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Natural Dyeing of Cotton Fabric with Nerium Oleander Flower Extract

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Abstract: The current research focuses on the extraction of natural dyes and their phytochemical and pharmacological properties from turmeric, clover, and oleander. Use water, acid, alcohol, and alkaline extraction methods to obtain dyes. The UV spectrum study of the dye shows that the maximum absorption rate and its color change depend on the pH value and solvent used in the extraction process. The colorant prepared from turmeric using the aqueous extraction method and the colorant prepared from fenugreek using the alkaline extraction method both showed good antibacterial activity. The extraction of oleander water and alcohol can inhibit the growth of many fungi, including Trichoderma, Rhodophyton, Candida albicans, Aspergillus niger, Cladosporium. The antibacterial properties of dyes are used for the development of antibacterial tissues. Optimal conditions for dyeing methods (conventional, ultrasonic, and microwave), such as temperature, pH, and dyeing volume. The stains used in this work cannot improve the washing performance of dyed fabrics. The strength properties are used for coloring. The conventional dyeing method has higher light resistance than any of these three methods, but in terms of washing resistance, there is not much difference in color resistance. From the comparison of the color intensity values, it can be seen that the color intensity value of the cotton fabric dyed by the microwave dyeing method is better than any of the three methods, but because the microwave and ultrasonic dyeing methods are not commercially available. Therefore, we decided to dye cotton fabrics in the usual way. The wastewater results show that the wastewater produced by flower dyeing has lower BOD and COD levels compared with reactive dye wastewater.

Keywords: Natural Dyes, Nerium Oleander Flower, BOD, COD, FTIR, infrared spectroscopy.

1. INTRODUCTION

Natural dyeing is a very promising field finding its applications from textile coloration to food industries. The importance of environmental aspects has forced the industry and manufacturers to find new natural coloring materials from plants, animals, and minerals. Textile materials are normally dyed to add significance, aesthetic appearance, and customer desires - Hsueh and Chen (2007). In ancient times the only coloring source was natural materials until the development of artificial dyes. Manmade dyes have a higher range of colors and can easily be formed from petrochemicals and due to their easy availability colorists choose them without any hesitation but it is alarming that almost all manmade dyes are either produced from dangerous chemicals or affect the natural ecosystem adversely - Kidak and Ince (2007). Thus, the growing awareness of the biological assessment of environmentally friendly goods there is growing interest in using natural dyes due to their biodegradability, sustainability, and compatibility. The recent industrial growth has charged the environment with a massive amount of toxic materials - Robinson *et al.* (2001). The existence of serval unwanted contaminants in wastewater frequently polluted freshwater resources as well as the soil. These toxic pollutants are now harming our food chains and other biological life - Nam *et al.* (2003). The precautions regarding reducing these environmental issues are already taken, but still, a major part remains untouched. This research was focused to study the possible uses of Nerium flower extract for dyeing the cotton fabric by exhaust method. As the natural colorants are ecofriendly and biodegradable as these are obtained from natural sources such as flowers, animals, plants, and minerals – He *et al.* (2008). These are used since ancient times for coloration purposes. However, there is a need for systematic investigation for the development of natural dyes at the commercial level due to their advantages of biodegradability, high sustainability, and ecofriendly properties - Dos Santos *et al.* (2007). This will decrease the dependency on petrochemical colorants. Natural colorants are used since ancient times especially for dyeing blue denim jeans dyed with blue indigo extracted from the plants. It has been widely used for a long period produced and increased consumer importance in the usage of textiles (especially goods made up of

