*Cord* 2008, **24** (2)

# Ecofriendly Method of Coir Retting and Pith Utilization Using Bioinoculants-"Coirret" and "Pithplus"

Anita Das Ravindranath

**Abstract**

Coir fibre and coir pith are byproducts of the coconut which are a renewable biomass. The coir fibre is used for the manufacture of natural fibre products such as yarn, brushes, brooms, door mats and floor covering products and the pith has potential for use as plant nutrient source. Biotechnology has been applied to improve upon the conventional drudgery prone, non hygienic and polluting methods to extract coir fibre from coconut husks. Technology has also been developed to convert pith into a soil conditioner and potting medium for use in agriculture and horticulture. This paper presents data on "Coirret" a bacterial consortium for enhancement of retting process of coconut husks / fibre bales and "Pithplus" a white rot fungal biomass developed for biodegradation of lignin in coir pith for economic utilisation.

**Keywords:** Coirret, Pithplus, Coir fibre, coir pith, ecofriendly technology.

---

Senior Scientific Officer (Microbiology) Department of Microbiology, Central Coir Research Institute, Kalavoor, Alappuzha 688522, Kerala, India
Email: anitadas30@gmail.com

## Introduction

The importance of natural coconut fibre (coir) and coir products as substitute to synthetics and coir pith as a potential growth substrate for plants led to research for production of superior quality coir fibre from coconut husks and conversion of the coir pith to organic manure.

Retting is one of the important steps in conventional method of coir extraction, which leads to the production of "white fibre". To obtain white fibre in traditional "retting" process, 11 months mature green coconut husks are arranged neatly into lots ranging from 5000 to 10000 secured with coir nets in a large circular bundle and released into the saline backwaters (Plate 1). The husk bundles are left undisturbed for 6 to 10 months for completion of retting process and then the husks are drawn out, beaten with wooden mallets to yield the "white fibre" (Plate 2). This process yields fibre of superior quality with respect to colour and softness for the spinning of coir yarn and weaving into mats, matting and other floor coverings. Conventional monitoring methods for coconut husk retting are subjective; more often an art than a technology. The physical appearance and quality of fibre varies widely with respect to colour, length, and percentage of impurities. The best quality fibre is bright in natural colour, possesses good staple length (between 15-20 cms) and is comparatively free from pith and impurities. However, retting leads to pollution of backwaters and emission of greenhouse gases (Aziz & Nair, 1978). Most environments support the growth of a wide range of microorganisms having many different metabolic capabilities. Microbial communities have an extremely important role to play in the degradation of simple and complex natural products. It is a commonly accepted fact that often the rate of biodegradation of a particular compound is faster in natural environments than with pure cultures of organisms isolated from that environment. This may be due to the concerted activity of a consortium of microorganisms available under natural conditions. Studies on such isolated communities clearly show that mixed populations confer beneficial effects and make the associations more successful than any of the individual population alone (Ravindranath, 1999).

Coconut husk retting involves microbial action and in any natural retting process microorganisms are the main agents of loosening tissues. Laboratory retting study revealed the presence of phenolic compounds in ret liquor (Ravindranath & Sarma, 1998). The conventional method of retting had several disadvantages. It was uneconomical due to the long retting time required, soaking and draining out of retted husks was a drudgery and this process leads to pollution of backwaters. Non-availability of adequate raw material for the coir industry was another limitation. Therefore in order to overcome the disadvantages of conventional retting process a consortium of bacteria which has the ability of degrading phenolic compounds named as "COIRRET" was developed and inoculated into husks soaked for retting and its effect was monitored. The same bacterial consortium was also inoculated on mechanically extracted coir fibre using a defibering machine and its quality assessed (Ravindranath & Sarma, 1993).

Coir pith is a waste material generated in coir fibre extraction process in large volumes and accumulates in the form of heaps of coarse and fine dust (Plate 3). Normally volume of pith produced is double the quantity of fibre. Therefore, during the extraction process of coir fibre, effective disposal of this material is a major concern. It is a fluffy, light, spongy material with increased water holding capacity. The lignocellulosic nature of coir pith renders its resistant to biodegradation due to the presence of pentosan-lignin ratio of 1:0.30. The minimum ratio required for moderately fast decomposition of such organic matter in the soil is 1: 0.50 (Joachim, 1929). Coir pith has been found to be an effective substitute for the natural peat. (Manna & Ganguli 1998).

