Effective Parameters Analysis of Cotton Woven Fabric by Natural Dye Lawsonia Inermis - Eco Friendly Approach

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Abstract The present study influences on natural dyestuff which is not kick in environmental pollution and undertaken to explore prognosticate than synthetic dyes. Natural dyes use are augmenting day by day causes of dyes has effective impact on fabric by different properties. The present study investigated that cotton woven fabric dyed with natural dye which is extracted from *Lawsonia Inermis.* The natural dyes henna influence on color strength properties with room low temperature. The result implies that this dye would not cause any retrogression effect on fabric strength. We got excellent color fastness properties by using this dye. We use one mordant coppers sulfate which much effect on fastness properties. With regards to current economic and environmental apprehension of natural dyes may be the unique way to get energy, water saving dyeing area of textile industry. Textile industry is committed to produce eco-friendly textiles in order to face the global competition. As a result, the concern for the environment has created a clamor for natural dyes compared to synthetic dyes in the textile industry.

Keywords Natural Dye, Henna dye, Color fastness, Color strength, Mordant, Eco-friendly, cotton woven fabric

1. Introduction

Natural dyes are mostly incorporated for dyeing of natural fiber textiles to progress their eco-friendly characteristics. Natural dyes were the main colorants equal to the end of 19th century and now days increasing more value of these causes of toxicity and allergic reactions which produced by synthetic dyes. Many countries demanding strict attention to rules and some procedures to safe their environmental clime[1]. Dyeing process is the most important part of fabric processing. After discovery of synthetic dyes 1856 decreasing the use of natural dyes[2]. According lowest prices and satisfied of color fastness use of synthetic dyes increases in present market[3]. Considering environmental fact natural dyes are more favorable than synthetic dyes[4].Usually chemicals are used for dyeing which is toxic that converted textile industry to most polluters. In textile sector approximately 230 to 270 ton water used which carry dyes including heavy amount of chemicals that pollute environment. In case of textile processing, we are saving environment from pollution by two ways like firstly, established enough and large effective effluent treatment plants and secondly use of environmental friendly dyes and chemicals [5]. According to the statistics annually produced dyes and pigments used over 7×10^5 tones and approximately 10,000 in world-wide. Produced and 10-15% dyes are lost in the effluent throughout the coloration process [6]. It produce very uncommon , comfort and soft shades as compared to synthetic dyes in significantly [7]. Usually natural dyes show better biodegradability and great less allergic, toxic response than synthetic dyes. It has great compatibility to the environment effect[8]. Since the mid-1980s some interest has shown on natural dyes and commercial dyes and increasing the possibility of using natural dyes some business had started[9]. After natural dyeing some bad results are found in some cases like poor color, inadequate fastness properties. By using mordant to solve these difficulty cause mordant or metal ions act as electron acceptors for making co-ordination bond with electron donors to insoluble them in water medium[10]. In textile dyeing some mordants used are alum, chrome, stannous chloride, copper sulphate, ferrous sulphate etc. as a common[11].Natural dye Henna leaves (*Lawsonia inermis*) is an ancient dye, which was found the Egyptian mummies found in the tombs that had their nails dyed with henna. In present days it is used in many countries for some occasion like religious festival, marriage and in Bangladesh mostly use of henna for dyeing the palms and fingernails is an

auspicious ritual event [12]. It is extracted from the plant *Lawsonia inermis,* whose color is due to the compound Lawson (2-hydroxy-1, 4-napthoquinone)[13].Extracted the coloring matters from henna leaves by water, and dyed the cotton fabric with 1.12%extractable dye[14]. The molecular structure of henna dye (Lawson) is shown in (Fig 1)

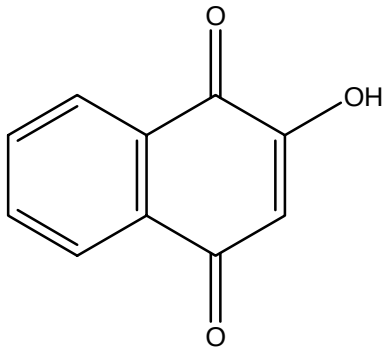

Fig 1. Molecular structure of Henna dye 2-hydroxy-1, 4-napthaquinone (Lawson)

In this paper we investigated that cotton woven fabric dyeing with henna leaves and we try to find out culminate result of dyeing by henna leaves. The influence of henna leaves in dyeing is very viable and moderately precise the effective parameters of dyed cotton woven fabric. We observed some effective parameters which accelerate color fastness, color strength and finally indicated to environmental concern area which very useful for textile dyeing.

