European Journal of Medicinal Chemistry 67 (2013) 464–468

Contents lists available at SciVerse ScienceDirect

European Journal of Medicinal Chemistry

journal homepage: http://www.elsevier.com/locate/ejmech

Short communication

Synthesis and study of 1-ethyl-3-carbohydrazide and 3-[1-oxo-2-hydrazino-3-{p-toluenesulfon}]quinolone derivatives against bacterial infections

Nivedita Srivastava*, Anil Kumar

Department of Applied Chemistry, Faculty of Engineering and Technology, M.J.P. Rohilkhand University, Bareilly 243006, U.P., India

ARTICLE INFO

Article history:
Received 21 March 2013
Received in revised form
20 June 2013
Accepted 24 June 2013
Available online 9 July 2013

Keywords:
Quinolone
Fluoroquinolone
Hydrazine
Sulfonamide
Antibacterial
Broad spectrum

ABSTRACT

We have synthesized newer series of quinolone derivatives substituted with hydrazine group (**6a**–**e**) and sulfonamide group (**7a**–**e**). These compounds were screened for antibacterial activity. All these compounds were fully characterized by spectroscopic means and elemental analysis. From minimum inhibitory concentration (MIC) data, it has been observed that all the synthesized compounds exhibited good antibacterial activity *in vitro*.

1. Introduction

Urinary tract infection is most common disease in human body. More than 150 millions cases are reported per year worldwide [1]. UTI infection is bacterial infection which affects urinary tract path of the body. If it is not treated in time, bacteria travel to the urethra and multiply, causing kidney infection [2]. Urinary tract infection is more common in ladies as the urethra part of female is shorter than male [3]. UTI is a pathogenic infection and is becoming resistant to all available antibiotics.

The most responsible bacterium for UTI is gram negative bacteria, which belongs to the family *Enterobacteriaceae*. Gram negative members of this family are *Escherichia coli*, *Salmonella typhi*, *Pseudomonas aeruginosa*. Gram positive bacteria viz *Staphylococcus* sp. is also responsible for UTI [4,5]. Quinolone is group of synthetic compounds with potent antimicrobial activity and is used orally and parentally in wide variety of infectious disease [6–8].

Our aim is to synthesize newer compounds which may prove to be more potent towards these pathogenic infections and thus inhibit or control the urinary tract infection. Quinolones [9] are chemotherapeutic gyrase or topoisomerases-II inhibitors, eradicating bacteria by interfering with DNA replication. Sulfonamides [10] are also used as antibacterial agents. They inhibit cell metabolism of bacteria as it mimics p-amino benzoic acid (PABA), one of the normal constitutes of folic acid. The enzyme accepts sulfonamide into its active site as the structure of sulfonamide is similar to PABA. Once it is bound, the sulfonamide prevents PABA from binding.

In our study we have synthesized quinolone compounds, substituted with hydrazine group and-1-oxo-2-hydrazino-3-(p-toluenesulfon) group at 3 position and want to see the results of these molecules as antibacterial. The combination therapy of sulfonamide and quinolone (**7a**–**e**) is new approach for the treatment of bacterial infections.

2. Results & discussion

2.1. Chemistry

We have already prepared the des-ethyl quinolone derivatives, substituted with carbohydrazide and sulfonyl groups at C-3, but these compounds did not give satisfactory results [11]. Therefore we have synthesized the quinolones (**6a**–**e**) and (**7a**–**e**) with N-1-ethyl

* Corresponding author. Tel.: +91 9415157863.
E-mail addresses: drnimjpru@rediffmail.com, niveditacdri2000@yahoo.com (N. Srivastava).

0223-5234/$ – see front matter © 2013 Elsevier Masson SAS. All rights reserved.
http://dx.doi.org/10.1016/j.ejmech.2013.06.056

substitution. This is the first report in which better results are obtained (Table 1) by the incorporation of sulfonamide moiety at 3-position of quinolone compounds.

