WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.074
Volume 8, Issue 8, 167-176. Review Article ISSN 2277– 7105

NATURAL ANTIMICROBIAL AGENTS FOR TEXTILE MATERIALS

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Article Received on
28 April 2019,

Revised on 18 May 2019,
Accepted on 07 June 2019,

DOI: 10.20959/wjpr20198-15182

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ABSTRACT

In the current scenario of environmental consciousness, the new quality requirement also emphasize production process that is environment-friendly they not only focus on the intrinsic functionality and long service life of a product. Therefore research on environment-friendly antimicrobial agents based on natural products is gaining worldwide interest for textile application.[1] Increasing awareness towards the health and hygienedemand for antimicrobial textiles among the consumers. On improvement in protection of textile substrate from microorganisms through an eco-friendly process, intense research is going on worldwide.[2] To conceal growth of microorganism, odour generation as well as its deterioration antimicrobial agent are applied.[3] This paper confer about the various potential antimicrobial agents such as neem, prickly chaff flower, azuki beans, aloe vera, turmeric, clove oil and tulsi leaves.

KEYWORDS: Antimicrobial agents; environment-friendly; natural herbal products; health and hygiene.

INTRODUCTION

India is well known as the hub of natural herbs. Textile materials can be colonized easily by high numbers of microbes or even decomposed by them. They act as carriers of microorganism such as pathogenic bacteria, odour generating bacteria, mould and fungi causing damage to clothing, strength loss, staining, discoloration and may even cause skin diseases. Natural fibres have protein (keratin) and cellulose, etc., they help bacterial growth and multiplication by providing basic requirements such as moisture, oxygen, nutrients and temperature. This leads to objectionable odour, dermal infection product deterioration, allergic responses and other related diseases.[4] Antimicrobial finishes maintain hygiene and enables to avoid infection from pathogens especially in hospitals, nursing homes, schools,

hotels, and crowded public areas. They prevent unpleasant odour on intimate apparel, underwear, socks and athletic wear. Microbes attack natural fibres because they are hydrophilic in nature.[5] Some of the plant materials have been used since ancient times for their good healing power. About 2,50,000-5,00,000 species of plants are estimated to be on earth.The growth of microorganisms is one of the factors that have resulted in the development of antibacterial finishes. So thisreview paper is a small step for connecting the views of various natural antimicrobial agents from plants and its textile. These antimicrobial agents can be effectively utilized for the development of antimicrobial textiles in the field of health and hygiene sector.

Classification of antimicrobial finishing

The growth of microorganisms is inhabited by antimicrobial textiles. It is classified into three main groups.

1. Rot proofing is an antimicrobial finish applied to protect the material against physical deterioration either by long term or short term.
2. Hygiene finishes are specialized development for the prevention of dust mites with the control of infection and unwanted bacteria.
3. Aesthetic finishes controls odour development and stains in the given material.[6]

Types of antimicrobials

Generally, antimicrobials are of two types.

Leaching type(conventional antimicrobials)

When the microbes are brought in contact with the garment the product gets diffused. Any microbes coming into the sphere and forming a sphere of activity are destroyed, products migrate off the garment.It just ‘hurts’ the microbes, giving them a chance to form a strain by mutation, but strength decreases in the course of time. As it acts on them the microbes consume the antimicrobials. The product slowly loses its effectiveness eventually used up by the bacteria.[2]

Non leaching type (non-conventional antimicrobials)

Allows control of the microorganisms and is bound to the product. The bacteria coming in contact with the surface of the garment is destroyed and the product does not migrate off the garment. The antimicrobials are not consumed by the microbes; by acting on the cell membrane microbes are destroyed. The finishing will remain functional and permanent

through the life of the fabric and withstands more than 40 laundry washes; these products do not lose their effectiveness.[2]

Evaluation of Antibacterial efficacy

AATCC 30: Antifungal activity, assessment on textile materials: mildew and rot resistance of textile materials

