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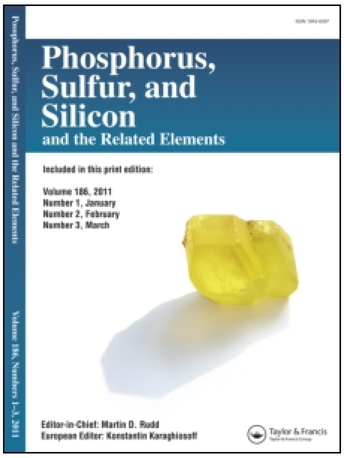

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# A NEW SYNTHESIS OF α-AMINO ACID DERIVATIVES BY REACTION OF N-ACYL-α-TRIPHENYLPHOSPHOSPHONIO-GLYCINATES WITH CARBON NUCLEOPHILES

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# A NEW SYNTHESIS OF α-AMINO ACID DERIVATIVES BY REACTION OF N-ACYL-α-TRIPHENYLPHOSPHONIO-GLYCINATES WITH CARBON NUCLEOPHILES

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*(Received December 16, 1999)*

Recently described[1], easily accessible N-acyl-α-triphenylphosphonioglycinates react smoothly with activated carbonyl compounds or enamines in the presence of a base (DBU or $Et_3N$) yielding the corresponding α-functionalized glycine derivatives.

*Keywords:* α-Triphenylphosphonioglycinates; cationic glycine equivalent; carbon nucleophiles; nucleophilic substitution; glycine α-functionalization

## INTRODUCTION

Since the pioneering investigations of Ben-Ishai *et. al.*[2] on the first glycine electrophilic equivalents (N-acyl-α-hydroxy- and N-acyl-α-methoxyglycinates), the important problem of synthesising α-amino acids by a new carbon-carbon bond formation between the glycine-cation equivalents and carbon nucleophiles has been attempted by many authors[3–5]. The most common way to carry out such a transformation consists in photochemical bromination of N-acylglycinates with bromine or NBS to α-bromoglycinates, followed by the nucleophilic substitution of bromide by carbon nucleophiles[4–7]. Many other electrophilic glycine equivalents have been introduced for the synthesis of α-amino acids in the course of the last 25 years, *e.g.* N-acyl-α-chloroglycinates[6], unstable N-acyliminoacetates[4,5,7], N-acyl-α-acetoxyglycinates[8], iminoacetates and iminoacetamides (esters

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and amides of Shiff bases derived from glycine)[9], α-acetoxy-, α-phenylthio-, α-dimethylamino- and α-methoxy-N-diphenylmethyleneglycinates[10], N-acyliminomalonates[11], chlorinated "bis-lactim ethers"[12] and 2,3,5,6-tetrahydro-4*H*-1,4-oxazin-2-one[13,14] or its 3-chloro- or 3-bromo- derivatives[14,15]. With the advent of peptide-derived chemotherapeutics, the synthesis, both, natural non-proteinogenic and unnatural α-amino acids by the functionalization of the glycine α-position with carbon nucleophiles attracts significant attention of organic chemists[3].

In our previous paper[1] we described a convenient and effective synthesis of crystalline, stable N-acyl-α-triphenylphosphonioglycinates **1** from 4-triphenylphosphoranylidene-5(4*H*)-oxazolones. We also described a simple method of the substitution of their triphenylphosphonium group by a variety of oxygen, sulphur and nitrogen nucleophiles, demonstrating in this way, that N-acyl-α-triphenylphosphonioglycinates may be considered as a new, interesting cationic glycine equivalent[1]. The described transformations enable an easy functionalization of the glycine α-position with heteroatom nucleophiles. In the present paper we want to report the application of N-acyl-α-triphenylphosphonioglycinates for the functionalization of glycine with two kinds of carbon nucleophiles: enolates of activated carbonyl compounds and enamines.

