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SALTS OF ALKYL-SUBSTITUTED 3,4-DIHYDROISOQUINOLINES WITH 2-ACETYLCYCLOPENTANE-1,3-DIONE

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Reactions of alkyl-substituted 3,4-dihydroisoquinolines with 2-acetylcyclopentane-1,3-dione were used to prepare 3,4-dihydroisoquinolinium 2-acetylcyclopentane-1,3-dionates, which could not be converted into ABCD-tetracyclic derivatives of the 8-azagonane series (benzo[a]cyclopentano[f]quinolizines). The salts obtained were studied and characterized by physicochemical methods. It was shown by combining the NMR and H/D-isotope exchange methods that for 1-alkyl-3,4-dihydroisoquinolines and their salts in solutions, an imine-enamine (iminium-enaminium), and for the 2-acetylcyclopentane-1,3-dione anion, a keto-enol tautomeric equilibrium takes place.

Salts of 3,4-dihydroisoquinolines and β diketones were first postulated as key intermediates of the synthesis, described in 1966, of condensed quinolizines and related compounds [1]. An experimental confirmation was obtained in a study that extended this reaction to β,β'-triketones [2], with the example of the partially characterized salt of 3,4-dihydroisoquinoline with 2-acetylcyclopentane-1,3-dione. In later studies [3, 4], attempts to prepare similar salts with 2-acylcyclohexane-1,3-diones were unsuccessful. In view of the fact that the reaction of annelation of cyclic Schiff bases by β-di- and β,β-tricarbonyl compounds has now assumed the importance of a general synthetic method for building polycyclic skeletons of condensed azines [1-8], and since its mechanism still remains largely obscure, it was desirable to prepare a series of such salts for the purpose of studying their physicochemical properties in greater detail.

In the present work, while studying the annelation of alkyl-substituted 3,4-dihydroisoquinolines (Ia-d) by 2-acetylcyclopentane-1,3-dione (II) for the purpose of obtaining $C_{(9)}$ angularly substituted 8-azagonane derivatives as potential immunodepressants [9, 10], we observed that the reaction stops with the formation of salts IIIa-d.

The experiments showed that the optimal conditions for obtaining the salts III are: (A) boiling or keeping at room temperature alcohol or ether-alcohol solutions of the reactants, followed by separation of the salt formed by filtering or its precipitation with a large excess of ether; (B) combining ether solutions of the reactants with vigorous, prolonged agitation followed by separation of salt III by filtering.

The salts obtained are colorless (IIIa, b) or lightly cream-colored (IIIc, d) crystalline substances with precise melting points. They are insoluble in nonpolar organic solvents (hexane, petroleum ether, ether, carbon tetrachloride), are moderately soluble in alcohols, lightly soluble in many polar organic solvents (chloroform, DMFA, DMSO), and, like typical salts, highly soluble in water. In the absence of illumination and in the absence of air, these salts are stable in storage (for more than a year). Their solutions in water are also stored for up to 6 months without any visible changes. When heated to melting, they darken and resinify, especially rapidly in contact with air. Prolonged heating of solutions of salts III in organic solvents or in water in an inert atmosphere results in their gradual darkening. In the absence of an inert atmosphere, this process accelerates, indirectly indicating the predominant role of oxidative mechanisms of decomposition of the salts in question. Let us note that all attempts (ranging from changing the reaction temperature from 20 to 160...180°C to changing the polar and acid-base properties of the reaction medium) at converting the salts obtained to ABCD-tetracyclic 8-azagonane derivatives (IV) were unsuccessful. This result, combined with known data on annelation of alkyl-substituted 3,4-dihydroisoquinolines by 2-acylcyclo-

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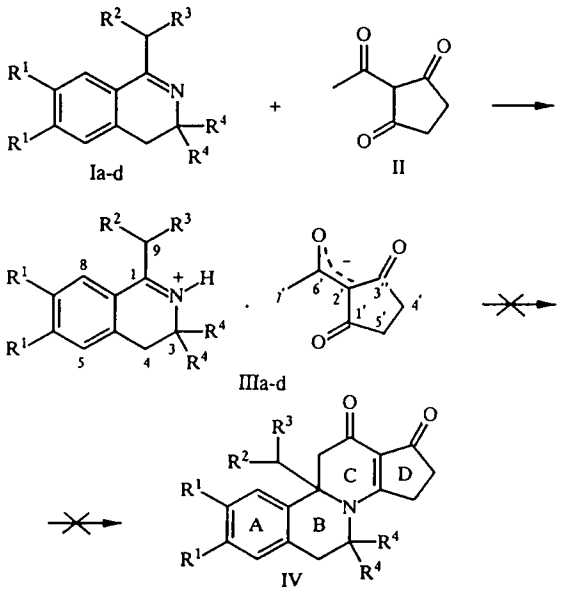


