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SYNTHESIS OF NAPHTHO[2',3':4,5]IMIDAZO[2,1-*b*][1,3]-THIAZOLE-5,10-DIONE AND NAPHTHO[2',3':4,5]IMIDAZO-[2,1-*b*][1,3]BENZOTHIAZOLE-7,12-DIONE

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The reaction of 2,3-dibromo-1,4-naphthoquinone with 2-aminothiazole in MeONa/MeOH at 60°C for 3 h gave naphtho[2',3':4,5]imidazo[2,1-b][1,3]thiazole-5,10-dione in 64% yield. The reaction of 2,3-dibromo-1,4-naphthoquinone with 2-aminobenzothiazole under the above-mentioned conditions gave 2-(benzo[d]thiazol-2-ylamino)-3-bromonaphthalene-1,4-dione in 64% yield, which on treatment with Na/THF or NaN_3/acetone under reflux conditions gave naphtho[2',3':4,5]imidazo[2,1-b][1,3]-benzothiazole-7,12-dione in 69 and 56% yields, respectively.

Keywords: 2,3-dibromo-1,4-naphthoquinone, naphtho[2',3':4,5]imidazo[2,1-*b*][1,3]benzothiazole-7,12-dione, naphtho[2',3':4,5]imidazo[2,1-*b*][1,3]thiazole-5,10-dione, ring cyclization.

2-Bromo- and 2,3-dibromo-1,4-naphthoquinones were prepared by Zinke [1] and McElrain [2], respectively, in the reaction of 1,4-naphthoquinone with bromine in acetic acid.

The reaction of 2-bromo-1,4-naphthoquinone with methyl (*Z*)-2-(pyrrolidin-2-ylidene)acetate in acetonitrile under nitrogen atmosphere to form 5,10-dioxo-2,3,5,10-tetrahydro-1H-benzo[*f*]pyrrolo[1,2-*a*]indole-11-carboxylate has been reported [3].

It has been reported [4] that the reaction of 2,3-dibromo-1,4-naphthoquinone with 2-aminophenol in KOH/MeOH gave 6-bromo-5H-benzo[*a*]phenoxazin-5-one, which on treatment with $Na_2S_2O_4/C_5H_5N$ formed 5H-benzo[*a*]phenoxazin-5-one.

We have reported [5] that the rearrangement of 2-(5-nitropyridin-2-yl)-3-(*o*-toluidino)-, 3-(2-methoxyphenylamino)-2-(5-nitropyridin-2-yl)-, and 3-(1-naphthylamino)-2-(5-nitropyridin-2-yl)isoxazol-5(2H)-ones produced the corresponding ethyl imidazo[1,2-*a*]pyridine-3-carboxylates in the presence of triethylamine.

We have also reported [6] the synthesis of new N-substituted derivatives of 3-arylaminoisoxazol-5(2H)-ones with benzoxazole and benzothiazole substituted at the nitrogen atom and their rearrangements in the presence of triethylamine in ethanol under reflux conditions to produce the corresponding indole and imidazobenzothiazole derivatives, respectively.

Here we report a new and efficient synthesis of naphtho[2',3':4,5]imidazo[2,1-*b*][1,3]thiazole-5,10-dione (**2**) and naphtho[2',3':4,5]imidazo[2,1-*b*][1,3]benzothiazole-7,12-dione (**4**) by reaction of 2,3-di-bromo-1,4-naphthoquinone (**1**) with 2-aminothiazole and 2-aminobenzothiazole, respectively

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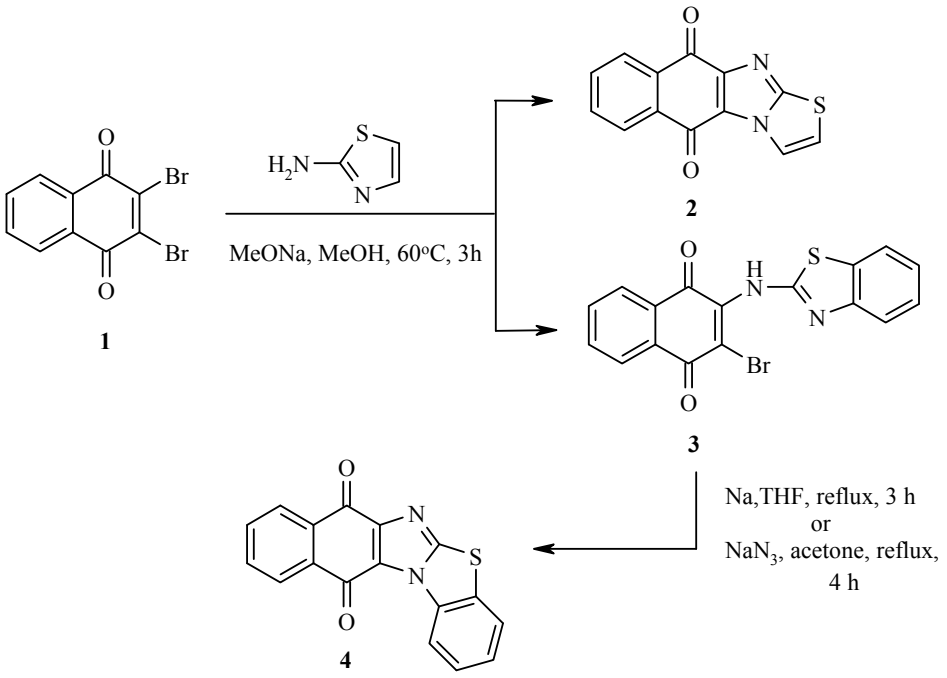
The reaction of 2,3-dibromo-1,4-naphthoquinone (**1**) with 2-aminothiazole in MeONa/MeOH (2 eq) at 60°C for 3 h gave the corresponding heterocycle, naphtho[2',3':4,5]imidazo[2,1-*b*][1,3]thiazole-5,10-dione (**2**), in 64% yield.