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natural) colored with natural dyes – Purwar, (2016).The use of blue jeans dyed with natural indigo dyes is one of the old dyeing methods along with natural colorants used in dyeing and printing the ajrak in Indus valley. These dyeing methods are still surviving and used in various regions of the world but vast development in artificial and low-cost colorants has reduced the importance of natural dyeing - Agulei (2016). Almost all dyers and fabric exporters have started to emphasize the large possibility of natural colorants application for dyeing and printing processes. For every natural textile material use of natural colorants for specific fiber, appropriate dyeing methods should be adopted. As the natural colorants are obtained from plants, animals, and minerals, therefore, an appropriate method should be selected for their extraction. Hence, to acquire a more recent shade with an acceptable behavior for colorfastness and reproducible color performance, it is necessary to obtain appropriate scientific dyeing techniques - Murthy (2016). Therefore, the relevant scientific studies and their result in the standardization of dyeing methods, the variables of the dyeing process, the dynamic of the dying, and the compatibility test of the discriminating natural colorants have become very essential. Therefore, this thesis is very appropriate to the present requirement for textile dyers. Here we tried to get a new color variety that was extracted from the names of the flowers as problems related to the Nerium flower - Thomas et al (2013).This work is selected to get a new variety of colors easily available in abundance. The Nerium plant is available all year round, it can easily be grown anywhere inPakistan. Secondly, the process of extracting this dye is very simple, economical, and environmentally friendly. It requires less energy for extraction, which significantly reduces the cost of extracting capital and, since it is extracted from natural sources, is environmentally friendly - Sabnis, (2017). The main purpose of this thesis is to create an ecological dye for the natural textile material to dye the fabric with Nerium flower extract with a conventional dyeing method and that the dye is a new dye that no one has previously worked for that process of dying. Then we will develop a new natural dye for the cotton fabric and we will obtain the best cheaper dye with` an economic dyeing process. The purpose of this study is to understand the dyeing effect of mordant on tenuiflora extract on cotton and to observe the effect of indigo-dyed popular cotton fabric - Hossain (2014). Two different types of indigo-dyed cotton and white dyed cotton fabric were used. Each tissue was stained with two different concentrations of vine extract. The mordant used is six different metal salts. After dyeing and etching the fabric, measure the colorimetric value and fastness value, such as light fastness, washing resistance, and abrasion resistance - Khatri (2011).

2. MATERIALS AND METHODOLOGY

2.1 Fabric

The Bleached cotton fabric used in this research work was provided by popular industries in Karachi. The fabric has the following quality parameters ends per inch (EPI) = 40, picks per inch (PPI) = 60, warp count = 20, weft count = 20, weight of fabric = 125 GSM – Ali *et al.* (2018).

2.2 Dyes and Auxiliaries

Nerium flowers were purchased from the local market, they were processed to extract the dye. Sodium hydroxide (NaOH) DAEJUNG Korea, sulphuric acid, and acetic acid of Merck for maintaining the alkaline and acidic pH. Alum and Ferrous sulfate of commercial-grade were used as mordant. The apparatus & devices for this thesis work were used are; Rapid HT (H-12C) machine for exhaust dyeing, U.S Cleaner (KMHI-120W6501) for ultrasonic dyeing technique, microwave Oven (Dawlance MD7), dryer, weighing balance, beakers, flasks, stirrers, soxhlet extractor, crock meter, spectrophotometer GretagMacbeth (Color-eye 7000a), conductivity TDS meter (HACH).Extraction of dye from Nerium flower **(Fig. 3.1)** is done by optimizing the temperature, time, concentrations, and pH on Rapid HT (H-12C) machine – Chequer *et al.* (2013). For observing their effects different samples were taken at varying parameters. Extraction is carried out at six different temperatures like 50 ^{0}C, 60 ^{0}C, 70 ^{0}C, 80 ^{0}C, 90 ^{0}C and 100 ^{0}C, at different time durations 40min, 50min, 60min and 70min, at different pH 2, 5, 7, 8, 10, 12, at different concentrations 6%, 8%, 10%, 12%, 14%, 16% on (w/v) in 150 ml solution. Among them, the optimized extraction results were used for optimizing the dyeing parameters–Daberao *et al.* (2016).Five fabric samples each weighing of 3 gm were colored by conventional exhaust dyeing method on Rapid HT (H-12C) machine (figure 3.2) with Nerium flower extract at a temperature of 45 ^{0}C, 60 ^{0}C, 75 ^{0}C, 90 ^{0}C, and 105 ^{0}C, respectively for 45min each at L: R of 1:20. All of these samples were carried out with maintained pH of 8. To investigate the influence of dyeing time, five samples of another set were colored for 30min, 45min, 60min, 75min, and 90min, consecutively at the optimum temperature of 105 ^{0}C by a conventional exhaust dyeing process by maintained L: R, and pH of 8.

