

Fabric Preferences of Atopic Dermatitis Patients

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Background: Atopic dermatitis (AD) patients have sensitive skin with impaired barrier function. Lyocell is a cellulosic fiber that offers unique characteristics and may be suitable for use by AD patients.

Objective: To compare preferences of subjects with atopic dermatitis and normal skin for 100% lyocell clothing and bedding versus 100% cotton fabrics.

Methods: Thirty subjects were enrolled and randomly selected to use cotton or lyocell shirts, pajamas, and bedding for 1 week. Following a 1-week washout period, participants wore the other fabric for 1 week. At the end of each week, participants completed a preference questionnaire, and AD subjects also rated daily itching on a visual analog scale. A random subset of AD and normal participants underwent measurement of transepidermal water loss (TEWL).

Results: Overall, there was a significant preference for lyocell (vs cotton) for its softness, temperature control, moisture control, and wrinkle resistance. AD subjects did not have stronger fabric preferences than did normal subjects. Although not significant, lower average itching and decreased TEWL were seen in participants while they wore lyocell.

Conclusion: Lyocell is superior to cotton in many performance characteristics and equivalent to cotton for itch reduction. Lyocell is currently available as a beneficial fabric to improve patient comfort.

ATOPIC DERMATITIS is a chronic relapsing inflammatory skin condition that usually appears in infancy and is commonly associated with varying combinations of asthma, seasonal allergy, and family history. The etiology of atopic dermatitis is multifactorial and necessitates a variety of treatments aimed at treating the inflammatory skin component coupled with the elimination of triggering factors and the improvement of skin barrier function. Optimal skin barrier function is essential to patients with atopic dermatitis to help prevent exacerbations.

Many different fibers make up textiles, and they can be divided into categories based on their source and composition (Table 1).¹ The effect of textiles on atopic dermatitis (AD) has been evaluated in a small number of studies. Wool has been shown to be irritating to atopic persons and is a minor feature in Hanifin and Rajka's criteria for AD.^{2,3} It has also been shown that synthetic

fibers such as polyester are irritating to patients with AD and that clothing made with cotton is better tolerated.^{4,5}

There have been new advances in using textiles as part of the treatment regimen for AD. DermaSilk clothes (AL.PRE.TEC., S.Dona di Piave, Venice, Italy) are undergarments made of raw silk treated with an antimicrobial finish (AEM 5772, AE6IS, Environmental Management, Millant, MI) that have been shown to decrease the severity of AD.^{6,7} In addition, silver-coated textiles have been shown to improve symptoms and decrease the severity of AD.^{8,9} Silver absorption through intact skin is minimal, and silver-impregnated textiles are expected to cause less systemic exposure than silver-based burn creams, but long-term safety studies are lacking.¹⁰

Lyocell (Tencel, Lenzing AG, Lenzing, Austria) is a man-made cellulosic fiber (meaning that it is produced from wood pulp cellulose). Production of lyocell fiber is environmentally sound, and the cellulose polymer is unchanged during processing. The cross section of the fiber is round, and the surface is smooth, which means that the fiber produces fabrics that are soft and smooth. The nanofibrillar structure of lyocell makes it hydrophilic with excellent moisture-wicking capability. Lyocell textiles have been shown to possess excellent comfort and thermoregulatory properties.¹¹

The intention of this study was to evaluate the preferences of AD patients for lyocell fabrics versus cotton fabrics and assess how lyocell affects skin barrier

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Table 1. Examples of Textile Fibers

<i>Natural Fibers</i>		<i>Manufactured Fibers</i>	
<i>Cellulose (Plant)</i>	<i>Animal</i>	<i>Cellulosic</i>	<i>Synthetic</i>
Cotton	Wool	Rayon (Viscose)	Polyester
Hemp	Silk	Lyocell (Tencel*)	Elastane
Linen		Acetate	Polyacrylic
		Modal*	Polyethylene
			Polypropylene

*Lenzing AG, Lenzing, Austria.

function. The study was approved by the University Hospital Case Medical Center Institutional Review Board (#020727).

