Supplementary Material

Cellulose modified with BINAP support Rh as an efficient heterogeneous catalyst for asymmetric hydrogenation

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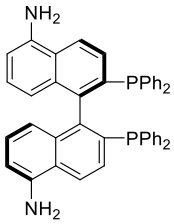
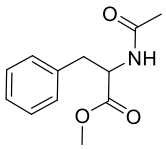
NMR spectra



R-5,5’-diamino Binap：

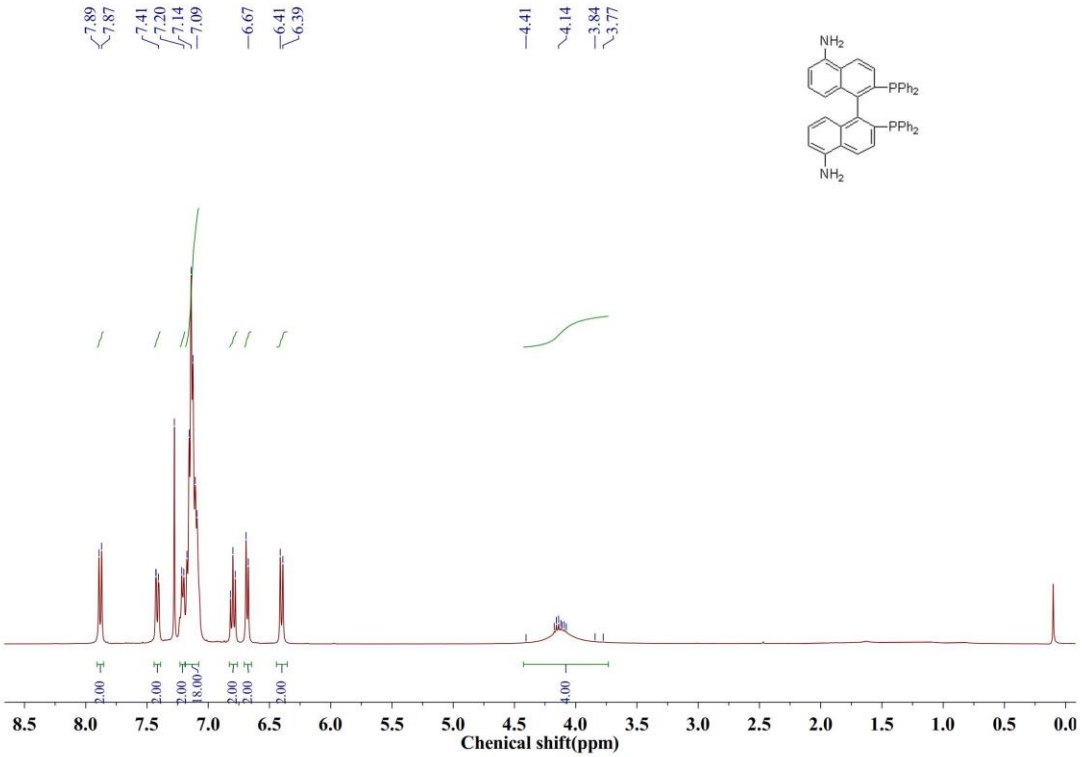
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, J = 8.7 Hz, 2H), 7.44 – 7.39 (m, 2H), 7.21 (d, J = 6.7 Hz, 2H), 7.13 (td, J = 13.6, 6.6 Hz, 18H), 6.80 (t, J = 7.9 Hz, 2H), 6.68 (d, J = 7.3 Hz, 2H), 6.40 (d, J = 8.4 Hz, 2H), 4.43 – 3.73 (m, 4H).



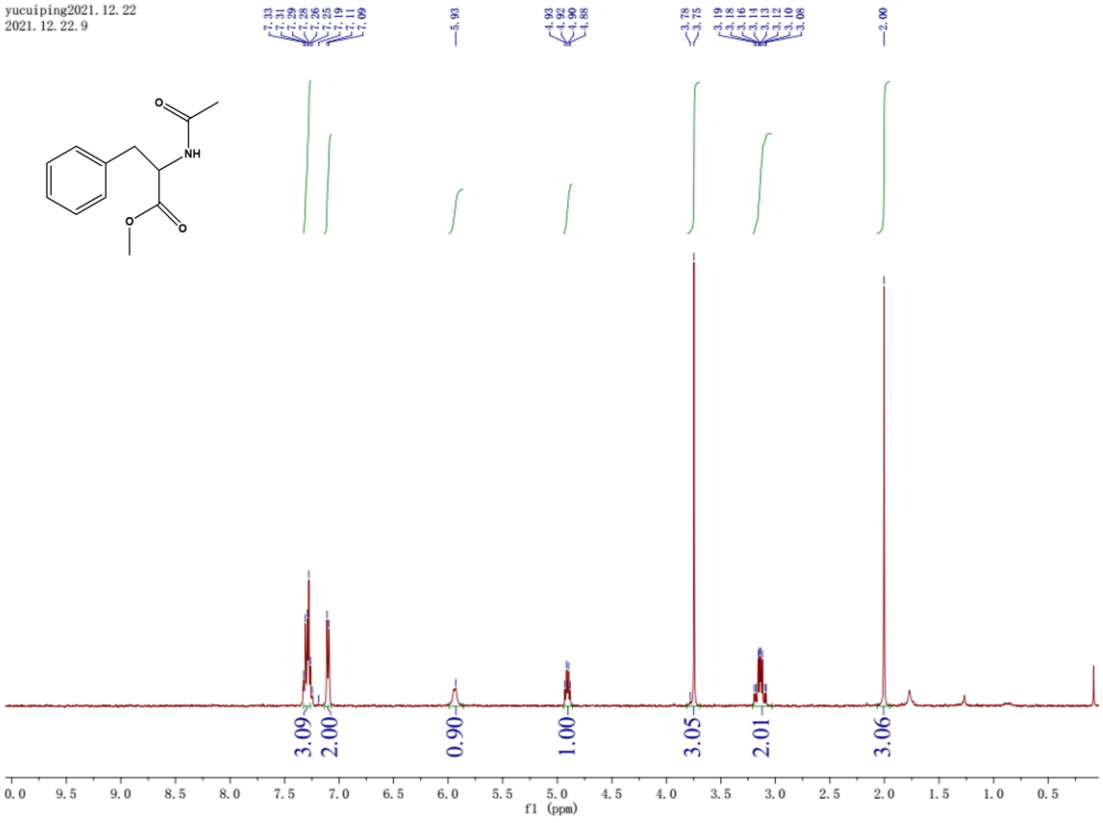
methyl acetylphenylalaninate：

1H NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.26 (m, 3H), 7.10 (d, J = 6.7 Hz, 2H), 5.93 (s, 1H), 4.91 (dd, J = 13.5, 5.8 Hz, 1H), 3.75 (s, 3H), 3.14 (qd, J = 13.9, 5.7 Hz, 2H), 2.00 (s, 3H).

