Collaborative Project between IICT and Coir Board

Validation of intellectual property of IICT

2016

Development of Coir Silk, Vertical Blinds and Carpet Backing using Coir Scrim Fabric

By

Indian Institute of Carpet Technology
Chauri Road
Bhadohi-221401

Presented before project review committee at CCRI, Alleppey, Kerala on January 29, 2016

Completion Report

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Project Team

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Contents

List of Figures

List of Tables

List of Annexure

Annexure I	Scanned copy of patent application no. 149/KOL/2012 dated 13.02.2012 (CBR No 1128)
Annexure II.	Scanned copy of the original proposal submitted to Coir Board
Annexure III	Scanned copy of letter no IICT(New)/3/30/2013-14, dated 22.09.2014 received from Coir Board regarding release of payment of Rs. 5,25,000/= towards 50% of the financial arrangement.
Annexure IV	Scanned copy of MOU duly signed by authorities of IICT and and Coir Board
Annexure V	Suggested designs for vertical blinds using coir fabric
Annexure VI	Feedback from industry on coir scrim fabric

General Introduction

Validation of intellectual property of IICT through lab study and explore new/ emerging technological breakthrough using coir fibre: Development of Coir Silk, Vertical Blinds and Carpet Backing using Coir Scrim Fabric.

1. The concept on "Method of regenerating cellulose from coir fibre" was already covered under IPR by IICT vide application no. 149/KOL/2012 dated 13.02.2012 (CBR No 1128) before submission of the project proposal to Coir Board (copy enclosed as Annexure I).

2. Thereafter, Coir Board was approached for funding the project for validation of the concept (copy enclosed as Annexure II).

3. In the mean time Coir Board released the payment of Rs. 5,25,000/= towards 50% of the financial arrangement vide letter no IICT(New)/3/30/2013-14, dated 22.09.2014 with the reference "Project on validation of intellectual property of IICT through Lab study and explore new emerging technological breakthrough using coir fibre-Cheque fdg-reg" (copy enclosed as Annexure III), who agreed to contribute Rs.10.5 lakhs towards Board's share wherein the responsibilities of IICT and scope of the work was not mentioned.

4. The final agreement was however signed on 14-01-2015. IICT took up the execution work as per MOU/ financial arrangement including its own contribution in terms of utilization of IICT block as per MOU Clause no. 7. (copy enclosed as Annexure IV) with the scope of the agreement, .duration of the project and responsibilities of IICT are as under:

Scope of the agreement "This agreement covers the modalities of executing the project for development of paper and regeneration of cellulose from coir-coir paper & coir silk, development of vertical blind from coir based fabric & development of coir based scrim fabric as per textural guidance from IICT which can be used as action backing for carpet backing, financial arrangements, responsibilities devolving on the Parties to the Agreement, technology transfer, training and other related issues."

Duration (1st Phase): One Year from the date of signing the MOU.

Responsibilities

i. To develop paper & regeneration of cellulose from coir-coir paper & coir silk.
ii. Development of vertical blind from coir based fabric.
iii. Carpet backing using coir based scrim fabric.
iv. Dissemination on completion of the project.

5. It is apparent from the above proceedings that the responsibilities of IICT had to be restricted to Phase I part only since no financial arrangement was provided for the both the phases . Therefore, pilot study on coir silk development part was kept at abeyance for Phase II, subject to sanction of extension of Phase I by Coir Board although laboratory experiments were explored which was found to be encouraging .The logical revised scope, duration and responsibilities are as under:

Scope and duration

"Execution of the project for development of paper and regeneration of cellulose from coir-coir paper (Pilot level) & coir silk(restricted to laboratory level only), development of vertical blind from coir based fabric & development of coir based scrim fabric as based on raw material in the form of yarn and fabric respectively obtained from CCRI " over a period of one year w.e.f 14.01.2015

Responsibilities

1. (a) To develop pre-treatment process for complete removal of pith. (b) To develop pulp and paper from pre-treated coir. (c) Preliminary laboratory level study to explore regeneration of cellulose from coir.
2. Development of vertical blind from coir based fabric.
3. Carpet backing using coir based scrim fabric.
4. Dissemination on completion of the project.

The details of work pertaining to validation of intellectual property and product developments as per logically revised scope and responsibilities are described in the following section.

Introduction

Coir fibre is extracted from the outer layer (husk) of the fruit of coconut tree *Cocos Nucifera L*. The coconut husk consists of a smooth waterproof outer skin (epicarp) and fibrous zone (mesocarp). The mesocarp comprises fibre strands of coir embedded in a non fibrous "cork-like" connective tissue usually referred to as pith. The pith ultimately becomes coir dust.

Coconut palms flower monthly and since it takes a year for the fruit to ripen, a tree always contains fruits at 12 stages of maturity. Harvesting usually take place on a 45-60 day cycle, with each tree yielding 50-100 coconuts per year.

Industrialization of coir products started in the organized sector predominantly by foreign companies in the middle of nineteenth century. The production of coir floor covering began in United Kingdom before the 2nd half of the 19th Century. In India, Alleppey stands as the birth place of coir manufacture as the first factory for production of coir mats, matting and other floor coverings was set up in 1859. During the initial years the performance was good and industry grew at a reasonably good rate. However, in the recent past, the industry has been stagnating owing to various reasons, some of which are enumerated below:

- Low raw material availability.
- Technological obsolescence and lack of timely technology upgradation.
- Inadequate marketing system.
- Low productivity.
- Indifferent and inconsistent quality and lack of awareness of the need for quality.
- Poor raw material utilization.
- Low value addition.
- Poor pricing.
- Lack of innovation and introduction of new products.
- Scant attention to research and development efforts which will help in developing improved and new products with more value-addition and acceptability in the domestic as well as in the foreign markets.
- Failure of the co-operative sector to meet the targets.
- Competition from other natural fibres like sisal, jute, etc.
- Government policies on social, economical and political issues.

Although coconut palms grow throughout the world's tropical regions, the vast majority of the commercially produced coir comes from India and Sri Lanka. Coconuts are primarily a food crop. In India, which produces about half of the world's coconuts each year, only 15% of the husk fibers are actually recovered for use. India annually produces about 550,000 metric tons of coir fiber. Coir is distinguished into following two categories:

Type I: Coir fibers recovered from fully ripened coconuts yield brown coir. Strong and highly resistant to abrasion, its method of processing also protects it from the damaging ultraviolet component of sunlight. Dark brown in color, it is used primarily in brushes, floor mats, and upholstery padding.

Type II: White coir comes from the husks of coconuts harvested shortly before they ripen. Actually light brown or white in color, this fiber is softer and less strong than brown coir. It is usually spun into yarn, which may be woven into mats or twisted into twine or rope.

Both brown and white coir consist of fibers ranging in length from 4-12 in (10-30 cm). Those that are at least 8" (20 cm) long are called bristle fiber. Shorter fibers, which are also finer in texture, are called mattress fiber. A 10-oz (300-g) coconut husk yields about 3 oz (80 g) of fiber, one-third of which is bristle fiber.

Raw Material Availability: Coconut, the source of coir fibre, is largely produced along the coastal regions of India. The fruit is abundantly available (~10 million tonnes per annum), ranking first and sharing ~50% of global production. Yield varies from region to region (3500 to 6000 nuts/ha/year). One tree may yield on average 70-100 nuts to a maximum of 150 nuts per year. The kernel (copra, coco-water and shell) comprises 65 per cent of total weight, while the husk contributes 35 per cent.

Coir fibres are extracted from the husks as a by-product of copra production. The husks are left on the fields as a mulch or used as fertilizer because of high potash content. Only a small part of the fibres available worldwide are utilized for production of commercially useful products (Table 1). The average fibre yield is dependent on geographical area and the variety of the coconut tree. In the south of India and Sri Lanka, for example, where the best quality fibres are produced the average yield is 80-90 g fibre per husk.

Table 1 List of traditional coir products manufactured in India.

Car Mat	Coir Matting Tiles	Mesh Mats
Carnatic Mats	Coir Mattings	Multishaft Weave
Carpet Mats	Coir Needled Felt	Mural Coir Products
Carpets	Coir Pile Carpets	Non-woven Mats
Coir Braid Carpets	Coir Polymer Composites	Ribbed Mattings
Coir Cricket Matting	Coir Yarn	Rope Mats
Coir Geo Textiles	Corridor Mats	Rubberized Coir
Coir Gypsum Board	Creel Mat	Sinnet Mats
Coir Matting Mats	Fibre Mats	
Coir Matting Rugs	Loop Mats	

Husks are composed of 70 per cent pith and 30 per cent fibre on a dry weight basis. On average, the ratio of yield of long, medium and short fibre, respectively, is 60:30:10. Only a small part (less than 10 per cent) of the potential enters commercial trade. Continuous expanding production of brown fibre reached 216 000 tonnes (70 per cent India, 27 per cent Sri Lanka) in 1996, while white fibre production (again, mainly in India) has remained stable at 125 000 tonnes.

Value Addition of Coir Products:

Value addition of the fibre is done in terms of conversion to various products like brushes and brooms, ropes and yarns for nets and bags and mats, and padding for mattresses. Coir composites with synthetic resins has developed as a new area for product development.

In consideration of all these aspects an attempt was taken in this project to develop new avenues for promotion of coir products. The details of the activities of IICT and output are described in the following section. The holocellulose and lignin increase in urea treated samples are higher probably indicating that some lignocellulosic material is removed during the process.

