

# EXAMINATION OF EFFECTS OF CONTAMINATION OF NATURALLY WHITE COTTON WITH NATURALLY COLORED COTTONS

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## Introduction

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The commercial availability of naturally colored cottons has inevitably raised concerns about contamination of naturally white cotton. Until recent years, the objective of cotton breeding programs has been to prevent the genes that impart “non-white” shades to cotton fibers from being expressed in the commercial varieties produced. But these natural colors are now being marketed as specialty fibers that, up to now, go through the textile manufacturing process without being dyed. The colors expressed within the existing gene pool of global cottons are limited to brown, red and green spectra; shades may be varied by blending these fibers with naturally white cottons and with other colored cottons.

It is well known that the cottons designated as being naturally white are not uniform. The Upland cottons from different production areas and regions have different degrees of “yellowness” and the extra long staple (ELS) cottons are much more “creamy” (i.e., much less “white”) than most Upland varieties of cotton.

Even slight variations in cotton color can have detrimental effects on the results of dyeing. Such problems are a constant challenge to quality control in the dyeing and finishing processes of textile manufacturing. Bleaching is the primary technique for enabling a uniformity of color and shading that is adequate for discriminating consumers.

It cannot be assumed that a typical bleaching process will overcome the effects of contamination by naturally colored cottons. Therefore, it is no surprise that responsible leaders in the cotton/textile complex are concerned about this

risk. The coexistence of naturally colored cottons with the naturally white varieties brings, even with effective regulatory controls, a possibility of minor contamination that worries the textile manufacturing sector and the cotton production sector that serves it.

This study examines the color effects of known (quantified) contamination of naturally white cotton with existing varieties of naturally colored cottons, using bleaching procedures that are considered to be moderate in the U.S. textile industry. Results provide (1) perspective about the risk inherent in allowing naturally colored cotton varieties to be grown along with the naturally white cotton varieties, and (2) guidance to the textile industry in processing naturally white cotton that is contaminated with naturally colored cottons.

## Experimental Procedures

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The naturally colored cottons used came from the lines sold by B. C. Cotton, Inc. of Bakersfield, California. These have been grown on several thousand acres in Texas, Arizona and California. The different colored varieties sold are:

- Green** - a light green fiber
- Mocha** - a creamy light brown fiber
- Brown** - a brown fiber
- Red** - a red/brown fiber

These were carefully blended with Upland cotton grown on the Texas High Plains, in order to get an exact “contamination” of 1.5% (one and one-half percent). The Texas cotton used is among the brightest whites of all the Upland cottons grown in the U.S. and worldwide; therefore, it provides a sensitive medium for

measuring color contamination. The contamination level of 1.5% is a higher level than would ever occur under the U.S. regulatory guidelines established for the breeding, growing and ginning of naturally colored cottons; i.e., this level of contamination would require a blatant violation of established procedures for keeping the seeds separated. A representative number of cotton plants on an acre of irrigated land is 40,000 to 60,000; therefore, a contamination level of 1.5% would require 600 to 900 naturally colored cotton plants per acre. Only sabotage or wanton violation of procedures could cause such a high level of contamination.

Along with the "control" of 100% Texas Upland white cotton, each of the four "contamination blends" were spun into yarns and then knitted into tube fabric on a FAK (fiber analysis knitter) machine. A Macbeth Color-Eye 3000 spectrophotometer (sphere geometry) instrument was used to measure color differences between the control fabric and the contaminated fabrics. Color differences were obtained using the CIE 1976 L\*a\*b\* color space. The indicators used, along with their meanings, are given in Table 1.

Based on the measurements obtained, it is determined whether the test samples are significantly different from the control sample. A "pass" is given if a test sample is not significantly different and a "fail" is given if it is significantly different from the control.

The bleaching formula and procedure used for all the fabrics are summarized in Table 2. The reader may satisfy himself that it amounts to a normal one-step scouring and bleaching process. Use of much stronger formulas is common, as is an array of chemicals to further brighten and whiten fabrics. It is probable that stronger processes would further alleviate the color effects of contamination with the naturally colored cottons; however, a basic approach was used to ensure that results were conservative.

In order to examine effects on color differences after dyeing, some of the knitted fabrics were

dyed with 1% Direct Blue 80. These dyed fabrics were then measured as before on the Macbeth spectrophotometer.

## Results

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Of course, all the contaminated samples failed to match the control prior to bleaching; if any had passed, the instrument would have been malfunctioning. Results for the bleached samples are summarized in Table 3, where it is seen that all of the contaminated fabrics were within the tolerances set, except the one with green fibers. While small differences were measured for the samples containing mocha, brown and red fibers, they were not significantly different from the 100% white cotton control fabric.

Results for the dyed samples are summarized in Table 4. After both bleaching and dyeing, all of the contaminated fabrics were within tolerances—even the one with green fibers. While small differences were measured for all the contaminated samples, none were significantly different from the control fabric.

## Conclusion

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Given the heavy contamination level used for the colored cottons in this study, the results are encouraging to those in the cotton and textile industries who are concerned about damaging the processing performance of U.S. cottons. It appears that normal bleaching operations in the U.S. will substantially alleviate color problems caused by such contamination.

These results do not indicate that it is feasible to eliminate regulatory controls aimed at assuring that the planting seeds of naturally colored varieties are not mixed with the planting seeds of naturally white varieties. Rather, they indicate that if some mixing of fibers does occur, then normal finishing processes will still result in acceptable colors.

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**Table 1. Color Differences Measured between Control Yarn and Contaminated Yarns**

Measure	A plus (+) value means:	A minus (-) value means:
<b>DL</b>	Lighter shade	Darker shade
<b>Da</b>	Redder color	Greener color
<b>Db</b>	Yellower color	Bluer color
	<b>Less than 100% means:</b>	<b>Greater than 100% means:</b>
<b>Apparent Strength</b>	Lighter shade	Darker shade

Note: Measurements were taken using illuminant D65 and a 10° angle of observation.

**Table 2. Bleaching Process**

<b>Formula:</b>	1% Tergital NP-9 (a non-ionic wetting agent) 4% caustic soda 2% sodium silicate 6% hydrogen peroxide (50% concentration) Note: All percentages are based on the weight of the goods (owf).
<b>Procedure:</b>	(1) Raise temperature of bath to 90°C & run 1 hr. (2) Drop (drain) the bath & refill (3) Raise temperature of bath to 90°C & run 15 min. (4) Drop bath, refill with cold water & rinse (5) Drop bath, refill with cold water & add acetic acid (0.25% owf) (6) Extract & dry

**Table 3. Color Differences for Bleached Cotton Fabrics: Pure White Cotton versus 1.5% Contamination of Colored Cottons**

Contaminant	DL	Da	Db	Apparent Strength	Pass or Fail
Green	-1.66	+0.25	+1.86	155.62%	Fail
Mocha	-0.18	-0.04	+0.21	105.39%	Pass
Brown	+0.19	-0.02	+0.07	95.47%	Pass
Red	+0.20	-0.01	-0.06	94.67%	Pass

**Table 4. Color Differences for Bleached and Dyed Cotton Fabrics: Pure White Cotton versus 1.5% Contamination of Colored Cottons**

Contaminant	DL	Da	Db	Apparent Strength	Pass or Fail
Green	+0.03	-0.07	+0.54	99.03%	Pass
Mocha	+0.19	+0.18	+0.54	98.00%	Pass
Brown	+0.17	+0.17	+0.11	98.03%	Pass
Red	+0.29	+0.12	+0.09	97.42%	Pass