Use of a Chiral Praseodymium Shift Reagent in Predicting the Complete Stereostructure of Glisoprenin A

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Preparation of Chiral Shift Reagents

See Supporting Information of preceding Letter.

Preparation of NMR Sample and Recovery of Natural Product

For the case of glisoprenin A (**1**) both (*R*)- and (*S*)-Pr(tfc)₃ (**3**) were dried at 100 °C under high vacuum for 36 h prior to use. Samples were prepared at a concentration of 0.02 M in a mixture of CD₂Cl₂:C₆D₆ (v/v 1:4) containing 20 mol% per OH of chiral shift reagent (CSR). The sample prepared was transferred to an NMR tube (that had previously been oven-/vacuum-dried and flushed with argon) via syringe and the tube sealed with teflon tape. Following acquisition, the natural product was recovered by filtration, first through a pipet column of silica gel (4 cm tall) and then through a pipet column of basic alumina (4 cm tall). For both steps a solvent gradient was employed (CH₂Cl₂ → 2.5% MeOH in CH₂Cl₂ → 5% MeOH in CH₂Cl₂).

Data Acquisition Parameters

¹H-NMR: A Varian Inova 500 spectrometer (500 MHz) was used to collect data. The recycle/relaxation delay (d1) was adjusted to 0.1 s and the experiment was acquired with 16 transients (nt=16). The readout of NMR spectra was adjusted to 0.001 ppm/point (sw = 15000, fn = 524288).

¹³C-NMR: A Varian Inova 500 spectrometer (500 MHz) was used to collect data. The recycle delay (d1) was adjusted to 0.0 s and the experiment was acquired with 30,000 transients (nt=30,000). The readout of NMR spectra was adjusted to 0.001 ppm/point (sw = 29996, fn = 524288).

¹H-¹H COSY for S-3: A Varian Inova 500 spectrometer (500 MHz) was used to collect data. The recycle delay (d1) was set to 0.2 s and the experiment was acquired with 256 increments (ni=256) with 148 scans (nt =148) per increment. The ¹H spectral window was adjusted to 5595 Hz

(sw=sw1=5595 Hz) with 2048 data points (np=2048) and zero-filled to 4096 (fn=4096). F_1 was linearly predicted to 512 and zero filled to 4096 (fn1=4096). Both F_1 and F_2 were processed with sine-bell apodization (sb=0.07, sb1=0.019).

^1H - ^1H COSY for R-3: A Varian Inova 500 spectrometer (500 MHz) was used to collect data. The recycle delay (d1) was adjusted to 0.21 s and the experiment was acquired with 256 increments (ni=256) with 148 scans (nt =148) per increment. The ^1H spectral window was adjusted to 5803 Hz (sw=sw1=5803 Hz) with 2048 data points (np=2048) and zero-filled to 4096 (fn=4096). F_1 was linearly predicted to 512 and zero filled to 4096 (fn1=4096). Both F_1 and F_2 were processed with sine-bell apodization (sb=0.07, sb1=0.019).

^{13}C - ^1H HSQC for S-3: A Varian Inova 500 spectrometer (500 MHz) was used to collect data. The recycle delay (d1) was adjusted to 0.3 s and the experiment was acquired with 512 increments (ni=512) with 120 scans (nt =120) per increment. The INEPT transfer delay was shortened to 1.7 ms (j1xh = 145 Hz), and both sspul and nullflg were set to 'n'. In the case of using the multiplicity-edited HSQC pulse sequence, the term 'mult' should be changed to 0. The ^1H spectral window was adjusted to 5595 Hz (sw=5595 Hz) with 2048 data points (np=2048) and zero-filled to 2048 (fn=2048). The ^{13}C spectral window was adjusted to 5278 Hz (sw1=5278 Hz) with 2×512 increments linearly predicted to 2048 and zero-filled to 8192 (fn1=8192). Both F_1 and F_2 were processed with Gaussian apodization (gf=0.03, gf1=0.1).

