Synthesis of Some Multiazaheterocycles as Substituents to Quinolone Moiety of Specific Biological Activity

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Received 1 September 1993

New Schiff bases, hydrazones and semicarbazones derived from 1,2-dihydro-4-hydroxy-6-methyl-2-oxoquinoline-3-carbaldehyde, have been synthesized. The semicarbazone was subjected to react with 2,3-dichloroquinoxaline, chloroacetic acid, and oxalyl chloride affording multiazaheterocycles substituted to quinolone moiety at position 3. Condensation of the 2-imidazolidinethione derivative with some amines and hydrazines yielded some new heterocyclic systems of expected biological activity. Some of these imine derivatives were tested for their bactericidal, fungicidal, and molluscicidal activities. The structures of all new quinolone derivatives have been characterized by chemical reactions and physical tools.

In the light of findings reported in the literature [1—8], 2-quinolones are of a diverse pharmaceutical importance. It is thought judicious to synthesize some new members of this class of compounds, study the action of certain reagents on them and test their biological potencies. The present work is a continuation of our current research work dealing with syntheses and reactions of 1,2-dihydro-4-hydroxy-2-oxoquinolines [9—15].

1,2-Dihydro-3-heteroaryliminomethyl-4-hydroxy-6-methyl-2-oxoquinolines (*IIIa*—*IIIh*) were synthesized by the reaction of 1,2-dihydro-4-hydroxy-6-methyl-2-oxoquinoline (*I*) with triethyl orthoformate and some amines, namely *p*-toluidine, 2,6-dichloro-4-nitroaniline, 6-bromo-2,4-dinitroaniline, 2-aminopyridine, 2-aminopyrimidine, 2-aminothiazole, 4-aminoantipyrine, and 2-amino-5-methylthiadiazole. Some of these Schiff bases, *IIIa*, *IIIg* were also obtained, when 1,2-dihydro-4-hydroxy-6-methyl-2-oxoquinoline-3-carbaldehyde (*II*) was reacted with the appropriate amines. Compounds *IIIa*—*IIIg* were screened for their bactericidal, fungicidal, and molluscicidal activities (*cf.* Tables 1 and 2).

Table 1. Antimicrobial Activity Data

Compound	*Escherichia coli*	*Pseudomonas aeruginosa*	*Klebsiella pneumoniae*	*Proteus mirabilis*	*Serratia narcescens*	*Bacillus subtilis*	*Staphylococcus aureus*	*Candida albicans*
IIIa	+	+	++	++	+	++	+	+
IIIb	+	+	+	+	+	+	+	–
IIIc	+	+	+	+	+	+	–	–
IIId	+	+	++	+	+	++	+	+
IIIe	–	+	+	–	–	+	–	–
IIIf	–	+	+	–	–	+	–	–
IIIg	+	+	+	+	+	++	++	–

Inhibition zone: ≤ 6 mm Inactive (–)
5—8 mm Slightly active (+)
9—12 mm Moderately active (++)

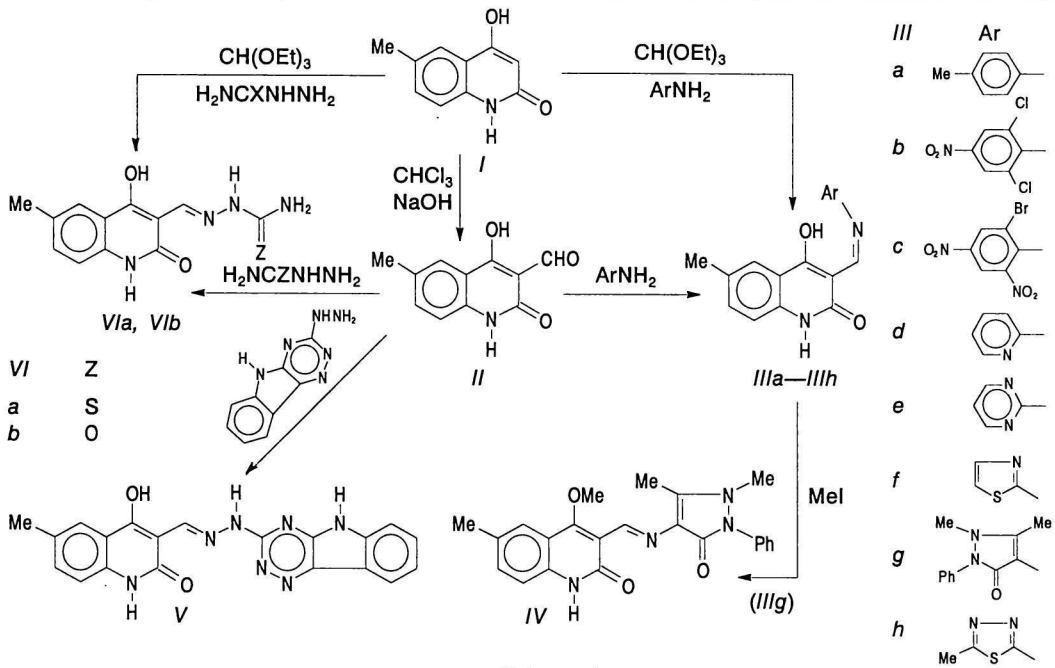
Table 2. Molluscicidal Activities Data

Compound	*w*(LC 50) / ppm	*w*(LC 90) / ppm	Slope[a]
IIIa	–	–	–
IIIb	58	150	2.11
IIIc	26	120	3.28
IIId	23	54	1.94
IIIe	–	–	–
IIIf	–	–	–
IIIg	86	190	1.89

