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LETTER OF APPROVAL

This project report prepared by **Shamim Shihab**(bearing ID: 142-23-155) and **Asif Ahmed Safwan** (bearing ID: 143-23-163**)** is approved in Partial Fulfilment 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 earnest.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Dr. Md. Ismail Hossain, Assistant Professor and Associate Head**, 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.

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This Project report is dedicated to our

Beloved Parents

Abstract

This study was aimed to make a comparison between natural dyes and synthetic dyes based on different fastness properties and the costing of the dyes and their dyeing procedure. We used turmeric powder as our natural dye and acid dye as synthetic dye. As we know that the textile materials have lower affinity to the natural dye, so a mordant is needed to be used to increase the affinity between textile fibre and dye molecules. We used here two types of mordant Aluminium Sulphate and Ferrous Sulphate in our study. We found here different result based on different criteria like shade% of dye, types of mordant and the concentration of the mordant. Where the fabric mordanted by alum provides good fastness properties than the fabric mordanted by ferrous sulphate. We also observed that in case of acid dyeing it was more cost effective than the natural dyeing and the cost difference was fluctuated between different mordant we used. Rather our study found that the color fastness properties is better in case of acid dyeing than the natural dyeing. Hence we all know natural dyes are more environment friendly than the synthetic dyes like acid dyes. After all our study is imperative to make a comparison between turmeric colorant and acid dye.

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Chapter-1: INTRODUCTION

1.1 Introduction

The use of natural dyes for dyeing of textile materials has long history. These dyes had been used to color food, leather as well as textile materials since prehistoric time. Natural dyes can be obtained from vegetable or animal matter with the application of no or a very little chemical processing. But after the invention of synthetic dyes in 1856 the demand of natural dyes to dye textile materials was declined gradually [1]. Moreover at the very beginning oftwentieth century the production cost of synthetic dyes was decreased at significant rate and for this reason natural dyes were almost ignored [2]. So, there is a drastic decline of the usage of natural dyes was happened then. But nowadays for increasing the environmental awareness the environmentalist put their attention on natural dyes because of their non-polluting, non-carcinogenic and eco- friendly nature.[3] This is mainly because comparing with synthetic dyes, natural dyes are more biodegradable and having better ultraviolet protection and high compatibility with nature. These dyes also have more antibacterial properties than synthetic dyes [5]. That's why many commercial dyers have started using natural dyes to dye textile materials to decrease the pollution created by the usage of synthetic dyes. Again, few synthetic dyes are harmful for human skin like azo dyes are reported to be carcinogenic and may cause allergenic problem to human being [4]. Germany was the first country which took the initiative to ban the production and application of numerous specific azo dyes. Netherlands, India, Bangladesh and some other countries also follow these ban strategies [6].

Natural dyes have a familiar property to produce a very uncommon, soothing, attractive and soft shade as compared to the synthetic dyes. This change in incense in favor of natural dyes is also imposed to rigorous environmental standards attributed by many countries in response to toxic and allergic effects as compared to the synthetic dyes [7]. Natural dyes demonstrate several important properties which exhibit them to a significant stage over synthetic dyes. Some of these properties are as follows:

- They are easily biodegradable, non-toxic and non-allergic
- They do not cross the pollutant level established by the government and also non-hazardous to the human body
- A wide range of color can be produced by using natural dyes and also a rare color ideas can be obtained
- Natural color can be bled but it don not stain the other fabric
- Most of the natural dyes are renewable and a significant number of them are obtained from different plants on the contrary synthetic dyes are produced from petroleum which are basically non-renewable source of energy. So the use of natural dyes in lieu of synthetic dyes has a great potential of earning carbon credits

- The application of natural dyes has was disposal problem because they are thoroughly biodegradable and also can be used as bio fertilizers in some cases such dyeing with indigo [2].

The dyestuffs which obtained from the different plant, animal, and mineral are considered as the main sources of natural dyes [8]. A natural ingredient named turmeric collected from the plants is used to produce the brightest yellow color, besides it is rich in phenolic compounds called curcuminoids belongs to the diaroylmethane group called diferuloylemethane [9]. It is the most popular natural dye which is environment-friendly. Besides, it is also eminent for anti-inflammatory, anti-microbial, anti-carcinogenic, anti-parasitic, anti-inceptive and anti-mutagenic properties and even for the development of sunscreen products [10-11]. Natural dyes have a very low substantivity to the textile materials. That's why it has to be applied with a suitable mordant [12]. These mordants are mainly the metallic salts and they have the attraction of both fiber and dye molecules. For this reason, the dye molecules are attracted to the mordanted textile materials and attached to them like a coating formation. The metallic salts of copper, aluminum, chromium, iron, and tin are mainly used as the mordanting chemical to mordant the textile materials [13]. In our research work, we have two mordants, they are the Aluminum Sulphate and Ferrous Sulphate. Among them, the first one is known as Alum which is very cheap and safe to use and the second one is commonly known as green vitriol which is thoroughly soluble in water and produces a brown shade. We have applied natural dye (produced from turmeric) on a synthetic fiber name nylon in different shade % and different amount of mordants. A very limited work was done previously on this basis. We have also dyed the same amount of nylon fabric with acid dye (yellow) in different shade% followed by the natural dye applying the general procedure of nylon fabric dyeing in this era. We have also done two types of fastness test (wash fastness and rubbing fastness) to all our dyed samples. We have also calculated the costing of these different dyeing procedures. Our main aim is to make a comparison between a natural dye and a synthetic dye on the basis of two criteria, one is fastness and other is the cost needed to dye that particular textile material.

1.2 Objectives of this study

- To dye nylon fabric with natural dye(Turmeric) and acid dye (yellow).
- To know the color fastness properties of natural dyes and synthetic dyes.
- To learn about the costing of dyeing procedure of natural dyes and synthetic dyes.
- To make the comparison between natural dyes and synthetic dye.

Chapter-2: Literature Review

2.1 Type of thesis :Experimental Studies

2.2 Natural Dyes

Natural dyes are the coloring substances which are directly extracted from different natural ingredients like fruits, flower, root, leaf, vegetables etc. Natural dyes are far more environmentally friendly than the synthetic dyes because these dyes are directly extracted from the natural ingredients that's why they contain no toxic chemicals. But these dyes are not used commercially till now because of their lower substantivity to the textile fibers and higher cost.

2.3 Mordant

To achieve bright colors by dyeing with natural dyes, we need to apply mordant on our test sample beforehand. Most natural dyes do not adhere very well to the fibers, that's why they need the help of a mordant [14]. In our research we used two types of mordants:

2.3.1 Alum: Alum is one of the most popular mordants used in natural dyeing. It is a specific compound is hydrated potassium aluminum Sulphate. Alum can sometimes be found in our local supermarket. Alum is also called as the safest mordant among all of the common mordants.

2.3.2 Ferrous Sulphate: Iron (II) Sulphate is used to darken the dye on the fiber or yarn. This mordant is used to create lovely browns [15].

2.4 Nylon

Nylon is a generic designation for a family of synthetic polymers, based on aliphatic or semi-aromatic polyamides. Nylon is a thermoplastic silky material that can be melt-processed into fibers, films or shapes. Nylon was the first commercially successful synthetic thermoplastic polymer. DuPont began its research project in 1930 [16].

2.5 Acid Dye

Acid dyes are highly water soluble, and have better light fastness than basic dyes. The textile acid dyes are effective for protein and some synthetic fibers such as silk, wool, nylon and modified acrylics. They contain sulphonic acid groups, which are usually present as sodium sulphonate salts. These increase solubility in water, and give the dye molecules a negative charge. In an acidic solution, the -NH2 functionalities of the fibers are protonated to give a positive charge: -NH3+. This charge interacts with the negative

dye charge, allowing the formation of ionic interactions. As well as this, Van-der-Waals bonds, dipolar bonds and hydrogen bonds are formed between dye and fiber [17].

2.6 Review of the Previous Studies:

There are many researchers have been done previously related to the natural dyes. A research paper titled "Rainbow of Natural Dyes on Textiles Using Plants Extracts: Sustainable and Eco-Friendly Processes" by Jyoti Arora*, Prerna Agarwal, Gunjan Gupta published in July 2017 which is related to natural dyes. In this study, the dyeing potential of different natural dyes extracted from varied plants was evaluated on different textile materials. The major objectives were as follows: 1. Extraction of dyes from different plant materials available locally or collected from the regional flora,2. Application of natural dyes to various textile materials, 3. Study the effect of different types of mordants and mordanting techniques in the dyeing process, 4. To obtain different colors of rainbow on textile using plant dyes and simple, effective, eco-friendly and sustainable methods. But in this study they didn't show any testing result of colored samples like color strength, wash fastness, rubbing fastness etc. [2]. They show the shade difference by using different dyes extracted from different plants but they didn't change any parameters like dye%, time, temperature etc. They also different mordant to show the color difference but they didn't change the quantity of the mordant. This study didn't show the costing calculation too. This study was done only on the basis of dyeing three different natural fibers (cotton, silk and wool) but they didn't try any synthetic fiber.

