BIOTECHNOLOGY IN COIR EXTRACTION & WASTE UTILIZATION

By

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Coir, the fibre extracted from the mesocarp of the drupe of the coconut palm *cocos nucifera* is used for the production of beautiful products like mats, matting, carpet, handicrafts etc. (Table I) Coir suits very well for geotextiles and insulating materials and being environment friendly has an edge over synthetics for application in environmental operations.

The world production of coconuts is over 54000 million nuts and although great potential exists in the form of the coconut husk less than 25% is exploited for coir production. Coir can be extracted from the husk by retting or by mechanical extraction. The former process involves retting of the husks to yield superior "white fibre" which is in good length, bright in colour and fine texture and ideal for the manufacture of coir products. Mechanical extraction of the husk is instantaneous, however, yields coir fibre that initially is bright coloured but is photoxidised, rendering the fibre of an inconsistent colour. The texture of this fibre is harsh and therefore comparatively the quality of mechanically extracted fibre is inferior.

Retting has disadvantages that it is a prolonged process (nine months), pollutes the retting water through release of phenolic substances, and is a cumbersome process (steeping of and drawing of each husk out from underwater on completion of retting). It is an established fact that the retting of husk is a microbiological process wherein the binding materials holding the fibres in the husk are biodegraded leading to the release of the fibre. The retting process in a natural system was studied from April to December and the changes occurring in the environment have been elucidated. The pH in the water samples drawn at different stages of retting exhibit a variation, decreasing and increasing to various levels, the minimum pH of 5.5 was recorded in the sample drawn in the fourth month of retting. (Chart 1). The salinity was highest at 10 parts per thousand (ppt) in the month before steeping of husks (zero) & ninth month decreasing significantly to 1 ppt during the fourth, fifth and sixth months. (Chart 1). The polyphenols identified in the water samples collected at different stages of retting are resorcinol, pyrogallic acid and catchall.

Application of selected strains possessing phenolytic properties have been successfully conducted to reduce the period of retting of coconut husks to three months. "COIRRET" a bacterial cocktail has been able to reduce the retting period to three months in the natural retting system and improve the quality of mechanically extracted fibre in 72 hours in RCC tanks. The application of a bacterial consortium grown on husk leachate in laboratory scale studies have been observed to yield encouraging results indicating that coir extraction using biotechnology can eliminate pollution caused by retting. The quality of the fibre has been observed to be equivalent to retted fibre as tested for lightfastness ratings and degree of softness.

Biobleaching of coir:

Bleaching process whitens the coir fibre and is conventionally carried out by chemical bleaching agents. The application of biotechnology may be well adopted for coir using bacterial and fungal cultures. Bleaching/brightening of coir may be effective if the surface lignin or the phenolic compounds released from the fibre could be destroyed so that the released phenolic compounds may

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not reunite on the fibre surface and thereby turn more brown. A biotechnological approach to bleaching involves the use of the enzyme xylanase. Fungi naturally produce xylanase to breakdown wood xylans into carbohydrates. The carbohydrates then become the energy source for the organism to grow. The chemistry of xylanase action is not completely clear but it appears to act by chopping up the xylan enough to allow entrapped lignin moieties to escape. It has also been theorized that xylanase breaks lignin-xylan covalent bonds, thereby releasing the lignin. Therefore microbial cultures eliciting ligninase, xylanase and hemicellulase have potentials for biobleaching of coir.

Biosoftening of Coir:

Coir is a hard fibre with a very high content of lignin 40% and high extensibility (about 37%) which distinguish it from other cellulosic fibres. The high extensibility of the coir fibre is chiefly because the microfibrils in the cell wall lie in perfect helical spirals, extension of the fibre being related with the changes of the spiral angle, that is, the angle which a microfibril element makes with the fibre axis. Softening of coir can be attempted by application of biological softening agents, which can modify the surface properties of fibres and thus improve its physical characteristics and by elimination of the incrusting substance to a desirable extent without adversely affecting the other properties. Microbial enzymes have potentials in bestowing the properties of softness to coir and this remains an area for research yet to be explored in coir.

