ANTIBACTERIAL PROPERTIES OF BIODEGRADABLE FIBRES

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ABSTRACT

Anti-bacterial products are leading textile products through protection of health, personal hygiene and comfort. Producting from renewable resources and degrading in nature after completing their times of use give added value to these textile products. These products are used widely in many areas such as work-wear, hospital garments, military clothing, home textiles, baby clothing, sportswear, underwears and socks
Within this study, polylacticacid, chitosan, cotton, lyocell fibers of different proportions were used. Fabrics which have derived from different mixtures of these fibers were designed. And biodegradable, anti-bacterial knitted fabrics were developed.
Fabrics were tested for their antibacterial properties. According to results of the tests, percentage of chitosan and lyocell fibers in the blended yarn was the most important parameter.

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Key Words: Antibacterial, PLA Fiber, Biodegradable Fibers, Chitosan

INTRODUCTION

Within the scope of high performance and protection products, using non-toxic materials, whose antibacterial properties are improved to protect against microorganisms and avoid odor generated by micro-organisms, and also don't react undesirable, are important. The expected properties of textile products are absorbency, flexibility, softness, breathing capability, sufficient resistance and being esthetic [1, 2].

Modern life and working conditions offer suitable atmosphere for multiplying fast to microorganisms. The microorganisms are in our body, in air, on soil and all surfaces. They reproduce themselves rapidly when suitable conditions are provided. Because textile materials create environment which offers necessary conditions such as temperature, humidity, nutrients for microorganisms to live and multiply, they lead to deterioration of product, generating stains and undesirable odors, spreading of microorganisms in crowded environments, allergic reactions which can result in infections in human body [3].

While it should keep under control nonpathogenic microorganisms because of undesirable odor and view, inhibition of multiply of pathogenic microorganisms has great significance because of dangerous effects on human health [3].

The microorganisms have summarized in terms of their pathogenic effects and diseases which were caused on the Table 1 below.

Table 1. Some pathogenic and non pathogenic microorganisms [4]

Microorganism	**Pathogenicity**	**Effects**
Bacillus subtilis	Generally non-pathogenic	Decomposition of foods
Escheria coli	Low pathogenic	Decomposition of foods, sometimes urinary infection
Klebsiella pnuemoniae	Pathogenic	Apical pneumonia, urinary bladder infection
Pseudomonas aeuroginosa	Low pathogenic	Various infections
Protcus vulgaris	Low pathogenic	Inflammations
Staphylococcus epidermis	Low pathogenic	Surgical wound infection
Staphylococcus aureus	Pathogenic	Toxic shock, purulence, apsis, fibrin coagulation, endocarditis

Antimicrobial substance has identified that they kill microorganisms like bacteria, mold, fungus, yeast,.. ext., prevented their reproduction as natural, synthetic or semi-synthetic material [9].

There are thousands of chemical substances destroyed the microorganisms. Most of them are natural substances like essences of vegetable and animal, arsenic, lead, tin, quicksilver, silver. However, most of them can be toxic on human and environment in practice. Therefore, not only a antibacterial substance which is used in textile industry kill the microorganisms but also it should be safe with regard to human and environment and they should not effect negatively on other properties of textile materials at the same time [8].

There are fibers which have natural antibacterial efficacy except these like bamboo, alginate, soy, chitosan fibers. Natural fibers like cotton are more exposed to microbial growth than synthetics fibers. Because porous, hydrophile structure of natural fibers offer excellent environment keeping water, oxygen and nutrient for bacterial growth [9].

Fiber needs are increasingly rise in today's conditions. It is predicted that the production of synthetic fibers will be more due to limited production areas of natural fibers and it is not possible that they are not able to answer sufficient level of this growing need in the industry. That's why, attention of fibers which are biodegradable, do not harm the environment, have similar features with natural fibers, is increasing day by day for new production technologies are improved. In this respect , PLA(polylacticacid) fibers which are produced %100 renewable resources(corn, sugar beet, wheat,…..) stand out with %100 biodegradable characteristics. It can obtained spun and filament yarn with PLA. It has foreseed that the fabrics which are generated from spun yarns show same hand feeling with cotton fabrics, because of low moisture holding capacity, high moisture transmission speed despite of the fact that they are not structural antibacterial due to not to be microbial source of nourishment play an active role in production of antibacterial fabric [6, 7].

Poly(lacticacid) (PLA) is a linear aliphatic thermoplastic polyester derived from 100% renewable sources. Although PET has similar characteristics in terms of form of derivation with PLA, PLA has different characteristics due to aromatic polymer structure and produce from mineral sources. PLA is obtained either by direct condensation of lactic acid or via the cyclic intermediate dimer (lactide), through a ring opening process. Energy from the sun promotes photosynthesis within the plant cells; carbon dioxide and water from the atmosphere are converted into starch. This starch is readily extracted from plant matter and converted to a fermentable sugar (e.g. glucose) by enzymatic hydrolysis. The carbon and other elements in these natural sugars are then converted to lactic acid through fermentation [7, 10]

PLA is well suited for melt spinning into fibers compared to the solvent-spinning process required for other cellulosic based synthetic fibers. Melt spinning allows PLA fibers to be made with both lower financial cost and lower environmental cost and allows the production of fibers with a wider range of properties [6, 7].

