Chemistry of Heterocyclic Compounds, Vol. 43, No. 9, 2007

4-HYDROXY-2-QUINOLINONES 128.* BROMINATION OF N-ALLYL-4-HYDROXY-2-OXO-1,2-DIHYDRO-QUINOLINES AND PYRIDINES UNSUBSTITUTED IN POSITION 3

I. V. Ukrainets[1], N. L. Bereznyakova[1], A. V. Turov[2], and S. V. Slobodzian[3]

Bromination of N-allyl-4-hydroxy-2-oxo-1,2-dihydroquinoline and N-allyl-5-ethoxycarbonyl-4-hydroxy-6-methyl-2-oxo-1,2-dihydropyridine is accompanied not only by closing of a five membered oxazole ring but also by a second bromination of the 2-bromomethyl-5-oxo-1,2-dihydro-5H-oxazolo[3,2-a]-derivatives formed at position 4.

Keywords: oxazolo[3,2-*a*]pyridines, oxazolo[3,2-*a*]quinolines, bromination, heterocyclization, X-ray structural analysis.

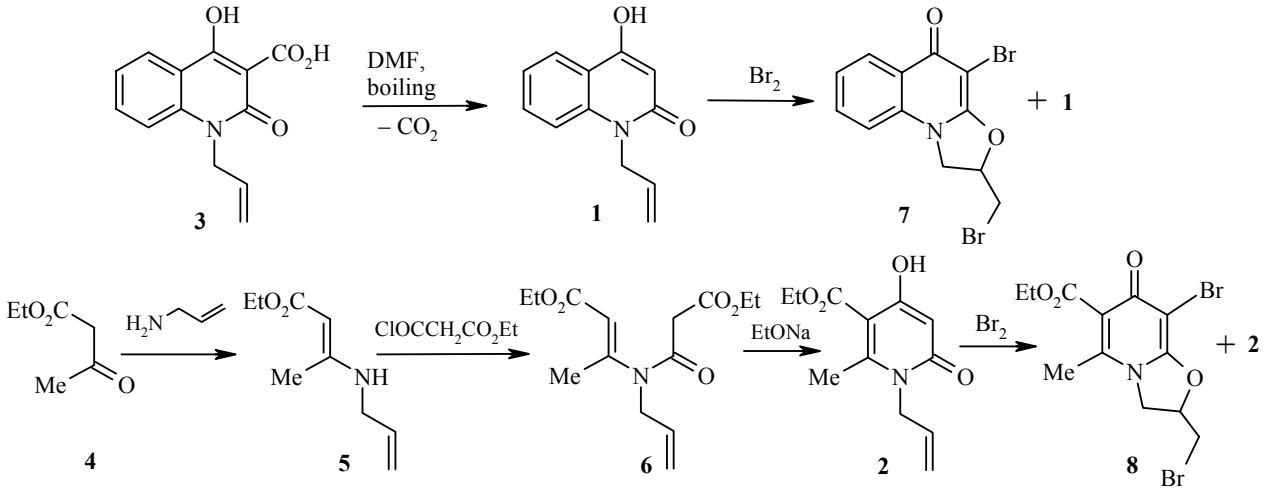
The treatment of N-allyl-4-hydroxy-2-oxo-1,2-dihydroquinoline-3-carboxylic acids, their esters, and analogs hydrogenated in the benzene part of the molecule with molecular bromine is a convenient and efficient method for preparing the corresponding 2-bromomethyl-5-oxo-1,2-dihydro-5H-oxazolo[3,2-*a*]quinolines [2, 3]. It would be logical for the 3H-derivatives to behave in the same way. However, as our experiments have shown, bromination of N-allyl-4-hydroxy-2-oxo-1,2-dihydroquinoline (**1**) and the structurally related N-allyl-5-ethoxycarbonyl-4-hydroxy-6-methyl-2-oxo-1,2-dihydropyridine (**2**) does not occur in this particular way although it is accompanied by closure of the five membered oxazole ring.

The 4-hydroxy-2-oxoquinoline **1** was prepared by decarboxylation of acid **3**. The synthesis of the 4-hydroxy-2-oxopyridine **2** involved formation of the pyridine ring in several stages starting from acetoacetic ester (**4**) and allylamine using a known scheme [4].

The N-allyl-substituted 3H-azaheterocycles **1** and **2** were apparently brominated without an anomaly, an introduced equimolar amount of bromine being decolorized almost instantaneously. In both cases, however, it was noted that they consist of two substances in the ratio 1:1 (^{1}H NMR spectroscopic data) which differ markedly in their solubility in organic solvents. After separation of the reaction mixture it was found that the compounds readily soluble in ether, against expectations, did not contain bromine in their structure and more detailed analysis showed them to be the starting N-allyl-substituted 3H-azaheterocycles **1** and **2**.

* For Communication 127 see [1].

