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Analysis of Enervation Conduct of Indian Maddar Natural Dye on Silk Fabric

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Abstract: Dying is a popular practice in textile industry which is prevalent at all parts of the world from the period of ancient civilization. Initially, natural dyes i.e. dye derived from natural resources like vegetables, flowers, minerals, plants etc. were used. Now-a-days, due to technological and scientific innovations synthetic dyes are processed at large scale in the laboratories as it is still one of the most profitable industry globally.

However, the rapid utilization of chemicals in textile industry for production of synthetic dyes causes degradation of environment like soil pollution, water pollution etc. Hence, it is necessary to promote the utilization of natural dyes globally. In this paper, the bleached silk fabric was dyed with Indian Madder natural dye at different temperature and the colour strength is measured spectrophotometrically in order to study the effectiveness of the dye.

Keywords: Natural dye, bleached silk fabric, Indian Madder, Colour strength

I. INTRODUCTION

Dyeing is a very old practiced existing since 2600 BC , at the very beginning when humans started making clothes , the clothes used to be of natural color which comprised of only white and grey , the whole human culture use to wear clothes of white and grey made of cotton and linseed fibre , with time when human civilization grew many new rules and regulations started to come up which included differentiating between male and female and different classes , in the region of Europe , Middle East and Asia . Textiles first started in India and spread to the rest of the world. where the use of natural dyes of the purpose of printing , painting and dyeing for clothes can be traced back to 1st century AD , Ajanta Painting are an example of natural dye being used , so it started from pre historic periods .The techniques for weaving was even found during the same era . In simples words dyeing can be delineated as providing color to textile – clothing .

There are natural dyes and synthetic dyes where the main focus of this paper is on natural dyes . Earlier the natural dyes were obtained from vegetables , fruits , minerals and animals , the Mineral dye was obtained from earth surface for instance Hematite was used to produce red color , Lazurite was used to produce blue color and limonite for yellow color , it was used to supply colour for textiles and didn't get degrade for years unless due obtained from flora and fauna , Vegetable dye would include extracting dye from bark , trees , leaves . Lichens have been used as a source of natural dyes in North America , by Greeks and Romans to produce different colour like orchil purpure , just like safflower and saffron was used to produce yellow colour and indigo for blue which was expensive and considered of high quality.

Animal dye was obtained from insects , shellfish and lichens , Cohineal and kermes where primarily animal dye used for extracting crimson red colour .Natural elements like Coffee beans , Gamboge tree , Chestnut hulls , Indigofera , Bamboo , Kamla , Pomegranata rind , Gold lichen , Berries , cherries , Peppermint , basil leaves , Madder roots , Myrobalan fruits , Iris root , Red Cabbage , Black berries , Teak leaf , Tumeric , Red and Pink roses , Logwood have been used as natural dye extracting elements to produce colour for clothes.

Natural dyes have been used in Textile Fashion over the years to produce cellulose fiber and Protein fiber due to their molecular structure and mordant treatments the cellular fiber incudes bamboo , cotton , flax , Rayon etc and Protein fiber would include Wool , Silk , Angora , Leather and many more . Hack fruits , Indigo trees , Onion skin , Madder roots , Tumeric , Henna Leaves , Logwood , Lac insects are widely used for dyeing textiles materials like yarn , fiber , cloth

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II. LITERATURE REVIEW

The natural dye has a lot of benefits attach to it , the natural dye is environmental friendly , as the whole textile process results in pollution , and the dyeing process requires huge sum of water , natural dyes don't cause harm to the environment , they do not produce pollution and are biodegradable , moreover they are extracted from renewable sources in any cases , Natural dye are best when you want a smoothing colour followed by this they produce rare colour for the textiles which looks attractive and they don't cause harm to your health for instances the presences of carmine in lipsticks , even though the whole process is costly compared to the synthetic dye , like for one pound of cotton dying can be done with just 5 grams of synthetic fiber but for the case of natural dyes it requires 230 grams of natural dye , whereas for the case of natural dyes the colour even fades faster compared to synthetic dye , availability of natural dye is difficult as it is extracted for natural elements which grow based on seasons , whereas synthetic fibers can be easily obtained from the laboratories . In India, different culture has different dressing sense and all the clothing comprises of a mixture of colours . It is a country which is filled with different colours like marigold and turmeric was used to extract ocher colour in India , the outer onion skin colour has been used to extract the bright yellow tint for the wools , silks and cottons . The Madder plant which has been used for centuries in India, Turkey and Iran as natural dyes to produce red and Pink pigment. Today due to environmental crisis, textiles are adopting natural dyes over other dyes.

III. MATERIALS

1) *Fabric:* Bleached silk fabric was used for the experiment, specifications of which are given below.

Ends per inch	89
Picks per inch	86
GSM	120

2) *Chemicals Used:* Laboratory grade glacial acetic acid was purchased from Merck Company. The same has been used without any Further purification.
3) *Dye Used:* A commercial grade Indian Madder roots in powder form was obtained from Sam vegetables and Colors Pvt. Ltd, Moradabad (U.P.), India. The same has been used without any further purification.
4) *Machine:* Water dyeing bath was used for the tint of mantua fabric with Indian Madder natural colorant . UV spectrophotometer (x-rite) was finally used to determine the surface colour strength of the dyed samples.

