FINAL REPORT FOR THE RESEARCH PROJECT ON COIR FIBRE.

Project title: Bio-softening and bio-bleaching / brightening of coir fibre with a view to diversified end-uses of the fibre.

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EXECUTIVE SUMMARY

A Biotechnological project on coir fiber for the softening and brightening of the fibers were undertaken by Professor Manju Ray of the Department of the Biological Chemistry, Indian Association For The Cultivation Of Science, Kolkata as a joint collaborative project with Central Coir Research Institute, Kalavoor, Kerala , in order to find its diversified end-uses by the industry.

Initially some time was spent to find out the appropriate microorganisms that can elicit enzyme to degrade lignin and xylan so as to soften and brighten coir fiber. Two of these species were especially found to be useful. Elaborate work on them were carried out on the optimal (a) condition of growth, (b) liberation of enzyme(c) maintenance of enzyme activity,(d) condition of application on coir fiber etc, and result will discussed.

For the benefit of the industry elaborate studies were undertaken to (a) simplify the mode of operation, (b) reduce the time of operation,(c) reduce the requirement of water and (d) increase the shelf-life of the enzyme kit.

Finally the processes has been demonstrated at

(a) Dhancheberia (West Bengal).
(b) Teisipur, Puri (Orissa) and
(c) CCRI, Kalavoor (Kerala).

Once demonstrated and shown, any worker in the industry would be able to carry out the process.

Industry is expected to get the benefit by using this eco-friendly process of softening and brightening coir fiber .The effluents from the tanks will not do any harm to the soil, rather they will help in growth of the plantation.

GENERAL BACKGROUND:

Coir fibre extracted from the husk of coconut after long period of retting is basically lignocellulosic fibre. They are golden to dark brown in colour depending upon colour. These lignocellulosic fibres are formed by encrustation of cellulose chains of lignin, which impart strength to the fibre. But the disadvantage is that the lignin component makes the fibre stiff. The higher the lignin content stiffer is the fibre. Because of the presence of higher degree of lignin specially on the surface the coir looks dull and dark.

Therefore softening and brightening or bleaching seems to be very important for making diversified end products from fibre. Chemical methods employed for softening and bleaching using compounds (like alkali, chlorine etc.), which are not environmental friendly.

Since, cellulose chains are entangled with hemicellulosic chains and lignin, attempts should be made to remove these two components partially.

Delignification can be done by fungal treatment. Many species of white rot fungi can selectively degrade lignin from wood without extensive loss of cellulose. On the other hand, soft and brown rot fungi can degrade cellulose and hemicellulose in preference to lignin. Eriksson and Goodell have isolate cellulase- less mutants of the white rot fungi *Sporotrichum pulverulentum,* which will partially delignify wood without affecting cellulose component. The source of these enzymes should be such that the process becomes economically viable for the coir industry.

OBJECTIVES:

Short-term

1. Soft coir fibres produced will result in softer and finer yarns and will not hurt the fingers of women spinners.
2. Brighter fibres and yarns will produce diversified fancy products. (at present only mats, floor coverings, and some room decorating products geotextiles are produced).
3. The new bio process will be smoothly accepted by industry.

Long-term

1. Automatic spinning machines will be developed in coir sector.
2. Small scale industry will emerge into big industrial houses.

BACKGROUND FOR THE SUBSEQUENT PHASE OF THE PROJECT:

In the first phase biotechnological process of softening and bleaching / brightening was applied on coir fibre.

Dry fibre was used for the experiments. After a good survey ten numbers of microorganisms liberating lignolytic and xylanolytic activities, were identified. All of these microorganisms were employed for the process. Among them *Pleurotus sajor-caju* and *Aspergillus niger* ware selected for better result.

Xylan $\xrightarrow{\text{Xylanse}}$ Cleaved Xylan

Xylanase causes increased permeability and allows passage of lignin to come out of the fiber.

Lignin $\xrightarrow{\text{Ligninase}}$ Degraded products of Lignin

Ligninase, can degrade lignin into its sub-products.

Enzymes used-

1. Ligninase- obtained from *Pleurotus sajor- caju*, grown in Molasses media
2. Xylanase- obtained from *Aspergillus niger*, grown in Potato Dextrose Broth media.