The general purpose of this method is to evaluate the efficacy of fungicides on textile materials and to determine the susceptibility of textile materials to mildew and rot and to evaluate the efficacy of fungicides on textile materials.[7]

AATCC 100: Assessment of antibacterial finishes on textile materials

Assessment of antibacterial finishes on textile materials is determined by the degree of antibacterial activity intended in the use of such materials. If only bacteriostatic activity (inhibition of multiplication) is intended, a qualitative procedure which clearly demonstrates antibacterial activity as contrasted with lack of such activity by an untreated specimen may be acceptable. However, if bactericidal activity is intended or implied, quantitative evaluation is necessary and it can provides a clearer picture for possible uses of such treated textile materials.[8]

AATCC 147: Antibacterial activity assessment of textile materials (Parallel streak method)

The parallel streak method has filled the need for a relatively quick and easily executed qualitative method to determine antibacterial activity of diffusible antimicrobial agents on treated textile materials. AATCC Method 100, is a quantitative procedure which is adequately sensitive but is cumbersome and time consuming for routine quality control and screening tests. Therefore, when the intent is to demonstrate bacteriostatic activity by the diffusion of the antibacterial agent through agar, Method 147 fulfils this need. In the parallel streak method, the agar surface is inoculated making it easier to distinguish between the test organism and contaminant organisms which may be present on the unsterilized specimen. The parallel streak method has proven effective over a number of years of use in providing evidence of antibacterial activity against both Gram positive and Gram negative bacteria. The incubated plates for interruption of growth along the streaks of inoculum beneath the specimen and for a clear zone of inhibition beyond its edge was then measured.[9]

Test Performance is based on the following

Diffusion Assays

Diffusion assays may be performed in two ways.

Disc diffusion assays

A single strain of bacteria is spread on the surface of the agar or may be added to an agar overlay and the test chemical placed on a filter disc on the surface of the agar orbacteria may be streaked in a line on the surface of the agar of the same plate and a disc saturated with test chemical placed on the surface of the agar in contact with the streaks.

Suspension assays

A bacterial suspension may be exposed to the test chemicals and the number of surviving bacteria determined (as colony forming units) either as a function of the concentration of test agents or as a function of time of treatment.[11]

Natural antimicrobial agents for textile applications

The natural plants such as Neem extracts, Prickly chaff flower, Azuki beans, Aloe vera, Turmeric, Clove oil and Tulsi leafpossess efficient antimicrobial property. Some of these natural extracts on textile materials are explained below.[12]

Neem extract

Neem an evergreen plant of India, belongs to the family Meliaceae and it has the best properties like insect control, antimicrobial and medicinal properties.[1,13] So it has been used as a traditional medicine against various human ailments from ancient times in India and about 700 herbal preparations based on neem are found in ayurvedha, siddha, unani, amchi and other local prescriptions.[18] The active ingredients of neem are found in all parts of neem tree but, the most important limonoids are azadirachtin, salannin and nimbin.[16,15] The compounds are further divided into two major classes: isoprenoids and others. The isoprenoids include diterpenoids and triterpenoids which contains protomeliacins, limonoids, azadirone and its derivatives, gedunin and its derivatives, vilasinin type of compounds and C-secomeliacins such as nimbin, salanin and azadirachtin.[13] It is known that more than 300 active compounds have been isolated from different parts such as leaves, bark and seeds of neem tree, while some of them have already been identified for their potential antimicrobial effect. The extraction of neem using methanol was applied on cotton fabric by different techniques.[17] The neem extracts have been widely used in herbal pesticide formulation as it

has pest repellent properties and also has a potential to inhabit growth of bacteria both gram positive(*Staphylococcus aureus*) and gram negative(*Escherichia coli*).[1,16]

