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Stereochemistry of N_5-acyltetrahydro-1,5-benzodiazepines – NMR spectra and semiempirical MO calculations

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The conformational preferences of N_5-acyltetrahydro-1,5-benzodiazepines **3-5** have been studied using NMR spectral techniques and semiempirical MO calculations (AM1 and PM3 methods). The N_5-formyl-, N_5-acetyl- and N_5-benzoyl-tetrahydro-2-methyl-2,4-diphenyl -1*H*-1,5 benzodiazepines **3-5** prefer boat conformations **BE** with exo orientation of the acyl groups at N5. The X-ray crystal structure of N_5-acetyl derivative **4** also shows a boat conformation **BE** with *exo* orientation of acetyl group at N5. The results obtained from semiempirical MO calculations (AM1 and PM3) are in excellent agreement with the results obtained from solution and solid states.

Keywords: N_5-Acyltetrahydro-1,5-benzodiazepine, N_5-formyl, N_5-acetyl, N_5-benzoyl, NMR spectra, semiempirical MO calculation, boat conformation, *exo*-orientation, X-ray crystal structure

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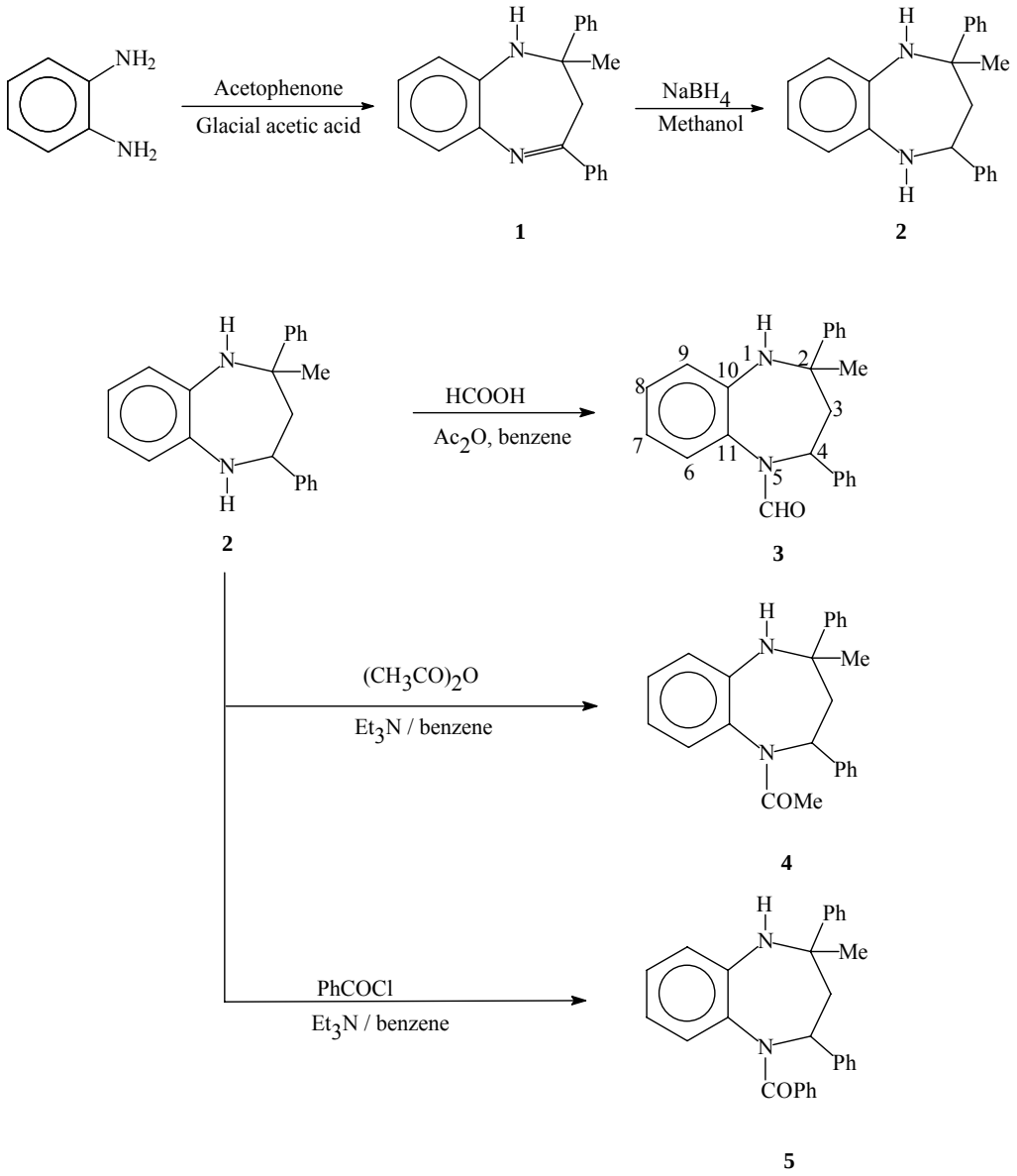
The fusion of benzene ring with hexahydrodiazepines introduces a double bond in the seven membered ring and the resulting tetrahydrobenzodiazepines resemble medium sized rings like cyclohexene, cycloheptene and ε-caprolactam in their stereochemical properties[1]. The introduction of –X=Y groups (-NO, -CHO, -COR *etc*.,) at nitrogen of the tetrahydrobenzodiazepines results in *peri*-hydrogen interaction between the -X=Y groups and the *ortho* hydrogen of the benzene ring which could lead to interesting conformational changes. With a view to studying the influence of the acyl functions at nitrogen over the conformational preferences of tetrahydro-1,5-benzodiazepines, N_5acyltetrahydro-2-methyl-2,4-diphenyl-1,5-benzodiazepines **3-5** have been synthesized and their preferred conformations have been determined by using NMR spectral techniques and semiempirical MO calculations (AM1 and PM3 of MOPAC).

