Inositol Derivatives. 7. Azidolysis of Disulfonates of *myo*-Inositol and 1,2-*O*-Cyclohexylidene Derivative[1]

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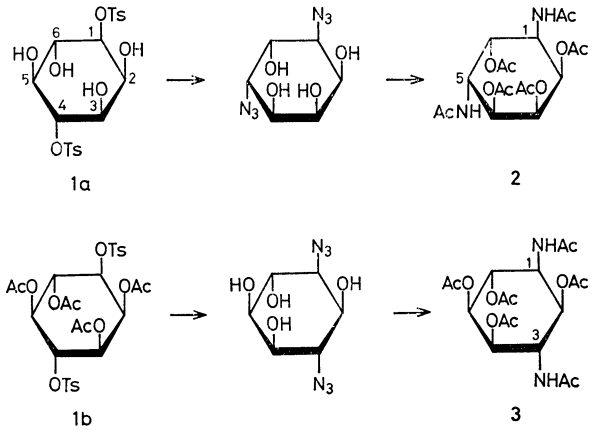
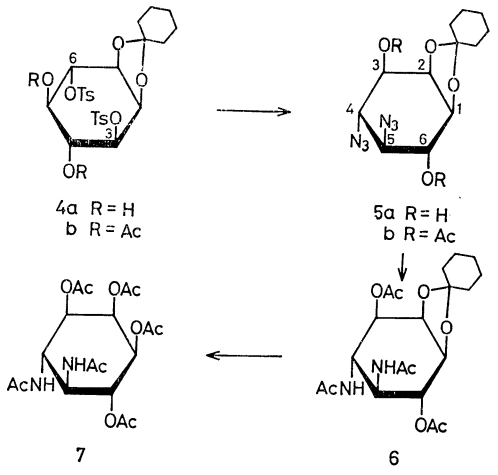
Reactions of azide ion with three disulfonates (1,4-, 1,5-, and 1,6-) of *myo*-inositol and its 1,2-*O*-cyclohexylidene derivative were studied. The structures of the new azido compounds thus obtained were established by PMR spectroscopy and reaction sequences. The reaction mechanisms of the neighboring-group participation reactions were discussed. Hydrogenation of the azido compounds followed by acetylation afforded the corresponding six inosadiamines as their hexaacetates: three known (*allo*-1,5, *muco*-1,3, and *myo*-4,5) and three hitherto unknown inosadiamines (*allo*-1,4, *muco*-1,2, and *chiro*-2,4).

Azido-deoxy- and diazido-dideoxy-inositols are useful intermediates for the synthesis of inosamines and inosadiamines or certain kinds of nucleoside analogs having pseudo sugar moieties. Investigations have been carried out on nucleophilic displacement reactions by azide ion with readily accessible sulfonate derivatives of inositols.[2] In the present paper, we wish to report on the azidolysis of three ditosylates of *myo*-inositol and its 1,2-*O*-cyclohexylidene derivative. The structures of the new azido compounds were established by PMR spectroscopy of their acetyl derivatives, and also by their transformation into known aminocyclitols. The reaction mechanisms in azidolysis were discussed.



Scheme 1

1,4-Ditosylates. Treatment of 1,4-di-*O*-tosyl-*myo*-inositol (**1a**)[3] with an excess amount of sodium azide in refluxing aqueous 2-methoxyethanol for 20 hr, followed by conventional acetylation, afforded an azido derivative as a syrup. The crude azido compound was catalytically hydrogenated and subsequently acetylated to give hexaacetyl *allo*-inosadiamine-1,5 (**2**)[4] in 58% yield. On the other hand, when 1,4-di-*O*-tosyl-*myo*-inositol tetraacetate (**1b**)[3] was treated with sodium azide under the same conditions, hexaacetyl *muco*-inosadiamine-1,3 (**3**)[4] was obtained exclusively in 44% yield. In the former reaction (**1a**→**2**), displacement of the sulfonyloxy group at C-4 takes place initially by participation of the hydroxyl group at C-5 forming an intermediary 4,5-epoxide. The epoxide ring is opened by azide ion preferentially in a *trans*-diaxial manner. Another sulfonyloxy group at C-1 is replaced by the participation of the hydroxyl group at C-6 to give a 1,6-epoxide, which is attacked by the nucleophile in the manner described above. In the latter reaction (**1b**→**3**), the initial formation of a 1,6- or 3,4-acetoxonium ion, and its *trans*-diaxial opening by the azide ion results in the formation of compound **3**.



