

USES OF COIR FIBRE, ITS PRODUCTS & IMPLEMENTATION OF GEO-COIR IN BANGLADESH

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Abstract: Coir fibre is obtained from husk of coconut & composed of highly lignified form of cellulose. [1] All coir fibre falls into two distinctly different categories viz. white coir and brown coir the differences between two categories are due to the conditions of husk used, the method of extraction, the physical properties as well as in the uses. Geo-coir are made of pure coir drawn from the husk of the coconut without adding any synthetic material - a cent percent natural product. The whole thing can be expressed as geo-textile. A large amount of coir fibres can be collected, processed & used in Bangladesh.

Keywords: Coir fibre, coir dust, Fibre extraction, Geo-coir.

1. Introduction to Coir Fibre

Coir fibre is obtained from the Outer layer of the fruit of Coconut tree (*Cocos Nucifera* L). This outer layer is called the coconut husk. The husk (exocarp) of the coconut consists of a smooth waterproof outer skin (epicarp) and fibrous zone (mesocarp). The mesocarp comprises of strands of fibro vascular bundles of coir embedded in a non fibrous paranchymatous "corky" connective tissue usually referred to as pith; which ultimately becomes coir dust. [3]

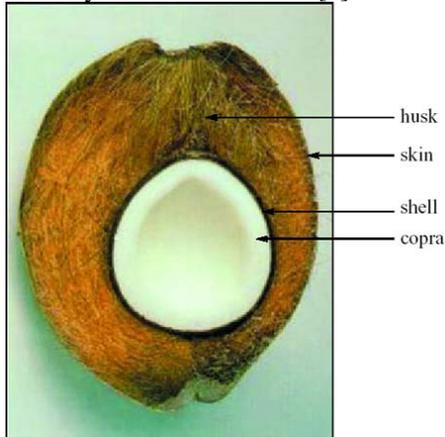


Fig. 1 Cross section of coconut [3]

Chemically coir fibre is composed of a highly lignified form of cellulose (cellulose lignin complex), which accounts for its colour, harshness and relative brittleness in comparison with pure cellulose fibre. The bulk of the ground tissue of the husk, on the other hand, is made up of pectin and hemicelluloses. i.e. pectin and hemicellulose act as a spongy binding material that bind the large fibre cells together to make up the husk. Coconut coir is in great demand unaccounted of natural resilience, durability, resistance to dampness and other properties. [3] Grading of coir is based on its fibre length, colour, resilience and general cleanliness in relation to the quantity of pith present.

All coir fibre falls into two distinctly different categories, white coir and brown coir the differences are due to the conditions of husk used, the method of extraction, the physical properties as well as in the uses. Coir obtained from immature green coconut is generally known as white fibre and is finer than the brown fibre obtained from seasoned coconuts, which has lost their green colour (>12 months). Both types of fibre are widely used and each has its own unique distinct type of application.



Fig. 2 Segregation of Coir fibre (Allepey, India) [1]

Coconuts are the seed of the palm trees, these palms flower on a monthly basis and the fruit takes 1 year to ripen. A typical palm tree has fruit in every stage of maturity. A mature tree can produce 50-100 coconuts per year. Coconuts can be harvested from the ground once they have ripened and fallen or they can be harvested while still on the tree. A human climber can harvest approximately 25 trees in a day, while a knife attached to a pole can up the number to 250 trees harvested in a day. Monkeys can also be trained to harvest the coconuts, but this practice is less efficient than other methods. Green coconuts, harvested after about six to twelve months on the plant, contain pliable white fibres. Brown fibre is obtained by harvesting fully mature coconuts when the nutritious layer surrounding the seed is ready to be processed into copra and desiccated coconut. The fibrous layer of the fruit is then separated from the hard shell (manually) by driving the fruit down onto a spike to split it (*De-husking*). A well seasoned husker can manually separate 2,000 coconuts per day. Machines are now available which crush the whole fruit to give the loose fibres. These machines can do up to 2,000 coconuts per hour [1].

1.1 Brown fibre

The fibrous husks are soaked in pits or in nets in a slow moving body of water to swell and soften the fibres. The long bristle fibres are separated from the shorter mattress fibres underneath the skin of the nut, a process known as *wet-milling*. [1] The mattress fibres are sifted to remove dirt and other rubbish, dried in the sun and packed into bales. Some mattress fibre is allowed to retain more moisture so that it retains its elasticity for 'twisted' fibre production. The coir fibre is elastic enough to twist without breaking and it holds a curl as though permanently waved. Twisting is done by simply making a rope of the hank of fibre and twisting it using a machine or by hand. The longer bristle fibre is washed in clean water and then dried before being tied into bundles or hunks. It may then be cleaned and 'hackled' by steel combs to straighten the fibres and remove any shorter fibre pieces. Coir bristle fibre can also be bleached and dyed to obtain hanks of different colours [1].

