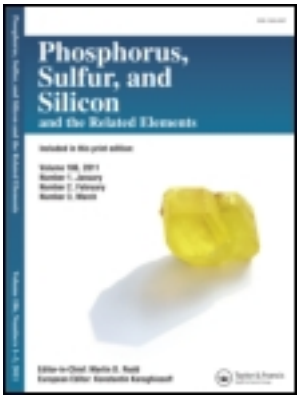
This article was downloaded by: [East Carolina University]
On: 20 September 2013, At: 11:11
Publisher: Taylor & Francis
Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Phosphorus, Sulfur, and Silicon and the Related Elements

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gpss20

Amidoalkylating Properties of 1-(N-Acylamino)Alkyltriphenylphosphonium Salts

Agnieszka Październiok-Holewa [a], Jakub Adamek [a], Roman Mazurkiewicz [a] & Katarzyna Zielińska [a]

[a] Department of Organic Chemistry, Biochemistry and Biotechnology, Silesian University of Technology, Krzywoustego 4, PL 44-100, Gliwice, Poland

Published online: 08 May 2013.

To cite this article: Agnieszka Październiok-Holewa, Jakub Adamek, Roman Mazurkiewicz & Katarzyna Zielińska (2013) Amidoalkylating Properties of 1-(N-Acylamino)Alkyltriphenylphosphonium Salts, Phosphorus, Sulfur, and Silicon and the Related Elements, 188:1-3, 205-212, DOI: 10.1080/10426507.2012.744014

To link to this article: http://dx.doi.org/10.1080/10426507.2012.744014

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms &

Conditions of access and use can be found at http://www.tandfonline.com/page/terms-and-conditions

Downloaded by [East Carolina University] at 11:11 20 September 2013

Phosphorus, Sulfur, and Silicon, 188:205–212, 2013
Copyright © Taylor & Francis Group, LLC
ISSN: 1042-6507 print / 1563-5325 online
DOI: 10.1080/10426507.2012.744014

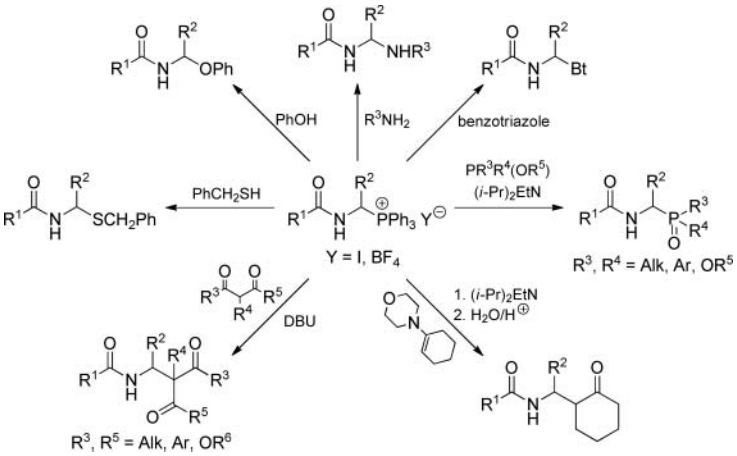
Downloaded by [East Carolina University] at 11:11 20 September 2013

AMIDOALKYLATING PROPERTIES OF 1-(*N*-ACYLAMINO)ALKYLTRIPHENYLPHOSPHONIUM SALTS

Agnieszka Październiok-Holewa, Jakub Adamek, Roman Mazurkiewicz, and Katarzyna Zielińska

Department of Organic Chemistry, Biochemistry and Biotechnology, Silesian University of Technology, Krzywoustego 4, PL 44-100 Gliwice, Poland

GRAPHICAL ABSTRACT



Abstract *Easily accessible 1-(N-acylamino)alkyltriphenylphosphonium salts react smoothly with nitrogen, sulfur, phosphorus and oxygen nucleophiles in the presence of (i-Pr)$_2$EtN to give the expected α-amidoalkylation products, usually in good or very good yields. α-Amidoalkylation of dialkyl malonates or acetylacetates requires the application of a much stronger base (DBU) and gives the best results under the influence of microwave irradiation. α-Amidoalkylation of enamines was carried out successfully in the presence of (i-Pr)$_2$EtN in a microwave reactor. 1-(N-Acylamino)alkyltriphenylphosphonium salts can be considered as new, convenient and effective α-amidoalkylation agents.*

Keywords α-Amidoalkylation; 1-(*N*-acylamino)alkyltriphenylphosphonium salts; nucleophilic substitution; enamines

Received 14 September 2012; accepted 23 October 2012.

