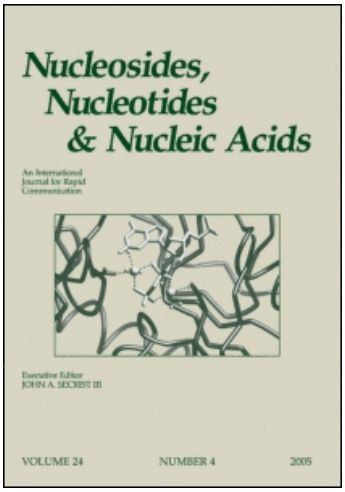

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REACTION OF GLYCOSYL ISOTHIOCYNATES WITH 3-INDOLYLAMINOMETHYL-KETONE HYDROCHLORIDE

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ABSTRACT

Reaction of glycosyl isothiocyanate **1a-c** with 3-indolylaminomethyl-ketone hydrochloride(**2**) yielded glycosylthiourea derivatives **3a-c**. Cyclodehydration of **3a-c** with acetic anhydride afforded 5-(indol-3-yl)-2-[N-per-O-acetyl-D-glycopyranosyl)amino]thiazoles **4a-c**. Deacetylation of **4a-c** gave 5-(indol-3-yl)-2-[N-(D-glycopyranosyl) amino] thiazoles **5a-c**.

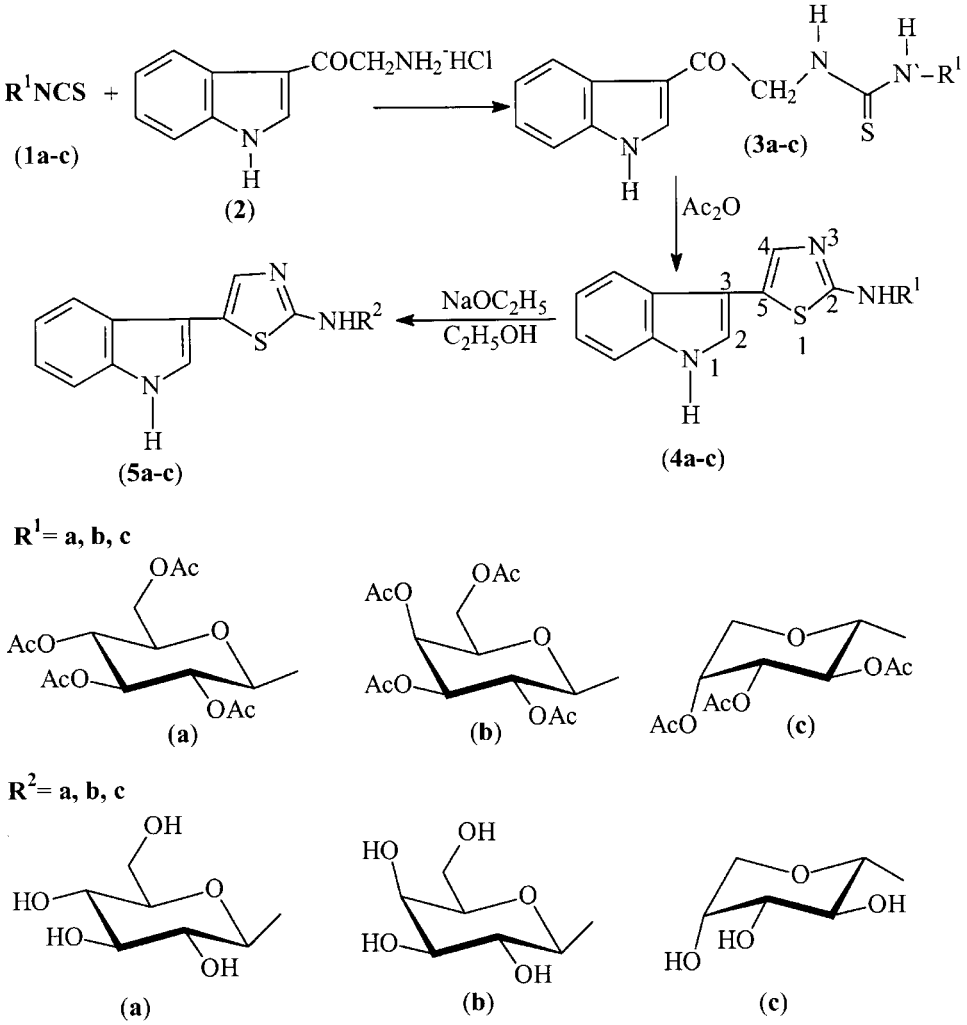
Key Words: Glycosyl isothiocyanates; 3-Indolylaminomethyl-ketone hydrochloride; Glycosylthiourea derivatives; Glycosylaminothiazole derivatives