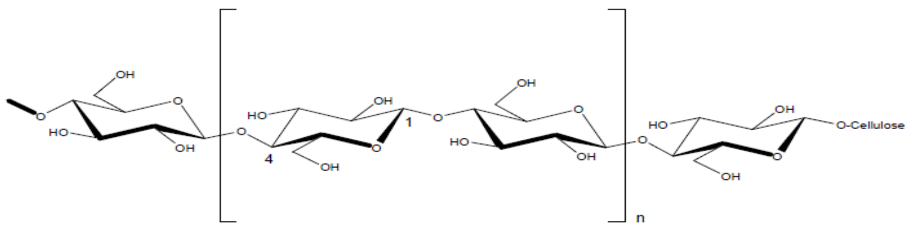
The coconut industry generates huge biomass waste in the form of husks which are usually discarded after consuming coconut. Thus, the husk serves as an inexpensive and prospective substrate to be used for pulp production due to the presence of relatively high levels of cellulose in it. The husk fiber is composed of cellulose, lignin, pectin, hemicellulose, and ash. Typical chemical composition of coconut husk vis-à-vis some wood species are summarized in Table -2

Table 2. Chemical composition of coir vis-a-viz some wood species.

Chemical composition (%)	Coir	Wood species			
		1	2	3	4
Water solubles	5.3 %	NA	NA	NA	NA
Cellulose	43.4%	40	39.5	45	41
Lignin	45.8%	27.7	27.5	31.3	22.0
Pectin & related compounds	3.3 %				
Hemi-cellulose	0.25 %	28.5	30.6	19.2	32.4
Ash	2.22 %				
Total extractives		3.5	2.1	2.8	3.0

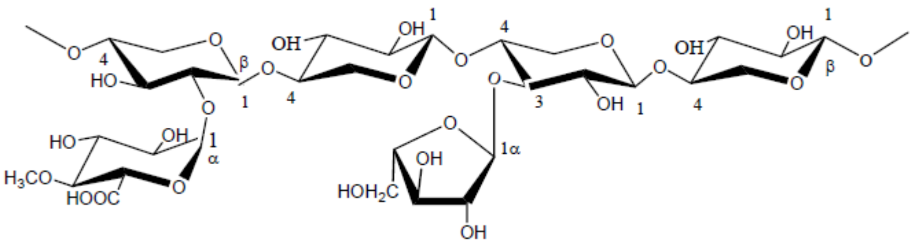
*1= Scots pine, 2= Spruce, 3= Eucalyptus, 4= Silver Birch

Cellulose is a long chain linear molecule formed by condensation of glucose monomers as shown below. Any reaction with the cellulose molecule is not wanted in the pulp production.



Hemicellulose on the other hand is a heteropolymer with the following characteristics:

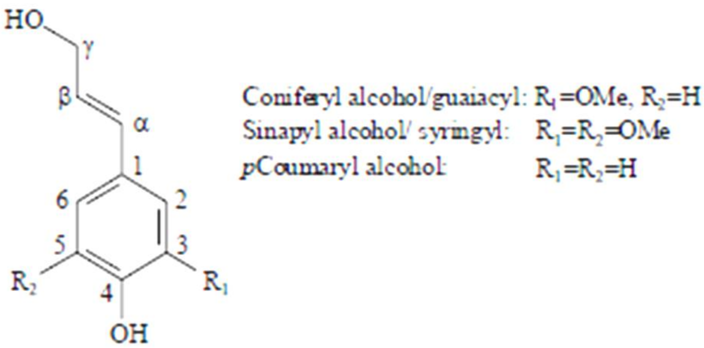
- More than one sugar (as in xylan or glucomannan)
- Branched or substituted backbone
- Low degree of polymerization
- Reducing and non-reducing ends
- Generally not crystalline



Structure of xylan

Native lignin is yet another natural polymer with following characteristics:

- Formed in situ by dehydrogenative polymerization of *trans* -coniferyl, *trans*- sinapyl , and *trans*- *p*-coumaryl alcohol units.
- A heterogeneous, branched and cross-linked polymer with phenylpropane units linked by C-C and C-O bonds.
- Cross-linked with polysaccharide chains



Monomers of lignin

Traditional coir products

'Weakness like coarseness and brittleness of coir fibres limits its utilization to mat/door mat and the like since long. However, coir products are becoming more and more acceptable worldwide as replacement of synthetics for various applications. The traditional utilization of coir as doormat and floor mat will continue but constant effort to enhance value addition is necessary to boost the socio-economic status of growers and fibre extractors.

Technological intervention is a need of the hour to develop innovative products for widening the market potential of coir. The chemical identity of coir may be related to lingo-cellulosic fibres which by its nomenclature indicate that the chief components of the fibre are cellulose and lignin. The fibre has the following properties which in some cases are more advantageous than other lingo-cellulosic materials like wood.

i. Perennial, lingo-cellulosic fibrous material
ii. Organic, biodegradable, renewable resource
iii. Water holding capacity up to 30 %
iv. Excellent wetting and re-wetting capacity
v. Organic nature mixes well with other raw materials in the growing medium
vi. Will not grow mildew on storage in compressed form
vii. Air filled porosity upto 70%

Theory of Kraft cooking

The main objective is to facilitate the disintegration of Lignocellulosic material into fibrous product. This is achieved by breaking the bonds in the lignin macromolecule which acts as a cementing material between biological cells containing cellulose. The main chemical reactions in the cooking process can be described as:

$$NaOH + Na_2S + \text{Lignocellulose} \rightarrow \text{Na-org.} + \text{S-lig.} + NaHS$$

where the lignocellulose (like coir) represents many different organic compounds, such as, lignin, cellulose, hemi-cellulose, and resins.

The purpose of cooking is to degrade lignin into water soluble fragments. Major reactions taking place during Kraft pulping may be described as follows:

- Cleavage of alpha- and beta- aryl ether to free phenolic units
- Enol ether formation
- Alpha- and beta- aryl ether cleavage in etherified units
- C-C bond cleavage
- Condensation
- Bonding to carbohydrates
- Other reactions

Consumption of Alkali

The solution of Sodium sulphite and Sodium hydroxide in water is generating an equilibrium as follows:

$$S^{2-} + H_2O \Longleftrightarrow SH^{-} + OHSH^{-}$$
$$H_2O \Longleftrightarrow H_2S + OH^{-}$$

Alkali in the cooking liquor is basically consumed in three different reactions: 1. with lignin, 2. neutralisation of organic acids, 3. with resins in the fibre.

Reactions with lignin

As the carbon to carbon bonds are stable in alkaline conditions, the cleavage of oxygen - carbon bonds are the most significant reaction in the cooking process. This reaction will take place and is producing phenolic hydroxyl groups from the cleavage of the aryl-alkyl-ether bounds, one of the main products being the phenyl coumaran.

Neutralisation of organic acids

Most of the alkaline is consumed in the cooking process by the saccharine acids formed in the degradation of hemicelluloses. Hemicellulose contained in plants, natural fibres and woods is a polysaccharide which includes galactoglucomannan, arabinoglucoronxylan, arabinos, arabino-galactan, glucurononxylan, glucomannan, and acids from glucorans and galactorons. The saccharinic acids formed by the degradation contains; isosaccharidic acids, formic acid and acetic acid etc.

1 (a) Development of pretreatment process for complete removal of pith.

1.1 Objectives:

To prepare of clean fibre by removal of pith, soil and other extraneous materials from raw coconut husk to facilitate pulping of coconut fibres at subsequent stage.

1.2 Raw Materials: The raw material, namely, coconut husks (200 kg) was provided by CCRI. These fibres were designated as FT-01.

1.3 Process: Treatment of coconut husk with urea, alkali and potassium permanganate in tandem.

1.4 Process control:

(a) Treatment with urea by hand spray technique:

Initially, attempts were taken to treat raw fibres (FT-01) with urea by hand spray technique. A weighed quantity of the fibre was spread on the floor and solution of urea applied to it (MLR 1:2). This technique did not work well as it took long time to complete one cycle.

(b) Treatment with urea by batch process: A batch containing 75 kg of raw fibre was loaded in a 2000 L Syntex tank and urea solution (0.35%, 300 L, pH 4-5) was sprinkled from the top. After applying the entire solution, the liquor accumulated at the bottom was collected (~200 L) and recycled. The process of recycling was repeated two times more. The tank was filled with water up to a level just to submerge the fibres (up to 1750 L mark). This was left as such for 24 hrs with the lid of the tank closed.

The next day, the mother liquor was drained off completely through the outlet at the bottom and the treated fibre extensively washed to remove excess of chemicals. The treated fibre was designated as FT-02.

(b) Treatment with Alkali:

An alkali solution was prepared by dissolving 1.25 kg of sodium hydroxide per 100 L of solution in a 100 L bucket. Similarly 200 L of solution was prepared using two 100 L buckets. These solutions (total of 300 L) were sprinkled over the urea treated fibre (FT-02) contained in the tank. The liquor collected at the bottom was taken out through the outlet tap and re-circulated two more times. Water was added until the water level rose to such a level that the fibres were just submerged (i.e. upto ~1750 L mark). The fibres were kept as such for 45 hrs. for the extraction of soluble matter.

The residual fibre left in the tank was thoroughly washed with water till the pH of the effluent dropped to ~7. This fibre was taken out from the tank and subjected to willowing for removal of pith and other impurities. This operation was attempted in a small and then a medium capacity m/c. These attempts did not give fruitful results. Willowing was finally done in 'Swarna" - a heavy duty fibre extraction machine developed by CCRI. Willowing was carried out two times which furnished a clean fibre. This fibre was designated as FT-03. The remainder of the raw fibre (FT-01) was similarly treated in two more batches to obtain fresh lots of FT-03.

(c) Treatment with alkaline potassium permanganate:

Alkali extracted and willowed fibre (FT-03, 5 kg) was dipped into a solution containing $KMnO_4$ (250 g), NaOH (500 g) and water 100 Ltrs and kept immersed for overnight. The supernatant liquor was drained off and the residual fibre was washed thoroughly with water. This was followed by treatment with oxalic acid acid solution (2%) when the colour of the fibre changed from dark black to pale yellow. The fibre was washed thoroughly with water till the washings were neutral. This was dried in the sun and the dried fibre designated as FT-04.