Another article named "Dyeing Nylon with Natural Dyes" by By H.T. Lokhande, Vishnu A. Dorugadealso related to natural dyes. They have done a unique experiment. They applied different natural dyes (extracted from different natural ingredients) on a synthetic fiber (Nylon). In the study, nylon fabric was dyed with three natural dyes derived from Onion (*Allium cepa*), Lac (*Lacciferlacca*) and Turmeric (*Curcuma longa*) using various mordants by two different techniques (viz. open bath and HTHP dyeing methods). HTHP dyeing has been found to give better results as compared to the open bath dyeing. Good wash fastness was obtained with all three natural dyes. Comparative higher ratings for ligh tfastness were achieved in the case of Onion and Lac, as compared to that of Turmeric.They used different types of mordant for every dyes [18]. They showed the effect of different mordant on the nylon fabric by measuring the color value in CIELAB method. They did the light fastness, sublimation fastness and wash fastness test too. They also presented a comparison between the effect of two dyeing process, one is the Open Bath process and other is the HTHP process.

But this study didn't show the effect of changing different parameters of dyeing process like time, temperature, dye% etc. They did all the experiments by keeping the amount of mordant as a constant value, i.e. they didn't show the effect of the usage of different mordant value.

Chapter-3: Materials & Methods

3.1 Equipment List

- Measuring Cylinder.
- Beaker.
- Digital Balance.
- Glass Rod.
- Dye Bath.
- Gas Burner.
- Tri-pod Stand.
- pH paper.
- Scissor.
- Crock Meter.
- Light Box.
- Gray Scales.
- GSM Cutter.
- Fabric inspection glass.
- Crock cloth.
- Multi-fibre.

3.2 Materials

3.2.1 Textile Materials

We have done all of our experiments by testing only one type of textile fabric which is a synthetic fabric. All the tested samples are Nylon fabric of 19 GSM.

3.2.2 Extraction Materials

We have chosen Turmeric as our source of dye which was extracted to produce our colorant.

3.2.3 Mordants

There are two types of mordants Aluminum Sulphate and Ferrous Sulphate were chosen for this study.

3.2.4 Testing Materials

We followed the normal procedure for testing the fastness of dyed materials. So we use light box and grey scale for color change to measure the color change and

multifiber and grey scale for staining to measure the color staining. Afterwards we used crockmeter and testing cloths for dry and wet rubbing tests.

3.3 Methods

3.3.1 Extraction of Dyes

For preparing 3% dye solution we dissolved 9g turmeric in 300 ml water at first. Then we heated that solution at 95^0C for 15 minutes with a gas burner. Then we filtered it properly. Finally we cooled it at room temperature and our final dye solution was prepared.

3.3.2 Mordanting

At first we collected 5gm of sample. Then we prepared the solution as per the recipe. Then we raised the temperature of the solution to 60^0C. Then we added our pre-treated collected sample to it. Then raise the temperature to 80^0C and run for 20 minutes with stirring. After all the bath was drained but the sample cannot be rinsed or washed.

3.3.3 Dyeing with Extracted Turmeric Solution

At first the required amount of initial water was taken in the dye bath. Then the required amount of dye solution is added to the dye bath. Then this solution was stirred for a few seconds and the bath was set on a gas burner. The solution was then heated and raised the temperature of it to 60°C. Then the pre-mordanted sample was added to the dye bath. Then the temperature was increased to 80°C and was run for 20 minutes with stirring. Then the bath was dropped but the sample couldn't be rinsed or washed. Then we dried the dyed sample with ironing.

3.3.4 Dyeing with Acid Dye

Acid dyes are one of the most suitable synthetic dyes to dye Nylon fabric. They have a great affinity nylon fabric and they work in acidic medium. For acid dyeing, first we collected sample and made stock solution of acid dye (yellow) and acetic acid. Then we took the required amount of initial water in a dye bath and after that we added acetic acid. Then we checked pH (pH should be 4.5-5.5). Then we added the dye solution as per the recipe. Then we set the bath on gas burner and increased the temperature of it to 60°C. Then the sample was added and raised the temperature to 100°C. It was run for 20 minutes with stirring. Then the bath was dropped and rinsed the sample. Then we washed the sample at 80°C temperature for five minutes and then again washed the sample with cold water. Finally we dried the sample with ironing.

3.3.5 Method of testing & assessment

After dyeing each sample we tested two color fastness properties of that dyed sample. They are the color fastness to wash and color fastness to rubbing. We measured the change of color and color staining in case of wash fastness test, and in rubbing fastness test, dry and wet rubbing done and assessed by staining of the rubbing cloth and also we evaluated the color stability against some influences. We used light box

and two types of gray scale one was gray scale for color change and another was gray scale for color staining to assess our tested sample. In the light box we used D65 light to assess all the tested sample. We did the color fastness to washing tests in ISO method and the code is ISO 105 C06 B2S.

Recipe of ISO 105 C06 B2S method

Table 3.3.5.1 : ISO 105 CO6 B2S method of washing

SL	Process Parameter	Unit	Rating
01	Detergent	g/L	4
02	Sodium Perborate	g/L	1
03	M:L	------	1:50
04	Temperature	°C	40
05	Time	min	30

3.3.6 Method of dyes and chemical costing :

Step-01

From percentage to g/L: $\frac{required\ Shade\% * 10}{Liquor\ ratio\ (only\ L\ value)}$

= **X** g/L

Step-02

So, For 1 Litre of Liquor that dye/chemical required = X gm.

For 150ml or 0.15L of Liquor that dye/chemical required = (X * 0.15) gm.

= **Y**gm.

Step-03

Now, to dye 5 gm. of fabric that dye/chemical required = **Y**gm

To dye 1 kg or 1000gm.of fabric that dye/chemical required = $\frac{\mathbf{Y}*1000}{5}$gm.

=**Z** gm.

Step-04

Let, The price of 1kg or 1000 gm. of that particular dye/chemical is **P** USD

So, the price of **Z** gm. of that particular dye/chemical will be = $\frac{\mathbf{P}*\mathbf{Z}}{1000}$ USD

= **R** USD

Note:

1. Cost of natural dyeing = cost for mordanting chemicals + cost for dyeing chemicals
2. When any chemical is given in the unit of g/L in the recipe then the costing calculation will be started from the **Step-02**

Chapter-4: Methodology

4.1 Experimental Procedure:

Our experimental project based on three different shade percentage of dyes which are 3%, 5%, and 7%. Also during our experiment we have use two different types of mordanting agent which are aluminium sulphate and ferrous sulphate and we used here three different value of mordant consumption like 1g/L, 2g/L, and 3g/L. Based on mordant we represent our experiment code as for aluminium sulphate is 'A' and for ferrous sulphate its 'I'. and the first numerical digit represent mordanting value and last numerical digit represent shade percentage used within each experiment. For example if the experiment code is "1A3" it means we used here 1g/L Aluminium sulphate for mordanting to dye with 3% shade. again if the code is "3I7" it means we used 3g/L ferrous sulphate for mordanting to dye 7% shade and for acid dyeing we used code AC3, AC5 and AC7 which represent 3%, 5% and 7% shade percentage respectively.

