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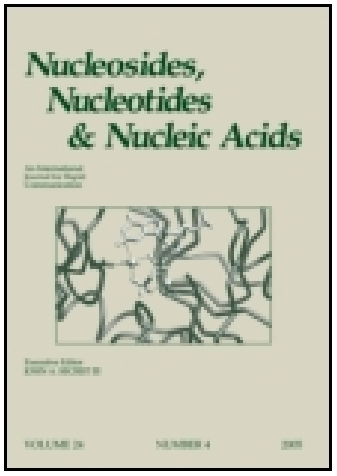

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Synthesis of N-Glycosylated Pyridiines as New Antimetabolite Agents

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NUCLEOSIDES & NUCLEOTIDES, 18(10), 2335–2343 (1999)

SYNTHESIS OF *N*-GLYCOSYLATED PYRIDINES AS NEW ANTIMETABOLITE AGENTS

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Abstract: Condensation of cyanoacetamide and cyanothioacetamide with the sodium salts of α-(hydroxymethylene)alkanones afforded the pyridine-2(1*H*)-ones and their corresponding thiones **3**. Compounds **3** served as a key intermediates for the synthesis of *N*-glycosylated pyridines.

In a series of reports on our work on the synthesis of antimetabolites[1-3], we have recently described that pyridinethione glycosides exerted inhibitory effects on both DNA and RNA containing viruses[4]. On the basis of these findings, it was of interest to prepare modified analogues to search for more effective agents. This paper describes the synthesis of *N*-glycosylated pyridinethione and their corresponding ketones. The latter compounds will be considered as precursors of modified nucleosides.

Thus, it has been found that the sodium salts of α-(hydroxymethylene)alkanones **1** reacted with cyanoacetamide and thioacetamide **1** to give the corresponding 3-cyanopyridine derivatives **3**. Compounds **3** reacted with peracetylated gluco- and galactopyranosyl bromides in the presence of aqueous potassium hydroxide to give the

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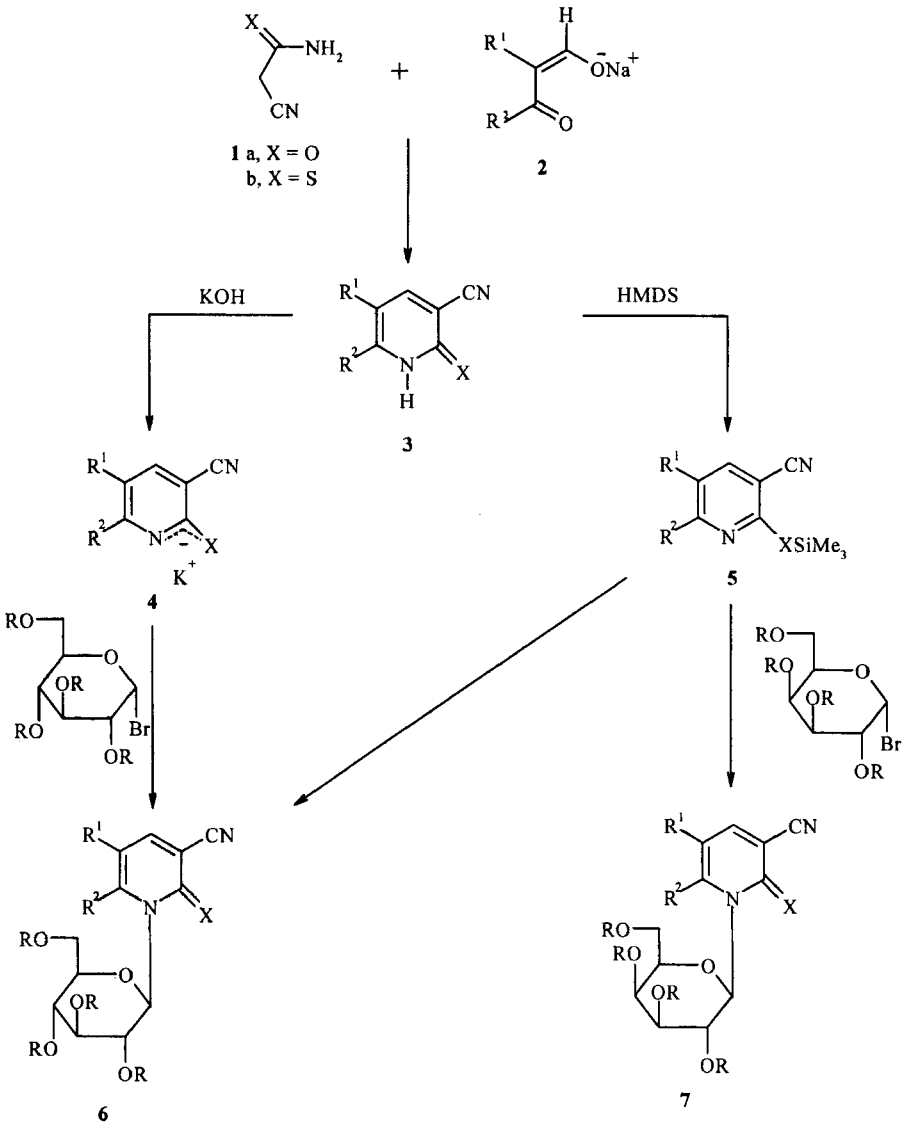

