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Underutilized Meghalyan Arecanut Husk Waste Fiber for Development of Nonwoven Textile Material

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ABSTRACT

Agro waste material utilization in Meghalaya is an important means to conserve the environment from dumping large quantity in to bare lands and it also helps in new innovative product development from no cost materials. Areca Catechu L. nut shells are an agri-waste but provide fiber, which has limited applications. This fiber has good breathing properties besides being skin friendly and easy to care. In the present study dried well matured Areca catechu fruits were collected in large quantities and the fiber was extracted by hand stripping method. This fiber was given alkali pre-treatment, scoured, bleached and then processed for needle punching for nonwoven preparation. The prepared webs were then tested for various performance properties. This can be concluded from the study that the prepared needle punched nonwoven made of Areca catechu fibers is suitable for various technical textile applications.

Key words: *Natural fibers, Areca catechu, Agro waste, Arecanut husk fibers, Nonwovens, Needle punching*

INTRODUCTION

In order to meet the global standards of eco-friendliness and sustainability, market is now penetrated by safer natural products which have the capability of giving multi functionalities to textiles applications[2]. Ecological concerns have resulted in a resumed interest in renewable resources-based products and natural fibers are considered as environmentally safe alternative[6]. All natural fibers have low density, less abrasive to processing equipments, biodegradable and economically viable[7]. Therefore, competitive products based on renewable resources need to be developed that have high quality, show excellent technical performance and harm the environment less than current products based on petrochemical materials[1]. Wastes and by-products from agro-industrial processes are rich sources of cellulose and hemicelluloses wrapped up in lignin, which is an inert polymer that protects the plant[8]. Arecanut fiber belongs to the species *Areca Catechu Linnaeus* under the family *Palmacea*.

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Among all the natural fibers Arecanut fiber, a type of nut shell fibers, is more promising because it is inexpensive, derived from very high potential perennial crop and abundantly available in Garo hills of Meghalaya but has limited applications[9]. In Meghalaya not much of applications are available for these Areca husk waste fibers. However, a part of these fibers are used as fuel and most of them are left as a waste in landfills and are difficult to manage. Improvements done to the Arecanut fibers can find new applications for these fibers. The unmanaged green *Areca* husk left in the plantation causes terrible odour and other decay-related problems[12]. Therefore, an extensive planning for the disposal of husk is necessary and finding better utilization leading to valuable product can be one solution to this unmanaged and underutilized husk. The husk of the fruit consists about 60% to 80% of the total weight of fresh fruit. The average filament length is around 4 cm, which is too short compared to other bio-fibers. Mainly two types of fibers are present – one very coarse and the other very fine. The coarser ones are ten times coarser than jute[9]. These fibers adjoining the inner layers are irregularly lignified group of cells called hard fibers. The portions of the middle layer below the outermost layer are soft fibers, which are very similar to the jute fibers[13]. The main objective of this study is to develop a nonwoven material from Arecanut coarser husk fibers. This prepared nonwoven will help in reducing the content of synthetic fibers in nonwovens thereby will also reduce the land fill considerably. New applications of agri waste fibers, like Arecanut husk fibers, will contribute to better management of agri-waste and facilitate sustainability.

Experiment

Collection of Fiber

Arecanut husk obtained from fruit harvesting at mature stage was collected. The epidermis of the fruit is thrown out as an agro waste or been used as a material for burning. This outer husk is a rich source of cellulose that has been used for nonwoven textile materials for this study.

Fiber extraction

Arecanut husk were treated with 2 per cent of urea and steeped in water for 15 and 30 days. Urea treated husk of Arecanut was washed thoroughly with water and dried for 2 to 3 days. Thereafter, fibres from the husk were separated manually by hand stripping method.

Pretreatment of Arecanut husk fibers

In present study the NaOH pre-treatments were given for arecanut fiber in order to reduce the hemicellulose and lignin content. Arecanut Husk fibre was softened in 1% Turkey Red Oil solution for 15 mins. Fibres were treated with 2% NaOH in 1:40 MLR for 45 mins at temperature of $50^{o}C$ to $60^{o}C$.

Bleaching

Treated Arecanut fibers were further subjected to bleaching process using 2% of bleaching agent (Hydrogen peroxide) and 1.5% sodium silicate, 0.5% teepol and turkey red oil in MLR of 1:50 at temperature 100ºC for 60 mins.

Web formation, web feeding and needle punching

Nonwoven material was prepared from extracted coarser or II- grade Arecanut husk fibers using needle punching method. Web was formed by placing two web layers i.e. first layer was placed in longitudinal direction then second layer was placed in crosswise direction. Arecanut husk fibers web was delivered to needle punching machine by means of web feeder. The web feeder prevented the layered web to get deformed. In needle punching machine, 3.5inch barbed needles were used for the preparation of non-woven fabric. The barbed needles having gauge 32 and the punch density was kept $105/cm^2$. The speed of needle punching was 2 m/min. The penetration of the needle in the web was 1.2 cm.

