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Optimization of dyeing condition and its dyeing on Palmyrah (*Borassus flabellifer*) leaves

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Abstract : *Palmyrah leaf based articles have been dyed mostly with direct dyes till today, which always have problems to dyers is that complications in dye reproducibility. Therefore this study was concluded about standardize the dyeing variables of alkaline dye. The optimum wave length was 600 nm, out of a set of wave length ranging from 400-700 nm on the basis of highest absorbance. Five dye concentrations (0.1-0.5g/l) were tried and 0.3g/l dye concentrations were selected on the basis of dye absorption. Likewise for the good dye absorption optimum temperature, optimum time and optimum leaf: liquor ratio was 100^{o}C, 30 min and 1:20 respectively. Significantly higher dye absorption and wash fastness was observed leaves with beaching than without bleaching while there was no significant different among the property of light fastness. Effect of auxiliary was studied with sodium chloride, sodium carbonate and naphthalene and naphthalene was selected as the best auxiliary based on the light fatness properties.*

Keywords: *Bleaching, Dye absorption, Fastness, Naphthalene, and Palmyrah leaf*

I. INTRODUCTION

Dyeing is a complex process, where numbers of variables are involved. Dyeing process is broadly governed by fabric, dye and time, temperature, pH of the fabric and liquor, type of auxiliary used etc. Any minor variation in any of these variables causes problems in dye reproducibility, though it is possible to achieve reproducibility in dyeing results. By standardizing each and every variable consistent reproducible results can be achieved.

The temperature of the dye bath affects the affinity of the dye molecules towards fibre, rate of hydrolysis, migration and covalent bond formation, therefore the dyeing temperature selected must be as per the dye type. Percentage of dye absorption increased with increase in temperature and after that, the dye absorption decreased [1], [2]. Auxiliaries play an important role in dyeing of reactive dyes. They help in better exhaustion of the dyes. References [3], [4] reported that the addition of electrolyte to the dye liquor of anionic dye increased the uptake of dye by the fabric. The electrolyte used in dyeing dissociates completely in aqueous dye liquor. For entering into the fabric, the charge on surface (negative in fabric) will have to be neutralized since both anionic dyes and fabric have the same charge. Sodium ion (Na+) from sodium chloride is cationic and in the dye liquor is attracted by the negatively charged fabric. By bonding the sodium cations neutralize the anionic surface charge of the fabric. Now the neutralized fabric can attract the organic dye molecules which have a greater affinity for the fabric than the aqueous solution. Dyes molecules permanently bind with cellulose based fibers (cotton, rayon, hemp, linen) as well as leaves, when the pH is raised. Soda ash (sodium carbonate) is generally used to raise the pH and is either added directly to the dye or in a solution of water in which garments are soaked before dyeing [5]. Because of this reason alkaline dyes were used for this study.

Some of the problems are identified in handicrafts design centers. Leaf based articles have been dyed mostly with direct dyes till today, which always have problems to dyers is that complications in dye reproducibility as well as consumers as these articles fades very easily so an attempt has been made to standardize the dyeing process for leaves using alkaline dye which have good colour fastness.

Objective of the **s**tudy is dyeing process to reduce the fade of dyed Palmyrah Leaves with the aim of optimization of alkaline dye and its dyeing on Palmyrah leaves

II. DESCRIPTION OF RESEARCH

Standardization of dyeing process for palmyrah tender leaves with alkaline dye: Experiments were carried out to optimize dye concentration, dyeing time, dyeing temperature and leaf liquor ratio for dyeing of palmyrah leaf with alkaline dye.

2.1 Determination of optimum wave length

For determining the optimum wavelength 1 ml of dye was diluted to 200 times and absorbance of the solution was taken on a spectrophotometer at different wave lengths from 400 to 700 nm. The wavelength reflecting the highest optical density was selected.

2.2 Optimization of dye concentration

For determining the optimum dye concentration, five different concentrations of reactive dye i.e. 0.1, 0.3, 0.5, 0.75 and 1g/L were taken and samples were dyed at 95-100°C for 30 minutes. Absorbance of dye solutions before and after dyeing was recorded at optimum wavelength. The dye solution giving the maximum dye absorption was taken as optimum dye concentration.

2.3 Optimization of dyeing temperature

To optimize dyeing temperature, dyeing was carried out using optimum concentration of dye at five different temperatures i.e. 70, 80, 90 and 100^oC. The temperature giving maximum dye absorption was taken as the optimum dyeing temperature.

