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STUDY AND EVALUATION OF DYEING BEHAVIOUR OF COIR FIBRE USING VARIOUS CLASSES OF DYES

ABSTRACT

Coir fibre is extracted by processing coconut husk through a series of machineries. During production a byproduct called coir pith is also extracted. Coir fibre is Scoured, Bleached, Enzyme Treated, and Tamarind Treated and also dyed with different classes of dyes. The sequences of wet processing was varied and also processed at different conditions, a study was made on the processed fibres, studies like mechanical properties, and fastness properties were evaluated and compared between the samples to figure out the best processing sequence on coir fibre.

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CHAPTER 1

1.0 INTRODUCTION

1.1 COIR EXTRACTION

Coir fibre is extracted from the coconut plants, basically coir belongs to palm category which is one of the oldest plant family. Coconut trees are majorly grown in irrigated areas and coastal regions where water source is plenty. India is also one of the major producer of the coconuts it stands third in the world coconut production just behind Indonesia and Philippines.

Only about 20% of total coconuts produced is converted into coir and coir by-products, the remaining 80% is being wasted.

When de-fibering of coir fibre is concerned there are two ways of de-fibering the coir from the husk in which de-fibering by busting and beating action is the first method and de-fibering by retting process the coconut husk is retted in backwaters where water resource is plenty; in case of limited water resource the retting is done in retting tanks.

In such cases few boosters are added to decrease the retting time and to produce good quality of fibres.

1.2 COIR DYEING

A dye is colored substance that has an affinity to the substrate to which it is being apply such as coir fibres and yarns. Dyes are either intrinsically soluble in water or can be made soluble in the medium in which dyeing is conducted. The medium is usually water dyes are molecules which absorb and reflect light at specific wavelength to give human eyes the sense of colour. They are incorporated into the fibre by chemical reaction, absorption or dispersion.

Dyes differ in their resistance to sun light, perspiration, washing, alkalies, gas and other agents their affinity for fibres. Their reaction to cleaning agents and methods, solubility and method of application.Dyeing is the collective name given to the process whereby colour are dissolved and transported to the fibre surface and as individual molecules or ions diffuse into the fibres for which they have some substantively. Dyeing is the process of adding color to the coir products like fibres and yarns.

Dyeing is normally done in a special solution containing dyes and particular chemical material. Dyeing is a method which imparts beauty to the coir products by applying various colours and their shades on to a fibres. The property of color fastness depends upon two factors – Selection of particular dye according to the properties of the coir fibres to be dyed and Selection of the method for dyeing the coir fibre.

The objectives of coloration treatments are to produce the desired color in dyeing. Some coir products like coir mats or mattings is one of the unique areas where coloration is used for aesthetic purpose. The whole operation of coir dyeing should be carried out at the lowest cost.

Before dyeing of fibres some pre- treatments are given to the coir fibres. Such as Scouring, Bleaching and treated with tamarind, these treatments are enhance the softness properties of coir fibre, as well as easy to penetration of dye into the interior of the fibres.

In this dissertation work four class of dyes are used. These dyes are mentioned below.

- Direct dyes
- Reactive dyes (cold brand)
- Acid dyes
- Basic dyes

1.3 OBJECTIVES

1. To Scour, Bleach and Tamarind Treat the coir fibre
2. To find out the affinity of the coir fibres to different classes of dyes.
3. To evaluate the mechanical and fastness properties of treated coir fibres.
4. To examine the best processing sequence for dyeing of coir fibres.

CHAPTER-2

2.0 LITERATURE SURVEY

2.1 NATURAL DYEING

Dyeing is a ancient craft which is practiced from the ancient times. There are some records which say dyeing was carried out 4000 years ago. In those ancient times dyes used was mainly from natural extracts.

These dyes extracted from vast varieties of plants which was found in vegetables, fruits, stem of a plant, root of a plant, bark of a plant etc., some extracts of dyes was also taken from animals also.

Figure 2.1 Natural Dyes Extracted From Flower, Plant, Bark

In 19th century there was a rapid boost in the dyeing sector especially in the mid 19th century which gave rise to plenty of synthetic dyes. Most of the dyes invented were carcinogenic dyes which were realized by the human in later part of the century when a lot of side effect was found in reality, research work.

Coir fibre dyeing might be the old practices followed but till now there is no available records or survey reports which will track the origin and time of the dyeing started on coir fibre. Coir fibre dyeing is not up to the mark in the present industrial scenario; most of the industries use unscientific methods of dyeing. This is due to lack of technological and scientific advancements in coir fibre processing.

Unlike other fibres like cellulosic and protein fibes, the coir fibre is composed of both lignin and cellulose, this creates a special track which needs a specialized interest to be taken to dye this golden fibre.

2.2 PROPERTIES OF COIR FIBRES

2.2.1Physical Properties of Coir Fibre

1. Ultimate length - 0.6 mm
2. Diameter/width - 16 micron
3. Length - 6 to 8 inches
4. Density - 1.4 g/cc
5. Tenacity - 10 g/ tex
6. Breaking Elongation - 30%
7. Moisture regain at 65% RH - 10.5%
8. Swelling in water - 5% in diameter

2.2.2 Chemical Properties (Composition) of Coir Fibre

1. Water soluble - 5.20%
2. Pectin & related compounds - 3.20%
3. Hemi-Cellulose - 0.23%
4. Cellulose - 43.46%
5. Lignin - 45.82%
6. Ash - 2.21%.

2.3 Chemical Composition of Plant Fibres

The chemical properties of natural fibres are shown in the below table 2.1. In which the coir (brown) fibre contain the cellulose percentage of 35.3, lignin percentage of 32.6, and some amount of hemicellulose and pectin. It shows the high lignin content among of them**.**

Table 2.1 Chemical Composition of Plant Fibres

Fibre Waxes	Cellulose	Hemicellulose	Pectin	Lignin	Extractives	Fats and Other impurities
per cent dry weight						
Cotton	91.7	6.4	-	-	1.2	0.7
Flax (bast)	71.1	18.6	2.1	2.3	4.4	1.6
Hemp (bast)	78.2	5.5	2.6	2.9	-	-
Jute (bast)	71.4	13.4	0.3	13.2	1.3	0.5
Coir (brown)	**35.3**	**15.5**	**5.2**	**32.6**	**3.1**	**-**
Coir (white)	**36.6**	**15.3**	**4.8**	**32.4**	**3.2**	**-**
Coir pith	19.8	11.9	7.1	53.2	0.4	-
Sisal	73.0	13.4	1.0	11.0	1.2	0.4
Abaca	70.1	21.8	0.7	5.5	1.5	0.2

2.4 SEM Image of coir fibre

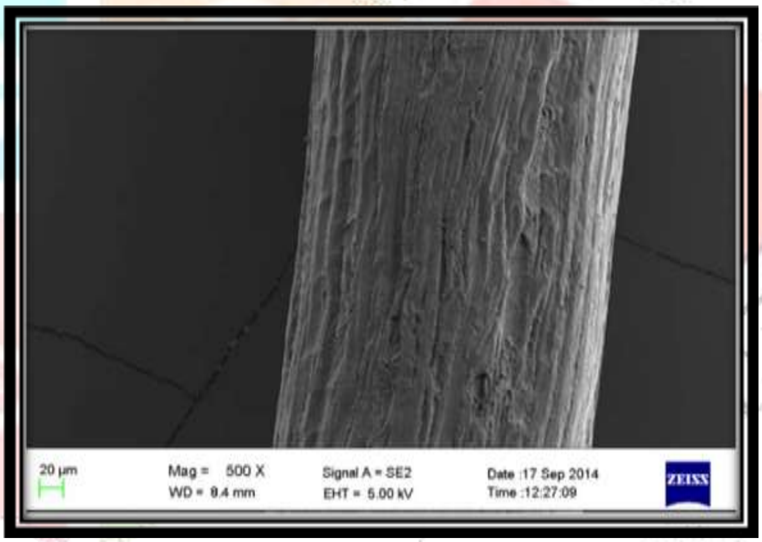

Figure 2.2 SEM Image of coir fibre

The figure 2.3 shows SEM image of raw coir fibre which is having a rough surface which can be softened by treating it with NaoH. Further softening is achieved by treating with highly concentrated NaoH.