INTRODUCTION

Isothiocyanates are versatile starting materials in synthesis, as they readily undergo cyclo and nucleophilic additions.[1] The glycosyl isothiocyanates and glycosylthioureas are valuable and versatile intermediates in the construction of N-nucleosides and glycosyl-aminoheterocycles,[2,3] with potential pharmaceutical properties.[4,5] Our interest in this field prompted the synthesis of several glycosylaminoheterocycle[6–10] which have exhibit antiproliferative activities against a wide variety of cancer cells. The present work aims to synthesize some new N-glycosides analogues using glycosyl isothiocyanate as starting materials. This should be beneficial for the synthesis analogues with potentially useful pharmacological properties.

RESULTS AND DISCUSSION

Treatment of 2,3,4,6-tetra-O-acetyl-β-D-glucopyranosyl isothiocyanate (**1a**),[11] 2,3,4,6-tetra-O-acetyl-β-D-galactopyranosyl isothiocyanate (**1b**)[11] or 2,3,4-tri-O-acetyl-α-D-arabinopyranosyl isothiocyanate (**1c**)[11] with 3-indolylaminomethyl-ketone hydrochloride (**2**)[12] gave N-(3-acetyl-indolyl)-N′-(2′,3′,4′,6′-tetra-O-acetyl-β-D-glucopyranosyl)thiourea (**3a**), N-(3-acetylindolyl)-N′-(2′,3′,4′,6′-tetra-O-acetyl-β-D-galactopyranosyl)thiourea (**3b**) and N-(3-acetylindolyl)-N′-(2′,3′,4′-tri-O-acetyl-α-D-arabinopyranosyl)thiourea (**3c**), respectively, Scheme 1.



Scheme 1.

Analytical IR, ^{1}H and ^{13}C NMR and mass spectra data of the obtained thioureas **3a-c** were consistent with the proposed structure (see Experimental section). The IR spectra of compounds **3a-c** showed absorption bands at 3455–3445 cm^{-1} (NH indole), 1225–1220 (C=S), 1752–1742 (CO ester), 1685–1675 (CO Ketone) and the absorption bands at 915–900 and 770–760 cm^{-1} region are characteristic for asymmetrical and symmetrical vibrations of the pyranose ring.[13]

The ^{1}H NMR spectra of compounds **3a** and **3b** showed signals at δ 5.75 and 5.72 (anomeric protons), respectively. The spin-spin coupling constant at C1′ and C2′ of the carbohydrate residue ($J_{1',2'} = 9.0$ Hz and 8.5 Hz respectively), indicates the β-configuration and $^4C_1$ (D) conformation[14–16] of **3a** and **3b**. The configuration in **3c** was α in $^1C_4$(D) conformation[14–16] ($J_{1',2'} = 8.2$ Hz).

The ^{13}C NMR spectrum of the compound **3a**, in which signals at 52.2, 182.5 and 193.5 ppm correspond to the (CH_2), (C=S) and (C=O), respectively.

The data from mass spectrometry also confirm the structure of thiourea derivatives **3a-c**. In their mass spectra showed the molecular ion peak [M^+] and showed peaks due to the sequential explusion of thiourea moiety, AcOH and CH_2CO fragment (see experimental), characteristic of glycosylthiourea derivatives,[17] were observed.