a) Slope = (Ed 84/Ed 50 + Ed 50/Ed 16)/2, where Ed 84, Ed 50, and Ed 16 are the mass concentrations (in ppm) which give 84 %, 50 %, and 16 % mortality, respectively [22].

Methylation of *IIIg* with methyl iodide affected the hydroxy group at position 4 only, yielding 1,2-dihydro-3-[(2,3-dimethyl-1-phenyl-5-oxo-4-pyrazolinyl)iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*IV*). Due to the reported biological importance of triazinoindoles [16], the aldehyde *II* was reacted with 3-hydrazino-5*H*-1,2,4-triazino[5,6-*b*]indole giving rise to 1,2-dihydro-4-hydroxy-6-methyl-2-oxoquinoline-3-carbaldehyde 5*H*-1,2,4-triazino[5,6-*b*]indol-3-ylhydrazone (*V*).

As cited recently, thiosemicarbazones revealed wide spectrum of biological activity [17]. This prompted us to synthesize thiosemicarbazones of the considered 2-oxoquinoline-3-carbaldehyde and utilize them as precursors for obtaining other 3-heteroaryl-substituted quinolones. Thus, reactions of the aldehyde *II* with thiosemicarbazide and semicarbazide yielded the thiosemicarbazone *VIa* and semicarbazone *VIb* (Scheme 1).



Scheme 1

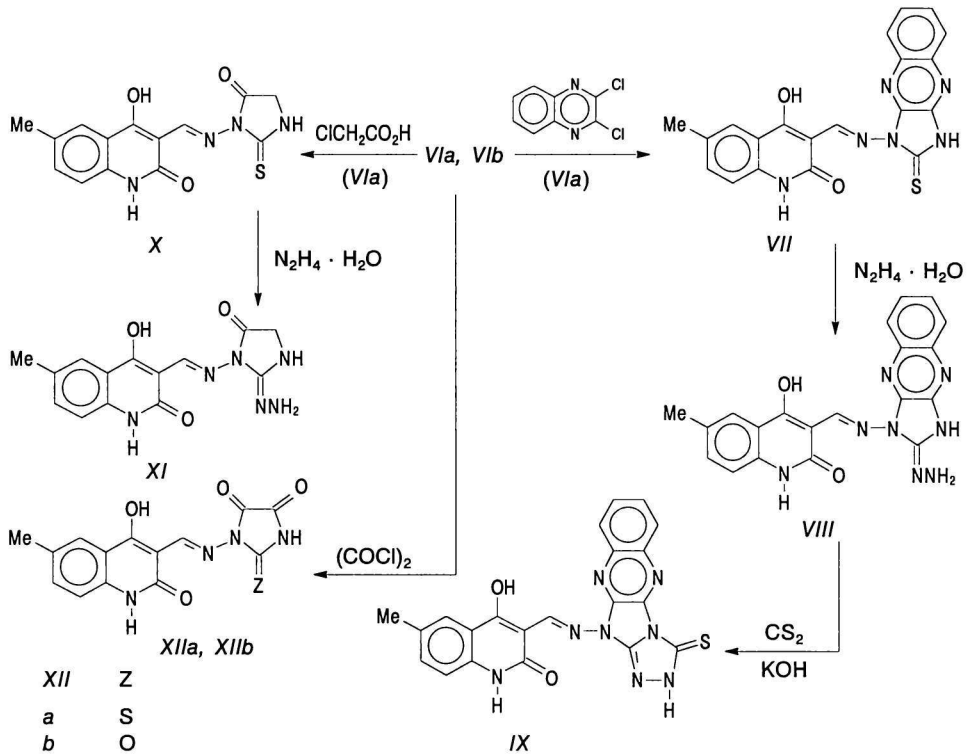
On reacting of the thiosemicarbazone *VIa* with 2,3-dichloroquinoxaline, 1,2-dihydro-3-[(2,3-dihydro-2-thioxoimidazolo[4,5-*b*]quinoxalin-1-yl)iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*VII*) was obtained. The easy conversion of compound *VII* to the corresponding hydrazino derivative *VIII* is advanced by the fact that the thiourea residue in compound *VIa* cyclizes with 2,3-dichloroquinoxaline at *N*,*N'*-atoms and this cyclization reaction does not involve the *S*-atom leading to the 2-imidazolethione and not the thiazole ring. IR and ^{1}H NMR spectra of the compound *VII* confirm satisfactorily the presence of (HNC=S) group.

