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Room Temperature Palladium Catalysed Coupling of Acyl Chlorides with Terminal Alkynes

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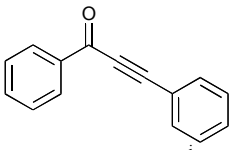
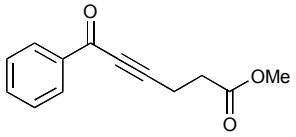
General Procedure for synthesis of acetylenic ketones. To a solution of the acid chloride (3 mmol) and alkyne (2 mmol) in anhydrous THF (4 mL), under a N_2 atmosphere, was added $PdCl_2(PPh_3)_2$ (12.6mg, 18μmol, 0.9 mol%) then CuI (11.4mg, 60μmol, 3 mol%). After 1 min of stirring Et_3N (2.5 mmol, distilled from 4 Å molecular seives) was added and the reaction left to stir for 40 min at RT. During this time Et_3NHCl precipitated out of solution and the solution became dark orange/brown in colour. The reaction was then diluted with Et_2O (30 mL) and washed with H_2O (30 mL). The aqueous layer was then extracted with CH_2Cl_2 (3 × 30 mL) and all organics combined and dried (Na_2SO_4). The suspension was then filtered, concentrated and purified by flash chromatography, or in the case of the *p*-nitrobenzoyl chloride reaction *via* recrystallisation.



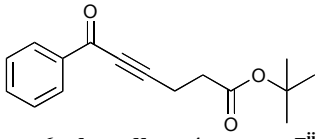
1-Oxo-1,3-diphenyl-prop-2-yne 5[i]

95:5 petrol-EtOAc used as solvent for chromatography (4:1 petrol-EtOAc, R_F 0.46) which gave 1,3-diphenyl-1-oxo-prop-2-yne (397 mg, 1.9 mmol, 96%) as a yellow oil. δ_H (270 MHz; $CDCl_3$) 8.23 (2 H, m, 2 × ArH), 7.67 (3 H, m, 3 × ArH), 7.45 (5 H, m, 5 × ArH); δ_C (101 MHz; $CDCl_3$) 178.0 (CO), 136.9 (Ar*C*C), 134.1 (ArCH), 133.1 (2 × ArCH), 130.8 (ArCH), 129.6 (2 × ArCH), 128.8 (2 × ArCH), 128.7 (2 × ArCH), 120.3 (Ar*C*C), 93.1 (C≡), 87.0 (C≡). Found C, 87.42; H, 4.71. $C_{15}H_{10}O$ requires C, 87.36; H, 4.89.



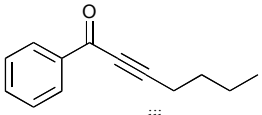
Methyl 6-oxo-6-phenylhex-4-ynoate 6

9:1 petrol-EtOAc used as solvent for chromatography (9:1 petrol-EtOAc, R_F 0.11) which gave methyl 6-oxo-6-phenylhex-4-ynoate (385 mg, 1.8 mmol, 89%) as a dark yellow oil. δ_H (400 MHz; $CDCl_3$) 8.13 (2 H, m, 2 × ArH), 7.62 (1 H, tt, *J* 7.3, 1.5, ArH), 7.46 (2 H, m, 2 × ArH), 3.75 (3 H, s, Me), 2.84 (2 H, td, *J* 6.8, 1.0, CH_2), 2.71 (2 H, m, CH_2); δ_C (70 MHz; $CDCl_3$) 177.9 (CO), 171.7 (CO), 136.8 (Ar*C*C), 134.0 (ArCH), 129.6 (2 × ArCH), 128.6 (2 × ArCH), 93.9 (C≡), 79.9 (C≡), 52.0 [Me), 32.4 (CH_2), 15.1 (CH_2); *m/z* (CI) 217 ($[MH]^+$, 96%), 185 ($[M\text{-}HOMe]^+$, 60); HRMS CI calc. $[MH]^+$ 217.0865, found 217.0865.



