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Optimization of Procedure for Dyeing of Cotton Fibers with *Rhododendron Arboreum* Flowers Using *Symplocos Racemosa* Leaves as Mordant

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ABSTRACT

Uttarakhand is marked by a rich biodiversity and diverse natural products. Henceforth one such highly useful natural product is dye. Traditional users of the state have been using several plants for dyeing of fibres. Flowers of Rhododendron arboreum, the state tree, offer a potential source of natural dye. In the present paper, an attempt has been made to extract natural dye from R.arboreum flowers and to optimize conditions of concentration and time for dyeing cotton sample from the extracted dye. Also, dyeing procedure was optimized by using Symplocos racemosa leaves as mordant.

Keywords: Natural dye, *Rhododendron arboretum*, *Symplocos racemosa*, Mordant, %absorbance.

INTRODUCTION

One of the important species of the genus Rhododendron is *Rhododendron arboreum* best known for its graceful flowers. The plant bears flowers in the months of March-April. The flowers of *R. arboreum* show variety in colour ranging from a deep scarlet to red with white markings, crimson to pale pink or white. The flower offers a spectacular sight when in full bloom as it bears upto 20 blossoms in a single truss. The bright red forms of this species are reported to be found at the lower elevations. The flowers are showy, red in dense globose, cymes [1]. The calyx is fine-cleft while the corolla is tube spotted funnel-shaped .The stamens are hypozygnous declining; the anthers are ovate and the style is capitates [2].

The dried flowers of *R. arboreum* are supposed to be highly efficient in checking diarrhea and blood dysentery [3]. The flowers which are sweet and sour in taste are used in preparing squash, jam, jellies and local brew. The acid-sweet fresh and dried corolla is prescribed when fish bones get struck in the gullet [4]. The squash of the flowers is used in the treatment of mental retardation [5,6]. An alcoholic (50%) extract of the flowers lowers blood pressure in dogs and albino rats. Apungent aromatic oil is obtained from the flowers.

Recently dye from the flowers of *R. arboreum* has been reported by Purohit et.al [7]. Use of leaves of the plant as mordant in combination with lemon juice has also been reported [8]. Many species in the genus Symplocos contain alum and can be used as mordants in dyeing [9]. As for *Symplocos racemosa* the bark and the leaves are used in dyeing and a yellow dye is extracted from both. The bark is mainly employed as

an auxiliary or mordant in dyeing with *Morinda tinctoria*, *Caesalpinia* and *Butea monosperma*. It is also a chief ingredient of the red powder- 'abir' used in Holy. The bark also finds use in calico-printing and dyeing leather. The yellow dye extracted from the leaves is used for dyeing silk in combination with other plants.

This paper aims at finding the optimum conditions of concentration, time and mordanting method for dyeing of cotton with *Rhododendron arboreum* flowers using *Symplocos racemosa* leaves as mordant.

MATERIALS AND METHODS

Collection of plant material: The flowers were collected in early April from the hills of Khandyusain, Pauri at an elevation of 1700m.

Textile Preparation for Dyeing: Cotton has been selected as the dyeing fiber for the present study. Before dyeing, the textile underwent the following processes:

Soaking: A thoroughly wet textile dyes well. As such, cotton was soaked in the tap water for about 12 h to get rid of the water soluble impurities.

Scouring: This process involves cleaning of textile with hot water and neutral soap to allow uniform dyeing. Cotton is scoured to remove natural waxes and to soften the fibers. The cotton fabric was boiled in a solution of soapy water and a little amount of washing soda and boiled for about two hours. After this the material was soaked in the soap bath overnight and then rinsed in hot water.

Determination of Rate of Exhaustion or Percentage Absorbance: The UV-Visible Shimadzu spectrophotometer (Model UV-1601) was used in determining the O.Ds (Optical Densities) or Absorbance of the dye bath before and after dyeing. In each case, distilled water was used as the blank to calibrate the instrument to zero absorbance. While using the instrument it was ensured that the wavelength was set to the maximum wavelength (i.e. wavelength of maximum absorbance λ_{max}) of the dye used at that point.
The Rate of Exhaustion or Percentage Absorbance was calculated as follows:

$$\textbf{Rate of Exhaustion (\%)} = \left[\frac{D1-D2}{D1}\right] \textbf{x100}$$

where D1 = O.D. before dyeing; D2 = O.D. after dyeing ; D1-D2 = amount of dye transferred into the fabric after dyeing

Optimization of Dyeing Procedure: For the present study, three parameters were taken into consideration-

Optimum concentration of dye: 10 g of *R. arboreum* flowers were soaked in varying volumes of hot water (200 mL, 400 mL and 600 mL each for 1 h) and heated for a fixed time period (30 min). After this, the solution was filtered and Optical Density (O.D.) of the filtrate was measured. Then the cotton fabric

was dipped in the solution for 30 min (Dyeing time = 30 min). The dipped fabric was then taken out of the solution, squeezed and spread to dry followed by the measurement of the O.D. of the remaining solution. Using the above formula, percentage absorbance or rate of exhaustion was derived in each case. The concentration of dye corresponding to maximum percentage absorbance was finalized as the optimum concentration for each sample.

