

**Facile bromination of the benzene ring during the cyclisation of the
1H-3-methyl-4-ethoxycarbonyl-5-
-arylidenehydrazonopyrazoles to the
3-substituted-aryl-1H-6-methyl-7-ethoxycarbonyl-
-pyrazolo[3,2-c]-s-triazoles**

Carol Csunderlik, Vasile Bercean*, Francisc Peter, and Valentin Badea

*Department of Organic Chemistry and Technologies, 6 Bocşa Str,
University "Politehnica" of Timisoara, 1900 Timișoara, Romania*

E-mail: vbercean@mail.dnttm.ro

(received 02 Oct 2001; accepted 24 Jun 2002; published on the web 02 Jul 2002)

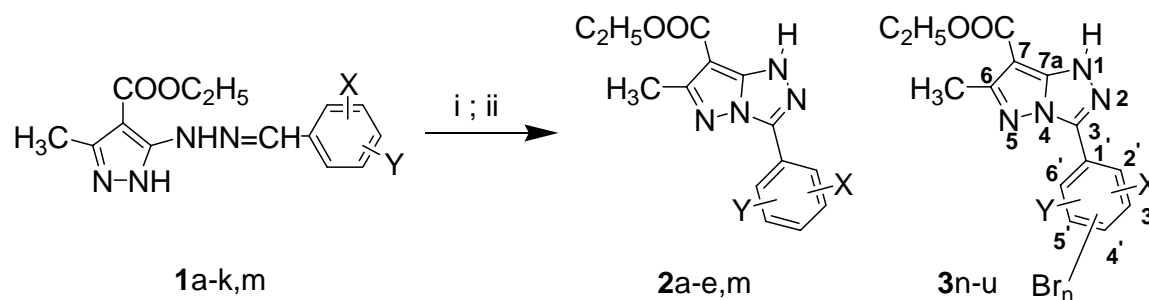
Abstract

1H-3-Substituted-aryl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-triazoles **2**, **3** were obtained by the action of the bromine on the 1H-3-methyl-4-ethoxycarbonyl-5-arylidenehydrazonopyrazoles **1** and were transformed, after hydrolysis-decarboxylation to 1H-3-substituted-aryl pyrazolo[3,2-c]-s-triazoles **5** in the azomethyne dyes **6**.

Keywords: Bromination, hydrolysis-decarboxylation, 5-arylidenehydrazonopyrazoles, pyrazolo[3,2-c]-s-triazoles, azomethyne dyes

Introduction

3,6-Disubstituted pyrazolo[3,2-c]-s-triazoles were synthesised¹ and utilized for the preparation of couplers for photographic materials^{2,3,4} and for their biological activities⁵. 1H-3-Substituted-aryl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-triazoles **2** were prepared by the action of the bromine in acetic acid in the presence of anhydrous sodium acetate¹ or by the action of lead tetraacetate in acetic acid⁶ on the 1H-3-methyl-4-ethoxycarbonyl-5-arylidenehydrazono-pyrazole **1** (Scheme 1).



i = Br₂ / CH₃COOH / CH₃COONa ii = Pb(CH₃COO)₄ / CH₃COOH

X=2-NO₂ Y=H b) X=4-NO₂ Y=H c) X=2-Cl Y=H d) X=4-CH₃ Y=H e) X=2-OCH₃ Y=H f) X=2-OH Y=H g) X=4-OH Y=H h) X=3-OH Y=H i) X=2-OH Y=4-OH j) X=4-OCH₃ Y=H k) X=2-OCH₃ Y=4-OCH₃ m) X=4-OH Y=3,5-(t-C₄H₉)₂ n) X=2-OCH₃ Y=H Br_n=(3)5-Br o) X=2-OH Y=H Br_n=3,5-Br₂ p) X=4-OH Y=H Br_n=3,5-Br₂ r) X=3-OH Y=H Br_n=2,4,6-Br₃ s) X=2-OH Y=4-OH Br_n=3,5-Br₂ t) X=4-OCH₃ Y=H Br_n=3-Br u) X=2-OCH₃ Y=4-OCH₃ Br_n=5-Br

Scheme 1

Results and Discussion

The bromine action on the 1H-3-methyl-4-ethoxycarbonyl-5-aryllidenehydrazono-pyrazole **1** in acetic acid in the presence of anhydrous sodium acetate led mainly to the pyrazolo-triazole **2a-e** in the case of the substituents X=2-NO₂ **1a**¹, 4-NO₂ **1b**¹, 2-Cl **1c**¹, 4-CH₃ **1d**¹ or p-N(CH₃)₂⁷ and 2-OCH₃ **1e**⁷. In the case of the electron donating groups (OH, OCH₃) and utilization of excess of the bromine in the presence of a calculated excess of anhydrous sodium acetate, the obtained pyrazolo triazoles **3n-u** are brominated at the benzene ring. The bromination occurs mainly at the activated free positions. In the case of the hydroxy groups, all the activated free positions, related to the hydroxy groups are substituted, but in the case of methoxy groups, only one position is occupied. If the activated positions are not free (**1m** X=4-OH, Y=3,5-tBu₂) the action of the bromine led to pyrazolo-triazole **2m**.

