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An Investigation of Antimicrobial Activity on Fibers and its Textiles Application in Recent Times

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Abstract

The study attempt to investigate the advancement of antimicrobial activity and its used in textiles in recent years (between 2000-1019) and the latest finding and innovation more to its field. In textile finishes to safeguard textiles from the infestation of microorganism (bacteria, fungi, mildew, algae etc.) antimicrobial finishes have been playing an excellent role. Antimicrobial finishes are important nowadays mostly because it imparts certain properties to the surface of fabric maintaining excellence level of hygiene; cleanliness and can last up to maximum wash times. It is an excellent mean to give fabric a smart finish which do not only prevent microbial activity but also impart smart functionalities. Besides textiles antimicrobial protection has been observingly found in food packaging, cosmetics and many more industries. The study is aimed to combine the future potentials and recent progression of antimicrobial finishes in various fields of our life and has been conducted by an empirical investigation from the previous works. The contributions are for the development of mankind and for more impactful results of the area of antimicrobial finishes so far taken place. But the possibilities in future where more advance applications can lead far more more development and innovation are yet to find out.

Keywords: Plant fibers; antimicrobial properties; textile uses; medical textile; benefits and recent advancements.

1. Introduction

Recent day's advancement has taken place of textile materials with anti-microbial properties. It is possible to combine antimicrobial additives during processes like fiber spinning or extrusion [1]. It is also possible to incorporate it finishing or dyes in the fabric. Not all fibers have antimicrobial properties. Normally fibers that are natural have a tendency grow microorganism.

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The fiber in contact with sweat, especially in damp, warmth or humid environment increases infestation of microorganism [2]. The emerging necessity of antimicrobial finish also increases in hygiene of textile significantly in medical textile. Application results of microbial finishes are effectively visible and can increase products longevity [3]. Few plant fibers like jute, sisal, banana, pineapple, hemp and many more have been found with antibacterial activity [4] but other fibers which do not contain such properties and however requires antimicrobial finishes. The earliest textile developments involved the use of natural materials such as cotton, wool, and flax. More recently, synthetic fibers were developed. Today needs for personal mobility, healthcare, or rehabilitation require that novel functions in sensing and actuating be integrated into textiles. The fundamental challenge in system-on-textile design is that the drapability and manufacturability of textiles and clothing must remain largely unaffected.

2. The Electrospinning Process and Antibacterial Dressings

There has been a rapid progression of making antibacterial dressing using the electrospinning for the development of nanofibers for the purpose of effective wound repair. Crude plant extracts, essential oils, and plant-derived chemical components has the functionality to promote cells proliferation, physical protection of the injured tissue. So an effective antimicrobial dressing produced using electrospinning method is a latest advancement for the field of both antimicrobial activity and nanofiber technology [9].

3. Essential Oils

Aromatic plants could be one possible source for Essential oils. Hydrophobic nature of Essential oils promotes antimicrobial activity [9]. EO's active antimicrobial properties has been found in natural plants like tea tree [10], lemongrass and peppermint [46], cinnamon [11,12], thyme [11] and many other. Electrospinning of these EO's have been used in producing fibrous scaffolds with antibacterial properties [9].

Table 1: Reported essential oils (% v/v) against micro-organisms

Common name	Plant species	Source	Escherichia coli	Salmonella typhimurium
Lime	Citrus aurantifolia	FRUIT	1.0	>2.0
Orange	Citrus aurantium	PEEL	>2.	>2.0
Peppermint	Mentha x piperita	HERB	0.5	1.0
French lavender	Lavandula angustifolia	FLOWER	0.5	>2.0
Tea tree	Melaleuca alternifolia	LEAVES & TWIGS	0.25	0.5
Basil	Ocimum basilicum	HERB	0.5	>2.0
Lemongrass	Cymbopogon citratus	LEAF	0.06	0.25
Oregano	Origanum vulgare	HERB	0.12	0.12
Coriander	Coriandrum sativum	SEED	0.25	1.0
Celery seed	Apium graveolens	SEED	2.0	>2.0
Carrot seed	Daucus carota	SEED	>2.0	>2.0