Firstly substituted aniline **1** was condensed with diethyl ethoxy methylene malonate **2** to give ethyl anilinomethylenemalonate **3** derivatives as reported by Claisen [12]. Each substituted ethyl anilinomethylenemalonate **3** was refluxed with diphenyl ether to give corresponding 1,4-dihydro-4-oxoquinoline-3-carboxylic acid ethyl ester **4** derivatives [13,14], which on refluxing with ethyl iodide and potassium carbonate for 10 h in the presence of DMF as solvent afforded substituted 1-ethyl-1,4-dihydro-4-oxoquinoline-3-carboxy lic acid ethyl ester **5** derivatives. Each **5** derivative on refluxing with hydrazine monohydrate in absolute ethanol afforded 1-ethyl-4-oxo-1,4-dihydroquinoline-3-carbohydrazide derivatives **6** respectively. Each carbohydrazide derivative **6** on treatment with p-toluenesulfonyl chloride in the presence of pyridine as base using dichloromethane and ethyl acetate as solvent, gave the corresponding substituted-1-ethyl-4-oxo-1,4-dihydro-3-[1-oxo-2-hydrazino-3-{p-toluenesulfon}]quinoline derivatives **7** (Scheme 1) respectively. All the compounds were purified by crystallization. Spectral (IR, ^{1}H NMR, ^{13}C NMR and EI-MS) data and elemental analysis reported in experimental section of this paper is in agreement with structures assigned to them.

2.2. Biological results

All synthesized compounds **6a**–**e** having hydrazine and **7a**–**e** having sulfonamide moieties at C-3 position were subjected for the antibacterial activity *in vitro*. These compounds were evaluated against gram negative namely *E. coli* (*ETEC*), *S. typhi* and *P. aeruginosa* and gram positive *Staphylococcus aureus* strains by using disc diffusion technique. All the results reported here in the form of minimum inhibitory concentrations (MICs) and compared with standard reference marketed drug norfloxacin & ciprofloxacin (Table 1). Minimum inhibitory concentration (MIC) reveals that all these synthesize compounds are good or equivalent as the reference marketed drug norfloxacin and ciprofloxacin.

Minimum inhibitory concentration (MIC) reveals that the all the synthesized compounds **6a**–**e** & **7a**–**e** are potent as standard reference drug norfloxacin and ciprofloxacin against pathogen *P. aeruginosa* and *S. aureus* (Table 1).

The compounds **6a**, **6d**, **6e** & **7b**–**e** have equivalent minimum inhibitory concentration as the reference drug norfloxacin and ciprofloxacin against *E. coli*. The reference norfloxacin and ciprofloxacin are 2 times more potent to the synthesized compound **6b** & **7a**, while the compound **6c** have only 1/4 activity of ciprofloxacin and norfloxacin against *E. coli* (Table 1).

All the synthesized compounds **6a**–**e** & **7a**–**c**, **e** are equipotent as the standard ciprofloxacin against *S. typhi*. The activity of compound **7d** is 1/2, when compared with standard ciprofloxacin against *S. typhi*. Except **7d**, all the compound **6a**–**e** & **7a**–**e** are 4 times more potent to the standard norfloxacin. Compound **7d** is also 2 times more potent to the norfloxacin against *S. typhi* (Table 1).

Table 1
Biological screening data of compounds (**6a**–**e**) and (**7a**–**e**).

Comp no.	Minimum inhibitory concentrations (MICs) μg/mL			
	Gram-negative			Gram-positive
	P. aeruginosa	*E. coli* (ETEC)	*S. typhi*	*S. aureus*
6a	0.0625	0.0625	0.0625	0.0625
6b	0.0625	0.125	0.0625	0.0625
6c	0.0625	0.25	0.0625	0.0625
6d	0.0625	0.0625	0.0625	0.0625
6e	0.0625	0.0625	0.0625	0.0625
7a	0.0625	0.125	0.0625	0.0625
7b	0.0625	0.0625	0.0625	0.0625
7c	0.0625	0.0625	0.0625	0.0625
7d	0.0625	0.0625	0.125	0.0625
7e	0.0625	0.0625	0.0625	0.0625
Nor	0.0625	0.0625	0.25	0.0625
Cip	0.0625	0.0625	0.0625	0.0625

P. aeruginosa = *Pseudomonas aeruginosa*, *E. coli* = *Escherichia coli*, *S. typhi* = *Salmonella typhi*, *S. aureus* = *Staphylococcus aureus*, Nor. = Norfloxacin, Cip. = Ciprofloxacin.