Prickly chaff flower

Prickly chaff flower (*Achyranthesaspera Linn*.) belongs to the family Amaranthaceae is one of the ayurvedic herbs found all over India.[1] It is used as a traditional medicine against various disorders from ancient times in India.It has been extensively used in Ayurveda as an anti-inflammatory agent. A study showed that the antimicrobial activity of prickly chaff flower against both the gram positive and gram negative bacteria.[23] The antibacterial activity of prickly chaff flower treated cotton fabric was tested by parallel streak method for gram negative bacteria(*Escherichia coli*) and the treated fabric showed mild antibacterial activity.[16,11]

Azuki beans

Azukibeans are a type of reddish-brown colored bean that belongs to the family Fabaceae. The water extracts of green, black and red colouredazukibeans (*Vignaangularis*) showed antibacterial effect against *Staphylococcus aureus*, *Aeromonashydrophila* and *Vibrio parahaemolyticus.*[1] The extract of white azuki beans showed no inhibition towards any of the microorganisms examined. The extracts of colouredazuki beans contains large amount of polyphenols including proanthocyanidins than the extract of white azuki beans. A study showed that the count of *Staphylococcus aureus* cells, inoculated in the medium containing the extracts of colouredazuki beans were significantly reduced when compared to those of controlled and white azuki beans after 24hrs.[16,18]

Aloe vera

Aloe vera (*Aloe barbadensis*, Miller) known as 'lily of the desert' which belongs to the family Liliaceae and has been used as skin care product for more than 2000 years.[1,2] Aloe leaf contains about 200 active ingredients including 75 nutrients, 20 minerals, 18 amino acids and 12 vitamins and has been used in most of all the cosmetic products and healing wounds and burns.Therefore, it is used for production of antimicrobial textiles for products such as wound dressing and suture. It is not only used for healing wounds, but also reduces inflammation.[1] The enzyme bradykinase in aloe stops the inflammatory reactions that are caused by sunburns.[16] Different polysaccharides are found in Aloe vera, which include glucomannan with different molecular weights, an acetylated glucomannan, galactogalacturan, galactoglucomannan with different compositions as well as acetylated

mannan or acemannan. Acemannan, a long-chain polymer that consists of randomly acetylated linear dmannopyranosyl units and has immunomodulation, antibacterial, antifungal, antitumour properties.[1,16] The extraction of aloe vera using glyoxal and applied on cotton fabric using different techniques and further it was observed that the treated fabric showed excellent antimicrobial property when compared to untreated one.[19]

Turmeric

Turmeric, commonly known as *Curcuma longa* that belongs to the family Zingiberaceae, it is a yellow pigmented dried rhizome that is a powerful antioxidant, antiseptic, anti-microbial, anti-inflammatory effect, anti-carcinogenic, anti-mutagenic, antithrombotic, hepatoprotective, anti-viral and anti-parasitic in nature.[20] The use of turmeric extracts for the antimicrobial activity has long been known. Turmeric and its extract have various beneficial effects on human health as they contain a number of monoterpenoids, sesquiterpenoids, and curcuminoids. Among those secondary metabolites, curcuminoids, such as curcumin, demethoxycurcumin, bisdemethoxycurcumin and tetrahydrocurcumin, are yellowish pigments that have antioxidative, anticarcinogenic, anti-inflammatory,and hypoglycemic effects.[21]

Clove oil

Clove oil (eugenol) is a main product of *Syzygiumaromaticum*that belongs to the family Myrtaceae.[1] It contain 13% tannin and oleanolic acid, which spreads antibacterial activities.Clove oil is used in aromatherapy and also used as pesticidal textile material for repelling various microorganisms.[2] Astudy showed that the cotton fabric treated with high percent of clove oil resulted in high zone of inhibition against *Staphylococcus aureus*(Gram positive) bacteria.[22]

Tulsi leaves

Tulsi(*Osmium basilicum)* belongs to the family Labiatae. Tulsi leaves are used as antimicrobial, insecticidal, antiprotozoal, diaphoretic, expectorant and aromatic carminative. It was observed that the methanolic extracts of tulsi leaves treated cotton fabric showed antimicrobial activity which is suitable for textile applications.[23]

