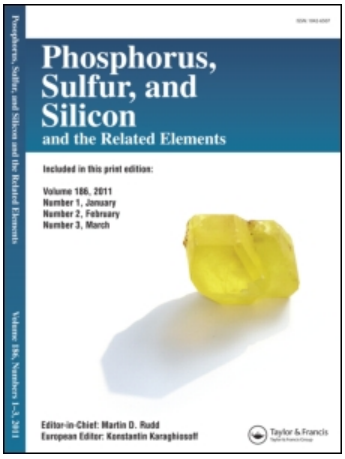

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THE REACTIONS OF DIETHYL 2,3-DIHYDRO-4H-1,3-BENZOXAZIN-4-ONE-2-PHOSPHONATE WITH NUCLEOPHILES

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The reactions of diethyl 2,3-dihydro-4H-1,3-benzoxazin-4-one-2-phosphonate with nucleophilic reagents (nitric, organophosphoric, and sulfuric) were investigated. Two lines of derivatives were obtained: *N*-salicyloylaminomethanephosphonates **2** and *N*-salycyloylaminoformamidine **3**.

Key words: 2,3-Dihydro-4H-1,3-benzoxazin-4-one-2-phosphonate; reactions with nucleophilic reagents.

The derivatives of 2,3-dihydro-4H—1,3-benzoxazin-4-one are interesting for both chemical[1–5] and biological[6–8] reasons. In their structure they are similar to the well known derivatives of benzo-γ-pyron of known and described pharmacological activity.[9]

So far there have been no reports on the synthesis of phosphoric derivatives of this system. The exception are patents concerning phosphoric esters of *N*-hydroxy-2,2-dialkyl-2,3-dihydrobenzoxazin-4-one.[10]

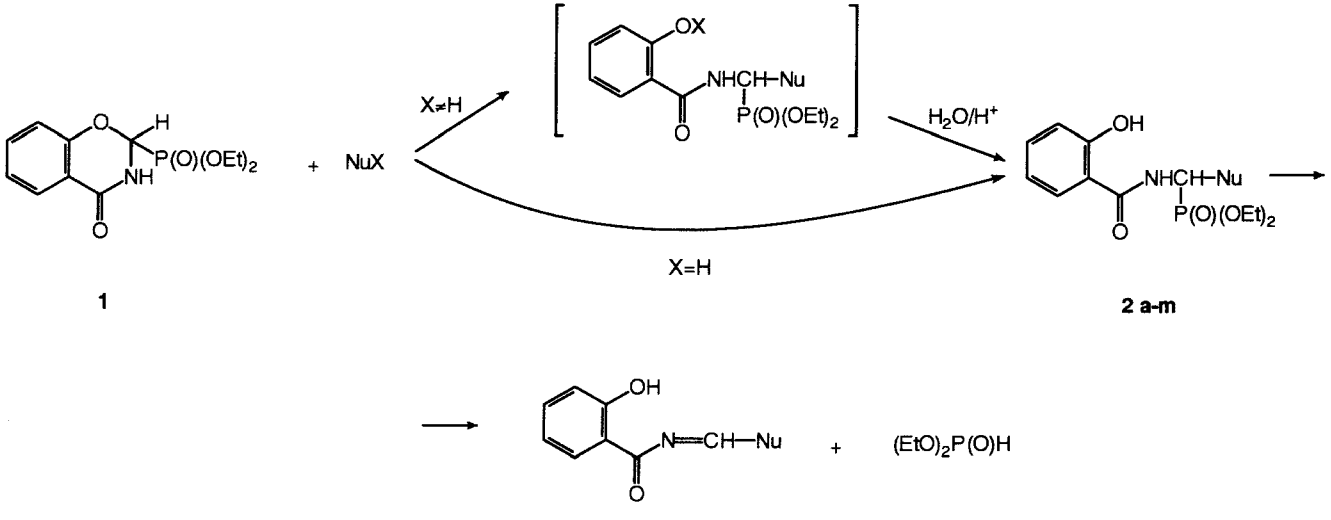
In our previous paper[11] we have described the synthesis and properties of diethyl 2,3-dihydro-4H-1,3-benzoxazin-4-one-2-phosphonate, a new compound of the structure of 2-phosphono-3-azachromanone. Its reactivity with some nucleophilic reagents was then presented. The reactions followed Scheme 1 with the formation of type **2** compounds. An exception was the reaction with pyrrolidine, where the product was formamidine, not containing phosphorus.

