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Synthesis and Antimicrobial Activity of Novel 1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-arylurea Derivatives

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2-Aminonicotinaldehyde **(1)** and 1-(3-nitrophenyl)ethanone **(2)** react each other in presence of piperidine to form 2-(3-nitrophenyl)-1,8-naphthyridine **(3)**. Compound **3** on reduction with hydrazine hydrate offered 3-(1,8-naphthyridin-2-yl)aniline **(4)**, which on condensation with different arylcarbamates results in formation of 1-[3-(1,8-naphthyridin-2-yl)phenyl]-3-arylurea derivatives **(6a-q)**. The structures of all the compounds are confirmed by IR, NMR and mass spectral data. Further the newly synthesized compounds were evaluated for antimicrobial activity. The results obtained revealed that the tested compounds possess inhibitory effect on the growth of bacterial cells.

Keywords: Naphthyridine derivatives, Piperidine, Urea, Antimicrobial activity.

INTRODUCTION

Naphthyridine derivatives have received significant attention due to their exceptionally broad spectrum of biological activity. Many researchers focus on synthesis of these molecules as they possess wide range of biological activity. For example, finding of the grown-up quinolinones, namely nalidixic acid, which has been used for the treating of a wide variety of diseases, led to the production of many 1,8-naphthyridin-5-one derivatives with the strong antibacterial enoxacin [1,2]. Many of the naphthyridines have shown bacterial, fungicidal and carcinogenic activities [3-6]. In recent past, study on derivatives of 1,8-naphthyridine has been concentrated as these compounds show a broad spectrum of biological activities [7-15]. A very few reports available on synthesis of urea derivative on naphthyridine. We have synthesized these compounds by using carbamates. In continuation of our earlier reports [16-24] on synthesis of naphthyridine derivatives, we herein report a novel approach to synthesize 1-[3-(1,8-naphthyridin-2-yl)phenyl]-3-arylurea derivatives.

EXPERIMENTAL

All the chemical used were obtained either from Fluka or Merck and were of analytical grade. Thin-layer chromatography (TLC) was performed on Merck AL silica gel 60 F254 plates and envisioned in UV light. IR spectra were recorded as KBr pellet with a Perkin-Elmer spectrum GX FTIR instrument and only diagnostic and/or intense peaks are reported. ^{1}H NMR spectra were recorded in DMSO-d_6 with a Varian Mercury plus 400 MHz instrument. Signals due to residual protonated solvent (^{1}H NMR) served as the internal standard. All the chemical shifts were presented in δ (ppm) using TMS as an internal standard. The ^{1}H NMR chemical shifts and coupling constants were determined assuming first-order behaviour. Mass spectra were recorded with a PE Sciex model API 3000 instrument. All the reactions were carried out under argon atmosphere.

Biological assay: The synthesized compounds were dissolved in dimethyl sulphoxide at 30 µg/µL concentration (standard antibacterial drug, ampicilline was used as the reference antibiotic) and tested against Gram-negative strains of *Escherichia coli*, *Klebsiella pneumonia* and Gram-positive strains of *Staphylococcus aureus* and *Bacillus subtilis* using agar well diffusion method. Activities were determined by zones showing complete inhibition (mm). Growth inhibition was calculated with reference to positive control. All the samples were taken in triplicates.

Synthesis of 2-(3-Nitrophenyl)-1,8-naphthyridine (3): To a stirred solution of 2-aminonicotinaldehyde (1 g, 8.18 mmol) in ethyl alcohol (20 mL) was added 1-(3-nitrophenyl)-ethanone (1.48 g, 9.00 mmol) and piperidine (2.09 g, 24.56 mmol) at room temperature and refluxed for 16 h. After completion of the reaction (monitored by TLC), the mixture was concentrated under reduced pressure and the crude product

washed with 10 % dichloromethane in diethyl ether to afford 2-(3-nitrophenyl)-1,8-naphthyridine **(3)**.

