Synthesis of α-(acylamino)polyhaloalkylphosphoryl compounds by the reaction of trivalent phosphorus chlorides with *N*-(α-hydroxypolyhaloalkyl)amides

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N-(α-Hydroxypolyhaloalkyl)amides react with trivalent phosphorus chlorides to give α-(acylamino)polyhaloalkylphosphoryl compounds *via* phosphorotropic rearrangement of intermediate phosphites or phosphinites.

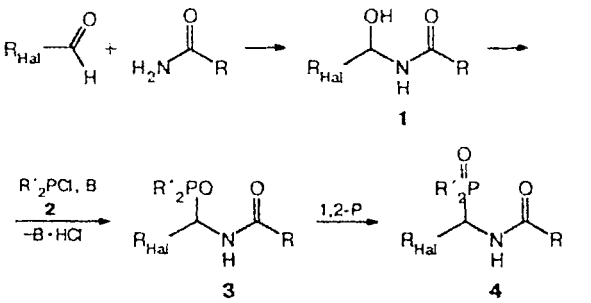
Key words: halogen-containing organic compounds, amidoalkylation; rearrangements; α-aminophosphonates, α-aminoalkylphosphinoxides.

Derivatives of α-aminophosphonic acids have attracted the constant attention of researchers, which is evidenced by a continuously increasing number of publications concerning this problem. First of all, this is related to the diverse biological activity of such compounds. As phosphorus-containing analogs of α-aminocarboxylic acids, they have been used in the production of enzyme inhibitors, antibacterial and neuroactive compounds, plant growth regulators, *etc.*[1–3] In 1952, M. I. Kabachnik *et al.*[4] and E. K. Fields[5] independently of one another elaborated a simple and quite versatile method for creating a P—C bond in the α-position with respect to the amino group by reaction of ammonia (amines) with carbonyl compounds and dialkyl phosphites (the Kabachnik—Fields reaction), which largely stimulated the development of the chemistry of α-aminophosphoryl derivatives. Later, other methods have been proposed (see the latest reviews[2,3]), but all these impose some restrictions. That is why a search for new approaches to the synthesis of compounds containing the phosphoryl and amino groups in the α-position with respect to each other still remains an urgent problem. In particular, traditional approaches are often insufficiently convenient for the synthesis of α-aminophosphoryl derivatives with polyhaloalkyl groups.

Earlier,[6] the *N*-acylated derivatives of α-aminopolyhaloalkylphosphoryl compounds have been obtained mostly by the addition of hydrophosphoryl compounds to *N*-acylimines or by the reaction of α-chloroalkylamides with the alkoxy derivatives of P^{III}. We elaborated a simpler method based on the reaction of *N*-(α-hydroxypolyhaloalkyl)amides **1** with trivalent phosphorus chlorides **2** (Scheme 1)[7,8] with subsequent phosphorotropic rearrangement **3** → **4**.

The initial hydroxyamides **1** can be obtained easily by condensation of polyhaloaldehydes with amides. The

Scheme 1



4	R_{Hal}	R	R′
a	CCl_3	Me	EtO
b	CCl_3	CH_2F	EtO
c	CCl_3	CF_3	EtO
d	CCl_3	EtO	EtO
e	CCl_3	2-ClC_6H_4	EtO
f	CCl_3	Me	Ph
g	CCl_3	CH_2F	Ph
h	CCl_3	CF_3	Ph
i	CCl_3	2-ClC_6H_4	Ph

4	R_{Hal}	R	R′ [R′$_2$]
j	CCl_3	EtO	Ph
k	CCl_3	EtO	Et_2N
l	CCl_3	Ph	EtO
m	$H(CF_2)_4$	MeO	EtO
n	$H(CF_2)_4$	EtO	EtO
o	$H(CF_2)_4$	EtO	Et_2N
p	$H(CF_2)_4$	EtO	Ph
q	$H(CF_2)_6$	EtO	Ph
r	CCl_3	EtO	[2-OC_6H_4O]

reaction of hydroxyamides with phosphorus chlorides proceeds under mild conditions (10—20 °C), first resulting in *O*-phosphorylated derivatives (**3**) and then in *C*-phosphorylated ones (**4**). The ease of the phosphorotropic isomerization **3** → **4** is greatly influenced by the substituents at the C atom of the carbonyl group and the nature of the phosphorous group. An increase in the electron-withdrawing properties of the amide substituent R and the nucleophilicity of the P^{III} atom favor the rearrangement. When the phosphorus atom has donor substituents, the isomerization **3** → **4** easily occurs un-

