lar conditions gave a 75 : 25 mixture of **16b** and **17b** in 76% yield. Since α-alkyl substituent is known to stabilize the adjacent carbon radical by *ca.* 3 kcal/mol,[9] the stabilizing effect of α-tributyltin group could be somewhat higher than this magnitude. When **15c** was treated with thiophenol and AIBN in refluxing benzene, the product formed decomposed during silica gel column chromatographic separation. Therefore, **15c** was treated with Bu_3SnH and AIBN in refluxing benzene for 4 h and only **17c** was isolated without the formation of **16c**, indicating that the stabilizing effect of α-tributyltin group should be far less than that of α-phenyl group. Finally, our affention was given to a competitive study between tributyltin group and trimethylsilyl group. When **15d** was treated with thiophenol and AIBN in refluxing benzene for 3 h, a 33 : 67 mixture of **16d** and **17d** was obtained in 40% yield. The result obtained in this study suggests that the stabilizing effect of α-tributyltin group seems to be slightly less than that of α-trimethylsilyl group and the general order for stabilizing adjacent carbon radicals woud be $Ph > Me_3Si > Bu_3Sn > alkyl$.

Acknowledgment. We gratefully acknowledge the financial support of the Organic Chemistry Research Center (KOSEF).

References

1. Kim, S.; Kee, I. S.; Lee, S. *J. Am. Chem. Soc.* **1991**, *113*, 9882.
2. Kim, S.; Kee, I. S. *Tetrahedron Lett.* **1993**, *34*, 4213.
3. Treatment of **9** with deuterochloride in dichloromethane at room temperature for 0.5 h gave **10** in essentially quantitative yields.
4. (a) The similar result was also obtained during the studies on 1, *n*-transfer of Bu_3Sn group. Kim, S.; Lim, K. M. *Tetrahedron Lett.* **1993**, *34*, 4851. (b) Kim, S.; Lim, K. M. *J. Chem. Soc., Chem. Commun.* **1993**, 1152.
5. (a) Auner, N.; Walsh, R.; Westrup, J. *J. Chem. Soc., Chem. Commun.* **1986**, 207. (b) Jackson, R. A.; Ingold, K. U.; Griller, D.; Nazram, A. S. *J. Am. Chem. Soc.*, **1985**, *107*, 208. (c) Davidson, I. M. T.; Barton, T. J.; Hughes, K. J.; Ijadi-Maghsoodi, S.; Revis, A.; Paul, G. C. *Orgnometallics.* **1987**, **6**, 644.
6. Miura, K.; Oshima, K.; Utimoto, K. *Tetrahedron Lett.* **1989**, **30**, 4413.
7. Negishi, E-I.; In *Organometallics in Organic Synthesis*; John Wiley: New York. U. S. A., 1980; p 398.
8. (i) CH_2I_2/I_2, Zn-Cu/DME/$(i\text{-Pr})_2NEt$, 60%, (ii) $(COCl)_2$/DMSO/Et_3N, 95%, (iii) $Ph_3P{=}CH_2$, 80%.
9. Laird, E. R.; Jorgensen, W. L. *J. Org. Chem.* **1990**, *55*, 9.

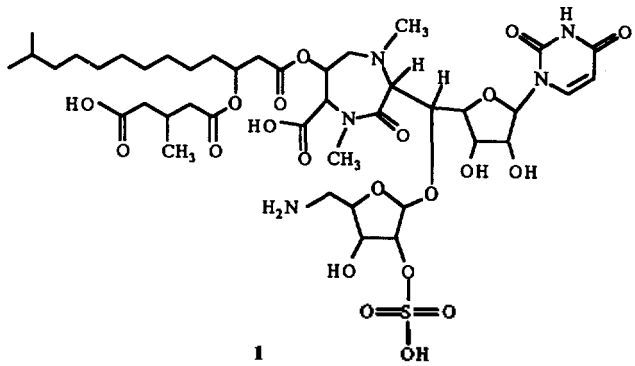
Synthetic Studies on Liposidomycins: Synthesis of 5-Aminopentose Moiety

Kwan Soo Kim*, Yeong Hee Ahn, Eun Young Hurh, Kun Tai Kim, and Yung Hyup Joo

Department of Chemistry, Yonsei University, Seoul 120-749, Korea

Received July 25, 1994

The liposidomycins are a family of novel lipid-containing nucleoside antibiotics of unusual complexity, recently found in the culture filtrate and mycelia of *Streptomyces griseosporeus*,[1] which inhibit formation of the lipid intermediate in peptidoglycan synthesis.[1,2] The primary site of action of liposidomycin C was found to be phospho-MurNAc-pentapeptide transferase, the first step of the peptidoglycan synthesis in the cell wall of *E. coli.* Y-10.[3] The structures of liposidomycins A,[4] B (**1**),[2] and C[2] were proposed on the basis of degradation and spectroscopic studies; their structures are identical except lipid parts. The overall structure of liposidomycins as well as structural components, namely, a diazepinone and a 5-aminopentose 2-sulfate is unique. The present communication reports the synthetic studies of the 5-amino-β-D-ribo-

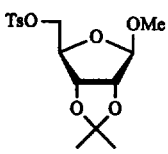


1

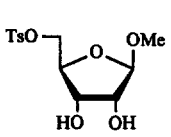
furanoside part of liposidomycins. There are a few points to be considered in the planning the synthesis; (i) introduction of the properly protected amino group at C-5, (ii) selective protection of 3-OH and sulfation of 2-OH, and (iii) β-glycosylation.

