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Antimicrobial Efficiency of Bio-Synthesised Nanosilver Finished Viscose Spunlace Non Woven Fabric

KEYWORDS: silver nanoparticles, bio synthesis, antimicrobial activity, spun lace viscose fabric

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ABSTRACT *Silver is a renowned antimicrobial agent used on textiles from very ancient time till date. A very small quantity of silver is required to inhibit a very wide range of pathogenic microorganisms. Application of silver in nano size on textile substrate has enhanced the antimicrobial efficiency of textiles. Biosynthesis of silver is simple and less hazardous and this green technology is having advantage over chemicals methods. Silver nanoparticles were prepared with plant extracts and were applied on viscose spun lace non-woven fabric. The treated fabric shows excellent antimicrobial activity towards E. coli, S. aureus, C. albicans, A. niger.*

INTRODUCTION

Textiles with inherent feature to inhibit microorganisms are in great demand today. Microbial growth on textiles causes its degradation leading to unpleasant odors, skin infections, discoloration and stains (Damle, Nerurkar, & Adivarekar, 2014). Several chemicals have been used to impart antimicrobial finish to textiles and among them silver had proven to be the best with broad range of antimicrobial efficiency with less toxicity towards mammalian cells (Zhang, Wu, Chen, & Lin, 2009). Antibacterial properties of inorganic materials like silver are due to the release of ions interfering with bacteria and cause decomposition (Farouk, Moussa, Ulbricht, Schollmeyer, & Textor, 2014).

Silver nanoparticls can be synthesised via various methods like electrochemical, facile technique, thermal decomposition, micro wave assisted process, sonochemical and green chemistry (Shafaghat, 2015). Syntheses of silver nanoparticles using plant extracts have received attention in the recent times as it is a simple and efficient method with low cost and less hazardous to nature (Vankar & Shukla, 2012), (Iyer, Yashwanthi, Soumya, Selvaraju, & Santhiya, 2013). Therefore the development of silver nanoparticles based on natural extracts is considered as most the appropriate method for environmental reasons (Di, Li, & Zhuang, 2012).

MATERIALS AND METHODS

Synthesis of silver nanoparticles

The synthesis of silver nanoparticles by reducing the silver ions in the silver nitrate solution with water extracts of Chromolaena odorata was done as per the procedure explained by Geetha, Harini, Showmya, and Priya, (2012).

Preparation of plant extracts

C odorata also known as siam weed is a perennial shrub widely known as pest that grows in open areas and interior shrub jungles of southern Asia and western Africa (Sukanya, Sudisha, Prakash, & Fathima, 2011). The plant is recognized for its anti-pyretic, antimicrobial and anti-inflammatory properties (Vaisakh & Pandey, 2012). The leaves of C odorata were collected from Palakkad district, Kerala, washed in distilled water, shade dried and powdered.

C odorata powdered leaf (one gram) was mixed with 10 ml distilled water and was kept for 10 minutes in a water bath at 60^0C. The mixture was filtered through Whatman No. 1 filter paper and the pure water extract obtained was used for the synthesis of silver nanoparticles.

Synthesis of silver nitrate solution

Silver Nitrate (0.03 %) was used to prepare solution with 100ml distilled water and add four ml of water extracts of C odorata leaf drop by drop to the silver nitrate solution under constant magnetic stirring for one minute. The colour of the solution changes from colorless to golden brown and to dark brown, indicates the formation of silver nanoparticles.

Selection of fabric

The need for best performance material at minimum cost has resulted in the usage of non-woven fabric (Walker, 2001). Good absorbency and low linting property makes viscose fiber an appropriate choice for fabricating wound dressings and absorbent pads (Chellamani, Balaji, & Veerasubramanian, 2013). Hence spun lace viscose fabric was selected for the study.