4. The peel of lemon and its antimicrobial activity

The lemon peel with different solvents like ethanol, acetone, and methanol were homogenized on microorganism like Pseudomonas aeruginosa NCIM 2036, Salmonella typhimurium NCIM 5021, and Micrococcus aureus NCIM 502 and result found as the peel of lemon is both an astringent and good antimicrobial agent [14]. Other fiber plants such as jute, bamboo, flax, sisal, kenaf, banana, and pineapple, have also been investigated and have shown some antibacterial activity.Antibacterial performance of bamboo extracts was reported, where methanol, ethanol, and other common solvent extracts of bamboo culms, shavings, and leaves were tested against a wide variety of bacteria (Mulyono and his colleagues 2013). Afrin and his colleagues (2012) claimed that antibacterial agents of bamboo (Phyllostachys pubescens) are located in lignin, not in hemicellulose or other water-soluble chemical components.

5. Biopolymers with antimicrobial agents

As biopolymers are used in antimicrobial textile finishes because they have certain characters like drug release, wound healing, antimicrobial activity, anti-static activity, adhesion ability. Biopolymers like Alginate, chitosan, sericin, cyclodextrin are found from different natural sources like brown sea weed, crustaceans, silk worm, and starch. Brown sea weed which is a source of biopolymers like algae have properties like high moisture absorbing capacity, biocompatibility, wound healing ability, antibacterial activity, can be used in Antimicrobial Finishing of Textiles [15]. From enzymatic extraction of fungi and decalcification, deproteination, decolorization of crustaceans Chitin and then Chitosen are extracted. Chitosen is a great source for the characteristics like biocompatible, biodegradable, antimicrobial activity, antistatic activity, non-toxic, chelating property, deodorizing property, film forming ability, chemical reactivity, polyelectrolyte nature, dyeing improvement ability, cost-effectiveness, thickening property, wound healing activity and thus is another excellent biopolymer for the finishing of textiles [15].

6. Chitosan derivatives for antimicrobial finishing

Different derivatives of chitosan for example: (a) N-(2-hydroxy) propyl-3- trimethylammonium chitosan chloride; (b) Oacrylamidomethyl-N-[(2-hydroxy-3- trimethylammoniu) propyl] chitosan chloride; (c) N-carboxymethyl derivatives of chitosan; (d) O-quaternizedN,N-biethyl-N-benzylammonium chitosan chloride; (e) O-quaternized-N-chitosan Schiff bases; (f) O-quaternized-N-benzyl-chitosan; (g) Cationic hyperbranced PAMAM-chitosan. It is possible to produced antimicrobial fabrics like Rayon very effective against gram positive and negative bacteria. But this has a limitation because the availability of crustaceans from shrimps, crabs, lobster and other seafood are seasonal.

