CHAPTER - 1

Synthesis of 1 - Tetra - O - benzoyl - β - D - glucopyranosyl - 3 - aroyl(II) thiocarbamides and their Antimicrobial study.

Abstract: Certain tetra - O - benzoyl - β - D - glucopyranosyl - 3 - aroyl(II) thiocarbamides (III) have been prepared by the interaction of 1 - tetra - O - benzoyl - β - D - glucopyranosyl isothiocyanate (I) and aroyl amines and ammonia (II). The identities of these new N - glucosides have been established on the basis of usual chemical transformations and IR, NMR and Mass spectral studies. These compounds were screened for their Antibacterial and Antifungal activities against E. coli, S. aureus, P. vulgaris, Pseudomonas, Bacillus, Salmonella, A. niger and Fusarium.

As already observed earlier (See General Introduction Page - 1 ) that very few thioamido group containing compounds having D - glucopyranosyl substituent on nitrogen have been prepared earlier. In view of our interest in the synthesis of N - glucosylated thioamido group containing compounds a synthetic method has been evolved for the synthesis of monosubstituted and 1, 3 - disubstituted thiocarbamides (In which one of the substituent is D - glucopyranosyl group). The present chapter describes these syntheses.

In the synthesis of such N - glucosylated compounds tetra - O - benzoyl - β - D - glucopyranosyl isothiocyanate (I) has been used as an intermediate. The earlier method reported for the preparation of tetra - O - benzoyl - β - D - glucopyranosyl isothiocyanate involved the use of silver thiocyanate. This method has been a costly one and therefore, some cheaper method of preparation of tetra - O - benzoyl - β - D - glucopyranosyl isothiocyanate was needed. This was realised by the interaction of tetra - O - benzoyl - α - D - glucopyranosyl bromide and lead thiocyanate.

Interaction of tetra - O - benzoyl - α - D - glucopyranosyl bromide and lead thiocyanate in boiling sodium dried xylene medium has been carried out for 3 hr. with frequent shaking. After the removal of liberated lead bromide the xylene filtrate was mixed with petroleum ether (60-80°) when tetra - O - benzoyl - β - D - glucopyranosyl isothiocyanate was precipitated out. It was purified by dissolving it in minimum quantity of ethanol and reprecipitating with water. The reaction may be stated as follows.
Tetra - O - benzoyl - α - D glucopyranosyl bromide.

Interaction of tetra - O - benzoyl - β - D glucopyranosyl isothiocyanate (I) and p - toluidine (IIa) has been carried out in boiling benzene medium for 3 hr. The solvent benzene was distilled off and sticky mass was isolated as residue. This when triturated several times with petroleum ether was converted to a granular solid. Crystallised from alcohol-water, m.p. 115°. The elemental analysis indicated the molecular formula of the product as C_{42}H_{36}O_{9}N_{2}S.

**Examination of the product with M.P. 115° (C_{42}H_{36}O_{9}N_{2}S).**

i) **Solubility:** The compound was insoluble in water and petroleum ether. However, it was found highly soluble in acetone, chloroform, benzene and moderately soluble in ethanol and acetic acid.

ii) **Action of alkaline plumbite solution:** On boiling with alkaline plumbite solution a black precipitate of lead sulphide was obtained.

iii) **Action of conc. sulphuric acid:** On boiling with sulphuric acid it charred indicating the presence of glucosyl group.

iv) **Reaction with benzyl chloride:** The product on refluxing with benzyl chloride in ethanol medium for 90 min. followed by treatment with dilute ammonium hydroxide afforded a free base of S - benzyl - 1 - tetra - O - benzoyl - β - D glucopyranosyl - 3 - p - tolyl isothiocarbamide M.P. 125°. It was found non desulphurisable when boiling with alkaline plumbite solution.

v) **Polarimetry:** The compound was found to be optically active and its specific rotation^4^, $\left[\alpha\right]_D^{34} = +39.89^\circ$ (c, 0.752, chloroform).

