Synthesis, Characterization, Antibacterial and Antifungal Activity of 2-(Aryl)-3-(3-((8-hydroxyquinolin-5-yl)diazenyl)phenyl)thiazolidin-4-ones

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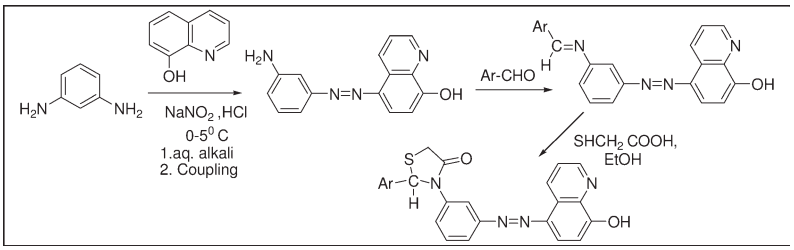

5-((3-aminophenyl)diazenyl)quinolin-8-ol (**1**) was synthesized by diazotization reaction and coupled with 8-hydroxyquinoline moiety. This amine on facile condensation with aromatic aldehydes in presence of glacial acetic acid and ethanol affords anils (**2**). These anils on cyclocondensation reaction with thioglycolic acid (*i.e.*, mercaptoacetic acid) yield the titled compound (**3**). The structure of the newly synthesized anils (**2**) and thiazolidinones (**3**) has been confirmed by elemental analysis and spectral analysis. The titled compounds have been screened against different bacterial and fungal strains.

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INTRODUCTION

The chemistry of quinoline has gained increasing attention due to its versatile pharmacological activities [1–3]. Quinoline ring fused with five- or six-membered ring in linear fashion is found in natural products as well as in synthetic compounds of biological interest. *Dictemine* and *skimmianine* are the examples of such class of naturally occurring compounds, which are associated with smooth muscle contracting properties.

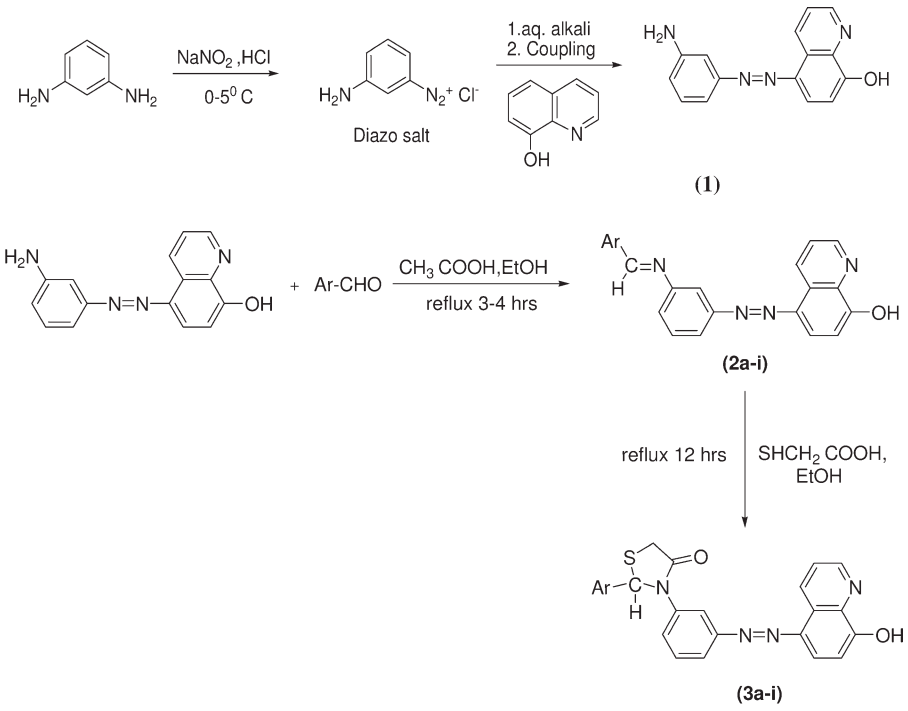
Quinolones are extensively investigated as broad spectrum antibacterial [4,5], antidiabetic [6], anticancer [7], antiviral [8], and anti-HIV [9] agents. Quinoline family compounds are widely used as a parent compound to make drugs especially antimalarial, fungicidal, and biocidal medicines due to their versatile biological activity. These properties are closely related with their capability for chelating metallic ions [10].

