115. Preparation of 3-Oxo- and 3-Ethylideneazetidine Derivatives[1])

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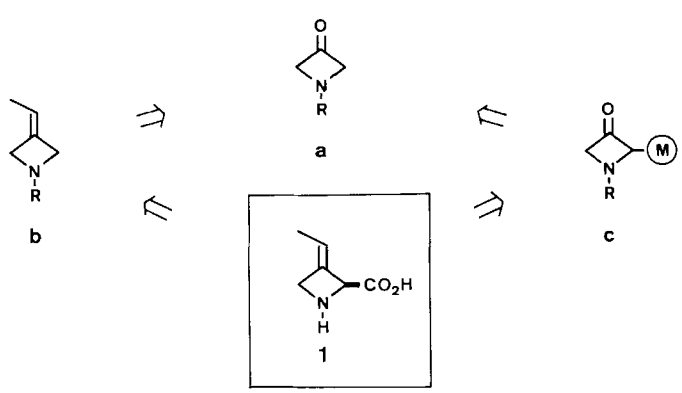
The preparation of 3-azetidinones with different *N*-substituents and their transformation to 3-ethylideneazetidines has been studied in relation with a projected synthesis of 3-ethylideneazetidine-2-carboxylic acid (= polyoximic acid; **1**). The stable crystalline 3-azetidinone hydrochloride (**18**), obtained by hydrogenolysis of the known 1-(diphenylmethyl)-3-azetidinone (**4**), is described for the first time. From this key intermediate, 3-oxoazetidine-derived amides, exemplified by benzamide **12**, urethanes (*e.g.* **17**), and ureas (*e.g.* **20**) can be prepared in good yield *(Scheme 3)*. The olefination of 3-azetidinones with alkylidene(triphenyl)phosphoranes is a preparatively useful process only for derivatives with a pyramidal N-atom, *e.g.* the diphenylmethyl derivative **4**, and not for the amide **12** or the urethane **17** *(Scheme 4)*. 3-Alkylidene-azetidines with an amide N-atom should, therefore, be prepared by exchange of the *N*-substituent after the introduction of the double bond.

In connection with a project aiming at a synthesis of polyoximic acid (**1**), an unusual amino acid which is a constituent of the nucleoside tripeptide antibiotic polyoxin A [2], we considered the elaboration of known azetidine derivatives a possibility to reach this strained structure[3]). Two such retrosynthetic paths starting from 3-azetidinones **a** are shown in *Scheme 1*. One approach leads to the β,γ-unsaturated amino acid **1** by addition

Scheme 1



R = suitable protecting group; M = masked carboxylate

[1]) This work is part of the Ph. D. thesis of *H. B.* [1].

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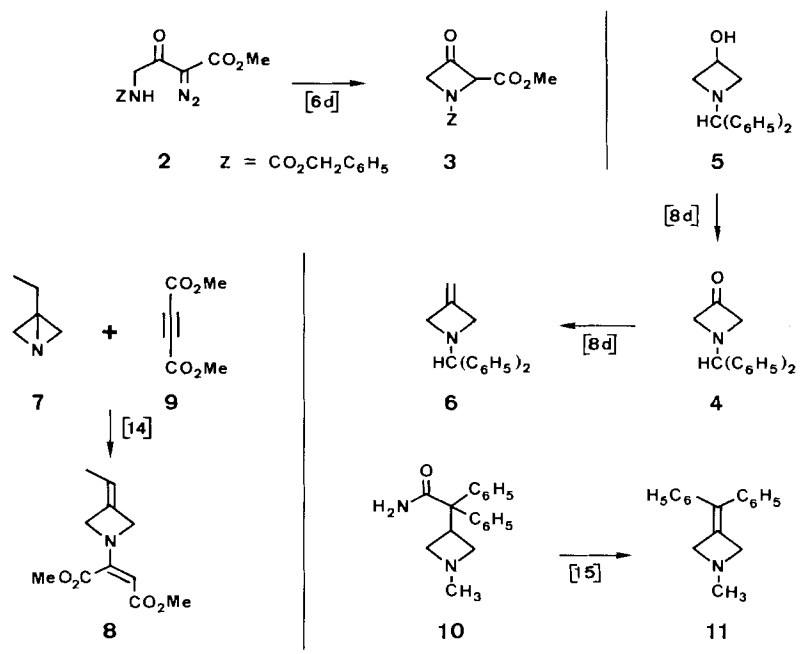
[3]) The context of this project and other approaches are discussed in more detail in [1] and also in the preceding paper [3].