The varied reactivity of compound **1** with nitric nucleophiles caused our greater interest in these conversions. Reactions with other nucleophilic reagents were performed. A number of interesting organophosphoric salicylamide derivatives (**2**) were obtained. Primary and secondary-order amines, thiols, and sodium ethoxide, and from organophosphoric compounds—diphenyltrimethylsilyloxyphosphine, triethyl phosphite, and the sodium salt of diethyl thiophosphite were used as nucleophiles.

The reactions were carried out in ethanol, tetrahydrofurane, benzene, or toluene at various temperatures. In the majority of cases the reaction followed Scheme 1.

In the case of the reactions with thiols base catalysis (potassium *t*-butoxide) had to be used. Sodium ethoxide and diethyl thiophosphite sodium salt open the dihydroxazinone ring and form addition products **2** already at room temperature. Diphenyltrimethylsilyloxyphosphine reacts in the same way at the temperature of boiling toluene. Triethyl phosphite does not react with compound **1**. It is a too weak nucleophile.

The reactions of compound **1** with nitric nucleophilic reagents differed in course depending on their basicity (Table I). Morpholine (pK = 5.30), benzylamine (pK = 4.38), tert-butylamine (pK = 3.55), and cyclohexylamine (pK = 3.36) form



	a	b	c	d	e	f	g
Nu	EtS-	iPrS-	tBuS-	PhS-	EtO-	$Ph_2P(O)$-	$(EtO)_2P(S)$-
X	K	K	K	K	Na	$SiMe_3$	Na

	h	i	k	l	m	n	o
Nu	$O(CH_2CH_2)_2N$-	$PhCH_2NH$-	tBuNH-	$C_6H_{11}NH$-	$CH_2(CH_2CH_2)_2N$-	$(CH_2)_4N$-	Me_2N-
X	H	H	H	H	H	H	H

SCHEME 1

TABLE I

Amine	pK	Product	Reaction time in hours*/						R_F**/	UV 365nm
			2	5	9	24	48	72		
Morpholine	5,30	2h	o	o	o	O	O	O	0,27	B
		3h								
Benzylamine	4,38	2i	o	o	o	O	O	O	0,37	B
		3i								
t-Butylamine	3,55	2k	o	o	o	O	O	O	0,38	B
		3k								
Cyclohexylamine	3,36	2l	O	O	O	O	O	O	0,39	B
		3l								
Piperidine	2,88	2m	O	O	O	O	O	O	0,46	B
		3m	o	o	O	O	O	O	0,54	G
Pyrrolidine	2,73	2n	o	O	O	O	O	O	0,33	B
		3n	o	O	O	O	O	O	0,46	G
Dimethylamine	3,29	2o	o	o	O	O	o	o	0,25	B
		3o	o	o	O	O	O	O	0,38	G

*/ Reactions performed with 50 mg of substrate, in 1 ml of ethanol, at 2-fold excess of the amine, at r.t.

**/ Reaction course was controlled chromatographically (silica gel plates MERCK art. 5554, chloroform:acetone 4:1).

B = blue fluorescence and G = green fluorescence.

products **2** quickly and with good yield. Amines as weak as aniline (pK = 9.42) and imidazole (pK = 6.97) were non-reactive and did not undergo these conversions. In reactions with strong bases compounds **2** and **3** were formed (Scheme 1). Both the products were separated after the reaction with piperidine (pK = 2.88). It has been found out that in conditions different from those used previously[11] (4°, tetrahydrofurane) pyrrolidine (pK = 2.73) forms compound **2n** which already at room temperature decomposes to pyrrolidinoformamidine (**3n**) with the elimination of diethyl phosphite. In the reaction of compound **1** with dimethylamine (pK = 3.29) we did not manage to separate compound **2o** even at low temperature, despite the fact of its presence in the reaction mixture (spectrum ^{31}P-NMR, TLC). Each time we received product **3o** and diethyl phosphite.

