

Investigation of Natural Variants for Antimicrobial Finishes in Innerwear

A Review Paper for Promotion of Natural Hygiene in Innerwear

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Abstract— This paper gives a review for scope of natural variants in the field of antimicrobial finishes. The main reason of increased interest in this field include: an increased awareness towards personal hygiene, demand for eco friendly finishes and to prevent skin infections, body odour to improve physiological comfort value of garments. The microbial infestation is a common problem especially in natural textiles due to their receptiveness for moisture, dirt, food particles giving scope for microbes growth. In case of innerwear that is next-to-skin the situation becomes more critical. This paper throws light on the present available variants that can be used as antimicrobial finish and how their effect can be evaluated to find out effective variant in terms of performance and durability.

Keywords— Natural Herbs, Microbes, Antimicrobial, Innerwear, Hygiene, Physiological Comfort.

I. INTRODUCTION

The use of antimicrobials dates back to ancient Egypt where these were used in the procurement of mummies. The first antimicrobial textile material, in modern history, was developed by Lister in 1867. Over the last few years there has been increased interest in antimicrobial finishes. The main reasons for this include: Promotion of healthier and physically active lifestyle; as increased awareness of the harmful effect of micro-organisms on textiles as well as on human hygiene and freshness, and the greater use of synthetic fibres and blends in the terms such as shirts, hosiery, blouses and innerwear, which tend to cause greater 'perspiration wetness' because of poor moisture transport properties as compared to the natural fibres.

II. MICROBES

Mould, mildew, fungus, yeast, bacteria and virus (micro-organisms) are part of our everyday lives. There are both good and bad types of

microorganisms. The thousand of species of micro-organisms that exist are found everywhere in the environment, on our garments and on our bodies. Microbes, their body parts, metabolic products and reproductive parts, cause multiple problems to textiles. There are human irritants, sensitizers, toxic-response agents, causers of disease and simple discomforting agents.

A. The Microbial Growth Promoters

The human skin is usually crowded with innumerable microbes. In favourable conditions certain bacteria can grow from a single germ to million in a very short period of time. They can double every 20 to 30 minutes in a warm and moist micro climate that has plenty of food for them, e.g. perspiration and other body secretion, skin particles, fats and leftovers from worn out threads. The common promoters are as following:

- Temperature
- Moisture
- Dirt
- Receptive Surface
- Perspiration
- Food Particles
- Textile Finishes

B. The Effect of Microbes on Textile and Humans

Although microbes can be useful in many ways, e.g. in brewing, baking and biotechnology, they can also be harmful to both textile and humans. The various effects of microbes are stated as follows:

- Bad Odour
- Skin and Soft Tissue Infections

- Staining of Fabric
- Slick slimy handle
- Loss of Functional Properties
- Decrease in Life of Textile

III. THE ANTIMICROBIALS

The term antimicrobial refers to a broad range of technologies that provide varying degrees of protection for products and buildings against microbes. Antimicrobials are very different in their chemical nature, mode of action, impact on people and the environment, in-plant-handling characteristics, durability on various substrates, costs, and how they interact with good and bad microbes. Antimicrobials are used on textiles to control bacteria, fungi, mould, mildew, and algae. This control reduces or eliminates the problem of deterioration, staining, odours, and health concerns that they cause. The microbial infection and body odour become critical to study in innerwear for various concerns that include: to tackle physiological discomfort, to save textile itself from damage and stain to maintain aesthetics, to maintain proper hygiene and as a value addition to end product.

A. Requirements from a Antimicrobial Finish

Following are the major requirements for an effective antimicrobial finish:

- Durability to washing, dry cleaning and hot pressing
- Selective activity to undesirable microbes
- It should not produce harmful effects to the manufacturer, user and the environment
- It should compile with the statutory requirements of regulating agencies
- Compatibility with the chemical processes
- Easy method of application
- No deterioration of fabric quality
- Resistant to the body fluids
- Resistant to disinfectant/sterilisation
- Quick acting and effective in killing or inhibiting the growth of a broad spectrum of microbes
- Non-selective and non-mutable to pathogens
- Fast to repeated laundering, dry cleaning and exposure to light

- Safe and comfortable to wear (No irritation to skin)
- Minimal environmental impact
- Compatible with other finishing agents
- Low cost

B. Available Antimicrobial Treatments

There are a number of options available to induce antimicrobial properties in textiles as follows:

- Oxidising Agents e.g. Aldehydes
- Coagulants e.g. Primary alcohols, halogens
- Triclosan Products e.g. Bis-phenyl derivatives
- Quarternary Ammonium Compounds
- Complex Metallic Compounds e.g. Based on Silver, Cadmium, Mercury
- Chitosan derived from Chitin
- Natural e.g. Plants, Herbs, Shrubs

