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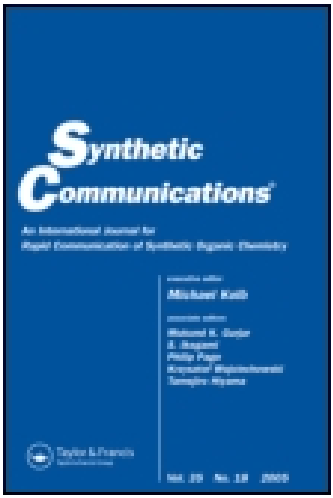

Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/lsyc20

EtOH/Ba(OH)$_2$ Triggers Self-Condensation of (E)-1,4-Diaryl-2-Butene-1,4-Diones to Cyclopentanol Derivatives

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Published online: 16 Aug 2006.

To cite this article: H. Surya Prakash Rao & S. P. Senthilkumar (2005) EtOH/Ba(OH)$_2$ Triggers Self-Condensation of (E)-1,4-Diaryl-2-Butene-1,4-Diones to Cyclopentanol Derivatives, Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry, 35:12, 1707-1714, DOI: 10.1081/SCC-200061715

To link to this article: http://dx.doi.org/10.1081/SCC-200061715

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Synthetic Communications®, 35: 1707–1714, 2005
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ISSN 0039-7911 print/1532-2432 online
DOI: 10.1081/SCC-200061715

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$EtOH/Ba(OH)_2$ Triggers Self-Condensation of (*E*)-1,4-Diaryl-2-Butene-1,4-Diones to Cyclopentanol Derivatives

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Abstract: Several stereo-defined penta-substituted cyclopentanols were synthesized from $EtOH/Ba(OH)_2$-induced self-condensation of (*E*)-1,4-diaryl-2-butene-1,4-diones formed via domino pathways.

Keywords: Barium hydroxide, 1,4-diaryl-2-butene-1,4-diones, domino reactions

The α,β-unsaturated carbonyl compounds have emerged as test systems to study the multicomponent condensation reactions involving the domino process.[1] In the domino reaction, the starting material undergoes a series of transformations in which the functional group generated in the first step serves to form the next bond in the subsequent step.[2] We have earlier reported that in the presence of barium hydroxide the enolate anion from cyclopentanone triggers multicomponent condensation of (*E*)-1,3-diaryl-2-propene-1-one (*trans*-chalcone) and phenyl vinyl ketone to furnish polycyclic products.[3] In continuation, $EtOH/Ba(OH)_2$-mediated self-condensation of (*E*)-1,4-diphenyl-2-butene-1,4-dione (*trans*-dibenzoylethylene, *trans*-DBE) to the cyclopentanol derivative has been presented here (Scheme 1). Previously, Cabrera and coworkers have reported the formation of some

Received in India November 2, 2004
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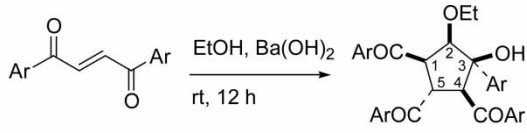

1a-d **2a-d**

1a, **2a**: Ar = C_6H_5; **1b**, **2b**: Ar = 4-Cl-C_6H_4; **1c**, **2c**: Ar = 4-Br-C_6H_4; **1d**, **2d**: Ar = 4-CH_3-C_6H_4

Scheme 1.

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tetrasubstituted cyclopentanol derivatives from *trans*-DBE in the presence of the one-electron reducing agent samarium (II) iodide.[4] Similarly, Al-Arab and co-workers reported the formation of cyclohexanol derivates from the base-mediated reaction of acetophenone with DBE.[5]

While attempting the condensation of cyclohexanone and *trans*-DBE in the presence of activated $Ba(OH)_2$, we noticed the formation of a polar product (6%) apart from the expected conjugate addition product (63%).[6] When the condensation reaction was conducted in the absence of cyclohexanone, the polar product was formed in 67% yield (Scheme 1). Its ^{1}H NMR and ^{13}C NMR spectra revealed the presence of least three diastereomeric cyclopentanols in the ratio of 61:28:11. The ratio of the diasteromers was determined on the integration of the cluster of signals located at δ 5.7 ppm in the ^{1}H NMR spectrum assignable to 5-H and the cluster of signals located at δ 90 ppm assignable to C-3. The major diastereomer **2a** was isolated in the pure form through fractional crystallization from the column fractions during column chromatography.