In the case of compound **1e** the action of one equivalent of the bromine led to **2e**⁷ whereas the action of two equivalent of the bromine led to **3n** and a little quantity of **2e**. The two molecular peaks M⁺(m/z) at 378, 380 confirm monobromination.

Differently, the action of one equivalent of the bromine on the **1j** afford to a mixture of **1j** **2j** and **3t** whereas two equivalent of the bromine led to **3t** and a little quantity of **2j**. The two molecular peaks M⁺ (m/z) at 378, 380 confirm monobromination and ¹H-NMR and ¹³C-NMR spectra proved the structure of the **3t**.

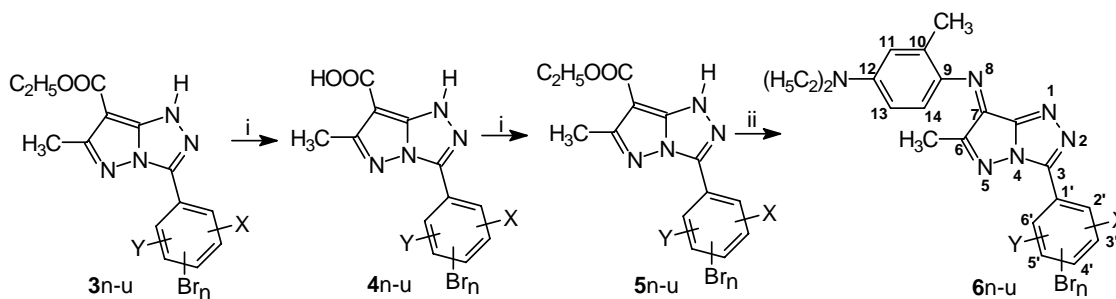
Also by the action of one equivalent of the bromine on the **1k**, a mixture of **1k** **2k** and **3u** was formed, whereas two equivalent of the bromine led to **3u**. The two molecular peaks M⁺ (m/z) at

408, 410 confirmed the monobromination and $^1\text{H-NMR}$ and $^{13}\text{C-NMR}$ spectra proved the structure of the **3u**.

In the case of the compounds **1f-i**, which contains hydroxy groups, utilization of one equivalent of the bromine led to a mixture of compounds. Use of three equivalents of the bromine for **1f** **1g** **1i** led to the dibrominated compounds **3o** **3p** **3s** whereas the utilization of four equivalents of the bromine for **1h** led to the tribrominated compound **3r**. The dibromination was confirmed by the three molecular peaks $\text{M}^+(\text{m/z})$ at 442, 444, 446 for **3o**, $\text{M}^+(\text{m/z})$ at 442, 444, 446 for **3p**, $\text{M}^+(\text{m/z})$ at 458, 460, 462 for **3s**, and the tribromination by the four molecular peaks $\text{M}^+(\text{m/z})$ at 520, 522, 524, 526 for **3r**. The structures of the compounds **3o-s** were confirmed also by $^1\text{H-NMR}$ and $^{13}\text{C-NMR}$ spectra.

The formation and the structure of compounds **3n-u** were also confirmed by the synthesis and characterization of compounds **5n-u** and of their azomethinic dyes **6n-u**. (Scheme 2). The ethoxycarbonyl groups from the 3-substituted aryl-1H-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-*c*]-s-triazoles **3n-u** were eliminated by hydrolysis and decarboxylation to the 3-substituted aryl-1H-6-methyl-pyrazolo[3,2-*c*]-s-triazoles **5** which were converted to the azomethine dyes **6** by coupling with 2-methyl-4-*N,N*-diethylamino-aniline **7** in aqueous-alkaline $\text{K}_3\text{Fe}(\text{CN})_6$ solution (Scheme 2).

Our preliminary experiments on the hydrolysis of the compounds **3n-u** by heating them 30min at 100 °C with concentrated H_2SO_4 , showed that the acids **4n-u** contained variable amounts of the decarboxylated compounds **5n-u** and in some cases, the starting material, the esters **3**.



i= H_2SO_4 80% / CH_3COOH 4-6 h reflux ii=2,4-(CH_3)(NEt_2) $\text{C}_6\text{H}_3\text{NH}_2$ **7** / $\text{K}_3\text{Fe}(\text{CN})_6$ / NH_4OH - $\text{C}_2\text{H}_5\text{OH}$

Scheme 2

This facile decarboxylation of the compounds **4** to **5** during the hydrolysis with concentrated H_2SO_4 determined us to try one-pot hydrolysis-decarboxylation of **3n-u** to **5n-u** by 4-6 hours of refluxing with a solution of 80% H_2SO_4 in acetic acid, method utilized by us for the previously described hydrolysis-decarboxylation of the compounds **2**.⁷ The new compounds **5n-u** were

characterized by melting point, mass spectrometry, which confirmed the degree of brominating, IR, $^1\text{H-NMR}$ and $^{13}\text{C-NMR}$ spectroscopy. They were also characterized by coupling with 2-methyl-4-N,N-diethylamino-aniline **7** in the presence of potassium fericyanide in ethanol-ammonium hydroxide solution. The new azomethyne dyes **6** were characterized by mass spectrometry, UV–VIS, $^1\text{H-NMR}$ and $^{13}\text{C-NMR}$ spectroscopy. The preparation of the compounds **5t** **6t** and **6s** were unsuccessful. A single alkaline-hydrolysis experiment of the compound **3f** to **4f** was successful and after the extension of the experiment to all the compounds **3** it will be reported.

