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PROPERTIES OF BHIMAL/VISCOSE BLENDED YARNS

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ABSTRACT

Bhimal Fibre: Unlocking its Potential through Blended Yarn Development

Bhimal fibre holds immense economic potential, yet its underutilization can be attributed to limited awareness and a lack of exploration in its applications. This study addresses this gap by investigating the development of blended yarns combining bhimal fibres with viscose, a man-made fibre known for its versatility and compatibility with a range of textiles. The research focuses on optimizing the processing of bhimal fibres and their incorporation into blended yarns to enhance their utility and market value.

Fibers sourced from the cambium layer of the Grewia optiva tree, known as Bhimal fibres, were processed through cottonization to render them compatible with traditional cotton spinning equipment. The cottonization process entailed reducing the fibre length to a manageable size, akin to that of viscose fibres. The fibres were further aligned using a plastic foil cutter and trimmed to a uniform length of 30-40 mm, ensuring compatibility with viscose fibres. This adjustment was critical for seamless processing during the spinning phase.

To produce the blended yarns, the sandwich blending technique was employed. This method ensured a uniform distribution of bhimal and viscose fibres, enhancing the blend’s cohesiveness. However, the inherent lack of cohesiveness in 100% Bhimal fibres posed significant challenges. These fibres, due to their tendency to disintegrate, were unsuitable for forming laps required in the spinning process. Consequently, various bhimal-to-viscose blending ratios were explored to identify compositions that improved yarn quality and performance.

Three primary blend ratios were investigated: 65:35, 50:50, and 35:65 (Bhimal:Viscose). The goal was to achieve a balance between the unique properties of bhimal fibres and the desirable characteristics of viscose, such as strength, softness, and elasticity. The inclusion of viscose not only provided structural support to the bhimal fibres but also enhanced the overall processability of the blend on standard machinery.

The research underscores the importance of blending in addressing the limitations of bhimal fibres. By incorporating viscose, the study successfully mitigated the issue of disintegration and improved the spinning efficiency. The subsequent analysis focused on the properties of the blended yarns, including yarn count, strength, elongation, and breaking force. These parameters are critical in determining the suitability of yarns for various textile applications.

The findings reveal that the blending ratios significantly impact the performance and quality of the yarn. Higher proportions of viscose improved the cohesiveness and tensile strength of the yarns, while maintaining an acceptable level of elongation and durability. Conversely, increasing the bhimal content in the blend provided opportunities for utilizing this eco-friendly and economically significant fibre, albeit with certain limitations in strength and processability.

In conclusion, the study demonstrates the viability of developing bhimal-viscose blended yarns and highlights their potential in expanding the applications of bhimal fibres in the textile industry. Future research could explore further optimization of the blending process, advanced finishing techniques, and broader applications in sustainable and technical textiles.

***Keywords**: Bhimal, blended yarns, viscose, spinning, cottonization, yarn properties, sustainability.*

INTRODUCTION

The growing awareness of environmental concerns has led to a global pivot toward eco-friendly and sustainable products, particularly in the textile industry. These products aim to minimize environmental impact during production and throughout their lifecycle. Among these, natural fibres have emerged as a crucial focus due to their functional and utilitarian properties. The increasing shift towards biodegradable and eco-friendly fibres is a direct response to the deteriorating environmental conditions, presenting a sustainable alternative to synthetic materials that often pose significant disposal challenges.

Natural fibres, classified into organic (vegetable and animal-based) and inorganic (mineral-based) categories, are now being widely recognized for their potential to replace synthetic fibres. Historically regarded as limited to rural and traditional uses, these fibres are undergoing a renaissance, with researchers exploring their broader applications in the modern textile industry. Their inherent biodegradability and renewable nature make them suitable for sustainable production practices, aligning with the industry's goals of reducing environmental degradation.

One significant challenge in the contemporary textile industry is to develop fabrics and materials with a reduced ecological footprint while maintaining high functionality and versatility. The cornerstone of sustainable textile production lies in the selection and utilization of renewable resources with minimal environmental repercussions. Bhimal (Grewia optiva) is one such resource, a resilient plant thriving in the temperate and tropical wastelands of the Himalayan foothills. Its fibres represent a sustainable, abundant natural material with promising potential in the textile domain.