8-Hydroxyquinoline or 8-quinolinol is well known as an analytical reagent [11,12]. One of the derivatives, *viz*. 5-chloromethyl 8-quinolinol can be synthesize facilely and studied extensively for number of derivatives [13]. Some of the ions exchanging resins are also reported with good potentiality [14–23]. Several azo dyes based on 8-quinolinol are also reported for dyeing of textiles as well as their chelating properties [24,25]. Biological importance of azo compounds is well known for their use as antineoplastics [26], antidiabetics [27], antiseptics [28], and other useful chemotherapeutic agents. It has been found that the activity of azo linkage increases on the incorporation of suitable heterocyclic moiety.

4-Thiazolidinones are one of the most intensively investigated classes of aromatic five membered heterocycles [29–32]. 4-Thiazolidinone derivatives exhibit broad spectrum of biological activity [33–36]. Its derivatives have been found to have potentially chemotherapic activities such as anticonvulsant [37], antibacterial [38], antifungal [39], anti-inflammatory [40], anticancer [41], and antipsychotic [42] properties. Some of the reported 4-thiazolidinones have showed envelope or half-chair conformation with different configurations [43]. Their structural and conformational features are essential to correlate to the biological activity. Because of this, the investigation of chemistry and biology of these compounds continue to appeal the synthetic and medicinal organic chemists.

With this background, it has been thought worth to synthesize some novel heterocyclic compounds comprising of thiazolidinone and azo-linkage in a single compound and to undertake the systematic study of these new compounds for their potency as an antibacterial and antifungal agents.

Scheme 1. Synthetic route for 2-(aryl)-3-(3-((8-hydroxyquinolin-5-yl)diazenyl)phenyl) thiazolidin-4-one.



Compd	-Ar	Compd	-Ar	Compd	-Ar
a	$-C_6H_5$	d		G	$2\text{-}NO_2$
b	2-OH	e	4-OH	H	4-Cl
c	$4\text{-}OCH_3$	f	$3\text{-}NO_2$	I	2-Cl

RESULTS AND DISCUSSION

In continuation of our efforts toward the synthesis and biological evaluation of different heterocyclic compounds [44–47], we, herein, report the synthesis of 2-(aryl)-3-(3-((8-hydroxyquinolin-5-yl)diazenyl)phenyl)thiazolidin-4-ones (**3**). The compound (**1**), that is, 5-((3-aminophenyl)diazenyl) quinolin-8-ol was synthesized by a simple azo-dye formation process. The condensation reaction of compound (**1**) with various aromatic aldehydes yields 5-((3-(arylbenzylideneamino)phenyl)diazenyl)quinolin-8-ol (**2**). Compound (**2**) on reaction with mercaptoacetic acid afford 2-(aryl)-3-(3-((8-hydroxyquinolin-5-yl)diazenyl) phenyl)thiazolidin-4-one (**3**). The synthetic route to obtain compound (**3**) has been summarized in **Scheme** 1. Yields of the synthesized compounds (**2** and **3**) were found to moderate to fair (60–85%). The purity of the compounds was monitored by TLC and the structure of the compounds was confirmed based on their elemental analysis and spectral data.

Biological Activity. Antibacterial activities of all the compound (**3**) using DMSO as solvent were studied against different bacterial strains such as *E. coli, B. subtilis*, *S. aureus*, *and P. vulageris*, whereas antifungal activity were checked against the *C. albicans and A. niger* strains. The antibacterial and antifungal activities of compound (**3**) were evaluated by measuring the zone of inhibition on nutrient agar plates and Sabouraudís agar plates, respectively. The results were recorded in duplicate using ampicillin as a standard drug for antibacterial activity, whereas flucanazole as a standard drug for antifungal activity. The study reveals that compounds possess moderate to good activity against all stains in comparison with standard drug (Table 1).

MATERIALS AND METHODS

General. All the chemicals and solvents were obtained from E-Merck, India (AR grade) and were used without further

Table 1

Biological activities of 2-(aryl)-3-(3-((8-hydroxyquinolin-5-yl)diazenyl)phenyl)thiazolidin-4-one.

