Some Transformations of 3-Amino-4-alkoxycarbonyl-6-hydroxy-2*H*-1-benzopyran-2-ones. The Synthesis of [1] Benzopyrano[3,4-*d*]-[1,3]oxazine and [1] Benzopyrano[3,4-*d*]pyrimidine Derivatives

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Received December 21, 1989

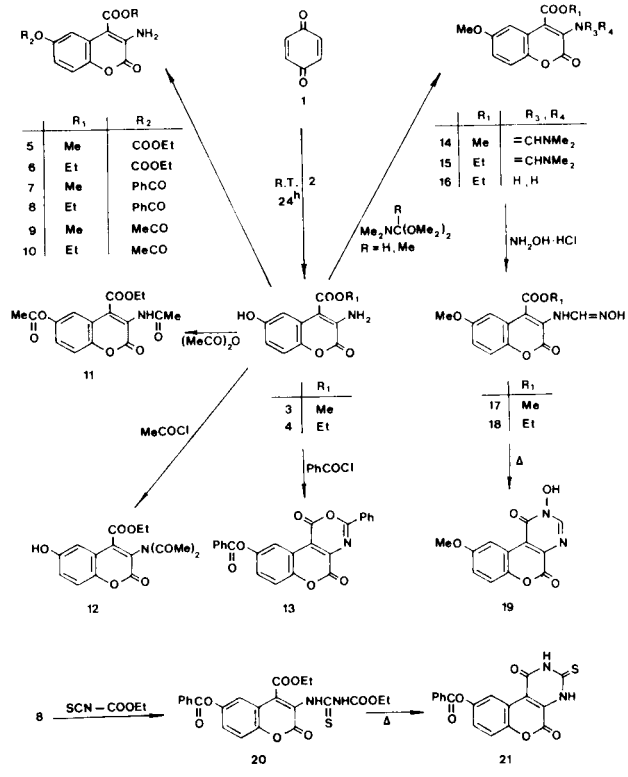
Acylation of 4-alkoxycarbonyl-3-amino-6-hydroxy-2*H*-1-benzopyran-2-one derivatives **3** and **4** gave under mild conditions the *O*-substituted derivatives **5-10**, *N,O*-disubstituted derivative **11** and *N,N*-disubstituted derivative **12**. The compound **4** was transformed with benzoyl chloride under more drastic conditions into **13**, a derivative of a new heterocyclic system 2-benzopyrano[3,4-*d*][1,3]oxazine. The derivatives of 1-benzopyrano-[3,4-*d*]pyrimidine **19** and **20** were prepared either from **3** and **4** through the corresponding *N*-heteroarylformamidines **14** and **15** and *N*-heteroarylformamide oximes **17** and **18** or by cyclization of thiourea derivative **20**.

J. Heterocyclic Chem., **27**, 1447 (1990).

Quinones as synthons are playing an important role in the synthesis of various heterocyclic systems [1]. It has been reported that 1,4-benzoquinone reacts with α-aminocrotonates affording 5-hydroxyindole derivatives, while in the reaction with diethyl aminofumarate 3-amino-4-ethoxycarbonyl-6-hydroxy-2*H*-1-benzopyran-2-one is formed [2].

