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Original Research

Eco-Friendly Dye of Olive Fruit Peel and Its Color Fastness Applications on Wool/Silk Fabrics

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Abstract

Most of synthetic dyes are toxic for the environment. On the other hand, natural dyes are eco-friendly and can replace synthetic toxic dyes. In the present studies, a natural dye was extracted from rinsed and grinded olive peel in 1:10 ratio (m/V) with water. Then, fabrics (wool and silk) were dyed with the peel extract by using different types of dulling and shining mordants ($FeSO_4$, $CuSO_4$, $CoSO_4$, $SnCl_2$, K_2SO_4, $Al_2(SO_4)_3$, $ZnSO_4$ and $NiSO_4$). The mordants have shown best results for wool at the acidic pH (4-5) and for silk at the basic pH (8-9). After dyeing wool (at 70-80ºC) and silk (at 100ºC) with olive peel extract, by simultaneous mordanting method, an interesting variety of beige, buff and khaki shades were obtained. Color fastness was noted by matching the dyed fabric color with grey scale. The colors of dyed fabric were again noted after its washing, pressing by iron, rubbing and light exposure. The fastness results were found quite satisfactory. The investigated procedure of natural dye extraction is eco-friendly, safe for the environment and a safe technique as it does not involve any organic solvent. The natural dyes can be satisfactory potential substitutes of the synthetic environmentally hazardous dyes.

Keywords: olive fruit dye, wool fabric, silk, shades, color fastness

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Introduction

Dyes are intensively colored compounds which are applied to substrates like fiber, cosmetics, paper, hair, etc. to give a specific color [1]. Synthetic dyes are detrimental for health and have some hazardous impacts on the environment as well [2, 3]. Natural dyes have emerged as an eco-friendly solution to the textile industries [4, 5] due to their diverse shades on textile fibers [6] and fabric [7]. They can be extracted from natural resources like plants [8, 9], herbs [10], fungi [11], lichens [1], minerals [12], insects [12] and different tissue cultures of animals [13, 14]. From plant resources, dyes are obtained from their roots, barks [12], leaves [15], berries, fruits [16], flowers [1]. Non-toxicity, non-carcinogenic behavior, renewability, accessibility and non-allergic behavior and bio-degradability are some of the qualities associated with the natural dyes [17]. Natural dyes also demonstrate antimicrobial and medicinal effects [18]. Due to their eco-friendly nature, dyes were extracted from a large number of plant resources and were then applied to textile items [7, 19]. In a study [20], peel of pomegranate was used for the extraction of natural dye which was applied on the cotton by using pre-mordanting, simultaneous-mordanting and post-mordanting substances. Dyes have also been extracted from olive leaves and beta vulgaris for their applications to the textile products [21]. *Rubia cordifolia* contains organic reddish orange dye in its roots, stem and leaves and was used for dying of cotton in a study [22]. Research was conducted on the bark of *Macaranga peltata* for yellow color extraction which showed an appreciable color fastness [23]. Natural dye from neem is proved to be efficient in color and has commercial importance [24]. The dyes extracted from mango peel and mango leaves has shown some excellent color fastness values on cotton fabric [25]. Distilled water and alkaline water were used to extract a natural dye from Henna leaves. Alkaline medium extracted dye was found to be more efficient as compared to the distilled water medium. [26]. In another study, colorants were extracted from nine different plants (Cochineal, *Rubia tinctorum*, Alkanna, Henna, Brazil wood, Red sandal, Safflower, Indigo and Logwood) and were then applied to dye cotton and wool fabric by using different mordants [27].

In a nut shell, plants find an important value because of their eco-friendly nature [28, 29], and nutritional [30, 31] and pharmaceutical value [32-34]. *Olea europaea L.* (olive) is a famous commercial crop [35, 36] due to its therapeutic and nutritional potential [37, 38] and is frequently cultivated worldwide including Spain, Italy, Tunisia, Turkey, Greece, Portugal, Morocco, Argentina [35], Iraq [39] etc. The plant contains flavonoids, flavanones, benzoic acid derivatives, iridoids, isochromans and many other metabolites [40]. The natural dye was extracted from the wasted leaves of olive plant and was later applied on cotton fabric to show antibacterial finishing effects [41]. It was also tested on cotton fabrics woven with handmade yarns by using 3 different mordant materials. The study concluded that dyeing with citric acid mordant (10%) gave the best fastness values [42]. Current studies were performed to develop a method for the extraction of a natural dye from the olive fruit peel. The obtained dye was used for coloring of wool/silk fabrics and its color fastness was also studied. The opted procedure for the extraction of dye is eco-friendly and does not involve an addition of hazardous chemicals. The results show a promising potential of these eco-friendly dyes to replace the synthetic environmentally hazardous dyes.