2.3 Mordanting

The effect of pre mordanting is studied using the alum and ferrous sulfate before dying. Cotton fabric samples were treated with alum and ferrous sulfate at 1%, 2%, 3%, 4%, and 5% on the weight of the sample for about 60 minutes at 60C with L: R of 1:20.For dyeing, bleached cotton was used. Metallic salts such as alum, stannic chloride, and stannous chloride. The plants were dissolved and boiled – Kakhia (2015). The

cotton and silk were dyed with dye extract while dyeing was done by conventional dyeing method as well as by sonicator. The color yield of both dyed and mordanted samples was evaluated by light reflectance measurements using the Premier Colorscan machine. It was shown that when placed in hot water, Nerium produced color very easily. It was observed that dyeing with Nerium gave fair to good fastness properties in sonicator dyeing. Nerium oleander, a widely cultivated evergreen shrub in warm temperature and subtropical regions, has been used for dyeing purposes on pretreated wool. The shrub, which has a height of four meters, has leaves ranging from 10 to 22 cm long, usually dark or grey-green. A dark pink variety of Nerium flowers were collected for the dyeing process of the wool. The chemicals used were metallic salts such as alum, stannic chloride, and stannous chloride. Flowers were crushed and dissolved in distilled water and were allowed to boil in a beaker for three hours. Scouring of wool yarn was done by putting it in a bath containing 0.5 g/L sodium carbonate and 2 g/L non-ionic detergent solution at 40-45°C for 30 minutes. Dyeing with Nerium flowers gave good fastness properties in the sonicator dyeing. The dye has good scope in the commercial dyeing of wool yarn for the carpet industry – Rather *et al.* (2017).

2.4 Testing

Test the color rendering (K/S value) of the dyed fabric samples on the Gretag Macbeth CE-7000A spectrophotometer, and wash on the Washtec machine with the color fastness (ISO 105 X12) on the multi-pot (local production) (ISO 105 C03). Local production at 60°C for half an hour), and light (ISO 105 B02) on an Apollo machine (James H. Heal, UK) for 24 hours. The colorfastness to washing is measured by the color transferred from the dyed fabric to the multiple fiber strips adjacent to the fabric. Use the standard grayscale to evaluate the hue and color change of the result. Determine the color fastness of the dyed sample to light, and use the blue wool color scale to evaluate the color loss of the dyed fabric against the hue change. Generally, the light fastness of natural dyes extracted from nerve flowers is considered to be poor. The abrasion resistance, washing resistance, and light fastness of dyed fabrics have been analyzed and compared – Zahrim *et al.* (2011). The colorfastness to abrasion of the dyed cotton fabric was evaluated by the amount of color transferred from the dyed fabric to the standard wipe under dry and wet conditions. After the test is completed, the standard wiping sliver is graded using standard gray scales for dyeing. The abrasion test is performed according to ISO X12 using an abrasion tester. The dyed material is placed on the floor of the test bench. Place a 5x5 cm white plain cotton cloth on the appropriate wiping area, and rub the 10 cm dyed sample back and forth 10 times under a load of 900 g in a straight line every 10 seconds. Evaluate unpainted cotton with the color flow with off-white grade and determine its abrasion resistance – Mouri *et al.* (2014).

2.5 Color Strength

The color strength of all dyed samples was examined by spectrophotometer (Gretag Macbeth CE-7000A), the illuminant used was D65. Kubelka-Munk equation was used for measuring color yield.

$$K/S = (1-R)^2 / 2R \quad (1)$$

Where K absorption coefficient, S is scattering coefficient and R is reflectance value at maximum absorption.

2.6 Fixation Percentage

The percentage of dye fixed on the cotton fabric was measured using the following equation.

$$\%F = {}^{(K/S)}\text{ after wash} / {}^{(K/S)}\text{ before wash} \quad (2)$$

Where %F is dye fixation percent.

This chapter describes the results and discussions of experiments with their analysis, the optimizations of process parameters and conditions for extraction of Nerium flower color, its applications on cotton fabric via exhaust dyeing method. During the dyeing process, the dyeing conditions and process parameters were optimized for exhaust dyeing. A comparative study of dyeing processes.

