ELSEVIER

Carbohydrate Research 264 (1994) 147–153

CARBOHYDRATE RESEARCH

Note

Improved preparation of (±)-(1,3/2,4)-5-cyclohexene-1,2,3,4-tetrol [(±)-conduritol-B] and its reaction with hydrobromic and hydrochloric acid; synthesis and characterisation of some (±)-1-deoxy-1-halo- and (±)-1,4-dideoxy-1,4-dihalo-conduritols

Zhao-Xia Guo, Alan H. Haines *, Simon M. Pyke, Susan G. Pyke, Richard J.K. Taylor [1,*]

School of Chemical Sciences, University of East Anglia, Norwich NR4 7TJ, United Kingdom

Received 25 March 1994; accepted 16 May 1994

Keywords: Synthesis; (±)-Conduritol-B; (±)-1-Deoxy-1-haloconduritols; (±)-1,4-Dideoxy-1,4-dihalo-conduritols; (±)-Deoxyhaloconduritols

The mixture of (±)-1-bromo-(1,3/2,4)-5-cyclohexene-2,3,4-triol [(±)-1-bromo-1-deoxyconduritol B] (**1**) and (±)-1-bromo-(1,2,4/3)-5-cyclohexene-2,3,4-triol [(±)-1-bromo-1-deoxyconduritol F] (**2**), formed [2] [1,2] on treatment of (±)-conduritol-B (**3**) with hydrogen bromide and termed ''bromoconduritol'', is an active-site directed, covalent inhibitor of α-glucosidases [1,2,4]. Since some glycosidase inhibitors show significant anti-HIV activity [5], it was of interest to synthesise compounds related to **1** and **2** as part of our programme [6–8] to investigate novel glycosidase inhibitors as agents for the treatment of AIDS.

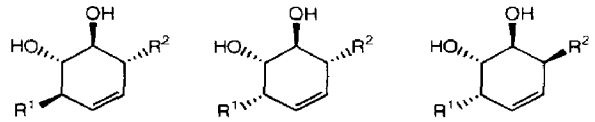
In view of the expected requirement for gram quantities of starting compound **3** and its non-availability from commercial sources, we first developed an efficient route to this compound from 1,4-benzoquinone (**4**), based on a combination and a modification of

* Corresponding authors.

[1] Present address: Department of Chemistry, University of York, York YO1 5DD, United Kingdom.

[2] The configurations of **1** and **2** were tentatively assigned [2] on the relative rates of dehydrobromination with sodium ethoxide and on the conversion [1] of one of them into a previously described [3] triacetate.

SSDI 0008-6215(94)00188-L

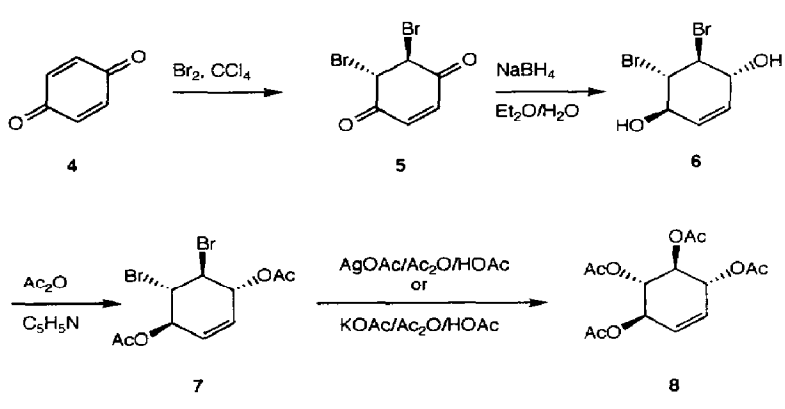


1 R^1 = Br, R^2 = OH **2** R^1 = Br, R^2 = OH **10** R^1 = R^2 = Br
3 R^1 = R^2 = OH **9** R^1 = R^2 = Br **15** R^1 = R^2 = Cl
11 R^1 = R^2 = Br **13** R^1 = Cl, R^2 = OH
12 R^1 = Cl, R^2 = OH **14** R^1 = R^2 = Cl
16 R^1 = R^2 = Cl