The structure and stereochemistry of the cyclopentanol derivative **2a**, obtained as a white crystalline solid (mp 184–186°C) was deduced on the basis of analytical and spectral data (IR, ^{1}H NMR, ^{13}C NMR, DEPT, COSY, and NOESY). Final confirmation of the proposed structure of **2a** was obtained by X-ray analysis (Figure 1) on the sample recrystallized from 10% EtOAc in hexanes. (See the Appendix.)

Having established the structure of the cyclopentanol derivative **2a**, the generality of the reaction was next studied by subjecting different *trans*-DBE derivatives with electron-withdrawing (Cl, **1b**, Br, **1c**) and electron-donating (Me, **1d**) groups located on the *para* position of the aryl rings to self-condensation. The reactions furnished cyclopentanol products **2b–d** in 64–72% yield. Although pure cyclopentanols **2b** and **2c** could be isolated from the fractional crystallization their respective mixture of isomers, **2d** could not be obtained as a single product by different chromatographic or recrystallization techniques.

Surprisingly, the present three-component condensation reaction involving two units of *trans*-DBE **1a** and the alkoxide anion did not take place with MeOH/$Ba(OH)_2$. Only conjugate addition product **6** was isolated from the reaction in moderate yield (34%; Scheme 2).[7]

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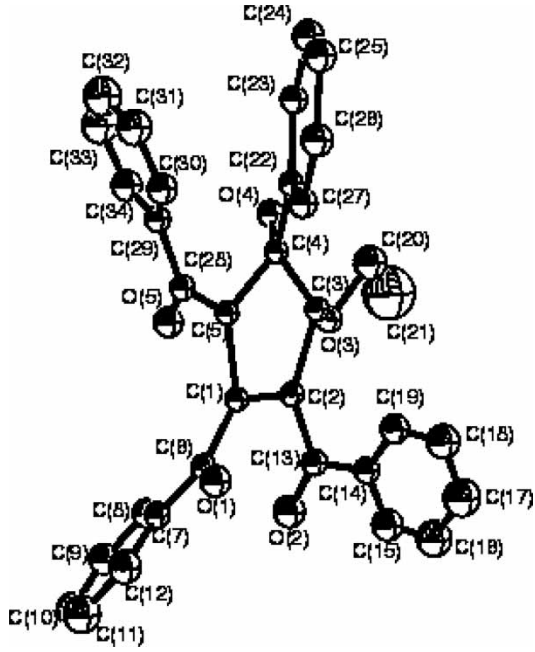
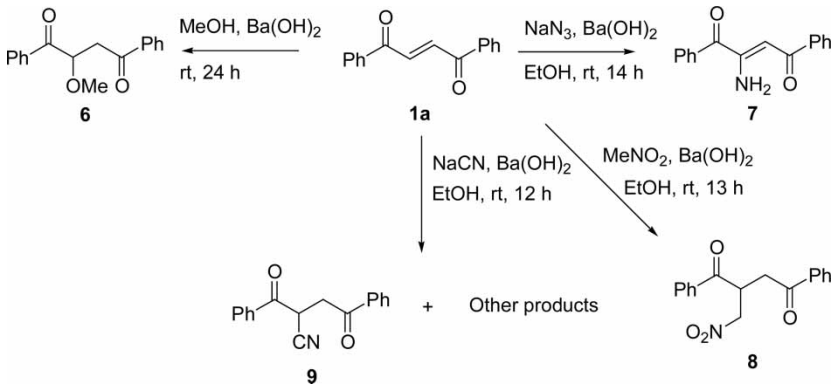


Figure 1. Crystal structure of [(1*R*,2*S*,3*S*,4*S*,5*R*)-4,5-dibenzoyl-2-ethoxy-3-hydroxy-3-phenylcyclopentyl](phenyl)methanone (**2a**, with crystal structure numbering; hydrogens were omitted for clarity).

