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New Podand Derivatives of 4*H*-Pyran-4-ones Possessing Sulfur Atoms

AZIZ SHAHRISA*, SHABNAM MOHAJERY and KUMARTH HASANZADEH
Department of Organic Chemistry, Faculty of Chemistry
University of Tabriz, Tabriz-51664, Iran
Fax: (98)(411)3340191; E-mail: ashahrisa@yahoo.com

Some new sulfur possessing podands of various pyrones were synthesized by means of nucleophilic reaction of 2,6-bis (bromomethyl)-4-oxo-4*H*-pyran-3, 5-dicarboxylic acid diethyl ester and 2, 6-bis(-4-bromomethylphenyl)-4*H*-pyran-4-one and 2,6-bis(bromomethyl)-3,5-diphenyl-4*H*-pyran-4-ones and 3,5-bis(bromomethyl)-2,6-diphenyl-4*H*-pyran-4-one with 8-mercaptoquinoline, mercaptoethanol and 2-mercaptobenzothiazole.

Key Words: Podand, 4*H*-pyran-4-one, Mercaptoquinoline, 2-Mercaptobenzothiazole, Mercaptoethanol, Open-chain crown.

INTRODUCTION

The biological activity of many functionalized pyrones has resulted in considerable effort in the development of routes to compounds of this category[1-3]. Many excellent podands are found in nature, but synthetic podands have advantages over these biological podands, in terms of facile synthesis and versatility of molecular structure. Although extensive studies of 4*H*-pyran-4-ones reactions have been reported[4], relatively little work has been directed toward the synthesis of podands and macrocyclic derivatives[5-9].

The incorporating of heteroatoms into the structure of podands and crown ethers increase the coordinating ability of these compounds with transition metals, potentially makes ligands of this type industrially and environmentally important for, ion selection, selective electrodes and other purposes[10-13]. In continuation of our investigation[13,14], the synthesis of some podand derivatives of pyrones possessing sulfur atoms is reported.

EXPERIMENTAL

Melting points were determined with an Electrothermal Instrument model 9100 and are uncorrected. Infrared spectra were run on FTIR-Shimadzu-4300 spectrophotometer. ^{1}H NMR and the ^{13}C NMR spectra were recorded on a FT-NMR-Bruker (400 MHz) spectrometer. Chemical shifts are reported in ppm with TMS as internal standard.Mass spectra were taken with a Finnigan Mat 711 double focusing mass spectrometer.

General procedure for the synthesis of compounds 5a-d_1

To a suspension of 8-mercaptoquinoline hydrochloride (0.46 mmol) in dry THF (20 mL) under argon atmosphere, was added slowly a suspension of sodium hydride 80 % (0.5 mmol , washed with dry THF, 2 × 5 mL) in dry THF (10 mL), in 45 min during which white precipitate was formed. A solution of 2,6-bis(bromomethyl)-3,5-dicarboxylic acid diethyl ester (0.23 mmol) in dry THF (20 mL) was added dropwise in 15 min and was stired for 18 h at room temperature. Water (3 mL)was added and pH adjusted at 7. The organic materials were extracted with diethyl ether (5 × 25 mL), dried over $MgSO_4$, filtered and finally purified by preparative layer chromatography (plc) and appropriate eluents. Specific details given for each compound.

2,6-Bis(quinoline-8-mercaptomethyl)-4-oxo-4*H*-pyran-3,5-dicarboxylic acid diethyl ester (5a)

Purified by plc on silica gel, using ethyl acetate-petroleum ether 40-60 (1:1) as eluent. Red oil, 69 % yield. IR (KBr, ν_{max} cm^{-1}): 3060, 2975,1735 (ester C=O), 1655 (pyrone C=O), 1600, 1495, 1260, 1095, 1035, 820, 785. ^{1}H NMR ($CDCl_3$): δ 1.075 (6H, t, J= 8 Hz, -CH_2-CH_3), 3.91 (4H, q, J=8 Hz, -CH_2-CH_3), 4.06 (4H,s, -SCH_2-), 7.26-7.60 (8H, m, aromatic-*H*), 8.02-8.85 (4H, m, aromatic-*H*) ppm. ^{13}C NMR ($CDCl_3$): δ 13.89, 33.24, 61.84, 121.41, 121.74, 126.50, 127.89, 128.70, 131.51, 133.39, 136.73, 146.61, 150.00, 163.01, 165.17, 171.56 ppm. MS : m/z 586 (M^+, 5 %), 530 (9), 426 (50), 380 (33), 255 (9), 174 (33), 173 (50), 161 (100), 117(33).