The financial help of the Ministry of Science and Higher Education of Poland (Grant No. N N204 165636) is gratefully acknowledged.

Address correspondence to Agnieszka Październiok-Holewa, or Roman Mazurkiewicz, Department of Organic Chemistry, Biochemistry and Biotechnology, Silesian University of Technology, Krzywoustego 4, PL 44-100 Gliwice, Poland. E-mail: roman.mazurkiewicz@polsl.pl or agnieszka.pazdzierniok@polsl.pl

INTRODUCTION

α-Aminoalkylation and α-amidoalkylation reactions play an important role in organic synthesis, especially in pharmaceutical chemistry.[1–5] The Mannich reaction, being the best known aminoalkylation reaction, has two important limitations: (i) it is limited, with few exceptions, to α-aminomethylation, and (ii) aminomethylation products (Mannich bases) easily undergo various kinds of secondary reactions that are difficult to avoid.[1,6,7] The α-amidoalkylation reaction can be considered as an important extension to the Mannich reaction.[5,7] Numerous α-amidoalkylating reagents of a general structure **1** have been reported, where X represents some nucleofugal leaving group, usually OH, OR, OCOR, Cl, Br, NHCOR, SO_2Ar, 1-benzotriazolyl or OTMS.[5,7–10] Limitations and disadvantages of α-amidoalkylation methods with the participation of most of the abovementioned amidoalkylating agents were reviewed by Katritzky et al.[4,5,7] (Figure 1).

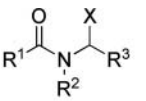
Recently, we have described three independent, efficient methods for the synthesis of 1-(*N*-acylamino)alkyltriphenylphosphonium salts **6** (Scheme 1).[11–15] In this paper, we describe the application of 1-(*N*-acylamino)alkyltriphenylphosphonium salts **6** as new versatile and effective amidoalkylating reagents for the α-amidoalkylation of a variety of nucleophiles (Scheme 1).

RESULTS AND DISCUSSION

1-(*N*-Acylamino)alkyltriphenylphosphonium salts **6** react smoothly with nitrogen, sulfur and oxygen nucleophiles with an active proton in the presence of catalytic amounts of $(i\text{-Pr})_2$EtN (Hünig's base) at 60°C or even at room temperature in a sealed glass vial to give the expected α-amidoalkylation products **7**, usually in good or even very good yields (Scheme 1, Table I, Procedure A). However, in reaction with phenol, the reaction yield was poor.

C—H Acids, e.g., dialkyl malonates or acetylacetates, do not react with 1-(*N*-acylamino)alkyltriphenylphosphonium salts **6** in the presence of the Hünig's base; the amidoalkylation of these compounds can be carried out, however, in the presence of the much stronger organic bases, e.g., DBU (Scheme 1, Table I, Procedure B). Application of microwave irradiation accelerated reactions with C—H acids and markedly improved reaction yields.

α-Amidoalkylation of carbon nucleophiles with 1-(*N*-acylamino)alkyltriphenylphosphonium salts **6** was successfully extended to enamines. The reactions were carried out in

