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RESEARCH ARTICLE

PERFORMANCE OF PARTHENIUM: POLYESTER BLENDED YARNS

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ABSTRACT

Blending of fibres can improve the yarn performance. In the present work, Parthenium fibre and Polyester fibre were blended in different ratios to evaluate the yarn properties. Fibres were blended in different ratios and yarns were developed on ring spinning system. Different properties of developed yarns such as yarn twist, tensile strength and elongation, yarn count and yarn unevenness were assessed as per standard test methods. It was concluded that increasing the polyester component in blend increases the yarn strength and elongation and decreases the yarn unevenness and imperfections. It was concluded that the yarn properties analysed improved the quality characteristics of the blended yarns developed.

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INTRODUCTION

Natural and eco-friendly fibres are becoming more and more in demand globally because of improving living standards and the need to protect the environment (Baheti, *et al*., 2013). Natural fibre's low density, biodegradability, low-cost abundance and renewability are the reasons for its rising demand (Bindal, *et al*., 2013). The process of blending various lots of fibres to produce a uniform material is called blending (Miao, 2018). Blending fibres with changing the properties, enhances specific qualities and improves yarn processing performance. In the spinning industry, blending is very common technique. The main goal of the blending process is to optimise the raw material's cost and improve the qualities of the final fibre mix. The characteristics of the individual fibres and how well they work together determine the qualities of blended yarns (Sowmya, *et al*., 2017). Babaarslan, *et al*., (2023) opined that the yarn's performance is greatly influenced by its structure. The quantity of waste produced during the operation and the quality of the spun yarn are frequently used to gauge spinnability. To produce high-quality yarns for clothing applications, fibres with low spinnability are frequently blended with cotton for fibre spinning (Abdullah, *et al*., 2020). Although there are many variables that affect the yarn structure, the most significant ones are the mechanical characteristics of the constituent fibres, the distribution of the fibres along the yarn cross-section, and relationship between the elements of the yarn structure, such as friction, different surface characteristics, and number of contact points, which are dictated by the spinning system, twisting level, chemical processing (Rask, *et al*., 2011). A common technique for improving a fabric's functionality and appearance is to blend different kinds of fibres. The unique advantage of blended yarns manufactured from natural and synthetic fibres is their ability to effectively combine the positive qualities of both fibre components, such as ease of maintenance and comfort of use. These advantages also allow for a greater range of items to be produced, which increases the marketing edge (Prakash, *et al*., 2012). Grey stage fibres can be blended, or they can undergo pre-treatment before being blended. In this study, environmentally friendly biocatalysts were used to treat lignocellulosic fibres, such as banana and jute, and hydrogen peroxide was used to bleach the fibre surface. The control and surface-modified fibres have been mixed in various ratios and their physical characteristics have been described. Additionally, the yarns visual and physical qualities have been assessed, and they have been used to create union fabric with cotton yarn as the warp (Chattopadhyay, *et al*., 2020). Blending fibres often involves combining various fibres with varied properties in order to achieve or enhance specific processing performance or yarn form attributes. The qualities of a fabric made from a single fibre may not be as good as those of a fabric made from blended yarn (Prakash, *et al*., 2011). One unique advantage of blended yarns manufactured from natural and synthetic fibres is their ability to effectively combine the beneficial characteristics of both fibre compositions, such as ease of care and comfort of use. These benefits also make it possible to produce a wider range of goods, which strengthens the competitive edge (Pan, *et al*., 2000). Blending is done in the production of staple fibre yarn for a variety of reasons, such as consistency, technical and engineering, functional, aesthetic, and financial considerations. Blending yarns made from natural and synthetic fibres offers the unique benefit of effectively combining the positive qualities of both fibre components, including cross-dyeing effects because of the different dye affinities of the two fibre types, cost reduction without significantly sacrificing yarn performance, and comfort of wear with easy-to-maintain properties (Samanta, *et al*., 2014). Due to customer demand for environmentally friendly products and the many advantages plant fibres offer over synthetic ones, parthenium fibres have once again gained popularity, especially in the automotive and aerospace industries. It has been demonstrated that plant fibres are more comfortable than other fibres (i.e., more sweat-absorbing, non-irritating to the skin, warmer in the winter and cooler in the summer, softer and less scratchy) (Vinod, *et al*., 2023). The highest amount of synthetic fibre produced globally is polyester fibre, more precisely poly ethylene terephthalate (PET) fibre.

