STRUCTURE AND SYNTHESIS OF A QUERCETIN GLUCOXYLOSIDE FROM *KALANCHOE PROLIFERA* (RAYM.-HAMET)

Bakonirina Razanamahefa[a], Costas Demetzos[b], Alexios-Léandros Skaltsounis[c], Marta Andriantisiferana[a], and François Tillequin*[c]

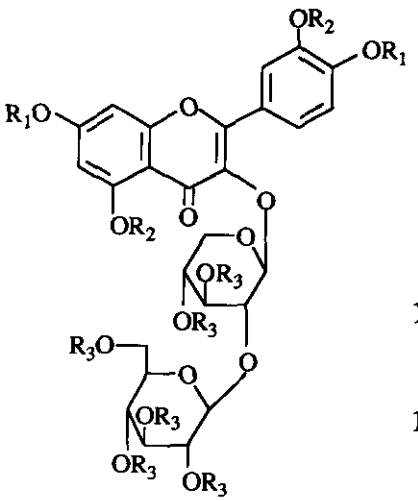
[a]Service de Chimie II, Etablissement d'Enseignement Supérieur de Sciences, Université d'Antananarivo, Antananarivo, Madagascar
[b]Laboratoire de Pharmacognosie, Département de Pharmacie, Université d'Athènes, Panepistimiopolis, Zografou, GR-15771 Athènes, Greece
[c]Laboratoire de Pharmacognosie de l'Université René Descartes, Unité associée au C.N.R.S. n° 1310, Faculté de Pharmacie, 4, Avenue de l'Observatoire, F-75006 Paris, France

Abstract - A quercetin glycoside has been isolated from *Kalanchoe prolifera*. Its structure has been established as quercetin-3-*O*-β-D-glucopyranosyl-(1→2)-β-D-xylopyranoside on the basis of its synthesis starting either from 1,2-*O*-isopropylidene-α-D-xylofuranose or from 1,3,4-tri-*O*-acetyl-α-D-xylopyranose.

Structure and natural occurrence of flavonol-3-*O*-glycosides is well documented.[1] Nevertheless, no glucopyranosylxylopyranoside belonging to this series has been previously unambiguously described or fully characterized.[2] We have recently isolated a compound of this type (**1**) [3], in course of our study of *Kalanchoe prolifera* Raym.-Hamet[4] (*Crassulaceae*), a species widely used in malagasian traditional medicine[5,6] for the treatment of rheumatism and arthrosis. Its uv spectrum exhibited absorptions typical for a quercetin substituted at OH-3.[7] The empirical formula $C_{26}H_{28}O_{16}$, was deduced from high resolution analysis of the quasi-molecular ion $(M+Na)^+$=619 in fab-ms. It accounted for a quercetin, a pentose and a hexose unit, in good agreement with the acid hydrolysis which led to the isolation of quercetin and to the characterization of xylose and glucose. The ^1H nmr spectrum exhibited the signals

of the aglycone together with only two other isolated signals, corresponding to the anomeric protons of the sugar units, at 5.44 ppm (J=4 Hz) and 4,55 ppm (J=8 Hz). In order to facilitate the ^1H nmr study of the sugar region,[8] the compound was acetylated and gave a deca-acetyl derivative (**2**), $(M+H)^+$=1017 in fab-ms. The signals of its ^1H and ^{13}C nmr spectra, typical for a quercetin-3-*O*-glucopyranosyl-xylopyranoside (see Experimental), were assigned by using 2D nmr techniques : COSY,[8] NOESY[9,10] and HETCORR. Evidence for a β-glucopyranosyl terminal unit linked at the 2"-position of a xylopyranosyl one was deduced from both the chemical shifts of the H-2" and C-2" signals and the strong cross peak observed between H-2" and H-1"' on the NOESY spectrum. Nevertheless neither the chemical shift of C-1", nor the coupling constants observed between H-1" and H-2" or H-1" and C-1" for both natural and acetylated glycosides, permitted us to determine unambiguoulsy the type of linkage (α or β) between the xylopyranose unit and the aglycone. The observed values may characterize an α-D-xylopyranosyl unit as well as a β-D-xylopyranosyl one, provided this latter does not adopt exclusively the usual $^4C_1$ conformation, due to steric hindrance.[11] Glycosylation at the 3-position of flavonol aglycones by 2,3,4-tri-*O*-acetyl-α-D-xylopyranosyl bromide under phase transfer-catalyzed conditions has been recently shown to lead stereospecifically to the corresponding β-D-xylopyranosides.[12] It was therefore possible to use this technique to synthesize quercetin-3-*O*-β-D-glucopyranosyl-(1→2)-β-D-xylopyranoside in order to compare it with the natural product and to solve the controversial problem of the anomeric configuration of the xylose unit.

Two different schemes can be considered to prepare 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-3,4-di-*O*-acetyl-α-D-xylopyranosyl bromide (**3**) required as starting material. The first one involves selective glucosylation at C-2 of a correctly protected xylofuranose followed by a change of this latter to a pyranose ring.[13,14] The second one implies the simple glucosylation at C-2 of a conveniently protected xylopyranose. We have studied these two possible routes[15], using methyl 3,5-di-*O*-benzyl-α and β-D-xylofuranosides (**4a** and **4b**)[16] as key intermediates in the former case and 1,3,4-tri-*O*-acetyl-α-D-xylopyranose (**5**)[17] in the latter.



1 $R_1 = R_2 = R_3 = H$

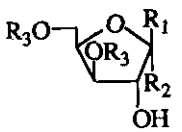
2 $R_1 = R_2 = R_3 = COCH_3$

16 $R_1 = CH_2\text{-}C_6H_5$, $R_2 = H$, $R_3 = COCH_3$

17 $R_1 = R_2 = H$, $R_3 = COCH_3$

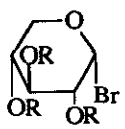
Starting from commercially available 1,2-*O*-isopropylidene-α-D-xylofuranose (**6**), methyl 3,5-di-*O*-benzyl-α- and β-D-xylofuranosides (**4a** and **4b**) were prepared through the intermediacy of 3,5-di-*O*-benzyl-1,2-*O*-isopropydidene-α-D-xylofuranose (**7**), according to the literature procedure.[16] The two anomers (**4a**) and (**4b**) could be easily separated by column chromatography and each of them was unambiguously characterized from its ^{13}C nmr data.[18] In order to permit clear descriptions of the disaccharidic intermediates, the following steps were carried out separately on the α and β series of methyl xylofuranosides. Coupling of 2,3,4,6-tetra-*O*-acetyl-α-D-glucopyranosyl bromide with **4a** under modified Königs-Knorr conditions[19] afforded the desired methyl 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-3,5-di-*O*-benzyl-α-D-xylofuranoside (**8a**) accompanied by the orthoester (**9a**) in 45% and 15% yield respectively. A similar reaction applied to **4b** gave methyl 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-3,5-di-*O*-benzyl-β-D-xylofuranoside (**8b**), the orthoester (**9b**) and the α-glucoside (**10**) in 36%, 15% and 12.5% yield. Debenzylation of **8a** and **8b** by catalytic hydrogenolysis[20] led to **11a** and **11b** which afforded respectively methyl 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-3,5-di-*O*-acetyl-α- and β-D-xylofuranosides (**12a** and **12b**) upon acetylation. Acetolysis of either **12a** or **12b** by acetic anhydride in the presence of sulfuric acid at room temperature[21,22] permitted the rupture of the xylofuranoside ring[23] to give the partly acyclic 2,3,4,6-tetra-*O*-acetyl-