C. Investigating Natural Variants Over Synthetic

The natural variants possess more potential for investigation because of following reasons:

- Eco-friendly
- Least toxicity
- Suitability for next-to-skin innerwear
- Vast scope of research to counteract microbe's resistant development towards antimicrobial finishes
- Safe handling

TABLE I
NATURAL SOURCES OF ANTIMICROBIALS

SNo	Natural Sources (Plants, Herbs)	
	Name	Botanic Name
1	Alfalfa	Medicago sativa
2	Allspice	Pimenta dioica
3	Aloe	Aloe barbadensis
4	Ashwagandha	Withania somniferum
5	Black Pepper	Pepper nigrum
6	Basil	Ocimum basilicum
7	Clove	Syzygium aromaticum
8	Garlic	Allium sativum
9	Hemp	Cannabis sativa
10	Lemon Balm	Melissa officinalis

These and many more natural variants are available in nature that can be used to extract out antimicrobial chemicals. Generally we need a specific medium for extraction of these variants e.g. water, ethanol, menthol, chloroform, dichloromenthol, ether, acetone, etc. .

D. Antimicrobial Application and Testing

The antimicrobial finishes are generally applied by following means to the textile substrate:

- Absorption or Surface Treatment
- Chemical Bonding
- Micro-encapsulation

The antimicrobial activities are generally tested both qualitatively and quantitatively through available standard tests as follows:

- AATCC 100-2004 (Assessment of antibacterial finishes on textile materials)
- AATCC 147-2004 (Parallel streak method)
- AATCC 90-2011 (Antibacterial activity assessment of textile materials: Agar plate method)

E. Characteristics of Innerwear

Functional innerwear is a base layer that efficiently transports moisture away from the skin, keeps you comfortable during workouts, ensures the best body temperature for optimal performance in all conditions and effective resistance to microbial growth to provide best hygiene to avoid skin infections (fig. 1).



Fig. 1 Microbial infection on skin

IV. CONCLUSIONS

The natural variant has immense scope for research in order to provide physiological comfortable innerwear with antimicrobial finish. The scope also lies in further investigation of physical properties to check the effect of antimicrobial finishes on them. With the word of Green Technology growing the field provides opportunity for research and applications.

REFERENCES

- [1] M. M. Cowan, "Plant Products as Antimicrobial Agents," *CLINICAL MICROBIOLOGY REVIEWS*, Vol. 12, No. 4, Oct. 1999, p. 564–582
- [2] S. K. Bajpai, V. Thomas, M. Bajpai, "Novel Strategy for Synthesis of ZnO Microparticles Loaded Cotton Fabrics and Investigation of their Antibacterial Properties," *Journal of Engineered Fibers and Fabrics*, Volume 6, Issue 3 – 2011, p. 73-81
- [3] D. N. Muanza, B. W. Kim, K. L. Euler, and L. Williams, "Antibacterial and Antifungal Activities of Nine Medicinal Plants from Zaire", *Pharmaceutical Biology*, Vol 32, Issue 4, October 1994 , p. 337 - 345S. Zhang, C. Zhu, J. K. O. Sin, and P. K. T. Mok, "A novel ultrathin elevated channel low-temperature poly-Si TFT," *IEEE Electron Device Lett.*, vol. 20, pp. 569–571, Nov. 1999.
- [4] Y. Gao and R. Cranston, "Recent advances in Antimicrobial Treatments of Textiles," *Textile Research Journal*, vol. 78, no.1, pp. 60–72. 2008.
- [5] A. I. Wasif, S. K. Laga, and Singh Rubal, "Use of aloe vera, β -cyclodextrin, zycrobial and chitosan as antimicrobial agents for cotton," *6th International Conference - TEXSCI 2007 (June 5-7)*, Liberec, Czech Republic.
- [6] Emmanuel E. I. Irabor1, Abiodun Falodun, "Antimicrobial evaluation of methanolic extract of *colliandra surinamensis* on some pathogenic organisms," *Acta Poloniae Pharmaceutica - Drug Research*, Vol. 63, No. 5, pp. 449-451, 2007
- [7] K.H. Chong, Z. Zuraini, S. Sasidharan, "Antimicrobial Activity of *Elaeis Guineensis* Leaf," *Pharmacologyonline* 3, p. 379-386 (2008)
- [8] David T.W. Chun, Gary R. Gamble, "Using the reactive dye method to attach antibacterial compounds to cotton," *2007 Beltwide Cotton Conferences, New Orleans, Louisiana, January 9-12, 2007*, p. 1242-1246.
- [9] S. Gupta, G. R. Dwivedi, M. P. Darokar and S. K. Srivastava, "Antimycobacterial activity of fractions and isolated compounds from *Vetiveria zizanioides*," *Medicinal Chemistry Research* July 2012, Volume 21, Issue 7, pp 1283-1289
- [10] G Thilagavathi, K Rajendra kumar and R Rajendran, "Development of antimicrobial textile finishes from plant species," *Fortnightly Insight for Textile Professionals*, 1-15 June 2005. www.expresstextile.com
- [11] K. Abascal, E. Yarnell, "Herbs and drug resistance: Part 2 ¾ clinical implications of research on microbial resistance to antibiotics," *Alternative & Complementary Therapies* 2002 October, p.184-290.
- [12] Baid and Arun M, "Method of dyeing the textile article from medicinally rich herbs," No. 7485158, Issued on February 3, 2009, <http://www.patentgenius.com/number.html>
- [13] Jirawan Oonmetta-aree, Tomoko Suzuki, Piyawan Gasaluck, Griangsak Eumkeb, "Antimicrobial properties and action of galangal (*Alpinia galanga* Linn.) on *Staphylococcus aureus*," *LWT* 39 (2006) p.1214–1220, www.elsevier.com/locate/lwt
- [14] W. Curtis White, Robert A. Monticello, "Antimicrobial Performance of Medical Textiles," *IFAI Expo* October 2002 p. 1-14
- [15] Youbo Di, Qingshan Li, and Xupin Zhuang, "Antibacterial Finishing of Tencel/Cotton Nonwoven Fabric Using Ag Nanoparticles-Chitosan Composite," *Journal of Engineered Fibers and Fabric*, Volume 7, Issue 2 – 2012, p. 24-29
- [16] C Valgas¹, S M de Souza; E F A Smân; Artur Smânia, "Screening methods to determine antibacterial activity of natural products," *Braz. J. Microbiol.*, vol.38, no.2, Apr./June 2007
- [17] I Home, "Antimicrobials Impart Durable Finishes," *International Dyer*, December 2002, p 9-11
- [18] T.S. Dhanaraj , K. Murugaiah and M. Jegadeesan, "Phytochemical Analysis and Antimicrobial Activity of *Aegle Marmelos* (L.) Corr," *Herbal Tech Industry* April 2011, p. 7-10
- [19] C. Jofré, F. Guzmánb, C. Cárdenas, F. Albericio, S. H. Marshall, "A natural peptide and its variants derived from the processing of infectious pancreatic necrosis virus (IPNV) displaying enhanced

