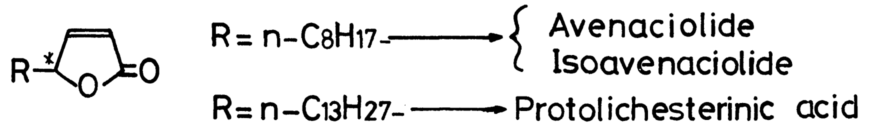
CHEMISTRY LETTERS, pp. 255-256, 1980.

ASYMMETRIC ADDITION OF ACETYLIDE TO ALIPHATIC ALDEHYDES
——PREPARATION OF OPTICALLY ACTIVE 5-OCTYL-2(5H)-FURANONE——

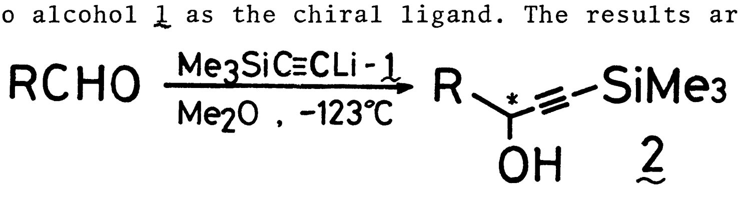
Teruaki MUKAIYAMA and Keisuke SUZUKI
Department of Chemistry, Faculty of Science
The University of Tokyo, Hongo, Bunkyo-ku, Tokyo 113

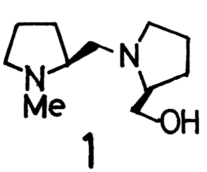
Various optically active acetylenic alcohols (40-80%e.e.) were obtained by enantioface-differentiating addition of lithium trimethylsilylacetylide to aliphatic aldehydes utilizing (2S, 2'S)-2-hydroxymethyl-1-[(1-methylpyrrolidin-2-yl)methyl]pyrrolidine as a chiral ligand. Optically active (R)-1-trimethylsilyl-1-undecyn-3-ol (80%e.e.) was transformed into optically active 5-octyl-2(5H)-furanone in good yield.

It is well known that 5-substituted-2(5H)-furanones are useful key intermediates in the total synthesis of some natural products, such as avenaciolide,[1a)] isoavenaciolide,[1b)] and protolichesterinic acid.[1c)] However, the preparation of these compounds in optically active form is one of the important problems remained unresolved.[2)] In the previous communication,[3)] we have reported the highly enantioselective addition of acetylene derivatives to benzaldehyde by employing (2S, 2'S)-2-hydroxymethyl-1-[(1-methylpyrrolidin-2-yl)methyl]pyrrolidine (1) as a chiral ligand. Since optically active acetylenic alcohols are regarded as the suitable precursors of 5-alkyl-2(5H)-furanone derivatives,[4)] we studied on i)the preparation of various chiral alkynyl alcohols 2 by enantioface-differentiating addition of lithium trimethylsilylacetylide to aliphatic aldehydes, and ii)the transformation of chiral 1-undecyn-3-ol into the optically active 5-octyl-2(5H)-furanone.



In the first place, the asymmetric addition of lithium trimethylsilylacetylide to various aliphatic aldehydes was investigated employing the chiral amino alcohol 1 as the chiral ligand. The results are summarized in Table I.





1

It should be noted that the present asymmetric reaction provides various chiral alkynyl alcohols by a simple procedure in high optical purity just starting from aliphatic aldehydes, while the conventional methods involve some

Table I Enantioselective Addition of Lithium Trimethylsilylacetylide to Aliphatic Aldehydes

