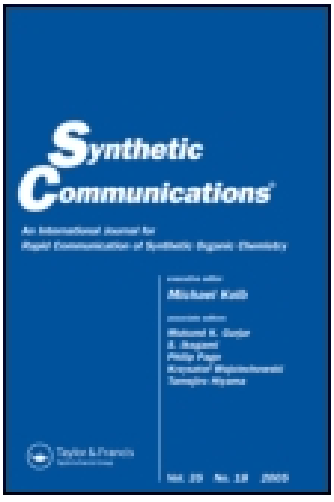


Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/lsyc20

# Expedient Synthesis of 2-Carboethoxy-4-methylnaphthalenes

Chandan P. Amonkar [a], Rupesh R. Patre [a] & Santosh G. Tilve [a]
[a] Department of Chemistry, Goa University, Goa, India
Published online: 21 Aug 2006.

To cite this article: Chandan P. Amonkar, Rupesh R. Patre & Santosh G. Tilve (2006) Expedient Synthesis of 2-Carboethoxy-4-methylnaphthalenes, Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry, 36:1, 13-20, DOI: 10.1080/00397910500328605

To link to this article: http://dx.doi.org/10.1080/00397910500328605

*Synthetic Communications*®, 36: 13–20, 2006

ISSN 0039-7911 print/1532-2432 online
DOI: 10.1080/00397910500328605



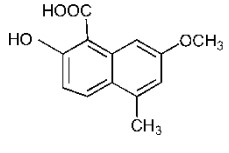
# Expedient Synthesis of 2-Carboethoxy-4-methylnaphthalenes#

**Chandan P. Amonkar, Rupesh R. Patre, and Santosh G. Tilve**
Department of Chemistry, Goa University, Goa, India

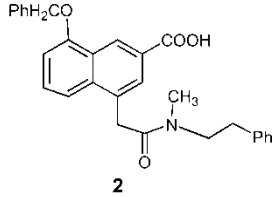
**Abstract:** A three-step synthesis of 2-carboethoxy-4-methylnaphthalenes **7a**–**d** from aryl aldehydes is described.

**Keywords:** Benzannulations, naphthalene, Wacker reaction, Wittig reaction

The naphthalene structural motif is widely present in nature[1] and in important biologically active molecules.[2]. For example, **1** is a segment of anticancer agent neocarzinostatin.[2a] Compound **2** is an orally active leukotriene $B_4$ receptor antagonist.[3] Various methods[3,4] are available for the synthesis of such naphthalene segments. However, most of these methods are either multistep methods or are useful to synthesize a specific segment. In view of this, we envisaged developing a convenient method for the synthesis of substituted 2-carboethoxy-4-methylnaphthalenes, which could act as common precursors for compounds such as **1** and **2** by carrying out normal functional-group transformations.




**1**




**2**

Received in India July 7, 2005

#Dedicated to Professor S. C. Chandrasekaran on the occasion of his 60th Birthday.

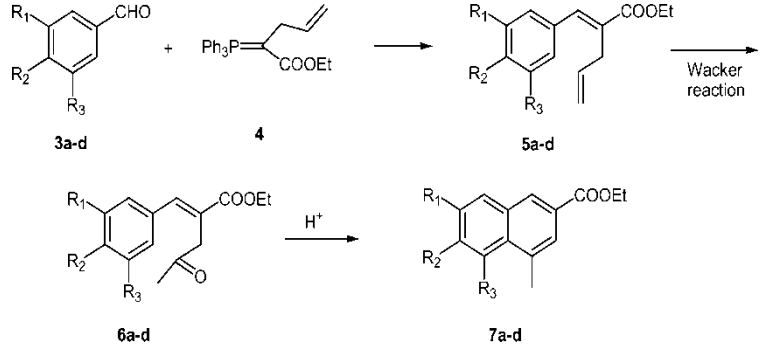
Address correspondence to Santosh G. Tilve, Department of Chemistry, Goa University, Taleigao Plateau, Goa 403206, India. Fax: 91-0832-2451184; E-mail: santoshtilve@yahoo.com