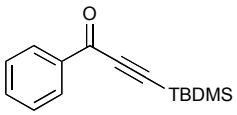
***tert-Butyl* 6-oxo-6-phenylhex-4-ynoate 7**[ii]

9:1 petrol-EtOAc used as solvent for chromatography (9:1 petrol-EtOAc, R_F 0.32) which gave *tert-butyl 6-oxo-6-phenylhex-4-ynoate* (435 mg, 1.7 mmol, 84%) as a brown oil. ν_{max} (neat)/cm^{-1} 2933 (CH), 2237 (C≡C), 2205 (C≡C), 1726 (CO), 1643 (CO); δ_H (400 MHz; $CDCl_3$) 8.13 (2 H, d, *J* 1.5, 2 × ArH), 7.60 (1 H, m, ArH), 7.47 (2 H, m, 2 × ArH), 2.77 (2 H, t, *J* 7.3, CH_2), 2.61 (2 H, t, *J* 7.3, CH_2), 1.48 (9 H, s, 3 × CH_3); δ_C (70 MHz; $CDCl_3$) 178.1 (CO), 170.6 (CO), 136.9 (Ar*C*C), 134.1 (ArCH), 129.7 (2 × ArCH), 128.6 (2 × ArCH), 94.6 (C≡), 81.4 ($C(CH_3)_3$), 79.9 (C≡), 33.8 (CH_2), 28.2 (3 × CH_3), 15.4 (CH_2); *m/z* (CI) 259 ($[MH]^+$, (34%)), 203 ($[MH_2\text{-}C(CH_3)_3]^+$, 100); HRMS EI calc. $[MNa]^+$ 281.1148, found 281.1139.



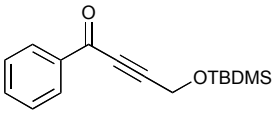
1-Oxo-1-phenylhept-2-yne 8[iii]

98:2 petrol-EtOAc used as solvent for chromatography (9:1 petrol-EtOAc, R_F 0.39) which gave the title compound (328 mg, 1.8 mmol, 88%) as a yellow oil. δ_H (270 MHz; $CDCl_3$) 8.14 (2 H, m, 2 × ArH), 7.60 (1 H, tt, *J* 7.4, 1.3, ArH), 7.47 (2 H, m, 2 × ArH), 2.51 (2 H, t, *J* 7.1, CH_2), 1.66 (2 H, m, CH_2), 1.51 (2 H, m, CH_2), 0.97 (2 H, t, *J* 7.3, CH_3); δ_C (101 MHz; $CDCl_3$) 178.1 (CO), 137.1 (Ar*C*C), 133.8 (ArCH), 129.5 (2 × ArCH), 128.5 (2 × ArCH), 96.8 (C≡), 79.8 (C≡), 29.9 (CH_2), 22.1 (CH_2), 18.9 (CH_2), 13.5 (Me); Found C, 84.31; H, 7.81. $C_{13}H_{14}O$ requires C, 83.83; H, 7.58.



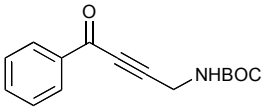
1-Oxo-1-phenyl-3-(*tert*-butyldimethylsilyl)prop-2-yne 9

98:2 petrol-EtOAc used as solvent for chromatography (98:2 petrol-EtOAc, R_F 0.25) which gave *1-oxo-1-phenyl-3-(tert-butyldimethylsilyl)prop-2-yne* (463 mg, 1.9 mmol, 96%) as a colourless oil. ν_{max} (neat)/cm^{-1} 2953 (CH), 2858 (CH), 2152 (C≡C), 1644 (CO); δ_H (270 MHz; $CDCl_3$) 8.15 (2 H, m, 2 × ArH), 7.62 (1 H, m, ArH), 7.47 (2 H, m, 2 × ArH), 1.03 (9 H, s, 3 × CH_3), 0.26 (6 H, s, 2 × CH_3); δ_C (101 MHz; $CDCl_3$) 177.5 (CO), 136.8 (Ar*C*C), 134.1 (ArCH), 129.6 (2 × ArCH), 128.6 (2 × ArCH), 101.8 (C≡), 99.3 (C≡), 26.1 (3 × CH_3), 16.7 (C), -5.0 (2 × CH_3); Found C, 73.47; H, 8.09. $C_{15}H_{20}OSi$ requires C, 73.71; H, 8.25.