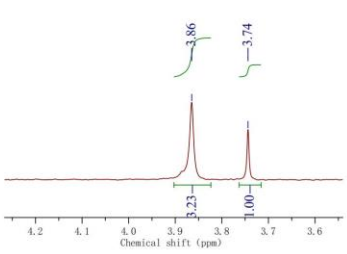
NMR spectra of *R*-5,5'-diamino Binap

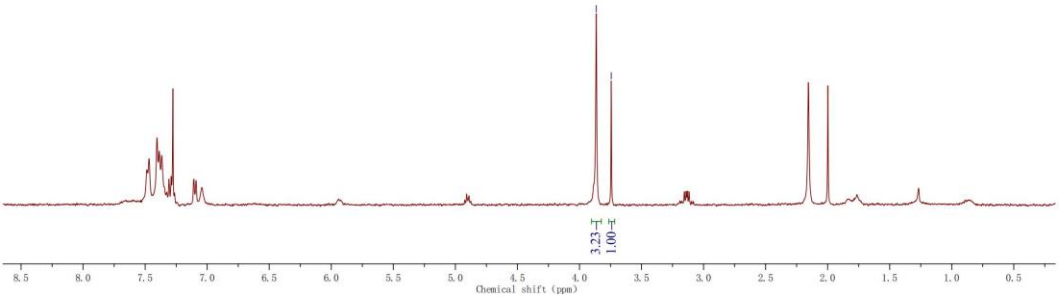


NMR spectra of methyl acetylphenylalaninate

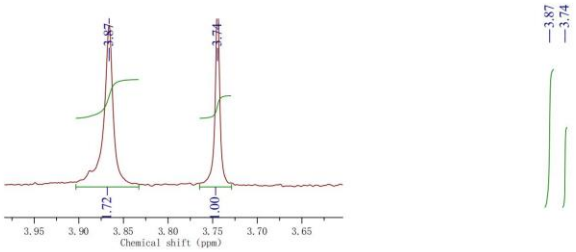


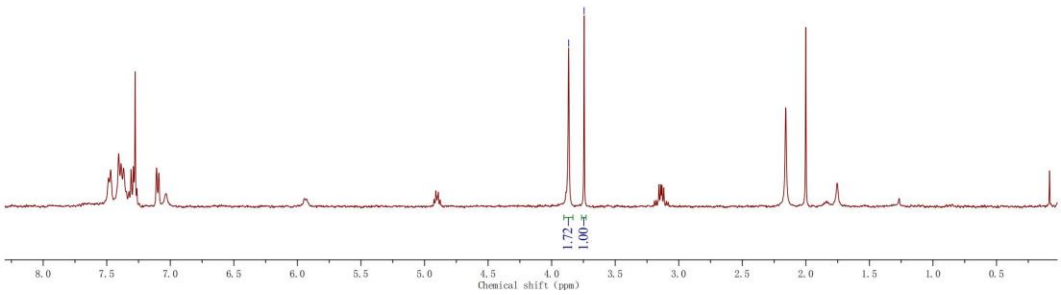
NMR spectra of 23% conversion



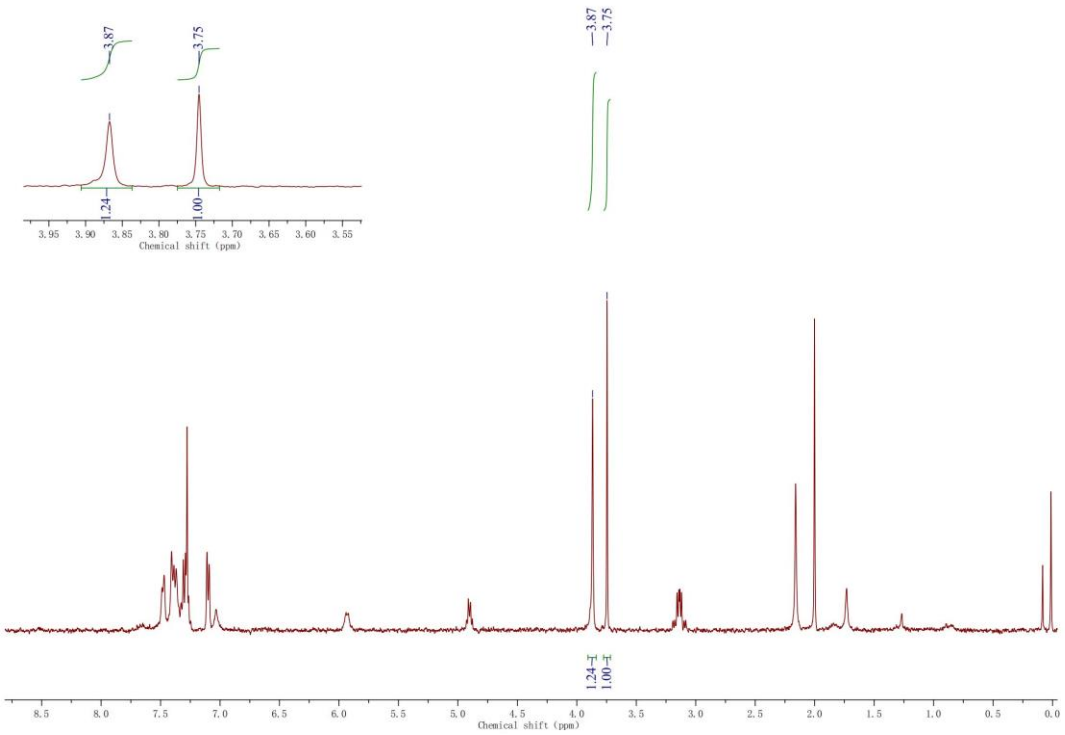


NMR spectra of 37% conversion

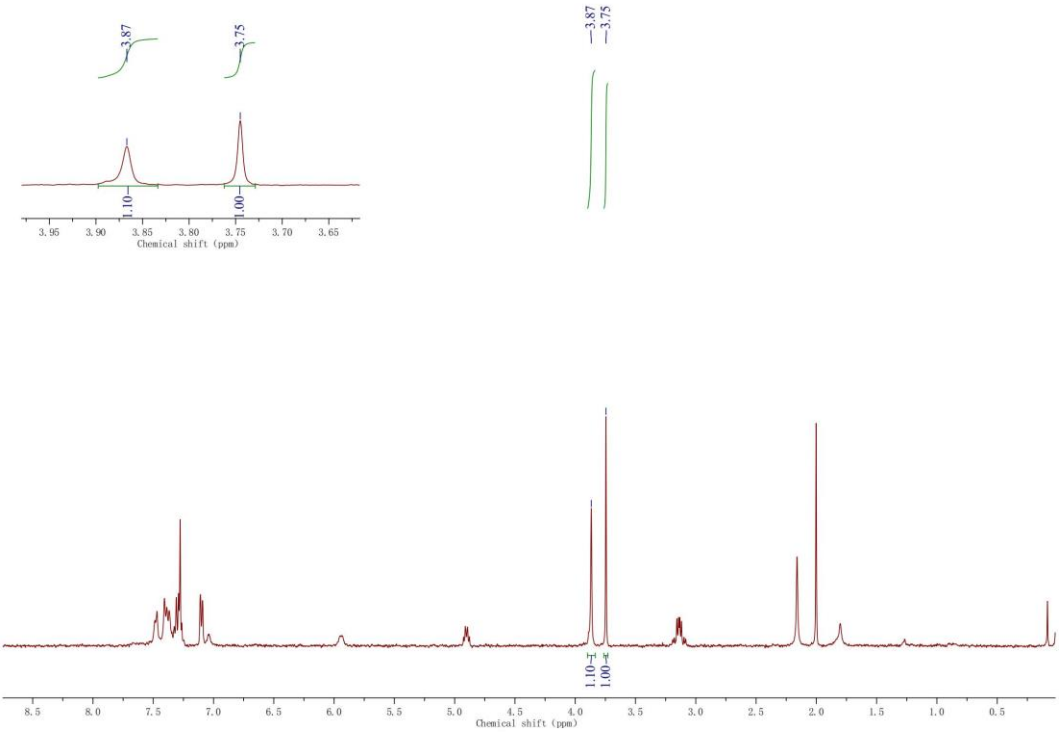




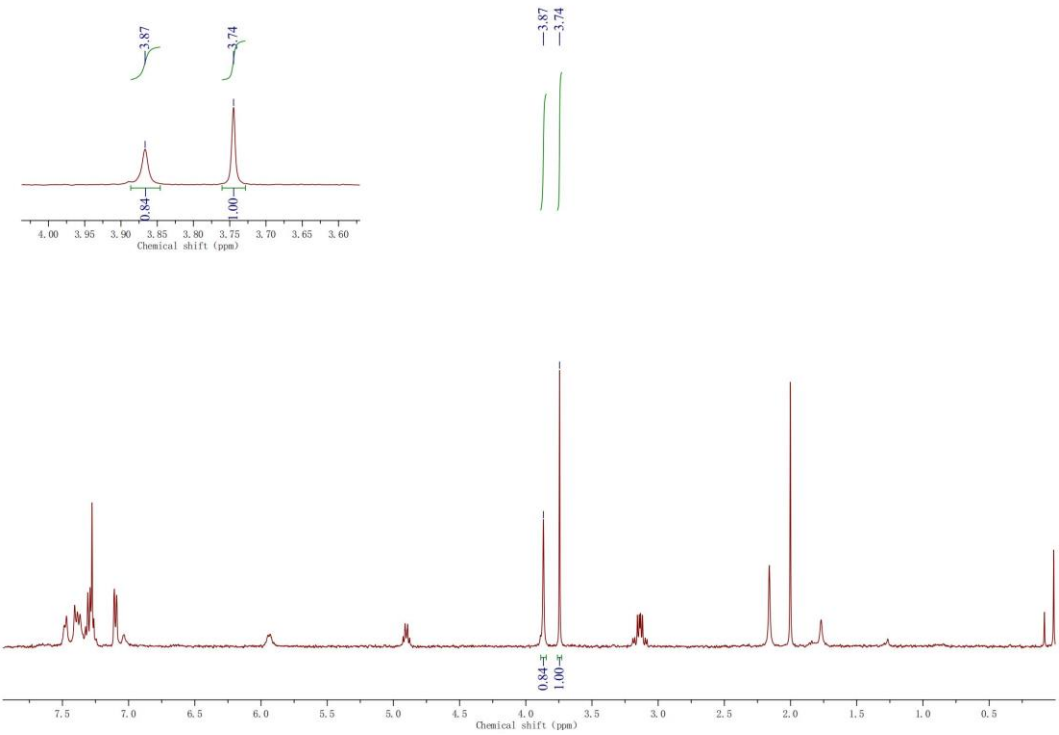
NMR spectra of 45% conversion



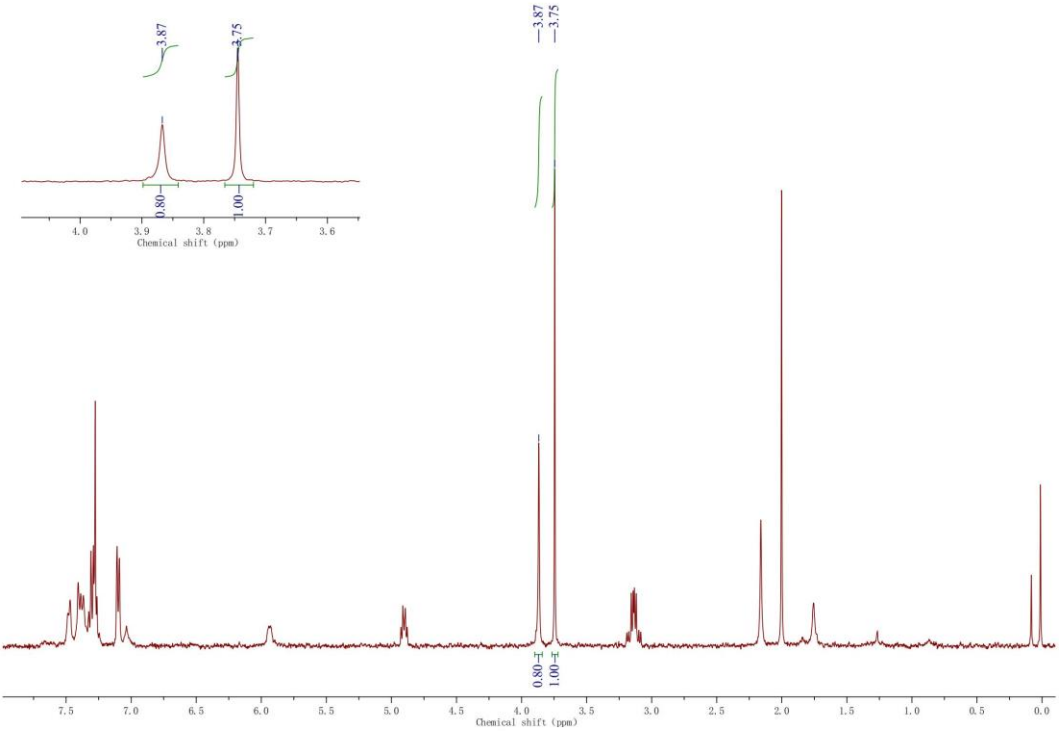
NMR spectra of 48% conversion



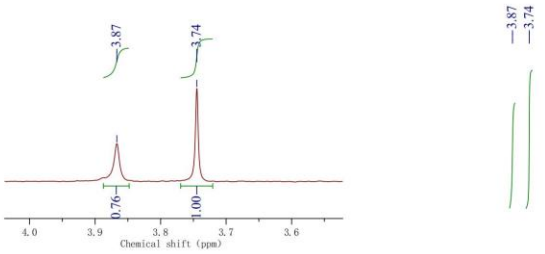
