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Antimicrobial Micro Encapsulated cellulosic Textiles

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Abstract: ***Increasing global competition in textiles has created many challenges for textile researchers. Novel finishes of high added value for apparel fabrics are also greatly appreciated by the most demanding consumer market. In the present study an attempt was made to finish cotton textiles with microcapsules from plant sources with combination of gum sources to impart the antimicrobial finish. Microcapsules were prepared with plant sources as a core material and gum sources as wall material at two different concentrations. Scanning Electron Microscope (SEM) at 1600 to 8500 magnification revealed that the microcapsules were between 1.24µm to 2.29 µm. Increase in gum percent resulted in increase in size of microcapsule. Finish was applied to woven and knitted textiles using pad-dry-cure method with curing at 35° to 40°C. The antibacterial activity was evaluated by a modified qualitative test method AATCC-147, 2004 for the growth inhibition and AATCC-30, 2004, for anti fungal activity against both Staphylococcus aureus and Escherichia coli. Antibacterial bacterial activity was found to be zero in both untreated woven and knitted fabrics. Among the treated fabrics, periwinkle with all gum sources showed higher Zoi against E.coli over S. aureus in both woven and knitted fabrics. Fabrics finished with microcapsules with 5 per cent gum as wall material had high Zoi than their counter parts. Treated knitted samples performed better than woven samples for all sources.***

Keywords: Micro encapsulation, Antimicrobial, cellulosic textiles, Staphylococcus aureus, Escherichia coli, Natural gum, plant

1. Introduction

Today, in the era of eco-friendliness, it has become very important for human beings also to live in a world of hygiene and freshness. The major hindrance that comes in their way is microorganisms, which are the causative agents of deterioration, staining and odour. Apart from this effect, microbes also cause harm to human being by transmitting diseases and infections. So it became very important to finish all garments where the chance of bacterial growth is high, and safety is of paramount importance.

A novel approach to the control release of the antimicrobials is the microencapsulation. In this technique, the active agent forms the core while a protective layer, the wall material is present over this core layer. The core material migrates to the outer layer as needed when the agent is leached out by water or by other means.

Microcapsules can be applied to textiles by padding, coating, spraying or immersion without altering their feel or colour. Use of natural materials for finishing is the hour of the day due to ill effects of synthetic materials and their impact on environment.

Finishing textiles using the plant material extract would reduce the effect of textiles from microbial attack. But the impact would not continue for more than one wash due to the agents solubility in water. Hence means and ways were looked into for a greater durability of these finishes. Microencapsulation is one among them with promising results.

Thilagavathi *et al.* (2007) studied that herbal extraction exhibited potential for anti microbial activity against *Staphylococcus aureus* and *Escherichia coli* in clearly measurable terms. Durability test comparing microencapsulated and directly applied herbal extracts methods revealed that the microencapsulated samples retained their activity for more than 15 washes.

Sathianarayanan *et al.* (2010) studied the anti bacterial finish for cotton fabric from herbal products. Herbal extracts from ocimum sanctum (Tulasi leaf) and rind of punica grantum (pomegranate) have been applied to cotton fabric by the method of direct application, micro-encapsulation, resin cross linking and their combinations. All the treatments showed good antibacterial properties for the fabrics except the method of direct application; with wash durability up to 15 washes. Krishnaveni and Asamani (2010) used Indian acalypha as herbal antimicrobial finish of garment for skin disease. A 100 per cent treated samples exhibited maximum antimicrobial activity in all the tests.

2. Materials and Methods

Plain woven and knitted cotton fabric were used for application of microencapsulated antimicrobial finish. The leaves (*Punica granatum, Cassia ariculata* and *Catharanthus roseus)* and gums (Gum acacia, Guar gum and bagawathi gum) were used. These plants were collected in and around Hyderabad. The collected leaves were cleaned with ethyl alcohol (ethanol) and distilled water in a proportion of 1:10 and dried in tray drier at 50°C temperature. The dried leaves were ground into powder and prepared microcapsules using nano particle nucleated microencapsulation technique.