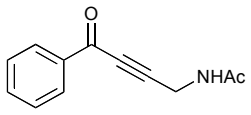
4-[(*O-tert*-Butyldimethylsilyl)oxy]-1-phenyl-1-oxo-but-2-yne 10[iv]

98:2 petrol-EtOAc used as solvent for chromatography (9:1 petrol-EtOAc, R_F 0.42) which gave the title compound (518 mg, 1.9 mmol, 94 %) as a yellow oil. δ_H (270 MHz; $CDCl_3$) 8.15 (2 H, m, 2 × ArH), 7.62 (1 H, tt, *J* 7.3, 1.3, ArH), 7.48 (2 H, m, 2 × ArH), 4.60 (2 h, s, CH_2), 0.94 (9 H, s, 3 × CH_3), 0.17 (6 H, s, 2 × CH_3); δ_C (68 MHz; $CDCl_3$) 177.6 (CO), 136.6 (Ar*C*C), 134.2 (ArCH), 129.7 (2 × ArCH), 128.6 (2 × ArCH), 92.9 (C≡), 82.8 (C≡), 51.8 (CH_2), 25.8 (3 × CH_3), 18.3 (C), -5.1 (2 × CH_3); Found C, 70.14; H, 8.20. $C_{15}H_{20}OSi$ requires C, 70.03; H, 8.08.



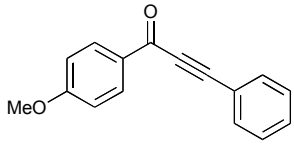
***N*-tertbutoxycarbonyl-4-amino-1-oxo-1-phenylbut-2-yne 11**

4:1 petrol-EtOAc used as the solvent for chromatography (4:1 petrol-EtOAc R_F 0.2) which gave the title compound as a red solid (496mg, 1.8mmol, 91%). m.p. 72°C. δ_H (270 MHz; $CDCl_3$) 8.13 (2H, m, Ph), 7.61 (1H, m, Ph), 7.48 (2H, m, Ph), 4.82 (1H, brs, NH), 4.21 (2H, d, *J* = 5.9, CH_2), 1.49 (9H, s, $C(CH_3)_3$); δ_C (68 MHz; $CDCl_3$) 177.5 (CO), 154.5 (OCON), 136.6 (Ph-CC), 134.3 (Ph-CH), 129.7 (2 × Ph-CH), 128.6 (2 × Ph-CH), 90.6 (C≡), 81.0 (C≡), 80.5 ($C(CH_3)_3$), 30.5 (CH_2), 28.4 (3 × CH_3); *m/z* (CI) 260 ([M]H$^+$, 35%), 204 ([M-C$(CH_3)_3$+H]H$^+$, 100%), 160 ([M-BOC+H]H$^+$, 40%); $C_{15}H_{17}NO_3$ requires: C, 69.48; H, 6.61; N, 5.40; Found: C, 69.14; H, 6.33; N, 5.26.



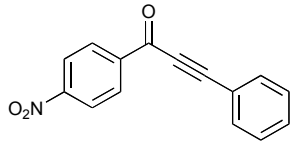
***N*-acetyl-4-amino-1-oxo-1-phenylbut-2-yne 12**

9:1 petrol-EtOAc used as the solvent for chromatography (4:1 petrol-EtOAc R_F 0.11) which gave the product as a yellow solid (280mg, 1.4mmol, 70%). m.p. 81-83°C. ν_{max} (neat) / cm^{-1} 3303, 3067, 2967, 2215, 2238, 1639, 1595, 1578, 1545. δ_H (270 MHz; $CDCl_3$) 8.11 (2H, m, ArCH), 7.60 (1H, m, ArH), 7.49 (2H, m, ArH), 5.83 (1H, brs, NH), 4.36 (2H, d, *J* 5.4, CH_2), 2.07 (3H, s, CH_3); δ_C (68 MHz; $CDCl_3$) 177.8 (CO), 170.1 (CON), 136.4 (ArCC), 134.4 (ArCH), 129.7 (2 × ArCH), 128.7 (2 × ArCH), 90.4 (C≡), 81.0 (C≡), 29.5 (CH_2), 22.9 (CH_3); *m/z* (CI) 220 ([M+H_2O]H$^+$, 40%), 202 ([M]H$^+$, 100%), 160 ([M-$COCH_3$+H]H$^+$, 55%); $C_{12}H_{12}NO_2$ ([M]H$^+$) calcd 202.0868, found 202.0867.



