ISBN: 978-93-90847-17-4

7. Mitigation of Coir Pith Wastes as Compost and Further Value Addition for Social Benefits

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7.1 Introduction:

Coconut (*Cocos nucifera*) plays a significant role in the economy of India. The coconut husk is the raw material for the coir industry. In India, which produces about one-fourth of the world's 55 billion coconuts each year, only 15% of the husk is actually used for recovery of coir fibers.

The most popular uses for coir are door mats, agricultural twine and geo textiles (blankets that are laid on bare soil to control erosion and promote the growth of protective ground covers) because of its durability, eventual biodegradability, ability to hold water and hairy texture.

7.1.1 Areas of Coconut Cultivation in World:

Although coconut palms grow throughout the tropical regions, the vast majority of the commercially produced coir comes from India and Sri Lanka.

In recent years, India has attained the top position amongst the coconut producing countries i.e., about 26.1%. Indonesia, Sri Lanka and Philippines are the other major countries. In India, coconut is primarily a food crop which produces about one-fourth of the world's 53,598 million coconuts each year, and 15% of the husk fibers are actually recovered for use.

7.1.2 Coir Fibre:

Coir is a 100% organic naturally occurring fiber derived from a renewable resource of coconut husk. Coir fibers resemble the wood fibers in terms of physical properties and chemical composition. Naturally resistant to rot, moulds and moisture, it is not treated with any chemicals during its spinning process for converting it into yarn. Hard and the strongest among all natural fibers, it can be spun and woven into different types of matting and mats.

Coir fibers are categorized in two ways. One distinction is based on whether they are recovered from ripe or immature coconut husks. The husks of fully ripened coconuts yield brown coir. Strong and highly resistant to abrasion, its method of processing also protects it from the damaging ultraviolet component of sunlight. Dark brown in color, it is used primarily in brushes, floor mats and upholstery padding. On the other hand, white coir comes from the husks of coconuts harvested shortly before they ripen.

Actually, SEM Structure of coir fibre light brown or white in color, this fiber is softer and less strong than brown coir. It is usually spun into yarn, which may be woven into mats or twisted into twine or rope.

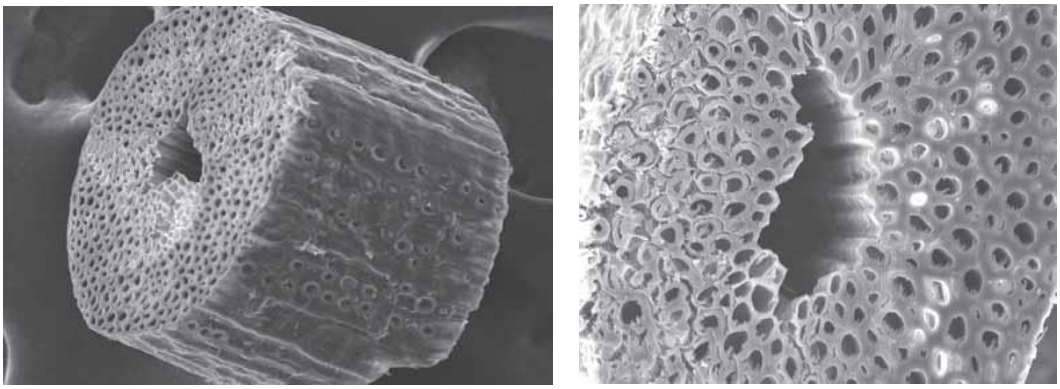

Figure 7.a: SEM Structure of coir fibre

7.1.3 Coir Pith:

Once harvested the whole coconut is separated into kernel and husk, where the kernel is used either directly as food or processed further into food products or oil. The husk goes to fibre mills where the coir fibre is extracted. In the process of extraction of coir fiber from husk generally about one third of it is obtained as fiber and two third of it is obtained as coir waste. Coir pith is a by-product of the coir fibre processing industry.

In the husk, coconut fibers are seen tightly packed along with non-fibrous, fluffy and light weight corky material known as coir pith or coir dust, which constitutes about 50-70 percent of the husk. The spongy material that binds the coir fiber in the husk is the coir pith or coir pith.