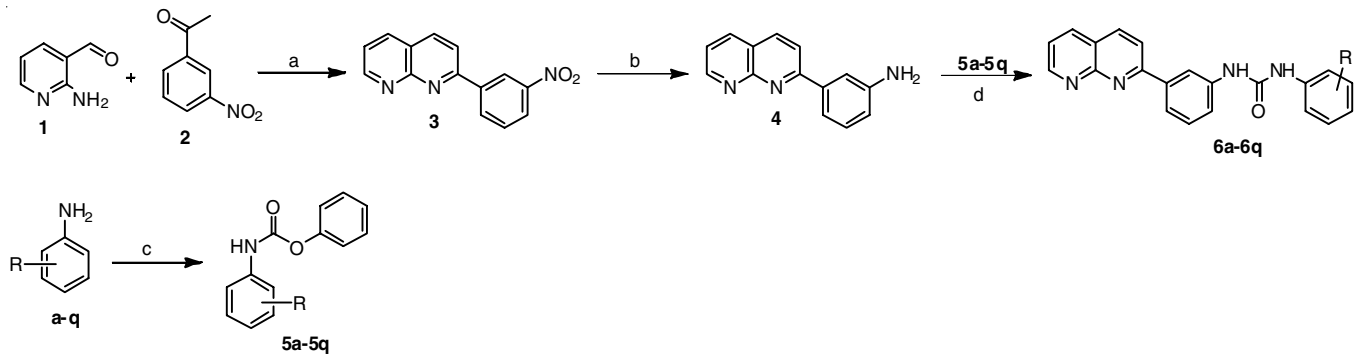
Off-white solid; Yield: 65 %; m.p: 220-223 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.16-9.14 (m, 2H), 8.77 (d, *J* = 7.5 Hz, 1H), 8.66 (d, *J* = 8.5 Hz, 1H), 8.54 (dd, *J* = 2.0, 8.0 Hz, 1H), 8.44 (d, *J* = 8.5 Hz, 1H), 8.39 (dd, *J* = 2.0, 8.0 Hz, 1H), 7.89 (t, *J* = 8.0 Hz, 1H), 7.68 (dd, *J* = 4.0, 8.5 Hz, 1H); ESI-MS: *m/z*, 252.0 (M+1).

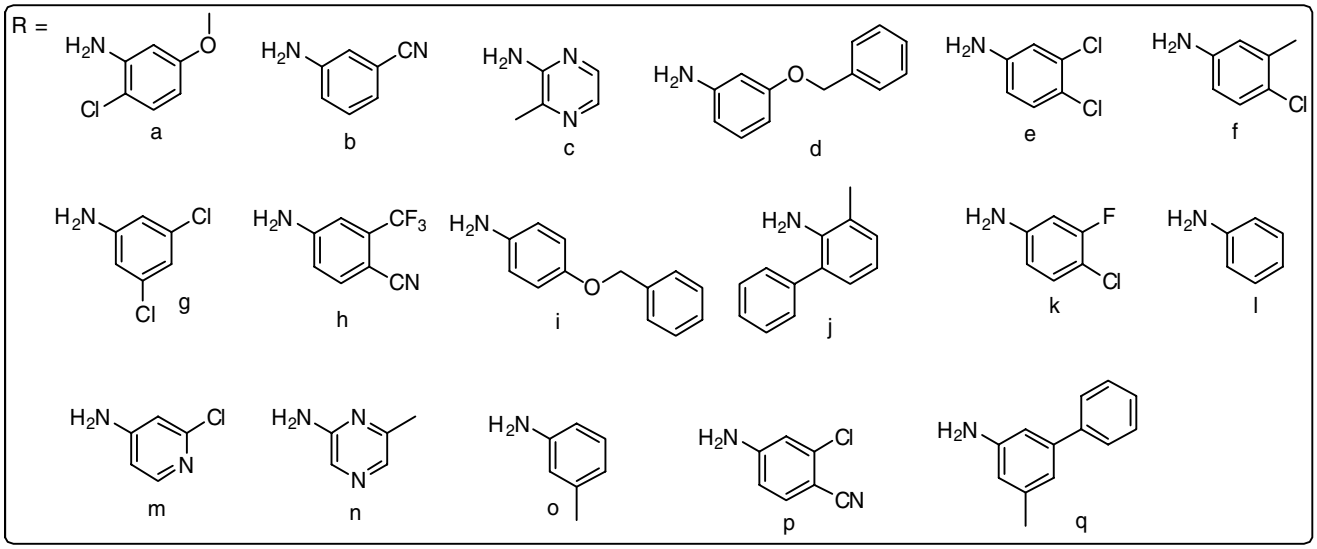
Synthesis of 3-(1,8-naphthyridin-2-yl)aniline (4): To a stirred suspension of raney nickel (0.92 g, 10.75 mmol) in ethyl alcohol (20 mL) was added 2-(3-nitrophenyl)-1,8-naphthyridine (1 g, 3.58 mmol) and hydrazine hydrate (80 %) (0.54 g, 10.75 mmol) at room temperature and stirred at room temperature for 3 h. After completion of the reaction (monitored by TLC), the mixture was filtered through celite pad and the filtrate was concentrated under reduced pressure. The crude product was washed with 10 % dichloromethane in diethyl ether to afford 3-(1,8-naphthyridin-2-yl)aniline **(4)**.