Scheme 2

In order to remove participation of the acetoxy group at C-3 in the replacement reaction of the sulfonyloxy group at C-4 in **1b**, two hydroxyl groups of **1a** at C-2 and C-3 were blocked by a nonparticipating cyclohexylidene group to give 1,2-*O*-cyclohexylidene-3,6-di-*O*-tosyl-*myo*-inositol (**4a**).[3] Compound **4a** and its diacetate (**4b**)[3] were subjected to azidolysis under the same conditions to give an azido compound (**5a**) as the sole crystalline product in fairly good yield. Acetylation of **5a** gave the diacetate (**5b**). Catalytic reduction of **5a**, followed by acetylation, afforded tetraacetyl *O*-cyclohexylidene-inosadiamine (**6**). Mild hydrolysis of **6** in aqueous acetic acid followed by acetylation gave hexaacetyl *myo*-inosadiamine-4,5 (**7**).[4] Compound **6** was thus assigned to 4,5-diacetamido-3,6-di-*O*-acetyl-1,2-*O*-cyclohexylidene-4,5-dideoxy-*myo*-inositol and **5a** to 4,5-diazido-1,2-*O*-cyclohexylidene-4,5-dideoxy-*myo*-inositol. The structure of **5b** was further confirmed by its PMR spectrum which allowed an interpretation by a first-order method with nicely resolved signals. The narrow doublets at τ 5.87 and 5.50 were respectively assigned to the protons at C-1

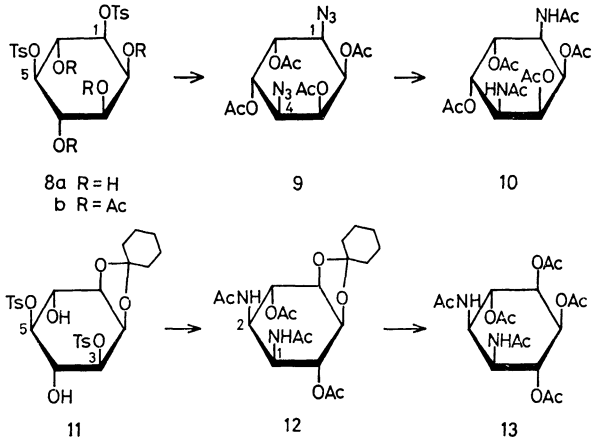
TABLE 1. CHEMICAL SHIFTS OF ACETYL METHYL PROTONS OF HEXAACETYL INOSADIAMINES[a)]

Compound	Configuration	Solvent	Chemical shifts
2	*allo*-1,5	C	8.06 (3)
			7.98 (9)
			7.89 (3)
			7.85 (3)
3	*muco*-1,3	C	8.02 (3)
			7.97 (3)
			7.92 (9)
			7.89 (3)
7	*myo*-4,5	C	8.07 (6)
			8.02 (3)
			7.99 (3)
			7.87 (3)
			7.80 (3)
10	*allo*-1,4	D	8.10 (6)
			7.96 (6)
			7.93 (6)
13	*muco*-1,2	C	7.99 (6)
			7.90 (6)
			7.87 (6)
20	*chiro*-2,4	D	8.23 (3)
			8.20 (3)
			8.07 (6)
			7.82 (6)

a) Measured at 60 MHz. Chemical shifts are expressed in terms of τ-values. Values in parentheses show number of protons. Abbreviations: C, $CDCl_3$; D, DMSO-d_6. The chemical shifts and pattern of the signals of known compounds (**2**, **3**, and **7**) are in good agreement with those reported by Nakajima *et al.*[4)]

and C-2 carrying the blocking group. The protons were shown to be coupled neither with H-4 (τ 6.72) nor with H-5 (τ 6.10).[5)]

In both reactions with **4a** and **4b**, the azidolysis involves the formation of an intermediary epoxide and acetoxonium ion, respectively, by participation of the neighboring group and its opening by an azide ion which is appreciably affected by the adjacent cyclohexylidene group in terms of steric and polar effects. Thus it is deduced that the opening of the 5,6-epoxide initially formed occurs in a *trans*-diaxial manner and the 3,4-epoxide is subsequently opened in a *trans*-diequatorial manner.



