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Synthesis, characterization and antimicrobial evaluation of 3,5 diphenyl-1*H*-1,2,4-triazole containing pyrazole function

Shantaram G. Khanage[1]*, Popat B. Mohite[1], Ramdas B. Pandhare[1], S. Appala Raju[2]

ABSTRACT

In the present study 1-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)ethanone (**2**) on condensation with various aromatic aldehydes in NaOH solution yielded the corresponding chalcones (3a-j). Chalcones on further reaction with isoncotinic acid hydrazide affords required [5-(substituted aryl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl) methanone (4a-j). The compounds were identified by spectral data analysis. All synthesized compound (3a-j and 4a-j) were screened for their *in vitro* antimicrobial activity by agar well method against *S. aureus* NCIM 2079, *E. coli* NCIM 2065, *C. albicans* NCIM 3471 and *A. niger* NCIM 1196. From newly synthesized series 2-chloro, 3-nitro, 4-methoxy, 4-hydroxy and 2,4-dimethoxy substituted compounds exhibited significant antimicrobial potential against the tested strains at 50µg/ml and 100µg/ml concentrations.

Keywords: *3,5-diphenyl-1H-1,2,4-triazol, pyrazole, aromatic aldehydes, antimicrobial activity.*

1. INTRODUCTION

The study of chemistry and biological evaluation of heterocyclic compounds has been an interesting field of medicinal chemistry. The synthesis of novel 1,2,4-triazole derivatives and investigation of their chemical and biological behavior has gained more importance in recent decades for biological and pharmaceutical reasons. 1,2,4-triazole represents important class of heterocyclic compounds. 1,2,4-triazole and their derivatives constitute an important class of organic medicinal compounds with diverse biological activities like anticancer [1], antimicrobial [2-5], anticonvulsant [6], antiinflammatory, analgesic [7], antidepressant [8], antitubercular [9], antimalarial [10] and hypoglycemic [11] activities. The pyrazole ring system is a five membered heterocyclic ring structure composed of two nitrogen atoms and used in the synthesis of pharmaceuticals. The pyrazole moiety is a versatile lead molecule in pharmaceutical development and has a wide range of biological activities. In the past few years, the therapeutic interest of pyrazole derivatives in pharmaceutical and medicinal field has been given a great attention to the medicinal chemist. Literature survey reveals that pyrazole derivatives are well known to have antiinflammatory, analgesic, antipyretic [12], antibacterial [13,14], anticancer [15,16], antitubercular [17], antimalarial [18] activities. We have recently reported the *in vitro* antimicrobial potential of 1-(3,5-diphenyl-1H-1,2,4-triazol-1-yl)-3-(substituted aryl) prop-2-en-1-one (chalcones) and MIC values of different derivatives were determined by liquid broth method [19]. The widespread properties of 1,2,4-triazoles and pyrazoles have prompted us to synthesize them in single molecular framework in order

[1] Department of Pharmaceutical chemistry, M.E.S. College of Pharmacy, Sonai, Tq-Newasa, Dist.-Ahmednagar, Maharashtra, India-414105.

*Corresponding author e-mail address: ***shantaram1982@gmail.com***

[2] Department of Pharmaceutical chemistry, H. K. E.'S College of Pharmacy, Sedam road, Gulbarga, Karnataka, India-585105.

to study their pharmacological activity. Hence, the present investigation was undertaken to study the antimicrobial potential of pyrazole derivatives containing 1,2,4-triazole moiety. We achieved the successful synthesis and significant antimicrobial potential of a series of [5-(substituted aryl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl)methanone (4a-j).

2. EXPERIMENTAL SECTION

2.1 Synthesis protocol

2.1.1 Synthesis of 3,5-diphenyl-1*H*-1,2,4-triazole (**1**).Benzohydrazide (0.1 mole) was dissolved in methanol, to this solution benzamide (0.1 mole) was added and stirred to get clear solution, then the resulting reaction mixture was refluxed for two hrs on water bath. Therafter the reaction mixture was cooled at room temperature and poured in ice cold water to get precipitated 3,5-diphenyl-1*H*-1,2,4-triazole. Then obtained product was recrystallized by dioxane:ethanol mixture, with an yield 83 %, m.p. 196-198^{O}C.

