Graphene oxide functionalized tannic acid- trimethylolpropane triglycidyl ether nanoparticles: a versatile network nanocatalyst for synthesis of 4-substituted-1,5-benzodiazepine derivatives

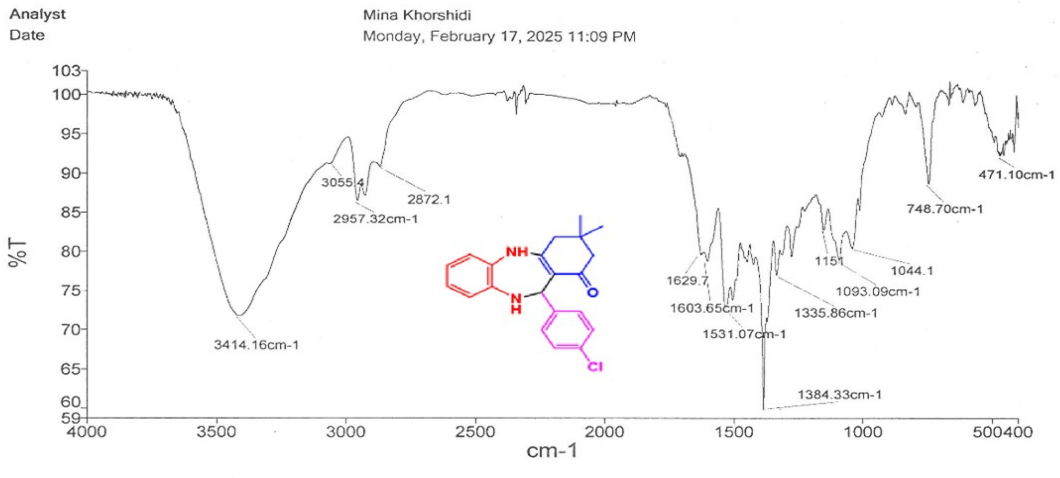
Alireza Gharehkhani, Maryam Hajjami*, Reza Hazbavi

Department of Organic Chemistry, Faculty of Chemistry and Petroleum Sciences, Bu-Ali Sina University, Postal code 6517838683,

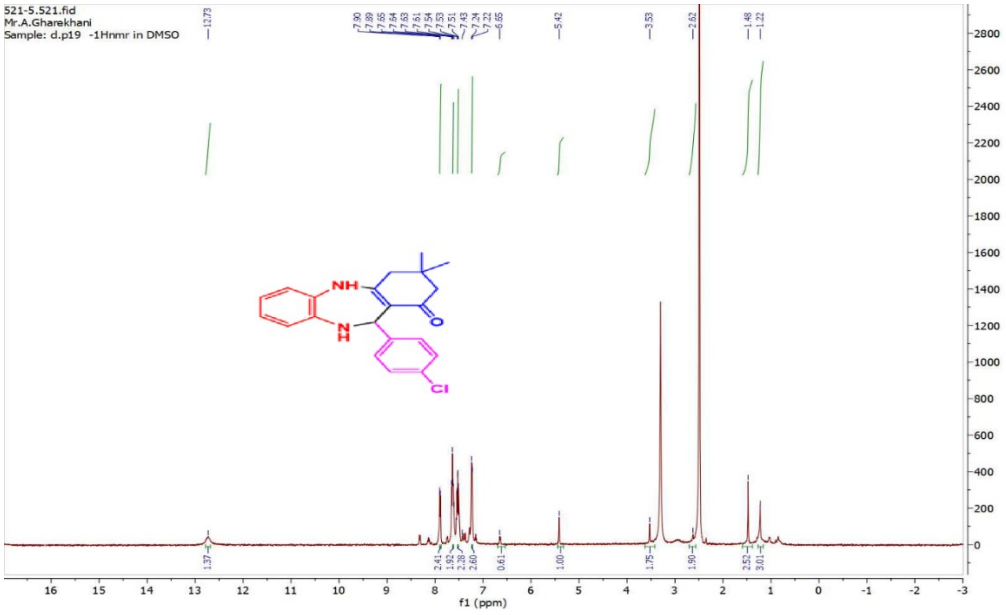
11-(4-chlorophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one:

FT-IR (KBr, cm^{-1}): 471, 748, 1044, 1093, 1151, 1335, 1384, 1531, 1603, 1629, 2872, 2957, 3055, 3414.

^{1}H NMR (400 MHz, DMSO-d_6): δ[1] 12.73 (s, 1H), 7.90 (d, *J* = 7.3 Hz, 2H), 7.63 (s, 2H), 7.52 (d, *J* = 8.5 Hz, 2H), 7.22 (s, 3H), 6.65 (s, 1H), 5.42 (s, 1H), 3.53 (s, 2H), 2.62 (s, 2H), 1.48 (s, 3H), 1.22 (s, 3H).



FT-IR spectrum of the compound 11-(4-chlorophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one



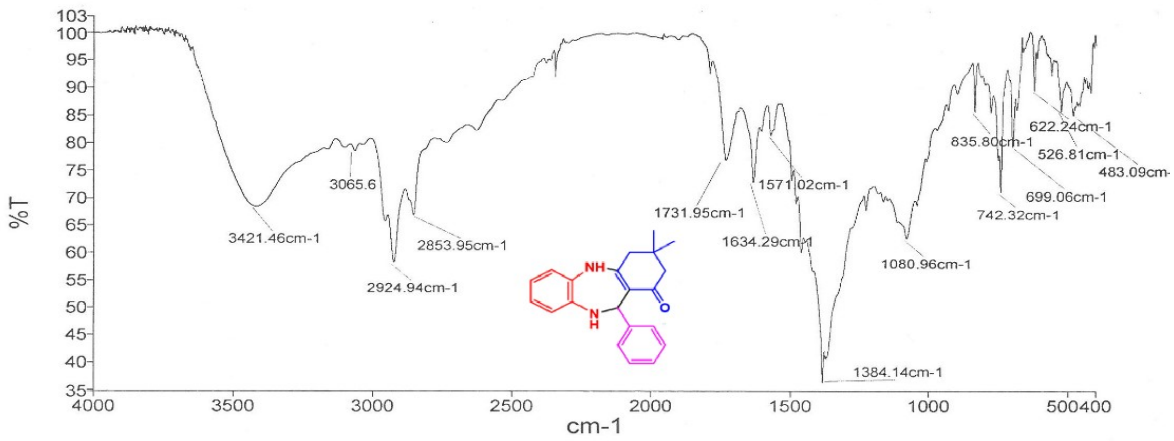
[1]H NMR spectrum of the compound 11-(4-chlorophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one

3,3-dimethyl-11-phenyl-2,3,4,5,10,11-hexahydro-1*H*-dibenzo[b,e][1,4]diazepin-1-one:

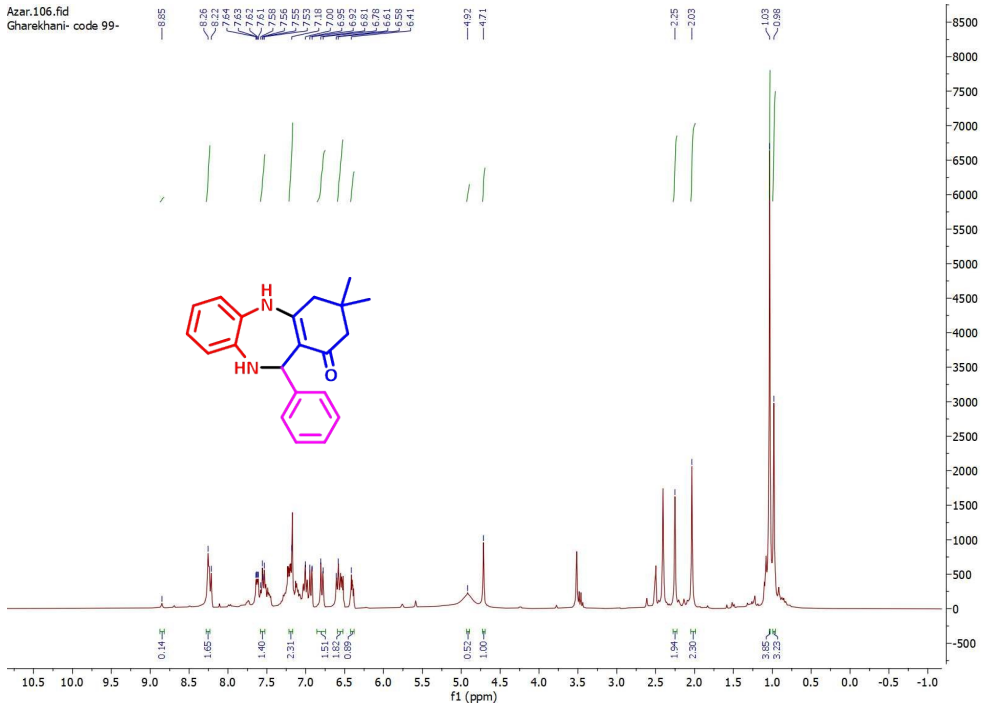
FT-IR (KBr, cm^{-1}):483, 526, 622, 699, 742, 835, 1080, 1384, 1571, 1634, 1731, 2853, 2824, 3065, 3421.

