Faculty of Engineering

Department of Textile Engineering

STUDY OF THE EFFECTS OF MORDANTS ON DYEING OF COTTON AND SILK FABRICS WITH HENNA EXTRACTS

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Submitted by:

Md. Rakib Rayhan, ID: 143-23-4025
Sushmita Sairin: ID: 143-23-4030

Supervised by:
Sumon Mozumder
Assistant Professor

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Advance in Wet Processing Technology

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Sumon Mozumder, Assistant Professor,** Department of Textile Engineering, Faculty of Engineering, Daffodil International University. We also declare that, neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

Md. Rakib Rayhan
ID: 143-23-4025
Department of TE
Daffodil International University

Sushmita Sairin
ID: 143-23-4030
Department of TE
Daffodil International University

LETTER OF APPROVAL

This project report prepared by **Md. Rakib Rayhan** bearing **Id: 143-23-4025** and **Sushmita Sairin** bearing **Id: 143-23-4030**, is approved in Partial Fulfillment of the Requirement for the Degree of BACHELOR OF SCIENCE IN TEXTILE ENGINEERING. The said students have completed their project work under my supervision. During the research period I found them sincere, hardworking and enthusiastic.

SUMON MOZUMDER
ASSISTANT PROFESSOR
DEPARTMENT OF TEXTILE ENGINEERING
FACULTY OF ENGINEERING
DAFFODIL INTERNATIONAL UNIVERSITY

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ABSTRACT

This study was started to assess the effect of different kinds of mordant (Ferrous Sulphate-$FeSO_4$, Alum-$KAl_2(SO_4)_3$, 2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$, 2g/l $KAl_2(SO_4)_3$ + 2g/l $FeSO_4$) uses for mordanting before dyeing with henna dye on both cotton and silk fabric. Mordanting is the process of making the fabric friendlier for the natural dye. Mordanting process is to increase the affinity of fiber to dye absorbency. This project was mainly focused on the effect of using different kinds of mordant and the combination of mordant using before dyeing with henna dye. To meet the demand of this project the work was to measure the stitch length, EPI, PPI, WPI, CPI, GSM, color fastness to wash and color fastness to dry and wet rubbing. The color fastness to wash and color fastness to dry & wet rubbing test were carried out to determine the dye color strength of the dye for using different kinds of mordant. For this project we took two type of fabric one is cotton single jersey fabric and another one is silk plain weave fabric. After completing all the work and analysis of this project we found that both cotton and silk were showing the changes in EPI, PPI, WPI, CPI, SL, GSM but silk show less changes than cotton and 2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$ was showing good resistance of color against rubbing and washing. For dye absorbency cotton was better than silk but for color fastness properties silk was far better than cotton. In case of dry and wet rubbing test cotton and silk both shows poor quality of color fastness. In case of wet rubbing it was too difficult to compare among the mordants for their quality.

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INTRODUCTION

Chapter-1
Introduction

Natural have been used since the commencement of the well-organized society. Dyeing with natural dye comprises some colorants which could be obtained without chemical process from animal and vegetable matters. The word of natural dye covers all types of dye which contain coloring matter can be extracted from different methods and mainly derived from the natural sources like leaves, fruits, roots, stems, barks, seeds etc.

Now a days synthetic dyes have been widely used for their wide range of bright shade and low price and comparing with natural dye with considerably improved color fastness properties. From petrochemical sources almost all the synthetic dyes being synthesized through hazardous chemical process which pose threat for our environment and also for human body health. And recently all over the world the main raising issue is environmental issue. And this is one of the important reason behind of transferring from synthetic dyes to natural dyes.

The main motive of using natural dye is to make the dyeing process environmental friendly and hygienic.

Hence focusing in natural dyes has increased considerably on the account of their higher compatibility with the environment. , as well as the availability of various types of natural coloring resources from plants, insects, minerals and fungi. Itt is reported that some natural dye can not only dye fabrics in unique and elegant colors abut also impart antibacterial and ultraviolet protective functions.

Lawsoniainermis L., generally known as Henna is small or shrub tree which often cultivated in some countries like India, Pakistan, Iran, Afghanistan, Yemen, Egypt and Sudan also. Powdered leaves of this plants are used as a cosmetic color for staining hand and hair and also sometimes it's used to dye the textiles. The dyeing properties as well as the UV absorption is attributed to the presence of Lawson, 2-hudroxy-1, 4-naphthaquinone in henna leaves.

1.1 Object of the study

The **broad objective** of this study is to study on the effects of mordants on dyeing of cotton and silk fabrics with henna extracts

The **specific objectives** of the project are mentioned below:

- ✓ To evaluate the resistance of natural color to rubbing and washing.
- ✓ To evaluate the changes of some fabric properties.
- ✓ To evaluate the dyeing properties of henna dye.
- ✓ To evaluate the difference between the dye absorbency of cotton and silk.

CHAPTER- 02

LITERATURE RIVEW

Chapter-2
Literature Review

2.1 Henna

Generally henna is being known as hennotannic acid or lawsone, a red orange pigment. It is seems as the chief constituent of henna leaves. According to the illustration of industrial classification lawsone is natural orange 6 and CI 74480 which is chemically known as 2-hydroxyl-1, 4-napthoquinone. For protein fiber and also for other textile fibers henna act as a substantive dye and it imparts orange color on the substrate. And as like other natural dyes it has different types of remarkable advantages like for health issue it does not possess any hazard, it easily harmonized with nature, it has a very much little chemical reactivity and adverse environmental problem.

1 2 3 4

Figure- 2.1: Henna Powder

2.1.1 Varieties of Henna

Natural henna

Natural henna produces a rich red brown stain which can darken in the days after it is first applied. It is most of the times known as "red henna" to differentiate it from products sold as "black henna" or "neutral henna" may not actually contain henna, but are instead made from other plants or dyes [1].

- ✓ Neutral henna
- ✓ Black henna

- ✓ Para-Phenylenediamine

2.2 Cotton Fiber

Cotton is a natural fiber, generally growing on a ball of cotton plant or sometimes in the seed pot. The composition of cotton fiber is of about 90 % cellulose and around 6% moisture. The remaining percentage contain natural impurities such as oil, wax, fat etc. The cotton fiber comes from the fruit of the cotton plant which grows in tropical regions. The fiber is known as 'seed hair' since it is the fibrous fluffy material which comes from the seeds of the plant. The fluffy material which covering the seed is also called 'ball' [4].

To know about cotton we have to know about the physical and chemical properties of cotton, I have mentioned some physical and chemical properties of cotton below.

2.2.1 Physical Properties of Cotton

- ✓ **Tenacity –** The properties of tenacity of cotton is very good.
- ✓ **Elasticity –** it has good elasticity for its crystalline polymer. And that's why cotton is wrinkle and crease readily.
- ✓ **Hydroscopic Nature –** It has hydroscopic properties. And it has polar OH group.
- ✓ **Thermal properties –** Cotton is less thermoplastic.
- ✓ **Luster –** cotton is less lusters.
- ✓ **Strength-** cotton have relatively strong strength. .
- ✓ **Resilience-** Cotton hase moderate resilience properties.
- ✓ **Drapability-** Drapability of cotton is good.
- ✓ **Absorbency–** Most of the time it depends on the structure of cotton.
- ✓ **Specific gravity-** It has the specific gravity of 1.52
- ✓ **Tenacity-** It has the tenacity of 4.0
- ✓ **Moisture Regain-** Cotton has the moisture regain of 7.5 [5]

2.2.2 Chemical Properties of Cotton

- **Effects of alkalis –** These fibers are very much resistant to alkalis and are comparatively unaffected by normal laundering.
- **Effect of Acids –** Cotton fibers is very week to the resistance to acid.
- **Effect of Bleaches** – Sodium hypochlorite and sodium perborate are comparatively more friendly to cotton.
- **Effect of Sunlight and weather –** The resistance of cotton to ultra violet rays of of sunlight is not so good, because it could be degrade.
- **Color Fastness –** The color fastness properties of cotton is comparatively good than other fabric [6].
- **Mildew –** Fungi could be threaten for cotton.
- **Insects –** Cotton has less threat for insects.

2.3 Silk

Silk is an animal fiber and it is also known as protein fiber. Silk is the only natural fiber which is found in the form of filament. Silk is produced by insects. The main chemical components of silk is fiber [7].

As like as all the textile fibers, silk has its own physical and chemical properties which are required to know for better processing in spinning, weaving, knitting, dyeing, printing as well as finishing. Here, I have written about physical and chemical properties of silk fiber.

2.3.1 Physical Properties of Silk

- **Color-** The color of silk fiber could be yellow, brown, green or grey.
- **Tensile Strength-** Silk is a strong fiber. It has a tenacity of 3.5 – 5 gm/den. The strength is greatly affected by moisture; the wet strength of silk is 75 – 85%, which is higher than dry strength.

- ✓ **Elongation at break-** 20 -25% at break.
- ✓ **Elastic Recovery-** Not so good.
- ✓ **Specific Gravity-** Specific gravity is 1.25 to 1.34.
- ✓ **Moisture Regain (MR %) -** Standard moisture regain is 11% but can absorb up to 35%. [8]
- ✓ **Effect of Heat-** Silk could be resist higher temperatures than wool. It will remain unaffected for prolonged periods at 1400C. Silk decomposes at 1750C.
- ✓ **Effect of Sun Light-** Sun light tends to encourage the decomposition of silk by atmospheric oxygen.
- ✓ **Luster-** Bright.

2.3.2 Chemical Properties of Silk

- ✓ **Effect of Acids-** Sometimes acid could decompose silk fiber.
- ✓ **Effects of Alkalis-** Comparing to wool silk could be less affected by alkalis.
- ✓ **Effect of Organic Solvent-** Commonly silk is insoluble to organic solvents.
- ✓ **Effects of Insects-** Silk will not affected by insects.
- ✓ **Effect of Mildew-** silk could be slightly affected by mildew.