I, III a $R^1 = R^2 = R^3 = R^4 = H$; b $R^1 = R^3 = R^4 = H$, $R^2 = Me$
c $R^1 = OMe$, $R^2 = R^3 = Me$, $R^4 = H$; d $R^1 = R^2 = R^3 = H$, $R^4 = Me$

alkane-1,3-diones [2, 8, 10-13], indicates a decisive role of steric factors in this reaction. At the same time, the salts obtained permit a more detailed study of some of the most minute and concealed details of the behavior of the reacting substrates.

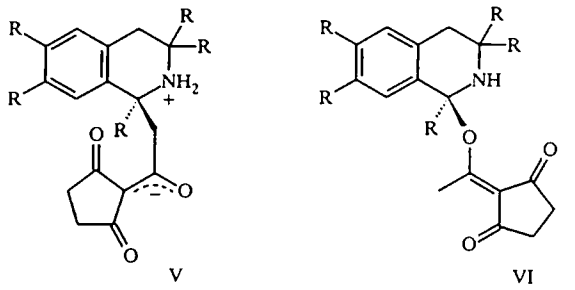
The structure of the salts obtained, IIIa-d, confirms the data of the ultimate analysis and spectral methods of investigation presented in Tables 1-3.

The electronic absorption spectra of salts IIIa-d are characterized by three absorption bands at 207...210, ~247, and 267...270 nm, and in the case of salts IIIc, two additional long-wavelength bands at 303 nm and 355 nm, caused by the chromophoric system of 6,7-dimethoxy-3,4-dihydroisoquinolinium ion (Table 2), are also observed. The shortest-wavelength absorption bands of salts IIIa-d, based on a comparison with the electronic spectra of the corresponding isoquinolines and their acetates, were assigned to the chromophoric systems of 3,4-dihydroisoquinolinium ions, and the band at 267...270 nm was assigned to the absorption of 2-acetylcyclopentanedione anion. It should be noted that the absorption bands are markedly broadened and weakly resolved, indicating their complex composite nature.

The vibrational spectra of salts IIIa-d show a very characteristic set of bands in the range 1700...1400 cm^{-1}, of which the band at 1660 cm^{-1} should be assigned to the anion of cyclopentanedione II. The bands at 1630...1590, 1560, and 1450...1400 cm^{-1} are markedly broadened, indicating their composite nature and complicating their correct assignment at this stage of investigation. Typical of all the salts described is the presence of a very broad absorption band of the iminium ion NH^+ (3100...2400 cm^{-1}). It is also of fundamental importance to note that the position of the signals of the C=O groups in the IR spectra of the triketone II, recorded for KBr pellets and for concentrated solutions in pyridine, is practically the same, but differs appreciably from the position of the analogous signals in the spectra of salts IIIa-d. This indicates fundamentally different interactions of triketone II with 3,4-dihydroisoquinolines Ia-d and pyridine. It is significant that the "salts" of β,β'-triketone II with pyridine are highly unstable and readily lose pyridine during storage in air, regenerating the unaltered triketone.

The most informative method from the standpoint of determination of the structure of the salts obtained, IIIa-d, is the PMR method. However, for the previously described salt of 3,4-dihydroisoquinoline with 2-acetylcyclopentane-1,3-dione [2], only the MPs and data of ultimate analysis and IR spectra were given; this is clearly insufficient for understanding the structure of this salt, particularly if the next step of the interaction is assumed to be alkylation of the C=N bond of the triketone methyl group with the formation of an intermediate tricyclic aminotriketone in the form of salt V.