The $Ba(OH)_2$-mediated three-component domino reaction of **1a** was attempted with azide, cyanide, and nitromethane anions. Although the nitromethane added to *trans*-DBE **1a** in conjugate mode to furnish known diketone **8**[8] (54%, Scheme 2), the product from the conjugate addition of



Scheme 2.

azide anion underwent further reduction to yield known 2-amino-1,4-diphenylbut-2-ene-1,4-dione **7**[9] (58%, Scheme 2). We did not notice any cyclopentanol products from these reactions. The reaction of **1a** with cyanide anion in the presence of activated $Ba(OH)_2$ furnished a complex mixture along with conjugate addition product **9**.[10] Surprisingly there was no $Ba(OH)_2$-mediated reaction of *trans*-DBE **1a** with thiophenol or heptanethiol.

In short, we have shown that $EtOH/Ba(OH)_2$ induces self-condensation of *trans*-DBE and its derivatives to furnish penta-substituted cyclopentanol derivatives with defined stereochemistry. It appears that the cyclopentanol formation is induced only in the presence of $EtOH/Ba(OH)_2$.

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EXPERIMENTAL

General

The progress of all the reactions was monitored by TLC (TLC silica gel; Qualigens or TLC alumina: SRL, India) using hexanes/ethyl acetate mixture as an eluent. Column chromatography was accomplished on silica gel (100–200 mesh, Acme Synthetic Chemicals) using hexanes/ethyl acetate mixture as an eluent. The IR spectra were recorded as a solution in KBr or neat using ABB Bomem MB-104 FT-IR spectrometer. The ^1H NMR and ^{13}C NMR spectra were recorded in $CDCl_3$ or $CDCl_3 \cdot CCl_4$ (1:1) using JEOL 400-MHz or Varian 300-MHz NMR spectrometer. The mass spectra were recorded on Finnigan MAT 8230 or JEOL DX-303 mass spectrometer. The elemental analysis was carried out on a Elementar vario EL (Germany) apparatus. The X-ray diffraction data was generated on SMART (Siemens) diffractometer. The *trans*-DBE and derivatives (**1a–d**) were prepared according to literature procedure.[11] The activated $Ba(OH)_2$ was prepared by heating commercial $Ba(OH)_2 \cdot 8H_2O$ at 200°C for 3 h in a furnace and then stored in a desiccator.[12]

Synthesis of (±) [(1R,2S,3S,4S,5R)-4,5-dibenzoyl-2-ethoxy-3-hydroxy-3-phenylcyclopentyl](phenyl)methanone **2a**; *representative procedure*: To a stirred mixture of activated $Ba(OH)_2$ (73 mg, 0.43 mmol) in 10 mL of absolute ethanol, *trans*-DBE **1a** (500 mg, 2.12 mmol) was added in four equal portions and allowed to stir at room temperature for 12 h. After complete disappearance of **1a** (TLC), the suspended solid particles were filtered through a celite pad. The clear filtrate was concentrated to 3 mL and was diluted with 30 mL of dichloromethane and then poured over ice-cooled water. The organic layer was separated, washed again with water (3×20 mL) and brine solution (2×10 mL), dried over anhydrous Na_2SO_4, and concentrated. The crude product was subjected to column

