

Organic Letters

SUPPORTING INFORMATION

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"Enantiopure *N*-Acyldihydropyridones as Synthetic Intermediates: Asymmetric Synthesis of Benzomorphans"

- I. Spectral data for **4-9, 11,14-15** and **17-21** (21 pages).
- II. Comparison tables of NMR data for synthetic **4a,b, 19** and **21** (4 pages).

Total pages of supporting information: (25).

DATA SHEET- Yue-Mei Zhang

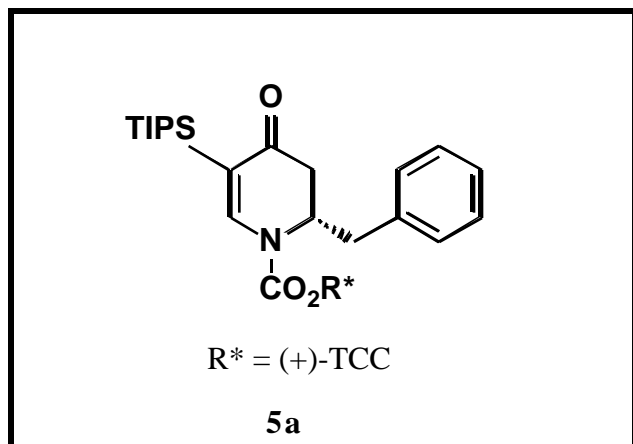
Compound: (2*S*)-1-[(*(1S,2R)*-*trans*-2-(*t*-Cumyl)cyclohexyl)oxy]carbonyl]-2-benzyl-5-(triisopropylsilyl)-2,3-dihydro-4-pyridone

Compound No.: (5a)

Formula: C₃₇H₅₃NO₃Si

Notebook Pg(s): YZ-II, 029-y

Molecular Weight: 587



Yield(s): 86%

de: 92%

Other:

Appearance: a white solid

Stability: stable at rt

mp: 120-121 °C (MeOH);

[α]_D²³ (c 0.35, CHCl₃): +21.1

	%C	%H	%N
Elemental Analysis (Atlantic Microlabs)			
Calculated:	75.59	9.09	2.38
Found:	75.49	9.15	2.33

IR (CHCl₃): 2943, 2865, 1710, 1654, 1601, 1573, 1388, 1326, 1294, 1255, 1206 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): 7.77 (s, 1 H), 7.15-7.36 (m, 8 H), 6.93 (m, 2 H), 4.81 (m, 1 H), 2.84 (m, 1 H), 2.48 (m, 1 H), 2.23 (m, 1 H), 2.07 (brd, 1 H, *J* = 9.3 Hz), 1.90 (d, 1 H, *J* = 15.8 Hz), 1.70-1.79 (m, 3 H), 0.95-1.39 (m, 33 H).

(¹³C, 75 MHz): 196.8, 152.6, 152.1, 147.2, 136.6, 129.6, 128.5, 128.2, 126.7, 125.0, 110.7, 78.0, 53.0, 51.1, 39.4, 39.2, 36.4, 33.4, 31.0, 26.8, 25.9, 24.6, 21.5, 18.9, 11.2.

DATA SHEET- Yue-Mei Zhang

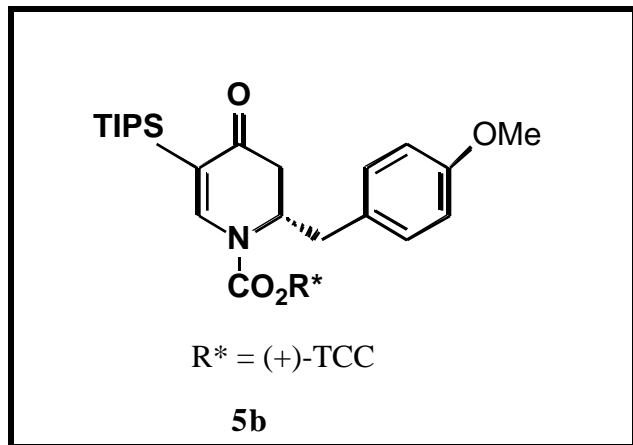
Compound: (2*S*)-1-(((1*S*,2*R*)-*trans*-2-(*n*-Cumyl)cyclohexyloxy)carbonyl]-2-(4-methoxybenzyl)-5-(triisopropylsilyl)-2,3-dihydro-4-pyridone

Compound No.: (**5b**)

Formula: C₃₈H₅₅NO₄Si

Notebook Pg(s): YZ-II, 032-y

Molecular Weight: 618



Yield(s): 89%
de: 90%

Other:

Appearance: a white solid

Stability: stable at rt

mp: 63-65 °C

[α]_D²³ (c 0.49, CHCl₃): +34.3

HRMS Calcd for C₃₈H₅₅NO₄Si: 618.3979. Found: 618.3989.

IR (CHCl₃): 2964, 2931, 2864, 1710, 1654, 1601, 1572, 1513, 1465, 1387, 1326, 1300, 1252, 1017 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): 7.76 (s, 1 H), 7.16-7.35 (m, 5 H), 6.83-6.99 (m, 4 H), 4.83 (d of t, 1 H, *J* = 10.0 Hz, *J*^l = 3.9 Hz), 3.79 (s, 3 H), 2.81 (m, 1 H), 2.43 (m, 2 H), 2.22 (m, 2 H), 2.06 (brd, 1 H, *J* = 10.5 Hz), 1.91 (d, 1 H, *J* = 16.4 Hz), 1.81 (m, 2 H), 1.71 (m, 1 H), 1.02-1.36 (m, 33 H).

(¹³C, 75 MHz): 196.8, 158.4, 152.5, 152.0, 147.1, 130.4, 128.5, 128.1, 124.8, 113.8, 110.4, 77.9, 55.1, 53.0, 51.0, 39.3, 39.0, 35.4, 33.4, 30.9, 26.7, 25.8, 24.5, 21.3, 18.8, 11.1.

DATA SHEET- Yue-Mei Zhang

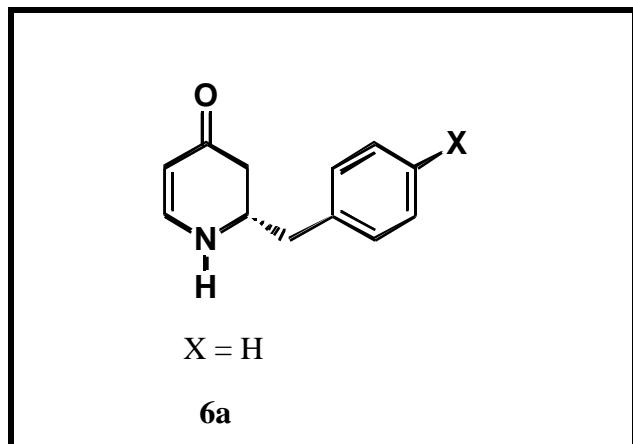
Compound: (2*S*)-2-Benzyl-2,3-dihydro-4-pyridone

Compound No.: (6a)

Formula: C₁₂H₁₃NO

Notebook Pg(s): YZ-II, 030-w

Molecular Weight: 187



Yield(s): 89%

Other:

Appearance: a light yellow solid

Stability: stored in freezer

mp: 101-103 °C

[α]_D²³ (c 0.225, CHCl₃): -151.1

HRMS Calcd for C₁₂H₁₃NO: 187.0997. Found: 187.0997.