The initial data on the salts which we synthesized, IIIa-d (chromatography with decomposition or change in composition, precision of the melting points, etc.), led to the assumption that we had synthesized theoretically possible [14] products of addition of β,β'-triketone II to imines Ia-d of general structure V or VI, which were ultimately rejected only after studies by PMR methods. Without discussing the data, shown in Table 3, for the PMR spectra of all the salts obtained, IIIa-d, and their isomers, it is useful to analyze the spectrum of the simplest of them, IIIa. In the latter, there is a four-proton singlet

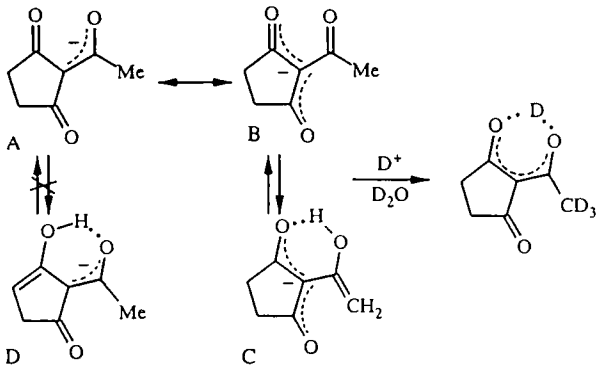


V VI

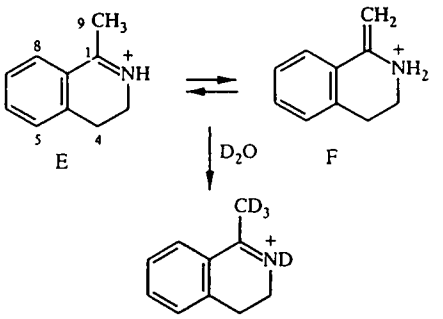
(δ 2.43 ppm) and a three-proton singlet (δ 2.46 ppm), which correspond to the methylene linkages of the ring and to the methyl group of the acetyl anion of the triketone. The final assignment of the four-proton singlet to the 4′- and 5′-methylene groups of the triketone anion was made by comparing the spectra of the salt IIIa and triethylammonium salt of β,β′-triketone II. The resonance signal of the methyl group of isoquinolinium cation, which shows up as a weakly resolved triplet (J=1.3 Hz), is observed at 2.73 ppm. The multiplicity of this signal is due to the homoallylic spin-spin interaction with the 3-methylene linkage, as was confirmed by double resonance. The presence of this interaction made possible a definitive identification of the methyl groups of the imine and triketone fragments of salt IIIa. The resonance signals of the 3- and the 4-CH_2 linkages of the dihydroisoquinoline fragment are manifested as a triplet of doublets at 3.95 ppm (J=7.8 Hz and 1.3 Hz) and a triplet at 3.08 ppm (J=7.8 Hz), respectively. In the range 7.36...7.73 ppm, there are very characteristic multiplet signals of aromatic protons of isoquinolinium ion, the assignment of which was made by using the methods of double resonance and homonuclear Overhauser effect. Finally, the iminium proton of the N^+H group is observed at 12.49 ppm in the form of a broadened singlet (~30 Hz). The location of this signal is concentration-dependent interionic interactions (characteristic of salt IIIa), not intramolecular interactions (characteristic of salt V).

A study of the H/D isotope exchange of salt IIIa showed that, in addition to the iminium proton, the protons of methyl groups at 2.46 ppm and 2.73 ppm also undergo isotope exchange. It should be noted that the resonance signal of the iminium proton disappears immediately after D_2O is added to the sample in $CDCl_3$, and the signals of the methyl groups lose their intensity much more slowly. Thus, the signal of the acyl methyl of triketone anion (δ 2.46 ppm) disappears in 12 h to 18 h, and the complete disappearance of the signal of the methyl group of iminium ion (δ, 2.73 ppm) requires 120 h.

H/D-Isotope exchange in the methyl group of triketone anion is a consequence of B ⇄ C keto-enol tautomerism, observation of which essentially solves the problem of the structure of the enols and anions of cyclopentane triketones [2, 15, 16], demonstrating that in addition to the structure of anion A, the structure of B is also realized. We previously observed the H/D-isotope exchange of the methyl group protons of the acyl fragment and α-methylene groups of the cyclic portion of 2-acyclycloalkane-1,3-diones [17], but the result obtained is fundamentally important in that it demonstrates the specifics of the conversions of β,β′-triketone II under conditions of interaction with cyclic Schiff bases Ia-d. We noted that no H-D-isotope exchange in the methylene linkages of the cyclic portion of triketone anion was observed even after a 30-day exposure of a sample of salt IIIa in the presence of D_2O, indicating the absence of A ⇄ D tautomerism.

