

Supporting Information

Green Process Development for the Preparation of 2, 6-Dibromo-4-nitroaniline from 4-Nitroaniline Using Bromide-Bromate Salts in Aqueous Acidic Medium

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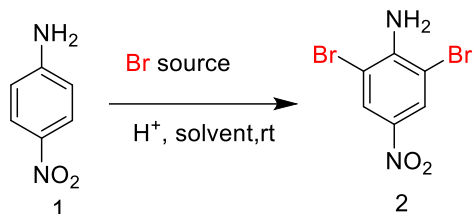
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Experimental Section:

General: All commercially available chemicals and reagents were used without any further purification unless otherwise indicated. ^1H and ^{13}C NMR spectra were recorded at 500 and 125 MHz, respectively. The spectra were recorded in DMSO-d_6 as solvent. Multiplicity was indicated as follows: s (singlet); Chemical shifts are reported in ppm relative to TMS as an internal standard. The peaks around delta values of ^1H NMR (2.5, 3.4), and ^{13}C NMR (40) are correspond to deuterated solvent DMSO-d_6 . Progress of the reactions was monitored by thin layer chromatography (GC).

General procedure for bromination of PNA in Table S1: 4-Nitroaniline (PNA), solvent, and aqueous brominating reagents (indicated in Table S1) were taken in a round bottomed flask (RBF) fitted with magnetic stirrer. To the above mixture, 3 equivalents of 35% HCl (1.58 g, 43.3 mmol) for entries 1 and 2 and 1.5 equivalents of 98% H_2SO_4 (10.65 g, 108 mmol) for entry 3 and 6 or 1 equiv of 98% H_2SO_4 (0.71 g, 7.24 mmol) for entry 4 and 5 was added drop wise slowly to the reaction mixture under stirring at room temperature for 30 minutes followed by 1.5 equiv of 30% H_2O_2 (0.3 g or 3.7 g, 10.8 mmol) for one hour (entries 3-5). After complete addition of H_2O_2 the stirring was continued for stirring 2.5 h. After completion of the reaction the reaction, it was filtered and washed with water. The yellow solid obtained was oven dried for one hour then characterized (yield and purity in indicated in Table S1). *Note:* Better yield of the product was obtained by performing the reaction with reverse addition; that is by the addition of brominating reagent solution slowly to the aqueous acidic PNA taken in the reaction flask.

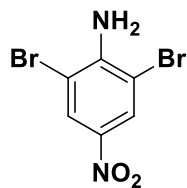
Table S1. Bromination of PNA under different conditions

entry	Br source	H ⁺ source(equiv)/ oxidant(equiv)	solvent(ml)	yield of 2(%)	GC-purity(%)
1	NaBr/NaBrO ₃ (2:1)	HCl (3)	DCM(20)	63	100
2	NaBr/NaBrO ₃ (2:1)	HCl (3)	CH ₃ OH(20)	85	95
3	Alkaline bromine(5:1)	H ₂ SO ₄ (1.5)/H ₂ O ₂ (2)	water	82	49
4	NaBr/NaBrO ₃ (5:1)	H ₂ SO ₄ (1)/H ₂ O ₂ (2)	water	75	35
5 ^a	NaBr/NaBrO ₃ (5:1)	H ₂ SO ₄ (1)/H ₂ O ₂ (2)	water	82	85
6 ^b	NaBr/NaBrO ₃ (2:1)	H ₂ SO ₄ (1.5)	water	95	100

Reaction conditions: Performed at 2.0 PNA (14.4 mmol) for entries 1 and 2, NaBr (1.98 g, 19 mmol), NaBrO₃ (1.44 g, 9.5 mmol); for entry 3 reaction performed at 10 g scale of PNA (72.4 mmol), 46.5 ml of alkaline bromine solution having total bromine content 0.25 g/ml; for entries 4 and 5 reaction performed at 1.0 g of PNA (7.24 mmol), NaBr (1.24 g, 12 mmol), NaBrO₃ (0.36 g, 2.38 mmol), reaction times 4h. ^aReaction performed in closed neck flask. ^bReaction performed by the addition of brominating reagent solution to the flask containing PNA, aqueous H₂SO₄.

Characterisation data for DBPNA:

2,6-dibromo-4-nitroaniline (2a):



