Monatshefte für Chemie 126, 615–619 (1995)

Monatshefte für Chemie
Chemical Monthly

Printed in Austria

Synthesis of Some New Dispiro[dipyrano-(2,4′:6,4″)bidithiolo(4,5-*b*:4′,5′-*e*)-4,8-benzoquinones]

A. M. Soliman, A. A. Sultan, and **A. K. El-Shafei***

Chemistry Department, Faculty of Science, Sohag, Egypt

Summary. The one pot reaction of acetylacetone, CS_2, and tetrabromobenzoquinone in a 2:2:1 molar ratio affords 2,6-di-(1-acetyl-2-oxopropylidene)-bidithiolo-(4,5-*b*:4′5′-*e*)-4,8-benzoquinone (**3**) which was allowed to react with some active methylene reagents in a 1:2 molar ratio to give the dispiro derivatives **5–11**. The reaction is assumed to proceed *via* a hydrolysis of the two acetyl groups in compound **3** followed by a nucleophilic addition of the active methylene reagents at the two ethylenic bonds and subsequent cyclization.

Keywords. Tetrabromobenzoquinone; Di-(sodiothio)-methylene pentane; Bidithiolobenzoquinone derivatives; Dispirodipyrano bidithiolobenzoquinone derivatives.

Synthese einiger neuer Dispiro[dipyrano(2,4′:6,4″)bidithiolo(4,5-*b*:4′,5′-*e*)-4,8-benzochinone]

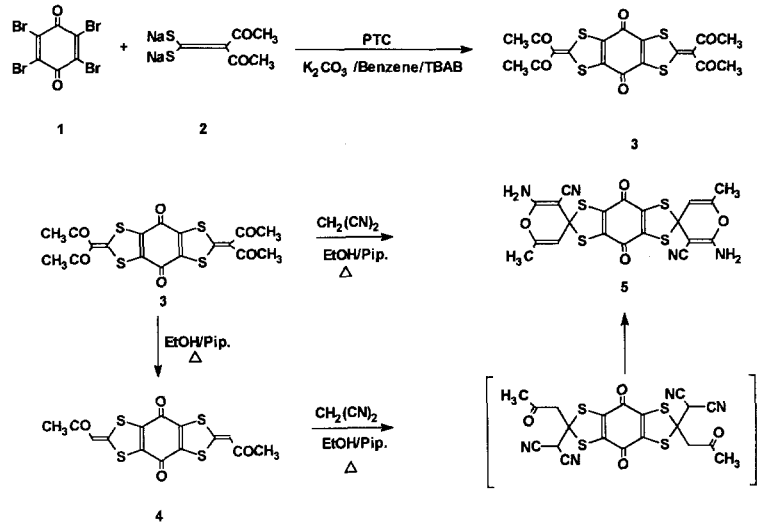
Zusammenfassung. Die Eintopfreaktion von Acetylaceton, CS_2 und Tetrabrombenzochinon in einem molaren Verhältnis von 2:2:1 liefert 2,6-Di-(1-acetyl-2-oxopropyliden)-bidithiolo-(4,5-*b*:4′,5′-*e*)-4,8-benzochinon (**3**), das anschließend mit aktivierten Methylenverbindungen im Verhältnis 1:2 zu den Dispiroverbindungen **5–11** umgesetzt wurde. Die Reaktion verläuft offenbar über eine Hydrolyse der beiden Acetylgruppen in Verbindung **3**, gefolgt von einer nucleophilen Addition der aktiven Methylengruppen an die ethylenischen Doppelbindungen und anschließender Cyclisierung.

Introduction

Ketene S,S-acetals prepared by the reaction of ketones [1] or nitriles [2] as well as heterocyclic ketene N,N- [3–9] or N,S-acetals [5, 10–14] have become a subject of current interest. Several papers and reviews have appeared in recent literature regarding preparation, structural studies, and the synthetic utility of these intermediates [15–17]. In an extension of our recent studies [18–21] on the application of ketoketene or cyanoketene S,S-acetals in heterocyclic synthesis, we report here a simple procedure for the synthesis of dispiro heterocyclic ring systems (**5–11**) from 2,6-di-(1-acetyl-2-oxopropylidene)-bidithiolo-(4,5-*b*:4′5′-*e*)-4,8-benzoquinone (**3**) (cf. Scheme 1).

