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The title compounds **3** were synthesized from dimethyl *N,N'*-arylenebisdithiocarbamates **1**. An alternative synthesis for **3** and their 3,3'-(6,6'-dibenzothiazole-2,2'-diyl) analogues **7** is also described.

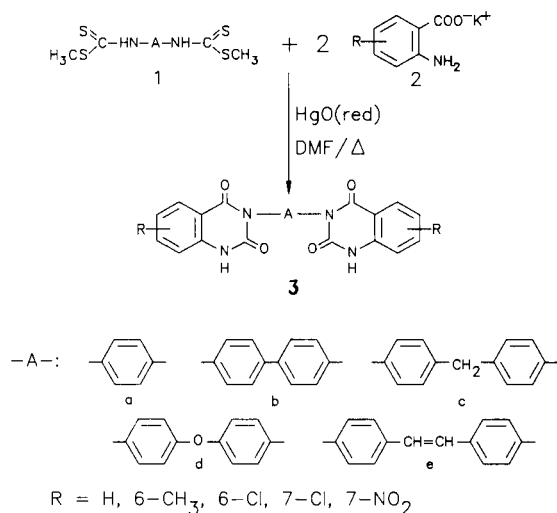
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As a result of continuing interest in the chemistry of diheterocyclic compounds, and as an extension of our previous work on bisbenzoazoles [2], it seemed interesting to investigate the applicability of our methodology to the synthesis of six-membered bisheterocycles such as the title compounds.

Although the most usual route to 3-substituted-2,4-dioxo-1,2,3,4-tetrahydroquinazolines is the reaction of anthranilic acid or derivatives with isocyanates [3], we showed that dithiocarbamates and dithiocarbonimidates could also be efficiently used in this synthesis [4] [5].

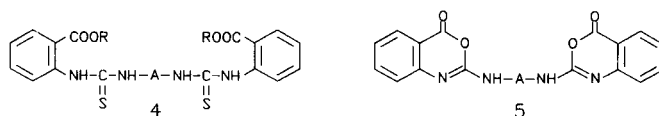
In the present paper, we report that the reaction of dimethyl *N,N'*-arylenebisdithiocarbamates **1a-e**, prepared as previously reported [6], with potassium anthranilates **2** in the presence of red mercury(II) oxide in dimethylformamide under reflux gives the title compounds **3** in yields ranging from 42% to 73% (Scheme I) (Table 1, method A).

Scheme I



This reaction is supposed to go through thiourea **4** ($R = K$), which undergoes desulfurization and the nucleophilic attack of the carboxylate anion, to give a benzoxazine intermediate **5** [4]. This, in turn, rearranges in refluxing dimethylformamide into the isomeric quinazoline **3** [7].

Figure



It is noteworthy that, while thiourea **4** ($R = H$) was obtained by the reaction of anthranilic acid with an arylene-diisothiocyanate, and gave **3** by heating with base and mercury(II) oxide, the intermediate benzoxazine **5** could not be isolated in any case although it was detected in the reaction mixture by ir spectroscopy ($\nu C=O \approx 1750 \text{ cm}^{-1}$) [3].

Compounds **3e** with a vinylidene bridge could not be isolated in a pure state, probably due to the complexation of mercury ions with the carbon-carbon double bond.

We recently described the synthesis of tetramethyl bis-[*N*-(2-benzothiazolyl)dithiocarbonimidates **6** and their reactivity to give benzoazole derivatives [8]. Furthermore, as mentioned above, the dithiocarbonimidates can produce quinazolines by reaction with potassium anthranilates [5], and it seemed interesting to investigate the ability of compounds **6** to yield bisquinazolines **7**.

