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CONTROL OF ALKENE PRODUCTS BY E2C-LIKE AND E2H-LIKE REACTIONS

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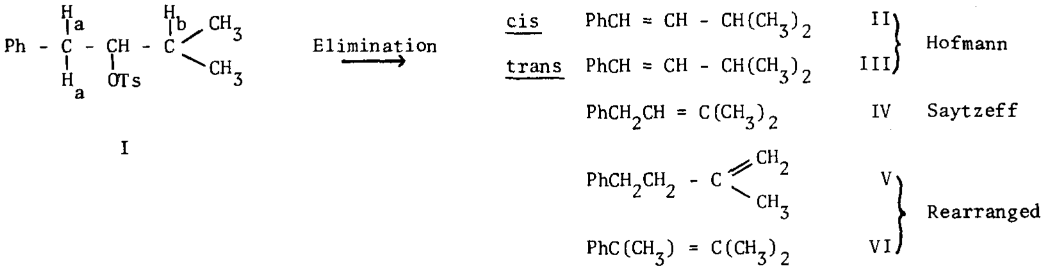
The preparation of a particular olefin from β-elimination of an alkyl bromide or tosylate is fraught with difficulties. Most frequently a mixture of two or more positional and geometric isomers is obtained (e.g. Scheme 1) whose composition depends on the substituents present and the choice of solvent and base[1]. Solvolysis (E1) reactions particularly give complex mixtures, including rearranged substitution and elimination products, and show little discrimination between cis and trans isomers. However, we[2,3] have shown that by carrying out E2 reactions with particular solvent and base systems, not only can the proportion of rearranged and cis olefins in the product be reduced markedly, but also that the proportion of Saytzeff to Hofmann olefin can be changed significantly. A spectrum of transition states, ranging from E2C to E2H is utilised and by applying this mechanistic concept, the synthetic organic chemist can predict and have some control over the products of elimination. A new example is the E2C and E2H eliminations of 1-phenyl 3-methyl-2 butyl-p-toluenesulphonate (I).



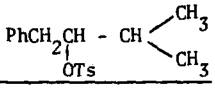
Scheme 1

With reference to the table, under E2H-like conditions using strong hydrogen but weak carbon-bases (e.g. KOBu-t in t-BuOH) the most acidic hydrogen H_a is eliminated and 97.6% Hofmann olefin (II and III) is obtained. Conversely, under E2C-like conditions using strong carbon but weak hydrogen-bases (e.g. NBu_4Br in acetone containing 2,6-lutidine), the Saytzef olefin (IV) is given in 90% yield with elimination of H_b on the more substituted carbon atom. This product is kinetically controlled and is very different from the equilibration product. Clearly conjugation of the developing double bond with the phenyl ring in the E2C-like transition-state is not significant, or else it is counteracted by some other deactivating effect of a phenyl group. However the phenyl ring plays an active role in acidifying α-hydrogens in the E2H reaction. This lack of strong activation by β-phenyl relative to β-methyl substituents in E2C reactions has been noted from reaction rate studies and some product studies[2,4] on simpler compounds.

Both E2C and E2H-like reactions give relatively cleaner products in higher yield than do equilibration or E1 reactions. Solvolysis leads to a comparatively low trans/cis ratio of II and III, but in the E2 reactions, it seems that bulky bases like Br^-, and to a greater extent t-BuO^-, encounter non-bonded interactions with the phenyl and isopropyl substituents in their respective transition-states and account for a much higher kinetically controlled trans/cis ratio. The E2C mechanism requires anti elimination as has been amply demonstrated by E2C-like eliminations from substituted cyclohexyl and cyclopentyl tosylates.[2,5]

The experiments summarized in the Table demonstrate that by harnessing the appropriate substituent effects, to a sensible choice of base, the olefinic products of dehydrotosylation and dehydrobromination can be often directed at will.

Elimination Products from



$PhCH_2CH(OTs)-CH(CH_3)_2$

Elimination Products[h] %

Mechanism	Half Lives	Rate[g] $\log k^{T^\circ}$	II	III	IV	V	others +VI	Yield	$\frac{\text{Saytzeff}}{\text{Hofmann}}$	$\frac{\text{trans}}{\text{cis}}$	
Equilibration[a] of III	b	fast^{50}	0.7	60.9	34.7	3.5	-	≯50%	0.55	86	130
" " III	c	"	0.2	63.3	33.2	3.3	-	≯30%		420	
" " IV	b	"	0.5	61.3	35.0	3.2	-	≯50%		126	
E2C[d]	5	-2.95^{75}	0.6	9.1	89.4	0.9	-	100%[i]	10.2	15	18
	22		0.4	8.6	91.2	0.8	-	100%[i]		22	
E2H[e]	5	-2.8^{75}	1.6	95.8	2.4	0.2	-	100%[i]	0.027	58	60
	30		1.5	95.5	2.8	0.2	-	100%[i]		62	
E1[f]	4	-3.3^{75}	0.7	5.5	30.9	6.6	0.7	40%[j]	~7	8	9
	10		0.5	5.3	40.9	6.4	0.6	25%[j]		10	
	65		0.7	6.6	48.2	7.1	0.7	25%[j]		10	

a) In 0.1M t-BuO$^-$/DMSO @ 50°C. b) Carried out for 25 mins. c) Carried out for 160 mins. d) 0.1M NBu_4Br in acetone containing 2,6-lutidine. e) 0.08M t-BuO$^-$/t-BuOH under nitrogen. f) In 50% v/v acetone-water. g) Expressed as second-order rate constants l.mole^{-1}sec^{-1} except for E1 which is pseudo-first order i.e. sec^{-1}. h) As measured by G.C. using 6' x 1/8" carbowax 20M @ 70°C. Products were identified either by synthesis and coinjection or by NMR analysis of fractions collected by preparative G.C. Peak areas were corrected for molar response, and normalised to 100%. i) Ref. 2. j) Total olefins II - VI based on 100% recovery of olefin + substitution products. Actual total yield of isolated olefins given in "Yield" as determined by internal standard comparisons.

REFERENCES

1. For example. A.K. Colter and D.R. McKelvey, Can. J. Chem., 43, 1282 (1965).
2. G. Biale, D. Cook, D.J. Lloyd, A.J. Parker, I.D.R. Stevens, J. Takahashi and S. Winstein, J. Am. Chem. Soc., (1971) in press.
3. D.J. Lloyd and A.J. Parker, Tetrahedron Letters, 637 (1971).
4. D.J. Lloyd and A.J. Parker, Tetrahedron Letters, 5029 (1970).
5. G. Biale, A.J. Parker, S.G. Smith, I.D.R. Stevens and S. Winstein, J. Am. Chem. Soc., 92, 115 (1970).