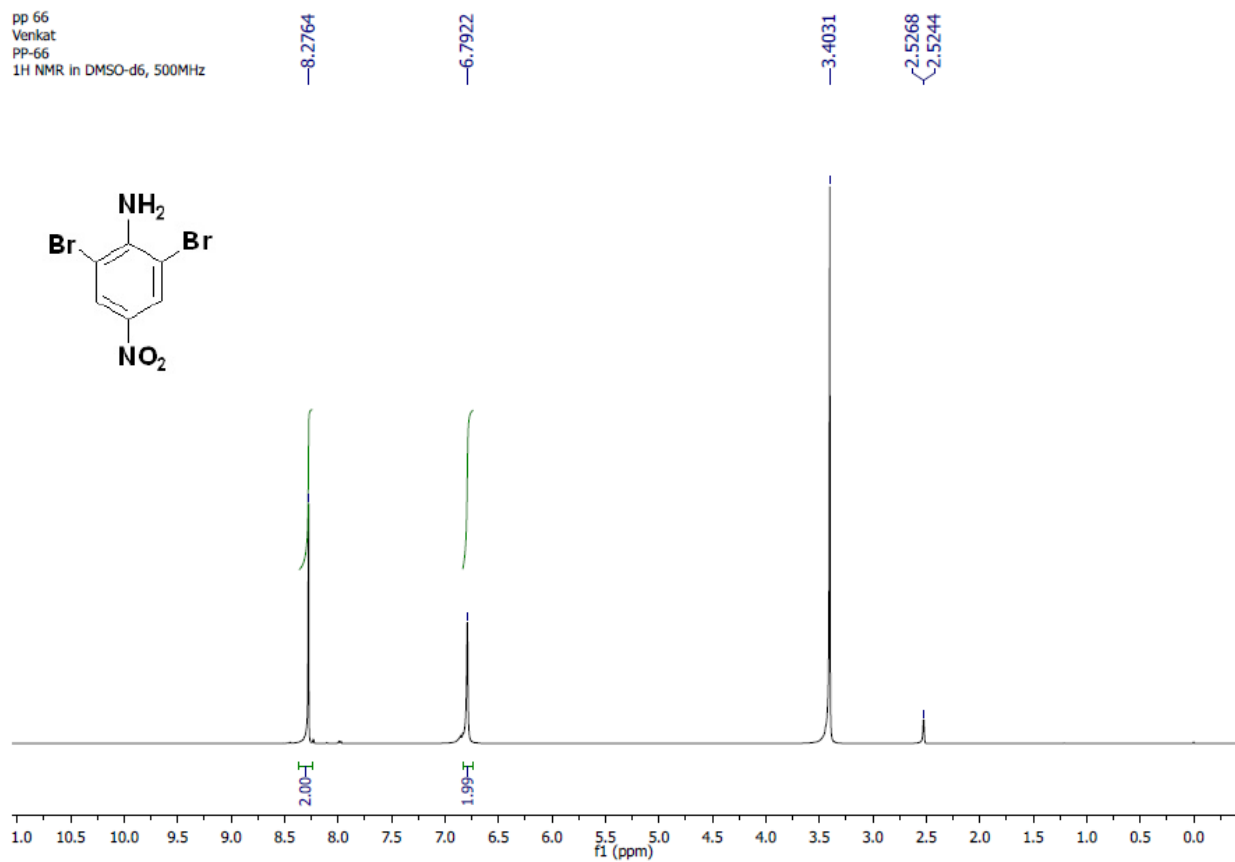
Yield (20.30 g, 95%, yellow solid, observed melting point 198 °C); ¹H NMR (500 MHz, DMSO-d₆): δ 8.27 (s, 2H), 6.79 (s, 2H); ¹³C NMR (125 MHz, DMSO-d₆): 149.6, 136.9, 128.4, 105.8.; FT-IR (KBr): 3480, 3370, 3084, 2664, 1606, 1500, 1299, 1124, 898, 459 cm⁻¹.; LC-MS: [M+H]⁺ = 294.80.

References:

- (1) a) Adimurthy, S.; Ramachandraiah, G.; Bedekar, A. V.; Ghosh, S.; Ranu, B. C.; Ghosh, P. K. *Green Chem.* **2006**, *8*, 916- 922.

¹H-NMR spectral of 2(DBPNA)

pp 66
Venkat
PP-66
1H NMR in DMSO-d₆, 500MHz



¹³C-NMR spectral of 2 (DBPNA)