Evaluation of the products

Physical properties

The SEM photomicrographs clearly show that cell wall debris is gradually removed from the fibre surface as a result of chemical treatments (Fig. 14). The pores on the surface become more and more prominent in passing from FT-02 onwards. In FT-04 some protruded inner fibrils are visible due to penetration of the reagents and partial removal of lignin by the action of alkaline permanganate. The physical properties of FT-01 to FT-04 are summarized in Table-3.

Table 3. Physical properties of chemically pretreated fibres

Sample	Fibre dia (mm)	Break Force (N)	Break Stress (N/mm^2)	Break Strain (%)
FT-01	0.237	7.213	163.4	31.1
FT-02	0.256	7.115	148.6	28.3
FT-03	0.249	7.774	165.7	34.8
FT-04	0.250	6.644	137.5	31.2

The results indicate that the fibre swells slightly at each stage of chemical treatment. Both break force and beak strain increase in FT-03 as comapared to FT-01. In FT-02 the break force and hence break stress diminishes slightly but the same drop significantly in FT-04. This shows that the alkaline permanganate is effective in partial removal of cementing materials in the middle lamella. The diminition in breaking stress in the case of FT-04 is also justified.

1.5.2 Proximate chemical analysis:

The coir fibres samples FT-01, FT-02, FT-03 and FT-04 were subjected to limited proximate analysis to evaluate the changes in chemical composition in respect of holocellulose, lignin, pentosans and ash contents. The results are summarized in Table-4.

Table 4. Result of limited proximate chemical analysis of pretreated coir fibres on OD weight basis.

Parameters	Coir fibre (FT-01)	Coir fibre (FT-02)	Coir fibre (FT-03)	Coir fibre (FT-04)
Dryness	100	100	100	100
Ash content, %	6.70	6.52	4.26	1.11
Holocellulose,% (After lignin and ash correction)	79.12	82.54	77.89	79.60
Klason Lignin,% (After ash correction)	32.76	38.00	34.89	35.97
Pentosan content , %	12.02	12.16	12.15	21.66

Test Methods: The test methods employed for proximate chemical analysis of fibres are summarized in Table 5

Table 5. Details of test methods used for proximate chemical analysis.

Test No	Description	Method
1.	Klason Lignin	TAPPI-T-222
2.	Holocellulose	Wise et al Paper Trade J 122 No. 2 35 (1946)
3.	Alpha cellulose	TAPP I203 OS74
4.	Pentosan	UV Method
5.	Ash	APPITA P3M-69

Observations:

- The acid insoluble lignin ranges from ~33 to 38 %, in the coir fibres samples which indicate high cooking chemical demand for pulping of coir fibre samples.
- The holocellulose and lignin contents of FT-02 (82.5 and 38 %, respectively) is higher than FT-01, indicating that some cell wall debris are removed during urea treatment. The SEM photomicrographs are supportive of this contention (Fig 1.14).
- The value of ash content in case of FT-04 is low i.e 1.1% compared to other coir fibres samples which is indicates that major portion of the inorganic materials are removed during the entire chemical processing.

Fig. 1(a) Laying of raw coconut husk for urea treatment by hand spray technique

Fig. 1 (b) Application of urea solution to raw coconut husk by hand spray technique

Fig. 2 (a) Loading of raw coconut husk into a 2000 L Syntex tank.

Fig. 2 (b) Application of urea solution on the coconut husk in reaction tank

Fig. 3 (a) **Raw coconut husk**

Fig. 3 (b) Coconut husk obtained after treatment with urea.

Fig. 4 Alkali treated fibre

Fig. 5 Collection of alkali soluble matter contained in the effluent

Fig. 6 (a) **An aliquot (250 mL) of the effluent taken for precipitation of the alkali-soluble lignin**

Fig. 6 (b) Precipitated lignin obtained from liquor

Fig. 7 Part of the black liquor collected after alkali extraction of FT-02.

Fig. 8 Fibre obtained by alkali extraction and washing of FT-02.

Fig. 9 **Willowing in 'Swarna' – a heavy duty fibre extraction machine**

Fig. 10 **First lot of fibre obtained after alkali extraction of FT-02, followed by willowing**

Fig. 11 Alkali extracted fibre before (left) and after (right) willowing. The removal of pith and other impurities is clearly visible.

Fig. 12 Alkaline permanganate treatment of FT-03

Fig. 13 Bit fibres generated during willowing operation.

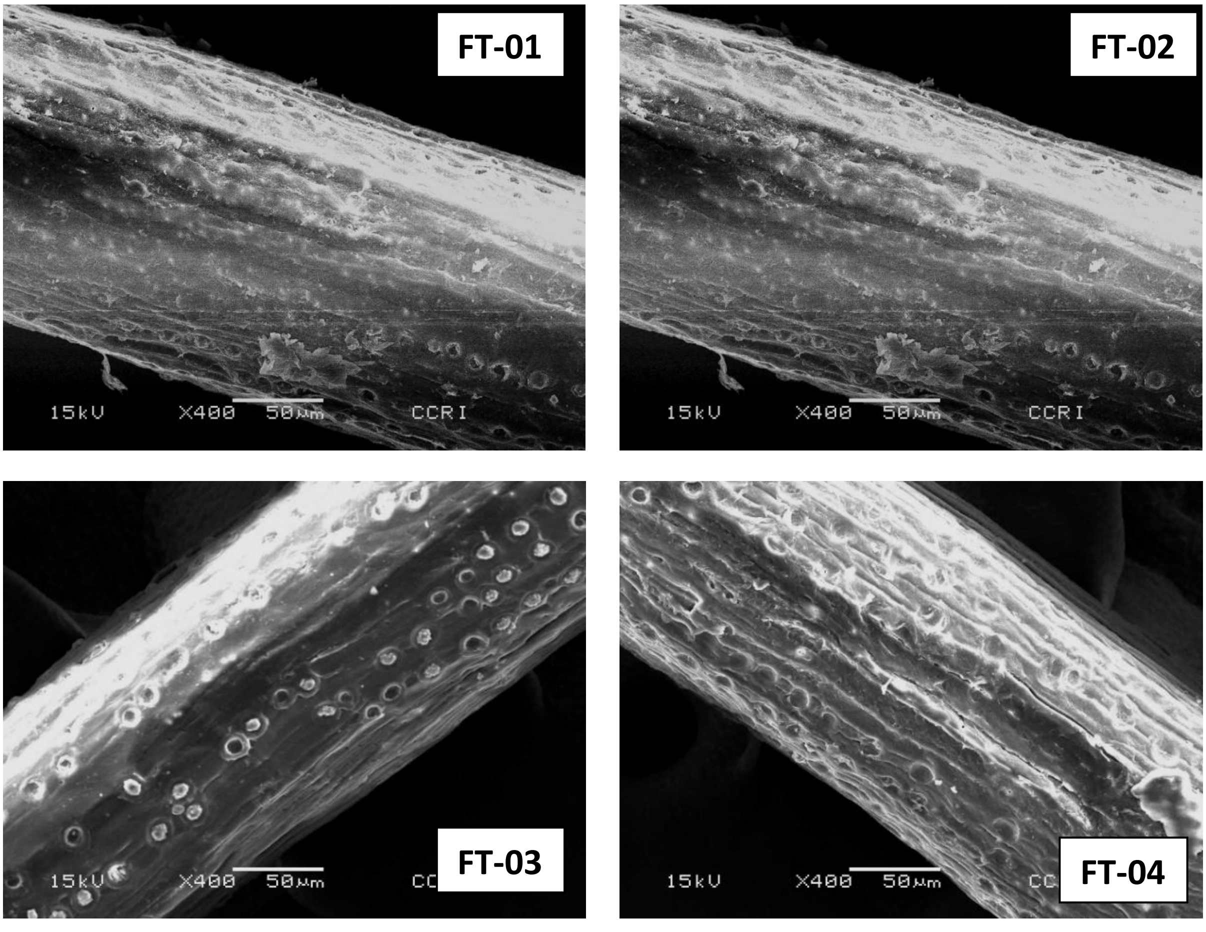


Fig. 14 SEM photomicrographs of FT-01, FT-02, FT-03 and FT-04

1 (b) Development of pulp and paper from pre-treated coir.

Objectives:

To conduct laboratory experiments on pulping & bleaching of coir fibers samples for optimization of various parameters to produce high alpha cellulose pulp

Work plan

Following work plan was prepared for detailed study of the samples:

- Limited proximate chemical analysis of FT-01,FT-02, FT-03 and FT-04 coir fibres
- Optimization of chemical dose for kraft cooking of FT-03 coir fibre for achieving chemical grade pulp.
- Large scale kraft cooking of FT-03 coir fibres sample applying standard conditions.
- Determination of pulp kappa number, screened and unscreened pulp yield, rejects, pulp viscosity and pulp brightness.
- DEpD bleaching of FT-03 coir fibres unbleached pulp
- Determination of bleached pulp viscosity and brightness.

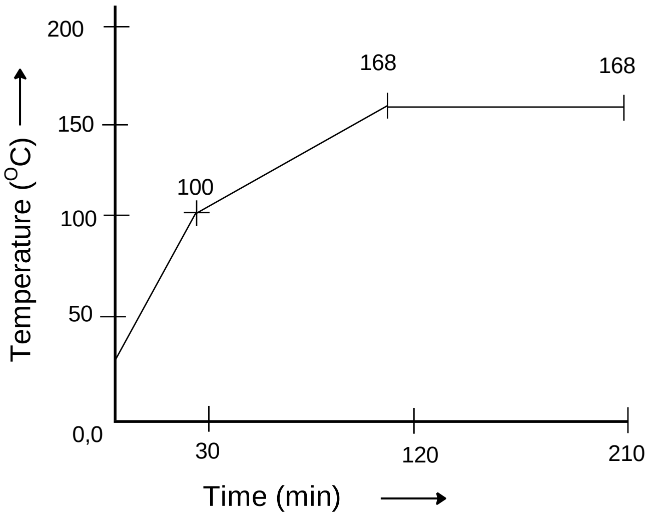
Process: Optimisation of pulping conditions**.**

Coir fibres of FT-01, FT-02, FT-03 and FT-04 samples were stored in polythene bags in order to retain uniform moisture level. Moisture of samples was determined before proceeding for further experiments. As mentioned earlier, limited proximate chemical analysis of FT-01, FT-02, FT-03 and FT-04 coir fibres samples were carried out as per the methods shown in Table - 5.

