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From the Editor's Desk

Coir: A Versatile Green Fiber

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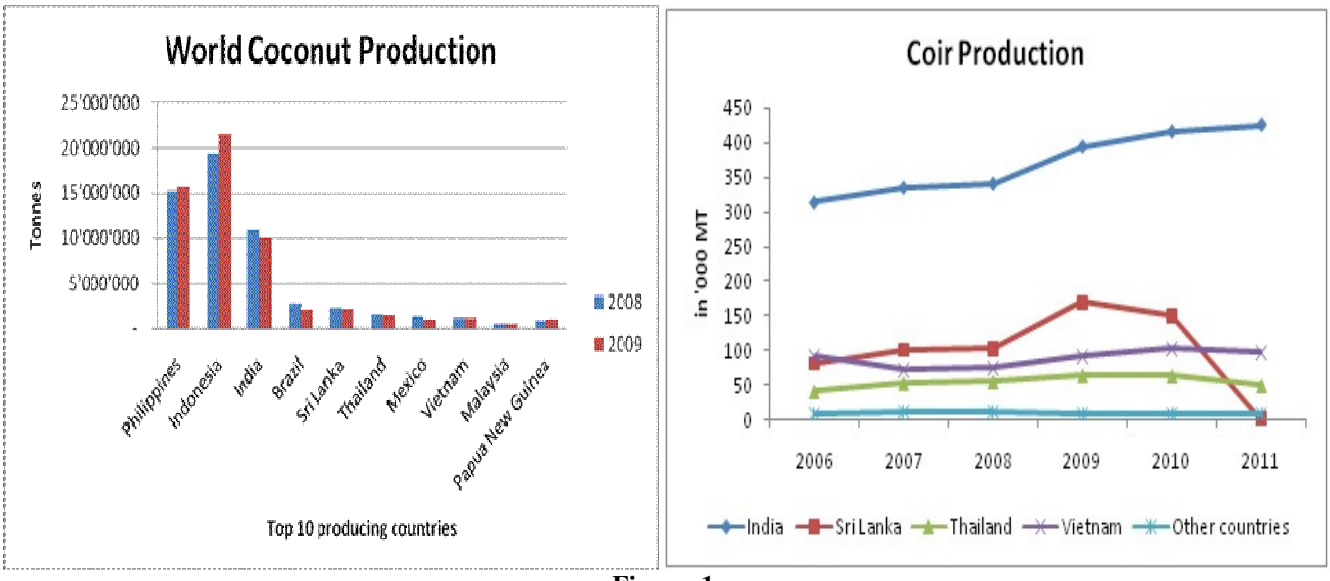
Introduction

Coir, a fruit fiber, is extracted from the tissues surrounding the seed of Cocos Nucifera Linn (Coconut palm). The fibers, after thrashing the husk is removed and used for manufacturing a variety of products. The unique color of this fiber has named it as 'The Golden Fiber'. Ropes and cordages made from coconut fiber have been in use from ancient times in India, mainly in ships. A coir industry in the United Kingdom was reported before the 2nd half of the 19th century. Globally, about 500 kilo tones of coir are produced annually, mainly in India and Srilanka (about 90 %, figure–1). Its total value is estimated to about $ 100 million (in the year 2009 – 2011). Over 50 % of the coir fiber produced annually throughout the world is consumed in the countries of its origin. Kerala State of India produces 25 % of the total world supply of white coir fiber. Srilanka produces, 36 % of the total brown fiber output of the world. India and Srilanka are the main exporters, followed by Thailand, Vietnam, the Philippines and Indonesia.

Production of Coir Fiber/Yarn: Coir is a fibrous material, found between the hard, internal shell and the outer coat of the coconut fruit. The two important varieties of coir fibers are popular, namely, brown coir and white coir. Green coconut, harvested after 6 – 12 month on the palm, contain pliable white fiber. Brown fiber is obtained by harvesting fully matured coconut when the nutritious layer surrounding the seed is ready to be processed into copra. The fibrous layer of the fruit is then separated from the hard shell manually. Machines are now available which crush the whole fruit to give loose fibers. Manually, it is possible to separate fibers from 2,000 coconuts per day while machine can process up to 2,000 coconuts per hour.