vi) **IR, NMR and Mass spectral studies:** The infrared spectral analysis of the product indicated the presence of vNH, vC = O, vC = N, vC = S, vMethyl C - H, vAromatic and band due to deformation vibration of β - D - glucopyranosyl ring^5^ - 14. The NMR spectrum displayed signals due to N-H proton, aromatic protons, Methyl protons and also those for protons of pyranose ring^13^ - 16. (See experi-
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Amines</th>
<th>1 - tetra - O - benzoyl - β - D - glucopyranosyl - 3 - aryl(H) thiocarbamides (III)</th>
<th>Yield %</th>
<th>M.P. °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>p - Toluidine.</td>
<td>--- 3 - p - tolyl - thiocarbamidine (IIIa)</td>
<td>57.14</td>
<td>115</td>
</tr>
<tr>
<td>2</td>
<td>o - Toluidine.</td>
<td>--- 3 - o - tolyl - thiocarbamidine (IIIb)</td>
<td>68.02</td>
<td>109</td>
</tr>
<tr>
<td>3</td>
<td>m - toluidine.</td>
<td>--- 3 - m - tolyl - thiocarbamidine (IIIc)</td>
<td>62.02</td>
<td>142</td>
</tr>
<tr>
<td>4</td>
<td>Aniline.</td>
<td>--- 3 - phenyl thiocarbamidine (IIId)</td>
<td>69.25</td>
<td>120</td>
</tr>
<tr>
<td>5</td>
<td>o - Cl - Aniline.</td>
<td>--- 3 - o - Cl - Phenyl thiocarbamidine (IIIE)</td>
<td>52.91</td>
<td>135</td>
</tr>
<tr>
<td>6</td>
<td>m - Cl - Aniline.</td>
<td>--- 3 - m - Cl - Phenyl thiocarbamidine (IIIe)</td>
<td>66.13</td>
<td>100</td>
</tr>
<tr>
<td>7</td>
<td>p - Cl - Aniline.</td>
<td>--- 3 - p - Cl - Phenyl thiocarbamidine (IIIF)</td>
<td>69.33</td>
<td>127</td>
</tr>
<tr>
<td>8</td>
<td>α - Naphthyl.</td>
<td>--- 3 - α - Naphthyl thiocarbamidine (IIIG)</td>
<td>75.32</td>
<td>150</td>
</tr>
<tr>
<td>9</td>
<td>Ammonia.</td>
<td>--- 3 - (H) - thiocarbamidine (IIII)</td>
<td>72.02</td>
<td>135</td>
</tr>
</tbody>
</table>
mental part. Page 47). On the basis of all the above facts the product with M. P. 115° was assigned the structure 1-tetra-O-benzoyl-β-D-glucopyranosyl-3-p-toly thiocarbamide (Ilia).

The reaction of tetra-O-benzoyl-β-D-glucopyranosyl isothiocyanate (I) was also extended to several other aryl amines/ammonia (II) and corresponding 1-tetra-O-benzoyl-β-D-glucopyranosyl-3-aryl(H) thiocarbamides, respectively (IIib-IIIi) (Table 1) have been isolated.

\[ \text{Tetra-O-benzoyl-β-D glucopyranosyl isothiocyanate} \]

\[ \text{1-tetra-O-benzoyl-β-D glucopyranosyl-3-substituted thiocarbamide.} \]

Where, Bz = Benzoyl = COC₆H₅.

\[ \text{Where,} \quad R = \ a) \ p\text{-toly,} \ b) \ o\text{-toly,} \ c) \ m\text{-toly,} \ d) \ \text{phenyl,} \ e) \ o\text{-Cl-phenyl,} \]

\[ \ f) \ m\text{-Cl-phenyl,} \ g) \ p\text{-Cl-phenyl,} \ h) \ α\text{-Naphthyl,} \ i) \ \text{hydrogen.} \]

Bz = COC₆H₅.
Antimicrobial activity:

Antibacterial activity:

All the compounds were screened for their antibacterial activity against various pathogenic bacteria such as *S. aureus*, *E. coli*, *P. vulgaris*, *Pseudomonas*, *Bacillus* and *Salmonella Sp.* by cup plate method\(^{20,21}\) at a concentration 100μg ml\(^{-1}\) in DMF by using the standard Co-Trimazine (25 μg ml\(^{-1}\)) for bacteria. Amongst the compounds tested for the antibacterial activity. The antibacterial activity of compounds IIIc, IIIe, IIIf and IIIg found higher for *S. aureus* while other compounds showed moderate activity. Against *E. coli* and *P. vulgaris* the compounds IIIc, IIIc, IIIf, IIIg and IIIh showed higher anti activity. While against *Bacillus*, *Pseudomonas* and *Salmonella Sp.* the compounds IIIa, IIIb, IIIe, IIIf, and IIIg showed good to moderate activity.