The composition and properties of coir pith vary depending on maturity of coconut, method of extraction and disposal, period between extraction and use and environmental factors.

Wide variations in C: N ratio of coir pith from 58:1 to 112:1 has been reported. Coir pith or dust is a biomass residue that decomposes very slowly due to its lignocellulosic nature. It is one of the largest agro wastes in tropical countries. Coir pith obtained from fully mature nuts has higher amounts of lignin and cellulose and lesser amount of water-soluble salts compared to younger nuts.

Coir pith has got many enviable characteristics, making it a highly potential resource if used after proper composting. Coir pith has very high moisture retention capacity of 600- 800 per cent and can be as high as 1100 per cent of dry weight. It has high potassium content and low bulk density (0.18g/cc) and particle density (0.8g/cc). High CEC, which varies from 20-30 meq/100 g, enables it to retain large amounts of nutrients and the absorption complex has high contents of exchangeable K, Na, Ca and Mg. Coir pith having a C: N ratio 24:1 or less could be used as a good source of organic matter for agricultural use. Physically, coir pith is a very light and compressible material. It is highly hygroscopic and has good water holding properties.

7.1.4 Properties of Coir Pith:

Coir pith is a recalcitrant agro-residue containing high amount of lignin and cellulose resisting decomposition by microorganisms under natural conditions. The recalcitrant nature of coir pith is due to the presence of lignin.

It contains 8-12% soluble tannin like phenolics. Coir pith has high water holding capacity of 8 times of its weight. It has fixed carbon, low sulphur, fats and ash. Nutrient content of coir pith varies with place, method of retting, rate of decomposition and storage method.

7.1.5 The Major Properties of Coir Pith Are:

- High water holding capacity, i.e., 6-8 times than its weight.
- Excellent moisture retention even after drying.
- Slow degradation due to high ligno cellulosic bonding.
- High porosity, stores and releases nutrients over extended periods of time.
- Greater physical resiliency that withstands compression better.
- Excellent aeration / oxygenation providing enhanced root penetration.
- Acceptable Electrical Conductivity (EC), pH and Cation Exchange Capacity (CEC).
- 100% degradable, organic and a renewable resource.

7.1.6 Composting of Coir Pith:

Coir pith when inoculated with a proprietary bio-formulation, such as PITHPLUS, and enriched with urea shows a definite reduction in lignin and cellulose contents with an increase in total nitrogen and other nutrient elements after a period of 30 days.

PITHPLUS is derived from *Pleurotus sajor caju, which is a fast growing, edible oyster* mushroom, originally found in India and grows naturally on a succulent plant (*Euphorbia royleans) in the foothills of the Himalayas.*

7.1.7 Method of Composting:

Apply one packet of Pithplus (400gm) uniformly over it. Inoculate the compost with compost organism like *Trimendas hirsuta, Cellulomonas fimii, Phanerochytae chrysosporium.*

Spread uniformly 100 kg coir pith in an area 5M x 3M. Cover with100 kg coir pith and apply 1 kg urea uniformly over it. Spread 100 kg coir pith again. Repeat the sandwiching process. Moisten the heap by sprinkling 25 buckets (approx) of water daily. Allow the heap to decompose for 30 days 200 % Moisture.

1 Ton Coir Pith + 2kg Pithplus + 5 kg Urea ----------> C-POM

7.2 Properties of C-POM:

- Excellent medium for plant growth.
- High moisture retention
- Improves physical and biological condition of soil.
- Reduces frequency of irrigation.
- Enhances strong and healthy root system.
- Contains natural enzymes and plant nutrients.
- Stimulates the production of phytohormones**.**

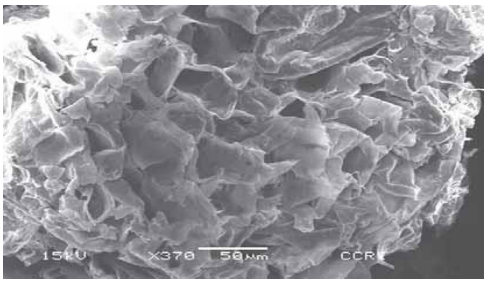

Figure 7.b: SEM view of C-POM

Figure 7.c: Coir pith compost heap

Figure 7.d: Pleurotus

Table 7.a: Nutritive value of raw and composted coir pith compost

Parameters	Raw coir pith (%)	Composted coir pith (%)
Lignin	30.00	4.80
Cellulose	26.52	10.10
Carbon	26.00	24.00
Nitrogen	0.26	1.24
Phosphorous	0.01	0.06
Potassium	0.78	1.20
Calcium	0.40	0.50
Magnesium	0.36	0.48
Iron(ppm)	0.07	0.09
Copper(ppm)	3.10	6.20
C:N ratio	112.1	24:1