IR (KBr, ν_{max}, cm^{-1}): 3413.58, 3318.2, 3215.0, 3028.2, 1600.60, 1323.72, 846.62. Off-white solid; Yield: 73 %; m.p: 172-176 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.07 (dd, *J* = 2.0, 4.0 Hz, 1H), 8.49 (d, *J* = 9.0 Hz, 1H), 8.44 (dd, *J* = 1.5, 8.0 Hz, 1H), 8.11 (d, *J* = 8.5 Hz, 1H), 7.60-7.57 (m, 2H), 7.40 (d, *J* = 7.5 Hz, 1H), 7.21 (t, *J* = 8.0 Hz, 1H), 6.74 (dd, *J* = 1.5, 7.5 Hz, 1H), 5.32 (s, 2H); ^{13}C NMR (75.47 MHz, DMSO-d_6): δ 159.7, 155.4, 153.7, 149.1, 138.8, 138.2, 137.1, 129.3, 121.8, 121.4, 119.5, 115.8, 115.2, 112.7; ESI-MS: *m/z*, 222.19 (M+1).

Synthesis of phenyl phenylcarbamate derivatives (5a-q): To a stirred solution of anilines (3.29 mmol) in dichloromethane (6 mL) was added triethylamine (9.89 mmol) at room temperature and stirred at room temperature for 10 min and added aryl chloro formate (4.93 mmol) at 0 °C and stirred at room temperature for 2 h. The reaction mixture was concentrated under reduced pressure and the crude material washed with 10 % diethyl ether in pentane to afford the pure compounds. Without further purification used for next step. Yields of the products varied between 65 to 85 %.

Preparation of novel 1-[3-(1,8-naphthyridin-2-yl)phenyl]-3-phenylurea derivatives (6a-6q): To a stirred solution of 3-(1,8-naphthyridin-2-yl)aniline (100 mg, 0.40 mmol) in dimethyl formamide (2 mL) was added corresponding arylcarbamates (1.2 mmol) and tri ethyl amine (2.0 mmol) at room temperature and stirred at 100 °C for 3 h. The reaction mixture was poured into water (4 mL) and extracted with ethyl acetate (3 × 5 mL). The combined organic layers were washed with water (5 mL) followed by brine solution (5 mL), dried over anhydrous sodium sulfate, filtered and concentrated under reduced pressure, to obtain crude material was washed with methanol to afford the pure compounds. Yields of the products varied between 50 to 80 % (**Scheme-I**).





Scheme-I: Synthesis of novel 1-[3-(1,8-naphthyridin-2-yl)phenyl]-3-arylurea derivatives (**6a-6q**). Reagents and conditions: (a) piperidine, ethanol, 70 °C, 16 h; (b) Raney Ni, $NH_2NH_2{\cdot}H_2O$, ethanol, room temperature, 3 h; (c) triethyl amine, DCM, 0 °C-RT, 2 h; (d) triethyl amine, DMF, 100 °C, 2 h