Figure 4.1 : Understanding of Experimental Code

4.2 Experimental Recipe Overview:

Table 4.2.1 : Recipe of Natural Coloration (Turmeric)

SL No.	Experimental Code	Mordant	Mordant Concentration (g/l)	Mordanting Temperature (°C)	Mordanting Time (min)	Shade (%)	Dyeing Time (min)	Dyeing Temp. (°C)
1	1A3	Aluminium Sulphate	1	100	20	3	20	80
2	2A3		2	100	20	3	20	80
3	3A3		3	100	20	3	20	80
4	1A5		1	100	20	5	20	80
5	2A5		2	100	20	5	20	80
6	3A5		3	100	20	5	20	80
7	1A7		1	100	20	7	20	80
8	2A7		2	100	20	7	20	80
9	3A7		3	100	20	7	20	80
10	1I3	Ferrous Sulphate	1	100	20	3	20	80
11	2I3		2	100	20	3	20	80
12	3I3		3	100	20	3	20	80

13	1I5		1	100	20	5	20	80
14	2I5		2	100	20	5	20	80
15	3I5		3	100	20	5	20	80
16	1I7		1	100	20	7	20	80
17	2I7		2	100	20	7	20	80
18	3I7		3	100	20	7	20	80

Table 4.2.2 : Recipe of Synthetic Coloration (Acid Yellow)

SL No.	Experimental Code	Shade (%)	Wetting Agent Conc. (g/L)	Acetic Acid Conc. (g/L)	Dyeing Time (min)	Dyeing Temp. (°C)
01	AC3	3	1	0.8	20	100
02	AC5	5	1	0.8	20	100
03	AC7	7	1	0.8	20	100

4.3 Natural Dyeing 1A3

Table 4.3.1 : Recipe of Mordanting (1A3)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Aluminium Sulfate	g/L	1	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Aluminium Sulfate = $\frac{150\ X\ 1}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 15mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (15) mL
= 150-15 mL
= 135 mL

Process sequence of Mordanting:

Add 135mL of Water
↓
Add 15 mL Aluminium Sulfate Solution
↓
Raise Temperature to 60°C
↓
Place 5gm 100% Nylon Fabric into dye bath
↓
Raise Temperature to 100°C and Run for 20 minutes
↓
Bath Drain

Table 4.3.2 : Recipe of Natural dyeing (1A3)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	3	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 3\%}{1\%}$mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 15 mL

Initial Water: = Total Liquor - (chemicals)
= 150 - (15) mL
= 150 - 15 mL
= 135 mL

Process sequence of Dyeing:

Add 135 mL of Water
↓
Add 15 mL Turmeric Solution
↓
Raise Temperature to 40°C
↓
Place 5gm 100% Pre-treated Nylon Fabric into dye bath
↓
Raise Temperature to 80°C and Run for 20 minutes
↓
Bath Drain
↓
Cold Rinsing and Hot Wash at 90°C
↓
Sample Squeezing and drying

Process Curve and Description

Figure 4.3.1 : Process Curve of Mordanting (1A3)

Figure 4.3.2 : Process curve of Dyeing (1A3)

Process Description:

At first 135 ml of water was taken in a dye bath. Then the calculated amount of aluminium sulphate solution (15ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 135 ml of water was taken in another dye bath and 15 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

4.4 Natural Dyeing 1I3

Table 4.4.1 : Recipe of Mordanting (1I3)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Ferrous Sulfate	g/L	1	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Ferrous Sulfate = $\frac{150\ X\ 1}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 15mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (15) mL
= 150-15 mL
= 135 mL

Process sequence of Mordanting:

Add 135mL of Water
↓

Add 15 mL FerousSulfate Solution

↓

Raise Temperature to 60°C

↓

Place 5gm 100% Nylon Fabric into dye bath

↓

Raise Temperature to 100°C and Run for 20 minutes

↓

Bath Drain

Table 4.4.2 : Recipe of Natural dyeing (1I3)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	3	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 3\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 15 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (15)mL
= 150 - 15 mL
= 135mL

Process sequence of Mordanting:

Add 135mL of Water

↓

Add 15 mL Turmeric Solution

↓

Raise Temperature to 40°C

↓

Place 5gm 100% Pre-treated Nylon Fabric into dye bath

↓

Raise Temperature to 80°C and Run for 20 minutes

↓

Bath Drain

↓

Cold Rinsing and Hot Wash at 90°C

↓

Sample Squeezing and drying

Process Curve and Description

Figure 4.4.1 : Process Curve of Mordanting (1I3)

Figure 4.4.2 : Process curve of Dyeing (1I3)

Process Description:

At first 135 ml of water was taken in a dye bath. Then the calculated amount of ferrous sulphate solution (15ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 135 ml of water was taken in another dye bath and 15 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

4.5 Natural Dyeing 2A3

Table 4.5.1 : Recipe of Mordanting (2A3)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Aluminium Sulfate	g/L	2	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Aluminium Sulfate = $\frac{150\ X\ 2}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 30 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (30) mL
= 150 - 30 mL
= 120 mL

Process sequence of Mordanting:

Add 120 mL of Water
↓
Add 30 mL Aluminium Sulfate Solution
↓
Raise Temperature to 60°C
↓
Place 5gm 100% Nylon Fabric into dye bath
↓
Raise Temperature to 100°C and Run for 20 minutes
↓
Bath Drain

Table 4.5.2 : Recipe of Natural dyeing (2A3)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	3	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 3\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 15 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (15)mL
= 150 - 15 mL
= 135mL

Process sequence of Dyeing:

Add 135mL of Water
↓
Add 15 mL Turmeric Solution
↓
Raise Temperature to 40°C
↓
Place 5gm 100% Pre-treated Nylon Fabric into dye bath
↓
Raise Temperature to 80°C and Run for 20 minutes
↓
Bath Drain
↓
Cold Rinsing and Hot Wash at 90°C
↓

Sample Squeezing and drying

Process Curve and Description

Figure 4.5.1 : Process Curve of Mordanting (2A3)

Figure 4.5.2 : Process curve of Dyeing (2A3)

Process Description:

At first 120 ml of water was taken in a dye bath. Then the calculated amount of aluminium sulphate solution (30ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 135 ml of water was taken in another dye bath and 15 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview

4.6 Natural Dyeing 2I3

Table 4.6.1 : Recipe of Mordanting (2I3)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Ferrous Sulfate	g/L	2	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Ferrous Sulfate = $\frac{150\ X\ 2}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 30 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (30) mL
= 150 - 30 mL
= 120 mL

Process sequence of Mordanting:

Add 120 mL of Water
↓
Add 30 mL Ferrous Sulfate Solution
↓
Raise Temperature to 60°C
↓
Place 5gm 100% Nylon Fabric into dye bath
↓
Raise Temperature to 100°C and Run for 20 minutes
↓
Bath Drain

Table 4.6.2 : Recipe of Natural dyeing (2I3)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	3	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 3\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 15 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (15)mL
= 150 - 15 mL
= 135mL

Process sequence of Dyeing:

Add 135mL of Water
↓
Add 15 mL Turmeric Solution
↓
Raise Temperature to 40°C
↓
Place 5gm 100% Pre-treated Nylon Fabric into dye bath
↓
Raise Temperature to 80°C and Run for 20 minutes
↓
Bath Drain
↓
Cold Rinsing and Hot Wash at 90°C
↓
Sample Squeezing and drying

Process Curve and Description

Figure 4.6.1 : Process Curve of Mordanting (2I3)

Figure 4.6.2 : Process curve of Dyeing (2I3)

Process Description:

At first 120 ml of water was taken in a dye bath. Then the calculated amount of ferrous sulphate solution (30ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 135 ml of water was taken in another dye bath and 15 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview:

Figure 4.6.3 : Dyed Sample of **2I3**

4.7 Natural Dyeing 3A3

Table 4.7.1 : Recipe of Mordanting (3A3)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Aluminium Sulfate	g/L	3	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Aluminium Sulfate = $\frac{150\ X\ 3}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 45 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (45) mL
= 150 - 45 mL
= 105 mL

Process sequence of Mordanting:

Add 105 mL of Water
↓
Add 45 mL Aluminium Sulfate Solution
↓
Raise Temperature to 60°C
↓
Place 5gm 100% Nylon Fabric into dye bath
↓
Raise Temperature to 100°C and Run for 20 minutes
↓
Bath Drain

Table 4.7.2 : Recipe of Natural dyeing (3A3)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	3	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 3\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 15 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (15)mL
= 150 - 15 mL
= 135mL

Process sequence of Dyeing:

Add 135mL of Water
↓
Add 15 mL Turmeric Solution
↓
Raise Temperature to 40°C
↓
Place 5gm 100% Pre-treated Nylon Fabric into dye bath
↓
Raise Temperature to 80°C and Run for 20 minutes
↓
Bath Drain
↓
Cold Rinsing and Hot Wash at 90°C
↓
Sample Squeezing and drying

Process Curve and Description

Figure 4.7.1 : Process Curve of Mordanting (3A3)

Figure 4.7.2 : Process curve of Dyeing (3A3)

Process Description:

At first 105 ml of water was taken in a dye bath. Then the calculated amount of aluminium sulphate solution (45ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 135 ml of water was taken in another dye bath and 15 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview :

Figure 4.7.3 : Dyed sample of **3A3**

4.8 Natural Dyeing 3I3

Table 4.8.1 : Recipe of Mordanting (3I3)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Ferrous Sulfate	g/L	3	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Ferrous Sulfate = $\frac{150\ X\ 3}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 45 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (45) mL
= 150 - 45 mL
= 105 mL

Process sequence of Mordanting:

Add 105 mL of Water
↓
Add 45 mL Ferrous Sulfate Solution
↓
Raise Temperature to 60°C
↓
Place 5gm 100% Nylon Fabric into dye bath
↓
Raise Temperature to 100°C and Run for 20 minutes
↓
Bath Drain