- antimicrobial activity: A novel alternative for the control of bacterial diseases,” *Peptides* 32 (2011) 852–858
- [20] Ncube, N.S., Afolayan, A. J and Okoh, A., “Assessment techniques of antimicrobial properties of natural compounds of plant origin: current methods and future trends,” *African journal of Biotechnology*, 7 (12) 2008, p. 1897 – 1806
- [21] M. Joshi, S. W. Ali, and R. Purwar, “Eco-friendly antimicrobial finishing of textiles using bioactive agents based on natural products,” *Indian Journal of Fibre & Textile Research*, Vol. 34, Sep 2009, p. 295-304
- [22] Kanazawa A, Ikeda T, Endo T, “Antibacterial activity of polymeric sulfonium salts,” *Journal of Polymer Science, Part A: Polymer Chemistry*, 1993, 31, p. 2873-2876.
- [23] Ingraham, J. and Ingraham, C., “Introduction to Microbiology,” Wadsworth, Belmont, CA (1995), pp. 220–223.
- [24] Singh R, Jain A, Panwar S, Gupta D and Khare SK, “Antimicrobial activity of some natural dyes” *Dyes and Pigments* 2005; 66, p. 99-102
- [25] Sarkar R. K, De P, Chauhan P. D., “Bacteria-resist finishes on textiles,” *Man Made Textiles India*, Dec 2001, p. 460-407
- [26] S.Mahesh, A.H.Manjunatha Reddy and G.Vijaya Kumar, “Studies on Antimicrobial Textile Finish Using Certain Plant Natural Products,” *International Conference on Advances in Biotechnology and Pharmaceutical Sciences (ICABPS'2011)* Bangkok Dec., 2011, p. 253-258
- [27] Isabel C. Gouveia, “Nanobiotechnology: A new strategy to develop non-toxic antimicrobial textiles,” *Current Research, Technology and education Topics in Applied Microbiology and Microbiol Biotechnology*, p. 407-414
- [28] O L Shanmugasundaram, “Antimicrobial finish in textiles,” <http://www.indiantextilejournal.com/articles/FAAdetails.asp?id=507>
- [29] Ha-Soo Seong, J P Kim and S W Ko, “Preparing Chito Oligosaccharides as Antimicrobial Agents for Cotton,” *Textile Research Journal*, Vol 69, No 7, p 483-488
- [30] Payne, J.D. and Kudner, D.W., “A new durable antimicrobial finish for cotton textiles,” *Am Dyest. Rep.* 85, p. 26–30 (1996)
- [31] G. Raj Kumar and V. Krishnaveni, “An Eco-friendly Herbal Antimicrobial Finish on cotton fabric using Aleo Barbadensis Miller (Aloe Vera),” <http://www.fibre2fashion.com>
- [32] R. Rajendran, C. Balakumar, Hasabo A. Mohammed Ahammed, S. Jayakumar, “Use of zinc oxide nano particles for production of antimicrobial textiles,” *International Journal of Engineering, Science and Technology* Vol. 2, No. 1, 2010, p. 202-208
- [33] Ammayappan L, Moses J., “Study of Antimicrobial Activity of Aloe vera, Chitosan, and Curcumin on Cotton, Wool, and Rabbit Hair,” *Fibers and Polymers*, 2009;10(2), p. 161-166
- [34] Seshadri D T, Bhat N V, “Use of polyaniline a san antimicrobial agent in textiles,” *Indian Journal of Fibre and Textile Research*, 2005, 30, p. 204-206.
- [35] M. C. Joerger, R. F. Koniz, S. Sabesan, J. Pennias, “Antimicrobial Polyester-containing Articles and Process for their Preparation”, *United States Patent* 7,081,139 (2006)
