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Overview of Some Materials and Test Methods for Antimicrobial Finishing on Textile.

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ABSTRACT

The microbial infestation is a common problem especially in textiles due to their receptiveness for moisture, dirt, food particles giving scope for microbe's growth. In case of innerwear that is nexttoskin the situation becomes more critical.Textiles formedical andhygienic use have become important areas in the textile industry. Therefore, to reduce/prevent infections, various antimicrobial compounds have been used for all types of textiles. This paper gives a review for Natural herbal extract, Various of dyes, Drug, heavy metal ions (silver and copper)and chemical materials(quaternary ammonium salts with long hydrocarbon chains), in the field of antimicrobial finishes andalso presents several methods to antimicrobialtests that the summary include, quantitative and qualitative tests.

Keywords:Antimicrobial Finishing, Textile, Treatment, Herbal Material, Fiber, Fabric

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INTRODUCTION

The thousands of species of microorganisms that exist are found everywhere in the environment and on our bodies [1]. These organisms impact producers, retailers, and users of all kinds of products. This is due to the fact that textile materials undergo biological degradation, and it seems that about 40 % of the damage is due to the effect of microorganisms. The activity of fungi and bacteria results in the reduced mechanical strength of a material, color change, stains and stale odor. In this regard, the use of materials with antimicrobial properties extends the service life of these materials, and avoids damage caused by biological degradation[1,2].In recent years, great interest in the antibacterial finishing of fibers and fabrics for practical applications has been observed [2,3].Most textile materials currently used in hospitals and hotels are conducive to crossinfection or transmission of diseases caused by microorganisms. Textiles formedical and hygienic use have become importantareas in thetextile industry.There's a lot of antibacterial material such as natural herbal extract(chitosan), several of dyes (disperse dyes), Drugs (salfonamides), heavy metal ions (silver and copper) and chemical materials (quaternary ammonium salts with long hydrocarbon chains,in the field of antimicrobial finishes[2-4]. Antimicrobial textiles can be used to produce many goods such as sportswear, outdoor apparels, undergarments, shoes, furnishings, upholstery, hospital linens, wound care wraps, towels and wipes[5,6].Self-sterilizing fabrics could have potential benefits to reduce disease transfers among hospital populations, bio warfare protection and other applications. Novel technologies in antimicrobial finishing are successfully employed in non-woven sector especially in medical textiles[3,5].Also there are several ways to antibacterial finishing that the summary include padding, Evaporating of solvent, Polymerization, Acting of goods with resins,Chemical changes in the fiber by covalent bonds and covering fiber surface[3,4].In general, antimicrobial properties can be imparted to textile materials by chemically or physically incorporating functional agents onto fibers or fabrics[3].

MICROBES

Mold, mildew, fungus, yeast, bacteria and virus (microorganisms) arepart of our everyday lives. There are both good andbad types ofmicroorganisms. Microbes, their body parts, metabolic products and reproductive parts, cause multiple problems to textiles[1,2].There are human irritants, sensitizers, toxic-response agents, causers of disease and simple discomforting agents[5].

MECHANISMS OF ANTIMICROBIAL ACTION

There are five main mechanisms by which antibacterial agents act [3]:

- -Inhibition of cell metabolism
- -Inhibition of bacterial cell wall synthesis
- -Interactions with the plasma membrane
- -Disruption of protein synthesis
- -Inhibition of nucleic acid transcription and replication

Biological And Herbal Material For Antimicrobial

Chitosan

Chitosan is a deacetylated derivate of chitin, which is a natural polysaccharide mainly derived from the shells of shrimps and other sea crustaceans. Chemically, it can be designated as poly-β-(1→4)-D-glucosamine or poly-(1,4)-2-amido-deoxy-β-D-glucose. In addition to its antimicrobial activity. Chitosan can also interact with the DNA of microorganisms to prevent protein synthesis[4].

Sericin

Silk sericin is a natural macromolecular protein derived from silkworm Bombyxmori and constitutes 25-30 %of silk protein.It envelops the fibroin fibers with successive sticky layers that help in the formation of cocoon [5].