pp 66
Venkat
PP-66
13C NMR in DMSO-d₆, 500MHz

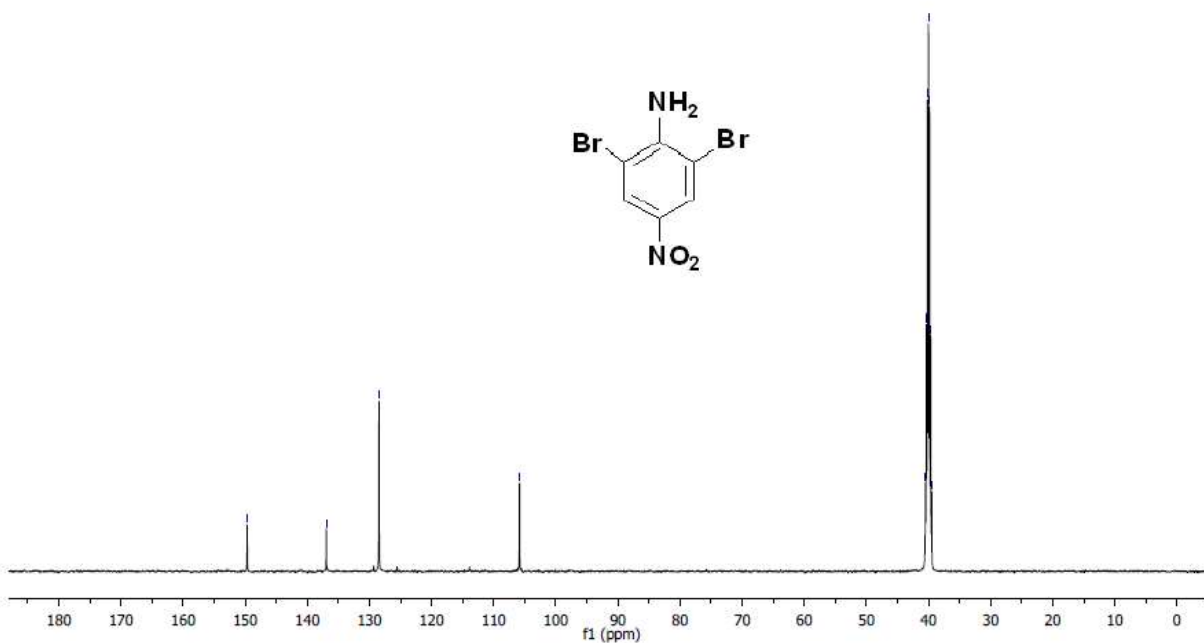
—149.6831

—136.9396

—128.4577

—105.8350

40.4871
40.3209
40.1544
39.9878
39.8210
39.6544
39.4880

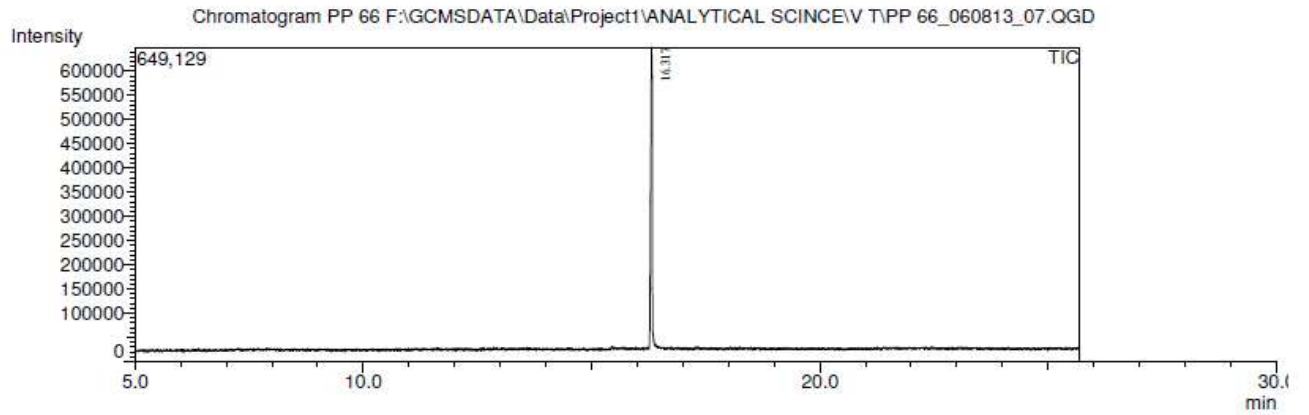


GC-MS of DBPNA

Central Salt and Marine Chemicals Research Institute

Sample Information

Analyzed by : Admin
Analyzed : 8/6/2013 3:56:33 PM
Sample Type : Unknown
Sample Name : PP 656
Sample ID : PP 656
Vial # : 1
Injection Volume : 0.200
Data File : F:\GCMSDATA\Data\Project1\ANALYTICAL SCINCE\V T\PP 66_060813_07.QGD
Method File : C:\GCMSsolution\Data\Project1\PNBBR.qgm
Tuning File : C:\GCMSsolution\System\Tune\1180713.qgt

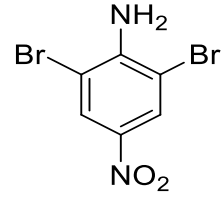
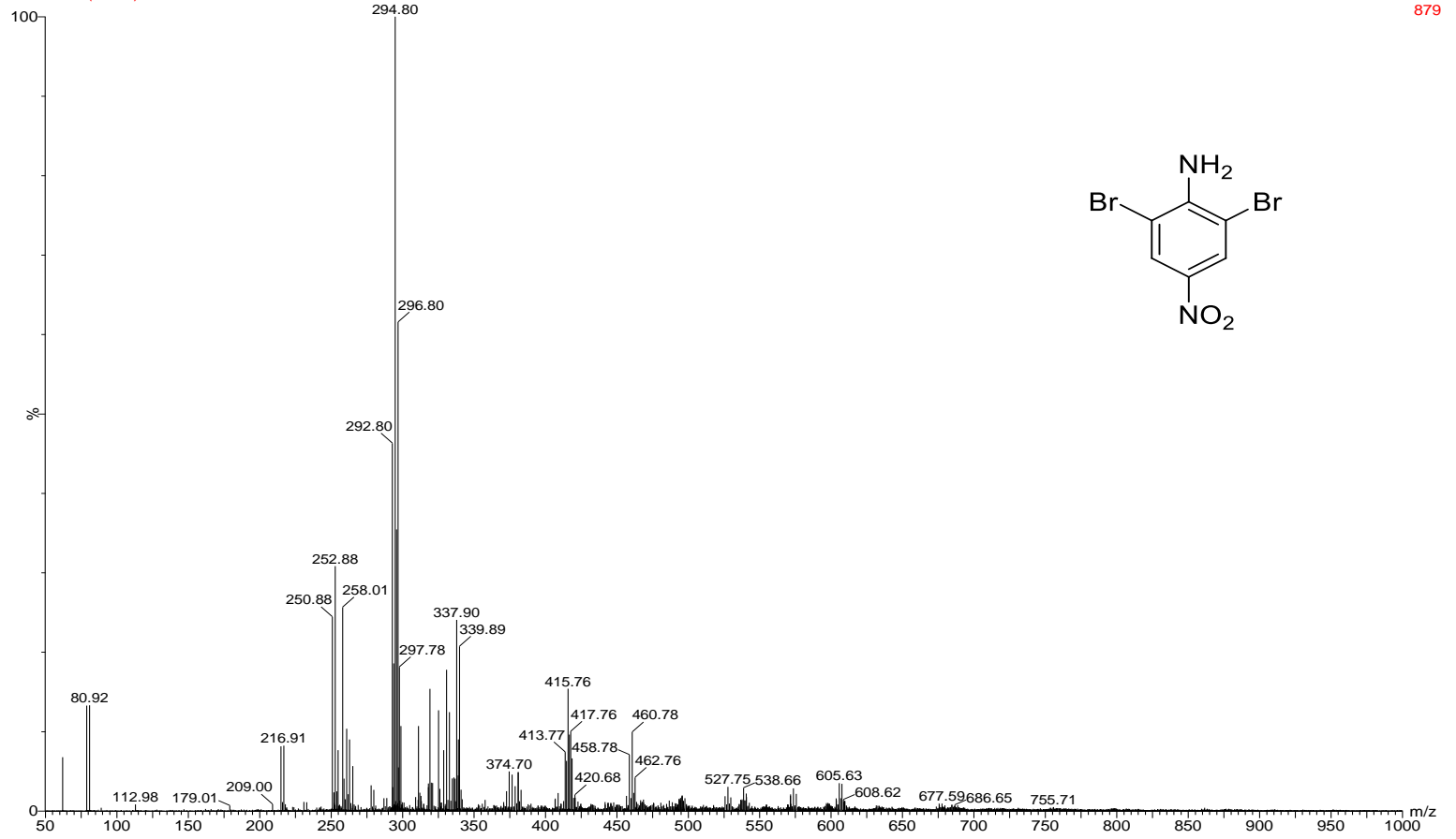