We had earlier used Pd-C–catalyzed ring annulation of the indole ring to carbazole the precursor of anticancer alkaloid olivacine.[5] Because we were not able to extend the same method for benzannulations to naphthalene, we thought that if we could convert the terminal olefin (Scheme 1) to a methyl ketone group by the Wacker reaction, we may get the naphthalene by ring annulation. Thus, the pentenoate **5a** obtained by Wittig condensation with phosphorane **4** on Wacker oxidation gave the keto-ester **6a** in 70% yield. The latter compounds are also useful substrates for the synthesis[6] of substituted $\gamma$-lactones. Keto ester **6a** was then cyclized to 2-carboethoxy-4-methyl naphthalene (**7a**) using PPA in good yield. With the facile preparation of naphthalene **7a**, we used this sequence of reactions to synthesize several substituted 2-carboethoxy-4-methylnaphthalenes (**7b**–**d**). In conclusion, we have developed an efficient three-step method for the synthesis of 2-carboethoxy-4-methylnaphthalenes (Table 1).

All melting points are uncorrected and were measured by the normal thiels-tube (paraffin) method. Column chromatography was performed on silica gel G (13% $CaSO_4$ as binder). IR spectra were recorded on a Shimadzu FT-IR spectrophotometer (KBr pellet or neat sample). All new compounds gave satisfactorily microanalysis: C $\pm$ 0.50; H $\pm$ 0.30. $^1$H NMR and $^{13}$CMR spectra were recorded on a Brucker 300-MHz instrument. The multiplicities of carbon signals were obtained from Distortionless Enhancement by Polarisation Transfer (DEPT) experiments.

## GENERAL PROCEDURE FOR THE PREPARATION OF PENTANOATES 5A–D

A mixture of aryl aldehyde **3a**–**d** (1 mmol), allyl phosphorane **4** (1 mmol), and chloroform (10 mL) was refluxed for 3 h. The solvent was removed under reduced pressure, and the residue was chromatographed on silica gel (hexanes–EtOAc = 95 : 5) to yield unsaturated esters **5a**–**d**.




*Scheme 1.*

*Table 1.* Yields of compounds 5, 6, and 7

| Compounds **3, 5–7** | $R_1$ | $R_2$ | $R_3$ | Compound **5** yield (%) | Compound **6** yield (%) | Compound **7** yield (%) |
|---|---|---|---|---|---|---|
| **a** | H | H | H | 95 | 75 | 70 |
| **b** | MeO | H | H | 71 | 77 | 69 |
| **c** | MeO | MeO | H | 69 | 70 | 71 |
| **d** | MeO | MeO | MeO | 65 | 72 | 66 |



## DATA

### Ethyl (*E*)-2-Benzylidenepent-4-enoate (5a)[7]

Yield: 95%; liquid; bp 136°C. IR (neat): $\nu_{max} = 1716, 1635, 1604\,cm^{-1}$. $^1H$ NMR (300 MHz, $CDCl_3$): $\delta = 1.33$ (t, $J = 7.2$ Hz, 3H, $OCH_2CH_3$), 3.28 (d, $J = 5.4$ Hz, 2H, $CH_2CH{=}CH_2$), 4.26 (q, $J = 7.2$ Hz, 2H, $OCH_2CH_3$), 5.11 (m, 2H, $CH_2CH{=}CH_2$), 6.00 (m, 1H, $CH_2CH{=}CH_2$), 7.30–7.41 (br.s, 5H, Ar-H), 7.80 (s, 1H,=CH). $^{13}C$ NMR ($CDCl_3$): $\delta = 14.18$ ($OCH_2CH_3$), 31.56 ($CH_2CH{=}CH_2$), 60.71 ($OCH_2CH_3$), 115.55 ($CH_2CH{=}CH_2$), 128.33 (CH), 128.47 (CH), 128.48 (CH), 129.16 (CH), 130.47 (C), 135.43 (C), 135.60 ($CH_2CH{=}CH_2$), 140.04 (CH), 167.83 (CO).