^{1}H NMR (300 MHz, DMSO) δ 8.26 (s, 1H), 7.58 – 6.41 (m, 8H), 4.92 (s, 1H), 4.71 (s, 1H), 2.25 (s, 2H), 2.03 (s, 2H), 1.03 (s, 3H), 0.98 (s, 3H).

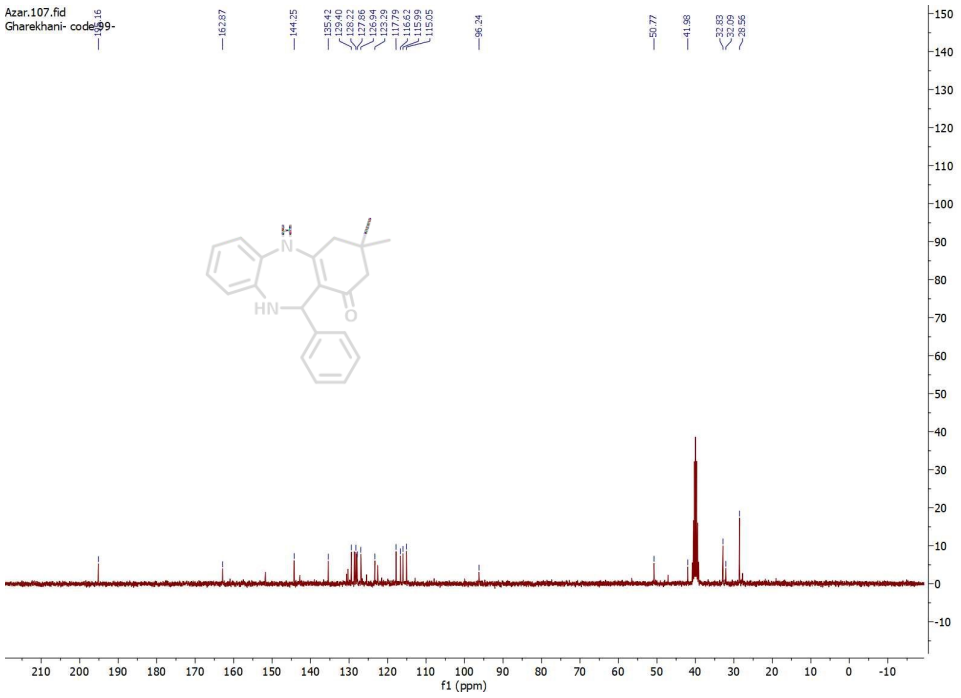
^{13}C NMR (75 MHz, DMSO) δ 195.1, 162.8, 144.2, 135.4, 129.4, 128.2, 127.8, 126.9, 123.2, 117.7, 116.6, 115.9, 115.0, 96.2, 50.7, 41.9, 32.8, 32.0, 28.5.



FT-IR spectrum of the compound 3,3-dimethyl-11-phenyl-2,3,4,5,10,11-hexahydro-1*H*-dibenzo[b,e][1,4]diazepin-1-one



^{1}H NMR spectrum of the compound 3,3-dimethyl-11-phenyl-2,3,4,5,10,11-hexahydro-1*H*-dibenzo[b,e][1,4]diazepin-1-one



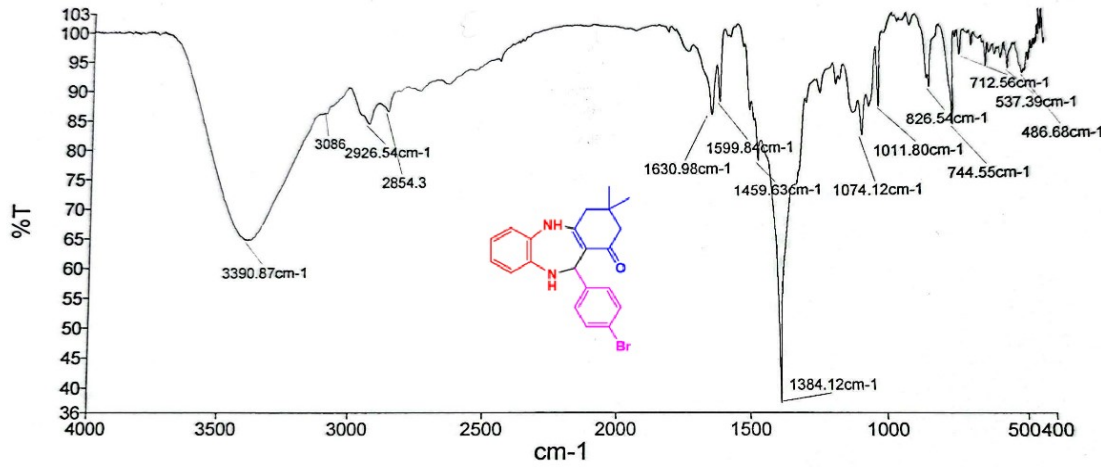
^{13}C NMR spectrum of the compound 3,3-dimethyl-11-phenyl-2,3,4,5,10,11-hexahydro-1*H*-dibenzo[b,e][1,4]diazepin-1-one

11-(4-bromophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one:

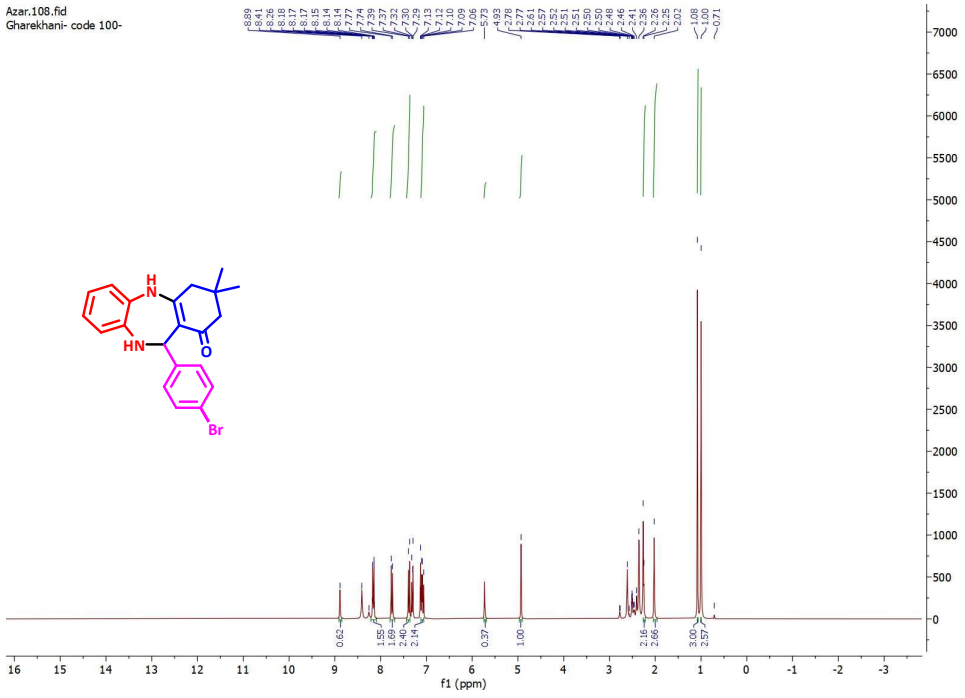
FT-IR (KBr, cm^{-1}):486, 537, 712, 744, 826, 1011, 1074, 1384, 1459, 1599, 1630, 2854, 2926, 3086, 3390.

^{1}H NMR (300 MHz, DMSO) δ 8.89 (s, 1H), 8.21 – 7.06 (m, 8H), 4.93 (s, 1H), 2.25 (s, 2H), 2.02 (s, 3H), 1.08 (s, 3H), 1.00 (s, 3H).