2.1.2 Synthesis of 1-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl) ethanone (**2**).[19] To a solution of compound 1 (0.05 mole) dissolved in methanol, acetic anhydride (0.05 mole) and 2-3 drops of concentrated sulfuric acid was added, then the resulting reaction mixture was warmed on a water bath for 20 min. The reaction mixture was cooled at room temperature and poured in to ice cold water to get precipitate of compound 2. The precipitate of compound 2 was purified by dioxane:ethanol mixture with an yield 76 %, m.p. 176-178^{O}C.

2.1.3 General procedure for synthesis of 1-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-3-(substituted aryl) prop-2-en-1-one (Chalcones, 3a-j).Compound 2 (0.05 mole) dissolved in methanol was treated with substituted aromatic aldehydes (0.05 mole) and 20% 10 ml NaOH, afterward stirred the reaction mixture for 7-8 hrs at room temperature. The mixture was poured in ice cold water to get precipitate of compounds 3a-j, subsequently recrystallized by dioxane:ethanol mixture.

2.1.4 General procedure for synthesis of [5-(substituted aryl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl)methanone (4a-j). A mixture of compound 3a-j (0.001 mole), isonicotinic acid hydrazide (0.005 mole) and acetic acid (40 ml) was refluxed for 3 hrs. Then reaction mixture was poured in to ice cold water to get compounds 4a-j and subsequently recrystallized by ethanol.

2.2 Antimicrobial Activity. The *in vitro* antimicrobial activity of compounds 3a-j and 4a-j was performed by agar well method (diffusion technique) against *S. aureus* NCIM 2079, *E. coli* NCIM 2065, *C. albicans* NCIM 3471 and *A. niger* NCIM 1196. The antibiotic Ampicillin and the antifungal agent Fluconazole were used as standard drugs for the study. The fresh bacterial culture was obtained by inoculating bacteria into peptone water liquid media and incubating at 37± 2 ^{0}C for 18-24 hours. This culture was mixed with nutrient agar media and poured in to Petri dishes. After culture media solidification four wells were made at equal distance by using a sterile steel cork borer (8mm diameter). In to these wells different concentrations of standard drug and synthesized compounds were introduced. Dimethyl Formamide (DMF) was used as a control. After introduction of standard drug and synthesized compounds, the plates were placed in a refrigerator at 8-10 ^{0}C for proper diffusion of drugs into the media. After two hours of cold incubation, the Petri plates were transferred to incubator and maintained at 37±2 ^{0}C for 18-24 hours. After the incubation period, the petri plates were observed for growth inhibition zone by using vernier scale. The results were evaluated by comparing the growth inhibition zone shown by the synthesized compounds with standard drugs. The results were presented as the mean value of growth inhibition zone measured in millimeters of three sets (Table 1). The standard drugs and synthesized compounds were dissolved in a minimum quantity of Dimethyl Formamide (DMF) and adjusted, to made up the volume with distilled water to get 50µg/ml and 100µg/ml concentrations.

3. RESULTS SECTION

3.1. Synthesis and spectral characterization. 1,2,4-triazole contains cyclic secondary amino group. 3,5-diphenyl-1*H*-1,2,4-triazole (1) being a secondary amine was acetylated to get the compound 2 by acetic anhydride and conc. H_2SO_4. Compound 2 was readily converted to corresponding 1-(3,5-

diphenyl-1*H*-1,2,4-triazol-1-yl)-3-(substituted aryl)prop-2-en-1-one (chalcones, 3a-j) by treating them with different aromatic aldehydes in sodium hydroxide solution. Then all Chalcones were subsequently cyclized with isonicotinic acid hydrazide in acidic medium to get required [5-(substituted aryl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl)methanone with good purity and yield. All synthesis steps are presented in scheme 1. Melting points were determined by open capillary and were uncorrected. FT-IR spectra were recorded on a Shimadzu FT-IR model 8010 spectrophotometer using KBr pellets in cm^{-1}, ^1H NMR spectra of compound 4a-j were recorded in DMSO in ppm on a Varian mercury FT-NMR model YH- 300 instrument using TMS as internal standard. Mass spectra of compound 4a-j were recorded on GC-MS auto tune EI instrument. Compound 3a-j were confirmed by IR and elemental analysis. Structures of compound 4a-j were confirmed by IR, ^1H-NMR, mass spectra and elemental analysis.