Experimental

Materials

Dried olive peel was obtained from the Sargodha Farmhouse and identified by Department of Biology, Lahore Garrison University Lahore, Pakistan. It was ground for further use. Two kinds of fabric i.e., silk and wool were used for to study the application of that extracted dye**.** Inorganic mordants i.e., ferrous sulphate, copper sulphate, cobalt sulphate, stannous chloride, potash alum, nickel sulphate and zinc sulphate were supplied by Pakistan Council of Scientific and Industrial Research (PCSIR).

Extraction of Colorant

Before extraction of natural dye, the chopped olive peel was soaked in water in 1:10 ratio (m/V) for 36-46 h at room temperature. Then, the water and olive oil mixture were boiled for 3-4 hours and filtered with the help of filter paper while hot to obtain the dye extract. The pH was maintained at 8 for silk and 4-5 for wool fabric.

Dyeing of Fabric

A simultaneous mordanting procedure was used for dyeing the fabrics, where the fabrics were treated with mordants for 45 minutes. The temperature was maintained at 60-80ºC for wool dyeing and 100ºC to dye the silk fabric. Liquor to goods ratio was 20:1. Extracted dye was used to color the fabrics. After completing the dyeing process of the fabric, these fibers were further processed for testing the fastness and quality of color through washing, light exposure, rubbing and ironing.

Results and Discussion

A natural dye was extracted from the rinsed and grinded olive peel in 1:10 ratio (m/V) with water. Inorganic mordants (ferrous sulphate, copper sulphate, cobalt sulphate, stannous chloride, potash alum, nickel sulphate and zinc sulphate) were applied to extend

Table 1. Results after light/wash/iron pressing/rubbing treatments of dyed wool/silk.

Sr. #	Samples	After light (41ºC) exposure for 24 hrs.		After washing with water (3 times)		After iron pressing		After rubbing			
								Wool		Silk	
		Wool	Silk	Wool	Silk	Wool	Silk	Dry	Wet	Dry	Wet
1.	Without mordant	4.5	3.5	4.5	4	4.5	4.5	4.5	4.5	3	4.5
2.	Zinc sulphate	5	4	3.5	4	5	4	5	5	3	4.5
3.	Ferrous sulphate	4.5	4.5	3	4	5	3.5	5	4.5	3.5	5
4.	Cobalt sulphate	5	4.5	4	3.5	5	4.5	3.5	3.5	3	4
5.	Potash alum	4.5	4.5	3.5	4	4.5	4	4.5	4.5	3.5	4
6.	Stannous chloride	4.5	4.5	4.5	3.5	4.5	4.5	4.5	4.5	4	4.5
7.	Nickel sulphate	5	4	3.5	4	4.5	4	4.5	4.5	3.5	4
8.	Copper sulphate	4.5	4.5	3.5	4.5	4.5	4.5	4.5	4.5	4	4.5

the variety of shades. The materials (cotton and wool fabrics) were colored with the brown dye of olive fruit peel. Next, the fabrics were tested for color fastness to exposure of light, iron pressing, rubbing and washing. The colorant was applied on wool and silk with or without mordants and the results were compared. The fastness properties were evaluated by using gray scale which is a scale of shades from black (dark) to white (light). Black and white colors were given arbitrary values of "9" and "1", respectively. This scale measures the intensity of the color or change in intensity of a color after testing. Gray scale measurements are commonly used in imaging and color technology [43]. In general, gray scale is the parameter or tool that measures the variation in color shades after the application of different fasting tests. We compared the color of the fabric with the gray scale before and after dyeing with extracted colorant. The obtained results have been summarized in Table 1 and graphically represented in Fig. 1.

After dyeing the fabric, an interesting variety of beige, buff and khaki shades was obtained. The inorganic mordants (like iron sulphate, stannous chloride, copper sulphate and cobalt sulphate) to extend the variety of shades showed variable results with interesting variety of shades. The mordants develop a kind of bonding with phenolic acids present in the olive fruit peel. Especially, the fabrics dyed in presence of mordants have shown best results for wool at the acidic pH (4-5) and basic pH (8) for wool and silk, respectively. Before evaluating fasting properties, the obtained colors/shades were given arbitrary value of 5 on gray scale. The dyed silk and wool fabrics were subjected to light, iron pressing, rubbing and washing to check the quality, efficiency (fastness) and strength of the extracted dye and the colors/shades were again noted. There were only slight changes (reduction) in colors in few cases where color was faded up to 3.5 as compared to the original 5 value; in most cases the colors remained the same (5 or 4.5) as shown in Table 1.

