Tetrahedron Letters, Vol.30, No.1, pp 91-94, 1989
Printed in Great Britain

0040-4039/89 $3.00 + .00
Pergamon Press plc

DIVERGENT SYNTHESIS OF 1,3- AND 1,4-DIKETONES FROM β-METHOXY-γ-PHENYLTHIO KETONES ACCESSIBLE THROUGH NOVEL PHENYLTHIO MIGRATION REACTION

Tsuneo Sato, Masami Inoue, Satoru Kobara, Junzo Otera,* and Hitosi Nozaki
Department of Applied Chemistry, Okayama University of Science, Ridai-cho
Okayama 700, Japan

Abstract. Both 1,3- and 1,4-diketones are obtained from common precursors, β-methoxy-γ-phenylthio ketones. These compounds are derived through the novel phenylthio migration reaction of the aldehyde adducts with methoxy(phenylthio)-methane upon exposure to enol silyl ethers. The compounds thus obtained are converted into 1,3- and 1,4-diketones.

Both 1,3- and 1,4-diketones are versatile intermediates in natural product synthesis.[1)] It therefore would be of great synthetic value if each type of compounds could be obtained from common precursors. Unfortunately, however, no such process is available yet despite a number of synthetic methodologies proposed for these respective compounds.[2,3)] Now we wish to report for the first time realization of this highly desired strategy employing β-methoxy-γ-phenylthio ketones **2** as key intermediates.

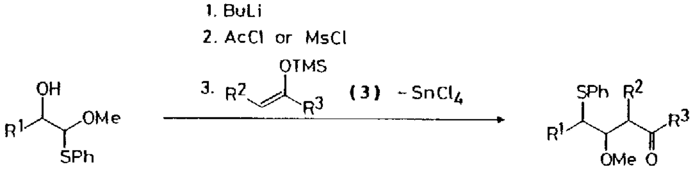
The present method has its foundation on facile one-pot synthesis of **2** through incorporation of enol silyl ethers **3** into the methoxy(phenylthio)methane-aldehyde adducts **1**[3,4)] induced by novel phenylthio migration (eq 1).[5)] To the best of our knowledge, this is the first example of the phenylthio migration concomitant with carbon-carbon bond formation although precedent studies disclosed conversion of **1** into α-sulfenylated carbonyl compounds[3,6)] as well as migration reaction of more simple β-hydroxy sulfides followed by dehydration giving rise to allyl sulfides.[7)] As shown in Table 1, an acetoxy group is the best leaving group for the adducts of aryl and α,β-unsaturated aldehydes whereas a methanesulfonyloxy group serves better for aliphatic aldehyde adducts. $SnCl_4$ proved to be more effective than other Lewis acids such as $TiCl_4$, $AlCl_3$, TMSOTf, and BF_3OEt_2. Generality and wide applicability of this reaction are apparent from the results thus obtained.

Oxidation of **2** with mCPBA followed by thermolysis in refluxing mesitylene and hydrolysis of the resulting enol ethers **4** provide 1,3-diketones **5** (eq 2, Table 2).[5)]

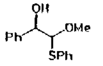
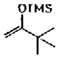
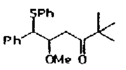
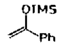
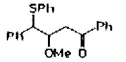
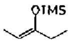
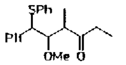
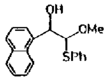
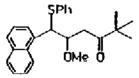
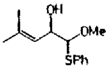
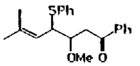
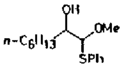
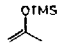
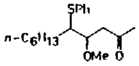
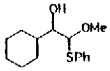
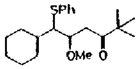
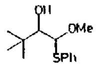
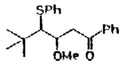
Exposure of **2** to t-BuOK[8)] and subsequent acid-hydrolysis of the alkenyl sulfides **6**[3)] lead us to arrive at 1,4-diketones **7** (eq 3, Table 3).[5)]

