Supporting Information

Solvent and Catalyst free synthesis of 3, 4-dihydropyrimidin-2(1H)-ones/thiones by Twin Screw Extrusion

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Table of Contents **Page No**

1. General Procedure for synthesis of 3, 4-dihydropyrimidin-2(1H)-ones/thiones by Solvent free Twin Screw Extrusion

A mixture of aldehyde (0.3 moles), ethyl acetoacetate (0.3 moles) and 1.2 moles of urea or thiourea, was taken in a glass mortar and gently mixed to cause the liquid reagents to adsorb onto the solid urea or thiourea. The mixture was then manually fed into the hopper of the extruder. The extrusion was carried out at various screw speeds in the co-rotatory mode and at different temperatures, to optimize the reaction. Care was taken to avoid overfilling of the barrel. The extrudate was then added to ice cold water with stirring and the precipitated product was filtered using a vacuum pump. The precipitate was then washed with cold water, dried under vacuum and recrystallized from ethanol to afford the pure products

2. ^{1}H NMR and FTIR Spectral data of synthesized compounds for Table 2

The compounds synthesized were analysed by ^{1}H NMR and FTIR spectroscopy. When required, deuterium exchange was done in NMR spectroscopy. Melting point was also carried out as a preliminary test before NMR spectroscopy. All the analytical data of compounds presented in Table 2 matched that found in the literature and is given below.

Ethyl 6-methyl-2-oxo-4-phenyl-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4a)

Melting point: 204-205 °C (Lit: 205-206°C)

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.55 (bs, 1H), 7.32-7.28 (m, 5H), 5.54 (bs, 1H), 5.41 (s, 1H), 4.07 (q, J=7.2 Hz, 2H), 2.35 (s, 3H), 1.16(t, J=7.2 Hz, 3H)

FTIR: 3241.7, 3113.2, 2980.8, 2930.2, 1726.8, 1703.4, 1648.9, 1468.8, 1286.7, 1220.5, 1092, 780.4 cm^{-1}

Ethyl 4-(4-chlorophenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4b)

Melting point: 213-215°C (Lit: 215-216°C)

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (bs, 1H), 7.30-7.24 (m, 4H), 5.58 (bs, 1H), 5.39 (s, 1H), 4.08 (q, J=7.0 Hz, 2H), 2.35 (s, 3H), 1.18 (t, 3H).

FTIR: 3241.7, 3121, 2980.8, 2957.4, 2934, 1726.8, 1707.3, 1648.9, 1590.5, 1459, 1403.5, 1290.6, 1224.4, 1092, 784.3 cm^{-1}

E*thyl 4-(4-methylphenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4c)*

Melting point: 216-217°C (Lit: 215-217°C)

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (d, J=8 Hz, 2H), 7.11 (d, J=8 Hz, 2H), 6.91 (bs, 1H), 5.37 (bs, 1H), 5.34 (s, 1H), 4.08 (q, J= 7 Hz, 2H), 2.34 (s, 3H), 2.32 (s, 3H), 1.18 (t, J=7.2 Hz, 3H).

D_2O Exchange ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (d, J= 7.6 Hz, 2H), 7.11 (d, J=8 Hz, 2H), 5.36 (s, 1H), 4.07 (q, J= 7.0 Hz, 2H), 2.34 (s, 3H), 2.32 (s, 3H), 1.17 (t, J= 7.0 Hz, 3H).

FTIR: 3245.6, 3117, 2980.8, 2957.4, 2934, 1722.9, 1707.3, 1648.9, 1594.3, 1462, 1399.6, 1286.7, 1224.4, 1092, 784.3 cm^{-}

Ethyl 4-(4-methoxyphenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4d)

Melting point: 205.5-207.5°C (Lit: 203-205°C)

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28-7.25 (m, 2H), 7.23 (s, 1H), 6.84 (d, J=6.8 Hz, 2H), 5.42 (bs, 1H), 5.36 (s, 1H), 4.08 (q, J=6.8 Hz, 2H), 3.79 (s, 3H), 2.34 (s, 3H), 1.17 (t, J= 7.0 Hz, 3H).

D_2O Exchange ^1H NMR (400 MHz, $CDCl_3$) δ 7.21 (d, J=6.8 Hz, 3H), 6.81 (d, J= 6.8 Hz, 2H), 5.33 (s, 1H), 4.05 (q, J= 6.8 Hz, 2H), 3.77 (s, 3H), 2.33 (s, 3H), 1.16 (t, J= 6.8 Hz 3H).
FTIR: 3245.6, 3113.2, 2984.7, 2953.5, 2930.2, 2836.7, 1722.9, 1707.3, 1652.8, 1512.6, 1458, 1278.9, 1224.4, 1088, 1029.6, 842.71, 792.09 cm^{-1}

Ethyl 6-methyl-4-phenyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4e)

Melting point: 204-208°C (Lit: 208-210°C)
^1H NMR (400 MHz, $CDCl_3$) δ 7.78 (bs, 1H), 7.33-7.27 (m, 5H), 7.19 (bs, 1H), 5.40 (s, 1H), 4.09 (q, J=6 Hz, 2H), 2.36 (s, 3H), 1.17 (t, J= 7.0 Hz, 3H).
FTIR: 3327.4, 3175.5, 3109.3, 2980.8, 2938, 2895.1, 1672.2, 1571, 1465.8, 1193.2, 1177.6, 694.7 cm^{-1}

Ethyl 4-(4-chlorophenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4f)

Melting point: 181-183°C (Lit: 179-180°C)
^1H NMR (400 MHz, $CDCl_3$) δ 7.94 (bs, 1H), 7.42 (bs, 1H), 7.21 (d, J=8.4 Hz, 2H), 7.23 (d, J=8.4 Hz, 2H), 5.38 (s, 1H), 4.10 (q, J= 7.0 Hz, 2H), 2.36 (s, 3H), 1.19 (t, J= 7.0 Hz, 3H).
FTIR: 3331.3, 3179.4, 3105.4, 2984.7, 2934, 2899, 1894.2, 1672.2, 1571, 1485.3, 1465.8, 1197.1, 1177.6, 1123.1, 803.77, 749.25, 760.9 cm^{-1}

