Brief Communications

Acylpyruvamides and acylpyruvoylhydrazines
7.* Reactions of aroylpyruvamides with hydrazine and phenylhydrazine

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Substituted aroylpyruvamides react with hydrazine and phenylhydrazine to give 5-aryl-5-hydroxy-2-pyrazoline-3-carboxamides rather than 5-arylpyrazole-3-carboxamides as suggested before. The structures of the compounds obtained are discussed.

Key words: aroylpyruvamides, reactions with hydrazine and phenylhydrazine, 5-aryl-5-hydroxy-2-pyrazoline-3-carboxamides.

Earlier,[2–5] products of reactions of substituted aroylpyruvamides (**1**) with hydrazine were assigned the structure of 5-arylpyrazole-3-carboxamides (**2**).

However, in examination of the ^{1}H NMR spectra of products of the reaction of some aroylpyruvamides (**1a—d**), obtained from 5-arylfuran-2,3-diones (**3a,b**) under the action of primary amines (ring-opening),[6,7] with hydrazine or phenylhydrazine (Scheme 1), a pronounced signal of the diastereotopic methylene protons (two doublets of the AB pattern) at δ 3.10—3.34 and δ 3.57—3.65 (^2J = 14.0—17.5 Hz) was observed, which suggests that the compounds synthesized are 5-aryl-5-hydroxy-2-pyrazoline-3-carboxamides (**4a—d**) rather than the corresponding pyrazolones **2**; formation of the latter could be expected.

When interpreting the NMR spectra of pyrazoline-3-carboxamide **4a** (Scheme 2, arbitrary numbering of the carbon atoms in molecule **4a** is given), note that a signal of the C(4)H$_2$ *gem*-protons in structurally similar substituted methyl 2-pyrazoline-3-carboxylates **5** appears at δ 3.14—3.23 and δ 3.52—3.65.[8] The ^{13}C NMR spectra of fluorine-containing pyrazolines **6** (see Scheme 2) exhibit a signal of the C(3) atom at δ 139.8—140.9, that of C(4) at δ 41.4—43.0, and that of C(5) at δ 93.0—94.7.[9]

The position of the carboxamide substituent at the C(3) ring atom in pyrazolines **4** suggests that the α-carbonyl group rather than the C(4)=O center in the starting amides **1** is under initial nucleophilic attack in reactions with phenylhydrazine. This fact correlates well with the published data[8–10] reporting that N-nucleophiles attack the α-carbonyl group of acylpyruvates.

In attempting to obtain pyrazoles **2** by dehydration of compounds **4**, the starting pyrazolines **4** were recovered.

Experimental

The IR spectrum was recorded on a Philips Analytical PU9716 IR spectrometer in Nujol (compound **4a**). ^{1}H NMR spectra of the compounds **4** synthesized were recorded on a

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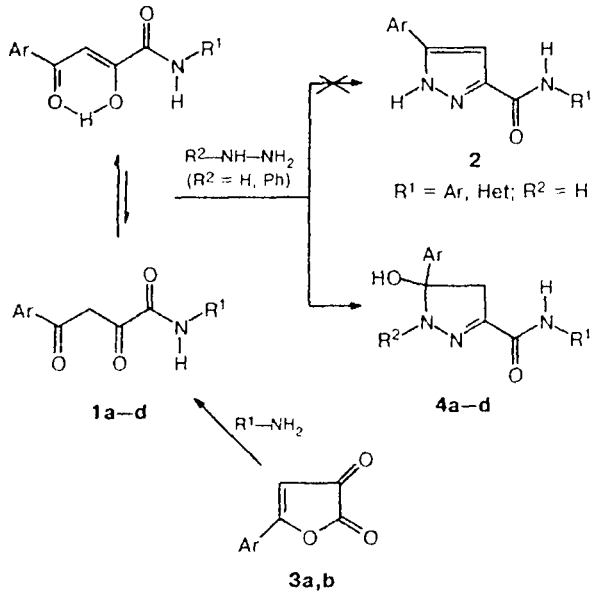
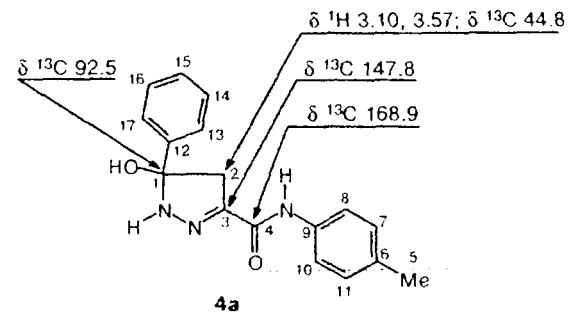
Scheme 1