IV. EXPERIMENT

In this experiment, bleached silk fabric was dyed with Indian Madder natural dye to determine the most optimum dyeing conditions (Schedule , converse and Application of dye). In order to do that, first silk fabric was dyed at 40^{o}C, 50^{o}C, 60^{o}C, 70^{o}C, 80^{o}C and 90^{o}C with a varying time i.e. 10 min, 20 min, 30 min, 40 min, 50 min, 60 min, 70 min and 80 min respectively. The samples were then taken to spectrophotometer to check the surface colour strength (K/S). With the values obtained, most optimum Schedule and converse profile for dyeing of silk with Indian Madder was determined. Using that optimum value, colourant process was further continued with varying dye concentrations ranging from 5% owm to 27.5% owm with an interval of 2.5%. Now surface colour strength of the new samples were measured.

A. Dyeing with Varying time and Temperature

First of all, the stock solution (1%) of Indian Madder natural dye was prepared. For this, 1 gramof dye powder was pasted with T.R. Oli and then 100 ml of purified water was added. The mixture was blend for 10 minutes.

B. Recipe and Conditions

Shade percentage – 10
Acetic acid - 3% on the weight of material.Dyeing temperature-40^{o}C
Dyeing time – 10 min, 20 min, 30 min, 40 min, 50 min, 60 min, 70 min, 80min.
pH – 4
MLR – 1:100
Before dyeing, the material samples were immersed in water for 10 minutes. The converse of the colourant bath was raised to 40^{o}C. The dyeing pots were put onto the dyeing bath with required amount of water and acetic acid. Next the dissolved dye solution was added to the pot and the mixture was blend.

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The material were next put into the dyeing pots and stirred continuously for better dyeing results. pH was checked and the temperature of the dyeing pots were constantly checked and adjusted as per the requirements. The fabric samples were withdrawn one by one at an interval of 10 minutes. The dyed fabrics were seared in shade at room converse . The tinting cycle for the study of exhaustion at 40°C at various time period has been shown in the figure below.

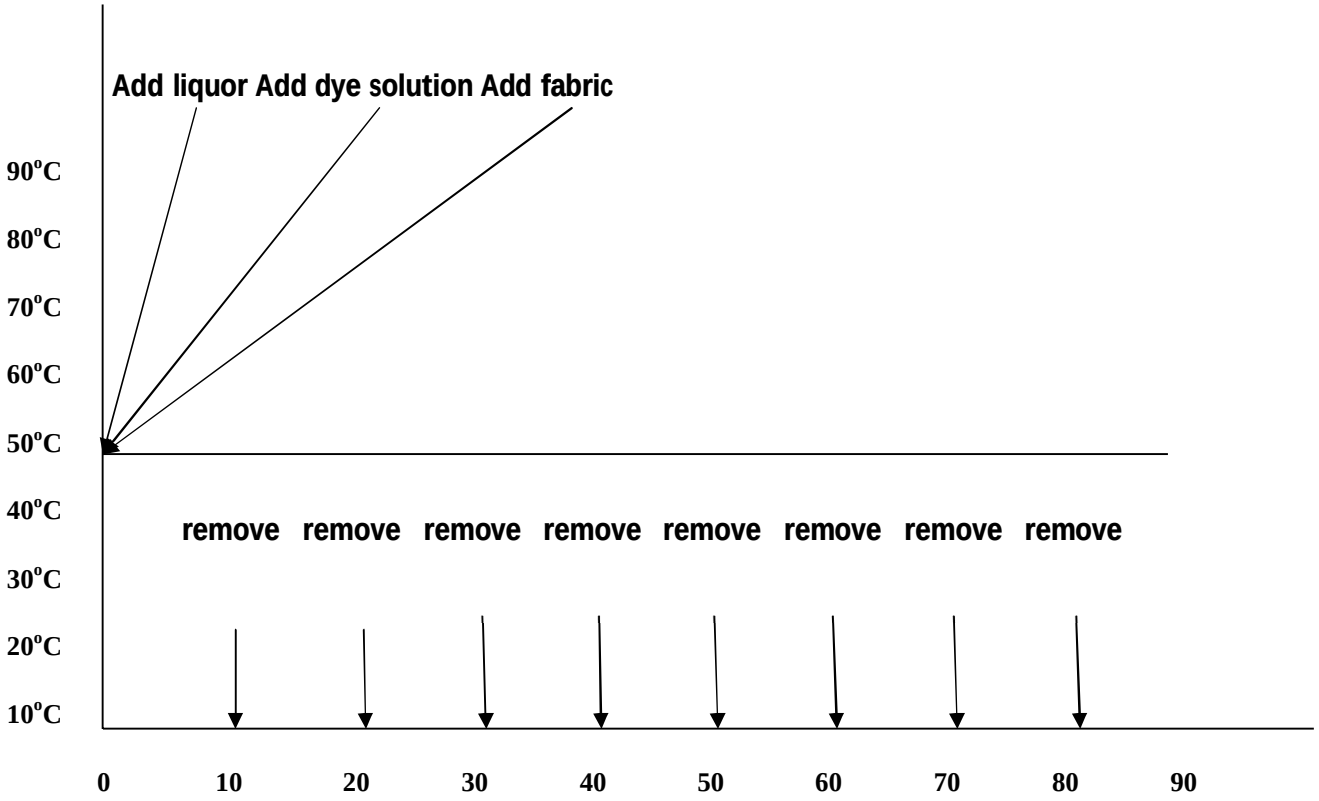

Figure 4: Cycle for study of exhaustion of Indian Madder on silk.

