

Investigation of Sumac (*Rhus glabra L.*) Leaves as a Natural Mordant on the Colorfastness of Laundering for Weld-dyed Cotton Batiste

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The textile dyeing and finishing industry is under scrutiny due to environmental and health hazards (Blacksmith Institute, 2012). Natural dyes from plants are being used in niche markets due to their ability to biodegrade, renew, and employ rural communities; as well as their carbon producing, UV protection, antimicrobial, and flame-resistant properties (Gupta, 2002; Saxena & Raja, 2014). A challenge associated with natural dyes is their poor colorfastness with cellulosic fibers. As a result, mordants, which create a molecular bond between dye and fiber, are used to improve dyeing efficiency. Aluminum acetate alone or in combination with tannic acid have been recommended for cellulose fibers (Brown, de Souza, & Ellis, 2010; Haar, Schrader, & Gatewood, 2013). Plants rich in tannin content (oak gall, myrobalan) or aluminum accumulating (symplocos) are potential sources of natural mordants. However, colorfastness results of natural mordants vary (Chairat, Darumas, Bremner, & Bangrak, 2011; İşmal, Yıldırım, & Özdoğan, 2014; Kumar & Bharti, 1998; Vankar, Shanker, Mahanta & Tiwari, 2008). The purpose of this research was to investigate sumac, a tannin rich regional shrub, as a potential natural mordant. While sumac's history is noted as a dye, mordant, medicine, and tanning agent, no colorfastness results were found (Cardon, 2007; Ogg, 1998).

Methods: Three different mordant treatments: 1) sumac leaves at 50%, 100%, 150%, and 200% owf, 2) combination of sumac leaves at 50%, 100%, 150%, and 200% owf and Aluminum Acetate at 5% owf, and 3) aluminum acetate at 5% owf were carried out on cotton batiste samples. Mordanted samples were dyed with 5% weld (*Reseda luteola*). Samples were exposed to colorfastness to laundering (AATCC 2009). Color coordinates and Gray Scale ratings were taken with an RM200QC Imaging Spectrocolorimeter (X-Rite, Michigan, USA). The resulting colorimeter data was analyzed using descriptive statistics and ANOVA within and across treatments.

Results: Results indicate that increasing the amount of sumac does not change color coordinates and overall color difference significantly for both sumac leaves alone ($F=0.01$, $p >0.05$) and sumac leaves plus alum acetate combination treatment ($F=0.04$, $p >0.05$). Sumac in combination with alum increases gray scale rating by one point (Staining=4, Color Change=3) compared to

the other two treatments. Among all the combination used, 200% sumac and alum combination showed better rating both in total color difference value ($\Delta E^* = 4.5$) and gray scale rating (Staining=4-5, Color Change=3-4) than sumac leaves only (ΔE^* : Mean=7.4, SD= 1; Staining Mean=4, Color Change Mean=2) and Alum Acetate treatment ($\Delta E^* = 11.7$; Staining=3, Color Change=2). However, all the natural sumac mordanted samples darken weld's traditional bright yellow color ($L^* = 86.7$, $a^* = -4.6$, $b^* = 58.8$) produced using aluminum acetate on cotton batiste.

Conclusion: To summarize, sumac in combination with aluminum acetate slightly improves ratings for colorfastness to laundering and staining. However, the tannin content darkens the overall value of weld dyed cotton. These findings contribute to the understanding of potential of sumac as a natural mordant and may aid further investigations of using sumac with other dyes; as well as contribute to the ongoing conversation of natural mordants.

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