2.5 Dyeing Technologies

Traditionally coir is dyed in large vessles and heated by the wood. The required quantities of dye stuff, chemicals and additives are added in paste form when the liquor in the dyeing bath has reached the required temperature. In conventional dyeing process stirring was done by manually. The fibres are dyed due to the process of agitation.

After dyeing the fibres removed from the dyeing bath and rinsed with cold water and dried. The major quantity of dyeing of coir fibres is done in the conventional process.

Some features of Conventional dyeing process are shown in below.

2.5.1 Conventional method of dyeing

a. In this method the dyeing is carried out in a big aluminum bath, the capacity of 50kg of fibre.
b. The heating is done by burning wood of wood underneath the bath.
c. The required amount of chemicals and water is added along with the dyestuff and dyeing is carried out.

To improve the quality of dyed fibre material, modern dyeing methods are adopted by the industry. The industry adopts the following methods of dyeing.

1. Improved method of dyeing
2. Mechanized method of dyeing.

2.5.2 Improved method of dyeing

a. This method of dyeing is carried out by highly skilled labors using large vats made up of stainless steel.
b. These vats do have an inlet and outlet valves for adding water and also to drain out the effluent after dyeing.
c. The effluent is carried away by connecting pipes and taken out for effluent treatment

2.5.3 Mechanized method of dyeing

a. In this method of dyeing the material is kept in motion.
b. The circulation of the dye is done in two directions for the sake of even dyeing. Highly skilled labor is required to perform an efficient dyeing process.

CHAPTER 3

3.0 MATERIALS AND METHODS

3.1 METHODS

3.1.1 EXTRACTION OF COIR FIBRE

A trial was made to know the amount of coir fibre that is extracted from a known mass of husk. This trial will also give the amount of pith collected also.

Five hundred husks were counted and weighed; these husks were subjected for extraction process and the sequence of machineries involved in de-fibering is shown below. The production of fibre is discussed in results and discussion chapter.

3.1.2. MACHIERY SEQUENCE

3.1.2.1 BUSTING M/C

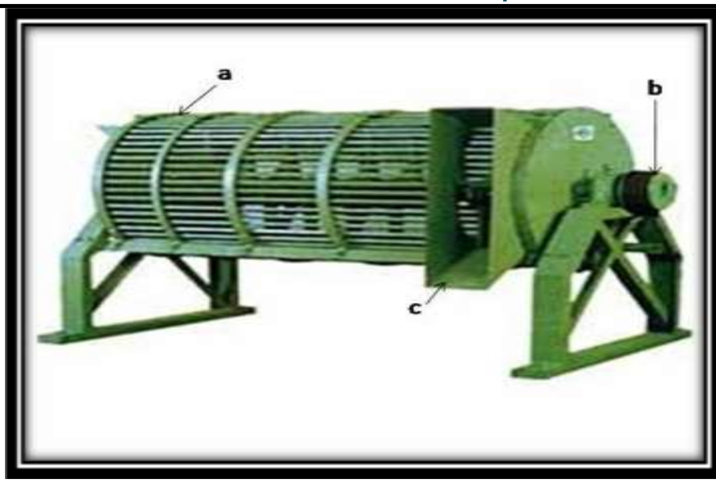

Figure 3.1 Busting m/c

a: cage **b**: beater **c**: feeding section

This is the first machine in the process of extraction of the coir fibre, the husk is the feeding material used here. Two types of processing is possible i.e. white fibre processing and brown fibre processing, brown fibre processing is normally done. Hence dried husk is fed to the machine, the description is mentioned below.

- In the figure above, **b** is the beater, which busts the husk so that the fibres get loosened partially and the outer part of husk is busted in this process.
- Cage **a** covers the beater which will not let the husk to fly away and make sure that the husk is busted by the beater and it also protects the worker from the fast revolving beater.
- Passage **c** is the feeding section.
- This machine runs on a 5hp motor which is fixed on the other side of the machine.
- The husk may be fed manually or by conveyor system, but the conveyor system of feeding is more effective way.
- The busted husk is kept in a damp state for at least minimum of three days, so the pith and fibres are loosened.

3.1.2.2 BEATING M/C

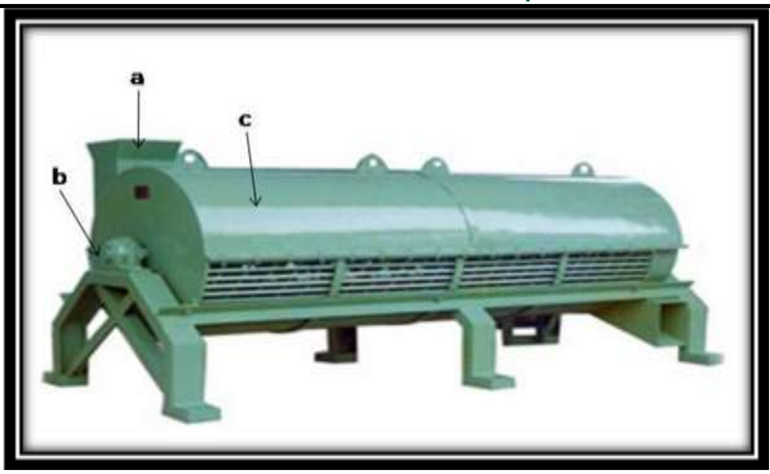

Figure 3.2 Beating m/c

a: feeding section b: beater c: cage

There is no big difference between beating and bursting machine, only change is the variation in the number of beating points. The busting machine has less beating points and beating m/c has more.

- In beating process the fibres are completely individualized from the pith.
- Above Fig shows the beating m/c where **a** is feeding chamber the busted fibres are fed to this feeding chamber manually or by conveyor system.
- **b** is the beating blade, the beater will beat the fibres with high speed which makes the fibres separate from the pith.
- The fibres fed should be in damp condition so that the fibres do not break due to the heavy beating action of the blades.
- Cage cover **c** is fixed to the buster.
- This is due to control the flying out of the pith, so it do not create dusty environment.
- The pith is collected at the bottom of the machine both in beater and buster which is carried out by conveyor system or can be extracted manually.
- The pith is extracted in the beating is high compared to the pith extracted in the

busting machine, this is due to the pith is delinked from the fibres completely in the wetting process.

3.1.2.3 SCREENING M/C

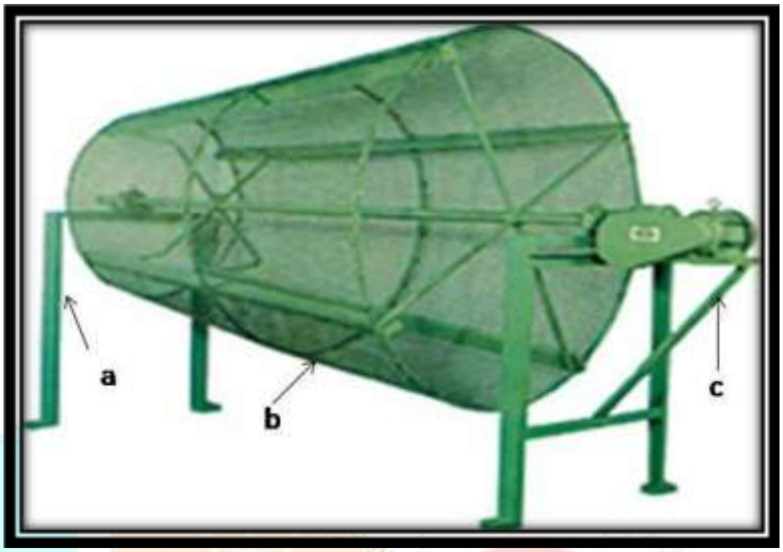

Figure 3.3 Screening m/c

a: stand b: perforated drum c: handle

- This is the process adopted for separation of the fibres completely from the pith.
- After beating the fibres are mixed with some amount of pith which is separated by the machine called screening.
- In the m/c **a** is the stand and b is a perforated drum which is conical in shape.
- The handle can be replaced by the motor so the drum is rotated with no person employed for it.
- The beaten fibres are fed to the smaller hole of the drum so the fed fibres are separated from the pith and the fibres are collected at the larger hole of the drum.