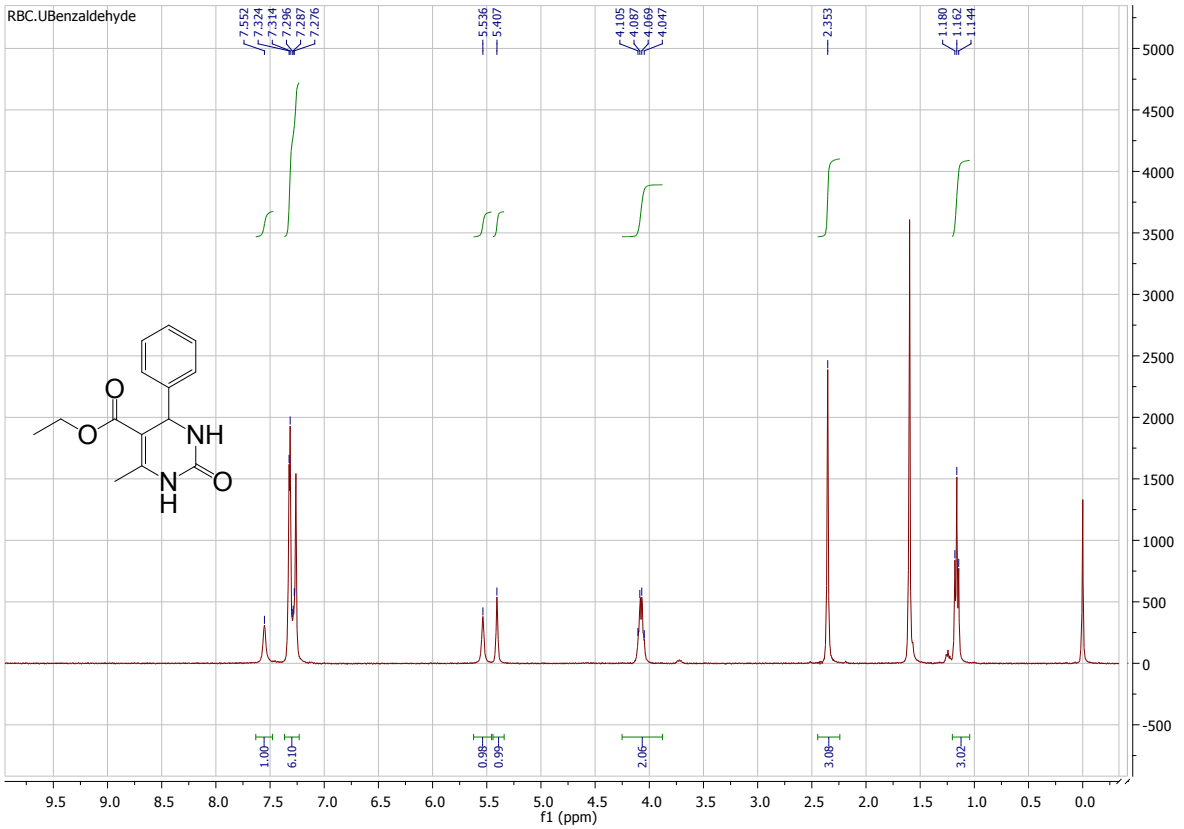
Ethyl 4-(4-methylphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4g)

Melting point: 185-187°C (Lit: 186-188°C)
^1H NMR (400 MHz, $CDCl_3$) δ 7.67 (bs, 1H), 7.18 (d, J=7.6 Hz, 2H), 7.13 (d, J=7.6 Hz, 2H), 7.08 (bs, 1H), 5.36 (s, 1H), 4.09 (q, J= 7.4 Hz, 2H), 2.35 (s, 3H), 2.32 (s, 3H), 1.18 (t, J= 7.0 Hz, 3H).
D_2O Exchange ^1H NMR (400 MHz, $CDCl_3$) δ 7.17 (d, J=8 Hz, 2H), 7.13 (d, J= 7.6 Hz, 2H), 5.35 (s, 1H), 4.09 (q, J= Hz, 2H), 2.35 (s, 3H), 2.32 (s, 3H), 1.18 (t, J=7.2 Hz, 3H).
FTIR: 3327.4, 3175.5, 3105.4, 3027, 2964.7, 2934, 2902.9, 1902, 1672.2, 1574.9, 1508.7, 1465.8, 1193.2, 1119.2, 1029.6, 760.93 cm^{-1}

Ethyl 4-(4-methoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4h)

Melting point: 155-157°C (Lit: 151-153°C)
^1H NMR (400 MHz, $CDCl_3$) δ 7.73 (bs, 1H), 7.21 (d, J= 8.4 Hz, 2H), 7.13 (bs, 1H), 6.85 (d, J= 8.4 Hz, 2H), 5.35 (s, 1H), 4.10 (q, J= 7.0 Hz, 2H), 3.79 (s, 3H), 2.36 (s, 3H), 1.18 (t, J= 7.0 Hz, 3H).
FTIR: 3315.7, 3175.5, 3109.3, 2984.7, 2934, 2902.9, 2836.7, 1668.3, 1610, 1578.8, 1512.6, 1462, 1197.1, 1173.7, 1123.1, 1029.3, 768.72 cm^{-1}

3.0 Copies of FTIR and 1H NMR spectra of synthesized compounds



Ethyl 6-methyl-2-oxo-4-phenyl-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4a)

Fig 1: NMR Spectrum of Ethyl 6-methyl-2-oxo-4-phenyl-1,2,3,4-tetrahydropyrimidine-5-carboxylate

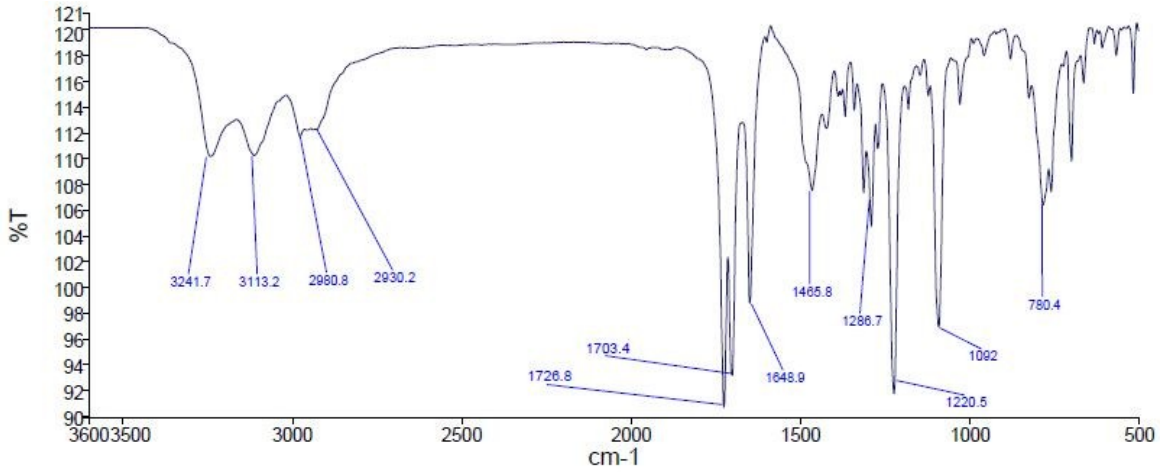


Fig 2: FTIR Spectrum of Ethyl 6-methyl-2-oxo-4-phenyl-1,2,3,4-tetrahydropyrimidine-5-carboxylate

Ethyl 4-(4-chlorophenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4b)

