Extraction, stabilization and application of antimicrobial agents from Aloe Vera

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Investigations have been carried out on the development of stabilized antimicrobial agents from plant extract for the application of 100% cotton fabric. Aloe Vera leaves were used to extract the antimicrobial agents and applied at 2%, 4% and 6% concentrations. Qualitative analysis was carried out to measure the antimicrobial activity against Gram-positive (Staphylococcus aureus) and Gram-negative (Klebsiella pneumonia) bacteria. The results showed that the treated cotton fabric reduced the growth of Gram-positive (Sa) and Gram-negative (Kp) bacteria up to 90% before wash and 58.5% after four washes at 6% concentration.

To understand more about antimicrobial agents, the effect on other parameters such as whiteness index and absorbency were studied. The CIE whiteness index value of fabrics was measured by a spectrophotometer using an appropriate computer software and embroidery hoop was used to determine absorbency.

The present study has yielded highly active and stabilized antimicrobial agents from Aloe Vera leaves.

Keywords: Natural antimicrobial agents, Aloe Vera extract, Antimicrobial stabilization, Cotton woven fabric.

Introduction

In the world of textiles, finishing process plays an essential role for characteristics and financial worth. In the past few decades importance is given to antimicrobial finishes since people are more conscious about health and hygiene. Natural fibers are more sensitive to bacterial attack than synthetic fiber due to their porous and hydrophobic nature and thereby offering optimal culture for rapid growth of micro-organisms. Additionally, direct contact with human body provides warmth, humidity and nutrients; particularly an excellent environment and best conditions for micro-organism growth. These micro-organisms create problems in textiles, including discoloration, stains and fiber damage, unpleasant odor and a slick, slimy feel. Antimicrobial agents destroy the growth of micro-organisms and their negative effects of odor, staining and deterioration. Present day textile processes preferred eco-friendly chemicals to relinquish antimicrobial finishing on textile. Aloe Vera is a natural plant who has antimicrobial activity against various microbes and inhibits the growth of Staphylococcus Aureus and Klebsiella pneumoniae.

In this research work, an eco-friendly finish from Aloe Vera plant is applied on cotton fabric, and a study is conducted to assess the antimicrobial activity of the finished samples.

Experimental data:

Materials:

Fabric: The characteristic parameters of the 100% bleached cotton fabric used for all the experiments, purchased from the market are presented in Table-1. Water: The water used during all bleaching and washing operations had the following qualities, as stated in Table-2. The Total Hardness was measured in terms of calcium carbonate. The pH, Total Hardness and Total Dissolve Solids (TDS) of water suitable for all textile processing are 6.5-7.5, 0-50 ppm and 65-150 ppm respectively.

Table 1: Basic characteristics of 100% cotton bleached fabric

<table>
<thead>
<tr>
<th>Fabric composition</th>
<th>Weave</th>
<th>Area weight (g/m²)</th>
<th>Warp yarn count (tex)</th>
<th>Weft yarn count (tex)</th>
<th>CIE Whiteness Index (WI)</th>
<th>Absorbency (Sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleached cotton</td>
<td>Plain</td>
<td>170</td>
<td>45</td>
<td>40</td>
<td>80.5</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Table 2: The quality of water

<table>
<thead>
<tr>
<th>pH</th>
<th>Total Hardness (ppm)</th>
<th>Total Dissolve Solids (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6</td>
<td>45.0</td>
<td>142</td>
</tr>
</tbody>
</table>

Collection of Plant: The fully expanded leaves of Aloe Vera were purchased from the market.

Equipment and methods:

SDL ‘ECO’ Infra Red Lab Machine: Antimicrobial finish runs were carried out in an SDL ‘ECO’ Infra Red lab machine with automatic temperature programming and agitation.

Digital pH meter: A digital pH/Temperature meter was used with a combination of glass electrode.

BÜCHI Rota Vapor R-114: A BÜCHI Rota Vapor R-114 was used to evaporate the Aloe Vera methanolic extract.