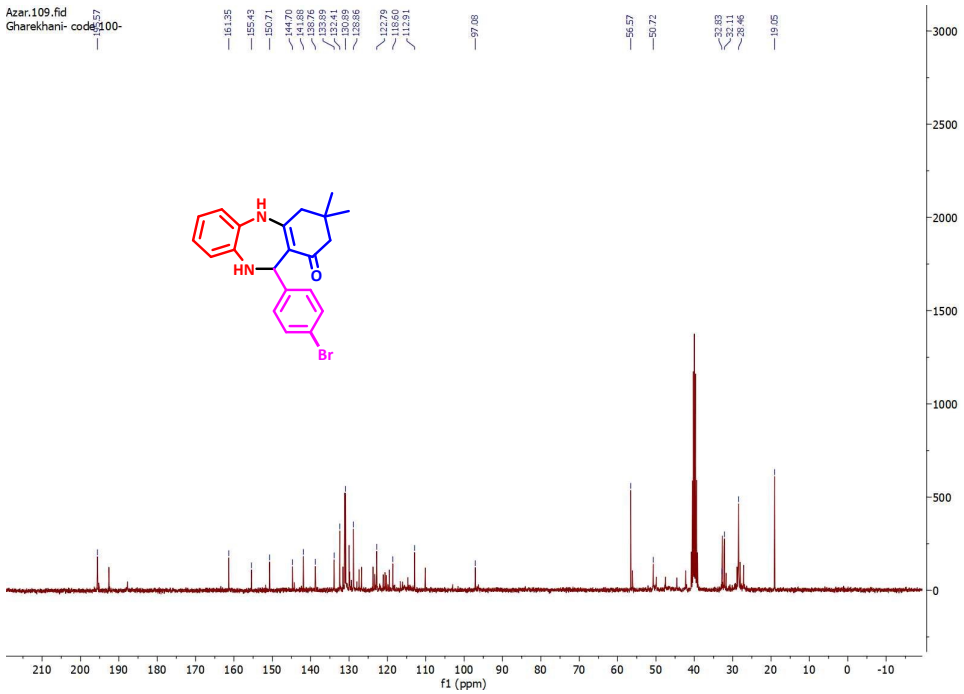
^{13}C NMR (75 MHz, DMSO) δ 195.1, 162.8, 144.2, 135.4, 129.4, 128.2, 127.8, 126.9, 123.2, 117.7, 116.6, 115.9, 115.0, 96.2, 50.7, 41.9, 32.8, 32.0, 28.5.



FT-IR spectrum of the compound 11-(4-bromophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one



[1]H NMR spectrum of the compound 11-(4-bromophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one



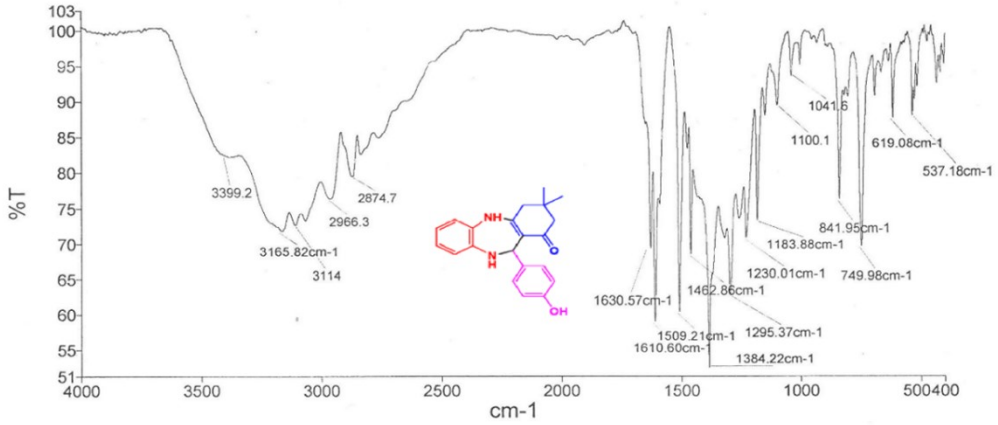
^{13}C NMR spectrum of the compound 11-(4-bromophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one

11-(4-hydroxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one:

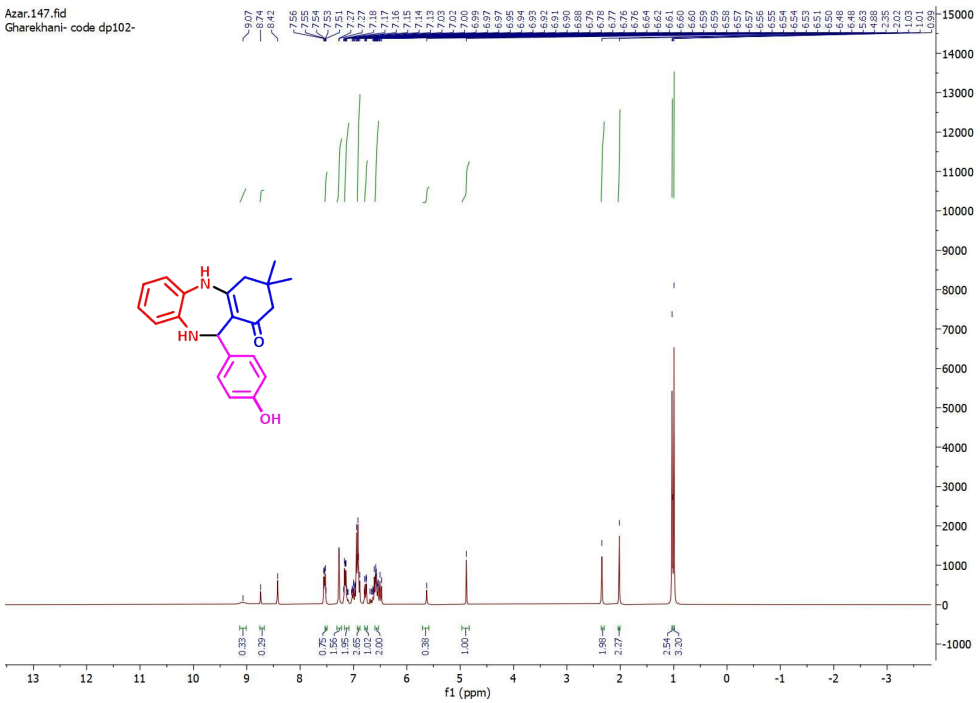
FT-IR (KBr, cm^{-1}): 537, 619, 749, 841, 1041, 1100, 1183, 1230, 1295, 1384, 1462, 1509, 1610, 1630, 2874, 2966, 3114, 3165, 3399.

^{1}H NMR (300 MHz, DMSO) δ 9.07 (s, 1H), 8.74 (s, 1H) 7.56-6.53 (m, 8H), 4.88 (s, 1H), 2.35 (s, 2H), 2.02 (s, 2H), 1.03 (s, 3H), 0.99 (s, 3H).

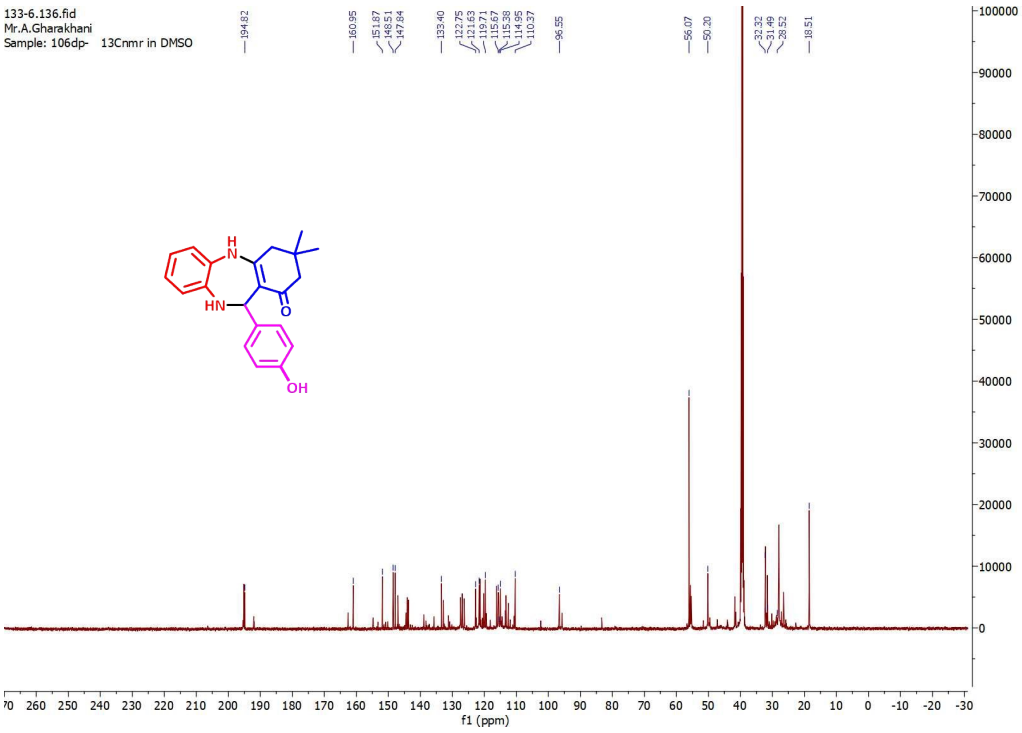
^{13}C NMR (75 MHz, DMSO) δ 195.1, 161.2, 159.6, 152.2, 144.2, 133.9, 129.4, 128.6, 127.8, 122.0, 121.5, 115.9, 114.8, 97.0, 56.5, 50.7, 32.8, 28.4, 19.0.



