# Facile Synthesis of Two Pyridine Alkaloids via Functionalized 3,4-Dialkylpyridines

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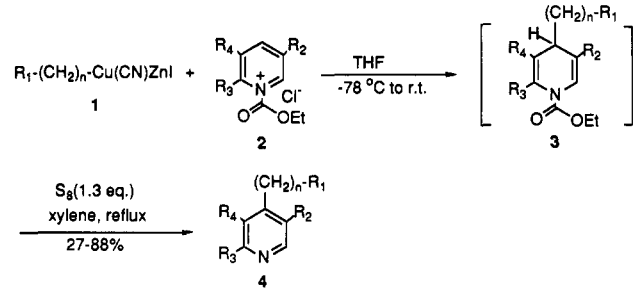
Regioselective addition of organometallic reagents **1** to 1-acylpyridinium salts **2** has become increasingly important in the preparation of 2- and 4-substituted pyridines.[1-3] From a synthetic and mechanistic point of view, the regioselectivity of these reactions is quite important. It has been suggested that the regioselectivity of nucleophilic attack on the pyridinium cation can be explained by the HSAB principle.[4] For example, it has been demonstrated that relatively hard nucleophiles show a preference for addition at the 2-position of the pyridine ring and relatively soft nucleophiles at the 4-position. Recently, we have successfully applied this methodology to prepare 4-benzylpyridines[5] by allowing mixed copper, zinc benzyl nucleophiles[6] to react with 1-(alkoxycarbonyl)pyridinium salts. 3,4-Disubstituted pyridines, useful intermediates in the morphinan[7] and indolepyridine alkaloid synthesis,[8] were thus prepared. A literature[9,10] survey revealed that little information existed regarding the selective synthesis of 3,4-disubstituted pyridines.[11] Therefore, a general synthetic and selective method to prepare these functionalized 3-substituted 4-alkylpyridines **4** was developed. This methodology was then applied to the syntheses of two pyridine alkaloids, namely 3,6,6-trimethyl-5,6-dihydro-2-pyrindin-7-one[12] (**6**) and (±)-actinidine[13] (**9**) using **4e** and **4f**, respectively, as starting materials.

The mixed copper, zinc alkyl organometallics **1**[14] were prepared by zinc metal insertion, followed by transmetalation with copper. Addition of the nucleophiles **1** to the pyridinium salts **2** was conducted at −78 °C in an inert atmosphere. The intermediates **3**, 1,4-dihydropyridines, unstable in air at room temperature, were oxidized by sulfur in boiling xylene (Scheme I). As shown in the Table I various functionalized 3-substituted 4-alkylpyridines **4** (entries 1–11) were obtained in good yields. It is found that 4-alkylpyridines were obtained regio- and chemoselectively by allowing mixed copper, zinc alkyl nucleophiles to react with various 3-substituted pyridinium salts. The regioselectivity of mixed copper, zinc alkyl nucleophiles was independent of the nature of the 3-substituent on the pyridine ring. It was observed that the attack of nucleophiles occurred predominately at the 4-position of pyridinium salts irrespective of the presence of the electron-donating groups, **4a–c** (entires 1–3), or electron-withdrawing groups, **4d–k** (entries 4–11). It is also worth pointing out that there was no reaction observed between those functional groups and the nucleophiles, which indicates the high chemoselectivity of the reaction. The present method can also be utilized for the preparation of the highly reactive aldehyde **4g** (entries 7), in a low yield (27%). Ethyl ester, nitrile, and methyl acetate substituents on the alkyl nucleophiles had no influence on the regio- and chemoselectivity.

**Scheme I**




Compounds **4e** and **4f** were then used as starting materials for the synthesis of two pyridine alkaloids. Thus, compound **4e** was cyclized with NaH in THF and then decarboxylated with NaCl in THF and water[15] to give 3,4-annelated pyridine **5** in 76% yield (Scheme II). Compound **5** was then dialkylated with methyl iodide to afford the pyridine alkaloid, 3,6,6-trimethyl-5,6-dihydro-2-pyrindin-7-one[12] (**6**) in 41% yield. Similarly, compound **4f** was cyclized and decarboxylated to give 3,4-annulated pyridine **7** in 85% yield. Compound **7** then was treated with methyltriphenylphosphonium bromide in presence of t-BuOK in toluene to obtain compound **8** in 90% yield. Hydrogenolysis of **8** gave (±)-actinidine[13] (**9**) in 85% yield.