Neem Extract

The active ingredients of neem are found in all parts of the tree but in general,seed,bark,leavesand roots are used for extraction purpose. More than 300 different active compounds have been reported from different parts of neem tree, but the most important limonoids are azadirachtin, salannin, nimbin. The neem extracts have been widely used in herbal pesticide formulation because of its pest repellent properties has a potential to inhibit growth of bacteria both Gram positive and Gram negative[3,5].

Aloe Vera

Aloe Vera leaf contains over 75 nutrients and 200 active compounds, including 20 minerals,18 amino acid and 12 vitamins.There are different polysaccharides in Aloe Vera,such as glucomannanwith different molecular weight, acetylated glucomannan, galactogalacturan, glucogalactomannan with different composition as well as acelylatedmannan or acemannan. Acemannan along chain polymer consisting of randomly acetylated linear D-mannopyranosyl units has immunomodulation, antimicrobial, antifungal and antitumor properties[1,3,5].

Tea Tree

Tea tree has antiseptic (five times stronger than the usual household disinfectants),dermatological(prevents dry skin), and anti-fungal benefits and can also be used to fight infections/infestations.Its oil is active against a wide range of bacteria,such as Escherichia coli, propioibacterium acnes, proteus vulgaris, pseudomonas aeruginosa, staphylococcous aureus, proteus mirabilis, salmonella typhimurium, and streptococcus pyogenes[5].

Clove oil

Bio activity of clove oil was explored in size paste as size preservative as well as finishing agent for textile to make it antimicrobial. Researchers showed that clove oil with 0.5 %conc. shows 17mm of zone of inhibition using staphylococcus aureus and klebsilla pneumonia [5].

Eucalyptus Oil

Eucalyptus oil has been shown to fight against infection causing bacteria, fungi, and virus very effectively. It is powerful in helping our psoriasis and also it is natural and complements the skin. To sol-gel immobilization and controlled release of eucalyptol from modified silica coatings were investigated in order to evaluate the suitability of functionalized textiles for the following application in skin-friendly textiles with antimicrobial and anti-allergic effects[3,5].

karanj

Karanj it has indicated the presence of abundant prenylated flavonoids such as furanoflavones, furanoflavonols. Seed oil contains karanj, a bioactive molecule with important biological attributes. Antimicrobial activity of Karanj in vitro against fourteen species of pathogenic bacteria was studied. Using the tube dilution method was observed that 57.14% of pathogens in microl /ml500, 14.28% in microl / ml 125 and 28.57% at microl / ml 250 were inhibited. karanj oil is anti-bacterial activity and is independent of temperature and energy. Many pathogens more rapidly at 4 ° C than at 37 ° C were killed. Karanj oil activity by inhibiting the synthesis of cell membranes, mainly because of the bacterium [6].

Garlic

Garlic (Allliumsativum) the land of which is said as Middle and West Asia steps has a place among eldest crop plants.It is declared that garlic,as an antibacterial agent, is effective against many more gram negative and gram positive bacteria like Helicobacter pylori, E.coil, Lactobacillus casei and that this effect is sourced from allicin inside it. It is revealed that active substances like allistatin 1 and allistatin 2 in garlic are powerful agents against staphylococcus and E.coli bacteria[7].

Onion Skin and Pulp Extracts

Onion (Allium cepa), member of the Lilliaceae family, are found in a bewildering array of recipes and preparations. Researchers studied the antimicrobial property of onion-treated cotton fabric. The zone of inhibition against staphylococcus areus bacteria was 1.1-0.8 cm by 10 min grafting time of onion skin extraction and 0.7-0.5 cm by 30 min grafting time of onion pulp extraction on the oxygen plasma treated cotton fabrics [5,7].

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ANTIMICROBIAL DYES

Disperse Dyes Based on Aminothiophenes

Synthesized disperse dyes such as disperse dyes Based on Aminothiophenes showed positive antimicrobial activities against at four of the tested microorganisms. In addition the biological activity of the synthesized dyes against Escherichiacoli and Pseudomonas aeruginosa (Gram negative bacteria), Bacillus subtilis and Staphylococcus aureus (Gram positive bacteria) and Candida albicans (yeast) was also evaluated. The antimicrobial activities of the synthesized disperse dyes were screened against selected bacteria and fungi by the agar well diffusion method and their inhibition zones diameters [8].