3.2 Physical and spectral data of compounds 3a-j and 4a-j

3a:1-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-3-(4-chlorophenyl)prop-2-en-1-one: Yield 63%, m.p. 96-98^{O}C. Elemental analysis found C 71.56; H 4.22; N 10.80, Calculated for ($C_{23}H_{16}ClN_3O$), C 71.59; H 4.18; N10.89. IR(KBr, cm^{-1}): 3080 (Ar-CH), 1625 (C=N, triazole), 1664 (C=O), 783 (-Cl). ^1H NMR (400 MHZ, DMSO) δ:7.12-8.12(14H, m, Ar-H), 6.71(1H, d, -CO-CH=), 7.02(1H, d, =CH-Ar).

3b:**1-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-3-(2-chlorophenyl)prop-2-en-1-one:** Yield 89%, m.p. 100-102^{O}C. Elemental analysis found C 71.55; H 4.19; N 10.86, Calculated for ($C_{23}H_{16}ClN_3O$), C 71.59; H 4.18; N 10.89. IR(KBr, cm^{-1}): 3092 (Ar-CH), 1610 (C=N, triazole), 1657 (C=O), 773 (-Cl). ^1H NMR (400 MHZ, DMSO) δ:7.19-8.29(14H, m, Ar-H), 6.65(1H, d, -CO-CH=), 7.10(1H, d, =CH-Ar).

3c:**1-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-3-(3-nitrophenyl)prop-2-en-1-one:** Yield 87%, m.p. 95-97^{O}C. Elemental analysis found C 69.74; H 4.11; N 14.12, Calculated for ($C_{23}H_{16}N_4O_3$), C 69.69; H 4.07; N14.13. IR (KBr, cm^{-1}): 3091 (Ar-CH), 1620 (C=N, triazole), 1660 (C=O), 1553(-NO_2). ^1H NMR (400 MHZ, DMSO) δ:7.08-8.19(14H, m, Ar-H), 6.68(1H, d, -CO-CH=), 7.07(1H, d, =CH-Ar).

3d:**1-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-3-(4-methoxyphenyl)prop-2-en-1-one:** Yield 79%, m.p. 94-96^{O}C. Elemental analysis found C 75.50; H 4.99; N 11.09, Calculated for ($C_{24}H_{19}N_3O_2$), C 75.57; H 5.02; N 11.02. IR (KBr, cm^{-1}): 3089(Ar-CH), 1617 (C=N triazole), 1662 (C=O), 1156 (-OCH_3). ^1H NMR (400 MHZ, DMSO) δ:7.11-8.25(14H, m, Ar-H), 6.67(1H, d, -CO-CH=), 7.05(1H, d, =CH-Ar), 3.79 (3H, s, OCH_3).

3e: **1-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-3-(4-dimethylaminophenyl)prop-2-en-1-one:** Yield 74%, m.p. 103-105^{O}C. Elemental analysis found C 76.18; H 5.59; N 14.20. Calculated for ($C_{25}H_{22}N_4O$), C 76.12; H 5.62; N 14.20. IR (KBr, cm^{-1}): 3023 (Ar-CH), 1619 (C=N, triazole), 1666 (C=O), 3152, 3144 (-NCH_3). ^1H NMR (400 MHZ, DMSO) δ:7.07-8.15(14H, m, Ar-H), 6.63(1H, d, -CO-CH=), 7.03(1H, d, =CH-Ar), 3.23 (6H, s, -N(CH_3)2).

3f:**1-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-3-(phenyl)prop-2-en-1-one:** Yield 85%, m.p. 90-92^{O}C. Elemental analysis found C 78.66; H 4.86; N 11.93. Calculated for ($C_{23}H_{17}N_3O$), C 78.61; H 4.88; N 11.96. IR (KBr, cm^{-1}): 3080(Ar-CH), 1623 (C=N, triazole), 1669 (C=O). ^1H NMR (400 MHZ, DMSO) δ:7.13-8.23(15H, m, Ar-H), 6.64(1H, d, -CO-CH=), 7.02(1H, d, =CH-Ar).