The structure of compound **2** was confirmed by IR, ^{1}H, and ^{13}C NMR spectroscopy, mass spectrometry, and elemental analysis.

The reaction of compound **1** with 2-aminobenzothiazole in MeONa/MeOH (1 eq) at 60°C for 3 h gave 2-(benzo[*d*]thiazol-2-ylamino)-3-bromonaphthalene-1,4-dione (**3**) in 65% yield.

It should be mentioned that using MeONa/MeOH (2 eq or excess) failed to produce the corresponding heterocycle by cyclization, and compound **3** was formed as the only product. The structure of compound **3** was confirmed by IR, ^{1}H, and ^{13}C NMR spectroscopy, and mass spectrometry.

When compound **3** was refluxed with Na in THF for 3 h, the corresponding heterocycle **4** was formed in 69% yield.

The structure of compound **4** was confirmed by IR, ^{1}H, and ^{13}C NMR spectroscopy, mass spectrometry, and elemental analysis. Using NaN_3/acetone instead of Na/THF and refluxing for 4 h and passing the crude product through a short column of silica gel gave the required heterocycle **4** in 52% yield. The product was characterized by its spectral data as identical to that obtained by the previous method.

EXPERIMENTAL

IR spectra were recorded on a Thermo Nicolet (Nexus 670) FT-IR spectrometer using sodium chloride cells and measured in KBr pellets. ^{1}H and ^{13}C NMR measurements were recorded on a Bruker 300 spectrometer (300 and 75 MHz, respectively) in $CDCl_3$ using TMS as the internal reference. Mass spectra were registered in a HP 5973 MSD connected to an HP 6890 GC. Microanalyses were performed on Leco Analyzer 932. Freshly distilled solvents were used throughout. Anhydrous solvents were dried according to Perrin and Armarego [7]. Melting points were determined on a Philip Harris C4954718 apparatus and are uncorrected.

Naphtho[2',3':4,5]imidazo[2,1-*b*][1,3]thiazole-5,10-dione (2). 2-Aminothiazole (100 mg, 1.00 mmol) was added to MeONa in MeOH (4 ml, 0.5 M), and the solution was stirred at room temperature for 10 min. A solution of 2,3-dibromo-1,4-naphthoquinone (**1**) (316 mg, 1.00 mmol) in dry methanol (2 ml) was added to the reaction mixture, and it was stirred at 60°C for 2 h. The reaction was left to cool to room temperature, and it was acidified with HCl (1 M). The precipitate was filtered and recrystallized from methanol to give the desired heterocycle as a red solid (163 mg, 64%); mp 157-158°C. FT-IR, ν_{max}, cm^{-1}: 1677, 1661, 1597, 1575, 1508, 1330, 1289, 1116, 714. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 7.17 (1H, d, *J* = 3.6, H-2); 7.53 (1H, d, *J* = 3.6, H-3); 7.74 (1H, dd, J_1 = 7.5, J_2 = 1.5, H-6 or H-9); 7.81 (1H, dd, J_1 = 7.5, J_2 = 1.5, H-9 or H-6); 8.13 (1H, td, J_1 = 7.4, J_2 = 1.2, H-7 or H-8); 8.20 (1H, td, J_1 = 7.5, J_2 = 1.2, H-8 or H-7). ^{13}C NMR, δ, ppm: 115.44, 119.16, 127.39, 127.72, 133.72, 133.86, 135.02, 135.11, 136.01, 143.77, 162.16, 177.17, 178.30. GC-MS (EI, 70 eV), *m/z* (*I*, %): 254 $[M]^+$ (100), 226 (20), 198 (14), 158 (10), 114 (11), 88 (9), 76 (11). Found, %: C 61.58; H 2.44; N 10.86. $C_{13}H_6N_2O_2S$. Calculated, %: C 61.41; H 2.38; N 11.02.

