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Scentry® and ZPTech®: A Bifunctional, Effective, and Durable Odor Solution for Polyester Activewear

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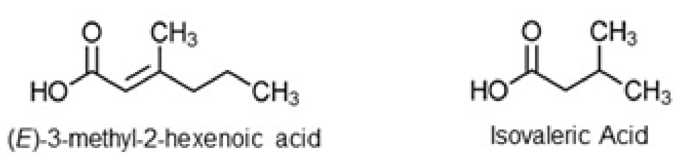
Introduction

The surface of human skin is covered with microorganisms, primarily Gram positive organisms including ***Corynebacteria***, ***Propionibacteria***, and ***Staphylococci***.[1,2] These microorganisms are contributors to human odor. In the underarm or axillary region, Corynebacteria transform odorless sweat into a complex mixture of odorous compounds that is dominated by nonpolar carboxylic acids such as 3-methyl-2-hexenoic acid (Figure 1)[3,4,5]. On the foot, Staphylococcus epidermidis transforms the amino acid leucine into a 5-carbon acid, isovaleric acid, which is responsible for the characteristic smell of foot odor.[6] And, although odor can vary from person to person and at various stages of life, carboxylic acids contribute strongly to the human odor profile.

Figure 1. Chemical Structures of Carboxylic Acid Odorants



1 Zhan Gao, Chi-hong Tseng, Zhiheng Pei, and Martin J. Blaeser, Molecular Analysis of Human Forearm Superficial Skin Bacterial Biota, ***Proceedings of the National Academy of Sciences of the Unites States of America***, **2007**, 104, 2927–2932.
2 Elizabeth A. Grice et al, Topographical and Temporal Diversity of the Human Skin Microbiome, ***Science***, **2009**, 324, 1190–1192.
3 James J. Leyden, Kenneth J. McGinley, Erhard Hölzle, John N. Labows, and Albert M. Kligman, The Microbiology of the Human Axilla and Its Relationship to Axillary Odor, ***The Journal of Investigative Dermatology***, **1981**, 77, 413–416.
4 John N. Labows, Kenneth J. McGinley, and Albert M. Kligman, Perspectives on Axillary Odor, ***Journal of the Society of Cosmetic Chemists***, **1982**, 34, 193–202.
5 Xiao-Nong Zeng, James J. Leyden, Henry J. Lawley, Kiyohito Sawano, Isao Nohara, and George Preti, Analysis of Characteristic Odors from Human Male Axillae, ***Journal of Chemical Ecology***, **1991**, 7, 1469–1492.
6 Katsutoshi Ara, Masakatsu Hama, Syunichi Akiba, Kenzo Koike, Koichi Okisaka, Toyoki Hagura, Tetsuro Hamiya, and Fusao Homita, Foot Odor Due to Microbial Metabolism and Its Control, ***Canadian Journal of Microbiology***, **2006**, 52, 357–364.

Preventing odor is a concern of increasing importance as the way we wear clothes is changing. Activewear apparel is becoming the choice for both exercise and everyday wear, with comfort figuring largely into the trend.[7] The desire for clothes to wash clean is also a top purchase driver. However, synthetic fibers such as polyester have been cited for the tendency to harbor nonpolar odors after wash, including carboxylic acids.[8,9] Accumulation of odor in textiles can decrease the useful lifetime of a garment and lead to more frequent washing. Clearly, there is a need for odor control. A contemporary approach to the prevention of odor in textiles is an antimicrobial treatment. However, some antimicrobial treatments are more effective than others.[10] In addition, antimicrobials will not be effective for odor control after an odor molecule is adsorbed by a garment. Therefore, an antimicrobial technology plus an odor adsorber is a more effective way to control odor in textiles, slowing the generation of odorous molecules on the textile and adsorbing the odors that are produced to keep garments smelling fresh.

Experimental

In this study, we developed a bifunctional odor control strategy to improve the functionality of polyester fabrics. Multiple types of polyester were used in the study. All of the fabrics studied were treated with the Scentry® odor capture technology developed at Microban. Scentry® was padded onto fabrics using a Mathis Horizontal Padder Type HF. The padded fabrics were cured with a Mathis dryer type LTE-IR. All of the fabrics were cured at 150 °C for 45 seconds. Microban ZPTech® antimicrobial was exhausted onto the fabrics with a Mathis Labomat BFA-24 in a typical polyester dyeing process.

