Copper enriched medicinal herbal treated garments for selective skin diseases

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Copper enriched herbal treated garments have been produced using alternate medical concepts to cure selective skin diseases. The extracts of three medicinal herbs, such as marigold, peppermint and camphor, have been imparted into the bamboo, micro-denier polyester and blends of bamboo and micro-denier polyester knitted fabrics by exhaust or direct application and by microencapsulation using pad – dry – cure method. Microcapsules are produced using herbal extracts as core and gum acacia as wall material. Structure of microcapsules has been evaluated using polarized microscope, and the presence of copper by FTIR spectroscopy, scanning electron microscope confirms the binding and availability of microcapsules on the fabrics. The antimicrobial efficacy by quantitative method in terms of bacterial reduction and the clinical trials also confirm the curative performance and antimicrobial activity of the treated samples.

Keywords: Bamboo, Camphor, Copper, Curative garments, Micro-denier polyester, Microencapsulation, Marigold, Peppermint

1 Introduction

Medical textiles are the products and constructions used for medical and biological applications and are used primarily for first aid, clinical and hygienic purposes. They consist of all the textile materials used in health and hygienic applications in both consumer and medical markets. Now-a-days due to environmental pollutions and global warming there is increase in global temperature and depletion in ozone layer which causes UV rays to enter into earth atmosphere. Higher temperature and UV rays cause various skin diseases amoung peoples. So many treatments are available to cure these diseases. But these treatments are not found to be good as they cause side effects and difficulties during treatment. Hence, it is necessary to look for another kind of painless treatment¹.

Human skin has small pores on its outer layer. If we apply any medicine on the skin, it absorbs only the required amount of dosage. Hence, dosage problem is not there, however, it is the main concern in allopathy treatments. To protect the mankind from skin diseases and to avoid cross infection, a need to apply herbal finish like copper herbs has become necessary³.

Copper plays an important role in curing many diseases, gives energy to the body and balances the nerves system¹. This is tested and confirmed by ayurvedha specialists²,³. Hence, extracts of copper based herbs are coated on the knitted fabrics by using direct application or exhaust and microencapsulation technique⁴,⁵. Copper enriched herbs like marigold flower (Tagetes erecta), peppermint leaves (Mentha piperita) and camphor (Borneo camphor) have been used; the amounts of copper content present in the plants are fund to be 7.50, 6.75 and 5.30 % respectively for the above three herbs. The herbal extracts have been applied on scoured bamboo, bamboo/micro-denier polyester (70:30) and micro-denier polyester knitted fabrics and their antimicrobial efficacy is studied.

2 Materials and Methods

2.1 Materials

Scoured bamboo (100%), bamboo / micro-denier polyester (70:30) and micro-denier polyester (100%) knitted fabrics were used to obtain curative garments with antimicrobial finish. The flower petals of marigold (Tagetes erecta), leaves of peppermint (Mentha piperita), and seeds of camphor (Borneo camphor) were used for antimicrobial finish for curative garments. These plants were locally collected.

2.2 Extraction Process

The collected herbs were shadow dried within a temperature range 30- 40°C. The moisture content of
the herbs collected was reduced to less than 14% with proper drying since most of the herbs have 60 – 80% moisture content and cannot be stored without drying. Proper drying has to be carried out otherwise important compounds may get contaminated. After drying, the grinding was carried out to break down the flower petals of marigold, leaves of peppermint, and seeds of camphor into very small units ranging from coarse fragments to fine powder. The powdered plant material was extracted with methanol by adding 20g of herbal powder in 100mL of methanol for 24h to separate the alkaloids.

2.3 Direct Application Method

The extracts of marigold, peppermint and camphor were applied onto the fabric at 40ºC by pad–dry–cure method with material–to–liquor ratio of 1:20. After padding for 30min, the samples are taken out and dried at room temperature.

2.4 Microencapsulation Method

Microencapsulation was done using marigold, peppermint, camphor extract as core material and gum acacia as wall material. The wall material was allowed to swell for half an hour by mixing with 100mL of hot water. To this mixture, 50mL of hot water was added, followed by stirring for 15min maintaining the temperature between 40ºC and 50ºC. Then 10mL of core material was added and stirred at 300 – 500 rpm for further 15min followed by drop – wise addition of 20% sodium sulphate solution (10mL) for 5–10min. The stirrer speed was reduced and then 5mL of 17% formaldehyde was added. The stirrer was stopped and mixture was freeze – dried. The bamboo, micro-denier polyester, and bamboo / micro-denier polyester knitted fabrics were immersed in the microcapsule solution using pneumatic padding mangle, squeezed and then dried in room temperature.

2.5 Analysis of Microcapsules and Microcapsules-treated Fabric

Microcapsules were examined under the different magnifications using polarized light microscopy to analyse the morphology of capsules. The morphology of microencapsulated treated fabric was analysed using scanning electron microscope SEM (Model JEOL-JSM-6396). The observation was performed in high vacuum mode with secondary electron detector and accelerating voltage of 3-10 kV. The Fourier transform infrared spectrometer (Model SHIMADZU – FTIR – 8400S) was used at a spectral range 4000 – 400 cm\(^{-1}\) and resolution 0.9 – 1 cm.