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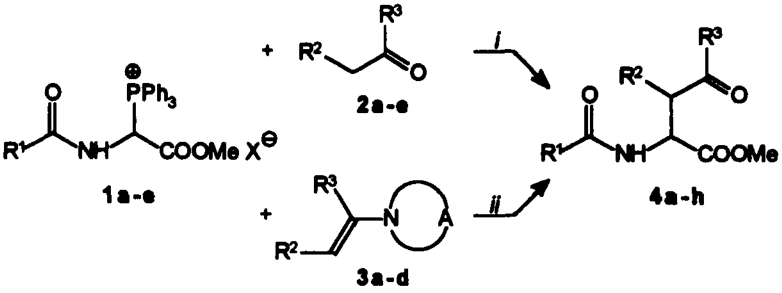
## RESULTS AND DISCUSSION

N-Acyl-α-triphenylphosphonioglycinates **1** react easily with β-dicarbonyl compounds **2** in the presence of 1,8-diazabicyclo[5.4.0]undecene (DBU) in acetonitrile at room temperature giving the corresponding α-functionalized glycine derivatives in 53 – 77 % yield (Scheme 1 and Table I).

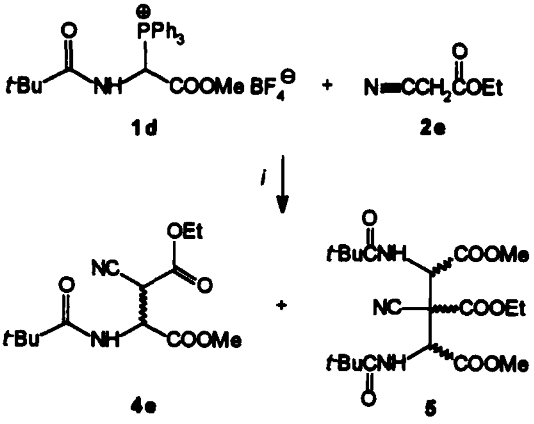
In the case of ethyl cyanoacetate we obtained the expected mixture of two diastereoisomeric substitution products **4e** merely in 40 % yield; apart from that we isolated a mixture of all the four possible diastereoisomeric by-products **5** (58 %) which are formed probably in result of the reaction of the primary substitution products **4e** with a second molecule of N-acyl-α-triphenylphosphonioglycinate (Scheme 2). It seems, that in this particular case the proton at the α-position in the substrate **2e** is less acidic than the corresponding proton of the product **4e**, due to the electron-withdrawing inductive effect of the acylamino and ethoxycarbonyl groups in **4e**. In consequence, the primary reaction product **4e** is more reactive towards triphenylphosphonioglycinate than the substrate **2e**.



*i*: DBU, MeCN; *ii*: a) $Et_3N$, MeCN, b) 20% aqueous citric acid.

SCHEME 1

Our attempts to extend the scope of this reaction into simple ketones, e.g. acetone, acetophenone or cyclohexanone, failed; no reaction was observed, probably because of the too low acidity of the protons at the α-position. If, however, a ketone is transformed into the corresponding enamine **3**, the substitution reaction becomes again possible (Scheme 1, Table I). Reactions with enamines run smoothly in the presence of triethylamine at room temperature. After hydrolysis of the primary reaction products with aqueous citric acid we obtained final products, which correspond to the compounds that should be formed in the reaction of N-acyl-α-triphenylphosphonioglycinates with the respective simple ketones.



*i*: DBU, MeCN.

SCHEME 2

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TABLE I Reactions of N-acyl-α-triphenylphosphonioglycinates (**1**) with enolates of carbonyl compounds (**2**) or enamines (**3**)