### Ethyl (*E*)-2-(m-Methoxybenzylidene)pent-4-enoate (5b)

Yield: 71%; oily liquid. IR (neat): 1715, 1635, 1600 $cm^{-1}$. $^1H$ NMR ($CDCl_3$): $\delta = 1.32$ (t, $J = 7.2$ Hz, 3H, $OCH_2CH_3$), 3.26 (d, $J = 5.4$ Hz, 2H, $CH_2CH{=}CH_2$), 3.89 (s, 3H, $OCH_3$), 4.31 (q, $J = 7.2$ Hz, 2H, $OCH_2CH_3$), 5.28 (m, 2H, $CH_2CH{=}CH_2$), 6.03 (m, 1H, $CH_2CH{=}CH_2$), 6.95–7.33 (m, 4H, Ar-H), 7.81 (s, 1H, =CH). $^{13}C$ NMR ($CDCl_3$): $\delta = 14.14$ ($OCH_2CH_3$), 31.02 ($CH_2CH{=}CH_2$), 57.69 ($OCH_3$), 61.23 ($OCH_2CH_3$), 111.67 ($CH_2CH{=}CH_2$), 113.12 (CH), 115.32 (CH), 123.03 (C), 128.35 (CH), 128.38 (CH), 135.02 (C), 139.98 (C), 147.74 ($CH_2CH{=}CH_2$), 149.11 (CH), 167.55 (CO). GC/MS: $m/z = 246$ $[M]^+$.

### Ethyl (*E*)-2-(3,4-Dimethoxybenzylidene)pent-4-enoate (5c)[7]

Yield: 69%; oily liquid. IR (neat): 1711, 1638, 1606 $cm^{-1}$. $^1H$ NMR ($CDCl_3$): $\delta = 1.33$ (t, $J = 7.2$ Hz, 3H, $OCH_2CH_3$), 3.33 (d, $J = 5.4$ Hz, 2H, $CH_2CH{=}CH_2$), 3.87 (s, 3H, $OCH_3$), 3.90 (s, 3H, $OCH_3$), 4.27 (q, $J = 7.2$ Hz, 2H, $OCH_2CH_3$), 5.13 (m, 2H, $CH_2CH{=}CH_2$), 6.03 (m, 1H, $CH_2CH{=}CH_2$), 6.88 (d, $J = 8.4$ Hz, 1H, Ar-H), 7.76 (t, $J = 8.4$, 1.8 Hz, 2H, Ar-H), 7.76 (s, 1H,=CH). $^{13}C$ NMR ($CDCl_3$): $\delta = 14.16$ ($OCH_2CH_3$), 31.65

($CH_2CH{=}CH_2$), 55.87 ($OCH_3$), 60.53 ($OCH_2CH_3$), 111.40 ($CH_2CH{=}CH_2$), 112.80 (CH), 115.30 (CH), 122.83 (C), 128.35 (C), 128.51 (CH), 135.77 (C), 139.89 (C), 148.94 ($CH_2CH{=}CH_2$), 149.81 (CH), 167.95 (CO).

### Ethyl (*E*)-2-(3,4,5-Trimethoxybenzylidene)pent-4-enoate (5d)[7]

Yield: 65%; oily liquid. IR (neat): 1711, 1638, 1585 $cm^{-1}$. $^1H$ NMR ($CDCl_3$): $\delta = 1.33$ (t, $J = 7.2$ Hz, 3H, $OCH_2CH_3$), 3.32 (d, $J = 5.1$ Hz, 2H, $CH_2CH{=}CH_2$), 3.83 (s, 6H, $2 \times OCH_3$), 3.86 (s, 3H, $OCH_3$), 4.26 (q, $J = 7.2$ Hz, 2H, $OCH_2CH_3$), 5.15 (m, 2H, $CH_2CH{=}CH_2$), 6.02 (m, 1H, $CH_2CH{=}CH_2$), 6.66 (s, 2H, Ar-H), 7.74 (s, 1H,=CH). $^{13}C$ NMR ($CDCl_3$): $\delta = 14.10$ ($OCH_2CH_3$), 37.71 ($CH_2CH{=}CH_2$), 55.98 ($OCH_3$), 60.58 ($OCH_2CH_3$), 106.68 ($CH_2CH{=}CH_2$), 115.30 (CH), 129.44 (C), 130.68 (C), 135.77 (C), 138.65 (C), 140.11 ($CH_2CH{=}CH_2$), 152.95 (CH), 167.74 (CO).

