Med Chem Res (2011) 20:1054–1067
DOI 10.1007/s00044-010-9443-x

MEDICINAL CHEMISTRY RESEARCH

ORIGINAL RESEARCH

Synthesis and in vitro microbial activities of amides of pyridoquinolone

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Received: 23 November 2009 / Accepted: 17 September 2010 / Published online: 2 October 2010

Abstract In this study, we report the antimicrobial evaluation of newly synthesized amides of pyridoquinolones from substituted aniline, substituted phenyl thioureas and 4-amino-*N*-(substitutedphenyl)benzenesulfonamide. Structures of selected compounds have been established by IR and ^{1}H NMR spectra and elemental analysis. The structure–activity releationships have been studied by screening of antimicrobial activity over *S. aureus, B. subtilis*, *E. coli*, *P. aeruginosa*, and *C. albicans* using cup–plate method.

Keywords Pyridoquinolone · Phenyl thioureas · Sulfonamides · Antimicrobial activity

Introduction

Discovery of nalidixic acid gave an important class of antibacterial known as fluoroquinolones. They can inhibit DNA gyrase and topoisomerase IV enzymes, essential for DNA supercoiling. Phenyl thiourea derivatives possess significant pharmacological importance, e.g., antiviral (Yan *et al*., 2009), antimicrobial (Turan-Zitouni *et al*., 2002), antidiabetic (Maruyama *et al*., 2009), antitubercular (Sycheva *et al*., 1966) etc. Sulfonamides demonstrated bacteriostatic activity by inhibiting the bio-synthesis of folic acid (Brown, 1962). Its derivatives possess versatile activity, e.g., carbonic anhydrase inhibitors (Supuran *et al*., 1998), anticancer (Reddy *et al*., 2004), anti-inflammatory (Li *et al*., 1995), anti-HIV (Selvam *et al*., 2001), COX-2 inhibitors (Dannhardt *et al*., 2002), selective 5-HT receptor antagonist (Bromidge *et al*., 2002), antitubercular (Kamal *et al*., 2007) and antifungal (Briganti *et al*., 1997) etc. Pyridoquinolones were synthesized and evaluated for antimicrobial activity (Lee *et al*., 1992; Lee and Chang, 1994, 1996), in which pyridine ring was fused with quinazoline ring, and generally known as phenanthroline. The structure–activity relationships of fluoroquinolone have been studied in some reviews (Mitscher, 2005; Bhanot *et al*., 2001); consideration of the above facts and the presence of fused pyrido ring in nalidixic acid urged us to synthesize structurally similar compounds to fluoroquinolone by replacing fluoro group with chloro and hydroxy groups at C–6 possition with fused pyrido ring; the carboxylic acid group was further converted to amides for enhanced antimicrobial activity.

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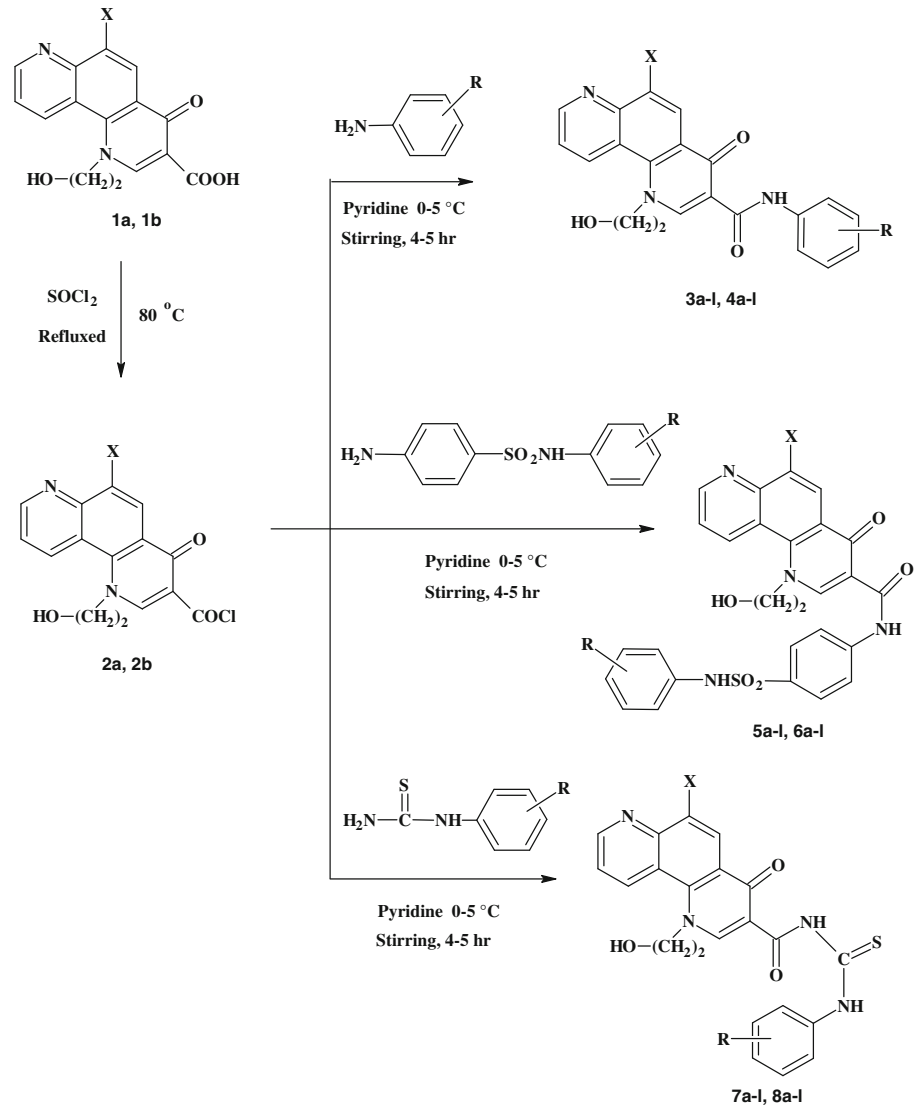
Results and discussion

Chemistry

We have synthesized amides of pyridoquinolone **3a–l**, **4a–l**, **5a–l**, **6a–l**, **7a–l**, and **8a–l** from substituted aniline, substituted phenyl thioureas, and 4-amino-*N*-(substitutedphenyl)benzenesulfonamide as illustrated in Scheme 1: their structures were confirmed by elemental analysis, IR, and ^{1}H NMR spectral data. IR absorption bands in cm^{-1} were obsevered at 3412 (NH), 3360 (OH), 2942, 2865 (CH), 1739 (>C=O of quinolone), 1640 (amide-I), 1535 (amide-II), 1305 (C–N), 1250 (amide-III), 810 (C–Cl), 1325, 1180 (S=O, sym, asym), and 1160 (>C=S), 1075 (S–N); some additional peaks appeared due to substitution in aromatic ring at 1512, 1352 (N=O sym, asym), 1265, 1046 (C–O–C), and 2236 (>C≡N). In ^{1}H NMR spectra, the following common signals appeared at δ_H (ppm) values: a singlet



X = Cl for 1a, 2a, 3a-l, 5a-l, 7a-l X = OH for 1b, 2b, 4a-l, 6a-l, 8a-l

R =

	a	b	c	d	e	f	g	h	i	j	K	l
3	-H	3-Cl	4-Cl	2-OCH_3	4-OCH_3	2-NO_2	3-NO_2	4-NO_2	2-CH_3	3-CH_3	4-CH_3	2,5-di-CH_3
4	-H	3-Cl	4-Cl	2-OCH_3	4-OCH_3	2-NO_2	3-NO_2	4-NO_2	2-CH_3	3-CH_3	4-CH_3	2,5-di-CH_3
5	-H	3-Cl	4-Cl	2-OCH_3	4-OCH_3	3-NO_2	4-NO_2	2-CH_3	3-CH_3	4-CH_3	2,5-di-CH_3	2-CN, 4-NO_2
6	-H	3-Cl	4-Cl	2-OCH_3	4-OCH_3	3-NO_2	4-NO_2	2-CH_3	3-CH_3	4-CH_3	2,5-di-CH_3	2-CN, 4-NO_2
7	-H	3-OH	4-OH	2-OCH_3	4-OCH_3	2-NO_2	3-NO_2	4-NO_2	2-CH_3	3-CH_3	4-CH_3	3-Cl
8	-H	3-OH	4-OH	2-OCH_3	4-OCH_3	2-NO_2	3-NO_2	4-NO_2	2-CH_3	3-CH_3	4-CH_3	3-Cl