Results and Discussion

The N-formyltetrahydro-2-methyl-2,4-diphenyl-1, 5-benzodiazepine **3** was prepared by the formylation of tetrahydro-2-methyl-2,4-diphenyl-1,5-benzodiazepine **2** using acetic-formic anhydride, generated *in situ* from acetic anhydride and formic acid. The N-acetyl and N-benzoyl derivatives **4** and **5** were prepared by the action of acetic anhydride and benzoyl chloride, respectively, on **2** in dry benzene and triethylamine (**Scheme I**).

In the IR spectra of the monoacylated compounds **3-5**, the stretching bands for both NH and amide C=O were observed (**Table I)**. In addition, in the ^{1}H NMR spectra of **3**, **4** and **5**, the signals at δ 3.93, 3.85 and 4.08, respectively, were assigned to NH protons on the basis of the D_2O exchange studies. In the mass spectra, the molecular ion peaks were observed at m/z 342, 356 and 418 and the fragmentation patterns corresponded to the monoformyl, monoacetyl and monobenzoyl derivatives **3, 4** and **5**, respectively. Moreover, the ^{13}C NMR chemical shifts of the C2 carbons of the compounds **3** (δ 57.63), **4** (δ 57.74) and **5** (δ 57.67) were closer to that of the compound **2** (δ 56.9) indicating that the N1 site is not substituted. Thus, the formylation, acetylation and benzoylation reactions were found to take place only at N5 in the compounds **3-5**.

The preferred conformations of the N_5-acyl-tetrahydro-2-methyl-2,4-diphenyl-1,5-benzodiazepines



Scheme I

Table I – Spectral characterization data of compounds **3**, **4** and **5**

Compd	^{1}H NMR($CDCl_3$)	^{13}C NMR($CDCl_3$)	MS(M^+)
3	1.91 (3H, s, Me at C2), 1.95 (1H, dd, H3A at C3), 2.56 (1H, dd, H3B at C3), 3.93 (N1-H, b, exchangable with D_2O), 5.70 (1H, dd, J = 4.1 and 12.9 Hz), 6.95-7.46 (14H, m, aromatic), 8.21 (1H, s, -CHO).	27.0 (Me at C2), 44.8 (C3), 53.0 (C4), 57.6 (C2), 119.2- -129.4 (aromatic), 141.7, 144.5, 151.3 (ipso), 163 (CO).	342
4	1.84 (3H, s, COMe), 1.87 (3H, s, Me at C2), 1.89 (1H, dd, H3A at C3), 2.40 (1H, dd, H3B at C3), 3.85 (N1-H, b, exchangable with D_2O), 5.95 (1H, dd, J = 4.5 and 12.9 Hz), 6.89-7.45 (14H, m, aromatic).	22.8 (COMe) 26.7 (Me at C2), 43.9 (C3), 52.4 (C4), 57.7 (C2)119.4-131.1 (aromatic), 141.3, 144.7, 151.7 (ipso), 170.7 (CO).	356
5	1.95 (1H, dd, H3A), 1.98 (3H, s, Me at C2), 2.52 (1H, dd, H3B), 4.1 (N1-H, b, exchangable with D_2O), 5.84 (1H, dd, J = 4.7 and 12.9 Hz), 7.07-7.56 (19H, m, aromatic).	27.0 (Me at C2), 45.0 (C3), 54.9 (C4), 57.7 (C2), 118.6-129.4 (aromatic), 129.7, 136.2, 141.7, 144.5, 151.8 (ipso), 170.4 (CO).	418

3-5 were derived from the ^1H and ^{13}C NMR spectral data in comparison with those of the tetrahydro-2-methyl-2,4-diphenyl-1,5-benzodiazepine **2** (**Tables I** and **II**). The SEFT (Spin Echo Fourier Transform) spectra were also used for the assignments.