## GENERAL PROCEDURE FOR THE PREPARATION OF KETO-ESTER 6A–D

A mixture of cuprous chloride (1 mmol), palladium chloride (0.1 mmol), and water (0.2 mL) in DMF (15 mL) was stirred under oxygen atmosphere for 1 h. Ester **5a–d** (1 mmol) in DMF (5 mL) was added, and the mixture was stirred for 10 h at room temperature under an oxygen atmosphere. The reaction mixture was then diluted with water and extracted with EtOAc ($3 \times 20$ mL). The organic layer was dried over anhyd. $Na_2SO_4$, filtered, and concentrated in vacuo. The residue was purified by column chromatography on silica gel (hexanes 60–80°C–EtOAc = 9 : 1) to yield keto-esters **6a–d**.

## DATA

### Ethyl-2-benzylidene-4-oxo-pentenoate (6a)[8]

Yield: 75%; viscous liquid. IR (neat): 1722, 1706 $cm^{-1}$. $^1H$ NMR ($CDCl_3$): $\delta = 1.25$ (t, $J = 7.2$ Hz, 3H, $OCH_2CH_3$), 2.17 (s, 3H, $CH_2COCH_3$), 3.53 (s, 2H, $CH_2COCH_3$), 4.17 (q, $J = 7.2$ Hz, 2H, $OCH_2CH_3$), 7.32–7.18 (m, 5H, Ar-H), 7.84 (s, 1H,=CH). $^{13}C$ NMR ($CDCl_3$): $\delta = 14.11$ ($OCH_2CH_3$), 29.97 ($CH_3CO$), 42.43 ($CH_2$), 61.07 ($OCH_2CH_3$), 106.13 (CH), 128.49 (CH), 128.68 (CH), 135.10 (C), 141.89 (CH), 153.13 (C), 167.30 (COOEt), 205.94 ($CH_3CO$).

### Ethyl-2-(m-methoxybenzylidene)-4-oxo-pentenoate (6b)

Yield: 77%; viscous liquid. IR (neat): 1722, 1700 $cm^{-1}$. $^1H$ NMR ($CDCl_3$): $\delta = 1.33$ (t, $J = 7.2$ Hz, 3H, $OCH_2CH_3$), 2.25 (s, 3H, $CH_2COCH_3$), 3.62

(s, 2H, $CH_2COCH_3$), 3.80 (s, 3H, $OCH_3$), 4.26 (q, $J = 7.2$ Hz, 2H, $OCH_2CH_3$), 6.86–6.90 (m, 2H, Ar-H), 7.26–7.31 (m, 2H, Ar-H), 7.90 (s, 1H,=C*H*). $^{13}$C NMR ($CDCl_3$): $\delta = 14.20$ ($OCH_2CH_3$), 29.96 ($CH_3CO$), 43.33 ($CH_2$), 54.99 ($OCH_3$), 61.34 ($OCH_2CH_3$), 111.46 (CH), 112.40 (CH), 123.23 (CH), 124.80 (C), 127.73 (C), 142.88 (CH), 148.78 (CH), 149.32 (C), 167.63 (*C*OOEt), 205.65 ($CH_3CO$). GC/MS: $m/z = 262$ $[M]^+$.

### Ethyl-2-(3,4-dimethoxybenzylidene)-4-oxo-pentenoate (6c)

Yield: 70%; viscous liquid. IR (neat): 1722, 1700 $cm^{-1}$. $^1$H NMR ($CDCl_3$): $\delta = 1.24$ (t, $J = 7.1$ Hz, 3H, $OCH_2CH_3$), 2.17 (s, 3H, $CH_2COCH_3$), 3.58 (s, 2H, $CH_2COCH_3$), 3.77 (s, 3H, $OCH_3$), 4.17 (q, $J = 7.1$ Hz, 2H, $OCH_2CH_3$), 6.76–6.84 (m, 3H, Ar-H), 7.84 (s, 1H,=C*H*). $^{13}$C NMR ($CDCl_3$): $\delta = 14.14$ ($OCH_2CH_3$), 29.89 ($CH_3CO$), 42.73 ($CH_2$), 55.79 ($OCH_3$), 61.00 ($OCH_2CH_3$), 110.96 (CH), 112.04 (CH), 122.23 (CH), 124.88 (C), 127.73 (C), 141.98 (CH), 148.78 (CH), 149.72 (C), 167.53 (*C*OOEt), 206.45 ($CH_3CO$). GC/MS: $m/z = 292$ $[M]^+$. HRMS: $m/z$ $[M + Na^+]$ calcd. for $C_{16}H_{20}O_5$: 315.3207; found: 315.2845.