| *um Salt 1* | *Carbonyl Nucleophile 2 or 3* | | | | *Reaction time [h]* | *Reaction product 4* | | *Diastereo-isomers ratio* | *Elemental analyses (calcd./four* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *X* | *No.* | *$R^2$* | *$R^3$* | *A* | | *No.* | *Yield [%]* | | *C* | *H* | |
| I | **2a** | Ac | Me | – | 1.5 | **4a** | 62[a] | – | 61.85/61.82 | 5.88/5.91 | 4.8 |
| $BF_4$ | **2b** | Ac | Me | – | 24 | **4b** | 77 | – | 52.40/52.45 | 6.60/6.55 | 6.1 |
| I | **2c** | Ac | OEt | – | 2.5 | **4c** | 53 | 54:46 | 59.81/59.64 | 5.96/5.84 | 4.3 |
| $BF_4$ | **2d** | EtOCO | OEt | – | 1.0 | **4d** | 63[b] | – | 58.11/58.32 | 6.02/6.21 | 3.9 |
| $BF_4$ | **2e** | CN | OEt | – | 1.0 | **4e** | 40 | 52:48 | 54.92/54.55 | 7.09/7.27 | 9.8 |
| I | **3a** | $-(CH_2)_3-$ | | $-(CH_2)_2O(CH_2)_2-$ | 1.5 | **4f** | 78 | 65 : 35 | 61.16/60.74 | 8.29/8.43 | 5.4 |
| I | **3b** | $-(CH_2)_3-$ | | $-(CH_2)_4-$ | 1.5 | **4f** | 57 | 53:47[c] | | | |
| I | **3c** | $-(CH_2)_4-$ | | $-(CH_2)_2O(CH_2)_2-$ | 1.5 | **4g** | 71 | 90 : 10 | 62.43/62.07 | 8.61/8.74 | 5.2 |
| $BF_4$ | **3d** | $-(CH_2)_5-$ | | $-(CH_2)_2O(CH_2)_2-$ | 2.0 | **4h** | 61 | 82 : 18 | 59.73/59.88 | 7.94/8.21 | 5.8 |

8.5–120°C;

–84.5°C;

d by comparison with the product obtained from **3a** (IR, $^1H$ and $^{13}C$ NMR).

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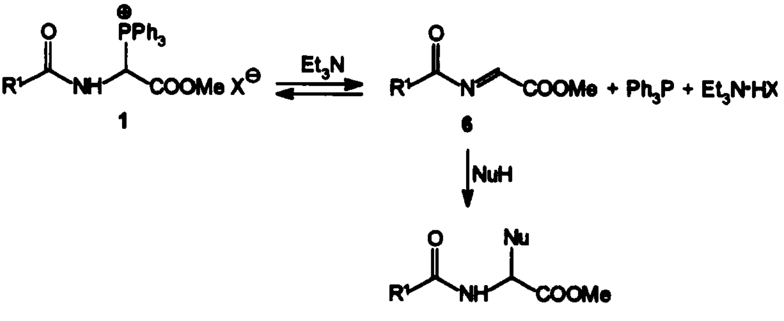
The structure of the obtained products was confirmed by their spectral properties (IR, $^1$H and $^{13}$C NMR; cf. Table II and III) as well as by satisfactory results of elemental analyses. In the case of prochiral ethyl acetylacetate, ethyl cyanoacetate and enamines the obtained products **4** were mixtures of two possible diastereoisomers, the ratio of which was determined using $^1$H NMR spectroscopy (Table II).

An alternative way of synthesis of N-acyl-α-triphenylphosphonioglycinates by reaction of unstable N-acyl-α-bromoglycinates with triphenylphosphine was mentioned in the paper of Kober and Steglich in 1983[16], however, the authors did not examine the reaction of the obtained compounds with nucleophiles. They proposed an equilibrium between N-acyl-α-triphenylphosphonioglycinate and the corresponding N-acyliminoacetate **6** in the presence of triethylamine[16]. In the later works Steglich and co-workers[4,7] and other authors[5,6] postulated that the reactions of N-acyl-α-halogenoglycinates with nucleophiles in the presence of triethylamine proceeds *via* the analogous N-acyliminoacetates as intermediates. Therefore, the nucleophilic substitution of the triphenylphosphonium group described here occurs probably *via* the N-acyliminoacetate intermediate **6** (Scheme 3), however further investigations on the mechanism of this reaction seem to be necessary.



SCHEME 3

Summing up, the recently reported easily accessible, stable N-acyl-α-triphenylphosphonioglycinates[1] enable an easy functionalization of the glycine α-position with carbon nucleophiles derived from activated carbonyl compounds or enamines.

