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Notes

Synthesis of New Pyrazoline Derivatives and Its Antimicrobial and Antioxidant Activities

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INTRODUCTION

Resistance gained by microorganism to conventional antimicrobial agents has lead to the development of new antimicrobial agents against pathogenic microbes. Chalcones and their derivatives proved to be an important molecular scaffold for the search of new pharmaceutically active molecules. Among the various derivatives of chalcones, synthesis of pyrazolines has gained major attention due to their promising biological activities such as anticancer, antimicrobial, antidepressant, immunosuppressive, anti-inflammatory, etc.[1–8] Many studies revealed that incorporation of pyrazole moiety into various heterocyclic ring systems gives worthwhile molecules from the biological point of view.[9–11] Several marketed drugs such ascelecoxib[12] and rimonabant[13] contains pyrazole as their core molecular unit.[14,15]

On the other hand, quinolines represent a prominent class of heterocyclic compounds exhibiting wide spectrum of pharmaceutical application.[16–20] Prompted by the potential biological activities of pyrazolines and quinolines, we designed new hybrid molecule having the synergistic effect of these heterocyclic moieties in single nucleus that would help in the development of new therapeutic lead molecules.

Furthermore, the newly synthesized compounds were tested for their *in vitro* antimicrobial activities against gram-positive, gram-negative bacteria and antioxidant activity.

EXPERIMENTAL

General

Chemicals were procured from commercial vendors and used as such without any purification. Reaction progress was monitored using thin layer chromatographic technique (TLC) on pre-coated aluminum sheets alichrosep silica gel-60/UV_{254} with I_2 and UV light as detecting agents. Melting point was measured using Thiele's tube in an open capillary tube and was uncorrected. IR spectra were recorded on Shimadzu FTIR spectrometer-8400s with KBr as background using press pellet technique. NMR analysis was done with Bruker NMR-400 MHz using TMS as an internal standard.

General procedure for the synthesis of chalcone derivatives 3(a-j)

2-Acetyl thiophene (20 mmol) was dissolved in minimum quantity of sodium hydroxide solutions (10%). To this added aromatic aldehyde (20 mmol) previously dissolved in ethanol (2 mL) and reaction mixture stirred to obtain a homogeneous mixture. Stirring was continued at room temperature for 8-10 h. On completion of reaction (checked by thin layer chromatography), reaction mixture was then poured into the beaker containing crushed ice and neutralized using dil. HCl. Precipitate formed was then filtered and washed with distilled water.

Procedure for the synthesis of quinoline hydrazide derivative (4)[21]

2-(4-Chloro-quinolin-8-yloxy) acetohydrazide (**4**) was prepared by reacting ethyl [(5-chloroquinolin-8-yl)oxy]acetate (1 mmol) and hydrazine hydrate, 99% (1.5 mmol) in ethanol (2 mL). Solid thus formed was filtered, dried and used directly for the next step.

2-[(5-Chloroquinolin-8-yl)oxy]acetohydrazide (4): Yield, 95%, m.p. 118–120 ºC; IR spectrum (γ-max cm^{-1}): 3041 (Ar-H), 2936 (CH_2), 1678 (C=O), 1589 (C=N), 1441 (C=C), 545 (Ar-C-Cl). ^{1}H NMR (400 MHz, DMSO-d_6) δ 10.4 (s, 1H, N-H), 8.87 (d, 1H, J = 3.4 Hz, quinoline ring-H), 8.14 (d, 1H, J = 8.4 Hz, quinoline ring-H), 7.84–7.68 (dd, 1H, quinoline ring-H), 7.42–7.44 (d, 1H, J = 8 Hz, quinoline ring-H), 7.25–7.27 (d, 1H, J = 8 Hz, quinoline ring-H),

5.68 (s, 2H, NH_2), 5.36 (s, 2H, OCH_2).^{13}C NMR (100 MHz, DMSO-d_6) δ 62.6, 112.0, 121.1, 122.3, 123.5, 123.7, 128.7, 129.8, 132.6, 132.9, 164.3. Elemental analysis, Anal. calcd. for $C_{11}H_{10}ClN_3O_2$:C, 52.47; H, 3.96; N, 16.74. Found: C, 52.50; H, 4.01; N, 16.70%.