2. Materials and Methods

2.1 Dye Sample preparation

Henna leaves (*Lawsonia inermis*) were collected from the ground are shown in (**Fig 2.** Henna PlantAfter collection it is washed with distilled water and dried with sun and room temperature. Then the dried leaves grounded with properly and got uniform particles size that is used for dyeing with cotton woven fabric.

Fig 2. Henna Plant

2.2 Raw Materials

The following raw materials are used-

Fabric Specification

Fabric type: plain woven fabric (Scoured and Bleached)

Warp Count of yarn : 23s

Weft Count of yarn : 21s

EPI : 61

PPI : 56

2.3 Equipment

For making experiment we used some valuable equipment's to get our desired result are shown in (Table 1. List of equipment's used in experiment

Table 1. List of equipment's used in experiment

Machine Name	Model	Company	Country
Electrical Balance	BJ-1000C	Precisa	Switzerland
Sample dyeing machine	XT 120A	Rotadyer	England
GSM Tester	N/A	James H Heal & Co. Ltd	England
Grey Scale	267A+267C	James H Heal & Co. Ltd	England
Crock Meter	670	James H Heal & Co. Ltd	England
Perspirometer	SDLMG2098	SDL Textile Machine Co.	England
Counting glass	ISO-105A02	MESDAN	Italy
Hydro Extractor	NH-EX10	Nisho apparel machinery	UK
Color Fastness tester(Rota wash)	SDLM228B	SDL Textile Machine Co.	England

2.4 Chemicals

The types of chemicals we have used our experiments that are shown in (Error! Reference source not found.).

Chemicals	Commercial / Brand Name	Company/supplier/Country
Lissapol_N	Wetting Agent	Eastern scientific Ltd. Dhaka, Bangladesh.
N/A	Leveling Agent	Dysin
Ethylenedinitrilo Tetraacitic Acid(EDTA)	Sequestering Agent	Eastern scientific Ltd. Dhaka, Bangladesh
Na_2CO_3	Soda ash	Indian
NaCl	Salt	Eastern scientific Ltd. Dhaka, Bangladesh
$Na_2SO_4.10H_2O$	Glubar salt	Dysin
Cu_2SO_4	Cupper sulphet	Indian
CH_3COOH	Acetic acid	Merck, Germany

2.5 Method

2.5.1 Pre-Mordanting method

The plain cotton wove fabric was immersed in de-ionized water for 30 min. here we took 8 g copper sulfate intended to mordanting and then took 100 ml de-ionized water to make the liquor. Then wetted sample was penetrated into the mordant solution which continued for 1 hour at 80^0 c and after 1 hour mordant sample was rinsed, squeezed and dried. After Mordanting should go immediately dyeing condition because we know some mordants are sensitive to light condition.

2.5.2 Dyeing method

The Dyeing process has been carried out in a full scale commercial sample Dyeing Machine in Lab is shown in (Fig 3.Sample dyeing Machine)At first sample and stock solution were prepared according to recipe. Then stock solution was taken into bath and rest water was added into the bath. Then the prepared sample was immersed into bath. In case of sample 1 required amount of (Leveling agent, EDTA, $CuSO_4$, Gluaber salt, and Henna dye) are taken in the dye bath. In case of sample 2 required amount of (Leveling agent, EDTA, $CuSO_4$, NaCl, and Henna dye).In case of sample 3 required amount of (Leveling agent, EDTA, $CuSO_4$, and Henna dye).In case of sample 4

required amount of (Leveling agent, EDTA, Gluaber salt, and Henna dye).In the case of sample 5 required amount of (Leveling agent, EDTA, NaCl, and Henna dye).In case of sample 6 required amount of (Leveling agent, EDTA, and Henna dye).In all cases dyeing is done at room temperature for 30 min. Then collected from bath the samples was cold wash was done normally. At last sample was dried by dryer machine.

Fig 3.Sample dyeing Machine

2.6 Test procedure

2.6.1 Estimation of color strength (K/S value)

The K/S values were calculated by The Kubelka Munk equation[15] is shown in (1).

$$k \quad \frac{K}{S} = \frac{(1-R\lambda max)^2}{2R\lambda max} \qquad (1)$$

K is the absorption coefficient and S is the scattering co efficient.

