Faculty of Engineering

Department of Textile Engineering

Project (Thesis) Report on

"Scouring of 100% Cotton Knitted Fabric with Soap-nut: A Sustainable & Economic Approach Towards Textile Pre-Treatment".

Course Code: TE-4214 **Course Title:** Project (Thesis).

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This Thesis report Presented in Partial Fulfilment of the Requirement for the degree of **Bachelor of Science in Textile Engineering.**

Advanced in Textile Wet Processing Technology

Fall-2022.

DECLARATION

I hereby declare that this project (Thesis) report has been Prepared by me under the supervision of Md. Kamrul Islam, Lecturer, Department of Textile Engineering, Faculty of Engineering, Daffodil International University. I also announce that neither this report or any part of it is not submitted anywhere else for the award of any degree.

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LETTER OF APPROVAL

To,

The Head

Department of Textile Engineering

Daffodil International University

Subject: Approval of final year thesis report.

Sir,

I am writing to let you know that, this thesis report titled as **"Scouring of 100% Cotton Knitted Fabric with Soap-nut: A Sustainable & Economic Approach Towards Textile Pre-Treatment"** is completed for final evaluation. The whole report is prepared based on proper investigation and interpretation though critical analysis of empirical data with required belongings. The student was directly involved in his project activities and the report becomes vital to spark off many valuable information for the readers.

Therefore, it will highly be appreciated if you kindly accept this project report and consider it for final evaluation.

Yours Sincerely,

Md. Kamrul Islam
Lecturer,
Department of Textile Engineering.
Faculty of Engineering.
Daffodil International University.

ACKNOWLEDGEMENT

At the beginning, I express my heartiest thanks and gratefulness to the almighty for the divine blessings which makes it possible to complete this project successfully.

I am grateful and feel truly indebt to my supervisor Md. Kamrul Islam, Lecturer, Department of Textile Engineering, Faculty of Engineering, Daffodil International University for his deep knowledge and keen interest in the field of textile pre-treatment, dyeing and finishing influenced me to carry out this project smoothly. His endless patience, spot-on guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior drafts and correcting them at all stages have made it possible to complete this project finally.

I also wish to express my gratitude to Md. Mominur Rahman Sir, Assistant Professor, Head in Charge, Department of Textile Engineering, Daffodil International University for his continuous guidance to prepare this project report. I would like to thank my course mates in Daffodil International University, who took part in the discussions while completion of the course works.

Finally, I must acknowledge with due respect for the constant supports and blessings of my teachers, friends and family members.

ABSTRACT

Commercial detergent contains a higher amount of amphiphilic molecules, which helps to neutralize the surface tension of water and are mostly used in the pretreatment of fabric at industrial level. But the industrial waste water containing detergent in it, can be disastrous to the aquatic domain out there.

This study is focused on the comparative study of natural detergent (Soap-nut/reetha) & synthetic detergent in case of 100% cotton knitted (S.J) fabric. Mainly I focus on the pre-treatment, shade differences, wash and rubbing fastness of following cotton fabric pre-treated & dyed with both conventional and with the use of soap-nut.

After completing, the quality parameters such as shade differences, spectrophotometric evaluation, rubbing, and wash fastness of both type of dyed samples have been compared. From the comparison, found that the sample pretreated with soap-nut & then dyed are lighter in shade but the other quality parameters are somewhat satisfactory.

Keywords: Scouring, Dyeing, Detergent, Soap-nut, Sustainability, Spectrophotometer.

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Chapter-1

Introduction.

INTRODUCTION

The continuous growth of textile industries are rapidly affecting the availability of fresh water. Textile industry involved with the various processing of fabric which needs the usages of a lot of water along with energy and most importantly harsh chemicals [1].

Conventional textile wet-processing methods require a series of treatments which requires a huge amount of water. For example, Scouring, Bleaching, Desizing, Dyeing, Washing, etc. Those processes involves a lots of synthetic chemicals & some of them are seriously environmental hazards. As cotton fibre holds about 10% non-cellulosic substance like waxes, pectic substances, organic acids, dust, non-cellulosic polysaccharides, and other unidentified compounds on the outer surface of the fibre, so it becomes the hindrance during fabric processing [2].

Scouring of the cotton fabric helps to remove the impurities from the fabric. A good scouring can remove both natural and additive impurities from the fabric & make the fabric ready for bleaching by removing those impurities which removes natural color from the fabric and improves the absorbency capacity of the fabric exponentially. Same goes for dyeing, the process requires a lots of water and synthetic color (dyes).

Traditional method of cotton pre treatment (scouring & bleaching) & dyeing requires a lots of water and chemicals, resulting a huge amount of toxic waste water, containing a very barbarous consequences toward the environment. Primarily in terms of high BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), toxicity and pH. For that reason, being environment concern researchers are trying to make the textile wet processing eco-friendly and sustainable [3].