6,7	R	R^2	R^1	X	3,4,5	R^2	R^1	X
a	Ac	CH_3	H	O	**a**	CH_3	H	O
b	Ac	4-ClC_6H_4	H	O	**b**	CH_3	CH_3	O
c	Ac	CH_3	CH_3	S	**c**	C_6H_5	H	O
d	Ac	C_6H_5	H	S	**d**	4-ClC_6H_4	H	O
e	Ac	4-ClC_6H_4	H	S	**e**	CH_3	H	S
f	H	CH_3	H	O	**f**	CH_3	CH_3	S
g	H	CH_3	CH_3	S	**g**	C_6H_5	H	S
h	H	C_6H_5	H	S	**h**	4-ClC_6H_4	H	S
i	H	4-ClC_6H_4	H	S				

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corresponding *N*-glucosyl **6a-e** and *N*-galactosyl compounds **7a-e**. Although the coupling of **3e-h** with glycosyl bromides could also give the corresponding thioglycosides, the formation of **6c-e** and **7c-e** was proved chemically. Reaction of **3e-h** with hexamethyldisilazane (HMDS) in the presence of ammonium sulfate gave the corresponding 22-trimethylsilylthiopyridines **5e-h**, which were subsequently treated with peracetylated sugars in the presence of redistilled $SnCl_4$ to afford the corresponding *N*-glycosyl compounds. All the previous literature reports that Lewis acid-induced coupling reactions of *S*-silylated heterocyclic bases with peracetylated sugars give the corresponding *N*-nucleosides as the sole product[5-7]. The structures of the reaction products **6** and **7** were established and confirmed by their elemental analyses and spectral data (MS, IR, UV, ^1H NMR, ^{13}C NMR). Thus, the analytical data for **6c** revealed a molecular formula $C_{22}H_{26}N_2SO_9$ (m/z 494). The ^1H NMR spectrum showed the anomeric proton as doublet at δ 6.08 with a spin-spin coupling constant of 11.2 Hz corresponding to a diaxial orientation of H-1' and H-2' protons, indicating the β-configuration. The UV spectra of compounds **6c** confirmed that the reaction takes place at the nitrogen atom of the pyridine ring, leading selectively to the formation of *N*-glycosides and excludes substitution at the sulfur atom. Thus, whereas the *S*-methyl derivative of compound **3f** shows two maxima at 282 and 323 nm, its *N*-glucosyl derivative exhibited three maximum absorption bands at 270, 304 and 432 nm. The protected nucleosides **6a-e** and **7a-e** were deblocked through treatment with methanolic ammonia to give the free glycosides **6f-i** and **7f-i** after chromatographic purification. The structures of compounds **6** and **7** were confirmed by their elemental analyses and spectral data. Thus, the analytical data for compound **7g** revealed a molecular formula $C_{14}H_{18}N_2SO_5$ (m/z 326). ^1H NMR spectroscopy was used to confirm this structure for the product. Thus, the ^1H NMR spectra revealed the presence of a doublet at δ 5.58 ($J_{1'-2'}$ = 10.75 Hz) indicating the presence of only the β-D-galactopyranose.