3. RESULTS AND DISCUSSIONS

3.1 Effect of temperature on extraction

Temperature is one of the key parameters that influence the process results, keeping in view, its effect was observed on the extraction of Nerium flower. To achieve the optimized extraction temperature, extraction was performed at different temperatures i.e. at 50^0C, 60^0C, 70^0C, 80^0C, 90^0C, and 100^0C, its effect on color strength (K/S) and fixation percentage (F%) of fabric dyed with Nerium flower extract was observed, the results of the samples dyed with various Nerium extracts, extracted at different temperatures – Pavithra *et al.* (2019). The results show that increasing the extraction temperature from 50-90 ^{0}C yields more color and follows a forms increasing trend in the graph. However further increasing the temperature to 100 ^{0}C the color strength value reduces this may be due to dye hydrolysis and thermal degradation and decomposition of natural pigments of Nerium flower. Therefore 90 ^{0}C was optimized for the further process due to higher color yield and fixation percentage values of 8.79% and 50.05% respectively.

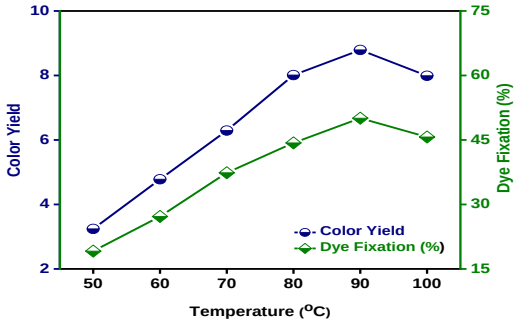

Fig. 1. Effect of Extraction temp: on color Strength % (K/S) and Fixation %

3.2 Effect of extraction pH on color strength

As natural colors are mostly extracted from the sources at certain conditions. Therefore, for better color yield and results it is of high importance to confirm the solution nature either alkalinity or acidity effect on the extraction process. Hence the extraction process was carried at various pH conditions of the solution to optimize the extraction pH. To assess the effects of pH on extraction, extraction was performed at various pH values at (2, 4, 6, 7, 8, 10, and 12) as shown in **(Fig: 4.1).** The extracted dye solution was applied on cotton fabric to assess the effects of pH on the relative color strength of Nerium flower extract dyed fabric - Das and Kalita (2016). The 100 ml extracted solution was used and pH conditions were maintained by using the diluted acid (HCL 1%, Acetic acid 5%) and base (NaOH 1%) solutions. The samples were dyed with these solutions (having different pH) with L: R 1:20 then assessed for the color properties. It was observed that the Nerium flower yields different colors at different pH conditions. This is due to the presence of high color pigments that changes color with variations of pH. However, it is clearly shown in **(Fig: 2).** that strength of color increases when the pH is increased up to 8, further when pH has increased the reduction in K/S values is obtained the possible cause can be the hydrolysis of dye in the alkaline region. At pH 08 the color strength and F% values were 9.55 and 53.40 respectively.

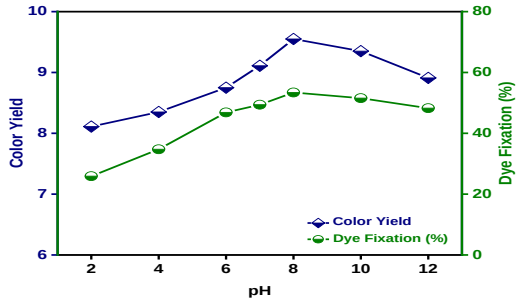

Fig. 2 Effect of extraction pH on color Strength % (K/S) and Fixation %

3.3 Effect of extraction time on color strength

Time is a crucial parameter in the extraction of natural color as it affects the quantity of color extracted therefore having its numeric values and their relevant effect on color extracted. Extraction was carried out at constant temperature 90^0C with different extraction time i.e. at 40, 50, 60, 70 minutes, its effect on relative color strength and fixation percentage of fabric dyed with Nerium flower extract was observed, the results of the samples dyes with various extraction solution extracted at different times are shown in **(Fig: 3)**. The results show that increasing the extraction time yields with an increase in the color strength values of the dyed samples. However, increasing the extraction time above 50 minutes reduces the color strength values. This may be due to dye hydrolysis with an increase in extraction time, the sample extracted at 90 ^{0}C for 50 minutes has higher values of F% and color yield – Rosana *et al.* (2014).