General procedure for the synthesis of pyrazoline derivatives 5(a-j)

A mixture of the chalcones **3(a-j)** (1 mmol), 5-chloro-2-(quinolin-8-yloxy) acetohydrazide 2 (1 mmol) and NaOH (5 mmol) was refluxed in PEG-400 (5 mL) for 8-10 h. The contents were cooled, and poured onto crushed ice and stirred for 1 h. The resulting precipitate was filtered and recrystalised using ethanol: DMF (10:1) to yield **5(a-j)** in pure form.

2-[(5-Chloroquinolin-8-yl)oxy]-1-[5-phenyl-3-(thiophen-2-yl)-4,5-dihydro-1*H*-pyrazol-1-yl]ethan-1-one (5a): Yield, 79.1%, m.p. 108–110 °C; IR spectrum (γ-max cm^{-1}): 3035 (Ar-H), 2928 (CH_2), 1683 (C=O), 1592 (C=N), 1446 (C=C), 546 (Ar-C-Cl). ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.92 (d, 1H, J = 4.2 Hz quinoline ring-H), 8.10 (d, 1H, J = 8.2 Hz, quinoline ring-H), 7.84-7.86 (d, 1H, J = 8.2 Hz, thiophene-H), 7.64–6.80 (m, 10H, Ar-H), 5.63(dd, 1H, J = 5.2,11.5 Hz, pyrazoline-CH), 5.40 (s, 2H, OCH_2), 3.75 (dd, 1H, J =11.6, 17.8 Hz, pyrazoline-CH_2), 3.21 (dd, 1H, J = 3.8, 17.4 Hz, pyrazoline-CH_2).^{13}C NMR (100 MHz, DMSO-d_6) δ 13.4, 14.1, 66.4, 68.6, 115.5, 121.1, 122.3, 123.5, 126.7, 127.3, 128.2, 128.4, 129.3, 132.6, 132.9, 140.6, 140.7, 149.1, 150.2, 150.7, 153.7, 154.0, 164.3, 169.5. Elemental analysis, Anal. calcd. for $C_{24}H_{18}ClN_3O_2S$:C, 64.35; H, 4.05; N, 9.38. Found: C, 64.39; H, 4.07; N, 9.43%.

1-[5-(4-Chlorophenyl)-3-(thiophen-2-yl)-4,5-dihydro-1*H*-pyrazol-1-yl]-2-[(5-chloroquinolin-8-yl)oxy]ethan-1-one (5b): Yield, 83.2%, m.p. 96–98 °C; IR spectrum (γ-max cm^{-1}): 3056 (Ar-H), 2931 (C-H),1656 (C=O), 1446 (C=C), 544 (Ar-C-Cl). ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.92 (d, 1H, J = 3.8 Hz, quinoline ring-H), 8.11 (d, 1H, J = 8.4 Hz, quinoline ring-H), 7.65–6.97 (m, 10H, Ar-H), 5.66 (dd, 1H, J = 4.1,12.3 Hz, pyrazoline-CH), 5.43 (s, 2H, OCH_2), 3.81 (dd, 1H, J = 12.2,18.1 Hz, pyrazoline-CH_2), 3.24 (dd, 1H, J = 4.7, 17.5 Hz, pyrazoline-CH_2).^{13}C NMR (100 MHz, DMSO-d_6) δ 13.1, 14.6, 66.7, 69.2, 110.6, 112.5, 115.7, 121.5, 122.7, 123.8, 126.9, 127.3, 128.2, 128.4, 129.6, 132.8, 140.6, 149.1, 150.2, 153.9, 154.4, 159.3, 164.3, 169.5. Elemental analysis, Anal. calcd. for $C_{24}H_{17}Cl_2N_3O_2S$: C, 59.76; H, 3.55; N, 8.71. Found: C, 59.79; H, 3.56; N, 8.67%.