[1]National University of Pharmacy, Kharkiv 61002, Ukraine; e-mail: uiv@kharkov.ua. [2]Taras Shevchenko National University, Kiev 01033, Ukraine; e-mail: nmrlab@univ.kiev.ua. [3]Ohio Northern University, Ada 45810, Ohio, USA; e-mail: s-slobodzian@onu.edu. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 9, pp. 1365-1373, September, 2007. Original article submitted May 18, 2006.



Bromine was found in the materials insoluble in ether. The results of the investigation of their structures by NMR showed that a five membered oxazole ring had closed upon bromination. Along with this, however, the unusual feature noted was the absence of singlet signals for the H-4 protons in the ^{1}H NMR spectra.

Scheme 1

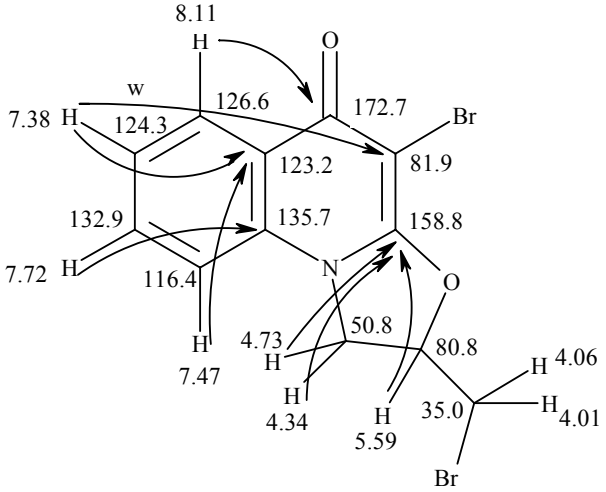


TABLE 1. Full Correlation List for the Oxazoloquinolone **7**

Bond	*l*, Å	Bond	*l*, Å	Bond	*l*, Å
$N_{(1A)}$–$C_{(1A)}$	1.394(3)	$C_{(1B)}$–$C_{(6B)}$	1.402(3)	$C_{(8A)}$–$C_{(10A)}$	1.468(3)
$N_{(1A)}$–$C_{(13A)}$	1.466(3)	$C_{(2B)}$–$C_{(3B)}$	1.381(3)	$C_{(13A)}$–$C_{(14A)}$	1.515(3)
$O_{(2A)}$–$C_{(7A)}$	1.330(3)	$C_{(4B)}$–$C_{(5B)}$	1.371(3)	$N_{(1B)}$–$C_{(9B)}$	1.405(3)
$O_{(4A)}$–$C_{(10A)}$	1.315(3)	$C_{(6B)}$–$C_{(7B)}$	1.429(3)	$O_{(1B)}$–$C_{(9B)}$	1.221(3)
$C_{(1A)}$–$C_{(6A)}$	1.393(3)	$C_{(8B)}$–$C_{(9B)}$	1.467(3)	$O_{(3B)}$–$C_{(10B)}$	1.234(3)
$C_{(2A)}$–$C_{(3A)}$	1.370(3)	$C_{(11B)}$–$C_{(12B)}$	1.499(3)	$O_{(4B)}$–$C_{(11B)}$	1.457(3)
$C_{(4A)}$–$C_{(5A)}$	1.373(3)	$N_{(1A)}$–$C_{(9A)}$	1.407(3)	$C_{(1B)}$–$C_{(2B)}$	1.408(3)
$C_{(6A)}$–$C_{(7A)}$	1.434(3)	$O_{(1A)}$–$C_{(9A)}$	1.227(2)	$C_{(3B)}$–$C_{(4B)}$	1.379(4)
$C_{(8A)}$–$C_{(9A)}$	1.456(3)	$O_{(3A)}$–$C_{(10A)}$	1.236(3)	$C_{(5B)}$–$C_{(6B)}$	1.408(3)
$C_{(11A)}$–$C_{(12A)}$	1.496(3)	$O_{(4A)}$–$C_{(11A)}$	1.459(3)	$C_{(7B)}$–$C_{(8B)}$	1.378(3)
$N_{(1B)}$–$C_{(1B)}$	1.391(3)	$C_{(1A)}$–$C_{(2A)}$	1.408(3)	$C_{(8B)}$–$C_{(10B)}$	1.470(3)
$N_{(1B)}$–$C_{(13B)}$	1.466(3)	$C_{(3A)}$–$C_{(4A)}$	1.378(4)	$C_{(13B)}$–$C_{(14B)}$	1.514(3)
$O_{(2B)}$–$C_{(7B)}$	1.333(3)	$C_{(5A)}$–$C_{(6A)}$	1.402(3)		
$O_{(4B)}$–$C_{(10B)}$	1.321(3)	$C_{(7A)}$–$C_{(8A)}$	1.383(3)		

^{13}C NMR spectra and heteronuclear ^{13}C–^{1}H correlations were carried out to establish the structure of the reaction products. Analysis of the carbon signals showed that they have the expected number of carbon atoms. However, one of these had an unexpected chemical shift of 81.9 ppm for compound **7** and 87.2 ppm for compound **8**. Measurement of the DEPT spectra showed that two methyl, three methylene groups and one methine proton were present in the molecule **8**. Hence it was found that a quaternary carbon atom with chemical shift of 87.2 ppm is present instead of that with an aromatic proton at position 4. In addition heteronuclear correlation experiments involving one chemical bond (HMQC) and 2-3 chemical bonds (HMBC) were carried out which allowed a full assignment of all of the carbon atom signals.