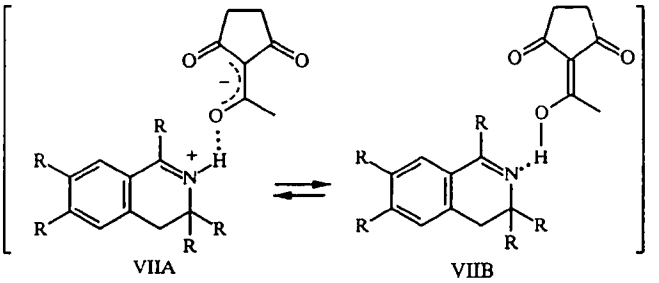


The discussed isotope exchange in the methyl group of the iminium ion of salt IIIa (correspondingly, in the methyl group of salt IIId, methylene group of salt IIIb, and methine group of salt IIIc) is a consequence of the imine-enamine, or more accurately, iminium-enaminium tautomerism of 3,4-dihydroisoquinolinium ion E ⇄ F.



The isotope exchange of the methyl group protons of 1-methyl-3,4-dihydroisoquinoline hydrochloride under the conditions of recording of the PMR spectra in $CDCl_3$ solutions in the presence of D_2O (heterophase) goes to completion in 1 to 2 h, whereas for salt IIIa, 120 h are required.

Of no less importance are ^{13}C NMR data obtained for salt IIIc. The coincidence of the signals of the carbon atoms of the methoxyl groups is probably random in nature, but the coincidence of the signals of the $C_{(1')}$ and $C_{(3')}$ atoms (this common signal is located 9 ppm deeper in the weak field compared to the signal of the $C_{(6')}$ atom of the acyl substituent) suggests that in solutions, in accordance with the Dieckman–Cohm rule, the anionic form of A is more populated [18]. Of essential importance is the fact that the signal of the $C_{(2')}$ atom of salt IIIc (δ 114.63 ppm) practically coincides with the signal of the analogous atom of unionized triketone II (δ 114.61 ppm) [16]. This can be regarded either as the result of a significant contribution of components Ic and II to the mixture, or as evidence of a salt structure that is closer to a compound with a hydrogen bond of type VIIa or VIIb.



Thus, the data obtained show that formulas III and VII give a highly simplified representation of the structure of the salts of 1-alkyl-3,4-dihydroisoquinolines Ia-d with 2-acetylcyclopentane-1,3-dione II. At the same time, the results of this work can serve as the basis for thermodynamic, kinetic, and stereochemical studies of the mechanism of the reaction of annelation of cyclic Schiff bases by β,β'-tricarbonyl compounds and their enol derivatives and prototropic processes involved in the interaction of azomethines with β-di- and β,β'-tricarbonyl compounds.

EXPERIMENTAL

The IR spectra were obtained on a UR-20 instrument in KBr pellets or in films for the liquid samples. The electronic spectra were recorded on Specord UV-vis and M-400 spectrophotometers in ethanol solutions. The NMR spectra were obtained on WM-360 Bruker (resonance frequencies of 360 MHz for ^1H and 90.56 MHz for ^{13}C) and Bruker AC-200 (resonance frequencies of 200 MHz for ^1H and 90.54 MHz for ^{13}C) microwave spectrometers. The internal standard was TMS, and precision of measurement for ^1H was ± 0.5 Hz, and for ^{13}C, ± 3 Hz. The regimes and conditions of the recording of the spectra corresponded to those indicated in [23]. The ^{13}C and ^{13}C-{^1H} NMR spectra were recorded with the aid of PGD and GD programs, which were included in the software of the instruments. The course of the reaction was monitored by means of TLC on Silufol UV-254 plates, the eluent was 8:2 chloroform–methanol, and the development was in UV light or iodine vapor with subsequent roasting at 205...350°C. The melting points were determined on a Boetius heating block.

3-4-Dihydroisoquinolines Ia-c were obtained under Bischler–Napieralski reaction conditions [19] by cyclodehydration of the corresponding phenethyl amides acted upon by polyphosphoric acid (in the case of compounds Ia, b) or phosphoryl chlo-

TABLE 1. Properties of Isoquinolinium Salts IIIa-d

Compound	Empirical formula	Found, % / Calculated, %			mp, °C	Yield, %†
		C	H	N		
IIIa	$C_{17}H_{19}NO_3$	71,42 / 71,56	6,77 / 6,71	5,03 / 4,91	146...148	97,9
IIIb	$C_{18}H_{21}NO_3$	72,31 / 72,22	7,16 / 7,07	4,55 / 4,68	115...118	96,9
IIIc	$C_{21}H_{27}NO_5$	67,40 / 67,54	7,17 / 7,29	3,60 / 3,75	135...137	94,6
IIId	$C_{19}H_{23}NO_3$	72,73 / 72,82	7,32 / 7,40	4,35 / 4,47	130...132	95,8

*Compounds III melt with decomposition.
†Maximum yields are given.