β-D-glucopyranosyl-(1→2)-1,1,3,4,5-penta-*O*-acetyl-*aldehydo*-D-xylose (**13**). Deacetylation of **13** by sodium methoxide in methanol followed by acetylation led to 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-1,3,4-tri-*O*-acetyl-α,β-D-xylopyranose (**14a,b**) which was readily converted into the required bromide (**3**) by treatment with hydrogen bromide in acetic acid.[24]

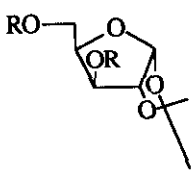


4a $R_1 = H$ $R_2 = OCH_3$ $R_3 = CH_2\text{-}C_6H_5$

4b $R_1 = OCH_3$ $R_2 = H$ $R_3 = CH_2\text{-}C_6H_5$

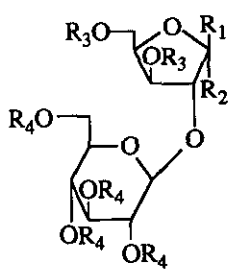


5 $R = COCH_3$



6 $R = H$

7 $R = CH_2\text{-}C_6H_5$



8a $R_1 = H$ $R_2 = OCH_3$ $R_3 = CH_2\text{-}C_6H_5$ $R_4 = COCH_3$

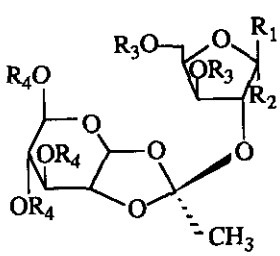
8b $R_1 = OCH_3$ $R_2 = H$ $R_3 = CH_2\text{-}C_6H_5$ $R_4 = COCH_3$

11a $R_1 = R_3 = H$ $R_2 = OCH_3$ $R_4 = COCH_3$

11b $R_1 = OCH_3$ $R_2 = R_3 = H$ $R_4 = COCH_3$

12a $R_1 = H$ $R_2 = OCH_3$ $R_3 = R_4 = COCH_3$

12b $R_1 = OCH_3$ $R_2 = H$ $R_3 = R_4 = COCH_3$

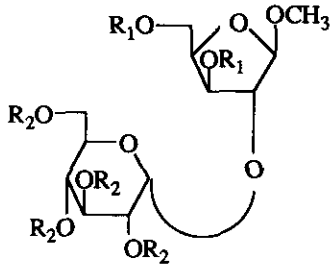


9a $R_1 = H$ $R_2 = OCH_3$ $R_3 = CH_2\text{-}C_6H_5$ $R_4 = COCH_3$

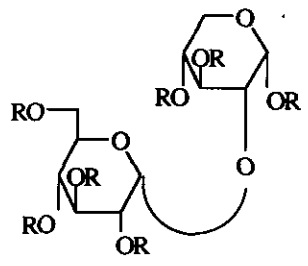
9b $R_1 = OCH_3$ $R_2 = H$ $R_3 = CH_2\text{-}C_6H_5$ $R_4 = COCH_3$

Alternately, 1,3,4-tri-*O*-acetyl-α-D-xylopyranose (**5**) was prepared in two steps from D-xylose by Helferich's method.[17] Reaction[15c,19] of **5** with 2,3,4,6-tetra-*O*-acetyl-α-D-glucopyranosyl bromide gave the key intermediate (**14a**) and 2,3,4,6-tetra-*O*-acetyl-

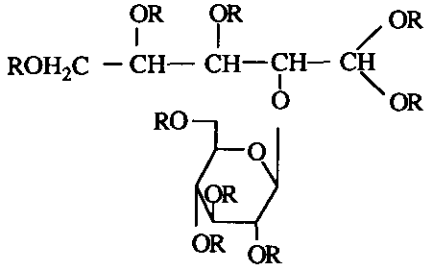
α-D-glucopyranosyl-(1→2)-1,3,4-tri-*O*-acetyl-α-D-xylopyranose (**15**) in 18 and 15% yield respectively.



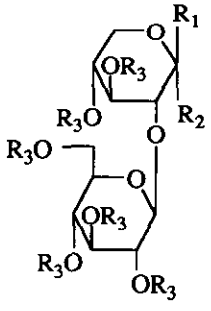
10 $R_1 = CH_2\text{-}C_6H_5$, $R_2 = COCH_3$



15 $R = COCH_3$



13 $R = COCH_3$



3 $R_1 = H$ $R_2 = Br$ $R_3 = COCH_3$

14a $R_1 = H$ $R_2 = OCOCH_3$ $R_3 = COCH_3$

14b $R_1 = OCOCH_3$ $R_2 = H$ $R_3 = COCH_3$

Condensation of 4',7-di-*O*-benzylquercetin[25] with **3** under phase transfer-catalyzed conditions led to 4',7-di-*O*-benzyl quercetin-3-*O*-(2,3,4,6-tetra-*O*-acetyl)-β-D-glucopyranosyl-(1→2)-3,4-di-*O*-acetyl-β-D-xylopyranoside (**16**) in 40% yield. This latter was submitted to hydrogenolysis to give **17**. Finally, deacetylation of **17** afforded **1** identical in all respects with the natural glycoside whose structure was

therefore unambiguously established as quercetin-3-*O*-β-D-glucopyranosyl-(1→2)-β-D-xylopyranoside.

EXPERIMENTAL

Optical rotations were measured on a Perkin-Elmer 141 polarimeter. Spectra were recorded on the following apparatus : ir, Perkin-Elmer 1600 FT; ms, Nermag R-10-10 C in electron impact (70eV) (ei) or desorption-chemical ionization (reagent gas : NH_3) (dci), VG Micromass 70-70 F in fast atom bombardment (matrix : thioglycerol) (fab); ^1H nmr, Bruker HX 270 (270 MHz) or Bruker AC 300 (300 MHz); ^{13}C nmr, Bruker AC 300 (75 MHz) or Bruker AM 500 (125 MHz). Multi-impulsional DEPT, COSY, ^1H-^{13}C HETCORR and NOESY (mixing time : 1500 ms) experiments were performed on Bruker AC 300 using the standard Bruker microprograms. Unless otherwise stated, column chromatographies were conducted using silica gel 60 Merck (particle size : 0.040-0.063 mm) as stationary phase, and the eluent is indicated for each individual case.

Extraction and isolation : The aerial parts of *Kalanchoe prolifera* were collected Ambohimangakely (region of Antananarivo, Madagascar), in March 1988. An herbarium sample is kept in the Département de Chimie Végétale of the University of Antananarivo. The dried plant material (1.0 kg) was crushed into small piecies, defatted with n-hexane (4 x 3 l) in a Soxhlet apparatus and extracted with MeOH (4 x 3 l) at room temperature (4 x 48 h). The MeOH extract (180 g) was submitted to column chromatography. Elution was with CH_2Cl_2-MeOH, and CH_2Cl_2-MeOH-H_2O mixtures of increasing polarity. The fraction obtained using CH_2Cl_2-MeOH (80:20) was subjected to a final purification over a reversed phase R-18 silica gel (0.040-0.063 mm) column (solvent : MeOH-H_2O 30:70) to afford compound (**1**) (43 mg).