Scheme 3

1,5-Ditosylates. Treatment of 1,5-di-*O*-tosyl-*myo*-inositol (**8a**)[3)] and its acetyl derivative (**8b**)[3)] with sodium azide under similar conditions, followed by acetylation, gave diazidodideoxyinositol tetraacetate (**9**) as the sole crystalline product in 13 and 39% yields, respectively. Besides product **9**, two other unidentified minor products were detectable on tlc. Catalytic reduction of **9**, followed by acetylation, afforded hitherto unknown hexaacetyl inosadiamine (**10**). The PMR spectrum of **10** revealed three singlets of equal intensity in the vicinity of τ 8, ascribed to two acetamido, two acetoxy, and two acetoxy groups.[6)] From the pattern of the signals and their chemical shifts, it was deduced to be the time-averaged spectrum derived from a rapid interconversion between two equivalent conformations. The PMR spectrum of **9**, however, showed a wide double doublet (J=3 and 11 Hz) and a narrow triplet (J=3 Hz) at τ 6.00 and 5.56, respectively, which do not couple with each other and are ascribable to the protons on the carbon atoms carrying the azido groups.[5)]

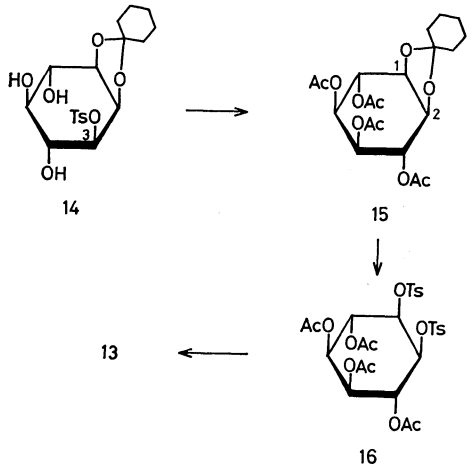
TABLE 2. PMR SPECTRAL DATA IN $CDCl_3$ AT 60 MHz[a)]

Compound	H_1 ($J_{1,2}$)	H_2 ($J_{2,3}$)	H_3 ($J_{3,4}$)	H_4 ($J_{4,5}$)	H_5 ($J_{5,6}$)	H_6 ($J_{1,6}$)	OAc	OTs
5b	5.87 dd	5.50 dd	4.96 dd	6.72 t	6.10 t	4.82 dd	7.84 (3) [b)]	
	(5)	(4)	(10)	(10)	(10)	(7.5)	7.79 (3)	
9	5.56 t	—	4.34 t	6.00 dd	—	4.34 t	7.99 (3)	
	(3)		(3)	(11)		(3)	7.87 (3)	
							7.83 (3)	
							7.79 (3)	
18	—	6.22 dd	4.68 dd	6.13 t	4.90 dd	—	7.94 (3)	
	(3)	(10)	(10)	(10)	(3)		7.82 (6)	
							7.79 (3)	
19	5.43 dd	4.32 t	4.99 dd	4.58 dd	5.00 t	6.05 t	8.03 (3)	7.52 (3)
	(3)	(3)	(10.5)	(10)	(10)	(10.5)	8.01 (3)	
							7.91 (3)	
							7.84 (3)	

a) Chemical shifts are given in terms of τ-values. Values given for coupling constants (Hz) are of first-order. Abbreviations: t (triplet); dd (double doublet). b) Values in parentheses show number of protons.

A narrow triplet (τ 4.34) should be due to an equatorial proton on the carbon atom attached by the acetoxy group. Besides the expectation from analogous reaction mechanism, the results indicate that **9** should possess either *allo*-1,4- or *neo*-1,5-configuration. Since the former configuration satisfied the behavior of **10** in PMR spectroscopy, **9** was assigned to 1,4-diazido-1,4-dideoxy-*allo*-inositol tetraacetate and **10** to hexaacetyl *allo*-inosadiamine-1,4. Mechanistically, participation of the hydroxyl or the acetoxy group on C-4 to C-5 occurs initially to give rise to a 4,5-cyclic intermediate.

