Azetidinyl Ketone Chemistry. C-Methylation Reactions and Stereostructure - Spectra Relationships (1)

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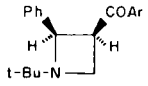
The *C*-methylation of the potassium salt of 1-*t*-butyl-2-phenyl-3-(*p*-phenylbenzoyl)azetidine (**1a**) with methyl iodide was studied in three solvents, and the stereochemical outcome of the reaction was shown to be dependent upon the solvent used. These results are rationalized in terms of the probable relative rates of the reaction in the various solvents and/or the effect of solvent on the structure of the anionic intermediate. Similar treatment of the potassium salt of 1-*t*-butyl-2-phenyl-3-benzoylazetidine (**3a**) in ethyl ether gave a comparable result. The configurations of the epimeric *C*-methyl products (**2a** and **2b**, and **4a**) were assigned on the basis of their spectral properties. With the aid of spectral data for a model compound, 1-*t*-butyl-3-benzoylazetidine (**5**), several stereostructure-spectra relationships for 3-azetidinyl ketones are presented.

INTRODUCTION

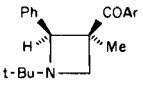
Since the appearance of our initial paper describing the synthesis of 3-azetidinyl ketones (3) a number of interesting photochemical reactions of these compounds have been reported (4). More recently, we reported a detailed p.m.r. study of a series of 1-alkyl-2-phenyl-3-aroylazetidines which confirmed our earlier configurational assignments (5). This study revealed some rather large dispersion effects which were ascribed to intramolecular van der Waals interactions, and also suggested a conformational variation of the four-membered ring which depended upon the steric requirement of the *N*-substituent. As a continuation of our interest in the chemistry of azetidinyl ketones, and our interest in small ring compounds in general (6,7), we investigated the stereochemistry of the *C*-methylation of *N*-*t*-butyl-azetidines **1a** and **3a**. The results of this study are contrasted with those previously reported for proton exchange in the 3-azetidinyl ketone series (3,5).

RESULTS

Treatment of azetidinyl ketone **1a** with two equivalents of potassium *t*-butoxide in an anhydrous solvent followed by treatment of the resulting colored solution with excess methyl iodide led to various diastereomeric mixtures of *C*-methylazetidines **2a** and **2b** depending upon the solvent used. Similar treatment of azetidinyl ketone **3a** in ethyl ether gave **4a** and **4b**. Neither products arising from fragmentation of the anion nor from *O*-methylation were observed in any of these reactions (8). The composition of the reaction products is recorded in Table I. The isomeric ratio of the *C*-methylated products **2a** and **2b** was shown to be independent of the percent conversion by interrupting the reaction at various stages and analyzing the products by p.m.r. spectrometry. These same experiments showed that **1a** yielded the corresponding *trans* azetidine (**1b**) very rapidly under these conditions. When **1a** was treated with potassium *t*-butoxide in dimethoxyethane (DME) or tetrahydrofuran (THF) the corresponding *trans* isomer (**1b**) was isolated in high yield. Thus, the stereochemistry of the starting azetidinyl ketone had no influence upon the final stereochemical outcome of the *C*-methylation reactions. In a control experiment *C*-methylazetidine (**2a**) was shown to be stable to potassium *t*-butoxide in THF solution.

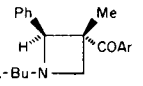


1a Ar = *p*-Ph-C_6H_4-
3a Ar = C_6H_5



cis

2a Ar = *p*-Ph-C_6H_4-
4b Ar = C_6H_5



trans

2b Ar = *p*-Ph-C_6H_4-
4b Ar = C_6H_5

TABLE I

Products from the Reaction of the Potassium Salts of Azetidinyl Ketones (**1a** and **3a**) with Methyl Iodide (a)

Reactant	Solvent	Products	
		% *cis*	% *trans*
1a	Et_2O	81 **2a**	19 **2b**
1a	THF	65 **2a**	35 **2b**
1a	DME	50 **2a**	50 **2b**
3a	Et_2O	84 **4a**	16 **4b**

(a) These percentages are reproducible within ± 3% and were determined by p.m.r. analysis.