IR (CHCl₃) 3416, 3002, 2964, 1633, 1596, 1494, 1344, 1236, 1198 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): 7.19-7.38 (m, 5 H), 7.08 (m, 1 H), 5.04 (d, 1 H, *J* = 7.5 Hz), 4.70 (brs, 1 H), 3.87 (m, 1 H), 2.96 (dd, 1 H, *J* = 13.6, 4.9 Hz), 2.83 (dd, 1 H, *J* = 13.6, 9.8 Hz), 2.56 (dd, 1 H, *J* = 16.2, 5.4 Hz), 2.45 (dd, 1 H, *J* = 16.2, 11.9 Hz).

(¹³C, 75 MHz): 192.5, 150.8, 136.5, 129.0, 128.8, 127.0, 99.1, 54.2, 42.0, 40.1.

DATA SHEET- Yue-Mei Zhang

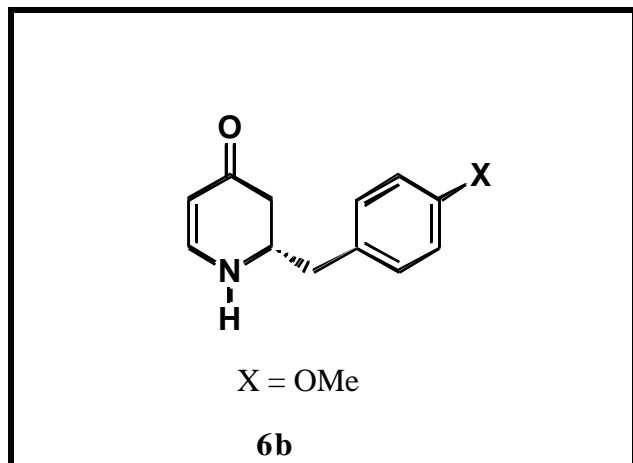
Compound: (2*S*)-2-(4-Methoxybenzyl)-2,3-dihydro-4-pyridone

Compound No.: (**6b**)

Formula: C₁₃H₁₅NO

Notebook Pg(s): YZ-II, 032-y

Molecular Weight: 217



Yield(s): 88%

Other:

Appearance: slightly yellow solid

Stability: stored in freezer

mp: 108-109 °C

[α]_D²³ (c 0.46, CHCl₃): -114.8

HRMS Calcd for C₁₃H₁₅NO: 217.1103. Found: 217.1097.

IR (CHCl₃) 3416, 3002, 2964, 1637, 1598, 1514, 1492, 1343, 1249, 1199 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): 7.06-7.13 (m, 3 H), 6.89 (d, 2 H, *J* = 8.0 HZ), 5.04 (d, 1 H, *J* = 7.4 Hz), 4.69 (brs, 1 H), 3.84 (m, 1 H), 3.80 (s, 3 H), 2.90 (dd, 1 H, *J* = 13.7, 4.7 Hz), 2.76 (dd, 1 H, *J* = 13.7, 9.8 Hz), 2.54 (dd, 1 H, *J* = 16.1, 5.1 Hz), 2.44 (dd, 1 H, *J* = 16.1, 12.3 Hz).

(¹³C, 75 MHz): 192.5, 158.5, 151.1, 130.0, 128.4, 114.1, 98.6, 55.1, 54.2, 41.7, 39.1.

DATA SHEET- Yue-Mei Zhang

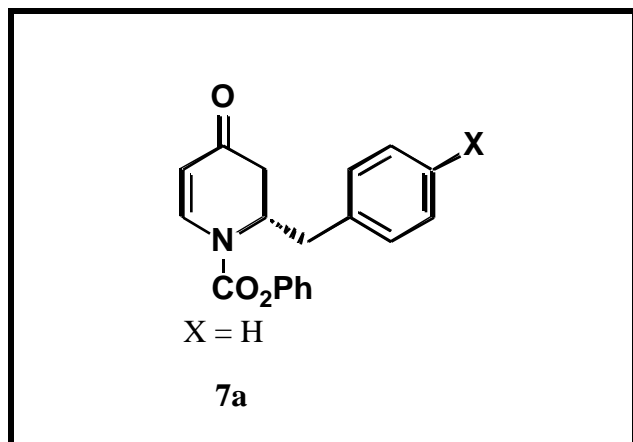
Compound: (2*S*)-2-Benzyl-1-[(phenyloxy)carbonyl]-2,3-dihydro-4-pyridone

Compound No.: (7a)

Formula: C₁₉H₁₇NO₃

Notebook Pg(s): YZ-II, 030-y

Molecular Weight: 307



Yield(s): 98%

Other:

Appearance: white solid

Stability: stable at rt

mp: 102-104 °C (EtOAc/hexanes)

[α]_D²³ (c 0.195, CHCl₃): -9.23

	%C	%H	%N
Elemental Analysis (Atlantic Microlabs)			
Calculated:	74.25	5.57	4.56
Found:	74.15	5.61	4.52

IR (CHCl₃): 3066, 2993, 1734, 1668, 1606, 1495, 1425, 1335, 1301, 1264, 1236, 1190 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): 7.94 (d, 1 H, *J* = 8.4 Hz), 6.80-7.40 (m, 10 H), 5.23 (brs, 1 H), 4.91 (brs, 1 H), 3.10 (brs, 1 H), 2.91 (dd, 1 H, *J* = 13.3, 8.8 Hz), 2.84 (brs, 1 H), 2.50 (d, 1 H, *J* = 16.6 Hz).

(¹³C, 75 MHz): 192.6, 150.3, 141.0, 140.9, 136.4, 129.6, 129.5, 128.7, 127.0, 126.3, 121.2, 108.4 and 108.2 (due to rotamers), 55.2, 38.9, 36.5.

DATA SHEET- Yue-Mei Zhang

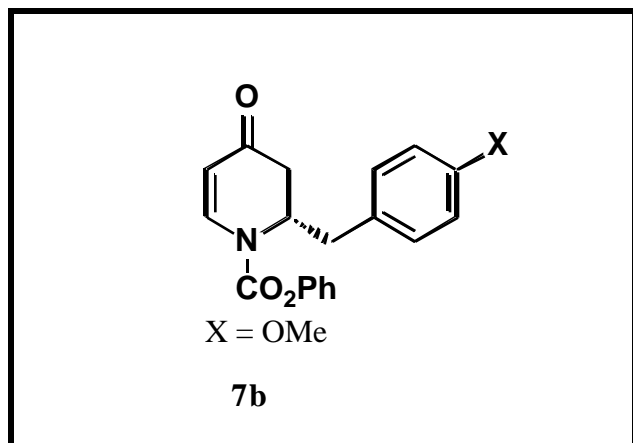
Compound: (2*S*)-2-(4-Methoxybenzyl)-1-[(phenyloxy)carbonyl]-2,3-dihydro-4-pyridone

Compound No.: (7b)

Formula: C₂₀H₁₉NO₄

Notebook Pg(s): YZ-II, 032-y

Molecular Weight: 337



Yield(s): 90%

Other:

Appearance: white solid

Stability: stable at rt

mp: 119-120 °C (EtOAc/hexanes)

[α]_D²³ (c 0.305, CHCl₃): -22.3

	%C	%H	%N
Elemental Analysis (Atlantic Microlabs)			
Calculated:	71.20	5.68	4.15
Found:	71.29	5.71	4.09

IR (CDCl₃) 1738, 1669, 1605, 1514, 1335, 1264, 1249, 1198 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): δ 7.94 (d, 1 H, *J* = 8.3 Hz), 6.83-7.41 (m, 9 H), 5.51 (brs, 1 H), 4.85 (brs, 1 H), 3.78 (s, 3 H), 3.10 (brs, 1 H), 2.86 (dd, 1 H, *J* = 13.4, 9.0 Hz), 2.81 (brs, 1 H), 2.50 (d, 1 H, *J* = 16.6 Hz).