of the carboxylate function to a 3-ethylideneazetidine **b** obtained by olefination of ketone **a**. Reversal of these two operations involves a β-keto ester **c** with a masked carboxylate as intermediate. Despite the fact that we did not proceed very far on either of these routes[4]), we decided to report our results on the preparation of 3-azetidinones **a** and 3-ethylideneazetidines **b**, classes of compounds which have not been examined extensively so far [4].

3-Azetidinones have been prepared by cyclization of α-amino-α'-halogeno ketones [5], or, more efficiently, by cyclization of analogous α-diazo ketones [5b] [6][5]). A recent example is the Rh-catalyzed reaction of 2-diazo-acetoacetate **2** giving the delicate 3-oxo-azetidine-2-carboxylate **3** [6d] *(Scheme 2)*. A conceptually different approach to 3-azetidinones is the oxidation of 3-azetidinols [8], illustrated by the preparation of the *N*-(diphenylmethyl) derivative **4** from alcohol **5** [8b–d] *(Scheme 2)*. The oxidative cleavage of 3-(hydroxyalkyl)-3-azetidinols has been used to prepare 2,2,4,4-tetramethyl-3-azetidinones [9]. Still another possibility, not exploited so far, would be the hydrolysis of 3-iminoazetidines obtainable by reaction of isocyanides with stabilized azomethine ylids [10]. In contrary to 3-alkylidene-β-lactams (*e.g.* [11]), only a few 3-alkylideneazetidines have been described. The most general method, exemplified by the preparation of the 3-methylidene derivative **6** from ketone **4** [8d], appears to be the *Wittig* olefination of 3-azetidinones [8d] [12]. Singular cases are, however, the desulfurization of an episulfide [13], the fragmentation of 1-azabicyclo[1.1.0]butane **7** leading to the adduct **8** of butyne-

Scheme 2



[4]) For details, *cf.* [1].

[5]) Related with this method is the intramolecular reaction of azo groups with α-diazo ketones studied by *Moore et al.* [7].

dioate **9** [14], and the unusual *Hoffmann* degradation of amide **10** affording the tetra-substituted olefin **11** [15] *(Scheme 2)*.

Important for the success of our project, the synthesis of 3-ethylideneazetidine-2-carboxylic acid (**1**), was the selection of an *N*-protecting group which can be removed at the end of the sequence without affecting this delicate structure. As it is known from the degradation of polyoxin A that **1** survives alcaline or acidic hydrolysis of a peptide bond [2], we first studied the preparation of amides and carbamates of 3-azetidinones and 3-ethylideneazetidine[6]).

Still the best access to 3-substituted azetidines is the reaction of epichlorohydrine with bulky primary amines discovered by *Gärtner* [17a]. Because of the facile *N*-deprotection by hydrogenolysis [17b], we chose *N*-(diphenylmethyl)-3-azetidinol (**5**) [17] as starting material.

In a first approach, the acetate hydrochloride **13** obtained from **5** could be *N*-dealkylated using 20% $Pd(OH)_2$ on charcoal (*Perlman* catalyst [18]) affording **14** *(Scheme 3)*. Subsequent *N*-acylation with either Ac_2O or methyl chloroformate in pyridine followed by acetate cleavage gave the azetidinols **15** and **16** in 60–75% yield based on **13**[7]). The planned oxidation of **16** to the ketone **17** turned out to be more difficult than anticipated. In contrary to the benzamide **12**, which is accessible by *Jones* oxidation of the corresponding alcohol [8a], several Cr(VI)-based methods failed for the conversion of **16** to **17**, most probably due to the instability of **17**. It is possible that this transformation could still be effected by milder procedures like the *Swern* oxidation [19].