Note: only one enantiomeric form of each racemic modification is shown.

literature procedures [9,10]. Bromination of **4** (Scheme 1) followed by borohydride reduction of the resulting dibromide **5** gave [9] diol **6** which was best purified as its diacetate [10] **7**. Treatment of **7** with silver acetate in acetic anhydride–acetic acid, essentially by the method used [10] to prepare radiolabelled material on a milligram scale, gave the tetraacetate (**8**) of (±)-conduritol-B. In order to avoid the use of the expensive silver salt and the toxic lead acetate which had been used [10] as an alternative to the silver salt, we conducted the latter conversion using anhydrous potassium acetate in acetic acid–acetic anhydride and were thus able to prepare **8** conveniently in multigram quantities. *O*-Deacetylation then gave (±)-conduritol-B (**3**), identical to an authentic sample prepared [2,11] by an alternative route from *myo*-inositol.

The earlier work on the reaction of **3** with 48% hydrobromic acid gave [1,2] a mixture of stereoisomers of mono- and di-bromo substitution products and it was suggested that reaction occurred by replacement of one or two of the allylic hydroxyl groups either directly or through an allylic rearrangement process. Formation of the dibromo derivatives, thought to be the isomeric 1,4-dibromo-5-cyclohexene-2,3-diols, was based, essentially, on chromatographic evidence. Theoretically, assuming that the 2,3-*trans*-diol relationship is retained, six chiral stereoisomers of these 1,4-dibromo compounds are possible and these will exist as three enantiomeric pairs. Of these compounds [**9**, **10**, and **11** (one enantiomer only is shown in each case)] two, **10** and **11**, possess a C_2 axis of symmetry. Since the



Scheme 1.

monobromo compounds **1** and **2**, the corresponding novel monochloro analogues, and the 1,4-dihalo compounds were all needed for our glycosidase inhibition studies, we decided to reinvestigate the reaction of **3** with the appropriate halo acids and to examine the structures of the products by NMR spectroscopy.

Treatment of **3** with 48% hydrobromic acid, essentially as described [1,2], gave a brown residue which appeared, by TLC, to contain four components, separation of which was attempted by chromatography on silica gel. Investigation of the most mobile component by high resolution mass spectrometry (HRMS) and NMR spectroscopy indicated the presence of two dibromo compounds, identified (see later) as **10** and **11**. Continued elution gave, after intermediate fractions containing mixtures of the three dibromo compounds, dibromo compound **9**, as a crystalline solid. Further elution afforded fractions containing the two least polar components, compounds **1** and **2**, which we were not able to separate because of their very similar mobility, but which were obtained as a crystalline mixture [3], mp 116–119°. The mixture of **1** and **2** could be partially separated by preparative centrifugal chromatography to give enriched samples, which aided interpretation of the NMR spectra of the mixtures.

Reaction of **3** with hydrochloric acid was much slower than with hydrobromic acid, and the reaction was conducted with 36% hydrochloric acid for 30 days at room temperature. Once again, TLC indicated that four components were present and attempted separation of these by column chromatography was only partially successful. Five products were eventually identified but only two were isolated in pure form. The fastest-running component was a 1:1 mixture of the two dichloro compounds **15** and **16**, which was followed by dichloro compound **14**. Separation of the two least mobile components was only partially successful. Early fractions allowed the isolation of the pure monochloro compound **12** in surprisingly good yield (60%) but the slightly slower monochloro compound **13** was only obtained as an enriched sample in a 3:1 mixture (13% yield) with **12**.