Extraction (Hackling)

Brown Fiber: The fibrous husks are soaked in pits or in nets in a slow-moving water to swell and soften the fiber. The long bristle fibers are separated from the shorter mattress fibers underneath the skin of a nut. This process is called wet milling. The mattress fibers are shifted to remove dirt and others contaminants, died in sun and packed into bales. The longer fibers may wash in clean water, dried before being tied into bundles, cleaned and hackled by steel comb to straighten. The longer fibers can also be bleached and dyed to obtain hanks of different colors (figure–2).

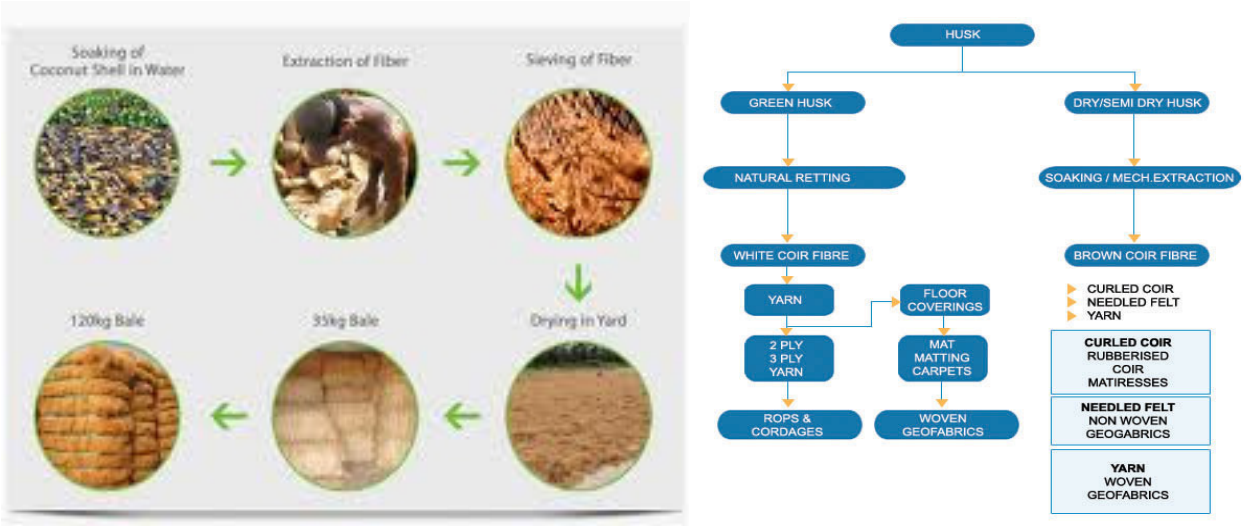


Figure–1
World Coconut Fruit and Coir Fiber Production

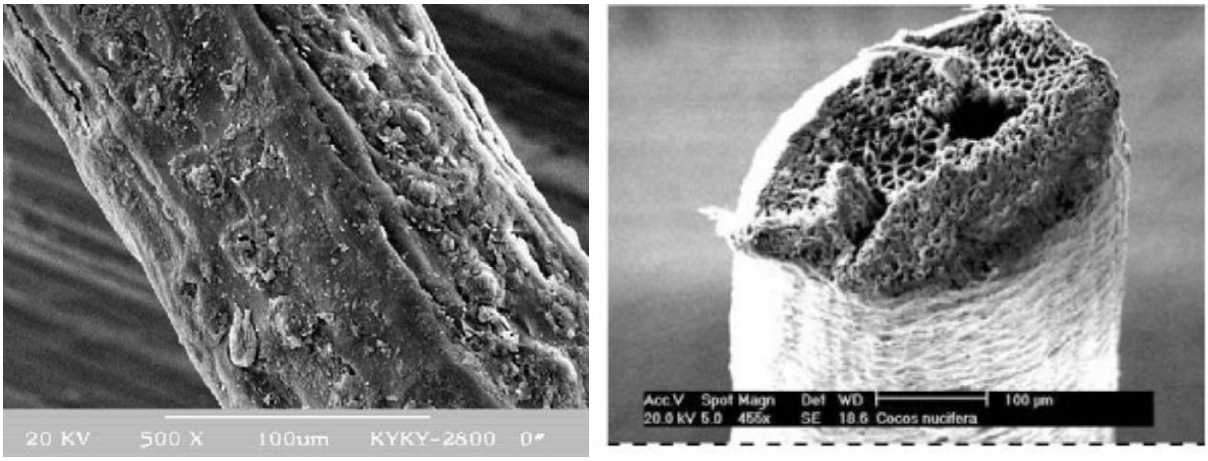
White Fiber: The immature husks are suspended in a river or water-filled pit for up to 10 months. During this period, micro-organisms break down the plant tissues surrounding the fibers to loosen them, a process known as retting. Segment of the long fibers, which are subsequently dried and cleaned, are kept ready for spinning into yarn using a simple one handed system or spinning wheel.

