Note

Table 1 — Reduction of azidocyclodextrins to aminocyclodextrins using \( \text{In/} \text{NH}_4 \text{Cl} \)

<table>
<thead>
<tr>
<th>Entry</th>
<th>Substrate</th>
<th>Product</th>
<th>Yield (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1a, ( n = 7; R = H )</td>
<td>2a, ( n = 7; R = H )</td>
<td>95</td>
</tr>
<tr>
<td>2.</td>
<td>1b, ( n = 7; R = \text{CH}_3 )</td>
<td>2b, ( n = 7; R = \text{CH}_3 )</td>
<td>96</td>
</tr>
<tr>
<td>3.</td>
<td>1c, ( n = 6; R = H )</td>
<td>2c, ( n = 6; R = H )</td>
<td>95</td>
</tr>
<tr>
<td>4.</td>
<td>1d, ( n = 6; R = \text{CH}_3 )</td>
<td>2d, ( n = 6; R = \text{CH}_3 )</td>
<td>98</td>
</tr>
<tr>
<td>5.</td>
<td>1e, ( n = 6; R = H )</td>
<td>2e, ( n = 6; R = H )</td>
<td>94</td>
</tr>
<tr>
<td>6.</td>
<td>1f, ( n = 6; R = \text{CH}_3 )</td>
<td>2f, ( n = 6; R = \text{CH}_3 )</td>
<td>98</td>
</tr>
<tr>
<td>7.</td>
<td>1g, ( n = 5; R = H )</td>
<td>2g, ( n = 5; R = H )</td>
<td>94</td>
</tr>
<tr>
<td>8.</td>
<td>1h, ( n = 5; R = \text{CH}_3 )</td>
<td>2h, ( n = 5; R = \text{CH}_3 )</td>
<td>96</td>
</tr>
</tbody>
</table>

Aminocyclodextrins (6-mono, 6-per) are very important intermediates in the synthesis of enzyme models,\(^1\) HIV protease inhibitors,\(^2\) antibacterial compounds,\(^3\) and chemosensors.\(^4\) The most commonly used and straightforward synthesis of aminocyclodextrins (6-mono, 6-per) consists of reducing the azidocyclodextrins with triphenylphosphine (\( \text{Ph}_3\text{P} \)).\(^5\) But the major drawback of this approach is the difficulty in removing \( \text{Ph}_3\text{P}/\text{Ph}_3\text{PO} \) from the product. This is due to the formation of complex between \( \text{Ph}_3\text{P}/\text{Ph}_3\text{PO} \) and aminocyclodextrin, which is not easily broken down after acidification. The complete removal of \( \text{Ph}_3\text{P}/\text{Ph}_3\text{PO} \) from the acidic solution of aminocyclodextrin could not be achieved even after stirring for longer duration.\(^6\) Apart from this, the methodology is also not suitable for cyclodextrins containing acid labile groups. Hence, to overcome this problem there is a need for better procedure.

We have applied here a recently reported procedure\(^7\) of reduction of azides to amines by indium metal for the conversion of azidocyclodextrins 1 to aminocyclodextrins 2. This has yielded aminocyclodextrins 2 in excellent yields with a simple workup of the reaction mixture.

Azidocyclodextrins (1a, 1c, 1e, 1g) were treated with indium and ammonium chloride in DMF : ethanol (80:20) at 80°C to give the corresponding aminocyclodextrins (2a, 2c, 2e, 2g) in nearly quantitative yields. Azidocyclodextrins (1b, 1d, 1f, 1h) were treated with indium and ammonium chloride in ethanol at reflux temperature to afford the corresponding aminocyclodextrins (2b, 2d, 2f, 2h) in excellent yields (Scheme I, Table I). All the aminocyclodextrins obtained were fully characterized by comparing the physical and analytical data with those of the known compounds.\(^5a,8\)

Experimental Section

Typical procedure. (a) Azidocyclodextrins (1a, 1c, 1e, 1g) (10 mmol) was treated with indium metal (12 mmol) and ammonium chloride (12 mmol) in DMF : ethanol (80:20) (50 mL) at 80°C for 3 hr. After completion of the reaction (monitored by TLC), the reaction mixture was brought to room
temperature, filtered and the filtrate was poured into water to get a white precipitate. It was filtered, washed with methanol and dried in vacuo to give the corresponding aminocyclodextrins (2a, 2c, 2e, 2g).

(b) Azidocyclodextrins (1b, 1d, 1f, 1h) (10 mmoles) were treated with indium metal (12 mmoles) and ammonium chloride (12 mmoles) in ethanol at 80°C for 3 hr. After completion of the reaction (monitored by TLC), the reaction mixture was brought to room temperature, filtered and the filtrate was removed under reduced pressure to give the corresponding aminocyclodextrins (2b, 2d, 2f, 2h).

Acknowledgement

Authors (LRR and MAR) thank the CSIR, New Delhi (India) for the award of fellowships.

References