Diol **3** obtained by hydrolysis of isopropylidene group of compound **2** was transformed into 2,3-O-stannylene sugar **4** in almost quantitative yield by treatment with dibutyltin oxide in refluxing methanol. Reaction of **4** with benzyl bromide in the presence of one equivalent of tetrabutylammonium bromide in refluxing toluene gave a 1 : 1 mixture of 5-bromo-2-O-benzyl ether **5**[5] and 5-bromo-3-O-benzyl ether **6**[6] in 68% yield and no dibenzyl ether was found. In the absence of tertrabutylammonium bromide, the bromination at C-5 did not occur and the benzylation was sluggish. Assignment of **5** and **6** was made on the basis of the 2D ^1H NMR NOESY spectroscopic data: NOE's were observed between methyl protons of the methoxy group and aromatic protons and between the anomeric proton and benzylic protons of the benzyl group in compound **5**. The ^1H NMR chemical shifts and coupling patterns of H-2 and H-3 of acetyl derivatives **10**[7] and **11**[8] further confirmed the assignment

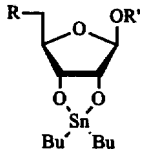
of **5** and **6**. Although the reactions 2',3'-O-stannylene nucleosides with various electophiles were extensively studied,[9] the study on the reaction of 2,3-O-stannylene ribosides is scarce. Reaction of stannylene sugar **7**, in which a protected amino group was already introduced at C-5, with benzyl bromide provide a 1 : 1 mixture of regioisomers. The reactions of stannylene sugars **4** and **7** with trityl chloride or *t*-butyldimethylsilyl chloride were more selective but the desired 3-protected sugars were produced always as minor isomers. Reaction of 2,3-O-stannylene of benzyl riboside **8** with benzyl bromide also produced an equal mixture of two regioisomers.



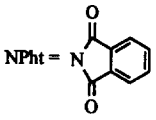
2

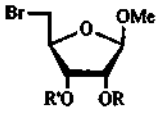


3

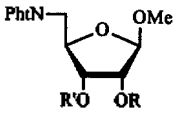


4 R=OTs, R'=Me
7 R=NPht, R'=Me
8 R=NPht, R'=CH_2Ph



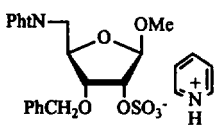


5 R=CH_2Ph, R'=H
6 R=H, R'=CH_2Ph

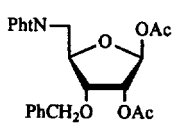


9 R=H, R'=CH_2Ph
10 R=CH_2Ph, R'=Ac
11 R=Ac, R'=CH_2Ph

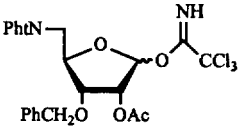
3-O-Benzyl ether **6** was chosen for the further elaboration because of the need for a participating group at C-2 and of convenince in separation[10] and handling. Compound **6** was treated with the potassium salt of phthalimide in the presence of potassium iodide in refluxing DMF to afford a protected aminosugar **9** in 70% yield. For the model study for the synthesis of liposidomycins, the formation of the β-glycosidic linkage at C-1 and the sulfation at C-2 of compound **9** were carried out. Reaction of **9** with sulfur trioxide-pyridine complex in pyridine at room temperature provided 2-O-sulfate salt **12**[11] in almost quantitative yield. For the glycosylation, acetate **13** and trichloroimidate **14** were examined as glycosyl donors[12] and diacetone-D-glucose and cyclohexanol as glycosyl acceptors. Acetate **13** was found to be a superior glycosyl donor over imidate **14** in the reaction with not only diacetone-D-glucose but also cyclohexanol. β-Acetate **13** was obtained in 70% yield by the reaction of **11** with acetic acid-acetic anhydride in the presence of a catalytic amount of sulfuric acid in methylene chloride. Reaction of acetate **13** with diacetone-D-glucose in the presence of a catalytic amount of tin(IV) chloride in methylene chloride afforded β-glycoside **15**[13] in 74% yield. The evidence for the β-glycosidic linkage of disaccharide **15** comes from a sharp singlet at 5.02 ppm in ^{1}H NMR spectrum owing to the anomeric proton of riboside part of **15**.



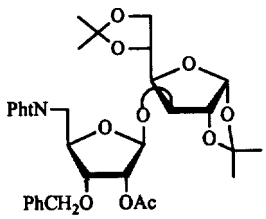
12



13



14



15

Acknowledgment. This work was supported by the Organic Chemistry Research Center.