NMR spectra of 54% conversion

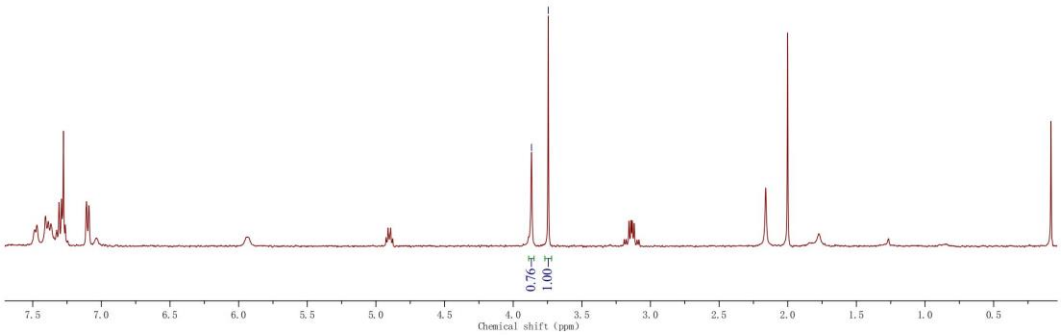


NMR spectra of 56% conversion

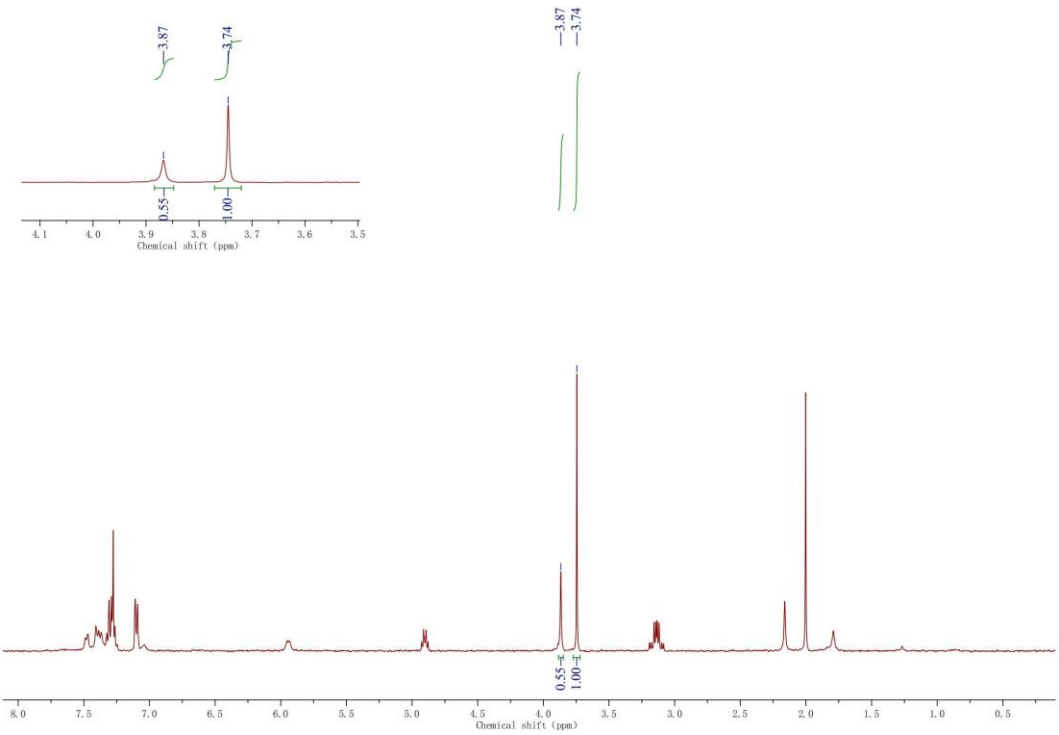


NMR spectra of 57% conversion





NMR spectra of 65% conversion

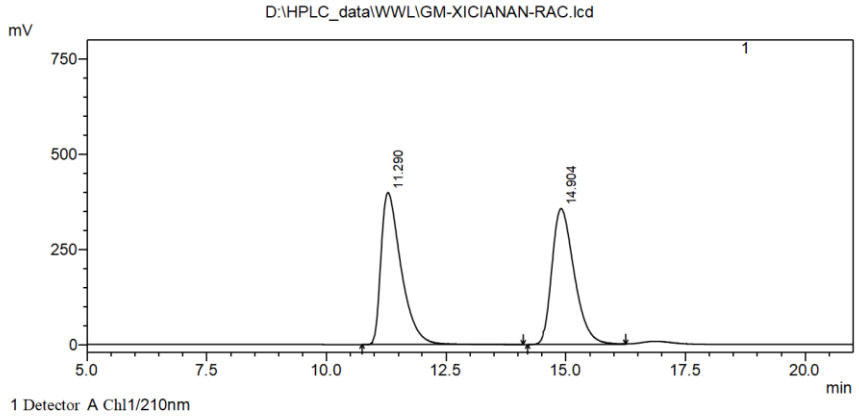


HPLC spectra of Table 1

Racemate

==== Shimadzu LCsolution analysis report **====**

Acq.Operator	: Admin
Acq.Instrument	: GM-XICIANAN-RAC
Acq.ID	:
Acq.	1
Seq.Line#	3
Inj Volume.	: 5 uL
Sample name	: GM-XICIANAN-RAC.lcd
Acq.Method.	: wwl-90-10-210-1-30min-OD.lcm
Data Collection	: 2021 3-30 16:13:41
. Data Processing	: 2021 3-30 16:43:44