1.2 White fibre

The immature husks are suspended in a river or water-filled pit for up to ten months. During this time micro-organisms break down the plant tissues surrounding the fibres to loosen them - a process known as retting. Segments of the husk are then beaten by hand to separate out the long fibres which are subsequently dried and cleaned. Cleaned fibre is ready for spinning into yarn using a simple one-handed system or a spinning wheel [1].

1.3 Coir Dust

Coir dust or coconut pith is the by-product of the coir fibre industry, the disposal of which was a problem. It is about 70% of the weight of the coconut husk. It is described as brown spongy particles of low weight, which falls out when the fibre is shredded from the husk. It is rich in lignin and tannin and it also has lignocellulosic bonds, which is resistant to microbiological attack. There is a high demand for coir dust otherwise termed coir fibre pith or coir peat, in the market as moisture retaining agent in potting mixtures for horticultural and agricultural applications and also used for producing domestic or industrial fuel, for producing hard boards, thermal insulator, hydro seeding and shotcreting [1].

2. Coir Fibre Processing

2.1 Fibre extraction

The effectiveness of the wet processes such as bleaching and dyeing of coir, are strongly dependent on the procedures used to extract fibres from the husks and the pretreatment given the fibres. Both state-of-the art and commonly used technologies for fibre extraction are described below.

2.1.1 Traditional fibre extraction

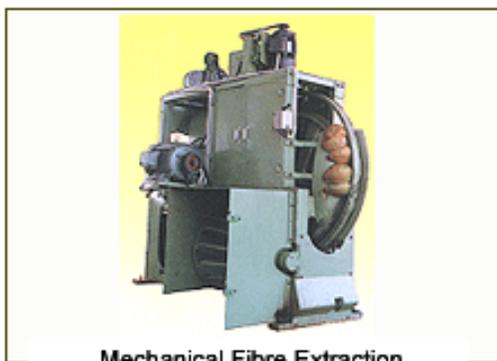
The traditional production of fibres from the husks is a laborious and time-consuming process. This is highly polluting of surface waters and results in the accumulation of large dumps of pith. After manual separation of the nut from the husk, the husks are processed by various retting techniques, and generally in ponds of brackish waters (for three to six months) or in salt backwaters or lagoons. This requires 10-12 months of anaerobic (bacterial) fermentation. By retting

the fibres they are softened and can be decorticated and extracted by beating, which is usually done by hand. After hackling, washing and drying (in the shade) the fibres are loosened manually and cleaned [3].

The fibre thus obtained is of highest quality and can be used for spinning and weaving purposes. Retted fibres from green husks are most suitable fibres for dyeing and bleaching.



Natural Retting
Fig. 3 Natural retting of husk



Mechanical Fibre Extraction
Fig. 4 Mechanical extraction of fibre

For the production of more coarse brown yarns, shorter periods of retting may be applied. Yarn thus obtained can be used extensively in geo-textile.

Alternatively, mechanical process can be applied by using either defibering or decortivating equipment to process the husks which require only five days of immersion in water tanks. Crushing the husk in a breaker opens the fibres. By using revolving "drums" the coarse long fibres are separated from the short woody parts and the pith. The stronger fibres are washed, cleaned, dried, hackled and combed. The quality of the fibre is greatly affected by these procedures.

2.2 Green decortications and enzyme treatments

New environmentally friendly methods of fibre production are of interest. These can be locally exploited on relative small-scale, and have the potential to produce a more constant quality of fibres. Novel developments by the Central Coir Research Institute (CCRI), Kalavoor using a biotechnological approach with specific microbial enzymes, for example, have substantially reduced the retting time from three to five days. High quality fibre production has been maintained [3].

Similar protocols can be developed to enhance the properties of the fibres with regard to surface properties such as smoothness and porosity. By using specific (microbial) lignolytic enzymes (laccase/phenoloxidase), the fibre surface can be bleached (or activated to react more easily with the dyes). Similar technology has been developed by NOVO-Nordisk to reduce the amounts of chemicals required to produce wood chips or fibreboard [3].

3. Fibre properties

The different fibre extraction processes yield different qualities of fibres: generally 56-65 per cent long fibres of over 150 mm (up to 350 mm staple length) and 5-8 per cent short fibres of under 50 mm. The fibre fineness varies between 50 and 300 μm . The fibres are composed of individual fibre cells of about 1 mm length and 5-8 μm diameters. The tensile strength of coir is relatively low when compared to sisal or abaca fibres, but it is less impaired by immersion in water. Coir fibre has the advantage of stretching beyond its elastic limit without rupturing, as well as having the power to take up a permanent stretch. Its resistance to microbial degradation and salt water is unique [3].

The comparison chemical composition of coir and other plant fibres is given in Table 1. It is observed from Table 1 that brown coir fibres contain relatively low amounts of cellulose (35 per cent) but have high lignin content (32 per cent). This exceptionally high lignin content implies that the available dyeing and bleaching techniques for textile fibres cannot simply be transferred to coir.