TABLE II $^{1}$H NMR and IR spectral data of the N-acyl-α-aminoacid methyl esters synthesised

| *on product* | | $^{1}$*H-NMR (CDCl$_3$/TMS, δ (ppm))* | *IR$^{a}$ [cm$^{-1}$]* |
|---|---|---|---|
| *R$^2$* | *R$^3$* | | |
| Ac | Me | 2.22 (s, 3H, COMe$^{b}$ ), 2.31 (s, 3H, COMe$^{b}$), 3.68 (s, 3H, OMe), 4.55 (d, 1H, $J$ = 3.9 Hz, NHCHC$\underline{\mathrm{H}}$), 5.47 (dd, 1H, $J_1$ = 9.0 Hz, $J_2$ = 3.9 Hz, NHC$\underline{\mathrm{H}}$), 7.24 (d, 1H, $J$ = 9.0 Hz, NH), 7.30–7.55 (m, 3H, Ph), 7.65–7.75 (m, 2H, Ph) | 3442m, 1723vs, 171<br>1665vs |
| Ac | Me | 2.00 (s, 3H, Me), 2.24 (s, 3H, COMe$^{b}$), 2.34 (s, 3H, COMe$^{b}$), 3.72 (s, 3H, OMe), 4.49 (d, 1H, $J$= 4.2 Hz, NHCHC$\underline{\mathrm{H}}$), 5.33 (dd, 1H, $J_1$ = 9.2 Hz, $J_2$ = 4.2 Hz, NHC$\underline{\mathrm{H}}$), 6.63 (d, 1H, $J$ = 9.0 Hz, NH) | 3430m, 1726vs, 171<br>1678vs |
| Ac | OEt | 1.18–1.33 (m, 3H, CH$_2$C$\underline{\mathrm{H}}_3$), 2.34 (s, 3H, COMe$^{c}$ ), 2.36 (s, 3H, COMe$^{d}$ ), 3.73 (s, 3H, OMe$^{c}$), 3.74 (s, 3H, OMe$^{d}$), 4.13–4.29 (m, 2H, CH$_2$), 4.43 (d, 1H, $J$ = 4.5 Hz, NHCHC$\underline{\mathrm{H}}$), 5.50 (dd, 1H, $J_1$= 8.7 Hz, $J_2$ = 4.5 Hz, NHC$\underline{\mathrm{H}}^{d}$), 5.51 (dd, 1H, $J_1$ = 9.0 Hz, $J_2$ = 3.9 Hz, NHC$\underline{\mathrm{H}}^{c}$), 7.38–7.58 (m, 4H, Ph and NH), 7.74–7.83 (m, 2H, Ph) | 3439m, 1736vs, 172<br>1664s |
| EtOCO | OEt | 1.22 (t, 3H, $J$ = 7.1 Hz, CH$_2$C$\underline{\mathrm{H}}_3{}^{b}$), 1.31 (t, 3H, $J$ = 7.1 Hz, CH$_2$C$\underline{\mathrm{H}}_3{}^{b}$), 3.78 (s, 3H, OMe), 4.18 (q, 2H, $J$ = 7.1 Hz, C$\underline{\mathrm{H}}_2$CH$_3{}^{e}$ ), 4.24–4.38 (m, 2H, C$\underline{\mathrm{H}}_2$CH$_3{}^{e}$), 4.28 (d, 1H, $J$ = 4.2 Hz, NHCHC$\underline{\mathrm{H}}$), 5.55 (dd, 1H, $J_1$ = 9.0 Hz, $J_2$ = 4.0 Hz, NHC$\underline{\mathrm{H}}$), 7.35–7.57 (m, 4H, Ph and NH), 7.77–7.83 (m, 2H, Ph) | 3440m, 1739vs, 166<br>1512s |
| CN | OEt | 1.23 (s, 9H, CMe$_3{}^{df}$ ), 1.26 (s, 9H, CMe$_3{}^{cf}$), 1.32–1.42 (m, 3H, OCH$_2$C$\underline{\mathrm{H}}_3{}^{g}$ ), 3.82 (s, 3H, OMe$^{c}$), 3.85 (s, OMe$^{d}$), 4.19–4.40 (m, 3H, NHCHC$\underline{\mathrm{H}}$+ OC$\underline{\mathrm{H}}_2$CH$_3{}^{g}$), 5.13 (dd, 1H, $J_1$ = 7.8 Hz, $J_2$= 3.9 Hz, NHC$\underline{\mathrm{H}}^{d}$), 5.29 (dd, 1H, $J_1$ = 7.5 Hz, $J_2$ = 3.9 Hz, NHC$\underline{\mathrm{H}}^{c}$), 6.59 (d, br, 1H, $J$ = 8.4 Hz, NH$^{d}$), 6.63 (d, br, 1H, $J$ = 7.5 Hz, NH$^{c}$) | 3439m, 3319m, 1750<br>1681s |
| -(CH$_2$)$_3$- | | 1.14 (s, 9H, $t$-Bu$^{d}$), 1.15 (s, 9H, $t$-Bu$^{c}$), 1.50–2.40 (m, 6H, C$_4$H$_7$CO), 2.48–3.24 (m, 1H, NHCHC$\underline{\mathrm{H}}^{c}$), 2.85 (ddd, 1H, $J_1$ = 11.3 Hz, $J_2$= 8.4 Hz, $J_3$ = 4.5 Hz, NHCHC$\underline{\mathrm{H}}^{d}$), 3.65 (s, 3H, OMe$^{c}$), 3.70 (s, 3H, OMe$^{d}$), 4.74 (dd, 1H, $J_1$ = 7.5 Hz, $J_2$ = 4.2 Hz, NHC$\underline{\mathrm{H}}^{d}$), 4.80 (dd, 1H, $J_1$ = 8.4 Hz, $J_2$ = 4.2 Hz, NHC$\underline{\mathrm{H}}^{c}$), 6.32 (d, 1H, $J$ = 7.5 Hz, NH$^{d}$), 7.00 (d, 1H, $J$ = 8.1 Hz, NH$^{c}$) | 3440m, 1751vs, 1735<br>1665vs |