3. Conclusion

We reported the preparation of (**6a**–**e**) by the incorporation of hydrazine moiety at 3-position of quinolone (**5a**–**e**). This hydrazine substituted quinolone derivatives (**6a**–**e**) was further treated with p-toluenesulfonyl chloride to give sulfonamide substituted quinolone derivatives (**7a**–**e**). It is observed that both series of synthesized compounds (**6a**–**e**) and (**7a**–**e**) show good antibacterial activity against some pathogens. The biological activity of quinolones having N-1 ethyl show better result in comparison to N-1-des-ethyl quinolone derivatives [11]. Incorporation of sulfonamide as well as hydrazine moiety at 3-position of N-1-ethyl quinolones show good antibacterial results. Results are awaited to see the effect of piperazine and other bases, at C-7 position, in our series of compounds.

4. Experimental protocols

4.1. General

Spectral data were recorded as follows: IR Spectra was run on a Perkin–Elmer and Shimadzu 8201 PC, FT Infrared spectrophotometer (ν_{max} in cm^{-1}). Mass spectra were recorded on Jeol SX-102 (FAB). ^{1}H NMR (400 MHz) and ^{13}C NMR (75 MHz) spectra have been recorded on Bruker Avance 400. Melting points were determined in open capillary method and were uncorrected. All reagents used were of commercial grade and were used as received without further purification unless otherwise specified. Dry DMF and anhydrous potassium carbonate were used wherever required. Reagent grade solvents were used in all other cases unless otherwise specified. Organic solutions were dried over anhydrous Na_2SO_4 and concentrated with a Buchi rotary evaporator at low pressure. Yield of purified products was not optimized.

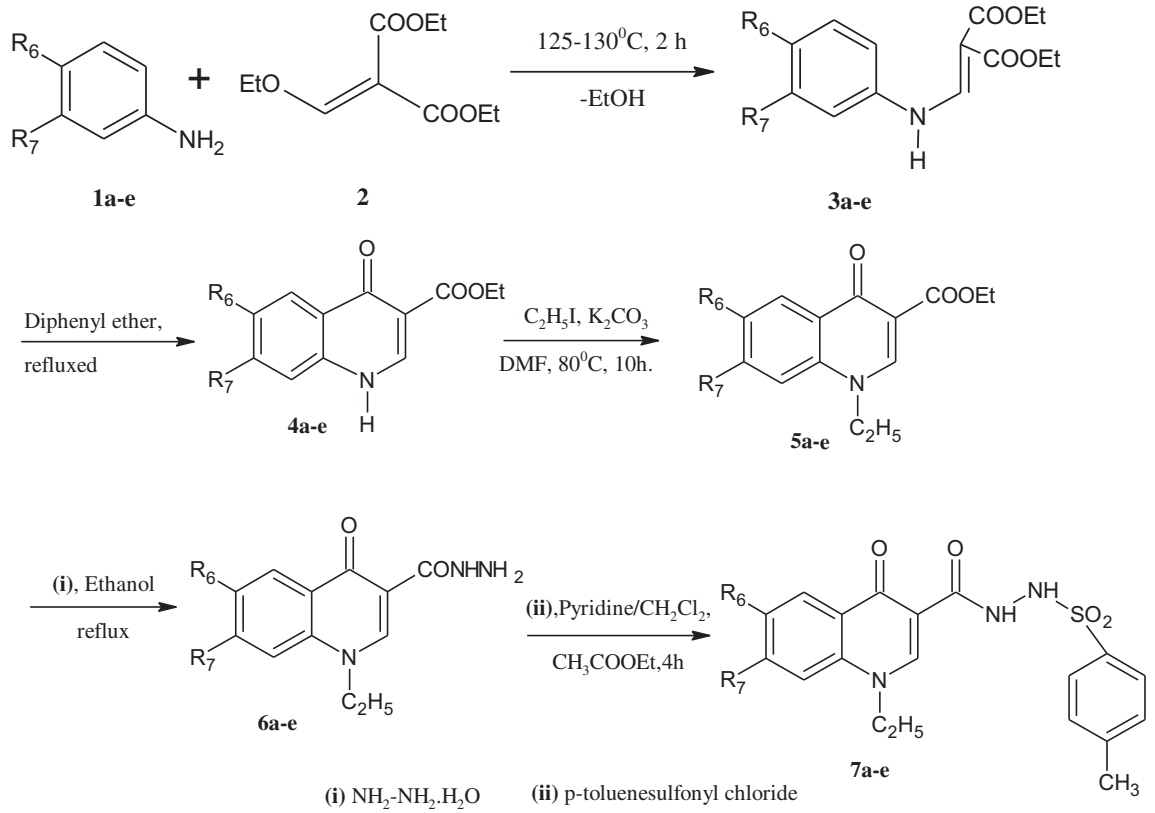
4.2. General procedure for the preparation of (*6*) and (*7*)