Process control:

Kraft Cooking

Experiments on kraft cooking were carried out in the laboratory in series digester with a view to optimizing the cooking chemical (as Na_2O) under specified cooking chemical dose and 20% sulphidity. Thus bleachable pulp with desired kappa number was obtained for production of chemical grade pulp. The dryness of each of FT-01, FT-02, FT-03 and FT-04 were determined separately. Calculated amounts of each samples was weighed on AD wt. basis and taken in bombs of a series digester so that each bomb contained 50.0 g of fibre on OD wt. basis. White liquor was added to each bomb to maintain a chemical charge of 22% and MLR of 1:6. The bombs were sealed air tight by placing the lids and tightening the screws. Unless stated otherwise, kraft cooking was done in a Sweden make, Stalvets Series Digester as per the following temperature programme:



Temperature programme of cooking bath.

After completion of digestion, the bombs were taken out and immediately dipped in water to cool. When the bomb attained the room temperature the lid was opened and the contents poured onto a polyester filter cloth. The pulp was pressed and the black liquor was collected in a beaker placed below the filter cloth. The black liquor was kept aside for the determination of TDS and residual active alkali (RAA). The pulp remaining in the bomb was quantitatively transferred on the filter cloth, washed thoroughly with water and then transferred into a beaker. Sufficient water was added and the slurry of pulp agitated with a stirrer for disintegration. The pulp was again filtered and then subjected to hydro-extraction. Washing and hydro-extraction steps were repeated three times and finally the pulp was collected for further treatment.

Table 6.Test methods for analysis of pulp.

Test No	Description	Method
6.	Kappa number	TAPPI T 236-OS-76
7.	Pulp Viscosity	SCAN C 15 : 65
8.	Total pulp yield	-
9.	Screened pulp yield	-
10.	Pulp rejects	-
11.	Pulp brightness	ISO 2469

Unbleached pulp was evaluated for kappa number, viscosity, total pulp yield, screened pulp yield, pulp rejects and pulp brightness according to test parameters described in Table-6. After cooking, the black liquor was recovered for evaluation of the test parameters 12-15 as described in Table - 7.

Table 7. Analysis of Black liquor characterization:

Test No	Description	Method
12.	pH	-
13.	RAA	TAPPI T-625 CM-85
14.	Total Solids	TAPPI T-625 CM-85
15.	Active Alkali	SCAN N2:63

Unbleached sample was evaluated for the test parameters 16-18 (vide Table – 8). The tests included freeness test, viscosity and brightness,

Table 8.Test methods for evaluation of unbleached pulp

Test No	Description	Method
16.	Freeness	ISODP5269
17.	Viscosity	SCAN C 15:65
18.	Brightness	ISO 2470

The unbleached pulp was subjected to chlorine dioxide – extraction with alkaline peroxide – chlorine dioxide (D_0E_PD) sequence of bleaching to achieve final brightness 80 ±1 % ISO. The experimental conditions maintained during bleaching are summarized in Table – 9.

Table 9. Description of the experimental conditions maintained during various stages of bleaching.

Parameter	D_0 stage	E_P stage	D stage
Consistency (%)	10	10	10
Time (min.)	15	90	180
Temperature (°C)	90	85	70
pH	2-3	9.5-10	3-4

Bleached pulps were analysed for test parameters brightness and viscosity (method 19-20) as per test methods shown in Table - 10.

Table 10.Tests performed on bleached pulps.

Test No	Description	Method
19.	Brightness	ISO 2470
20.	Viscosity	SCAN C 15:65

Fig. 15 Feeding of fibre and cooking chemical solutions in bombs.

Fig. 16 Bombs being set into the series digester chamber for cooking.

Fig. 17 A bomb being taken out from digester chamber after the cooking is over (top) and immediately dipped in a water tank to stop the reaction (bottom).

Fig. 18 Washing of cooked pulp in progress

Fig. 19 Hydroextraction of cooked pulp

Fig. 20 Screened and air dried, unbleached kraft pulp

Fig. 21 Determination of kappa number using screened pulp

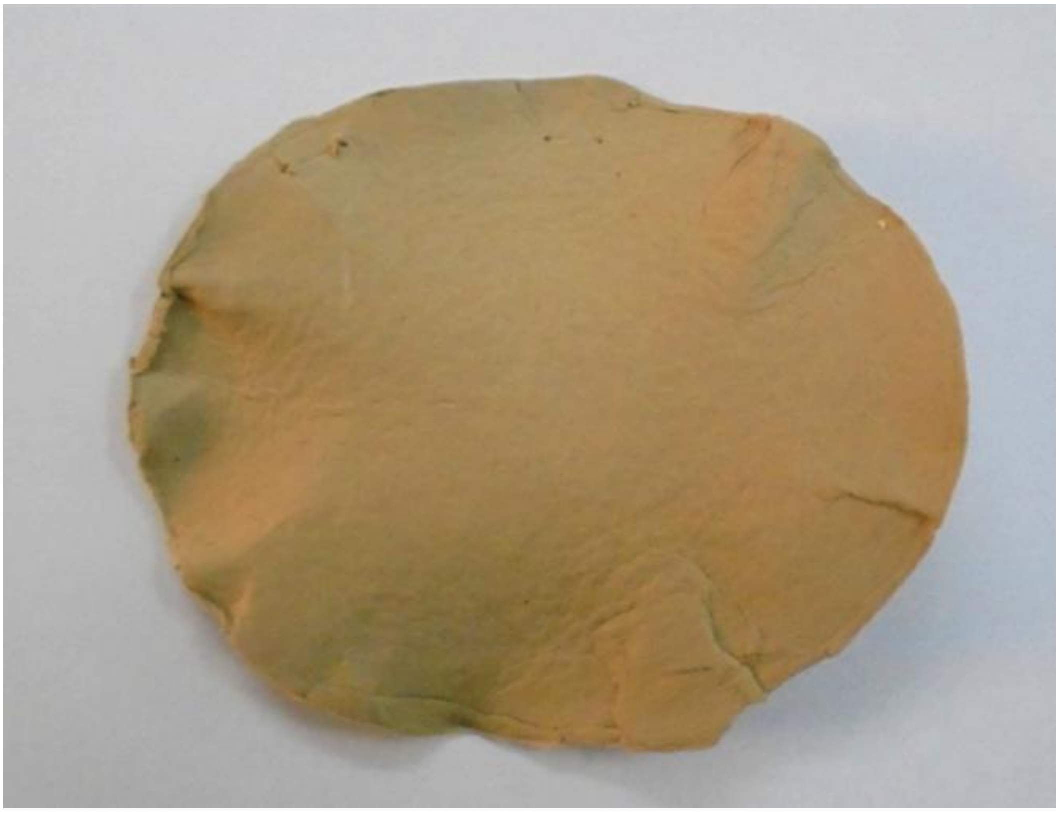


Fig. 22 **Pad prepared from unbleached pulp**

Fig. 23 **Pads prepared from bleached pulp**

Evaluation of pulps

The results of kraft pulping of FT-01, FT-02, FT-03 and FT-04 coir fibres samples at high alkali charge of 22% and sulphidity of 21% are shown in Table 11.

Table 11. Result of kraft pulping of coir fibres under identical conditions

Parameters	FT-01	FT-02	FT-03	FT-04
O.D Wt	50	50	50	50
Raw material to liquor ratio	1:6	1:6	1:6	1:6
Charge as Na_2O%	22	22	22	22
Sulfidity	21	21	21	21
Unscreened pulp yield	36.22	39.08	40.40	41.48
Rejects %	nil	Nil	Nil	Nil
Screened pulp yield	36.22	39.08	40.4	41.48
Pulp brightness	22.8	23.2	23.0	23.6
Pulp viscosity (cm^3/g)	-	-	300	-
Kappa number.	20.83	21.08	18.21	17.0
Black liquor Properties				
pH	12.02	12.34	12.47	12.25
Total Solids ,(% w/w)	10.96	9.76	9.69	9.72
RAA , gpl as Na_2O	7.98	7.65	8.37	8.10

Observa*tion:

- No rejects are obtained in any of the above experiments.
- At an active alkali concentration of 22% and under identical cooking conditions, maximum pulp yield is obtained in FT-04. Also, the kappa number is least in this case suggesting that cellulose is preserved most effectively in FT-04.
- The unbleached pulp brightness stands at ~23 in all cases.
- The kappa number significantly drops down for FT-03 indicating that some lignin had been removed during its preparative stage from raw fibre. This effect is more pronounced in the case of FT-04 in which case the kappa number stands at 17.0 compared to 21.8 for FT-01.
- Pulp viscosity is too low indicating extensive cellulose degradation.
- Screened pulp yield is maximum (47.9) at a chemical charge of 18%.
- Brightness of unbleached pulp remains practically unaffected.
- Kappa number is slightly higher for 18% active alkali charge (32.5) than bleachable pulp.
- Pulp viscosity requires further improvement

From the results of previous experiments it was decided to try cooking in two stages on FT-03. In the first stage the fibre (FT-03) was subjected to pre-hydrolysis with or without alkali at 110 °C for 1 hr. The concentration of alkali was maintained at 2% wherever alkali was used in the first stage and three such identical sets of experiments were conducted. In the second stage, the pre-hydrolyzed material was cooked with variable amounts of alkali; 20% active alkali for set 1 where no alkali was used in the pre-hydrolysis stage and 14-18% active alkali when 2% alkali was used in the pre-hydrolysis stage.