Table 4.8.2 : Recipe of Natural dyeing (3I3)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	3	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 3\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 15 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (15)mL
= 150 - 15 mL
= 135mL

Process sequence of Dyeing:

Add 135mL of Water
↓
Add 15 mL Turmeric Solution
↓
Raise Temperature to 40°C
↓
Place 5gm 100% Pre-treated Nylon Fabric into dye bath
↓
Raise Temperature to 80°C and Run for 20 minutes
↓
Bath Drain
↓
Cold Rinsing and Hot Wash at 90°C
↓
Sample Squeezing and drying

Process Curve and Description

Figure 4.8.1 : Process Curve of Mordanting (3I3)

Figure 4.8.2 : Process curve of Dyeing (3I3)

Process Description:

At first 105 ml of water was taken in a dye bath. Then the calculated amount of ferrous sulphate solution (45ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 135 ml of water was taken in another dye bath and 15 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample overview

4.9 Acid Dyeing 3%

Table 4.9.1 : Dyeing Recipe of AC3

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Acid Dye	%	3	1%
02	Wetting Agent	g/L	1	1%
03	Acetic Acid	g/L	0.8	1%
04	Sample Weight	gm	5	----
05	M:L	-----	1:30	----
06	pH	-----	4.5 - 5.5	----
07	Temperature	°C	100	----
08	Time	min	20	----

Calculation:

Total Liquor = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Acid Dye = $\frac{5\ X\ 3\%}{1\%}$mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 15 mL

Wetting Agent = $\frac{150\ X\ 1}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%)X\ 1000}$)
= 15mL

Acetic Acid = $\frac{150\ X\ 0.8}{1\%\ X\ 1000}$mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%)X\ 1000}$)
= 12mL

Initial Water = Total Liquor - (chemicals)
= 150 - (15+15+12) mL
= 150 - 42 mL
= 108 mL

Process Sequence

Take 108ml water into dye bath

↓

Raise temperature to 60°C

↓

Add 15 ml wetting agent solution

↓

Add 12 ml acetic acid solution

↓

Check pH and its about 4.5

↓

Add 15ml Acid dye solution

↓

Add 5gm 100% nylon fabric sample

↓

Raise temperature to 100°C

↓

Run for 20 minute

↓

Bath Drain

↓

Hot Wash done at 80°C

↓

Cold Rinsing

↓

Drying

Process Curve and Description:

Figure 4.9.1 : Process Curve of Acid Dyeing AC3

Process Description

At first 108 ml of water was taken in a dye bath. Then it was heated and raised the temperature to 60°C then 15ml of wetting agent solution and 12ml of acetic acid solution added than we checked the pH of the dye bath and it was 4.5, after confirmed pH value of the bath we added 15ml of acid dye solution and added wet sample in the bath. Then it was set on a gas burner and heated. Then the temperature was raised to 100°C and run for 20 min with stirring. Then the bath was dropped and we processed the sample with a hot wash at 80°C and two cold rinsing are done. Finally, the sample was dried by ironing.

Sample Overview

4.10 Natural Dyeing 1A5

Table 4.10.1 : Recipe of Mordanting (1A5)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Aluminium Sulfate	g/L	1	1%
02	Sample Weight	Gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	Min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Aluminium Sulfate = $\frac{150\ X\ 1}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 15mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (15) mL
= 150-15 mL
= 135 mL

Process sequence of Mordanting:

Add 135 mL of Water

↓

Add 15 mL Aluminium Sulfate Solution

↓

Raise Temperature to 60°C

↓

Place 5gm 100% Nylon Fabric into dye bath

↓

Raise Temperature to 100°C and Run for 20 minutes

↓

Bath Drain

Table 4.10.2 : Recipe of Natural dyeing (1A5)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	5	1%
02	Sample Weight	Gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	Min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 5\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 25 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (25) mL
= 150 - 25 mL
= 125 mL

Process sequence of Dyeing:

Add 125mL of Water

↓

Add 25 mL Turmeric Solution

↓

Raise Temperature to 40°C

↓

Place 5gm 100% Pre-treated Nylon Fabric into dye bath

↓

Raise Temperature to 80°C and Run for 20 minutes

↓

Bath Drain

↓

Cold Rinsing and Hot Wash at 90°C

↓

Sample Squeezing and drying

Process Curve and Description

Figure 4.10.1 : Process Curve of Mordanting (1A5)

Figure 4.10.2 : Process curve of Dyeing (1A5)

Process Description:

At first 135 ml of water was taken in a dye bath. Then the calculated amount of aluminium sulphate solution (15ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 125 ml of water was taken in another dye bath and 25 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview:

4.11 Natural Dyeing 1I5

Table 4.11.1 : Recipe of Mordanting (1I5)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Ferrous Sulfate	g/L	1	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Ferrous Sulfate = $\frac{150\ X\ 1}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 15mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (15) mL
= 150-15 mL
= 135 mL

❖ **Process sequence of Mordanting:**

Add 135 mL of Water
↓
Add 15 mL Ferrous Sulfate Solution
↓
Raise Temperature to 60°C

↓

Place 5gm 100% Nylon Fabric into dye bath

↓

Raise Temperature to 100°C and Run for 20 minutes

↓

Bath Drain

Table 4.11.2 : Recipe of Natural dyeing (1I5)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	5	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 5\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 25 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (25) mL
= 150 - 25 mL
= 125 mL

Process sequence of Dyeing:

Add 125mL of Water

↓

Add 25 mL Turmeric Solution

↓

Raise Temperature to 40°C

↓

Place 5gm 100% Pre-treated Nylon Fabric into dye bath

↓

Raise Temperature to 80°C and Run for 20 minutes

↓

Bath Drain

↓

Cold Rinsing and Hot Wash at 90°C

↓

Sample Squeezing and drying

Process Curve and Description

Figure 4.11.1 : Process Curve of Mordanting (1I5)

Figure 4.11.2 : Process curve of Dyeing (1I5)

Process Description:

At first 135 ml of water was taken in a dye bath. Then the calculated amount of ferrous sulphate solution (15ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 125 ml of water was taken in another dye bath and 25 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview:

4.12 Natural Dyeing 2A5

Table 4.12.1 : Recipe of Mordanting (2A5)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Aluminium Sulfate	g/L	2	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Aluminium Sulfate = $\frac{150\ X\ 2}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 30 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (30) mL
= 150 - 30 mL
= 120 mL

Process sequence of Mordanting:

Add 120 mL of Water
↓
Add 30 mL Aluminium Sulfate Solution
↓
Raise Temperature to 60°C
↓

Place 5gm 100% Nylon Fabric into dye bath

↓

Raise Temperature to 100°C and Run for 20 minutes

↓

Bath Drain

Table 4.12.2 : Recipe of Natural dyeing (2A5)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	5	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 5\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 25 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (25) mL
= 150 - 25 mL
= 125 mL

Process sequence of Dyeing:

Add 125mL of Water

↓

Add 25 mL Turmeric Solution

↓

Raise Temperature to 40°C

↓

Place 5gm 100% Pre-treated Nylon Fabric into dye bath

↓

Raise Temperature to 80°C and Run for 20 minutes

↓

Bath Drain

↓

Cold Rinsing and Hot Wash at 90°C

↓

Sample Squeezing and drying

Process Curve and Description

Figure 4.12.1 : Process Curve of Mordanting (2A5)

Figure 4.12.2 : Process curve of Dyeing (2A5)

Process Description:

At first 120 ml of water was taken in a dye bath. Then the calculated amount of aluminium sulphate solution (30ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 125 ml of water was taken in another dye bath and 25 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview:

Figure 4.12.3 : Dyed sample of **2A5**

4.13 Natural Dyeing 2I5

Table 4.13.1 : Recipe of Mordanting (2I5)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Ferrous Sulfate	g/L	2	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Ferrous Sulfate = $\frac{150\ X\ 2}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 30 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (30) mL
= 150 - 30 mL
= 120 mL

Process sequence of Mordanting:

Add 120 mL of Water
↓
Add 30 mL Ferrous Sulfate Solution
↓
Raise Temperature to 60°C
↓

Place 5gm 100% Nylon Fabric into dye bath

↓

Raise Temperature to 100°C and Run for 20 minutes

↓

Bath Drain

Table 4.13.2 : Recipe of Natural dyeing (2I5)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	5	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 5\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 25 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (25) mL
= 150 - 25 mL
= 125 mL

Process sequence of Dyeing:

Add 125mL of Water

↓

Add 25 mL Turmeric Solution

↓

Raise Temperature to 40°C

↓

Place 5gm 100% Pre-treated Nylon Fabric into dye bath

↓

Raise Temperature to 80°C and Run for 20 minutes

↓

Bath Drain

↓

Cold Rinsing and Hot Wash at 90°C

↓

Sample Squeezing and drying

Process Curve and Description

Figure 4.13.1 : Process Curve of Mordanting (2I5)

Figure 4.13.2 : Process curve of Dyeing (2I5)

Process Description:

At first 120 ml of water was taken in a dye bath. Then the calculated amount of ferrous sulphate solution (30ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 125 ml of water was taken in another dye bath and 25 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview:

4.14 Natural Dyeing 3A5

Table 4.14.1 : Recipe of Mordanting (3A5)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Aluminium Sulfate	g/L	3	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Aluminium Sulfate = $\frac{150\ X\ 3}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 45 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (45) mL
= 150 - 45 mL
= 105 mL

Process sequence of Mordanting:

Add 105 mL of Water
↓
Add 45 mL Aluminium Sulfate Solution
↓
Raise Temperature to 60°C
↓

Place 5gm 100% Nylon Fabric into dye bath

↓

Raise Temperature to 100°C and Run for 20 minutes

↓

Bath Drain

Table 4.14.2 : Recipe of Natural dyeing (3A5)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	5	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 5\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 25 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (25) mL
= 150 - 25 mL
= 125 mL

Process sequence of Dyeing:

Add 125mL of Water

↓

Add 25 mL Turmeric Solution

↓

Raise Temperature to 40°C

↓

Place 5gm 100% Pre-treated Nylon Fabric into dye bath

↓

Raise Temperature to 80°C and Run for 20 minutes

↓

Bath Drain

↓

Cold Rinsing and Hot Wash at 90°C

↓

Sample Squeezing and drying

Process Curve and Description

Figure 4.14.1 : Process Curve of Mordanting (3A5)

Figure 4.14.2 : Process curve of Dyeing (3A5)

Process Description:

At first 105 ml of water was taken in a dye bath. Then the calculated amount of aluminium sulphate solution (45ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 125 ml of water was taken in another dye bath and 25 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview:

Figure 4.14.3 : Dyed sample of **3A5**

4.15 Natural Dyeing 3I5

Table 4.15.1 : Recipe of Mordanting (3I5)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Ferrous Sulfate	g/L	3	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Ferrous Sulfate = $\frac{150\ X\ 3}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 45 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (45) mL
= 150 - 45 mL
= 105 mL

Process sequence of Mordanting:

Add 105 mL of Water
↓

Add 45 mL Ferrous Sulfate Solution

↓

Raise Temperature to 60°C

↓

Place 5gm 100% Nylon Fabric into dye bath

↓

Raise Temperature to 100°C and Run for 20 minutes

↓

Bath Drain

Table 4.15.2 : Recipe of Natural dyeing (3I5)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	5	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 5\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 25 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (25) mL
= 150 - 25 mL
= 125 mL

Process sequence of Dyeing:

Add 125mL of Water

↓

Add 25 mL Turmeric Solution

↓

Raise Temperature to 40°C

↓

Place 5gm 100% Pre-treated Nylon Fabric into dye bath

↓

Raise Temperature to 80°C and Run for 20 minutes

↓

Bath Drain

↓

Cold Rinsing and Hot Wash at 90°C

↓

Sample Squeezing and drying

Process Curve and Description

Figure 4.15.1 : Process Curve of Mordanting (3I5)

Figure 4.15.2 : Process curve of Dyeing (3I5)

Process Description:

At first 105 ml of water was taken in a dye bath. Then the calculated amount of ferrous sulphate solution (45ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 125 ml of water was taken in another dye bath and 25 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview

Figure 4.15.3 : Dyed sample of **3I5**

4.16 Acid Dyeing 5%

Table 4.16.1 : Dyeing Recipe of AC5

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Acid Dye	%	5	1%
02	Wetting Agent	g/L	1	1%
03	Acetic Acid	g/L	0.8	2%
04	Sample Weight	gm	5	----
05	M:L	-----	1:30	----
06	pH	-----	4.5 - 5.5	----
07	Temperature	°C	100	----
08	Time	min	20	----

Calculation:

Total Liquor = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Acid Dye = $\frac{5\ X\ 5\%}{1\%}$mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 25 mL

Wetting Agent = $\frac{150\ X\ 1}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%)X\ 1000}$)
= 15mL

Acetic Acid = $\frac{150\ X\ 0.8}{2\%\ X\ 1000}$mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%)X\ 1000}$)

= 12mL

Initial Water = Total Liquor - (chemicals)
= 150 - (25+15+12) mL
= 150 - 52 mL
= 98 mL

Process Sequence

Take 98ml water into dye bath

↓

Raise temperature to 60°C

↓

Add 15 ml wetting agent solution

↓

Add 12 ml acetic acid solution

↓

Check pH and its about 4.5

↓

Add 25 ml Acid dye solution

↓

Add 5gm 100% nylon fabric sample

↓

Raise temperature to 100°C

↓

Run for 20 minute

↓

Bath Drain

↓

Hot Wash done at 80°C

↓

Cold Rinsing

↓

Drying

Process Curve and Description:

Figure 4.16.1 : Process Curve of Acid Dyeing (AC5)

Process Description

At first 98 ml of water was taken in a dye bath. Then it was heated and raised the temperature to 60°C then 15ml of wetting agent solution and 12ml of acetic acid solution added than we checked the pH of the dye bath and it was 4.5, after confirmed pH value of the bath we added 25 ml of acid dye solution and added wet sample in the bath. Then it was set on a gas burner and heated. Then the temperature was raised to 100°C and run for 20 min with stirring. Then the bath was dropped and we processed the sample with a hot wash at 80°C and two cold rinsing are done. Finally, the sample was dried by ironing.

Sample Overview :

Figure 4.16.2 : Dyed sample of **AC5**

4.17 Natural Dyeing 1A7

Table 4.17.1 : Recipe of Mordanting (1A7)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Aluminium Sulfate	g/L	1	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------

05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Aluminium Sulfate = $\frac{150\ X\ 1}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 15mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (15) mL
= 150-15 mL
= 135 mL

Process sequence of Mordanting:

Add 135 mL of Water
↓
Add 15 mL Aluminium Sulfate Solution
↓
Raise Temperature to 60°C
↓
Place 5gm 100% Nylon Fabric into dye bath
↓
Raise Temperature to 100°C and Run for 20 minutes
↓
Bath Drain

Table 4.17.2 : Recipe of Natural dyeing (1A7)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	7	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 7\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 35 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (35) mL
= 150 - 35 mL
= 115 mL

Process sequence of Dyeing:

Add 115mL of Water
↓
Add 35 mL Turmeric Solution
↓
Raise Temperature to 40°C
↓
Place 5gm 100% Pre-treated Nylon Fabric into dye bath
↓
Raise Temperature to 80°C and Run for 20 minutes
↓
Bath Drain
↓
Cold Rinsing and Hot Wash at 90°C
↓
Sample Squeezing and drying

Process Curve and Description

Figure 4.17.1 : Process Curve of Mordanting (1A7)

Figure 4.17.2 : Process curve of Dyeing (1A7)

Process Description:

At first 135 ml of water was taken in a dye bath. Then the calculated amount of aluminium sulphate solution (15ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 115 ml of water was taken in another dye bath and 35 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview:

Figure 4.17.3 : Dyed sample of **1A7**

4.18 Natural Dyeing 1I7

Table 4.18.1 : Recipe of Mordanting (1I7)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Ferrous Sulfate	g/L	1	1%
02	Sample Weight	gm	5	------

03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Ferrous Sulfate = $\frac{150\ X\ 1}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 15mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (15) mL
= 150-15 mL
= 135 mL

Process sequence of Mordanting:

Add 135 mL of Water
↓
Add 15 mL Ferrous Sulfate Solution
↓
Raise Temperature to 60°C
↓
Place 5gm 100% Nylon Fabric into dye bath
↓
Raise Temperature to 100°C and Run for 20 minutes
↓
Bath Drain

Table 4.18.2 : Recipe of Natural dyeing (1I7)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	7	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 7\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 35 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (35) mL
= 150 - 35 mL
= 115 mL

Process sequence of Dyeing:

Add 115mL of Water
↓
Add 35 mL Turmeric Solution
↓
Raise Temperature to 40°C
↓
Place 5gm 100% Pre-treated Nylon Fabric into dye bath
↓
Raise Temperature to 80°C and Run for 20 minutes
↓
Bath Drain
↓
Cold Rinsing and Hot Wash at 90°C
↓
Sample Squeezing and drying

Process Curve and Description

Figure 4.18.1 : Process Curve of Mordanting (1I7)

