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The Visible Effects That Laundering Has on Dyed Cotton When a Non-formaldehyde Resin Finish Has Been Applied

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ABSTRACT

"Color is one of the most important characteristics in any clothing or household textile. It is one of the first considerations when purchasing a garment." (Hollen, 1954). Another characteristic of fabrics that is very important to persons buying clothing is wrinkle resistance. Cotton, a very comfortable fabric, is naturally inelastic and therefore wrinkles badly. Since 1933-34 manufactures have been researching different types of resin finishes to take care of the wrinkle problem (Wingate, 1942). Until recent years, these finishes worked very well. The problem that arose was that these finishes are formaldehyde-based, and when scientists found out that formaldehyde was a carcinogen, it became necessary to find new resins without the formaldehyde to finish the cotton. The purpose of this experiment was to examine what effects a nonformaldehyde-based resin finish had on the colorfastness properties (laundering fastness) of the dyed cotton. The cotton was dyed and then treated with one of two resins; either a glyxol/glycol treatment or a butanetetracarboxylic acid (BTCA) treatment. The control group was dyed but not treated with any resin finish at all. When washed there were no outstanding qualities of either treatment of resin. This study found that neither a glyxol/glycol resin treatment or a BTCA resin treatment was a better protector of color. However, the BTCA treatment provided the most colorfastness for the reactive red 4, the glyxol/glycol was preferable with reactive blue 2, and neither worked exceptionally well with the indigo. In fact, it was found that a lot of color was lost in laundering no matter which resin finish treatment was used.

INTRODUCTION

The use of cotton has become very popular in recent decades due to some of its qualities which include dyeability, comfort, and breathability. One major problem with early types of cotton was wrinkling. Since people don't want wrinkles in their nice church or work clothes, the cotton had to be altered to have an even looking surface without ironing after the cotton garment was washed (Andrews, 1989). Early resins that were created to solve the problem of wrinkling after washing had a problem of their own. Early resins, based on methylolamides have formaldehyde as a starting point (Andrews, 1992). These resins were very economical and had the best effect on the cotton at that time. In later years it was found that formaldehyde is a toxic chemical and is carcinogenic to humans. Therefore, new resins had to be found that do not have this formaldehyde as a base. Many nonformaldehyde finishes have been found, but due to high costs, fabric yellowing, and inadequate reactivity they are not used commercially (Hiebert, 1994). A good nonformaldehyde finish must be found to coat the cotton so that it will not wrinkle.

As recently as the late 1980's studies have shown that polycarboxylic acids are good resins to use on cotton. They provide high wrinkle-free and durability percentages (Welch, 1988). After doing research on a lot of the possibilities, butanetetracarboxylic acid (BTCA) was found to be one of the best resins in wrinkle-free ability (Hiebert, 1994). However, I want to see how the resin does with colorfastness. The other resin that I will be using is a glyxol/glycol sulfate resin. This resin helps cut down the yellowing of the fabric. But what exactly does it do for the colorfastness of the dyes? Will these two resins keep the color very well or will they allow the color to bleed and fade?

Through my research I have found that there are a few finishes that work well for wrinkle control and durability. However, there has not been a finish found that is good at wrinkle control, durability and colorfastness.

By using spectroscopy I will determine how much change, if any, in color has taken place. Do the colors themselves have an effect on the colorfastness properties or is it just the resin finishes? How much color is lost in the washing process? These are several questions that I plan to answer.

MATERIALS AND METHODS

Bleached, mercerized, undyed cotton was cut into strips measuring 10cm by 40cm, and then dyed with three different colors of dye. Those three colors were: indigo, reactive blue 2, and reactive red 4. Each one was then treated with two different resin finishes. The first resin finish being 1,2,3,4-butanetetracarboxylic acid (BTCA) with sodium hypophosphite as a catalyst and the second treatment was a glyoxal/glycol sulfate base with an aluminum sulfate catalyst. Unfinished dyed cotton was used for a control in the experiment.

The reactive blue 2 dye was applied using 2.0g of reactive blue 2 powder and 1200ml of distilled water. This solution was then heated for ten minutes. The strips were then soaked for ten minutes in the solution, followed by ten minutes of drying at 125 C. For reactive red 4, 1.0g of reactive red powder was used with 1400ml of water. The indigo dye contained 3.0g of indigo powder with 1400ml of water. The dying procedure was the same for all three colors. No mordants were used with these dyes.

The procedure for applying the resin was as follows.

