The α-Heteroarylation of Esters, Lactones, Amides and Lactams by Nucleophilic Aromatic Substitution

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All experiments were carried out in oven-dried glassware under an atmosphere of dry nitrogen with magnetic stirring. Anhydrous solvents were transferred by oven-dried syringe. Anhydrous toluene, THF, diethyl ether and dioxane were purchased from Aldrich and used as received.

Flash chromatography was performed with biotage system using Si 25 S/M cartriges. Analytical thin layer chromatography (TLC) was performed with EM Reagent 0.25 mm silica gel 60-F commercial silica gel plates. Visualization was accomplished with UV light and potassium permanganate stain, followed by heating.

LC/MS data were recorded by the Agilent 1100 series and Waters Micromass ZQ system.

^{1}H nuclear magnetic resonance (NMR) spectra were recorded on Varian UI-500 (500 MHz) spectrometers. The chemical shifts are reported in PPM with $CDCl_3$ (δ=7.24) or TMS (δ=0.00) as the internal standard unless otherwise noted.

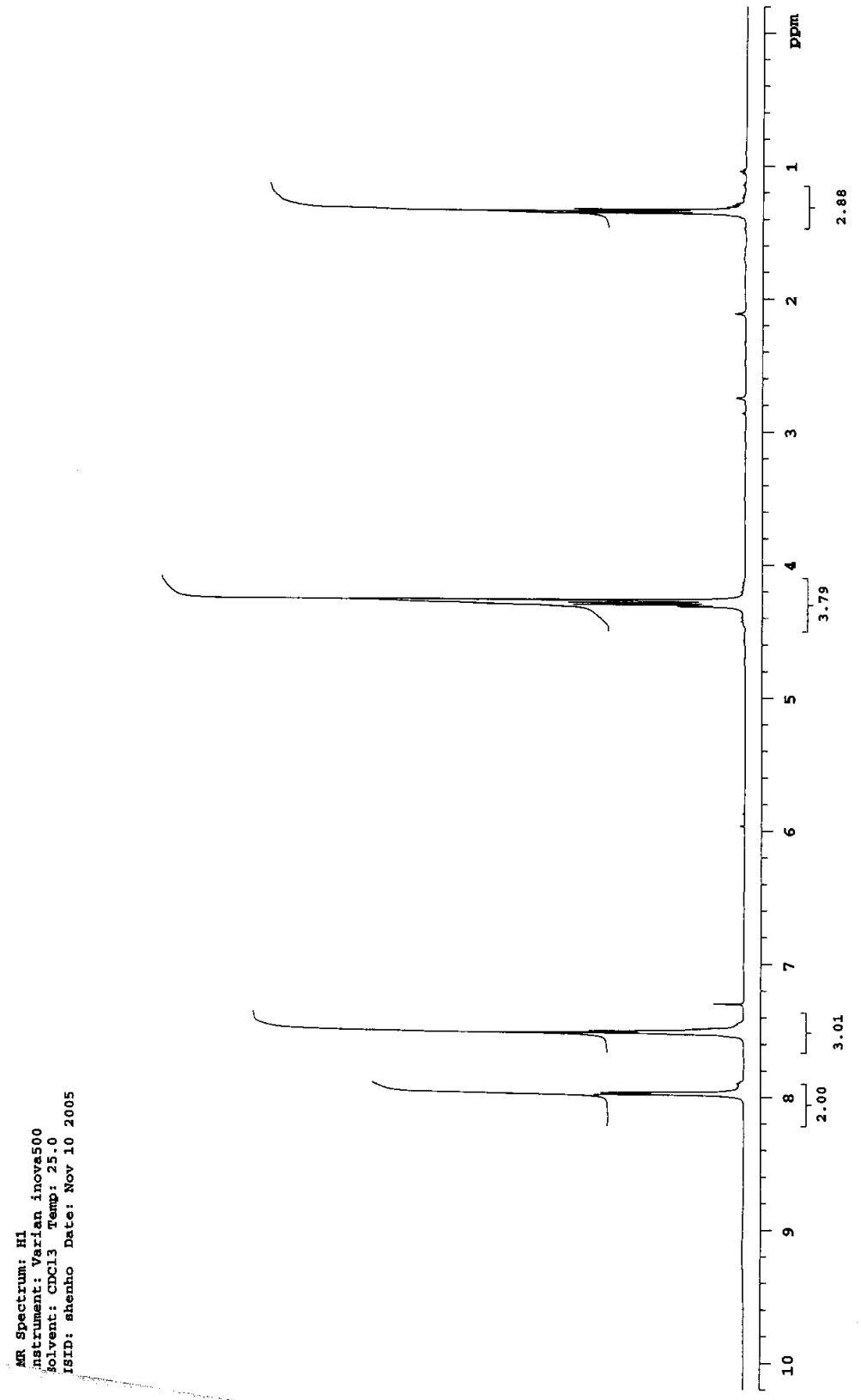
General Procedures:

A (for α-arylation): The solution of **10** (111 mg, 0.65 mmol) and *t*-butyl propionate (86 mg, 0.65 mmol) in 3 mL of toluene was degassed with nitrogen for 5 min. To this solution at 0^{o}C was slowly added NaHMDS (1.3 mmol, 2.2 mL, 0.6 M in toluene). After 2 h, the resulting solution was warmed to rt and stirred for 12 h before the mixture was quenched with ammonium chloride aqueous solution (10 mL, 1 N). Extracted the mixture with ethyl acetate (20 mL x2). The organic layers were combined and concentrated *in vacuo*. The residue was purified by biotage eluting with 5-25% ethyl acetate in hexanes to give **14** (156 mg, 0.59 mmol, 91%) as a colorless oil.

B (for tandem α-arylation and α-hydroxylation): The solution of **10** (111 mg, 0.65 mmol) and *t*-butyl propionate (86 mg, 0.65 mmol) in 3 mL of toluene was degassed with nitrogen for 5 min. To this solution at 0^{o}C was slowly added NaHMDS (1.3 mmol, 2.2 mL, 0.6 M in toluene). The reaction mixture was warmed to rt and stirred under nitrogen. After 2 h, the the resulting solution was exposed to air for 12 h before the mixture was quenched with ammonium chloride aqueous solution (10 mL, 1 N). Extracted the mixture with ethyl acetate (20 mL x2). The organic layers were combined and concentrated *in vacuo*. The residue was purified by biotage eluting with 10-25% ethyl acetate in hexanes to give **15** (152 mg, 0.54 mmol, 84%) as a colorless oil.

A medium scale reaction (Preparation of compound **9**): The solution of **8** (1.00 g, 5.09 mmol) and *t*-butyl propionate (1.77 g, 2.1 mL, 15.3 mmol) in 20 mL of toluene was degassed with nitrogen for 5 min. To this solution at 0^{o}C was slowly added NaHMDS (25.5 mL, 15.3 mmol, 0.6 M in toluene). After 5 h, the resulting solution was warmed to rt and stirred for 12 h before the mixture was quenched with ammonium chloride aqueous solution (50 mL, 1 N). Extracted the mixture with ethyl acetate (200 mL x2). The organic layers were combined and concentrated *in vacuo*. The residue was purified by biotage eluting with 5-15% ethyl acetate in hexanes to give **9** (1.11 g, 4.02 mmol, 79%) as a colorless oil.

Appendix: (The H-NMR and LC/MS of new compounds)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Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Nov 10 2005
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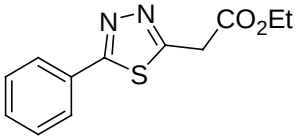
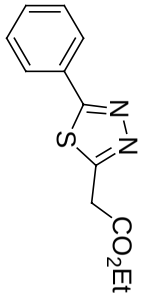
3.79
3.01
2.00

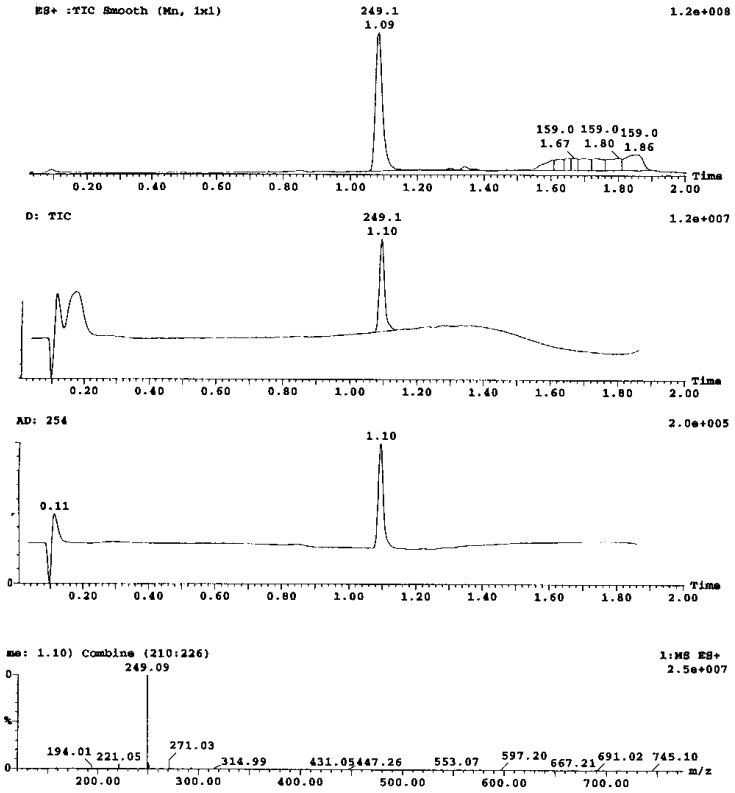

N
N
S
CO2Et

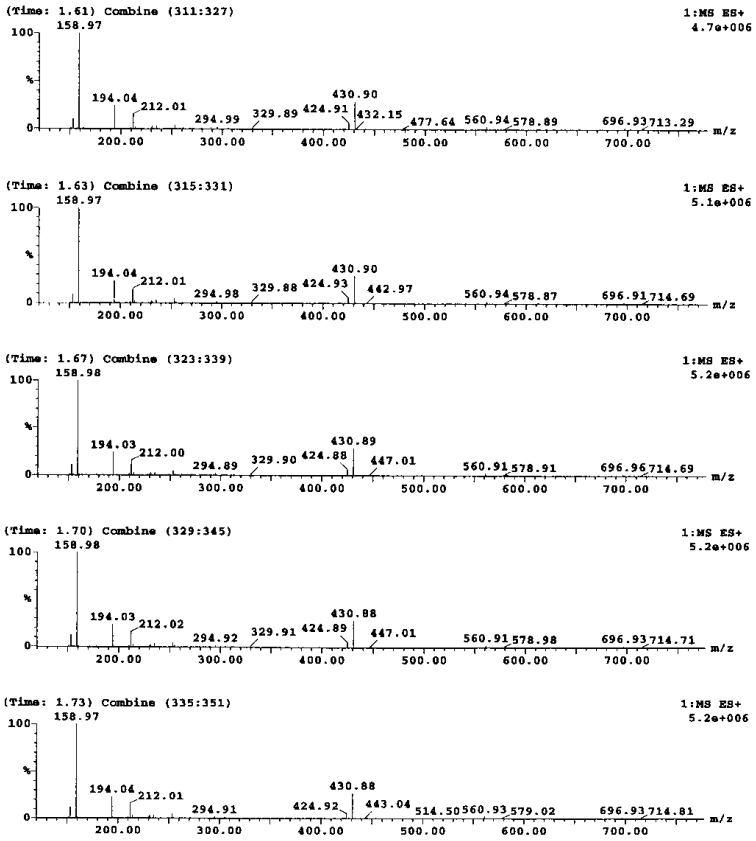
3


N
N
S
CO2Et

3

3


ES+ :TIC Smooth (Mn, 1x1)
1.2e+008
249.1
1.09
159.0 159.0 159.0
1.67 1.80 1.86
Time
D: TIC
1.2e+007
249.1
1.10
AD: 254
2.0e+005
1.10
0.11
me: 1.10) Combine (210:226)
1:MS ES+
2.5e+007
249.09
194.01 221.05 271.03 314.99 431.05 447.26 553.07 597.20 667.21 691.02 745.10
m/z


(Time: 1.61) Combine (311:327)
1:MS ES+
4.7e+006
158.97
194.04 212.01 294.99 329.89 424.91 430.90 432.15 477.64 560.94 578.89 696.93 713.29
m/z
(Time: 1.63) Combine (315:331)
1:MS ES+
5.1e+006
158.97
194.04 212.01 294.98 329.88 424.93 430.90 442.97 560.94 578.87 696.91 714.69
m/z
(Time: 1.67) Combine (323:339)
1:MS ES+
5.2e+006
158.98
194.03 212.00 294.89 329.90 424.88 430.89 447.01 560.91 578.91 696.96 714.69
m/z
(Time: 1.70) Combine (329:345)
1:MS ES+
5.2e+006
158.98
194.03 212.02 294.92 329.91 424.89 430.88 447.01 560.91 578.98 696.93 714.71
m/z
(Time: 1.73) Combine (335:351)
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158.97
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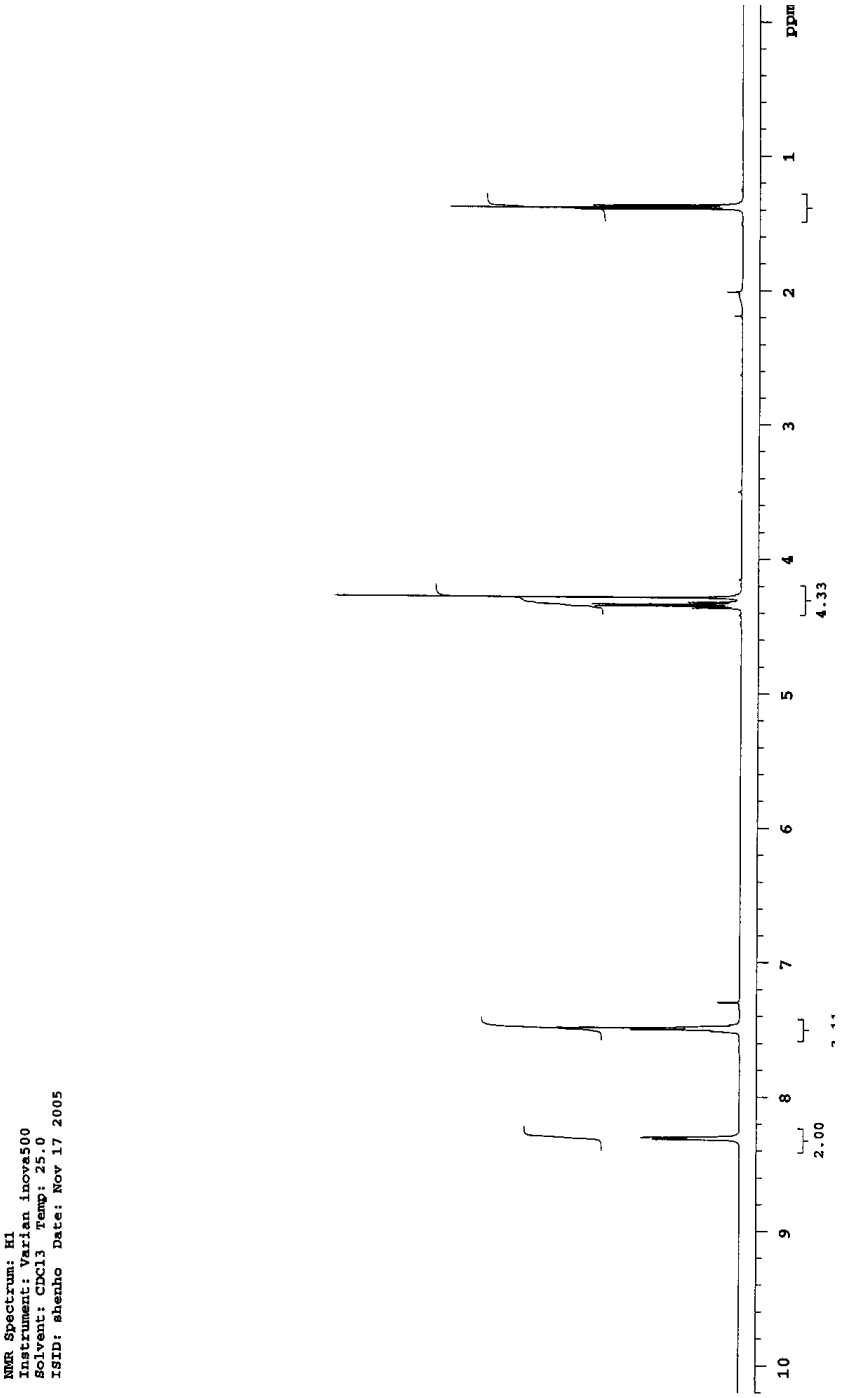
m/z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Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Nov 17 2005
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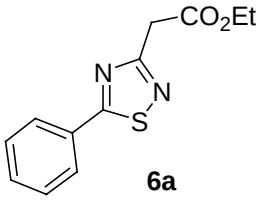
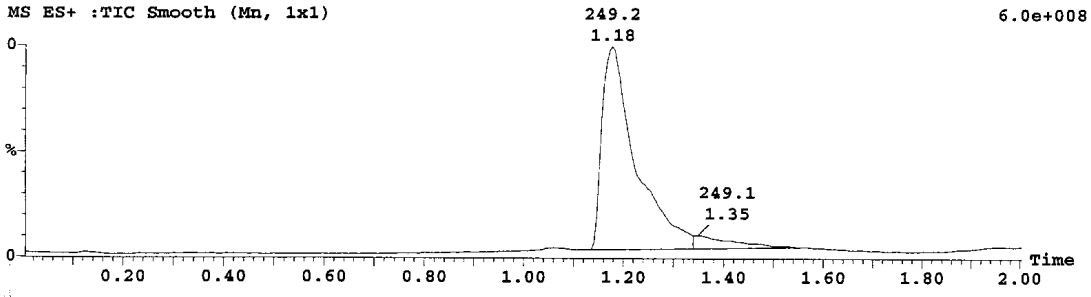
1
2
3
4
5
6
7
8
9
10
4.33
2.00


CO2Et
N
N
S

6a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6.0e+008
249.1
1.35
Time
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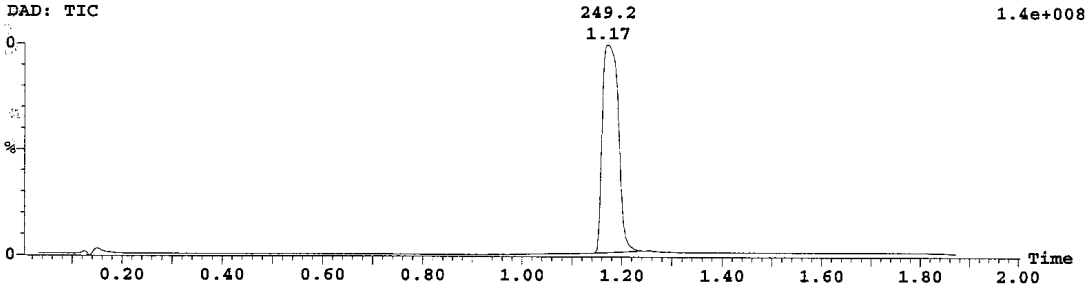
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249.2
1.17
1.4e+008
Time
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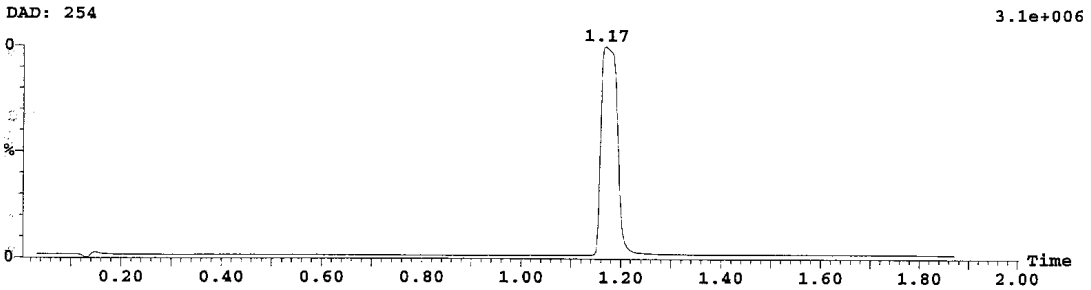
DAD: 254
1.17
3.1e+006
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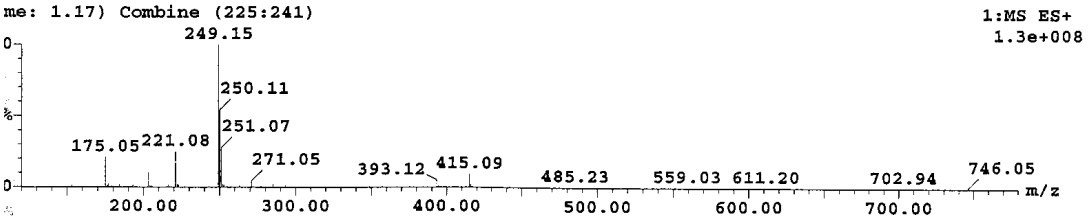
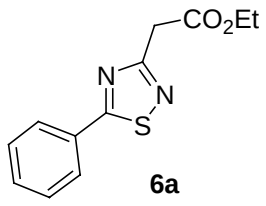
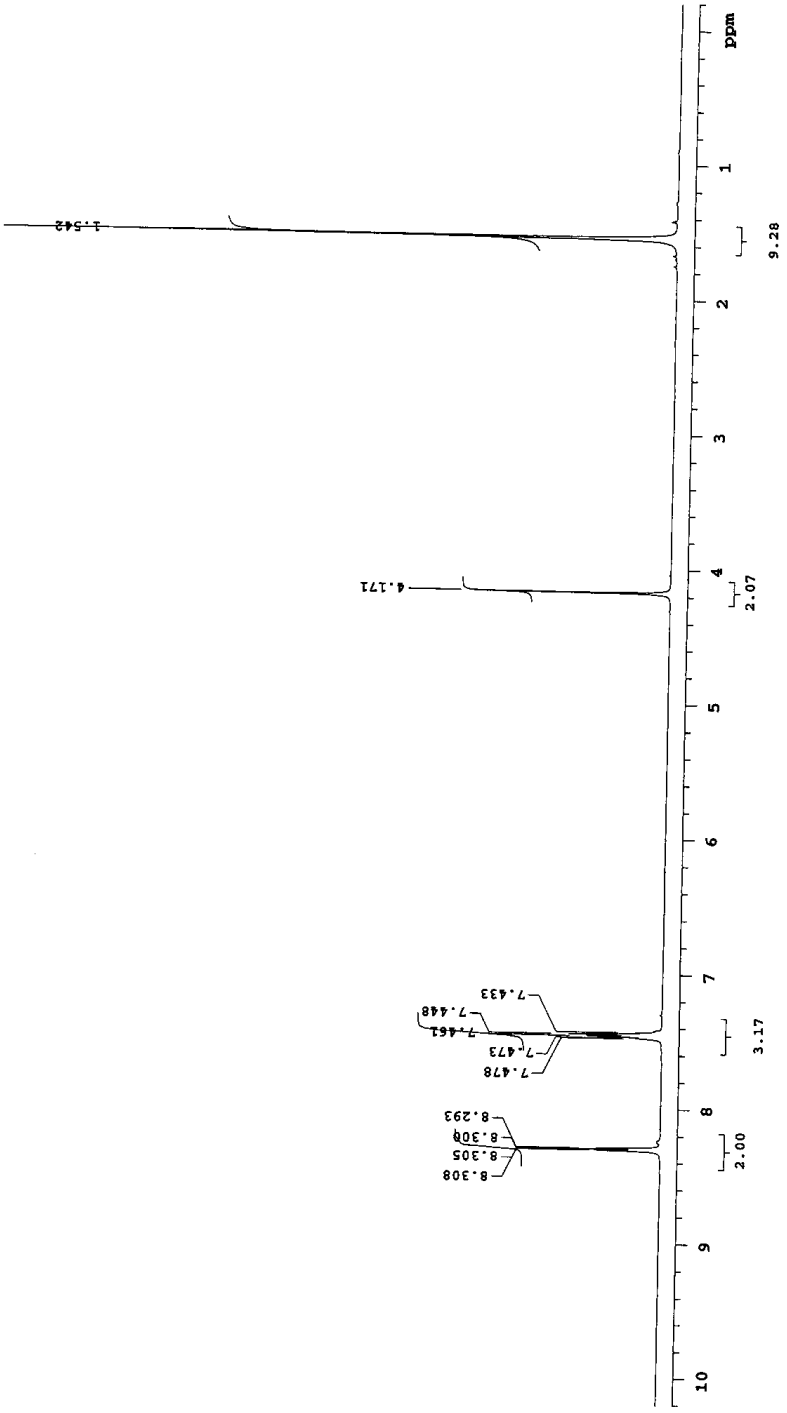

me: 1.17) Combine (225:241)
1:MS ES+
1.3e+008
249.15
250.11
251.07
175.05
221.08
271.05
393.12
415.09
485.23
559.03
611.20
702.94
746.05
m/z
200.00 300.00 400.00 500.00 600.00 700.00


CO2Et
N
N
S

6a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7.433
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7.461
7.473
7.478
8.293
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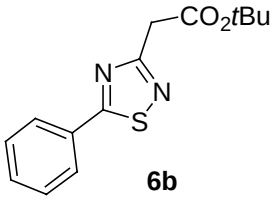
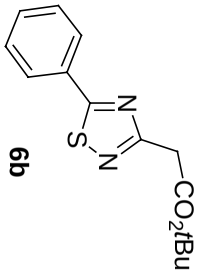
8.308
8.305
ppm
9.28
2.07
3.17
2.00


CO2tBu
N
N
S

6b



6b

Ic Chemistry Open Access LC/MS Report
Page 1
Instrument:
Time 09:31:01
Submitter:Shen, Hong x1755 (SHENHO)
Filename:RY800_04_0006607