In summary, we have investigated the regio- and chemoselectivity of the reaction of mixed copper, zinc alkyl organometallics with 3-substituted pyridinium salts. This method provides easy access to functionalized 3-substituted 4-alkylpyridines **4**. By using **4e** and **4f** we are able to achieve a facile synthesis of two pyridine alkaloids, 3,6,6-trimethyl-5,6-dihydro-2-pyrindin-7-one (**6**) (total yield, 31%) and (±)-actinidine (**9**) (total yield, 65%) in two and three steps, respectively.

## Experimental Section

Melting points are uncorrected. Reagent-grade solvents were distilled prior to use. All reactions were carried out under $N_2$.

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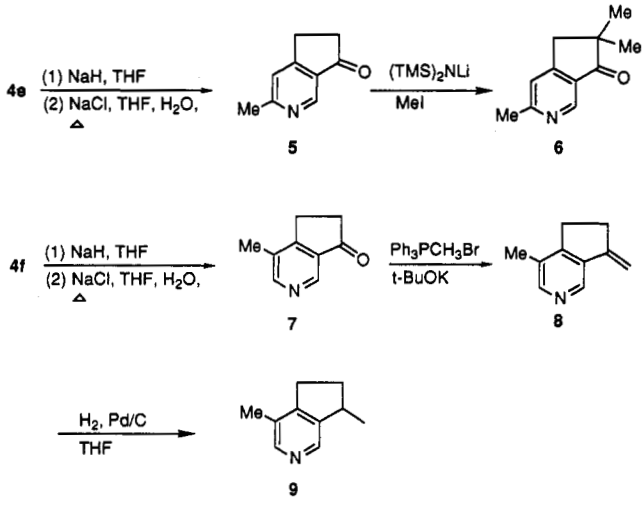
**Table I. Syntheses of Functionalized 3,4-Dialkylpyridines 4a–k**

| entry | 4 | $n$ | $R_1$ | $R_2$ | $R_3$ | $R_4$ | yield,[a] % |
|---|---|---|---|---|---|---|---|
| 1 | 4a | 2 | $CO_2Et$ | $CH_2CO_2Et$ | H | H | 86 |
| 2 | 4b | 2 | $CO_2Et$ | $OCH_3$ | H | H | 60 |
| 3 | 4c | 2 | CN | $CH_2CO_2Et$ | H | H | 59 |
| 4 | 4d | 2 | $CO_2Et$ | $CO_2Me$ | H | H | 88 |
| 5 | 4e | 2 | $CO_2Et$ | $CO_2Me$ | $CH_3$ | H | 80 |
| 6 | 4f | 2 | $CO_2Et$ | $CO_2Me$ | H | $CH_3$ | 75 |
| 7 | 4g | 2 | $CO_2Et$ | CHO | H | H | 27 |
| 8 | 4h | 2 | $CO_2Et$ | F | H | H | 38 |
| 9 | 4i | 2 | CN | $CO_2Me$ | H | H | 51 |
| 10 | 4j | 2 | CN | $CO_2Me$ | $CH_3$ | H | 83 |
| 11 | 4k | 4 | OCOMe | $CO_2Me$ | H | H | 43 |

[a] Based on purified material.

**Scheme II**




Products were purified by column chromatography with Merck silica gel (230–400 mesh). Ethyl 3-pyridylacetate, methyl nicotinate, methyl 6-methylnicotinate, 3-fluoropyridine, 3-pyridinecarboxaldehyde, and 4-iodobutyl acetate were purchased from Aldrich Chemical Co.