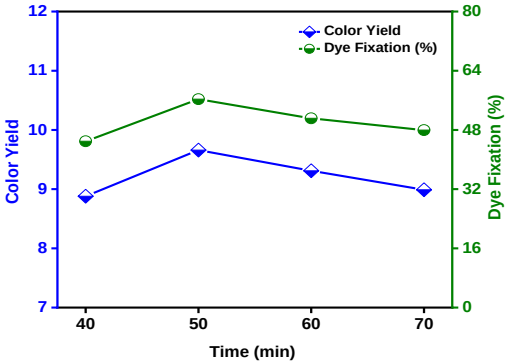

Fig. 3 Effect of extraction time on color Strength % (K/S) and Fixation %

3.4 Effect Nerium flower concentration on color strength

Concentration is one of the parameters that affect the color yield therefore, to observe its effect the concentration was varied to determine its effect on the color yield during the extraction process. The concentration of followers taken as different concentrations i-e 6% (6 grams of flowers in 100 ml water) 8%, 10%, 12%, 14%, and 16% and extracted for 50 minutes and solutions pH was maintained at 8 by using 1% solution of NaOH. Initially, 150 ml of solution was prepared and extracted, and later on, the concentration of the solution was reduced to 100 ml by evaporating the remaining water by using the soxhlet extraction unit. The dyeing process was carried out at L: R 1:20 in 100 ml. The results are shown in **(Fig. 4)** shows that strength of color increases with an increase in dye concentration up to 12%, further increase in dye concentration results decrease in color strength this may be due to the occupation of fiber sites by the dye molecules with an increase in dye there are no further

fiber sites to attach the dye molecules – Jabli *et al.* (2018).

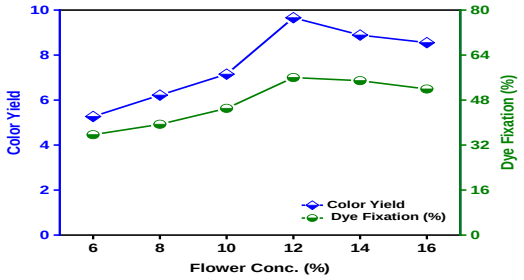

Fig. 4 Effect of Nerium flower concentration on color strength

3.5 Optimization Of Dyeing Conditions

To observe the effect of dyeing conditions and parameters on the color strength of the fabric, the dyeing conditions and parameters were optimized after optimizing the extraction parameters.

3.6 Optimization of dyeing temperature

For observing the effect of dyeing temperature, cotton samples were dyed at different temperatures i.e. at 45^{0}C, 60^{0}C, 75^{0}C, 90^{0}C and 105^{0}C by the conventional exhaust dyeing method with L: R of 1:20 for 45 minutes, pH of 8, and Nerium flower concentration of 12%. The results of dyeing temperature on color strength are given in **(Fig. 5).** It can be observed that color strength increases at 60^{0}C with an increase in dyeing temperature and then starts decreasing up to 105^{0}C, the results of color strength at 60^{0}C were optimized due to better color yield. The highest K/S value was achieved at 60^{0}C with F%56.89. The decrease in the cotton color strength means that temperature affects up to a certain level. The results show that the K/S value of dyed fabrics increased gradually with the increase of temperature from 45°C to 60°C. At 75°C the color uptake results getting down which may be due to diffusion of dye from the core of the fiber, or electrolyte addition may improve the case but we did not use any auxiliaries. Hence, the optimum value of temperature used maybe 60°C, which helps in saving energy – Selvam *et al.* (2015).

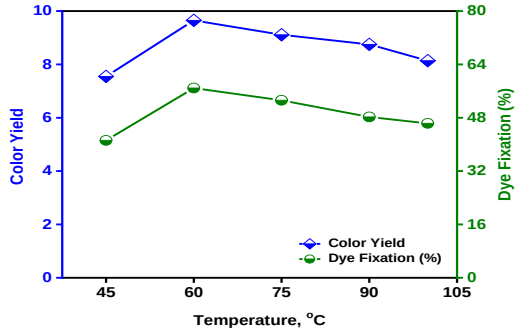

Fig. 5 Effect of dyeing temperature on color strength K/S

3.7 Optimization of dyeing time

For observing the effect of dyeing time, cotton samples were dyed at different time intervals i.e. at 30, 45, 60, 75, and 90 minutes by conventional exhaust dyeing method with L: R of 1:20 at an optimized temperature of 105^{0}C, pH of 8 and Nerium flower concentration of 12%. The results of dyeing time and their effect on color strength are given in **(Fig. 6)**. Results show that color strength increases with an increase in dyeing time, color strength values reach a maximum of 9.69% value at 75 minutes dyeing time, further increasing the dyeing time to 90 minutes' results decrease in color strength which may be due to achieving the dyeing equilibrium. Therefore 75 minutes dyeing time is optimized.