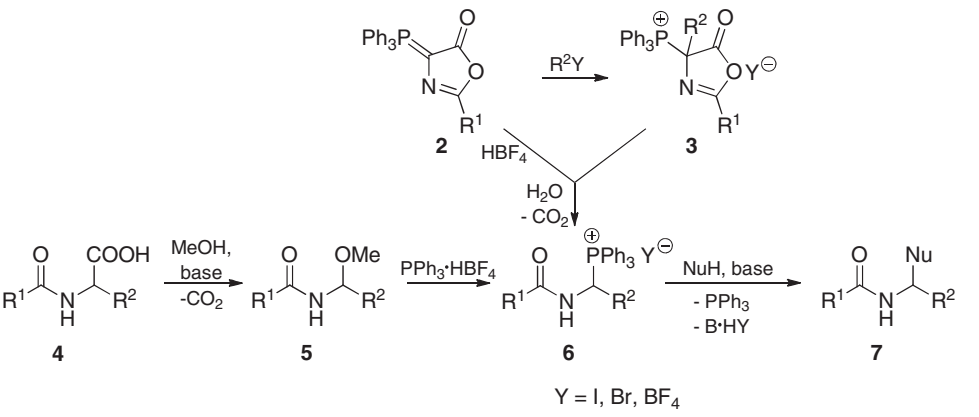


1

X = OH, OR, OCOR, halogen, NHCOR, SO_2Ar, 1-benzotriazolyl, OTMS

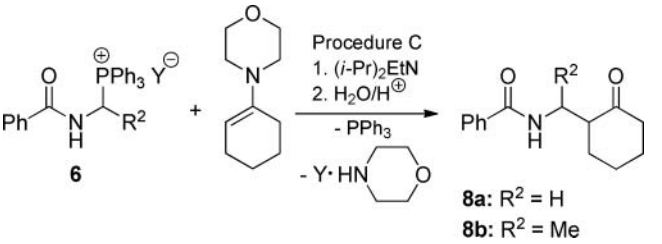
Figure 1

Downloaded by [East Carolina University] at 11:11 20 September 2013



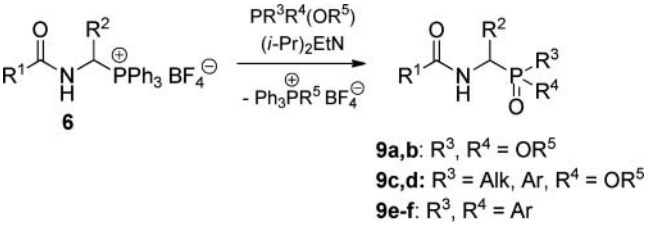
Scheme 1

the presence of the Hünig's base under the influence of microwave irradiation (Scheme 2, Table I, Procedure C).



Scheme 2

Reactions with trialkyl phosphites, dialkyl phosphonites and alkyl phosphinites gave the expected product of the Michaelis-Arbuzov-like reaction in good to excellent yields (Scheme 3, Table 1, Procedure D).



Scheme 3

The structures of obtained products were confirmed by their spectroscopic properties (IR, ^{1}H, ^{13}C, and ^{31}P NMR); in the case of all new compounds, we also obtained satisfactory results of their elemental analyses.

Downloaded by [East Carolina University] at 11:11 20 September 2013

Downloaded by [East Carolina University] at 11:11 20 September 2013

Table 1 Reactions of 1-(*N*-Acylamino)alkyltriphenylphosphonium salts **6** with nucleophiles

Phosphonium salt **6**					Reaction conditions				Product **7**, **8** or **9**		
No.	R^1	R^2	Y	Nucleophile	Proc.	Molar ratio of salt **6**:nucl.:base	Base	Time	No.	Yield [%]	m.p. [°C]
6a	*t*-Bu	H	BF_4	$PhCH_2SH$	A	1:2:1.5	$(i\text{-Pr})_2EtN$	4 d	**7a**	92	45.5–46
6b	Ph	H	BF_4	Benzotriazole	A	1:1.1:1.5	$(i\text{-Pr})_2EtN$	5.5 h	**7b**	98[a]	173–174[b]
6b	Ph	H	BF_4	$PhCH_2NH_2$	A	1:2:1.5	$(i\text{-Pr})_2EtN$	1.5 h	**7c**	64	85–86[c]
6b	Ph	H	BF_4	PhOH	A	1:1.1:1.5	$(i\text{-Pr})_2EtN$	8 h	**7d**	29	125–126[d]
6c	*t*-Bu	CH_2OMe	I	Phthalimide	A	1:1.1:1.5	$(i\text{-Pr})_2EtN$	10.5 h	**7e**	76	122–123
6b	Ph	H	BF_4	Dimethyl malonate	B	1:8:2	DBU	1.5 h	**7f**	64	94–95
6d	Me	H	BF_4	Ethyl acetoacetate	B	1:6:2	DBU	2.5 h	**7g**	70	oil
6d	Me	H	BF_4	Ethyl 2-methylacetoacetate	B	1:2:1.5	DBU	2.0 h	**7h**	85	oil
6e	*t*-Bu	Me	I	Diethyl malonate	B	1:6:2	DBU	1.5 h	**7i**	61	oil
6b	Ph	H	BF_4	1-Morpholino-1-cyclohexene	C	1:2:1.2	$(i\text{-Pr})_2EtN$	1 h	**8a**	70	89–90
6f	Ph	Me	I	1-Morpholino-1-cyclohexene	C	1:2:1.2	$(i\text{-Pr})_2EtN$	1 h	**8b**	76	132.5–133
6g	*t*-Bu	Me	BF_4	$P(OMe)_3$	D	1:1.5:0.1[e]	$(i\text{-Pr})_2EtN$	2 h	**9a**	89	128–129
6h	BnO	Bn	BF_4	$P(OMe)_3$	D	1:1.5:0.1[e]	$(i\text{-Pr})_2EtN$	2 h	**9b**	82	67–68[f]
6g	*t*-Bu	Me	BF_4	$EtP(OEt)_2$	D	1:1.5:0.1[e]	$(i\text{-Pr})_2EtN$	2 h	**9c**	64	resin
6i	BnO	CH_2O-*t*-Bu	BF_4	$PhP(OEt)_2$	D	1:1.5:0.1[e]	$(i\text{-Pr})_2EtN$	2 h	**9d**	66	oil
6g	*t*-Bu	Me	BF_4	Ph_2POMe	D	1:1.5:0.1[e]	$(i\text{-Pr})_2EtN$	2 h	**9e**	98	196–197
6j	BnO	*i*-Bu	BF_4	Ph_2POMe	D	1:1.5:0.1[e]	$(i\text{-Pr})_2EtN$	2 h	**9f**	56	173–174
6i	BnO	CH_2O-*t*-Bu	BF_4	Ph_2POMe	D	1:1.5:0.1[e]	$(i\text{-Pr})_2EtN$	2 h	**9g**	80	170–171