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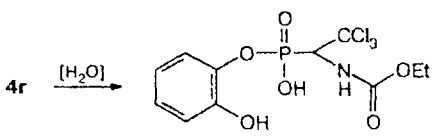
der the conditions of the synthesis of these phosphorylated derivatives from compounds **1** and **2** (Ph_2P, $(Et_2N)_2P$ > $(EtO)_2P$ ≫ (o-OC_6H_4O)P). When hydroxyamide **1** (R = EtO, R_{Hal} = CCl_3) reacts with $(EtO)_2PCl$ or $(Et_2N)_2PCl$ in the presence of Et_3N (ether, 15—20 °C), the ratio of isomers **4** : **3** amounts (after 1 h) to 1 : 10 and 4 : 1, respectively, whereas no intermediate phosphinite **3** (R′ = Ph) was detected in the reaction of this hydroxyamide with Ph_2PCl under similar conditions. This indicates that the rate-limiting stage in the latter case is the formation of compound **3** rather than its isomerization. The nucleophilicity of phosphorus in phenylenedioxyphosphite **3** (R_{Hal} = CCl_3 and R′$_2$ = o-OC_6H_4O) (δP 135) is lower, and heating is required to isomerize it. During isolation, the corresponding phosphonate **4r** (δP 32.2) undergoes opening of the phospholane ring to give monoester **5** (Scheme 2).[8]

Scheme 2



5

To estimate the influence of the amide substituents on the rate of the phosphorotropic rearrangement **3** → **4**, we determined the ratio between isomers **3** and **4** (R_{Hal} = CCl_3, R′ = EtO) for different substituents R by ^{31}P NMR spectroscopy, 1 and 3 h after mixing the reagents (ether, 15—20 °C):

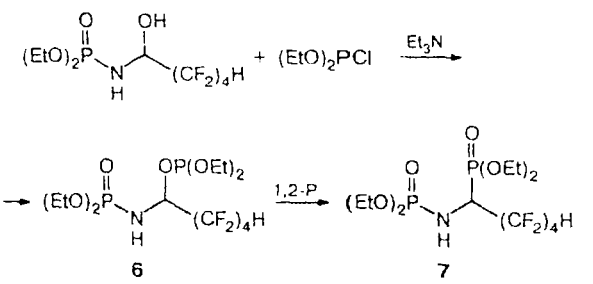
R	4 : 3		R	4 : 3	
	1 h	3 h		1 h	3 h
Ph	>95 : 1	100 : 0	Me	—	1.5 : 1.0
CF_3	12 : 1	100 : 0	EtO	1 : 10	4 : 10
CH_2F	<1 : 20	5 : 1			

From the above data, it follows that the nature of amide substituents R substantially influences the rate of isomerization **3** → **4** (Ph > CF_3 > CH_2F > Me > EtO), the influence of electron-withdrawing properties becoming particularly pronounced when small electronegative F atoms are introduced successively into the methyl group (CF_3 > CH_2F > CH_3).

A replacement of *N*-acyl substituent by the phosphoryl group does not hinder the rearrangement (Scheme 3, **6** → **7**).

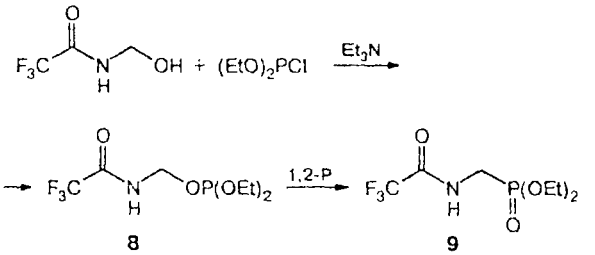
The presence of a polyhaloalkyl substituent R_{Hal} at the α-C atom is not required for the isomerization. Thus, the reaction of *N*-hydroxymethyltrifluoroacetamide with $(EtO)_2PCl$ in the presence of Et_3N yields phosphite **8** (δP 140.6), which is easily isomerized to give phosphonate **9** (Scheme 4). Twenty minutes after mixing the reagents (ether, 15—20 °C) the **9** to **8** ratio is equal to 10 : 1, and after 1.5 h no more isomer **8** is present in the reaction mixture. Thus, the rearrangement **8** → **9** occurs even faster than it does in the case of trichloromethyl analog **3** (R_{Hal} = CCl_3, R′ = EtO), which can be explained by the steric influence of the trichloromethyl group.