Cyclization of the hydrazino derivative *VIII via* the reaction with carbon disulfide in the presence of alcoholic potassium hydroxide afforded an interesting polynuclear ring system, *viz*. 1,2-dihydro-3-[(1-thioxo-2*H*-quinoxalino[2,3-4,5]imidazo[1,2-*d*]-1,2,4-triazol-4-yl)iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*IX*) (Scheme 2).

On the other hand, compound *VIa* cyclized to 1,2-dihydro-3-[(5-oxo-2-thioxo-1-imidazolidinyl)iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*X*) with chloroacetic acid, in a base-catalyzed reaction. The absence of $\nu(NH_2)$ and the presence of $\nu(C{=}S)$ ($\tilde{\nu}$ = 1245 cm^{-1} and 1350 cm^{-1}) in the IR spectrum of the compound *X* suggested strongly the cyclization to imidazolidine and not to thiazolidine ring. A confirmatory test reaction for the structure *X* is the simple condensation between hydrazine and compound *X*, accompanied with evolution of H_2S, leading to the formation of hydrazino derivative *XI*. Again, compounds *VIa, VIb* undergo cyclocondensation reaction using oxalyl chloride to give the imidazolyl derivatives *XIIa, XIIb*. The formation of a trioxoimidazole ring system *XIIb* instead of the isomeric dioxooxazolidine moiety is easily deduced from IR spectroscopic data: compound *XIIb* exhibits a strong C=O absorption band at $\tilde{\nu}$ = 1690—1705 cm^{-1} characteristic of five-membered lactams, while the $\nu(C{=}O)$ peak characteristic of five-membered lactones, is not present [18]. Furthermore, compound *XIIa* reveals absorptions at $\tilde{\nu}$ = 1250 cm^{-1} and 1345 cm^{-1} in its spectrum, specific for (NHC=S) group, indicating that a similar cyclization took part (Scheme 2).

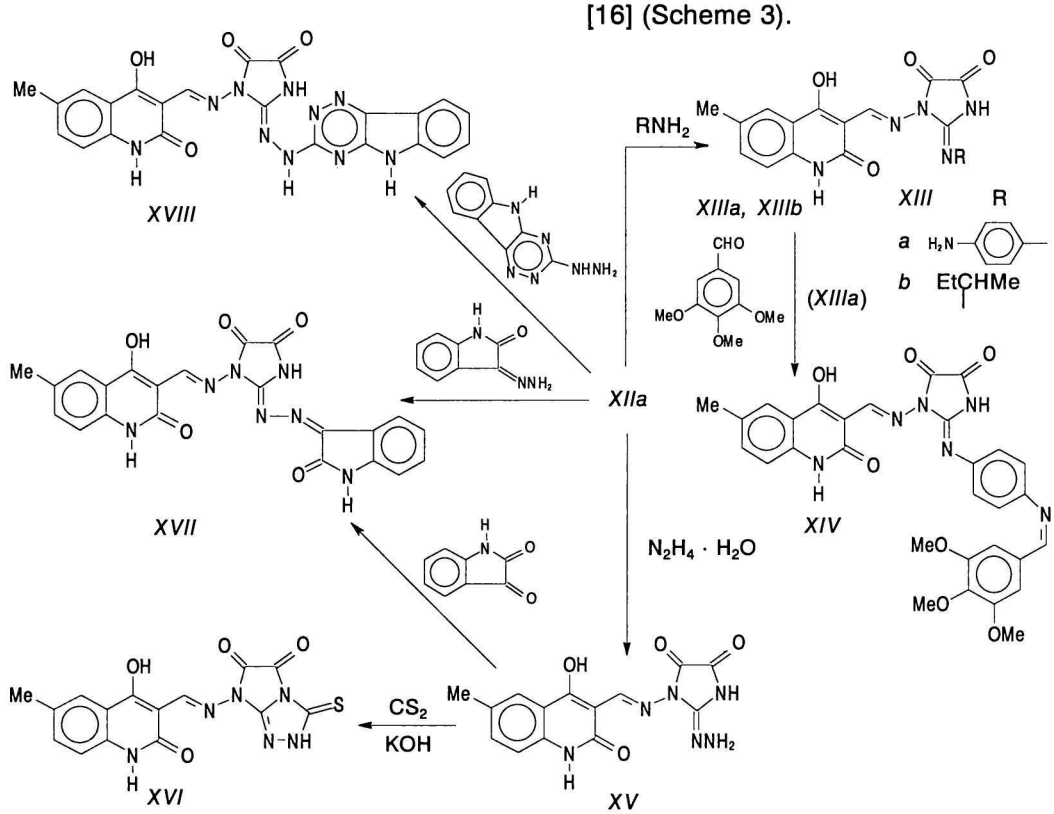
On reacting of *XIIa* with *p*-phenylenediamine and *sec*-butylamine at the mole ratio x_r = 1 : 1, simple condensation products *XIIIa* and *XIIIb* were obtained with a loss of H_2S. IR spectrum of *XIIIa* shows $\nu(NH_2)$ at $\tilde{\nu} \approx 3280$ cm^{-1}, but this band is absent in the spectrum of *XIV*, the product formed by the reaction between *XIIIa* and 3,4,5-trimethoxybenzaldehyde. The structure of the compound *XIV* was established on the basis of its IR and ^{1}H NMR spectrum as well as elemental microanalysis.