2.4 Scouring of Cotton

Textile scouring is a process in which the fabric is treated with alkali at room temperature or at suitable higher temperatures and by this process oil, fat, wax and other natural and added impurities are removed. Absorbency of the fabric also increases a greater extent in this process i.e. makes the fabrics highly hydrophilic. It also helps to clean textile material by adding alkali. It is a vital process of wet processing.

2.4.1 Scouring reaction:

During scouring HaOH will react with the steeric acid and for this reaction oil, wax fat is removed and the surface of the fabric become hydrophilic.

$C_nH_{2n+1}COOH + NaOH = C_nH_{2n+1}COONa + H_2O$

2.4.2 Impurities of raw cotton:

Raw cotton contains a wide range of organic and mineral impurities in such amount that vary according to the origin of the cotton.

Pectins 0.7-1.2%

Waxes 0.4-1%

Proteins 1.1-1.9%

Inorganic components 0.7-1.6%

Other organic compounds 0.5-1.0%

2.4.3 Objects of scouring:

- ✓ To remove natural fat, wax and oil materials containing in the fabrics without damaging the fibers.
- ✓ To accelerate dye and chemical absorption of the fabrics.
- ✓ To improve the handle of the goods.
- ✓ To remove natural color and make the fabric ready for next process.
- ✓ To remove non-cellulosic substance in case of cotton.

2.4.4 Changes occurring of cotton fiber during scouring process:

- ✓ Oil, wax fat changes into soap.
- ✓ Salt and pectic acid produced from pectine and pectos.

- ✓ Degradation of protein occurred.
- ✓ Desolation of mineral matters.

2.4.5 Scouring process of cotton depends on:

There are some factors which are responsible for scouring effects of cotton. They are:

- ✓ The type of cotton
- ✓ The color of cotton
- ✓ The cleanliness of cotton
- ✓ The twist and count of the yarn
- ✓ The construction of fabric

2.4.6 Chemical used:

For scouring of cotton fabric the main chemical is caustic soda and soda ash. There are also used surfactants, detergents, chelating agents, sodium silicates, builder, solvent etc.

Auxiliary chemicals:

- ✓ Leveling agent
- ✓ Tinting agent
- ✓ Wetting agent
- ✓ Solvent
- ✓ Form of scouring:

2.4.7 Yarn and fabric scouring is done in different form. They are:

Yarn scouring:

- ✓ Hank form
- ✓ Package form
- ✓ Continuous sheet warp form

Fabric scouring:

- ✓ Open width form: a. Jigger, b. Padbatch, c. Progressive jigger
- ✓ Rope form: a. Kier, b. Washer

2.4.8 Scouring process:

- ✓ Batch process
- ✓ Semi-continuous process
- ✓ Discontinuous process
- ✓ Modern process

2.4.9 General Recipe of Scouring of Cotton

Wetting agent: 0.5-1.0 g/L

Detergent: 1.0-2.0 g/L

Sequestering agent: 1.0-3.0 g/L

Caustic soda: (36oBe) 2.0-4.0 g/L

Temperature: 95-100oC

Time: 15-45 minutes

pH: 10.5-11.0

M:L – 1:10

2.5 Degumming of Silk

As like as scouring of cotton silk also need a treatment of degumming. On silk there is substance called gum and the chemical compound of gum is sericin which produce a protective layer on the surface of silk and it’s a big problem for dyeing. So before dyeing of silk sericine should be removed by doing degumming process. [10]

Table 2.1. Typical Recipe for Silk Degumming:

Wetting agent = 0.5-1.0 g/l	Sequestering agent = 1.0-2.0 g/l
Antifoaming agent = 0.5-1.0 g/l	Natural soap = 15.0-30.0 g/l
TSP/Soda ash = 1.0-3.0 g/l	Detergent = 1.0-3.0 g/l (not mandatory if use soda)
Temperature = 90-95°C	Time = 90-120 min
pH = 9.5-10.5	M:L = 1:10

2.5.1 Working Procedure:

- ✓ At first set the bath with substrate at room temperature and soap and other necessary auxiliaries are added.
- ✓ Add trisodium phosphate (TSP) or soda ash if necessary to maintain desired pH 9-10.
- ✓ Raise the temperature to 95° and run for 2 hours for optimum removal of sericin gum.
- ✓ Cool down the temperature to 70°C and then drop the bath.
- ✓ Wash it with warm and cold water successively.

2.6 Mordanting

Mordant is added to the dye source to influence it, it does not serve as a color source on its own. The fabric is impregnated with the mordant, then during the dyeing process the dye reacts with the mordant, forming a chemical bond and attaching it firmly to the fabric.

The choice of mordant depends upon the fabric. An alkali mordant, such as soda ash, works well with cotton, and acid mordant such as vinegar works well with wool [11].

2.6.1 Methods of Mordanting

The amount of chemical maintenance is very important for mordanting. Sometimes quality of dyeing depends on mordanting process. Mordanting could be done by three methods [12]. They are as follows:

- ✓ Pre-mordanting, where the mordant is applied first, followed by dyeing.
- ✓ Post-mordanting, where the dyeing is done first and then mordantingis carried out.
- ✓ Simultaneous mordanting, where mordant and dye are mixed together and applied.

2.6.2 Different types of Mordants

There are different types of mordant depending upon toxicity, commercial availability, acidity, alkalinity etc.

2.6.3 Common mordants used in Natural dyeing

Alum: Alum is the most common mordant so far.

Iron: These mordant basically used in case of dyeing of cotton and wool fiber.

Tin: It’s used for boom and brighter color. .

Blue vitriol: It’s used for sadden color. It also act as a good additives.

Tannic acid: basically it’s used for vegetable fiber.

Cream of tartar: Used as additives sometimes for getting better evenness.

2.7 Dyeing with Henna Dye

2.7.1 Extraction of Henna Dye

Drying of the fresh leaves of henna in the sunlight for 1 day and then dried at 80 °C for 1 h in an oven followed by washing and cleaning with distilled water. Dried leaves were ground to powder form to make sure that the extraction results will be proper and desirable. The extracts were obtained by soaking the henna powder in water–ethanol mixture (90:10 v/v) at room temperature for 24 h.

2.7.2 General Dyeing Procedure of Cotton with Henna Dye

Without addition of salt using cat ionized cotton fabric will dyed with henna dye by using exhaust method. Samples were immersed in a dye bath composed of Henna extract (1%) and sodium carbonate (15g/l), using dye liquor ratio (1:20). [13] All the dyeing experiments were carried out at a general temperatures of 80℃ 100 90℃ for 40 min, 60 min and 80 min respectively. After that the cotton fabric carried out from the dye bath and rinse with cold water. After rinsing wash could be done.

2.7.2 Measurement of Color Strength and Related Parameters

Color measurement spectrophotometer is used to analyze the color yield of henna dyed fabric sample. The depth of color of the dyed fabric was determined by analyzing the K/S value of a given dyed sample by Kubelka–Munk equation

KS= (1−R) 22R

Where R reflectance percentage; K absorption co-efficient; and S scattering co-efficient of dyes. This value was derived from the attenuation ratio of light due to absorption and scattering, which was found based on reflectance.

2.7.3 Determination of Colorfastness Properties

The colorfastness property of dyed fabric samples against washing was conducted according to ISO 105-C03: 1989 by wash fastness tester. The color fastness to rubbing was performed according to ISO 105-X12:2016 by rubbing fastness tester.

CHAPTER- 03

EXPERIMENTAL DETAILS

Chapter-3
Experimental Details

3.1 Materials

In order to complete this project we took two grey fabric samples, one is cotton and another one is silk. The specification of those samples are mentioned below in the Table 3.2

Table 3.1: Sample Specification

Sample No.	Fabric Composition	Fabric Type	GSM	WPI/EPI	CPI/ PPI	TPI	Stitch Length(mm)	Yarn Count	Yarn Twist Direction
01	100% Cotton	Single Jersey	140	30	59	22	2.54	28Ne	Z
01	100% Silk	Plain Weave	91	166	65	20		110d	Z

Chemicals used in Scouring & Bleaching

- ✓ Detergent
- ✓ Sodium hydroxide
- ✓ Hydrogen peroxide
- ✓ Peroxide stabilizer
- ✓ Sequestering agent

Chemicals Used in Degumming

- ✓ Detergent
- ✓ Soap solution
- ✓ Soda ash
- ✓ Sequestering agent

Chemicals Used in Bleaching of Silk

- ✓ Hydrogen peroxide
- ✓ Peroxide stabilizer
- ✓ Wetting agent
- ✓ Soda ash
- ✓ Sequestering agent

Chemicals Used in Mordanting of Fabric

- ✓ Mordant
- ✓ Ferrous Sulphate

The function of the chemicals used regarding our project are discussed below on Table 3.2

Table 3.2: Functions of Chemicals

Name of Chemicals	Function
Detergent	It used to remove stains and to clean the material
Sodium hydroxide(NaOH)	Its function is to create the covalent bond and fixed the color of the fabric. It also used to increase the absorbency of the fabric and to control pH.
Peroxide stabilizer	It used to keep the hydrogen peroxide active during bleaching.
Hydrogen peroxide(H_20_2)	Its function is to remove the natural color of the fabric.
Sequestering agent	It’s used to reduce the water hardness and also to deactivate the metal ions.
Soda ash(Na_2Co_3)	Its main function is to maintain the pH
Ferrous sulphate ($FeSo_4$)	It’s used as a color shifter
Wetting agent	It used to reduce the surface tension of water.

3.2 Methods

Scouring and Bleaching of Cotton

To increase the dye absorbency and whiteness of cotton fabric sample scouring and bleaching process were carried out at combined stage with detergent, sodium hydroxide, of hydrogen per oxide, of peroxide stabilizer and of sequestering agent at the boiling temperature for 60 minutes.

Table 3.3: Scouring & Bleaching Recipe of Cotton

Name of Item	Dossing
Detergent	1 g/l
Sodium hydroxide	3 g/l
Hydrogen peroxide	4 g/l
Peroxide stabilizer	1 g/l
Sequestering agent	0.7 g/l
pH	10.7
Sample Weight	8 gm
M:L	1:40
Temperature	100^0 C
Time	30 min.