Spectral data

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-(2-chloro-5-methoxyphenyl)urea (6a): IR (KBr, ν_{max}, cm^{-1}): 3296.22, 3054.46, 1709.44, 1533.36, 1209.47. Yellow solid; Yield: 75 %; m.p: 262-265 °C; ^{1}H NMR (300 MHz, DMSO-d_6): δ 9.80 (s, 1H), 9.11 (s, 1H), 8.57 (d, *J* = 8.4 Hz, 1H), 8.50-8.48 (m, 2H), 8.31 (s, 1H), 8.23 (d, *J* = 8.4 Hz, 1H), 7.94-7.91 (m, 2H), 7.68-7.66 (m, 2H), 7.51 (t, *J* = 7.8 Hz, 1H), 7.36 (d, *J* = 8.7 Hz, 1H), 6.63 (dd, *J* = 2.1, 8.7 Hz, 1H), 3.76 (s, 3H); ESI-MS: *m/z*, 405.3 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-(3-cyanophenyl)urea (6b): IR (KBr, ν_{max}, cm^{-1}): 3333.9, 3020.25, 1562.1, 1200.4, 789.960. Yellow solid; Yield: 80 %; m.p: 146-149 °C; ^{1}H NMR (300 MHz, DMSO-d_6): δ 9.14 (s, 1H), 9.11 (brs, 1H), 9.08 (s, 1H), 8.57 (d, *J* = 8.4 Hz, 1H), 8.51-8.49 (m, 1H), 8.48 (d, *J* = 1.5 Hz, 1H), 8.22 (d, *J* = 8.4 Hz, 1H), 8.03 (t, *J* = 1.8 Hz, 1H), 7.92 (d, *J* = 7.8 Hz, 1H), 7.72 (d, *J* = 8.4 Hz, 1H), 7.65-7.61 (m, 2H), 7.51 (t, *J* = 7.2 Hz, 1H), 7.45-7.42 (m, 2H); ^{13}C NMR (75.47 MHz, DMSO-d_6): δ 159.0, 155.4, 154.0, 152.6, 140.6, 140.2, 140.0, 138.9, 137.4, 130.2, 129.5, 125.5, 123.2, 123.1, 122.7, 122.2, 121.2, 121.0, 120.4, 119.6, 118.9, 117.6; ESI-MS: *m/z*, 366.1 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-(3-methylpyrazin-2-yl)urea (6c): IR (KBr, ν_{max}, cm^{-1}): 3256.9, 3028.6, 1697.2, 1483.2, 1254.5, 752.1. White solid; Yield: 65 %; m.p: 282-286 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.86 (s, 1H), 9.59 (s, 1H), 9.12 (dd, *J* = 2.0, 2.0 Hz, 1H), 8.77 (s, 1H), 8.58 (d, *J* = 8.5 Hz, 1H), 8.52-8.49 (m, 3H), 8.19 (d, *J* = 8.5 Hz, 1H), 7.94-7.90 (m, 1H), 7.59-7.52 (m, 1H), 7.63 (d, *J* = 4.0 Hz, 1H), 7.54 (t, *J* = 8.0 Hz, 1H), 2.46 (s, 3H); ESI-MS: *m/z*, 357 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-[3-(benzyloxy)-phenyl]urea (6d): IR (KBr, ν_{max}, cm^{-1}): 3300.7, 3062.68, 1563.2, 1238.1, 793.8. Off-white solid; Yield: 70 %; m.p: 200-202 °C; ^{1}H NMR (300 MHz, DMSO-d_6): δ 9.11 (s, 1H), 8.88 (s, 1H), 8.58 (s, 1H), 8.55 (d, *J* = 4.5 Hz, 1H), 8.51 (s, 1H), 8.47 (d, *J* = 3.6 Hz, 1H), 8.21 (d, *J* = 8.4 Hz, 1H), 7.87 (d, *J* = 7.5 Hz, 1H), 7.65-7.60 (m, 2H), 7.50-7.32 (m, 9H), 6.96 (d, *J* = 9.0 Hz, 1H), 5.07 (s, 2H); ESI-MS: *m/z*, 447 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-(3,4-dichlorophenyl)urea (6e): Off-white solid; Yield: 65 %; m.p: 150-152 °C; ^{1}H NMR (300 MHz, DMSO-d_6): δ 9.10-9.05 (m, 3H), 8.57 (d, *J* = 8.4 Hz, 1H), 8.58-8.48 (m, 2H), 8.22 (d, *J* = 8.1 Hz, 1H), 7.93-7.91 (m, 2H), 7.65-7.60 (m, 2H), 7.54-7.47 (m, 2H), 7.38 (dd, *J* = 8.7, 1.8 Hz, 1H); ^{13}C NMR (75.47 MHz, DMSO-d_6): δ 159.0, 155.4, 154.0, 152.5, 140.0, 139.9, 138.9, 137.4, 131.1, 130.6, 129.5, 123.3, 122.2, 121.7, 121.6, 120.4, 119.7, 119.6, 119.5, 118.5, 117.6; ESI-MS: *m/z*, 409 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-(4-chloro-3-methylphenyl)urea (6f): Light brown solid; Yield: 60 %; m.p: 245-249 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.11 (dd, *J* = 4.0, 2.0 Hz, 1H), 8.97 (s, 1H), 8.77 (s, 1H), 8.74 (s, 1H), 8.56 (d, *J* = 8.5 Hz, 1H), 8.51-8.48 (m, 1H), 8.21 (d, *J* = 8.5 Hz, 1H), 7.89 (d, *J* = 7.5 Hz, 1H), 7.64-7.59 (m, 1H), 7.52-7.47 (m, 1H), 7.44 (s, 1H), 7.34 (dd, *J* = 8.5, 2.0 Hz, 1H), 7.31-7.28 (m, 2H), 2.31 (s, 3H); ESI-MS: *m/z*, 389 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-(3,5-dichlorophenyl)urea (6g): Light brown solid; Yield: 50 %; m.p: 187-189 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.32 (s, 1H), 9.21 (s, 1H), 9.16 (s, 1H), 9.10 (d, *J* = 2.5 Hz, 1H), 8.56 (d, *J* = 8.5 Hz, 1H), 