

SELECTIVE REDUCTIONS OF CONJUGATED ACETYLENES WITH MAGNESIUM IN METHANOL AND
 METHANOL-D

Robert O. Hutchins* and Suchismita
 Department of Chemistry, Drexel University, Philadelphia, PA 19104

Robert E. Zipkin, Ira M. Taffer, R. Sivakumar, Arthur Monaghan and E. Michael Elisseou
 BIOMOL Research Laboratories, Inc., 5166 Campus Drive, Plymouth Meeting, PA 19462

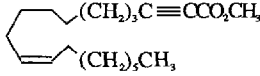
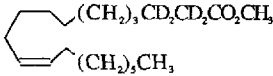
Abstract: The combination of magnesium in methanol or methanol-d offers an efficient, convenient and selective method for reduction of acetylenic bonds conjugated to esters (but not acids) or to two phenyl groups to the saturated or tetradeuterated derivatives, respectively.

Recent disclosures of the selective double bond reductions of α,β -olefinic esters¹ and other functionalities² with magnesium in methanol suggested that this methodology, using methanol-d, would enable the incorporation of deuterium in the α and β positions of long chain polyunsaturated fatty esters³. In fact, although Mg/MeOD reduction of methyl 2-octenoate afforded selective reduction of the conjugated alkene, the product contained >1 deuterium at the α position, presumably due to methoxide induced exchange. We envisioned that clean introduction of four deuteriums might be obtainable if such reductions were applicable to henceforth unexplored α,β -acetylenic esters. Indeed, we report that Mg/MeOH or Mg/MeOD cleanly and selectively converts conjugated acetylenic esters to saturated or tetradeuterated derivatives, respectively, as indicated in the Table. Furthermore, selectivity investigations revealed that while isolated acetylenes remain intact, triple (and double^{2d}) bonds conjugated to two (but not one) phenyl groups are smoothly reduced (entries 9-12, 17) as are phenyl conjugated diynes and dienes (to alkenes, entries 14, 15). Alkyl substituted conjugated dienes and diynes remain intact (entries 13, 16). Interestingly, α,β -acetylenic acids are not reduced (entry 8), probably due to rapid generation of the carboxylate anions preventing electron transfer to the pi system. The experimental procedure utilized was straightforward and convenient. The compound was dissolved in methanol or methanol-d (7.5 mL/mmol) and magnesium (5 eq.) added and the mixture stirred at room temperature until the Mg had dissolved (usually 1-6 hr). The mixture was poured into water, acidified with dilute HCl, extracted with ether which was dried, concentrated and the products purified by distillation.

Table I. Reductions of Conjugated Π -Systems with Magnesium in Methanol or Methanol-d

Entry	Compound	Solvent	Product	% Yield ^a (% rec)
1	$\text{CH}_3\text{C}\equiv\text{CCO}_2\text{CH}_3$	CH_3OH	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_3$	68 ^b
2		CH_3OD	$\text{CH}_3\text{CD}_2\text{CD}_2\text{CO}_2\text{CH}_3$	68 ^b
3	$\text{CH}_3(\text{CH}_2)_4\text{C}\equiv\text{CCO}_2\text{CH}_3$	CH_3OH	$\text{CH}_3(\text{CH}_2)_6\text{CO}_2\text{CH}_3$	76
4		CH_3OD	$\text{CH}_3(\text{CH}_2)_4\text{CD}_2\text{CD}_2\text{CO}_2\text{CH}_3$	72
5	$\text{CH}_3(\text{CH}_2)_7\text{C}\equiv\text{CCO}_2\text{CH}_3$	CH_3OH	$\text{CH}_3(\text{CH}_2)_9\text{CO}_2\text{CH}_3$	78
6		CH_3OD	$\text{CH}_3(\text{CH}_2)_7\text{CD}_2\text{CD}_2\text{CO}_2\text{CH}_3$	72

Table 1 (continued)

Entry	Compound	Solvent	Product	% Yielda (% rec)
7		CH ₃ OD		65
8	CH ₃ (CH ₂) ₄ C≡CCO ₂ H	CH ₃ OH	NR	(72)
9	CH ₃ (CH ₂) ₄ C≡CH ₂ OH	CH ₃ OH	NR	(73)
10	C ₆ H ₅ C≡CC ₆ H ₅	CH ₃ OH	C ₆ H ₅ CH ₂ CH ₂ C ₆ H ₅	85
11	C ₆ H ₅ C≡CCH ₃	CH ₃ OH	NR	(73)
12	C ₆ H ₅ C≡CH	CH ₃ OH	NR	(67)
13	CH ₃ (CH ₂) ₃ (C≡C) ₂ (CH ₂) ₃ CH ₃	CH ₃ OH	NR	(90)
14	C ₆ H ₅ (C≡C) ₂ C ₆ H ₅	CH ₃ OH	C ₆ H ₅ CH ₂ CH=CHCH ₂ C ₆ H ₅ , 62%	93 ^c
			C ₆ H ₅ CH ₂ CH=CHC ₆ H ₅ , 9%	
15	C ₆ H ₅ CH=CHCH=CHC ₆ H ₅	CH ₃ OH	C ₆ H ₅ CH ₂ CH=CH ₂ CHC ₆ H ₅ , 5.5 + C ₆ H ₅ CH=CHCH ₂ CH ₂ C ₆ H ₅ , 1	96 ^d
16	CH ₃ (CH ₂) ₃ CH=CHCH=CHCH ₃	CH ₃ OH	NR	(80)
17	C ₆ H ₅ CH=CHC ₆ H ₅	CH ₃ OH	C ₆ H ₅ CH ₂ CH ₂ C ₆ H ₅	87 ^e

a. yields are for isolated, purified products (or starting materials) unless indicated otherwise. b. determined by GC. c. relative % determined by GC; the remainder (29%) was two additional components in approximately equal amounts tentatively identified as 1,4-diphenyl-2-butyne and 1,4-diphenyl-1-butyne (NMR) but not isolated. d. relative amounts determined by GC. e. ref. 2d reports 99-100% yields (by GC or NMR).

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