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Comparative Study of Shrinkage and Moisture Regain of Silk, Viscose Rayon and Polyester Filament Yarn

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ABSTRACT

Both natural and man made fibres are made up of large molecules called "polymers" in which small molecules called "monomers" are repeatedly linked together in a regular pattern. In the present research, the natural and artificial silk (man-made polyester and rayon filaments) have been compared for their shrinkage and moisture content. The results show that maximum value for shrinkage and moisture regain was observed for viscose rayon, while silk shows minimum shrinkage and minimum value of moisture regain was recorded for polyester.

Key Words: Silk; Shrinkage; Moisture; Polyester

INTRODUCTION

The first man-made fibre was produced as a substitute for silk and was known as "artificial silk". Man-made fibres are produced in much the same way as the silk worm produced silk filament. Viscose rayon is a cellulosic fibre manufactured by wood pulp generally from bamboo pulp. In kingdom of man-made fibres, polyester possesses a remarkable position among the synthetic derivatives due to its multi-end uses. High tenacity, low elongation and low moisture absorption are among the important attributes of fibres (Peter, 1970; Moncrieff, 1975; Munro, 1987). The present study was therefore, planned to compare the shrinkage and moisture regain of silk, viscose rayon and polyester fibre.

MATERIALS AND METHODS

The present research work initiated in the Department of Fibre Technology, University of Agriculture Faisalabad. The reeling of cocoons was done at Alsani Silk House Changa Manga, Distt. Kasur, while the testing of the samples was conducted at Rupali Polyester Ltd. Sheikhupura. The sample of rayon and polyester filament yarn (100, 120 and 180 denier) were collected from market.

Shrinkage in boiling water. Shrinkage percentage was measured according to the method described by Anonymous (1997). In this method, a uniform parallel bundle of conditioned filament is lightly loaded between clamps and the nip-to-nip length was measured without being removed from the clamps. The samples were then exposed to the test environment, for 30 min, typically, boiling water. After reconditioning, the bundle length was measured under some light loading. Calculations were computed with the following formula:

$$\text{Shrinkage \%} = \frac{L1 - L2}{L1}$$

Where, L1 = original loop length (mm) of the skein, and L2 = loop length (mm) of the skein after treatment

Moisture regain. Moisture regain of silk, viscose and polyester filament was determined by ASTM standard method (1997). Oven drying procedure, using ambient air heated to 105^0C was adopted to record the moisture regain percentage for the given samples according to the following formula.

$$\text{Moisture regain \%age} = \frac{L - W \times 100}{W}$$

Where, L = weight (g) of the specimen before drying, and W = weight (g) of oven dried specimen

RESULTS AND DISCUSSION

Shrinkage percentage. The effect of different filament yarns viz. silk, viscose and polyester and their linear densities (100, 120, and 180 deniers) upon shrinkage was highly significant, whereas their interaction showed non significant effect (Table Ia). These results reveal that with the change in fibre type and linear density, shrinkage value changes significantly. This is because of structural differences in the filaments and due to the changes in filament size (denier). Munro (1987) mentioned that the arrangement of the monomers in the polymer affects its physical properties. Individual comparison between the mean values of shrinkage for different filament yarns viz. silk, viscous rayon and polyester were recorded as 1.03, 1.86, and 1.65%, respectively (Table Ib). All these values differed significantly from one another. It is evident from the data that viscose filament yarn depicted maximum shrinkage, whereas silk shows the minimum shrinkage while polyester filament yarn recorded moderate shrinkage. The present results regarding the shrinkage of silk are very close to those reported by Quaynor *et al.* (1999) who reported that by laundry, silk shrinks less than cotton; whereas Peter (1970) expressed that shrinkage of viscose

Table Ia. Analysis of variance for shrinkage

Source	D.F	S.S	M.S	F.Value	Prob.
Filament (F)	2	3.365	1.682	355.45	0.000**
Linear Density (D)	2	0.365	0.182	38.55	0.000**
F x D	4	0.20	0.005	1.056	0.4064
Error	18	0.85	0.005		
Total	26	3.835			

