. $C_{19}H_{22}N_4O_2$. Calculated, *m/z*: 339.1743.

**Antimicrobial activity.** The antimicrobial testing of newly synthesized compounds was assessed *in vitro* against Gram-negative bacteria – *E. coli* (MTCC 443), *E. aerogenes* (NCDC 106), *K. pneumoniae* (NCDC 138), Gram-positive bacteria – *S. aureus* (MTCC 3160) and two fungal strains – *C. albicans* (MTCC 227), *A. niger* (MTCC 282) through standard serial dilution method [33] using a stock solution of 100 µg/mL concentration. Nutrient broth and sabouraud dextrose were employed as culture media for bacteria and fungus, respectively. Norfloxacin and Fluconazole were used as standard drug for bacterial and fungal activity assay, respectively. A stock solution of test compounds and control drug were serially diluted to get concentration of 50, 25, 12.5, 6.25, and 3.12 µg/mL. All these dilutions were inoculated with respective bacterial and fungal strain in saline solution and incubated at 37°C for 24 h in case of all bacteria, at 25°C in case of *C. albicans* for 48 h and at 25°C for 120 h in case of *A. niger* and then compared with control drug. The antimicrobial activity of compounds was represented in

terms of minimum inhibitory concentration (MIC, μmol/mL) which reflects as the lowest concentration of compound that completely inhibits the growth of each strain.

## CONCLUSION

A small library of 2-(4-(hydroxyalkyl)-1*H*-1,2,3-triazol-1-yl)-*N*-substituted propanamides (**5a**–**5u**) have been synthesized via Cu(I) catalyzed reaction of terminal alkynes and 2-azido-*N*-substituted propanamide. Further, these triazoles were tested *in vitro* antimicrobial activity against Gram-negative bacteria – *E. coli*, *E. aerogenes*, *K. pneumoniae*, and Gram-positive bacteria – *S. aureus* and two fungal strains – *C. albicans* and *A. niger* by a standard serial dilution method. Compounds **5r** and **5t** showed potent activity against all the microbial strains.

### REFERENCES AND NOTES

[1] Thirumurugan, P.; Matosiuk, D.; Jozwiak, K. Chem Rev 2013, 113, 4905.

[2] Agalave, S. G.; Maujan, S. R.; Pore, V. S. Chem Asian J 2011, 6, 2696.

[3] Lal, K.; Kaushik, C. P.; Kumar, K.; Kumar, A.; Qazi, A. K.; Hamid, A.; Jaglan, S. Med Chem Res 2014, 23, 4761.

[4] Madasu, C.; Vadithe, L. N.; Sistla, R.; Uppulur, V. M. Eur J Med Chem 2016, 114, 293.

[5] Sirivolu, V. A.; Vernekar, S. K. V.; Ilina, T.; Myshakina, N. S.; Parniak, M. A.; Wang, Z. J Med Chem 2013, 56, 8765.

[6] Addla, D.; Jallapally, A.; Gurram, D.; Yogeeswari, P.; Sriram, D.; Kantevaria, S. Bioorg Med Chem Lett 2014, 24, 1974.

[7] Menendez, C.; Chollet, A.; Rodriguez, F.; Inard, C.; Pasca, M. R.; Lherbet, C.; Baltas, M. Eur J Med Chem 2012, 52, 275.

[8] Tan, W.; Li, Q.; Li, W.; Dong, F.; Guo, Z. Int J Biol Macromol 2016, 82, 404.

[9] Shirame, S. P.; Jadhav, S. Y.; Bhosal, R. B. Asian J Pharm Clin Res 2014, 7, 163.

[10] Junqueira, G. G.; Carvalho, M. R.; Andrade, P.; Lopes, C. D.; Carneiro, Z. A.; SestiCosta, R.; Silva, J. S.; Carvalho, I. J Braz Chem Soc 2014, 25, 1872.

[11] Kaushik, C. P.; Kumar, K.; Singh, D.; Singh, S. K.; Jindal, D. K.; Luxmi, R. Synth Comm 2015, 45, 1977.

[12] Kaushik, C. P.; Kumar, K.; Narasimhan, B.; Singh, D.; Kumar, P.; Pahwa, A. Monatsh Chem 2017, 148, 765.