8.48 (d, *J* = 7.5 Hz, 1H), 8.21 (dd, *J* = 8.5, 1.0 Hz, 1H), 7.95-7.87 (m, 1H), 7.66-7.60 (m, 2H), 7.58 (d, *J* = 1.5 Hz, 1H), 7.49 (dt, *J* = 3.0, 3.5, 3.5 Hz, 1H), 7.19-7.11 (m, 1H), 6.97-6.92 (m, 1H); ESI-MS: *m/z*, 407 (M-1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-[4-cyano-3-(trifluoromethyl)phenyl]urea (6h): Light brown solid; Yield: 60 %; m.p: 180-183 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.64 (s, 1H), 9.31 (s, 1H), 9.11 (dd, *J* = 3.5, 1.5 Hz, 1H), 8.58 (d, *J* = 9.0 Hz, 1H), 8.52 (t, *J* = 1.5 Hz, 1H), 8.50 (dd, *J* = 8.0, 1.5 Hz, 1H), 8.26 (d, *J* = 1.5 Hz, 1H), 8.23 (d, *J* = 8.5 Hz, 1H), 8.05 (d, *J* = 8.5 Hz, 1H), 7.96 (d, *J* = 7.5 Hz, 1H), 7.83 (dd, *J* = 8.0, 1.0 Hz, 1H), 7.65-7.62 (m, 2H), 7.53 (t, *J* = 8.0 Hz, 1H); ESI-MS: *m/z*, 434 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-[4-(benzyloxy)-phenyl]urea (6i): Light brown solid; Yield: 72 %; m.p: 172-177 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.11 (dd, *J* = 4.0, 1.5 Hz, 1H), 8.87 (brs, 1H), 8.57-8.46 (m, 1H), 8.38 (brs, 1H), 8.21 (d, *J* = 8.5 Hz, 1H), 7.87 (d, *J* = 7.5 Hz, 1H), 7.63 (dd, *J* = 8.5, 4.5 Hz, 1H), 7.60 (brs, 1H), 7.49-7.30 (m, 9H), 6.97-6.92 (m, 3H), 5.05 (s, 2H); ESI-MS: *m/z*, 447 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-(3-methyl-[1,1'-biphenyl]-2-yl)urea (6j): Off-white solid; Yield: 66 %; m.p: 225-227 °C; ^{1}H NMR (400 MHz, DMSO-d_6): δ 9.09 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.87 (bs, 1H), 8.55 (d, *J* = 8.4 Hz, 1H), 8.47 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.35 (bs, 1H), 8.29 (s, 1H), 8.16 (d, *J* = 8.4 Hz, 1H), 7.83 (d, *J* = 8.0 Hz, 1H), 7.63-7.60 (m, 2H), 7.55 (d, *J* = 8.0 Hz, 1H), 7.45-7.38 (m, 4H), 7.34-7.25 (m, 3H), 7.17 (dd, *J* = 7.2, 1.6 Hz, 1H), 2.31 (s, 3H); ESI-MS: *m/z*, 431 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-(4-chloro-3-fluorophenyl)urea (6k): White solid; Yield: 72 %; m.p: 230-235 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.11 (dd, *J* = 2.0, 2.0 Hz, 1H), 9.06 (s, 1H), 8.95 (s, 1H), 8.57 (d, *J* = 8.5 Hz, 1H), 8.51 (d, *J* = 2.0 Hz, 1H), 8.49 (t, *J* = 2.0 Hz, 1H), 8.22 (d, *J* = 9.0 Hz, 1H), 7.92-7.91 (m, 1H), 7.87-7.85 (m, 1H), 7.64 (d, *J* = 4.5 Hz, 1H), 7.63-7.61 (m, 1H), 7.50 (t, *J* = 8.0 Hz, 1H), 7.36-7.34 (m, 2H); ^{13}C NMR (75.47 MHz, DMSO-d_6): δ 159.0, 155.4, 154.1, 152.7, 140.1, 138.9, 137.4, 137.0, 136.9, 129.5, 122.3, 121.8, 121.5, 120.4, 119.8, 119.7, 118.8, 118.7, 117.6, 117.0, 116.8; ESI-MS: *m/z*, 393 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-phenylurea (6l): Light brown solid; Yield: 66 %; m.p: 218-220 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.11 (dd, *J* = 2.0, 2.0 Hz, 1H), 8.94 (s, 1H), 8.71 (s, 1H), 8.57 (d, *J* = 8.5 Hz, 1H), 8.50 (d, *J* = 2.0 Hz, 1H), 8.49-8.48 (m, 1H), 8.21 (d, *J* = 8.0 Hz, 1H), 7.89 (d, *J* = 8.0 Hz, 1H), 7.64-7.61 (m, 2H), 7.51-7.44 (m, 3H), 7.31-7.26 (m, 2H), 7.00-6.95 (m, 1H); ESI-MS: *m/z*, 341 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-(2-chloropyridin-4-yl)urea (6m): Light brown solid; Yield: 76 %; m.p: 180-185 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.43 (s, 1H), 9.28 (s, 1H), 9.11 (dd, *J* = 1.5, 1.5 Hz, 1H), 8.57 (d, *J* = 9.0 Hz, 1H), 8.50 (t, *J* = 2.0 Hz, 1H), 8.48 (d, *J* = 2.0 Hz, 1H), 8.22 (d, *J* = 8.5 Hz, 1H), 8.19 (d, *J* = 5.5 Hz, 1H), 7.95 (d, *J* = 7.5 Hz, 1H), 7.70 (d, *J* = 1.5 Hz, 1H), 7.64 (d, *J* = 4.5 Hz, 1H), 7.63-7.61 (m, 1H), 7.52 (t, *J* = 8.0 Hz, 1H), 7.37 (dd, *J* = 2.0, 1.5 Hz, 1H); ESI-MS: *m/z*, 376 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-(6-methylpyrazin-2-yl)urea (6n): Light brown solid; Yield: 66 %; m.p:

