Acetylene Chemistry. Part 23 [1]. *N*-Vinylation on Acridinones

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The vinylation of 9(10*H*)-acridinones **1a-1d** with propiolic acid ethylester resulting in acridinonyl-*N*-acrylic esters is reported.

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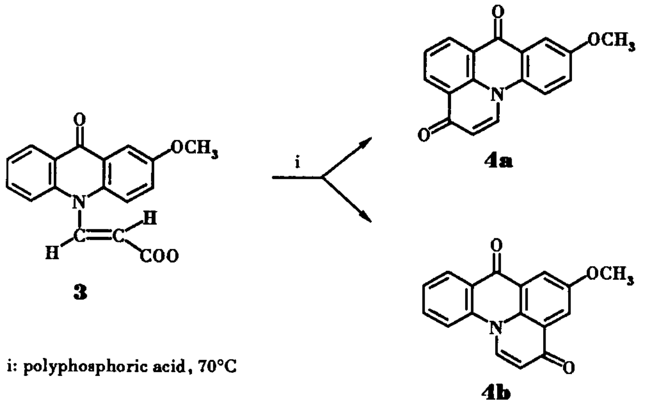
In continuation of our studies on vinylation with propiolic ester [3], the synthesis of acridinonyl-*N*-acrylic acid ester and further cyclisation to yield 9-methoxy-3*H*,7*H*-pyrido[3,2,1-*de*]acridine-3,7-dione (**4a**) and 5-methoxy-3*H*,7*H*-pyrido[3,2,1-*de*]acridine-3,7-dione (**4b**) has been reported here.

Previously the formation of acridinonyl-*N*-acrylic ester was investigated successfully [4], but the yield of the product was very low (7%). A yield of 34% vinylation product was obtained under a slightly modified procedure. The effect of the position of the activating methoxy group was examined. With ethyl 3-(3-methoxy-9-oxo-10(9*H*)-acridinyl)acrylate (**2c**), the vinylation product was formed in a yield of 35%. When the methoxy group is at position 4, a very low yield of 7% of ethyl 3-(4-methoxy-9-oxo-10(9*H*)-acridinyl)acrylate (**2c**) was obtained, perhaps due to steric hindrance. Interestingly 2-methoxyacridinone (**1b**) gave the respective vinylation product ethyl 3-(2-methoxy-9-oxo-10(9*H*)-acridinyl)acrylate (**2b**) rapidly in a higher yield of 59%. This may be due to the *para*-position of the methoxy group facilitating an easier electrophilic attack on nitrogen.

By virtue of the presence of the methoxy group, the seven aromatic protons appeared separately in the ^{1}H-nmr of all the compounds. The nmr spectrum of **2b** has been chosen as an example for discussion. The vinyl protons gave two doublets at δ = 6.40 ppm and δ = 8.00 ppm characteristically. The higher coupling constant (J = 14 Hz) indicates the formation of the *trans*-isomer. An upfield shift of the 1-H and 3-H proton signals was observed as a neighbouring group effect. A strong low field shift of δ = 30 ppm was seen in the ^{13}C spectrum for C-2 carbon giving the signal at δ = 153 ppm. Similarly C-1 and C-3 signals were appeared at δ = 107 ppm and δ = 123 ppm and the vinyl carbons C-1′ and C-2′ signals were recorded at δ = 140 ppm and δ = 124 ppm respectively.

A similar trial, using the same procedure, with 9(*H*)-carbazole, indole, 1*H*-pyrrolo[2,3-*b*]pyridine resulted in the respective acrylic esters with higher percentage of yields in general. Interestingly, in addition to the major *trans*-product (56% yield) a *cis*-isomer was also isolated (11%). The formation of the *cis*-product may be favoured by the absence of steric hindrance. The same was not observed with acridinones, as efforts to isolate a *cis*-product were not successful. Probably the planer molecular structure of acridinone does not favour the formation of the *cis*-product. Further attempts to cyclise esters **2a-2d** using polyphosphoric acid were not fruitful. However the free acrylic acid **3** could be cyclised to yield an isomeric mixture of 9-methoxy-3*H*,7*H*-pyrido[3,2,1-*de*]acridine-3,7-dione (**4a**) and 5-methoxy-3*H*,7*H*-pyrido[3,2,1-*de*]acridine-3,7-dione (**4b**) as intensive yellow needles. The ease of dehydrocycli-

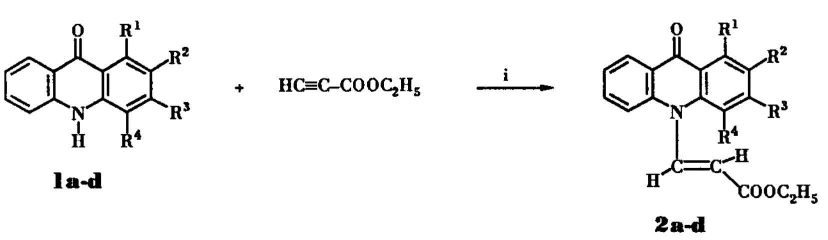


3

4a

4b

i: polyphosphoric acid, 70°C



1a-d

2a-d

i: Et$_3$N, [Pd(PPh$_3$)$_2$]Cl$_2$, N$_2$, 90°C, **a**: R^1 = R^2 = R^3 = R^4 = H, **b**: R^1 = R^3 = R^4 = H, R^2 = -OMe, **c**: R^1 = R^2 = R^4 = H, R^3 = -OMe, **d**: R^1 = R^2 = R^3 = H, R^4 = -OMe sation may possibly be the reason. Although the separation of the two isomers **4a** and **4b** could not be achieved, their formation was expected from the ^{1}H-nmr and ^{13}C-nmr data. A shift in the C-4 and C-5 signals confirm this assumption.