The reaction of **6** with potassium anthranilates was car-

Scheme II

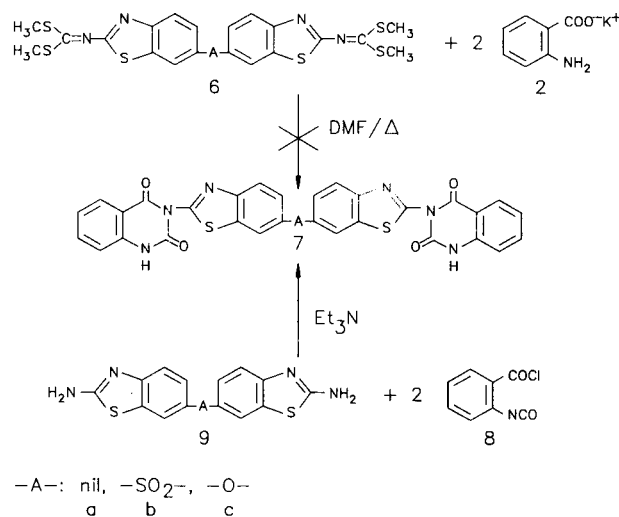


Table 1
3,3'-Arylenebis(2,4-dioxo-1,2,3,4-tetrahydroquinazolines) **3**

Compound	R	mp (°C) [a]	Reaction time (hours) [b]	Yield (%)	
				Method A [c]	Method B [d]
3a	H	>300	6	63	96
	6-CH ₃	>300	6	61	
	6-Cl	>300	6	56	
	7-Cl	>300	6	52	
	7-NO ₂	>300	12	55	
3b	H	>300	18	63	95
	6-CH ₃	>300	18	60	
	6-Cl	>300	18	57	
	7-Cl	>300	18	58	
	7-NO ₂	>300	24	48	
3c	H	>300	24	56	92
	6-CH ₃	>300	24	52	
	6-Cl	>300	24	67	
	7-Cl	>300	24	73	
	7-NO ₂	>300	36	44	
3d	H	>300	24	68	95
	6-CH ₃	>300	24	59	
	6-Cl	>300	24	54	
	7-Cl	>300	24	58	
	7-NO ₂	>300	36	42	
3e	H	>300			94

[a] Recrystallized from DMSO. [b] Method A. [c] From **1** and **2**. [d] From **10** and **8**.

ried out in refluxing dimethylformamide, but surprisingly, after acidic workup only complex mixtures were obtained. Nevertheless, compounds **7** were obtained by an alternative synthesis, which consisted in the reaction of the corresponding 2,2'-diamino-6,6'-dibenzothiazole **9** [9] with 2-isocyanatobenzoyl chloride **8**, easily prepared from isatoic anhydride and thionyl chloride [10]. Bisquinazolines **7** were thus obtained in medium yields (Scheme II) (Table 2).

Table 2
3,3'-(6,6'-Dibenzothiazol-2,2'-diyl)bis(2,4-dioxo-1,2,3,4-tetrahydroquinazolines) **7**

Compound	A	mp (°C) [a]	Yield (%)
7a	nil	>300	61
7b	-SO ₂	>300	51
7c	-O-	>300	53

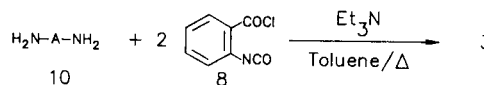
[a] Recrystallized from DMSO/water.

This alternative synthesis was also examined for **3**, starting from the corresponding arylenediamines **10**, and gave compounds **3** (R = H) in very good yields (Scheme III) (Table 1, method B).

Using this procedure we were finally able to synthesize the vinylidene derivative **3e** (R = H).

In conclusion, in this paper we show that bisdithiocarbamates **1** can be used as good precursors of bisquinazolines **3**. The availability of the starting products is the

Scheme III



-A- as in Scheme I

main advantage of this approach since, in the case of **3** (R ≠ H) the alternative synthesis depicted in Scheme III would require substituted isatoic anhydrides, which are not generally available, or the use of phosgene or its derivatives.