The fibre extraction process for bhimal is notably eco-conscious. Minimal chemical use ensures reduced environmental harm, resulting in wastewater that does not require extensive treatment. Such sustainable practices underscore the importance of balancing industrial needs with ecological preservation. However, the processing of bast fibres like bhimal is laborintensive and time-consuming, necessitating advancements in techniques to streamline the process.

One such approach is cottonization, a process which reduces the fibre length to a size comparable to that of cotton, allowing them to be processed on machinery, which is designed for cotton. According to Kadolph, 2009, although cottonized fibres may not retain some of the intrinsic qualities of cotton, such as feel, sheen, and durability, this technique broadens the potential implementation of fibres like flax, ramie, and cannabis. Bhimal fibres, too, underwent cottonization to make them suitable for blending with viscose fibres. These fibres were aligned and trimmed to a length of 30-40mm to match the viscose fibres used for merging. The viscose fibres, in a bleached state, were blended with bhimal fibres to combine the best attributes of both materials.

Blending fibres is a meticulous process aimed at enhancing the overall properties of the final yarn. Bhimal fibres, known for their coarse texture, benefited from blending with viscose, which imparted improved softness and uniformity to the resulting yarn. The properties of the blended yarns, including yarn count, strength, elongation, and twist, were systematically evaluated to ensure optimal quality.

The development of yarns using bhimal and viscose fibres reflects a step forward in sustainable textile production. By combining traditional natural resources with modern processing techniques, the textile industry can create eco-friendly materials without compromising on performance or aesthetic appeal. The outlined process for bhimal fibre extraction, cottonization, and blending with viscose serves as a model for integrating sustainability into textile manufacturing practices.

In conclusion, the use of natural fibres like bhimal offers a viable solution to the growing demand for sustainable textiles. By leveraging innovative techniques and blending practices, the industry can harness the potential of these fibres to create products that align with ecological and consumer demands. This paradigm shift not only supports environmental preservation but also paves the way for a sustainable future in textiles.

METHODOLOGY

To produce the blended yarns, the sandwich blending technique was employed to combine bhimal with viscose. In this technique, sequential layers of fibres, each weighed in precise amounts, were systematically stacked to ensure uniformity in the findings. Three distinct blend proportions were selected as follows:

Bhimal (Grewia optiva) (Percentage by weight)	**Viscose (Percentage by weight)**
65	35
50	50
35	65

The machinery specifications used at the Pilot Plant for yarn production are presented in Table 1.1. The procedure for creating blended yarns from Bhimal and Viscose is outlined as follows:

Table 1. Machinery Specifications utilized in Yarn Manufacturing

Name	Model	Make
Blow room	-	Lakshmi Machine Works, (LMW), Coimbatore
Carding	C 1/2 A	Lakshmi Machine Works, (LMW), Coimbatore
Draw frame	DO/2S	Lakshmi Machine Works, (LMW), Coimbatore
Roving (Simplex)	GS	Lakshmi Machine Works, (LMW), Coimbatore
Ring frame	Super Spinner	Mafatial Engineering India (MEI)

Blow Room

The blow room functions as the initial processing stage where sandwich-blended fibres undergo systematic cleaning and opening. The bale breaker first separates compressed fibre masses into small tufts, which then move through the ERM cleaner for impurity removal via mechanical and pneumatic actions. The Kirschner beater performs final opening and cleaning before the fibres are consolidated into a uniform lap structure for subsequent carding operations.

Carding

The carding machine is a critical component in yarn processing that converts raw fibres into an organized form through mechanical action. The process begins as the feed roller delivers fibre tufts to the main cylinder fitted with wire teeth, which work alongside stationary and revolving flats. As the cylinder rotates, the opposing tooth directions and varying speeds separate, clean, and align the fibres in parallel while eliminating impurities and short fibres. The processed fibres are then collected by the doffer cylinder and transformed into a continuous card sliver, which is coiled into cans for subsequent processing stages.

