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Antimicrobial and Antifungal Activity of Fabrics Dyed with *Viburnum opulus* and Onion Skins

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Abstract: Microorganisms such as bacteria and fungi can cause serious health and hygiene problems for this reason, products with antimicrobial activity gains importance day by day. As is known, textile products can also provide a suitable environment for the development of microorganisms. In this context, we aimed to develop textile products which can provide antimicrobial and antifungal effect. For this purpose, woolen fabrics were dyed with onion (*Allium cepa*) skins and juice of gilaburu (*Viburnum opulus)* plant fruit in our study. The dyeings were carried out without using of any mordanting agent and no prior extraction of the herbal sources was carried out in other words these natural dye sources (onion skins and juice of *Viburnum opulus* plant fruit) were directly added to the dye bath. Samples after dyeing with these natural dye sources were tested in terms of antimicrobial activity using two bacteria (*Escherichia coli*, *Enterobacter aeroginosa)* and a yeast strain (*Candida albicans*). Meanwhile the dyed samples were also investigated in terms of obtained colors. For this purpose, color measurement of the dyed samples has been managed and color efficiencies and color values has been collected. After the evaluation of the results, it was observed that onion (*Allium cepa*) skin and gilaburu (*Viburnum opulus*) fruit juice had an antimicrobial effect. While the dyed fabric with *Viburnum opulus* juice showed higher activity on bacterial strains, the onion skin had a higher effect on the yeast. *Viburnum opulus* provided the highest activity on *E. coli*, whereas onion skins showed the highest activity on *C. albicans*. Meanwhile it was observed that different colors can be obtained with the use of these tested natural dye sources

Keywords: Antimicrobial textiles, bacteria, biotechnology, fungi, natural dye.

1. INTRODUCTION

Natural dyes were used to colour a fiber or to paint. They may be found hidden in such diverse places as the roots of a plant, a parasitic insect and the secretions of a sea snail [1]. Textile materials used to be colored for value addition, look and desire of the customers. Anciently, this purpose of colouring textile was initiated using colors of natural source, until synthetic colors/dyes were invented and commercialized [2]. In this study gilaburu fruit and onion skin has been used for the coloration of wool fabrics and the anti-microbial/fungal activities of the dyed samples have been analyzed.

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Cranberry (*Viburnum opulus* L.), called gilaburu in the Middle-Anatolia region, especially Kayseri city, Turkey and European cranberry bush in English, belonging to the plant family of *Caprifoliaceae*, is widely distributed in Turkey [3]. Allium cepa is commonly called onions and the bulb comprises fleshy layers of modified leaves, surrounded by papery outer layers. Skin of Allium cepa which is a kitchen waste material can be used in natural dyeing of different textile materials [4].

Textile goods, especially those made from natural fibers; provide an excellent environment for microorganisms to grow, because of their large surface area and ability to retain moisture [5]. Growing awareness of health and hygiene has increased the demand for bioactive or antimicrobial textiles [6]. There is increasing interest in adding value to textiles by the use of natural products. Many of the plants from which natural dyes are obtained are, for example, also known to have medicinal properties [7]. It is easy to find different studies on the usability of natural dye sources for ensuring the antimicrobial efficiencies. For example, Davulcu et al. reported the antimicrobial efficiency of cotton fabrics dyed with thyme and pomegranate peel without use of any mordanting agent [8]. In another study, Singh et al. have studied on antimicrobial activity of different natural dye sources such as *Acacia catechu, Kerria lacca, Quercus infectoria, Rubia cordifolia and Rumex maritimus and* tested the antimicrobial efficiency of samples against some common pathogens. Finally they found different antimicrobial efficiencies against the tested pathogens [9].

In this context, the aim of this study was to investigate the antibacterial and antifungal effect of fabrics dyed with the onion skin and juice of gilaburu fruit. By this way it was planned to use a common waste “onion skin” and a regional plant “gilaburu”.

2. MATERIAL and METHODS

In the study woven wool fabrics, which were ready for dyeing processes and in the weight of 160 g/m^2, were used. As a natural dye source gilaburu (Viburnum opulus) plant fruits were provided from the local markets in Kayseri. Onion skins which are vegetable waste were selected as a second natural dye source. The dyeings were carried out without using of any mordanting agent and no prior extraction of the selected herbal sources were carried out. In the dyeing processes the juice of *Viburnum opulus* plant fruits and the milled onion skins were used (Figure 1).

The milled onion skins

Fruits of *Viburnum opulus* plant

Figure 1. Natural dye sources used in coloration of wool

In the dyeing processes of wool fabrics with the *Viburnum opulus* plant fruit, the juice of the fruits were obtained by squeezing the fruits, then for 2 g of textile material 100 ml of this juice was used as a dye bath so a liquor ratio of 1:50 has been obtained. For the dyeings with onion skins, the same amount of grinded onion skins with fabric were used and so for 2 g of textile material 2 g grinded onion skins was added to 100 ml of the bath containing only water to ensure the liquor ratio of 1:50. The dyeing process was carried out in a laboratory-type sample dyeing machine. The dyeing was started at 40°C for 10 minutes then the bath was

heated to 100°C and at 100°C dyeing was conducted for 1 hour. Afterwards, the dyed samples were washed and subsequently dried at room temperature.