Reaction of the thione *XIIa* with hydrazine hydrate afforded its hydrazino analogue *XV*. Cyclization of the 2-hydrazinoimidazolidine *XV* with carbon disulfide gave the imidazolotriazole derivative *XVI*.



Scheme 2

Compound *XV* condensed with isatin in boiling ethanol, giving rise to the azine *XVII.* The same product was obtained by reacting *XIIa* with isatin 3-hydrazone (identified by its melting point, mixed melting point, and spectra). Also, compound *XIIa* was used to obtain the 1,2,4-triazino[5,6-*b*]indole-3-hydrazone derivative *XVIII*, a ring system in general is well known for its potential biological activity [16] (Scheme 3).



Scheme 3

The screening bactericidal and fungicidal tests for the compounds *IIIa—IIIg* were performed by the disc diffusion method [19]. These compounds were tested against two gram-positive and five gram-negative bacteria and a fungus strain (*Candida albicans*). The tested compounds (at dose level ρ = 500 μg cm^{-3}) were placed on the surface of solid medium and then transferred to an incubator at 37 °C for bacteria and at 28 °C for yeast, the inhibition zones were evaluated after 24 h and 72 h, respectively. The results reveal that compounds *IIIa*, *IIId*, and *IIIg* are only moderately active towards some tested gram-positive and gram-negative bacteria, while these compounds and other tested ones are slightly active or even inactive against the test microorganisms (*cf.* Table 1).

Compounds *IIIa—IIIg* were tested as chemical molluscicides for *Biomphalaria alexandrina* snails, the intermediate hosts of *Schistosoma mansoni.* A standard procedure was followed [20, 21]. Different dilutions, ranging between *w* = 10—200 mass ppm, of the tested compounds were prepared. LC 50 and LC 90 of the different tested compounds were determined and the slope in each case was calculated according to *Litchfield* and *Wilcoxson* [22] (*cf.* Table 2).

The screening test revealed that both compounds *IIIc* and *IIId* are the most potent against snails with LC 50 (*w* = 26 ppm and 23 ppm, respectively). The slope functions obtained are large enough, indicating that larger time is needed for developing resistance in snails using compounds *IIIb—IIId* and *IIIg*.

EXPERIMENTAL

Melting points were determined in open capillary tubes and are uncorrected. Infrared spectra were recorded on a Perkin—Elmer 598 spectrophotometer using samples in KBr discs. ^{1}H NMR spectra were taken on a Varian 390 EM spectrometer (DMSO-d_6; 90 MHz), using TMS as an internal standard. Characterization of the prepared compounds is given in Table 3. 1,2-Dihydro-4-hydroxy-6-methyl-2-oxoquinoline (*I*) and 1,2-dihydro-4-hydroxy-6-methyl-2-oxoquinoline-3-carbaldehyde (*II*) were prepared according to the described procedures by *Mohamed et al.* [9, 15].

3-Aryliminomethyl-1,2-dihydro-4-hydroxy-6-methyl-2-oxoquinolines *IIIa—IIIh*

a) A mixture of *I* (0.1 mol), triethyl orthoformate (0.1 mol), and appropriate amine (namely *p*-toluidine, 2,6-dichloro-4-aminoaniline, 6-bromo-2,4-dinitroaniline, 2-aminopyridine, 2-aminopyrimidine, 2-aminothiazole, 4-aminoantipyridine, and 2-amino-5-methylthiadiazole) in ethylene glycol (20 cm^3) was heated with stirring at 110—115 °C for 20 min and the temperature was raised gradually to 190 °C during 1 h. Then the reaction mixture was left to cool at room temperature and treated with 50 cm^3 of ethanol. The yellow precipitate was collected, washed with cold ethanol and crystallized. IR spectrum (KBr), $\tilde{\nu}$/cm^{-1} (*IIIb*): 630—700 ν(C—Cl), 1340, 1530 ν(NO_2), 1580—1610 ν(C=N), 1645 ν(C=O), ≈ 2500 ν(H-bonded OH), 3200 ν($NH_{quinolone}$). ^{1}H NMR spectrum, δ (*IIIg*): 2.2 (s, 3H, CH_3-$6_{quinolone}$), 2.3 (s, 3H, CH_3-$5_{pyrazolone}$), 3.1 (s, 3H, N—CH_3), 6.8—7.8 (m, 9H, CH=N, H_{arom}), 9.9 (s, 1H, NH), 11.5 (s, 1H, OH). ^{1}H NMR spectrum, δ (*IIIh*): 2.25 (s, 3H, CH_3-$6_{quinolone}$), 3.0 (s, 3H, CH_3-$2_{thiadiazole}$), 7.1—7.9 (m, 3H, H_{arom}), 8.3 (s, 1H, CH=N), 9.9 (br, s, 1H, NH), 11.5 (br, s, 1H, OH).

b) A mixture of the 3-formyl derivative *II* (0.01 mol) and *p*-toluidine resp. 4-aminoantipyrine (0.012 mol) in ethanol (25 cm^3) was refluxed for 3 h. Then the hot reaction mixture was filtered off and the collected solid was crystallized.