It has been reported that the tetrahydro-2-methyl-2,4-diphenyl-1,5-benzodiazepine **2** prefers to exist in a chair conformation on the basis of the vicinal coupling constants of 11.6 ($J_{3a,4a}$) and 1.7 Hz ($J_{3e,4a}$) between protons at C3 and C4 (ref. 2).

Orientation of acyl group at N5

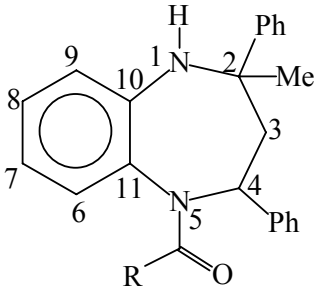
The ^1H and ^{13}C NMR spectra of the N_5-formyl-tetrahydro-2-methyl-2,4-diphenyl-1,5-benzodiazepine **3** showed isochronous nature of the proton and carbon signals at RT indicating that either the rotation about N-CO bond may be fast or the N-C=O group might be locked in one of the possible orientations *viz*., *exo* or *endo* (among the two possible orientations of the N-CO group, the one in which the oxygen is directed towards the benzene ring is designated as *endo* and the other in which oxygen is away from benzene ring is *exo*, **Figure 1**). The shielding of α-carbon signals[3-6] in the ^{13}C NMR spectrum of the compound **3** compared to that of the parent **2** was used to decide the orientation of the formyl group. The *syn* orientation of C=O with reference to the α-carbon would result in an eclipsing interaction of C-O with N5-C4 and N5-C11 bonds and hence the α-carbon is expected to be shielded[3-6]. Even if there is a fast N-C rotation, the α-carbons are expected to be shielded. It was observed that the *ipso* carbon signal (C11) was deshielded by 1.6 ppm and C4 carbon signal was shielded by 4.4 ppm. Hence the formyl group at N5 position may adopt an *exo* orientation (*syn* to C4). The *exo* orientation of formyl group at N5 is also supported by semiempirical calculations (AM1 and PM3 methods).

Table II — The vicinal coupling constant data (in Hz) and the corresponding dihedral angles (in degrees) estimated using DAERM of the N_5-acyltetrahydro-1,5-benzodiazepines **3-5** and parent amine **2**

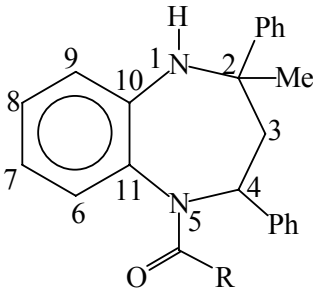
Compd	$J_{3e,4a}$	$J_{3a,4a}$	$\phi_{3e,4a}$	$\phi_{3a,4a}$
3	4.10	12.96	53	173
4	4.51	12.92	51	171
5	4.65	12.93	51	171
2	1.70	11.63	65	185

Ring conformations

The N-formyl derivative **3** may prefer to adopt any of the chair conformations (**CE** or **CA)** or the boat conformations (**BE** or **BA)** or twist-boat conformation (**B1**) (**Figure 2)**. The chair form (**CA**) is obtained from parent chair (**CE**) by flipping both the C2-C3-C4 part and aromatic part of the ring (*i.e*. N1-C10-C11-N5). The boat forms may be obtained either by flipping the C2-C3-C4 part of the ring (**BA**) or the aromatic part of the ring (**BE**) (*i.e*. N1-C10-C11-N5) from the parent chair. In the chair **CA** and boat **BA** forms, the flipping of the C2-C3-C4 part of the ring would move the C2- and C4-equatorial phenyl groups into the axial position and C2-axial methyl group and C4-axial hydrogen into the equatorial position resulting in 1,3-diaxial interaction between axial C2- and C4-phenyl groups.



