

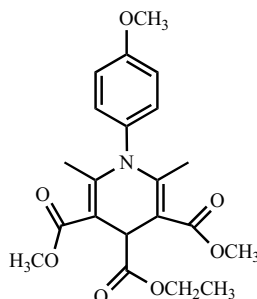
SUPPORTING INFORMATION

General Procedure for the Preparation of Imines

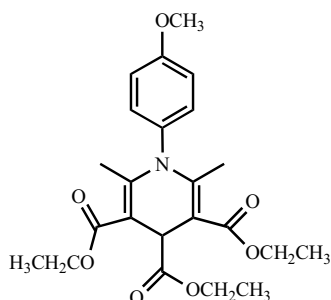
To a solution of p-methoxyaniline (1.23g, 10mmol) in 20ml of toluene was added anhydrous sodium sulfate (7.1g, 50 mmol) under stirring. After the mixture was stirred for several minutes at room temperature, ethyl glyoxalate (1.2g, 12 mmol) was added in dropwise. The mixture was stirred for another one hour until the disappearance of amine monitored by TLC. Removing of sodium sulfate by filtration and toluene under vacuum gave the crude imine in almost quantitative yield which was used for the next step without purification.

General Procedure for the Synthesis of 1,4-dihydropyridines

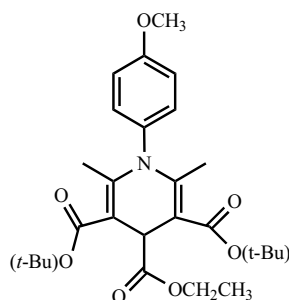
Imine (1.0mmol) and β -ketoester (2.1mmol) were added to a round-bottomed flask containing copper (II) bromide (0.1mmol). The mixture was stirred at room temperature for 18h. After the reaction completed (monitored by TLC), the crude product was purified by flash column chromatography (1:10 ethyl acetate/petroleum ether as eluents) to afford the desired 1,4-dihydropyridine products.

4-ethyl 3,5-dimethyl 1-(4-methoxyphenyl)-2,6-dimethyl-1,4-dihydropyridine-3,4,5-tricarboxylate (2)

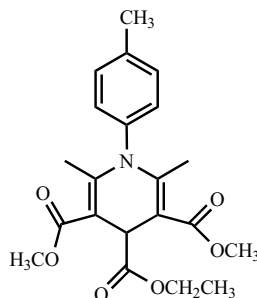
Yellow solid. ^1H NMR (CDCl_3 , 300MHz) δ 1.22-1.27 (t, 3H), 2.06 (s, 6H), 3.75 (s, 6H), 3.83 (s, 3H), 4.12-4.14 (q, 2H), 4.85 (s, 1H), 6.89-6.92 (d, 2H), 7.04-7.07 (d, 2H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.62, 18.57, 40.22, 51.78, 55.82, 61.02, 100.88, 114.65, 131.44, 149.87, 159.56, 168.04, 173.70.

triethyl 1-(4-methoxyphenyl)-2,6-dimethyl-1,4-dihydropyridine-3,4,5-tricarboxylate (1)

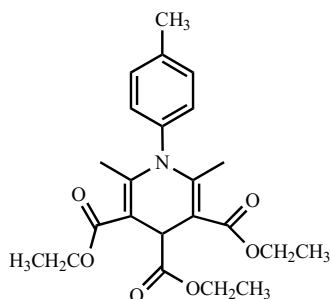
Yellow solid. ^1H NMR (CDCl_3 , 300MHz) δ 1.24-1.32 (m, 9H), 2.05 (s, 6H), 3.83(s, 3H), 4.11-4.23 (m, 6H), 4.85(s, 1H), 6.88-6.91 (d, 2H), 7.05-7.08 (d, 2H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.72, 18.55, 40.44, 55.80, 60.40, 60.89, 101.35, 114.63, 131.49, 149.38, 159.55, 167.63, 173.95.