256-258 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.86 (s, 1H), 9.59 (s, 1H), 9.12 (dd, *J* = 2.0, 2.0 Hz, 1H), 8.87 (s, 1H), 8.58 (d, *J* = 8.5 Hz, 1H), 8.52-8.49 (m, 2H), 8.24 (d, *J* = 8.5 Hz, 1H), 8.17 (s, 1H), 7.97-7.95 (m, 1H), 7.66-7.64 (m, 1H), 7.63 (d, *J* = 4.0 Hz, 1H), 7.54 (t, *J* = 8.0 Hz, 1H), 2.46 (s, 3H); ESI-MS: *m/z*, 357.09 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-(*m*-tolyl)urea (6o): Light brown solid; Yield: 70 %; m.p: 207-211 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.11 (dd, *J* = 4.0, 2.0 Hz, 1H), 8.94 (brs, 1H), 8.64 (brs, 1H), 8.57 (d, *J* = 8.5 Hz, 1H), 8.50 (t, *J* = 2.0 Hz, 1H), 8.48 (d, *J* = 1.5 Hz, 1H), 8.21 (d, *J* = 8.5 Hz, 1H), 7.89 (d, *J* = 8.0 Hz, 1H), 7.64-7.59 (m, 1H), 7.48 (t, *J* = 7.5 Hz, 1H), 7.36 (brs, 1H), 7.29-7.25 (m, 1H), 7.22-7.13 (m, 2H), 6.81-6.77 (m, 1H), 2.27 (s, 3H); ESI-MS: *m/z*, 355 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-(3-chloro-4-cyanophenyl)urea (6p): Light brown solid; Yield: 55 %; m.p: 230-235 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.47 (s, 1H), 9.28 (s, 1H), 9.12 (dd, *J* = 1.5, 1.5 Hz, 1H), 8.59 (d, *J* = 8.5 Hz, 1H), 8.52 (q, *J* = 3.0, 1.5 Hz, 1H), 8.51 (d, *J* = 2.0 Hz, 1H), 8.24 (d, *J* = 8.5 Hz, 1H), 8.01 (d, *J* = 2.0 Hz, 1H), 7.95-7.93 (m, 1H), 7.86 (d, *J* = 9.0 Hz, 1H), 7.66-7.64 (m, 1H), 7.62 (d, *J* = 1.5 Hz, 1H), 7.55-7.52 (m, 1H), 7.50 (d, *J* = 2.0 Hz, 1H); ESI-MS: *m/z*, 400 (M+1).