Decolourisation and detoxification of processing effluents of coir:

The decolourisation of coir retting effluents has been successfully carried out using chemical means at the Central Coir Research Institute. The process has been patented and can be carried out in combination with the COIRRET treatment on husks and fibre. Biotechnological means for treatment of coir dyeing and bleaching agents are being experimented at CCRI. The enzymes produced by white rot fungi have potentials for application in this field.

Biodegradation of coir pith:

The extraction of fibre from husks liberates huge amounts of dust or "coir pith" which is lignocellulosic in nature. The lignin in the pith can be biodegraded by lignin degrading microorganisms (Table III) to yield an organic soil additive with excellent physical and chemical properties. Its bountiful availability and ecofriendly nature renders it as an apt substitute for peat moss.

Conclusion:

The principal problem in environmental biotechnology is process control and predictability. In contrast to contained biotechnology involving bioreactors, where the process engineer is able to work with homogeneous or semi-homogeneous systems and to monitor and control all essential parameters, uncontained environmental applications are generally carried out in heterogeneous systems where critical process parameters may be difficult to monitor and even more difficult to control. In such uses, processes are governed more by ecological parameters pertinent to the particular environment in which the process is carried out. At present in the field of coir, ecological parameters which determine process efficiency are still being and yet to be studied. Quantum increase in performance, predictability, reproducibility, spectrum and safety of environmental biotechnological applications for coir can be achieved, through:

- elucidation of critical ecological processes which regulate or influence open biotechnological processes

- development of genetic tools and strategies to construct performance, and predictable process strains
- investigation of the ecological impacts, including possible perturbations, of environmental biotechnology applications.

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TABLE I
Products from Coir

ITEM	USE
Mats, Matting, Mourzouks,Carpets Rugs.	Floor Covering.
Geotextiles	Protection of road, rail & canal Embankments.
Drainage filter material for application as pipe envelopes.	To prevent flooding in grazing meadows, orchards, sport fields & gardens.
Ship Requisites	Fender, Rope
Tent Components & Army Requisites	Salitah, Wall bag, Pole & Pin bag Camouflage net, dumping net.
Household Articles	House maids Kneeler, scrubber Shopping bags.
Specialty Articles	Cricket pitch matting, billiard surrounds, golf tee mat, wrestling mat, tablemat, tealeaf bags.

TABLE II
World -Area Under and Production of Coconut in Nut Equivalent in the Different Coconut Growing Countries of the World. (1999)

SL No.	Country	Area in million	Percentage Share	Production in million nuts	Percentage share
1.	F.S. Micronesia	17	0.14	40	0.07
2.	Fiji	54	0.45	137	0.25
3.	India*	1,908	16.03	14,925	27.57
4.	Indonesia	3,712	31.17	13,946	25.76
5.	Malaysia	226	1.91	580	1.07
6.	Papua New Guinea	260	2.18	1,020	1.88
7.	Philippines	3,077	25.83	10,504	19.40
8.	Samoa	92	0.77	168	0.34
9.	Solomon Islands	59	0.49	318	0.60
10.	Sri Lanka	422	3.71	2,828	5.22
11.	Thailand	372	3.12	1,108	2.05
12.	Vanuatu	96	0.81	346	0.64
13.	Vietnam	173	1.45	1,044	1.93
14.	Palau	14	0.12	70	0.13
15.	Other African Countries	662	5.56	2,294	4.24
16.	Other American Countries	577	4.84	3,687	6.82
17.	Other Asian Countries	96	0.81	747	1.38
18.	Other Pacific Countries	72	0.61	349	065
	T O T A L	**11,909**	**100**	**54,129**	**100**

Source: APCC Statistical Year Book 1999 * Revised Fig. Coconut Development Board.

TABLE III
Lignin degrading Microorganisms

Microbe classification	Example
Actinomycetes	
Soil bacteria	*Nocardia, Streptomyces*
Fungi Imperfecti	
Soil fungi	*Fusarium*
Soft rot fungi	*Papulospora*
Ascomycetes	
Soft rot fungi	*Chaetomium*
Basidiomycetes	*Collybia, Mycena*
White rot fungi	*Coriolus, Phanerochaete, Poria*
Brown rot	*Gloeophyllum, Poria*

Chart 1