EXPERIMENTAL

Melting points were determined on a Büchi 510 apparatus and are uncorrected. The ir spectra were recorded on a Perkin-Elmer FT 1600 instrument. The nmr spectra were recorded on a Bruker WP 80 CW and a Varian VXR-300 spectrometer with TMS as internal reference.

Synthesis of 3,3'-Arylenebis(2,4-dioxo-1,2,3,4-tetrahydroquinazolines) **3**.

General Procedures.

Method A.

To a suspension of the corresponding potassium anthranilate **2** (5 mmoles) and red mercury(II) oxide (1.62 g, 7.5 mmoles) in dimethylformamide (10 ml), a solution of dimethyl *N,N'*-arylenebis-dithiocarbamate **1** [6] (2.5 mmoles) in dimethylformamide (15 ml) was added. The mixture was stirred and heated under reflux for 6-36 hours, depending on both A in **1** and R in **2**. The reaction

mixture was then cooled to 50° and filtered at this temperature. The filtrate thus obtained was poured into ice-water (200 ml), acidified to pH = 3 with 1N hydrochloric acid and the resulting solid was filtered and washed with water and ethanol. The crude product was purified by recrystallization from dimethyl sulfoxide.

Method B.

To a solution of 2-isocyanatobenzoyl chloride **8** [10] (0.6 g, 3.3 mmoles), in toluene (8 ml), a mixture of the corresponding aryl-enediamine **10** (1.67 mmoles) and triethylamine (0.34 g, 3.3 mmoles) in toluene (15 ml) was added dropwise with stirring at 0°. The reaction mixture was maintained at this temperature for 1 hour, and then at room temperature for another hour. After heating under reflux for 36 hours, and cooling, the mixture was filtered and the solid obtained was dried and treated with hot water for 1 hour to remove the triethylamine hydrochloride. The remaining solid was filtered, washed with water and ethanol and dried to yield **3**.

3,3'-(1,4-Phenylene)bis(2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3a**, R = H).

This compound had ir: 1730, 1670 cm⁻¹; ¹H-nmr (DMSO-d₆): δ 11.52 (s, 1H), 7.92 (d, J = 8.1, 1H), 7.70-7.62 (m, 1H), 7.37 (s, 2H), 7.24-7.14 (m, 2H).

Anal. Calcd. for C₂₂H₁₄N₄O₄: C, 66.33; H, 3.54; N, 14.06. Found: C, 66.25; H, 3.57; N, 14.20.

3,3'-(1,4-Phenylene)bis(6-methyl-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3a**, R = 6-CH₃).

This compound had ir: 1730, 1670 cm⁻¹; ¹H-nmr (trifluoroacetic acid): δ 8.1 (s, 1H), 7.7 (d, J = 8, 1H), 7.6 (s, 2H), 7.3 (d, J = 8, 1H), 2.4 (s, 3H).

Anal. Calcd. for C₂₂H₁₆N₄O₄: C, 67.60; H, 4.25; N, 13.14. Found: C, 67.46; H, 4.33; N, 13.27.

3,3'-(1,4-Phenylene)bis(6-chloro-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3a**, R = 6-Cl).

This compound had ir: 1730, 1680 cm⁻¹; ¹H-nmr (trifluoroacetic acid): δ 8.2 (s, 1H), 7.7 (d, J = 8, 1H), 7.6 (s, 2H), 7.3 (d, J = 8, 1H).

Anal. Calcd. for C₂₂H₁₂Cl₂N₄O₄: C, 56.55; H, 2.59; N, 11.99. Found: C, 56.36; H, 2.68; N, 11.82.

3,3'-(1,4-Phenylene)bis(7-chloro-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3a**, R = 7-Cl).

This compound had ir: 1750, 1670 cm⁻¹; ¹H-nmr (trifluoroacetic acid): δ 8.2 (d, J = 8, 1H), 7.6 (s, 2H), 7.5-7.4 (m, 2H).