3.1.2.4 WILLOWING

Figure 3.4 Willowing

a: motor pulley b: beater pulley c: beater blade

- Willowing is the process of separation of any entangled and foreign materials from the fibres.
- During de-fibering of the fibres there is small amount of fibre bunches or entangled fibres or some foreign materials which do not undergo beating action and is passed away in the fibre bulk.
- These substances cannot be separated by in screening process hence willowing is the machine which is designed for this reason.
- In figure above, **a** is the motor and **b** is the beater pulley which is connected to motor pulley by means of belt.
- Beater pulley rotates the beater shown in the figure above.
- This beater here will not beat the fibres instead it loosens the fibres by its throwing action.
- The fibres are loosened and thrown out of the machine.
- The blades create an centrifugal force against the fibres hence the heavy materials like entangled fibres and foreign material materials are thrown far away from the other fibres.

3.2 WET PROCESSING OF COIR

3.2.1 Scouring

To remove the natural impurities present in the coir and also to analyze the effect of scouring on the coir fibre was done.

Table 3.1 Scouring Recipe

Recipe			
Sl No.	**Input**	**Unit**	**Concentration/ Ratio/ amount**
1	Wetting agent	Drops	2-4
2	Liquor ratio	CC	1:40
3	NAOH	%	2
4	NA_2CO_3	GPL	3
	Factor	**Unit**	**Condition**
5	Temperature	^oC	80-90

6	Duration	Hrs	2.5
7	PH	-	9.5-10.5

3.2.1.1 Procedure

- Wetting the sample in wetting agent for 20 mins and taken out.
- Calculated required amount of chemicals and water mentioned above is taken.
- Material is entered when the bath temperature raises to 40^{o} c
- Work for $2^{1/2}$ hours.
- Takeout the material and wash with cold water and dry the sample.

The above recipe used is considered as standard recipe and the change in concentration and rest of constraints was made according to the sequence shown below.

3.2.1.2 Standard Sequence of processing

Figure 3.5 Scouring Process

The scouring process was carried out in the above sequence, the concentration and the condition of the material which is scoured will vary from sample to sample which is mentioned below.

3.2.1.3 Variation in Constraints

Table 3.2 Scouring Recipe

Variation – 1,2 &3				
Sl No.	**Input**	**Unit**	**Sample (S)**	**Concentration/ Ratio/ amount**
1	Wetting agent	Drops		2-4
2	Liquor ratio	CC		1:40
3	NAOH	%	**S1**	**2**
			S2	**5**
			S3	**10**
			S4	**15**
4	NA_2CO_3	GPL	**S1**	**3**
			S2	**6**
			S3	**12**
			S4	**18**

	Factor	Unit	Condition
5	Temperature	ºC	80-90
6	Duration	Hrs	2.5
7	PH	-	9.5-10.5

1. The variation in the concentration and conditions were made to find out the resistance of coir fibre at different levels of concentration.
2. The coir fibre was also processed in the above fashion to find out the efficiency of the coir fibre in further process.
3. The process like bleaching and dying was analyzed to find out the best suitable recipe for scouring coir.

3.2.2 Bleaching

1. Bleaching is done to brighten the coir fibre.
2. Here H_2o_2 Bleaching is preferred because it is cheap and safe but the major drawback is evaporated fumes affect on eyes and respiratory system.
3. If the precautionary measures is taken this problem can be eliminated.

Table 3.3 Bleaching Recipe

Recipe			
Sl No.	**Input**	**Unit**	**Concentration/ Ratio/ amount**
1	Wetting agent	Drops	3-4
2	Liquor ratio	CC	1:40

3	H_2O_2	Ml/ltr	70
4	Ammonia	%	3
5	Sodium Silicate	%	3
6	Soda ash	%	1
	Factor	**Unit**	**Condition**
7	Temperature	^oC	80-85
8	Duration	Hrs	1.5
9	PH	-	10-11

3.2.2.1 Procedure

- Wetting the sample in wetting agent for 20 mins and taken out.
- Calculated required amount of chemicals and water mentioned above is taken.
- Material is entered when the bath temperature raises to 40^o c
- Work for $1^{1/2}$ hours.
- Takeout the material and wash with cold water and dry the sample.

The above recipe is considered as a standard recipe. The different sequence of bleaching coir fibre is mentioned below.

3.2.2.2 Standard Sequence of processing

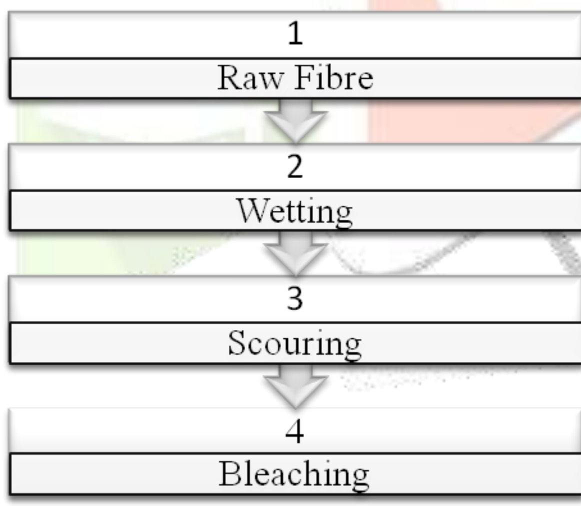

Figure 3.6 SBleaching Process

Variation in Sequence

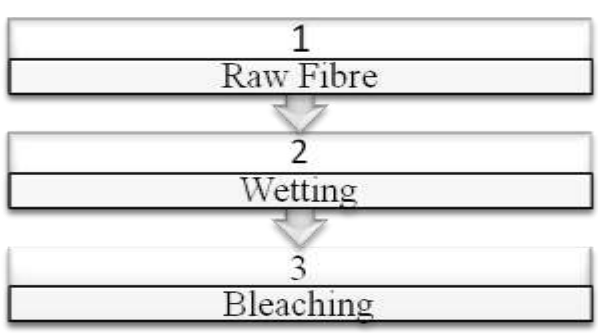

Figure 3.7 Bleaching Process

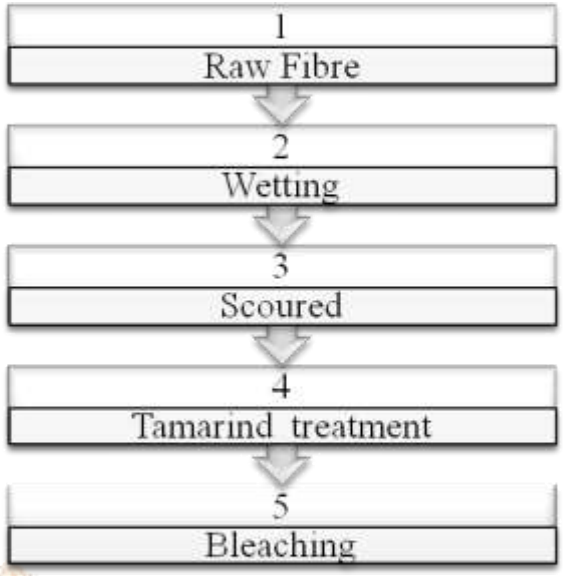

Figure 3.8 STBleaching Process

Figure 3.9 'O' Bleaching Process

1. The bleaching was carried out by varying many constraints and also the sequence of processing was also changed to bring out the best possible method of bleaching.
2. In over all process bleaching and scouring was done all at a time, the standard recipe was followed.

3.2.3Tamarind Treatment

Another trial was made to soften the fibre using tamarind syrup.

Table 3.4 Tamarind Recipe

Recipe			
Sl No.	**Input**	**Unit**	**Concentration/ Ratio/ amount**
1	Liquor ratio	CC	1:40
2	Wetting agent	Drops	4-5
3	Tamarind Syrup	CC/ltr	50
	Factor	**Unit**	**Condition**

4	Temperature	^{o}C	45-55
5	Duration	Hrs	1.5
6	PH	-	4.5-5.5

The above table was considered as the standard procedure respectively the fibres were treated in the following processing sequence.