Optimum time: Optimum concentration (as determined in the previous step) was heated for different time intervals and filtered. The O.D. of the filtrate was determined. Thereafter, the cotton fabric was soaked in the solution for 30 min, after which it was taken out, squeezed and spread to dry. Then the O.D. of the left solution was determined and percentage absorbance or rate of exhaustion was derived in each case. The value of time corresponding to maximum percentage absorbance was taken as the optimum time for each sample.

Mordanting method: After getting the optimum concentration and time of the dye, the cotton fabric was subjected to all the three types of mordanting (Pre-, Post- and Simultaneous).

Pre-mordanting: In this case, the selected fabric was first dipped and heated for 10 min in the mordant solution and then dipped in the dye solution and heated further for another 10 min. The fabric was taken out and spread to dry. The O.D was measured before and after dyeing.

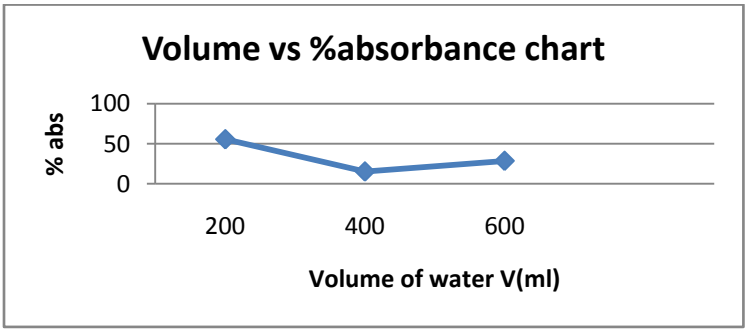
Post-mordanting: In this case, the selected fabric was first soaked and heated in the dye solution and then in an equal volume of mordant solution for 10 min each. The fabric was taken out and spread to dry. The O.D. was determined before and after dyeing.

Simultaneous mordanting: Equal volumes of the dye and mordant solutions were mixed together and the fiber was dipped in this. The solution was heated for 20 min. The fabric was taken out and spread to dry. O.D. was measured before and after dyeing.

Optimization of concentration of dye material: The values are presented in table 1 and fig 1

Table 1: Determination of optimum concentration
V = volume of hot water taken for 10 g flowers
C = Concentration of solution = weight of flowers/volume of hot water taken=10/V
λ_{max} : 238 nm

Sample	V(mL)	C(g mL^{-1})	D1	D2	D1 – D2	% abs.
S-200	200	0.05	3.980	1.768	2.212	55.570
S-400	400	0.025	3.311	2.808	0.503	15.190
S-600	600	0.016	3.931	2.808	1.123	28.560



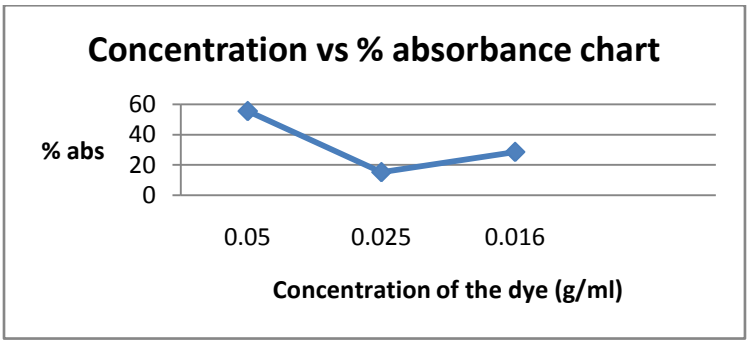
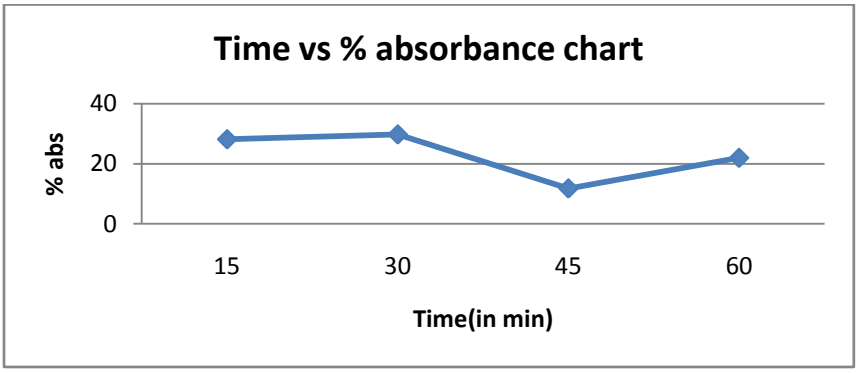


Figure 1

Optimization of Time: The cotton sample (S-200 for cotton) was heated for 15, 30, 45 and 60 min and then dyed for 30 min. O.D. was measured in each case to get the optimum time for dyeing cotton samples and the values are given in table 2 and results are shown in fig. 2.