**Preparation of 3-[3-[(Ethoxycarbonyl)methyl]pyridin-4-yl]propionic Acid Ethyl Ester (4a). Typical Procedure Follows.** To a solution of ethyl 3-iodopropionate[16] (13 mmol) in THF (20 mL) was added freshly dried and heated zinc (15.6 mmol) at 40 °C under nitrogen. The reaction mixture was stirred for 2 h at 40 °C and then allowed to cool to rt. This solution was then added to another THF solution (20 mL) containing CuCN (0.9 g, 10 mmol) and LiCl (0.9 g, 10 mmol) at −40 °C with stirring. The resulting solution was warmed to 0 °C for 5 min and again cooled to −78 °C. This solution was finally added to a solution of pyridinium chloride **2** [prepared from the reaction of ethyl chloroformate (10 mmol) with the pyridine derivative (10 mmol) in THF (40 mL) at −25 °C for 30 min][1,5] at −78 °C. The resulting reaction mixture was slowly warmed to rt and quenched with 5% $NH_4OH$ solution, and the organic layer was separated and then dried over $MgSO_4$. Removal of the solvent under vacuo gave the intermediate which was oxidized with sulfur (0.41 g, 13 mmol) in boiling xylene (15 mL). The reaction product **4a** (86%) was obtained as a colorless oil by removing the solvent, followed by purification by chromatography (silica gel, hexane/EtOAc (3:1)): bp 225–228 °C/4 Torr; IR (film) 1733, 1720 $cm^{-1}$; $^1H$-NMR ($CDCl_3$) $\delta$ 1.20–1.30 (m, 6 H), 2.64 (t, 2 H, $J$ = 8.0 Hz), 2.97 (t, 2 H, $J$ = 8.0 Hz), 3.71 (s, 2 H), 4.08–4.22 (m, 4 H), 7.13 (d, 1 H, $J$ = 5.4 Hz), 8.42 (s, 1 H), 8.43 (d, 1 H, $J$ = 5.4); MS $m/z$ 265 (relative intensity) ($M^+$, 8), 219 (100), 192 (41), 173 (31), 147 (32), 118 (69). Anal. Calcd for $C_{14}H_{19}NO_4$ (265.31): C, 63.38; H, 7.22; N, 5.28. Found: C, 63.49; H, 7.16; N, 5.20. Compounds **4b–k** were similarly prepared.

**3-(3-Methoxypyridin-4-yl)propionic Acid Ethyl Ester (4b).** **4b** was obtained as a colorless oil from 3-methoxypyridine and ethyl 3-iodopropionate in 60% yield: bp 155–159 °C/4 Torr; IR (film) $\nu$ 1729 (ester) $cm^{-1}$; $^1H$-NMR ($CDCl_3$) $\delta$ 1.24 (t, 3 H, $J$ = 7.2 Hz), 2.62 (t, 2 H, $J$ = 7.6 Hz), 2.94 (t, 2 H, $J$ = 7.6 Hz), 3.93 (s, 3 H), 4.13 (q, 2 H, $J$ = 7.2 Hz), 7.09 (d, 1 H, $J$ = 4.7 Hz), 8.16 (d, 1 H, $J$ = 4.7 Hz), 8.20 (s, 1 H); MS $m/z$ (relative intensity) 209 ($M^+$, 96), 164 (33), 135 (100), 120 (27), 106 (23). Anal. Calcd for $C_{11}H_{15}NO_3$ (209.25): C, 63.14; H, 7.23; N, 6.69. Found: C, 62.98; H, 7.54; N, 6.43.

**[4-2-(Cyanoethyl)pyridin-3-yl]acetic Acid Ethyl Ester (4c).** **4c** was obtained as a colorless oil from ethyl 3-pyridylacetate and 3-iodopropionitrile in 59% yield: bp 180–182 °C/3 Torr; IR (film) 2248, 1730 $cm^{-1}$; $^1H$-NMR ($CDCl_3$) $\delta$ 1.27 (t, 3 H, $J$ = 7.1 Hz), 2.70 (t, 2 H, $J$ = 7.9 Hz), 3.02 (t, 2 H, $J$ = 7.9 Hz), 3.69 (s, 2 H), 4.17 (q, 2 H, $J$ = 7.1 Hz), 7.19 (d, 1 H, $J$ = 5.0 Hz), 8.48 (s, 1 H), 8.52 (d, 1 H, $J$ = 5.0 Hz); MS $m/z$ (relative intensity) 218 ($M^+$, 64), 172 (58), 145 (62), 118 (100), 106 (36). Anal. Calcd for $C_{12}H_{14}N_2O_2$ (218.26): C, 66.04; H, 6.47; N, 12.84. Found: C, 65.91; H, 6.57; N, 12.72.