### Ethyl-2-(3,4,5-trimethoxybenzylidene)-4-oxo-pentenoate (6d)

Yield: 72%; viscous liquid. IR (neat): 1722, 1705 $cm^{-1}$. $^1$H NMR ($CDCl_3$): $\delta = 1.24$ (t, $J = 7.1$ Hz, 3H, $OCH_2CH_3$), 2.17 (s, 3H, $CH_2COCH_3$), 3.54 (s, 2H, $CH_2COCH_3$), 3.73 (s, 6H, $2 \times OCH_3$), 3.76 (s, 3H, $OCH_3$), 4.16 (q, $J = 7.1$ Hz, 2H, $OCH_2CH_3$), 6.49 (s, 2H, Ar-H), 7.76 (s, 1H,=C*H*). $^{13}$C NMR ($CDCl_3$): $\delta = 14.12$ ($OCH_2CH_3$), 29.78 ($CH_3CO$), 42.77 ($CH_2$), 56.03 ($OCH_3$), 90.76 ($OCH_3$), 61.10 ($OCH_2CH_3$), 106.09 (CH), 126.13 (C), 130.43 (C), 138.64 (C), 142.18 (CH), 153.10 (C), 167.29 (*C*OOEt), 206.40 ($CH_3CO$). HRMS: $m/z$ $[M + Na^+]$ calcd. for $C_{17}H_{22}O_6$: 345.1314; found: 345.1285.

## GENERAL PROCEDURE FOR THE PREPARATION NAPHTHALENE 7A–D

A slurry of phosphorus pentoxide (5 g) and 88% phosphoric acid (3 mL) was stirred at 70°C on an oil bath. To this slurry, keto-ester **6a–d** (2 mmol) was added in one portion, and the mixture was stirred for 10 min. After cooling, crushed ice was added, and the reaction mixture was extracted in EtOAc. The organic layer was dried over anhyd. $Na_2SO_4$ and was concentrated in vacuo. The residue was purified by column chromatography on silica gel (petroleum ether 60–80°C–EtOAc = 9 : 1) to yield naphthoic esters **7a–d**.

## DATA

### Ethyl-4-methyl-2-naphthoate (7a)[9]

Yield: 70%; white crystals; mp 52°C. IR (KBr): 1722, 1630, 1605 $cm^{-1}$. $^1H$ NMR ($CDCl_3$): $\delta = 1.46$ (t, $J = 7.2$ Hz, 3H, $OCH_2CH_3$), 2.73 (s, 3H, $ArCH_3$), 4.45 (q, $J = 7.2$ Hz, 2H, $OCH_2CH_3$), 7.52–7.65 (m, 2H, Ar-H), 7.93–8.03 (m, 3H, Ar-H), 8.48 (s, 1H, Ar-H). $^{13}C$ NMR ($CDCl_3$): $\delta = 14.35$ ($OCH_2CH_3$), 19.25 ($CH_3$), 60.94 ($OCH_2CH_3$), 124.00 (CH), 125.56 (CH), 126.16 (CH), 127.21 (C), 127.95 (CH), 129.35 (CH), 129.94 (CH), 132.61 (C), 134.64 (C), 166.85 (COOEt).

### Ethyl-7-methoxy-4-methyl-2-naphthoate (7b)

Yield: 69%; white solid; mp 55°C. IR (KBr): 1710, 1635, 1600 $cm^{-1}$. $^1H$ NMR ($CDCl_3$): $\delta = 1.44$ (t, $J = 7.2$ Hz, 3H, $OCH_2CH_3$), 2.69 (s, 3H, $ArCH_3$), 3.94 (s, 3H, $OCH_3$), 4.42 (q, $J = 7.2$ Hz, 2H, $OCH_2CH_3$), 7.26–7.26 (m, 2H, Ar-H), 7.77 (s, 1H, Ar-H), 7.92 (d, $J = 9.0$ Hz, 1H, Ar-H), 8.36 (s, 1H, Ar-H). $^{13}C$ NMR ($CDCl_3$): $\delta = 14.30$ ($OCH_2CH_3$), 20.45 ($CH_3$), 55.67 ($OCH_3$), 60.78 ($OCH_2CH_3$), 102.73 (CH), 106.88 (CH), 124.40 (CH), 126.68 (CH), 127.63 (C), 128.73 (CH), 130.22 (C), 133.77 (C), 149.89 (C), 151.52 (C), 168.11 (COOEt). GC/MS: $m/z = 244$ $[M]^+$.