exo



endo

R = H, Me, Ph

Figure 1

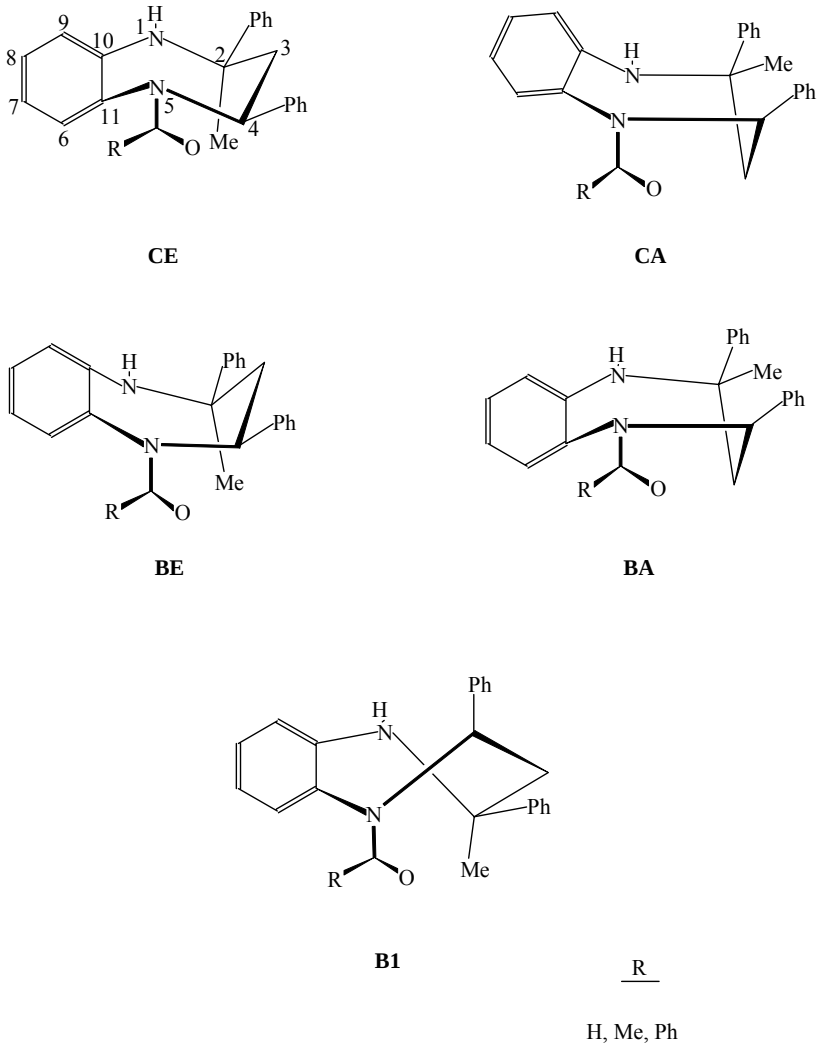


Figure 2—Possible conformations of N-acyltetrahydro-1,5-benzodiazepines **3-5**

In the chair **CA** and boat **BA** forms, both the coupling constants $J_{3a,4e}$ and $J_{3e,4e}$ are expected to be around 2-5 Hz. But the observed coupling constants were found to be 12.9 and 4.1 Hz. In addition, analysis using Dreiding models indicated that the chair **CA** and boat **BA** conformations require an approximate *cis* ($\varphi_{3a,4e}$) and *trans* ($\varphi_{3e,4e}$) angle of 60°. But the *cis* and *trans* angles calculated using DAERM[7] from the coupling constant values were 173° and 53°, respectively. Hence, on the basis of the observed coupling constants and calculated dihedral angles the possibility of the chair **CA** and boat **BA** conformations was ruled out.

In the twist-boat conformation (**B1**), the dihedral angles between the protons at C3 and C4 are expected to be around 60°. But the observed dihedral angles (173° and 53°) eliminated the possibility of the twist-boat conformation (**B1**). The observed coupling constants (12.9 and 4.1 Hz) and the dihedral angles (173° and 53°) may be explained using both the forms **BE** and **CE**. Since the C2-C3-C4 part of the chair **CE** and boat **BE** conformations are almost similar, protons at C3 and C4 are expected to show similar coupling constants in both the conformations. Hence, it may not be possible to use the coupling constants to decide the possibility for the conformations **CE** and **BE**. Thus, the choice between the conformations **CE** and **BE** could be decided by considering the chemical shift of the axial methyl group at C2. Analysis of the Dreiding models indicated that in the chair conformation **CE**, the methyl group at C2 would fall into the periphery of the aromatic ring. But in the boat conformation **BE** (which is obtained by the flipping of N1-C10-C11-N5 part of the ring), the methyl group

is away from the aromatic ring. Hence, the chemical shift of methyl group at C2 may be deshielded in boat conformation **BE** compared to that of parent chair **CE**. The methyl group at C2 of the N-formyl derivative **3** was deshielded by 3.47 ppm indicating that the compound **3** may prefer to adopt a boat conformation **BE**. The AM1 and PM3 calculations (**Table III**) also showed a preference for the boat form **BE** over the chair form **CE** by about 2.78 and 2.86 kcal mol^{-1}, respectively.

The dihedral angles $\varphi_{3a,4a}$ and $\varphi_{3e,4a}$ were found to be decreased (173 and 53°, respectively) in the case of compound **3** compared to those of the diazepine **2** (185 and 65°, respectively) by 12° which may be due to the *exo* orientation of formyl group resulting in $A^{1,3}$-strain[3,8] between the carbonyl group and the C4-α-equatorial phenyl group. In order to avoid the $A^{1,3}$-strain the phenyl group may deviate from the equatorial orientation. Analysis using Dreiding models indicated that the deviation would result in a decrease of both φ_{trans} and φ_{cis} angles. The deviation of phenyl group from equatorial position would also move the $H4_{ax}$ proton towards the amide plane. Hence, the deshielding effect of $H4_{ax}$ proton (1.48 ppm) may be explained on the basis of Paulsen and Todt's model for the anisotropic effect of amides[9].