DisazoCompounds

Some synthesized disazo compounds such as The disazo compounds I (derived 4,4'-diaminostilbene- 2,2'-disulfonic acid) and II (derived 4,4'-diaminobenzanilide) were subjected to antibacterial activity screening against two gram-positive bacteria (Staphylococcus aureus and Streptococcus pyogenes) and three gram-negative bacteria (Pseudomonas aeruginosa, Proteus vulgaris and Escherichia coli) employing the disk diffusion technique. Inhibitory effect of the compounds was established at zones greater than 12 mm[9].

Reactive Dye

Many studies looked at the feasibility of utilizing common antibacterial drugs and chemically converting them in order to obtain a reactive dye type molecule, which could be applied to textiles with the goal of imparting the antibacterial properties of the antibiotic compounds to the fabrics. For example, Trimethoprim and sulfamethoxazole were modified to act as reactive dyes.The results indicate that both trimethoprim and sulfamethoxazole individually or together depressed the bacterial density of K. pneumonia and S. aureussignifcantly after 24-hr incubation. Sulfamethoxazole was less effective than trimethoprim alone or when both trimethoprim and sulfamethoxazole were attached to the fabric. This also suggests that the reactive trimethoprim may have been preferentially attached to the cotton fabric and that even at half the dose could account for the lower bacterial density when combined sulfamethoxazole There is a possibility that the two compounds may have had a synergistic effect to account for the low bacterial density compared with trimethoprim alone or the amount of the trimethoprim applied alone was in excess to what is needed to effectively lower the bacterial density to this level [10].

Cationic Dye

Some synthesized cationic dyes and their mono functional analogue was studied forsimultaneous dyeing and antibacterial finishing of textile using exhaust method. For example, Berberine is a cationic dye and because of its quaternary ammonium structure can act as an antibacterial agent. The berberine colorant is a quaternary ammonium compound, containing a positive charge on N atom that could destroy the negatively charged cell membrane of the bacteria by disturbing charge balances of cell membrane[11-13]. Other

detrimental effects of quaternary ammonium compounds on microbes are denaturizing of proteins and disruption of the cell structure [14-18]. During inactivation of bacterial cells, the quaternary ammonium group remains intact and retains its antimicrobial ability as long as the compound is attached to textiles[11].

Reactive Cationic Dyes

Antibacterial bifunctional reactive cationic dye was synthesized for simultaneous dyeing and antibacterial finishing for textile with high application performance. For example textiles dyed with reactive cationicdyes 1 (Bifunctionalbis (MCT/QA) reactive cationic)and 2 (Monofunctional MCT/QA reactive cationic) were subjected to disk diffusion susceptibility test method. The results of undyed samples show clear growth of bacteria under them with no zone of inhibition. The investigated dyes inhibit bacterial growth asis evident from the absence of growth under all dyed samples. Zone of inhibition, is more than that of the mono functional dye 2because of the presence of bis (QA) groups in its molecular structure.Because positive electrical charges allow dye molecules to be adsorbed readily onto microbial surfaces and then penetrate the cell membrane, followed by destruction of cell membranes and leakage of cellinclusion body of bacteria [19-23].

CHEMICAL AGENTS FOR ANTIMICROBIAL TREATMENT

N-Halamines

N-halamines are heterocyclic organic compounds containing one or two covalent bonds formed between nitrogen and a halogen (N–X), in which the latter is usually chlorine N-halaminesare biocides that are active for a broad spectrum of bacteria, fungi and viruses. Their antimicrobial properties are based on the electrophilic substitution ofCl in the N-Cl bond with H; this reaction can be carried out in the presence of water and results in the transfer of Cl ions that can bind to acceptor regions on microorganisms. This hinders enzymatic and metabolic processes, leading to the destruction of the microorganisms[5,15].