Experimental Section

General Procedures. TLC was performed using aluminium plates precoated with silica gel 60 or 60 F₂₅₄ (Merck) and visualized by iodine or UV light (254 nm). Melting points were determined on a Böetius PHMK (Veb Analytik Dresden) apparatus. The NMR spectra were recorded on a Varian Gemini 300 and Bruker DRX 400 spectrometer at 25 °C, unless otherwise stated. $^1\text{H-}$ and $^{13}\text{C-NMR}$ signals were referenced to TMS and the solvent shift ($(\text{CD}_3)_2\text{SO}$ δ_{H} 2.50 and δ_{C} 39.5). Coupling constants are given in Hz and without sign. The IR-spectra were recorded (KBr) on a Jasco FT/IR-410 instrument; the UV–VIS spectra were recorded (CH_3OH) on a M40 Karl Zeiss Jena instrument. Mass spectrometry was carried out on a Varian FINNIGAN MAT 212 instrument and the elemental analysis on the Perkin Elmer 240 instrument.

Materials. 1H-3-methyl-4-ethoxycarbonyl-5-aryllidene-hydrazono-pyrazoles **1e-k,m** were obtained according to the literature.^{1,7} The others materials were commercial samples. All organic solvents were of analytical quality and used as purchased. Solvent mixtures are defined by volume ratios (v/v).

1H-3-Substituted aryl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-triazoles 3n-u

To a solution of 5 mmol 1H-3-methyl-4-ethoxycarbonyl-5-aryllidenehydrazono-pyrazole **1 e-k**, **m** in 15-25 mL acetic acid was added

10 mmol anhydrous sodium acetate for the compounds **1m**

20 mmol anhydrous sodium acetate for the compounds **1e, j, k**

30 mmol anhydrous sodium acetate for the compounds **1f, g, i** and

40 mmol anhydrous sodium acetate for the compounds **1h**

After dissolution by heating of the anhydrous sodium acetate, the solution was cooled to room temperature (water bath) and a solution of

5 mmol Br_2 in 5 mL solution of acetic acid for the compounds **1m**

10 mmol Br_2 in 10 mL solution of acetic acid for the compounds **1e, j, k**

15 mmol Br_2 in 15 mL solution of acetic acid for the compounds **1f, g, i** and

20 mmol Br_2 in 20 mL solution of acetic acid for the compounds **1h**

was dropped during 10-15 minutes. The formed solution (suspension) was stirred to room temperature for 30 minutes and 1 hour to 100 °C (water bath). After cooling to room temperature, the suspensions were filtered to afford the compounds **3n,o,r-u** or the solutions were precipitated in water to afford the compounds **2m 3 p**.

1H-3-(5-Bromo-2-methoxy)-phenyl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-triazole

(3n). White powder (yield 78%); mp 186-188 °C (acetic acid); MS m/z: 378, 380(M⁺): IR ν 3227, 3077, 3037, 2978, 2929, 2909, 2843, 1715, 1627, 1596, 1501, 1275, 1217, 1159, 1098, 1014, 879, 808, 771, 727, 689, 621 cm⁻¹; Anal. Calcd for C₁₅H₁₅BrN₄O₃: C,47.51; H,3.99; N, 14.77; Found: C,47.43; H,4.05; N,14.74.

1H-3-(3,5-Dibromo-2-hydroxy)-phenyl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-

triazoles (3o). White powder (yield 88%); mp 300-302 °C (acetic acid); MS m/z: 442, 444, 446 (M⁺); IR ν 3190, 3071, 2990, 2971, 1655, 1626, 1322, 1258, 1233, 1187, 1178, 1094, 1045, 1018, 645, 604 cm⁻¹; ¹H-NMR δ 10.61 (1H, bs, NH), 8.58 (1H, d, *J*=2.0, 6'-H), 8.01 (1H, d, *J*=2.0, 4'-H), 4.34 (2H, q, *J*=7.1, CH₃-CH₂-O), 3.35 (1H, bs, OH), 2.60 (3H, s, CH₃-6-C), 1.42 (3H, t, *J*=7.1, CH₃-CH₂-O); ¹³C-NMR δ 162.99 (C=O), 160.83 (2'-C), 152.73 (7a-C), 148.79 (6-C), 137.35 (4'-C), 129.54 (6'-C), 114.02 (1'-C), 112.92 (5'-C), 112.03 (3'-C), 88.71 (7-C), 59.83 (CH₃-CH₂-O), 15.22 (CH₃-CH₂-O), 14.85 (CH₃-6-C), (Bruker DPX 300); Anal. Calcd for C₁₄H₁₂Br₂N₄O₃: C,37.86; H,2.72; N, 12.62; Found: C,37.81; H,2.81; N,12.64.

