Supplementary Information

Regioselective carboannulation of electron-deficient allenes with dialkyl (2-formylphenyl)malonates leading to multisubstituted naphthalenes

Nagaraju Koppanathi and K. C. Kumara Swamy*

School of Chemistry, University of Hyderabad, Hyderabad 500 046, Telangana, India.
E-mail: kckssc@uohyd.ac.in; kckss@ yahoo.com

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General procedure for the synthesis of carboxylic acid precursors to 1j and 1k:

Compounds 2-(1,3-diisopropoxy-1,3-dioxopropan-2-yl)benzoic acid and 2-(1,3-di-tert-butoxy-1,3-dioxopropan-2-yl)benzoic acid were prepared by a literature procedure.\textsuperscript{11b}

\textbf{2-(1,3-Diisopropoxy-1,3-dioxopropan-2-yl)benzoic acid (precursor to 1j).} Yield 1.5 g (using 6.66 mmol of 2,4-dimethylbenzoic acid), 67\% (white solid): mp 150-152 °C; IR (KBr, cm\textsuperscript{-1}) 2981, 1731, 1611, 1375, 1178, 1101, 1025, 833, 731; \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) \(\delta\) 7.15 (s, 1H), 7.08 (s, 1H), 5.18-5.08 (m, 2H), 4.97 (s, 1H), 2.48 (s, 3H), 2.37 (s, 3H), 1.30 (d, \(J = 6.2\) Hz, 6H), 1.27 (d, \(J = 6.2\) Hz, 6H); \textsuperscript{13}C NMR (100 MHz, CDCl\textsubscript{3}) \(\delta\) 172.2, 167.9, 140.8, 137.4, 131.9, 131.6, 129.1, 127.9, 69.6, 56.0, 21.6, 21.5, 21.3, 21.0; HRMS (ESI) Calcd. for C\textsubscript{18}H\textsubscript{24}O\textsubscript{6}Na \([M^+\text{+Na}]\): \(m/z\) 359.1471. Found: 359.1474.

\textbf{2-(1,3-Di-tert-butoxy-1,3-dioxopropan-2-yl)benzoic acid (precursor to 1k).} Yield 1.6 g (using 6.66 mmol of 2,4-dimethylbenzoic acid), 66\% (white gummy solid): IR (neat, cm\textsuperscript{-1}) 2981, 1731, 1616, 1457, 1375, 1299, 1129, 1036, 855, 734; \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) \(\delta\) 7.17 (s, 1H), 7.06 (s, 1H), 4.87 (s, 1H), 2.48 (s, 3H), 2.37 (s, 3H), 1.5 (s, 18H); \textsuperscript{13}C NMR (100 MHz, CDCl\textsubscript{3}) \(\delta\) 173.3, 167.8, 140.7, 137.4, 132.6, 131.4, 129.2, 127.7, 82.4, 57.6, 27.9, 21.4, 21.1; HRMS (ESI) Calcd. for C\textsubscript{20}H\textsubscript{29}O\textsubscript{6} \([M^+\text{+H}]\): \(m/z\) 365.1964. Found: 365.1959.
Figure S2. $^1$H NMR spectrum of compound 163
Figure S3. $^{13}$C NMR spectrum of compound 163

Figure S4. $^1$H NMR spectrum of compound 164
Figure S5. $^{13}$C NMR spectrum of compound 164

Figure S6. $^1$H NMR spectrum of compound 1b
Figure S7. $^{13}$C NMR spectrum of compound 1b

Figure S8. $^1$H NMR spectrum of compound 1c
Figure S9. $^{13}$C NMR spectrum of compound 1c

Figure S10. $^1$H NMR spectrum of compound 1d
**Figure S11.** $^{13}$C NMR spectrum of compound 1d

**Figure S12.** $^1$H NMR spectrum of compound 1e
Figure S13. $^{13}C$ NMR spectrum of compound 1e

Figure S14. $^{13}C$ NMR spectrum of compound 1f
Figure S15. $^{13}$C NMR spectrum of compound 1f

Figure S16. $^{13}$C NMR spectrum of compound 1g
Figure S17. $^{13}$C NMR spectrum of compound 1g

Figure S18. $^1$HNMR spectrum of compound 1h
Figure S19. $^{13}$C NMR spectrum of compound 1h
Figure S20. $^1$HNMR spectrum of compound 1i