However, we then discovered a new method which should allow the preparation of a variety of 3-azetidinones with different *N*-substituents: *The parent 3-azetidinone could be obtained and isolated as its crystalline hydrochloride* **18**[8]) *by hydrogenation of* **19**, the hydrochloride of the known 1-(diphenylmethyl)-3-azetidinone (**4**) [8d][9]). Despite the fact that the free base of **18** is expected to be extremely unstable and prone to self-condensation, we succeeded in preparing *N*-derivatives when a weak base (pyridine and a catalytic amount of 4-(dimethylamino)pyridine) was slowly added to a mixture of **18** and an excess of an acylating agent. In this way, the benzamide **12**, the carbamate **17**, and the urea **20** could be prepared in good yields *(Scheme 3)* [10]).

When the work of *Nitta et al.* [16] appeared, we found that the carbamate **17** is more conveniently obtained directly from **4** by dealkylation with methyl chloroformate. However, no conversion to **12** was observed, when **4** was treated with the less reactive benzoyl chloride.

With different types of *N*-protected 3-azetidinones at hand, we spent some effort studying the olefination of these compounds. Applying the harsh conditions needed for

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[6]) At the beginning of this investigation [1], *N*-benzoyl-3-azetidinone (**12**) [8a] was the only reported amide, the work of *Nitta et al.* [16] had not been published then.

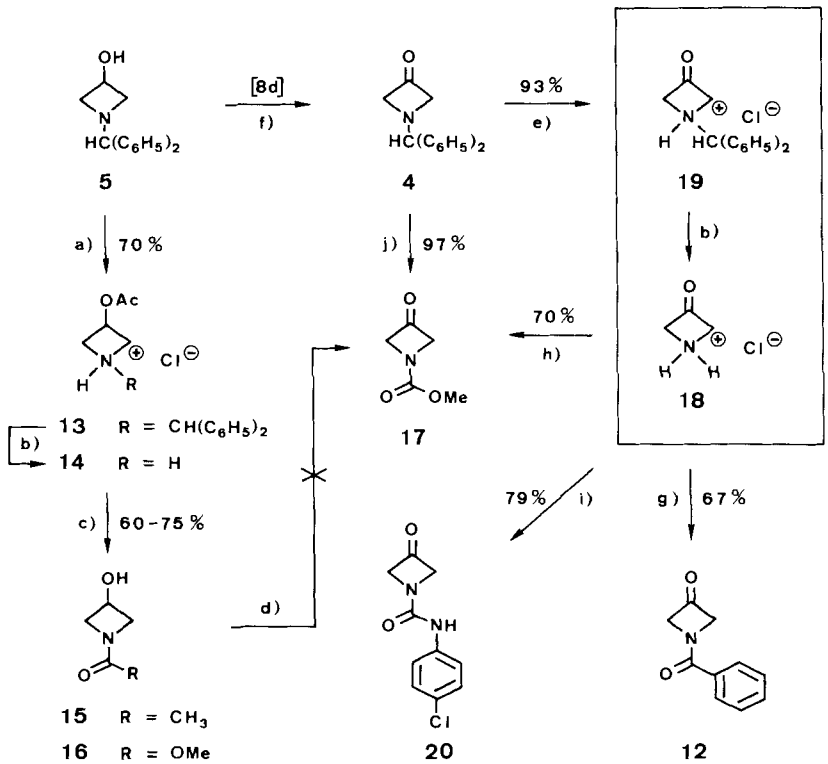
[7]) For an experimental description, *cf.* [1].