Scheme 1 shows the assignments of the ^{1}H and ^{13}C signals for the oxazoloquinolone **7**. The spin connections in the proton multiplets were determined from COSY-90 spectra. Assignment of the protonated carbon atoms was made on the basis of the correlation through one bond in the HMQC spectrum, The arrows indicate the important correlations in the HMBC spectra which served as the basis for assigning the quaternary carbon atoms.

As is evident from the scheme presented the assignment of all of the quaternary carbon atoms can be made on the basis of the correlation in the HMBC spectrum. Thus the carbonyl $C_{(5)}$ atom of the quinolone fragment correlates with proton H-6 absorbing at 8.11 ppm. The bridging atoms $C_{(5a)}$ and $C_{(9a)}$ can be assigned on the basis of the correlations with H-7 and H-8 respectively. The $C_{(3a)}$ signal correlates with the signals of all of the protons of the oxazolidine ring. Finally, the $C_{(4)}$ atom absorbing at 81.9 ppm and bearing the bromine atom in our proposal has a weak correlation through 5 bonds with the H-7 proton (ω-interaction). All of the heteronuclear correlations found for the oxazoloquinolone **7** are given in Table 1.

Scheme 2

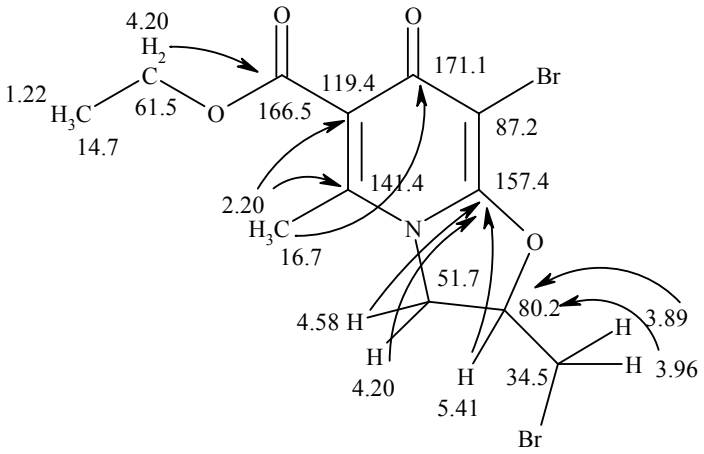


TABLE 2. Full Correlation List for the Oxazolopyridone **8**

δ, ppm	HMQC	HMBC
5.41	80.2	34.5; 157.4
4.58	51.7	157.4; 80.2; 34.5
4.20	61.5; 51.7	157.4; 166.5; 80.2; 34.5; 14.7
3.89; 3.96	34.5	80.2; 51.7
2.20	16.7	141.4; 119.4; 171.1
1.22	14.7	61.5

Analysis of the 2D heteronuclear ^{13}C–^{1}H correlated spectra for the oxazolopyridone **8** showed that the majority have the correlations recorded for compound **7**. This indicated the closely analogous structures of the compounds studied. Assignment of the signals in the proton and carbon spectra was carried out similarly. The HMBC chemical shift values and correlations which served as the basis for assigning the quaternary carbon atoms are given in Scheme 2.

Hence the signal for the carbonyl carbon atom of the ethoxycarbonyl group was assigned from its correlation with the methylene protons at 4.20 ppm. The signal for the 7-CH_3 methyl group protons has a correlation with the signals for the carbon atoms at 141.4 and 119.4 ppm. This allowed us to assign these signals to $C_{(7)}$ and $C_{(6)}$ respectively. The presence of a weak, ω-type correlation between the 7-CH_3 signal and that at 171.1 ppm led us to assign this signal to the carbonyl $C_{(5)}$ atom. The $C_{(3a)}$ signal was assigned from the presence of a correlation with all of the oxazolidine ring protons. The full list of the heteronuclear correlations for the oxazolopyridone **8** is given in Table 2.

From the overall NMR data we came to the conclusion that the bromination products of the N-allyl-substituted 3H-azaheterocycles **1** and **2** are the 4-bromo-2-bromomethyl-1,2-dihydrooxazolo[3,2-*a*]-quinolin-5-one (**5**) and 4-bromo-2-bromomethyl-6-ethoxycarbonyl-7-methyl-1,2-dihydrooxazolo[3,2-*a*]pyridin-5-one (**8**) respectively. This was confirmed by their chromato mass spectra, distinguishing features of which for dibromo-substituted compound [5] are the triplet peaks for the molecular ions in the intensity ratio 1:2:1.

A conclusive argument for the proposed structures was the X-ray structural investigation of one of these, the dibromo-substituted oxazoloquinolone **7** (Fig. 1).