Scheme 3



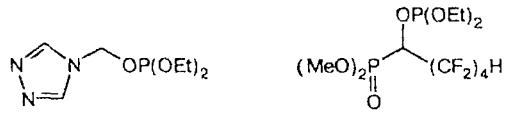
6 **7**

Scheme 4



8 **9**

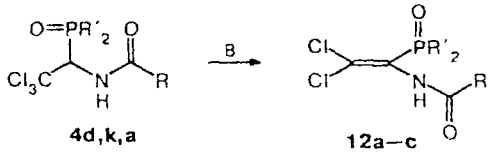
The decisive factor for the rearrangement is the presence of an amide group in the type **3**, **6**, and **8** derivatives. Thus, compounds **10** and **11** are not isomerized into the corresponding phosphonates under similar conditions.



10 **11**

Phosphite **10** (δP 140.1) remains unchanged with heating (100 °C, 2 h) or when distilled. Compound **11** (δP 14 and 140.6) is stable at room temperature. When heated, it decomposes to give a series of unidentified products.

Compounds **4** (R_{Hal} = CCl_3) in the presence of bases are easily dehydrochlorinated (especially at R = EtO, Et_2N) to give the corresponding vinylamides **12** (*cf.* Ref. 6 and 9).



4d,k,a **12a—c**

12: R = EtO, R′ = EtO (**a**), Et_2N (**b**); R = Me, R′ = EtO (**c**)

Table 1. The yields, elemental analysis data, some physicochemical characteristics, and IR spectra of compounds **4**, **7**, and **9**

Compound	Yield (%)	M.p./°C [B.p./°C (*p*/Torr)]	Found / Calculated (%) Cl (F)	P	Molecular formula	δ ^{31}P (A : B)[a]	IR, ν/cm^{-1}
4a	62	115—116	32.39 32.57	9.26 9.49	$C_8H_{15}Cl_3NO_4P$	15.1	1050 (POC); 1255 (P=O); 1705 (C=O); 3270 (NH)
4b	48	98	30.72 30.87	8.93 8.99	$C_8H_{14}Cl_3FNO_4P$	12.8	—
4c	38	110—112	27.61 27.95	7.92 8.14	$C_8H_{12}Cl_3F_3NO_4P$	12.1	1050 (POC); 1265 (P=O); 1735 (C=O); 3210 (NH)
4e	57	120	33.84 33.52	7.30 7.32	$C_{13}H_{16}Cl_4NO_4P$	13.0	1035 (POC); 1275 (P=O); 1680 (C=O); 3180 (NH)
4f	45	175	26.93 27.22	8.21 7.93	$C_{16}H_{15}Cl_3NO_2P$	30.7 (A); 31.4 (B) (5 : 1)	1200 (P=O); 1685 (C=O); 3190, 3270 (NH)
4g	49	212	25.80 26.02	7.73 7.58	$C_{16}H_{14}Cl_3FNO_2P$	28.3	1120 (C—F); 1195 (P=O); 1705 (C=O); 3200 (NH)
4h	56	168—170	24.03 23.92	7.02 6.97	$C_{16}H_{12}Cl_3F_3NO_2P$	28.7 (A); 27.8 (B) (20 : 1)	1170, 1210 (CF_3, P=O); 1725 (C=O); 3170 (NH)
4i	52	220—222	29.21 29.11	6.31 6.36	$C_{21}H_{16}Cl_4NO_2P$	28.8	1205 (P=O); 1685 (C=O); 3150 (NH)
4l	66	120—122[b]	—	—	—	14.7	
4m	52	[130—134 (0.04)]	(36.81) (37.14)	7.82 7.57	$C_{11}H_{16}F_8NO_4P$	14.0	1275 (P=O); 1725 (C=O); 3210 (NH)
4q	24	157	—	5.45 5.13	$C_{22}H_{18}F_{12}NO_3P$	30.5	—
7	52	44	—	12.13 12.31	$C_{13}H_{23}F_8NO_6P_2$	7.6 (N—P); 16.2 (C—P)	—
9	63	[130—136 (0.05)]	(21.30) (21.66)	11.94 11.77	$C_7H_{13}F_3NO_4P$	20.7	—

[a] The main and the minor isomers, respectively.
[b] Literature data[15]: m.p. 121—122 °C.