(¹³C, 75 MHz): 192.3, 158.4, 150.1, 140.7, 130.7, 129.2, 128.8, 128.1, 125.9, 120.9, 113.9, 107.9, 54.9, 38.6, 38.5, 35.3.

DATA SHEET- Yue-Mei Zhang

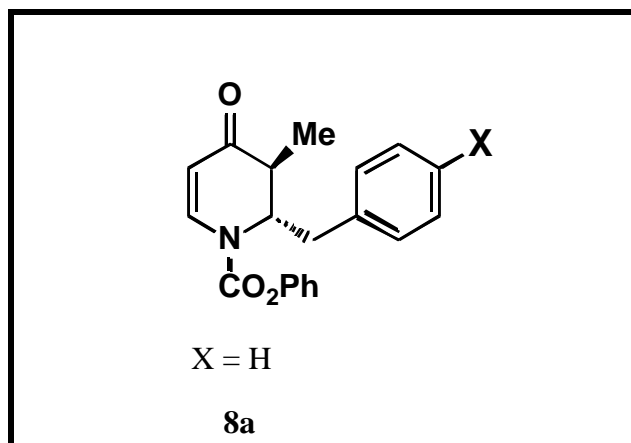
Compound: (2*S*,3*S*)-2-Benzyl-3-methyl-1-[(phenyloxy)carbonyl]-2,3-dihydro-4-pyridone

Compound No.: (8a)

Formula: C₂₀H₁₉NO₃

Notebook Pg(s): YZ-II, 031-y, 032-w

Molecular Weight: 321



Yield(s): 90%

Other:

Appearance: white solid

Stability: avoid bases and acids

mp: 122-124 °C (EtOAc/hexanes)

[α]_D²³ (c 0.42, CHCl₃): -88.6

	%C	%H	%N
Elemental Analysis (Atlantic Microlabs)			
Calculated:	74.75	5.96	4.36
Found:	74.78	6.01	4.32

IR (CDCl₃) 1737, 1666, 1605, 1333, 1249, 1194 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): 7.90 (d, 1 H, *J* = 8.5 Hz), 6.82-7.33 (m, 10 H), 5.44 (brm, 1 H), 4.59 (brs, 1 H), 3.08 (m, 1 H), 2.86 (dd, 1 H, *J* = 13.1, 8.2 Hz), 2.48 (m, 1 H), 1.22 (d, 3 H, *J* = 6.5 Hz).

(¹³C, 75 MHz): 197.1, 150.3, 140.1, 139.6, 136.4, 129.6, 129.5, 129.4, 128.7, 126.9, 126.2, 121.1, 106.7 and 106.0 (due to rotamers), 61.5 and 61.1 (due to rotamers), 43.4 and 42.4 (due to rotamers), 36.7 and 36.5 (due to rotamers), 16.8.

DATA SHEET- Yue-Mei Zhang

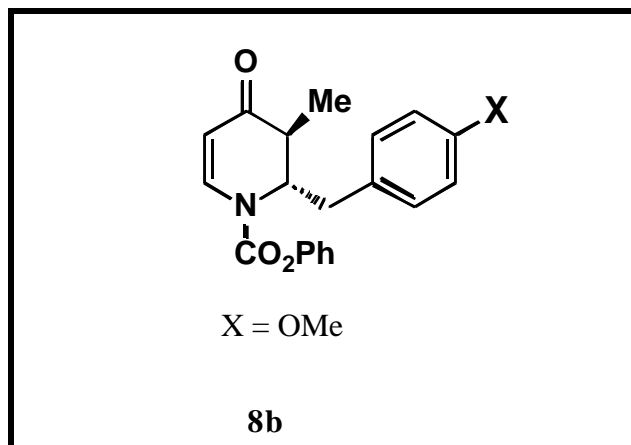
Compound: (2*S*,3*S*)-2-(4-Methoxybenzyl)-3-methyl-1-[(phenyloxy)carbonyl]-2,3-dihydro-4-pyridone

Compound No.: (8b)

Formula: C₂₁H₂₁NO₄

Notebook Pg(s): YZ-II, 033-y

Molecular Weight: 351



Yield(s): 92%

Other:

Appearance: white solid

Stability: avoid bases and acids

mp: 105-108 °C (EtOAc/hexanes)

[α]_D²³ (c 0.395, CHCl₃): -90.6

	%C	%H	%N
Elemental Analysis (Atlantic Microlabs)			
Calculated:	71.78	6.02	3.99
Found:	71.75	6.05	3.95

IR (CDCl₃) 1738, 1666, 1606, 1514, 1332, 1249, 1194 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz) δ 7.90 (d, 1 H, *J* = 8.2 Hz), 6.82-7.37 (m, 9 H), 5.45 (brm, 1 H), 4.53 (brm, 1 H), 3.78 (s, 3 H), 3.03 (m, 1 H), 2.81 (dd, 1 H, *J* = 13.5, 8.6 Hz), 2.48 (m, 1 H), 1.25 (d, 3 H, *J* = 7.2 Hz).

(¹³C, 75 MHz): 196.9, 158.5, 150.2, 139.9, 139.5, 130.4, 129.2, 128.2, 126.0, 121.0, 114.0, 106.5 and 105.7 (due to rotamers), 61.5 and 61.0 (due to rotomers), 55.0, 43.1 and 42.1 (due to rotomers), 35.7 and 35.4 (due to rotomers), 16.6.

DATA SHEET- Yue-Mei Zhang

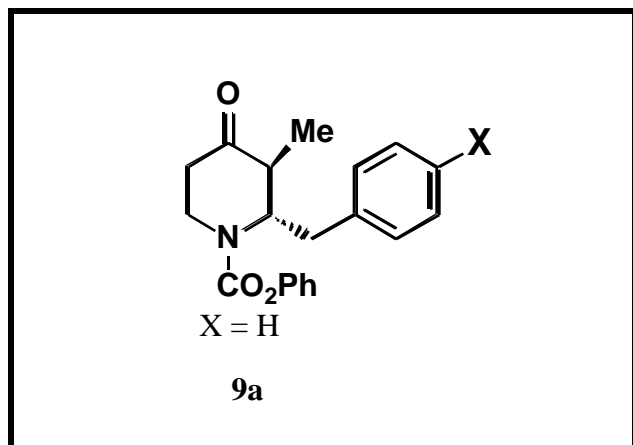
Compound: (2*S*,3*S*)-2-Benzyl-3-methyl-1-[(phenyloxy)carbonyl]-4-piperidone

Compound No.: (9a)

Formula: C₂₀H₂₁NO₃

Notebook Pg(s): YZ-II, 034-y

Molecular Weight: 323



Yield(s): 94%

Other:

Appearance: white solid

Stability: avoid bases and acids

mp: 104-106 °C

[α]_D²³ (c 0.25, CHCl₃): +75.2

	%C	%H	%N
Elemental Analysis (Atlantic Microlabs)			
Calculated:	74.28	6.54	4.33
Found:	74.31	6.57	4.33

IR (CDCl₃) 1707, 1601, 1418, 1236, 1194 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): δ 7.21-7.35 (m, 9 H), 7.04 and 6.83 (two d due to rotamers, 1 H, *J* = 7.8 Hz), 4.62 (m, 1 H), 4.48 (m, 1 H), 3.37 (m, 1 H), 2.96 (m, 2 H), 2.78 (ddd, 1 H, *J* = 12.2, 15.9, 7.7 Hz), 2.61 (m, 1 H), 2.34 (dd, 1 H, *J* = 15.8, 3.2 Hz), 1.34 and 1.27 (two d due to rotamers, 3 H, *J* = 7.0 Hz).

