

A Selective Catalytic Method of Enol-acetylation under Microwave Irradiation†‡

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Six-membered cyclic ketones on treatment with acetic anhydride and a catalytic amount of iodine under microwave irradiation give the corresponding enol acetates in good yield.

In pursuance of our interest on iodine as a catalyst for various reactions such as acylation,¹ acetylation,² acetalization,³ *etc.* we had studied the effect of iodine on the reaction of acetic anhydride with ketones. When cyclohexanone was refluxed in THF with acetic anhydride and iodine for 8 h an indication of a less polar spot was observed in TLC. The same reaction when heated under microwave irradiation for 5 min furnished a quantitative yield of the corresponding enol acetate. To generalise the reaction, several examples were performed, and results are given in Table 1.

Enol esters of ketones are extremely valuable intermediates in synthetic organic chemistry. Various manipulations, such as epoxidation, halogenation, photolysis, *etc.* on such intermediates afford different important products.⁴ This is also a reaction of preparative value for 17 α -hydroxycorticoids including cortison.⁵ Despite their importance as valuable intermediates, only a limited number of methods are available for the preparation of enol acetates.

Earlier methods of enol acetylation of ketones described mainly the use of acetic anhydride with acidic catalysts such as perchloric acid,⁶ toluene-*p*-sulfonic acid⁷ or acetic anhydride with basic catalysts such as potassium carbonate,⁸ triethyl amine,⁹ *etc.* Another method utilized isopropenyl acetate and toluene-*p*-sulfonic acid¹⁰ as the reagent of choice. Ladjama and Riehl¹¹ used KH–AcCl for enol acetylation of aldehydes while Limat and Schlosser¹² reported recently the use of acyl fluoride for the same purpose. In two different reports Choudhury *et al.*¹³ and Caliez *et al.*¹⁴ used chlorotrimethylsilane as a catalyst for enol acetylation of ketones with acetic anhydride.

Earlier methods of enol acetylation used either strong acids or bases as catalysts which may be detrimental to delicate substrates. Our present method is fast and utilizes a mild non-toxic catalyst. Moreover the present reagent system is selective to six-membered cyclic ketones only. It does not react with open-chain or five-membered cyclic ketones (entries 9 and 10 in Table 1) or with α , β -unsaturated acyclic ketones (entry 8) under these conditions. Longer reaction times or use of higher microwave power on these substrates leads to decomposition only. In contradiction to an earlier report,¹³ carvone under the reaction conditions gives carvacrol instead of an enol acetate or carvacrol acetate.

Experimental

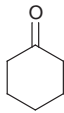
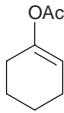
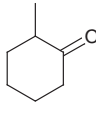
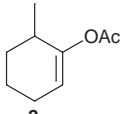
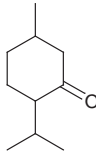
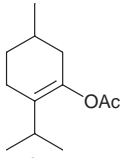
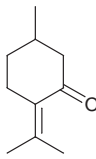
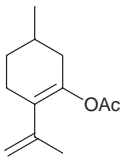
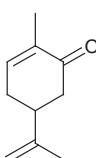
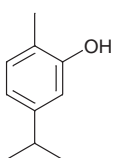
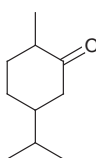
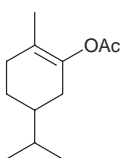
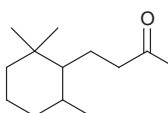
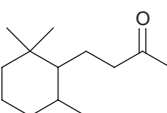
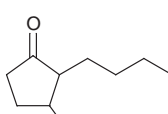
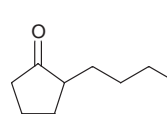
IR spectra were recorded on a Perkin Elmer 237B IR spectrophotometer, NMR spectra on a Varian 360L instrument and mass spectra on a INCOS 50 GC-MS instrument.

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† This is a **Short Paper** as defined in the Instructions for Authors, Section 5.0 [see *J. Chem. Research (S)*, 1999, Issue 1]; there is therefore no corresponding material in *J. Chem. Research (M)*.

‡ Dedicated to Dr R. P. Sharma on his 60th Birthday.