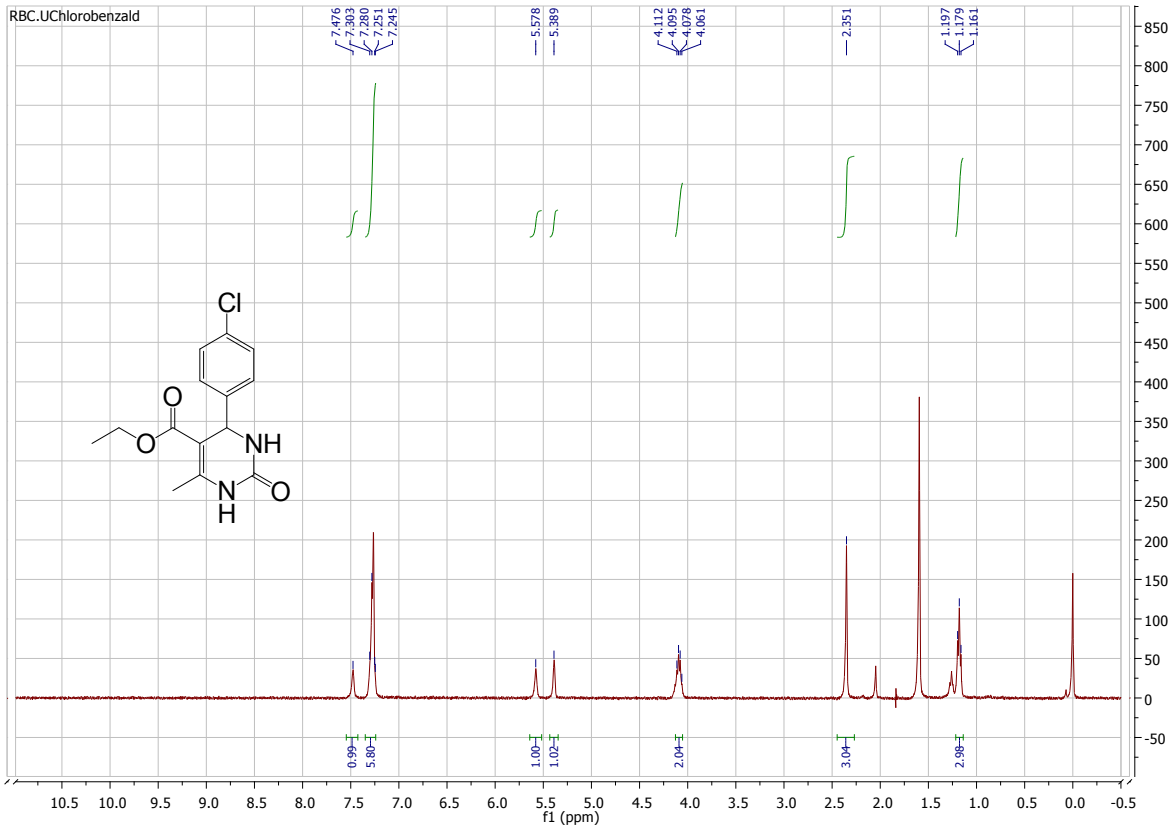


Fig 3: NMR Spectrum of Ethyl 4-(4-chlorophenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

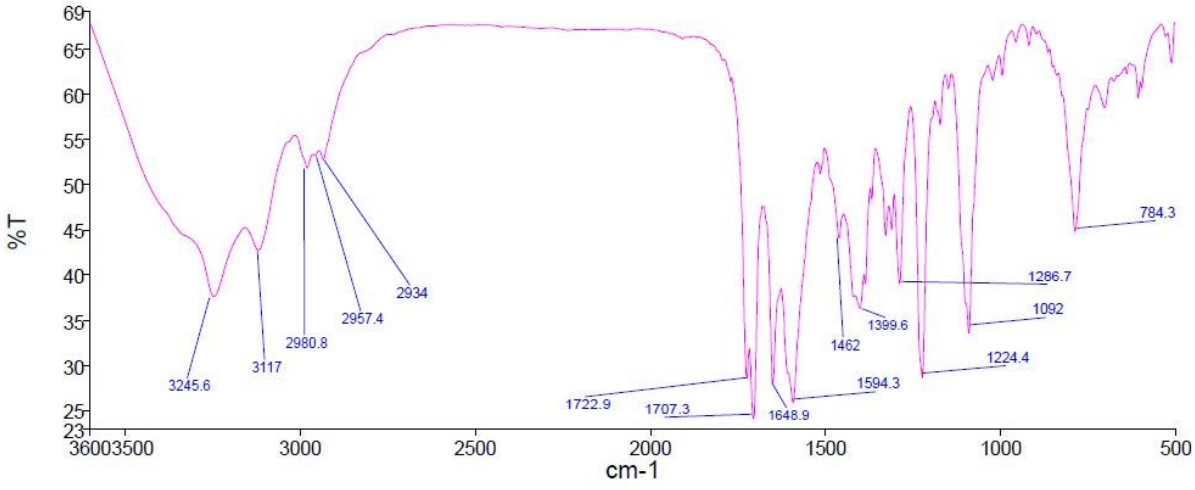


Fig 4: FTIR Spectrum of Ethyl 4-(4-chlorophenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

Ethyl 4-(4-methylphenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4c)