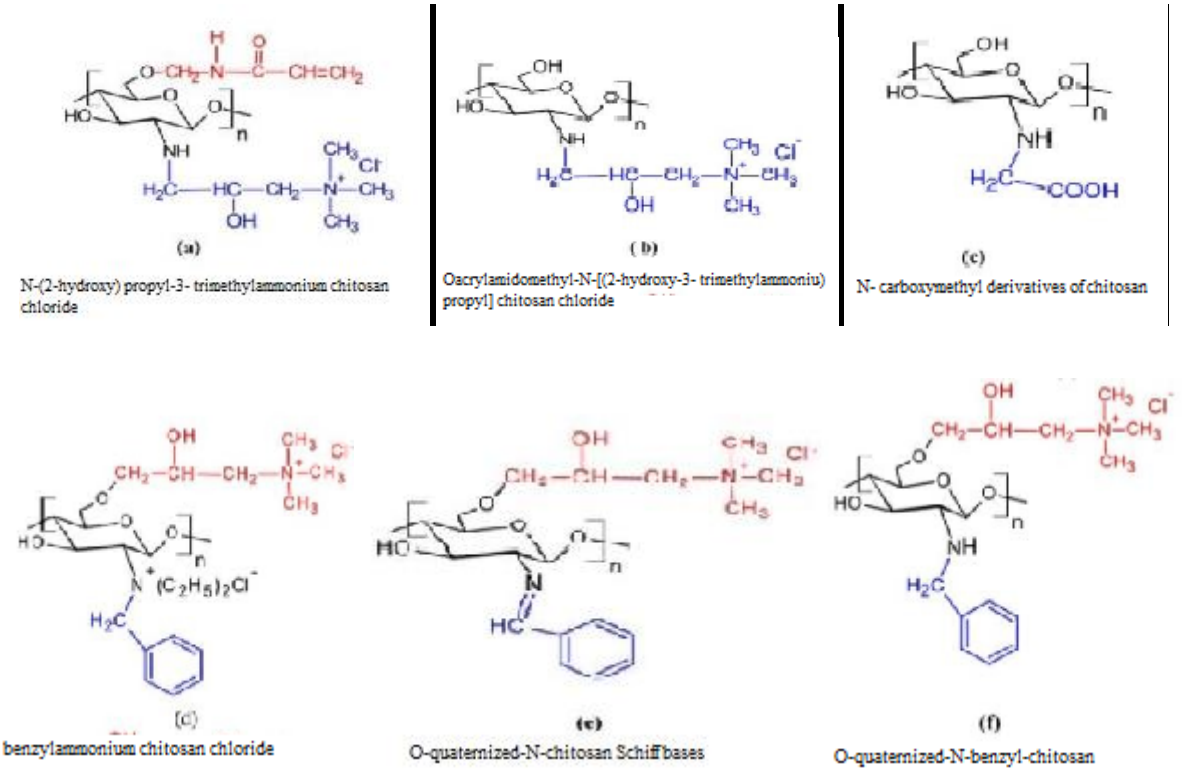

Figure 1

So alternate to this this is growing significant amount of fungi to produce chitosan. There are immense possibilities to develop medical and bioactive textile and many hygiene applications from this. The important use of chitosan derivatives is to provide antimicrobial finishing to textiles. Chitosan is multifunctional thus it is possible to impart other important functionalities at same time. However, the main problem lies in its poor durability, low solubility and less biological activity in its native form. This is possible to overcome by using a number of water soluble chitosan derivatives as antimicrobial agents on textiles.

7. Surface Modification and Functional Finishes of Textiles

There are some huge advantages of using surface modification on textiles (ex: fabric). Different methods have been using for the surface modification and functional finishes. Enzyme treatment, UV irradiation, Chemical wet finish and plasma treatment are one of few treatments among them. These functional finishes have very few limitations compared to its benefits on textiles. UV irradiation is one such finish that enhances antimicrobial finish. Plasma treatment on the other hand has low environmental impacts as well as with other functional properties along with antimicrobial properties. Enzyme treatments also shows improves shrink resistance; ecofriendly nature; need mild experimental conditions.

8. Application of Biocides

Biocides are compounds that has been using as antimicrobial agents in commercial textiles, Silver, triclosan, polyhexamethylene biguanide (PHMB) and quaternary ammonium compounds, are biocides [16]. Biocides play

a very crucial role resisting the enzyme activity or lipid synthesis occurs on the cell wall of microorganism (e.g. bacterium, fungus). The consumers of textile products look for hygiene and the manufacturers in the textile industry have responded to this demand by launching their brands of antimicrobial products [16]. Antimicrobial textiles provide the benefits in hygiene, odor control and protection of the fabric from microbial attack, bacterial resistance to the biocides used and their toxic breakdown products in the household and environment have been concerns. Some treatments are applied at the finishing stage while in other cases the biocide can be incorporated into synthetic fibers during extrusion. Biocides for ex: silver can be applied on polyester, wool as finishing agent and can be extruded with during the production of nylon; the release can be slow but durable. QAC's another biocide commonly used for very durable and possible bacterial resistance on fibers like cotton, polyester nylon and wool.