Peak#	R.Time	Area	Area%	Name	Base m/z
1	16.317	1422982	100.00	Benzenamine, 2,6-dibromo-4-nitro-	265.75
		1422982	100.00		

LC-MS for DBPNA:

PP 66 N 3 (0.036)

1: TOF MS ES-
879



FT-IR- spectra of DBPNA.

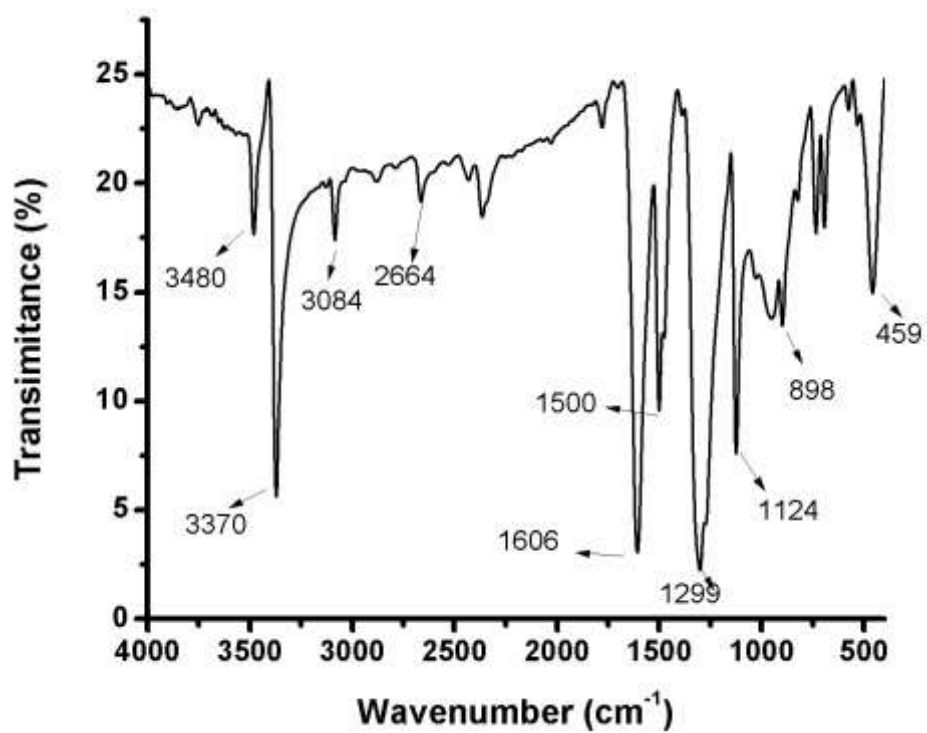


Table S2. Analysis of DBPNA by Colourtex Industries.

Colourtex Industries Ltd

Survey No. 91, Paikee of Bhestan
 Bhestan – 395 023, DIST, SURAT (INDIA)
 Ph : 91-261-2891427/ 2891428
 Fax : 91-261-2890080
 Email : ctx.export@colourtex.co.in



Certificate of Analysis

DATE: 19/03/2013

PRODUCT NAME : 2:6 Dibromo p- Nitro Aniline
Lot. No. : ----
Customer : ----

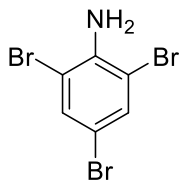
No.	Property	Colourtex Specification	Observation
1	Physical Appearance	Yellowish powder	Yellowish powder
2	Purity (by HPTLC)	98.00% Min.	96.83%
3	OBPNA Content (by HPTLC)	0.50% Max.	1.14%
4	Moisture Content (by K.F.)	0.50% Max.	0.20%
5	PNA Content (by HPTLC)	ND	ND
6	DCPNA Content (by HPLC)	100 ppm Max.	60.58 ppm
7	PCP Content (by HPLC)	10 ppm Max.	0.36 ppm
8	Sum of TeCP Content (by HPLC)	10 ppm Max.	0.41 ppm
9	Sum of CB's Content (by GCMS)	10 ppm Max.	2.32 ppm

Approved & passed By

Colourtex Industries Ltd

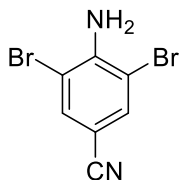
Characterization of other synthesized products

2,4,6-tribromoaniline:



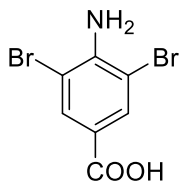
Yield (1.5 g, 94%); $^1\text{H NMR}$ (200 MHz, DMSO) δ 7.63 (s, 2H), 5.54 (s, 2H).