Table 12. Result of pre-hydrolysis of FT-30 with (2%) or without alkali.

Parameters	Set 1 (FT-03)	Set 2 (FT-03)	Set 3 (FT-03)	Set 4 (FT-03)
First stage: Pre-hydrolysis	**Without alkali**	**With alkali**	**With alkali**	**With alkali**
O.D Wt	50	50	50	50
Raw material to liquor ratio	1:6	1:6	1:6	1:6
Charge as NaOH%	**0.0**	**2.0**	**2.0**	**2.0**
Temperature °C	110	110	110	110
Time (min)	60	60	60	60
pH	8.25	9.50	9.86	10.0
Liquor Volume (ml)	200	235	235	235
Total Solids w/w	1.04	1.48	1.40	1.42
Second stage: Cooking				
Alkali Charge (as Na_2O%)	**20**	**14**	**16**	**18**
Sulfidity	20	20	20	20
Unscreened pulp yield	49.65	50.49	45.49	49.74
Rejects %	0.014	0.1	Nil	Nil
Screened pulp yield	49.63	45.39	45.49	49.74
Pulp brightness	-	23.2	23.8	-
Pulp viscosity (cm^3/g)	483	ND	533	496
Kappa number	36.39	38.90	27.80	23.99
Black liquor Properties				
pH	12.87	11.03	11.0	12.86
Total Solids, (%w/w)	11.81	9.42	8.53	8.10
RAA, gpl as Na_2O	6.76	3.72	4.58	4.03

Observations:

- Both screened and unscreened pulp yield was found to be nearly same (~50%) when no alkali was used in the first stage and 20% alkali in the cooking stage. However, kappa number was very high in this case indicating that the final product contained a substantial amount of residual lignin.
- Similar results were obtained in set no. 4 experiment where 2% alkali was used in the first stage and 18% active alkali in the second. In this case the kappa number was found to be lowest at 24.

Table 13. Laboratory Result of DEpD bleaching of FT-03 unbleached coir fibre pulp

Sl. No.	Parameters	Units	Results*	
			Set 1	Set 3
1	Kappa number of unbleached pulp		21.0	27.80
2	Pulp brightness	%,(ISO)	23.0	23.80
3	Pulp viscosity	cc/gm	300	533
	Ep stage			
4	NaOH dose	%	2.0	-
5	Peroxide added	%	2.0	-
6	Kappa number		9.88	-
7	Pulp brightness	%	38.43	-
	D_0 stage			
8	ClO_2 applied as available Cl_2	%	2.2	1.04
	Extraction stage E_P			
9	Alkali applied	%	2.0	2.0
10	Peroxide applied	%	1.0	1.0
11	Pulp brightness	(SO)	72.33	
	D_1 Stage			
12	ClO_2 applied as available Cl_2	%	0.52	0.39
13	Pulp brightness, ISO	%	87.0	79.30
14	Pulp viscosity, (cm^3/g)		145	398.21

Observation:

- A high degree of brightness (87%) was observed in the bleached pulp obtained from set 1 but the same also suffered from high cellulosic degradation as evident from the pulp viscosity.
- In order to preserve the pulp viscosity it was desirable to maintain a little higher kappa number.
- The kappa number of unbleached pulp using 18% cooking chemicals as Na_2O is ~ 28.
- The viscosity of above unbleached pulp was found to be 533 cc/g which dropped to ~ 400 cc/g after DEpD bleaching sequence.

Pilot plant Kraft Pulping and Bleaching trials of coir fibre

Objective: To prepare high alpha cellulose chemical pulp in the pilot scale using chemically pre-treated coir fibre FT-03.

Process: Kraft cooking process.

Process control:

After thorough scrutiny of the data obtained in the laboratory experiments, the cooking parameters were set as shown in Table-14. The fibres were loaded manually in the digester by opening its lid. Requisite amount of chemicals in solution were added and calculated volume of water was added to adjust the material to liquor ratio at 1:4. Active alkali concentration and sulphidity were maintained at 19% and 20%, respectively. The temperature programme was maintained as mentioned in Table 14.

Table 14.Cooking conditions for coir fibres in CPPRI pilot plant

Parameter	Value
Type of digester	Rotary
Capacity of digester (m^3)	11
Raw material taken (kg)	80
Moisture content in raw materials (%)	18.34
Cooking chemical applied (as Na_2O, %)	19
Sulphidity,%	20
Active alkali concentration in gpl	95
Bath Ratio (raw material to liquor ratio)	1 : 4
Cooking Temperature	165^oC
Cooking Schedule	
Ambient to 100 ^oC	30 min.
100 ^oC to 165 ^oC	90 min.
At 165 ^oC	90 min.

After the cooking was over, the outlet valve of the digester was connected to the blow tank and steam was released. Due to the internal steam pressure the pulp was forced into the blow tank. The digester was once again filled with steam and the steam release operation repeated once again. As the pulp settled at the bottom of the blow tank, it was diluted to a consistency of 8% and then transferred on to the double belt washer for further washing and extraction of the pulp in the form of continuous sheet. The sheets were crushed manually and taken to laboratory for further treatments in small batches.

The pulp obtained above was thoroughly washed to remove all residual chemicals. It was then disintegrated and subjected to screening by passing the pulp through 0.2 mm screen in a Summerville Vibrating apparatus at a water flow rate of 8.6 $\pm$ 0.2 litres per min. The screened pulp was hydroextracted to reduce the moisture level at ~60%. The product thus obtained was passed on for bleaching.

Evaluation of pulp:

Reasonable good yield of 43.2% for unscreened pulp was obtained. The screened pulp yield was found to be 39.8%. The kappa number was intentionally kept on higher side in order to keep down the cellulosic degradation. The viscosity could be improved (678 cm^3/g) as compared to those achieved in the laboratory experiments. The results are shown in Table 15.

Table 15. Result of kraft pulping of coir fibre in CPPRI pilot plant

Parameters	Kraft pulping
Unscreened yield, %	43.2
Rejects content, %	0.41
Screened pulp yield, %	39.8
Pulp kappa number	36.4
Pulp viscosity, cm^3/g	678
Pulp brightness, % (ISO)	23.7

Observations:

- Kraft pulping of coir fibers was carried out in CPPRI pilot plant using cooking chemical 19% (as Na_2O) to maintain sulphidity around 20 under optimized cooking conditions.
- The kappa number of unbleached pulp was a little high (36.4).
- The viscosity 678 cm^3/g and pulp brightness 23.7% (ISO) were satisfactory.

Fig. 24 Loading of digester with pre-treated coconut husk FT-03

Fig. 25 Digestion of FT-03 in Pilot Plant digester in progress

Fig. 26 Blow out operation of cooked pulp in Blow Tank.

Fig. 27 A view of the double belt washer employed for washing cooked pulp obtained from pilot plant experiment

Fig. 28 Pulp sheets being collected after primary washing in the double belt washer

Fig. 29 Disintegration of cooked pulp obtained from double belt washer

Bleaching of coir pulp

Objective: To achieve minimum pulp brightness of 80 (ISO) and maintain the pulp viscosity of at ~500 cm^3/g.

Process: ED_0EpD_1

Process control: Bleaching was carried out in 5 kg batches as per schedule elaborated in Table – 13 for laboratory trials. Each batch was divided into 5 lots weighing I kg each.

Evaluation of the product:

Bleached pulp (25 kg) was produced in the laboratory using ED_0EpD_1 to get final brightness of pulp 80 (ISO). Pulp viscosity was very close to the target value. The results are summarized in Table 16.

Table 16. Result of D_0EpD_1 bleaching of coir fibres

S. No.	Parameters	Units	Value
1	Unbleached kappa number		36.4
2	Pulp brightness	% (ISO)	23.7
3	Pulp viscosity	cc/gm	678
	D_0 stage		
4	Unbleached pulp taken	kg	25
5	ClO_2 applied as D	%	7.5
6	ClO_2 strength	gpl	65
7	Residual ClO2 applied as D	%	nil
	Pulp brightness, % (ISO)	%	48.9
	Pulp viscosity	cc/gm	601
8	Final pH		2.9
	Extraction stage Ep		
9	Pulp taken	kg	25
10	Alkali applied	%	2.5
11	Intitial pH		10.5-11.0
12	Hydrogen Peroxide applied	%	1.0
13	Hydrogen Peroxide strength	gpl	30
14	Pulp brightness, (I SO)	%	68.4
15	Pulp viscosity	cc/gm	512
16	Final pH		10.2
	D_1 Stage		
17	Pulp taken	kg	25
18	ClO_2 applied as available Cl_2	%	1.0
19	Residual ClO_2 applied as avl Cl_2	%	0.05
20	Pulp brightness	% (I SO)	80
21	Pulp viscosity	cc/gm	485

The characteristics of bleached pulp are summarized in Table-17.

Table 17. Bleached pulp characteristics of coir fibres produced at CPPRI pilot plant

Sl.No.	Parameters	Unit	Result
1	S_{10} Solubility of bleached pulp	%	12.1
2	S_{18}Solubility of bleached pulp	%	11.1
3	$S_{21.5}$ Solubility of bleached pulp	%	10.5
4	Alpha cellulose of bleached pulp	%	77.4
5	Ash content	%	1.29
6	Extractive content	%	0.24
7	Pentosan content	%	12.0
8	Bleached pulp viscosity	cc/gm	485
9	Pulp brightness	%(ISO)	80
10	Iron Fe	ppm	23
11	Ca as Cao	ppm	67

Observations:

- Bleached pulp characteristics i.e. pulp brightness and viscosity were 485 cm^3/g and 80.0 % (ISO) respectively.
- Bleached pulp has low alpha cellulose content i.e. 77.4% and high pentosan content i.e. 12.0 %. Nevertheless, regenerated cellulose could be produced in the laboratory using this pulp.
- Ash and extractive contents in bleached pulp are 1.29 & 0.24%, respectively.
- The value of calcium and Iron in bleached pulp sample i.e. 23 and 67 ppm respectively.