Drawing out

In yarn processing, the drawing out process consists of feeding several carded slivers through rollers operating at varying speeds. This procedure elongates and attenuate the fibres, which enhances uniformity, strength, and consistency in the sliver. The resultant drawn sliver is smoother and more refined, making it suitable for the following stages.

Roving

The roving frame, commonly referred to as the simplex, refines the sliver by elongating it and incorporating a slight twist, converting it into roving, which is a finer strand of fibre with minimal twist. This process alters the sliver into roving, a finer strand of fibre with a gentle twist. The roving is then wound onto a bobbin, where it is prepared for the final spinning process, which will turn it into yarn. The main purpose of the roving frame is to improve fibre alignment and consistency before spinning.

Ring frame

The ring frame is a crucial element in yarn manufacturing, where it transforms mooching into yarn. In this process, the roving is fed from spools and drawn out by breakers to further lengthen the filaments. The elongated roving also passes through eyelets and is guided by a rubberneck that moves around a stationary ring. The spindle's gyration imparts twist to the roving, which strengthens and binds the filaments together. contemporaneously, the crooked yarn is wound onto a conical bobbin. This process of delineation, wringing, and winding produces the final yarn, which is prepared for the coming stages of cloth product.

The bhimal-viscose blend was developed by manually combining bhimal fibres with viscose to ensure a uniform mixture. Due to their lack of cohesiveness, pure bhimal fibres could not be formed into laps as they tended to disintegrate. Consequently, blends of bhimal and viscose in ratios of 65:35, 50:50, and 35:65 were explored. A admixture of anti-static lubricant and water was applied to the carded stages, which softened the fibres, bettered their malleability, and eased spinning issues associated with the coarse and rough texture of bhimal fibres (Basu, De & Samanta, 2009).

In the 65:35 blend, the fibres were evenly dispersed across the conveyor belt of the Mini-Card, where they were transformed into laps. During the carding process, the fibres were guided through rotating rollers embedded with fine wire brushes, effectively disentangling them and organizing them into delicate layers. These layers were subsequently advanced through the breaker and finisher drawing stages, which refined their alignment and improved their uniformity, culminating in the formation of a sliver.

The sliver was subsequently drawn through rollers operating at varying speeds, stretching the fibres and transforming it into a more consistent strand. It was further refined in the speed frame, where it was stretched into roving through a series of rollers in the ring frame. During this stage, the roving passed through eyelets and the traveler on the ring, which added a twist to the yarn at a steady rate. The twisted yarn was then wrapped onto a bobbin. Yarn production for the 65:35 bhimal-viscose blend was accomplished through ring spinning, with the 50:50 and 35:65 blends being processed in a similar manner. Among the three blended yarns evaluated, the 35:65 bhimal-viscose blend exhibited superior evenness with a lower incidence of protruding ends.

RESULT & DISCUSSION

Yarns produced from bhimal fibre blends exhibit distinct characteristics, primarily due to the intrinsic properties of bast fibres. These yarns are marked by a high frequency of protruding ends and significant irregularities in their diameter, with noticeable thick and thin areas along their length. Such attributes can be traced back to the structural composition of bast fibres, wherein individual fibres within the bundles tend to remain largely intact during processing. This unique nature of bast fibres contributes to the irregularities observed in the yarn structure.

In the case of bhimal fibres, their processing into staple lengths prior to blending plays a critical role in defining the final yarn characteristics. Unlike continuous filament fibres, staple fibres inherently lack uniformity, which is further pronounced when dealing with bast fibres like bhimal. This results in a yarn structure that, while texturally unique, often deviates from the uniformity typically seen in yarns spun from synthetic or highly processed natural fibres. The staple processing method leads to the formation of a soft and fluffy surface texture in the resulting yarns, lending them a distinct tactile quality.

Furthermore, the tendency of bhimal fibre yarns to display a high degree of protruding ends can be linked to their shorter fibre lengths and natural coarseness. These features contribute to the yarn's soft hand and bulk, making them suitable for applications where these properties are desirable. However, the structural variability and irregularities in yarn diameter might present challenges in specific textile applications requiring uniformity and precision.