The configurations of the *C*-methylated azetidines were assigned primarily on the basis of their spectral properties. Both **2a** and **2b** showed maxima at *ca.* 280 mμ in the ultraviolet. However, the molar extinction coefficients of these maxima were significantly different for the two compounds. Thus, the compound having the larger molar extinction coefficient (26.7×10^3) was assigned the *trans* structure (**2b**) and the one having the smaller extinction coefficient (21.0×10^3) was assigned the *cis* configuration (**2a**) by analogy with previous rationalizations of the ultraviolet spectra of other azetidinyl ketones (5).

The mass spectra of **2a** and **2b** were in excellent agreement with the assigned configurations. The mass spectrum of **2b** showed a large M-17 peak (24% of the base peak) which can be rationalized in terms of a McLafferty-type rearrangement of the β-benzylic hydrogen followed by loss of a hydroxyl radical (*vide infra*). One would expect this on the basis of the activation of the β-benzylic hydrogen, whereas this process would not be expected to be favored for the *cis* compounds (9). Accordingly, the mass spectra of *cis*-*C*-methylazetidines (**2a** and **4a**) contain M-17 peaks which are less than three percent of the base peak. The overall fragmentation patterns of **2a**, **2b** and **4a** are consistent with those previously reported for some analogous azetidinyl ketones (9). The entire mass spectral data for **2a**, **2b** and **4a** along with that for **1'b** and **5** are reported in Table II.

The p.m.r. spectra of **2a**, **2b** and **4a** provided conclusive evidence for the gross structures and configurations. The p.m.r. spectrum of **1a** showed an AX pattern at 183 and 253 Hz (J = 7Hz) for the ring methylene group. The C-2 proton appears as a singlet at 273 Hz and the *C*-methyl protons appear as a singlet at 100 Hz. The *N*-*t*-butyl protons absorb at 56 Hz and the expected multiplet for the aromatic protons was observed. The p.m.r. spectrum of *trans*-azetidine (**2b**), showed the expected multiplet for the aromatic nuclei and a singlet at 56.5 Hz for the *N*-*t*-butyl group. The geminal ring methylene protons of **2b** constitute a typical AB spectrum, $\Delta\gamma AB$ = 17 Hz and J_{AB} = 7 Hz, centered at 215.5 Hz. The C-2 proton appears as a singlet at 304 Hz and the C-3 methyl protons appear at 76 Hz. These data are consistent with the assigned structures, the C-3 methyl group of *trans* azetidine **2b** experiencing significant shielding (10), due to its *cis* relationship to the C-2 phenyl, relative to the C-3 methyl group in the corresponding *cis* isomer (**2a**).

The appearance of the *C*-methyl group signals at relatively low field for both isomers is probably due to intramolecular van der Waals interactions between the *N*-*t*-butyl and the *C*-methyl groups (1,3-interactions) which result in net deshielding (5). In addition, the C-2 proton of **2b** is deshielded relative to the C-2 proton in **2a** due to the *cis* relationship of the C-2 proton and 3-aroyl function in the former compound. In each case the upfield portion of the two-spin system for the geminal methylene ring protons is assigned to the proton which is *trans* to the 3-aroyl group. The infrared spectra of **2a** and **2b** showed carbonyl absorption at *ca.* 1675 cm^{-1} for the aromatic ketone function.

cis-1-*t*-Butyl-2-phenyl-3-benzoyl-3-methylazetidine (**4a**) showed a maximum in the ultraviolet at 240 mμ (ε, 9,600). This maximum and extinction coefficient are comparable to those previously reported for other *cis*-2-phenyl-3-benzoylazetidines (5). The p.m.r. and mass spectra of **4a** were comparable to those of the 3-(*p*-phenylbenzoyl)-analogue **2a**. 1-*t*-Butyl-3-benzoylazetidine (5) was synthesized and its spectra determined for comparison with the more highly substituted 3-benzoylazetidines (e.g., **4a**).

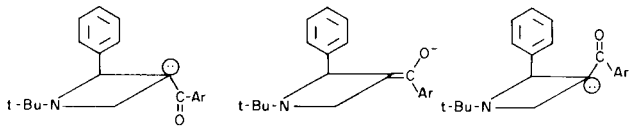
The infrared spectrum of **5** has strong carbonyl absorption at 1680 cm^{-1} and the ultraviolet maximum appears at 240 mμ (ε, 13,200).