3,5-di-tert-butyl 4-ethyl 1-(4-methoxyphenyl)-2,6-dimethyl-1,4-dihydropyridine-3,4,5-tricarboxylate (3)

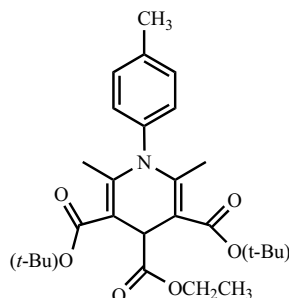
Colorless oil. ^1H NMR (CDCl_3 , 300MHz) δ 1.21-1.29 (t, 3H), 1.45 (s, 18H), 2.01 (s, 6H), 3.83 (s, 3H), 4.11-4.18 (t, 2H), 4.79 (s, 1H), 6.88-6.91 (d, 2H), 7.06-7.08 (d, 2H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.79, 18.41, 28.60, 41.17, 55.78, 60.80, 80.22, 102.58, 114.50, 131.61, 148.44, 159.38, 167.05, 174.26.

4-ethyl 3,5-dimethyl 2,6-dimethyl-1-p-tolyl-1,4-dihydropyridine-3,4,5-tricarboxylate (4)

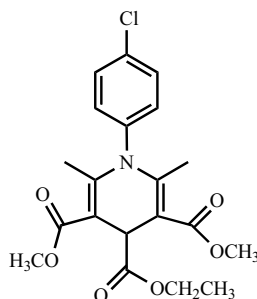
Colorless oil. ^1H NMR (CDCl_3 , 300MHz) δ 1.21-1.26 (t, 3H), 2.06 (s, 6H), 2.40 (s, 3H), 3.74 (s, 6H), 4.12-4.15 (q, 2H), 4.86 (s, 1H), 7.01-7.04 (d, 2H), 7.19-7.25 (d, 2H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.52, 18.47, 21.41, 40.11, 51.63, 60.89, 100.70, 130.12, 137.38, 138.83, 149.47, 167.87, 173.52.

triethyl 2,6-dimethyl-1-p-tolyl-1,4-dihydropyridine-3,4,5-tricarboxylate (5)

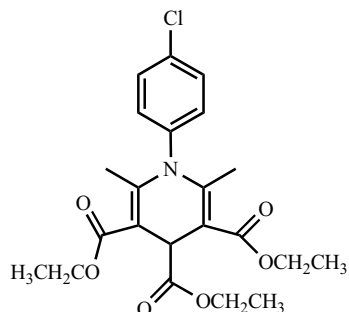
Yellow solid. ^1H NMR (CDCl_3 , 300MHz) δ 1.26-1.33 (m, 9H), 2.05 (s, 6H), 2.39 (s, 3H), 4.12-4.24 (m, 6H), 4.86 (s, 1H), 7.02-7.04 (d, 2H), 7.19-7.26 (d, 2H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.73, 18.60, 21.53, 40.38, 60.40, 101.16, 130.15, 130.23, 137.60, 138.82, 149.16, 167.67, 173.96.

3,5-di-tert-butyl 4-ethyl 2,6-dimethyl-1-p-tolyl-1,4-dihydropyridine-3,4,5-tricarboxylate (6)

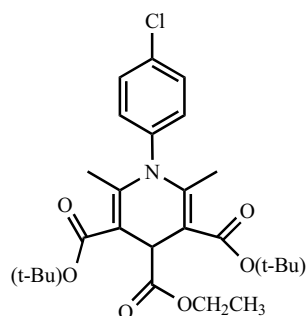
Yellow solid. ^1H NMR (CDCl_3 , 300MHz) δ 1.25-1.28 (t, 3H), 1.51 (s, 18H), 2.01 (s, 6H), 2.38 (s, 3H), 4.13-4.16 (q, 2H), 7.05-7.08 (d, 2H), 7.14-7.21 (d, 2H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.78, 18.44, 21.54, 28.60, 41.18, 60.80, 80.20, 102.48, 130.38, 137.84, 138.63, 148.19, 167.06, 174.25.

