Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Copper Iodide nanoparticles supported on magnetic aminomethylpyridine functionalized cellulose: a new heterogeneous and recyclable nanomagnetic catalyst for the facile access to *N*-sulfonylamidines under solvent free conditions

Zarrin Ghasemi,* Salman Shojaei and Aziz Shahrisa

Experimental section

4-Methyl-*N*-[1-morpholino-2-phenylethylidene] benzenesulfonamide (4a):

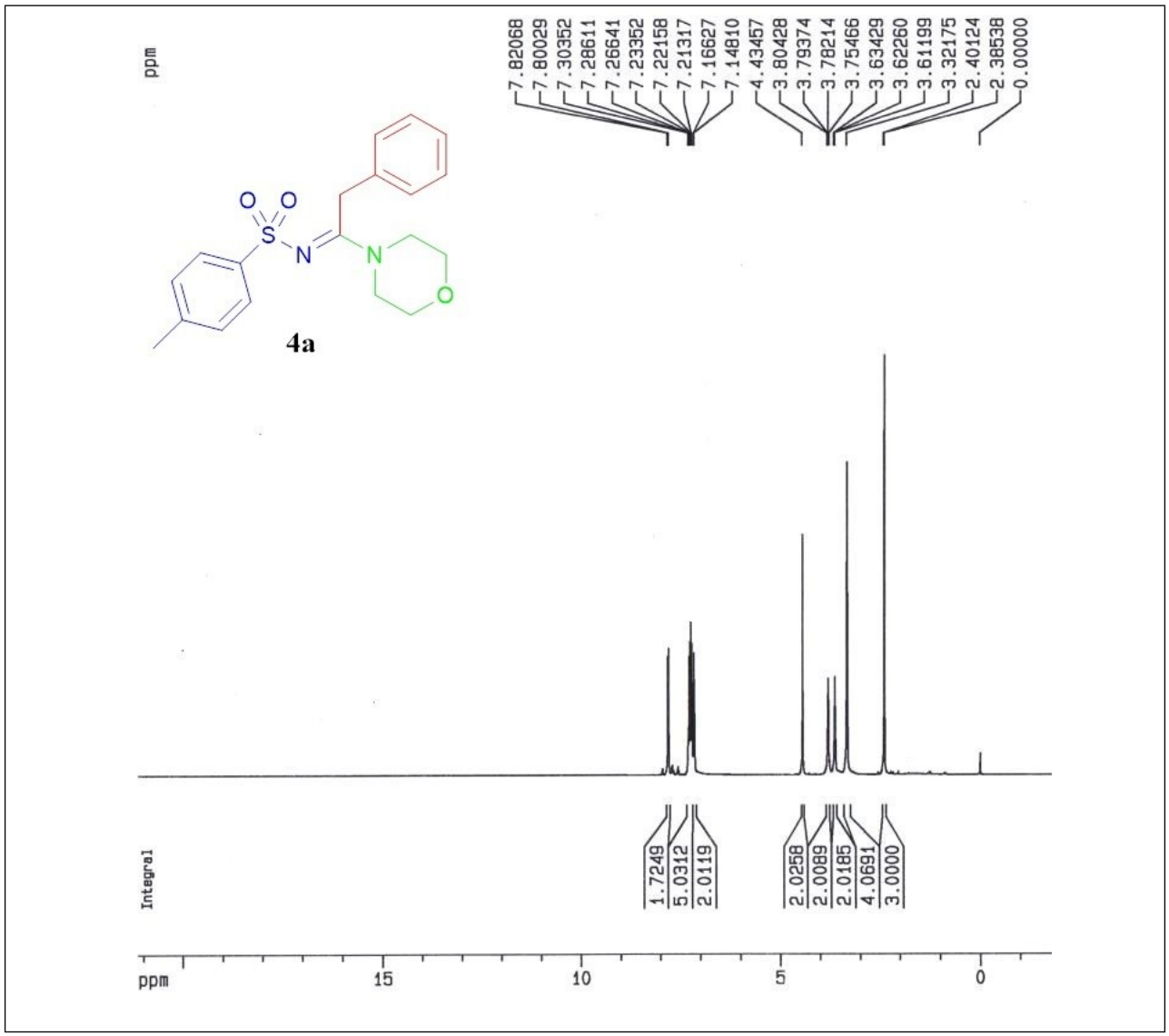

Figure 1: ^{1}H NMR spectrum (400 MHz) of compound **4a** in $CDCl_3$.

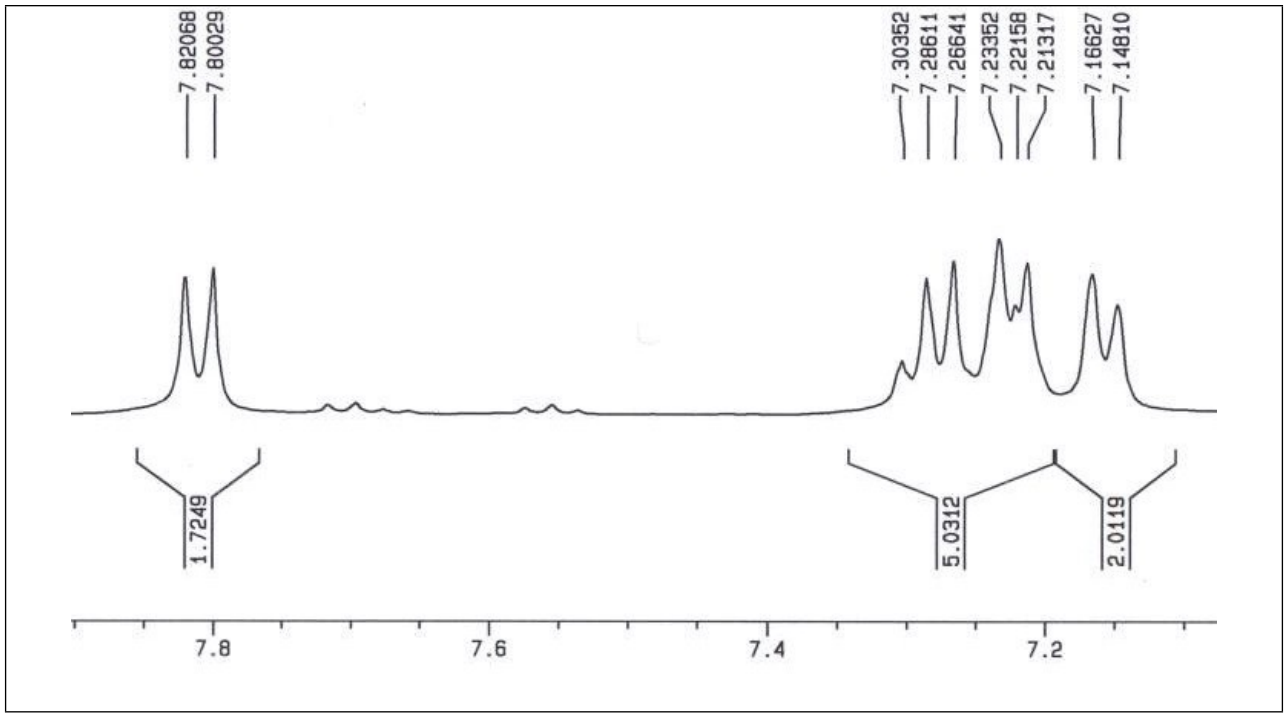

Figure 2: Expanded (1) ^{1}H NMR spectrum (400 MHz) of compound **4a** in $CDCl_3$.

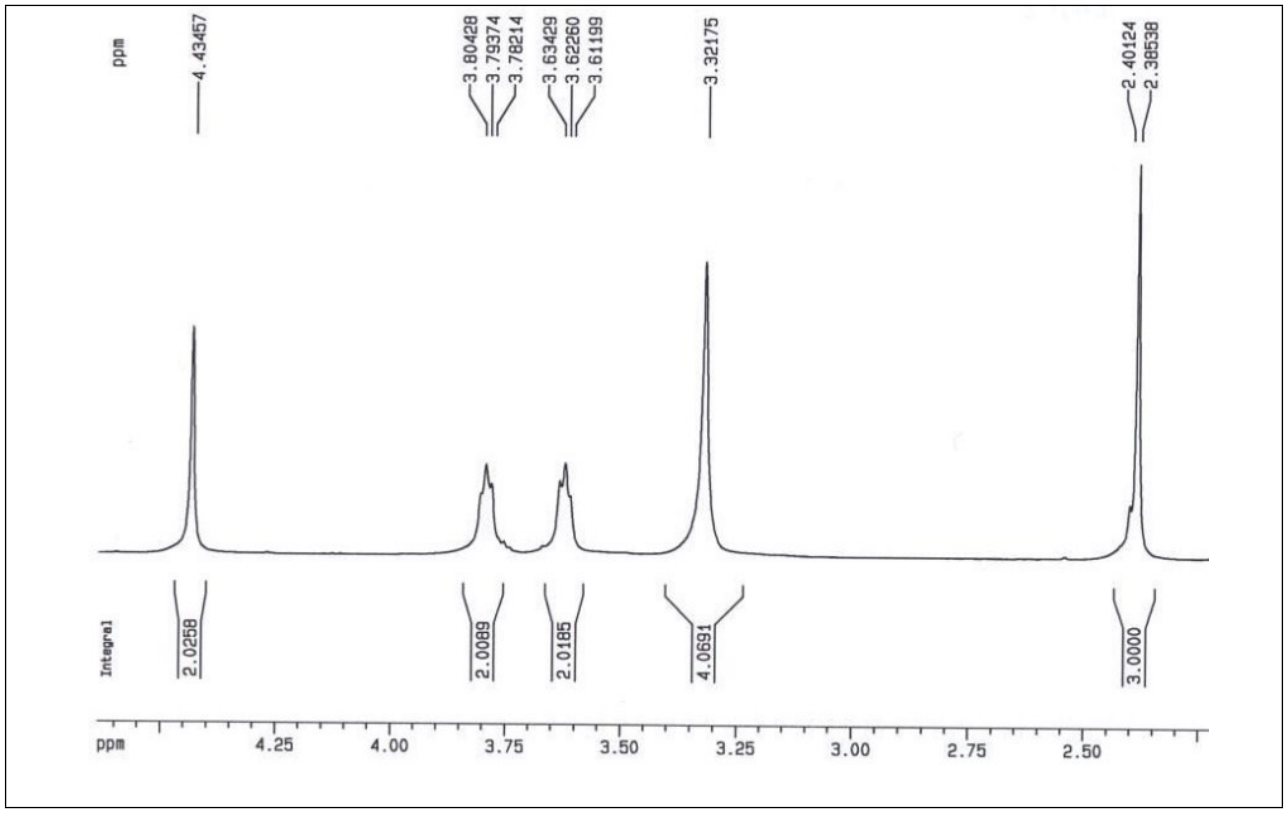

Figure 3: Expanded (2) ^{1}H NMR spectrum (400 MHz) of compound **4a** in $CDCl_3$.

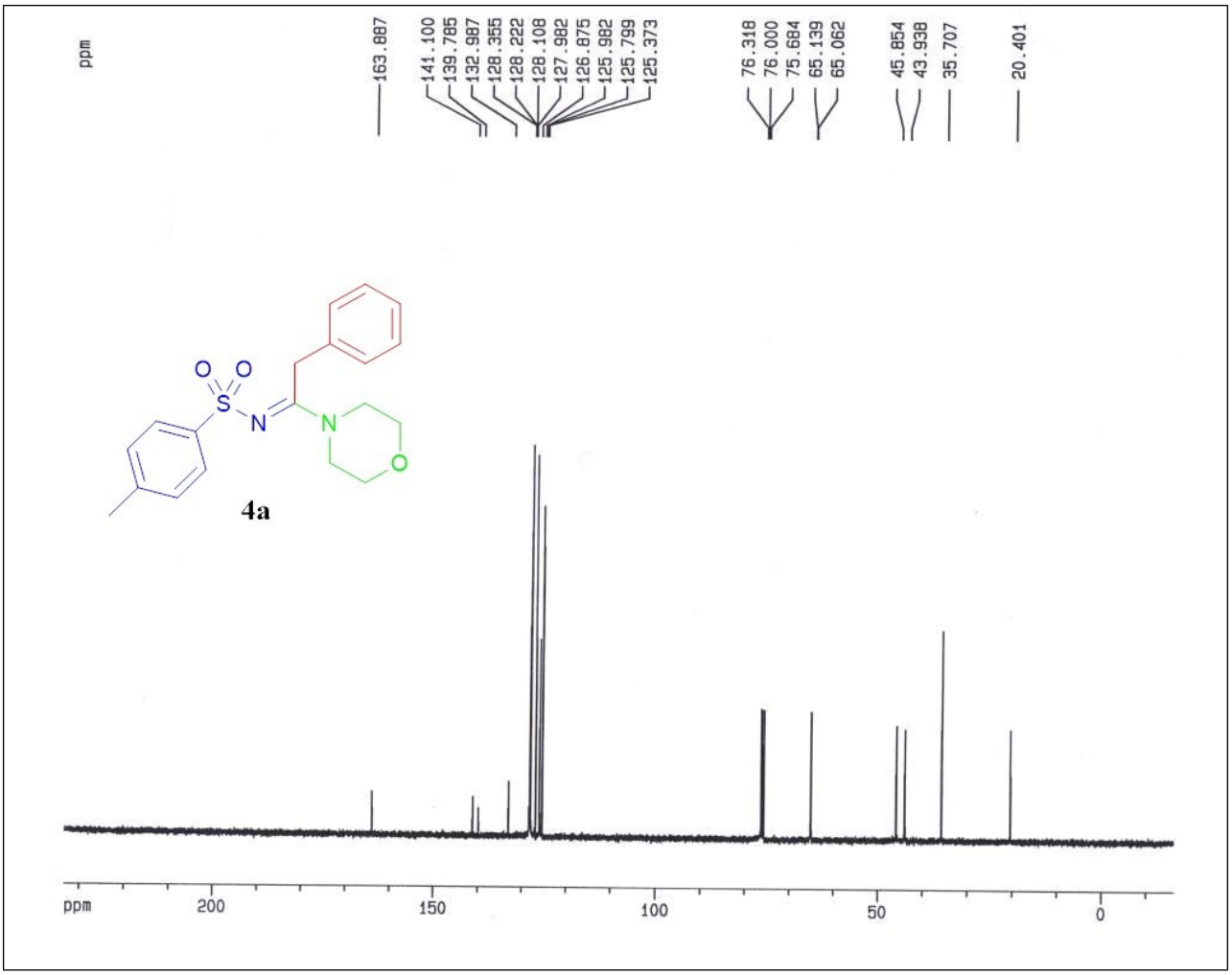

Figure 4: ^{13}C NMR spectrum (100 MHz) of compound **4a** in $CDCl_3$.

4-Methyl-*N*-[2-phenyl-1-(piperidin-1-yl) ethylidene] benzenesulfonamide (4b):

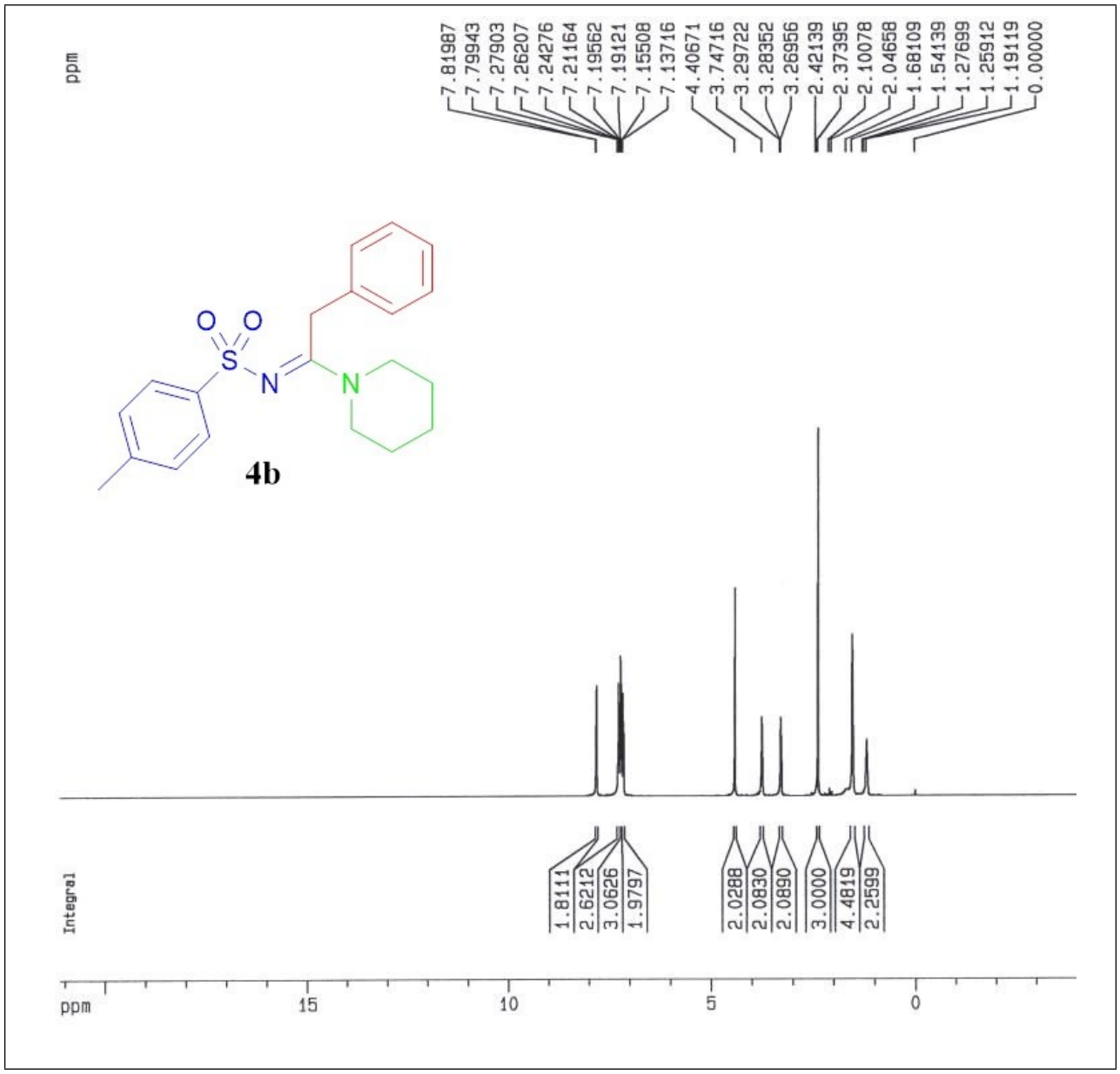

Figure 5: ^{1}H NMR spectrum (400 MHz) of compound **4b** in $CDCl_3$.

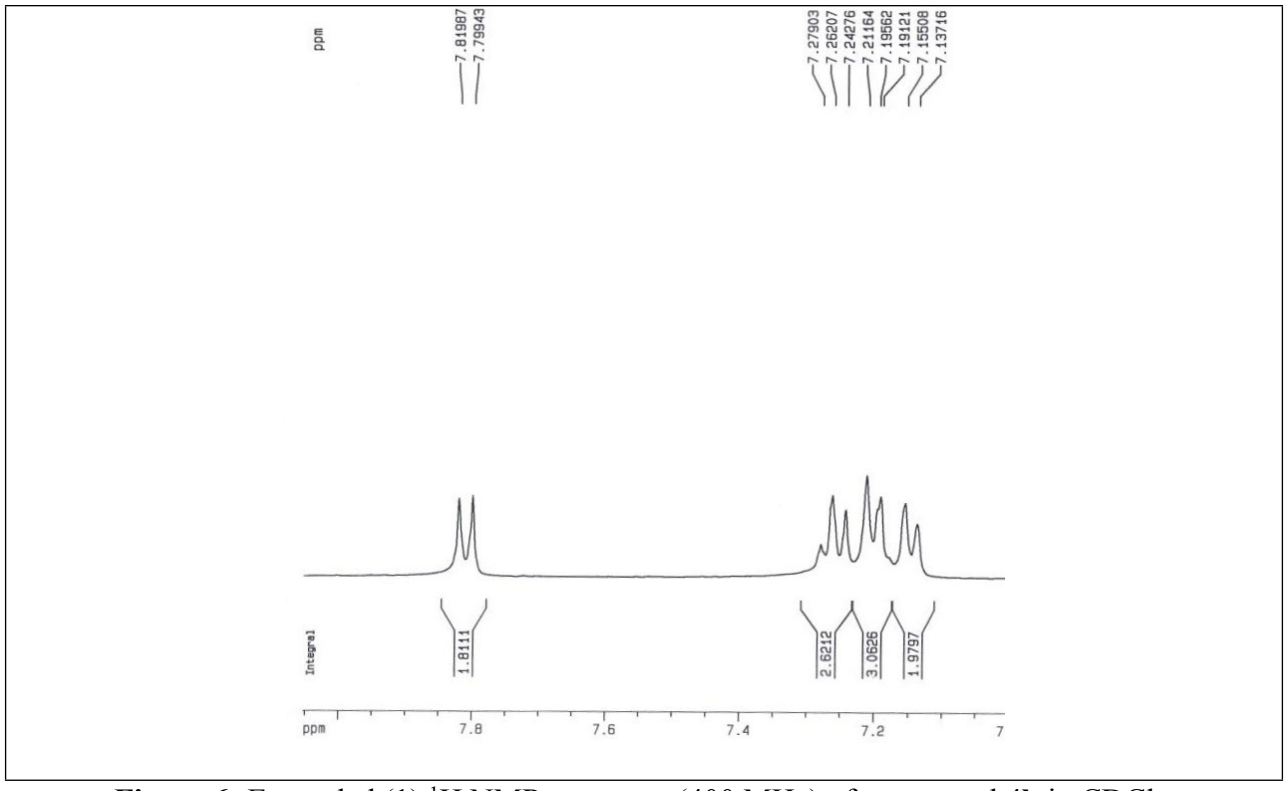

Figure 6: Expanded (1) ^{1}H NMR spectrum (400 MHz) of compound **4b** in $CDCl_3$.

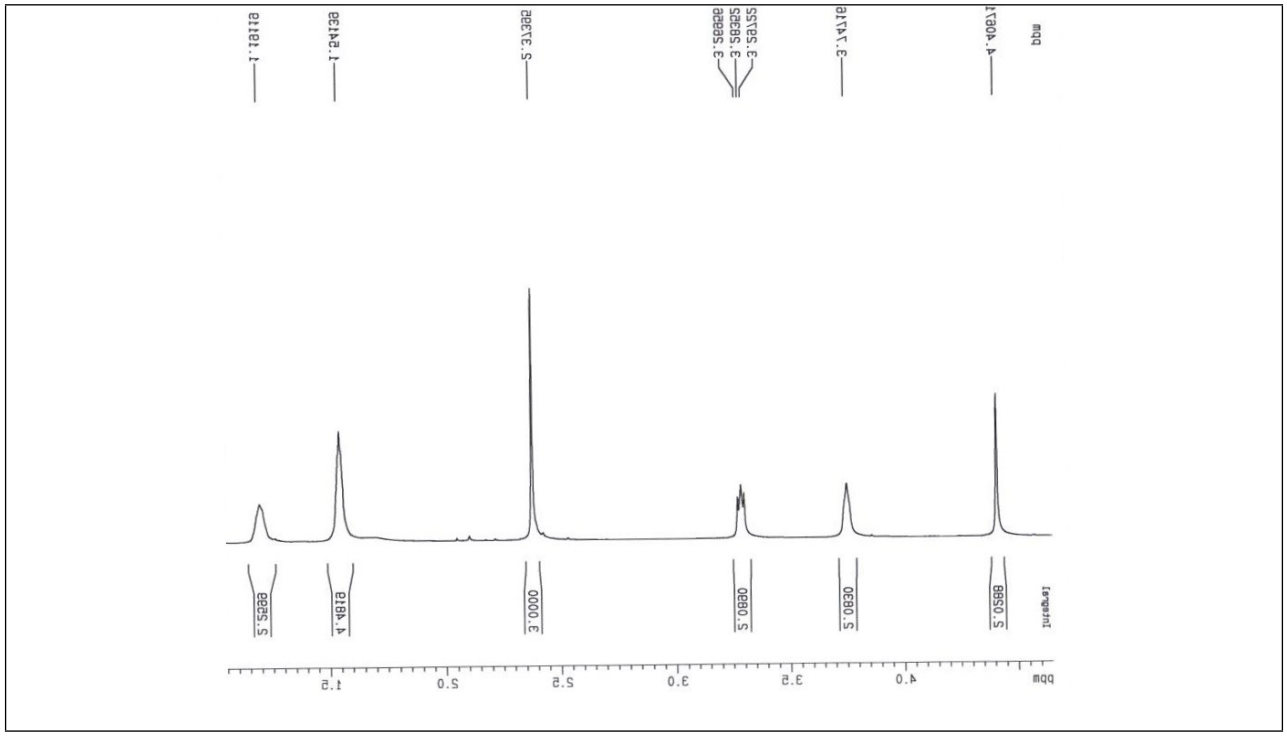

Figure 7: Expanded (2) ^{1}H NMR spectrum (400 MHz) of compound **4b** in $CDCl_3$.

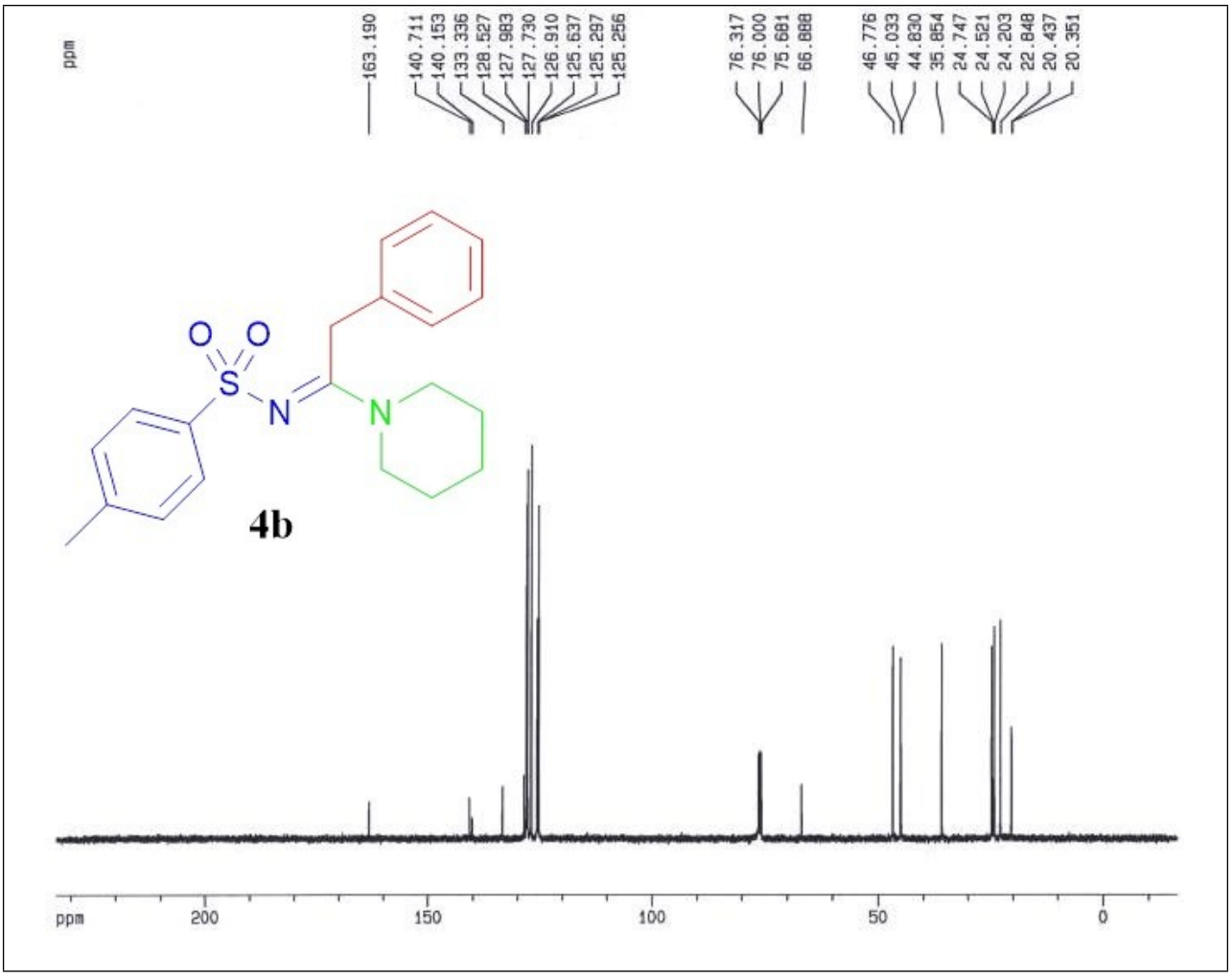

Figure 8: ^{13}C NMR spectrum (100 MHz) of compound **4b** in $CDCl_3$.

4-Methyl-*N*-[2-phenyl-1-(pyrrolidin-1-yl) ethylidene] benzenesulfonamide (4c):

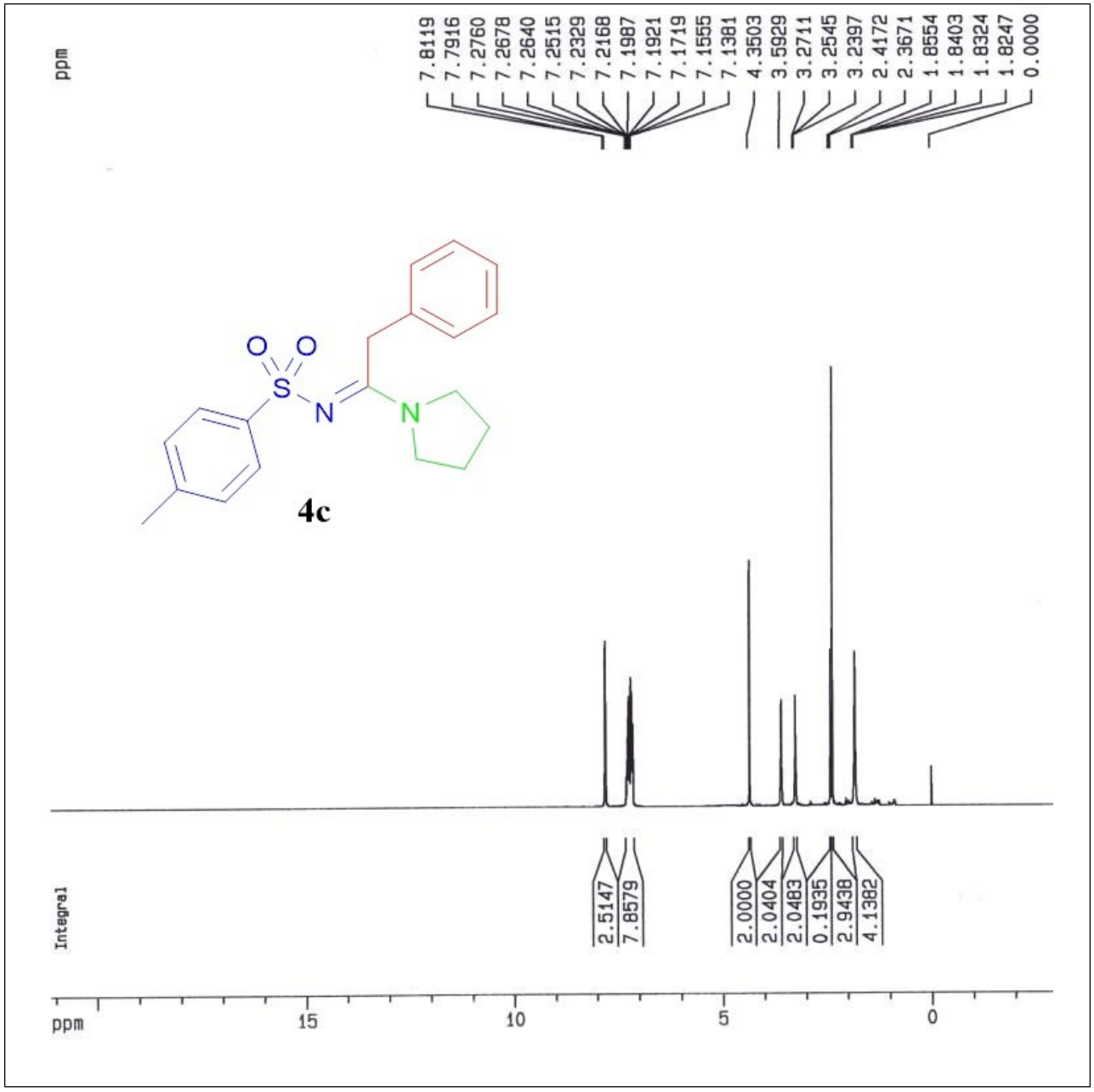

Figure 9: ^{1}H NMR spectrum (400 MHz) of compound **4c** in $CDCl_3$.

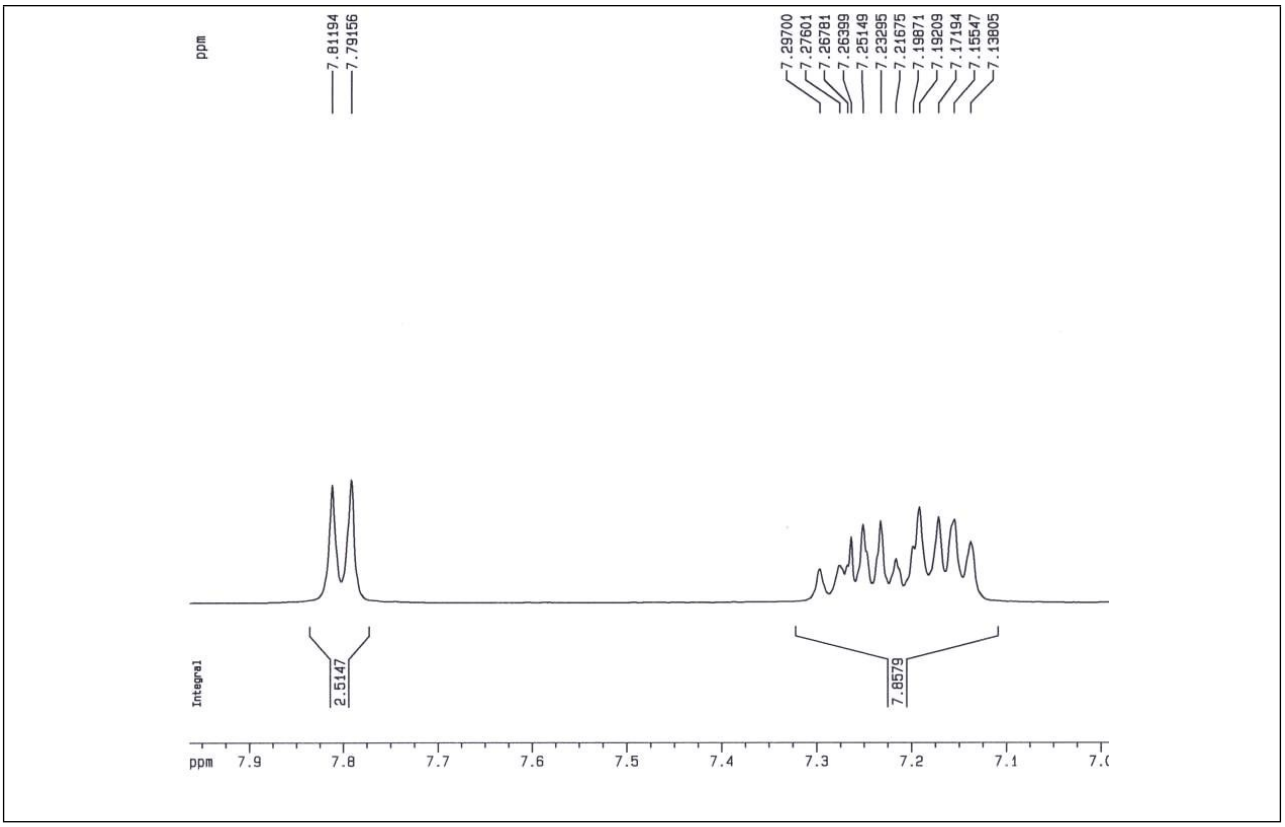

Figure 10: Expanded (1) ^{1}H NMR spectrum (400 MHz) of compound **4c** in $CDCl_3$.

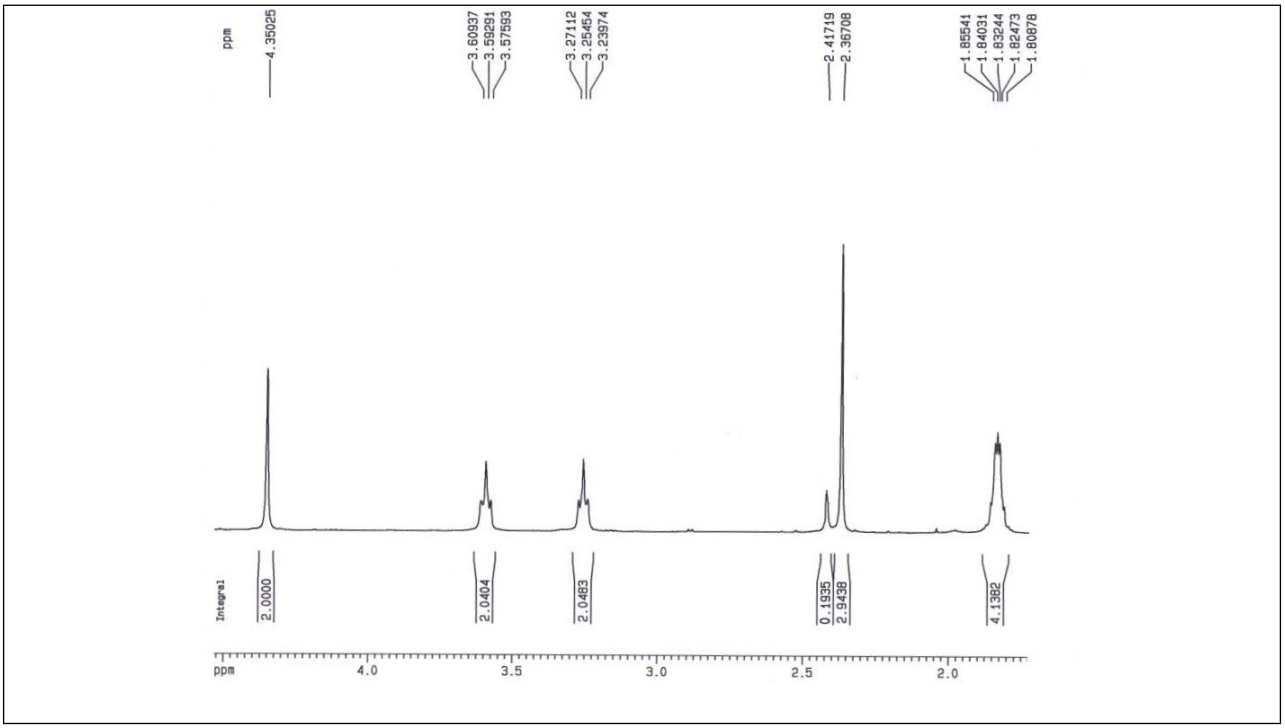

Figure 11: Expanded (2) ^{1}H NMR spectrum (400 MHz) of compound **4c** in $CDCl_3$.