The study and understanding of such characteristics are essential for optimizing the blending and spinning processes when working with bhimal fibres. Adjustments in processing techniques, such as refining the fibre preparation or modifying the spinning parameters, may help mitigate some of these irregularities while retaining the beneficial properties of the fibres. Consequently, the unique properties of yarns made from bhimal fibre blends can be harnessed effectively, provided their limitations are addressed through targeted technological interventions.

The findings underscore the importance of considering the inherent traits of bast fibres like bhimal in textile production, offering valuable insights into the opportunities and challenges they present (Kadolph, 2009). This knowledge contributes to expanding the utility of such sustainable fibres within the modern textile industry.

Evaluation of yarn performance parameters

Bhimal fibres were blended with viscose fibres in three distinct ratios—65B/35V, 50B/50V, and 35B/65V—during the carding stage. The blended fibre mixtures were processed using the Ring Spinning System, a versatile technology that facilitates efficient fibre blending and allows for the conversion of diverse fibre types into high-quality yarns. The primary objective of blending bhimal fibres with viscose was to mitigate their inherent limitations, such as rough texture and stiffness, by leveraging the superior properties of viscose fibres. This blending strategy not only enhances the spinnability of bhimal fibres but also opens new avenues for developing innovative textiles that cater to evolving market demands.

Gahlot (2007) highlighted that the brittle nature of tasar silk fibres posed challenges in yarn formation due to significant breakage during the processing of pure tasar waste fibres. Viscose fibres played a crucial role as a carrier, improving the processability of these fibres on the Ring Spinning System. This insight reinforces the critical role of viscose in enhancing the spinning performance of natural fibres, including bhimal, thus expanding their application potential in textile manufacturing.

Yarn properties are essential in shaping fabric characteristics, impacting both the structural integrity and visual appeal of textiles. The yarn's size, structural strength, and quality are vital in textile design, as they directly affect the fabric's look, feel, and functionality. A thorough understanding of the interdependence among these yarn properties is essential, necessitating rigorous testing to evaluate their individual and collective effects on the final fabric characteristics.

The blending of bhimal and viscose fibres exemplifies the potential to create versatile yarns with tailored properties, thereby contributing to the production of unique and functional textiles. This approach aligns with the growing demand for innovative, sustainable, and high-performance fabrics in the modern textile industry. The properties of the developed blended yarns are meticulously analyzed and discussed in subsequent sections, each focusing on specific yarn characteristics to provide comprehensive insights into their performance and application potential. This research underscores the transformative impact of fibre blending in advancing textile technology and broadening the scope of product development.

1. Yarn count

Yarn count is a measure of yarn fineness, which directly impacts the thickness and texture of the resulting fabric. In this research, yarn count was determined using the Ne (Cotton Count) system, an indirect method of yarn numbering. Within this system, a higher count number corresponds to a finer yarn, indicating a greater number of yarns per unit length (Hollen and Saddler, 1973). Mean values are presented in Table 1.1 and illustrated in Figure 1.

Table 1.1 Yarn Count in blended Yarn

S.No	Blend Ratio	Yarn Count (Ne)
1	65B/35V	4.20
2	50B/50V	6.17
3	35B/65V	19.34
4	100V	24.73

B=Bhimal, V=Viscose

Table 1.2 demonstrates that the 100% viscose yarn exhibited a higher yarn count compared to the blended yarns. A consistent trend was observed across all viscose blends: increasing the proportion of bhimal fibres resulted in a decrease in yarn count, indicating an increase in yarn thickness. The 35:65 bhimal-viscose blend exhibited the highest yarn count, signifying it as the finest yarn among the three developed samples. Conversely, the 65:35 bhimal-viscose blend displayed the lowest yarn count, indicating it was the coarsest yarn.

