n-Pentenyl Esters *versus* n-Pentenyl Glycosides. Synthesis and Reactivity in Glycosidation Reactions

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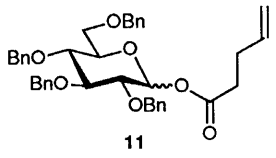
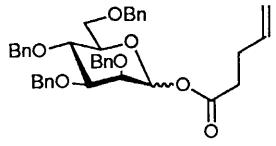
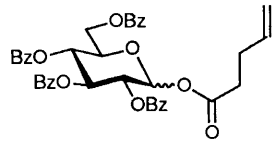
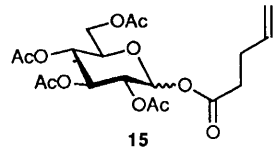
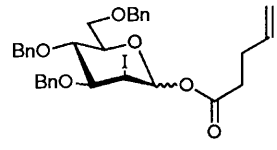
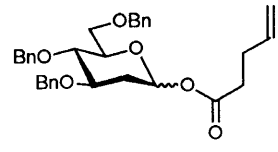
n-Pentenyl esters, which are readily obtained by mild esterification of the anomeric hydroxy group of sugars, can be efficiently used in glycosidation reactions, and they appear to be less prone to armed–disarmed phenomena than their n-pentenyl glycoside counterparts.

Several months ago we reported that n-pentenyl glycosides (NPGs)[1] could be used to provide enantioselective access to optically active tetrahydrofuranoid compounds,[2] such as **5a**, which are split off in the hydrolytic process **1a**→**4**. The value of **5a** was illustrated with a synthesis of lactone **10**, a pheromone of the *Bledius* species,[3] the final step of which involved oxidation of the optically active furan **9**.[4] The low yield associated with this transformation led us to consider alternative ways of gaining access to furano-lactones in which such an oxidative step would be avoided. It seemed to us that this could be achieved by use of an n-pentenyl ester (NPE), **1b**, instead of an NPG, **1a**. In this communication we disclose our

Table 1

Entry	Yield (%) (process B)[a]	Sugar–NPE ⇄ Sugar–OH (A / B)	Yield (%) (process A)[b]
i	87	 **11**	85
ii	73		80
iii	70		35[c]
iv	78	 **15**	36[c]
v	70		48
vi			73

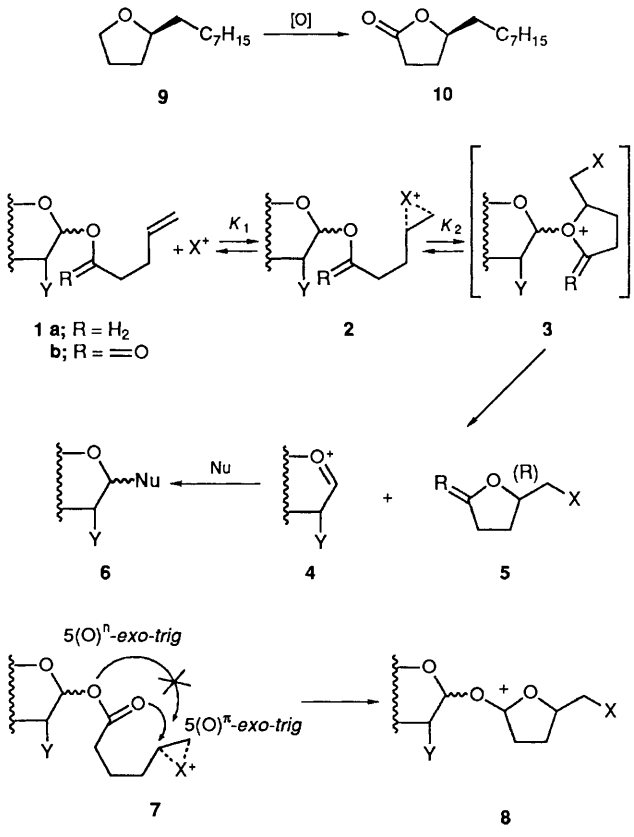
[a] *Reaction conditions:* solution of the 1-OH sugar in dry CH_2Cl_2 and pent-4-enoic acid (1.4 equiv.) was treated sequentially with DCC (1.6 equiv.) and a catalytic amount of DMAP at room temp. with stirring, and left overnight, work-up was followed by column chromatography on silica gel. [b] *Reaction conditions*: NBS (2.5 equiv.), was added to a solution of the NPE in 1% aqueous acetonitrile (20 ml/mmol). The reaction was monitored by TLC and quenched by addition of 10% aqueous sodium thiosulphate solution after 1.5 h. The solvent was removed *in vacuo*, and the residue was diluted with water and extracted with diethyl ether. The ethereal extract was dried (Na_2SO_4), filtered and evaporated *in vacuo*. Column chromatography of the resulting residue afforded the respective pyranose. [c] 50% conversion as judged by TLC. The yield is corrected for recovered starting material.

preliminary results on the preparation and use of NPEs in glycosidation reactions, and draw some comparisons with analogous reactions of NPGs.