Despite the difficulties of separation, it was possible to identify the compounds in the reaction components. In view of the relatively small amounts of products isolated, elemental composition was obtained by HRMS measurements except for compound **12** and the mixture of **12** and **13** for which conventional elemental analyses were obtained. In the case of the dihalo compounds **11** and **16**, confirmatory evidence as regards our structure determinations was obtained as a result of the availablity of these compounds from an alternative type of synthesis [8].

A study of the ^{1}H NMR spectra of the non-symmetrical compounds, **1**, **2**, **9**, **12**, **13**, and **14** was undertaken and the coupling constants measured for these deoxyhaloconduritols are collected in Table 1. The ^{1}H NMR spectrum of the monochlorodeoxyconduritol **12**, (±)-1-chloro-(1,3/2,4)-5-cyclohexene-2,3,4-triol [(±)-1-chloro-1-deoxyconduritol B] was unequivocally assigned by means of a COSY-45 experiment. In this case, coupling between the hydroxyls and the ring protons was observed, allowing unambiguous assignment of H-1 and hence the coupling constant $J_{1,2}$ (see Table 1). The magnitude of $J_{1,2}$, 8.2 Hz, indicates that H-1 and H-2 are diaxially disposed. The magnitudes of $J_{2,3}$ and $J_{3,4}$, 10.1 and 7.9 Hz, respectively, indicate the axial disposition of H-2 and H-3 and the pseudoaxial disposition

[3] Material of mp 117–119°C, largely if not solely the monobromo compound **1**, was previously obtained by Legler and Lotz [1] by crystallisation of the crude reaction product from ethanol–benzene.

Table 1
Coupling constants (Hz) for the ring protons of the deoxyhaloconduritols **1**, **2**, **9**, **12**, **13**, and **14**

Compound	Coupling constant								
	$J_{1,2}$	$^5J_{1,4}$	$^4J_{1,5}$	$J_{1,6}$	$J_{2,3}$	$J_{3,4}$	$J_{4,5}$	$^4J_{4,6}$	$J_{5,6}$
1	8.1		2.4	1.9	10.2	7.8	2.6	1.9	10.3
2	4.0	<0.5 [a]		5.2	10.0	7.8	2.3	2.1	9.8
9	4.5	0.8		5.6	9.8	8.2	2.4	1.8	9.7
12	8.2		2.1	1.5	10.1	7.9	2.4	1.2	10.3
13	4.0	<0.5 [a]		5.2	[b]	6.1	2.3	2.1	9.8
14	4.1	0.9		5.5	10.2	8.0	2.4	2.1	9.8

[a] Visible only as line broadening.
[b] Could not be determined due to overlap of signals for H-2 and H-3.

of H-4. Thus, the relative configuration of **12** is defined as shown in Fig. 1. The monobromodeoxyconduritol **1** was assigned in a similar fashion. The other monohalo compounds **2** and **13** must have the inverted configuration at C-1, and this was confirmed by the magnitude of $J_{1,2}$ (4.0 Hz) in each case. The structures of the asymmetric dihalo compounds **9** and **14** were confirmed in a similar manner.

We were able to isolate only the C_2 symmetric dideoxydihaloconduritols **10**,**11** and **15**,**16** as mixtures, and the presence of just six resonances in the ^{13}C NMR spectrum of the mixture of each pair confirmed their symmetry. The availability of **11** and **16**, through an alternative synthesis [8] from (±)-(1,2/3,4)-1,2:3,4-diepoxy-5-cyclohexene (*anti*-benzene dioxide), enabled identification of the ^{13}C resonances of these compounds and also, thereby, the corresponding resonances of the other component of each mixture, compounds **10** and **15**, respectively.

The properties of these deoxyhaloconduritols as glucosidase inhibitors will be reported separately.