	Antibacterial activity				Antifungal activity	
	(Zone of inhibition in mm at 500 μg/mL)					
Compd.	*E. coli*	*B. subtilis*	*S. aureus*	*P. vulageris*	*C. albicans*	*A. niger*
3a	20	22	21	18	19	13
3b	23	25	18	17	14	14
3c	22	17	19	21	15	10
3d	18	23	20	16	10	14
3e	19	17	23	20	8	10
3f	24	16	18	19	10	12
3g	18	15	20	17	11	16
3h	19	17	22	14	14	15
3i	20	16	19	10	18	18
Standard Drug	22	20	24	16	18	15

purification. Melting points were taken in an open capillary tube. IR spectra were recorded on a Shimadzu Dr-8031 instrument. Elemental analyses were carried out using a Perkin-Elmer, CHN elemental analyzer model 2400. ^{1}H NMR spectra of the synthesized compounds were recorded on a Bruker-Avance (300 MHz) and Varian-Gemini (200 MHz) spectrophotometer using $CDCl_3$ solvent and TMS as an internal standard. EI-MS spectra were determined on a LCQ ion trap mass spectrometer (Thermo Fisher, San Jose, CA), equipped with an EI source.

Synthesis of 5-((3-aminophenyl)diazenyl)quinolin-8-ol (1). The diazo salt solution of *m*-phenylenediamine was prepared by simple diazotization reaction and then coupled with 8-hydroxy quinoline moiety. 8-Hydroxy quinoline (0.01 mol) was dissolved in required amount of aqueous alkali, and the solution was then cooled to 0–5°C. To this well-stirred solution, the diazonium salt of *m*-phenylenediamine was added slowly, so that temperature did not rise above 5°C. While maintaining pH of the reaction mixture within the range of 4.5–5.5 by the action of sodium acetate solution (10% w/v), the mixture was then stirred for 1 h at 0–5°C. The resulting solid dye material was filtered off, washed with boiling water, and then air-dried. It was red amorphous powder. It is soluble in ethanol, chloroform, DMF, and DMSO. Melting point of compound (**1**) was found to be 210°C.

Characterization data of 5-((3-aminophenyl)diazenyl) quinolin-8-ol (1). M.p.: 140°C, IR (KBr): 1450 cm^{-1} (N=N); 2990 cm^{-1} (Ar-OH); 3450 cm^{-1} (Ar-NH_2); ^{1}H NMR: δ = 5.30 (s, 2H, Ar-NH_2) 6.80 (s, 1H, Ar-CH); 7.20–7.40 (m, 4H, Ar-CH); 7.60 (t, 1H, Ar-CH); 7.80 (d, 1H, Ar-CH); 8.40 (d, 2H, Ar-CH); 8.90 (d, 1H, Ar-CH); 9.80 (s, 1H, Ar-OH); Anal. Calcd. For $C_{15}H_{12}N_4O$: C, 68.17; H, 4.58; N, 21.20; Found: C, 68.00; H, 4.20; N, 21.10; Mass spectra, *m/z* = 264 (100%).

Synthesis of 5-((3-(arylbenzylideneamino)phenyl) diazenyl)quinolin-8-ol (2a–i). Equimolar amount of 5-((3-aminophenyl)diazenyl)quinolin-8-ol (**1**) (0.01 mol) and aromatic aldehyde (0.01 mol) and two to three drops of glacial acetic acid in ethanol (10 mL) was refluxed for 3–4 h. The reaction was monitored by TLC. After completion of the reaction, the reaction mixture was set on one side to cool. Then, the reaction mixture was poured in ice-cold water, and the solid precipitate was separated out. The precipitate was filtered out, and the crude product was recrystallized from chloroform.