Area Percent Report

Peak#	RetTime	Area	Area %
1	11.290	11681852	50.402
2	14.904	11495525	49.598
Totals		23177377	100.000

D:\HPLC_data\WWL\GM-XICIANAN-RAC.lcd

Table 1-entry1

Date File: d:\Chem32\1\Data\YCP 2021-12-26 11-09-58\001-1.D

Sample Name: 20211226YCP-1

```
Acq. Operator     : Admin
 Acq.             :   1
Instrument        :  1260
Entry date        : 2021/12/26 11:11:26
Inj               : 1
Inj Volume.       : 5.000 µl
Acq. Method.      : d:\Chem32\1\Data\YCP 2021-12-26 11-09-58\YCP.M
Analysis Method   : d:\Chem32\1\Data\YCP 2021-12-26 11-09-58\YCP.M
                    (Sequence Method)
Last Changed      : 2021/12/26 11:12:15 : AM by SYSTEM(modified
                    after loading)
Additional Info   : Peak(s) manually integrated
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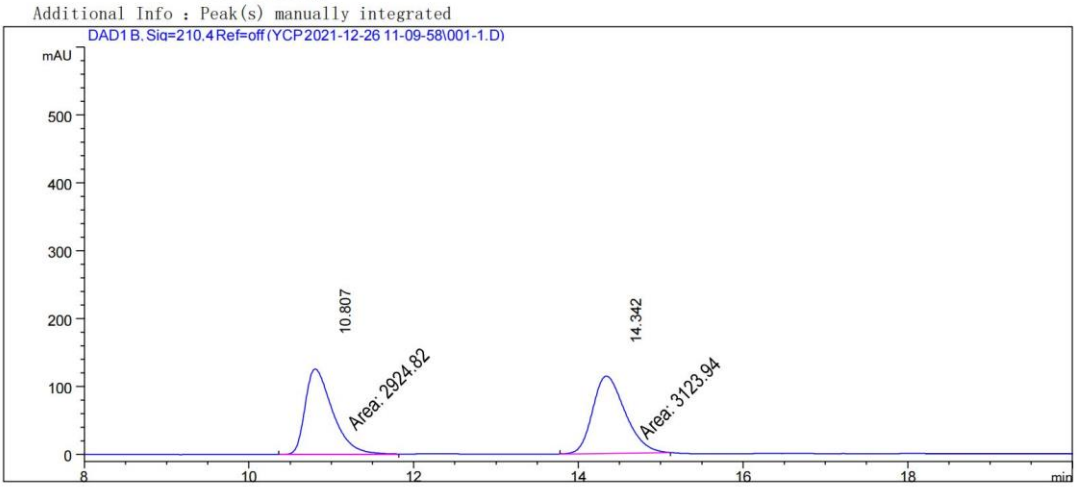


Area Percent Report