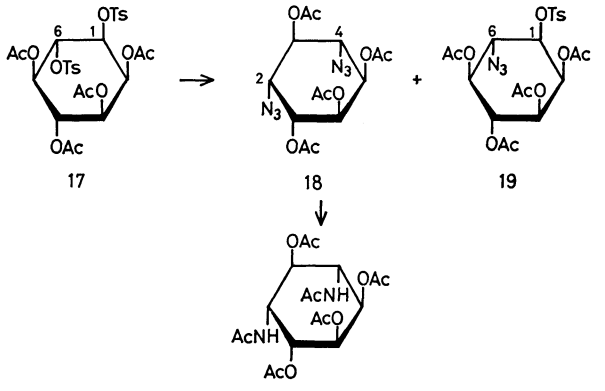
On the other hand, two hydroxyl groups at C-2 and C-3 of **8a** were blocked by a cyclohexylidene group to give compound **11**.[3] Azidolysis of **11** under similar conditions and subsequent acylation afforded tetraacetyl *O*-cyclohexylidene-inosadiamine (**12**) in 34% yield, which was converted into hitherto unknown inosadiamine (**13**). The PMR spectrum of **12** revealed four acetyl methyl protons as two singlets of equal intensities at τ 8.00 and 7.86, which were ascribed to two equivalent acetamido and acetoxy groups, respectively. The configuration of **12** is thus limited to *muco*-1,2 and *allo*-1,4. The PMR spectrum of **13** showed three singlets (1 : 1 : 1) due to six acetyl methyl protons, also supporting the above assignments.



Scheme 4

For the sake of confirmation, an alternative synthesis of **13** was successfully attempted as follows. 1,2-*O*-Cyclohexylidene-3-*O*-tosyl-*myo*-inositol (**14**)[3] was heated in aqueous 2-methoxyethanol with sodium carbonate and subsequently acetylated to give 1,2-*O*-cyclohexylidene-*muco*-inositol tetraacetate (**15**) in 65% yield. By removing the cyclohexylidene group in aqueous acetic acid, **15** was converted into *muco*-inositol tetraacetate, which was treated with tosyl chloride in pyridine to give 1,2-di-*O*-tosyl-*muco*-inositol tetraacetate (**16**). Azidolysis of **16** in the usual way followed by reduction and acetylation afforded **13** in 30% yield.

Consequently, the structure of **13** was established as hexaacetyl *muco*-inosadiamine-1,2. In the case of **11**, the nucleophilic substitution of the intermediate epoxides is also affected by the cyclohexylidene group located in *trans* orientation to them resulting in the initial *trans*-diequatorial opening of the 5,6-epoxide[7] followed by subsequent *trans*-diaxial opening of the 3,4-epoxide.



Scheme 5

1,6-Ditosylates. Treatment of 1,6-di-*O*-tosyl-*myo*-inositol tetraacetate (**17**)[3] with sodium azide by the usual method gave two major products, which were separated by fractional crystallization from ethanol into diazido compound (**18**) and monoazido compound (**19**) in 44 and 18% yields, respectively. Catalytic reduction of **18** and subsequent acetylation afforded a new hexaacetyl inosadiamine (**20**) in 42% yield. By analogy with the preceding results, the reaction involves the initial formation of the 5,6-acetoxonium ion, followed by its preferential diaxial opening with azide ion. However, in a favorable conformation of the intermediate, an attack of azide ion at C-5 would be somewhat interrupted by the adjacent *trans*-acetoxy group in pseudo equatorial orientation, which is probably reflected to a formation of **18** and **19** with a ratio of 2.4: 1. Another tosyloxy group at C-1 in **18** is replaced by the nucleophile in a direct S_N2 manner. **18** is therefore tentatively assigned to 2,4-diazido-2,4-dideoxy-*chiro*-inositol tetraacetate and **19** to 6-azido-6-deoxy-1-*O*-tosyl-*myo*-inositol tetraacetate.

The PMR spectrum of **18** (Table 1) shows a triplet (τ 6.13) and a double doublet (τ 6.22) which do not couple with each other, indicating the presence of the azido groups at C-2 and C-4. The chemical shifts of acetyl methyl protons of **20** also support its *chiro*-2,4 configuration. In the PMR spectrum of **19** (Table 1), the triplet (τ 6.05) due to a proton on the carbon atom bearing the azido group is coupled with H-1 double doublet (τ 5.43), supporting the above assignment.

In the case of **19**, the displacement of tosyloxy group at C-1 is significantly retarded by the existence of the neighboring azido group in *trans* orientation.