chromatography (silica gel, 100–200 mesh) and eluted with 10% EtOAc–hexanes to give **2a** (63 mg, 12%) as a crystalline solid. Mp 184–186°C; $R_f = 0.43$ (10% EtOAc–hexanes); IR (KBr) 3466, 1683, 1596, 1449, 1258, 709, 691 cm^{-1}; ^{1}H NMR (300 MHz, $CDCl_3$) δ 0.68 (t, $J = 7.2$ Hz, 3H), 2.85 (m, 1H), 3.09 (m, 1H), 4.20 (s, 1H), 4.49 (d, $J = 7.8$ Hz, 1H), 4.55 (d, $J = 10.5$ Hz, 1H), 4.78 (dd, $J = 7.8$, 10.5 Hz, 1H), 5.76 (t, $J = 10.2$ Hz, 1H), 7.05 (t, $J = 7.8$ Hz, 2H), 7.21–7.54 (m, 14H), 7.89 (d, $J = 8.7$ Hz, 2H), 8.26 (d, $J = 8.7$ Hz, 2H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$) δ 14.6, 46.1, 54.8, 62.3, 68.9, 82.7, 89.7, 124.8, 127.3, 127.8, 128.0, 128.3, 128.5 (2C), 128.6, 129.4, 132.4, 133.1, 133.6, 136.2, 137.2, 137.3, 144.7, 196.9, 197.5, 202.5 ppm; FAB-MS 519 ($M^+ + 1$); Anal. calcd. for $C_{34}H_{30}O_5$: C, 78.74; H, 5.83. Found: C, 78.77; H, 5.87.

(±) *(4-Chlorophenyl)[(1R,2S,3S,4S,5R)-4,5-di(4-chlorobenzoyl)-3-(4-chlorophenyl)-2-ethoxy-3-hydroxycyclopentyl]methanone* **2b**: Mp 168–170°C; $R_f = 0.36$ (10% EtOAc–hexanes); IR (KBr) 3466, 2975, 2929, 1684, 1588, 1489, 1401, 1247, 1093, 1006, 840 cm^{-1}; ^{1}H NMR (300 MHz, $CDCl_3$/CCl_4) δ 0.76 (t, $J = 6.9$ Hz, 3H), 2.81–2.91 (m, 1H), 3.06–3.16 (m, 1H), 4.04 (s, 1H), 4.30 (d, $J = 10.8$ Hz, 1H), 4.35 (d, $J = 9.9$ Hz, 1H), 4.60 (t, $J = 7.5$ Hz, 1H), 5.56 (t, $J = 10.2$ Hz, 1H), 7.07 (d, $J = 8.4$ Hz, 2H), 7.24 (d, $J = 8.1$ Hz, 2H), 7.31 (d, $J = 8.1$ Hz, 2H), 7.39–7.50 (m, 6H), 7.81 (d, $J = 8.4$ Hz, 2H), 8.16 (d, $J = 8.4$ Hz, 2H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$/CCl_4) δ 14.98, 45.86, 54.60, 62.44, 69.04, 82.53, 89.73, 126.38, 128.29, 129.00, 129.15, 129.51, 129.77, 130.21, 131.15, 133.87, 134.29, 135.50, 135.61, 139.33, 139.87, 140.63, 143.37, 194.65, 195.09, 200.72 ppm; LRMS M^+ did not appear, 639 (7), 517 (19), 515 (30), 497 (18), 468 (29), 447 (15), 445 (35), 443 (27), 428 (20), 364 (31), 348 (24), 348 (18), 307 (69), 305 (100), 304 (74), 181 (12), 183 (7), 113 (27), 111 (78), 89 (19), 75 (55), 69 (18); Anal. calcd. for $C_{34}H_{24}Cl_4O_5$: C, 62.24; H, 3.99. Found: C, 62.21; H, 4.02.