One of most important polymer providing antibacterial protection is chitin. Chitin is most widespread biopolymer afterwards cellulose in the world. Chitin is derived from shells of seefoods like crabs and shrimps. Chitosan which is polysaccharide is obtained by a result of deacetylation of chitin.

Chitosan which is biodegradable, biocompatible, has attracted by textile industy within lots of other sectors because of nontoxic on the livings. It shows superior physical and chemical properties compared to other biopolymers besides chitosan is a biopolymer which can easly produce from resources being in nature [5].

Chitosan indicate antibacterial activity due to polycationic structure on various bacterias and fungus. So that it has wide using area in hygiene products of textile industry.

EXPERIMENTAL

The purpose of this project is improved antibacterial, biodegradable knitted fabrics using different mixtures of chitosan, polylacticacid, cotton and lyocell fibers in the light of all mentioned information above.

In this study, the constructions of designed fabrics are 30/1 single jersey , 150-160 gr/m^2

The fiber specifications are for 30/1 open-end yarn;

PLA	1,3den 1,5inch
CHITOSAN	1,67dtex 38mm
COTTON	1,8dtex 30mm
LYOCELL	1,3dtex 38mm

Firstly, wicks have obtained in Quickspin machine from the fibers and then spinned in open-end system as 30/1 yarn. After that, textile materials was generated as 30/1 single jersey using Mesdanlab sock knitted machine. These fabrics which had different proportions were tested by antibacterial activity.

It has evaluated antibacterial efficiency on Staphylococcus Aureus and Klebsiella Pneumoniae as appling AATCC 100 (quantitative method) and AATCC 147 (semi quantitative method) difusion agar method for quantitatively measured to degree of antibacterial activity of textile structures.

Klebsiella pneumoniae which is gram-negative bacteria is opportunistic pathogen on comprise wound infections, urinary system infections, upper respiratory tract infections and nasocomial infections which are very critical in terms of human health. Staphylococcus aureus which is gram-positive is a bacteria caused several infections on human beings. They are being intensively on nasal and throat cavity, on faeces of human and animal, on abscessed wound of skin and on acnes. And also they are being mostly on foods, on food factories, on someones preparing food by hand, on hospital stuffs and in hospitals.

At the beginning , the yarns of %100 pla, %100 cotton, %100 chitosan, %100 lyocell have produced as reference.

To observe of the influence when these fibers mixed the other fibers, below blends were planned.

-%85pla-%15chitosan
-%85cotton-%15chitosan
-%85lyocell-%15chitosan

RESULTS

It has been given the results of antibacterial activity towards to Staphylococcus Aureus and Klebsiella Pneumoniae according to AATCC-147-1998 test standard below (Table 2).

Table 2. AATCC-147-1998 Test Results

Fabric	Staphylococcus Aureus	Klebsiella Pneumoniae
100% Chitosan	Effective(+)	Ineffective (-)
100% PLA	Ineffective(-)	Ineffective (-)

It has been given the results of antibacterial activity towards to Staphylococcus Aureus and Klebsiella Pneumoniae according to AATCC-100-1999 test standard below (Table 3).

Table 3. AATCC-100-1999 Test Results

Fabric	Staphylococcus Aureus(% reduction)
%100 Chitosan	99,990
%15 Chitosan %85 PLA	98,600
%15 Chitosan %85 Lyocell	99,999
%15Chitosan %85 Cotton	96,630

While %100 Chitosan 30/1 single jersey fabric showed antibacterial activity towards to Staphylococcus Aureus, it did not show antibacterial activity towards to Klebsiella

Pneumoniae. %100 PLA 30/1 single jersey fabric did not show antibacterial activity on both bacterias.

%100 Chitosan 30/1 single jersey fabric has been reduced at the rate of %99,99 growing of Staphylococcus Aureus bacteria. Bacterial reduction has been become %98,6 on the mixture of %85PLA %15Chitosan. It has been seen that bacterial reduction was higher as %99,99 when it has used Lyocell instead of PLA.In this case, it has been established that the influence obtained by %100 chitosan was the same at this mixture rate too. When the rate of mixture was %15 Chitosan %85 Cotton , the rate of bacterial reduction declined to %96,630.

Staphylococcus aureus which is gram-positive is a bacteria caused several infections on human beings. They are being mostly on foods, on food factories, on someones preparing food by hand, on hospital stuffs and in hospitals. It is reveal that designed textile structures can be alternative for textile materials which is used in this areas.

DISCUSSION

When the test results has examined, it has been seen that antibacterial activities of all blends were more than %95.

Therefore, it is decided that chitosan fiber should certainly used in all mixtures which is designed in future.

And also It has been suggested that it should been continued to working for finding most suitable combination in terms of performance and cost with the reduced rate of chitosan.

CONCLUSIONS

Consequently, it has been seen that Chitosan fiber has showed antibacterial activity on Staphylococcus Aureus bacteria. The rate of bacterial reduction has been become maximum level in all blend designed with mixing chitosan fiber.

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