It has also been found that products **2** with amines have, in contrast to the other ones, unclear melting points and their mass spectra show the lack of molecular ion.

Thermogravimetric investigations of four chosen compounds (**2i**, **2h**, **2k**, **2m**) have shown that decomposition connected with marked loss of mass starts almost at the same time as melting. The exception here was only the product with benzylamine (**2i**) which started to decompose 25–30° above the melting point.

While summing up it must be stated that there exists a great range in the stability of amine derivatives of *N*-phosphonomethylsalicylamide: from the none isolable product of reaction with dimethylamine (**2o**) through the compound with pyrrolidine (**2n**) decomposing (in solution) at room temperature, to the more stable one with piperidine (**2m**), up to the stable connections with the remaining amines (**2h–l**). Compound **2i** obtained from benzylamine did not undergo elimination to formamidine even in boiling xylene. Multidirectional slow decomposition occurred (controlled by TLC).

EXPERIMENTAL

All melting points are uncorrected. IR spectra were performed on Pye-Unicam 200G spectrometer, ^{1}H NMR spectra were recorded at 60 MHz by means of Varian EM-360 spectrometer, and ^{31}P NMR at 81.01 MHz by means of Brucker AC 200 spectrometer. Mass spectra were performed by means of LKB 2091 Mass Spectrometer (with ionization energy 70 eV). Thermograms were obtained from Derivatograph Q 1500 Hungarian Optical Works. TLC analysis were obtained on silica gel plates (Art. 5554 Merck) For column chromatography 70–230 mesh silica gel was used (Art. 7734 Merck).

Diethyl N-salicyloyl-1-ethylthioaminomethanephosphonate (**2a**). To the suspension of **1** (0.70 g, 2.5 mmol) in tetrahydrofurane (10 ml) ethanethiol (0.3 ml, 0.5 mmol) and potassium tert-butoxide (0.05 g, 0.5 mmol) were added. After several hours of stirring at room temperature acetic acid was added (2–3 drops) and the excess of thiol as well as the solvent were removed under reduced pressure. The product was separated from the residue by means of column chromatography (chloroform-acetone 9:1, R_F = 0.30). After crystallization from the mixture of diisopropyl ether and benzene 0.40 g of **2a** were received, mp. 114–116°C, yield 46%.

$C_{14}H_{22}NO_5PS$	calc.	C 48.40	H 6.39	N 4.03	P 8.92	S 9.23%
(347.4)	found	48.55	6.52	4.02	8.80	9.04%

MS: m/z (%) = 347 (M^+, 8.4), 148 (47), 121 (100), 90 (13), 28 (15)

^{1}H NMR ($CDCl_3$): δ (ppm) = 1.00–1.60 (m, 9H, 3x**CH$_3$**CH$_2$, $^3J_{HH}$ = 7 Hz), 2.45 (q, 2H, -SCH$_2$, $^3J_{HH}$ = 7 Hz), 4.15 and 4.27 (2 dq, 4H, POCH$_2$), 5.70 (dd, 1H, NH**CH**P, $^2J_{PCH}$ = 18 Hz, $^3J_{HNCH}$ = 9 Hz), 6.60–8.00 (m, 4H$_{arom}$), 8.47 (d, 1H, NH, $^3J_{HCNH}$ = 9 Hz), 11.88 (s, 1H, OH)

^{31}P NMR ($CDCl_3$) δ (ppm) = 19.2

IR (KBr): ν (cm^{-1}) = 3200, 2900, 1635, 1590, 1530, 1220, 1050, 1020, 765

Diethyl N-salicyloyl-1-isopropylthioaminomethanephosphonate (**2b**). Obtained according to the method described for **2a**: compound **1** (0.70 g, 2.5 mmol), and isopropanthiol (0.4 ml, 4.3 mmol). After crystallization from diisopropyl ether 0.44 g of **2b** were obtained, mp. 118–120°C, yield 49%.