(±) *(4-Bromophenyl)[(1R,2S,3S,4S,5R)-4,5-di(4-bromobenzoyl)-3-(4-bromophenyl)-2-ethoxy-3-hydroxycyclopentyl]methanone* **2c**: Mp 176–178°C; $R_f = 0.38$ (10% EtOAc–hexanes); IR (KBr) 3496, 2971, 2927, 1671, 1585, 1486, 1398, 1234, 1096, 1073, 1003, 980, 834 cm^{-1}; ^{1}H NMR (300 MHz, $CDCl_3$/CCl_4) δ 0.71 (t, $J = 14.1$ Hz, 3H), 2.82–2.92 (m, 1H), 3.03–3.13 (m, 1H), 4.07 (s, 1H), 4.36 (d, $J = 10.8$ Hz, 1H), 4.41 (d, J = 7.8 Hz, 1H), 4.62 (t, $J = 18.0$ Hz, 1H), 5.61 (t, $J = 20.4$ Hz, 1H), 7.17 (d, $J = 7.5$ Hz, 2H), 7.25 (d, $J = 8.1$ Hz, 2H), 7.38 (d, $J = 8.1$ Hz, 2H), 7.46 (d, $J = 8.7$ Hz, 2H), 7.60 (dd, $J = 6.3$, 4.8 Hz, 4H), 7.74 (d, $J = 8.4$ Hz, 2H), 8.11 (d, $J = 8.4$ Hz, 2H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$/CCl_4) δ 14.64, 45.81, 54.56, 62.29, 69.14, 82.40, 89.32, 121.74, 126.60, 127.94 (2C), 128.55 (2C), 129.44, 129.64, 130.97, 131.23, 131.84, 131.96, 132.11, 134.71, 135.91, 143.41, 195.42, 196.10, 201.24 ppm; LRMS M^+ peak did not

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appear, 338 (20), 228 (100), 216 (12), 117 (10), 117 (38), 90 (40), 57 (42); Anal. calcd. for $C_{34}H_{24}Br_4O_5$: C, 48.94; H, 3.14. Found: C, 48.91; H, 3.19.

(±) *[2-Ethoxy-3-hydroxy-4,5-di(4-methylbenzoyl)-3-(4-methylphenyl)cyclopentyl](4-methylphenyl)methanone* **2d**: Mp 200–202°C; $R_f = 0.40$ (10% EtOAc–hexanes); IR (KBr) 3463, 2923, 2853, 1670, 1606, 1573, 1463, 1377, 1240, 1182, 1104, 1006, 828, 721 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$/CCl_4, 1:1) δ 0.76 (t, $J = 7.5$ Hz, 3H), 2.28 (s, 3H), 2.31 (s, 3H), 2.37 (s, 3H), 2.44 (s, 3H), 2.86–2.91 (m, 1H), 3.09–3.17 (m, 1H), 4.15 (s, 1H), 4.31 (d, $J = 7.2$ Hz, 1H), 4.40 (d, $J = 7.8$ Hz, 1H), 4.58 (dd, $J = 5.7$, 13.8 Hz, 1H), 5.59 (t, $J = 10.2$ Hz, 1H), 6.81–6.86 (m, 2H), 7.07–7.29 (m, 4H), 7.42–7.53 (m, 2H), 7.75–7.85 (m, 4H), 7.95 (d, $J = 8.40$ Hz, 2H), 8.08 (d, $J = 8.40$ Hz, 2H) ppm; ^{13}C NMR (75 MHz, $CDCl_3/CCl_4$, 1:1) δ 15.38, 21.09, 21.25 (2C), 21.79, 47.05, 56.24, 62.71, 68.66, 83.00, 90.42, 125.03, 126.02, 128.34, 128.47, 128.95, 129.16, 129.29, 129.84, 132.98, 134.08, 135.07, 136.20, 138.28, 139.90, 142.85, 145.10, 196.01, 199.98, 201.71 ppm; FAB-MS 575 ($M^+ + 1$); Anal. calcd for $C_{38}H_{38}O_5$: C, 79.44; H, 6.66. Found: C, 79.42; H, 6.69.

2-Methoxy-1,4-diphenyl-1,4-butanedione **6**: $R_f = 0.38$ (10% EtOAc–hexanes); IR (KBr) 763, 841, 1005, 1250, 1401, 1489, 1588, 1683, 2929, 2977, 3070 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 1.83 (t, $J = 6.35$ Hz, 1H), 2.31 (t, $J = 6.35$ Hz, 1H), 3.41 (s, 3H), 5.39 (dd, $J = 4.39$, 11.72 Hz, 1H), 7.41–7.59 (m, 6H), 7.95 (d, $J = 7.81$ Hz, 2H), 8.04 (d, $J = 7.81$ Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 40.62, 57.80, 78.59, 127.58, 128.21, 128.32, 128.35, 133.42, 133.53, 135.06, 136.53, 196.72, 199.60 ppm.