FT-IR spectrum of the compound 11-(4-hydroxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one



[1]H NMR spectrum of the compound 11-(4-hydroxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one



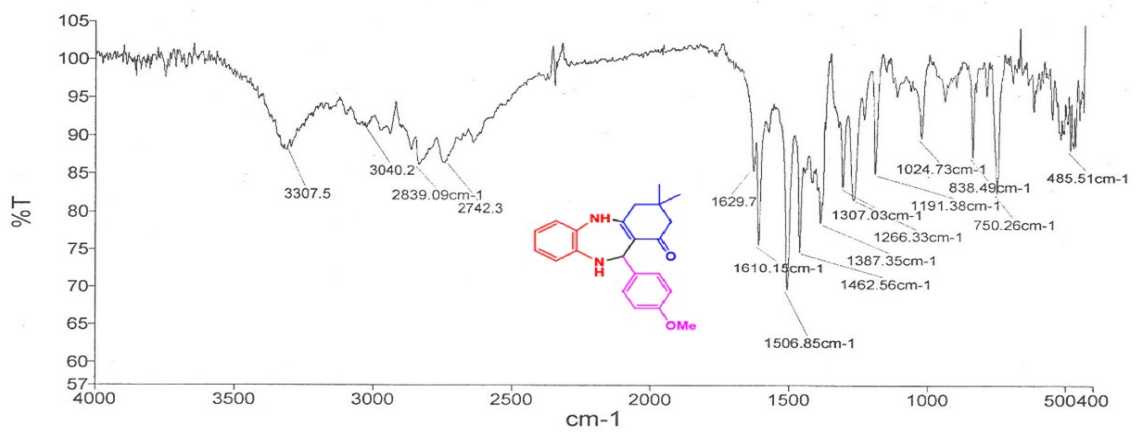
[13]C NMR spectrum of the compound 11-(4-hydroxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one

11-(4-methoxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one:

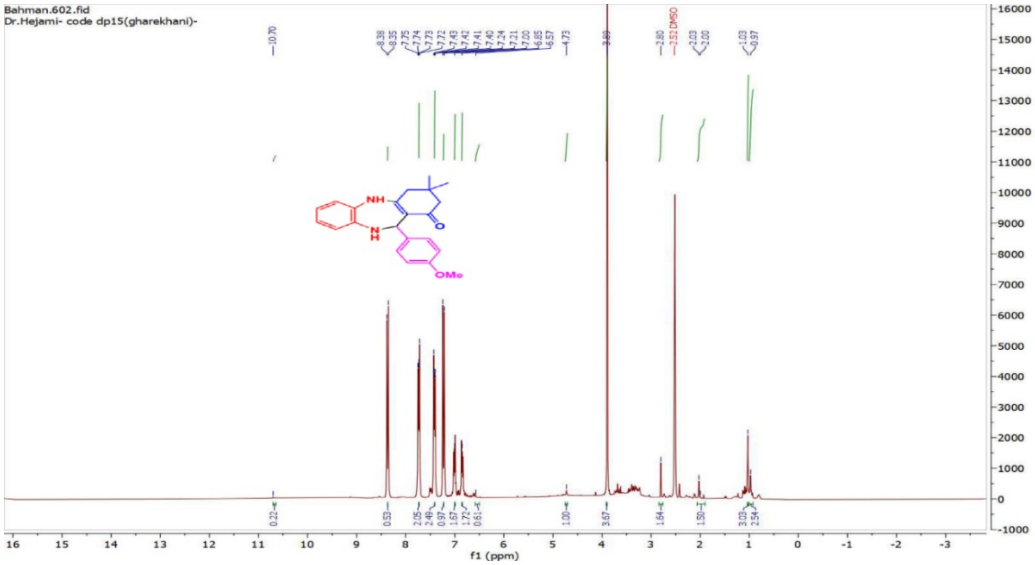
FT-IR (KBr, cm^{-1}):485, 750, 838, 1024, 1191, 1266, 1307, 1387, 1462, 1506, 1610, 1629, 2742, 2839, 3040, 3307.

^{1}H NMR (400 MHz, DMSO-d_6): δ 10.70 (s.1H), 7.73 - 6.85 (m, 8H), 6.57 (s, 1H), 4.73 (s, 1H), 3.89 (s, 4H), 2.80 (s, 2H), 2.03 (s, 2H), 1.03 (s, 3H), 0.97 (s, 3H).

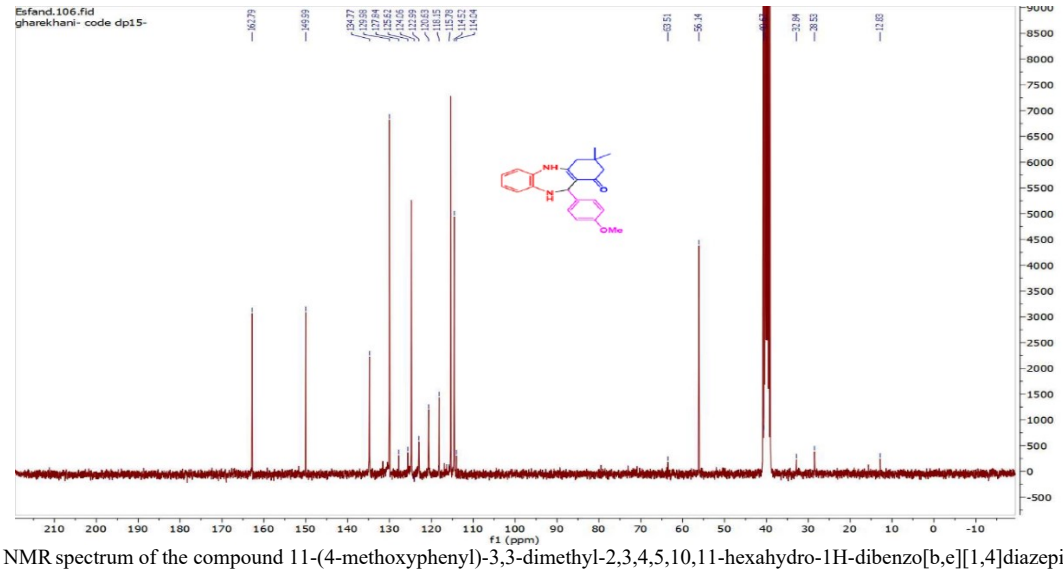
^{13}C NMR (100 MHz, DMSO-d_6) δ 162.7, 149.9, 134.7, 129.9, 127.8, 125.6, 122.9, 120.6, 118.1, 114.5, 114.0, 63.5, 56.1, 40.6, 32.8, 28.5, 12.8.



FT-IR spectrum of the compound 11-(4-methoxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one



^{1}H NMR spectrum of the compound 11-(4-methoxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one



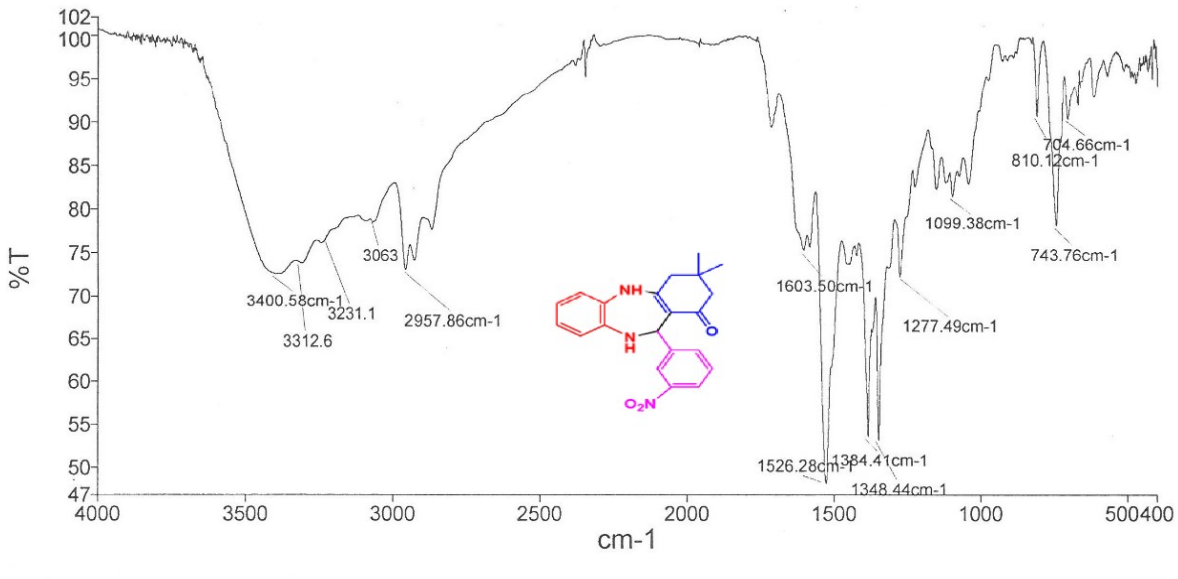
^{13}C NMR spectrum of the compound 11-(4-methoxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one

