

SIMPLE SYNTHESSES OF INDOL-1-YL GLUCOSIDES¹

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Abstract — A lithium hydroxide promoted glucosidation of 1-hydroxyindoles with 2,3,4,6-tetra-*O*-acetyl- α -D-glucopyranosyl bromide is newly developed. Applying this method, the first and simple syntheses of novel indol-1-yl glucosides were achieved.

Variety of glycosides and nucleosides are widely distributed in nature and they play important roles in living organisms.² In our 1-hydroxyindole hypotheses,^{3a} we speculated the existence and roles of a novel type of compounds, indol-1-yl glycosides (**1**, **2**, etc.) as shown in general formulae in Figure 1. Although many glucosidation methods have been reported,⁴ we have not been able to obtain satisfactory results in applying them⁵ to 1-hydroxyindoles with an hope to produce **1**. Now, we wish to report the success in developing a novel synthetic method well-suited for the preparation of **1**.

Among various 1-hydroxyindoles, 1-hydroxy-*Nb*-methoxycarbonyltryptamine (**3a**), a potent platelet aggregation inhibitor,⁶ was selected as a substrate for examining glucosidation with 2,3,4,6-tetra-*O*-acetyl- α -D-glucopyranosyl bromide⁷ (**4**) as shown in Scheme 1. Since 1-hydroxyindoles are weak acids,^{3b} the reaction was carried out in the presence of base, and the glucosidated products were isolated after acetylation with Ac₂O and pyridine in order to facilitate separation.

Typical procedure is as follows. Initially, **3a** was dissolved in a methanol solution containing an appropriate base (6 mol eq.) and the solvent was evaporated under reduced pressure to dryness. To the resultant metal salt of **3a** was added a solution of **4** (3 mol eq.) in DMF and allowed to react at room temperature for 4 h. After usual work up, the products were acetylated with Ac₂O and pyridine at room temperature to give **5a** and **6a**.

It was found that DMF is the solvent of choice among the examined MeOH, Et₂O, THF, and DMF, and the yield of **5a** depends on bases. Thus, when Cs₂CO₃ was used, **5a** and **6a** were generated in 15 and 65% yields, respectively. Employing CsOH·H₂O, the yield of **5a** was raised to 24% together with 30% yield of **6a**. Slight increase in the yield of **5a** to 28% was observed upon use of KOH in addition to 37% yield of **6a**. In the case of NaOH, **5a** and **6a** were produced in 43 and 52% yields, respectively. Dramatical improvement in the yield of **5a** up to 93% (Table 1, Entry 1) was finally achieved upon employing LiOH as the base though formation of **6a** was observed in 6% yield. The β -configuration of **5a** was proved by the coupling constant of the anomeric proton ($J=8.1$ Hz) which is readily discernible in the NMR spectrum of indol-1-yl β -D-glucopyranoside (**7**) obtained in 84% yield by hydrolysis of **5a** with NaOMe in MeOH.

Under the same reaction conditions, the LiOH promoted reaction was successfully applied to other biolog-

Figure 1

Y, Z = an appropriate substituent

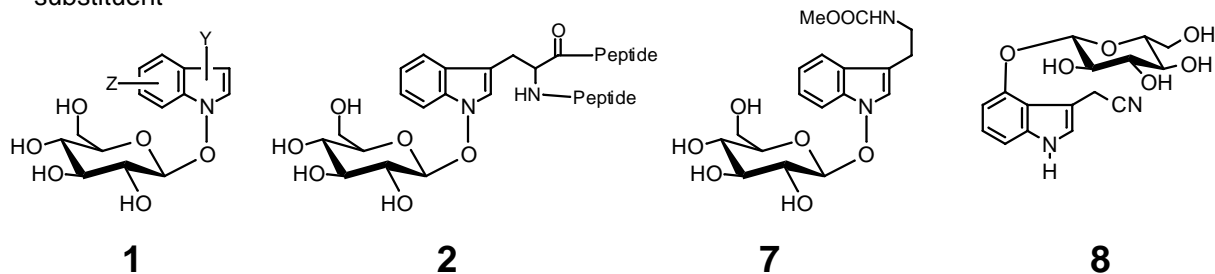
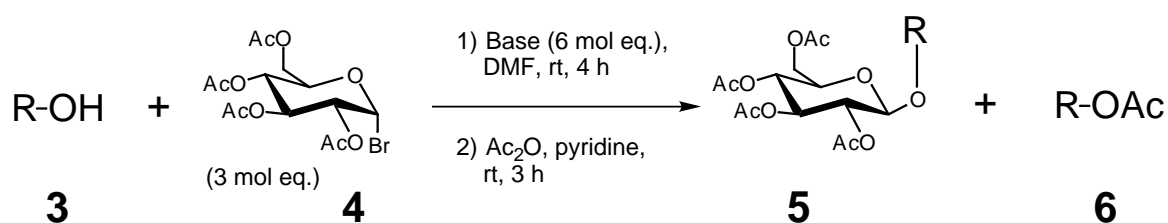
**Scheme 1**