Dimethlytetradecyl (3-(trimethoxysilyl) Ammonium Chloride(DTAC)

It was stated by manufacturer that DTAC was reported as highly bacteriostatic and is safe to man and the environment [24]. The compound is comprised of membrane active microbiostatics. It has been known that the action mechanism of such cationic surfactants is electrostatic interaction and physical disruption. The positively charged ammonium action of the agent is able to bind to negatively charged sites of the bacteria cell wall surface and finally cell death .Antibacterial activity of tested fabrics against Gram positive cocci was greater than that against Gram negative rods. Because, Gram positive cocci have a simple cell wall structure in which the cytoplasm membrane has a rigid peptidoglycan layer composed of with plenty of pores, which allow foreign molecules to enter the cell without any difficulty [3,24].

Quaternary Ammonium Compounds

As antimicrobial agents for textiles, monoammonium and "gemini'' or "dimeric'' ammonium surfactants (with an alkyl, alkyl, aryl and perfluorinated hydrocarbon group) are used. These are active against a broad spectrum of microorganisms such as Gram-positive and Gram-negative bacteria, fungi and certain types of viruses. The antimicrobial function arises from attractive interactions between the cationic ammonium group of the QAS and the negatively charged cell membrane of the microbe.QASs also affect bacterial DNA, causing a loss of multiplication ability [25-28].

Halogenated Phenols

Among halogenated phenols, triclosan 5-chloro-2-(2.4-dichlorophenoxy) phenol is the most widely used biocide. At bactericidal concentration, triclosan is very effective against a broad range of microorganisms, including antibiotic- resistant bacteria. As the widespread use of triclosan could represent a potential risk in terms ofthe development of resistant microorganisms strong binding to solid surfaces with subsequent controlled release is important [25,29].

METALLIC SALTS

Silver

The antimicrobial activity of silver has been recognized by clinicians for over 100 years, whenexposed to aqueous environments, some ionic silver(Ag+) is released certain salts.Silver nanoparticles havealso been demonstrated to exhibit antimicrobial properties against both bacteria and viruses with close attachment to the microbial cell/virus particles being demonstrated with activity being size dependent.Highly bio active silver ions bindwith proteins inside and outside bacterial cell membranes thus inhibiting cell respiration and reproduction[30].

Zinc OxideNanoparticles

ZnO nanoparticles have been shown to be useful antibacterial and antifungal agents when used as a surface coating on materials and textiles [30]. A study by Yamamoto (2001), to evaluate the antibacterial activity of ZnO with different particle sizes showed that ZnO nanoparticles (10-50 nm) exhibit better antimicrobial properties than bulk ZnO (2 µm). The antibacterial activity of Zn Onanoparticles is due in part to their electrostatic interaction with cell surfaces. (Sharma et al. 2010), showed that on contact with bacteria[29,31].

TiO_2Nanoparticles

Titanium dioxide irradiation by light with more energy compared to its band gaps generates electron (e^-)hole pairs that induce redox reactions at the surface of the titanium dioxide. Consequently, electrons in TiO_2 jump from the valence band to the conduction band, and the electron (e^-) and electric hole (h+) pairs are formed on the surface of the photo-catalyst. The created negative electrons and oxygen will combine into O_2^-, the

positive electric holes and water will generate hydroxyl radicals. Ultimately, various highly active oxygen species can oxidize organic compounds of cell to carbon dioxide (CO_2) and water (H_2O). Thus, titanium dioxide can decompose common organic matters in the air such as odor molecules, bacteria and viruses[15,32].

Gold Nanoparticles

Gold nanoparticles are known as a novel biomedical application. Their potent antibacterial effectiveness against acne or scurf and no tolerance to the antibiotic have caused their commercial usage in soap and cosmetic industries. They can remove waste materials from the skin and control sebum[32,33].

Another Metallic salts

Many heavy metals are toxic to microbes at very low concentrations either in the Free State or in compounds. They kill microbes by binding to intracellular proteins and inactivating them[33].The results of antibacterial efficiency for Cu, Ni and Co loaded samples are very good. And the antibacterial activity for Sn and Ti is moderate as compared with the mentioned elements, However better antibacterial efficiency were achieved for Sb treated sample as compared with Sn[15,29, 33].