In this communication we report on some transformations of 2*H*-1-benzopyran-2-one derivatives **3** and **4**, prepared from 1,4-benzoquinone (**1**) and dimethyl (**2**, R = Me) or diethyl 2-aminofumarate (**2**, R = Et). Since these compounds contain an amino and an ester group in the *ortho* position, they seem to be suitable for the preparation of some polycyclic systems. First, we tried to introduce a reactive group, suitable for further transformations, to the amino group at position 3, such as ethoxycarbonyl, benzoyl and acetyl group. However, it turned out that, when the compounds **3** and **4** were treated with ethyl chloroformate in pyridine for 24 hours at room temperature, only ethoxycarbonylation of hydroxy group at position 6 took place to produce the compounds **5** and **6** in 55% and 48% yield, respectively. A similar reaction course was observed with benzoyl chloride. Compounds **3** and **4** yielded in pyridine after three days at room temperature the 6-benzoyl derivatives **7** and **8** in 97% and 86% yield, respectively. On the other hand, acetylation produced three different products, dependent on the reaction conditions. Acetylation of **3** and **4** with acetic anhydride in methylene chloride in the presence of 4-dimethylaminopyridine and triethylamine gave at room temperature after 24 hours the 6-acetoxy derivatives **9** and **10** in 88% and 68% yield, respectively. When the compound **4** was heated with acetic anhydride for six hours the corresponding 6-acetoxy-3-acetylamino derivative **11** was isolated in 28% yield, while with acetyl chloride in methylene chloride the compound **4** was transformed in 24 hours at room temperature into 3-diacetylamino derivative **12** in 63% yield (Scheme 1).

Scheme 1



The structure determination of the compounds **5-12** is based on microanalytical data, ^{1}H nmr and ir spectra. Namely, the parent compounds **3** and **4** show in ^{1}H nmr spectra two singlets at δ = 7.20 ppm, integrating for two protons, and at δ = 9.35 ppm, integrating for one proton, corresponding to the amino group at position 3 and the hydroxy group at position 6, respectively. In the spectra of the acylated compounds **5-10**, the signals at lower field disappear, while signals at higher field, integrating for two protons, appear as broad singlets at δ = 6.83-7.55 ppm, indicating that hydroxy group is in all of these examples

Table 1
^{1}H NMR and IR Data for NH_2, NH and OH Group of Compounds **3-12**

Compound		^{1}H NMR, δ ppm	IR [cm^{-1}]		^{1}H NMR, δ ppm	IR [cm^{-1}]
3	NH_2	7.19 (br s)	3520, 3390	OH	9.31 (br s)	
4	NH_2	7.20 (br s)	3500, 3360	OH	9.35 (br, s)	
5	NH_2	7.0-7.3 (br s)	3550, 3420			
6	NH_2	6.95-7.55 (br s)	3500, 3390			
7	NH_2	[a]	3530, 3410			
8	NH_2	[a]	3510, 3390			
9	NH_2	6.93-7.29 (br s)	3500, 3380			
10	NH_2	6.85-7.30 9br s)	2540, 3400			
11	NHAc	[b]	3500			
12	NAc_2	-	-	OH	8.22 (br s)	3380

[a] Overlapped with aromatic protons. [b] Exchanged.

more reactive than the amino group. In the diacetylated product **12** a broad signal at $\delta = 8.22$ ppm, integrating for one proton, indicates that both acetyl groups are attached at nitrogen. The second diacetylated product **11** can therefore be only the *N,O*-diacetyl compound **11**. This assignment is also supported by ir spectral data. The amino group in the compounds **3** and **4** appears as a doublet at ν = 3500-3540 cm^{-1} and ν = 3360-3420 cm^{-1}. The second band is much stronger since it is overlapped with a broad band of the hydroxy group. In acylated products **5-10** two bands of approximately equal intensity appear, corresponding to the free amino group, while in compound **11** only one band at ν = 3500 cm^{-1} corresponding to NH group is visible (Table 1).

When compound **3** was heated with two equivalents of benzoyl chrloride in pyridine for five hours, benzoylation of the hydroxy group at position 6 and of the amino group at position 3 occurred, followed by cyclization of the benzoylamino group with the ester group at *ortho* position to produce 9-benzoyloxy-3-phenyl[1]benzopyrano[3,4-*d*][1,3]-oxazine-1,5[1*H*,5*H*)-dione (**13**), a derivative of a new heterocyclic system, in 49% yield.

Another attempt was directed towards the synthesis of the pyrimidine ring fused to the benzopyran system by transformation of the amino group in compounds **3** and **4** into formamidines and formamide oximes followed by cyclization with the ester group at the *ortho* position. This methodology we have successfully employed previously for the preparation of pyridopyrimidines [3], pyrimidopyridazines [4], pyrimidopyrazines [5] and other systems [6].