In summary, we have achieved a regiospecific synthesis of interesting pyridine nucleosides by the reaction of substituted pyridine-2(1*H*)-thiones and corresponding ketones with *o*-halogeno sugars. These nucleosides can be utilized as excellent starting materials for the synthesis of other carbohydrate derivatives and for biological evaluation studies.

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Antiviral and Antitumor Activity

All compounds were screened for anti-HIV and antitumor activity, no activity was found when the compounds were tested against HIV. For antitumor activity, only compound **6e** (IC_{50}/EC_{50} = 16.8 in MT-4 cells) showed promising activity to be further tested with other additional tumor systems.

Experimental

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All evaporations were carried out under reduced pressure at 40°C. Melting points are uncorrected. TLC aluminium sheets silica gel 60 F_{254} (Merck) was used for thin layer chromatography; ddetection by short-wavelength UV light. IR spectra were obtained (KBr disc) with a pye Unicam Spectra-1000. ^1H NMR and ^{13}C NMR spectra were measured with a Wilmad 270 MHz or a Varian 400 MHz spectrometer for solutions in $(CD_3)_2SO$ using $SiMe_4$ as internal standard. Mass spectra were recorded with a double-focusing Varian MAT 112 and Finnigan MAT 8430 spectrometers, low resolution chemical ionization (CI), reagent gas was NH_3. Analytical data were obtained from the Microanalytical data Center at Cairo University.

3-Cyanopyridine-2(1*H*)-ones and -2(1*H*)-thiones 3a-h

A solution of α-(hydroxymethylene)alkanones **2** (0.01 mol), cyanoacetamide or cyanothioacetamide **1** (0.01 mol) and piperidine aacetate (0.95 mml) [prepared from glacial acetic acid (4.2 ml), water (10 ml) and piperidine (7.2 ml)] in water (10 ml) was refluxed for 10 minutes. Acetic acid (1.5 ml) was added to the hot solution. The precipitated solid was collected by filtration and crystallized from the appropriate solvent.

3a: m.p. 292 °C, yield 58%. IR cm^{-1} 3450, 3400 (NH), 2220 (CN), 1670 (CO); ^1H NMR δ 2.38 (s, 3H, CH_3), 6.88 (s, 1H, CH), 7.88 (s, 1H, CH), 12.70 (s, br, 1H, NH); m/z 134 (Found: C, 62.9; H, 4.5; N, 21.1. $C_7H_6N_2O$ requires C, 62.7; H, 4.5; N, 20.9%).

3b: m.p. 270 C, yield 56%. IR cm^{-1} 3380, 3300 (NH), 2225 (CN), 1650 (CO); ^1H NMR δ 2.29 (s, 3H, CH_3), 3.44 (s, 3H, CH_3), 7.89 (s, 1H, CH), 12.42 (s, br, 1H, NH); m/z 148 (Found: C, 65.0; H, 5.5; N, 18.8. $C_8H_8N_2O$ requires C, 64.9; H, 5.4; N, 18.9 %).

