Tandem Transformations of *N*-Alkyl-*N*-allenylmethylanilines to *N*-Alkyl-2-ethenylindoles

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Treatment of *N*-alkyl-*N*-allenylmethylanilines with magnesium monoperoxyphthalate in methanol–water underwent tandem transformations to furnish *N*-alkyl-2-ethenylindoles in good yield.

Considerable attention has been focused recently on the synthesis of indoles for constructing biologically active compounds.[1] In this context 2- and 3-vinylindoles have found useful applications as synthons in the synthesis of many [*b*]annelated indoles, indole alkaloids and carbazoles.[2] However, compared with the corresponding 3-substituted isomers, 2-vinylindoles are not that easily accessible. The more commonly adopted method employs the Wittig reaction of 2-formylindoles.[3] Blechert *et al.* reported a novel synthesis of 2-vinylindoles with substituents on the vinyl part based on a tandem process.[4] The first synthesis of the parent 2-vinylindole is based on an intramolecular Wittig reaction of 2-(*N*-propenoylamino)benzyltriphenyl phosphonium bromide is due to Pindur *et al.*[5]

Here, we report a facile and efficient route to *N*-alkyl-2-ethenylindoles from *N*-alkyl-*N*-allenylmethylanilines by a tandem process.

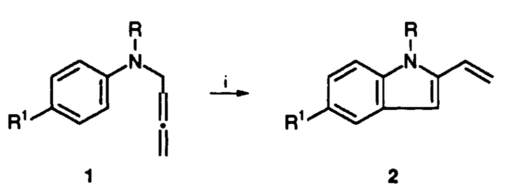
The required *N*-alkyl-*N*-allenylmethylanilines† **1a–d** were prepared from the corresponding *N*-alkyl-*N*-propynylanilines employing a similar procedure reported previously for the O-analogue.[6] Treatment of *N*-methyl-*N*-allenylmethylaniline in methanol with aqueous magnesium monoperoxyphthalate (MMPP) at room temperature for 3 h yielded *N*-methyl-2-ethenylindole **2a** in 80% yield.‡ Similarly, 2-ethenylindoles **2b–d** were prepared from the corresponding *N*-alkyl-*N*-allenylmethylanilines **1b–d** in good yield§¶ (Scheme 1). Thus, our novel synthesis of 2-ethenylindoles constitutes the first example of a tandem transformation on the hitherto unreported *N*-alkyl-*N*-allenylmethylanilines.

From a preliminary mechanistic consideration of this transformation, the pathway outlined in Scheme 2 looks reasonable. The sequence consists of oxidation of amine to amine oxide, 2,3-sigmatropic rearrangement of the *N*-oxide involving allene function, hetero-Cope rearrangement, aromatization followed by cyclization, and finally dehydration to 2-ethenylindole. The mechanism suggested above closely parallels the tandem reaction of *N*-arylpropynylamine oxide to an indole.[7] While the *N*-propynyl system involves an allenic intermediate, in our case the reaction proceeds through a butadiene intermediate (Scheme 2).

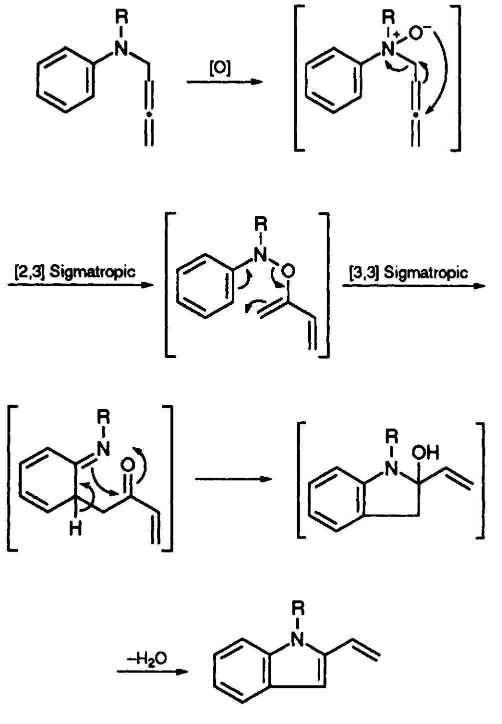
None of the intermediates envisaged in Scheme 2 could be isolated. Also monitoring the progress of this transformation by TLC showed only the spots corresponding to the starting material and the final product. A point worth noting at this juncture is the compatability of the allene functionality towards the oxidation conditions and its high reactivity towards 2,3-sigmatropic rearrangement.[8]