**4-[2-(Ethoxycarbonyl)ethyl]nicotinic Acid Methyl Ester (4d).** **4d** was obtained as a colorless oil from methyl nicotinate and ethyl 3-iodopropionate in 88% yield: bp 162–164 °C/Torr; IR (film) 1741, 1724 $cm^{-1}$; $^1H$-NMR ($CDCl_3$) $\delta$ 1.23 (t, 3 H, $J$ = 7.1 Hz), 2.68 (t, 2 H, $J$ = 7.5 Hz), 3.31 (t, 2 H, $J$ = 7.5 Hz), 3.94 (s, 3 H), 4.13 (q, 2 H, $J$ = 7.1 Hz), 7.25 (d, 1 H, $J$ = 5.0 Hz), 8.61 (d, 1 H, $J$ = 5.0 Hz), 9.10 (s, 1 H); MS $m/z$ (relative intensity) 237 ($M^+$, 6), 205 (27), 192 (15), 177 (23), 137 (72), 106 (100). Anal. Calcd for $C_{12}H_{15}NO_4$ (237.26): C, 60.75; H, 6.37; N, 5.90. Found: C, 60.36; H, 6.46; N, 5.91.

**4-[2-(Ethoxycarbonyl)ethyl]-6-methylnicotinic Acid Methyl Ester (4e).** **4e** was obtained as a yellow oil from methyl 6-methylnicotinate and ethyl 3-iodopropionate in 80% yield: bp 188–191 °C/5 Torr; IR (film) 1740, 1725 $cm^{-1}$; $^1H$-NMR ($CDCl_3$) $\delta$ 1.24 (t, 3 H, $J$ = 7.1 Hz), 2.57 (s, 3 H), 2.66 (t, 2 H, $J$ = 7.5 Hz), 3.27 (t, 2 H, $J$ = 7.5 Hz), 3.92 (s, 3 H), 4.13 (q, 2 H, $J$ = 7.1 Hz), 7.11 (s, 1 H), 8.99 (s, 1 H); MS $m/z$ (relative intensity) 251 ($M^+$, 17), 219 (79), 206 (42), 191 (66), 177 (49), 163 (38), 146 (100). Anal. Calcd for $C_{13}H_{17}NO_4$ (251.28): C, 62.14; H, 6.82; N, 5.57. Found: C, 61.85; H, 6.73; N, 5.90.

**4-[2-(Ethoxycarbonyl)ethyl]-5-methylnicotinic Acid Methyl Ester (4f).** **4f** was obtained as a yellow oil from 5-methyl methylnicotinate[17] and ethyl 3-iodopropionate in 75% yield: bp 176–179 °C/4 Torr; IR (film) 1739, 1723 $cm^{-1}$; $^1H$-NMR ($CDCl_3$) $\delta$ 1.27 (t, 3 H, $J$ = 7.1 Hz), 2.38 (s, 3 H), 2.58 (t, 2 H, $J$ = 7.8 Hz), 3.26 (t, 2 H, $J$ = 7.8 Hz), 3.92 (s, 3 H), 4.16 (q, 2 H, $J$ = 7.1 Hz), 8.49 (s, 1 H), 8.89 (s, 1 H); MS $m/z$ (relative intensity) 251 ($M^+$, 10), 219 (12), 206 (16), 195 (52), 177 (16), 164 (100), 136 (34). Anal. Calcd for $C_{13}H_{17}NO_4$ (251.28): C, 62.14; H, 6.82; N, 5.57. Found: C, 62.16; H, 6.83; N, 5.41.

