CHAPTER-VIII

Synthesis of sulfated β-cyclodextrin functionalized cotton fabric and its improved antibacterial activity with Ocimum tenuiflorum and Nyctanthes arbor-tristis extracts treatment

8.1. Introduction

Cellulosic polymers like cotton, cyclodextrins and chitosan are playing an important role in our society. Cotton is mostly used in textile sectors due to their unique properties [1]. The consumption of world textile fiber, cotton materials has increased due to population growth [2]. The structural modified cellulosic polymers have some functional behaviors. These types of textile materials are required in the increasing demand of modern human society and our environment [3-5].

Cyclodextrins are used in a variety of different textile applications and owing to the complex abilities of cyclodextrins [6-8]. It performs new functional properties in textile materials. The possibility of permanent cyclodextrin fixation in polymeric materials has been studied [9,10]. The cyclodextrin crosslinking may exhibit good dyeability due to its multihydroxyl groups and also the sulfur groups act as an antibacterial agent. Antimicrobial active substances are complexed by crosslinked cyclodextrins. The cyclodextrin treated materials are convenient and safe for wearing [11]. The functionalized cotton and its composite materials have increased activities such as textiles, drug delivery systems and personal care products [12].
Some of the natural extracts prepared from leaves, sparks, flowers, and roots of medicinal plants. These extracts are biodegradable, high medicinal value and compatibility with the environment [13, 14]. This chapter aimed to study the antibacterial behavior with *Ocimum tenuiflorum* (tulasi) and *Nyctanthes arbor-tristis* (parijaraka) extract on sb-cd/cotton composite fabric. The schematic representation of this work shown in figure 8.1

![Figure 8.1. Graphical images of sb-cd/cellulose composite fabric synthesis and extract treatment](image-url)
8.2. Results and Discussion

8.2.1. FTIR analysis of Ocimum tenuiflorum and Nyctanthes arbor-tristis extract treated cotton

FTIR spectra of tulasi and Parijataka extracts were already discussed in chapter -V. The FTIR spectrum of tulasi extract treated sb-cd/cotton showed in figure 8.2a. The peak ranges from 3000 cm\(^{-1}\) to 3600cm\(^{-1}\) indicates some structural changes in -OH stretching. This may be due to some compounds presented in tulasi extract like Eugenol and Carvacrol derivatives [15]. The –CH\(_2\) stretching corresponds from peak at 2972 cm\(^{-1}\). The S-O stretching shows at 1130 cm\(^{-1}\) and the S-O vibration peak noticed at 697 cm\(^{-1}\). From these results, cellulose/ sb-cd polymer composite spectrum has some characteristic compounds of tulasi extract reacted on cellulose and this result conclude that tulasi extract was treated on sb-cd/cotton fabric.

The FTIR spectrum of Parijataka extract treated sb-cd/cotton shown in figure 8.2.b. the –OH stretching indicates at 3511cm\(^{-1}\). A peak at 1114 cm\(^{-1}\) exhibits C-O-C stretching and it is the evidence for flavanol glycoside present in parajataka extract. The other characteristic peaks indicate and phytochemicals like flavanol glycoside, oleanic acid, carotene, friedeline, lupeol, glucose, benzoic acid [16]. The S-O vibration peak noticed at 672 cm\(^{-1}\). That is asymmetric and symmetric stretching of -SO\(_3\) groups. It indicated that sulfonic acid group crosslinked on cotton fabric. These FTIR results are evidence for the parijataka extract treatment on sb-cd/cotton fabric.

8.2.2. Surface morphology of cotton and sb-cd/cellulose cotton fabric

The unmodified cellulose surface shows grooves, cracks and fibrils ripen like surface (Fig.8.3a). From EDX spectra the unmodified fabrics shows no new elements are present
(Fig. 8.3b). But these characteristics completely disappear on the surface of sb-cd treated cellulose composite fabrics. The treated polymer clearly visible on sb-cd treated fabric and the increasing swelling nature also exhibited (Fig. 8.4a.). The corresponding EDX spectrum exhibits S element present in sb-cd/ cellulose fabric (Fig. 8.4b) and Au indicates the sputtering material for conductivity. From these results confirms the crosslinking of sb-cd polymer on cotton cellulose.