### Ethyl-6,7-dimethoxy-4-methyl-2-naphthoate (7c)

Yield: 70%; white crystals; mp 144°C. IR (KBr): 1716, 1635, 1601 $cm^{-1}$. $^1H$ NMR ($CDCl_3$): $\delta = 1.43$ (t, $J = 7.2$ Hz, 3H, $OCH_2CH_3$), 2.66 (s, 3H, $ArCH_3$), 4.01 (s, 3H, $OCH_3$), 4.05 (s, 3H, $OCH_3$), 4.41 (q, $J = 7.2$ Hz, 2H, $OCH_2CH_3$), 7.20 (s, 1H, Ar-H), 7.23 (s, 1H, Ar-H), 7.80 (s, 1H, Ar-H), 8.33 (s, 1H, Ar-H). $^{13}C$ NMR ($CDCl_3$): $\delta = 14.33$ ($OCH_2CH_3$), 19.47 ($CH_3$), 55.79 ($OCH_3$), 60.70 ($OCH_2CH_3$), 102.73 (CH), 107.98 (CH), 124.42 (CH), 125.62 (C), 127.63 (CH), 128.33 (C), 130.82 (C), 132.78 (C), 149.49 (C), 151.00 (C), 167.05 (COOEt). GC/MS: $m/z = 274$ $[M]^+$. HRMS: $m/z$ $[M + Na^+]$ calcd. for $C_{16}H_{18}O_4$: 297.1103; found: 297.1097.

### Ethyl-5,6,7-trimethoxy-4-methyl-2-naphthoate (7d)

Yield: 66%; pale yellow crystals; mp 140°C. IR (KBr): 1720, 1638, 1606 $cm^{-1}$. $^1H$ NMR ($CDCl_3$): $\delta = 1.43$ (t, $J = 7.2$ Hz, 3H, $OCH_2CH_3$), 2.88 (s, 3H, $ArCH_3$), 3.95 (s, 3H, $OCH_3$), 3.98 (s, 6H, $2 \times OCH_3$), 4.41 (q, $J = 7.2$ Hz, 2H, $OCH_2CH_3$), 7.06 (s, 1H, Ar-H), 7.68 (s, 1H, Ar-H),

8.27 (s, 1H, Ar-H). $^{13}$C NMR ($CDCl_3$): $\delta = 14.29$ ($OCH_2\mathit{C}H_3$), 23.34 ($\mathit{C}H_3$), 55.67 ($OCH_3$), 60.79 ($O\mathit{C}H_3$), 61.15 ($O\mathit{C}H_2CH_3$), 104.76 (CH), 125.91 (CH), 126.67 (C), 128.01 (CH), 131.13 (C), 134.27 (C), 143.94 (C), 150.46 (C), 152.66 (C), 166.74 (*C*OOEt).

## ACKNOWLEDGMENT

We thank CSIR and UGC for support of this work; NIO, Goa, for spectral analysis; Department of Organic Chemistry IISc, Banglore, for HRMS; and RSIC, Mumbai, for analysis and GC/MS. C. P. A. thanks CSIR, New Delhi, for the award of research fellowship.