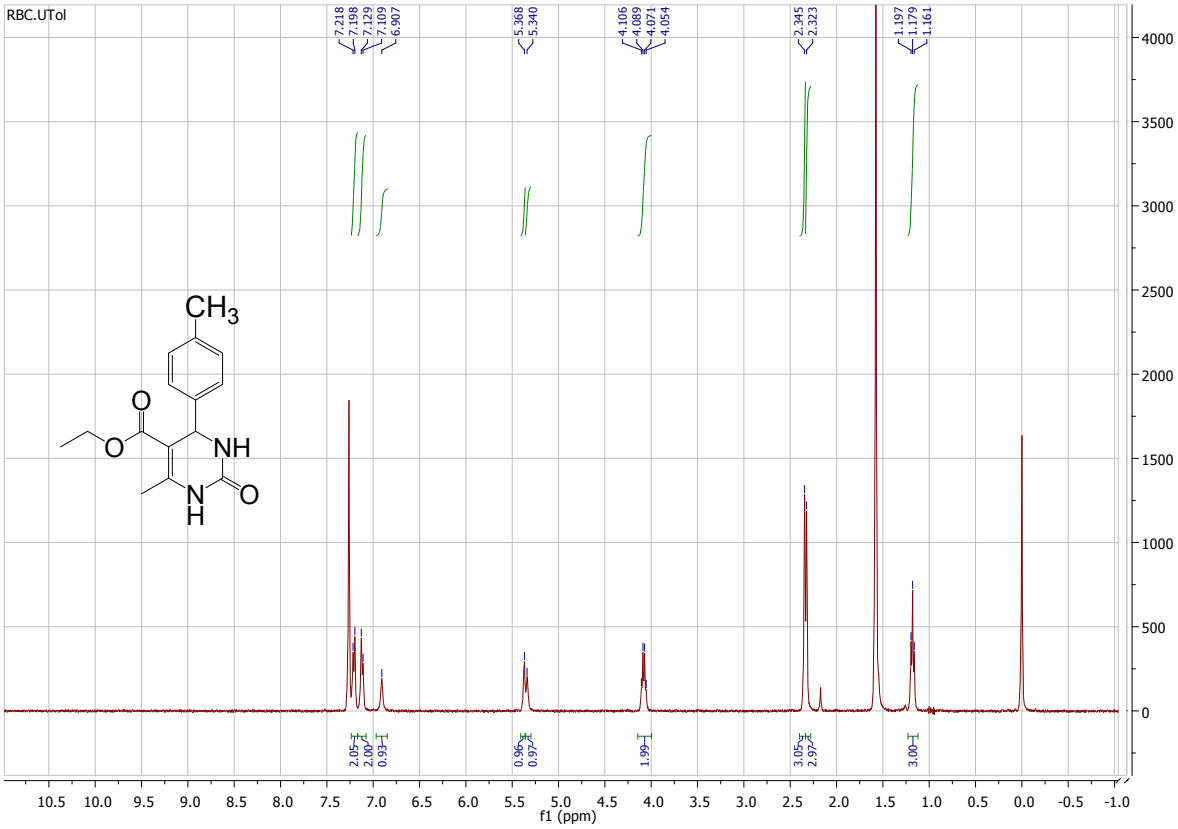
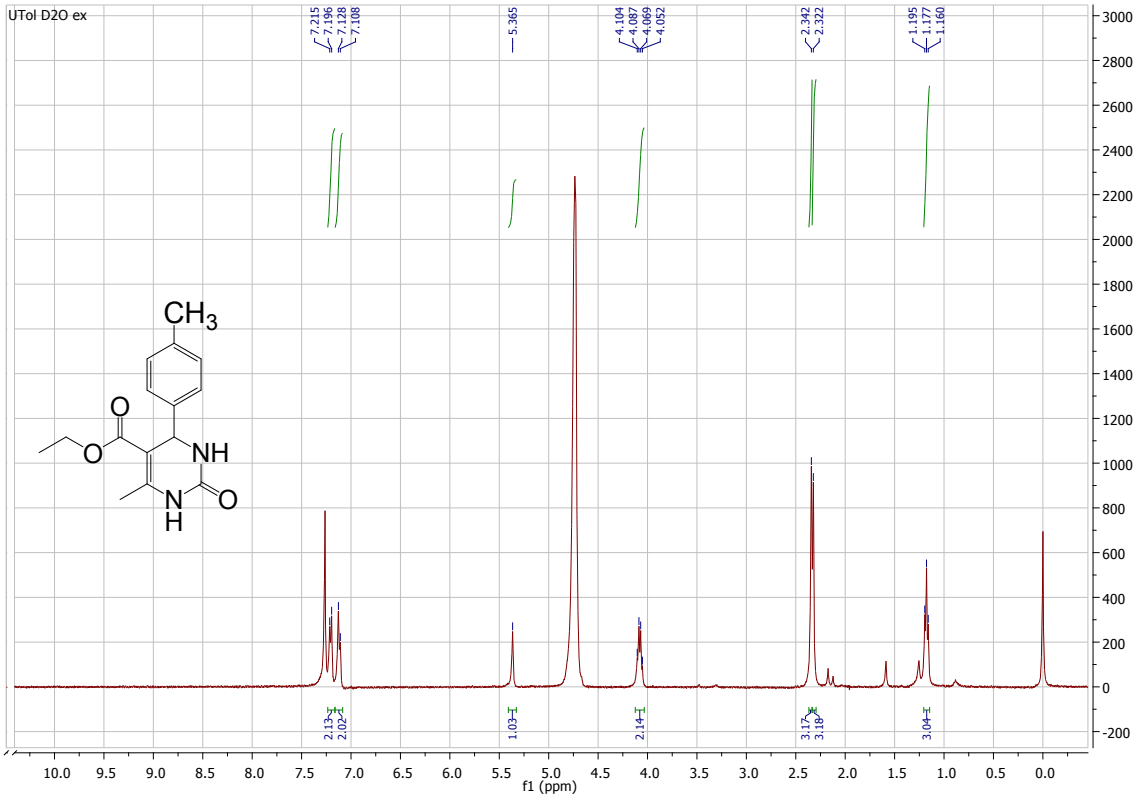


Fig 5: NMR Spectrum of Ethyl 4-(4-methylphenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

Ethyl 4-(4-methylphenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4c)



(D$_2$O exchange)

Fig 6: D$_2$O exchange NMR Spectrum of Ethyl 4-(4-methylphenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

Fig 7: FTIR Spectrum of Ethyl 4-(4-methylphenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

Ethyl 4-(4-methoxyphenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4d)

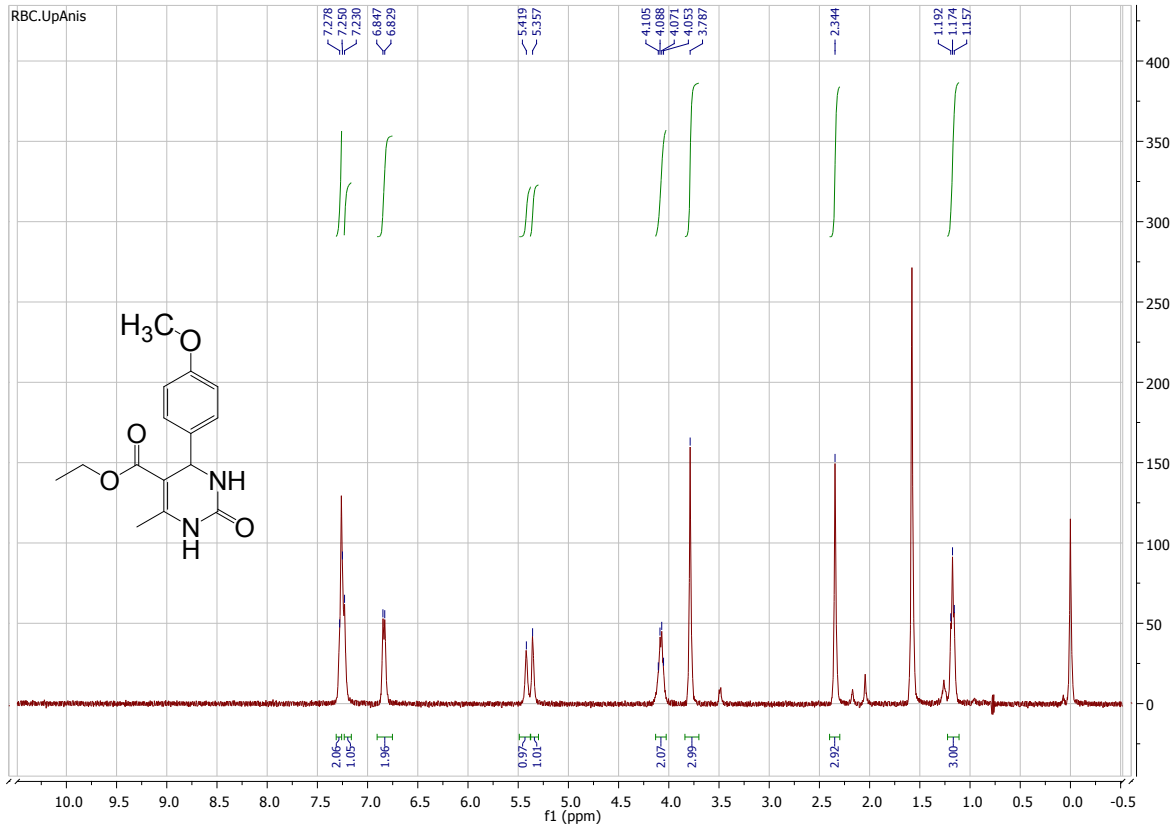
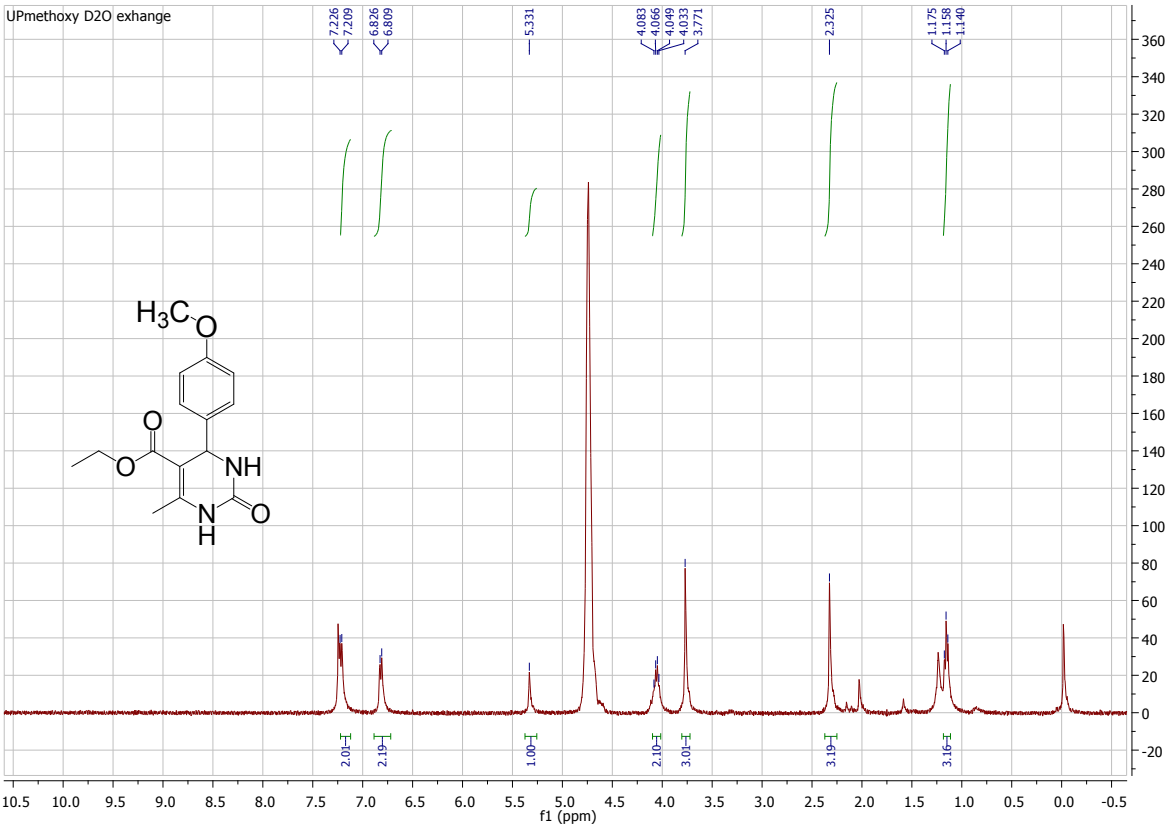