Anal. Calcd. for C₂₂H₁₂Cl₂N₄O₄: C, 56.55; H, 2.59; N, 11.99. Found: C, 56.37; H, 2.54; N, 12.17.

3,3'-(1,4-Phenylene)bis(7-nitro-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3a**, R = 7-NO₂).

This compound had ir: 1750, 1670 cm⁻¹; ¹H-nmr (trifluoroacetic acid): δ 8.6-8.1 (m, 3H), 7.6 (s, 2H).

Anal. Calcd. for C₂₂H₁₂N₆O₆: C, 54.11; H, 2.48; N, 17.21. Found: C, 54.17; H, 2.30; N, 17.13.

3,3'-(4,4'-Biphenylene)bis(2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3b**, R = H).

This compound had ir: 1725, 1680 cm⁻¹; ¹H-nmr (DMSO-d₆): δ 11.54 (s, 1H), 7.92 (d, J = 7.8, 1H), 7.77 (d, J = 8.4, 2H), 7.70-7.61 (m, 1H), 7.40 (d, J = 8.4, 2H), 7.23-7.15 (m, 2H).

Anal. Calcd. for C₂₈H₁₈N₄O₄: C, 70.88; H, 3.82; N, 11.81. Found: C, 71.07; H, 3.90; N, 11.63.

3,3'-(4,4'-Biphenylene)bis(6-methyl-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3b**, R = 6-CH₃).

This compound had ir: 1750, 1670 cm⁻¹; ¹H-nmr (trifluoroacetic acid): δ 8.1 (s, 1H); 7.9-7.2 (m, 6H); 2.4 (s, 3H).

Anal. Calcd. for C₃₀H₂₂N₄O₄: C, 71.70; H, 4.41; N, 11.15. Found: C, 71.92; H, 4.50; N, 11.29.

3,3'-(4,4'-Biphenylene)bis(6-chloro-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3b**, R = 6-Cl).

This compound had ir: 1740, 1670 cm⁻¹; ¹H-nmr (trifluoroacetic acid): δ 8.3 (s, 1H), 8.0-7.3 (m, 6H).

Anal. Calcd. for C₂₈H₁₆Cl₂N₄O₄: C, 61.89; H, 2.97; N, 10.31. Found: C, 61.67; H, 2.87; N, 10.46.

3,3'-(4,4'-Biphenylene)bis(7-chloro-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3b**, R = 7-Cl).

This compound had ir: 1740, 1670 cm⁻¹; ¹H-nmr (trifluoroacetic acid): δ 8.4-8.3 (m, 1H), 7.9-7.2 (m, 6H).

Anal. Calcd. for C₂₈H₁₆Cl₂N₄O₄: C, 61.89; H, 2.97; N, 10.31. Found: C, 61.95; H, 3.11; N, 10.27.

3,3'-(4,4'-Biphenylene)bis(7-nitro-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3b**, R = 7-NO₂).

This compound had ir: 1740, 1660 cm⁻¹; ¹H-nmr (trifluoroacetic acid): δ 8.6-8.1 (m, 2H), 7.9-7.4 (m, 5H).

Anal. Calcd. for C₂₈H₁₆N₆O₆: C, 59.58; H, 2.86; N, 14.89. Found: C, 59.68; H, 2.95; N, 14.73.

3,3'-(4,4'-Methylenediphenylene)bis(2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3c**, R = H).

This compound had ir: 1725, 1670 cm⁻¹; ¹H-nmr (DMSO-d₆): δ 11.53 (s, 1H), 7.90 (d, J = 7.8, 1H), 7.70-7.61 (m, 1H), 7.34 (d, J = 8.1, 2H), 7.25-7.15 (m, 4H), 4.03 (s, 1H).

Anal. Calcd. for C₂₉H₂₀N₄O₄: C, 71.30; H, 4.13; N, 11.47. Found: C, 71.17; H, 4.15; N, 11.60.