The technologies were evaluated for durability to laundering. All laundering was performed in a top-loading machine used for home laundering. Tide Free and Gentle® detergent was used. The fabrics were tumble dried after laundering. The odor capture performance of the treated fabrics was evaluated using an in-house method. Briefly, one microliter of a 2.3% solution of isovaleric acid in water and ethanol (2:1) was added to a 20-ml glass vial with a PTFE septum. A textile swatch measuring 3.5 cm by 3.5 cm was added to the vial. The vial was incubated at 60 °C for one hour, and then a sample of headspace gas was withdrawn and analyzed using a GCMS Instrument (GC-MS QP-2010, Shimadzu Scientific Instruments, Columbia, MD, USA; AOC-6000 autosampler, CTC Analytics AG, Zwingen, Switzerland). Analysis of carboxylic acids was accomplished using a ZB-FFAP or ZB-WaxPlus column (Phenomenex, Torrance, CA, USA). Percent reduction was calculated against a vial containing no fabric, and is reported as the average of three replicate measurements.

The antimicrobial efficacy of treated fabrics was performed according to the JIS L 1902 Standard method, with a 5% nutrient level and Staphylococcus aureus and Klebsiella pneumoniae organisms, respectively. Log reductions were calculated by comparison with the inoculum and are reported as the average of three replicate measurements.

Results and Discussion

Odor Capture

Figure 2 shows a dramatic improvement in performance over the untreated control fabric—91% for Scentry-treated fabric versus 49% reduction afforded by the control. The results indicate that the Scentry® formulation has a great

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7 Cotton Incorporated Supply Chain Insights: Winning in the U.S. Activewear Market, **2014**, http://www.cottoninc.com/corporate/Market-Data/Supply-ChainInsights/Winning-In-The-US-Activewear-Market/Winning-In-The-US-Activewear-Market.pdf, accessed 8/31/2016.

8 Signe Munk, Charlotte Johansen, Louiuse H. Stahnke, and Jens Adler-Nissen, Microbial Survival and Odor in Laundry, ***Journal of Surfactants and Detergents***, **2001**, 4, 385–394.

9 Rachel H. McQueen, James J. Harynuk, Wendy H. Vismer, Monica Keelan, Yin Xu, A Paulina de la Mata, Axillary Odour Build-up in Knit Fabrics Fillowing Multiple Use Cycles, ***International Journal of Clothing Science and Technology***, **2014**, 26, 274–290.

10 Yin Xu, Rachel McQueen, and Wendy Wismer, A Preliminary Study on the Collection of Axillary Odor within Textiles, ***Journal of Textile and Apparel Technology and Management***, **2013**, 8, http://ojs.cnr.ncsu.edu/index.php/JTATM/article/view/3940, accessed 8/4/2016.

affinity for isovaleric acid, as well as other carboxylic acids that contribute to body odor. The Scentry® technology attracts the acid odorant molecules and prevents them from associating with the fabric. When the textile is laundered, the action of the detergent effectively removes the attached odor molecules and regenerates the Scentry® treatment.

Figure 2. Odor Capture Performance of Scentry® Treated Polyester Compared to Untreated Control