4.2.1. Substituted-1-ethyl-1,4-dihydro-4-oxoquinoline-3-carbo hydrazide derivatives (*6a*–*e*)

In 100 mL round bottomed flask, each substituted-1-ethyl-1,4-dihydro-4-oxoquinoline-3-carboxylic acid ethyl ester (**5a**–**e**) (0.01 mol) was refluxed with hydrazine monohydrate (0.01 mol) in absolute ethanol (9 mL) for 10 h to give corresponding substituted-1-ethyl-4-oxo-1,4-dihydroquinoline-3-carbohydrazide (**6a**–**e**). The excess solvent was evaporated off and the resulting mixture was poured into crushed ice. The solid separated was filtered on sintered funnel, washed with water and dried. The crude solid was purified by recrystallization twice from ethanol to give (**6a**–**e**) as white solid. Purity of the compound was checked on silica gel TLC plates. TLC was run in chloroform–methanol (9:1) as eluent.

4.2.2. Substituted-1-ethyl-4-oxo-1,4-dihydro-3-[1-oxo-2-hydrazino-3-{p-toluenesulfon}]quinoline derivatives (*7a*–*e*)

In 100 mL round bottomed flask, each substituted-1-ethyl-1,4-dihydro-4-oxoquinoline-3-carbohydrazide derivatives (**6a**–**e**)(0.005 mol) was mixed with pyridine (0.01 mol), dichloromethane (6 mL)



	R_6	R_7
a	H	H
b	F	H
c	Cl	H
d	H	Cl
e	F	Cl

Scheme 1. Synthesis of carbohydrazide (**6a**–**e**) and sulfonamide (**7a**–**e**) derivatives.

and ethyl acetate (6 mL). The reaction mixture was placed in ice bath and the p-toluenesulfonyl chloride (0.005 mol) was added into the reaction mixture in two portions and stirred for 4 h under ice condition. The reaction mixture was allowed to stand in ice for 30 min. The reaction mixture was filtered on sintered funnel. Crude solid was washed with water and dried. The solid compound (**7a**–**e**) was recrystallized (twice) with dichloromethane. Purity of the compound was checked on silica gel TLC plates. TLC was run in chloroform–methanol (9.5:0.5) as eluent.

5. Spectral data

5.1. Ethyl-1,4-dihydro-4-oxoquinoline-3-carbohydrazide (*6a*)

Solvent of crystallization ethanol. Yield 86.35%. Mp >300 °C. IR (KBr) ν_{max}: 3651–3021 (br), 1654 (s, >CO hydrazide), 1615 (s, >CO ketone), 1494 (w), 1218 (s), 764 (s) cm^{-1}. ^1H NMR (400 MHz; DMSO-d_6) δ (ppm): 10.92 (s, 1H, –CONH–), 8.87 (s, 1H, H-2), 8.47–7.40 (m, 4H, ArH), 4.43–4.26 (m, 4H, $-C\mathbf{H}_2CH_3$, $-N\mathbf{H}_2$), 1.48 (t, 3H, $-CH_2C\mathbf{H}_3$); ^{13}C NMR (75 MHz, $CDCl_3$-d) δ (ppm): 174.60, 164.05, 143.59, 139.10, 135.41, 129.71, 128.10, 126.79, 126.01, 110.21, 48.03, 14.39; MS *m*/*z*: 231 (M^+), Anal. Calcd for $C_{12}H_{13}N_3O_2$: C, 62.33; H, 5.62; N, 18.18. Found: C, 62.26; H, 5.57; N, 18.05.