Calculation:

Total liquor: 32 × 30 = 1280ml

Detergent: (1× 1280)/1000 = 1.28 gm

Sodium hydroxide: (3×1280)/1000 = 3.84 gm

Hydrogen peroxide: (4×1280)/1000 = 5.12 gm

Peroxide stabilizer: (1× 1280)/1000 = 1.28 gm

Sequestering agent: (0.7×1280)/1000 = 0.896 gm

Process Flowchart of Scouring

Collection of sample

↓

Preparation of the solution

↓

Checking pH

↓

Scouring and bleaching of sample at 100^0 C for 30 minute

↓

Cold rinsing

↓

Cold wash

Process Curve of Scouring & Bleaching of Cotton

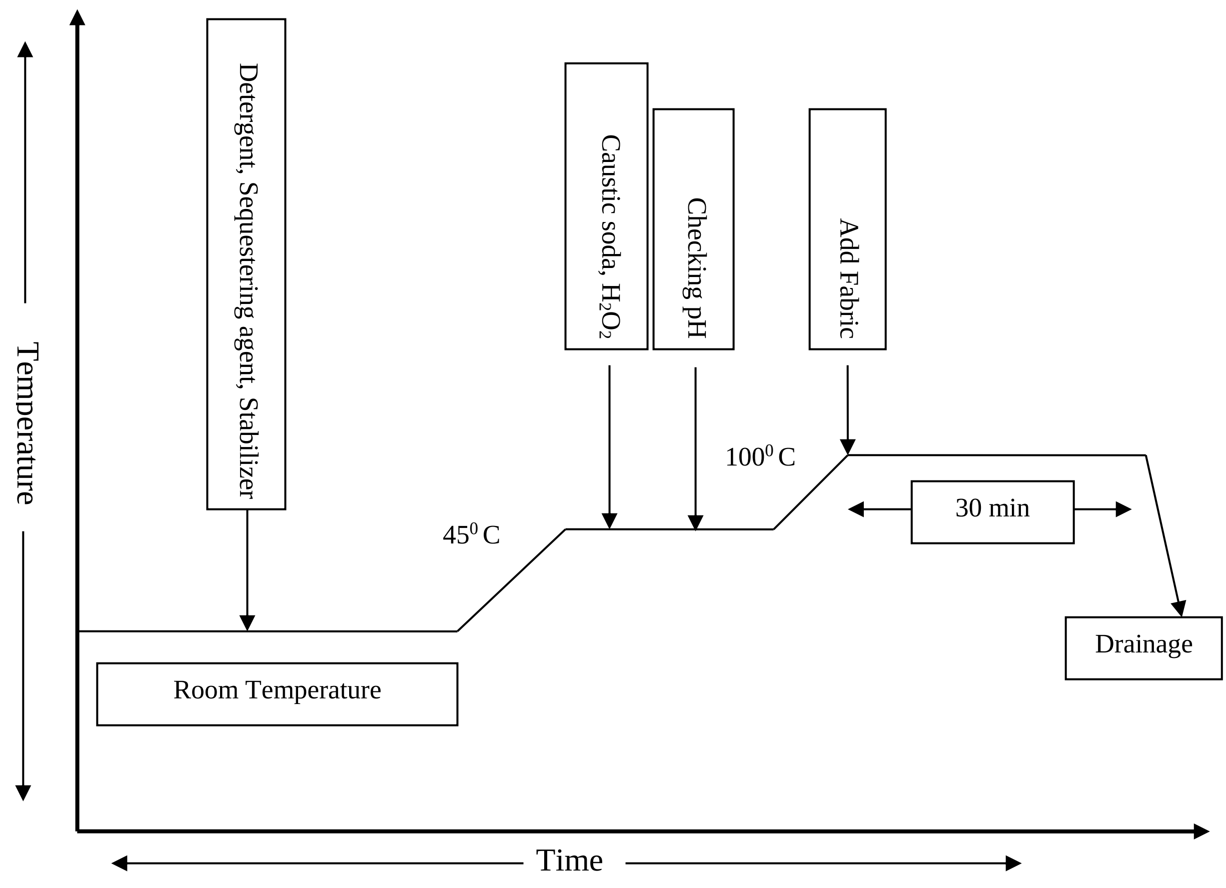

Figure-3.1: Process Curve of Scouring & Bleaching of Cotton

Degumming & Bleaching of Silk

Due to having gummy substance, called as sericin in its structure, silk sample was not hydrophilic, so it was needed to do degumming process on the fabric sample with detergent, soap solution, soda ash and sequestering agent at 80˚C temperature for 60 minutes. After that, cold rinsing and hot wash at 70˚C were done on the silk pre-treated sample. In addition to this, bleaching process later on silk samples could improve the whiteness by decomposing the natural color bodies from it. This bleaching process was carried out at 70˚C for 60 minutes with wetting agent, soda ash, hydrogen per oxide, peroxide stabilizer and sequestering agent.

The recipe of degumming and bleaching of silk are given below on the Table 3.4 and Table 3.5

Table 3.4: Degumming Recipe of Silk

Name of Item	**Dossing**
Detergent	1 g/l
Soap solution	10 g/l
Soda ash	2 g/l
Sequestering agent	0.7 g/l
pH	10.2
Sample Weight	8 gm
M:L	1:40
Temperature	80^0 C
Time	30 min

Calculation:

Total liquor: 32 × 30 = 1280ml

Detergent: (1× 1280)/1000 = 1.28 gm

Soap solution: (10×1280)/1000 = 12.8 gm

Soda ash: (2×1280)/1000 = 2.56 gm

Sequestering agent: (0.7×1280)/1000 = 8.96 gm

Table 3.5: Bleaching Recipe of Silk

Name of Item	Dossing
Hydrogen peroxide	3 g/l
Peroxide stabilizer	1 g/l
Wetting agent	0.8 g/l
Soda ash	3 g/l
Sequestering agent	0.7 g/l
pH	10.5
Sample Weight	8 gm
M:L	1:40
Temperature	70^0 C
Time	30 min

Calculation:

Total liquor: 32 × 30 = 1280ml

Hydrogen peroxide: (3×1280)/1000 = 3.84 gm

Peroxide stabilizer: (1× 1280)/1000 = 1.28 gm

Wetting agent: (0.8×1280)/1000 = 1.024 gm

Soda ash: (3×1280)/1000 = 3.84 gm

Sequestering agent: (0.7×1280)/1000 = 8.96 gm

Process Flowchart of Degumming of Silk

Collection of sample

↓

Preparation of the solution

↓

Checking pH

↓

Degummin of sample at 80^0 C for 30 minute

↓

Cold rinsing

↓

Cold wash

Process Curve of Degumming of Silk

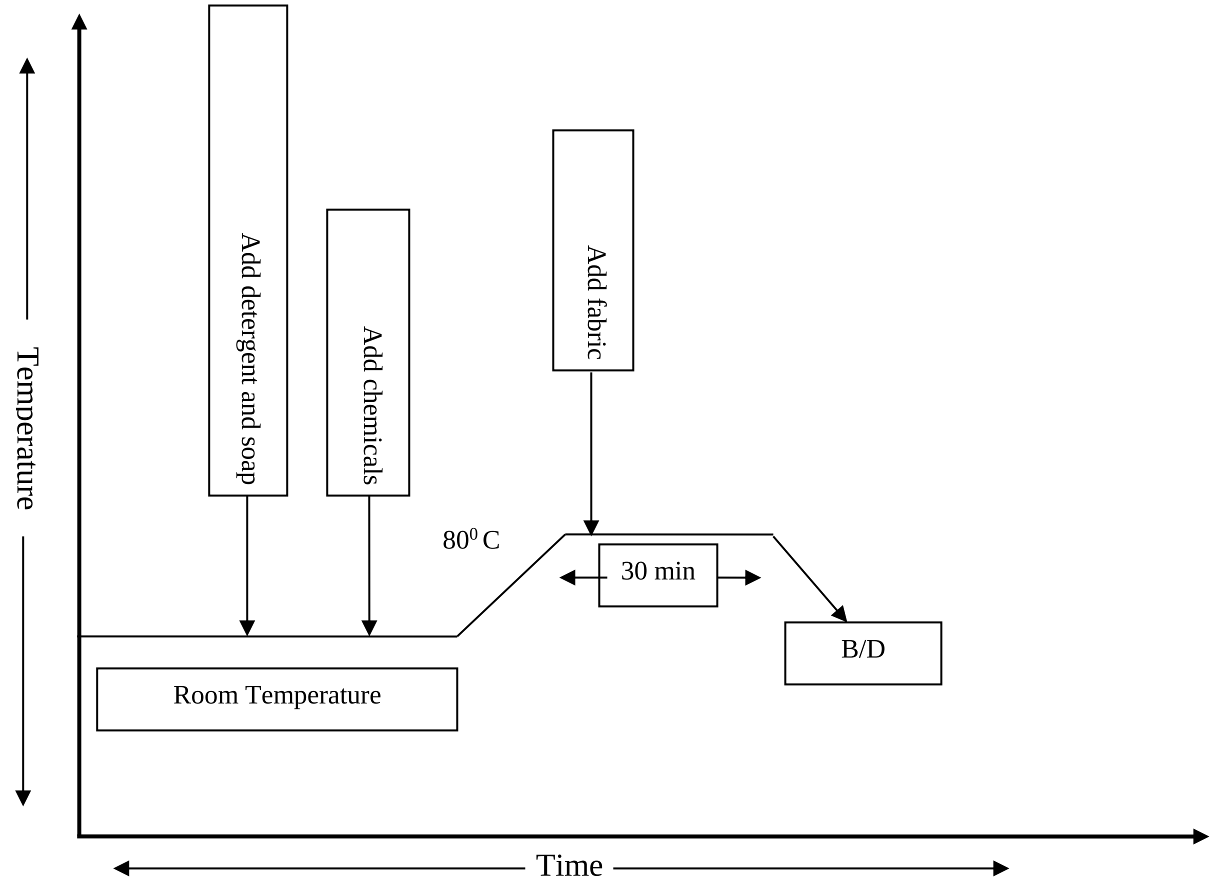

Figure-3.2: Process curve of degumming

Process Flowchart of Bleaching of Silk

Collection of sample

↓

Preparation of the solution

↓

Checking pH

↓

Bleaching of sample at 70^0 C for 30 minute

↓

Cold rinsing

↓

Cold wash

Process Curve of Bleaching of Silk

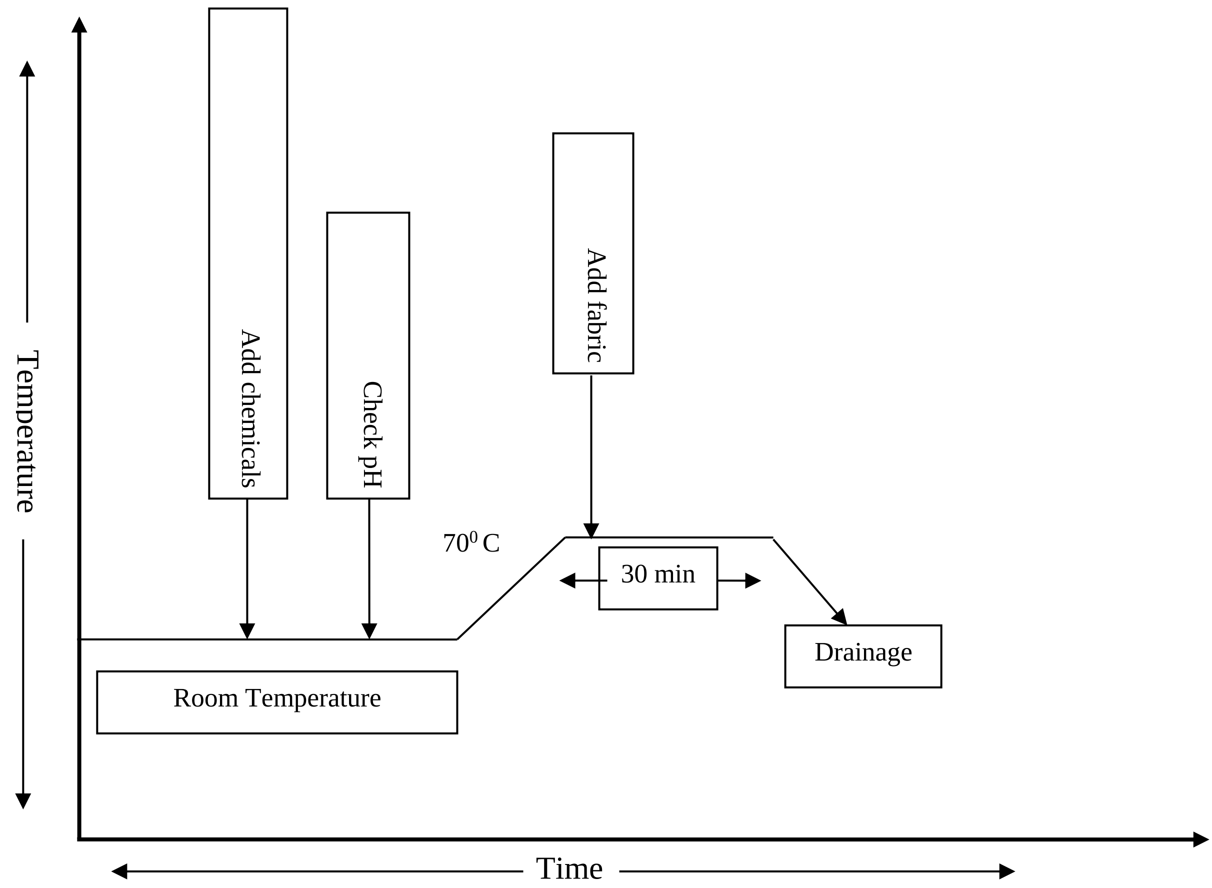

Figure-3.3: Process curve of bleaching of silk

Mordanting of Cotton & Silk

It is a process made using mordants, especially mineral or synthetic salts (such as potassium alum), but also vegetable materials (such as tannins). Depending on the type of natural fiber to be dyed, the techniques for mordanting may vary. [11]

Table 3.6: Bleaching Recipe of Silk

Name of Item	**Dossing**
Ferrous Sulphate-$FeSO_4$	3 g/l
Alum-$KAl_2(SO_4)_3$	3 g/l
$FeSO_4$ + $KAl_2(SO_4)_3$	2 g/l + 1 g/l
$KAl_2(SO_4)_3$ + $FeSO_4$	2 g/l + 1 g/l
Sample Weight	8 gm
M:L	1:40
Temperature	100^0 C
Time	30 min

Process Flowchart of Mordanting of Cotton & Silk

Collection of sample

↓

Preparation of the solution

↓

Mordanting of sample at 100^0 C for 30 minute

↓

Cold rinsing

↓

Cold wash

Process Curve of Mordanting of Cotton & Silk

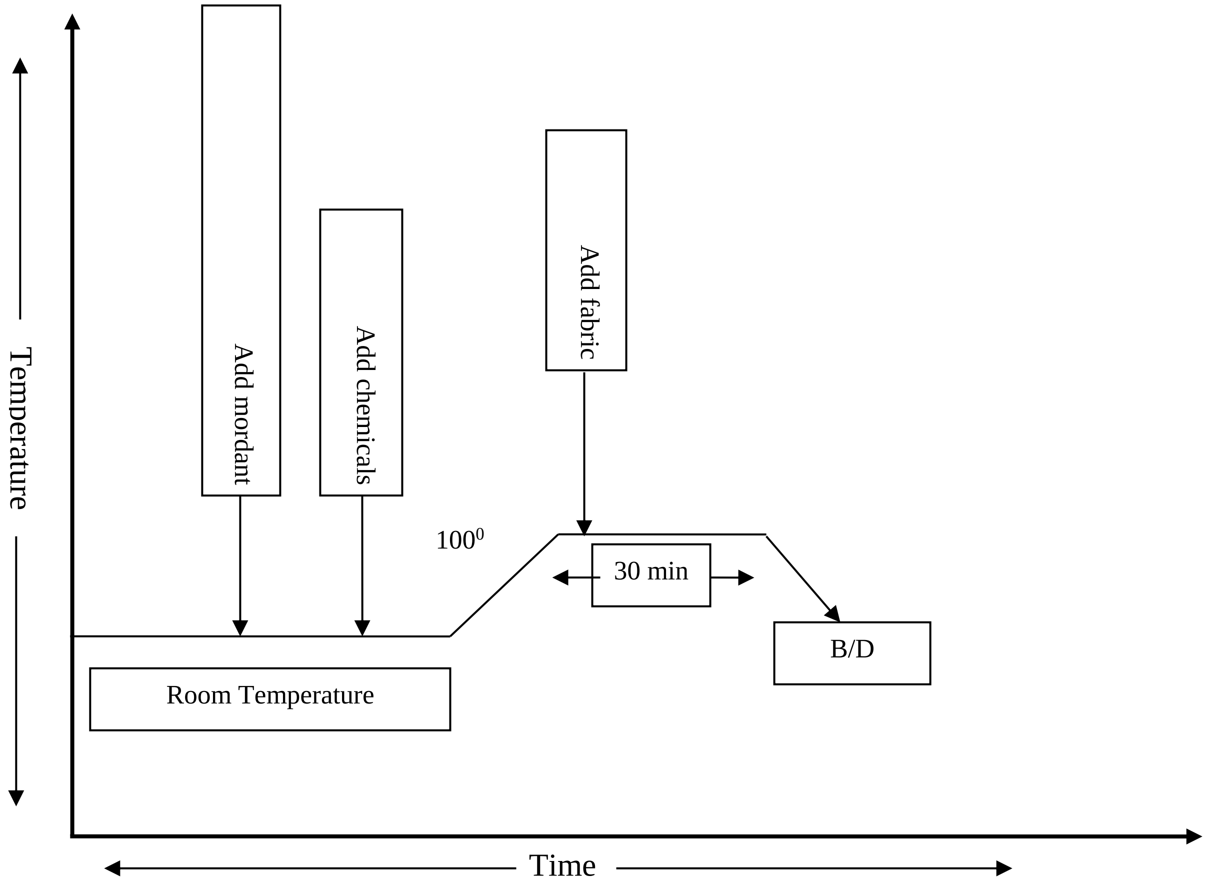

Figure-3.4: Process curve of mordanting of cotton & silk

Dyeing of Cotton & Silk

In the modern study natural dye extract was prepared from henna powder was used as a source of natural dyes for dyeing of cotton and silk samples.

Apparatus Used

Table 3.7: Apparatus Used

Name	Function
Dyeing bath	To dye the fabric.
Thermometer	To check the temperature.
Glass rod	To stirring measure and mixing the chemicals.
Pipette	To take exact amount of chemicals or solutions.
pH meter	To check the pH.
Electric balance	To measure the weight of the specimen.
Gas burner	To produce heat or increase temperature.
Tri pot stand	To give support to the dye bath.
Scissor	To cut the fabric.
Measuring scale	To measure the length of the specimen.
GSM cutter	To cut 100sqm fabric.
Water measuring cylinder	To measure the exact amount of water.