These data confirm our previous proposal concerning the effect of steric crowding on the probability of the aroyl $\pi \rightarrow \pi^*$ transitions for azetidinyl ketones (5), and also support our proposal regarding four-ring carbonyl interactions for these compounds. Note that the extinction coefficient for **5** is considerably larger than that of **4a** and those of *cis*-2-phenyl-3-benzoylazetidines (ε, *ca.* 10,500), but less than those of *trans*-2-phenyl-3-benzoylazetidines (ε, *ca.* 15,500). The parent ketone of **5**, propiophenone, has a maximum (λ 238 mμ, ε, 11.5×10^{-3}) at lower wave length with a smaller extinction coefficient than **5** (11). It is also of some interest to note that the carbonyl bands for azetidinyl ketones **2a** and **2b** appear at *ca.* 1675 cm^{-1}, indicating that branching at the α-carbon causes a slight increased polarization of the carbonyl group in the ground state (12).

DISCUSSION

The *C*-methylation reaction of these azetidinyl ketones would be expected to lead to the kinetically favored products since the methylated products are stable under the reaction conditions and the reaction is irreversible. Thus, the product resulting from the least crowded transition state might be expected to predominate.

In contrast to the results obtained upon proton exchange, where the thermodynamically more stable product was obtained in practically quantitative yield, *C*-methylation of **1a** and **3a** yielded mixtures of products. The results obtained from reactions in ether solution suggest that in this solvent the anion is attacked from the least hindered position, i.e., opposite the 2-phenyl group. This reaction may be formulated as proceeding through a planar enolate type ion (B). Based on the ease with which proton exchange takes place in this system (5) one might expect considerable stabilization of the anion by the carbonyl function, i.e., a large contribution from B, However, if electronic factors are important, three extreme structures (A, B and C) might contribute to the exact nature of the reacting species depending upon the solvent used.



A B C

Recent work by Zook, *et al.*, (13) has shown that polyethers greatly enhance the rate of alkylation of sodiobutyrophenone over the rate in ethyl ether, and provide some evidence with regard to the nature of the ion pair in various solvents. Zook suggested that chelation of the cation by the polyethers indirectly influences the structure of the enolate ion. If the rate of *C*-methylation of the potassium salt of **1a** is enhanced by a factor on the order of that reported by Zook in changing from ethyl ether to dimethoxyethane the absence of stereoselectivity in the latter solvent can be rationalized, provided that the steric factors are completely eliminated.

Another reasonable explanation is that the structure of the anion is significantly different in the various solvents. If the structure of the anion is indeed a hybrid of A, B, and C, then the exact nature of the intermediate, and more

TABLE II

The Mass Spectra of Some Substituted 3-Aroylazetidines (a)

1'b: 57(16), 70(21), 77(5.4), 104(20), 118(62), 119(9), 133(5), 147(10), 149(6), 151(8), 152(30), 153(23), 160(13), 167(12), 177.5(7), 181(100), 182(15), 244(13), 313(46), 314(14), 352(M-18(b), 9.2), 353(M-17(b), 7.6), 355(19.6), 356(5.5), 370(c)(10.4), 371(2.96).

2a: 55(5.3), 56(5.8), 57(42), 69(5.5), 70(18), 76(10), 77(16), 91(13), 104(19), 106(25), 118(5.5), 131(13), 146(78), 147(10), 149(14), 151(11), 152(45), 153(30), 160(6.2), 181(100), 182(15), 222(18), 243(14), 326(33), 366(M-17(b), 2.6), 383(8.3).

2b: 57(67), 69(7.6), 70(8.4), 76(5.6), 77(10), 91(15), 104(45), 105(13), 106(15), 131(27), 146(52), 147(33), 149(8.1), 151(13), 152(47), 153(33), 160(39), 167(11), 181(100), 182(17), 221(10), 222(15), 243(7.3), 310(17), 326(20), 327(17), 366(M-17(b), 24), 367(7.1), 368(13), 383(c)(13.7).

4a: 57(37), 70(25), 77(50), 91(16), 104(16), 105(22), 106(34), 117(5.8), 131(42), 146(100), 147(33), 160(7.6), 167(8.1), 222(7.2), 250(99), 251(19), 290(M-17(b), 2.5), 292(13), 307(c)(8.5).