(¹³C, 75 MHz): 210.4, 154.3, 151.0, 136.9, 136.7, 129.2, 128.7, 126.9, 125.4, 121.5, 60.4 and 59.5 (due to rotamers), 48.0 and 46.9 (due to rotamers), 39.5 and 38.9 (due to rotamers), 38.6 and 38.1 (due to rotamers), 37.5 and 37.1 (due to rotamers), 16.0 and 15.7 (due to rotamers).

DATA SHEET- Yue-Mei Zhang

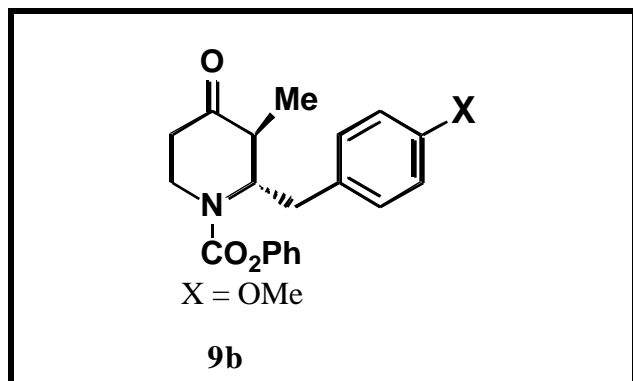
Compound: (2*S*,3*S*)-2-(4-Methoxybenzyl)-3-methyl-1-[(phenyloxy)carbonyl]-4-piperidone

Compound No.: (9b)

Formula: C₂₁H₂₃NO₄

Notebook Pg(s): YZ-II, 035-y

Molecular Weight: 354



Yield(s): 92%

Other:

Appearance: colorless oil

Stability: avoid bases and acids

[α]_D²³ (c 0.17, CHCl₃): +54.1

HRMS Calcd for C₂₁H₂₃NO₄: 354.1705. Found: 354.1711

IR (CHCl₃) 1708, 1602, 1514, 1419, 1250, 1232, 1200 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): 7.03-7.36 (m, 6 H), 6.84-6.87 (m, 3 H), 4.51 (m, 2 H), 3.80 (s, 3 H), 3.33 (m, 1 H), 2.89 (m, 2 H), 2.78 (ddd, 1 H, *J* = 12.2, 15.9, 7.5 Hz), 2.60 (m, 1 H), 2.32 (dd, 1 H, *J* = 15.9, 2.3 Hz), 1.33 and 1.26 (two d due to rotamers, 3 H, *J* = 6.7 Hz).

(¹³C, 75 MHz): 210.5, 158.6, 154.3, 151.1, 130.2, 129.2, 128.8, 125.4, 121.5, 114.1, 60.5 and 59.6 (due to rotamers), 55.2, 47.7 and 46.7 (due to rotamers), 39.5 and 38.9 (due to rotamers), 37.7, 37.6 and 37.2 (due to rotamers), 16.0 and 15.6 (due to rotamers).

DATA SHEET- Yue-Mei Zhang

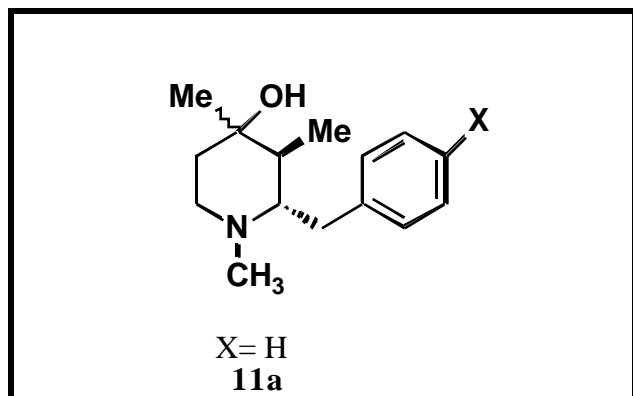
Compound: (2*S*,3*S*,4*S*/*R*)-2-Benzyl-1,3,4-trimethyl-4-piperidinol

Compound No.: (11a)

Formula: C₁₅H₂₃NO

Notebook Pg(s): YZ-II, 041-w

Molecular Weight: 234



Yield(s): 95%

Other:

Appearance: yellow oil

Stability: stored in freezer

Major [α]_D^{23.5} +10.0 (c 0.32, CHCl₃);

Minor [α]_D^{23.5} +14.2 (c 0.22, CHCl₃)

HRMS Calcd for C₁₅H₂₃NO: 234.1858. Found: 234.1856.

IR (CDCl₃) 3371, 3052, 3011, 2930, 2854, 1603, 1495, 1454, 1382, 1279, 1240, 1155, 1090, 1010, 912 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): Major 7.17-7.33 (m, 5 H), 3.06 (dd, 1 H, *J* = 15.3, 4.2 Hz), 2.84 (m, 1 H), 2.76 (dd, 1 H, *J* = 15.3, 4.2 Hz), 2.36 (s, 3 H), 2.27 (m, 1 H), 2.17 (t of d, 1 H, *J*^d = 8.5 Hz, *J*^f = 4.3 Hz), 1.69 (m, 2 H), 1.56 (m, 1 H), 1.11 (s, 3 H), 0.91 (d, 3 H, *J* = 6.8 Hz);

(¹³C, 75 MHz) _ 139.9, 129.5, 128.1, 125.8, 71.7, 68.1, 53.2, 43.8, 43.0, 39.5, 36.3, 21.6, 13.0;

(¹H, 300 MHz) Minor_ 7.17-7.35 (m, 5 H), 3.04 (dd, 1 H, *J* = 16.0, 3.7 Hz), 2.75 (dd, 1 H, *J* = 16.0, 3.7 Hz), 2.69 (m, 1 H), 2.53 (ddd, 1 H, *J* = 12.2, 12.1, 3.3 Hz), 2.35 (s, 3 H), 2.32 (m, 1 H), 1.75 (ddd, 1 H, *J* = 13.1, 13.3, 4.9 Hz), 1.60 (t of d, 1 H, *J*^d = 13.7 Hz, *J*^f = 2.8 Hz), 1.43 (m, 1 H), 1.17 (s, 3 H), 0.96 (d, 3 H, *J* = 6.7 Hz);

(¹³C, 75 MHz) _ 139.9, 128.9, 128.3, 125.8, 71.1, 65.5, 53.2, 43.2, 41.4, 35.6, 35.4, 27.1, 8.8;

DATA SHEET- Yue-Mei Zhang

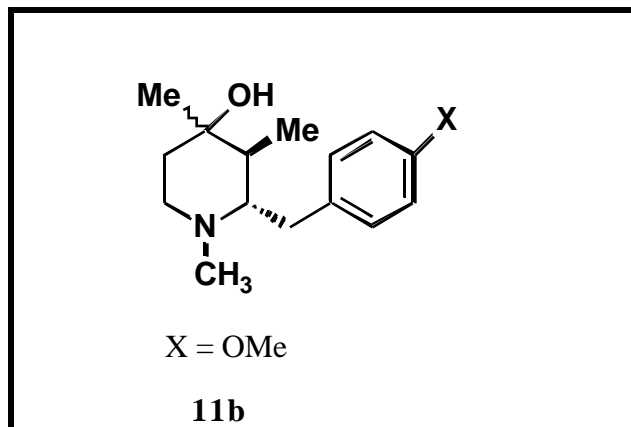
Compound: (2*S*,3*S*,4*S*/*R*)-2-(4-Methoxybenzyl)-1,3,4-trimethyl-4-piperidinol

Compound No.: (11b)

Formula: C₁₆H₂₅NO₂

Notebook Pg(s): YZ-II, 043-w

Molecular Weight: 264



Yield(s): 90%

Other:

Appearance: yellow oil

Stability: stored in freezer

Major [α]_D^{23.5} +13.0 (*c* 0.755, CHCl₃);

Minor [α]_D^{23.5} +15.1 (*c* 0.69, CHCl₃)

HRMS Calcd for C₁₆H₂₅NO₂: 264.1964. Found 264.1946.

