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Herbal treated microbial resistant fabrics for healthcare textiles

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This study deals with the effect of coating herbs on single jersey knitted fabric to evaluate the microbial resistance nature of healthcare textiles. In this work four types of herbs were identified such as Neem (*Azadirachta indica* A. Juss.), *Konrai* (*Cassia fistula* L.), *Henna* (*Lawsonia inermis* L.) and Papaya (*Carica papaya* L.). The application methods were adopted in both direct/exhaust (aqueous and methanol with citric acid is a cross linking agent extract) and microencapsulation of herbal extracts on single jersey knitted fabric by pad-dry-cure method. Herbal treated fabrics underwent SEM analysis and antimicrobial activity (both quantitative and qualitative) was conducted. The treated samples were evaluated for wash durability by AATCC–100–2004. The microencapsulated treated fabrics showed better antibacterial activity up to 15 washes compared to directly applied, aqueous and menthol extract treated fabrics.

Keywords: Antimicrobial finish, Herbal, Microencapsulation, Pad-dry-cure, Textile.

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Introduction

Recovery and purification of active ingredients/components from herbs material are typically accomplished through various extraction techniques. Solvent extraction is the most commonly used technique for isolation of plant compounds[1-3]. However, extract yields are strongly dependent on the extraction solvent used as different compounds with various chemical characteristics and polarities may or may not be soluble in a particular solvent. Solvent polarity plays a key role in increasing the solubility of a compound[3-5]. Water along with aqueous mixtures of methanol is commonly used extraction solvents[6]. Microencapsulation is a rapidly expanding technique that is mostly applicable in hygiene textiles. The uniqueness of microencapsulation is the smallness of coated particles and it gives a stability packing, spreading and storing materials on microscopic scale for later release specific controlled condition, after converting these herbs into microcapsules, coating on the single jersey fabric by using pad–dry–cure method[6-9]. The present research is concentrated on developing microbial resistance healthcare textiles.

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Materials and Methods

Scoured, bleached 100 % cotton single jersey knitted fabric (count 40^s, WPI 42, CPI 56 and GSM of 171.6) was used for the application of curative fabrics. The medicinal herbs, Neem (*Azadirachta indica* A. Juss.), *Konrai* (*Cassia fistula* L.), *Henna* (*Lawsonia inermis* L.) and Papaya (*Carica papaya* L.) were sourced from the organic farms of Tamil Nadu and Kerala. The herbs were washed, shadow dried, then powdered.

Aqueous extraction

Ten gram of plants powder was added to 100 mL of distilled water and mixed well. After 24 h the supernatant was collected and concentrated to make the crude extract and stored at 4 ^oC.

Methanol extraction

Ten gram of plants powder was added to 100 mL of methanol in a conical flask and plugged with cotton wool. After 24 h the supernatant was collected and the solvent was evaporated to make the crude extract and stored at 4 ^oC.

Microencapsulation method

Microcapsules were formed by using polymer interface method. Microencapsulation was done using the herbal extracts of *A. indica* A. Juss., *C. fistula* L., *L. inermis* L. and *C. papaya* L. as core

material and gum acacia as wall material[1-3]. 10 g of wall material (gum acacia) was allowed to swell for half an hour by mixing with 100 mL of hot water. To this mixture, 50 mL of hot water was added, stirred for 15 min maintaining the temperature between 40 and 50 ºC. 10 mL of core material was added and stirred at 300-500 rpm for further 15 min, followed by drop-wise addition of 20 % sodium sulphate solution (10 mL) and it was stirred for 5-10 min. The stirrer speed was reduced and then 5 mL of 17 % glycerol was added. After that, stirrer was stopped and the mixture was freeze–dried.

Application method

100 % cotton single jersey knitted fabric was used and the application method used for all the three treatments namely aqueous extract, methanol extract using 8 % citric acid as a cross linking agent and microencapsulation was pad-dry-cure method. The fabrics were first washed with normal water and squeezed, then immersed in the extract or microencapsule solution as per the treatment. Then the fabric is padded through padding mangle with an expression of 80 % wet pickup. After padding the samples were taken and dried at 80 ^{o}C for 10 min and cured at 150 ^{o}C for 3 min.

