Application of Antimicrobial Finish on Nonwoven Fabric with Plant Extracts

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Abstract- *This investigation is to study the application of eco friendly antimicrobial finishing on nonwovens. TencelR is a bio degradable and nontoxic fabric which was selected for the study. On consideration of toxicity and the adverse side effects of healthcare and hygiene, the screening of plant extracts such as Aegle marmalos, Alphinia galangal, Terminalia bellerica was done based on its potent antimicrobial activity. The various solvent extracts such as ethanol, petroleum ether, chloroform and aqueous was selected for the invitro antimicrobial activity against ten clinical human pathogenic bacteria viz., Acineto baumanii, Bacillus cereus, Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginosa, Proteus mirabilis, Staphylococcus aureus, Staphylococcus epidermidis, Methicillin-resistant Staphylococcus aureus and Streptococcus pyogens. Ethanolic extract of Terminalia bellerica was selected based on its significant antimicrobial activity and it was coated on nonwoven fabrics. The antimicrobial activity of coated fabric was assessed for AATCC 147. FTIR analysis of the selected ethanolic extract confirms the presence of functional groups such as phenols, alcohol, amines and carboxylic group. Hence the study states Terminalia bellerica possess broad spectrum of antimicrobial activity and can be used as medicinal herb in case of application in medical non-implantables, healthcare and hygiene.*

Keywords- AATCC 147, Antimicrobial, FTIR, Non-Implantables,Non-Woven.

I. INTRODUCTION

Medical textile is one among the emerging fields in technical textile market and the major products cover in health care and hygiene, non-implantable and clinical sectors. Such textile material plays important role in prevention and management of infection1. The reusable textiles encourage the growth of microorganisms and give a place for forthcoming infections2. But the disposable nonwoven overcomes it, as they act as a barrier protective from fluid, particulate, micro organism and thereby reducing the rate of cross infections.

The infection and cross contaminations can be prevented only by means of topical ailments or by introducing antimicrobial finishing on the textile substrates. The adverse side effects of continued usage of antibiotic drugs result in bacterial resistance3 and stimulation of toxin production towards existing drugs4. Thus the increase in rate of infection and increase in number of resistant bacterial strains are the common problems that the researcher faces nowadays1, 5.

Also the development of new antibiotic, isolated and expensive drugs are not readily available in the market. Hence the search for new drug from novel source like plants has been traditionally followed up6. They are major source of commercially marketed drug due to active substance such as phenols, alkaloids and tannin compounds7. The bioactive nature and the constituents are effective against infective organisms11.

The plant substances have little or no toxicity to host cells as their phytochemical compounds contains new antibiotic drugs8, 9. So it is necessary to search for natural compounds from plants to replace antibiotics or synthetic antimicrobial drugs.

Aegle marmalos, Alphinia galangal and Terminalia bellerica are the common plants which are well known to their medicinal properties in traditional, ayurvedic and folk medicinal system. They are used to treat curative diseases. Ancient literatures prove the use of this plant for various treatments to cure health issues 12.

The present research work is to evaluate the active compounds that are responsible for the antimicrobial activity from the three different herbs at different solvent extracts towards ten human pathogenic bacteria. The best activity herb was selected and the coating was done on to nonwoven fabric to prove the test results. The work aims at the possible invention of new drug for the prevention and treatment of infection.

II. MATERIALS AND METHODS

Materials

TencelR spunlace nonwoven fabric of weight 45gm/cm2 was purchased from Shanghai Guizhi International Co Ltd, China. The three medicinal herbs Aegle marmalos, Alphinia galangal and Terminalia bellerica were procured from the local market, Coimbatore, India. Solvents of chloroform, petroleum ether, ethanol and aqueous was supplied by Precision Scientific Chemicals, Coimbatore, India.