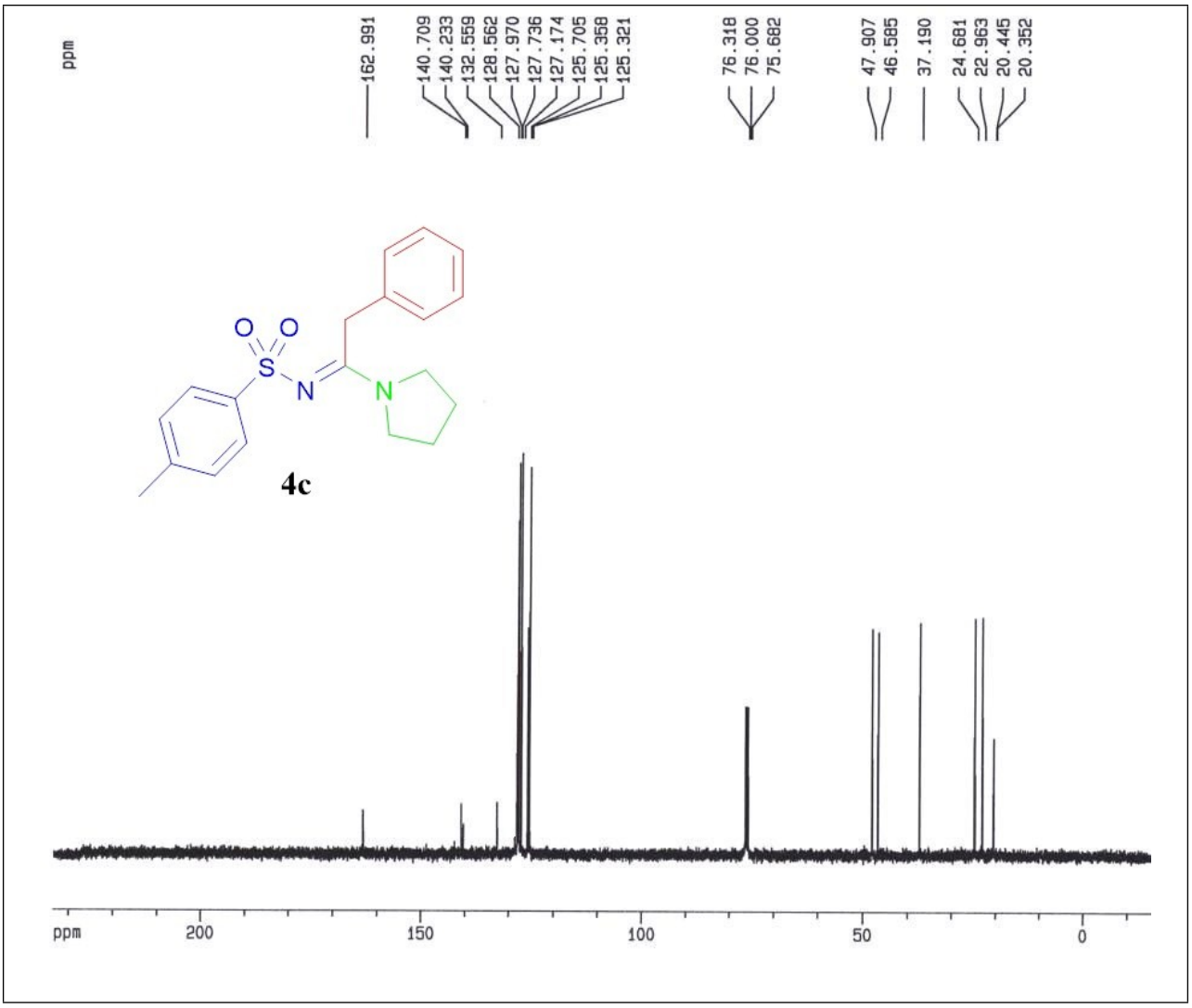

Figure 12: ^{13}C NMR spectrum (100 MHz) of compound **4c** in $CDCl_3$.

For previous methods for synthesis of **(4a, 4b and 4c),** see reference **1**.

4-Methyl-*N*-[1-(4-methylpiperazin-1-yl)-2-phenylethylidene] benzenesulfonamide (4d):

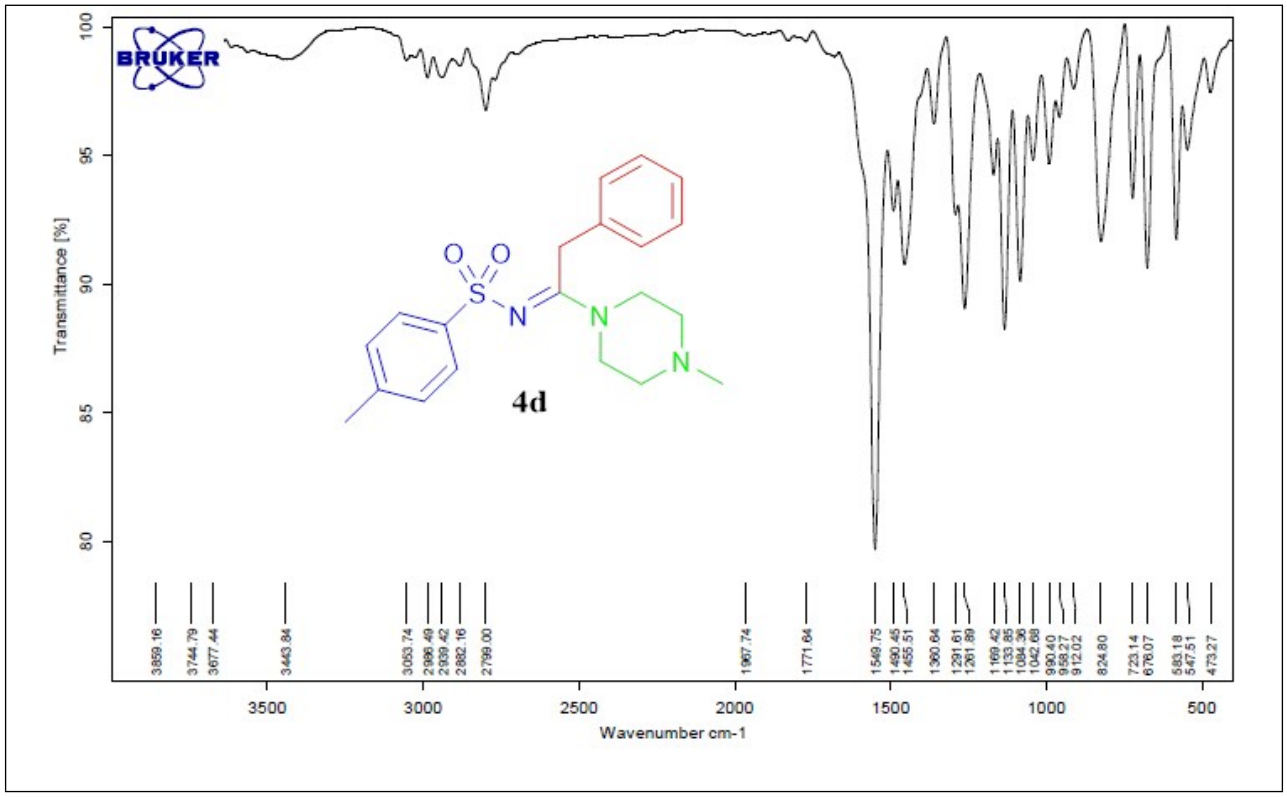

Figure 13: FTIR spectrum (KBr) of compound **4d**.

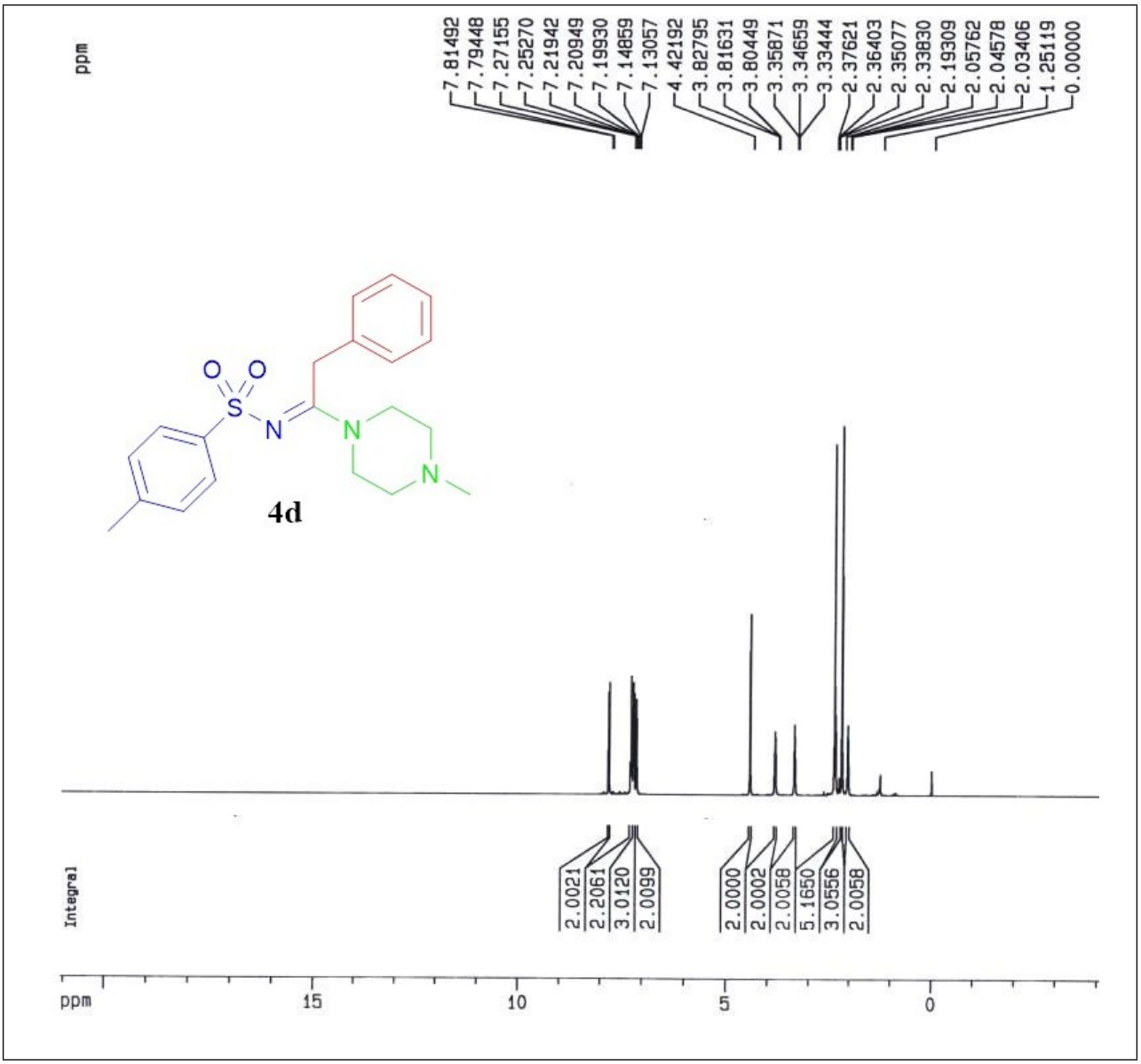

Figure 14: ^{1}H NMR spectrum (400 MHz) of compound **4d** in $CDCl_3$.

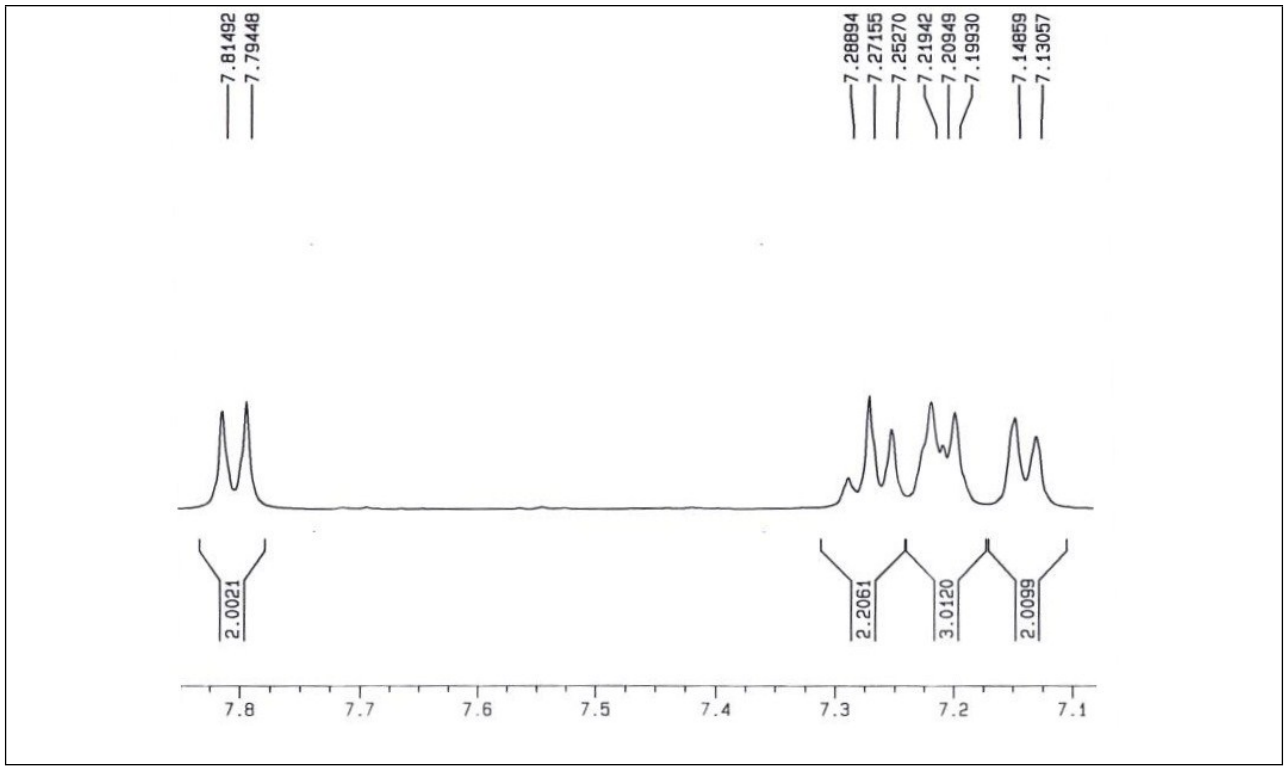

Figure 15: Expanded (1) ^{1}H NMR spectrum (400 MHz) of compound **4d** in $CDCl_3$.

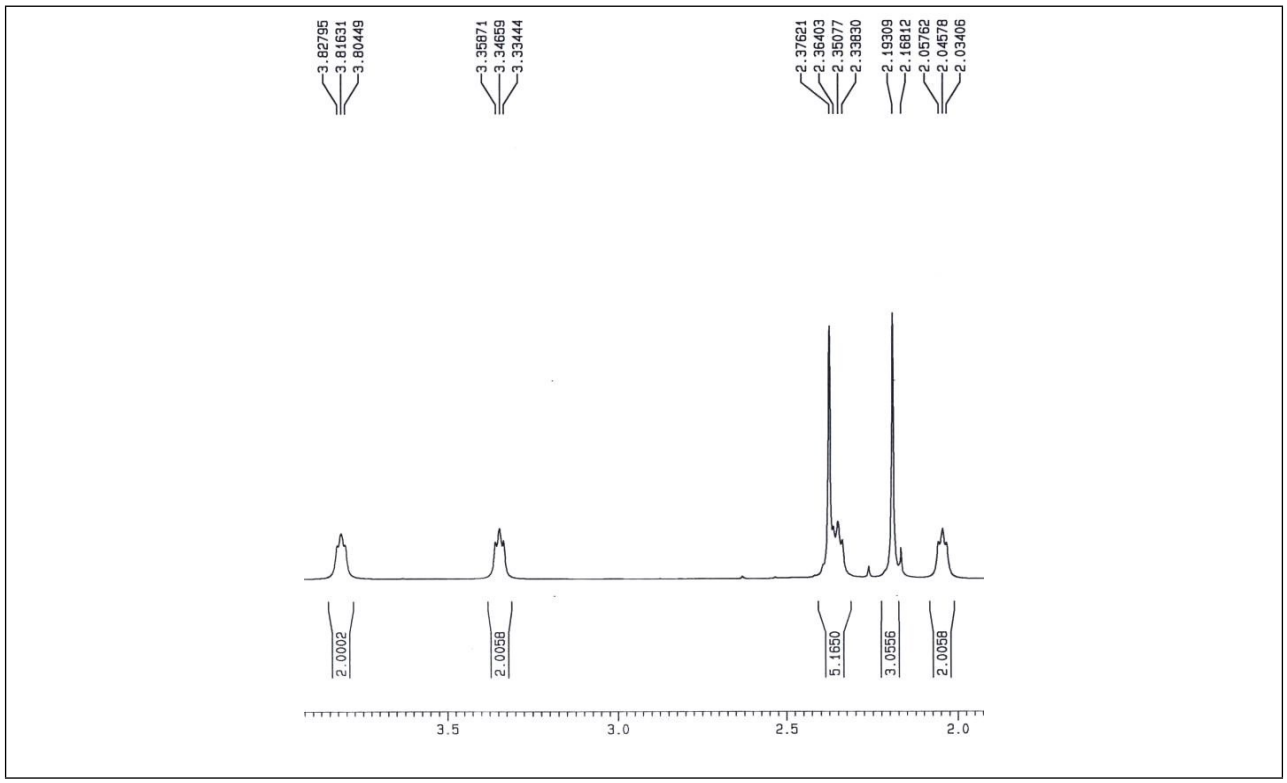

Figure 16: Expanded (2) ^{1}H NMR spectrum (400 MHz) of compound **4d** in $CDCl_3$.

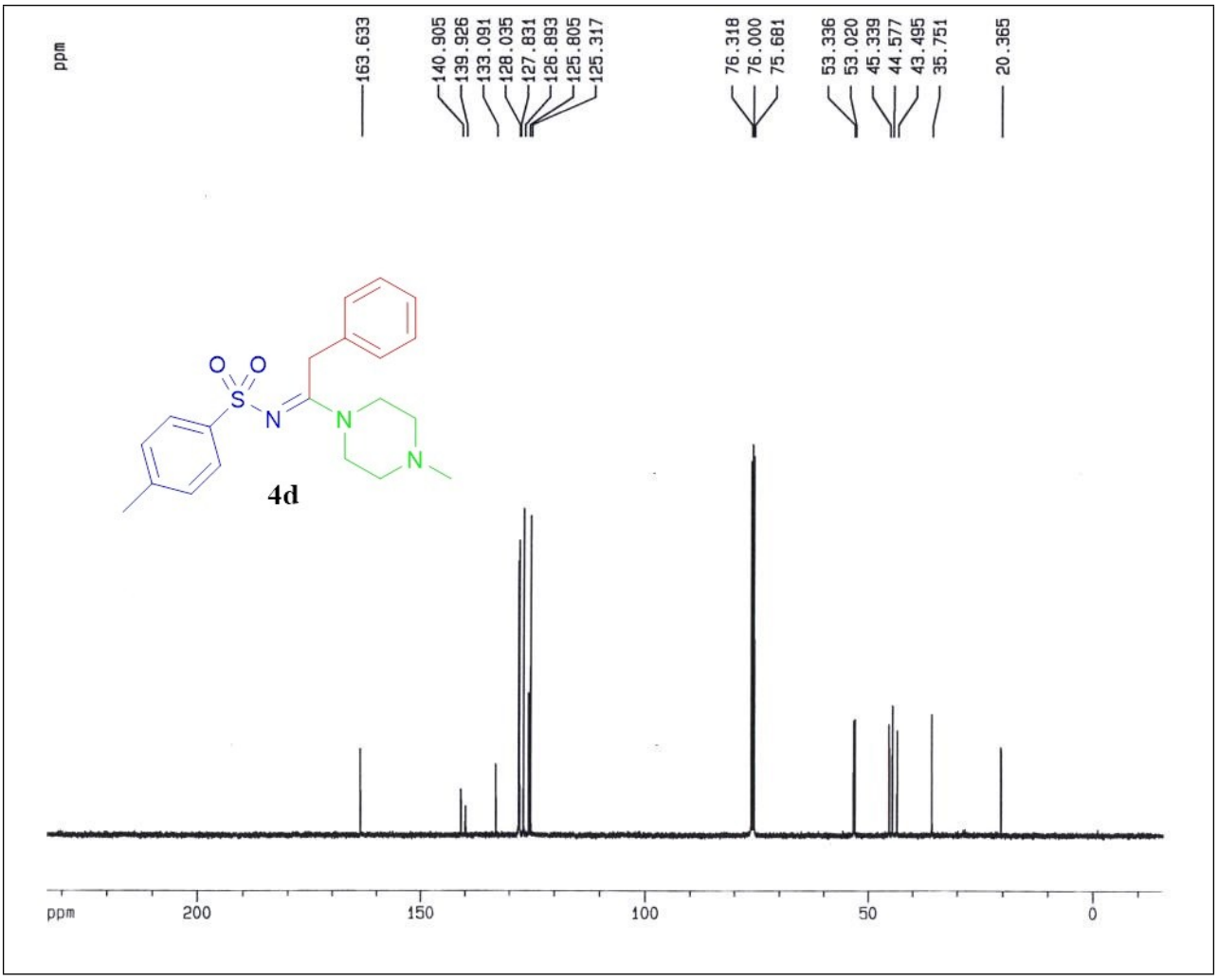

Figure 17: ^{13}C NMR spectrum (100 MHz) of compound **4d** in $CDCl_3$.

***N*-[1-(4-Methylpiperazin-1-yl)-2-phenylethylidene] benzenesulfonamide (4e):**

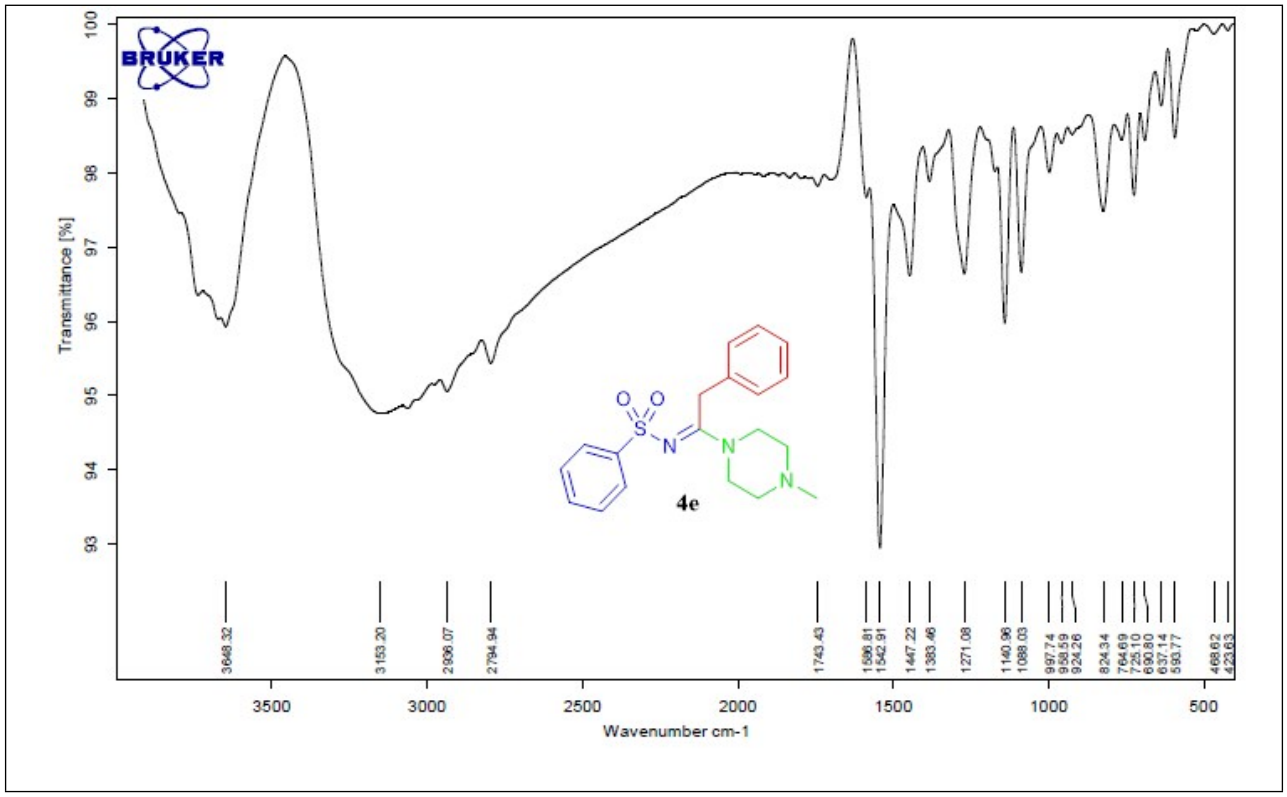

Figure 18: FTIR spectrum (KBr) of compound **4e**.

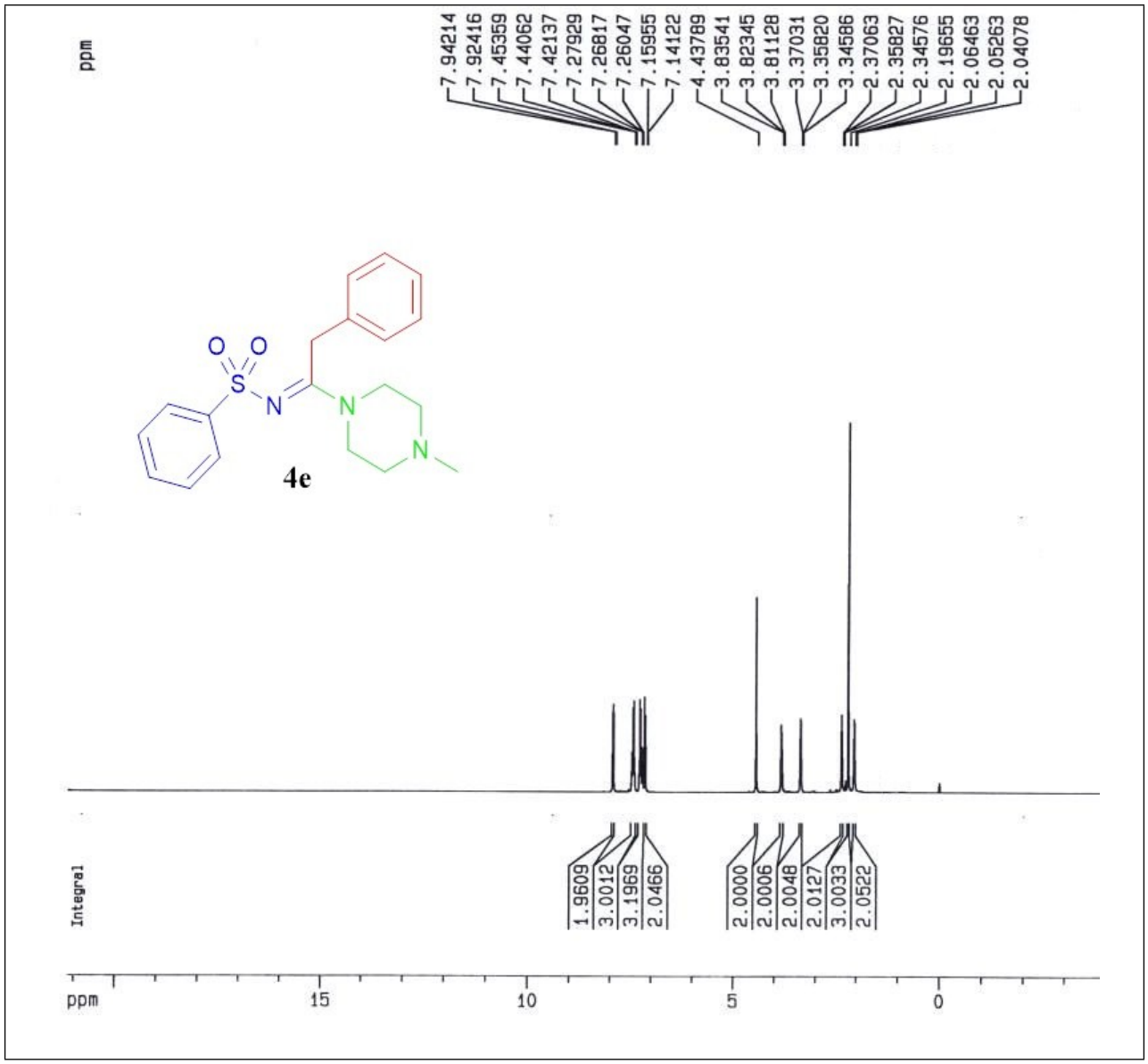

Figure 19: ^{1}H NMR spectrum (400 MHz) of compound **4e** in $CDCl_3$.

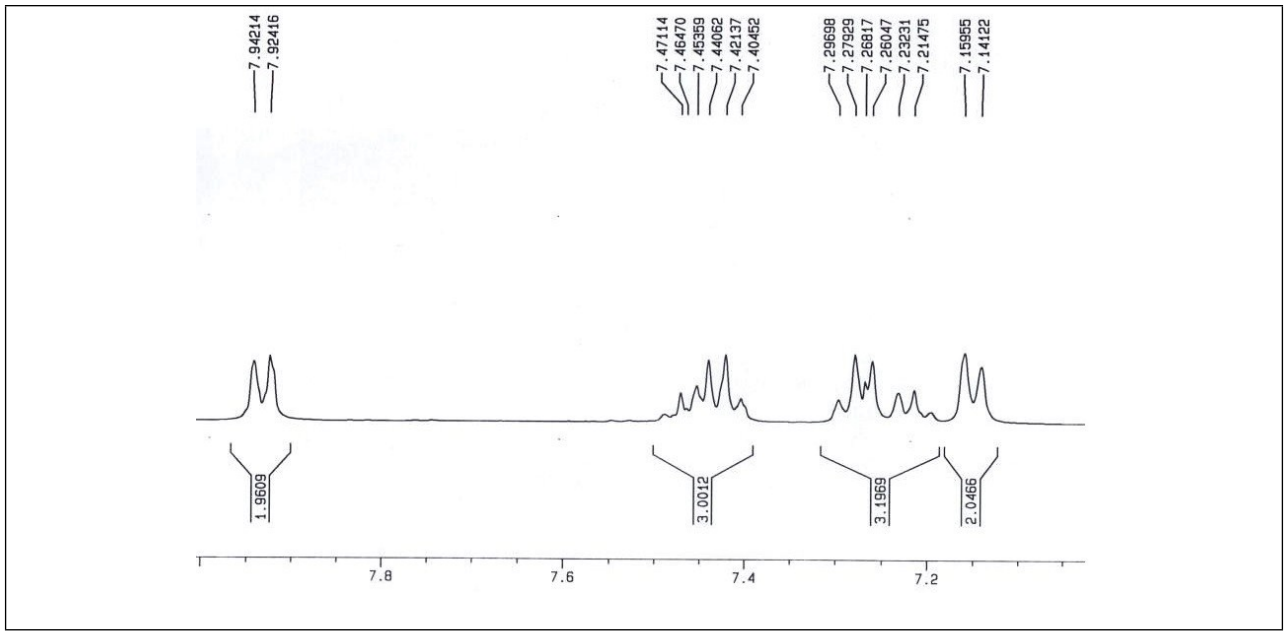

Figure 20: Expanded (1) ^{1}H NMR spectrum (400 MHz) of compound **4e** in $CDCl_3$.

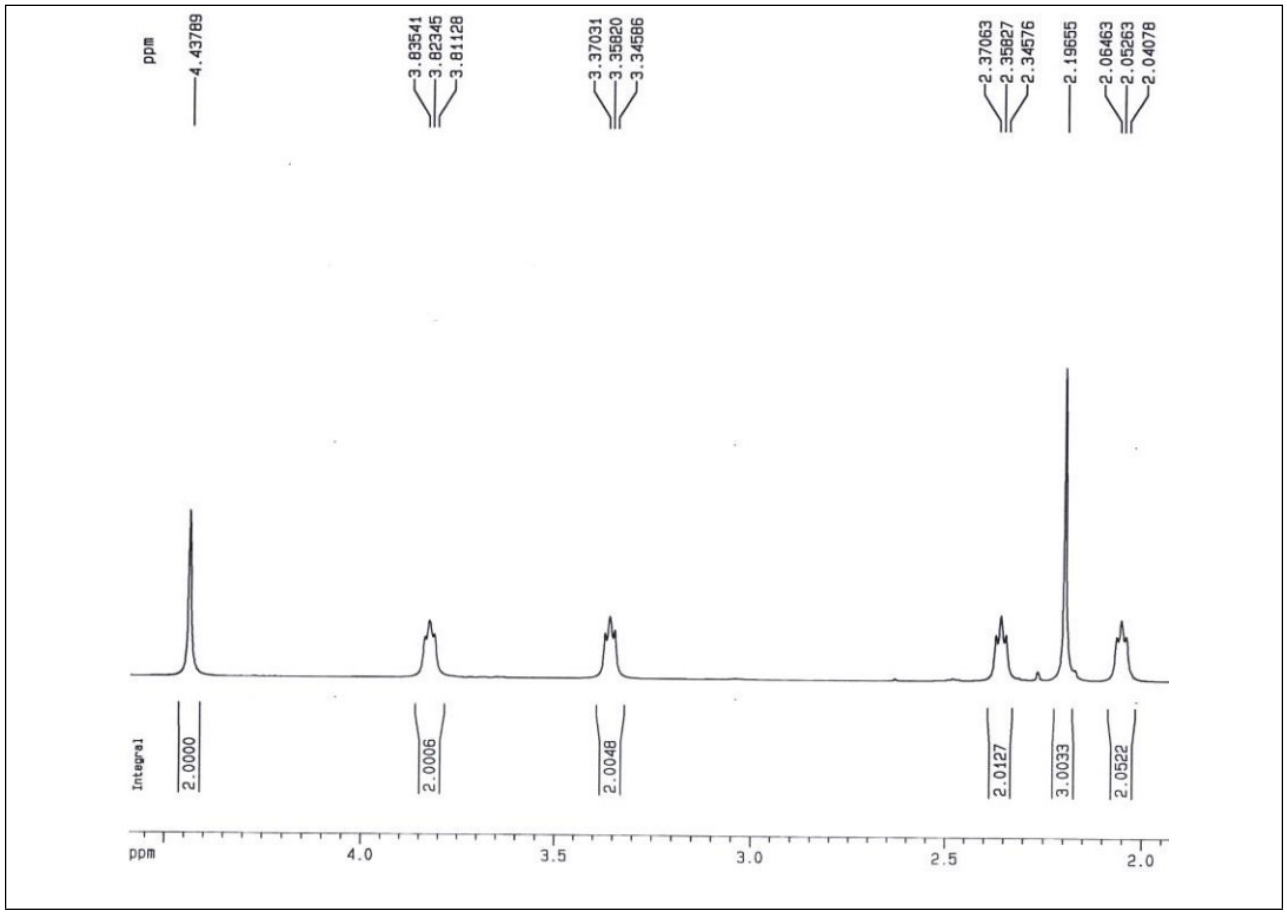

Figure 21: Expanded (2) ^{1}H NMR spectrum (400 MHz) of compound **4e** in $CDCl_3$.

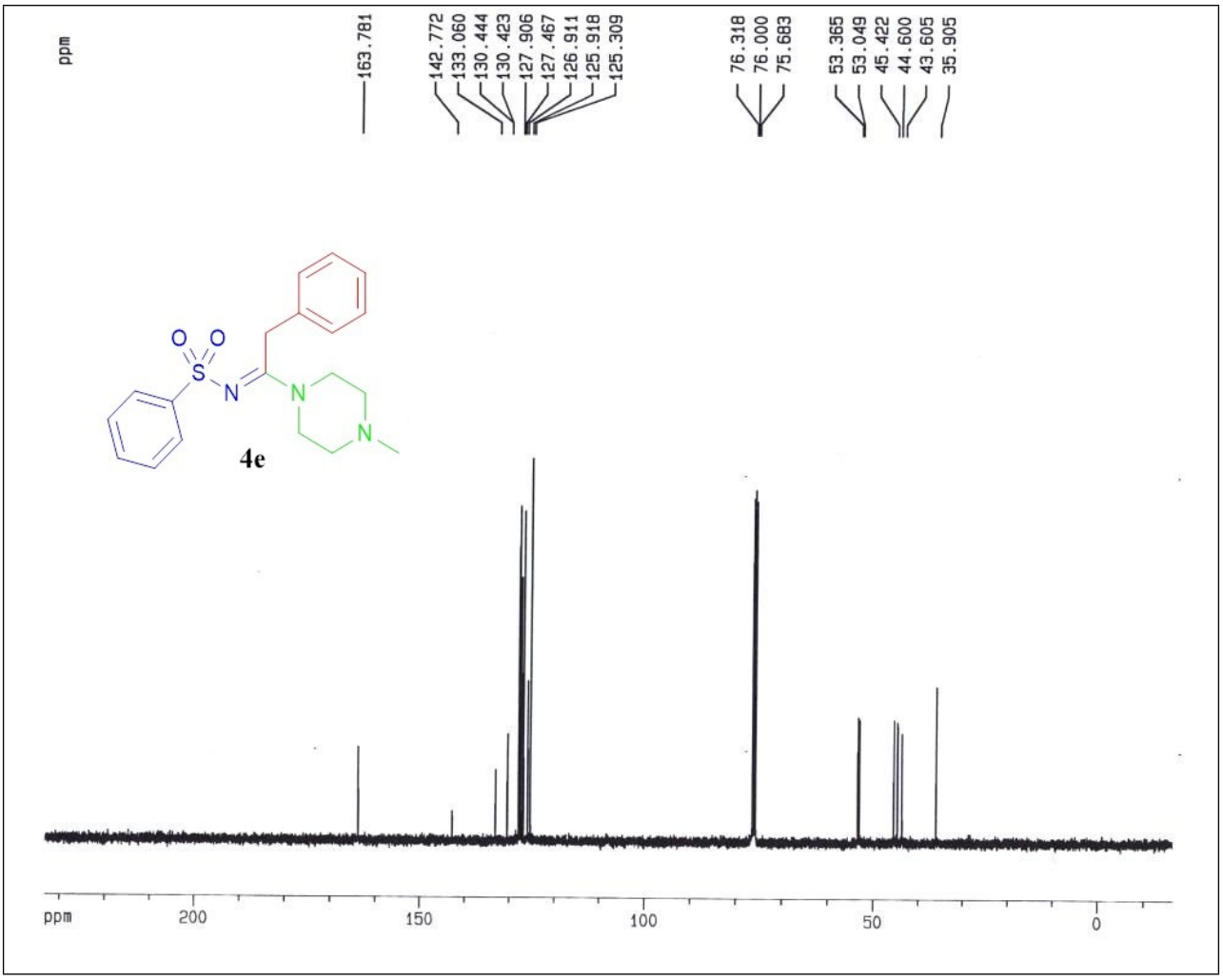

Figure 22: ^{13}C NMR spectrum (100 MHz) of compound **4e** in $CDCl_3$.

***N*-[2-phenyl-1-[4-(phenylsulfonyl) piperazin-1-yl] ethylidene] benzenesulfonamide (4f):**

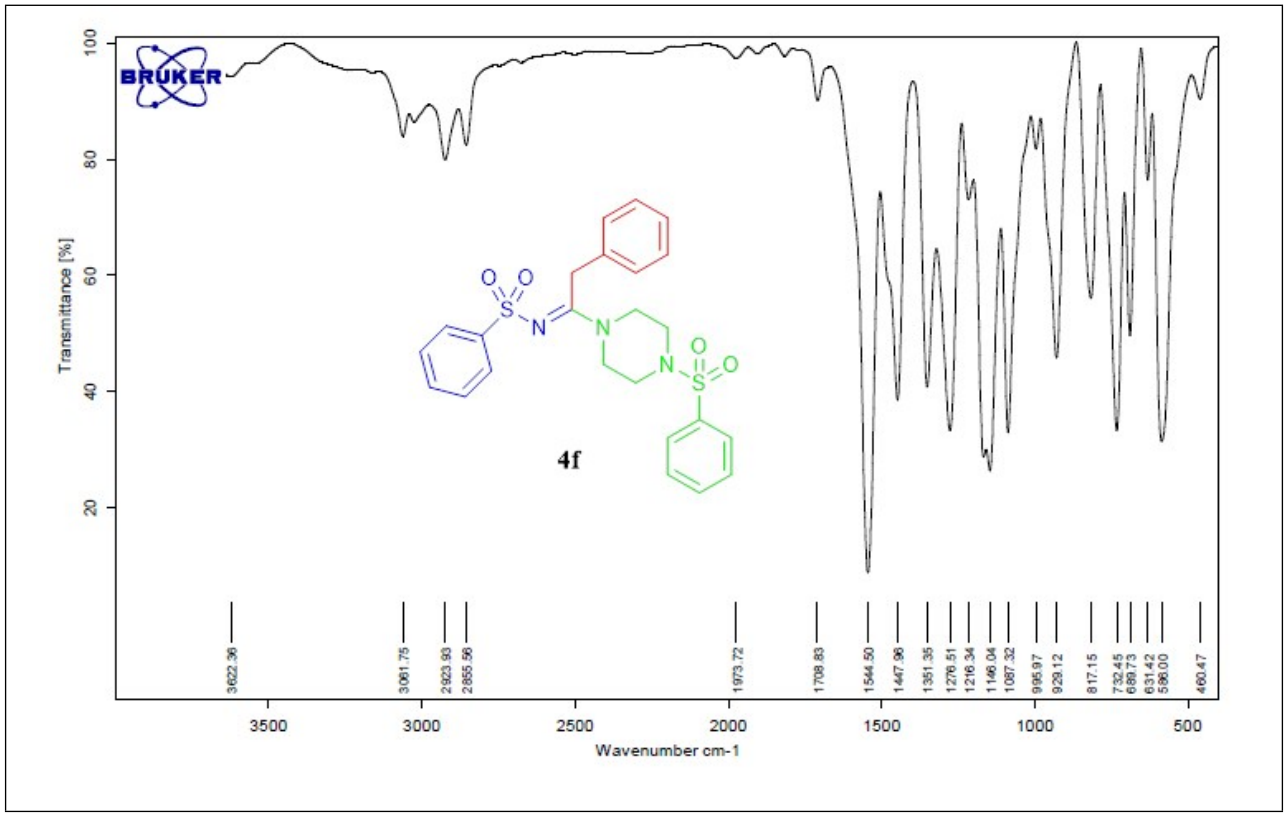

Figure 23: FTIR spectrum (KBr) of compound **4f**.