OBJECTIVE

Objectives of the study:

- ✓ To compare between the scouring effect of cotton fabric with synthetic detergent and by using natural detergent (soap-nut/reetha).
- ✓ Compare the dyeing results between those two samples.
- ✓ To compare the colorfastness property (Colorfastness to rubbing, Colorfastness to wash) of those two samples.
- ✓ To investigate the possibilities of using soap-nut/reetha as an alternative of synthetic detergents.
- ✓ To reduce the cost of textile pretreatment and introduce a sustainable & environment friendly method of pre-treatment.

Chapter- 2

Literature Review

LITERATURE REVIEW

Pre-Treatment:

The term ‘pre-treatment’ stands for the treatment of something with some kind of chemicals before use. It can also be defined as an act or instance of treating someone or something in advance.

The textile pretreatment process can help eliminate sizing agents, oils, waxes, seed hulls, soils, pectin and other impurities, while improving whiteness and feel of the fabric. A typical pretreatment process includes three main steps:-

- ✓ De-sizing.
- ✓ Scouring and.
- ✓ Bleaching.

Scouring:

Scouring is the preparatory process for many textile materials. It helps to remove natural and additive impurities from the textile material like: oil, wax, soil, dust, dirt, broken seed, dried leaf, fat, etc. By removing the impurities scouring makes the material ready for the subsequent process like bleaching and dyeing.

Bleaching:

Bleaching is the process of removing natural color of a textile material and providing it with permanent whiteness. Bleaching is the preparatory process for dyeing.

Dyeing:

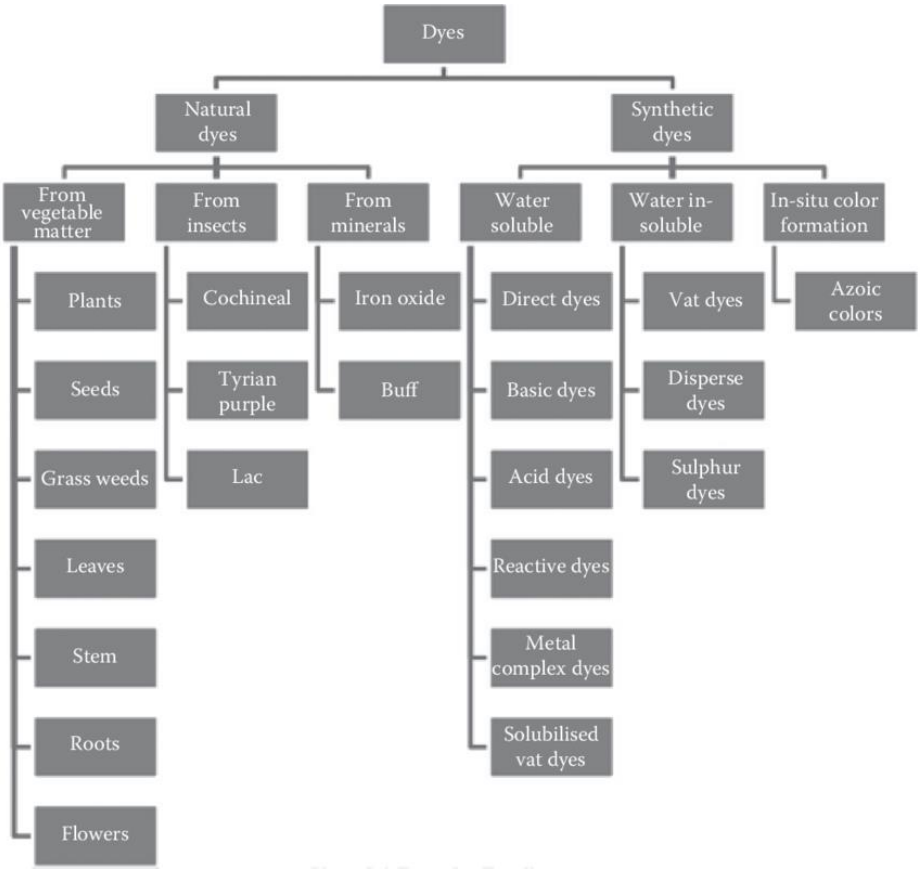
The coloration process of textile materials is known as dyeing. It is basically the application of colorant on a textile substance like fibre, yarn, fabric or garment in order to achieve the desired colored material with appropriate properties. The dyeing method can be different based on the nature of the materials, but the most common and popular method is by immersing the material in a dye bath while maintain a standard M:L (Material : liquor ratio). Textile materials are colored by creating some short of bond between dye particles and the molecules of the materials (except for pigment, it requires binder to create the bond). Different materials require different types of dyes and methods.

