

Heterocycles from Carbohydrate Precursors. Part XIX.
The X-ray Crystal Structure Determination of the Reaction Product of
4-(2-Acetoxyethylidene)-4-hydroxy-2,3-dioxobutyro-1,4-lactone-2-
(*p*-bromophenylhydrazone) with Methylhydrazine

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X-ray crystallographic data show that the product obtained in the reaction of 4-(2-acetoxyethylidene)-4-hydroxy-2,3-dioxobutyro-1,4-lactone-2-(*p*-bromophenylhydrazone) with methylhydrazine is the bicyclic compound 2,6-dimethyl-3,4-dioxo-2,3,4,6,7,8-hexahydropyridazino-[4,3-*c*]pyridazine 4-(*p*-bromophenylhydrazone) (**10**) and not as originally suggested 1-methyl-3-(1-methylpyrazolin-3-yl)-4,5-pyrazoledione 4-(*p*-bromophenylhydrazone) (**8**).

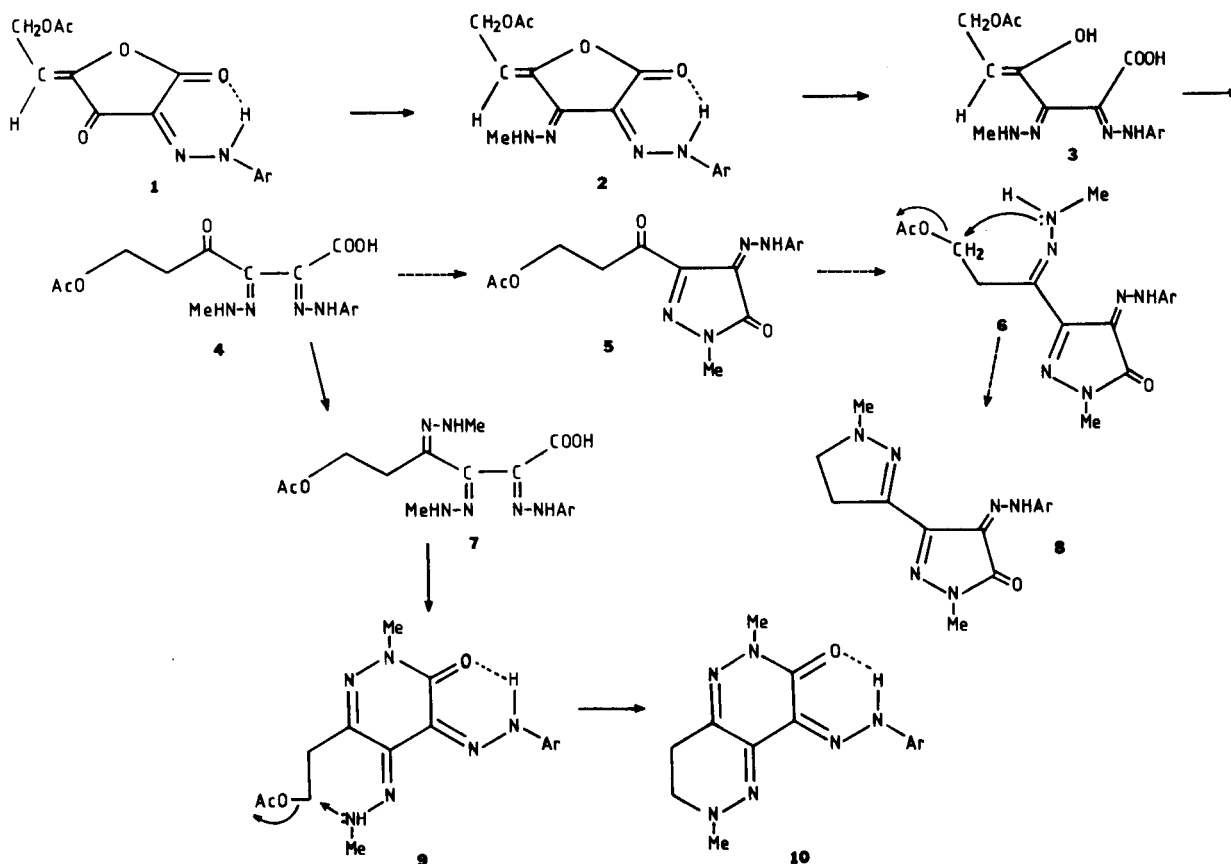
J. Heterocyclic Chem., **17**, 617 (1980).