(Z)-2-Amino-1,4-diphenyl-2-butene-1,4-dione **7**: Mp 132–134°C (lit.[9] 133–134°C); $R_f = 0.48$ (10% EtOAc–hexanes); IR (KBr) 3378, 3269, 1664, 1613, 1593, 1527, 1445, 1275, 1239, 1172, 768, 725 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 6.23 (s, 1H), 7.39–7.56 (m, 4H), 7.66 (t, $J = 14.86$ Hz, 2H), 7.82 (t, $J = 8.61$ Hz, 2H), 7.88 (t, $J = 8.66$ Hz, 2H), 9.5 (br s, 2H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$) δ 97.63, 127.37, 128.51, 128.58, 129.81, 131.96, 133.41, 135.42, 139.28, 152.57, 191.75, 193.63 ppm.

2-(Nitromethyl)-1,4-diphenyl-1,4-butanedione **8**: Mp 93–94°C (lit.[8] 95°C); $R_f = 0.30$ (10% EtOAc–hexanes); IR (KBr) 3066, 2978, 1679, 1552, 1447, 1416, 1386, 1253, 1216, 984, 961, 757, 691 cm^{-1}; ^1H NMR (300 MHz, $CDCl_3$) δ 3.25 (dd, $J = 6.91$, 7.40 Hz, 1H), 3.55 (dd, $J = 4.76$, 1.58 Hz, 1H), 4.60–4.68 (m, 1H), 4.88–4.96 (m, 2H), 7.44–7.63 (m, 6H), 7.91 (d, $J = 8.69$ Hz, 2H), 8.04 (d, $J = 8.74$ Hz, 2H) ppm; ^{13}C NMR (75 MHz, $CDCl_3$) δ 37.99, 39.5, 74.62, 128.12, 128.66, 128.84, 129.06, 133.95, 134.0, 134.91, 135.69, 195.81, 198.46 ppm.

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APPENDIX

Crystal structure analysis was carried out by Professor H.-K. Fun, Universiti Sains Malaysia, Malaysia. Crystal data and experimental crystallographic details for **2a**; Cambridge Crystallographic Data Center, deposition no. CCDC 226255.

Empirical formula	$C_{34}H_{30}O_5$
Formula weight	518.58
Temperature	293(2) K
Wavelength	0.71073
Crystal system, space group	Triclinic, P-1
Unit cell dimensions	a = 11.0603(4) A α = 108.079(1) deg. b = 11.2631(4) A β = 91.207(1) deg. c = 12.4962(4) A γ = 106.913(1) deg.
Volume	1405.18(8) $\AA^3$
z, calculated density	2, 1.226 Mg/m^3
Absorption coefficient	0.081 mm^{-1}
F(000)	548
Crystal size	0.40 × 0.32 × 0.24 mm
Theta range for data collection	1.73 to 29.37 deg.
Limiting indices	$-13 \le h \le 15$, $-9 \le k \le 15$, $-17 \le l \le 16$
Reflection collected/unique	10071/6641 [R(int) = 0.0499]
Completeness to theta = 29.37	85.7%
Absorption correction	None
Refinement method	Full-matrix least-squares on F^2
Data/restraints/parameters	6641/0/352
Goodness of fit	0.882
Final R indices [I > 2 sigma(I)]	R1 = 0.0657, wR2 = 0.1516
R indices (all data)	R1 = 0.1400, wR2 = 0.1803
Largest diff. peak and hole/eA^{-3}	0.272 and −0.287

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ACKNOWLEDGMENT

SPSK thanks CSIR, India for fellowship. HSPR thanks UGC-SAP and CSIR, India, for financial support. The authors thank A. Srikrishna, Hans Scheeren, and SIF, IISc, Bangalore, for recording spectra. The authors also thank H.-K. Fun, Universiti Sains Malaysia, Malaysia, for solving X-ray crystal structure. X-ray data was deposited in Cambridge Crystallographic Data Centre, No: CCDC 226255.