Characterization data of 5-((3-(benzylideneamino) phenyl)diazenyl)quinolin-8-ol (2a). Yield: 74%, M.p.: 170°C, IR (KBr): 1460 cm^{-1} (N=N); 1618 (—C=N—), 2990 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 7.15–7.20 (d, 2H, Ar-CH); 7.50–7.60 (m, 6H, Ar-CH); 7.80 (t, 3H, Ar-CH); 8.00 (t, 1H, Ar-CH); 8.40 (d, 1H, Ar-CH); 8.60 (s, 1H, N=CH); 8.90 (d, 1H, Ar-CH); 9.75 (s, 1H, Ar-OH); Anal. Calcd. For $C_{22}H_{16}N_4O$: C, 74.98; H, 4.58; N, 15.90; Found: C, 74.50; H, 4.10; N, 15.30; Mass spectra, *m/z* = 352.13 (100%).

Characterization data of 5-((3-(2-hydroxybenzylidene amino)phenyl)diazenyl)quinolin-8-ol (2b). Yield: 70%, M.p.: 178°C, IR (KBr): 1478 cm^{-1} (N=N); 1625 (—C=N—), 3015 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 7.00–7.20 (m, 4H, Ar-CH); 7.50–7.65 (m, 5H, Ar-CH); 7.90 (s, 1H, Ar-CH); 8.10 (s, 1H, Ar-CH); 8.30 (d, 2H, Ar-CH); 8.80 (s, 1H, N=CH); 9.70 (s, 1H, Ar-OH); 11.20 (s, 1H, Ar-OH) Anal. Calcd. For $C_{22}H_{16}N_4O_2$: C, 71.73; H, 4.38; N, 15.21; Found: C, 71.20; H, 4.20; N, 15.10; Mass spectra, *m/z* = 368.13 (100%).

Characterization data of 5-((3-(4-methoxybenzylidene amino)phenyl)diazenyl)quinolin-8-ol (2c). Yield: 78%, M.p.: 175°C, IR (KBr): 1480 cm^{-1} (N=N); 1630 (—C=N—), 2986 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 3.80 (s, 3H, Ar-OCH_3) 7.00 (d, 2H, Ar-CH); 7.20 (d, 2H, Ar-CH); 7.60–7.70 (t, 3H, Ar-CH); 7.80 (t, 3H, Ar-CH); 8.00 (s, 1H, Ar-CH); 8.20 (d, 1H, Ar-CH); 8.50 (s, 1H, N=CH); 8.80 (s, 1H, Ar-CH); 9.60 (s, 1H, Ar-OH); Anal. Calcd. For $C_{23}H_{18}N_4O_2$: C, 72.24; H, 4.74; N, 14.65; Found: C, 72.00; H, 4.30; N, 14.20; Mass spectra, *m/z* = 382.10 (100%).

Characterization data of 5-((3-(4-(dimethylamino) benzylideneamino)phenyl)diazenyl)quinolin-8-ol (2d). Yield: 62%, M.p.: 168°C, IR (KBr): 1470 cm^{-1} (N=N); 1650 (—C=N—), 2965 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 3.06 (s, 6H, $N(CH_3)_2$) 6.80 (d, 2H, Ar-CH); 7.30 (d, 2H, Ar-CH); 7.50 (d, 2H, Ar-CH); 7.60 (d, 2H, Ar-CH); 7.70 (s, 1H, Ar-CH); 7.80(s, 1H, Ar-CH); 8.00(s, 1H, Ar-CH); 8.30 (s, 1H, Ar-CH); 8.70 (s, 1H, N=CH); 8.90 (s, 1H, Ar-CH); 9.75 (s, 1H, Ar-OH); Anal. Calcd. For $C_{24}H_{21}N_5O$: C, 72.89; H, 5.35; N, 17.71; Found: C, 72.50; H, 5.10; N, 17.20; Mass spectra, *m/z* = 395.10 (100%).

Characterization data of 5-((3-(4-hydroxybenzylidene amino)phenyl)diazenyl)quinolin-8-ol (2e). Yield: 75%, M.p.: 165°C, IR (KBr): 1450 cm^{-1} (N=N); 1640 (—C=N—), 2960 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 6.80 (d, 2H, Ar-CH); 7.20 (d, 2H, Ar-CH); 7.60–7.80 (m, 6H, Ar-CH); 8.10 (s, 1H, Ar-CH); 8.30 (s, 1H, Ar-CH); 8.70 (s, 1H, N=CH); 8.90 (s, 1H, Ar-CH); 9.40(s, 1H, Ar-OH); 9.70 (s, 1H, Ar-OH); Anal. Calcd. For $C_{22}H_{16}N_4O_2$: C, 71.73; H, 4.38; N, 15.21; Found: C, 71.10; H, 4.20; N, 15.00; Mass spectra, *m/z* = 368.10 (100%).