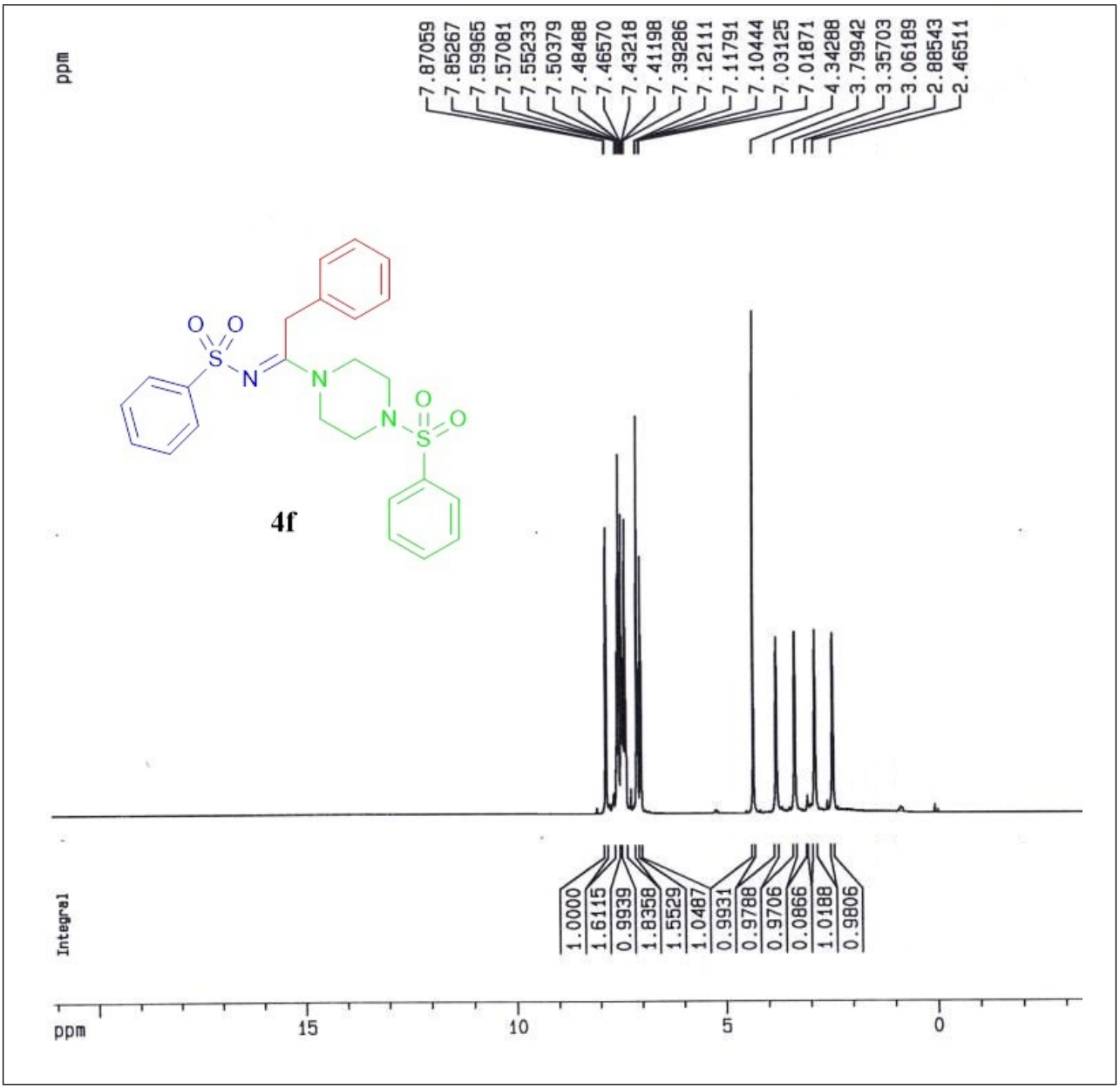

Figure 24: ^{1}H NMR spectrum (400 MHz) of compound **4f** in $CDCl_3$.

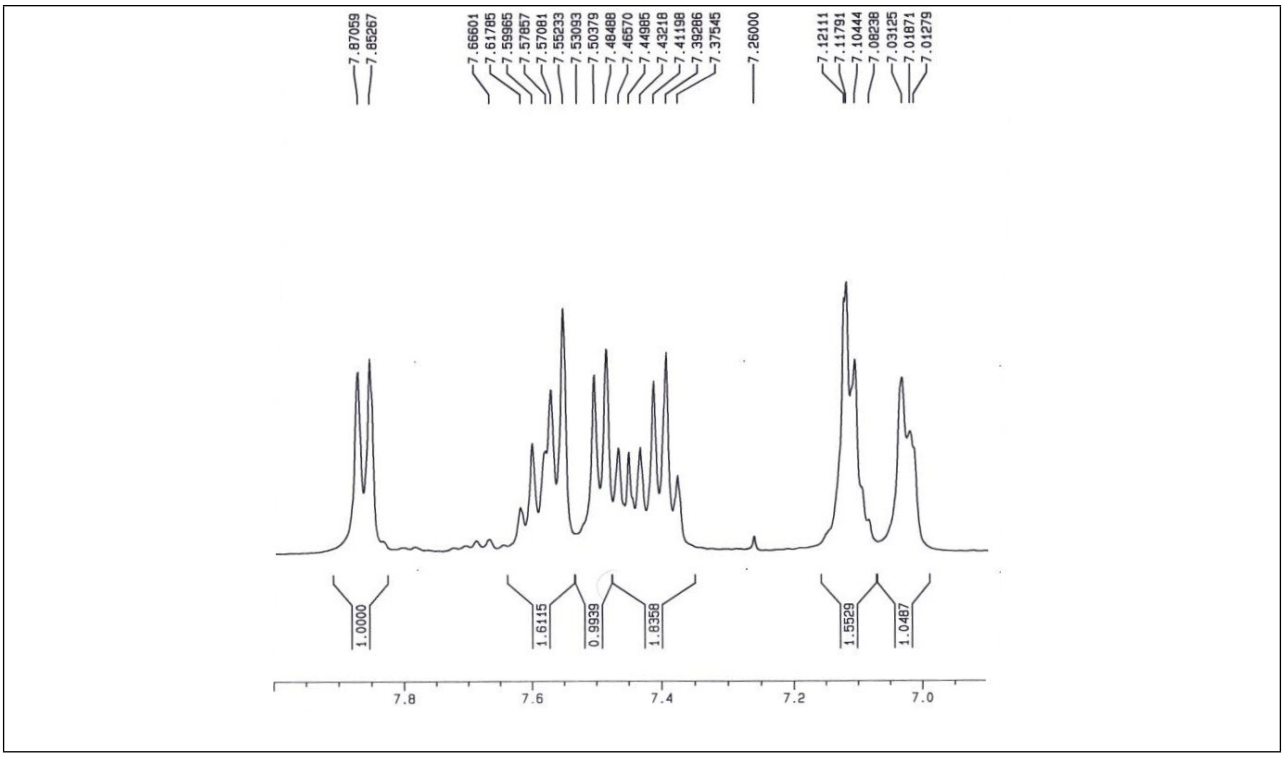

Figure 25: Expanded (1) ^{1}H NMR spectrum (400 MHz) of compound **4f** in $CDCl_3$.

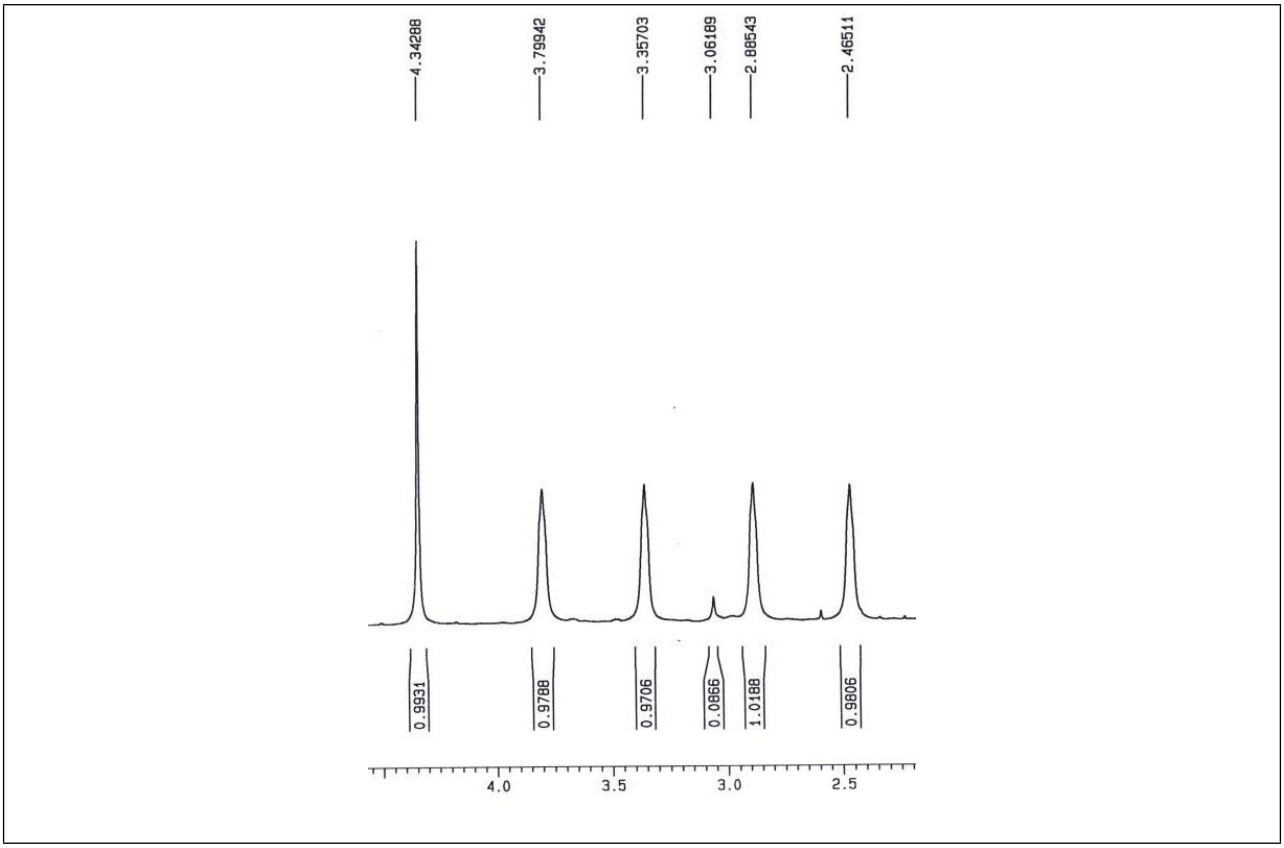

Figure 26: Expanded (2) ^{1}H NMR spectrum (400 MHz) of compound **4f** in $CDCl_3$.

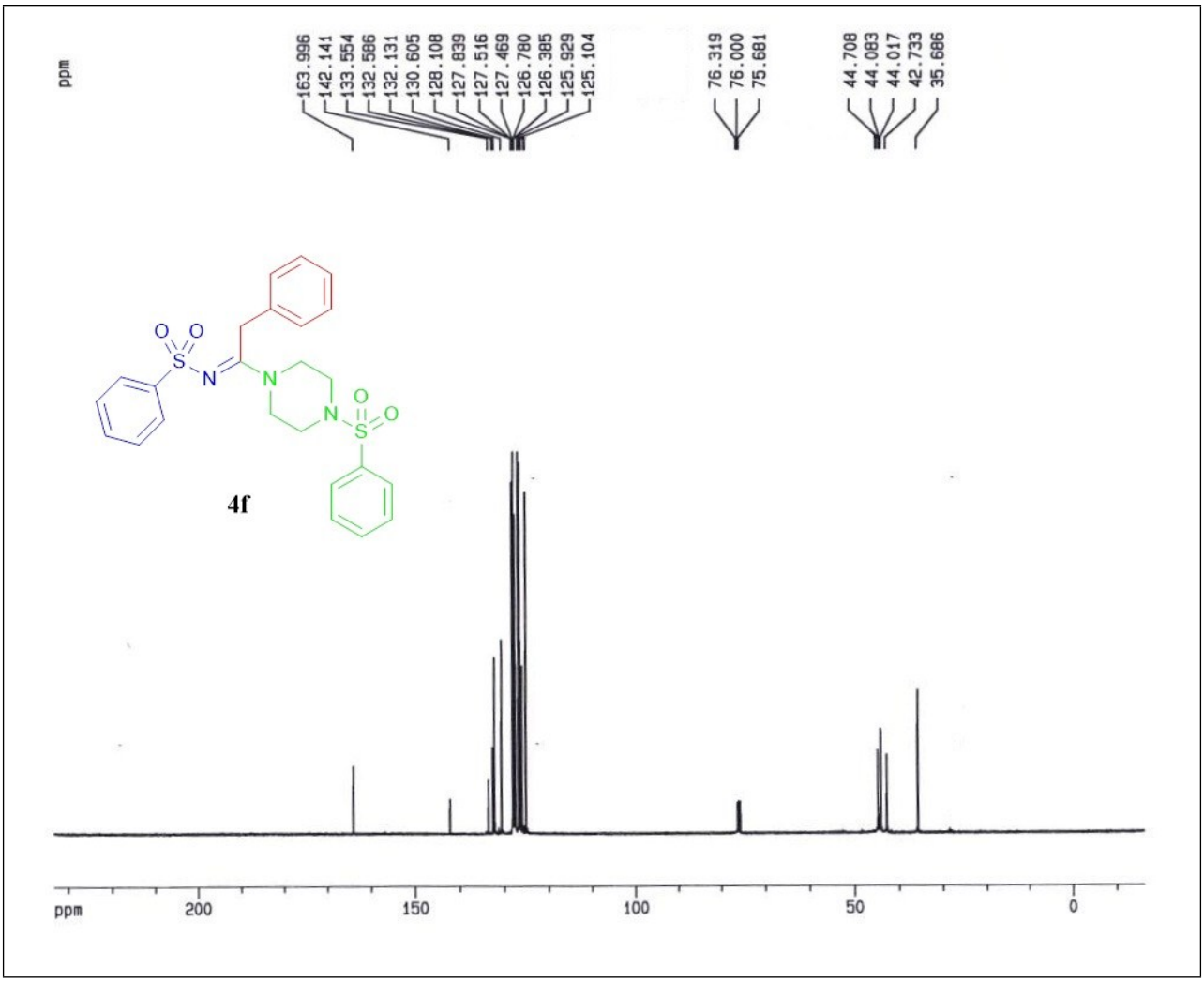

Figure 27: ^{13}C NMR spectrum (100 MHz) of compound **4f** in $CDCl_3$.

N^1-Cyclohexyl- N^1-methyl-N^2-(4-methylbenzensulfonyl)-2-phenylacetamidine (4g):

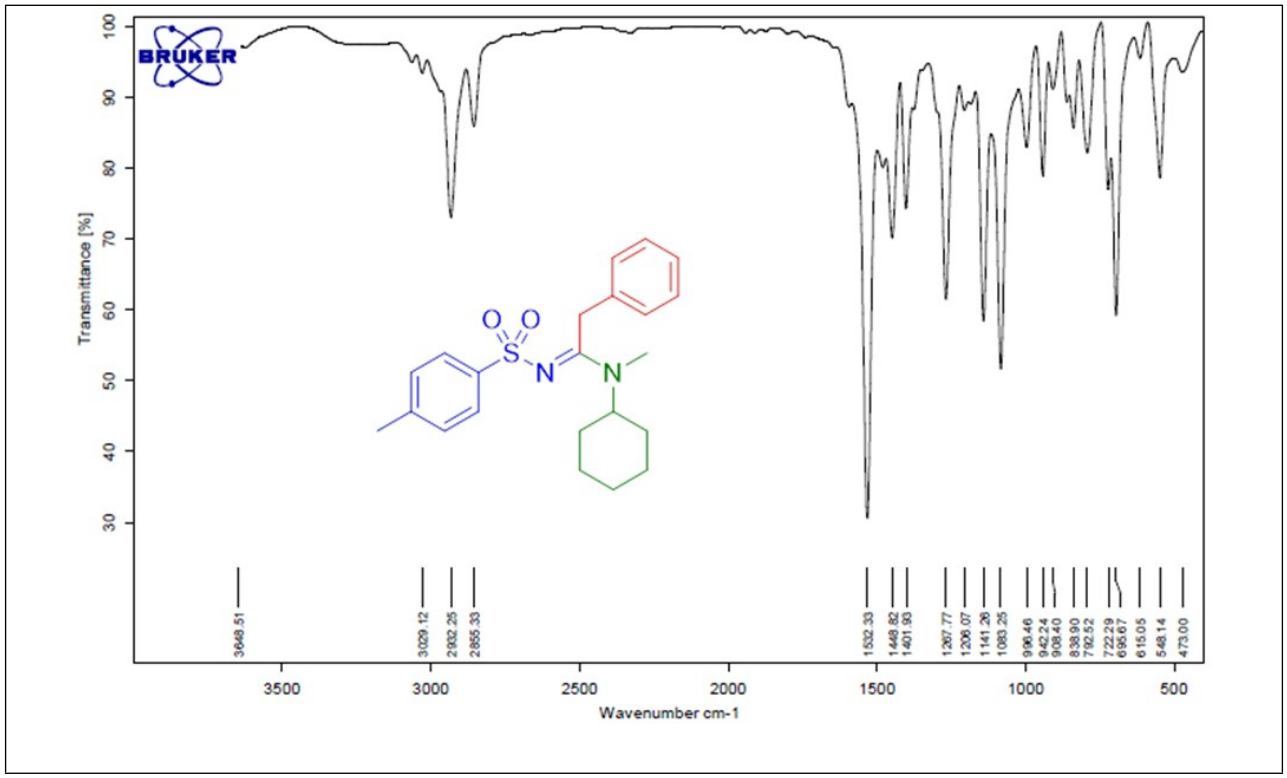

Figure 28: FTIR spectrum (KBr) of compound **4g**.

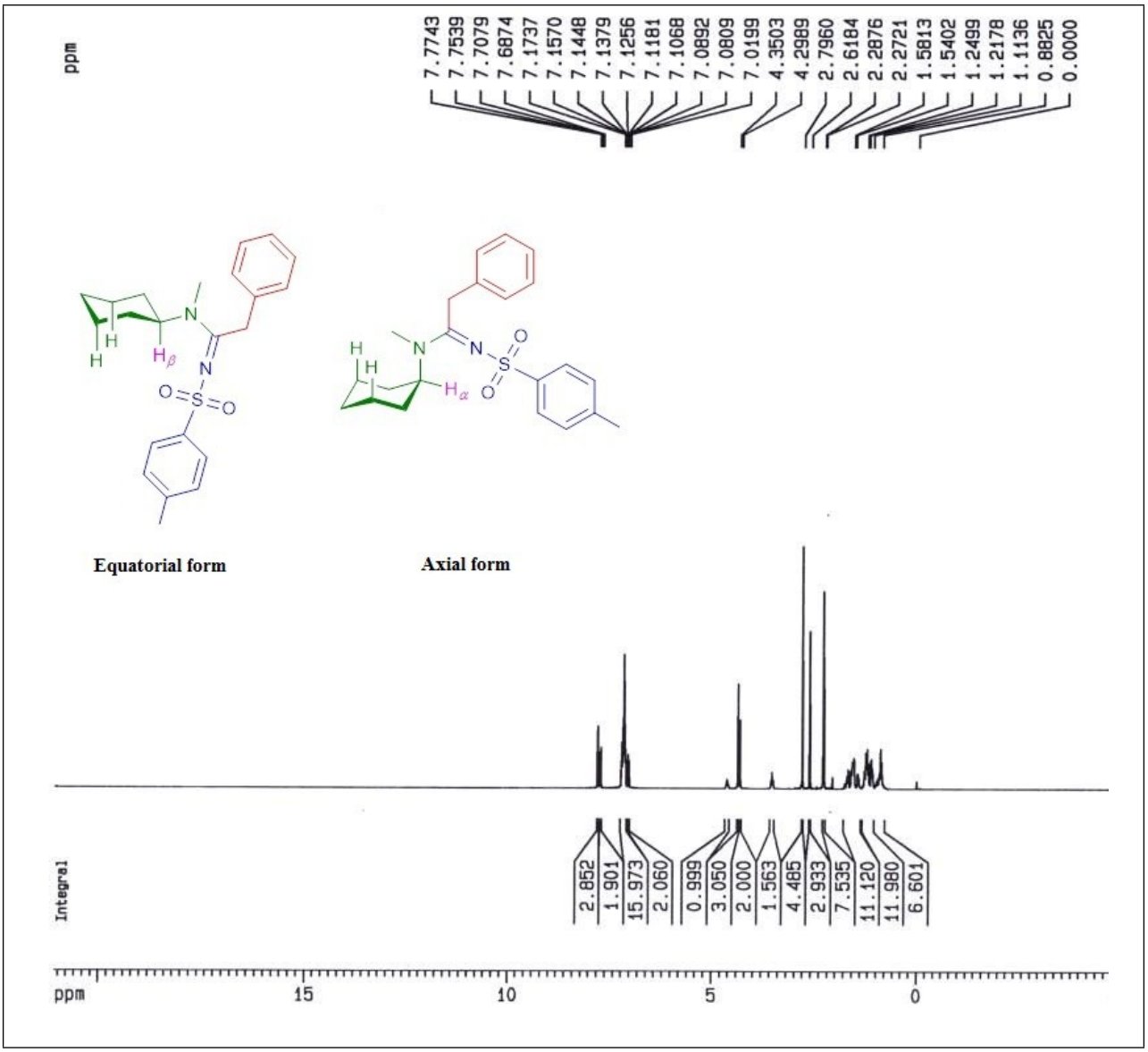

Figure 29: ^{1}H NMR spectrum (400 MHz) of compound **4g** in $CDCl_3$.

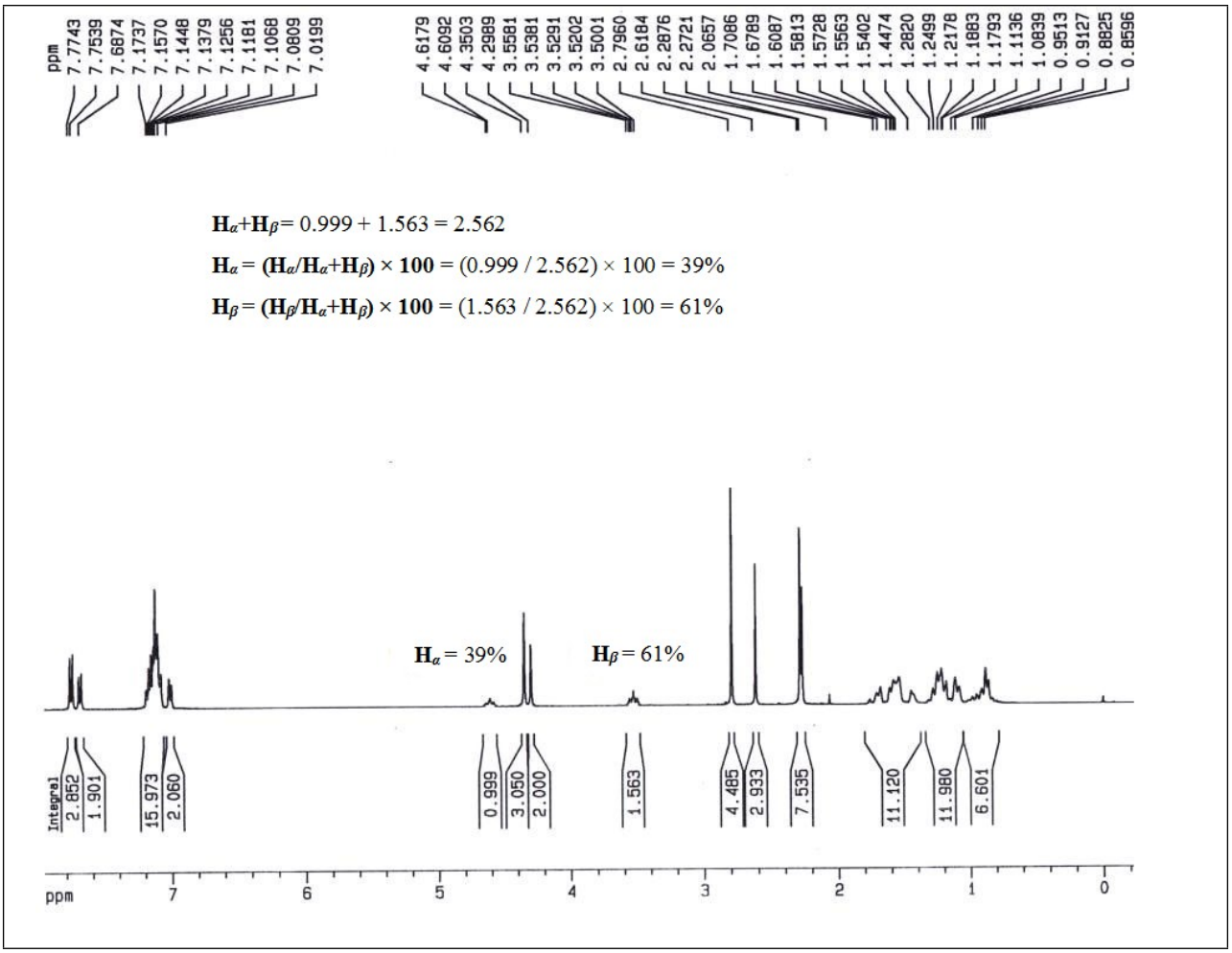

Figure 30: Expanded (1) ^{1}H NMR spectrum (400 MHz) of compound **4g** in $CDCl_3$.

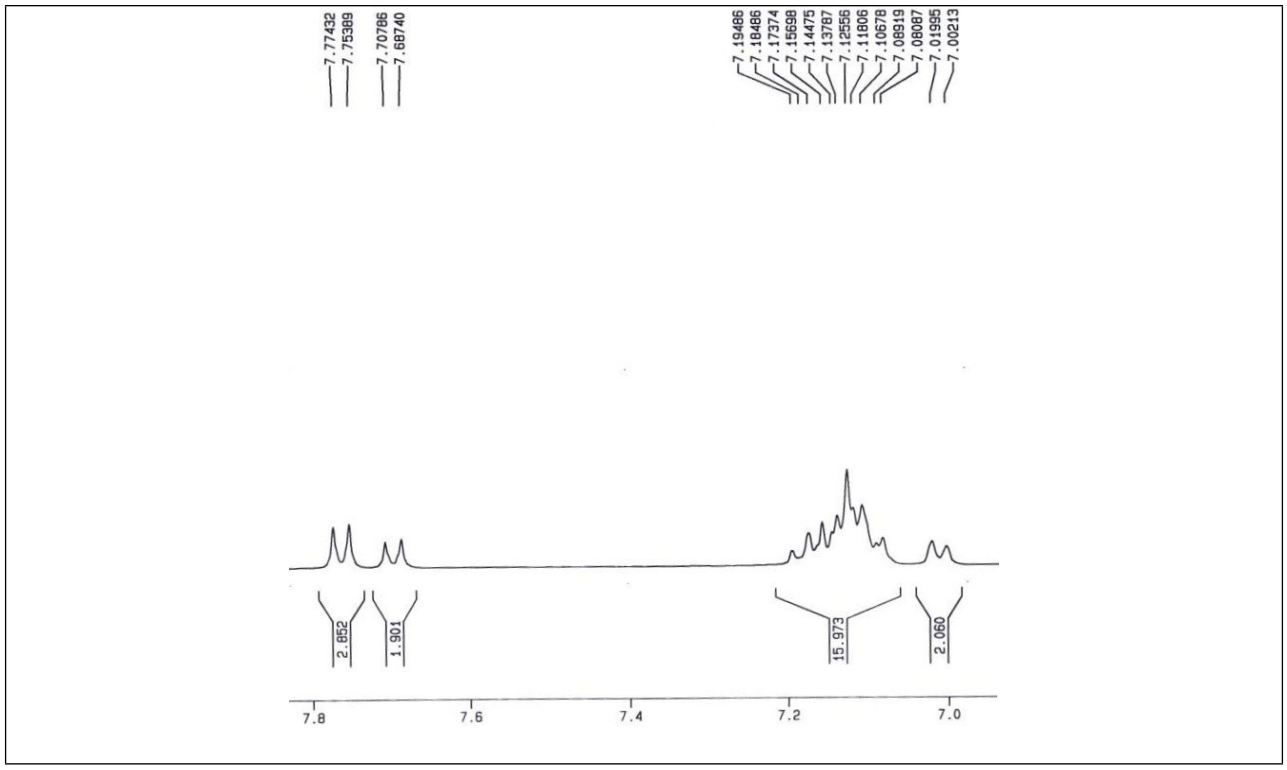

Figure 31: Expanded (2) ^{1}H NMR spectrum (400 MHz) of compound **4g** in $CDCl_3$.

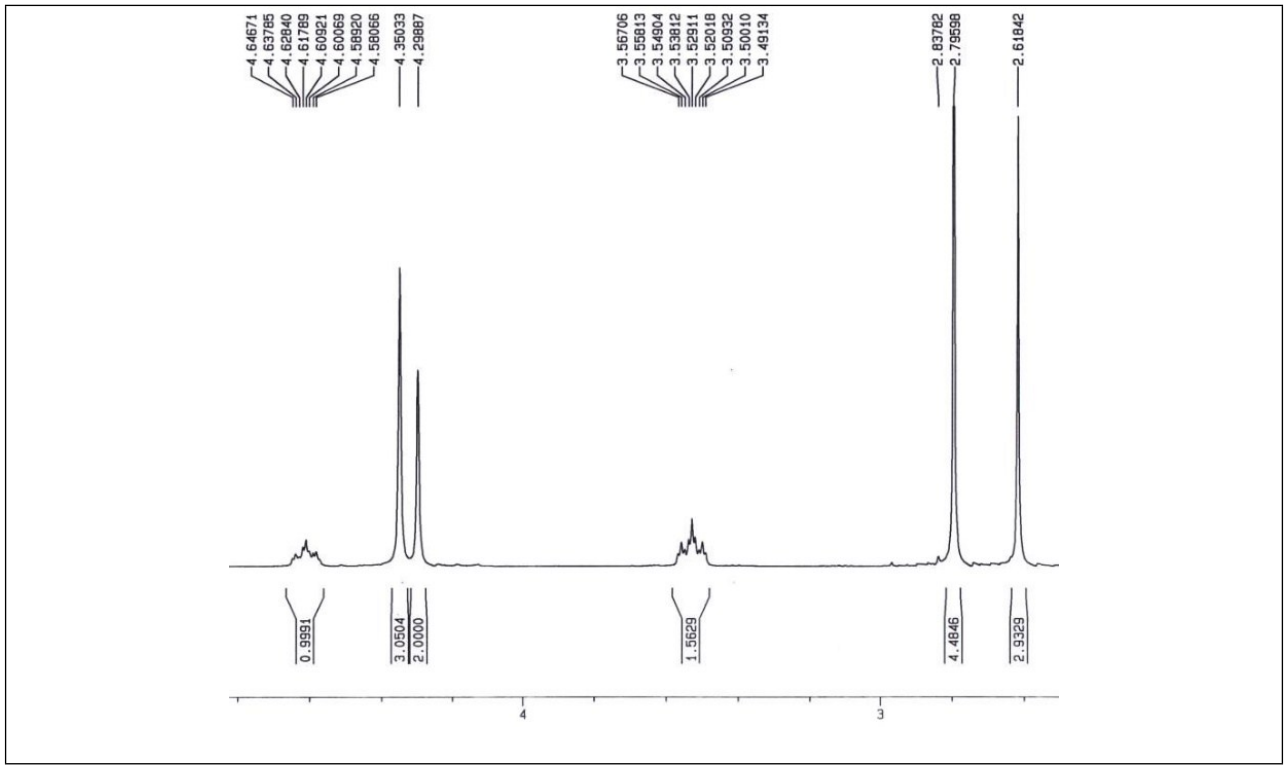

Figure 32: Expanded (3) ^{1}H NMR spectrum (400 MHz) of compound **4g** in $CDCl_3$.

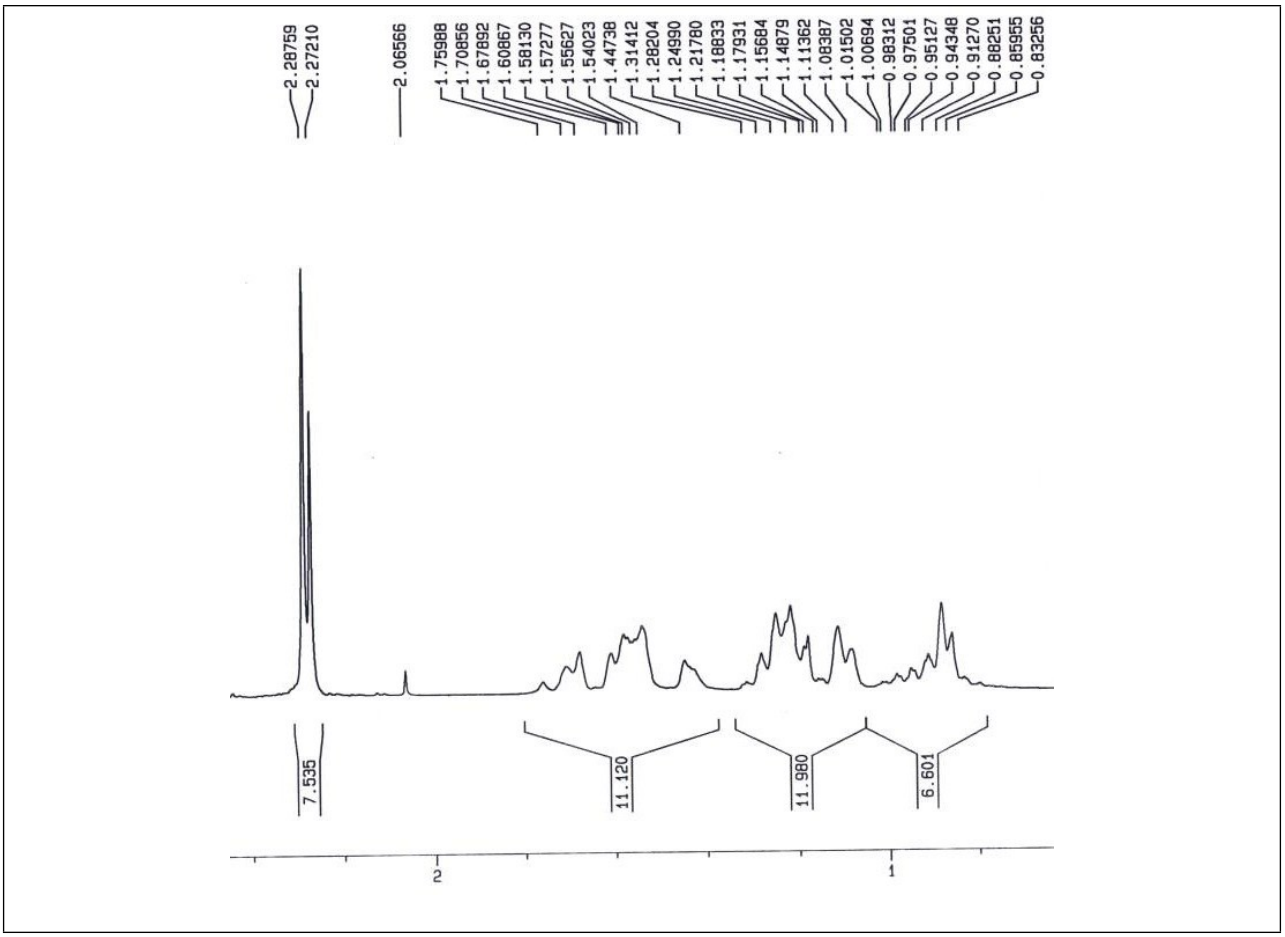

Figure 33: Expanded (4) ^{1}H NMR spectrum (400 MHz) of compound **4g** in $CDCl_3$.

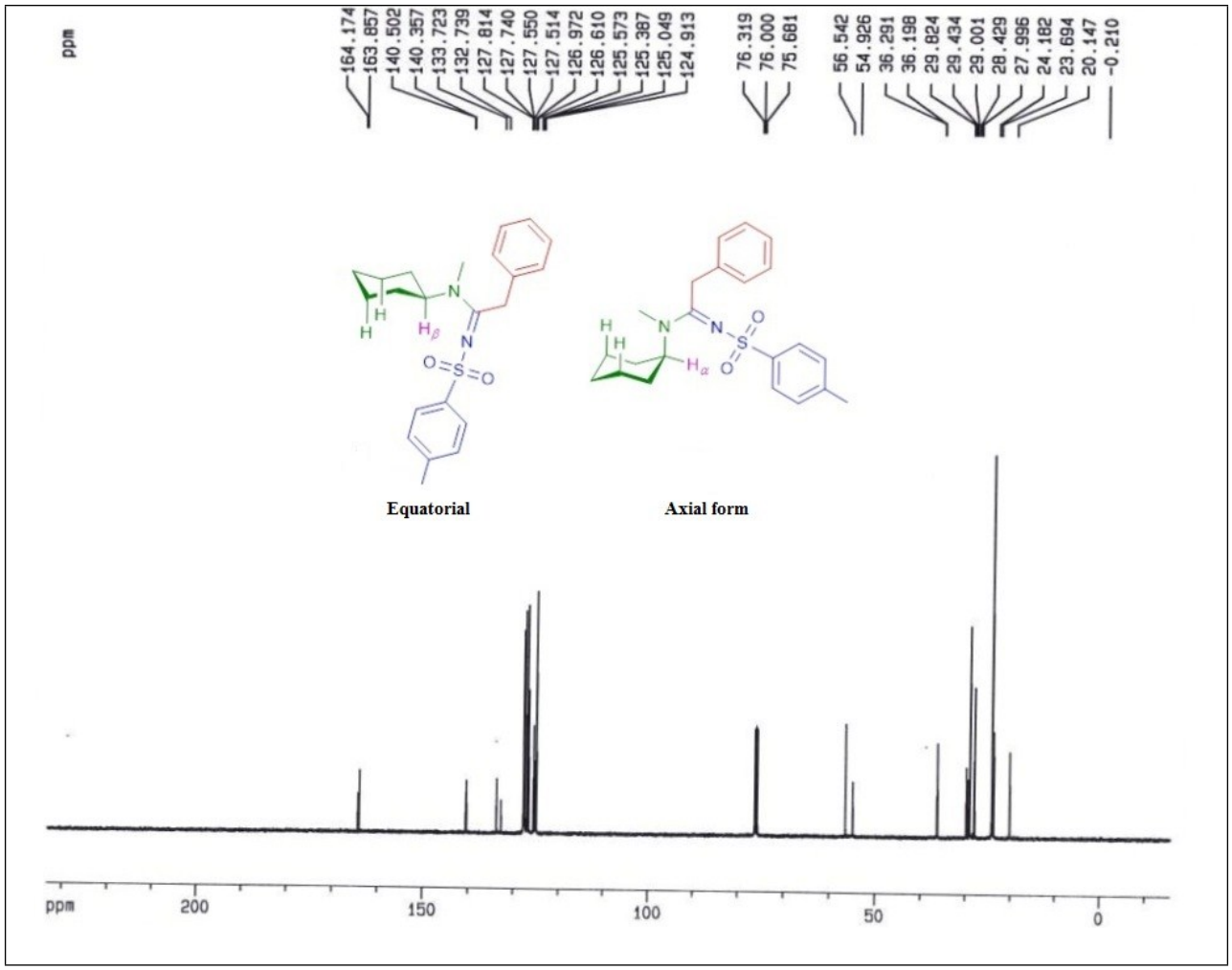

Figure 34: ^{13}C NMR spectrum (100 MHz) of compound **4g** in $CDCl_3$.