Sir:

A. Introduction and Discussion.

The conversion of the *mono* and *bis*(hydrazones) of carbohydrate derivatives into nitrogen heterocycles has

the interest of one of the authors as an avenue for the synthesis of various types of heterocyclic compounds (2-7). The reaction of *L-threo*-2,3-hexodiulosono-1,4-lactone 2-(arylhyazone)s (**8**) with various types of hydrazines gave the corresponding mixed *bis*(hydrazones)



which could be rearranged into other heterocycles (9-12). With methylhydrazine the *bis*(hydrazones) could not be isolated and a pyrazole derivative was directly obtained. The reaction of the olefinic acetate 4-(2-acetoxyethylidene)-4-hydroxy-2,3-dioxobutyro-1,4-lactone 2-(arylhydrazone) (**1**) with methylhydrazine was found to give a more complicated reaction mixture. Products could be isolated (7,9-12) of which the elemental analyses and mass spectral data agreed with the molecular formula $C_{13}H_{15}N_4O_4R$ ($R = H, Cl, Br, OCH_3$). It indicates that two moles of methylhydrazine were consumed in the reaction. By combining these data with those obtained by ir as well as 1H -nmr spectroscopy the suggestion was made that the product formed in this reaction has structure **8**. Its formation was explained *via* the intermediacy of the lactone *bis*(hydrazone) **4**, the pyrazolone **5**, and pyrazole *bis*(hydrazone) **6**. However, it cannot be excluded that prior to cyclisation of **4** into **5**, hydrazinolysis of the keto group in **4** takes place, yielding the *tris*(hydrazone) **7**. Cyclisation as indicated leads then to the pyridazine derivative **9**, which by a renewed cyclisation gives compound **10**, being isomeric with **8**. In order to establish unequivocally the structure of the product obtained in the reaction of **1** with methylhydrazine we investigated by X-ray crystallography the reaction product of **1** ($Ar = p\text{-}BrC_6H_5$) with methylhydrazine. By this method it was found that the product obtained is not 1-methyl-3-(1-methylpyrazolin-3-yl)-4,5-pyrazoledione 4-(*p*-bromophenylhydrazone) (**8**) as originally suggested, but 2,6-dimethyl-3,4-dioxo-2,3,4,6,7,8-hexahydropyridazino[4,3-*c*]pyridazine 4-(*p*-bromophenylhydrazone) (**10**, $Ar = p\text{-}BrC_6H_4$).

B. Crystallographic Determination of Structure **10**.

B. 1 Crystal and Intensity Data.

Crystals of the title compound are monoclinic with space group $P2_1/c$ and 4 molecules in a unit cell of dimensions: $a = 9.382(1)$, $b = 15.928(2)$, $c = 10.030(1)$ Å and $\beta = 93.49(1)^\circ$. 1945 reflexions with intensities above the 2σ -level were measured on a NONIUS CAD4 single crystal diffractometer using graphite monochromatized $CuK\alpha$ radiation. No absorption correction was applied (crystal dimensions: $0.2 \times 0.2 \times 0.1$ mm; $\mu = 38.7 \text{ cm}^{-1}$).