Application of silver nanoparticles on fabric

The prepared silver nanoparticles suspended solution was sprayed on spun lace viscose fabric within one minute after preparation, with the aid of ultrasonic atomizer at a dispensing speed 100 ml per minute and the treated fabric was dried at room temperature.

Scanning electron microscopy

Field Emission Scanning Electron Microscope (FESEM) was used to evaluate the silver nanoparticles size and its adhesion on the fabric surface. The samples were analyzed with a magnification of 5.31 KX and 30.0 KX.

Antimicrobial assessment of treated fabric

Antimicrobial efficiency of the silver nano particles treated fabric was done as per AATCC Test method 90 – 2011, Agar plate method. Various organisms selected for testing were Staphylococcus aurous (NCIM No. 2079), Escherichia coli (NCIM No. 2065), Candida albicans (NCIM NO. 3471) and Aspergillus niger (NCIM No.596) procured from

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National Collection of Industrial Microorganisms (NCIM), Pune.

Physical performance of the silver nanoparticles treated fabric

Strength and Elongation

Strength and elongation of the samples were done as per ASTM standard D 5035 – 06. Ten specimens of 50 mm in width and 200 mm length were cut down and mounted in the clamp of the testing machine. The loading rate was set at 300± 10 mm /min and the machine was operated until the specimen broke and the breaking force and elongation was recorded.

Absorbency

The absorbency of samples was tested as per AATCC Test method 79 – 2010. Samples of dimension 200 ± 5 X 200 ± 5 mm were mounted in an embroidery hoop and placed 10± 1.0 mm underneath the tip of the burette which was filled with distilled water. One drop of water was allowed to fall on the cloth and time required for the water to lose its reflectivity was measured with a stop watch and marked in seconds and the same process was repeated for five tests.

Air permeability

Air permeability of the sample was done as per ASTM D 737–04. It is an important factor relating to the performance of the fabric to check its breathability. Ten samples of dimension 25 cm X 25 cm was cut and clamped in Textest Instrument for analysis.

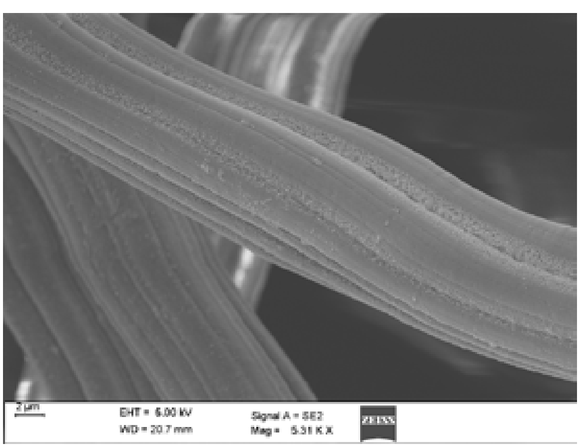
Stiffness

The stiffness was measured with Shirley stiffness tester. Samples were cut as per the template and was kept underneath the template with scale engraved and slides slowly, when the sliding edge falls and touches the index line, the values were noted and four readings for each specimen at up and down for each ends (Booth, 1996).

RESULT AND DISCUSSION

Surface morphology

FESEM analysis reveals the adsorption and morphology of silver nanoparticles on fabric. It is clear from Figure 1 that the size of silver nanoparticles was 25 nm to 30 nm. The particles formed were even in size and they were deposited on all over the fabric surface.



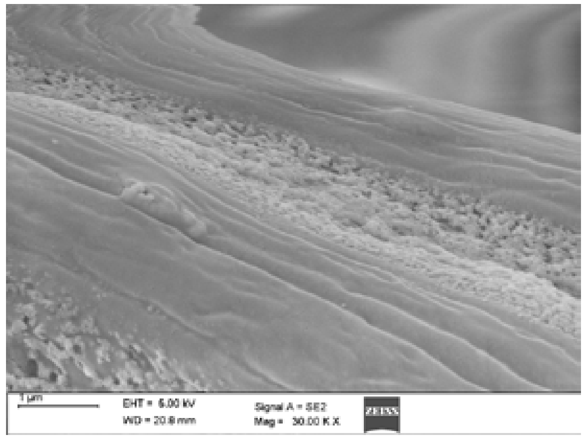


Figure 1: FESEM image of silver nanoparticles treated spun lace viscose fabric

Antimicrobial efficiency

The antimicrobial efficiency of silver nanoparticles treated spun lace viscose fabric is represented in Table I and Figure 2.