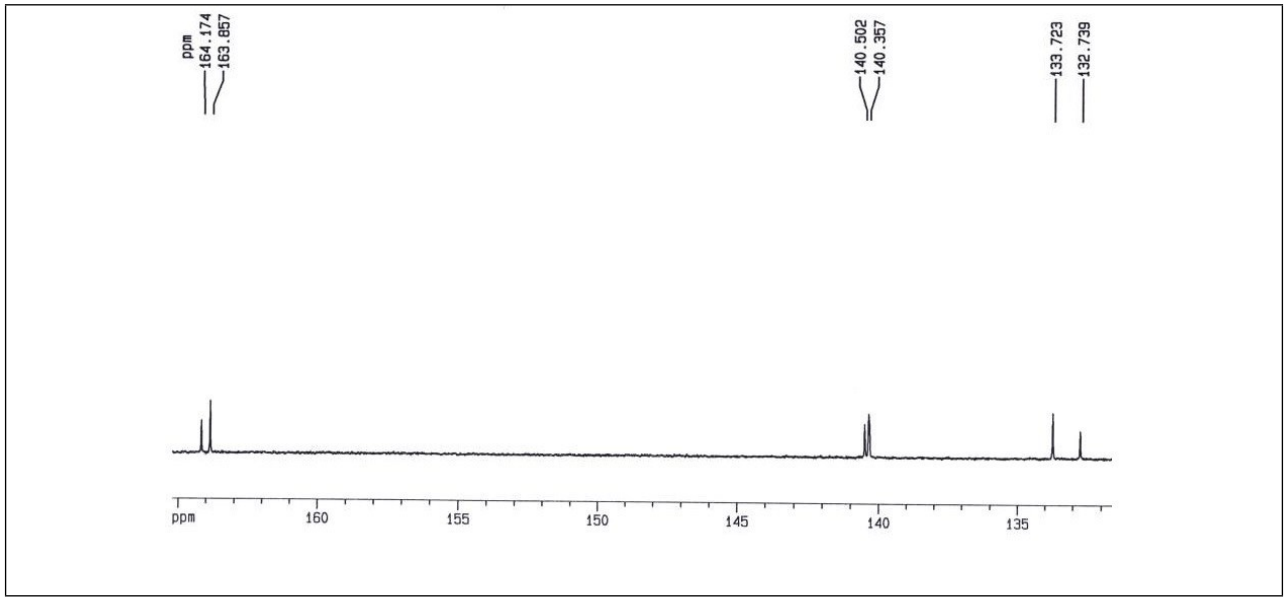

Figure 35: Expanded (1) ^{13}C NMR spectrum (100 MHz) of compound **4g** in $CDCl_3$.

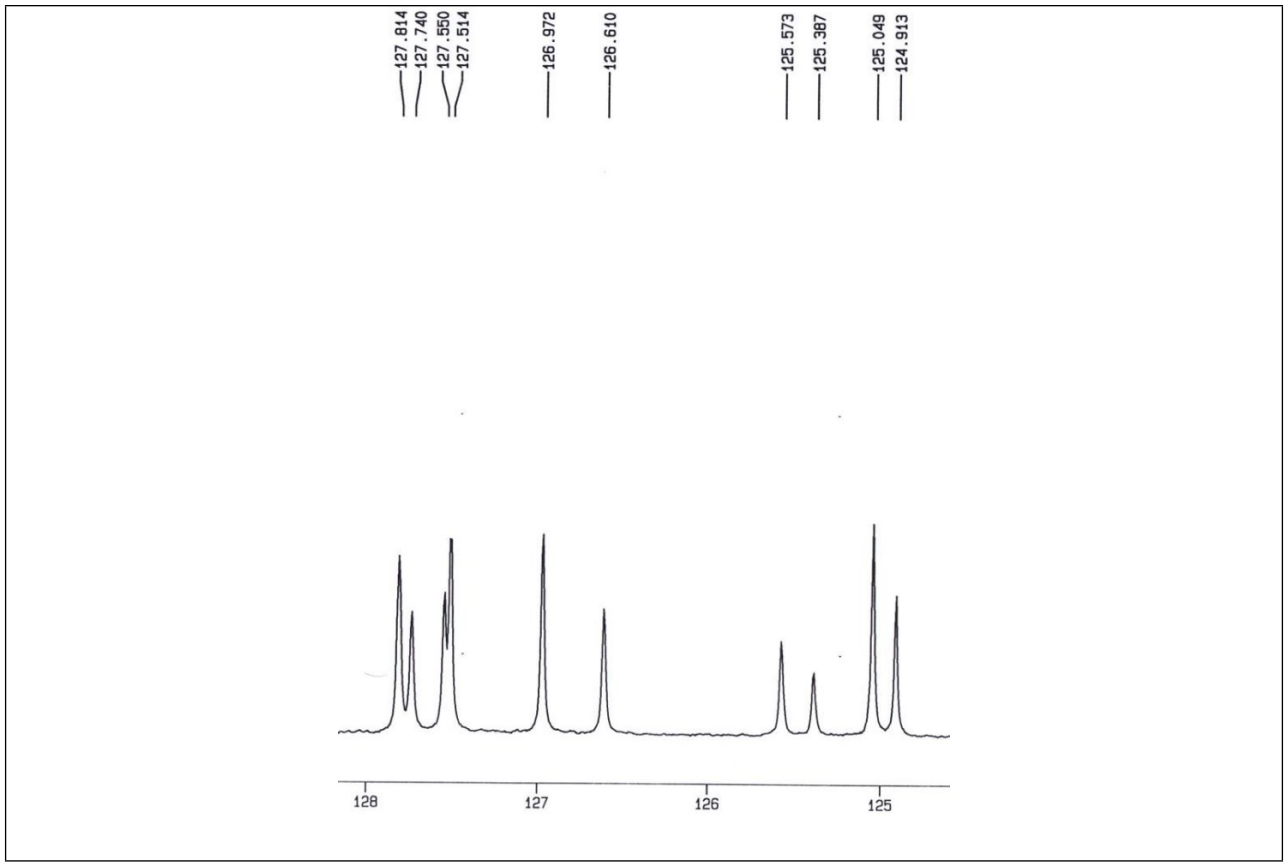

Figure 36: Expanded (2) ^{13}C NMR spectrum (100 MHz) of compound **4g** in $CDCl_3$.

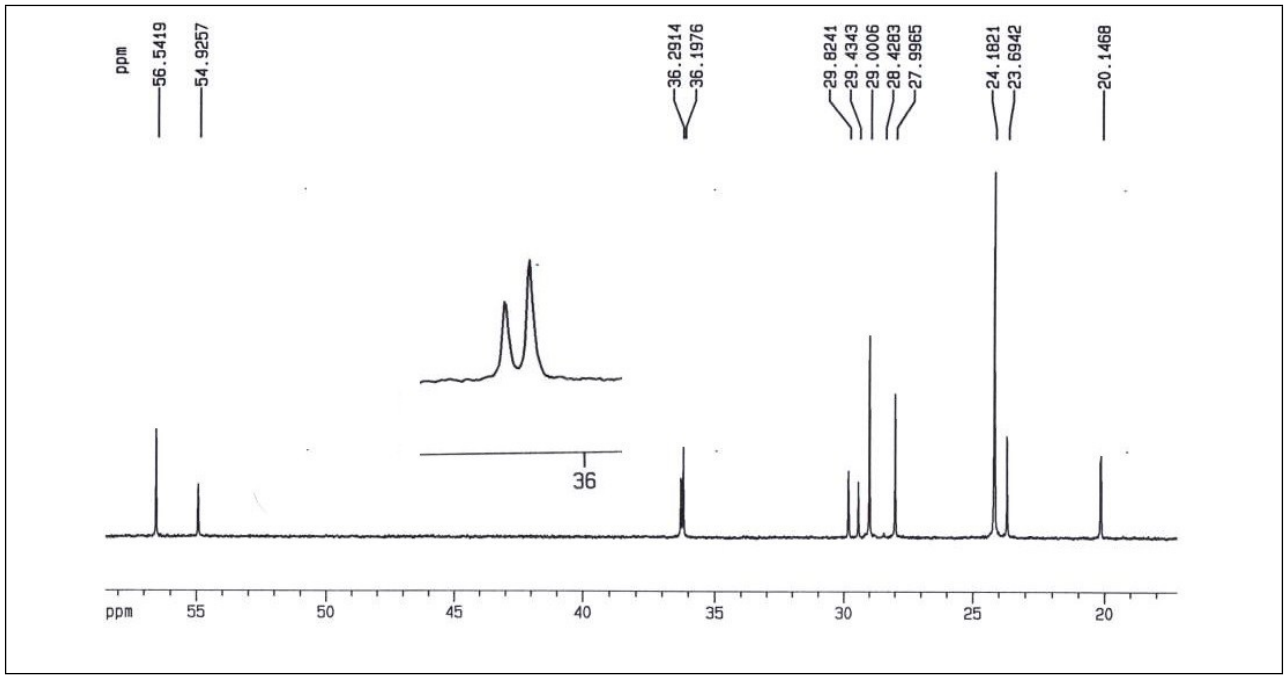

Figure 37: Expanded (3) ^{13}C NMR spectrum (100 MHz) of compound **4g** in $CDCl_3$.

***N*^{1}-Cyclohexyl-*N*^{1}-methyl-*N*^{2}-(phenylsulfonyl)-2-phenylacetamidine (4h):**

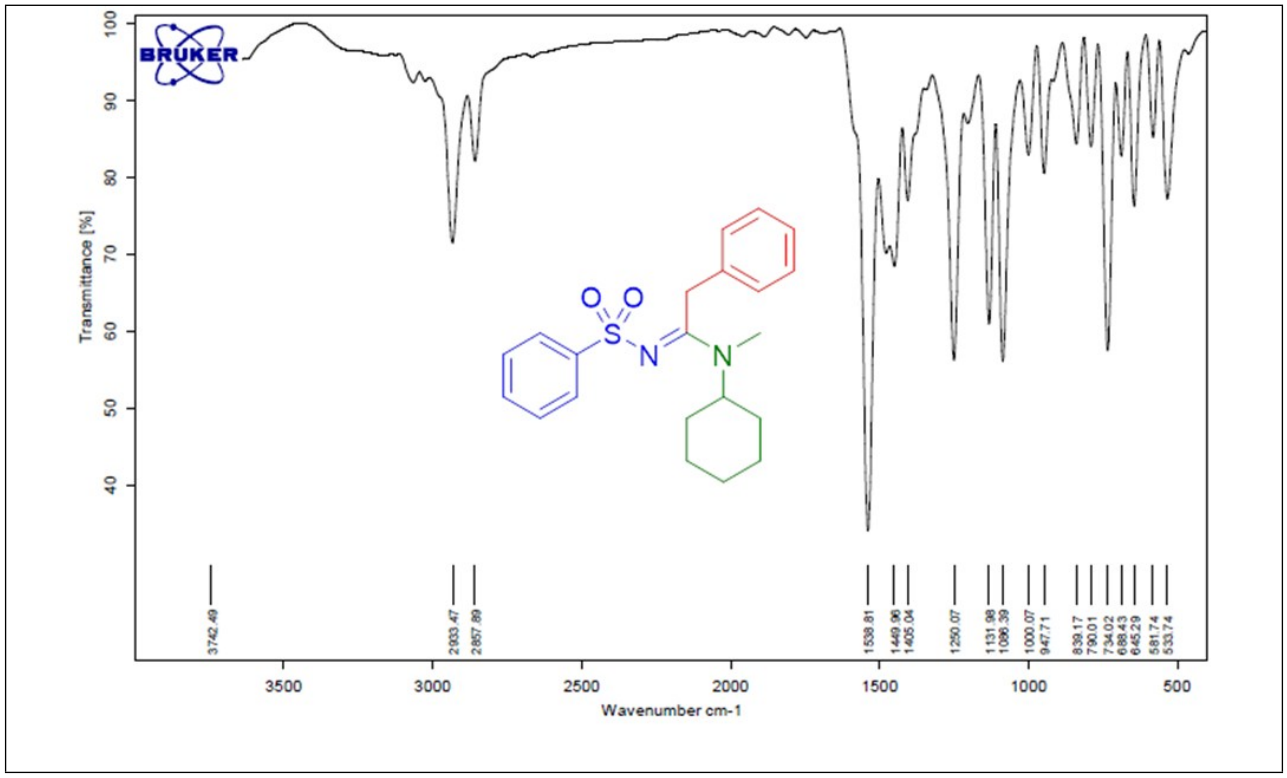

Figure 38: FTIR spectrum (KBr) of compound **4h**.

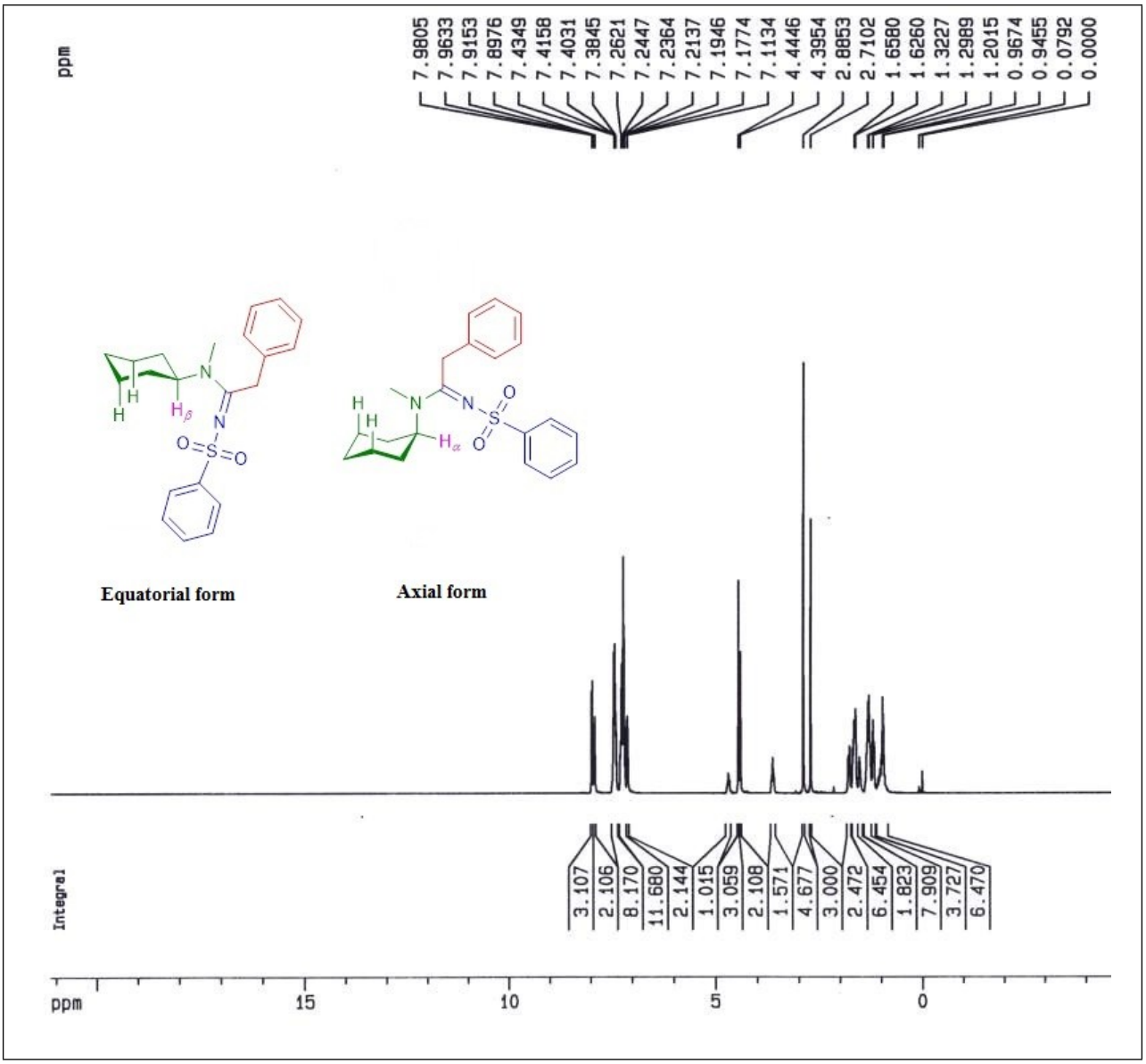

Figure 39: ^{1}H NMR spectrum (400 MHz) of compound **4h** in $CDCl_3$.

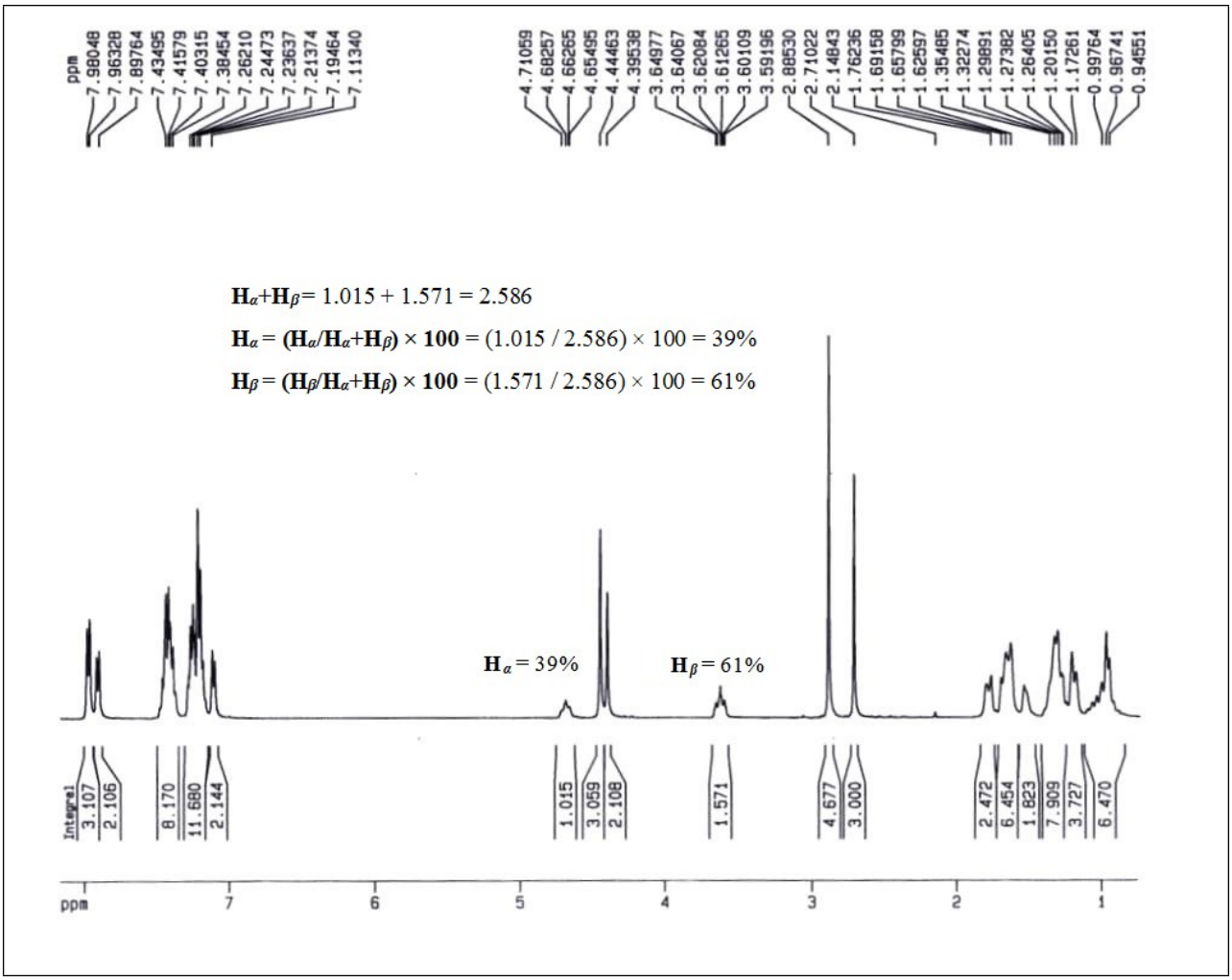

Figure 40: Expanded (1) ^{1}H NMR spectrum (400 MHz) of compound **4h** in $CDCl_3$.

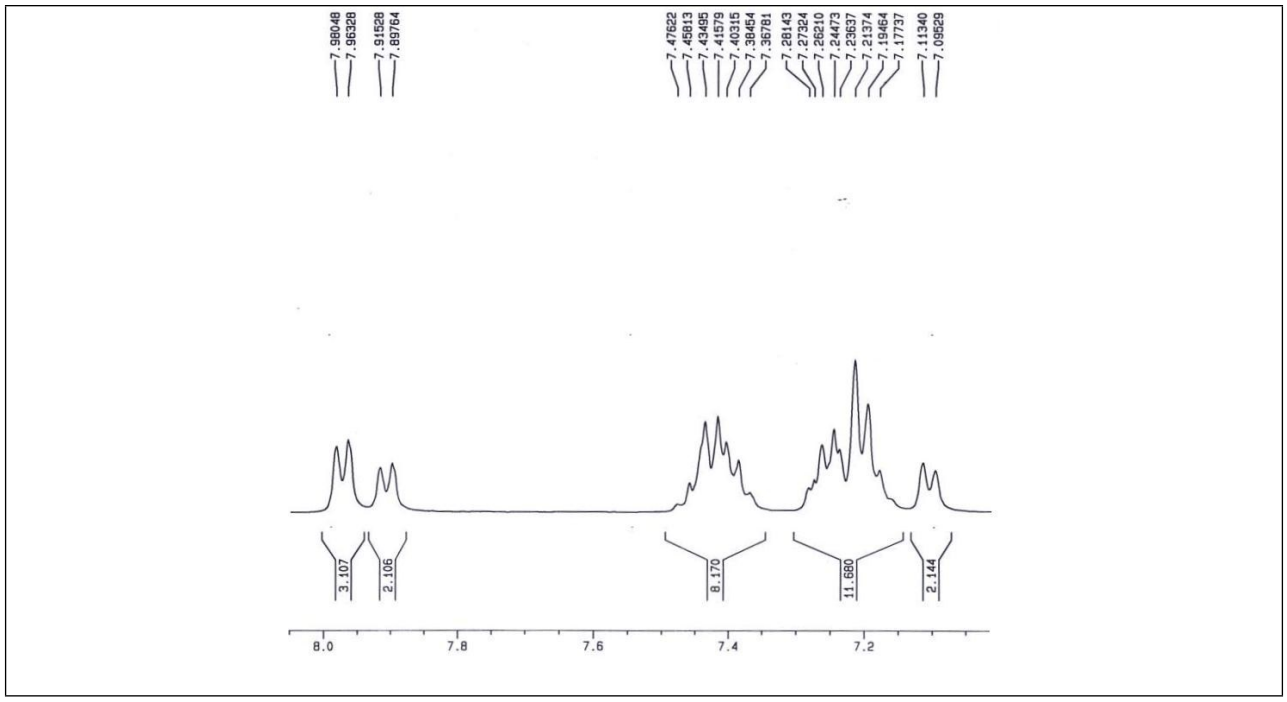

Figure 41: Expanded (2) ^{1}H NMR spectrum (400 MHz) of compound **4h** in $CDCl_3$.

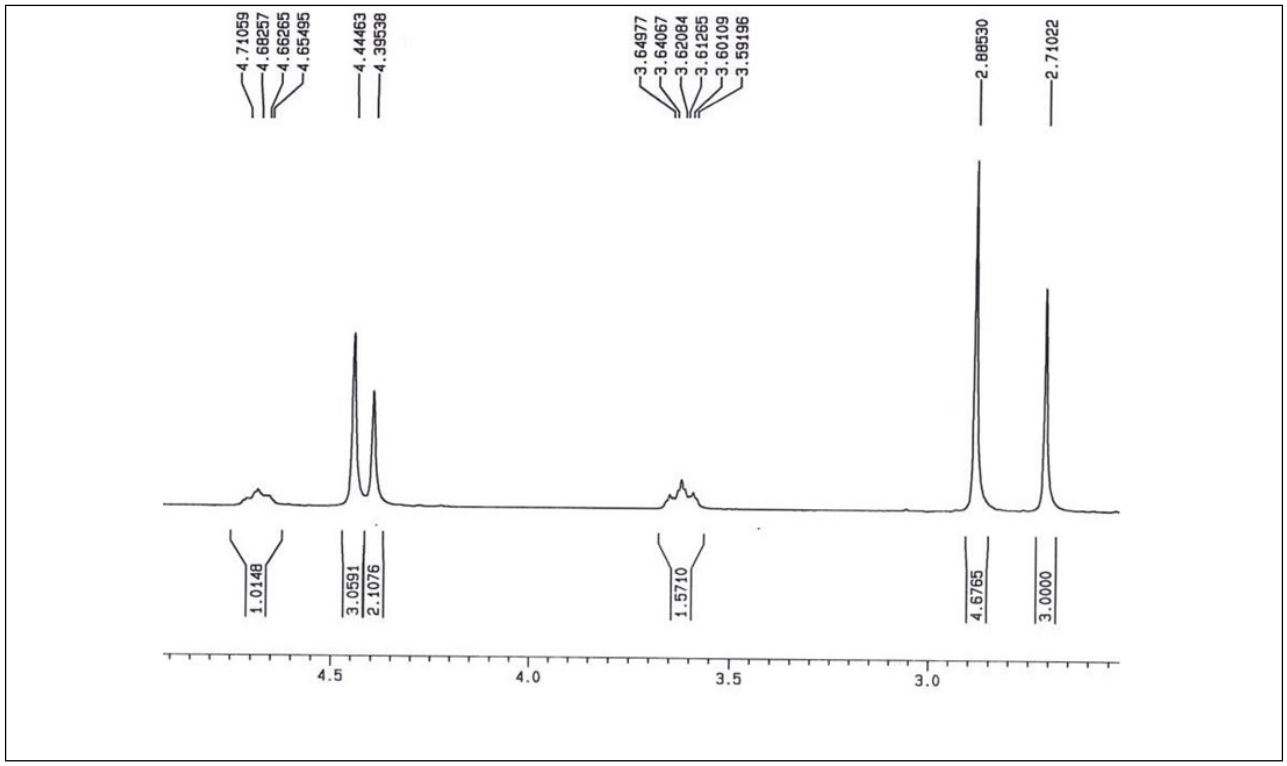

Figure 42: Expanded (3) ^{1}H NMR spectrum (400 MHz) of compound **4h** in $CDCl_3$.

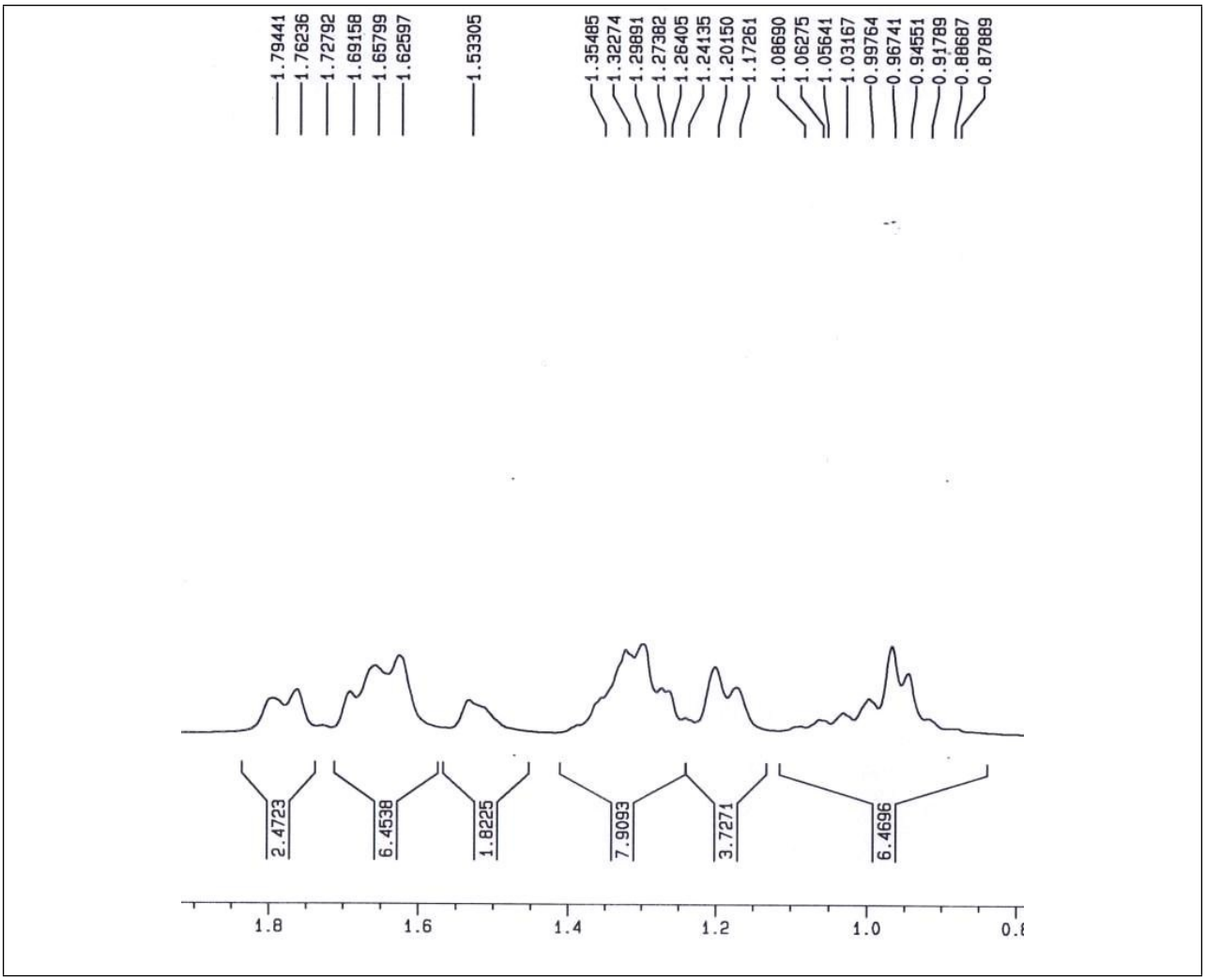

Figure 43: Expanded (4) ^{1}H NMR spectrum (400 MHz) of compound **4h** in $CDCl_3$.

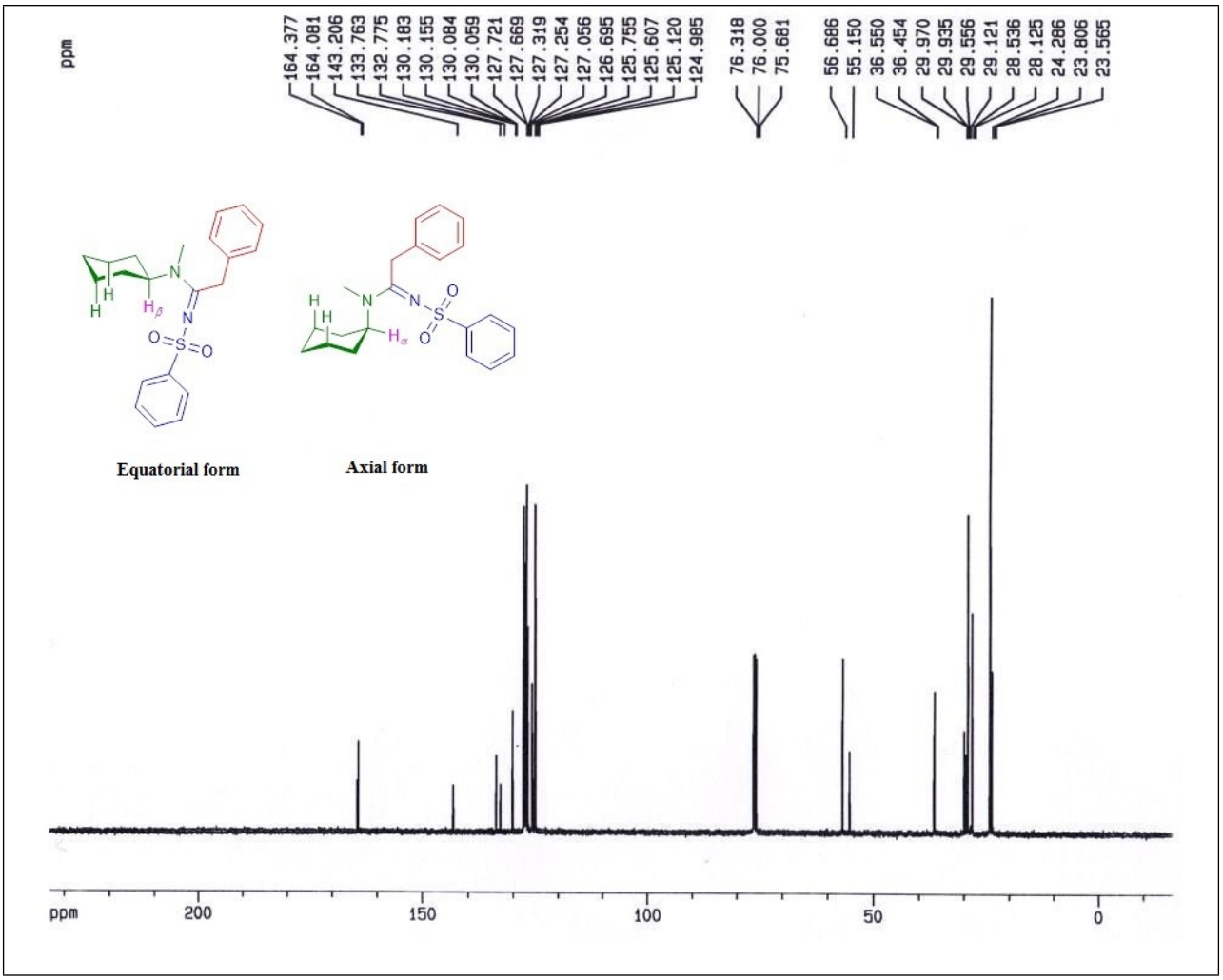

Figure 44: ^{13}C NMR spectrum (400 MHz) of compound **4h** in $CDCl_3$.

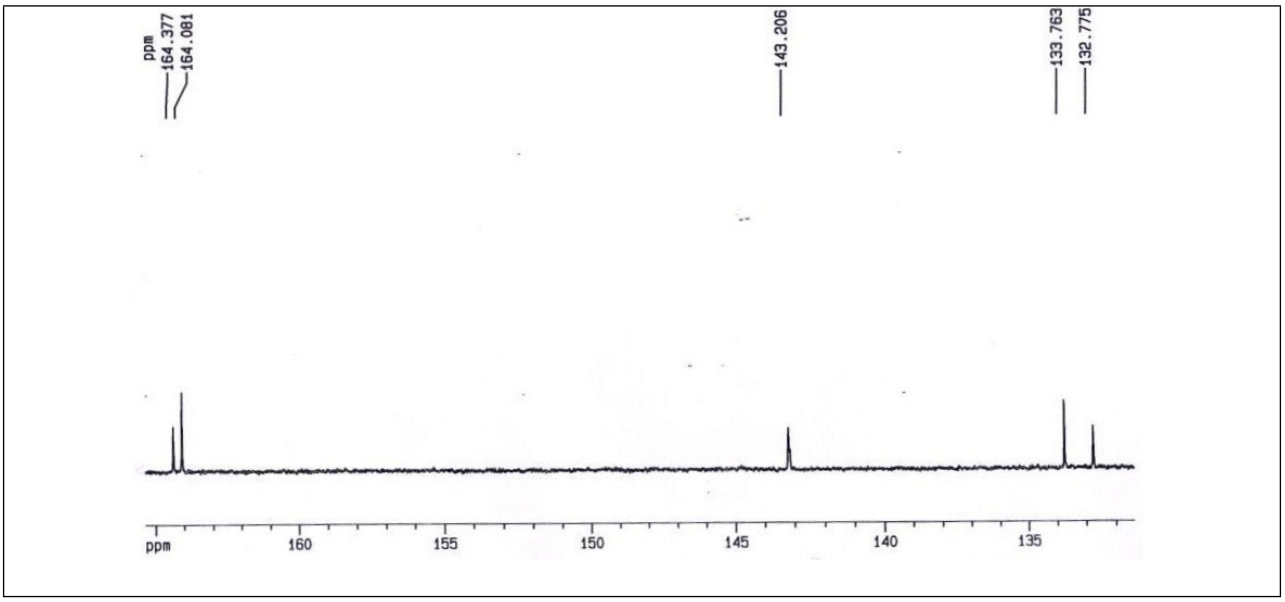

Figure 45: Expanded (1) ^{13}C NMR spectrum (400 MHz) of compound **4h** in $CDCl_3$.

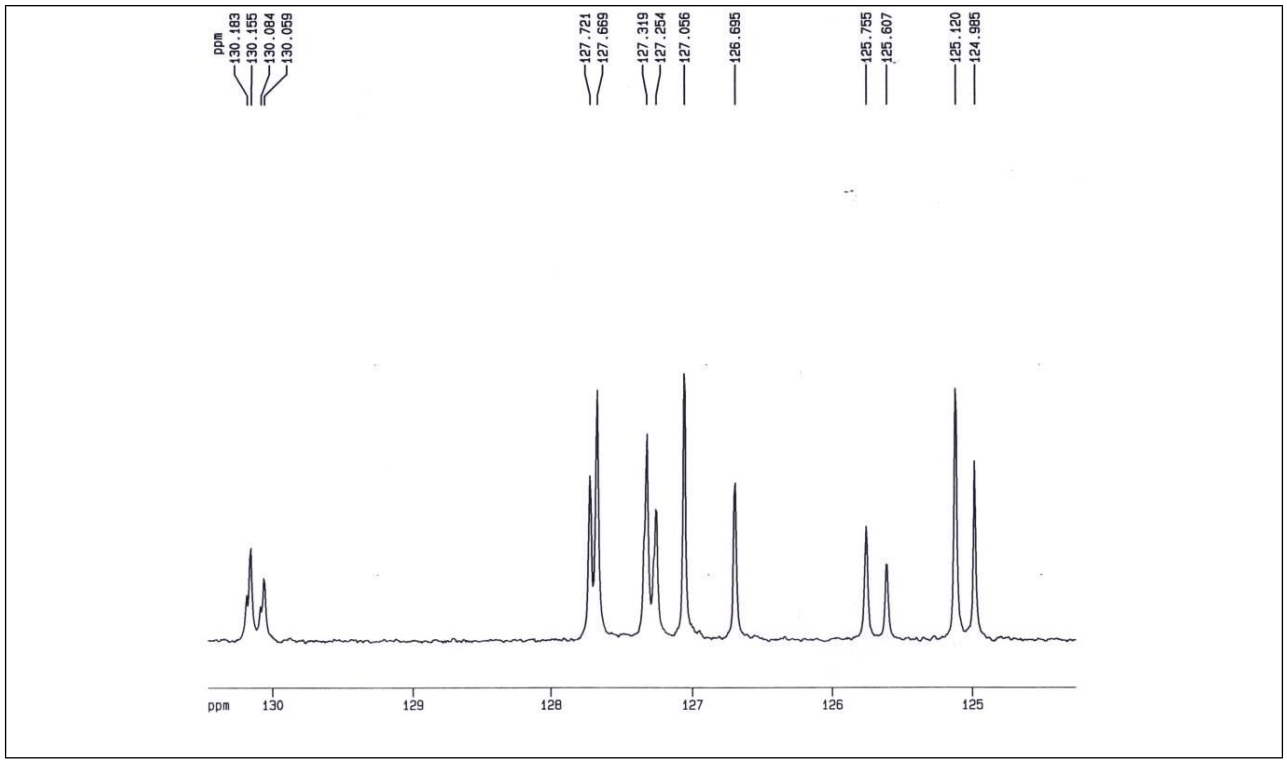

Figure 46: Expanded (2) ^{13}C NMR spectrum (100 MHz) of compound **4h** in $CDCl_3$.