1. Experimental

^1H NMR spectra were recorded (internal Me_4Si) at 400 MHz, and ^{13}C NMR spectra at 100 MHz using a Jeol JNM-GX 400 spectrometer unless stated otherwise. Analytical TLC was performed on Merck 554 aluminium-backed silica gel plates (detection by aqueous, alkaline potassium permanganate or concentrated sulphuric acid) and column chromatography on silica gel (Sorbosil 60-H). Preparative centrifugal chromatography was performed

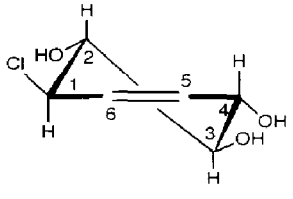


Fig. 1. Configuration of **12** based on its ^1H NMR spectrum.

on a Chromatron Model 7924T, using silica gel plates (Merck 7749). Paper chromatography was carried out on Whatman No. 1 paper.

(±)-(1,3/2,4)-1,2,3,4-Tetra-O-acetyl-5-cyclohexene-1,2,3,4-tetrol (**8**).—A vigorously stirred mixture of (±)-(1,3/2,4)-1,4-diacetoxy-2,3-dibromo-5-cyclohexene [10] (**7**; 10 g, 28 mmol), glacial AcOH (150 mL), Ac_2O (30 mL), and anhyd KOAc (13.8 g, 0.14 mol) was heated under reflux for 66 h, after which the solvent was removed under reduced pressure. Methanol (40 mL) was added and, after 10 min, the solution was concentrated and the residue was partitioned between ether (150 mL) and water (100 mL). The organic layer was washed with aq 10% $NaHCO_3$ (3×30 mL), satd aq NaCl (100 mL), dried, and concentrated to yield a solid (8.1 g) which was recrystallised from EtOH–water to give **8** (6.42 g, 72%); mp 85–87°C; lit. [11] mp 85–85.5°C. A second crop afforded slightly less pure material (0.66 g, 7%); mp 83.5–86°C. The spectral properties of these materials were identical to those of a sample of **8** prepared by an alternative route [11] from *myo*-inositol.

(±)-(1,3/2,4)-5-Cyclohexene-1,2,3,4-tetrol [(±)-conduritol-B] (**3**).—*O*-Deacetylation of **8** (5 g, 16 mmol) in 7:3 MeOH–water (50 mL) containing Et_3N (4.5 mL) at 17°C for 12 h and crystallisation of the crude product from MeOH-toluene gave (±)-conduritol-B (**3**; 2.05 g, 88%); mp 201–204°C; lit. [11] mp 199.5–201°C. Anal. Calcd for $C_6H_{10}O_4$: C, 49.3; H, 6.8. Found: C, 49.3; H, 6.9.

Reaction of (±)-conduritol-B (**3**) *with hydrobromic acid.*—A solution of **3** (0.4 g, 2.7 mmol) in 48% hydrobromic acid (2.5 mL) was stored in the dark at 17°C for 24 h, and the brown solution was then transferred to a 6-cm Petri dish and solvent removed by storage over KOH pellets in a desiccator. The viscous brown residue was dissolved in EtOAc with the aid of sonication and chromatographed on silica gel (70 g), eluting with EtOAc. Fractions were collected and examined by TLC (20:8:0.3 EtOAc–MeCN–H_2O), appropriate fractions were then pooled, and the products isolated by evaporation.

First eluted (R_f 0.71) was a 1:1 mixture (58 mg, 8%) of (±)-1,4-dibromo-(1,2/3,4)-5-cyclohexene-2,3-diol [(±)-1,4-dibromo-1,4-dideoxyconduritol E] (**10**) and (±)-1,4-dibromo-(1,3/2,4)-5-cyclohexene-2,3-diol [(±)-1,4-dibromo-1,4-dideoxyconduritol B] (**11**); mp 129–137°C. NMR data [$(CD_3)_2CO$] (*i*) for **10**: ^1H, δ 3.81–3.82 (m, 2 H, H-2,3), 5.04–5.05 (m, 2 H, H-1,4), 5.97–5.98 (m, 2 H, H-5,6); ^{13}C, δ 55.34 (C-1,4), 68.93 (C-2,3), 130.77 (C-5,6); (*ii*) for **11**: ^1H, δ 3.72–3.74 (m, 2 H, H-2,3), 4.72–4.74 (m, 2 H, H-1,4), 5.81 (br s, 2 H, H-5,6); ^{13}C, δ 54.10 (C-1,4), 78.83 (C-2,3), 130.31 (C-5,6). Mass spectrum (CI): m/z 289.9214 ($M+NH_4$).