Results and Discussion

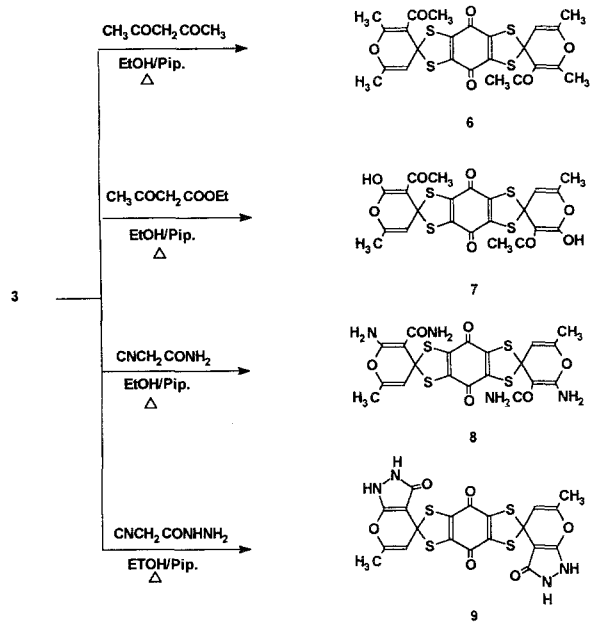
Compound **3** was prepared in a one pot reaction starting with acetylacetone, CS_2, and tetrabromobenzoquinone in a 2:2:1 molar ratio using PTC (K_2CO_3/benzene/tetrabutylammonium bromide (*TBAB*)). The reaction pathway involves the formation of the intermediate compound 2-(di-(sodiothio)-methylene)-pentane-2,4-dione (**2**) which reacts with tetrabromobenzoquinone to give compound (**3**) *via* NaBr elimination. Compound (**3**) was then isolated and reacted with two moles of malononitrile in refluxing ethanol in presence of piperidine. Dispiro[(2′,2″-diamino-3′,3″-dicyano-6′-6″dimethyl)-dipyrano-(2,4′:6,4″)-bidithiolo-(4,5-*b*:4′5′-*e*)-4,8-benzoquinone] (**5**) was precipitated on cooling after reflux for 3 hours. The reaction pathway is assumed to proceed *via* a preliminary hydrolysis of two acetyl groups in compound **3** followed by a nucleophilic addition of malononitrile at the two ethylenic bonds and subsequent cyclization. This proposed mechanism was confirmed by a two-step reaction where compound **3** was hydrolyzed by boiling in ethanol in presence of piperidine after 30 minutes to yield the intermediate product 2,6-di-(2-oxopropylidene)-bidithiolo-(4,5-*b*:4′5′-*e*)-4,8-benzoquinone **4** which was refluxed in boiling ethanol with malononitrile for 2 hours in the presence of a catalytic amount of piperidine to afford compound **5**.



Scheme 1

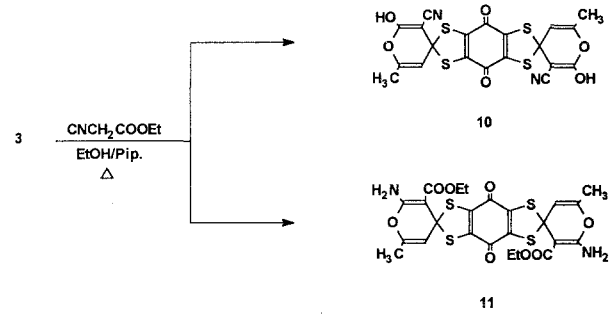
Compound **3** was then reacted with a variety of active methylene compounds including acetylacetone, ethyl acetoacetate, cyanoacetamide, and cyanoacetohydrazide in refluxing ethanol containing piperidine as a catalyst. In each reaction, a preliminary hydrolysis of two acetyl groups was effected followed by a nucleophilic addition of the formed carbanion at the two ethylenic bonds and cyclization to give the desired dispiro heterocycles **6**–**11**.

In the case of the reaction of compound **3** with cyanoacetohydrazide NH_3 evolution was observed and the analytical and spectral data (cf. Table 1) of the obtained product revealed that a fused pyrazolone ring was formed, most probably *via* a nucleophilic attack of the -$NHNH_2$ group at the C-NH_2 linkage of the γ-pyran nucleus followed by cyclization to compound **9** (cf. Scheme 2).



Scheme 2

The reaction of **3** with ethyl cyanoacetate under the same experimental conditions gave compounds **10** and **11**. These two products were obtained from the cooled reaction mixture and the mother liquor, respectively. The reaction pathway is thus assumed to involve an intramolecular nucleophilic attack of the -OH group in the intermediate compound at either the ethoxycarbonyl or the cyano groups to give compounds **10** or **11**.