1-Oxo-1-*p*-methoxyphenyl-3-phenyl-prop-2-yne 13[1]

9:1 petrol-EtOAc used as solvent for chromatography (9:1 petrol-EtOAc, R_F 0.14) which gave 1-oxo-1-*p*-methoxyphenyl-3-phenyl-prop-2-yne (461 mg, 2.0 mmol, 98%) as a tan solid. m.p. softened at 90 °C, melted 92-94 °C; δ_H (400 MHz; $CDCl_3$) 8.20 (2 H, m, 2 × ArH), 7.67 (2 H, m, 2 × ArH), 7.43 (3 H, m, 3 × ArH), 6.98 (2 H, m, 2 × ArH), 3.90 (3 H, s, Me); δ_C (101 MHz; $CDCl_3$) 176.8 (CO), 164.6 (ArCO), 133.0 (2 × ArCH), 132.0 (2 × ArCH), 130.6 (ArCH), 130.5 (Ar*C*C), 128.7 (2 × ArCH), 120.5 (Ar*C*C), 113.9 (2 × ArCH), 92.3 (C≡), 87.0 (C≡), 55.6 (Me); *m/z* (EI) 236 ([M]$^+$, 96%), 208 ([M-CO]$^+$, 100), 193 ([M-CO-Me]$^+$, 66), 129 ([M-$MeOC_6H_4$]$^+$, 60).

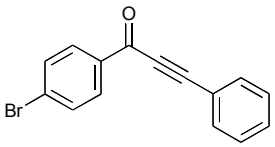


1-*p*-Nitrophenyl-1-oxo-3-phenyl-prop-2-yne 14[1]

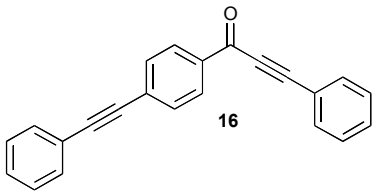
Recrystallised from EtOAc/petrol to yield 1-*p*-nitrophenyl-1-oxo-3-phenyl-prop-2-yne (249 mg, 1.0 mmol, 50%) as a tan solid. (9:1 petrol:EtOAc, R_F 0.24); m.p. 162 °C; δ_H (270 MHz; $CDCl_3$) 8.38 (4 H, s, 4 × ArH), 7.73 (2 H, m, 2 × ArH), 7.48 (3 H, m, 3 × ArH); δ_C (101 MHz; $CDCl_3$) 175.8 (CO), 151.4 (ArCN), 141.2 (Ar*C*C), 133.3 (2 × ArCH), 131.5 (ArCH), 130.5 (2 × ArCH), 128.9 (2 × ArCH), 123.9 (2 × ArCH), 119.5 (Ar*C*C), 95.4 (C≡), 86.6 (C

Crystal data for **14**: $C_{15}H_9NO_3$, Monoclinic, a = 7.6488(6), b = 7.1371(6), c = 10.9816(9) Å, β = 97.617(2) º, V = 594.20(8) Å^3, T = 173 K, space group $P2_1$ (No. 4), Z = 2, μ[Mo-K_α) = 0.099 mm^{-1}, 3914 reflections measured, R_{int} = 1.9%. Final residuals: R_1 = 3.1% [2386 data with $I > 2\sigma(I)$), wR_2 = 8.1% (all 2515

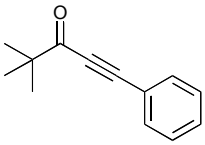
unique data). No attempt was made to determine the Flack parameter.



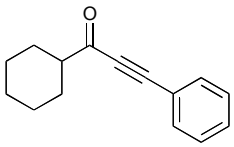
1-*p*-Bromophenyl-1-oxo-3-phenyl-prop-2-yne 15[v]
95:5 petrol-EtOAc used as solvent for chromatography (9:1 petrol-EtOAc, R_F 0.35) which gave 1-*p*-bromophenyl-1-oxo-3-phenyl-prop-2-yne (507 mg, 1.8 mmol, 89%) as a yellow solid. δ_H (400 MHz; $CDCl_3$) 8.08 (2 H, dd, *J* 6.8, 2.0, 2 × ArH), 7.67 (4 H, m, 4 × ArH), 7.50 (1 H, m, ArH), 7.44 (2 H, m, 2 × ArH); δ_C (101 MHz; $CDCl_3$) 176.8 (CO), 135.7 (Ar*C*C), 133.1 (2 × ArCH), 132.0 (2 × ArCH), 131.0 (ArCH), 130.9 (2 × ArCH), 129.6 (Ar*C*C), 128.7 (2 × ArCH), 119.9 (Ar*C*C), 93.7 (C≡), 86.6 (C≡); Found C, 63.39; H, 3.13. $C_{15}H_9BrO$ requires C, 63.18; H, 3.18.



