Title
Aminosugars. XXVIII. A Facile Synthesis of Benzyl α- and β-Kasugaminides via the Corresponding Abequosides

Author(s)
吉村 寿次; YOSHIMURA, Juji; 佐藤 憲一; SATO, Kenichi; 橋本 弘信; HASHIMOTO, Hironobu; SHIMIZU, Kuniaki

Citation
Bulletin of the Chemical Society of Japan, 50(12): 3305-3309

Date
1977-12

Type
Journal Article

Rights
publisher
Aminosugars. XXVIII. A Facile Synthesis of Benzyl \(\alpha\)- and \(\beta\)-Kasugaminides via the Corresponding Abequosides\(^1\)

Juji Yoshimura, Ken-ichi Sato, Hironobu Hashimoto, and Kuniaki Shimizu

Laboratory of Chemistry for Natural Products, Faculty of Science, Tokyo Institute of Technology, Meguro-ku, Tokyo 152

(Received April 19, 1977)

Synthesis of benzyl \(\alpha\)- and \(\beta\)-kasugaminides (benzyl \(2,4\)-diamino-2,3,4,6-tetrahydroxy-2,4-di-O-mesityl-a-D-arabinohexopyranoside) was carried out by the simultaneous substitution at 2,4-positions of 2,4-di-O-mesityl-abequosides (3,6-dideoxy-2,4-dimethyl-\(\alpha\)-D-arabinohexopyranoside) with sodium azide followed by hydrogenation. The substitution in \(p\)-nitrophenylhydroxylamine at higher temperature gave the elimination products (4-azido-2,3-unsaturated derivatives) and the subsequently rearranged products (3,4-unsaturated 2-azido derivatives), but, that in hexamethylene phosphoric triamide at lower temperature gave the desired compounds in fairly good yields.

In connection with synthetic studies on kasugamycin \(^2\), a few reports on the synthesis of racemic \(^3\) and optically active \(^6\) methyl \(\alpha\)-kasugaminide (methyl 2,4-diamino-2,3,4,6-tetrahydroxy-2,4-di-O-mesityl-a-D-arabinohexopyranoside) have been published. The necessity of the resolution of a racemate is a shortcoming in the former synthesis, whereas the stepwise conversion in the latter takes longer steps, and consequently gives a lower overall yield.

In order to study the relationship between the configuration of aminosugar moiety in kasugamycin and the biological activity, we intended to develop a better pathway for synthesis of optically active kasugaminide and its diastereomers. In this paper, a facile synthesis of benzyl \(\alpha\)- and \(\beta\)-kasugaminides via the simultaneous substitutions at 2,4-positions of the corresponding abequosides (benzyl 3,6-dideoxy-\(\alpha\)- and \(\beta\)-D-xyllo-hexopyranosides) is described. As methyl \(\alpha\)-abequoside \(^7\) is known to be synthesized by the simultaneous deoxygenation of 3,6-positions of methyl 3,4-anhydro-6-O-p-tolylsulfonyl-\(\alpha\)-D-galactopyranoside obtainable from D-glucose, the pathway offered here is advantageous.

**Results and Discussion**

According to the method of Siewert and Westphal, \(^7\) benzyl \(\alpha\)- and \(\beta\)-abequosides were newly prepared. Benzoylation of benzyl 4,6-O-benzylidene-\(\alpha\)- \(^{10}\) and \(\beta\)-D-glucopyranosides \(^{11}\) in the usual manner gave the 2,3-di-O-benzoates (1\(\alpha\) and 1\(\beta\)) in good yields, respectively. Partial hydrolysis of the 4,6-O-benzylidene group in 1\(\alpha\) and 1\(\beta\) proceeded quantitatively in 70% acetic acid at 90—95°C to give 2\(\alpha\) and 2\(\beta\), respectively. Mesylation of 2\(\alpha\) and 2\(\beta\) in the usual manner gave the corresponding 4,6-di-O-mesylates (3\(\alpha\) and 3\(\beta\)) in good yields, respectively. Benzyl 2,3-di-O-benzoyl-4,6-di-O-p-tolylsulfonyl-\(\beta\)-D-glucopyranoside (4) was also prepared from 2\(\beta\) in a similar manner.

Examination of the conversion of 3\(\beta\) in dichloromethane or chloroform into the corresponding epoxide (7\(\beta\)) by treatment with sodium methoxide in methanol indicated that 3\(\beta\) was once changed into an intermediate (5) within 6 h and then gradually converted into 7\(\beta\).