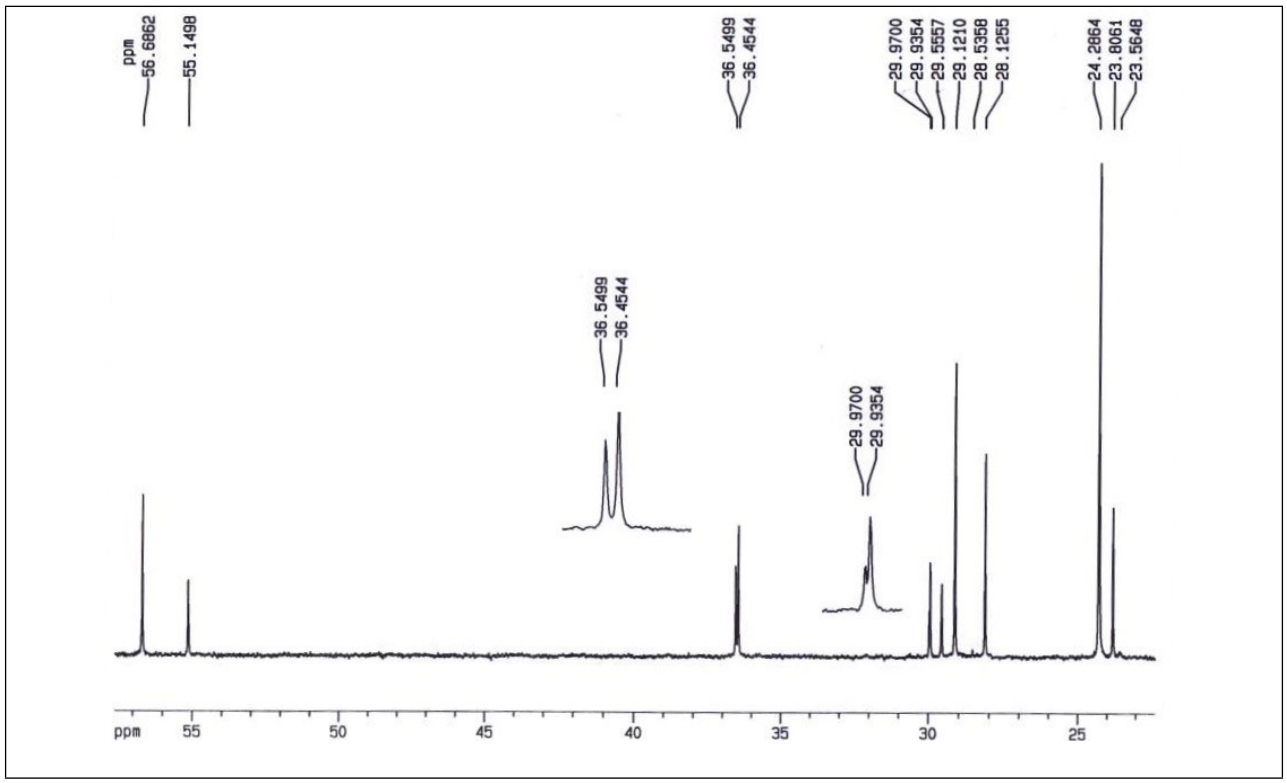

Figure 47: Expanded (3) ^{13}C NMR spectrum (100 MHz) of compound **4h** in $CDCl_3$.

***N*^{1}-Cyclohexyl-*N*^{1}-methyl-*N*^{2}-(methylsulfonyl)-2-phenylacetamidine (4i):**

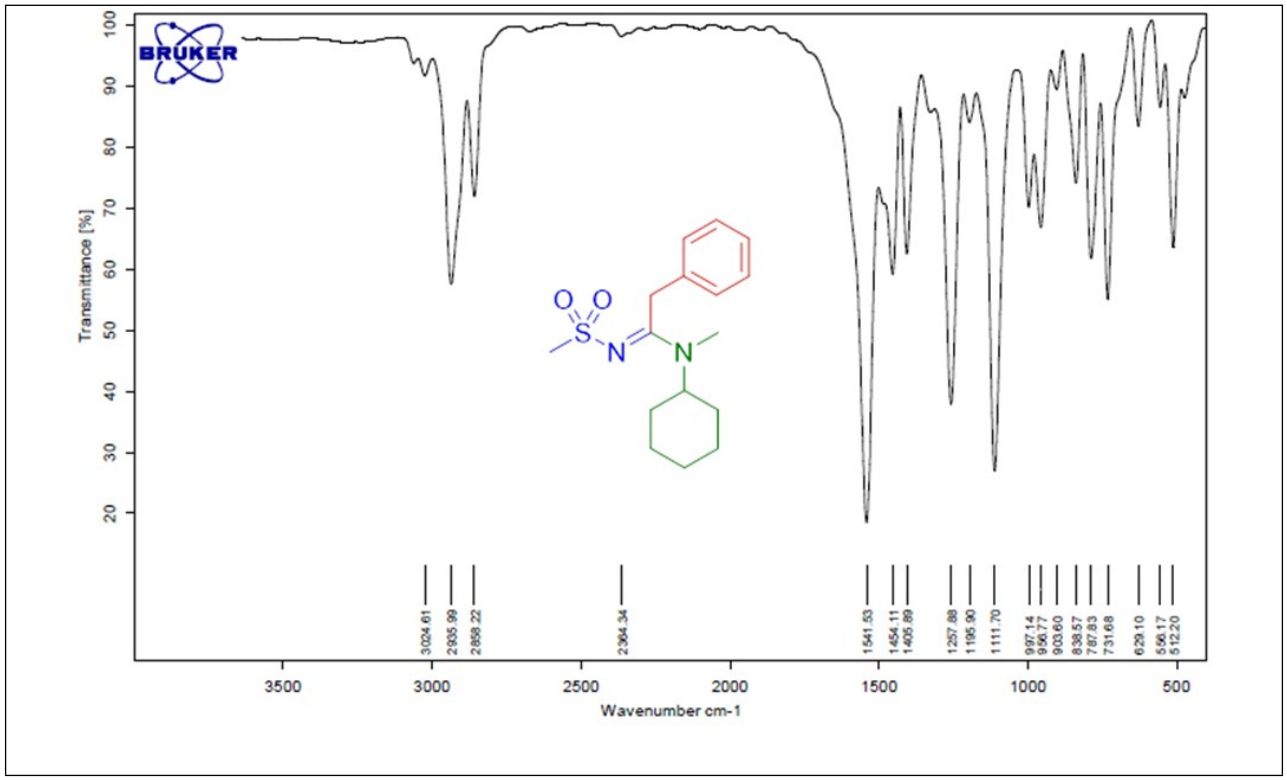

Figure 48: FTIR spectrum (KBr) of compound **4i**.

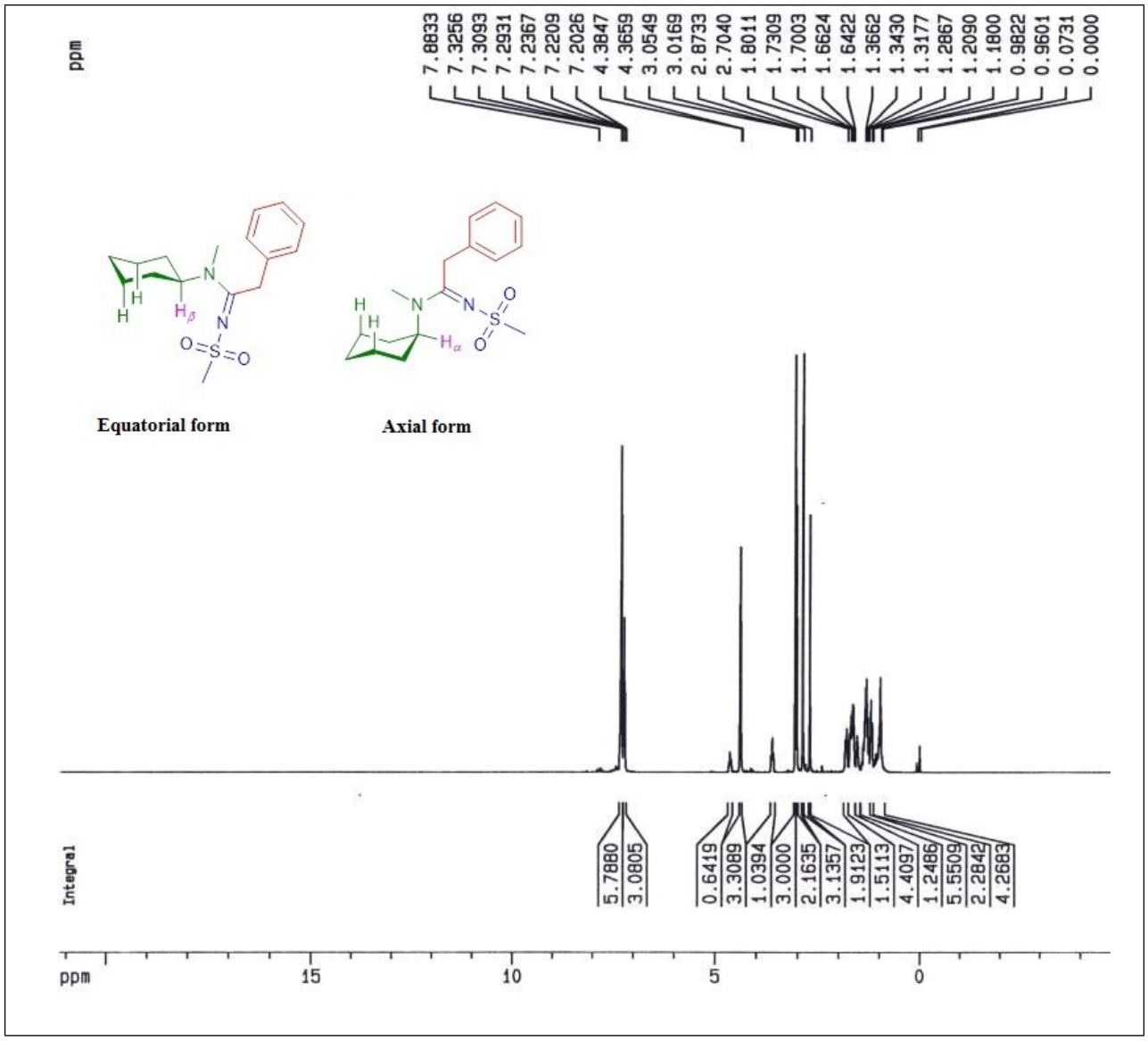

Figure 49: ^{1}H NMR spectrum (400 MHz) of compound **4i** in $CDCl_3$.

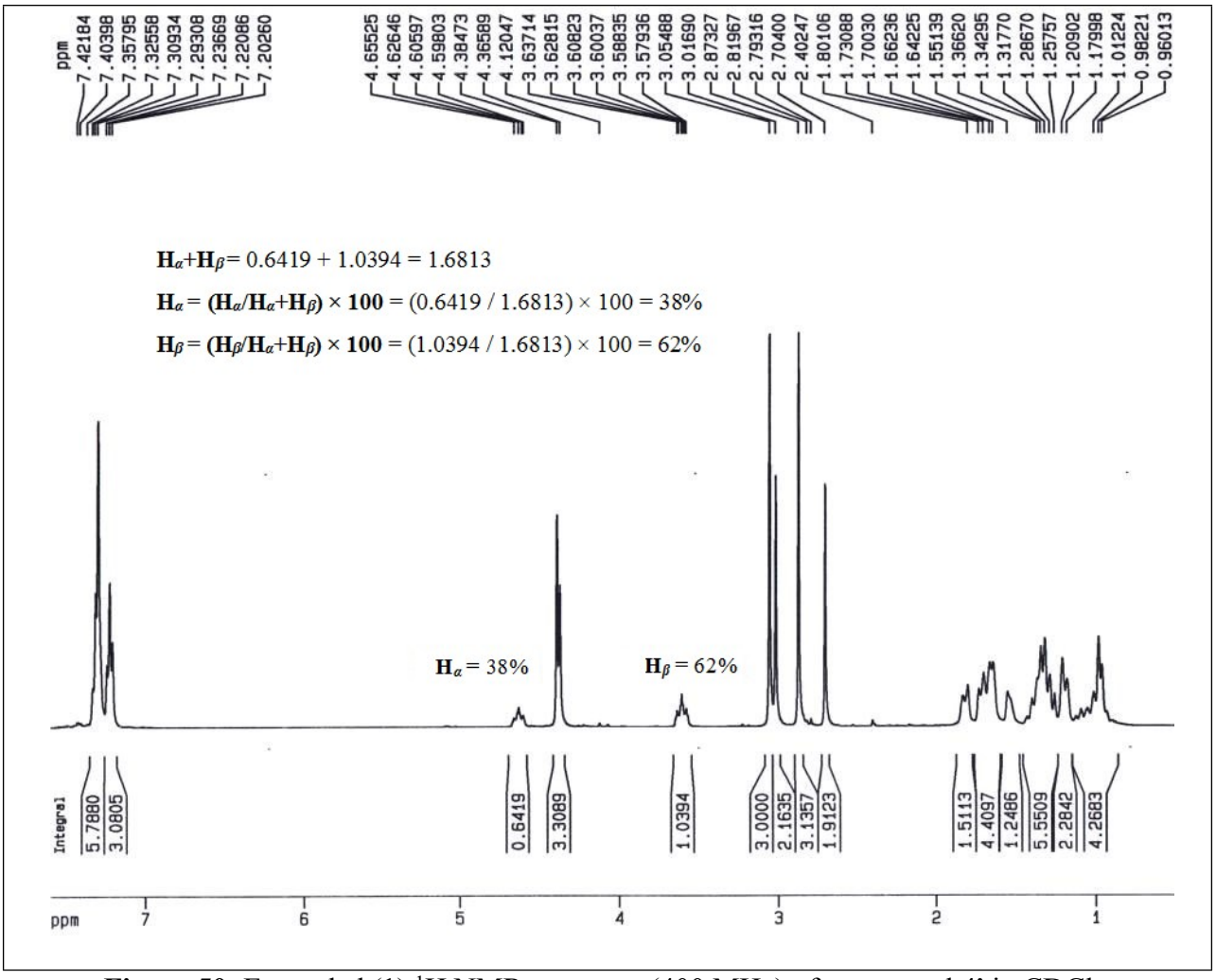

Figure 50: Expanded (1) ^{1}H NMR spectrum (400 MHz) of compound **4i** in $CDCl_3$.

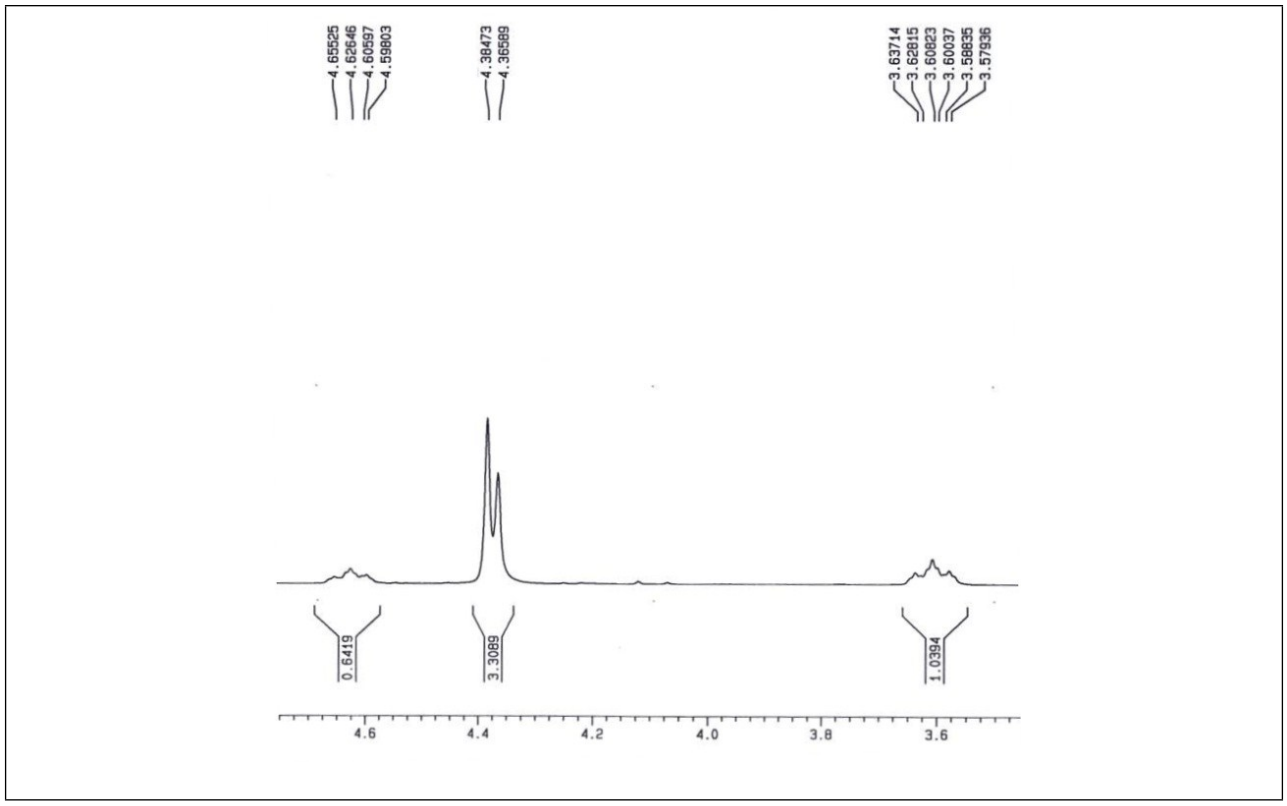

Figure 51: Expanded (2) ^{1}H NMR spectrum (400 MHz) of compound **4i** in $CDCl_3$.

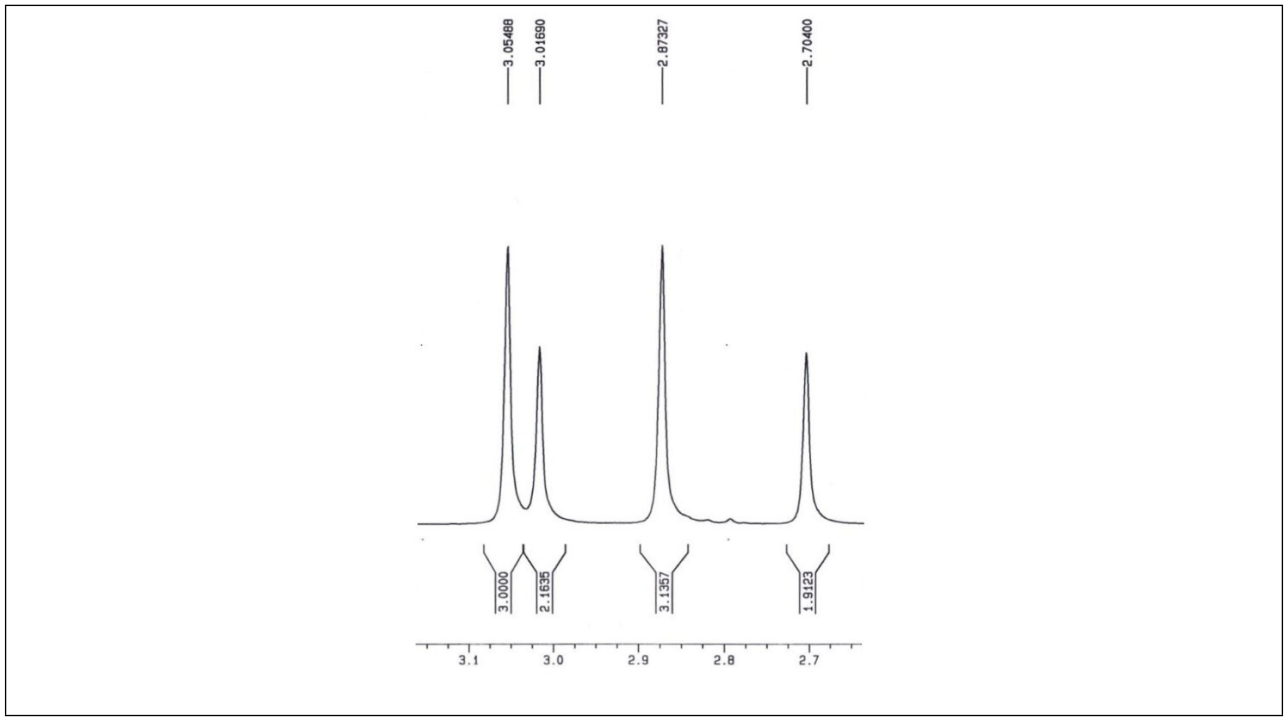

Figure 52: Expanded (3) ^{1}H NMR spectrum (400 MHz) of compound **4i** in $CDCl_3$.

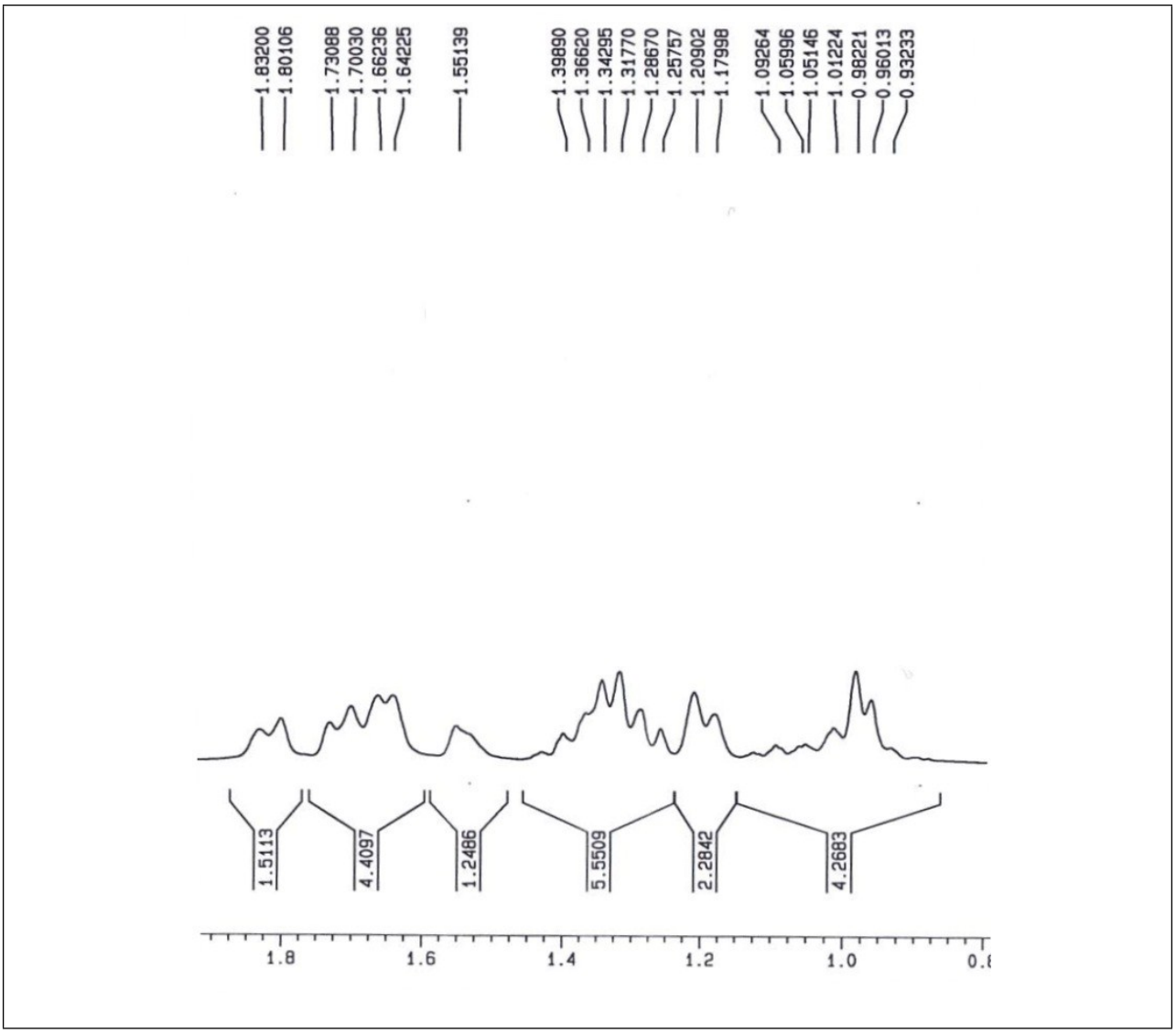

Figure 53: Expanded (4) ^{1}H NMR spectrum (400 MHz) of compound **4i** in $CDCl_3$.

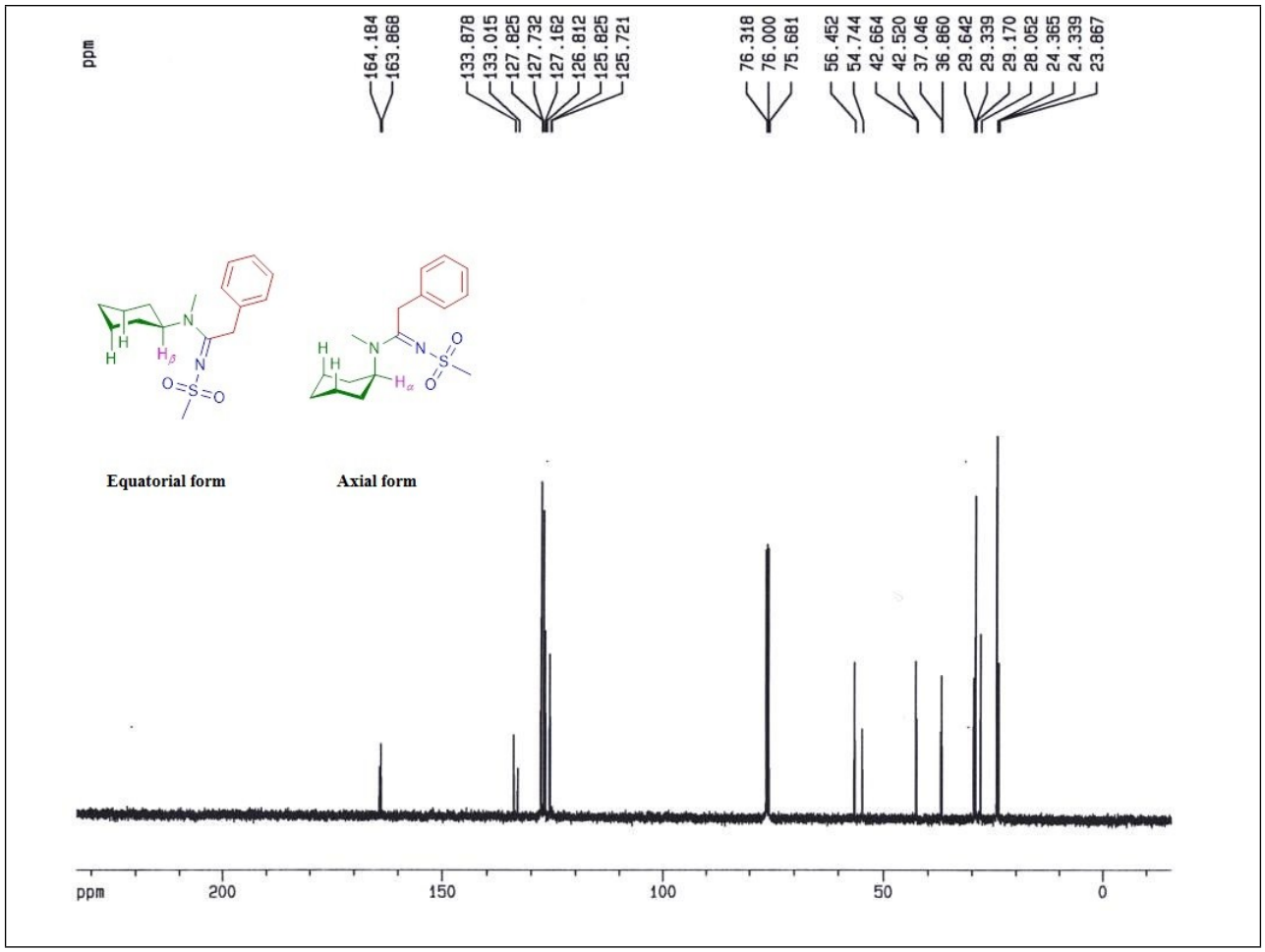

Figure 54: ^{13}C NMR spectrum (100 MHz) of compound **4i** in $CDCl_3$.

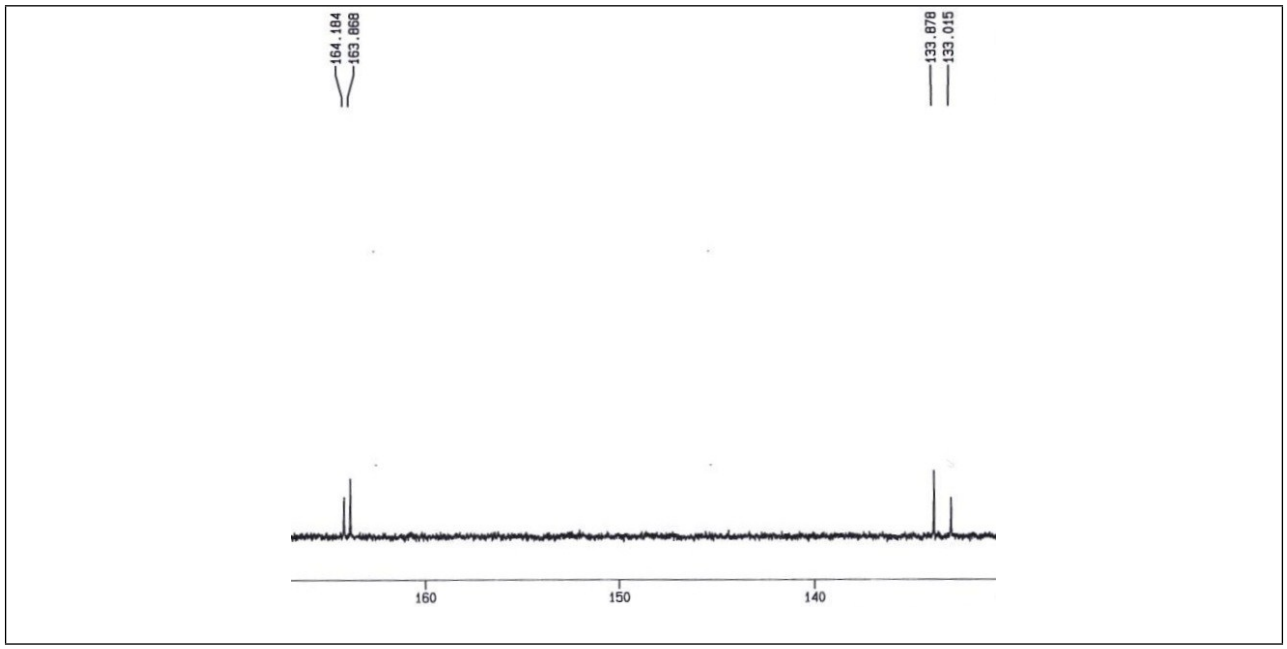

Figure 55: Expanded (1) ^{13}C NMR spectrum (400 MHz) of compound **4i** in $CDCl_3$.

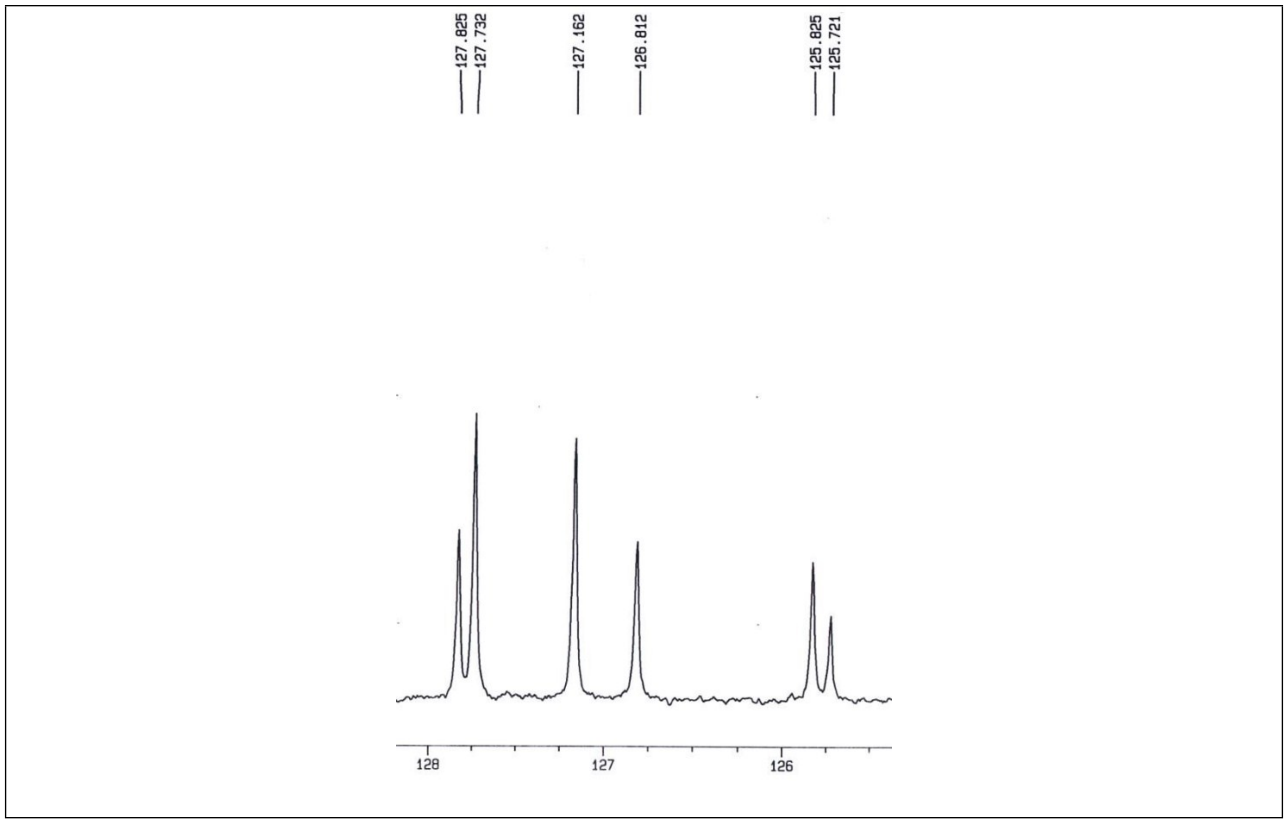

Figure 56: Expanded (2) ^{13}C NMR spectrum (100 MHz) of compound **4i** in $CDCl_3$.

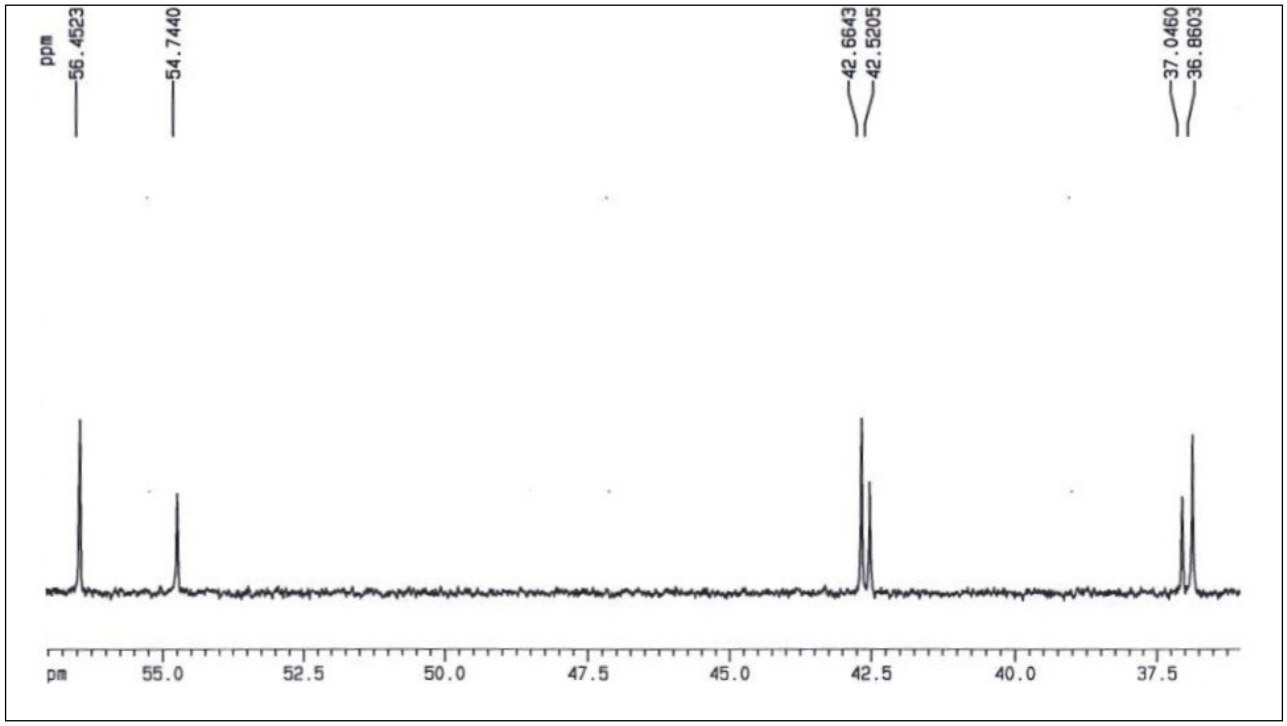

Figure 57: Expanded (3) ^{13}C NMR spectrum (400 MHz) of compound **4i** in $CDCl_3$.

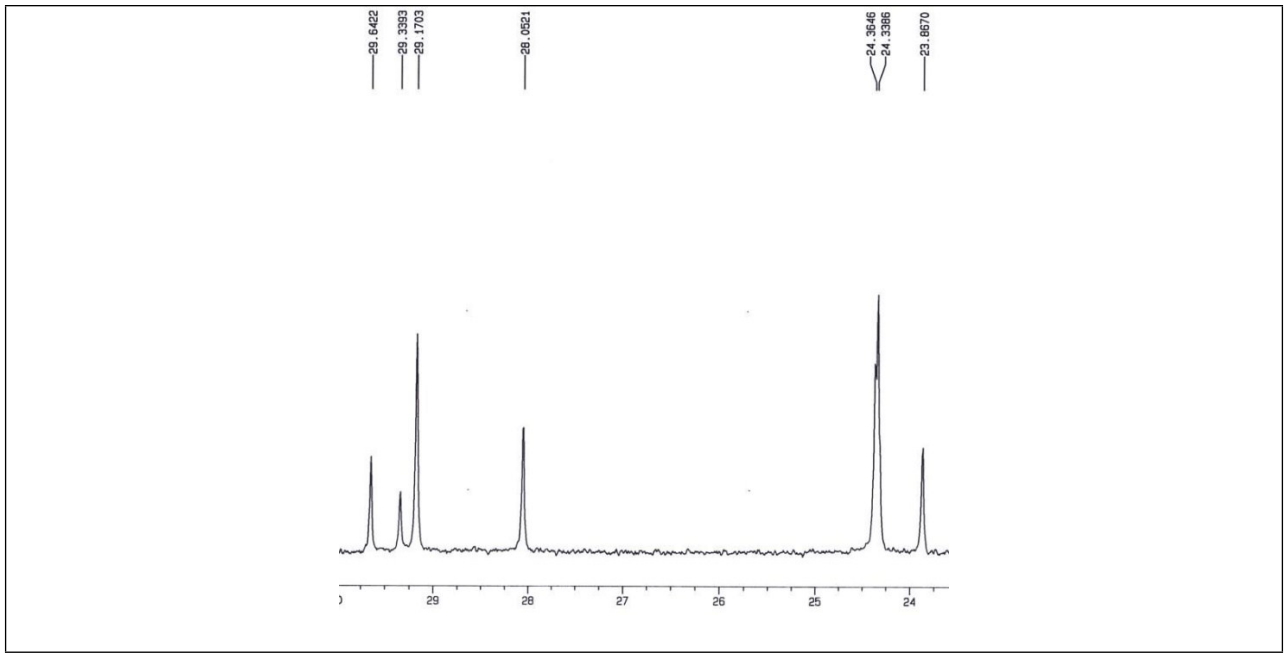

Figure 58: Expanded (4) ^{13}C NMR spectrum (100 MHz) of compound **4i** in $CDCl_3$.