PREPARATION OF MEDIA

Molasses Broth medium

Molasses- containing 4% sucrose
Di-ammonium hydrogen phosphate- 0.8%
pH-5.6

40 g crude molasses and 8 g di-ammonium hydrogen phosphate were added to water, the volume was made up to 1 litres, so that medium contain 4% sucrose and 0.8% di-ammonium hydrogen phosphate at pH- 5.6.

Potato Dextrose Broth medium

Potato – 200 g
Dextrose - 20 g
pH - 5.6
Diced potatoes were added in 500 ml of water and boiled until thoroughly cooked, filtered though cheese cloth .Glucose was added to the filtrate; volume was adjusted to 1.0 lit with water.
50 ml aliquots of this medium were transferred to 500 ml conical flasks and autoclaved for 15 mins. at 15 lbs pressure.

The contents of each flask were inoculated with equal quantity of the organism ***Pleurotus sajor- caju*** (in molasses medium) and ***Aspergillus niger*** (in potato dextrose broth) and incubated in room temperature (30°C) for 7 days and 2 days respectively. Each flask produced about 10 g of fungal biomass, which were collected, washed with water and pooled.

CRUDE ENZYME PREPARATION

Microorganisms for Ligninase and Xylanase grown in respective media

Pleurotus sajor- caju ***Aspergillus niger***

Sieve and biomass collected Sieve biomass and liquor collected

Biomass homogenized in mixer grinder with sodium citrate buffer pH-6

Added toluene (0.2%) and kept the overnight in shaking condition to disintegrate the cell walls

Crude Ligninase homogenised paste + liquor

Crude Xylanase

Crude enzyme kit ready for use

TREATMENT OF DRY HUSK

5 kg fibre treatment (with crude enzyme kit):

Common salt (0.3%) dissolved in 65 litres water + 150g deseeded tamarind squashed in water for bringing the pH to 4.8 + Crude enzyme mixture (containing ligninase and xylanase in 1:1 ratio) added.

↓

Fibers soaked in the above mixture and, kept overnight

↓

Fibre washed with water and dried

↓

Soft and bleached coir

↓

TABLE – I

Softening Effect of Coir Fibre on treatment with crude enzyme kit

Sample	Flexural Rigidity (Gf, gcm^2)	Rigidity (%)	Improvement in Softness Reduction of Flexural Rigidity %
Dry Husk			
Control	1.162	100	0
Treated	0.462	35	65

TABLE –II

Improvement of Colour of Coir Fibre on Treatment with crude enzyme kit

Sample	Colour (based on whiteness) (white means100%)	Improvement (%)
Dry Husk		
Control	27.33	
Treated	56.41	~ 64

TABLE –III

Effect on Tenacity and Extension at break of coir fiber after Treatment with crude enzyme kit

Sample	Tenacity (gm/tex)	Extension at break %
Dry Husk		
Control	14.84	25.72
Treated	14.84	28.35

The results as shown in the following tables are highly encouraging Softness increased (hardness i.e. Flexural rigidity reduced) by more than 60%. The color improved by 27% to 56% from control. The tenacity and extension at break of the fiber remain same.

The fiber strength or elongation at break was not affected significantly.

The entire operation from decorticated fibre stage to the soft and bright fibre stage requires only eight to ten days to be completed.

It does not require the hazardous process of retting for long periods in Kerala backwaters and subsequent manual unhygienic cleaning of the fibres.

Consequently the biotechnological process is pollution free .Repeated experiments shown consistent results.

RESULTS

In the second phase of the project, efforts were made to improve the results further and see that process be implemented to industry. As a result it has been possible to

(1) Scale up the process from laboratory to pilot plant scale.

(2) To minimize the use of water, liquor from one tank could be reused to another tank with same or better result.

(3) There is indication that the final effluent was beneficial for plant growth.

(4) For the benefit of the industry an enzyme kit has been prepared.

(5) Shelf life of the kit (as of today) is three months.