3c: m.p. 340 °C, yield 60%. IR cm^{-1} 3500, 3430 (NH), 2220 (CN), 1647

(CO);^{1}H NMR δ 6.80 (s, 1H, CH), 7.12-7.89 (m, 5H, C_6H_5), 8.87 (s, 1H, CH), 12.70 (s, br, 1H, NH); m/z 196 (Found: C, 73.7; H, 4.2; N, 14.5. $C_{12}H_8N_2O$ requires C, 73.5; H, 4.1; N, 14.3 %).

3d: m.p. 269 °C, yield 61%. IR cm^{-1} 3480, 3400 (NH), 2222 (CN), 1650 (CO); ^{1}H NMR δ 6.88 (s, 1H, CH), 6.99-7.90 (m, 4H, C_6H_4), 7.88 (s, 1H, CH), 12.48 (s, br, 1H, NH); m/z 231 (Found: C, 62.6; H, 3.2; N, 12.3. $C_{12}H_7ClN_2O$ requires C, 62.5; H, 3.0; N, 12.1 %).

3e: m.p. 248 °C, yield 68%. IR cm^{-1} 3420, 3400, 3380 (NH), 2222 (CN); ^{1}H NMR δ 2.28 (s, 3H, CH_3), 7.12 (s, 1H, CH), 8.33 (s, 1H, CH), 13.90 (s, br, 1H, NH); m/z 150 (Found: C,56.2; H, 4.1; N, 18.9. $C_7H_6N_2S$ requires C, 56.0; H, 4.0; N, 18.7 %).

3f: m.p. 276°C; yield 70%. IR cm^{-1} 3420, 3348 (NH), 2220 (CN); ^{1}H NMR δ 2.26 (s, 3H, CH_3), 7.90 (s, 1H, CH), 14.10 (s, br, 1H, NH); m/z 164 (Found: C, 58.6; H, 5.0; N, 17.0. $C_8H_8N_2S$ requires C, 58.5; H, 4.9; N, 17.1 %).

3g: 288 °C, yield 72%. IR cm^{-1} 3490, 3460, 3400 (NH), 2228 (CN); ^{1}H NMR δ 7.12 (s, 1H, CH), 7.22-7.87 (m, 5H, C_6H_5), 8.23 (s, 1H, CH), 14.13 (s, br, 1H, NH); m/z 212 (Found: C, 68.1; H, 3.9; N, 13.5. $C_{12}H_8N_2S$ requires C, 67.9; H, 3.8; N, 13.2 %).

3h: m.p. 278 °C, yield 74%. IR cm^{-1} 3400-3330 (NH), 2220 (CN);^{1}H NMR δ 6.99 (s, 1H, CH), 7.10-7.85 (m, 4H, C_6H_4), 8.23 (s, 1H, CH), 14.22 (s, br, 1H, NH); m/z 247 (Found: C, 58.5; H, 2.9; N, 11.5. $C_{12}H_7ClN_2S$ requires C, 58.4; H, 2.8; N, 11.4 %).

3-Cyano-1-peracetylated-gluco- and galactopyranosyl pyridin-2-ones and -2-thiones 6a-e and 7a-d.

General coupling procedures.

Method A: To a solution of 3-cyano-2-pyridones or their corresponding thiones **3** (0.01 mol) in aqueous potassium hydroxide [0.56 g (0.01 mol) in 6 ml of distilled water], a solution of peracetylatedgluco- or galactopyranosyl bromide (4.521 g, 0.011 mol) in acetone (30 ml) was added. The mixture was stirred at room temperature until the reaction was judged complete by TLC (solvent CH_2Cl_2-MeOH in a 1:1; 30 min to 20 h), then evaporated under reduced pressure at 40 °C and the residue washed with distilled water to remove KBr. The product was dried and crystallized from EtOH to afford pale yellow crystals.