The same dyeing technique had been carried out to prepare samples at 50°C, 60°C, 70°C, 80°Cand 90°C. Total of 48 number of samples were prepared using this technique.

C. Dyeing with Varying Concentration of dye Solution

Using the optimum time temperature profile for dyeing of silk with Indian Madder natural dye, dye bath was prepared. Silk had been dyed with 5% shade, 7.5% shade, 10%shade, 12.5% shade, 15% shade, 17.5% shade, 20% shade, 22.5% shade, 25% shade, 27.5% shade at certain time and temperatures.

For this process, the stock solution (1%) of Indian Madder natural dye was prepared. For this, 1 gram of dye powder was pasted with T.R. Oli and then 100 ml of distilled water was added. The mixture was blend for 10 minutes.

D. Recipe and Conditions

Shade percentage – 5%, 7.5%, 10%, 12.5%, 15%, 17.5%, 20%, 22.5%, 25%, 27.5%
Acetic acid - 3% on the weight of material.Dyeing temperature-40°C
Dyeing time – 40 minpH – 4
MLR – 1:100

Again, the fabric samples were submerge in water for 10 minutes. The temperature of the dyeing bath was raised to 40°C. The dyeing pots were put onto the dyeing bath with required amount of water and acetic acid. Next the dissolved dye solution was added to the pot and the solution was stirred. The fabrics were next put into the dyeing pots and stirred continuously for better dyeing results. pH was checked and the temperature of the dyeing pots were constantly checked and adjusted as per the requirements. The fabric samples were withdrawn one by one at an interval of 10 minutes. The dyed fabrics were seared in shade at room temperature. The surface colour strength of the colorant samples were steady using reflectance spectrophotometer.

V. RESULTS AND DISCUSSION

A. *Surface Colour Strength Measurement of Samples*

The samples so prepared were taken to reflectance spectrophotometer for surface colour strength measurement. Details are shown in the following tables

B. *K/S value of Dyed Silk Samples at 40°C with variable time Scale.*

Time(min)	10	20	30	40	50	60	70	80
K/S value	3.51	3.74	4.28	4.84	4.35	4.2	4.21	4.23

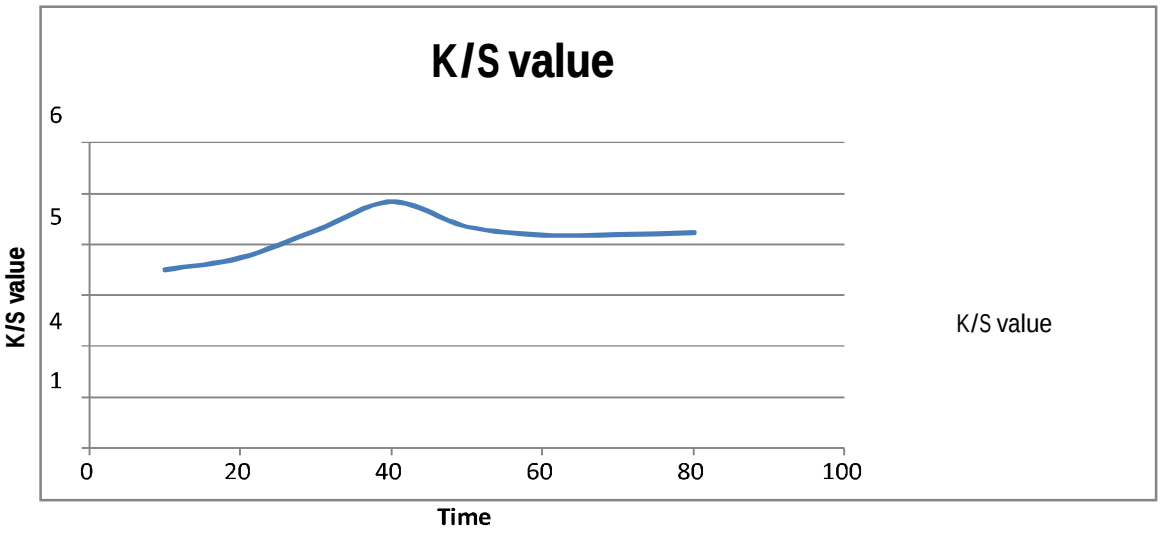

Figure 5: K/S value of silk dyed with Indian Madder with variations in dyeing time

From the chart and graph shown above, it is seen that surface colour strength increases with an increase in time from 10 min to 40 min. After 40 minute, the surface colour strength slightly decreases and remains unchanged with respect of time.

