



Studies on Tensile Properties of Ramie Blended Yarns Based on its Component Fibre Properties

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Abstract: Blending of different fibres having similar or different properties is at present an important consideration for improving certain functional property of the product whether used as apparel or in the area of Technical Textiles. Hamburger [1] in 1949 developed a theory based on tensile properties of component fibres of blended yarn. After development of various man-made fibres, Industry started developing various marketable blended products depending on the buyer's choice. Present study shows the importance of such identified tensile properties on the yarn properties when where properties of component fibres are widely varying. Ramie fibre was blended with both viscose of finer tex and having higher extensibility and pineapple of nearly same extensibility. Hamburger theory was applied to understand the compatibility of these fibres and analysis showed the incompatibility of finer and higher extensible viscose with Ramie although Pineapple fibre is compatible with Ramie. Ramie-cotton (similar properties of viscose are widely acceptable product at present in the world market.

Keywords: blending; degumming; Ramie and Pineapple; Compatibility; Tensile Properties

I. Introduction

Ramie, one of the strongest textile fibre of plant origin ruled the textile world as king of natural fibres. Due to difficulty in degumming [2 – 8] and lack of knowledge of mechanical processing, its popularity in the textile world is limited. Increasing ecological consciousness has accelerated interest in ramie originating plants that are safe, bio-degradable and recyclable. If the apparent demerits can be masked, an excellent diverse range of product can be engineered by exploiting the intrinsic properties of ramie. The demand for Ramie fibre is mainly felt in the fields of blending with the other fibre. Ramie can be blended with cotton, flax, wool, polyester, acrylic and silk etc. Considering the advantage of this fibre like high strength, resistant to bacteria, mildew, and insect attack, good absorbency, lustrous appearance etc. ramie and its blended products are increasingly become popular for various textile uses like apparel, under garments, technical textiles, anti-bedsore bedding etc.

Ramie is most often blended with other fibres for its unique strength, absorbency, and lustre and dye affinity. When blended with high-quality cotton it offers increased lustre, strength and colour. When mixed with wool, ramie adds lightness and minimizes shrinkage. When blended with rayon, it offsets the low wet strength Ramie being a coarser bast fibre, its properties is not suitable for ideal blending with other finer fibres like cotton and man-made fibres although products are being developed using such non-compatible fibres. Keeping the Hamburger [1] model under consideration, the present study deals with

1. Blending of ramie with an incompatible fibre, viscose (finer and high extensible) in cotton system, specially to study the behaviour of these two fibres in yarn simultaneously to study the tensile properties of the yarn.
2. Blending ramie with a compatible fibre (natural leaf fibre - pineapple) in cotton system and to analyze and compare their properties.

II. Materials and Methods

Ramie and Pineapple fibres were cut into 39 mm staple and viscose fibre of same staple were used in different proportion for blending. Ramie-Viscose and Ramie-Pineapple blends were prepared in the proportion of 100:00, 75:25, 50:50, 25:75, 00:100.

Laboratory scale small machines were used suitable for cotton fibre with special opener for initial opening. Standard machine parameters were chosen.

III. Testing of Fibres and Yarns

Tensile properties of fibres were tested in ZWICK tensile tester whereas Tensile properties of yarns were tested in Instron Tensile Tester. In both cases standard testing parameters were chosen.

- Ramie and pineapple fibres were tested following the single strand testing method i.e., single fibre was clamped between the two jaws
- For testing the finer fibre viscose, window testing method was followed.

Table 1: Tensile Properties of Fibres

Properties	Viscose	Pineapple	Ramie
Tenacity (cN/tex)	25.24	30.18	37.14
Extension (%)	14.22	4.81	3.58
Fineness (tex)	0.17	2.1	1.2

IV. Results and Discussions

A. Tensile Properties of Ramie-Viscose Blended Yarns

Table 2: Tensile properties of blended yarn (Ramie-viscose)

SAMPLE	100% R	75% R 25% V	50% R 50% V	25% R 75% V	100% V
Tenacity (cN/tex)	9.02	8.99	8.79	10.00	11.75
Breaking extension (%)	3.31	3.84	4.63	7.19	9.27

Analysis:

From the results obtained in **table1** and **table2**, we can plot a graph showing the tensile behavior of the two incompatible fibres ramie and viscose. Again from the graph we can show how the tenacity of the ramie–viscose blended yarn should change according to the blending ratio with the help of HAMBURGER THEORY.

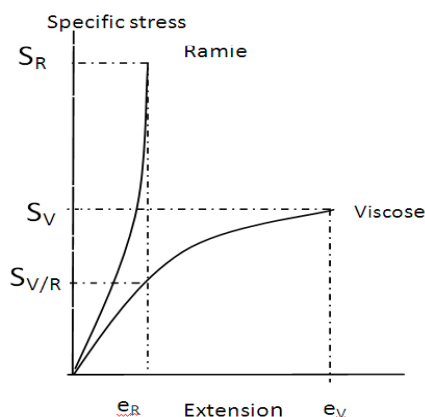


Fig. 1 Curve shows the tensile behaviour of two fibres

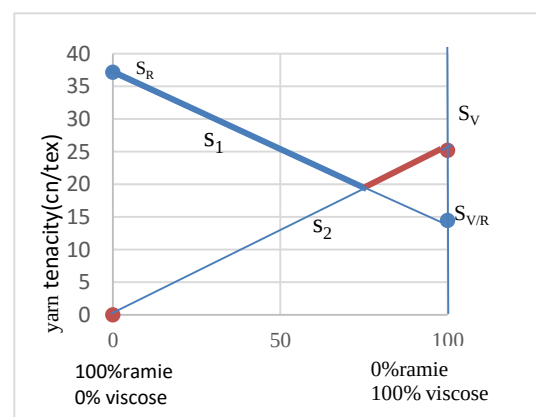


Fig.2 Change of yarn tenacity with blend composition

Here e_R is the first rupture point where all ramie fibres are strained to breaking point as its extensibility is lower than viscose and e_V is the second rupture point when all viscose fibres breaks.