3,3'-(4,4'-Methylenediphenylene)bis(6-methyl-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3c**, R = 6-CH₃).

This compound had ir: 1740, 1670 cm⁻¹; ¹H-nmr (trifluoroacetic acid): δ 8.2 (s, 1H), 7.9-7.3 (m, 6H), 4.3 (s, 1H), 2.5 (s, 3H).

Anal. Calcd. for C₃₁H₂₄N₄O₄: C, 72.08; H, 4.68; N, 10.85. Found: C, 72.15; H, 4.56; N, 10.87.

3,3'-(4,4'-Methylenediphenylene)bis(6-chloro-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3c**, R = 6-Cl).

This compound had ir: 1730, 1660 cm⁻¹; ¹H-nmr (trifluoroacetic acid): δ 8.2 (s, 1H), 7.9-7.7 (m, 1H), 7.6-7.2 (m, 5H), 4.2 (s, 1H).

Anal. Calcd. for C₂₉H₁₈Cl₂N₄O₄: C, 62.49; H, 3.26; N, 10.05. Found: C, 62.58; H, 3.25; N, 10.12.

3,3'-(4,4'-Methylenediphenylene)bis(7-chloro-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3c**, R = 7-Cl).

This compound had ir: 1730, 1670 cm⁻¹; ¹H-nmr (trifluoroacetic acid): δ 8.2 (s, 1H); 7.6-7.1 (m, 6H); 4.1 (s, 1H).

Anal. Calcd. for C₂₉H₁₈Cl₂N₄O₄: C, 62.49; H, 3.26; N, 10.05. Found: C, 62.40; H, 3.17; N, 10.19.

3,3'-(4,4'-Methylenediphenylene)bis(7-nitro-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3c**, R = 7-NO₂).

This compound had ir: 1740, 1690 cm⁻¹; ¹H-nmr (trifluoroacetic acid):

tic acid): δ 8.6-8.1 (m, 3H), 7.7-7.0 (m, 4H), 4.3 (s, 1H).

Anal. Calcd. for $C_{29}H_{18}N_6O_5$: C, 60.21; H, 3.14; N, 14.53. Found: C, 60.14; H, 3.19; N, 14.60.

3,3'-(4,4'-Oxydiphenylene)bis(2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3d**, R = H).

This compound had ir: 1730, 1670 cm^{-1} ; 1H -nmr (DMSO- d_6): δ 11.56 (s, 1H), 7.92 (dd, J = 8.1, J' = 0.9, 1H), 7.70-7.63 (m, 1H), 7.35 (d, J = 8.7, 2H), 7.23-7.16 (m, 2H), 7.13 (d, J = 8.7, 2H).

Anal. Calcd. for $C_{28}H_{18}N_6O_5$: C, 68.57; H, 3.70; N, 11.42. Found: C, 68.37; H, 3.80; N, 11.40.

3,3'-(4,4'-Oxydiphenylene)bis(6-methyl-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3d**, R = 6-CH₃).

This compound had ir: 1740, 1670 cm^{-1} ; 1H -nmr (trifluoroacetic acid): δ 8.2-8.0 (m, 1H), 7.8-7.1 (m, 6H), 2.4 (s, 3H).

Anal. Calcd. for $C_{30}H_{22}N_6O_5$: C, 69.49; H, 4.28; N, 10.80. Found: C, 69.29; H, 4.35; N, 10.91.

3,3'-(4,4'-Oxydiphenylene)bis(6-chloro-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3d**, R = 6-Cl).

This compound had ir: 1740, 1670 cm^{-1} ; 1H -nmr (trifluoroacetic acid): δ 8.2 (s, 1H), 7.9-7.6 (m, 1H), 7.4-7.1 (m, 5H).