The glycosylaminoheterocycles analogue 5-(indol-3-yl)-2-[N-(2′,3′,4′,6′-tetra-O-acetyl-β-D-glucopyranosyl)amino]thiazole (**4a**), 5-(indol-3-yl)-2-[N-(2′,3′,4′,6′-tetra-O-acetyl-β-D-galactopyranosyl)amino]thiazole (**4b**) and 5-(indol-3-yl)-2-[N-(2′,3′,4′-tri-O-acetyl-α-D-arabinopyranosyl)amino]thiazole (**4c**) were quantitatively prepared by cyclodehydration of **3a-c** with acetic anhydride. The structure of the obtained glycosides **4a-c** were confirmed by the data from IR, elemental analysis and mass spectrometry and by their NMR spectra (see experimental section). The IR spectra of **4a-c** showed no (C=O) bands at 1685–1675 cm^{-1} and no (C=S) bands at 1225–1220 cm^{-1} but (C=N) bands at 1640–1630 cm^{-1} were observed. Their ^{1}H-NMR spectra showed singlet at δ 7.20–7.34 (H-4 of thiazole ring) that were similar to those for glycosylaminothiazoles[18] and simple arylaminothiazoles.[19] The configuration in compounds **4a** and **4b** were β in $^4C_1$(D) conformation[14–16] ($J_{1',2'} = 8.5$ Hz for **4a** and 9.3 Hz for **4b**), but configuration in compound **4c** was α in $^1C_4$ conformation[14–16] ($J_{1',2'} = 10.0$ Hz for **3c**). The ^{13}C NMR spectra of **4a-c** showed disappearance of (CH_2), (C=O) and (C=S) bands which were replaced by signals at 126.8–127.5, 132.8–134.1 and 166.8–168.3 ppm which were assigned to C-4, C-5 and C-2 of the thiazole ring[20] respectively. The established structure also agrees with the data from mass spectra of compounds **4a-c**, in which strong peaks are observed for the molecular ion [M^+]. Direct cleavage of the glycosidic bond produced m/z 215 (Hetero-NH_2^+) and the normal carbohydrate fragment at m/z 331 (for **4a** and **4b**) and 259 (for **4c**) (see experimental section).

Deacetylation of compounds **4a-c** by the Zemplen method[21] gave the fully deprotected glycosides **5a-c** in excellent yield. The IR spectra of compounds **5a-c** showed disappearance of (C=O ester) bands at 1755–1749 cm^{-1}. The configuration and conformation of the sugar moiety in **5a** and **5b** has been shown to be β configuration in $^4C_1$ (D) conformation[14–16] by the value of coupling constants ($J_{1',2'} = 8.5$ Hz for **5a** and 9.2 Hz for **5b**) but in **5c** has been shown to be α configuration in $^1C_4$(D) conformation[14–16] ($J_{1',2'} = 7.9$ Hz for **5c**).

EXPERIMENTAL

Melting points (uncorrected) were recorded in open capillaries using electrothermal melting MEL-TEMP apparatus. The IR spectra were recorded in vaseline oil with a Perkin Elmer 457 instrument. ^1H and ^{13}C NMR spectra were recorded with a Varian. XL-200 instrument at 200 MHz for ^1H and 60 MHz for ^{13}C measurements using TMS as internal standard. Elemental analyses were obtained from the centeral laboratory service of microanalysis, Cairo University. The mass spectra were obtained with a Varian MAT-311 instrument. For analysis by TLC silufol were used and the following solvent systems: A) benzene:acetone (3:1). B) 2-Propanol: benzene:25% ammonia (10:5:2) Ehrilchs reagent was used as developer.