Fig 8: NMR Spectrum of Ethyl 4-(4-methoxyphenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

Ethyl 4-(4-methoxyphenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4d)



(D_2O exchange)

Fig 9: D_2O exchange NMR Spectrum of Ethyl 4-(4-methoxyphenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

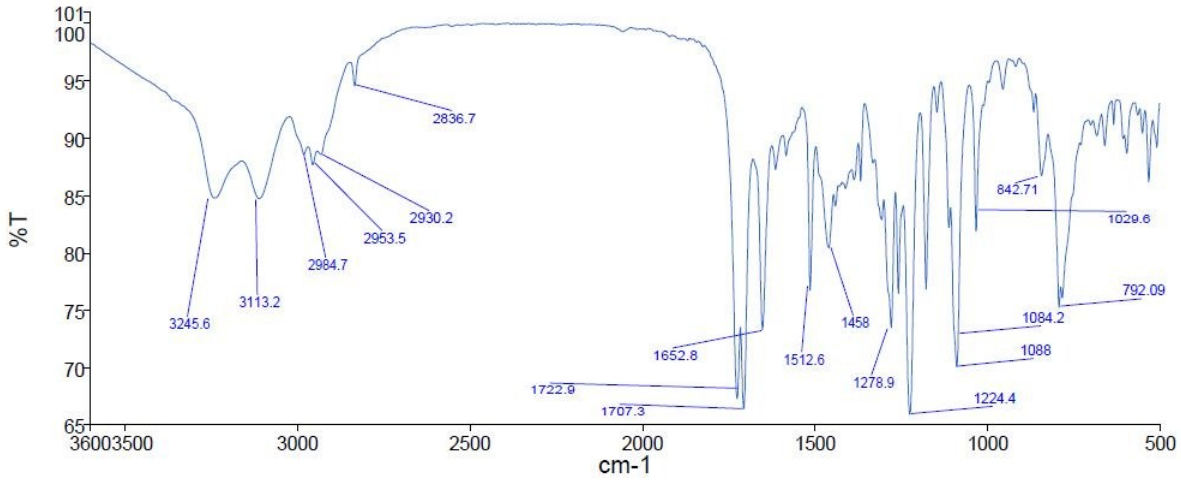


Fig 10: FTIR Spectrum of Ethyl 4-(4-methoxyphenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

Ethyl 6-methyl-4-phenyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4e)

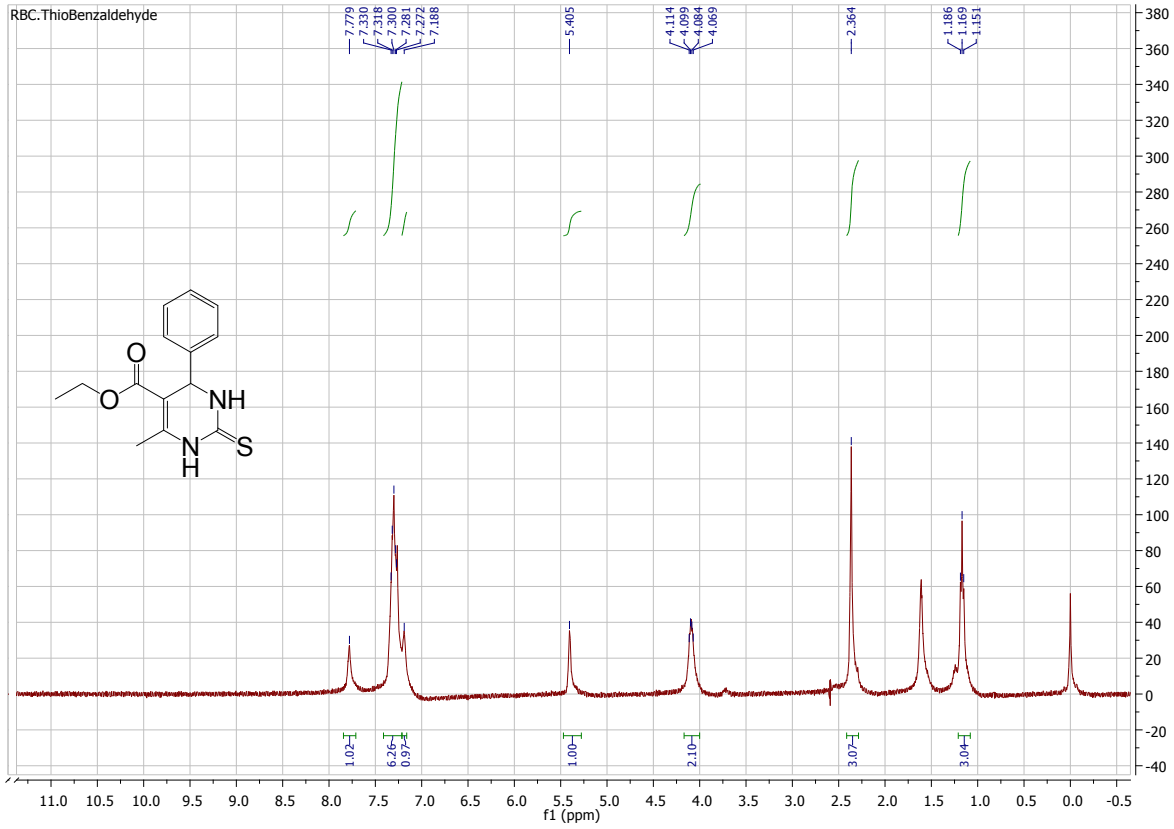


Fig 11: NMR Spectrum of Ethyl 6-methyl-4-phenyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