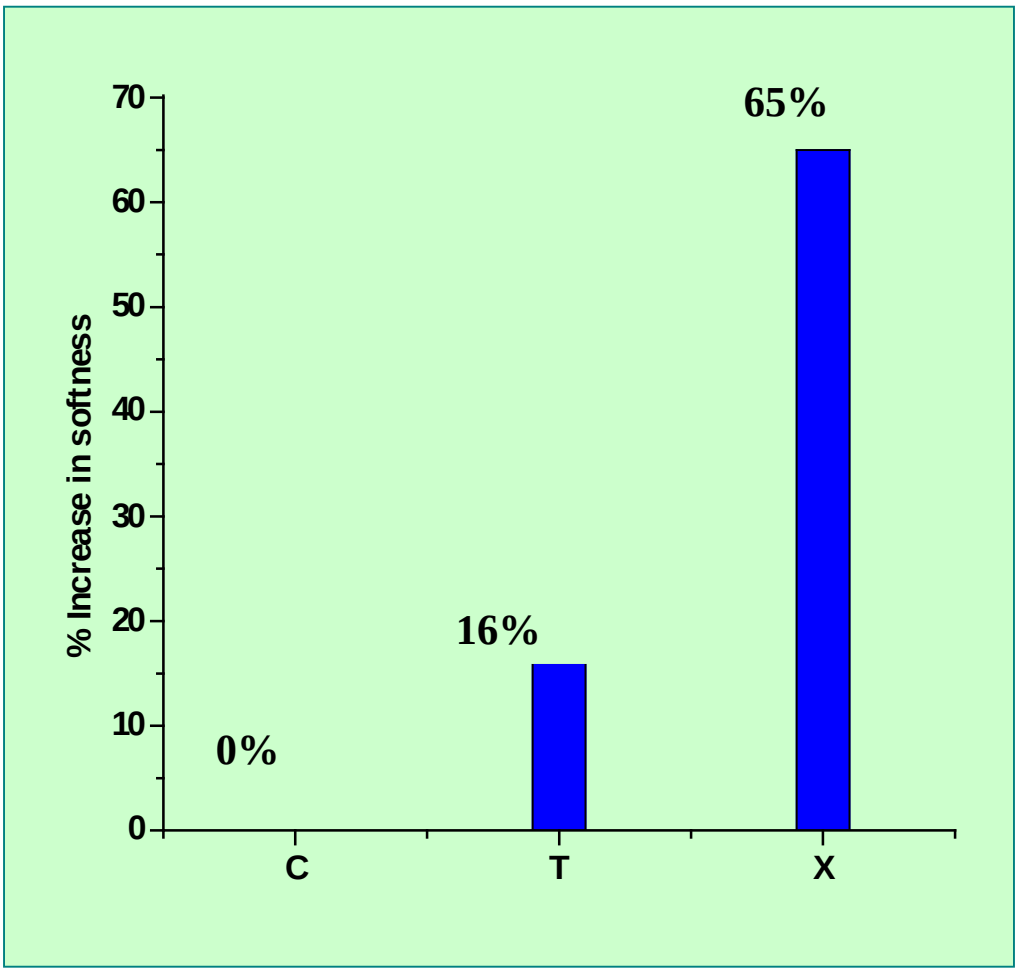
The results are shown is following figures .While achieving such useful results,it was found that there is still scope for further improvement, viz;

(1) Whether it is possible to reduce the total time of the Biotechnological process.

(2) Whether it is possible to make thermally stable kit at a wider range of temperature and with longer life.