2-Vinylindoles are useful substrates for Diels–Alder reaction where they may react as dienes,[9] as well as dienophiles.[10] In the present study, the 2-ethenylindole **2a** has been found to act as a diene in the [4 + 2] cycloaddition with symmetrical carbodienophiles. Thus, refluxing *N*-methyl-2-ethenylindole **2a** with dimethyl acetylenedicarboxylate (DMAD) in toluene for 6 h afforded the known carbazole derivative **3** in 60% yield.[3b] Similarly, reaction of **2a** with *N*-phenylmaleimide furnished the carbazole derivative **4** in 52% yield.[3a] (Scheme 3).

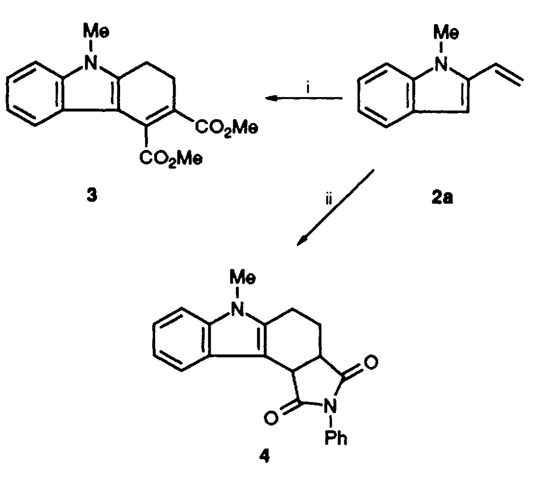
Thus, the easy accessibility of the starting material, facile tandem reactions and the high yield of the products render this novel transformation an alternative route for the synthesis of 2-ethenylindoles in a 'one pot' reaction.



Scheme 1 *Reagents and conditions*: i, MMPP, MeOH–H_2O (10:1), room temp., 3 h. *Yields*: 80, 82, 63, and 80% for R(R^1) = Me(H), Et(H), $PhCH_2$(H), Et(Cl), respectively.



Scheme 2



Scheme 3 *Reagents and conditions*: i, $MeO_2C–C≡C–CO_2Me$, PhMe, reflux, 6 h; ii, *N*-phenylmaleimide, PhMe, reflux, 16 h

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Footnotes

† *N*-Alkyl-*N*-allenylmethylanilines were prepared from the corresponding *N*-monoalkylated anilines in 70–80% overall yield. The steps involved are propynylation followed by allene homologation.

‡ Similar observation was made when *m*-chloroperbenzoic acid was used instead of MMPP. However, owing to ease of handling we preferred MMPP.

§ General experimental procedure: to a solution of *N*-alkyl-*N*-allenylmethylaniline (1 mmol) in methanol (5 ml), magnesium monoperoxyphthalate (0.5 mmol) dissolved in 0.5 ml of water was added in one portion. The mixture was stirred at room temp. for 3 h. Methanol was evaporated under vacuum and the residue was repeatedly extracted with diethyl ether. The combined ethereal extracts were washed with water, saturated hydrogencarbonate solution, again with water, NaCl solution, dried (Na_2SO_4) and evaporated to give *N*-alkyl-2-ethenylindole.

¶ All the compounds reported in this communication were thoroughly characterized by spectral and analytical data.

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