C. *K/S value of dyed silk samples at 50°C with variable time scale.*

Time(min)	10	20	30	40	50	60	70	80
K/S value	3.74	4.01	4.24	4.42	4.15	4.10	3.95	3.99

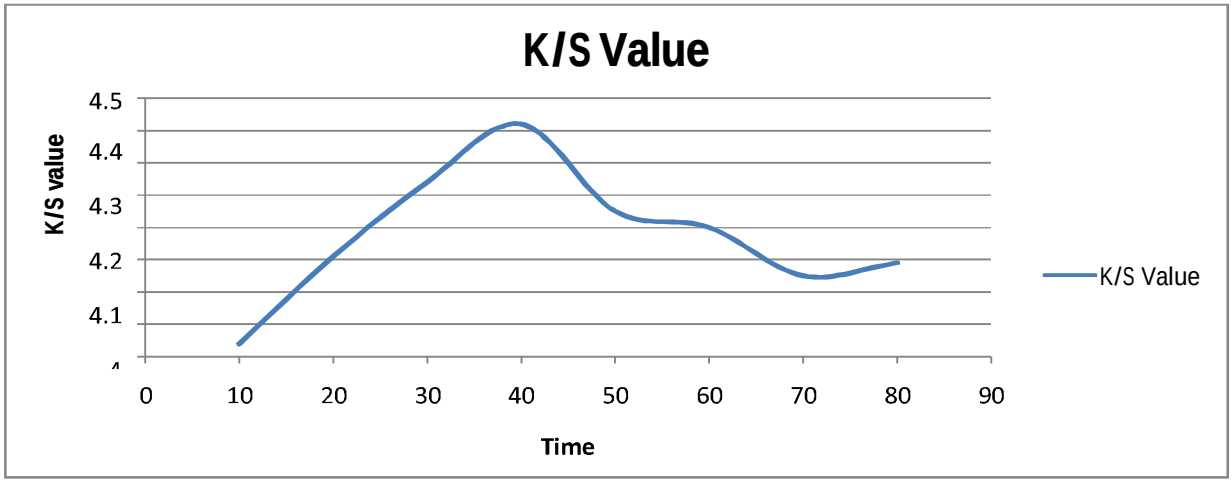

Figure 6: K/S value of silk dyed with Indian Madder with variations in dyeing time.

The above table and figure shows that when silk fabric is dyed with Indian madder natural dye, an increase in surface colour strength is observed till 40 min. The same is noticed to decrease when the dyeing process is carried out for 50 to 80 minute.

D. K/S value of dyed silk samples at 60°C with variable time scale.

Time(min)	10	20	30	40	50	60	70	80
K/S value	3.81	4.00	4.21	4.37	4.20	4.19	4.10	3.99

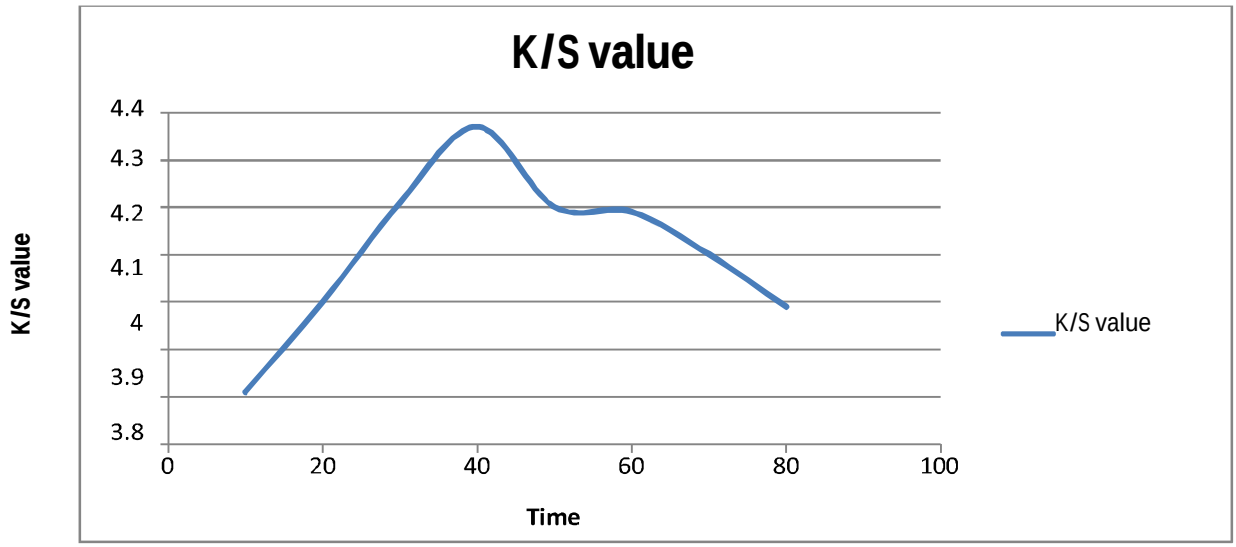

Figure 7: K/S value of silk dyed with Indian Madder with variations in dyeing time.

When silk fabric is dyed with Indian madder natural dye, significant change in surface colour strength is seen from 10 min to 40 minute, the value of which is 3.81 to 4.37. At the same time itis observed that further increase in dyeing time leads to a drop in surface colour strength value from 4.37 to 3.99.