Uses of antimicrobials in textile products

Where moisture and microbes meet the antibacterial textiles are used. The materials used in various application includes health care, hygiene, medical devices, sportswear, food

packaging, storage, thermal and mechanical protection, automotive textiles, heating, ventilation and air conditioning, air filters and water purification systems. They are used to protect functional clothing with health care personnel as well as fabrics all around the home, which includes socks, mattresses, baby diapers and coverings.

Antimicrobial fibres can be seen in some shape or fashion anywhere there are substances for the microorganisms to feed on. For examples Substances added to the fibres such as antistatics, natural-based auxiliaries, lubricants that also includes thickeners, sizes, hand modifiers and dirt which provides microorganisms their food sources. Antimicrobials of varying strength are used to prevent, inhibit, remove or kill microbes.[2]

Global scenario for the antimicrobial textiles

The global antimicrobial medical textiles market size in 2015 was USD 422.3 million, over the forecast period it is expected to witness significant growth in order to raise awareness regarding better health care practices and primarily owing to its superior properties. It is expected to boost demand for antimicrobial textile due to the growing awareness regarding hospital related diseases as they possess the inherent ability to restrict the growth of disease-causing micro-organisms. The products such as non-implantable goods and healthcare & hygiene products can stimulate the market growth of antimicrobial textiles that further leads to a high demand for wound care market. The increasing number of hospitals and government initiatives aimed at creating awareness about first-aid kits are expected to augment the demand for these products over the forecast period.In 2016, global healthcare revenue was valued at around 1.60 trillion.[24] Due to the growing awareness regarding better healthcare practices and its superior properties, the global antimicrobial textiles market size will increase gradually from 2017 to 2024.

CONCLUSION

Microorganisms can cause offensive odours, visual spoilage, disfiguring stain etc, which render an article unusable from the hygienic and aesthetic point of view. Numerous manufacturers in the textile industry have come across this demand and launched their brands of antimicrobial products.[2] The coating using plant natural products on the cotton fabric was found to exhibit antibacterial properties.[25] The use of several other biocides such as chitosan, specific dyes etc., are in the development stage. These products vary in their effectiveness and durability. The future research is focused on the environment-friendly products which should give the durable antimicrobial effect[2] andthis field continues to be one of the most

dynamic and one of that needs to be kept a watch on for newer and innovative technologies.[10]

REFERENCES

1. M Joshi[a], S Wazed Ali & R Purwar, Ecofriendly antimicrobial finishing of textiles using bioactive agents based on natural products. Indian journal of fibre & textile research vol.34, September 2009.
2. Dr. Vishnu A. Dorugade and Bhagyashri K, Antimicrobial finishing of textiles, 2010.
3. Banupriya J[*] and Maheswari v, Comparative study in antibacterial finishes by herbal and conventional methods on the woven fabric, 2013.
4. Chandrasekaran K[1*], Ramachandran T[2] & Vigneswaran C[3], Effects of medicinal herb extracts treated garments on selected diseases, Indian journal of traditional knowledge, July 2012; 11(3).
5. Dhiman and Chakraborty, Antimicrobial performance of cotton finished with triclosan, silver and chitosan, Fashion and Textiles, 2015.
6. Heywood D., Textile Finishing, Society of Dyers and Colourists Publication, 2003; 351-355.
7. AATCC 30, 2004. Antifungal activity, assessment on textile materials: Mildew and rot resistance of textile materials. Research Triangle Part, NC. USA, 81.
8. AATCC-100-2004, 2005. Antibacterial finishes on textile materials: Assessment of. American Association of Textile Chemists and Colorists. AATCC Technical Manual, 80: 149-151.
9. AATCC 147, 2004. Antibacterial activity assessment of textile materials: Parallel streak method. Research Triangle Part, NC. USA, 263.
10. A review Barbara Simonc ˇic ˇ and Danijela Klemenc ˇic, Preparation and performance of silver as an antimicrobial agent for textiles: Textile research journal, 2015.
11. G Thilagavathi[1*] and T Kannaian, Application of prickly chaff (achyranthesaspera Linn.) Leaves as Herbal antimicrobial finish for cotton fabric used in healthcare textiles, Natural product radiance, 2008; 7(4).
12. G Thilagavathi[a] & K Rajendrakumar, Development of ecofriendly antimicrobial textile finishes using herbs, Indian journal of fibre & textile research, 30, December 2005.
13. Kausik Biswas, Ishita Chattopadhyay, Ranajit K. Banerjee* and Uday Bandyopadhyay, Biological activities and medicinal properties of neem (Azadirachtaindica), 2002.