2-[(5-Chloroquinolin-8-yl)oxy]-1-[5-(4-fluorophenyl)-3-(thiophen-2-yl)-4,5-dihydro-1*H*-pyrazol-1-yl]ethan-1-one (5c): Yield, 83.7%, m.p. 102–104 °C; IR spectrum (γ-max cm^{-1}): 3051 (Ar-H), 2922 (C-H), 1629 (C=O), 1599 (C=N), 1458 (Ar C=C), 548 (Ar-C-Cl). ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.92 (d, 1H, J = 4.4 Hz, quinoline ring-H), 8.10 (d, 1H, J = 7.8 Hz, quinoline ring-H), 7.71–6.80 (m, 10H, Ar-H), 5.61 (dd, 1H, J = 5.1, 11.4 Hz, pyrazoline-CH), 5.46 (s, 2H, OCH_2), 3.78 (dd, 1H, J = 12.3, 17.7 Hz, pyrazoline-CH_2), 3.22 (dd, 1H, J = 4.6, 17.8 Hz, pyrazoline-CH_2). ^{13}C NMR (100 MHz, DMSO-d_6) δ 12.9, 13.8, 66.5, 69.4, 110.9, 112.7, 116.1, 121.7, 122.9, 127.3, 127.7, 128.5, 129.8, 133.1, 133.6, 141.5, 148.7, 149.1, 150.2, 153.8, 154.6, 156.4, 163.9, 169.6. Elemental analysis, Anal. Calcd. for $C_{24}H_{17}ClFN_3O_2S$: C, 61.87; H, 3.68; N, 9.02. Found: C, 61.89; H, 3.69; N, 9.05%.

2-[(5-Chloroquinolin-8-yl)oxy]-1-[5-(4-hydroxyphenyl)-3-(thiophen-2-yl)-4,5-dihydro-1*H*-pyrazol-1-yl]ethan-1-one (5d): Yield, 82.15%, m.p. 112–114 °C; IR spectrum (γ-max cm^{-1}): 3340 (Ar O–H), 3097, 3055 (Ar–H), 2953, 2922 (C-H), 1600, 1573, 545 (Ar-C-Cl). ^{1}H NMR (400 MHz, DMSO-d_6) δ 10.42 (s, 1H, Ar-OH), 8.93 (d, 1H, J = 4.1 Hz, quinoline ring-H), 8.11 (d, 1H, J = 7.8 Hz, quinoline ring-H), 7.79–6.96 (m, 10H, Ar-H), 5.62 (dd,1H, J = 5.1, 12.3 Hz, pyrazoline-CH), 5.43 (s, 2H, OCH_2), 3.85 (dd, 1H, J = 11.8, 17.6 Hz, pyrazoline-CH_2), 3.24 (dd, 1H, J = 5.3, 17.7 Hz, pyrazoline-CH_2). ^{13}C NMR (100 MHz, DMSO-d_6) δ 13.3, 13.9, 66.8, 70.2, 111.3, 112.7, 116.1, 121.7, 122.9, 124.1, 123.9, 127.3, 127.7, 128.5, 130.2, 133.1, 140.3, 141.5, 148.7, 149.1, 150.2, 153.8, 159.8, 163.9, 169.6. Elemental analysis, Anal. calcd. for $C_{24}H_{18}ClN_3O_3S$: C, 62.13; H, 3.91; N, 9.06. Found: C, 62.15; H, 3.96; N, 9.07.

2-[(5-Chloroquinolin-8-yl)oxy]-1-[5-(4-nitrophenyl)-3-(thiophen-2-yl)-4,5-dihydro-1*H*-pyrazol-1-yl]ethan-1-one (5e): Yield, 82.15%, m.p. 106–108 °C; IR spectrum (γ-max cm^{-1}): 3082, 3057 (Ar–H), 2960, 2924, 2852 (C-H), 1566, 1512, 1456 (Ar-C=C), 550 (Ar-C-Cl).^{1}H NMR (400 MHz, DMSO-d_6) δ 8.92 (d, 1H, J = 3.6 Hz, quinoline ring-H), 8.10 (d, 1H, J = 8.1 Hz, quinoline ring-H), 7.71–6.97 (m, 10H, Ar-H), 5.62 (dd, 1H, J = 4.1,12.2 Hz, pyrazoline-CH), 5.42 (s, 2H, OCH_2), 3.78 (dd, 1H, J = 11.7, 18.2 Hz, pyrazoline-CH_2), 3.21 (dd, 1H, J = 4.1, 17.8 Hz, pyrazoline-CH_2). ^{13}C NMR (100 MHz, DMSO-d_6) δ 13.9, 14.3, 67.1, 70.3, 111.7, 112.9, 116.2, 121.8, 123.4, 124.2, 127.5, 128.9, 130.2, 133.7, 140.8, 141.7, 148.8, 149.3, 150.5, 154.7, 156.4, 160.4, 163.9, 169.9. Elemental analysis, Anal. calcd. for $C_{24}H_{17}ClN_4O_4S$: C, 58.48; H, 3.48; N, 11.37. Found: C, 58.51; H, 3.49; N, 11.40%.