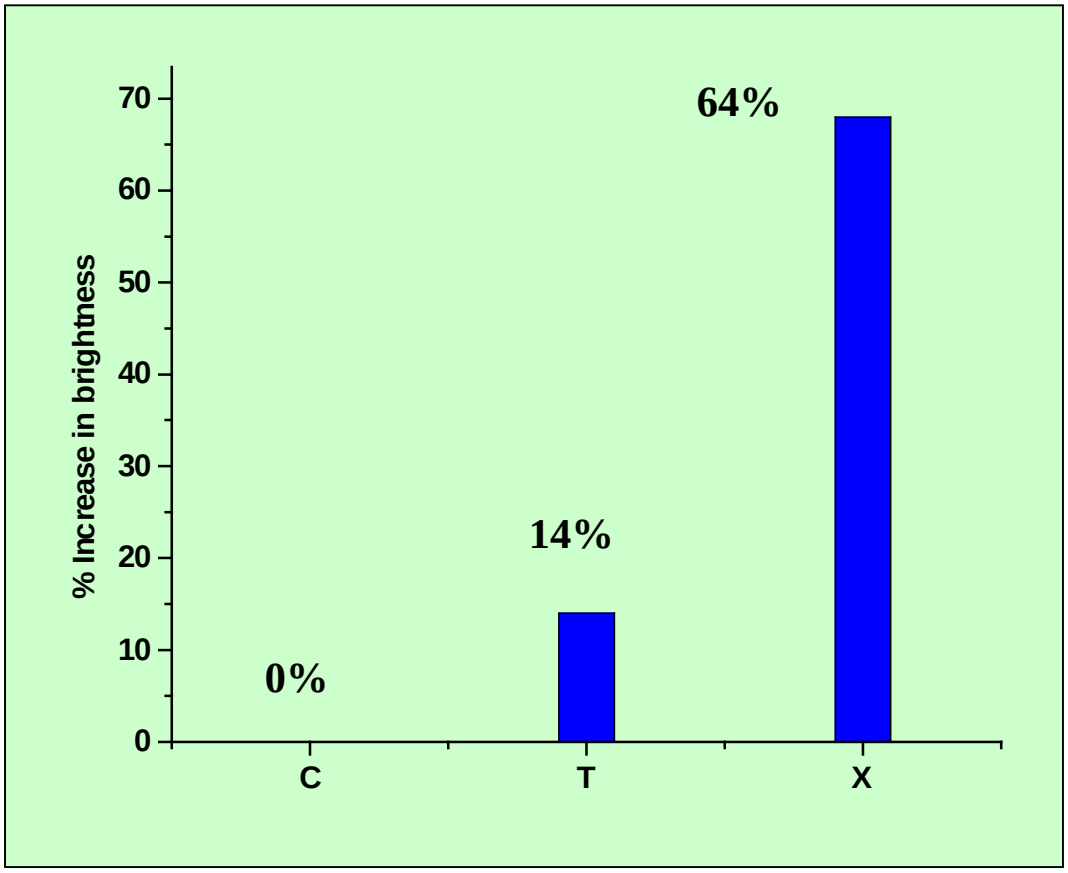
(3) Whether it is possible to confirm that the final effluent is beneficial for plant growth.

IMPROVEMENT IN SOFTNESS OF DRY HUSK



C - Untreated
T - Tamarind Treated
X - Ligninase + Xylanase Treated

IMPROVEMENT IN BRIGHTNESS OF DRY HUSK



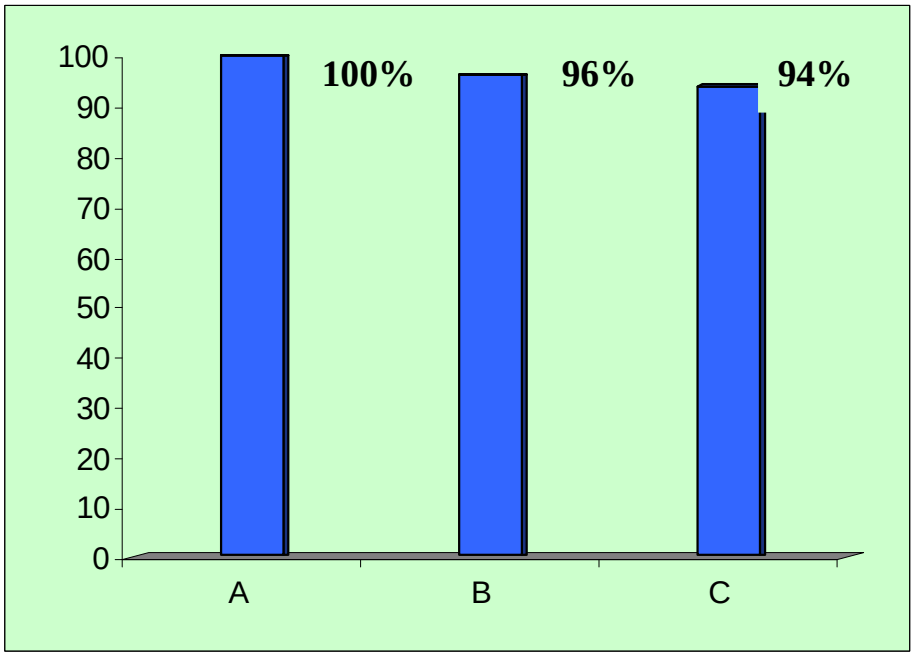
C - Untreated
T - Tamarind Treated
X – Ligninase + Xylanase Treated

