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Sustainable Textiles: Antimicrobial Finishes Using Natural Resources

S. V. Chavan & P. V. Kadole

Abstract
Textile materials whether natural or synthetic are prone to attack of microoraganisms like bacteia, fungi, algae, dust mites etc. These microorganism grow on textile substrates under specific conditions of storage as well atmosphere. In rainy season the problem is more accute as drying of clothing takes long time due to which unwanted odour is imparted to the colthes and surface staining also occurs. Such clothes can cause problems to the skin of wearer which generally results in etching of skin, irritation, skin allergies etc. The problem is severe in case of textile materials used for sanitaion purpose such as sanitary napkin, diapers which are directly in contact with skin and the area is humid and warm which is prone to get attacked easily by microbes. Hence tretament with antimicrobial agents play an important role in case of textile substrates. Considering sustainable processing, this work deals with treatment of textile substrates with natural antimicrobial agents like Tulsi (Ocimum Sanctum) and Neem (Azadirachta Indica) extracts. The ethanolic extraction process is adopted to get the antimicrobial agent from Neem (Azadirachta Indica) and Tulsi (Ocimum Sanctum) These natural antimicrobials agents are applied by Pad - Dry
Cure technique and the antimicrobial perfromance is tetsted by test method AATCC 147. It is found that these agents exhibited good antimicrobial properties against gram positive and gram negative bacteria.

Keywords: Antimicrobial finish; Sanitary napkin; Neem (Azadirachta Indica); Tulsi (Ocimum Sanctum); Sustainable processing

Introduction

The use of antimicrobial finishing on fabric is aimed at preventing the growth of various microorganisms such as bacteria, viruses, fungi, algae, mold, and mildew. Different antimicrobial agents are applied to fabrics using various processes, and their effectiveness can vary. Some antimicrobials work by leaching or moving from the surface they are applied on, poisoning microorganisms in the process. However, a bound unconventional antimicrobial technology, specifically an organo-functional silane, works differently. It remains affixed to the substrate, killing microorganisms upon contact and maintaining its effectiveness over time without leaching or diminishing. This technology polymerizes with the substrate upon application, creating an antimicrobial surface. It is particularly useful in textiles that come into contact with humans or require durability. The antimicrobial finishing of textiles is generally done for antimicrobial treatment for fabric is done to control microorganisms, to reduce odour from perspiration, stains and other soil on textile material, to reduce the risk of cross infection being carried by feet from ward to ward in hospital, to control spread of disease and danger of infection following injury, to control the deterioration of textiles particularly fabrics made from natural fibres caused by mildew.
Textile materials, especially garments, are prone to wear and tear, necessitating consideration of stress, strain, thermal, and mechanical effects on finished substrates. To maximize the benefits of finishing treatments, several requirements must be met which are durability to washing, dry cleaning and hot pressing, activity to undesirable microorganisms, no harm to manufacturer, fabric quality, user and environment, compatibility with chemical processes, ease of application, resistivity to sterilization and disinfection etc.

Material and Methodology*:*
Following materials were used for the work

- Selection of Raw material: Wool, cotton (Woven and Knitted), Viscose Woven and Nonwoven, Bamboo (Woven and Knitted) etc
- Processing of Fabrics: Above fabrics were given treatments like desizing for removal of size, Scouring to impart absorbency and Bleaching to improve whiteness by standard processing formulations.
- Extraction of Antimicrobial agent: Natural antimicrobial agents like Neem (Azadirachta Indica) and Tulsi (Ocimum Sanctum) were selected for this study and the extraction of natural antimicrobial agents was done by ethanolic extraction method.
- Ethanolic extraction of Neem (Azadirachta Indica): 250 grams of mature, fresh Neem (Azadirachta Indica) leaves were collected and washed in distilled water. The leaves were dried using autoclave. Then the leaves were ground into fine powder and packed in muslin cloth bag for the process of extraction.100ml of 99.9% of ethanol were used as a solvent. The extraction was done using Soxhlet apparatus as shown in Fig.1a and Fig.1b. The samples were macerated in ethanol for 3 to 4 hours at temp of 50°C matching the boiling point of solvent. The extraction was followed by re-flux method. Water was supplied continuously to the condenser to cool the solvent in order to

prevent the evaporation and facilitate the process of extraction. The procedure was continued till the crude Neem (Azadirachta Indica) extract was obtained. The extract was distilled to remove the solvent in order to get a concentrated extract. Solvent thus extracted was evaporated by hot water bath and the extract was stored in refrigerator.