2-[(5-Chloroquinolin-8-yl)oxy]-1-[5-(2,4-dichlorophenyl)-3-(thiophen-2-yl)-4,5-dihydro-1*H*-pyrazol-1-yl]ethan-1-one (5f): Yield, 72.15%, m.p. 114–116 °C; IR spectrum

(γ-max, cm^{-1}): 3042 (Ar-H), 2928 (CH_2), 1684 (C=O), 1595 (C=N), 1434 (C=C), 548 (Ar-C-Cl). ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.93 (d, 1H, J = 3.9 Hz, quinoline-H), 8.10 (d, 1H, *J* = 8.1 Hz, quinoline ring-H), 7.79–6.98 (m, 9H, Ar-H), 5.62 (dd, 1H, *J* = 4.5, 11.7 Hz, pyrazoline-CH), 5.44 (s, 2H, OCH_2), 3.82 (dd, 1H, *J* = 11.7, 18.2 Hz, pyrazoline-CH_2), 3.26 (dd, 1H, *J* = 4.8, 18.2 Hz, pyrazoline-CH_2). ^{13}C NMR (100 MHz, DMSO-d_6) δ 13.4, 14.2, 66.8, 70.4, 111.9, 113.1, 115.8, 122.2, 123.6, 124.8, 127.4, 128.2, 128.7, 128.9, 129.3, 130.3, 133.5, 141.8, 149.4, 150.5, 154.5, 156.6, 160.5, 164.5, 170.1. Elemental analysis, Anal. calcd. for $C_{24}H_{16}Cl_3N_3O_2S$: C, 55.78; H, 3.16; 8.11. Found: C, 55.77; H, 3.12; 8.13%.

2-[(5-Chloroquinolin-8-yl)oxy]-1-[5-(pyridin-4-yl)-3-(thiophen-2-yl)-4,5-dihydro-1*H*-pyrazol-1-yl]ethan-1-one (5g): Yield, 72.05%, m.p. 104–106 ºC; IR spectrum (γ-max, cm^{-1}): 3340 (Ar O-H); 2924 (C-H); 1597, 1575, 1512, 1487 (Ar-C=C), 547 (Ar-C-Cl). ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.92 (d, 1H, *J* = 4.2 Hz, quinoline ring-H), 8.10 (d, 1H, *J* = 8.4 Hz, quinoline ring-H), 7.79–6.99 (m, 10H, Ar-H), 5.68 (dd, 1H, *J* = 4.8, 11.6 Hz, pyrazoline-CH), 5.43 (s, 2H, OCH_2), 3.84 (dd, 1H, *J* = 12.1, 17.7 Hz, pyrazoline-CH_2), 3.28 (dd, 1H, *J* = 5.1, 17.4 Hz, pyrazoline-CH_2). ^{13}C NMR (100 MHz, DMSO-d_6) δ 14.1, 14.5, 67.2, 70.6, 111.9, 113.4, 116.5, 123.7, 124.5, 127.3, 127.9, 128.4, 129.6, 130.3, 133.9, 141.7, 148.9, 149.4, 150.7, 154.9, 156.6, 160.7, 164.4, 168.6. Elemental analysis, Anal. calcd. for $C_{23}H_{17}ClN_4O_2S$: C, 61.54; H, 3.82; N, 12.48. Found: C, 61.57; H, 3.78; N, 12.50%.

