CHEMISTRY LETTERS, pp. 1419-1422, 1977. Published by the Chemical Society of Japan

BASE-CATALYZED EQUILIBRIUM OF SHYOBUNONE AND RELATED COMPOUNDS

Masatake NIWA, Masanobu IGUCHI, and Shosuke YAMAMURA*
Faculty of Pharmacy, Meijo University, Tenpaku-ku, Nagoya 468

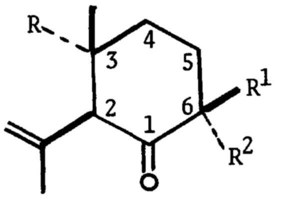
On treatment with MeONa - MeOH (under reflux, 7 - 9 h), shyobunone and related compounds were converted into a mixture of six possible isomers (1, 2, 3, 4, 5 and 6), including the starting material, in the following ratio: 1/2/3/4/5/6 = 3 : 6 : 3 : 1 : 7 : 13. In the cases of the corresponding dihydro compounds, six isomers were also obtained in the following ratio remarkably different from that of shyobunone [7/8/9/10/11/12 = 23 : 7 : 14 : 15 : 21 : 19]. The stereostructures and conformations of these compounds are discussed on the basis of their ORD data.

From a structural point of view, base-catalyzed isomerization of shyobunone (1) and related compounds was carried out, and all possible isomers were obtained. We here describe the stereostructures and conformations of these elemene-type compounds.

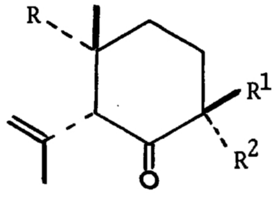
A solution of shyobunone (430 mg) in MeOH (30 ml) containing MeONa (400 mg) was heated under reflux for 9 h and diluted with water (50 ml), and then extracted with hexane to give a colorless liquid (425 mg), which was further separated by preparative TLC [1) Kieselgel PF_{254}, benzene; 2) 10% $AgNO_3$-Kieselgel PF_{254}, hexane - benzene (1 : 1)] to give six compounds in ca. 95% yield (relative ratio: 1/2/3/4/5/6 = 3 : 6 : 3 : 1 : 7 : 13).[1,2]

All of them have the same molecular formula [$C_{15}H_{24}O$ (m/e 220(M^+))]. In addition, the IR and mass spectra of these compounds are quite similar to one another except for two α,β-unsaturated ketones (5) and (6), and their NMR and ORD data are shown in Table 1.

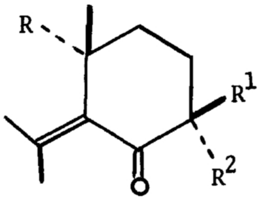
As estimated from their ORD data (1, A = +115; 2, A = -94),[3] shyobunone (1), whose absolute configuration has been unambiguously established,[4] should adopt a conformation [A], while 2,6-diepishyobunone (2) is in a conformation [B]. The stereostructures of 2-epi- and 6-epishyobunone are also assignable to 3 and 4, respectively, on the basis of their ORD curves indicating a strong Cotton effect (3, A = -242; 4, A = +245). In the cases of 3 and 4, two possible conformers [C and D] are considered, but none of them seem to be ruled out.



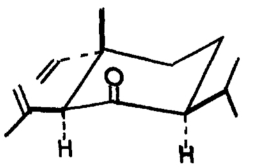
1 R = CH=CH$_2$, R^1= i-Pr, R^2= H
4 R = CH=CH$_2$, R^1= H, R^2= i-Pr
7 R = Et, R^1= i-Pr, R^2= H
10 R = Et, R^1= H, R^2= i-Pr



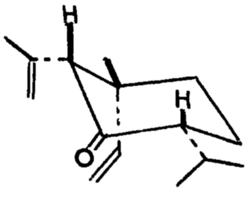
2 R = CH=CH$_2$, R^1= H, R^2= i-Pr
3 R = CH=CH$_2$, R^1= i-Pr, R^2= H
8 R = Et, R^1= H, R^2= i-Pr
9 R = Et, R^1= i-Pr, R^2= H



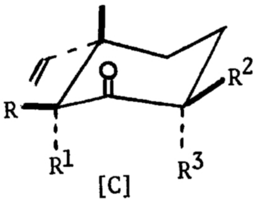
5 R = CH=CH$_2$, R^1= i-Pr, R^2= H
6 R = CH=CH$_2$, R^1= H, R^2= i-Pr
11 R = Et, R^1= i-Pr, R^2= H
12 R = Et, R^1= H, R^2= i-Pr



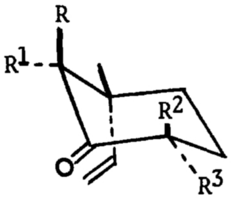
[A]



[B]



[C]



[D]