Quality Assessment of Arecanut Nonwoven material

Various physical properties viz., fabric weight (g/m^2), fabric thickness (mm), tensile strength (kg) and elongation of prepared nonwoven fabrics were carried out.

Fabric weight per unit area of the woven and non-woven fabrics was tested on electronic weighing balance. The value in grams was multiplied by 100 which gave the GSM of the fabric.

Fabric thickness of nonwoven material was measured by “Paramount Fabric Thickness Tester”. The tensile strength and elongation (IS: 1969-1968) of nonwoven Aarecanut material was measured as per the procedure given in ISI Handbook of Textile Testing. “Electronic Tensile Tester” was used to measure the tensile strength and elongation of nonwoven fabrics.

RESULTS AND DISCUSSION

Matured Arecanut waste husk fibers of II-grade (coarser fibers) were chosen for preparation of nonwoven material. The nuts inside are used in the factories for the production of supari, medicine, colouring and many other. The epidermis of the fruit is thrown out as an agro waste or been used as a material for burning. This outer husk is a rich source of cellulose which has great potential to fabricate into nonwoven material. Urea retting methods were employed for extraction of Arecanut fiber. Alkali treatment of natural fibres is used to produce high-quality fibres by transferring crystallinity from cellulose I into cellulose II. Alkali treatment also removes lignin and hemicelluloses[10]. Sodium hydroxide (NaOH) aids the greatest in degradation of lignin when compared to other alkalis, such as sodium carbonate, ammonium hydroxide, calcium hydroxide and hydrogen peroxide[9]. Thereafter; fibres from the husk were separated manually by hand stripping method.

Nonwoven textile material was prepared from grade-II Arecanut coarser fibers by using needle punching method. The fibers were carded by using carding machine and the web was prepared by keeping two layers one in longitudinal and another one in cross-sectional direction. After the formation of web, the fibers were interlocked by inserting and ejecting of the barbed needle in between the fiber’s layer. Thus a needle punched Arecanut nonwoven structure is prepared which need to be further tested for technical textile applications.

Table 1: Description of prepared Arecanut nonwoven material

NONWOVEN Arecanut Material	**Product description**
	• Nonwoven mats (2’x1.5’) • Needle punching nonwoven technique was used • Grade II (coarser fiber) Arecanut husk fiber is used for nonwoven.

Various physical properties viz., fabric weight (g/m^2), fabric thickness (mm), tensile strength (kg) and elongation of prepared nonwoven materials were assessed for technical textile applications.

Table 2: Properties of Arecanut Nonwoven material

Properties of Nonwoven					
Fabric weight (g/m^2)	**Fabric thickness (mm)**	**Strength (Kgf)**		**Elongation (%)**	
		MD	CD	MD	CD
266.5	2.15	1.2	3.0	24	23

(MD: Machine Direction CD: Cross Direction)

It is clear from Table 2 that the average weight of needle punched Arecanut nonwoven material was 266.5 g/m^2. Weight of nonwoven material depends on the amount of fiber present in per unit area of fabricated structure. Thickness of Arecanut nonwoven structure was 2.15mm. Tensile strength was less in (1.2 kgf) machine direction than in cross direction (3.0 kgf). The higher strength in cross direction of nonwoven material could be related to the compactness of fibers in web in cross direction which resulted in less slippage. Some researchers had also stated that the non woven fabric structure was more consolidated in cross direction than in machine direction resulting in less slippage of fiber in cross direction which led to higher tensile strength[13].

Table- 2 also reveals that the elongation of Arecanut nonwoven material was more in machine (24 per cent) than in cross direction (23 per cent). It may be attributed to the fact that the strength of Arecanut nonwoven was found more in cross direction than the strength in machine direction which is inversely related to elongation. Therefore the elongation was less in cross direction. The strength of the fiber is average with good elongation property. The density of the fiber is matching with a manmade fiber and the moisture property is near to bast fibers. Thus it can be said that Arecanut husk the agro waste fiber has remarkable features to be used as textile material.

CONCLUSION

Present investigation on developing nonwoven samples from *Areca Catechu* fibers introduces a new functionality to the Meghalayan agri-waste *Areca Catechu* husk fibers. This study also paved way to sustainability as the waste has been utilized to produce a valuable textile product. About 50percent of arecanut husk is finer than other fibres and the remaining 50 per cent of fibre is coarser than those fibres. The tenacity value of Arecanut husk fibre is comparable to that of goat hair and woollenised jute. Wet weight of Arecanut husk fibre is comparable to that of other fibres. The weight and thickness of all fibre reinforced plastic sheets are comparable[10,15]. On the basis of quality parameters tested, this needle punched Arecanut nonwoven material could be used for various technical textile applications viz. mulching material in Agro-tech, as substitute of jute in Geo-textile, fillers and low buoyancy material in Automobile-textile, packaging, sanitary napkins and nonwoven fabrics in medical textiles etc. This developed husk fiber nonwoven material is both environment and farmer-friendly and also, the fabric made out of the husk is eco-friendly and contains no chemicals.

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