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Development of an Antimicrobial Sewing Thread Using Natural Sources

Engr. Muhammad Qamar Khan[1], Engr. Muhammad Mudasar Sharif[2]

[1]National Textile University, Textile Engineering Department, SFDAC Karachi, Pakistan

[2]Assist.manager production, US Apparel, Lahore, Pakistan

Abstract: ***In textile sector the use of natural sources is advancing day by day for function based articles. In this project antimicrobial sewing thread is prepared by using natural sources. Chitosan and silver nanoparticles are used in different concentrations for this purpose 100% cotton yarn is used for this project. Chitosan and silver particles in different concentrations are applied on yarn and analyzed the antimicrobial activity. It is analyzed that how antimicrobial activity is effected by changing concentrations of sliver particles and chitosan. Antimicrobial testing was done by qualitative method AATCC-147 (zone of the inhibition) to check antimicrobial activity. From region of inhibition we calculated antimicrobial activity. It was concluded at the end that changing the concentration of Nano particles and chitosan the antimicrobial property of cotton yarn also changes.***

Keywords: Antimicrobial, Chitosan, sewing thread, silver

1. Introduction

Textile materials/clothing play important role in providing media for development of microorganisms such as bacteria and fungi, etc. According to current reports, microorganisms could last on fabric ingredients for more than 90 days in a hospital location. Such an extraordinary survival rate of pathogens on medically recycled textiles may give to transmissions of ailments in hospitals. As a means to lessen bacterial inhabitants in healthcare sites and possibly to scratch pathogenic infections initiated by the textile materials, the use of antimicrobial textile become a vital importance to be used [6]. Bacteria are microscopic (~1 μm) in size and unicellular (single celled) organisms that lack a mitochondria, chloroplasts, and most particularly a nucleus, which categorizes it as a prokaryote. They reproduce themselves by simply division, i.e. binary fission. Bacteria are more reliant on host or environment, greater can synthesize additional of specific ingredients.

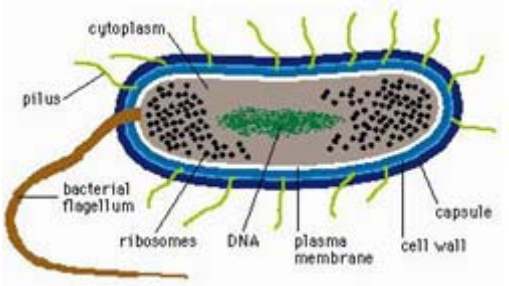

Figure 1.1: Structure of Bacteria

Most of Bacteria are free existing; a few are necessitating intracellular vermin. Bacterial structure comprises of mainly six parts given as follows:

1) Nucleoid (nuclear or chromatin body),
2) Cytoplasm membrane (CM) (inner membrane or IM in gram -),
3) Mesosomes,
4) Cell wall,
5) Outer membrane,
6) Periplasmic space.

Cell wall breadth is base for classifying gram stain.

- Bacteria having dense cell walls retain (= gram +) Thin cell walls (= gram -).

2. Experimental Method and Material

This section demonstrates the chemical contents, processes, various trials carried out during the research, reasons and answers for success and failure of the trials.

2.1 Materials

Table2.1: Specification of the substrate

Substrate	100%
Yarn	16 Ne
Sample	10 inches
Twist pe	15

2.2 Chemicals

Chitosan forms aqueous solution in acidic medium so for this purpose 1% acetic acid is used to create acidic environment. Sodium hydroxide is used in small amount to maintain PH value.

Table2.2: Showing type, nature and brand of chemicals used in research work

Type of chemical	*Chemical nature*	*Brand*
Silver Nano particles	Inorganic	-
Binder	Acrylic based	BASF(Helltow)
Sodium hydroxide	Alkali	-
Chitosan	Organic	-
Acetic acid	Acid	-
Wetting agent	Neutral	PTF

2.3 Design of Experiment for the preparation of sample from silver nanoparticle and Chitosan

The research study was started for the development of antimicrobial thread using chitosan and Silver nanoparticles.

15 trials were carried out to prepare sample from Silver nanoparticles and chitosan. The details of the trials are given in this chapter. Trials were divided into three major categories. For first five samples concentration of silver particles were kept zero while chitosan concentration kept in increasing order from 1g to 5g. For second five samples concentration of chitosan were kept fix 1g while concentration of silver particles kept in increasing order from 1ml to 5 ml. For third five samples both chitosan and silver particles are usedand concentrations of silver particle were kept constant 1ml while chitosan is in increasing order from 2g to 6g.