In fact, 5 deposited from the reaction mixture, when the amount of solvents (especially methanol) was not enough. This conversion proceeded slower than that of the corresponding methyl glucoside, \(^7\) and the use of a little excess (1.3—1.4 mol) sodium methoxide gave a better result. Thus, 7\(\alpha\) and 7\(\beta\) were obtained in 64 and 75% yields, respectively. In a similar way, tosylated intermediate (6) and tosylated epoxide (8) were obtained from 4. It was characteristic that NMR spectra of these epoxides showed a coupling between OH and \(\beta\)O in tetrahydrofuran (THF) with 3 mol of lithium aluminium hydride (LAH) gave sirupy benzyl abequosides (9\(\alpha\) and 9\(\beta\)), respectively. When 1.5 mol of LAH was used in one instance, crystalline benzyl 3-deoxy-\(\beta\)-D-arabinohexopyranoside (10) was separated on a silica gel column in 22% yield, indicating that the epoxide ring was more reducible than the 6-O-sulfonate group. Excepting the last step in the synthesis of 9\(\alpha\) and 9\(\beta\), the purification of the product in each reaction was not always necessary, and both \(\alpha\)- and \(\beta\)-abequosides could be actually obtained in ca. 20% overall yield from D-glucose. Mesylation of 9\(\alpha\) or 9\(\beta\) and 10 gave the corresponding 2,4-di-O-mesyates (11\(\alpha\) or 11\(\beta\)) and 2,4,6-tri-O-mesylate (12) in good yields, respectively.
The simultaneous substitution at 2,4-positions of mesylates mentioned above with sodium azide was unexpectedly accompanied with the formation of unsaturated products. Reaction of 11β in N,N-dimethylformamide (DMF) with 3 mol of sodium azide at 120 °C overnight was incomplete, and two spots other than a small amount of the starting material were detected on TLC. Separation of the products on a silica gel column gave one monoazide (14β) in pure state, but the NMR spectrum of another fraction indicated the presence of unsaturated compounds. Reaction of 12 under the same condition gave also the corresponding 4,6-diazide (15) in a low yield. Even after the reaction of 11β was continued at 160—165 °C(9) until 14β disappeared, the mixture of products could not be separated by repeating column chromatography. Therefore, the separation was tried after hydrogenation of the products with LAH in THF followed by N-acetylation. Thus, benzyl N,N'-diacetyl-β-kasugamidine (16β) and benzyl 4-acetamido-2,3,4,6-tetrahydroxy-β-D-erythro-hex-2-enopyranoside (17) could be isolated in 12 and 19% yields, respectively. When the hydrogenation was carried out in the presence of Raney nickel, the corresponding saturated amino derivatives could be separated by column chromatography into three sirupy products (19, 20, and 18) in 8, 19, and 42% yields, respectively. These compounds were characterized after quantitative conversion into N-acetyl derivatives (21, 22, and 16β). The first-order analysis of the NMR spectrum of 16β (cf. Experimental) completely proved the allocated structure, and J₁,₂ values of 21 (J₁,₁₂=2.4, J₁,₁₃=8.0) and 22 (J₁,₁₃=8.2) supported them. It will be noteworthy that 19 is a glycoside of the enantiomer of natural l-tolypomine.\(^{12,13}\)

The results mentioned above suggest that the second substitution at C-2 of the initial product (14β) gives 2,4-diazide (13β), but the substitution is followed by the elimination of axial C₂-azido group to give benzyl 4-azido-2,3,4,6-tetrahydroxy-β-D-erythro-hex-2-enopyranoside (23), which subsequently rearranges to the corresponding 2-azido-3-enopyranoside (24). Recently, several papers have been published on the thermal rearrangement of 2,3-unsaturated 4-azido- and 4-thiocyanatoglycopyranosides to 3,4-unsaturated sugars having nitrogen function at C-2.\(^{14-16}\) These conversions were explained as a [3,3]-sigmatropic rearrangement of cyclic allylic systems in which the asymmetry at the initial allylic centre is transmitted to the new centre by the suprafacial migration.\(^{14}\) Although the formation of a small amount of unsaturated product in the substitution of equatorial C₂-sulfonyloxy group attached to 3-deoxy-hexopyranoside-ring with sodium azide in DMF has been reported,\(^{15}\) the question whether the formation of 23 is initiated from the equatorial C₂-sulfonyloxy group of 14β or from axial C₂-azido group of 13β was remained ambiguous.