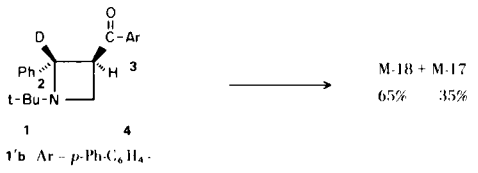
5: 55(23), 56(17), 57(47), 69(12), 70(41), 77(31), 83(14), 84(13), 91(24), 97(14), 99(10), 105(49), 106(7), 117(27), 119(28), 133(10), 160(19), 200(M-17(b), 13), 202(100), 217(c)(8.0).

(a) All peaks larger than 5% of the base peak are reported and the m/e values are followed by the percentage in parentheses. (b) Metastables were observed for the transition. (c) Molecular ion.

importantly, the nature of the transition state might be sensitive to mild solvent changes. Thus, the varying stereochemical outcome of the methylation reaction of these azetidinyl ketones can be qualitatively explained by assuming the proper contribution from structures A, B, and C. The increase in the proportion of *trans* compound (i.e., attack *cis* to the 2-phenyl) for the reactions run in dimethoxyethane over those run in ethyl ether would then suggest a larger contribution from A in the former solvent. In any case, it is improbable that structure C makes a significant contribution due to severe steric interactions. Whether both the relative rates of the reactions and the proposed structural variation of the intermediates in the various solvents contribute to the stereochemical outcome, or one of these factors predominates, cannot be distinguished on the basis of available data.

Mass Spectra.

The mass spectrum of *trans*-2-deuterioazetidine (**1'b**) was determined in an attempt to establish the source of the hydrogen atom involved in the rearrangement which led to the M-17 ions in the previously reported spectra of analogous compounds (9). A comparison of the intensities of the parent ion (M^+) and the M + 1 ion for **1'b** (the calculated $(M + 1)^+/(M^+)$ ratio is 28.86% and the observed value is 28.5%) indicated practically quantitative deuteration (>98%) at C-2, in agreement with an earlier p.m.r. study (5). A comparison of the intensities of the



1'b Ar = *p*-Ph-C_6H_4-

M-18 versus the M-17 peak showed these peaks to have a ratio of *ca.* 2:1. These data indicate that the more active benzylic deuterium atom is preferentially transferred onto the carbonyl function with subsequent loss of OD, while a hydrogen atom is also transferred from some other source (probably from C-4).

In view of previous mass spectral studies (9) on some of these 3-aroylazetidines and data now available, there is apparently at least a second factor which affects the extent to which a hydrogen atom is tranferred on to the carbonyl function. Apparently the *cis* azetidinyl ketones give rise to relatively small amounts of M-17 ions, or this peak is absent (9), because ring cleavage reactions which are strain relieving are highly favored. Thus, *cis* isomers lead preferentially to ring cleavage reactions rather than the McLafferty-type rearrangement. Note that for **5**, where there is no benzylic hydrogen present, the M-17 peak in the spectrum of this compound is 13% of the base peak. These data indicate that since there is little strain between groups, the McLafferty-type rearrangement is operative although the β-hydrogens are not activated except for being α to nitrogen. The overall fragmentation pattern of **5** is consistent with that reported previously for related 3-aroylazetidines (9) except for a peak at M/e 117 (27%). This ion probably arises from a phenyl migration to a carbon atom of the azetidine ring *via* a secondary fragmentation mode.

In agreement with previously reported differences in the mass spectra of *cis* and *trans*-2-phenyl-3-aroylazetidines (9), the general utility of this method for configurational assignments of isomers in this series is indicated. However, some *cis* compounds, **2a** and **4a** for example, do show M-17 peaks in their spectra, although this same peak in the *trans* isomers is considerably larger. In addition, the M-17 peak in the spectrum of *cis*-1-methyl-2-phenyl-3-(*p*-phenylbenzoyl)azetidine is substantial (10%), but for the corresponding *trans* compound this peak is 79% of the base peak (13).

EXPERIMENTAL (14)

1-*t*-Butyl-2-phenyl-3-methyl-3-(*p*-phenylbenzoyl)azetidines (**2a** and **2b**).