1H-3-(3,5-Dibromo-4-hydroxy)-phenyl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-

triazole (3p). Faintly violet powder (yield 84%); mp 213-215°C (ethanol); MS m/z: 442, 444, 446 (M⁺); IR ν 3470, 3256, 3078, 2980, 2932, 1702, 1658, 1621, 1326, 1232, 1172, 1103, 1022, 685, 652, 583 cm⁻¹; ¹H-NMR δ 10.58 (1H, bs, NH), 8.11 (2H, s, 2'-H, 6'-H), 8.00 (1H, bs, OH), 4.23 (2H, q, *J*=7.1, CH₃-CH₂-O), 2.28 (3H, s, CH₃-6-C), 1.30 (3H, t, *J*=7.1, CH₃-CH₂-O); ¹³C-NMR δ 159.00 (7a-C), 161.43 (C=O), 151.00 (3-C), 137.00 (6-C), 129.46 (2'-C, 6'-C), 122.50 (1'-C), 112.17 (3'-C, 5'-C), 82.5 (7-C), 59.08 (CH₃-CH₂-O), 14.51 (CH₃-CH₂-O), 14.37 (CH₃-6-C); Anal. Calcd. for C₁₄H₁₂Br₂N₄O₃: C,37.86; H,2.72; N, 12.62; Found: C,37.83; H,2.85; N,12.57.

1H-3-(3,5-Dibromo-2,4-dihydroxy)-phenyl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-

triazole (3s). Faintly brown powder (yield 75%); mp 302-305 °C (ethanol); MS m/z:458, 460, 462(M⁺);IR ν 3493, 3263, 3188, 2988, 2935, 1651, 1616, 1322, 1213, 1174, 1105, 1026, 698, 657, 605 cm⁻¹; ¹³C-NMR δ 161.74 (C=O), 159.47 (4'-C), 153.50 (2'-C), 152.95 (7a-C), 146.68 (6-C), 136.56 (3-C), 128.71 (6'-C), 118.77 (1'-C), 104.37 (5'-C), 101.11 (3'-C), 86.75 (7-C), 59.09 (CH₃-CH₂-O), 14.33 (CH₃-CH₂-O), 14.32 (CH₃-6-C), (Bruker AC 200); Anal. Calcd. for C₁₄H₁₂Br₂N₄O₄: C,36.55; H,2.63; N, 12.18; Found: C,36.53; H,2.72; N,12.09.

1H-3-(5-Bromo-2,4-dimethoxy)-phenyl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-

triazole (3u). White powder (yield 60%); mp 222-224°C (ethanol); MS m/z:408, 410(M⁺); IR ν 3430, 3151, 2978, 2938, 2845, 1700, 1619, 1605, 1506, 1369,1277, 1210, 1160, 1096, 1021, 693, 570, 547 cm⁻¹; ¹H-NMR (CDCl₃) δ 7.75 (1H, s, 6'-H), 6.82 (1H, s, 3'-H), 4.30 (2H, q, *J*=7.1, CH₃-CH₂-O), 3.95 (3H, s, CH₃-O), 3.88 (3H, s, CH₃-O), 2.32 (3H, s, CH₃-6-C), 1.29 (3H, t, *J*=7.1, CH₃-CH₂-O); ¹³C-NMR δ 162.63(C=O), 161.54 (4'-C), 158.45 (2'-C), 153.02 (3-C),

151.90 (7a-C), 148.15 (6-C), 132.05 (6'-C), 131.89 (3'-C), 113.60 (1'-C), 100.75 (5'-C), 88.65 (7-C), 59.61 (CH₃-CH₂-O), 56.92 (CH₃O), 56.25 (CH₃O), 15.31 (CH₃-CH₂-O), 13.10 (CH₃-6-C); Anal. Calcd. for C₁₆H₁₇BrN₄O₄: C,46.96; H,4.19; N, 13.69; Found: C,46.91; H,4.25; N,13.59.

1H-3-(3-Bromo-4-methoxy)-phenyl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-triazole (3t). Faintly gray powder (yield 80%); mp 196-198 °C (acetic acid); MS m/z: 378, 380(M+); IR ν 3209, 3000, 2972, 2933, 2833, 1649, 1626, 1504, 1321, 1252, 1175, 1098, 1021,1001, 739, 609, 520 cm⁻¹; ¹H-NMR δ 13.90 (1H, s, NH), 8.48 (1H, d, *J*=2.0, 2'-H), 8.27 (1H, dd, *J*=8.8, 2.0, 6'-H), 7.33 (1H, d, *J*=8.8, 5'-H), 4.24 (2H, q, *J*=7.1, CH₃-CH₂-O), 3.95 (3H, s, CH₃O), 2.58 (3H, s, CH₃-6-C), 1.33 (3H, t, *J*=7.1, CH₃-CH₂-O); ¹³C-NMR δ 162.06 (C=O), 159.15 (4'-C), 156.80 (7a-C), 147.89 (3-C), 137.05 (6-C), 130.00 (2'-C), 126.85 (6'-C), 118.84 (1'-C), 113.04 (5'-C), 111.01 (3'-C), 86.67 (7-C), 59.02 (CH₃-CH₂-O), 56.47 (CH₃-O), 14.48 (CH₃-CH₂-O), 13.52 (CH₃-6-C); Anal. Calcd. for C₁₅H₁₅BrN₄O₃: C,47.51; H,3.99; N, 14.77; Found: C,47.48; H,4.06; N,14.69.

A small amount of the isomeric 1H-3-(2-bromo-4-methoxy)-phenyl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-triazole was evidenced in the 400MHz spectra.