[8]) Compound **18** has been described before in the patent literature as putative monomeric intermediate of polyunsaturated polymers [20]. Besides the fact that we were unable to reproduce these experiments (*Examples I* and *II* of [20]), the structures seem highly improbable from a theoretical standpoint. Furthermore, the physical characteristics of **18** and the intermediate of *Example II* with assumed structure **18** (based on IR) are different: our compound decomposes below 150°, whereas the intermediate of [20] melts at 290–300°; 3-azetidinone hydrochloride (**18**) as obtained by us is soluble in H_2O or 5% HCl solution; according to [20], the compound prepared from imino-diacetate is isolated by filtration from 5% HCl solution.

[9]) We obtained the crystalline ketone **4** conveniently by *Swern* oxidation [19] of **5** and sublimation of the crude product under high vacuum.

[10]) Since the salt **18** contained variable amounts of tightly bound CH_3OH, the yields are based on **19**.

Scheme 3

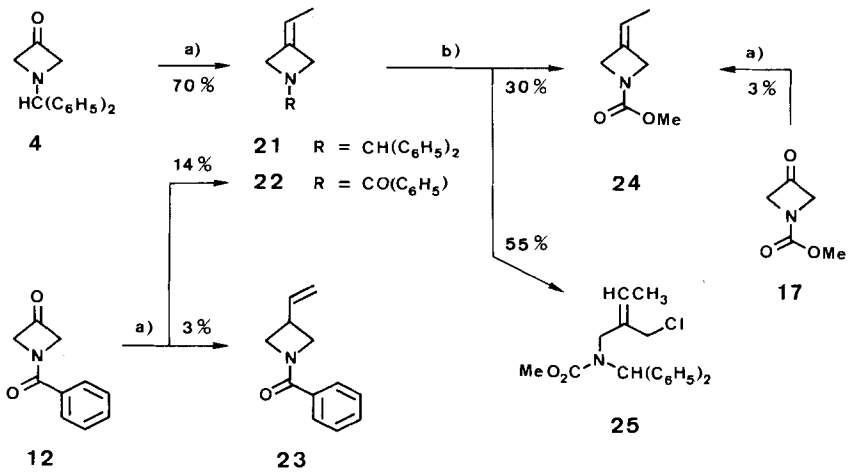


a) 1. Ac_2O/pyridine, 2. HCl/Et_2O[7]); *b)* H_2 (60 psi), 20% $Pd(OH)_2$/C,CH_3OH[7]); *c)* 1. Ac_2O or $ClCO_2CH_3$/pyridine, 2. 10% K_2CO_3/H_2O, CH_3OH, reflux (1 h)[7]); *d) Jones* oxidation, CrO_3/pyridine, or PyH–$ClCrO_3$; *e)* HCl/Et_2O; *f)* $(CF_3CO)_2O$/DMSO/Et_3N; *g)* Benzoyl chloride, Py/(Me_2N)Py (cat.), CH_2Cl_2; *h)* $ClCO_2CH_3$, Py/(Me_2N)Py (cat.), CH_2Cl_2; *i)* (4-chlorophenyl)isocyanate, Py/(Me_2N)Py (cat.), CH_2Cl_2; *j)* $ClCO_2CH_3/CH_2Cl_2$, reflux

the methylidenation of **4** [8d], the analogous ethylidene derivative **21** could be obtained in reasonable yield *(Scheme 4)*. However, when the benzamide **12** was subjected to this *Wittig* olefination, the desired product **22** was obtained in poor yield together with some double-bond isomer **23**. The situation turned out to be even worse in the case of the carbamate **17**, where only trace amounts of the ethylidene derivative **24** could be isolated from the complex reaction mixture. A somewhat better yield of **24** was obtained by dealkylation of the diphenylmethyl derivative **21** with methyl chloroformate at low temperature. Not unexpectedly, the major pathway of this reaction is ring cleavage to the allylic chloride **25** *(Scheme 4)*.

Concluding, it can be stated that various *N*-acylated 3-azetidinones are available from the *N*-(diphenylmethyl) derivative **4** either by the dealkylation procedure of *Nitta et al.* [16] or by the acylation of 3-azetidinone hydrochloride (**18**) described in this work, two complementary methods. Only crystalline 3-azetidinones appear to be storeable for prolonged periods, *e.g.* **4**, **12**, and **18**. Oily compounds like **17** or solutions slowly decompose, even at low temperatures.