Figure 4.18.2 : Process curve of Dyeing (1I7)

Process Description:

At first 135 ml of water was taken in a dye bath. Then the calculated amount of ferrous sulphate solution (15ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 115 ml of water was taken in another dye bath and 35 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview:

Figure 4.18.3 : Dyed sample of **1I7**

4.19 Natural Dyeing 2A7

Table 4.19.1 : Recipe of Mordanting (2A7)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Aluminium Sulfate	g/L	2	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Aluminium Sulfate = $\frac{150\ X\ 2}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 30 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (30) mL
= 150 - 30 mL
= 120 mL

Process sequence of Mordanting:

Add 120 mL of Water
↓
Add 30 mL Aluminium Sulfate Solution
↓
Raise Temperature to 60°C
↓
Place 5gm 100% Nylon Fabric into dye bath
↓
Raise Temperature to 100°C and Run for 20 minutes
↓
Bath Drain

Table 4.19.2 : Recipe of Natural dyeing (2A7)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	7	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }

= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 7\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 35 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (35) mL
= 150 - 35 mL
= 115 mL

Process sequence of Dyeing:

Add 115mL of Water
↓
Add 35 mL Turmeric Solution
↓
Raise Temperature to 40°C
↓
Place 5gm 100% Pre-treated Nylon Fabric into dye bath
↓
Raise Temperature to 80°C and Run for 20 minutes
↓
Bath Drain
↓
Cold Rinsing and Hot Wash at 90°C
↓
Sample Squeezing and drying

Process Curve and Description

Figure 4.19.1 : Process Curve of Mordanting (2A7)

Figure 4.19.2 : Process curve of Dyeing (2A7)

Process Description:

At first 120 ml of water was taken in a dye bath. Then the calculated amount of aluminium sulphate solution (30ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 115 ml of water was taken in another dye bath and 35 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview:

Figure 4.19.3 : Dyed sample of **2A7**

4.20 Natural Dyeing 2I7

Table 4.20.1 : Recipe of Mordanting (2I7)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Ferrous Sulfate	g/L	2	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Ferrous Sulfate = $\frac{150\ X\ 2}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 30 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (30) mL
= 150 - 30 mL
= 120 mL

Process sequence of Mordanting:

Add 120 mL of Water
↓
Add 30 mL Ferrous Sulfate Solution
↓
Raise Temperature to 60°C
↓
Place 5gm 100% Nylon Fabric into dye bath
↓
Raise Temperature to 100°C and Run for 20 minutes
↓
Bath Drain

Table 4.20.2 : Recipe of Natural dyeing (2I7)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	7	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 7\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)

= 35 mL

Initial Water : = Total Liquor - (chemicals)

= 150 - (35) mL

= 150 - 35 mL

= 115 mL

Process sequence of Dyeing:

Add 115mL of Water

↓

Add 35 mL Turmeric Solution

↓

Raise Temperature to 40°C

↓

Place 5gm 100% Pre-treated Nylon Fabric into dye bath

↓

Raise Temperature to 80°C and Run for 20 minutes

↓

Bath Drain

↓

Cold Rinsing and Hot Wash at 90°C

↓

Sample Squeezing and drying

Process Curve and Description

Figure 4.20.1 : Process Curve of Mordanting (2I7)

Figure 4.20.2 : Process curve of Dyeing (2I7)

Process Description:

At first 120 ml of water was taken in a dye bath. Then the calculated amount of ferrous sulphate solution (30ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 115 ml of water was taken in another dye bath and 35 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview:

Figure 4.20.3 : Dyed sample of **2I7**

4.21 Natural Dyeing 3A7

Table 4.21.1 : Recipe of Mordanting (3A7)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Aluminium Sulfate	g/L	3	1%
02	Sample Weight	gm	5	------
03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Aluminium Sulfate = $\frac{150\ X\ 3}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 45 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (45) mL
= 150 - 45 mL
= 105 mL

Process sequence of Mordanting:

Add 105 mL of Water
↓
Add 45 mL Aluminium Sulfate Solution
↓
Raise Temperature to 60°C
↓
Place 5gm 100% Nylon Fabric into dye bath
↓
Raise Temperature to 100°C and Run for 20 minutes
↓
Bath Drain

Table 4.21.2 : Recipe of Natural dyeing (3A7)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	7	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30

= 150 mL

Natural Dye: $= \frac{5\ X\ 7\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)

= 35 mL

Initial Water : = Total Liquor - (chemicals)

= 150 - (35) mL

= 150 - 35 mL

= 115 mL

Process sequence of Dyeing:

Add 115mL of Water

↓

Add 35 mL Turmeric Solution

↓

Raise Temperature to 40°C

↓

Place 5gm 100% Pre-treated Nylon Fabric into dye bath

↓

Raise Temperature to 80°C and Run for 20 minutes

↓

Bath Drain

↓

Cold Rinsing and Hot Wash at 90°C

↓

Sample Squeezing and drying

Process Curve and Description

Figure 4.21.1 : Process Curve of Mordanting (3A7)

Figure 4.21.2 : Process curve of Dyeing (3A7)

Process Description:

At first 105 ml of water was taken in a dye bath. Then the calculated amount of aluminium sulphate solution (45ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 115 ml of water was taken in another dye bath and 35 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview:

Figure 4.21.3 : Dyed sample of **3A7**

4.22 Natural Dyeing 3I7

Table 4.22.1 : Recipe of Mordanting (3I7)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Ferrous Sulfate	g/L	3	1%
02	Sample Weight	gm	5	------

03	M:L Ratio	------	1:30	------
04	Temperature	°C	100	------
05	Time	min	20	-------

Calculation:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Ferrous Sulfate = $\frac{150\ X\ 3}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}$)
= 45 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (45) mL
= 150 - 45 mL
= 105 mL

Process sequence of Mordanting:

Add 105 mL of Water
↓
Add 45 mL Ferrous Sulfate Solution
↓
Raise Temperature to 60°C
↓
Place 5gm 100% Nylon Fabric into dye bath
↓
Raise Temperature to 100°C and Run for 20 minutes
↓
Bath Drain

Table 4.22.2 : Recipe of Natural dyeing (3I7)

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Turmeric Powder	%	7	1%
02	Sample Weight	gm	5	------
03	M:L	------	1:30	------
04	Temperature	°C	80	------
05	Time	min	20	-------

❖ **Calculation**:

Total Liquor: = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Natural Dye: $= \frac{5\ X\ 7\%}{1\%}$ mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 35 mL

Initial Water : = Total Liquor - (chemicals)
= 150 - (35) mL
= 150 - 35 mL
= 115 mL

Process sequence of Dyeing:

Add 115mL of Water
↓
Add 35 mL Turmeric Solution
↓
Raise Temperature to 40°C
↓
Place 5gm 100% Pre-treated Nylon Fabric into dye bath
↓
Raise Temperature to 80°C and Run for 20 minutes
↓
Bath Drain
↓
Cold Rinsing and Hot Wash at 90°C
↓
Sample Squeezing and drying

Process Curve and Description

Figure 4.22.1 : Process Curve of Mordanting (3I7)

Figure 4.22.2 : Process curve of Dyeing (3I7)

Process Description:

At first 105 ml of water was taken in a dye bath. Then the calculated amount of ferrous sulphate solution (45ml) was added to it. Then it was heated and raised the temperature to 60°C. Then the sample was added to it and raised the temperature to 80°C. Then it was run for 20 min with stirring. Then the bath was dropped but the sample cannot be rinsed or washed. Again 115 ml of water was taken in another dye bath and 35 ml of dye solution was added to it. Then it was set on a gas burner and heated. When the temperature reached 40°C that mordant sample was taken out from the previous bath and added to it. Then the temperature was raised to 80°C and run for 20 min with stirring. Then the bath was dropped and rinsed the sample a bit but it cannot be washed. Finally, the sample was dried by ironing.