MS ES+ :TIC Smooth (Mn, 1x1) 3.0e+008
221.2
1.22
221.1
1.36
Time

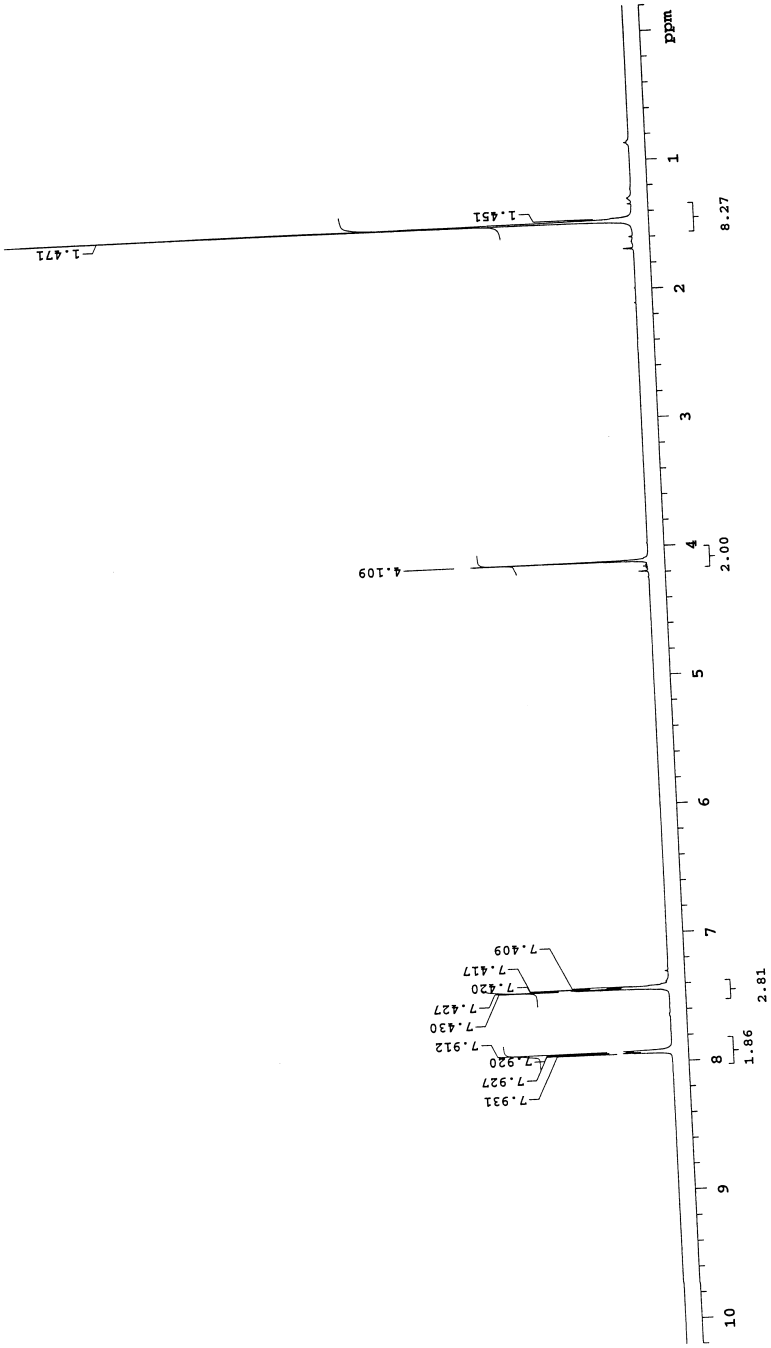
AD: TIC 1.1e+008
221.2
1.22
Time

AD: 254 2.5e+006
1.22
Time

e: 1.22: Combine (234:250) 1:MS ES+ 1.2e+008
221.16
222.19
175.09 277.15 301.21 361.25 434.36 507.30 529.18 637.15 655.20
m/z

Basic Chemistry Open Access LC/MS Report
Page 2
Sample ID:RY8004_005084-1
Date:14-Nov-2005
Method:C:\MassLynx\LC2M_Low_Pos.olp
Instrument:
Time:09:31:01
Submitter:Shen, Hong x1755 (SHENHO)
Filename:RY800_04_0006607

(Time: 1.36) Combine (262:278) 1:MS ES+ 6.8e+006
221.09
333.23
179.06 247.12 263.16 319.20 335.23 381.13 384.14 437.17 493.32 579.26 601.28 635.03 687.47 730.44
m/z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7.409
7.417
7.420
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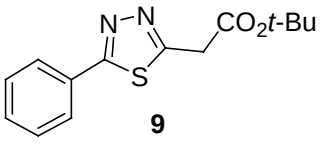
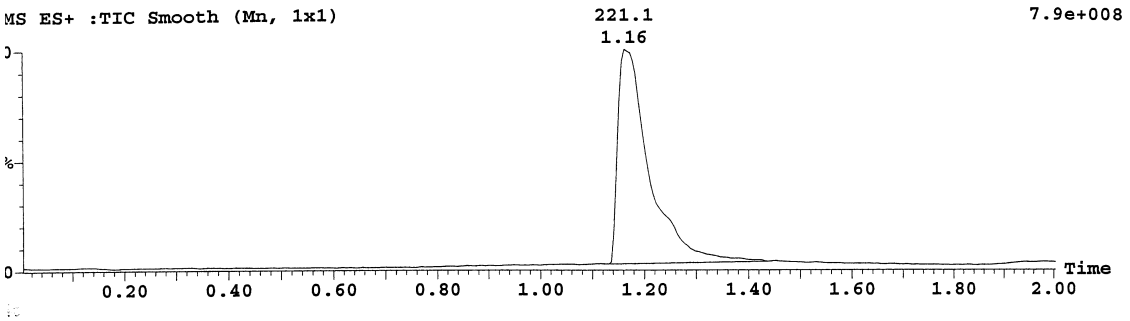
7.430
7.912
7.920
7.927
7.931
8.27
2.00
2.81
1.86


N
N
S
CO2t-Bu

9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7.9e+008
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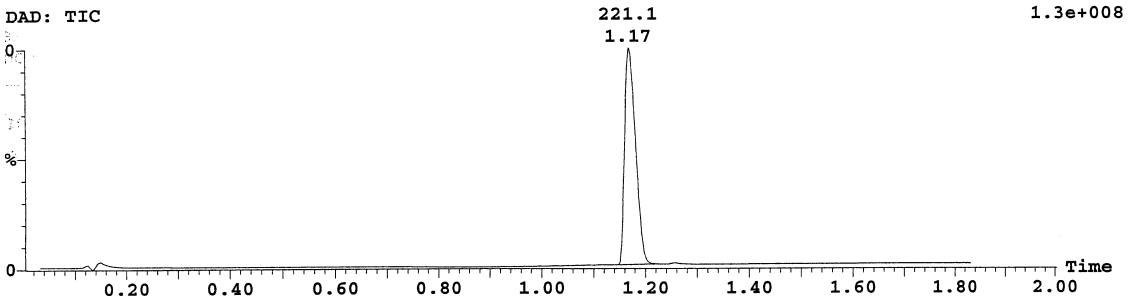
DAD: TIC
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1.17
1.3e+008
Time
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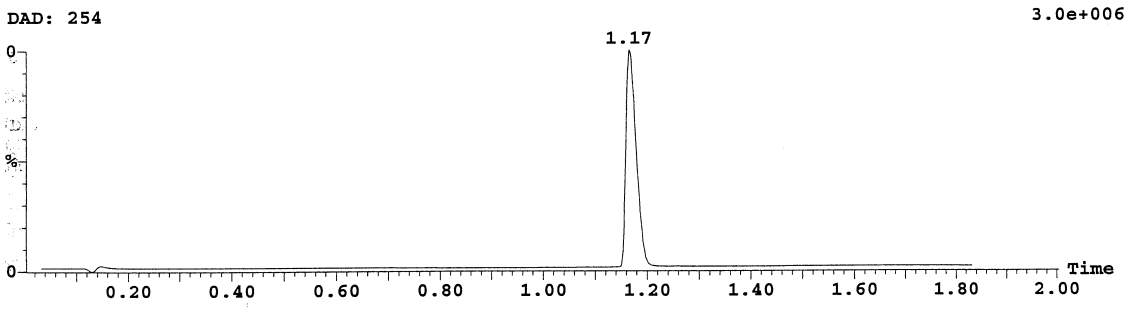
DAD: 254
1.17
3.0e+006
Time
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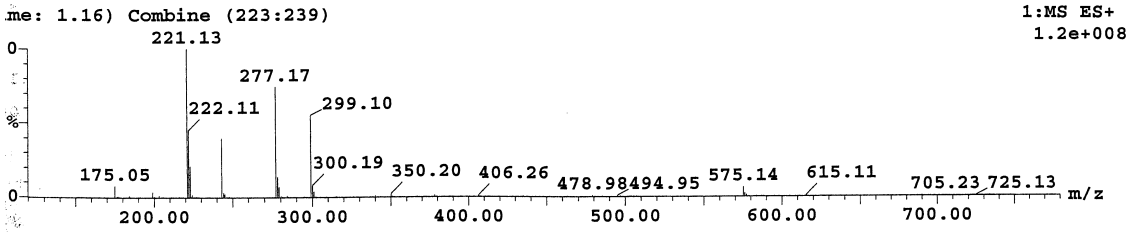
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1.2e+008
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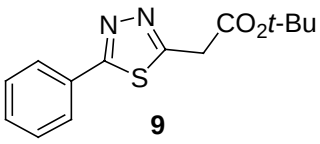
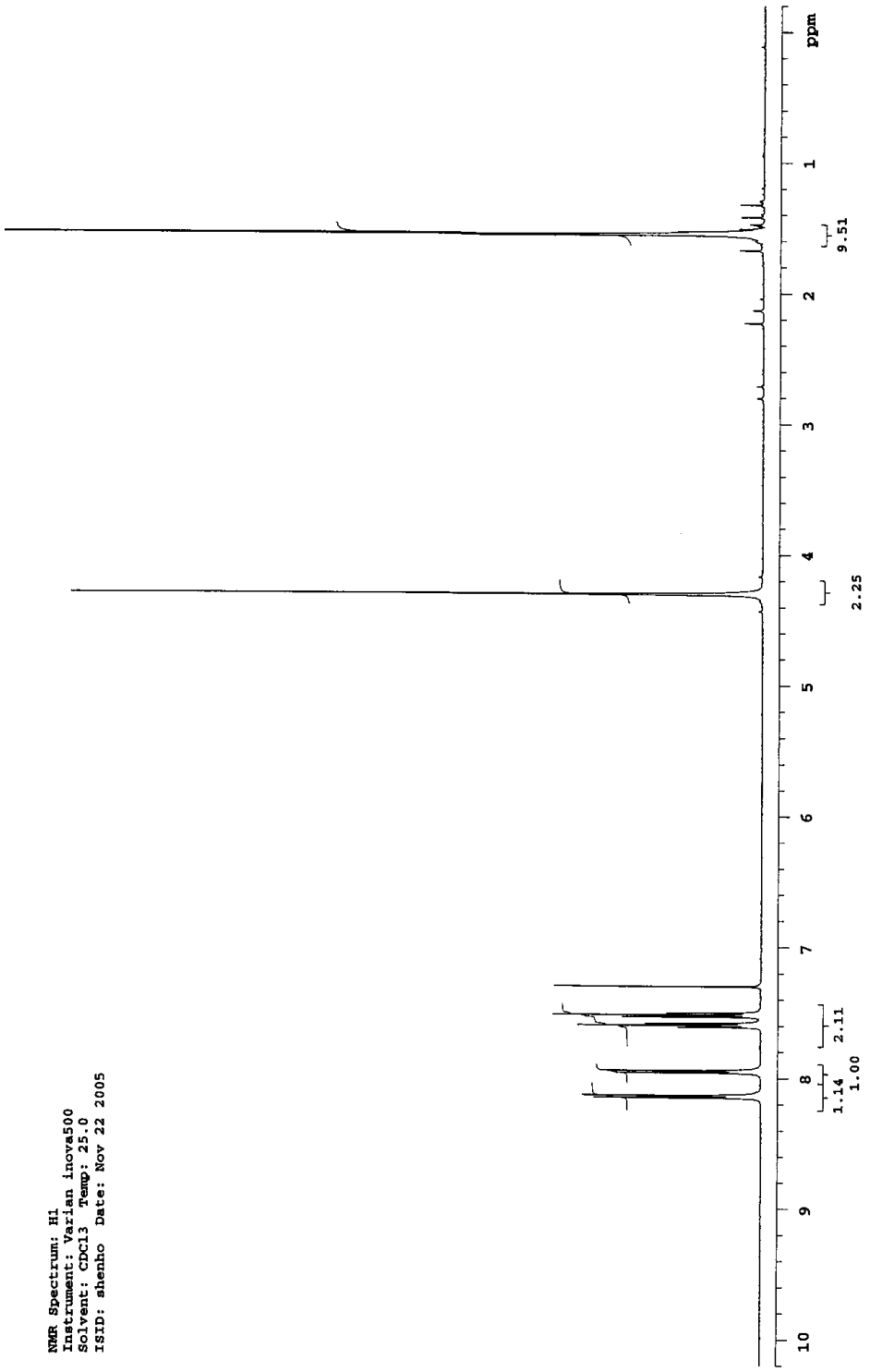
277.17
222.11
299.10
175.05
300.19
350.20
406.26
478.98
494.95
575.14
615.11
705.23
725.13
m/z
200.00 300.00 400.00 500.00 600.00 700.00


N
N
S
CO2t-Bu

9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Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Nov 22 2005
ppm
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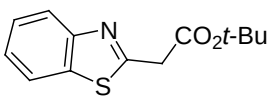
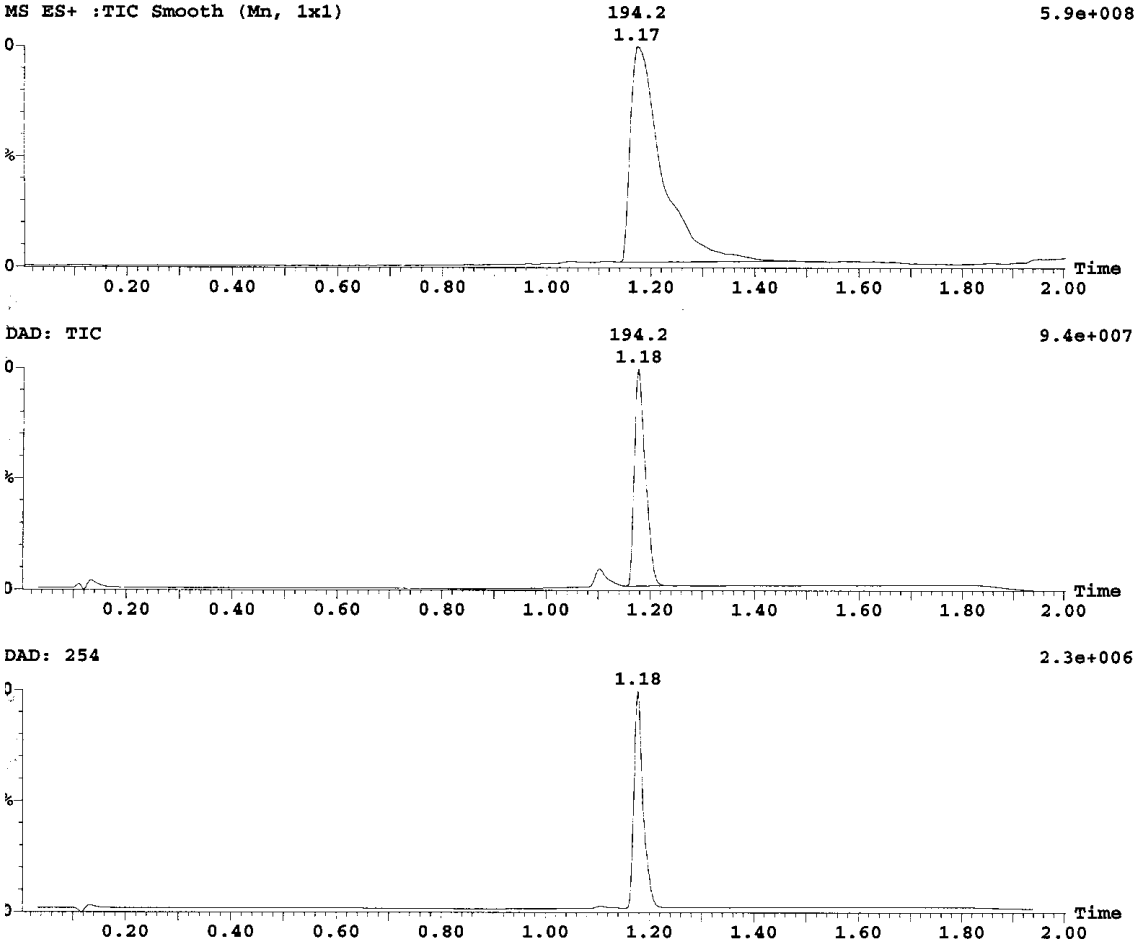
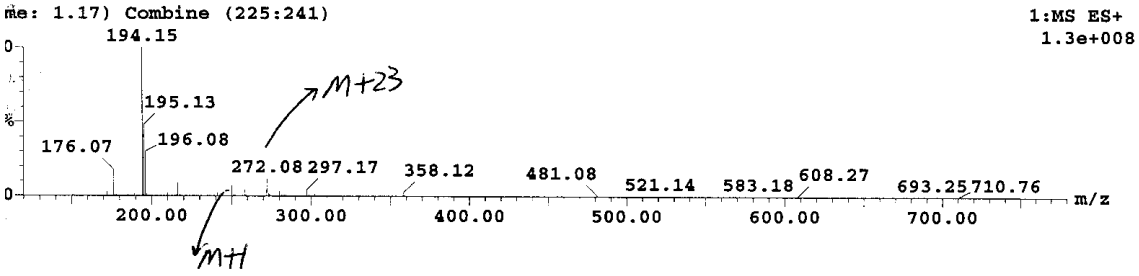
2.25
2.11
1.14
1.00


N
S
CO2t-Bu

11


MS ES+ :TIC Smooth (Mn, 1x1)
194.2
1.17
5.9e+008
DAD: TIC
194.2
1.18
9.4e+007
DAD: 254
1.18
2.3e+006
Time
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00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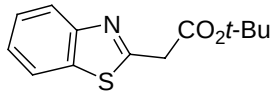
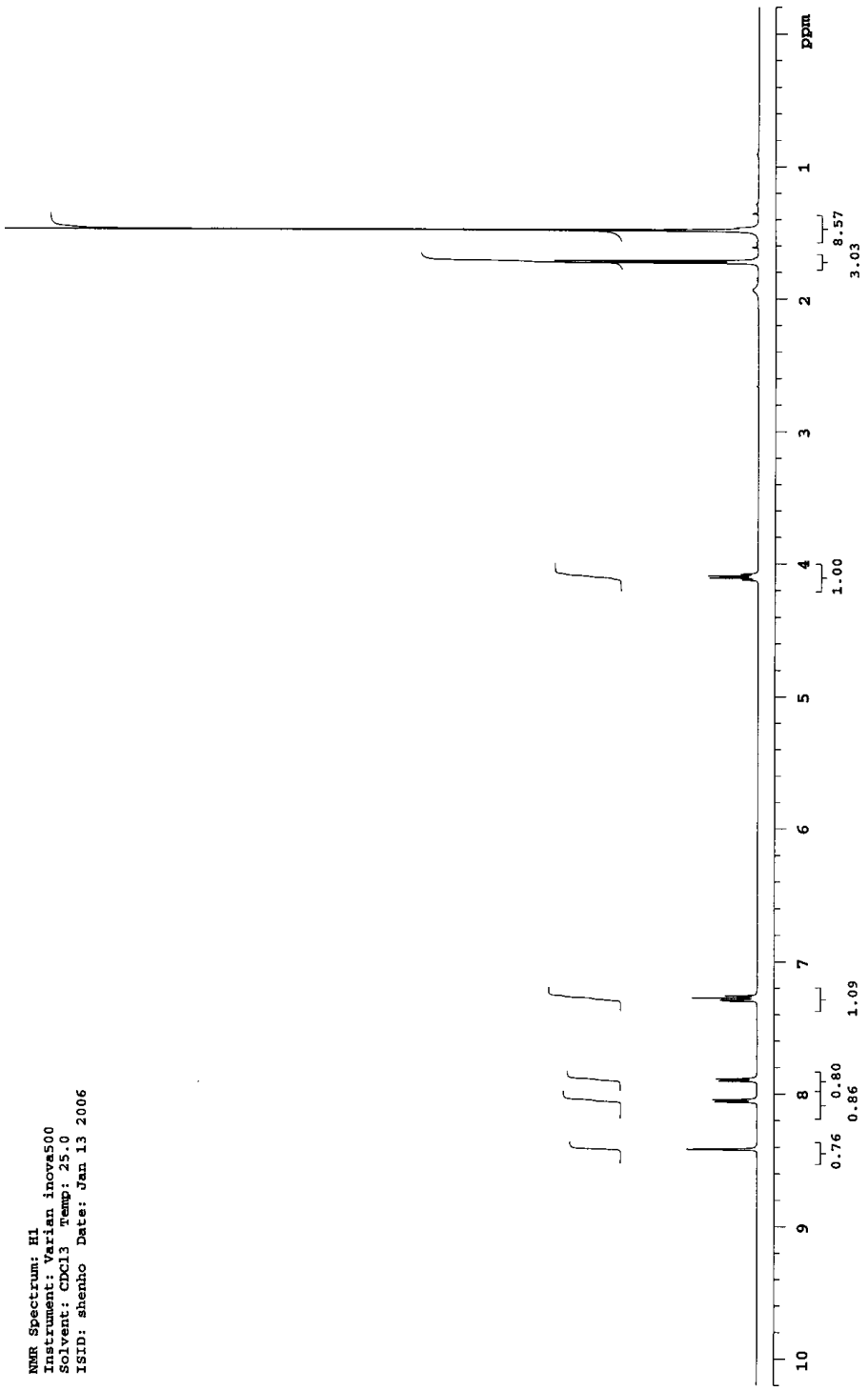
195.13
196.08
176.07
272.08
297.17
358.12
481.08
521.14
583.18
608.27
693.25
710.76
M+23
M+H
m/z
200.00
300.00
400.00
500.00
600.00
700.00


N
S
CO2t-Bu

11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Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Jan 13 2006
ppm
1
2
3
4
5
6
7
8
9
10
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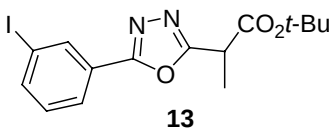
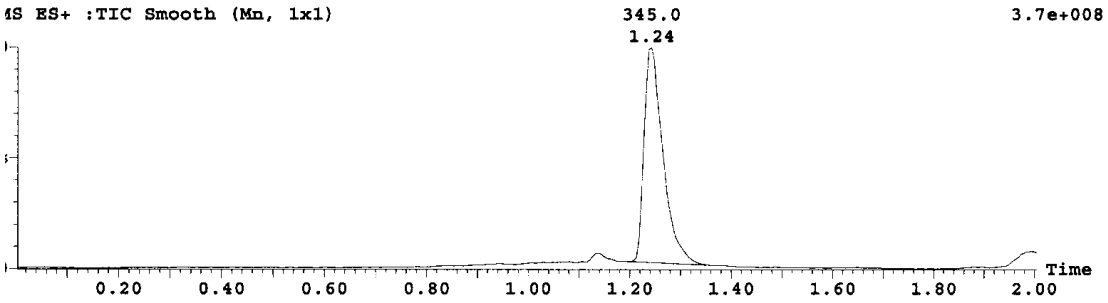
3.03
1.00
1.09
0.80
0.86
0.76


I
N
N
O
CO2t-Bu

13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1.24
3.7e+008
Time
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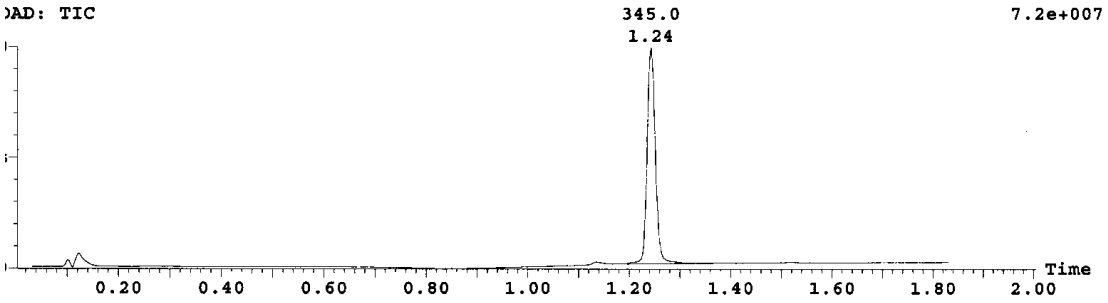
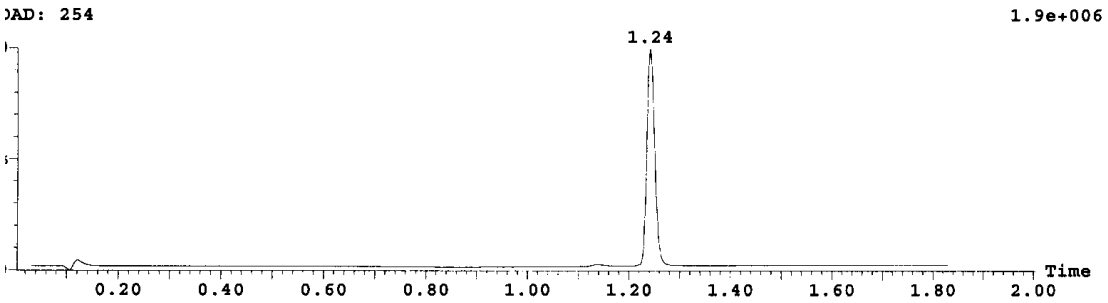

