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Performance of Binary Blends of Indigenous Ramie - Acrylic

Dey SK*
ICAR - Central Institute for Research on Cotton Technology, Mumbai, India

Abstract

Utilization of underexploited natural fibres are not only the major thrust area in the international scenario but also the need of the hour. Blending of different fibres having similar or different properties is an important issue globally in the area of textiles. Blending of indigenous ramie with acrylic will help development of textiles with better functional properties by combining positive features of both the fibres. The mechanical properties of blended yarns and performance of indigenous ramie-acrylic blends on conventional jute spinning frame reveals that properties of fibre like tenacity, fineness and breaking extension mainly governs the tensile characteristics of the blended yarn. The critical blend level for 4 denier acrylic fibre and indigenous ramie has been found to be 62/38. The theoretical and actual blend composition by chemical method reveals matching with each other.

Keywords: Degumming; Indigenous ramie; Acrylic; Blending; Tensile properties; Critical Blend

Introduction

Ramie, is a member of the bast family, grown mainly in temperate and tropical areas, and well known as "China Grass" in Western Europe and America. Ramie fibre obtained from the stem of the plant *Boehmeria nivea*, (L). Gaud, by decortication and washing are known to contain about 19-30% of an incrusting material known as gum, depending upon the variety, agro-climatic condition of cultivation and other factors. As one of the most promising natural fibres, the α-cellulose content of ramie is higher in comparison to other bast fibres like flax, hemp and jute. Ramie fibre is considered as a valuable textile material for its high strength especially wet strength, lustre and microbial resistivity [1]. Increasing ecological consciousness has accelerated interest in ramie as a commercial knitwear fibre. Research to evaluate the response of ramie fibre to degumming, mechanical processing and chemical processing is thus desirable. The decorticated ramie in moist condition is very much prone to microbial attack. Proper degumming of the decorticated ramie fibre is, therefore, necessary to unveil its unique properties and make it suitable for textile purpose [2-12].

Several workers have reported discussions on degumming and processing of ramie fibres alone or in blends with other fibres, but little work has been reported on the blending behavior and analysis of ramie blends with acrylic since the early work of Mazumder et al. [7]. Pal et al. [8] reported on ramie-polyester blend. Cheng et al. [9] reported on ramie-acrylic yarns by siro spinning technology owing to the remarkable and significant improvement in yarn properties, siro spinning technology to be employed in ramie yarn production will have a high potential particularly for the high count single yarn fabrics. Gupta et al. [10,11] investigated the physico-mechanical properties of ramie-tasar and ramie-polypropylene blended yarn in semi worsted spinning system. Dey et al. [12] reported the mechanical properties of ramie-tasar waste in spun silk processing system. Gupta et al. [13] studied the yarn properties and processing performance of ramie-polypropylene blends on jute rove spinning system. Chemical texturization of ramie-polypropylene blends results in the formation of crimp in ramie fibre which improves the yarn bulk and extensibility with loss of strength.

It is well known that polyester and cotton or wool and acrylic are complementary to each other due to their versatility. Since ramie is often blended with acrylic fibres to improve the performance and hand, information on specific changes that occur during blending should be of interest.

An investigation to blend indigenous degummed ramie fibre with acrylic fibre for developing a blended yarn which may be suitable for knitting purpose and also Ladies shawl for warmth. The performance of ramie–acrylic blended yarn in jute spinning system and the mechanical characteristics along with and quantitative analysis of ramie-acrylic blends by chemical method are reported below.

Materials and Methods

Our binary blends were made from acrylic fibres, non-shrinkable, 4 denier, 100 mm long, from Indian Petrochemicals Corporation Limited (I.P.C.L.), Baroda, and decorticated ramie fibres received from the Ramie Research Station, ICAR-Central Research Institute for Jute and Allied Fibres, Sorbhog, Assam. All chemicals were analytical grade. Decorticated ramie fibres were degummed chemically to a residual gum content of 5.47% following a simple degumming method by Dey [14,15].