Next fractions contained **10**, **11**, and (±)-1,4-dibromo-(1,2,4/3)-5-cyclohexene-2,3-diol [(±)-1,4-dibromo-1,4-dideoxyconduritol F] (**9**) in the ratio **9**:(**10**+**11**) = 4:1. The following fractions (R_f 0.67) contained only **9** (45 mg, 6%); mp 139–142°C. NMR data [$(CD_3)_2CO$]: ^1H, δ 3.34 (dd, 1 H, $J_{1,2}$ 4.5, $J_{2,3}$ 9.8 Hz, H-2), 3.92 (dd, 1 H, $J_{3,4}$ 8.2 Hz, H-3), 4.77 (m, 1 H, $J_{4,5}$ 2.4, $J_{4,6}$ 1.8, $J_{1,4}$ 0.8 Hz, H-4), 4.86 (ddd, 1 H, $J_{1,6}$ 5.6 Hz, H-1), 5.83 (dd, 1 H, $J_{5,6}$ 9.7 Hz, H-5), 5.94 (ddd, 1 H, H-6); ^{13}C (22.5 MHz), δ 53.24 (C-1), 54.19 (C-4), 71.34 (C-2), 71.44 (C-3), 128.84 (C-6), 131.43 (C-5). Mass spectrum (CI): m/z 289.9214 ($M+NH_4$).

The later fractions contained a mixture of (±)-1-bromo-(1,3/2,4)-5-cyclohexene-2,3,4-triol [(±)-1-bromo-1-deoxyconduritol B] (**1**) (R_f 0.42) and (±)-1-bromo-(1,2,4/3)-5-cyclohexene-2,3,4-triol [(±)-1-bromo-1-deoxyconduritol F] (**2**) (R_f 0.42) (163 mg,

29%); mp 115–119°C; lit. [1] mp 117–119°C. These compounds could not be separated by column chromatography but were partially separated by preparative centrifugal chromatography (1:1 EtOAc–CH_2Cl_2) to give enriched samples of each isomer. ^{1}H NMR data [$(CD_3)_2SO$]: (*i*) for **1**, δ 3.14 (dd, 1 H, $J_{2,3}$ 10.2, $J_{3,4}$ 7.8 Hz, H-3), 3.56 (dd, 1 H, $J_{1,2}$ 8.1 Hz, H-2), 3.99 (ddd, 1 H, $J_{4,5}$ 2.6, $J_{4,6}$ 1.9 Hz, H-4), 4.64 (ddd, 1 H, $J_{1,5}$ 2.4, $J_{1,6}$ 1.9 Hz, H-1), 5.52 (dt, 1 H, $J_{5,6}$ 10.3 Hz, H-6), 5.69 (ddd, H-5); (*ii*) for **2**, δ 3.27 (dd, 1 H, $J_{1,2}$ 4.0, $J_{2,3}$ 10.0 Hz, H-2), 3.52 (dd, 1 H, $J_{3,4}$ 7.8 Hz, H-3), 3.99 (m, 1 H, $J_{4,5}$ 2.3, $J_{4,6}$ 2.1, $J_{1,4}$ < 0.5 Hz, H-4), 4.85 (dd, 1 H, $J_{1,6}$ 5.2 Hz, H-1), 5.58 (dd, 1 H, $J_{5,6}$ 9.8 Hz, H-5), 5.83 (ddd, H-6).