Wash durability

This method had a material to liquor ratio of 1:30 with 0.2 % detergent using 1993 AATCC standard reference detergent. The washing machine condition used was as follws - water level: 18±1 gpl, agitator speed: 179±2 rpm, wash time: 12 min, spin speed: 645±15 rpm, final spin cycle: 5-6 min. One laundering cycle included subsequent steps of 5 min of laundering, 2 min of rinsing followed by another 2 min of rinsing and tumble drying.

Evaluation methods

Analysis of microcapsules and SEM studies

Microcapsules were examined under different magnifications using polarized light microscopy to analyze the morphology. The morphology of microcapsules treated samples were analyzed using high resolution Scanning Electron Microscope (SEM) JEOL - M - JSM 6360 with a high-energy beam of electrons in a raster scan pattern. The SEM was used for confirming the binding, alignment and availability of microcapsules on the fabric sample.

Antimicrobial property assessment

To analyze the antimicrobial activity, the samples were subjected to Agar Diffusion test (SN 195920). The organisms used in both the tests were, *Staphylococcus aureus* (ATCC 6538) and *Escherichia coli* (ATCC 11230). Both these bacteria cause most of the hospital infections[4]. The former is used as a representative Gram positive organism and the later is used as a representative Gram negative organism. The evaluation of agar diffusion test was made on the basis of zone of inhibition of bacteria around the test sample.

All the herbal treated samples were tested for quantitative analysis of antibacterial activity against *S. aureus* and *E. coli* (AATCC–100). Treated and control samples were inoculated with test organisms. After incubation, the bacteria were eluted from the swatches by shaking in known amounts of neutralizing solution. The number of bacteria present in this liquid was determined and the percentage reduction by the treated specimen was calculated. The bacterial counts were reported as the no. of bacteria/sample (swatches in jar) and not as the no. of bacteria/mL of neutralizing solution. '0' counts at 100 dilution was reported as "less than 100". The percentage reduction (*R*) of bacteria by the specimen is calculated using the following formula:

$$R = 100\ (B-A)/B$$

where, *A* is the number of bacteria recovered from the inoculated treated test specimen swatches in the jar incubated over the desired contact period; and *B*, the number of bacteria recovered from the inoculum treated test specimen swatches in the jar immediately after inoculation (at '0' contact time).

Results and Discussion

Evaluation of microcapsules and microcapsules- treated Fabric

The polarized light microscope and SEM have been used to analyse the size, shape and distribution of the microcapsules. The Table 1 and Plate 1 show

Table 1—Average size of microcapsules

S. No.	Core material	Magnification range	Average size of capsules
1	*A. indica* A. Juss.	400X	8.12 µm
2	*C. fistula* L.	400X	7.72 µm
3	*L. inermis* L.	400X	7.17 µm
4	*C. papaya* L.	400X	7.52 µm

Table 2-Antimicrobial efficacy of qualitative and quantitative analysis of herbal treated fabric

S. No.	Herbs	Method of extraction	Antibacterial activity qualitative and quantitative			
			Staphylococcus aureus		*Escherichia coli*	
			(Zone of incubation– mm)	Bacterial reduction %	(Zone of incubation– mm)	Bacterial reduction %
1	*A. indica* A. Juss.	Aqueous extract	37	100	30	72.83
		Methanol extract	34.5	85.52	32	79.17
		Microencapsulation method	30	70.84	28	61.51
2	*C. fistula* L.	Aqueous extract	34	87.5	27	58.33
		Methanol extract	32	80.29	29	66.17
		Microencapsulation method	29	68.56	26	54.57
3	*L. inermis* L.	Aqueous extract	31	75	26	52.36
		Methanol extract	29	63.26	27	55.14
		Microencapsulation method	26	53.35	25	51.26
4	*C. papaya* L.	Aqueous extract	30	71.06	26	50.61
		Methanol extract	28	64.27	26	51.84
		Microencapsulation method	29	69.41	24	50.22

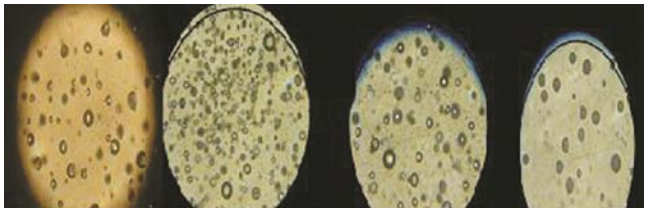

Plate 1—Images of Microcapsules (herbal extracts core material and gum acacia as wall material)