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Method B: 3-Cyano-2-pyridones and their corresponding thiones **3** (0.01 mol) were boiled under reflux, with stirring, under anhydrous conditions for 48 hours with hexamethyldisilazane (25 ml) $(NH_4)_2SO_4$ (0.02 g). The excess of hexamethyldisilazane was removed under diminished pressure, providing the silylated bases **5e-h** as colourless oils. To a solution of silylated base in dry MeCN (30 ml) was added a solution of α-D-glucose- or α-D-galactose pentaacetate (0.011 mol) in dry MeCN (20 ml) followed by $SnCl_4$ (1.6 ml). The reaction mixture was stirred at room temperature until reaction was judged complete by TLC (solvent CH_2Cl_2-MeOH in a ratio 1:1; 3 to 6 h), then poured into saturated $NaHCO_3$ solution and extracted with $CHCl_3$. The organic layers were dried over $MgSO_4$, filtered and concentrated to give the crude nucleosides which were purified by recrystallization from EtOH to afford pale yellow crystals.

6a: m.p. 197 °C, yield 57%. IR 2222 (CN), 1752 (CO) cm^{-1}; ^1H NMR δ 1.88-2.09 (4s, 12H, $4CH_3CO$), 2.22 (s, 3H, CH_3), 4.19 (m, 2H, H-6',6" and 1H, H-5'), 5.06 (m, 2H, H-4' and H-2'), 5.54 (t, 1H, H-3'), 6.41(d, $J_{1'-2'}$=10.10 Hz, 1H, H-1'), 6.82 (s, 1H, CH), 8.05 (s, 1H, CH); m/z 464 (Found: C, 54.5; H, 5.2; N, 6.3. $C_{21}H_{24}N_2O_{10}$ requires C, 54.3; H, 5.2; N, 6.0 %).

6b: m.p. 140 °C, yield 63%. IR 2226 (CN), 1750 (CO)cm^{-1}; ^1H NMR δ 1.80-1.99 (4s, 12H, 4CH3CO), 4.13 (m, 2H, H-6',6"and 1H, H-5'), 5.00 (m, 2H, H-4' and H-2'), 5.22 (t, 1H, H-3'), 6.38 (d, $J_{1'-2'}$=10.00 Hz, 1H, H-1'), 6.80 (s, 1H, CH), 6.92-7.72 (m, 4H, C_6H_4), 7.98 (s, 1H, CH); m/z 561 (Found; C, 55.8; H, 4.6; N, 5.2. $C_{26}H_{25}ClN_2O_{10}$ requires C, 55.7; H, 4.5; N, 5.0 %).

6c: m.p. 180 °C, yield 71%. IR 2219, 1761; UV max 270, 304 and 432 nm cm^{-1}; ^1H NMR δ1.86-2.05 (4s, 12H, $4CH_3CO$), 2.26 (s, 3H, CH_3), 2.41(s, 3H, CH_3), 4.11(m, 2H, H-6',6" and 1H, H-5'), 5.08(m, 2H, H-4' and H-2'), 5.50 (t, 1H, H-3'), 6.08 (d, $J_{1'-2'}$=11.24 Hz, 1H, H-1'), 8.00 (s, 1H, CH); m/z 494 (Found: C, 53.7; H, 5.2; N, 5.8. $C_{22}H_{26}N_2SO_9$ requires C, 53.4; H, 5.3; N, 5.7 %).

6d: m.p. 172 °C, yield 74%. IR 2221, 1750 cm^{-1}; ^1H NMR δ 1.82-2.08 (4s, 12H, $4CH_3CO$), 4.05 (m, 2H, H-6',6" and 1H, H-5'), 5.12 (m, 2H, H-4' and H-2'), 5.52 (t, 1H, H-3'), 6.06 (d, $J_{1'-2'}$=11.45 Hz, 1H, H-1'), 7.38 (d, 1H, CH), 7.42-7.99 (m, 5H, C6H5), 8.15 (d, 1H, CH); m/z 542 (Found: C, 57.8; H, 4.9; N, 5.1. $C_{26}H_{26}N_2SO_9$ requires C, 57.6; H, 4.8; N, 5.2%).