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| n product | | $^{1}H$-NMR ($CDCl_3$/TMS, δ (ppm)) | IR[a] [$cm^{-1}$] |
|---|---|---|---|
| $R^2$ | $R^3$ | | |
| -($CH_2$)$_4$- | | 1.20 (s, 9H, *t*-Bu[c]), 1.22 (s, 9H, *t*-Bu[d]), 1.40–2.40 (m, 8H, $C_5H_9CO$), 2.78 (m, 1H, NHCH-C$\underline{H}$[c]), 3.32 (ddd, 1H, $J_1$ = 13.2 Hz, $J_2$= 5.1 Hz, $J_3$ = 3.1 Hz, NHCHC$\underline{H}$[d]), 3.70 (s, 3H, OMe[d]), 3.72 (s, 3H, OMe[c]), 4.53 (dd, 1H, $J_1$ = 8.1 Hz, $J_2$ = 3.8 Hz, NHC$\underline{H}$[c]), 4.74 (dd, 1H, $J_1$ = 9.6 Hz, $J_2$ = 3.0 Hz, NHC$\underline{H}$[d]), 6.55 (d, 1H, *J* = 9.3 Hz, NH[d]), 6.67 (d, 1H, *J* = 8.1 Hz, NH[c]) | 3460m, 1744s, 1732s<br>1706vs, 1660vs |
| -($CH_2$)$_5$- | | 1.13–2.02 (m, 8H, $C_7H_{10}CO$), 2.02 (s, 3H, Me[c]), 2.05 (s, 3H, Me[d]), 2.30–2.66 (m, 2H, $C_7H_{10}CO$), 2.92–3.02 (m, 1H, NHCHC$\underline{H}$[c]), 3.45–3.56 (m, 1H, NHCHC$\underline{H}$[d]), 3.69 (s, 3H, OMe[d]), 3.72 (s, 3H, OMe[c]), 4.64 (dd, 1H, $J_1$= 8.1 Hz, $J_2$ = 4.2 Hz, NHC$\underline{H}$[c]), 4.90 (dd, 1H, $J_1$ = 9.8 Hz, $J_2$ = 3.9 Hz, NHC$\underline{H}$[d]), 6.03 (d, 1H, *J* = 8.4 Hz, NH[c]), 6.54 (d, 1H, *J*= 9.7 Hz, NH[d]) | 3439m, 1750vs, 1735<br>1680vs |

in $CHCl_3$;
otopic Me groups;
astereoizomer;
astereoizomer;
otopic $CH_2$ groups;
assignment also possible;
ng signals of both diastereoizomers.