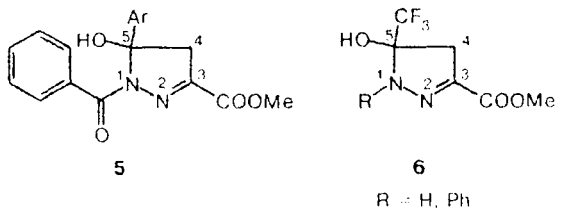


Ar = Ph (**1a,b,c**, **3a**, **4a,b,c**), 4-ClC_6H_4 (**1d**, **3b**, **4d**);
R^1 = 4-MeC_6H_4 (**1a**, **4a**), 4-$MeOC_6H_4$ (**1b**, **4b**), Bu^t (**1c**, **4c**), Ph (**1d**, **4d**);
R^2 = H (**4a,b,d**), Ph (**4c**)

Bruker AC-300 instrument (300.13MHz) in DMSO-d_6 with Me_4Si as the internal standard. The ^{13}C NMR spectrum was recorded on a JEOL EX-90A FT-NMR spectrometer (22.30 MHz) in DMSO (compound **4a**). The course of the reactions was monitored, and the purity of compounds was checked by TLC on Silufol UV-254 plates in the benzene—ether—acetone system (10 : 9 : 1); spots were visualized with iodine.

Scheme 2





The starting aroylpyruvamides (**1a—d**) existing in solution as an equilibrium mixture of the OH chelate and minor β-diketone forms[11] were obtained according to the known procedure.[6,7]

5-Aryl-5-hydroxy-2-pyrazoline-3-carboxamides (4a—d). A 70% aqueous solution of hydrazine (1 mL), or phenylhydrazine (1.08 g, 10 mmol), was added to a suspension of aroylpyruvamides[6,7] (**1a—d**) (10 mmol) in 50 mL of dioxane. The reaction mixture was heated to dissolution and refluxed for 2—5 min (monitored by TLC). The precipitate that formed was filtered off and recrystallized from EtOH (compounds **4a,c**) or a DMF—H_2O (1 : 1) mixture (compounds **4b,d**).

Compound 4a. Yield 2.33 g (79%), m.p. 246—247 °C (decomp.). IR, ν/cm^{-1}: 1665 (CONH); 3320 (CONH). ^1H NMR (DMSO-d_6), δ: 2.28 (s, 3 H, CH_3); 3.10, 3.57 (both d, 2 H, CH_2, AB system, ^2J = 14.0 Hz); 6.69 (s, 1 H, OH); 7.12—7.68 (m, 9 H, Ph, C_6H_4); 9.58 (s, 1 H, NH_{amide}). ^{13}C NMR (DMSO), δ (for numbering of the carbon atoms, see Scheme 2): 20.2 (C(5)); 44.8 (C(2)); 92.5 (C(1)); 120.2 (C(10)); 120.8 (C(8)); 126.3 (C(13), C(17)); 128.3 (C(15)); 129.0 (C(14), C(16)); 129.4 (C(7), C(11)); 133.1 (C(6)); 134.3 (C(9)); 136.7 (C(12)); 147.8 (C(3)); 168.9 (C(4)). Found (%): C, 69.58; H, 5.36; N, 13.90. $C_{17}H_{17}N_3O_2$. Calculated (%): C, 69.14; H, 5.80; N, 14.23. Molecular weight 295.34.

Compound 4b. Yield 2.76 g (89%), m.p. 227—228 °C (decomp.). ^1H NMR (DMSO-d_6), δ: 3.12, 3.60 (both d, 2 H, CH_2, AB system, ^2J = 15.0 Hz); 3.78 (s, 3 H, CH_3O); 6.47 (s, 1 H, OH); 6.67—7.80 (m, 9 H, Ph, C_6H_4); 9.43 (s, 1 H, NH_{amide}); 13.50 (s, 1 H, $NH_{pyrazole}$). Found (%): C, 65.21; H, 5.84; N, 13.37. $C_{17}H_{17}N_3O_3$. Calculated (%): C, 65.58; H, 5.50; N, 13.50. Molecular weight 311.34.