Scheme I conceptualizes the present process as a whole. The new route for 1,3-diketones stemmed from fabrication of the three components, a carbocation, a carbonyl 1,1-dipole, and an enolate. Particularly worthy of note is conversion of the carbonyl function of the aldehydes into a methylene moiety. On the other hand, 1,4-diketones are assembled through the $C_1 + C_1 + C_2$ coupling mode, which has been previously prosposed by us in a little more indirect manner.[3)] In this instance, methoxy(phenylthio)methane works as a methylene 1,1-dipole equivalent[9)] in contrast to a carbonyl 1,1-dipole equivalent[10)]

Table 1. Synthesis of β-methoxy-γ-phenylthio ketones **2**.[a]



1 **2** (1)

entry	**1**	**3**	reactn time, h	**2**	yield,%[b]
1	 (**1a**)	 (**3a**)	2	 (**2a**)	60
2	**1a**	 (**3b**)	1	 (**2b**)	64
3	**1a**	 (**3c**)	3	 (**2c**)	65
4		**3a**	1	 (**2d**)	76
5		**3b**	1	 (**2e**)	81
6		 (**3d**)	0.5	 (**2f**)	59
7		**3a**	1	 (**2g**)	60
8		**3b**	1	 (**2h**)	54

[a] Reaction conditions: (1) BuLi, CH_2Cl_2, -78 - 0 °C, 0.5 h, (2) AcCl for entries 1-5 or MsCl for entries 6-8, 0 °C, 1 h, and (3) **3**, $SnCl_4$ (1.0 equiv), -78 °C. [b] Isolated yields.

in the former case. Apparently, this unique transposition of the carbonyl function results from the selective elimination of the vicinally located methoxy or phenylthio group in **1**[11] coupled with the novel phenylthio migration.

Scheme I

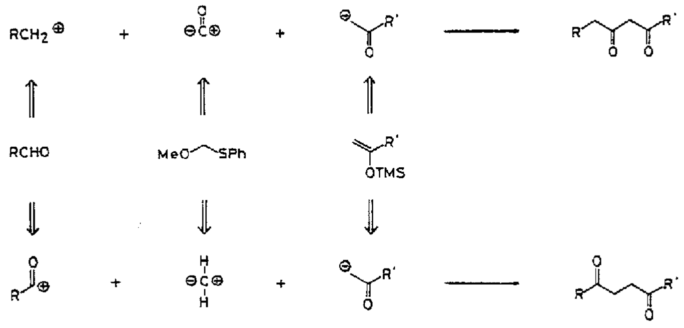
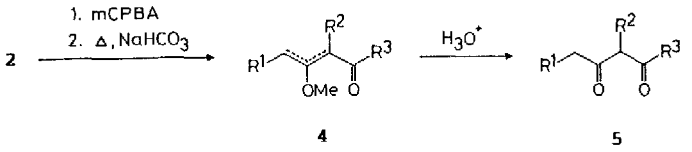
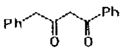
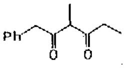
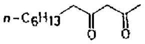
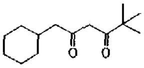


Table 2. Synthesis of 1,3-diketones **5**.[a]

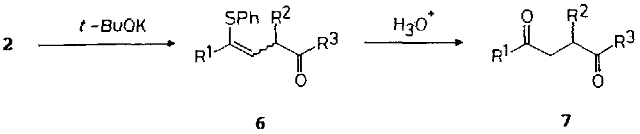


(2)

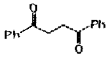
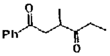
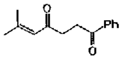
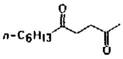
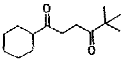
2	reactn time, h	yield of **4**,%[b]	reactn time, h	**5**	yield,%[b]
2b	0.5	51	1		59
2c	1	63	1		62
2f	1	48	2		42
2g	0.5	53	1		64

[a] Reaction conditions from **2** to **4**: mCPBA, CH_2Cl_2, -50 °C, 0.5 - 1 h, and then $NaHCO_3$, mesitylene, reflux. Reaction conditions from **4** to **5**: $ZnCl_2$, $CF_3COOH-H_2O$ (4:1), rt.
[b] Isolated yields.