6e: m.p. 169 °C, yield 73%. IR 2219, 1747 cm^{-1}; ^1H NMR δ 1.65-2.00 (4s, 12H, $4CH_3CO$), 4.16 (m, 2H, H-6',6" and 1H, H-5'), 5.08 (m, 2H, H-4' and H-2'), 5.72 (t, 1H, H-3'), 6.24 (d, $J_{1'-2'}$ =9.45 Hz, 1H, H-1'), 7.62 (d, 2H, Ar-H), 8.04 (d, 1H, CH), 8.35 (d, 2H, Ar-H and 1H, CH); m/z 577 (Found: C, 54.3; H, 4.3; N, 5.1. $C_{26}H_{25}ClN_2SO_9$ requires C, 54.1; H, 4.3; N, 4.9 %).

7a: m.p. 165 °C, yield 53 %. IR 2220, 1748 cm^{-1}; ^1H NMR δ 1.78-2.05 (4s, 12H, $4CH_3CO$), 2.18(s, 3H, CH_3), 4.08 (m, 2H, H-6',6"), 4.46 (t, 1H, H-5'), 5.34 (m, 3H, H-4', H-2' and H-3'), 6.36 (d, $J_{1'-2'}$ = 11.25 Hz, 1H, H-1'), 7.16 (d, 1H, CH), 8.20(d, 1H, CH); m/z 464 (Found: C, 54.6; H, 5.4; N, 6.2. $C_{21}H_{24}N_2O_{10}$ requires C, 54.3; H, 5.2; N, 6.0 %).

7b: m.p. 154°C, yield 61 %. IR 2229, 1750 cm^{-1}; ^1H NMR δ 1.85-1.99 (4s, 12H, $4CH_3CO$), 2.24 (s, 3H, CH_3), 4.05 (m, 2H, H-6',6" and 1H, H-5'), 5.10 (m, 2H, H-4' and H-2'), 5.50 (t, 1H, H-3'), 6.50 (d, $J_{1',2'}$=10.00 Hz, 1H, H-1'), 8.00 (s, 1H, CH); m/z 561 (Found: C, 55.7; H, 4.4; N, 5.1. $C_{26}H_{25}ClN_2O_{10}$ requires C, 55.7; H, 4.5; N, 5.0 %).

7c: m.p. 130°C, yield 70%. IR 2218, 1758 cm^{-1}, ^1H NMR δ 1.82-2.09 (4s, 12H, $4CH_3CO$), 2.20 (s, 3H, CH_3), 2.28 (s, 3H, CH_3), 4.04 (m, 2H, H-6',6"), 4.41(t, 1H, H-5'), 5.36(m, 3H, H-4', H-2' and H-3'), 6.05 (d, $J_{1'-2'}$ = 11.45 Hz, 1H, H-1'), 8.00 (s, 1H, CH); m/z 494 (Found: C, 53.5; H, 5.5; N, 5.9. $C_{22}H_{26}N_2SO_9$ requires C, 53.4; H, 5.3; N, 5.7%).

7d: m.p. 184 °C, yield 72 %. IR 2216, 1752 cm^{-1}; ^1H NMR δ 1.88-2.14 (4s, 12H, $4CH_3CO$), 4.01 (m, 2H, H-6',6"), 4.40 (t, 1H, H-5'), 5.38(m, 3H, H-4', H-2' and H-3'), 6.05(d, $J_{1'-2'}$ = 10.73 Hz, 1H, H-1'), 7.28 (d, 1H, CH), 7.33-8.00 (m, 5H, C6H5), 8.12 (d, 1H, CH); m/z 542 (Found: C, 57.9; H, 4.9; N, 5.5. $C_{26}H_{26}N_2SO_9$ requires C, 57.6; H, 4.8; N, 5.2 %).