On the basis of the above observations, it was concluded that the N5-formyltetrahydro-2-methyl-2,4-diphenyl-1*H*-1,5-benzodiazepine **3** may prefer to adopt a boat conformation **BE** with *exo* orientation (*syn* to C4) of formyl group at N5 position.

The N_5-acetyltetrahydro-2-methyl-2,4-diphenyl-1*H*-1,5-benzodiazepine **4** and the N_5-benzoyltetrahydro-2-methyl-2,4-diphenyl-1*H*-1,5-benzodiazepine **5** also showed similar changes in the ^1H and ^{13}C NMR data from the parent diazepine **2** as in the case of N_5-formyltetrahydro-2-methyl-2,4-diphenyl-1*H*-1,5-benzodiazepine **3**. The methyl group at C2 was deshielded by 3.10 and 3.39 ppm in the compounds **4** and **5**, respectively, indicating that these compounds may prefer to adopt boat conformation **BE**. The AM1 and PM3 calculations (**Table III**) also supported a preference for boat conformation **BE** over the chair conformation **CE** for the compound **4** by about 2.96 and 2.78 kcal mol^{-1}, respectively, and for the compound **5** by about 2.73 and 2.73 kcal mol^{-1}, respectively. Though the observed difference in heat of formation values is not very high, but it still suggests the preference for the boat conformation **BE** over the chair conformation **CE**. In the ^{13}C NMR spectra of compounds **4** and **5**, the C4 carbon was shielded ($\Delta\delta$ = -5.0 and -2.6 ppm, respectively) while the ipsc carbon (C11) was deshielded ($\Delta\delta$= 2.0 and 2.0 ppm, respectively) indicating the *exo* orientation of the acetyl and benzoyl groups (*syn* to C4), respectively. The coupling constants obtained from the ^1H NMR spectra of N-acetylbenzodiazepine **4** and N-benzoylbenzodiazepine **5** ($J_{3a,4a}$ = 12.9 and $J_{3e,4a}$ = 4.5 Hz for **4** and $J_{3a,4a}$ = 12.9 and $J_{3e,4a}$ = 4.7 Hz for **5**) and the corresponding dihedral angles estimated using DAERM[7]($\varphi_{3a,4a}$ = 171° and $\varphi_{3e,4a}$ = 51° for **4** and $\varphi_{3a,4a}$ = 171° and $\varphi_{3e,4a}$ = 51° for **5**) were comparable to those of the N-formylbenzodiazepine **3** ($J_{3a,4a}$ = 13.0 and $J_{3e,4a}$ = 4.1 Hz and $\varphi_{3a,4a}$ = 173° and $\varphi_{3e,4a}$= 53°). Hence, similar to the N-formyltetrahydrobenzodiazepine **3,** N-acetyltetrahydrobenzodiazepine **4** and N-benzoyltetrahydrobenzodiazepine **5** were also found to adopt boat conformations **BE** with *exo* orientation (*syn* to C4) of acyl groups at N5 position.

Semiempirical MO calculations

The heats of formation of various ring conformations of the N-acyltetrahydrobenzodiazepines **3-5** obtained by semiempirical MO calculations

Table III — Calculated relative heats of formation (kcal mol^{-1}) of various ring conformations of the N_5-acyltetrahydro-1,5-benzodiazepines **3-5** by AM1 and PM3 methods

		Relative heats of formation (kcal mol^{-1})									
		Conformations AM1					Conformations PM3				
Compd	Rotamers	CE	CA	BE	BA	B1	CE	CA	BE	BA	B1
3	*endo*	2.66	10.54	2.29	7.94	8.23	1.45	10.44	1.45	8.45	---
	exo	2.78	7.41	0.00	8.34	5.76	2.86	8.72	0.00	7.79	---
4	*endo*	5.70	11.64	2.47	10.04	7.51	2.24	8.49	0.72	9.21	9.35
	exo	2.96	8.35	0.00	9.65	9.26	2.78	8.56	0.00	8.10	8.60
5	*endo*	7.09	10.09	1.98	9.72	7.97	3.64	9.05	0.25	9.26	7.14
	exo	2.73	8.42	0.00	8.99	7.94	2.73	8.96	0.00	7.65	6.13

using the AM1 and PM3 methods available in MOPAC-6[10] were used to derive the relative stability of the conformations.