4-amino-3,5-dibromobenzonitrile:



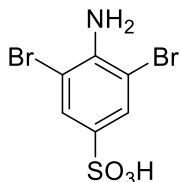
Yield (1.29 g, 93%); $^1\text{H NMR}$ (200 MHz, CDCl_3) δ 7.65 (s, 2H), 5.13 (s, 2H).

4-amino-3,5-dibromobenzoic acid:



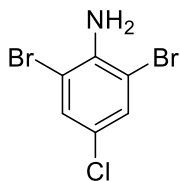
Yield (1.35 g, 95%); $^1\text{H NMR}$ (200 MHz, DMSO) δ 7.63 (s, 2H), 5.53 (s, 2H).

4-amino-3,5-dibromobenzenesulfonic acid:



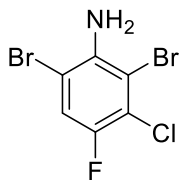
Yield (1.35 g, 95%); $^1\text{H NMR}$ (200 MHz, DMSO) δ 7.63 (s, 2H), 5.52 (s, 2H).

2,6-dibromo-4-chloroaniline:



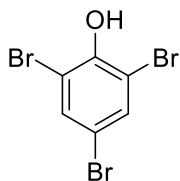
Yield (1.27 g, 84%); $^1\text{H NMR}$ (200 MHz, CDCl_3) δ 7.38 (s, 2H), 4.54 (s, 2H).

2,6-dibromo-3-chloro-4-fluoroaniline:



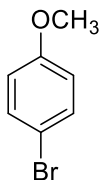
Yield (1.4 g, 92%); $^1\text{H NMR}$ (200 MHz, CDCl_3) δ 7.31 (d, $J = 8.1$ Hz, 1H), 4.55 (s, 2H).

2,4,6-tribromophenol:



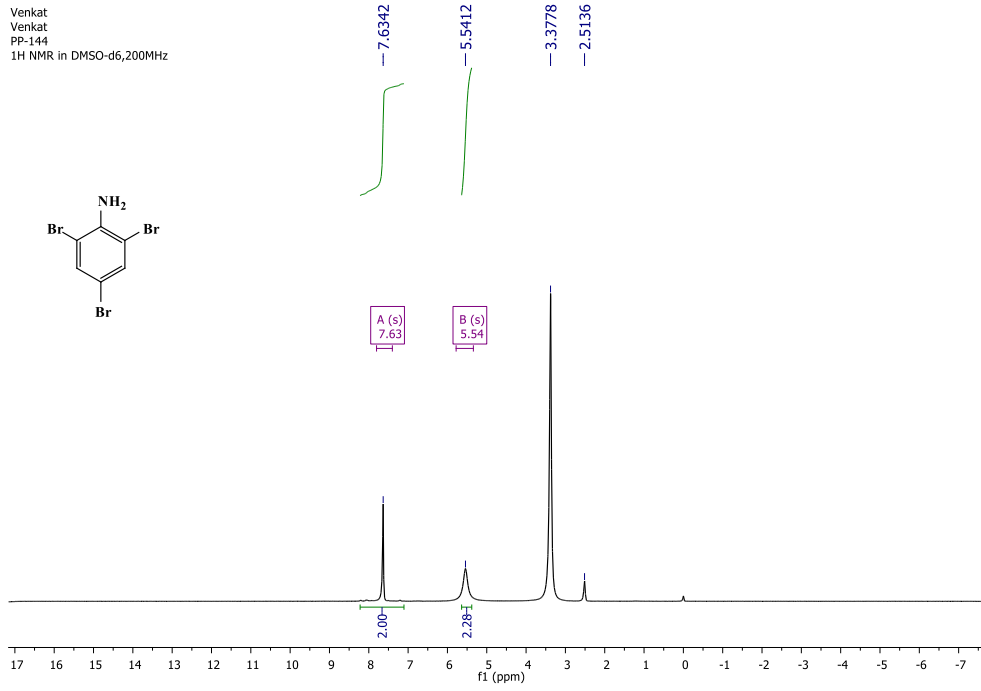
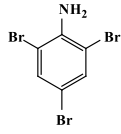
Yield (1.5 g, 90%); $^1\text{H NMR}$ (200 MHz, CDCl_3) δ 7.58 (s, 1H), 5.89 (s, 1H).