3g:1-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-3-(2-furyl)prop-2-en-1-one: Yield 82 %, m.p. 93-95^{O}C. Elemental analysis found C 73.83; H 4.40; N 12.39, Calculated for ($C_{21}H_{15}N_3O_2$), C 73.89; H 4.43; N 12.31. IR(KBr, cm^{-1}): 3075 (Ar-CH), 1618 (C=N, triazole), 1667 (C=O), 1221 (C-O-C). ^1H NMR (400 MHZ, DMSO) δ:7.05-8.19(13H, m, Ar-H), 6.66(1H, d, -CO-CH=), 7.07(1H, d, =CH-Ar).

3h:1-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-3-(4-bromophenyl)prop-2-en-1-one: Yield 72 %, m.p. 84-86^{O}C. Elemental analysis found C 64.27; H 3.66; N 9.72, Calculated for ($C_{23}H_{16}BrN_3O$), C 64.20; H 3.75; N 9.77. IR(KBr, cm^{-1}): 3082 (Ar-CH), 1627 (C=N, triazole), 1659 (C=O), 695 (-Br). ^1H NMR (400 MHZ, DMSO) δ:7.17-8.27(14H, m, Ar-H), 6.63(1H, d, -CO-CH=), 7.05(1H, d, =CH-Ar).

3i:1-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-3-(4-hydroxyphenyl)prop-2-en-1-one: Yield 83 %, m.p. 89-91^{O}C. Elemental analysis found C 75.50; H 4.51; N 11.56, Calculated for ($C_{23}H_{17}N_3O_2$), C 75.19;

H 4.66; N 11.44. IR(KBr, cm^{-1}): 3076(Ar-CH),1624 (C=N, triazole), 1665 (C=O), 3353 (-OH). ^1H NMR (400 MHZ, DMSO) δ:7.16-8.18(14H, m, Ar-H), 6.79(1H, d, -CO-CH=), 7.11(1H, d, =CH-Ar), 10.12 (s, 1H, Ar-OH).

3j:1-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-3-(2,4-dimethoxyphenyl)prop-2-en-1-one: Yield 79 %, m.p. 100-102^{O}C. Elemental analysis found C 72.86; H 5.33; N 10.05, Calculated for ($C_{25}H_{21}N_3O_3$), C 72.98; H 5.14; N 10.21. IR(KBr, cm^{-1}): 3079 (Ar-CH), 1627 (C=N, triazole), 1663 (C=O), 1159 (-OCH_3). ^1H NMR (400 MHZ, DMSO) δ:7.08-8.21(13H, m, Ar-H), 6.62(1H, d, -CO-CH=), 7.08(1H, d, =CH-Ar), 3.82 (6H, s, OCH_3).

4a:[5-(4-chlorophenyl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl)methanone: Yield 86 %, m.p. 143-145^{O}C. Elemental analysis Found C 68.71; H 4.32; N 16.23, Calculated for ($C_{29}H_{21}ClN_6O$), C 68.98; H 4.19; N 16.64. IR(KBr, cm^{-1}): 3075 (Ar-CH), 1625 (C=N, triazole), 1720 (C=O), 784 (-Cl). MS m/z: 504(M^+). ^1H NMR (400 MHZ, DMSO) δ: 6.69-8.40 (18H, m, Ar-H), 2.3 (2H, s,CH_2 of pyrazole), 3.2 (1H,s,CH of pyrazole).

4b:[5-(2-chlorophenyl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl)methanone: Yield 79 %, m.p. 145-147^{O}C. Elemental analysis Found C 68.67; H 4.21; N 16.72, Calculated for ($C_{29}H_{21}ClN_6O$), C 68.98; H 4.19; N 16.64. IR(KBr, cm^{-1}): 3073 (Ar-CH), 1624 (C=N, triazole), 1725 (C=O), 775 (-Cl). MS m/z: 504(M^+). ^1H NMR (400 MHZ, DMSO) δ: 6.65-8.10 (18H, m, Ar-H), 2.4 (2H, s,CH_2 of pyrazole), 3.2 (1H,s,CH of pyrazole).