The most common natural peat is sphagnum peat that is currently used extensively in horticulture. However, composted coir pith provides many advantages over natural peat as a horticultural material, for instance, the sphagnum peat has less capillary pores than the coir pith and becomes hydrophobic once dried. Consequently, it requires frequent watering to maintain its moisture content. Further, sphagnum peat has less physical stability to retain shape when in use than the composted coir pith and requires the use of basic substances like lime to maintain the pH close to neutral. In addition, sphagnum peat has lesser residual nitrogen, phosphorus and potassium than those found in the composted coir pith. Sphagnum peat is non-renewable in nature and its resources are rapidly depleting due to continuous mining. Being organic in nature there are advantages of the application of coir pith in organic agriculture. (Ravindranath 1991). The use of coir pith in 10-15 tons per hectare has also been found to improve soil physical conditions and productivity of many field crops Nagarajan *et al.* (1987) As a saline soil conditioner, coir pith can also be used to convert arid and semi arid land into arable land. The use of coir pith has also been proved to be good as a soil ameliorant for reclaiming saline alkaline soils. Coir pith is gaining popularity as a plant growth medium in the U.K. and elsewhere in Europe as an excellent natural alternative to other soil conditioners (Ammal and Durairajmuthiah, 1996), (Vavrina *et al.* 1996). The fibrous nature of pith makes it capable of breaking lumps of the heaviest of clay soils, allowing free drainage. Because of its sponge like structure, coir pith helps to retain water and oxygen and prevent loss of vital nutrients. Coir pith offers good scope for export if it could be processed for use as a soil conditioner. The most recent realization of shortage of peat moss and harmful effects to the environment brought out by indiscriminate exploitation of bogs have opened an opportunity for coir pith to fill up the growing market demand for gardening supplies.

Natural coir pith was inoculated with Pithplus and enriched with urea in a defined method to study the effect on its nutrient status. Ravindranath *et al.* (2006).

## Materials and methods

### Coirret

The study on retting of coconut husks was carried out at Kuripuzha in Kollam district of Kerala and treatment on mechanically extracted fibre in Poochakkal, Cherthala district of Kerala. *Pseudomonas desmolyticum, Mycoplana dimorpha and Mycoplana bullata* are the species constituting "Coirret". The three bacteria species belong to the Family Pseudomonadaceae. *Pseudomonas desmolyticum* is mainly Gram negative rods motile with one to five polar flagellae and has the capability of assimilating phenol and similar aromatic compounds. *Mycoplana dimorpha* is Gram negative, occasionally cocoid straight rods, motile with one to five polar flagellae and has the capability of assimilating phenol similar aromatic compounds. Bacteria *Mycoplana bullata* is Gram negative rods, curved motile with polar flagellae and has the capability of assimilating phenol and similar aromatic compounds. The ratio between the three species was maintained at 1:1:1 for best results. The species were inoculated in nutrient agar medium in culture flasks and incubated at 37 degrees for seven days to form the treating medium for husks and fibre. Four kilograms of Coirret was applied in two steps on coconut husks bundled and soaked for retting in the backwaters. The first addition of two kilograms is carried out seven days after soaking of husks and the second, one month after the first addition. Husks were drawn out after three months from the beginning of the study, fibre was extracted (A) and the quality of fibre was assessed by Xenotest (Ravindranath and Sarma, 1993) and Flexural Rigidity Test. (Ravindranath and Bhosle, 1999).

One metric ton of baled machine extracted coir fibre was soaked in water in RCC tanks for 12 hours and then drained out water. The tank was refilled with water and six kilograms of Coirret was added to the mechanically extracted coir fibre and allowed to remain for 48 hours. The water was drained out and refilled with fresh water and maintained for 12 hours following which the fibre was drained free of water and dried. The colour and softness of the treated fibre samples (B) were assessed by measuring the light fastness rating using Xenotest and degree of fastness using the Flexural Rigdity Test. The quality was compared with the "white fibre" (C) extracted from husks retted for 11 months by the conventional method.

**Assessment of lightfastness ratings using the Xenotest** This is a uniform specification for rating the lightfastness and weatherfastness of materials more quickly than naturally. It has a 1500 watt Xenon arc lamp as a source of radiation; the filtered spectrum of this lamp when used in the Xenotest is the same as sunlight. The samples were subjected to alternate periods of light and dark. This mimics conditions of day and night approximately. A test time of 24 hours in the Xenotest was roughly equivalent to the radiation received over 10 days in the open air averaged throughout the year. Samples fading within 80 min of test exposure were rated as Grade I and those after 80 min as Grade II.