For the sake of comparison, 2,3-*O*-cyclohexylidene derivatives of the 1,6-ditosylates (**21a** and **21b**)[3] were subjected to azidolysis. Azidolysis of **21a** and **21b** proceeded in a quite different way to give 1,4-anhydro-5,6-*O*-cyclohexylidene-3-*O*-tosyl-*chiro*-inositol (**22**)[7] in 73 and 65% yields, respectively. This shows that the attack of the hydroxyl group (at C-6) on C-3 is preferential, the conformation being brought closer to that of boat form.[8]

Experimental

Unless otherwise stated, melting points were determined on a Mitamura Riken micro hot stage and are uncorrected. The melting points marked with asteriks were determined in a liquid bath and are uncorrected. IR spectra were measured on a JASCO IR-E spectrophotometer in KBr disks. PMR spectra were obtained on a Varian Associates A-60D (60 MHz) spectrometer at a concentration *ca.* 10% in deuteriochloroform ($CDCl_3$) or dimethylsulfoxide-d_6 (DMSO-d_6), with tetramethylsilane as an internal standard. Chemical shifts are given in terms of τ-values, signals being denoted by s (singlet), d (doublet), t (triplet), dd (double doublet), or m (complex multiplet). Values given for coupling constants are of first-order. All the solutions were concentrated by a rotary evaporator at 40—50 °C under reduced pressure, and a trace of residual pyridine was removed by coevaporation with toluene. Catalytic hydrogenation was carried out with a Parr shaker apparatus in the presence of Raney nickel T-4[9] catalyst in the initial hydrogen pressure of 3.5 kg/cm² at room temperature. Tlc was performed on silica gel (Wakogel B-10, Wako Pure Chemical Industries, Ltd.) using a mixture of 2-butanone and toluene. The spots were indicated by heating above 150 °C after spraying with 30% sulfuric acid.

Hexaacetyl allo-*Inosadiamine-1,5 (2).* A mixture of 1,4-di-*O*-tosyl-*myo*-inositol (**1a**)[3] (3.0 g), sodium azide (3.0 g), and 90% aqueous 2-methoxyethanol (100 ml) was refluxed for 20 hr. The mixture was then evaporated to dryness and the residue was treated with acetic anhydride (10 ml) and pyridine (10 ml) overnight at room temperature. The insoluble material was removed by filtration and the filtrate was evaporated to dryness. The residue was extracted with hot ethyl acetate (50 ml) and the extract was purified by passing through a short alumina column. The solution was evaporated to give a syrup, which was, without further purification, hydrogenated in an ethanol solution (20 ml) for 15 hr. The catalyst was filtered off and the filtrate was concentrated to give an oily product, which was acetylated in the usual way to give crystals (1.56 g, 58%) of **2**, mp 202—204 °C. Recrystallization from ethanol–ether afforded an analytically pure sample, mp 204.5—205.5 °C (lit,[4] 203—204 °C). Found: C, 50.21; H, 6.08; N, 6.43%.

Hexaacetyl muco-*Inosadiamine-1,3 (3).* A mixture of 1,4-di-*O*-tosyl-*myo*-inositol tetraacetate (**1b**)[3] (2.5 g), sodium azide (2.5 g), and 90% aqueous 2-methoxyethanol (100 ml) was refluxed for 16 hr. The reaction mixture was then treated as in the preparation of **2**. The crude crystals were recrystallized from ethyl acetate to afford pure crystals (0.72 g, 44%) of **3**, mp 229—231 °C (lit,[4] 227—228 °C). Found: C, 49.81; H, 6.01; N, 6.35%.

*4,5-Diazido-1,2-*O*-cyclohexylidene-4,5-dideoxy-*myo*-inositol (5a).*

a): A mixture of 1,2-*O*-cyclohexylidene-3,6-di-*O*-tosyl-*myo*-inositol (**4a**)[3] (1.4 g), sodium azide (1.4 g), and 90% aqueous 2-methoxyethanol (30 ml) was refluxed for 20 hr. The reaction mixture was evaporated to dryness and the residue was extracted with hot ethyl acetate (60 ml). The extract was passed through a short alumina column and was then concentrated to give a syrup, which was crystallized from ethanol to afford colorless plates (0.46 g, 60%) of **5a**, mp 70—90 °C. Recrystallization twice from ethanol gave an analytical sample, mp 102—105 °C (after melting and resolidifying at 68—83 °C).

Found: C, 47.35; H, 6.86; N, 23.49%. Calcd for $C_{12}H_{18}N_6O_4$: C, 46.44; H, 5.85; N, 27.08%. Calcd for $C_{12}H_{18}N_6O_4 \cdot C_2H_5OH$: C, 47.18; H, 6.79; N, 23.58%.

The crystals lose ethanol by drying *in vacuo* over phosphorus pentoxide at 80—90 °C overnight.

