Fabric To Dye For

Samples of wool/cotton crosswoven blends dyed in a single dye bath. The solid-color swatches were pretreated so that both the wool and cotton yarns would pick up the dye evenly. In the untreated fabrics, the cotton stayed largely undyed.

Peggy Greb (K9139-1)

Cotton may soon be afforded the same upscale recognition as wool, thanks to new technology. ARS chemists Jeanette M. Cardamone and William N. Marmer have found a way to make cotton more chemically similar to its high-end counterpart—wool—so that a fabric blend of the two can be easily dyed.

Dyeing a cotton/wool blend is difficult because the two fibers have different chemical makeups. Wool, which is sheep hair, is made of animal proteins, while cotton is made of plant cellulose—the main part of a plant's cell wall. Normally, when wool and cotton are blended together, two separate dye baths are required because the wool takes up most of the dye.

"The process we developed is a new single-bath dyeing procedure called union dyeing," says Cardamone. She and Marmer are with the Hides, Lipids, and Wool Research Unit at ARS' Eastern Regional Research Center (ERRC), in Wyndmoor, Pennsylvania. "This process helps textile manufacturers overcome a major technological barrier: dyeing all-natural blends to the same depth of shade in one step."

In the conventional procedure, Cardamone explains, cotton is dyed first and wool second. Wool is dyed in an acidic environment at high temperatures, and cotton is dyed in a nonacidic environment at lower temperatures. This difference requires that the wool and cotton be dyed either separately, or sequentially in one bath in which the pH and temperature levels are changed.

"Our improved method uses pretreatments to make the cotton as receptive to dye uptake as the wool," she says.

Opposites Attract

Cardamone and Marmer's simple approach is to reverse the chemical charge of cotton from negative to positive before dyeing; wool is already positive. To do this, they use cationic fixatives—positively charged ions—which are typically used after cotton is dyed to help it keep its color. Applying the fixatives before dyeing gives both fiber components of the fabric a positive charge. Since the dye is negatively charged—and opposites attract—the cotton and wool dye to a uniform shade because the dye is attracted equally to both fibers. This union-dyeing process uses one dye in one bath, under one set of conditions.

PEGGY GREB (K9143-1)

Technician Chet Sutton studies colorfastness of a union-dyed wool/cotton blend.

Cotton industry officials are excited about the new process. "This technology is easy to adopt," says John Turner, a senior chemist with Cotton Incorporated in Cary, North Carolina.

"It doesn't require elaborate equipment or expense. In the past, there was no satisfactory method for cotton mills to dye blends. This technology could potentially increase the use of cotton." Cotton Incorporated wants to expand the use of cotton and make it more profitable for cotton farmers and the textile industry.

"This process gives cotton an upscale market. A cotton/wool blend would have greater value than a 100-percent cotton item," Turner says. "And depending on the blend level, it could be cleaned in the washing machine." Cotton Incorporated has a research partnership with the ERRC scientists.

PEGGY GREB (K9137-3)

Chemists Jeanette Cardamone and William Marmer study records of the effect of dyeing regimen on dye uptake.

The wool industry also finds the concept appealing because it creates a new market for wool. Approximately 66,800 sheep producers raise 7.2 million sheep and lambs, producing about 49.2 million pounds of wool in the United States. Even so, the country still imports wool from Australia and New Zealand. This technology could help open more markets for American wool by increasing demand.

Keeping Colors Colorful

The ERRC scientists also use another method that helps make dyeing wool/cotton blends possible—a durable-press finishing resin. The resin treatment was originally developed by chemists at the ARS Southern Regional Research Center (SRRC) in New Orleans, Louisiana, to prevent wrinkling in 100-percent cotton. SRRC scientists further developed the technology to increase cotton's dyeability. SRRC chemist Eugene Blanchard collaborated with ERRC scientists on using the durable-press finishing resin treatment for cotton/wool blends.

Cardamone says resin treatments, which are alternatives to cationic fixatives, are important for good colorfastness in laundering. Colorfastness is a textile industry standard that determines how stable the color is in a garment. Good colorfastness means the garment won't fade after one washing. Resin pretreatment is best for garments that require excellent colorfastness. Cationic fixatives could be used for outerwear garments where colorfastness to washing is moderate but colorfastness to dry cleaning is high, notes Cardamone.

"Both pretreatment systems will effectively lead to union-dyeing of wool/cotton blends, but the treatment should be selected to accommodate the anticipated end use. A wool/cotton-blend fabric is ideal for multiseason apparel because wool provides inherent resiliency and warmth while cotton contributes comfort and coolness," says Cardamone. "These experimental textile treatments may broaden the market for cool-weather garments made of cotton/wool blends. In sweaters, for example, the blend's wool component retains body heat and imparts thickness, while cotton makes it comfortable to wear. Both natural fibers are great at wicking away moisture, too."

Through a cooperative research and development agreement between ERRC researchers and chemical specialties manufacturer Hercules, Incorporated, other pretreatment systems are being investigated.

Applied commercially, these technologies may cut textile dyeing costs—savings that can be passed on to consumers seeking versatile garments for spring and fall.—By **Tara Weaver-Missick,** ARS.

This research is part of New Uses, Quality, and Marketability of Plant and Animal Products, an ARS National Program (#306) described on the World Wide Web at http://www.nps.ars.usda.gov.

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PEGGY GREB (K9140-1)

Technician Kimberly Baxendale dyes samples of a wool/cotton blend fabric.