[a]According to ^1H NMR the product contained about 6% of benzotriazol-2-yl derivative. [b]Lit. m.p. 177–179°C.[16] [c]Lit. m.p. 83–85°C.[17] [d]Lit. m.p. 120–122°C.[18] [e]Methyltriphenylphosphonium iodide (0.25 mol per mol substrate **6**) was additionally used as a catalyst. [f] Lit. oil[19]

CONCLUSIONS

In conclusion, easily accessible 1-(*N*-acylamino)alkyltriphenylphosphonium salts can be considered as new, convenient and effective α-amidoalkylation reagents. In contrast to many other α-amidoalkylating agents 1-(*N*-acylamino)alkyltriphenylphosphonium salts are usually crystalline, stable, easy-to-use compounds, that can be stored for prolonged time under laboratory conditions. They are easily activated as α-amidoalkylating reagents with organic bases, which is more advantageous than the alternative usage of Lewis acids, usually recommended as catalyst for α-amidoalkylation reactions.

EXPERIMENTAL

General

Melting points are determined in capillary tubes in a Stuart Scientific SMP3 melting point apparatus, and are uncorrected. IR spectra were recorded on a Zeiss Specord M80 spectrophotometer. ^{1}H and ^{13}C NMR spectra were recorded in $CDCl_3$ on a Varian UNITY INOVA-300 spectrometer at operating frequencies of 300 and 75.5 MHz or on a Varian 600 spectrometer at operating frequencies of 600 and 150.8 MHz, respectively, in the FT mode using TMS as an internal standard. ^{31}P NMR spectra were recorded on a Varian 600 spectrometer at operating frequencies of 242.8 MHz, using 80% orthophosphoric acid as the resonance shift standard. Elemental analyses (C, H, N) proved to be in satisfactory agreement ($\pm 0.2\%$) with the calculated values. Reactions with application of microwave irradiation were carried out using a CEM Matthews microwave reactor. Kieselgel 60 (Merck, 0.063–0.200 mm) was used for column chromatography. 1-(*N*-Acylamino)alkyltriphenylphosphonium salts **6** were synthesized as described in our previous paper.[11–15]

General Procedures for Reaction of 1-(*N*-acylamino) alkyltriphenylphosphonium Salts 6 with Nucleophiles

Procedure A. Reactions were carried out in a glass vial sealed with a screw-cap. To a solution of 1-(*N*-acylamino)alkyltriphenylphosphonium salt **6** (1 mmol) in 2.0 cm^3 of MeCN, a solution of nucleophilic reagent and diisopropylethylamine (in amounts given in Table I) in 2 cm^3 of MeCN was added. The mixture was kept at room temperature (**7a**) or heated at 60°C in an oil bath (**7b-c, 7e**) for the time given in Table I. Only in the case of compound **7d** the mixture was irradiated at a power of 8 W at 60°C in a microwave reactor. The solvent was evaporated under reduced pressure, and the product was isolated by column chromatography [toluene/AcOEt (**7a-b** and **7d-e**) or toluene/MeOH (**7c**)]. The crystalline crude product was recrystallised from a mixture of toluene and hexane (**7a**, **7e**), CH_2Cl_2 (**7b**) or toluene (**7c**, **7d**).