In this connection the compounds **3** and **4** were treated with *N,N*-dimethylformamide dimethyl acetal (DMFDMA) in boiling toluene to give the *N*-substituted formamidines **14** in 70% yield and **15** in 62% yield showing that also methylation of the hydroxy group at position 6 is taking place under these conditions. On the other hand, when compound **4** was heated in toluene with *N,N*-dimethylacetamide dimethyl acetal (DMFDMA), only selective methylation [7] of the hydroxy group at postion 6 was observed to give compound **16**. The compounds **14** and **15** were transformed with hydroxylamine hydrochloride in ethanol at room temperature into the corresponding formamdide oximes **17** in 73% yield and **18** in quantitative yield. The latter two compounds were then cyclized into a derivative of [1]benzopyrano[3,4-*d*]pyrimidine-1,5(1*H*,5*H*)-dione **19** either by heating *in vacuo* for three hours at 260° or by heating under reflux in hydrochloric acid, in high yield. Another approach according to which the derivatives of the same system could be prepared is represented by transformation of compound **8** with ethoxycarbonyl isothiocyanate into the corresponding thiourea derivative **20** in 71% yield, which cyclized by heating in ethanol in the presence of triethylamine into [1]benzopyrano[3,4-*d*]-pyrimidine derivative **21** in practically quantitative yield (Scheme 1). These two methods for the preparation of [1]-benzopyrano[3,4-*d*]pyrimidines represent alternative procedures in comparison to that described in the literature, starting from chroman-3-one and cyanoguanidine (Scheme 1).

EXPERIMENTAL

Melting points were taken on a Kofler micro hot stage. The ^{1}H nmr spectra were obtained on a JEOL 90Q FT spectrometer with TMS as internal standard, ir spectra on a Perkin-Elmer spectrometer 1310 and elemental analyses for C, H, and N on a Perkin-Elmer CHN Analyser 240 C.

3-Amino-6-hydroxy-4-methoxycarbonyl-2*H*-1-benzopyran-2-one (**3**) [8].

A suspension of *p*-benzoquinone (**1**, 324 mg, 0.003 mole) in acetic acid (5 ml) was added slowly during stirring to dimethyl 2-aminofumarate (**2**, 500 mg, 0.00314 mole) at 0°. The mixture was left at room temperature overnight. The solid was then collected by filtration and washed with 1-propanol to give **3** (240 mg, 34%),

mp 198-204° (from a mixture of DMF and water); ^{1}H nmr (DMSO-d_6): δ 3.88 (s, COOMe), 6.62 (dd, H_7), 7.06 (d, H_8), 7.19 (br s, NH_2), 7.51 (d, H_5), 9.31 (s, OH), J_{H_7,H_8} = 9.0 Hz, J_{H_5,H_7} = 3.0 Hz.

Anal. Calcd. for $C_{11}H_9NO_5$: C, 56.17; H, 3.86; N, 5.96. Found: C, 55.98; H, 3.83; N, 5.82.

3-Amino-4-ethoxycarbonyl-6-hydroxy-2*H*-1-benzopyran-2-one (**4**).

This compound was prepared according to the procedure described in the literature [2], mp 166-167°, lit [2] mp 172°; ^{1}H nmr (DMSO-d_6): δ 1.40 (t, *Me*CH_2O), 4.40 (q, MeCH_2), 6.65 (dd, H_7), 7.10 (d, H_8), 7.20 (br s, NH_2), 7.60 (d, H_5), 9.35 (s, OH), J_{CHCH} = 7.5 Hz, J_{H_7,H_8} = 9.0 Hz, J_{H_5,H_7} = 4.0 Hz.

3-Amino-6-ethoxycarbonyl-4-methoxycarbonyl-2*H*-1-benzopyran-2-one (**5**).

