Tender Coconut Husk - various uses

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The coconut is an important fruit tree around the world, providing food, fuel and fibre for billions of people, especially in tropical and subtropical regions. As the palm has multiple uses it is aptly called the “the tree of life“. Coconut and its products are also known as a 'functional food,' since it provides health benefits over and beyond the basic nutrients. At any given time, a coconut palm bears 12 different types of nuts ranging from the stage of flower opening to ripened nut. Tender coconut (6-7 months maturity) water, the liquid endosperm inside the nut, is a wholesome and nutritious drink. It has an important role to play in the rapidly expanding functional foods market particularly nutraceuticals and pharmaceuticals.

The consumption of tender coconut water is prevalent in countries such as India. Accordingly, increase in the consumption of tender coconut water across various countries has led to expansion of market for coconut water during the last few years. Coconut water is the nutritious clear liquid inside the coconut fruit which is rich in vitamins and minerals. The amount of coconut water that can be harvested from each nut depends on the stage of maturity and the variety.

The increased consumption of tender coconut water has caused an increase in the generation of by products, such as the husk, which corresponds to approximately 60-65% of the fruit weight. The husks are generally discarded on embankments and left in the open environment as waste, where it takes eight to ten years to degrade (Corradini et al. 2009). Hence, consumption of tender nut water causes the generation and accumulation of bio-waste. As a result, contamination of the soil has become a problem. Moreover, husks are the breeding ground of

mosquitoes and other insects. Due to this, cities like Mumbai have banned the shops of tender coconut near hospitals. Therefore, there is a need for finding novel ways to use the husks from tender coconuts, particularly for value addition. This is because the fibers which is obtained from the mesocarp of coconuts, are cheap, recyclable, abundant and non-poisonous (*Satyanarayana et al. 2007*). Additionally, coir fiber is a versatile material, with applications in various engineering sectors, including the development of sustainable construction materials (*Ali, 2010*).

Tender coconut husk find multitude of applications. Some of the current uses of tender coconut husk includes- the fibre extracted from tender coconut husk is used in production of floor mats, door mats, brushes and mattresses, white coir harvested from unripe coconuts is used for making fine brushes, rope, and fishing nets. Young coconut husk can be converted into ash and used as partial cement replacement in masonry application, dried tender coconut husk can be used for production of bio char, activated carbon, etc.,. The texture of tender coconut husk is generally smooth and has a very high moisture content of about 80-85%. The rigidity of tender coconut is mainly attributed to its lignin content. Another major application of tender coconut husk is its conversion into convenient form of fuel for clean combustion.

The recent applications of tender coconut husk are highlighted in the present paper.

▶ *Fuel for clean combustion*

The tender coconut husk is in the soft form but it contains high moisture content with adequate fuel efficiency. Hence, processing the tender coconut husk could offer a valuable clean combustion fuel. The processed tender coconut fuel finds use in cooking. The methodology followed in the production of fuel from tender coconut husk involves the dewatering of the husk followed by drying and further processing to produce sustainable fuel which can be used as a fuel wood alternative. The shredded tender husk is used for fuel production and processing so that it could be used in domestic and community cooking applications.

▶ *Bio-oil production*

Because of its high volatile matter content, coconut husk can be used for the production of bio oil. The main biochemical components of husk include-lignin, cellulose and hemicellulose. Bio oil is a liquid which is produced by steam condensation process

from the pyrolysis process. The sub components such as lignin, hemicellulose and cellulose are oxidised to phenolic compounds as the main component of bio oil (*Fardhyanti and Damayanti, 2017*).

▶ *Second generation Bio ethanol*

By following the lignocellulosic ethanol production process, a fuel with the highest ethanol concentration per mass of initial substrate for the lowest price, less energy consumption could be made from tender coconut husk. The general processing steps adopted include –pre-treatment of coconut husk (alkaline, acid or other), hydrolysis (enzymatic/acid) and fermentation. The highest ethanol concentration was obtained using alkaline pre-treatment and acid hydrolysis (Maria bolivar- Telleria et al., 2018).