14. Subapriya, R., & Nagini, S. (2005). Medicinal properties of neem leaves: A review. Current Medicinal Chemistry Anti Cancer Agents, 5: 149–156.
15. Schmutter H, *The Neem Tree: Source of Unique Natural Products For Integrated Pest Management, Medicine, Industry and other Purpose* (VCH, Weinheim, Germany), 1995.
16. K. Murugesh Babua & K.B. Ravindraa, Bioactive antimicrobial agents for finishing of textiles for health care products, December 2014.
17. Vyas, S. K., Ingale, S. V., Mukhopadhyay, S., & Saraf, N. (2008). Aloe vera and neem as antimicrobial agents. Conference Paper.
18. Hori Y, Sato S & Hatai A, *Phytother Res*, 2006; 20: 162.
19. Wasif, S. K., & Rubal, S. (2007). Proceedings, 6th International Conference – TEXCSI, Liberec, Czech Republic.
20. S. Sudha* and V. Yamuna, Development of anti-microbial textiles using microencapsulated honey and turmeric, international journal of pharmacy & life science, Aug 2013.
21. BYEOUNG-SOO PARK,† JAE-GYU KIM,†,‡ MI-RAN KIM,‡ SUNG-EUN LEE,§ GARY R. TAKEOKA,# KI-BONG OH,†,‡ AND JEONG-HAN KIM*,†,Curcuma longaL. Constituents Inhibit Sortase A and Staphylococcus aureusCell Adhesion to Fibronectin, 2005.
22. Sarkar R K, Purushottam D & Chauhan P D, *Indian J Fibre Text Res*, 2003; 28(9).
23. Thilagavathi G, Rajendrakumar K & Rajendran R, *Indian J Fiber Text Res*, 2005; 30(12): 430.
24. Deepti Gupta, Somes Bhaumik, Antimicrobial treatment for textiles, indian journal of fibre & textile research, July 2007; 32(2).
25. Antimicrobial Medical Textiles Market Analysis By Finishing Agent (Quaternary Ammonium, Triclosan, Metallic Salts), By Application (Implantable Goods, Non-implantable Goods, Healthcare & Hygiene Products) And Segment Forecasts To, 2024, 2015.
26. M.S. Yogendra Kumar*, T.S. Raghu, Pankaj Kumar, F.V. Varghese and T.M. Kotresh, Application of Enriched Fraction of Seabuckthorn Leaf Extract as Antimicrobial Finish on Technical Textile, Defence Life Science Journal, October 2017; 2(4).
27. A. Mitchella,* M. Spencerb, C. Edmiston Jrc, Role of healthcare apparel and other healthcare textiles in the transmission of pathogens: a review of the literature, 2015.
28. L. Constituents Inhibit Sortase A and Staphylococcus aureus Cell Adhesion to Fibronectin.

29. S.Mahesh, A.H.Manjunatha Reddy and G.Vijaya Kumar, Studies on Antimicrobial Textile Finish Using Certain Plant Natural Products, Dec, 2011.