9. Dyes exhibiting Antimicrobial Activity

It is possible during these days to add antimicrobial activities at the time of textiles are being dye. The azo disperse dyestuffs, prepared by the reaction of sulphanilamidodiazonium chloride derivatives with indan-1,3-dione, gave excellent dyeing and antimicrobial results on wool and nylon [28]. Covalently attach a biocide to a dye via a linker can make a simultaneous dye and antimicrobial finish. Natural dyes have also been examined for antimicrobial ability is Curcumin, which exhibit durable antimicrobial efficacy when attached to textiles. Besisides dye isolated from Quercus infectoria [25] and the colorant Berberinealso shows antimicrobial efficacy [26].

8. Conclusion

The one major shift has noticeably observed while reviewing the works on anti-microbial activities (2000-1019) that, earlier days the plants based activities (example: coconut husk, lemon peel, stems of neem, Alchornea cordifolia) were more of in used. It all begin with plant extract essential oil and been observed for its antimicrobial activity against S.a; B.s., E.c., P.a., K.p., A.n., C.a. (Ebi, 2001). Barks, stems, leaves, root barks different portion have been identified with different chemical components containing anti-microbial activity. Later in years works like Chitin, Chitosen extracted from crustacean from animals or plants like brown sea weeds, different fungi, Nano fibrillated cellulose, Nano silver are in use to observe antimicrobial activity. Recently green chemistry based antimicrobial textiles base works have been taking place all over. More remarkably Nanofiber, electrospun antimicrobial mats are more in demand. Moreover synthetic fibers are these days incorporating with antimicrobial treatments and finishes. This is already being in most demand for textiles packages, fiber and medical textiles this way contributing impactful results and the development of mankind.

Reference

[1] Antimicrobial Treatments for Textiles | Antimicrobial Textiles | BioCote Ltd. (2016). Retrieved February 8, 2019, from https://www.biocote.com/blog/antimicrobial-treatments-textiles/ ("Antimicrobial Treatments for Textiles | Antimicrobial Textiles | BioCote Ltd," 2016)[2] Reena Mital. (2016). Antimicrobial Finish Is The Most Desired Functional Finish In The Global Textile And Apparel

Market - Textile Excellence - Textile & Apparel Newspaper / Magazine. Retrieved February 8, 2019, from https://www.textileexcellence.com/news/rendezvous/antimicrobial-finish- is-the-most-desired-functional-finish-in-the-global-textile-and-apparel-market/

[3] Admistrator. (2016). what are the benefits of antimicrobial technology for Textiles? Retrieved February 8, 2019, from http://www.sciessent.com/faq/what-are-the-benefits-of-antimicrobial- technology-for-textiles

[4] Khan, B. A., Warner, P., & Wang, H. (2014). Antibacterial Properties of Hemp and Other Natural Fibre Plants: A Review. Bio Resources, 9(2), 3642–3659. https://doi.org/10.15376/biores.9.2.3642-3659 (Khan, Warner, & Wang, 2014)

[5] P. Wojtaszek, Oxidative burst an early response to pathogen infection, Biochem. J. 322 (1997) 681–692.

[6] J.A. Duke, Handbook of Phytochemical Constituents of Gras Herbs and Other Economic Plants, CRC Press, 1992.

[7] Khan, B. A., Warner, P., & Wang, H. (2014). Antibacterial Properties of Hemp and Other Natural Fibre Plants: A Review. Bio Resources, 9(2), 3642–3659. https://doi.org/10.15376/biores.9.2.3642-3659 (Khan, Warner, & Wang, 2014)

[8] S.M.K. Rates, Plants as source of drugs, Toxicon 39 (2001) 603–13. [9] (Zhang, Ronca, & Mele, 2017)

[11] Karami, Z.; Rezaeian, I.; Zahedi, P.; Abdollahi, M. Preparation and performance evaluations of electrospun poly("-caprolactone), poly (lactic acid), and their hybrid (50/50) nanofibrous mats containing thymol as an herbal drug for effective wound healing. J. Appl. Polym. Sci. 2013, 129, 756–766. [CrossRef]