More than 50 million tonnes were produced overall in 2016, and its growth rate was significantly higher than that of any other fibre, synthetic or natural. PET (poly ethylene terephthalate) fibre's overwhelming success can be attributed to its low cost, easy processing, blend ability with cotton and other natural fibres, easy recycling, and exceptional and customisable performance (Jaffe, *et al*., 2020). Excellent mechanical qualities, low moisture absorption, abrasion resistance and good light resistanceare all attributes of polyester fibre (Jia, *et al*., 2023). Low moisture absorption, good resilience, dimensional stability, superior wear resistance, resistance to light and weather, resistance to abrasion, and blending ability with cotton are all attributes of polyester fibres.

They are thermoplastic, biologically inert, and comparatively resistant to flames, microbes, and insects (Militký, 2018). Synthetic materials like polyester and polypropylene fibres are widely utilised in many different industries because of their superior mechanical qualities, resistance to chemicals, and cost. These fibres are renowned for their low rate of water absorption, excellent tensile strength, and resistance to acids and alkalies (Elfaleh, *et al*., 2023). Blending of parthenium and polyester fibre was done for development of parthenium and polyester blended yarns. This experimental work studied the effect of Parthenium/Polyester blended proportion, strength, and twist level on yarn processing. The work will be a step forward towards converting waste into useful product for textile industry.

MATERIAL AND METHODS

For this study, Parthenium fibre was extracted from the stem of the *Parthenium hysterophorus* plant and Polyester fibre was purchased from NITRA Ghaziabad. Blending and spinning of fibres was done on ring spinning system. Yarns of 10 Ne count were prepared. The Polyester and Parthenium fibre were blended in two different ratios via 50:50, 65:35 of Parthenium/ Polyester. Parthenium 100 % and polyester 100% yarn were developed for base reference. Total 4 blended yarns were prepared.

Testing of Samples: The blended yarn samples are conditioned for 24 hours before testing. Testing wasconducted at a temperature of 20 °C ± 2 °C and 65% ± 2% relative humidity. The testing of the developed yarn was done. Yarn count was measuredby as per IS 1315-1977.Yarn unevenness was tested by as per ASTM D-1425. IS 832-2 standard method was used to assess yarn twist. Breakingforce in gms/tex and elongation % were tested as per ASTM D 2256. The yarn properties measured were analyzed for performance characteristics. Statistical tools were used for analysing the data.

RESULTS AND DISCUSSION

Yarn Count: Yarn count is a numerical measure that indicates the fineness of a yarn (Booth, 1996). The parameters may differ significantly depending on the yarn's intended usage. Yarn count is one of the most crucial identifying characteristics for yarn (Goswami,1977).

Table 1. Count of Yarns

S. No.	Sample code	Yarn count (Ne)	CV%
1	Parthenium 100	8.2	1.53
2	Polyester 100	10.20	3.34
3	PHF1 50: POF2 50	6.25	0.81
4	PHF1 65: POF2 35	9.66	0.81

It is depicted that yarn count of polyester 100 % is maximum (10.20 Ne) and for PHF1 50: POF2 50, it is minimum i.e., 6.25 Ne. One way ANOVA has been calculated to find out the effect blend ratios on thread count of the fabric. Significant difference at one percent level is found between construction parameters (F=954.016).

Yarn Twist: The measurement of the spiral turns that a yarn has to keep its constituent fibres or threads together is called yarn twist. Twist gives a yarn strength and coherence. The fibre in the yarn has a Z twist that is orientated towards the yarn's axis and slopes towards the middle part of the letter Z (Jewel, 2017). When component fibres or yarn are twisted together, the yarn's linear density, abrasion resistance, and rigidity are all uniformly improved (Rosaic, *et al*., 2003).

Table 2. Twist of Yarns

S. No.	Sample code	Yarn Twist (TPI)	CV%
1	Parthenium 100	33.00	0.90
2	Polyester 100	35.45	4.15
3	PHF1 50: POF2 50	35.00	1.59
4	PHF1 65: POF2 35	39.77	3.06

It is revealed that twist per inch of PHF1 65: POF2 35 is maximum and it is minimum for Parthenium 100. The data shows that as percentage of polyester decreased, the twist per inch decreased. Typically, the number of spins per unit length is used to express twist. The yarn's twist affects the woven product's strength, feel, and hand. The strength of the yarn increases as the twist increases until it reaches its maximum, after which it begins to diminish (Vanishee, *et al*., 2018). One way analysis shows that the effect of blend ratio on twist per inch of yarn is significant at one percent level of significance (F= 20.497).

Strength of Yarn: Strength is one of the most important characteristics of yarn as it influences ultimate fabric strength. Yarn strength measuresthe constant force required to break the yarn. It is determined by the breaking load in grams of weight for an individual yarn.