E. K/S Value of Dyed Silk Samples at 70°C with Variable Time Scale.

Time(min)	10	20	30	40	50	60	70	80
K/S value	3.86	3.95	4.10	4.23	4.05	4.00	3.91	3.93

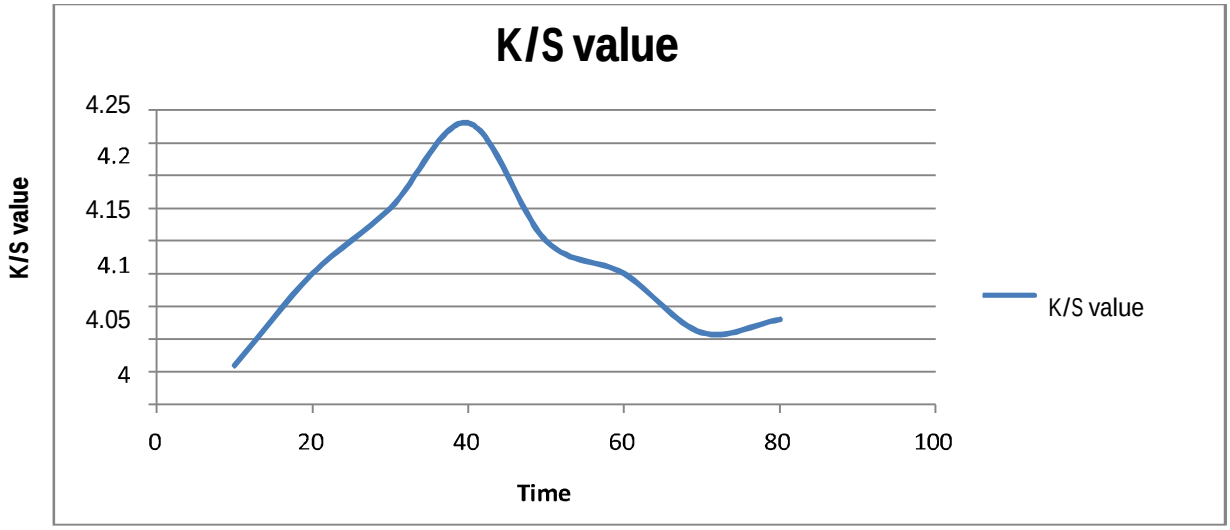

Figure 8: K/S value of silk dyed with Indian Madder with variations in dyeing time.

In the study of exhaustion of Indian Madder on silk fabric, at 70°C the surface colour strength value appears to be maximum when the dyeing time is 40 min. Dyeing for further time periods i.e. 50 min, 60 min, 70 min & 80 min shows abrupt reduction in the surface colour strength.

F. K/S Value of Dyed Silk samples at 80°C with variable time Scale.

Time(min)	10	20	30	40	50	60	70	80
K/S value	3.72	3.98	4.18	4.25	4.13	3.95	3.91	3.86

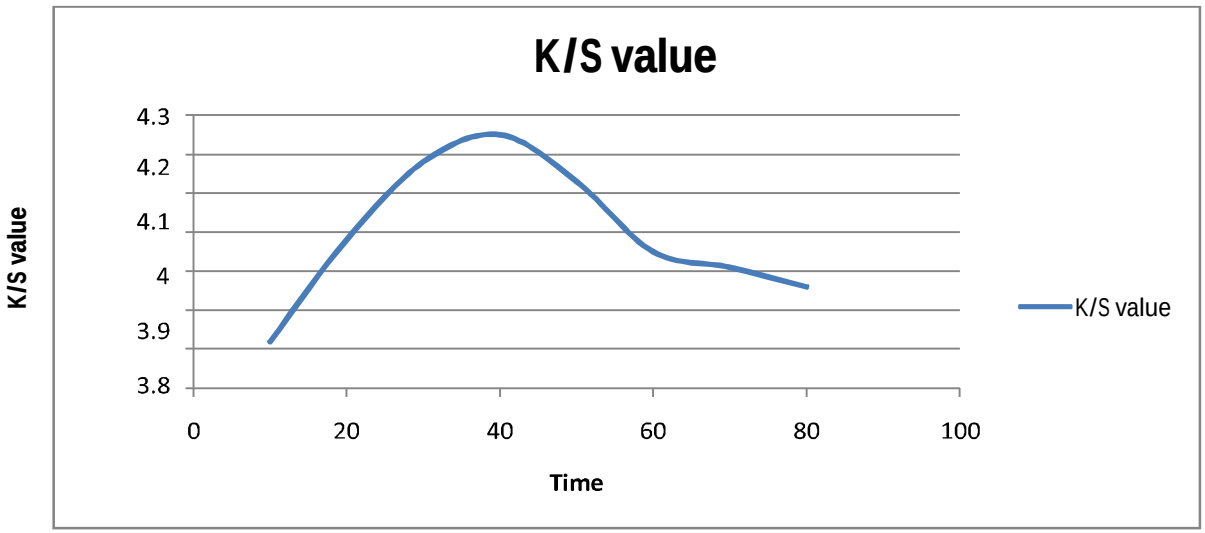

Figure 9: K/S value of silk dyed with Indian Madder with variations in dyeing time.

The above table and figure shows that when silk fabric is dyed with Indian madder natural dye, an increase in surface colour strength is observed till 40 min. The same is noticed to decrease when the dyeing process is carried out for 50 to 80 minute.