***N*^{1}, *N*^{1}-Dipropyl-*N*^{2}-tosyl-2-phenylacetamidine (4j):**

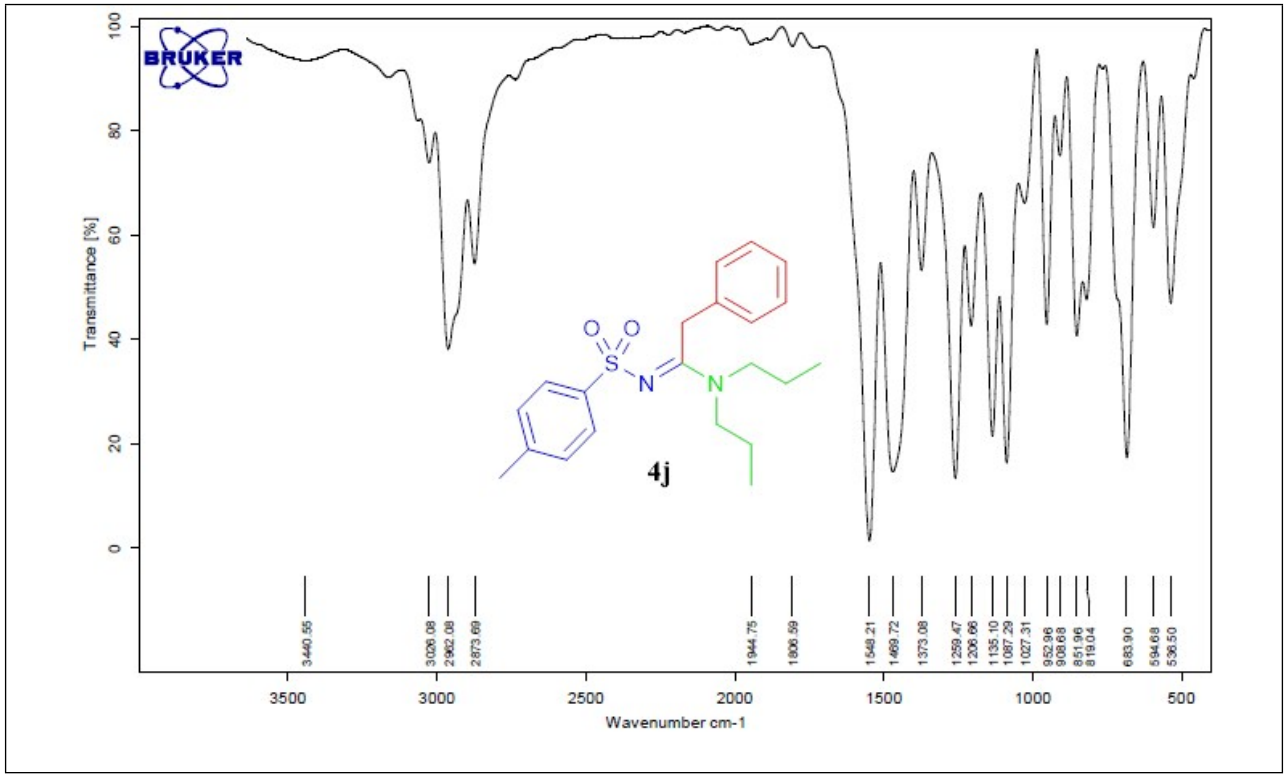

Figure 59: FTIR spectrum (KBr) of compound **4j**.

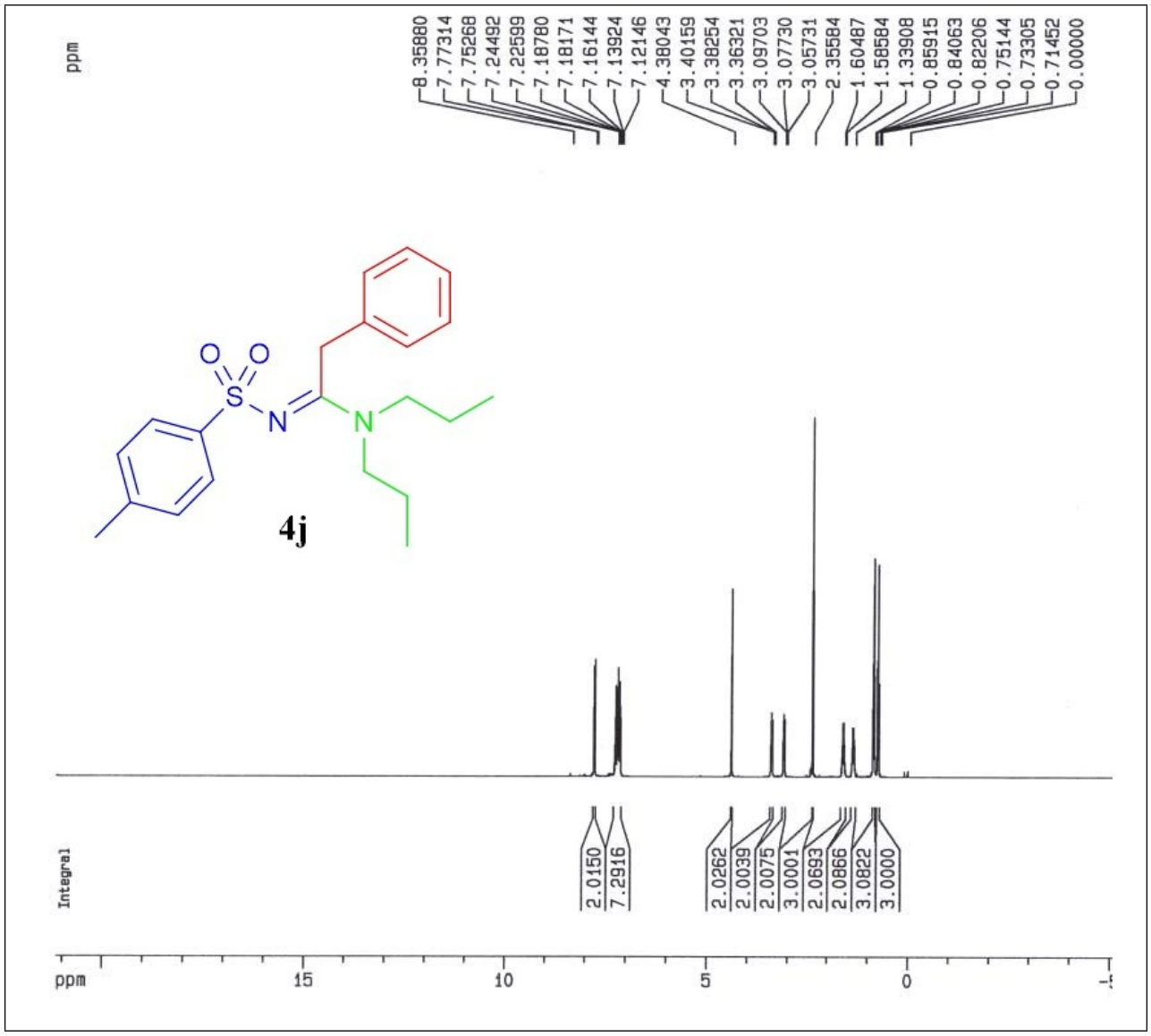

Figure 60: ^{1}H NMR spectrum (400 MHz) of compound **4j** in $CDCl_3$.

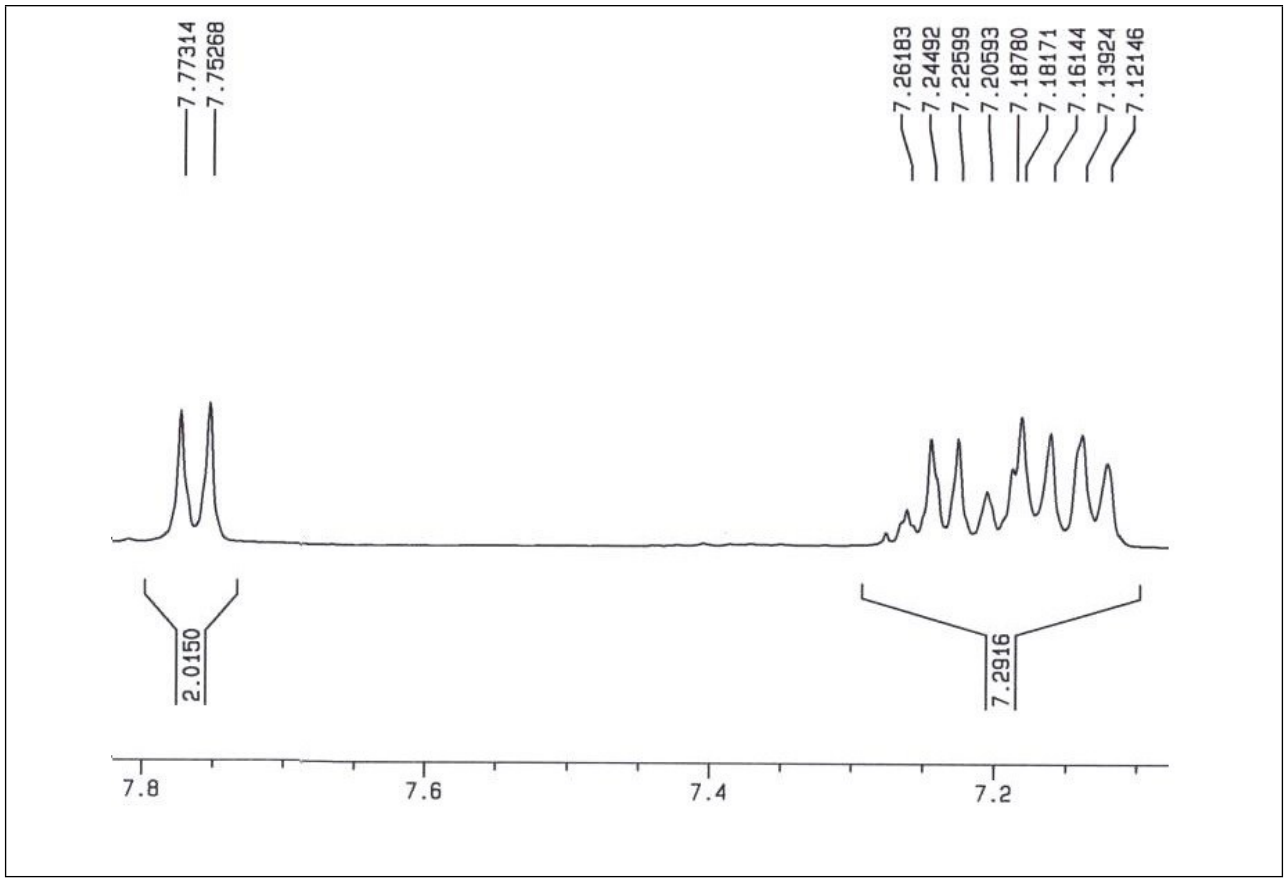

Figure 61: Expanded (1) ^{1}H NMR spectrum (400 MHz) of compound **4j** in $CDCl_3$.

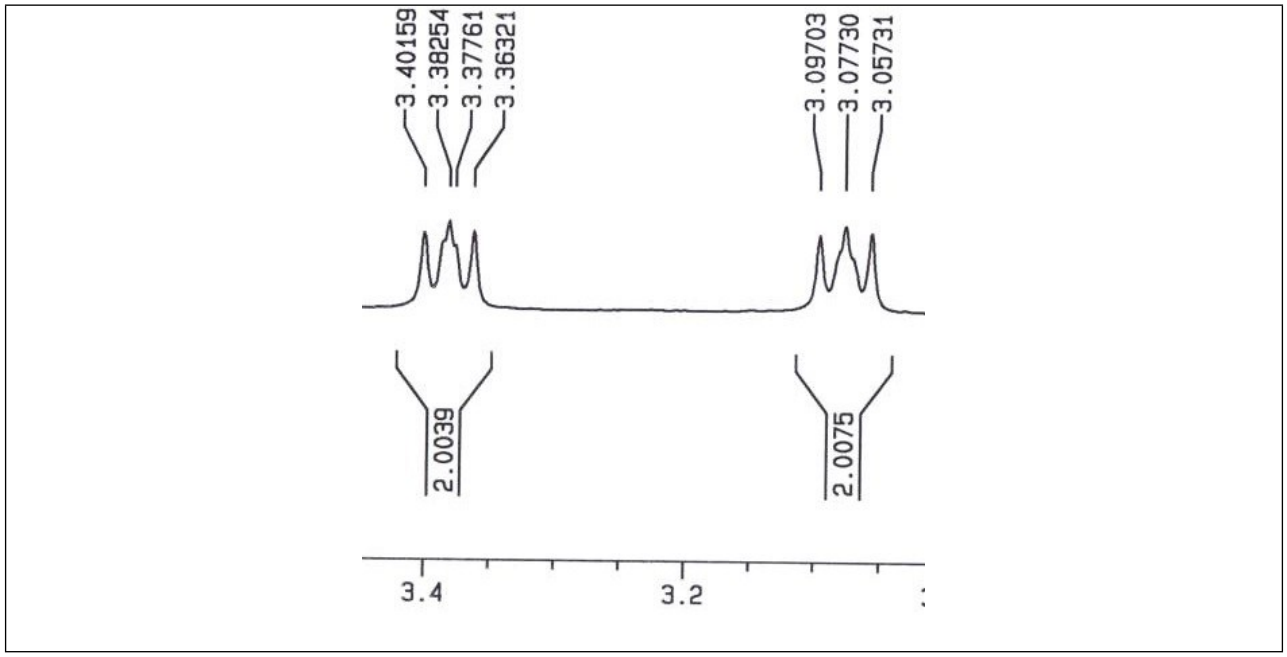

Figure 62: Expanded (2) ^{1}H NMR spectrum (400 MHz) of compound **4j** in $CDCl_3$.

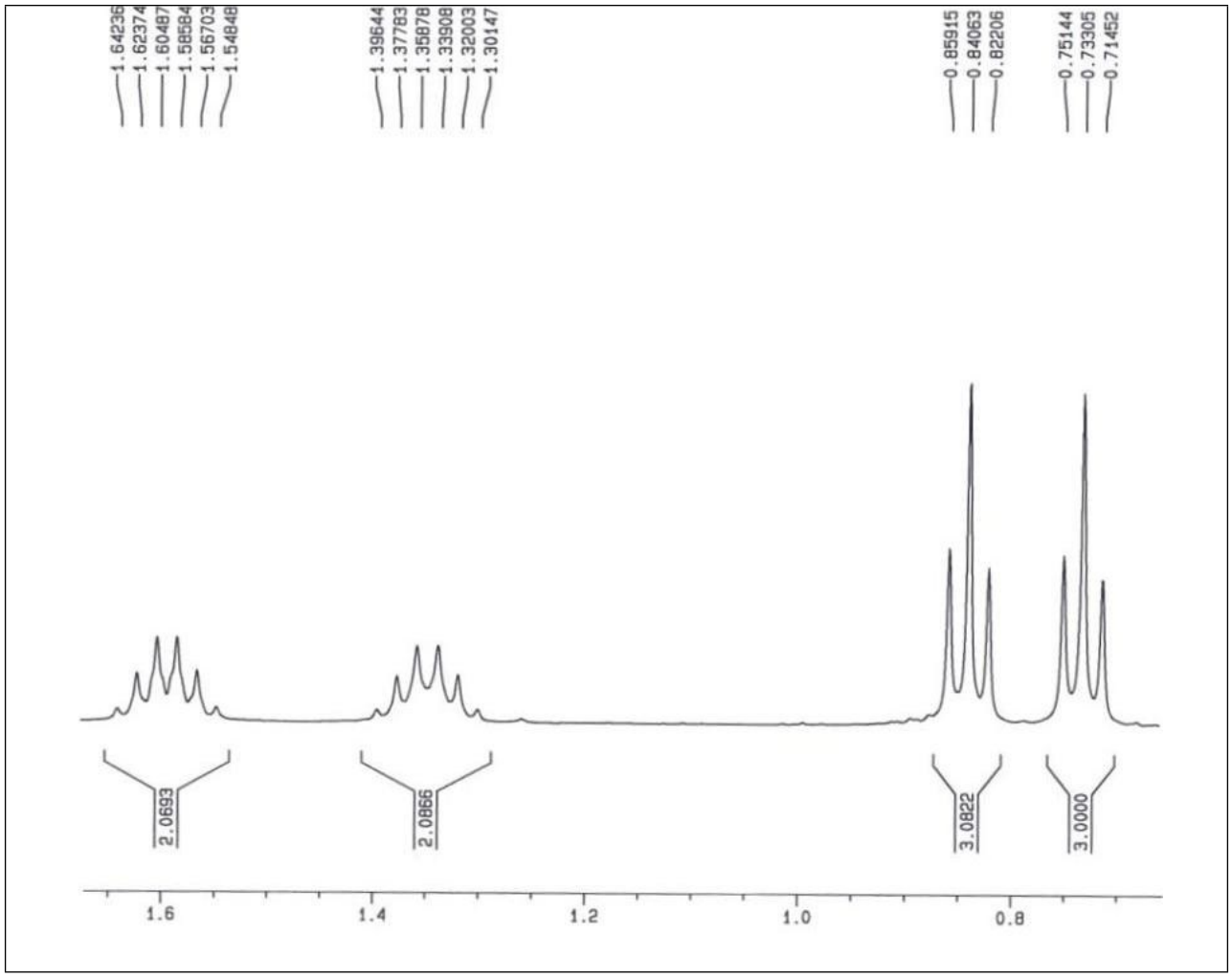

Figure 63: Expanded (3) ^{1}H NMR spectrum (400 MHz) of compound **4j** in $CDCl_3$.

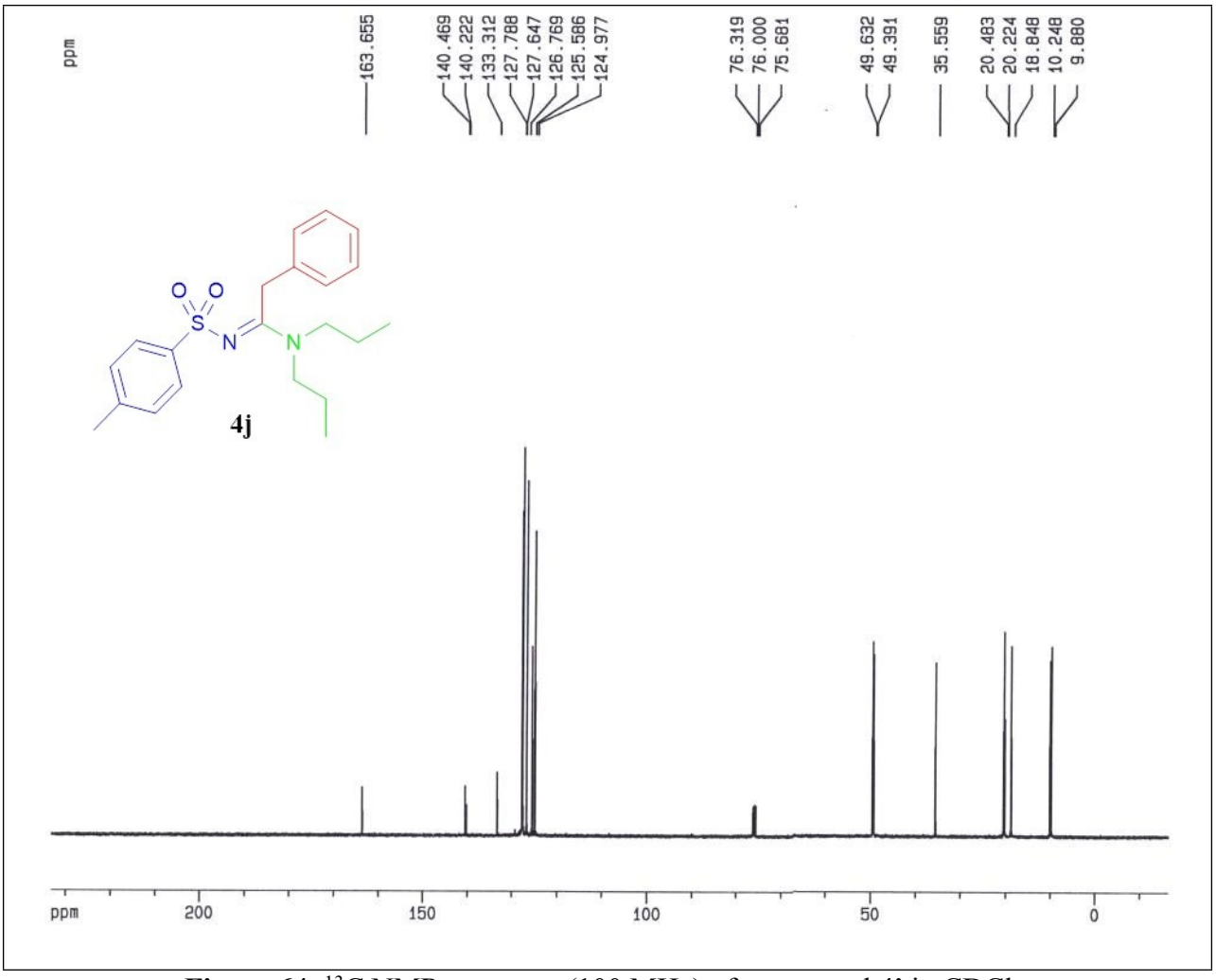

Figure 64: ^{13}C NMR spectrum (100 MHz) of compound **4j** in $CDCl_3$.

For previous methods for synthesis of ***N*^{1}, *N*^{1}-Dipropyl-*N*^{2}-tosyl-2-phenylacetamidine (4j),** see reference **2a** and **2c.**

***N*[1], *N*[1]-Dibutyl-*N*[2]-tosyl-2-phenylacetamidine (4k):**

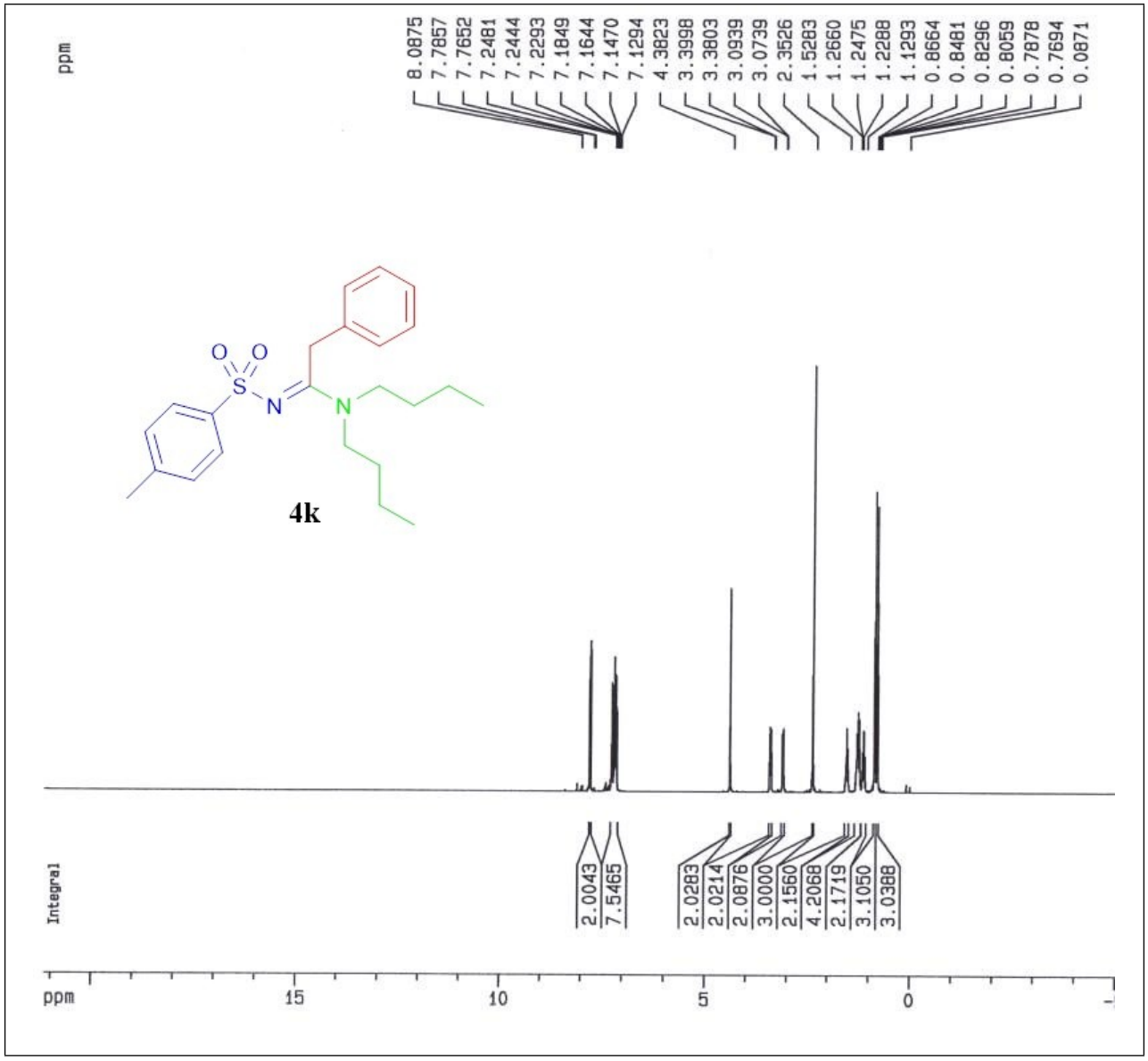

Figure 65: ^{1}H NMR spectrum (400 MHz) of compound **4k** in $CDCl_3$.

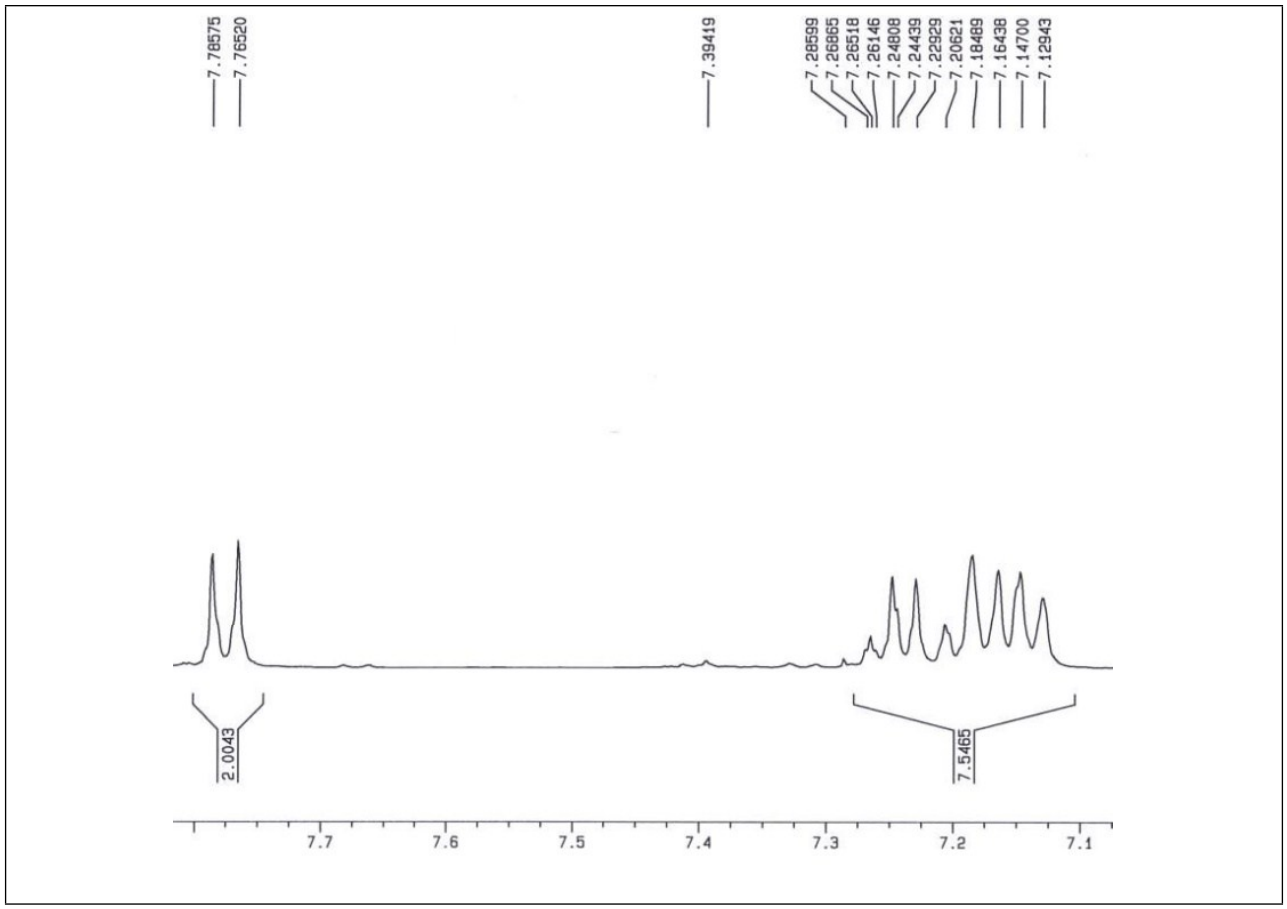

Figure 66: Expanded (1) ^{1}H NMR spectrum (400 MHz) of compound **4k** in $CDCl_3$.

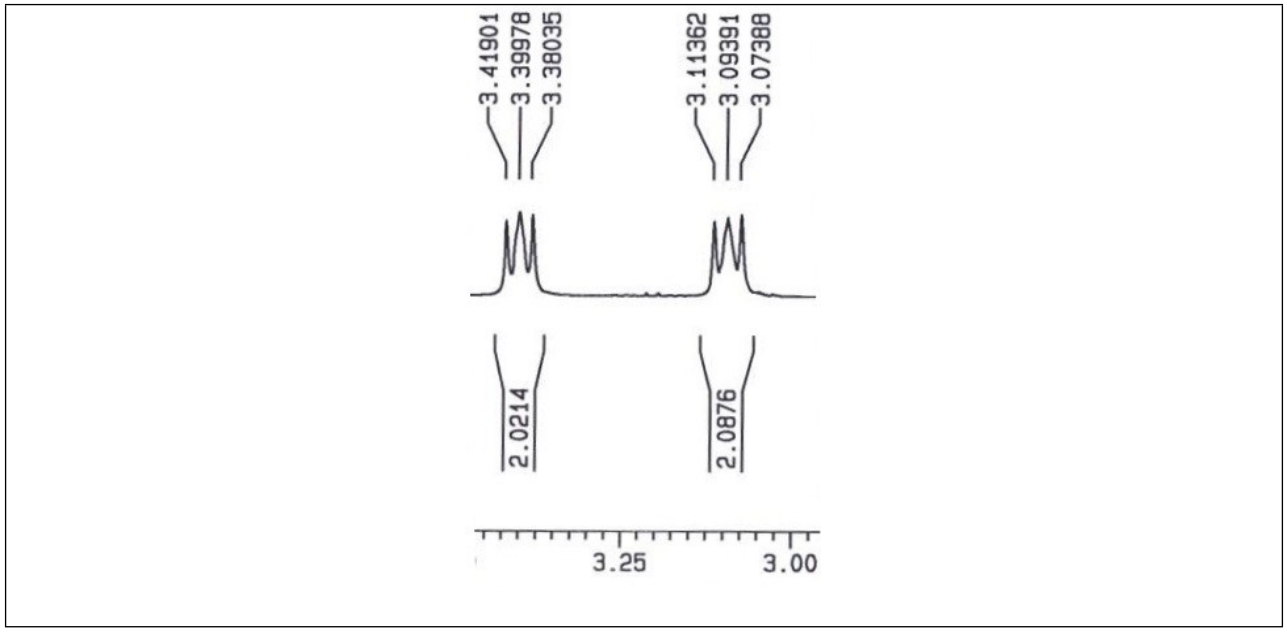

Figure 67: Expanded (2) ^{1}H NMR spectrum (400 MHz) of compound **4k** in $CDCl_3$.

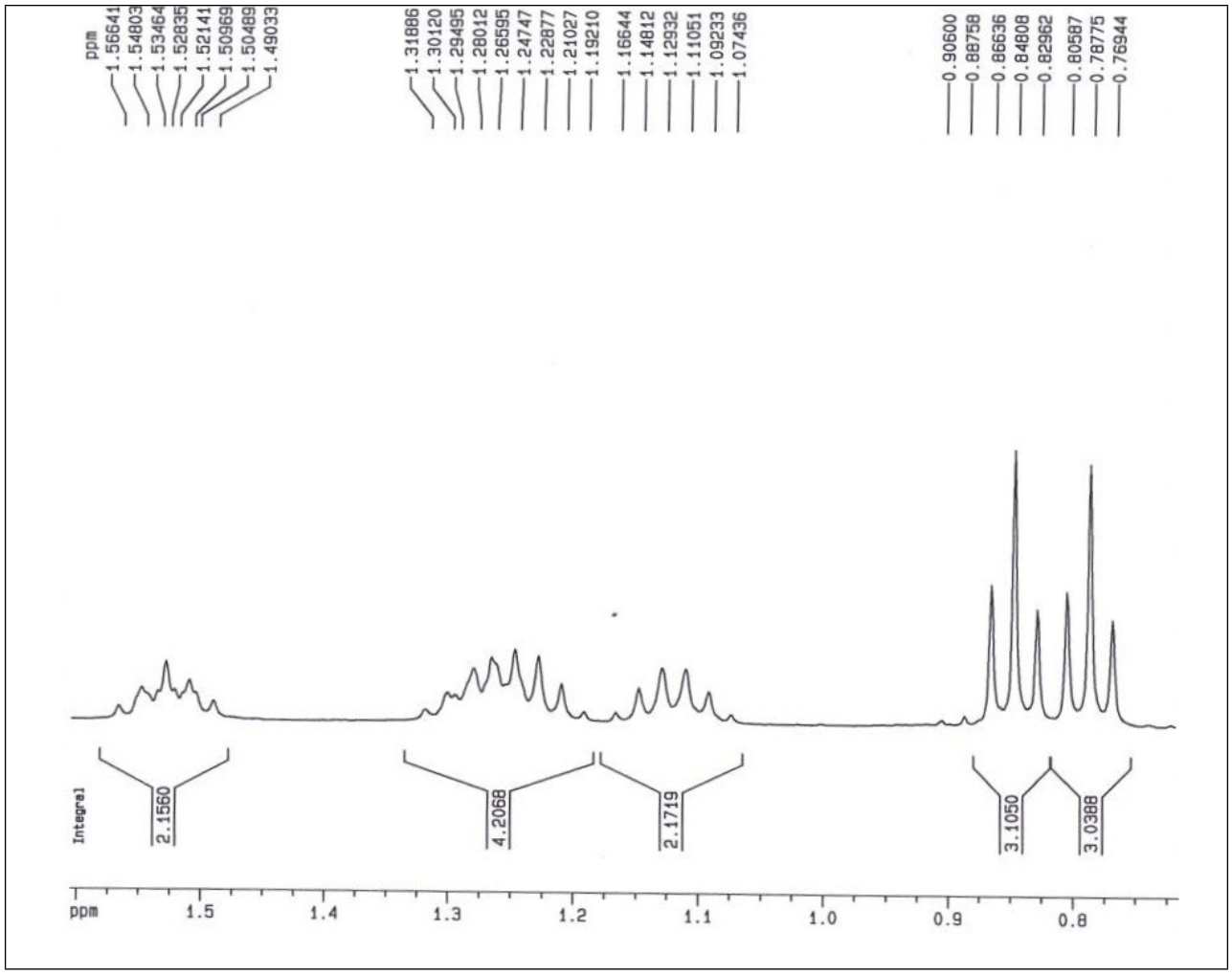

Figure 68: Expanded (3) ^{1}H NMR spectrum (400 MHz) of compound **4k** in $CDCl_3$.

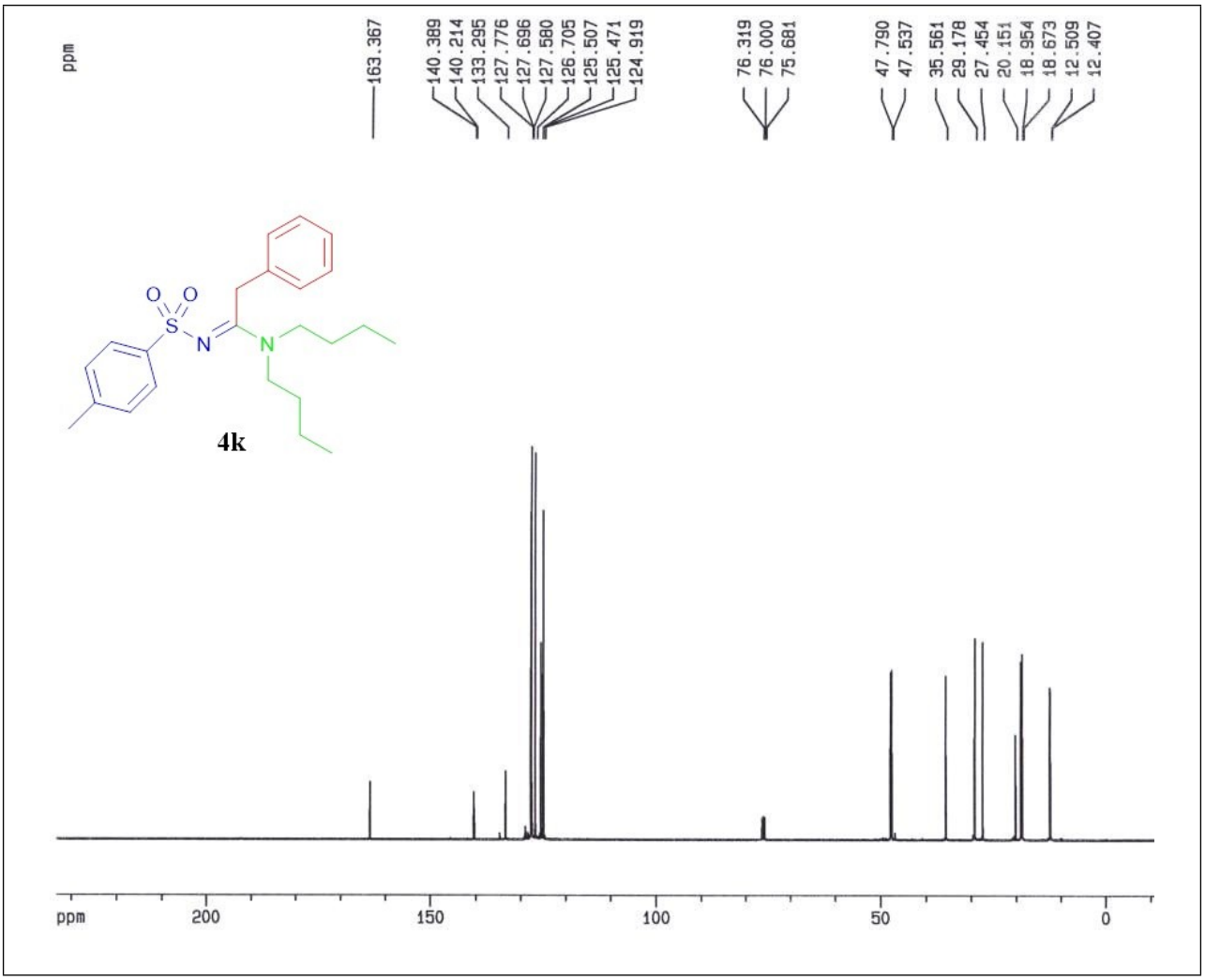

Figure 69: ^{13}C NMR spectrum (100 MHz) of compound **4k** in $CDCl_3$.

