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Full Length Research Article

ANALYSIS OF DIFFERENT CHEMICAL DYES ON FABRICS BASED ON THEIR DYEING PROPERTIES

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ABSTRACT

Dyes are coloured substances which can adhere to the surface of material and are used to give colour to paper, food stuffs and various textiles such as cotton, wool, synthetic fibre, silk etc. Dyeing of textiles has been practiced for thousands of years. The present work focuses on dyeing of cotton and wool by dyes like malachite green and vasantha colour. Also the dyeing properties of cotton without using the mordant is also analysed.

INTRODUCTION

A dye can generally be described as coloured substances that have affinity to the substrate to which it is being applied. The dye is generally applied in an aqueous solution and may require a mordant to improve the fastness of the dye on the fiber. Example for dyes used are Alizarin, Congo red, Indigo etc (Bahl *et al*., 1987). Chemically a dye contains:

- Chromophore [such as azo, indigoid, triphenylmethyl, anthraquinone etc.] which is responsible for the colour of dyes. They are capable of absorbing light in the near ultraviolet region.
- Auxochrome [such as $–NH_2$, $-SO_3H$, -COOH etc.] which forms stable chemical bonds in acidic or basic medium. They stick to the fibre by formation of some salts. A chromogene without an auxochrome can never act as dye (Sharma, 2012).

Both dyes and pigments appear to be coloured because they absorb some wavelength of light preferentially. In contrast with a dye, a pigment is generally insoluble, and has no affinity for the substrate. The dyed fabrics appear to be coloured because a particular dye absorbs radiation of some specific wavelength from the visible region of electromagnetic radiation which fall on its surface. The remaining radiation that is the complementary colour of the light is reflected. The colour which we observe is due to the reflected light. For example: if a dye absorbs light in the wavelength region corresponding to red (605nm-750nm) it would appear blue-green which the complementary colour of red (Abrahart, 1977). There are many kinds of dyes, which include acid dyes, basic dyes, direct dyes, mordant dyes and vat dyes. This classification is based on their structure and mode of dyeing action (Ukoha *et al*., 2001 and Aspland, 1997). Chemical structure of some common dyes are given below (Gregory, 1986).

The present work focuses on fastness of various fabrics to dyes. The dyeing property depends on the chemical nature of the cloth, constitution of the dye material and the presence of mordant along with the dye material. Here we have selected cotton and wool as the cloth materials and malachite green and vasantha dye are the dyes selected. The results of this study have extensive applications in cloth, leather, paper and jute industry.

MATERIALS AND METHODS

Sodium Carbonate (Na_2CO_3), Tannic acid and Malachite green dye were purchased from Spectrum chemicals. Wool cloth and cotton cloth were purchased from textile shops.

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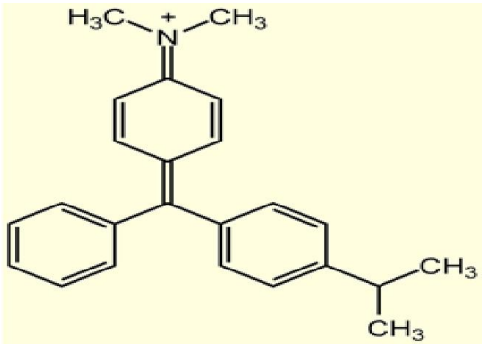


Fig. 1. Structure of Malachite green

Fig. 2. Structure of Alizarin

Fig. 3. Wool dyed in malachite green dye

Fig. 4. Cotton dyed in malachite green dye (Reference sample) (Reference sample)

PROCEDURE

1. Preparation of Na_2CO_3 solution Take about 0.5 g of solid Na2CO3 and dissolve it in 250ml of H2O.
2. Preparation of Tannic acid solution Take 100 ml of H_2O in a beaker and add about 1 g of tannic acid to it. Heat the solution. On heating clear solution of tannic acid is obtained.
3. Preparation of Dye solution Take about 0.1 g of Malachite green dye and add to 400 ml of H_2O. On warming clear solution of dye results.
4. Dyeing of Wool or silk Take about 200ml of dye solution and dip it in the woolen cloth to be dyed. Boil the solution in about 2 minutes after that remove the cloth and wash it with hot water 3 to 4 times, squeeze and keep it for drying.
5. Dyeing of Cotton (Alderman, 1985; Kulkarni, 1986 and Olden *et al*., 2008) Cotton does not absorb Malachite green readily. Therefore it requires the use of mordant. For dyeing a cotton cloth, dip it in Na_2CO_3 solution for about 10 minutes and then rinse with water. Then put the cloth in hot tannic acid solution for about 5 minutes. Now take out the cloth. Remove the cloth and squeeze it with spatula to remove most of the solution. Now place the cloth in boiling solution of dyed cloth thoroughly with water, squeeze and keep for drying.
6. Dyeing of cotton directly Take another piece of cotton cloth and put it directly into boiling solution of the dye. Keep it dipped about for 2 minutes. Remove the cloth, wash it with water, squeeze and keep it for drying. Compare the colour of this cloth with that of dyed by using mordant.