G. K/S Value of Dyed silk Samples at 90°C with Variable time Scale.

Time (min)	10	20	30	40	50	60	70	80
K/S value	3.89	4.01	4.08	4.12	4.23	4.17	3.99	3.88

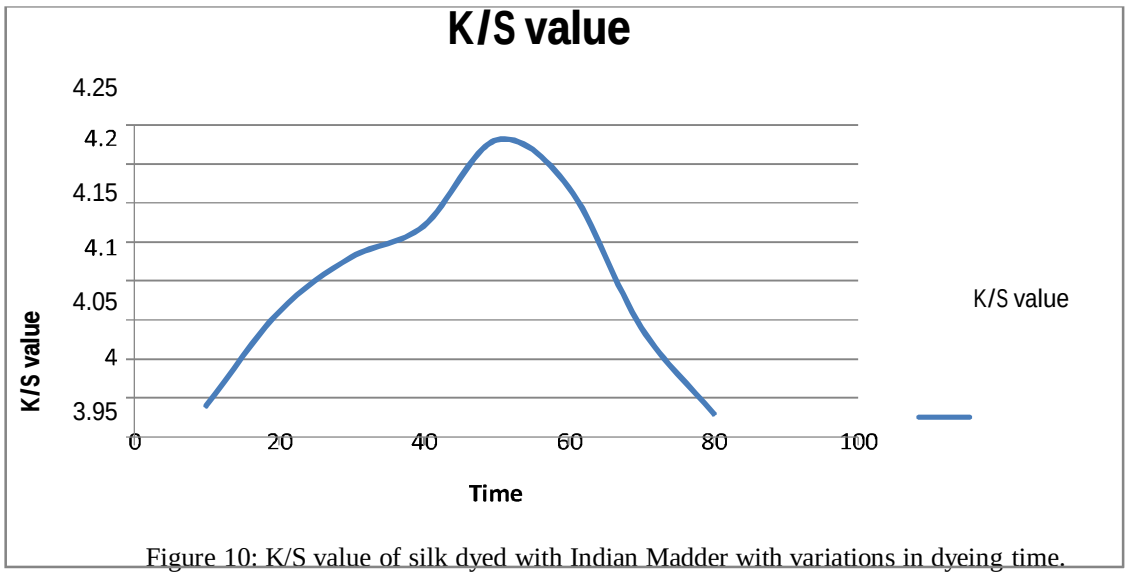

Figure 10: K/S value of silk dyed with Indian Madder with variations in dyeing time.

When Silk is dyed at 90°C the maximum surface colour strength is seen at 50 minute dyeing time. But a drop in the value of the same is also noticed in dyeing times like 60 min, 70 min &80 min.

H. K/S Values of Dyed silk Samples with Respect to Time & Temperature

	10 min	20 min	30 min	40 min	50 min	60 min	70 min	80 min
40°C	3.51	3.74	4.28	4.84	4.35	4.2	4.21	4.23
50°C	3.74	4.01	4.24	4.42	4.15	4.10	3.95	3.99
60°C	3.81	4.00	4.21	4.37	4.20	4.19	4.10	3.99
70°C	3.86	4.00	4.10	4.23	4.05	4.00	3.91	3.93
80°C	3.72	3.98	4.18	4.25	4.13	3.95	3.91	3.86
90°C	3.89	4.01	4.08	4.12	4.23	4.17	3.99	3.88

Table: K/S values of all samples prepared with varying time and temperature.

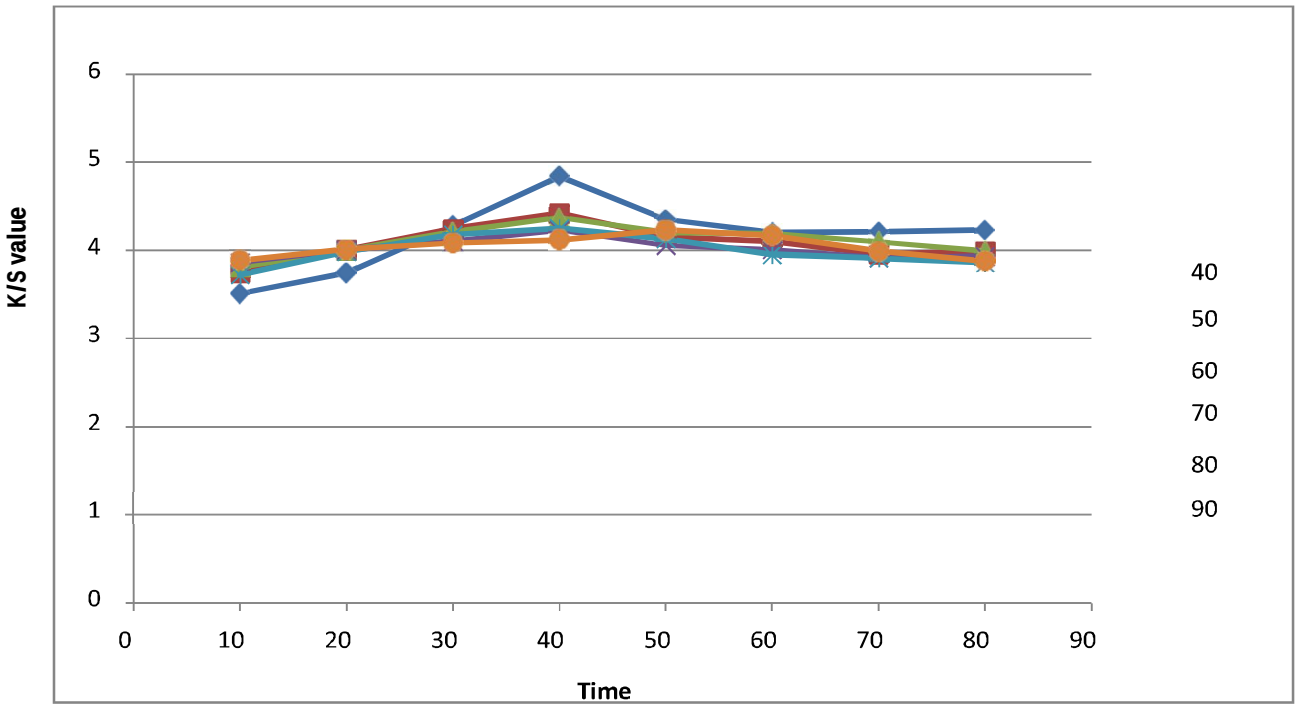

Figure 11: A comparative study of K/S values of all set of samples prepared with varying time and temperature.