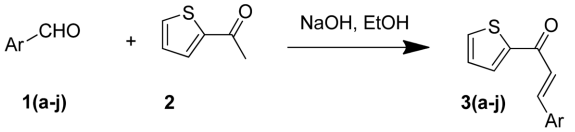
2-[(5-Chloroquinolin-8-yl)oxy]-1-[5-(pyridin-3-yl)-3-(thiophen-2-yl)-4,5-dihydro-1*H*-pyrazol-1-yl]ethan-1-one (5h): Yield, 87.18%, m.p. 108–110 ºC; IR spectrum (γ-max cm^{-1}): 3038 (Ar-H), 2926 (CH_2), 1674 (C=O), 1593 (C=N), 1441 (C=C), 548 (Ar-C-Cl). ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.93 (d,1H, *J* = 4.2 Hz, Ar-H), 8.12 (d,1H, *J* = 7.8 Hz, Ar-H), 7.79–7.06 (m, 10H, Ar-H), 5.66 (dd, 1H, *J* = 4.9, 11.5 Hz, pyrazoline-CH), 5.42 (s, 2H, OCH_2), 3.83 (dd, 1H, *J* = 11.8,18.4 Hz, pyrazoline-CH_2), 3.26 (dd, 1H, *J* = 5.1, 18.2 Hz, pyrazoline-CH_2). ^{13}C NMR (100 MHz, DMSO-d_6) δ 13.4, 13.9, 66.8, 70.1, 111.5, 113.5, 116.5, 122.3, 123.5, 124.8, 127.6, 128.5, 130.3, 133.9, 134.2, 140.9, 141.5, 149.7, 154.8, 156.7, 160.7, 164.4, 170.3. Elemental analysis, Anal. calcd. for $C_{23}H_{17}ClN_4O_2S$: C, 61.57; H, 3.85; N, 12.53. Found: C, 61.54; H, 3.82; N, 12.48%.

2-[(5-Chloroquinolin-8-yl)oxy]-1-[5-(furan-2-yl)-3-(thiophen-2-yl)-4,5-dihydro-1*H*-pyrazol-1-yl]ethan-1-one (5i): Yield, 78.05%, m.p. 104–106 ºC; IR spectrum (γ-max cm^{-1}): 3043 (Ar-H), 2927 (CH2), 1682 (C=O), 1594 (C=N), 1440 (C=C), 545 (Ar-C-Cl). ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.93 (d, 1H, *J* = 4.1 Hz, quinoline ring-H), 8.11 (d, 1H, *J* = 8.2 Hz, quinoline ring-H), 7.77–7.07 (m, 8H, Ar-H), 5.62 (dd, 1H, *J* = 4.9, 11.7 Hz, pyrazoline-CH), 5.49 (s, 2H, OCH_2), 3.88 (dd, 1H, *J* = 11.8, 17.7 Hz, pyrazoline-CH_2), 3.16 (dd, 1H, *J* = 5.1, 18.2 Hz, pyrazoline-CH_2). ^{13}C NMR (100 MHz, DMSO-d_6) δ 14.1, 14.7, 67.2, 70.3, 111.9, 113.5, 116.7, 122.3, 123.5, 124.6, 127.7, 128.2, 128.9, 130.4, 133.9, 140.6, 141.5, 149.5, 150.6, 154.4, 156.6, 160.5, 164.5, 168.9. Elemental analysis, Anal. calcd. for $C_{23}H_{17}ClN_4O_2S$: C, 61.54; H, 3.82; N, 12.48. Found: C, 61.59; H, 3.79; N, 12.50%.

2-[(5-Chloroquinolin-8-yl)oxy]-1-[5-(2-methoxy-1-naphthyl)-3-(thiophen-2-yl)-4,5-dihydro-1*H*-pyrazol-1-yl]ethan-1-one (5j): Yield, 83.5%, m.p. 118–120 ºC; IR spectrum (γ-max cm^{-1}): 3068 (Ar-H), 2913 (CH_3), 1683 (C=O), 1596 (C=N),1466 (C=C), 547 (Ar-C-Cl). ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.94 (d,1H, *J* = 3.8 Hz, quinolinering-H), 8.10 (d, 1H, *J* = 8.1 Hz, quinoline ring-H), 7.79–7.01 (m, 9H, Ar-H), 5.62 (dd, 1H, *J* = 4.5, 11.7 Hz, pyrazoline-CH), 5.44 (s, 2H, OCH_2), 3.85 (dd, 1H, *J* = 12, 18 Hz, pyrazoline-CH_2), 3.25 (dd, 1H, *J* = 4.8, 17.7 Hz, pyrazoline-CH_2) 3.72 (s, 3H, OCH_3). ^{13}C NMR (100 MHz, DMSO-d_6) δ 14.3, 14.7, 62.5, 67.3, 70.5, 111.9, 112.5, 116.3,.122.3, 123.6, 124.4, 127.7, 128.6, 128.9, 129.5, 130.4, 133.7, 134.1, 141.2, 141.9, 149.3, 150.1, 150.5, 154.2, 154.8, 156.3, 160.6, 164.2, 169.5. Elemental analysis, Anal. calcd. for $C_{29}H_{22}ClN_3O_3S$: C, 65.97; H, 4.20; N, 7.96. Found: C, 66.02; H, 4.24; N, 7.95%.