2.6 Assessment of Antimicrobial Activity and Clinical Trial

Swatches of untreated materials were qualitatively assessed by agar diffusion method (SN195920) for Gram positive bacteria (Staphylococcus aureus) and Gram negative bacteria (Escherichia coli). The activity was evaluated quantitatively after 24 h of incubation at 28ºC. A clear area of uninterrupted growth was observed underneath and along the side of the test material, indicating the antibacterial effectiveness of the fabric. The area of the inhibition zone is a measure of antibacterial effectiveness of the material.

The antimicrobial activity of fabric samples was assessed after washing the treated samples using Laundrometer at a speed of 40 rpm, with ISO 3 test method. The samples were than withdrawn after the specified number of wash cycles and washed thoroughly before further assessment. Simultaneously the treated samples were made into garments and given to the patients having selective skin diseases, like allergic dermatitis, detergent allergy in hands (chemical allergy), parthenia allergy, and psoriasis for clinical trials.

3 Results and Discussion

3.1 Evaluations of Microcapsules and Microencapsulated Samples

The conventional light microscope and scanning electron microscope have been used to analyse the shape and distribution of the microcapsules. Both methods are used to analyze the core and outer structure (wall) of microcapsules. Figure 1 shows the
microcapsules of copper enriched herbs extract as a core material and gum acacia as a wall material. It is clear from the figures that microcapsules produced are of small spherical shape with a fairly uniform size distribution. The presence of binding and availability of microcapsules on the fabric are analyzed using scanning electron microscopy. The SEM photographs are shown in Fig. 2 at magnification level of ×5 µm. It indicates clearly that the microcapsules are present in interstices of the fibre assembly of fabric.

The FTIR analyses (Fig.3) indicate that the treating materials having excellent amount of copper content are present in interstices of the fibre assembly of fabric. Fourier transform infrared spectroscopy of marigold treated fabric shows the highest peak at 3842.02 cm\(^{-1}\) and it decreases to 421.39 cm\(^{-1}\), this shows the major copper zone. Peppermint treated fabric also shows the highest peak in 3845.67 cm\(^{-1}\) and it decreases to 438.41 cm\(^{-1}\). The camphor treated fabric shows the highest peak is in 3936.57 cm\(^{-1}\) and it decreases to 433.49 cm\(^{-1}\). All the samples show presence of copper content as evidenced by the presence of characteristics band 15-17.

### Table 1—Antimicrobial efficacy of exhaust or directly applied and microencapsulated fabrics

<table>
<thead>
<tr>
<th>Fabric</th>
<th>Exhaust method</th>
<th>Microencapsulation</th>
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<tbody>
<tr>
<td></td>
<td>S.aureus</td>
<td>E.coli</td>
</tr>
<tr>
<td>Bamboo knitted fabric</td>
<td>34</td>
<td>27</td>
</tr>
<tr>
<td>Micro-denier polyester knitted fabric</td>
<td>30</td>
<td>24</td>
</tr>
<tr>
<td>Bamboo / Micro-denier polyester knitted fabric</td>
<td>33</td>
<td>27</td>
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### 3.2 Antimicrobial Efficacy of Direct and Microencapsulated Herbal Extracts

Table 1 shows the antimicrobial activity, and zone of inhabitation of direct and microencapsulated copper enriched herbal treated samples. It is clear that the fabric treated with herbal extracts, applied using microencapsulated pad – dry – cure method and using direct applied or exhaust method how better activity against Staphylococcus aureus than against Escherichia coli. Also, bamboo, and 70/30 bamboo + micro-denier polyester fabrics have higher zone of inhibition as compared to micro-denier polyester 11-13.

### 3.3 Evaluation of Field Trail

Garment made from microencapsulated fabric is given to the various patients having various skin diseases, like allergic dermatitis, detergent allergy in hands (chemical allergy), parthenia allergy, and psoriasis. The results are shown in Table 2. The biochemical properties of copper enriched herbal extracts can be elucidated and its exact role in the mechanism of curing the diseases can be well established. This work is an alternative method of drug delivery, which minimizes the
side effects produced by the intake of the herbal extracts through oral route. Based on the clinical trial, it is observed that the activity of copper enriched herbal treated garments is lasted upto 10 -15 washes for all the washable knitted garments as shown in Table 3. This is because the use of non – ionic detergents for washing helps the garment to retain the curative performance.

Table 2—Field trail results

<table>
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<tr>
<th>Herbs</th>
<th>Disease</th>
<th>Result</th>
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<tbody>
<tr>
<td>Marigold</td>
<td>Allergic dermatitis</td>
<td>85% (Good)</td>
</tr>
<tr>
<td>Peppermint</td>
<td>Detergent allergy in hands (chemical allergy)</td>
<td>64% (Average)</td>
</tr>
<tr>
<td>Camphor</td>
<td>Parthenia allergy</td>
<td>92 % (Excellent)</td>
</tr>
<tr>
<td>Camphor</td>
<td>Psoriasis</td>
<td>60% (Average)</td>
</tr>
</tbody>
</table>

Fig. 3—Fourier transform infrared spectroscopy of (a) marigold, (b) peppermint, and (c) camphor
4 Conclusion

The assessment of antimicrobial activity of copper enriched herbs treated samples exhibits a better performance for selective skin diseases. 100% bamboo and 70/30 blends of bamboo and micro-denier polyester fabrics have higher zone of inhibition as compared to 100% micro-denier polyester. The bio-chemical properties of copper enriched herbal extracts can be elucidated and its exact role in the mechanism of curing the diseases can be well established. This work is an alternative method of drug delivery, which minimizes the side effects produced by the intake of the herbal extracts through oral route.

Acknowledgement

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References