5.2. Ethyl-6-fluoro-1,4-dihydro-4-oxoquinoline-3-carbohydrazide (*6b*)

Solvent of crystallization ethanol. Yield 81.43%. Mp 205 °C. IR (KBr) ν_{max}: 3645–3018 (br), 1656 (s, >CO hydrazide Str.) 1604 (s, >CO), 1492 (w), 1216 (s), 762 (s) cm^{-1}. ^1H NMR (400 MHz; $CDCl_3$-d) δ (ppm): 10.76 (s, 1H, –CONH–), 8.75 (s, 1H, H-2), 8.16–7.45 (m, 3H, ArH), 4.35 (q, 2H, $-C\mathbf{H}_2CH_3$), 4.19 (s, 2H, $-NH_2$), 1.57 (t, 3H, $-CH_2C\mathbf{H}_3$); ^{13}C NMR (100 MHz, $CDCl_3$-d) δ (ppm): 175.07, 165.30, 146.62, 135.15, 129.73, 129.66, 121.54, 121.29, 118.01, 110.61, 49.33, 14.54; MS *m*/*z*: 250 (M^+), Anal. Calcd for $C_{12}H_{12}FN_3O_2$: C, 57.60; H, 4.80; N, 16.80. Found: C, 57.12; H, 4.44; N, 16.69.

*5.3. 6-Chloro-1-ethyl-1,4-dihydro-4-oxoquinoline-3-carbohydrazide (**6c**)*

Solvent of crystallization ethanol. Yield 79.10%. Mp 238 °C. IR (KBr) ν_{max}: 3603–3008 (br), 1655 (s, >CO hydrazide Str.) 1607 (s, >CO), 1483 (w), 1216 (s), 764 (s) cm^{-1}. ^1H NMR (400 MHz; $CDCl_3$-d) δ (ppm): 10.75 (s, 1H, –CONH–), 8.76 (s, 1H, H-2), 8.50–7.49 (m, 3H, ArH), 4.35 (q, 2H, $-CH_2CH_3$), 4.20 (s, 2H, $-NH_2$), 1.60 (t, 3H, $-CH_2CH_3$); ^{13}C NMR (75 MHz, $CDCl_3$-d) δ (ppm): 174.89, 165.21, 146.92, 137.14, 133.19, 131.51, 129.11, 127.10, 117.38, 111.55, 49.25, 14.55; MS *m*/*z*: 266 (M^+), Anal. Calcd for $C_{12}H_{12}ClN_3O_2$: C, 54.13; H, 4.51; N, 15.78. Found: C, 54.11; H, 4.49; N, 15.63.

*5.4. 7-Chloro-1-ethyl-1,4-dihydro-4-oxoquinoline-3-carbohydrazide (**6d**)*

Solvent of crystallization ethanol. Yield 77.37%. Mp 226 °C. IR (KBr) ν_{max}: 3578–3014 (br), 1657 (s, >CO hydrazide), 1597 (s, >CO), 1465 (w), 1217 (s), 762 (s) cm^{-1}. ^1H NMR (400 MHz; DMSO-d_6) δ (ppm): 10.73 (s, 1H, –CONH–), 8.81 (s, 1H, H-2), 8.42–7.43 (m, 3H, ArH), 4.44–4.37 (m, 4H, $-CH_2CH_3$, $-NH_2$), 1.54 (t, 3H, $-CH_2CH_3$); ^{13}C NMR (100 MHz, $CDCl_3$-d) δ (ppm): 175.33, 165.14, 147.18, 139.51, 139.42, 129.23, 126.30, 125.68, 115.53, 111.69, 49.10, 14.45; MS *m*/*z*: 266 (M^+), Anal. Calcd for $C_{12}H_{12}ClN_3O_2$: C, 54.13; H, 4.51; N, 15.78. Found: C, 54.02; H, 4.48; N, 15.62.

*5.5. 7-Chloro-1-ethyl-6-fluoro-1,4-dihydro-4-oxoquinoline-3-car bohydrazide (**6e**)*

Solvent of crystallization ethanol. Yield 81.49%. Mp 263 °C. IR (KBr) ν_{max}: 3651–3016 (br), 1640 (s, >CO hydrazide), 1616 (s, >CO), 1498 (w), 1217 (s), 769 (s) cm^{-1}. ^1H NMR (400 MHz, DMSO-d_6) δ (ppm): 11.04 (s, 1H, –CONH–), 9.17 (s, 1H, H-2), 8.57 (d, 1H, H-5), 8.19 (d, 1H, H-8), 4.80–4.76 (m, 4H, $-CH_2CH_3$, $-NH_2$), 1.91 (t, 3H, $-CH_2CH_3$); ^{13}C NMR (75 MHz, $CDCl_3$-d) δ (ppm): 175.39, 165.02, 155.78, 147.09, 135.98, 128.22, 126.10, 118.16, 114.01, 113.71, 49.44, 14.52; MS *m*/*z*: 284 (M^+), Anal. Calcd for $C_{12}H_{11}ClFN_3O_2$: C, 50.70; H, 3.87; N, 14.78. Found: C, 50.11; H, 3.78; N, 14.68.