Bacterial Strains

Ten human pathogenic bacteria Acineto baumanii, Bacillus cereus, Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginosa, Proteus mirabilis, Staphylococcus aureus, Staphylococcus epidermidis, Methicillin-resistant Staphylococcus aureus and Streptococcus pyogens were obtained from KMCH, Coimbatore, India

Plant Extraction

Both aqueous and alcoholic extraction was done by cold maceration process. 5g of powdered plant material was dissolved in 25 ml of solvent in a conical flask and kept in a rotary shaker at room temperature for 48 hrs. The extracts were filtered through Whatman No 1 filter paper and the solvent was made to evaporate and mixed with DMSO (1ml/0.1 g). This was then stored in screw capped bottle for further study.

Screening of Herbs and Preliminary Assessment of Antibacterial Activity

The Screening of best activity herb out of Aegle marmalos, Alphinia galangal and Terminalia bellerica in four solvent extracts was evaluated by Well Diffusion method (Aida et al 2001).

Preliminary Assessment of Antibacterial Susceptibility Testing

The ten bacterial strains was inoculated for 1hr culture into nutrient broth and incubated for the growth at 37oC. After incubation a sterile cotton swab was immersed into the bacterial suspension and swabbed aseptically on the sterile Muller-Hinton agar plates. Wells of 6 mm diameter were punctured on the agar medium. About 150µl of the extracts was added to the wells. After which the plates were incubated at 37oC for 24 hrs in an incubator. Later on the zone of inhibition was measured and recorded.

Application of antibacterial finishing on nonwoven

Direct Application

The selected best activity showing herb and the solvent was finished on TencelR nonwoven fabric by dip-dry method.

Assessment of Antibacterial Qualitative Test (AATCC147)

The treated and untreated Tencel nonwoven fabric was cut into 5 cm X 2.5 cm and they were placed on the AATCC nutrient agar plates streaked with five parallel lines of bacterial inoculums. The plates were incubated at 37oC for 24 hrs. The sample was then observed for the zone of inhibition around and beneath the fabric.

III. RESULTS AND DISCUSSIONS

Preliminary Assessment of Antibacterial Susceptibility Testing (Well Diffusion method)

The selected plant extracts was observed for the zone of inhibition. The results observed were interpreted in the figure 1 indicating the growth inhibition produced by terminalia bellerica towards clinical bacterial pathogens. The study result illustrates that the extracts of terminalia bellerica was found to be more effective to control bacterial pathogens among the other two plant extracts. Aqueous extract of terminalia bellerica showed significant activity with respect to petroleum ether and chloroform extracts. The chloroform extract of the Terminalia bellerica showed moderate zone of inhibition and petroleum ether exhibited less zone of inhibition against tested bacterial pathogens. Whereas poonkothai et al (2014) reported the similar results. The extracts exhibited significant results when compared with standard antibiotic (Tetracycline) and no Zone of Inhibition in case of DMSO. The highest zone of inhibition was observed against Klebsiella pneumonia and the least inhibition against Escherichia coli and Pseudomonas aeruginosa and Staphylococcus aureus and MRSA.

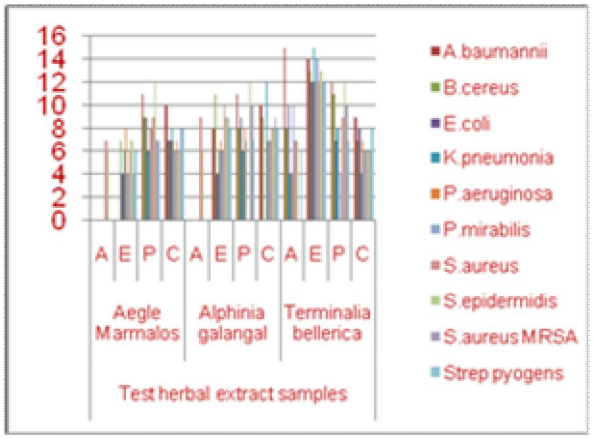
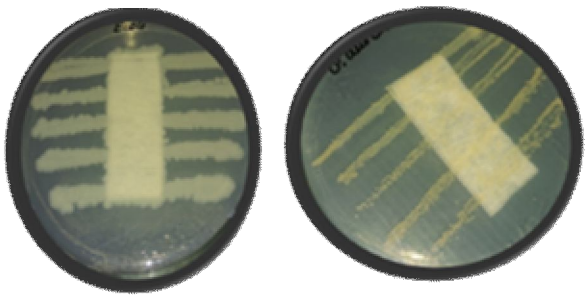