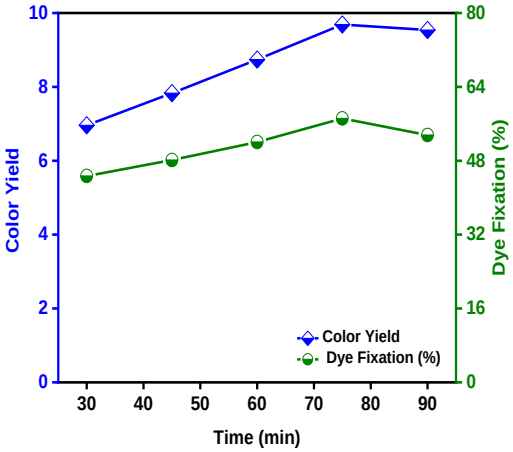

Fig. 6 Effect of dyeing time on color strength K/S

3.8 Effect of mordant on washing fastness properties

Commonly, natural dyes have poor washing fastness, it can be improved by using the mordants which forms the complexes with the dye molecules to retain them in the fiber polymer system, however for improving the washing fastness properties of Nerium flower extraction dyed fabric samples were treated with mordant, ferrous sulfate and alum were used as mordant their concentration was varied from 0.5%, 1%, 1.5%, and 2% (w/v). The results are given in Table 1. The results show that using alum and ferrous sulfate as mordant does not improve the washing properties significantly therefore no significant result has been achieved with washing fastness. This is due to the chemistry of alum and ferrous sulfate that they do not form bonds with cotton therefore no significant results of fixation percentage were achieved. We selected these mordants due to their eco-friendly behavior, as the Cu and Cr containing transition metals are not recommended due to their ecotoxicity to be used as mordants – Ghaly *et al.* (2014).

Table 1 Effect of mordants on color strength K/S of dyed cotton samples before and after wash

Mordant	Concentration	K/S (before washing)	K/S (after washing)
Ferrous Sulphate	0.5%	7.27	4.02
	1%	12.57	4.34
	1.5%	10.18	4.41
	2%	12.72	4.81
Alum	0.5%	5.98	3.71
	1%	6.78	4.08
	1.5%	6.28	3.77
	2%	7.29	4.89

3.9 Comparison of exhaust dyeing processes

The cotton fabric sample was separately dyed by these three techniques (i-e conventional, ultrasonic, and microwave dyeing) with optimized conditions. For dyeing with these three dying techniques, the same solution recipe was used however the process parameters and conditions were changed due to the sensitivity of each process. For conventional dyeing, the conditions were as pH 8, time 75minute, temperature 105^0C, and dye concentration 12%, whereas for ultrasonic the conditions were time 60 minute, temperature 60C, for microwave the conditions were time 8 minutes, temperature medium for other parameters were same. **(Table 2)** given below shows the color strength of dyed samples dyed with three dyeing techniques. The results show that the color strength of microwave dyeing was better than the other two processes with a K/S value of 12.14% whereas ultrasonic and conventional dyeing has results of K/S 9.29 and 6.63 respectively.

Table 2 Comparison of color strength for different dyeing techniques

Dyeing Method	K/S % (before washing)	K/S % (after washing)
Conventional Dyeing	10.63	4.49
Ultrasonic Dyeing	9.29	4.10
Microwave Dyeing	12.14	4.30

3.10 FTIR analysis.

Samples were then subjected to Fourier transmission infrared attenuated total reflection spectroscopy (FTIR-ATR) for further analysis. A typical broad bend between 3500-3100 cm-1 displaying -OH stretching, the C–H stretching at 2893 cm−1, and the C–H wagging at 1314 cm−1 attributed to cellulose can be observed. Both the samples display nearly identical spectra and dye interaction with fiber could not be identified due to the small ratio of dye concentration to fiber mass – Tüfekci *et al.* (2007).