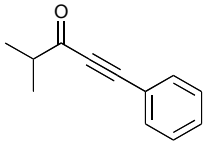
3-Phenyl-1-(4-phenylethynyl-phenyl)-propynone 16
(DR IV 148) Using 2.0 eq. of phenylacetylene and 9:1 petrol-EtOAc as the chromatography solvent (9:1 petrol-EtOAc RF 0.36) which gave the product as a yellow solid (405mg, 1.32mmol, 66%). m.p. 104-106˚C. ν_{max} (neat) / cm^{-1} 3056, 2198, 1627, 1601, 1553, 1486, 1443, 1405. δ_H (400 MHz; $CDCl_3$) 8.20 (2H, d, *J* 8.3), 7.70 (2H, d, *J* 7.2), 7.66 (2H, d, *J* 8.3), 7.55 (2H, m), 7.50 (3H, m), 7.39 (3H, m); δ_C (100 MHz; $CDCl_3$) 177.0 (CO), 136.7 (ArCC), 133.6 (2 × ArCH), 132.3 (2 × ArCH), 132.2 (2 × ArCH), 131.3 (ArCH), 130.0 (2 × ArCH), 129.8 (ArCC), 129.4 (ArCH), 129.2 (2 × ArCH), 129.0 (2 × ArCH), 123.1 (ArCC), 120.0 (ArCC), 94.1 (C≡), 94.0 (C≡), 89.2 (C≡), 87.4 (C≡); *m/z* (CI) 307 ($[M]H^+$, 100%), 205 ($[M\text{-}C{\equiv}CPh]^+$, 30%), 129 ($[M\text{-}PhC{\equiv}CC_6H_4]^+$, 45%), $C_{23}H_{15}O$ ($[M]H^+$) requires 308.1156, found 308.1140



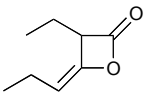
2,2-dimethyl-3-oxo-5-phenyl-pent-4-yne 17[vi]
(DR IV 127) Using 97:3 petrol-EtOAc as the chromatography solvent (4:1 petrol-EtOAC RF 0.54) which gave the product as a brown oil (320mg, 1.7mmol, 86%. δ_H (400 MHz; $CDCl_3$) 7.58 (2H, m, ArH), 7.40 (3H, m, ArH), 1.28 (9H, s, 3 × CH_3); δ_C (100 MHz; $CDCl_3$) 194.1 (CO), 132.9 (2 × ArCH), 130.6 (Ar CH), 128.7 (2 × ArCH), 120.4 (ArCC), 92.2 (C≡), 86.1 (C≡), 44.9 ($C(CH_3)_3$), 26.2 (3 × CH_3); Found C, 83.44; H, 7.41. $C_{13}H_{14}O$ requires C, 83.83; H, 7.58.



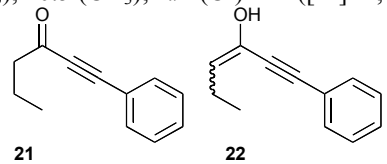
1-Cyclohexyl-1-oxo-3-phenyl-prop-2-yne 18[1]
98:2 petrol-EtOAc used as solvent for chromatography (98:2 petrol-EtOAc, R_F 0.22) which gave 1-cyclohexyl-1-oxo-3-phenyl-prop-2-yne (408 mg, 1.9 mmol, 96%) as a yellow oil. δ_H (400 MHz; $CDCl_3$) 7.58 (2 H, dd, *J* 6.8, 1.5, 2 × ArH), 7.45 (1 H, tt, *J* 7.6, 1.5, ArH), 7.38 (2 H, m, 2 × ArH), 2.5 (1 H, m, CH), 2.05 (2 H, m, CH_2), 1.81 (dt, *J* 13.2, 3.9, CH_2), 1.69 (1 H, m, CH*H*), 1.50 (2 H, qd, *J* 11.7, 3.4, CH_2), 1.17-1.4 (3 H, m, C*H*H + CH_2); δ_C (101 MHz; $CDCl_3$) 191.3 (CO), 132.9 (2 × ArCH), 130.5 (ArCH), 128.5 (2 × ArCH), 120.1 (Ar*C*C), 91.2 (C≡), 87.1 (C≡), 52.2 (CH), 28.4 (CH_2), 25.8 (CH_2), 25.5 (CH_2). Found C, 85.17; H, 7.65. $C_{15}H_{16}O$ requires C, 84.87; H, 7.60.