Antifungal activity:

All the compounds were also screened for their antifungal activities by cup plate method at a concentration 100 μg ml\(^{-1}\) in DMF by using the standard Griseofulvin (100 μg ml\(^{-1}\)) against *Aspergillus niger* and *Fusarium*. The compounds IIIc and IIIf showed good activity against *Fusarium* while other compounds found resistant against *Aspergillus niger*. 
EXPERIMENTAL PART

The reagents required for the reactions carried out in this chapter were prepared as follows:

I Preparation of tetra-<i>O</i>-benzoyl-<i>β</i>-<i>D</i>-glucopyranosyl isothioevanate:

This has been prepared by the interaction of tetra-<i>O</i>-benzoyl-<i>α</i>-<i>D</i>-glucopyranosyl bromide and lead thiocyante the former was prepared according to the procedure described earlier. Details of a typical preparation are as follows.

a) Preparation of glucose pentabenoate<sup>32</sup>:

In a 1-litre flange flask fitted with a multiple socket head carrying a mechanical stirrer, a calcium chloride guard tube, a 250 ml dropping funnel and a thermometer, 126 ml of dry pyridine and 105 ml of dry chloroform was taken. The flask was cooled in an ice-salt bath and from the dropping funnel, with stirring, was added a previously prepared cooled solution of 127 g (105 ml, 0.9 Mol) of benzoyl chloride in 105 ml of dry chloroform. The dropping funnel was removed and 50 g (0.28 Mol) of dry powdered D-glucose was added portion wise to the vigorously stirred benzoylating reagent at a rate which maintains the temperature of the reaction below 10°C. The pink-coloured solution was allowed to stand at 0°C for 24 hours, it was diluted with 400 ml chloroform and the solution was transferred to a 2-litre separatory funnel. The solution was washed several times with dilute aqueous sulphuric acid (2 M) followed by water then by saturated aqueous sodium hydrogen carbonate and finally with water. The solution was then dried over anhydrous sodium sulphate. Afterwards the chloroform was removed on rotary evaporator. Gave a yellow solid which was ground up with industrial spirit filtered and washed well with spirit. The solid was reccrystallised from acetone-water which gave a pure product. 

m.p. 184-186°C. [α]<sub>D</sub> <sup>20</sup> = + 184.4<sup>o</sup> (c, 1.75 in chloroform), yield (77%).

b) Preparation of brominating reagent<sup>32</sup>:

Glacial acetic acid (30 ml) was taken in a conical flask and to it was added red phosphorous (4.0 g). To this mixture molecular bromine (7 ml) was added gradually with constant shaking and cooling the resultant mixture was allowed to stand at ice cold temperature for about 30 min.

c) Synthesis of tetra-<i>O</i>-benzoyl-<i>α</i>-<i>D</i>-glucopyranosyl bromide:

The finely powdered D-glucopyranose pentabenoate (0.02 M; 14.0 g)
was added gradually to the brominating reagent. After the addition the contents of the flask was refluxed on low flame for 1.30 hr. Then it was kept overnight at room temperature. The reaction mixture was then mixed with carbon tetrachloride (30 ml) and then the mixture was shaken vigorously for about 15 min. The resultant mixture was poured into ice cold water. The carbon tetrachloride layer was then separated. It was washed several times with aqueous sodium bicarbonate to remove excess of acetic acid followed by aqueous sodium metabisulphite to remove excess of bromine and finally 2-3 times with water. The carbon tetrachloride on addition of petroleum ether afforded a solid (10.2g). This solid was the expected tetra- O - benzoyl - α - D - glucopyranosyl bromide. It was crystallised from ethanol, m.p. 125-129°. (lit., m.p. 129-130°c)22.

d) Preparation of lead thiocyanate:

Lead thiocyanate was prepared by mixing aqueous solution of lead nitrate and ammonium thiocyanate. The white granular lead thiocyanate was filtered washed with distilled water and dried at 50°.

Preparation of tetra- O - benzoyl - β - D - glucopyranosyl isothiocyanate:

To a solution of tetra- O - benzoyl - α - D - glucopyranosyl bromide (20 g) in sodium dried xylene (150 ml) was added lead thiocyanate (16 g). The reaction mixture was refluxed gently for 3 hr with frequent shaking. This solution was then cooled and the separated lead bromide was removed by filtration. The xylene filtrate was then treated with petroleum ether (60-80°) with stirring a white solid was obtained (14 g). This solid was the expected tetra- O - benzoyl - β - D - glucopyranosyl isothiocyanate. It was partially purified by dissolving it in minimum quantity of ethanol and reprecipitating with water m.p. 125°. [Found : C, 64.96, H, 4.09, N, 2.12, S, 4.98. C_{31}H_{27}O_{9}NS requires ; C, 65.86, H, 4.23, N, 2.19, S, 5.01%].