*5.6. 1-Ethyl-4-oxo-1,4-dihydro-3-[1-oxo-2-hydrazino-3-{p-toluene sulfon}]quinoline (**7a**)*

Solvent of crystallization dichloromethane. Yield 88.74%. Mp 228 °C. IR (KBr) ν_{max}: 3475.6–2948 (br), 1647 (s, >CO hydrazide), 1603 (s, >CO), 1479 (w), 1327 (s, $-SO_2-$ asym. str.), 1216 (s), 1150 (s, $-SO_2-$ sym. str.), 763 (s) cm^{-1}. ^1H NMR (400 MHz; DMSO-d_6) δ (ppm): 11.40 (s, 1H, –CONH–), 9.92 (s, 1H, $-NHSO_2-$), 8.82 (s, 1H, H-2), 8.32–7.37 (m, 8H, ArH), 4.47 (q, 2H, $-CH_2CH_3$), 2.38 (s, 3H, $-CH_3$), 1.35 (t, 3H, $-CH_2CH_3$); ^{13}C NMR (75 MHz, DMSO-d_6) δ (ppm): 175.04, 163.53, 148.13, 143.44, 138.55, 135.79, 133.34, 129.53, 127.49, 126.94, 126.37, 125.36, 117.46, 109.54, 48.37, 21.04, 14.46; MS *m*/*z*: 386 (M^+), Anal. Calcd for $C_{19}H_{20}N_3O_4S$: C, 59.06; H, 5.18; N, 10.88. Found: C, 58.98; H, 5.15; N, 10.72.

*5.7. 1-Ethyl-6-fluoro-4-oxo-1,4-dihydro-3-[1-oxo-2-hydrazino-3-{p-toluenesulfon}]quinoline (**7b**)*

Solvent of crystallization dichloromethane. Yield 83.43%. Mp 238 °C. IR (KBr) ν_{max}: 3475–3021 (br), 1665 (s, >CO hydrazide), 1610 (s, >CO), 1488 (w), 1343 (s, $-SO_2-$ asym. str.), 1216 (s), 1147 (s, $-SO_2-$ sym. str.), 761 (s) cm^{-1}. ^1H NMR (400 MHz, DMSO-d_6) δ (ppm): 11.30 (s, 1H, –CONH–), 10.01 (s, 1H, $-NHSO_2-$), 8.78 (s, 1H, H-2), 8.03–7.77 (m, 7H, ArH), 4.49 (q, 2H, $-CH_2CH_3$), 2.38 (s, 3H, $-CH_3$), 1.35 (t, 3H, $-CH_2CH_3$); ^{13}C NMR (75 MHz, DMSO-d_6) δ (ppm): 175.29, 165.79, 148.08, 143.92, 136.29, 132.79, 130.02, 129.01, 127.99, 126.80, 125.02, 121.02, 119.90, 110.59, 49.33, 21.20, 14.54; MS *m*/*z*: 404 (M^+), Anal. Calcd for $C_{19}H_{19}FN_3O_4S$: C, 56.43; H, 4.70; N, 10.39. Found: C, 56.40; H, 4.68; N, 10.34.

*5.8. 6-Chloro-1-ethyl-4-oxo-1,4-dihydro-3-[1-oxo-2-hydrazino-3-{p-toluenesulfon}]quinoline (**7c**)*