[13] Kaushik, C. P.; Kumar, K.; Singh, S. K.; Singh, D.; Saini, S. Arab J Chem 2016, 9, 865.

[14] Kaushik, C. P.; Pahwa, A.; Thakur, R.; Kaur, P. Synth Commun 2017, 47, 368.

[15] Kaushik, C. P.; Luxmi, R.; Singh, D.; Kumar, A. Mol Divers 2017, 21, 137.

[16] Karakurt, A.; Aytemir, M. D.; Stables, J. P.; Ozalp, M.; Betul, F. K.; Ozbey, S.; Dalkara, S. Arch Pharm Chem Life Sci 2006, 339, 513.

[17] Pereira, G. R.; Brandao, G. C.; Arantes, L. M.; Oliveira, H. A.; Paula, R. C.; Nascimento, M. F. A.; Santos, F. M.; Rocha, R. K.; Lopes, J. C. D.; Oliveira, A. B. Eur J Med Chem 2014, 73, 295.

[18] Pingaew, R.; Saekee, A.; Mandi, P.; Nantasenamat, C.; Prachayasittikul, S.; Ruchirawat, S.; Prachayasittikul, V. Eur J Med Chem 2014, 85, 65.

[19] Buckle, D. R.; Rockell, C. J. M.; Smith, H.; Spicer, B. A. J Med Chem 1986, 29, 2262.

[20] Cruz, E. H. G.; Hussene, C. M. B.; Dias, G. G.; Diogo, E. B. T.; Melo, I. M. M.; Rodrigues, B. L.; Silva, M. G.; Valenca, W. O.; Camara, C. A.; Oliveira, R. N.; Paiva, Y. G.; Goulart, M. O. F.; Cavalcanti, B. C.; Pessoa, C.; Junior, E. N. S. Bioorg Med Chem 2014, 22, 1608.

[21] Ismail, T.; Shafi, S.; Hyder, I.; Shidiq, T.; Khajuria, A.; Alam, S. M.; Halmuthur, M. S. K. Arch Pharm Chem Life Sci 2015, 348, 796.

[22] Ferreira, M. L. G.; Pinheiro, L. C. S.; Santos-Filho, O. A.; Pecanha, M. D. S.; Sacramento, C. Q.; Machado, V.; Ferreira, V. F.; Souza, T. M. L.; Boechat, N. Med Chem Res 2014, 23, 1501.

[23] Glowacka, I. E.; Balzarini, J.; Wroblewski, A. E. Nucleos Nucleot Nucle 2012, 31, 293.

[24] Ali, Y.; Alam, M. S.; Hamid, H.; Husain, A.; Bano, S.; Dhulap, A.; Kharbanda, C.; Nazreen, S.; Haider, S. Eur J Med Chem 2015, 92, 490.

[25] Rao, P. S.; Kurumurthy, C.; Veeraswamy, B.; Kumar, G. S.; Poornachandra, Y.; Kumar, C. G.; Vasamsetti, S. B.; Kotamraju, S.; Narsaiah, B. Eur J Med Chem 2014, 80, 184.

[26] Alaoui, L. M.; Hammouti, B.; Bellaouchou, A.; Benbachir, A.; Guenbour, A.; Kertit, S. D. Pharma Chemica 2011, 3, 353.

[27] Duan, T.; Fan, K.; Zhong, C.; Chen, X.; Peng, T.; Qin, J. Dyes Pigm 2012, 94, 28.

[28] Ramchander, J.; Rameshwar, N.; Reddy, T. S.; Raju, G.; Reddy, A. R. J Chem Sci 2014, 126, 1063.

[29] Singh, M. S.; Chowdhury, S.; Koley, S. Tetrahedron 2016, 72, 5257.

[30] Huisgen, R.; Padwa, A. Ed. Wiley, New York, 1984, 1, 1.

[31] Kolb, H. C.; Finn, M. G.; Sharpless, K. B. Angew Chem Int Ed 2001, 40, 2004.

[32] Tornøe, C. W.; Christensen, C.; Meldal, M. J Org Chem 2002, 67, 3057.

[33] Kaushik, C. P.; Kumar, K.; Lal, K.; Narasimhan, B.; Kumar, A. Monatsh Chem 2016, 147, 817.

## SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.