$C_{15}H_{24}NO_5PS$	calc.	C 49.85	H 6.69	N 3.88	P 8.57	S 8.87%
(361.4)	found	49.89	6.99	3.79	8.56	8.78%

MS: m/z (%) = 361 (M^+, 3.4), 148 (35), 121 (100), 104 (11), 65 (13)

^{1}H NMR ($CDCl_3$): δ (ppm) = 1.08–1.62 (m, 12H, 4xCH$_3$), 3.17 (m, 1H, **CH**(CH$_3$)$_2$, $^3J_{HCCH}$ = 6 Hz), 4.18 and 4.28 (2dq, 4H, POCH$_2$,), 5.77 (dd, 1H, NH**CH**P, $^2J_{PCH}$ = 19 Hz, $^3J_{HNCH}$ = 9 Hz), 6.60–8.10 (m, 4H$_{arom}$), 8.83 (d, 1H, NH, $^3J_{HCNH}$ = 9 Hz), 11.60 (broad, 1H, OH)

^{31}P NMR ($CDCl_3$) δ (ppm) = 17.9

IR (KBr): ν (cm^{-1}) = 3200, 2900, 1635, 1590, 1530, 1335, 1220, 1050, 1020, 765

Diethyl N-salicyloyl-1-tert-butylthioaminomethane phosphonate (**2c**). Obtained according to the method described for **2a**: compound **1** (0.70 g, 2.5 mmol) and tertbutanthiol (0.4 ml, 3.8 mmol). After crystallization from the mixture of diisopropyl ether and benzene 0.20 g of **2c** were obtained, mp. 173–175°C, yield 49%.

$C_{16}H_{26}NO_5PS$	calc.	C 51.19	H 6.98	N 3.73	P 8.25	S 8.54%
(375.4)	found	51.10	6.88	3.85	8.19	8.67%

MS: m/z (%) = 375 (M^+, 4.8), 148 (48), 121 (100), 65 (10), 57 (10)

^{1}H NMR ($CDCl_3$): δ (ppm) = 1.00–1.55 (m, 6H, 2xOCH$_2$**CH$_3$**), 1.32 (s, 9H, C(CH$_3$)), 4.17 and 4.28 (2dq, 4H, 2xO**CH$_2$**CH$_3$), 5.80 (dd, 1H, NH**CH**P, $^2J_{PCH}$ = 20 Hz, $^3J_{HNCH}$ = 9 Hz), 6.68–8.10 (m, 4H$_{arom}$), 8.83 (d, 1H, NH, $^3J_{HCNH}$ = 9 Hz), 11.60 (broad, 1H, OH)

^{31}P NMR ($CDCl_3$) δ (ppm) = 18.0

Diethyl N-salicyloyl-1-phenylthioaminomethanephosphonate (**2d**). Obtained according to the method described for **2a**: compound **1** (0.70 g, 2.5 mmol) and thiophenol (0.275 g, 2.5 mmol). The product was purified by means of column chromatography (chloroform, R_F = 0.21). After crystallization from the mixture of diisopropyl ether and benzene 0.60 g of **2d** were obtained, mp. 118–120°C, yield 60%.

$C_{18}H_{22}NO_5PS$	calc.	C 54.67	H 5.61	N 3.54	P 7.83	S 8.11%
(395.4)	found	54.42	5.72	3.46	8.03	7.95%

MS: m/z (%) = 395 (M^+, 20), 286 (13), 166 (16), 148 (82), 139 (19), 121 (100), 110 (32), 93 (11), 65 (16), 29 (15)

^{1}H NMR ($CDCl_3$): δ (ppm) = 1.25 and 1.37 (2t, 6H, 2x$OCH_2\mathbf{CH_3}$), 4.17 and 4.28 (2 dq, 4H, 2x$\mathbf{OCH_2}CH_3$), 5.97 (dd, 1H, NH**CHP**, $^2J_{PCH}$ = 17 Hz, $^3J_{HNCH}$ = 9 Hz), 6.57–7.87 (m, $9H_{arom}$), 8.42 (d, 1H, NH, $^3J_{HCNH}$ = 9 Hz), 11.62 (s, 1H, OH)