Dye:

Dye is a colored substance used to pass on color to other substance in a reasonably permanent way. Dyes are normally used in a solution & are capable of being fixed onto a material and making the material colored. In order to be a good dye, a dye must have some properties. The dye should be chemically stable so that the color shouldn't wash out with soap or detergent, shouldn't fade when the dyed material is exposure to sunlight, etc. Dyes molecules contain chromophore and auxochrome groups. That Chromophore group is responsible for the color due to their saturation. The Auxochrome group is liable for the dye fiber reaction mainly.

Different type of dyes:

Numerous types of dyes are being used in textile coloration process. Those types depend on the origin of dyes, source of dyes, water solubility of dyes, etc. For example:



Colorfastness:

The term ‘colorfastness’ refers to the resistance of a color to destructive factors. In other words, it is the resistance of color of a finished textile material toward any destructive factors like washing, rubbing, perspiration, saliva etc. which may occur during the materials life time. Due to that reason, higher colorfastness properties are essential for all textile materials to ensure it’s purpose. During the production and end usage by consumers, textiles products can be subjected to considerable stresses, resulting in color changes like color fading, color staining, color bleeding, etc. These factors are normally unwanted by producers or consumers, hence it is very important to determine the colorfastness of textiles materials at a very early stage [4].

Types of Colorfastness:

Different types of colorfastness are available for different types of fabrics. Some of them are given bellow:

- ✓ Colorfastness to washing.
- ✓ Colorfastness to rubbing.
- ✓ Colorfastness to Perspiration.
- ✓ Colorfastness to light.
- ✓ Colorfastness to light,
- ✓ Etc.

Chapter- 3

Materials & Method

Materials & Method

Materials:

Fabric:

- 100% cotton Grey single jersey.
- 170 GSM.
- 16/1 yarn.
- 5 grams.

Scouring & Bleaching Chemicals (conventional):

- Detergent
- NaOH
- H_2O_2
- Peroxide stabilizer
- Sequestering Agent

Scouring Chemicals (With soap-nut):

- Soap-nut
- NaOH
- Sequestering Agent.

Dyeing Chemicals:

- Levelling Agent
- Reactive Red
- Glauber Salt
- Soda Ash

METDODS

Scouring & Bleaching (Conventional Method):

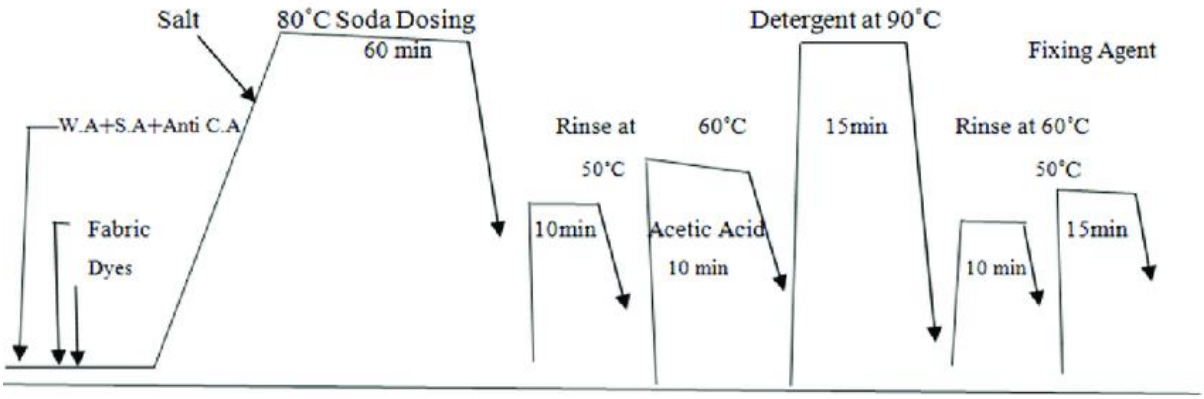
At the beginning of the process, I collected 100% cotton single jersey grey fabric with 170 GSM. From there I took a sample of 5gm. The liquor ratio I used during the process is M:L = 1:30. For the conventional scouring and bleaching process, I used one bath method. Used recipe and the process flowchart is given bellow:

Recipe:

SL	Name	Unit	Dossing	Stock Solution%
1	H_2O_2	Gm/l	4	3%
2	Peroxide Stabilizer	Gm/l	1	1%
3	NaOH	Gm/l	2	2%
4	Sequestering Agent	Gm/l	1	1%
5	Detergent	Gm/l	1	1%
6	Temperature	˚C	100	--
7	Time	min	60	--

Process sequence:

- Collection of Sample.
- Scouring & Bleaching at 95-100˚C.
- Cold Rinsing.
- Hot Wash.
- Cold Wash.