1,2-Dihydro-3-[(2,3-dimethyl-1-phenyl-5-oxo-4-pyrazolinyl)iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*IV*)

A mixture of *IIIg* (0.01 mol), methyl iodide (0.01 mol), and anhydrous potassium carbonate (1 g) was heated under reflux in DMF (10 cm^3) for 6 h, cooled, and poured into cold water. The solid product that separated was filtered off and crystallized. IR spectrum (KBr), $\tilde{\nu}$/cm^{-1}: 1080 ν(C—O—C), 1590—1605 ν(C=N), 1645 ν(C=O), 2970—2980 (CH_{aliph}), 3200 ν($NH_{quinolone}$). ^{1}H NMR spectrum, δ: 2.2 (s, 3H, CH_3-$6_{quinolone}$), 2.3 (s, 3H, CH_3-$5_{pyrazolone}$), 3.1 (s, 3H, NCH_3), 3.9 (s, 3H, OCH_3), 6.8—7.9 (m, 9H, CH=N, H_{arom}), 9.9 (s, 1H, NH).

1,2-Dihydro-4-hydroxy-6-methyl-2-oxoquinoline-3-carbaldehyde-5*H*-1,2,4-triazino[5,6-*b*]indol-3-ylhydrazone (*V*)

A mixture of aldehyde *II* (0.01 mol) and 3-hydrazino-5*H*-1,2,4-triazino[5,6-*b*]indole (0.01 mol) in ethanol (25 cm^3) was refluxed for 3 h, cooled and poured into water. The solid that separated was collected and crystallized. IR spectrum (KBr), $\tilde{\nu}$/cm^{-1}: 1600—1620 ν(C=N), 1640 ν(C=O), ≈ 2560 ν(br, OH), 3080—3180 ν(br, $NH_{quinolone}$). ^{1}H NMR spectrum, δ: 2.3 (s, 3H, CH_3), 7.2—8.1 (m, 7H, H_{arom}), 8.6 (s, 1H, CH=N), 9.85 (br, s, 1H, $NH_{quinolone}$), 10.1—11.15 (br, 2H, 2 × NH), 12.1 (br, 1H, OH).

Table 3. Characterization of the New Compounds

Compound	Formula M_r	w_i(calc.)/% w_i(found)/% C	H	N	Yield %	M.p. °C	Solvent
IIIa	$C_{18}H_{16}N_2O_2$ 292	73.97 73.50	5.48 5.40	9.59 9.30	71[a] 59[b]	> 300	AcOH—H_2O
IIIb	$C_{17}H_{11}N_3Cl_2O_4$ 392	52.04 52.20	2.81 2.70	10.71 10.50	86[a]	> 300	AcOH—H_2O
IIIc	$C_{17}H_{11}N_4O_6Br$ 447	45.64 45.40	2.46 2.30	12.53 12.10	70[a]	> 300	AcOH—H
IIId	$C_{16}H_{13}N_3O_2$ 279	68.82 69.00	4.66 4.50	15.05 15.00	66[a]	> 300	AcOH—H_2O
IIIe	$C_{15}H_{12}N_4O_2$ 280	64.29 64.10	4.29 4.00	20.00 19.70	58[a]	> 300	AcOH—H_2O
IIIf	$C_{14}H_{11}N_3O_2S$ 285	58.95 58.80	3.86 4.00	14.74 14.40	52[a]	> 300	Acetic acid
IIIg	$C_{22}H_{20}N_4O_3$ 388	68.04 67.90	5.15 5.20	14.43 14.10	63[a] 48[b]	> 300	Acetic acid
IIIh	$C_{14}H_{12}N_4O_2S$ 300	56.00 56.00	4.00 4.10	18.67 18.60	53[a]	> 300	Acetic acid
IV	$C_{23}H_{22}N_4O_3$ 402	68.66 68.70	5.47 5.30	13.93 13.80	40[a]	260	DMF
V	$C_{20}H_{15}N_7O_2$ 385	62.34 62.30	3.90 3.90	25.45 25.30	60[a]	> 300	DMSO
VIa	$C_{12}H_{12}N_4O_2S$ 276	52.17 52.10	4.35 4.20	20.29 19.90	73[a] 52[b]	> 300	DMF
VIb	$C_{12}H_{12}N_4O_3$ 260	55.38 55.40	4.62 4.60	21.54 21.40	78[a] 56[b]	> 300	Acetic acid
VII	$C_{20}H_{14}N_6O_2S$ 402	59.70 59.60	3.48 3.30	20.90 21.00	53	250	DMF
VIII	$C_{20}H_{16}N_8O_2$ 400	60.00 59.90	4.00 4.00	28.00 28.10	60[a]	270	DMF
IX	$C_{21}H_{14}N_8O_2S$ 442	57.01 57.00	3.17 3.20	25.34 25.20	50[a]	199	DMF
X	$C_{14}H_{12}N_4O_3S$ 316	53.16 53.00	3.80 3.80	17.72 17.60	66[a]	> 300	DMSO
XI	$C_{14}H_{14}N_6O_3$ 314	53.50 53.20	4.46 4.50	26.75 26.50	72[a]	> 300	DMF—Ethanol
XIIa	$C_{14}H_{10}N_4O_4S$ 330	50.91 50.80	3.03 3.00	16.97 17.00	90[a]	> 300	DMF
XIIb	$C_{14}H_{10}N_4O_5$ 314	53.50 53.60	3.18 3.10	17.83 17.70	85[a]	> 300	DMF
XIIIa	$C_{20}H_{16}N_6O_4$ 404	59.41 59.30	3.96 3.90	20.79 20.80	85[a]	253—255	DMF—Ethanol
XIIIb	$C_{18}H_{19}N_5O_4$ 369	58.54 58.50	5.15 4.70	18.97 19.00	65[a]	170	DMF
XIV	$C_{30}H_{26}N_6O_7$ 582	61.86 61.50	4.47 4.30	14.43 14.00	65[a]	> 300	Acetic acid
XV	$C_{14}H_{12}N_6O_4$ 328	51.22 51.30	3.66 3.60	25.61 25.70	65[a]	> 300	DMF
XVI	$C_{15}H_{10}N_6O_4S$ 370	48.65 48.40	2.70 2.60	22.70 22.60	55[a]	> 300	DMF
XVII	$C_{22}H_{15}N_7O_5$ 457	55.43 55.40	3.46 3.40	28.23 28.30	70[a] 62[b]	190	Acetic acid
XVIII	$C_{23}H_{16}N_{10}O_4$ 496	55.65 55.60	3.23 3.30	28.23 28.30	80[a]	285—290	DMF