^{31}P NMR ($CDCl_3$) δ (ppm) = 17.3

IR (KBr): ν (cm^{-1}) = 3200, 3020, 2910, 1635, 1590, 1530, 1340, 1240, 1060, 760

Diethyl N-salicyloyl-1-ethoxyaminomethanephosphonate (**2e**). To the solution of sodium ethoxide (from 0.04 g sodium) in ethanol (4 ccm) compound **1** (0.50 g, 1.75 mmol) was added with vigorous stirring. The formed clear solution was stirred at room temperature for several hours and neutralized with acetic acid (0.12 ml). Ethanol was distilled off under reduced pressure and the residue was separated on a chromatographic column (chloroform-aceton 4:1, R_F = 0.33). After crystallization from the mixture of diisopropyl ether and benzene 0.28 g of **2e** were obtained, mp. 116–118°C, yield 48%.

$C_{14}H_{22}NO_6P$	calc.	C 50.75	H 6.69	N 4.23	P 9.35%
(331.3)	found	50.91	6.75	4.00	9.25%

MS: m/z (%) = 331 (M^+, 3.2), 285 (25), 194 (18), 193 (23), 148 (100), 121 (98), 120 (58), 93 (19), 92 (22), 74 (59), 65 (29), 46 (17), 39 (12), 29 (20), 27 (11)

^{1}H NMR ($CDCl_3$): δ (ppm) = 0.83–1.53 (m, 9H, $3xCH_3$), 3.40–4.50 (m, 6H, $3xCH_2$), 5.70 (dd, 1H, **HNCHP**, $^2J_{PCH}$ = 9 Hz, $^3J_{HNCH}$ = 9 Hz), 6.60–7.80 (m, $4H_{arom}$ and NH), 11.67 (broad, 1H, OH)

^{31}P NMR ($CDCl_3$) δ (ppm) = 16.7

IR (KBr): ν (cm^{-1}) = 3340, 3060, 2980, 1605, 1550, 1450, 1200, 1030, 750

Diethyl N-salicyloyl-1-diphenylphosphinylaminomethanephosphonate (**2f**).[11] Into the suspension of **1** (2.8 g, 10 mmol) in anhydrous toluene (15 ml) diphenyltrimethylsililoxyphosphine (3 ml, 11 mmol) was added. The mixture was heated at boiling temperature in the atmosphere of dry argon for 7 hours. After cooling, water was added to the mixture (0.3 ml) and it was vigorously shaken. The formed white precipitate was filtered off, washed with toluene, and crystallized from ethanol. 2.3 g of **2f** were obtained, mp. 233–235°C, yield 47%.[11]

Diethyl N-salicyloyl-1-diethylthionophosphoryl-aminomethanephosphonate (**2g**). Compound **1** (0.70 g, 2.5 mmol) in benzene (8 ml) was added to sodium salt of diethyl thiophosphite (from 0.39 g of thiophosphite and 0.1 g of sodium hydride in oil, 60%, 2.5 mmol) in benzene (6 ml). After several hours of stirring at room temperature acetic acid (0.2 ml) was added for neutralization. The mixture was washed with water (3 × 3 ml) and the organic layer was dried with anhydrous Na_2SO_4. After evaporation of the solvent the crude product was separated on a chromatographic column (chloroform-acetone 9:1, R_F = 0.43) and crystallized from the mixture of diisopropyl ether and benzene. 0.50 g of **2g** were obtained, mp. 107–109°C, yield 46%.