N-(3-Acetylindolyl)-N′-(2′,3′,4′,6′-tetra-O-acetyl-β-D-glucopyranosyl) thiorea (3a). A solution of indolyl-3-aminomethyl ketone hydrochloride (**2**) (210 mg 1 mmol in water (2.5 mL was neutralised with sodium hydrogen carbonate (84 mg 1 mmole) and added to a solution of 2,3,4,6-tetra-O-acetyl-β-D-glucopyranosyl isothiocyanate **1a** (390 mg, 1 mmole) in xylene (10 mL). The resulting solution was kept at room temperature until TLC showed no presence of the starting materials (2 h). The solution was evaporated to dryness under diminished pressure and the residue triturated with dry ether and crystallized from ethanol to give compound **3a** (410 mg 73.2% yield); m.p. 171–173°C. IR : 3445 (NH-indole), 3155 (NH-C=S) 1222 (C=S), 1745 (CO ester) and 1675 (CO ketone) cm^{-1}. ^1H NMR ($CDCl_3$):δ 2.04, 2.05, 2.07 and 2.07 (4s, 12H, 4Ac), 5.75 (t, 1H, β anomeric proton $J_{1',2'} = 9.0$ Hz), 5.21 (t, 1H, H-2′, $J_{2',3'} = 9.2$ Hz), 5.44 (t, 1H, H-3′, $J_{3',4'} = 9.2$ Hz), 5.17 (t, 1H, H-4′, $J_{4',5'} = 9.2$ Hz), 4.00 (m, 1H, H-5′), 4.03–4.45 (m, 2H, H-6′ and H-6″), 5.05 (d, 2 H, CH_2, $J_{gem} = 18.0$ Hz), 11.85 (s, 1H, NH-indole), 7.42 (d, 1H, N′H), 7.50 (t, 1H, NH), 7.15–8.14 (m, 5H, CH of indole ring). ^{13}C MNR($CDCl_3$): δ 20.4, 20.5, 20.6 and 20.7 ($4CH_3$), 170.6–173.7 (4 CO ester), 52.2 (CH_2), 182.5 (C=S), 193.5 (CO ketone), 122.1, 127.5, 134.5 and 139.5 (4C, C-5, C-7a, C-3a, C-2, of indole), 104.3, 108.2, 115.5 and 130.7 (4C C-7, C-6, C-4, C-3, of indole), 83.4 (β C-1′), 61.7, 68.7,70.5, 72.7 and 73.7 (β C-6′, C-4′, C-2′, C-3′ and C-5′). Mass spectrum :

m/z 563 (8, M^+), 545 (12, M^+—H_2O), 530 (6, M^+-SH), 331 (24, glucopyranosyl acetate, S^+), 233 (15, Heterothiourea, $C_{11}H_{11}N_3OS^+$), 271 (3, 331-AcOH), 229 (2, 271 - CH_2CO), 187 (2, 229 - CH_2CO), 127 (7, 187 - AcOH), 43 (100, Ac^+).

Anal. Calcd for $C_{25}H_{29}O_{10}N_3S$ (563.21): C, 53.29; H, 5.15; N, 7.46; S, 5.68. Found: C, 52.99; H, 5.37; N, 7.72; S, 6.10.