1H-3-(3-Hydroxy-2,4,6-tribromo)-phenyl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-triazole (3r). White powder (yield 50%); MS m/z: 520, 522, 524, 526(M+); IR ν 3497, 3173, 3074, 3005, 2940, 1660, 1616, 1328, 1223, 1181, 1117, 1094, 1016, 688, 672, 592 cm⁻¹; ¹H-NMR δ 10.78 (1H, bs, NH), 8.10 (1H, s, 5'-H), 3.38 (1H, bs, OH), 2.72 (2H, q, *J*=7.1, CH₃-CH₂-O), 2.42 (3H, s, CH₃-6-C), 1.28 (3H, t, *J*=7.1, CH₃-CH₂-O); ¹³C-NMR δ 161.96 (C=O), 159.28 (3'-C), 151.54 (7a-C), 147.11 (3-C), 137.60 (6-C), 134.94 (5'-C), 127.49 (1'-C), 116.21 (6'-C), 116.17 (4'-C), 114.49 (2'-C), 87.00 (7-C), 59.14 (CH₃-CH₂-O), 14.55 (CH₃-6-C), 14.55 (CH₃-CH₂-O). (Bruker AC 200); Anal. Calcd. for C₁₄H₁₁Br₃N₄O₃: C,32.15; H,2.12; N, 10.71; Found: C,32.13; H,2.17; N,10.69.

1H-3-(4-Hydroxy-3,5-di-t-butyl)-phenyl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-triazole (2m). Faintly yellow powder (yield 95%); mp 253-256 °C (benzene-petr. et.); MS m/z:398(M+); IR ν 3605, 3447, 3144, 2958, 2909, 2874, 1713, 1669, 1622, 1319, 1240, 1223, 1198, 1159, 1099, 1024 cm⁻¹; ¹H-NMR δ 13.69 (1H, s, NH), 9.83 (1H, s, OH), 8.21 (2H, s, 2'-H, 6'-H), 4.30 (2H, q, *J*=7.1, CH₃-CH₂-O), 2.50 (3H, s, CH₃-6-C), 1.46 (18H, s, t-Bu), 1.33 (3H, t, *J*=7.1, CH₃-CH₂-O); ¹³C-NMR δ 162.21 (C=O), 158.78 (7a-C), 156.00 (3-C), 147.94 (4'-C), 139.39 (3'-C), 139.36 (6-C), 122.92 (6'-C), 116.60 (1'-C), 86.41 (7-C), 58.96 (CH₃-CH₂-O), 34.69 (C-Me₃), 30.04 (C-Me₃), 14.80 (CH₃-CH₂-O), 14.50 (CH₃-6-C).

A small amount (up to 5%) of the 1H-3-(3-bromo-4-hydroxy-5-t-butyl)-phenyl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-triazole was evidenced in the 400 MHz spectra.

1H-3-Substituted aryl-6-methyl-pyrazolo[3,2-c]-s-triazoles (5n-u)

A mixture of 1mmol 1H-3-substituted aryl-6-methyl-7-ethoxycarbonyl-pyrazolo[3,2-c]-s-triazoles 3n-u in 8 mL acetic acid and 2mL H₂SO₄ 80% was refluxed for 4-7 h (TLC benzene / ethyl acetate 1:1). The reaction mixture was filtered, the solution precipitated in 50 mL water, neutralized with 10% NaOH solution, the suspension filtered and the products 5n-u recrystallised.

Preparation of the azomethyne dyes: 3-Substituted-phenyl-6-methyl-7-(2-methyl-4-diethylamino-phenyl-imino-pyrazolo-[3,2-c]-s-triazoles 6n-u

To a solution of 1mmol of the compounds 5n-u and 1,1 mmol 7 in 15-20 mL ethanol was dropped with stirring a solution of 4,4 mmol $K_3Fe(CN)_6$ in 10 mL water and 2 mL 25% ammonium hydroxide. After 10 minute stirring to room temperature the reaction mixture was poured into 100 mL water and filtered. The compounds 6n-u were recrystallised from $CH_3COOC_2H_5$ -petroleum ether.

1H-3-(5-Bromo-2-methoxy)-phenyl-6-methyl-pyrazolo[3,2-c]-s-triazole (5n). White powder (yield 59%); MS m/z: 306, 308(M⁺); IR ν 3429, 3220, 3155, 3105, 3074, 3021, 2968, 2928, 2897, 2838, 1611, 1506, 1261, 1185, 1085, 1020, 695, 630, 563, 546 cm^{-1} ; 1H -NMR ($CDCl_3$ with CF_3COOH) δ 7.87 (1H, d, $J=2.50$, 6'-H), 7.33 (1H, dd, $J=2.50$, $J=9.0$, 4'-H), 7.03 (1H, d, $J=9.0$, 3'-H), 6.27 (1H, bs, 7-H), 3.95 (3H, s, OCH_3), 2.55 (3H, s, CH_3 -6-C); ^{13}C -NMR δ 161.65 (2'-C), 156.35 (7a-C), 154.50 (3-C), 148.12 (6-C), 137.49 (4'-C), 133.03 (6'-C), 120.21 (1'-C), 114.14 (3'-C), 108.88 (5'-C), 82.26 (7-C), 57.00 (CH_3O -2'C), 12.64 (CH_3 -6C); Anal. Calcd. for $C_{12}H_{11}BrN_4O$: C,46.93; H,3.61; N, 18.24; Found: C,46.89; H,3.70; N,18.27.