Quercetin-3-*O*-β-D-glucopyranosyl-(1→2)-β-D-xylopyranoside (**1**) : A yellow amorphous solid, $[\alpha]^{20}_D$ -32° (*c* 0.5, MeOH); uv λ max (MeOH) : 257, 268 (sh.), 300 (sh.), 367 nm; (MeOH + $AlCl_3$) : 275, 307 (sh.), 338 (sh.), 448 nm; (MeOH + HCl) : 271, 303 (sh.), 418 nm; (MeOH + NaOAc) : 275, 328 (sh.), 403 nm; (MeOH + H_3BO_3) : 264, 298

(sh.), 386 nm; ir : ν max (KBr) : 3410, 2990, 1645, 1580, 1360, 1275, 810 cm-1; ms (dci) (m/z) : 597 $(M+H)^+$, 435, 303, 180; ^1H nmr (DMSO-d_6) : δ : 12.62 (s, D_2O exch., OH-C_5), 7.57 (dd, J=9, 2 Hz, H-$C_{6'}$), 7.51 (d, J=2 Hz, H-$C_{2'}$), 6.88 (d, J=9 Hz, H-$C_{5'}$), 6.44 (d, J=2 Hz, H-C_8), 6.20 (d, J=2 Hz, H-C_6), 5.44 (d, J=4 Hz, H-$C_{1''}$), 4.55 (d, J=8 Hz, H-$C_{1'''}$), 3.86-2.95 (m, 11 sugar protons). High resolution fab ms : Calcd for $(C_{26}H_{28}O_{16} + Na)^+$: 619.1275. Found; 619.1306.

3',4',5,7-tetra-*O*-acetylquercetin-3-*O*-(2,3,4,6-tetra-*O*-acetyl)-β-D-gluco-pyranosyl-(1→2)-3,4-di-*O*-acetyl-β-D-xylopyranoside (2) : Acetic anhydric (1 ml, 10.5 mmol) was added to a solution of **1** (23 mg, 0.04 mmol) in pyridine (1 ml) and the mixture was left at 25°C for 72 h. Evaporation of the solvent under reduced pressure afforded **2** as a foam (36 mg, 88%), $[\alpha]^{20}_D$ -100° (c 1.2, $CHCl_3$); ms (dci) (m/z) :1017 $(M+H)^+$, 564, 331; ^1H nmr ($CDCl_3$) : δ : 7.86 (dd, J=9, 2 Hz, H-$C_{6'}$), 7.84 (d, J=2 Hz, H-$C_{2'}$), 7.37 (d, J=9 Hz, H-$C_{5'}$), 7.31 (d, J=2 Hz, H-C_8), 6.84 (d, J=2 Hz, H-C_6), 5.65 (d, J=3 Hz, H-$C_{1''}$), 5.23 (t, J=9 Hz, H-$C_{3'''}$), 5.13 (t, J=9 Hz, H-$C_{4'''}$), 5.05 (dd, J=9, 8 Hz, H-$C_{2'''}$), 5.03 (t, J=5 Hz, H-$C_{3''}$), 4.86 (d, J=8 Hz, H-$C_{1'''}$), 4.73 (td, J=5, 4 Hz, H-$C_{4''}$), 4.24 (dd, J=12, 4 Hz, H_a-$C_{6'''}$), 4.12 (dd, J=5, 3 Hz, H-$C_{2''}$), 3.94 (dd, J=12, 3 Hz, H_b-$C_{6'''}$), 3.86 (dd, J=12, 4 Hz, H_e-$C_{5''}$), 3.77 (ddd, J=9, 4, 3 Hz, H-$C_{5'''}$), 3.35 (dd, J=12, 5 Hz, H_a-$C_{5''}$), 2.46 (s, Ac-O-C-C_5), 2.36, 2.35, 2.35, 2.15, 2.12, 2.08, 2.07, 2.03, 1.95 (9s, H_3COOC); ^{13}C nmr ($CDCl_3$) : δ : 172.6 (C_4), 170.7, 170.5, 170.3, 169.5, 169.4, 169.3, 169.2, 167.9, 167.8, 167.2 (10 $COCH_3$), 156.7 (C_9), 154.3(C_7), 154.1 (C_5), 150.3 (C_2), 144.2 ($C_{4'}$), 142.1 ($C_{3'}$), 138.2 (C_3), 128.6 ($C_{1'}$), 127.2 ($C_{2'}$), 124.7 ($C_{6'}$), 123.7 ($C_{5'}$), 115.3 (C_{10}), 113.7 (C_6), 109.0 (C_8), 102.2 ($C_{1'''}$), 99.8 ($C_{1''}$, $^1J_{CH}$=175.2 Hz), 77.1 ($C_{2''}$), 73.1 ($C_{3'''}$), 71.9 ($C_{5'''}$), 71.3 ($C_{3''}$), 69.8 ($C_{2'''}$), 68.2($C_{4'''}$), 68.1 ($C_{4''}$), 61.6 ($C_{6'''}$), 60.9 ($C_{5''}$), 21.9-20.6 (10 $COCH_3$). High resolution fab ms : Calcd for $(C_{46}H_{48}O_{26} + H)^+$: 1017.2512. Found; 1017.2514.

3,5-Di-*O*-benzyl-1,2-*O*-isopropylidene-α-D-xylofuranose (7) : This compound was prepared according to the literature procedure;[16] syrup; ms (dci) (m/z) : 388 $(M+NH_4)^+$, 371 $(M+H)^+$; ^1H nmr ($CDCl_3$) : δ : 7.25-7.10 (m, 10 Ar-*H*), 5.85 (d, J=4 Hz, H-

C_1), 4.55 (d, J=4 Hz, H-C_2), 4.60-4.45 (4d, J=11 Hz, 2 Ar-CH_2), 4.35 (ddd, J=7, 6, 3 Hz, H-C_4), 3.95 (d, J=3 Hz, H-C_3), 3.75 (m, H_a-C_5, H_b-C_5), 1.48, 1.30 (2 CH_3).

Methyl 3,5-di-*O*-benzyl-α-D-xylofuranoside (4a) and **Methyl 3,5-di-*O*-benzyl-β-D-xylofuranoside (4b)** : These compounds were prepared in 42 % and 39 % yield respectively from **7** by the method of Bowering and Timell.[16] They were easily separated by column chromatography (solvent : hexane-EtOAc 80:20).

4a : Syrup; ms (dci) (m/z) : 362 $(M+NH_4)^+$, 345 $(M+H)^+$, 91; ^1H nmr ($CDCl_3$) : δ : 7.31-7.10 (m, 10 Ar-*H*), 4.92 (d, J=4 Hz, H-C_1), 4.68, 4.58, 4.51, 4.48 (4d, J=12 Hz, 2 Ar-CH_2), 4.34 (td, J=6, 4 Hz, H-C_4), 4.21 (ddd, J=7, 6, 4 Hz, H-C_2), 3.97 (t, J=6 Hz, H-C_3), 3.71 (dd, J=10, 4 Hz, H_a-C_5), 3.63 (dd, J=10, 6 Hz, H_b-C_5), 3.46 (s, H_3CO-C_1), 2.68 (d, J=7 Hz, D_2O exch., OH-C_2); ^{13}C nmr ($CDCl_3$) : δ : 138.2, 138.0, 128.4 (2C), 128.3 (2C), 127.7, 127.6, 127.5 (2C), 127.4 (2C)(12 Ar-*C*), 101.7 (C_1), 83.5 (C_3), 77.3 (C_4), 76.8 (C_2), 73.4 (Ar-CH_2), 71.8(Ar-CH_2), 69.0 (C_5), 55.7 (OCH_3).