2-methyl-3-oxo-4-phenylbut-4-yne 19[vii]
Using 98:2 petrol-EtOAc as the chromatography solvent (4:1 petrol-EtOAc RF 0.50) which gave the product as a yellow oil (332mg, 1.9mmol, 97). δ_H (400 MHz; $CDCl_3$) 7.58 (2H, m, ArCH), 7.46 (1H, m, ArH), 7.39 (2H, m, ArH), 2.76 (1H, septet, *J* 6.84, CH), 1.25 (6H, d, *J* 6.84, 2 × CH_3); δ_C (100 MHz; $CDCl_3$) 192.0 (CO), 133.0 (2 × ArCH), 130.6 (ArCH), 128.6 (2 × ArCH), 120.3 (ArCC), 91.6 (C≡), 86.9 (C≡), 43.1 (CH), 18.1 (2 × CH_3); Found C, 83.96; H, 6.92. $C_{12}H_{12}O$ requires C, 83.69; H, 7.02).

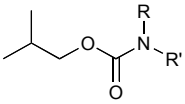


(±)-2-ethylidene-3-ethyl-oxetane-4-one 20[viii]
Chromatography using 9:1 petrol-EtOAc (4:1 petrol-EtOAc R_F 0.5) gave the product as a brown oil (70mg, 0.46mmol, 46%). δ_H (400 MHz; $CDCl_3$) 4.72 (1H, dt, *J* 7.8, *J* 1.5, CH=), 3.92 (1H, m, CH), 2.16 (1H, dq, *J* 7.3, *J* 7.3, C*H*H), 2.15 (1H, dq, *J* 7.3, *J* 7.3, CH*H*), 1.82 (2H, dq, *J* 7.8, *J* 7.3, CH_2), 1.06 (3H, t, *J* 7.3, CH_3), 1.03 (3H, t, *J* 7.3, CH_3); δ_C (101 MHz; $CDCl_3$) 169.4 (CO), 145.0 (C), 103.3 (CH), 55.1 (CH), 20.8 (CH_2), 18.2 (CH_2), 14.1 (CH_3), 10.5 (CH_3); *m/z* (CI) 141 ($[M]H^+$, 100%).



4-oxo-6-phenyl-hex-5-yne 21 and *E* and *Z* 4-hydroxy-6-phenylhex-3-en-5-yne 22[ix]
Using DIPEA as the base and 9:1 petrol-EtOAc as the chromatography solvent (4:1 petrol-EtOAc R_F 0.6) yielded an equilibrium mixture of the expected ketone (53%) and enol forms (47%, of which 4:1 mixture of *E*

and *Z* forms) (147mg, 0.85mmol, 43%). δ_H (400 MHz; $CDCl_3$) 7.57 (2 H, dd, *J* 6.8, 1.5, 2 × ArH, keto form), 7.27-7.48 (5 H, m, 5 × ArH enol **A** and **B** + 3 H, m, 3 × ArH, keto form), 5.77 (1 H, m, CH, enol **A**), 5.70 (1 H, t, *J* 7.8 enol **B**), 2.66 (2 H, t, *J* 7.3, $COCH_2$, keto form), 2.37 (2 H, dq, *J* 7.8, 7.8, CH_2, enol **B**), 2.1 (2 H, m, CH_2, enol **A**), 1.78 (2 H, m, CH_2, keto form), 1.09 (3 H, t, *J* 7.8, CH_3, enol **B**), 1.01 (3 H, m, CH_3, keto form and enol **A**); δ_C (101 MHz; $CDCl_3$) 187.7 (CO), 171.1 (=CH, enol **B**), 170.8 (=CH, enol **A**), 133.0 (2 × ArCH), 131.7 (2 × ArCH), 130.6 (ArCH), 130.4 (CH, enol **A**), 129.5 (*ArCC*), 128.8 (ArCH), 128.6 (2 × ArCH), 128.3 (2 × ArCH), 122.3 (=COH), 120.2 (=COH), 93.8 (C), 90.5 (C), 88.5 (C), 87.9 (C), 84.0 (C), 81.9 (C), 47.4 ($COCH_2$, keto form), 19.7 (CH_2, enol **A**), 17.8 (CH_2, keto form), 13.6 (2 × CH_3, keto form and enol **A**), 13.1 (CH_3, enol **B**) [Signals from the enol forms often too weak to measure, especially enol **B**]; *m/z* (CI) 201 ($[M+H_2O]H^+$, 20%), 173 ($[M]H^+$, 100%), 155 ($[M-H_2O]H^+$, 80%).