A mixture of **3** (423 mg, 0.0018 mole), ethyl chloroformate (271 mg, 0.0025 mole), 4-dimethylaminopyridine (49 mg) and triethylamine (303 mg, 0.003 mole) in methylene chloride (2.5 ml) was heated under reflux for 3 hours. The solvent was evaporated *in vacuo*, methanol (1 ml) was added to the residue and the solid was collected by filtration to give **5** (305 mg, 55%), mp 155-157° (from a mixture of benzene and cyclohexane); ^{1}H nmr (deuteriochloroform): δ 1.46 (t, *Me*CH_2O), 4.08 (s, MeO), 4.42 (q, MeCH_2), 7.22 (dd, H_7), 7.0-7.3 (br s, NH_2), 7.45 (dd, H_8), 8.19 (dd, H_5), J_{CHCH} = 7.0 Hz, J_{H_7,H_8} = 9.0 Hz, J_{H_5,H_7} = 3.0 Hz, J_{H_5,H_8} = 0.5 Hz.

Anal. Calcd. for $C_{14}H_{13}NO_7$: C, 56.32; H, 4.00; C, 5.05. Found: C, 56.23; H, 4.09; N, 4.85.

3-Amino-4-ethoxycarbonyl-6-ethoxycarbonyloxy-2*H*-1-benzopyran-2-one (**6**).

A mixture of **4** (2.490 g, 0.01 mole and ethyl chloroformate (1 ml) in pyridine (10 ml) was stirred for 24 hours at room temperature. The solid was collected by filtration to give **6** (1.535 g, 48%), mp 117-119° (from a mixture of benzene and petroleum ether); ^{1}H nmr (deuteriochloroform): δ 1.42 (t) and 1.49 (t) (2 x *Me*CH_2O), 4.44 (q) and 4.58 (q) (2 x MeCH_2O), 6.96-7.55 (br s, NH_2), 7.19 (dd, H_7), 7.43 (d, H_8), 8.37 (d, H_5), J_{CHCH} = 7.5 Hz, J_{H_5,H_7} = 3.0 Hz, J_{H_7,H_8} = 9.0 Hz.

Anal. Calcd. for $C_{15}H_{15}NO_7$: C, 56.08; H, 4.71; N, 4.36. Found: C, 56.43; H, 4.85; N, 3.89.

3-Amino-6-benzoyloxy-4-methoxycarbonyl-2*H*-1-benzopyran-2-one (**7**).

This compound was prepared from **3** in essentially the same way as **6** in 97% yield, mp 191-192° (from a mixture of chloroform and methanol); ^{1}H nmr (DMSO-d_6): δ 3.95 (s, OMe), 7.32 (dd, H_7), 7.45-7.93 (m, 5H arom), 8.13-8.39 (m, 3H arom), J_{H_7,H_8} = 9.0 Hz, J_{H_5,H_7} = 3.0 Hz.

Anal. Calcd. for $C_{18}H_{13}NO_6$: C, 63.72; H, 3.86; N, 4.13. Found: C, 63.39; H, 3.81; N, 4.30.

3-Amino-6-benzoyloxy-4-ethoxycarbonyl-2*H*-1-benzopyran-2-one (**8**).

A mixture of **4** (498 mg, 0.002 mole) and benzoyl chloride (295 mg, 0.0021 mole) in pyridine (5 ml) was left for 3 days at room temperature. The solution was refrigerated for several hours and the solid collected by filtration to give **8** (610 mg, 86%), mp 155-158° (from a mixture of DMF and water); ^{1}H nmr (DMSO-d_6): δ 1.36 (t, *Me*CH_2O), 4.47 (q, MeCH_2O), 7.35 (dd, H_7), 7.48-7.97 (m, 5H arom), 8.19-8.42 (m, 3H arom), J_{H_7,H_8} = 9.0 Hz, J_{H_5,H_7} = 3.0 Hz.