Figure.1a Dried Neem Leaves

Figure. 1b Ethanolic extraction of Neem

- Ethanolic extraction of Tulsi (Ocimum Sanctum): Take 500 grams of dry rhizomes Tulsi were collected and thoroughly washed with water to remove the soil particles and chopped in to small pieces, powdered using a grinder. The samples were weighed and transferred to a cylinder which is attached to the Soxhlet apparatus. 100ml of 99.99% of ethanol were used as a solvent. The samples were soaked in ethanol for 3 to 4 hours at temp of 50°C matching the boiling point of solvent as shown in Fig 2a and Fig. 2b. The extraction was followed by re-flux method. Water was supplied continuously to the condenser to cool the solvent in order to prevent the evaporation and facilitate the process of extraction. The procedure was continued till the crude turmeric extract was obtained. The extract was distilled to remove the solvent in order to get a concentrated extract. Solvent thus extracted was evaporated by hot water bath and the extract was stored in refrigerator.
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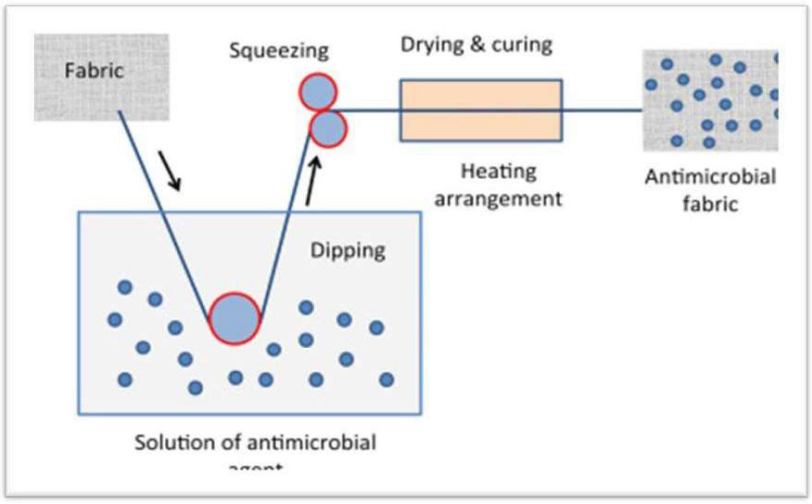
Figure. 2a Tulsi Dry Leaves

Figure 2b Ethanolic extraction of Tulsi

- Application of antimicrobial agent: The applcation of antimicrobial agent was done using 10gpl concentration of Neem (Azadirachta Indica) and Tulsi (Ocimum Sanctum) (Ocimum Sanctum) each on above fabrics by pad- dry- cure method. Padding was carried out with 70% expression on laboratory padding mangle followed by drying the fabric at 80^0C and curing at 140^0C as shown in Fig 3.

Fig 3 Pad-Dry-Cure Process for application of Antimicrobial Finish



- Testing :

The antimicrobial activity of Neem (Azadirachta Indica) and Tulsi (Ocimum Sanctum) on wool, cotton, bamboo, viscose fabrics was tested by Agar diffusion test at BIOCYTE Institute of Research and Development, Sangli. The inoculum of the microorganism was prepared from the bacterial cultures. 15ml of nutrient agar (Hi media) medium was poured in clean sterilized Petri plates and allowed to cool and solidify. 100 µl of broth of bacterial strain was pipette out and spread over the medium evenly with a spreading rod till it dried properly. Wells of 6mm in diameter were bored using a sterile cork borer. Solutions of all the compounds (100µl/ml) inDMSO were prepared. 100µl of plant extracts solutions was added to the wells. The petri plates incubated at 37^0C for 24 h. streptomycin (1mg/ml) was prepared as a positive control DMSO was taken as negative control. Antibacterial activity was evaluated by measuring the diameters of the zone of inhibitions (ZI) all the determination were performed in triplicates.

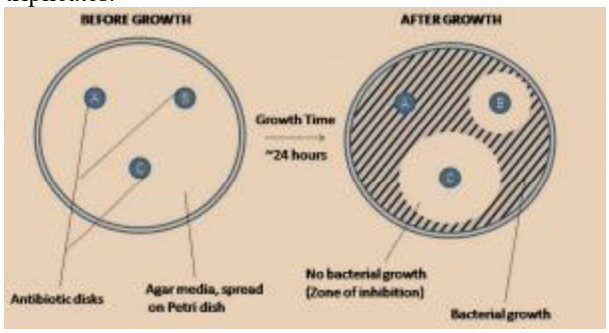
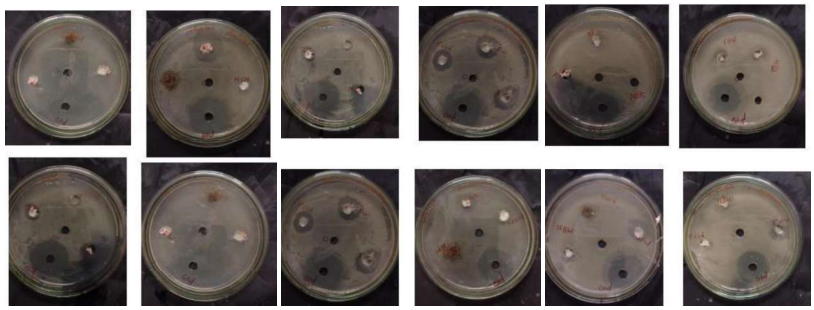


Fig. 4 Agar Diffusion Test

Result And Discussion

The antimicrobial activity of Neem (Azadirachta Indica) and Tulsi (Ocimum Sanctum) on cotton woven and knitted, Bamboo woven and knitted, viscose nonwoven, wool nonwoven was evaluated by measuring the diameters of zone of inhibition as shown in Fig 5.