2,6-Bis(benzothiazol-2-yl-mercaptomethyl)-4-oxo-4*H*-pyran-3,5-dicarboxylic acid diethyl ester (5a_1)

Purified by plc on silica gel, using ethyl acetate-petroleum ether 40-60 (1:1). White crystals, 66 % yield, m.p. 98ºC. IR (KBr, ν_{max} cm^{-1}): 3000, 2950, 1735 (ester C=O), 1660 (pyrone C=O), 1620, 1405, 1254, 750. ^{1}H NMR ($CDCl_3$): δ 1.32 (6H,t, J = 7Hz, -OCH_2-CH_3), 4.37 (4H, q, J = 7 Hz, OCH_2-CH_3), 4.5 (4H,s, -CH_2S-), 7.29-7.9 (8H, aromatic-*H*). ^{13}C NMR ($CDCl_3$): δ 13.04, 31.66, 61.27, 120.05, 120.81, 121.08, 123.75, 125.25, 134.53, 151.46, 161.85, 162.37, 162.77, 170.31 ppm. MS: m/z 598 (M^+, 7 %, at sensitivity 200), 430 (23), 386 (47), 166 (100), 108 (27), 69 (17).

2,6-Bis(2-hydroxyethylthiomethyl)-4-oxo-4*H*-pyran-3, 5-dicarboxylic acid diethyl ester (5a_2)

Purified by plc on silica gel using ethanol-petroleum ether 40-60 (8.5: 1.5) to give the title compound. Yellow oil, 44 % yield. IR (KBr, ν_{max} cm^{-1}): 3450 (hydrogen bonding), 2925,1730 (ester C=O), 1650 (pyrone C=O), 1410, 1260, 1095, 1035. ^{1}H NMR ($CDCl_3$): δ 1, 29 (6H, t, J = 8Hz, -OCH_2CH_3), 2.7(4H, d, J=8Hz, -SCH_2CH_2OH), 3.65 (4H, s, pyrone

-CH_2S-), 3.68 (2H, t, J = 8 Hz, -SCH_2CH_2OH), 3.8 (4H, m, -SCH_2CH_2OH), 4.29 (4H, q, J= 7Hz, -OCH_2CH_3) ppm. MS: m/z 402 (M^+-H_2O, 7 %, at sensitivity 10).

2,6-Bis(quinoline-8-mercaptomethyl)-3,5-diphenyl-4*H*-pyran-4-one (5b)

Purified by plc on silica gel using ethyl acetate-petroleum ether 40-60 (2:1) to give the title compound. White crystals, 34 % yield, m.p. 275ºC. IR :(KBr, ν_{max} cm^{-1}): 3050, 2910, 1640 (pyrone C=O), 1600, 1420,1290, 1070, 800, 750, 690. ^1H NMR ($CDCl_3$): δ 4.02 (4H, s, -CH_2S-), 6.95-8.8 (16H, m, aromatic-*H*). MS: m/z 594 (M^+, 5%), 402 (17), 274 (27), 245 (8), 204 (8), 160 (100), 161 (93), 117 (50), 89 (15).

3,5-Bis(quinoline-8-mercaptomethyl)-2,6-diphenyl-4*H*-pyran-4-one (5c)

Recrystallized from *n*-hexane-ether (4:1) to give the title compound. White crystals 74 % yield, m.p. 172ºC. IR (KBr, ν_{max} cm^{-1}): 3080, 2950, 1645 (pyrone C=O), 1625, 1495, 1455, 1407, 1310, 1160, 950, 753, 705. ^1H NMR ($CDCl_3$): δ 4.28 (4H, s, -CH_2S-), 7.32-8.9 (22H, aromatic-*H*). MS:m/z 594 (M^+,13%, at sensitivity 20), 435 (16), 433 (40), 330 (10), 301 (12), 274 (34), 255 (40), 161 (80), 116 (36), 105 (100), 77 (17).