In order to evaluate the obtained colors, the color efficiencies (K/S) and the color values (CIE L*a*b*) of the dyed samples were measured with Konica Minolta 3600d spectrophotometer and for visual evaluation the samples were scanned. Moreover the antimicrobial activities of the fabrics were tested too. For this aim the strains were cultured on appropriate media and incubated aerobically at 37°C overnight as detailed in AATCC 100/AATCC 147. *Escherichia coli*, *Enterobacter aeruginosa* and *Candida albicans* are strains used for antimicrobial susceptibility testing. Antimicrobial activity was evaluated by quantitative test methods. The 1 inch^2 fabric (dyed and undyed) was introduced in the 100 mL nutrient broth inoculated with the desired microbe and incubated at 37 °C overnight (16 h). The assay was performed in triplicate and the mean value was reported. The reduction of bacterial growth by dye was expressed as follows:

$$\% \text{ Reduction} = [(A-B)/A] \times 100 \quad \text{(Equation I)}$$

where A and B are the surviving cells (CFU/ml) for the flasks containing the control (blank wool fabric) and test samples (natural dyed wool fabric), respectively, after 18 hrs of contact time.

3. RESULTS and DISCUSSIONS

3.1. Evaluation of obtained colors after dyeing processes

For the evaluation of the obtained colors the CIEL*a*b* values of the samples and the images of the scanned samples were collected in table 1. As seen from the images of the samples onion skins and *Viburnum opulus* plant fruit juice based dyeings have given different colors. In the CIE L*a*b* space, L* indicates the lightness of the color; the colors with a* higher than 0 represent redness and those with a* lower than 0 greenness; b* higher than 0 indicate yellowness and b* lower than 0 indicate blueness [10]. In the light of this it can be easily told that the color after dyeing with onion skins were redder than the samples dyed with Juice of *Viburnum opulus* plant fruit. It was also confirmed from the images of the dyed samples.

Table 1. Colors of the dyed samples

Natural Dye Source	K/S	L*	a*	b*	c*	h*	
Onion (*Allium cepa*) Skins	22.93	40.8	21.16	27.71	34.87	52.63	
Juice of *Viburnum opulus* Plant Fruit	14.74	40.97	7.99	23.68	24.99	71.36	

3.2. Evaluation of antimicrobial activities after dyeing processes

Fabrics treated with natural dyes were screened for their antimicrobial activity against microorganisms. According to results of study, onion skin and *Viburnum opulus* fruit juice had an antimicrobial effect. The *Viburnum* juice inhibited the growth of *E. coli* by 3.19%, E. aeruginosa by 0.77% and *C. albicans* by 2.05%. On the other hand, the Onion has reduced the growth of *E. coli* by 0.52%, *E. aeruginosa* by 0.26% and C. *albicans* by 4.97%. While the dyed fabric with *Viburnum opulus* juice showed higher activity on bacterial strains, the onion skin

had a higher effect on the yeast. *Viburnum opulus* provided the highest activity on *E. coli*, whereas onion skins showed the highest activity on *C. albicans*.

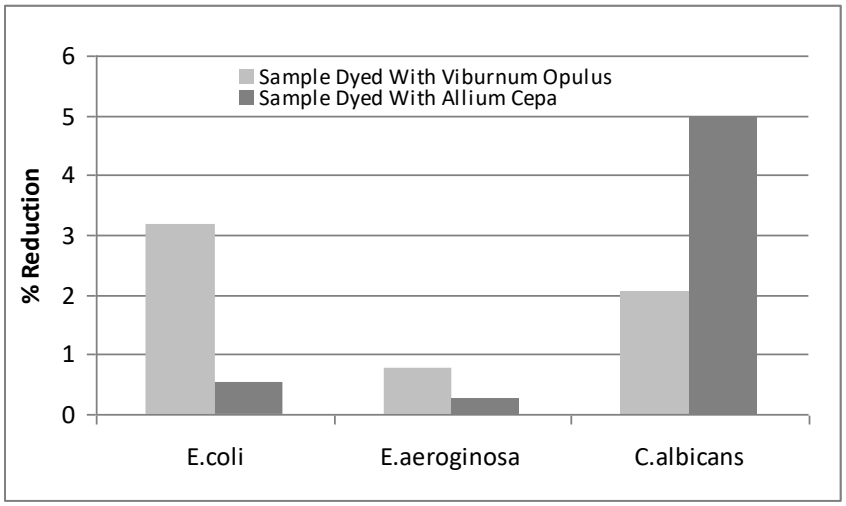

Figure 2. Antimicrobial activity of textile materials dyed with *Viburnum opulus and Allium cepa*.

4. CONCLUSION

Textile materials have an important place in human life and they can be constantly in contact with human body. For this reason the characteristics of textile materials also affect our life comfort. In this context antimicrobial textiles are becoming of interest. In this study wool fabrics were dyed with onion (*Allium cepa*) skins and juice of gilaburu (*Viburnum opulus*) plant fruit and the antimicrobial and antifungal activities of the dyed samples were tested. It was observed that the dyed fabric with *Viburnum opulus* juice showed higher activity on bacterial strains and the onion skin had a higher effect on the yeast. *Viburnum opulus* provided the highest activity on *E. coli*, whereas onion skins showed the highest activity on *C. albicans*. Meanwhile different colors were observed after the dyeings with the tested natural dye sources.

Conflict of Interests

Authors declare that there is no conflict of interests.

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