Fig. 30 Final washing of unbleached pulp by manual process

Fig. 31 Separation of rejects by passing through 0.2 mm screen.

Fig. 32 Washing of beached pulp in small batches after DEp stage

Fig. 33 Paper and paper board prepared from bleached coir pulp

Fig. 34 Dr. (Mrs) P. S. Lal of Central Pulp & Paper Research Institute with Director, Indian Institute of Carpet Technology, Prof. (Dr) K. K. Goswami (on her left) and Dr. N. N. Das, Project consultant (on her right).

1 (c) Laboratory experiments for conversion of pulp to regenerated cellulose

Circular paper board (300 gsm) was prepared from pulp obtained in the preceding section. A single board weighing 7 g was soaked in sodium hydroxide solution (24% w/w, at 1: 1.5 MLR) for overnight to obtain soda cellulose. The resultant material was aged in beaker for 48 hrs at 27 ± 5°C and RH of 65 ± 5%. The excess of alkali was removed by passing the sheet through a padding mangle under pressure. The pressed sheet was shredded into granules to which was added 50% carbon disulfide (o.w.m) and left at a controlled temperature of 30°C for 48 hrs. Cellulose xanthate thus prepared was dissolved in a weak caustic soda solution (2%, w/w) to produce a viscous solution. The solution was appropriately diluted and forced into sulfuric acid bath through a hypodermic syringe. The regenerated cellulose coagulated as granular mass in the process. The product was passed through a Nylon cloth, the residue washed with water and dried in granular form.

Regenerated cellulose could not be obtained in filament form due to lack proper infrastructure.

Fig. 35 Coir silk in granular form prepared in the laboratory of IICT

Conclusion:

- There is potential scope for producing regenerated cellulose from pulp prepared from coir. Production of regenerated cellulose is worth trying at pilot level in organizations where infrastructural facilities are available.
- Regeneration of cellulose from unbleached pulp may be attempted to produce special grade rayon suitable for making pile yarns for carpets.
- A pilot plant may be installed at CCRI (Alleppey) subject to availability of funds.

2. Development of Coir Vertical Blind

Objective: To develop an eco-friendly vertical blind using coir to replace those made from synthetic materials.

Introduction

Vertical blinds usually refer to window blinds, made of different materials and mechanical systems. Generally they are made from slats of fabric, wood, plastic or metal that adjusts by rotating from an open position to a closed position by allowing slats to overlap. There are also window blinds that use a single piece of material instead of slats. Some window blinds include mini blinds (Venetian blinds with very narrow slats, usually 1 in (25 mm) wide), micro blinds (usually 1/2 in (12 mm) wide), louvers, jalousies, brise soleil, Holland blinds, pleated blinds, Roman shades, and roller shades. Stationary vertical blinds are hung in the doorways of some homes and businesses which generally leave the door open. Roller blinds are usually stiffened polyester, mounted on a metal pole and operated with a side chain or spring mechanism.

This part of the work has not been covered by IPR and consequently application for patent may be made.

Raw Materials: The base fabrics made with cotton yarns in the warp direction and coir yarns in the weft direction were provided by CCRI. The specifications of the yarns are as follows:

Warp yarn: 2-Ply cotton yarn of 11 Ne count

Weft yarn – 2 Ply coir yarn of 20 Ne count

Process: Treatment with stiffening agent PIDICRYL VTN

Process control:

Table 18. Composition of recipe used for stiffening coir fabric

Ingredient	Quantity
PIDICRYL VTN	500 g
Water	250 mL
Liquor ammonia	25 mL
CMC Solution (1%)	250 mL

The mixture was applied manually on the fabric surface with the help of a brush to obtain a uniform coating. The coated fabric was sun dried till completion. The dried fabric was subjected to Decatization in a …… steam Decatizing machine. The total add-on was calculated from the difference in weight of before and after application of the stiffening agent..

Evaluation of the products:

The experimentation with respect to vertical blind is encouraging which has been appreciated by CCRI and Coir Board. The type of blind belongs to stationary type vertical blind using coir-cotton blended fabric as the base material. Cotton yarns were used in the warp direction and coir yarns in the weft direction. Blind was coated with synthetic stiffening agent to impart stiffness. Further, the treated fabric was decatized to achieve desired finish in terms of feel and drape (see Fig.-37). Some attractive designs have been suggested which may be developed for vertical blinds using coir fabric (Annexure V)

Table 19. Properties of vertical blind at different stages of development.

Parameters	Control sample inished	Coir Based Sample				
		Grey Sample	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Warp yarn						
Count (Ne)	2/11	2/20				2/20
Composition						
Weft yarn						
Count (Ne)	2/11	2/1.2				Grey coir – 2/0.9 Bleached yarn – 2/1.5
Composition	Polyester spun	Grey coir				
EPI	10.5x4 = 42	25				25
PPI	14x4 = 56	10				10
Mass (g/m^2)	430	490	-	-		
Weight of fabric before treatment (g)					456	481
Weight of fabric after treatment (g)					570	610
Add on					~25%	
Stiffness Bending Length						
Warp way (cm)	7.5	1.8	1.8	1.9	4.2	4.8
Weft way (cm)	8.0	>10	9.5-10	>10	>10	>10

Note: Treatment 1 – Ironed sample A; Treatment 2 – Decatized sample A; Treatment 3 – Decatized sample I after treatment with stiffening agent; Treatment 4 – Decatized sample II after treatment with stiffening agent.

Vertical blind and its performance

Vertical Blind (VB) in the form of several strips where each strip (~4 inches) hangs from the pelmet of the window across its width to decorate the home of the window. The figure below depicts the actual decoration of a window using VB as a home textile.

Fig. 36 Usage conventional of VB

There is no standard data available for adjudging its performance. However it has been observed that existing VBs in the market are in general woven synthetic fabrics with or without colour and or weave effect. The feel and

apparent analysis reveals that grey fabrics have been treated to achieve the desired stiffness. It also appears that polymeric materials/ resin/ adhesive(s) are sprayed or coated over the said fabric, dried and cured. Most of the products prevalent in the market are reported to be imported. Recent report however also reveal about indigenization. The inherent stiffness in coir yarn was considered to be potential for converting a fabric using coir yarn in the weft to be used as VB. The present research work has been in that direction.
Thus there was a necessity to assess the performance of the fabric/ treatment for which measurement of stiffness or limpness was resorted to.

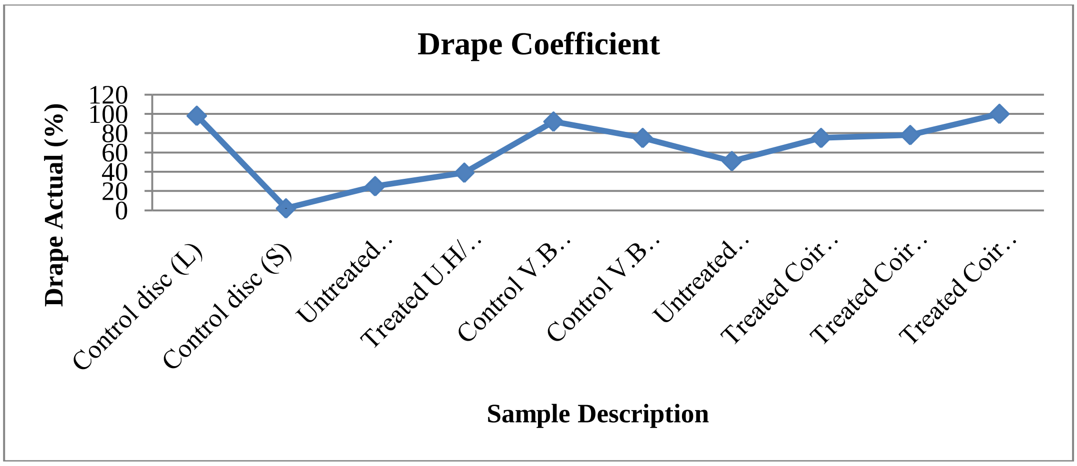
The table below gives the data in terms of drape coefficient for control, as well various samples including untreated and treated coir based vertical blend developed for the purpose. The figure below also depicts the performance for each sample through graphics for better and clear understanding. It can be clearly seen that coir VB in the untreated stage itself adds 26 units of drape coefficient which went up to 75 to make it 100. Thus the concept of exploring the potential of coir in terms of stiffness which was otherwise a weakness could be materialized.

The soiling behaviour an important parameter for VB needs also to be assessed and appropriate pre treatment as necessary should be incorporated. The presently developed coir VB is potential as room separator also by which a big hall can be converted to many rooms suitable for holding parallel panel discussion in any conference.

Table 20. Experimental data on Drape Coefficient

Sr. No.	Sample Description	Drape Coefficient		Cumulative effect	Remarks
		Actual	Calculated Ideal		
1	Control disc (L)	98	100		No limp/Total stiff situation
2	Control disc (S)	2	0		Total limp No stiff situation
3	Untreated U.H/Curtain	25			Substitute to VB
4	Treated U.H/ Curtain	39		14	Substitute to VB
5	Control V.B (Imported)	92		67	Synthetic treated VB
6	Control V.B (Indigenous)	75		50	Synthetic treated VB
7	Untreated Coir V.B	51		26	Eco coir VB
8	Treated Coir V.B1	75		50	Eco coir VB1
9	Treated Coir V.B2	78		53	Eco coir VB with Silk
10	Treated Coir V.B3	100		75	Treated Eco coir VB

*Note: There is a scope to optimize the recipe/ formulation keeping drape coefficient nearing value for Control VB



Drape behavior of Coir VB vis a vis Control data

Fig. 37 Decatizing machine

Fig. 38 Decatization of fabric in progress

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Fig. 39 Vertical blinds developed by IICT

3 Carpet backing using coir based scrim fabric.

Introduction

Carpets are manufactured with different constructions, such as loop, cut or combinations of the two. Carpets are commercially manufactured by tufting or weaving.

