SYNTHESIS OF BENZO[C][2,7]NAPHTHYRIDINES BY ONE-POT MULTICOMPONENT REACTION USING CERIC (IV) AMMONIUM NITRATE (CAN)

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GENERAL INFORMATION

Analytical thin layer chromatography (TLC) was carried out using silica gel 60 F254 pre-coated plates. Visualization was accomplished with UV lamp or I₂ stain. All products were characterized by their NMR and HRMS spectra. The ¹H NMR (300 MHz) spectra were recorded on Bruker Avance spectrometer and ¹³C NMR (75 MHz) spectra were recorded on Bruker Avance spectrometers using TMS as an internal standard, chemical shifts were reported in parts per million (ppm, δ) downfield from tetramethylsilane. ESI, HRMS were recorded on 'High Resolution QSTAR XL hybrid MS/MS system, Applied biosystems' under Electron Spray Ionization conditions preparing sample solutions in MeOH. IR spectra were recorded on Perkin-Elmer Infrared-683 spectrometer.

Ethyl 5-phenyl-1,2-dihydrobenzo[*c*][2,7]naphthyridine-3(4*H*)-carboxylate (4a)

Yellow oil. Yield: 279 mg, 84%. IR (KBr) : 2981, 1692, 1598, 1474, 1433, 1380, 1319, 1237, 1171, 1118, 1067, 1015, 919, 817, 765 cm⁻¹. ¹H NMR (300 MHz, CDCl₃) δ : 7.62-7.58(m, 1H); 7.46-7.32(m, 8H); 4.75-4.66(br s, 2H); 4.15(q, *J* = 7.3Hz, 2H); 3.81(t, *J* = 6.6 Hz, 2H); 2.65(t, *J* = 6.6 Hz, 2H); 1.34-1.19(m, 3H). ¹³C NMR (75 MHz, CDCl₃) δ : 155.0, 137.2, 134.3, 131.3, 130.0, 130.4, 129.4, 128.7, 128.2, 127.3, 114.9, 61.6, 44.8, 40.7, 14.7. ESI-HRMS: [M+H]⁺, calcd for C₂₁H₂₀N₂O₂: 333.1603, found: 333.1613.

Ethyl 7-fluoro-5-phenyl-1,2-dihydrobenzo[*c*][2,7]naphthyridine-3(4*H*)-carboxylate (4b)

Yellow oil. Yield: 255 mg, 73%. IR (KBr) : 2981, 1690, 1597, 1474, 1436, 1380, 1318, 1237, 1171, 1118, 1067, 1015, 919, 764 cm⁻¹. ¹H NMR (300 MHz, CDCl₃) δ : 7.66-7.54(m, 1H); 7.50-7.30(m, 8H); 4.78-4.60(br s, 2H); 4.15(q, *J* = 7.1Hz, 2H); 3.82(t, *J* = 6.2 Hz, 2H); 2.65(t, *J* = 6.2 Hz, 2H); 1.34-1.14(m, 3H). ¹³C NMR (75 MHz, CDCl₃) δ : 155.9, 137.1, 134.0, 131.1, 130.3, 129.3, 128.5, 128.1, 61.6, 44.6, 40.5, 38.8, 14.7. ESI-HRMS: [M]⁺, calcd for C₂₁H₁₉FN₂O₂: 350.2371, found: 350.2354.

Ethyl 9-bromo-5-phenyl-1,2-dihydrobenzo[*c*][2,7]naphthyridine-3(4*H*)-carboxylate (4c)

Brownish oil. Yield: 307 mg, 75%. IR (KBr) : 2981, 1694, 1597, 1479, 1435, 1381, 1317, 1238, 1172, 1118, 1068, 1015, 919, 819, 766 cm^{-1} . ^1H NMR (300 MHz, CDCl_3) δ : 7.63-7.58(m, 1H); 7.44-7.32(m, 7H); 4.74-4.66(br s, 2H); 4.15(q, $J = 7.5$ Hz, 2H); 3.82(t, $J = 6.0$ Hz, 2H); 2.65(t, $J = 6.0$ Hz, 2H); 1.35-1.18(m, 3H). ^{13}C NMR (75 MHz, CDCl_3) δ : 155.2, 137.3, 133.3, 131.2, 130.4, 130.0, 129.4, 128.6, 128.3, 61.7, 44.8, 40.6, 14.5. ESI-HRMS: $[\text{M}+\text{H}]^+$, calcd for $\text{C}_{21}\text{H}_{19}\text{BrN}_2\text{O}_2$: 411.0708, found: 411.0698.