Table 3. Synthesis of 1,4-diketones **7**.[a]



(3)

2	yield of **6**[b] (E:Z)		reactn condn temp, °C	time, h	**7**	yield,%[b]
2b	96[c]	(1:9)	20	5.5		71[d]
2c	90	(1:6)	-20	1		50
2e	77	(1:1)	-20	1		72
2f	55	(1:1)	20	6		91[d]
2g	56	(0:10)	20	0.5		56

[a] Reaction conditions from **2** to **6**: t-BuOK, THF, -78 °C, 0.5 - 1 h unless otherwise noted. Reaction conditions from **6** to **7**: $CF_3COOH-H_2O$ (4:1). [b] Isolated yields. [c] At room temperature. [d] Ref. 3.

Acknowledgment. This work was partially suported by Grant-in-Aid (No. 62607521 and 63607528) from The Ministry of Education, Science, and Culture, Japan

References

(1) Applications of 1,3-diketones to natural product syntheses: T. M. Harris and C. M. Harris, Tetrahedron, **33**, 2159 (1977). T. M. Harris and C. M. Harris, Pure Appl. Chem., **58**, 283 (1986). For 1,4-diketones, see T.-L. Ho, Synth. Commun., **4**, 265 (1974).

(2) 1,3-Diketones: C. R. Hauser, F. W. Swamer,and J. T. Adams, Org. React., **8**, 59 (1954). H. O. House, "Modern Synthetic Reactions", 2nd ed. W. A. Benjamin, Inc. 1972, Chapter 11. I. Kopka and M. W. Rathke, J. Org. Chem., **46**, 3771 (1981). M. Suzuki, A. Watanabe, and R. Noyori, J. Am. Chem. Soc., **102**, 2095 (1980), and references therein. R. E. Tirpak and M. W. Rathke, J. Org. Chem., **47**, 5099 (1982).

(3) For 1,4-diketones, see T. Sato, H. Okazaki, J. Otera, and H. Nozaki, J. Am. Chem. Soc., **110**, 5209 (1988), and references therein.

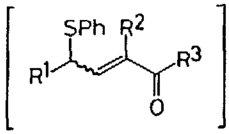
(4) T. Mandai, K. Hara, T. Nakajima, M. Kawada, and J. Otera, Tetrahedron Lett., **24**, 4993 (1983).

(5) All products gave satisfactory IR, NMR, and HRMS data.

(6) Ae. de Groot and B. J. M. Jansen, Tetrahedron Lett., **22**, 887 (1981).

(7) For the most recent work, see V. K. Aggarwal and S. Warren, J. Chem. Soc. Perkin Trans. I **1987**, 2579.

(8) Conversion of 2-methoxyalkyl sulfides into the corresponding 1-alkenyl sulfides with recourse to BuLi-TMEDA was reported; T. Takeda, T. Furukawa, M. Fujimori, K. Suzuki, and T. Fujiwara, Bull. Chem. Soc. Jpn.,**57**, 1863 (1984). The treatment of these compounds with _t_-BuOK, however, has proved to induce no reaction. Our reaction is thus assumed to involve initial abstraction of the hydrogen α to a carbonyl group, not α to a phenylthio group, yielding γ-phenylthio-α,β-unsaturated ketones **8** as intermediates. Isomerization of **8** into **6** catalyzed by _t_-BuOK has been disclosed.3)



8

(9) Dialkylated methylene 1,1-dipole equivalents: B. M. Trost and M. R. Ghadiri, J. Am. Chem. Soc., **106**, 7260 (1984). Sulfur ylids may be viewed as the parent methylene 1,1-dipole equivalents: E. J. Corey and M. Chaykovsky, J. Am. Chem. Soc., **87**, 1353 (1965).

(10) Carbonyl 1,1-dipole equivalents based on sulfonyl functionality was reported: B. M. Trost and P. Quayle, J. Am. Chem. Soc., **106**, 2469 (1984).

(11) Synthetic potentialities of the vicinal disubstitution with oxygen and sulfur functions: J. Otera, Synthesis, **1988**, 95.

(Received in Japan 7 October 1988)