Table 3.8: Apparatus Used

Name of Item	Dossing
Henna dye	5 %
Sample Weight	8 gm
M:L	1:40
Temperature	100^0 C
Time	30 min

Calculation:

Total liquor: 32 × 30 = 1280ml

Henna dye: (64×5%)/10% = 32 ml

Water required= 1280 – 32 = 1248 ml

Process Flowchart of Dyeing of Cotton & Silk

Collection of sample

↓

Preparation of the solution

↓

Dyeing of sample at 100^0 C for 30 minute

↓

Drying

↓

Curing

Process Curve of Dyeing of Cotton & Silk

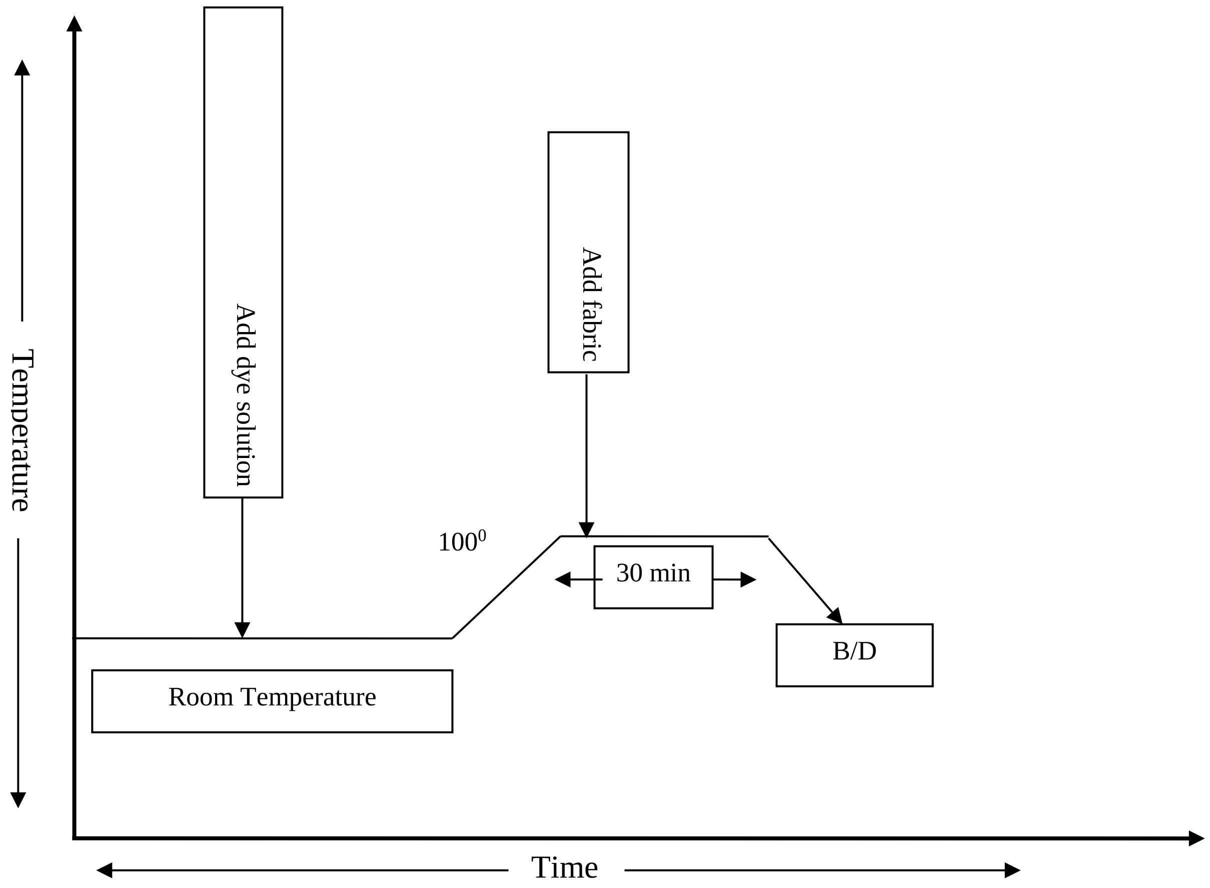

Figure-3.5: Process curve of dyeing of cotton & silk

3.3 Method of Evaluation

Determination of EPI & PPI

EPI means "Ends per Inch" is the popular word in the garments & textile industry. Number of yarn in warp direction is measured by EPI. Normally, ends per Inch are the number of wrap threads. It is the represent vertical thread of the fabric. It is called the wrap yarn. PPI means "Picks per Inch" is also the most popular word in the textile & garments industry. Number of Weft yarn in fabric is measured by PPI. Picks per inch is the number of weft threads of the fabric. It is represent the horizontal threads. It is the called weft yarn. [12]

Measuring the EPI and PPI by using magnifying glass setting multiplier

- ✓ Collect the fabric swatch. Put the fabric swatch on the plain table. And also marks wrap & weft direction of the fabric.
- ✓ Mark 1X1 inch on the fabric sample.
- ✓ Vertical or wrap yarn count one by one. And find out how many wrap yarns. And also horizontal or weft yarn count one by one. Find out how many weft yarns.

Determination of WPI & CPI

In knit fabric yarn is measure in course and Wales direction. CPI means yarn is in course per inch and WPI means Wales per inch.

Measure the CPI & WPI with the magnifying glass setting multiplier:

- ✓ According to course and wales wise marking 1 inch by ball pen.
- ✓ After that set the marking to the multiplier scale and count the CPI and WPI of that knitted fabric.
- ✓ Counting is done by magnifying counting glass.

Determination of GSM

The GSM of fabric is one kind of specification of fabric which is very important for a textile engineer for understanding and production of fabric. ‘GSM’ means ‘Gram per square meter’ that is the weight of fabric in gram per one square meter. By this we can compare the fabrics in unit area which is heavier and which is lighter.

Collection of sample

↓

Placing the sample under the GSM cutter

↓

Cutting the sample by GSM cutter

↓

Taking the weight of the sample by electronic balance

↓

Converting the weight to gm. /m^2

Determination of color fastness

Colorfastness is the property of a dye to retain its color when the dyed or printed textile material is exposed to various environmental conditions. The assessment of colorfastness against washing and perspiration was carried out in the usual way in terms of the gray scale values for staining of adjacent multifiber fabric and alteration in shade. However, rubbing fastness was evaluated only color staining option in both dry and wet condition.

SAMPLE ATTACHMENT

Sample for Dyeing

Cotton (Single Jersey)				
Before Dyeing	After Dyeing **Ferrous Sulphate-$FeSO_4$**	After Dyeing **Alum-$KAl_2(SO_4)_3$**	After Dyeing **2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$**	After Dyeing **2g/l $KAl_2(SO_4)_3$ + 2g/l $FeSO_4$**

Silk (Plain Weave)				
Before Dyeing	After Dyeing **Ferrous Sulphate-$FeSO_4$**	After Dyeing **Alum-$KAl_2(SO_4)_3$**	After Dyeing **2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$**	After Dyeing **2g/l $KAl_2(SO_4)_3$ + 2g/l $FeSO_4$**

Sample for Colorfastness Test to Wash (Color Change)

Cotton (Single Jersey)				
Before Wash	After Wash **Ferrous Sulphate-$FeSO_4$**	After Wash **Alum-$KAl_2(SO_4)_3$**	After Wash **2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$**	After Wash **2g/l $KAl_2(SO_4)_3$ + 2g/l $FeSO_4$**

Silk (Plain Weave)				
Before Wash	After Wash **Ferrous Sulphate-$FeSO_4$**	After Wash **Alum-$KAl_2(SO_4)_3$**	After Wash **2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$**	After Wash **2g/l $KAl_2(SO_4)_3$ + 2g/l $FeSO_4$**

Sample for Colorfastness to Wash Test

Silk (Plain Weave)				
Before Wash	After Wash **Ferrous Sulphate-$FeSO_4$**	After Wash **Alum-$KAl_2(SO_4)_3$**	After Wash **2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$**	After Wash **2g/l $KAl_2(SO_4)_3$ + 2g/l $FeSO_4$**

Sample for Colorfastness to Rubbing Test (Dry)

Cotton (Single Jersey)				
Before Dyeing	After Dyeing **Ferrous Sulphate-$FeSO_4$**	After Dyeing **Alum-$KAl_2(SO_4)_3$**	After Dyeing **2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$**	After Dyeing **2g/l $KAl_2(SO_4)_3$ + 2g/l $FeSO_4$**

Silk (Plain Weave)				
Before Dyeing	After Dyeing **Ferrous Sulphate-$FeSO_4$**	After Dyeing **Alum-$KAl_2(SO_4)_3$**	After Dyeing **2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$**	After Dyeing **2g/l $KAl_2(SO_4)_3$ + 2g/l $FeSO_4$**

Sample for Colorfastness to Rubbing Test (Wet)

Cotton (Single Jersey)				
Before Dyeing	After Dyeing	After Dyeing	After Dyeing	After Dyeing

	Ferrous Sulphate-$FeSO_4$	**Alum-$KAl_2(SO_4)_3$**	**2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$**	**2g/l $KAl_2(SO_4)_3$ + 2g/l $FeSO_4$**

Silk (Plain Weave)				
Before Dyeing	After Dyeing **Ferrous Sulphate-$FeSO_4$**	After Dyeing **Alum-$KAl_2(SO_4)_3$**	After Dyeing **2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$**	After Dyeing **2g/l $KAl_2(SO_4)_3$ + 2g/l $FeSO_4$**

CHAPTER- 04

DISCUSSION OF RESULT

Chapter-4
Discussion of Results

4.1. Colorfastness (change in color) to wash properties of fabric after dyeing

After completing the dyeing process color fastness (color change) to wash rating of both cotton and silk fabric for using different types and different combination of mordant value were recorded in the appendix- A1. The changes of color rating value for using different types of mordant and different combination of mordant has been used to draw the below following figure 4.1