Scheme 3

Experimental

All melting points were determined on a Kofler melting point apparatus and are uncorrected. IR spectra were obtained on a Nicolet 710 FT-IR spectrometer. ^{1}H NMR spectra were obtained on a Varian EM 360 A at 60 MHz using *TMS* as an internal standard. The elemental analyses were carried out on an elemental analyzer model 240 °C.

Table 1. Physical and analytical data of the prepared compounds

Comp. No.	t (h)	m.p (Solvent)	Yield (%)	Mol. Formula (Mol. Wt.)	Analytical data (calc./found %)			
					C	H	N	S
3	4	215 (EtOH)	92	$C_{18}H_{12}O_6S_4$ (452.53)	47.77 47.51	2.67 2.53		28.34 28.47
4	0.5	120 (EtOH)	79	$C_{14}H_8O_4S_4$ (368.46)	45.63 45.79	2.19 2.29		34.81 34.61
5	3	190 (MeOH)	82	$C_{20}H_{12}N_4O_4S_4$ (500.38)	47.98 47.82	2.42 2.58	11.19 11.39	25.62 25.49
6	3	202 (*THF*)	77	$C_{24}H_{20}O_6S_4$ (532.65)	54.11 54.31	3.78 3.61		24.08 24.28
7	3	187 (MeOH)	71	$C_{22}H_{16}O_8S_4$ (536.60)	49.24 49.11	3.01 3.19		23.90 23.78
8	3.5	193 (EtOH)	68	$C_{20}H_{16}N_4O_6S_4$ (536.61)	44.76 44.88	3.01 3.18	10.44 10.31	23.90 23.68
9	4.5	240 (Dioxane)	63	$C_{20}H_{12}N_4O_6S_4$ (532.58)	45.10 45.24	2.27 2.13	10.52 10.39	24.08 24.29
10	5	185 ($CHCl_3$)	49	$C_{20}H_8N_2O_6S_4$ (500.53)	47.99 47.83	1.61 1.72	5.60 5.49	25.62 25.73
11	5	194 (Benzene)	28	$C_{24}H_{22}N_2O_8S_4$ (594.68)	48.47 48.51	3.73 3.61	4.71 4.87	21.57 21.42

Table 2. IR and ^{1}H NMR spectra of the prepared compounds

Comp. No.	IR (KBr) ν(cm^{-1})	^{1}H NMR (*DMSO*-d$_6$) δ(ppm)
3	2926 (CH, aliph.), 1771, 1717, 1666 (C=O)	2.70–2.30 (m, 12H, 4 $COCH_3$)
4	2920 (CH-aliph.), 1771, 1666 (C=O)	4.90 (s, 2H, 2=CH), 1.90–1.60 (m, 6H, 2CH_3)
5	3427, 3320, 3230 (2NH_2), 2984–2868 (CH, aliph.), 2202 (CN), 1637 (C=O)	6.10–5.90 (m, 4H, 2NH_2), 4.90 (s, 2H, 2=CH), 1.80 (m, 6H, 2CH_3)
6	2934 (CH, aliph.), 1705, 1676 (C=O)	4.80 (s, 2H, 2=CH), 2.60 (s, 6H, 2$COCH_3$), 1.70 (m, 6H, 2CH_3)
7	3416 (br, OH), 2931 (CH, aliph.), 1716, (C=O), 1615 (C=O)	9.50 (s, 2H, 2OH), 4.70 (s, 2H, 2=CH), 2.60 (s, 6H, 2$COCH_3$), 1.70 (s, 6H, 2CH_3)
8	3320, 3230, 3100 (2$CONH_2$), 2925 (CH, aliph.), 1664, 1638 (C=O)	5.80 (m, 4H, 2$CONH_2$), 4.90 (s, 2H, 2=CH), 1.80 (s, 6H, 2CH_3)
9	3471, 3346 (4NH), 2935 (CH, aliph.), 1683, 1620 (C=O)	8.30 (d, 4H, 4NH), 5.00 (s, 2H, 2=CH), 1.80 (s, 6H, 2CH_3)
10	3446 (OH), 2984–2936 (CH, aliph.), 2209 (CN), 1719, 1616 (C=O)	8.40 (s, 2H, 2OH), 5.1 (s, 2H, 2=CH), 1.80 (s, 6H, 2CH_3)
11	3420, 3319, 3230 (2NH_2), 2939 (CH, aliph.), 1720, 1620 (C=O)	6.00–5.80 (m, 4H, 2NH_2), 4.70 (s, 2H, 2=CH), 3.60–3.20 (q, 4H, 2CH_2), 1.80 (s, 6H, 2CH_3), 1.30–1.00 (t, 6H, 2CH_3)