a) Prepared using procedure *a*; *b*) Prepared using procedure *b*.

1,2-Dihydro-4-hydroxy-6-methyl-2-oxoquinoline-3-carbaldehyde Thiosemicarbazone (*VIa*) and Semicarbazone (*VIb*)

a) A mixture of the aldehyde *II* (0.01 mol) and thiosemicarbazide or semicarbazide (0.012 mol) in ethanol (30 cm^3) was refluxed for 3 h. The formed yellow solid product was filtered off, dried and crystallized. IR spectrum (KBr), $\tilde{\nu}/cm^{-1}$ (*VIa*): 1250, 1370 ν(C=S), 1590—1605 ν(C=N), 1610 ν(NH_2 def), 1635—1650 ν(C=O), ≈ 2500 ν(H-bonded OH), 3180 ν(NH), 3390 ν(NH_2). ^{1}H NMR spectrum, δ (*VIa*): 2.2 (s, 3H, CH_3), 7.2—7.9 (m, 3H, H_{arom}), 8.4 (s, 1H, CH=N), 9.9—10.1 (br, 2H, 2 × NH), 11.5 (br, 1H, OH), 11.9 (br, 2H, NH_2).

b) A mixture of the compound *I* (0.01 mol) and thiosemicarbazide or semicarbazide (0.01 mol) was dissolved in acetic acid (20 cm^3) and the resulting solution was treated with triethyl orthoformate (0.01 mol). The mixture was refluxed for 2 h and then cooled, poured into water and the separated yellow solid was collected and crystallized.

1,2-Dihydro-3-[(2,3-dihydro-2-thioxoimidazolo-[4,5-*b*]-quinoxalin-1-yl)iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*VII*)

A mixture of the compound *VIa* (0.01 mol) and 2,3-dichloroquinoxaline (0.01 mol) in pyridine (25 cm^3) was refluxed for 2 h, then cooled and poured into ice-cold diluted HCl (50 cm^3; *w* = 5 %). The solid that separated was collected and crystallized. IR spectrum (KBr), $\tilde{\nu}/cm^{-1}$: 1230, 1350 ν(NHC=S), 1580—1610 ν(C=N), 1640 ν(C=O), ≈ 2500 ν(H-bonded OH), 2900—2980 ν(C—H_{aliph}), 3240 ν(NH). ^{1}H NMR spectrum, δ: 2.3 (s, 3H, CH_3), 6.9—7.9 (m, 7H, H_{arom}), 8.5 (s, 1H, CH=N), 10.0 (s, 1H, $NH_{quinolone}$), 11.8 (s, 1H, NHC=S), 12.0 (s, 1H, OH).

1,2-Dihydro-3-[(2,3-dihydro-2-hydrazinoimid-azole[4,5-*b*]-quinoxalin-1-yl)iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*VIII*)

To a suspension of *VII* (0.01 mol) in absolute ethanol (20 cm^3), hydrazine hydrate (0.015 mol; *w* = 98 %) was added and the reaction mixture was refluxed for 2 h. The mixture was then cooled, treated with one drop of HCl and the separated pale yellow product was filtered off, dried and crystallized. IR spectrum (KBr), $\tilde{\nu}/cm^{-1}$: 1590—1605 ν(C=N), 1615 ν(NH_2 def), 1660 ν(C=O), ≈ 2500 (H-bonded OH), 3170—3400 ν(NH, NH_2).