Subjects, Materials, and Methods

Control volunteers aged 14 years and older were recruited by flyer and newspaper advertising. Subjects with AD were recruited by flyer, newspaper advertising, and department referral. All AD subjects met the criteria established by Hanifin and Rajka.² Control subjects were to have no history of chronic dermatitis and no history of asthma; a history of seasonal rhinitis or chronic sinusitis was allowed. Subjects were not to diverge from their current skin care regimen for 2 weeks prior to the study and for the duration of the study.

Materials used in this study were made by Lenzing Fibers (Lenzing AG) and consisted of short-sleeved T-shirts, long-sleeved pajama tops, pajama pants, and bedding (two pillowcases, fitted sheets, and flat sheets). The fabrics were either 100% cotton or 100% lyocell (Tencel) (Table 2). All items were the same cut and color and came packaged by number identifiable only by the investigator; fabrics were not identifiable by the study's participants.

Study Plan

This was a single-blind randomized prospective study. A total of 15 atopic individuals and 15 individuals with normal skin between 24 and 83 years of age were enrolled. T-shirts were to be worn at all times during the day until

the subjects changed into pajamas of the same fabric to wear nightly as a single layer. Fitted and flat sheets and pillowcases made of the same fabric were also used during the same interval. Subjects were to launder the fabrics in the same manner in which they laundered their own personal fabrics. Subjects were randomized by a computer-generated list, with two halves each assigned to start the study wearing either cotton or lyocell.¹² After the first week, subjects wore their usual clothing and used their normal bedding for a 1-week washout period, then wore items made of the other study fabric during the third week.

Subjects filled out a fabric preference questionnaire rating the study fabric used each week versus the subjects' usual clothing on the following performance characteristics: softness and smoothness, temperature control, moisture control, odor control, wrinkle resistance, and stain removal. Atopic subjects were also to complete a visual analog scale rating their itch level each week (0 indicated no itch, and 10 represented the greatest degree of itch). Five atopic subjects and five control subjects were also randomly selected to have their transepidermal water loss (TEWL) measured throughout the study. TEWL was measured at the right posterior axillary line in subjects randomized to this group. Additional TEWL measurements were taken at the end of the second (washout) and third (second fabric use) weeks.

Measurement of Transepidermal Water Loss

The DermaLab Transepidermal Water Loss Module (Cortex Technology, Hadsund, Denmark) was used. Participants remained in the same room with the device for 30 minutes to equilibrate to the ambient temperature and humidity. TEWL was measured on bare skin at the posterior axillary line. The device measures ambient temperature and ambient humidity, which were recorded.

Results

The null hypothesis of "no fabric preference" was tested for each characteristic with a chi-square goodness-of-fit test. *p*-Values were adjusted for multiple comparisons.

Table 2. Characteristics of Fabric Items

<i>Fabric Items</i>	<i>Composition</i>	<i>Description</i>	<i>Weight (g/m²)</i>
Cotton shirt and pajamas	100% cotton	Single jersey knit	213
Tencel shirt and pajamas	100% lyocell	Single jersey knit	215
Cotton bedding	100% cotton	Woven	143
Tencel bedding	100% lyocell	Woven	133

Data from 27 of the original 30 subjects were used for the final analysis. (Two patients who enrolled withdrew before the first visit, and one subject withdrew for reasons unrelated to the study.) According to the calendar kept by the study's participants, the overall daily compliance for using each fabric per protocol was approximately 97%.

Fabric Preference

Using the performance questionnaires that were completed at the end of each week, we compared the lyocell items to the subjects' usual clothing. Overall, lyocell was preferred for all performance characteristics. Lyocell was significantly preferred over the subjects' usual clothing for smoothness and softness and for temperature control (p -values of .0001 and .0011, respectively) (Fig 1).