Anal. Calcd. for $C_{19}H_{15}NO_6$: C, 64.59; H, 4.28; N, 3.96. Found: C, 64.40; H, 4.33; N, 4.05.

6-Acetyloxy-3-amino-4-methoxycarbonyl-2*H*-1-benzopyran-2-one (**9**).

A mixture of **3** (470 mg, 0.002 mole), acetic anhydride (255 mg, 0.0025 mole), 4-dimethylaminopyridine (49 mg) and triethylamine (303 mg, 0.003 mole) in methylene chloride (2.5 ml) was stirred for 4 hours at room temperature. The precipitate was collected by filtration to give **9** (490 mg, 88%), mp 186-187° (from a mixture of chloroform and ethanol); ^{1}H nmr (deuteriochloroform): δ 2.33 (s, MeCO), 4.02 (s, MeO), 6.93-7.29 (br s, NH_2), 7.12 (dd, H_7), 7.42 (d, H_8), 8.19 (d, H_5), J_{H_7,H_8} = 9.0 Hz, J_{H_5,H_7} = 3.0 Hz.

Anal. Calcd. for $C_{13}H_{11}NO_6$: C, 56.32; H, 4.00; N, 5.05. Found: C, 56.23; H, 4.09; N, 4.85.

6-Acetyloxy-3-amino-4-ethoxycarbonyl-2*H*-1-benzopyran-2-one (**10**).

A mixture of **4** (498 mg, 0.002 mole), acetic anhydride (255 mg, 0.0025 mole), triethylamine (303 mg, 0.003 mole), and 4-dimethylaminopyridine (49 mg) in methylene chloride (2.5 ml) was stirred for 24 hours at room temperature. The solid was collected by filtration to give **10** (395 mg, 68%), mp 155-156° (from ethanol); ^{1}H nmr (deuteriochloroform): δ 1.49 (t, *Me*CH_2O), 2.38 (s, MeCO), 4.55 (q, MeCH_2O), 6.85-7.30 (br s, NH_2), 7.12 (dd, H_7), 7.38 (d, H_8), 8.23 (d, H_5), J_{CHCH} = 7.0 Hz, J_{H_7,H_8} = 8.5 Hz, J_{H_5,H_7} = 3.0 Hz.

Anal. Calcd. for $C_{14}H_{13}NO_6$: C, 57.73; H, 4.50; N, 4.81. Found: C, 58.00; H, 4.71; N, 4.69.

3-Acetylamino-6-acetoxy-4-ethoxycarbonyl-2*H*-1-benzopyran-2-one (**11**).

A mixture of **4** (249 mg, 0.001 mole) and acetic anhydride (2.5 ml) was heated under reflux for 6 hours. The solid was, after cooling, removed by filtration to give **10** (95 mg, 28%). The filtrate was neutralized with solid sodium carbonate, and the precipitate was collected by filtration to give **11** (215 mg, 65%), mp 156-161° (from water); ^{1}H nmr (deuteriochloroform): δ 1.30 (t, *Me*CH_2O), 2.36 (s) and 2.40 (s) (MeCONH, MeCOO), 4.53 (q, MeCH_2O), 7.61-7.81 (m, H_5, H_7, H_8).

Anal. Calcd. for $C_{16}H_{15}NO_7$: C, 57.66; H, 4.54; N, 4.20. Found: C, 57.41; H, 4.59; N, 4.08.

3-(*N,N*-Diacetylamino)-4-ethoxycarbonyl-6-hydroxy-2*H*-1-benzopyran-2-one (**12**).

A mixture of **4** (249 mg, 0.001 mole) and acetyl chloride (0.5 ml) in methylene chloride (5 ml) was stirred for 2 days at room temperature. The solid was collected by filtration to give **12** (210 mg, 63%), mp 207-209° (from a mixture of chloroform and methanol); ^{1}H nmr (deuteriochloroform): δ 1.41 (t, *Me*CH_2O), 2.27 (s) and 2.37 (s) (NAc_2), 4.51 (q, MeCH_2O), 7.34 (dd, H_7), 7.50 (d, H_8), 7.79 (d, H_5), 10.26 (br s, OH), J_{CHCH} = 7.0 Hz, J_{H_7,H_8} = 9.0 Hz, J_{H_5,H_7} = 3.0 Hz.