General characteristics of tetra - O - benzoyl - β - D - glucopyranosyl isothiocyanate:

It was found soluble in alcohol, acetone, chloroform, carbon tetrachloride and benzene while insoluble in water and petroleum ether. On boiling with an alkaline plumbite solution it was desulphurised. It charred when warmed with sulphuric acid.

As expected it reacted with ethyl alcohol and produced N - tetra - O -
benzoyl-β-D-glucopyranosyl ethyl thiocarbamate (see chapter II, page 68).

Its specific rotation, [α]D^24 = +136.18° (in chloroform, c, 1.028).

The main absorption bands observed in the IR spectrum of I (Fig. 1) are listed below.

<table>
<thead>
<tr>
<th>Absorption observed (cm⁻¹)</th>
<th>Assignment</th>
<th>Absorption expected (cm⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2056 (S)</td>
<td>Aromatic isothiocyanate R-N = C = S. C = O stretching in saturated esters.</td>
<td>2000 - 2250⁶⁺,⁹⁺,¹²⁺</td>
</tr>
<tr>
<td>1733 (S)</td>
<td>C = S stretching.</td>
<td>1750 - 1735⁵⁺,¹²⁺,¹³⁺,¹⁴⁺</td>
</tr>
<tr>
<td>1091</td>
<td>β - D - glucopyranosyl ring deformation.</td>
<td>1200 - 1050⁸⁺,⁹⁺</td>
</tr>
<tr>
<td>857</td>
<td></td>
<td>844 ± 8⁰¹⁰</td>
</tr>
</tbody>
</table>

The NMR spectrum of I (Fig. 2) distinctly displayed the signals due to protons of pyranosyl ring at δ4.2 - 4.6 and δ5.3 - 5.8 ppm¹³⁻¹⁵⁻¹⁶ and aromatic protons δ5.9 - 8.0 ppm¹⁴⁻¹⁶.

Interaction of I-tetra-O-benzoyl-β-D-glucopyranosyl isothiocyanate and aryl amines/ammonia: Formation of I-tetra-O-benzoyl-β-D-glucopyranosyl-3-aryl(H) thiocarbamides (II).

Synthesis of I-tetra-O-benzoyl-β-D-glucopyranosyl-3-p-tolyl thiocarbamide (IIa).

To a benzene solution of p-toluidine (0.01M, 1.07g in 20 ml) was added a solution of tetra-O-benzoyl-β-D-glucopyranosyl isothiocyanate (0.01 M, 6.3g in 40 ml benzene) and the reaction mixture was refluxed over a boiling water bath for 3 hr. After refluxing the solvent was distilled off and the sticky mass obtained as residue was triturated several times with petroleum ether.

A granular white solid, (4.1g) was obtained. Crystallised from ethanol-water, m.p. 115°. [Found: C, 66.92, H, 4.20, N, 3.09, S, 4.10, C_{42}H_{36}O_{9}N_{2}S. requires; C, 67.66, H, 4.83, N, 3.75, S, 4.29%].

The product was found soluble in alcohol, acetone, chloroform, carbon tetrachloride and benzene while insoluble in water and petroleum ether. It charred when warmed with conc. sulphuric acid. On boiling with alkaline plumbite solution desulphurisation was noticed. Its specific rotation [α]D^24 was found to be +39.89° (c, 0.752 in chloroform).
The main absorption bands observed in the IR spectrum of IIIa (Fig. 3) are listed below.

<table>
<thead>
<tr>
<th>Absorption observed (cm⁻¹)</th>
<th>Assignment</th>
<th>Absorption expected (cm⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3363</td>
<td>N-H stretching.</td>
<td>3500-3100⁶⁸,13</td>
</tr>
<tr>
<td>1728</td>
<td>C=O stretching in saturated esters.</td>
<td>1730-1715⁵₅,1₂,1₃,1₄</td>
</tr>
<tr>
<td>1269</td>
<td>C - N stretching.</td>
<td>1350-1280⁴₄</td>
</tr>
<tr>
<td>1099</td>
<td>C = S stretching.</td>
<td>1200-1050⁸₆,⁹₀</td>
</tr>
<tr>
<td>854</td>
<td>β-D- glucopyranosyl ring (deformation).</td>
<td>844 ± 8¹₀</td>
</tr>
<tr>
<td>806</td>
<td>Para aromatic (4 adjacent H)</td>
<td>800-900⁶₆</td>
</tr>
</tbody>
</table>

The NMR spectrum of IIIa (Fig-4) distinctly displayed the signals due to N - H proton at δ6.25 ppm⁸⁶,¹₃. Aromatic protons at δ8.1 - 6.8 ppm¹⁴,¹₅,¹₆. Methyl protons of p - tolyl at δ2.4 ppm and also showed signals due to protons of pyranosyl ring at δ4.2 - 4.5 and δ4.6 - 5.3 ppm¹³,¹₅,¹₆.