Whiteness measurement: The CIE Whiteness Index value (CIE WI) was determined for the Aloe Vera extract treated fabric using AATCC Test method (110–1995). The whiteness was measured using a DataColor Spectraflash SF 600X with the following setting: illuminants D-65, large area view, specular included and CIE 1964 supplemental standard observer (1 observer). Each sample was folded twice to give an opaque sample with four piles and the whiteness was measured four times at the different fabric surface. The average value of (CIE WI) was recorded.

Absorbency: Absorbency was determined as per AATCC Test Method (79-1986) [9]. Absorbency is one of the several factors that determine the suitability of a fabric for a particular use wet ability or absorbency of textiles or fabric can be determined by this test method.

Antimicrobial activity assessment: Antimicrobial activity assessment of textile material was determined as per AATCC Test Method (100-2004) Parallel Streak Method [10].

Test organisms: Staphylococcus Aureus, AATCC NO. 6538 and Klebsiella Pneumonia, AATCC NO.: 4352

Chemicals

Wetting agent: AV WET OPTRA (non ionic) wetting agent supplied by AVM Chemical Industries.

Sodium Benzoate and Sodium Carbonate: Sodium benzoate and Sodium carbonate supplied by MERCK (Germany).

Acetic acid: AV AECTIC ACID supplied by AVM Chemicals, CO., Ltd. (China).

Methanol: Methanol supplied by Shijiazhuang Arier Chemical, CO., Ltd (China).

Standard soap: Standard soap supplied by James H Heal (UK).
Preparation of Aloe Vera extract

The fully expanded leaves of Aloe Vera were selected from the plant and washed with water. When a leaf of Aloe Vera is cut, an orange yellow sap drips from the open end. Carefully remove the inner gel while avoiding the yellow sap (latex). The gel was collected from leaves into a clean beaker. For the better extraction of antimicrobial agent from the Aloe Vera, the gel was dried in the oven at 75°C for about two days and then powdered.

200gm of grinded powder was steeped in methanol (1:2) for 3-6 days in dark conditions at 20°C, 30°C and 40°C. By checking the antimicrobial activity every day and temperature. It was found that the activity was low during first three days, while the optimum activity was reached after five days at 30°C and decline was observed after five days at each temperature. Antimicrobial activity was less when soaking time was allowed to proceed during day light. For preservation of antimicrobial extract, 0.2% sodium benzoate provided stabilization for about six months at 25°C in the air tight and dark containers. After 5 days, extract was removed by filtration through Whatman filter paper No. 1 and filtrate was evaporated under vacuum to dryness. The dried extract was further powdered and stored.

Finish application of Aloe Vera methanolic extract by exhaust method

The antimicrobial agent can be applied on cotton fabric by exhaust, pad-dry-cure and coating methods. The exhaust method is used in this study, which is a popular and simple method and the recipe used is shown in Table-3.

Aloe Vera methanolic extract finish durability to washing:

The finished samples of Aloe Vera were washed with standard soap 2% (owf) and 1% (owf) sodium carbonate at 60°C for 10 minutes followed by cold wash and air dried.

The antimicrobial activities were evaluated before wash, after second and forth wash of each sample.

Results and discussion

The present study aims to develop an environmentally friendly natural antimicrobial finish from Aloe Vera plant extracts for cotton fabric. The plant extract was applied to cotton fabric and study was conducted to evaluate the antimicrobial effectiveness before and after washing by employing the standard Test Method AATCC (100-2004). To understand more about the finished samples, other parameters such as whiteness index and absorbency were also studied. All the findings are listed in Table 4.

It can be seen that the application of Aloe Vera extracts at 2%, 4% and 6% concentrations, the reduction of bacterial growth of Gram-positive (Staphylococcus aureus) and Gram-negative (Klebsiella pneumonia) bacteria were 50%, 78% and 90% before wash respectively. These results showed excellent performance of Aloe Vera extracted at 6% concentration.