Scouring & Bleaching with Soap-nut:

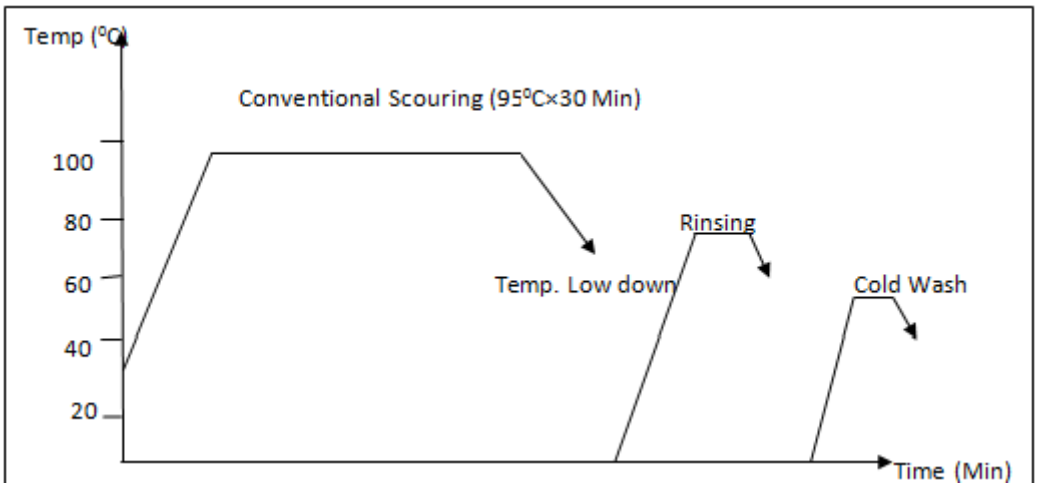
To do the Scouring & Bleaching with soap-nut, I had to use the two bath method. In the first one I did the scouring with different concentrations of soap-nut, then in the second bath, I did the bleaching.

For the scouring recipe:

SL	Name	Unit	Dossing	Stock Solution%
1	Soap-nut	Gm/l	4,6,10	5%
2	NaOH	Gm/l	2	2%
3	Sequestering Agent	Gm/l	1	1%
4	Temperature	˚C	100	--
5	Time	min	45	--

Process sequence of scouring:

- Sample collection.
- Scouring at 100˚C.
- Hot wash.
- Cold Wash.

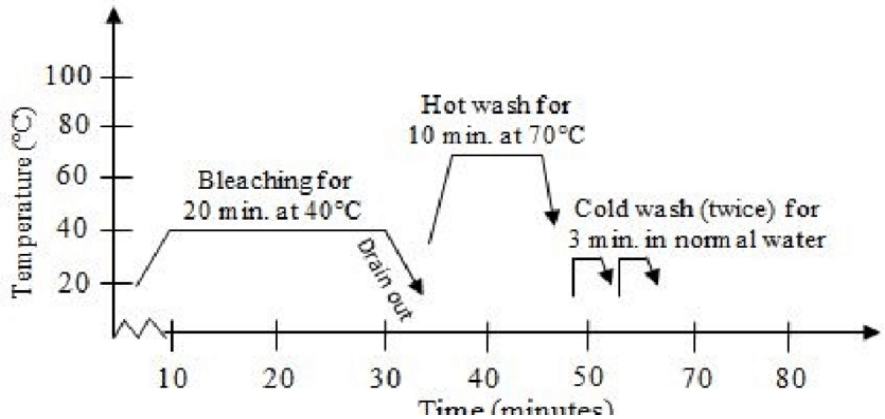


For the bleaching recipe:

SL	Name	Unit	Dossing	Stock Solution%
1	H_2O_2	Gm/l	4	3%
2	Peroxide Stabilizer	Gm/l	1	1%
3	NaOH	Gm/l	2	2%
4	Sequestering Agent	Gm/l	1	1%
5	Temperature	˚C	100	--
6	Time	min	40	--