Anal. Calcd. for $C_{16}H_{15}NO_7$: C, 57.66; H, 4.54; N, 4.20. Found: C, 57.71; H, 4.64; N, 4.11.

The same compound was obtained when the reaction mixture was heated at reflux for 2 hours in 43% yield.

9-Benzoyloxy-3-phenyl[1]benzopyrano[3,4-*d*][1,3]oxazin-1,5(1*H*,-5*H*)-dione (**13**).

A mixture of **3** (1.176 g, 0.005 mole) and benzoyl chloride (1.5 g, 0.01067 mole) in pyridine (7 ml) was heated under reflux for 5

hours. The solid was, after cooling, collected by filtration to give **13** (1 g, 49%), mp 293-299° (from DMF); ^{1}H nmr (DMSO-d_6): δ 7.58-8.00 (m, 8H arom), 8.23-8.55 (m, 4H arom), 8.81 (dd, H_{10}), $J_{H_8,H_{10}}$ = 2.3 Hz, $J_{H_7,H_{10}}$ = 1.2 Hz.

Anal. Calcd. for $C_{24}H_{13}NO_6$: C, 70.07; H, 3.19; N, 3.40. Found: C, 69.99; H, 3.22; N, 3.80.

The same compound was obtained from **4** under essentially the same reaction conditions in 55% yield.

3-(*N,N*-Dimethylaminomethyleneamino)-6-methoxy-4-methoxycarbonyl-2*H*-1-benzopyran-2-one (**14**).

A mixture of **3** (235 mg, 0.001 mole) and DMFDMA (300 mg, 0.00225 mole) in toluene (3 ml) was heated under reflux for 3 hours. The solvent was evaporated *in vacuo* to give the crude **14** (212 mg, 70%), mp 114-117° (from cyclohexane); ^{1}H nmr (deuteriochloroform): δ 2.95 (s) and 3.00 (s) (NMe_2), 3.78 (s, OMe), 3.95 (s, COOMe), 6.69 (dd, H_7), 6.90 (d, H_5), 7.15 (d, H_8), 8.55 (s, CH=N), J_{H_7,H_8} = 8.0 Hz, J_{H_5,H_7} = 3.0 Hz.

Anal. Calcd. for $C_{15}H_{16}N_2O_5$: C, 59.21; H, 5.30; N, 9.21. Found: C, 59.00; H, 5.35; N, 8.94.

3-(*N,N*-Dimethylaminomethyleneamino)-4-ethoxycarbonyl-6-methoxy-2*H*-1-benzopyran-2-one (**15**).

A mixture of **4** (49 mg, 0.001 mole) and dimethylformamide dimethyl acetal (DMFDMA) (300 mg, 0.0025 mole) in toluene (3 ml) was heated under reflux for 3 hours. The solvent was evaporated *in vacuo*. Cyclohexane (3 ml) was added to the oily residue, the mixture was heated to the boiling and ethanol was added dropwise until a clear solution was obtained. The solution was cooled in refrigerator and the precipitate was collected by filtration to give **15** (197 mg, 62%), mp 133° (from a mixture of cyclohexane and ethanol); ^{1}H nmr (deuteriochloroform): δ 1.44 (t, $MeCH_2O$), 2.98 (s) and 3.07 (s) (NMe_2), 3.80 (s, OMe), 4.48 (q, $MeCH_2O$), 6.75 (dd, H_7), 6.95 (d, H_5), 7.19 (d, H_8), 8.65 (s, CH=N), J_{CHCH} = 7.0 Hz, J_{H_7,H_8} = 7.0 Hz, J_{H_5,H_7} = 3.0 Hz.

