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Dibyashree Saikia
Department of Textiles and Apparel Designing, College of Community Science, Assam Agricultural University, Jorhat, Assam, India

Dr. Binita Baishya Kalita
Department of Textiles and Apparel Designing, College of Community Science, Assam Agricultural University, Jorhat, Assam, India

Dr. Sunita Boruah
Department of Textiles and Apparel Designing, College of Community Science, Assam Agricultural University, Jorhat, Assam, India

Corresponding Author:
Dibyashree Saikia
Department of Textiles and Apparel Designing, College of Community Science, Assam Agricultural University, Jorhat, Assam, India

Blending of Odal (*Sterculia villosa*) and jute for diversified end uses

Dibyashree Saikia, Dr. Binita Baishya Kalita and Dr. Sunita Boruah

Abstract
Environmentally friendly new textiles materials from natural fibers have been getting significant importance day by day as substituted for synthetic fiber. Today, in the present world researchers are paying interest with some under exploited fibers, which are having high potential applications in textiles due to low cost, fairly good mechanical properties, high specific strength, non-abrasive, and bio-degradability characteristics. India has a big role to play in such a situation by utilizing its large reservoir of fibers in the most diverse terrine of the country. This study was attempted to explore the possibilities of Odal (*Sterculia villosa*) fibre blending with jute fibre through needle punching techniques in different ratios. The constructed fabrics were then analyzed for functional properties such as tensile strength, elongation, tearing strength and air permeability. The study on the fabric properties showed satisfactory results for textile use. Among the fabric samples highest thickness (3.4mm) was showed by Odal/Jute 50:50 while, controlled Odal showed least fabric thickness (2.3mm). In the controlled and blended fabrics controlled jute has the highest crease recovery angle (115.2°). Regarding the stiffness, the maximum stiffness noticed in Odal-Jute 50:50 as (4.5cm) and lowest in controlled Odal as (3.2cm).Regarding the tensile strength among the controlled and blended fabrics *viz*., Odal/Jute 50:50 and Odal/Jute 70:30highest tensile strength was showed by Odal/jute 50:50 (0.14g/tex) and lowest in Odal/Jute 70:30 as (0.1g/tex). Regarding the elongation highest elongation percentage was revealed in Odal/Jute 70:30 (39.73%).In comparison between the controlled and blended fabrics, highest tearing strength was found in Odal/Jute 50:50 fabric (36g/m²) and least was observed in controlled jute (26.8g/m²).

Keywords: Odal, non-woven, thickness, crease recovery, bending length, tensile strength

Introduction
Utilization of natural fiber, particularly minor fiber needs further improvement as anenduring strategy to develop the incredible wealth of natural plant fibers that are currently underutilized. (Tanvir Sultana *et al.* 2019 and Rudi Dungani, *et al.* 2016) [1]. Natural Fibers are fibers that are produced by plants, animals, and geological processes. Natural fibers can also be matted into sheets to make products such as paper, felt or fabric. Natural fibers can be used for high-tech applications, such as composite parts for automobiles. Natural fibers can have different advantages over synthetic fibers. Most notably they are biodegradable and renewable. Additionally, they often have low densities and lower processing costs than synthetic materials. In the early part of the 19th century and the beginning of the 20th century, men started producing fibres other than natural sources, which have been called as man-made fibres. Later on, these man-made fibres rose up drastically in textile industries for producing clothing and other important materials. However, some of the synthetic fibres used for producing clothing materials for day to day use are not devoid of health hazards (Gokhale and Katli, 1995) [2]. Natural fibers are nowadays increasingly employed for making nonwoven, replacing the synthetic materials due to economic and environmental considerations. *Sterculia villosa* is a non-conventional fibres which are utilized by the people and is abundantly available in North-Eastern region of India.It produces a strong and brown colour fibre. Jute is a biopolymer of cellulose, hemicelluloses and lignin, which is abundantly grown in India, Bangladesh, China, Nepal and Thailand. Jute is a lignocellulosic best fibre. Due to its harshness it is difficult to produce apparel and other fancy fabric in our day to day life. Blending is one of the methods to create novel combinations in many ways. Blends combine the attributes of each of its component, minimize the negative characteristics and economize the cost of the material (Gahlot and Pant, 2011) [3]. Extracted Odal fibre and Jute was blended in different ratios for production of nonwoven fabrics through needle punching method.

Nonwoven, as an important fabric, is extensively used in construction, medical treatment, environmental protection, clothing, automobile, aerospace, and such fields. In recent years, along with rapid growth of nonwoven fabric demand, as well as its technical production development, the main characteristic of nonwoven fabric is permeating through high and new technology and new materials using. The survival of textile industry depends primarily on the diversification of end products to meet the national as well as international demands. Diversification in the product can be brought about at various stages *viz*., yarn, fabric, design, fashion and style. Blends fabrics can be created with variegated novelty effect that caters the domestic and international market. Keeping in view about the tremendous scope for making diversified products, different products have been prepared from Odal (*Sterculia villosa*) and Jute blended non-woven fabric in the present study.