Procedure B. Reactions were carried out in a glass vial sealed with a screw-cap. To a solution of 1-(*N*-acylamino)alkyltriphenylphosphonium salt **6** (1 mmol) in 4.0 cm^3 of MeCN, a solution of nucleophilic reagent and DBU (in amounts given in Table I) in 4 cm^3 of MeCN was added. The mixture was irradiated at a power of 10–12 W at 60°C in a microwave reactor for the time given in Table I. The solvent was evaporated under reduced pressure, and the product was isolated by column chromatography (silica gel, toluene/EtOAc). The crystalline crude compound **7f** was recrystallised from toluene.

Downloaded by [East Carolina University] at 11:11 20 September 2013

Procedure C. Reactions were carried out in a glass vial sealed with a screw-cap. To a solution of 1-(*N*-acylamino)alkyltriphenylphosphonium salt **6** (1 mmol) in 2 cm^3 of MeCN, a solution of 1-morpholino-1-cyclohexene (0.34 cm^3, 0.34 g, 2 mmol) and diisopropylethylamine (0.2 cm^3, 0,15 g, 1.2 mmol) in 2 cm^3 of MeCN was added. The mixture was irradiated at a power of 8 W at 60°C in a microwave reactor for 1 h. After cooling to room temperature, 4.5 cm^3 of the water solution of citric acid (20%) was added, the suspension was stirred for 45 min, a saturated solution of $KHCO_3$ was added, the mixture was extracted with CH_2Cl_2 (4 × 4 cm^3), the organic layer was dried ($MgSO_4$), and the solvent was evaporated under reduced pressure. Finally, the product was separated by column chromatography [(toluene and AcOEt in a volume ratio of 1:1 (**8a**) or 2:1 (**8b**)] and recrystallised from a mixture of toluene and hexane (**8a**) or toluene (**8b**).

Procedure D. Reactions were carried out in a glass vial sealed with a screw-cap. To a solution of 1-(*N*-acylamino)alkyltriphenylphosphonium salt **6** (1 mmol) in 2.0 cm^3 of CH_2Cl_2, methyltriphenylphosphonium iodide (0.10 g, 0.25 mmol), trimethyl phosphite, diethyl phenylphosphonite, diethyl ethylphosponite or methyl diphenylphosphinite (1.25 mmol) and diisopropylethylamine (0.017 cm^3, 0.013 g, 0.1 mmol) was added. The mixture was heated at 60°C for 2 h. The solvent was evaporated under reduced pressure and the residue was extracted with toluene (3×1 cm^3) at 50°C. The solvent was evaporated under reduced pressure, and the product was isolated by column chromatography (silica gel, CH_2Cl_2/MeOH, 20:1 v/v or 40:1 v/v). The crude product was purified by crystallisation (toluene/hexane).

Spectral and physical data for compounds **7a**, **7e**, **7f**-**7i** and **9a-9d** was described in our previous papers.[20–23]

N-(Benzotriazol-1-ylmethyl)benzamide (7b)

IR (CH_2Cl_2), ν (cm^{-1}): 3440, 1664, 1520. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 8.58 (*t*, *J* = 6.6 Hz, 1H, NH), 8.04–7.26 (m, 9H, Ph and $C_6\underline{H}_4N_3$), 6.32 (d, *J* = 6.6 Hz, 2H, CH_2) ppm. ^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 167.9 (CONH); 145.9, 132.5, 132.5, 132.2, 128.5, 127.9, 127.4, 124.4, 119.2, 111.1 (aromatic carbons); 51.5 ($\underline{C}$H) ppm.

N-(Benzylaminomethyl)benzamide (7c)

IR (CH_2Cl_2), ν (cm^{-1}): 3448, 1664, 1512, 1484. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.74–7.21 (m, 10H, Ph), 6.85 (br s, 1H, NH), 4.42 (d, *J* = 5.7 Hz, 2H, NHC$\underline{H}_2$), 3.87 (s, 2H, HNC$\underline{H}_2$Ph), 2.28 (br s, $\underline{H}$NCH$_2$Ph) ppm. ^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 168.0 (CONH); 139.8, 134.1, 131.6, 128.6, 128.5, 128.0, 127.1, 126.8 (aromatic carbons); 55.1 (NH$\underline{C}$H$_2$NH), 50.4 (Ph$\underline{C}$H$_2$NH) ppm.