3.2.3.1 Sequence Followed

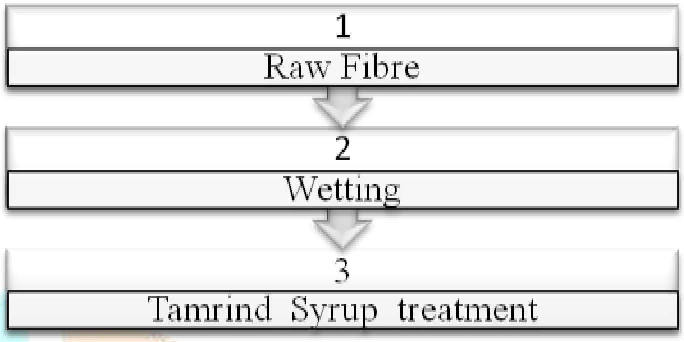

Figure 3.10 Tamarind Process

3.2.3.2 Variation in constraint

Table 3.5 Tamarind Recipe Variation in Constraints

Sl No.	Factor	Unit	Sampe(S)	Condition
1	Temperature	^{o}C	S1	80
			S2	Room Temperature (Overnight)
2	Duration	Hrs		1.5
3	PH	-		4.5-5.5

3.3 Dyeing

1. Generally acid dye is used for dying coir fibre in the industries due to its low cost and easy to dye.
2. Dying with acid dye does not require any training any one can dye with less knowledge.
3. There are many combinations and concentration of dye was experimented.
4. In which a special segment of dying process where the dye bath was reused again and again was experiment.
5. The k/s of the above special experiment was also founded and which is explained in results and discussion chapter.

Dyeing is carried out considering the marketability prospective. Four classes of dyes were selected namely.

3.3.1 Direct dye

a. Direct dye is majorly a sulphonated azo compounds which shows more affinity to cellulosic compounds.
b. Since the coir fibre consists of 40% of cellulose content this dye is also considered for comparative studies.

3.3.1.1 Direct Dyeing

Table 3.6 Direct Dyeing Recipe

Direct dye –Durazol Red 2BS			
Sl No.	**Input**	**Unit**	**Concentration/ Ratio/ amount**
1	Wetting agent	Drops	2-4
2	Liquor ratio	CC	1:40
3	Nacl	%	10
4	NA_2CO_3	%	2
5	Dye shade	%	2
	Factor	**Unit**	**Condition**
6	Temperature	^oC	80-90
7	Duration	Hrs	1
8	PH	-	9-10

3.3.1.2 Procedure of dyeing

- Wetting the sample in wetting agent for 20 mins and taken out.
- Calculated amount of chemicals and water mentioned above is taken in one vat.
- 2% dye shade is prepared separately and both vats are mixed and kept for dyeing.
- Material is entered when the bath temperature raises to 40^o c
- Work for 1hour.
- Takeout the material and wash with cold water and dry the sample.

3.3.2 REACTIVE DYE (COLD BRAND)

a. In this class of dying the dye molecules is diffused into the fibre structure by covalent bonds.

b. This was the criterion which is observed to select this class of dye.

c. These dyes require an alkaline bath for proper exhaustion, hence sodium chloride and sodium carbonate was used for dying.

d. This class of dye especially cold brand class in reactive dye was selected due to its nature of exhaustion in room conditions

3.3.2.1 Reactive Dyeing

Table 3.7 Reactive Dyeing

Reactive dye (Cold Brand)– Reactive Red M5B			
Sl No.	**Input**	**Unit**	**Concentration/**

			Ratio/ amount
1	Wetting agent	Drops	2-4
2	Liquor ratio	CC	1:40
3	Nacl	GPL	15
4	NA_2CO_3	GPL	7
5	Dye shade	%	2
	Factor	**Unit**	**Condition**
6	Temperature	^oC	Room
7	Duration	Hrs	1
8	PH	-	9-10

3.3.2.2 Procedure of dyeing

- Wetting the sample in wetting agent for 20 mins and taken out.
- Calculated amount of chemicals and water mentioned above is taken in one vat.
- 2% dye shade is prepared separately and both vats are mixed and kept for dyeing.
- Material is entered into dye bath directly
- Nacl is added after 15 mins in three installments.
- Work for 1hour.
- Takeout the material and wash with cold water and dry the sample.

3.3.3 BASIC DYE

a. These are banned class of dyes.

b. Even though this class of dye was considered for the experimental purpose to find out the affinity of the coir fibre towards these dyes.

c. These are basically from acidic class of dyes which will show affinity towards lignin content of coir fibre.

d. The lignin content is more than 40% in coir fibre which is friendlier towards acid class of dyes like acid and basic dye.

Table 3.8 Basic Dyeing

Modranting Process.

Sl No.	Input	Unit	Concentration/ Ratio/ amount
1	Wetting agent	Drops	2-4
2	Liquor ratio	CC	1:40
3	Tannic acid	%	2
	Factor	**Unit**	**Condition**
4	Temperature	^{o}C	60
5	Duration	Hrs	0.5
	Fixing Process.		
Sl No.	**Input**	**Unit**	**Concentration/ Ratio/ amount**
1	Wetting agent	Drops	2-4
2	Liquor ratio	CC	1:40
3	Antimony Potassium tartarenaric acid	%	2
	Factor	**Unit**	**Condition**
4	Temperature	^{o}C	Room
5	Duration	Hrs	0.5
	Dyeing Process.		
Sl No.	**Input**	**Unit**	**Concentration/ Ratio/ amount**
1	Wetting agent	Drops	2-4
2	Liquor ratio	CC	1:40
3	Dye Shade	%	2
4	Acetic acid	%	3
	Factor	**Unit**	**Condition**
5	Temperature	^{o}C	80
6	Duration	Hrs	1

3.3.3.1 Procedure of dyeing

3.3.3.1.1 Modranting process

- Wetting the sample in wetting agent for 20 mins and taken out.
- Calculated amount of chemicals and water mentioned above is taken in one vat.
- Material is entered into moderating bath directly into the vat.
- Work for 30 mins.

- The material is taken out for fixing process.

3.3.3.1.2Fixing Process

- The sample after modranting is treated with Antimony Potassium taratarameric acid.
- The material is worked for 30 mins in room temperature.

3.3.3.1.3Dyeing Process

- Sample is treated with CH_3CooH.
- 2% dye shade is added and the material is worked for 60 mins.

3.3.4 ACID DYE

1.5 They are extensively used in coir industries especially the industries which were surveyed in the areasikere region.

1.6 These dyes are having high affinity towards amino acids.

1.7 But the reason for consideration is its application in present coir industries.

1.8 These dyes give bright shades but lack in light fastness.

After completion of half of the experiments, realizing vat **dyes is showing less affinity** to the coir fibre **Acid dye was selected** as reinforcement for remaining half of the experiments.

3.3.4.1 Acid dyeing

Table 3.9 Acid Dyeing

Acid dye- coomassle milling scarlet GS			
Sl No.	**Input**	**Unit**	**Concentration/ Ratio/ amount**
1	Wetting agent	Drops	2-4
2	Liquor ratio	CC	1:40
3	Sulphuric acid	%	2

4	Glabour Salt	%	7
5	Dye shade	%	2
	Factor	**Unit**	**Condition**
6	Temperature	°C	80-85
7	Duration	Hrs	1

3.3.4.2 Procedure of dyeing

- Wetting the sample in wetting agent for 20 mins and taken out.
- Calculated amount of chemicals and water mentioned above is taken in one vat.
- 2% dye shade is prepared separately and both vats are mixed and kept for dyeing.
- Material is entered when the bath temperature is raised to 40° C.
- Work for 1hour.

To know which processing sequence gives the good yield, the fibres are dyed with four classes of dye for each experiment which is abbreviated as below.

ABBRIVATIONS USED

D- DIRECT DYE

R- REACTIVE COLD BRAND

B- BASIC DYE

A- ACID DYE

SIMILARLY

S- SCOURING

A- BLEACHING

T- TAMARIND TREATMENT

Most of the processing sequences are abbreviated. For example if coir fibre is scoured, bleached and reactive dyed it is abdicated as SB**RD.** The dyeing process is marked in bold letters.