TABLE 2. IR and UV Spectral Data for Synthesized Salts IIIa-d, Some Initial Compounds, and Their Salts

Compound	IR spectrum, ν, cm^{-1}	UV spectrum, λ, nm (log ε)	
		max	min
IIIa	3100...2400, 1660, 1625...1595, 1560, 1444, 1422, 1300, 1141, 920	210(14255), 247,7 (17650), 267(17650)	226,4(6650), 258,9 (17025)
IIIb	3150...2400, 1660, 1630...1590, 1540 sh, 1500, 1450...1405	207,8(16790), 247,5(22320), 268,4(20310)	227,1(8365), 258,4(19500)
IIIc	3150...2400, 1660, 1630...1595, 1570...1530, 1425, 1340, 1286, 1219, 1145, 1037	214,4(13165), 246(38240), 272,7(16860), 303,7(10005), 355,4(8165)	205(9455), 221(12120), 261(16680), 292(9085), 325,4(5050)
IIId	3100...2400, 1661, 1630...1590, 1560, 1540 sh, 1442, 1421	210(16415), 247,5(21540), 269,3(20225)	226,8(7605), 258,2(18985)
Ia*	1634, 1576, 1455, 1435, 1374, 1292, 1280, 767, 741	207(12100), 209(8150), 213(6250), 250(3100)	223(1515)
Ia · AcOH	3100...2300, 1720, 1670, 1636, 1610, 1577, 1460, 1440...1425, 1390...1360, 1310...1240, 1050, 912, 883, 772, 744	210(20530), 214 sh,(15100), 250(7550), 278 sh,(1940)	223(2130)
Ic	1630, 1607, 1575, 1518, 1467, 1454, 1446, 1409, 1377, 1352, 1330, 1289, 1274, 1235, 1215, 1161, 1065, 1010, 962, 875, 813		
II	3100...240, 1705, 1655...1635, 1595...1575, 1450...1425, 1365, 1318, 1280, 1180...1155	225(11700), 262(8450)	238(6110)
II · Py*	3600...2400, 1702, 1665 sh, 1650, 1620, 1590 sh, 1565...1540, 1450...1415, 1320, 1180...1155, 925...880, 827, 760		

*The IR spectrum was taken in a film.

ride (in the case of Ic). 3-4-Dihydroisoquinoline Id was obtained under Ritter reaction conditions [20]. 2-Acetylcyclopentane-1,3-dione II was obtained by O,C-isomerization of 1,3-cyclopentanedione enol acetate under Clauson–Kaas reaction conditions [21, 22].

The yields, melting points, IR, UV, and PMR spectral data for salts IIIa-d and the comparative properties of the reaction substrates and their salts as well as isotope isomers of salts IIIa-d are listed in Tables 1-3.

TABLE 3. PMR Spectra of Salts IIIa-d, Their $[^2H]_2$ Isotope Isomers, 3,4-Dihydroisoquinolines Ia, b, d, β,β′-Triketone II, Their Salts, and $[^2H]$-Isotope Isomers, δ, ppm (SSCC, Hz)