| TABLE 1. SUBSTITUTION OF 11β AND 11α WITH SODIUM AZIDE IN HMPA |
|-----------------|-----------------|-----------------|-----------------|
| Conditions Products (%) | Temp (°C) | Time (h) | 14 | 13 | Unsaturated products |
|-----------------|-----------------|-----------------|-----------------|
| 11α | 80 | 20 | 86 | — | — |
| 11α | 120 | 42 | — | 69 | 12β |
| 11β | 80 | 20 | 81 | — | — |
| 11β | 100 | 5 | 78 | — | — |
| 11β | 120 | 18 | — | 55 | 31α |

In order to prevent the formation of unsaturated compounds, the same substitution of 11α and 11β was examined at a lower temperature, using hexamethylphosphoric triamide (HMPA) as a solvent. As shown in Table 1, the reaction at 80 °C gave exclusively monosubstituted 14 in good yields. The continuation of the reaction at 120 °C until 14 disappeared also resulted in the formation of unsaturated compounds, but the yields of the desired diazides (13) were improved. Actually, 16α and 16β were obtained from the crude products in 60 and 46% yields, respectively, by subsequent hydrogenation and N-acetylation. The structure of 16α and 16β was further confirmed by respective hydrogenation into known N,N'-diacetyl-kasugammine (25).\(^{17}\) It has been reported that the substitution of methyl 4,6-O-isopropylidene-3-O-methyl-2-O-methylsulfonyl-β-D-gluco- and β-mannopyranoside with potassium benzoate in DMF proceeded smoothly, whereas that of α-anomers did not occur.\(^{18}\) Slower but steady substitution of the α-anomer in this experiment will be attributed to the absence of substituent at C-3 and to the flexibility of 11α.
Experimental

All melting points are uncorrected. The solutions were evaporated under diminished pressure at a bath temperature not exceeding 45 °C. Specific rotations were measured in a 0.5-dm tube, with a Carl Zeiss LEP-AI polarimeter. The IR spectra were recorded with a Hitachi Model EPI-G2 spectrometer. The NMR spectra were taken with a JOEL-4H-100 MHz spectrometer using tetramethylsilane as an internal standard, in deuteriochloroform unless otherwise stated. Chemical shifts and coupling constants were recorded in δ and Hz units, and IR frequencies in cm⁻¹.

Benzyl 2,3-Di-O-benzoyl-4,6-O-benzylidene-α- and β-D-glucopyranosides (1α and 1β).

Benzyl 4,6-O-benzylidene-β-D-glucopyranoside (1α) was benzoylated with benzoyl chloride in benzene. A usual work up and recrystallization of the product from ethanol gave pure 1α in 95.5% yield. Mp 165-166 °C; 3,6-Dideoxy-α- and β-D-xylo-hexopyranosides (9α and 7β).

Found: C, 72.34; H, 5.77%. Calcd for C₇₀H₄₀O₃₂S: C, 72.02; H, 5.34%.

Similarly, benzoylation of benzyl 4,6-O-benzylidene-α-D-glucopyranoside (1α) gave 9α in 93% yield. Mp 134–136 °C; [α]D +123.2 ° (0.35, CHCl₃). IR: 1700 (ester), (1600 (Ph); NMR: 7.95 and 7.50–7.10 (Ph; m); 6.10 (H₂:(ts, J₁₂= 9.3), 5.51 (CH₃: s), 5.28 (H₂: broad s), 5.23 (H₂: d, J₁₂= 3.5), 4.72 and 4.53 (CH₂: ABq, J₁₂= 13.0), 4.33–3.70 (H₄, H₂, and H₃). Found: C, 72.28; H, 5.34%.

Similarly, benzoylation of benzyl 4,6-O-benzylidene-α-D-glucopyranoside (1α) was benzoylated with benzoyl chloride in benzene. A usual work up and recrystallization of the product from ethanol gave pure 1β in 94% yield. Mp 182–183 °C, 3,6-Dideoxy-α- and β-D-xylo-hexopyranosides (9β and 7β).

Found: C, 72.02; H, 5.34%.