3,3-dimethyl-11-(3-nitrophenyl)-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one:

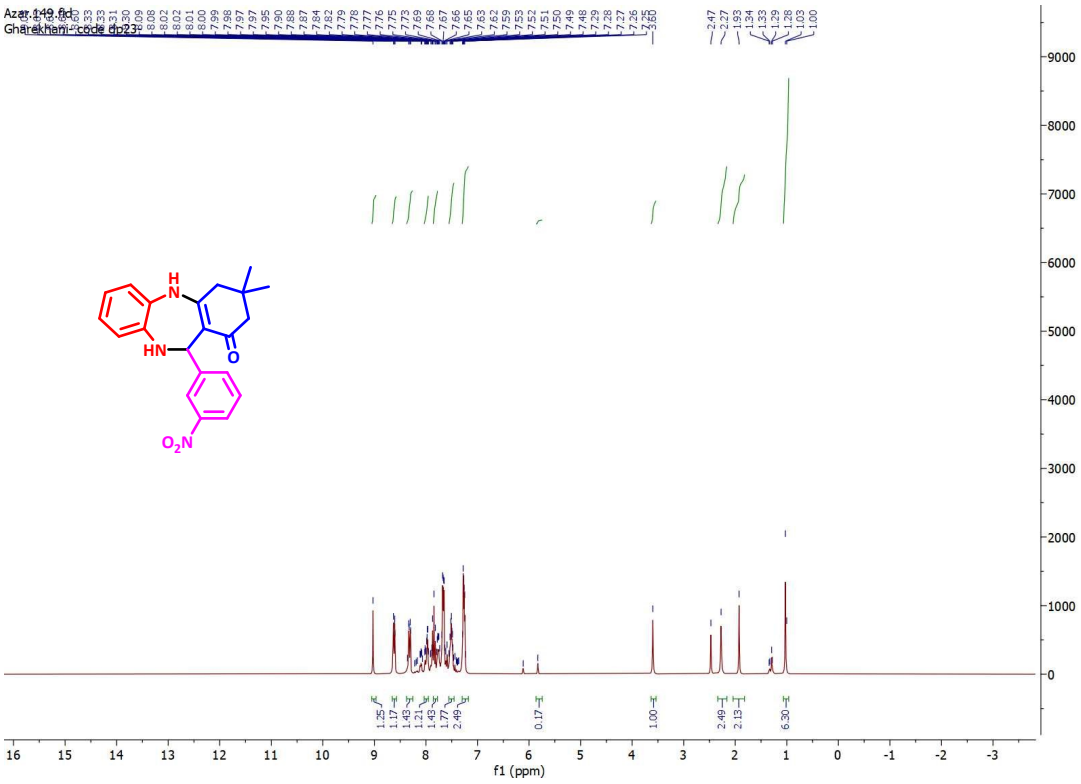
FT-IR (KBr, cm^{-1}):704, 743, 810, 1099, 1277, 1248, 1384, 1426, 1603, 2957, 3063, 3231, 3312 3400.

^{1}H NMR (300 MHz, DMSO) **δ** 9.01 (s, 1H), 8.64 - 6.54 (m, 8 H), 5.82 (s, 1H), 3.60 (s, 1H), 2.46 (s, 2H), 2.28 (s, 2H), 1.02 (s, 3H), 0.97 (s, 3H).

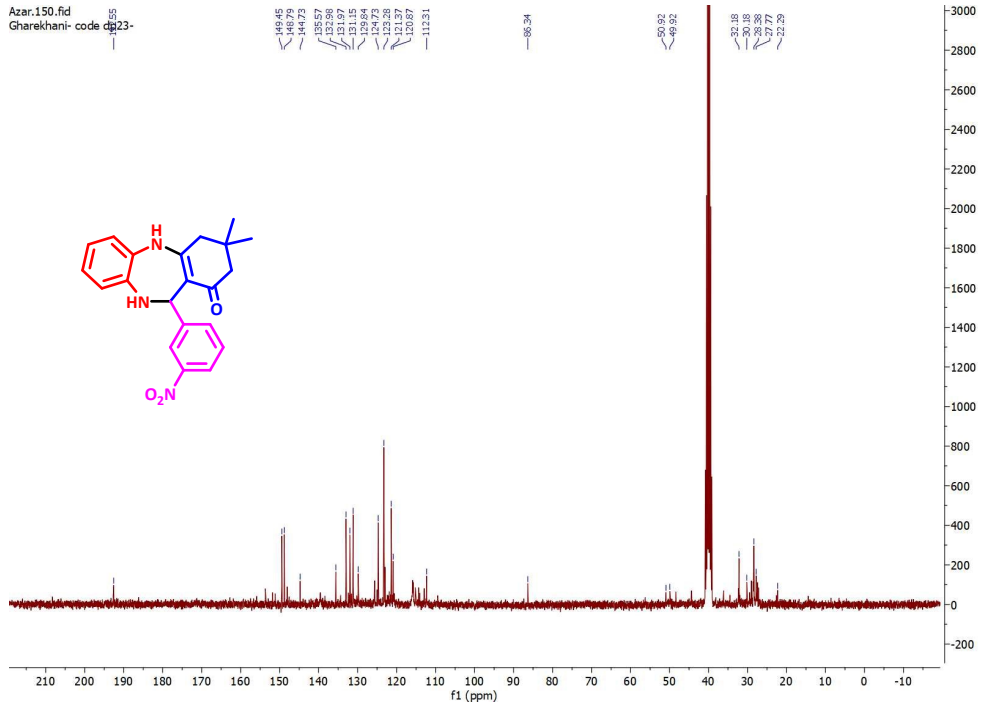
^{13}C NMR (75 MHz, DMSO) **δ** 192.5, 149.4, 148.7, 135.5, 132.9, 131.9, 131.1, 129.8, 124.7, 123.7, 123.2, 121.3, 120.8, 112.3, 86.3, 50.9, 32.1, 28.3, 27.7, 22.2.



FT-IR spectrum of the compound 3,3-dimethyl-11-(3-nitrophenyl)-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one



^{1}H NMR spectrum of the compound 3,3-dimethyl-11-(3-nitrophenyl)-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one



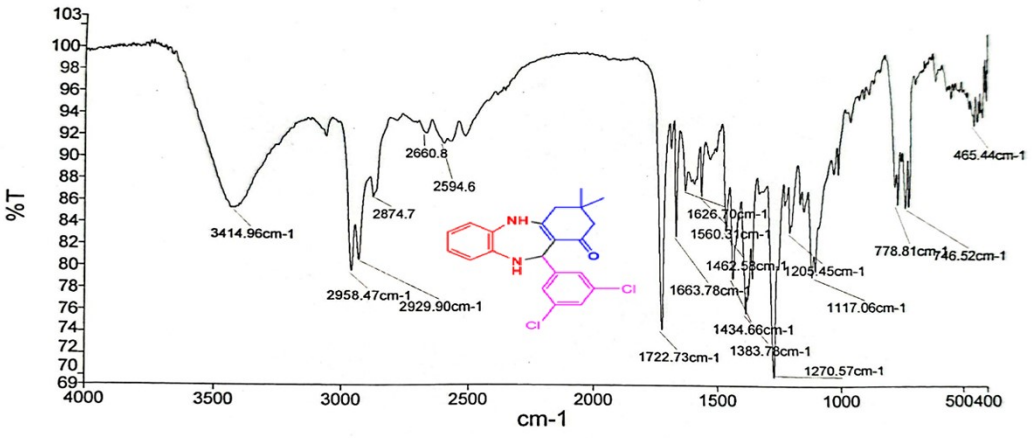
^{13}C NMR spectrum of the compound 3,3-dimethyl-11-(3-nitrophenyl)-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one

11-(3,5-dichlorophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one:

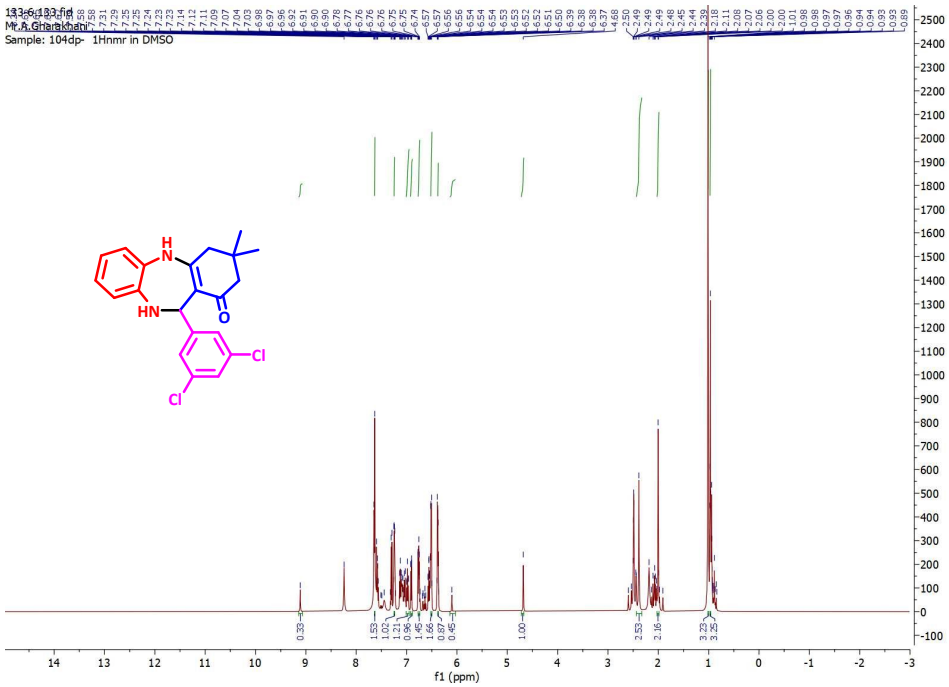
FT-IR (KBr, cm^{-1}): 465, 778, 1117, 1205, 1270, 1383, 1434, 1462, 1560, 1626, 1663, 1722, 2594, 2660, 2874, 2929, 2958, 3414.

^{1}H NMR (500 MHz, DMSO) δ 9.01 (s, 1H), 7.63- 6.37 (m, 7H), 4.68 (s, 1H), 2.39 (s, 3H), 2.00 (s, 2H), 1.01 (s, 3H), 0.96 (s, 3H).

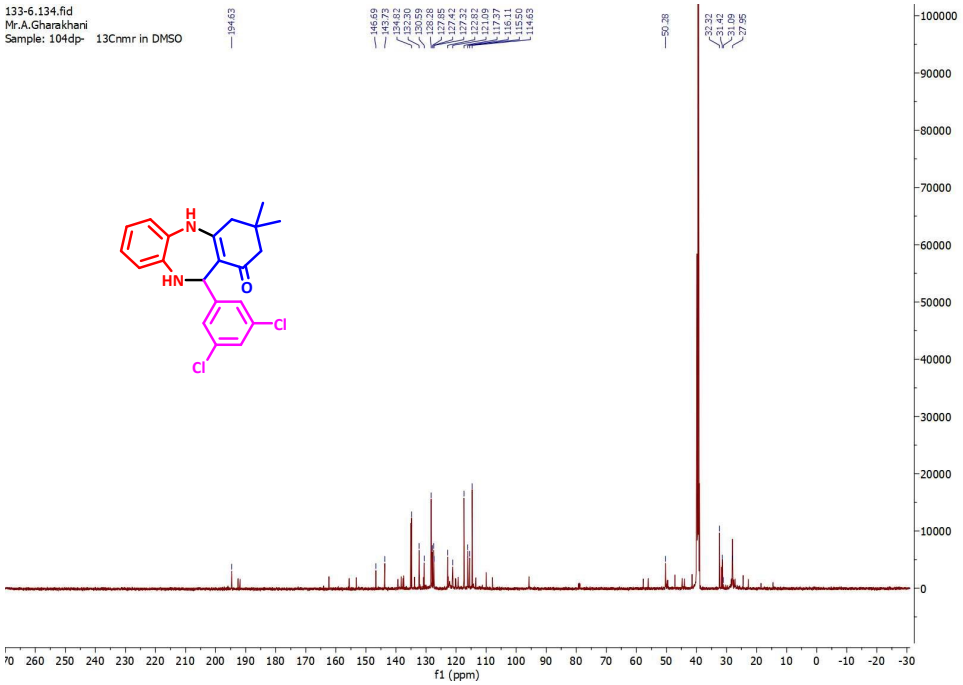
^{13}C NMR (126 MHz, DMSO) δ 194.6, 146.6, 143.7, 134.8, 132.3, 130.5, 128.2, 127.8, 127.4, 127.3, 122.8, 121.0, 117.3, 116.1, 115.5, 114.6, 50.2, 32.3, 31.4, 31.0, 27.9.



FT-IR spectrum of the compound 11-(3,5-dichlorophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one



^{1}H NMR spectrum of the compound 11-(3,5-dichlorophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one



^{13}C NMR spectrum of the compound 11-(3,5-dichlorophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one

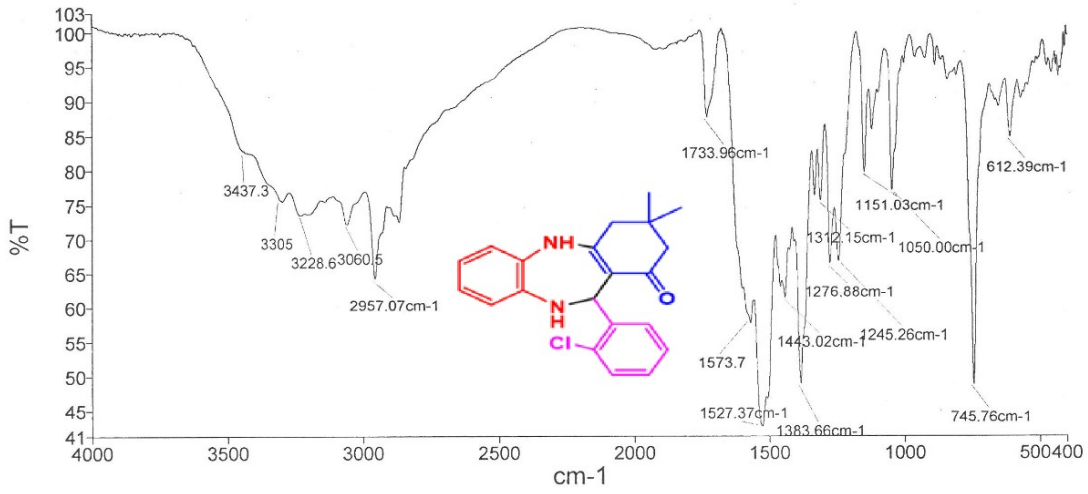
11-(2-chlorophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one

FT-IR (KBr, cm^{-1}): 612, 745, 1050, 1151, 1245, 1312, 1383, 1443, 1527, 1573, 1733, 2957, 3060, 3228,

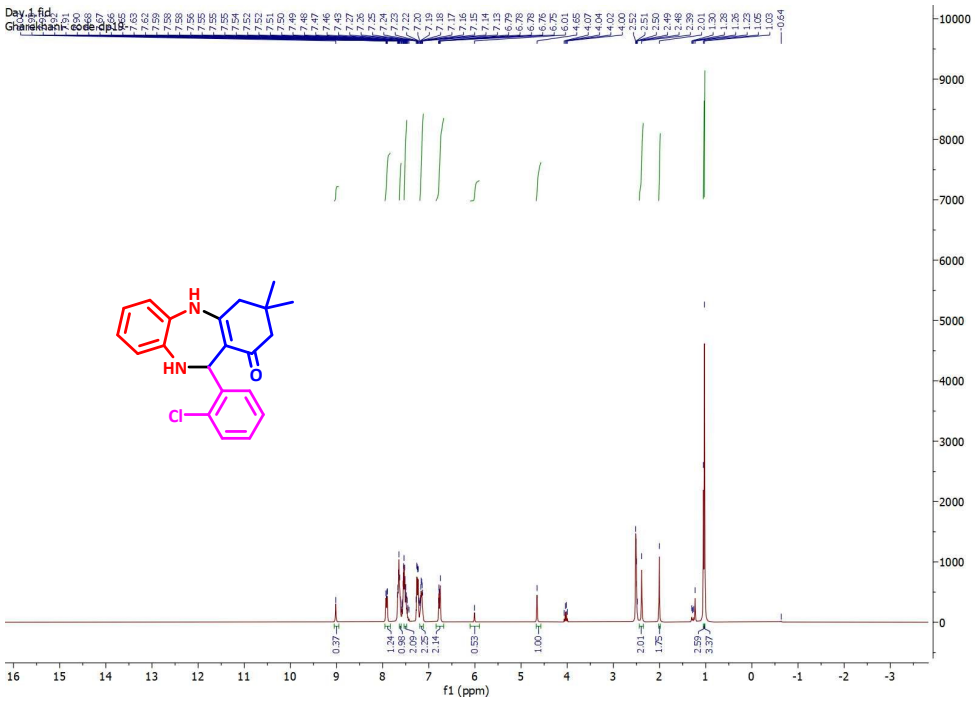
2205, 3437.

