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LETTERS TO THE EDITOR

SYNTHESIS AND PRODUCTS OF THE METHYLATION OF 2-(2-FURYL)IMIDAZO-[4,5-*f*]BENZIMIDAZOLE

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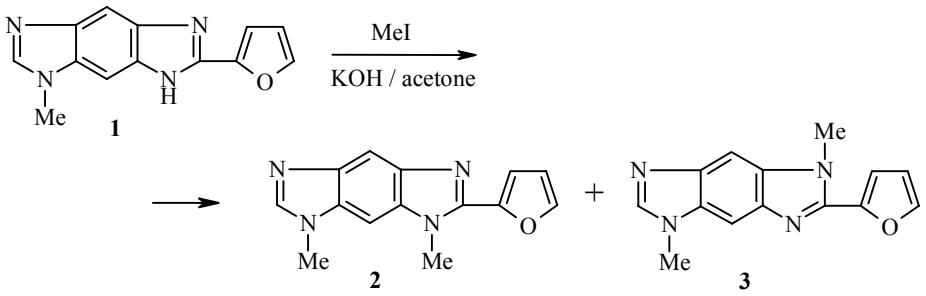
There is almost no information in the literature on furyl derivatives of imidazo[4,5-*f*]benzimidazole. In our view, this results from the unsuitability of the Weidenhagen synthesis, which is most commonly employed for the preparation of various hetarylbenzimidazoles, for the preparation of furylimidazo[4,5-*f*]benzimidazole [1]. This failure may be related to formation of the strong complex by starting 5,6-diaminobenzimidazole with copper diacetate or sulfate under the reaction conditions, which prevents formation of the copper salt of the desired product. We have overcome this problem by using 1-methyl-5,6-dinitrobenzimidazole obtained by the methylation of 5,6-dinitrobenzimidazole by methyl iodide in the KOH–methylpyrrolidone system with subsequent reduction of the methylation product by tin in hydrochloric acid. The reaction of the resultant diamine with furfural in the presence of $Cu(OAc)_2$ proceeds rather smoothly.

This is the first reported synthesis of 2-(2-furyl)-7-methyl-1H-imidazo[4,5-*f*]benzimidazole (**1**). This product was subjected to methylation in the KOH–acetone system [2]. ^{1}H NMR spectroscopy showed that the methylation product is a ~1:1 mixture of two isomers.



Column chromatography was used to separate isomers **2** and **3**. The structures of these isomers were determined using ^{1}H NMR spectroscopy. The structure of **2** as the 1,7-dimethyl derivative follows from the singlet of the aromatic proton at $C_{(4)}$, which is downfield relative to the proton at $C_{(8)}$. This behavior is

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undoubtedly related to the effect of the pyridinic nitrogen atoms on the proton at $C_{(4)}$ and the effect of the methyl groups on the proton at $C_{(8)}$. The analogous signals in the spectrum of **3**, as expected, have almost the same chemical shifts.

2-(2-Furyl)-7-methyl-1H-imidazo[4,5-*f*]benzimidazole (1). A mixture of 5,6-diamino-1-methylbenzimidazole (6.48 g, 40 mmol) in 2-propanol (75 ml), cupric acetate (16 g, 80 mmol) in water (200 ml), and furfural (3.84 g, 40 mmol) was heated at 80-90°C for 2 h. The reaction mixture was cooled. The copper salt precipitate was separate and suspended in 2-propanol (150 ml). Then, hydrogen sulfide was passed through the suspension for 1 h. Copper sulfide was filtered off and the filtrate was evaporated to half volume. The precipitate was diluted with water to give 4.95 g (52%) of compound **1**; mp 303-304°C (ethanol). ^{1}H NMR spectrum (300 MHz, DMSO), δ, ppm (*J*, Hz): 3.87 (3H, s, N–CH_3); 6.65 (1H, br. s, 4'-H); 7.15 (1H, br. s, 3'-H); 7.57 (1H, br. s, 5'-H); 7.70 (1H, s, 8-Ar); 7.80 (1H, s, 4-Ar); 8.10 (1H, s, 2-H). Found, %: C 65.22; H 4.09; N 23.17. $C_{13}H_{10}N_4O$. Calculated, %: C 65.64; H 4.31; N 23.52.

2-(2-Furyl)-1,7-dimethylimidazo[4,5-*f*]benzimidazole (2) and 2-(2'-Furyl)-1,5-dimethylimidazo-[4,5-*f*]benzimidazole (3). A sample of methyl iodide (1.56 g, 11 mmol) was added dropwise with vigorous stirring to solution of **1** (2.38 g, 10 mmol) in acetone (10 ml) in the presence of powdered KOH (0.62 g, 11 mmol) at 15-20°C. The mixture was stirred for 2 h and poured into water (100 ml). The reaction product was extracted with two 50-ml chloroform portions. The chloroform solution was evaporated to 20 ml and dried over Na_2SO_4. The solvent was removed to give 2.07 g (82%) of an isomer mixture. Chromatography was carried out on a 10-cm column (*d* 3.5 cm) packed with alumina (Brockmann activity II) using chloroform as the eluent to separate **2** and **3**.

Isomer 2 was obtained in 38% yield (0.97 g); mp 260-261°C (methanol). ^{1}H NMR spectrum (300 MHz, $CDCl_3$), δ, ppm (*J*, Hz): 3.86 (3H, s, N–CH_3); 4.07 (3H, s, N–CH_3); 6.60 (1H, m, 4'-H); 7.15 (1H, s, 8-HAr); 7.18 (1H, d, *J* = 3.3, 3'-H); 7.62 (1H, d, *J* = 2.2, 5'-H); 7.87 (1H, s, 6-H); 8.15 (1H, s, 4-HAr). Found, %: C 66.87; H 5.03; N 22.47. $C_{14}H_{12}N_4O$. Calculated, %: C 66.65; H 4.79; N 22.21.

Isomer 3 was obtained in 32% yield (0.81 g); mp 80-81°C (methanol). ^{1}H NMR spectrum (300 MHz, $CDCl_3$), δ, ppm (*J*, Hz): 3.86 (3H, s, N–CH_3); 4.10 (3H, s, N–CH_3); 6.60 (1H, m, 4'-H); 7.18 (1H, d, *J* = 3.5, 3'-H); 7.62 (1H, d, *J* = 2.2, 5'-H); 7.65 (1H, s, 8-HAr); 7.68 (1H, s, 4-HAr); 7.88 (1H, s, 6-H). Found, %: N 22.15. $C_{14}H_{12}N_4O$. Calculated, %: N 22.21.

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