The above graph represents the surface colour strength of sample which are dyed with varying time and temperature. It is clear from the figure that the maximum surface colour strength has been observed in case of the samples which are dyed for 40 minutes at each temperature except 90°C. At 90°C the maximum colour strength is measured at 50 minutes which is of no significance.

I. K/S Values of Samples dyed for 40 Minutes with Varying Temperatures.

Temperature	40	50	60	70	80	90
K/S value	4.84	4.42	4.37	4.23	4.25	4.12

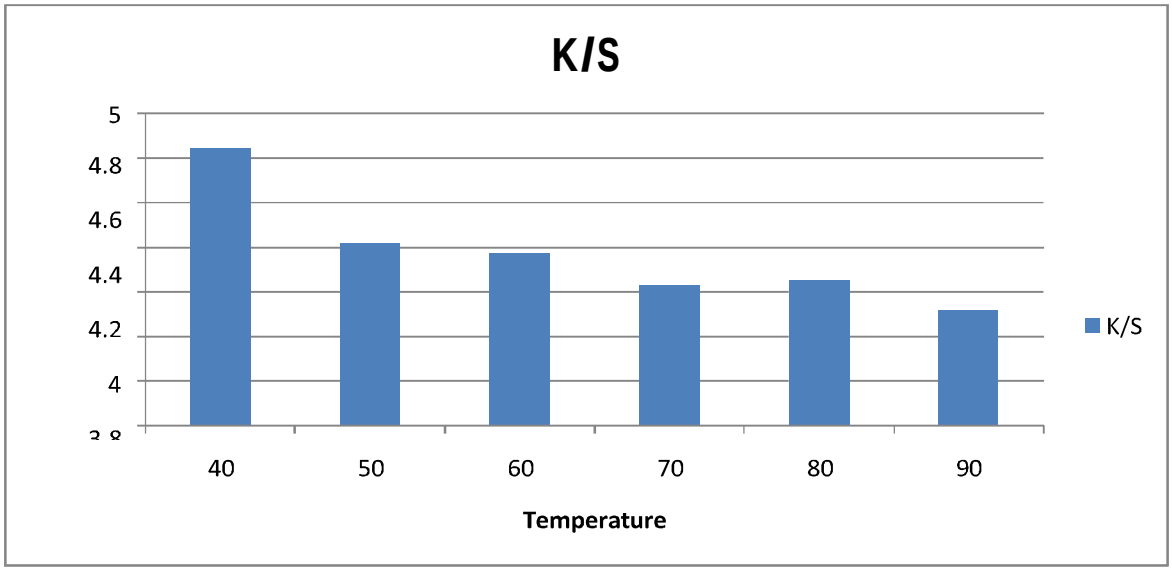

Figure 12: Change in K/S values with respect to temperature

J. Dye Saturation Concentration of Indian Madder on silk at 40°C for 40 Min

Concentrationof Dye	5%	7.5%	10%	12.5%	15%	17.5%	20%	22.5%	25%	27.5%
K/S value	4.49	4.69	4.90	5.21	5.53	5.95	6.33	6.32	6.30	6.33

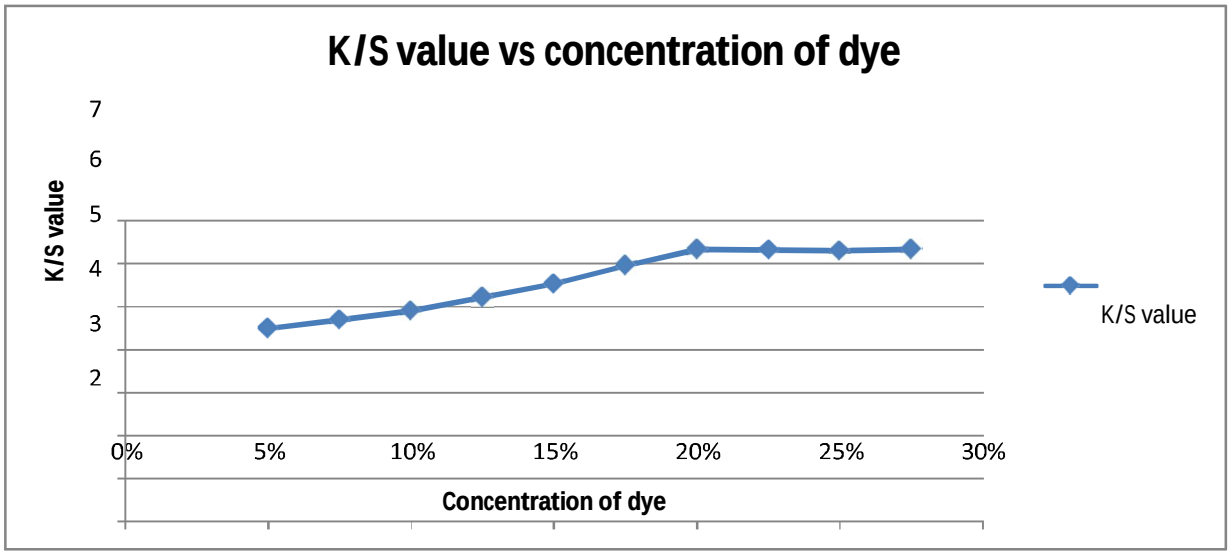

Figure 13: K/S value of silk dyed with Indian Madder with varying concentration of dye ata specific time and temperature.