▶ *Handmade papers and garden articles*

Handmade papers and garden articles can be made from organosolv pulp (organosolv pulp involving hydrolysis and removal of lignin with an organic solvent). The pulp is usually diluted with water and poured uniformly over a screen. The wet pulp is then transferred to a cloth to remove excess water. As water drains, the fibres become closer, and after pressing and drying, calendaring of the handmade paper is done. The pulp can also be utilised in making paper plates, cups, glass covers, and garden articles such as paper pots for seedling and packaging by moulding into the desired shape and size.

▶ *Partial cement replacement in masonry application*

The discarded tender coconut husks with their shells were collected and burnt at about 600°C to produce ash that was mixed with fine aggregates and water as partial replacement of cement. Water-cement ratio of 0.485 and proportion of sand to cement is 1:2.75. The research findings stated that the suitability of using young coconut husk ash (YCHA) as cement replacement for concrete masonry application in the construction industry. The compressive strength obtained at 20% and 40% YCHA designed mixtures provide favourable conditions for masonry applications (Olan *et al., 2016)*.

▶ *Bio char production*

Bio char can be produced by the thermochemical degradation of biomass in a zero or limited oxygen environment through the process of pyrolysis. It is perhaps the most recalcitrant form of organic matter in soil, which sustenance extends from few hundreds to thousands of years, rendering it an excellent means for carbon sequestration. It improves the chemical properties of soil. Owing to the highly porous nature of bio char, soil application of bio char would ultimately lead to an enhancement of a wide range of soil physical, chemical and biological properties (*Atkinson et al., 2010*). The bio char production process involves sun drying of the coconut biomass residues until the moisture contents of the feed stocks reduce considerably. The dried feedstock was then layered into the kiln and heated at fluctuating temperatures of 350–450 °C range for 2–6 hr for producing the bio chars. The colour of the smoke was used as a visual indicator for the process of carbonization. No harvesting of the volatiles released during the process was adopted. Once the material was carbonized (turned black colour) through partial combustion, water was sprinkled over the hot bio char and allowed to cool. The cooled bio chars were then crushed to coarse particles and stored.

▶ *Production of activated carbon*

Activated carbon can be prepared from tender coconut husk by physicochemical activation method consisting of potassium hydroxide treatment and carbon dioxide gasification. The activated carbon preparation conditions were optimized by maximizing both the 2, 4, 6 trichlorophenol (TCP) uptake and the activated carbon yield (Tan, Ahmad, and Hameed, 2008). The production process is generally carried out in 3 stages namely- determination of lignin content, carbonization and activation step. The activated carbon thus obtained find use in several applications such as filtering of fruit juices, waste water treatment, etc., (Pattananandecha et al., 2019). Coconut-based activated carbon generally have the most micro porous pore structure, and possess the highest hardness compared to other types of activated carbon. Thus it is considered the best carbon for water filtration and it generates the least ash during production.

▶ *Mattresses*

Rubberized coir is a versatile product used largely as a less expensive substitute cushioning material for foam rubber in furniture, upholstery, and mattresses. Rubberized coir is made from curled fiber, which should be free from dust. The coir is made into endless fleece which is conveyed to the first set of rubber latex spray gums. Thickness of sheets is built by fixing multi layers fleeces and spraying is repeated to get a good bonding of layers. Then the sheet is hydraulically pressed and vulcanized to set the fibers. Rubberized Coir Mattress is made out of Rubberized Coir Sheets and Natural Latex Form Sheets. Rubberized Coir Mattress is gaining economic importance due to its high strength and durability among the market. The advantages of coir mattresses over the conventional are reliable, high strength, dimensionally accurate, and durable. The rubberized coir mattresses are widely accepted as bed for modern living style.

Conclusion

Tender coconut husk is accumulated as a bio waste in road side. The proper utilization of tender coconut husk will increase the income to coconut growers, street vendors and farmer's producer companies. However, there is no potential cost effective technology for proper utilization of husk. In this context, ICAR-CPCRI is working on the area of value addition of tender coconut husk.

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