4c:[5-(3-nitrophenyl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl)methanone: Yield 82 %, m.p. 144-146^{O}C. Elemental analysis Found C 67.16; H 4.02; N 19.24, Calculated for ($C_{29}H_{21}N_7O_3$), C 67.56; H 4.11; N 19.02. IR(KBr, cm^{-1}): 3078 (Ar-CH), 1628 (C=N, triazole), 1722(C=O), 1556 (-NO_2). MS m/z: 515(M^+). ^1H NMR (400 MHZ, DMSO) δ: 6.45-7.76 (18H, m, Ar-H), 2.3 (2H, s,CH_2 of pyrazole), 3.1 (1H,s,CH of pyrazole).

4d:[5-(4-methoxyphenyl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl)methanone: Yield 78 %, m.p. 140-142^{O}C. Elemental analysis Found C 71.55; H 4.70; N 16.53, Calculated for ($C_{30}H_{24}N_6O_2$), C 71.98; H 4.83; N 16.79. IR(KBr, cm^{-1}): 3075 (Ar-CH), 1625 (C=N, triazole), 1729(C=O), 1156 (-OCH_3). MS m/z: 500(M^+). ^1H NMR (400 MHZ, DMSO) δ: 6.75-7.80 (18H, m, Ar-H), 3.82 (3H, s, OCH_3), 2.5 (2H, s,CH_2 of pyrazole), 3.3 (1H,s,CH of pyrazole).

4e:[5-(4-dimethylaminophenyl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl)methanone: Yield 83 %, m.p. 150-152^{O}C. Elemental analysis Found C 72.32; H 5.17; N 19.21, Calculated for ($C_{31}H_{27}N_7O$), C 72.50; H 5.30; N 19.09. IR(KBr, cm^{-1}): 3076 (Ar-CH), 1622 (C=N, triazole), 1725(C=O), 3159, 3146 (-NCH_3). MS m/z: 513(M^+). ^1H NMR (400 MHZ, DMSO) δ: 7.61-8.56 (18H, m, Ar-H), 3.19 (6H, s, -N(CH_3)2), 2.3 (2H, s,CH_2 of pyrazole), 3.2 (1H,s,CH of pyrazole).

4f:[5-(phenyl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl)methanone: Yield 72 %, m.p. 146-148^{O}C. Elemental analysis Found C 74.20; H 4.57; N 17.68, Calculated for ($C_{29}H_{22}N_6O$), C 74.03; H 4.71; N 17.86. IR(KBr, cm^{-1}): 3079 (Ar-CH), 1624 (C=N, triazole), 1729 (C=O). MS m/z: 470(M^+). ^1H NMR (400 MHZ, DMSO) δ: 6.86-8.29 (19H, m, Ar-H), 2.2 (2H, s,CH_2 of pyrazole), 3.2 (1H,s,CH of pyrazole).