Compound	NH^+, s, 1H	3-R_2^4	4-H_2, 2H	5-H, 1H	6-R^1	7-R^1	8-H, 1H	1-CHR^2R^3	4′-H_2, 2H	5′-H_2, 2H	CH_3CO, s, 3H
1	2	3	4	5	6	7	8	9	10	11	12
IIIa	12,49	3,59 d. d. d, 2H, (8,0; 1,2)	3,08 t (8,0)	7,36 d (7,5)	7,47 t, 1H (7,5)	7,64 t, 1H (7,5)	7,73 d (7,5)	2,73 t, 3H (1,2)	2,43 s	2,43 s	2,46
$[7^2H]$ IIIa*		3,94 t, 2H (8,0)	3,08 t (8,0)	7,36 d (7,5)	7,47 t, 1H (7,5)	7,64 t (7,5)	7,74 d (7,5)		2,43 s	2,43 s	
IIIb	10,92	3,88 d. d. d, 2H (7,5; 1,5)	3,02 t (7,5)	7,34 d (8,0)	7,44 t, 1H (8,0)	7,59 t, 1H (8,0)	7,69 d (8,0)	3,06 d. d. d. d, 2H; 1,34 t, 3H (CH_3) (1,5)	2,46 s	2,46 s	2,47
$[6^2H]$ IIIb*[2]		3,87 t, 2H (7,5)	3,02 t (7,5)	7,34 d (8,0)	7,44 t, 1H (8,0)	7,59 t, 1H (8,0)	7,69 d (8,0)	1,35 s, 3H(CH_3)	2,46 s	2,46 s	
IIIc	11,90	3,84 d. d. d, 2H (8,0; 1,2)	2,95 t (8,0)	6,86 s	3,95 s, 3H(OCH_3)	4,00 s, 3H(OCH_3)	7,20 s	3,44 d. d. d. d, 1H; 1,40 d, 6H($2CH_3$) (7,0; 1,2) (7,0)	2,44 s	2,44 s	2,47
$[5^2H]$ IIIc*[3]		3,84 t, 2H (8,0)	2,95 t (8,0)	6,86 s	3,95 s, 3H(OCH_3)	4,00 s, 3H(OCH_3)	7,20 s	1,40 s, 6H($2CH_3$)	2,44 s	2,44 s	
IIId	10,85	1,40 s, 6H($2CH_3$)	2,86 s	7,30 d (8,0)	7,42 t, 1H (8,0)	7,59 t, 1H (8,0)	7,70 d (8,0)	2,66 s, 3H	2,48 s	2,48 s	2,49
$[7^2H]$ IIId*[4]		1,40 s, 6H($2CH_3$)	2,86 s	7,29 d (8,0)	7,41 t, 1H (8,0)	7,59 t, 1H (8,0)	7,70 d (8,0)		2,48 s	2,48 s	
Ia		3,66 d. d. d, 2H (7,2; 1,2)	2,70 t (7,2)	7,17 d (7,5)	7,29 t, 1H (7,5)	7,35 t, 1H (7,5)	7,48 d (7,5)	2,39 t, 3H (1,2)	2,48 s	2,48 s	

TABLE 3 (continued)

1	2	3	4	5	6	7	8	9	10	11	12
[3^2H] Ia*[5]		3,67 t, 2H (7,2)	2,70 t (7,2)	7,16 d (7,5)	7,30 t, 1H (7,5)	7,36 t, 1H (7,5)	7,50 d (7,5)				
Ib		3,68 t. t. t, 2H (6,3; 1,5)	2,69 t (6,3)	7,19 d (7,0)	7,30 t, 1H (7,0)	7,35 t, 1H (7,0)	7,50 d (7,00)	2,77 t.t.t.t, (6,5; 1,5) 2H; 1,22 t, 3H(CH_3) (6,5)			
[3^2H] Ib*[6]		3,69 t, 2H (6,5)	2,70 t (6,5)	7,15 d (7,0)	7,29 t, 1H (7,0)	7,34 t, 1H (7,0)	7,49 d (7,0)	1,21 s, 3H(CH_3)			
Id		1,20 s, 6H($2CH_3$)	2,68 s	7,13 d (7,0)	7,26 t, 1H (7,0)	7,34 τ, 1H (7,0)	7,[illegible] d (7,0)	2,37 s, 3H			
[3^2H] Id*		1,21 s, 6H ($2CH_3$)	2,66 s	7,12 d (7,0)	7,26 t, 1H (7,0)	7,33 t, 1H (7,0)	7,46 d (7,0)				
II*[8]	15,30 s*[9]	–	–	–	–	–	–	–	2,78 m	2,78 m	2,55
II · TEA*[10]	11,85 s*[11]	–	–	–	–	–	–	–	2,56 s	2,56 s	2,47

*[2,9,9,9,7',7',7'-^{2}H]-Isotope isomer of salt IIIa.

*2[2,9,9,7',7',7'-^{2}H]-Isotope isomer of salt IIIb.

*3[2,9,7',7',7'-^{2}H]-Isotope isomer of salt IIIc.

*4[2,9,9,9,7',7',7'-^{2}H]-Isotope isomer of salt IIId.

*5[9,9,9-^{2}H]-Isotope isomer of 3,4-dihydroisoquinoline Ia.

*6[9,9-^{2}H]-Isotope isomer of dihydroisoquinoline Ib.

*7[9,9,9-^{2}H]-Isotope isomer of dihydroisoquinoline Ic.

