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OXIRANYL β-AMINOVINYL KETONES.
5.* TRANSFORMATION OF 2-METHYL-2-(1-HALOGENOALKYL)-3(2H)-FURANONES INTO OXIRANYL β-AMINOVINYL KETONES

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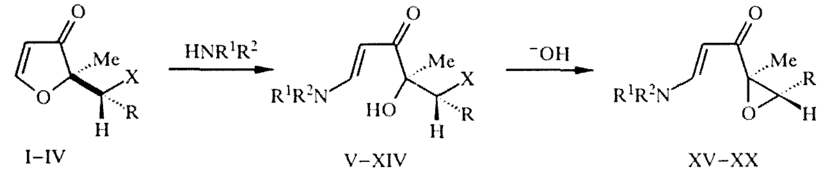
In reaction with amines 2-methyl-2-(1-halogenoalkyl)-3(2H)-furanones form 5-amino-1-halogeno-3-hydroxy-2-methyl-4-penten-3-ones and 6-amino-2-halogeno-3-hydroxy-3-methyl-5-hexen-3-ones, which are converted by the action of bases into the corresponding oxiranyl β-aminovinyl ketones.

2-Methyl-2-(halogenoalkyl)-3(2H)-furanones are easily formed in the reaction of the corresponding oxiranyl β-aminovinyl ketones with dilute hydrochloric and hydrobromic acids [2]. It can be supposed that this process takes place through the formation of intermediate aminohalogenoepoxy ketones, which cannot be isolated owing to their cyclization to 3(2H)-furanones.

We found that 1-halogenoalkyl-3(2H)-furanones (I-IV) are easily transformed in reaction with amines into 5-amino-1-halogeno-2-hydroxy-2-methyl-4-penten-3-ones (V-X) and 6-amino-2-halogeno-3-hydroxy-3-methyl-5-hexen-4-ones (XI-XIV). The products were transformed by treatment with bases into the epoxyaminovinyl ketones (XV-XX) with yields of 65-75% (Table 1).



The IR spectra of the halogenohydrins (V-XIV) contain bands characteristic of β-aminovinyl ketones [3] for the absorption of the carbonyl group conjugated with the double bond at 1650-1640 and of the double bond at 1560-1550; there are broad absorption bands in the region of 3380-3350 cm^{-1}, due to the stretching vibrations of the molecularly associated hydroxyl group. The PMR spectra (Table 2) of the halogenohydrins (V-XIV) and the oxiranyl aminovinyl ketones (XV-XX) confirm the structure of the indicated compounds.

According to the $H_\alpha H_\beta$ spin—spin coupling constant of 13 Hz, compounds (V-IX) have the trans configuration, while the halogenohydrins (X, XIV) exist in the Z-S-Z-chelate form. This is confirmed by the chemical shift of the proton attached to the nitrogen atom (11.4, 11.5) and by the spin—spin coupling constant of 8 Hz.

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*For Communication 4, see [1].

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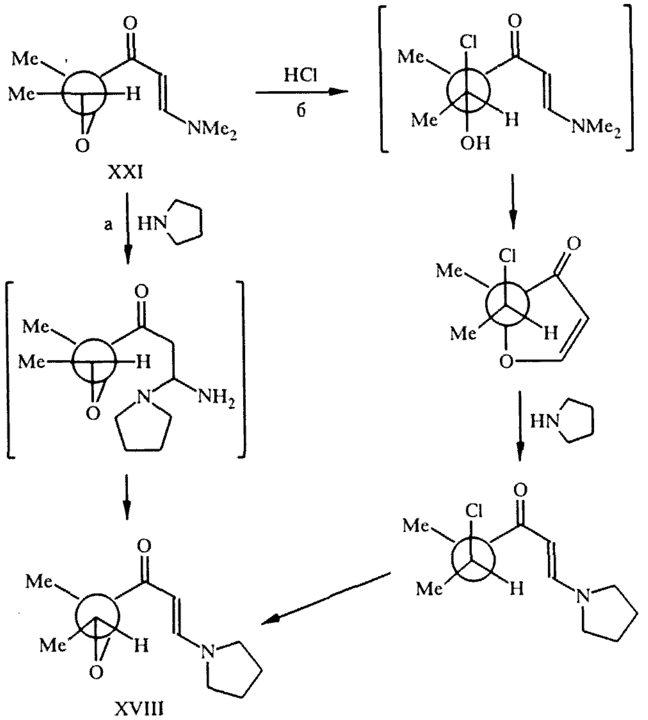
TABLE 1. The Constants and Yields of the Synthesized Compounds