```
Sorted By             : Signal
Multiplier            :   1.0000
Dilution              :   1.0000
 DO not use Multiplier  & Dilution Factor with ISTDs
 signal 1: DAD1 B, Sig=210,4 Ref=off
```

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.807	MM	0.3871	2924.82104	125.93480	48.3541
2	14.342	MM	0.4572	3123.93994	113.88740	51.6459
Totals :				6048.76099	239.82220	

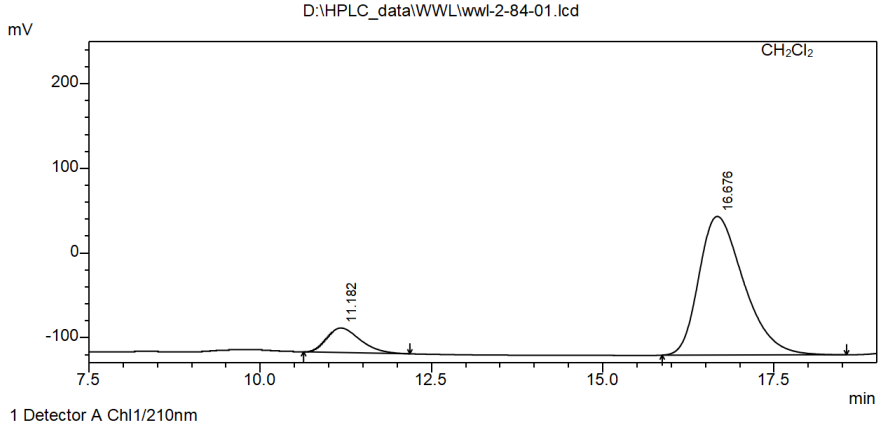
*** End of Report ***

Table 1-entry2

==== Shimadzu LCsolution analysis report **====**

Acq.Operator	: Admin
Acq.Instrument	: wwl-2-84-01
Acq.ID	:
Acq.	1
Seq.Line#	2
Inj Volume.	: 2 uL
Sample name	: wwl-2-84-01.lcd
Acq.Method.	: wwl-90-10-210-1-25min-OD.lcm
Data Collection	: 2021 9-5 14:39:46
Data Processing	: 2021 9-5 15:04:48

D:\HPLC_data\WWL\wwl-2-84-01.lcd



1 Detector A Chl1/210nm

Area Percent Report

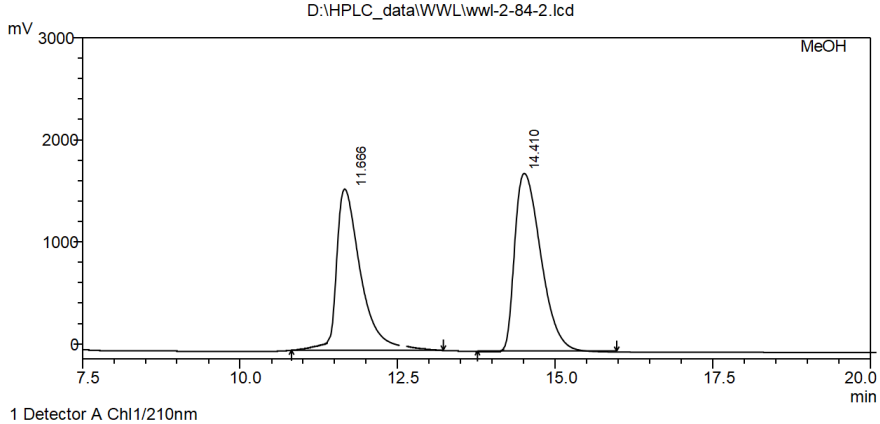
Peak#	RetTime	Area	Area %
1	11.182	987850	11.677
2	16.676	7471666	88.323
Totals		8459517	100.000

Table 1-entry3

==== Shimadzu LCsolution analysis report **====**

Acq.Operator	: Admin
Acq.Instrument	:wwl-2-84-2
Acq.ID	:
Acq.	1
Seq.Line#	3
Inj Volume.	: 5 uL
Sample name	: wwl-2-84-01.lcd
Acq.Method.	: wwl-90-10-210-1-25min-OD.lcm
Data Collection	: 2021 9-4 16:15:34
Data Processing	: 2021 9-9 16:19:42

D:\HPLC_data\WWL\wwl-2-84-2.lcd



1 Detector A Ch1/210nm

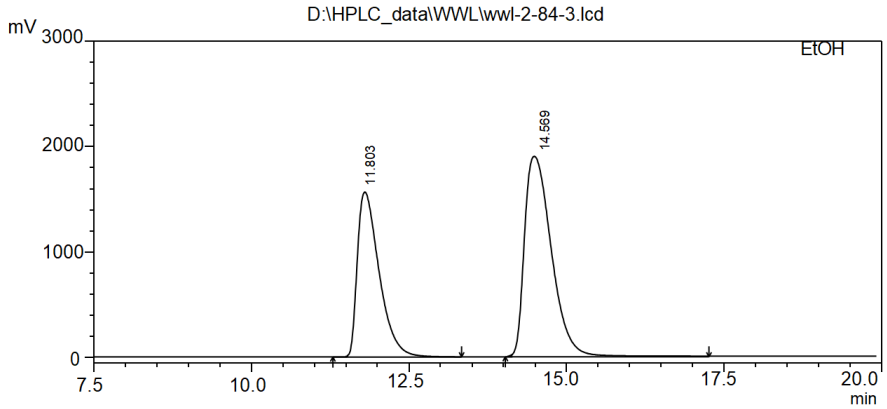
Area Percent Report

Peak#	RetTime	Area	Area%
1	11.666	42076576	45.347
2	14.410	50711834	54.653
Totals		92788411	100.000

Table 1-entry4

==== Shimadzu LCsolution analysis report **====**

Acq.Operator	: Admin
Acq.Instrument	:wwl-2-84-3
Acq.ID	:
Acq.	1
Seq.Line#	4
Inj Volume.	: 5 uL
Sample name	: wwl-2-84-3.lcd
Acq.Method.	: wwl-90-10-210-1-25min-OD.lcm
Data Collection	: 2021 9-4 16:40:59
. Data Processing	: 2021 9-4 17:06:02



1 Detector A Chl1/210nm

Area Percent Repc

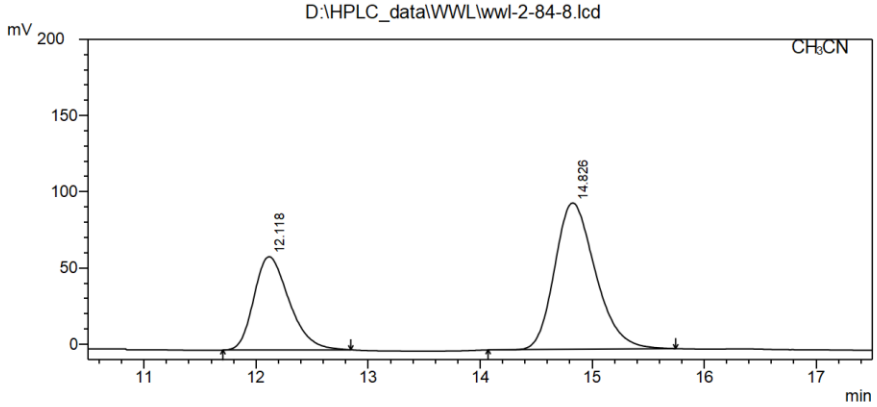
Peak#	RetTime	Area	Area%
1	11.803	37669700	40.336
2	14.569	55720684	59.664
Totals		93390384	100.000

Table 1-entry5

==== Shimadzu LCsolution analysis report ====

采集人	: Admin
样品名称	: wwl-2-84-8
样品 ID	:
样品架	1
样品瓶#	9
进样体积	: 2 uL
数据文件名	: wwl-2-84-8.lcd
方法文件名	: wwl-90-10-210-1-25min-OD-td.lcm
批处理文件名	: wwl-gm01-2-84.lcb
报告文件名	: Default.lcr
数据采集	: 2021 9-5 15:56:08
数据处理	: 2021 9-5 16:21:11
Acq.Operator	: Admin
Acq.Instrument	:wwl-2-84-8
Acq.ID	:
Acq.	1
Seq.Line#	9
Inj Volume.	: 5 uL
Sample name	: wwl-2-84-8.lcd
Acq.Method.	: wwl-90-10-210-1-25min-OD.lcm
Data Collection	: 2021 9-5 15:56:08
Data Processing	: 2021 9-5 16:21:11

D:\HPLC_data\WWL\wwl-2-84-8.lcd



1 Detector A Ch1/210nm

Area Percent Report

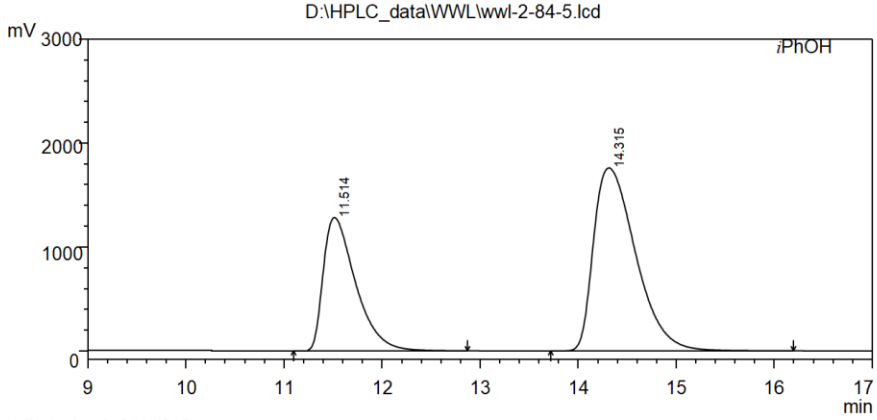
Peak#	RetTime	Area	Area%
1	12.118	1341924	35.560
2	14.826	2431734	64.440
Totals		3773658	100.000

Table 1-entry6

==== Shimadzu LCsolution analysis report **====**

Acq.Operator	: Admin
Acq.Instrument	:wwl-2-84-3
Acq.ID	:
Acq.	1
Seq.Line#	6
Inj Volume.	: 5 uL
Sample name	: wwl-2-84-5.lcd
Acq.Method.	: wwl-90-10-210-1-25min-OD.lcm
Data Collection	: 2021 9-4 17:31:55
.Data Processing	: 2021 9-4 17:56:58