That is why one should avoid using an excess of base in their synthesis. According to the literature data,[10] the preparation of compounds **4** (R_{Hal} = CCl_3, R′ = Ph) by the Arbuzov reaction from tetrachloroethylamides $CCl_3CH(Cl)NHCOR$ and Ph_2POEt is accompanied by the formation of vinylamides **12**, which prevents phosphinoxides **4** from being isolated in the individual state. At R′ = EtO, the accompanying dehydrochlorination is not so characteristic. We believe that the dehydrochlorination in the course of the Arbuzov reaction occurs in a quasiphosphonium intermediate whose lifetime at R′ = Ph is sufficient for partial realization of this process (*cf.* Ref. 11). Use of ester amides of phosphorous acid in the synthesis of compounds **4** is also not suitable. At the same time, the synthesis of phosphinoxides **4** by the reaction of hydroxyalkylamides **1** with Ph_2PCl or $(R_2N)_2PCl$ creates no problems.

The compositions and structures of *N*-acylated aminophosphoryl compounds **4**, **7**, **9**, and **12** were confirmed by data from elemental analysis and ^{1}H, ^{31}P, and ^{19}F NMR and IR spectroscopy (Tables 1 and 2). In particular, chemical shifts in the ^{31}P NMR spectrum that correspond to the phosphorus atom of the phosphonate or phosphinoxide group as well as a characteristic value of spin-spin coupling constant $^2J_{HP}$ = 5—20 Hz correlate well with the presence of the P—C bond. The signal for the CHP proton in the ^{1}H NMR spectra of compounds **4**, recorded in solvents containing traces of water (*e.g.*, acetone-d_6), appears as a superposition of a doublet of doublets (splitting on the P atom and the NH proton) and a doublet (splitting only on the P atom). When D_2O is added, this multiplet is transformed into a doublet. In the spectra of polyfluoroalkyl derivatives (R_{Hal} = $H(CF_2)_4$ and $H(CF_2)_6$), the signal of the CHP proton takes the form of a complex multiplet owing to an additional spin-spin coupling with the diastereotopic F atoms.

A hindered rotation around the amide bond in the molecules of α-acylaminopolyhaloalkylphosphoryl compounds implies their geometric isomerism. Derivatives **4** and **12** obtained by us exist mainly as one isomer, but in some cases (see Tables 1 and 2 and Experimental),

Table 2. The parameters of the ^1H and ^{19}F NMR spectra of compounds **4**, **7**, and **9**