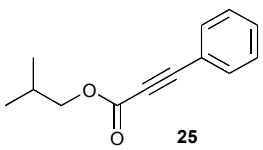


24 a R = Et, R' = Et
b R = ^{i}Pr, R' = Et
c R = Et, R' = ^{i}Pr

Diethyl-carbamic acid isobutyl ester 24a and *N*-ethyl-*N*-isopropyl-carbamic acid isobutyl ester isomers 24b+c.

Using Et_3N as the base and 95:5 petrol-EtOAc as the chromatography solvent afforded the diethyl carbamate **24a** as a colourless oil (145mg, 0.84mmol, 42%). ν_{max} (neat) /cm^{-1} 2965, 1695, 1480, 1471, 1424. δ_H (400 MHz; $CDCl_3$) 3.85 (2H, d, *J* 6.4, OCH_2), 3.28 (4H, brs, 2 × NCH_2), 1.92 (1H, m, CH), 1.12 (6H, t, *J* 7.3, 2 × CH_3), 0.94 (6H, d, *J* 6.8, 2 × CH_3); δ_C (100 MHz; $CDCl_3$); *m/z* (CI) 174 ($[M]H^+$, 25%), 118 ($M-(CH_3)_2CHCH_2)+H]H^+$, 100).

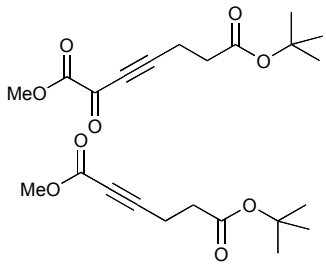
Using DIPEA as the base and 98:2 petrol-EtOAc as the chromatography solvent afforded the ethylisopropyl carbamate as a colourless oil (approx 9:1 mixture of isomers **24b+c**, 135mg, 0.72mmol, 36%). ν_{max} (neat) /cm^{-1} 2966, 1648, 1455, 1417. δ_H (270 MHz; $CDCl_3$) 4.35 (1H, brm, NCH), 3.86 (2H, d, J 6.6, OCH_2), 3.18 (2H, brm, NCH_2), 1.95 (1H, m, CH), 1.15 (9H, m, 3 × CH_3), 0.95 (6H, d, J 6.8, 2 × CH_3); δ_C (100 MHz; $CDCl_3$) 156.2 (CO), 71.2 (OCH_2), 47.4 (CH), 37.0 (NCH_2), 28.1 (3 × CH_3), 20.8 (CH), 19.2 (2 × CH_3), 15.7 (NCH); *m/z* (CI) 188 ($[M]H^+$, 40%), 132 ($[M-(CH_3)_2CHCH_2)+H]H^+$, 100), calcd for $C_{10}H_{22}NO_2$ ($[M]H^+$) 188.1651, found 188.1648.