D:\HPLC_data\WWL\wwl-2-84-5.lcd



1 Detector A Chl1/210nm

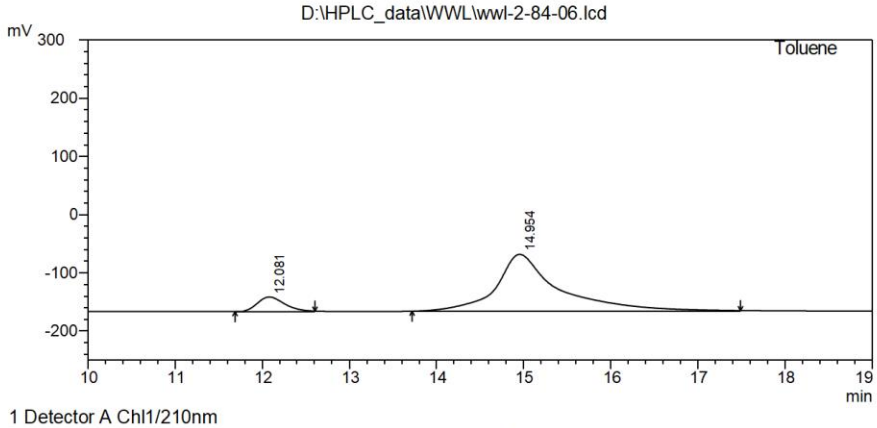
Area Percent Report

Peak#	RetTime	Area	Area%
1	11.514	29423776	35.859
2	14.315	52629883	64.141
Totals		82053659	100.000

Table 1-entry7

==== Shimadzu LCsolution analysis report **====**

Acq.Operator	: Admin
Acq.Instrument	:wwl-2-84-3
Acq.ID	:
Acq.	1
Seq.Line#	7
Inj Volume.	: 5 uL
Sample name	: wwl-2-84-06.lcd
Acq.Method.	: wwl-90-10-210-1-25min-OD.lcm
Data Collection	: 2021 9-5 15:05:12
.Data Processing	: 2021 9-5 15:30:17



1 Detector A Chl1/210nm

Area Percent Report

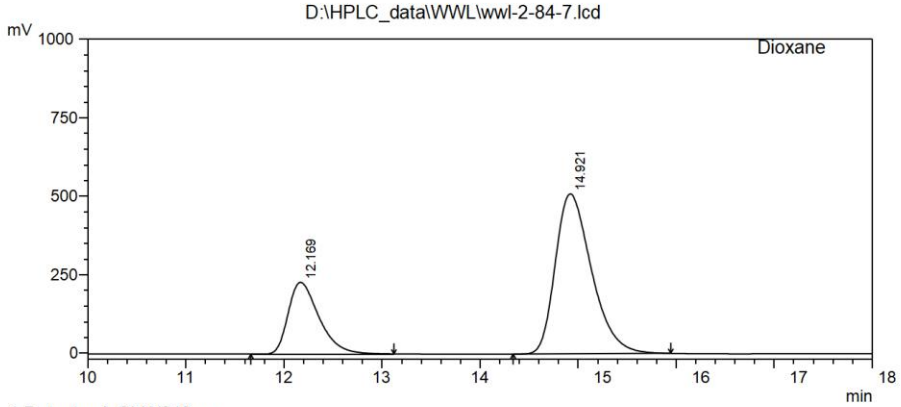
Peak#	RetTime	Area	Area%
1	12.081	528552	9.966
2	14.954	4775090	90.034
Totals		5303642	100.000

Table 1-entry8

==== Shimadzu LCsolution analysis report **====**

Acq.Operator : Admin
Acq.Instrument :wwl-2-84-7
Acq.ID :
Acq. 1
Seq.Line# 8
Inj Volume. : 5 uL
Sample name : wwl-2-84-7.lcd
Acq.Method. : wwl-90-10-210-1-25min-OD.lcm
Data Collection : 2021 9-5 15:30:42
Data Processing : 2021 9-5 15:55:44

D:\HPLC_data\WWL\wwl-2-84-7.lcd



1 Detector A Chl1/210nm

Area Percent Report

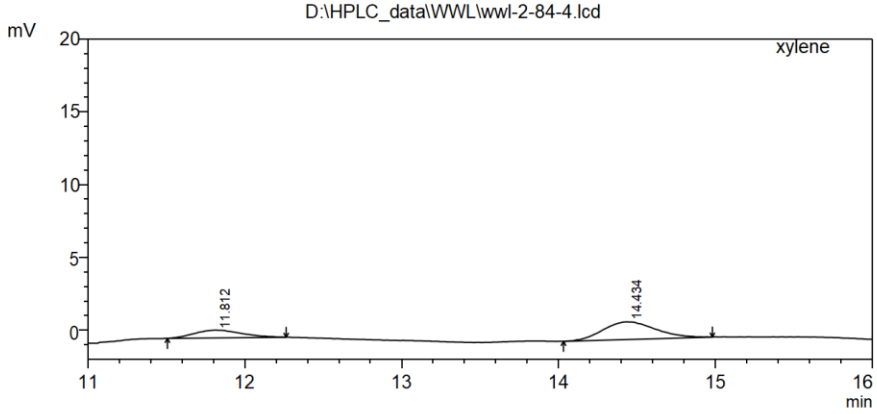
Peak#	RetTime	Area	Area%
1	12.169	5022026	27.704
2	14.921	13105326	72.296
Totals		18127352	100.000

Table 1-entry9

==== Shimadzu LCsolution analysis report **====**

Acq.Operator	: Admin
Acq.Instrument	:wwl-2-84-3
Acq.ID	:
Acq.	1
Seq.Line#	5
Inj Volume.	: 5 uL
Sample name	: wwl-2-84-4.lcd
Acq.Method.	: wwl-90-10-210-1-25min-OD.lcm
Data Collection	: 2021 9-4 17:06:27
.Data Processing	: 2021 9-4 17:31:30

D:\HPLC_data\WWL\wwl-2-84-4.lcd



1 Detector A Chl1/210nm

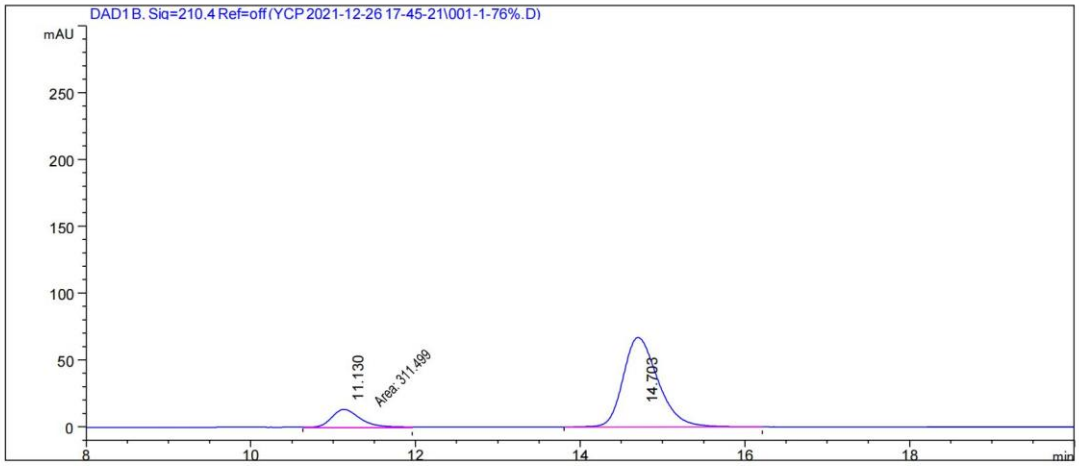
Area Percent Report

Peak#	RetTime	Area	Area%
1	11.812	11123	28.257
2	14.434	28241	71.743
Totals		39364	100.000

Table 1-entry10

Date File: d:\Chem32\1\Data\YCP 2021-12-26 17-45-21\001-1-76%.D
Sample Name: 20211225-GM-1

Acq.Operator : Admin Acq. : 1
Instrument : 1260 Location : 1
Entry date : 2021/12/26 17:46:48 Inj : 1
Inj Volume. : 5.000 µl
Acq.Method. : d:\Chem32\1\Data\YCP 2021-12-26 17-45-21\YCP.M
Analysis Method : 2021/12/26 17:45:45
Analysis Method. : d:\Chem32\1\Data\YCP 2021-12-26 17-45-21\YCP.M (Sequence Method)
Last Changed : 2021/12/26 19:06:53 : AM by SYSTEM(modified after loading)
Additional Info : Peak(s) manually integrated



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
DO not use Multiplier & Dilution Factor with ISTDs
signal 1: DAD1 B, Sig=210,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.130	MM	0.3910	311.49854	13.27631	13.5764
2	14.703	BB	0.4531	1982.90503	67.03899	86.4236
Totals :				2294.40356	80.31530	

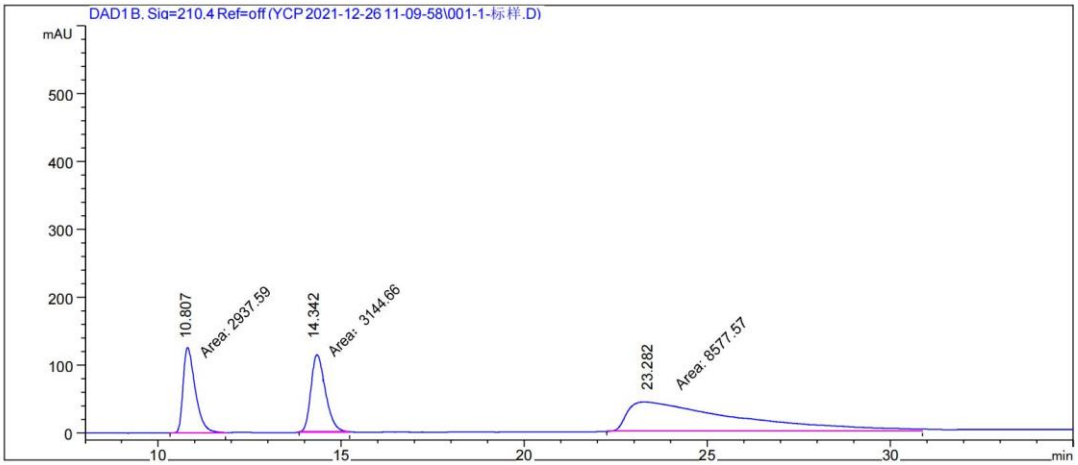
*** End of Report ***

HPLC spectra of Table 2

standard solution

Date File: d:\Chem32\1\Data\YCP 2021-12-26 11-09-58\001-1-standard.D
Sample Name: standard

Acq.Operator : Admin Acq. : 1
Instrument : 1260 Location : 1
Entry date : 2021/12/26 11:11:26 Inj : 1
Inj Volume. : 5.000 µl
Acq.Method. : d:\Chem32\1\Data\YCP 2021-12-26 11-09-58\YCP.M