N-(Phenoxymethyl)benzamide (7d)

IR (CH_2Cl_2), ν (cm^{-1}): 3448, 1680, 1600, 1516, 1484. ^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.80–7.77 (m, 2H, Ph), 7.55–7.40 (m, 3H, Ph), 7.33–7.26 (m, 2H, Ph), 7.03–6.97 (m, 3H, Ph and 1H, NH), 5.52 (d, *J* = 6.9 Hz, 2H, CH_2) ppm. ^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 167.4 (CONH); 156.5, 133.5, 132.1, 129.6, 128.7, 127.2, 121.8, 115.7 (aromatic carbons); 68.7 ($\underline{C}H_2$) ppm.

Downloaded by [East Carolina University] at 11:11 20 September 2013

Downloaded by [East Carolina University] at 11:11 20 September 2013

N-(2-Oxocyclohexylmethyl)benzamide (8a)

IR (CH_2Cl_2), ν (cm^{-1}): 3452, 1704, 1660, 1520. ^1H NMR (300 MHz, $CDCl_3$): δ = 7.77–7.73 (m, 2H, Ph), 7.52–7.38 (m, 3H, Ph), 6.92 (br s, 1H, NH), 3.73 (ddd, $J_1 = 13.5$ Hz, $J_2 = 7.5$ Hz, $J_3 = 3.6$ Hz, 1H, HNC$\underline{H}_2$), 3.38 (ddd, $J_1 = 13.2$ Hz, $J_2 = 8.1$ Hz, $J_3 = 5.1$ Hz, 1H, HNC$\underline{H}_2$), 2.73–2.62 (m, 1H, $CH_2C\underline{H}$), 2.45–1.38 (m, 8H, $C_5H_9C{=}O$) ppm. ^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 214.0 ($C_5H_9\underline{C}{=}O$), 167.1 (CONH); 134.4, 131.4, 128.5, 126.9 (aromatic carbons); 50.9 (HN$\underline{C}H_2$), 42.3 ($CH_2\underline{C}H$); 39.7, 31.8, 27.8, 24.8 ($C_5H_9C{=}O$: C_3, C_6, C_4, C_5) ppm. Elemental analysis Calcd. for $C_{14}H_{17}NO_2$: C, 72.70; H, 7.41; N, 6.06; Found: C, 72.57; H, 7.19; N, 6.02%.

N-[1-(2-Oxocyclohexyl)ethyl]benzamide (8b)

IR (CH_2Cl_2), ν (cm^{-1}): 3440, 1704, 1660, 1512. ^1H NMR (300 MHz, $CDCl_3$): δ = 7.80–7.74 (m, 2H, Ph), 7.53–7.39 (m, 3H, Ph), 7.15 (d, $J = 9.0$ Hz, 1H, NH), 4.45–4.32 (m, 1H, HNC$\underline{H}CH_3$), 2.67–2.61(m, 1H, HNCHC$\underline{H}$), 2.41–1.55 (m, 8H, $C_5H_9C{=}O$), 1.35 (d, $J = 6.9$ Hz, 3H, CH_3) ppm. ^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 214.3 ($C_5H_9\underline{C}{=}O$), 166.6 (CONH); 134.6, 131.3, 128.5, 126.9 (aromatic carbons); 55.3 (HN$\underline{C}HCH_3$), 46.4 (HNCH$\underline{C}$H); 43.2, 32.8, 28.3, 24.9 ($C_5H_9C{=}O$: C_3, C_6, C_4, C_5); 20.1 (CH_3) ppm. Elemental analysis Calcd. for $C_{15}H_{19}NO_2$: C, 73.44; H, 7.81; N, 5.71. Found: C, 73.48; H, 7.78; N, 5.73%.

Diphenyl 1-(*N*-pivaloylamino)ethylphosphine oxide (9e)

IR (CH_2Cl_2), ν (cm^{-1}): 3259, 2969, 1647, 1528, 1438, 1177, 1119. ^1H NMR (300 MHz, $CDCl_3$): δ = 7.86–7.42 (m, 10H, Ph), 6.30 (d, $J = 9.3$ Hz, 1H, NH), 5.23 (ddq, $J_1 = 9.9$ Hz, $J_2 = 2.7$ Hz, $J_3 = 7.2$ Hz, 1H, CH), 1.33 (dd, $J_1 = 14.4$ Hz, $J_2 = 7.2$ Hz, 3H, CH_3), 0.95 (s, 9H, *t*-Bu) ppm. ^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 177.6 (d, $J = 4.5$ Hz, C=O); 132.1 (d, $J = 3.0$ Hz), 132.0 (d, $J = 3.0$ Hz), 131.0 (d, $J = 9.0$ Hz), 130.8 (d, $J = 9.0$ Hz), 130.5, 130.4, 128.8 (d, $J = 10.6$ Hz), 128.4 (d, $J = 12.1$ Hz) - aromatic carbons; 42.5 (d, $J = 78.4$ Hz, CH), 38.6 ($\underline{C}(CH_3)_3$), 27.1 ($C(\underline{C}H_3)_3$), 14.5 (d, $J = 3.0$ Hz, CH_3) ppm. ^{31}P NMR (242.8 MHz, $CDCl_3$): δ = 35.1 ppm. Elemental analysis Calcd. for $C_{19}H_{24}NO_2P$: C, 69.28; H, 7.34; N, 4.25; P, 9.40. Found: C, 69.18; H, 7.33; N, 4.05; P, 9.36%.