For previous methods for synthesis of ***N*^{1}, *N*^{1}-Dibutyl-*N*^{2}-tosyl-2-phenylacetamidine (4k),** see reference **2.**

N^1, N^1-dibenzyl-N^2-(4-methylbenzensulfonyl)-2-phenylacetamidine (4l):

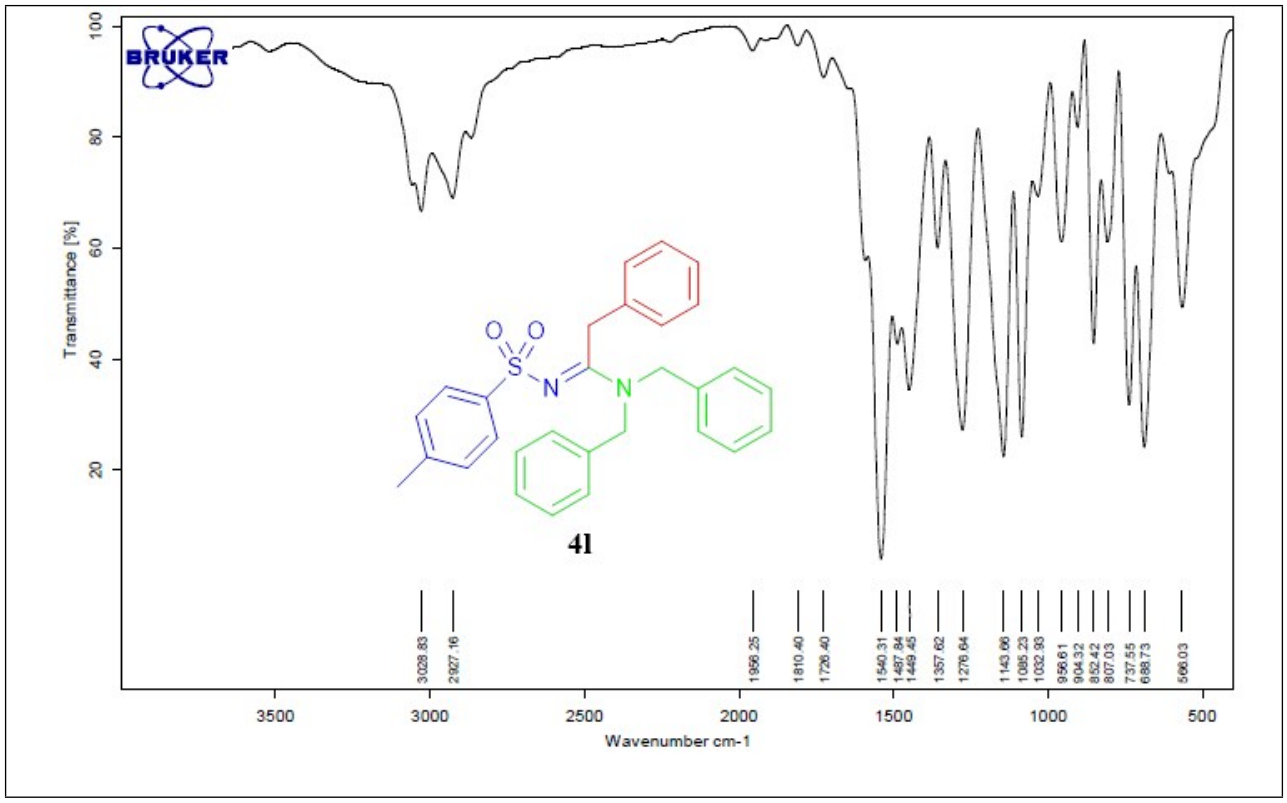

Figure 70: FTIR spectrum (KBr) of compound **4l**.

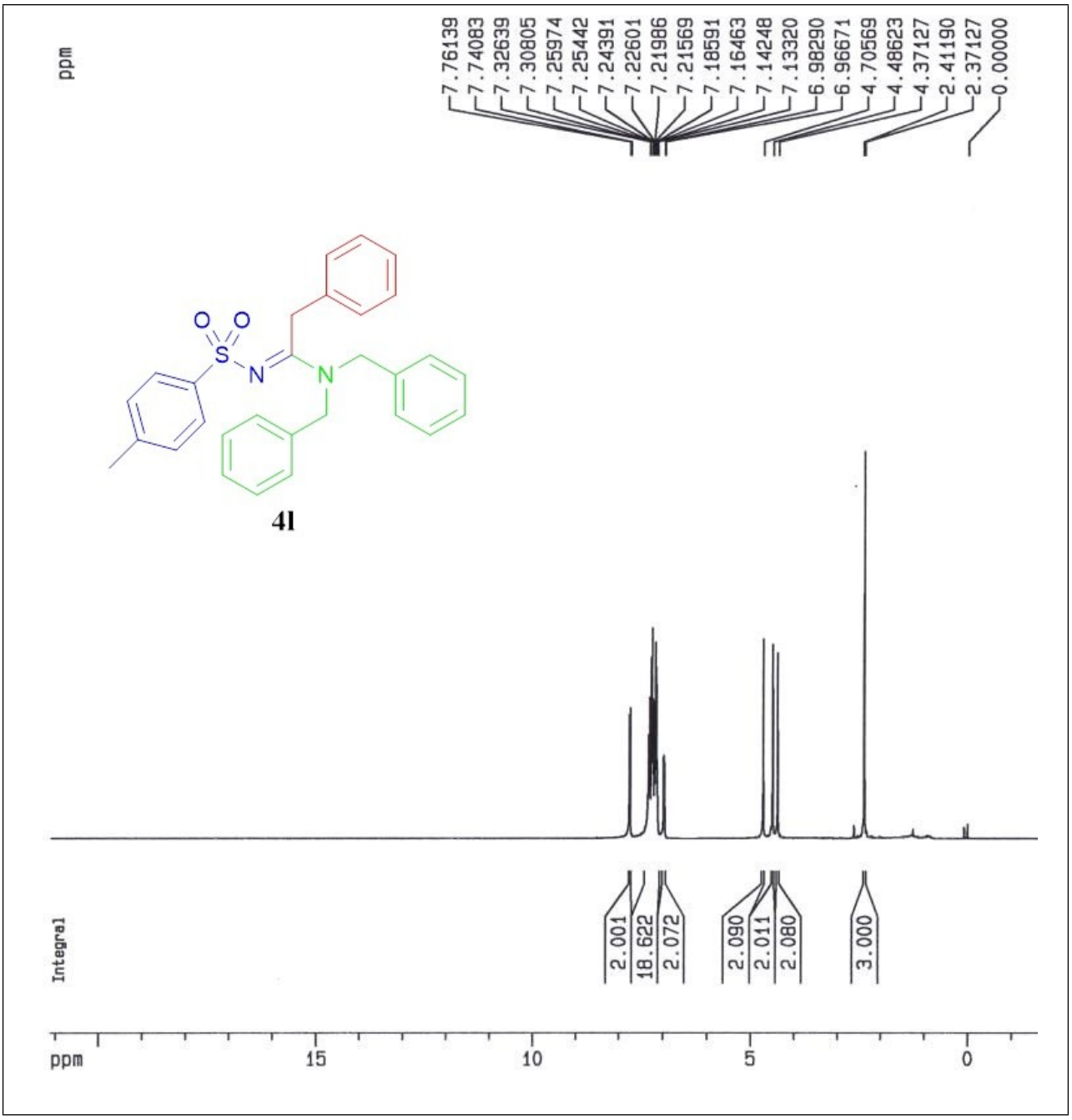

Figure 71: ^{1}H NMR spectrum (400 MHz) of compound **4l** in $CDCl_3$.

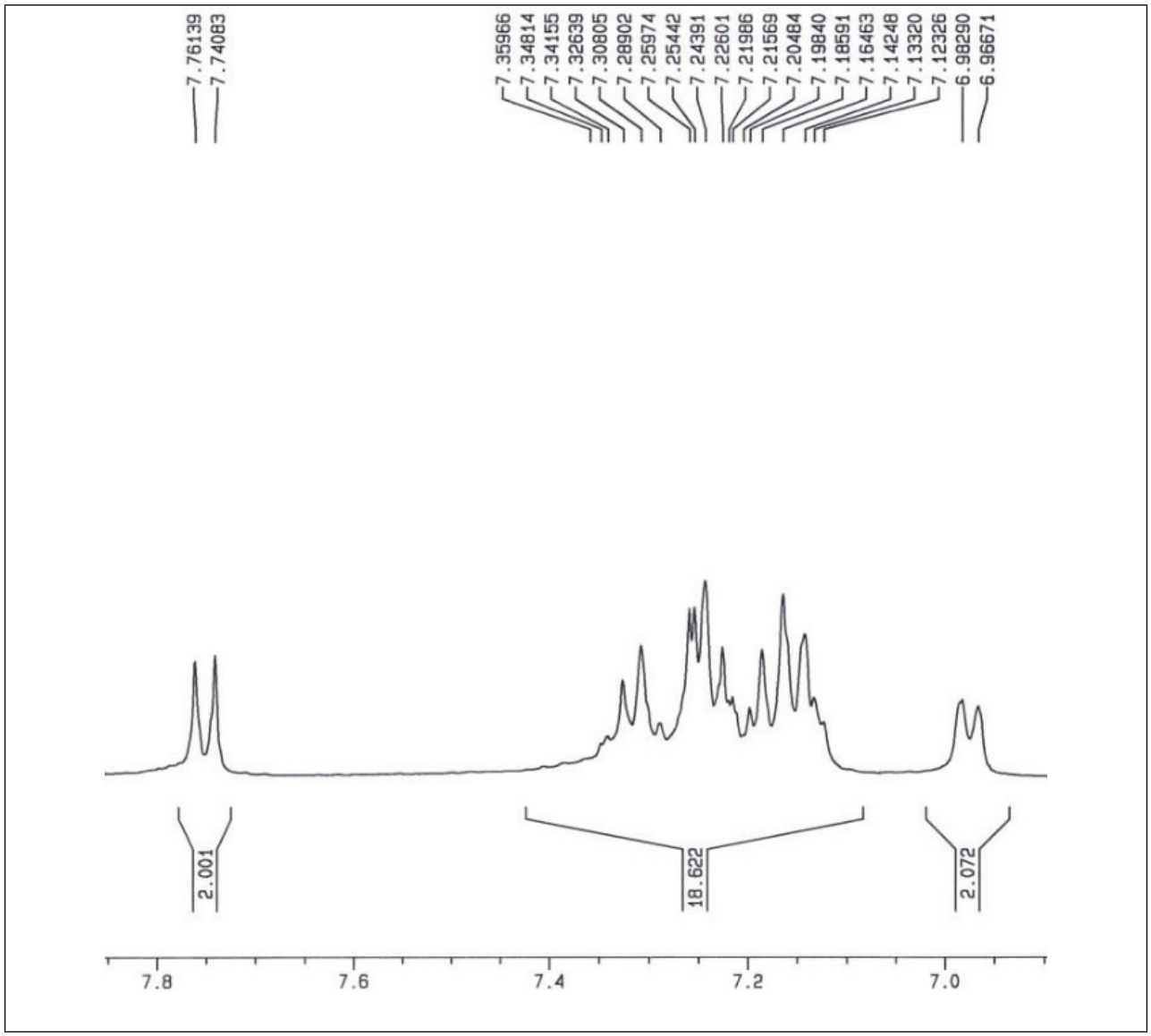

Figure 72: Expanded ^{1}H NMR spectrum (400 MHz) of compound **4l** in $CDCl_3$.

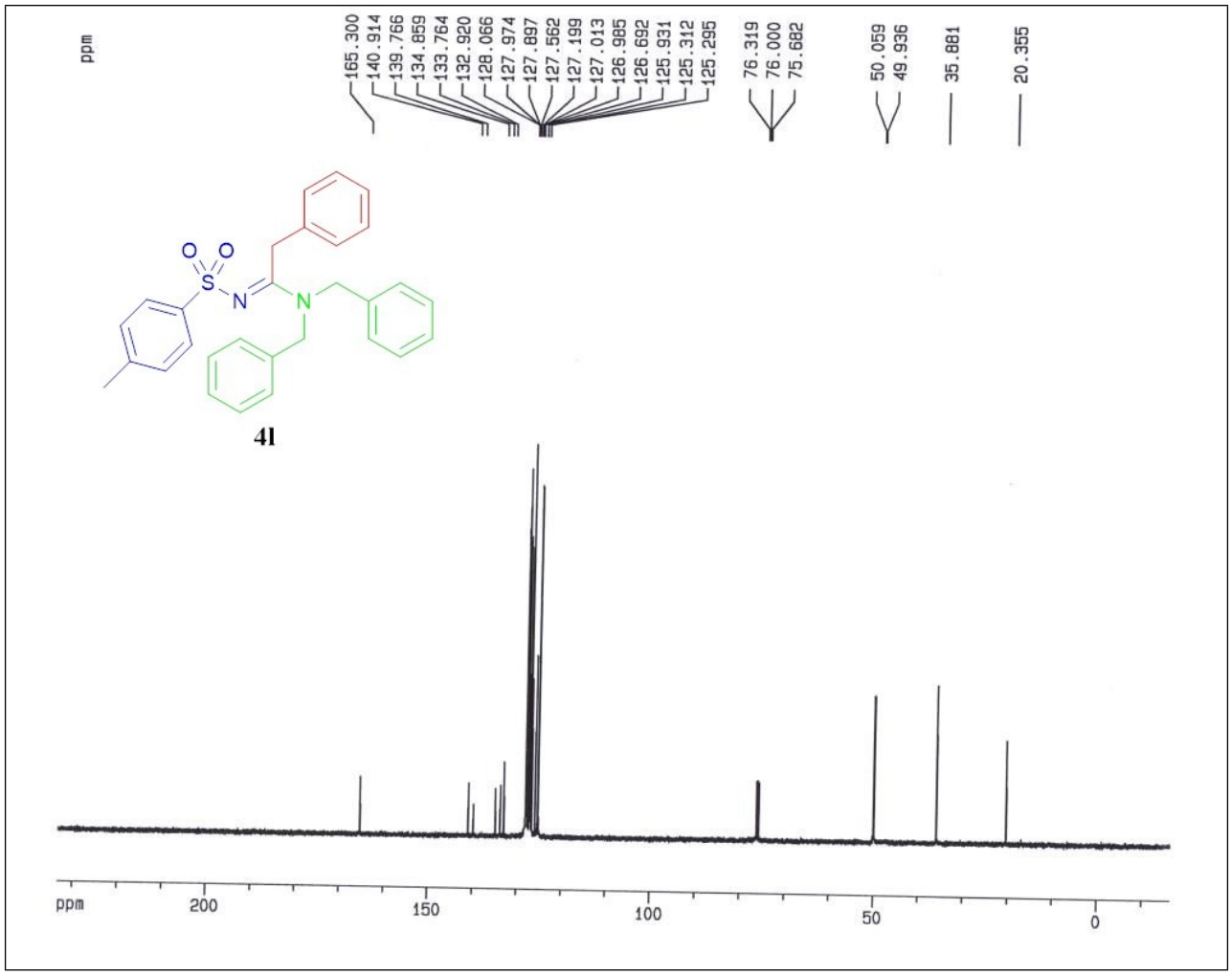

Figure 73: ^{13}C NMR spectrum (100 MHz) of compound **4l** in $CDCl_3$.

***N*[1], *N*[1]-dibenzyl-*N*[2]-(phenylsulfonyl)-2-phenylacetamidine (4m):**

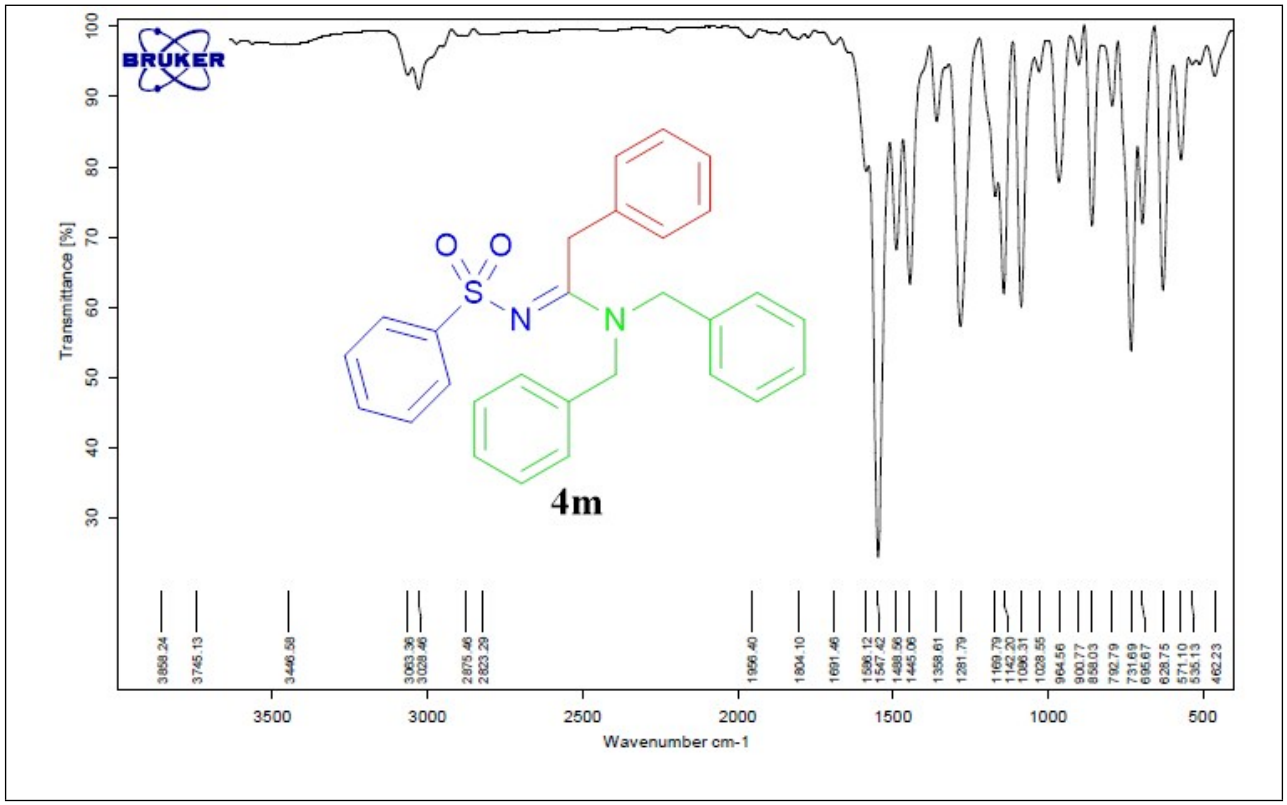

Figure 74: FTIR spectrum (KBr) compound **4m**.

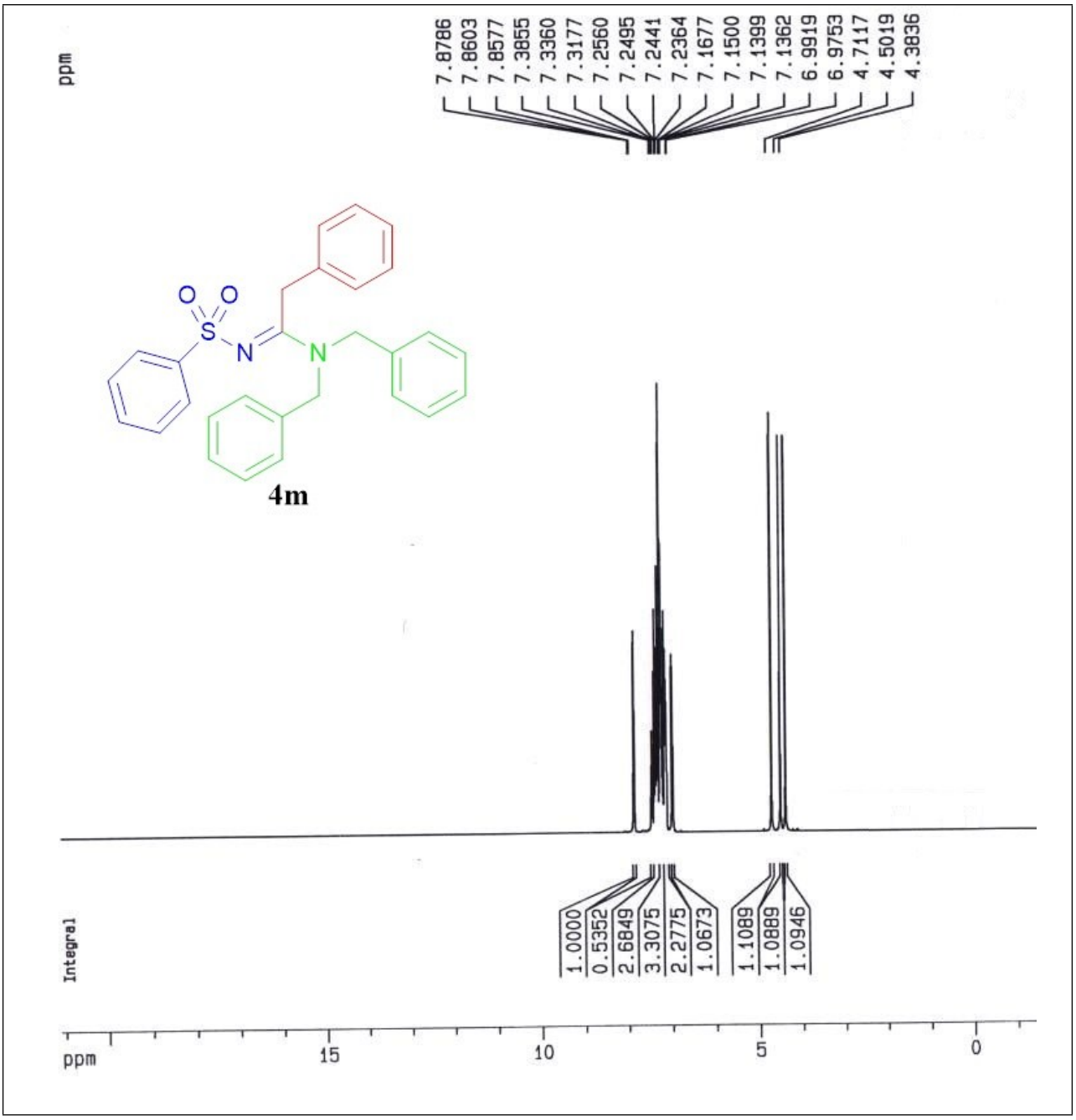

Figure 75: ^{1}H NMR spectrum (400 MHz) of compound **4m** in $CDCl_3$.

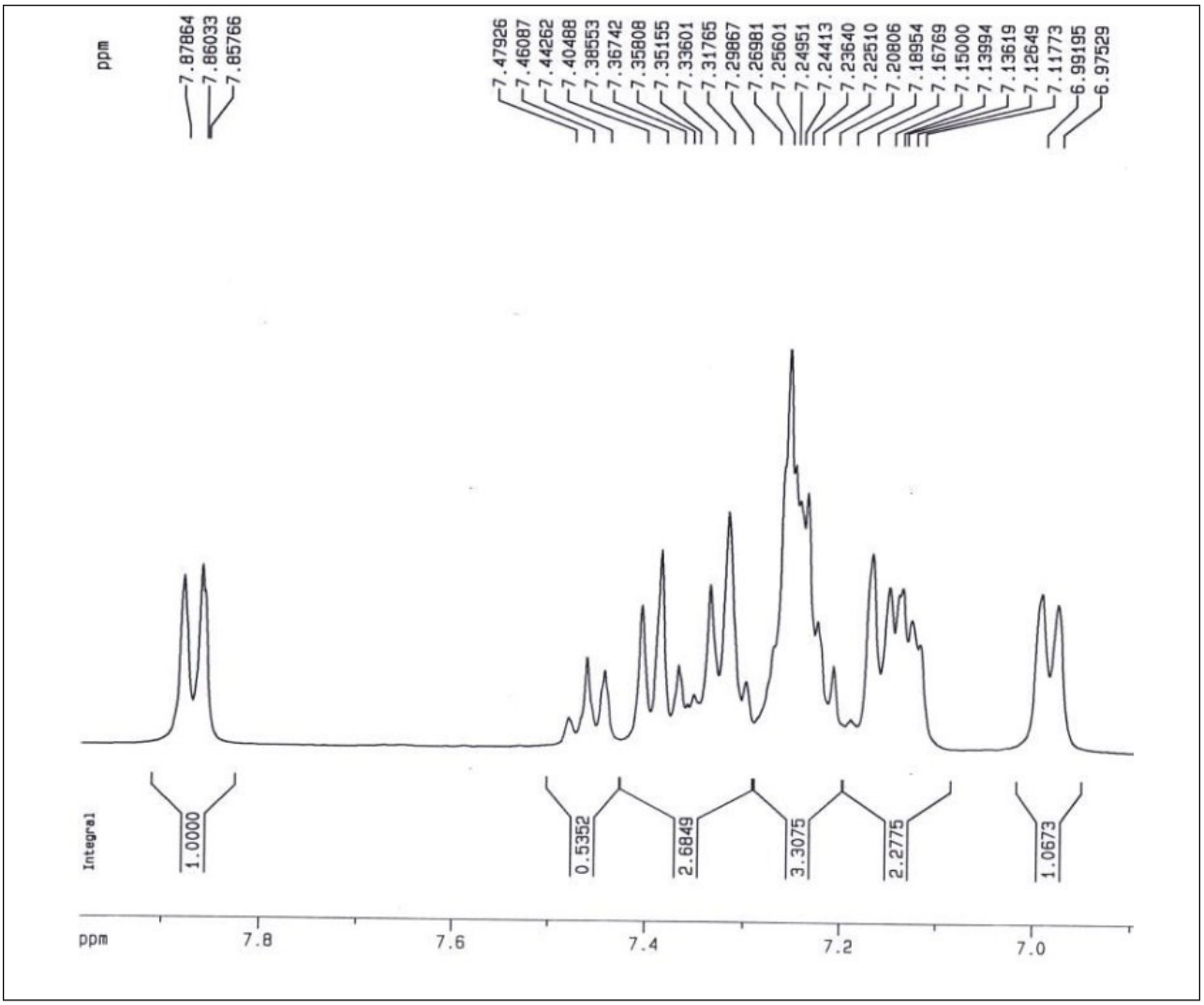

Figure 76: Expanded ^{1}H NMR spectrum (400 MHz) of compound **4m** in $CDCl_3$.

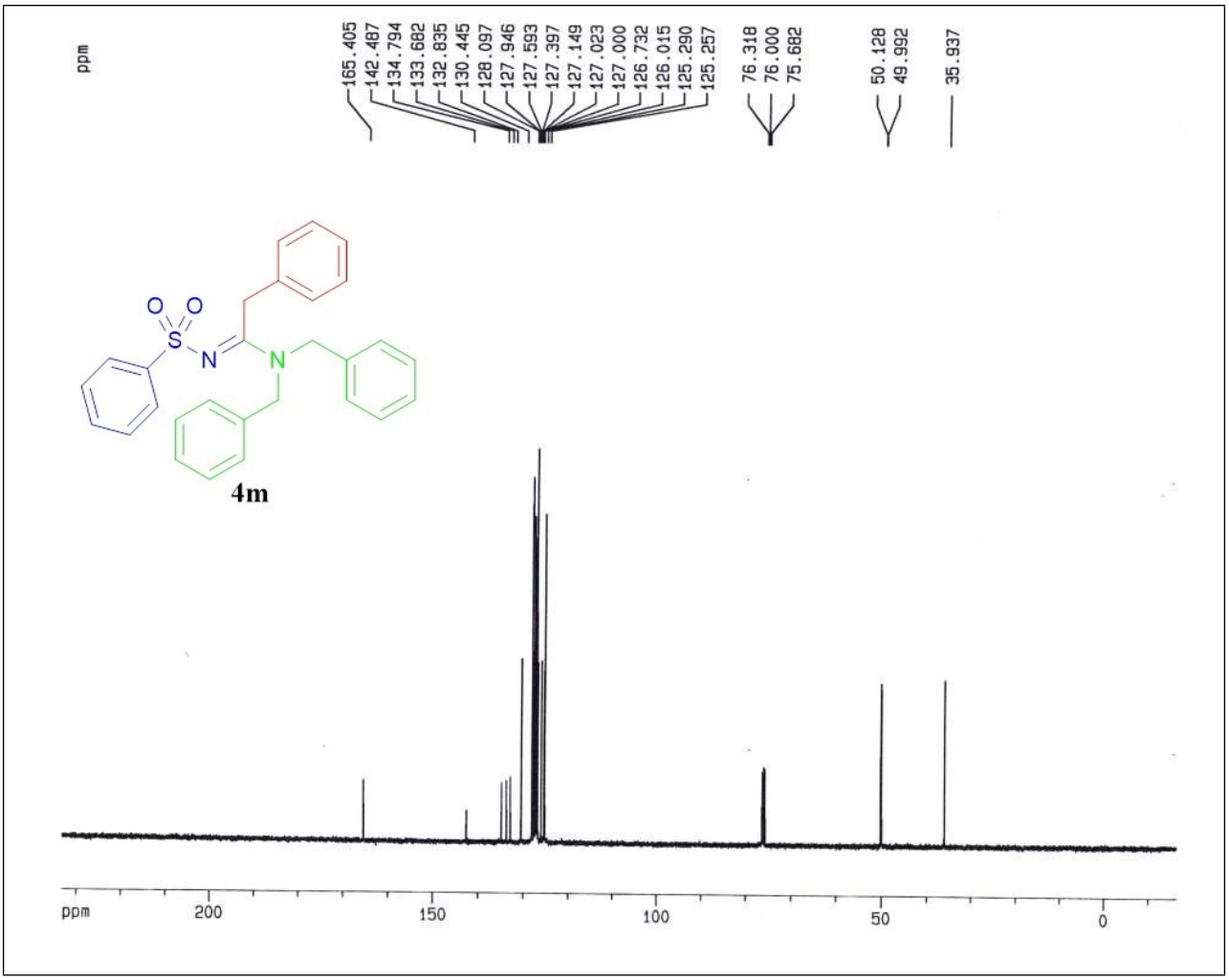

Figure 77: ^{13}C NMR spectrum (100 MHz) of compound **4m** in $CDCl_3$.

***N*[1], *N*[1]-Dibenzyl-*N*[2]-(methylsulfonyl)-2-phenylacetamidine (4n):**

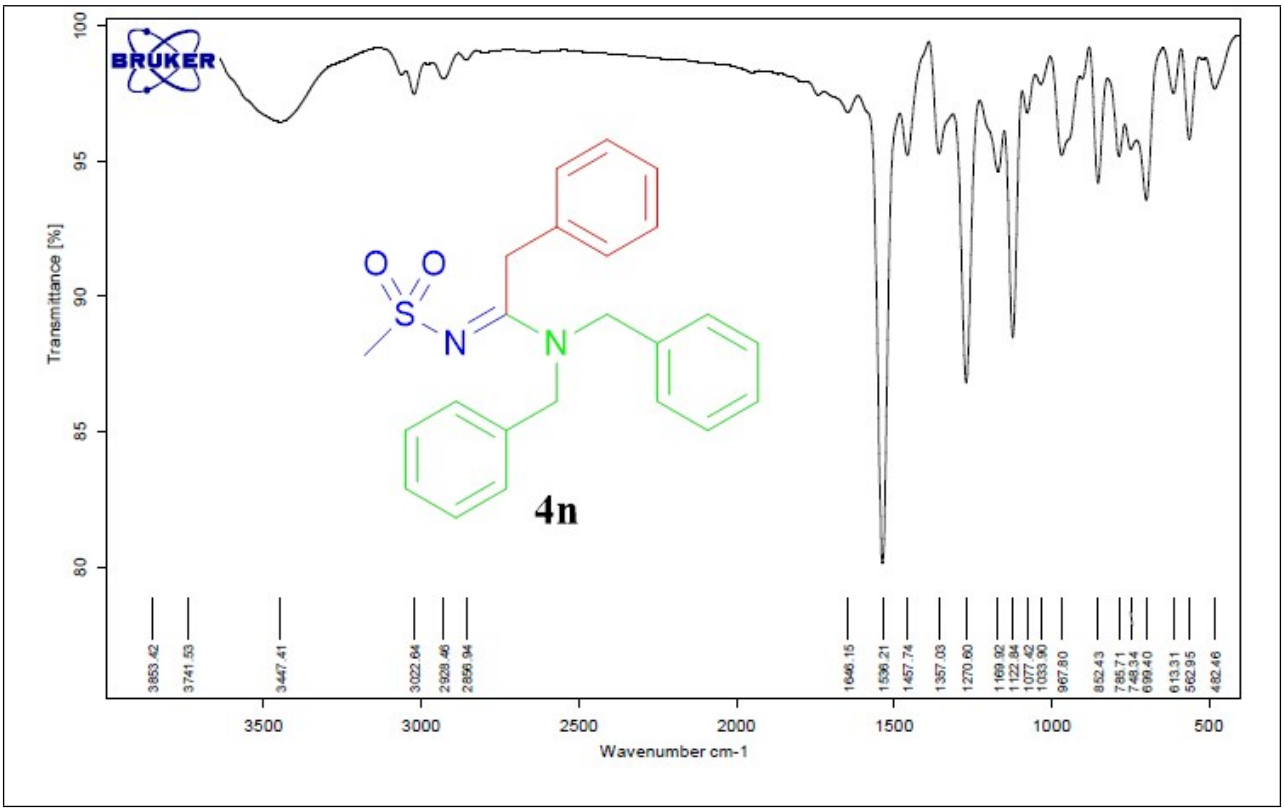

Figure 78: FTIR spectrum (KBr) of compound **4n**.

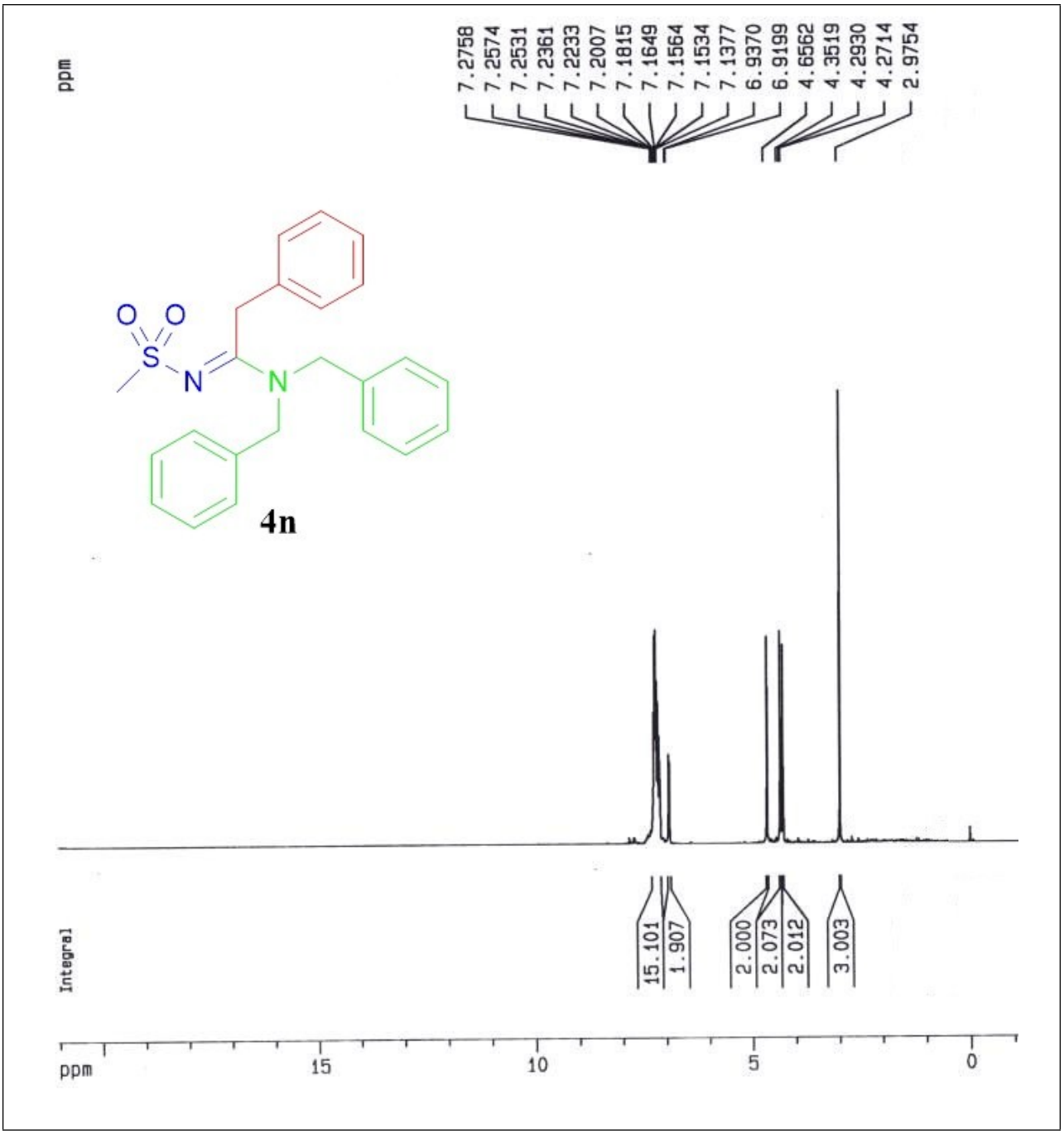

Figure 79: ^{1}H NMR spectrum (400 MHz) of compound **4n** in $CDCl_3$.

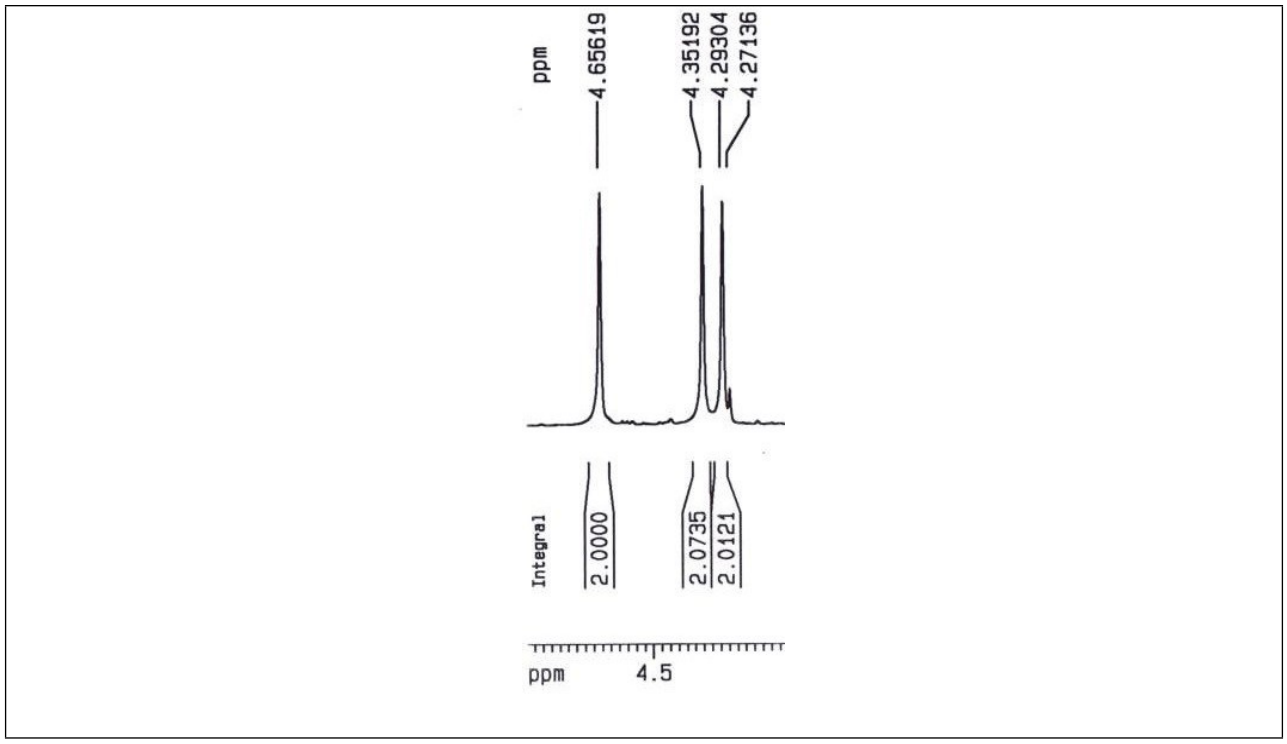

Figure 80: Expanded (1) ^{1}H NMR spectrum (400 MHz) of compound **4n** in $CDCl_3$.