1-bromo-4-methoxybenzene:

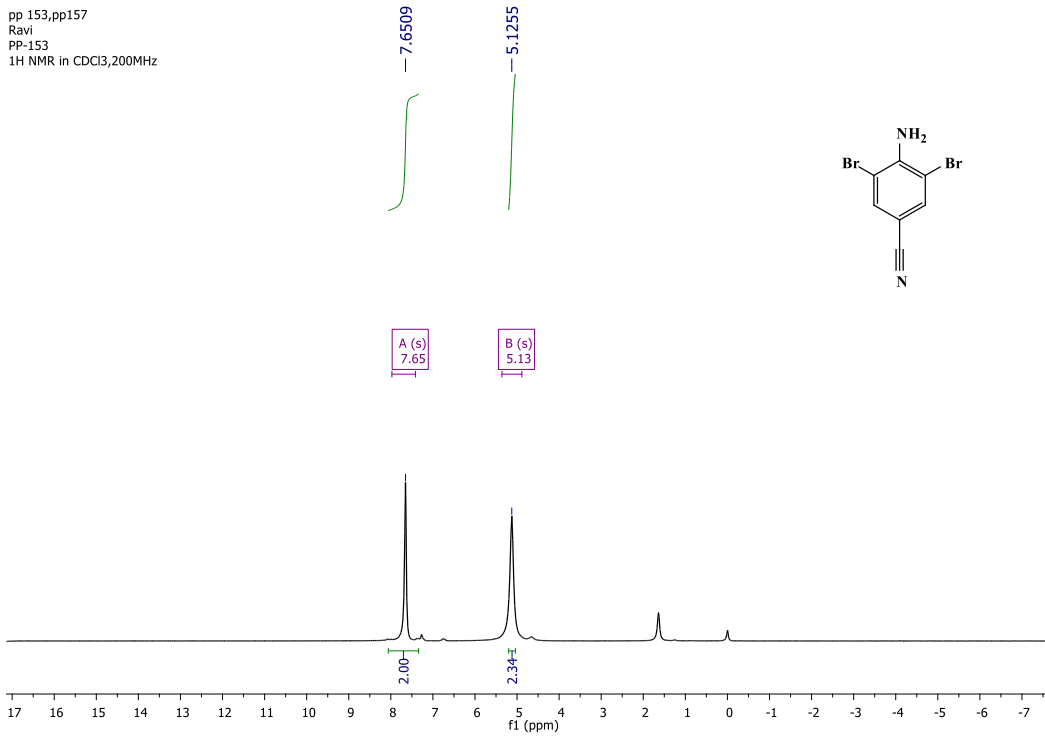
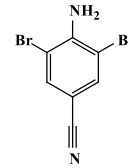


Yield (0.927 g, 98%); $^1\text{H NMR}$ (200 MHz, CDCl_3) δ 7.26 (d, $J = 8.9$ Hz, 2H), 6.66 (d, $J = 8.9$ Hz, 2H), 3.65 (s, 3H).

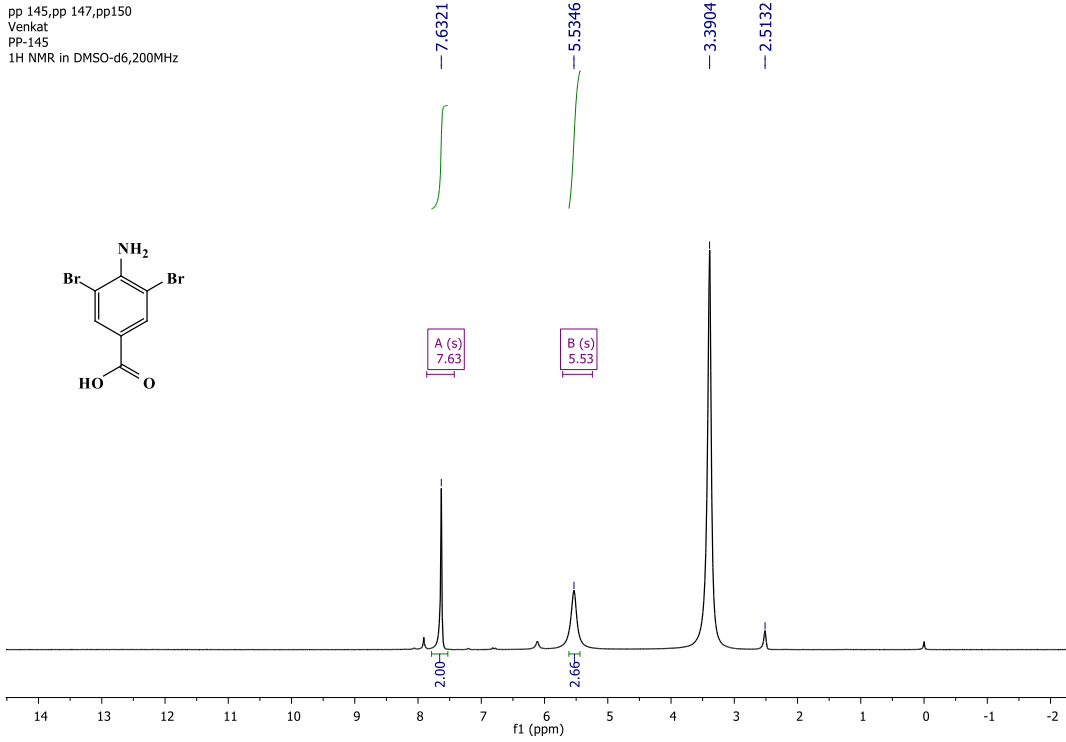
Venkat
Venkat
PP-144
1H NMR in DMSO-d6,200MHz



