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DYEING PROPERTIES OF NATURAL DYE EXTRACTED FROM PUNICA GRANATUM BARK.

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ABSTRACT

Natural dyes being biodegradable, compatible and generally nontoxic and non-allergic to the skin are getting great attention now a days. Furthermore, these are easily available in almost all the parts of the world. A natural dye was extracted from *Punica granatum* bark in aqueous medium and was used to dye the scoured cotton by direct dyeing method. Dye extraction was carried out by soaking the material for one night and following boiling at 100^0C with stirring for 100 minutes. Three mordants; alum, ferrous sulphate, and oxalic acid, (1%, 2% & 3%) were applied for dyeing which act as electron acceptor for the electron donor dye molecules and form co-ordinate covalent bond rendering them suitable for the dyeing process. Dyeing was carried out at 95^0C for 30-35 minutes and color fastness properties at rubbing, perspiration and in light were assessed. The dye has good saturation on cotton fabrics without mordants and excellent results with oxalic acid mordant were obtained. Our study shows that natural dye obtained from pomegranate bark can provide good bright hues and color fastness properties. This can serve as a rich source of raw material for dyeing of cotton fabric in future.

KEYWORDS: Pomegranate, Natural dye, Mordant, Oxalic acid, Grey scale.

INTRODUCTION

Dyes are substances with considerable coloring capacity which are widely employed in the textile, pharmaceutical, food, cosmetics, plastics, photographic and paper industries.[1–4] The dyes can adhere to compatible surfaces in solution by forming covalent bond or complexes with salts or metals by physical adsorption or by mechanical retention.[1,2] Dyes are classified according to their application and chemical structure. The chromophores are responsible for the dye color which includes azo, anthraquinone, methine, nitro, aril-methane, carbonyl and

others. In addition, electrons withdrawing or donating substituents generate or intensify the color of the chromophores are known as auxochromes which include amine, carboxyl, sulfonate and hydroxyl.[5-7] It is estimated that over 10,000 different dyes and pigments are used industrially and over 7x 10^5 tons of synthetic dyes are annually produced worldwide.[8,9] Textile materials such as fiber, yarn, fabric, fabric construction and garment can be dyed using batch, continuous or semi-continuous processes.[10]

Increased environment and health hazards associated with the synthesis, processing and use of synthetic dyes has created a worldwide concern in textile industry.[8] In the textile industry, up to 200,000 tons of these dyes are lost to effluents every year during dyeing and finishing operations, due to the inefficiency of the dyeing process.[11] Un-fortunately, most of these dyes escape conventional wastewater treatment processes and persist in the environment as a result of their high stability to light, temperature, water, detergents, chemicals, soap and other parameters such as bleach and perspiration.[12] In addition, anti-microbial agents resistant to biological degradation are frequently used in the manufacture of textiles, particularly for natural fibers such as cotton.[13,14] The synthetic origin and complex aromatic structure of these agents make them more recalcitrant to biodegradation.[15]

Awareness about negative impact of synthetic dyes, leads the increased demand of natural dyes in food, pharmaceutical, cosmetic as well as textile industry. Natural dyes are mostly eco-friendly, bio-degradable, less toxic and less carcinogenic as compared to the synthetic dyes.[16-18] Inspite of such advantages of natural dyes over the synthetic dyes the use of the former is still very limited. A lot of research work is being carried out on the application of natural dyes (1-10). Most of the natural dyes have no substantivity for the fiber and are required to be used in conjunction with mordants. A mordant, which is usually a metallic salt, is regarded as a chemical which can itself be fixed on the fiber and it also combines with the dyestuff. By this way a link is formed between the fibers to be fixed. Mordants improve the up-take quantity of the fabric and help improve colour and light fastness.

The present study is concerned with the extraction of dye from pomegranate bark and its application on cotton fiber in endeavor to investigate extraction and its application to attain desirable fastness properties.

2. MATERIALS AND EQUIPMENT

2.1 Instruments

D400 IR dyeing machine (SDL Atlas England) Lauderometer (Roaches), Perspirometer kit (SDL Atlas England), Hot air oven, Weatherometer (SDL Atlas England), Multifiber.

2.2 Chemicals and reagents

Detergent ECE (without optical brightener), sodium per borate, 1-histidine monochloride monohydrate, sodium dihydrogen orthophosphate, distilled water, sodium carbonate, sodium hydroxide, acetic acid and sulphuric acid. (All the chemicals and solvents used were AR grade).

2.3 Extraction and preparation

Pomegranate bark was collected from local fruit farm, it was washed thoroughly with water and dried at ambient conditions under shade for ten days to remove the moisture contents. The dried bark pieces were then crushed into powder form and sieved through a 22 mesh size strainer. The dried powder obtained was used for the process of extraction.

2.3.1 Dye Extraction/optimization of extraction conditions

Extraction of dye from the *Punica granatum* bark powder was carried out at 100ºC for 100 min with continuous stirring.

2.4 Dyeing of Cotton

The detailed dyeing procedure is given in the literature.[16-18] Two methods of dyeing was used i.e dyeing without using a mordant and dyeing with a mordant.

