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CYCLIZATION OF POLYENES IX
ASYMMETRIC CYCLIZATION OF OPTICALLY ACTIVE ESTERS

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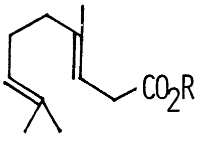
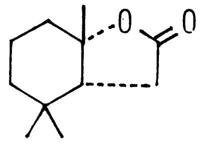
Optically active esters of homogeranic acid (1) and its related compounds (3,4) were subjected to cyclize under various conditions and 41.5% optical yield of (2) was gained when homogeranic acid-ℓ-menthyl ester was treated with $SnCl_4$ at -20°.

In a previous communication[1], we reported the partial asymmetric cyclization of esters of homogeranic acid (1, R=H), which afforded cis-tetrahydroactinidiolide (2) in 20% optical yield. As a further extension of this asymmetric cyclization, several reaction conditions were examined to obtain the optimum optical yield, and also the cyclization was tried with other polyene esters (3), and (4) to find the scope and limitation of this method. The latter compound was chosen as a model experiment for the asymmetric synthesis of higher terpenes possessing a hydroxyl group at 3 position.

ℓ-Menthyl and 1,2:5,6-di-O-isopropylidene-α-D-glucofuranosyl esters of homogeranic acid were subjected to cyclize with $AgBF_4$-AcCl or $SnCl_4$ under different conditions and the results were shown in table 1 and 2. The reagent, $AgBF_4$-AcCl, was first used by Semenovsky et al[2], who carried out the cyclization of polyenes with simultaneous introduction of acetyl group in the cyclized products. In our experiments, however, no acetyl group was inserted to a cyclized product. When $AgBF_4$ or AcCl was used



(1)



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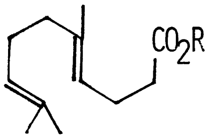

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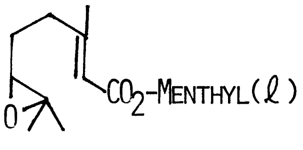

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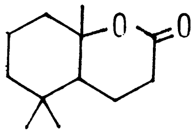

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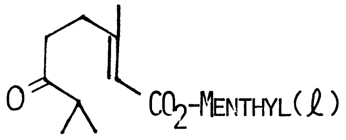

(6)

Table 1 cis-Tetrahydroactinidiolide (2) from ℓ-menthyl homogeranate

Acid	Temperature °C	Solvent	Chemical yield of (2) % *1	Purity *2 of (2) %	$[\alpha]_D^{CHCl_3}$	Optical yield %
$SnCl_4$	0	CH_3NO_2	31	99.6	-11.4° (c=0.97)	17.7
	-20	CH_3NO_2	13	99.1	-26.8° (c=1.00)	41.5
	-70	$CH_3(CH_2)_2NO_2$	7	99.0	-24.0° (c=0.88)	37.2
$AgBF_4$-AcCl	0	CH_3NO_2	22	99.5	-8.5° (c=2.13)	13.2
	-20	CH_3NO_2	25	99.0	-18.6° (c=0.86)	28.9
	-70	$CH_3(CH_2)_2NO_2$	12	99.4	-21.8° (c=1.15)	33.8

Table 2 cis-Tetrahydroactinidiolide (2) from 1,2:5,6-di-O-isopropylidene-α-D-glucofuranosyl homogeranate

Acid	Temperature °C	Solvent	Chemical yield of (2) %	Purity of (2) %	$[\alpha]_D^{CHCl_3}$	Optical yield %
$SnCl_4$	0	CH_3NO_2	51	100	-12.2° (c=1.48)	19.0
	-20	CH_3NO_2	30	100	-10.2° (c=1.02)	15.8
	-70	$CH_3(CH_2)_2NO_2$	43	100	-12.0° (c=2.0)	18.6
$AgBF_4$-AcCl	0	CH_3NO_2	41	100	-2.5° (c=0.88)	3.9
	-20	CH_3NO_2	33	100	-4.0° (c=2.79)	6.0
	-70	$CH_3(CH_2)_2NO_2$	38	100	-2.6° (c=2.31)	4.0

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*1 The chemical yields listed here are not optimum, especially those at lower temperature. The other isolable product is mainly the recovered starting material.

*2 The purity of (2) was analyzed using gas-liquid chromatography references of ℓ-menthol versus the lactone (2), which were made by mixing ℓ-menthol (1,3, and 5%) with an authentic sample of the lactone (2) obtained by catalytic reduction of dl-dihydroactinidiolide.

alone, no cyclization occurred.

As evident from the tables, higher optical yields were obtained by $SnCl_4$ rather than $AgBF_4$-AcCl, and the temperature dependency of the cyclization was clearly observed in the case of ℓ-menthyl ester, indicating the existence of a suitable conformation of the polyene under relatively lower temperature.

Since glucofuranosyl ester, which has polyfunctional groups in a molecule, afforded the cyclized product in less optical yields as compared with those of ℓ-menthyl ester, it appears likely that ester of the hydrocarbon alcohol would be preferable for this sort of asymmetric cyclization.

As in the case of homogeranic acid (1, R=H), compound (3, R=H), which was obtained from geranyl bromide according to Corey's method[3], followed by hydrolysis of the cyano group, afforded δ-lactone (5) easily upon treatment with $SnCl_4$. However, no lactone formation was observed from the corresponding esters (3, R=ℓ-menthyl, or 1,2:5,6-di-O-isopropylidene-α-D-glucofuranosyl), only resulting in the recovery of the starting material under mild conditions or polymerization under vigorous conditions. The esters were prepared in more than 70% yield from the reaction of acid chloride of (3) and the optically active alcohol at the presence of pyridine in benzene solution. The epoxide (4), which was made from geranic acid ℓ-menthyl ester by successive treatments with NBS into the corresponding bromohydrin and then aqueous methanolic KOH, was merely converted to keto ester (6) and an uncharacterized hydroxyl compound without formation of any cyclized products under several acidic conditions. The acids employed for the reaction of (3) contained $SnCl_4$, $AgBF_4$-AcCl, BF_3-ether, H_2SO_4, $AlCl_3$, and $ZnCl_2$-HCl under different temperature.

From the above evidence, we can conclude that the asymmetric cyclization of optically active polyene esters proceeds in a fairly good optical yield only with limited compounds.

References

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1. T.Kato, S.Kumazawa, Y.Kitahara, Synthesis, 537 (1972)
2. W.A.Smit, A.V.Semenovsky, V.F.Kucherov, T.N.Chernova, M.Z.Krimer, O.V.Lubinskaya, Tetrahedron Letters, 3101 (1971)
3. E.J.Corey, I.Kuwajima, Tetrahedron Letters, 487 (1972)

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