1-[3-(1,8-Naphthyridin-2-yl)phenyl]-3-(5-methyl-[1,1'-biphenyl]-3-yl)urea (6q): Light brown solid; Yield: 62 %; m.p: 230-235 °C; ^{1}H NMR (500 MHz, DMSO-d_6): δ 9.11 (s, 1H), 8.99 (s, 1H), 8.75 (s, 1H), 8.57 (d, *J* = 8.0 Hz, 1H), 8.53 (s, 1H), 8.50 (d, *J* = 7.5 Hz, 1H), 8.22 (d, *J* = 8.5 Hz, 1H), 7.90 (d, *J* = 7.5 Hz, 1H), 7.64-7.60 (m, 5H), 7.51-7.46 (m, 3H), 7.37 (t, *J* = 7.5 Hz, 1H), 7.31 (s, 1H), 7.10 (s, 1H), 2.37 (s, 3H); ESI-MS: *m/z*, 431 (M+1).

RESULTS AND DISCUSSION

Antibacterial activity: All the synthesized compounds (**6a-q**) were evaluated for their antibacterial activity against two Gram-negative and two Gram-positive bacterial strains *viz.*, *Escherichia coli, Klebsiella pneumonia, Staphylococcus aureus* and *Bacillus subtilis*. The results are summarized in Table-1 and ampicilline was used as positive control. It is observed that compounds **6g**, **6h** and **6p** revealed excellent antibacterial activity with zone of inhibition 30-33 mm against *Escherichia coli, Klebsiella pneumonia, Staphylococcus aureus* and *Bacillus subtilis*, while compounds **6g**, **6h** and **6p** displayed excellent antibacterial activity with zone of inhibition 9-12 mm.

TABLE-1
ANTIMICROBIAL ACTIVITY (ZONE OF INHIBITION) OF NOVEL 1-[3-(1,8-NAPHTHYRIDIN-2-YL)PHENYL]-3-ARYLUREA DERIVATIVES (conc. 20 µg/10 µL)

Compd. No.	*Escherichia coli*	*Staphylococcus aureus*	*Klebsiella pneumonia*	*Bacillus subtilis*
6a	2	1	1	1
6b	2	1	1	1
6c	1	1	2	1
6d	3	6	3	4
6e	8	7	2	6
6f	2	5	0	3
6g	11	9	4	0
6h	12	4	3	3
6i	2	5	3	3
6j	2	3	3	0
6k	8	6	5	4
6l	5	4	5	2
6m	9	8	8	9
6n	3	2	0	0
6o	2	5	2	0
6p	10	9	7	7
6q	3	2	2	0
Ampllicin	13	15	14	13

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