8.2.3. Effect of modification on extract treatments

Photographic images of untreated and extract treated fabrics showed in table 8.1. Tulasi extract treated cellulose cotton fabric showed light green in color. In sb-cd modified fabric exhibited dark green color with tulasi extract treatment. Parijataka extract treated fabric showed light orange colored fabric. In sb-cd/cotton fabric exhibited brown in color. These color change may be due to effect of modification. From these results sulfated-β-cyclodextrin may improve the absorbency of natural extracts on cellulosic fabric.

8.2.4. Antibacterial activity test

Table 8.2 showed antibacterial activity of untreated and extract treated fabrics. The untreated cotton fabric exhibited no antibacterial activity for both S.aureus and E.coli bacterium. Sb-cd/cotton fabric exhibited 85% and 78% of bacterial reduction for both S.aureus and E.coli at 30 min. In the case of tulasi extract treated fabric showed maximum bacterial reduction of 98% for S.aureus and 86% for E.coli at 30 min. From these results extract treated sb-cd/cotton fabric exhibited very good antibacterial activity. This may be due to the Eugenol and Carvacrol derivatives of tulasi extract. These compounds has a system of delocalized electrons are important for the antimicrobial activity. Such a particular structure would allow these compounds to act as proton exchanger, thereby reducing the gradient across the cytoplasmic membrane. The results are collapse of the proton and depletion of the
ATP pool lead eventually to death of bacteria cell [17, 18]. The sulfated or sulfonated polymers also inhibit the in vitro growth of bacteria and N-sulfonated compound acts as a microbial inhibition compound.

8.3. Conclusion

The sb-cd/cotton composite fabric was synthesised and treated with natural extracts. In this research work following results are drawn. The FTIR studies prove the -SO₃ groups showed sb-cd/cellulose composite fabric and also exhibited functional groups of tulasi and Parijataka extract’s phytochemicals. Tulasi extract treated sb-cd/ cellulose composite fabric produced dark green color and the Parijataka extract treated modified fabric exhibited brown color. Tulasi and Parijataka extract treated sb-cd/ cellulose cotton fabrics exhibited very good antibacterial activity. This type of cellulosic fabric is advisable for the preparation of wound and surgical cloths.
8.4. References


8.5. Legends

8.5.1. Tables

Table 8.1. Effect of extract treatment on unmodified and sb-cd modified cotton fabrics

Table 8.2. Antibacterial activity test of the untreated and treated fabrics against S.aureus and E.coli

8.5.2. Figures

Figure 8.2. FTIR spectra of Ocimum tenuiflorum (a) and Nyctanthes arbor-tristis (b) extract treated sb-cd/cotton fabric

Figure 8.3. SEM(a) and EDX(b) images untreated cotton fabric

Figure 8.4. SEM(a) and EDX(b) images sb-cd/cotton fabric
Table 8.1. Effect of extract treatment on unmodified and sb-cd modified cotton fabrics

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of fabric samples</th>
<th>Fabric images</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Untreated cotton</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>2</td>
<td>Sb-cd modified fabric</td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>3</td>
<td>Tulasi extract treated fabric</td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>4</td>
<td>Parijataka extract treated fabric</td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>5</td>
<td>Sb-cd modified tulasi extract treated fabric</td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
</tbody>
</table>
Table 8.2. Antibacterial Activity Test of the Untreated and treated fabrics against S.aureus and E.coli

<table>
<thead>
<tr>
<th>Sample</th>
<th>S.aureus</th>
<th>E.coli</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 min.</td>
<td>15 min.</td>
</tr>
<tr>
<td></td>
<td>% R</td>
<td>% R</td>
</tr>
<tr>
<td>Time duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cotton</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Sb-cd/cotton</td>
<td>45</td>
<td>64</td>
</tr>
<tr>
<td>Tulasi + cotton</td>
<td>38</td>
<td>57</td>
</tr>
<tr>
<td>Parijataka + cotton</td>
<td>24</td>
<td>38</td>
</tr>
<tr>
<td>Tulasi + sb-cd/Cotton</td>
<td>51</td>
<td>76</td>
</tr>
<tr>
<td>Parijataka + sb-cd/cotton</td>
<td>47</td>
<td>69</td>
</tr>
</tbody>
</table>

* = good antibacterial activity
Figure 8.2: FTIR spectra of Ocimum tenuiflorum (a) and Nyctanthes arbor-tristis (b) extract treated sb-cd/cellulose composite fabric
Figure 8.3: SEM(a) and EDX(b) images untreated cotton fabric
Figure 8.4: SEM(a) and EDX(b) images sb-cd/cellulose composite fabric