TABLE – I

ANTIMICROBIAL EFFICIENCY OF SILVER NANOPARTICLES TREATED FABRC

Fabric Samples	Antimicrobial Activity Zone of inhibition (mm)			
	E coli	S aureus	C albicans	A niger
Silver Nanoparticles treated fabric	1	2	5	5
Control fabric (untreated)	0	0	0	0

It is noticeable from Table I and Figure 2, that nano silver finished textiles was having good antimicrobial efficiency. A zone of inhibition of 1 mm was formed towards E coli and 2 mm towards S aureus. Strong antifungal property was evident from the zone of inhibition of 5mm towards A niger and C albicans. The antimicrobial action of silver nanoparticles was due to the penetration of silver into the DNA molecule of microbe and turns into condensed form in which it loses its ability to replicate leading to cell death (Vankar & Shukla, 2012).

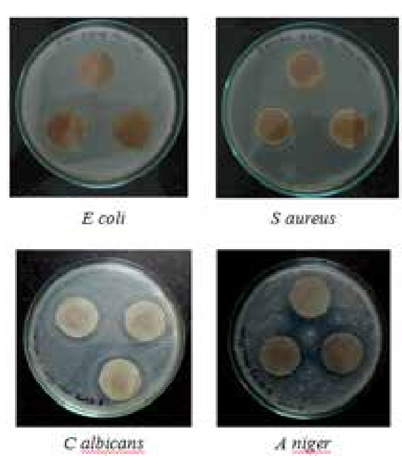


Figure 2: Zone of inhibition formed for silver nanoparticles treated fabric

Properties of the silver nanoparticles treated fabric

The performance of nano silver treated fabric was evaluated with various tests like tensile strength and elongation, air permeability, absorbency and stiffness as per standards and the results were depicted in Table II.

TABLE – II

PROPERTIES OF SILVER NANOPARTICLES TREATED FABRIC

Samples	Strength (lbs)	Elongation (inches)	Absorbency (S)	Air permeability CM³ /CM² / S 3 / CM 2 /S	Stiffness (cm)
Silver nanoparticles treated fabric	11.4	2.54	0	196	2.8
Untreated fabric	13.4	2.26	0	179	3.12

The tensile strength of nano silver finished fabric decreased while comparing to untreated fabric which reveals that nano silver finish on textiles decreases its strength, but the adsorption of nano silver particles increase the elongation of the fabric. Absorbency property of the fabric was not altered by treating with silver nanoparticles, and it was proven both the fabrics took less than one second to absorb the water which is an essential quality of fabrics intended to use as wipes or wound dressings.

The air permeability of the treated fabric increased from 179 CM^3 /CM^2 / S to 196 CM^3 /CM^2/S unveil that nano silver finishing is not affecting the pores of the fabric and it increases breathability. The stiffness of the treated fabric (2.8 cm) and untreated fabric (3.12 cm) discloses that silver nanoparticles have the ability to soften the textiles.

CONCLUSIONS

Biosynthesized silver nanoparticles can act efficient antibacterial agent for spun lace viscose fabric. The test results supports that 0.03% of silver was required to inhibit microbes. Various fabric tests also supports that nano silver has enhanced the air permeability, stiffness and elongation of the fabric with little variation to strength and without any alteration to absorbency of the fabric. Hence it can be concluded that biosynthesized silver nanoparticles can be used as an efficient antimicrobial agent for textiles.

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