References

1. Isono, K.; Uramoto, M.; Kusakabe, K.; Kimura, K.; Izaki, K.; Nelson, C. C.; McCloskey, J. A. *J. Antibiot.* **1985**, *38*, 1617.
2. Ubukata, M.; Isono, K.; Kimura, K.; Nelson, C. C.; McCloskey, J. A. *J. Am. Chem. Soc.* **1988**, *110*, 4416.
3. Kimura, K.; Miyata, N.; Kawanishi, G.; Kamio, Y.; Izaki, K.; Isono, K. *Agric. Biol. Chem.* **1989**, *53*, 1811.
4. Ubukata, M.; Kimura, K.; Isono, K.; Nelson, C. C.; Gregson, J. M.; McCloskey, J. A. *J. Org. Chem.* **1992**, *57*, 6392.
5. Compound **5**: $[\alpha]_D$ −0.6° (*c* 0.87, $CHCl_3$); ^{1}H NMR (300 MHz, $CDCl_3$) δ 2.68 (brs, 1H), 3.37 (s, 3H), 3.44-3.59 (m, 2H), 3.90 (d, *J*=5.2 Hz, 1H), 4.13 (m, 1H), 4.23 (m, 1H), 4.64 and 4.74 (ABq, *J*=11.6 Hz, 2H), 4.91 (s, 1H), 7.32-7.41 (m, 5 H).
6. Compound **6**: $[\alpha]_D$ −28.2° (*c* 0.85, $CHCl_3$); ^{1}H NMR (300 MHz, $CDCl_3$) δ 2.71 (brs, 1H), 3.37 (s, 3H), 3.44 (m, 2H), 4.05 (d, *J*=4.9 Hz, 1H), 4.11 (m, 1H), 4.27 (m, 1H), 4.61 and 4.65 (ABq, *J*=11.5 Hz, 2H), 4.89 (s, 1H); 7.36-7.40 (m, 5H).
7. Compound **10**: $[\alpha]_D$ +18.3° (*c* 0.30, $CHCl_3$); ^{1}H NMR (300 MHz, $CDCl_3$) δ 2.02 (s, 3H), 3.35 (s, 3H), 3.92 (m, 2H), 4.15 (dd, *J*=4.9, 1.2 Hz, 1H), 4.49 (m, 1H), 4.55 (s, 2H), 4.85 (d, *J*=1.2 Hz, 1H), 5.09 (dd, *J*=6.4, 4.9 Hz, 1H), 7.28 (m, 5H), 7.70-7.88 (m, 4H).
8. Compound **11**: $[\alpha]_D$ +2.8° (*c* 0.29, $CHCl_3$); ^{1}H NMR (270 MHz, $CDCl_3$) δ 2.07 (s, 3H), 3.32 (s, 3H), 3.94 (m, 2H), 4.22 (m, 1H), 4.28 (m, 1H), 4.42 and 4.55 (ABq, *J*=10.8 Hz, 2H), 4.80 (s, 1H), 5.20 (d, *J*=2.7 Hz, 1H), 7.23 (s, 5H), 7.69-7.85 (m, 4H).
9. (a) Wagner, D.; Verheyden, J. P. H.; Moffatt, J. G. *J. Org. Chem.* **1974**, *39*, 24; (b) David, S.; Hanessian, S. *Tetrahedron* **1985**, *41*, 643.
10. The mixture of **5** and **6** were readily separated by flash column chromatography whereas other regioisomers obtained from 2,3-O-stannylene sugars **4**, **7** and **8** could be separated only after repeated fractional crystallization and subsequent chromatography.
11. Compound **12**: ^{1}H NMR (300 MHz, DMSO-d_6) δ 3.29 (s, 3H), 3.80-3.94 (m, 2H), 4.11 (m, 2H), 4.30 (d, *J*=9.0 Hz, 1H), 4.60-4.67 (m, 2H), 5.04 (s, 1H), 7.13-7.27 (m, 5H), 7.94-7.97 (m, 4H), 8.13 (t, *J*=6.0 Hz, 2H), 8.65 (t, *J*=4.5 Hz, 1H), 8.94 (d, *J*=5.0 Hz, 2H).
12. Trichloroimidate sugar as a glycosyl donor, see: Schmidt,

R. R.; Michel, J. *Angew. Chem. Int. Ed. Engl.* **1980**, *19*, 731.

13. Compound **15**: $[\alpha]_D$ −5.5° (*c* 0.80, $CHCl_3$); ^1H NMR (300 MHz, $CDCl_3$): δ 1.33 (s, 3H), 1.34 (s, 3H), 1.50 (s, 3H), 2.06 (s, 3H), 3.50-4.30 (m, 6H), 4.38 and 4.53 (ABq, J=10.6 Hz, 2H), 4.57 (d, J=3.8 Hz, 1H), 5.02 (s, 1H), 5.30 (d, J=3.5 Hz, 1H), 6.00 (d, J=3.8 Hz, 1H), 7.09-7.18 (m, 5H), 7.68-7.84 (m, 4H).