DRY HUSK TREATMENT

Tamarind Treated **Enzyme Treated** **Untreated**

Enzyme Treated **Untreated**

STABILITY OF ENZYME KIT



Stability determined by-

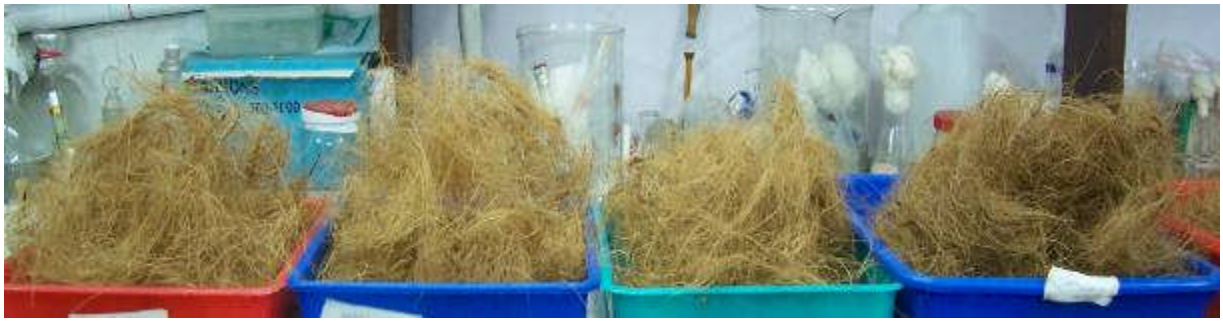
1) Enzyme assay

2) By determining the brightness of coir fibre

(Day 1 taken as 100%)