DYEING OF CLOTH USING VASANTHA DYE

- Boil the cloth to be dyed in water.
- Boil about 200ml of water separately.
- When the water is boiled, add vasantha powder to it.
- After that put the cloth to be dyed in this solution for about 10 min.
- Then add some salt to the solution.
- Keep it for one or two minutes.
- Then wash the cloth thoroughly for three – four times.
- Squeeze it and keep it for drying.

RESULTS

Fig. 5. Wool cloth dyed directly by dipping in a hot solution of Malachite green dye

Fig.6. Cotton cloth dyed by dipping in a hot solution (without using mordant) of Malachite green

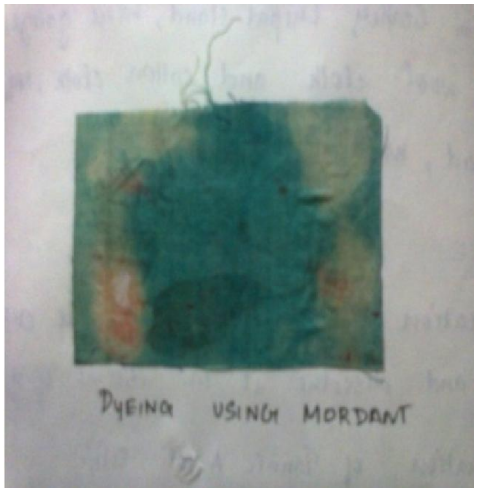


Fig. 7. The colour of cotton cloth dyed directly using mordant and then by dipping in hot solution of Malachite green

Fig. 8. Dyeing of cloth using Vasantha colour

DISCUSSION

Colour of cotton cloth dyed by dipping it directly in the dye is neither uniform nor fast to washing. Cotton cellulose has high anion concentration. Dyeing is a redox reaction in which the dye compound gets reduced and the fabric gets oxidized.

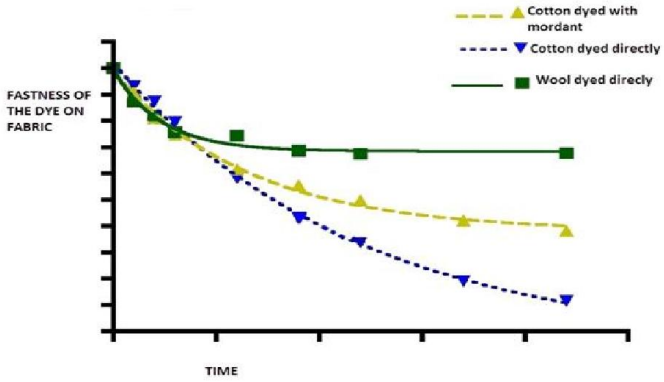
Kinetics investigation of redox reaction between malachite green, MG+ and hydroxyl ion was carried out in aqueous medium at 22 ± 10C at ionic strength = 0.5moldm-3. The reaction is first order with respect to both MG+ and OH- having the empirical rate law:

$$-d[MG^+]/dt = k2[MG^+][OH^-]$$

Where K2 = 47.36 ± 0.14 dm3mol-1min-1

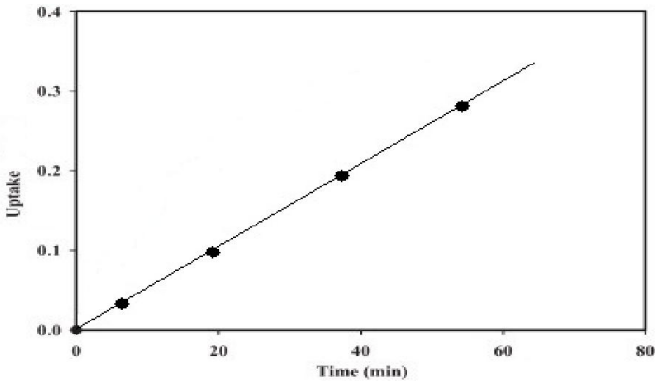
The reaction displays a negative salt effect and the reaction rate decreases with increasing anion concentration (Atkins *et al*., 2002). There is a decrease in reaction rate. This observation can be explained on the basis of repulsion between MG+ and OH- at the rate determining step. Result of this nature is in conformity with reaction proceeding by outer sphere mechanistic pathway. Colour of cotton cloth dyed by dipping in tannic acid prior to dye solution is very uniform and does not fade on exposure to light and washing. The mordant used reduces the ion concentration by neutralizing the fibre and making the less polar cotton into a polar one thus increasing the fastness of the dye. Colour of woolen cloth dyed directly dipping in the dye solution is fast and uniform. Wool is a protein fibre. It can bind to the fibres thoroughly and symmetrically. Also wool contain many anionic polar sites readily forming forming ionic bonds with cationic sites in triphenyl methane dyes such as malachite green. Thus direct dyeing of wool is possible. Thus it is found that malachite green is direct dye for wool but is a mordant dye for cotton.

Graph showing removal of dye from the fabric after every wash

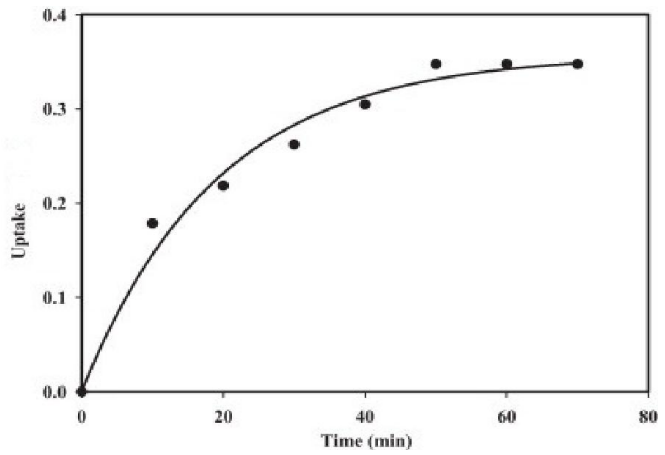


Graphs showing uptakes of dye with time in different fabrics

1. Wool



2. Cotton dyed with mordant



3. Cotton dyed directly

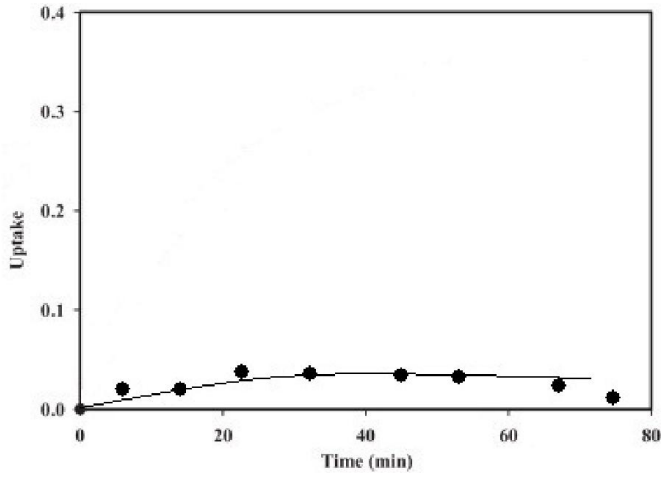


Table 1. Action of different dyes on different fabrics

Dye	Fabric	Results
Malachite green	Wool	Fast
Malachite green	Silk	Fast
Malachite green	Cotton	Poor
Malachite green with tannic acid mordant	Cotton	Fast
Vasantha colour	Cotton	Fast

Conclusion

It can be concluded that malachite green which is an extensively used dye used for dyeing not only fabrics like wool and silk but also for dyeing paper, leather, jute etc. is a good agent for wool and also for cotton if it is mordentated. By dying wool directly using malachite green dye we get a colour fast to washing. The wool does not lose colour or fade out even when dried in sun establishing the aptness of malachite green dye for wool. Cotton when dyed directly with the dye shows negative results as the cotton fibre is not fast to dyeing with malachite green dye. The dye gets off the cloth fibre each time washing is conducted. Instead of dyeing it directly, usage of a mordant such as tannic acid can give better results. But still the degree of fastness is not as good as that of wool or silk. Dyeing of a cloth using vasantha colour is fast to washing and usage. It is also commercially important and the works done in the "tie and dye" method find great importance in Indian handloom industry. Thus it can be concluded that the dyes that are studied in this work are of extensive use in cloth, leather, paper and jute industry.

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