CHEMISTRY OF COUMARINS - SYNTHESIS OF SOME 3,4-SUBSTITUTED COUMARINS USING THE HSAB PRINCIPLE

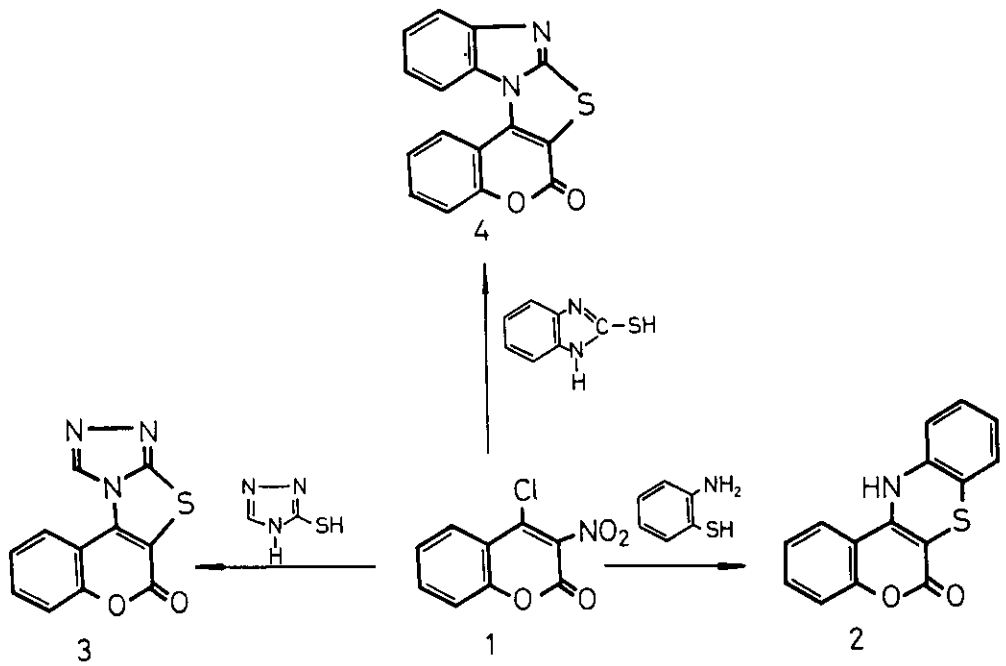
Ibro Tabaković, Katmerka Tabaković, and Radoslav Grujić
Faculty of Technology, The Gjuro Pucar Stari University, 78000 Banja Luka, Bosnia and Herzegovina, Yugoslavia

Nenad Trinajstić and Zlatko Meić
The Rugjer Bošković Institute, P.O.B. 1016, 41001 Zagreb, Croatia, Yugoslavia

Abstract — Novel heterocyclic systems (2, 3, and 4) have been obtained by reactons of the corresponding bidentate nucleophiles, e.g. 2-mercaptoaniline, 3-mercapto-1,2,4-triazole and 2-mercaptobenzimidazole respectively, with 4-chloro-3-nitrocoumarin (1).

In the course of our studies[1-6] on the chemistry of coumarins and related structures, we have investigated reactions for the preparation of a variety of 3,4-substituted coumarins. We found that Pearson's HSAB (hard and soft acids and bases) principle,[7-17] which predicts the effect of substitution for interactions of hard acids (acceptors) with hard bases (donors), and soft acids (acceptors) with soft bases (donors), may be used as a guiding principle in the case of nucleophilic attack on 4-chloro-3-nitrocoumarin (1). According to our results,[6] hard nucleophiles substituted for a chlorine in position 4 and soft nucleophiles substituted for a nitro group in position 3 of 1.

In this paper we report the reactions of various bidentate nucleophiles, having both hard (amino) and soft (mercapto) nucleophiles, with 4-chloro-3-nitrocoumarin (1). These reactions represent a simple and practical procedure for the preparation of new heterocyclic systems, according to the following scheme:



Treatment of 1 with 2-mercaptoaniline resulted in the formation of 2. All spectroscopic data and mp 337-340°C are in accord with the assigned structure. The same compound 2 was obtained by an independent synthesis where it was found that the cyclisation is not accompanied by the Smiles rearrangement. Compound 1 can be converted into 3 or to 4, on reacting with 3-mercapto-1,2,4-triazole and 2-mercaptobenzimidazole, respectively. The proposed structure of 2 is confirmed by the ^{13}C NMR spectrum with a characteristic C-3 signal at 90.8 ppm resulting from simultaneous effects from neighbouring O and S atoms.[18] Since this signal is not present in the spectra of 3 and 4, this indicates either a different isomeric structure or an effect of the size of the ring adjacent to the coumarin moiety.[19]

EXPERIMENTAL

All melting points are uncorrected. Microanalyses were performed on a Perkin-Elmer Model 240 elemental analyser. Infrared spectra were recorded on a Perkin-Elmer M-337 spectrometer (KBr pellet), ^{1}H NMR spectra (TMS=0) were recorded on a Perkin-Elmer R 12 A (60 MHz) spectrometer, and mass spectra recorded on a Hitachi Perkin-Elmer RMV-GL spectrometer (at 75 eV). ^{13}C NMR spectra were measured with a JEOL FX-100 Fourier transform spectrometer (25.05 MHz) from DMSO-d_6 solu-

tions using internal TMS.

