SYNTHESIS OF SUBSTITUTED 6-AMINO-4-ARYL-5-CYANO-2H,4H-PYRANO[2,3-c]PYRAZOLE.

CRYSTAL AND MOLECULAR STRUCTURE OF 6-AMINO-5-CYANO-3-METHYL-4-(2',4',6'-TRIETHYLPHENYL)-2H,4H-PYRANO[2,3-c]PYRAZOLE

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Substituted 6-aminopyrano[2,3-c]pyrazoles were synthesized by the two-component condensation of arylidenemalononitriles and substituted 5-pyrazolones or three-component condensation of aromatic aldehydes, malononitrile, and substituted 5-pyrazolones. It was established by X-ray crystallographic analysis that pyranopyrazoles exist in the 2H and not the 1H tautomeric form.

Keywords: Michael adduct, pyrazole, pyran, pyranopyrazole, X-ray crystallographic analysis.

Substituted 6-aminopyrano[2,3-c]pyrazoles were first obtained by the reaction of 3-methyl-5-pyrazolone with tetracyanoethylene [1]. Later different methods were developed for the synthesis of these compounds from arylidenemalononitriles and 3-methyl-5-pyrazolone or 4-arylidene-3-methyl-5-pyrazolones and malononitrile and also by the three-component condensation of aromatic aldehydes, malononitrile, and 3-methyl-5-pyrazolone [2-5].

There is still no common opinion about the structure of the products of these reactions. Thus, the authors in [6] assigned the structure of diiminopyranopyrazole (1) to the products of the reactions of arylidenemalononitriles and 3-methyl-5-pyrazolone. More recently it was established that the reaction takes place through the tautomeric Michael adducts $2 \rightleftharpoons 3$, the structure of which was not finally resolved. However, it was shown that these adducts undergo cyclization in the presence of bases to 6-amino-4-aryl-5-cyano-3-methyl-1H,4H-pyran[2,3-c]pyrazoles (4) [3, 4], which can exist in the tautomeric form 5.

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Recently we synthesized new 6-amino-5-cyano-3-methylpyrano[2,3-c]pyrazoles \( 4 \rightleftharpoons 5 \), containing alkyl, spirocyclohexyl, and spiropiperidine substituents at position 4. The structure of these compounds was also studied by X-ray crystallographic analysis, about which we reported previously [7-9]. However, to judge from the data in [10] the question of the structure of the preferred tautomers of the pyranopyrazoles remains open.

In order to extend the range of methods available for the synthesis of pyranopyrazoles, to determine the structure of the products of these reactions, and to study the effect of the substituent at position 3 of the pyranopyrazoles \( 5 \) on the proton attached to one of the nitrogen atoms of the pyrazole ring we synthesized new pyranopyrazoles, using sterically hindered polyalkylbenzaldehydes, heterocyclic aldehydes, and 5-pyrazolones containing not only a methyl substituent but also phenyl, methoxymethylene, trifluoromethyl, tert-butyl, and other substituents at position 3. We proved the structure of one of the pyranopyrazoles conclusively by X-ray crystallographic analysis.

By varying the methods for the synthesis of pyranopyrazoles described above and using new substituted aldehydes and 5-pyrazolones we came to the conclusion that the simplest method for the production of pyranopyrazoles with sufficiently high yields is three-component condensation (method A, Scheme). Thus, when equimolar amounts of compounds \( 6, 7, \) and \( 8 \) were heated briefly in ethanol in the presence of triethylamine as catalyst the required compounds \( 4 \rightleftharpoons 5 \) were obtained with yields of 52-95%. In the case of sterically hindered aldehydes \( 6 \), however, these compounds can also be obtained by two-component condensation (method B) of the previously synthesized arylidenemalonitriles \( 9 \) and 5-pyrazolones \( 8 \).

The compounds \( 5 \) that we obtained were stable analytically pure colorless powders, which could be recrystallized from ethanol or acetonitrile. The structure of all the obtained products was confirmed by various methods (Tables 1 and 2). The IR spectra of the compounds contain absorption bands for the stretching and deformation vibrations of the amino and cyano groups. In the \(^1\)H NMR spectra there are signals for the protons of the aryl, alkyl, amino, and other groups.