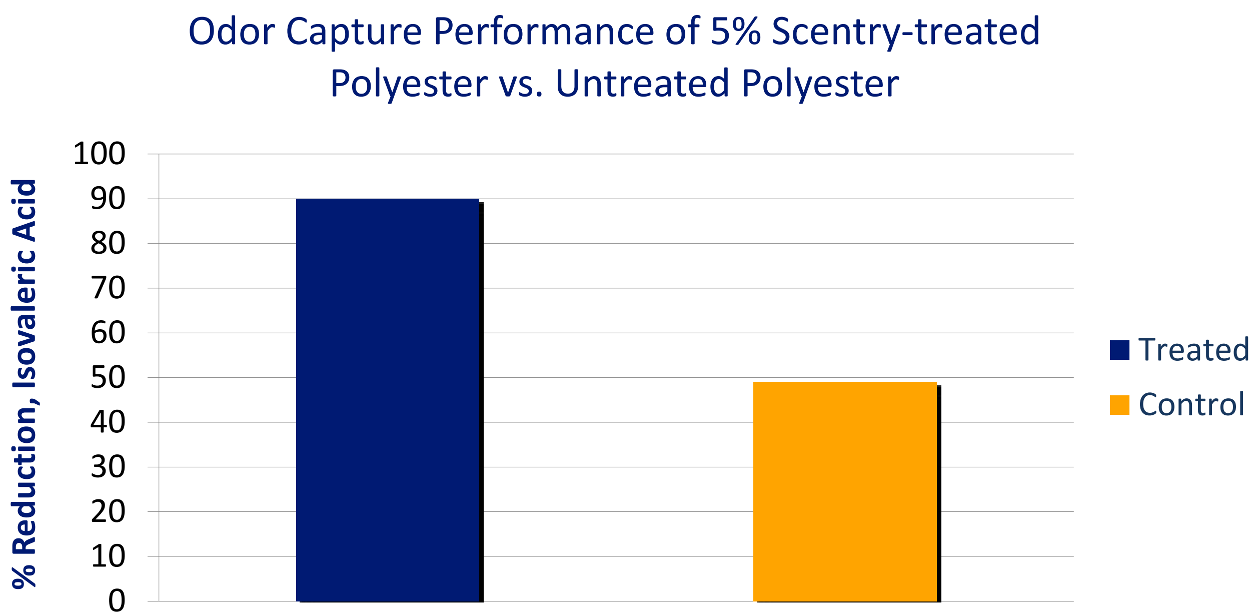
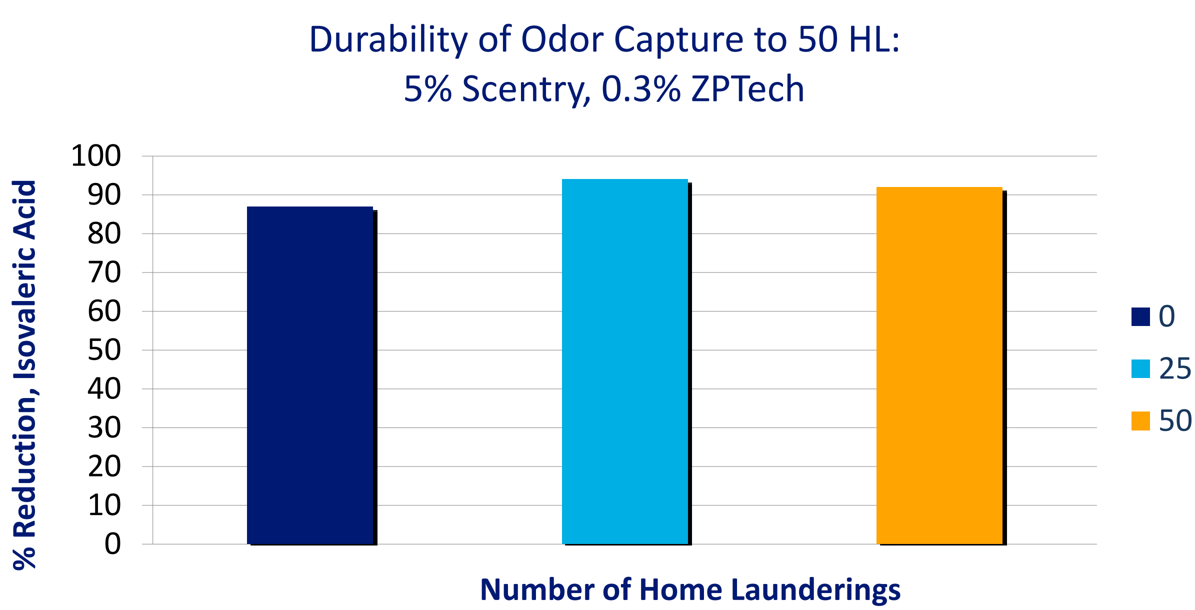


Figure 3. Odor Capture Performance to 50 Home Launderings by Scentry®–ZPTech® Treated Polyester



A dyed polyester fleece was treated with Scentry® and ZPTech® as described and tested for odor capture performance versus an untreated control fabric, at 0, 25, and 50 home launderings (Figure 3). The effectiveness of Scentry® for odor capture is durable to laundering, as the odor capture performance remains at a high level after 50 home launderings. Remarkably, this performance was achieved without the use of a binder.

Antimicrobial Efficacy

In the JIS L 1902 antimicrobial test, Scentry®–ZPTech® treated fabric achieved a 4-log reduction against both Gramnegative and Gram-positive organisms at 0 and 50 home launderings (Table 1). In addition, the Scentry® and ZPTech® treatments are fully compatible, providing durable odor adsorption and antimicrobial efficacy when used in combination. In addition, the treatments do not compromise essential fabric properties such as hand, colorfastness to wash, colorfastness to light, and wet and dry crock.

Table 1. Antimicrobial Efficacy and Durability of Scentry®–ZPTech® Treated Polyester Fabric

Treatment	Organism	Log Reduction at 0 HL	Log Reduction at 50 HL
ZPTech® 0.6%	*S. aureus*	3.7	4
	K. pneumoniae	4	2
Scentry® 2%, ZPTech® 0.6%	*S. aureus*	4.1	4.1
	K. pneumoniae	4	2.3
Scentry® 5%, ZPTech® 0.6%	*S. aureus*	4.1	4.1
	K. pneumoniae	4	4
Untreated	*S. aureus*	0	—
	K. pneumoniae	0	—

In conclusion, the Scentry® formulation was developed in response to a need for odor control in polyester activewear, targeting specifically the carboxylic acids that contribute strongly to body odor. When Scentry® is combined with the antimicrobial technology ZPTech®, it creates a bifunctional odor solution for polyester textiles that is effective and durable.