DAD: TIC
345.0
1.24
7.2e+007
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00


DAD: 254
1.24
1.9e+006
Time
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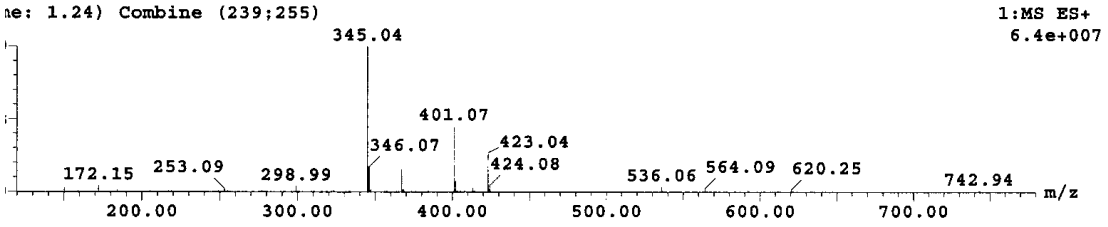
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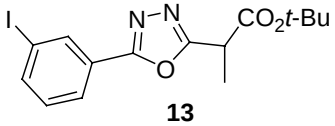
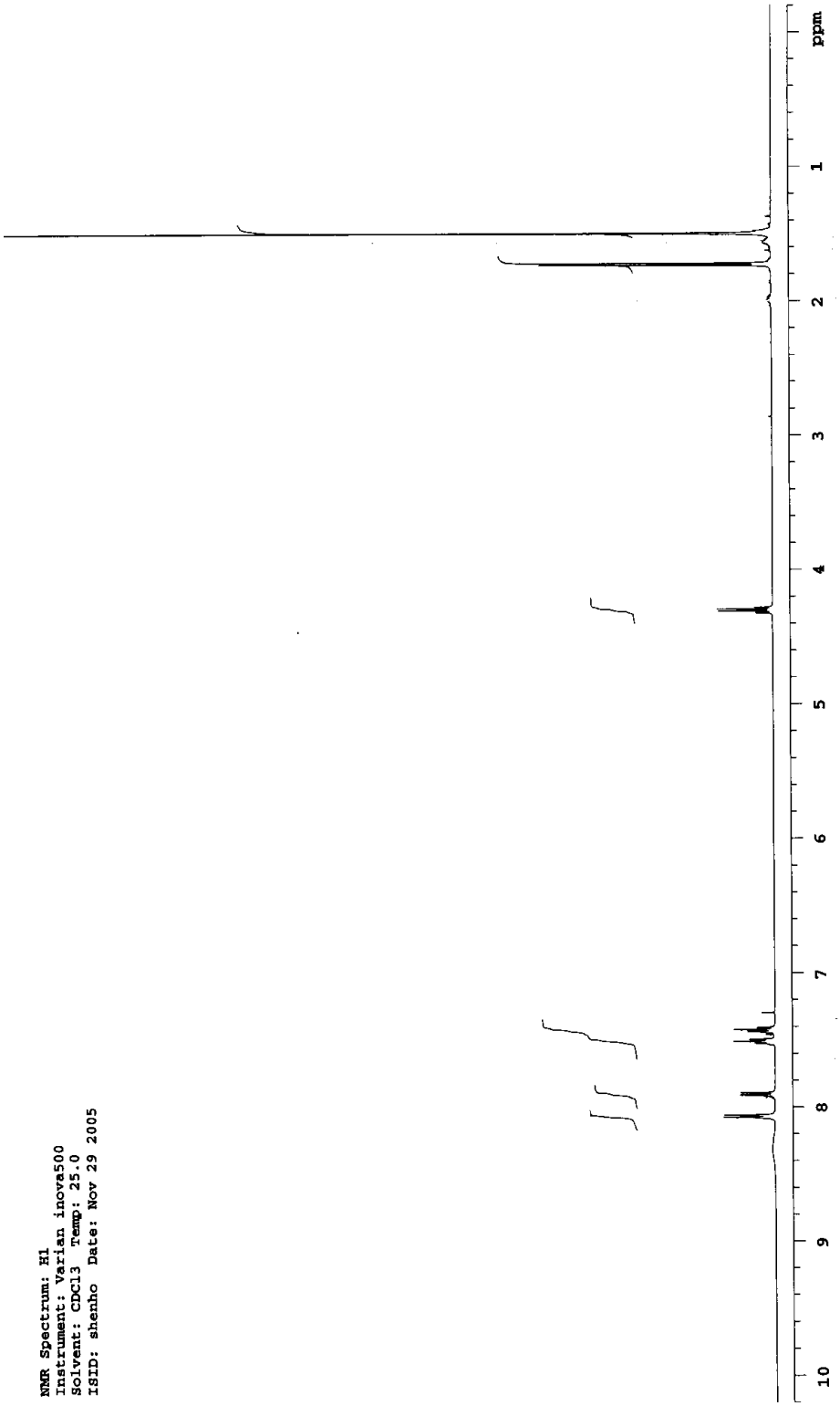
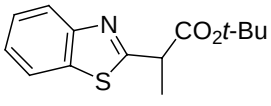
345.04
401.07
346.07
423.04
424.08
172.15
253.09
298.99
536.06
564.09
620.25
742.94
m/z
200.00 300.00 400.00 500.00 600.00 700.00


I
N
N
O
CO2t-Bu

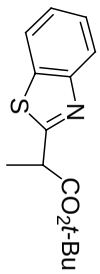
13


NMR Spectrum: H1
Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Nov 29 2005
ppm
1
2
3
4
5
6
7
8
9
10


N
S
CO2t-Bu

14

14



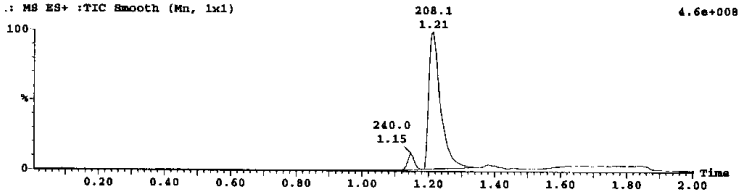
[redacted]istry Open Access LC/MS Report

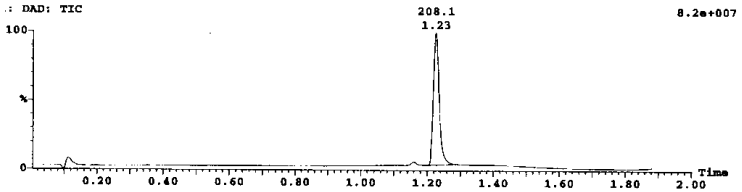
Page 1

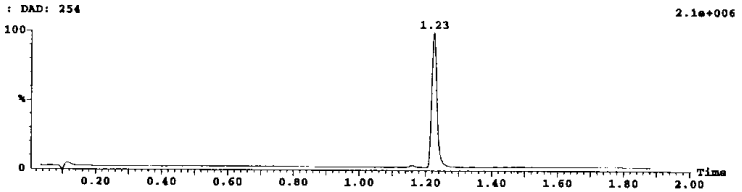
ample ID:1
Date:29-Nov-2005
Method:C:\MassLynx\LC2M_Low_Pos.olp

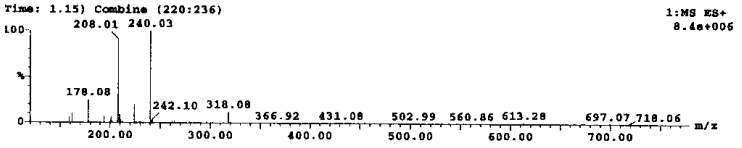
Instrument:
Time:07:58:04

Submitter:Shen, Hong x1755 (SHENHO)
Filename:20058007003863









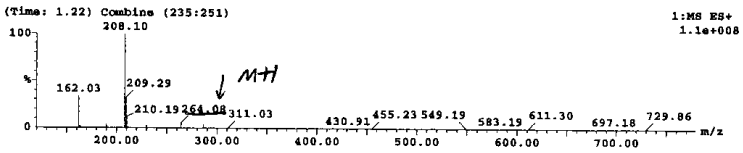
Basic Chemistry Open Access LC/MS Report

Page 2

Sample ID:1
Date:29-Nov-2005
Method:C:\MassLynx\LC2M_Low_Pos.olp

Instrument:
Time:07:58:04

Submitter:Shen, Hong x1755 (SHENHO)
Filename:20058007003863



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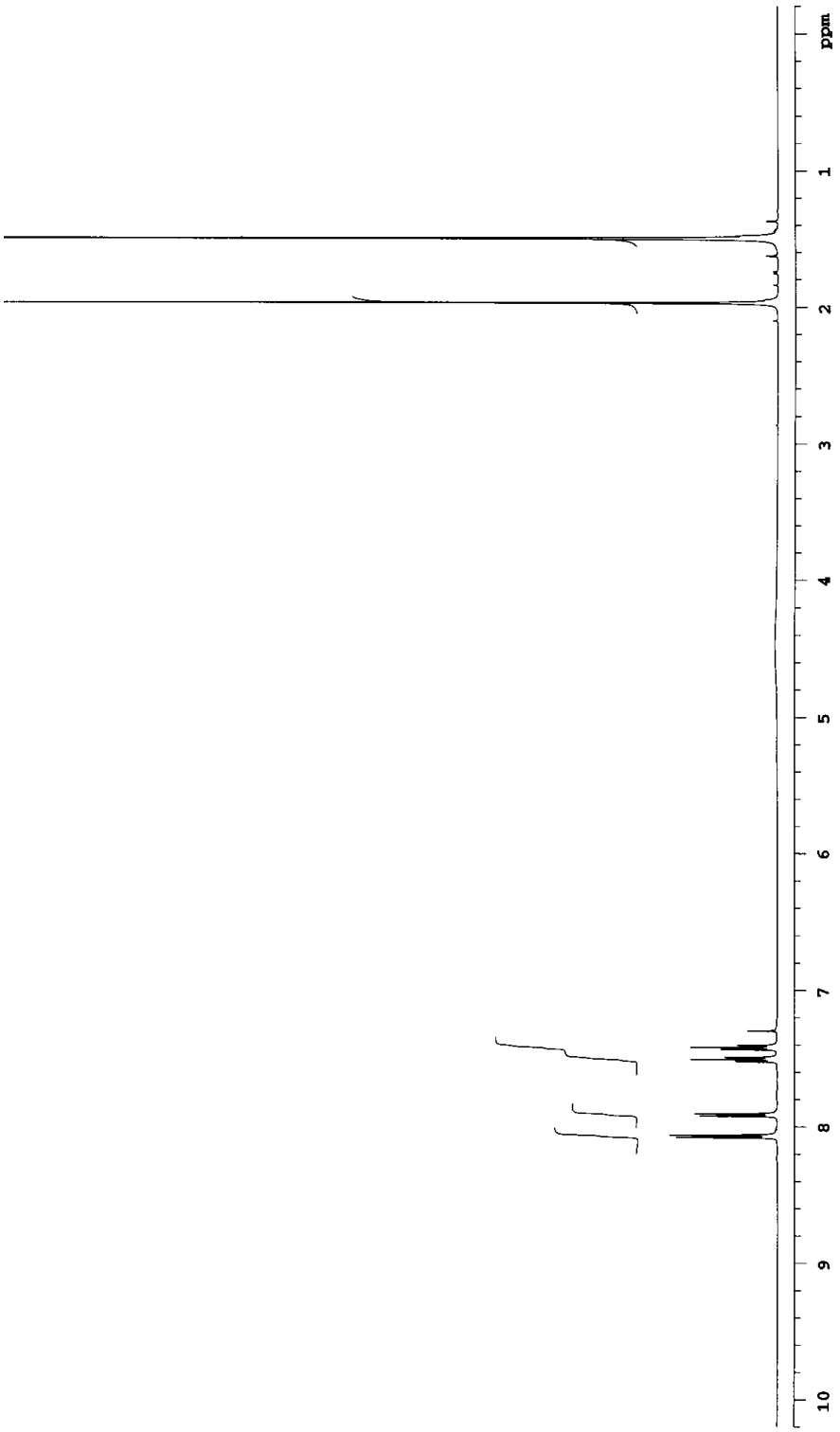
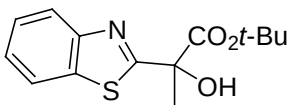
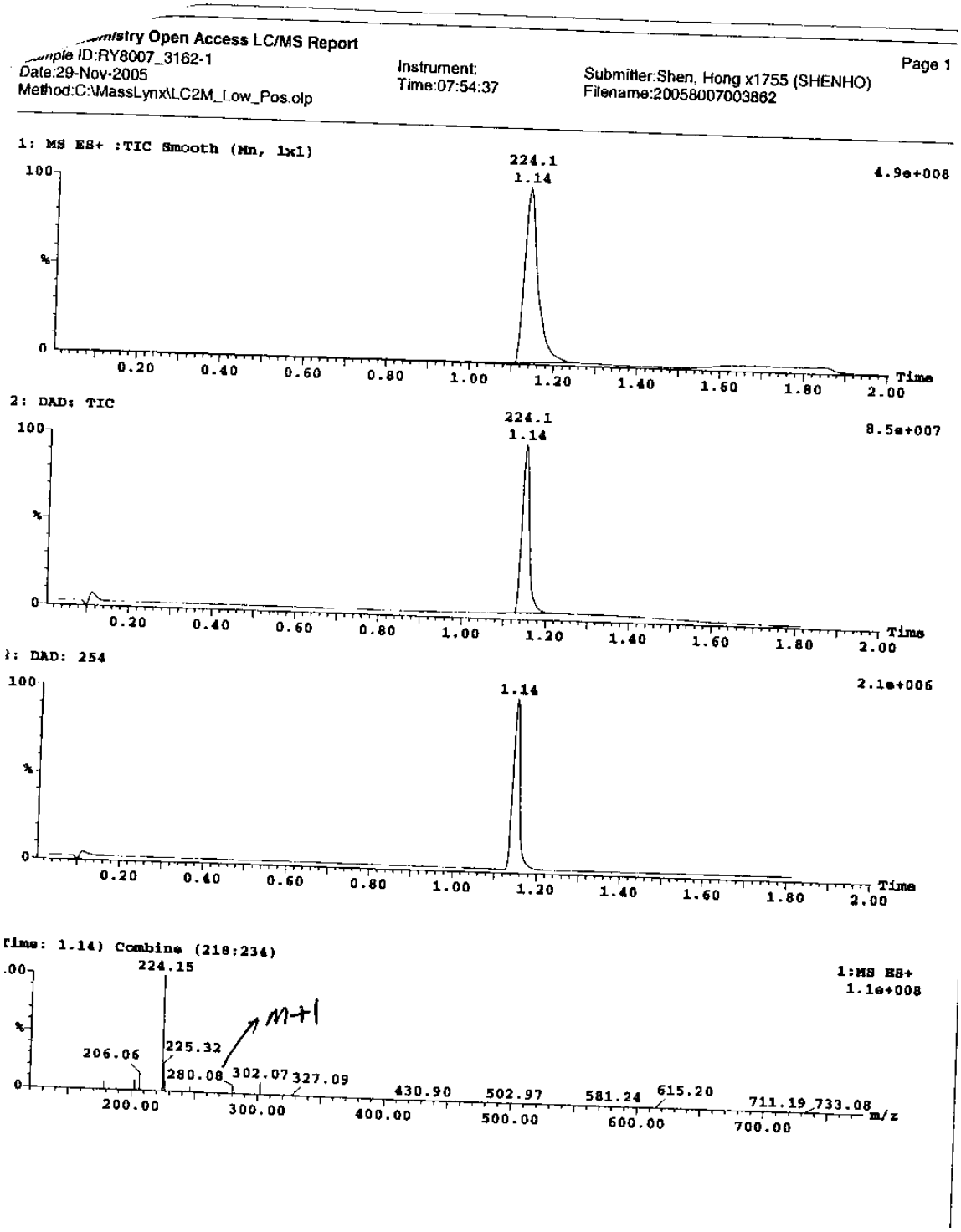
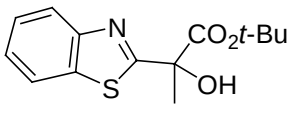


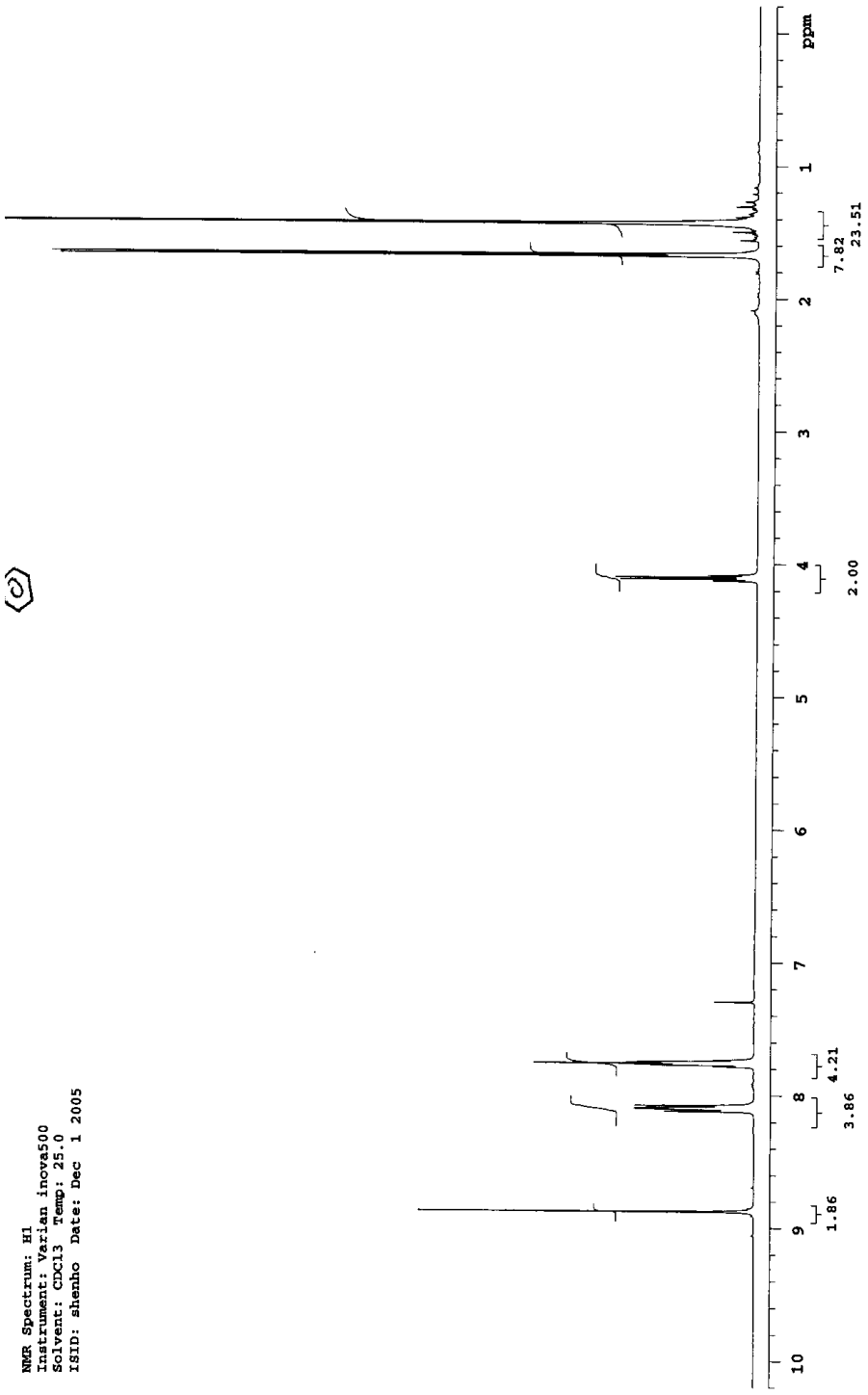


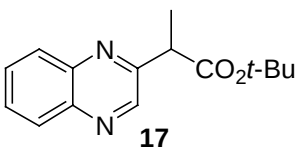
15


istry Open Access LC/MS Report
mple ID:RY8007_3162-1
Date:29-Nov-2005
Method:C:\MassLynx\LC2M_Low_Pos.olp
Instrument:
Time:07:54:37
Submitter:Shen, Hong x1755 (SHENHO)
Filename:20058007003862
Page 1
1: MS ES+ :TIC Smooth (Mn, 1x1)
224.1
1.14
4.9e+008
2: DAD: TIC
224.1
1.14
8.5e+007
3: DAD: 254
1.14
2.1e+006
Time: 1.14) Combine (218:234)
224.15
1:MS ES+
1.1e+008
M+1
206.06
225.32
280.08
302.07
327.09
430.90
502.97
581.24
615.20
711.19
733.08
m/z
Time


N
CO2t-Bu
S
OH

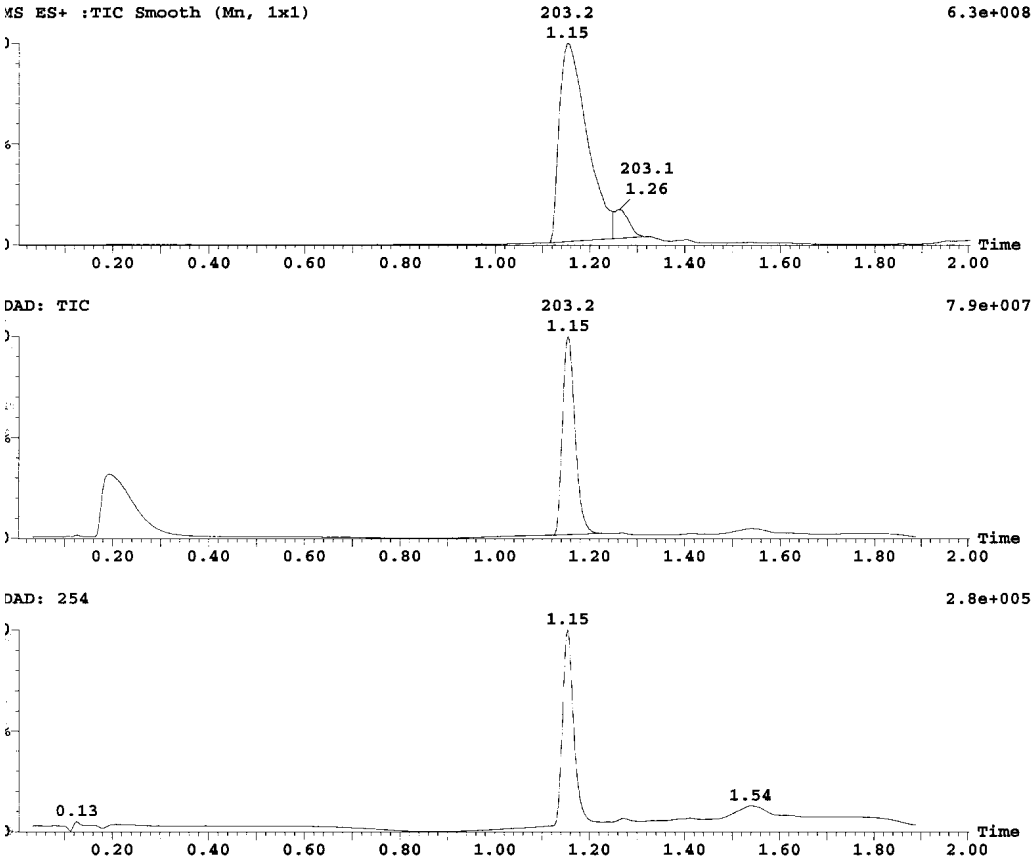
15

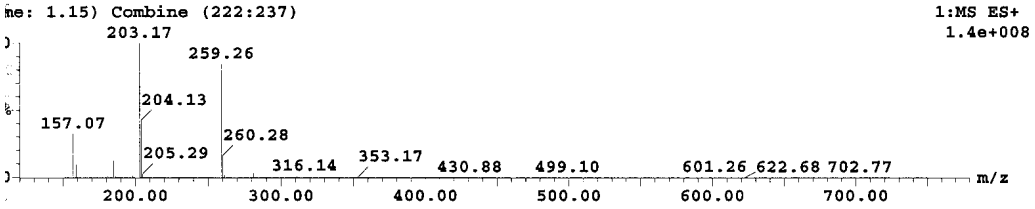

NMR Spectrum: H1
Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Dec 1 2005
ppm
1.86
4.21
3.86
2.00
7.82
23.51