Spinning: The usual practice in hand spinning is to roll the fiber into short length of 6 to 9 inches giving a clockwise twist by hands. When a sufficient quality has been made, two or three short lengths are taken in hand together and made into yarn by giving a counter twist, using both palms. When the counter twist reaches near the end of the striking, further pieces of shorter lengths are added one after other. This is reeled in the form of a hank and knot is made at the end. Spinning can also be done by wheel spinning, which is slowly replacing hand spinning. To prepare two ply coir yarns on the spinning wheel, one set of two wheels, one stationary and the other movable is required. Coir fiber consist high amount of sodium and potassium and therefore, it is treated in a calcium buffering solution before use.

Characteristics of Coir Fiber: The individual fiber cells are narrow and hollow, with thick walls made of cellulose (figure – 3). They are pale when immature, but later become hardened and yellower as layer of lignin deposited on the walls. Each cell is about 1 mm long and 10 to 20 µm in diameter. Fibers are typically 10 to 30 cm long. Chemically coir is a cellulosic fiber, but consist high amount of lignin (table – 1). Mature brown coir fibers contain more lignin and les cellulose than cotton, ramie and flax. White coir fibers contain high cellulose, smoother, finer and weaker.



Figure–2
Flow Diagram of Coir Production



Figure–3
Microscopical Structure of Coir Fiber

The wonders of coir fiber can be highlighted as follow: i.Mothproof; resistance to fungi and rot, ii. Provides excellent insulation against temperature and sound, iii. Not easily combustible, iv. Flame-retardant, v. Unaffected by moisture and dampness, vi. Tough and durable, vii. Resilient; springs back to shape even after constant use, viii. Totally static free, ix. Easy to clean, x. Resistance to salt water (sea water).

The chemical compositions and important other physical properties of coir fiber is reported in table – 1.

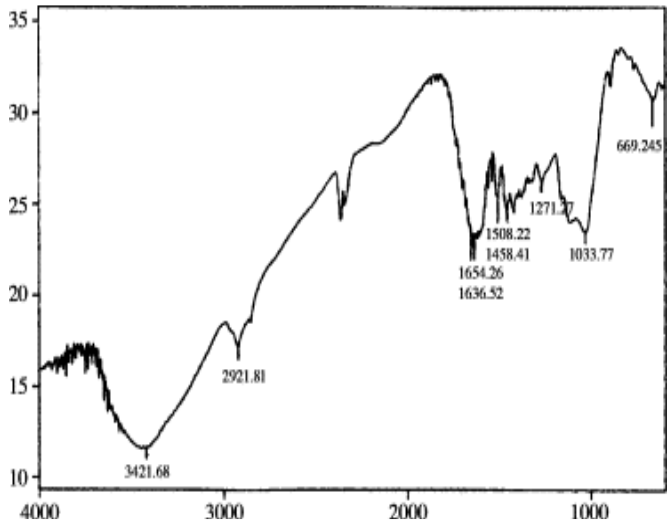
Table–1
Chemical Compositions and Important Characteristics of Coir Fiber