Compound	mp, °C	PMR spectrum, δ, ppm (J, Hz)	Yield, %
V	98...99	1,17 (3H, s, 2-CH_3), 3,36 (2H, s, 1-CH_2), 3,96 (1H, bs , 2-OH), 4,91 (1H, d, J_{45} = 13,0, 4-H), 7,71 (1H, d, J_{54} = 13,0, 5-H), 1,67...2,10 (4H, m), 2,78...3,66 (4H, m, $N(CH_2)_4$)	95
VI	121...122	1,26 (3H, s, 2-CH_3), 3,35 (2H, s, 1-CH_2), 4,23 (1H, s, 2-OH), 4,91 (1H, d, J_{45} = 13,0, 4-H), 7,73 (1H, d, J_{54} = 13,0, 5-H), 1,66...2,16, 2,86...3,63 (8H, m, $N(CH_2)_4$)	90
VII	84...85	1,21 (3H, s, 2-CH_3), 3,41 (2H, s, 1-CH_2), 3,93 (1H, s, 2-OH), 5,10 (1H, d, J_{45} = 13,0, 4-H), 7,43 (1H, d, J_{54} = 13,0, 5-H), 1,36...1,75, 3,10...3,46 (10H, m, $N(CH_2)_5$)	89
VIII	104...105	1,27 (3H, s, 2-CH_3), 3,50 (2H, s, 1-CH_2), 4,07 (1H, s, 2-OH), 5,20 (1H, d, J_{45} = 13,0, 4-H), 7,54 (1H, d, J_{54} = 13,0, 5-H), 3,07...3,72 (8H, m, $N(CH_2CH_2OCH_2CH_2)$)	91
IX	127...128	1,31 (3H, s, 2-CH_3), 3,43 (2H, s, 1-CH_2), 4,23 (1H, s, 2-OH), 5,16 (1H, d, J_{45} = 13,0, 4-H), 7,56 (1H, d, J_{54} = 13,0, 5-H), 3,06...3,73 (8H, m, $N(CH_2CH_2OCH_2CH_2)$)	85
X	104...105	1,25 (3H, s, 2-CH_3), 3,43 (2H, s, 1-CH_2), 3,85 (1H, s, 2-OH), 5,30 (1H, d, J_{45} = 8,0, 4-H), 7,20 (1H, d, J_{54} = 8,0, 5-H), 2,25 (3H, s, $CH_3C_6H_4N$), 6,83 (4H, q, C_6H_4), 11,43 (1H, d, J = 12,0, NH)	78
XI	75...76	1,23 (3H, s, 3-CH_3), 1,15 (3H, d, J = 7,1, 2-CH_3), 3,97 (1H, к, J = 7,1, 2-H), 3,93 (1H, s, 3-OH), 4,93 (1H, d, J_{56} = 13,0, 5-H), 7,71 (1H, d, J_{65} = 13,0, 6-H), 1,66...2,17, 2,85...3,73 (8H, m, $N(CH_2)_4$)	93
XII	116...117	1,21 (3H, s, 3-CH_3), 1,13 (3H, d, J = 7,1, 2-CH_3), 3,98 (1H, q, J = 7,1, 2-H), 3,86 (1H, s, 3-OH), 5,05 (1H, d, J_{56} = 13,0, 5-H), 7,45 (1H, d, J_{65} = 13,0, 6-H), 1,42...1,81, 3,03...3,36 (10H, m, $N(CH_2)_5$)	88