When the amount of solvents or the reaction time in the above reaction was not enough, the intermediate, benzyl 4,6-di-O-methylsulfonyl-β-D-glucopyranoside (5) deposited from the reaction mixture or from the chloroform layer during the washing with water. It was characterized as follows: mp 101–103 °C; [α]D +41.8 ° (c 0.86, MeOH); IR: 3400 (OH), 1490 (Ph), 1350 and 1190 (sulfate). Found: C, 52.12; H, 5.39; S, 14.74%. Caled for C₇₀H₆₀O₃₂S: C, 50.90; H, 5.49; S, 9.71%.

Benzyl 3,4-Anhydro-6-O-methylsulfonyl-α- and β-D-glucopyranosides (7α and 7β).

To a solution of 3β (14.8 g, 124 mmol) in chloroform (150 ml) was added a methanol solution (100 ml) of sodium methoxide (0.56 g, 0.12 equivalent of sodium) and then kept in a refrigerator overnight. The reaction mixture was diluted with chloroform (100 ml), and then washed three times with water. The chloroform layer was dried and evaporated to give a sirup which was crystallized from benzene–petroleum ether. Yield 5.8 g (75%); mp 77–78 °C; [α]D +108.3 ° (c 1.0, CHCl₃). IR: 3400 (OH), 1490 (Ph), 1350 and 1190 (sulfate); NMR: 7.30 (Ph; s), 4.80 and 4.53 (CH₂: ABq, J₁₂= 11.5), 4.42–4.30 (H₂ and H₃; m), 4.22 (H₂; d, J₁₂= 7.0), 4.19 (H₂; ts, J₁₂= 5.7), 3.68 (H₂: d, J₁₂= 3.8), 3.21 and 3.12 (H₂ and H₃; each: d, J₁₂= 3.8), 2.99 (OSO₂CH₃), 2.66 (OH; d). Found: C, 51.38; H, 5.42; S, 9.41%. Caled for C₇₀H₆₀O₃₂S: C, 50.90; H, 5.49; S, 9.71%.

Similarly, 3α was converted into 7α in 64% yield. Mp 73–74 °C (from ethanol–hexane); [α]D +42.4 ° (c 0.5, CHCl₃); IR: 3350 (OH), 1495 (Ph), 1350 and 1190 (sulfate); NMR: 7.40 (Ph, s), 4.94 (H₂: d, J₁₂= 4.8), 4.84 and 4.60 (CH₂: ABq, J₁₂= 11.5), 4.45–4.30 (H₂ and H₃; m), 3.85 (H₂: d, J₁₂= 10.5), 3.30 and 3.24 (H₂ and H₃; ABq, J₁₂= 2.6), 5.07 (OSO₂CH₃), 2.50 (OH; d). Found: C, 50.02; H, 5.56; S, 9.53%. Caled for C₇₀H₆₀O₃₂S: C, 50.90; H, 5.49; S, 9.71%.

Benzyl 3,4-Anhydro-6-O-p-tolylsulfonyl-β-D-glucopyranoside (8). 

Benzyl 4,6-Di-O-p-tolylsulfonyl-β-D-glucopyranoside (9). 

Epoxidation of 4 in the same manner as above, and separation of the product on a silica gel column gave 8 (5irup) and 9 (mp 110–112 °C in 48.4% and 25% yields, respectively.

Benzyl 3,4-Anhydro-6-O-p-tolylsulfonyl-β-D-glucopyranoside (8). 

Benzyl 4,6-Di-O-p-tolylsulfonyl-β-D-glucopyranoside (9). 

A suspension of lithium aluminium hydride (LAH, 2.4 g, 63 mmol) in tetrahydrofuran (THF, 100 ml) was added dropwise a solution of 7β (8 g, 18 mmol) in THF (70 ml) with stirring. The reaction mixture was refluxed for 5 h, and a mixture solution of water and ethyl acetate was added to decompose excess LAH. After bubbling carbon dioxide into the reaction mixture, it was filtered, and the filtered mass was washed with methanol–water (1:1). The filtrate and.

December, 1977

A Facile Synthesis of Kasugaminides via Abequosides

3307
9P was a mixture of 14P and 1175 (sulfate). Found: C, 45.86; H, 7.72%. Calcd for C13H11O5S: C, 46.32; H, 7.14%.

The same compound was also obtained from B in 48.5% yield. In a similar manner mentioned above, 9a was obtained from 7a in 53% yield as a sirup. [x]D +119 ° (c 0.8, CHCl3). Found: C, 64.98; H, 7.38%. Calcd for C13H11O5S: C, 65.33; H, 7.61%.