IR (CHCl₃) 3580, 3038, 2954, 1602, 1512, 1464, 1244, 1180, 1038, 909 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): Major 7.25 (d, 2 H, *J* = 8.6 Hz), 6.82 (d, 2 H, *J* = 8.6 Hz), 3.78 (s, 3 H), 2.98 (dd, 1 H, *J* = 15.6, 4.5 Hz), 2.85 (t of d, 1 H, *J*^d = 11.9 Hz, *J* = 4.4 Hz), 2.70 (dd, 1 H, *J* = 15.4, 4.4 Hz), 2.36 (s, 3 H), 2.28 (m, 1 H), 2.09 (m, 1 H), 1.65 (m, 2 H), 1.52 (m, 1 H), 1.11 (s, 3 H), 0.90 (d, 3 H, *J* = 6.9 Hz);

(¹³C, 75 MHz) _ 157.7, 131.7, 130.3, 113.5, 71.6, 68.2, 55.1, 53.3, 43.5, 42.9, 39.6, 35.1, 21.4, 12.8;

(¹H, 300 MHz) _ Minor 7.25 (d, 2 H, *J* = 8.6 Hz), 6.82 (d, 2 H, *J* = 8.6 Hz), 3.78 (s, 3 H), 2.98 (dd, 1 H, *J* = 15.6, 4.5 Hz), 2.70 (m, 2 H), 2.53 (d of t, 1 H, *J*^d = 12.4 Hz, *J*^d = 3.4 Hz), 2.35 (s, 3 H), 2.29 (m, 1 H), 1.75 (m, 1 H), 1.58 (t of d, 1 H, *J*^d = 13.7 Hz, *J* = 3.0 Hz), 1.41 (m, 1 H), 1.16 (s, 3 H), 0.95 (d, 3 H, *J* = 6.7 Hz);

(¹³C, 75 MHz) _ 157.7, 132.0, 130.2, 113.5, 70.0, 66.0, 55.1, 51.4, 43.4, 42.1, 38.6, 35.1, 28.8, 11.7.

DATA SHEET- Yue-Mei Zhang

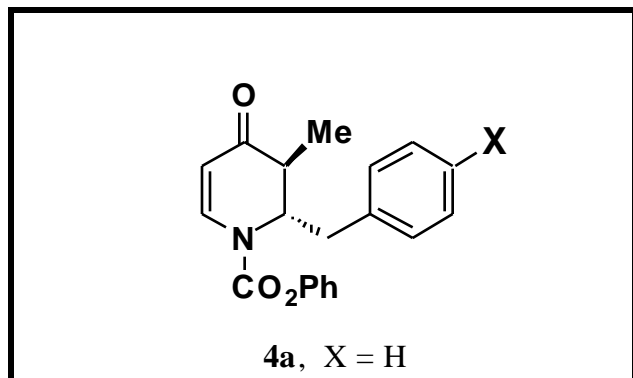
Compound: (1*S*,5*S*,9*S*)-5,9-Dimethyl-2-methyl-6,7-benzomorphan

Compound No.: (4a)

Formula: C₁₅H₂₁N

Notebook Pg(s): YZ-II, 041-y

Molecular Weight: 215



Yield(s): 81%

Other:

Appearance: an oil

Stability: stored in freezer, avoid acids

[α]_D²³ (c 0.81, CHCl₃): +62.0

IR (CHCl₃) 2965, 2928, 2846, 2808, 1602, 1490, 1447, 1382, 1230 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): 7.06-7.26 (m, 4 H), 3.03 (d, 1 H, *J* = 18.6 Hz), 2.85-2.88 (m, 1 H), 2.69 (dd, 1 H, *J* = 18.4, 5.8 Hz), 2.35-2.47 (m, 1 H), 2.40 (s, 3 H), 2.05 (d of t, 1 H, *J*¹ = 12.4 Hz, *J*¹ = 3.0 Hz), 1.88 (m, 1 H), 1.82 (dd, 1 H, *J* = 12.6, 4.6 Hz), 1.26-1.39 (m, 1 H), 1.37 (s, 3 H), 0.85 (d, 3 H, *J* = 7.0 Hz).

(¹³C, 75 MHz): 141.8, 136.6, 127.2, 126.1, 125.6, 125.4, 59.3, 47.4, 42.7, 42.4, 42.1, 35.8, 25.4, 23.4, 14.1.

DATA SHEET- Yue-Mei Zhang

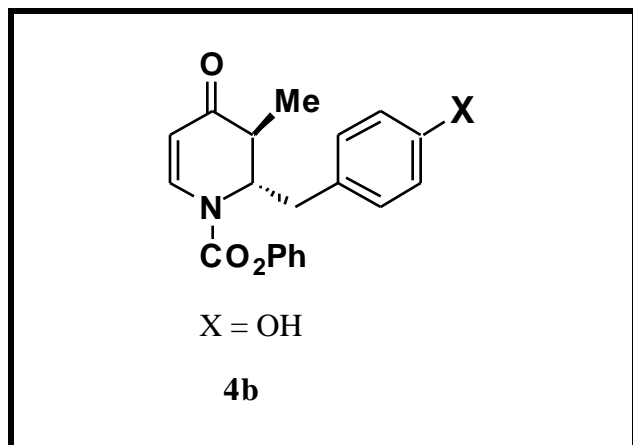
Compound: (+)-Metazocine

Compound No.: (4b)

Formula: C₁₅H₂₁NO

Notebook Pg(s): YZ-II, 043-y

Molecular Weight: 231



Yield(s): 70%

Other:

Appearance: white solid

Stability: avoid acids

mp/bp: 190-192 °C

[α]_D²⁵ (c 0.91, EtOH): +82.6

IR (CHCl₃) 2964, 2914, 2848, 1608, 1584, 1496, 1462, 1381, 1281, 1240 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): δ 6.94 (d, 1 H, *J* = 8.2 Hz), 6.71 (d, 1 H, *J* = 2.4 Hz), 6.60 (dd, 1 H, *J* = 8.2, 2.4 Hz), 2.95 (d, 1 H, *J* = 18.2 Hz), 2.86 (m, 1 H), 2.62 (dd, 1 H, *J* = 18.3, 5.8 Hz), 2.46 (m, 1 H), 2.40 (s, 3 H), 2.10 (d of t, 1 H, *J*^t = 12.2 Hz, *J*^d = 2.8 Hz), 1.89 (m, 1 H), 1.81 (dd, 1 H, *J* = 12.7, 4.6 Hz), 1.31-1.39 (m, 1 H), 1.33 (s, 3 H), 0.85 (d, 3 H, *J* = 7.0 Hz).

(¹³C, 75 MHz): 155.3, 142.8, 128.1, 127.0, 113.4, 112.6, 59.4, 47.4, 42.3, 41.6, 41.0, 35.7, 25.3, 22.7, 14.1.