2-(Benzo[*d*]thiazol-2-ylamino)-3-bromonaphthalene-1,4-dione (3). 2-Aminobenzothiazole (150 mg, 1.00 mmol) in dry methanol (4 ml) was added to sodium methoxide (2 ml, 0.5 M) in dry methanol (4 ml), and compound **1** (316 mg, 1.00 mmol) in dry methanol (2 ml) was added. The reaction mixture was heated at 60°C for 3 h, left to cool to room temperature, and then acidified with HCl (1 M). The precipitate was filtered and recrystallized from methanol to give the desired product (250 mg, 65%) as dark-red crystals; mp 194-196°C. FT-IR, ν_{max}, cm^{-1}: 3500, 3233, 1675, 1622, 1598, 1537, 1468, 1318, 1292, 1176, 1124, 986, 795, 754, 715. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 8.30 (1H, d, *J* = 8.4, Ar); 8.21 (1H, d, *J* = 7.2, Ar); 7.80–7.69 (4H, m, Ar); 7.44 (1H, t, *J* = 7.5, Ar); 7.32 (1H, t, *J* = 7.5, Ar); 5.95 (1H, br. s, NH). ^{13}C NMR spectrum, δ, ppm: 178.71, 177.58, 159.54, 147.88, 145.37, 135.40, 134.82, 133.71, 131.72, 130.26, 127.84, 127.63, 127.23, 126.68, 124.50, 121.45, 120.36. MS (EI, 70 eV), *m/z* (*I*, %): 384 $[M]^+$ (6), 305 (100), 254 (19), 252 (19), 238 (10), 173 (10), 149 (24), 138 (19), 105 (17).

Naphtho[2',3':4,5]imidazo[2,1-*b*][1,3]benzothiazole-7,12-dione (4). A. Compound **3** (55 mg, 0.14 mmol) in dry THF (4 ml) was added to sodium (10 mg, 0.43 mmol) in dry THF, and the reaction mixture was refluxed for 3 h. The solution was acidified by hydrochloric acid (1M), and the precipitate was filtered. Recrystallization from ethanol gave the cyclized product (30 mg, 69%) as orange needles; mp 247-249°C. FT-IR, ν_{max}, cm^{-1}: 2923, 1679, 1657, 1589, 1489, 1344, 1209, 981, 752, 718. ^{1}H NMR spectrum, δ, ppm: 9.35 (1H, d, *J* = 8.1, Ar); 8.31 (2H, dd, J_1 = 6.9, J_2 = 2.0, Ar); 7.82–7.79 (3H, m, Ar); 7.65 (1H, t, *J* = 7.2, Ar); 7.55 (1H, t, *J* = 7.5, Ar). ^{13}C NMR spectrum, δ, ppm: 179.01, 156.18, 148.48, 133.97, 133.88, 132.95, 132.48, 132.38, 130.88, 127.22, 127.17, 127.07, 126.99, 123.94, 118.48. MS (EI, 70 eV), *m/z* (*I*, %): 304 $[M]^+$ (100), 276 (13), 248 (15), 146 (11), 76 (11). Found, %: C 66.92; H 2.75; N 9.13. $C_{17}H_8N_2O_2S$. Calculated, %: C 67.09; H 2.65; N 9.21.

B. A solution of compound **3** (50 mg, 0.129 mmol) in acetone (5 ml) was added dropwise during 1 h to a solution of sodium azide (40 mg, 0.615 mmol) in water–acetone, 3 ml:2 ml. The reaction mixture was then refluxed for 4 h. The acetone was removed, and the residue was acidified with hydrochloric acid. The precipitate was filtered and passed through a short column of silica gel using chloroform–ethyl acetate, 8:1, as an eluent. Removal of solvent gave the cyclized product **4** (22 mg, 56%) as orange needles; mp 247-250°C.
The spectral data correspond to those of compound **4** obtained by method A.

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REFERENCES

1. G. Zinke, *Ber.*, **20**, 1514 (1887).
2. S. M. McElrain and E. L. Engelhard, *J. Am. Chem. Soc.*, **66**, 1077 (1994).

3. S. William and J. Partick, *Tetrahedron Lett*., **33**, 53 (1992).
4. Y. Ueno, K. Maeda, J. Koshitani, and T. Yoshida, *J. Heterocycl. Chem.*, **19**, 189 (1982).
5. M. M. Baradarani, J. Khalafy, S. Khadivi, and A. Poursattar Marjani, *Khim. Geterotsikl. Soedin.*, 751 (2008). [*Chem. Heterocycl. Comp.*, **44,** 594 (2008)].
6. J. Khalafy, A. Poursattar Marjani, and A. R. Molla Ebrahimlo, *J. Braz. Chem. Soc.*, **17**, 570 (2006).
7. D. D. Perrin and W. L. F. Armarego, *Purification of Laboratory Chemicals*, Pergamon Press: Oxford (UK), 1988, p. 20.