*8The numbering of the atoms of salt III anion is retained.

*9Signal of enol proton.

*10Proton signals of triethylammonium ethyl groups: 1.28 t, 3H (6.3); 3.22 q, 2H (6.3).

1-Methyl-3,4-dihydroisoquinolinium 2-acetylcyclopentane-1,3-dionate (IIIa). A. To a solution of 1.45 g (10 mmole) of isoquinoline Ia in 10 ml of ethanol is added a solution of 1.4 g (10 mmole) of β,β′-triketone II in 10 ml of ethanol, and the mixture obtained is boiled in an argon atmosphere. After 0.5 h, an abundant crystalline precipitate appears which is filtered off, washed with cold alcohol, then ether, and dried at reduced pressure. Salt IIIa is obtained as white crystals in an amount of 2.55 g (89.4%).

B. To a solution of 0.58 g (4 mmole) of isoquinoline Ia in 10 mmole of ether is added a solution of 0.56 g (4 mmole) of β,β′-triketone II in 7 ml of ethanol, and the mixture obtained is allowed to stand for ~16 h at room temperature. The precipitated product, IIIa, is filtered off, washed with ether, and dried. Salt IIIa, identical to the sample described above (MP, IR spectrum), is obtained in an amount of 1.1 g (96.5%).

C. To a solution of 0.29 g (2 mmole) of isoquinoline Ia in 10 mmole of ether is added dropwise with vigorous stirring a solution of 0.28 g (2 mmole) of β,β′-triketone II in 10 ml of ethanol. The suspension obtained is stirred for 1 h, then the precipitate of product IIIa is filtered off, washed with ether, and dried at reduced pressure. There is obtained 0.56 g of salt IIIa, identical to the samples obtained by methods A and B (MP).

1-Ethyl-3,4-dihydroisoquinolinium 2-acetylcyclopentane-1,3-dionate (IIIb). To a solution of 2.39 g (15 mmole) of isoquinoline Ib in 30 mmole of dry ether is added with constant shaking a solution of 2.1 g (15 mmole) of β,β′-triketone II in 20 ml of ether. The mixture obtained is shaken for another 2 h, and the precipitate is filtered off, washed with ether (3 × 20 ml), and dried. Salt IIIb (4.35 g) is obtained in the form of white crystals.

6,7-Dimethoxy-1-isopropyl-3,4-dihydroisoquinolinium 2-acetylcyclopentane-1,3-dionate (IIIc). To a solution of 2.3 g (10 mmole) of isoquinoline Ic in 10 ml of ethanol is added a solution of 1.4 g (10 mmole) of β,β′-triketone II in 20 ml of ether, the reaction mixture is stirred for 0.5 h, then another 20 ml of ether is added, and the mixture is kept at +5°C for ~16 h. The precipitated crystals are separated, washed with ether, and dried. Salt IIIc is obtained in the form of cream-colored crystals in an amount of 3.5 g. ^{13}C NMR spectrum: 20.11 q $C_{(9)}$ ($\underline{C}H_3)_2$; 25.50 t ($C_{(4)}$); 28.96 q ($C_{(7')}$); 32.16 d ($C_{(9)}$); 33.16 t ($C_{(4')}$), ($C_{(5')}$); 42.15 t ($C_{(3')}$); 54.4 q ($C_{(6)}O\underline{Me}$), ($C_{(6)}O\underline{Me}$ $C_{(7)}O\underline{Me}$); 110.43 d ($C_{(5)}$); 110.99 d ($C_{(8)}$); 114.63 s ($C_{(2')}$); 117.75 s ($C_{(8a)}$); 113.38 s ($C_{(4a)}$); 148.44 s ($C_{(7)}$); 154.99 s ($C_{(6)}$); 177.57 s ($C_{(1)}$); 195.03 s ($C_{(6')}$); 203.92 s ($C_{(1')}$), ($C_{(3')}$).

1,3,3-Trimethyl-3,4-dihydroisoquinolinium 2-acetylcyclopentane-1,3-dionate (IIId). To a solution of 1.73 g (10 mmole) of isoquinoline Id in 20 ml of ether is added with vigorous stirring a solution of 1.4 g (10 mmole) of β,β′-triketone II in 30 ml of ether. The suspension obtained is shaken for 1 h, then the precipitate is filtered off, washed with ether, and dried at reduced pressure. There is obtained 3.0 g of salt IIId in the form of lightly cream-colored crystals.