Table 1 Enol-acetylation reactions under microwave irradiation

Entry	Substrate	t / min	Power setting	Product	Yield (%)
1		5	2	 1	90
2		5	2	 2	75
3		10	3	 3	72
4		5	2	 4	50
5		10	3	 5	85
6		5	2	 6	75
7	Cholestan-3-one	5	2	2-cholestene-3-ol acetate	90
8	α -Ionone	5	2	α -Ionone	NR ^a
9		5	2		NR
10		5	2		NR

NR = no reaction.

Table 2 Spectral data for the products^a

Compound	$\nu_{\max}/\text{cm}^{-1}$	δ_{H}	Ref.
1	1725	5.00 (br s, 1H), 1.90 (br s, 7H), 1.50 (m, 4H)	15
2	1730	5.00 (d, $J = 5$ Hz, 1H), 1.85 (br s) overlapped with 1.20–2.10 (m), 0.80 (d, $J = 6$ Hz, 3H)	16
3	1730	2.45 (spt $J = 7$ Hz, 1H), 1.85 (s, overlapped), 1.30–2.10 (m overlapped), 0.85 (d, $J = 7$ Hz, 3H), 0.75 (d, $J = 7$ Hz, 6H)	—
4	1730	4.50 (m, 2H), 1.80 (s, overlapped), 1.70–2.15 (m, overlapped), 1.60 (br s, 3H), 0.75 (d, $J = 6$ Hz, 3H)	— ^b
6	1730	2.00 (s, overlapped), 1.80–2.35 (m, overlapped), 1.35 (br s, 3H), 0.75 (d, $J = 6$ Hz, 6H)	— ^b

^a The products were also compared directly (IR, NMR, MS) with authentic materials prepared by known methods.⁷ ^b This work.

General Procedure.—In a typical reaction, 5 mmol of cyclohexanone was mixed with 15 mmol of acetic anhydride and 0.5 mmol (10%) of iodine, and irradiated in a kitchen type microwave oven (2450 MHz) for 5 min at 'low' power level (level two in a seven point scale). The mixture was diluted with chloroform, washed with a dilute solution of sodium thiosulfate followed by water and dried over anhydrous sodium sulfate. Evaporation of the solvent yielded a clean product in 90% yield. The same procedure was adopted with different reaction times and power levels for the substrates as

indicated in Table 1. The products were characterised by spectroscopic methods (Table 2) as well as direct comparison (TLC, spectra) with authentic materials.

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References

- 1 N. Deka, D. J. Kalita, R. Borah and J. C. Sarma, *J. Org. Chem.*, 1997, **62**, 1563.
- 2 R. Borah, N. Deka and J. C. Sarma, *J. Chem. Res. (S)*, 1997, 110.
- 3 D. J. Kalita, R. Borah and J. C. Sarma, *Tetrahedron Lett.*, 1998, **39**, 4573.
- 4 R. C. Larock, K. Oertte and K. M. Beatty, *J. Am. Chem. Soc.*, 1980, **102**, 1966.
- 5 T. H. Kritchevsky and T. F. Gallagher, *J. Am. Chem. Soc.*, 1951, **73**, 184.
- 6 J. Champagne, H. Favre, D. Vocelle and I. Zoikowski, *Can. J. Chem.*, 1964, **42**, 212.
- 7 H. Ozbal and W. W. Zajac Jr., *J. Org. Chem.*, 1981, **46**, 3082.
- 8 P. Barbier and C. Benezra, *J. Org. Chem.*, 1983, **48**, 2705.
- 9 R. C. Larock, *Comprehensive Organic Transformations*, VCH, New York, 1989, p. 743.
- 10 J. O. Karlsson and T. Fredj, *J. Org. Chem.*, 1983, **48**, 1921.
- 11 D. Ladjama and J. J. Riehl, *Synthesis*, 1979, 504.
- 12 D. Lima and M. Schlosser, *Tetrahedron*, 1995, **51**, 5799.
- 13 P. K. Chowdhury, R. P. Sharma and J. N. Barua, *Tetrahedron Lett.*, 1983, **24**, 3383.
- 14 G. Caliez, B. Figadere and P. Clery, *Tetrahedron Lett.*, 1994, **35**, 6295.
- 15 P. Z. Bedoukian, *J. Am. Chem. Soc.*, 1945, **67**, 1430.
- 16 C. J. R. Adderly, G. V. Beddeley and F. R. Hewgill, *Tetrahedron*, 1967, **23**, 4143.