4-ethyl 3,5-dimethyl 1-(4-chlorophenyl)-2,6-dimethyl-1,4-dihydropyridine-3,4,5-tricarboxylate (7)

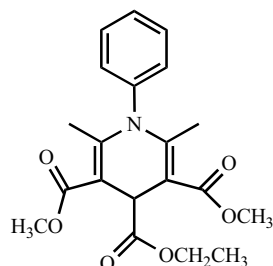
Yellow solid. ^1H NMR (CDCl_3 , 300MHz) δ 1.23-1.27 (t, 3H), 2.06 (s, 6H), 3.75 (s, 6H), 4.13-4.15 (q, 2H), 4.85 (s, 1H), 7.12-7.15 (d, 2H), 7.40-7.42 (d, 2H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.58, 18.51, 40.20, 51.82, 61.10, 101.51, 129.85, 131.91, 134.92, 138.68, 148.88, 167.74, 173.50.

triethyl 1-(4-chlorophenyl)-2,6-dimethyl-1,4-dihydropyridine-3,4,5-tricarboxylate (8)

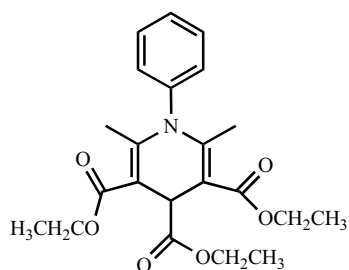
Colorless oil. ^1H NMR (CDCl_3 , 300MHz) δ 1.20-1.30 (m, 9H), 2.01 (s, 6H), 4.00-4.21 (m, 6H), 4.81 (s, 1H), 7.10-7.13 (d, 2H), 7.36-7.37 (d, 2H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.68, 18.51, 40.40, 60.52, 101.94, 129.81, 131.97, 134.85, 138.48, 148.48, 167.40, 173.85.

3,5-di-tert-butyl 4-ethyl 1-(4-chlorophenyl)-2,6-dimethyl-1,4-dihydropyridine-3,4,5-tricarboxylate (9)

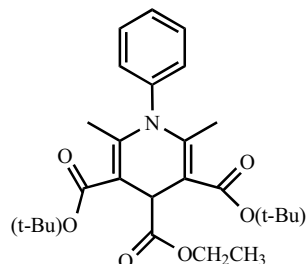
Colorless oil. ^1H NMR (CDCl_3 , 300MHz) δ 1.20-1.22 (t, 3H), 1.41 (s, 18H), 2.31 (s, 6H), 3.95 (s, 1H), 4.54-4.62 (q, 2H), 6.61-6.64 (d, 2H), 7.09-7.13 (d, 2H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.40, 28.22, 30.05, 57.16, 62.11, 83.59, 102.35, 115.24, 129.29, 129.37, 145.65, 152.28, 167.01, 173.79.

4-ethyl 3,5-dimethyl 2,6-dimethyl-1-phenyl-1,4-dihydropyridine-3,4,5-tricarboxylate (10)

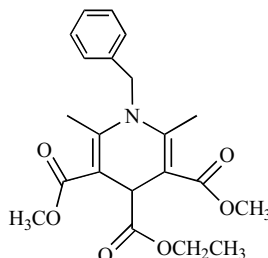
Colorless oil. ^1H NMR (CDCl_3 , 300MHz) δ 1.19-1.23 (t, 3H), 2.02 (s, 6H), 3.71 (s, 6H), 4.09-4.12 (q, 2H), 4.84 (s, 1H), 7.12-7.14 (d, 2H), 7.25-7.37 (d, 2H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.58, 18.56, 40.21, 51.74, 61.00, 100.94, 129.58, 130.52, 140.13, 149.29, 167.93, 173.59.

triethyl 2,6-dimethyl-1-phenyl-1,4-dihydropyridine-3,4,5-tricarboxylate (11)

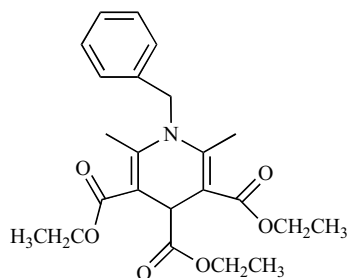
Yellow solid ^1H NMR (CDCl_3 , 300MHz) δ 1.28-1.31 (m, 9H), 2.05 (s, 6H), 4.13-4.24 (m, 6H), 4.87 (s, 1H), 7.17-7.19 (d, 2H), 7.26-7.40 (d, 2H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.73, 18.62, 40.41, 60.46, 101.37, 129.56, 130.62, 140.32, 148.92, 167.63, 173.94.