Scheme 1 Synthetic route of compounds **3a–l**, **4a–l**, **5a–l**, **6a–l**, **7a–l**, **8a–l**

signal at δ 7.80, and 8.50 corresponding to H-2 and H-5 of quinolone ring, respectively; a multiplet at δ 3.20 corresponding to >N–$(CH_2)_2$–O; a singlet at δ 4.25 corresponding to CH_2OH; a multiplet at δ 8.75–9.50 corresponding to pyrido ring; a singlet at δ 5.40 corresponding to Ar–OH; a singlet at δ 10.10 corresponding to >CO.NH; and a singlet single at δ 10.20 and 10.28 corresponding to –$SONH_2$ and >CS.NH, respectively, Due to the substitution on aromatic ring, a singlet appeared at δ 6.56 and 3.85 corresponding to Ar–OH and Ar–OCH_3, repectively. Substituted phenyl thiourea derivatives (Venkatesh and Pandeya, 2009; Bhusari *et al.*, 2008) and substituted 4-amino-*N*-(substitutedphenyl)benzenesulfonamide (Hirpara *et al.*, 2004) have been synthesized as per the previously reported methods (Table 1).

Table 1 Antibacterial and antifungal activity of synthesized compounds

Zone of inhibition in mm at 100 μg/ml										
Compd.	Gram negative				Gram positive				Fugal species	
	E. coli		*P. aeruginosa*		*S. aureus*		*B. subtilis*		*C. albicans*	
	Z.I	A.I	Z.I	A.I	Z.I.	A.I.	Z.I.	A.I.	Z.I.	A.I.
3a	12	0.8	09	0.52	12	0.7	11	0.68	05	0.55
3b	07	0.46	07	0.41	08	0.47	09	0.6	03	0.33
3c	06	0.4	06	0.35	05	0.29	07	0.43	02	0.22
3d	08	0.53	08	0.47	09	0.52	10	0.62	03	0.33
3e	00	–	06	0.35	06	0.66	06	0.35	02	0.22
3f	11	0.73	11	0.64	08	0.47	10	0.62	04	0.44
3g	09	0.6	09	0.52	09	0.52	06	0.35	03	0.33
3h	09	0.6	10	0.58	10	0.66	06	0.35	04	0.44
3i	07	0.46	04	0.23	00	–	05	0.31	00	–
3j	10	0.66	10	0.58	10	0.66	09	0.6	04	0.44
3k	04	0.26	05	0.29	05	0.29	07	0.43	00	–
3l	10	0.66	08	0.47	08	0.47	09	0.6	00	–
4a	08	0.53	08	0.47	07	0.41	06	0.35	01	0.11
4b	04	0.26	04	0.23	00	–	06	0.35	00	–
4c	10	0.66	08	0.47	12	0.7	10	0.62	05	0.55
4d	06	0.4	00	–	06	0.66	08	0.5	01	0.11
4e	11	0.73	10	0.58	10	0.58	12	0.75	05	0.55
4f	09	0.6	09	0.52	10	0.58	11	0.68	04	0.44
4g	08	0.53	10	0.58	07	0.41	08	0.5	02	0.22
4h	06	0.4	06	0.35	08	0.47	07	0.43	00	–
4i	09	0.6	10	0.58	06	0.66	06	0.35	00	–
4j	00	–	06	0.35	05	0.29	06	0.35	01	0.11
4k	10	0.66	09	0.52	09	0.52	08	0.5	03	0.33
4l	09	0.6	08	0.47	08	0.47	09	0.6	02	0.22
5a	06	0.4	07	0.41	08	0.47	10	0.62	02	0.22
5b	10	0.66	10	0.58	11	0.64	09	0.6	04	0.44
5c	08	0.53	00	–	06	0.66	07	0.43	01	0.11
5d	05	0.33	05	0.29	06	0.66	06	0.35	02	0.22
5e	09	0.6	10	0.58	09	0.52	10	0.62	03	0.33
5f	07	0.46	05	0.29	06	0.66	08	0.5	02	0.22
5g	11	0.73	09	0.52	09	0.52	10	0.62	03	0.33
5h	09	0.6	09	0.52	09	0.52	10	0.62	03	0.33
5i	00	–	04	0.23	00	–	06	0.35	00	–
5j	05	0.33	07	0.41	05	0.29	06	0.35	01	0.11
5k	10	0.66	10	0.58	10	0.58	09	0.6	04	0.44
5l	08	0.53	08	0.47	08	0.47	09	0.6	02	0.22
6a	09	0.6	10	0.58	09	0.52	08	0.5	03	0.33
6b	09	0.6	08	0.47	08	0.47	09	0.6	03	0.33
6c	04	0.26	04	0.23	00	–	06	0.35	00	–
6d	00	–	06	0.35	06	0.66	08	0.5	01	0.11
6e	08	0.53	08	0.47	10	0.58	11	0.68	04	0.44
6f	08	0.53	07	0.41	08	0.47	08	0.5	02	0.22
6g	12	0.8	10	0.58	10	0.58	11	0.68	04	0.44
6h	00	–	04	0.23	04	0.26	06	0.35	00	–
6i	10	0.66	11	0.64	11	0.64	12	0.75	05	0.55

Table 1 continued

Zone of inhibition in mm at 100 μg/ml										
Compd.	Gram negative				Gram positive				Fugal species	
	E. coli		*P. aeruginosa*		*S. aureus*		*B. subtilis*		*C. albicans*	
	Z.I	A.I	Z.I	A.I	Z.I.	A.I.	Z.I.	A.I.	Z.I.	A.I.
6j	05	0.33	00	–	05	0.29	06	0.35	00	–
6k	10	0.66	11	0.64	11	0.64	09	0.6	04	0.44
6l	06	0.4	08	0.47	08	0.47	06	0.35	02	0.22
7a	10	0.66	09	0.52	09	0.52	11	0.68	03	0.33
7b	08	0.53	06	0.35	08	0.47	09	0.6	02	0.22
7c	12	0.80	11	0.64	12	0.7	11	0.68	05	0.55
7d	05	0.33	03	0.17	00	–	06	0.35	00	–
7e	08	0.53	06	0.35	08	0.47	09	0.6	02	0.22
7f	10	0.66	08	0.47	12	0.7	09	0.6	04	0.44
7g	00	–	08	0.47	08	0.47	06	0.35	01	0.11
7h	10	0.66	09	0.52	11	0.64	12	0.75	05	0.55
7i	00	–	04	0.23	06		08	0.5	02	0.22
7j	11	0.73	10	0.58	10	0.58	09	0.6	04	0.44
7k	06	0.4	00	–	06	0.66	06	0.35	00	–
7l	09	0.6	09	0.52	08	0.47	10	0.62	03	0.33
8a	11	0.73	10	0.58	11	0.64	15	0.93	04	0.44
8b	09	0.6	07	0.41	08	0.47	10	0.66	03	0.33
8c	06	0.4	06	0.35	06	0.66	07	0.43	00	–
8d	00	–	04	0.23	04	0.26	00	–	00	–
8e	08	0.53	08	0.47	08	0.47	06	0.35	02	0.22
8f	05	0.33	04	0.23	00	–	05	0.31	01	0.11
8g	09	0.6	10	0.58	07	0.41	07	0.43	00	–
8h	12	0.8	10	0.58	10	0.58	09	0.6	04	0.44
8i	06	0.4	00	–	05	0.29	07	0.43	00	–
8j	09	0.6	09	0.52	09	0.52	08	0.5	03	0.33
8k	06	0.4	04	0.23	00	–	06	0.35	01	0.11
8l	10	0.66	09	0.52	09	0.52	10	0.62	03	0.33
Ciprofloxacin	15	1	17	1	17	1	16	1		
Amphoterian-B									9	1

Z.I Zone of inhibition in mm, *A.I.* Activity index

A.I. = Zone of inhibition of compounds/Zone of inhibition of standard drug

Antimicrobial activity

Antibacterial and antifungal activity of all the synthesized compounds have been screened against five different strains, e.g., two Gram-positive *S. aureus*, *B. subtilis*, two Gram-negative *E. coli*, *P. aeruginosa* bacteria and fungi *C. albicans* by cup–plate method (Collee *et al*., 1996) at 100 μg/mL concentration, compared with standard drug ciprofloxacin and amphotericin-B.