Reaction of (±)-conduritol-B (**3**) *with hydrochloric acid.*—(±)-Conduritol-B (**3**) (0.4 g, 2.7 mmol) was dissolved in 36% hydrochloric acid (5 mL) and the solution was stored at room temperature for 30 days in the dark. Solvent was removed over KOH as in the related experiment involving hydrobromic acid and a solution of the residue in EtOAc was chromatographed on silica gel (70 g), eluting with EtOAc. The compositions of collected fractions were examined by TLC (20:8:0.3 EtOAc–MeCN–H_2O).

The earliest fractions contained, as an inseparable 1:1 mixture (R_f 0.71), (±)-1,4-dichloro-(1,2/3,4)-5-cyclohexene-2,3-diol [(±)-1,4-dichloro-1,4-dideoxyconduritol E] (**15**) and (±)-1,4-dichloro-(1,3/2,4)-5-cyclohexene-2,3-diol [(±)-1,4-dichloro-1,4-dideoxyconduritol B] (**16**) (11 mg, 2%); mp 141–144°C. NMR data [$(CD_3)_2CO$] (*i*) for **15**: ^{1}H, δ 4.13–4.19 (m, 2 H, H-2,3), 4.84–4.88 (m, 2 H, H-1,4), 5.89–5.90 (m, 2 H, H-5,6); ^{13}C, δ 59.88 (C-1,4), 68.92 (C-2,3), 129.52 (C-5,6); (*ii*) for **16**: ^{1}H, δ 3.62–3.64 (m, 2 H, H-2,3), 4.57–4.58 (m, 2 H, H-1,4), 5.73 (m, 2 H, H-5,6); ^{13}C, δ 62.00 (C-1,4), 77.86 (C-2,3), 129.74 (C-5,6). Mass spectrum (CI): *m/z* 200.0245 ($M+NH_4$).

From the following fractions (R_f 0.66) was isolated (±)-1,4-dichloro-(1,2,4/3)-5-cyclohexene-2,3-diol [(±)-1,4-dichloro-1,4-dideoxyconduritol F] (**14**; 15 mg, 3%); mp 147–152°C. NMR data [$(CD_3)_2CO$]: ^{1}H, δ 3.81 (dd, 1 H, $J_{1,2}$ 4.1, $J_{2,3}$ 10.2 Hz, H-2), 3.98 (dd, 1 H, $J_{3,4}$ 8.0 Hz, H-3), 4.52 (m, 1 H, $J_{4,5}$ 2.4, $J_{4,6}$ 2.1, $J_{1,4}$ 0.9 Hz, H-4), 4.76 (ddd, 1 H, $J_{1,6}$ 5.5 Hz, H-1), 5.81 (dd, 1 H, $J_{5,6}$ 9.8 Hz, H-5), 6.00 (ddd, 1 H, H-6); ^{13}C, δ 59.26 (C-1), 62.59 (C-4), 71.38 (C-2), 74.29 (C-3), 128.14 (C-6), 131.29 (C-5). Mass spectrum (CI): *m/z* 200.0245 ($M+NH_4$).

The compound next eluted (R_f 0.4) was (±)-1-chloro-(1,3/2,4)-5-cyclohexene-2,3,4-triol [(±)-1-chloro-1-deoxyconduritol B] (**12**; 0.27 g, 61%); mp 136–139°C; ^{1}H NMR data [$(CD_3)_2SO$]: δ 3.17 (ddd, 1 H, $J_{2,3}$ 10.1, $J_{3,4}$ 7.9, $J_{3,OH}$ 4.6 Hz, H-3), 3.41 (ddd, 1 H, $J_{1,2}$ 8.2, $J_{2,OH}$ 5.5 Hz, H-2), 3.95 (m, 1 H, $J_{4,5}$ 2.4, $J_{4,6}$ 1.2, $J_{4,OH}$ 5.8 Hz, H-4), 4.48–4.51 (m, 1 H, $J_{1,5}$ 2.1, $J_{1,6}$ 1.5 Hz, H-1), 5.13 (d, 1 H, HO-4), 5.19 (d, 1 H, HO-3), 5.43 (d, 1 H, HO-2), 5.52–5.60 (m, 2 H, $J_{5,6}$ 10.3 Hz, H-5,6); ^{13}C, δ 63.55 (C-1), 71.04 (C-4), 76.37 (C-2,3), 126.34 (C-6), 132.76 (C-5). Anal. Calcd for $C_6H_9ClO_3$: C, 43.8; H, 5.5; Cl, 21.5. Found: C, 43.9; H, 5.5; Cl, 21.4.