Samples were analyzed with scanning electron microscope (SEM – Model: JEOL-JSM 5600) at required magnifications as per the standard. Bacterial activity was evaluated by a modified qualitative AATCC 147 test method for the growth inhibition of *Escherichia coli* and *Staphylococcus aureus*.

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3. Results and discussion

The results revealed that there was no *Zoi* observed for both woven and knitted untreated samples.

1. Antibacterial activity of treated woven fabric against *S. aureus* and *E.coli.*

The combinations of the all plant and gum sources have registered highest *Zoi* against *E. coli* over *S. aureus* in the capsulated form. Microcapsules prepared with 5 per cent gum sources as wall material with all plant sources showed high *Zoi*'s than 10 per cent concentrations. Microencapsulated material of PW with all gum sources at both concentrations on woven samples showed good antibacterial activity with a Zoi of 7 to 10 mm.

2. Antibacterial activity of treated knitted fabric against *S. aureus* and *E.coli*

***Zoi* in mm**							
Plant sources		**G.A 5%**	**G.A 10%**	**G.G 5%**	**G.G 10%**	**BG 5%**	**BG 10%**
PG	***S. aureus***	5	2.5	2	2	3	1.5
	E.coli	5	2	6	6	7	3
CS	***S. aureus***	2.5	3	4.5	3.5	2	1.5
	E.coli	5	3.5	2.5	2	6	3.5
PW	***S. aureus***	2.5	1.5	3.5	2	6.5	5
	E.coli	13	7	12	3	10	9

he highest *Zoi* was found in the PW with combination of all the gums ranging from 3 to 13 mm against E. *coli* over *S. aureus*. The plant sources of CS, PG with BG at 10 per cent concentration against *S. aureus* showed least *Zoi* than others. The results also indicated that microcapsules prepared with 5 per cent gum sources with all plant sources yielding high *Zoi*'s than their 10 per cent concentration.

3. Antibacterial activity of treated woven fabric after first wash against *S. aureus* and *E.coli*

Zoi in mm							
Plant sources		G.A 5%	G.A 10%	G.G 5%	G.G 10%	BG 5%	BG 10%
PG	S. aureus	3.5	1.5	2	2	2	0
	E.coli	4	1.5	6	5.5	5.5	2
CS	S. aureus	3	3	1.5	1.5	4	2.5
	E.coli	3	2.5	1.5	1.5	4	3
PW	S. aureus	1.5	4	2.5	2	5.5	5
	E.coli	9	8	7	8	9	8

Treated woven samples had slightly low *Zoi* compared to their unwashed samples. Samples treated with PG and BG at 10 per cent concentration showed no *Zoi* while samples treated with PW and BG, GA at 10 per cent retained its antimicrobial property.

4. Antibacterial activity of treated knitted fabric after first wash against *S. aureus* and *E.coli*

Zoi in mm							
Plant sources		G.A 5%	G.A 10%	G.G 5%	G.G 10%	BG 5%	BG 10%
PG	*S. aureus*	4	1.5	1.5	1.5	2.5	0
	E.coli	4	2	5	5	6	2.5
CS	*S. aureus*	2	2	1.5	1.5	4	2.5
	E.coli	3	2.5	2	1.5	3	3.25
PW	*S. aureus*	5	1	3	1	5	5
	E.coli	9	8.5	5	10.5	9	8.5

The antibacterial activity of the treated fabric was reduced after the first wash. The combination of PW with all gum sources showed highest *Zoi* against E. coli over *S. aureus*. No *Zoi* was found in 10 per cent of BG with PG. Bacterial activity doubled in PW + GA at 5 per cent against *S. aureus* and PW + GG at 10 per cent against *E. coli.* This may be due to rupture wall material releasing the core material during the wash.