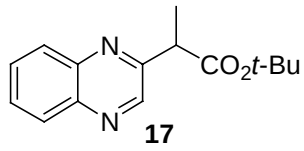

N
N
CO2t-Bu

17

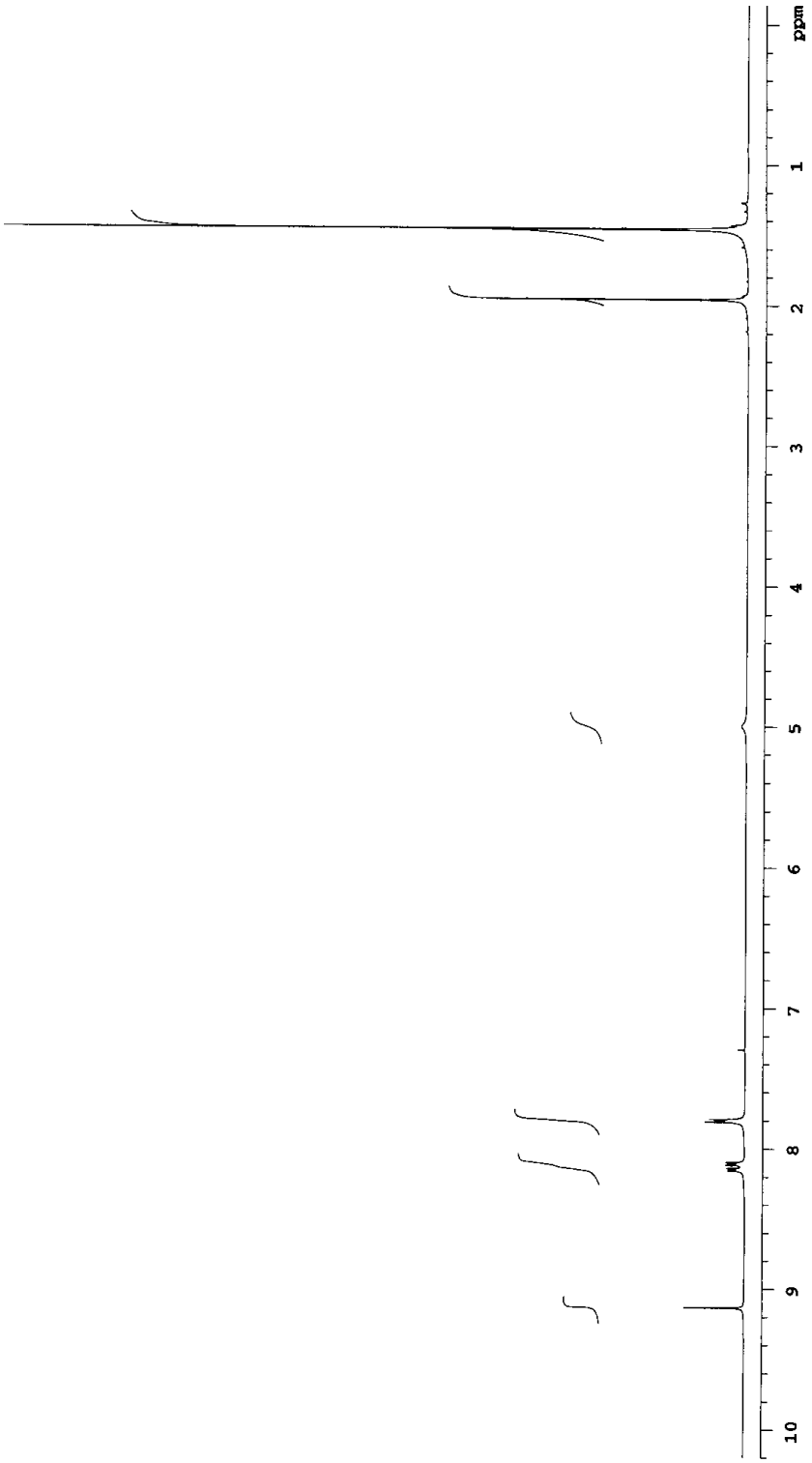
ple ID:RY8004_005408-1 Instrument: Submitter:Shen, Hong x1755 (SHENHO)
:01-Dec-2005 Time:17:40:44 Filename:RY800_04_0007022
iod:C:\MassLynx\LC2M_Low_Pos.olp

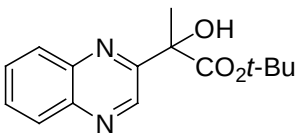




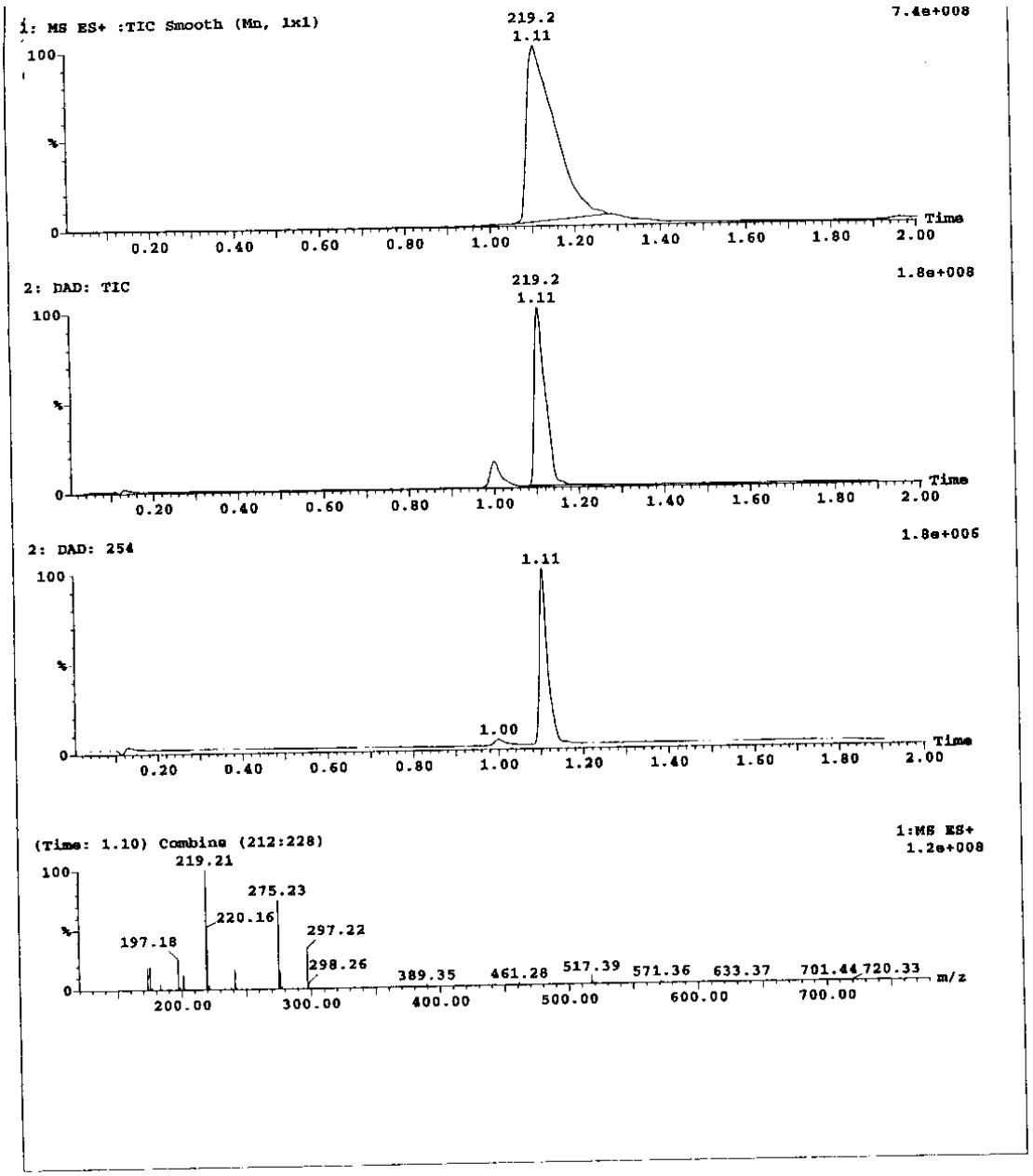


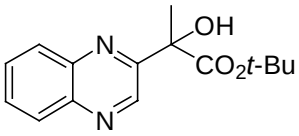
17



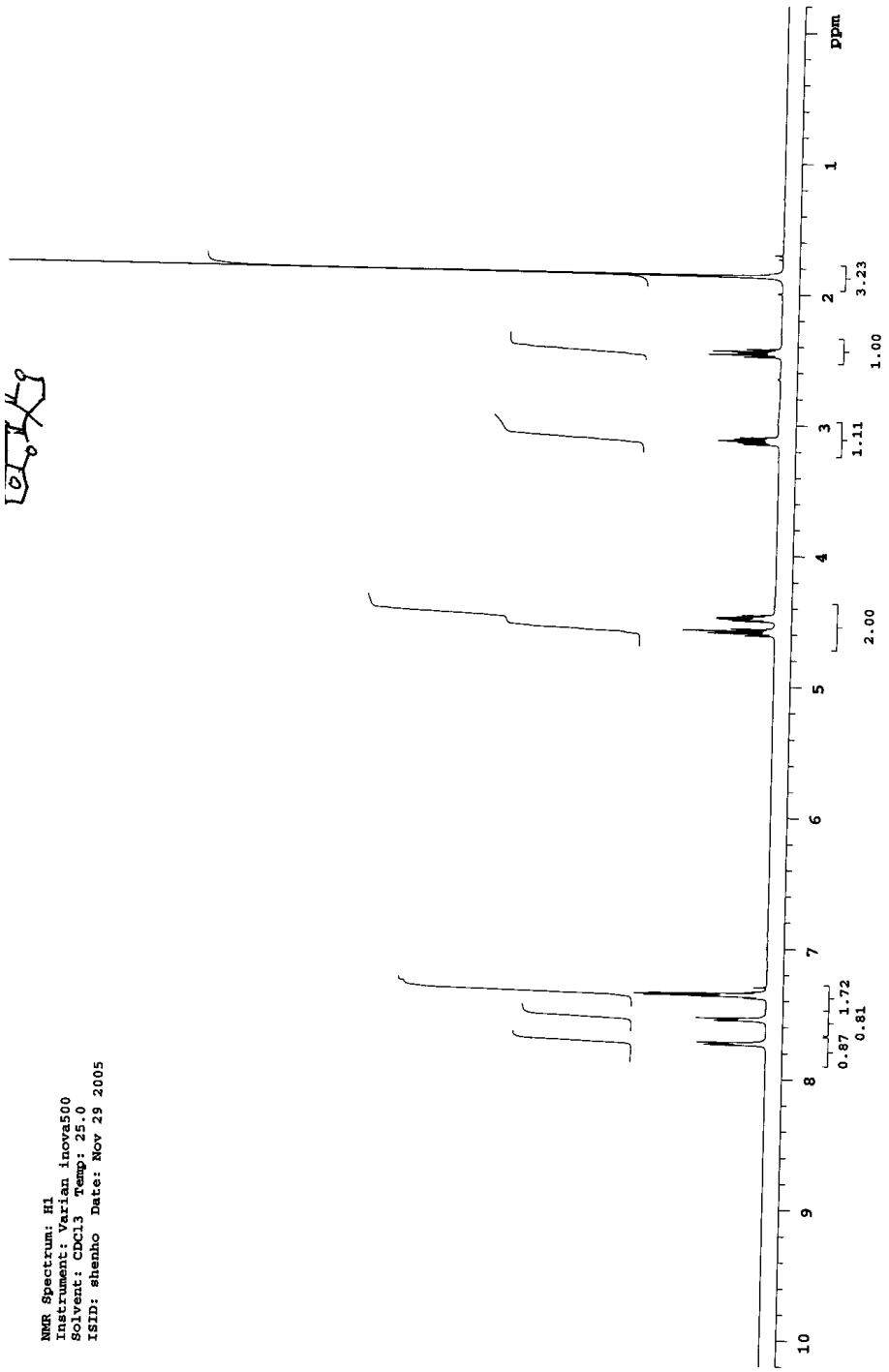


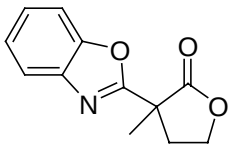
18


1: MS ES+ :TIC Smooth (Mn, 1x1)
7.4e+008
219.2
1.11
100
%
0
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00
Time
2: DAD: TIC
1.8e+008
219.2
1.11
100
%
0
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00
Time
2: DAD: 254
1.8e+006
1.11
100
%
1.00
0
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00
Time
(Time: 1.10) Combine (212:228)
1:MS ES+
1.2e+008
219.21
275.23
220.16
297.22
197.18
298.26
389.35
461.28
517.39
571.36
633.37
701.44
720.33
100
%
0
200.00 300.00 400.00 500.00 600.00 700.00
m/z

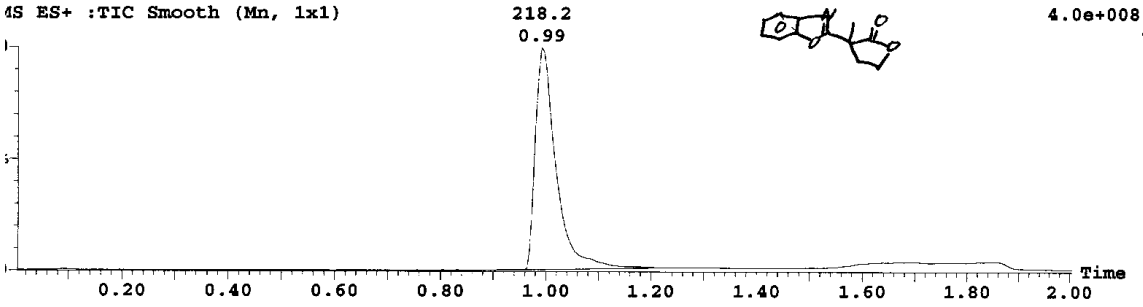

N
OH
CO2t-Bu
N

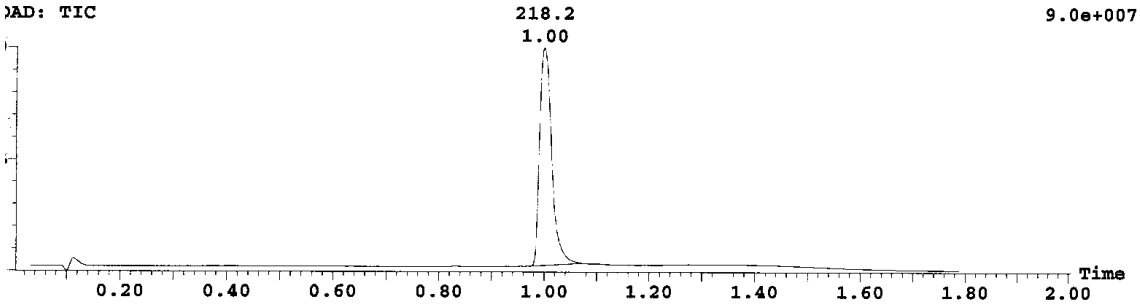
18

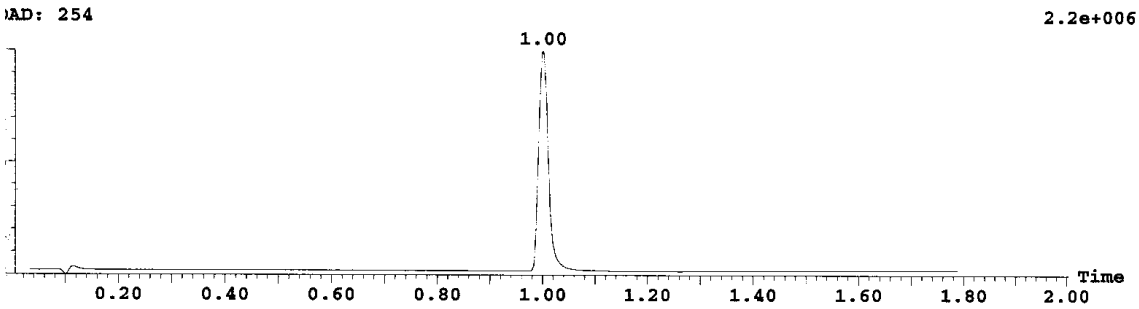

NMR Spectrum: H1
Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenko Date: Nov 29 2005
ppm
1
2
3
4
5
6
7
8
9
10
3.23
1.00
1.11
2.00
0.87
1.72
0.81

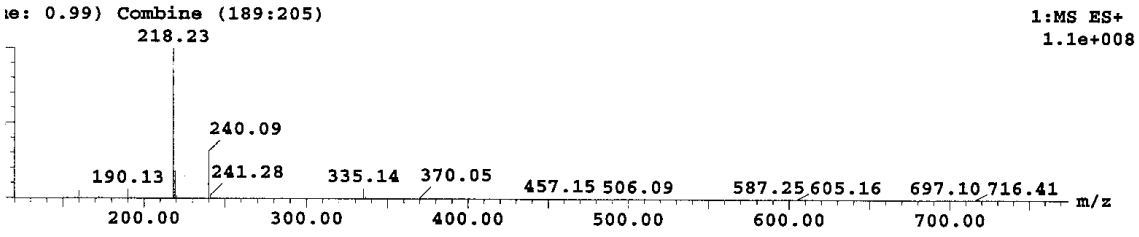

O
O
N
O

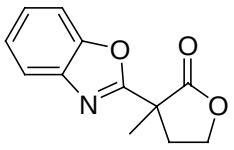
21


4S ES+ :TIC Smooth (Mn, 1x1)
218.2
0.99
4.0e+008
Time
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00

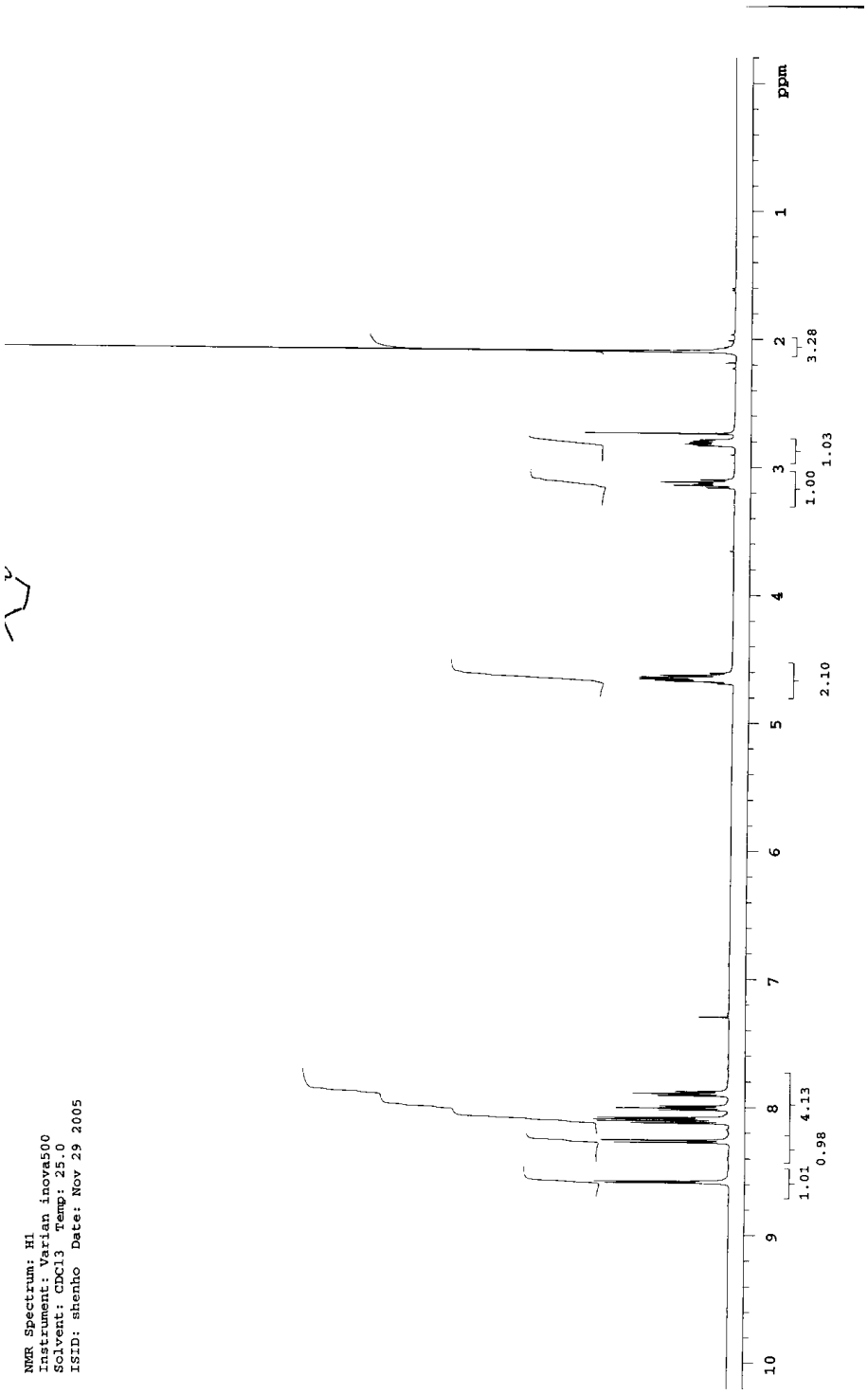

DAD: TIC
218.2
1.00
9.0e+007
Time
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00


DAD: 254
1.00
2.2e+006
Time
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00

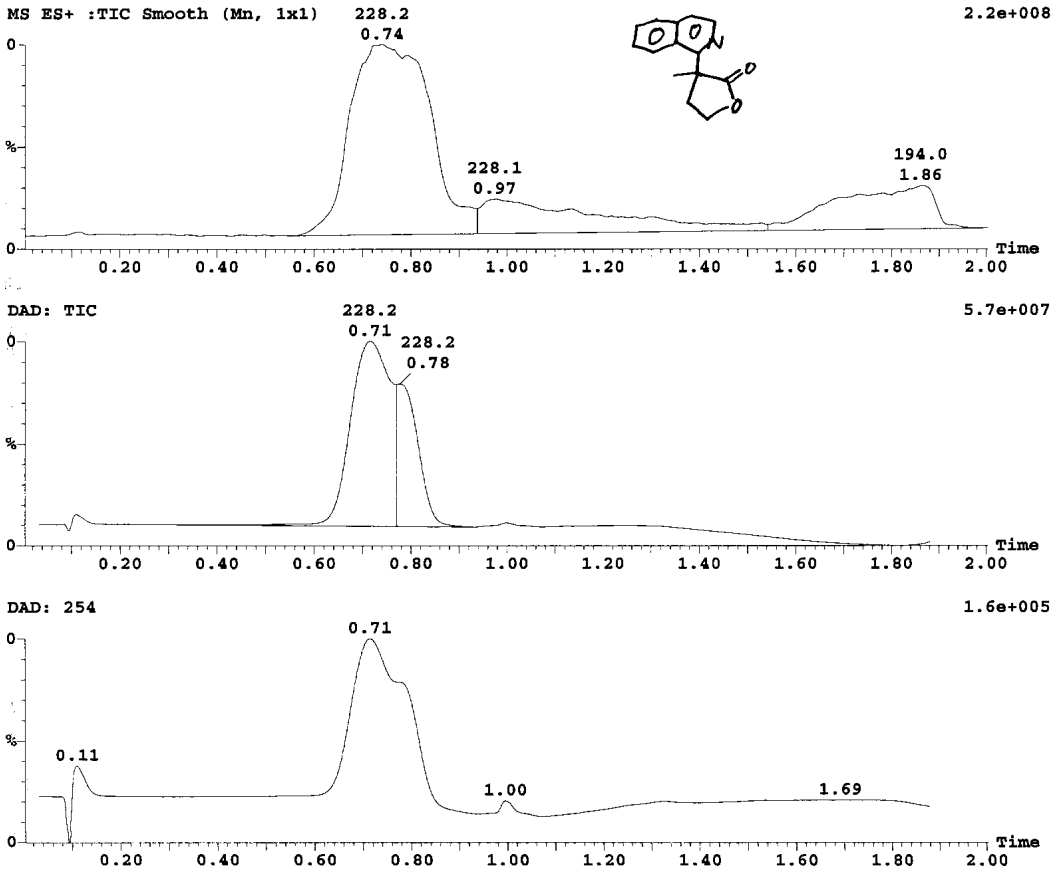

e: 0.99) Combine (189:205)
1:MS ES+
1.1e+008
218.23
240.09
190.13
241.28
335.14
370.05
457.15
506.09
587.25
605.16
697.10
716.41
m/z
200.00
300.00
400.00
500.00
600.00
700.00

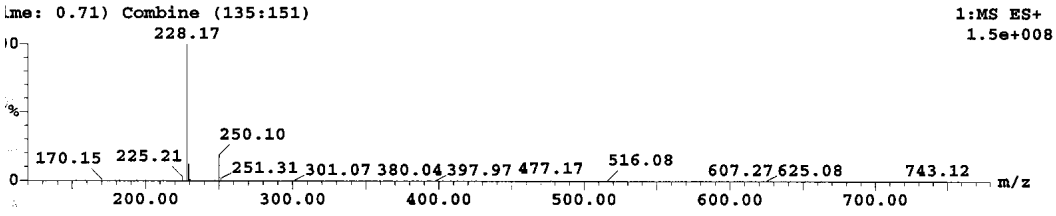

O
O
N
O

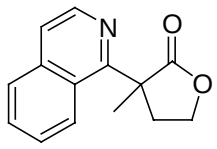
21


NMR Spectrum: H1
Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Nov 29 2005
ppm
1
2
3
4
5
6
7
8
9
10
3.28
1.00
1.03
2.10
1.01
4.13
0.98
N
O
O

23


MS ES+ :TIC Smooth (Mn, 1x1)
228.2
0.74
228.1
0.97
194.0
1.86
2.2e+008
DAD: TIC
228.2
0.71
228.2
0.78
5.7e+007
DAD: 254
0.71
0.11
1.00
1.69
1.6e+005
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00


Lme: 0.71) Combine (135:151)
228.17
250.10
170.15 225.21
251.31 301.07 380.04 397.97 477.17 516.08 607.27 625.08 743.12
1:MS ES+
1.5e+008
m/z
200.00 300.00 400.00 500.00 600.00 700.00