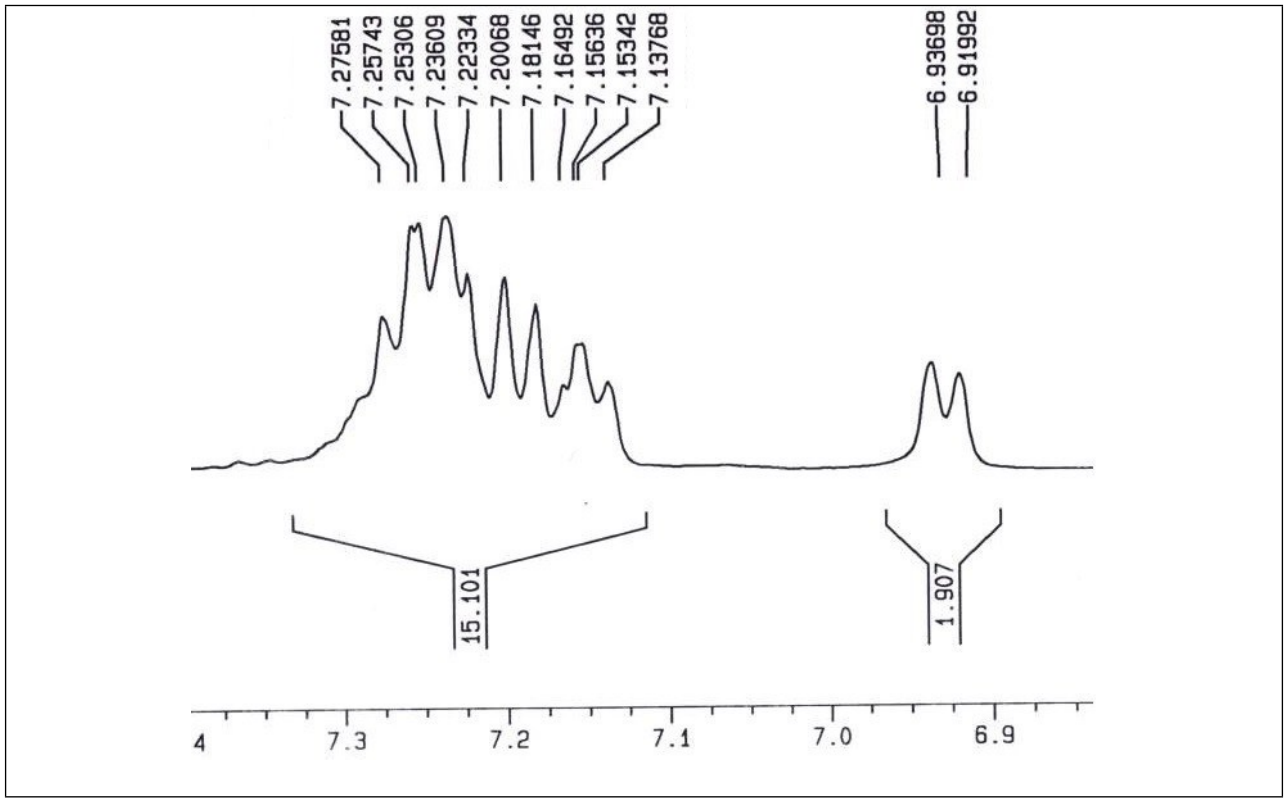

Figure 81: Expanded (2) ^{1}H NMR spectrum (400 MHz) of compound **4n** in $CDCl_3$.

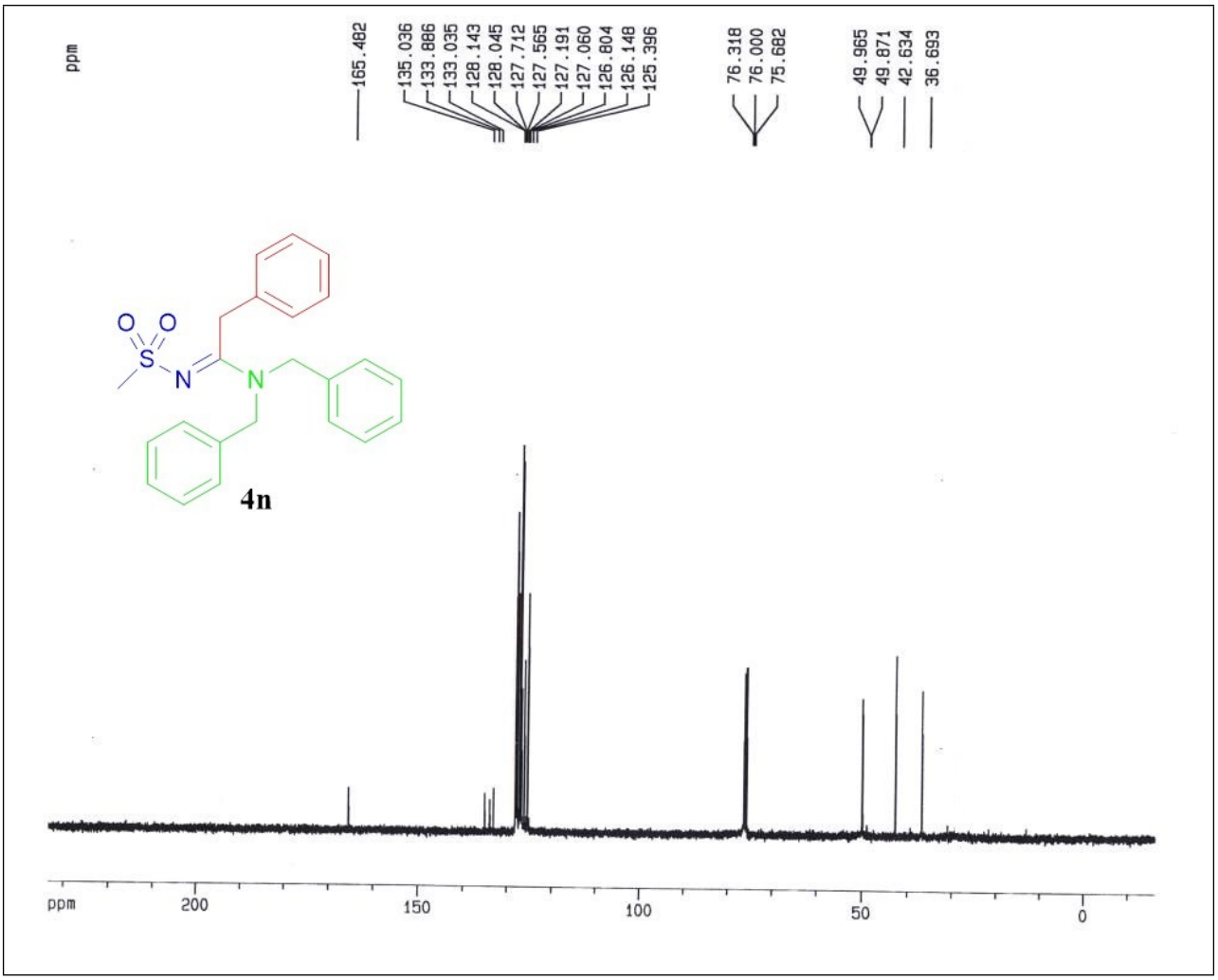

Figure 82: ^{13}C NMR spectrum (100 MHz) of compound **4n** in $CDCl_3$.

***N*^{1}, *N*^{1}-Dibenzyl-*N*^{2}-(4-methylbenzensulfonyl)-pentanamidine (4o):**

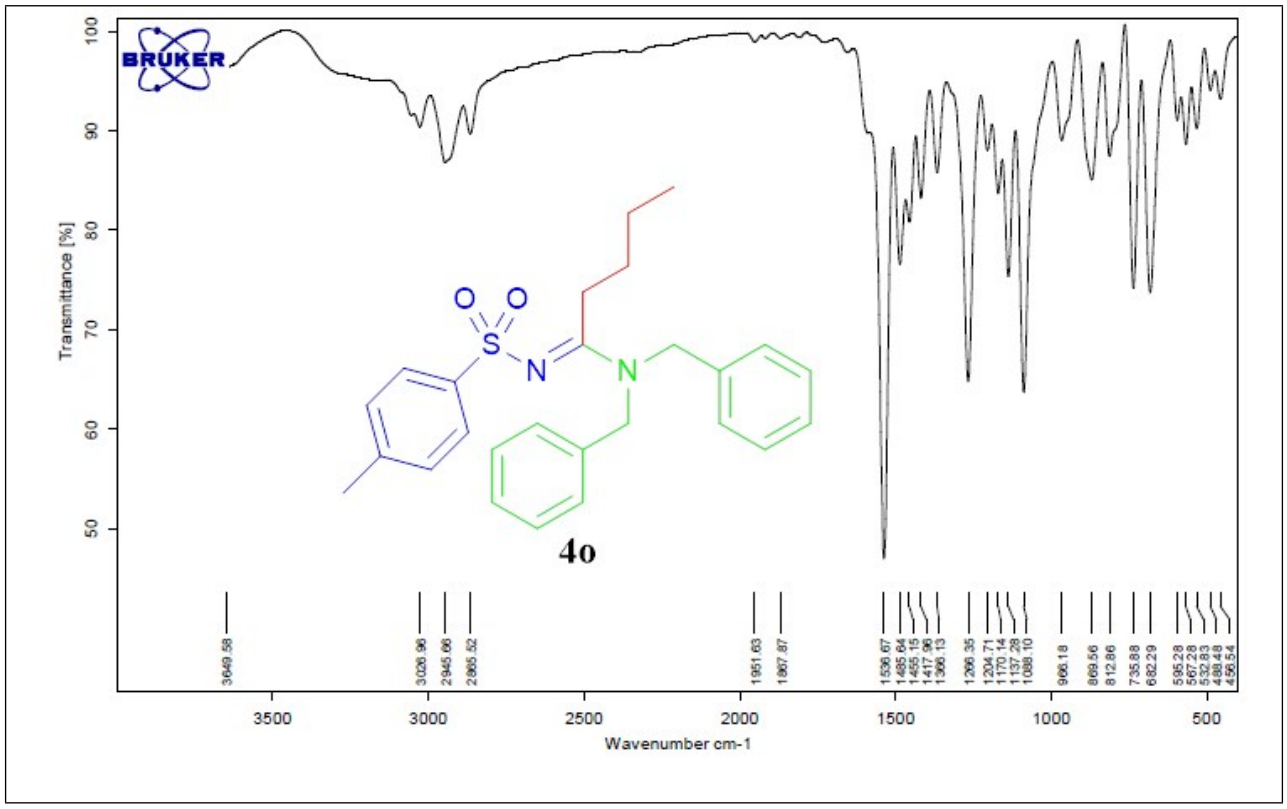

Figure 83: FTIR spectrum (KBr) of compound **4o**.

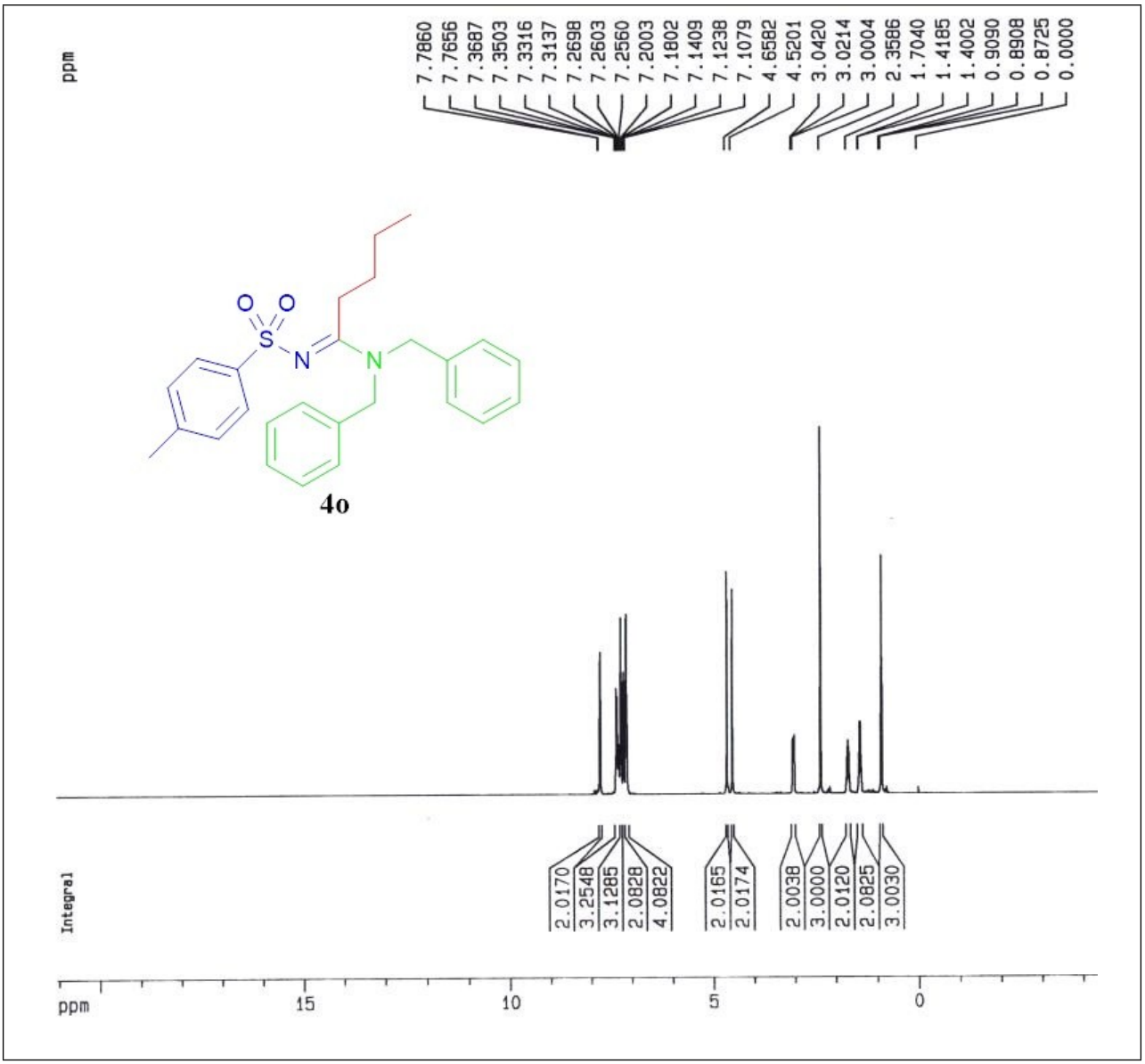

Figure 84: ^{1}H NMR spectrum (400 MHz) of compound **4o** in $CDCl_3$.

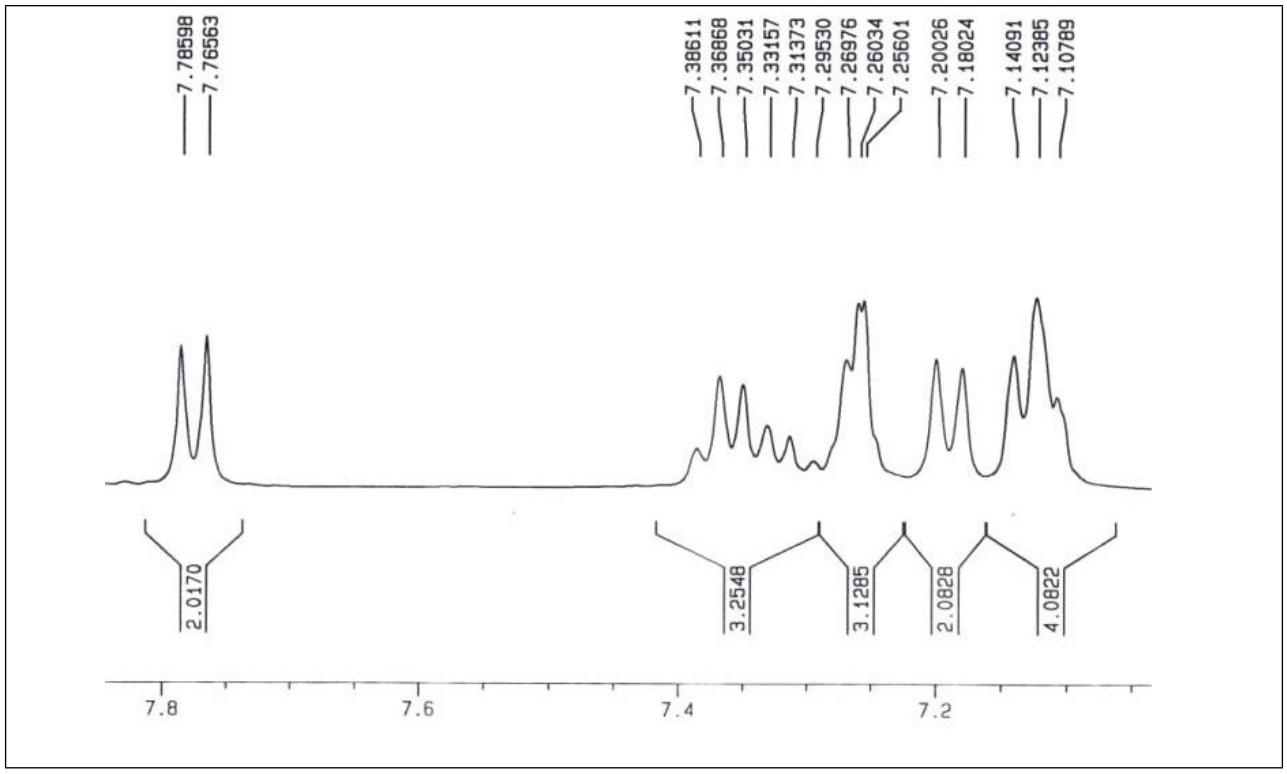

Figure 85: Expanded (1) ^{1}H NMR spectrum (400 MHz) of compound **4o** in $CDCl_3$.

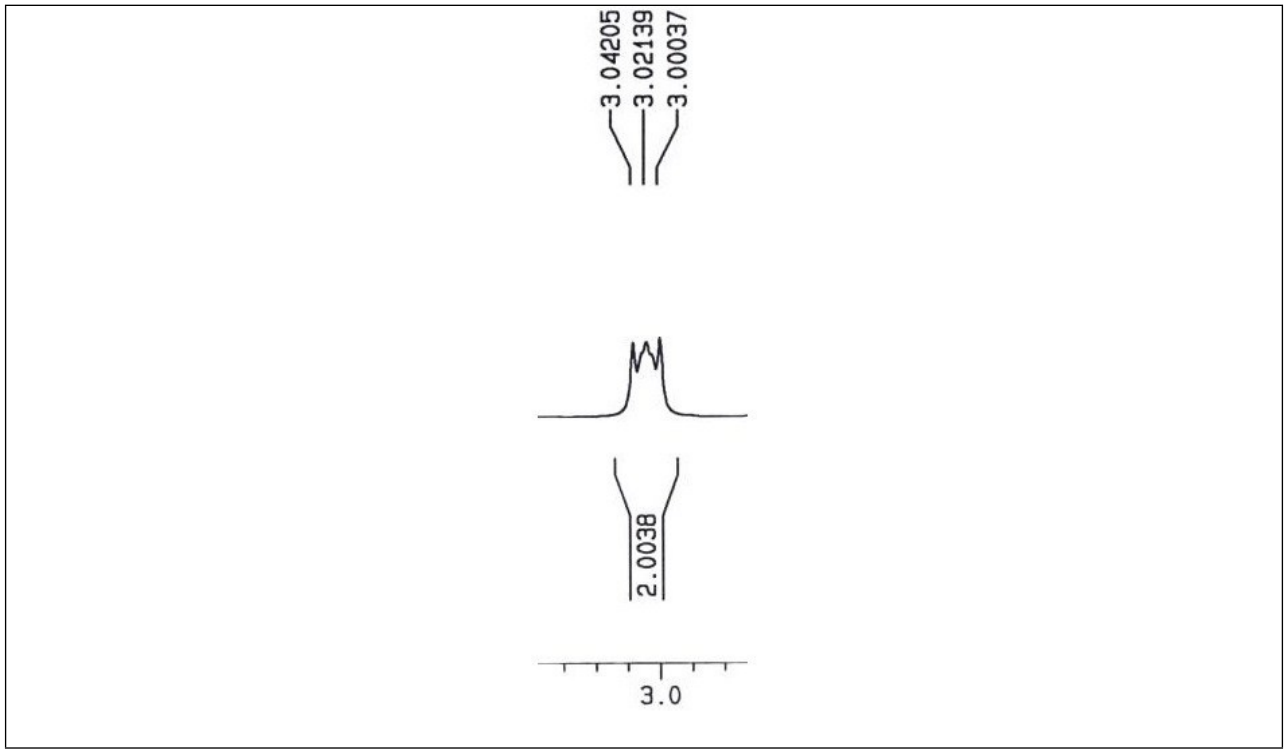

Figure 86: Expanded (2) ^{1}H NMR spectrum (400 MHz) of compound **4o** in $CDCl_3$.

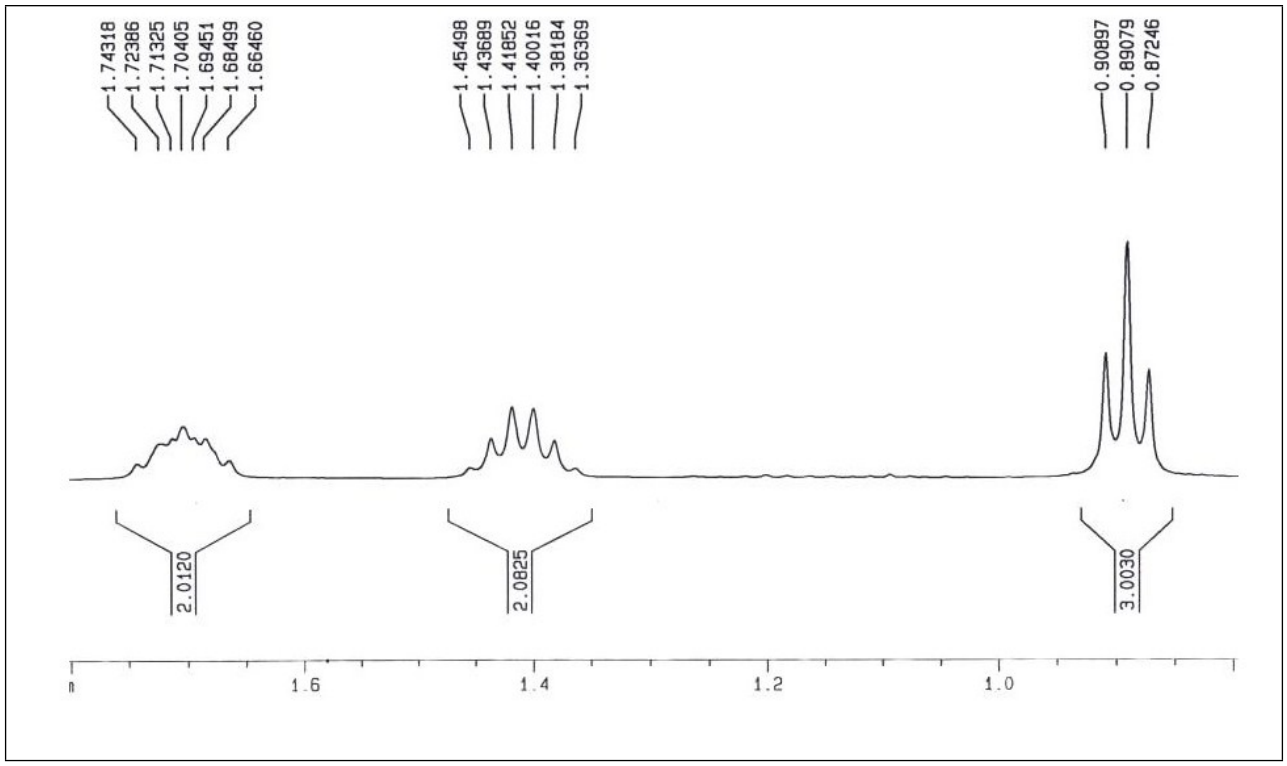

Figure 87: Expanded (3) ^{1}H NMR spectrum (400 MHz) of compound **4o** in $CDCl_3$.

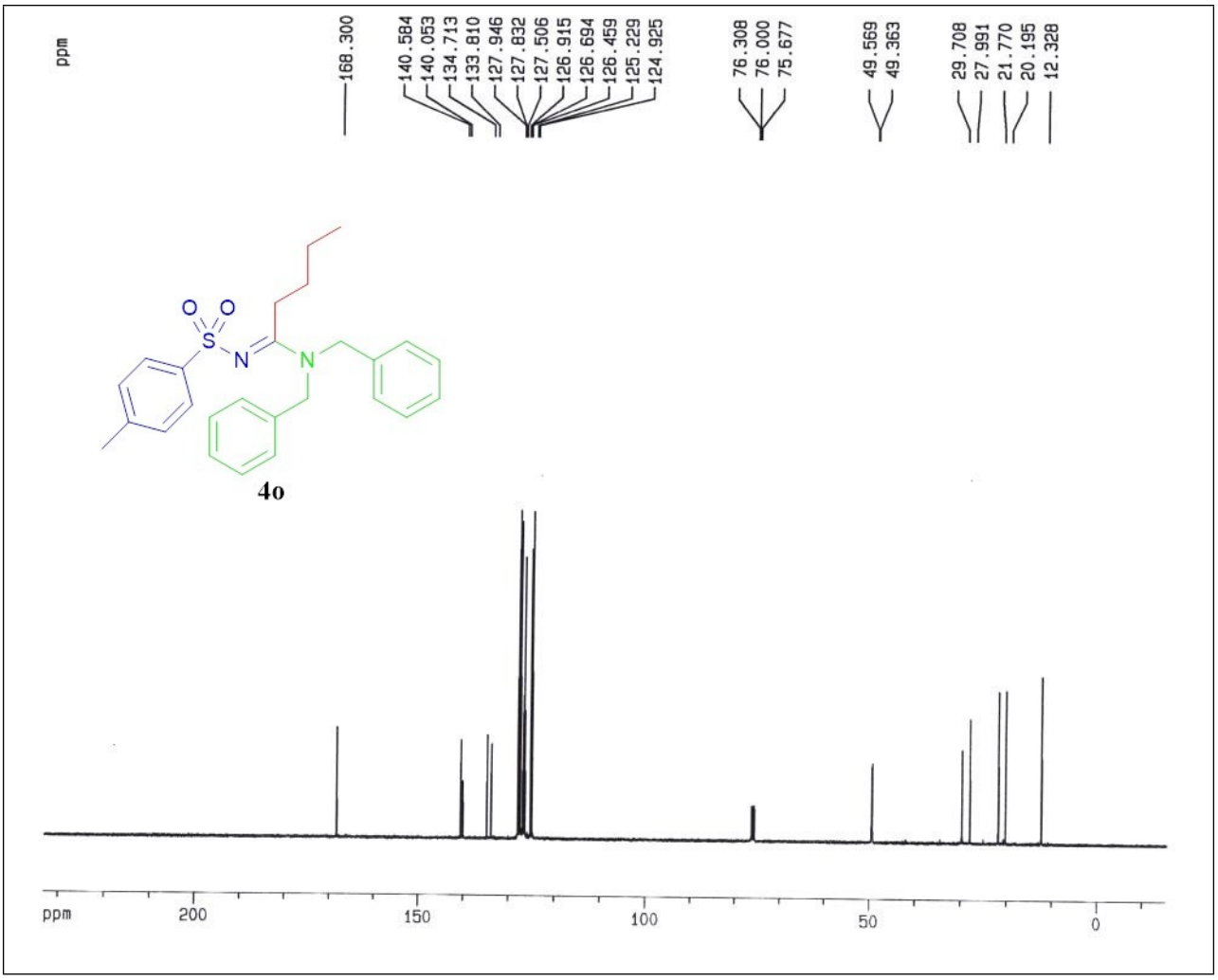

Figure 88: ^{13}C NMR spectrum (100 MHz) of compound **4o** in $CDCl_3$.

***N*[1], *N*[1]-Diphenyl-*N*[2]-tosyl-2-phenylacetamidine (4p):**

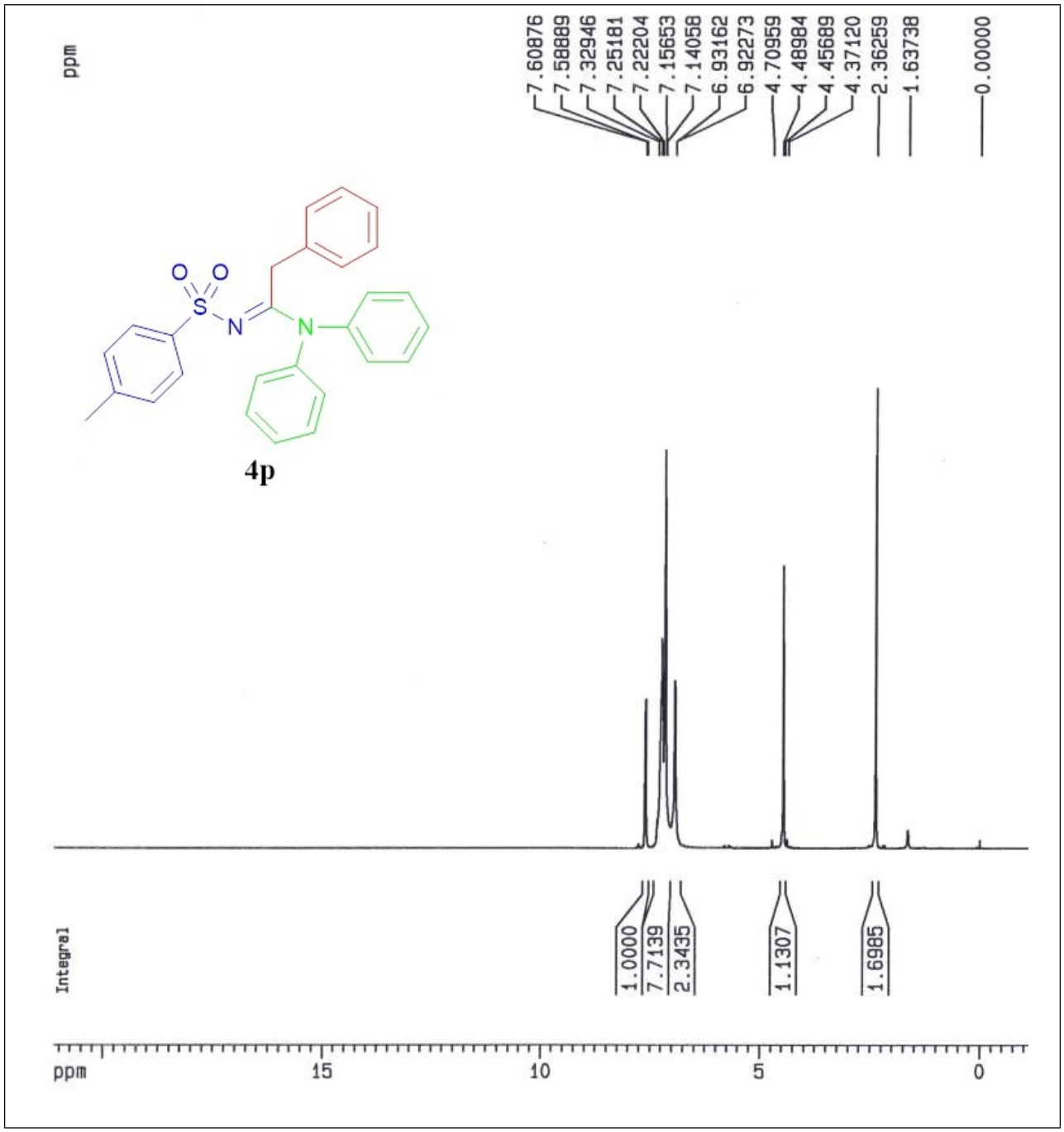

Figure 89: ^{1}H NMR spectrum (400 MHz) of compound **4p** in $CDCl_3$.

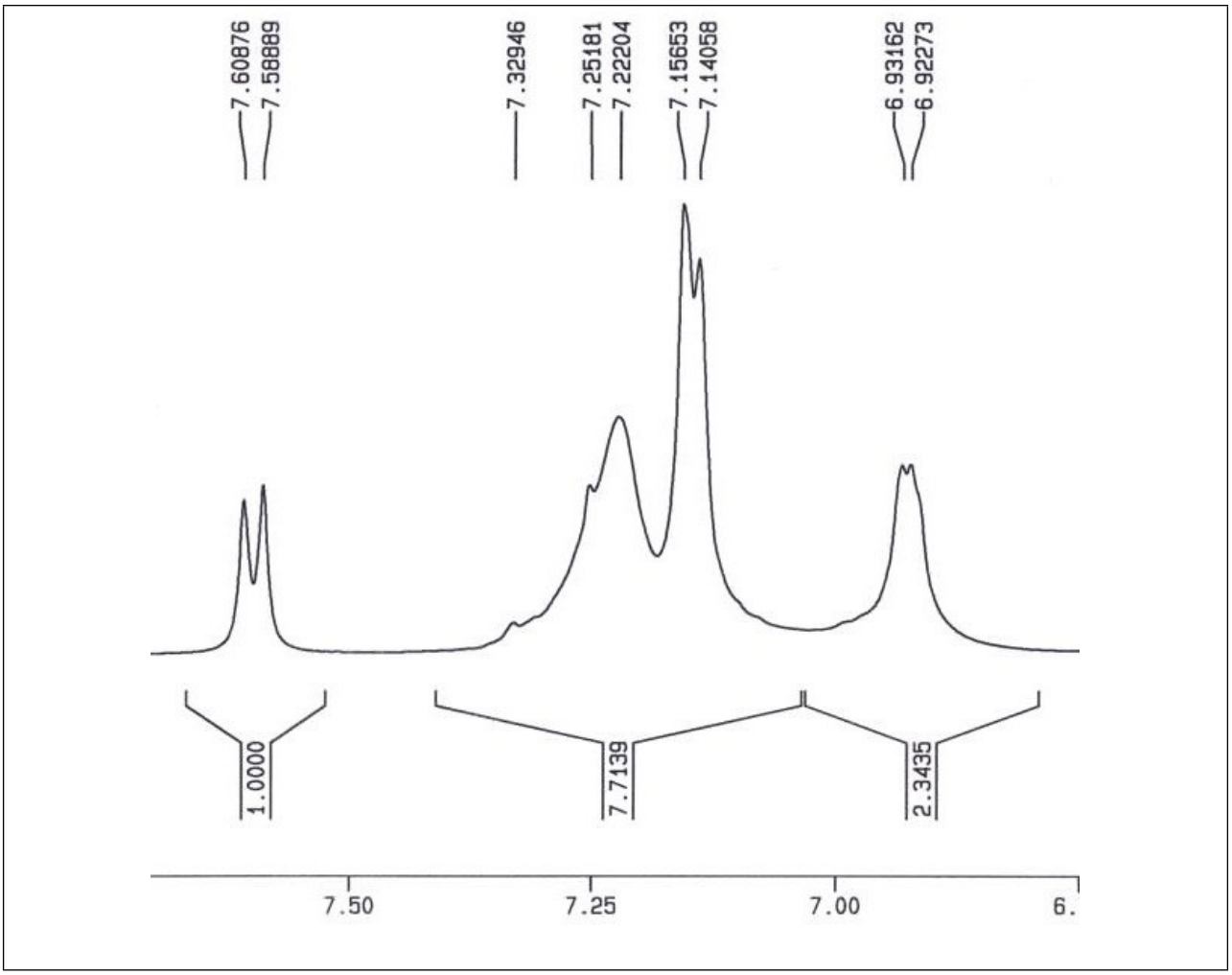

Figure 90: Expanded ^{1}H NMR spectrum (400 MHz) of compound **4p** in $CDCl_3$.

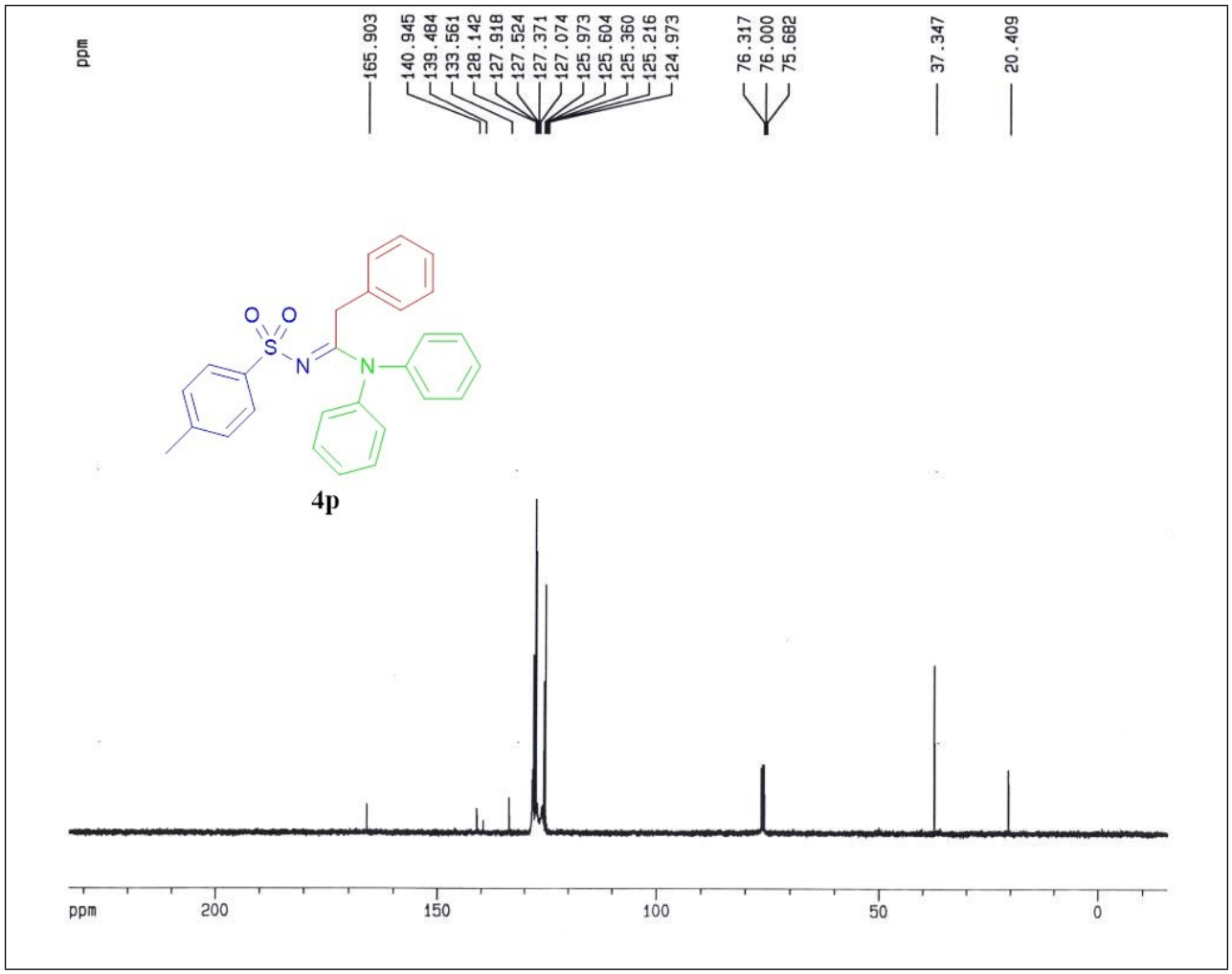

Figure 91: ^{13}C NMR spectrum (400 MHz) of compound **4p** in $CDCl_3$.

For previous methods for synthesis of ***N*^{1}, *N*^{1}-Diphenyl-*N*^{2}-tosyl-2-phenylacetamidine (4p),** see reference **3**.

References

[1] E. J. Yoo, I. Bae, S. H. Cho, H. Han and S. Chang, *Org. Lett.*, 2006, **8**, 1347-1350.

[2] (a) J. Kim and S. S. Stahl, *J. Org. Chem.,* 2015, **80**, 2448-2454; (b) H. E. Xinwei, S. Yongjia, H. U. Jinsong, J. U. Kai, J. Wei and W. Sufang, *Sci. China Chem.*, 2012, **55**, 214-222; (c) M. Jagadale, P. Bhange, R. Salunkhe, D. Bhange, M. Rajmane and G. Rashinkar, *Appl. Catal. A Gen.*, 2016, **511**, 95-105.

[3] T. Yang, H. Cui, C. Zhang, L. Zhang and C. -Y. Su, *Inorg. Chem.,* 2013, **52**, 9053-9059.