ANTIMICROBIAL DRUGS FOR USING TEXTILE TREATMENT

Ampicillin

In the recent research,Electrospunpoly (ε-caprolactone) nanofibers containing ampicillin have been produced and collected as wellaligned fiber bundles using a custommade electrospinning system.The alignment and size of the fibers, the antimicrobial effectiveness of the yarns on two microorganisms, Gram-positive Staphylococcus aureus and Gram-negative Klebsiella pneumonia. The zone of inhibition results suggest that the ampicillin retains its antimicrobial efficacy after being incorporated into the polymer solution, spun into fibers and twisted into yarns, and released from the fibers [34].

Sulfonamide

The sulfonamides act as competitive enzyme inhibitors and block the biosynthesis of the vitamin folk acid in bacterial cells .They do this by inhibiting the enzyme responsible for linking together the component parts of folic acid. Sulfonamides act as inhibitors by mimicking p-aminobenzoic acid (PABA) one of the normal constituents of folic acid [15, 32].

N-Phthalimido-α-Hydroxyaceticacid

The antimicrobial finishing of textiles is intended to provide protection of textiles against microbial corrosion, prevention of malodor or prophylaxis and therapy ofinfections, respectively. Evaluates the applicability of N-Phthalimido-α-hydroxyaceticacid as antibacterial in textile finishing.It was synthesized by the reaction between Phthalimide

and Glyoxalic acid in THF medium. The synthesized compound was identified by Phthalimide and Glyoxalicattached tothe cotton fabric bytwo-stage process of chemical modification[35].

ANTIMICROBIAL ACCTIVITY EVALUATION

QUALITATIVE TESTS

Agar Diffusion Method

Bacteriostatic agar was dispensed in sterile petriplates.24 hour's broth cultures of the test organisms (E.coli and S.aureus) were used as inoculums. Using sterile cotton swab the test organisms were swabbed over the surface of the agar plates. The test fabrics & Control was gently pressed in the center of the mat culture. The plates were incubated at 37°C for 18-24 hours[3,5,36].

Parallel Streak Method: (AATCC Test method 147-1992)

Sterile bacteriostatic agar was dispensed in petriplates. 24 hours broth cultures of the test organisms (E.coli and S.aureus) were used as inoculums. Using 2 mm inoculation loop, 1 loop full of culture was loaded and transferred to the surface of the agar plate by making 7.5cm long parallel streaks 1cm apart in the center of the plate, without refilling the loop. The test specimen & Control was gently pressed transversely, across the five inoculums of streaks to ensure intimate contact with the agar surface. The plates were incubated at 37°C for 18-24 hours[3,25,36].

QUANTITAIVE TESTS

Percentage Reduction Test

Specimens of the test material were shaken in a known concentration of bacteria suspensionand the reduction in bacterial activity in standard time was measured. The efficiency of the antimicrobial treatment is determined by comparing the reduction in bacterial concentration of the treated sample with that of control sample expressed as a percentage reduction in standard time. The evaluation of modified. Hohenstein test was made on the basis of the percentage reduction of bacteria by the sample. [15,25,36]

CONCLUSION

The main reason of increased antimicrobial finishing include: an increased aware ness towards personal hygiene, demand for ecofriendly finishes and to prevent skin infections, body odor to improve physiological comfort value of garments and clothes.Application of antimicrobial textiles and fibers are in wipes, wound care, sports, clothes
air filtration systems in hospitals, water filtration.Several materials such as Natural herbal extract, Various of dyes, Drug, heavy metal ions (silver and copper) and chemical materials (quaternary ammonium salts with long hydrocarbon chains) have been used to antimicrobial treatment for textiles. Dyes are among the compounds which are suitable for

biocidal treatment of textilematerials due to the fact that some of them exhibit biological activity, resulting from thepresence in their molecule of some antiseptic groups that form a definite type of bonding withthe molecules of the fibrous material. The qualitative and quantitative tests are common methods for antimicrobial activity evaluation.

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