7.3 Benefits of composted coir pith:

- The addition of composted coir dust improves soil texture, structure and tilth, sandy soil become more compact and clayey soil become more arable.
- It improves the soil aggregation
- It improves the water holding capacity (more than 5 times its dry weight) contributing towards increased soil moisture.
- The bulk density of both the sub surface (15-30 cm) soil is reduced to considerable extent with the application composted coir pith.
- Composted coir dust contains all plant nutrient elements, and it can provide a supplemental effect along with inorganic fertilizers.
- There is improvement in cation exchange capacity of soils, where composted coir pith is applied.
- Coir pith compost application increased the soil native micro flora because of addition of humic materials.
- Ammonification, nitrification and nitrogen fixation are increased due to improved microbiological activity.
- Application of coir pith compost
- It is recommended that 5 tons of composted coir pith per hectare of land irrespective of the raised.

- It is advised that composted coir pith should be applied basally before taking up the sowing.
- For nursery development in poly bags and in mud pots, while preparing the potting mixture 20 % of composted coir pith can be mixed with the soil and sand before filing it in the poly bag or mud pot
- For applying to the established trees like coconut, mango, banana and other fruit bearing trees, minimum 5 kg composted coir pith is required.

Table 7.b: Specification

Moisture	30- 40%
pH	6.6-6.9
Electrical Conductivity (EC)	< 0.25 Milliohms/cm
Salinity	0-1 ppt
Cation Exchange Capacity (CEC)	40-60 meq/100 gm
Porosity	65-70%

7.4 Coir Pith Grow Bags:

Coir pith grow bags are manufactured by blending coir pith with adequate quantity of short Coir fibre. This is then compressed and packed loosely in a UV stabilized black and white polythene bag and sprayed with. At the user end suitable holes are to be cut for planting as well as for drainage. Coir pith grow bags enable to enjoy delicious crop such as tomatoes, strawberries and cucumbers. The bags are ready to use as planting containers. Simply transplant plants into the coir pith grow bags during the planting season.

7.4.1 Specification:

- Weight 350 g +/- 30g
- Size 100 x 18 x 13 cm
- Compression ratio 5:1
- Moisture content less than 20%

7.5 Physical and Chemical Properties

- Composition: usually, 30% chips and 70% husk but customizable
- Electrical conductivity, E.C.: < 5 mS/cm (24 hours saturated paste method)
- pH: 5.5 – 6.5
- Packaged in white/black or black/black plastic treated against UV rays.
- Bags can be controllable for planting cut holes or pre-cut holes, drip holes, pre-drilled drip holes, drainage cuts, and cut for drip line.
- Grow slab also can be supplied without plastic

Grow Bags are mainly used for hydroponic growing under greenhouse conditions. Grow bags comes in various sizes.

Coco slab usually contains 30% husk chips and 70% coir pith (coco). This ratio can be customized according to grower's requirements.

They are suitable for a wide variety of crops such as:

- Tomato
- English cucumber
- Bell pepper
- Strawberry
- Watermelon
- Egg plant

Continue addting water - Note the expansion of the compressed coco peat inside the grow bag

Fully water absorbed grow bag - ready for plants

7.6 Product Facts:

- Place the grow bag where it is going to be cultivated.
- Center the slab inside the bag to allow an equal expansion.
- To hydrate the slabs, puncture the irrigation drips on the upper part of the slab
- Apply water or nutrient solution in a few irrigation cycles (10 minutes) so the coir will be hydrated slowly, and it will reach all its expected volume. Water required per slab will be approximately 75% of the slab final volume.
- Final expanded volume will be reached in 24 hours.
- After the total expansion, it is necessary to make some cuts in the bottom part of the slab for the drainage.
- The number of cuts will depend on the land's slope.
- Normally three cuts on each side of the slab are done.
- Check out the water drainage electrical conductivity.