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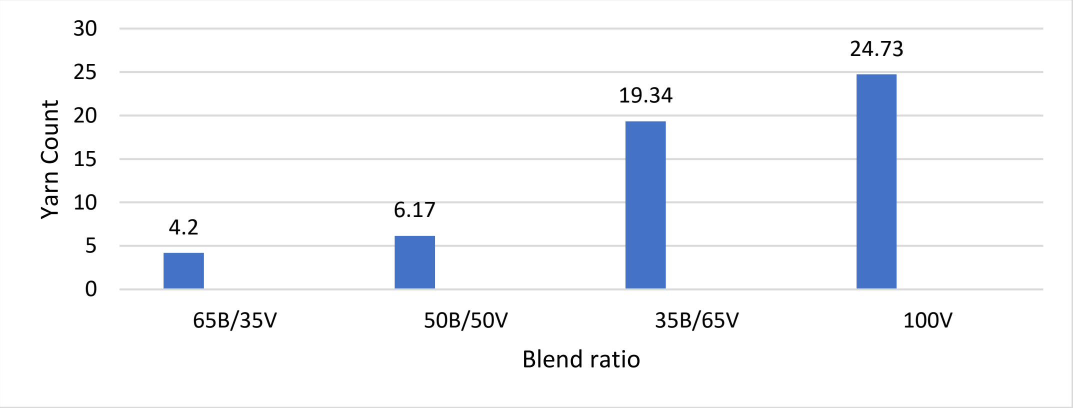


Figure 1. Yarn Count of blended yarn

The thicker diameter of bhimal fibres, in comparison to viscose fibres, resulted in a reduction in yarn fineness. As the proportion of bhimal fibres in the blend increased, a corresponding increase in yarn thickness was observed. Furthermore, the superior spinnability of 100% viscose, due to its longer staple length and improved cohesiveness from a higher degree of crimp, likely facilitated the production of finer yarns. In contrast, increasing the bhimal fibre content in the blend made it more challenging to achieve finer yarn counts.

2. Yarn Twist

Yarn twist is a crucial structural feature that greatly affects important yarn properties, such as tensile strength, and plays a vital role in the efficiency of subsequent processing steps.

Table 1.2 Amount of Twist in blended yarn

S.No	Blended Ratio	Twist (turns/inch)	C.V(%)	Direction of Twist
1	65B/35V	12.19	1.77	Z
2	50B/50V	12.61	4.74	Z
3	35B/65V	21.43	4.77	Z
4	100V	10.38	5.81	Z

B=Bhimal, V=Viscose

Table 1.2 reveals that the twist count of the blended yarns fell within a range of 10.38 to 21.43 twists per inch. The observed variation in yarn twist can be attributed to the well-established principle that twist level is directly influenced by yarn thickness. High-count yarns, typically necessitate an increased level of twist to achieve the desired yarn durability and consistency (Basu, 2001). All three of the produced yarns exhibited a Z-twist.

Yarn Strength

Yarn strength is crucial for fabric durability. The tenacity (resistance to break) and elongation (stretchability) of each yarn were measured, with the average values shown in Table 1.3.

Among the blended yarns, the 65B/35V blend exhibited the lowest tenacity. A progressive increase in viscose fibre content, from 35% to 65%, resulted in a corresponding improvement in yarn tenacity.

Table 1.3 demonstrates that the 100% viscose yarn exhibited the lowest strength, followed by the 65B/35V and 50B/50V blends. Notably, the 100% viscose yarn displayed the lowest coefficient of variation (CV) percentage. A positive correlation was observed between the proportion of bhimal fibres in the blended yarns and the CV percentage, indicating increased variability with higher bhimal fibre content. A higher CV percentage signifies greater variability within the yarn.

Table 1.3 Tensile Properties of Blended yarns

S.No	Ratio of Blend Yarn	Tensile Breaking Point (gf)	C.V (%)	Breaking Elongation (%)	C.V (%)	Tenacity (g/tex)	C.V (%)
1	65B/35V	907.50	7.90	4.65	18.5	2.61	11.4
2	50B/50V	901.4	8.1	5.10	19.30	6.22	16.7
3	35B/65V	489.20	8.70	5.46	8.80	8.43	6.2
4	100V	560.2	5.87	71.45	8.72	15.51	5.87

B=Bhimal, V=Viscose

Elongation at break was maximal in 100% viscose yarn, as observed in Table 1.3. This value decreased progressively with increasing bhimal fibre ratios in the blended yarn samples.