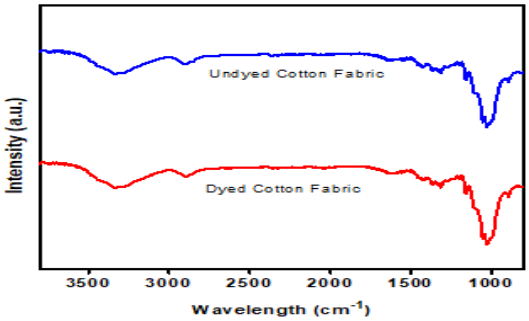

Fig. 7 FTIR analysis of dye obtained from Nerium Flower

3.11 Comparison of dyeing processes for fastness properties

The results given in **(Table 3)** show the fastness properties of the dyed samples dyed with three dyeing processes to make a comparative analysis of the effect of dyeing processes on the fastness properties of the Nerium flower extracted dyed fabric. The three processes conventional dyeing method, ultrasonic dyeing method, and microwave were used for comparative studies. The results show that the microwave dyeing technique has better light fastness properties than the other two processes, the washing fastness to color results of the three processes are 2/3, 3, and 2/3 for the conventional dyed, ultrasonic, and microwave dyed samples respectively. Colorfastness to staining results of the three processes is very good with a 4/5 rating on all fibers except cotton which has a staining rating of 4. Rubbing fastness results for microwave the rating was 2/3, ultrasonic with a rating of 3 and conventional process rating remained lower with a rating of 2 – Bechtold *et al.* (2006).

Table 3. Comparison of fastness Properties of dyeing processes

Dyeing	W-Fastness							R-Fastness		L-Fastness
	color	Staining						Dry	Wet	
		CT	CO	PES	PA	PAC	W			
C-Dyeing	2/3	4/5	4	4/5	4/5	4/5	4/5	4	2	4
U-Dyeing	3	4/5	4	4/5	4/5	4/5	4/5	4/5	3	5
M-Dyeing	2/3	4/5	4	4/5	4/5	4/5	4/5	4	2/3	6

3.12 Effluent comparative analysis

BOD is a measure of the polluting efficiency of water. Oxygen is required in the effluent for the oxidation of inorganic and organic matter. The demand

for oxygen by the organic matter is known as BOD which is defined as the amount of oxygen required to carry out the biological decomposition of dissolved solids under aerobic conditions at a standard temperature. Whereas the COD is the measure of oxygen required to oxidize unstable materials in a sample utilizing a dichromate in an acid solution. The effluent of the dyeing solution was collected at the end and it was observed for the BOD, COD, and TDS characteristics. A representative solution of 1% was prepared and it was evaluated. The results are given in Table 4. It was observed that Nerium flower extract has lower BOD and COD values than the synthetic dyes. When compared with the findings of the previously reported natural dyes effluent, our results are very much comparable with the previous work. Which mostly remains in between the 30 -100 for BOD and COD. The higher BOD, COD values may be due to the lower fixation percentage than the synthetic dyes and due to the use of higher concentrations of Nerium – Căilean *et al.* (2009).

Table 4 Dye's Wastewater Effluent Analysis

Dye	COD (mg/l)	BOD(mg/ l)	TDS
Reactive Dye (Drimarine CL)	230	150	1789
Nerium Flower Extract	80	120	683

4. CONCLUSION

It is concluded from the findings of our research work that Nerium flower has wide potential to be used as the natural colorants for dyeing of cotton fabrics. It was observed that increasing the temperature of extraction causes more color yield. However further increasing temperature above 90 0C has a negative influence on color tone by changing the pH varying color ranges could be achieved. It was observed that extraction solution pH affects the color tone the possibility to dye the cotton fabric with conventional, ultrasonic as well as microwave dyeing methods with extract of natural Nerium flower. The mordants used during this work could not improve the washing properties of the dyed fabric. Fastness properties were accessed for dyeing. The conventional dyeing method has relatively more light fastness properties than either three but for washing fastness, there was not much difference between the colorfastness properties. From the comparison of color strength values, it can be observed that the color strength value of cotton fabric dyed by microwave dyeing method is better than either three methods but microwave and ultrasonic dyeing methods are not commercially available. Therefore, we have opted to dye the cotton fabric with the conventional dyeing method. The results of effluent suggest that the Nerium flower dyeing effluent has lower BOD and COD levels than the reactive dye effluent.

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