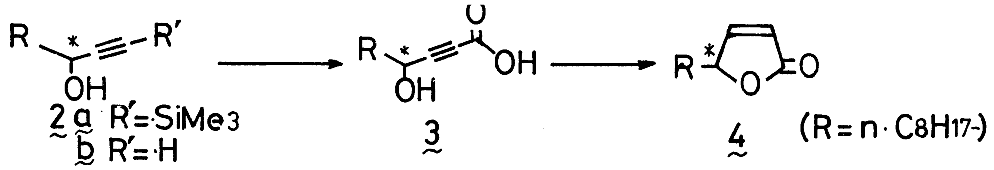
Run[a)]	R	S.Y.(%)	O.Y.(%)[b)]	Config.
1	n-C_2H_5-	77	68	R
2	n-C_5H_{11}-	87	76	R
3	n-C_8H_{17}-	83	80	R
4	n-$C_{11}H_{23}$-	82	70	R
5	n-$C_{13}H_{27}$-	76	73	R
6	$(CH_3)_2CHCH_2$-	54	65	R
7	$CH_3(CH_2)_2CH{=}CH$-	74	40	R

a) The reaction was carried out in a similar manner as described in the previous communication. b) The optical purity of the resulting alcohol was determined by NMR measurement of its MTPA derivative (Mosher's method)[6)] utilizing benzene-d^6 as a solvent.

disadvantages, that is, the method of asymmetric reduction of acetylenic ketone consists of laborious multistep sequence, and chemical[5b)] or microbial[5c)] resolution method wastes half of the material.

Next, the optically active (R)-1-trimethylsilyl-1-undecyn-3-ol (2a) was transformed into 5-octyl-2(5H)-furanone in 61% overall yield according to Scheme I.

Scheme I



Hydrolysis of 2a with 0.1N NaOH-MeOH(room temperature, 3h) afforded (R)-1-undecyn-3-ol (2b)(89%; $[\alpha]_D^{24}$+12°, (c 12, Et_2O)),[5c)] which was treated with two equivalents of BuLi in THF at -50°C for 30 min, followed by carboxylation in a sealed tube to yield (R)-4-hydroxy-2-dodecynoic acid (3)(73%; $[\alpha]_D^{25}$+0.6(c 11, CH_2Cl_2)). This acetylenic acid was partially hydrogenated in MeOH using Pd-$BaSO_4$-quinoline to afford (R)-5-octyl-2(5H)-furanone (4)(94%; $[\alpha]_D^{24}$-53°(c 2.6, EtOH)).

The obtained lactone had R-configuration, and therefore could lead to naturally occurring avenaciolide[7)] according to the stereoselective sequence reported by Schlessinger et al.[1a)]

References

1) a) J. L. Herrmann, M. H. Berger, and R. H. Schlessinger, J. Am. Chem. Soc., 101, 1544 (1979). b) R. E. Damon and R. H. Schlessinger, Tetrahedron Lett., 1975, 4551. c) R. E. Damon and R. H. Schlessinger, Tetrahedron Lett., 1976, 1561.
2) a) K. Shingu, S. Hagishita, and M. Nakagawa, Tetrahedron Lett., 1967, 4371. b) S. Musienrowicz and A. W. Roelewski, Zesz. Nauk. Politech. Lodz. Chem., 1974, 165.
3) T. Mukaiyama, K. Suzuki, K. Soai, and T. Sato, Chem. Lett., 1979, 447.
4) A. Nobuhara, Agric. Biol. Chem., 34, 1745 (1970).
5) a) R. S. Brinkmeyer and V. M. Kapoor, J. Am. Chem. Soc., 99, 8339 (1977). b) R. Pappo, P. Collins, and C. Jung, Ann. N. Y. Acad, Sci., 180, 64 (1971). c) K. Mori and H. Akao, Tetrahedron Lett., 1978, 4127.
6) J. A. Dale and H. S. Mosher, J. Am. Chem. Soc., 95, 512 (1973).
7) a) R. C. Anderson and B. F. Reid, J. Am. Chem. Soc., 97, 3870 (1975). b) H. Ohrui and S. Emoto, Tetrahedron Lett., 1975, 3657.

(Received October 30, 1979)