Sample Overview:

Figure 4.22.3 : Dyed sample of **3I7**

4.23 Acid Dyeing 7%

Table 4.23.1 : Dyeing Recipe AC7

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Acid Dye	%	7	1%

02	Wetting Agent	g/L	1	1%
03	Acetic Acid	g/L	0.8	2%
04	Sample Weight	gm	5	----
05	M:L	-----	1:30	----
06	pH	-----	4.5 - 5.5	----
07	Temperature	°C	100	----
08	Time	min	20	----

Calculation:

Total Liquor = Material Weight X L { M:L }
= 5gm X 30
= 150 mL

Acid Dye = $\frac{5\ X\ 7\%}{1\%}$mL ($\frac{Material\ weight\ X\ chemical\ amount\ (\%)}{stock\ solution\ (\%)}$)
= 35 mL

Wetting Agent = $\frac{150\ X\ 1}{1\%\ X\ 1000}$ mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%)X\ 1000}$)
= 15mL

Acetic Acid = $\frac{150\ X\ 0.8}{2\%\ X\ 1000}$mL ($\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%)X\ 1000}$)
= 12mL

Initial Water = Total Liquor - (chemicals)
= 150 - (35+15+12) mL
= 150 - 62 mL
= 88 mL

Process Sequence

Take 88ml water into dye bath

↓

Raise temperature to 60°C

↓

Add 15 ml wetting agent solution

↓

Add 12 ml acetic acid solution

↓

Check pH and its about 4.5

↓

Add 35 ml Acid dye solution

↓

Add 5gm 100% nylon fabric sample

↓

Raise temperature to 100°C

↓

Run for 20 minute

↓

Bath Drain

↓

Hot Wash done at 80°C

↓

Cold Rinsing

↓

Drying

Process Curve and Description:

Figure 4.23.1 : Process Curve of Acid Dyeing AC7

Process Description

At first 88 ml of water was taken in a dye bath. Then it was heated and raised the temperature to 60°C then 15ml of wetting agent solution and 12ml of acetic acid solution added than we checked the pH of the dye bath and it was 4.5, after confirmed pH value of the bath we added 35 ml of acid dye solution and added wet sample in the bath. Then it was set on a gas burner and heated. Then the temperature was raised to 100°C and run for 20 min with stirring. Then the bath was dropped and we processed the sample with a hot wash at 80°C and two cold rinsing are done. Finally, the sample was dried by ironing.

Sample Overview:

Figure 4.23.2 : Dyed sample of **AC7**

4.24 Testing of color fastness to wash :

Table 4.24.1 : Recipe of Washing

SL	Process Parameter	Unit	Dossing	Stock Solution
01	Detergent	g/L	4	1%
02	Sodium Perborate	g/L	1	1%
03	M:L	------	1:50	------
04	Temperature	°C	40	------
05	Time	min	30	-------

Calculation:

Total Liquor: = 50mL

Detergent : $= \frac{50\ X\ 4}{1\%\ X\ 1000}$ mL $\left(\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}\right)$

= 20mL

Sodium Perborate : $= \frac{50\ X\ 1}{1\%\ X\ 1000}$ mL $\left(\frac{Total\ Liquor\ X\ chemical\ amount\ in\ gm/L}{Stock\ solution(\%) X\ 1000}\right)$

= 5mL

Initial Water : = Total Liquor - (chemicals)

= 50 - (20+5)mL

= 50-25 mL

= 25mL

Process Flow Chart:

Sample & Multi-fibre conditioned as lab standard (20±2)°C temperature and relative humidity (65±2).

↓

Take multi-fibre & sample of 10X4 cm^2.

↓

Sewing both multi-fibre and test specimen together.

↓

Wash sewed specimen as per recipe.

↓

Final assessment with both type of gray scale.

Process Curve and Description

Figure 4.24.1 : Process Curve of Washing

Process Description:

At first we need to collect conditioned dyed sample and multi-fibre of 10X4 cm^2 and stitch them together. Then we need to set bath and take chemicals as per recipe. Then we immersed sample to the bath and heated it up to 40°C for 30 minutes. After the process it need to dry the sample and compare with gray scale to color change for dyed sample and compare with gray scale to color staining for multi-fibre.

Sample Assesment 1A3:

Figure 4.24.2 : Multi-fibre after washing 1A3

Table 4.24.2 : Rating of staning (Multi-fibre) 1A3

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4/5	4/5	5	5	5

Rating for color change (1A3) : 4/5

- **Sample Assesment 1I3:**

Figure 4.24.3 : Multi-fibre after washing 1I3

Table 4.24.3 : Rating of staning (Multi-fibre) 1I3

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4/5	4/5	5	5	5

Rating for color change 1I3 : 4/5

- **Sample Assesment 2A3:**

Figure 4.24.4 : Multi-fibre after washing 2A3

Table 4.24.4 : Rating of staning (Multi-fibre) 2A3

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4/5	4	5	5	5

Rating for color change 2A3 : 4/5

- **Sample Assesment 2I3:**

Figure 4.24.5 : Multi-fibre after washing 2I3

Table 4.24.5: Rating of staning (Multi-fibre) 2I3

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4/5	4/5	5	5	5

Rating for color change 2I3 : 4/5

- **Sample Assesment 3A3:**

Figure 4.24.6 : Multi-fibre after washing 3A3

Table 4.24.6 : Rating of staning (Multi-fibre) for 3A3

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4	4	5	5	5

Rating for color change 3A3 : 4/5

- **Sample Assesment 3I3:**

Figure 4.24.7 : Multi-fibre after washing 3I3

Table 4.24.7 : Rating of staning (Multi-fibre) 3I3

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4/5	4/5	5	5	5

Rating for color change 3I3 : 4/5

- **Sample Assesment Acid dyeing 3%:**

Figure 4.24.8 : Multi-fibre after washing AC3

Table 4.24.8 : Rating of staning (Multi-fibre) AC3

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	5	4/5	5	5	5

Rating for color change AC3 : 5

- **Sample Assesment 1A5:**

Figure 4.24.9 : Multi-fibre after washing 1A5

Table 4.24.9 : Rating of staning (Multi-fibre) 1A5

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4/5	4	5	5	5

Rating for color change 1A5 : 4/5

- **Sample Assesment 1I5:**

Figure 4.24.10 : Multi-fibre after washing 1I5

Table 4.24.10 : Rating of staning (Multi-fibre) 1I5

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4	4	5	5	5

Rating for color change 1I5 : 4

- **Sample Assesment 2A5:**

Figure 4.24.11 : Multi-fibre after washing 2A5

Table 4.24.11 : Rating of staning (Multi-fibre) 2A5

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4	4	5	5	5

Rating for color change 2A5 : 4/5

- **Sample Assesment 2I5:**

Figure 4.24.12: Multi-fibre after washing 2I5

Table 4.24.12 : Rating of staning (Multi-fibre) 2I5

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4	4/5	5	5	5

Rating for color change 2I5 : 4

- **Sample Assesment 3A5:**

Figure 4.24.13 : Multi-fibre after washing 3A5

Table 4.24.13 : Rating of staning (Multi-fibre) 3A5

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4	4	5	5	5

Rating for color change 3A5 : 4

- **Sample Assesment 3I5:**

Figure 4.24.14: Multi-fibre after washing 3I5

Table 4.24.14 : Rating of staning (Multi-fibre) 3I5

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4	3/4	5	5	5

Rating for color change 3I5 : 3/4

- **Sample Assesment Acid dyeing 5%:**

Figure 4.24.15 : Multi-fibre after washing AC5

Table 4.24.15 : Rating of staning (Multi-fibre) AC5

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	5	4/5	5	5	4/5

Rating for color change AC5 : 5

- **Sample Assesment 1A7:**

Figure 4.24.16 : Multi-fibre after washing 1A7

Table 4.24.16 : Rating of staning (Multi-fibre) 1A7

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4	2/3	5	5	5

Rating for color change 1A7 : 4

- **Sample Assesment 1I7:**

Figure 4.24.17 : Multi-fibre after washing 1I7

Table 4.24.17 : Rating of staning (Multi-fibre) 1I7

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4	3/4	5	5	5

Rating for color change 1I7 : 3/4

- **Sample Assesment 2A7:**

Figure 4.24.18 : Multi-fibre after washing 2A7

Table 4.24.18 : Rating of staning (Multi-fibre) 2A7

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4	4	5	5	5

Rating for color change 2A7 : 4

- **Sample Assesment 2I7:**

Figure 4.24.19 : Multi-fibre after washing 2I7

Table 4.24.19 : Rating of staning (Multi-fibre) 2I7

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4	3/4	5	5	5

Rating for color change 2I7 : 3/4

- **Sample Assesment 3A7:**

Figure 4.24.20 : Multi-fibre after washing 3A7

Table 4.24.20 : Rating of staning (Multi-fibre) 3A7

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4/5	4/5	5	5	5

Rating for color change 3A7 : 4/5

- **Sample Assesment 3I7:**

Figure 4.24.21: Multi-fibre after washing 3I7

Table 4.24.21 : Rating of staning (Multi-fibre) 3I7

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	4	3/4	5	5	5

Rating for color change 3I7 : 3/4

- **Sample Assesment Acid dyeing 7%:**

Figure 4.24.22: Multi-fibre after washing AC7

Table 4.24.22: Rating of staning (Multi-fibre) AC7

Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
5	5	4	5	5	4/5

Rating for color change AC7 : 4/5

4.25 Color Fastness to rubbing

Two types of rubbing test are done :

- ❖ Dry rub
- ❖ Wet rub

Testing Procedure:

- Test specimen 15cm x 5cm is placed on the base of the Crock meter.
- A square of white test cloth (5cm x 5cm) which is of plain weave, desized, bleached but without finished cotton fabric (as ready to dye) is taken.
- White test cloth is attached to the finger of the crock meter.
- This finger is used in rubbing action on the sample specimen
- Rubbing is done to and fro, 10 cycles at 10seconds, i.e.20 rubs in 10s and finger pressure on the specimen is 9N.
- Rubbing test is done both for warp way and weft way.
- For dry and wet rubbing test, separate sample is used.
- For wet rubbing, the sample is dry but crocking cloth is wet. For wetting, M:L ratio is maintained not less than 1:50,water is drained after wetting and not squeezed.