REFERENCES

1. M. von Strandtmann, M. P. Cohen, and J. Shavel, Jr., J. Org. Chem., **31**, 803 (1966).
2. A. A. Akhrem, A. M. Moiseenkov, V. A. Krivoruchko, F. A. Lakhvich, and A. I. Poselenov, Izv. Akad Nauk SSSR Ser. Khim., No. 9, 2078 (1972).
3. A. L. Mikhal'chuk, O. V. Gulyakevich, A. A. Zenyuk, A. V. Korchik, L. G. Lis, V. A. Khripach, L. I. Ukhova, and A. A. Akhrem, Dokl. Akad. Nauk, **317**, 1397 (1991).
4. A. L. Mikhal'chuk, O. V. Gulyakevich, and A. A. Akhrem, Khim. Geterotsikl. Soedin., No. 1, 86 (1993).
5. A. A. Akhrem, A. M. Moiseenkov, and V. A. Krivoruchko, Izv. Akad. Nauk SSSR Ser. Khim., No. 6, 1302 (1973).
6. A. A. Akhrem and Yu. G. Chernov, Dokl. Akad. Nauk, **291**, 603 (1986).
7. O. V. Gulyakevich, A. L. Mikhal'chuk, V. P. Peresada, A. M. Likhosherstov, and A. A. Akhrema, Zh. Obshch. Khim., **63**, 701 (1993).
8. A. L. Mikhal'chuk, O. V. Gulyakevich, K. A. Krasnov, A. I. Slesarev, and A. A. Akhrem, Zh. Org. Khim., **29**, 1236 (1993).
9. B. B. Kuz'mitskii, I. G. Dad'kov, Yu. L. Zhuravkov, N. A. Konoplya, G. S. Lyubin, A. E. Mashkovich, V. M. Nasek, O. V. Gulyakevich, V. N. Pshenichnyi, and V. A. Khripach, Vestsi AN BSSR, Ser. Khim. Navuk, No. 1, 64 (1989).
10. N. A. Konoplya, O. V. Gulyakevich, A. L. Mikhal'chuk, and B. B. Kuz'mitskii, Vestsi AN Belarusi, Ser. Khim. Navuk, No. 3, 91 (1994).
11. O. V. Gulyakevich and A. L. Mikhal'chuk, Zh. Obshch. Khim., **62**, 715 (1992).

12. A. L. Mikhal'chuk, O. V. Gulyakevich, A. A. Zenyuk, Yu. V. Shklyaev, V. S. Shklyaev, and M. M. Akhrem, Zh. Obshch. Khim., **63** 1891 (1993).
13. A. L. Mikhal'chuk, O. V. Gulyakevich, D. B. Rubinov, and A. A. Akhrem, Zh. Obshch. Khim., **64**, 1041 (1994).
14. G. Becker, Introduction to the Electronic Theory of Organic Reactions [Russian translation], Mir, Moscow (1977), p. 394.
15. E. V. Borisov, T. S. Khlebnikova, D. B. Rubinov, and F. A. Lakhvich, Zh. Org. Khim., **28**, 1306 (1992).
16. V. G. Avakyan, V. V. Gromak, and A. E. Yatsenko, Izv. Akad. Nauk Ser. Khim., No. 1, 57 (1994).
17. A. L. Mikhal'chuk and O. V. Gulyakevich, Physiologically Active Compounds Labelled with Radioactive and Stable Isotopes, IAE, Moscow (1991), p. 90.
18. H. C. Brown, J. H. Brewster, and H. Shechter, J. Am. Chem. Soc., **76**, 467 (1954).
19. W. M. Whaley and T. R. Govindachari, Organic Reactions [Russian translation], IL, Moscow (1953), Issue 6, p. 98.
20. V. S. Shklyaev, B. B. Aleksandrov, G. I. Legotkina, M. I. Vakhrin, M. S. Gavrilov, and A. G. Mikhailov, Khim. Geterotsikl. Soedin., No. 11, 1560 (1983).
21. K. V. Vatsuro and G. L. Mishchenko, Name Reactions in Organic Chemistry [in Russian], Khimiya, Moscow (1976), p. 213.
22. A. A. Akhrem, F. A. Lakhvich, and T. S. Khlebnikova, Dokl. Akad. Nauk, **246**, 330 (1979).
23. V. N. Pshenichnyi, O. V. Gulyakevich, E. V. Borisov, and V. A. Khripach, Zh. Org. Khim., **23**, 1765 (1987).