Sample No.	*Concentrations*	*Concentrations*
GMA00 Untreated Cotton		
GMA01	1g Chitosan	0ml Silver nanoparticles
GMA02	2g	0ml
GMA03	3g	0ml
GMA04	4g	0ml
GMA05	5g	0ml
GMA06	1g	1ml
GMA07	1g	2ml
GMA08	1g	3ml
GMA09	1g	4ml
GMA10	1g	5ml
GMA11	2g	1ml
GMA12	3g	1ml
GMA13	4g	1ml
GMA14	5g	1ml
GMA15	6g	1ml

3. Preparation of Chitosan solution

This experiment was carried out to find out the compatibility of chitosan particles with 100% cotton yarn. The antimicrobial property was obtained from chitosan which have the inherent antimicrobial property.

Trails carried out to get the uniform solution of chitosan

a) Trial first

The distilled water was taken in a steel beaker and boiled on burner. Then 1% chitosan was weighed with the help weighing balance. 100ml hot water was taken in beaker and 1gram of chitosan was added to the hot water. The mixture was stirred with the help of electric stirrer for 10 minutes. The chitosan didn't dissolve in the hot water and the result was un-dissolved mixture.

b) Trial second

This trial was successful in the formation of uniform chitosan solution. The distilled water was taken in the steel beaker and boiled on the burner. 100ml of hot water was taken in another beaker and 1% acetic acid solution was prepared. Then 1gram of chitosan was added to the above solution to get the 1% chitosan solution. The solution was stirred with the help of electric stirrer for 10 minutes. The result was formation of uniform chitosan paste.

We made five chitosan solutions samples based upon the trial second.

Sample 1

- All the procedure for this sample was used same as above, except solution concentration parameter that is given below.
- 1g chitosan in 100 ml of hot water

Sample 2

- All the procedure for this sample was used same as above, except solution concentration parameter that is given below.
- 2g chitosan in 100 ml of hot water.

Sample 3

- All the procedure for this sample was used same as above, except solution concentration parameter that is given below.
- 3g chitosan in 100 ml of hot water.

Sample 4

- All the procedure for this sample was used same as above, except solution concentration parameter that is given below.
- 4g chitosan in 100 ml of hot water.

Sample 5

- All the procedure for this sample was used same as above, except solution concentration parameter that is given below.
- 5g chitosan in 100 ml of hot water

Preparation of Chitosan and silver particle solution

This experiment was performed to find out the compatibility of silver nanoparticles with 100% cotton yarn.it was also found that either Chitosan and silver particles solution is formed or not.

Antimicrobial testing of coated yarn

AATCC Test Method 147 is the easy and efficient method of qualitative analysis of antimicrobial activity of diffusible antimicrobial agents on the treated textile materials. In this method the agar surface is inoculated making is easier to distinguish between test organisms and contaminant organism which may be present on unsterilized specimen. This method is very efficient to find antimicrobial activity against gram positive and gram negative bacteria. All the samples were then tested for anti -microbial activity.

Apparatus/Equipment

Scissor, Scale, Weight balance, PH meter, Autoclave, Burner, Inoculum, Centrifuging rotator, Orbital Shaker, Manual Shaker, Incubator, Fridge, Petri Dishes (circular), Conical flask, Glass bottles, Test tube, Isolated chamber, Spectrophotometer UV range,Gloves.

4. Results

Chitosan is a positively charged polymer. Its antimicrobial activity generates from its polycationicnatural surroundings, which is producedthrough protonation of amino groups atatom (C-2) of the glucosamine unit of chitosan. Positively charged glucosaminegroups attach firmly with the negatively chargedsurface of bacteria, which resultsin disorder of cell membrane of bacteria and increasesits permeability. Chitosan can alsoreactby the DNA of microbes to inhibit protein synthesis.

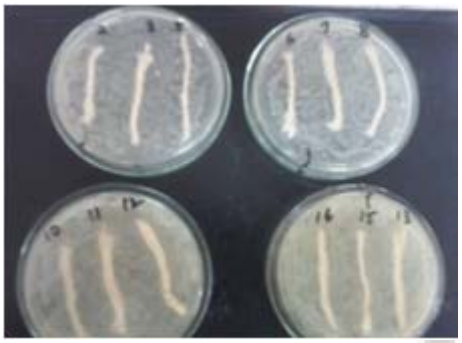

Figure 1: zone of inhibition, circular plates, AATCC 147 method

A. Antimicrobial activity of untreated cotton and chitosan (1g and 2g) treated cotton yarn

In fig 2 there are three samples placed in dish. Sample 16 represents untreated cotton. It is observed that 100% cotton sample gives no resistance to the bacterial population.Sample 13 & 15 represents the samples having concentration of chitosan, from 1g and 2g and no silver particles.These two samples show that chitosan gives a little antimicrobial property due to the inherent antimicrobial property of the chitosan. Results reveal that growth of bacteria is around the samples but not on the yarn. It means chitosan does not kill bacteria; it protects the substrate from bacteria so it has bacteriostatic property.