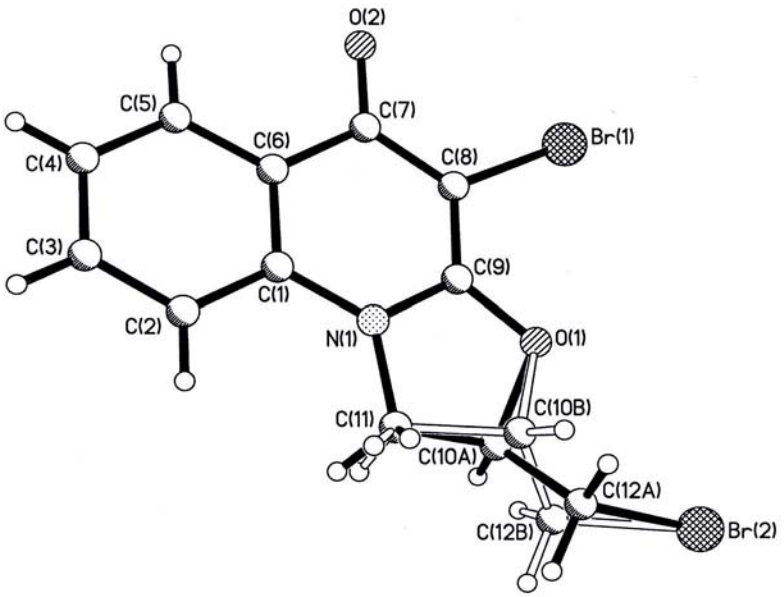
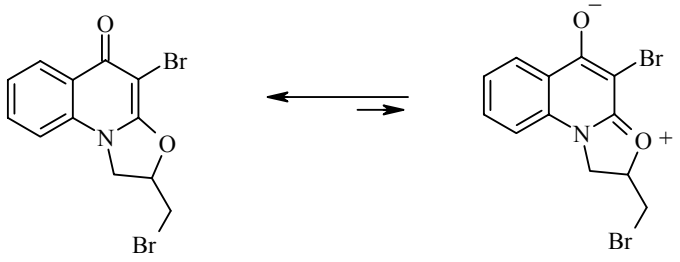


Fig. 1. Structure of the dibromo-substituted oxazoloquinolone **7** with atomic numbering.

It was found that the quinoline fragment and the $O_{(2)}$, $Br_{(1)}$, $O_{(1)}$, and $C_{(11)}$ atoms lie in a single plane to an accuracy of 0.02 Å. The $O_{(2)}$–$C_{(7)}$ 1.242(6) and $C_{(8)}$–$C_{(9)}$ 1.361(6) Å bonds are lengthened when compared with their mean values [6] of 1.210 and 1.326 Å respectively and the $C_{(7)}$–$C_{(8)}$ 1.405(7) and $C_{(9)}$–$O_{(1)}$ 1.319(6) are shortened (mean values 1.455 and 1.354 Å). This change in bond lengths suggest that the structure of the molecule examined is a superposition of two resonance structures, the 5-oxo form **7** predominating.

The five-membered heterocycle is randomized in two envelope conformations (**A** and **B**) in the ratio 45: 55%. The $C_{(10)}$ atom deviates from the mean plane of the remaining ring atoms in conformer **A** by -0.42 and in conformed **B** by 0.30 Å. The bromomethyl has a pseudoequatorial orientation in both conformers (torsional angle $N_{(1)}$–$C_{(11)}$–$C_{(10)}$–$C_{(12)}$ 135(1) in **A** and -133.0(8)º in **B**). The bromine atom is not randomized and is found in an *ap*-conformation relative to $C_{(11)}$–$C_{(10)}$ bond in both conformers (torsional angle $C_{(11)}$–$C_{(10)}$–$C_{(12)}$–$Br_{(2)}$ 177.7(8) in **A** and -176.3(6)º in **B**). A shortened intramolecular contact $H_{(2)}\cdots C_{(11)}$ of 2.69 Å is observed in the tricyclic fragment (sum of van der Waal radii 2.87 Å [7]).