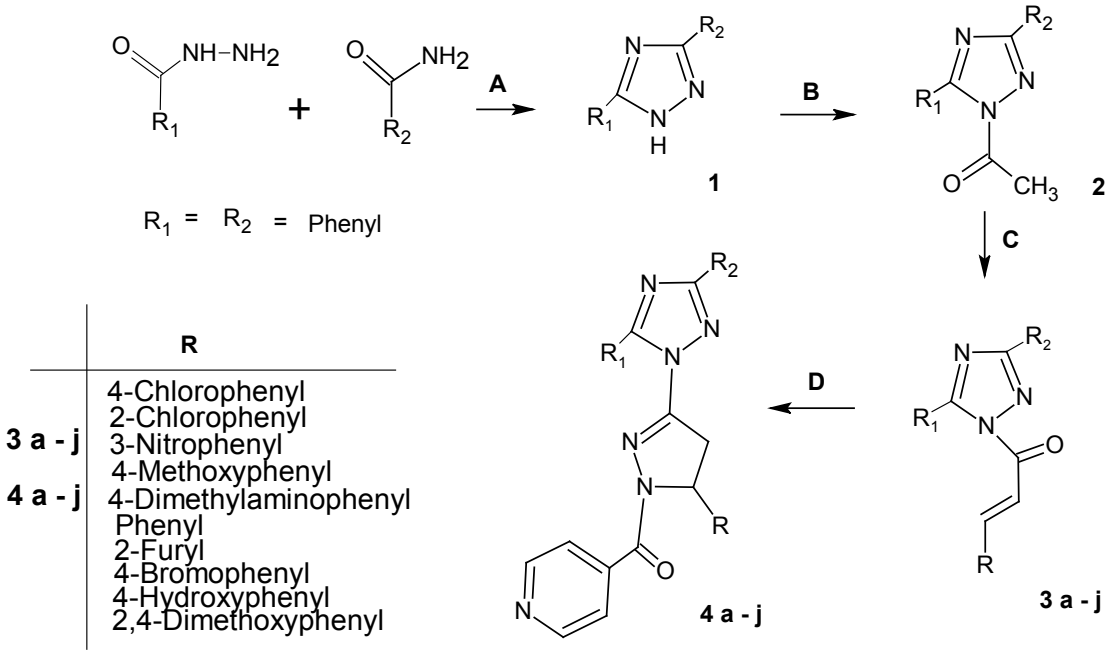
4g:[5-(2-furyl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl)methanone: Yield 74%, m.p. 141-143^{O}C. Elemental analysis Found C 70.53; H 4.29; N 18.15, Calculated for ($C_{27}H_{20}N_6O_2$), C 70.42; H 4.38; N 18.25. IR(KBr, cm^{-1}): 3059 (Ar-CH), 1628 (C=N, triazole), 1725 (C=O), 1224 (C-O-C). MS m/z: 460(M^+). ^1H NMR (400 MHZ, DMSO) δ: 7.06-8.28 (17 H, m, Ar-H), 2.3 (2H, s,CH_2 of pyrazole), 3.3 (1H,s,CH of pyrazole).

4h:[5-(4-bromophenyl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl)methanone: Yield 85 %, m.p. 153-155^{O}C. Elemental analysis Found C 63.37; H 3.75; N 15.19, Calculated for ($C_{29}H_{21}BrN_6O$), C 63.40; H 3.85; N 15.30. IR(KBr, cm^{-1}): 3065 (Ar-CH), 1620 (C=N, triazole), 1720 (C=O), 695 (-Br). MS m/z: 549(M^+). ^1H NMR (400 MHZ, DMSO) δ: 6.85-7.49 (18H, m, Ar-H), 2.3 (2H, s,CH_2 of pyrazole), 3.2 (1H,s,CH of pyrazole).

4i:[5-(4-hydroxyphenyl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl)methanone: Yield 69 %, m.p. 157-159^{O}C. Elemental analysis Found C 71.61; H

4.64; N 17.47, Calculated for ($C_{29}H_{22}N_6O_2$), C 71.59; H 4.56; N 17.27. IR(KBr, cm^{-1}): 3073 (Ar-CH), 1622 (C=N, triazole), 1721 (C=O), 3355 (-OH). MS m/z: 486(M^+). ^{1}H NMR (400 MHZ, DMSO) δ: 6.78-7.59 (18H, m, Ar-H), 10.16 (s, 1H, Ar-OH), 2.2 (2H, s,CH_2 of pyrazole), 3.2 (1H,s,CH of pyrazole).

4j:[5-(2,4-dimethxyphenyl)-3-(3,5-diphenyl-1*H*-1,2,4-triazol-1-yl)-4,5-dihydro-1*H*-pyrazol-1-yl](pyridin-4-yl)methanone: Yield 67 %, m.p. 135-137^{O}C. Elemental analysis Found C 70.22; H 4.92; N 15.84, Calculated for ($C_{31}H_{26}N_6O_3$), C 70.17; H 4.94; N 15.84. IR(KBr, cm^{-1}): 3075 (Ar-CH), 1626 (C=N, triazole), 1723 (C=O), 1154 (-OCH_3). MS m/z: 530(M^+). ^{1}H NMR (400 MHZ, DMSO) δ: 6.81-7.74 (17 H, m, Ar-H), 3.87 (6H, s, OCH_3), 2.2 (2H, s,CH_2 of pyrazole), 3.3 (1H,s,CH of pyrazole).