Compound	^1H NMR, δ (*J*/Hz)			^{19}F NMR, δ (*J*/Hz)
	CHP ($^2J_{HP}/^3J_{HH}$)	NH ($^3J_{HH}$)	Other signals	
4a[a]	5.38 (dd, *J* = 18.5/10)	8.38 (d, *J* = 10)	1.30, 1.33 (both t, 6 H, 2 $C\underline{H}_3CH_2$, *J* = 7); 2.12 (s, 3 H, MeCO); 4.12 (m, 4 H, 2 OCH_2)	—
4b[a]	5.35 (dd, *J* = 19/10.5)	8.03 (d, *J* = 10.5)	1.31, 1.33 (both t, 6 H, 2 $C\underline{H}_3CH_2$, *J* = 7); 4.12 (m, 4 H, OCH_2); 5.07 (d, 2 H, CH_2F, $^2J_{HF}$ = 47.1)	−68.67 (t, J_{FH} = 47)
4c[b]	5.26 (dd, *J* = 18.5/10.2)	8.57 (br.d, *J* = 10)	1.35, 1.39 (both t, 6 H, 2 $C\underline{H}_3CH_2$, *J* = 7); 4.2 (m, 4 H, 2 OCH_2)	−77.2 (s)
4e[b]	5.52 (dd, *J* = 18.6/10.5)	8.03 (d, *J* = 10.5)	1.29, 1.32 (both t, 6 H, 2 Me, *J* = 7.5); 4.2 (m, 4 H, 2 OCH_2); 7.25—7.45 (m, 3 H, Ar); 7.66 (d, 1 H, Ar, *J* = 9)	—
4f[c]	5.95 (dd, *J* = 6.5/10.8); 5.73 (d, *J* = 6/—)	8.03 (d, *J* = 10.8); 8.8 (br)	1.63, 1.91 (both s, the 5 : 1 ratio, Me); 7.3—8.1 (m, 10 H, Ph)	—
4g[a]	6.02 (dd, *J* = 6.3/10.5)	8.23 (d, *J* = 10.5)	4.60, 4.82 (both dd, CH_2, AB system, $J_{H_AH_B}$ = 14.4, $^2J_{HF}$ = 47); 7.5—7.7 (m, 6 H, Ph); 7.9—8.1 (m, 4 H, Ph)	−66.61 (t, J_{FH} = 47)
4h[a]	5.70 (dd, *J* = 4.5/10)	—	7.5—8.0 (m, 11 H, Ph, NH)	−75.0 (s)
4i[b]	6.08 (dd, *J* = 5/10.5)	—	7.5—8.0 (m, 15 H, Ph, NH)	—
4m[a]	5.0 (m, *J* = —/10.5)	7.36 (d, *J* = 10.5)	1.30, 1.33 (both t, 6 H, 2 $C\underline{H}_3CH_2$, *J* = 7); 3.69 (s, 3 H, MeO); 4.2 (m, 4 H, 2 OCH_2); 6.71 (tt, 1 H, CHF_2, $^2J_{HF}$ = 51, $^3J_{HF}$ = 5.5)	−136.8 (m, 2 F); −130.2 (1 F); −128.8 (1 F); −123.0 (2 F); −115.4, −111.6 (m, 2 F, CF_AF_B, J_{AB} = 290)
4q[b]	5.5 (m)	5.78 (d, *J* = 10.5)	1.02 (t, 3 H, Me, *J* = 7); 3.91 (q, 2 H, CH_2, *J* = 7); 6.00 (tt, 1 H, CHF_2, J_{HF} = 52, $^3J_{HF}$ = 5.5); 7.6 (m, 6 H, Ph); 7.9 (m, 4 H, Ph)	—
7[a]	4.5 (m)	4.95 (m, *J* = 11)	1.2—1.4 (m, 12 H, 4 Me); 3.9—4.3 (m, 8 H, 4 CH_2); 6.73 (tt, 1 H, CHF_2, $^2J_{HF}$ = 51, $^3J_{HF}$ = 5.5)	−139.3 to −139.8 (m, 2 F); −131.3 (s, 2 F); −124.1, −122.2 (m, 2 F, CF_AF_B, J_{AB} = 300); −115.2, −112.0 (m, 2 F, CF_AF_B, J_{AB} = 284)
9[a]	3.82 (*J* = 12.3/6)	9.4 (br)	1.30 (t, 6 H, 2 Me, *J* = 7); 4.15 (quint, 4 H, 2 OCH_2, $J_{HP} \approx J_{HH} \approx 7$)	—

[a] In acetone-d_6.
[b] In $CDCl_3$.
[c] In DMSO-d_6.

signals for a minor isomer were also observed in the ^1H and ^{31}P NMR spectra (*cf.* Ref. 9). The presence of a chiral center in compounds **4** and **7** predetermines the splitting of signals for the diastereotopic groups (EtO, CH_2, and CF_2) in the ^1H and ^{19}F NMR spectra (see Table 2). When hydrogen chloride is eliminated, the chiral center disappears and that is why vinyl phosphonates **12** are not diastereotopic.

Thus, the reaction of *N*-(α-hydroxypolyhaloalkyl)amides with trivalent phosphorus chlorides is a convenient method of synthesis of *N*-acylated and *N*-phosphorylated derivatives of α-aminopolyhaloalkylphosphonic acids and phosphinoxides. This approach successfully supplements the method developed in recent years[12—14] and based on the reaction of carbonyl compounds with carboxamides and P^{III} chlorides because the latter method is unsuitable for α-halocarbonyl compounds.[12] It is also significant that despite the apparent similarity of these processes, they differ principally. Detailed investigations suggest that it is nucleophilic "activated" derivatives of the Cl_2POH, Cl_2POAc, $ClP(OH)_2$, and H_3PO_3 types formed *in situ* from P^{III} chlorides and acetic acid that take an important part in the latter case, as in the reactions of hydroxymethylamides $RCONHCH_2OH$ with PCl_3.[13,14]