An ethereal solution (50 ml.) of 0.93 g. (0.0025 mole) of *cis*-1-*t*-butyl-2-phenyl-3-(*p*-phenylbenzoyl)azetidine (**1a**) (5) and 0.56 g. (0.0050 mole) of potassium *t*-butoxide were allowed to react while being stirred at room temperature until a deep orange color developed. Methyl iodide (4.6 g., 0.033 mole) was then added and the mixture was allowed to react for 72 hours. (Much shorter reaction times have since been found to be sufficient for *ca.* 100% conversion.) Removal of the suspended salts and evaporation of the solvent yielded a yellow solid. This mixture was extracted with dry ethyl ether (100 ml.), the solvent was again removed and a double evaporation with carbon tetrachloride gave a crude yellow mixture. The p.m.r. spectrum of this crude mixture showed peaks corresponding to two products and also indicated that conversion was practically quantitative. Recrystallization of this material from methanol yielded 0.67 g. (70%) of the *cis* isomer (**2a**), m.p. 141-142°; λ max (isooctane) 282 mμ (ε, 21,000); γ (c=o) 1673 cm^{-1} (carbon tetrachloride).

The p.m.r. spectrum (deuteriochloroform) of **2a** contained multiplets (14H) at *ca.* 422, 444 Hz (aromatic), a singlet (1H) at 273 Hz (C-2 proton), two doublets (1H each, J = 7 Hz) at 253, 183 Hz (C-4 protons), a singlet (3H) at 100 Hz (C-3 methyl) and a singlet (9H) at 56 Hz (*t*-butyl).

Anal. Calcd. for $C_{27}H_{29}NO$: C, 84.55; H, 7.62; N, 3.65. Found: C, 84.49; H, 7.67; N, 3.72.

The filtrate from the crystallization of **2a** (concentrated in **2b**) was combined with the filtrate from another 0.93 g. run and chromatographed on a florosil column (20 g.). Approximately 0.4 g. of the yellow oily material (consisting mainly of **2b** by p.m.r. spectrometry) was placed on a florosil column (in a minimum amount of chloroform) which was developed with petroleum ether (b.p. 60-69°). Elution of the column with 3% ethyl ether-petroleum ether yielded crystalline **2b** upon evaporation of the

solvent. Recrystallization of this material from *n*-pentane yielded 0.31 g. of white crystals, m.p. 128-129°; λ max (isooctane) 280 mμ (ε, 26,700); γ (c=o), 1675 cm^{-1} (carbon tetrachloride).

The p.m.r. spectrum (deuteriochloroform) of **2b** contained a multiplet (14H) in the range 425 to 480 Hz (aromatic), a singlet (1H) at 304 Hz (C-2 proton), doublets (1H each, J = 7 Hz), some additional fine splitting was observed at 207.5, 223.5 Hz (C-4 protons), a singlet (3H) at 76 Hz (C-3 methyl), and a singlet (9H) at 56.5 Hz (*t*-butyl).

Anal. Calcd. for $C_{27}H_{29}NO$: C, 84.55; H, 7.62; H, 3.65. Found: C, 84.66; H, 7.67; N, 3.66.

cis-1-*t*-Butyl-2-phenyl-3-benzoyl-3-methylazetidine (**4a**).

To a 0.74 g. (0.0025 mole) sample of *cis*-1-*t*-butyl-2-phenyl-3-benzoylazetidine (**3a**) (3) dissolved in 50 ml. of dry ethyl ether was added 0.56 g. (0.0050 mole) of potassium *t*-butoxide. The mixture was allowed to react with stirring for 0.5 hour until the solution became deep yellow. Methyl iodide (2.3 g., 0.016 mole) was added rapidly and the mixture was allowed to react for six hours. The usual workup (*vide supra*) yielded a yellow oil. The p.m.r. spectrum of this material indicated the presence of only *C*-methylated products and starting material could not be detected. The *cis C*-methylated product (**4a**) predominated. The p.m.r. spectrum indicated that the gross product consisted of *ca.* 84% of **4a** and *ca.* 16% of the corresponding *trans* isomer (**4b**). The product was crystallized from methanol, then recrystallized from petroleum ether (b.p. 60-69°) and yielded 0.51 g. (67%) of **4a**, m.p. 97-98°; λ max (isooctane), 240 mμ (ε, 9,600); γ (c=o), 1678 cm^{-1} (carbon tetrachloride). The *trans* isomer (**4b**) was not isolated and characterized. However, the p.m.r. spectrum of the crude oil from the crystallization was comparable to the spectrum of the *p*-phenylbenzoyl analogue **2b**.

