Tetrahedron Letters No. 18, pp 1815 - 1816, 1972. Pergamon Press. Printed in Great Britain.

A SIMPLE ROUTE TO α,β-UNSATURATED ALDEHYDES FROM PROPARGYLIC ALCOHOLS

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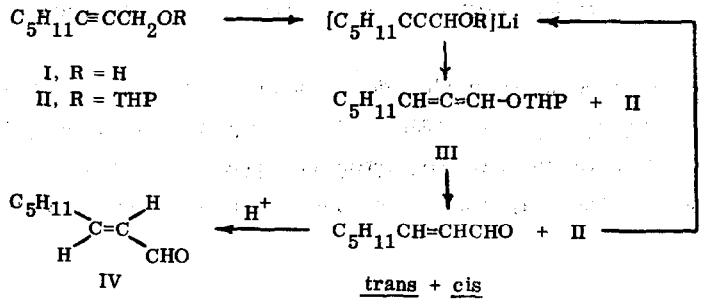
(Received in USA 23 February 1972; received in UK for publication 27 March 1972)

In connection with the study of new approaches to the synthesis of prostaglandins, a method of preparation of trans-2-octenal (IV) was sought which would be simpler and more expeditious than existing methods (1). We report here a new process which has been found to be highly satisfactory and convenient for either small or large scale synthesis.

Commercially available 2-octyn-1-ol (I) (2) was converted into the tetrahydropyranyl derivative (II) (3) in quantitative yield by treatment with 1.1 equiv. of 2,3-dihydropyran and 0.005 equiv. of p-toluenesulfonic acid in methylene chloride (12 ml./g. of I) at 25° for 30 min. Metalation of II to form a propargylic lithium compound (4) was effected using 1.05 equiv. of n-butyllithium (1.4 M in pentane) in tetrahydrofuran (8 ml./g. of II) at -25° for 2.5 hr. under argon, and this intermediate was quenched with methanol--ice containing a little potassium carbonate to give in quantitative yield a mixture of the allene III (3a) and the acetylene II in a ratio of 70:30 by n.m.r. analysis. Selective hydrolysis of the enol ether III was readily accomplished by exposure of the mixture to acetic acid--water--tetrahydrofuran (ratio by vol. 1:1:2) at 40-45°



for 4 hr. to yield cleanly the starting acetylenic ether II and trans- and cis-2-octen-1-al (trans-cis ratio, 76:24 by n.m.r. analysis). The mixture obtained from this reaction after extraction with ether--pentane (1:1) was easily separated by distillation into a fraction containing the isomeric octenals, b.p. 30-32° (0.1 mm.), and a fraction consisting of the starting ether II, b.p. 72-79° (0.1 mm.). The octenal fraction was isomerized to the trans aldehyde IV quantitatively by treatment with 0.02 equiv. of p-toluenesulfonic acid in methylene chloride (3 ml./g. of octenals) at 25° for 2 hr. Distillation then gave trans-2-octenal (IV) (3) (88% isolated yield), b.p. 39° (0.25 mm.) in very pure condition.

The overall process described above is highly efficient despite the fact that the protonation of the lithium derivative of II produces some acetylene in addition to the predominating allene. The pure starting acetylene II is easily recovered during isolation of the octenals, and the only appreciable loss of material during the process is mechanical (e.g., during distillation) and quite minimal. The basic approach outlined here can clearly be used to good advantage in aldehyde synthesis, especially when the requisite propargylic alcohols are commercially available (5).

References

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3. Satisfactory (a) infrared, nuclear magnetic resonance, and (b) mass spectrometric data were obtained for this product.
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5. This work was assisted financially by the National Institutes of Health and the Agency for International Development.