Characterization data of 5-((3-(3-nitrobenzylidene amino)phenyl)diazenyl)quinolin-8-ol (2f). Yield: 82%, M.p.: 175°C, IR (KBr): 1445 cm^{-1} (N=N); 1660 (—C=N—), 2975 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 7.20 (d, 2H, Ar-CH); 7.60–7.80 (m, 5H, Ar-CH); 8.00 (s, 1H, Ar-CH); 8.20(d, 2H, Ar-CH); 8.40 (s, 1H, Ar-CH); 8.50 (s, 1H, Ar-CH); 8.70 (s, 1H, N=CH); 8.85 (s, 1H, Ar-CH); 9.80 (s, 1H, Ar-OH); Anal. Calcd. For $C_{22}H_{15}N_5O_3$: C, 66.49; H, 3.80; N, 17.62; Found: C, 66.30; H, 3.20; N, 17.10; Mass spectra, *m/z* = 397.10 (100%).

Characterization data of 5-((3-(2-nitrobenzylidene amino)phenyl)diazenyl)quinolin-8-ol (2g). Yield: 70%, M.p.: 180°C, IR (KBr): 1460 cm^{-1} (N=N); 1680 (—C=N—), 2985 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 7.10 (d, 2H, Ar-CH); 7.50–7.70 (m, 4H, Ar-CH); 7.80–8.10 (m, 5H, Ar-CH); 8.30(s, 1H, Ar-CH); 8.80 (s, 1H, N=CH); 8.90 (s, 1H, Ar-CH); 9.70 (s, 1H, Ar-OH); Anal. Calcd. For $C_{22}H_{15}N_5O_3$: C, 66.49; H, 3.80; N, 17.62; Found: C, 66.10; H, 3.00; N, 17.30; Mass spectra, *m/z* = 397.00 (100%).

Characterization data of 5-((3-(4-chlorobenzylidene amino)phenyl)diazenyl)quinolin-8-ol (2h). Yield: 80%, M.p.: 182°C, IR (KBr): 1476 cm^{-1} (N=N); 1630 (—C=N—), 2998 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 7.30 (d, 2H, Ar-CH); 7.50–7.80 (m, 8H, Ar-CH); 8.10 (s, 1H, Ar-CH); 8.30(s, 1H, Ar-CH); 8.50 (s, 1H, N=CH); 8.90 (s, 1H, Ar-CH); 9.90 (s, 1H, Ar-OH); Anal. Calcd. For $C_{22}H_{15}ClN_4O$: C, 68.31; H, 3.91; N, 14.48; Found: C, 68.00; H, 3.40; N, 14.20; Mass spectra, *m/z* = 386.00 (100%).

Characterization data of 5-((3-(2-chlorobenzylidene amino)phenyl)diazenyl)quinolin-8-ol (2i). Yield: 78%, M.p.: 185°C, IR (KBr): 1470 cm^{-1} (N=N); 1670 (—C=N—), 2995 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 7.20 (d, 2H, Ar-CH); 7.30–7.80 (m, 8H, Ar-CH); 8.00 (s, 1H, Ar-CH); 8.40(s, 1H, Ar-CH); 8.80 (s, 1H, N=CH); 9.10 (s, 1H, Ar-CH); 9.80 (s, 1H, Ar-OH); Anal. Calcd. For $C_{22}H_{15}ClN_4O$: C, 68.31; H, 3.91; N, 14.48; Found: C, 68.10; H, 3.50; N, 14.00; Mass spectra, *m/z* = 385.90 (100%).

Synthesis of 2-(aryl)-3-(3-((8-hydroxyquinolin-5-yl) diazenyl)phenyl)thiazolidin-4-one (3a-i). Equimolar amount of Schiff base (0.002 mol) and thioglycolic acid (0.002 mol) was dissolved in ethanol (10 mL), and the reaction mixture was refluxed for 12 h. The completion of the reaction was monitored by TLC. After the completion of reaction, it was poured in ice-cold water, and the solid precipitate was separated out. The solid deposited was separated by filtration. The crude product obtained was recrystallized from chloroform.