Analysis Method. : d:\Chem32\1\Data\YCP 2021-12-26 11-09-58\YCP.M (Sequence Method)
Last Changed : 2021/12/26 15:37:18 : AM by SYSTEM(modified after loading)
Additional Info : Peak(s) manually integrated



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
DO not use Multiplier & Dilution Factor with ISTDs
signal 1: DAD1 B, Sig=210,4 Ref=off

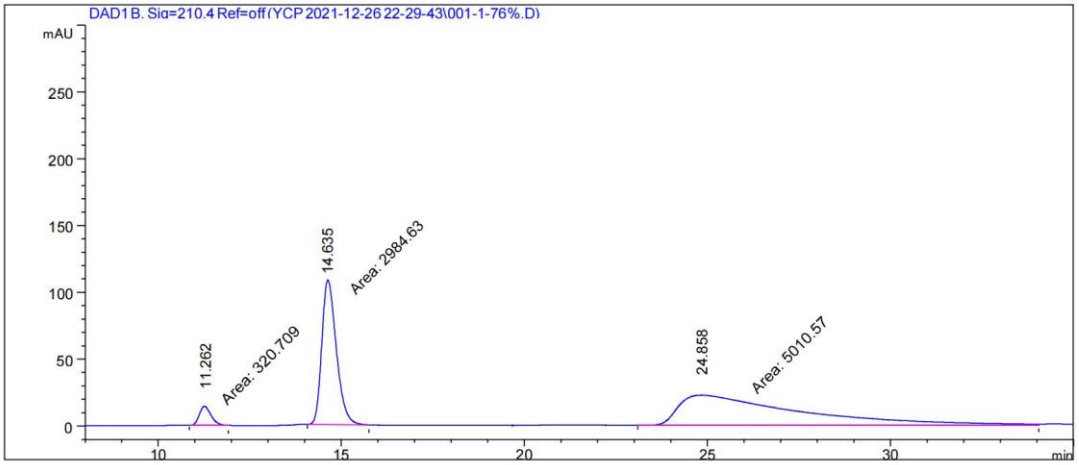
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.807	MM	0.3882	2937.59424	126.13116	20.0384
2	14.342	MM	0.4600	3144.65796	113.94315	21.4509
3	23.282	MM	2.2841	8577.57129	43.92063	58.5107
Totals :				1.46598e4	283.99495	

*** 报告结束 ***

Table 2- Cycle 1

Date File: d:\Chem32\1\Data\YCP 2021-12-26 22-29-43\001-1-76%.D
Sample Name: GM-1

Acq.Operator : Admin Acq. : 1
Instrument : 1260 Location : 1
Entry date : 2021/12/26 22:31:10 Inj: 1
Inj Volume. : 5.000 µl
Acq.Method. : d:\Chem32\1\Data\YCP 2021-12-26 22-29-43\YCP.M
Analysis Method : d:\Chem32\1\Data\YCP 2021-12-26 22-29-43\YCP.M (Sequence Method)
Last Changed : 2021/12/26 23:14:57 : AM by SYSTEM(modified after loading)
Additional Info : Peak(s) manually integrated



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
DO not use Multiplier & Dilution Factor with ISTDs
signal 1: DAD1 B, Sig=210,4 Ref=off

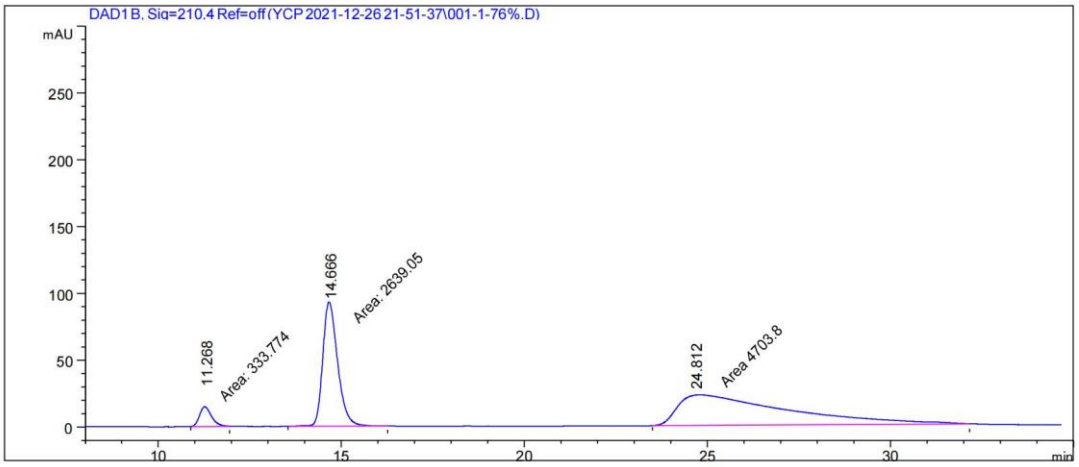
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.262	MM	0.3724	320.70917	14.35367	3.8566
2	14.635	MM	0.4605	2984.62866	108.02036	35.8906
3	24.858	MM	3.6967	5010.56885	22.59050	60.2528
Totals :				8315.90668	144.96454	

*** End of Report ***

Table 2- Cycle 2

Date File: d:\Chem32\1\Data\YCP 2021-12-26 21-51-37\001-1-76%.D
Sample Name: GM-2

Acq. Operator : Admin Acq. : 1
Instrument : 1260 Location : 1
Entry date : 2021/12/26 21:53:03 Inj : 1
Inj Volume. : 5.000 µl
Acq. Method. : d:\Chem32\1\Data\YCP 2021-12-26 21-51-37\YCP.M
Analysis Method : d:\Chem32\1\Data\YCP 2021-12-26 21-51-37\YCP.M (Sequence Method)
Last Changed : 2021/12/26 22:35:28 : AM by SYSTEM(modified after loading)
Additional Info : Peak(s) manually integrated



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
DO not use Multiplier & Dilution Factor with ISTDs
signal 1: DAD1 B, Sig=210,4 Ref=off

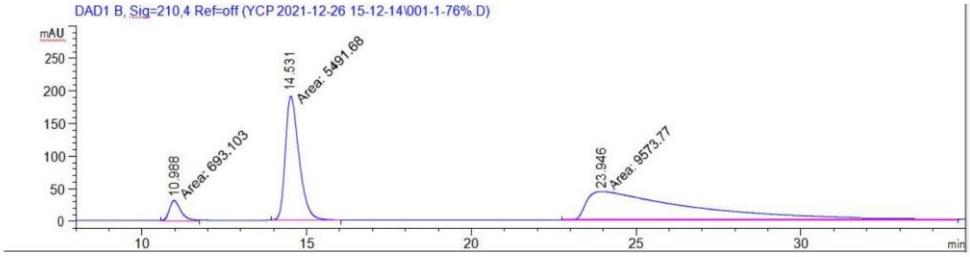
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.268	MM	0.3773	333.77365	14.74219	4.3479
2	14.666	MM	0.4730	2639.05347	92.99316	34.3778
3	24.812	MM	3.4355	4703.79883	22.81958	61.2743
Totals :				7676.62595	130.55493	

*** End of Report ***

Table 2- Cycle 3

Date File: d:\Chem32\1\Data\YCP 2021-12-26 15-12-14\001-1-76%.D
Sample Name: GM-3

Acq.Operator : Admin Acq. : 1
Instrument : 1260 Location : 1
Entry date : 2021/12/26 15:13:40 Inj : 1
Inj Volume. : 5.000 µl
Acq.Method. : d:\Chem32\1\Data\YCP 2021-12-26 15-12-14\YCP.M
Analysis Method : d:\Chem32\1\Data\YCP 2021-12-26 15-12-14\YCP.M
(Sequence Method)
Last Changed : 2021/12/26 22:10:10 : AM by SYSTEM(modified after loading)
Additional Info : Peak(s) manually integrated



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
DO not use Multiplier & Dilution Factor with ISTDs