Found: C, 46.49; H, 5.78; N, 26.91%.

b): 1,2-*O*-Cyclohexylidene-3,6-di-*O*-tosyl-*myo*-inositol diacetate (**4b**)[3] (2.0 g) was allowed to react with sodium azide (2.0 g) in refluxing 90% aqueous 2-methoxyethanol (60 ml) for 19 hr followed by a similar treatment to that described above to yield crystals (0.42 g, 43%) of **5a**, mp 70—90 °C.

Compound **5a** (69 mg) was treated with acetic anhydride (0.5 ml) in pyridine (0.5 ml) for 30 min at 80 °C. The mixture was then poured into ice and water giving crystals (69 mg, 78%) of the diacetate (**5b**), mp 149—150.5 °C. Recrystallization from ethanol afforded a pure sample. needles, mp 150—151 °C.

Found: C, 49.03; H, 5.76; N, 20.90%. Calcd for $C_{16}H_{22}N_6O_6$: C, 48.72; H, 5.62; N, 21.31%.

*4,5-Diacetamido-3,6-di-*O*-acetyl-1,2-*O*-cyclohexylidene-4,5-dideoxy-*myo*-inositol (6).* The crude crystals of **5a** derived from **4a** (1.5 g) was hydrogenated in an ethanol solution (10 ml) overnight. The product was treated with acetic anhydride (2 ml) and pyridine (3 ml) overnight at room temperature to give a crystalline product, which was crystallized from ethanol affording crystals (0.45 g, 43%) of **6**, mp* 249—250.5 °C. An analytical sample was obtained by recrystallization from chloroform–ethanol, needles, mp* 249—250 °C. PMR ($CDCl_3$): τ 8.08, 8.06, 7.91, 7.86 (3-proton s, OAc), 4.78 (dd, $J_{1,6}=7.5$ Hz, $J_{5,6}=11$ Hz, H-6), 4.70 (dd, $J_{2,3}=4$ Hz, $J_{3,4}=10$ Hz, H-3).

Found: C, 56.39; H, 6.93; N, 6.51%. Calcd for $C_{20}H_{30}N_2O_8$: C, 56.32; H, 7.09; N, 6.57%.

Hexaacetyl myo-*Inosadiamine-4,5 (7).* Compound **6** (0.20 g) was refluxed with 80% aqueous acetic acid (10 ml) for 2 hr and the mixture was evaporated to dryness. The residue was treated with acetic anhydride (0.5 ml) and pyridine (1 ml) overnight at room temperature. The product was crystallized from chloroform–ethanol to afford pure needles (0.18 g, 84%) of **7**, mp* 303—303.5 °C (lit[4], 294—295 °C). Found: C, 50.04; H, 6.03; N, 6.37%. In the PMR spectrum of **7** in $CDCl_3$, the chemical shifts of signals due to the acetyl groups (Table 1) were in good agreement with those of an authentic sample.[4]

*1,4-Diazido-1,4-dideoxy-*allo-*inositol Tetraacetate (9).*

a): A mixture of 1,5-di-*O*-tosyl-*myo*-inositol (**8a**)[3] (2.0 g), sodium azide (2.0 g), and 90% aqueous 2-methoxyethanol (80 ml) was refluxed for 14 hr. The reaction mixture was treated as in the preparation of **5a** to yield a syrupy compound. Tlc (1:5 2-butanone–toluene) indicated the formation of three components having close R_f values. The syrup was dissolved in ethanol–ligroin and the solution was allowed to stand in a refrigerator for a week giving crystals (0.22 g, 13%) of **9**, mp 145—150 °C. Recrystallization from ethanol gave an analytical sample, mp 151—152 °C.

Found: C, 42.32; H, 4.54; N, 20.94%. Calcd for $C_{14}H_{18}N_6O_8$: C, 42.21; H, 4.55; N, 21.10%.

The mother liquor of **9** was concentrated to give a syrup, which was hydrogenated in an ethanol solution (20 ml) overnight. The product was acetylated in the usual way to afford a syrupy product, which was without further purification de-*O*-acetylated by treatment with a catalytic amount of sodium methoxide in a methanol solution. The product was crystallized from ethanol to give white powder (0.13 g) of di-*N*-acetyl inosadiamine. A 52 mg portion of this compound was acetylated in the usual way to give crystals of hexaacetyl *allo*-inosadiamine-1,4 (**10**), mp* 247.5—248 °C. The yield of **10** was 10% based on **8a**.