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TABLE III $^{13}$C NMR spectral data of the N-acyl- α-aminoacid methyl esters synthesised

| Product | | | | | $^{13}$C-NMR ($CDCl_3$/TMS, δ (ppm))$^{a}$ | |
|---|---|---|---|---|---|---|
| H | $\underline{C}HR^2R^3$ | $\underline{C}OOMe$ | OMe | $NHCH\underline{C}$ | $R^1$ | Other carbons |
| | 50.9 | 170.4 | 53.2 | 66.7 | 127.2, 128.7, 132.2, 133.1 (Ph: $C_3$, $C_2$, $C_4$, $C_1$) | 30.2, 30.4 ($CO\underline{Me}^{b}$); 203.3, 205.0 ($\underline{C}OMe^{d}$) |
| | 50.3 | 170.4 | 53.1 | 66.7 | 23.0 (Me) | 30.2, 30.1 ($CO\underline{Me}^{b}$); 203.3, 204.7 ($\underline{C}OMe^{d}$) |
| | 51.4$^{e}$ | 170.4$^{e}$ | 53.1$^{e}$ | 59.5$^{e}$ | 127.18, 128.8, 128.9, 132.0 (Ph: $C_4$, $C_2$, $C_3$, $C_1{}^{e}$); 127.21, 128.6, 128.3, 132.1 (Ph: $C_2$, $C_3$, $C_4$, $C_1{}^{f}$) | 13.94$^{e}$, 13.99$^{f}$ ($OCH_2\underline{C}H_3$); 29.79$^{f}$, 29.97$^{e}$ (C<br>62.0$^{f}$, 62.2$^{e}$ |
| | 51.1$^{f}$ | 170.3$^{f}$ | 53.2$^{f}$ | 59.7$^{f}$ | | ($O\underline{C}H_2CH_3$); 167.5$^{e}$, 168.5$^{f}$ ($\underline{C}OOEt^{g}$); 201.4<br>203.4$^{e}$ ($\underline{C}OMe$) |
| | 51.4 | 170.1 | 53.1$^{i}$ | 53.1$^{i}$ | 127.2, 128.7, 132.0, 133.6 (Ph: $C_3$, $C_2$, $C_4$, $C_1$) | 13.95, 13.99 ($OCH_2\underline{C}H_3{}^{b}$); 62.16, 62 26 ($O\underline{C}H_2CH_3{}^{c}$); 166.9, 168.3 ($\underline{C}OOEt^{dh}$) |
| | 50.5$^{e}$ | 167.5$^{e}$ | 52.5$^{ej}$ | 63.2$^{e}$ | 26.25 ($\underline{Me}_3C^{e}$); 39.0 ($Me_3\underline{C}^{e}$) | 12.8$^{f}$, 12.9$^{e}$ ($OCH_2\underline{C}H_3$); 62.48$^{e}$, 62 55$^{f}$ ($O\underline{C}H_2CH_3$); 112.8 ($C\equiv N^{j}$); 163.0 ($\underline{C}OOEt^{j}$) |
| | 50.6$^{f}$ | 167.6$^{f}$ | 52.5$^{fj}$ | 63.1$^{f}$ | 26.21 ($\underline{Me}_3C^{f}$); 39.2 ($Me_3\underline{C}^{f}$) | |
| | 50.8$^{e}$ | 170.4$^{e}$ | 51.5$^{e}$ | 49.5$^{e}$ | 26.33 ($\underline{Me}_3C^{e}$); 37.7 ($Me_3\underline{C}^{e}$) | 21.2, 25.46, 37.2, 219.6 ($C_4H_7CO$: $C_5$, $C_4$, $C_3$ |
| | 49.9$^{f}$ | 170.6$^{f}$ | 51.6$^{f}$ | 50.4$^{f}$ | 26.39 ($\underline{Me}_3C^{f}$); 37.8 ($Me_3\underline{C}^{f}$) | 20.9, 25.42, 36.9, 218.1, ($C_4H_7CO$: $C_5$, $C_4$, C |
| | 51.2$^{e}$ | 170.7$^{ie}$ | 51.5$^{e}$ | 53.3$^{e}$ | 26.35 ($\underline{Me}_3C^{e}$); 37.5 ($Me_3\underline{C}^{e}$) | 25.7, 30.2, 37.5, 40.7, 211.2 ($C_5H_9CO$: $C_5$, C<br>$C_3$, $C_2{}^{e}$) |