$C_{16}H_{27}NO_7P_2S$	calc.	C 43.73	H 6.19	N 3.19	P 14.10	S 7.30%
(439.4)	found	43.88	6.25	3.24	14.16	7.60%

MS: m/z (%) = 439 (M^+, 7), 393 (30), 287 (4), 148 (11), 121 (100), 93 (12), 65 (12), 29 (13)

^{1}H NMR ($CDCl_3$): δ (ppm) = 1.07–1.57 (m, 12H, $4xCH_3$), 3.83–4.52 (m, 8H, $4xCH_2$), 5.28 (dt, 1H, **HNCHP**, $^2J_{PCH}$ = 20 Hz, $^3J_{HNCH}$ = 10 Hz), 6.67–7.70 (m, $4H_{arom}$ and NH), 11.43 (s, 1H, OH)

^{31}P NMR ($CDCl_3$) δ (ppm) = 16.0 (d) and 83.3 (d, $2J_{PCP}$ = 37 Hz)

IR (KBr): ν (cm^{-1}) = 3210, 2940, 1635, 1590, 1545, 1340, 1250, 1050, 765

Diethyl N-salicyloyl-1-morpholylaminomethanephosphonate (**2h**). Morpholine (0.25 ml, 2.9 mmol) was added to compound **1** (0.70 g, 2.5 mmol) in absolute ethanol (5 ml). The mixture was left at room temperature for four days. The solvent was removed under reduced pressure. The obtained colourless oil, which after some time crystallized, was recrystallized from the mixture of ethanol and petrol ether. 0.90 g of **2h** were obtained, mp. 138–140°C, yield 97%.

$C_{16}H_{25}N_2O_6P$	calc.	C 51.61	H 6.77	N 7.53	P 8.32%
(372.4)	found	51.62	6.95	7.19	8.36%

MS: m/z (%) = 285 (M-87, 8), 234 (8), 148 (100), 121 (69), 120 (10), 92 (15), 65 (18), 57 (12), 29 (13), 28 (11)

^{1}H NMR ($CDCl_3$): δ (ppm) = 1.20 and 1.43 (2t, 6H, 2xCH_3), 2.30–3.20 and 3.62 (2m, 8H, morpholyl), 4.00 and 4.27 (2 dq, 4H, 2xCH_2), 5.38 (dd, 1H, HN**CH**P, $^2J_{PCH}$ = 21 Hz, $^3J_{HNCH}$ = 9 Hz), 6.57–7.95 (m, 4H_{arom}), 8.28 (dd, 1H, NH, $^3J_{HCNH}$ = 9 Hz, $^2J_{PCNH}$ = 3 Hz), 11.37 (broad, 1H, OH)

^{31}P NMR ($CDCl_3$) δ (ppm) = 17.4

IR (KBr): ν(cm^{-1}) = 3140, 2900, 1620, 1570, 1510, 1220, 1040, 755

Diethyl N^1-benzyl N^2-salicyloyldiaminomethanephosphonate (**2i**).[11] Obtained as **2h** from compound **1** (0.70 g, 2.5 mmol) and benzylamine (0.3 ml, 2.7 mmol). Reaction time is two days. Crystallized from ethanol. Obtained 0.70 g of **2i**, mp. 102–103°C, yield 71%.[11]

Diethyl N^1-tert-butyl-N^2-salicyloyldiaminomethanephosphonate (**2k**). Obtained as **2h** from compound **1** (0.70 g, 2.5 mmol) and tert-bytylamine (0.3 ml, 2.9 mmol). Reaction time is two days. Crystallized from ethanol. Obtained 0.57 g of **2k**, mp. 128–130°C, yield 64%.

$C_{16}H_{27}N_2O_5P$	calc.	C 53.62	H 7.60	N 7.82	P 8.64%
(358.4)	found	53.75	7.67	7.89	8.65%

MS: m/z (%) = 307 (M-51, 29), 285 (1.7), 186 (99.9), 148 (14), 130 (18), 129 (47), 124 (85), 121 (17), 120 (16), 114 (49), 101 (17), 99 (17), 98 (22), 97 (16), 96 (17), 87 (12), 86 (55), 82 (14), 71 (11), 70 (57), 69 (61), 58 (32), 57 (53), 55 (68), 45 (14), 44 (12), 43 (26), 42 (44), 41 (68), 39 (19), 36 (12), 32 (12), 30 (19), 29 (84), 28 (100), 27 (39), 18 (32)