Anal. Calcd. for $C_{16}H_{18}N_2O_5$: C, 60.37; H, 5.70; N, 8.80. Found: C, 60.24; H, 5.76; N, 8.73.

3-Amino-4-ethoxycarbonyl-6-methoxy-2*H*-1-benzopyran-2-one (**16**).

A mixture of **4** (0.001 mole) and dimethylacetamide dimethyl acetal (DMADMA) (300 mg, 0.00225 mole) in toluene (3 ml) was heated under reflux for 3 hours. The precipitate was, after cooling, filtered to give **16** (170 mg, 65%), mp 122-123° (from ethanol), lit [2] mp 123°; ^{1}H nmr (deuteriochloroform, 60 MHz): δ 1.48 (t, $MeCH_2O$), 3.75 (s, OMe), 4.42 (q, $MeCH_2O$), 6.70 (dd and br s, H_7, NH_2), 7.10 (d, H_8), 7.77 (d, H_5), J_{CHCH} = 7.0 Hz, J_{H_7,H_8} = 9.0 Hz, J_{H_5,H_7} = 3.0 Hz.

The compound is identical with that described in lit [2].

3-Hydroxyiminomethylamino-6-methoxy-4-methoxycarbonyl-2*H*-1-benzopyran-2-one (**17**).

A mixture of **14** (50 mg, 0.000164 mole) and hydroxylamine hydrochloride (15 mg, 0.00022 mole) in ethanol (2 ml) was stirred for one hour at room temperature. The solid was collected by filtration and washed ethanol to give **14** (35 mg, 73%), mp 175° dec (from ethanol); ^{1}H nmr spectrum was not obtained, since the compound is not soluble at room temperature, at higher temperature (~90°) cyclization into **19** is taking place.

Anal. Calcd. for $C_{13}H_{12}N_2O_6$: C, 53.43; H, 4.14; N, 9.59. Found: C, 53.53; H, 3.90; N, 9.83.

4-Ethoxycarbonyl-3-hydroxyiminomethylamino-6-methoxy-2*H*-1-benzopyran-2-one (**18**).

A mixture of **15** (218 mg, 0.001 mole) and hydroxylamine hydrochloride (100 mg, 0.00144 mole) in ethanol (2 ml) was stirred at room temperature for one hour. The precipitate was collected by filtration to give **18** in quantitative yield, mp 165° dec (from ethanol). The ^{1}H nmr spectrum was not possible to obtain, since the compound cyclized into **9** in DMSO-d_6 solution.

Anal. Calcd. for $C_{14}H_{14}N_2O_6$: C, 54.90; H, 4.61; N, 9.15. Found: C, 54.79; H, 4.63; N, 9.56.

2-Hydroxy-9-methoxy-1*H*,5*H*[1]benzopyrano[3,4-*d*]pyrimidine-1,5-dione (**19**).

Method A.

The compound **18** (100 mg, 0.00033 mole) was heated in a glass tube *in vacuo* (3 torr) for 3 hours at 260°. The cyclized product sublimed into the cold part of the tube to give **19** (70 mg, 82%), mp, sublimes over 240°; ^{1}H nmr (DMSO-d_6): δ 3.75 (s, OMe), 6.90-7.25 (m), 8.45-8.70 (m).

Anal. Calcd. for $C_{12}H_8N_2O_5$: C, 55.39; H, 3.10; N, 10.77. Found: C, 55.66; H, 3.06; N, 10.78.

Method B.

A mixture of **18** (206 mg, 0.001 mole) and hydrochloric acid (18%, 3 ml) was heated under reflux for one hour. The product was, after cooling, collected by filtration to give **19** in quantitative yield. The product was identical with that obtained according to Method A.

Method C.

A mixture of **17** (292 mg, 0.001 mole) and hydrochloric acid (18%, 3 ml) was heated under reflux for one hour. The solid was, after cooling, collected by filtration to give **19** in quantitative yield. The compound was identical with that obtained according to method A.

