Investigating the Antibacterial Properties of Woolen Yarn Dyed with Rosa Damascene Mill Residue Obtained from Kashan Rose Extract

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Introduction

Natural dyes are a group of dyes with high fastness with plant and animal sources which play effective roles in traditional dyeing. Eco-friendly nature, beautiful and attractive colors, and economic issues have resulted in the significance of using natural dyes, in spite of the production of various chemical dyes. One of the most important problems in using natural dyes instead of harmful chemical dyes is the huelimitation and sometimes the high cost of dyeing plants. Rosa damascene mill residue is a waste material that is produced and disposed of in a large volume during rose gleaning operations, which costs significantly for the rose gleaning industry of Kashan. Furthermore, the surface of textiles with natural fibers, including hand-woven carpets, in the presence of moisture and heat, is exposed to the growth and proliferation of bacteria, and this leads to problems in the durability, appearance and hygiene of the goods. In this research, in addition to evaluating the color characteristics and light fastness of wool dyed with aqueous and alcoholic extract of the rose water residue, the comparison of their antibacterial effects on two *Gram-positive Staphylococcus aureus* and *Gram-negative Escherichia coli* bacteria has also been investigated.

Materials and Methods

Rosa damascene mill residue, obtained from Kashan damask rose essential water extraction, was used as a dye. In addition, Iranian woolen yarn with a 4.5 metric number and 65 twists per meter were applied. Considering that the extraction of the effective substance in plants depends on the type of solvent used, three different solvents--water, ethanol, and methanol--were used to prepare rose petal extract; the aforementioned fibers were dyed with the extracted dyes using the simultaneous mordant method with the Aluminum and potassium double sulfate. Aqueous and alcoholic extracts were prepared by percolation and return methods in Soxhlet apparatus, respectively. For this purpose, dyeing bath with L: R=1:50 containing

natural fibers, 3% oxalic acid, 5% dentate and 30% dye was used. The dyeing processes for both baths continued for 90 minutes in Bain Marie device. Color parameters (a*, b*, L*), color strength (K/S), the reflectance spectrum (R) were performed by spectro-photometric method, and the antibacterial property of each dyed fiber was evaluated with aqueous, ethanolic, and methanolic dye extracts. On the other hand, the lightingfastness of the dyed fibers was measured according to the 2010 ISO 105-B01 standard by the blue standard. To measure the antibacterial property, 0.03 grams of each of fibers dyed with the desired dyes were soaked in 1500 microliters of serum containing Staphylococcus aureus and Escherichia coli bacteria for 24 hours. Then, by dilution method in plates, Nutrient agar was cultured and colonies were counted. Quantification of the active substance of rosa damascene mill residue (cyaniding diglucoside) in the extracts was done using HPLC analysis.

Results and Findings

The reflective spectro-photometric evaluations of the samples showed that the woolen yarn dyed with the aqueous and alcoholic extracts of the rose petals, obtained from rose extract, had positive a* and b* levels, which indicated the red and yellow undertones of the dyed samples. Among these, the reddest tone belonged to the sample dyed with the methanolic extract of the mentioned dye. The numerical results agree with the visual qualitative evaluations in the optical cabinet. The evaluation of the color strength of wool dyed with aqueous and alcoholic extracts of primary petals and the rose petals residue showed that the methanol extract of the dye could create the highest color strength on the wool fibers, which indicated the high percentage of the dye in this extract. In addition, the comparison of the color strength of the primary petal and the residue of the rose flower showed that the rose flower residue obtained from rose essential water extraction had the same color strength as the primary petal. Therefore, using it as a dye was more economical than the first flower petal. The evaluation of lighting fastness showed that the samples dyed with the ethanolic extract of the mentioned dyes had less paleness and more lighting fastness after light irradiation than the aqueous and methanolic extracts. However, in general, all four samples had acceptable lighting fastness. Antibacterial properties of aqueous, ethanolic and methanolic extracts of rose flower residue were measured by measuring the average diameter of the no-growth halo for two types of bacteria, Escherichia coli and Staphylococcus aureus. The results showed that the alcoholic extracts of rose petals, especially its ethanolic extract, showed more antibacterial power, which indicated the presence of higher amounts of effective phenolic and phenolic compounds in this extract. In addition, the calculation of the inhibition percentage of the growth of bacteria on the dyed fibers showed that although all the extracts used provided good antibacterial properties to the woolen yarn, the wool dyed with the ethanolic extract showed a significant inhibition percentage for both types of bacteria, because of the higher anthocyanin content of this extract. HPLC analysis showed a total number of four different anthocyanins: cyanidin 2-glucoside, anthocyanin delphinidin 3-glucoside, pelargoidin and malvinidin in rose petals, which were responsible for the red color and antibacterial properties of rose petals, which are in good agreement with scientific reports.

Conclusion

In this article, the comparison of the color characteristics and antibacterial properties of woolen yarn dyed with aqueous and alcoholic extracts of rosehip waste, obtained from rose water, was discussed. Spectro-photometric evaluations of the samples dyed with the waste extracts of the rose flower and the primary petal confirmed the red and yellow tones created. Also, the color strength of these two dyes did not show significant difference. Although anthocyanin dyes generally do not show high fastness, the light fastness of dyed samples with dye extracts was acceptable. The findings of this study suggest the use of the dye extracted from the waste of rose water as a suitable antibacterial dye on natural fibers, which can be effective in preventing and treating infectious diseases caused by Escherichia coli and Staphylococcus aureus bacteria. The reason for this is the presence of significant amounts of cyanidin diglucoside and phenolic compounds, flavonoids and tannins, which were proven by the phytochemical analyses carried out in this research.

Keywords: natural dyeing, wool, rosa damascene residue, antibacterial properties, cyanidin diglucoside.