In case of 1.5 mol of LAH were used for hydrogenation of 7a, fractionation of the product gave benzyl deoxy-β-D-xyl-hexopyranosyriodide (10) in 22% yield. Mp 95—95.5 °C; [x]D +50.9° (c 1.1, MeOH). Found: C, 61.17; H, 7.08%. Calcd for C13H11O5S: C, 61.49; H, 7.14%.

Benzyl 3,6-Dideoxy-2,4-di-O-methylsulfonflyl-α- and β-D-xyl-hexopyranosyriodide (11a and 11b). Mesylation of 9b in the usual manner, and crystallization of the product from ethanol gave 11b in 77% yield. Mp 104—105 °C; [x]D +64.0° (c 1.0, CHCl3). IR: 1360 and 1170 (sulfate); NMR: 7.32 (Ph, s), 4.92 and 4.53 (CH2: ABq, J=12.0), 2.43 (H2: m), 4.68—4.50 (H2: m) and 3.08 (2×OSO2CH2): 2.71 (H2: m, J=12.0) 2.04 (H2: m), 1.35 (CH3: d, J=6.3). Found: C, 45.91; H, 5.68; S, 16.28%. Calcd for C13H15O5S2: C, 45.67; H, 5.62; S, 16.26%.

Similarly, 9a was mesylated to give 11a quantitatively. Mp 92—93 °C (from ethanol–hexane); [x]D +95.2° (c 0.6, CHCl3). IR: 1940 and 1175 (sulfate). Found: C, 45.86; H, 5.69; S, 16.51%. Calcd for C13H15O5S2: C, 45.67; H, 5.62; S, 16.26%.

Benzyl 3-Deoxy-2,3,6-tri-O-methylsulfonflyl-β-oxo-xyl-hexopyranosyriodide (12). Mesylation of 10 in pyridine with methanesulfonflyl chloride gave the tri-O-mesylate in 76% yield. Mp 123—126 °C; [x]D -59.6° (c 1.0, CHCl3); IR: 1350 and 1180 (sulfate); NMR: 7.32 (Ph: s), 4.97 (H2: m), 4.90 and 4.65 (CH2: ABq, J=12.0), 4.67—4.56 (H2: m) and 4.40—4.25 (H2: m), 3.80 (H2: octet, J=1.5), 2.91 and 3.08 (2×OSO2CH2): 2.71 (H2: m, J=12.0) 2.04 (H2: m), 1.35 (CH3: d, J=6.3). Found: C, 45.91; H, 5.68; S, 16.28%. Calcd for C13H15O5S2: C, 45.67; H, 5.62; S, 16.26%.

The reaction of 11a with sodium azide (780 mg, 12 mmol) in DMF (13 ml) was stirred at 120 °C overnight, filtered, and the filtrate was evaporated. A usual extraction gave a sirup which showed two spots other than 12 on TLC. Separation of the sirup on a silica gel column (benzene: ethanol=10:1) gave two main fractions of which the first fraction (230 mg, 35%) showed no absorption of a sulfonflyl group, but the second fraction (110 mg, 14.3%) showed the mesy signal in the NMR spectrum. The former was rechromatographed, but it could not be purified. The latter fraction was crystallized on standing, and recrystallized from benzene–petroleum ether. Mp 78—80 °C; [x]D +25.2° (c 0.6, CHCl3); IR: 2100 (N3), 1365 and 1180 (sulfate); NMR: 7.30 (Ph, s), 4.88 and 4.58 (CH2: ABq, J=11.5), 4.51 (H2: m) and 4.43 (H2: m), 3.41 (H2: broad s), 2.90 (OSO2CH2): 2.67 (H2: t, J=12.0), 1.81 (H2: broad q, J=7.0=11.0=15.0). Found: C, 44.26; H, 4.65; N, 22.33; S, 7.99%. Calcd for C13H15N3O5S: C, 43.97; H, 4.74; N, 21.98; S, 8.39%.