3,5-Bis (benzothiazole-2-yl-mercaptomethyl)-2,6-diphenyl-4*H*-pyran-4-one ($5c_1$)

Purified by plc on silica gel using ethyl acetate-petroleum ether 40-60 (7:3) as eluent. White crystals, 87 % yield, m.p. 143ºC. IR (KBr, ν_{max} cm^{-1}): 3060, 2940, 1640 (pyrone C=O), 1615, 1450, 1235, 750. ^1H NMR ($CDCl_3$): 4.57 (4H, s, -CH_2S-), 7.18-7.63 (18H, m, aromatic-*H*) ppm. MS: m/z 606 (M^+, 11%), 529 (5), 440 (20), 439 (20), 303 (40), 274 (46), 166 (100), 119 (15), 77 (8).

2,6-Bis[4(8-quinolinemercaptomethyl)phenyl]-4*H*-pyran-4-one (5d)

Purified by plc on silica gel using ethyl acetate-petroleum ether 40-60 (2:1) to give the title compound. White solid, 73 % yield, m.p. 275ºC. IR (KBr, ν_{max} cm^{-1}): 3080, 2925, 1640 (pyrone C=O) 1620, 1420, 1330, 1290, 1070, 780, 750. ^1H NMR ($CDCl_3$): δ 4.4 (4H, s, -CH_2S), 6,7 (2H, s, pyrone = CH-), 7.26-7.74 (10H, m, aromatic-*H*) ppm. ^{13}C NMR ($CDCl_3$): d 34.98, 110.27, 120.75, 123.97, 124.74, 125.09, 125.53, 127.36, 128.68, 129.33, 135.48, 136.29, 139.87, 144.75, 148.49, 162.02, 179.14 ppm. MS: m/z 594 (M^+, 5 % at sensitivity 20), 287 (30), 248 (100), 192 (49), 161 (45).

2,6-Bis[4(8-benzothiazole-2-yl-mercaptomethyl)pheny]}-4*H*-pyran-4-one ($5d_1$)

Yellow precipitates were collected and dried to give the title compound, 65 % yield, m.p. 196.5ºC. IR (KBr, ν_{max} cm^{-1}): 3068, 2970, 1652 (pyrone

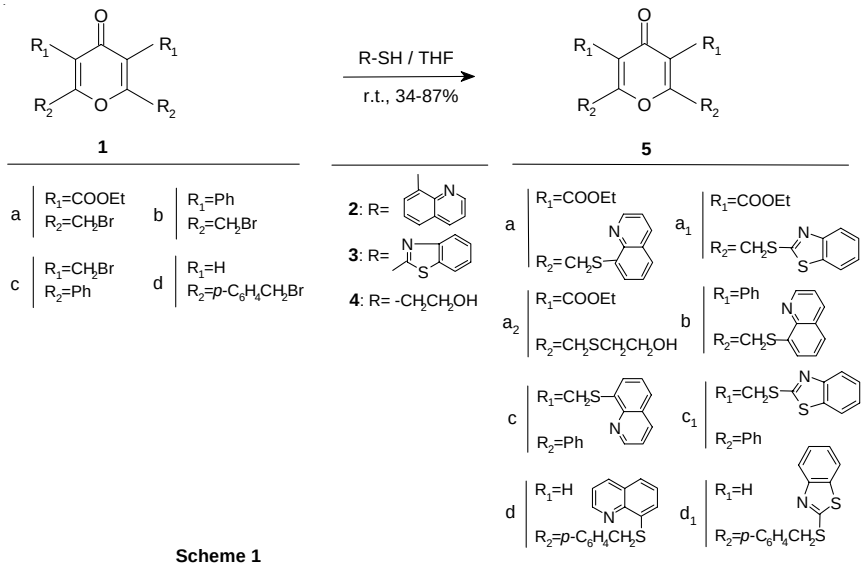
C=O), 1608, 1456, 1421, 1074, 1017, 997, 754. ^{1}H NMR ($CDCl_3$): 4.67 (4H, s, -CH_2S-), 6.96 (2H, s, pyrone = CH-), 7.31-7.82 (16H, m, aromatic-*H*) ppm. ^{13}C NMR ($CDCl_3$): δ 35.95, 110.25, 120.60, 120.57, 123.47, 125.15, 125.25, 128.89, 129.56, 134.35, 139.56, 151.92, 162.04, 164.49, 179.14 ppm. MS: m/z 606 (M^+, 8 % at sensitivity 70), 166 (100).