Amides **3d**, **3g**, **3h**, **3j**, **3l**, **4a**, **4f**, **4c**, **4g**, **4i**, **4k**, **4l**, sulfonamides **5b**, **5c**, **5e**, **5k**, **5l**, **6a**, **6b**, **6e**, **6f**, **6k,** and thioureido amides **7a**, **7b**, **7e**, **7f**, **7h**, **7l**, **8b**, **8e**, **8g**, **8j**, **8l**; demostrated good activity against *E. coli*; whereas amides **3a**, **3f**, **4e**, sulfonamides **5g**, **6g** and thioureido amides **7c**, **7j**, **8a**, **8h** demostrated strong activity against *E. coli*.

Amides **3a**, **3f**, **3g**, **3h**, **3j**, **4e**, **4g**, **4i**, **4f**, **4k**, sulfonamides **5b**, **5e**, **5g**, **5h**, **5k**, **6a**, **6g**, **6i**, **6k,** and thioureido amides **7c**, **7j**, **7l**, **8a**, **8g**, **8h**, **8j**, **8l** demostrated good activity against *P. aeruginosa*. Amides **3a**, **3d**, **3e**, **3g–j**, **4c–f**, **4i**, **4k**, sulfonamides **5b–h**, **5k**, **6a**, **6d**, **6e**, **6g**, **6i**, **6k** and thioureido amides **7a**, **7c**, **7f**, **7h**, **7j**, **7k**, **8a**, **8c**, **8h**, **8j**, **8l** showed good activity against *S. aureus*.

Amides **3a**, **3b**, **3d**, **3f**, **3j**, **3l**, **4c**, **4d**, **4f**, **4g**, **4k**, **4l**, sulfonamides **5a**, **5b**, **5e–h**, **5l**, **6a**, **6b**, **6e**, **6f**, **6g**, **6k**, and

thioureido amides **7a–c**, **7e**, **7f**, **7j**, **7l**, **8b**, **8h**, **8j**, **8l** demostrated good activity against *B. substilis*; whereas amide **4e**, sulfonamides **6i**, and thioureido amides **7h**, **8a** demostrated srong activity against *B. substilis*.

Amides **3a**, **4c**, **4e**; sulfonamide **6i**, and thioureido amides **7c**, **7h**, showed good activity against *C. albicans*.

Conclusion

The structure–activity relationship study demonstrated that electron withdrawing as well as eletrodonating groups at phenyl ring were active; whereas chloro and hydroxyl groups at C–6 possition showed similar activity. Variations in antimicrobial activities of amides were observed.

Activities of amides in increasing order:

Thioureido amides < Sulfonamides < Amide

Activities against bacteria in increasing order:

P. aeruginosa < *S. aureus* < *B. substilis* < *E. coli*

Experimental

General

Melting points (m.p.) were determined in open capillaries and left uncorrected. The IR spectra were recorded on Shimadzu FTIR spectrophotometer, using KBr pallets. ^{1}H NMR spectra were recorded in (DMSO-d_6) using Bruker DRX-300 spectrometer at 300 MHz; the chemical shifts are reported in part per million (δ ppm) using tetramethylsilane (TMS) as an internal standard. Elemental analysis (C, H, and N) of compounds was performed on Carlo Erba 1108.

6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (**1a**)

The parent molecule was prepared from 5-amino-8-chloro quinoline on reaction with diethyl ethoxymethelene malonate and cyclized in diethyl ether; further condensation with chloroethanol gave ester, which finally hydrolyzed to title compounds (Lee *et al*., 1992). ^{1}H NMR (DMSO-d_6): δ 3.61 (m, 4H, >N(CH_2)$_2$O), 4.25 (s, 1H, CH_2OH), 8.50 (s, H-2, quinolone), 7.80 (s, H-5, quinolone), 8.75–9.40 (m, 3H, pyrido), and 13.00 (s, 1H, COOH).

6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (**1b**)

The parent molecule was prepared from 5-amino-8-hydroxy quinoline on reaction with diethyl ethoxymethelene malonate and cyclized in diethyl ether; further condensation with chloroethanol gave ester, which finally hydrolyzed to title compounds (Lee *et al*., 1992). ^{1}H NMR (DMSO-d_6): δ 3.61 (m, 4H, >N(CH_2)$_2$O), 4.25 (s, 1H, CH_2OH), 8.50 (s, H-2, quinolone), 7.80 (s, H-5, quinolone), 5.65 (s, 1H, Ar–OH), 8.75–9.40 (m, 3H, pyrido), and 13.00 (s, 1H, COOH).

6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl chloride (**2a**)

The mixture of 6-chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylic acid (**1a**) (0.01 mol) and thionyl chloride (0.01 mol) was refluxed using chloroform as a solvent in water bath at 80°C for 5–6 h in anhydrous condition with the help of calcium chloride guard tube, until the HCl gas evolution ceased, and then solvent was removed by distillation. The solid material of the title compound was obtained and used in next step.

6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl chloride (**2b**)

The mixture of 6-hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylic acid (**1b**) (0.01 mol) and thionyl chloride (0.01 mol) was refluxed using chloroform as a solvent in water bath at 80°C for 5–6 h in anhydrous condition with the help of calcium chloride guard tube, until the HCl gas evolution ceased, and then solvent was removed by distillation. The solid material of the title compound was obtained and used in next step.

6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (substitutedphenyl)amide (**3a–l**)

Substituted aniline (0.005 mol) was dissolved in dry pyridine and added dropwise in solution of carbonyl chloride (**2a**) (0.005 mol) in pyridine within 1.5 h with constant stirring at 0–5°C and refluxed for 8 h; then, material was poured into acidic crushed ice, and the solid mass was filtered and washed thoroughly with $NaHCO_3$ solution for neutralization. The purity of the compounds was monitored by TLC on silica gel glass plate using benzene:ethylacetate (1:1) as mobile phase.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid phenylamide (**3a**)*

Yield = 62%, m.p. 256–258°C. IR (KBr) cm^{-1}: 3412 (NH); 3360 (OH); 2942, 2865 (CH); 1739 (>C=O of quinolone); 1640 (amide-I); 1535 (amide-II); 1305 (C–N); 1250 (amide-III); and 810 (C–Cl). ^{1}H NMR (DMSO-d_6):

δ 3.25 (m, 4H, >N$(CH_2)_2$O); 4.45 (s, 1H, CH_2OH); 8.71 (s, H-2, quinolone); 8.88 (s, H-5, quinolone); 8.94–9.55 (m, 3H, pyrido); 10.10 (s, 1H, CO.NH); and 7.28–7.92 (m, 5H, Ar–H). Anal. Calcd. for $C_{21}H_{16}O_3N_3Cl$: C, 64.11; H, 4.10; and N, 10.69. Found: C, 64.12; H, 4.12; and N, 10.65.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (3-chlorophenyl)amide (**3b**)*

Yield = 53%, m.p. 278–280°C.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (4-chlorophenyl)amide (**3c**)*

Yield = 65%. m.p. 247–249°C. IR (KBr) cm^{-1}: 3425 (NH); 3365 (OH); 2937; 2864 (CH); 1745 (>C=O of quinolone); 1645 (amide-I); 1525 (amide-II); 1315 (C–N); 1254 (amide-III); and 786 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.20 (m, 4H, >N$(CH_2)_2$O); 4.35 (s, 1H, CH_2OH); 8.70 (s, H-2, quinolone); 8.84 (s, H-5, quinolone); 8.95–9.55 (m, 3H, pyrido); 10.15 (s, 1H, CO.NH); and 7.20–7.95 (m, 4H, Ar–H). Anal. Calcd. for $C_{21}H_{15}O_3N_3Cl_2$: C, 59.01; H, 3.54; and N, 9.84. Found: C, 59.05; H, 3.56; and N, 9.82.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (2-methoxyphenyl)amide (**3d**)*

Yield = 67%, m.p. 255–257°C.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (4-methoxyphenyl)amide (**3e**)*