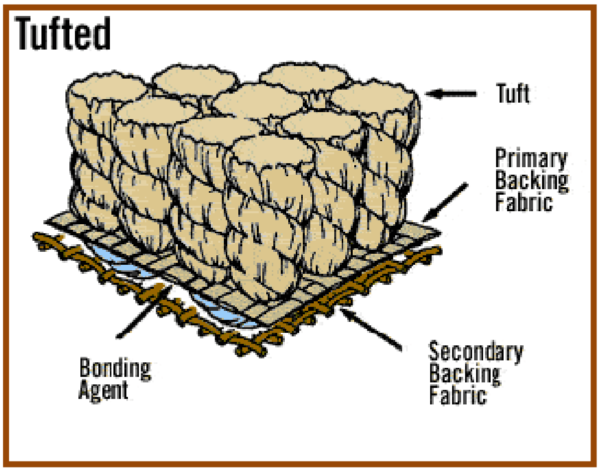
Tufting is the process of creating carpets on specialized multi-needle sewing machines. Several hundred needles stitch hundreds of rows of pile yarn tufts on primary backing. The needles push yarn through a primary backing fabric, where a loop holds the yarn in place to form a tuft as the needle is removed. The yarn is caught by loopers and held in place for loop-pile carpet or cut by blades for cut-pile carpet. The pile yarns are held in place by pasting a secondary backing on the back side.

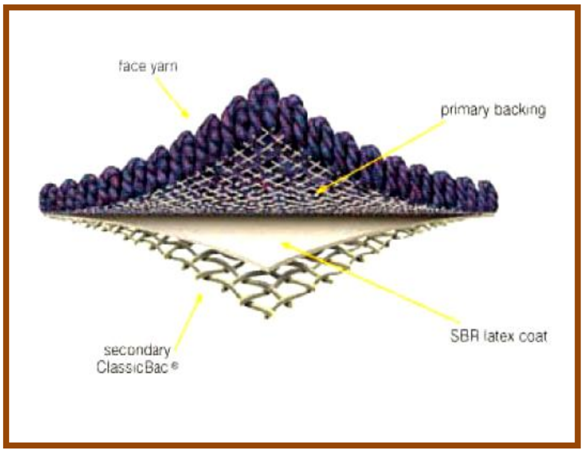
Woven carpet is created on looms by simultaneously interlacing face yarns and backing yarns into a complete product, thereby eliminating the need for a secondary backing. A small amount of latex-back coating is usually applied for bulk.

Carpet Backing

The carpet backing Plays an important role in providing shape, structural stability, and protection to the carpet it backs. There are a number of different styles of carpet backing, and it can be made from an assortment of materials, ranging from natural fibers to polyurethane.

Carpet fibers are sewn into a primary backing, and then a secondary backing is fused to the fibers and primary backing with latex. This helps provide a structurally sound carpet that usually stands up to many years of use. Natural fibre backings often use cotton/jute fibres, while synthetic backings usually are made from polypropylene or polyurethane.





Cotton is the most common type of natural fibre used in primary and secondary carpet backings. Many prefer jute because it is a natural material and is very strong and durable, creating a superior carpet backing. Polyurethane has become increasingly popular as a carpet backing material but this material might not serve as the most environmentally friendly choice. An ideal backing would be inexpensive for a manufacturer to produce as well as durable and cost-efficient for the consumer. Coir satisfies both attributes and hence it is worth trying for its application as a secondary backing material.

There are two main components to carpet backing, which can vary from carpet to carpet. The first is primary backing, which forms a structural element of the carpet. It is the coarse material through which the fibers of the carpet are woven or tufted. Secondary backing is not structural, but it provides support to the overall carpet, and it may help to insulate the carpet from moisture, bacteria, and mold which could seep up from the floor below; it tends to be less coarse, since it is not a substrate for tufted material.

All carpets have some type of backing system or chemistry that helps keep the tufts in place. Backing systems are made from a variety of materials and may also come with various kinds of protective treatments (such as anti-microbial or anti-stain) or beneficial properties (such as anti-static). The manufacturers' end use recommendations help determine which product will meet the established performance expectations.

Rationale for using coir scrim as backing

The use of synthetic scrim of around 100 gsm as action backing is in vogue. To promote eco-friendlyness it was considered prudent to explore use of coir scrim as backing.

Experimental

Preparation of latex paste: The latex paste was prepared according to the recipe shown in Table …

Procedure:

Chalk powder was mixed in 30 litres of water then sulphur was slowly added while slowly stirring the mix (A).

Sodium silicate (1kg) was mixed with 800 gms of carboxy methyl cellulose (CMC) in 24 litres of water (B).

A & B mixed well with stirring and applied @ 40 sq. yds of carpet.

Table 21. Composition of the latex paste

Recipe		
	Qty	Unit
Water	30	Litre
Chalk Powder	50	Kg
Sulphur	0.750	Kg
Silicate	1.0	Kg
CMC	0.800	Kg
Natural rubber latex	15.0	Litre

Observations by manufacturer:

- The flexibility of the yarns in the current form is not suitable for hand tufted carpets. The flexibility needs to be further improved.
- Scrim fabric made from finer and lighter count of yarns may give better results

Fig. 40 Synthetic action backing fabric (warp polyester and weft polypropylene interlaced by lino technique)

Fig. 41 Coir scrim fabric made from 2- ply coir-sisal blended yarn (80:20%)

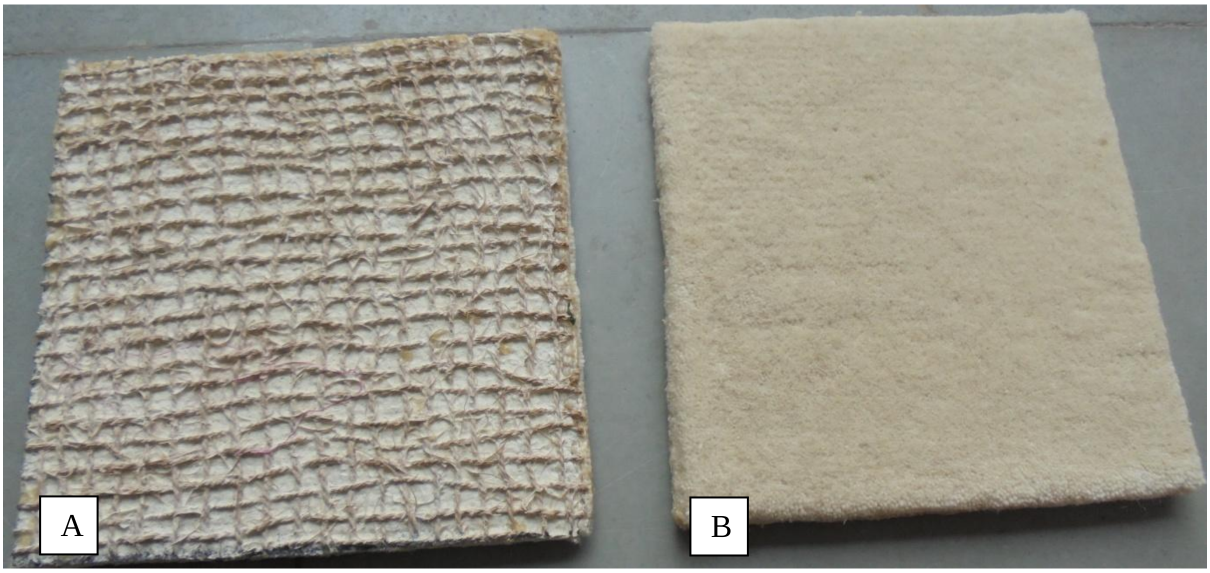


Fig. 42 Carpet backing produced with low density coir scrim fabric; (A) Back side and (B) front side of woolen carpet

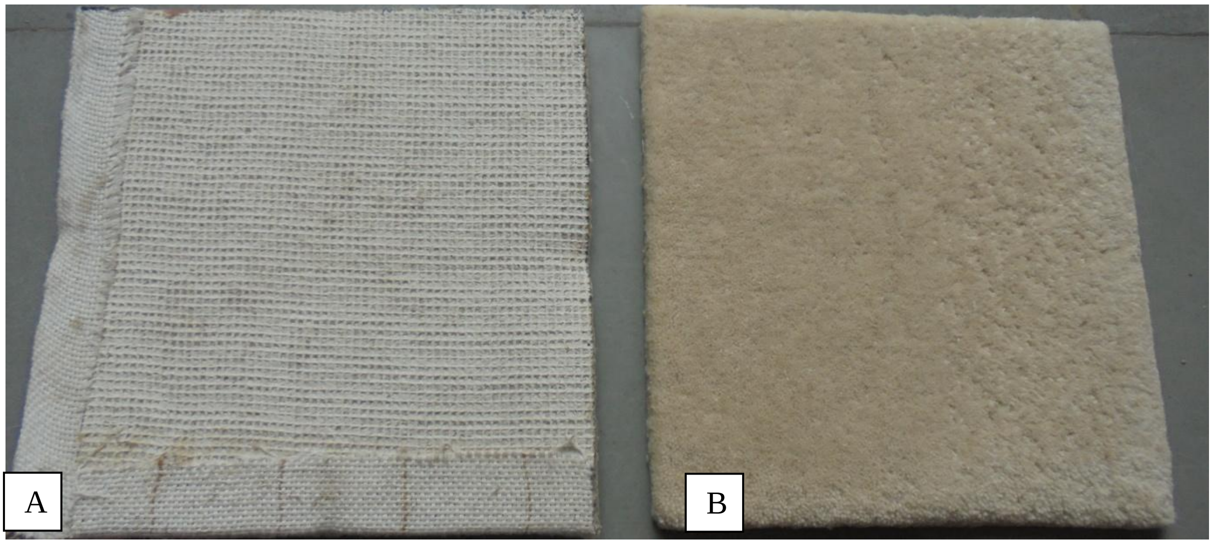


Fig. 43 Carpet backing produced with synthetic scrim fabric; (A) Back side and (B) front side of woolen carpet

Fig. 44 Carpet backing produced with high density coir scrim fabric; (A) Back side and (B) front side of woolen carpet

Fig. 45 Carpet backing produced with high density coir scrim fabric; (A) Back side and (B) front side of woolen carpet

Observations by manufacturer:

The following observations were reported by carpet manufacturer regarding coir scrim fabric (vide Annexure VI)

- The flexibility of the yarns in the current form is not suitable for hand tufted carpets. The flexibility needs to be further improved.
- Scrim fabric made from finer and lighter count of yarns may give better results.