2.6.2 Evaluation of color fastness to wash test

As the sample to be tested is in fabric form a piece measuring 10cm by 4cm was cut from each of the dyed fabrics. The specimen to be tested was placed between two specified pieces of undyed cloth measuring 5cm by 4cm, and the three pieces were held together by stitching round the edges, leaving 5cm by 4cm of the dyed sample exposed. The pieces of the undyed cloth enable the degree of staining during test to the assessed. For ISO3, the sample was washed with 5g/l of soap and 2g/l of soda ash in a solution of liquor ratio 50:1, at a temperature of 60°C for 30mins, followed by rinsing and drying. The change in color of the tested specimen and the staining of the adjacent undyed cloths were assessed with the appropriate grey scales.

2.6.3 Evaluation of color fastness to light fastness test

The artificial light source method of determination of light fastness was used in this study. The specimen and the blue standard were exposed behind a glass and inserted into the light fastness testing machine. Exposure was carried out for 48hrs. Exposure was terminated after the contrast between the exposed and the unexposed portion of the specimen is equal to the grades on the grey scale, for assessing change in colour. Change in colour was assessed by comparing the tested fabric and original fabric under a white light with the blue standard as reference

2.6.4 Evaluation of color fastness to rubbing test

This test method is designed to determine the degree of color transfer from the surface of textile floor coverings to other surfaces by rubbing. Color fastness to rubbing (dry and wet) was assessed as per ISO 105 E04 method using a manually operated crock meter and grey scale as per ISO-105-AO3 (extent of staining). Here, Specimen size at least 50 x 140 mm, Vertical Load - 9 +/- 0.2 N ,Finger Diameter - 16 mm Position warp parallel to long dimension for one specimen and weft parallel to long dimension for other specimen or diagonally. Rubbing distance: 104 +/- 3mm. Evaluation is done by Grey scale in a dyed color matching cabinet and rate from 1 to 5.

2.5.6 Evaluation of color fastness to perspiration test

Color fastness to rubbing (dry and wet) was assessed as per ISO 105 E04 method. Sample size will be 10 CM * 4 CM then Wet-o0ut the composite test sample in mentioned alkaline or acidic solution at room temperature. The Material ration will be 1:50 and leave for 30 minutes. Then Pour off excess solution and place the composite sample between two glass plate or acrylic plate under a pressure of 4.5 KG and place in an oven for 4 hours at 37+- and 2 degree centigrade temperature. Then Remove the specimen and hang to dry in warn air not exceeding 60 Degree centigrade. Evaluation is done by Grey scale in a dyed color matching cabinet and rate from 1 to 5.

3. Result & Discussion

Scoured and bleached cotton woven fabric s are dyed by henna day are shown in (Figure 4).