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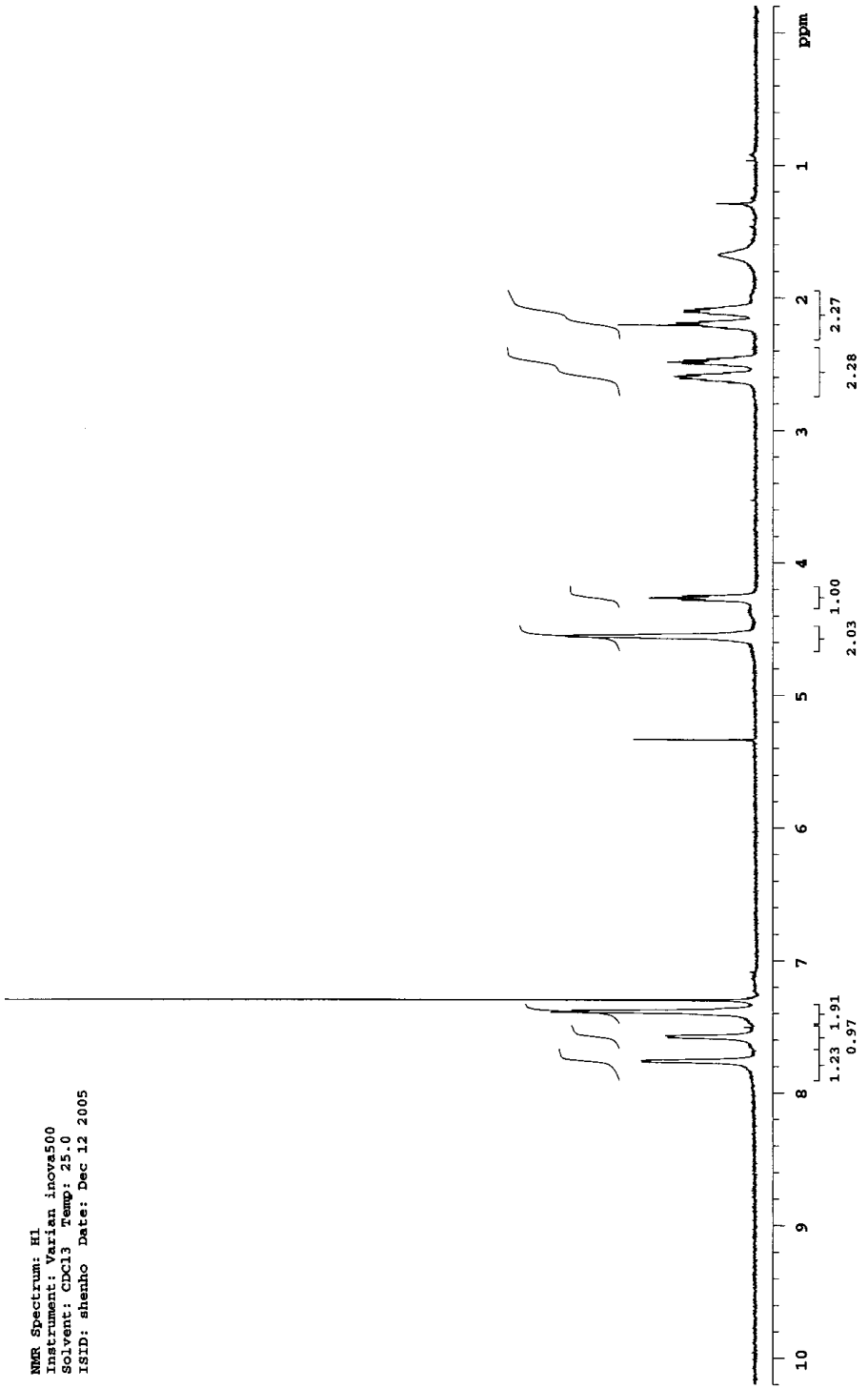
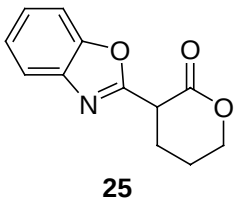
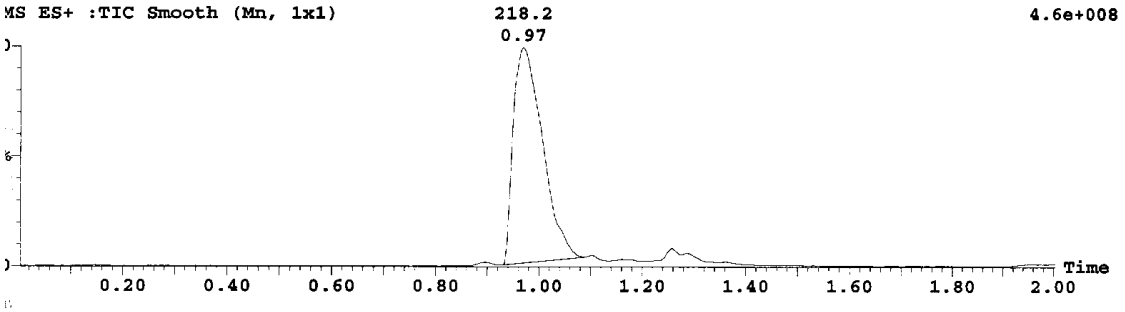
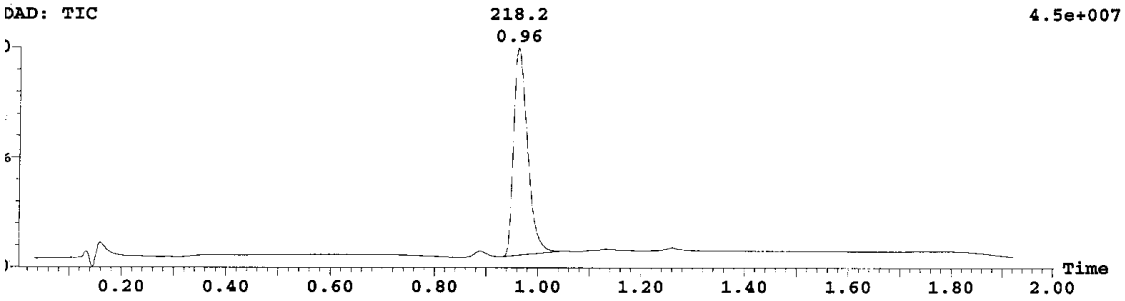
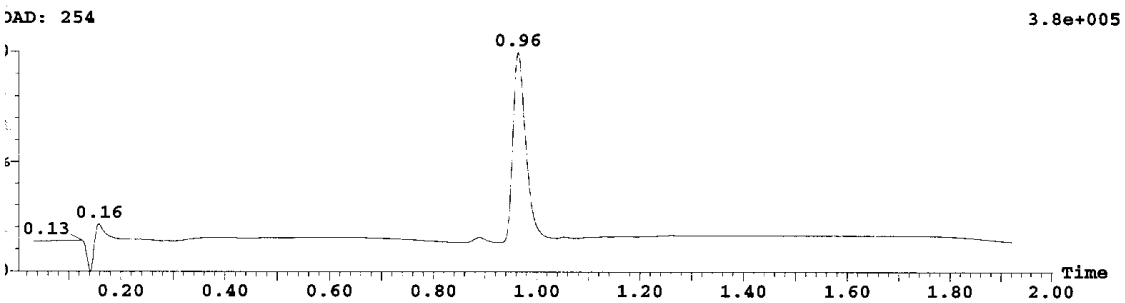

NMR Spectrum: H1
Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Dec 12 2005
ppm
1.23 1.91
0.97
1.00
2.03
2.27
2.28

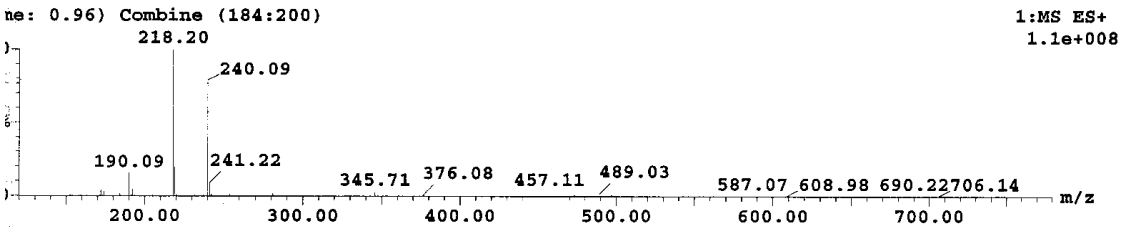

O
O
N
O

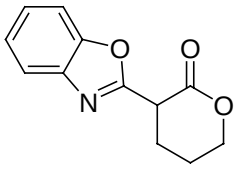
25


MS ES+ :TIC Smooth (Mn, 1x1)
218.2
0.97
4.6e+008
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00

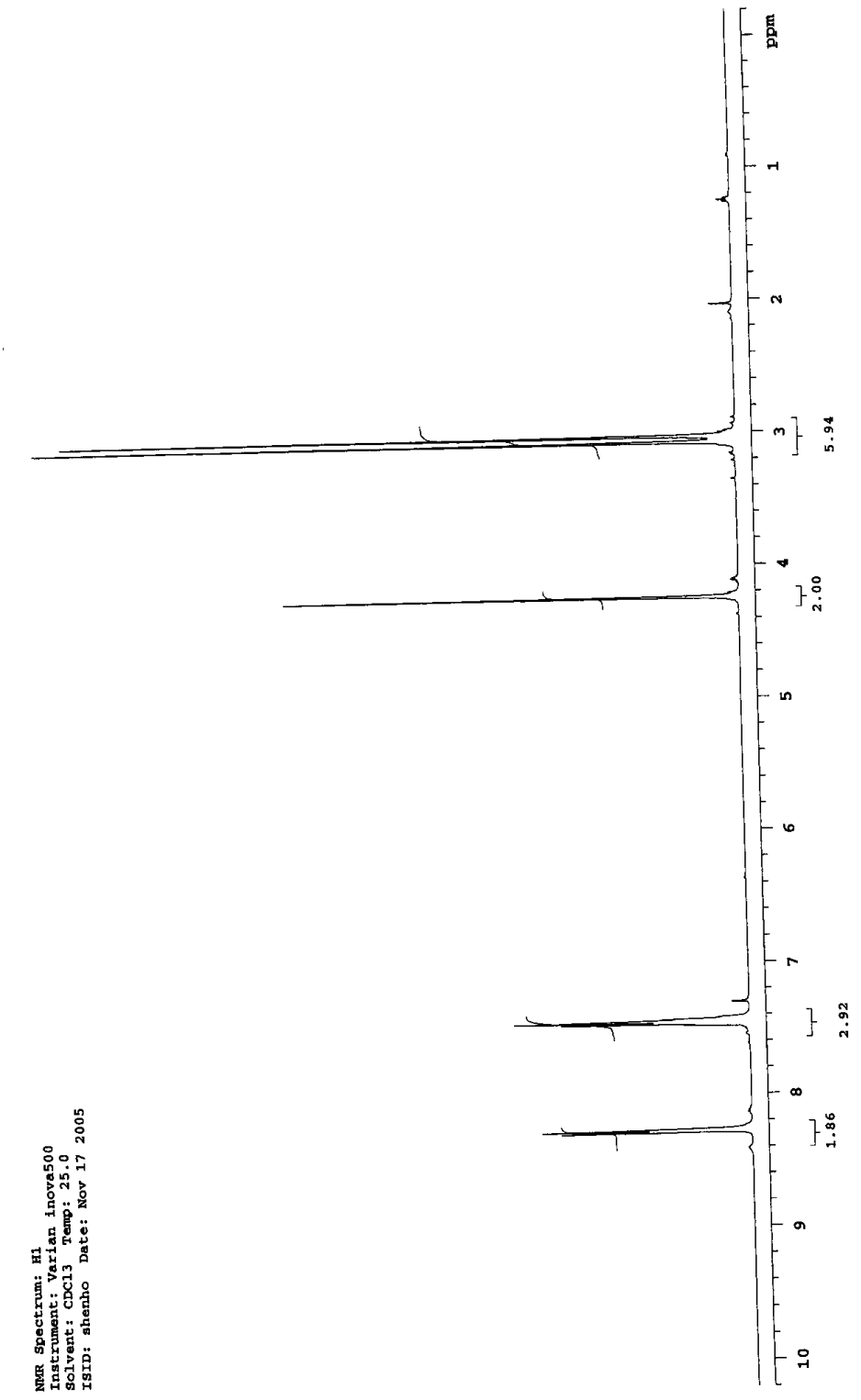

DAD: TIC
218.2
0.96
4.5e+007
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00

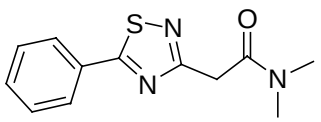

DAD: 254
0.96
3.8e+005
0.13
0.16
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00


ne: 0.96) Combine (184:200)
1:MS ES+
1.1e+008
218.20
240.09
190.09
241.22
345.71
376.08
457.11
489.03
587.07
608.98
690.22
706.14
m/z
200.00 300.00 400.00 500.00 600.00 700.00

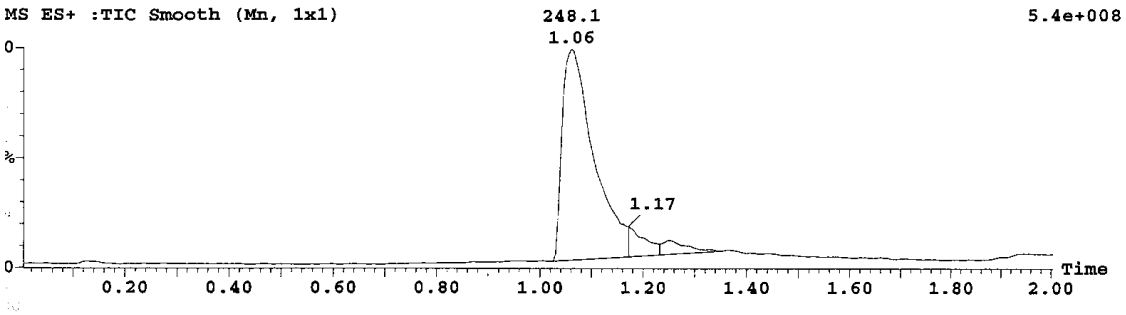

O
O
N
O

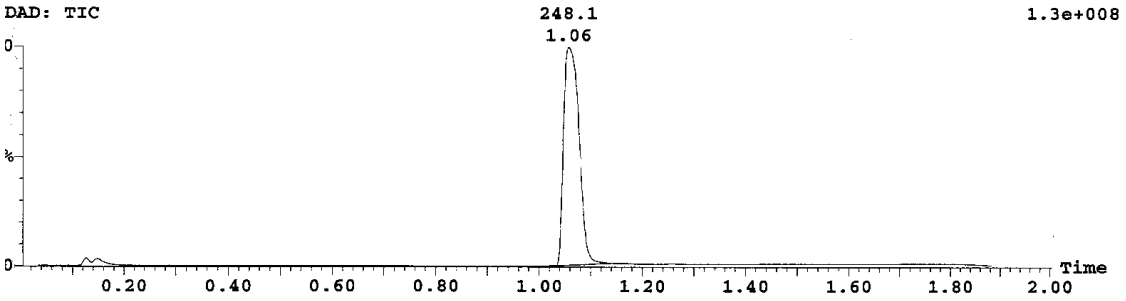
25

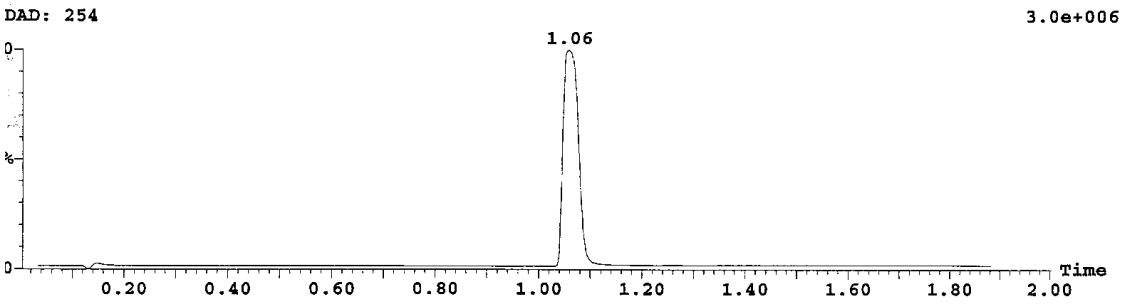

NMR Spectrum: H1
Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Nov 17 2005
ppm
1
2
3
4
5
6
7
8
9
10
5.94
2.00
2.92
1.86

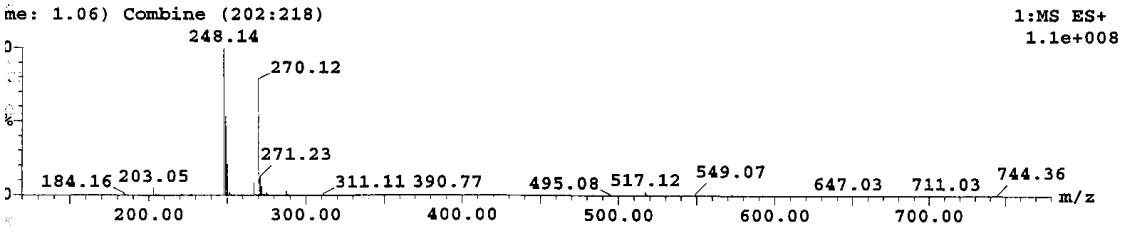

S
N
N
O
N

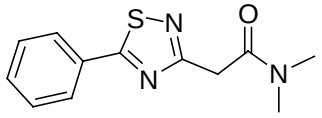
27


MS ES+ :TIC Smooth (Mn, 1x1)
248.1
1.06
5.4e+008
1.17
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00

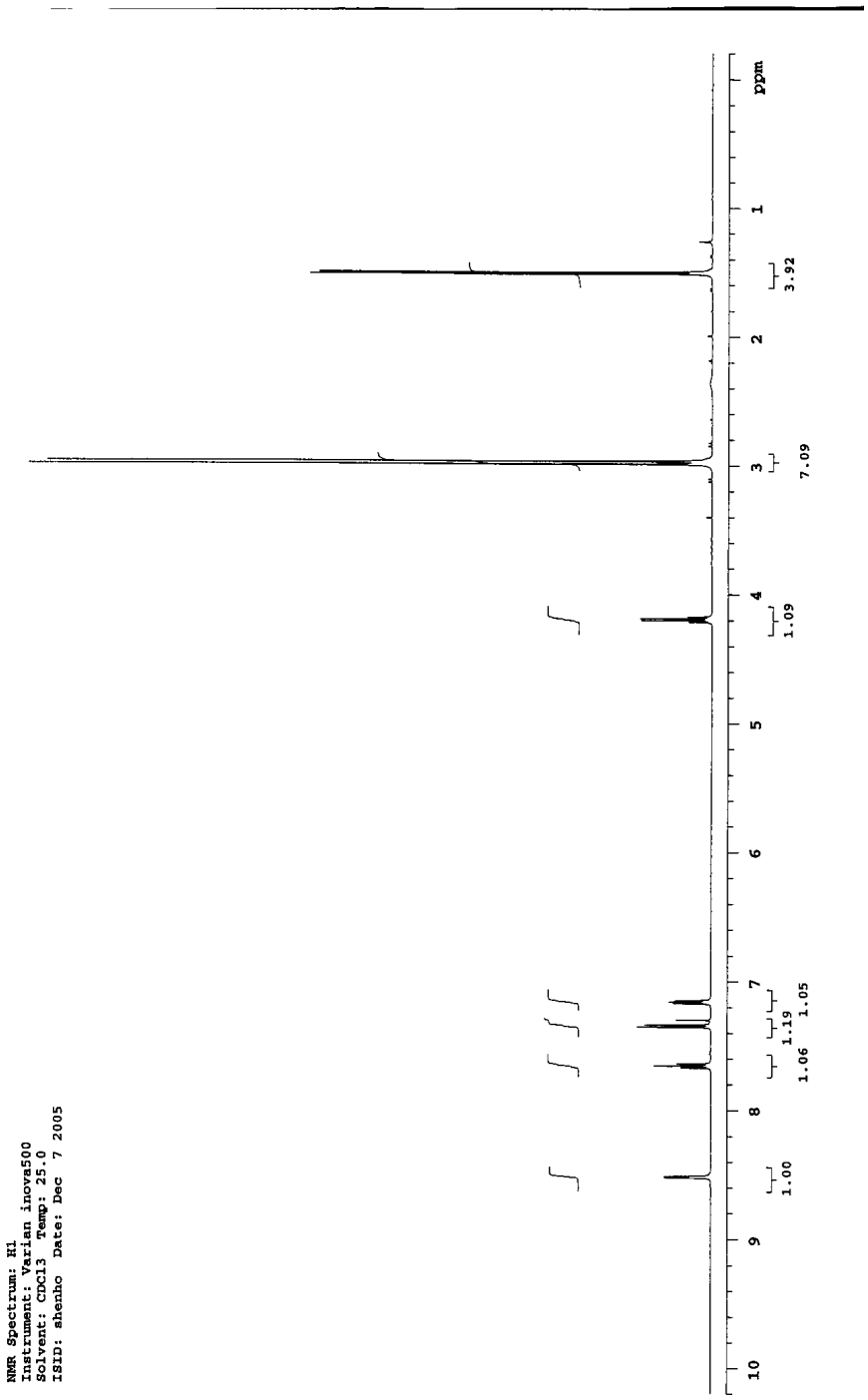

DAD: TIC
248.1
1.06
1.3e+008
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00

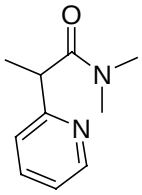

DAD: 254
3.0e+006
1.06
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00


me: 1.06) Combine (202:218)
1:MS ES+
1.1e+008
248.14
270.12
271.23
184.16 203.05 311.11 390.77 495.08 517.12 549.07 647.03 711.03 744.36
m/z
200.00 300.00 400.00 500.00 600.00 700.00


S
N
O
N
N

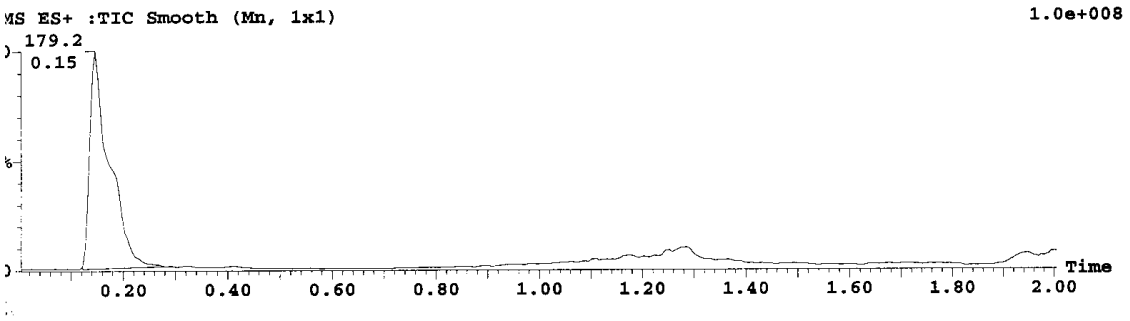
27


NMR Spectrum: H1
Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Dec 7 2005
ppm
1.00
1.06
1.19
1.05
1.09
7.09
3.92

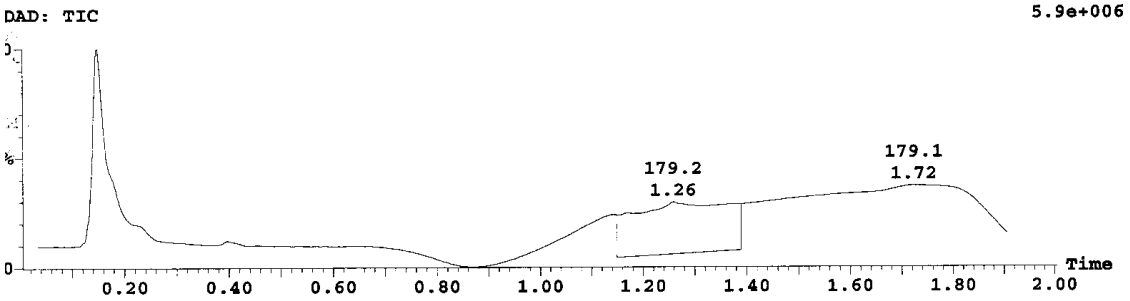

O
N
N

29

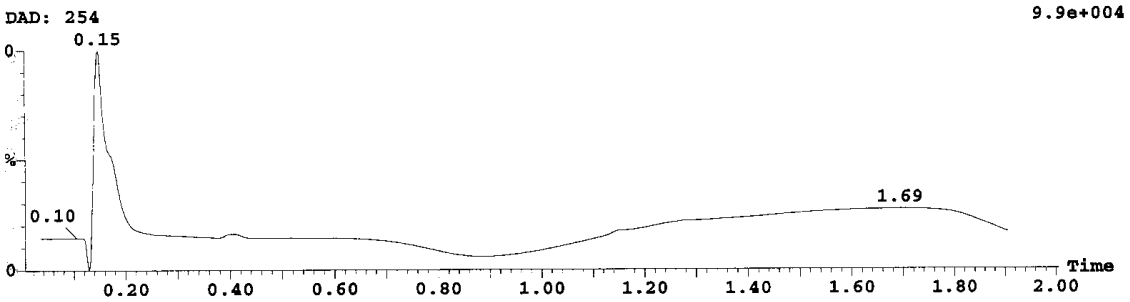
MS ES+ :TIC Smooth (Mn, 1x1)