Table 3. Strength of Yarns

S. No.	Sample code	Breaking Force (gm/tex)	CV%
1	Parthenium 100	500	0.45
2	Polyester 100	920	1.89
3	PHF1 50: POF2 50	571.6	1.53
4	PHF1 65: POF2 35	405.5	1.62

The above data reveals that the breaking force in gm/tex of Polyester yarn and blended yarns. Breaking force of blended yarn is less than 100 % Polyester yarn. In case of blended yarn, the breaking force of PHF1 50: POF250is little more than PHF1 65: POF2 35 blend. In general, yarn strength is influenced by fibre type, yarn count, and yarn twist. If a yarn has a higher twist per inch, the greater the yarn strength (Booth, 1996). The lignocellulosic nature of natural bast fibres and their high strength could be the cause of this. However, because of the lack of cohesion, a higher percentage of bast fibre reduced the strength (Dhanalaxmi, *et al*., 2012). The result indicates as polyester component increases, the value of breaking force in g/tex also increased. Babaarsan, *et al*., (2021) studied that the strength of the yarn is gradually improved by increasing the amount of polyester. A higher percentage of polyester fibre in the yarn indicates greater strength because polyester fibre is stronger than cellulosic fibre. Not much difference is found in strength of two blended yarns i.e. PHF1 65: POF2 35 and PHF1 50: POF2 50. One-way Anova is calculated to find out the effect of blend ratio and yarn parameters on breaking force of the yarn. The parameters and blend ratios were found significant at one percent level of significance (F=707.395).

Elongation at break of yarn: Technically significant is the yarn's elongation percentage at maximum stress or break (Basu, 2001). The major cause of blended yarn's low strength is the variation in the breaking elongation of its constituent fibres (Bhattachary, 2001).

Table 4. Elongation of yarns

S. No.	Sample code	Elongation %	CV%
1	Parthenium 100	12.00	1.17
2	Polyester 100	15. 34	3.16
3	PHF1 50: POF2 50	10.71	1.62
4	PHF1 65: POF35	14.72	0.99

It can be deduced that increase percentage of parthenium component increase the elongation at break %. The table no. 4 reveals that in case of polyester yarn, maximum elongation at break is observed and the minimum value is observed for the yarn sample of PHF1 50: POF2 50 (10.71). ANOVA was applied to find out the effect of blend ratios on elongation of yarn. Effect of blend ratio was found significant at one percent level of significance on elongation at break (F= 1.058).

Yarn Unevenness: Salhotra, (2004) reported that yarn unevenness is an important factor when visualappearance of the fabric is assessed. According to Grover and Hamby (1998), an almost numerous ranges of variables can affect the evenness of a textile yarn.

Table 5. Unevenness of Yarns

S. No.	Sample code	Unevenness	CV%
1	Parthenium 100	12.00	3.61
2	Polyester 100	10.30	3.79
3	PHF1 50: POF2 50	11.32	0.72
4	PHF1 65: POF35	11.77	1.71

The above data depicts that the unevenness of pure polyester and blended yarns. It was observed that pure polyester yarn (10.30) unevenness is less than blended yarns. The PHF1 65: POF2 35 blend (11.77) unevenness is more than PHF1 50: POF2 50 blend (11.32). It can bededuced that as parthenium content increases in the blend ratio, unevenness increases. There is significant difference in yarn unevenness at one percent level of significance (F=11.598).

Yarn Hairiness: Hairiness refers to the extent and length of fibre ends or loops protruding from the yarn's surface, giving it a fuzzy appearance. While it can be beneficial for applications like thermal insulation, it is undesirable in contexts requiring cleanliness. This is because abrasion causes fibre ends to break off and shed from hairy yarns. This impact of hairiness depends on the specific application requirements (Li, 2010).

Table 6. Hairiness of Yarns

S. No.	Sample code	Hairiness	CV%
1	Parthenium 100	24.25	3.16
2	Polyester 100	10.50	2.43
3	PF1 50:PF2 50	15.45	3.43
4	PF1 65: PF35	23.50	1.62

The above table 6 show that parthenium 100 has maximum hairiness % (24.25) and minimum (10.50) is found for polyester 100. In blended yarn, the PHF1 65: POF2 35 hairiness is more than PHF1 50: POF2 50. Thus, it can be inferred that as parthenium component increases, hairiness percentage also increases.

CONCLUSION

An increase in parthenium content in parthenium polyester blended yarn significantly influences its quality, especially regarding imperfections and mechanical properties like strength and elongation. Notably, 65 Parthenium: Polyester 35 blend demonstrates the improvement in performancecharacteristics. Therefore, blending parthenium with polyester is recommended to achieve optimal fabric comfort and cost -effectiveness.

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