Ethyl 5-(*p*-tolyl)-1,2-dihydrobenzo[*c*][2,7]naphthyridine-3(4*H*)-carboxylate (4d)

Yellow oil. Yield: 287 mg, 83%. IR (KBr) : 2981, 1695, 1597, 1479, 1437, 1381, 1318, 1238, 1172, 1118, 1069, 1017, 919, 766 cm^{-1} . ^1H NMR (300 MHz, CDCl_3) δ : 7.60-7.56(m, 1H); 7.35-7.17(m, 7H); 4.73-4.67(br s, 2H); 4.15(q, $J = 6.8$ Hz, 2H); 3.81(t, $J = 6.8$ Hz, 2H); 2.63(t, $J = 6.8$ Hz, 2H); 2.40(s, 3H); 1.32-1.20 (m, 3H). ^{13}C NMR (75 MHz, CDCl_3) δ : 155.2, 139.9, 137.4, 130.6, 130.4, 130.3, 130.0, 129.4, 129.1, 128.9, 128.2, 126.5, 122.2, 61.7, 44.9, 40.6, 21.3, 14.5. ESI-HRMS: $[\text{M}+\text{H}]^+$, calcd for $\text{C}_{22}\text{H}_{22}\text{N}_2\text{O}_2$: 347.1759, found: 347.1771.

Ethyl 5-(4-bromophenyl)-1,2-dihydrobenzo[*c*][2,7]naphthyridine-3(4*H*)-carboxylate (4e)

Brownish oil. Yield: 316 mg, 77%. IR (KBr) : 2920, 2851, 691, 1594, 1483, 1433, 1320, 1239, 1119, 1071, 1011, 917, 825, 760 cm^{-1} . ^1H NMR (300 MHz, CDCl_3) δ : 7.63-7.57(m, 1H); 7.48-7.31(m, 7H); 4.74-4.65 (br s, 2H); 4.15(q, $J = 7.5$ Hz, 2H); 3.81(t, $J = 6.0$ Hz, 2H); 2.65(t, $J = 6.0$ Hz, 2H); 1.35-1.17 (m, 3H). ^{13}C NMR (75 MHz, CDCl_3) δ : 155.2, 135.9, 133.1, 132.0, 131.9, 130.2, 129.2, 126.9, 124.0, 122.3, 61.9, 44.8, 40.7, 14.6. ESI-HRMS: $[\text{M}+\text{H}]^+$, calcd for $\text{C}_{21}\text{H}_{19}\text{BrN}_2\text{O}_2$: 411.0708, found: 411.0710.

Ethyl 5-(thiophen-2-yl)-1,2-dihydrobenzo[*c*][2,7]naphthyridine-3(4*H*)-carboxylate (4f)

Yellow oil. Yield: 275 mg, 81%. IR (KBr) : 2980, 1698, 1578, 1472, 1431, 1377, 1324, 1238, 1173, 1118, 1048, 1015, 916, 858, 767 cm^{-1} . ^1H NMR (300 MHz, CDCl_3) δ : 7.86-7.79(m, 3H); 7.56(d, $J = 5.2$ Hz, 1H); 7.32(d, $J = 3.7$ Hz, 1H); 7.12 (t, $J = 5.2$ Hz, 2H); 4.72-4.65(br s, 2H); 4.14(q, $J = 6.7$ Hz, 2H); 3.77(t, $J = 6.0$ Hz, 2H); 2.58(t, $J = 6.0$ Hz, 2H); 1.23 (t, $J = 6.7$ Hz, 3H). ^{13}C NMR (75 MHz, CDCl_3) δ : 155.2, 137.7, 134.0, 131.5, 129.6, 128.1, 127.3, 61.8, 45.2, 40.5, 14.6. ESI-HRMS: $[\text{M}+\text{H}]^+$, calcd for $\text{C}_{19}\text{H}_{18}\text{N}_2\text{O}_2\text{S}$: 339.1167, found: 339.1163.

4a

4a

Acq. File: 12OCT10.wiff

Sample ID: TuneSampleID

Acq. Date: Tuesday, October 12, 2010

Sample Comment: K. NIDHAN RAO, MSR-BAR, ESI HRMS +VE

Acq. Time: 12:03