Solvent of crystallization dichloromethane. Yield 81.57%. Mp 232 °C. IR (KBr) ν_{max}: 3457–3020 (br), 1689 (s, >CO hydrazide), 1603 (s, >CO), 1479 (s), 1336 (s, $-SO_2-$ asym. str.), 1216 (s), 1151 (s, $-SO_2-$ sym. str.), 758 (s) cm^{-1}. ^1H NMR (400 MHz; DMSO-d_6) δ (ppm): 11.24 (s, 1H, –CONH–), 9.98 (s, 1H, $-NHSO_2-$), 8.79 (s, 1H, H-2), 8.21 (d, 1H, H-5), 7.94 (d, 1H, H-7), 7.89 (d, 1H, H-8), 7.71 (dd, 2H, ArH), 7.38 (dd, 2H, ArH), 4.47 (q, 2H, $-CH_2CH_3$), 2.38 (s, 3H, $-CH_3$), 1.34 (t, 3H, $-CH_2CH_3$); ^{13}C NMR (75 MHz, DMSO-d_6) δ (ppm): 173.89, 163.20, 148.47, 143.49, 137.31, 135.73, 133.18, 130.26, 129.55, 128.14, 127.49, 125.19, 120.08, 109.97, 48.63, 21.04, 14.42; MS *m*/*z*: 420 (M^+), Anal. Calcd for $C_{19}H_{19}ClN_3O_4S$: C, 54.28; H, 4.52; N, 10.00. Found: C, 54.24; H, 4.49; N, 9.94.

*5.9. 7-Chloro-1-ethyl-4-oxo-1,4-dihydro-3-[1-oxo-2-hydrazino-3-{p-toluenesulfon}]quinoline (**7d**)*

Solvent of crystallization dichloromethane. Yield 79.89%. Mp 227 °C. IR (KBr) ν_{max}: 3408–3014 (br), 1666 (s, >CO hydrazide), 1599 (s, >CO), 1469 (w), 1336 (s, $-SO_2-$ asym. str.), 1216 (s), 1149 (s, $-SO_2-$ sym. str.), 762 (s) cm^{-1}. ^1H NMR (400 MHz; DMSO-d_6) δ (ppm): 11.30 (s, 1H, –CONH–), 9.62 (s, 1H, $-NHSO_2-$), 8.62 (s, 1H, H-2), 8.29 (d, 1H, H-5), 7.87 (d, 1H, H-8), 7.81 (dd, 2H, ArH), 7.41 (d, 1H, H-6), 7.22 (dd, 2H, ArH), 4.32 (q, 2H, $-CH_2CH_3$), 2.35 (s, 3H, $-CH_3$), 1.41 (t, 3H, $-CH_2CH_3$); ^{13}C NMR (75 MHz, DMSO-d_6) δ (ppm): 174.49, 163.20, 148.82, 143.47, 139.49, 138.46, 135.74, 129.53, 128.46, 127.49, 125.72, 125.62, 117.06, 110.17, 48.45, 21.03, 14.41; MS *m*/*z*: 420 (M^+), Anal. Calcd for $C_{19}H_{19}ClN_3O_4S$: C, 54.28; H, 4.52; N, 10.00. Found: C, 54.22; H, 4.48; N, 9.98.

*5.10. 7-Chloro-1-ethyl-6-fluoro-4-oxo-1,4-dihydro-3-[1-oxo-2-hydrazino-3-{p-toluenesulfon}]quinoline (**7e**)*

Solvent of crystallization dichloromethane. Yield 82.32%. Mp 212 °C. IR (KBr) ν_{max}: 3459–3022 (br), 1670 (s, >CO hydrazide), 1605 (s, >CO), 1482 (s), 1336 (s, $-SO_2-$ asym. str.), 1217 (s), 1142 (s, $-SO_2-$ sym. str.), 763 (s) cm^{-1}. ^1H NMR (400 MHz; DMSO-d_6) δ (ppm): 10.11 (s, 1H, –CONH–), 8.95 (s, 1H, $-NHSO_2-$), 7.70 (s, 1H, H-2), 7.19 (d, 1H, H-5), 7.03 (d, 1H, H-8), 6.63 (dd, 2H, ArH), 6.29 (dd, 2H, ArH), 3.39 (q, 2H, $-CH_2CH_3$), 2.38 (s, 3H, $-CH_3$), 1.25 (t, 3H, $-CH_2CH_3$); ^{13}C NMR (75 MHz, DMSO-d_6) δ (ppm): 173.75, 163.08, 156.16, 152.88, 148.72, 143.50, 135.72, 129.55, 127.49, 126.50, 126.24, 120.39, 112.21, 109.62, 48.81, 21.04, 14.50; MS *m*/*z*: 438 (M^+), Anal. Calcd for $C_{19}H_{18}FClN_3O_4S$: C, 52.05; H, 4.11; N, 9.58. Found: C, 51.98; H, 4.08; N, 9.48.