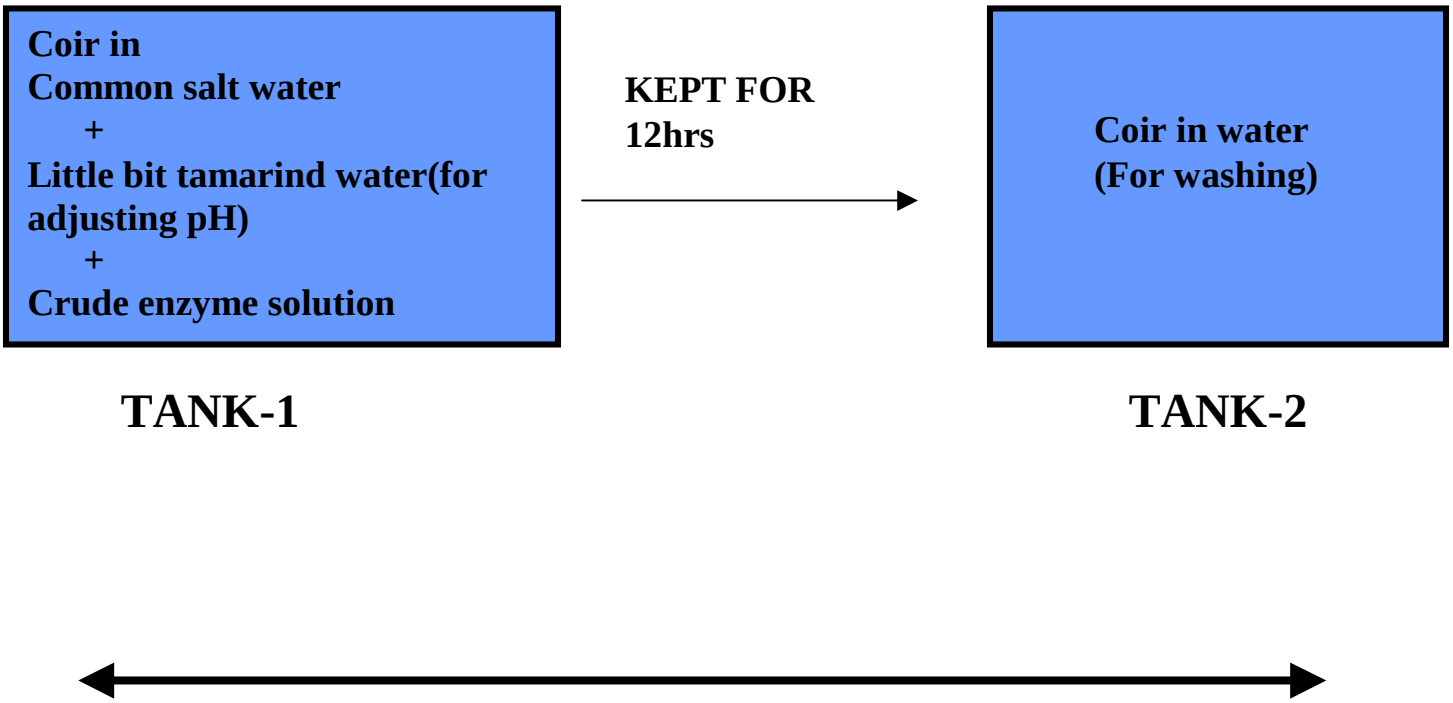
A = 0 day
B = 1 month
C = 6 months

STABILITY OF ENZYME KIT



Treatment (After 6 months) | **Treatment (After 1 month)** | **Treatment (1st day)** | **Untreated**

REUSE OF WATER



THREE TIMES REUSE

BENEFICIAL EFFECT OF DISPOSABLE LIQUOR ON PLANT GROWTH

CONTROL

TREATED (Disposable liquor poured into the soil)

(Height in cms indicated in the scale)

Experiments conducted on general plants available at I.QA.C.S.
Adverse effects were not found in any of the plants that were tried.

DEMONSTRATION CUM WORKSHOPS AT DHANCHABERIA (WB), TEISIPUR, PURI (ORISSA) AND KALAVOOR (KERALA):

The final phase of the project on Bio-softening and bio-bleaching / brightening of coir fibre under Professor Manju Ray, Dean, Indian Association for the Cultivation of Science, Kolkata was intended to disseminate the knowledge of the process of bio-softening and bio-bleaching/brightening of coir fibre to industry.

After an initial communication gap between the project group and the coir board for quite sometime (there was an unfortunate “No response” from the coir board side, even though it is a collaborative project between IACS, Kolkata and CCRI, Alleppey).

The project group initiated contacts with a coir fibre-training centre at Dhancheberia involving officials of the Government of West Bengal on fixed dates. The project group carried out a demonstration programme with the trainees and other local entrepreneurs in presence of West Bengal Government officials. This has been reported in the first six monthly report. The Project leader Prof. Manju Ray then requested coir board to arrange a demonstration programme at Bhubaneswar. But once again there was no response. So the project leader directly contacted the coir board-training

centre at Bhubaneswar. There were good communications with this centre, who in turn sent messages to the coir board and finally agreed to arrange for a demonstration cum workshop at a venue, viz., State Coir Training and Design Centre at Teisipur, Puri since they have a bigger space on 10, 11 and 12th May, 2009.

They made good arrangement for the workshop, but the entire cost had to be bourn by the project.

In the workshop, discussions on how the enzyme is prepared, and how it is applied on coir fibre to get soft and bleached /bright fibres in a simple fashion, were held with those who were present. There were infact a big gathering (please find the list of those present in the Annexure).

RESULTS:

Visually and on touch it was found that the treated fibers were much brighter and softer than the untreated ones. The local entrepreneurs also made ropes out of the treated and untreated fibers and that there is big difference in appearance.

However, for quantitative estimation the samples were left with the training centre who agreed to send them to CCRI, for test. After examining the reports the actual position will be understood.