1,2-Dihydro-3-[(1-thioxo-2*H*-quinoxalino[2,3-4,5]imidazo[1,2-*d*]-1,2,4-triazol-4-yl)imino-methyl]-4-hydroxy-6-methyl-2-oxoquinoline (*IX*)

An alcoholic potassium hydroxide solution (0.02 mol) in ethanol (35 cm^3, *w* = 95 %) was added to a mixture of *VIII* (0.01 mol) and carbon disulfide (10 cm^3). The reaction mixture was refluxed for 12 h and the excess CS_2 was then evaporated. The solid that was obtained, was dissolved in water, filtered off from any insoluble materials and acidified with diluted HCl (*w* = 15 %), the brown precipitate that formed was filtered off and crystallized. IR spectrum (KBr), $\tilde{\nu}/cm^{-1}$: 1370 ν(NHC=S), 1580—1610 ν(C=N), 1645 ν(C=O), ≈ 2500 ν(H-bonded OH), 3175—3240 (NH). ^{1}H NMR spectrum, δ: 2.3 (s, 3H, CH_3), 7.0—7.9 (m, 7H, H_{arom}), 8.6 (s, 1H, CH=N), 10.1 (s, 1H, $NH_{quinolone}$), 11.4 (s, 1H, NHC=S), 11.6 (s, 1H, OH).

1,2-Dihydro-3-[(5-oxo-2-thioxo-1-imidazolidinyl)-iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*X*)

A mixture of *IIIa* (0.01 mol), chloroacetic acid (0.011 mol), and potassium hydroxide (0.02 mol) in ethanol (25 cm^3) was refluxed for 4 h. The reaction mixture was cooled, diluted with water and stirred with KOH solution (25 cm^3; 15 mass %), filtered from any insoluble materials and the clear alkaline solution was acidified. The precipitate was filtered off, washed with water, dried and crystallized. IR spectrum (KBr), $\tilde{\nu}/cm^{-1}$: 1245, 1350 ν(C=S), 1590 ν(C=N), 1645—1660 ν(C=O), ≈ 2500 ν(H-bonded OH), 3175 ν(N—H).

1,2-Dihydro-3-[(2-hydrazino-5-oxo-1-imid-azolidinyl)iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*XI*)

To a suspension of *X* (0.01 mol) in ethanol (20 cm^3), hydrazine hydrate (0.015 mol) was added and the reaction mixture was then refluxed for 2 h, cooled and poured into cold water. The solid product formed was collected by filtration and crystallized. IR spectrum (KBr), $\tilde{\nu}/cm^{-1}$: 1595—1605 ν(C=N), 1640—1650 ν(C=O), ≈ 2500 ν(H-bonded OH), 3350—3400 ν(NH, NH_2).

1,2-Dihydro-3-[(4,5-dioxo-2-thioxo-1-imid-azolidinyl)iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*XIIa*)

A mixture of compound *VIa* (0.01 mol) and oxalyl chloride (0.01 mol) in dry benzene (20 cm^3) was refluxed on a water bath for 3 h and then the solvent was distilled off *in vacuo*. The residue was washed with ethanol, then dried and crystallized. IR spectrum (KBr), $\tilde{\nu}/cm^{-1}$: 1250, 1345 ν(C=S), 1595 ν(C=N), 1640—1690 ν(C=O groups), ≈ 2600 ν(H-bonded OH), 3220 ν(N—H). ^{1}H NMR spectrum, δ: 2.3 (s, 3H, CH_3), 7.2—8.0 (m, 3H, H_{arom}), 10.2 (s, 1H, $NH_{quinolone}$), 11.8 (s, 1H, OH), 12.4 (br, s, 1H, HNC=S).

1,2-Dihydro-3-[(2,4,5-trioxoimidazolidinyl)iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*XIIb*)

The above compound was obtained from *VIb* (0.01 mol) and oxalyl chloride (0.01 mol) using the same method as described for *XIIa*. IR spectrum (KBr), $\tilde{\nu}$/cm^{-1}: 1580—1610 ν(C=N groups), 1635, 1690, 1705 ν(C=O groups), ≈ 2500 ν(H-bonded OH), 3165—3250 ν(N—H).

1,2-Dihydro-3-[(2-(*p*-aminophenyl/2-butyl)imino-4,5-dioxo-1-imidazolidinyl)iminomethyl]-4-hydroxy-6-methyl-2-oxoquinolines (*XIIIa*, *XIIIb*)

A mixture of *XIIa* (0.01 mol) and *p*-phenylenediamine or *sec*-butylamine (0.012 mol) in ethanol (30 cm^3) was refluxed for 3 h. The solid that separated was filtered off, washed with ethanol, dried and crystallized to afford *XIIIa* and *XIIIb*. IR spectra (KBr), $\tilde{\nu}$/cm^{-1} (*XIIIa*): 1580—1590 ν(C=N), 1625—1690 ν(C=O groups), ≈ 2600 ν(H-bonded OH), 3170—3280 ν(NH, NH_2); $\tilde{\nu}$/cm^{-1} (*XIIIb*): 1585—1600 ν(C=N), 1640—1690 ν(C=O groups), ≈ 2560 (H-bonded OH), 2860—2920 ν(C—H_{aliph}), 3120—3170 ν(N—H).