B. Antimicrobial activity of chitosan (3g to 5g) treated cotton yarn

In fig 3 there are three samples placed in dish. Sample 10,11 12 represents the samples having concentration of chitosan, 3g, 4g and 5g respectively, and no silver particles. These three samples show that chitosan gives a little antimicrobial property due to the inherent antimicrobial property of the chitosan. Results reveal that growth of bacteria is around the samples but not on the yarn. But these antimicrobial activity results are better than results in fig.3.2. This concludes that antimicrobial activity increases with increasing chitosan concentration.

Figure 1: Antimicrobial test of control group and chitosan (1g and 2g)

C. Antimicrobial activity of chitosan (1g) and silver (1ml to 5ml) treated cotton yarn

In fig 4 there are three samples placed in dish. Sample 6, 7, 8 represents the samples having concentration of chitosan, 1g,and silver nanoparticles are from 1ml to 5 ml. These three samples show that chitosan gives a little antimicrobial property. These antimicrobial activity results are better than results in fig.2 and fig 3. This concludes that antimicrobial activity behavior changes when silver nanoparticles are used. . Results reveal that inhibition of bacteria is occurring around the samples and also on the yarn. It means that silver particles not only inhibits but also attacks and kills the bacteria. This states that Silver particles keep bactericidal property.

D. Antimicrobial activity of chitosan (2g to 6g) and silver (1ml) treated cotton yarn

In fig 5 there are three samples placed in dish. Sample 2, 3, 5 represents the samples having concentration of chitosan, 2g to 6g, and silver nanoparticles 1ml in each. These three samples show that chitosan gives a little antimicrobial property. These antimicrobial activity results are best than all results of experiment. This concludes that antimicrobial activity behavior changes when silver nanoparticles are used along with chitosan. Results reveal that inhibition of bacteria is occurring around the samples and also on the yarn. It means that silver particles not only inhibits but also attacks and kills the bacteria. This states that Silver particles keep bactericidal property.

E. Antimicrobial activity of chitosan (2g to 6g) and silver (1ml) treated cotton yarn

In fig 5 there are three samples placed in dish. Sample 2, 3, 5 represents the samples having concentration of chitosan, 2g to 6g, and silver nanoparticles 1ml in each. These three samples show that chitosan gives a little antimicrobial property. These antimicrobial activity results are best than all results of experiment. This concludes that antimicrobial activity behavior changes when silver nanoparticles are used along with chitosan. Results reveal that inhibition of bacteria is occurring around the samples and also on the yarn. It means biostatic properties of chitosan and bactericidal properties of silver particles work together to give tremendous results.

Figure 2: Antimicrobial test of chitosan (2g to 6g) and silver (1ml) coated cotton yarn

5. Conclusion

It is concluded that chitosan which can be prepared by deacetylation of chitin has great compatibility with cellulosic structure so it is applied on 100% cotton yarn. The antimicrobial property was checked by using the AATCC test method 147. The result shows that the chitosan effectively gives the antimicrobial property to the yarn. In experiment concentration is variedwhich concludes that antimicrobial activity increases with increasing concentration of chitosan. But this antimicrobial activity is not so significant. Chitosan does not attack and kill bacteria but only protects substrate from bacteria. So chitosan has biostatic properties. This property becomes more effective at higher concentration of chitosan but remain less effective at lower concentration.

Silver nanoparticles have high surface area to volume ratio and it has high compatibility with cotton yarn. This is concluded that silvernanoparticles have also the property of microbes‟ inhibition. Silver particles kill bacteria via strangling them in warm and humid environment (Bactericidal). This bactericidalproperty of silver nanoparticles is highly affected by changing the concentration of nanoparticles. Particles concentration is almost directly proportional to antimicrobial. Unlike most other antibiotics, which are consumed while destroying bacteria, silver remains unconsumed during constantly working as a catalyst.

When both chitosan and silver particles are used in combined form then it is noted that they showed excellent antimicrobial properties. It is also very easy to mix up these two solutions and they do not disturb properties of each and other. In this way, bacteriostatic properties of chitosan and bactericidal properties of silver particles, work together to give tremendous results.

Nanotechnology is new emerging field and it has positive and economic effect on textile fabric finishing. Chitosan and silver particles both are eco-friendly, economical and harmless for human so it can be used to make antibacterial sewing thread.

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Author Profile

Engr. Muhammad Qamar Khan received the B.Sc.Textile Engg. Degree from National Textile University Faisalabad, Pakistan in 2013 and M.E. degrees in Textile Engineering from NED University of Engg. And Technology Karachi, Pakistan is in Progress. He is working as a Lecture and Student Advisor in National Textile University Karachi Campus. He is also working as a member in R&D Department.