Study of varying concentration of dye at a specific time and temperature had been done. The surface colour strength of the samples are shown in the above table and figure 8. It is seen that, with an increase in concentration of dye, the surface colour strength increases up to 20%. No significant change in the value is observed thereafter. As the values seem to have got the saturation at that point.

VI. CONCLUSION

From the above data which are found from the experiment, it can be concluded that

A. Maximum exhaustion is found in the sample which was dyed at 40°C for a time period of 40 minutes. No significant change above the said time and temperature is recorded. So, for dyeing of Silk fabric with Indian Madder natural dye, it is advisable to keep the exhaustion temperature 40°C and exhaustion time 40 minute. So, less amount of energy is needed and the process is time saving also.

B. Though above study was carried out using 10% dye concentration, it is found that the surface colour strength increases when the dye concentration is increased up to 20%. So, for darker shade, higher amount of dye can be used.

C. Maximum exhaustion at equilibrium decreases with an increase in temperature. That is why, it is better to keep the exhaustion temperature at 40°C.

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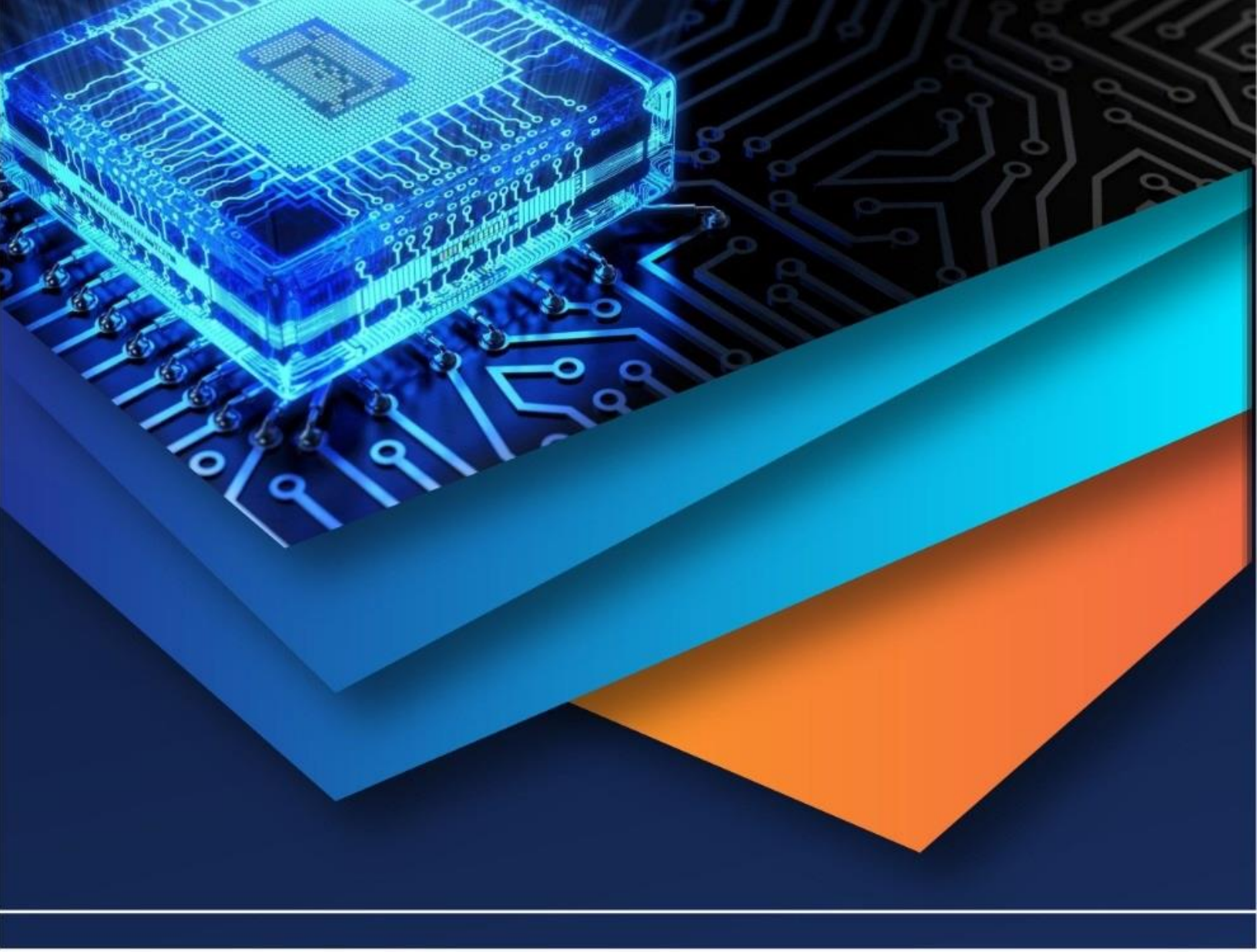

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