Table Ib. Individual comparison of treatment means values of shrinkage

Fibre Type	Means (%)	Linear Density	Means (%)
Silk (F_1)	1.03 c	D_1	1.38 c
Rayon (F_2)	1.86 a	D_2	1.50 b
Polyester (F_3)	1.65 b	D_3	1.67 a

Any two means not sharing a letter differ significantly at 5% level of probability a,b,c are used separately for each column

Table IIa. Analysis of variance for moisture regain

Source	D.F	S.S	M.S	F.Value	Prob.
Filament (F)	2	710.610	355.30	85273.454	0.000**
Linear Density (D)	2	3.226	1.613	387.0971	0.000**
F x D	4	0.307	0.077	18.4427	0.000**
Error	18	0.075	0.004		
Total	26	714.218			

Table IIb. Individual comparison of treatment means values of moisture regain

Fibre Type	Means (%)	Linear Density	Means (%)
Silk (F_1)	10.74 b	D_1	7.53 c
Rayon (F_2)	12.32 a	D_2	7.89 b
Polyester (F_3)	0.73 c	D_3	8.38 a

Any two means not sharing a letter differ significantly at 5% level of probability a,b,c are used separately for each column

rayon is less than 2%. Results produced by polyester filament yarn coincide with 1 to 10% range given by Kobayashi *et al.* (1977), but Manuersberger (1954) stated that polyester fibre has shrinkage about 7% at higher temperature. This variation in shrinkage might be due to the processing conditions of the manufacturing plants. Ludewing (1971) reported that higher draw ratio produces higher orientation. Shrinkage was increased at lower drawing speed and at low draw ratio.

Under different linear densities highly significant differences among the mean values of shrinkage at 100, 120 and 180 deniers are 1.38, 1.8 and 1.67%, respectively. The highest mean value of shrinkage (1.67%) was recorded at 180 denier and minimum (1.38%) was found at 100 denier. All the above values significantly differed from one another. These results clearly indicate that a direct relationship exists between shrinkage and filament denier i.e., with the increase in the denier, shrinkage increases and vice versa.

Moisture regain. The effect of different filament yarns *viz.* silk, viscose rayon and polyester and their linear densities (100, 120 and 180 denier) upon moisture regain was highly significant (Table IIa). These results reveal that with the change in filament type and size (denier), moisture regain changed significantly. This is due to the difference in structures of fibres as well as changes in liner density as Munro (1987) narrated that arrangement of monomers in the polymer affects its physical properties.

The moisture regain for different filaments *viz.* silk viscose rayon and polyester was 10.74, 12.32 and 0.73%, respectively. All these values differed significantly from one another. It is evident from the data that viscose rayon showed maximum moisture regain. Munro (1987) has also expressed that viscose rayon is highly absorbent of moisture and has a similar affinity for dye as cotton, where as polyester recorded minimum moisture regain, due to its complex molecular structure and silk shows medium moisture regain. The present results regarding the moisture regain are in close agreement with those of Kirkothmer (1982) and Hess (1954) for silk, Shenai (1991) for viscose rayon and Moncrieff (1975) and Kirhothmer (1982) for polyester. However these results differ from those reported by Trotman (1975) who stated that the moisture regain of the polyester is 0.4%. The variation in the moisture regain of the polyester is might be due to the process conditions as pointed out by Ziabicki (1978), that variation in physical characteristics of fibre or yarn are due to the process conditions. Under different linear densities (100, 120 and 180), highly significant differences among the mean values of moisture regain were recorded. The mean values of moisture regain at 100, 120 and 180 deniers were 7.53, 7.89 and 8.38%, respectively. All these values were significantly differ from one another. These results clearly depict that moisture regain increases with the increase in denier. Previously, Moncrieff (1975) has expressed that the fine denier, filament has high tenacity, low elongation low dye affinity and low moisture absorption.

CONCLUSION

The silk filament recorded the best value of shrinkage percentage. The results also indicate that the polyester filament somewhat closer to silk filament, but the latter has the best value of moisture regain percentage. On the other hand viscose rayon being regenerated fibre possess inferior properties as compared to silk and polyester.

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