XIII	101...102	1,23 (3H, s, 3-CH_3), 1,15 (3H, d, J = 7,1, 2-CH_3), 3,98 (1H, q, J = 7,1, 2-H), 3,88 (1H, s, 3-OH), 5,21 (1H, d, J_{56} = 13,0, 5-H), 7,38 (1H, d, J_{65} = 13,0, 6-H), 3,06...3,73 (8H, m, $N(CH_2CH_2OCH_2CH_2)$)	86
XIV	126...127	1,28 (3H, s, 3-CH_3), 1,18 (3H, d, J = 7,1, 2-CH_3), 4,00 (1H, q, J = 7,1, 2-H), 3,85 (1H, s, 3-OH), 5,18 (1H, d, J_{56} = 8,0, 5-H), 7,26 (1H, d, J_{65} = 8,0, 6-H), 2,15 (3H, s, $CH_3C_6H_4$), 6,85 (4H, q, C_6H_4), 11,48 (1H, d, J = 12,0, NH)	75
XV	43...44	1,35 (3H, s, 2-CH_3), 2,61 (2H, s, CH_2), 1,70...3,13, 2,83...3,76 (8H, m, $N(CH_2)_4$), 5,93 (1H, d, J_{45} = 13,0, 4-H), 7,56 (1H, d, J_{54} = 13,0, 5-H)	75
XVI	52...53	1,25 (3H, s, 2-CH_3), 2,55 (2H, s, CH_2), 1,40...1,50, 2,83...3,40 (10H, m, $N(CH_2)_5$), 4,96 (1H, d, J_{45} = 13,0, 4-H), 7,23 (1H, d, J_{54} = 13,0, 5-H)	72
XVII	117...118	1,28 (3H, s, 2-CH_3), 2,53 (2H, s, CH_2), 2,96...3,70 (8H, m, $N(C_2H_4OC_2H_4)$, 5,06 (1H, d, J_{45} = 13,0, 4-H), 7,26 (1H, d, J_{54} = 13,0, 5-H)	74
XVIII	71...72	1,25 (3H, s, 3-CH_3), 1,18 (3H, d, J = 6,5, $\underline{CH_3}CH$), 2,73 (1H, q, J = 6,5, $CH_3\underline{CH}$), 1,66...2,16, 2,90...3,60 (8H, m, $N(CH_2)_4$), 4,93 (1H, d, J_{56} = 13,0, 5-H), 7,53 (1H, d, J_{65} = 13,0, 6-H)	68
XIX	68...69	1,29 (3H, s, 3-CH_3), 1,23 (3H, d, J = 6,5, $\underline{CH_3}CH$), 2,83 (1H, q, J = 6,5, CH_3CH), 1,51...1,83, 2,06...3,52 (10H, m, $N(CH_2)_5$), 5,16 (1H, d, J_{56} = 13,0, 5-H), 7,36 (1H, d, J_{65} = 13,0, 6-H)	66
XX	62...63	1,30 (3H, s, 3-CH_3), 1,21 (3H, d, J = 6,5, $\underline{CH_3}CH$), 2,81 (1H, q, J = 6,5, $CH_3\underline{CH}$), 3,06...3,80 (8H, m, $N(C_2H_4OC_2H_4)$), 5,20 (1H, d, J_{56} = 13,0, 5-H), 7,36 (1H, d, J_{65} = 13,0, 6-H)	65