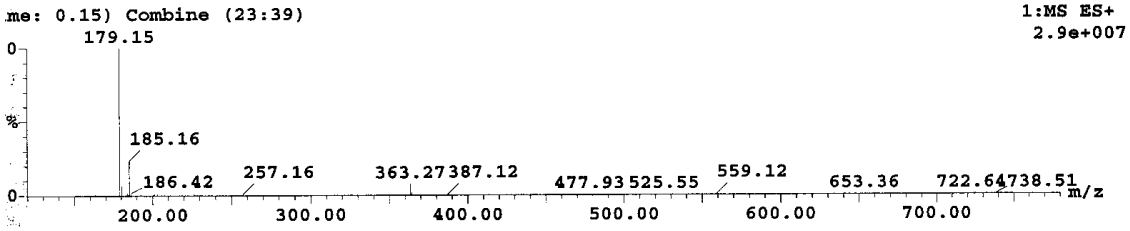
DAD: TIC

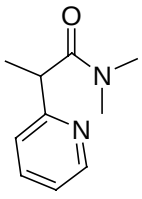


DAD: 254

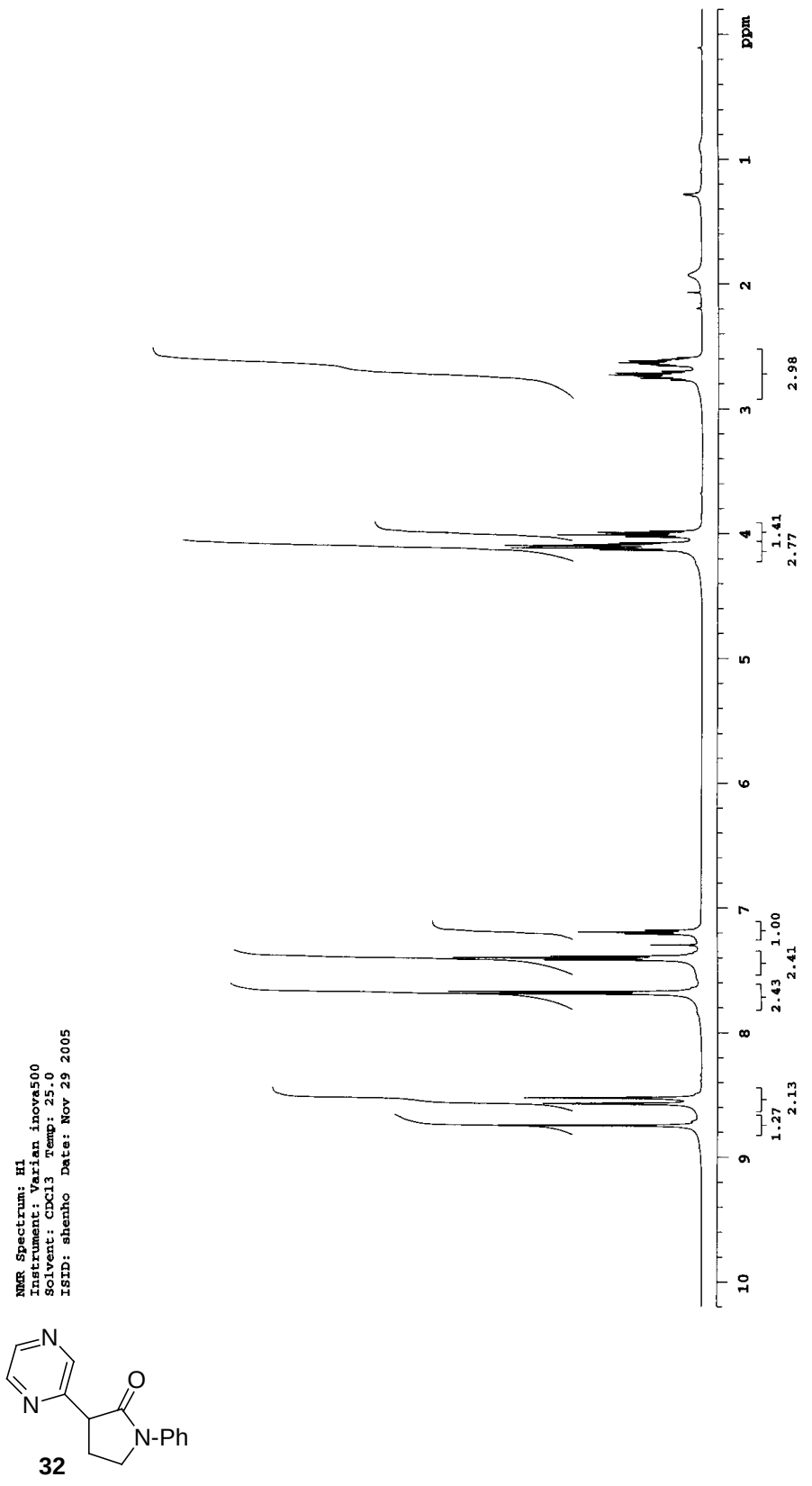


me: 0.15) Combine (23:39)

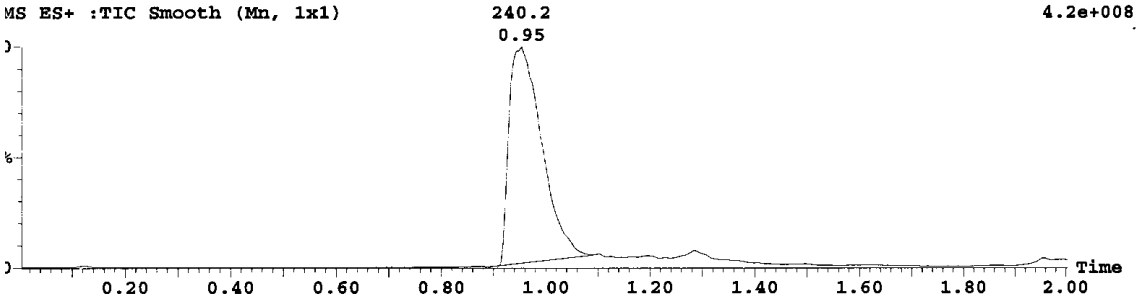


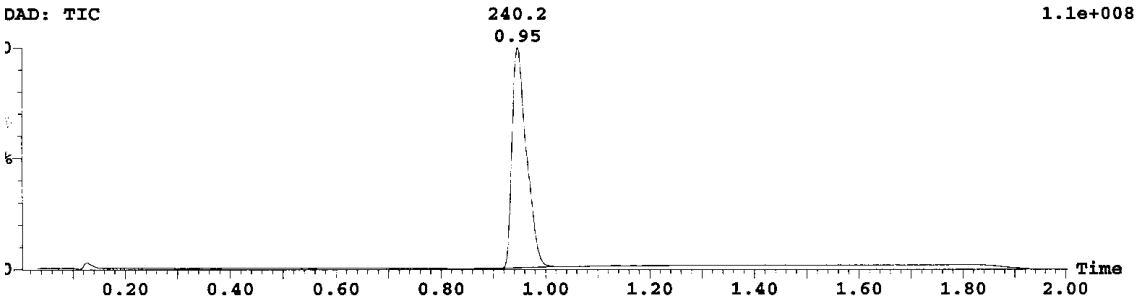


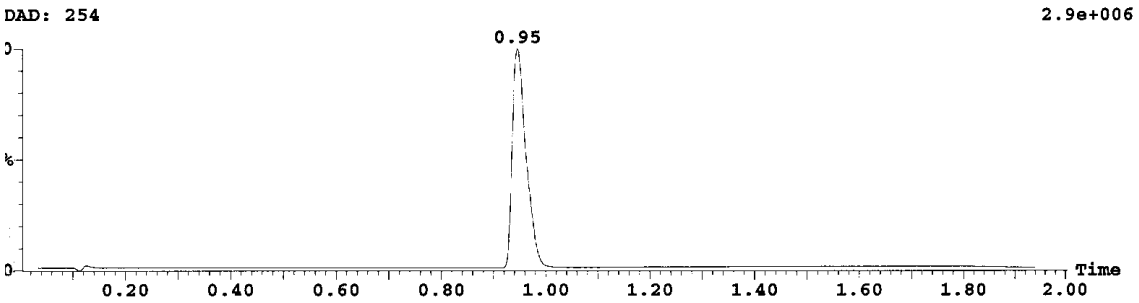
29

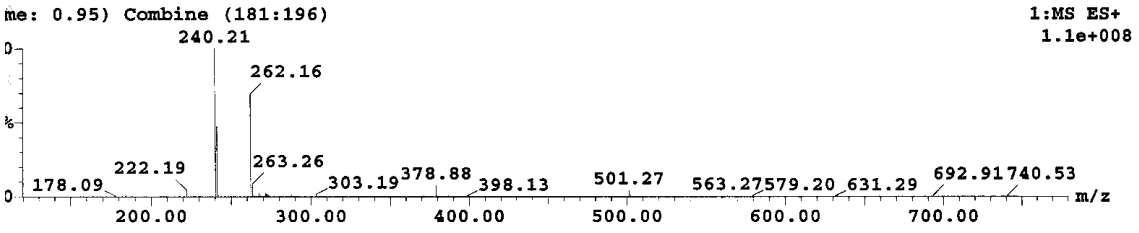

NMR Spectrum: H1
Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Nov 29 2005
ppm
1.27
2.13
2.43
1.00
2.41
1.41
2.77
2.98
N
N
O
N-Ph

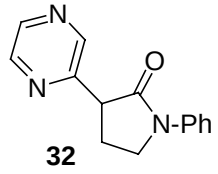
32


MS ES+ :TIC Smooth (Mn, 1x1)
240.2
0.95
4.2e+008
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00

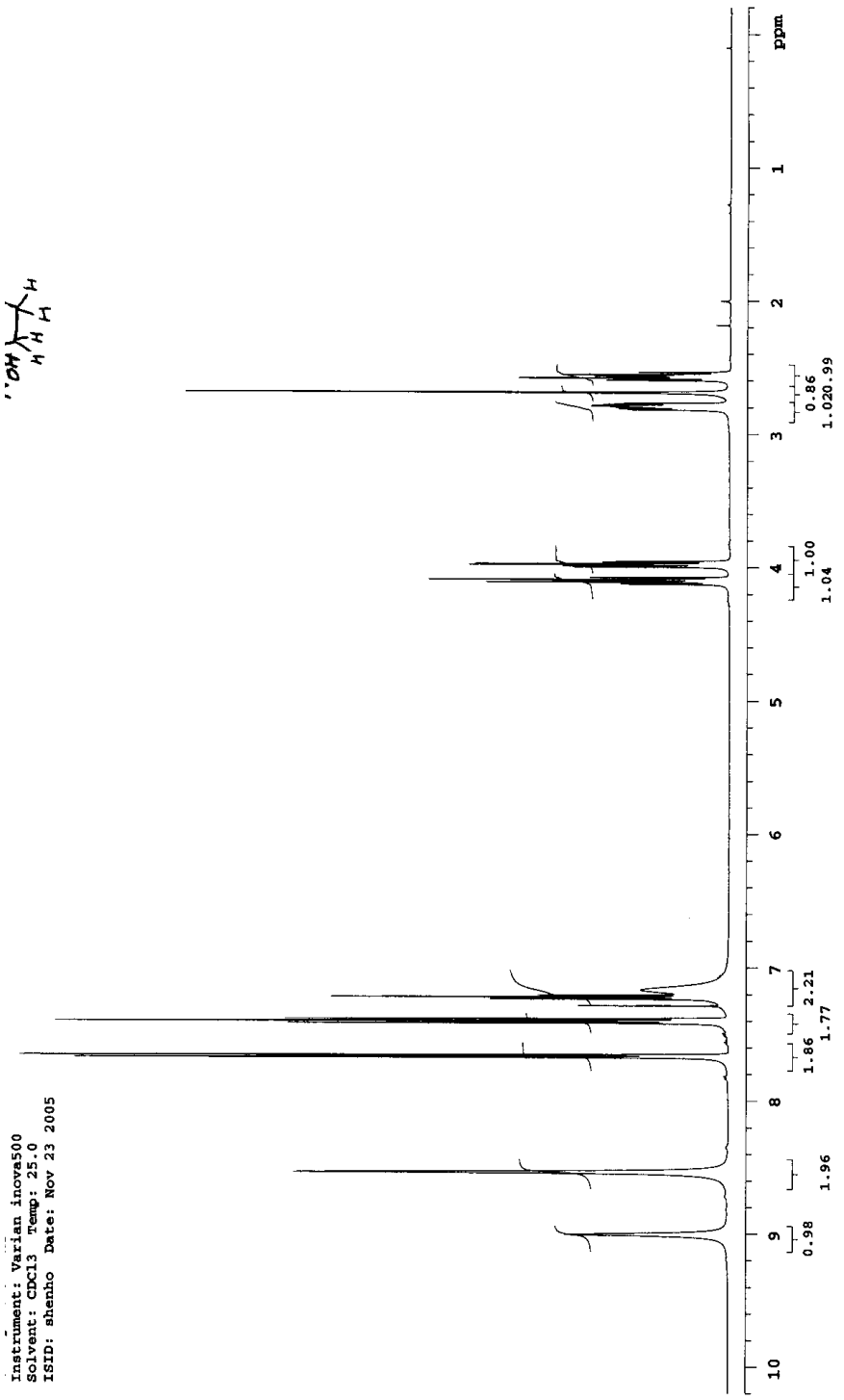

DAD: TIC
240.2
0.95
1.1e+008
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00

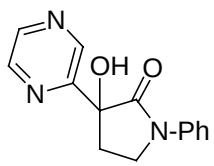

DAD: 254
0.95
2.9e+006
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00


me: 0.95) Combine (181:196)
1:MS ES+
1.1e+008
240.21
262.16
222.19
263.26
178.09
303.19
378.88
398.13
501.27
563.27
579.20
631.29
692.91
740.53
m/z
200.00 300.00 400.00 500.00 600.00 700.00

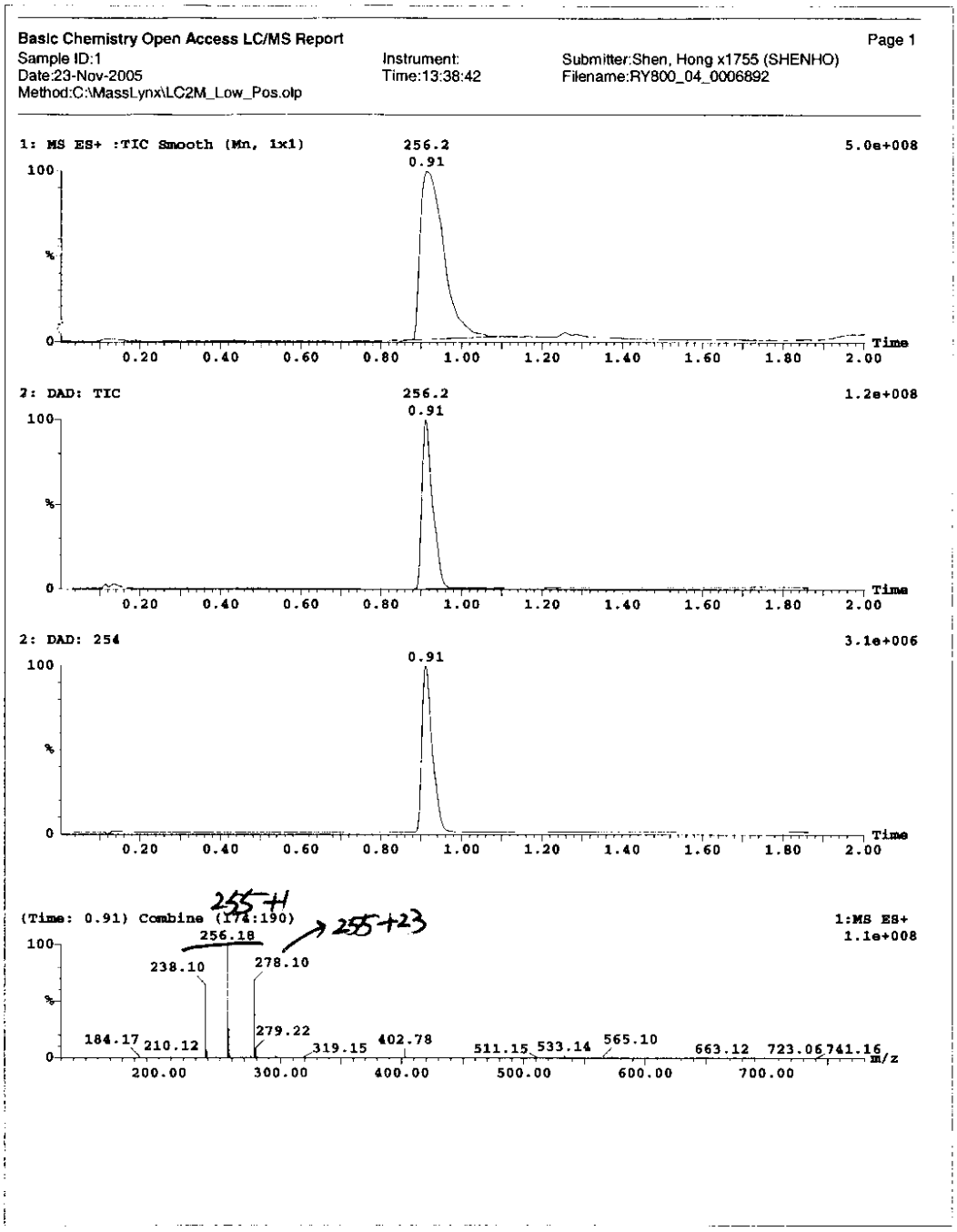

N
N
O
N-Ph

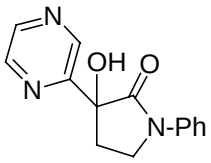
32


Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Nov 23 2005
ppm
1.96
1.86
2.21
1.77
1.00
1.04
0.86
1.020.99
0.98

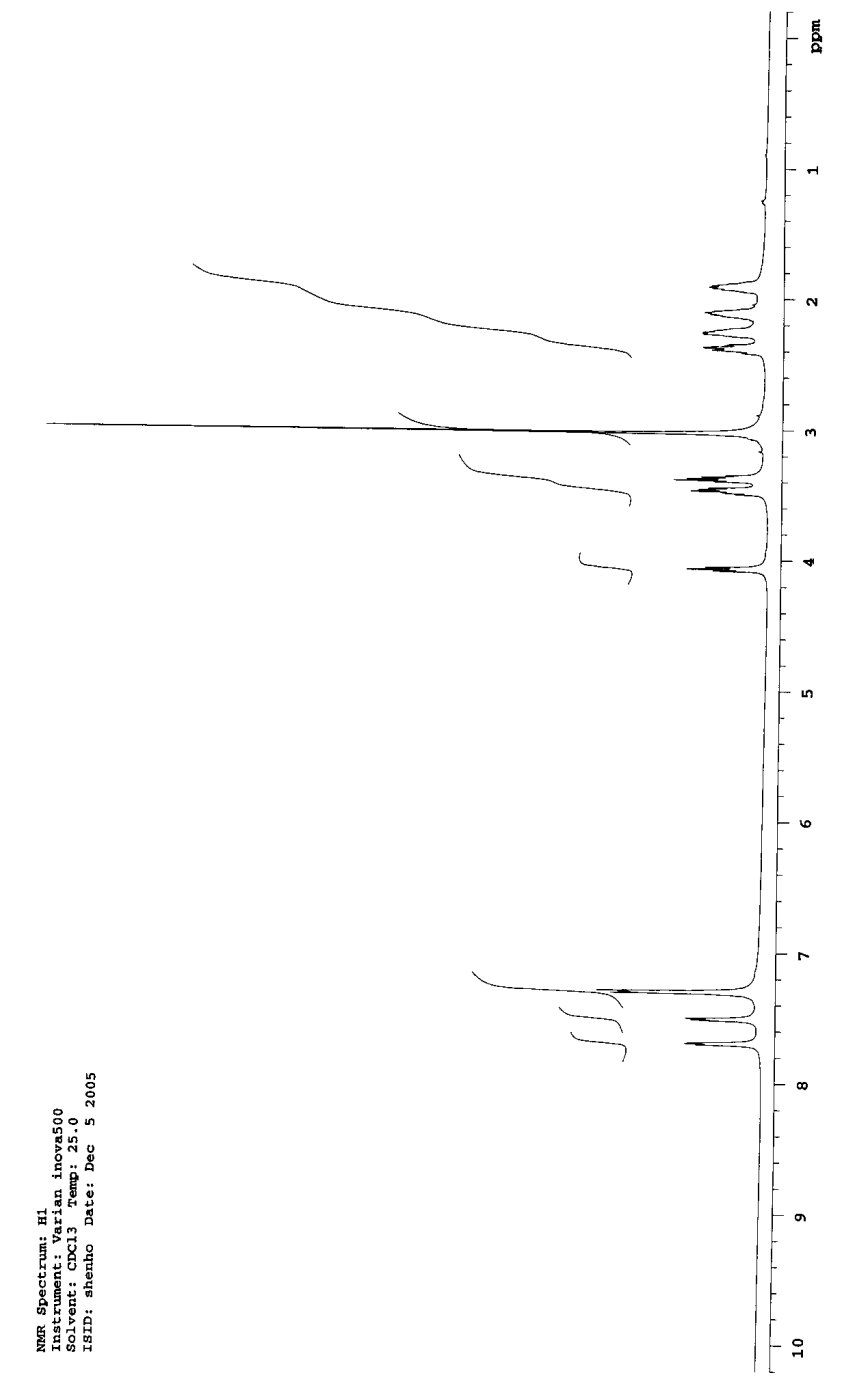

N
OH
O
N
N-Ph

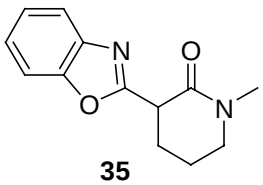
33


Basic Chemistry Open Access LC/MS Report
Page 1
Sample ID:1
Instrument:
Submitter:Shen, Hong x1755 (SHENHO)
Date:23-Nov-2005
Time:13:38:42
Filename:RY800_04_0006892
Method:C:\MassLynx\LC2M_Low_Pos.olp
1: MS ES+ :TIC Smooth (Mn, 1x1)
256.2
0.91
5.0e+008
2: DAD: TIC
256.2
0.91
1.2e+008
2: DAD: 254
0.91
3.1e+006
(Time: 0.91) Combine (174:190)
255+1
255+23
256.18
238.10
278.10
279.22
184.17
210.12
319.15
402.78
511.15
533.14
565.10
663.12
723.06
741.16
1:MS ES+
1.1e+008
m/z
Time

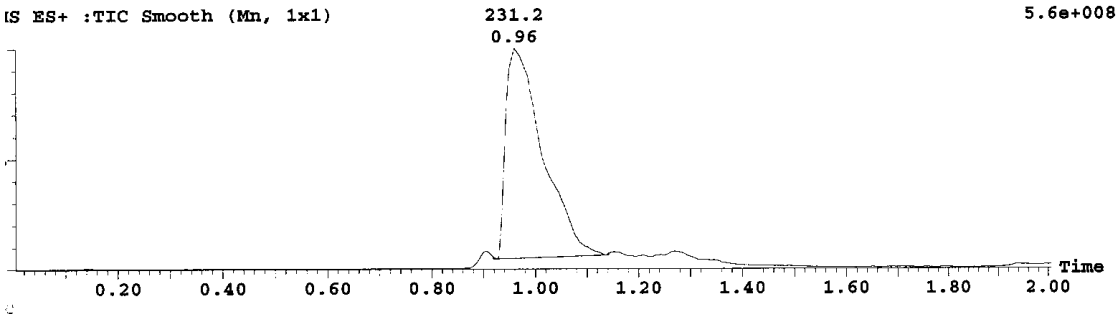

N
OH
O
N
N-Ph

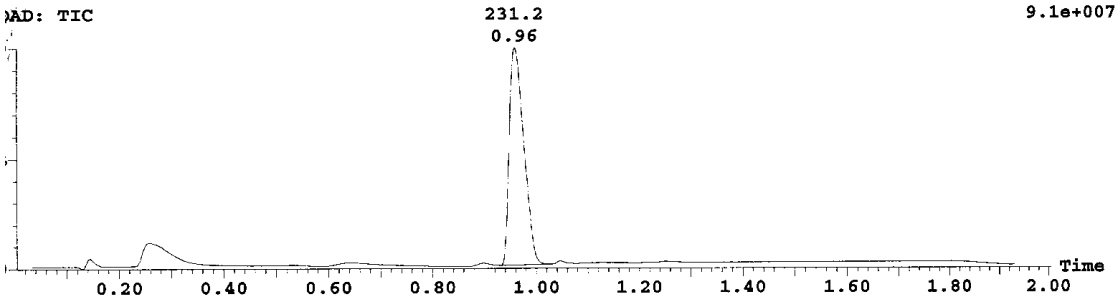
33

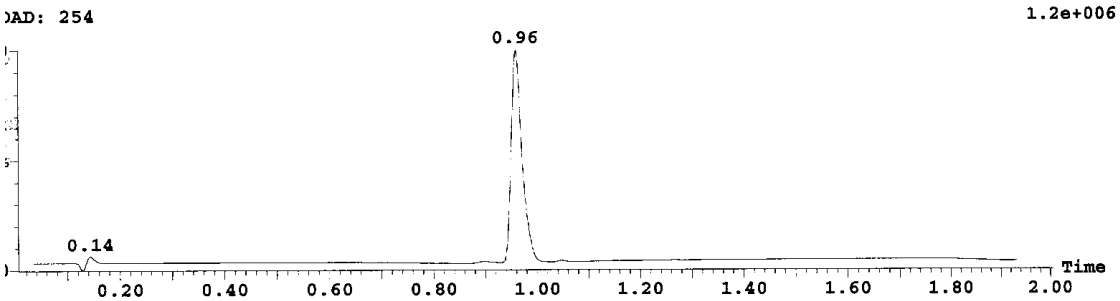

NMR Spectrum: H1
Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Dec 5 2005
ppm
1
2
3
4
5
6
7
8
9
10

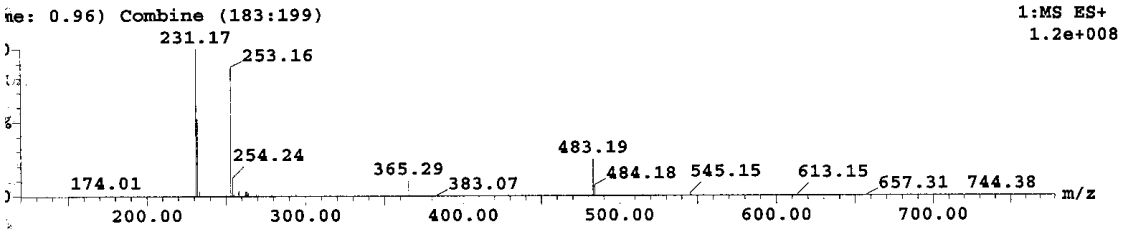

N
O
O
N

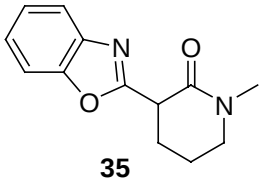
35


IS ES+ :TIC Smooth (Mn, 1x1)
231.2
0.96
5.6e+008
Time
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00