Characterization data of 3-(3-((8-hydroxyquinolin-5-yl)diazenyl)phenyl)-2-phenylthiazolidin-4-one(3a). Yield: 70%; M.p.: 160°C, IR (KBr): 660 (C—S—C, 4-thiazolidinone), 736 (1, 2 disubstituted benzene ring), 1220 (C—N), 1440 (C=C), 1610 (C=O, thiazolidinone), 2370 (Ar-CH), 3110 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 3.90–4.00 (m, 2H, Ar-CH); 6.40 (s, 1H, Ar-CH); 7.20–7.30 (m, 6H, Ar-CH, thiazolidinone); 7.60–7.70 (t, 3H, Ar-CH); 7.80 (s, 1H, Ar-CH); 7.90 (d, 2H, Ar-CH); 8.40 (s, 1H, Ar-CH); 8.80 (s, 1H, Ar-CH); 9.50 (s, 1H, Ar-OH); Anal. Calcd. For $C_{24}H_{18}N_4O_2S$: C, 67.59; H, 4.25; N, 13.14; S, 7.52; Found: C, 67.20; H, 4.10; N, 13.00; S, 7.35; Mass spectra, *m/z* = 426 (100%).

Characterization data of 2-(2-hydroxyphenyl)-3-(3-((8-hydroxyquinolin-5-yl)diazenyl) phenyl)thiazo lidin-4-one (3b). Yield: 65%; M.p.: 190°C, IR (KBr): 690 (C—S—C, 4-thiazolidinone), 756 (1, 2 disubstituted benzene ring), 1253 (C—N), 1483 (C=C), 1608 (C=O, thiazolidinone), 2363 (Ar-CH), 3067 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 3.90 (m, 2H, Ar-CH); 6.30 (s, 1H, Ar-CH); 6.80 (d, 2H, Ar-CH, thiazolidinone); 7.00 (d, 2H, Ar-CH); 7.20 (s, 1H, Ar-CH); 7.30 (s, 1H, Ar-CH); 7.60 (d, 2H, Ar-CH); 7.80 (s, 1H, Ar-CH); 7.90 (d, 2H, Ar-CH); 8.40 (s, 1H, Ar-CH); 8.90 (s, 1H, Ar-CH); 9.60(s, 1H, Ar-OH); 9.70 (s, 1H, Ar-OH); Anal. Calcd. For $C_{24}H_{18}N_4O_3S$: C, 65.14; H, 4.10; N, 12.66; S, 7.25; Found: C, 65.00; H, 4.00; N, 12.16; S, 7.25; Mass spectra, *m/z* = 442 (100%).

Characterization data of 3-(3-((8-hydroxyquinolin-5-yl)diazenyl)phenyl)-2-(4-methoxyphenyl)thiazolidin-4-one (3c). Yield: 75%; M.p.: 180°C, IR (KBr): 680 (C—S—C, 4-thiazolidinone), 750 (1, 2 disubstituted benzene ring), 1250 (C—N), 1480 (C=C), 1620 (C=O, thiazolidinone), 2360 (Ar-CH), 3060 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 3.80 (s, 3H, Ar-OCH_3); 3.90 (d, 2H, Ar-CH); 6.40 (s, 1H, Ar-CH); 6.80 (d, 2H, Ar-CH, thiazolidinone); 7.20 (s, 1H, Ar-CH); 7.60 (t, 1H, Ar-CH); 7.70 (d, 2H, Ar-CH); 7.80 (t, 3H, Ar-CH); 7.90 (d, 2H, Ar-CH); 8.40 (s, 1H, Ar-CH); 8.90 (s, 1H, Ar-CH); 9.80 (s, 1H, Ar-OH); Anal. Calcd. For $C_{25}H_{20}N_4O_3S$: C, 65.77; H, 4.42; N, 12.27; S, 7.02; Found: C, 65.40; H, 4.10; N, 12.00; S, 6.85; Mass spectra, *m/z* = 456.10 (100%).