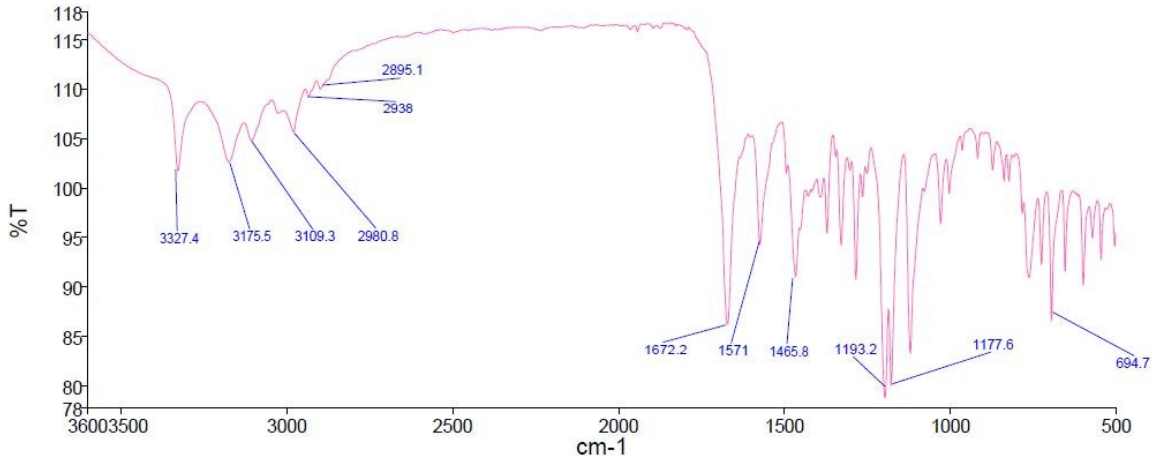


Fig 12: FTIR Spectrum of Ethyl 6-methyl-4-phenyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

Ethyl 4-(4-chlorophenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4f)

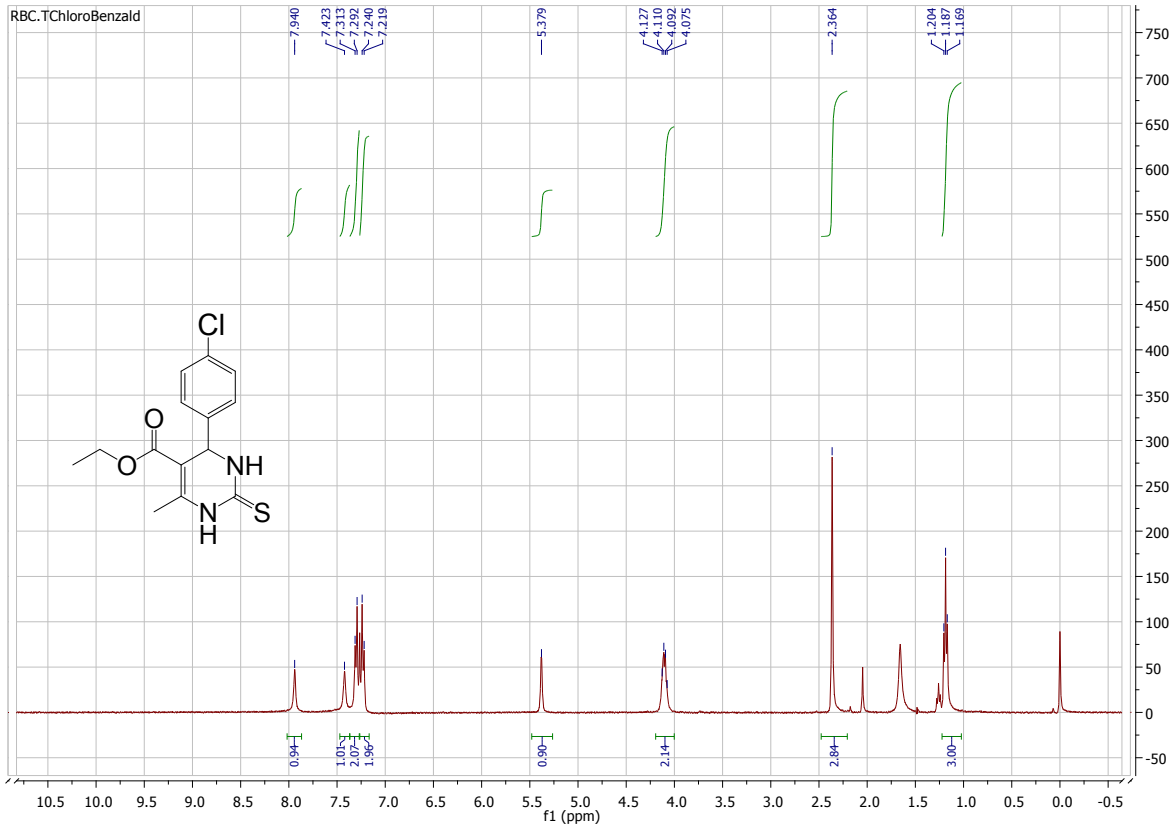


Fig 13: NMR Spectrum of Ethyl 4-(4-chlorophenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

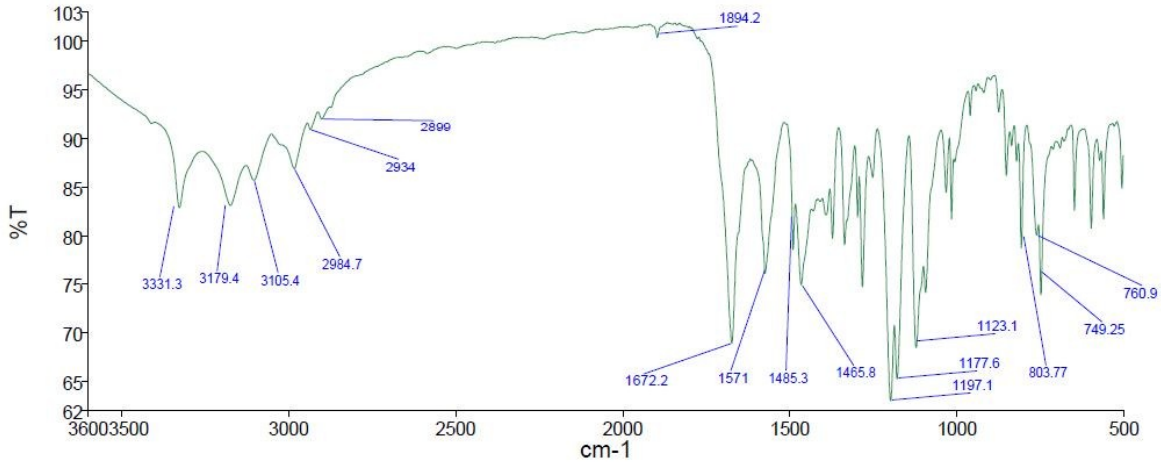


Fig 14: FTIR Spectrum of Ethyl 4-(4-chlorophenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