6-Benzoyloxy-4-ethoxycarbonyl-3-ethoxycarbonylthioureylene-2*H*-1-benzopyran-2-one (**20**).

A mixture of **8** (2.80 g, 0.00792 mole) and ethoxycarbonyl isothiocyanate (5.2 g) was heated at 70° for 7 hours. The precipitate was, after cooling, collected by filtration to give **20** (2.73 g, 71%), mp 184-186° (from a mixture of benzene and hexane); ^{1}H nmr (deuteriochloroform): δ 1.43 (t) and 1.49 (t) (2 x $MeCH_2O$), 4.58 (q) and 4.73 (q) (2 x $MeCH_2O$), 7.67-8.32 (m, H_5, H_7, H_8, 3H arom), 8.60-8.90 (m, 2H arom), 9.01 (br s) and 11.95 (br s) (2 x NH).

Anal. Calcd. for $C_{23}H_{20}N_2O_8S$: C, 57.02; H, 4.16; N, 5.78. Found: C, 57.10; H, 4.35; N, 5.88.

9-Benzoyl-1,5-dioxo-3-thiooxo-1,2,3,4-tetrahydro-5*H*[1]benzopyrano[3,4-*d*]pyrimidine (**21**).

A mixture of **20** (420 mg, 0.00089 mole) and triethylamine (1.5 ml) in ethanol (9 ml) was heated under reflux for one hour. The solvent was evaporated, ethanol (3 ml) was added to the residue and the solution was adjusted to *p*H = 5 by addition of hydrochloric acid (5%). The precipitate was collected by filtration to give **21** in quantitative yield, mp 200-204° (from a mixture of DMF and ethanol); ^{1}H nmr (DMSO-d_6): δ 7.58-8.03 (m, 5H arom), 8.19-8.42 (m, H_7, H_8), 8.94 (m, H_{10}), $J_{H_7,H_{10}}$ = $J_{H_8,H_{10}}$ = 1.5 Hz, J_{H_7,H_8} = 4.5 Hz.

Anal. Calcd. for $C_{18}H_{10}N_2O_5S$: C, 59.01; H, 2.75; N, 7.65. Found: C, 59.26; H, 2.72; N, 7.89.

Acknowledgements.

The authors wish to express their gratitude to the Research Council of Slovenia for partial financial support of this investigation.

REFERENCES AND NOTES

[1a] For reviews see: K. T. Finley, Quinones as Synthons, in The Chemistry of the Quinoid Compounds, S. Patai and Z. Rapport, eds, Vol **2**, Part 1, John Wiley and Sons, New York 1988, pp 537-717; [b] M. Tišler, Heterocyclic Quinones, *Adv. Heterocyclic Chem.*, **45**, 38 (1989).

[2] G. Domschke, *Chem. Ber.*, **98**, 2920 (1965) and references cited therein.

[3] M. Debeljak-Šuštar, B. Stanovnik, M. Tišler and Z. Zrimšek, *J. Org. Chem.*, **43**, 393 (1978).

[4] B. Stanovnik, V. Stibilj and M. Tišler, *Synthesis*, 807 (1986).

[5] M. Kočevar, B. Stanovnik and M. Tišler, *Tetrahedron*, **39**, 823 (1983).

[6] For a review see: B. Stanovnik, New Approaches to the Synthesis of Bicyclic and Polycyclic Nitrogen-Containing Heterocycles, in Organic Synthesis: Modern Trends, O. Chizhov, ed, Blackwell Scientific Publications, Oxford 1987, pp 315-327.

[7] For selective methylations using DMFDMA see: B. Stanovnik, M. Tišler, A. Hribar, G. B. Barlin and D. J. Brown, *Aust. J. Chem.*, **34**, 1729 (1981) and reference cited therein.

[8] For the preparation of this compound essentially the same procedure was used as described in literature [2] for the compound **4**.