Scheme 4



a) Ethyl(triphenyl)phosphonium bromide/KO(*t*-Bu)/DMSO, 60°, 36 h; *b)* $ClCO_2CH_3/CH_2Cl_2$, 0°, 24 h

Like the ketones, 3-alkylideneazetidines are strained structures, and elevated temperatures are necessary for their preparation by *Wittig* olefination. This strain is increased by planarisation of the N-atom and might be the reason that the olefination gives acceptable results only when applied to 3-azetidinones with a pyramidal N-atom. Therefore, 3-alkylideneazetidine-derived amides should be prepared by exchange of the *N*-substituent after the introduction of the double bond. The possibilities for such transformations are, however, limited as most reductive procedures are not tolerated by the strained double bond and chloroformate treatment results in ring cleavage. A solution to this problem might be offered by acid-labile functions like the *N*-[bis(4-methoxyphenyl)methyl] group [21]. It remaines to be mentioned, that 3-alkylideneazetidines are also of limited stability. After two weeks of storage at 8°, the oily **24** was decomposed to the extent of more than 50%, and aldehyde signal in the ^{1}H-NMR-spectrum indicating autooxidation and ring cleavage.

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Experimental Part

General. See [3].

20% Pd(OH)$_2$ on Charcoal [18]. A suspension of $PdCl_2$ (5.008 g, 28.2 mmol) and *Norite* (*Darco-G 80*, 12 g) in H_2O (100 ml) was heated to 80° under stirring and kept at 80° for ½ h. Li(OH) (12 ml of a 4.97M soln., 59.6 mmol) was then added and stirring continued overnight at r.t. The product was collected by filtration, washed with 0.5% AcOH soln. (500 ml), and dried overnight under high vacuum (60°): 15.2 g.

3-Azetidinone Hydrochloride (**18**). A soln. of freshly sublimed **4** (15.5 g, 65.5 mmol) in dry Et_2O (750 ml) was purged with gaseous HCl. After removal of excess HCl with Ar, the precipitate was collected by filtration, washed with Et_2O, and dried under high vacuum: 16.7 g (93%) of **19**. A soln. of **19** (4.922 g, 18 mmol) in 100 ml of abs.

CH_3OH was hydrogenated at r.t. (58 psi of H_2) with 600 mg of 20% $Pd(OH)_2/C$ in a *Parr* shaker. After 65 h (TLC: no **19** left) the catalyst was filtered off and the filtrate concentrated until it became cloudy. Upon addition of benzene (100 ml) and preferably after seeding with crystals, the product crystallized and was collected by filtration. Drying under high vacuum for 2 days gave 2.004 g (*ca.* 80%) of **18**, containing, according to ^{1}H-NMR, *ca.* 20% (w/w) of CH_3OH. M.p. 110–140° (dec.). IR (KBr): 3700–2300*m*, 2930*s*, 1830*s*, 1460*w*, 1445*w*, 1422*w*, 1383*m*, 1322*w*, 1265*w*, 1250*w*, 1212*m*, 1185*s*, 1090*m*, 1023*m*, 965*w*, 930*w*, 915*w*, 885*w*, 870*w*, 705*m*, 456*m*. ^{1}H-NMR (90 MHz, (D_6)DMSO): 3.91 (*m*, $w_{1/2} \approx 6$, 2 H–C(2), 2 H–C(4)); 8.8–10.5 (br., NH_2).