Table 1. Reaction of Hydroxy Compound (**3**) with 2,3,4,6-Tetra- O-acetyl- α -D-glucopyranosyl Bromide (**4**) in the Presence of LiOH, Followed by Acetylation with Ac_2O and Pyridine

Entry	R-OH 3	Yield (%) of 5	Entry	R-OH 3	Yield (%) of 5
1	a 	93	4	d 	54
2	b 	78	5	e 	42
3	c 	77	6	f 	35
			7	g 	29

ically active 1-hydroxyindoles. Methyl 1-hydroxyindole-3-butylate⁶ (**3b**) and 1-hydroxymelatonin (**3c**) afforded **5b** and **5c** in 78 and 77% yields, respectively (Entries 2,3). When the reaction was applied to

p-methoxyphenol (**3d**), the yield of the expected glucoside (**5d**)⁸ was 54% (Entry 4). On the other hand, more acidic 1-hydroxy-5-nitroindole (**3e**), 8-oxyquinoline (**3f**), and *p*-nitrophenol (**3g**) afforded the corresponding glucosides, (**5e**, **5f**, and **5g**)⁹, in 42, 35, and 29% yields, respectively (Entries 5—7). Application of these facts to the first synthesis of capparilosides A¹⁰ (**8**) was successfully carried out as reported in the previous paper.¹¹

These data clearly suggest that this LiOH promoted reaction is *pK_a* dependent and it seems to give sufficient results for the hydroxy compounds having *pK_a* values of 8—10.^{3b}

In conclusion, we have developed a novel method which is suitable for the syntheses of glucosides of 1-hydroxyindoles. A study for investigating their chemical reactivities and biological evaluations, and further extension to various glycosides syntheses are currently in progress.

REFERENCES AND NOTES

1. This is Part 101 of a series entitled "The Chemistry of Indoles". Part 100: M. Somei, Y. Fukui, M. Hasegawa, N. Oshikiri, and T. Hayashi, *Heterocycles*, 2000, **53**, 1725. All new compounds gave satisfactory spectral and elemental analysis or high-resolution MS data for crystals or oils, respectively. **5a**, colorless oil, $[\alpha]_{\text{D}}^{24} -8.4^{\circ}$ (c=0.25, MeOH); **5b**, mp 88—89 °C (EtOH), $[\alpha]_{\text{D}}^{28} -24.2^{\circ}$ (c=0.43, CHCl₃); **5c**, mp 138—140 °C (MeOH), $[\alpha]_{\text{D}}^{27} -22.2^{\circ}$ (c=0.28, CHCl₃); **5e**, mp 211—212 °C (MeOH), $[\alpha]_{\text{D}}^{26} -38.2^{\circ}$ (c=0.34, CHCl₃); **5f**, mp 166—168 °C (EtOH), $[\alpha]_{\text{D}}^{26} -57.7^{\circ}$ (c=0.24, CHCl₃); **7**, colorless oil, $[\alpha]_{\text{D}}^{27} -42.5^{\circ}$ (c=0.21, MeOH).
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3. a) Review: M. Somei, *Heterocycles*, 1999, **50**, 1157 and references cited therein. b) The *pK_a* values of compounds: (±)-*Nb*-acetyl-1-hydroxytryprophan methyl ester, 9.8; **3b**, 8.4; **3d**, 10.2; **3e**, 6.8; **3f**, 4.99, **3g**, 6.9.
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5. Direct heating of **3a-c** with α -D-glucose and usual acid catalyzed acetal exchange reaction⁴ of penta-*O*-acetyl- α -D-glucopyranoside^{4a} with **3a-c** did not afford the expected glucosides (**5a-c**). Reactions of **3a-c** with **4** using Bu₄N⁺HSO₄⁻ in aq. NaOH-CHCl₃^{9b} was not successful. Reactions of **3a-c** with 2,3,4,6-tetra-*O*-acetyl- α -D-glucopyranosyl trichloroacetimidate^{4b} under acidic conditions resulted in the formations of tars.
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