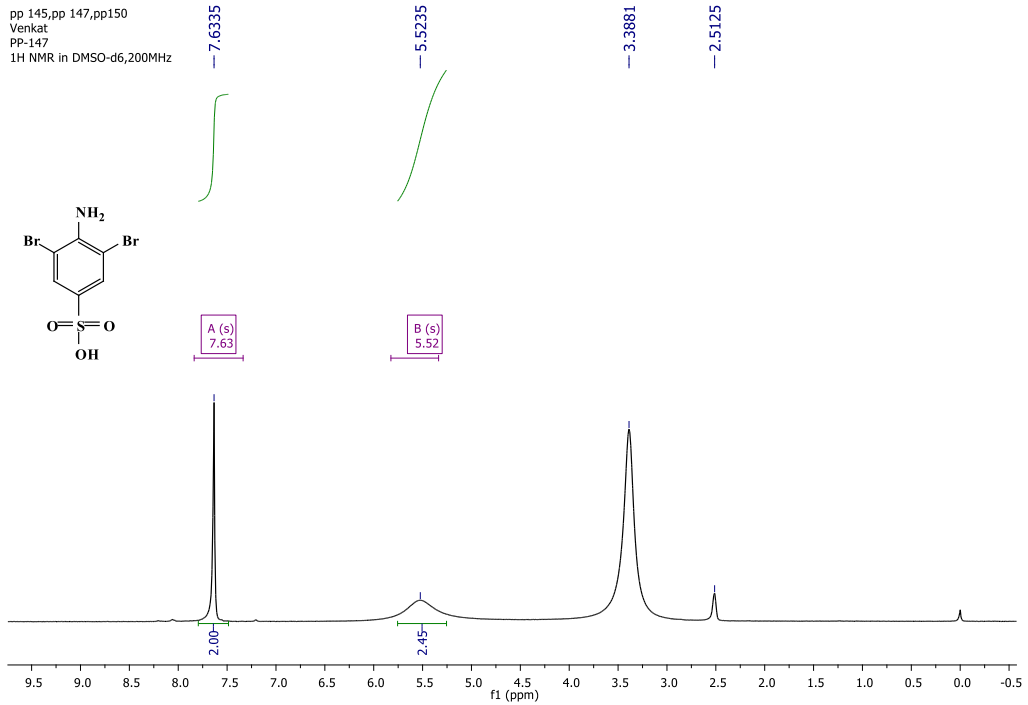
pp 153,pp157
Ravi
PP-153
1H NMR in CDCl3,200MHz



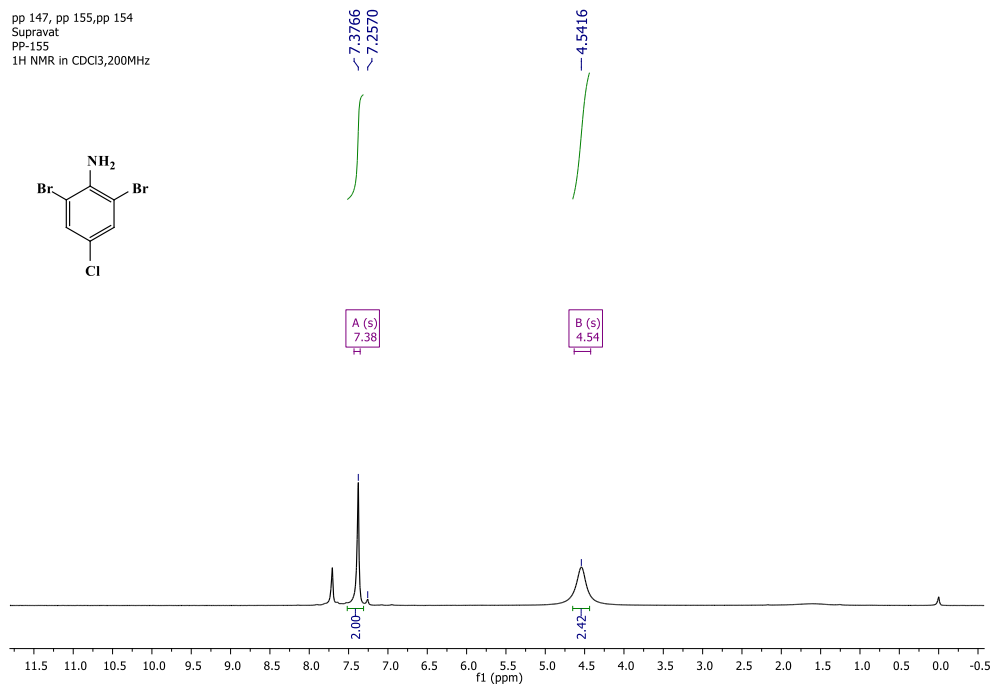
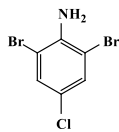
pp 145,pp 147,pp150
Venkat
PP-145
1H NMR in DMSO-d6,200MHz