EXPERIMENTAL

Melting points were determined on a Kofler hot stage apparatus and are uncorrected. The ir and electronic absorptions spectra were measured with a Zeiss DMR 21 and Pye-Unicam SP3-200 respectively. The ^{1}H- and ^{13}C-nmr were recorded with a Gemini 200 (200 MHz) spectrometer, using tetramethylsilane as the internal standard. The mass spectra were obtained on a Varian MAT 44S and MAT 312 instrument at 70 eV. Merck silica gel 60 (grain size: 0.063-0.2 mm) was used for "flash" chromatography.

General Procedure for the Synthesis of Acrylic Acid Esters.

To a suspension of acridinone (5 mmoles) and 30 mg of $[Pd(PPh_3)_2]Cl_2$ in 180 ml of triethylamine, propiolic acid ethyl ester (10 mmoles) was added under nitrogen atmosphere and the reaction mixture was heated under reflux for 6 hours. The precipitate was collected by filtration and washed with methanol. It was purified by column chromatography on silica gel using chloroform/ethylacete (5:1) as the eluent and further recrystallisation from methanol.

Ethyl 3-(9-Oxo-10(9*H*)-acridinyl)acrylate (**2a**).

This general procedure gave **2a** as yellow needles, mp 182-185° (methanol); ir (potassium bromide): 3020, 2950, 1720, 1630, 1600, 1480, 1440, 1180 cm^{-1}; uv (methanol): λ max (log ϵ) 251 nm (4.84), 380 (4.15), 392 (4.15); ^{1}H-nmr (deuteriochloroform): δ 1.40 (t, J = 7.14 Hz, 3H, $-CH_3$), 4.37 (q, J = 7.14 Hz, 2H, $-CH_2-$), 6.10 (d, J = 13.84 Hz, 1H, 2'-H), 7.35 (ddd, J = 8.00 Hz and 1.26 Hz, 2H, 2-H 7-H), 7.60 (ddd, J = 7.86 Hz and 1.29 Hz, 2H, 4-H 5-H), 7.69 (ddd, J = 7.97 Hz and 1.73 Hz, 2H, 3-H 6-H), 7.92 (d, J = 13.99 Hz, 1H, 1'-H), 8.52 (dd, J = 8.00 Hz and 1.73 Hz, 2H, 1-H 8-H); ^{13}C-nmr (deuteriochloroform): δ 14.34 ($-CH_3$), 61.49 (CH_2), 112.67 (C-8a C-9a), 116.59 (C-4 C-5), 122.94 (C-2'), 123.25 (C-2 C-7), 128.21 (C-1 C-8), 134.17 (C-3 C-6), 140.31 (C-1'), 141.28 (C-4a C-10a), 165.92 (C-3'), 178.36 (C-9); ms: (70 eV) m/z (%) 293 (37, M^+), 248 (15, M^+-OEt), 220 (100, 248-CO), 191 (10, 220-CHO), 59 (22).

Anal. Calcd. for $C_{18}H_{15}NO_3$: C, 73.71; H, 5.15; N, 4.78. Found: C, 73.74; H, 5.01; N, 4.60.

Ethyl 3-(2-Methoxy-9-oxo-10(9*H*)-acridinyl)acrylate (**2b**).

The same general procedure gave **2b** as yellow needles mp 136-137° (methanol); ir (potassium bromide): 3020, 2950, 2800, 1720, 1630, 1600, 1500, 1195 cm^{-1}; uv (methanol): λ max (log ϵ) 250 nm (4.79), 266 (4.73), 396 (4.15), 408 (4.18); ^{1}H-nmr (deuteriochloroform): δ 1.4 (t, J = 7.14 Hz, 3H, $-CH_3$), 3.94 (s, 3H, OCH_3), 4.37 (q, J = 7.12 Hz, 2H, $-CH_2-$), 6.40 (d, J = 14.00 Hz, 1H, 2'-H), 7.32 (dd, J = 9.21 Hz and 3.10 Hz, 1H, 3-H), 7.36 (dd, J = 8.63 Hz, 1H, 7-H), 7.60 (d, J = 9.27 Hz, 1H, 4-H), 7.62 (d, J = 8.67 Hz, 1H, 5-H), 7.70 (dd, J = 8.70 Hz, 1H, 6-H), 7.92 (d, J = 3.13 Hz, 1H, 1-H), 8.00 (d, J = 14.20 Hz, 1H, 1'-H), 8.53 (d, J = 8.50 Hz, 1H, 8-H); ^{13}C-nmr (deuteriochloroform): δ 14.35 (CH_3), 56.00 (C-2), 61.44 ($-CH_2-$), 107.35 (C-1), 116.50 (C-5), 118.56 (C-4), 121.60 (C-7), 122.41 (C-8a), 123.09 (C-3), 123.97 (C-9a), 124.44 (C-2'), 128.18 (C-8), 133.98 (C-6), 135.81 (C-4a), 140.43 (C-1'), 140.96 (C-10a), 156.05 (C-2), 166.11 (C-3'), 178.00 (C-9); ms: (70 eV) m/z (%) 323 (100, M^+), 308 (7, M^+-CH_3), 278 (11, M^+-OEt), 250 (76, M^+-COOEt), 235 (14, 250-CH_3), 207 (13, 235-CO), 178 (6, 235-CHO), 72 (20).