Found: C, 50.15; H, 6.05; N, 6.30%. Calcd for $C_{18}H_{26}N_2O_{10}$: C, 50.23; H, 6.09; N, 6.51%.

b): A mixture of 1,5-di-*O*-tosyl-*myo*-inositol tetraacetate (**8b**)[3] (1.0 g), sodium azide (1.0 g) and 90% aqueous 2-methoxyethanol (40 ml) was refluxed for 17 hr. The reaction mixture was then treated as in the preparation of *a)* to give crystals (0.24 g, 39%) of **9**, mp 147—150 °C. The product was identified with the compound obtained before by comparison of IR spectra.

Hexaacetyl allo-*Inosadiamins-1,4 (**10**).* Compound **9** (154 mg) was hydrogenated in an ethanol solution (15 ml) overnight. The product was acetylated in the usual way to give crystals after crystallization from ethanol–ether: yield 52 mg (31%), mp* 247.5—248 °C. It was shown to be identical with the compound obtained before by comparison of IR spectra.

*1,2-Diacetamido-3,6-di-*O*-acetyl-4,5-*O*-cyclohexylidene-1,2-dideoxy*-muco-*inositol (**12**).* A mixture of 1,2-*O*-cyclohexylidene-3,5-di-*O*-tosyl-*myo*-inositol (**11**)[3] (1.0 g), sodium azide (1.0 g), and 90% aqueous 2-methoxyethanol (20 ml) was refluxed for 17 hr. The reaction mixture was then treated as in the preparation of **5a** to give an oily azido compound. Tlc (1:5 2-butanone-toluene) showed the formation of one major component along with a trace of one minor component. The crude compound was directly hydrogenated and then acetylated in the usual manner to give crystals, which were recrystallized from ethanol to afford thin needles (0.25 g, 34%) of **12**, mp* 182—185 °C. An analytical sample was obtained by recrystallization from ethanol; mp* 186—187 °C. PMR ($CDCl_3$): τ 8.00 (3-proton s, NHAc), 7.87 (6-proton s, OAc), 5.64 (2-proton broad d, J=4 Hz, H-4 and H-5), 5.45 (2-proton broad d, H-1 and H-2), 4.73 (2-proton m, H-3 and H-6), 3.50 (2-proton d, J=8 Hz, NHAc).

Found: C, 55.94; H, 6.97; N, 6.35%. Calcd for $C_{20}H_{30}N_2O_8$: C, 56.32; H, 7.09; N, 6.57%.

Hexaacetyl muco-*Inosadiamine-1,2 (**13**).* Compound **12** (0.10 g) was refluxed with 80% aqueous acetic acid (5 ml) for 1 hr, and then acetylated in the usual way to give crystals (62 mg, 57%) of **13**, mp 90—120 °C. Recrystallization from ethanol–ether afforded an analytical sample, needles, which melted* at 220—221.5 °C sharply after melting at 90—120 °C and then resolidifying at 150—155 °C.

Found: C, 50.18; H, 6.36; N, 6.37%. Calcd for $C_{18}H_{26}N_2O_{10}$: C, 50.23; H, 6.09; N, 6.51%.

*1,2-*O*-Cyclohexylidene-*muco-*inositol Tetraacetate (**15**).* A mixture of 1,2-*O*-cyclohexylidene-3-*O*-tosyl-*myo*-inositol (**14**)[3] (0.50 g), potassium carbonate (0.50 g), and 80% aqueous 2-methoxyethanol was refluxed for 4.5 hr. The reaction mixture was evaporated to dryness and the residue was treated with acetic anhydride (10 ml) and pyridine (10 ml) overnight at room temperature. The insoluble material was filtered off and the filtrate was evaporated to give a syrup, which was crystallized from ethanol to afford plates (0.34 g, 65%) of **15**, mp 130—131 °C. Recrystallization from ethanol–petroleum ether afforded an analytical sample, mp 134—134.5 °C PMR ($CDCl_3$): τ 7.93, 7.89 (6-proton s, OAc), 5.75 (2-proton m, H-1 and H-2), 4.77 (2-proton m, H-4 and H-5). The two multiplets are consistent with the A_2 portion of the A_2X_2 system.

Found: C, 56.42; H, 6.54%. Calcd for $C_{20}H_{28}O_{10}$: C, 56.07; H, 6.59%.