**3-(3-Formylpyridin-4-yl)propionic Acid Ethyl Ester (4g).** **4g** was obtained as a colorless oil from 3-pyridinecarboxaldehyde and ethyl 3-iodopropionate in 27% yield: bp 143–145 °C/4 Torr; IR (film) 1728, 1698 $cm^{-1}$; $^1H$-NMR ($CDCl_3$) $\delta$ 1.22 (t, 3 H, $J$ = 7.1 Hz), 2.69 (t, 2 H, $J$ = 7.4 Hz), 3.37 (t, 2 H, $J$ = 7.4 Hz), 4.12 (q, 2 H, $J$ = 7.1 Hz), 7.31 (d, 1 H, $J$ = 5.2 Hz), 8.69 (d, 1 H, $J$ = 5.2 Hz), 8.97 (s, 1 H), 10.27 (s, 1 H); MS $m/z$ (relative intensity) 207 ($M^+$, 14), 178 (15), 161 (68), 133 (100), 107 (86), 78 (73). Anal. Calcd for $C_{11}H_{13}NO_3$ (207.23): C, 63.76; H, 6.32; N, 6.76. Found: C, 63.25; H, 6.31; N, 6.77.

**3-(3-Fluoropyridin-4-yl)propionic Acid Ethyl Ester (4h).** **4h** was obtained as a colorless oil from 3-fluoropyridine and ethyl 3-iodopropionate in 38% yield: bp 141–143 °C/4 Torr; IR (film) 1722 $cm^{-1}$; $^1H$-NMR ($CDCl_3$) $\delta$ 1.16 (t, 3 H, $J$ = 7.2 Hz), 2.60 (t, 2 H, $J$ = 7.6 Hz), 2.94 (t, 2 H, $J$ = 7.6 Hz), 4.06 (q, 2 H, $J$ = 7.2 Hz), 7.13 (t, 1 H, $J$ = 5.0 Hz), 8.25 (d, 1 H, $J$ = 5.0 Hz), 8.32 (s, 1 H); MS $m/z$ (relative intensity) 197 ($M^+$, 100), 169 (21), 152 (47), 124 (97), 110 (17), 96 (15). Anal. Calcd for $C_{10}H_{12}NO_2F$ (197.21): C, 60.91; H, 6.13; N, 7.10. Found: C, 60.74; H, 6.54; N, 6.86.

**4-(2-Cyanoethyl)nicotinic Acid Methyl Ester (4i).** **4i** was obtained from methyl nicotinate and 3-iodopropionitrile in 51% yield: mp 46–48 °C (EtOAc); IR (film) 2250, 1721 $cm^{-1}$; $^1H$-NMR ($CDCl_3$) $\delta$ 2.78 (t, 3 H, $J$ = 7.1 Hz), 3.31 (t, 2 H, $J$ = 7.1 Hz), 3.96 (s, 3 H), 7.30 (d, 1 H, $J$ = 5.0 Hz), 8.72 (d, 1 H, $J$ = 5.0 Hz), 8.19

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(s, 1 H); MS $m/z$ (relative intensity) 190 ($M^+$, 29), 175 (29), 158 (81), 131 (65), 104 (22), 77 (15), 62 (100). Anal. Calcd for $C_{10}H_{10}N_2O_2$ (190.20): C, 63.15; H, 5.30; N, 14.73. Found: C, 63.31; H, 5.37; N, 14.69.

**4-(2-Cyanoethyl)-6-methylnicotinic Acid Methyl Ester (4j).** 4j was obtained as a colorless oil from methyl 6-methylnicotinate and 3-iodopropionitrile in 83% yield: bp 193–197 °C/5 Torr; IR (film) 2247, 1719 $cm^{-1}$; $^1$H-NMR ($CDCl_3$) $\delta$ 2.54 (s, 3 H), 2.70 (t, 2 H, $J$ = 7.2 Hz), 3.20 (t, 2 H, $J$ = 7.2 Hz), 3.86 (s, 3 H), 7.07 (s, 1 H), 8.89 (s, 1 H); MS $m/z$ (relative intensity) 204 ($M^+$, 36), 189 (27), 172 (100), 145 (57), 118 (13), 91 (8). Anal. Calcd for $C_{11}H_{12}N_2O_2$ (204.23): C, 64.69; H, 5.92; N, 13.72. Found: C, 64.58; H, 5.94; N, 13.59.