For each N-acyltetrahydrobenzodiazepines **3-5** the possible ring conformations (**Figure 2**), such as chair (**CE**), a flipped chair in which phenyl groups occupy axial positions (**CA**), a boat form with the phenyl groups occupying equatorial orientations (**BE**), a boat conformation with phenyl groups occupying axial orientations (**BA**) and a twist-boat conformation (**B1**), were considered. The optimization of these conformations was carried out by varying the torsion angle C4-N5-C=O within the possible range in 10° increments and the results are summarized in **Table III**.

Table III shows the relative formation energies obtained for various conformations of the N-acyl-tetrahydrobenzodiazepines **3-5** arrived at by the AM1 and PM3 methods, respectively. The results from calculations indicated that the boat conformation (**BE**) with *exo* orientation of acyl group at N5 is the favoured one for the N-acyltetrahydrobenzodiaze-pines **3-5** in both the AM1 and PM3 methods. The AM1 optimized structures of N-acetyltetrahydro-benzodiazepine **4** are given in **Figure 3** as a representative example. The X-ray crystal structure of **4** shows two independent molecules (molecules A and B) in the asymmetric unit[11] (**Figure 4)**. The seven membered ring in both the molecules adopts boat conformation **BE**. An excellent agreement was observed between X-ray crystallographic studies and semiempirical MO calculations while comparing the bond lengths, bond angles and dihedral angles of **BE** conformation of **4** (**Table IV**).

On the basis of the above observations, it was concluded that the N_5-acyltetrahydro-2-methyl-2, 4-diphenyl-1*H*-1,5-benzodiazepines **3-5**, prefer to adopt boat conformations **BE** with *exo* orientation of the acyl groups at N5. The X-ray crystal structure of **4** also showed a boat conformation **BE** with *exo* orientation of acetyl group at N5**.** The semiempirical calculations (AM1 and PM3 methods) also support the preferred conformation obtained in solution state through NMR spectra and in solid state through X-ray crystallography.

Experimental Section

All the melting points were determined using an electrically heated block with a calibrated thermometer and are uncorrected. Infrared spectra were recorded on Shimadzu IR-435 spectrophoto-meter as KBr pellets. The ^1H and ^{13}C NMR spectra were recorded on a Bruker AMX-400 MHz and Bruker DRX-500 MHz spectrometers in $CDCl_3$ solution using TMS as internal reference. Mass spectra were recorded on a Jeol JMS-D 300 spectrometer operating at 70 eV.

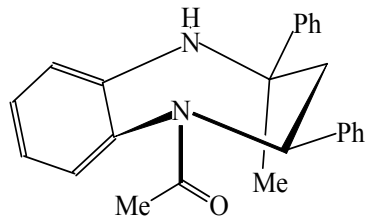
Computational details

The AM1 and PM3 methods available in MOPAC 6.1 version[10] were used to perform the calculations on Pentium personal computers. The optimization of the conformations was performed by using an analytic gradient minimization method (BFGS, PRECISE option). Furthermore, the eigenvector (EF option) procedure was used to lower the mean gradient up to values below 0.01 kcal mol^{-1}/Å.

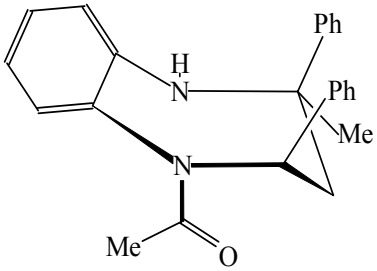
2,3-Dihydro-2-methyl-2,4-diphenyl-1*H*-1,5-benzo diazepine 1. To a solution of 1,2-diaminobenzene (10.80 g, 100 mmoles) in glacial acetic acid (50 mL), acetophenone (24 mL, 200 mmoles) was added while shaking and kept stirred at 25°C for 6 hr. The reaction mixture was then poured into crushed ice and basified with ammonia solution. The precipitated solid was separated, washed thoroughly with water and dried. The brownish yellow solid was dissolved in methanol, allowed to reflux with charcoal, filtered through fluted filter paper, evaporated partially over water bath and kept aside at 10-15°C. Yellow crystals of **1** obtained were separated, washed with benzene (2 × 10 mL) and dried, yield 9.5 g (30.4%), m.p. 77-78°C [lit. m.p. 79-81°C[2]].

Tetrahydro-2-methyl-2,4-diphenyl-1*H*-1,5-benzo diazepine 2. To a stirred solution of benzodiazepine **1** (3.12 g, 10 mmoles) in methanol (200 mL), sodium borohydride (0.74 g, 20 mmoles) was added in seven portions for a period of 3 hr. The temperature of the reaction mixture was maintained at 40°C using a water bath. After the completion of the reaction, the reaction mixture was concentrated and left undisturbed for one day. The crystals appeared in the flask were separated, washed with methanol and dried. Repeated purification by recrystallisation from ethanol afforded pure colorless needles of **2**, yield 2.20 g (70%), m.p. 117-118°C. [lit. m.p. 118-120°C[2]].