7 **7a**

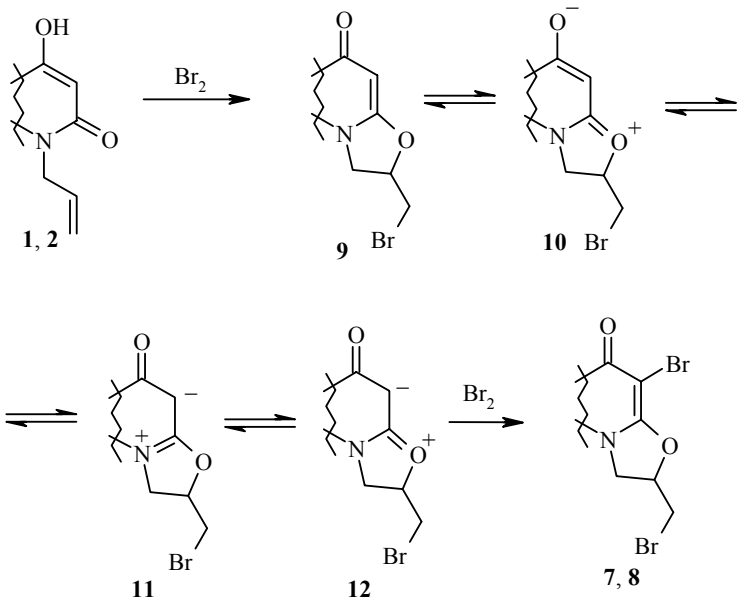
The shortened intermolecular contacts found between the oxazoloquinolone molecules **7** in the crystal are: $H_{(2)}\cdots C_{(12a')}$ (-1-*x*, -1-*y*, -0.5+*z*) 2.78 (2.87), $H_{(3)}\cdots Br_{(1')}$ (-0.5-*x*, 1+*y*, -0.5+*z*) 3.02 (3.23), $H_{(10a)}\cdots Br_{(1')}$ (-0.5-*x*, *y*, -0.5+*z*) 2.84 (3.23), $H_{(10b)}\cdots Br_{(1')}$ (-0.5-*x*, y, 0.5+*z*) 3.14 (3.23), $Br_{(1)}\cdots H_{(12b')}$ (-0.5-*x*, *y*, -0.5+*z*) 3.01 (3.23), $Br_{(1)}\cdots H_{(12c')}$ (-0.5-*x*, *y*, 0.5+*z*) 3.11 (3.23), and $Br_{(2)}\cdots H_{(12c')}$ (-1-*x*, -2-*y*, 0.5+*z*) 3.18 Å (3.23 Å).

Hence the bromination by an equimolar amount of molecular bromine of the N-allyl-4-hydroxy-2-oxo-1,2-dihydroquinoline (**1**) and N-allyl-5-ethoxycarbonyl-4-hydroxy-6-methyl-2-oxo-1,2-dihydropyridine (2) which are unsubstituted in position 3 gives the corresponding 4-bromo-2-bromomethyl-1,2-dihydrooxazolo[3,2-*a*]-hetaryl-5-ones **7** and **8**. Moreover, half of the starting N-allyl derivatives do not take part in the reaction.

It follows from this that the initially formed 4H-2-bromomethyloxazoles **9** immediately undergo a second bromination, the rate of this process being significantly greater than the rate of bromination of the N-allyl heterocycles **1** or **2**. The reason for this effect is undoubtedly due to structural features of the oxazolopyridones of general formula **9**. Because in the resonance hybrid of the final dibromo-substituted oxazoloquinolone **7** the form **7a** makes a marked contribution a second bromination of the intermediate 4H-2-bromomethyloxazoles **9** in the analogous bipolar form **10** seems very likely. The high nucleophilicity of the $C_{(4)}$ atom in such compounds is evidently linked with the fact that it simultaneously behaves as enamine and vinyl ether, as a result of which the corresponding mesomeric forms **11** or **12** can be brominated considerably faster than the OH forms **1, 2** (analogous to phenols and phenoxide ions [8]).

TABLE 3. Bond Lengths (*l*) in the Dibromo-substituted Oxazoloquinolone **7**

Bond	*l*, Å	Bond	*l*, Å	Bond	*l*, Å
$Br_{(1)}$–$C_{(8)}$	1.879(5)	$C_{(6)}$–$C_{(7)}$	1.472(7)	$O_{(2)}$–$C_{(7)}$	1.242(6)
$Br_{(2)}$–$C_{(12A)}$	1.99(1)	$C_{(8)}$–$C_{(9)}$	1.361(6)	$C_{(1)}$–$C_{(2)}$	1.400(7)
$N_{(1)}$–$C_{(1)}$	1.383(6)	$C_{(11)}$–$C_{(10B)}$	1.55(1)	$C_{(3)}$–$C_{(4)}$	1.361(9)
$O_{(1)}$–$C_{(9)}$	1.319(6)	$C_{(10B)}$–$C_{(12B)}$	1.48(2)	$C_{(5)}$–$C_{(6)}$	1.396(8)
$O_{(1)}$–$C_{(10B)}$	1.50(1)	$Br_{(2)}$–$C_{(12B)}$	1.90(1)	$C_{(7)}$–$C_{(8)}$	1.405(7)
$C_{(1)}$–$C_{(6)}$	1.398(7)	$N_{(1)}$–$C_{(9)}$	1.358(6)	$C_{(11)}$–$C_{(10A)}$	1.54(2)
$C_{(2)}$–$C_{(3)}$	1.362(8)	$N_{(1)}$–$C_{(11)}$	1.454(6)	$C_{(10A)}$–$C_{(12A)}$	1.48(2)
$C_{(4)}$–$C_{(5)}$	1.359(8)	$O_{(1)}$–$C_{(10A)}$	1.49(2)		



In conclusion and based on the results of this investigation it should be stressed that the bromination of 1-N-allyl-substituted 3H-4-hydroxy-2-oxoazaheterocycles should be carried out with a two fold amount of molecular bromine in order to avoid the formation of reaction mixtures.