DATA SHEET- Yue-Mei Zhang

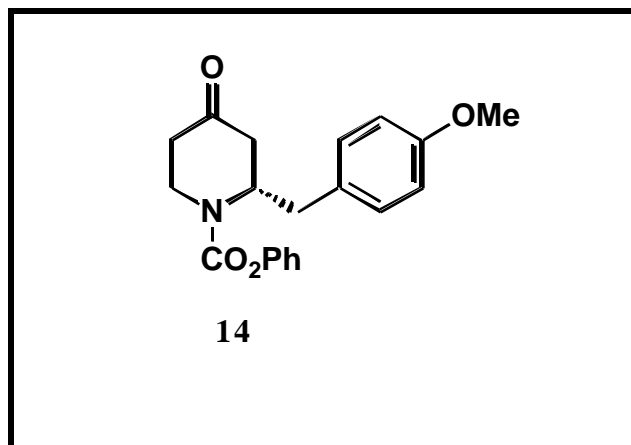
Compound: (2*S*)-2-(4-Methoxybenzyl)-1-[(phenyloxy)carbonyl]-4-piperidone

Compound No.: (14)

Formula: C₂₀H₂₁NO₄

Notebook Pg(s): YZ-II, 033-w

Molecular Weight: 339



Yield(s): 80%

Other:

Appearance: white solid

Stability: stable at rt

mp: 100-102 °C

[α]_D²³ (c 0.45, CHCl₃): -16.0

HRMS Calcd for C₂₀H₂₁NO₄: 339.1471. Found: 339.1483.

IR (CDCl₃) 1708, 1602, 1514, 1418, 1248, 1180 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): δ 6.90-7.37 (m, 7 H), 6.85 (d, 2 H, *J* = 8.4 Hz), 4.92 (brm, 1 H), 4.47 (m, 1 H), 3.79 (s, 3 H), 3.55 (brm, 1 H), 2.92 (dd, 1 H, *J* = 13.6, 7.1 Hz), 2.59-2.81 (m, 3 H), 2.47 (brd, 2 H, *J* = 15.3 Hz)

(¹³C, 75 MHz): 207.3, 158.6, 153.7, 151.1, 130.3, 129.3, 128.8, 125.5, 121.6, 114.1, 55.2, 54.5 and 54.4 (due to rotamers), 44.1 and 43.4 (due to rotamers), 40.4, 39.4, 38.3.

DATA SHEET- Yue-Mei Zhang

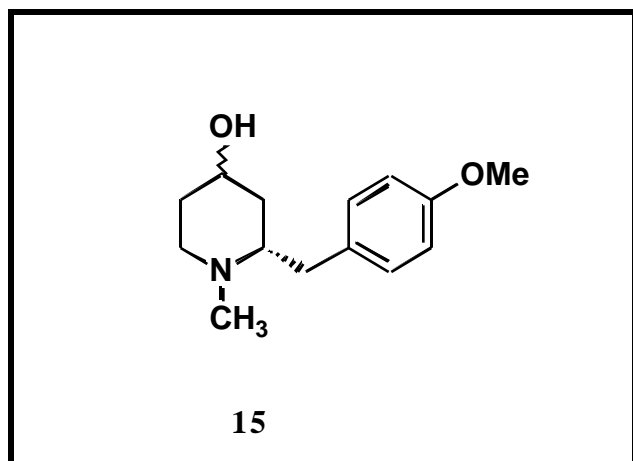
Compound: (2*S*,4*S*/*R*)-2-(4-Methoxybenzyl)-1-methyl-4-piperidinol

Compound No.: (15)

Formula: C₁₄H₂₁NO₂

Notebook Pg(s): YZ-II, 034-w

Molecular Weight: 235



Yield(s): 84%

Other:

Appearance: solids

Stability: stored in freezer, avoid acids

mp: trans 117-120 °C, cis 117-120 °C

trans [$\alpha \text{ } ^{24}_{\text{D}}$] +90.6 (c 0.17, CDCl₃);

cis [$\alpha \text{ } ^{24}_{\text{D}}$] +88.4 (c 0.19, CDCl₃)

IR (CHCl₃) 3580, 3012, 2938, 2856, 2796, 1612, 1513, 1464, 1247, 1036 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): trans **10b'** 7.07 (d, 2 H, *J* = 8.4 Hz), 6.82 (d, 2 H, *J* = 8.4 Hz), 4.04 (m, 1 H), 3.79 (s, 3 H), 3.11 (dd, 1 H, *J* = 13.2, 4.1 Hz), 2.54-2.70 (m, 3 H), 2.45 (s, 3 H), 2.35 (dd, 1 H, *J* = 13.1, 9.9 Hz), 1.87 (m, 1 H), 1.66 (m, 1 H), 1.50 (m, 2 H);

cis **10b''** 7.07 (d, 2 H, *J* = 8.4 Hz), 6.82 (d, 2 H, *J* = 8.4 Hz), 3.79 (s, 3 H), 3.48 (m, 1 H), 3.13 (dd, 1 H, *J* = 13.2, 4.3 Hz), 2.93 (t of d, 1 H, *J*^d = 12.1 Hz, *J*^t = 3.3 Hz), 2.40 (s, 3 H), 2.35 (dd, 1 H, *J* = 13.1, 9.9 Hz), 2.16 (d of t, 1 H, *J*^t = 12.4 Hz, *J*^d = 2.3 Hz), 2.06 (m, 1 H), 1.89 (m, 1 H), 1.74 (m, 1 H), 1.64 (d of t, 1 H, *J*^t = 12.6 Hz, *J*^d = 4.0 Hz), 1.34 (dd, 1 H, *J* = 22.9, 11.2 Hz).

DATA SHEET- Yue-Mei Zhang

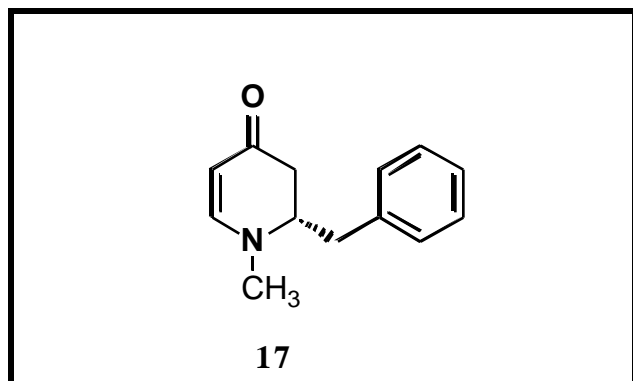
Compound: (2R)-1-Methyl-benzyl-2,3-dihydro-4-pyridone

Compound No.: (17)

Formula: C₁₃H₁₅NO

Notebook Pg(s): YZ-II, 047-y

Molecular Weight: 201



Yield(s): 99%

Other:

Appearance: oil

Stability: avoid acid

[α]_D²³ -185.8 (c 0.605, CHCl₃);

IR (CHCl₃) 3434, 3022, 2912, 1632, 1587, 1481, 1454, 1423, 1376, 1342, 1241, 1185, 1082, 1032, 752, 702 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): ¹H NMR (CDCl₃, 300 MHz) 7.16-7.34 (m, 5 H), 6.91 (d, 1 H, *J* = 7.3 Hz), 4.96 (d, 1 H, *J* = 7.3 Hz), 3.58 (m, 1 H), 3.07 (dd, 1 H, *J* = 13.3, 6.1 Hz), 2.93 (s, 3 H), 2.84 (dd, 1 H, *J* = 13.2, 8.8 Hz), 2.69 (dd, 1 H, *J* = 16.4, 6.8 Hz), 2.24 (dd, 1 H, *J* = 16.4, 1.4 Hz).

(¹³C, 75 MHz): 188.8, 152.1, 136.3, 128.6, 127.7, 125.8, 95.7, 59.3, 40.8, 37.7, 32.9.