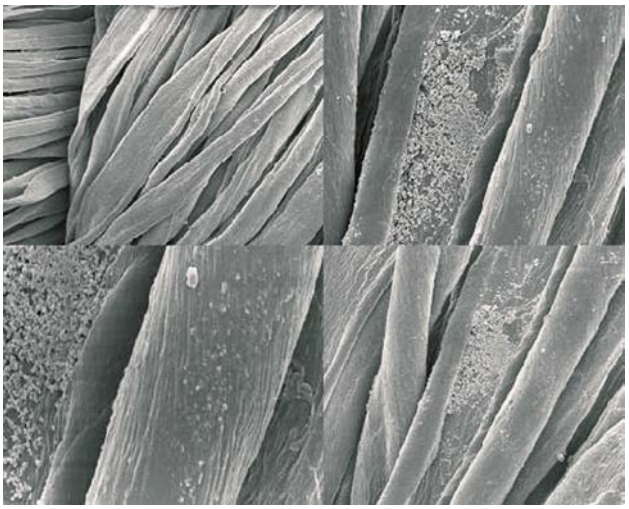

Plate 2—SEM photographs of untreated and microencapsulated herbal treated fabrics

the average size and structure of microcapsules, which contains herbal extract as core material and gum acacia as wall material. It is clear from the figures that microcapsules produced are of small spherical shape with a fairly uniform size distribution.

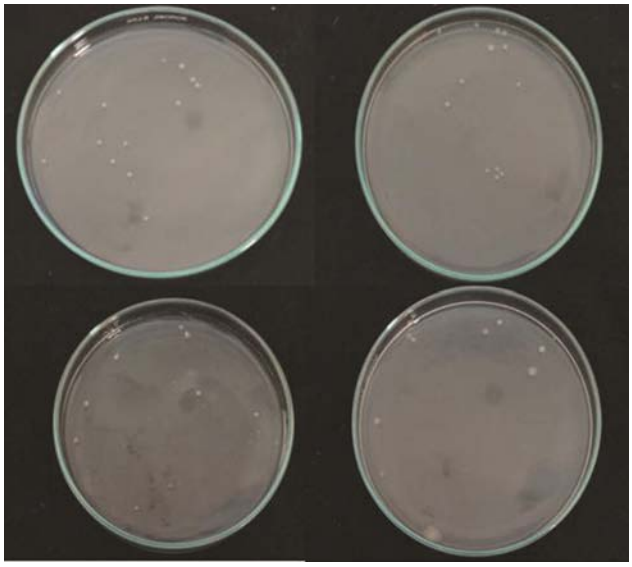

Plate 3—Bacterial reduction % of herbal treated fabrics, (a) *A. indica* A. Juss., (b) *C. fistula* L., (c) *L. inermis* L. and (d) *C. papaya* L.

The presence, binding and availability of microcapsules on the herbal treated fabric analyzed using SEM indicated that the microcapsules are present in spaces of the fiber assembly of fabric as shown in Plate 2.

Antimicrobial efficacy of extracts treated samples

Table 2 shows the antimicrobial efficacy in terms of zone of inhibition (qualitative analysis) and bacterial reduction % (quantitative analysis) of *A. indica* A. Juss., *C. fistula* L., *L. inermis* L. and *C. papaya* L. extract treated fabric samples. Plate 3 shows the antimicrobial activity (bacterial reduction %) of herbal

treated samples against on *S. aureus* and *E. coli*. It is clear that the aqueous and methanol extract applied fabric showed better activity than microencapsulated fabrics because the encapsulated fabrics will release the core material after one or two washes. The bacterial reduction % (antimicrobial activity) of both water and methanol extract and microencapsulated herbal treated samples were assessed after each 5 and 10 washes by using agar diffusion test[1-3]. It was observed that the microbes resistant activity of directly extract treated samples didn't show much better activity after 15 washes because the herbs extracts were coated only on the surface and core of the fibre assembly. Microencapsulated samples showed higher bacterial reduction even after 15 washes against *S. aureus* and *E. coli*[3,10].