3,5-di-tert-butyl 4-ethyl 2,6-dimethyl-1-phenyl-1,4-dihydropyridine-3,4,5-tricarboxylate (12)

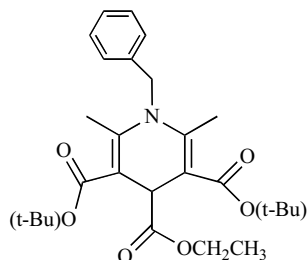
Colorless oil. ^1H NMR (CDCl_3 , 300MHz) δ 1.25-1.27 (t, 3H), 1.49 (s, 18H), 2.00 (s, 6H), 4.13-4.18 (q, 2H), 4.79 (s, 1H), 7.17-7.26 (d, 2H), 7.27-7.37 (d, 2H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.79, 18.46, 28.60, 41.20, 60.84, 80.29, 102.70, 128.72, 130.77, 140.57, 147.96, 167.03, 174.23.

4-ethyl 3,5-dimethyl 1-benzyl-2,6-dimethyl-1,4-dihydropyridine-3,4,5-tricarboxylate (13)

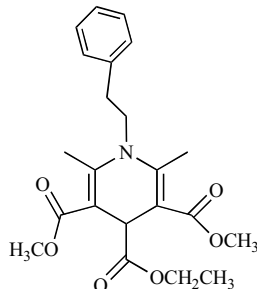
Colorless oil. ^1H NMR (CDCl_3 , 300MHz) δ 1.15-1.20 (t, 3H), 2.40 (s, 6H), 3.74 (s, 6H), 4.01-4.09 (q, 3H), 4.85 (s, 2H), 4.94 (s, 1H), 7.10-7.32 (m, 5H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.53, 16.95, 40.24, 49.73, 51.82, 61.02, 102.10, 125.93, 127.60, 129.06, 137.84, 149.73, 168.08, 173.42.

triethyl 1-benzyl-2,6-dimethyl-1,4-dihydropyridine-3,4,5-tricarboxylate (14)

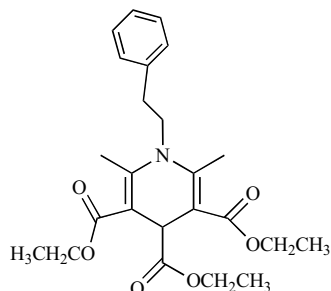
Colorless oil. ^1H NMR (CDCl_3 , 300MHz) δ 1.19-1.31 (m, 9H), 2.40 (s, 6H), 4.13-4.27 (m, 6H), 4.84 (s, 2H), 4.95 (s, 1H), 7.11-7.34 (m, 5H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.73, 16.95, 40.40, 49.70, 60.93, 102.43, 125.96, 127.56, 129.04, 137.97, 149.31, 167.73, 173.62.

3,5-di-tert-butyl 4-ethyl 1-benzyl-2,6-dimethyl-1,4-dihydropyridine-3,4,5-tricarboxylate (15)

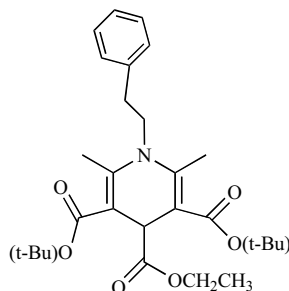
Colorless oil. ^1H NMR (CDCl_3 , 300MHz) δ 1.26-1.30 (t, 3H), 1.50 (s, 18H), 2.47 (s, 6H), 4.06-4.43 (m, 4H), 4.81 (s, 1H), 7.23-7.30 (m, 5H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.71, 16.77, 28.58, 41.23, 49.57, 60.76, 80.17, 103.73, 126.01, 127.46, 128.98, 138.29, 148.34, 167.13, 173.86.