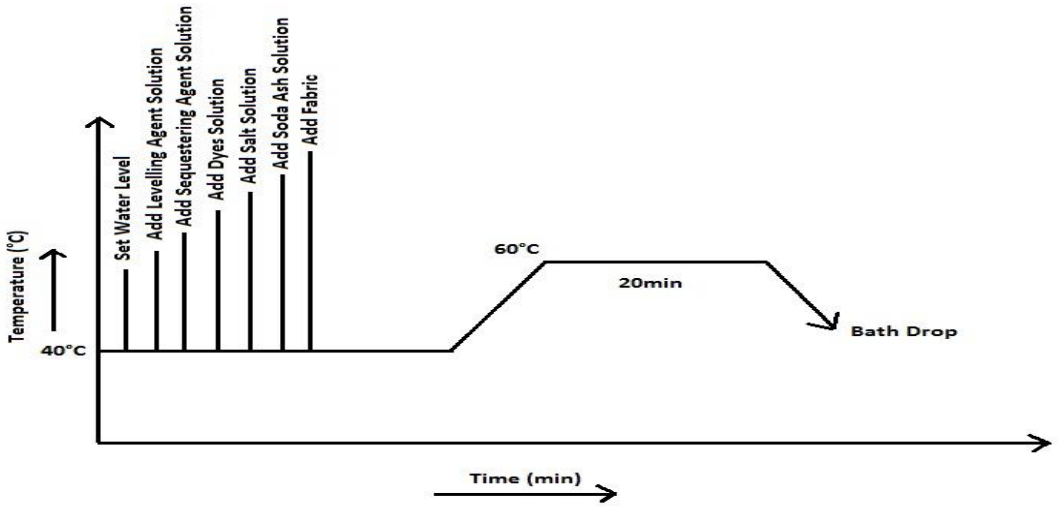
Process sequence of bleaching:

- Collection of scoured sample.
- Bleaching at 100˚C.
- Hot wash.
- Cold wash.



Laboratory dyeing process of test sample:

At first, I took 5 100% cotton single jersey fabric, each sample weights 5 gm. Where 2 are conventionally scoured and bleached samples and 3 samples are scoured with three different concentrations of soap-nut solution and then bleached. I used laboratory IR dyeing machine to conduct the dyeing process. I took those samples and immersed them in the dyeing pot, where dye solution is already being poured. For the identification, I marked them with small cut marks at the edge of each sample. The liquor ratio I used for the process is 1:30. For the dyeing chemicals, I used Glauber salt (Electrolyte), Neocrystal BC-4500 (Levelling Agent), Seraquest W-CON-XC (Sequestering Agent) & Reactive dye. Then the sample is dyed at 60˚C, for 20 minutes, then I added Caustic soda and let it run for another 40 minutes. After completing the process, the samples are then washed with normal water, and dried by linear drying method.



Dyeing recipe:

SL	Name	Unit	Dossing	Stock solution
1	Levelling Agent	g/l	1	1%
2	Dye	%	2	1%
3	Glauber Salt	g/l	40	15%
4	Soda Ash	g/l	10	10%
5	Sample Weight	Gm	5	--
6	M:L	--	1:30	--
7	Temperature	˚C	60	--
8	Time	Min	20	--

TESTING METHODS

Colorfastness test:

Dyed textile materials must contain a good colorfastness property. There are different types of colorfastness tests available for different purposes. Most common colorfastness tests are Color fastness to washing & colorfastness to rubbing.

Colorfastness to Wash (ISO – 105 C06):

Colorfastness to wash is the most common test of colorfastness, it refers to the resistance of a colored textile material to change it's shade during washing with a soaping agent (detergent). To conduct the test, I took test sample of 10×4 cm and let it condition for about 2 hours at 20±2˚C & 65±2% RH. To actually understand the colorfastness, we need a special type of fabric known as a multi fibre fabric. I took multifibre fabric of the same 10×4 cm size as the test sample & sew the multifibre fabric and my test sample at an end with a sewing machine. Then I put the sample in a solution of detergent (ECE) – 4 gm/l & Na_2CO_3 – 1 gm/l solution.

To conduct the washing process, I used a laboratory washing machine. I put the test sample with the solution in the machine pot with 25 stainless steel balls and start the process. The process was running for 30 minutes at 60˚C temperature. After the washing process was completed, I did a cold wash to the test sample and then it was dried at laboratory incubator oven. After the test samples were dried, the final assessment was done.

Colorfastness to Rubbing (ISO-105 X2):

Colorfastness to rubbing stands for the resistance of a color to abrasion or to staining to other matetrial. The test is conducted by two ways, one at a dry condition & the other is by wet condition. Crock meter (manual or automatic) is used to conduct the test.

Dry test:

At first I took my test sample and set it at the sample attaching section of the machine. A 100% nonwoven fabric of 5×5 cm is then attached to the machine finger by a clip. Machine finger is then lowered on top of the attached sample and turned the machine on to continue the test. It completes 10 cycles at 10 seconds. Then the test fabric is collected from the machine finger and the fastness ids measured by a grey scale.

Wet test:

For wet test I followed the same procedures as the dry test, but here I used a wet sample instead of a dried sample. The test sample here is wetted by using distilled water (Grade-3).

Shade variation:

Shade variation is compared between the conventionally pre-treated sample and the sample scoured by using soap-nut with the same dyeing conditions. The test is carried out by using CCMS- Computer Color Matching System with data color machine.