2.4.1 Dyeing without a mordant

The cotton fabric was dyed at a liquor ratio of 30:1, in the dye bath. The temperature was raised to 95^0C for 30 mints. The dyeing was carried out in the bath of dyeing machine. The dyed fabric was rinsed with water after taking them out of the bath after the stipulated time.

2.4.2 Dyeing with mordant

Meta-mordanting method (i.e. dyeing in the presence of mordant) was used to dye the cotton fabric. In this dyeing method the cotton fabric were immersed in a dyeing bath containing mordant solution and the dye extract and the dyeing bath was maintained at 95^0C for 35 min. the fabric was rinsed three times with water , squeezed and dried. After dyeing, excess dye was removed from the dyeing by rinsing three times with cold water.

2.4.4 Fastness testing

Wash fastness of the samples dyed under the optimised conditions was tested according to the standard methods. The results are shown in table. No. 1, 2 & 3.

Table-1: Colour Fastness to Rubbing properties of the dye obtained from *Punica granatum*.

Control Natural	Mordant Conc.	Rubbing Fastness			
		Dry Rubbing	Wet Rubbing	Dry Rubbing	Wet Rubbing
Control Natural	Nil	4	3-4	4	3-4
Alum	1 %	4-5	4	4-5	3-4
	2%	4-5	4	4	3-4
	3%	4-5	4-5	4-5	4
Oxalic Acid	1%	4-5	4	4-5	4
	2%	4-5	4-5	4-5	4
	3%	4-5	4-5	4-5	4
Ferrous sulfate	1%	4-5	3-4	4-5	4-5
	2%	3-4	3-4	4-5	3-4
	3%	4-5	4	4	4

Table-2: Colour Fastness to Perspiration properties of the dye obtained from *Punica granatum*.

Control	Mord. Conc.	Alkaline (Staining)	Acidic (Staining)	Change in colour
Control Natural	Nil	4-5	4-5	4
Alum	1%	3-4	4	4-5
	2%	4-5	4-5	3-4
	3%	4-5	3-4	4-5
Oxalic Acid	1%	4-5	4-5	4-5
	2%	4-5	4-5	4-5
	3%	4-5	4-5	4-5
Ferrous sulfate	1%	4-5	4-5	3-4
	2%	3-4	3-4	4-5
	3%	4-5	4-5	4-5

Table-3: Colour Fastness to Light properties of the dye obtained from *Punica granatum*.

Control	Mord. Conc.	Stained	Stained	Change in shade
Control Natural	Nil	4	4	2-3
Alum	1%	3-4	4	3
	2%	4-5	3-4	3-4
	3%	3-4	4-5	4
Oxalic Acid	1%	4-5	4-5	4-5
	2%	4-5	4-5	4-5
	3%	3-4	3-4	3-4

Ferrous sulfate	1%	3-4	3-4	4
	2%	4-5	3-4	3-4
	3%	3-4	4-5	2-3

3. RESULTS AND DISCUSSION

The dye was extracted from the bark of *Punica granatum* by soaking for overnight and then boiling at 100^0C for 100 minutes with continuous stirring. It may be attributed to the softening of the cell wall because of soaking, which may have resulted in the release of impurities along with the colouring component during extraction. The natural dye from pomegranate is substantive to cotton and can be applied using suitable mordant either natural or synthetic to improve the dye quality on the fabric.

Different mordants of concentrations 0.1 M with 1%, 2%, 3% oxalic acid, 0.1 M alum with 1%, 2%, 3% and 0.1 M $FeSO_4$ with 1%, 2%, 3% were used for dyeing cotton fabric by meta-mordanting method with pomegranate bark dye. Application of different mordants not only increases the depth of shade but also changed the colour of the dye because in meta-mordanting method process of dyeing most of the dye is absorbed on the fabric.

The results of fastness studies of cotton fabric dyed with original dye and meta-mordant treated dyed fabrics are given in Tables 1, 2, and 3. The control fabrics dyed with pomegranate gave (2-3) rating which is satisfactory but after meta-mordanting dyeing, the rating of fastness properties was excellent. When oxalic acid was used as mordant with concentration of 1%, 2%, 3% the shade were bright and intense with excellent rating of 5. Whereas alum and Ferrous sulphate mordants gave best rating (4-5) on cotton fabrics.

Table 1, 2 & 3 show the fastness properties of the cotton sample dyed under optimized conditions. As can be seen from the results the dye has fairly well to moderate fastness properties. Washing and light fastness properties are comparable with the commercially available direct and sulphur dyes. Dry rubbing fastness is quite good. Similar findings have also been reported by Shahid et al, 2009, but they have used different mordant like potassium chloride, sodium sulfate and sodium chloride.[19]

4. CONCLUSIONS

The natural dye extracted from *Punica granatum* bark was applied on cotton fabrics by using different mordants. The subsequent application of this dye shows good results when used with different mordants and it enhanced the effectiveness of colour fastness quality. The

colours are intense and permanent. The dye has good saturation on cotton fabrics without mordants and excellent results with oxalic acid mordant. The dye is environment friendly, non-carcinogenic, non-allergenic. Our study shows that natural dye obtained from *Punica granatum* bark can provide good bright hues and colour fastness properties. This can serve as a rich source of raw material in future.

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