Sr No	Characteristics	Values
1	Chemical Compositions	
	Cellulose	35 – 45
	Lignin	40 – 45
	Pectin & Related Components	2.7 – 4
	Hemicellulose	0.15 – 0.25
	Water Soluble Component	4 – 5.5
2	Ultimate length	0.6 mm
3	Diameter/Width Ratio	16 micron
4	Breaking Elongation (%)	15 – 40
5	Moisture regain (At 65 % RH in %)	10.5
6	Swelling in water (%)	4 – 6
7	Density (g/cc)	1.15
8	Tensile Strength (MPa)	131 – 175
9	Young Modulus (GPa)	4 – 6

Infra red spectra of coir fiber shows a broad peak at 3421 cm^{-1} which is attributed to the polysaccharides hydroxyl. The C-H symmetrical stretching at 2921 cm^{-1} indicates presence of polysaccharide. The characteristic peaks nearer to 1650 cm^{-1} is related to the C=O stretching of the acetyl groups of hemicelluloses and P-coumaric acids of lignin. The sharp peaks at 1508 and 1458 cm^{-1} seems to indicate high content of lignin. The picks at 1271 cm^{-1} is associated with C-O stretching of aryl group in lignin.

Processing of Coir Fiber

Pretreatment: The pretreatment processes of coir fiber strongly depend on the extraction method adopted. Fibers extracted from green husks are the most suitable for dyeing and bleaching. Bleaching of coir fiber and yarn is carried out to obtain lighter color fibers and attractive commercial products. It is estimated that about 20 % of coir fibers used in various products are bleached. The bleaching process is designed to remove the colored and lignin components either by reduction or oxidation reaction. Hydrogen peroxide is a universal bleaching agent, which is cheap and can be used safely. However, it can irritate eyes and respiratory system of the labors. Peracetic acid and bio-bleaching are the new emerging safer pretreatment processes for coir fibers.



Figure–4
IR Spectra of Coir Fiber

Dyeing: Dyeing of coir fiber is carried out for diversification of markets and to nhance the appeal of the products. Traditional dyeing practices for coir fibers are widely used in India (figure –5). Mainly basic, direct, reactive and vat dyes are used for coloration of coir fibers. The main constrains in dyeing processes are use of banned dyes, effluent treatments and laborious process. A technological development at high scale is required for the processing of coir fibers. Recently "A Coir Express".

Uses of Coir Fiber: Brown coir is mainly used for floor mats, doormats, brushes, mattresses, floor tiles and sacking. Pods of curled brown coir fiber made by needle felting, are shaped and cut to fill matteresses and for use in erosion control on river banks and hillsides. A major proportion of brown coir pads are sprayed with rubber latex which bonds the fibers together and used as upholstery pading for the automobile industry.

The important use of white coir fiber is in manufacturing of string, ropes, fishing nets and in finer brushes.

In horticulture, coir is strongly recommended because it is free of bacteria and fungal spores and produces good results without the environmental damage caused by peat mining. Coir is also used to deter snails from delicate plantings and as a growing media in intensive glass house horticulture. In horticulture it is also used as a substrate to grow mushroms. Coir can be used as a terrarium substrate for reptiles or arachnids.

Figure–5
Traditional and Recent Dyeing Process of Coir Fiber

Figure–6
Varioous Products of Coir Fibers

Conclusion

Coir markets have been dwindling few years back due to strong competition from synthetic products. However, the strong trends in developed countries towards the production and use of environmental benign products uplift the coir production technology. Renewable raw materials such as plant fibers and products may have good market perspective if they can be produced at an economical competitive price and quality. Coir Board of India and other organizations have made lot efforts to upgrade coir through diversified products preparation. Recently, coir has gain wide potential as geo textile to prevent soil erosion, particularly on sea bands. The growing demand of said fiber may also support significantly in socio-economy status of farmers (particularly women farmers) of Indian states namely, Kerala, Karnataka, Andhra Pradesh and Tamil Nadu. Recently "A Coir Express" sponsored by Coir Board of India is moving on the road from Kanyakumari to Kashmir (between November 2013 to January 2014) for promotion of the coir products.