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Comparing Color Strength Results through Analysis of Rinse Water between Wool Dyed with Onion Skins and Mordants and Synthetic Dye

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ABSTRACT

The textile industry is one of the biggest global polluters releasing chemicals into the air, land, and water. The majority of these emissions are due to the chemicals that enter the water stream from the textile dyeing process. While synthetic dye effluents are very hard to remove from the wastewater, natural dyes have a very minimal effect on the environment due to their biodegradability. One major issue that prevents the textile industry from using natural dyes is the differences in colorfastness between the synthetic dyes and natural dyes. Because of this, this study will evaluate if the use of a mordant before fiber dyeing could increase the colorfastness of a natural dye so that the use of natural dyes can be increased in the textile industry. Harvesting a dye from yellow onion skins has proved to be an attractive dye product not only due to its color performance but since it is a natural waste product, not interfering in the food supply chain. Dye from onion skins was compared to a synthetic dye counterpart, Rit brand dye. One wool sample was dyed with Rit, and three others with the onion dye without a mordant, and with lemon juice or iron ferrous sulfate as mordants. These samples were then washed until the rinse water became clear. The rinse water was then evaluated with a UV-visible spectrophotometer. The Kubelka-Munk theory was used to solve for color strength of the rinse water or how much dye bled from the wool during washing. In conclusion the Rit dye and the onion dye with the lemon mordant performed better than the onion dyes without a mordant and with an iron mordant.

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Experimental

Sample Preparation

A total number of 4 2-ounce bundles of wool roving were dyed with onion skins (A, B, C) after one of these bundles was mordanted with lemon juice (B) and another was mordanted with ferrous sulfate and cream of tartar (C). The last bundle of wool roving was dyed with Rit dye (D). Details of each dye method can be given below:

B- 1 L of distilled water and 100 mL of lemon juice were heated to 100 Cº. 1 bundle of wool roving was then added, and the pot was kept at 100 Cº for 30 minutes.

C- 8 oz of distilled water was heated to 60 Cº before 4 g of ferrous sulfate and 4 g of cream of tartar were added. This solution was then added to 1 L of distilled water. Wool was added and simmered for 45 mins.

A, B, C- Onion skin dye was prepared by weighing out 51.03 grams of yellow onion skins (30% weight of total wool to be dyed). The onion skins were heated in 1 ½ L distilled water at 100 Cº for 1 hour.

D- Instructions on the package were used for the amount of dye used and general procedure.

Wash Procedure

Each bundle was washed in a separate container with 1 L distilled water at 40 Cº with 8 g of powdered detergent for 30 minutes. After each wash the wool was rinsed with 1 L distilled water to remove soap residue. Washing and testing was repeated until the rinse water was clear*.

*This took 6 washes for the wool dyed with Rit dye and 3 washes for the wool samples that were dyed with the onion dye.

Data Collection

After each wash the rinse water was tested using a UV VIS Spectrophotometer. The percentage of light reflected (R) was calculated with Equation 1 using the absorbance and transmittance. The Kubelka-Munk theory (Equation 2) was used to calculate the color strength of the wash off, the greater this ratio is the greater the degree of dye bleeding [1].

Equation 1: R=100-(A+T)

Equation 2: K/S= ⟦(1-0.01R) ⟧^2/0.02R

Colorimetric data was found using Adobe color [2]. Images of the roving before washing and after the final wash were uploaded and L*a*b* values were averaged across 5 points for each image. The average values were used to plot a* by b*, the a* value indicating red/green values while the b* value represents blue/yellow values [3].