RESULTS AND DISCUSSION

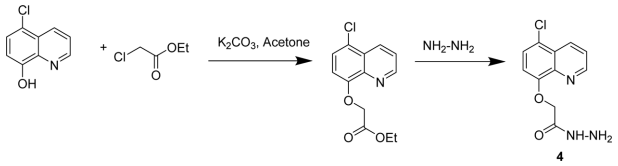
A reaction sequence for the preparation of pyrazolines **5(a–j)** is outlined in *Scheme* 1-3. The required chalcones were prepared by reacting 2-acetyl thiophene with appropriate aldehyde in presence of base by conventional Claisen-



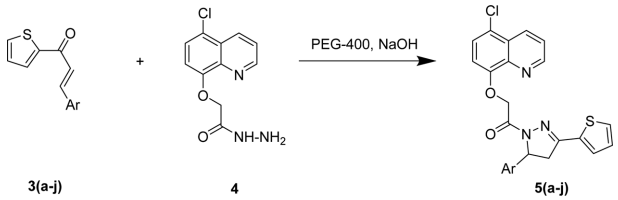
Ar = Ph, 4-Cl-Ph, 4-F-Ph, 4-OH-Ph, 4-NO_2-Ph, 2,4-Dichloro, 4-Pyridinyl, 3-Pyridinyl, 2-Furyl, 2-OMe-1-Napthyl

Compound	Ar	Compound	Ar
3a	Ph	**3f**	2,4-Dichloro-Ph
3b	4-Cl-Ph	**3g**	4-Pyridinyl
3c	4-F-Ph	**3h**	3-Pyridinyl
3d	4-OH-Ph	**3i**	Furan-2-yl
3e	4-NO_2-Ph	**3j**	2-OMe-1-Naphthyl

***Scheme* 1.** Synthesis of chalcone derivatives.



***Scheme* 2.** Synthesis of 5-chloro-quinoline hydrazide derivatives.



Ar = Ph, 4-Cl-Ph, 4-F-Ph, 4-OH-Ph, 4-NO_2-Ph, 2,4-Dichloro, 4-Pyridinyl, 3-Pyridinyl, 2-Furyl, 2-OMe-1-Napthyl

Compound	Ar	Compound	Ar
5a	Ph	**5f**	2,4-Dichloro-Ph
5b	4-Cl-Ph	**5g**	4-Pyridinyl
5c	4-F-Ph	**5h**	3-Pyridinyl
5d	4-OH-Ph	**5i**	Furan-2-yl
5e	4-NO_2-Ph	**5j**	2-OMe-1-Naphthyl

***Scheme* 3.** Synthesis of pyrazoline derivatives.

Schmidt condensation (*Scheme* 2). Reaction between chalcone with 5-chloro-quinolynyl hydrazide in PEG-400 in the presence of NaOH (reaction time varies from 8 to 10 h) afforded titled pyrazolines **5(a–j)** in 70–82% yield.

The purity of the compounds was checked by thin layer chromatography and elemental analyses. Spectral data (^{1}H & ^{13}C NMR, IR) of all the synthesized compounds were in full agreement with the proposed structures. In general, Infrared spectra (IR) shown C=O, C=N and C-N peak in the region of 1640–1630, 1590–1585 and 1320–1290 cm^{-1}, respectively. ^{1}H NMR signals of the respective protons of all the compounds were assigned based on their chemical shifts, multiplicities and coupling constants. The spectra showed doublet of doublet in the range of δ 3.7–3.2 corresponding to methylene proton of pyrazoline ring (geminal protons); singlet in the range of δ 5.6–5.2 corresponding to -OCH_2 group; and multiplet at δ 8.5–8.2 for quinolinyl proton. The elemental analysis results were within ±0.4% of the theoretical values.

Antibacterial Activities

The synthesized pyrazoline derivatives **5(a–j)** were evaluated in vitro for their antibacterial activity against Gram-positive *S. aureus*, *B. subtilis* and Gram-negative *E. coli* by using agar diffusion method as recommended by the National Committee for Clinical Laboratory Standards, (NCCLS)[22] using ciprofloxacin as reference standard, Dimethyl sulphoxide (1%, DMSO) as control.