**Assessment of degree of softness:** Softness imparted to coir by any treatment can be measured by the Flexural Rigidity Tester. This is a device developed by the loop methods to determine the flexural rigidity of the fibre. In this method, a ring of radius 'r'formed by a fibre is allowed to deform with the help of a fixed weight. The amount of deformation with a fixed weight depends upon the softness of the fibre.

Flexural rigidity $G_{fr} = 0.0047\ mg\ (2\pi r)^2 \cos\theta/\tan\theta$

where mg = weight of load applied

$\theta = 493/2\pi r$

d = deformation of lower end of ring

Fifty samples of the retted fibre was tied up on a PVC rod to attain the form of a ring having a radius of 2.3 cm and allowed to remain for 24 hours. The rings were then tested on a Flexural Rigidity Tester with and without load and the Flexural rigidity $G_{fr}$ calculated.

**Pithplus**

*Pithplus* is the formulation of *Pleurotus sajor caju*, which is a fast-growing, edible oyster mushroom, originally found in India, and which grows naturally on a succulent plant (*Euphorbia royleans*) in the foothills of the Himalayas. The mushroom is cultured on sorghum and incubated at 15 degrees for 15 days

**Composting of coir pith using *Pithplus***

The pith (one metric ton) is composted in an area of 5 metre long and 3 metre wide in a multi-layered structure each layer consisting of 100 kilograms. The different pith layers are interspersed with layers of *Pithplus* and urea. A typical schematic diagram of such a multilayered structure is shown in Figure 1. As shown in the figure, the first layer of pith is covered with a layer of *Pithplus*. The layer of *Pithplus* provides the necessary cellular organisms to biodegrade the coir pith. The layer of *Pithplus* is covered by an additional layer of coir pith, followed by a layer of urea. Urea provides the necessary nutrient media to proliferate the growth of the fungal mycelia that cause the composting of the coir pith. The urea layer is finally topped off by a layer of pith and *Pithplus* respectively. Five metric ton of pith can be laid out for composting in a single bed to a height of approximately one meter. The moisture in the heap is maintained at 200 % by sprinkling water every day. The *Pithplus*, in the presence of urea and air, composts the coir pith in about 25 days and the pith gradually deepens in color and there is a reduction in the particle size, indicating the composting of the coir pith moving towards completion. The organic manure thus obtained was tested for nitrogen,

**Table 1. Light fastness Studies on Coir Fibre**

Test Method: Exposure to Xenon Arc Lamp Quarzlampen Gesellschaft M.B.H. Hanau FRG.
Light and Dark Method

Humidity : 70%
Temperature : 37°C
Test : 1006 : 1955

| Sample | Description | Grade* |
|---|---|---|
| A | Fibre from "Coirret" treated husk | II |
| B | Fibre from untreated husk | I |
| C | Fibre from naturally retted husk | II |
| D | "Coirret" treated mechanically extracted fibre | II |

*Grades were determined by comparing with the fading time of grey scale standards.

**Table 2. Flexural Rigidity $G_{fr}$ of fibre samples**

| Fibre Sample From | Flexural Rigidity $G_{fr}$ |
|---|---|
| Naturally retted husk | 1.47 |
| "Coirret" treated husk | 1.13 |
| Coirret" treated mechanically extracted | 0.15 |
| Untreated Control husk | 2.00 |

**Table 3. Variation in physical & chemical parameters in coir Pith after inoculation with Pithplus & Urea**

| Parameter | Pithplus & urea treated coir pith | Untreated coir pith (control) |
|---|---|---|
| PH | 6.8 | 5.8 |
| Electrical conductivity (millimhos/cm) | 0.19 | 0.8 |
| Cation Exchange Capacity | 80 meq/ 100 gms | 20 meq /100gms |
| Nitrogen | 1.26% | 0.26% |
| Phosphorous | 0.06% | 0.01% |
| Potassium | 1.20% | 0.78% |
| Copper (ppm) | 6.20 | 3.1 |
| Organic carbon | 24.4% | 29% |
| C: N ratio | 19:1 | 112:1 |
| Lignin | 4.8% | 30% |
| Total Organic Matter | 95.6% | 85% |