6,12-Dihydro[1]benzopyrano[3,4-b][1,4]benzothiazin-6-one (2):

To a solution of 1 (1.0 g, 4.4 mmol) in acetonitrile (25 ml), a solution of 2-mercaptoaniline (0.55 g, 4.4 mmol) in acetonitrile (20 ml) was added dropwise. The resulting solution was stirred for 2 h at room temperature and during this period the product precipitated from the solution. The precipitate was collected and recrystallized from MeOH to give 1.97 g (74%) of 2; mp 337-340°C. (Lit.[1] mp 337-340°C).

6H-[1]Benzopyrano[4',3':4,5]thiazolo[2,3-c][1,2,4]triazol-6-one (3):

To a solution of 1 (1.0 g, 4.4 mmol) in acetonitrile (25 ml), a solution of 3-mercapto-1,2,4-triazole (0.34 g, 4.4 mmol) was added dropwise. The resulting solution was stirred for 2.5 h at room temperature. The yellow precipitate formed during the reaction was filtered off and recrystallization from EtOH gave 0.36 g (34%) of 3; mp 147-149°C. IR(KBr-pellet): 1725 (pyrone C=O), 1610 (C=N), 1595 (C=C), 1535, 1480, 1230, 1070, 765 cm^{-1}; ^1H NMR [D_6]DMSO: δ=7.0-8.1 (m, 4H, arom), 8.45 (s, 1H) ppm. MS: m/e (relative intensity) = 243 (100), 205 (5.3), 183 (4.6), 186 (31), 187 (6.8), 159 (3.0), 144 (4.6), 135 (9.8), 129 (3.8), 128 (22.1), 121 (9.1), 120 (25.8), 116 (7.6), 104 (6.8), 103 (17.4). $C_{11}H_5N_3O_2S$ (243.2) Calc. C, 54.33; H, 2.07; N, 17.27. Found C, 54.02; H, 2.06; N, 17.42.

6H-[1]Benzopyrano[4',3':4,5]thiazolo[3,2-a]benzimidazol-6-one (4):

To a solution of 1 (1.0 g, 4.4 mmol) in acetonitrile 125 ml, a solution of 2-mercaptobenzimidazole (0.66 g, 4.4 mmol) was added dropwise. The resulting solution was stirred for 3 h at room temperature. The yellow precipitate was filtered off and washed with 70 ml of an aqueous solution of $NaHCO_3$. Recrystallization from ETOH gave 1.26 g (98%) of 4: mp 201-203°C. IR (KBr-pellet): 1735 (pyrone C=O), 1605 (C=N), 1590 (C=C), 1450, 1280, 1070, 770 cm^{-1}. ^1H NMR [D_6]DMSO: δ= 7.1-8.2 (m, 8H, arom). MS: m/e (relative intensity): 292 (30.1), 248 (4.5), 246 (5.1), 227 (5.6), 222 (15.9), 167 (18.1), 152 (6.8), 151 (11.3), 150 (100.0), 149 (9.0), 134 (4.5), 125 (15.9), 124 (66), 123 (47.7), 122 (10.2), 121 (4.5), 120 (7.9). $C_{16}H_8N_2O_2S$ (292.3) Calc. C, 65.74; H, 2.76; N, 9.58. Found C, 65.38; H, 2.79; N, 9.71.

REFERENCES

1. K.Tabaković, I.Tabaković, M.Trkovnik, A.Jurić and N.Trinajstić, J. Heterocyclic Chem., 1980, 17, 801.
2. K.Tabaković, Ph.D.Thesis, University of Banja Luka, Banja Luka (1980).
3. P.Ilić, A.Jurić, and N.Trinajstić, Croat. Chem. Acta, 1980, 53, 587.
4. K.Tabaković and I.Tabaković, Croat. Chem. Acta, 1981, 54, 451.
5. P.Ilić, B.Mohar, J.V.Knop, A.Jurić, and N.Trinajstić, J. Heterocyclic Chem., 1982, 19, 625.
6. K.Tabaković, I.Tabaković, M.Trkovnik, and N.Trinajstić, Liebigs Ann., 1983, 98, 1901.
7. R.G.Pearson, J. Am. Chem. Soc., 1963, 85, 3533.
8. R.G.Pearson, Science, 1966, 151, 72.
9. R.G.Pearson, Chem. Brit., 1967, 3, 102.
10. R.G.Pearson, J. Chem. Educ., 1968, 45, 643.
11. B.Saville, Angew. Chem., Int. Ed. Engl., 1967, 6, 928.
12. R.G.Pearson (editor), Hard and Soft Acids and Bases, Dowden, Hutchinson, and Ross, Stroudsburg, PA (1973).
13. T.L.Ho, Chem. Rev., 1975, 75, 1.
14. T.L.Ho, Hard and Soft Acids and Bases Principle in Organic Chemistry, Academic, New York (1977).
15. W.B.Jensen, The Lewis Acid-Base Concepts, Wiley, New York (1980).
16. T.Moeller, Inorganic Chemistry, Wiley, New York (1982).
17. R.G.Parr and R.G.Pearson, J. Am. Chem. Soc., 1983, 105, 7512.
18. E.Breitmaier and W.Voelter, ^{13}C NMR Spectroscopy, 2nd Ed., Verlag Chemie, Weinheim (1978).
19. A complete analysis of ^{13}C NMR spectra will be reported elsewhere.

Received, 11th May, 1984