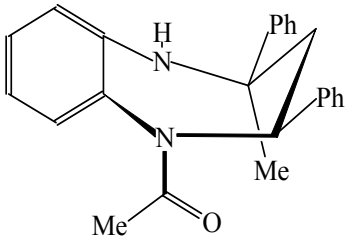
N_5-Formyltetrahydro-2-methyl-2,4-diphenyl-1*H* -1,5-benzodiazepine 3. Acetic anhydride (10 mL) was cooled to 5°C and 85% formic acid (5 mL) was added slowly to it. After the addition was over, the solution was heated to 60°C and then maintained at



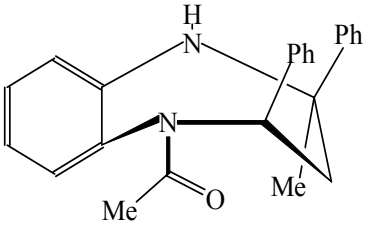
CE



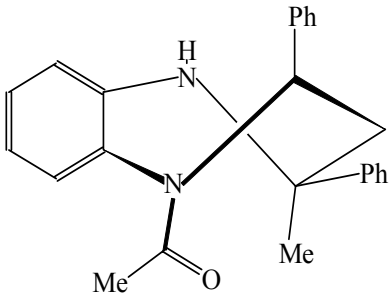
CA



BE



BA



B1

Figure 3—AM1 Optimized Structures of **4**

50-60°C for 1.5 hr. The solution was cooled to 5°C and added slowly to a cold solution of tetrahydrobenzodiazepine **2** (0.79, 2.5 mmoles) in anhydrous benzene (50 mL). The reaction mixture was stirred at RT for 10 hr and the solution was poured into water (250 mL). The benzene layer was separated and the aqueous layer was extracted with chloroform (4 × 25 mL). The organic extracts were combined, dried (anhydrous Na_2SO_4), passed through a short column of silica and concentrated. Purification by recrystallization from ethanol yielded colourless crystals of **3**, yield 0.72 g (84.7%), m.p. 171-72°C. Anal. Calcd for $C_{23}H_{22}N_2O$: C, 80.70; H, 6.43; N, 8.19. Found: C, 80.89; H, 6.65; N, 8.42%.

N_5-Acetyltetrahydro-2-methyl-2,4-diphenyl-1*H*-1,5-benzodiazepine 4. To a solution of tetrahydrobenzodiazepine **2** (0.79 g, 2.5 mmoles) in anhydrous benzene (50 mL) was added triethylamine (1.4 mL, 10 mmoles) and acetic anhydride (1 mL, 10 mmoles). The contents were allowed to reflux on a water bath for 6 hr. The reaction mixture was washed with sodium bicarbonate solution (10%), water and

