Natural Dyes for Volume Dyeing: Colorfastness to Laundering

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Background and Purpose: As consumer awareness of environmental hazards of the textile dyeing industry grows, the interest in volume dyeing with natural dyes has also increased (Yusuf, Shabbir, & Mohammad, 2017). Concerns related to natural dyeing include the availability of dyestuff, multiple wet processing steps, color consistency and fastness, and scalability (Fletcher & Grose, 2012; Bechtold, Turcanu, Ganglberger, & Geissler, 2003). In response to these challenges, Couleurs de Plantes, a dye-plant research and manufacturing center in France partnered with US distributor, De La Terre Colours (DLT), to offer Global Organic Textile Standard (GOTS) certified 'all-in-one' natural dyes for volume dyeing (De La Terre Colours). The 'all-in-one', also called simultaneous mordanting, eliminates the pre-mordant wet processing step as the mordant and any auxiliary chemicals are mixed in with the dye extract.

The aim of the project was to investigate viability of natural dyes for Wool & Prince, a U.S. menswear company looking to add naturally dyed wool and wool/nylon blend textiles to their apparel offerings. In this abstract, we report the colorfastness of wool/nylon knit fabric to laundering results for: a) existing synthetically dyed samples; b) traditional pre-mordant and naturally dyed samples; and c) DLT combined mordant and dye samples. Dye color selection was based on the company's color palette.

Methods: Synthetically colored samples, dyed with red, blue, and black acid milling dyes, were provided by the company. For traditional pre-mordanted and naturally dyed textiles, the company's jersey knit fabric samples (fiber content of 78% Merino wool and 22% nylon) were scoured and pre-mordanted with potassium aluminum sulfate and dyed with fustic shavings (yellow), madder extract (red), and logwood grey extract (gray). Bath pH was 5. Un-mordanted samples were dyed blue with indigo in a vat (pH 10) reduced with fructose and calcium hydroxide. For the DLT combined mordant and dye, samples were quickly heated (70 °C) then cooled in acidic aqueous baths (pH 4), followed by dyeing in the acidic condition. DLT dyestuff and mordant combinations were myrobalan and titanium oxalate (orange), madder and aluminum lactate (red), chestnut and ferrous lactate (brown), and myrobalan, gallic acid, ferrous lactate and titanium oxalate (black).

Colorfastness to laundering was conducting according to American Association of Textile Chemists and Colorists (AATCC) 61-2007, Accelerated, Test No. 1A (AATCC, 2009).

Specimens were agitated in an Atlas Launder-ometer for 45 min at 40 °C with resulting color change and staining similar to that produced by five hand launderings. Color change and staining evaluation followed AATCC Evaluation Procedures 1-2007 and 2-2007, Gray Scale for Color Change and Gary Scale for Staining (AATCC, 2009). A rating of 4 or higher for color change and 3 or higher for staining is considered acceptable by the American Society for Testing of Materials for apparel and home goods.

Results and Discussion: All dyed samples met ASTM's color change standard of 4 or higher after the equivalent of five hand launderings. Evaluation of staining did not meet ASTM standards for some of the dyes on the nylon and silk staining strips. There was considerable to noticeable staining on nylon from pre-mordant dyes fustic, madder, and indigo; as well as DLT madder and chestnut. While madder has shown staining on nylon in prior studies (Haar, Schrader & Gatewood, 2013), it was not expected that the dyewoods would have considerable staining from unbound dye. All of the black, gray, and blue synthetic and natural dyes had severe staining on silk as a pink stain. This may be from acidic conditions; however, the indigo was an alkaline condition. A more likely explanation is unbound red dye in the black, gray, and blue color complexes.

Overall, the dyes were acceptable in terms of colorfastness to laundering, with staining concerns across all three dye types. The natural dyes reacted to the mixed fiber content of wool and nylon, creating a subtle heather effect, while the synthetic dye masked the fiber differences. In the end, we provided a mixed recommendation for the use of the DLT dyes. Positive aspects were improved efficiency for volume dyeing by eliminating the time-consuming pre-mordant step where quality issues often arise. DLT dyes are manufactured for volume dyeing by Arrdhor CRITT Horticole, a well-respected leader in natural dye research and production for various industries. Our concerns were unknown amounts and unfamiliarity with the mordant additives, as well as potential for simultaneous mordanting to increase amount of dye and mordant waste as there may be increased bonding between dye and water prior to fiber bonding. In addition, the acidic condition (pH 4) can be an irritant to workers during dyeing.

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