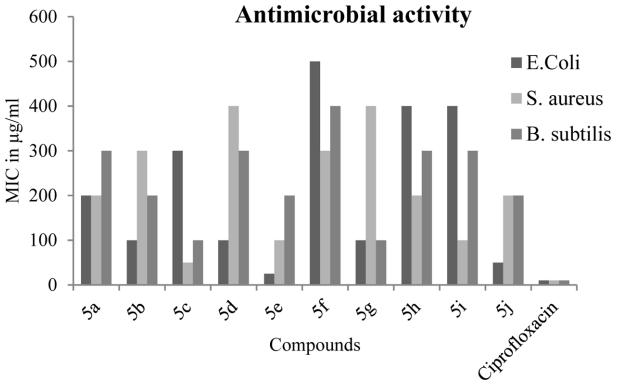


***Figure* 1.** Antimicrobial activity of compounds **5(a–j)**.

The culture strains of bacteria were maintained on nutrient agar slant at 37 °C for 24 h. The antibacterial activity was evaluated using nutrient agar plate seeded with 0.1 mL of respective bacterial culture strain suspension prepared in sterile saline (0.85%) of 105 CFU/mL dilutions (by comparing with Mcfarland standard solution). The wells of 6 mm diameter were filled with 0.1 mL of target compound dilution ranging from 25 to 250 μg/mL separately for each bacterial strain. All the plates were incubated at 37 °C for 24 h. Zone of inhibition and minimum inhibitory concentrations (MICs) were noted. The results of antibacterial studies are given in *Fig.* 1.

The compounds **5e** and **5j** were found to be the most effective antibacterial agents having MIC values 50 and 75 μg/mL, respectively against *E. coli.* The antibacterial activity value of these compounds approaches the antibacterial potential of the standard drug ciprofloxacin. In case of *S. aureus*, compounds **5c** and **5e** have shown marked antibacterial potential at MIC values less than 100 μg/mL. For antibacterial activity against *B. subtilis* compounds **5c** and **5g** had shown better antibacterial activity with MIC values of 75 μg/mL, respectively.

The compounds were also found to be more active against Gram-negative *E. coli* as compared to Gram-positive *B. subtilis* and *S. aureus*.

Antioxidant Activity: 1,1-Diphenyl-2-picryl Hydrazyl (DPPH) Assay

Antioxidant activity was studied using DPPH assay. The assay was carried out in a 96 well microtiter plate. To 100 μl of DPPH solution, 100 μl of each of the test sample or the standard drug was added separately in wells of the microtiter plate. The plates were incubated at 37 °C for 20 minute and the absorbance of each solution was measured

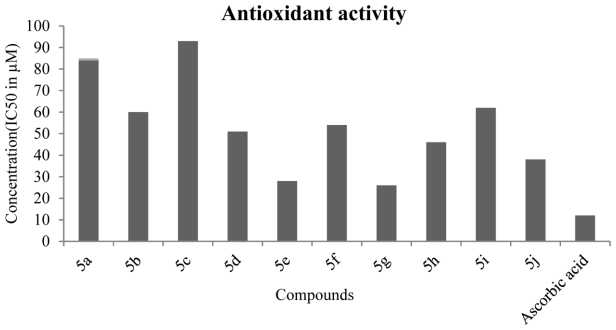


***Figure* 2.** Antioxidant activity of compounds **5(a–j)**.

at 540 nm, using ELISA microtiter plate reader. The experiment was performed in triplicate and% scavenging activity was calculated using the formula given below. IC50 (Inhibitory concentration) is the concentration of the sample required to scavenge 50% of DPPH free radicals and it was calculated from the graph, % scavenging vs. concentration.

$$\% \text{ DPPH radical scavenging} = \frac{\text{Absorbance of control - Absorbance of test sample}}{\text{Absorbance of test sample}} \times 100$$

Compounds **5e** and **5g** have shown good radical scavenging activity with the values IC50 28 and 26 µM respectively and are comparable with that of standard (i.e. Ascorbic acid) which is shown IC50 value of 12 µM (*Fig.* 2).

CONCLUSION

A series of quinoline substituted pyrazolines **5(a–j)** was synthesized successfully from chalcones under basic condition in presence of PEG-400 as a reaction medium. All the compounds were subjected to antibacterial and antioxidant studies where, most of the compound showed promising activities. The compound **5e** found to be the potent molecule being showed both antibacterial and antioxidant properties. Hence, the target compounds appear to be of greater potential for further exploration of various other activities.

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