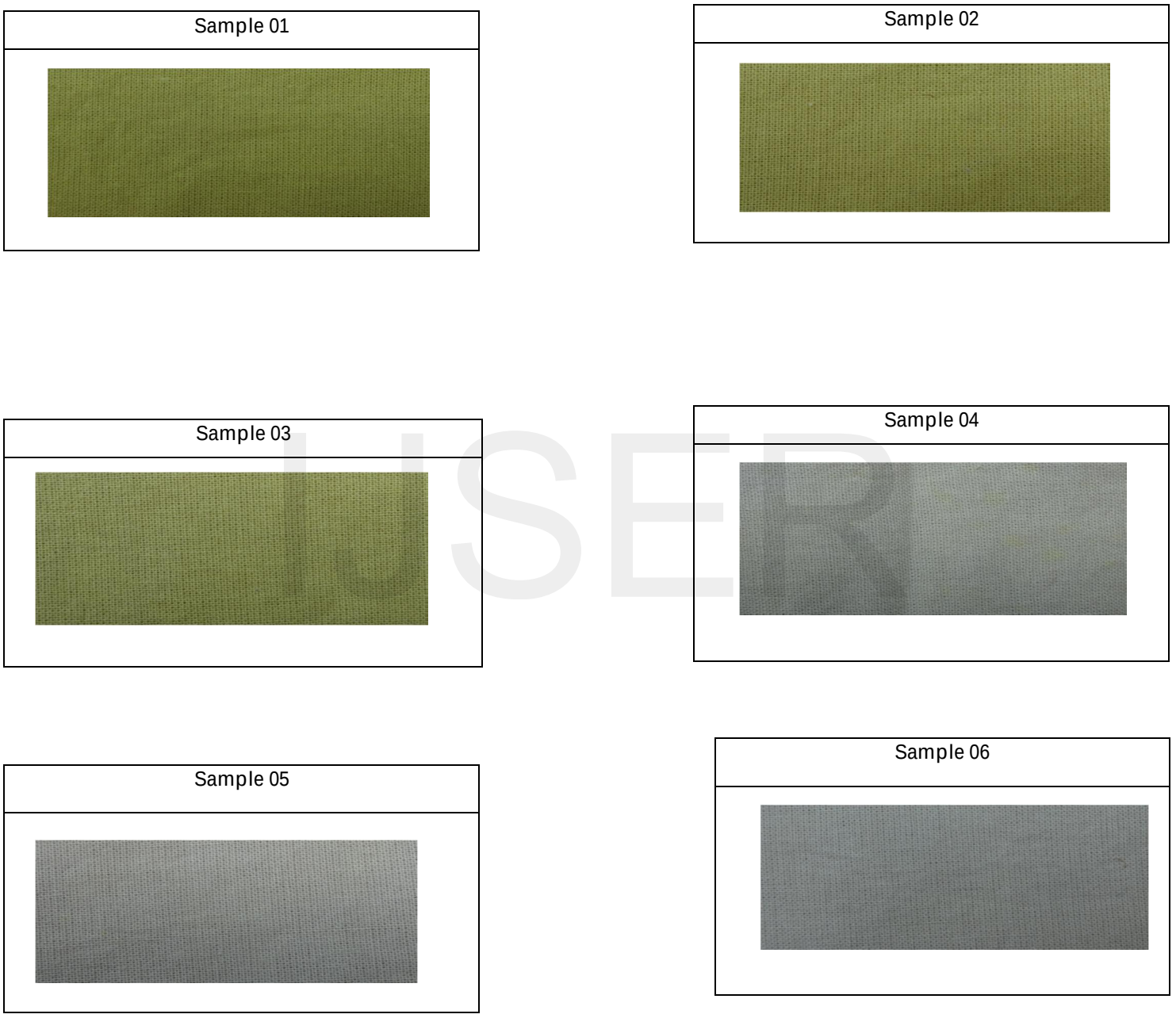

Figure 4. Samples of dyed fabric

3.2 LCH and CMC values of dyed samples

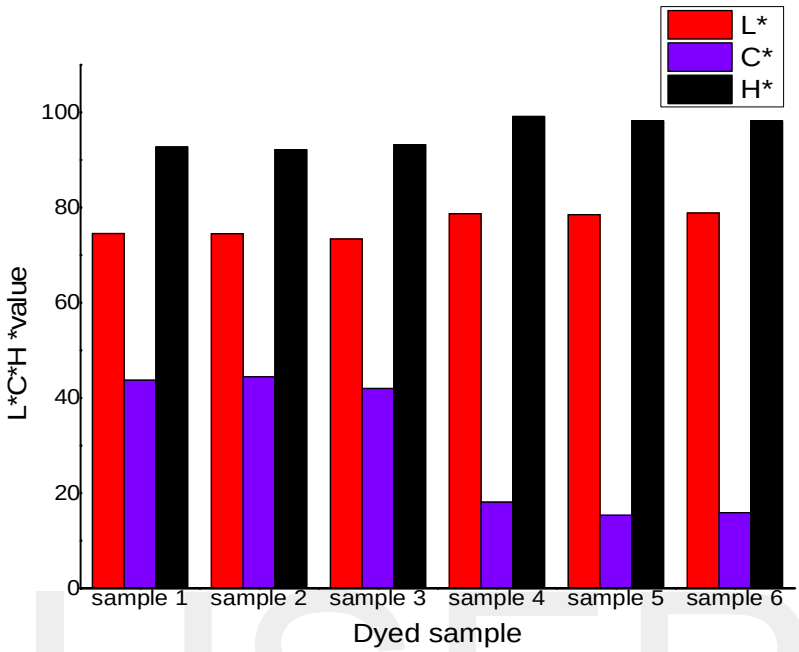

Fig 5. L*C*H* values of different dyed sample

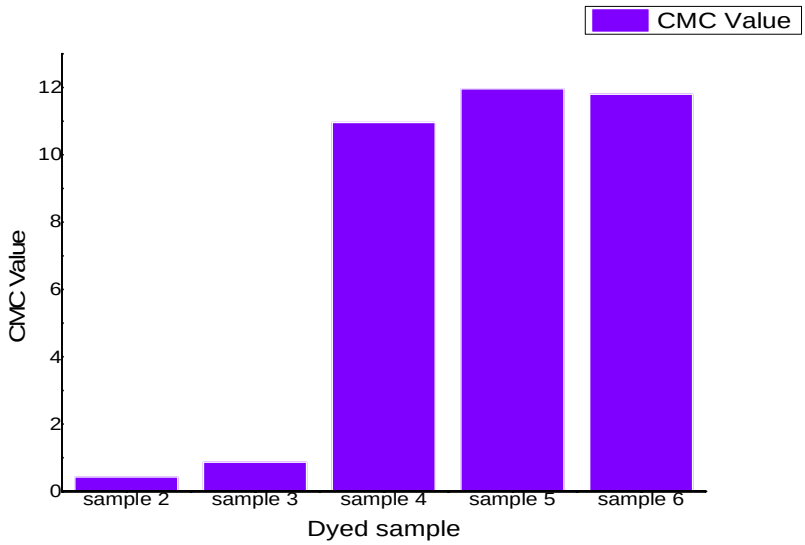

Fig 6. CMC values of different dyed samples

3.3 Color strength (K/S) values of different dyed samples

Here, Color strength (K/S) values of different dyed samples are shown in (Figure 7).

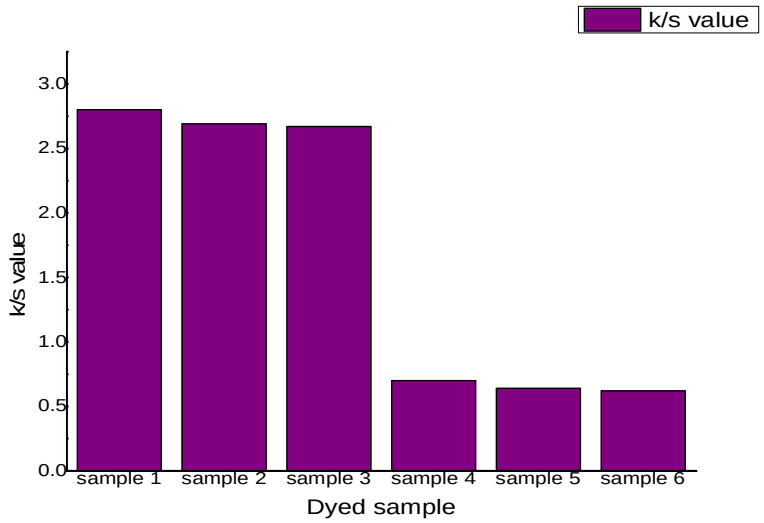

Figure 7. Color strength (K/S) values of different dyed samples

3.4 Color fastness to wash

Table 2. Color fastness to wash test (ISO 3) values of different samples for cotton woven fabric

Sample No	Wash test rating	
	Staining	color change
01	4/5	4/5
02	4/5	4/5
03	4	4
04	3/5	3/5
05	3	3/4
06	¾	3

Keys:

5 = excellent 4 = very good 3 = good 2 = moderate 1 = poor

3.5 color fastness to light

Table 3. Color fastness to light test values of different samples for cotton woven fabric

Sample No	Light fastness rating
01	4/5
02	4/5
03	4
04	3/4
05	3
06	2

Table 4. The light fastness grade

Grade	Degree of fading	Light fastness type
8	No fading	Outstanding
7	Very slight fading	Excellent
6	Slight fading	Very good
5	Moderate fading	Good
4	Appreciable fading	Moderate
3	Significant fading	Fair
2	Extensive fading	poor
1	Very extensive fading	Very poor

3.6 color fastness to rubbing

Table 5. Color fastness to rubbing test in dry condition for cotton woven fabric

Sample No	Dry Rubbing test rating	
	Staining	color change
01	4/5	4/5
02	4	4/5
03	4	4
04	3/5	3
05	3	3/4
06	3	3

Table 6. Color fastness to rubbing test in wet condition for cotton woven fabric

Sample No	Dry Rubbing test rating	
	Staining	color change
01	4/5	4/5
02	4	4/5
03	4	4
04	3	3/5
05	¾	3
06	3	3

Keys:

5 = excellent 4 = very good 3 = good 2 = moderate 1 = poor

3.7 color fastness to perspiration

Table 7.Color fastness to perspiration test in acid condition for cotton woven fabric

Sample No	Perspiration (acidic) test rating	
	Staining	color change
01	5	4
02	4/5	3/5
03	4	3
04	¾	3
05	3	2
06	3	2/5

Table 8. Color fastness to perspiration test in alkali condition for cotton woven fabric

Sample No	Perspiration (alkali) test rating	
	Staining	color change
01	5	4
02	4	4
03	4	3
04	¾	2
05	3	2/5
06	3	2

Keys:

5 = excellent 4 = very good 3 = good 2 = moderate 1 = poor

3.8 Result Analysis

According to our experimental results we showed dyed sample in (Fig 4) and it is concluded that for determination of CMC value here we incorporated LCH value for measuring CMC value of different sample that is clearly view in (Fig 5). Here we used different recipe for different samples and first three samples results are good cause here mordant, salt used but other sample we got less quite good and here no mordant used. The present study revealed that CMC value after dyeing with henna leaves are constituted with different values. We observed Sample 1 support to the CMC value and it is treated as a standard sample. Then sample 2 slightly support the standard CMC value but not fully standard. Then sample 3 also close to the standard CMC value but not standard. Then sample 4, 5, 6 are less support the standard CMC value are shown in (Fig 6).

The anthraquinone type Lawsone is more suitable in water and organic media; it tends to attach the cotton fiber. When such extracts are used for dyeing, more color strength rates are obtained because the dye is absorbed more and more on cotton fabric and other insoluble component either got mixed with media or scattered during dyeing. Here we used CuSO4 as a mordant which increases the color strength more concentration accumulates on the fabric surface, the dye is absorbed on the cotton and other insoluble integral and formation more complex bond dye-metal Here salt accelerate the value of color strength we know by immersing cellulose fiber gained electrical charge then produce repels attraction because dye and fiber both are negative charge. By minimizing this repulsion and incorporated attraction added salt into the dye bath and try to reduce negative charge then dye creates hydrogen or other bond with fiber to enhance the effective dyeing process shows sample 1 k/s value is high than other samples and sample 2 and 3 were normally good color strength obtained than other Also show in (Figure 7). It is revealed that from (Table 2) shows color fastness to wash test values for different samples. We observed first three samples results are good this result due to happens

(Lawson) contain functional groups which is capable of forming covalent bonds with active sites in the fiber such as hydroxyl group in the cotton, such bond formation between the functional groups and the substrate result in high wash fastness and others are moderate. It is seen from (Table 3) we observed first three samples results are good and others are poor to moderate. This might be due to the chemical structure of the colorant because the resistance of a dye or pigment to chemical or photochemical attack is directly related to its chemical structure. Dyes with large chemical structure exhibit higher light fastness value. According to (Table 5 &

Table 6) we got values of rubbing test in dry and wet condition which is indicated by color change and color staining. We observed first three samples results are good and others are less good. From (Table 7 &Table 8) it is observed that perspiration test values and first three samples results are good and others are moderate to good that is measured in color change and color staining.

4. Conclusion

From the studying of scientific and research report we found that natural dyeing with textile still is skimpy than needed. It is worthwhile notice that use of henna dye is more viable for eco-friendly dyeing. At present eco-friendly dyeing to natural dyes has gained a lot of importance because of this biodegradability and compatibility with the environment medium. It is time to take modern and scientific knowledge of dyeing process like many other countries India, Nigeria, Liberia and Uganda where available plant has seen which is useful for commercial application of dyes. With regards to color fastness properties we observed from our study all color fastness properties excellent, good especially for first three samples but another samples get moderate rating for color fastness properties. At last we can say here different recipe gives different results especially first here sample recipe is good according to result. These results give us different data for evaluation of fastness properties under consideration and which are helpful for textile industries to utilization of Natural dyes.

5. Recommendation

According to present report that natural dyes are very much significant for eco-friendly textile dyeing with saving energy, water. Here first three samples meet desired properties but another sample does not get valuable properties may be we use only copper sulfate mordant if we use more mordant or ferrous sulfate and dye-fixing can be applied to improve color fastness then we may be get desired properties. Therefore it is hope that we will work on this scanty on properties and have to be conducted on overall dyeing process ingredients. Therefore it is recommended that further and detailed works have to be conducted on this *Lawsonia inermis.*

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