Diphenyl 1-(*N*-Benzyloxycarbonylamino)-3-methylbutylphosphine oxide (9f)

IR (CH_2Cl_2), ν (cm^{-1}): 3191, 2955, 1705, 1542, 1438, 1264, 1185, 1119. ^1H NMR (300 MHz, $CDCl_3$): δ = 7.85–7.12 (m, 15H, Ph), 5.45 (d, $J = 10.5$ Hz, 1H, NH), 5.02 (d, $J = 12.6$ Hz, 1H, OCH_2), 4.89 (d, $J = 12.6$ Hz, 1H, OCH_2), 4.83–4.71 (m, 1H, $C_\alpha H$), 1.83–1.66 (m, 2H, $C_\beta H_2$), 1.34–1.21 (m, 1H, $C_\gamma H$), 0.90 (d, $J = 6.6$ Hz, 3H, CH_3), 0.86 (d, $J = 6.6$ Hz, 3H, CH_3) ppm. ^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 156.1 (d, $J = 3.8$ Hz, C=O); 136.4, 132.0 (d, $J = 3.0$ Hz), 131.9 (d, $J = 2.3$ Hz), 131.5, 131.3, 131.1 (d, $J = 9.1$ Hz), 131.0 (d, $J = 9.1$ Hz), 128.8 (d, $J = 11.3$ Hz), 128.4 (d, $J = 11.3$ Hz), 128.4, 127.9, 127.6 (aromatic carbons); 66.8 (OCH_2), 48.0 (d, $J = 79.3$ Hz, CH), 37.4 (d, $J = 3.0$ Hz, $C_\beta H_2$), 24.4 (d, $J = 10.5$ Hz, $C_\gamma H$), 23.4 (CH_3), 21.0 (CH_3) ppm. ^{31}P NMR (242.8 MHz, $CDCl_3$): δ = 34.5 ppm. Elemental analysis Calcd. for $C_{25}H_{28}NO_3P$: C, 71.24; H, 6.70; N, 3.32; P, 7.35. Found: C, 71.17; H, 6.87; N, 3.33; P, 7.20%.

Diphenyl 1-(*N*-Benzyloxycarbonylamino)-2-*t*-butoxyethylphosphine oxide (9g)

IR (CH_2Cl_2), ν (cm^{-1}): 2974, 1706, 1542, 1438, 1270, 1240, 1181. ^1H NMR (300 MHz, $CDCl_3$): $\delta = 7.89–7.17$ (m, 15H, Ph), 5.68 (d, $J = 9.6$ Hz, 1H, NH), 5.03 (s, 2H, OCH_2), 4.93–4.82 (m, 1H, $C_\alpha H$), 3.76 (ddd, $J_1 = 9.4$ Hz, $J_2 = 9.3$ Hz, $J_3 = 5.3$ Hz, 1H, $C_\beta H$), 3.89 (ddd, $J_1 = 14.4$ Hz, $J_2 = 9.2$ Hz, $J_3 = 5.3$ Hz, 1H, $C_\beta H$), 0.97 (s, 9H, *t*-Bu) ppm. ^{13}C NMR (75.5 MHz, $CDCl_3$): $\delta = 156.0$ (d, $J = 5.3$ Hz, C=O); 136.3, 131.8 (d, $J = 3.0$ Hz), 131.7 (d, $J = 2.3$ Hz), 131.4 (d, $J = 9.8$ Hz), 131.1 (d, $J = 9.8$ Hz), 130.5, 130.4, 128.4, 128.4 (d, $J = 11.3$ Hz), 128.3 (d, $J = 12.1$ Hz), 128.0, 127.7 - aromatic carbons; 73.4 ($\underline{C}(CH_3)_3$), 66.9 (OCH_2), 60.1 (d, $J = 3.8$ Hz, $C_\beta H_2$), 50.6 (d, $J = 80.0$ Hz, CH), 27.0 ($C(\underline{C}H_3)_3$) ppm. ^{31}P NMR (242.8 MHz, $CDCl_3$): $\delta = 31.9$ ppm. Elemental analysis Calcd. for $C_{26}H_{30}NO_4P$: C, 69.17; H, 6.70; N, 3.10; P, 6.86. Found: C, 69.24; H, 6.82; N, 3.12; P, 6.73%.