Remedial measure identified by IICT:

- CCRI to supply or arrange finest possible yarn to match closest possible to pore size.
- The flexibility of the yarn and/ or fabric may be improved by mechanical and/or chemical finish through a separate research work.

The following processes were developed under the project:

1. (a) Pre-treatment process for complete removal of pith from coir husks (b) Production of pulp for making paper from pre-treated coir in pilot plant. (c) Preparation of regeneration of cellulose from coir pulp in the laboratory.
2. Development of vertical blind from coir based fabric.
3. Carpet backing using coir based scrim fabric.

The knowledge on above processes was disseminated through exhibitions held at Varanasi and New Delhi.

Fig. 46 Exhibits are displayed and explained in an exhibition held at Varanasi

5. Conclusions

1. Development of pre-treatment process for complete removal of pith.

   i. Method for complete removal of pith from coir fibre has been developed. This is an important achievement since presence of even small quantity of pith is detrimental for production of high alpha-cellulose pulp for preparation of regenerated cellulose.

   ii. Development of pulp and paper from pre-treated coir.

   The experimental conditions for preparation of pulp from coir with acceptable viscosity and brightness properties have been optimized in the laboratory scale. The pulp may be utilized for production of regenerated cellulose. Pilot plant experiments were successfully carried out using 80 kg of processed husks to produce Kraft pulp. High brightness for production of regenerated cellulose could be attained for bleached pulp through bleaching of unbleached pulp by 3-stage process.

   iii. Preliminary laboratory level study could be conducted to explore regeneration of cellulose from coir. Pilot scale study need to be carried out – minimum requirement @ 20 kgs of sheet of 10 inch x 15 inch size for each trial has been identified. Informal tie up with Indian and international R&D unit has been made. Coir board /CCRI may like to grant the second phase of the proposal submitted herewith to enable give a shape to coir silk development.

2. Development of vertical blind from coir based fabric.

   i. Vertical blind made from coir fabric offered by CCRI has been developed successfully. A technique to measure the performance could be devised. Performance data reveals potentiality of utilization of coir in fabric to be used as VB. The development of VB without treatment is found to be possible.

   ii. Marketing effort to follow where colour and weave effect may be integrated to diversify its usage and satisfy wide range of customers. Treatment to improve soil /stain resistance may be incorporated as per need.

   iii. The product can well be utilized as ‘Q’ master e.g. in Airport ‘Q’ system synthetic (see the demonstration during presentation) can be replaced. In addition the presently developed coir VB potential as room separator where in a big hall can be converted to many rooms suitable for holding parallel panel discussion in any conference can be explored.

3. Development of carpet backing using coir based scrim fabric

   i. Attempts to develop coir scrim fabric as secondary backing was met with limited success.

   ii. Fine yarn is required to expand the success.

   iii. Non woven also can be tried both as action backing and normal carpet backing.

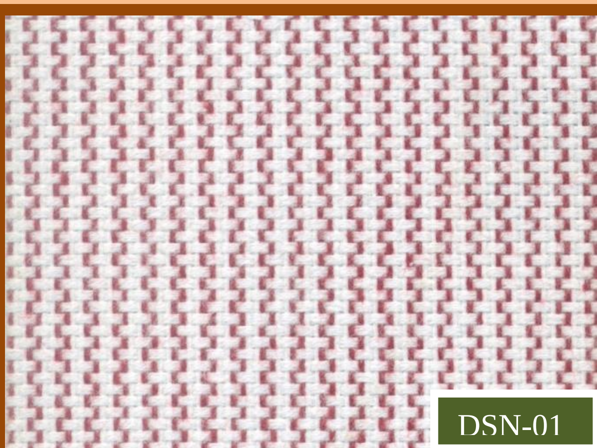
iv. Treatment to improve rigidity in yarn and or fabric should be tried to expand the success.

4. Dissemination on completion of the project.

The knowledge on developed technologies were disseminated by demonstrations in exhibitions held at Varanasi and New Delhi. Moreover these developments have been show cased to visitors at various places wherever possible including at IICT.

ANNEXURE V

Suggested designs for vertical blinds that may be developed using coir fabric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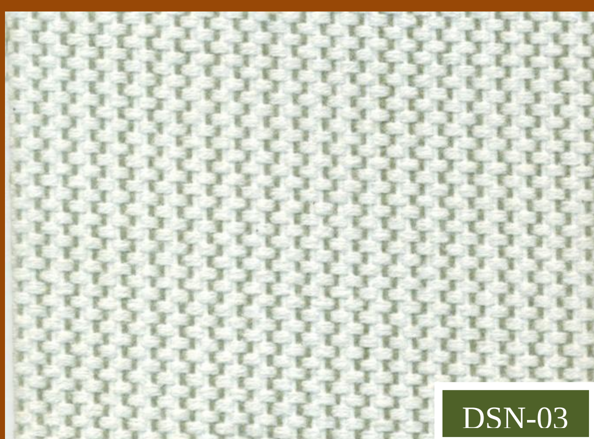
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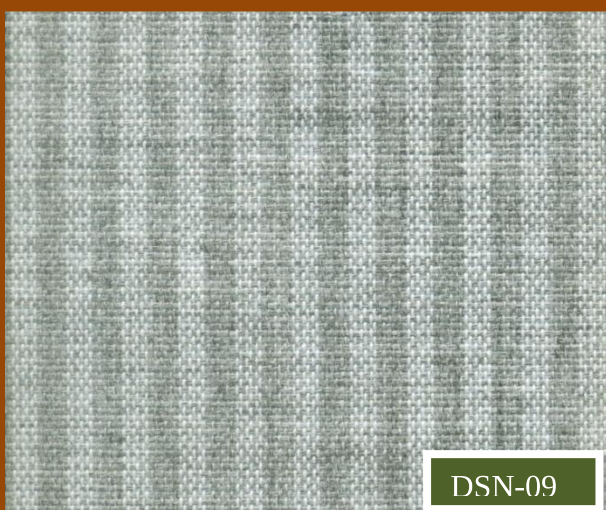
DSN-05


DSN-06


DSN-07


DSN-08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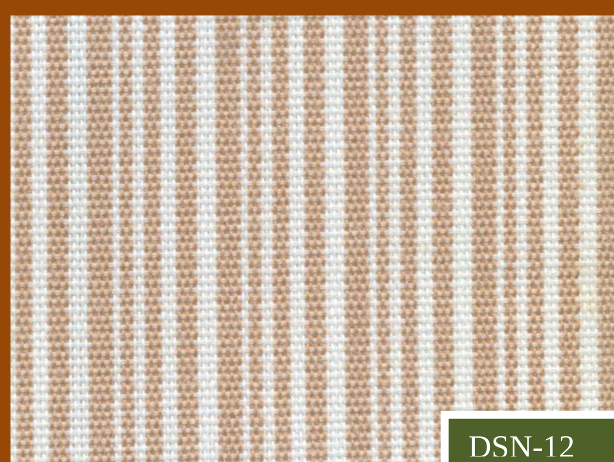
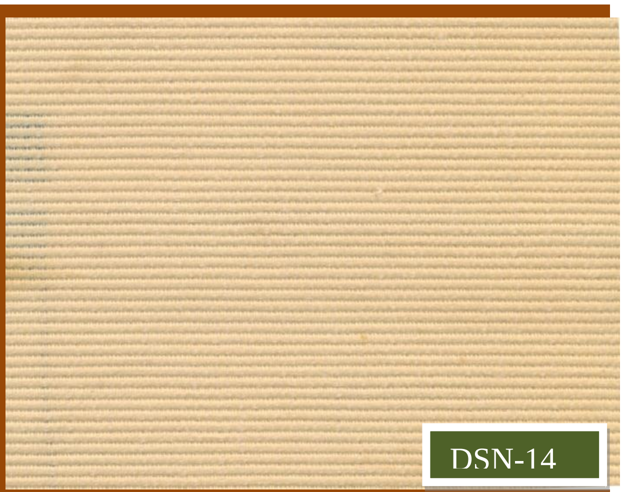
DSN-10


DSN-11


DSN-12

DSN-13



DSN-14

DSN-15

DSN-16

DSN-17

DSN-18

Annexure VI

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Manufacturers & Exporters of
INDIAN HANDMADE WOOLLEN CARPETS & DRUGGETS

VILLAGE : SARAIYYA
POST : BHADOHI-221401
DISTT. BHADOHI
U.P. (INDIA)

Ref. No.

Date 1st November 2015

DAK-No. 4435
DATE 3/12/15
DMC, IICT BHADOHI

To,
The Director,
IICT,
Bhadohi

DJ
2/12/15

Sub:- Trial of coir screen fabric

Dear Sir,

We compared the given sample by you and our standard used screen. Samples for both are being handed over to you.

Our observation says that if the coir fabric is made using thinner material and ligher material, it can be tried again.

The current flexibility is not suitable for hand tufted carpets. This needs to be further improved.

The weight should be very light to save on freight and handling cost.

Thanks & best regards.

(PRANAY PATODIA)