EXPERIMENTAL

The ^{1}H and ^{13}C NMR spectra of the dibromo-substituted oxazoloheterocycles **7** and **8**, 2D COSY spectra, and the heteronuclear HMQC and HMBC correlations were recorded on a Varian Mercury-400 (400 and 100 MHz respectively). All of the 2D experiments were carried out with gradient selection of useful signals. The

TABLE 4. Valence Angles (ω) in the Dibromo-substituted Oxazoloquinolone **7**

Angle	ω, deg	Angle	ω, deg
$C_{(12B)}$–$Br_{(2)}$–$C_{(12A)}$	30.8(5)	$C_{(9)}$–$N_{(1)}$–$C_{(1)}$	121.9(4)
$C_{(9)}$–$N_{(1)}$–$C_{(11)}$	110.9(4)	$C_{(1)}$–$N_{(1)}$–$C_{(11)}$	127.2(4)
$C_{(9)}$–$O_{(1)}$–$C_{(10A)}$	107.6(7)	$C_{(9)}$–$O_{(1)}$–$C_{(10B)}$	109.2(6)
$N_{(1)}$–$C_{(1)}$–$C_{(6)}$	118.7(5)	$N_{(1)}$–$C_{(1)}$–$C_{(2)}$	121.5(4)
$C_{(6)}$–$C_{(1)}$–$C_{(2)}$	119.8(5)	$C_{(3)}$–$C_{(2)}$–$C_{(1)}$	120.2(5)
$C_{(4)}$–$C_{(3)}$–$C_{(2)}$	120.3(6)	$C_{(5)}$–$C_{(4)}$–$C_{(3)}$	120.7(6)
$C_{(4)}$–$C_{(5)}$–$C_{(6)}$	121.4(5)	$C_{(5)}$–$C_{(6)}$–$C_{(1)}$	117.6(5)
$C_{(5)}$–$C_{(6)}$–$C_{(7)}$	122.3(5)	$C_{(1)}$–$C_{(6)}$–$C_{(7)}$	120.1(5)
$O_{(2)}$–$C_{(7)}$–$C_{(8)}$	123.1(5)	$O_{(2)}$–$C_{(7)}$–$C_{(6)}$	120.5(5)
$C_{(8)}$–$C_{(7)}$–$C_{(6)}$	116.4(4)	$C_{(9)}$–$C_{(8)}$–$C_{(7)}$	121.3(5)
$C_{(9)}$–$C_{(8)}$–$Br_{(1)}$	118.0(4)	$C_{(7)}$–$C_{(8)}$–$Br_{(1)}$	120.7(3)
$O_{(1)}$–$C_{(9)}$–$N_{(1)}$	111.6(4)	$O_{(1)}$–$C_{(9)}$–$C_{(8)}$	126.8(5)
$N_{(1)}$–$C_{(9)}$–$C_{(8)}$	121.5(5)	$N_{(1)}$–$C_{(11)}$–$C_{(10A)}$	101.2(7)
$N_{(1)}$–$C_{(11)}$–$C_{(10B)}$	102.0(6)	$C_{(12A)}$–$C_{(10A)}$–$O_{(1)}$	107(1)
$C_{(12A)}$–$C_{(10A)}$–$C_{(11)}$	110(1)	$O_{(1)}$–$C_{(10A)}$–$C_{(11)}$	103(1)
$C_{(10A)}$–$C_{(12A)}$–$Br_{(2)}$	110.1(9)	$C_{(12B)}$–$C_{(10B)}$–$O_{(1)}$	106.0(8)
$C_{(12B)}$–$C_{(10B)}$–$C_{(11)}$	114(1)	$O_{(1)}$–$C_{(10B)}$–$C_{(11)}$	101.9(7)
$C_{(10B)}$–$C_{(12B)}$–$Br_{(2)}$	113.2(8)		

mixing times in the pulse sequences were respectively $^{1}J_{CH}$ = 140 and $^{2\text{-}3}J_{CH}$ = 8 Hz. The number of increments in the COSY and HMQC experiments were 128 and 400 respectively. The ^{1}H NMR spectra of the starting N-allyl derivatives **1** and **2** were taken on a Varian Mercury-VX-200 instrument (200 MHz). In all of the experiments DMSO-d_6 was used as solvent and TMS as internal standard. Chromato-mass spectra of the dibromo-substituted **7** and **8** were recorded on an Agilent 1100 LC/MSD spectrometer using the APCI ionization method (atmospheric pressure chemical ionization). The chromatographic column parameters were: length 50 mm, diameter 4.6 mm, stationary phase ZORBAX Eclipse XDB-C18, solvent aqueous acetonitrile, acidifier 0.1% trifluoroacetic acid, gradient elution, and solvent flow rate 2.4 ml/min.