Table 1: Comparison of Chemical composition of coir with other plant fibres[3]

Fibre Waxes	Cellulose	Hemi cellulose	Pectin	Lignin	Extractives	Fats &
per cent dry weight						
Cotton	91.8	6.3	-	-	1.1	0.7
Flax (bast)	71.2	18.5	2.0	2.2	4.3	1.6
Hemp (bast)	78.3	5.4	2.5	2.9	-	-
Jute (bast)	71.5	13.3	0.2	13.1	1.2	0.6
Coir (brown)	35.6	15.4	5.1	32.7	3.0	-
Coir (white)	36.7	15.2	4.7	32.5	3.1	-
Coir pith	19.9	11.9	7.0	53.3	0.3	-
Sisal	73.1	13.3	0.9	11.0	1.3	0.3
Abaca	70.2	21.7	0.6	5.6	1.6	0.2

Table 2: Physical Properties of Coir Fibre[3]

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

4. Coir Fibre - Uses & Applications[2]

4.1 Traditional Applications

- > Mattress Filling - *Mattress Fibre*
- > Automobile Upholstery - *Twisted Fibre*
- > Shipping Industry And Fishing - *Coir Ropes*
- > Tube Well Filter - *Coir Twine/Coir Yarn*
- > Hop Industry - *Coir Twine*
- > See Weed Cultivation - *Coir Twine*

4.2 Newly Developed Applications

Erosion Control

- > Road Embankments

- > Bio Engineering
- > Soil Erosion Control
- > Capping Land Fills
- > Mining And Wastelands
- > Stream Bank Stabilisation
- > Golf Courses
- > Landscaping
- > Ski Slopes And Ski Lift Tracks
- > Re-Vegetation
- > Shoreline stabilisation
- > Roof Greening
 - *Woven Geotextiles*
 - *Stitched erosion control blankets*
 - *Soil bags*
 - *Mattress slabs*

- *Reed beds*
- *Coco Gabions*

4.3 Horticultural Applications

- > Growing medium
- > Seed Germination and Root Development
- > Soil Conditioner
 - *Coir Bio Fibres*
 - *Coir Peat/Dust*
 - *Coconut Husk Chips*
- > Plant Nurseries and Re-Vegetation
 - *Coir pillows*
 - *Grow Bags*
- > Growing Aid For Climbing Plants
- > Indoor and Out Door Horticultural Décor

- *Coco Poles*
- > Coir pots/ Jiffy Pots
 - *Coir Bio Fibres*
 - *Coir Peat/Dust*
- > Root Balling and Transferring of Plants
 - *Root Balls*

4.4 Farm Lands/Cattle & Horse Barns, Piggeries And Horse Race Tracks

- *Coir Bio Fibre/Coir Dust*

4.5 Sound Barrier Applications

- *Stitched Blankets*
- *Coir Blankets*

4.6 Fences & Partitioning

- *Coco Pole fences*



Fig.5 Mattress fibre,



Twisted fibre,



Woven geo-textiles,



Coir logs,



Fig.6 Stitched erosion



control blanket,



Coir pillow,



Bio-fibres, Coconut husk chips



Fig.7 Cocopoles / Grow stick,



Reed bed,



Coir Mattress,

5. Geo-Coir

Geo-coir geo-textiles are made of pure coir obtained from the husk of the coconut without adding any synthetic material - a cent percent natural product. This is Geo-coir's most essential, distinctive feature compared to conventional geo-textiles used for soil stabilization, reinforcement, landscaping and erosion control.

As soon as they have accomplished their function as slope protection/erosion control (10 years depending upon application), Geo-coir geo-textiles decompose and fit into the natural ecological cycle, thus fulfilling the claim for indulgent, near-natural landscaping. Apart from decomposing after doing their job, coir fibers have other enormous advantages compared with synthetic fibers. They are highly water absorbent, while

retaining their physical properties. They store up water and build an ideal microclimate for the seeds underneath. Of all natural fibers, coir has the greatest tensile strength.



Fig.8 Secured by using wooden stakes as pictured here [4].



Fig. 9 Perfect for high altitude steep slopes. Lasting for greater than five growing seasons [4]

5.1 Advantages

- Handles high water velocities
- UV resistant vs. synthetics
- High tensile strength
- Biodegradable after 4-10 years
- Water absorbent
- Accepts hydro seeding
- Plant through fabric
- Flexible - easy to handle
- Traps sediment-builds deposition

- Blends with environment
- Economical to install
- Esthetically pleasing
- Economical alternative to rip-rap/synthetics

5.2 Uses

- Stream/river bank stabilization
- High altitude - short growing season
- Silt fencing
- Construct vegetated geo-grids
- Re-vegetation projects
- Effective on all soil surfaces
- Proven effective on 1:1 slopes and those greater than 1:1
- Channel re-vegetation
- All soil bio-engineering applications
- Re-sedimentation projects

6. Conclusion

In Bangladesh Coir fibre can be used in every way as mentioned above. We have plenty of coconut trees in coastal areas of Bangladesh. So, a large amount of coir fibres can be collected, processed & used in Bangladesh. Government of Bangladesh can take necessary steps to encourage the use of this fibre and its products especially for stabilization, reinforcement, landscaping and erosion control.

7. References:

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