6n. MS m/z: 480, 482(M⁺); λ_{max} : 558nm(ϵ 5.9×10^4); 1H -NMR ($CDCl_3$) δ 9.22 (1H, d, $J=9.50$, 14-H), 7.96 (1H, d, $J=2.50$, 6'-H), 7.55 (1H, dd, $J=2.50$, $J=8.90$, 4'-H), 6.93 (1H, d, $J=8.90$, 3'-H), 6.79 (1H, dd, $J=3.00$, $J=9.50$, 13-H), 6.63 (1H, d, $J=3.00$, 11-H), 3.89 (3H, s, OCH_3), 3.51 (4H, q, $J=7.10$, -N- CH_2 - CH_3), 2.57 (3H, s, CH_3 -6-C), 2.49 (3H, s, CH_3 -10-C), 1.27 (6H, t, $J=7.10$, N- CH_2 - CH_3); ^{13}C -NMR δ 168.09 (7-C), 156.94 (2'-C), 153.00 (3-C), 151.62 (7a-C), 148.59 (6-C), 146.19 (12-C), 142.20 (9-C), 135.20 (10-C), 134.34 (4'-C), 133.74 (6'-C), 127.05 (14-C), 116.75 (1'-C), 113.59 (3'-C), 112.80 (5'-C), 112.57 (11-C), 110.40 (13-C), 56.28 (CH_3O -), 45.01 (CH_3 - CH_2 -N), 19.45 (CH_3 -10-C), 12.88 (CH_3 - CH_2 -N), 12.66 (CH_3 -6-C); Anal. Calcd. for $C_{23}H_{25}BrN_6O$: C,57.39; H,5.23; N, 17.46; Found: C,57.32; H,5.28; N,17.39.

1H-3-(3,5-Dibromo-2-hydroxy)-phenyl-6-methyl-pyrazolo[3,2-c]-s-triazole (5o). White powder (yield 90%); mp 235-237 °C (ethanol-water); MS m/z: 370, 372, 374(M⁺); IR ν 3595, 3407, 3143, 3075, 2976, 2927, 1607, 1237, 1188, 1103, 1032, 647, 618, 556 cm^{-1} ; 1H -NMR ($CDCl_3$ with CF_3COOH) δ 7.92 (1H, d, $J=2.50$, 6'-H), 7.89 (1H, d, $J=2.50$, 4'-H), 6.29 (1H, s, 7-H), 2.57 (3H, s, CH_3 -6-C); ^{13}C -NMR δ 161.48 (2'-C), 155.10 (7a-C), 149.05 (6-C), 148.31 (3-C), 138.82 (4'-C), 131.60 (6'-C), 119.80 (1'-C), 114.38 (5'-C), 108.49 (3'-C), 86.05 (7-C), 12.30 (CH_3 -6-C); Anal. Calcd. for $C_{11}H_8Br_2N_4O$: C,35.51; H,2.17; N, 15.06; Found: C,35.49; H,2.22; N,15.02.

6o. MS m/z: 544, 546, 548(M⁺); λ_{max} : 576nm(ϵ 7.9×10^4); 1H -NMR ($CDCl_3$) δ 9.10 (1H, d, $J=9.35$, 14-H), 8.51 (1H, d, $J=2.35$, 6'-H), 7.76 (1H, d, $J=2.35$, 4'-H), 6.82 (1H, dd, $J=9.35$, $J=2.90$, 13-H), 6.62 (1H, d, $J=2.90$, 11-H), 3.51 (4H, q, N- CH_2 - CH_3), 2.57 (3H, s, CH_3 -6-C), 1.29 (6H, t, $J=7.10$, N- CH_2 - CH_3); ^{13}C -NMR δ 167.90 (7-C), 160.00 (2'-C), 152.82 (3-C), 149.30 (7a-C), 148.20 (6-C), 144.63 (12-C), 141.03 (9-C), 137.02 (4'-C), 135.80 (10-C), 128.49 (6'-C), 127.57 (14-C), 119.10(1'-C), 113.18 (13-C), 112.20 (11-C), 111.30 (5'-C), 111.05 (3'-C), 45.67 (CH_3 - CH_2 -N), 19.92 (CH_3 -10-C), 13.41 (CH_3 - CH_2 -N), 13.27 (CH_3 -6-C); Anal. Calcd. for $C_{22}H_{22}Br_2N_6O$: C,48.37; H,4.06; N, 15.38; Found: C,48.39; H,4.12; N,15.33.