Yield = 62%, m.p. 271–272°C. IR (KBr) cm^{-1}: 3427 (NH); 3360 (OH); 2935, 2861 (CH); 1752 (>C=O of quinolone); 1652 (amide-I); 1535 (amide-II); 1312 (C–N); 1245 (amide-III); 1235, 1040 (C–O–C); and 786 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.21 (m, 4H, >N$(CH_2)_2$O); 4.27 (s, 1H, CH_2OH); 8.65 (s, H-2, quinolone); 8.88 (s, H-5, quinolone); 8.97–9.61 (m, 3H, pyrido); 10.25 (s, 1H, CONH); 7.21–7.79 (m, 4H, Ar–H); and 3.85 (s, 3H, Ar–OCH_3). Anal. Calcd. for $C_{22}H_{18}O_4N_3Cl$: C, 62.40; H, 4.29; and N, 9.93. Found: C, 62.38; H, 4.27; and N, 9.90.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (2-nitrophenyl)amide (**3f**)*

Yield = 55%, m.p. 260–262°C.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (3-nitrophenyl)amide (**3g**)*

Yield = 66%, m.p. 277–279°C. IR (KBr) cm^{-1}: 3433 (NH); 3355 (OH); 2937, 2865 (CH); 1745 (>C=O of quinolone); 1645 (amide-I); 1525 (amide-II); 1510, 1330 (N=O sym, asym); 1320 (C–N); 1235 (amide-III); and 792 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.28 (m, 4H, >N$(CH_2)_2$O); 4.25 (s, 1H, CH_2OH); 8.61 (s, H-2, quinolone); 8.87 (s, H-5, quinolone); 8.81–9.65 (m, 3H, pyrido); 10.21 (s, 1H, CO.NH); and 7.18–7.65 (m, 4H, Ar–H). Anal. Calcd. for $C_{21}H_{15}O_5N_4Cl$: C, 57.52; H, 3.45; and N, 12.79. Found: C, 57.51; H, 3.42; and N, 12.77.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (4-nitrophenyl)amide (**3h**)*

Yield = 62%, m.p. 250–252°C.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (2-methylphenyl)amide (**3i**)*

Yield = 53%, m.p. 247–249°C. IR (KBr) cm^{-1}: 3435 (NH); 3358 (OH); 2925, 2861 (CH); 1745 (>C=O of quinolone); 1645 (amide-I); 1525 (amide-II); 1308 (C–N); 1232 (amide-III); and 798 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.27 (m, 4H, >N$(CH_2)_2$O); 4.25 (s, 1H, CH_2OH); 8.61 (s, H-2, quinolone); 8.79 (s, H-5, quinolone); 8.85–9.61 (m, 3H, pyrido); 10.14 (s, 1H, CO.NH); 7.22–7.80 (m, 4H, Ar–H); and 2.22 (s, 3H, Ar–CH_3). Anal. Calcd. for $C_{22}H_{18}O_3N_3Cl$: C, 64.85; H, 4.46; and N, 10.32. Found: C, 64.81; H, 4.42; and N, 10.37.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (3-methylphenyl)amide (**3j**)*

Yield = 58%, m.p. 268–270°C.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (4-methylphenyl)amide (**3k**)*

Yield = 64%, m.p. 241–243°C. IR (KBr) cm^{-1}: 3425 (NH); 3345 (OH); 2935, 2865 (CH); 1752 (>C=O of quinolone); 1648 (amide-I); 1521 (amide-II); 1315 (C–N); 1237 (amide-III); and 788 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.29 (m, 4H, >N$(CH_2)_2$O); 4.21 (s, 1H, CH_2OH); 8.56 (s, H-2, quinolone); 8.85 (s, H-5, quinolone); 8.90–9.62 (m, 3H, pyrido); 10.15 (s, 1H, CO.NH); 7.21–7.82 (m, 4H,

Ar–H); 2.25 (s, 3H, Ar–CH_3). Anal. Calcd. for $C_{22}H_{18}O_3N_3Cl$: C, 64.85; H, 4.46; and N, 10.32. Found: C, 64.82; H, 4.41; and N, 10.35.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (2,5-dimethylphenyl)amide (**3l**)*

Yield = 60%, m.p. 265–267°C.

6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (substitutedphenyl)amide (**4a–l**)

Substituted aniline (0.005 mol) was dissolved in dry pyridine and added dropwise in solution of carbonyl chloride (**2b**) (0.005 mol) in pyridine within 1.5 h with constant stirring at 0–5°C and refluxed for 8 h, then refluxed material was poured into acidic crushed ice, the solid mass was filtered and washed thoroughly with $NaHCO_3$ solution for neutralization. The purity of the compounds was monitored by TLC on silica gel glass plate using benzene:ethylacetate (1:1) as mobile phase.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid phenylamide (**4a**)*

Yield = 58%, m.p. 244–246°C. IR (KBr) cm^{-1}: 3425 (NH); 3345 (OH); 2965, 2854 (CH); 1749 (>C=O of quinolone); 1668 (amide-I); 1565 (amide-II); 1315 (C–N); and 1258 (amide-III). ^1H NMR (DMSO-d_6): δ 3.60 (m, 4H, >N(CH_2)$_2$O); 4.35 (s, 1H, CH_2OH); 8.70 (s, H-2, quinolone); 8.15 (s, H-5, quinolone); 9.10–9.60 (m, 3H, pyrido); 10.10 (s, 1H, CO.NH); 5.65 (s, 1H, Ar–OH); and 6.95–7.40 (m, 5H, Ar–H). Anal. Calcd. for $C_{21}H_{17}O_4N_3$: C, 67.18; H, 4.57; and N, 11.20. Found: C, 67.15; H, 4.55; and N, 11.18.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (3-chlorophenyl)amide (**4b**)*

Yield = 64%, m.p. 265–267°C.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (4-chlorophenyl)amide (**4c**)*

Yield = 62%, m.p. 261–263°C. IR (KBr) cm^{-1}: 3421 (NH); 3335 (OH); 2961, 2851 (CH); 1751 (>C=O of quinolone); 1665 (amide-I); 1569 (amide-II); 1312 (C–N); 1252 (amide-III); and 788 (C–Cl). ^1H NMR (DMSO-d_6): δ 3.61 (m, 4H, >N(CH_2)$_2$O); 4.25 (s, 1H, CH_2OH); 8.65 (s, H-2, quinolone); 8.10 (s, H-5, quinolone); 9.12–9.65 (m, 3H, pyrido); 10.15 (s, 1H, CO.NH); 5.62 (s, 1H, Ar–OH); and 6.85–7.45 (m, 4H, Ar–H). Anal. Calcd. for $C_{21}H_{16}O_4N_3Cl$: C, 61.60; H, 3.94; and N, 10.27. Found: C, 61.62; H, 3.92; and N, 10.22.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (2-methoxyphenyl)amide (**4d**)*

Yield = 62%, m.p. 261–263°C.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (4-methoxyphenyl)amide (**4e**)*

Yield = 65%, m.p. 258–260°C. IR (KBr) cm^{-1}: 3422 (NH); 3339 (OH); 2961, 2852 (CH); 1752 (>C=O of quinolone); 1664 (amide-I); 1561 (amide-II); 1310 (C–N); 1245 (amide-III) 1225, and 1038 (C–O–C). ^1H NMR (DMSO-d_6): δ 3.68 (m, 4H, >N(CH_2)$_2$O); 4.37 (s, 1H, CH_2OH); 8.68 (s, H-2, quinolone); 8.25 (s, H-5, quinolone); 9.15–9.65 (m, 3H, pyrido); 10.15 (s, 1H, CO.NH); 5.61 (s, 1H, Ar–OH); 6.85-7.45 (m, 4H, Ar–H); and 3.95 (s, 3H, Ar–OCH_3). Anal. Calcd. for $C_{22}H_{19}O_5N_3$: C, 65.16; H, 4.73; and N,10.37. Found: C, 65.15; H, 4.51; and N, 10.35.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (2-nitrophenyl)amide (**4f**)*

Yield = 60%, m.p. 266–267°C.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (3-nitrophenyl)amide (**4g**)*

Yield = 66%, m.p. 235–237°C. IR (KBr) cm^{-1}: 3428 (NH); 3325 (OH); 2965, 2858 (CH); 1745 (>C=O of quinolone); 1662 (amide-I); 1565 (amide-II); 1512, 1339 (N=O sym, asym); 1307 (C–N); and 1252 (amide-III). ^1H NMR (DMSO-d_6): δ 3.65 (m, 4H, >N(CH_2)$_2$O); 4.32 (s, 1H, CH_2OH); 8.71 (s, H-2, quinolone); 8.15 (s, H-5, quinolone); 9.10–9.62 (m, 3H, pyrido); 10.12 (s, 1H, CO.NH); 5.62 (s, 1H, Ar–OH); and 6.79–7.35 (m, 4H, Ar–H). Anal. Calcd. for $C_{21}H_{16}O_6N_4$: C, 59.98; H, 3.84; and N, 13.33. Found: C, 59.95; H, 3.82; and N, 13.31.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (4-nitrophenyl)amide (**4h**)*