The p.m.r. spectrum (deuteriochloroform) of **4a** contained a complex multiplet (10H) in the range 415 to 460 Hz (aromatic), a singlet (1H) at 273 Hz (C-2 proton), doublets (1H each, J = 7 Hz) at 183, 252 Hz (C-4 protons), a singlet (3H) at 98 Hz (methyl), and a singlet (9H) at 56 Hz (*t*-butyl).

Anal. Calcd. for $C_{21}H_{25}NO$: C, 82.04; H, 8.20; N, 4.56. Found: C, 81.80; H, 8.25; N, 4.65.

Solvent Effects on the Stereochemistry of *C*-Methylation.

A. In Ethyl Ether.

A 0.30 g. (0.0008 mole) sample of **1a** was dissolved in 20 ml. of dry ethyl ether, 0.20 g. (0.0018 mole) potassium *t*-butoxide was added and the mixture was allowed to react while being stirred for 0.5 hour to allow for the formation of the anion. Methyl iodide (2.3 g., 0.016 mole) was added and the color of the solution gradually faded. The mixture was allowed to react for 20 hours and filtered to remove precipitated solids. The precipitate was washed with 20 ml. of dry ethyl ether and the combined ethereal solution was washed with water and dried (magnesium sulfate). Evaporation of the ethereal solution yielded a yellow solid and the p.m.r. spectrum of this solid material indicated the *cis*- and *trans*-*C*-methylated products (**2a** and **2b**) in 81 and 19% yields, respectively (by electronic integration of signals due to the respective ring protons).

B. In Tetrahydrofuran.

A 0.30 g. (0.0008 mole) sample of **1a** was dissolved in 20 ml. of dry tetrahydrofuran, 0.20 g. (0.0018 mole) of potassium *t*-butoxide was added and the mixture was allowed to react for 0.5 hour while being stirred (a small amount of solid material remained suspended). Methyl iodide (2.3 g., 0.016 mole) was added to the vigorously stirred solution. The yellow color rapidly disappeared with concomitant precipitation of a white solid. The mixture was allowed to react for 2.5 hours. The reaction was worked up in exactly the same manner as for the reaction run in ethyl ether. The p.m.r. spectrum of the crude product indicated *ca.* 100% conversion and the presence of **2a** and **2b** in 65 and 35% yields, respectively.

C. In Dimethoxyethane.

To a 0.30 g. (0.0008 mole) sample of **1a** in 20 ml. of solvent was added 0.20 g. (0.0018 mole) of potassium *t*-butoxide. The homogeneous solution immediately became deep yellow to orange.

The color immediately disappeared upon rapid addition of methyl iodide (2.3 g., 0.016 mole) and a white precipitate separated. The mixture was allowed to react for 20 hours. The reaction mixture was worked up in the usuall manner and a dark red solid was obtained. The p.m.r. spectrum of this material indicated practically quantitative conversion to the *C*-methylated products **2a** and **2b** in a 50:50 ratio.

When this experiment was repeated with the concentration of potassium *t*-butoxide doubled (0.40 g. in 20 ml. of solvent), no observable change in isomer ratio could be detected. Addition of lithium bromide (0.40 g. in 20 ml.) also had no affect on the stereochemistry of methylated products in dimethoxyethane solution.

Equilibration of *cis*-Azetidine (**1a**).

To a 0.20 g. (0.00054 mole) sample of **1a** dissolved in 20 ml. of dimethoxyethane (or tetrahydrofuran) was added 0.20 g. (0.0018 mole) of potassium *t*-butoxide contaminated with *t*-butanol. The mixture was allowed to react with stirring for 18 hours. Evaporation of the solvent, extraction with dry ethyl ether, filtration and evaporation of the ethereal solution yielded a white solid. The p.m.r. spectrum of this material indicated the presence of only the corresponding *trans* isomer (**1b**). Recrystallization of this material from methanol gave a high yield of **1b**, m.p. 127-128°.

Stability of **2a** to Potassium *t*-Butoxide in Tetrahydrofuran.