signal 1: DAD1 B, Sig=210,4 Ref=off

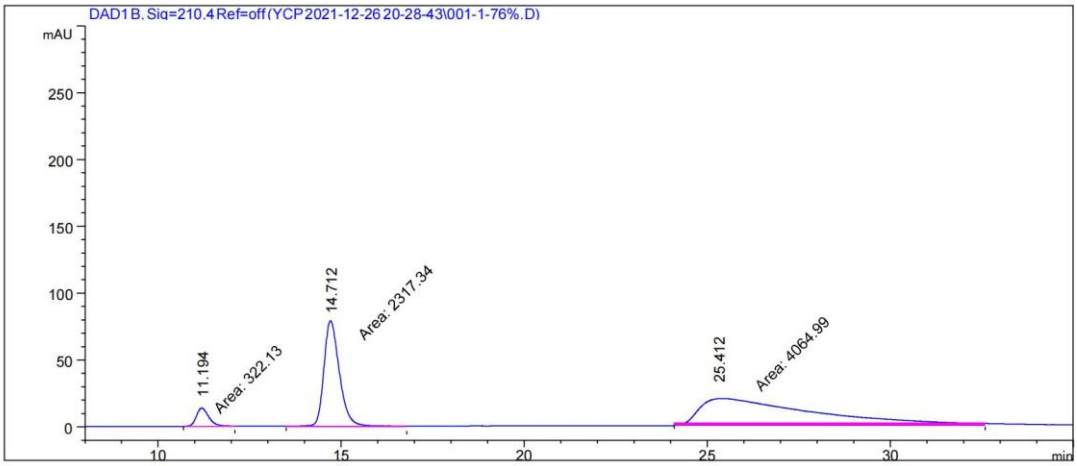
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.988	MM	0.3803	693.10272	30.37226	4.3983
2	14.531	MM	0.4814	5491.68164	190.11597	34.8489
3	23.946	MM	3.6648	9573.77246	43.53986	60.7529
Totals :				1.57586e4	264.02808	

*** End of Report ***

Table 2- Cycle 4

Date File: d:\Chem32\1\Data\YCP 2021-12-26 20-28-43\001-1-76%.D
Sample Name: gm-4

Acq. Operator : Admin
Acq. : 1
Instrument : 1260
Location : 1
Entry date : 2021/12/26 20:30:12
Inj : 1
Inj Volume. : 5.000 µl
Acq. Method. : d:\Chem32\1\Data\YCP 2021-12-26 20-28-43\YCP.M
Analysis Method : d:\Chem32\1\Data\YCP 2021-12-26 20-28-43\YCP.M
(Sequence Method)
Last Changed : 2021/12/26 21:14:39 : AM by SYSTEM(modified after loading)
Additional Info : Peak(s) manually integrated



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
DO not use Multiplier & Dilution Factor with ISTDs
signal 1: DAD1 B, Sig=210,4 Ref=off

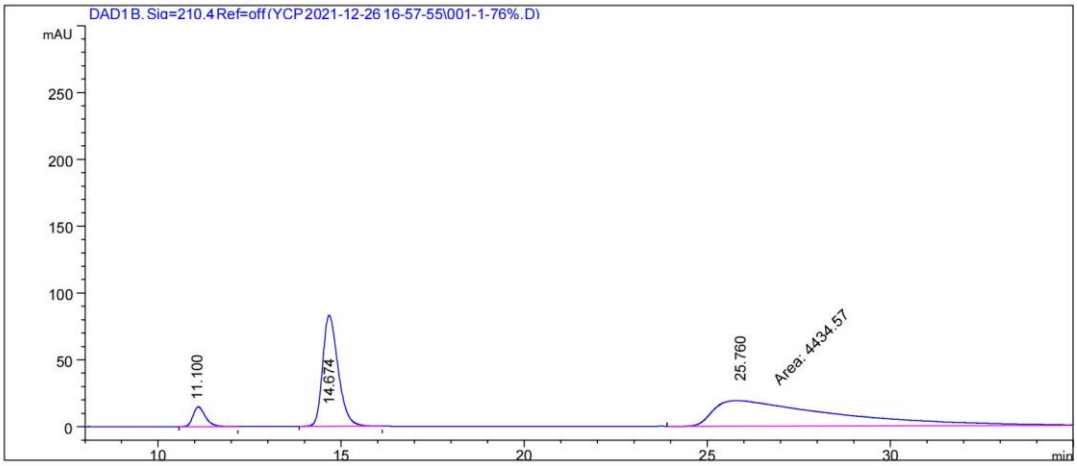
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.194	MM	0.3931	322.13019	13.65763	4.8047
2	14.712	MM	0.4894	2317.34229	78.92244	34.5642
3	25.412	MM	3.3846	4064.98535	20.01729	60.6311
Totals :				6704.45782	112.59735	

*** End of Report ***

Table 2- Cycle 5

Date File: d:\Chem32\1\Data\YCP 2021-12-26 16-57-55\001-1-76%.D
Sample Name:GM-5

Acq.Operator : Admin Acq. : 1
Instrument : 1260 Location : 1
Entry date : 2021/12/26 16:59:24 Inj : 1
Inj Volume. : 5.000 µl
Acq.Method. : d:\Chem32\1\Data\YCP 2021-12-26 16-57-55\YCP.M
Analysis Method : d:\Chem32\1\Data\YCP 2021-12-26 16-57-55\YCP.M (Sequence Method)
Last Changed : 2021/12/26 17:44:22 : AM by SYSTEM(modified after loading)
Additional Info : Peak(s) manually integrated



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
DO not use Multiplier & Dilution Factor with ISTDs
signal 1: DAD1 B, Sig=210,4 Ref=off

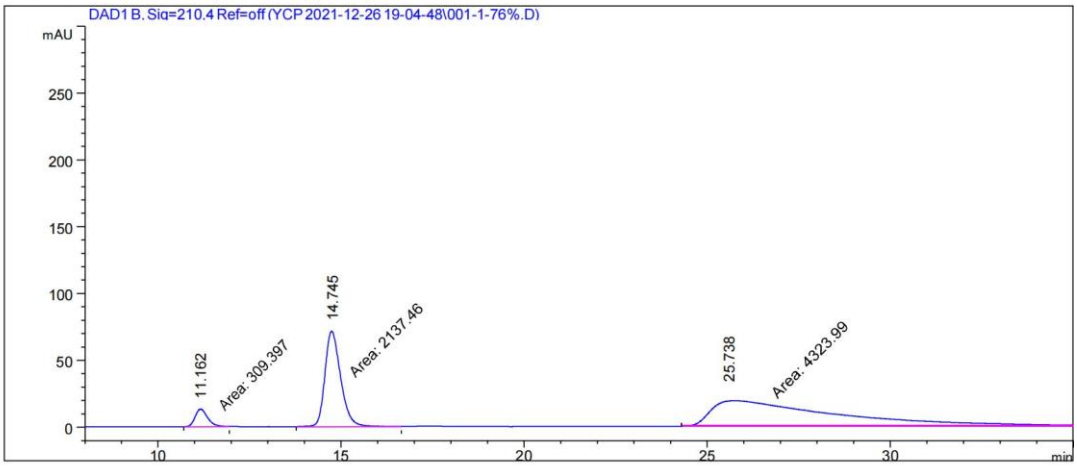
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.100	BB	0.3580	348.62469	14.73816	4.8201
2	14.674	BB	0.4521	2449.56372	83.06202	33.8676
3	25.760	MM	3.8830	4434.56787	19.03411	61.3123
Totals:				7232.75629	116.83429	

*** End of Report ***

Table 2- Cycle 6

Date File: d:\Chem32\1\Data\YCP 2021-12-26 19-04-48\001-1-76%.D
Sample Name: GM-6

Acq.Operator : Admin Acq. : 1
Instrument : 1260 Location : 1
Entry date : 2021/12/26 19:06:14 Inj : 1
Inj Volume. : 5.000 µl
Acq.Method. : d:\Chem32\1\Data\YCP 2021-12-26 19-04-48\YCP.M
Analysis Method : d:\Chem32\1\Data\YCP 2021-12-26 19-04-48\YCP.M (Sequence Method)
Last Changed : 2021/12/26 19:51:41 : AM by SYSTEM(modified after loading)
Additional Info : Peak(s) manually integrated



Area Percent Report

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
DO not use Multiplier & Dilution Factor with ISTDs
signal 1: DAD1 B, Sig=210,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.162	MM	0.3927	309.39694	13.13089	4.5695
2	14.745	MM	0.4989	2137.45996	71.41241	31.5686
3	25.738	MM	3.7952	4323.98926	18.98874	63.8619
Totals:				6770.84616	103.53205	

*** End of Report ***