## REFERENCES

1. (a) Meyers, A. G.; Horiguchi, Y. *Tetrahedron Lett.* **1997**, 4363; (b) Pande, A.; Shukla, Y. N. *Phytochemistry* **1993**, *32*, 1350; (c) Charlton, J. L.; Lee, K. A. *Tetrahedron Lett.* **1984**, 7311; (d) Buta, J. G.; Steffens, G. L. *Phytochemistry* **1974**, *13*, 1033; (e) Gupta, R. K.; Dhar, M. M. *Phytochemistry* **1969**, *8*, 789; (f) Chen, C. L.; Hostettler, F. D. *Tetrahedron* **1969**, *25*, 3223.
2. (a) Shoji, J. *J. Antibiot.* **1961**, *14*, 27; (b) Ishida, N.; Miyazaki, M.; Kumangi, K.; Rikimaru, M. *J. Antibiot.* **1965**, *18*, 68; (c) Sartori, G.; Bigi, F.; Canali, G.; Mazzi, R.; Casnati, G.; Tao, X. *J. Org. Chem.* **1993**, *58*, 840; (d) Coleman, R. S.; Grant, E. B. *J. Org. Chem.* **1991**, *56*, 1357; (e) Yu, K.-L.; Spinazze, P.; Ostrowski, J.; Currier, S. J.; Pack, E. J.; Hammer, L.; Roalsvig, T.; Honeyman, J. A.; Tortolani, D. R.; Reczek, P. R.; Mansuri, M. M.; Starrett, J. E., Jr. *J. Med. Chem.* **1996**, *39* (12), 2411.
3. Huang, F.-C.; Chan, W.-K.; Warus, J. D.; Morrisette, M. M.; Moriarty, K. J.; Chang, M. N; Travis, J. J.; Mitchell, L. S.; Nuss, G. W.; Sutherland, C. A. *J. Med. Chem.* **1992**, *35*, 4235.
4. (a) Koning, C. B.; Rousseau, A. L.; van Otterlo, W. A. L. *Tetrahedron* **2003**, *59* (7), and references cited therein; (b) Takahashi, K.; Suzuki, T.; Hirama, M. *Tetrahedron Lett.* **1992**, 4603; (c) Shibuya, M.; Toyooka, K.; Kubota, S. *Tetrahedron Lett.* **1984**, 1171; (d) Shishido, K.; Yamashita, A.; Hiroya, K.; Fukumoto, K.; Kametani, T. *Tetrahedron Lett.* **1989**, 111; (e) Myers, A. G.; Subramanian, V.; Hammond, M. *Tetrahedron Lett.* **1996**, 587; (f) Takahashi, K.; Tanaka, T.; Suzuki, T.; Hirama, M. *Tetrahedron* **1994**, *50*, 1327; (g) Corey, E. J.; Palani, A. *Tetrahedron Lett.* **1997**, 2397; (h) Boger, D. L.; Mullican, M. D. *J. Org. Chem.* **1980**, *45*, 5002; (i) Ila, H.; Junjappa, H.; Mohanta, P. K. *Prog. Het. Chem.* **2001**, *13*, 1; (j) Krohn, K.; Bernhard, S. *Eur. J. Org. Chem.* **1999**, 3099; (k) Takaki, K.; Okada, M.; Yamada, M.; Negoro, K. *J. Org. Chem.* **1982**, *47*, 1200; (l) Vorogushhin, A. V.; Wulff, W. D.; Hansen, H.-J. *J. Am. Chem. Soc.* **2002**, *124*, 6512; (m) Dudley, G. B.; Takaki, K. S.; Cha, D. D.; Danheiser, R. L. *Org. Lett.* **1994**, *35*, 1127; (n) Ciufoline, M. A.; Weiss, T. J. *Tetrahedron Lett.* **1994**, *35*, 1127; (o) Gordon, D. M.; Danishefsky, S. J.; Schulte, G. K. *J. Org. Chem.* **1992**, *57*, 7052; (p) Parker, K. A.; Coburn, C. A. *J. Org. Chem.* **1991**, *56*, 1666.

5. Tilve, S. G.; Tilve, A. S.; Desai, V. D. *Synth. Commun.* **1996**, *26*, 1921.
6. Ballini, R.; Bosica, G. *Synlett.* **1996**, 1115.
7. Mali, R. S.; Babu, K. N. *Helv. Chim. Acta.* **2002**, *85*, 3525.
8. Kim, J. M.; Im, Y. J.; Kim, T. H.; Nyoung, K. J. *Bull. Korean Chem. Soc.* **2002**, *23* (5), 657.
9. (a) Kim, J. N.; Im, Y. J.; Gong, J. H. *Tetrahedron Lett.* **2001**, *42*, 4195; (b) Im, Y. J.; Chung, Y. M.; Gong, J. H. *Bull. Korean Chem. Soc.* **2004**, *23*, 787.