DATA SHEET- Yue-Mei Zhang

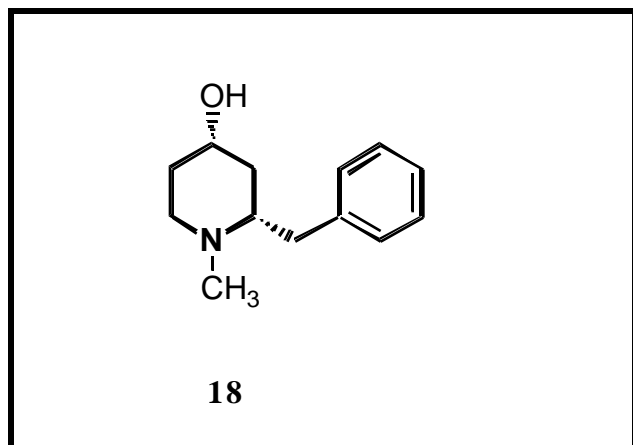
Compound: (2*S*,4*S*)-2-Benzyl-1-methyl-4-piperidinol

Compound No.: (18)

Formula: C₁₃H₁₉NO

Notebook Pg(s): YZ-II, 050-w

Molecular Weight: 205



Yield(s): 75%

Other:

Appearance: white solid

Stability: avoid acid

mp: 118-120 °C

[α]_D²³ +55.2 (*c* 1.28, CHCl₃).

IR (CHCl₃): 3419, 2927, 2854, 2790, 1602, 1492, 1460, 1447, 1389, 1265, 1068, 1005 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): 3.46 (m, 1 H), 3.19 (dd, 1 H, *J* = 13.0, 4.0 Hz), 2.91 (t of d, 1 H, *J*^d = 12.1, *J*^t = 3.5 Hz), 2.40 (s, 3 H), 2.36-2.43 (m, 1 H), 2.22 (m, 1 H), 2.14 (m, 1 H), 1.84 (m, 1 H), 1.70 (m, 1 H), 1.56 (ddd, 1 H, *J* = 24.2, 12.3, 3.6 Hz), 1.13 (dd, 1 H, *J* = 23.3, 11.2 Hz).

(¹³C, 75 MHz): 139.1, 129.4, 128.3, 126.1, 69.0, 63.6, 55.4, 42.3, 40.4, 39.7, 34.7.

DATA SHEET- Yue-Mei Zhang

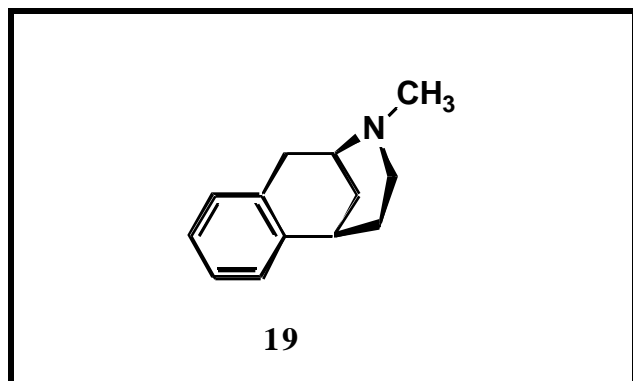
Compound: 2-Methyl-6,7-benzomorphan

Compound No.: (19)

Formula: C₁₃H₁₇N

Notebook Pg(s): YZ-II, 049-y

Molecular Weight: 187



Yield(s): 51%

Other:

Appearance: oil

Stability: avoid acid

[α]_D²³ +116 (*c* 0.1, CHCl₃);

IR (CHCl₃) 2926, 2852, 2803, 1149, 1264, 1139 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): 7.08 (s, 4 H), 3.20 (m, 1 H), 3.13 (d, 1 H, *J* = 18.6 Hz), 3.02 (m, 1 H), 2.69 (dd, 1 H, *J* = 18.5, 5.8 Hz), 2.48 (m, 1 H), 2.42 (s, 3 H), 2.06-2.18 (m, 3 H), 1.90 (m, 1 H), 1.51 (m, 1 H).

(¹³C, 75 MHz): 140.6, 137.3, 128.2, 127.7, 125.9, 125.7, 53.4, 46.0, 43.2, 33.1, 32.2, 31.7, 26.3.

DATA SHEET- Yue-Mei Zhang

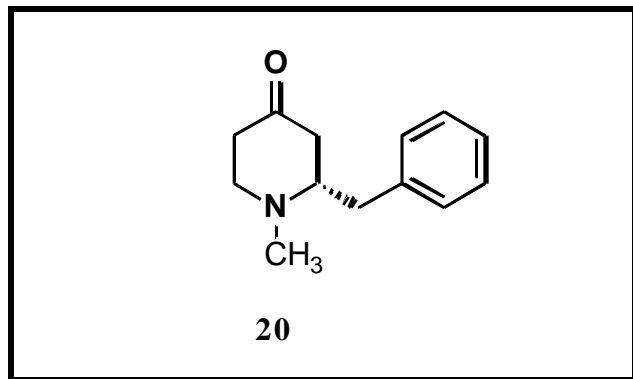
Compound: (2*S*)-Benzyl-1-methyl-4-piperidone

Compound No.: (20)

Formula: C₁₃H₁₇NO

Notebook Pg(s): YZ-II, 050-y

Molecular Weight: 203



Yield(s): 87%

Other:

Appearance: oil

Stability: avoid acid

[α]_D²³ (c 0.2, CHCl₃): +54

IR (CHCl₃): 2949, 2859, 2801, 1715, 1605, 1495, 1467, 1451, 1420, 1373, 1353, 1274, 1133, 1117 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): 7.13-7.31 (m, 5 H), 3.07-3.18 (m, 2 H), 2.81 (m, 1 H), 2.69 (m, 1 H), 2.56 (s, 3 H), 2.46-2.58 (m, 2 H), 2.40 (m, 1 H), 2.23 (m, 2 H).

(¹³C, 75 MHz): 208.8, 138.0, 129.2, 128.4, 126.3, 64.2, 53.4, 44.4, 41.3, 40.4, 38.2.

DATA SHEET- Yue-Mei Zhang

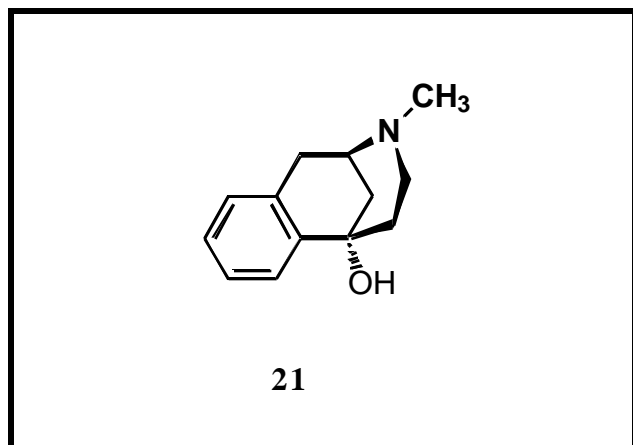
Compound: 5-Hydroxy-2-methyl-6,7-benzomorphan

Compound No.: (21)

Formula: C₁₃H₁₇NO

Notebook Pg(s): YZ-II, 048-y

Molecular Weight: 203



Yield(s): 88%

Other:

Appearance: white solids

Stability: avoid acid

mp: 185-187 °C

[α]_D²³ +24.6 (c 0.39, CHCl₃)

IR (CHCl₃) 3067, 3008, 2924, 2849, 2807, 1601, 1484, 1451, 1334, 1279, 1082, 1058 cm⁻¹.

NMR (CDCl₃):

(¹H, 300 MHz): 7.60 (d, 1 H, *J* = 7.0 Hz), 7.09-7.26 (m, 3 H), 3.32 (m, 1 H), 3.09 (d, 1 H, *J* = 18.4 Hz), 2.74 (dd, 1 H, *J* = 18.3, 5.8 Hz), 2.62 (m, 1 H), 2.41 (s, 3 H), 1.96-2.15 (m, 5 H), 1.58 (m, 1 H).