**Reaction with benzyl chloride:**

The product (7.4 g) was refluxed with benzyl chloride (1.2 g) in ethanolic medium for 90 min. It was cooled and basified with dilute ammonium hydroxide, a semisolid mass was obtained which on purification with ethanol water afforded a solid m.p. 125⁰C. The compound was non-desulphurisable with boiling alkaline plumbite solution. This has clearly indicated the formation of S-benzyl - 1 - tetra - O - benzoyl - β - D - glucopyranosyl - 3 - p - tolyl isothiocarbamide.

**Experiment No. 2: Formation of 1 - tetra - O - benzoyl - β - D - glucopyranosyl - 3 - o - tolyl thiocarbamide (IIIa).**

To a benzene solution of o - toluidine (0.01M, 1.07g in 20 ml) was added a solution of tetra - O - benzoyl - β - D - glucopyranosyl isothiocyanate (0.01 M, 6.3g in 40 ml benzene) and the reaction mixture was refluxed over a boiling water bath for 3 hr. After refluxing the solvent was distilled off and the sticky mass obtained as residue was triturated several times with petroleum ether. A granular white solid, (4.9g) was obtained. Crystallised from ethanol-water, m.p. 109⁰. [Found : C, 66.98, H, 4.50, N, 3.62, S, 4.2. C₄₂H₃₆O₃N₂S requires; C, 67.66, H, 4.83, N, 3.75, S, 4.29%].

The product was found soluble in alcohol, acetone, chloroform,
carbon tetrachloride and benzene while insoluble in water and petroleum ether. It charred when warmed with conc. sulphuric acid. On boiling with alkaline plumbite solution desulphurisation was noticed. Its specific rotation $[\alpha]_D^{34}$ was found to be $+78.12^\circ$ (c, 0.896 in chloroform).

**Experiment No. 3:** Formation of 1-tetra-O-benzoyl-β-D-glucopyranosyl-3-m-tolyl thiocarbamide (IIIc).

To a benzene solution of tetra-O-benzoyl-β-D-glucopyranosyl isothiocyanate (0.01 M, 6.3 g in 50 ml) was added m-toluidine (0.01 M 1.07 g) and reaction mixture was refluxed over a boiling waterbath for 3 hr. After refluxing the solvent was distilled off and the sticky mass obtained as residue was triturated several times with petroleum ether. A granular white solid (5 g) was obtained. Crystallised from ethanol-water, m.p. 142°C. [Found: C, 67.01, H, 4.60, N, 3.66, S, 4.19. C$_{12}$H$_{16}$O$_9$N$_2$S requires; C, 67.66, H, 4.83, N, 3.75, S, 4.29 %].

The product was found soluble in alcohol, acetone, chloroform, carbon tetrachloride and benzene while insoluble in water and petroleum ether. It charred when warmed with conc. sulphuric acid on boiling with alkaline plumbite solution desulphurisation was noticed. Its specific rotation $[\alpha]_D^{34}$ was found to be $+63.28^\circ$ (c, 0.926 in chloroform).

**Experiment No. 4:** Formation of 1-tetra-O-benzoyl-β-D-glucopyranosyl-3-phenyl thiocarbamide (IIIId).

To a benzene solution of tetra-O-benzoyl-β-D-glucopyranosyl isothiocyanate (0.01 M, 6.3 g in 40 ml) was added aniline (0.01 M 0.9 g in 10 ml benzene) and the reaction mixture was refluxed over a boiling water bath for 3 hr. Benzene was removed by distillation and the sticky mass was triturated several times with petroleum ether. A granular solid (4.9 g) was obtained which was crystallised from aqueous ethanol. m.p. 120°C. [Found: C, 66.98, H, 4.41, N, 3.26, S, 4.33. C$_{14}$H$_{14}$O$_9$N$_2$S requires; C, 67.39, H, 4.65, N, 3.83, S, 4.37 %].