1H-3-(3,5-Dibromo-4-hydroxy)-phenyl-6-methyl-pyrazolo[3,2-c]-s-triazole (5p). Brown powder (yield 41%); MS m/z: 370, 372, 374(M+); IR ν 3612, 3488, 3381, 3142, 3078, 2990, 2923, 1601, 1243, 1163, 1095, 1041, 1000, 678, 621, 558 cm^{-1} ; $^1\text{H-NMR}$ (CDCl_3 with CF_3COOH) δ 8.02 (2H, s, 2', 6'-H), 6.26 (1H, s, 7-H), 2.56 (3H, s, CH_3 -6-C);

$^{13}\text{C-NMR}$ δ 162.10 (4'-C), 156.50 (7a-C), 153.30 (3-C), 149.10 (6-C), 130.67 (2'-C, 6'-C), 120.31 (1'-C), 108.99 (3'-C, 5'-C), 86.81 (7-C), 12.67 (CH_3 -6-C); Anal. Calcd. for $\text{C}_{11}\text{H}_8\text{Br}_2\text{N}_4\text{O}$: C, 35.51; H, 2.17; N, 15.06; Found: C, 35.47; H, 2.25; N, 15.01.

6p. MS m/z: 544, 546, 548(M+); λ_{max} : 572nm(ϵ 3.5×10^4); $^1\text{H-NMR}$ (CDCl_3) δ 8.98 (1H, d, $J=9.30$, 14-H), 7.84 (2H, s, 2', 6'-H), 6.83 (1H, dd, $J=9.30$, $J=2.90$, 13-H), 6.60 (1H, d, $J=2.90$, 11-H), 3.51 (4H, q, $J=7.10$, N- CH_2 - CH_3), 2.55 (3H, s, CH_3 -6-C), 2.53 (3H, s, CH_3 -10-C), 1.28 (6H, t, $J=7.10$, N- CH_2 - CH_3); $^{13}\text{C-NMR}$ δ 165.85 (7-C), 163.20 (4'-C), 152.80 (3-C), 151.60 (7a-C), 148.70 (6-C), 146.50 (12-C), 142.31 (9-C), 134.93 (10-C), 130.82 (2'-C, 6'-C), 126.80 (14-C), 119.50 (1'-C), 112.80 (11-C), 111.85 (3'-C, 5'-C), 109.85 (13'-C), 45.10 (CH_3 - CH_2 -N), 19.40 (CH_3 -10-C), 12.81 (CH_3 - CH_2 -N), 12.65 (CH_3 -6-C); Anal. Calcd. for $\text{C}_{22}\text{H}_{22}\text{Br}_2\text{N}_6\text{O}$: C, 48.37; H, 4.06; N, 15.38; Found: C, 48.32; H, 4.12; N, 15.33.

1H-3-(3-Hydroxy-2,4,6-tribromo)-phenyl-6-methyl-pyrazolo[3,2-c]-s-triazole (5r). White-pink powder (yield 40%); MS m/z: 448, 450, 452, 454(M+); IR ν 3556, 3320, 3159, 3074, 2980, 2928, 1599, 1335, 1225, 1176, 1099, 1065, 1014, 684, 656, 585 cm^{-1} ; $^1\text{H-NMR}$ (CDCl_3 with CF_3COOH) δ 7.90 (1H, s, 5'-H), 6.27 (1H, s, 7-H), 2.56 (3H, s, CH_3 -6-C); $^{13}\text{C-NMR}$ δ 164.10 (3'-C), 155.37 (7a-C), 150.77 (3-C), 147.64 (6-C), 135.81 (5'-C), 124.01 (1'-C), 120.20 (6'-C), 115.31 (4'-C), 108.87 (2'-C), 85.90 (7-C), 12.81 (CH_3 -6-C); Anal. Calcd. for $\text{C}_{11}\text{H}_7\text{Br}_3\text{N}_4\text{O}$: C, 29.30; H, 1.56; N, 12.43; Found: C, 29.25; H, 1.60; N, 12.36.

6r. MS m/z: 622, 624, 626, 628 (M+); λ_{max} : 553nm(ϵ 4.8×10^4); $^1\text{H-NMR}$ (CDCl_3) δ 9.05 (1H, d, $J=9.30$, 14-H), 8.15 (1H, s, 5'-H), 6.78 (1H, dd, $J=9.30$, $J=2.90$, 13-H), 6.56 (1H, d, $J=2.90$, 11-H), 3.50 (4H, q, $J=7.10$, N- CH_2 - CH_3), 2.55 (3H, s, CH_3 -6-C), 1.27 (6H, t, $J=7.10$, N- CH_2 - CH_3); $^{13}\text{C-NMR}$ δ 164.25 (7-C), 163.10 (3'-C), 153.05 (3-C), 148.95 (7a-C), 148.35 (6-C), 144.52 (12-C), 143.50 (1'-C), 141.10 (9-C), 136.25 (5'-C), 135.76 (10-C), 127.60 (14-C), 118.76 (6'-C), 113.20 (13-C), 112.20 (11-C), 111.75 (4'-C), 110.20 (2'-C), 45.52 (CH_3 - CH_2 -N), 19.85 (CH_3 -10-C), 13.45 (CH_3 - CH_2 -N), 13.25 (CH_3 -6-C); Anal. Calcd. for $\text{C}_{22}\text{H}_{21}\text{Br}_3\text{N}_6\text{O}$: C, 42.27; H, 1.39; N, 13.44; Found: C, 42.21; H, 1.45; N, 13.37.