1,2-Dihydro-3-[(4,5-dioxo-2-[4-(3,4,5-trimethoxybenzalimino)phenylimino]-1-imidazolidinyl)-iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*XIV*)

To a suspension of *XIIIa* (0.01 mol) in ethanol (30 cm^3), 3,4,5-trimethoxybenzaldehyde (0.01 mol) was added and the reaction mixture was refluxed for 4 h and cooled. The solid that separated was filtered off and crystallized. IR spectrum (KBr), $\tilde{\nu}$/cm^{-1}: 1100—1110 ν(C—O—C), 1570—1580 ν(C=N), 1640, 1650, 1680 ν(C=O groups), 2850—2990 ν(C—H_{aliph}), 3140—3170 ν(N—H). ^{1}H NMR spectrum, δ: 2.3 (s, 3H, CH_3-$6_{quinolone}$), 3.90 (s, 9H, 3 × OCH_3), 6.9—8.1 (m, 9H, H_{arom}), 8.5—8.7 (br, 2H, 2 × CH=N), 10.1 (br, s, 1H, $NH_{quinolone}$), 11.2 (br, s, 1H, $NH_{imidazolidine}$), 11.9 (br, s, 1H, OH).

1,2-Dihydro-3-[(4,5-dioxo-2-hydrazino-1-imidazolidinyl)iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*XV*)

The above compound was obtained from *XIIa* (1 mol) and hydrazine hydrate (1.2 mol) using the same method as described for *VIII*. IR spectrum (KBr), $\tilde{\nu}$/cm^{-1}: 1580—1590 ν(C=N), 1635, 1655, 1680 ν(C=O groups), ≈ 2500 ν(H-bonded OH), 3170, 3240, 3360 ν(NH, NH_2).

1,2-Dihydro-3-[(5,6-dioxo-1-thioxoimidazolo[2,3-*c*]-1,2,4-triazolin-4-yl)iminomethyl]-4-hydroxy-6-methyl-2-oxoquinoline (*XVI*)

The above compound was obtained from *XV* and carbon disulfide using the same method as described for compound *IX*. IR spectrum (KBr), $\tilde{\nu}$/cm^{-1}: 1240, 1360 ν(NHC=S), 1590—1610 ν(C=N), 1625, 1650, 1680—1695 ν(C=O groups), ≈ 2500 ν(H-bonded OH), 3170—3210 ν(N—H).

1-[(1,2-Dihydro-4-hydroxy-6-methyl-2-oxo-3-quinolinyl)methylimino]-2-[(2,3-dihydro-2-oxo-3-indolylidene)azino]-4,5-dioxoimidazolidine (*XVII*)

a) A mixture of the hydrazino derivative *XV* (0.01 mol) and isatin (0.01 mol) in ethanol (10 cm^3) was refluxed for 2 h. The formed brown solid product was filtered off, dried and crystallized. IR spectrum (KBr), $\tilde{\nu}$/cm^{-1}: 1580—1610 ν(C=N), 1635, 1650, 1660, 1685 ν(C=O groups), ≈ 2500 ν(H-bonded OH), 3165—3180 ν(N—H).

b) *XVII* was obtained from compound *XIIa* and isatin 3-hydrazone using the same method as described for *XIII*.

1-[(1,2-Dihydro-4-hydroxy-6-methyl-2-oxo-3-quinolinyl)methylimino]-2-[(5*H*-1,2,4-triazino-[5,6-*b*]indol-3-yl)hydrazino]-4,5-dioxoimidazolidine (*XVIII*)

The above compound was obtained from *XIIa* (0.01 mol) and 3-hydrazino-5*H*-1,2,4-triazino[5,6-*b*]indole using the method as described for *V*. IR spectrum (KBr), $\tilde{\nu}$/cm^{-1}: 1580—1610 ν(C=N), 1635, 1650, 1690 ν(C=O), ≈ 2500 ν(H-bonded OH), 2800—2990 ν(C—H_{aliph}), 3140—3220 ν(N—H). ^{1}H NMR spectrum, δ: 2.2 (s, 3H, CH_3), 6.9—7.9 (m, 7H, H_{arom}), 8.6 (s, 1H, CH=N), 10.2 (br, s, 1H, $NH_{quinolone}$), 10.9—11.3 (br, m, 3H, 3 × NH), 12.0 (br, s, 1H, OH).

Acknowledgements. The authors thank Dr. H. A. Farrag from the National Centre for Radiation Research and Technology for antimicrobial screening as well as Dr. M. Zaki, National Centre for Research for molluscicidal evaluation.

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