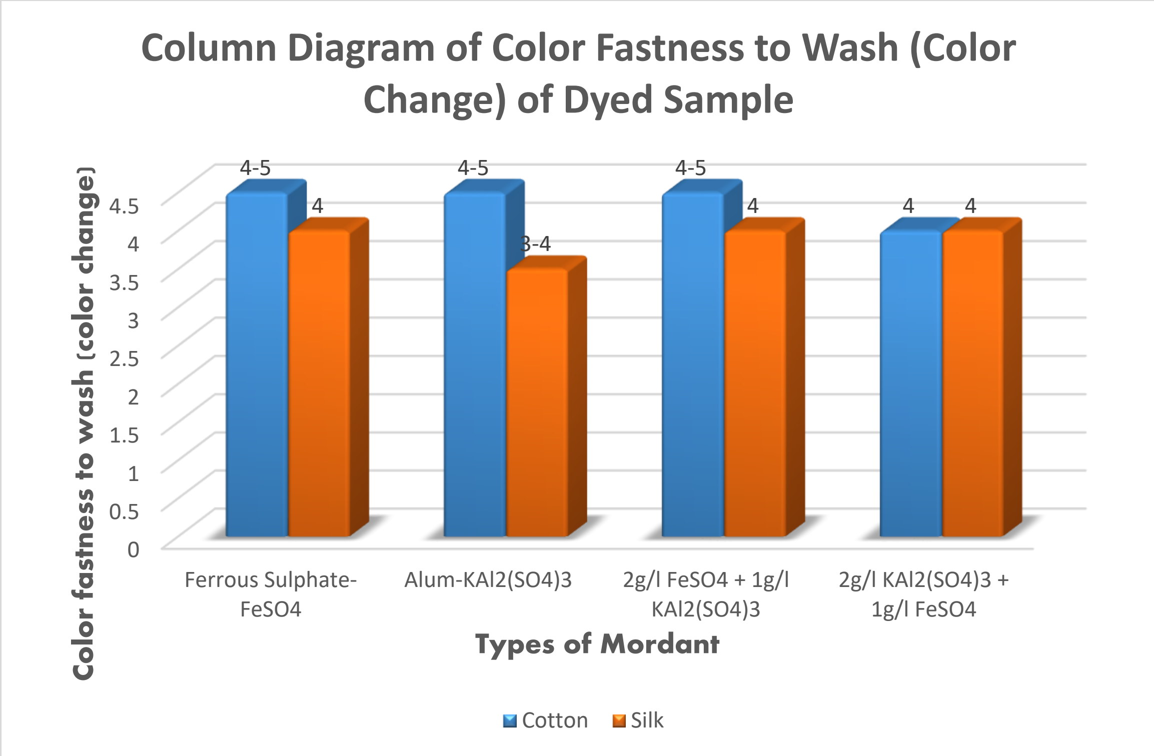

Figure 4.1: Column diagram of color fastness to wash (color change) of cotton & silk for different mordant

Above column diagram shows the amount of color change of both cotton and silk due to wash for using different types of mordant and their different combination. In this column diagram different types of mordant and their combination are used along the X axis or horizontally and the changes in color in rating shows along the Y axis or vertically. For the change in types of mordant the changes rating of color are changing for both cotton and silk. Here in the column diagram we see that the color fastness (change in color) properties of cotton is little bit better than silk due to wash. The column shows different color fastness (change in color) properties for different types of mordant, and here we noticed that the color fastness (change in color) properties for using Ferrous Sulphate-$FeSO_4$ and 2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$ is better than other mordant.

4.2. Color fastness to wash (color staining) properties of fabric after dyeing

After completing the dyeing process color fastness (color staining) to wash rating of both cotton and silk fabric for using different types and different combination of mordant value were recorded in the appendix- A1. The color staining rating value for using different types and different combination of mordant has been used to draw the below following figure 4.2

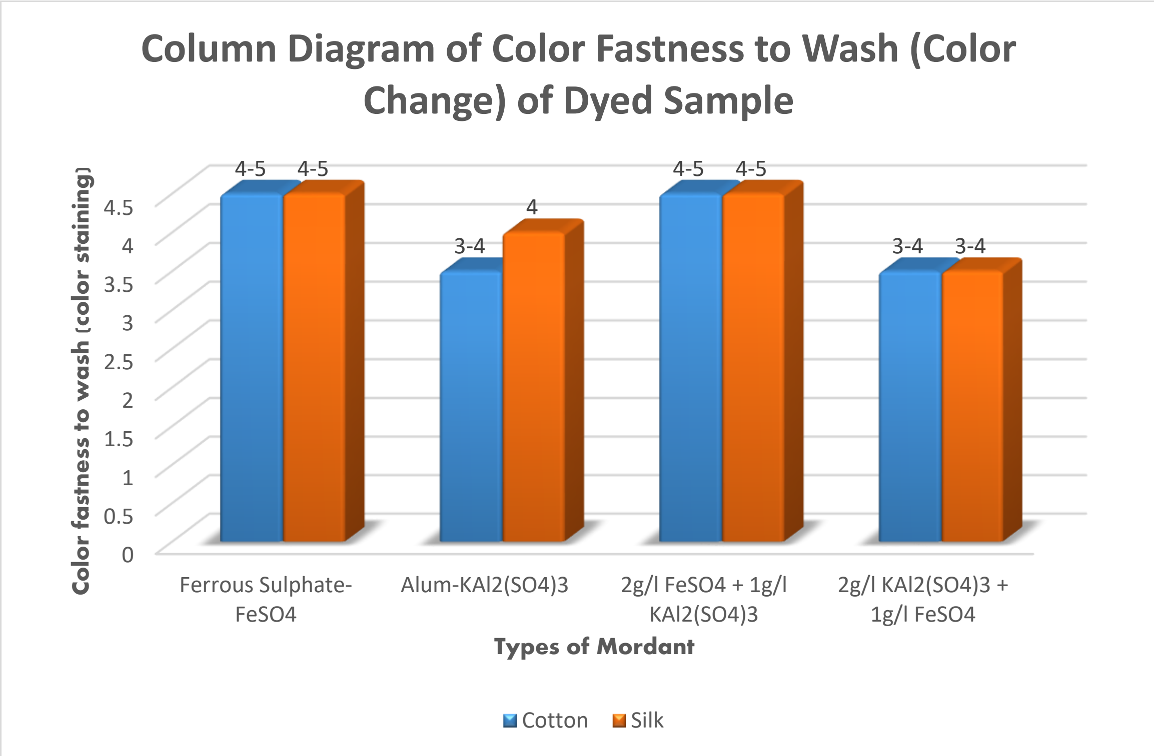

Figure 4.2: Column diagram of color fastness to wash (color staining) of cotton & silk for different mordant

Above column diagram shows the amount of color staining of both cotton and silk due to wash for using different types of mordant and their different combination. In this column diagram different types of mordant and their combination are used along the X axis or horizontally and the color staining rating shows along the Y axis or vertically. For the change in types of mordant the changes rating of color staining for both cotton and silk. Here in the column diagram we see that the color fastness (color staining) properties of cotton and silk almost same but only for Alum-$KAl_2(SO_4)_3$ the sating properties of silk is better than cotton due to wash. The column shows different color fastness (color staining) properties for different types of mordant, and here we noticed that the color fastness (color staining) properties for using Ferrous Sulphate-$FeSO_4$ and 2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$ is better than other mordant.

4.3. Color fastness to rubbing (Dry) properties of fabric after dyeing

After completing the dyeing process color fastness to rubbing (dry) rating of both cotton and silk fabric for using different types and different combination of mordant value were recorded in the appendix- A2. The changes of color rating value for using different types of mordant and different combination of mordant has been used to draw the below following figure 4.3

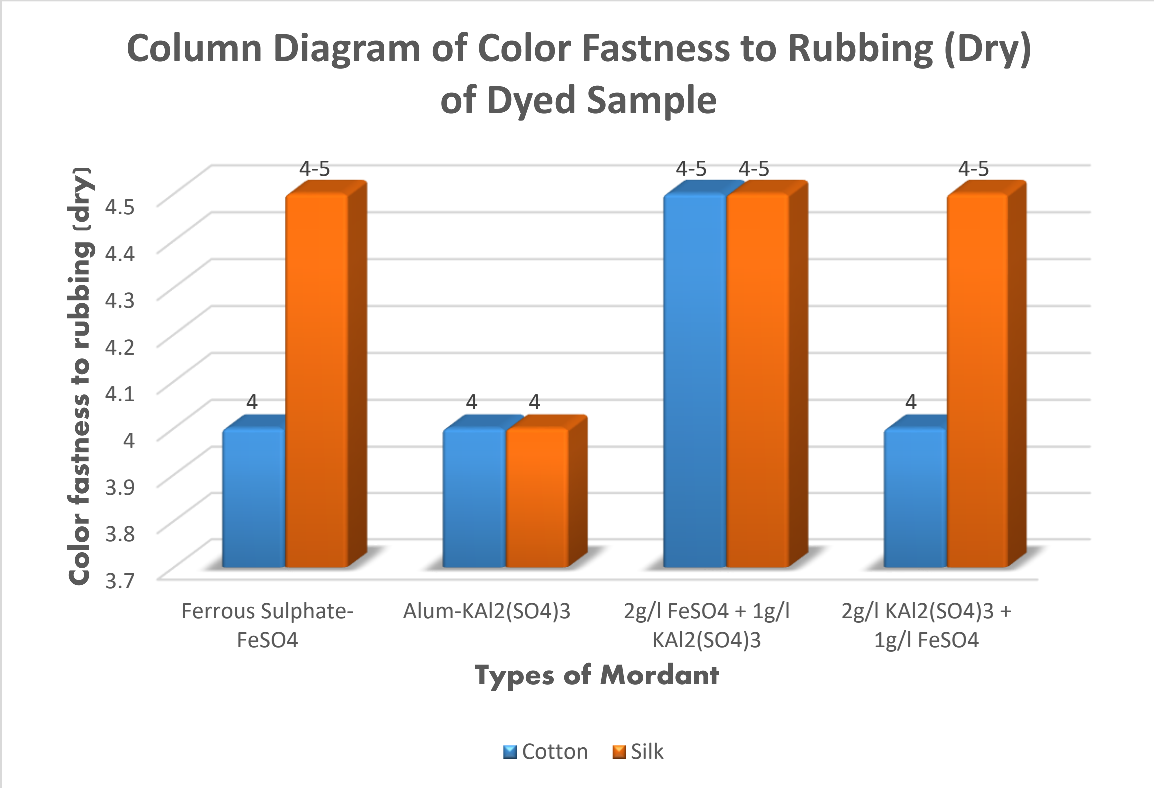

Figure 4.3: Column diagram of color fastness to rubbing (dry) of cotton & silk for different mordant

Above Column diagram shows the amount of color staining of both cotton and silk due to dry rubbing for using different types of mordant and their different combination. In this column diagram different types of mordant and their combination are used along the X axis or horizontally and the changes in color in rating shows along the Y axis or vertically. For the change in types of mordant the rating of color staining are changing for both cotton and silk. Here in the column diagram we see that the color fastness to rubbing (dry) properties of silk is better than cotton. The column shows different color fastness (change in color) properties for different types of mordant, and here we noticed that the color fastness to rubbing (dry) for using 2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$ is better than other mordant.