Conclusion

In the present study four medicinal herbs, *A. indica* A. Juss., *C. fistula* L., *L. inermis* L., *C. papaya* L. have been selected for evaluation of microbial resistance performance of healthcare textiles. Herbal extraction was done with aqueous and methanol that was applied on the naturally scoured, bleached 100 % cotton single jersey knitted fabric with citric acid as a cross linking agent. Microencapsulation of herbal extracts were prepared and applied on knitted fabric using pad-dry-cure method. The conventional light microscope and SEM was used to analyse and confirm the size, shape and distribution of the microcapsules. The SEM study confirms the presence, binding and availability of microcapsules on the herbal treated fabric, which were present in interstices of the fiber assembly of fabric. The antimicrobial efficacy in terms of zone of inhibition (qualitative analysis) and bacterial reduction % (quantitative analysis) for herbal treated fabric samples were analysed and compared with microencapsulated, aqueous and methanol extracts method which revealed that the microencapsulated samples retained their activity even after 15 washes.

References

1. Ganesan P, Tamil Selvi C and Ramachandran T, Microencapsulation of copper enriched herbals for curative garments, *Indian J Trad Knowledge*, 2012, **11** (3), 532-536.
2. Ganesan P, Ramachandran T, Karthik T and Kandha Vadivu P, Extraction of copper enriched seeds for healthcare textiles, *Indian J Fibre Text Res*, 2013, **38**(3), 313-316.
3. Ganesan P, Ramachandran T, Karthik T, Prem Anand V S and Gowthaman T, Process optimization of *Aerva lanata* extract treated textile material for microbial resistance in healthcare textiles, *Fibres Polymers*, 2013, **14**(10), 1663-1673.
4. Chandrasekaran K, Ramachandran T, Vigneswaran C, Effect of medicinal herb extracts treated garments on selected diseases, *Indian J Trad Knowledge*, 2012, **11**(3), 493-498.
5. Thilagavathi G and Krishna Bala S, Microencapsulation of herbal extracts for microbial resistance in healthcare textiles, *Indian J Fibre Text Res*, 2007, **32**, 351-354.
6. Sultana B, Anwar F and Ashraf M, Effect of extraction solvent/technique on the antioxidant activity of selected medicinal plant extracts, *Molecule*, 2009, **14**, 2167-2180.
7. Yang J, Kim J S, Sa Y J, Kim M O, Jeong H J, Yu C Y and Kim M J, Antioxidant, antibacterial and α-glucosidase inhibitory activities of different extracts of Cortex Moutan, *Afr J Biotechnol*, 2011, **10** (46), 9438-9444.
8. Gupta D, Antimicrobial treatment for textiles, *Indian J Fibre Text Res*, 2007, **32**, 254-263,
9. Oktem T, Surface treatment of cotton fabrics with chitosan, *Colouration Technol*, 2003, **119**, 241-245.
10. Kavitha T, Padmashwini R, Swarna A, Giri Dev V R, Neelakandan R and Senthil Kumar M, Effect of chitosan treatment on the properties of turmeric dyed cotton yarn, *Indian J Fibre Text Res*, 2007, **32**, 53-56.
11. Harbone J B, Phytochemical Methods, Chapman and Hill, London, 1973.
12. Mohanraj S, Vanathi P, Sowbaringa N and Saravanan D, Antimicrobial effectiveness of *Vitex negundo* leaf extracts, *Indian J Fibre Text Res*, 2012, **37**, 389-392.
13. Antibacterial finishes on textile material, AATCC Technical manual, 2005, **80**, 149-151.
14. Ramachandran T, Rajendrakumar K and Rajendran R, Antimicrobial Textiles–An overview, *IE (I) J – TX*, 2004, **84**, 42-47.
15. Manonmani K, Jayasekhar M, Gailce Leo J C and Thangaselvabai T, Identification of Active Principle in the herbal extracts possessing bactericidal action against citrus canker, *Xanthomonas axonopodis* pv. *Citri*, *Indian J Agric Res*, 2009, **43**(2), 129-133.
16. Ganesan P and Ramachandran T, Copper enriched medicinal herbal treated garments for selective skin diseases, 2014, **39**, 185-189.
17. Ganesan P and Kavipriya, G, Modification of textiles using functional finishes, *Text Excel*, 2008, **6**(5), 13-15.
18. Lam K, Cheng S Y, Lam P L, Yuen M C W, Wong R S M, Lau F Y, Lai P B S, Gambari R and Chui C H, Microencapsulation: past, present and future, *Minerva Biotechnol*, 2010, **22**(1) 23-28.