RESULTS AND DISCUSSION

In preparation of novel 4*H*-pyran-4-one derivatives, the sulfur possessing podand of pyrones is synthesized. Bis(bromomethyl)pyrones **1(a-c)** and bis(bromomethylphenyl)pyrone (**1d**) were chosen as starting material since they can be easily prepared[14-17].

As shown in **Scheme-1**, treatment of bromopyrone (**1a**) with 8-mercaptoquinoline (**2**), 2-mercaptobenzothiazole (**3**) and mercaptoethanol (**4**) in dry THF and in the presence of sodium hydride at room temperature produced the corresponding podands **5a-a₂** in 69, 66 and 44 % yields, respectively.

The reaction of bis(bromopyrone) (**1b**) with thiol (**2**) in THF and in the presence of sodium hydride resulted in to the formation of **5b** in 34 % yield. Treatment of **1c** with thiols **2** and **3** produced the corresponding products **5c** and **5c₁** in 74 and 87 % yields, respectively. In a similar manner treatment of 1d with thiols **2** and **3** afforded the compounds **5d** and **5d₁** in 73 and 65% yields, respectively (**Scheme-1**).



Scheme 1

All the isolated new compounds gave satisfactory spectroscopic data for the proposed structures.

Conclusions

In this paper, the synthesis of some sulfur possessing podands of various 4-pyrones (**5a-d$_1$**) is reported. Complexation ability of these compounds is under investigation.

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REFERENCES

1. L. Costantino,G. Rastelli and A. Albasini, *Eur. J. Med. Chem.*, **31**, 693 (1996).
2. D. Garey, M. Ramirez, S. Gonzales, A. Wertsching, S.Tith, K. Keefe and M.R. Pena, *J. Org. Chem.*, **61**, 4853 (1996).
3. Y. Matsumura, K. Shirai, T. Maki, Y. Itakura and Y. Kodera, *Tetrahedron Lett.*, **39**, 2339 (1998).
4. D.J. Hepworth, in eds.: A.J. Boulton and A. Mckillop, Comprehensive Heterocyclic Chemistry, Pergamon press, Oxford, pp. 737-828 (1984).
5. W. Lowe, S. Bratter, C. Dietrich, M. Weber and P. Luger, *J. Heterocycl. Chem.*, **34**, 1173 (1997).
6. W. Lowe, S.A. Bratter, M. Weber, P. Luger and J. Buddrus, *J. Heterocycl. Chem.*, **38**, 365 (2001).
7. A. Shahrisa and R. Tabrizi, *Iran. J. Chem. & Chem. Eng.*, **18**, 91 (1999).
8. A. Shahrisa and A. Banaei, *Molecules*, **5**, 200 (2000).
9. A. Shahrisa and A. Banaei, *Molecules*, **6**, 721 (2001).
10. E . Lachowicz, *Analyst*, **112**, 1623 (1987).
11. F. Vogtle and E. Weber, *Angew. Chem. Int. Ed.*, **18**, 753 (1979).
12. H. Ashassi-Sorkhabi, T. Rostamikia, A. Shahrisa and A. Banaei, *Bull. Electrochem.*, **17**, 545 (2001).
13. A. Shahrisa, R. Tabrizi and F. Abrishami, *Acta Chem. Sloven.*, **49**, 347 (2002).
14. A. Shahrisa, R. Tabrizi and H.R. Ahsani, *Org. Prep. Proced. Internat.*, **32**, 47 (2000).
15. J. Allwohn, M. Brumm, G. Frenking, M. Hornivius, W. Massa, F.W. Steubert and S. Wocaldo, *J. Prakt. Chem.*, **335**, 503 (1993).
16. W. Massa, M. Schween, F.W. Steuber and S. Wocaldo, *Chem. Ber.*, **123**, 1587 (1990).
17. W. Flitsch and M. Niedenbrueck, *Liebigs Ann. Chem.*, **1**, 55 (1991); *Chem. Abstr.* 122316a (1991).

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