^{13}C - ^1H HSQC for R-3: A Varian Inova 500 spectrometer (500 MHz) was used to collect data. The recycle delay (d1) was adjusted to 0.23 s and the experiment was acquired with 512 increments (ni=512) with 128 scans (nt =120) per increment. The INEPT transfer delay was shortened to 1.7 ms (j1xh = 145 Hz), and both sspul and nullflg were set to 'n'. In the case of using the multiplicity-edited HSQC pulse sequence, the term 'mult' should be changed to 0. The ^1H spectral window was adjusted to 5803 Hz (sw=5803 Hz) with 2048 data points (np=2048) and zero-filled to 2048 (fn=2048). The ^{13}C spectral window was adjusted to 5529 Hz (sw1=5529 Hz) with 2×512 increments linearly predicted to 2048 and zero-filled to 8192 (fn1=8192). Both F_1 and F_2 were processed with Gaussian apodization (gf=0.03, gf1=0.08).

HSQMBC: A Varian Inova 500 spectrometer (500 MHz) was used to collect data. The HSQC pulse sequence was employed with the following changes. The recycle delay (d1) was set to 0.35 s and the experiment was acquired with 128 increments (ni=128) with 192 scans (nt =120) per increment. The INEPT transfer delay was changed to 22.7 ms (j1xh = 11 Hz), and both sspul and nullflg were set to 'n'. In the case of using the multiplicity-edited HSQC pulse sequence, the term 'mult' should be changed to 0. The ^1H spectral window was adjusted to 5997 Hz (sw=5997 Hz) with 2048 data points (np=2048) and zero-filled to 2048 (fn=2048). The ^{13}C spectral window was adjusted to 1257 Hz (sw1=1257 Hz) with 2×128 increments linearly predicted to 1024 and zero-filled to 8192 (fn1=8192). Both F_1 and F_2 were processed with Gaussian apodization (gf=0.03, gf1=0.07).

Selected NMR Spectra

¹H-NMR Spectrum of **1** (500 MHz, in CD₃OD)

STANDARD PROTON PARAMETERS

Data Collected on:
nmrSun2-inova500
Archive directory:
/export/home/ds2/vnmrSYS/data
Sample directory:

File: IG-glisopreninA-natural-H1-MeOH-Sept13

Pulse Sequence: s2pu1

Solvent: CD3OD

Temp. 23.0 C / 296.1 K

Relax. delay 0.200 sec

Pulse 52.8 degrees

Acq. time 2.048 sec

Width 8000.0 Hz

64 repetitions

OBSERVE H1, 499.7488925 MHz

DATA PROCESSING

Line broadening 0.1 Hz

FT size 32768

Total time 2 min

¹³C-NMR Spectrum of **1** (100 MHz, in CD₃OD)

13C OBSERVE

Data Collected on:
nmrsun2-inova500
Archive directory:
/export/home/ds2/vnmrsys/data
Sample directory:
File: IG-glisprenin-A-natural-C13-MeOH-Sept12
Pulse Sequence: s2pul
Solvent: CD3OD
Temp. 22.0 C / 295.1 K
Pulse 36.5 degrees
Acq. time 1.311 sec
Width 25000.0 Hz
81499 repetitions
OBSERVE C13, 100.5861013 MHz
DECOUPLE H1, 400.0265406 MHz
Power 48 dB,
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 524288
Total time 36 hr, 39 min

^{13}C -NMR Spectrum of **1** (100 MHz, in CD_3OD)

¹³C-NMR Spectrum of **1** (125 MHz, in a 5:2 mixture of d₂₈-(*R,R*)-BMBA-*p*-Me: CDCl₃)

13C OBSERVE
Pulse Sequence: s2pul
Solvent: CDCl₃
Temp: 22.0 C / 295.1 K
File: 0426-13C
INOVIA-500 "nmrsun2"
Pulse 37.5 degrees
Acq. time 1.280 sec
Width 25000.0 Hz
24859 repetitions
OBSERVE C13, 100.5916883 MHz
DECOUPLE H1, 400.0464601 MHz
Power 46 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 65536
Total time 25 h, 3 min, 41 sec

^{13}C -NMR Spectrum of **1** (125 MHz, in a 5:2 mixture of $\text{d}_{28}\text{-(R,R)-BMBA-}p\text{-Me}$: CDCl_3)