(¹³C, 75 MHz): 142.9, 136.3, 127.2, 126.8, 126.2, 123.7, 69.6, 55.4, 48.4, 42.2, 40.7, 40.3, 27.1.

Table 1. Data comparison of 6,7-benzomorphan (**4a**)Literature* : Génisson, Y.; Marazano, C.; Das B. C. *J. Org. Chem.* **1993**, 58, 2052

literature ¹ H NMR (200 MHz, CDCl ₃)	Synthetic ¹ H NMR (300 MHz, CDCl ₃)	literature ¹³ C NMR (50.2MHz, CDCl ₃)	Synthetic ¹³ C NMR (75 MHz)
7.03-7.28 (m, 4 H)	7.06-7.26 (m, 4 H)	140.9, 135.2,	141.8, 136.6,
3.03 (d, 1 H, <i>J</i> = 18 Hz)	3.03 (d, 1 H, <i>J</i> = 18.6 Hz)	127.3, 126.6,	127.2, 126.1,
2.84-2.91 (m, 1 H)	2.85-2.88 (m, 1 H)	126.0, 125.7,	125.6, 125.4,
2.69 (dd, 1 H, <i>J</i> = 18, 6 Hz)	2.69 (dd, 1 H, <i>J</i> = 18.4, 5.8 Hz)	60.0, 47.6,	59.3, 47.4,
2.35-2.57 (m, 1 H)	2.35-2.47 (m, 1 H)	42.2, 41.4,	42.7, 42.4,
2.40 (s, 3 H)	2.40 (s, 3 H)	41.1, 35.5,	42.1, 35.8,
1.76-2.15 (m, 3 H)	2.05 (d of t, 1 H, <i>J</i> ^t = 12.4 Hz, <i>J</i> ^d = 3.0 Hz)	25.1, 23.7,	25.4, 23.4,
	1.88 (m, 1 H)	13.9	14.1
	1.82 (dd, 1 H, <i>J</i> = 12.6, 4.6 Hz)		
1.28-1.41 (m, 1 H)	1.26-1.39 (m, 1 H)		
1.37 (s, 3 H)	1.37 (s, 3 H)		
0.86 (td, 3 H, <i>J</i> = 7 Hz)	0.85 (d, 3 H, <i>J</i> = 7.0 Hz)		

Literature* [α]_D + 63° (c 0.6, CHCl₃); our synthetic **4a**: [α]_D²² +62.0° (c 0.81, CHCl₃)

Table 2. Data comparison of (+)-metazocine (**4b**)

Literature* : Meyers, A. I.; Dickman, D. A.; Bailey, T. R. *J. Am. Chem. Soc.* **1985**, *107*, 7974

literature ¹ H NMR (CDCl ₃)	Synthetic ¹ H NMR (300 MHz, CDCl ₃)	literature ¹³ C NMR (CDCl ₃)	Synthetic ¹³ C NMR (75 MHz)
6.94 (d, 1 H, <i>J</i> = 8.2 Hz)	6.94 (d, 1 H, <i>J</i> = 8.2 Hz)	NA	155.3, 142.8,
6.69 (d, 1 H, <i>J</i> = 2.5 Hz)	6.71 (d, 1 H, <i>J</i> = 2.4 Hz)		128.1, 127.0,
6.59 (dd, 1 H, <i>J</i> = 8.2, 2.5 Hz)	6.60 (dd, 1 H, <i>J</i> = 8.2, 2.4 Hz)		113.4, 112.6,
2.97 (d, 1 H, <i>J</i> = 18.6 Hz)	2.95 (d, 1 H, <i>J</i> = 18.2 Hz)		59.4, 47.4,
2.91 (m, 1 H)	2.86 (m, 1 H)		42.3, 41.6,
2.68 (dd, 1 H, <i>J</i> = 18.2, 5.5 Hz)	2.62 (dd, 1 H, <i>J</i> = 18.3, 5.8 Hz)		41.0, 35.7,
2.50 (m, 1 H)	2.46 (m, 1 H)		25.3, 22.7,
2.41 (s, 3 H)	2.40 (s, 3 H)		14.1
2.17 (d of t, 1 H, <i>J</i> = 12.2, 3.0 Hz)	2.10 (d of t, 1 H, <i>J</i> ^t = 12.2 Hz, <i>J</i> ^d = 2.8 Hz)		
1.90 (m, 3 H)	1.89 (m, 1 H)		
	1.81 (dd, 1 H, <i>J</i> = 12.7, 4.6 Hz)		
	1.39-1.31 (m, 1 H)		
1.31 (s, 3 H)	1.33 (s, 3 H)		
0.852 (d, 1 H, <i>J</i> = 7.0 Hz)	0.85 (d, 1 H, <i>J</i> = 7.0 Hz)		

Literature* [α]_D²⁵ + 81.8° (c 0.83, EtOH); synthetic **4b**: [α]_D²⁵ + 82.6° (c 0.91, EtOH)

Table 3.**Comparison Table of Spectral Data of
2-Methyl-6,7-benzomorphan (19)**Literature* : Stella, L.; Raynier, B.; Surzur, J. M. *Tetrahedron* **1981**, 37, 2843

literature ¹ H NMR (CDCl ₃)	Synthetic ¹ H NMR (300 MHz, CDCl ₃)	literature ¹³ C NMR (75 MHz, CDCl ₃)	Synthetic ¹³ C NMR (75 MHz)
7.08 (s, 4 H)	7.08 (s, 4 H)	NA	140.6, 137.3,
2.90-3.30 (m, 3 H)	3.20 (m, 1 H) 3.13 (d, 1 H, <i>J</i> = 18.6 Hz) 3.02 (m, 1 H)		128.2, 127.7, 125.9, 125.7,
2.72 (d, 1 H)	2.69 (dd, 1 H, <i>J</i> = 18.5, 5.8 Hz)		53.4, 46.0, 43.2, 33.1,
2.37 (s, 3 H)	2.42 (s, 3 H)		32.2, 31.7,
1.4-2.6 (m, 6 H)	2.48 (m, 1 H) 2.06-2.18 (m, 3 H) 1.90 (m, 1 H) 1.51 (m, 1 H)		26.3

Table 4.**Comparison Table of 5-Hydroxy-2-methyl-6,7-benzomorphan (21)**Literature: Mikio Takeda: Everette L. May *J. Med. Chem.* **1970**, *13*, 1223

Lit. ¹ H NMR (60 Hz, DMSO) (racemic)	Synthetic ¹ H NMR (300 Hz, CDCl ₃) (enantiomeric)	Lit. ¹³ C NMR	Synthetic ¹³ C NMR (60 Hz) (enantiomeric)
2.28 (s, 3 H)	1.96-2.15 (m, 5 H) 2.41 (s, 3 H) 2.62 (m, 1 H) 2.74 (dd, 1 H, <i>J</i> = 18.3, 5.8 Hz)	NA	142.9, 136.3, 127.2, 126.8, 126.2, 123.7,
3.23 (s, 1 H)	3.09 (d, 1 H, <i>J</i> = 18.4 Hz) 3.32 (m, 1 H)		69.6, 55.4, 48.4, 42.2, 40.7, 40.3,
7.0-7.6 (m, 4 H)	7.09-7.26 (m, 3 H) 7.60 (d, 1 H, <i>J</i> = 7.0 Hz)		27.1

[α]_D²³ +24.6 (*c* 0.39, CHCl₃)IR 3067, 3008, 2924, 2849, 2807, 1601, 1484, 1451, 1334, 1279, 1082, 1058 cm⁻¹