The product was found soluble in alcohol, acetone, chloroform, carbon tetrachloride, and benzene, while insoluble in water and petroleum ether. It was desulphurisable when boiled with alkaline plumbite solution. Its specific rotation $[\alpha]_D^{34}$ was found to be $+79.68^\circ$ (c, 1.004 chloroform).
FIG. 5: INFRARED SPECTRUM OF III.

Sample No. = GVK-9
RS12 No. = 3734

01/07/27 15:11
X: 4 scans, 4.0 cm⁻¹, flat, smooth, abex
Scheme - 1

Probable fragmentation pattern of 1-tetra-O-benzoyl-β-D-glucopyranosyl-3-phenyl thiocarbamide (IIIα).

(M+1) (M/z 731) located Protonated

M⁺ (M/z 730) located

(M/z 608)

(M/z 579)

(M/z 351)

(M/z 245)

(M/z 322)

(M/z 153)

(M/z 231)

Where, Bz = Benzoyl = COC₆H₅
The following absorption bands were located in its IR spectrum (Fig. 5).

<table>
<thead>
<tr>
<th>Absorption observed (cm⁻¹)</th>
<th>Assignment</th>
<th>Absorption expected (cm⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3361</td>
<td>N-H stretching.</td>
<td>3500-3100⁶⁶, ¹³</td>
</tr>
<tr>
<td>1728</td>
<td>C=O stretching in saturated esters.</td>
<td>1750-1735⁵⁶, ¹², ¹³, ¹⁴</td>
</tr>
<tr>
<td>1268</td>
<td>C - N stretching.</td>
<td>1350-1280¹⁴</td>
</tr>
<tr>
<td>1533</td>
<td>Phenyl nucleus.</td>
<td>1600-1585⁸⁸</td>
</tr>
<tr>
<td>1094</td>
<td>C' = S stretching.</td>
<td>1200-1050⁶⁸, ⁷⁹</td>
</tr>
<tr>
<td>854</td>
<td>β-D- glucopyranosyl ring (deformation)</td>
<td>844 ± 8¹⁰⁹</td>
</tr>
</tbody>
</table>

The NMR spectrum of IIId (Fig.6) distinctly displayed the signals due to N-H proton at δ6.66 ppm⁶⁶, ¹³, aromatic protons at δ6.9-7.4 and 7.78-8.0 ppm¹⁴⁸, ¹⁵, ¹⁶. It also showed the signals due to protons of pyranosyl ring at δ5.46-4.6 and δ4.4-4.2 ppm¹⁵, ¹⁵, ¹⁶.

The Mass spectrum of the product¹⁷ - ¹⁹ was also recorded (Fig. 7). The molecular ion peak, as well as the other important fragment peaks with their relative abundances are listed in table 2. The probable fragmentation patterns of the molecular ion are shown in scheme 1.

### Table 2

**Mass spectral data of IIId.**

<table>
<thead>
<tr>
<th>Ion</th>
<th>M/z</th>
</tr>
</thead>
<tbody>
<tr>
<td>M⁺</td>
<td>736</td>
</tr>
<tr>
<td>Protonated</td>
<td>731</td>
</tr>
<tr>
<td>[M - C₆H₄NS]</td>
<td>608</td>
</tr>
<tr>
<td>[M - C₆H₄NS, NCH₃]</td>
<td>579</td>
</tr>
<tr>
<td>[TBG - C₁₂H₁₁O₂]</td>
<td>235</td>
</tr>
<tr>
<td>[TBG - C₁₃H₁₃O₂]</td>
<td>322</td>
</tr>
<tr>
<td>[TBG - C₁₃H₁₉O₄]</td>
<td>245</td>
</tr>
<tr>
<td>[C₆H₄O₄]⁺</td>
<td>153</td>
</tr>
<tr>
<td>[M - C₁₃H₂₆O₅NS]</td>
<td>487</td>
</tr>
<tr>
<td>[M - C₁₃H₂₆O₅NS, C₁₃H₁₉N]</td>
<td>307</td>
</tr>
<tr>
<td>[C₆H₁₁O₄]⁺</td>
<td>231</td>
</tr>
<tr>
<td>[C₈H₆O₂]⁺ [Base peak]</td>
<td>138</td>
</tr>
</tbody>
</table>

Where, TBGI = tetra - O - benzoyl - β - D - glucopyranosyl.
Bz = Benzoyl
* Relative abundance of the base peak has been taken to be 100%
Experiment No. 5: Formation of 1- tetra- O- benzoyl- β- D- glucopyranosyl - 3 - O - Cl - Phenyl thiocarbamide (IIIe).

