FIBER CHEMISTRY EFFECTS ON DYE UPTAKE

Gary R. Gamble
USDA-ARS-Cotton Quality Research Station
Clemson, SC

Abstract

The market value of raw cotton is determined by a number of critical factors, including fiber length uniformity, fiber strength, leaf grade and color grade. Color grade is classed by the Agricultural Marketing Service using HVI (Uster Technologies, Knoxville, TN), and is based on measured Rd (diffuse reflectance) and $^{+}$b (yellowness) values. Textile mills typically attempt to place bales of similar color grade into a laydown, due in part to the common perception that Rd and +b differences between bales in the same laydown may influence the color quality of the resulting dyed fabric. A common example of color defects is barré, an effect caused by differential dye uptake by the yarns comprised by the fabric. One possible additional cause may be due to differences in metal contents between bales in the laydown. Following scouring, bleaching and dyeing of the fabric, Ca^{2+} and Mg^{2+} remain associated with the fiber in substantial quantities. The possibility that these native metal cations may interfere with dyeing, either by forming complexes with the dye molecules or with the cellulose itself , has not been fully addressed in the literature. The purpose of the present work is twofold: (1) determine whether Rd and +b differences will affect the color properties of the final dyed products, and (2) determine whether residual metal content in the fiber after preparation for dying will affect the color properties of the final dyed product. To accomplish this, cotton from a single bale of cotton was spun and knit into fabric. The resulting fabric was divided into a control (no heat) and heated (50^{o}C for 10 days to simulate the color change which occurs with ageing). Samples of the fabrics were collected at each stage of preparation for dyeing: greige, scoured, soaking in either water or a buffered EDTA solution, bleached, and dyed with Reactive Blue 5. Color analysis (L*a*b*) was subsequently performed on each of these collected samples. Results indicate that L* is lower for the heated fabrics in both the greige and scoured form, as compared to the non-heated fabric. Soaking in EDTA solution increases L* in both the control and heated fabric compared with soaking in water alone. Following bleaching and dyeing, the EDTA treated samples also exhibit increased L*, while no difference is observed due to heating as compared to the non-heated fabric. Results for a* and b* show similar trends. Heating results in higher values in the greige, scoured and bleaches fabric, and soaking in EDTA solution results in decreased values in both the control and heated fabrics. The dyed EDTA treated fabrics show increased (less negative) values compared to no EDTA treatment. The present results suggest that changes in L*a*b* values of the greige and scoured fabrics due to accelerated ageing of cotton fiber do not appear to lead to any affect upon dye uptake in the final product when using a reactive dye. Removal of Ca^{2+} and Mg^{2+}, accomplished by treatment of the scoured fabrics in EDTA solution, does appear to lead to a decrease in dye uptake in the final product when using a reactive dye. The mechanism for this effect may involve the interaction of free hydroxyl groups associated with cellulose with Ca^{2+} and Mg^{2+}, resulting in a greater accessibility to the reactive dye. This will be the subject of ongoing investigation.

Details of the present work will be presented in a manuscript to be submitted to the Textile Research Journal.