Spinning of yarn

Degummed ramie was sprayed with 2% oil-emulsion, passed through Frasers jute softener machine (63 pair rollers) and binned for 48 hours. It was then manually cut into 200 mm staple lengths. Slivers of ramie and acrylic were prepared in Flax finisher card. Degummed ramie and acrylic slivers were blended at first drawing stage in five different blend compositions-80:20, 60:40, 50:50, 40:60 and 20:80. Yarns of 84 tex were spun on a Rove spinning machine using modified conventional jute processing machinery with blend percentage of ramie ranging from 20 to 80%. Three sets of experiments were designed to conduct the spinning trials to examine the a) optimum twist factor of ramie, acrylic and 50:50 ramie-acrylic blend b) effect of blend composition on the quality of yarn and c) optimum stage of blending of ramie and acrylic fibre.

***Corresponding author:** Dey SK, ICAR - Central Institute for Research on Cotton Technology, Mumbai, India, Tel: 09433458203, 08689871246; E-mail: syamalkumardey@gmail.com

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Tensile testers of INSTRON and ZWICK make were used for testing the tensile properties of fibre and yarn respectively using standard testing parameters.

Results and Discussion

Optimum twist factor of yarns

The optimum twist factor of degummed ramie, acrylic and ramie-acrylic blended yarn were evaluated in jute spinning machinery with the technical know-how developed to process this special fibre. There was no difficulty encountered to process acrylic top in jute screw gill drawing, roving and rove spinning machine. The carded slivers of degummed ramie and acrylic top were blended at first drawing stage with a blend proportion of ramie: acrylic - 50: 50.Yarns of nominal linear density of 84 tex were spun from degummed ramie, acrylic and ramie-acrylic (50:50) blend with a varying twist factor. The tenacity of different yarns with varying twist factor was plotted graphically in Figure 1 to evaluate the optimum twist factor. It is observed from the figure that the optimum twist factor on the basis of maximum strength of the above three yarns are achieved as follows.

Degummed ramie Yarn : 10.92

Acrylic Yarn : 10.14

Degummed ramie/Acrylic (50:50) Yarn : 9.36

Effect of blend composition on the quality of yarn

Blending of degummed ramie and acrylic top were done at first drawing stage with five different blend compositions ,viz.80:20,60:40,50:50,40:60 and 20:80.The yarns of linear density of 84 tex with a T.P.I of 6.5 were spun in Rove spinning machine from five different blend compositions. The results of the effect of blend compositions on the quality of the yarns are enumerated in Table 1.

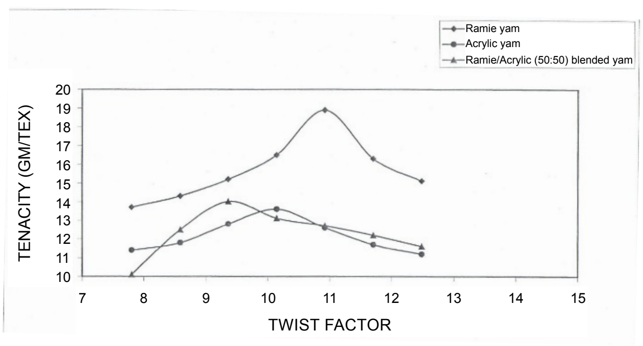

Figure 1: Twist vs. Tenacity curve.

Optimum stage of blending of degummed ramie and acrylic fibre

Degummed ramie/acrylic (50:50) blended yarns of linear density of 84 tex with a T.P.I of 6.5 were developed in modified conventional jute processing machinery. The performance of the blended yarns was studied to evaluate the optimum stage of mechanical processing for binary blending of ramie and acrylic. It reveals from Table 2 that the performance in respect of strength, and regularity properties was better when blended at carding stage compared to blending at drawing stages. The probable reason may be that in carding stage of blending, the fibres might have got scope to mix intimately to make a homogeneous mixture of fibres do that each fibre component contributes their own share proportionately in the yarn structure which ultimately helps to achieve a good quality yarn blended at carding stage. The wet tensile strength indicates that on wetting, yarn strength increases considerably. This can be attributed to the higher wet strength of ramie fibre and increase of fibre friction on wetting. A similar increase in yarn strength due to wetting was observed by Lawson et al. and Chakraborty et al. while studying the properties of cotton and pineapple leaf fibre respectively.