In the comparison of lyocell to cotton, lyocell was preferred overall for all performance characteristics (Fig 2). Lyocell was significantly preferred over cotton for smoothness and softness ($p = .0001$), temperature control ($p = .0039$), moisture control ($p = .0003$), and wrinkle resistance ($p = .0124$).

Itch Scale Score

Only atopic subjects rated itch weekly on a visual analog itch scale. Overall, the average itch score was lower during the week subjects wore lyocell (2.08) than during the week they wore cotton (2.67). Both lyocell and cotton produced a lower itch score than the participants' usual clothing (3.42) (Fig 3). These values were not found to be statistically significant ($p = .501$).

Transepidermal Water Loss

Measurement of TEWL was taken at the end of each 7-day period in a random subset of five atopic subjects and five

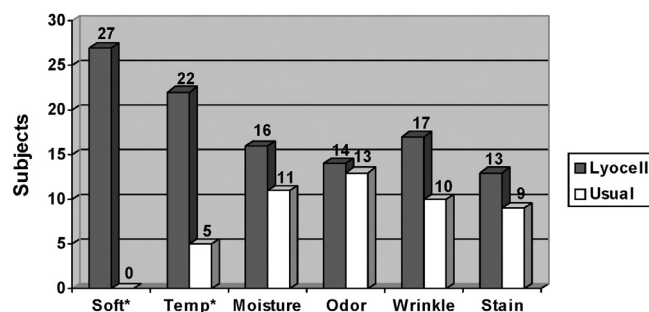


Figure 1. Subjects' preferences for fabric characteristics of lyocell versus usual clothing (Soft = softness; Temp = temperature control) ($p < .05$).

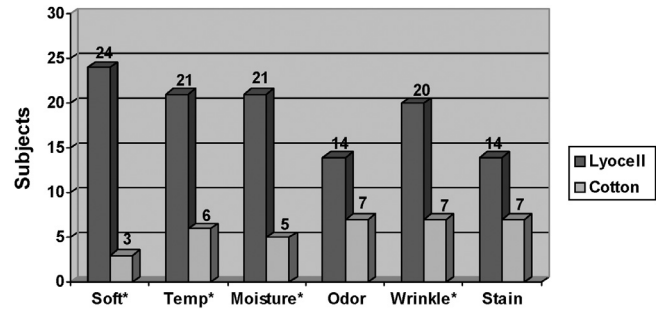


Figure 2. Subjects' preferences for fabric characteristics of lyocell versus cotton (Soft = softness; Temp = temperature control) ($p < .05$).

control subjects. The final data analysis included a period effect analysis, and it was concluded that the order in which the fabrics were tested did not affect the final TEWL data. Decreases in TEWL were seen in some subjects whether they were wearing cotton clothing, lyocell clothing, or their usual clothing, and the results of the TEWL measurements were not found to be statistically significant.

Discussion

Lyocell Properties

Man-made cellulose fibers are normally produced from wood pulp, which is produced from the cellulosic component of trees. Lyocell is produced by mixing wood pulp with a solvent that is 99.8% recovered and recycled. This process is environmentally sound as compared to that used to produce synthetic textiles.¹³

Lyocell fibers are formed in such a way that the cellulose molecules group together in bundles to form

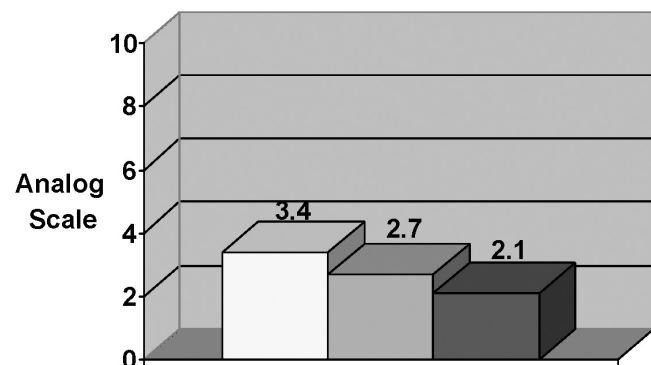


Figure 3. Atopic itch scale ($p < .501$).