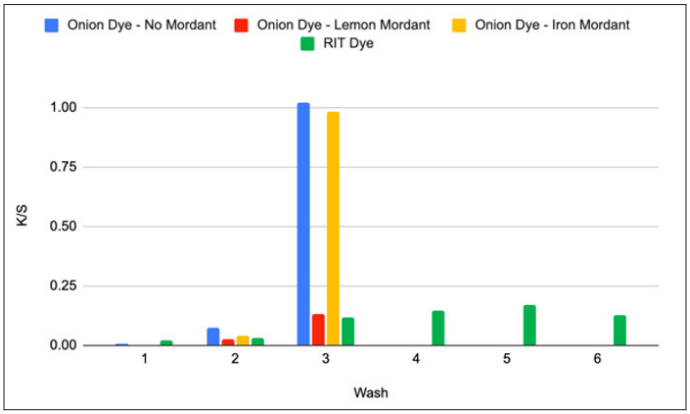

Figure 1: Graph of K/S Values for Respective Dyes and Mordants per Wash

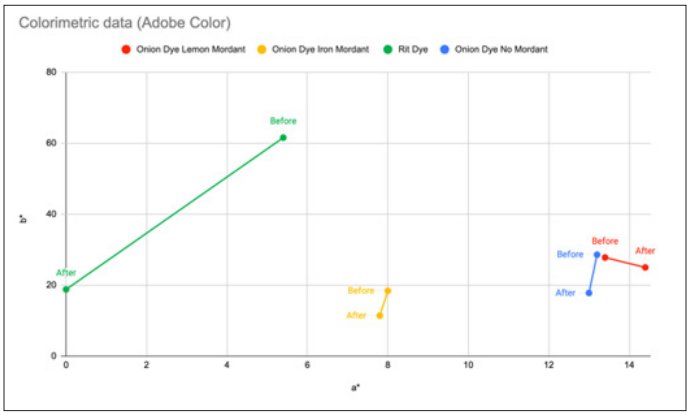

Figure 2: Before and After Washing b* vs a*

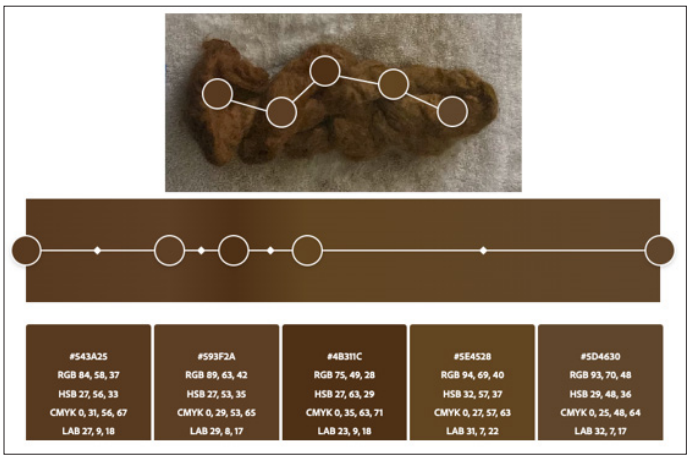

Image 1: How Calorimetric Data was procured from Adobe Color

Table 1: Images of Wool before Washing and after Wool has Been Washed until Rinse Water is Clear

	Onion No Mord- ant	Onion Lemon Mord- ant	Onion Iron Mord- ant	Rit Dye
Before				
After				

Results and Discussion

From the K/S values for the rinse water after each wash the wool pre-mordanted with lemon juice provided the lowest scores overall, 0.89 lower than the un-mordanted wool and 0.85 lower than the wool mordanted with Iron. Dye continued to show in the rinse water of the wool dyed with the Rit dye at a near constant rate after the third wash.

Because dye continued to show, the wool dyed with the Rit dye was washed twice as many times thus twice as much water was used in the process. After washing, the wool dyed with the Rit dye lost the most color compared to the wool samples that were dyed with the onion dye. The wool dyed with the onion and mordanted with lemon juice was left with the highest a* and b* scores after washing. 6.2 points higher in the b* scale and 14.4 points higher in the a* scale.

Future Work

After an interview with the senior wash engineer at Target Corporation, it was discussed that the standardization of color as well as issues with light fastness come to be a large hindrance to natural dye usage. A replicable experiment on lightfastness with the same dyes and mordants will be completed [4].

Natural dyes that affect the food supply chain are cautioned, but as onion skins are a byproduct of the food system it will be evaluated the ease of collecting the skins from grocers and or food service to evaluate feasibility.

Conclusion

The use of lemon juice as a mordant on wool dyed with onion skin dye has proven to be successful and comparable to the competing synthetic dye when the rinse water was evaluated. The use of different mordants and dyes provides different color data even between the same dye when using different mordants (i.e. Lemon and Iron mordant).

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