Characterization data of 2-(4-(dimethylamino)phenyl)-3-(3-((8-hydroxyquinolin-5-yl)diazenyl)phenyl) thiazolidin-4-one (3d). Yield: 60%; M.p.: 175°C, IR (KBr): 660 (C—S—C, 4-thiazolidinone), 730 (1, 2 disubstituted benzene ring), 1220 (C—N), 1450 (C=C), 1630 (C=O, thiazolidinone), 2380 (Ar-CH), 3260 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 3.10 (s, 6H, $N(CH_3)_2$); 3.80 (d, 2H, Ar-CH); 6.50 (s, 1H, Ar-CH); 6.70 (d, 2H, Ar-CH, thiazolidinone); 7.10 (d, 2H, Ar-CH); 7.20 (s, 1H, Ar-CH); 7.40 (d, 2H, Ar-CH); 7.70 (s, 1H, Ar-CH); 7.80 (s, 1H, Ar-CH); 7.90 (d, 2H, Ar-CH); 8.40 (s, 1H, Ar-CH); 8.90 (s, 1H, Ar-CH); 9.80 (s, 1H, Ar-OH); Anal. Calcd. For $C_{26}H_{23}N_5O_2S$: C, 66.50; H, 4.94; N, 14.91; S, 6.83; Found: C, 66.20; H, 4.20; N, 14.30; S, 6.55; Mass spectra, *m/z* = 469.10 (100%).

Characterization data of 2-(4-hydroxyphenyl)-3-(3-((8-hydroxyquinolin-5-yl)diazenyl)phenyl)thiazolidin-4-one (3e). Yield: 72%; M.p.: 175°C, IR (KBr): 680 (C—S—C, 4-thiazolidinone), 735 (1, 2 disubstituted benzene ring), 1233 (C—N), 1460 (C=C), 1640 (C=O, thiazolidinone), 2340 (Ar-CH), 3120 cm^{-1} (Ar-OH); ^{1}H NMR: δ = 4.00 (m, 2H, Ar-CH); 6.30 (s, 1H, Ar-CH); 6.60 (d, 2H, Ar-CH, thiazolidinone); 7.30 (s, 1H, Ar-CH); 7.40 (s, 1H, Ar-CH); 7.60–7.80 (m, 5H, Ar-CH); 8.00 (d, 2H, Ar-CH); 8.40 (s, 1H, Ar-CH); 8.90 (s, 1H, Ar-CH); 9.40(s, 1H, Ar-OH); 9.80 (s, 1H, Ar-OH); Anal. Calcd. For $C_{24}H_{18}N_4O_3S$: C, 65.14; H, 4.10; N, 12.66; S, 7.25; Found: C, 64.90; H, 4.05; N, 12.40; S, 7.15; Mass spectra, *m/z* = 442.10 (100%).

Characterization data of 3-(3-((8-hydroxyquinolin-5-yl)diazenyl)phenyl)-2-(3-nitrophenyl)thiazolidin-4-one (3f). Yield: 80%; M.p.: 190°C, IR (KBr): 620 (C—S—C, 4-thiazolidinone), 760 (1, 2 disubstituted benzene ring), 1240 (C—N), 1470

(C=C), 1670 (C=O, thiazolidinone), 2980 (Ar-CH), 3270 cm^{-1} (Ar-OH); ^1H NMR: δ = 4.10 (d, 2H, Ar-CH); 6.30 (s, 1H, Ar-CH); 7.10 (s, 1H, Ar-CH, thiazolidinone); 7.40 (s, 1H, Ar-CH); 7.50–7.80 (m, 5H, Ar-CH); 7.95–8.10 (m, 4H, Ar-CH); 8.40 (s, 1H, Ar-CH); 8.90 (s, 1H, Ar-CH); 9.80 (s, 1H, Ar-OH); Anal. Calcd. For $C_{24}H_{17}N_5O_4S$: C, 61.14; H, 3.63; N, 14.85; S, 6.80; Found: C, 59.90; H, 3.50; N, 14.20; S, 6.30; Mass spectra, *m/z* = 471 (100%).