**4-(4-Acetoxybutyl)nicotinic Acid Methyl Ester (4k).** 4k was obtained as a colorless oil from methyl nicotinate and 4-iodobutyl acetate in 43% yield: bp 178–182 °C/5 Torr; IR (film) 1730, 1721 $cm^{-1}$; $^1$H-NMR ($CDCl_3$) $\delta$ 1.71 (m, 4 H), 2.05 (s, 3 H), 3.02 (t, 2 H, $J$ = 6.0 Hz), 3.93 (s, 3 H), 4.11 (t, 2 H, $J$ = 6.0 Hz), 7.21 (d, 1 H, $J$ = 5.1 Hz), 8.59 (d, 1 H, $J$ = 5.1 Hz), 9.07 (s, 1 H); MS $m/z$ (relative intensity) 251 ($M^+$, 189), 192 (32), 177 (29), 164 (100), 151 (22), 132 (48), 120 (15). Anal. Calcd for $C_{13}H_{17}NO_4$ (251.28): C, 62.14; H, 6.82; N, 5.57. Found: C, 62.05; H, 6.93; N, 5.41.

**3-Methyl-5,6-dihydro-2-pyrindin-7-one (5).** Diester 4e (1.04 g, 4.14 mmol) and sodium hydride (80% dispersion; 0.26 g, 8.6 mmol) in dry THF (50 mL) were heated under reflux for 18 h. The reaction mixture was cooled to 0 °C and acidified with 10% HCl. The solvent was removed at reduced pressure. NaCl (180 mg), water (2 mL), and THF (3 mL) were added, and the resulting mixture was heated under reflux overnight.[17] The reaction mixture was cooled to 0 °C, diluted with $CH_2Cl_2$, washed with water and brine, dried over anhydrous $Na_2SO_4$, and evaporated at reduced pressure. The residue was further purified by TLC (hexane/ethyl acetate (3:1)) to give 0.46 g (76%) of 5 as a white solid: mp 79 °C dec (ether); IR ($CHCl_3$) 3041, 2926, 1716, 1600, 1237 $cm^{-1}$; $^1$H-NMR ($CDCl_3$) $\delta$ 2.65 (s, 3 H), 2.70 (m, 2 H), 3.13 (m, 2 H), 7.31 (s, 1 H), 8.90 (s, 1 H); MS $m/z$ (relative density) 147 ($M^+$, 100), 132 (4), 119 (18), 104 (5), 91 (18), 77 (6). Anal. Calcd for $C_9H_9NO$ (147.18): C, 73.45; H, 6.16; N, 9.52. Found: C, 73.21; H, 6.11; N, 9.43.

**3,6,6-Trimethyl-5,6-dihydro-2-pyrindin-7-one[12] (6).** A mixture of 5 (0.1 g, 0.68 mmol) and methyl iodide (0.85 mL, 1.94 mmol) in dry THF (5 mL) was cooled to −20 °C. Lithium bis(trimethylsilyl)amide (1.0 M, 1.7 mL) in dry THF was added to this mixture. After, being stirred for 1 h, the reaction mixture was warmed to rt and then stirred for another 2 h. The mixture was quenched with $NH_4Cl$ (aq) and then extracted with ether (3 × 50 mL). The organic layer was washed with water and brine and then dried over anhydrous $Na_2SO_4$. Solvent was evaporated at reduced pressure, and the residue was purified by TLC (hexane/ethyl acetate (3:1)) to give 175 mg (41%) of 6 as a white solid: mp 75–76 °C (ether); IR ($CHCl_3$) 2973, 2955, 1718, 1601, 1429, 1254 $cm^{-1}$; $^1$H-NMR ($CDCl_3$) $\delta$ 1.24 (s, 6 H), 1.81 (s, 3 H), 2.78 (s, 3 H), 2.98 (s, 2 H), 7.28 (s, 1 H), 8.91 (s, 1 H); MS $m/z$ (relative density) 175 ($M^+$, 60), 160 (100), 146 (8), 133 (15), 117 (12), 91 (8), 77 (10). Anal. Calcd for $C_{11}H_{13}NO$ (175.23): C, 75.40; H, 7.48; N, 7.99. Found: C, 74.70; H, 7.51; N, 7.82.