7e: m.p. 162 °C, yield 70 %. IR 2223. 1749 cm^{-1}; ^1H NMR δ 1.58-2.08 (4s, 12H, $4CH_3CO$), 4.00 (m, 2H, H-6',6"), 4.46(t, 1H, H-5'), 5.32(m, 2H, H-4' and H-2'), 5.61 (m, 1H, H-3'), 6.22(d, $J_{1'-2'}$=11.25 Hz, 1H, H-1'), 7.62(d, 2H, Ar-H), 8.05 (d, 1H, CH), 8.38 (m, 3H, Ar-H and 1H, CH); m/z 577 (Found: C, 54.4; H, 4.5; N, 5.0. $C_{26}H_{25}ClN_2SO_9$ requires C, 54.1; H, 4.3; N, 4.9 %).

3-Cyano-1-)β-D-gluco- and galactopyranosyl)-2-pyridones and their corresponding thiones 6f-i and 7f-i.

General procedure for nucleoside deacylation.

Dry gaseous NH_3 was passed through a solution of protected nucleosides

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6a-e and **7a-e** (0.5 g) in dry MeOH (25 ml) at 0 ^{o}C for about 0.5 hour, then the reaction mixture was stirred until judged complete by TLC (benzene-MeOH in a ratio 1:2; 6 to 18 h). The resulting reaction mixture was evaporated under reduced pressure at 40 ^{o}C giving a solid residue which was crystallized from MeOH to afford colourless crystals

6f: m.p. 229 ^{o}C, yield 81 %. IR 3480-3238, 2228 cm^{-1}; ^{1}H NMR δ 2.18 (s, 3H, CH_3), 3.16-3.78 (m, 6H, H-6',6", H-5', H-4', H-3' and H-2'), 4.55 (t, 1H, 2'-OH), 5.02 (d, 2H, 3'-OH and 4'-OH), 5.34 (d, 1H, 6'-OH), 5.96 (d, $J_{1'-2'}$= 10.01 Hz, 1H, H-1'), 7.26 (d, 1H, CH), 7.98 (d, 1H, CH); m/z 296 (Found: C, 52.9; H, 5.5; N, 9.7. $C_{13}H_{16}N_2O_6$ requires C, 52.7; H, 5.4; N, 9.5 %).

6g: m.p. 239^{o}C, yield 83 %. IR 3487-3246, 2240 cm^{-1}; ^{1}H NMR δ2.21 (s, 3H, CH_3), 2.40 (s, 3H, CH_3), 3.12-3.78 (m, 6H, H-6',6", H-5', H-4', H-3' and H-2'), 4.40 (t, 1H, 2'-OH), 5.00 (d, 1H, 3'-OH), 5.18 (d, 1H, 4'-OH), 5.48 (d, 1H, 6'-OH), 5.72 (d, $J_{1'-2'}$ = 9.65 Hz, 1H, H-1'), 7.96 (s, 1H, CH); m/z 326 (Found: C, 51.7; H, 5.6; N, 8.8. $C_{14}H_{18}N_2SO_5$ requires C, 51.5; H, 5.5; N, 8.6 %).

6h: m.p. 200^{o}C, yield 84 %. IR 3520-3280, 2225 cm^{-1}; ^{1}H NMR δ 3.18-3.74 (m, 6H, H-6',6", H-5', H-4', H-3' and H-2'), 4.46 (t, 1H, 2'-OH), 5.00 (d, 1H, 3'-OH), 5.18 (d, 1H, 4'-OH), 5.42 (d, 1H, 6'-OH), 5.58 (d, $J_{1'-2'}$ = 10.72 Hz, 1H, H-1'), 7.2 (d, 1H, CH), 7.29-7.89 (m, 5H, C_6H_5), 8.08 (d, 1H, CH); m/z 374 (Found: C, 57.9; H, 4.8; N, 7.8. $C_{18}H_{18}N_2SO_5$ requires C, 57.8; H, 4.8; N, 7.5 %).