2.4 Optimization of dyeing time

The leaves samples were dyed using optimum dye concentration for five different time durations i.e. 10, 20, 30 and 40 minutes. The optimum dyeing time was selected on the basis of maximum dye absorption.

2.5 Optimization of leaf liquor ratio

To ascertain the optimum dyeing liquor leaf (L: R) ratio, five samples were dyed at the optimum concentration, temperature and time at 1:10, 1:15, 1:20, 1:25 and 1: 30. Optimum dyeing leaf liquor (L: R) ratio was decided on the basis of maximum dye absorption.

2.6 Effect of bleaching agent

This palmyrah leaf contained high amount of lignin therefore the leaves samples were heated at 100^oC for 10min with hydrogen peroxide (4ml/l) and then dyed using optimum dyeing condition. For control treatment was done without pre heating and hydrogen peroxide. The optimum dyeing was selected on the basis of maximum dye absorption.

2.7 Effect of auxiliaries

Different auxiliaries such as sodium chloride, sodium carbonate and naphthalene (10g/l) were added in dye bath separately. Best auxiliary was decided on the basis of maximum dye absorption.

2.8 Fastness testing

Wash fastness of the leaves dyed without bleaching, dyed with bleaching, dyed with naphthalene, dyed with NaCl, dyed with Na_2CO_3 and dyed with bleaching and Naphthalene under optimized condition was tested according to ISO 105 –CO3 method. The above dyed leaves were washed in soap solution (Na salted) for 30 min at room temperature. Half of the dyed leaf was draped with black paper and covered with glass slide then placed on direct sun light for 24h. Then light fastness was tested by colour scale is for assessing changes in colour of leaf in colour fastness tests, for example the leaf consists of five number of colour each representing a visual difference and contrast. The fastness rating goes step-wise from:

Note 5 = no visual change (best rating)

Note 1 = a large visual change (worst rating).

The colour scale has the 5 possible values: 5, 4, 3, 2 and 1

III. Results And Discussion

Basic or cationic dyes on ionization give coloured cations and form an electrovalent bond with the –COOH group of wool and silk. These dyes are applied from neutral to mildly acidic pH. These dyes have poor light fastness.

3.1 Determination of wave length:

Optimum wave length is the wave length at which maximum absorbance was observed. The absorbance was recorded from 400 to 700 nm. The maximum absorbance was observed at 600 nm hence this wave length was selected for further studies (Fig: 1).

3.2 Optimization of dye concentration

On the basis of dye absorption to optimize the dye concentration 0.1, 0.2, 0.3, 0.4 and 0.5 g/L dye concentration were taken (Fig: 2). There was no significant difference ($P > 0.05$) between treatments with higher absorbance of dye with the concentration of 0.3, 0.4 and 0.5 g/L. Hence 0.3 g/L dye concentration was selected because mean difference between 0.5 and 0.3g/L is greater than mean difference between 0.3 and 0.4 g/L and also 0.3 g/L is cost effective concentration when compared with higher absorbance concentrations. It is found that dye absorption by cotton fabric increased with the increase in dye concentration in the dye bath because the absolute quantity of the absorbed dye increases while the relative quantity diminishes [6].

3.3 Optimization of dyeing temperature

Dyeing temperature is the temperature that is suitable for dye absorption and fixation of dye on the leaf material. For optimizing dyeing temperature, dyeing was carried out at four different temperatures i.e. 70, 80, 90 and 100^{o}C. The percent dye absorption at different temperatures is given in TABLE: 1. Mean absorption value for temperature 90 and 100^{o}C is significantly higher than that of temperature 70 and 80^{o}C, while there was no significant difference between the absorptions of temperature for 90 and 100^{o}C. Therefore 100^{o}C (boiling) was selected as the optimum dyeing temperature. Ali [7] reported that this increase in dye uptake can be attributed to better dye exhaustion at higher temperature.

3.4 Optimization of dyeing time

Dyeing time is the time required to get the dye fixed on palmyrah leaves. The effect of dyeing time on absorbance is shown in TABLE 2. Mean absorption value for time at 30 and 40min is significantly higher than that of time at 10 and 20min, while there was no significant difference between the absorptions of time for 30 and 40min. Therefore 30min was selected as the optimum dyeing time for better exhaustion. Longer the dyeing time create higher absorbance until dye exhaustion attains equilibrium [7].