4b : Syrup; ms (dci) (m/z) : 362 $(M+NH_4)^+$, 91; ^1H nmr ($CDCl_3$) : δ : 7.31-7.15 (m, 10 Ar-*H*), 4.75 (d, J=1 Hz, H-C_1), 4.60, 4.51, 4.48, 4.46 (4d, J=12 Hz, 2 Ar-CH_2), 4.45 (td, J=7, 5 Hz, H-C_4), 4.17 (ddd, J=5, 3, 1 Hz, H-C_2), 3.90 (dd, J=7, 3 Hz, H-C_3), 3.77 (dd, J=11, 5 Hz, H_a-C_5), 3.60 (dd, J=11, 7 Hz, H_b-C_5), 3.37 (s, H_3CO-C_1), 1.90 (d, J=5 Hz, D_2O exch., *OH-C*$_2$); ^{13}C *nmr* ($CDCl_3$) : δ : 138.1, 137.8, 128.4 (2C), 128.3 (2C), 127.8 (2C), 127.7, 127.6 (2C), 127.5(12 Ar-*C*), 109.5 (C_1), 83.3 (C_3), 80.0 (C_4), 79.3 (C_2), 73.4 (Ar-CH_2), 72.2 (Ar-CH_2), 69.9 (C_5), 55.6 (OCH_3).

Methyl 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-3,5-di-*O*-benzyl-α-D-xylofuranoside (8a) *and* **3,4,6-Tri-*O*-acetyl-1,2-*O*-[1(S)-methyl-(3,5-di-*O*-benzyl-α-D-xylofuranoside-2-yl)-ethylidene]-α-D-glucopyranose (9a)** : mixture of **4a** (0.138 g, 0.4 mmol), mercuric cyanide (0.125 g, 0.52 mmol), mercuric bromide (0.125 g, 0.35 mmol) and molecular sieve 3 Å (5 g) in dry acetonitrile (7 ml) was stirred for 10 min, and 2,3,4,6-tetra-*O*-acetyl-α-D-glucopyranosyl bromide (0.411 g, 1.0 mmol) was added. After 12 h with continuous stirring at 25°C, the mixture was

filtered. The organic solution was washed succesively with saturated aq. $NaHCO_3$ solution, 5% aq. KBr solution, water, dried over an. Na_2SO_4, and evaporated under reduced pressure. Column chromatography (solvent : CH_2Cl_2) of the residue afforded succesively **9a** (0.041 g, 15%) and **8a** (0.121 g, 45%).

8a : Syrup; $[\alpha]^{20}_D$ +41° (c 1.5, $CHCl_3$); ms (dci) (m/z) : 692 $(M+NH_4)^+$; ^1H nmr ($CDCl_3$) : δ : 7.30-7.12 (m, 10 Ar-*H*), 5.12 (t, J=9 Hz, H-$C_{3'}$), 5.06 (dd, J=9, 8 Hz, H-$C_{2'}$), 4.99 (t, J=9 Hz, H-$C_{4'}$), 4.78 (d, J=4 Hz, H-C_1), 4.61 (d, J=8Hz, H-$C_{1'}$), 4.58, 4.52, 4.50, 4.42 (4d, J=11 Hz, 2 Ar-CH_2), 4.30 (m, H-C_3, H-C_4), 4.12 (m, H_a-$C_{6'}$, H_b-$C_{6'}$), 4.07 (dd, J=7, 4 Hz, H-C_2), 3.63 (dd, J=10, 3 Hz, H_a-C_5), 3.60 (m, H-$C_{5'}$), 3.57 (dd, J=10, 6 Hz, H_b-C_5), 3.33 (s, H_3CO-C_1), 2.12, 2.09, 2.02, 1.99 (4s, H_3COOC). Anal. Calcd for $C_{34}H_{42}O_{14}$: C, 60.53; H, 6.27. Found : C, 60.34; H, 6.29.

9a : Syrup; $[\alpha]^{20}_D$ +75° (c 0.75, $CHCl_3$); ms (dci) (m/z) : 692 $(M+NH_4)^+$, 331; ^1H nmr ($CDCl_3$) : δ : 7.27-7.11 (m, 10 Ar-*H*), 5.51 (d, J=5 Hz, H-$C_{1'}$), 5.13 (t, J=3 Hz, H-$C_{3'}$), 4.83 (dd, J=9, 3 Hz, H-$C_{4'}$), 4.81 (d, J=4 Hz, H-C_1), 4.65, 4.56, 4.46, 4.45 (4d, J=11 Hz, 2 Ar-CH_2), 4.38 (dd, J=5, 3 Hz, H-$C_{2'}$), 4.24 (m, H-C_2, H-C_4), 4.16 (m, H_a-$C_{6'}$, H_b-$C_{6'}$), 4.09 (m, H-C_3), 3.86 (ddd, J=9, 5, 2 Hz, H-$C_{5'}$), 3.66 (dd, J=10, 4 Hz, H_a-C_5), 3.55 (dd, J=10, 6 Hz, H_b-C_5), 3.36 (s, H_3CO-C_1), 2.12, 2.05, 2.03 (3s, H_3COOC), 1.73 (s, H_3C-C). Anal. Calcd for $C_{34}H_{42}O_{14}$: C, 60.53; H, 6.27. Found : C, 60.61; H, 6.26.

Methyl 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-3,5-di-*O*-benzy β-D-xylofuranoside (8b), Methyl 2,3,4,6-tetra-*O*-acetyl-α-D-glucopyra osyl-(1→2)-3,5-di-*O*-benzyl-β-D-xylofuranoside (10) and **3,4,6-Tri-*O*-ace tyl-1,2-*O*-[1(S)-methyl-(3,5-di-*O*-benzyl-β-D-xylofuranoside-2-yl)-ethy-lidene]-α-D-glucopyranose (9b)** : A mixture of **4b** (0.138 g, 0.4 mmol), mercuri cyanide (0.125 g, 0.52 mmol), mercuric chloride (0.027 g, 0.1 mmol) and molecular sieve 3 Å (5 g) in dry acetonitrile (7 ml) was stirred for 10 min, and 2,3,4,6-tetra-*O*-acetyl-α-D-glucopyranosyl bromide (0.411 g, 1.0 mmol) was added. After 24 h with continuous stirring at 25°C, the mixture was processed as described above. Column chromatography (solvent : CH_2Cl_2) afforded succesively **9b** (0.040 g, 15%), **10** (0.034 g, 12.5%) and **8b** (0.097 g, 36%).

