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A NEW METHOD FOR THE CLEAVAGE OF ALLYL GLYCOSIDES

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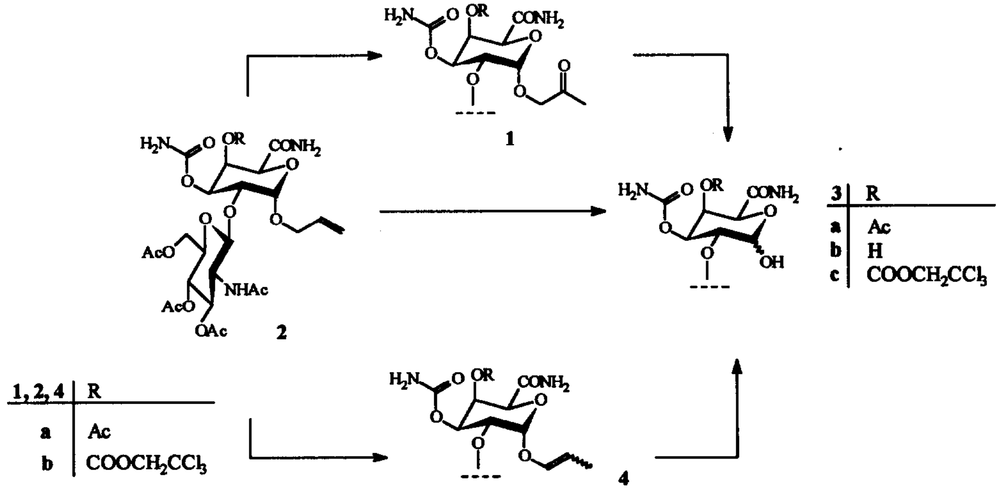
Abstract - Allyl glycosides can be cleaved by Wacker oxidation followed by photolysis in the presence of triethylamine.

Allyl protection of the anomeric position is common in carbohydrate chemistry.[1,2] Deprotection may be achieved by a number of methods. Most of them are two-step procedures consisting of (i) the rearrangement of the allyl to a propenyl ether grouping induced by KOtBu in DMSO[3] or a transition metal catalyst (Rh(I),[4] Ir(I),[5] Pd-C,[6] $H_2Ru(PPh_3)_4$[7]), and (ii) cleavage of the enol ether either by oxidation-hydrolysis[8] or via a very labile hemiacetal formed on addition of XOH to the double bond.[9] Related is a procedure which is based on allylic oxidation with SeO_2.[10] Other methods involve (i) reductive cleavage of the bond between the allyl group and the sugar oxygen with low valent zirconium (zirconocene),[11] samarium,[12] and Pd ($Pd(PPh_3)_4$)[13] species, respectively, (ii) cleavage with Lewis acids,[14] and (iii) with Pd(II)[15] via an intermediate π-allyl complex.

Some time ago we decided to employ anomeric allyl protection for the uronic acid moiety *en-route* to synthetic moenomycin analogues.[16] This decision led to serious deprotection problems. Since in the moenomycin area we are dealing with very polar compounds all deprotection methods mentioned above which are not compatible with polar solvents cannot be used. Further, Lewis acid-based procedures are excluded for obvious reasons. The rearrangement with Rh(I) was found to be very capricious. In the case of **2a** and **2b** success of the rearrangement was highly dependent on the quality of the Wilkinson catalyst,[17] in other cases we could not identify the reasons for the poor results.[18,19] The Pd(II)-induced cleavage which is performed in aqueous acetic acid solution (buffered with sodium acetate) is applicable as far as solubility is concerned. It suffers, however, from a serious side reaction, the formation of the Wacker product (cf. **1a**) which was obtained from of **2a** in a yield of 30% alongside with the desired **3a** (44% yield).[17,20,21]

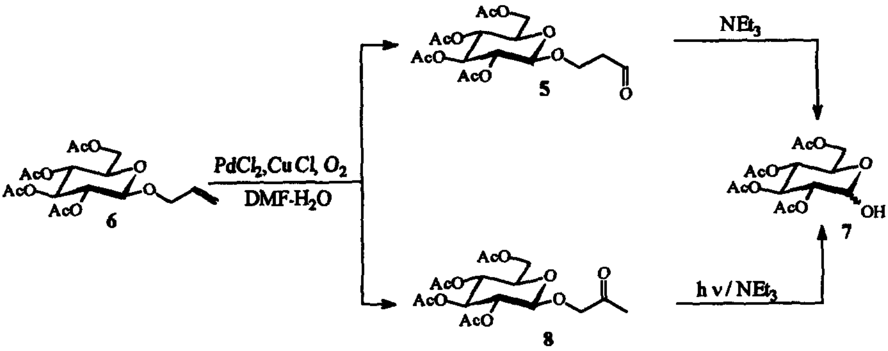


3	R
a	Ac
b	H
c	$COOCH_2CCl_3$

1,2,4	R
a	Ac
b	$COOCH_2CCl_3$

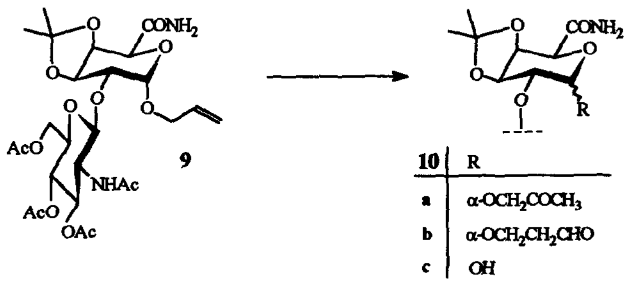
In this Communication we wish to report a new method which originated from the desire to convert **1a** into **3a**. We reasoned that electron transfer to **1a** in its photoexcited state would induce cleavage of the CO bond *α to the carbonyl group*. *Indeed*, *photolysis* (*mercury high pressure lamp, quartz vessel*) in acetonitrile solution in the presence of triethylamine[22] resulted in clean and almost *quantitative* conversion of **1a** into **3a** (98%).[23]