Benzyl 2,4-Diacetamido-2,3,4,6-tetrahydroxy-2-oxo-p-ribo-hexopyranosyriodide (16). A suspension of 11b (900 mg, 2 mmol) and sodium azide (700 mg, 10.8 mmol) in DMF (15 ml) was stirred at 120 °C for one day, and then at 160—165 °C until the initial product 14b disappeared (8 h). Treatment of the reaction mixture in the usual way and purified on a silica gel column gave a sirup (450 mg). A suspension of this sirup (350 mg) and LAH (380 mg, 10 mmol) in THF was refluxed on a oil-bath for 3 h, and a small amount of water containing ethyl acetate was added to decompose excess LAH, and then filtered. After neutralization of the filtrate, it was evaporated. The residue was dried, and then acetylated in the usual manner to give a sirup which contained two main components. The two products were isolated in pure state by column chromatography repeated twice. Thus, the first fraction 16i and the second 17 were obtained in 50 mg (12%) and 80 mg (19.4%) yields, respectively.

16i: Mp 146—147.5 °C; [x]D +45.2° (c 1.0, CHCl3); IR: 3270 (NH); 1650 and 1550 (amide); NMR: 7.29 (Ph: s), 4.80 and 4.55 (CH2: ABq, J=12.0), 4.54 (H2: m, J=12.0), 4.14 (H2: broad s), 3.83 (H2: m), 3.43 (H2: m), 2.18 (H2: m, J=12.0, J=12.0, J=12.0=15.0=19.5), and 1.93 and 1.96 (2×Nac), 1.53 (CH3: octet, J=10.0, J=9.0, J=4.0), 1.29 (CH2: d, J=6.3=7.0). Found: C, 64.03; H, 7.02; N, 8.73%.
A Facile Synthesis of Kasugaminides via Aboqueosides

Calcd for C_{19}H_{20}NO_{3}: C, 63.73; H, 7.55; N, 8.74%.

17: Mp 162–164 °C; [α]_{D}^{20}=−249° (c 0.2, CHCl_{3}); IR: 3270 (NH), 1640 and 1550 (amide); NMR: 7.30 (Ph, s), 7.5 5.7 (olefinic H, m), 4.83 and 4.57 (CH_{2}: ABq, J_{ab}=12.0), 4.63 (H_{2}, d, J_{d}^{ab}=4.5), 4.5–4.2 (H_{2} and H_{4}: m), 1.91 (NAC), 1.33 (CH_{3}: d, J_{d}^{ch}=7.0). Found: C, 69.23; H, 7.29; N, 5.52%. Calcd for C_{19}H_{20}NO_{3}: C, 68.94; H, 7.33; N, 5.36%.

Preparation of Benzyl β-Kasugaminide (18), Benzyl α-Amino-2,3,4,6-tetra-oxy-β-L-erythro-hexopyranoside (19), Benzyl 2-Amino-2,3,4,6-tetra-oxy-β-L-erythro-hexopyranoside (20), and Their Conversion into the Corresponding N-Acetates (16β, 21, and 22).

In the same manner mentioned above, the reaction of 11β (7.5 g) with sodium azide was carried out, and the crude product was hydrogenated in the presence of Raney nickel at 50 °C for 5 h under 50 atm hydrogen gas to give a sirup which showed three spots on TLC. The sirup on a silica gel (80 g Wako gel C-200) column was eluted with benzene–ethyl acetate (7:3) to give 19 (0.8 g, 19.0%), 18 (0.34 g, 8.1%), and 17 (1.82 g, 41.9%) as a sirup, respectively. Each sirup was acetylated with acetic anhydride and pyridine. The reaction mixture was directly evaporated to dryness, and the product was purified by column chromatography if necessary. Each acetate obtained in almost quantitative yield was characterized with NMR spectrum, respectively.

Compound 20 was not characterized.

22: mp 161.5–162 °C; [α]_{D}^{20}=−90.4° (c 0.6, CHCl_{3}); IR: 3280 (NH), 1635 and 1550 (amide); NMR: 7.35 (Ph, s), 4.88 and 4.58 (CH_{2}: ABq, J_{ab}=12.0), 4.36 (H_{2}, d, J_{d}^{ab}=8.2), 3.82–3.40 (H_{2} and H_{4}: m), 2.3–1.3 (H_{3}, H_{5}, H_{6}, and H_{7}: m), 1.90 (NAc), 1.26 (CH_{3}: d, J_{d}^{ch}=6.5). Found: C, 68.72; H, 8.30; N, 5.60%. Calcd for C_{19}H_{20}NO_{3}: C, 68.41; H, 8.04; N, 5.32%.

The authors are indebted to the members of the Laboratory of Organic Analysis for microanalysis and to Mr. H. Matsumoto for NMR measurements.

References