1H-3-(3,5-Dibromo-2,4-dihydroxy)-phenyl-6-methyl-pyrazolo[3,2-c]-s-triazole (5s). Black powder (yield 76%); mp 145-147 °C (ethanol-water); MS m/z: 386, 388, 390 (M+); IR ν 3585, 3350, 3140, 3073, 2993, 2927, 1605, 1324, 1212, 1100, 1018, 695, 647, 551 cm^{-1} ; $^1\text{H-NMR}$ (CDCl_3 with CF_3COOH) δ 7.67 (1H, s, 6'-H), 6.31 (1H, s, 7-H), 2.55 (3H, s, CH_3 -6-C); $^{13}\text{C-NMR}$ δ 167.62 (4'-C), 161.50 (2'-C), 156.42 (7a-C), 154.82 (3-C), 146.20 (6-C), 135.43 (6'-C), 115.32 (1'-C), 106.77 (5'-C), 101.20 (3'-C), 87.21 (7-C), 13.24 (CH_3 -6-C); Anal. Calcd. for $\text{C}_{11}\text{H}_8\text{Br}_2\text{N}_4\text{O}_2$: C, 34.05; H, 2.08; N, 14.44; Found: C, 34.00; H, 2.12; N, 14.39.

1H-3-(5-Bromo-2,4-dimethoxy)-phenyl-6-methyl-pyrazolo[3,2-c]-s-triazole (5u). Grey powder (yield 83%); mp 240-242 °C (ethanol); MS m/z: 336, 338(M+); IR ν 3368, 3061, 2941, 2838, 2749, 1605, 1280, 1213, 1173, 1092, 1017, 550 cm^{-1} ; $^1\text{H-NMR}$ δ 7.26 (1H, s, 6'-H), 6.61

(1H, s, 3'-H), 5.56 (1H, s, 7-H), 3.98 (3H, s, CH₃-O), 3.91 (3H, s, CH₃-O), 2.43 (3H, s, CH₃-6-C); ¹³C-NMR δ 162.00 (4'-C), 157.00 (2'-C), 156.50 (7a-C), 132.54 (6'-C), 132.50 (3'-C), 108.50 (1'-C), 98.28 (5'-C), 76.57 (7-C), 56.33 (CH₃O), 56.32 (CH₃O), 14.58 (CH₃-6-C) (Bruker DPX 300); Anal. Calcd. for C₁₃H₁₃BrN₄O₂: C, 46.31; H, 3.89; N, 16.62; Found: C,46.27; H,3.96; N,16.58.

6u. MS m/z: 510, 512(M+); λ_{max} 576 nm; ¹H-NMR (CDCl₃) δ 9.08 (1H, d, J=9.35, 14-H), 7.32 (1H, s, 6'-H), 6.90 (1H, dd, J=9.30, J=2.90, 13-H), 6.72 (1H, s, 3'-H), 6.57 (1H, d, J=2.90, 11-H), 3.98 (3H, s, CH₃-O), 3.51 (4H, q, J=7.10, N-CH₂-CH₃), 2.53 (3H, s, CH₃-10-C), 2.43 (3H, s, CH₃-6-C), 1.28 (6H, t, J=7.10, N-CH₂-CH₃); ¹³C-NMR δ 163.25 (7-C), 162.85 (4'-C), 157.43 (2'-C), 152.23 (3-C), 151.94 (7a-C), 148.22 (6-C), 146.73 (12-C), 142.11 (9-C), 135.22 (10-C), 132.68 (6'-C), 132.33 (3'-C), 125.47 (14-C), 112.63 (1'-C), 111.81 (11-C), 109.90 (13-C), 99.19 (5'-C), 57.05 (CH₃O), 56.32 (CH₃O), 45.14 (CH₃-CH₂-N), 19.36 (CH₃-10-C), 13.90 (CH₃-CH₂-N), 13.21 (CH₃-6-C); Anal. Calcd. for C₂₄H₂₇BrN₆O₂: C, 56.36; H, 5.32; N, 16.43; Found: C,56.31; H,5.38; N,16.38 Anal. Calcd. for C₂₄H₂₇BrN₆O₂: C, 56.36; H, 5.32; N, 16.43; Found: C,56.31; H,5.38; N,16.38.

Acknowledgements

The work was effected with the financial support (Grant CNCSIS 19D) of the Romanian Ministry of Education and Research. Many thanks to Prof. Dr. M. Fild for his help in performing the 400 MHz NMR spectra at the "Institut für Anorganische und Analytische Chemie" Technische Universität Braunschweig, Germany.

References

1. Bailey, J. *J.Chem.Soc., Perkin Trans I* **1977**, 18, 2047.
2. Buckland, P. R.; Leyshon, L. L. *J. Eur. Pat* 0 200 354 1986 Int. Cl. G03C7/38.
3. Nishijima, T.; Onodera, K. *U. S. Pat.* 4,752,561 1988 Int.Cl.G03C1/08.
4. Katoh, K.; Kawakatsu, S.; Masuda, K.; Miyagi, K.; Nakayama, N.; Kimura, T.
5. *U. S. Pat.* 4,581,326 1986 Int.Cl.G03C7/26.
6. Abdel Sayed, N. I. *Egypt. J. Chem.* **1999**, 42, 2175.
7. Pizey, J. S. *Synthetic Reagents*, John Wiley & Sons Inc.: New-York, 1977; Vol.3, pp 319.
8. Bercean, V. N. Ph. D. Thesis 1998 University "Politehnica" of Timisoara.