3.3.4.3 VARIATION IN DYEING SEQUENCE

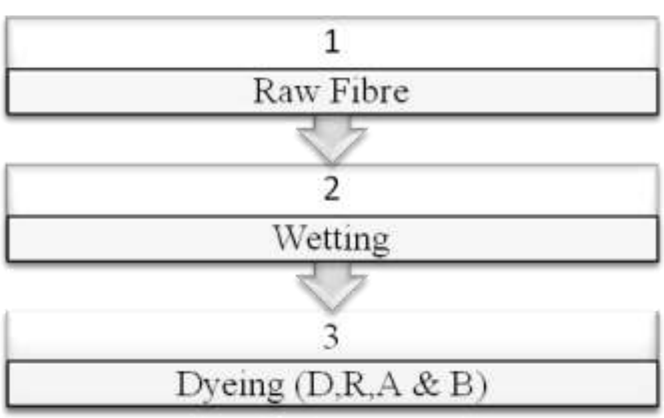

Figure 3.11 Variation in Dyeing Sequence

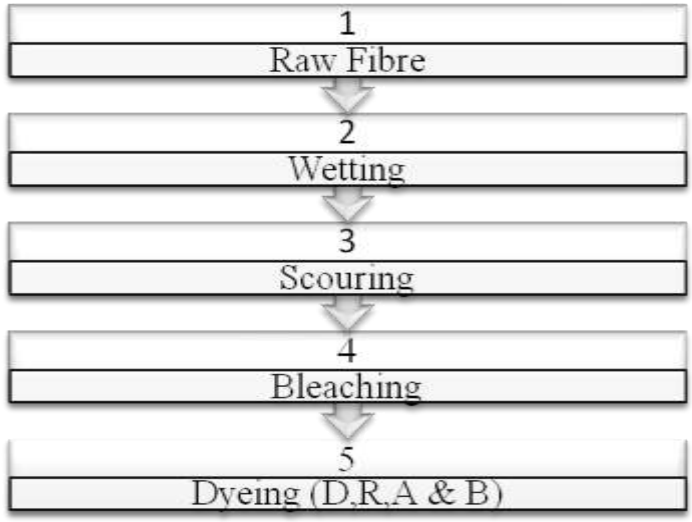

Figure 3.12 Variation in Dyeing Sequence

Figure 3.13Variation in Dyeing Sequence

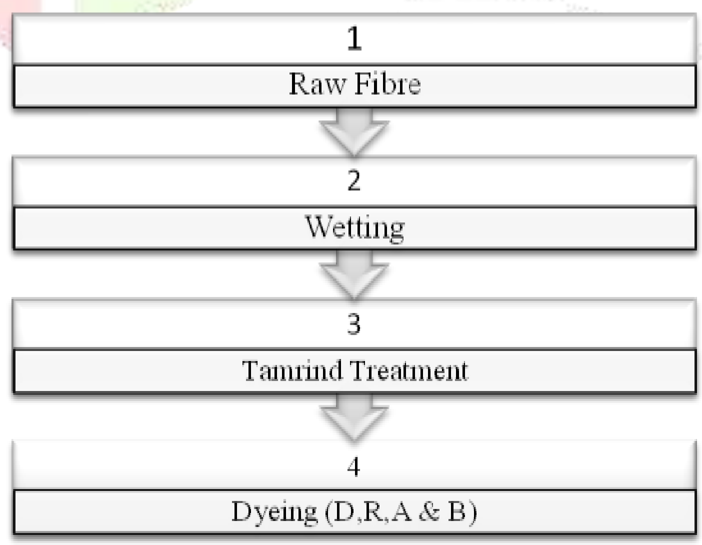

Figure 3.14 Variation in Dyeing Sequence

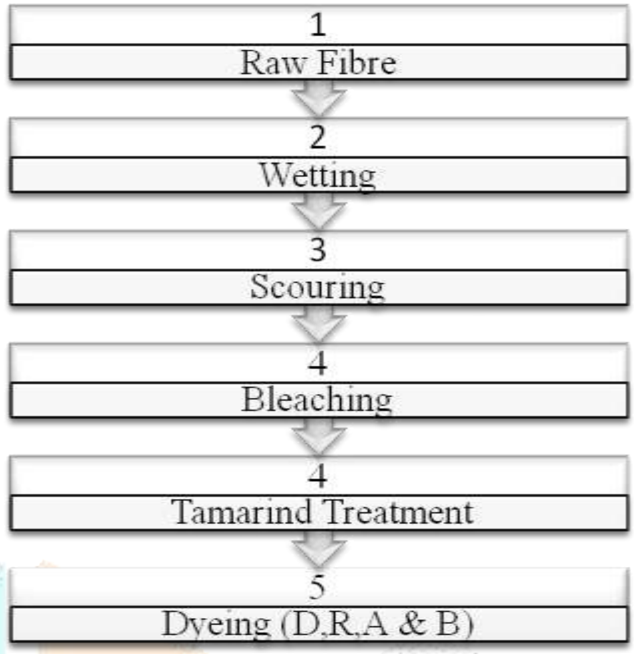

Figure 3.15Variation in Dyeing Sequence

3.3.5 SOAPING

Amount of soap used-0.5 gpl

Liquor ratio- 1:30 cc

Time: 15 mins

Temperature: 60 mins

Soaping is done to remove all the unfixed dye from the surface of the fibre. Soaping is done to all the dyed samples in the project and taken for k/s evaluation.

3.4 FASTNESS PROPERTIES

3.4.1 Rubbing Fastness (Crockmeter)

1. Rubbing was done on a crockmeter instrument.
2. Rubbing is mainly done to find out fastness of the dye for rubbing.
3. Here crock meter instrument is used and rubbing fastness is carried out to find out rubbing fastness of wet and dry samples.
4. The material was in fibre state hence the fibres were tightly tied to the rubbing finger and fastness values were noted down which is discussed in results and discussions chapter.

3.4.2Washing fastness

1. A white bleached cloth is taken, folded to half and stitched on two sides to form a pouch.
2. A known weight of dyed sample is taken and added into the pouch and the pouch is closed by stitching the remaining end.
3. The water is taken in the ratio of 1:40 cc with 5gpl soap and heated for 40 degrees the material was added into the bath and worked for 1 hour.
4. The material later is taken out the stitches were opened the cloth was dried and measured for staining using grey scale.

3.5 Grey Scale

Grey scale used was illustrated from AATCC standard scale.