Fig 5: Agar diffusion test – Zone of inhibition on the textile substrates.



The results of diameters of zone of inhibition are as follows.

Table 1: Antimicrobial Activity of Textiles against Bacillus subtilis

Sr. No	Samples	Concentration ((µg/ml)	Zone in Diameter (mm)
1	Control	--	0
2	Standard (Streptomycin)	10	28
3	Cotton Woven	10	10
4	Cotton Knitted	10	22
5	Bamboo Woven	10	6
6	Bamboo Knitted	10	8
7	Wool nonwoven	10	8
8	Viscose Nonwoven	10	16
9	ViscoseWoven	10	13

Table 1 Indicates the results of Antimicrobial Activity of natural antimicrobial agent Neem (Azadirachta Indica) on above textile substrates against Bacillus subtilis which reveals that at the concentration 10µg/ml, the samples treated using Neem (Azadirachta Indica) extract show good activity against Bacillus subtilis.

Table 2: Antimicrobial Activity of textiles against Pseudomonas aeruginosa

Sr. No	Samples	Concentration ((µg/ml)	Zone in Diameter (mm)
1	Control	--	0
2	Standard (Streptomycin)	10	26
3	Cotton Woven	10	8
4	Cotton Knitted	10	21
5	Bamboo Woven	10	5
6	Bamboo Knitted	10	7
7	Wool nonwoven	10	8
8	Viscose Nonwoven	10	16
9	ViscoseWoven	10	13

Table 2 Indicates the results of Antimicrobial Activity of natural antimicrobial agent Neem (Azadirachta Indica) on the textile substrates against Pseudomonas aeruginosa which show that at the concentration 10µg/ml, the samples treated using Neem (Azadirachta Indica) extract show good activity against Pseudomonas aeruginosa.

Table 3: Antimicrobial Activity of Textiles against Bacillus subtilis

Sr. No	Samples	Concentration ((µg/ml)	Zone in Diameter (mm)
1	Control	--	0
2	Standard (Streptomycin)	10	28
3	Cotton Woven	10	20
4	Cotton Knitted	10	4
5	Bamboo Woven	10	6
6	Bamboo Knitted	10	12
7	Wool nonwoven	10	8
8	Viscose Nonwoven	10	18
9	ViscoseWoven	10	15

Table 3 Indicates the results of Antimicrobial Activity of natural antimicrobial agent Tulsi (Ocimum Sanctum) on the textile substrates against Bacillus subtilis. From the results, it can be stated that at the concentration 10µg/ml, the samples treated using Tulsi (Ocimum Sanctum) extract show good activity against Bacillus subtilis.

Table 4: Antimicrobial Activity of textiles against Pseudomonas aeruginosa

Sr. No	Samples	Concentration ((µg/ml)	Zone in Diameter (mm)
1	Control	--	0
2	Standard (Streptomycin)	10	26
3	Cotton Woven	10	18
4	Cotton Knitted	10	4
5	Bamboo Woven	10	6
6	Bamboo Knitted	10	11
7	Wool nonwoven	10	9
8	Viscose Nonwoven	10	15
9	ViscoseWoven	10	13

Table 4 Indicates the results of Antimicrobial Activity of natural antimicrobial agent Tulsi (Ocimum Sanctum) on the textile substrates against Pseudomonas aeruginosa.which exhibits that at the concentration 10µg/ml, the samples treated using Tulsi (Ocimum Sanctum) extract show good activity against Pseudomonas aeruginosa.

Conclusion:

- Natural antimicrobial agents from Neem (Azadirachta Indica) (Azadirachta Indica) and Tulsi (Ocimum Sanctum) (Ocimum Sanctum) can be extracted by ethanolic extraction method.
- The extracted antmicrobial finihes can be applied by pad-dry-cure technique on natural textile substrates like cotton, wool and bamboo.
- The natural antimcrobial finishes can be applied on well regenrated substrates like viscose. The substrates can be in woven, knitted or nonwoven form.
- The antimicrobial efficieniency of both the antimicrobial finishes Tulsi (Ocimum Sanctum) and Neem (Azadirachta Indica) are found to be good against Bacillus subtilis and Pseudomonas aeruginosa bacterial.
- These natural antimicrobial finsh applied textile substrates can be used for various applicatios where antimicrobial property is essential such as daily wear garments, cloth based sanitary napkins, baby wear, appareals for patients.
- There is greater scope to produce textile substrates using natural antimicrobial finishes theryby contributing to sustainable processing practices.

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