1-Allyl-4-hydroxy-2-oxo-1,2-dihydroquinoline (1). A solution of 1-allyl-4-hydroxy-2-oxo-1,2-dihydroquinoline-3-carboxylic acid (**3**, [2]) (2.45 g, 0.01 mol) in DMF (15 ml) was refluxed for 10 min, cooled, and diluted with cold water. The precipitated derivative **1** was filtered off, washed with water, and dried. Yield 1.87 g (93%); mp 224-226ºC (ethanol). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 11.42 (1H, s, OH); 7.88 (1H, dd, *J* = 7.9, 1.4, H-5); 7.56 (1H, td, *J* = 7.7, 1.7, H-7); 7.35 (1H, d, *J* = 8.4, H-8); 7.19 (1H, t, *J* = 7.3, H-6); 5.88 (1H, s, H-3); 5.83 (1H, m, C<u>H</u>=CH$_2$); 5.07 (1H, dd, *J* = 10.3, 1.4, NCH$_2$CH=C<u>H</u>-*cis*); 4.89 (1H, dd, *J* = 17.4, 1.4, NCH$_2$CH=C<u>H</u>-*trans*); 4.80 (2H, d, *J* = 4.7, NCH$_2$). Found, %: C 71.72; H 5.64; N 6.88. $C_{12}H_{11}NO_2$. Calculated, %: C 71.63, 5.51; N 6.96.

Ethyl 1-Allyl-4-hydroxy-6-methyl-2-oxo-1,2-dihydropyridine-5-carboxylate (2). Allylamine (11.3 ml, 0.15 mol) was added to acetoacetic ester (12.7 ml, 0.1 mol) and left for 3 days with periodic stirring at room temperature. Hexane (50 ml) was added, thoroughly stirred, the water separated in the reaction process was removed, and the allylamine and solvent were removed *in vacuo*. The residue of ethyl N-allylaminocrotonate **5** was dissolved in CH_2Cl_2 (200 ml). Triethylamine (15.4 ml, 0.11 mol) was added and then ethoxymalonyl chloride (16.6 g, 0.11 mol) dropwise with vigorous stirring and the product was allowed to stand at room temperature for 4-5 h. It was then diluted with water and the organic layer was separated and dried using anhydrous $CaCl_2$. Solvent was removed *in vacuo*. A solution of sodium ethylate [prepared from metallic sodium (2.3 g, 0.1 mol) and absolute ethanol (100 ml)] was added to the residue of diester **6**, refluxed for 1 h, and the alcohol distilled off. The product was cooled, diluted with water, and acidified with dilute HCl (1:1) to pH 4-4.5. The precipitate of ester **2** was filtered, washed with water, and dried. Yield 18.9 g (80%); mp 121-123ºC (aqueous ethanol). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 10.99 (1H, s, OH); 5.85 (1H, m, C<u>H</u>=CH$_2$); 5.59 (1H, s, H-3); 5.09 (1H, dd, *J* = 10.5, 1.5, NCH$_2$CH=C<u>H</u>-*cis*); 4.85 (1H, dd, *J* = 17.2, 1.5, NCH$_2$CH=C<u>H</u>-*trans*); 4.57 (2H, d, *J* = 4.8, NCH$_2$); 4.20 (2H, q, *J* = 7.0, OCH$_2$); 2.24 (3H, s, 6-CH$_3$); 1.22 (3H, t, *J* = 7.0, OCH$_2$C<u>H</u>$_3$). Found, %: C 60.61; H 6.26; N 5.81. $C_{12}H_{15}NO_4$. Calculated, %: C 60.75; H 6.37; N 5.90.

4-Bromo-2-bromomethyl-1,2-dihydrooxazolo[3,2-a]quinolin-5-one (7). Bromine (1.04 ml, 0.02 mol) was added with stirring to a solution of compound **1** (2.01 g, 0.01 mol) in acetic acid (20 ml) and it immediately decolorized. The reaction mixture was diluted with cold water. The precipitate formed was filtered off, washed with water, and dried. Yield 3.41 g (95%); mp 218-220ºC (ethanol). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 8.11 (1H, d, *J* = 7.9, H-6); 7.72 (1H, t, *J* = 7.4, H-8); 7.47 (1H, d, *J* = 8.1, H-9); 7.38 (1H, t, *J* = 7.4, H-7); 5.59 (1H, m, CHO); 4.73 (1H, t, *J* = 9.5, NCH); 4.34 (1H, dd, J = 8.7, 6.6, NCH); 4.06 (1H, dd, *J* = 11.2, 4.3, CHBr); 4.01 (1H, dd, *J* = 11.2, 3.5, CHBr). ^{13}C NMR spectrum, δ, ppm: 172.7 (C=O), 158.8 (C_{3a}), 135.7 (C_{9a}), 132.9 ($C_{(8)}$), 126.6 ($C_{(6)}$), 124.3 ($C_{(7)}$), 123.2 ($C_{(5a)}$), 116.4 ($C_{(9)}$), 81.9 ($C_{(4)}$), 80.8 (CHO), 50.8 (NCH$_2$), 35.0 (CH$_2$Br). Mass spectrum, *m/z* (I_{rel}, %): 358 $[M+H]^+$ (100), value only given for the ^{79}Br isotope. Found, %: C 40.24; H 2.47; N 3.83. $C_{12}H_9Br_2NO_2$. Calculated, %: C 40.15; H 2.53; N 3.90.