Figure 1. Preliminary Assessment of Antibacterial Susceptibility Testing

The Higher antibacterial activity of alcoholic extracts is the character of biological active compounds which may be enhanced in the presence of ethanol. They also have the stronger capacity to extract the compounds that may be active constituents of the antibacterial activity (Ghosh et al, 2008). Thus in the present study similar results say that the ethanolic extracts of Terminalia bellerica showed good results among the other solvents.

Assessment of Antibacterial Qualitative Test (AATCC147)

The treated and untreated samples were subjected to Qualitative Assessment AATCC 147 (Parallel streak method) against the test organism S.aureus and E.Coli. The result obtained is given in figure 2 which states that the untreated nonwoven fabric shows clear microbial growth around and beneath the fabric with no zone of inhibition which proves that the control fabric sample do not inhibit microbial growth. Whereas the treated nonwoven fabric shows no microbial growth under the fabric incase of E.coli and there is zone of inhibition around the sample against S.aureus. Lack of zone of inhibition does not mean the absence of activity. The fabric may need to be treated with some durable finishes.



(A) (B)

(C) (D)

Figure 2:
A. Untreated nonwoven Fabric against E.coli
B. Untreated nonwoven Fabric against S.aureus
C. Treated nonwoven Fabric against E.coli
D. Treated nonwoven Fabric against S.aureus

Chemical characterization - FT-IR analysis

FTIR was adopted to characterize the potential interactions and to find the functional groups of the extract. FTIR spectra of herbal extract and bulk combinatorial herbal extract were analyzed and shown figure 3. In the spectra of herbal ethanolic extract, the broad band at 3649.32, 3572.17 and 3495.01 cm-1 corresponded to the alcohols and phenols.

The peaks at 2924.09, 2854.65 cm-1 was caused by C-H stretch which showed the presence of alkanes. The C= = = C stretch indicated the presence of alkynes (2299.15 and 2206.57 cm-1). The peaks at 1743.65 and 1721.79 cm-1 corresponded to C=O stretch of carboxyl, esters and saturated aliphatic. The peak at 1527.62 represents the presence of nitro compounds with asymmetric stretch, C-C stretch at 1458.18 confirms the occurrence of aromatic compounds.

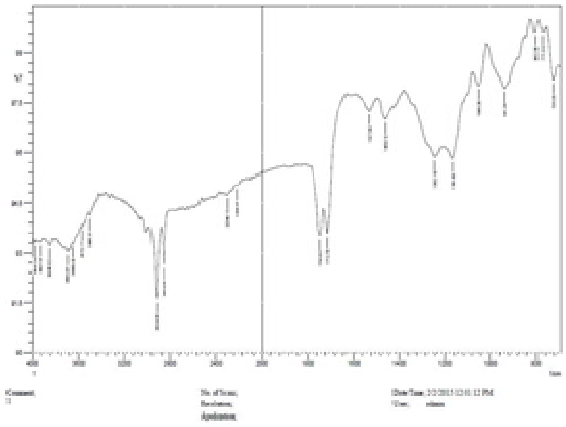


Figure 3. FT-IR analysis of Plant extract

The peak at 1242.16 , 1165 , 1049.28 cm-1 represented the C–N stretch which indicated the presence of aliphatic amines. =C–H bend states the presents of alkenes at

941 cm-1. The peak at 802.39, 771.53 and 725.2 corresponds to c==H of aromatic compounds.

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