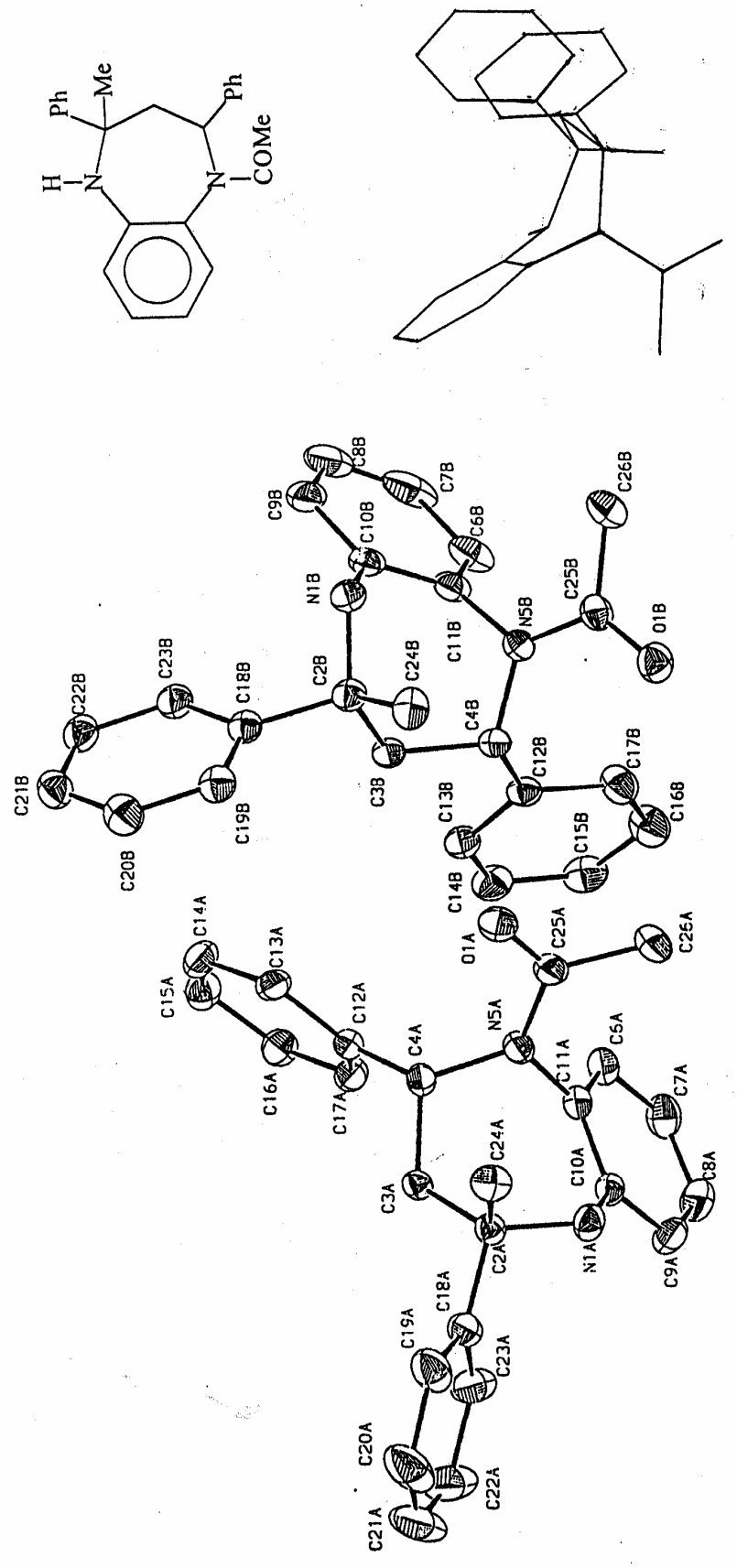


Figure 4—X-ray Crystal structure of **4**

Table IV —Comparison of selected bond lengths (Å), bond angles (degrees) and dihedral angles (degrees) of N_5-acetyltetrahydro-1,5-benzodiazepine **4** from X-ray crystallography and semiempirical MO calculations

	X-ray		AM1	PM3
	Molecule A	Molecule B		
Bond length (Å)				
C4-N5	1.47	1.48	1.46	1.50
C4-C11	1.43	1.43	1.42	1.46
N5-C25	1.37	1.36	1.40	1.44
C25-O1	1.23	1.23	1.25	1.22
Bond angle (degrees)				
C4-N5-C11	118.92	117.23	117.47	116.63
C4-N5-C25	118.14	120.37	119.57	119.16
C11-N5-C25	122.89	122.14	119.37	117.00
N5-C25-O1	120.90	122.24	120.33	118.30
Dihedral angle (degrees)				
N1-C2-C3-C4	-69.95	68.88	65.58	58.04
C2-C3-C4-N5	50.44	-49.31	-53.39	-69.15
C3-C4-N5-C11	39.18	-41.87	-31.72	-12.91
C4-N5-C11-C10	-69.42	75.75	65.11	58.05
N5-C11-C10-N1	-2.20	-1.46	5.05	1.57
C11-C10-N1-C2	53.70	-54.13	-60.84	-71.65
C2-C3-C4-C18	176.73	-172.69	-179.10	168.56
C4-C3-C2-C12	173.15	-173.80	-173.31	-177.13
C4-C3-C2-C24	49.41	-51.41	-54.91	-59.80
C4-N5-C25-O1	-4.06	7.76	8.27	15.29
C11-N5-C25-O1	178.57	-178.30	166.39	164.65

dried with sodium sulphate. Evaporation of the solvent and purification by recrystallization from ethanol gave crystals of **4**, yield 0.76 g (85.4%), m.p. 145-46°C. Anal. Calcd for $C_{24}H_{24}N_2O$: C, 80.90; H, 6.74; N, 7.87. Found: C, 81.22; H, 6.56; N, 7.56%.

N_5-Benzoyltetrahydro-2-methyl-2,4-diphenyl-1*H*-1,5-benzodiazepine 5. To a solution of tetrahydrobenzodiazepine **2** (0.79 g, 2.5 mmoles) in anhydrous benzene (50 mL) was added triethylamine (1.4 mL, 10.0 mmoles) and benzoyl chloride (1.2 mL, 10 mmol). The reaction mixture was allowed to reflux on a water bath for 8 hr. The reaction mixture was poured into water (200 mL) and the organic layer was separated. The aqueous layer was extracted with benzene (2 × 20 mL). The organic layers were combined and washed with 2 *N* solution of HCl (5 × 25 mL) followed by water (5 × 100 mL) and dried over anhydrous sodium sulphate. The solvent was evaporated and the solid was purified by recrystallization from ethanol to get colourless crystals of **5**, yield 0.87 g (82.9%), m.p. 199-200°C. Anal. Calcd for $C_{29}H_{26}N_2O$: C, 83.25; H, 6.22; N, 6.70. Found: C, 83.54; H, 6.44; N, 6.45%.

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