Anal. Calcd. for $C_{28}H_{16}Cl_2N_6O_5$: C, 60.12; H, 2.88; N, 10.02. Found: C, 60.26; H, 3.00; N, 9.93.

3,3'-(4,4'-Oxydiphenylene)bis(7-chloro-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3d**, R = 7-Cl).

This compound had ir: 1750, 1680 cm^{-1} ; 1H -nmr (trifluoroacetic acid): δ 8.5-8.1 (m, 2H), 7.6-7.1 (m, 5H).

Anal. Calcd. for $C_{28}H_{16}Cl_2N_6O_5$: C, 60.12; H, 2.88; N, 10.02. Found: C, 59.95; H, 2.98; N, 9.96.

3,3'-(4,4'-Oxydiphenylene)bis(7-nitro-2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3d**, R = 7-NO₂).

This compound had ir: 1750, 1690 cm^{-1} ; 1H -nmr (trifluoroacetic acid): δ 8.6-8.2 (m, 3H), 7.6-7.2 (m, 4H).

Anal. Calcd. for $C_{28}H_{16}N_6O_7$: C, 57.94; H, 2.78; N, 14.48. Found: C, 57.97; H, 2.95; N, 14.59.

3,3'-(4,4'-Vinylenediphenylene)bis(2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**3e**, R = H).

This compound had ir: 1730, 1660 cm^{-1} ; 1H -nmr (DMSO- d_6): δ 11.49 (s, 1H), 7.90 (d, J = 7.8, 1H), 7.72-7.58 (m, 1H), 7.38-7.12 (m, 7H).

Anal. Calcd. for $C_{30}H_{20}N_6O_4$: C, 71.99; H, 4.03; N, 11.19. Found: C, 71.87; H, 3.98; N, 11.13.

Synthesis of 3,3'-(6,6'-Dibenzothiazol-2,2'-diyl)bis(2,4-dioxo-1,2,3,4-tetrahydroquinazolines) (**7**).

General Procedure.

To a suspension of the corresponding 2,2'-diamino-6,6'-dibenzothiazole **9** [9] (5 mmoles) and 2-isocyanatobenzoyl chloride **8** [10] (1.82 g, 10 mmoles) in toluene (20 ml), triethylamine (1.01 g, 10 mmoles) was added. The mixture was stirred for 1 hour at room temperature and then for 48 hours under reflux. The reaction mixture was worked up as above for **3** (Method B) and recrystallization from DMSO/water yielded pure **7**.

3,3'-(6,6'-Bibenzothiazol-2,2'-diyl)bis(2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**7a**).

This compound had ir: 1740, 1680 cm^{-1} ; 1H -nmr (DMSO- d_6): δ 11.9 (s, 1H), 8.6 (s, 1H), 8.3-7.2 (m, 6H).

Anal. Calcd. for $C_{30}H_{16}N_6O_4S_2$: C, 61.22; H, 2.74; N, 13.28. Found: C, 61.11; H, 2.86; N, 14.13.

3,3'-(6,6'-Sulfonyldibenzothiazol-2,2'-diyl)bis(2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**7b**).

This compound had ir: 1730, 1680 cm^{-1} ; 1H -nmr: insoluble in all the usual solvents.

Anal. Calcd. for $C_{30}H_{16}N_6O_6S_2$: C, 55.21; H, 2.47; N, 12.88. Found: C, 55.02; H, 2.63; N, 13.06.

3,3'-(6,6'-Oxydibenzothiazol-2,2'-diyl)bis(2,4-dioxo-1,2,3,4-tetrahydroquinazoline) (**7c**).

This compound had ir: 1730, 1680 cm^{-1} ; 1H -nmr (DMSO- d_6): δ 11.7 (s, 1H), 8.1-7.0 (m, 7H).

Anal. Calcd. for $C_{30}H_{16}N_6O_5S_2$: C, 59.60; H, 2.67; N, 13.90. Found: C, 59.84; H, 2.59; N, 13.83.

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