8b : Syrup; $[\alpha]^{20}_D$ -9° (c 1.65, $CHCl_3$); ms (dci) (m/z) : 692 $(M+NH_4)^+$; ^1H nmr ($CDCl_3$) : δ : 7.41-7.23 (m, 10 Ar-*H*), 5.13 (t, J=9 Hz, H-$C_{3'}$), 5.04 (t, J=9 Hz, H-$C_{4'}$), 4.93 (d, J=1 Hz, H-C_1), 4.92 (*dd*, J=9, 8 Hz, H-$C_{2'}$), 4.65, 4.63, 4.49, 4.46 (4d, J=11 Hz, 2 Ar-CH_2), 4.37 (d, J=8 Hz, H-$C_{1'}$), 4.30 (ddd, J=7, 6, 5 Hz, H-C_4), 4.22 (dd, J=12, 5 Hz, H_a-$C_{6'}$), 4.12 (dd, J=3, 1 Hz, H-C_2), 4.11 (dd, J=12, 4 Hz, H_b-$C_{6'}$), 3.97 (dd, J=6, 3 Hz, H-C_3), 3.80 (dd, J=10, 5 Hz, H_a-C_5), 3.68 (dd, J=10, 7 Hz, H_b-C_5), 3.57 (ddd, J=9, 5, 4 Hz, H-$C_{5'}$), 3.40 (s, H_3CO-C_1), 2.07, 2.04, 1.98, 1.93 (4s, H_3COOC). Anal. Calcd for $C_{34}H_{42}O_{14}$: C, 60.53; H, 6.27. Found : C, 60.54; H, 6.24.

10 : Syrup; $[\alpha]^{20}_D$ +50° (c 0.7, $CHCl_3$); ms (dci) (m/z) : 692 $(M+NH_4)^+$; ^1H nmr ($CDCl_3$) : δ : 7.30-7.14 (m, 10 Ar-*H*), 5.33 (t, J=9 Hz, H-$C_{3'}$), 5.11 (d, J=4 Hz, H-$C_{1'}$), 4.97 (t, J=9 Hz, H-$C_{4'}$), 4.77 (dd, J=9, 4 Hz, H-$C_{2'}$), 4.71 (d, J=1 Hz, H-C_1), 4.57, 4.56, 4.48, 4.46 (4d, J=11 Hz, 2 Ar-CH_2), 4.40 (ddd, J=7, 6, 5 Hz, H-C_4), 4.15-4.06 (m, H-C_2, H-C_3, H_a-$C_{6'}$, H_b-$C_{6'}$), 3.95 (m, H-$C_{5'}$), 3.73 (dd, J=11, 5 Hz, H_a-C_5), 3.64 (dd, J=11, 7 Hz, H_b-C_5), 3.40 (s, H_3CO-C_1), 2.12, 2.09, 2.07, 2.04 (4s, H_3COOC). Anal. Calcd for $C_{34}H_{42}O_{14}$: C, 60.53; H, 6.27. Found : C, 60.46; H, 6.32.

9b : Syrup; $[\alpha]^{20}_D$ +3° (c 1.25, $CHCl_3$); ms (dci) (m/z) : 692 $(M+NH_4)^+$, 362, 331; ^1H nmr ($CDCl_3$) : δ : 7.38-7.17 (m, 10 Ar-*H*), 5.68 (d, J=6 Hz, H-$C_{1'}$), 5.15 (t, J=3 Hz, H-$C_{3'}$), 4.88 (dd, J=10, 3 Hz, H-$C_{4'}$), 4.82 (d, J=1 Hz, H-C_1), 4.64, 4.58, 4.53, 4.52 (4d, J=11 Hz, 2 Ar-CH_2), 4.40 (ddd, J=7, 6, 5 Hz, H-C_4), 4;33 (dd, J=6, 3 Hz, H-$C_{2'}$), 4.20 (m, H_a-$C_{6'}$, H_b-$C_{6'}$), 4.13 (dd, J=3, 1 Hz, H-C_2), 3.95 (dd, J=6, 3 Hz, H-C_3), 3.91 (m, H-$C_{5'}$), 3.77 (dd, J=10, 5 Hz, H_a-C_5), 3.68 (dd, J=10, 7 Hz, H_b-C_5), 3.40 (s, H_3CO-C_1), 2.11, 2.10, 2.08 (3s, H_3COOC), 1.73 (s, H_3C-C). Anal. Calcd for $C_{34}H_{42}O_{14}$: C, 60.53; H, 6.27. Found : C, 60.59; H, 6.24

Methyl 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-α-D-xylofuranoside (11a) : A solution of **8a** (0.082 g, 0.12 mmol) in EtOH (5 ml) containing 10% Pd-C (0.04 g) was submitted to hydrogenolysis (H_2, 1 atm.) at 25°C for 3 h. After filtration over celite and evaporation of the solvent under reduced pressure, column chromatography (solvent : CH_2Cl_2-MeOH 98:2) yielded **11a** as a syrup (0.040 g, 67%) : $[\alpha]^{20}_D$ +66° (c 0.75, $CHCl_3$); ms (dci) (m/z) : 512 $(M+NH_4)^+$; ^1H nmr ($CDCl_3$) : δ : 5.20 (t, J=9 Hz, H-$C_{3'}$), 5.06 (dd, J=9, 8 Hz, H-$C_{2'}$), 5.04 (t, J=9 Hz, H-$C_{4'}$), 4.83 (d, J=8Hz, H-$C_{1'}$),

4.78 (d, J=4 Hz, H-C_1), 4.45 (ddd, J=6, 4, 3 Hz, H-C_4), 4.16 (m, H-C_3, H_a-$C_{6'}$, H_b-$C_{6'}$), 4.08 (dd, J=6, 4 Hz, H-C_2), 3.81 (m, H_a-C_5, H_b-C_5), 3.71 (ddd, J=9, 4, 3 Hz, H-$C_{5'}$), 3.36 (s, H_3CO-C_1), 3.27 (d, J=6 Hz, D_2O exch., OH-C_3), 2.44 (t, J=5 Hz, D_2O exch., OH-C_5), 2.11, 2.07, 2.05, 2.03 (4s, H_3COOC). Anal. Calcd for $C_{20}H_{30}O_{14}$: C, 48.58; H, 6.12. Found : C, 48.46; H, 6.15.

Methyl 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-β-D-xylofuranoside (11b) : Hydrogenolysis of **8b** (0.082 g) in conditions similar to those described for the preparation of **11a** from **8a** afforded **11b** as a syrup (0.043 g, 72%) : $[\alpha]^{20}_D$ -71° (c 1.25, $CHCl_3$); ms (dci) (m/z) : 512 $(M+NH_4)^+$; ^1H nmr ($CDCl_3$) : 5.14 (t, J=9 Hz, H-$C_{3'}$), 5.11 (t, J=9 Hz, H-$C_{4'}$), 5.02 (dd, J=9, 8 Hz, H-$C_{2'}$), 5.01 (d, J=1 Hz, H-C_1), 4.64 (d, J=8 Hz, H-$C_{1'}$), 4.26-4.07 (m, H-C_2, H-C_3, H-C_4, H_a-$C_{6'}$, H_b-$C_{6'}$), 3.83 (m, H_a-C_5, H_b-C_5), 3.68 (m, H-$C_{5'}$), 3.37 (s, H_3CO-C_1), 3.27 (d, J=9 Hz, D_2O exch., OH-C_3), 2.73 (t, J=5 Hz, D_2O exch., OH-C_5), 2.12, 2.08, 2.06, 2.03 (4s, H_3COOC). Anal. Calcd for $C_{20}H_{30}O_{14}$: C, 48.58; H, 6.12. Found : C, 48.54; H, 6.13.