Ethyl 4-(4-methylphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4g)

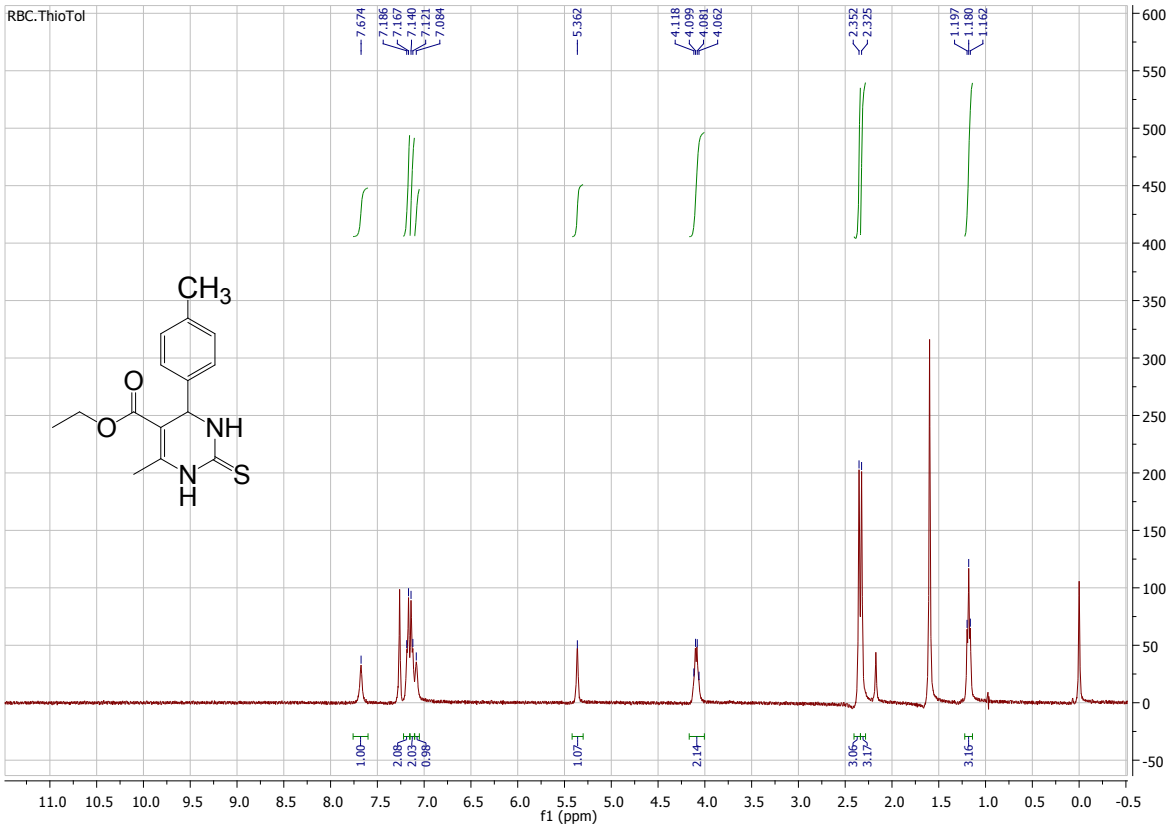


Fig 15: NMR Spectrum of Ethyl 4-(4-methylphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

Ethyl 4-(4-methylphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4g) (D_2O exchange)

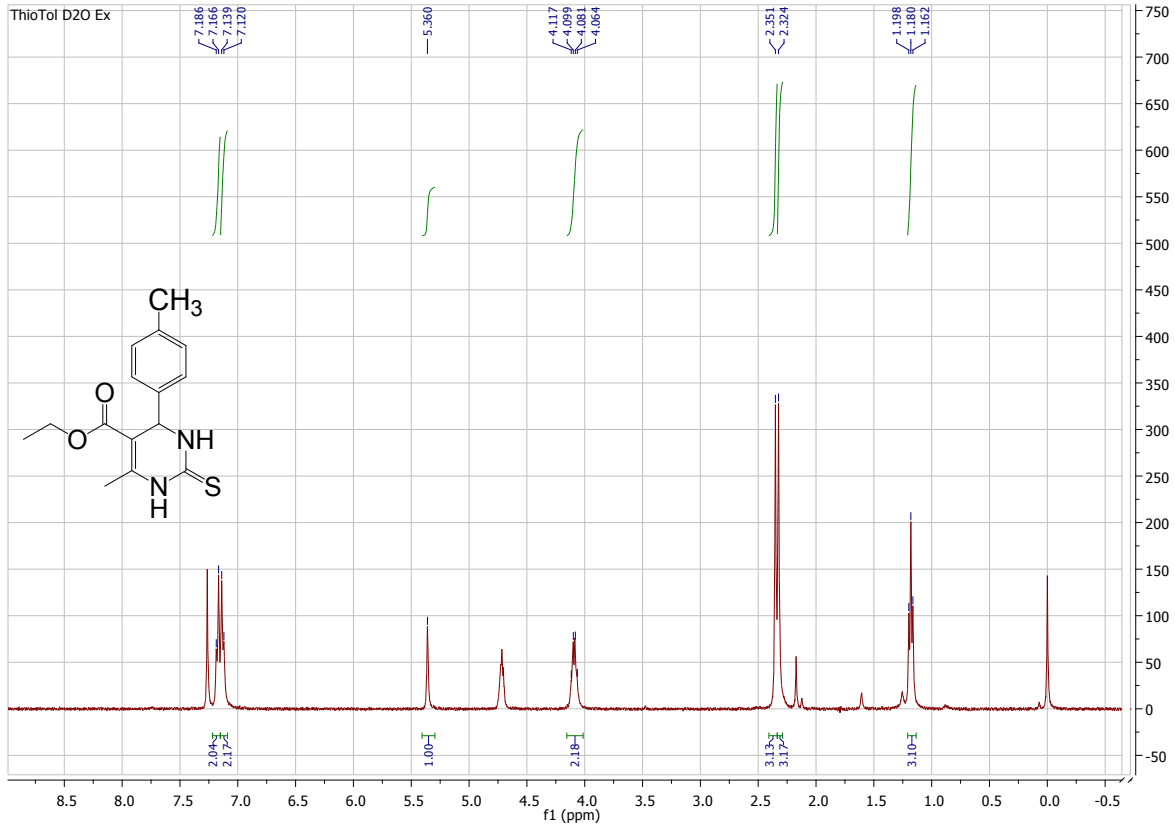


Fig 16: D_2O exchange NMR Spectrum of Ethyl 4-(4-methylphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

