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IODINE-INITIATED ADDITION OF ALKOXY GROUPS TO A DOUBLE BOND. ONE-STEP SYNTHESIS OF p-METHOXY SUBSTITUTED α,α'-DIALKOXYBIBENZYLS AND 2,3-DIPHENYLDIOXANES FROM STILBENE DERIVATIVES.

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It has been shown that the iodine-catalyzed isomerization of 4-methoxy- and 4,4'-dimethoxy-cis-stilbene in CCl_4, $CHCl_3$ or AcOH at room temperature proceeds via an ionic mechanism[1]. We found that the intermediate carbonium ion, formed by addition of a positive iodine ion to the olefinic bond, can be captured in more nucleophilic solvents like alcohols. It appears that such a precedure gives a very simple preparative method for α,α'-dialkoxybibenzyls.

1 g of 4-methoxy-cis-stilbene (cM) and 5 g of iodine are dissolved in 30 ml of methanol. After 24 hours the mixture is diluted with 300 ml of water leaving a strongly acidic solution (pH~1). Iodine is removed by addition of an excess of sodium sulphite and the residual solution is extracted with CCl_4. After evaporation of the solvent α,α',4-trimethoxybibenzyl is left as an oily product; NMR ($CDCl_3$, TMS): τ=6.76 (3H,s) and 6.77 (3H,s); 6.16 (3H,s); 5.83 (1H,d, J=8 cps) and 5.11 (1H,d, J=8 cps); 3.0 (9H,m). The product is free of cis or trans stilbene, the yield is virtually 100%. Starting with the trans isomer (tM), a similar result is obtained.

The NMR spectrum indicates the presence of only one diastereoisomer in the product, probably the erythro compound on account of the rather large coupling constants of the methine protons.

The stoichiometry of the overall-reaction,

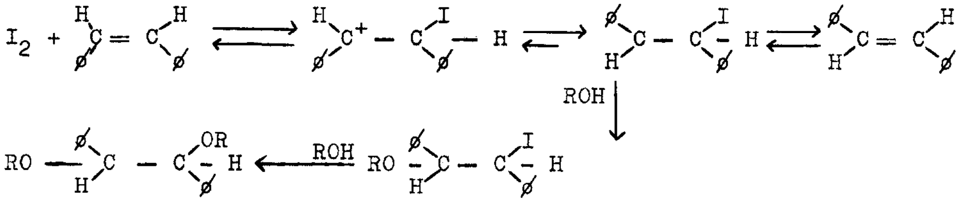
$$2\ ROH + I_2 + pCH_3O\text{-}C_6H_4\text{-}CH{=}CH\text{-}C_6H_5 \longrightarrow pCH_3OC_6H_4\text{-}CH(OR)\text{-}CH(OR)\text{-}C_6H_5 + 2\ HI$$

was proved by interrupting the conversion halfway, titration of hydrogen iodide and weighing of the amounts of addition product formed and stilbene left after separation by crystallisation.

By the same procedure 4,4'-dimethoxy-cis- or trans-stilbene (cMM or tMM) could be converted into α,α',4,4'-tetramethoxybibenzyl, but the yield was about 50% and the product had to be separated from tMM by two crystallisations from methanol. Its melting point 141-142° should point out the meso configuration (lit.[2] meso: m.p. 143.5-144.5°; dl: m.p. 113°). NMR ($CDCl_3$, TMS): τ=6.90 (6H,s); 6.25 (6H,s); 5.79 (2H,s); 3.1 (8H,m).

With cMM and iodine in ethanol, even after long reaction times (up to one week), only 18% of a diastereoisomer of α,α'-diethoxy-4,4'-dimethoxybibenzyl was obtained in pure form; m.p. 92.5-93.5°; NMR ($CDCl_3$, TMS):τ=9.02 (6H,t); 6.76 (4H,m); 6.24 (6H,s); 5.76 (2H,s); 3.0 (8H,m).

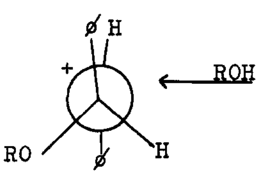
The following reaction scheme accounts for the observed facts:



Iodine dissociates heterolytically as described for the isomerization reaction[1]. The positive iodide ion adds to the double bond. The carbonium ion rotates quickly and can form either the trans-stilbene derivative or react with (m)ethanol.

The next step will be a fast substitution of I by OR. The reaction will probably be of the S_N1 type, because of the good leaving group properties of the I^- ion, the polar solvent and the stable carbonium ion formed as an intermediate.

The ROH group will approach the carbonium ion from the least hindered side so that the most stable configuration (meso or erythro)-dialkoxybibenzyl is formed as reaction product.



With glycol instead of methanol or ethanol as the solvent and using rather long reaction times cM could be converted into 2-phenyl-3-p-anisyldioxan; m.p. 61-63°; yield 37%; NMR ($CDCl_3$, TMS):τ=6.29 (3H,s); 6.24 (4H,s), 5.84 (1H,d, J=5 cps); 4.52 (1H,d, J=5 cps); 3.0 (9H,m); whereas cMM yielded 2,3-di-p-anisyldioxan; m.p. 107-108°, yield 50%; NMR ($CDCl_3$, TMS):τ=6.28 (6H,s); 6.24 (4H, multiplet at high resolution); 5.89 (1H,d, J=5 cps); 4.56 (1H,d, J=5 cps); 3.0 (8H,m). The latter compound differs from 2,3-di-p-anisyldioxan (m.p. 79-80°) obtained by Summerbell[3,4].

The NMR spectra of the dioxanes show a large difference in chemical shift for the methine protons at C_2 and C_3. These products have therefore probably a rigid structure with axial and equatorial protons.
This is consistent with cis-di-p-anisyl dioxane in the chair conformation.

References:
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