Thus, it became necessary to find conditions which would allow efficient conversion of allyl into 2-oxopropyl glycosides. This was studied with model compound **6**.[24] Under classical Wacker conditions[25,26] from **6** a 2.3:1 mixture (^{1}H NMR) of **8** and **5** in essentially quantitative yield was obtained. The ratio of **8** and **5** was solvent-dependent (1.4:1 when the reaction was performed in 1:1 DMF-H_2O). The conversion of **6** to **5** and **8** was also accomplished under the conditions reported many years ago by Rodeheaver and Hunt.[27] Thus, oxymercuration of **6** in THF-H_2O (1.2:1) with $Hg(OAc)_2$ and subsequent transmetallation with Li_2PdCl_4[28] (*final solvent composition* THF-H_2O 3:1) yielded **8** almost quantitatively (94%) after stirring for 3 h at 65°C.



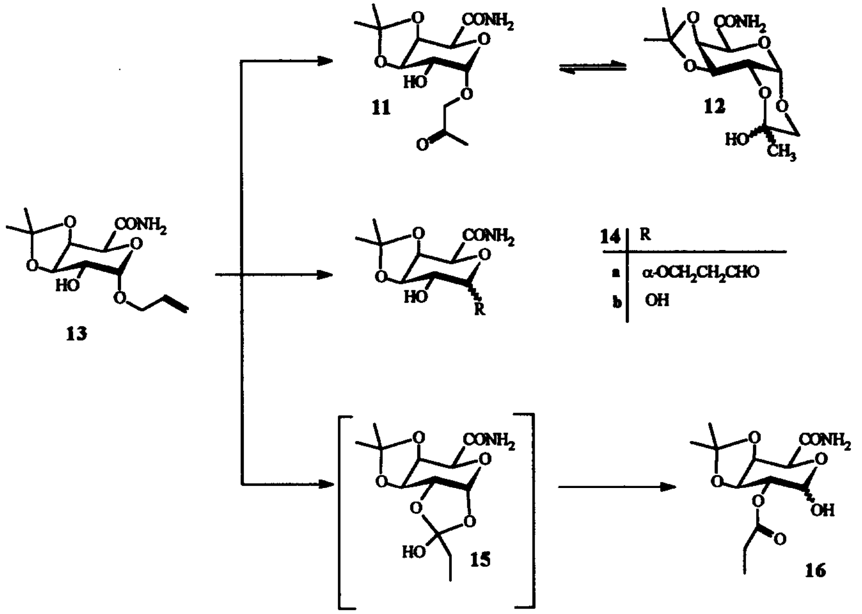
For releasing the free sugar **7** it was of no concern whether pure **8** or a mixture of **5** and **8** was employed. Alongside to the cleavage of **8** by electron transfer in the photoexcited state as reported above the triethylamine present in the reaction mixture caused decomposition of aldol **5** to give **7**.[29] When the Wacker oxidation of **6** and the subsequent cleavage were performed without purification of the intermediates the overall yield of **7** was 82%.

Wacker oxidation of disaccharide derivative **9** gave **10a** and **10b**.[30] Subsequent photolysis in CH_3CN solution in the presence of NEt_3 furnished **10c** in an overall yield of 67%.



10	R
a	α-OCH_2COCH_3
b	α-OCH_2CH_2CHO
c	OH

When **13** with a free 2-OH group was oxidized under Wacker conditions in 1:1 DMF-H_2O, a mixture of **11**/**12** (24%), **14b** (43%), and **15** (15%) was obtained. **14b** was obviously formed directly from **14a** under the reaction conditions, whereas **16** must be the result of the Wacker oxidation of the propenyl ether derived from **13**. Photolytic cleavage of the **11**/**12** equilibrium mixture in the presence of triethylamine was rather sluggish. One limitation of the new method has been observed: When **1b**[31] was photolysed in the presence of NEt_3, besides cleavage of the hydroxyacetone C-O bond loss of the TrOC group took place to give **3b**.



In conclusion: We have developed a new deprotection method for allyl glycosides which is compatible with many functional and protective groups and can (most notably) be performed in very polar solvents. In the moenomycin area we encountered several cases where the new deallylation procedure was the only one that gave satisfactory results. This will be reported in due course.

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Dedicated with best wishes to Professor Wolfgang Steglich on the occasion of his 60th birthday.

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[30] Only **10a** was fully characterized.

[31] Obtained besides **3c**, when **2b** was submitted to the PdCl$_2$ deallylation procedure.[17]

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