- [36] Ghosh S, Yadav S, Vasanthan N, Sekosan G, “A study of antimicrobial property of textile fabric treated with modified dendrimers,” *Journal of Applied Polymer Science*. 2010,115, p. 716-722.
- [37] Padmavathy N. and Vijayaraghavan R., “Enhanced bioactivity of ZnO nanoparticles - an antimicrobial study,” *Science and Technology of Advanced Materials*, 2008, Vol. 9
- [38] Daniela Enescu, “Use of Chitosan in Surface Modification of Textile Materials,” *Roumanian Biotechnological Letters* Vol. 13, No. 6, 2008, p. 4037-4048
- [39] Weber, D. and Rutula, W., “Use of metals as microbicides in preventing infections in healthcare, in Disinfection, Sterilization and Preservation, S. Block (ed.), *5th edition, Lippincott, Williams & Wilkins* (2001).
- [40] Gao Y, Cranston R, “An effective antimicrobial treatment for wool using polyhexamethylene biguanide as the biocide, Part 2: Further characterizations of the fabrics,” *Journal of Applied Polymer Science*. 2010, 117, p. 2882-2887
- [41] C. LIANG., “Anti-microbial Chitosan Composition for Textile Products”, United States Patent Application no 20060008515 (2005).
- [42] S. K Vyas, S. V. Ingale, S. Mukhopadhyay & N. Saraf “Aloe Vera and Neem as Antimicrobial Agents,” www.fibertofashion.com
- [43] A.I. Wasif and S.K. Laga, “Use Of Nano Silver As An Antimicrobial Agent For Cotton,” *AUTEX Research Journal*, Vol. 9, No1, March 2009, p. 5-13
- [44] T. L. Vigo, “Protection of textiles from biological attack” *Handbook of Fiber Science and Technology. Chemical Processing of Fibers and Fabrics, Functional Finishes. Part A.* In M. LEWIN, S. B. SELLO, , Marcel Dekker, inc., New York, vol. II, 1983, pp. 367–426.
- [45] Seyam, A., Oxenham, W. (2004), “Static Generation and Control in Textile Systems,” *National Textile Center Annual Report*.
- [46] Ghoranneviss.M, Shahidi.S,” Effect of Various Metallic Salts on Antibacterial Activity and Physical Properties of Cotton Fabrics,” *Journal of Industrial Textile*, online published, 2012
- [47] S.Mahesh, A.H.Manjunatha Reddy and G.Vijaya Kumar, “Studies on Antimicrobial Textile Finish Using Certain Plant Natural Products,” *International Conference on Advances in Biotechnology and Pharmaceutical Sciences (ICABPS'2011)* Bangkok Dec., 2011
- [48] Heywood.D, “Textile Finishing,” *Society of Dyers and Colourists*, 2003,
- [49] Schindler.W.D , Hauser.P.J, “Chemical finishing of textiles”, *woodhead publishing*,2004
- [50] Askew P. D., “Measuring activity in antimicrobial textiles” *Chemistry Today*, 2009; 27, p.16–20.
- [51] Thiry MC. Small game hunting: anti microbials take the field,” *AATCC Rev*, Nov 2001, p. 11-17
- [52] Rajendran R, Radhai R, and Balakumar C, “Synthesis and Characterization of Neem Chitosan Nanocomposites for Development of Antimicrobial Cotton Textiles,” *Journal of Engineered Fibers and Fabrics*, Volume 7, Issue 1 – 2012, p. 136-141