3 R = H, R^1= i-Propenyl, R^2= i-Pr, R^3= H
4 R = i-Propenyl, R^1= H, R^2= H, R^3= i-Pr

Table 1. NMR and ORD data of shyobunone and related compounds

Shyobunone (1)	2,6-Diepishyobunone (2)	2-Epishyobunone (3)	6-Epishyobunone (4)
δ (CDCl$_3$)	δ (CDCl$_3$)	δ (CDCl$_3$)	δ (CDCl$_3$)
0.89(3H, d, J= 7.0Hz)	0.88(3H, d, J= 6.5Hz)	0.86(3H, J= 6.0Hz)	0.85(3H, d, J= 6.5Hz)
0.93(3H, d, J= 7.0Hz)	0.93(3H, d, J= 6.5Hz)	0.95(3H, d, J= 6.0Hz)	0.92(3H, d, J= 6.5Hz)
1.05(3H, s)	1.17(3H, s)	1.11(3H, s)	1.09(3H, s)
1.77(3H, d, J= 1.0Hz)	1.75(3H, d, J= 1.0Hz)	1.73(3H, d, J= 1.0Hz)	1.81(3H, d, J= 1.0Hz)
3.02(1H, s)	2.97(1H, s)	2.96(1H, s)	3.11(1H, s)
4.68-5.05(4H, m)	4.65-5.10(4H, m)	4.86-5.12(4H, m)	4.70-5.05(4H, m)
5.78(1H, q, J= 18,10Hz)	5.93(1H, q, J= 17,10Hz)	5.97(1H, q, J= 17,10Hz)	5.73(1H, q, J= 18,10Hz)
ORD (MeOH)*	ORD (MeOH)	ORD (MeOH)	ORD (MeOH)
$[\phi]^{P}_{317}$ +57.9° x 10^2	$[\phi]^{T}_{318}$ -48.7° x 10^2	$[\phi]^{T}_{320}$ -118.8° x 10^2	$[\phi]^{P}_{319}$ +111.3° x 10^2
$[\phi]^{T}_{273}$ -57.2° x 10^2	$[\phi]^{P}_{273}$ -45.3° x 10^2	$[\phi]^{P}_{277}$ +123.2° x 10^2	$[\phi]^{T}_{273}$ -133.6° x 10^2
A = +115	A = -94	A = -242	A = +245

* Slightly different from the values cited in the reference 2.

Under essentially the same conditions as that of shyobunone (**1**), base-catalyzed equilibrium of 6-epidihydroisoshyobunone (**12**) was carried out using MeONa - MeOH to afford six possible isomers in 99% yield (relative ratio: **7**/**8**/**9**/**10**/**11**/**12** = 23 : 7 : 14 : 15 : 21 : 19).[2,5] All of them have the same molecular formula [$C_{15}H_{26}O$ (m/e 222(M^+))], and their IR and mass spectra are also quite similar to one another except for two α,β-unsaturated ketones (**11** and **12**).[6] The NMR and ORD data of these ketones (**7**, **8**, **9** and **10**) are cited in Table 2.

Table 2. NMR and ORD data of dihydroshyobunone and related compounds

7	**8**	**9**	**10**
δ ($CDCl_3$)	δ ($CDCl_3$)	δ ($CDCl_3$)	δ ($CDCl_3$)
0.75-1.0(9H, complex)	0.68-1.0(9H, complex)	0.68-1.0(9H, complex)	0.75-1.0(9H, complex)
0.90(3H, s)	0.97(3H, s)	0.90(3H, s)	0.94(3H, s)
1.82(3H, d, J= 1.0Hz)	1.84(3H, br.s)	1.81(3H, br.s)	1.83(3H, d, J= 1.0Hz)
2.96(1H, s)	2.94(1H, s)	2.81(1H, s)	2.94(1H, s)
4.67(1H, br.s)	4.76(1H, br.s)	4.95(1H, br.s)	4.80(1H, br.s)
4.93(1H, t, J= 1.0Hz)	5.03(1H, br.s)	5.02(1H, t, J= 1.0Hz)	4.98(1H, t, J= 1.0Hz)
ORD (MeOH)	ORD (MeOH)	ORD (MeOH)	ORD (MeOH)
$[\phi]^{P}_{315}$ +38.0° x 10^2	$[\phi]^{T}_{315}$ -32.8° x 10^2	$[\phi]^{T}_{323}$ -109.7° x 10^2	$[\phi]^{P}_{315}$ +76.3° x 10^2
$[\phi]^{T}_{272}$ -39.5° x 10^2	$[\phi]^{P}_{271}$ +26.1° x 10^2	$[\phi]^{P}_{278}$ +113.5° x 10^2	$[\phi]^{T}_{273}$ -83.6° x 10^2
A = +78	A = -59	A = -223	A = +160

As judged from its ORD data, dihydroshyobunone (**7**), which has been readily hydrogenated over PtO_2 to tetrahydroshyobunone,[3] must adopt the same conformation as that of shyobunone (**1**). In the case of 2,6-diepidihydroshyobunone (**8**), this epimer is also in the same conformation as that of 2,6-diepishyobunone (**2**).

In the above base-catalyzed reactions, as expected, dihydroshyobunone (**7**) with an axial Me group at C_3-position is more stable than 2,6-diepidihydroshyobunone (**8**), in which an axial Et group is present at the same position (relative ratio: **7**/**8** = 3.3). On the other hand, interestingly, 2,6-diepishyobunone (**2**) with an axial vinyl group at C_3-position is more stable than shyobunone (**1**) having an axial Me group at the same position (relative ratio: **2**/**1** = 2), although the vinyl group seems to be much bulky. In the cases of the four α,β-unsaturated ketones (**5**, **6**, **11** and **12**), the similar results have been also obtained (relative ratios: **6**/**5** = 2, 11/12 = 1.1). To date, unambiguous evidences enough to explain these interesting results have not yet been obtained.

The ORD curves were taken on a JASCO J-20 spectropolarimeter using MeOH as the solvent.

REFERENCES AND FOOTNOTES

1. The similar relative ratios have been found in the cases of the other isomers.
2. Each value means an isolated yield.
3. S. Yamamura, M. Iguchi, A. Nishiyama, M. Niwa, H. Koyama, and Y. Hirata, Tetrahedron, 27, 5419 (1971).
4. K. Kato, Y. Hirata, and S. Yamamura, Tetrahedron, 27, 5987 (1971).
5. The similar relative ratios have been also found in the cases of the other isomers.
6. Physical data of these two compounds are cited in the preceding paper.

(Received August 10, 1977)