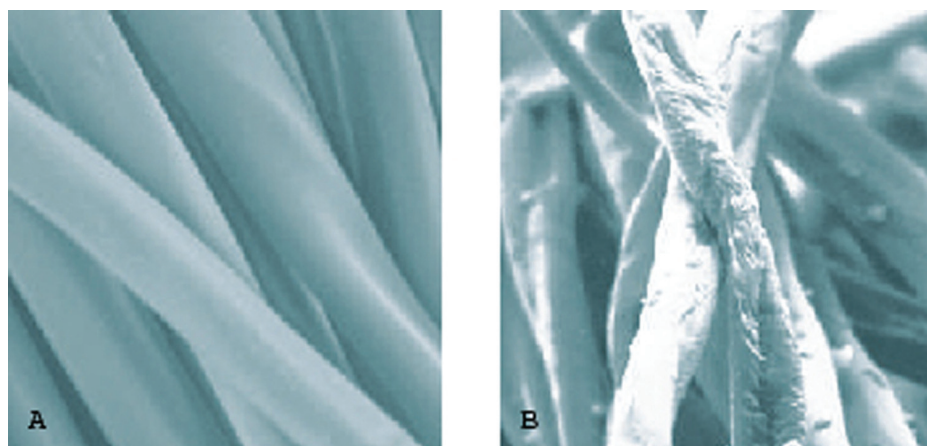


Figure 4. Scanning electron micrographs of, *A*, lyocell fibers and, *B*, cotton fibers ($\times 250$ original magnification).

nanofibrils. A large number of nanofibrils make up a single fiber, and this nanofibrillar structure is very strong and smooth.¹⁴ By contrast, cotton has a much rougher surface (Fig 4) and also absorbs less water than lyocell absorbs. The inherent stiffness of the fiber reduces the need for the use of finishing resins that may lead to allergic contact dermatitis. To produce good wash-and-wear performance, a cotton fabric will typically require 50% more resin than a similar lyocell fabric (Tom Burrow, Lenzing AG, personal communication, August 1, 2007). However, various clothing manufacturers may have different standards for textile finishing.

The spaces between the nanofibrils are easily accessible to water; water is brought to the center of lyocell fibers, decreasing both the moisture film on the skin surface and the possibility of amplified bacterial growth. Other synthetics such as polyester have little to no ability to wick water from the epidermal surface; water stays on the outside of these fibers and in contact with the skin. Better moisture control (particularly in humid conditions) facilitates better temperature control and may also reduce body odor.

Lyocell, Cotton, and Atopic Dermatitis

Decreased ceramides and epidermal lipid content are contributing factors to the barrier dysfunction seen in atopic patients.^{15,16} Epidermal barrier dysfunction can be expressed as a function of TEWL, with higher TEWL indicating increased barrier dysfunction. We did not show a significant difference in TEWL in subjects wearing different fabrics in our study. High humidity at the time of the study may have minimized changes in TEWL. It may take many days for the epidermal barrier to normalize in normal skin¹⁶ and may take even longer in atopic

individuals. Providing a longer time interval between the wearing of the fabric and TEWL measurement may have produced different results.

The subjects' overall preference for lyocell clothing over their usual clothing is important because it can be assumed that people select the clothing that feels best to them. The significant preference for lyocell over cotton for softness, temperature, and moisture control shows that lyocell may be used as an alternative to cotton for patients with AD. Although lyocell was not shown to be superior to cotton in itch reduction, our results indicate that lyocell is equivalent to cotton in reducing pruritus in AD patients and that lyocell may be used with cotton or as an alternative to cotton for patients with AD.

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