4.4. Color fastness to rubbing (Wet) properties of fabric after dyeing

After completing the dyeing process color fastness to rubbing (wet) rating of both cotton and silk fabric for using different types and different combination of mordant value were recorded in the appendix- A2. The changes of color rating value for using different types of mordant and different combination of mordant has been used to draw the below following figure 4.4

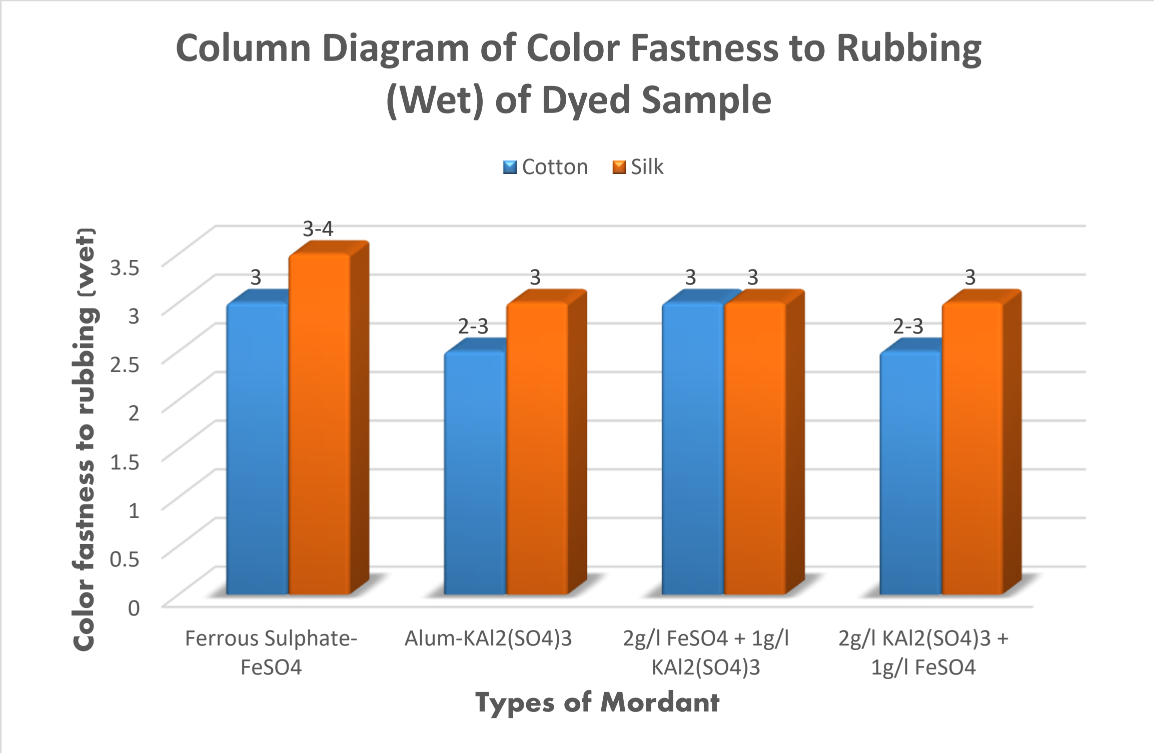

Figure 4.4: Column diagram of color fastness to rubbing (wet) of cotton & silk for different mordant

Above Column diagram shows the amount of color staining of both cotton and silk due to wet rubbing for using different types of mordant and their different combination. In this column diagram different types of mordant and their combination are used along the X axis or horizontally and the changes in color in rating shows along the Y axis or vertically. For the change in types of mordant the rating of color staining are changing for both cotton and silk. Here in the column diagram we see that the color fastness to rubbing (wet) properties of silk is better than cotton. The column shows different color fastness (change in color) properties for different types of mordant, and here we noticed that the color fastness to rubbing (wet) for using Ferrous Sulphate-$FeSO_4$ is better than other mordant.

4.5. Changes in stitch length of cotton after processing

After completing the dyeing process many properties of sample is changed due to scouring, bleaching, mordanting and dyeing and as other properties stitch length is also changed. After completing the dyeing change in stitch length of cotton fabric for using different types and different combination of mordant value were recorded in the appendix- A3. Due to processing of cotton sample changes in stitch length is occurred. The changes in stitch length for using different types of chemical has been used to draw the following figure 4.5

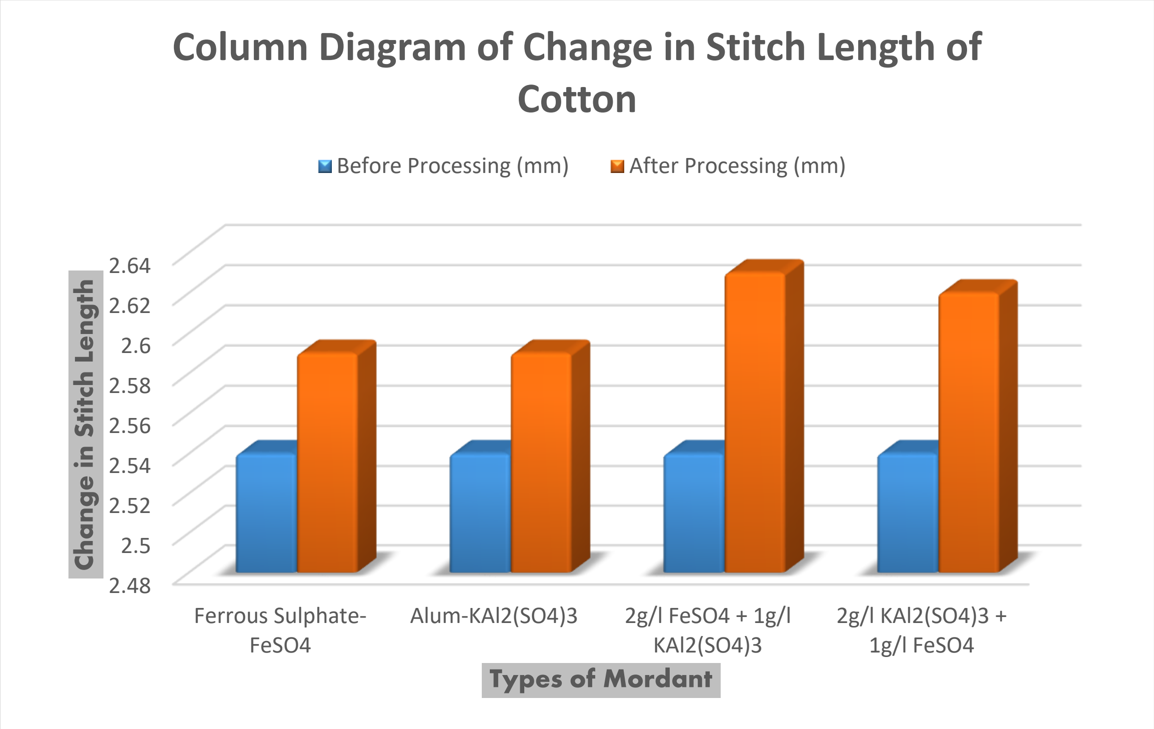

Figure 4.5: Column diagram of change in stitch length of cotton for different mordant

The column diagram shows the changes in stitch length of cotton due to scouring, bleaching, mordanting and dyeing. The changes in stitch length shows along the Y axis and the types of mordant used shows along the X axis. In the diagram we see that the changes in stitch length for using 2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$ and is more than other mordant.

4.6. Changes in WPI & CPI of cotton after processing

After completing the dyeing process many properties of sample is changed due to scouring, bleaching, mordanting and dyeing and as other properties WPI and CPI is changed. After completing the dyeing change in WPI and CPI of cotton fabric for using different types and different combination of mordant value were recorded in the appendix- A4 and A5. Due to processing of cotton sample changes in WPI and CPI is occurred. The changes in WPI and CPI for using different types of chemical has been used to draw the following figure 4.6

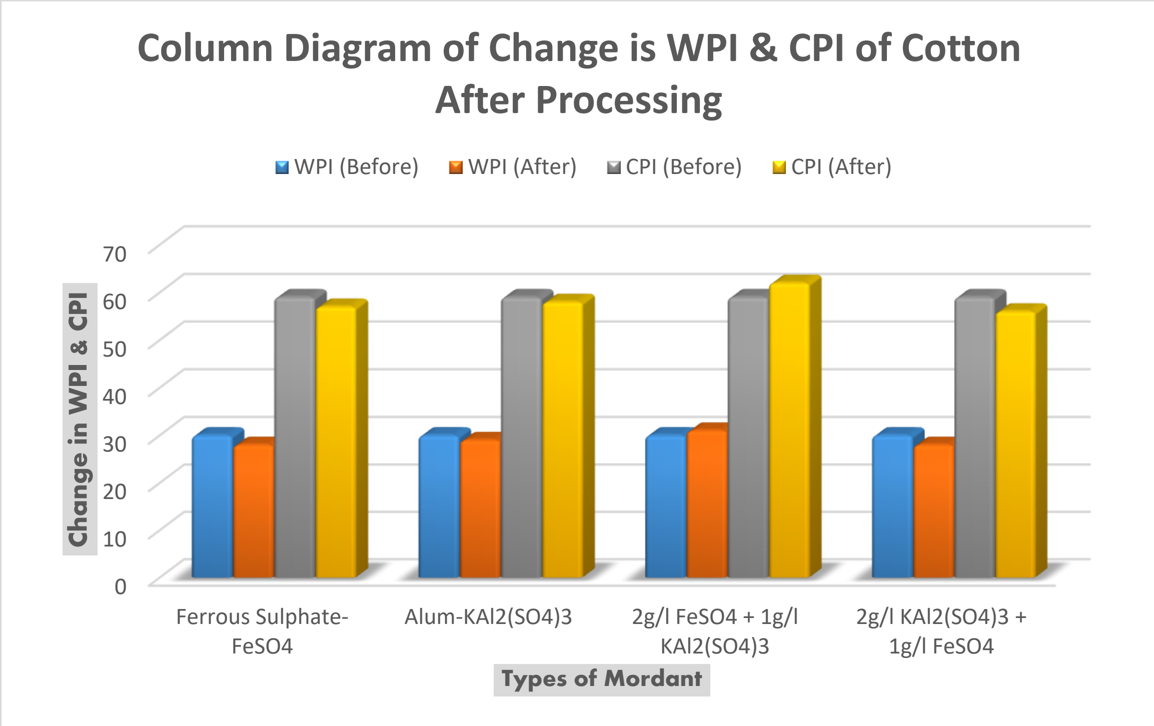

Figure 4.6: Column diagram of change in WPI & CPI of cotton for different mordant

The column diagram shows the changes of WPI and CPI of cotton due to scouring, bleaching, mordanting and dyeing. The changes in WPI nad CPI shows along the Y axis and the types of mordant used shows along the Y axis. In the diagram we see the changes in WPI and CPI is almost same for all four types of mordant but we identify that the changes in WPI and CPI for using 2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$ is more than other mordant.