Methyl 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-3,5-di-*O*-acetyl--D-xylofuranoside (12a) : Acetic anhydride (2 ml, 21 mmol) was added to a solution of **11a** (0.040 g, 0.08 mmol) in pyridine (2 ml) and the mixture was left at 25° for 24 h. Evaporation of the solvent under reduced pressure followed by column chromatography (solvent : CH_2Cl_2) afforded **12a** as a syrup (0.045 g, 96%), $[\alpha]^{20}_D$ +49° (c 0.75, $CHCl_3$); ms (dci) (m/z) : 596 $(M+NH_4)^+$; ^1H nmr ($CDCl_3$) : δ : 5.35 (dd, J=7, 6 Hz, H-C_3), 5.15 (t, J=9 Hz, H-$C_{3'}$), 5.01 (t, J=9 Hz, H-$C_{4'}$), 4.97 (dd, J=9, 8 Hz, H-$C_{2'}$), 4.84 (d, J=4 Hz, H-C_1), 4.64 (d, J=8 Hz, H-$C_{1'}$), 4.37 (ddd, J=6, 4, 3 Hz, H-C_4), 4.17-4.00 (m, H-C_2, H_a-C_5, H_a-$C_{6'}$, H_b-$C_{6'}$), 4.02 (dd, J=10, 4 Hz, H_b-C_5), 3.67 (m, H-$C_{5'}$), 3.37 (s, H_3CO-C_1), 2.12, 2.10, 2.03, 2.02, 2.01, 2.00 (6s, H_3COOC). Anal. Calcd for $C_{24}H_{34}O_{16}$: C, 49.83; H, 5.92. Found : C, 49.91; H, 5.87.

Methyl 2,3,4,6-tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-3,5-di-*O*-acetyl-β-D-xylofuranoside (12b) : Acetylation of **11b** (0.040 g, 0.08 mmol) in condition

similar to those described for the preparation of **12a** from **11a** afforded **12b** as a syrup (0.045 g, 96%), $[\alpha]^{20}_D$ -36° (c 0.75, $CHCl_3$); ms (dci) (m/z) : 596 $(M+NH_4)^+$; ^1H nmr ($CDCl_3$) : δ : 5.16 (t, J=9 Hz, H-$C_{3'}$), 5.02 (t, J=9 Hz, H-$C_{4'}$), 5.00 (dd, J=5, 1 Hz, H-C_3), 4.91 (dd, J=9, 8 Hz, H-$C_{2'}$), 4.90 (d, J=1 Hz, H-C_1), 4.74 (d, J=8 Hz, H-$C_{1'}$), 4.40 (td, J=5, 4 Hz, H-C_4), 4.25 (dd, J=10, 5 Hz, H_a-C_5), 4.22 (dd, J=12, 4 Hz, H_a-$C_{6'}$), 4.15 (dd, J=10, 4 Hz, H_b-C_5), 4.12 (t, J=1 Hz, H-C_2), 4.08 (dd, J=12, 2 Hz, H_b-$C_{6'}$), 3.70 (ddd, J=9, 4, 2 Hz, H-$C_{5'}$), 3.35 (s, H_3CO-C_1), 2.11, 2.10, 2.09, 2.05, 2.03, 2.01 (6s, H_3COOC). Anal. Calcd for $C_{24}H_{34}O_{16}$: C, 49.83; H, 5.92. Found : C, 49.81; H, 5.88.

2,3,4,6-Tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-1,1,3,4,5-penta-*O*-acetyl-*aldehydo*-D-xylose (13) : A solution of **12a** (or **12b**) (0.116 g, 0.2 mmol) in acetic anhydride (0.4 ml, 4.2 mmol) was shaken with concentrated sulfuric acid (0.012 ml, 0.2 mmol) in acetic anhydride (0.6 ml, 6.3 mmol) for 6 h at 20°C. The reaction mixture was diluted with CH_2Cl_2 (20 ml) and washed with water (3 x 20 ml), saturated aq. $NaHCO_3$ solution (2 x 20 ml), and again with water (2 x 20 ml). The organic solution was dried over an. Na_2SO_4, and evaporated under reduced pressure. Column chromatography (solvent : CH_2Cl_2) of the residue gave **13** as a syrup (0.079 g, 56%), $[\alpha]^{20}_D$ -5° (c 0.65, $CHCl_3$); ms (dci) (m/z) : 726 $(M+NH_4)^+$, 624, 564; ^1H nmr ($CDCl_3$) : δ : 6.70 (d, J=3 Hz, H-C_1), 5.35 (dd, J=8, 3 Hz, H-C_3), 5.18 (ddd, J=6, 5, 3 Hz, H-C_4), 5.10 (t, J=9 Hz, H-$C_{3'}$), 5.02 (t, J=9 Hz, H-$C_{4'}$), 4.97 (dd, J=9, 8 Hz, H-$C_{2'}$), 4.62 (d, J=8 Hz, H-$C_{1'}$), 4.25 (dd, J=12, 5 Hz, H_a-C_5), 4.21 (dd, J=12, 5 Hz, H_a-$C_{6'}$), 4.08 (dd, J=8, 3 Hz, H-C_2), 4.06 (dd, J=12, 2 Hz, H_b-$C_{6'}$), 3.92 (dd, J=12, 6 Hz, H_b-C_5), 3.70 (ddd, J=9, 5, 2 Hz, H-$C_{5'}$), 2.08, 2.05, 2.04, 2.03, 2.02, 2.01, 2.00, 1.99, 1.97 (9s, H_3COOC). Anal. Calcd for $C_{29}H_{40}O_{20}$: C, 49.15; H, 5.69. Found : C, 49.23; H, 5.68.

2,3,4,6-Tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-1,3,4-tri-*O*-acetyl-α,β-D xylopyranose (14a,b) : To a solution of **13** (0.071 g, 0.1 mmol) in MeOH (1 ml), was added 1*N* NaOMe in MeOH (2 ml). The mixture was stirred for 12 h at 20°C. After neutralization by addition of Amberlite IRC 50 H^+ ion exchange resin and filtration, the solvent was removed by evaporation, and the residue was acetylated by acetic

anhydride (2 ml, 21 mmol) in dry pyridine (2 ml, 27 mmol) for 36 h at 20°C. The reaction mixture was evaporated under reduced pressure. Column chromatography (solvent : CH_2Cl_2.MeOH 98:2) of the residue gave **14a,b** (0.042 g, 69%) as a syrupy inseparable mixture.