3.5 Optimization of Leaf liquor Ratio

The effect of leaf liquor ratio on absorbance is shown in figure 2. Mean absorption value for L: R for1:10, 1:15 and 1:20 is significantly higher than that of L: R for 1:25 and 1:30, while there was no significant difference between the absorptions of L: R for for1:10, 1:15 and 1:20 (Fig: 3). Therefore 1:20 was selected as the optimum dyeing L: R for better exhaustion. Higher absorbance value at lower L: R may be explained by crowding of dye molecule at lower L: R resulting in increased dye exhaustion of the leaf [7].

3.6 Effect of bleaching agent

The leaves samples were heated at 100^{o}C for 10min with hydrogen peroxide (4ml/l) and then dyed using optimum dyeing condition. For control treatment dyeing was done without preheating (Fig: 4). Mean percentage of dye absorption was significantly higher for dyed with bleaching than dyed with non-bleaching method.

3.7 Effect of auxiliaries

A mordant is more important than the dye itself. Moreover, the ideal mordant for bulk use should produce appreciable colour yield in practicable dyeing conditions at low cost, without seriously affecting physical properties of fibre or fastness properties of the dyes. Different auxiliaries such as sodium chloride, sodium carbonate and naphthalene (10g/l) were added in dye bath separately.

Percentage of dye absorption with Na_2CO_3 was significantly higher than other auxiliary this may be due to de-colouration of dye on alkaline medium. Among the NaCl and naphthalene there was no significant different between on dye absorption while de-colouration to direct sunlight for 24h was higher for NaCl than naphthalene (Fig: 5). Therefore Naphthalene was selected for further study.

3.8 Fastness testing

Wash fastness for colour scale for dyed with bleaching and dyed with bleaching and Naphthalene was showed higher than other treatments (TABLE 3) while those treatments showed less light fastness colour scale although dyed with naphthalene showed good light fastness (Fig: 6) property.

IV. FIGURES AND TABLES

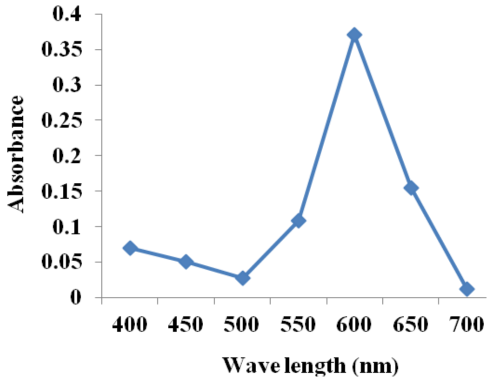

Fig 1: Wave length of alkaline dye (Malachite green).