¹³C-NMR Spectrum of **1** (100 MHz, in a 5:2 mixture of d₂₈-(S,S)-BMBA-*p*-Me: CDCl₃)

Pulse Sequence: s2pul
 Solvent: Acetone
 Temp: 22.0 C / 295.1 K
 Mercury-40088
 Pulse 37.5 degrees
 Acq. time 1.280 sec
 Width 25000.0 Hz
 29000 repetitions
 OBSERVE C13, 100.591688 MHz
 DECDUPLE H1, 400.0485364 MHz
 Power 46 dB
 continuously on
 WALTZ-16 modulated
 DATA PROCESSING
 Line broadening 1.0 Hz
 FT size 65536
 Total time 12 hr, 34 min, 18 sec

^{13}C -NMR Spectrum of **1** (100 MHz, in a 5:2 mixture of $\text{d}_{28}\text{-(S,S)}$ -BMBA-*p*-Me: CDCl_3)

¹H-NMR Spectrum of **1** (500 MHz, with 20 mol% per OH of (*R*)-Prtfc₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

STANDARD PROTON PARAMETERS

Data Collected on:
nmrsum2-inova500
Archive directory:
/expdrt/home/ds2/vnmrsys/data
Sample directory:

File: IG-II-160-H1-RPrtfc-Aug21

Pulse Sequence: s2pul

Solvent: Benzene

Temp. 23.0 C / 296.1 K

Relax. delay 0.100 sec

Pulse 88.5 degrees

Acq. time 2.048 sec

Width 15000.9 Hz

8 repetitions

OBSERVE H1, 499.7479461 MHz

DATA PROCESSING

Line broadening 0.1 Hz

FT size 65536

Total time 0 min

¹³C-NMR Spectrum of **1** (125 MHz, with 20 mol% per OH of (*R*)-Prtfc₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

STANDARD CARBON PARAMETERS

Data Collected on:
nmrsum2-inova500
Archive directory:
/export/home/ds2/vnmrsys/data
Sample directory:
File: IG-IP-159-C13-RPrtfc-Aug21
Pulse Sequence: s2pul
Solvent: Benzene
Temp. 23.0 C / 296.1 K
User: 1-14-97
Pulse 90.0 degrees
Acq. time 1.092 sec
Width 29966.3 Hz
24935 repetitions
OBSERVE C13 125.6616771 MHZ
DECOUPLE H1 499.7504551 MHZ
Power 34 dB
continuous on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 65536
Total time 30 hr, 35 min

STANDARD CARBON PARAMETERS

Data Collected on:
nmrsun2-inova500
Archive directory:
/export/home/ds2/vnmrsys/data
Sample directory:
File: IG-II-159-C13-RPrffc-Aug21
Pulse Sequence: s2pul
Solvent: Benzene
Temp. 23.0 C / 296.1 K
User: 1-14-87

Pulse 90.0 degrees
Acq. time 1.092 sec
Width 29996.3 Hz
24935 repetitions
OBSERVE C13, 125.6616771 MHz
DECOUPLE H1, 499.7504531 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Resol. enhancement 1.8 Hz
Gauss apodization 0.200 sec
FT size 65536
Total time 30 hr, 35 min

¹³C-NMR Spectrum of **1** (125 MHz, with 20 mol% per OH of (*R*)-Prffc₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

¹³C-H HSQC Spectrum of **1** (500 MHz, with 20 mol% per OH of (*R*)-PrTfc₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

STANDARD PROTON PARAMETERS

Data Collected on:
nmrsum2-inova500
Archive directory:
/export/home/ds2/vnmrsys/data
Sample directory:

File: IG-II-160-RPrTfc-HSQC-Aug22

Pulse Sequence: gHSQC

Solvent: Benzene

Temp. 23.0 C / 296.1 K

User: 1-14-87

Relax. delay 0.230 sec

Acq. time 0.176 sec

Width 5803.0 Hz

2D Width 5523.1 Hz

128 repetitions

2 x 512 increments

OBSERVE H1, 499.7479819 MHz

DECOUPLE C13, 125.6647089 MHz

Power 43 dB

on during acquisition

off during delay

GARP-1 modulated

DATA PROCESSING

Gauss apodization 0.030 sec

F1 DATA PROCESSING

Gauss apodization 0.080 sec

FT size 2048 x 8192

Total time 17 hr, 37 min

¹H-¹H COSY Spectrum of **1** (500 MHz, with 20 mol% per OH of (*R*)-Prffc₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