*1,2-Di-*O*-tosyl-*muco-*inositol Tetraacetate (**16**).* A mixture of **15** (1.5 g) and 30% aqueous acetic acid (20 ml) was heated for 3 hr at 75 °C. The reaction mixture was then evaporated to give a partly crystalline compound, from which **15** (0.12 g) was recovered. The resulting syrup was concentrated to dryness and treated with tosyl chloride (3.5 g) in pyridine (20 ml) overnight at room temperature. The mixture was poured into ice water and the resulting crystals were collected by filtration. Recrystallization from ethanol afforded pure crystals (1.15 g, 56%) of **16**, mp 160 °C. PMR ($CDCl_3$): τ 7.99, 7.97 (6-proton s, OAc), 7.53 (6-proton s, OTs), 5.16 (2-proton m, H-1 and H-2), 4.73 (2-proton m, H-4 and H-5). The two multiplets are consistent with the A_2 portion of the A_2X_2 system.

Found: C, 51.38; H, 5.16; S, 9.64%. Calcd for $C_{28}H_{32}O_{14}S_2$: C, 51.21; H, 4.91; S, 9.76%.

*Preparation of **13** from **16**.* A mixture of **16** (0.51 g), sodium azide (0.55 g), and 90% aqueous 2-methoxyethanol (30 ml) was refluxed for 20 hr. The reaction mixture was evaporated to dryness and the residue was dried by coevaporation with toluene. The solid residue was treated with acetic anhydride (10 ml) and pyridine (10 ml) overnight at room temperature. The insoluble material was removed by filtration and the filtrate was evaporated. The syrupy residue was purified with a short alumina column with chloroform as an eluent. The product was then hydrogenated and subsequently acetylated in the usual manner to give crystals, which were recrystallized from ethanol–ether to afford needles (97 mg, 30%) of **13**, mp* 213—216 °C. It was identified with the compound obtained before by comparison of IR spectra.

*2,4-Diazido-2,4-dideoxy-*chiro-*inositol Tetraacetate (**18**) and 6-Azido-6-deoxy-1-*O*-tosyl-*myo-*inositol Tetraacetate (**19**).* A mixture of 1,6-di-*O*-tosyl-*myo*-inositol tetraacetate (**17**)[3] (4.0 g), sodium azide (4.0 g), and 90% aqueous 2-methoxyethanol (150 ml) was refluxed for 12 hr. The reaction mixture was then treated as in the preparation of **9** to yield an oily azido compound which was found to consist of two major components. They were fractionally crystallized from ethanol to afford almost pure crystals (1.25 g, 47.8%) of **18** and pure prisms (0.695 g, 22.7%) of **19**. Recrystallization from ethanol gave needles (1.16 g, 44.4%) of **18**, mp 147—148 °C.

Found: C, 42.15; H, 4.57; N, 21.32%. Calcd for $C_{14}H_{18}N_6O_8$: C, 42.21; H, 4.55; N, 21.10%.

Recrystallization from chloroform-ethanol gave prisms (0.633 g, 18.3%) of **19**, mp 163.5—164.5 °C.

Found: C, 47.99; H, 4.83; N, 7.81; S, 6.31%. Calcd for $C_{21}H_{25}N_3O_{11}S$: C, 47.82; H, 4.78; N, 7.97; S, 6.08%.

Hexaacetyl chiro-*Inosadiamine-2,4 (**20**).* Compound **18** (0.22 g) was hydrogenated in an ethanol solution (20 ml) overnight. The product was acetylated in the usual way and the product was crystallized from ethanol–ether to afford prisms (0.10 g, 42%) of **20**, mp 253—256 °C. Recrystallization from ethanol–ether gave large prisms after long storage in a refrigerator; mp 160—170 °C.

Found: C, 48.31; H, 6.34; N, 6.33%. Calcd for $C_{18}H_{26}N_2O_{10}\cdot H_2O$: C, 48.21; H, 6.29; N, 6.25%.

*1,4-Anhydro-5,6-*O*-cyclohexylidene-2-*O*-tosyl-*chiro-*inositol (**22**).* A mixture of 5,6-di-*O*-acetyl-1,2-*O*-cyclohexylidene-3,4-di-*O*-tosyl-*myo*-inositol (**21b**)[3] (1.1 g), sodium azide (1.1 g), and 90% aqueous 2-methoxyethanol (20 ml) was refluxed for 15 hr. The reaction mixture was evaporated to dryness and the residue was extracted with hot ethyl acetate. The extracts were evaporated to give crystals which were recrystallized from ethanol to afford crystals (0.47 g, 65%) of **22**, mp 114.5—116 °C. The product was identified with an authentic IR spectrum.

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