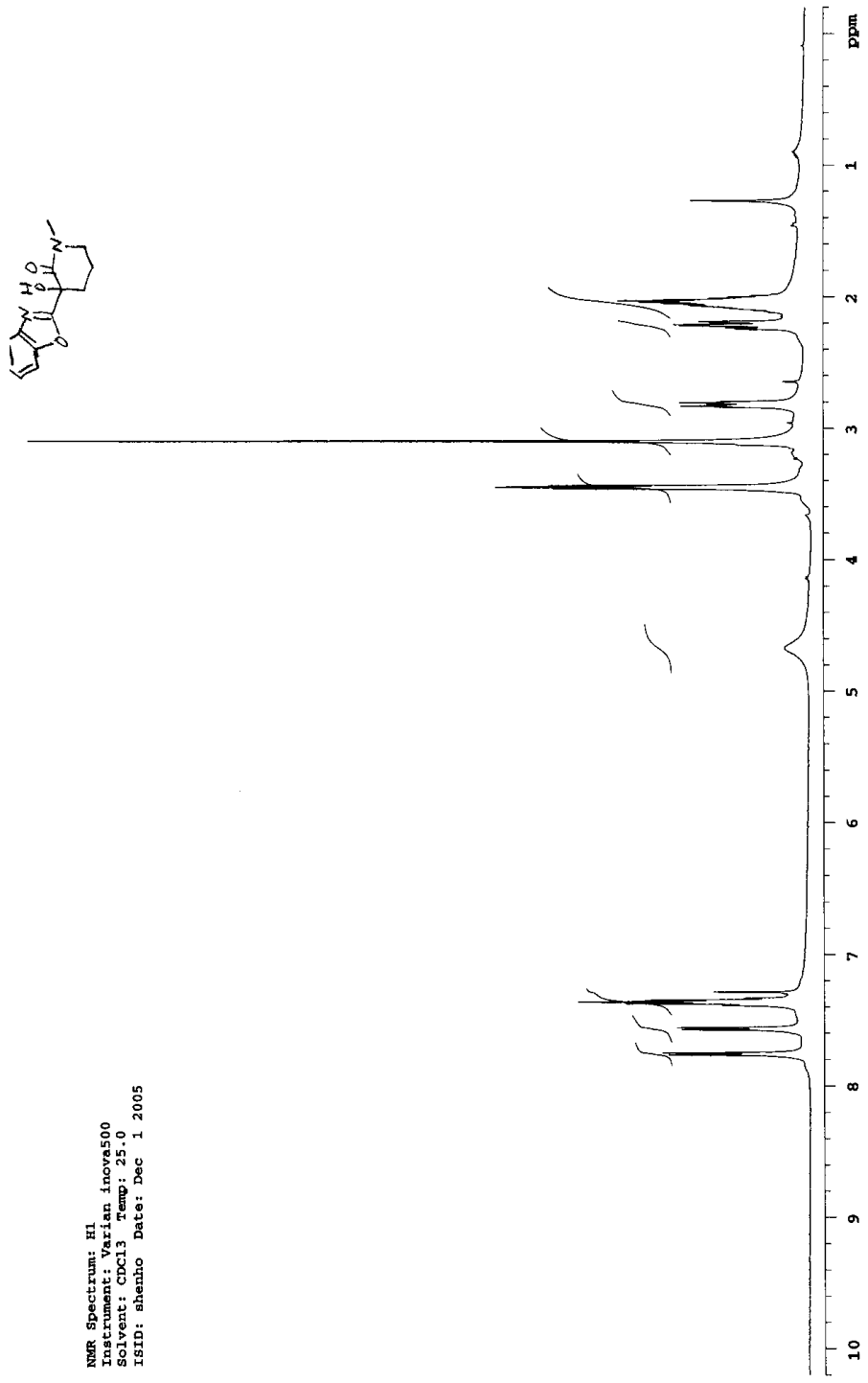

AD: TIC
231.2
0.96
9.1e+007
Time
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00

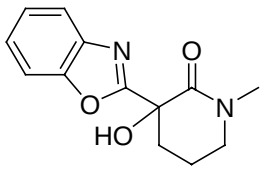

AD: 254
0.96
1.2e+006
0.14
Time
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00


ne: 0.96) Combine (183:199)
1:MS ES+
1.2e+008
231.17
253.16
254.24
174.01
365.29
383.07
483.19
484.18
545.15
613.15
657.31
744.38
m/z
200.00
300.00
400.00
500.00
600.00
700.00

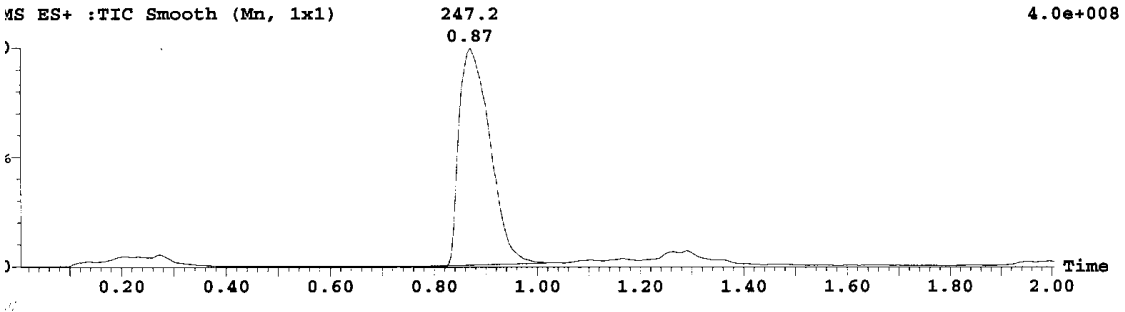

N
O
O
N

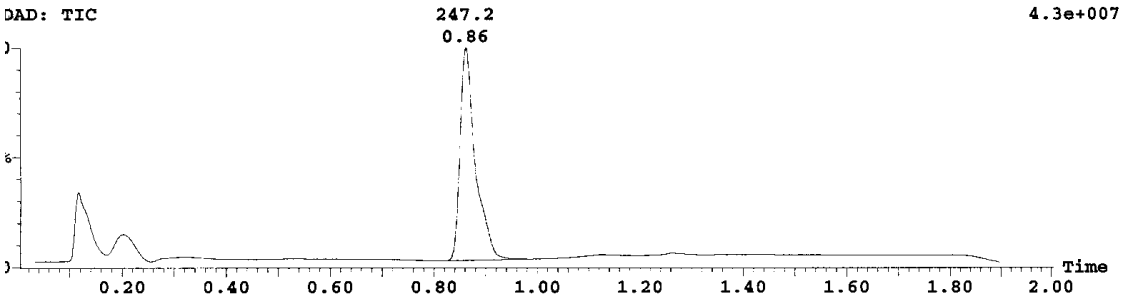
35

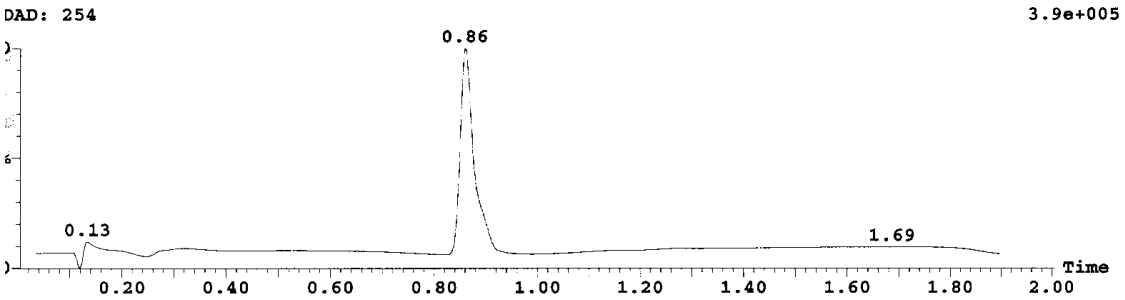

NMR Spectrum: H1
Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Dec 1 2005
ppm
1
2
3
4
5
6
7
8
9
10

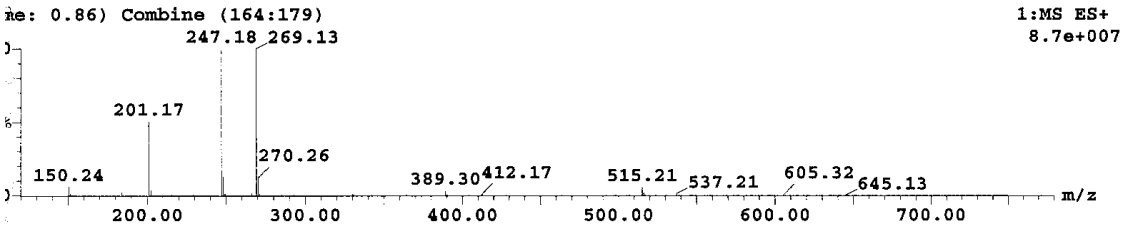

N
O
O
N
HO

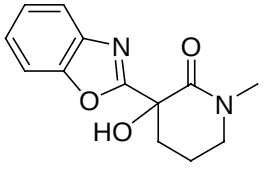
36


MS ES+ :TIC Smooth (Mn, 1x1)
247.2
0.87
4.0e+008
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00

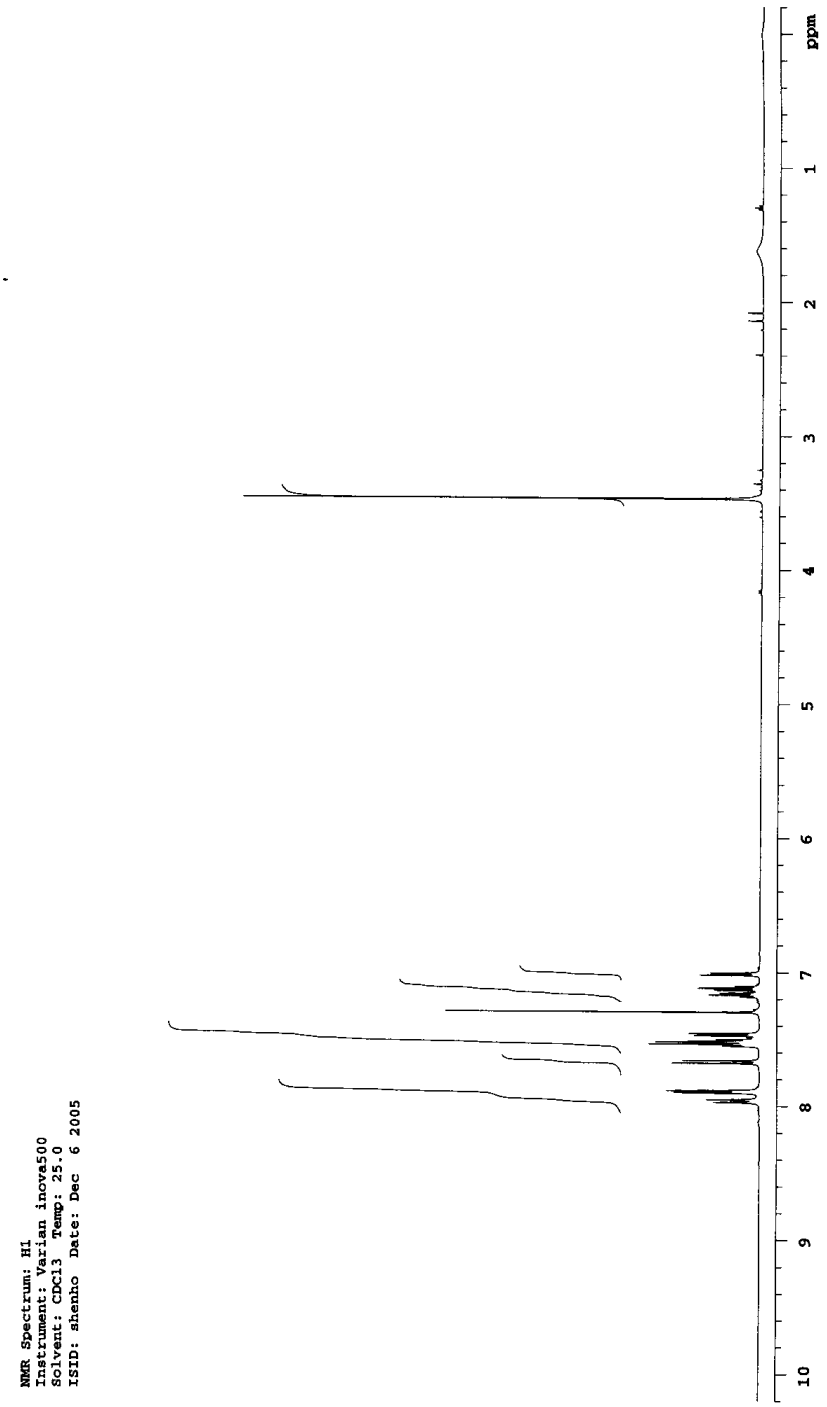

DAD: TIC
247.2
0.86
4.3e+007
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00

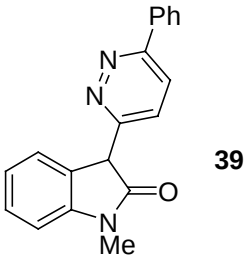

DAD: 254
0.86
3.9e+005
0.13
1.69
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00


ne: 0.86) Combine (164:179)
1:MS ES+
8.7e+007
247.18
269.13
201.17
270.26
150.24
389.30
412.17
515.21
537.21
605.32
645.13
m/z
200.00 300.00 400.00 500.00 600.00 700.00

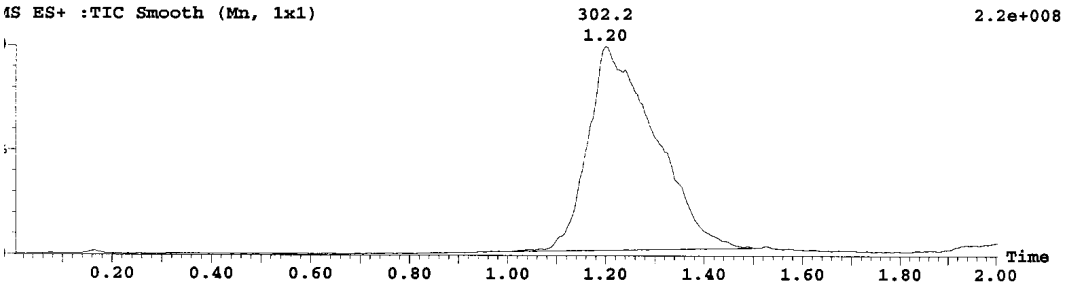

N
O
O
N
HO

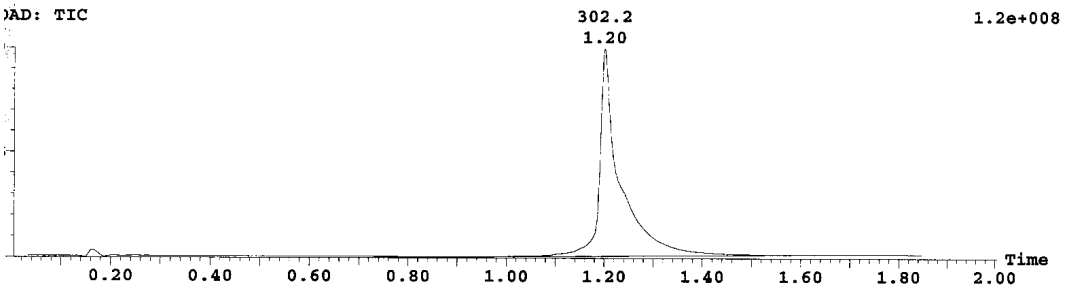
36

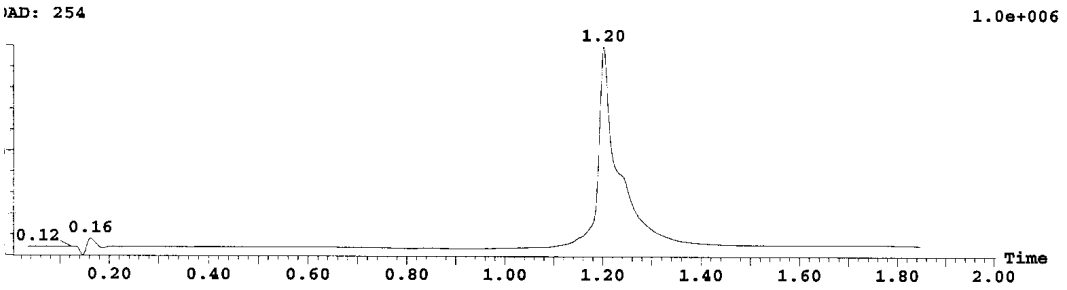

NMR Spectrum: H1
Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Dec 6 2005
ppm
10
9
8
7
6
5
4
3
2
1

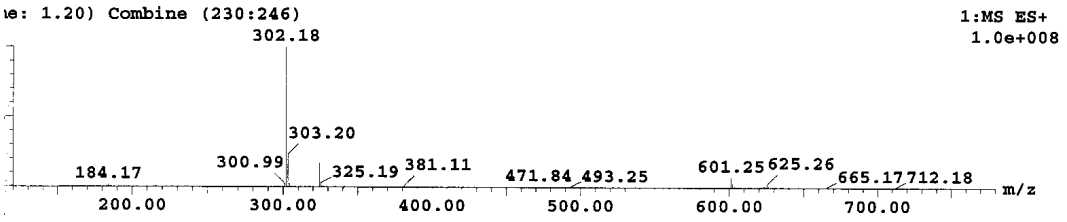

Ph
N
N
O
N
Me

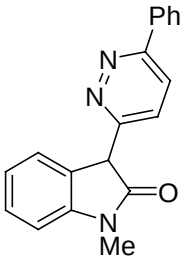
39


1S ES+ :TIC Smooth (Mn, 1x1)
302.2
1.20
2.2e+008
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00

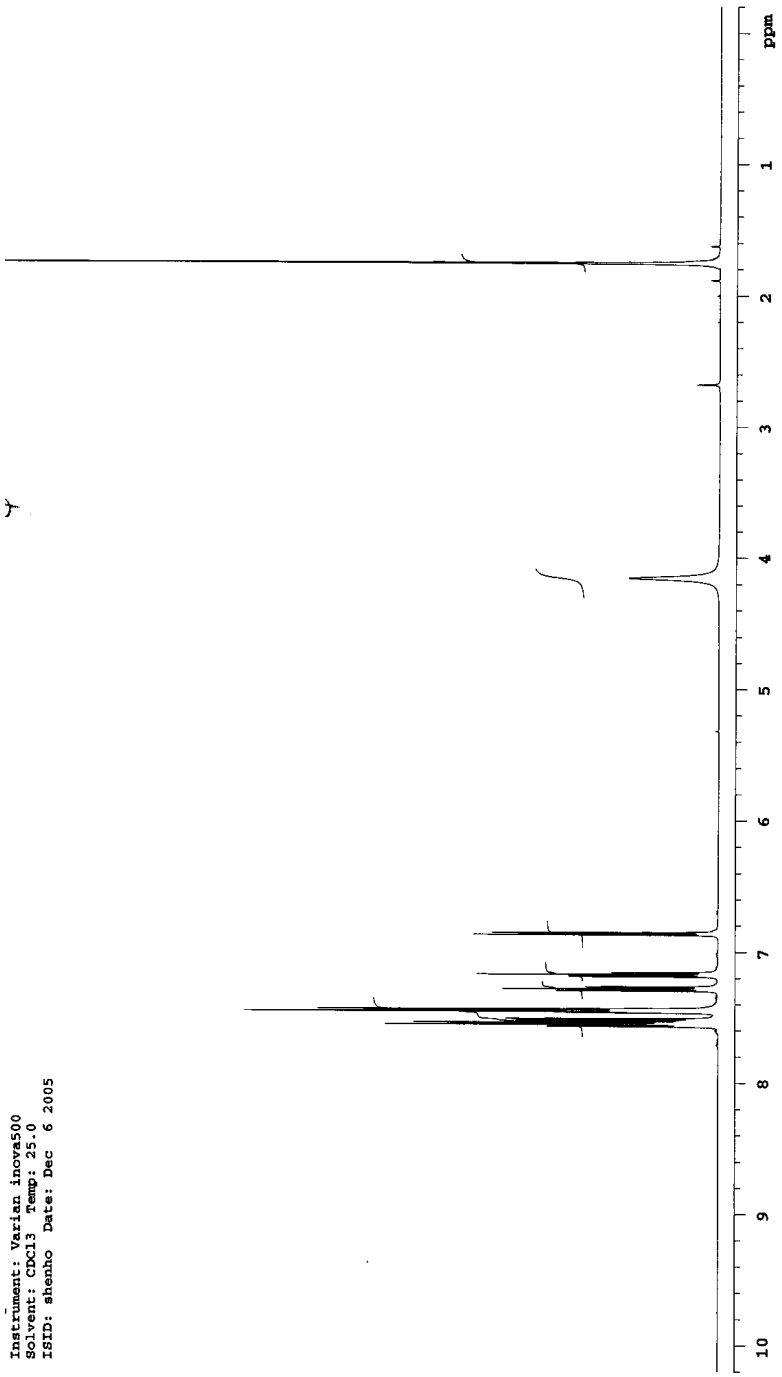

DAD: TIC
302.2
1.20
1.2e+008
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00

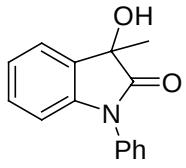

DAD: 254
1.20
1.0e+006
0.12
0.16
Time
0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00


1e: 1.20) Combine (230:246)
1:MS ES+
1.0e+008
302.18
303.20
184.17
300.99
325.19
381.11
471.84
493.25
601.25
625.26
665.17
712.18
m/z
200.00 300.00 400.00 500.00 600.00 700.00

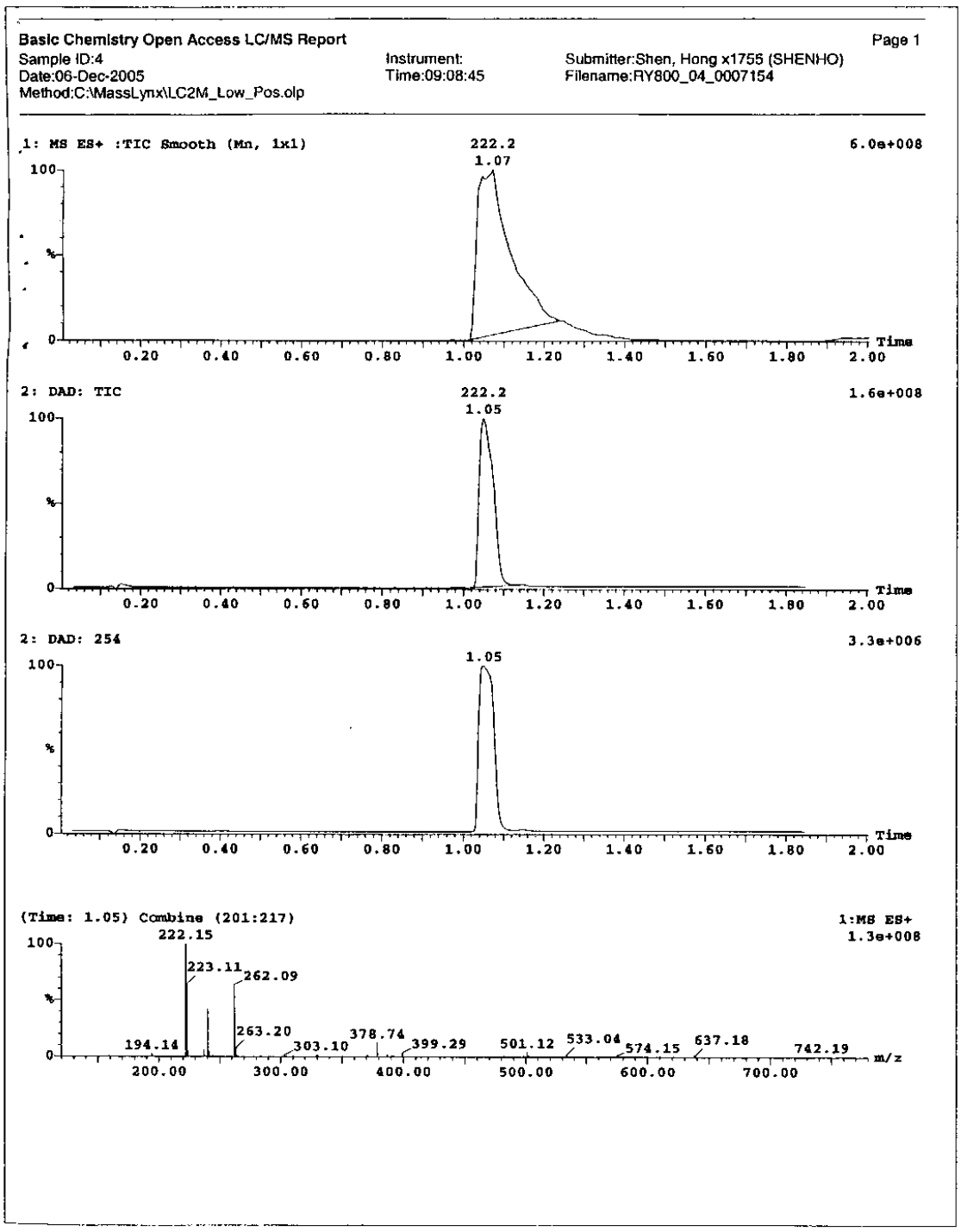

Ph
N
N
O
N
Me

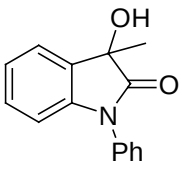
39


Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Dec 6 2005
ppm
1
2
3
4
5
6
7
8
9
10