Solution number one was prepared by combining: 250ml of distilled water, 23.75g of BTCA, and 16.5g sodium hypophosphite. The second solution contained: 216ml of water, 12g glyoxal, 22g glycol sulfite, 0.95g aluminum sulfate, and 0.925g tartaric acid. Six strips of each color of cotton were dipped twice in BTCA and air dried overnight. The same procedure was used for the second treatment.

Both the finished and unfinished dyed cotton were then subjected to washing tests. Each color was washed separately with 3L of distilled water and 10g of Tide laundry detergent. The strips were agitated for 5 min., let sit for 5 min., and rinsed for 5 min. The purpose of these tests was to observe the colorfastness properties of the cotton with the resin finish compared to the cotton without the resin finish. To determine if any of the colors bled during the washing visual observations were made and a sample of the wash water was taken for spectroscopy observations and run against a sample of clean water. The clean water did not contain 10g Tide/3L of water.

RESULTS

After the cotton was dyed and then dried, it was treated. There were two different treatments. During these treatments there was some color loss that could be seen in the solutions. Visual comparison of the wash waters indicated that no one specific treatment was better for all three colors. For reactive red 4, treatment number two (glyoxal/glycol solution) provided more colorfastness. This same treatment also worked for reactive blue 2. As you can see in figure 1 the glyxoal/glycol treatment provided better colorfastness for reactive blue 2 than it did for reactive red 4. Neither treatment worked very well on the indigo, but the spectroscopy showed that the BTCA worked slightly better than glyoxal/glycol. The treated indigo wash water looked as dark as the untreated indigo wash water. The spectroscopy supplied results that backed up the visual observations (Figure 1). Neither treatment worked for all three of the colors.

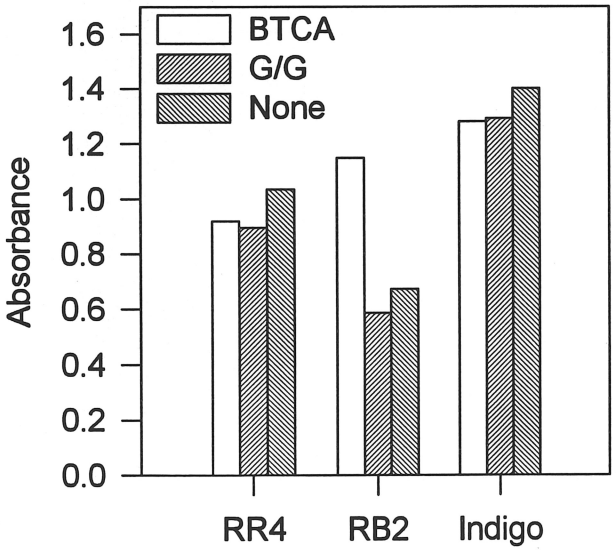

Figure 1. Spectrophotometric comparisons of rinsewater for cotton cloth dyed with reactive red 4 (RR4), reactive blue 2 (RB2), or indigo and treated with either BTCA or glyoxal/glycol (G/G).

DISCUSSION

In my research I found that colorfastness depends not only on the type of fiber to which the color is applied, but also on the treatment, the type of dye used, and how the dye and the treatment are applied (Chambers, 1961). This may explain why all three of the dyes lost some color during the finish treatment and laundering processes. Another explanation for decreased colorfastness may be that the dyes were not applied with a mordant, a chemical which has an affinity for both the dyestuff and the fabric (Wingate, 1942). Without a mordant certain dyestuffs do not combine well with fabrics. Cotton, however, should not have a problem with any dyestuffs except the "basic dyes" (Wingate, 1942).

In previous studies the BTCA/sodium hypophosphite treatment, due to the reductive nature of the catalyst sodium hypophosphite, was the least effective on some dye colors (Hiebert, 1994). In my research I have also found that the BTCA treatment was the least effective toward two of the three colors. This is a problem considering that a finish needs to work well on all colors, not just a few.

Catalysts are very important in the treatment processes. Catalysts help to crosslink the cellulose cotton fibers with the polycarboxylic acids (Bertoniere, 1992). Catalysts also help speed up the time needed to perform the treatment process (Welch, 1988). A catalyst may improve other properties of the cotton, including durable press and tensile strength (Pandey, 1987). Considering that the problem is in the catalyst, other catalysts must be found to reduce the price of nonformaldehyde based finishes. By finding different catalysts to put with the BTCA and glyxol (two of the best crosslinking agents) maybe the amount of formaldehyde based finishes now in use can be reduced.

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