STANDARD PROTON PARAMETERS

Data Collected on:
nmrsum2-inova500
Archive directory:
/export/home/ds2/vnmrsys/data
Sample directory:

File: IG-II-160-COSY-RPrffc-Aug23

Pulse Sequence: gCOSY

Solvent: Benzene

Temp. 23.0 C / 296.1 K

Relax. delay 0.210 sec

Acq. time 0.176 sec

Width 5803.0 Hz

2D Width 5803.0 Hz

148 repetitions

256 increments

OBSERVE H1, 499.7479418 MHz

DATA PROCESSING

Sine bell 0.070 sec

F1 DATA PROCESSING

Sine bell 0.019 sec

FT size 4096 x 4096

Total time 4 hr, 20 min

¹H-¹H COSY Spectrum of **1** (500 MHz, with 20 mol% per OH of (*R*)-Prtfc₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

STANDARD PROTON PARAMETERS

Data Collected on:
nmrsun2-inova500
Archive directory:
/export/home/ds2/vnmrsys/data
Sample directory:
File: IG-II-160-COSY-RPrtfc-Aug23
Pulse Sequence: gCOSY
Solvent: Benzene
Temp. 23.0 C / 296.1 K
Relax. delay 0.210 sec
Acq. time 0.176 sec
Width 5803.0 Hz
2D Width 5803.0 Hz
148 repetitions
256 increments
OBSERVE H1 499.7479418 MHz
DATA PROCESSING
Sine bell 0.070 sec
F1 DATA PROCESSING
Sine bell 0.019 sec
FT size 4096 x 4096
Total time 4 hr, 20 min

¹H-NMR Spectrum of **1** (500 MHz, with 20 mol% per OH of (S)-Prtfc₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

STANDARD PROTON PARAMETERS

Data Collected on:
nmrSun2-inova500
Archive directory:
/export/home/ds2/vnmrsys/data
Sample directory:
File: IG-II-159-H1-SPrtfcAug16
Pulse Sequence: s2pu1
Solvent: Benzene
Temp. 23.0 C / 296.1 K
Relax. delay 0.100 sec
Pulse 86.9 degrees
Acq. time 2.048 sec
Width 15000.9 Hz
8 repetitions
OBSERVE H1, 499.7479499 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 524288
Total time 0 min

¹³C-NMR Spectrum of **1** (125MHz, with 20 mol% per OH of (S)-Prftfc₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

STANDARD CARBON PARAMETERS

Data Collected On:
nmrsun2-llnova500
Archive directory:
/export/llnme/ds2/vnmrsys/data
Sample directory:
File: IG-IT-159-C13-SPrtfc-Aug14
Pulse Sequence: s2pu1
Solvent: Benzene
Temp. 23.0 °C / 296.1 K
User: 1-114-87
Pulse 90.2 degrees
Acq. time 11.092 sec
Width 29996.3 Hz
21165 repetitions
OBSERVE C13, 125.6616780 MHz
DECOUPLE H1, 499.7504531 MHz
Power 34 dB
continuous W on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 524288
Total time 30 hr, 35 min

^{13}C -NMR Spectrum of **1** (125MHz, with 20 mol% per OH of (S)-Pttfc₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

HSQMCB Spectrum of **1** (500 MHz, with 20 mol% per OH of (S)-Prffc₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

STANDARD PROTON PARAMETERS

Data Collected on: nmrsun2-inova500
 Archive directory: /export/home/ds2/vnmrsys/data
 Sample directory: File: IG-II-glispreninA-HSQMBC20%SPrtfcu122
 Pulse Sequence: gHSQC
 Solvent: Benzene
 Temp. 23.0 C / 296.1 K
 User: 1-14-87
 Relax. delay 0.350 sec
 Acq. time 0.171 sec
 Width 5997.5 Hz
 2D Width 1256.6 Hz
 192 repetitions
 2 x 128 increments
 OBSERVE H1, 499.7480026 MHz
 DECOUPLE C13, 125.6668452 MHz
 Power 43 dB
 on during acquisition
 off during delay
 GARP-1 modulated
 DATA PROCESSING
 Gauss apodization 0.030 sec
 F1 DATA PROCESSING 0.070 sec
 Gauss apodization 0.070 sec
 FT size 2048 x 8192
 Total time 9 hr, 22 min