N-(3-Acetylindolyl)-N′-(2′,3′,4′,6′-tetra-O-acetyl-β-D-galactopyranosyl)thiourea (3b). Similarly to compound **3a** from 210 mg of **2** and 390 mg of **1b** was obtained 370 mg (65% yield) of the compound **3b**, m.p. 105–107°C (from benzene). IR : 3447 (NH-indole), 3152 (NH-C=S), 1225 (C=S), 1746 (CO ester), and 1672 (CO Ketone) cm^{-1}. ^1H NMR ($CDCl_3$) : δ 2.03, 2.05, 2.07 and 2.13 (4 s, 12H, 4Ac), 5.72 (t, 1H, β anomeric proton, $J_{1',2'} = 8.5$ Hz), 5.35 (dd, 1H, H-2′, $J_{2',3'} = 9.4$ Hz), 5.24(dd, 1H, H-3′, $J_{3',4'} = 3.6$ Hz), 5.60(d, 1H, H-4′, $J_{4',5'} = 2.7$ Hz), 4.95 (t, 1H, H-5′, $J_{5',6'} = 6.4$ Hz), 3.80–4.45 (m, 2H, H-6′ and H-6″), 12.00 (s, 1H, NH-indole), 7.46 (t, 1H, NH), 7.12 (d, 1H, N′H), 5.03 (d, 2H, CH_2, $J_{gem} = 17.0$ Hz), 7.13–8.16 (m, 5H, CH of indole ring). ^{13}C NMR($CDCl_3$): δ 82.9 (β, C-1′), 62.4, 67.2, 68.5, 72.2 and 74.1 (β, C-6′, C-4′, C-2′, C-3′, C-5′), 20.6, 20.6, 20.5 and 21.2 (4 CH_3), 169.3, 169.8, 170.2 and 170.5 (4CO ester), 51.9 (CH_2), 183.1 (C=S), 194.2 (C=O), 123.0, 126.4, 133.2 and 137.8, (4C, C-5, C-7a, C-3a, C-2 of indole), 103.5, 110.1, 116.2 and 131.0 (4C, C-7, C-6, C-4, C-3, of indole). Mass spectrum : *m/z*, 564 (3, M^++1), 530 (5, M^+-SH), 331 (17, galactopyranosyl acetate, S^+), 271 (5, 331 - AcOH), 233 (12, Heterothiourea, $C_{11}H_{11}N_3OS^+$), 60 (100, $AcOH^+$), 43 (70, Ac^+).

Anal. Calcd for $C_{25}H_{29}O_{10}N_3S$ (563.21) : C, 53.29; H, 5.15; N, 7.46; S, 5.68. Found: C, 52.97; H, 5.32; N, 7.66; S, 6.02.

N-(3-Acetylindolyl)-N′-(2′,3′,4′-tri-O-acetyl-α-D-arabinopyranosyl)thiourea (3c). Compound **3c** was obtained as a colourless syrup similarly to compound **3a** from 210 mg of **2** and 320 mg of **1c** in 48% yield (240 mg). IR: 3442 (NH-indole), 3148 (NH-C=S), 1221 (C=S), 1742 (CO ester), and 1672 (CO ketone) cm^{-1}. ^1H NMR (DMSO-d_6): δ 2.04, 2.06 and 2.17 (3s, 9H, 3Ac), 5.55 (t, 1H, α anomeric proton, $J_{1',2'} = 8.2$ Hz), 5.25 (d, 1H, H-2′, $J_{2',3'} = 8.4$ Hz), 5.19 (m, 1H, H-3′, $J_{3',4'} = 3.0$ Hz), 5.14 (m, 1H, H-4′, $J_{4',5'} = 2.3$ Hz), 4.02 (q, 1H, H-5e′), 3.75 (q, 1H, H-5a′), 5.04 (d, 2H, CH_2, $J_{gem} = 18.0$), 7.15 (bs, 1H, N′H), 7.82 (t, 1H, NH) and 7.10–8.15 (m, 5H, indole ring). ^{13}C NMR(DMSO-d_6): δ 20.1, 20.3 and 20.6 (3C, 3 CH_3), 168.8, 169.0 and 169.36 (3 CO ester), 52.6 (CH_2), 182.4 (C=S), 192.6 (C=O ketone), 81.4 (α, C-1′), 62.4, 66.1, 68.6 and 68.6 (α, C-5′, C-2′, C-3′, C-4′), 128.4, 129.1, 134.0 and 140.4 (4C, C-7a, C-5, C-3a, C-2 of indole ring), 105.1, 108.2, 113.5 and 117.7, (4C C-7, C-6, C-4, C-3, of indole ring). Mass spectrum : *m/z*, 491 (7, M^+), 473 (4, M^+-H_2O), 259 (21, arabinopyranosyl acetate, S^+),

233 (10, Heterothiourea, $C_{11}H_{11}N_3OS^+$), 199 (8, 259-AcOH), 139 (12, 199 - AcOH), 97 (13, 139 - CH_2O), 69(21, 97 - CO), 60 (100, $AcOH^+$), 43 (60, Ac^+).