Yield = 64%, m.p. 255–258°C.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (2-methylphenyl)amide (**4i**)*

Yield = 55%, m.p. 247–249°C. IR (KBr) cm^{-1}: 3435 (NH); 3320 (OH); 2955, 2854 (CH); 1751 (>C=O of quinolone); 1665 (amide-I); 1561 (amide-II); 1310 (C–N); and 1245 (amide-III). ^1H NMR (DMSO-d_6): δ 3.67 (m, 4H, $>N(CH_2)_2O$); 4.21 (s, 1H, CH_2OH); 8.65 (s, H-2, quinolone); 8.05 (s, H-5, quinolone); 9.12–9.55 (m, 3H, pyrido); 10.18 (s, 1H, CO.NH); 5.65 (s, 1H, Ar–OH); 6.71–7.25 (m, 4H, Ar–H); and 2.14 (s, 3H, Ar–CH_3). Anal. Calcd. for $C_{22}H_{19}O_4N_3$: C, 67.84; H, 4.92; and N, 10.80. Found: C, 67.82; H, 4.91; and N, 10.78.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylic acid (3-methylphenyl)amide (**4j**)*

Yield = 67%, m.p. 270–271°C.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (4-methylphenyl)amide (**4k**)*

Yield = 62%, m.p. 261–263°C.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid (2,5-dimethylphenyl)amide (**4l**)*

Yield = 57%, m.p. 255–257°C.

6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(phenylsulfamoyl)phenyl]amide (**5a–l**)

4-Amino-*N*-(substitutedphenyl)benzenesulfonamides (0.005 mol) was dissolved in dry pyridine and added dropwise in solution of carbonyl chloride **2a** (0.005 mol) in pyridine within 1.5 h with constant stirring at 0–5°C and refluxed for 8 h, then refluxed material was poured into acidic crushed ice, the solid mass was filtered and washed thoroughly with $NaHCO_3$ solution for neutralization. The purity of the compounds was monitored by TLC on silica gel glass plate using benzene:ethylacetate (1:1) as mobile phase.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(phenylsulfamoyl)phenyl]amide (**5a**)*

Yield = 66%, m.p. 241–243°C.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(3-chlorophenylsulfamoyl)phenyl]amide (**5b**)*

Yield = 60%, m.p. 239–240°C. IR (KBr) cm^{-1}: 3425 (NH); 3365 (OH); 2945, 2850 (CH); 1742 (>C=O of quinolone); 1680 (amide-I); 1565 (amide-II); 1325, 1180 (S=O, sym, asym); 1310 (C–N); 1255 (amide-III); 1075 (S–N); and 798 (C–Cl). ^1H NMR (DMSO-d_6): δ 3.58 (m, 4H, $>N(CH_2)_2O$); 4.44 (s, 1H, CH_2OH); 8.68 (s, H-2, quinolone); 7.95 (s, H-5, quinolone); 8.98–9.75 (m, 3H, pyrido); 10.10 (s, 1H, CO.NH); 10.32 (s, 1H, SO_2NH); and 7.15–7.70 (m, 4H, Ar–H). Anal. Calcd. for $C_{27}H_{20}O_5N_4SCl_2$: C, 55.67; H, 3.46; and N, 9.62. Found: C, 55.62; H, 3.42; and N, 9.60.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(4-chlorophenylsulfamoyl)phenyl]amide (**5c**)*

Yield = 56%, m.p. 260–262°C.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(2-methoxyphenylsulfamoyl)phenyl]amide (**5d**)*

Yield = 64%, m.p. 257–259°C. IR (KBr) cm^{-1}: 3431 (NH); 3361 (OH); 2937, 2848 (CH); 1748 (>C=O of quinolone); 1665 (amide-I); 1557 (amide-II); 1325, 1180 (S=O, sym, asym); 1310 (C–N); 1255 (amide-III); 1212, 1035 (C–O–C); 1075 (S–N); and 798 (C–Cl). ^1H NMR (DMSO-d_6): δ 3.62(m, 4H, $>N(CH_2)_2O$); 4.47 (s, 1H, CH_2OH); 8.61 (s, H-2, quinolone); 7.90 (s, H-5, quinolone); 8.91–9.72 (m, 3H, pyrido); 10.15 (s, 1H, CO.NH); 9.95 (s, 1H, SO_2NH); 7.01–7.65 (m, 4H, Ar–H); and 3.82 (s, 3H, Ar–OCH_3). Anal. Calcd. for $C_{28}H_{23}O_6N_4SCl$: C, 58.12; H, 4.01; and N, 9.69. Found: C, 58.10; H, 4.06; and N, 9.64.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(4-methoxyphenylsulfamoyl)phenyl]amide (**5e**)*

Yield = 52%, m.p. 274–276°C.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(3-nitrophenylsulfamoyl)phenyl]amide (**5f**)*

Yield = 55%, m.p. 247–249°C. IR (KBr) cm^{-1}: 3426 (NH); 3358 (OH); 2928, 2835 (CH); 1751 (>C=O of quinolone); 1671 (amide-I); 1562 (amide-II); 1528, 1332 (N=O sym, asym); 1335, 1182 (S=O, sym, asym); 1315

(C–N); 1265 (amide-III); and 1065 (S–N); 795 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.62 (m, 4H, >N(CH_2)$_2$O); 4.47 (s, 1H, CH_2OH); 8.61 (s, H-2, quinolone); 7.90 (s, H-5, quinolone); 8.91–9.72 (m, 3H, pyrido); 10.15 (s, 1H, CO.NH); 9.95 (s, 1H, SO_2NH); and 7.01–7.65 (m, 4H, Ar–H). Anal. Calcd. for $C_{27}H_{20}O_7N_5SCl$: C, 54.63; H, 3.40; and N, 11.81. Found: C, 54.60; H, 3.38; and N, 11.78.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(4-nitrophenylsulfamoyl)phenyl]amide (**5g**)*

Yield = 61%, m.p. 259–261°C.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(2-methyphenylsulfamoyl)phenyl]amide (**5h**)*

Yield = 63%, m.p. 236–237°C. IR (KBr) cm^{-1}: 3420 (NH); 3345 (OH); 2932, 2821 (CH); 1741 (>C=O of quinolone); 1665 (amide-I); 1565 (amide-II); 1325, 1179 (S=O, sym, asym); 1310 (C–N); 1262 (amide-III); 1062 (S–N); and 805 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.62 (m, 4H, >N(CH_2)$_2$O); 4.47 (s, 1H, CH_2OH); 8.69 (s, H-2, quinolone); 7.91 (s, H-5, quinolone); 8.85–9.68 (m, 3H, pyrido); 10.10 (s, 1H, CO.NH); 9.91 (s, 1H, SO_2NH); 7.15–7.70 (m, 4H, Ar–H); and 2.10 (s, 3H, Ar–CH_3). Anal. Calcd. for $C_{27}H_{20}O_7N_5SCl$: C, 59.78; H, 4.12; and N, 9.96. Found: C, 59.75; H, 4.10; and N, 9.95.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(3-methyphenylsulfamoyl)phenyl]amide (**5i**)*

Yield = 59%, m.p. 231–233°C.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(4-methyphenylsulfamoyl)phenyl]amide (**5j**)*

Yield = 67%, m.p. 255–257°C. IR (KBr) cm^{-1}: 3425 (NH); 3341 (OH); 2935, 2825 (CH); 1745 (>C=O of quinolone); 1670 (amide-I); 1562 (amide-II); 1321, 1175 (S=O, sym, asym); 1315 (C–N); 1265 (amide-III); 1058 (S–N); and 795 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.67 (m, 4H, >N(CH_2)$_2$O); 4.42 (s, 1H, CH_2OH); 8.65 (s, H-2, quinolone); 7.88 (s, H-5, quinolone); 8.81–9.65 (m, 3H, pyrido); 10.15 (s, 1H, CO.NH); 9.95 (s, 1H, SO_2NH); 7.19–7.65 (m, 4H, Ar–H); and 2.10 (s, 3H, Ar–CH_3). Anal. Calcd. for $C_{27}H_{20}O_7N_5SCl$: C, 59.78; H, 4.12; and N, 9.96. Found: C, 59.74; H, 4.09; and N, 9.92.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(2,5-dimethyphenylsulfamoyl)phenyl]amide (**5k**)*

Yield = 60%, m.p. 258–260°C.