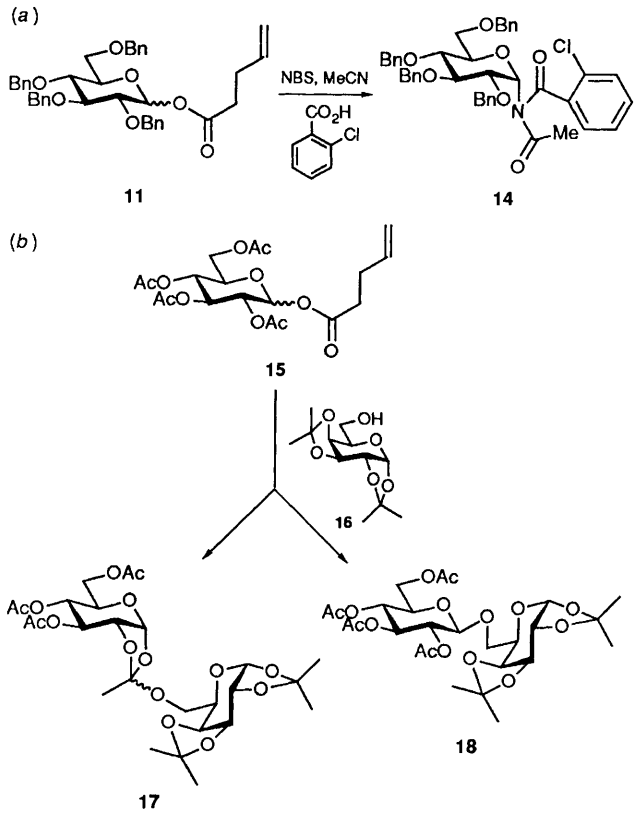
NPEs **1b** are prepared easily and in good yield from the corresponding 1-hydroxy sugars by simple treatment with 1.4 equiv. of commercially available pent-4-enoic acid in the presence of 1,3-dicyclohexylcarbodiimide (DCC; 1.6 equiv.) and a catalytic amount of 4-dimethylaminopyridine (DMAP) in methylene chloride as a solvent.[5]

As indicated in Table 1, NPEs undergo ready oxidative hydrolysis upon treatment with *N*-bromosuccinimide (NBS) in wet acetonitrile (process A). The reaction is chemospecific thereby allowing the glycosyl ester to be cleaved without affecting *O*-acyl protecting groups (entries iii and iv).

In order to draw comparisons with NPGs, we examined the preparation of disaccharide **13** (Table 2) obtained previously by reaction of the corresponding NPG with **12**.[6] With the NPE **11** as glycosyl donor, **13** was formed in comparable yields and with similar solvent dependence of α : β ratio, as with the NPG (Table 2, entries i–iii). Interestingly, the highly potent promoters described recently[7,8] afforded 1 : 1 mixtures of α and β anomers with wide variation in yields (entries iv and v).



Scheme 1

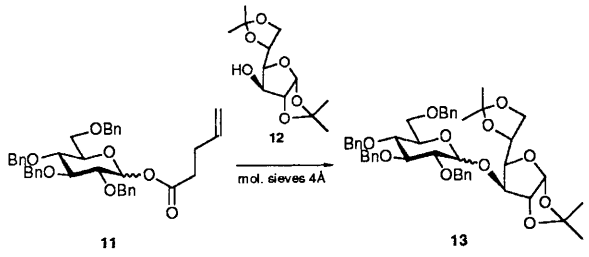


Scheme 2

Ester **11** can also be utilized for obtaining *N,N*-diacyl derivatives *e.g.* **14** with complete α selectivity and in comparable yields as were described for NPGs.[9]

Entries iii–v of Table 1 reveal that NPEs are not as strongly disarmed[10] by C2-electron withdrawing groups as are NPGs. Their greater reactivity can be rationalized by assuming that the reaction is 5(*O*)$^{\pi}$-*exo-trig* rather than 5(*O*)^{n}-*exo-trig*[11] (see **7**), as a result of which the attacking lone pair is farther removed from the inductive effects of C2 substituents. The practical value of this observation is seen in Scheme 2(*b*) where the reaction of **15** and **16** mediated by iodonium dicollidine perchlorate[12] gave the orthoester **17**, the formation of which is undoubtedly associated with the liberated collidine.[13] Indeed with *N*-iodosuccinimide–$Et_3SiOSO_2CF_3$ as promoter[9] the product was the disaccharide **18**.

Table 2



Entry	Solvent	Promoter	Yield (%)	Ratio α : β
i	CH_2Cl_2	IDCP	65 (58)[a]	3 : 1 (3 : 1)[a]
ii	MeCN	IDCP	26 (20)[a]	2.5 : 1 (2 : 1)[a]
iii	Et_2O–CH_2Cl_2 (4 : 1)	IDCP	43 (86)[a]	4.5 : 1 (4 : 1)[a]
iv	CH_2Cl_2	NIS–CF_3SO_3H	62	1 : 1
v	CH_2Cl_2	NIS–$AgOSO_2CF_3$	20	1 : 1

[a] Yield for the transformation of the correspondent NPG quoted from ref. 6. NIS = *N*-iodosuccinimide.

The lower cost of pent-4-enoic acid, the near equimolar amounts required and the ease of their preparation make NPEs very attractive glycosyl donors. Comparative studies with NPGs are continuing.

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