^{1}H NMR ($CDCl_3$): δ (ppm) = 1.10 (s, 9H, C(CH_3)), 1.23 and 1.40 (2t, 6H, 2xOCH_2**CH_3**), 2.38 (broad, 1H, NH—C(CH_3)), 4.08 and 4.27 (2 dq, 4H, 2x**OCH_2**CH_3), 5.47 (dd, 1H, HN**CH**P, $^2J_{PCH}$ = 17 Hz, $^3J_{HNCH}$ = 8 Hz), 6.50–7.90 (m, 4H_{arom}), 8.87 (d, 1H, NH, $^3J_{HCNH}$ = 8 Hz), 12.50 (s, 1H, OH)

^{31}P NMR ($CDCl_3$) δ (ppm) = 19.8

IR (KBr): ν (cm^{-1}) = 3170, 2895, 1605, 1670, 1510, 1325, 1215, 1030, 750

Diethyl N^1-cyclohexyl-N^2-salicyloyldiaminomethanephosphonate (**2l**). Obtained as **2h** from compound **1** (0.50 g, 1.75 mmol) and cyclohexylamine (0.22 ml, 1.9 mmol). Reaction time is 16 hours. Crystallized from diisopropyl ether. Obtained 0.33 g of **2l**, mp. 124–126°C, yield 49%.

$C_{18}H_{29}N_2O_5P$	calc.	C 56.24	H 7.60	N 7.29	P 8.06%
(384.4)	found	56.14	7.45	7.05	8.16%

MS: m/z (%) = 285 (M-99, 8.5), 246 (5.9), 148 (100), 121 (55), 120 (13), 93 (11), 92 (17), 65 (20), 39 (12), 29 (16), 28 (10), 27 (13)

^{1}H NMR ($CDCl_3$): δ (ppm) = 0.75–2.40 (m, 11H, cyclohexyl), 1.25 and 1.43 (2t, 6H, 2xCH_3), 2.67 (broad, 1H, NH-cyclohexyl), 4.17 and 4.37 (2 dq, 4H, 2x**OCH_2**CH_3), 5.57 (m, 1H, HN**CH**P), 6.67–8.10 (m, 4H_{arom}), 8.76 (d, 1H, C(O)**NH**CH, $^3J_{HCNH}$ = 9 Hz), 12.56 (broad, 1H, OH)

^{31}P NMR ($CDCl_3$) δ (ppm) = 19.9

IR (KBr): ν(cm^{-1}) = 3260, 2920, 2840, 1590, 1550, 1500, 1315, 1200, 1030, 960, 750

Diethyl N-salicyloyl-1-piperydylaminomethanephosphonate (**2m**) *and N-salicyloylpiperidinoformamidine* (**3m**). Piperidine (0.18 ml, 1.8 mmol) was added to the suspension of **1** (0.50 g, 1.75 mmol) in absolute ethanol. The mixture was left at room temperature for 16 hours. The solvent was evaporated under reduced pressure. The residue was separated on a chromatographic column (chloroform-acetone 10:1). Two reaction products were obtained: **2m** (R_F = 0.31) and **3m** (R_F = 0.46). They were crystallized from the mixture of tetrahydrofurane and petrol ether:

compound **2m**: 0.35 g mp. 114–116°C yield 54%

$C_{17}H_{27}N_2O_5P$	calc.	C 55.12	H 7.35	N 7.57	P 8.36%
(370.4)	found	55.44	7.26	7.66	8.19%

MS: m/z (%) = 234 (21), 233 (M-137, 37), 232 (21), 148 (30), 121 (46), 120 (10), 113 (61), 111 (18), 93 (15), 92 (14), 85 (31), 84 (100), 83 (21), 65 (21), 57 (22), 56 (26), 44 (14), 43 (13), 42 (17), 41 (17), 39 (19), 36 (15), 30 (14)), 29 (28), 28 (29), 27 (22),

^{1}H NMR ($CDCl_3$): δ (ppm) = 1.00–1.77 (m, 12H, 2xCH_3 and 3,4,5-H in piperydyl), 2.73 (m, 4H, 2,6-H in piperydyl), 3.65–4.50 (m, 4H, 2x**OCH_2**CH_3), 5.33 (dd, 1H, HN**CH**P, $^2J_{PCH}$ = 20 Hz, $^3J_{HNCH}$ = 9 Hz), 6.55–7.90 (m, 4H_{arom}), 8.10 (d, 1H, NH, $^3J_{HCNH}$ = 9 Hz), 11.70 (broad, 1H, OH)