3.5.1 Grey Scale for assessing change in color

Illustration from AATCC Evaluation Procedure

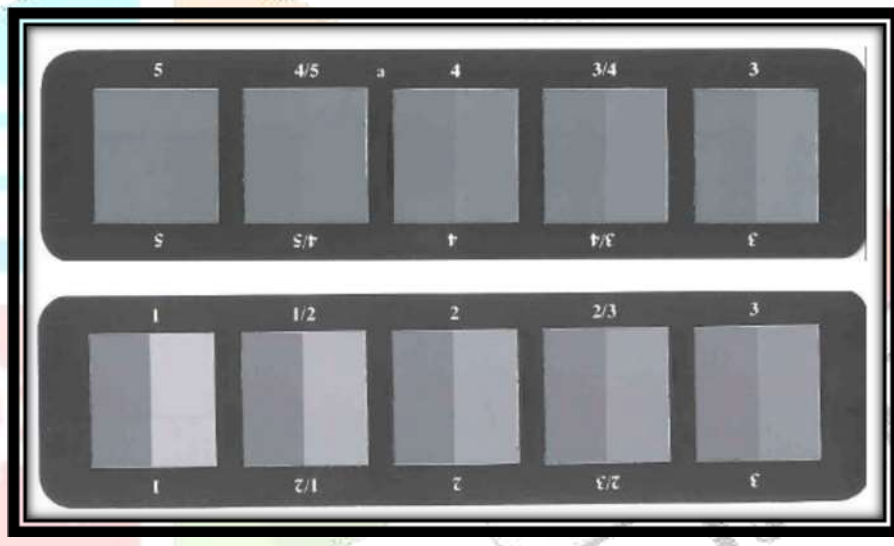

Figure 3.16 Grey Scale

There are ten shades developed by AATCC; where:-

5 being the best and

1 being the least rating

3.5.2 Grey scale for assessing staining

Illustration from AATCC Evaluation Procedure

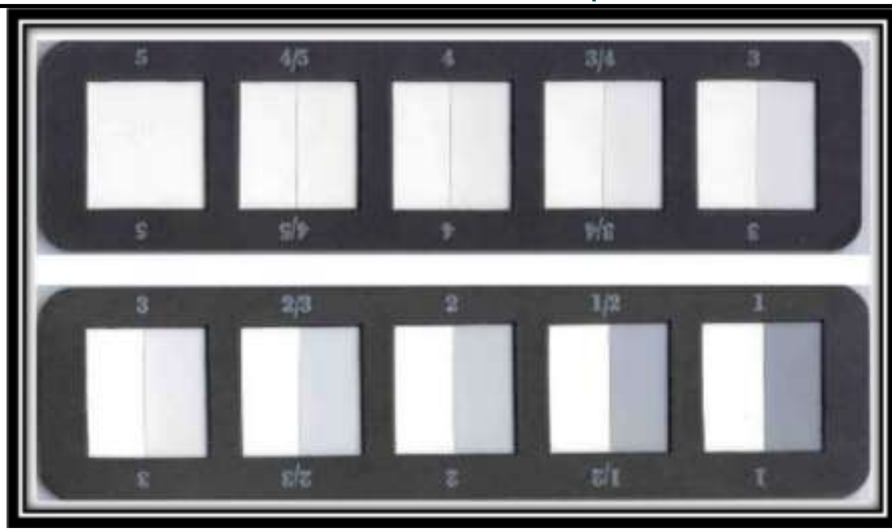

Figure 3.17 Grey Scale

There are ten shades developed by AATCC; where:-

5 being the best and

1 being the least rating

3.6 LIGHT REFLECTANCE AND DYE CONCENTRATION (KUBELKA- MUNK FUNCTION)

To increase the dye concentration on a textile material results in a decrease in the reflectance, this is most marked at the wavelength usually corresponding closely to the λ_{max} of the dye in solution.

Suggestions give that approximately linear variation with concentration include

a. The reciprocal of reflectance
b. The simplified KUBELKA MUNK functions and other functions.

The relationship between the reflectance (R) and the concentration of the dye (C) for a thick opaque pattern is given by the **KUBELKA- MUNK EQUATION.**

$$K/S = \frac{(1-R)^2}{2R} = F(R)$$

3.6.1 SPECTROPHOTOMETER

Gretag Macbath 7000a Reflectance Spectrophotometer

3.6.1.1 COLOR MEASUREMENT

1. Spectrophotometer measures the measurement of color by scanning the samples at different directions.
2. It evaluates the strength of dye present on the sample.
3. k/s value is plotted by evaluating the concentration of dye.
4. And also it measures the light reflectance from the dyed material.

5. **Gretag Macbath 7000a Reflectance Spectrophotometer** has the wave length ranging from 380 nm- 700 nm.
6. Fulfilling of the instruments work depends on a number of criteria such as:
   a. The absorption curves of the component dye mixture should be as dissimilar as possible.
   b. The component dye should not interact, so that any wave length the absorbance of the mixture should be the sum of the absorbencies of the components.
   c. The choice of optimum wavelength is made so that the absorption coefficient of the components is as different as possible.

3.6.1.2 BASIC ELEMENTS OF SPECTROPHOTOMETER

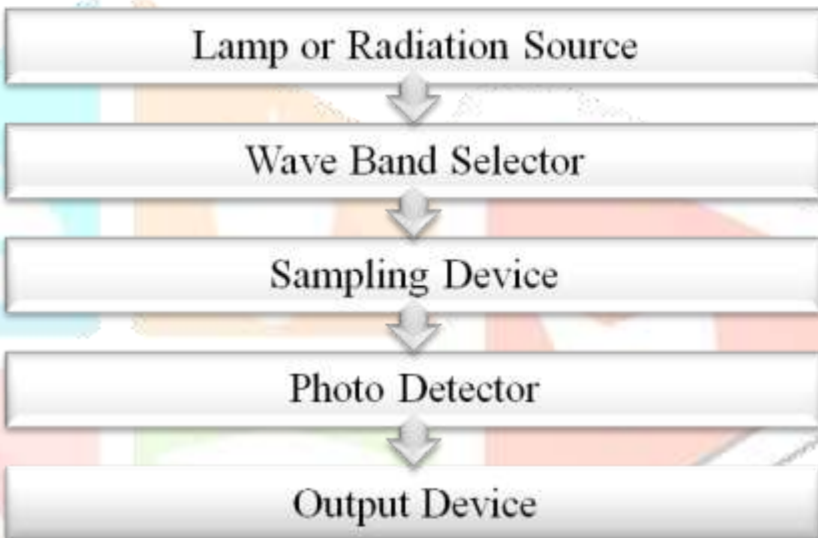

Figure 3.18 Basic Elements Of Spectrophotometer

Color analysis:

a. λ_{max}
b. L, a,b,c,h.
c. whiteness and yellowness indices
d. color differences.
e. Dye strength.

Whereas;

a. λ_{max} = wavelength.
b. L= Lightness
c. a= R.G (Red and Green)

d. b= Y.V (Yellow and Blue)

3.7 COSTING

3.7.1 LIST OF CHEMICALS AND THEIR WHOLESALE COST

Table 3.10 Chemicals Name and their Cost

Sl. No.	Chemical Name	Price/Kg or Ltr (INR)
1.	Sodium carbonate	25
2.	Sodium chloride	26.3
3.	Sodium hydro sulphate	215
4.	Sodium hydroxide	63.3
5.	Sulphuric acid	105.5
6.	Potassium di-chromate	527.5
7.	Tannic acid	80
8.	Antimony potassium tartarte	80
9.	Acetic acid	50
10.	Hydrogen peroxide	79
11.	Sodium silicate	20
12.	Ammonia	9
13.	Formic acid	40
14.	Direct dye	284.8
15.	Reactive dye	200
16.	Basic dye	348
17.	Acid dye	290

CHAPTER - 4

4.0 RESULTS AND DISCUSSIONS

4.1 EXTRACTION OF COIR FIBRE

the production was calculated by taking two such trials which is shown below.

Table 4.1 Extraction of Coir Fibre

BUSTING		
	TRIAL 1	**TRIAL 2**
NO. OF HUSK FED	**500**	**500**
TOTAL WEIGHT OF HUSK	**109**	**102.5**
TIME TAKEKN TO BUST	**16**	**14**
FIBRE PRODUCED IN KG	**83**	**72.5**

PITH PRODUCED IN KG	**24**	**28**
LOSS OF WEIGHT DUE TO FLYING OUT in kg	**2**	**2**
BEATING		
WEIGHT OF BUSTED FIBRE	**83**	**72.5**
TIME TAKEN TO BEAT	**12**	**09**
FIBRE PRODUCED IN KG	**37**	**34**
PITH PRODUCED IN KG	**43**	**36**
LOSS OF FIBRES DUE TO FLYING OUT IN KG	**3**	**2.5**
SCREENING		
BEATED FIBRE FED INKG	**37**	**34**
WEIGHT OF LONG FIBRE OBTAINED	**29.6**	**27.2**
WEIGHT OF SHORT FIBRE OBTAINED	**7.4**	**6.8**
WILLOWING		
WEIGHT OF BEATED FIBRES	**29.6**	**27.2**
TIME TAKEN IN MINS	**16**	**15**
FIBRE PRODUCED IN KG	**26**	**25**
WASTE FIBRES	**3.6**	**2.2**

It is observed from the above table 4.1all the process carried out to extract of coir fibres .busting,beating, screening and willowing operation can be used to get good fibres, long fibre extracted is 28.4% and remaining 71.6% is pith and short fibres. 500 husk is extract from the fibre production of 83%.

The pith is taken for making pith blocks and short fibres which is considered as waste which is used as filling material in bedding.