25

Isobutyl 3-phenyl-propynoate 25

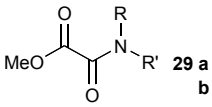
Using DIPEA as the base and 98:2 petrol-EtOAc as the chromatography solvent afforded the title compound as a brown oil (48mg, 0.23mmol, 8%). ν_{max} (neat) /cm^{-1} 3060, 2962, 2221, 1704, 1490, 1469, 1444. δ_H (400 MHz; $CDCl_3$) 7.59 (2H, m, ArH), 7.45 (1H, m, ArH), 7.37 (2H, m, ArH), 4.03 (2H, d, J 6.8, OCH2), 2.03 (1H, m, CH), 0.99 (6H, d, *J* 6.8, 2 × CH_3); δ_C (100 MHz; $CDCl_3$) 154.3 (CO), 133.0 (2 × ArCH), 130.6 (ArCH), 128.6 (2 × ArCH), 119.8 (ArCC), 86.1 (C≡), 80.8 (C≡), 72.1 (OCH_2), 27.7 (CH), 19.1 (2 × CH_3); *m/z* (CI) 203 ($[M]H^+$, 50%), 147 ($[M-(CH_3)_2CHCH_2)+H]H^+$, 100); calcd for $C_{13}H_{15}O_2$ ($[M]H^+$) 203.1072, found 203.1066.



2-Oxo-hept-3-ynedioic acid 7-*tert*-butyl ester 1-methyl ester 27 and Hex-2-ynedioic acid 6-*tert*-butyl ester 1-methyl ester 28

Using 9:1 petrol-EtOAc as the chromatography solvent (9:1 petrol-EtOAc R_F 0.15) gave the title compound **27** as a yellow oil (38.5mg, 0.16mmol, 8%). δ_H (400 MHz; $CDCl_3$) 3.90 (3H, s, OMe), 2.74 (2H, t, *J* 7.3, CH_2), 2.57 (2H, t, *J* 7.3, CH_2), 1.45 (9H, s, O^{t}Bu); δ_C (100 MHz; $CDCl_3$) 170.0 (CO), 169.1 (CO), 159.6 (CO), 100.1 ($OC(CH_3)_3$), 82.0 (C≡), 79.95 (C≡), 53.4 (OMe), 33.2 (CH_2), 28.1 (3 × CH_3), 15.5 (CH_2); *m/z* (CI) 241 ($[M]H^+$, 10%), 185 ($[M-^tBu+H]H^+$, 95), 125 ($[MeO_2CC(O)C{\equiv}CCH_2]^+$, 100).

Using 9:1 petrol-EtOAc as the chromatography solvent (9:1 petrol-EtOAc R_F 0.15) gave the title compound **28** as a yellow oil (34mg, 0.16mmol, 8%). δ_H (270 MHz; $CDCl_3$) 3.74 (3H, s, OMe), 2.55, 2H, m, CH_2), 2.51 (2H, m, CH_2), 1.46 (9H, O^{t}Bu); δ_C (100 MHz; $CDCl_3$) 170.3 (CO), 154.0 (CO), 87.6 (C≡), 81.3 (C≡), 73.2 ($OC(CH_3)_3$), 52.5 (OMe), 33.4 (CH_2), 28.1 (3 × CH_3), 14.7 (CH_2).



29 a R = ^{i}Pr, R' = Et
b R = Et, R' = ^{i}Pr

***N*-Ethyl-*N*-isopropyl-oxalamic acid methyl ester 29**

Using 4:1 petrol-EtOAc as the chromatography solvent (4:1 petrol-EtOAc RF 0.16) afforded **29** as a colourless oil (60 mg, 0.35 mmol, 14%) as a brown oil and a mixture of rotamers **A** (major) and **B** (minor). δ_H (400 MHz; $CDCl_3$) 4.47 (0.34H, septet, *J* 6.8, CHN, **B**), 3.86 (3H, s, OMe), 3.80 (0.66H, septet, J 6.8, CHN, **A**) 3.31 (0.66H, q, *J* 7.4, CH_2N, **A**), 3.25 (0.34H, q, *J* 7.3, CH_2N, **B**), 1.24 (9H, m, 3 × CH_3); δ_C (101 MHz; $CDCl_3$) 164.0 (CO, **A**), 163.8 (CO, **B**), 161.8 (CO, **B**), 161.5 (CO, **A**), 52.4 (OMe, **A**) 52.3 (OMe, **B**), 50.1 (CH, **A**), 46.4 (CH, **B**), 39.2 (CH_2, **B**), 35.2 (CH_2, **A**), 21.2 (2 × CH_3, **A**), 20.1 (2 × CH_3, **B**), 16.5 (CH_3, **B**), 14.3 (CH_3, **A**); *m/z* (CI) 174 [$(MH)^+$, (24%)], 132 [$(MH_2-CH(CH_3)_2)^+$, (15)]; HRMS CI $(MH)^+$ calc. 174.1130, found 174.1124.

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