Effect of blend proportions of ramie-acrylic blended yarns

The fineness or linear density of ramie and acrylic are different which are presented in Table 1. The average fineness and tenacity of the degummed ramie fibres were 0.83 tex and 443.22 mN /tex, respectively whereas acrylic fibres fineness and tenacity were 0.44 tex and 215.82 mN/tex. The higher fineness of acrylic fibre improves the spinnability of blended yarn and also results in a more regular yarn by providing more numbers of fibres per yarn cross section. The stress –strain curves of ramie and acrylic (Figure 2) reveals that ramie fibre is almost linear but that of acrylic is non-linear. It is evident from the stress-strain curves that strength and modulus of ramie fibre is much higher compared to acrylic fibre. But on the contrary the elongation percentage of acrylic is much higher than ramie. The wide difference of ramie and acrylic will have effect on the tensile properties of the blended yarn.

It is clear from Table 1 that C.V% of yarn parameters goes on decreasing with increase in proportion of acrylic component in the blends. The reason may be the better fineness of acrylic fibre which provides more number of fibres per unit cross section of yarn. The yarn diameter increases with increase in acrylic component in the blend. This can be attributed to the higher specific volume of acrylic fibre

Property	Proportions of Acrylic in the blended yarn (%)						
	0	20	40	50	60	80	100
Fibre linear density (Tex)	0.83						0.44
Yarn linear density (Tex)	87	90	94	89	81	91	92
Diameter μ(x 10^{-4}cm)	406	417	423	428	437	445	456
Tenacity (Gm/tex) Dry	18.3 (26)*	15.1 (22)	14.4 (22)	13.6 (19)	12.1 (18)	12.5 (16)	13.8 (15)
Wet	21.1 (24)	17.3 (21)	16.9 (21)	15.8 (17.5)	13.7 (16.3)	12.9 (14.8)	13.6 (14.2)
Wet to Dry tenacity ratio	1.15	1.14	1.17	1.16	1.13	1.03	0.98
Breaking elongation (%) Dry	2.1 (17)	2.1 (19)	2.6 (17)	3.7 (20)	8.1 (16)	15.0 (15)	24.8 (12)
Wet	3.8 (16)	3.9 (18)	3.8 (16.5)	4.2 (18)	9.8 (14.9)	16.4 (13.6)	24.6 (11.2)
Wet to Dry Breaking elongation (%) ratio	1.81	1.86	1.46	1.14	1.21	1.09	0.99
Weight C.V% on 2” Cut length	26	23	22	24	21	19	14
Grist C.V%	6	5	4	3	4	5	4

Figures in the parenthesis indicate C.V%.

Table 1: Effect of blend compositions on yarn quality.

Sl No	Stage of blending	Nominal linear density (Tex)	Actual linear density (Tex)	Tenacity (Gm/tex)		Breaking Extension (%)		C.V%					Grist C.V%
								Strength		Extension		Wt. on 2" cut length	
				Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet		
1	Carding	84	81	14.9	16.3	3.05	3.92	19	18	20	18	22	7
2	First Drawing	84	92	13.8	16.1	3.90	4.10	17	16	20	18	23	8
3	Second drawing	84	93	11.1	12.7	2.60	4.17	26	24	28	25	27	9
4	Third Drawing	84	94	11.4	11.2	2.70	3.33	33	32	39	35	28	14

Table 2: Performance of Ramie-Acrylic (50:50) blend at different stages of jute processing.

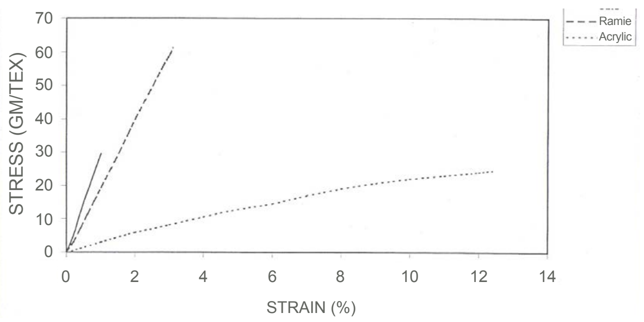

Figure 2: Stress vs. Strain Curves of Ramie and Acrylic fibres.