Table 5: Antibacterial activity of treated woven fabric after fifth wash against *S. aureus* and *E.coli*

Zoi in mm							
Plant sources		G.A 5%	G.A 10%	G.G 5%	G.G 10%	BG 5%	BG 10%
PG	*S. aureus*	1	0	1	1.5	1	0
	E.coli	1	1	1.5	2	2.5	1
CS	*S. aureus*	2	1.5	0.5	0.5	2	1.5
	E.coli	1.5	1.5	0.5	0.5	1.5	1
PW	*S. aureus*	3.5	0.5	2	1	2.5	2
	E.coli	2	3	3	2	3	3

Antibacterial activity decreased in all combinations against to both organisms compared to first and third wash. PW with all combinations of gum was found to have high *Zoi* and least results were found in CS with GG at 5 and 10 per cent for the both the organisms.

6. Antibacterial activity of treated knitted fabric after fifth wash against *S. aureus* and *E.coli*

Zoi in mm							
Plant sources		G.A 5%	G.A 10%	G.G 5%	G.G 10%	BG 5%	BG 10%
PG	*S. aureus*	2.5	1	1.5	1.5	1.5	0
	E.coli	1.5	1	1.5	1.5	2	1.5
CS	*S. aureus*	2	1.5	1	1	3	2.5
	E.coli	2	1	0.5	0.5	1	1
PW	*S. aureus*	10.5	1	10	2	4	3.5
	E.coli	2	2.5	3	1.5	3.5	2.5

Antibacterial activity remained the same for PW with all gum sources at both the concentrations against *S. aureus*. It has been observed throughout that knitted samples have retained good antibacterial activity over woven samples.

7. Antibacterial activity of treated woven fabric after ten washes against *S. aureus* and *E.coli*

Zoi in mm							
Plant sources		G.A 5%	G.A 10%	G.G 5%	G.G 10%	BG 5%	BG 10%
PG	*S. aureus*	1	0	1	0	1	0
	E.coli	1	1	1	0	1.5	0
CS	*S. aureus*	1	0	0	0	0	0
	E.coli	1.5	0	0	0	1.5	0.5
PW	*S. aureus*	1.5	1	1.5	0	2	2
	E.coli	1.5	0	1	0	0	0

Guar gum with the combination of all plant sources did not show any *Zoi* against both the organisms at 10 percent level. All plant sources with 5 per cent GA were found to have high *Zoi* among all treatments against both organisms though the *Zoi* had decreased compared to previous washes.

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8. Antibacterial activity of treated knitted fabric after ten washes against *S. aureus* and *E.coli*

		Zoi in mm					
Plant source		G.A 5%	G.A 10%	G.G 5%	G.G 10%	BG 5%	BG 10%
PG	*S. aureus*	0	0	0.5	0	0	0
	E.coli	1	0	1.5	1	1	0
CS	*S. aureus*	0	0	0	0	0	0
	E.coli	0	0	0	0	1	0.5
PW	*S. aureus*	1.5	0	0	1	0	0
	E.coli	1	0	0	0	2.5	2

Contrary to the results of woven samples, in knitted fabric An alarming decrease was found in PW+GA 5 per cent and PW+GG 5 per cent followed by PW+BG 5 and 10 per cent concentrations. Fabrics treated with CS and gum sources showed no *Zoi* except those with BG at both concentrations. All the treated samples with all combinations indicated decrease of *Zoi* after each wash cycle.

4. Conclusion

There is a demand for eco friendly textiles because of growing needs of people in aspects health and hygiene. This study indicated that antimicrobial property can be imparted to cotton woven and knitted fabrics through microencapsulation of natural agents like pomegranate, cassia, periwinkle as core material with combination of wall materials, gum acacia, guar gum and bagawathi gum. It was found that all the treated samples with all combinations indicated better *Zoi* in each wash cycle. Few samples registered increase of *Zoi*. Fabric treated with all plant sources with 5 per cent GA were found to possess high *Zoi* among all treatments in woven samples against both organisms, even after ten washes. The difference of *Zoi* was observed between the concentrations of gums used. Samples treated with microcapsules with 5 per cent gum showed better *Zoi* than 10 per cent gum.

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