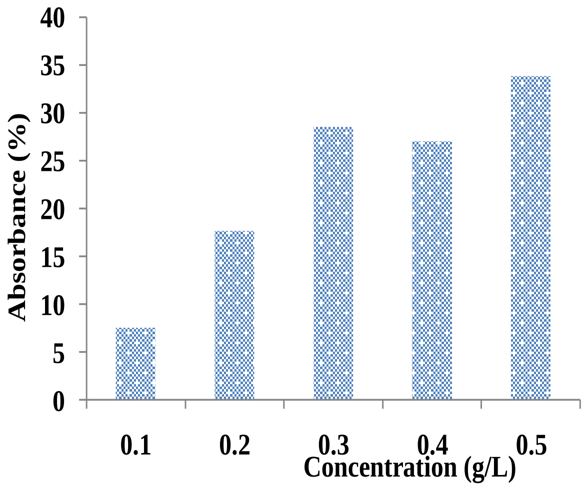

Fig 2: Optimization of dye concentration on the basis of dye absorption

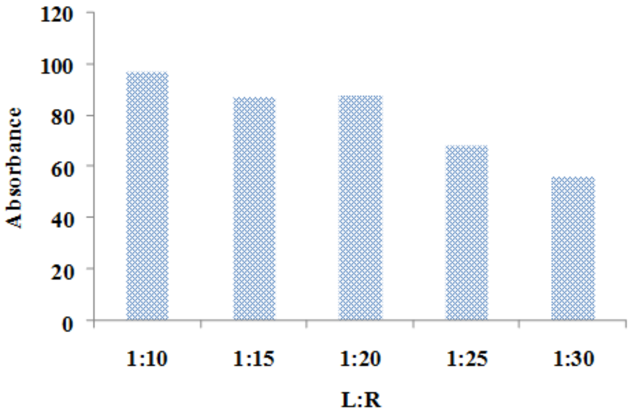

Fig 3: Optimization of leaf liquor ratio on the basis of dye absorption

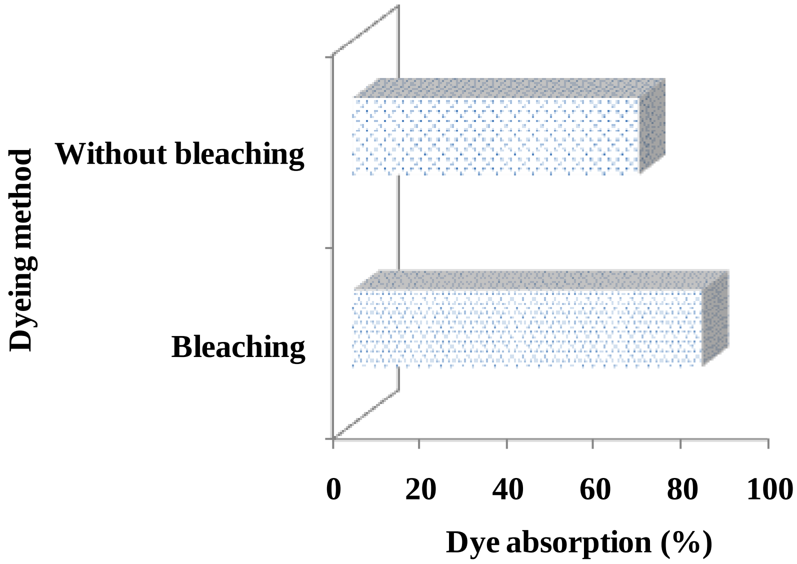

Fig 4: Effect of bleaching on dye absorption

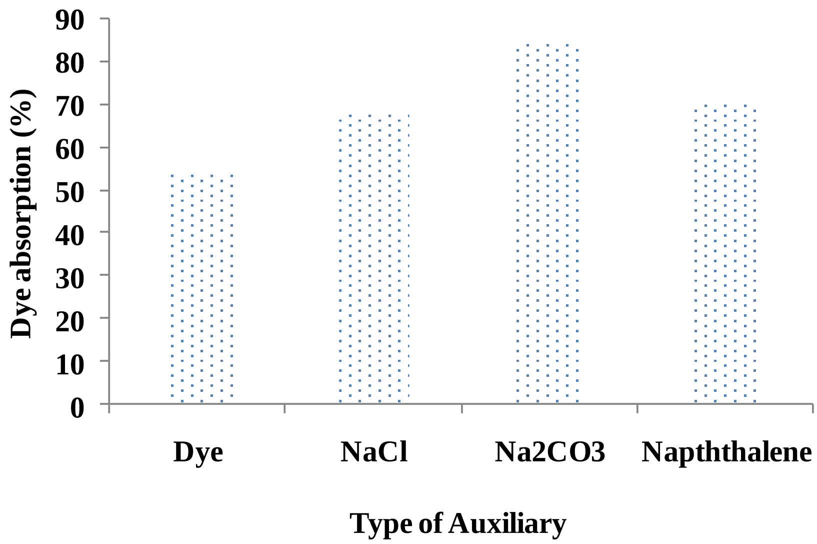

Fig 5: Effect of auxiliary on dye absorption

Fig 6: Dyed without bleaching (B), dyed with bleaching (A_{24}), dyed with naphthalene (A_{10}), dyed with NaCl (C), dyed with Na_2CO_3 (D) and dyed with bleaching and Naphthalene (A_{25}).

TABLE 1: Optimization of dyeing temperature on the basis of dye absorption

Temperature (^oC)	Absorbance (%)
70	17
80	21
90	64
100	86

TABLE 2: Optimization of dyeing temperature on the basis of dye absorption

Time (min)	Absorbance (%)
10	70
20	75
30	86
40	91

TABLE 3: Colour score for fastness test of different dyed method

Method of dyeing	Wash fastness	Light fastness
Dyed without bleaching	4	3
Dyed with bleaching	5	3
Dyed with naphthalene	4	4
Dyed with NaCl	3	3
Dyed with Na_2CO_3	2	2
Dyed with bleaching and Naphthalene	5	3

V. CONCLUSION

This study could be conclude for optimum dyeing with good dye absorption accordingly leaf materials have to dyed with the concentration of 0.3g/l, Temperature 100^{o}C, Time of dyeing 30 min and leaf: Liquor ratio 1: 20. Besides dyed with bleaching was showed best wash fastness and dyed with naphthalene showed good light fastness.

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