0 - Cl - Aniline (0.01 M, 1.2 g in 10 ml benzene) was added to a benzene solution of tetra- O- benzoyl- β- D- glucopyranosyl isothiocyanate (0.01 M, 6.3 g in 50 ml) and the reaction mixture was refluxed over a boiling water bath for 3 hr. After refluxing, the solvent benzene was distilled off and the resultant sticky mass was triturated several times with petroleum ether. A granular white solid (3.8 g) was obtained. Crystallised from ethanol-water, m.p. 135°. [Found: C, 63.98, H, 4.01, N, 3.50, S, 4.12. C₁₄₇H₃₃O₄N₇Cl requires; C, 64.39, H, 4.31, N, 3.66, S, 4.18%].

The product charred when heated with conc. sulphuric acid, on boiling with alkaline plumbite solution desulphurisation was observed. Its specific rotation [α]₃₃ was found to be +154.44° (c, 1.036 in chloroform).

The following absorption bands were located in its IR spectrum. (Fig. 8)

<table>
<thead>
<tr>
<th>Absorption observed (cm⁻¹)</th>
<th>Assignment</th>
<th>Absorption expected (cm⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3366</td>
<td>NH-stretching.</td>
<td>3500-3100⁶, ¹³</td>
</tr>
<tr>
<td>1728</td>
<td>C=O stretching in saturated esters.</td>
<td>1750-1715¹², ¹³, ¹⁴a</td>
</tr>
<tr>
<td>1269</td>
<td>C - N stretching.</td>
<td>1350-1280¹⁴c</td>
</tr>
<tr>
<td>1533</td>
<td>Phenyl nucleus.</td>
<td>1600-1585⁵b</td>
</tr>
<tr>
<td>1094</td>
<td>C = S stretching.</td>
<td>1200-1050⁸a, ⁹b</td>
</tr>
<tr>
<td>853</td>
<td>β-D- glucopyranosyl ring (deformation).</td>
<td>844 ± 8¹⁰a</td>
</tr>
<tr>
<td>753</td>
<td>Ortho aromatic (4 adjacent).</td>
<td>735-770⁹c</td>
</tr>
</tbody>
</table>

The NMR spectrum of IIIe (Fig. 9) distinctly displayed the signals due to N-H proton at δ6.9 ppm⁶, ¹³, aromatic protons at δ8-7.7 and δ7.5-7.2 ppm¹⁴, ¹⁵, ¹⁶. It also showed the signals due to protons of pyranosyl ring at δ4.2-4.4 and δ4.6-5.3 ppm¹³, ¹⁵, ¹⁶.

The Mass spectrum of the product¹⁷ - ¹⁹ was also recorded (Fig. 10) the molecular ion peak, as well as the other important fragment peaks with their relative abundances are listed in table 3. The probable fragmentation patterns of the molecular ion are shown in scheme 2.
Scheme - 2

Probable fragmentation pattern of 1-tetra- O-benzoyl-β-D-glucopyranosyl-3-o-Cl-phenyl thiocarbamide (IIIe).

\[ \text{Scheme Diagram} \]

\[ (M^+ \text{, M/z 765 }) \text{ located} \]

\[ \text{Pronounced} \]

\[ (M^+ \text{, M/z 607}) \]

\[ (M^+ \text{, M/z 579}) \]

\[ (M^+ \text{, M/z 307}) \]

\[ [C_6H_5-\text{CH}_2-\text{COOH}]^+ \text{, M/z 136} \]

\[ [C_6H_5-\text{C}=\text{O}]^+ \text{, M/z 105} \]

Where, Bz = Benzoyl = COC_6H_5
Table 3

Mass spectral data of IIIe.

<table>
<thead>
<tr>
<th>Ion</th>
<th>M/z</th>
</tr>
</thead>
<tbody>
<tr>
<td>M⁺</td>
<td>764</td>
</tr>
<tr>
<td>Protonated</td>
<td>765</td>
</tr>
<tr>
<td>[M - Cl]</td>
<td>729</td>
</tr>
<tr>
<td>[M - Cl, C₆H₄NS]</td>
<td>607</td>
</tr>
<tr>
<td>[M - Cl, C₇H₆N₂S]</td>
<td>579</td>
</tr>
<tr>
<td>[TBG - C₁₅H₁₂O₂]</td>
<td>307</td>
</tr>
<tr>
<td>[TBG - C₁₆H₁₈O₂]</td>
<td>289</td>
</tr>
<tr>
<td>[C₆H₅O₂]⁺ [Base peak]⁺</td>
<td>136</td>
</tr>
<tr>
<td>[C₆H₅C = O]⁺</td>
<td>105</td>
</tr>
</tbody>
</table>

Where, TBG = tetra - O - benzoyl - β - D - glucopyranosyl.