The last fractions provided a 1:3 mixture of **12** and (±)-1-chloro-(1,2,4/3)-5-cyclohexene-2,3,4-triol [(±)-1-chloro-1-deoxyconduritol F] (**13**) (R_f 0.37) (57 mg, 13%); mp 105–108°C; NMR data [$(CD_3)_2SO$] for **13**: ^{1}H, δ 3.47-3.57 (m, 2 H, H-2,3), 3.87 (m, 1 H, $J_{3,4}$ 6.1, $J_{4,OH}$ 5.8 Hz, H-4), 4.67 (dd, 1 H, $J_{1,6}$ 5.2, $J_{1,2}$ 4.0 Hz, H-1), 5.01 (d, 1 H, $J_{3,OH}$ 4.0 Hz, HO-3 [4]), 5.17 (d, 1 H, HO-4), 5.23 (d, 1 H, $J_{2,OH}$ 4.0 Hz, HO-2[4]), 5.64 (dd,

[4] These assignments may be reversed.

1 H, $J_{5,6}$ 9.8, $J_{4,5}$ 2.3 Hz, H-5), 5.76 (ddd, 1 H, $J_{4,6}$ 2.1 Hz, H-6); ^{13}C (22.5 MHz), δ 60.58 (C-1), 69.32 (C-4), 72.20 (C-2), 72.48 (C-3), 124.96 (C-6), 134.03 (C-5). Anal. Calcd for $C_6H_9ClO_3$: C, 43.8; H, 5.5; Cl, 21.5. Found: C, 43.8; H, 5.4; Cl, 21.9.

Acknowledgements

This work was supported under the MRC AIDS Directed Programme. We thank the SERC Mass Spectrometry Service Centre, Swansea, for determination of the high resolution mass spectra.

References

[1] G. Legler and W. Lotz, *Hoppe-Seyler's Z. Physiol. Chem.*, 354 (1973) 243–254.
[2] G. Legler, *Methods Enzymol.*, 46 (1977) 368-381; see especially pp 380–381.
[3] G. Legler, *Hoppe-Seyler's Z. Physiol. Chem.*, 345 (1966) 197–214.
[4] R. Datema, P.A. Romero, G. Legler, and R.T. Schwarz, *Proc. Natl. Acad. Sci. U.S.A.*, 79 (1982) 6787–6791.
[5] A.S. Tyms. D.L. Taylor, P.S. Sunkara, and M.S. Kang, in E. De Clercq (Ed.), *Design of Anti-Aids Drugs*, Elsevier, Amsterdam, 1990, pp 257–318.
[6] J.C. Briggs, A.H. Haines, and R.J.K. Taylor, *J. Chem. Soc, Chem. Commun.*, (1992) 1039–1041.
[7] J.C. Briggs, A.H. Haines, and R.J.K. Taylor, *J. Chem. Soc. Chem. Commun.*, (1993) 1410–1411.
[8] Z.-X. Guo, A.H. Haines, and R.J.K. Taylor, *Synlett*, (1993) 607–608.
[9] H.J. Altenbach, H. Stegelmeier, and E. Vogel, *Tetrahedron Lett.*, (1978) 3333–3337.
[10] A.E. Gal and J.P. Voorstaad, *J. Labelled Compd. Radiopharm,*. 24 (1987) 397–407.
[11] T.L. Nagabhushan, *Can. J. Chem.*, 48 (1969) 383–384.