Assessment of yarn breaking strength demonstrated a positive relationship with bhimal fibre content while elongation and tenacity declined as the bhimal fibre content rose, despite its superior intrinsic strength compared to viscose fibre. The interaction between fibres within a blend significantly influences the overall yarn strength, which cannot be predicted solely based on the individual fibre strengths. Bhattacharya (2001) observed that variations in elongation properties between fibres in a blend play a significant role in reducing yarn strength. The differing elongation capacities of fibres lead to uneven stress distribution, resulting in a weaker yarn. In this study, Viscose fibre exhibited a considerably higher breaking elongation of 71.45%, while bhimal fibre showed a lower elongation of 3.77%.

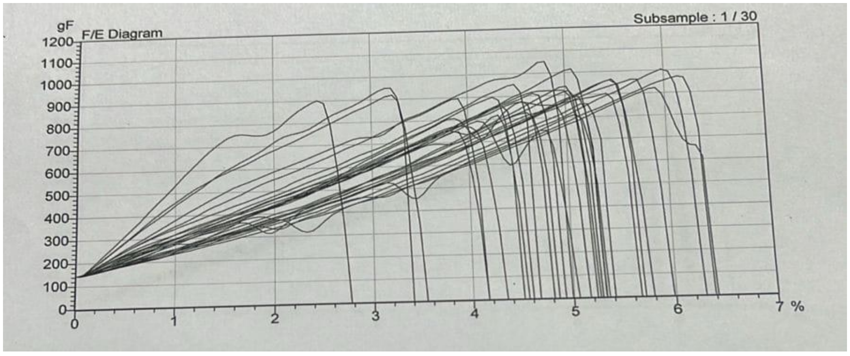
The incorporation of fibres with dissimilar elongation properties in blended yarns significantly impacts their mechanical performance. In his pivotal study, Goodwin (1959) demonstrated that heterogeneous fibre elongation characteristics result in uneven stress distribution within the yarn structure. Fibers with lower elongation capabilities experience heightened stress concentrations, thereby limiting the yarn's overall extensibility. Conversely, mono-fibre yarns exhibit enhanced strength characteristics owing to their uniform elongation behavior, underscoring how fibre uniformity influences composite yarn performance. In a study Press (1959) highlighted a key flaw in blended yarn is that the fibre with lower elongation will snap first when subjected to stretching or tearing. This occurrence restricts the reinforcing qualities of the fibre’s strengths to the stress absorbed until the elongation limit of the lower-elongation element is met. Various intrinsic factors affect the final strength of spun yarn, and the consistency of yarn uniformity is a key element (Grover and Hamby1988). They indicated that more uniformity is associated with higher yarn strength, while unevenness lowers its strength.

It is summarized by Salhotra (2004) that a significant body of research on the tensile strength of blended yarns has consistently demonstrates that the observed yarn strength is lower than the theoretical average strength, which is evaluated from the individual component fibres' strengths and their respective proportions.