2,6-di-(1-Acetyl-2-oxopropylidene)-bidithiolo-(4,5-b:4'5'-e)-4,8-benzoquinone (**3**)

An equimolar mixture (0.05 mol) of acetylacetone and CS_2 in 70 ml benzene was treated with 7 g of anhydrous K_2CO_3. The formed dianionic ambident compound was then treated with 0.025 mol of tetrabromo-*p*-benzoquinone and a catalytic amount of tetrabutylammonium bromide (*TBAB*, 3 mmol). The reaction mixture was then stirred for about 4 hours at 60 °C. The desired product was precipitated during the course of reaction and was obtained by filtration along with the potassium carbonate layer. The precipitate was washed thoroughly with water and was recrystallized from EtOH.

2,6-di-(2-Oxopropylidene)-bidithiolo-(4,5-b:4'5'-e)-4,8-benzoquinone (**4**)

A mixture of compound **3** (0.01 mol) and piperidine (1 ml) in EtOH (30 ml) was refluxed for 30 minutes and the mixture was concentrated to half of its volume. On cooling, a solid precipitated and was filtered off and recrystallized from EtOH.

Dispiro[dipyrano-(2,4':6,4")-bidithiolo-(4,5-b:4'5'-e)-4,8-benzoquinones](**5–11**); *General Procedure*

Compound **3** (0.01 mol) and piperidine (1 ml) were added to a stirred suspension of the appropriate active methylene reagent (0.02 mol) in EtOH (50 ml). The reaction mixture was refluxed over different periods of time (3–5 hours) and then allowed to cool. The resulting solid was collected by filtration and recrystallized from the proper solvent (cf. Table 1).

References

[1] Thuiller A., Vialle J. (1959) Bull. Chem. Soc. Fr, 1398
[2] Kobayashi G., Matsuda Y., Natsuki R. (1973) Chem. Pharm. Bull. **21**: 921
[3] Gompper R., Schaefer H. (1967) Chem. Ber. **100**: 591
[4] Rajappa S., Sreenivasan R., Advani B. G., Summerville R. H., Hoffman R. (1977) Indian J. Chem. Sec. B. **15**: 297
[5] Augustin M., Doelling W. (1982) J. Prak. Chem. **324**: 3
[6] Nair M. D., Rajappa S., Dessai J. A. (1982) Indian J. Chem. Sec. B. **21**: 1
[7] Nair M. D., Dessai J. A. (1982) Indian J. Chem. Soc. B. **21**: 4
[8] Rajappa S., Nair M. D., Sreenivasan R., Advani B. G. (1982) Tetrahedron **36**: 1673
[9] Huang Z.-T., Liu Z.-R. (1987) Synthesis, 357
[10] Gompper R., Toepfl W. (1962) Chem. Ber. **95**: 2861
[11] Hirai K., Matsuda H., Kishda Y. (1971) Chem. Pharm. Bull. **20**: 97
[12] Mansour N. B., Rudorf W.-D., Augustin M. Z. (1981) Chem. **21**: 69
[13] Rajappa S., Advani B. G. (1982) Proc. Indian Acad. Sci. (Chem. Sci.) **91**: 463
[14] Huang Z.-T., Xian Shi (1990) Synthesis 162
[15] Dieter R. K. (1986) Tetrahedron **42**: 3029
[16] Junjappa H., Ila H., Asokan C. V. (1990) Tetrahedron **46**: 5423
[17] Kolb M. (1990) Synthesis 171
[18] El-Shafei, A. K., El-Saghier, A. M. M., Sultan A., Soliman A. M. (1992) Phosphorus, Sulfur and Silicon **72**: 73
[19] El-Shafei A. K., Abdel-Ghany H. A., Sultan A., El-Saghier A. M. M. (1992) Phosphorus, Sulfur and Silicon **73**: 15
[20] El-Shafei A. K., El-Saghier A. M. M., Ahmed E. A. (1994) Synthesis 152
[21] El-Shafei A. K., El-Sayed A. M., El-Saghier A. M. M. (1994) Phosphorus, Sulfur and Silicon (in press)
[22] Sandstrom, J. Wennarbeck I. (1970) Acta Chem. Scand. **24**: 1191

Received August 3, 1994. Accepted (revised) October 3, 1994