1-Benzoyl-3-azetidinone (**12**). Hydrochloride **19** (2.688 g, 9.83 mmol) was hydrogenated as described above and the resulting **18** (1.067 g) suspended in CH_2Cl_2 (10 ml). Benzoyl chloride (3 ml, 25.8 mmol) was added followed by the slow addition (15 h) of a soln. of pyridine (2.5 ml, 25.8 mmol) and 4-(dimethylamino)pyridine (1.2 g, 9.85 mmol) in CH_2Cl_2 (11 ml) at r.t. with stirring. Solvents and volatile reagents were evaporated, and the residue was treated with CH_2Cl_2/Et_2O 4:1 (100 ml). Filtration, chromatography of the residue of the filtrate (silica gel, CH_2Cl_2/AcOEt 2:1), and crystallization (hexane/CH_2Cl_2) gave 1.025 g (59%) of **12**. Chromatography of the mother liquor as above gave additional 131 mg (8%) of **12**. IR ($CHCl_3$): 2995*w*, 2920*w*, 1827*s*, 1655–1635*s*, 1600*w*, 1574*m*, 1490*w*, 1445*m*, 1390*s*, 1050*m*, 1025*w*, 1003*w*, 960*m*, 869*m*. ^{1}H-NMR (80 MHz, $CDCl_3$): 4.95 (*s*, 2 H–C(2), 2 H–C(4)); 7.3–7.85 (*m*, C_6H_5CO). MS: 147 (17, $M^{+\cdot} - 28$), *105* (100), 91 (1), 77 (54), 51 (15).

Methyl 3-Oxoazetidine-1-carboxylate (**17**). a) *From* **4**. A soln. of **4** (2.39 g, 10.08 mmol) and methyl chloroformate (5 ml, 64.5 mmol) in CH_2Cl_2 (50 ml) was heated under reflux for 15 h under Ar. Solvent and excess of reagent were evaporated. Chromatography (silica gel, CH_2Cl_2/AcOEt 95:5) afforded 1.27 g (97%) of **17**. IR ($CHCl_3$): 3020*w*, 2950*w*, 2930*w*, 1830*s*, 1710*s*, 1450*m*, 1435*w*, 1420*w*, 1385*m*, 1330*w*, 1265*w*, 1195*w*, 1135*m*, 1055*w*, 978*w*. ^{1}H-NMR (60 MHz, $CDCl_3$): 3.66 (*s*, CH_3O); 4.63 (*s*, 2 H–C(2), 2 H–C(4)). MS: 101 (65, $M^{+\cdot} - 28$), 98 (18, $M^{+\cdot} - 31$), 59 (30), 56 (11), *42* (100).

b) *From Hydrochloride* **18**. To a suspension of **18** (799 mg, containing *ca.* 20% of CH_3OH, 5.95 mmol) in methyl chloroformate (1.8 ml, 22.8 mmol) and CH_2Cl_2 (10 ml), a soln. of pyridine (3.5 ml, 43.3 mmol) and 4-(dimethylamino)pyridine (611 mg, 5 mmol) in CH_2Cl_2 (5 ml) was added within 2 h under stirring (Ar). After 16 h at r.t., CH_3OH (10 ml) was added and stirring continued for 3 h. Solvents were then evaporated, and the residue was repeatedly coevaporated with hexane in order to remove pyridine. The residue was triturated with CH_2Cl_2/Et_2O 4:1 (100 ml) and filtered. Bulb-to-bulb distillation (150°, high vacuum) of the residue of the filtrate gave 548 mg (*ca.* 70%) of impure **17** which gradually decomposed upon storage in a refrigerator at 8°.