Table 3: Application recipe of Aloe Vera methanolic extract

<table>
<thead>
<tr>
<th>Application of Aloe Vera Extract (%)</th>
<th>No. of Washes</th>
<th>Bacterial Reduction of (*Sa) and (*Kp) (%)</th>
<th>CIE Whiteness Index (WI)</th>
<th>Absorbency (Sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0</td>
<td>50</td>
<td>66.01</td>
<td>1.8</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>78</td>
<td>59.59</td>
<td>2.3</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>90</td>
<td>52.37</td>
<td>3.0</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>47.5</td>
<td>72.65</td>
<td>1.4</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>73.8</td>
<td>68.53</td>
<td>1.9</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>86.2</td>
<td>62.76</td>
<td>2.4</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>39.0</td>
<td>76.58</td>
<td>1.0</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>58.5</td>
<td>60.15</td>
<td>1.5</td>
</tr>
</tbody>
</table>

*Sa: Staphylococcus Aureus, *Kp: Klebsiella Pneumonia

When CIE whiteness index and absorbency of the finished samples were measured, it was noticed that at 2%, 4% and 6% concentrations the whiteness index was dropped about 18%, 26% and 35% from the untreated sample. The absorbency (time required for the specular reflection of the water drop to disappear) of the samples were decreased from 1.0 sec to 1.8 sec, 2.3 sec and 3.0 sec respectively. The graphical results are represented in Fig. 1, 2 and 3.
When the efficiency of Aloe Vera extract was measured after forth wash at 2%, 4% and 6% concentrations, it was noticed that the reduction of bacterial growth of Staphylococcus aureus and Klebsiella pneumonia were 0%, 39% and 58.5% respectively. The results of CIE whiteness index were improved about 16%, 20% and 15% and the absorbency of the treated samples were improved from 1.4 sec to 1.0 sec, 1.9 sec to 1.2 sec and 2.4 sec to 1.5 sec from the unwashed samples respectively. The same results are shown in the graphical form in Fig. 7, 8 and 9.

Conclusion
In these study antimicrobial agents from Aloe Vera leaves have been studies as an alternative to commercially available synthetic antimicrobial agents for the finishing of cotton fabric. Aloe Vera extract treated cotton fabric showed 90.0%, 78.0% and 50.0% reduction to Gram-positive (Staphylococcus aureus) and Gram-negative (Klebsiella pneumonia) bacteria before wash and 58.5%, 39.0% and 0.0% reduction after four washes at 6%, 4% and 2% concentrations respectively. This indicates that the direct application of the treated fabric does not have the wash durability and if the fabric is for only single use application then this technique can be adopted. It is also possible to stabilize antimicrobial agents for about six months by using sodium benzoate. The observations reported in the present study, therefore, indicate the possibility of commercial application of Aloe Vera extract made from cheap or waste plant material for antimicrobial of cotton fabric in textile industry.

References

Setex training of Controller and PLC programming

Noon International organized a training course on SETEX Controller and PLC programming for dyeing and finishing industry during 23rd to 28th of January 2012 at their Head Office in Lahore, Pakistan.

Noon International (Pvt) Ltd., is a trading company of Noon Group, established in 1972. Today, it has offices in Karachi, Lahore, Faisalabad and Islamabad with another company Textile Services (established in 1964) to provide after sales back-up and services to over 400 customers of Noon International.

Textile Services offers complete “Customer Support Service” in Pakistan, including training, technical service and spare parts and employs 35 persons including 12 Sales and Service Engineers. SETEX Schermuly textile computer GmbH is a global company operating as a high-tech corporation that realizes and develops computer based control systems and software solutions for the textile industry.

SETEX has become one of the worldwide leading specialist for automation systems in dye houses and finishing plants, by using the latest technologies as well as running a large number of service and sales stations worldwide.

According to Setex, “Leading technological competence form the basis to safeguard and expand this leading market position. In this context, leading textile machine manufacturers all over the world are successfully using for years, the controllers of the SECOM family on their machines.”

SETEX product range include following areas:

✓ Industrial PCs for the fully automatic control of continuous and discontinuous textile machinery.
✓ PPS systems and control stations for higher ranking systems for the control of the complete finishing.
✓ PLC controls.
✓ Sensors for dye machines and dryers for textile finishing.
✓ CCD camera system for the automatic control of the fabric density and shrinkage (overfeed) control.