^{1}H NMR (300 MHz, DMSO) δ 9.0 (s, 1H), 7.95 – 6.68 (m, 8H), 6.01 (s, 1H), 4.65 (s, 1H), 2.39 (s, 2H), 2.01 (s, 2H), 1.05 (s, 3H), 1.03 (s, 3H).

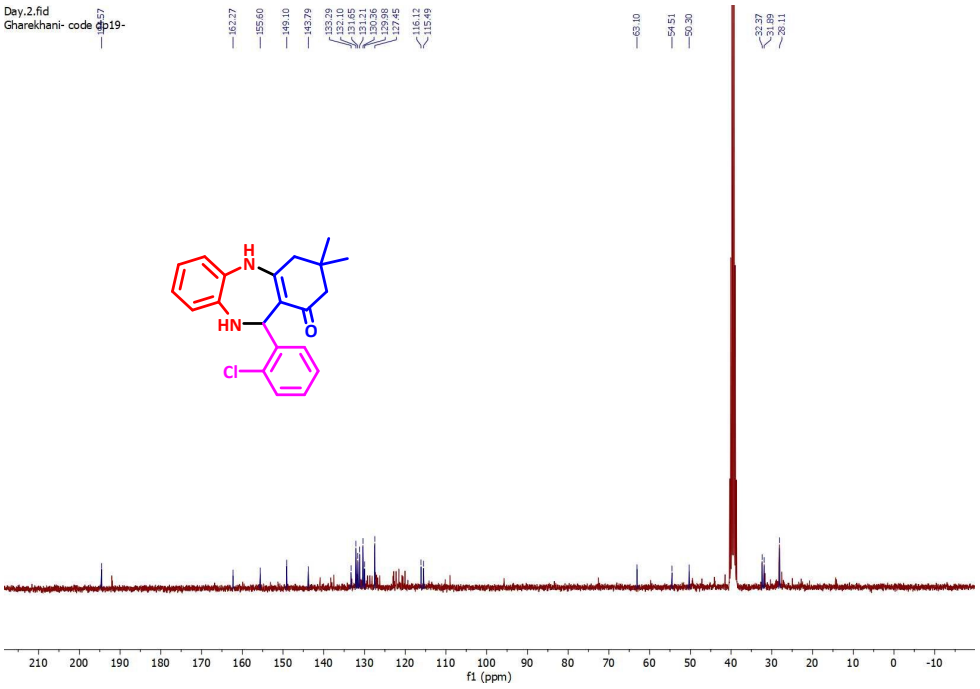
^{13}C NMR (75 MHz, DMSO) δ 194.5, 162.2, 155.6, 149.1, 143.7, 133.2, 132.1, 131.6, 131.2, 130.3, 129.9, 127.4, 116.1, 115.4, 63.1, 54.5, 50.3, 32.3, 31.8, 28.1.



FT-IR spectrum of the compound 11-(2-chlorophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one



^{1}H NMR spectrum of the compound 11-(2-chlorophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one



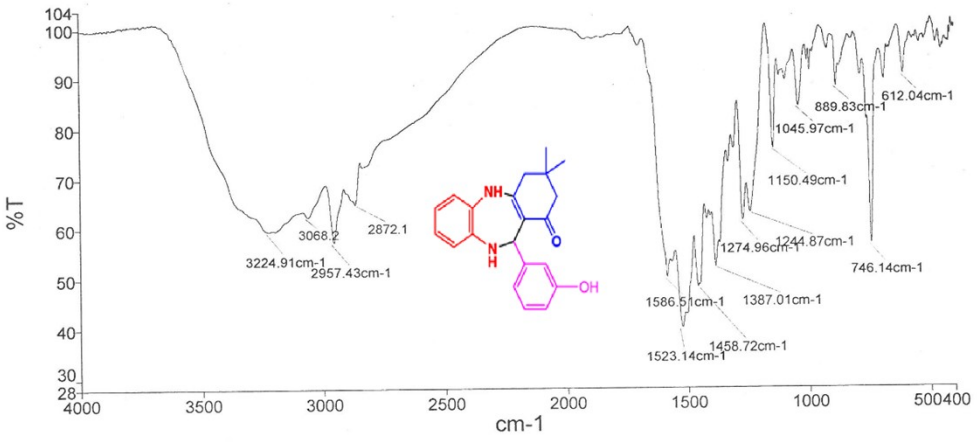
^{13}C NMR spectrum of the compound 11-(2-chlorophenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-one

11-(3-hydroxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-One

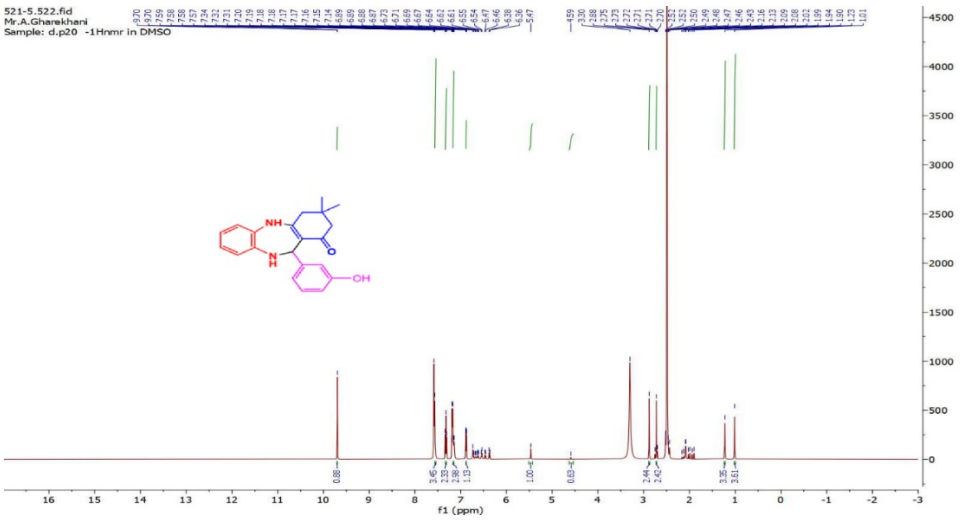
FT-IR (KBr, cm^{-1}): 612, 746, 889, 1045, 1150, 1244, 1274, 1387, 1458, 1523, 1586, 2872, 2957, 3068, 3224.

^{1}H NMR (300 MHz, DMSO) δ 9.76 (s, 1H), 8.20 (s, 1H), 7.62 – 6.57 (m, 8H), 4.66 (s, 1H), 2.50 (s, 2H), 2.01 (s, 2H), 1.03 (s, 3H), 0.98 (d, J = 4.2 Hz, 3H).

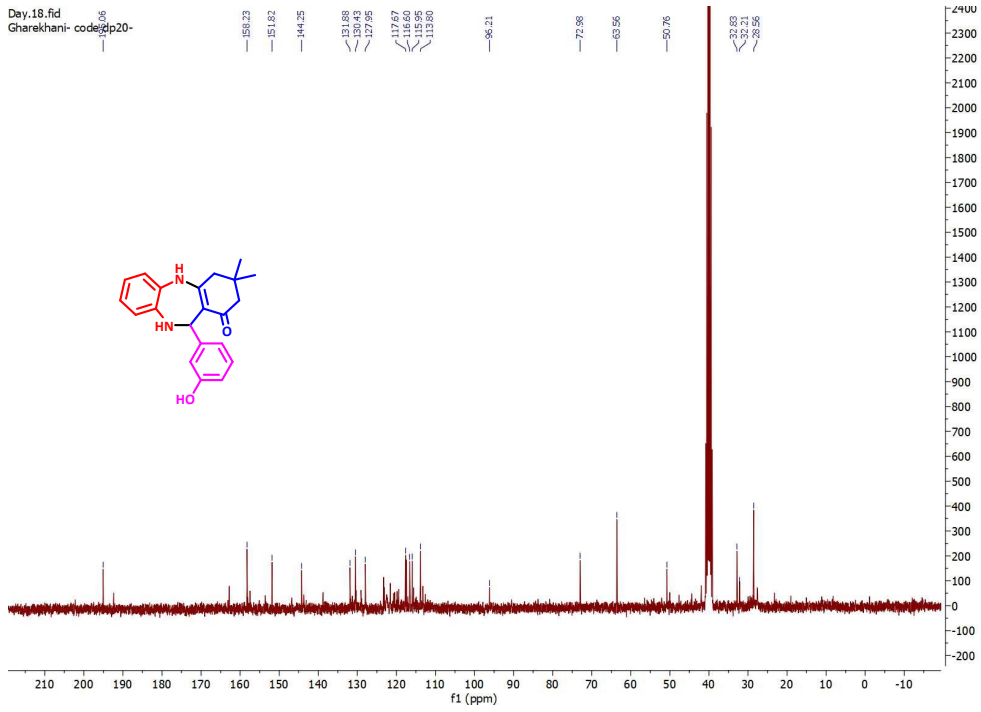
^{13}C NMR (75 MHz, DMSO) δ 195.0, 158.2, 151.8, 144.2, 131.8, 130.4, 127.9, 117.6, 116.6, 115.9, 113.8, 96.2, 72.9, 63.5, 50.7, 32.8, 32.2, 28.5.