6i: m.p.232^{o}C; yield 80 %. IR 3436-3200, 2219 cm^{-1}, ^{1}H NMR δ 3.09-3.55 (m, 6H, H-6',6", H-5', H-4', H-3' and H-2'), 4.22 (t, 1H, 2'), 4.40 (t, 1H, 2'-OH), 5.05 (d, 1H, 3'-OH), 5.15 (d, 1H, 4'-OH), 5.38 (d, 1H, 6'-OH), 5.62 (d, J1',2'= 10.00 Hz, 1H, H-1'), 7.20 (d, 1H, CH), 7.28-7.88 (m, 4H, C_6H_4), 8.11 (d, 1H, CH); m/z 409 (Found: C, 53.1; H, 4.4; N, 7.0. $C_{18}H_{17}ClN_2SO_5$ requires C, 52.9; H, 4.2; N, 6.9 %).

7f: m.p. 214^{o}C, yield 83 %. IR 3540-3260, 2216 cm^{-1}; ^{1}H NMR δ2.24 (s, 3H, CH_3), 3.21-3.76 (m, 6H, H-6',6", H-5', H-4', H-3' and H-2'), 4.08-5.38 (m, 4H, 2'-OH, 3'-OH, 4'-OH and 6'-OH), 5.98 (d, $J_{1'-2'}$=9.47 Hz, 1H, H-1'), 7.30 (d, 1H, CH), 7.98 (d, 1H, CH); m/z 296 (Found: C, 53.0; H, 5.6; N, 9.6. $C_{13}H_{16}N_2O_6$ requires C, 52.7; H, 5.4; N, 9.5 %).

7g: m.p. 208^{o}C, yield 84 %. IR 3600-3250, 2220 cm^{-1}; ^{1}H NMR δ 1.86 (s, 3H, CH_3), 2.26 (s, 3H, CH_3), 3.28-3.80 (m, 6H, H-6', 6", H-5', H-4', H-3'

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and H-2'), 4.56 (d, 2H, 2'-OH and 3'-OH), 4.94 (d, 1H, 4'-OH), 5.38 (d, 1H, 6'-OH), 5.58 (d, $J_{1'-2'}$ = 10.75 Hz, 1H, H-1'), 7.95 (s, 1H, CH); m/z 326 (Found: C, 51.8; H, 5.6; N, 8.8. $C_{14}H_{18}N_2SO_5$ requires C, 51.5; H, 5.5; N, 8.6 %).

7h: m.p. 197°C, yield 82 %. IR 3521-3367, 2215 cm^{-1}; ^1H NMR δ 3.24-3.76 (m, 6H, H-6', 6", H-5', H-4', H-3' and H-2'), 4.44 (d, 2H, 2'-OH and 3'-OH), 4.96 (d, 1H, 4'-OH), 4.35 (d, 1H, 6'-OH), 5.56 (d, $J_{1'-2'}$ = 11.09 Hz, 1H, H-1'), 7.20 (d, 1H, CH), 7.27-7.80 (m, 5H, C_6H_5), 8.10 (d, 1H, CH); m/z 374 (Found: C, 58.1; H, 4.9; N, 7.8. $C_{18}H_{18}N_2SO_5$ requires C, 57.8; H, 4.8; N, 7.5 %).

7i: m.p. 248°C, yield 85 %. IR 3449-3190, 2219 cm^{-1}; ^1H NMR δ .22-3.88 (m, 6H, H-6',6", H-5', H-4', H-3' and H-2'), 4.66 (m, 2H, 2'-OH and 3'-OH), 5.02 (d, 1H 4'-OH), 5.40 (d, 1H, 6'-OH), 5.60 (d, $J_{1'-2'}$ = 10.08 Hz, 1H, H-1'), 7.61 (d, 2H, Ar-H), 7.88 (d, 1H, CH), 8.30 (m, 2H, Ar-H and 1H, CH); m/z 409 (Found: C, 53.2; H, 4.4; N, 6.9. $C_{18}H_{17}ClN_2SO_5$ requires C, 52.9; H, 4.2; N, 6.9 %).

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