*6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(2-cyno-4-nitrophenylsulfamoyl)phenyl]amide (**5l**)*

Yield = 64%, m.p. 233–235°C. IR (KBr) cm^{-1}: 3428 (NH); 3335 (OH); 2925, 2818 (CH); 2236 (>C≡N); 1755 (>C=O of quinolone); 1665 (amide-I); 1565 (amide-II); 1528, 1332 (N=O sym, asym); 1325, 1174 (S=O, sym, asym); 1304 (C–N); 1260 (amide-III); 1062 (S–N); and 795 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.67 (m, 4H, >N(CH_2)$_2$O); 4.42 (s, 1H, CH_2OH); 8.65 (s, H-2, quinolone); 7.88 (s, H-5, quinolone); 8.81–9.65 (m, 3H, pyrido); 10.15 (s, 1H, CO.NH); 9.95 (s, 1H, SO_2NH); and 7.19–7.65 (m, 3H, Ar–H). Anal. Calcd. for $C_{27}H_{20}O_7N_5SCl$: C, 59.78; H, 4.12; and N, 9.96. Found: C, 59.74; H, 4.09; and N, 9.92.

6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(substitutedphenylsulfamoyl)phenyl]amide (**6a–l**)

4-Amino-*N*-(substitutedphenyl)benzenesulfonamides (0.005 mol) was dissolved in dry pyridine and added dropwise in solution of carbonyl chloride **2b** (0.005 mol) in pyridine within 1.5 h with constant stirring at 0–5°C and refluxed for 8 h, Then, refluxed material was poured into acidic crushed ice, and the solid mass was filtered and washed thoroughly with $NaHCO_3$ solution for neutralization. The purity of the compounds was monitored by TLC on silica gel glass plate using benzene:ethylacetate (1:1) as mobile phase.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(phenylsulfamoyl)phenyl]amide (**6a**)*

Yield = 62%, m.p. 235–237°C.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(3-chlorophenylsulfamoyl)phenyl]amide (**6b**)*

Yield = 65%, m.p. 271–273°C. IR (KBr) cm^{-1}: 3432 (NH); 3395 (OH); 2945, 2858 (CH); 1746 (>C=O of quinolone); 1668 (amide-I); 1528 (amide-II); 1352, 1165 (S=O, sym, asym); 1314 (C–N); 1265 (amide-III); 1075 (S–N); and 795 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.67

(m, 4H, >N(CH_2)$_2$O); 4.42 (s, 1H, CH_2OH); 8.65 (s, H-2, quinolone); 7.88 (s, H-5, quinolone); 8.81–9.65 (m, 3H, pyrido); 10.15 (s, 1H, CO.NH); 9.95 (s, 1H, SO_2NH); 5.60 (s, 1H, Ar–OH); 7.19-7.65 (m, 4H, Ar–H). Anal. Calcd. for $C_{27}H_{21}O6N_4SCl$: C, 57.44; H, 3.75; and N, 9.93. Found: C, 57.42; H, 3.72; and N, 9.90.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(4-chlorophenylsulfamoyl)phenyl]amide (**6c**)*

Yield = 54%, m.p. 258–260°C.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(2-methoxyphenylsulfamoyl)phenyl]amide (**6d**)*

Yield = 66%, m.p. 245–248°C. IR (KBr) cm^{-1}: 3435 (NH); 3385 (OH); 2942, 2848 (CH); 1755 (>C=O of quinolone); 1674 (amide-I); 1532 (amide-II); 1345, 1166 (S=O, sym, asym); 1320 (C–N); 1261 (amide-III); 1269, 1040 (C–O–C); and 1065 (S–N). ^{1}H NMR (DMSO-d_6): δ 3.61 (m, 4H, >N(CH_2)$_2$O); 4.47 (s, 1H, CH_2OH); 8.69 (s, H-2, quinolone); 7.85 (s, H-5, quinolone); 8.79–9.62 (m, 3H, pyrido); 10.25 (s, 1H, CO.NH); 10.12 (s, 1H, SO_2NH); 5.64 (s, 1H, Ar–OH); 7.20–7.52 (m, 4H, Ar–H); and 3.78 (s, 3H, Ar–OCH_3). Anal. Calcd. for $C_{28}H_{24}O_7N_4S$: C, 59.99; H, 4.32; and N,10.00. Found: C, 59.96; H, 4.30; and N,10.02.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(4-methoxyphenylsulfamoyl)phenyl]amide (**6e**)*

Yield = 59%, m.p. 275–277°C.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(3-nitrophenylsulfamoyl)phenyl]amide (**6f**)*

Yield = 67%, m.p. 263–265°C. IR (KBr) cm^{-1}: 3441 (NH); 3387 (OH); 2937, 2845 (CH); 1749 (>C=O of quinolone); 1672 (amide-I); 1535 (amide-II); 1525, 1325 (N=O sym, asym); 1335, 1162 (S=O, sym, asym); 1315 (C–N); 1265 (amide-III); and 1065 (S–N). ^{1}H NMR (DMSO-d_6): δ 3.65 (m, 4H, >N(CH_2)$_2$O); 4.48 (s, 1H, CH_2OH); 8.65 (s, H-2, quinolone); 7.84 (s, H-5, quinolone); 8.75–9.61 (m, 3H, pyrido); 10.15 (s, 1H, CO.NH); 10.15 (s, 1H, SO_2NH); 5.65 (s, 1H, Ar–OH); and 7.15–7.45 (m, 4H, Ar–H). Anal. Calcd. for $C_{27}H_{21}O_8N_5S$: C, 56.34; H, 3.68; and N,12.17. Found: C, 56.32; H, 3.65; and N,12.15.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(4-nitrophenylsulfamoyl)phenyl]amide (**6g**)*

Yield = 63%, m.p. 255–257°C.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(2-methylphenylsulfamoyl)phenyl]amide (**6h**)*

Yield = 60%, m.p. 275–277°C. IR (KBr) cm^{-1}: 3438 (NH); 3375 (OH); 2939, 2852 (CH); 1752 (>C=O of quinolone); 1665 (amide-I); 1538 (amide-II); 1338, 1165 (S=O, sym, asym); 1305 (C–N); 1261 (amide-III); and 1060 (S–N). ^{1}H NMR (DMSO-d_6): δ 3.66 (m, 4H, >N(CH_2)$_2$O); 4.45 (s, 1H, CH_2OH); 8.60 (s, H-2, quinolone); 7.89 (s, H-5, quinolone); 8.74–9.69 (m, 3H, pyrido); 10.10 (s, 1H, CO.NH); 9.95 (s, 1H, SO_2NH); 5.62 (s, 1H, Ar–OH); 7.05–7.41 (m, 4H, Ar–H); and 2.21 (s, 3H, Ar-CH_3). Anal. Calcd. for $C_{28}H_{24}O6N_4S$: C, 61.75; H, 4.45; and N,10.29. Found: C, 61.72; H, 4.42; and N,10.27.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(3-methylphenylsulfamoyl)phenyl]amide (**6i**)*

Yield = 58%, m.p. 240–241°C.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(4-methylphenylsulfamoyl)phenyl]amide (**6j**)*

Yield = 62%, m.p. 264-266°C. IR (KBr) cm^{-1}: 3435 (NH); 3371 (OH); 2935, 2845 (CH); 1745 (>C=O of quinolone); 1668 (amide-I); 1535 (amide-II); 1340, 1168 (S=O, sym, asym); 1315 (C–N); 1265 (amide-III); and 1065 (S–N). ^{1}H NMR (DMSO-d_6): δ δ 3.60 (m, 4H, >N(CH_2)$_2$O); 4.48 (s, 1H, CH_2OH); 8.62 (s, H-2, quinolone); 7.88 (s, H-5, quinolone); 8.65–9.65 (m, 3H, pyrido); 10.15 (s, 1H, CO.NH); 9.98 (s, 1H, SO_2NH); 5.68 (s, 1H, Ar–OH); 7.15–7.48 (m, 4H, Ar–H); and 2.15 (s, 3H, Ar-CH_3). Anal. Calcd. for $C_{28}H_{24}O6N_4S$: C, 61.75; H, 4.45; and N,10.29. Found: C, 61.70; H, 4.44; and N,10.31.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(2,5-dimethylphenylsulfamoyl)phenyl]amide (**6k**)*

Yield = 67%, m.p. 277–279°C.