FT-IR spectrum of the compound 11-(3-hydroxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-One



[1]H NMR spectrum of the compound 11-(3-hydroxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-One



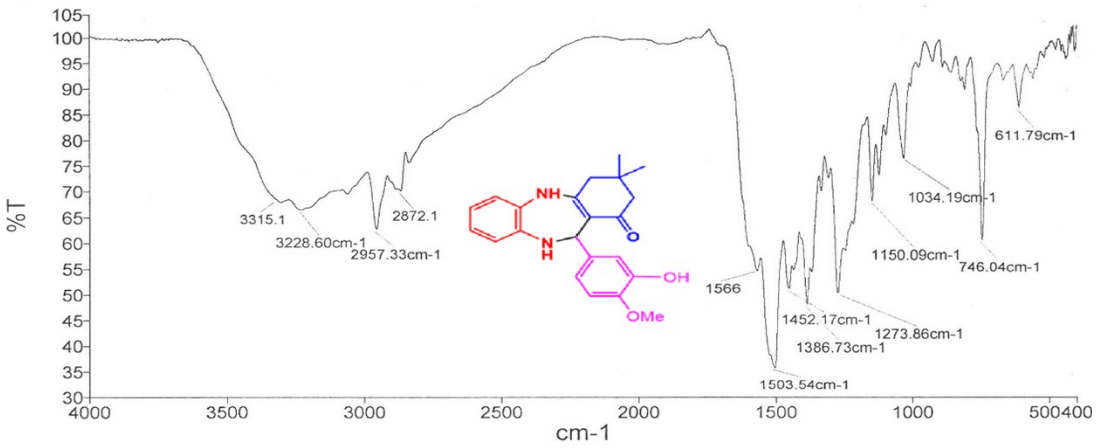
[13]C NMR spectrum of the compound 11-(3-hydroxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H-dibenzo[b,e][1,4]diazepin-1-One

11-(3-hydroxy-4-methoxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H dibenzo[b,e][1,4]diazepin-1-one:

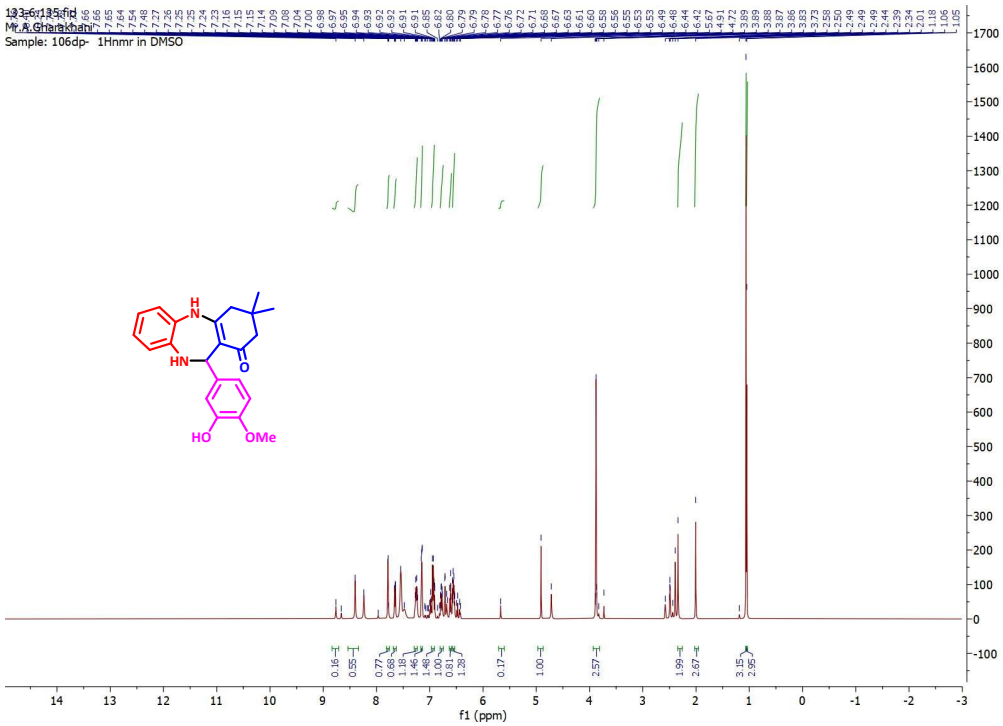
FT-IR (KBr, cm^{-1}): 611, 746, 1034, 1150, 1273, 1386, 1452, 1503, 1566, 2872, 2957, 3228, 3315.

^{1}H NMR (500 MHz, DMSO) δ 8.40 (s, 1H), 7.78- 6.53 (m, 7H), 4.91 (s, 1H), 3.88 (s, 3H), 2.34 (s, 2H), 2.01 (s, 3H), 1.06 (s, 3H), 1.05 (s, 3H).

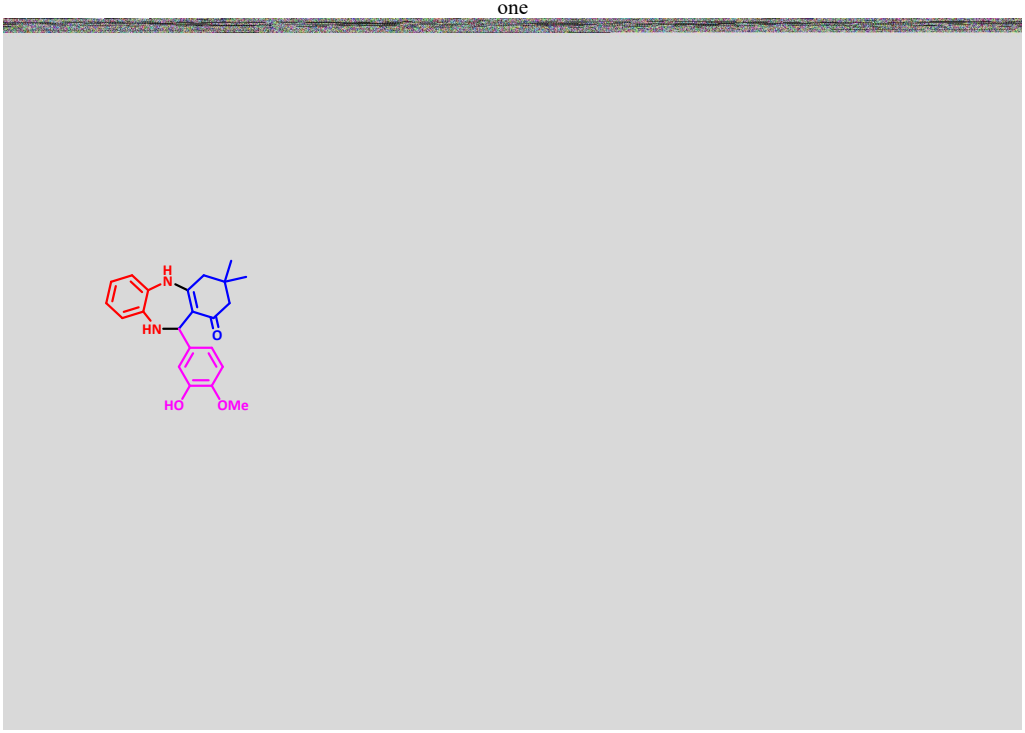
^{13}C NMR (126 MHz, DMSO) δ 194.8, 160.9, 151.8, 148.5, 147.8, 133.4, 122.7, 121.6, 119.7, 115.6, 115.3, 114.9, 110.3, 96.5, 56.0, 50.2, 32.3, 31.4, 28.5, 18.5.



FT-IR spectrum of the compound 11-(3-hydroxy-4-methoxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H dibenzo[b,e][1,4]diazepin-1-one



^{1}H NMR spectrum of the compound 11-(3-hydroxy-4-methoxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H dibenzo[b,e][1,4]diazepin-1-one



^{13}C NMR spectrum of the compound 11-(3-hydroxy-4-methoxyphenyl)-3,3-dimethyl-2,3,4,5,10,11-hexahydro-1H dibenzo[b,e][1,4]diazepin-1-one