7.6.1 Coir Grow Bags are 100% Eco Friendly:

Coir grows bags have proven to be an extremely versatile, biodegradable, 100% eco-friendly, fully renewable material procured from Mother Earth, in addition, these bags have presented a consistent quality along with a high water-retention capacity.

It has been observed that coir grows bags retain water up to eight times its actual weight, besides releasing water over an extended period of time, thereby taking care of frequent watering needs and providing excellent drainage and aeration to the roots. It maintains an optimum air water ratio at all times.

7.6.2 Coir Grow Bags Helps for Root Growth:

Coir grow bags are intrinsically nutrient rich and have the best physical and chemical properties that promote better root growth and healthier plants or crops.

Plants grown in coir grow bags are not just healthier but also have a better root growth compared to other growing mediums. There is never a difficulty with regard to fungus growth in the soil, as coir fundamentally has many anti-fungal properties.

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7.6.4 Coir Grow Bags are Reusable

Many people prefer to cultivate their vegetable garden exclusively in this coir grow bags as they are odorless with very little land preparation needs. The results are a better harvest with plump fruits and vegetables as there is little nutrient wastage in addition to a huge savings with regard to labor cost and reusability factor.

Typically, coir grow bags will nearly have no weed growth, are PH neutral, inexpensive and will never develop crack-ages. Besides, the coir doesn't shrink, so the grow bags maintain their structure and are easy to reprocess for several crop cycles. It is easily disposable without any environmental hazards. The only care to be taken before transplantation of another crop is of careful sterilization of the coir in the grow bag.

- Coir pith block is specially designed for commercial nurseries and greenhouses. This soil conditioner is suitable for all types of garden plants, lawns, flowers, orchids and vegetables in pots or on the ground
- Available Sizes- 5 kg and 650 gm

Weight	Expanded Volume	650gm +/- 30gm
Size	30 x 30 x 13 cm	20 x 10 x 5 cm
Compression ratio	5:1	8:1
Moisture content	< 20%	< 20%
Electrical Conductivity	< 0.5 milliohms/cm	< 0.5 milliohms/cm
Expanded Volume	13 to 14 L/kg	8 to 9 L/kg

7.6.5 Coir Pith Disc Specification:

- Disc & coin Sizes - 20 mm to 100 mm diameter
- Product Weight – 5 gms to 120 gms
- Tonnage Capacity - 200 tons
- Power – 15 kw / 20 hp

7.6.6 Coir Pith Briquette Specifications:

- Weight 650gm +/- 30gm
- Size 20 x 10 x 5 cm
- Compression ratio 8:1
- Moisture content less than 20%
- Electrical Conductivity less than 0.5 mS/cm
- Expanded Volume 8 to 9 Litres
- Packing 2000 briquettes per pallet
- Load ability 20 pallets / 26 MT in one 40 feet HC container

7.6.7 Manufacturing Process:

- The process of manufacturing coir pith blocks involves the following sequence of operations
- The coir pith completely free from seeds, weeds and other foreign particles and brought to the factory.
- The processed coco peat from coconut fibre factory consists of 10 to 20 percent baby fibres
- The incoming material is checked for EC and Ph values to maintain its purity.
- The material is passed to sieving machine. The processed coco peat from coconut fibre factory consists of 10 to 20 percent baby fibres.
- A specially designed rotary sieving machine with a quarter inch mesh is used for effective removal of baby fibre from coconut pith
- The Raw Material is washed with fresh water to reduce the EC level
- Input material EC 3 to ms/cm,Output material EC <0.5 ms/cm V
- The sieved material is sent to squeezing machine to remove excess water
- The sieved material is dried to bring down the moisture to 15%. a specially designed drying plat form is used to dry to 15% moisture which is essential for binding during compaction.
- The dried powder is compressed into blocks or grows bags and sprinkled with EM solution.
- Block size 30X30X10 cm

7.6.8 Preparation of COCOLAWN:

The following materials are used for making a readymade lawn of natural grass comprising:

- A layer of (Coir bhoovastra) netting material made of coir
- A single or plurality of non-woven layers (Coir Needled felt) layer / Coir fibre
- A raw coir pith layer on non-woven layer.
- A layer of fertilizer viz. coir pith organic manure (C-POM) containing inoculated microorganism and natural grass on the coir pith layer.
- Non-woven layers provide thickness to the lawn and allows grass roots to get entangled in the non-woven material. The layer of coir pith gives a support base, coir pith layer can be treated with other nutrients such as mushroom seeds and urea etc. and allowed to mature till the weight is substantially reduced as lignin is consumed by fungi or mushroom seeds.
- After making the coir bed using 'coir bhoovastra' and pith, the grass is planted on it. The lawn will become ready for use within one month. Readymade lawn can be made in the form of rolled like blankets which can be laid on any surface.
- The open weave of the supporting fabric also helps in supporting the roots of the planted grass slips, which form a mat by entangling with the coir fiber and yarn. The coir netting can therefore be laid on any arid surface or even concrete floor to act as a support material as the surface only forms a support for the blanket without contributing to the sustenance of grass.
- The netting also helps to drain the excess water accumulated during irrigation. Coir non-woven [needled] felt has been used as a semi-permeable membrane to retain the coir pith with C-POM, and to give support to the readymade lawn. It helps in creating a microclimate which boosts plant development.
- The non-woven layers impart thickness or bulk properties to the lawn. Another function of the non-woven layers is to allow the grass roots to form a bush and get positively entangled in the non-woven material.
- Grass is planted on the top most layer of Coir Pith Organic Manure, C-POM. Initially, C-POM is required to sustain the grass by providing nutrients like Nitrogen, Phosphorus and Potassium and other micronutrients essential for the growth of grass.

7.7 Advantages:

- Coir based lawns are devoid of pesticides, weeds which are normally associated with grass turfs.
- Further, the composted coir pith provides long term sustainability by slowly releasing the nutrients unlike grass turfs.

- The coir-based lawn is lighter in weight and therefore, easy to handle in comparison to the grass turfs.
- Synthetic lawns are usually treated with ultraviolet radiation resistant chemicals to extend their durability. The disposal of such synthetic lawns becomes a problem.
- Artificial turf tends to be much hotter than natural grass when exposed to the Sun. The abrasions caused by artificial turf have been linked to a higher incidence of infections. Sometimes artificial turf requires infill such as silicon sand and/or granulated rubber made from recycled car tyres.
- This material carries heavy metals which can leach into the water table. Periodic disinfection is required as pathogens are not broken down by natural processes in the same manner as for the coir based natural grass lawn. Recent studies suggest certain microbial life is less active.

Figure 7.e: Potting Media

7.8 As Soil Substitute:

- Mostly the coir pith from India and Sri Lanka are briquettes or compressed into bale or block form. It is done only for loading convenience and to reduce freight cost.
- The importers reprocess the compressed pith by wetting into loose forms and grade according to particle size and mixed in different ratios according to the farmers requirements, either for floriculture or horticulture.

- They also mix fertilizers and micronutrients with it depending on the crop to grow in the pot. EM liquid is sprayed to enhance the growth. It is then transferred to the pot-filling machine where different sizes of pots are filled with this mixed material automatically.

Figure 7.f: Coir baskets

- These are moulded rubberized coir fiber baskets made from sheets of coir fiber, which are mainly available in spherical shape. Used as liners to wire baskets after filled with coir pith or husk chips as growing medium along with effective microorganism for climbers and hanging plants in agri-horti floricultures.
- They are also available in "U" shape and conical shapes. They are used in roof gardens.
- The wall thickness varies from 10 mm to 15 mm. The diameter of ¼ sphere shape is usually of 16 inches, the diameter of ½ sphere shape ranges from 10 inch to 20 inch, "U" shape from 10 inch to 12 inch and conical shape from 9 inch to 20 inch.

7.9 Other Uses of Coir Pith Wastes:

- Preparation of particle board
- Production of bio fuel
- Production of bio-oil
- Production of bio ethanol
- Production of nano cellulose
- Extraction of sodium ligno sulphonate