4-ethyl 3,5-dimethyl 2,6-dimethyl-1-phenethyl-1,4-dihydropyridine-3,4,5-tricarboxylate (16)

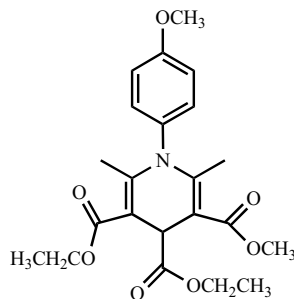
Colorless oil. ^1H NMR (CDCl_3 , 300MHz) δ 1.18-1.23 (t, 3H), 2.40 (s, 6H), 2.50-2.73 (m, 2H), 3.76 (s, 6H), 3.80-3.83 (t, 2H), 4.06-4.08 (q, 2H), 4.89 (s, 1H), 7.16-7.30 (m, 5H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.56, 16.76, 38.23, 40.18, 47.28, 51.85, 61.01, 103.15, 127.03, 128.70, 129.12, 149.22, 167.90, 175.46.

triethyl 2,6-dimethyl-1-phenethyl-1,4-dihydropyridine-3,4,5-tricarboxylate (17)

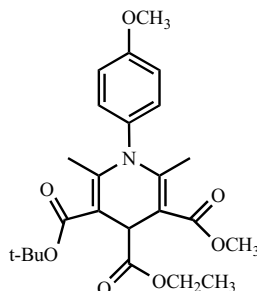
Colorless oil. ^1H NMR (CDCl_3 , 300MHz) δ 1.42-1.62 (m, 9H), 2.37 (s, 6H), 2.72-2.92 (m, 2H), 3.42-3.81 (t, 2H), 4.18-4.31 (m, 6H), 7.22 (m, 5H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.76, 21.31, 28.60, 37.43, 52.44, 54.32, 104.98, 128.92, 138.84, 140.29, 150.37, 168.09, 176.01.

3,5-di-tert-butyl 4-ethyl 2,6-dimethyl-1-phenethyl-1,4-dihydropyridine-3,4,5-tricarboxylate (18)

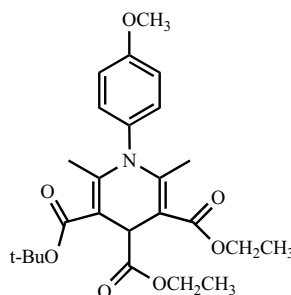
Colorless oil. ^1H NMR (CDCl_3 , 300MHz) δ 1.30-1.52 (m, 21H), 2.39 (s, 6H), 2.70-2.88 (m, 2H), 3.79-3.85 (t, 2H), 4.20-4.25 (q, 2H), 4.91 (s, 1H), 7.16-7.29 (m, 5H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.73, 16.82, 28.59, 40.33, 47.26, 55.20, 60.50, 80.94, 103.55, 123.94, 126.98, 138.28, 148.79, 167.57, 175.82.

3,4-diethyl 5-methyl 1-(4-methoxyphenyl)-2,6-dimethyl-1,4-dihydropyridine-3,4,5-tricarboxylate (19)

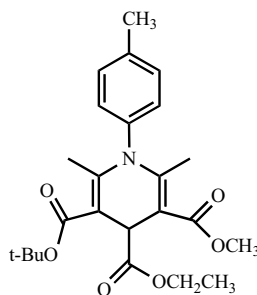
Colorless oil. ^1H NMR (CDCl_3 , 300MHz) δ 1.25-1.31 (m, 6H), 2.06 (s, 6H), 3.75 (s, 3H), 3.84 (s, 3H), 4.12-4.23 (m, 4H), 4.85 (s, 1H), 6.89-6.92 (d, 2H), 7.05-7.05 (d, 2H). ^{13}C NMR (CDCl_3 , 75MHz) δ 14.75, 18.58, 40.28, 51.73, 55.74, 60.95, 100.78, 101.31, 131.42, 132.77, 149.85, 159.51, 168.05, 173.80.

3-tert-butyl 4-ethyl 5-methyl 1-(4-methoxyphenyl)-2,6-dimethyl-1,4-dihydropyridine-3,4,5-tricarboxylate

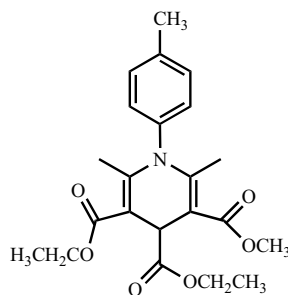
Colorless oil. ^1H NMR (CDCl_3 , 400MHz) δ 1.16-1.19 (t, 3H), 1.43 (s, 9H), 1.93 (s, 3H), 1.97 (s, 3H), 3.66 (s, 3H), 3.75 (s, 3H), 4.05-4.08 (q, 2H), 4.72 (s, 1H), 6.82-6.84 (d, 2H), 6.99-7.01 (d, 2H). ^{13}C NMR (CDCl_3 , 100MHz) δ 13.28, 17.04, 17.19, 27.25, 39.42, 50.29, 54.45, 59.54, 79.22, 99.37, 102.05, 113.40, 130.36, 131.86, 146.64, 148.86, 158.42, 165.91, 167.03, 172.86.