Anal. Calcd for $C_{22}H_{25}N_3O_8S$: (491.20) C,53.77; H, 5.09; N, 8.55; S, 6.52. Found: C, 53.24; H, 5.25; N, 8.16; S, 6.84.

5-(Indol-3-yl)-2-[N-(2′,3′,4′,6′-tetra-O-acetyl-β-D-glucopyranosyl)-amino]thiazole (4a). The corresponding glucosylthiourea derivative **3a** (281 mg 0.50 mmole) was suspended on a mixture of dry ethanol (7 mL) and acetic anhydride (5.8 mL). The suspension was heated 50°C for 5 h and then concentrated to dryness in vacuum. The oily substance was extracted with chloroform, the extract layer was washed with water, dried under $MgSO_4$, evaporated and the residue was crystallized from ethanol to give compound **4a** (190 mg 69.8%), m.p. 122–124°C. IR : 3450 (NH-indole), 3275 (-NH), 1755 (CO ester), 1630 (C=N) cm^{-1}. ^1H NMR (DMSO-d_6) : δ 12.00 (s, 1H, indole NH), 6.25 (s, 1H, glucosidic NH), 2.02, 2.04, 2.06, and 2.07 (4 s 12 H, 4 Ac) 5.14 (t, 1H, β anomeric proton, $J_{1',2'} = 8.5$ Hz), 5.21 (t, 1H, H-2′, $J_{2',3'} = 8.5$ Hz), 5.07 (t, 1H, H-3′, $J_{3',4'} = 9.2$ Hz), 5.04 (t, 1H, H-4′, $J_{4',5'} = 9.7$ Hz), 3.90 (m, 1H, H-5′, $J_{5',6'} = 5.3$ Hz, 4.35 (dd, 1H, H-6′, $J_{5',6''} = 1.9$ Hz), 4.12 (dd, 1H, H-6″, $J_{6',6''} = 12.4$ Hz), 7.20 (s, 1H, H-4 of thiazole ring), 7.18–8.17 (m, 5 H, CH indole ring). ^{13}C NMR(DMSO-d_6): δ, 20.2, 20.2, 20.3, 20.5 (4C, 4 CH_3), 169.0, 169.2, 170.4 and 171.2 (4C, 4 CO), 89.5 (β, C-1′), 62.4, 68.2, 70.6, 72.7 and 73.8 (C-6′, C-4′, C-2′, C-3′, C-5′), 124.1, 129.2, 136.5 and 140.2, (4C, C-5, C-7a, C-3a, C-2 of indole) 106.3, 109.0,117.5, and 131.1 (4C, C-7, C-6, C-4, C-3, of indole), 127.7, 133.5 and 167.2 (3C, C-5, C-4, C-2 of thiazole ring). Mass spectrum : *m/z*, 545 (8, M^+), 485 (12, M^+ - AcOH), 331 (15, glucopyranosyl acetate, S^+), 215 (22, Hetero-NH_2^+, $C_{11}H_9N_3S^+$), 60 (45, $AcOH^+$), 43 (100, Ac^+).

Anal. Calcd for $C_{25}H_{27}N_3O_9S$ (545.22) : C, 55.06 ; H, 4.95; N, 7.71. Found: C, 54.65; H, 5.36; N, 7.49.