2,3,4,6-Tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-1,3,4-tri-*O*-acetyl-α-D-xylopyranose (14a) and **2,3,4,6-Tetra-*O*-acetyl-α-D-glucopyranosyl-(1→2) 1,3,4-tri-*O*-acetyl-α-D-xylopyranose (15)** : To a solution of mercuric cyanide (1.0 g, 4.2 mmol) and mercuric bromide (1.0 g, 2.8 mmol) in dry acetonitrile (21 ml) were added successively 1,3,4-tri-*O*-acetyl-α-D-xylopyranose[17] (0.450 g, 1.63 mmol) and 2,3,4,6-tetra-*O*-acetyl-α-D-glucopyranosyl bromide (1.3 g, 3.16 mmol). After 24 h with continuous stirring, the mixture was filtered. The organic solution was worked up as described for the preparation of **8a-9a**. Column chromatography (solvent : CH_2Cl_2) of the residue afforded successively **14a** (0.18 g, 18%) and **15** (0.15 g, 15%).
14a : Syrup; $[\alpha]^{20}_D$ -65° (c 0.65, $CHCl_3$); ms (dci) (m/z) : 624 $(M+NH_4)^+$; ^1H nmr ($CDCl_3$) : δ : 6.16 (d, J=4 Hz, H-C_1), 5.37 (t, J=9 Hz, H-C_3), 5.10 (t, J=9 Hz, H-$C_{3'}$), 4.98 (t, J=9 Hz, H-$C_{4'}$), 4.91 (ddd, J=11, 9, 5 Hz, H-C_4), 4.88 (dd, J=9, 8 Hz, H-$C_{2'}$), 4.54 (d, J=8Hz, H-$C_{1'}$), 4.13 (m, H_a-$C_{6'}$, H_b-$C_{6'}$), 3.83 (dd, J=11, 4 Hz, H_e-C_5), 3.82 (dd, J=9, 4 Hz, H-C_2), 3.65 (m, H-$C_{5'}$), 3.57 (t, J=11 Hz, H_a-C_5), 2.15, 2.12, 2.10, 2.04, 2.03, 2.02,1.99 (7s, H_3COOC).
Anal. Calcd for $C_{25}H_{34}O_{17}$: C, 49.51; H, 5.65. Found : C, 49.53; H, 5.62.
15 : Syrup; $[\alpha]^{20}_D$ +107° (c 0.75, $CHCl_3$); ms (dci) (m/z) : 624 $(M+NH_4)^+$; ^1H nmr ($CDCl_3$) : δ : 6.16 (d, J=4 Hz, H-C_1), 5.40 (t, J=9 Hz, H-C_3), 5.28 (t, J=10 Hz, H-$C_{3'}$), 5.05 (d, J=4Hz, H-$C_{1'}$), 5.02 (dd, J=10, 9 Hz, H-$C_{4'}$), 4.91 (ddd, J=11, 9, 6 Hz, H-C_4), 4.85 (dd, J=10, 4 Hz, H-$C_{2'}$), 4.17 (m, H_a-$C_{6'}$, H_b-$C_{6'}$), 4.02 (m, H-$C_{5'}$), 3.98 (dd, J=9, 4 Hz, H-C_2), 3.85 (dd, J=11, 6 Hz, H_e-C_5), 3.57 (t, J=11 Hz, H_a-C_5), 2.21, 2.13, 2.12, 2.09, 2.08, 2.04, 2.00 (7s, H_3COOC). Anal. Calcd for $C_{25}H_{34}O_{17}$: C, 49.51; H, 5.65. Found : C, 49.49; H, 5.68.

2,3,4,6-Tetra-*O*-acetyl-β-D-glucopyranosyl-(1→2)-3,4-di-*O*-acetyl-α-D-xylopyranosyl bromide (3) : To a solution of **14a** (or of a **14a,b** mixture) (0.60 g, 1 mmol) in glacial acetic acid (0.6 ml) and dry chlorofom (0.6 ml), was added 33%

hydrogen bromide (6.7 mmol) in acetic acid (1.2 ml). The mixture was stirred for 3 h at 0°C, diluted with chloroform (20 ml), washed successively at 0°C with water (2 x 20 ml), saturated aq. $NaHCO_3$ solution (30 ml), and water (20 ml), and dried over an. Na_2SO_4. Evaporation of the solvents under reduced pressure gave crude **3** (0.57 g, 91%) as a syrup which was used in the next step without further purification.

4',7-Di-*O*-benzylquercetin-3-*O*-(2,3,4,6-tetra-*O*-acetyl)-β-D-gluco-pyranosyl-(1→2)-3,4-di-*O*-acetyl-β-D-xylopyranoside (16) : A solution of **3** (0.140 g, 0.22 mmol) and 4',7-di-*O*-benzylquercetin[25] (0.120 g, 0.25 mmol) in chloroform (5 ml) was stirred at reflux with benzyltriethylammonium bromide (0.055 g, 0.2 mmol) in 1.25*M* aqueous KOH for 15 h. After dilution with water (10 ml), the two phases were separated and the organic layer was washed with 1.25*M* aq. KOH (2 x 50 ml) and evaporated under reduced pressure. Purification by column chromatography (solvent : toluene-EtOAc 90:10) afforded the glycoside (**16**) as a foam (0.103 g, 40%), $[\alpha]^{20}_D$ -48° (*c* 0.25, $CHCl_3$); *ms* (dci) (*m/z*) : 1029 $(M+H)^+$; ^1H *nmr* ($CDCl_3$) : δ : 12.30 (s, D_2O exch., OH-C_5), 7.48-7.28 (m, 10 Ar-*H*), 7.17 (d, J=2 Hz, H-$C_{2'}$), 7.13 (dd, J=9, 2 Hz, H-$C_{6'}$), 6.97 (d, J=9 Hz, H-$C_{5'}$), 6.43 (d, J=2 Hz, H-C_8), 6.36 (d, J=2 Hz, H-C_6), 5.82 (s, D_2O exch., OH-$C_{3'}$), 5.43 (d, J=4 Hz, H-$C_{1''}$), 5.21-505 (m, H-$C_{3'''}$, H-$C_{4'''}$, H-$C_{2'''}$, 2 Ar-CH_2), 5.02 (t, J=6 Hz, H-$C_{3''}$), 4.77 (d, J=8 Hz, H-$C_{1'''}$), 4.71 (ddd, J=6, 5, 4 Hz, H-$C_{4''}$), 4.33 (dd, J=12, 4 Hz, H_a-$C_{6'''}$), 4.10 (dd, J=12, 2 Hz, H_b-$C_{6'''}$), 4.07 (dd, J=6, 4 Hz, H-$C_{2''}$), 4.00 (dd, J=12, 4 Hz, H_a-$C_{5''}$), 3.76 (m, H-$C_{5'''}$), 3.33 (dd, J=12, 5 Hz, H_b-$C_{5''}$), 2.17, 2.13, 2.08, 2.07, 2.02, 2.00 (6s, H_3COOC). Anal. Calcd for $C_{52}H_{52}O_{22}$: C, 60.70; H, 5.09. *Found* : C, 60.64; H, 5.08.

Deblocking of glycoside 16 : A solution of **16** (0.075 g, 0.07 mmol) in MeOH (5 ml) containing 10% Pd-C (0.04 g) was submitted to hydrogenolysis (H_2, 1 atm.) at 20°C for 4 h. The catalyst was removed by filtration and the solvent was evaporated under reduced pressure to give crude **17** which was dissolved in 1*N* NaOMe in MeOH (3 ml). The mixture was stirred for 3 h at 20°C. After neutralization by addition of Amberlite IRC 50 H^+ ion exchange resin and filtration, the solvent was removed by evaporation

to afford pure **1** as an amorphous solid (0.031 g, 71% overall yield from **16**), identical ($[\alpha]^{20}_D$, uv, ir, nmr, tlc) with the natural product.