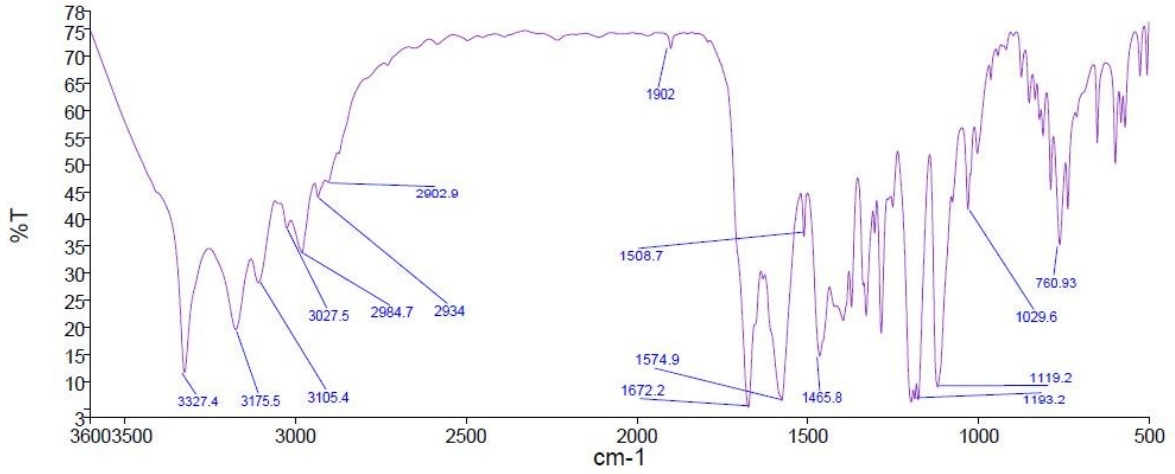


Fig 17: FTIR Spectrum of Ethyl 4-(4-methylphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

Ethyl 4-(4-methoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (4h)

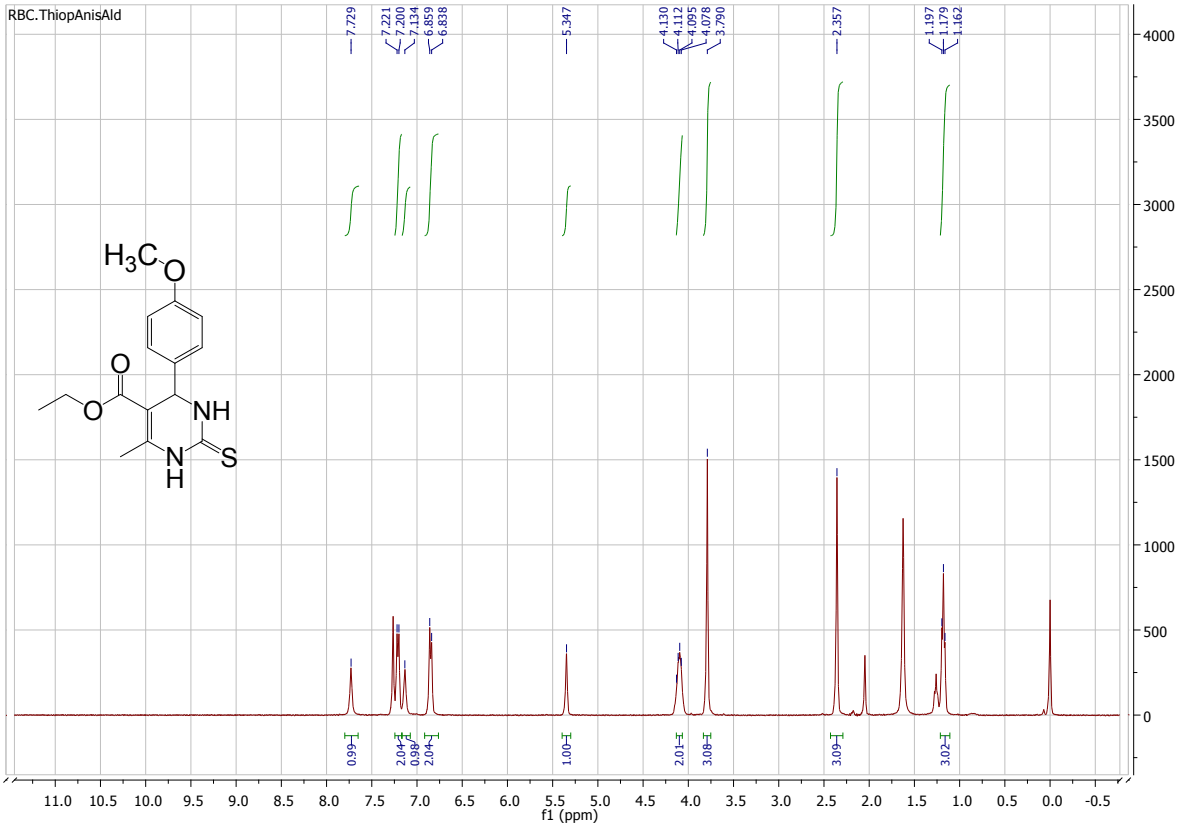


Fig 18: NMR Spectrum of Ethyl 4-(4-methoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

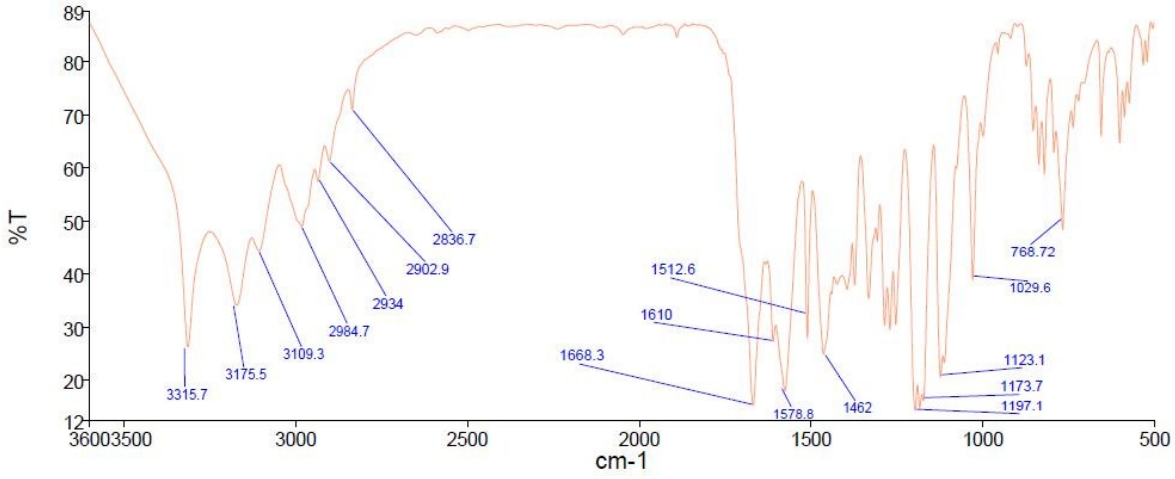


Fig 19: FTIR Spectrum of Ethyl 4-(4-methoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate

4.0 References

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