Bz = Benzoyl

* Relative abundance of the base peak has been taken to be 100%

Experiment No. 6: Formation of 1-tetra - O - benzoyl - β - D - glucopyranosyl - 3 - m - Cl - Phenyl thiocarbamide (IIIf).

To a benzene solution of tetra - O - benzoyl - β - D - glucopyranosyl isothiocyanate (0.01 M, 6.3 g in 40 ml) was added to the solution of m-cl-aniline (0.01 M 1.2 g in 10 ml benzene) and the reaction mixture was refluxed over a boiling water bath for 3 hr. On working out the reaction as described in earlier experiment a white solid (4.9 g) was obtained. Crystallised from ethanol-water mixture, m.p. 100°. [Found : C, 63.95, H, 4.19, N, 3.54, S, 4.1. C₄₁H₂₇O₉N₂SCl requires; C, 64.39, H, 4.31, N, 3.65, S, 4.18 %]. The product charred when heated with conc. sulphuric acid. On boiling with an alkaline plumbite solution desulphurisation was noticed. Its specific rotation [α]D₀⁴ was found to be +84.26° (c, 1.068 chloroform).

Experiment No. 7: Formation of 1-tetra - O - benzoyl - β - D - glucopyranosyl - 3 - p - Cl - Phenyl thiocarbamide (IIIg).

To a benzene solution of tetra - O - benzoyl - β - D - glucopyranosyl isothiocyanate (0.01 M, 6.3 g in 40 ml) was added a solution of p-cl-aniline (0.01 M 1.2 g in 20 ml benzene) and the reaction mixture was refluxed over a boiling water bath for 3 hr. On working out the reaction as described in earlier experiment a white solid (5.2 g) was obtained. Crystallised from a mixture of ethanol-

The product charred when heated with sulphuric acid. On boiling with alkaline plumbite solution desulphurisation was observed. Its specific rotation [α]₁₉°₃⁴ was found to be +100.44⁰ (c, 0.896 in chloroform).

**Experiment No. 8: Formation of 1 - tetra - O - benzoyl - β - D - glucopyranosyl - 3 - α-Napthyl thiocarbamide (IIIb).**

α-Napthylamine solution (0.01 M, 1.4 g in 10 ml benzene) was added to the benzene solution of tetra - O - benzoyl - β - D - glucopyranosyl isothiocyanate (0.01 M, 6.3 g in 50 ml) and the reaction mixture was refluxed over a boiling water bath for 3 hr. On working out the reaction as described in earlier experiment a white solid (5.7 g) was obtained. Crystallised from a mixture of ethanol-water, m.p. 150°C. [Found: C, 69.10, H, 4.23, N, 3.52, S, 4.02. C₄₅H₃₆O₅N₂S requires: C, 69.23, H, 4.61, N, 3.85, S, 4.10%].

The product charred when heated with sulphuric acid. On boiling with an alkaline plumbite solution desulphurisation was observed. Its specific rotation [α]₁₉°₃³ was found to be +117.18⁰ (c, 1.024 chloroform).

**Experiment No. 9: Formation of 1 - tetra - O - benzoyl - β - D - glucopyranosyl - 3 - thiocarbamide (III).**

Concentrated ammonia solution (d 0.88, 2 ml) was added to a benzene solution of tetra - O - benzoyl - β - D - glucopyranosyl isothiocyanate (0.01 M, 6.3 g in 40 ml) and the reaction mixture was refluxed over a boiling water bath for 30 min. After refluxing the solvent was distilled off and a sticky mass obtained as residue. After addition of 20 ml of petroleum ether 60-80°C to a sticky mass a white solid was obtained. (4.6 g) Crystallised from ethanol. m.p. 135°. [Found: C, 64.12, H, 4.48, N, 4.31, S, 4.70. C₃₅H₃₆O₅N₂S requires: C, 64.22, H, 4.58, N, 4.27, S, 4.88%].

The product found soluble in acetone, chloroform, carbon tetrachloride and benzene and insoluble in alcohol, water and petroleum ether. It charred when warmed with sulphuric acid. On boiling with alkaline plumbite solution desulphurisation was noticed.

Its specific rotation [α]₁₉°₃₄ was found to be +70.11° (c, 0.923 in chloroform).
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