Experimental

^1H, ^{19}F, and ^{31}P NMR spectra were recorded on a Varian VXR-300 spectrometer (299.95, 282.20, and 121.42 MHz, respectively). Chemical shifts are given with respect to the tetramethylsilane (δ ^1H) and $CFCl_3$ (δ ^{19}F) as the internal standards and 85% H_3PO_4 (δ ^{31}P) as the external standard. IR spectra were recorded on a UR-20 instrument (KBr or thin film).

N-(1-Hydroxypolyfluoroalkyl)amides **1** (R = $H(CF_2)_4$ and $H(CF_2)_6$) have been described by us earlier.[7,16] *N*-(1-Hydroxytrichloroethyl)amides were synthesized according to the known procedure.[6]

***N*-(1-Hydroxy-2,2,2-trichloroethyl)fluoroacetamide**, yield 72%, m.p. 98—100 °C (from benzene). Found (%): Cl, 47.27. $C_4H_5Cl_3FNO_2$. Calculated (%): Cl, 47.39. ^{1}H NMR (acetone-d_6), δ: 4.94 (d, 2 H, $^2J_{HF}$ = 47.1 Hz); 5.98 (d, 1 H, $^3J_{H-NH}$ = 8.7 Hz); 6.35 (br.s, OH); 7.84 (br.d, NH).

***N*-(1-Hydroxy-2,2,2-trichloroethyl)-2-chlorobenzamide**, yield 75%, m.p. 148—149 °C. Found (%): Cl, 46.59. $C_9H_7Cl_4NO_2$. Calculated (%): Cl, 46.81. IR (KBr), ν/cm^{-1}: 1670 (C=O); 3100, 3280 (NH, OH).

The reaction of hydroxyamides 1 with trivalent phosphorus chlorides (general procedure). A solution of chloride **2** (10 mmol) was added to a stirred solution of compound **1** (10 mmol) and Et_3N (12 mmol) in ether or benzene at 10—15 °C. The reaction mixture was stirred at 20 °C for 3 h. After 12 h, the precipitate that formed was filtered off, and the filtrate was washed with water and dried over $MgSO_4$. The solvent was removed and the residue was washed with petroleum ether and purified by recrystallization. If the phosphorus-containing product precipitated with triethylamine hydrochloride (at R' = Ph), the precipitate was washed on the filter with water and dried to give compound **4**. Compounds **4d,j,k,n—p** and **5** have been described in previous reports.[7,8] The characteristics of the new compounds are given in Tables 1 and 2.

***O,O*-Diethyl 1-ethoxycarbonylamino-2,2-dichlorovinyl phosphonate (12a).** Et_3N (4 mmol) was added to a benzene solution of phosphonate **4d** (3 mmol) and stirred at 40—60 °C for 10 h. The precipitate of $Et_3N \cdot HCl$ was filtered off, and the filtrate was washed with water and dried over $MgSO_4$. The solvent was evaporated to give compound **12a** (liquid), yield 89%. Found (%): Cl, 21.56; P, 9.46. $C_9H_{16}Cl_2NO_5P$. Calculated (%): Cl, 22.15; P, 9.68. IR (thin film), ν/cm^{-1}: 1070 (POC); 1275 (P=O); 1590 (C=C); 1750 (C=O); 3270 (NH). ^{1}H NMR ($CDCl_3$), δ: 1.28 (t, 3 H, Me, *J* = 7 Hz); 1.37 (t, 6 H, 2 Me, *J* = 7 Hz); 4.2 (m, 6 H, 3 OCH_2); 6.74 (br.d, 1 H, NH, $^3J_{HP}$ = 2.5 Hz). ^{31}P NMR ($CDCl_3$), δ: 9.15.

Bis(diethylamido)-1-ethoxycarbonylamino-2,2-dichlorovinyl phosphonate (12b) was obtained similarly, yield 78%, m.p. 103—104 °C. Found (%): Cl, 18.57; P, 8.37. $C_{13}H_{26}Cl_2N_3O_3P$. Calculated (%): Cl, 18.95; P, 8.28. ^{1}H NMR (acetone-d_6—CCl_4, 1 : 1), δ: 1.12 (t, 12 H, 4 CH_3CH_2N, *J* = 7 Hz); 1.36 (t, 6 H, 2 CH_3CH_2O, *J* = 7 Hz); 4.10 (q, 2 H, OCH_2, *J* = 7 Hz); 6.99 (br.s, 1 H, NH). ^{31}P NMR ($CDCl_3$), δ: 21.7, 23.4 (10 : 1).