Compound 4c. Yield 2.40 g (71%), m.p. 160—161 °C. ^1H NMR (DMSO-d_6), δ: 1.37 (s, 9 H, $3C(CH_3)_3$); 3.34, 3.65 (both d, 2 H, CH_2, AB system, ^2J = 17.5 Hz); 6.80 (s, 1 H, OH); 7.18—7.70 (m, 10 H, 2 Ph); 7.75 (s, 1 H, NH_{amide}). Found (%): C, 70.83; H, 7.15; N, 12.69. $C_{20}H_{23}N_3O_2$. Calculated (%): C, 71.19; H, 6.87; N, 12.45. Molecular weight 337.42.

Compound 4d. Yield 2.45 g (78%), m.p. 273—274 °C (decomp.). ^1H NMR (DMSO-d_6), δ: 3.11, 3.58 (both d, 2 H, CH_2, AB system, ^2J = 14.0 Hz); 6.52 (s, 1 H, OH); 7.07—7.85 (m, 9 H, Ph, C_6H_4); 10.08 (s, 1 H, NH_{amide}). Found (%): C, 60.39; H, 4.22; Cl, 11.61; N, 13.70. $C_{16}H_{14}ClN_3O_2$. Calculated (%): C, 60.86; H, 4.47; Cl, 11.23; N, 13.31. Molecular weight 315.76. (Probably, the same product was isolated upon a similar reaction of *N*-phenyl-*p*-chlorobenzoylpyruvamide (**1d**) with hydrazine hydrate, which had been described earlier,[3] but the structure of *N*-phenyl-5-(4-chlorophenyl)pyrazole-3-carboxamide (**2a**: Ar = 4-ClC_6H_4, R^1 = Ph)) was erroneously assigned to it.

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Synthesis of β-nitramino derivatives of *gem*-dinitroalkanes

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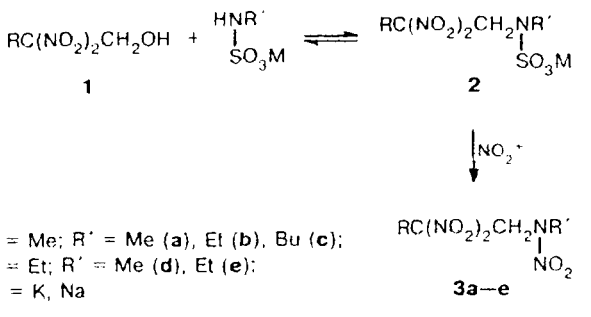
A method for the synthesis of β-nitramino derivatives of *gem*-dinitroalkanes by nitration of the products of condensation of sulfamic acid derivatives with the corresponding *gem*-dinitroalkanes was proposed.

Key words: *gem*-dinitroalkanes, formaldehyde, *N*-alkylsulfamates.

β-Nitramino derivatives of *gem*-dinitroalkanes can be synthesized in various ways. The main way includes reaction of *gem*-dinitroalkanes with amines and formaldehyde with subsequent nitration of the resulting Mannich bases.[1] The chief drawback to this scheme is the low stability of nonnitrated Mannich bases, which significantly reduces the yield of the final products.

Apparently, Mannich bases would be more stable when their amine component is replaced by the amide one. As the latter, we used derivatives of sulfamic acid because they are relatively easily available and their sulfamate group is readily transformed into a nitramino group.[2,3]

Dinitromethane, 1,1-*gem*-dinitroethane, and 1,1-*gem*-dinitropropane were selected as the initial dinitroalkanes. However, 1,1-*gem*-dinitroethane hardly reacted with potassium *N*-methylsulfamate and formaldehyde in aqueous alcoholic media. Much better results were obtained with *gem*-dinitroalkanols **1** as the starting compounds, which had been derived from *gem*-dinitroalkanes by hydroxymethylation.



As expected, condensation of compounds **1** with potassium or sodium *N*-methylsulfamate was a pH- and temperature-dependent reaction. The optimum pH value was found to be ~4.5–5.0. The condensation was terminated after forced removal of water to give products **2** in

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