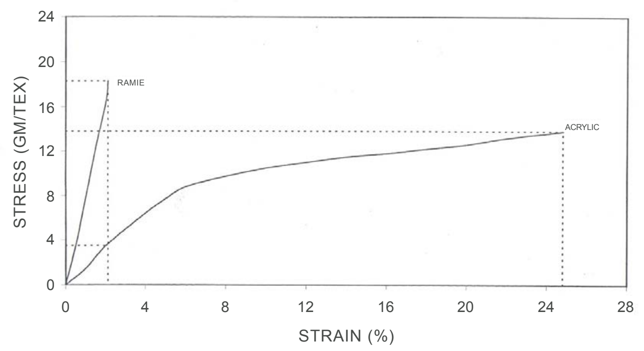

Figure 3: Stress vs. Strain Curves of Ramie and Acrylic yarn.

compared to ramie. The findings of Luniak [2] and Mukhopadhyay [16] states that diameter of ramie yarn is lower than cotton yarn of same linear density. The findings of Gupta et al. on ramie-polypropylene and ramie-tasar blends reveals the same result. The theoretical breaking stresses for different blends were computed from stress-strain curves of the yarns made out of one component fibres (Figure 3) instead of individual fibres. The predicted curves are presented in Figure 4. The critical blend level for 4 denier acrylic fibre and ramie has been found to be 62/38.

Chemical analysis of blends

The actual blend proportions were determined chemically as per the method IS: 3421-1966 for blend estimation [15-17]. All samples were extracted with a benzene-methanol (3:2) mixture to remove oil and any finishing materials that had been added during processing. Each blended sample was analyzed twice and the average value was reported in Table 3. Dey et al. reported that the blend compositions of ramie-acrylic blends can be unambiguously assessed using infrared spectra with the help of calibration plot [15]. These compositions match those obtained by chemical methods.

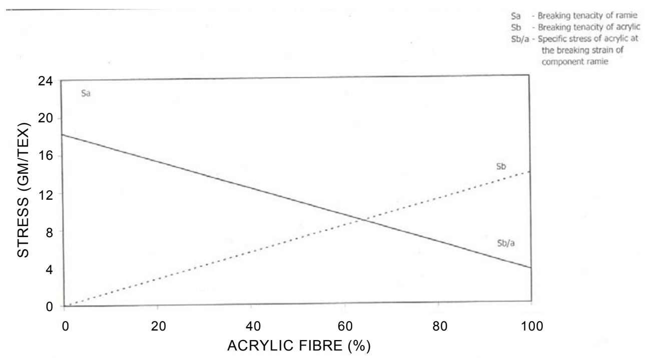

Figure 4: Prediction of Strength of Blended yarns.

Theoretical Blend percentage Acrylic/ ramie	Actual blend compositions by chemical method,%			
	Without added moisture		With added moisture	
	Acrylic	Ramie	Acrylic	Ramie
1	22.06	77.94	21.17	78.83
2	39.57	60.43	38.31	61.69
3	47.44	52.56	46.14	53.86
4	60.56	39.44	59.42	40.58
5	77.51	22.49	76.57	23.43

Table 3: Blend extimation by chemical method.

Conclusion

Indigenous ramie-acrylic blends can be processed in conventional jute spinning system. Properties of fibre like tenacity, fineness and breaking extension mainly governs the tensile characteristics of the blended yarn. In general, the addition of acrylic improves the breaking extension and regularity and yarn bulk. The performance in respect of strength, and regularity properties was better when blended at carding stage compared to blending at drawing stages. The critical blend level for 4 denier acrylic fibre and indigenous ramie has been found to be 62/38. The blend compositions of acrylic/ramie blends can be unambiguously assessed using by chemical methods.

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