Table 2: Determination of optimum time for dyeing cotton λ_{max} = 238 nm

Sample	Time(min)	D1	D2	D1-D2	% abs
C-15	15	3.704	2.660	1.044	28.185
C-30	30	3.980	1.768	2.212	55.570
C-45	45	3.068	2.706	0.362	11.799
C-60	60	3.215	2.508	0.707	21.99



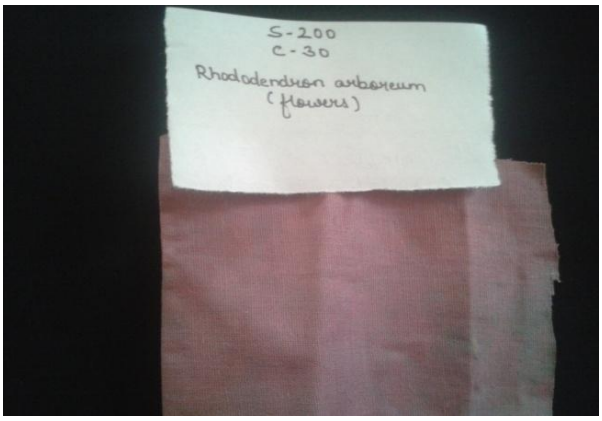
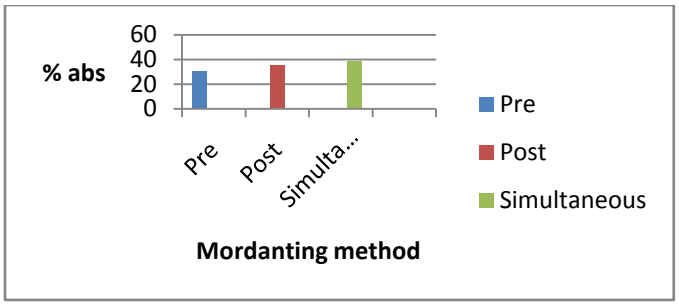


Fig. 2 *R.arboreum* (flowers): 200 mL, 30 min

Optimization of Mordanting Method: The results are given in table 3 and shown in fig 3.

Table 3: Mordanting of cotton with *S. racemosa* leaves
Fibre : Cotton, **Dye :** *R.arboreum* flowers, **Mordant :** *Symplocos racemosa* leaves, λ_{max} = 416 nm

Type of Mordanting	D1	D2	D1-D2	% abs	Shade obtained
Pre	3.913	2.721	1.192	30.46	Pale yellow
Post	3.913	2.537	1.376	35.16	Pale yellow
Simultaneous	3.913	2.420	1.493	38.15	Golden yellow



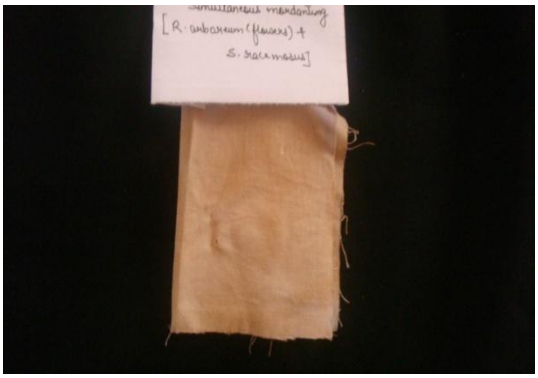


Fig.3. *R.arboreum*(flowers)+*S.racemosa*(leaves): Simultaneous mordanting

RESULTS AND DISCUSSION

On the basis of what has been depicted in the related tables and charts, the following results were obtained. It is clear from table 1 that the cotton sample corresponding to S-200 gave maximum percentage absorbance. It implies that the optimum concentration of *R. arboreum* flowers for dyeing cotton is 10g 200 mL^{-1} hot water or 0.05 g mL^{-1}.

Table 2 makes it clear that sample C-30 (Fig.2) showed maximum percentage absorbance. Thus, for dyeing cotton 10g of flowers per 200 mL hot water extracted for 30 min gave the best result. For dyeing cotton simultaneous mordanting (Fig 3) was found to be the best method using ***S. racemosa*** **leaves** as mordant (Table 3). Thus, the above dyeing procedure was optimized as follows- Optimum concentration of the dye: 0.05 g mL^{-1}, Optimum time of extraction: 30 min, Optimum mordanting method: Simultaneous mordanting method.

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