*6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carboxylicacid [4-(2-cyno-4-nitrophenylsulfamoyl)phenyl]amide (**6l**)*

Yield = 65%, m.p. 280–282°C. IR (KBr) cm^{-1}: 3428 (NH); 3365 (OH); 2925, 2832 (CH); 2236 (>C≡N); 1751 (>C=O of quinolone); 1665 (amide-I); 1532 (amide-II); 1528, 1332 (N=O sym, asym); 1345, 1160 (S=O, sym, asym); 1325 (C–N); 1262 (amide-III); and 1056 (S–N). ^{1}H NMR (DMSO-d_6): δ 3.68 (m, 4H, >N(CH_2)$_2$O); 4.47 (s, 1H, CH_2OH); 8.65 (s, H-2, quinolone); 7.85 (s, H-5, quinolone); 8.62–9.62 (m, 3H, pyrido); 10.10 (s, 1H, CO.NH); 9.95 (s, 1H, SO_2NH); 5.69 (s, 1H, Ar–OH); and 7.10-7.52 (m, 3H, Ar–H). Anal. Calcd. for $C_{28}H_{20}O_8N_4S$: C, 58.73; H, 3.52; and N,9.79. Found: C, 58.70; H, 3.50; and N,9.76.

1-[6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(substitutedphenyl)thiourea (**7a**–**l**)

Substitutedphenyl thioureas (0.005 mol) was dissolved in dry pyridine and added dropwise in solution of carbonyl chloride **2a** (0.005 mol) in pyridine within 1.5 h with constant stirring at 0–5°C and refluxed for 8 h, Then, refluxed material was suspended into acidic crushed ice, and the solid mass was filtered and washed thoroughly with $NaHCO_3$ solution for neutralization. The purity of the compounds were monitored by TLC on silica gel glass plate using benzene:ethylacetate (1:1) as mobile phase.

*1-[6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-phenylthiourea (**7a**)*

Yield = 55%, m.p. 257–258°C. IR (KBr) cm^{-1}: 3434 (NH); 3322 (OH); 2950, 2860 (CH); 1735 (>C=O of quinolone); 1650 (amide-I); 1540 (amide-II); 1300 (C–N); 1256 (amide-III); 1190 (>C=S); and 766 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.31 (m, 4H, >N(CH_2)$_2$O); 4.35 (s, 1H, CH_2OH); 8.70 (s, H-2, quinolone); 8.14 (s, H-5, quinolone); 8.88–9.45 (m, 3H, pyrido); 10.05 (s, 1H, CO.NH); 10.25 (s, 1H, CS.NH); and 7.30–7.92 (m, 5H, Ar–H). Anal. Calcd. for $C_{22}H_{17}O_3N_4SCl$: C, 58.40; H, 3.79; and N,12.39. Found: C, 58.38; H, 3.76; and N,12.36.

*1-[6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(3-hydroxyphenyl)thiourea (**7b**)*

Yield = 65%, m.p. 244–246°C.

*1-[6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(4-hydroxyphenyl)thiourea (**7c**)*

Yield = 60%, m.p. 275–276°C. IR (KBr) cm^{-1}: 3445 (NH); 3315 (OH); 2945, 2865 (CH); 1741 (>C=O of quinolone); 1645 (amide-I); 1540 (amide-II); 1305 (C–N); 1258 (amide-III); 1165 (>C=S); and 766 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.45 (m, 4H, >N(CH_2)$_2$O); 4.25 (s, 1H, CH_2OH); 8.85 (s, H-2, quinolone); 8.24 (s, H-5, quinolone); 8.85–9.35 (m, 3H, pyrido); 10.10 (s, 1H, CO.NH); 10.35 (s, 1H, CS.NH); 7.25–7.85 (m, 4H, Ar–H); and 5.65 (s, 1H, Ar–OH). Anal. Calcd. for $C_{22}H_{17}O_4N_4SCl$: C, 56.40; H, 3.66; and N,11.97. Found: C, 56.37; H, 3.64; and N,11.95.

*1-[6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(2-methoxyphenyl)thiourea (**7d**)*

Yield = 57%, m.p. 277–279°C.

*1-[6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(4-methoxyphenyl)thiourea (**7e**)*

Yield = 60%, m.p. 255–256°C. IR (KBr) cm^{-1}: 3452 (NH); 3325 (OH); 2935, 2860 (CH); 1748 (>C=O of quinolone); 1656 (amide-I); 1535 (amide-II); 1315 (C–N); 1269, 1040 (C–O–C); 1255 (amide-III); 1160 (>C=S); and 769 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.52 (m, 4H, >N(CH_2)$_2$O); 4.30 (s, 1H, CH_2OH); 8.78 (s, H-2, quinolone); 8.30 (s, H-5, quinolone); 8.75–9.25 (m, 3H, pyrido); 10.05 (s, 1H, CO.NH); 10.15 (s, 1H, CS.NH); 7.26–7.75 (m, 4H, Ar–H); and 3.85 (s, 3H, Ar–OCH_3). Anal. Calcd. for $C_{23}H_{19}O_4N_4SCl$: C, 57.25; H, 3.62; and N,11.93. Found: C, 57.25; H, 3.64; and N,11.95.

*1-[6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(2-nitrophenyl)thiourea (**7f**)*

Yield = 67%, m.p. 284–286°C.

*1-[6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(3-nitrophenyl)thiourea (**7g**)*

Yield = 56%, m.p. 261–263°C. IR (KBr) cm^{-1}: 3456 (NH); 3330 (OH); 2925, 2865 (CH); 1755 (>C=O of quinolone); 1665 (amide-I); 1520 (amide-II); 1528, 1332

(N=O); 1325 (C–N); 1245 (amide-III); 1165 (>C=S); and 777 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.51 (m, 4H, >N(CH_2)$_2$O); 4.41 (s, 1H, CH_2OH); 8.80 (s, H-2, quinolone); 8.25 (s, H-5, quinolone); 8.68–9.20 (m, 3H, pyrido); 10.00 (s, 1H, CO.NH); 10.22 (s, 1H, CS.NH); and 7.24–7.71 (m, 4H, Ar–H). Anal. Calcd. for $C_{22}H_{16}O_5N_5$ SCl: C, 53.11; H, 3.24; and N,14.09. Found: C, 53.09; H, 3.24; and N,14.07.

*1-[6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(4-nitrophenyl)thiourea (**7h**)*

Yield = 61%, m.p. 249–251°C. IR (KBr) cm^{-1}: 3445 (NH); 3325 (OH); 2920, 2862 (CH); 1748 (>C=O of quinolone); 1662 (amide-I); 1528 (amide-II); 1535, 1340 (N=O); 1320 (C–N); 1235 (amide-III); 1160 (>C=S); and 772 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.55 (m, 4H, >N(CH_2)$_2$O); 4.47 (s, 1H, CH_2OH); 8.75 (s, H-2, quinolone); 8.15 (s, H-5, quinolone); 8.65–9.15 (m, 3H, pyrido); 10.05 (s, 1H, CO.NH); 10.28 (s, 1H, CS.NH); and 7.14–7.65 (m, 4H, Ar–H). Anal. Calcd. for $C_{23}H_{19}O_3N_4$ SCl: C, 59.22; H, 4.11; and N,12.02. Found: C, 59.20; H, 4.09; and N,12.04.

*1-[6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(2-methylphenyl)thiourea (**7i**)*

Yield = 67%, m.p. 243–244°C.

*1-[6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(3-methylphenyl)thiourea (**7j**)*

Yield = 62%, m.p. 241–243°C.

*1-[6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(4-methylphenyl)thiourea (**7k**)*

Yield = 63%, m.p. 263–265°C. IR (KBr) cm^{-1}: 3452 (NH); 3330 (OH); 2922, 2865 (CH); 1752 (>C=O of quinolone); 1665 (amide-I); 1522 (amide-II); 1325 (C–N); 1231 (amide-III); 1165 (>C=S); and 762 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.57 (m, 4H, >N(CH_2)$_2$O); 4.51 (s, 1H, CH_2OH); 8.65 (s, H-2, quinolone); 8.20 (s, H-5, quinolone); 8.62–9.20 (m, 3H, pyrido); 10.12 (s, 1H, CO.NH); 10.22 (s, 1H, CS.NH); 7.25–7.74 (m, 4H, Ar–H); and 2.22 (s, 1H, Ar–CH_3). Anal. Calcd. for $C_{23}H_{19}O_3N_4$SCl: C, 59.22; H, 4.11; and N,12.02. Found: C, 59.24; H, 4.13; and N,12.00.