Methods and Materials

Materials

Odal *(Sterculia villosa)* plant was taken as raw material and was collected from Tinsukia district, Assam, India. The extraction of fibres from the barks of the plant species were carried out by decortications and retting process. The extracted fibres were subjected to degumming and bleaching in different time periods and concentrations with sodium carbonate, hydrogen peroxide.Different physico-chemical properties were also evaluated. Later the treated Odal fibres were blended with jute fibres in different ratio to prepare the nonwoven fabric.

Blending of fibre and preparation nonwoven fabrics

Blending of *Sterculia villosa* with Jute was carried out at National Institute of Jute and Allied Fibres technology (NIRJAFT), Ranikuthi, Kolkata. Needle-punched nonwovens are created by mechanically oriented and interlocking the fibres. This mechanical interlocking is achieved with thousands of barbed felting needles repeatedly passing into and out of the web (Pal, 2009) [4].

For this study the blending of Odal (*Sterculia villosa*) fibre and Jute fiber were done at carding stage at the ratio 50:50 (Raw jute and Degummed Odal) and 70:30 (Raw Jute and Degummed Odal). Both the fibers are allow passing through openers and then fed into carding machine in predetermined quantity by electric auto scale controlled system and trapped in the wires of the series of rotating cylinders. The fibres were aligned in the parallel direction. A web or net was formed on card which was passed by doffer to the cross-lapper and cross-lapped by placing the web first in the longitudinal direction and then in the cross wise direction. Layered webs are adjusted to meet the standards and delivered to needle punching by means of web feeder. After that in pre needle punching, various layers are interlacing each other with lower needle density. It is a preliminary 3D interleaving to entangle the fibers.

The pre punched layered web of blended fibers (each separately) was delivered by means of conveyer belt and rollers through two needle punching looms placed back to back. Fabric passed from first loom to second loom where the web gets needle punched successively to get the middle density nonwoven fabric of recycled fibers. In this process of needle punching the fiber web is passed through there needle punching looms, so that the more compressed nonwoven fabric can be developed.

Calendaring is a finishing process used on nonwoven where fabric is passed under hot rollers at high temperatures and pressures. The fabric runs through rollers that polish the surface and make the fabric smoother and more lustrous. High temperatures and pressure are used as well. Fabrics that go through the calendaring process feel thin, glossy and papery. For the present study 180°C temperature was kept for upper roller and 170°C was kept for lower roller. The needle punching and calendaring process was carried out separately for each kind of recycled blended fiber samples.

Slitting, Winding and Edge cutting- Nonwoven roll goods are converted in a variety ways, such as slitting, Winding and Edge cutting.

Assessment of properties of blended non-woven fabrics

Thickness is the distance between the upper and lower surface of material measured under a specified pressure. Thickness of all the developed fabric samples were analyzed using B.S. Method 2544:1954 (Booth, 1968) [5]. Crease recovery is nothing but allowed the fabric to recover from the crease. Crease recovery (degree) of samples was analyzed using Shirley's crease tester according to I.S 4681–1968 method. Stiffness is the resistance of fabric to bending. Bending length is the length of the fabric that bends under its own weight to a definite extend. Bending length of developed nonwoven fabrics were tested as directed in BS test method: 3356-1961.The tensile strength was determined according to ASTM procedure (1962-1964) [6] by using Stelometer. The breaking load was indicated by the pointer which moves over the large scale graduated from 0-10kg load. Paramount tear tester iz™ is use to determine the ballistic tearing strength of the non-woven fabrics.

Preparation of product from the non-woven

Different diversified products were prepared from the developed nonwoven fabrics at cottage level. Increased use of nonwoven fabrics from minor fibres for production value added product is expected to have some ripple effects in the textile sectors.

Results and Discussion

Assessment of the properties of blended non-woven fabric

Table 1: Thickness of controlled and blended nonwoven fabrics

Fabrics	Thickness(mm)
Controlled Jute	2.3
Controlled Odal	2.4
Odal/Jute 50:50	3.4
Odal/Jute 70:30	2.6
SEd(±)	0.068
CD(0.05)	0.142

The results were mean of 5 observations.

The empirical data presented in Table 1 displayed fabric thickness of controlled jute as (2.3mm),controlled Odal as (2.4 mm),Odal-Jute 50:50 as (3.4mm) and Odal-Jute 70:30 as (2.6mm). In comparison between the controlled and blended non-woven fabrics it was found that thickness of the Odal-Jute 50:50 blended fabrics showed highest thickness as (3.4mm) and lowest in controlled Odal as (2.3mm). In case of Jute controlled nonwoven fabrics the thickness was slightly decreases. Similar observations were also reported by (Singh, 2010) [7] the thickness of nonwoven fabric prepared from *Sesbania* fibre through needle punching method ranged between 4.6 to 7.9mm.The ANOVA relating to thickness of the fabric depicted a significant difference between the controlled and blended fabrics.