To a 0.30 g. (0.0008 mole) sample of **2a** dissolved in 20 ml. of tetrahydrofuran was added 0.20 g. (0.0018 mole) of potassium *t*-butoxide. The mixture was stirred at room temperature for 24 hours. The reaction mixture was worked up in the usual manner and **2a** was recovered unchanged, m.p. 141-142°. The p.m.r. spectrum of the white solid which resulted upon evaporation of the solvent indicated the presence of only **2a**.

1-*t*-Butyl-3-benzoylazetidine (**5**).

Treatment of a 6.0 g. (0.047 mole) sample of 1-*t*-butylazetidinol (**16**) with 18.0 g. (0.095 mole) of *p*-toluenesulfonyl chloride in pyridine solution according to the procedure of Chen *et al.* (16) yielded 4.33 g. (32%) of white crystals of 1-*t*-butyl-3-azetidinyl tosylate from *n*-hexane, m.p. 70-71° (17).

A 4.0 g. (0.014 mole) sample of the tosylate was treated with 4.0 g. (0.063 mole) of potassium cyanide in 40 ml. of methanol for two days at room temperature (17). The reaction mixture was filtered to remove a white precipitate and the filtrate was concentrated under reduced pressure. The residue which resulted was extracted with 100 ml. of dry ethyl ether. Evaporation of the ethereal solution yielded a yellow oil, which was taken up in carbon tetrachloride and again concentrated. The p.m.r. spectrum of the oil in carbon tetrachloride was identical with that reported in the literature (17) for 1-*t*-butyl-3-cyanoazetidine (**6**).

To this crude sample of **6** dissolved in 15 ml. of dry ethyl ether was added in a dropwise manner an excess (8.0 ml. of 3 *M*) of phenylmagnesium bromide (Commerical grade, Arapahoe Chemical Company) in 15 ml. of the same solvent. The ethereal solution was heated at reflux temperature for six hours. The reaction mixture was then cooled and slowly hydrolyzed by adding aqueous saturated ammonium chloride in a dropwise manner. After standing for one hour the ether layer was diluted with 100 ml. of ethyl ether, the organic layer separated and then was washed with two 50 ml. portions of water. The solution was dried (magnesium sulfate) and the solvent was removed under reduced pressure to yield *ca.* 4 ml. of a brownish oil. Vacuum distillation of this material gave 0.83 g. of yellow oil, b.p. 85-100° (0.5 mm.), consisting of **5** and a small amount of biphenyl. The oil was placed on a florosil column (in a minimum amount of chloroform) which was eluted with petroleum ether (b.p. 60-69°). Biphenyl eluted first (identified by m.p. and mixture m.p. with authentic biphenyl) in petroleum ether. The column was then flushed with methanol (2,000 ml.) yielding a yellow oil upon evaporation of the solvent. Extraction of this material with reagent grade carbon tetrachloride and evaporation of the solvent followed by three successive extractions and evaporations yielded **5** as a yellow oil; λ max (isooctane), 240 mμ (ε, 13,200) and γ (c=O), 1680 cm^{-1} (carbon tetrachloride).

The p.m.r. spectrum of **5** contained a multiplet (5H) in the range of 425 to 480 Hz (aromatic), a multiplet (5H) in the range 200 to 270 Hz (azetidine ring protons) and a singlet (9H) at 58 Hz (*t*-butyl).

1-*t*-Butyl-3-benzoylazetidine (**5**) was analyzed as its picrate, m.p. 154-156° (ethanol).

Anal. Calcd. for $C_{20}H_{22}N_4O_8$: C, 53.81; H, 4.97; N, 12.55. Found: C, 53.71; H, 5.06; N, 12.59.

Mass Spectra.

The mass spectra were determined with a Perkin-Elmer-Hitachi RMU-6D mass spectrometer operating at 80 ev. The samples were introduced directly into the ion source at the lowest temperature at which a spectrum could be obtained (source < 180°, sample < 120°).

Acknowledgment.

This work was supported in part by Grant CA-02931 from the National Cancer Institute of the U. S. Public Health Service and in part by a National Science Foundation Departmental Science Development Award, Grant No. GU-2054. The authors also wish to thank Mr. D. L. von Minden for determining the mass spectra of the azetidinyl ketones.

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Received January 23, 1969 Lincoln, Nebraska 68508