4.2 PROPERTIES OF PROCESSED SAMPLES

4.2.1 Preparatory dyeing process

4.2.1.1 SCOURING

Table 4.2 Scouring

Sample	NAOH (%)	NA_2CO_3 GPL	Tenacity (gf/den)	Tensile Strain (%)	C.V.% Tenacity	C.V.% Tensile Strain
S1	2	3	**0.9**	**23.7**	32.7	66.7
S2	5	6	**0.8**	**24.2**	33.5	65.6
S3	10	12	**0.6**	**26.3**	35.7	68.2
S4	15	18	**0.5**	**27.4**	40.1	67.9
Raw sample			**1.3**	**20.6**	**12.2**	**59.1**

It is revealed from the table4.2 raw sample is considered as control, it is observed that increase in concentration there is a gradual decrease in tenacity but increase in concentration will increase the strain %.

Treating coir with NaoH will reduce the hardness which can be observed by feeling the treated. The increased concentration will also increase the softness of the material.

As there is lot of difference between the fineness of the fibre within a single husk and between the bulk populations which is de-fibered, there might be a chance of selecting of a finer fibre than the rest of the samples in other process

4.2.1.2 BLEACHING

Table 4.3 Bleaching

Sample	Tenacity (gf/den)	Tensile Strain (%)	C.V.% Tenacity	C.V.% Tensile Strain
SB	**1.8**	**35.2**	30.1	52.2
B	**1.6**	**22.2**	4.1	50.5

STB	**1.4**	**34.2**	30.4	18.1
OA	**1.3**	**20.5**	35.2	40.3
Scoured sample	**0.9**	**23.7**	**32.7**	**66.7**

It is observed from the table 4.3 Scoured sample is considered as a control, bleaching increases the tenacity when compared to control sample. Sample scoured and bleached is showing high tenacity than others. There is a improvement in fibre's elongation in SB and STB.

4.2.1.3 TAMARIND TREATMENT

Table 4.4 Tamarind Treatment

Sample	Tamarind Syrup cc / ltr	Tenacity (gf/den)	Tensile Strain(%)	C.V.% Tenacity	C.V.% Tensile Strain
S1	10	**1.4**	**34.2**	19.2	25.3
S2	15	**1.7**	**33.0**	20.3	29.6
S3	20	**1.8**	**37.0**	26.6	24.6
S4	25	**2.0**	**40.5**	28.9	30.6
Raw sample		**1.3**	**20.6**	**12.2**	**59.1**

It is revealed from the table 4.4 by evaluating the results the sample treated with Tamarind is showing higher breaking load and showing high elongation from the raw sample. The tamarind treated sample is the only sample which is processed in acidic medium and the rest of the process carried out in the basic medium. Tamarind is composed of Tartaric acid.

The reasons for this behavior of coir fibre have to be analyzed but looking at the review of the test report we can say that the mechanical properties of coir fibre is increased when processed with tamarind syrup.

4.3 ABBRIVATIONS

SL NO	ABBRIVATION CODE	SL NO	ABBRIVATION CODE
1	D- DIRECT DYE	6	B-BLEACHING
2	R-REACTIVECOLD BRAND	7	T- TAMARIND TREATMENT
3	A- ACID DYE	8	Cc-CHANGE IN COLOR
4	B- BASIC DYE	9	Cs-CHANGE IN STAINING
5	S- SCOURING		

4.4 DYEING PROCESS ON COIR FIBRE WITH DIFFERENT PROCESS

4.4.1DIRECT DYEING

Table 4.5 Direct Dyeing (D,R,A & B)

Direct Dyeing (D,R,A & B)									
Sample	**Tenacity (gf/den)**	**Tensile Strain (%)**	**C.V.% Tenacity**	**C.V.% Tensile Strain**	**Rubbing fastness**		**Washing fastness**		**Reflectance (%)**
					Dry	**Wet**	**Cc**	**Cs**	
Direct dye	**1.4**	**19**	24.1	59.6	3	2	2	3	4.6
Reactive dye	**1.5**	**20**	26.3	62.3	4	3	4	4	3.76
Acid dye	**1.5**	**19.5**	29.2	58.5	3	1	2	3	3.65
Basic dye	**1.1**	**18.5**	30.4	61.3	3	2	2	2	4.36
Un-dyed Raw sample	**1.3**	**20.6**	**12.2**	**59.1**					

Table 4.5 shows there is no loss in tenacity when fibres are processed with Direct, Reactive & Acid Dye. But the samples when treated with basic dye have reduced the strength when compared to raw sample.

There is slight difference in elongation percentage. The reactive dye is showing excellent fastness for rubbing and washing. The reflectance value is also good in reactive dye and acid dye.

4.4.2 SBD DYEING

Table 4.6 SBD Dyeing (D,R,A & B)

SBD Dyeing (D,R,A & B)									
Sample	Tenacity (gf/den)	Tensile Strain (%)	C.V.% Tenacity	C.V.% Tensile Strain	Rubbing fastness		Washing fastness		Reflectance (%)
					Dry	Wet	Cc	Cs	
Direct dye	1.5	32.5	39.6	45.3	2	2	2	2	3.94
Reactive dye	1.7	34.00	37.3	55.6	4	3	4	4	3.64
Acid dye	1.6	33.00	39.3	59.3	3	1	3	2	3.51
Basic dye	1.6	33.00	25.1	55.2	2	2	3	3	4.1
SB sample	1.8	35.21	30.1	52.2					

From the above table4.6 it is observed that, there is a slight decrease in tenacity and elongation of all the samples, the reason may be the fibres might have gone pass through three wet processing phases. In this table reactive dye shows the high tenacity and among of dyed samples.

The reactive dye is showing excellent fastness for rubbing and washing. The reflectance value is also good in reactive dye and acid dye.

4.4.3.BD DYEING

Table 4.7 BD Dyeing (D,R,A & B)

BD Dyeing (D,R,A & B)							
Sample	Tenacity (gf/den)	Tensile Strain	C.V.% Tenacity	C.V.% Tensile	Rubbing fastness	Washing fastness	Reflectance (%)

		(%)		**Strain**	**Dry**	**Wet**	**Cc**	**Cs**	
Direct dye	**1.4**	**19.02**	19.2	58.63	2	2	2	2	4.06
Reactive dye	**1.5**	**21.02**	20.6	56.44	4	4	5	4	3.8
Acid dye	**1.5**	**20.02**	24.3	57.35	3	1	3	1	3.7
Basic dye	**1.3**	**19.20**	25.3	54.39	3	3	3	2	3.9
B sample	**1.6**	**22.2**	**4.1**	**50.50**					

It is observed from the above table 4.7 control sample is bleached sample compare with above dyed sample are showing less tenacity than control sample. elongation is slightly differ from the control sample due the dyeing procees. The reactive dye is showing excellent fastness for rubbing and washing. The reflectance value is also good in reactive dye and acid dye.

4.4.4 TD DYEING

Table 4.8 TD Dyeing (D,R,A & B)

TD Dyeing (D,R,A & B)									
Sample	**Tenacity (gf/den)**	**Tensile Strain (%)**	**C.V.% Tenacity**	**C.V.% Tensile Strain**	**Rubbing fastness**		**Washing fastness**		**Reflectance (%)**
					Dry	**Wet**	**Cc**	**Cs**	
Direct dye	**1.4**	**28.00**	18.2	24.00	2	2	2	1	4.10
Reactive dye	**1.5**	**31.08**	280.1	30.2	4	3	4	2	3.9
Acid dye	**1.5**	**30.08**	26.02	30.5	3	1	3	1	3.8
Basic dye	**1.4**	**32.07**	20.09	28.5	3	3	2	2	4.5
T sample	**1.6**	**32.07**	**19.2**	**25.0**					

From the above table4.8 it is observed that tamarind sample is considered as control sample, reactive dye and acid dye is showing more tenacity than the others. basic dye is showing high elongation among of them.

The reactive dye is showing excellent fastness for rubbing and washing. The reflectance value is also good in reactive dye and acid dye.

4.4.5 SBTD DYEING

Table 4.9 SBTD Dyeing (D,R,A & B)

SBTD Dyeing (D,R,A & B)									
Sample	**Tenacity (gf/den)**	**Tensile Strain (%)**	**C.V.% Tenacity**	**C.V.% Tensile Strain**	**Rubbing fastness**		**Washing fastness**		**Reflectance (%)**
					Dry	**Wet**	**Cc**	**Cs**	
Direct dye	**1.2**	**31.02**	24.08	20.0	2	2	3	2	4.06
Reactive dye	**1.3**	**33.02**	38.05	18.5	4	4	4	4	3.6
Acid dye	**1.3**	**33.00**	33.0	20.6	3	2	3	2	3.4
Basic dye	**1.2**	**31.00**	34.2	22.0	3	3	3	3	3.8
SBT sample	**1.4**	**34.2**	**19.2**	**25.3**					

It is observed from the above table 4.9 SBT sample is consider as control sample tenacity is less than the control sample and also elongation, among dyed sample reactive and acid dye showing high tenacity and elongation. The reactive dye is showing excellent fastness for rubbing and washing. The reflectance value is also good in reactive dye and acid dye.