|  | *Product* |  |  | *$^{13}$C-NMR (CDCl$_3$/TMS, δ (ppm))$^a$* |  |  |
|---|---|---|---|---|---|---|
| *H* | *$\underline{C}HR^2R^3$* | *$\underline{C}OOMe$* | *OMe* | *$NHCH\underline{C}$* | *$R^1$* | *Other carbons* |
|  | 50.4$^f$ | 170.7$^{if}$ | 51.2$^f$ | 51.9$^f$ | 26.32 ($\underline{Me}_3C^f$); 37.7 ($Me_3\underline{C}^f$) | 23.7, 26.5, 30.0, 41.0, 211.2 ($C_5H_9CO$: $C_5$, $C$<br>$C_3$, $C_2^f$) |
|  | 53.7$^f$ | 170.6$^f$ | 52.7$^{fk}$ | 52.6$^{fk}$ | 23.2 ($Me^f$) | 23.4, 28.3, 29.3, 29.4, 43.5, 216.1 ($C_7H_{10}CO$:<br>$C_6$, $C_5$, $C_4$, $C_3$, $C_2^f$) |

ent based on HECTOR experiments;
otopic Me groups;
otopic $CH_2$ groups;
otopic carbonyl groups;
astereoizomer;
astereoizomer;
assignment also possible;
assignment also possible;
rlaping signals;
ng signals of both diastereoizomers;
assignment also possible.

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## EXPERIMENTAL

### General

M. p.'s, determined in capillary tubes, are uncorrected. IR spectra were recorded on a Zeiss Specord M 80 spectrophotometer; the measurements were carried out in $CHCl_3$ (0.2 *M*) using cells of 0.075 mm. $^1H$ 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, respectively, in the FT mode using TMS as an internal standard. The yields of isolated products given were not optimised.

### Starting materials

N-Acyl-α-triphenylphosphonioglycinates were synthesised as previously described[1]. Commercial grade acetonitrile was distilled and dried over molecular sieves 4A. Kieselgel 60 Merck (0.063–0.200 mm) was used for column chromatography. The other reagents were of commercial quality.

### *Reaction of N-acyl-α-triphenylphosphonioglycinates (1) with carbonyl compounds (2); General procedure*

A solution of carbonyl compound **2** (20 mmol) and DBU (1.78 ml, 12 mmol) in acetonitrile (16.0 ml) was added dropwise to a stirred solution or suspension of N-acyl-α-triphenylphosphonioglycinate **1** (10 mmol) in acetonitrile (24.0 ml). The mixture was stirred at room temperature for the time given in Table I and the solvent was removed under reduced pressure. The pure product was isolated by column chromatography on silica gel (90 ml) eluting with a mixture of ethyl acetate and benzene in a volume ratio of 1:10 or 1:5. Crystalline products **4** were recrystallised from a mixture of benzene and hexane.

### *Reaction of N-acyl-α-triphenylphosphonioglycinates (1) with enamines (3); General procedure*

A solution of enamine **3** (20 mmol) and triethylamine (1.67 ml, 12 mmol) in acetonitrile (16.0 ml) was added dropwise to a stirred solution or suspension of N-acyl-α-triphenylphosphonioglycinate **1** (10 mmol) in acetonitrile (24.0 ml). The mixture was stirred at room temperature for the time given in Table I, after that aqueous citric acid (45 ml, 20%) was added, the mixture was stirred at room temperature for 1 h and then neutralised with saturated aqueous sodium hydrogen carbonate. The product was extracted with $CH_2Cl_2$ (4 × 25 ml), the organic phase was dried with $MgSO_4$ and evaporated under reduced pressure. The pure product **4** was isolated by column chromatography on silica gel (90 ml) eluting with ethyl acetate or a mixture of ethyl acetate and benzene in a volume ratio of 1:2.

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