N-(4-Chlorophenyl)-3-oxoazetidine-1-carboxamide (**20**). To a mixture of **18** (1.144 g, containing *ca.* 7 mmol of CH_3OH, 7.85 mmol) and (4-chlorophenyl)isocyanate (3.449 g, 22.5 mmol) in CH_2Cl_2 (20 ml, *freshly filtered through alumina*), a soln. of pyridine (1.6 ml, 19.8 mmol) and 4-(dimethylamino)pyridine (864 mg, 7.07 mmol) in CH_2Cl_2 (10 ml) was added within 5 h at r.t. under stirring. After stirring for 20 h at r.t., the solvent was evaporated and the residue filtered through silica gel (CH_2Cl_2/AcOEt 2:1). Chromatography (silica gel, CH_2Cl_2/AcOEt 3:2) of the eluate yielded 1.793 g (79% based on **19**) of **20**. IR ($CHCl_3$): 3435*m*, 3000*w*, 2920*w*, 1832*s*, 1685–1675*s*, 1592*m*, 1508*s*, 1493*s*, 1402*s*, 1345*m*, 1285*m*, 1175*w*, 1115*w*, 1086*m*, 1047*m*, 1010*w*. ^{1}H-NMR (80 MHz, $CDCl_3$): 4.79 (*s*, 2 H–C(2), 2 H–C(4)); 7.15–7.4, 7.45–7.7 (2*m*, ClC_6H_4NH); 8.93 (br., $w_{1/2} \approx 4$, NH). MS (d.i.): 226 (11, M^+), 224 (32, M^+), 155 (8), 154 (10), 153 (21), 128 (8), 127 (9), 126 (23), 125 (13), 111 (10), 99 (13), 98 (19), 75 (10), 63 (9), 56 (7), *43* (100).

1-(Diphenylmethyl)-3-ethylideneazetidine (**21**). To a soln. of ethyl(triphenyl)phosphonium bromide (20 g, 53.9 mmol) in dry DMSO (80 ml), KO(*t*-Bu) (6 g, 53.5 mmol) was added followed by the slow addition (1 h) of a soln. of **4** (7 g, 29.5 mmol) in DMSO (40 ml). The dark soln. was stirred for 1.5 days at 60° under Ar, quenched with ice-water, and extracted with Et_2O. The org. phase was washed with H_2O (3×) and sat. NaCl soln., dried ($MgSO_4$), and evaporated. Filtration (silica gel, hexane/CH_2Cl_2/Et_2O 13:6:1) followed by chromatography as above gave 5.28 g (70%) of **21**. M.p. 49–50.5°. IR ($CHCl_3$): 3060*w*, 3000*w*, 2920*m*, 2880*w*, 2860*w*, 2820*m*, 1598*m*, 1585*w*, 1490*m*, 1450*s*, 1380*w*, 1345*w*, 1305*w*, 1262*m*, 1168*w*, 1075*m*, 1027*m*, 974*m*, 930*m*. ^{1}H-NMR (80 MHz, $CDCl_3$): 1.46 (*d*, $J \approx 7$, further split by small couplings, *m*, 3 H–C(2′)); 3.72 (*m*, $w_{1/2} \approx 6$, 2 H–C(2), 2 H–C(4)); 4.47 (*s*, $(C_6H_5)_2CHN$); 5.0–5.4 (*m*, H–C(1′)); 7.1–7.6 (*m*, $(C_6H_5)_2CHN$). MS: 249 (22, $M^{+\cdot}$), 182 (4), 180 (3), *172* (100), 167 (88), 165 (39), 152 (20), 104 (8), 91 (19), 82 (22), 77 (10), 69 (10), 41 (11).

Wittig *Olefination of Ketone* **12**. To a soln. of freshly sublimed KO(*t*-Bu) (1.095 g, 9.76 mmol) in DMSO (15 ml), ethyl(triphenyl)phosphonium bromide (3.62 g, 9.76 mmol, dried over P_2O_5) was added, followed by a soln. of **12** (525 mg, 3 mmol) in DMSO (5 ml). The mixture was heated to 60° for 38 h under Ar, quenched with ice/H_2O, and extracted with AcOEt. Chromatography (silica gel, cyclohexane/AcOEt 3:2) afforded **22** (83 mg, 14%) and **23** (17 mg, 3%).

Data of 1-Benzoyl-3-ethylideneazetidine (**22**). IR ($CHCl_3$): 2990*m*, 2925*m*, 2860*m*, 1615–1630*s*, 1575*m*, 1490*w*, 1446*s*, 1410*s*, 1380*m*, 1330*w*, 1270*w*, 1175*w*, 1157*w*, 1113*w*, 1072*w*, 1026*w*, 1000*w*, 975*w*, 946*w*, 932*w*, 880*m*.