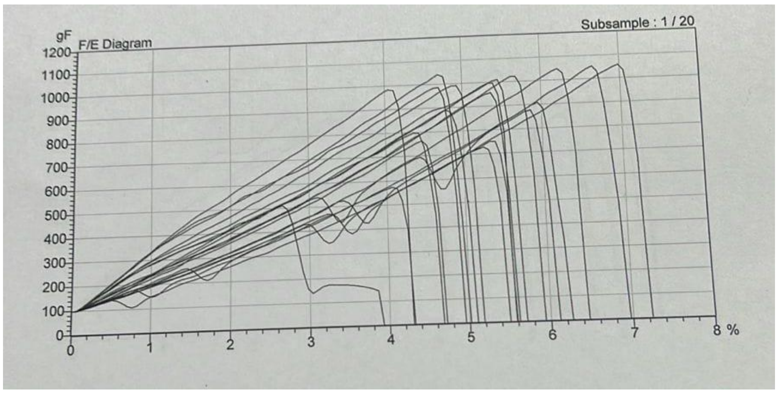
3. Stress-strain curve

Figure 2 illustrates the stress-strain curves for various blended yarn samples, with strain percentage and load in grams force plotted on the X-axis and Y-axis, respectively. Each curve represents 30 readings for a specific sample. While a general trend of increasing strain with increasing load was observed, significant variability existed among the samples. Some samples exhibited higher load-bearing capacity and strain at failure, while others failed at lower loads and strains. Diversity observed across the stress-strain curves is evident in the broad spectrum of extreme values, straying considerably from the average values for both load and strain.

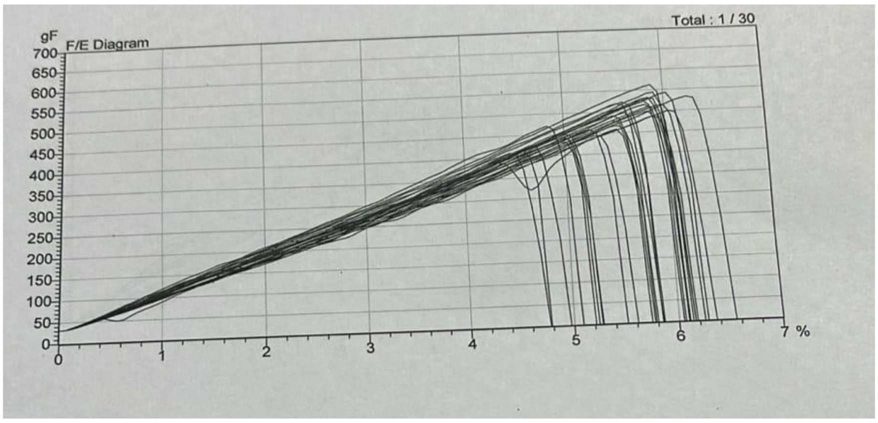
Figure 2 Stress-strain Curve



65B/35V



50B/50V



35B/65V

B=Bhimal, V=Viscose

Conclusion: Bhimal (Grewia optiva): A Sustainable Fiber for Blended Textile Applications

Bhimal (Grewia optiva), a versatile plant, holds immense potential in diverse applications ranging from fodder and fuel to dyeing and textile production. Its sustainable and eco-friendly nature has garnered attention for use in modern textile development. Recent research highlights the potential of blending bhimal fibre with viscose to enhance its utility and overcome inherent limitations, such as rough texture and rigidity.

Blended yarns of bhimal and viscose were produced using the ring spinning method in three distinct ratios: 65:35, 50:50, and 35:65. An in-depth analysis of the physical properties of these blends revealed noteworthy improvements, particularly in the 50:50 and 35:65 ratios. These blends demonstrated enhanced performance metrics, including finer yarn counts, greater tensile strength, and superior elongation properties. Among the developed blends, the 35:65 bhimal-viscose yarn exhibited optimal characteristics, achieving a yarn count of 19.34 Ne, elongation of 5.46%, and tensile strength of 8.43 g/tex.

This innovative approach to blending addresses the fundamental challenges posed by bhimal fibre’s natural coarseness and rigidity. By combining it with viscose, a smoother and more flexible fibre, the resulting blends significantly enhance the overall attributes of the yarn. The synergistic effect of this combination opens up avenues for the creation of novel textile products that are both functional and aesthetically pleasing.

The research findings underscore the potential of bhimal-viscose blends in contributing to the textile industry's shift towards sustainable practices. Bhimal, a renewable resource, when integrated with viscose, not only elevates the material’s performance but also aligns with global efforts to reduce environmental impact. The development of such blended yarns can support the creation of eco-friendly textiles suited for diverse applications, including apparel and home furnishings.

In conclusion, the study demonstrates that the strategic blending of bhimal fibre with viscose not only overcomes inherent material constraints but also paves the way for innovative and sustainable textile solutions. By leveraging the unique properties of bhimal, the research contributes to advancing the field of eco-friendly textiles while promoting resource optimization and sustainability in textile manufacturing.

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