3-tert-butyl 4,5-diethyl 1-(4-methoxyphenyl)-2,6-dimethyl-1,4-dihydropyridine-3,4,5-tricarboxylate

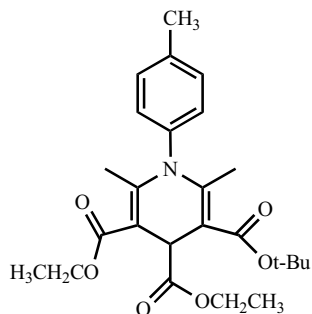
Colorless oil. ^1H NMR (CDCl_3 , 400MHz) δ 1.16-1.23 (m, 6H), 1.43 (s, 9H), 1.93 (s, 3H), 1.97 (s, 3H), 3.75 (s, 3H), 4.05-4.13 (m, 4H), 4.75 (s, 1H), 6.82-6.84 (d, 2H), 7.00-7.02 (d, 2H). ^{13}C NMR (CDCl_3 , 100MHz) δ 13.29, 17.03, 17.12, 27.24, 39.48, 54.45, 58.97, 59.51, 79.13, 99.75, 101.91, 113.39, 130.39, 131.91, 146.81, 148.52, 158.40, 165.92, 166.56, 172.99.

3-tert-butyl 4-ethyl 5-methyl 2,6-dimethyl-1-p-tolyl-1,4-dihydropyridine-3,4,5-tricarboxylate

Colorless oil. ^1H NMR (CDCl_3 , 400MHz) δ 1.16-1.19 (t, 3H), 1.43 (s, 9H), 1.92 (s, 3H), 1.97 (s, 3H), 2.30 (s, 3H), 3.65 (s, 3H), 4.05-4.08 (q, 2H), 4.73 (s, 1H), 6.95-6.97 (d, 2H), 7.12-7.23 (d, 2H). ^{13}C NMR (CDCl_3 , 100MHz) δ 13.28, 17.07, 17.22, 27.25, 39.43, 50.27, 79.20, 101.98, 128.94, 129.14, 136.62, 137.59, 146.38, 148.58, 172.83.

3,4-diethyl 5-methyl 2,6-dimethyl-1-p-tolyl-1,4-dihydropyridine-3,4,5-tricarboxylate

Colorless oil. ^1H NMR (CDCl_3 , 400MHz) δ 1.15-1.24 (m, 6H), 1.97-1.98 (d, 6H), 2.31 (s, 3H), 3.67 (s, 3H), 4.04-4.17 (m, 4H), 4.79 (s, 1H), 6.96-6.98 (d, 2H), 7.13-7.15 (d, 2H). ^{13}C NMR (CDCl_3 , 100MHz) δ 13.22, 13.35, 17.16, 17.20, 20.11, 39.03, 50.36, 59.11, 59.62, 99.63, 100.14, 128.99, 129.07, 136.48, 137.71, 147.94, 148.42, 166.49, 166.98, 172.71.

3-tert-butyl 4,5-diethyl 2,6-dimethyl-1-p-tolyl-1,4-dihydropyridine-3,4,5-tricarboxylate

Colorless oil. ^1H NMR (CDCl_3 , 400MHz) δ 1.17-1.23 (m, 6H), 1.43 (s, 9H), 1.93 (s, 3H), 1.97 (s, 3H), 2.31 (s, 3H), 4.04-4.14 (m, 4H), 4.76 (s, 1H), 6.96-6.98 (d, 2H), 7.12-7.14 (d, 2H). ^{13}C NMR (CDCl_3 , 100MHz) δ 13.29, 17.06, 17.16, 20.11, 27.24, 39.49, 58.96, 59.50, 79.13, 99.66, 101.83, 128.91, 129.17, 136.66, 137.56, 146.56, 148.25, 165.94, 166.59, 172.99.