Different Machines Used for the Study:

Electric Balance

IR Dyeing Machine

Incubator oven

Automatic Crock meter

Washing Machine

Spectrophotometer

Chapter- 4

Result & Discussion

RESULT & DISCUSSION

Estimation of scouring Effect (Weight loss %):

To find out whether the scouring is good or bad, we conduct this test. The most common and popular way of knowing if the scouring is good or not is the weight loss test. It is expressed in % & is determined by the following formula,

$$\frac{Sample\ weight\ before\ scouring - Sample\ weight\ after\ scouring}{Sample\ weight\ before\ scouring} \times 100$$

Weight loss percentage for the samples scoured with different concentrations of soap-nut solution are,

[**NOTE:** The term SN indicates soap-nut treated sample numbers, SN-1 refers to the sample treated with 4gm/l, SN-2 for 6gm/l & SN-3 for 10gm/l].

SL	SN Concentration	Weight Loss%
1	SN-1	1.6%
2	SN-2	1.31%
3	SN-3	1.47%

Colorfastness to Rubbing:

Color fastness to rub or the rubbing fastness of a fabric determines the degree of color which may transfer from a colored sample to the test fabric due to the frictional force. The results of the colorfastness to rubbing test are given bellow,

Results of conventionally pre-treated sample:

SL	Dry Process	Wet Process
1	4-5	3-4
2	4-5	3
3	4	3-4

Result of the samples treated with soap-nut:

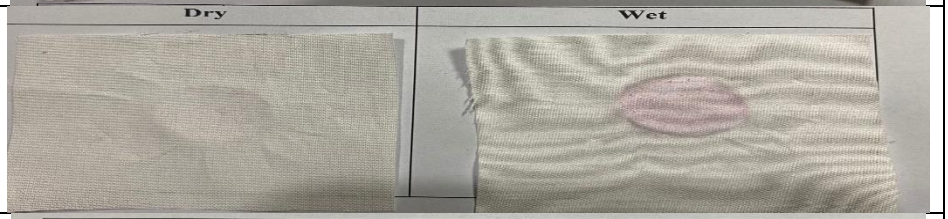
SL	Dry Process	Wet Process
SN-1	4-5	2
SN-2	4-5	2-3
SN-3	4	3-4

From the table, it is clear that both of the samples are showing very good to excellent rubbing fastness at the dry process (4-5). But the result changes drastically during the wet test process. Here the conventionally pre-treated & dyed sample shows better performance than those sample scoured with samples. Conventional samples provides a result of Good to Very good (3-4). On the other hand, samples scoured with soap-nut gives ratings like, 2 for 4 gm/l, 2-3 for 6 gm/l & 3-4 for 10 gm/l.

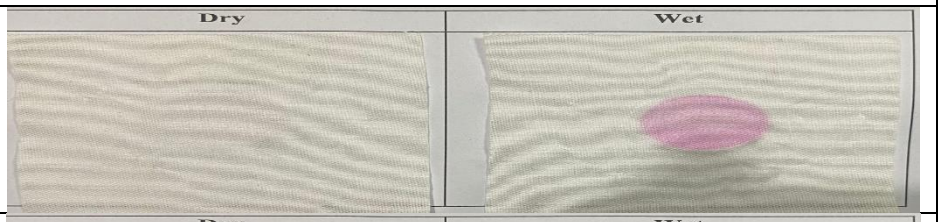
Sample Attachment:

For conventionally pre-treated samples:

[**NOTE:** In the table bellow, **C** refers to the conventional method & **SN** refers to different concentrations of Soap-nut].

SL	Name	Attachment
1	**C-1**	
2	**C-2**	
3	**C-3**	

For the samples scoured with soap-nut:

SL	Name	Attachment
1	SN-1	
2	SN-2	
3	SN-3	

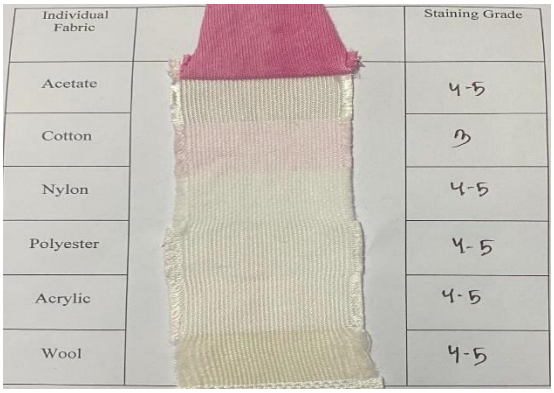
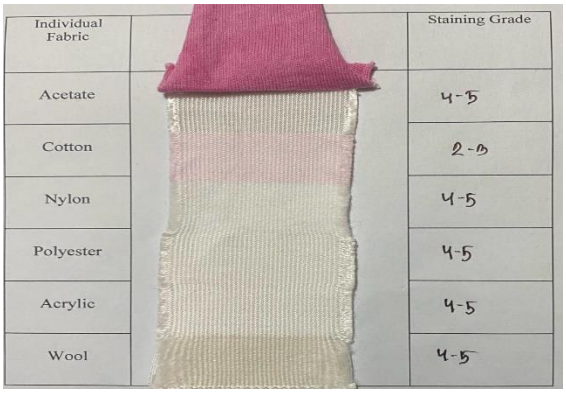
Colorfastness to washing:

Colorfastness to wash or wash fastness is the resistance of a dyed material to change in any of it's color characteristics due to washing with any sort of soaping agent or detergents. Test samples are washed and dried by encubator oven. Dried samples are then evaluated with respect to the main sample by the help of Greyscale. Dyeing recipe & the results of color fastness to wash are given bellow:

Average result for the conventionally pre-treated & dyed samples:

Results for the Samples scoured with Soap-nut & then dyed:

[**NOTE:** In the table bellow, **SN** refers to different concentrations of Soap-nut].

SL	Name	Sample Attachment
1	**SN- 1**	
2	**SN- 2**	
3	**SN- 3**	

Shade % comparison:

In this study both types of sample are dyed with the same dyeing recipe, but were introduced with two different kind of pre-treatment methods. The difference in shade between those two types of samples are provided bellow:

SL	Sample pre-treated & dyed with conventional method	Sample scoured with soap-nut & then dyed
1	 C-1	 SN-1
2	 C-2	 SN-2
3	 C-3	 SN-3

It can be clearly seen that the samples which were scoured with soapnut is lighter in shade & shows uneven shade compared to the samples conventionally pre-treated & dyed samples.

Spectrophotometric Evaluation:

Spectrophotometer is a instrument used to calculate the reflectance of visible light, UV light, Infrared light. It is widely used in textile industries in order to calculate the capability of a

textile materials to absorb light, and based on that it can also calculate the closest recipe to regenerate the color of that material. In a spectrophotometer result,

DL= Lightness or Darkness.

Da = CIE lab value

Db = CIE lab value

Dc = Chroma (saturation)

DH = Hue (tone)

DE = Total deviation of color.

Considering the conventionally pre-treated and dyed sample as standard the CCMS result for both types of samples are given bellow:

Sample	Illum/obs	DE	DL	Da	Db	DC	DH
SN- 1	D65- 10 DEG	5.56	1.15	-13.84	-0.81	-13.55	-2.89
SN- 2	D65 10DEG	0.32	0.25	-0.71	-0.15	-0.68	-0.24
SN- 3	D65 10DEG	5.72	2.43	-14.17	-0.43	-13.95	-2.51

Mainly DE values express the color difference between dyed fabric samples. From this experiment I found that if we use 6 gm/l (5% stock solution) of soap-nut for the scouring of 100% cotton single jersey fabric and then dyed, desired shade can be obtained.

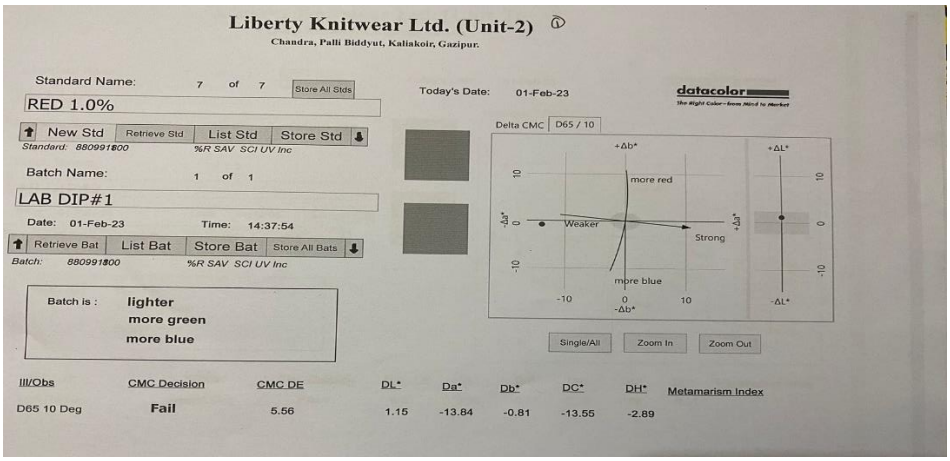
Sample attachment of spectrophotometer:

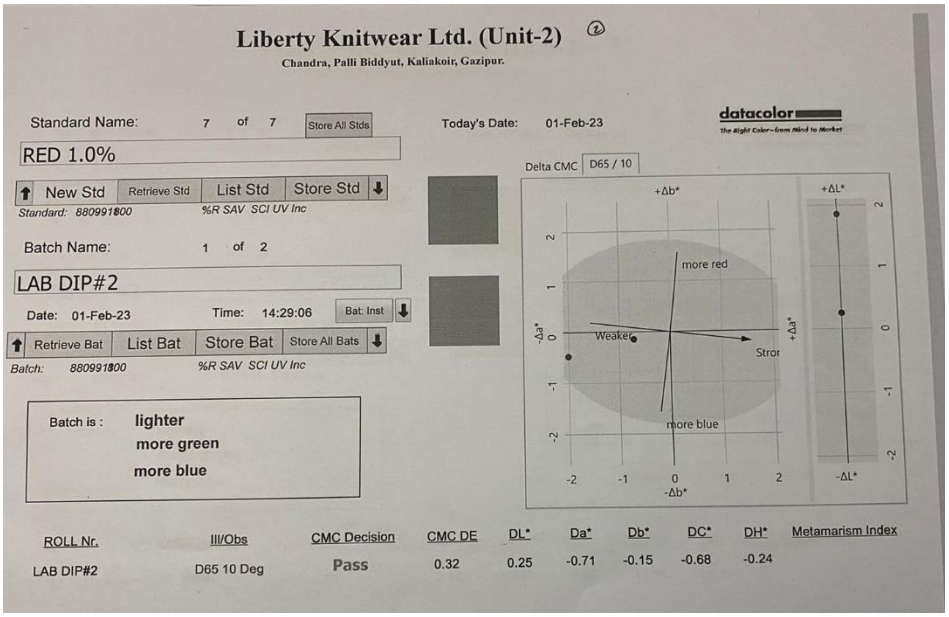
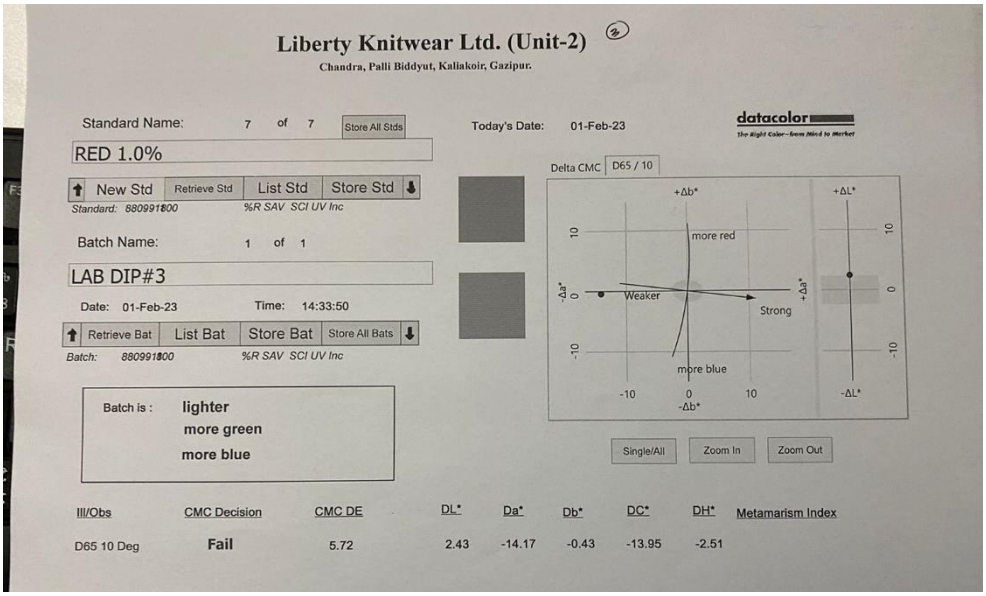
Spectrophotometer result for the conventionally pre- treated sample:

[**NOTE:** In the table bellow, **C** refers to the conventional method & **SN** refers to different concentrations of Soap-nut].

Sample	Illum/Obs	DE	DL	Da	Db	DC	DH
C	D65 - 10DEG	0.32	-0.25	0.71	0.15	0.68	0.24

Spectrophotometer results for soap-nut pre-treated samples:

SL	Name	Attachment
1	SN-1	

2	**SN-2**	
3	**SN-3**	

Chapter- 5

Conclusion

CONCLUSION

During the study, I have realized that soap-nut can actually be sed as an alternate to synthetic detergents. But it is best suited for the purpose of washing rather than as an agent of textile pre-treatment, because it causes hydrolysis during the dyeing period resulting uneven shade over dyeing. On the positive side, it can remove impurities like dust, dirt, oil, wax, etc. quite finely, higher concentration of soap-nut can remove the same or even better amount of impurities than synthetic soaping agents or detergents. Moreover, it is a natural substance so the source is renewable.

To conclude, I would say that soap-nut can be sustainable and cheaper alternative to synthetic soaping agent or detergent and it shows possibility to be a scouring agent if the right method is used and with some modifications o the dyeing technique the hydrolysis problem during the dyeing can hopefully be removed.

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