B. 2 Structure Determination and Refinement.

Br was located from an E^2 -1 Patterson synthesis. A Patterson minimum function based on the positions of the 4 Br atoms in the unit cell enabled the positions of the remaining non-hydrogen atoms to be obtained. Refinement proceeded by means of least-squares calculations, anisotropic for the non-hydrogen atoms and isotropic for the hydrogen atoms which had been found in a difference fourier synthesis. A weighting scheme $w = 1/(7.4 + F_o + 0.0083F_o^2)$ was used (13) and a dispersion correction for Br was taken into account. The final R value was 0.041. The final coordinates are listed in Table I. The atomic numbering is indicated in Figure I.

B. 3 Results and Discussion.

The molecule as found is depicted in Figure I. It proves unequivocally structure **10**. The bond lengths and angles are also indicated in Figure I. The calculated standard deviations are 0.005 - 0.008 Å for the bond

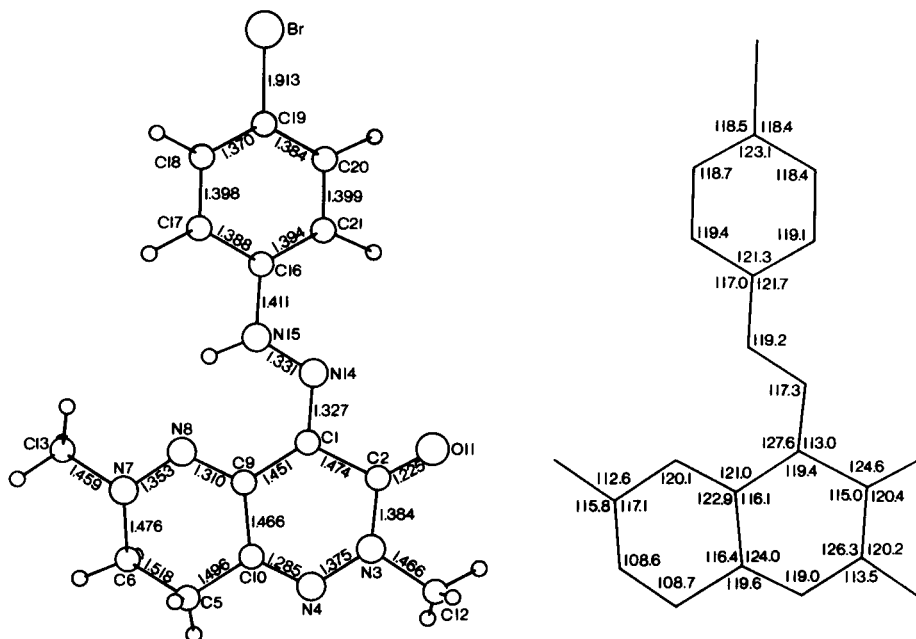


Figure 1. Bond lengths and angles in a projection onto plane II (see Table II).

Table I

Final Atomic Coordinates with
Calculated Standard Derivations between Parentheses