**Plate 1. Coconut husks and fibre soaked in backwaters for "retting"**

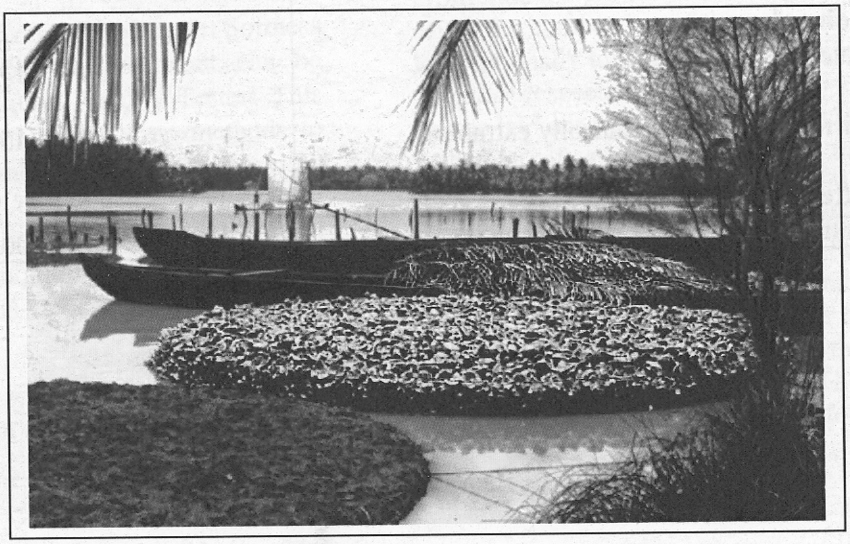


**Plate 2. Fibre extraction from "retted husks"**

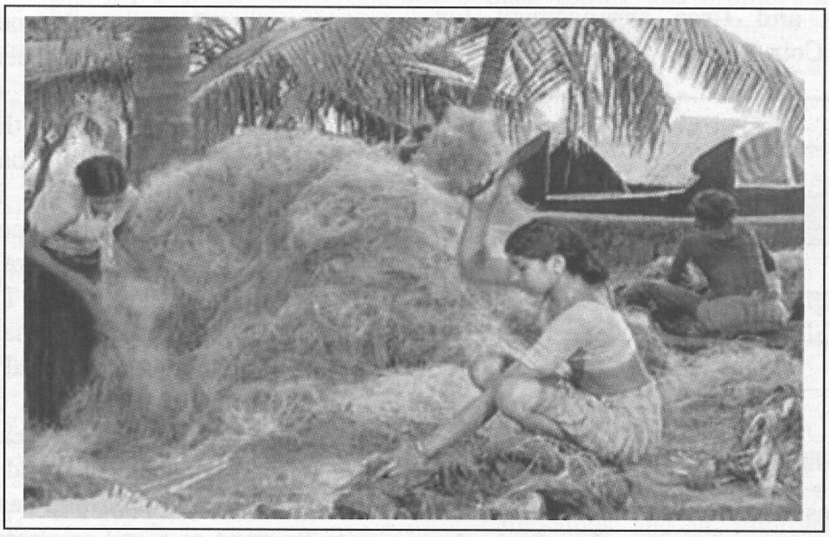
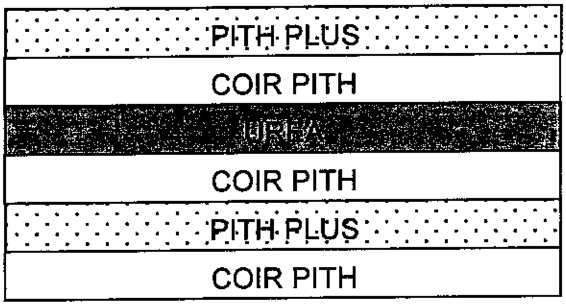


**Plate 3. Coir pith accumulating in a fibre extraction unit**

phosphorus and potassium and nutrient parameters as per AOAC Standard methods.

**Figure 1. Multilayered Arrangement of Coir-Pith, Pithplus and Urea arrangement for composting of Coir-Pith**




## Results and discussion

Retting has been observed to be completed in three months time as compared to 9 months by conventional methods. The colour and softness of the treated fibre has been measured by assessing the light fastness rating using Xenotest and assessing the degree of fastness using the Flexural Rigdity Tester (Table 1 & 2). The quality was compared to the "white fibre" extracted from husks retted for 11 months by the conventional method. The retted fibre exhibits a rating of Grade II whereas untreated mechanically extracted fibre shows a rating of Grade I. The treatment yields an improved quality fibre in seventy two hours (3 days).