X-ray Structural Investigation. Crystals of the dibromo-substituted oxazoloquinolone **7** are rhombic, at 20ºC: *a* = 16.929(3), *b* = 9.252(2), *c* = 7.538(1) Å, *V* = 1180.6(4) Å^3, M_r = 359.02, *Z* = 4, space group *P*ca2$_1$, d_{calc} = 2.020 g/cm^3, μ(MoKα) = 6.853 mm^{-1}, *F*(000) = 696. The unit cell parameters and intensities of 12,601 reflections (3,288 independent, R_{int} = 0.089) were measured on an Xcalibur-3, four circle automatic diffractometer (MoKα radiation, CCD detector, graphite monochromator, ω-scanning, $2\theta_{max}$ =60º). Absorption was included analytically (T_{min} = 0.400, T_{max} = 0.933).

The structure was solved by a direct method using the SHELXTL [9] program package. The positions of the hydrogen atoms were calculated geometrically and refined using the "riding" model with $U_{iso} = 1.2 \times U_{eq}$ for a non-hydrogen atom bound with the given hydrogen. The structure was refined by F^2 full matrix least squares analysis in the anisotropic approximation for non-hydrogen atoms to $wR_2 = 0.095$ for 3261 reflections ($R_1 = 0.047$ for 2086 reflections with $F>4\sigma(F)$, $S = 0.975$). The complete crystallographic data have been placed in the Cambridge structural data base, reference CCDC 608698. The interatomic distances and valence angles are given in Tables 3 and 4.

4-Bromo-2-bromomethyl-6-ethoxycarbonyl-7-methyl-1,2-dihdrooxazolo[3,2-a]pyridin-5-one (8) was prepared similarly to oxazoloquinolone **7** from the ethyl ester **2**. Yield 3.63 g (92%); mp 167-169ºC (ethanol). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 5.41 (1H, m, CHO); 4.58 (1H, t, *J* = 9.4, NCH); 4.20 (3H, m, NCH + $COOCH_2$); 3.96 (1H, dd, *J* = 11.4, 5.6, CHBr); 3.89 (1H, dd, *J* = 11.4, 4.5, CHBr); 2.20 (3H, s, 7-CH_3); 1.22 (3H, t, *J* = 7.5, $COOCH_2C\underline{H}_3$). ^{13}C NMR spectrum, δ, ppm: 171.1 (C=O), 166.5 (COO), 157.4 ($C_{(3a)}$), 141.4 ($C_{(7)}$), 119.4 ($C_{(6)}$), 87.2 ($C_{(4)}$), 80.2 (CHO), 61.5 (OCH_2), 51.7 (NCH_2), 34.5 (CH_2Br), 16.7 (7-CH_3), 14.7 ($CH_2C\underline{H}_3$). Mass spectrum, *m/z* (I_{rel}, %): 394 $[M+H]^+$ (100), value only given for the ^{79}Br isotope. Found, %: C 36.37; H 3.40; N 3.63. $C_{12}H_{13}Br_2NO_4$. Calculated, %: C 36.48; H 3.32; N 3.55.

REFERENCES

1. I. V. Ukrainets, N. L. Bereznyakova, and S. V. Shishkina, *Khim. Geterotsikl. Soedin.*, 1359 (2007). [*Chem. Heterocycl. Comp.*, **43**, 1154 (2007)].
2. I. V.Ukrainets, L. V. Sidorenko, O. V. Gorokhova, S. V. Shishkina, and A. V. Turov, *Khim. Geterotsikl. Soedin.*, 736 (2007). [*Chem. Heterocycl. Comp.*, **43**, 617 (2007)].
3. I. V. Ukrainets, N. L. Bereznyakova, O. V. Gorokhova, A. V. Turov, and S. V. Shishkina, *Khim. Geterotsikl. Soedin.*, 1180 (2007). [*Chem. Heterocycl. Comp.*, **43**, 1001 (2007)].
4. I. V. Ukrainets, L. V. Sidorenko, O. V. Gorokhova, and O. V. Shishkina, *Khim. Geterotsikl. Soedin.*, 217 (2006). [*Chem. Heterocycl. Comp.*, **42**, 191 (2006)].
5. P. B. Terentiev and A. P. Stankevicius, *Mass Spectrometric Analysis of Biologically Active Nitrogen Compounds* [in Russian], Mokslas, Vilnius (1987), p. 255.
6. H. –B. Burgi and J. D. Dunitz, *Structure Correlation*, Vol. 2, Weinheim (1994), p. 741.
7. Yu. V. Zefirov, *Krystallografiya*, **42**, 936 (1997).
8. P. Sykes, *A Guidebok to Mechanisms in Organic Chemistry* [Russian translation], Khimiya, Moscow (1991).
9. G. M. Sheldrick, *SHELXTL PLUS. PC Version. A System of Computer Programs for the Determination of Crystal Structure from X-Ray Diffraction Data*, Rev. 5.1 (1998).