¹³C-H HSQC Spectrum of **1** (500 MHz, with 20 mol% per OH of (S)-Prffc₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

STANDARD PROTON PARAMETERS

Data Collected on:
nmrsun2-inova500
Archive directory:
/export/home/ds2/vnmrsys/data
Sample directory:
File: IG-II-159-HSQC-SPrtfc-Aug17
Pulse Sequence: gHSQC
Solvent: Benzene
Temp. 23.0 C / 296.1 K
User: 1-14-87
Relax. delay 0.300 sec
Acq. time 0.183 sec
Width 5594.8 Hz
2D Width 5277.7 Hz
120 repetitions
2 x 512 increments
OBSERVE H1, 499.7479913 MHz
DECOUPLE C13, 125.6645833 MHz
Power 43 db
on during acquisition
off during delay
GARP-1 modulated
DATA PROCESSING
Gauss apodization 0.030 sec
F1 DATA PROCESSING
Gauss apodization 0.100 sec
FT size 2048 x 8192
Total time 19 hr, 12 min

¹³C-H HSQC Spectrum of **1** (500 MHz, with 20 mol% per OH of (S)-Prffc₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

STANDARD PROTON PARAMETERS

Data Collected on:
nmrsun2-inova500
Archive directory:
/export/home/ds2/vnmrsvs/data
Sample directory:

File: IG-II-159-HSQC-SPrtfc-Aug17

Pulse Sequence: ghsqc

Solvent: Benzene

Temp. 23.0 C / 296.1 K

User: 1-14-87

Relax. delay 0.300 sec

Acq. time 0.183 sec

Width 5594.8 Hz

2D Width 5277.7 Hz

120 repetitions

2 x 512 increments

OBSERVE H1, 499.7479913 MHz

DECOUPLE C13, 125.6645833 MHz

Power 43 dB

on during acquisition

off during delay

GARP-1 modulated

DATA PROCESSING

Gauss apodization 0.030 sec

F1 DATA PROCESSING

Gauss apodization 0.100 sec

FT size 2048 X 8192

Total time 19 hr, 12 min

^1H - ^1H COSY Spectrum of **1** (500 MHz, with 20 mol% per OH of (S)-Prffc₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

STANDARD PROTON PARAMETERS

Data Collected on:
nmrsum2-inova500
Archive directory:
/export/home/ds2/vnmrSYS/data
Sample directory:

File: gcosy081804

Pulse Sequence: gCOSY

Solvent: Benzene

Temp. 23.0 C / 296.1 K

Relax. delay 0.200 sec
Acq. time 0.183 sec
Width 5594.8 Hz
2D Width 5594.8 Hz
148 repetitions
256 increments

OBSERVE H1, 499.7479563 MHz

DATA PROCESSING

Sine bell 0.070 sec

F1 DATA PROCESSING

Sine bell 0.019 sec

F1 size 4096 x 4096

Total time 4 hr, 19 min

^1H - ^1H COSY Spectrum of **1** (500 MHz, with 20 mol% per OH of (S)-Prtf₃ in a 1:4 mixture of CD₂Cl₂:C₆D₆)

STANDARD PROTON PARAMETERS

Data Collected on:
nmrsun2-inova500
Archive directory:
/export/home/ds2/vnmrSYS/data
Sample directory:

File: gcosy081804

Pulse Sequence: gCOSY
Solvent: Benzene

Temp. 23.0 C / 296.1 K

Relax. delay 0.200 sec

Acq. time 0.183 sec

Width 5594.8 Hz

2D Width 5594.8 Hz

148 repetitions

256 increments

OBSERVE H1 499.7479563 MHz

DATA PROCESSING

Sine bell 0.070 sec

F1 DATA PROCESSING

Sine bell 0.019 sec

FT size 4096 x 4096

Total time 4 hr, 19 min