5-(Indol-3-yl)-2-[N-(2′,3′,4′,6′-tetra-O-acetyl-β-D-galactopyrano-syl)amino]thiazole (4b). Compound **4b** was prepared in the same manner as described for **4a**, using compound **3b** (281 mg 0.50 mmole) and the reaction was monitored by TLC (t 7 h and the product was crystallized from absolute. ethanol (150 mg, 55%), m.p. 132–134°C. IR : 3448 (NH-indole), 3195 (galactosidic bond NH), 1749 (CO ester) and 1640 (C=N) cm^{-1}. ^1H NMR (DMSO-d_6) : δ 11.85 (s, 1H, NH-indole), 6.17 (s, 1H, glycosidic NH), 1.98, 2.00, 2.04 and 2.17 (4 s, 12 H, 4Ac), 5.13 (t, 1H, β anomeric proton, $J_{1',2'} = 9.3$ Hz), 5.26 (dd, 1H, H-2′, $J_{2',3'} = 8.9$ Hz), 5.19 (dd, 1H, H-3′, $J_{3',4'} = 2.8$ Hz), 5.46 (d, 1H, H-4′, $J_{4',5'} = 2.3$ Hz), 4.07–4.18 (m, 3H, H-5′, H-6′, H-6″), 7.34 (s, 1H, H-4 of thiazole ring) and 7.22 – 8.19 (m, 5H, CH indole ring).^{13}C NMR(DMSO-d_6): δ 20.4 (2C, 2 CH_3), 20.6, 20.6 (2C, 2CH_3), 169.0, 169.5, 170.4 and 171.2 (4C 4CO), 90.2 (β, C-1′), 61.2, 66.1, 68.4,

71.9 and 74.0 (β C-6′, C-4′,C-2′, C-3′, C-5′), 127.7, 134.5, and 166.8 (3C, C-5, C-4, C-2, of thaizole ring), 125.0, 128.8, 136.5 and 139.8 (4C, C-5, C-7a, C-3a, C-2 of indole ring) and 105.4, 108.9, 117.5 and 131.0 (4C, C-7, C-6, C-4, C-3, of indole ring). Mass spectrum : m/z 527 (10, M^+-H_2O), 331 (12, galacto-pyranosyl acetate, S^+), 215 (17, Hetero-NH_2^+, $C_{11}H_9N_3S^+$), 60 (45, $AcOH^+$) and 43 (100, Ac^+).

Anal. Calcd. for $C_{25}H_{27}N_3O_9S$ (545.22) : C, 55.06; H, 4.95; N, 7.71; Found: C, 55.27; H, 4.67; N, 7.50.

5-(Indol-3-yl)-2-[N-(2′,3′,4′-tri-O-acetyl-α-D-arabinopyranosyl)amino] thiazole (4c). Compound **3c** (245 mg, 0.50 mmole) was treated with acetic anhydride to give compound **4c** as described for compound **3a** and the reaction was monitored by TLC (t 10 h). Compound **4c** (125 mg, 53 %) was colourless syrup. IR : 3445 (NH-indole), 3241 (glycosidic NH), 1752 (CO ester) and 1632 (C=N) cm^{-1}. ^1H NMR (DMSO-d_6) : δ, 12.00 (s, 1H, NH indole), 6.25 (s, 1H, glycosidic NH), 2.04, 2.05, 2.16 (3 s, 9H, 3Ac), 5.04 (d, 1H, α anomeric proton, $J_{1',2'} = 10.0$ Hz), 5.20 (d, 1H, H-2′ $J_{2',3'} = 9.7$ Hz), 5.15 (m, 1H, H-3′, $J_{3',4'} = 3.2$ Hz), 5.10 (m, 1H, H-4′, $J_{4',5'} = 2.3$ Hz), 3.98 (q, 1H, H-5′e), 3.02 (q, 1H, H-5′a, $J_{5a',5e'} = 12.7$ Hz), 7.31 (s, 1H, H-4 of thiazole ring) and 7.21–8.16 (m, 5H, CH of indole ring). ^{13}C NMR(DMSO-d_6): δ 20.2, 20.3, 20.4 (3C, $3CH_3$), 169.7, 169.7, 170.3 (3C, 3 CO), 88.6 (α, C-1′), 67.1, 69.9, 72.0 and 75.0, (α C-5′, C-4′, C-3′, C-2′), 126.8, 134.3 and 165.8, (3C, C-5, C-3, C-2 of thiazole ring), 128.4, 129.1, 134.0 and 141.4, (4C, C-7a, C-5, C-3a, C-2, of indole ring) and 105.1, 108.2, 113.5 and 117.7 (4C, C-7, C-6, C-4, C-3 of indole ring). Mass spectrum: m/z 473 (8, M^+), 440 (6, M^+-SH), 259 (28, arabinopyranosyl acetate, S^+), 215 (19, Hetero-NH_2^+), 199 (12, 259-AcOH), 139 (10, 259 – 2 AcOH) and 60 (62, $AcOH^+$).