REFERENCES

1. Laue, T.; Plagens, A. *Named Organic Reaction*, Wiley & Sons: Chichester, **2000**.
2. Saidi, M. R.; Nazari, M. *Monatsh. Chem.* **2004,** 135, 309-312.
3. Kleinmann, E. F. *Comprehensive Organic Synthesis*. In B. M. Trost; I. Flemming (Ed.) Pergamon Press: New York, **1991**.
4. Katritzky, A. R.; Pernak, J.; Fan, W-Q.; Saczewski, F. *J. Org. Chem.* **1991,** 56, 4439-4443.
5. Katritzky, A. R.; Lan, X.; Yang, J. Z.; Denisko, O. V. *Chem. Rev.* **1998,** 98, 409-548.
6. Katritzky, A. R.; Rachwal, S.; Hitchings, G. J. *Tetrahedron* **1991,** 47, 2683-2732.
7. Katritzky, A. R.; Manju, K.; Singh, S. K.; Meher, N. K. *Tetrahedron* **2005,** 61, 2555-2581.
8. For reviews see: (a) Zaugg, H. E. *Synthesis* **1970,** 49-73 (b) Zaugg, H. E. *Synthesis* **1984,** 85-110 (c) Zaugg, H. E. *Synthesis* **1984,** 181-212.
9. Petrini, M. *Chem. Rev.* **2005,** 105, 3949-3977.
10. Zhang, L.; Wei, Ch.; Li, Ch-J. *Tetrahedron Lett.* **2002,** 43, 5731-5733.
11. Mazurkiewicz, R.; Pierwocha, A. *Monatsh. Chem*. **1996,** 127, 219-225.
12. Mazurkiewicz, R.; Pierwocha, A. *Monatsh. Chem.* **1997,** 128, 893-900.
13. Mazurkiewicz, R.; Adamek, J.; Październiok-Holewa, A.; Zielińska, K.; Simka, W.; Gajos, A.; Szymura, K. *J. Org. Chem.* **2012,** 77, 1952-1960.
14. Mazurkiewicz, R.; Październiok-Holewa, A.; Grymel, M. *Tetrahedron Lett.* **2008,** 49, 1801-1803.
15. Mazurkiewicz, R.; Październiok-Holewa, A.; Grymel, M. *Phosphorus Sulfur Silicon Relat. Elem.*, **2009,** 184, 1017-1027.
16. Katritzky, A. R.; Drewniak, M. *J. Chem. Soc. Perkin Trans.* 1 **1988,** 2339-2344.
17. Watase, Y.; Terao, Y.; Sekiya, M. *Chem. Pharm. Bull.* **1973,** 21, 2775-2778.
18. Getz, J. J.; Prankerd, R. J.; Sloan, K. B. *J. Org. Chem.* **1992,** 97, 1702-1706.
19. Wang, D.-Y.; Huang, J.-D.; Hu, X.-P.; Deng, J.; Yu, S.-B.; Duan, Z.-C.; Zheng, Z., *J. Org. Chem.* **2008,** 73, 2011-2014.
20. Październiok-Holewa, A.; Adamek, J.; Zielińska, K.; Piernikarczyk, K.; Mazurkiewicz, R. *Arkivoc* **2012,** iv, 314-329.
21. Mazurkiewicz, R.; Październiok-Holewa, A.; Orlińska, B.; Stecko, S. *Tetrahedron Lett.* **2009,** 50, 4606-4609.
22. Mazurkiewicz, R.; Październiok-Holewa, A.; Kononienko, A. *Phosphorus Sulfur Silicon Relat. Elem.*, **2010,** 185, 1986-1992.
23. Adamek, J.; Październiok-Holewa, A.; Zielińska, K.; Mazurkiewicz, R. *Phosphorus, Sulfur, Silicon Relat. Elem.* DOI 10.1080/10426507.2012.729237.

Downloaded by [East Carolina University] at 11:11 20 September 2013