DEMONSTRATION AT DHANCHEBERIA (WB)

Worker group of Dhancheberia

Treatment of Fibre at Dhancheberia

Control Liquor **Tamarind Treated Liquor** **Enzyme Treated Liquor**

Enzyme Treated Fibre **Untreated Fibre**

DEMONSTRATION AT TEISIPUR, PURI (ORISSA)

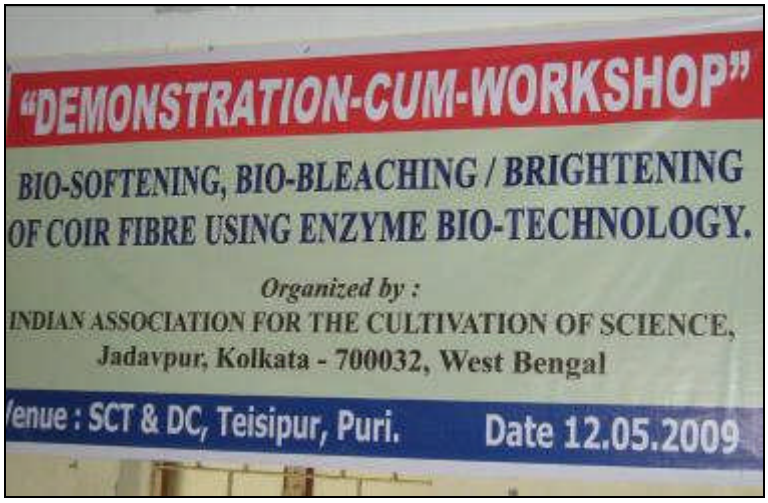


Fig.1 Untreated Fibre.

Fig.2 Enzyme Treated Fibre.

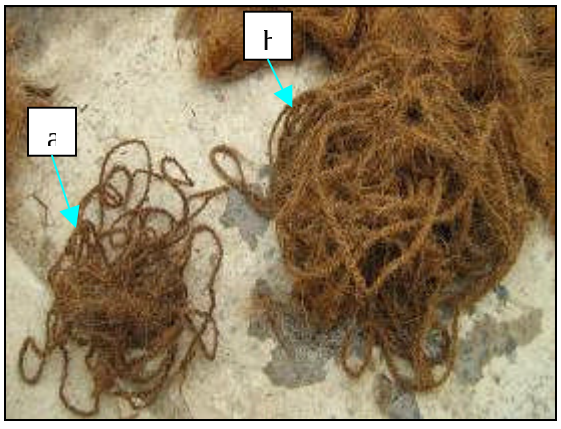


Fig.3- Rope bundles: Untreated (a) & Treated (b).

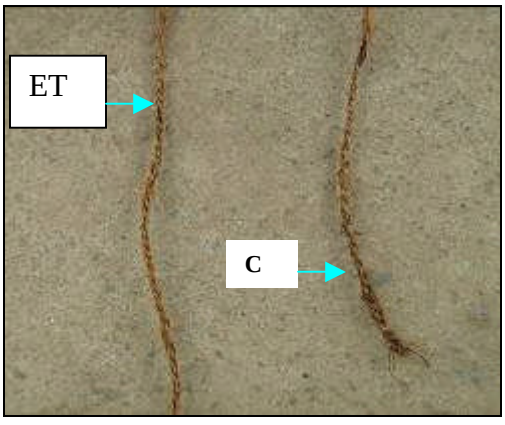


Fig.4- Ropes made out of Enzyme Treated (ET) & Untreated (C) fibres by local enterpreneurs.

DEMONSTRATION AT CCRI, KALAVOOR (KERALA)

TREATMENT OF FIBRE AT CCRI

Treated Fibre

Untreated Fibre

Effluent after 2nd treatment	Effluent after 1st treatment	Tamarind treated effluent	Control effluent

COMMENTS.

A. The processes is eco friendly.

B. The process can be carried out at any part of country and not restricted to Kerala.

C. The softened fibres will not harm the fingers of the female spinners.

D. The process is expected to increase the rate of production of yarns.

E. The exact extent of benefits of softening and brightening could not be qualified due to lack of cooperation from CCRI in getting the fibers tested by them.

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