**4-Methyl-5,6-dihydro-2-pyrindin-7-one (7).** 7 was obtained from the diester 4f in 85% yield in a procedure similar to the preparation of 5 as a white solid: mp 100–101 °C (ether); IR ($CHCl_3$) 3072, 2923, 1717, 1583, 1464, 1405 $cm^{-1}$; $^1$H-NMR ($CDCl_3$) $\delta$ 2.38 (s, 3 H), 2.73 (m, 2 H), 3.07 (m, 2 H), 8.55 (s, 1 H), 8.86 (s, 1 H); $^{13}$C-NMR ($CDCl_3$) $\delta$ 24.9, 24.9, 25.0, 42.3, 45.6, 121.1, 128.8, 146.4, 160.6, 163.8, 209.4; MS $m/z$ (relative density) 147 ($M^+$, 100), 132 (8), 118 (50), 105 (10), 91 (25), 77 (8), 65 (10); HRMS calcd for $C_9H_9NO$ 147.0684, found 147.0674. Anal. Calcd for $C_9H_9NO$ (147.18): C, 73.45; H, 6.16; N, 9.52. Found: C, 73.32; H, 6.35; N, 9.41.

**4-Methyl-7-methylene-6,7-dihydro-2(5*H*)-pyrindine (8).** t-BuOK (1.02 g, 9.10 mmol) was added to the stirred solution of methyltriophenylphosphonium bromide (3.58 g, 10.03 mmol) in anhydrous toluene (20 mL), and the resulting solution was stirred overnight at rt. Ketone 7 (268 mg, 1.82 mmol) was added, and this mixture was then stirred for another 1 h. 10% NaOH (10 mL) was added, and the solution was extracted with toluene (30 mL). The organic layer was washed with water and brine and dried over anhydrous $Na_2SO_4$. Solvent was evaporated at reduced pressure, and the residue was purified by TLC (hexane/ethyl acetate (3:1)) to give 237 mg (90%) of 8 as a white solid: mp 68–69 °C (ether); IR ($CHCl_3$) 3009, 1640, 1585, 1436, 1115 $cm^{-1}$. $^1$H-NMR ($CDCl_3$) $\delta$ 2.23 (s, 3 H), 2.77–2.89 (m, 4 H), 5.12 (t, 1 H, $J$ = 2.0 Hz), 5.55 (t, 1 H, $J$ = 2.0 Hz), 8.21 (s, 1 H), 8.58 (s, 1 H); $^{13}$C-NMR ($CDCl_3$) $\delta$ 15.5, 28.5, 30.5, 104.4, 129.7, 136.3, 140.5, 148.0, 148.5, 154.0; MS $m/z$ (relative density) 145 ($M^+$, 95), 144 (100), 130 (12), 115 (13), 103 (8), 77 (80); HRMS calcd for $C_{10}H_{11}N$ 145.0891, found 145.0896.

**4,7-Dimethyl-6,7-dihydro-2-(5*H*)-pyrindine ((±)-Actinidine)[13] (9).** A mixture of compound 8 (0.3 g, 0.21 mmol) and 10% Pd on charcoal (35 mg) in THF (1 mL) was stirred for 2 h while hydrogen was bubbled into the reaction system. Solid was filtered off and then washed with ethyl acetate (20 mL × 2), and the filtrate was evaporated at reduced pressure. The residue was purified by TLC (hexane/ethyl acetate (1:2)) to give 26.4 mg (85%) of 9 as a yellow oil: IR ($CHCl_3$) 2964, 2254, 1589, 1451, 1375 $cm^{-1}$; $^1$H-NMR ($CDCl_3$) $\delta$ 1.29 (d, 3 H, $J$ = 6.8 Hz), 1.56–1.71 (m, 1 H), 2.24 (s, 3 H), 2.28–2.42 (m, 1 H), 2.72–2.86 (m, 1 H), 3.22–3.29 (m, 1 H), 8.19 (s, 1 H), 8.25 (s, 1 H); $^{13}$C-NMR ($CDCl_3$) $\delta$ 15.8, 19.9, 29.6, 33.6, 37.8, 129.1, 142.0, 143.6, 147.2, 152.1; MS $m/z$ (relative density) 147 ($M^+$, 55), 132 (100), 117 (27), 103 (6); HRMS calcd for $C_{10}H_{13}N$ 147.1080, found 147.1071.

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