Anal. Calcd for $C_{22}H_{23}N_3O_7S$ (473.21) : C, 55.81; H, 4.86; N, 8.88. Found: C, 55.70; H, 4.99; N, 8.50.

5-(Indol-3-yl)-2-[N-(β-D-glucopyranosyl)amino]thiazole (5a). To a solution of **4a**(150 mg, 0.28 mmole) in 20 mL of absolute ethanol was added 2 mL of a 2N solution of sodium ethoxide in ethanol. The mixture was left at room temperature (25°C) for 8 h, after which it was treated to pH 6 with Dowex-50 (H^+) ion exchange resin and filtered. The filtrate was evaporated to dryness, the residue triturated with dry ether (3×10 mL) and crystallized from ethanol to give compound **5a** (95 mg 92.20%) m.p. 157–159°C. I.R. : 3448 (NH indole), 3215 (NH, OH) and 1637 (C=N) cm^{-1}. ^1H NMR ($CDCl_3$): δ, 4.57 (t, 1H, β-anomeric proton, $J_{1',2'} = 8.5$ Hz), 3.20 – 4.00 (m, 6H, glucosyl protons), 7.18 (s, 1H, H-4 of thiazole ring) and 7.16 – 8.15 (m, 5H, CH of indole ring).

Anal. Calcd for $C_{17}H_{19}N_3O_5S$ (377.18) : C, 54.11; H, 5.04; N, 11.14. Found: C, 53.77; H, 5.18; N, 11.28.

5-(Indol-3-yl)-2-[N-(β-D-galactopyranosyl)amino]thiazole (5b). The compound was obtained similarly from **4b** (150 mg, 0.28 mmole). The product crystallized from ethanol (86 mg, 83.5%), m.p. 141–142°C. IR : 3458 (NH indole), 3232 (NH, OH) and 1642 (C=N) cm^{-1}, 1H NMR ($CDCl_3$), 4.58 (t, 1H, β-anomeric proton, $J_{1',2'} = 9.2$ Hz), 3.10–3.86 (m, 6H, galactosyl protons), 7.20 (s, H-4 of thiazole ring) and 7.18–8.18 (m, 5H, CH of indole ring).

Anal. Calcd for $C_{17}H_{19}N_3O_5S$ (377.18) : C, 54.11; H, 5.04; N, 11.14. Found: C, 53.85; H; 5.16; N; 11.04.

5-(Indol-3-yl)-2-[N-(α -D-arabinopyranosyl)amino]thiazole (5c). Similar treatment of **4c** (122 mg, 0.28 mmole) with sodium ethoxide in dry ethanol to give compound **5c** as colourless syrup (70 mg 78.7% yield). IR: 3448 (-NH indole) 3192 (NH, OH) and 1642 (C=N) cm^{-1}. ^{1}H-NMR ($CDCl_3$) : δ, 4.55 (t, 1H, α-anomeric proton, $J_{1',2'} = 7.9$ Hz), 3.56–4.21 (m, 5H, arabinosyl protons) 7.21 (s, 1H, H-4 of thiazole ring) and 7.17–8.19 (m, 5H, CH of indole ring).

Anal. Calcd for $C_{16}H_{17}N_3O_4S$ (347.18) : C, 55.33; H, 4.90; N, 12.10. Found: C, 55.54; H, 4.61; N, 12.28.

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