Figure S21. $^{13}$C NMR spectrum of compound 1i

Figure S22. $^1$H NMR spectrum of compound 1j
Figure S23. $^{13}$C NMR spectrum of compound 1j

Figure S24. $^1$H NMR spectrum of compound 1k
Figure S25. $^{13}$C NMR spectrum of compound 1k

Figure S26. $^1$H NMR spectrum of compound 3aa
Figure S27. $^{13}$C NMR spectrum of compound 3aa
Figure S28. $^1$H NMR spectrum of compound 3ab

Figure S29. $^{13}$C NMR spectrum of compound 3ab

Figure S30. $^1$H NMR spectrum of compound 3ac
Figure S31. $^{13}$C NMR spectrum of compound 3ac

Figure S32. $^1$H NMR spectrum of compound 3ad
Figure S33. $^{13}$C NMR spectrum of compound 3ad
Figure S34. $^1$H NMR spectrum of compound 3ba

Figure S35. $^{13}$C NMR spectrum of compound 3ba

Figure S36. $^1$H NMR spectrum of compound 3ca
Figure S37. $^{13}$C NMR spectrum of compound 3ca

Figure S38. $^1$H NMR spectrum of compound 3da
**Figure S39.** $^{13}$C NMR spectrum of compound 3da
**Figure S40.** $^1$H NMR spectrum of compound 3ea

**Figure S41.** $^{13}$C NMR spectrum of compound 3ea
Figure S42. $^1$H NMR spectrum of compound 3fa

![Figure S42](image)

Figure S43. $^{13}$C NMR spectrum of compound 3fa

![Figure S43](image)

Figure S44. $^1$H NMR spectrum of compound 3ga

![Figure S44](image)
Figure S45. $^{13}$C NMR spectrum of compound 3ga

Figure S46. $^1$H NMR spectrum of compound 3ha
Figure S47. $^{13}$C NMR spectrum of compound 3ha

Figure S48. $^1$H NMR spectrum of compound 3ic
Figure S49. $^{13}$C NMR spectrum of compound 3ic

Figure S50. $^1$H NMR spectrum of compound 3jc
Figure S51. $^{13}$C NMR spectrum of compound 3jc

Figure S52. $^1$H NMR spectrum of compound 3kc
Figure S53. $^{13}$C NMR spectrum of compound 3kc

Figure S54. $^1$H NMR spectrum of compound 3ae
Figure S55. $^{13}$C NMR spectrum of compound 3ae

Figure S56. $^{31}$P NMR spectrum of compound 3ae
Figure S57. $^1$H NMR spectrum of compound 3af

Figure S58. $^{13}$C NMR spectrum of compound 3af
Figure S59. $^{31}$P NMR spectrum of compound 3af

Figure S60. $^1$H NMR spectrum of compound 3ag
Figure S61. $^{13}$C NMR spectrum of compound 3ag

Figure S62. $^{31}$P NMR spectrum of compound 3ag
Figure S63. $^1$H NMR spectrum of compound 3ah

Figure S64. $^{13}$C NMR spectrum of compound 3ah
Figure S65. $^1$H NMR spectrum of compound 4ah

Figure S66. $^{13}$C NMR spectrum of compound 4ah
Figure S67. $^1$H NMR spectrum of compound 3ai

Figure S68. $^{13}$C NMR spectrum of compound 3ai
Figure S69. $^1$H NMR spectrum of compound 4ai

Figure S70. $^{13}$C NMR spectrum of compound 4ai
Figure S71. $^1$H NMR spectrum of compound 3aj

Figure S72. $^{13}$C NMR spectrum of compound 3aj
Figure S73. $^1$H NMR spectrum of compound 4aj

Figure S74. $^{13}$C NMR spectrum of compound 4aj
Figure S75. $^1$H NMR spectrum of compound 3ak

Figure S76. $^{13}$C NMR spectrum of compound 3ak
Figure S77. $^1$H NMR spectrum of compound 4ak

Figure S78. $^{13}$C NMR spectrum of compound 4ak
Figure S79. $^1$H NMR spectrum of compound 3ij

Figure S80. $^{13}$C NMR spectrum of compound 3ij
Figure S81. $^1$H NMR spectrum of compound 5

Figure S82. $^{13}$C NMR spectrum of compound 5
Figure S83. $^{31}$P NMR spectrum of compound 5