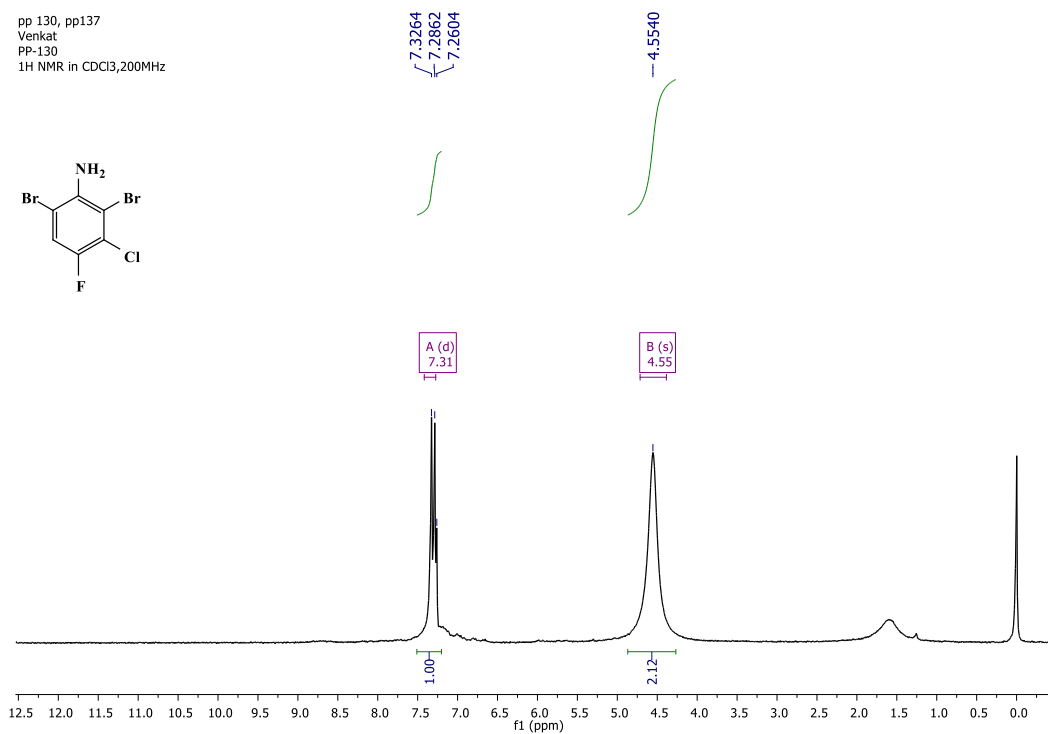
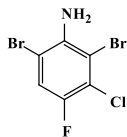
pp 145,pp 147,pp150
Venkat
PP-147
1H NMR in DMSO-d6,200MHz



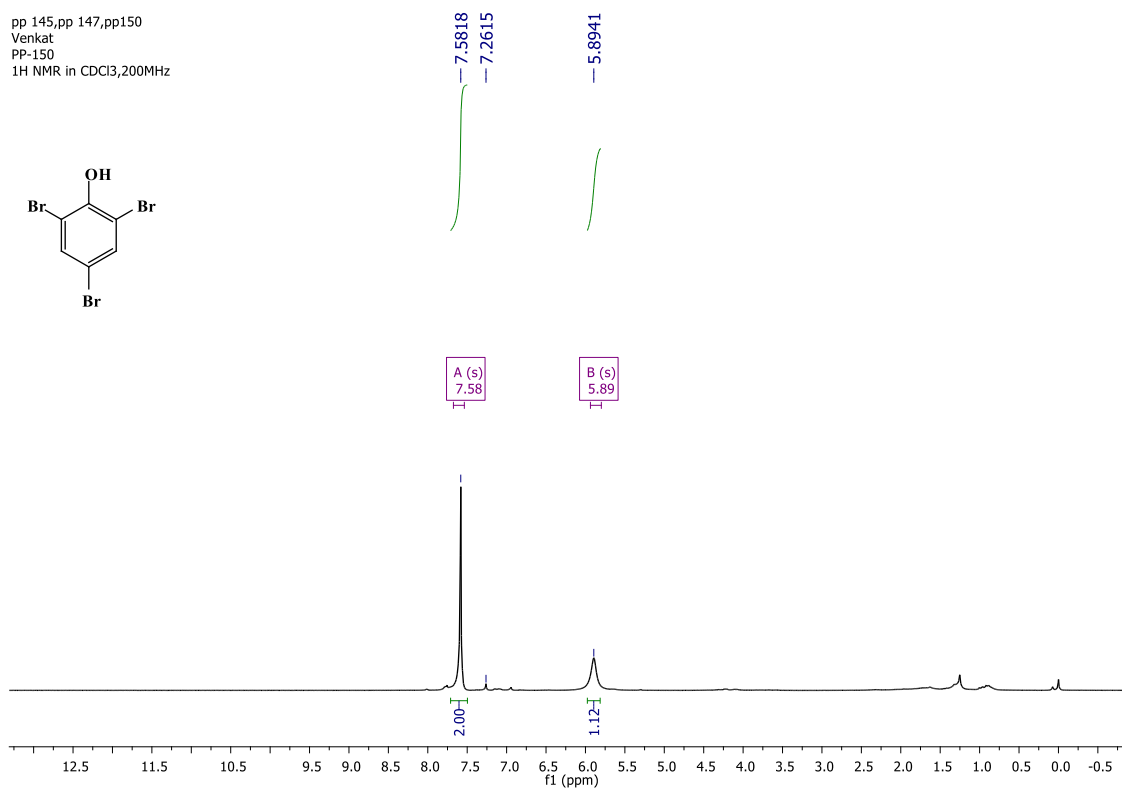
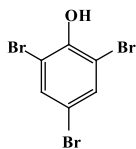
pp 147, pp 155, pp 154
Supravat
PP-155
1H NMR in CDCl₃, 200MHz



pp 130, pp137
Venkat
PP-130
1H NMR in CDCl₃, 200MHz



pp 145, pp 147, pp 150
Venkat
PP-150
1H NMR in CDCl₃, 200MHz



pp 130, pp 137
Venkat
PP-137
1H NMR in CDCl₃, 200MHz

7.2785
7.2341
6.6815
6.6373