	x	y	z
Br	0.11352 (7)	0.17944 (4)	0.27806 (5)
C-1	0.4155 (5)	0.0955 (3)	1.0443 (5)
C-2	0.5360 (6)	0.1414 (4)	1.1113 (5)
N-3	0.5734 (5)	0.1156 (3)	1.2405 (4)
N-4	0.5046 (5)	0.00558 (3)	1.3118 (4)
C-5	0.3185 (6)	-0.0463 (4)	1.3330 (5)
C-6	0.2579 (6)	-0.1134 (4)	1.2382 (5)
N-7	0.1718 (5)	-0.0721 (3)	1.1290 (4)
N-8	0.2362 (4)	-0.0112 (3)	1.0603 (4)
C-9	0.3450 (6)	0.0300 (3)	1.1162 (5)
C-10	0.3984 (6)	0.0161 (3)	1.2548 (5)
O-11	0.6006 (4)	0.1989 (2)	1.0608 (4)
C-12	0.6928 (7)	0.1558 (4)	1.3170 (6)
C-13	0.0840 (6)	-0.1276 (4)	1.0423 (6)
N-14	0.3878 (5)	0.1195 (3)	0.9187 (4)
N-15	0.2784 (5)	0.0828 (3)	0.8510 (4)
C-16	0.2447 (6)	0.1066 (4)	0.7173 (5)
C-17	0.1158 (6)	0.0781 (4)	0.6587 (5)
C-18	0.0754 (6)	0.1016 (4)	0.5275 (5)
C-19	0.1658 (6)	0.1513 (3)	0.4599 (5)
C-20	0.2955 (6)	0.1798 (4)	0.5156 (5)
C-21	0.3353 (6)	0.1575 (4)	0.6475 (5)
H-51	0.234 (6)	-0.011 (3)	1.374 (5)
H-52	0.385 (6)	-0.072 (4)	1.385 (5)
H-61	0.335 (5)	-0.149 (3)	1.201 (5)
H-62	0.192 (5)	-0.155 (3)	1.277 (5)
H-121	0.769 (6)	0.184 (4)	1.264 (6)
H-122	0.754 (9)	0.105 (5)	1.343 (8)
H-123	0.659 (8)	0.209 (5)	1.362 (7)
H-131	0.161 (7)	-0.175 (4)	0.999 (6)
H-132	0.023 (7)	-0.167 (4)	1.103 (6)
H-133	0.027 (7)	-0.854 (4)	0.986 (6)
H-15	0.227 (7)	0.034 (4)	0.883 (7)
H-17	0.039 (5)	0.039 (3)	0.712 (5)
H-18	-0.018 (5)	0.080 (3)	0.488 (5)
H-20	0.369 (6)	0.220 (4)	0.466 (5)
H-21	0.428 (6)	0.189 (4)	0.686 (6)

Table II

Distances (Å) from the Best Planes through:

I C-1 C-2 N-3 N-4 C-10 C-9
II C-1 C-2 N-3 N-4 C-10 C-9 N-7 N-8 N-14 N-15 C-16 C-19
III C-16 - C-21

The atoms used to calculate the planes have been marked with an asterisk

	I	II	III
C-1	0.004*	0.010*	
C-2	0.014*	0.015*	
N-3	-0.021*	-0.023*	
N-4	0.006*	0.008*	
C-5	0.106	0.116	
C-6	-0.604	-0.589	
N-7	-0.027	-0.011*	
N-8	-0.006	0.006*	
C-9	-0.017*	-0.008*	
C-10	0.013*	0.019*	
O-11	0.062	0.060	
C-12	-0.032	-0.038	
C-13	-0.414	-0.393	
N-14	-0.025	-0.018*	0.259
N-15	-0.005	0.006*	0.026
C-16	-0.030	-0.017*	0.001*
C-17	0.231	0.249	-0.006*
C-18	0.254	0.274	0.004*
C-19	-0.003	0.013*	0.002*
C-20	-0.281	-0.268	-0.007*
C-21	-0.283	-0.273	0.005*
Br	-0.043	-0.024	-0.058

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lengths and 0.4 - 0.5° for the bond angles. The bond lengths are roughly in agreement with structure **10**. There are, however, a number of deviations from the standard bond lengths (1.47 Å for C-N and N-N, 1.28 Å for C=N, 1.24 Å for N=N) (14) which are difficult to explain in terms of possible resonance structures. There is an internal hydrogen bond of 2.62 Å between N-8 and N-15. (N-8 - H-15: 1.92 Å; N-15 - H-15: 0.98 Å; N-15 H-15 N-8: 127°). The six-membered ring C-1 C-2 N-3 N-4 C-10 C-9 is approximately planar (plane I in Table II). N-7, N-8, N-14, N-15, C-16 and C-19 are at less than 0.030 Å from this plane. The distances from the best plane through these 12 atoms are also listed in Table II (plane II). The benzene ring C-16 - C-21 is planar within the limits of accuracy (plane III in Table II). The angle between planes I and III is 12.5°.