^{31}P NMR ($CDCl_3$) δ (ppm) = 18.2

IR (KBr): ν (cm^{-1}) = 3140, 2840, 1610, 1570, 1510, 1325, 1230, 1020, 745

compound **3m**: 0.08 g mp. 127–129°C yield 20%

$C_{13}H_{16}N_2O_2$ calc. C 67.22 H 6.94 N 12.06%
(232.3) found 67.56 6.78 12.12%

MS: m/z (%) = 233 (15), 232 (M^+, 98), 148 (29), 139 (15), 121 (69), 120 (20), 111 (21), 93 (19), 92 (34), 85 (70), 84 (100), 83 (12), 70 (12), 69 (14), 65 (52), 64 (14), 63 (15), 57 (19), 56 (33), 55 (10), 42 (13), 41 (31), 39 (38), 29 (11), 28 (22), 27 (11)

^{1}H NMR ($CDCl_3$): δ (ppm) = 1.73 (m, 6H, 3,4,5-H in piperydyl), 3.30–3.80 (m, 4H, 2,6-H in piperydyl), 6.60–8.10 (m, $4H_{arom}$), 8.67 (s, 1H, N=CH—N), 13.23 (s, 1H, OH) IR (KBr): ν (cm^{-1}) = 2930, 1605, 1545, 1420, 1310, 1080, 1005, 755, 690

Diethyl N-salicyloyl-1-pyrrolidylaminomethanephosphonate (**2n**) *and N-salicyloylpyrrolidinoformamidine* (**3n**).[11] The mixture of **1** (0.50 g, 1.75 mmol) and pyrrolidine (0.15 ml, 1.8 mmol) in tetrahydrofurane (3 ml) was left for several days at 4°C. The crystalline residue of crude **2n** was filtered off, 0.12 g were obtained, mp. 118–123°C, yield 19%.

$C_{16}H_{25}N_2O_5P$ calc. C 53.92 H 7.07 N 7.86 P 8.69%
(356.4) found 56.56 7.45 9.32 7.10%

^{31}P NMR ($CDCl_3$) δ (ppm) = 20.7

Petrol ether (4 ml) was added to the filtrate and it was left standing at 4°C. 0.22 g of compound **3n** were obtained, mp. 127–128°C, yield 58%.[11]

N^1,N^1-Dimethyl-N^2-salicyloylformamidine (**3o**). The solution of dimethylamine (0.1 g, 2.2 mmol) in ethanol was added to the suspension of **1** (0.50 g, 1.75 mmol) in absolute ethanol (5 ml). The mixture was left at room temperature for 16 hours. Under reduced pressure the light-yellow solution was condensed to ¼ of its volume, petrol ether was added (3 ml) and the flask was placed in a refrigerator. 0.12 g of a yellow, crystalline substance were obtained. 0.08 g of the compound were additionally separated from the filtrate. 0.20 g of **3o** were obtained, mp. 123–125°C, yield 60%.

$C_{10}H_{12}N_2O_2$ calc. C 62.48 H 6.29 N 14.58%
(192.2) found 62.35 6.18 14.28%

MS: m/z (%) = 193 (18), 192 (M^+, 79), 148 (63), 121 (100), 120 (15), 99 (23), 93 (19), 92 (25), 73 (15), 65 (37), 64 (11), 63 (14), 57 (14), 44 (99.5), 43 (18), 42 (18), 39 (25), 28 (12)

^{1}H NMR ($CDCl_3$): δ (ppm) = 3.10 and 3.17 (2s, 6H, 2xCH_3), 6.60–8.10 (m, $4H_{arom}$), 8.60 (s, 1H, N=CH—N), 13.20 (s, 1H, OH)

IR (KBr): ν (cm^{-1}) = 2920, 1620, 1560, 1425, 1315, 1080, 910, 755, 700

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