Acknowledgements

This work was financially supported by the University Grant Commission (UGC), grant no 31-128/2005 SR. We gratefully acknowledge the UGC, New Delhi for financial support and Sophisticated Analytical Instrument Facility (SAIF), Central Drug Research Institute, Lucknow-226001 (India) for providing spectral data on payment basis. We are also thankful to BioGenics, Research and Training Centre in Biotechnology, Hubli-580031, Karnataka for providing antibacterial assays to generate MIC data on payment basis.

References

[1] K. Todar, Pathogenic *E. coli*. Online Text Book of Bacteriology, University of Wisconsin–Madison Department of Bacteriology, pp. 11–30. Retrived on 2007.
[2] C. Kunin, Urinary Tract Infections, fifth ed., Williams & Wilkins, Baltimore, 1997, pp. 301–304.
[3] I.R. Iroha, M.U. Adikwu, C.O. Esimone, I. Aibinu, E.S. Amadi, Pak. J. Med. Sci. 25 (2009) 279–282.
[4] (a) G. Murakawa, J. Clin. Dermatol. 21 (2003) 56–63;
(b) K. Gupta, T.M. Hooton, K.G. Naber, B. Wult, R. Colgan, L.G. Miller, G.J. Moran, L.E. Nicolle, R. Raz, A.J. Schaeffer, D.E. Soper, Clin. Infect. Dis. 52 (2011) 103–120;
(c) W.E. Starre, J.T. Dissel, C. Nieuwkoop, Curr. Infect. Dis. Rep. 13 (2011) 571–578.
[5] A.R. Gennaro, Remington's Pharmaceutical Sciences, 18th ed., Mack Publishing Company, Philadelphia, PA, 1990.
[6] D.Z. Ross, C.M. Riley, Int. J. Pharm. 63 (1990) 237–250.
[7] W. Stamm, R. Norrby, J. Infect. Dis. (2001) 183.
[8] (a) M.D. Bethesda, National Kidney and Urologic Diseases Information Clearing House, NIH Publication, 2005, pp. 08–3925;
(b) S.H. David, A.S. Joseph, T. Francisco, S. Richard, D.H. John, L.D. Pamela, Urinary Tract Infections, Comprehensive Study Guide, sixth ed., (2008), pp. 606–612. New York.
[9] (a) T. Plech, M. Wujec, U. Kosikowska, A. Malm, B. Rajtar, M.P. Dacewicz, Eur. J. Med. Chem. 60 (2013) 128–134;
(b) G. Hiltensperger, N.G. Jones, S. Niedermeier, A. Stich, M. Kaiser, J. Jung, S. Puhl, A. Damme, H. Braunschweig, L. Meinel, M. Engstler, U. Holzgrabe, J. Med. Chem. 55 (2012) 2538–2548;
(c) S.H. Elsea, N. Osheroff, J.L. Nitiss, J. Biol. Chem. 19 (1992) 13150–13153;
(d) Q.D. You, Z.Y. Li, C.H. Huang, Q. Yang, X.J. Wang, Q.L. Guo, X.G. Chen, X.G. He, T.K. Li, J.W. Chern, J. Med. Chem. 52 (2009) 5649–5661;
(e) Y. Asahina, I. Araya, K. Iwase, F. Iinuma, M. Hosaka, T. Ishizaki, J. Med. Chem. 48 (2005) 3443–3446;
(f) G. Cianchetta, R. Mannhold, G. Cruciani, M. Baroni, V. Cecchetti, J. Med. Chem. 47 (2004) 3193–3201.
[10] H.H. Chung, J.B. Lee, Y.H. Chung, K.G. Lee, Food Chem. 113 (2009) 297–301.
[11] (a) A. Kumar, Synthesis of Heterocyclic Compounds with Special Attention to the Biological Activity of Quinolones and Their Analogues (2013). A part of Ph.D thesis submitted to the M.J.P. Rohilkhand University, Bareilly, (U.P.), India – 243006;
(b) N. Srivastava, A. Kumar, Orient. J. Chem. 29 (2013) 507–511.
[12] L. Claisen, Ann. Chem. 77 (1897) 297.
[13] R. Camps, Ber. Chem. 34 (1901) 2714.
[14] H. Koga, A. Itoh, S. Murayama, S. Suzue, T. Irikura, J. Med. Chem. 23 (1980) 1358–1363.