^{1}H-NMR (80 MHz, $CDCl_3$): 1.4–1.8 (*m*, 2 main peaks, 3 H–C(2′)); 4.75 (*m*, $w_{1/2} \approx 7$, 2 H–C(2), 2 H–C(4)); 5.2–5.6 (*m*, H–C(1′)); 7.25–7.75 (*m*, C_6H_5CO). MS: 187 (16, M^+), 172 (2), *105* (100), 77 (37), 51 (10).

Data of 1-Benzoyl-3-vinylazetidine (**23**). IR ($CHCl_3$): 3060*w*, 2990*m*, 2880*m*, 1630–1615*s*, 1575*m*, 1490*w*, 1447*s*, 1430*s*, 1410*s*, 1280*w*, 1175*w*, 1140*w*, 1070*w*, 1025*w*, 990*m*, 920*m*, 865*w*. ^{1}H-NMR (80 MHz, $CDCl_3$): 3.1–3.6 (*m*, 5 main peaks, H–C(3)); 4.07 (*dd*, $J = 9$, 6), 4.43 (*t*, $J = 9$, 2) (H–C(2), 2 H–C(4)); 5.0–5.3 (*m*, 2 main peaks, 2 H–C(2′)); 6.06 (*ddd*, $J = 17$, 10, 7, H–C(1′)); 7.2–7.8 (*m*, C_6H_5CO). MS: 187 (15, M^+), *105* (100), 77 (38), 51 (9).

Treatment of **21** *with ClCOOMe.* A soln. of **21** (0.67 g, 2.69 mmol) and ClCOOMe (1.2 ml, 15.5 mmol) in CH_2Cl_2 (12 ml) was stirred for 24 h at 0° under Ar. Evaporation of volatiles and chromatography (silica gel, CH_2Cl_2 + 4% EtOAc) of the residue afforded 0.51 g (55%) of **25** and 0.124 g (30%) of **24**.

Data of Methyl N*-(Diphenylmethyl)-*N*-[2′-(chloromethyl)-2′-butenyl]carbamate* (**25**). IR ($CHCl_3$): 3080*w*, 3055*w*, 3000*m*, 2950*w*, 2850*w*, 1690*s*, 1600*w*, 1580*w*, 1490*m*, 1450*s*, 1390*m*, 1350*w*, 1320*w*, 1190*m*, 1150*w*, 1115*m*, 1075*w*, 1030*w*, 980*w*, 940*w*, 920*w*. ^{1}H-NMR (300 MHz, $CDCl_3$): 1.55 (*d*, $J = 7$, 3 H–C(4′)); 3.66 (*s*, CH_3O); 3.78 (*s*, 2 H–C(1′)); 4.33 (*s*, CH_2Cl); 5.66 (*q*, $J = 7$, H–C(3′)); 6.18 (*s*, $(C_6H_5)_2CH$); 7.15–7.4 (*m*, $(C_6H_5)_2CH$). MS: 345 (2, M^+), 343 (10, M^+), 308 (50), 240 (59), *167* (100), 165 (30), 152 (17), 77 (10), 44 (18).

Data of Methyl 3-Ethylideneazetidine-1-carboxylate (**24**). IR ($CHCl_3$): 2950*w*, 2860*w*, 1710*s*, 1450*s*, 1385*s*, 1330*w*, 1280*w*, 1195*m*, 1130*m*, 1045*w*, 980*w*. ^{1}H-NMR (300 MHz, $CDCl_3$): 1.55 (*d*, $J \approx 6$, further split by small couplings, *m*, 3 H–C(2′)); 3.66 (*s*, CH_3O); 4.4–4.55 (*m*, 2 main peaks, 2 H–C(2), 2 H–C(4)); 5.25–5.4 (*m*, H–C(1′)). MS: *141* (100, M^+), 126 (77), 88 (9), 82 (54), 67 (50), 59 (44), 55 (64), 53 (30).

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