Investigating Marigolds as a Dyestuff for a Small Business: Extraction, Colorfastness, and Care of Silk and Linen

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Keywords: Natural, dye, colorfastness, marigolds

Background and Purpose. The researchers have a relationship with a small U.S. business, Lions in Four, that produces some of its product at a women's training center in southern India. As the center includes gardening and natural dyeing, it was requested to investigate the feasibility of marigolds for coloring linen and silk for home product textiles. The objectives of the project were to investigate marigold dye extraction and colorfastness to home laundering using commercially available detergents that would result in care label washing instructions for silk and linen home products for the U.S consumer.

Solutions for extraction of marigold dye for silk dyeing are aqueous, aqueous and sodium chloride, and ethanol (Jothi, 2008; Sarkar, Mazumdar, Datta, & Sinha, 2005; and Vankar, Shanker, & Wijayapala, 2009). Extracted annatto dye solutions have been successfully stored through refrigeration (Nakatsuka & Abeta, 1982). Synthetic dye storage varied between -10 ºC to 80 ºC (Rao, Satyanarayana, & Rao, 2002). When mordanted with aluminum sulfate silk-dyed marigold colorfastness to laundering gray scale ratings were reported between 3 and 5 that is good to excellent. The current project, extracted marigold dye in an aqueous solution and used as either fresh (immediate dyeing) or preserved (frozen).

We found no research investigating marigold dyed linen, nor colorfastness to home laundering or hand wash procedures for naturally dyed products using commercially available detergents. Tide Free and Woolite detergents were selected for evaluation as they are readily available to the U. S. consumer and recommended for handwashing (Boerner, 2016).

Methods and Analysis. Dried marigold (*Tagetes patula* and *erecta*) petals were extracted as an aqueous solution. The dye liquor concentrated conditions were a) fresh, that is dyed with following extraction, or b) preserved through freezing. Silk crepe de chine fabric was premordanted with 10% owf potassium aluminum sulfate and the linen fabric with 5% aluminum acetate. Pre-testing results and client preference determined the 10% dye concentration to weight of fiber (owf). Both marigold liquor dyed silk & linen samples were exposed to five home launderings (AATCC Monograph 6-2016, AATCC, 2009) using two detergents, Tide Free and Woolite. Color change was measured with an X-rite RM200QC and AATCC gray scale (AATCC, 2009). Color strength percent was measured as the ratio between the K/S-value between treatments. A two-tailed t-test was used, significance level 0.05, for statistical analysis. CIELAB color differences were calculated as $\Delta E = [(L\text{Trial} - L\text{Standard})^2 + (a\text{Trial} - a\text{Standard})^2 + (b\text{Trial} - b\text{Standard})^2]1/2$.

Results and Discussion. The preserved marigold treatment had significantly ($p < 0.05$) darker and warmer color strength on both the silk and linen (see Table 1). The linen color strength was

similar between detergents, while preserved liquor on silk had significantly higher color strength with Tide Free.

Table 2. *Color Strength and Colorfastness to Home Laundering Color Change with CIELAB Values and Gray Scale for Marigold Dyed Silk and Linen in Fresh and Preserved Conditions*

Fiber Condition	Control CS %	Laundered with Tide Free				Laundered with Woolite			
		CS%	ΔE	GSc	GSs	CS%	ΔE	GSc	GSs
Silk Fresh	100	79.0	4.7	3-4	4-5	72.0	5.5	3-4	4 -5
Silk Preserved	112	92.7	4.7	3-4	4-5	80.3	6.4	3	4
Linen Fresh	100	69.3	5.2	3	4-5	65.7	7.0	3	4
Linen Preserved	113	78.0	4.5	3-4	4-5	79.7	5.7	3-4	4-5

Note. CS= color strength. Gray Scale for color change (GSc) and staining (GSs) ratings are 0=off shade, 1=much, 2=considerable, 3=noticeable, 4=slight, and 5=equal.

Color change & staining from exposure to home laundering were not significantly different between fresh and preserved dye solutions, nor between detergents. Gray scale staining ratings met the ASTM standard of 3 or higher for home goods. However, color change ratings, regardless of treatment, did not meet the ASTM standard rating of 4. This finding contradicts prior colorfastness research for silk. Possible reasons may be the home laundering method or use of commercial detergent. In addition, the detergent's chemistry with the cellulosic and protein fiber may also have impacted color change.

The concentrated liquor solutions may simplify dye bath preparation and the preserved method would reduce need for dried dyestuff storage. While the preserved method was darker and warmer, maintaining the frozen state may be challenging at the center where power can be inconsistent. The results of this study do not support home laundering for marigold dyed silk and linen. Future work should evaluate these treatments against hand laundering conditions. Even though the marigold dyed and laundering samples did not meet ASTM color change standards, the visual color difference to the human eye is not drastic. Thus, for home products that require minimal laundering, the color change may be acceptable for artisan produced products.

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