Table 2: Crease recovery and stiffness of controlled and blended nonwoven fabrics

Fabric	Recovery (degree)	Stiffness (cm)
Controlled Jute	115.2	3.24
Controlled Odal	114.2	3.20
Odal/Jute 50:50	104.8	4.50
Odal/Jute 70:30	114.6	3.30
SEd(±)	1.475	0.179
CD(0.05)	3.077	0.374

The results were mean of 5 observations.

The investigated data revealed that crease recovery angle of controlled Jute and controlled Odal was (115.2 degree) and (114.2 degree) respectively. In comparison between the controlled and blended nonwoven fabrics, highest recovery angle was observed in controlled Jute as (115.2 degree) and lowest in Odal-Jute 50:50 as (104.8 degree). Regarding the stiffness, the maximum stiffness noticed in Odal-Jute 50:50 as (4.5cm) and lowest in controlled Odal as (3.2cm).However, the statistical analysis revealed that there was significant difference in the crease recovery degree at 5% level of significant. Also the stiffness of the fabrics showed significant difference at 5% level of significance.

Table 3: Tensile strength (g/tex), elongation (%) and tearing strength (g/m²) of controlled and blended nonwoven fabrics

Fabric	Tensile strength (g/tex)	Elongation (%)	Tearing strength(g/m²)
Controlled Jute	0.12	39.00	26.8
Controlled Odal	0.11	39.12	27.0
Odal- Jute 50:50	0.14	39.41	36.0
Odal- Jute 70:30	0.10	39.73	30.0
SEd(±)	0.022	0.796	0.704
CD(0.05)	0.047	1.660	1.469

The results were mean of 5 observations.

The tensile strength and elongation of controlled and blended fabrics were assessed and presented in Table 3.

It was evident from the Table that among the controlled and blended fabrics *viz.*, Odal /Jute 50:50 and Odal/Jute 70:30 highest tensile strength was observed in Odal/Jute 50:50 (0.14g/tex) and lowest in Odal/Jute 70:30 as (0.1g/tex). The strength of the needle-punched fabrics depends on the choice of fibres, strength of the fibre, length of the fibre and the chemical component present in the fibre.

From the table it was inferred that among the controlled and blended fabrics highest elongation per cent was showed in Odal/Jute 70:30 (39.73%) and lowest in Odal/Jute 50:50 (39.41%).The lowest elongation observed in Odal/Jute 50:50 may be due to the higher strength of the fabrics whereas, lowest elongation noticed in 70:30 blend proportion due to the highest strength of the fabric (Patel and Bhrambhatt, 2016) [8].

In comparison between the controlled and blended fabrics, highest tearing strength was found in Odal-Jute 50:50 fabrics (36g/m²) and least were observed in controlled jute (26.8 g/m²). It can be deduced from the results that the nonwovens prepared from blended fibres exhibited more tearing strength than the nonwovens prepared from controlled fibres.

On the basis of ANOVA, it was found that there was a significant difference between the controlled and blended fabrics. Statistical analysis also revealed that there was significant difference between the mean values of elongation at 5% level of significance. In case of tearing strength it was found that there was significant difference between controlled and blended fabrics. In case of both controlled fabrics the results of tensile strength, tearing strength and elongation were at par.

Diversified products from developed Nonwoven fabric (Odal and jute)

Diversified products such as Air bag, File cover, Flask cover and Duster were prepared from developed Odal and jute blended nonwoven fabric which was shown in the fig 1, 2, 3 and 4.

Fig 1: Airbag ((Odal/Jute50:50)

Fig 2: File cover (100% Jute)

Fig 3: Flask cover (Odal/Jute70:30)

Fig 4: Duster (100% Odal)

Conclusion

In recent years, emphasis has been put to explore more and more natural resources and derived fibre to produce various textile materials for safer use. It is investigated that there will be a global shortage of conventional natural fibres in the recent years. Therefore, search for new fibres specially fibres from non-conventional plant sources have been started in many parts of the world, as it felt to be appropriate step towards meeting the future demand of natural fibres. The new non-conventional plant fibres have broad space for development and market potential.

With the growing scarcity of biodegradable fibres, plant fibres could suitably be used as alternative source of fibres. Blending of Odal fibre and jute fibre was an attempt to compensate the properties of each fibre as well as the reduction of cost. Besides this blending also opens up ways for range of diversified products by offering something new and unique to the market. The blended fabrics can be utilized for different value added products with distinct characteristics.

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