Anal. Calcd. for $C_{19}H_{17}NO_4$: C, 70.58; H, 5.30; N, 4.33. Found: C, 70.60; H, 4.98; N, 4.15.

9-Methoxy-3*H*,7*H*-pyrido[3,2,1-*de*]acridine-3,7-dione (**4a**) and 5-Methoxy-3*H*,7*H*-pyrido[3,2,1-*de*]acridine-3,7-dione (**4b**).

The same general procedure gave **4a** as yellow needles mp 235-236° (methanol); ir (potassium bromide): 3010, 2790, 1650, 1610, 1500, 1480, 1300 cm^{-1}; uv (methanol): λ max (log ϵ) 242 nm (4.42), 260 (4.36), 316 (3.32), 324 (3.44), 422 (3.96).

9-Methoxy-3*H*,7*H*-pyrido[3,2,1-*de*]acridine-3,7-dione (**4a**).

This compound had ^{1}H-nmr (deuteriochloroform/methanol 3:1): δ 4.00 (s, 3H, $-OCH_3$), 6.63 (d, J = 8.40 Hz, 1H, 2-H), 7.50 (dd, J = 9.41 and 3.20 Hz, 1H, 10-H), 7.79 (dd, J = 7.75 Hz, 1H, 5-H), 7.89 (d, J = 3.13 Hz, 1H, 8-H), 8.03 (d, J = 9.53, 1H, 11-H), 8.79 (d, J = 7.84, 1H, 6-H), 8.85 (d, J = 7.66 Hz, 1H, 4-H), 8.93 (d, J = 8.39 Hz, 1H, 1-H); ^{13}C-nmr (deuteriochloroform/methanol 3:1): δ 56.08 ($-OCH_3$), 108.69 (C-8), 114.04 (C-2), 117.02 (C-11), 122.80 (C-6a), 124.65 (C-7a), 124.79 (C-10), 125.46 (C-5), 126.07 (C-11a), 133.23 (C-12a), 133.55 (C-4), 133.66 (C-6), 136.01 (C-1), 139.01 (C-3a), 157.92 (C-9), 177.69 (C-7), 178.85 (C-3).

5-Methoxy-3*H*,7*H*-pyrido[3,2,1-*de*]acridine-3,7-dione (**4b**).

This compound had ^{1}H-nmr (deuteriochloroform/methanol 3:1): δ 4.05 (s, 3H, $-OCH_3$), 6.63 (d, J = 8.40 Hz, 1H, 2-H), 7.58 (dd, J = 7.52 Hz, 1H, 10-H), 7.92 (dd, J = 7.60 Hz, 1.69 Hz, 1H, 9-H), 8.08 (d, J = 8.53 Hz, 1H, 8-H), 8.24 (d, J = 3.36, 1H, 4-H), 8.33 (d, J = 3.32, 1H, 6-H), 8.50 (dd, J = 7.77 Hz, 1.56 Hz, 1H, 11-H), 8.93 (d, J = 8.59 Hz, 1H, 1-H); ^{13}C-nmr (deuteriochloroform/methanol 3:1): δ 56.30 (OCH_3), 113.14 (C-2), 115.17 (C-8), 116.92 (C-4), 119.13 (C-6), 123.28 (C-7a), 125.95 (C-6a), 126.07 (C-10), 127.74 (C-12a), 128.60 (C-11), 135.31 (C-1), 135.62 (C-9), 136.13 (C-11a), 136.94 (C-3a), 157.38 (C-5), 179.17 (C-7), 179.74 (C-3); ms: (70 eV) m/z (%) 277 (100, M^+), 262 (26, M^+-CH_3), 247 (23, M^+-CH_2O), 234 (5, 262-CO), 219 (7, 247-CO), 206 (23, 234-CO); 191 (4, 219-CO), 178 (8, 206-CHO), 152 (5, 191-CHN), 105 (15), 91 (11), 75 (12); hrms: Calcd. for $C_{17}H_{11}NO_3$: 277.073994. Found: 277.0742216.

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