Characterization data of 3-(3-((8-hydroxyquinolin-5-yl)diazenyl)phenyl)-2-(2-nitrophenyl)thiazolidin-4-one (3g). Yield: 67%; M.p.: 172°C, IR (KBr): 640 (C—S—C, 4-thiazolidinone), 720 (1, 2 disubstituted benzene ring), 1270 (C—N), 1430 (C=C), 1650 (C=O, thiazolidinone), 2960 (Ar-CH), 3210 cm^{-1} (Ar-OH); ^1H NMR: δ = 4.20 (d, 2H, Ar-CH); 6.50 (s, 1H, Ar-CH); 7.30 (s, 1H, Ar-CH, thiazolidinone); 7.50–7.70 (m, 6H, Ar-CH); 7.80–8.00 (m, 4H, Ar-CH); 8.50 (s, 1H, Ar-CH); 8.80 (s, 1H, Ar-CH); 9.60 (s, 1H, Ar-OH); Anal. Calcd. For $C_{24}H_{17}N_5O_4S$: C, 61.14; H, 3.63; N, 14.85; S, 6.80; Found: C, 59.80; H, 3.50; N, 14.50; S, 6.10; Mass spectra, *m/z* = 471.05 (100%).

Characterization data of 2-(4-chlorophenyl)-3-(3-((8-hydroxyquinolin-5-yl)diazenyl)phenyl)thiazolidin-4-one (3h). Yield: 77%; M.p.: 165°C, IR (KBr): 680 (C—S—C, 4-thiazolidinone), 710 (1, 2 disubstituted benzene ring), 1280 (C—N), 1420 (C=C), 1640 (C=O, thiazolidinone), 2960 (Ar-CH), 3190 cm^{-1} (Ar-OH); ^1H NMR: δ = 4.20 (d, 2H, Ar-CH); 6.30 (s, 1H, Ar-CH); 7.10–7.20 (t, 3H, Ar-CH, thiazolidinone); 7.40 (d, 2H, Ar-CH); 7.50 (s, 1H, Ar-CH); 7.70 (d, 2H, Ar-CH); 7.80 (s, 1H, Ar-CH); 8.00 (d, 2H, Ar-CH); 8.40(s, 1H, Ar-CH); 8.90 (s, 1H, Ar-CH); 9.80 (s, 1H, Ar-OH); Anal. Calcd. For $C_{24}H_{17}N_4O_2SCl$: C, 62.54; H, 3.72; N, 12.16; S, 6.96; Found: C, 62.10; H, 3.60; N, 12.00; S, 6.20; Mass spectra, *m/z* = 460 (100%).

Characterization data of 2-(2-chlorophenyl)-3-(3-((8-hydroxyquinolin-5-yl)diazenyl)phenyl)thiazolidin-4-one (3i). Yield: 75%; M.p.: 185°C, IR (KBr): 670 (C—S—C, 4-thiazolidinone), 730 (1, 2 disubstituted benzene ring), 1250 (C—N), 1470 (C=C), 1690 (C=O, thiazolidinone), 2930 (Ar-CH), 3220 cm^{-1} (Ar-OH); ^1H NMR: δ = 4.00 (s, 1H, Ar-CH); 6.40 (s, 1H, Ar-CH); 7.10–7.20 (m, 4H, Ar-CH, thiazolidinone); 7.30 (s, 1H, Ar-CH); 7.60–7.70 (t, 3H, Ar-CH); 7.80 (s, 1H, Ar-CH); 7.90 (d, 2H, Ar-CH); 8.40 (d, 2H, Ar-CH); 8.90(s, 1H, Ar-CH); 9.80 (s, 1H, Ar-OH); Anal. Calcd. For $C_{24}H_{17}N_4O_2SCl$: C, 62.54; H, 3.72; N, 12.16; S, 6.96; Found: C, 62.30; H, 3.20; N, 11.90; S, 6.60; Mass spectra, *m/z* = 460 (100%).

CONCLUSIONS

In summary, we have synthesized some bioactive thiazolidinones having 8-hydroxyquinoline moiety. The antibacterial and antifungal studies reveal that the newly synthesized compound (3) possesses good to moderate activity. Hence, these bioactive thiazolidinones can be used in the development of synthesis of new antibiotic drugs.

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