4.7. Changes in EPI & PPI of silk after processing

After completing the dyeing process many properties of sample is changed due to degumming, bleaching, mordanting and dyeing and as other properties EPI and PPI is changed. After completing the dyeing change in EPI and PPI of silk fabric for using different types and different combination of mordant value were recorded in the appendix-A6 and A7. Due to processing of silk sample changes in EPI and PPI is occurred. The changes in EPI and PPI for using different types of chemical has been used to draw the following figure 4.7

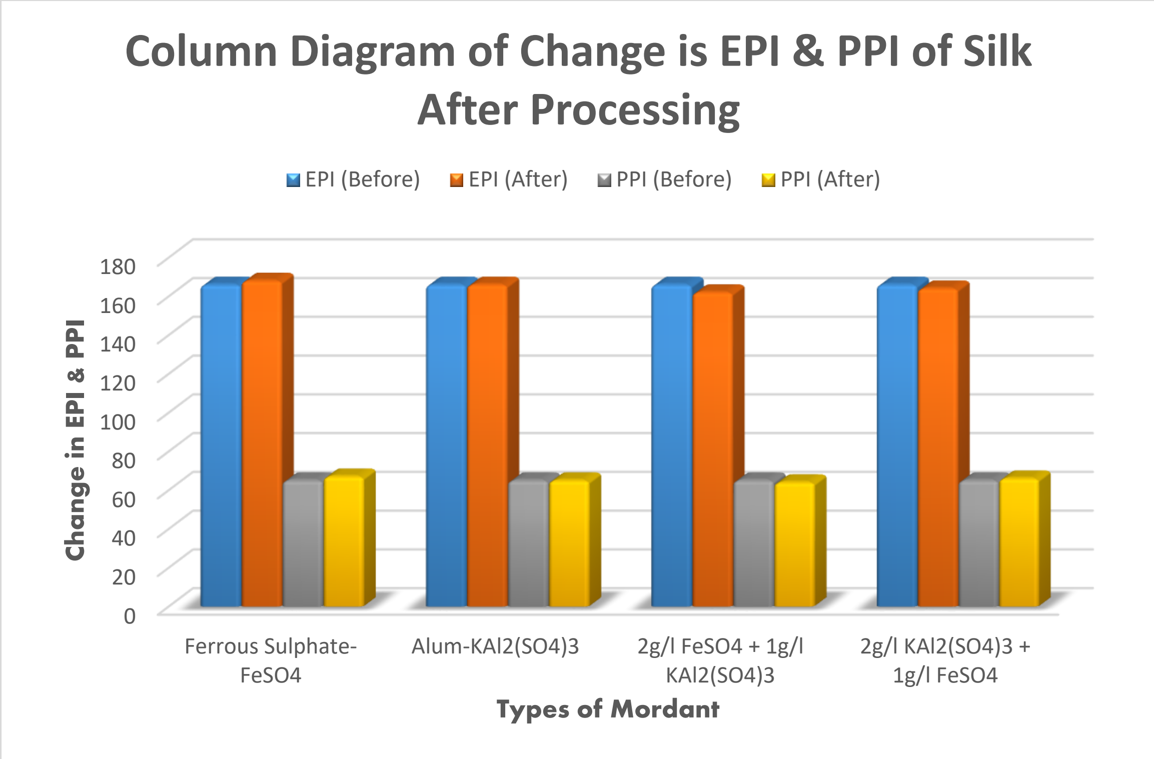

Figure 4.7: Column diagram of change in WPI & CPI of silk for different mordant

The column diagram shows the changes of EPI and PPI of cotton due to degumming, bleaching, mordanting and dyeing. The changes in EPI nad PPI shows along the Y axis and the types of mordant used shows along the X axis. In the diagram we see the changes in EPI and PPI is almost same for all four types of mordant but we identify that the changes in EPI and PPI for using 2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$ and Ferrous Sulphate-$FeSO_4$ is more than other mordant.

CHAPTER- 05
CONCLUSION

Chapter-5
Conclusion

After completing the project work we have gather a lot of information of using different types of mordant for mordanting to dyeing with natural dye (Henna dye). Before starting the project work we did not have any actual and accurate information about the effect of different types of mordant for dyeing with natural dye (Henna dye). We also learn about some properties like stitch length, WPI, CPI, EPI, PPI of cotton and silk fabric. During the analysis of using different types of mordant for dyeing with natural dye (Henna dye) we have reached at the end with some outcome mentioned below:-

- ✓ For cotton fabric using Ferrous Sulphate-$FeSO_4$ as a mordant for dyeing with henna dye is more effective for the color changing and color staining properties due to wash.
- ✓ For silk fabric using Ferrous Sulphate-$FeSO_4$ and 2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$ as a mordant for dyeing with henna dye is more effective for the color change and color staining properties due to wash.
- ✓ In case of color fastness to both dry and wet rubbing of cotton fabric 2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$ as a mordant shows better resistance than other mordant.
- ✓ And in case of color fastness to both dry and wet rubbing of silk Ferrous Sulphate-$FeSO_4$ as a mordant for dyeing with henna dye is more effective comparing to other types of mordant.
- ✓ For using 2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$ as a mordant maximum changes in the properties of both cotton and silk are occurred.

And now finally we are able to say that in case of dyeing with natural dye (Henna dye) for mordanting process Ferrous Sulphate-$FeSO_4$ and 2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$ will be more effective than other two types of mordant.

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Appendix

Table A1: Color fastness to wash

Name of Mordant	**Cotton**		**Silk**	
	Color Change	Color Staining	Color Change	Color Staining
Ferrous Sulphate-$FeSO_4$	4-5	4-5	4	4-5
Alum-$KAl_2(SO_4)_3$	4-5	3-4	3-4	4
2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$	4-5	4-5	4	4-5
2g/l $KAl_2(SO_4)_3$ + 1g/l $FeSO_4$	4	3-4	4	3-4

Table A2: Color fastness to rubbing

Name of Mordant	Cotton		Silk	
	Dry Rubbing	Wet Rubbing	Dry Rubbing	Wet Rubbing
Ferrous Sulphate-$FeSO_4$	4	3	4-5	3-4
Alum-$KAl_2(SO_4)_3$	4	2-3	4	3
2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$	4-5	3	4-5	3
2g/l $KAl_2(SO_4)_3$ + 1g/l $FeSO_4$	4	2-3	4-5	3

Table A3: Changes in stitch length of cotton after scouring, bleaching, mordanting and dyeing

Sample No.	Types of Mordant	Stitch length of sample before processing (mm)	Stitch length of sample after processing (mm)	Changes in stitch length	Percentage of change in stitch length (mm)
01	Ferrous Sulphate-$FeSO_4$	2.54	2.59	0.05	1.97%
02	Alum-$KAl_2(SO_4)_3$	2.54	2.59	0.05	1.97%
03	2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$	2.54	2.63	0.09	3.54%
04	2g/l $KAl_2(SO_4)_3$ + 1g/l $FeSO_4$	2.54	2.62	0.15	3.14%

Table A4: Changes in WPI of cotton after scouring, bleaching, mordanting and dyeing

Sample No.	Types of Mordant	WPI of sample before processing	WPI of sample after processing	Changes in WPI	Percentage of change in WPI
01	Ferrous Sulphate-$FeSO_4$	30	28	2	6.67%
02	Alum-$KAl_2(SO_4)_3$	30	29	1	3.33%
03	2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$	30	31	1	3.33%

Table A5: Changes in CPI of cotton after scouring, bleaching, mordanting and dyeing

Sample No.	**Types of Mordant**	**CPI of sample before processing**	**CPI of sample after processing**	**Changes in CPI**	**Percentage of change in CPI**
01	Ferrous Sulphate-$FeSO_4$	59	57	2	3.39%
02	Alum-$KAl_2(SO_4)_3$	59	58	1	1.69%
03	2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$	59	62	3	5.08%
04	2g/l $KAl_2(SO_4)_3$ + 1g/l $FeSO_4$	59	56	3	5.08%

Table A6: Changes in EPI of silk after degumming, scouring, bleaching, mordanting and dyeing

Sample No.	Types of Mordant	EPI of sample before processing	EPI of sample after processing	Changes in EPI	Percentage of change in EPI
01	Ferrous Sulphate-$FeSO_4$	166	168	2	1.20%
02	Alum-$KAl_2(SO_4)_3$	166	166	0	0.00%
03	2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$	166	162	4	2.41%
04	2g/l $KAl_2(SO_4)_3$ + 1g/l $FeSO_4$	166	164	2	1.20%

Table A7: Changes in PPI of silk after, degumming, bleaching, mordanting and dyeing

Sample No.	Types of Mordant	PPI of sample before processing	PPI of sample after processing	Changes in PPI	Percentage of change in PPI
01	Ferrous Sulphate-$FeSO_4$	65	67	2	3.07%
02	Alum-$KAl_2(SO_4)_3$	65	65	0	0.00%
03	2g/l $FeSO_4$ + 1g/l $KAl_2(SO_4)_3$	65	64	1	1.54%
04	2g/l $KAl_2(SO_4)_3$ + 1g/l $FeSO_4$	65	66	1	1.54%