Natural coir pith when inoculated with *Pithplus* and enriched with urea shows a definite reduction in lignin and increase in total nitrogen and other nutrient elements after a period of 25 days. (Table 3)

Coir pith has been found to be an effective substitute for the natural peat. The most common natural peat is sphagnum peat that is currently used extensively in horticulture. However, composted coir pith provides many advantages over natural peat as a horticultural material, for instance, the sphagnum peat has less capillary pores than the coir pith and becomes hydrophobic once dried. Consequently, it requires frequent watering to maintain its moisture content. Further, sphagnum peat has less physical stability to retain shape when in use than the composted coir pith and requires the use of basic substances like lime to maintain the pH close to neutral. In addition, sphagnum peat has lesser residual nitrogen, phosphorus and potassium than those found in the composted coir pith. Sphagnum peat is non-renewable in nature and its resources are rapidly depleting due to continuous mining. Being organic in nature there are advantages of coir pith use in agriculture. The use of coir pith in 10-15 tons per hectare has also been found to improve soil physical properties and productivity of many field crops As a saline soil conditioner, coir pith can also be used to convert arid and semi arid land into arable land. The use of coir pith has also been proved to be good as a soil ameliorant for reclaiming saline alkaline soils. Coir pith is gaining popularity as a plant growth medium in the U.K. and elsewhere in Europe as an excellent natural alternative to other soil conditioners. The fibrous nature of pith makes it capable of breaking lumps of the heaviest of clay soils, allowing free drainage. Because of its sponge like nature, coir pith helps to retain water and oxygen and prevent loss of vital nutrients. Processed coir pith use as a soil conditioner. The most recent realization of shortage of peat moss and the realization that indiscriminate exploitation of bogs was harmful to the environment have opened an opportunity for coir pith to fill up the growing market demand for gardening supplies.

The patented process technologies of COIRRET and PITHPLUS can be used for eco-friendly coir production and pith utilization in all coconut growing regions for economic utilization of the coconut husk.

## Acknowledgement

Thanks are due to the encouragement and support of the Director, RDTE, CCRI for the development of Coirret and Pithplus. Thanks are also due to the different chief executives of the Coir Board who evinced keen interest in the implementation of the technologies in the coir industry. The assistance of Shri. S. Radhakrishnan and Shri. T. Devidas is gratefully acknowledged.

**References**

Ammal, U.B., Durairajmuthiah, N. 1996. Utilization of coir pith as manure for rice and potassium use efficiency. *Journal of the Indian Society of Soil Science,* **44(3):** 445.

Aziz, P.K.A. and Nair, N.B. 1978. The nature of pollution in the retting zones of the backwaters of Kerala *Aqua. Biol.*, **3**: 41-62.

Joachim, A.W.R. 1929. The manorial value and decomposability of coir fibre dust. *Trop. Agri.*, **73**:272-273.

Manna M.C. and Ganguli T.K. 1998. Recycling of organic wastes: its potential turnover and maintenance in soil-A Review, *Agric. Rev.*, **19(2)**. 86-104.

Nagarajan, R., Manickam, T.S. and Kathandaraman, G. V. 1987. Utilization of coir pith as manure for groundnut. *Madras Agric.*, **73 (8)**: 425-429.

Official methods of Analysis of AOAC International 2000 17th Edition. Vol. I & II Dr. William Horwitz, Editor.

Ravindranath, A.D., 1991. Coir Pith- Potential wealth in India. *Proceedings of the seminar on utilization of coir pith in agriculture, Tamilnadu Agricultural University, November 20th, Coimbatore*: 2-5.

Ravindranath A.D. 1999. Studies on coconut husk retting and bioinoculant treatment for process improvement in a natural system. *Ph.D. Thesis* Goa University, India

Ravindranath, A.D. and Bhosle. S. 1999. Bacterial consortia for retting of coconut husks in tanks, *Cord,* **XV** (1): 26-32.

Ravindranath, A.D. and Sarma, U.S. 1993. Bioinoculant treatment of unretted green husk fibre for quality improvement. *Coir,* **XXXVII:** 31-36.

Ravindranath, A.D. and Sarma, U.S. 1998. Application of microorganisms to enhance biodegradation of phenolic compounds and to improve retting of coir. *J.Scient.Ind.Res.*, **57**: 825-827.

Ravindranath, A.D., Sarma U.S. and Radhakrishnan S. 2006. "Coir - A renewable agro-waste for horticulture". Paper presented at the National Seminar on Plant Physiology" 28th-30th November 2006, Vellanikkara, Thrissur, Kerala. Lead paper & abstracts: ix-xi.

Vavrina C.S., Armbrester K., Arenas M. and Pena M.1996. Coconut coir as an alternative to peat media for vegetable transplant production (*Southwest Florida Research and Education Center Station Report-VEG 96.7)*, University of Florida: 1-11.