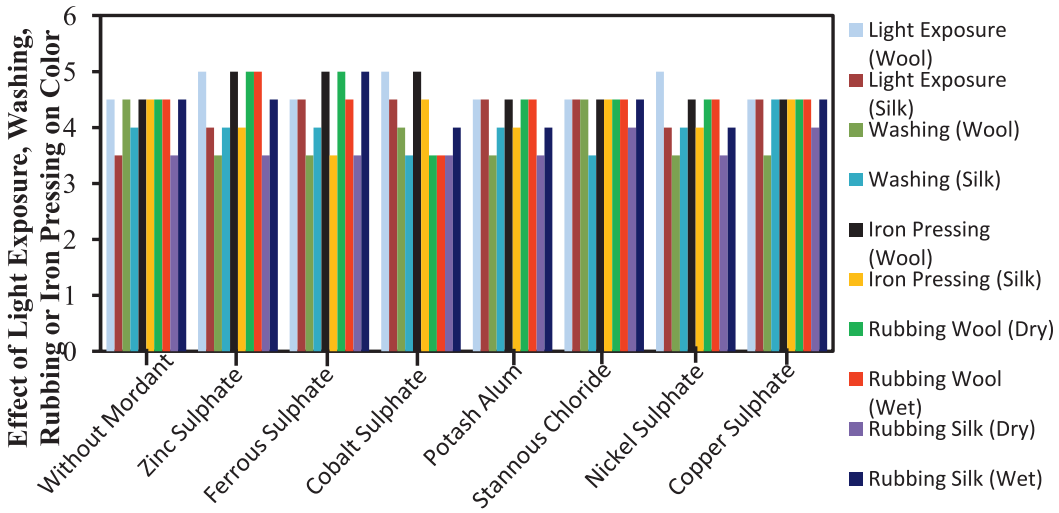

Fig. 1. Graphical representation of color change upon light exposure, washing, rubbing or iron pressing of dyed cloth.

It is obvious from the data that wool and silk are resistant to changes in shades after undergoing different fasting tests. In the presence of investigated mordants (ferrous sulphate, copper sulphate, cobalt sulphate, stannous chloride, potash alum, nickel sulphate and zinc sulphate), the fabric shows almost no change in the gray scale value before and after undergoing fastness tests (Table 1).

It can be demonstrated from Fig. 1 that there were no significant changes in colors/shades even when dyed materials were exposed to sunlight or underwent washing/rubbing/pressing. Moreover, better results are obtained in cases of some mordanted dyed materials as compared to non-mordanted dyed materials. Generally, wool has displayed better results as compared to silk as indicated by nine longest bars out of total nine (longest) in graph (Fig. 1). Superb results were obtained in case of wool dyed in the presence of zinc sulfate, cobalt sulfate and nickel sulfate (mordants), which showed no change in color when it was exposed to sunlight; the fabrics dyed in presence of in the presence of zinc sulfate, cobalt sulfate and ferrous sulfate (mordants) have also shown same kinds of results (outstanding) after iron press testing. As far as, the rubbing fastness results are concerned (Fig. 1, Table 1), dying in presence of ferrous sulfate mordant gives exceptional results for dry wool and wet silk whereas dying with zinc sulfate mordant gives most superb results for dry wool and wet wool. Current studies demonstrate that olive natural resources potentially find a prodigious worth in textile pigmentation. The ground peel of the olive fruit is an important source of natural dye that can be applied on silk and wool to yield promising results of dye shades; it finds excellent ability to produce stable and persistent brown shades on both kinds of fabric (i.e., wool and silk) in the presence/absence of mordants. In addition, mordants demonstrated very good shades on fabrics.

Natural dye extraction is an eco-friendly safe method. In addition, the natural dyes can be used as antibacterial, decolorizing and UV-protection agents as well as colorants for food products. Many scientific studies have shown that natural dyes are as good as synthetic dyes for coloring purposes [44]. However, they have several advantages over the synthetic dyes because the preparation of synthetic dyes involves the addition of toxic, and hazardous intermediates.

Conclusions

The olive fruit peel may be used as a good source of natural brown dye for textile pigmentation. The obtained dye can be applied on silk and wool to give them good shades. A simultaneous mordanting dyeing process was used in which different mordants like iron sulphate, stannous chloride, copper sulphate and cobalt sulphate were applied. The mordants have shown appreciable shades on fabrics. The colors of fabrics (wool and silk) are not faded after dying them with natural dye from olive fruit peel even when the dyed material is subjected to prolonged light exposure, washing, pressing by iron and rubbing. The opted procedure is eco-friendly since it does not involve any outside addition of toxic chemicals.

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Conflicts of Interest

The authors declare no conflict of interest.

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