***O,O*-Diethyl 1-acetylamino-2,2-dichlorovinyl phosphonate (12c)** was obtained similarly, liquid, yield 60%. Found (%): Cl, 24.98; P, 10.32. $C_8H_{14}Cl_2NO_4P$. Calculated (%): Cl, 24.44; P, 10.68. ^{1}H NMR (acetone-d_6—CCl_4, 1 : 1), δ: 1.31 (t, 6 H, 2 CH_3CH_2, *J* = 7 Hz); 1.96 (s, 3 H, MeCO); 4.08 (quint, 4 H, 2 OCH_2, $^3J_{HH} \approx {}^3J_{HP} \approx 7$ Hz); 8.84 (br.s, 1 H, NH). ^{31}P NMR, δ: 9.64.

References

1. P. Kafarski and B. Lejczak, *Phosph., Sulf., and Silicon*, 1991, **63**, 193.
2. V. P. Kukhar, V. A. Soloshonok, and V. A. Solodenko, *Phosph., Sulf., and Silicon*, 1994, **92**, 239.
3. G. Uziel and G. P. Genet, *Zh. Org. Khim.*, 1997, **33**, 1605 [*Russ. J. Org. Chem.*, 1997, **33** (Engl. Transl.)].
4. M. I. Kabachnik and T. Ya. Medved', *Dokl. Akad. Nauk SSSR*, 1952, **83**, 689 [*Dokl. Chem.*, 1952 (Engl. Transl.)].
5. E. K. Fields, *J. Am. Chem. Soc.*, 1952, **74**, 1528.
6. B. S. Drach, V. S. Brovarets, and O. S. Smolii, *Sintezy azotsoderzhashchikh geterotsiklicheskikh soedinenii na osnove amidoalkiliruyushchikh agentov* [*Syntheses of Nitrogen-Containing Heterocyclic Compounds Based on Amidoalkylating Agents*], Naukova Dumka, Kiev, 1992 (in Russian).
7. E. A. Suvalova, T. I. Chudakova, P. P. Onys'ko, and A. D. Sinitsa, *Zh. Obshch. Khim.*, 1995, **65**, 1223 [*Russ. J. Gen. Chem.*, 1995, **65** (Engl. Transl.)].
8. P. P. Onys'ko, *Zh. Obshch. Khim.*, 1997, **67**, 1216 [*Russ. J. Gen. Chem.*, 1997, **67** (Engl. Transl.)].
9. A. Köckritz, S. Scheidecker, and M. Schnell, *J. prakt. Chem.*, 1990, **332**, 968.
10. B. S. Drach, E. P. Sviridov, and A. V. Kirsanov, *Zh. Obshch. Khim.*, 1975, **45**, 12 [*J. Gen. Chem. USSR*, 1975, **45** (Engl. Transl.)].
11. P. P. Onys'ko, T. V. Kim, E. I. Kiseleva, V. P. Prokopenko, and A. D. Sinitsa, *Zh. Obshch. Khim.*, 1996, **66**, 1283 [*Russ. J. Gen. Chem.*, 1996, **66** (Engl. Transl.)].
12. J. Oleksyszyn, *J. prakt. Chem.*, 1987, **329**, 19.
13. M. Soroka, D. Javorska, and Z. Szczesny, *Lieb. Ann.*, 1990, 115; M. Soroka, *Lieb. Ann.*, 1990, 331.
14. M. Soroka, *Synthesis*, 1989, 547.
15. B. S. Drach and E. P. Sviridov, *Zh. Obshch. Khim.*, 1973, **43**, 1648 [*J. Gen. Chem. USSR*, 1973, **43** (Engl. Transl.)].
16. M. V. Vovk, P. P. Onys'ko, and A. V. Bol'but, *Zh. Obshch. Khim.*, 1996, **32**, 1432 [*Russ. J. Org. Chem.*, 1996, **32** (Engl. Transl.)].

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