ACKNOWLEDGEMENTS

We wish to thank Pr. M. Koch (Laboratoire de Pharmacognosie de l'Université René Descartes, Paris, France) for his kind interest in this work.

REFERENCES AND NOTES

1. For reviews, see : a) J. B. Harborne and C. A. Williams, "Flavone and Flavonol Glycosides", *in* The Flavonoids, ed. by J. B. Harborne, T. J. Mabry, and M. Mabry, Chapman and Hall, London, 1975, pp. 376-441; b) J. B. Harborne and C. A. Williams, "Flavone and Flavonol Glycosides", *in* The Flavonoids : Advances in Research, ed. by J. B. Harborne and T. Mabry, Chapman and Hall, London, 1982, pp. 261-311; c) J. B. Harborne and C. A. Williams, "Flavone and Flavonol Glycosides", *in* The Flavonoids : Advances in Reasearch since 1980, ed. by J. B. Harborne, Chapman and Hall, London, 1988, pp. 303-328.
2. The single previous record of a "quercetol-3-glucoxyloside" describes its isolation from *Sorbus commixta* Hedl., but neither the forms (furanose or pyranose) of the sugars, nor the type and position of the interglycosidic linkage have been determined, see : W. Bylka, Z. Kowalewski, and K. Oleksiak, *Herba Pol.*, **1977**, *23*, 105.
3. B. Razanamahefa, "Contribution à l'étude des constituants flavoniques de *Kalanchoe prolifera* Raym.-Hamet", Thèse de Doctorat de 3e cycle, University of Antananarivo, 1991, pp. 1-138.
4. R. Hamet, *Bull. Herb. Boiss. Ser. B*, **1907**, *7*, 896.
5. R. Pernet, *Mem. Inst. Sc. Madagascar Ser. B.*, **1957**, *8*, 1.
6. Z. A. Rabesa, "Pharmacopée de l'Alaotra", Nanitonana, Antananarivo, 1986, pp. 160-161.
7. T. J. Mabry, K. R. Markham, and M. B. Thomas, "The Systematic Identification of Flavonoids", Springer-Verlag, New York, 1970.

8. D. Stosic, M. Gorunovic, A.-L. Skaltsounis, F. Tillequin, and M. Koch, *Helv. Chim. Acta*, **1988**, *71*, 348

9. M. Mizuno, M. Iinuma, T. Tanaka, N. Sakakibara, M. Nishi, A. Inada, and T. Nakanishi, *Phytochemistry*, **1989**, *28*, 2527.

10 F. Tomas-Lorente, M. M. Garcia-Grau, J. L. Nieto, and F. A. Tomas-Barberan, *Phytochemistry*, **1992**, *31*, 2027.

11. Equilibrium between $^1C_4$ and $^4C_1$ conformers with significant alteration of $^3J_{H1,H2}$ and $^1J_{C1,H1}$ values has been previously observed in the case of various natural 2-*O*-glucosylated α-L-arabinopyranosides of various bulky aglycones, see: a) H. Ishii, I. Kitagawa, K. Shirakawa, K. Tori, T. Tozyo, M. Yoshikawa, and Y. Yoshimura, *Tetrahedron Lett.*, 1981, **22**, 1529; b) K. Mizutani, A. Hayashi, R. Kasai, Y. Tanaka, N. Yoshida, and T. Nakajina, *Carbohydr. Res.*, **1984**, *126*, 177; c) K. Nizutani, K. Ohtani, R. Kasai, O. Tanaka, and H. Matsuura, *Chem. Pharm. Bull.*, **1985**, *33*, 2266. In the D-xylopyranose series, such observations have only been reported for simple derivatives, see : a) P. L.Durette, D. Horton and N. S. Bhacca, *Carbohydr. Res.*, **1969**, *10*, 565; b) P. L. Durette and D. Horton, *J. Org. Chem.*, **1971**, *36*, 2658; c) K. Bock and C. Pedersen, *Acta Chem. Scand.*, **1975**, *B29*, 258; d) J. Schraml, E. Petravoka, O. Pihar, J. Hirsch, and V. Chvalovsky, *Collect. Czech. Chem. Commun.*, **1983**, *48*, 1829.

12 C. Demetzos, A. L. Skaltsounis, F. Tillequin, and M. Koch, *Carbohydr. Res.*, **1990** , *207*, 131.

13. W. D. S. Bowering and T. E. Timell, *J. Am. Chem. Soc.*, **1960**, *82*, 2827.

14. J. K. N. Jones and P.E. Reid, *Can. J. Chem.*, **1960**, *38*, 944.

15. Until now, four intermediates have been used for the synthesis of (1→2)-linked disaccharides with xylose at the reducing end : a) methyl 3,4-di-*O*-acetyl-β-D-xylopyranoside : P. Kovac and R. Palovcik, *Carbohydr. Res.*, **1977**, *54*, C11; b) methyl 3,5-*O*-isopropylidene-α-β-D-xylopyranose : refs. 13 and 14; c) 1,3,4-tri-*O*-acetyl-α–D-xylopyranose : S. Kamiya, R; Tanaka, and S. Esaki, *Agric. Biol. Chem.*, **1983**, *47*, 2929; d) benzyl 3,4-di-*O*-benzyl-β-D-xylopyranoside : P. Kovac and E.

Petrakova, *Chem. Zvesti*, **1980**, *34*, 537 ; E. Petrakova, I. Krupova, J. Schraml, and J. Hirsch, *Collect. Czech. Chem. Commun.*, **1991**, *56*, 1300.

16. W. D. S. Bowering and T. E. Timell, *Can. J. Chem.*, **1958**, *36*, 283.
17. B. Helferich and W. Ost, *Chem. Ber.*, **1962**, *95*, 2616.
18. a) R. G. S. Ritchie, N. Cyr, B. Korsch, H. J. Koch, and A. S. Perlin, *Can. J. Chem.*, **1975**, *53*, 1424 ; b) K. Bock and H. Thogersen, *Ann. Rep. NMR Spectrosc.* **1982**, *13*, 1.
19. T. Usui and S. Umezawa, *Carbohydr. Res.*, **1988**, *174*, 133.
20. A. Liptak, P. Nanasi, A. Neszméli, and H. Wagner, *Tetrahedron*, **1980**, *36*, 1261.
21. R. H. Hann and C. S. Hudson, *J. Am. Chem. Soc.*, **1934**, *56*, 2465.
22. K. Freudenberg and K. Soff, *Ber.*, **1937**, *70*, 264.
23. For examples of similar acid-catalyzed ring ruptures in the acetolysis of methyl *pento*- and *hexo*-pyranosides, see : a) ref. 22, b) H. Bredereck, A. Wagner, G. Hagelloch, and G. Faber, *Chem. Ber.*, **1958**, *91*, 515; c) F. W. Lichtenthaler, J. Breunig, and W. Fischer, *Tetrahedron Lett.*, **1971**, 2825.
24. L. R. Schroeder, K. M. Counts, and F. C. Haigh, *Carbohydr. Res.*,**1974**, *37*, 368.
25. L. Jurd, *J. Org. Chem.*, **1962**, *27*, 1294.

Received, 27th September, 1993