The epoxides are formed from the chlorohydrins on the condition that the hydroxyl group and the halogen are in the trans orientation, i.e., closure of the epoxide ring is accompanied by inversion of the configuration at the carbon atom attached to the halogen. The oxiranyl β-aminovinyl ketones (XVIII-XX) must therefore have the *pref* configuration at the chiral carbon atoms of the epoxide ring. This suggestion is confirmed by the following transformations. Oxiranyl β-aminovinyl ketone (XXI) and pyrrolidine gave the epoxyaminovinyl ketone, the physicochemical and spectral characteristics of which were identical with the characteristics of compound (XVIII). A mixed melting test with these compounds did not give a melting point depression.



These data show that the transformation of the oxiranyl β-dimethylaminovinyl ketone (XXI) into (XVIII) by path b takes place with double inversion of the configuration at the carbon atom, thereby confirming the *pref* configuration of the chiral centers in the 3(2H)-furanones (III, IV) and halogenohydrins (XI-XIV).

EXPERIMENTAL

The PMR spectra were recorded on a Tesla BS-467 spectrometer at 60 MHz in carbon tetrachloride with HMDS as internal standard. The IR spectra of 0.15 M solutions in carbon tetrachloride were recorded on an IR-75 spectrophotometer. The 3(2H)-furanones (I-IV) were obtained according to [2], while the oxiranyl β-aminovinyl ketone (XXI) was obtained according to [4]. The individuality of the obtained compounds was confirmed by TLC on Silufol UV-254 plates.

5-Amino-1-halogeno-2-hydroxy-2-methyl-4-penten-3-ones (V-X) and 6-Amino-1-halogeno-3-hydroxy-3-methyl-5-hexen-4-ones (XI-XIV). A solution of 0.01 mole of the 3(2H)-furanone (I-IV) and 0.01 mole of the respective amine in 5-10 ml of toluene was left overnight. The solvent was removed under vacuum and the residue was crystallized from a 1:1 mixture of hexane and ethyl acetate. The yields and the physicochemical constants of compounds (V-XIV) are given in Table 1.

Oxiranyl β-Aminovinyl Ketones (XV-XX). A solution of 0.01 mole of the halogenohydrin (V-X) in 10 ml of toluene was shaken for 30-45 min with 10 ml of a 10% aqueous solution of potassium hydroxide. The organic layer was separated, the residue was crystallized from a 2:1 mixture of hexane and ethyl acetate, and compounds (XV-XX) were obtained (Table 1).

trans,trans-4-Methyl-1-pyrrolidino-4,5-epoxy-1-hexen-3-one (XVIII). A solution of 0.01 mole of oxiranyl β-aminovinyl ketone (XXI) and 0.02 mole of pyrrolidine in 10 ml of isopropanol was kept at room temperature for 24 h. The

TABLE 2. The Elemental Analyses of Compounds (V-XX)

Compound	Molecular formula	Found % Calculated %				
		C	H	Cl	Br	N
V	$C_{10}H_{16}ClNO_2$	55,23 55,17	7,21 7,41	16,45 16,29	—	6,43 6,43
VI	$C_{10}H_{16}BrNO_2$	45,64 45,82	6,27 6,15	—	30,75 30,48	5,55 5,34
VII	$C_{11}H_{16}ClNO_2$	57,32 57,02	7,63 7,83	15,16 15,30	—	6,31 6,04
VIII	$C_{10}H_{16}ClNO_3$	51,35 51,40	6,74 6,90	15,26 15,17	—	6,22 5,99
IX	$C_{10}H_{16}BrNO_3$	43,29 43,18	5,94 5,80	—	28,91 27,73	5,30 5,04
X	$C_{13}H_{16}ClNO_2$	61,48 61,54	6,59 6,36	14,11 13,97	—	5,78 5,52
XI	$C_{11}H_{18}ClNO_2$	57,29 57,02	8,02 7,83	15,25 15,30	—	6,19 6,04
XII	$C_{12}H_{20}ClNO_2$	58,77 58,63	8,06 8,20	14,33 14,42	—	5,98 5,70
XIII	$C_{11}H_{18}ClNO_2$	53,54 53,33	7,51 7,32	14,22 14,31	—	5,91 5,65
XIV	$C_{14}H_{18}ClNO_2$	62,66 62,80	6,54 6,78	13,09 13,24	—	5,44 5,23
XV	$C_{10}H_{15}NO_2$	66,38 66,27	8,48 8,34	—	—	7,97 7,73
XVI	$C_{11}H_{17}NO_2$	67,87 67,66	8,66 8,78	—	—	7,35 7,17
XVII	$C_{10}H_{16}NO_2$	61,05 60,90	7,85 7,67	—	—	7,26 7,10
XVIII	$C_{11}H_{17}NO_2$	67,56 67,66	8,57 8,78	—	—	7,23 7,17
XIX	$C_{12}H_{19}NO_2$	69,08 68,87	9,20 9,15	—	—	6,93 6,69
XX	$C_{11}H_{17}NO_2$	62,29 62,54	8,04 8,11	—	—	6,90 6,63

solvent was removed at reduced pressure, and the residue was crystallized from a 1:3 mixture of isopropanol and hexane. The yield was 64%. The obtained compound was identical with the epoxyaminovinyl ketone (XVIII) (Table 1).

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