Let, count of the yarn composed of ramie and viscose is T tex.

The **fig 1** shows stress-strain curve of these two components.

Fig2 shows change of yarn tenacity with blend composition

If r & v be the percentage by weight of ramie and viscose fibres respectively then,

T_r = tex no of ramie

T_v =tex no of viscose

When strain reaches the point e_R all the fibres of ramie break. At this point total load P_1 is supported by the composite yarn will be the sum of loads supported by the two components ($P_{1R}+P_{1V}$)

$$P_{1R}=rTS_R/100, \quad P_{1V}=vTS_{R/V}/100$$

$$\text{Yarn tenacity at } e_R = S_1 = (aS_R+bS_{R/V})/100$$

e_V is the second rupture and the load is P_2 which is supported by the fibres of viscose and break at this point

$$P_2=P_{2V}=vT/100$$

$$\text{Yarn tenacity at } e_V = S_2 = P_2/T = bS_V/100$$

- ❖ But the graph obtained from **table2** show that the tenacity of ramie yarn is less than that of viscose yarn although the tenacity of ramie fibre is more than that of viscose fibre. The fibre strength utilization percent in ramie yarn is 24.26% where as in ramie yarn is 45.95%. The higher fibre strength utilization in viscose yarn is due to the presence of more number of fibres in the yarn cross section as the fibre fineness values of viscose and ramie fibres are 0.166tex and 1.2tex respectively but the linear densities of the yarns are same which is 78 tex. The viscose yarn is more regular than ramie yarn as given both in terms of mass CV% as well as strength CV% which is given in **table 3**.

Table 3: Strength CV% of Ramie and Viscose Yarns

Yarn type	Strength CV%
100% ramie	23.8
100% viscose	11.6

Due to the large difference in their linear densities these two fibres are not compatible for blending due to which the results deviates from the blend mechanics proposed by Hamburger¹.

B. Tensile properties of Ramie-Pineapple blended yarn

Table 4: Tensile Properties of Ramie-Pineapple Blended Yarns

SAMPLE	100% R	75% R 25% P	50% R 50% P	25% R 75% P	100% P
Tenacity (cN/tex)	9.02	7.60	7.40	6.50	4.62
Breaking extension (%)	2.08	2.51	2.59	2.76	3.31

The yarn tenacity increases as percentage of ramie increases in the blend.

Again from the results of tensile properties of ramie and pineapple fibres obtained in Table1 we can plot a graph showing the tensile behavior of the two fibres ramie and pineapple (Figure 3). The blended yarn tenacity graph can be obtained by applying Hamburger Theory (Figure 4). The two graphs describing the theory are shown below.

In Fig-3, e_R is 1st rupture and e_P is 2nd rupture point. As ramie and pineapple are two compatible fibres, their extensibility is almost same. So when load is applied to the ramie-pineapple blended yarn, the fibres of both the components are strained to the breaking point at the same time hence there occurs only one rupture.

Comparing fig-3 and fig-4 it is clear that the ramie-pineapple blended yarn follows the hamburger theory as in both case same trend is found.

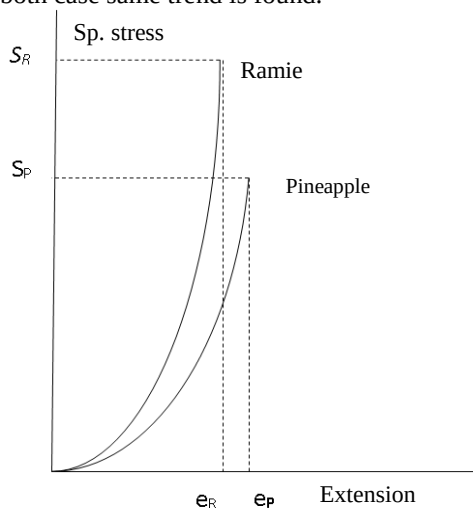


Fig.3 Curve shows the tensile behaviour of two fibres

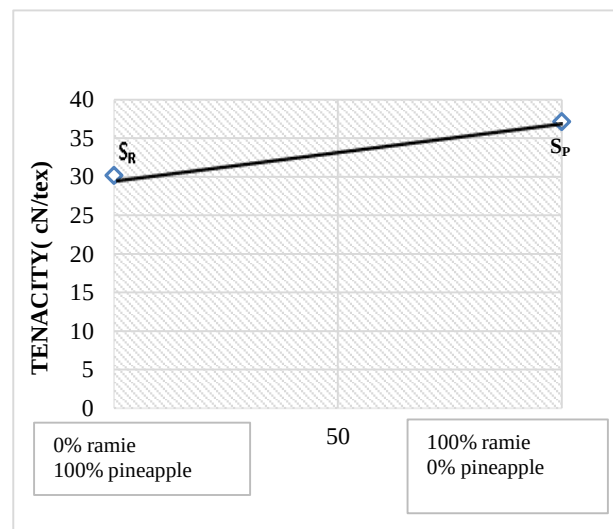


Fig. 4 Change of yarn tenacity with blend composition

V. Conclusion

From the present study of two types of ramie blended yarn it can be concluded that

- Ramie being a less extensible fibre with high specific stress when blended with more extensible fibre viscose should follow the Hamburger theory but as there is a huge difference in their fineness and strength utilization property it is deviating from the theory.

- On the other hand when ramie is blended with a compatible fibre pineapple having an extensibility slightly higher than ramie and less specific stress it follows the Hamburger theory.

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