*1-[6-Chloro-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(3-chlorophenyl)thiourea (**7l**)*

Yield = 60%, m.p. 251–253°C. IR (KBr) cm^{-1}: 3435 (NH); 3325 (OH); 2945, 2845 (CH); 1745 (>C=O of quinolone); 1665 (amide-I); 1562 (amide-II); 1312 (C–N); 1245 (amide-III); 1160 (>C=S); and 764 (C–Cl). ^{1}H NMR (DMSO-d_6): δ 3.35 (m, 4H, >N(CH_2)$_2$O); 4.37 (s, 1H, CH_2OH); 8.75 (s, H-2, quinolone); 8.10 (s, H-5, quinolone); 8.90–9.52 (m, 3H, pyrido); 9.90 (s, 1H, CO.NH); 10.22 (s, 1H, CS.NH); and 7.18–7.95 (m, 4H, Ar–H). Anal. Calcd. for $C_{22}H_{18}O_4N_4S$: C, 60.81; H, 4.18; and N,12.90. Found: C, 60.78; H, 4.15; and N,12.85.

1-[6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(substitutedhydroxyphenyl)thiourea (**8a–l**)

Substitutedphenyl thioureas (0.005 mol) was dissolved in dry pyridine and added dropwise the solution of carbonyl chloride **2b** (0.005 mol) in pyridine within 1.5 h with constant stirring at 0–5°C and refluxed for 8 h; then, refluxed material was poured into acidic crushed ice; and the solid mass was filtered and was washed thoroughly with $NaHCO_3$ solution for neutralization. The purity of the compounds was monitored by TLC on silica gel glass plate using benzene:ethylacetate (1:1) as mobile phase.

*1-[6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-phenylthiourea (**8a**)*

Yield = 66%, m.p. 246–247°C.

*1-[6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(3-hydroxyphenyl)thiourea (**8b**)*

Yield = 62%, m.p. 281–283°C.

*1-[6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(4-hydroxyphenyl)thiourea (**8c**)*

Yield = 56%, m.p. 246–248°C. IR (KBr) cm^{-1}: 3425 (NH); 3315 (OH); 2952, 2838 (CH); 1745 (>C=O of quinolone); 1662 (amide-I); 1562 (amide-II); 1315 (C–N); 1248 (amide-III); and 1165 (>C=S). ^{1}H NMR (DMSO-d_6): δ 3.42 (m, 4H, >N(CH_2)$_2$O); 4.35 (s, 1H, CH_2OH); 8.74 (s, H-2, quinolone); 8.15 (s, H-5, quinolone); 8.88–9.45 (m, 3H, pyrido); 9.95 (s, 1H, CO.NH); 10.15 (s, 1H, CS.NH); 7.18–7.95 (m, 4H, Ar–H); and 5.40, 6.20 (s, 1H,

Ar–OH). Anal. Calcd. for $C_{22}H_{18}O_5N_4S$: C, 58.65; H, 4.03; and N,12.44. Found: C, 58.62; H, 4.01; and N,12.42.

*1-[6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(2-methoxyphenyl)thiourea (**8d**)*

Yield = 56%, m.p. 241–243°C.

*1-[6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(4-methoxyphenyl)thiourea (**8e**)*

Yield = 60%, m.p. 233–235°C. IR (KBr) cm^{-1}: 3445 (NH); 3324 (OH); 2945, 2825 (CH); 1748 (>C=O of quinolone); 1665 (amide-I); 1565 (amide-II); 1323 (C–N); 1252 (amide-III); 1235, 1020 (C–O–C); and 1161 (>C=S). ^{1}H NMR (DMSO-d_6): δ 3.44 (m, 4H, >N$(CH_2)_2$O); 4.45 (s, 1H, CH_2OH); 8.78 (s, H-2, quinolone); 8.05 (s, H-5, quinolone); 8.08–9.35 (m, 3H, pyrido); 9.98 (s, 1H, CO.NH); 10.18 (s, 1H, CS.NH); 7.28–7.85 (m, 4H, Ar–H); and 3.85 (s, 1H, Ar–OCH_3). Anal. Calcd. for $C_{23}H_{20}O_5N_4S$: C, 59.47; H, 4.34; and N,12.07. Found: C, 59.45; H, 4.24; and N,12.05.

*1-[6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(2-nitrophenyl)thiourea (**8f**)*

Yield = 63%, m.p. 253–254°C.

*1-[6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(3-nitrophenyl)thiourea (**8g**)*

Yield = 56%, m.p. 244–246°C. IR (KBr) cm^{-1}: 3450 (NH); 3314 (OH); 2948, 2828 (CH); 1748 (>C=O of quinolone); 1675 (amide-I); 1564 (amide-II); 1315 (C–N); 1248 (amide-III); 1512, 1352 (N=O sym, asym); and 1168 (>C=S). ^{1}H NMR (DMSO-d_6): δ 3.48 (m, 4H, >N$(CH_2)_2$O); 4.42 (s, 1H, CH_2OH); 8.88 (s, H-2, quinolone); 8.11 (s, H-5, quinolone); 8.15–9.25 (m, 3H, pyrido); 9.92 (s, 1H, CO.NH); 10.15 (s, 1H, CS.NH); and 7.25–7.75 (m, 4H, Ar–H). Anal. Calcd. for $C_{23}H_{20}O_5N_4S$: C, 55.10; H, 3.58; and N,14.61. Found: C, 55.05; H, 3.45; and N,14.59.

*1-[6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(4-nitrophenyl)thiourea (**8h**)*

Yield = 58%, m.p. 251–253°C. IR (KBr) cm^{-1}: 3445 (NH); 3310 (OH); 2958, 2818 (CH); 1752 (>C=O of quinolone); 1665 (amide-I); 1562 (amide-II); 1321 (C–N); 1352 (N=O sym, asym); 1252 (amide-III); and 1168 (>C=S). ^{1}H NMR (DMSO-d_6): δ 3.52 (m, 4H, >N$(CH_2)_2$O); 4.40 (s, 1H, CH_2OH); 8.85 (s, H-2, quinolone); 8.14 (s, H-5, quinolone); 8.01–9.15 (m, 3H, pyrido); 9.85 (s, 1H, CO.NH); 10.25 (s, 1H, CS.NH); and 7.15–7.85 (m, 4H, Ar–H). Anal. Calcd.for $C_{23}H_{20}O_4N_4S$:C, 61.59; H,4.50; and N,12.50. Found: C,61.55; H,4.48; and N, 12.47.

*1-[6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(2-methylphenyl)thiourea (**8i**)*

Yield = 60%, m.p. 235–237°C.

*1-[6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(3-methylphenyl)thiourea (**8j**)*

Yield = 52%, m.p. 237–239°C.

*1-[6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(4-methylphenyl)thiourea (**8k**)*

Yield = 60%, m.p. 251–253°C. IR (KBr) cm^{-1}: 3452 (NH); 3315 (OH); 2945, 2810 (CH); 1742 (>C=O of quinolone); 1675 (amide-I); 1565 (amide-II); 1328 (C–N); 1245 (amide-III); and 1160 (>C=S). ^{1}H NMR (DMSO-d_6): δ 3.47 (m, 4H, >N$(CH_2)_2$O); 4.35 (s, 1H, CH_2OH); 8.75 (s, H-2, quinolone); 8.18 (s, H-5, quinolone); 8.05–9.25 (m, 3H, pyrido); 9.88 (s, 1H, CO.NH); 10.28 (s, 1H, CS.NH); 7.05–7.78 (m, 4H, Ar–H); and 2.44 (s, 3H, Ar–CH_3). Anal. Calcd. for $C_{23}H_{20}O_4N_4S$: C, 61.59; H, 4.50; and N,12.50. Found: C, 61.54; H, 4.47; and N,12.46.

*1-[6-Hydroxy-1-(2-hydroxyethyl)-4-oxo-1,4-dihydro-[1,7]phenanthroline-3-carbonyl]-3-(3-chlorophenyl)thiourea (**8l**)*

Yield = 51%, m.p. 246–248°C.

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