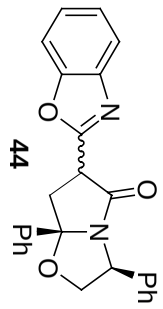

OH
O
N
Ph

42


Basic Chemistry Open Access LC/MS Report
Page 1
Sample ID:4
Instrument:
Submitter:Shen, Hong x1755 (SHENHO)
Date:06-Dec-2005
Time:09:08:45
Filename:RY800_04_0007154
Method:C:\MassLynx\LC2M_Low_Pos.olp
1: MS ES+ :TIC Smooth (Mn, 1x1)
222.2
1.07
6.0e+008
2: DAD: TIC
222.2
1.05
1.6e+008
2: DAD: 254
1.05
3.3e+006
Time
(Time: 1.05) Combine (201:217)
1:MS ES+
1.3e+008
222.15
223.11
262.09
263.20
194.14
303.10
378.74
399.29
501.12
533.04
574.15
637.18
742.19
m/z

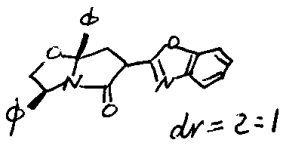

OH
O
N
Ph

42

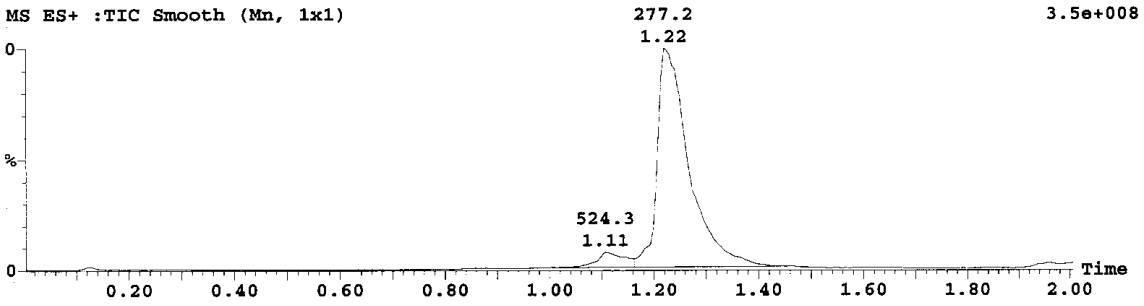


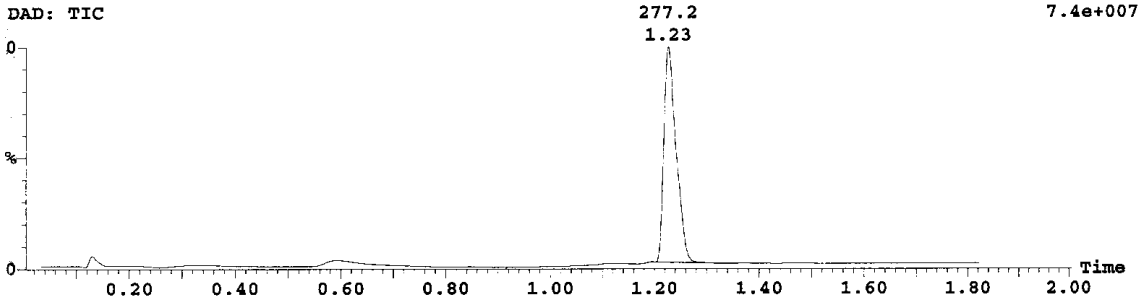
44

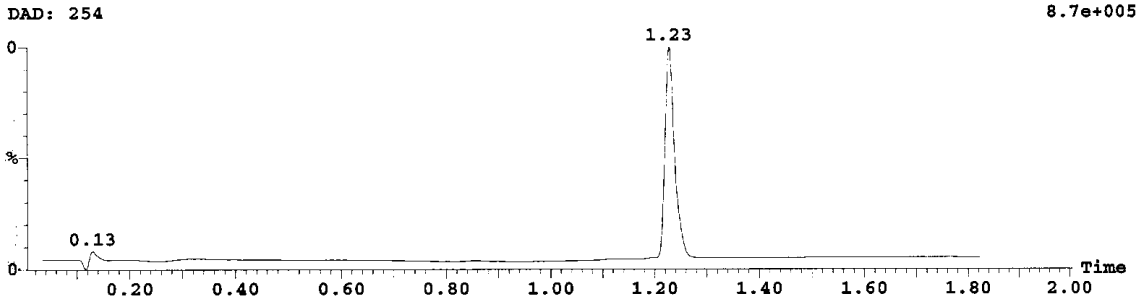
NMR Spectrum: H1
Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Nov 30 2005

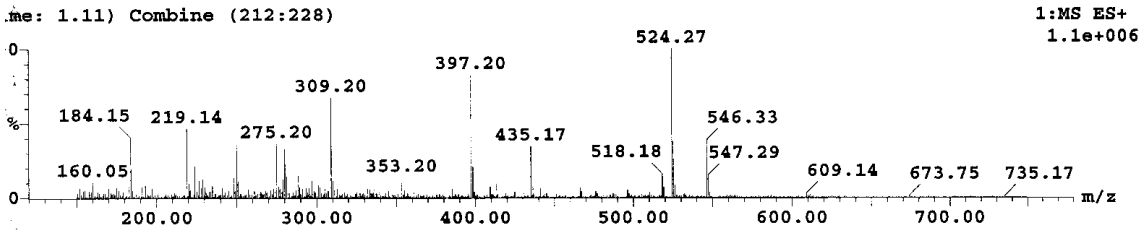


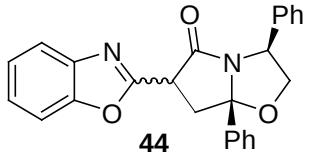
ıple ID:RY8004_005374-1 Instrument: Submitter:Shen, Hong x1755 (SHENHO)
:30-Nov-2005 Time:17:58:28 Filename:RY800_04_0006979
ıod:C:\MassLynx\LC2M_Low_Pos.olp





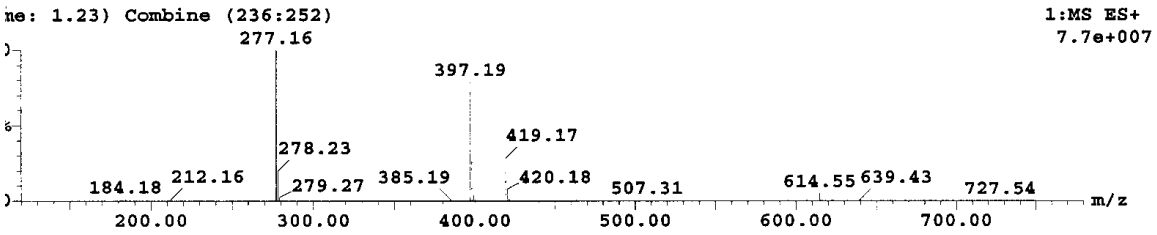


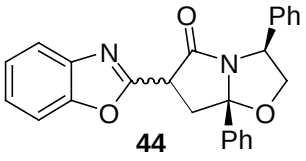




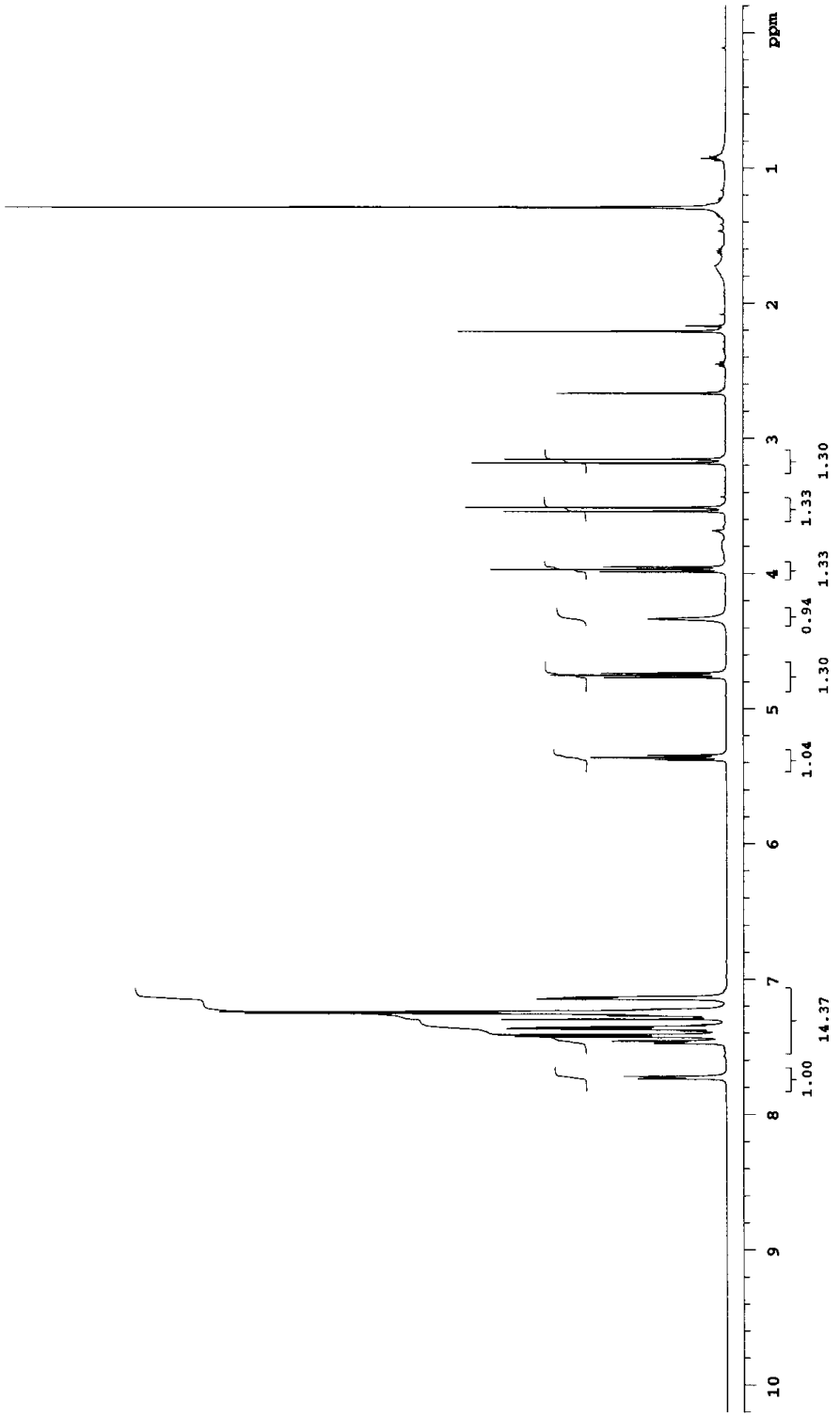
44

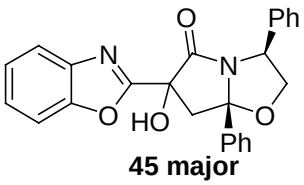
ple ID:RY8004_005374-1 Instrument: Submitter:Shen, Hong x1755 (SHENHO)
:30-Nov-2005 Time:17:58:28 Filename:RY800_04_0006979
ıod:C:\MassLynx\LC2M_Low_Pos.olp





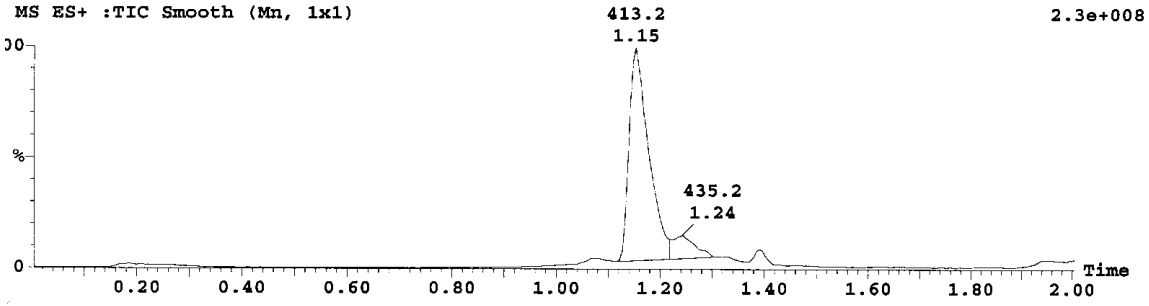
44

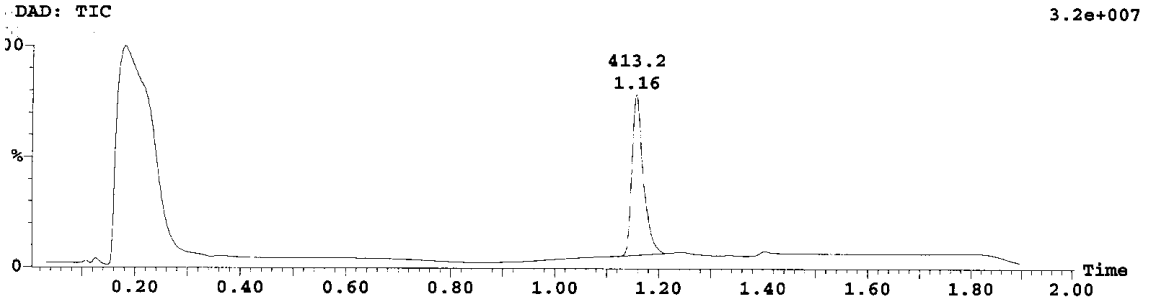

ppm
1
2
3
4
5
6
7
8
9
10
1.30
1.33
1.33
0.94
1.30
1.04
14.37
1.00

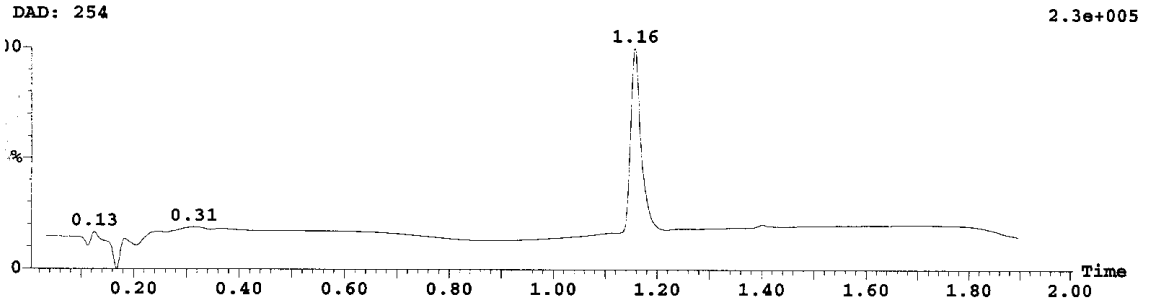

O
Ph
N
N
O
HO
O
Ph

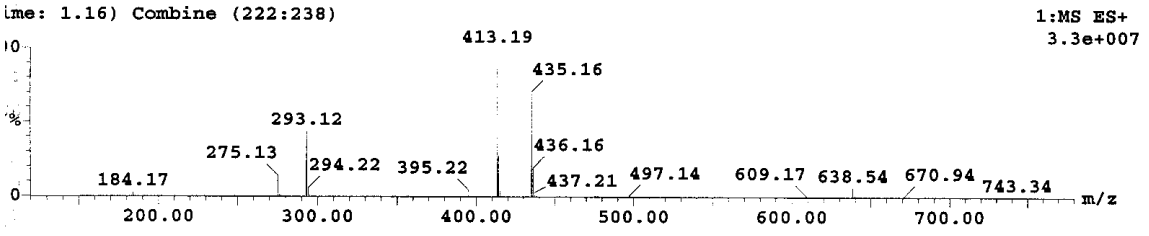
45 major

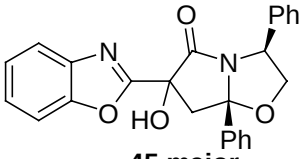
mple ID:RY8004_005376-1 Instrument: Submitter:Shen, Hong x1755 (SHENHO)
te:30-Nov-2005 Time:18:47:19 Filename:RY800_04_0006981
thod:C:\MassLynx\LC2M_Low_Pos.olp



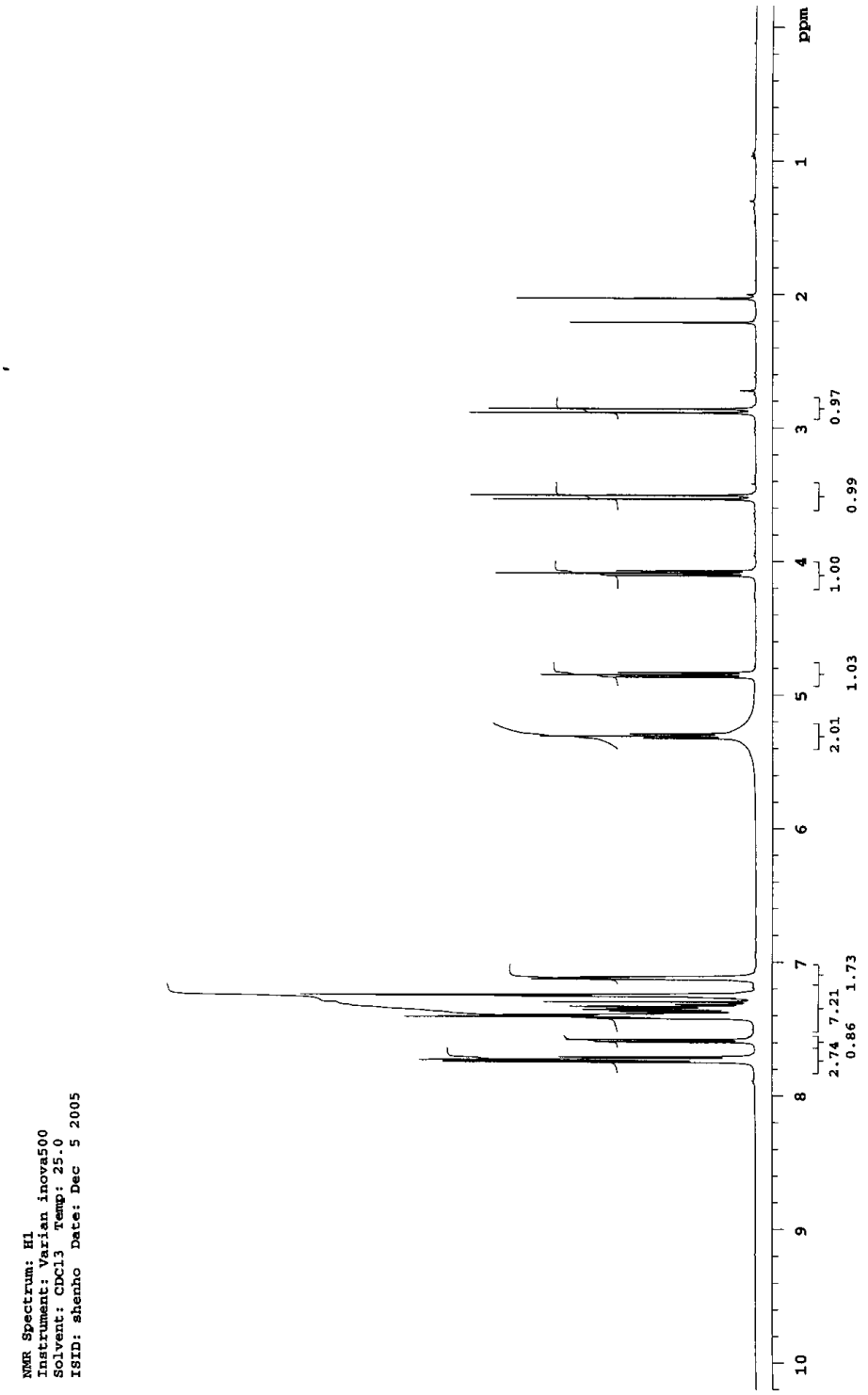


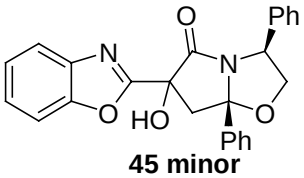




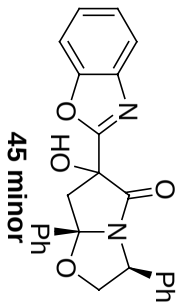


45 major

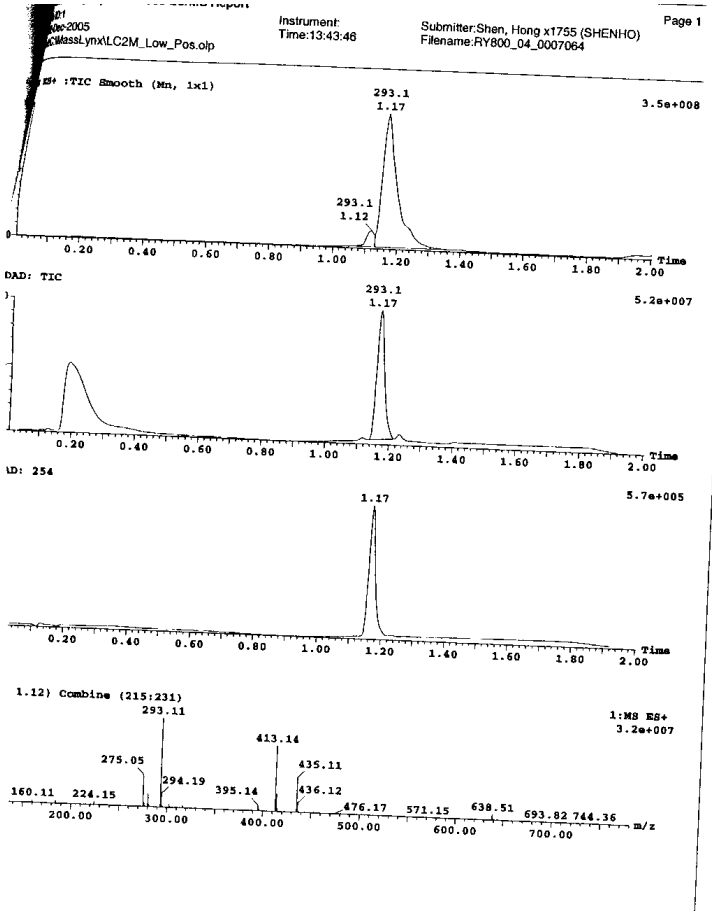

NMR Spectrum: H1
Instrument: Varian inova500
Solvent: CDCl3 Temp: 25.0
ISID: shenho Date: Dec 5 2005
ppm
2.74 7.21
0.86 1.73
2.01
1.03
1.00
0.99
0.97

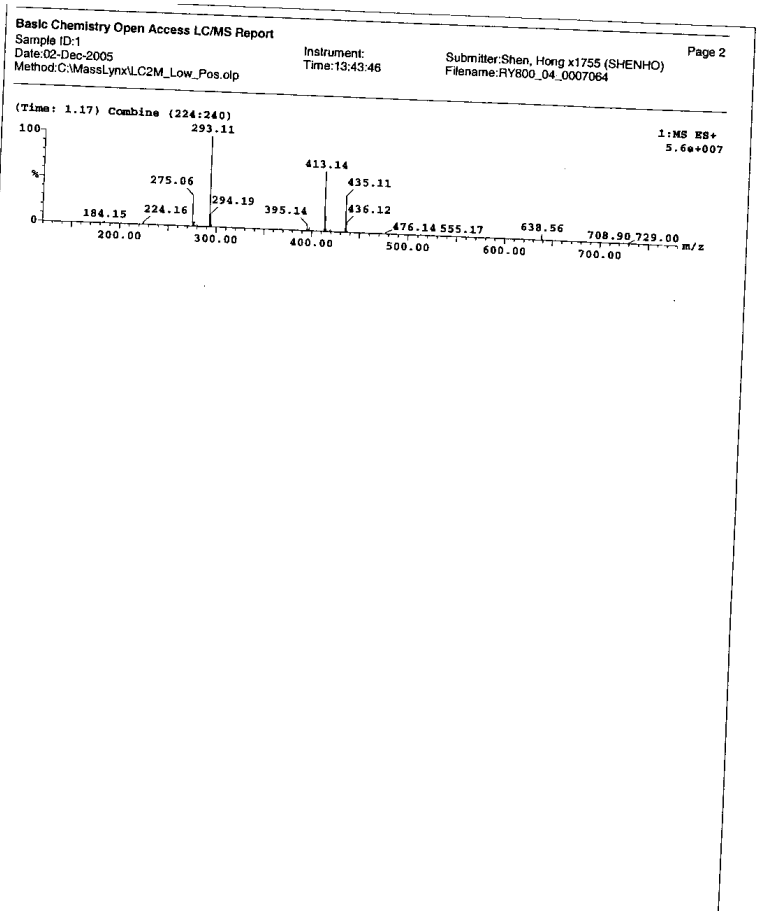

O
Ph
N
N
O
HO
O
Ph

45 minor


O
HO
N
O
N
O
Ph
Ph

45 minor


Instrument:
Time:13:43:46
Submitter:Shen, Hong x1755 (SHENHO)
Filename:RY800_04_0007064
Page 1
:TIC Smooth (Mn, 1x1)
293.1
1.17
3.5e+008
293.1
1.12
Time
DAD: TIC
293.1
1.17
5.2e+007
Time
1.17
5.7e+005
Time
1.12) Combine (215:231)
293.11
413.14
275.05
435.11
294.19
160.11
224.15
395.14
436.12
476.17
571.15
638.51
693.82
744.36
1:MS ES+
3.2e+007
m/z


Basic Chemistry Open Access LC/MS Report
Sample ID:1
Date:02-Dec-2005
Method:C:\MassLynx\LC2M_Low_Pos.olp
Instrument:
Time:13:43:46
Submitter:Shen, Hong x1755 (SHENHO)
Filename:RY800_04_0007064
Page 2
(Time: 1.17) Combine (224:240)
293.11
1:MS ES+
5.6e+007
413.14
275.06
435.11
294.19
184.15
224.16
395.14
436.12
476.14
555.17
638.56
708.90
729.00
m/z