[10] Bai, M.-Y.; Chou, T.-C.; Tsai, J.-C.; Yang, H.-C. Active ingredient-containing chitosan/polycaprolactone nonwoven mats: Characterizations and their functional assays. Mater. Sci. Eng. C 2013, 33, 224–233. [CrossRef] [PubMed]

[12] Liakos, I.; Rizzello, L.; Hajiali, H.; Brunetti, V.; Carzino, R.; Pompa, P.P.; Athanassiou, A.; Mele, E. Fibrous wound dressings encapsulating essential oils as natural antimicrobial agents. J. Mater. Chem. B 2015, 3, 1583–1589. [CrossRef]

[13] Ebi, G. C. (2001). Antimicrobial activities of Alchornea cordifolia. *Fitoterapia*, *72*(1), 69-72.

[14] Shahid, M., & Mohammad, F. (2013). Green Chemistry Approaches to Develop Antimicrobial Textiles Based on Sustainable Biopolymers A Review. *Industrial & Engineering Chemistry Research*, *52*(15), 5245-5260.

[15] Gao, Y., & Cranston, R. (2008). Recent advances in antimicrobial treatments of textiles. *Textile Research Journal*, *78*(1), 60-72.

[16]. Lee, H. J., Yeo, S. Y, and Jeong, S. H., Antibacterial Effect of Nanosized Silver Colloidal Solution on Textile Fabrics, J.Mater. Sci., 38, 2199–2204 (2003).

[17] Ye, W. J. et al., Novel Core–Shell Particles with Poly(n-butylacrylate) Cores and Chitosan Shells as an Antibacterial Coating for Textiles, Polymer, 46, 10538–10543 (2005).

[18] Ye, W. J. et al., Durable Antibacterial Finish on Cotton Fabricby using Chitosan-based Polymeric Core–Shell Particles, J.Appl. Polymer Sci., 102, 1787–1793 (2006).

[19] Lim, S. H., and Hudson, S. M., Application of a Fiber-reactive Chitosan Derivative to Cotton Fabric as an Antimicrobial Textile Finish, Carbohydr. Polymer, 56, 227–234 (2004).

[20] Diz, M., Jocic, D., Infante, M. R., and Erra, P., Reaction of a New Thiol Cationic Surfactant with Bunte Salt in Wool Fibers, Textil. Res. J., 67, 486–493 (1997).

[21] Ma, M. H., Sun, Y. Y., and Sun, G., Antimicrobial Cationic Dyes. Part 1: Synthesis and Characterization, Dyes Pigments, 58, 27–35 (2003)

[22] Sun, G., and Ma, M., "Multifunctional Antimicrobial Dyes", United States Patent Application no 20050011012 (2005).

[23] Ma, M. H., and Sun, G., Antimicrobial Cationic Dyes. Part 3: Simultaneous Dyeing and Antimicrobial Finishing of Acrylic Fabrics, Dyes Pigments, 66, 33–41 (2005).

[24] Han, S. Y., and Yang, Y., Antimicrobial Activity of Wool Fabric Treated with Curcumin, Dyes Pigments, 64, 157–161 (2005).

[25] Singh, R., Jain, A., Panwar, S., Gupta, D., and Khare, S. K.Antimicrobial Activity of Some Natural Dyes, Dyes Pigments, 66, 99–102 (2005).

[26]Kim, T. K., and Son, Y. A., Effect of Reactive Anionic Agent on Dyeing of Cellulosic Fibers with a Berberine Colorant—Part 2: Anionic Agent Treatment and Antimicrobial Activity of a Berberine Dyeing, Dyes Pigments, 64, 85–89 (2005).

[27]Russell, A. D., Biocide Usage and Antibiotic Resistance: The Relevance of Laboratory Findings to Clinical and Environmental Situations, Lancet Infect. Dis., 3, 794–803 (2003)

[28] Sun, G., and Huang, L. K., "Regenerable Antimicrobial Polymers and Fibers with Oxygen Bleaches", United States Patent no 6,962,608 (2005)