Assessment Technique:

- The tested sample compared with dyed sample and under light box using D65 light source and rated by the help of color change gray scale.
- The Dry rubbed crock cloth also visually assessed under light box with D65 light source and rated with the help of color staining gray scale.
- In case of wet rubbed cloth at first it assessed after drying the crock cloth the procedure was same as dry rubbed crock cloth

Figure 4.25.1 : Crock Meter (Left) & Light Box (Right)

Color Staining Rating:

Table 4.25.1 : Color Fastness to Rubbing For sample 1A3

Dry Rub	Wet Rub
5	**5**

Table 4.25.2 : Color Fastness to Rubbing For sample 1I3

Dry Rub	Wet Rub
4/5	**4**

Table 4.25.3 : Color Fastness to Rubbing For sample 2A3

Dry Rub	Wet Rub
5	**4/5**

Table 4.25.4 : Color Fastness to Rubbing For sample 2I3

Dry Rub	Wet Rub
4	**4**

Table 4.25.5 : Color Fastness to Rubbing For sample 3A3

Dry Rub	Wet Rub
5	**4/5**

Table 4.25.6 : Color Fastness to Rubbing For sample 3I3

Dry Rub	Wet Rub
4	**5**

Table 4.25.7 : Color Fastness to Rubbing For sample AC3

Dry Rub	Wet Rub
5	**5**

Table 4.25.8 : Color Fastness to Rubbing For sample 1A5

Dry Rub	Wet Rub

5	**5**

Table 4.25.9 : Color Fastness to Rubbing For sample 1I5

Dry Rub	Wet Rub
5	**5**

Table 4.25.10 : Color Fastness to Rubbing For sample 2A5

Dry Rub	Wet Rub
5	**5**

Table 4.25.11 : Color Fastness to Rubbing For sample 2I5

Dry Rub	Wet Rub
4/5	**5**

Table 4.25.12 : Color Fastness to Rubbing For sample 3A5

Dry Rub	Wet Rub
4/5	**4**

Table 4.25.13 : Color Fastness to Rubbing For sample 3I5

Dry Rub	Wet Rub
4/5	**5**

Table 4.25.14 : Color Fastness to Rubbing For sample AC5

Dry Rub	Wet Rub
5	**5**

Table 4.25.15 : Color Fastness to Rubbing For sample 1A7

Dry Rub	Wet Rub
5	5

Table 4.25.16 : Color Fastness to Rubbing For sample 1I7

Dry Rub	Wet Rub
4	4/5

Table 4.25.17 : Color Fastness to Rubbing For sample 2A7

Dry Rub	Wet Rub
5	4/5

Table 4.25.18 : Color Fastness to Rubbing For sample 2I7

Dry Rub	Wet Rub
4/5	4/5

Table 4.25.19 : Color Fastness to Rubbing For sample 3A7

Dry Rub	Wet Rub
4/5	4

Table 4.25.20 : Color Fastness to Rubbing For sample 3I7

Dry Rub	Wet Rub
4	4/5

Table 4.25.21 : Color Fastness to Rubbing For sample AC7

Dry Rub	Wet Rub
5	4/5

Chapter-5: Result and discussion

After doing all of those tests we found a comparative result between natural dye and synthetic dye. The result of color fastness to wash is shown in **Table-5.1**, the result of color fastness to rubbing is shown in **Table-5.2** and the result of dyes and chemical costing is shown in **Table-5.3**. All of these results are also represented graphically after each table.

Table 5.1 : Comparison between Natural and Acid dye in case of color fastness to wash.

Natural Dye(Turmeric)				**Acid Dye**			
SL No.	**Experimental Code**	**Color Fastness to Wash**		**SL No.**	**Experimental Code**	**Color Fastness to Wash**	
		Color Change	**Staining**			**Color Change**	**Staining**
01	1A3	4/5	4/5	1	AC3	5	4/5
02	1I3	4/5	4/5				
03	2A3	4/5	4				
04	2I3	4/5	4/5				
05	3A3	4/5	4				
06	3I3	4/5	4/5				
07	1A5	4/5	4	2	AC5	5	4/5
08	1I5	4	4				
09	2A5	4/5	4				
10	2I5	4	4/5				
11	3A5	4	4				
12	3I5	3/4	3/4				
13	1A7	4	3	3	AC7	4/5	4
14	1I7	3/4	3/4				
15	2A7	4	4				
16	2I7	3/4	3/4				
17	3A7	4/5	4/5				
18	3I7	3/4	4				

Figure 5.1 : Graph of Color Fastness to wash

Table 5.2 : Comparison between Natural and Acid dye in case of color fastness to rubbing.

Natural Dye (Turmeric)				Acid Dye			
SL No.	**Experimental code**	**Rubbing Fastness**		**SL No.**	**Experimental Code**	**Rubbing Fastness**	
		Dry	**Wet**			**Dry**	**Wet**
01	1A3	5	5	01	AC3	5	5
02	1I3	4/5	4				
03	2A3	5	4/5				
04	2I3	4	4				
05	3A3	5	4/5				

06	3I3	4	5				
07	1A5	5	5	02	AC5	5	5
08	1I5	5	5				
09	2A5	5	5				
10	2I5	4/5	5				
11	3A5	4/5	4				
12	3I5	4/5	5				
13	1A7	5	5	03	AC7	5	4/5
14	1I7	4	4/5				
15	2A7	5	4/5				
16	2I7	4/5	4/5				
17	3A7	4/5	4				
18	3I7	4	4/5				

Figure 5.2 : Graph of Color Fastness to rubbing.

Table 5.3: Dyes and chemical costing comparison between natural and acid dye

Natural Dye (Turmeric)			Acid Dye		
SL No.	Experimental Code	Cost per kg of fabric dyeing (USD)	SL NO.	Experimental Code	Cost per kg of fabric dyeing (USD)
01	1A3	0.3789	01	AC3	0.2472
02	1I3	0.3264			
03	2A3	0.6153			
04	2I3	0.5103			
05	3A3	0.8517			
06	3I3	0.6942			
07	1A5	0.4739	02	AC5	0.3592
08	1I5	0.4214			
09	2A5	0.7103			
10	2I5	0.6053			
11	3A5	0.9467			
12	3I5	0.7892			
13	1A7	0.5689	03	AC7	0.4712
14	1I7	0.5164			
15	2A7	0.8053			
16	2I7	0.7003			

17	3A7	1.0417			
18	3I7	0.8842			

Figure 5.3 : Graph of dyes and chemical costing

The higher the dye shade% the poorer the fastness properties. When the shade% is less, the fastness properties for both mordants are almost same but when the shade% is increased the alum mordanted dyed samples provide a better fastness than the ferrous sulphate dyed sample. Though the alum mordanted dyed samples have a good fastness, it is not as good as acid dyed sample. The cost of alum mordanting is more expensive than ferrous sulphate mordanting. On the basis dyes and chemical costing acid dyeing is more cost effective than both alum mordanted dyeing and ferrous sulphate mordanted dyeing.

Chapter-6: Conclusion

We found that the dye solution prepared from the turmeric is very suitable to dye nylon fabric. We found a good variation of shade from mordant to mordant. The samples dyed with alum mordant gave a bright shade and the samples dyed with ferrous sulphate mordant produced a dull shade. We found a good fastness properties. But these fastness properties also varied from mordant to mordant. The samples which was dyed by using alum mordant has better wash and rubbing fastness than the sample of same shade% dyed by using ferrous sulphate mordant. The fastness also varied with the dye dye percentage used. The higher dye shade percentage has less fastness properties than the lower ones. But the problem is that when we compared those sample with acid dyed sample we found comparatively poorer fastness properties in several cases than acid dyed sample. According to dyes and chemical costing acid dyeing is also more beneficial than the natural dyeing Hence, we hope that this work will be imperative and very helpful for the readers and industry people to do further work with the natural dyes, especially using turmeric in textile dyeing from ecological and commercial viewpoint.

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