4.5 COSTING OF WET PROCESSING ON COIR FIBRE

4.5.1 Preparatory process costing

Wet processing is calculated for processing 1Kg. of fibre

Table 4.10 Costing Of Wet Processing

Sl. No.	Process	Cost (INR)
1.	Scouring	2.1
2.	Bleaching (H_2O_2)	15.43
3.	Direct Dye Dyeing	8.81
4.	Reactive Dye Dyeing (Cold Brand)	12.67
5.	Basic Dye Dyeing	11.66
6.	Acid Dye Dyeing	7.00
7.	Tamarind Treatment	3.75

From the above table4.10 it is observed that costing on each process, here bleaching showing high cost and scouring process shows least cost per kg.

The quantity of chemicals used is as per the standard recipe discussed in chapter 4.

4.5.2 Dyeing Process Costing (INR) per 1 K.G. of Fibre.

Table 4.11 Costing Of Wet Processing

SL NO	Samples	Costing

1	D**DD**	8.81
2	D**RD**	12.67
3	D**AD**	7.00
4	D**BD**	11.66
5	SB**DD**	26.34
6	SB**RD**	30.14
7	SB**AD**	24.53
8	SB**BD**	29.19
9	B**DD**	24.24
10	B**RD**	28.1
11	B**AD**	22.43
12	B**BD**	27.09
13	T**DD**	12.56
14	T**RD**	16.42
15	T**AD**	10.75
16	T**BD**	19.18
17	SBT**DD**	30.09
18	SBT**RD**	33.95
19	SBT**AD**	28.28
20	SBT**BD**	32.94

From the above table4.11 it is observed that Sample SBTRD costs more because it undergoes four wet processing sequences. But the worth of wet processing of a particular sequence can be evaluated only by looking at the other parameters like fastness for rubbing and washing, strength etc.,

4.6 DYED SAMPLE GRADING

By evaluating the above test reports a final decision has to be made to find out the best result yielding process; hence top three samples giving good results was taken from each test and points were granted in the following manner.

Here tenacity, Washing Fastness and Rubbing fastness are graded by giving points 1 to 5. Rest of the parameters are graded from 1 to 20 i.e., total number of samples considered for grading.

Here higher the grade points most excellent is the result.

Table 4.12 Dyed Sample Grading

Samples	Tenacity	Tensile Strain	**Rubbing fastness**		**Washing fastness**		**Reflectance (%)**	**Costing Per 1 kg**	**Total**
			Dry	**Wet**	**Cc**	**Cs**			
D**DD**	**4**	**02**	3	2	2	3	01	19	36
D**RD**	**5**	**06**	4	3	4	4	14	15	55
D**AD**	**5**	**05**	3	1	2	3	16	20	55
D**BD**	**1**	**01**	3	2	2	2	02	17	30
SB**DD**	**5**	**14**	2	2	2	2	08	9	44
SB**RD**	**7**	**20**	4	3	4	4	17	3	62
SB**AD**	**6**	**19**	3	1	3	2	19	10	63
SB**BD**	**6**	**18**	2	2	3	3	05	5	44
B**DD**	**4**	**04**	2	2	2	2	07	11	34
B**RD**	**5**	**08**	4	4	5	4	11	7	48
B**AD**	**5**	**07**	3	1	3	1	15	12	47
B**BD**	**3**	**03**	3	3	3	2	10	8	35
T**DD**	**4**	**09**	2	2	2	1	04	16	40
T**RD**	**5**	**13**	4	3	4	2	09	14	54
T**AD**	**5**	**10**	3	1	3	1	12	18	53
T**BD**	**4**	**15**	3	3	2	2	03	13	45
SBT**DD**	**2**	**12**	2	2	3	2	06	4	33
SBT**RD**	**3**	**17**	4	4	4	4	18	1	57
SBT**AD**	**3**	**16**	3	2	3	2	20	6	55
SBT**BD**	**2**	**11**	3	3	3	3	13	2	40

The grading for fastness and tensile properties varies from 1 to 5 grade points especially in fastness properties the samples are graded and points are allotted by grey scale, the grey scale values obtained by each sample will be their grading value here.

In case of tenacity the coir fibre is showing tenacity values from 1.1 to 1.7, all the samples tenacity values fall in between this limit, hence they are granted grade points ranging from 1 to 7.

Dyed Sample Ranking

Table 4.13 Dyed Sample Ranking

Sample	Total grade points	Ranking

SB**AD**	63	1
SB**RD**	62	2
SBT**RD**	57	3
D**RD**	55	4
D**AD**	55	5
SBT**AD**	55	6
T**RD**	54	7
T**AD**	53	8
B**RD**	48	9
B**AD**	47	10
T**BD**	45	11
SB**DD**	44	12
SB**BD**	44	13
T**DD**	40	14
SBT**BD**	40	15
D**DD**	36	16
B**BD**	35	17
B**DD**	34	18
SBT**DD**	33	19
D**BD**	30	20

After finding the sum of grade points of all parameters, it is found that SBAD sample is at the 1st position by scoring 63 grade points. SBRD, SBTRD, DRD are next in the list by gaining 62, 57, 55 grade points each.
It is noticed that Basic dye and Direct dye are the least ones in the rankings.

It is also noticed that there is a narrow distance between SBAD and SBRD, the reason SBAD is on top is because of low processing cost where as SBRD sample processing cost is relatively high compared to SBAD.

CHAPTER-5

CONCLUSION

It is known that 33% of fibres are obtained from the coconut husk and remaining 67% is pith. But in the experiment **28.4% of long fibres, 6.6% short fibres** are obtained and remaining **65%** obtained is **coir pith**.

It is concluded that there is a change in mechanical properties in coir fibre after wet processing, it is identified that by scouring the strength of the fibre is reduced to a large extent. It is difficult to judge the samples mechanical behavior in the coir fibre because there is lot of **variations in the fineness of the fibre within a single husk**. This might have led to variation in testing hence samples are showing **high C.V. %** .

Two classes out of four classes of dyes is showing more affinity towards coir fibre i.e., **Acid Dye and Reactive Dye** (Cold Brand); the main reason is the lignin content and cellulose content in coir fibre is almost equal, the lignin shows more affinity towards acid dye and cellulose shows affinity towards reactive dye, both dyes show similar affinity to coir fibre.

The absorption of acid dye is slightly higher compared to reactive dye (Cold Brand) as the affinity is **increased by 2%** because of lignin content in the fibre is 2% higher than the cellulose content i.e., **45% of lignin and 43%** of cellulose is present in the coir fibre.

It is known that reactive dye forms a strong bond (Covalent) in the intermolecular structure of the fibre which is not in the case of acid dye; the test results of washing and rubbing is dominated by the reactive class dyed samples.

From the sample test results it is observed that the **SBAD** sample has gained **63 points** which is the highest grade points scored by any sample Followed by **SBRD** (Cold Brand) sample settled at **62**, which is short of 1 grade point to equal the SBAD sample.

It is finally concluded that **SBRD sample is the best than SBAD**, because all the **test parameters like fastness and mechanical properties of SBRD sample is excellent than the SBAD sample** except **Reflectance value** and **wet processing cost**.

Even though there is only slight **increase in cost** of **SBRD** processing, but **quality wise** it has **overtaken SBAD**. Hence it is **recommended to follow SBRD sequence for coir fibre processing.**

CHAPTER-6

SCOPE FOR FURTHER STUDY

- Find out New methods to fix acid dye on coir fibre.
- Dyeing with Reactive hot brand treating with various types of enzymes
- To design a machine for dyeing coir fibre, enzyme washing, yarn dyeing
- Specialty finishes can be tried on coir fibres.

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