Scheme 1: Synthesis of compound 3a-j and 4a-j. **Reagents and conditions**: **A** methanol, reflux 2h.; **B** methanol, acetic anhydride, warm 20 min.; **C** R-CHO, 20% NaOH, methanol; **D** Isoncotinic acid hydrazide/GAA, reflux 3h.

Infrared spectrum of the compound 4a-j showed a sharp absorption at 1556, 775-784, 1154-1156, 695, 3355 and 3146-3159 cm^{-1} which is attributed to -NO_2, -Cl, -OCH_3, Br, OH and -N-(CH3)2 groups. Synthesized target compounds 4a-j showed appropriate ^{1}H-NMR signals, 1H (CH) proton of the pyrazole showed characteristic delta values in the range of δ 3.1-3.3. Aromatic protons showed multiplets in the range of δ 6.45–8.56, the expected signals with appropriate multiplicities for different types of protons were observed for the derivatives. Mass spectra of the compounds 4a-j showed molecular ion peaks with high abundance at m/z in agreement with their molecular formula.

3.3 Antibacterial and antifungal activity. The compounds 3a-j and 4a-j were evaluated *in vitro* for their antimicrobial potential. The *in vitro* antimicrobial activity of the tested compounds was determined by agar wells method. The results are summarized in Table 1. The obtained data clearly indicated that the presence of methoxy, chloro, nitro and hydroxy substitution on chalcone and pyrazole produced a remarkable improvement of the antimicrobial activity. Phenyl substitution is weakly active among the synthesized compounds. The compound 4c showed significant antibacterial activity against *S. aureus* and *E. coli*. Compound 4b showed fungicidal potential against *C. albicans* and *A. niger*. The *in vitro* antimicrobial study clearly revealed that pyrazole derivatives (4a-j) were

found to have better antimicrobial activity as compared to chalcones (3a-j) probably due to the pharmacologically active pyrazole and pyridine nucleus attached with 1,2,4-triazole.

Table 1: Antimicrobial activity of the compounds 3a-j and 4a-j.

Compound	Zone of inhibition (in mm)							
	S. aureus		*E. coli*		*C. albicans*		*A. niger*	
	50µg	100 µg	50µg	100 µg	50 µg	100 µg	50 µg	100 µg
3a	17	18	18	17	19	15	16	18
3b	14	16	18	14	17	16	19	20
3c	19	21	20	21	14	15	15	17
3d	17	16	14	15	14	13	12	13
3e	12	13	11	14	14	13	14	11
3f	14	17	17	16	16	14	16	17
3g	10	12	11	09	14	12	13	15
3h	16	17	16	17	20	17	19	18
3i	15	15	16	19	18	18	17	15
3j	12	16	14	18	18	16	13	14
4a	19	21	18	23	20	23	18	21
4b	18	21	19	23	23	25	22	25
4c	23	25	24	25	19	22	18	23
4d	19	22	19	22	23	22	22	21
4e	18	17	17	20	20	21	19	20
4f	17	17	17	16	18	17	16	18
4g	16	19	17	20	15	19	17	21
4h	18	20	21	19	19	22	21	19
4i	21	19	22	20	21	18	22	22
4j	22	21	20	20	19	18	16	19
Ampicillin	21	25	24	26	-	-	-	-
Fluconazole	-	-	-	-	24	26	23	25
DMF	-	-	-	-	-	-	-	-

4. CONCLUSIONS

In conclusion, new triazole chalcone and pyrazoles were synthesized and evaluated for their antimicrobial properties. The newly synthesized heterocycles exhibited promising antimicrobial activity against the tested microorganisms. The compounds 3c, 4b, 4c, 4d, 4i and 4j were found to be the most active antimicrobial agents from synthesized series. These results suggest that novel triazole chalcones and pyrazole derivatives are interesting lead molecules for further synthetic and biological evaluation.

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