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REFERENCES

1. (a) Kaupp, G.; Poyodda, U.; Atfah, A.; Meier, H.; Vierengel, A. A new reaction type in the conversion of enamines with 1,4-diphenyl-2-butene-1,4-dione to give Cage compounds. *Angew. Chem., Int. Ed. Engl.* **1992**, *31*, 768–770; (b) Atfah, M. A.; Al-Arab, M. M. Novel bicyclo[2.2.2]lactones from a facile condensation of dibenzoylethylene with arylacetonitriles. *J. Heterocycl. Chem.* **1990**, *27*, 599–603.
2. Tietze, L. F.; Petersen, S. Stereoselective total synthesis of a novel D-homosteroid by a twofold heck reaction. *Eur. J. Org. Chem.* **2000**, 1827–1830.
3. (a) Rao, H. S. P.; Jeyalakshmi, K.; Senthilkumar, S. P. Novel domino products from the reaction of phenyl vinyl ketone and its derivatives with cyclic ketones. *Tetrahedron* **2002**, *58*, 2189–2199; (b) Rao, H. S. P.; Jeyalakshmi, K.; Bharathi, B.; Pushpalatha, L.; Uma Maheswari, V. Domino products from the reaction of 1,3-diaryl-2-propen-1-ones (chalcones) with cyclopentanone. *J. Indian Chem. Soc.* **2001**, *78*, 787–795.
4. Cabrera, A.; Lagadee, R. L.; Sharma, P.; Arias, J. L.; Toscano, R. A.; Velasco, L.; Gavino, R.; Alvarez, C.; Salman, M. Cyclo- and hydrodimerization of α,β-unsaturated ketones promoted by samarium diiodide. *J. Chem. Soc., Perkin Trans. 1* **1998**, 3609–3518.
5. Al-Arab, M. M.; Atfeh, M. A.; Al-Saleh, F. S. The Michael reaction of acetophenones with *trans*-dibenzoylethylene. *Tetrahedron* **1997**, *53*, 1045–1052.
6. Rao, H. S. P.; Senthilkumar, S. P. Microwave assisted synthesis of phenyl(2-phenyl-5,6,7,8-tetrahydro-4-quinolinyl)methanone and its derivatives. *Ind. J. Chem.* **2004**, *43B*, 2426–2430.
7. Lutz, R. E.; Chi-Kang, D. α-Substituted β-diketones. Stereoisomeric enols of α-phenacyldibenzoylmethane. Addition-enolization of unsaturated triketones. *J. Org. Chem.* **1956**, *21*, 551–560.
8. Strumza, J.; Altschuler, S. Michael reaction with nitroform and related syntheses. *Israel J. Chem.* **1963**, *1*, 106–114; Chemical Abstracts Number (CAN): **1964**, 60:60367.
9. (a) Seko, S.; Miyake, K. Amination of α,β-unsaturated γ-dicarbonyl compounds with methoxyamines. *Synth. Commun.* **1999**, *29*, 2487–2492; (b) Tamura, Y.; Sumoto, K.; Matsushima, H.; Taniguchi, H.; Ikda, M. Reactions of *N*-substituted arylsulfilimines with acylating agents and with activated halobenzenes, alkynes and alkenes. *J. Org. Chem.* **1973**, *38*, 4324–4328.
10. Nguyen, V. H.; Nishino, H.; Kurosawa, K. Manganese (III) based facile synthesis of 3-cyano-4,5-dihydrofurans and 4-cyano-1,2-dioxan-3-ols using alkenes and acylacetonitrile building blocks. *Synthesis* **1997**, *8*, 899–908.
11. (a) Conant, J. B.; Lutz, R. E. A new method of preparing dibenzoylethylene and related compounds. *J. Am. Chem. Soc.* **1923**, *45*, 1303–1307; (b) Campaigne, E.; Foye, W. O. The synthesis of 2,5-diarylthiophenes. *J. Org. Chem.* **1952**, *17*, 1405–1412.
12. Garcia-Raso, A.; Garcia-Raso, J.; Campaner, B.; Mestres, R.; Sinistera, J. V. An improved procedure for the Michael reaction of chalcones. *Synthesis* **1982**, 1037–1040.