The effects of air-flow fineness, gravimetric fineness, diameter and bundle tenacity of fibres and yarn tenacity on the hairiness of jute yarn were examined. Hairiness increased significantly with increase in gravimetric fineness, whereas the air-flow fineness had no significant effect. Increase in fibre diameter increased the hairiness of yarn. A stronger yarn was less hairy.

Keywords: Air-flow fineness, Bundle tenacity, Fibre diameter, Gravimetric fineness, Jute yarn, Yarn hairiness

1 Introduction

High-value jute decoratives need smooth yarns with lesser number of hairs on their body. As the hairiness of jute yarn affects the appearance, handle and wet processing treatments, high dust pick-up and fibre shredding properties of jute products may also be due to the hairiness of jute yarn.

Extensive work on the hairiness of different yarns has been reported, but published data on the hairiness of jute yarn are scanty. We have reported earlier\(^{1-3}\) the effects of different processing parameters on the hairiness of jute yarn. In this paper, the effects of air-flow fineness, gravimetric fineness, diameter and bundle tenacity of fibres and yarn tenacity have been reported.

2 Materials and Methods

The fineness values of 23 different \(W_2\) grade raw jute fibre samples were determined by the air-flow method\(^4\). Nineteen other fibre samples having different tenacity values were also collected. All the 42 fibre samples, 5 kg each, were emulsified with a standard oil-in-water emulsion (20:80) by applying 30% emulsion on the weight of the fibres and passed through a softener machine. The fibres were then binned for 72 h and processed through a standard jute machinery to spin yarns of 276 tex following the small-scale spinning technique\(^5\). The sequence of machinery was: \(JF_2\) breaker card, \(JF_4\) finisher card, three passages of Mackie screwgill drawing frames and 4.25 in. Mackie slip draft spinning frame.

Out of the yarns spun from the fibres of different fineness values, 6 yarn samples were selected. The fibres from each yarn sample were taken out by untwisting the yarn at different zones and the gravimetric fineness of fibres was determined by the cut and weigh method, counting and weighing 100 pieces of fibres, each of 1 cm length. Care was taken so that no filament or branching of fibre was broken while untwisting the fibres from the yarn.

After determining the gravimetric fineness of the fibres taken out of the yarns, the diameter of fibres were measured on a Projectina microscope \((\times 20)\). The average of 100 readings was taken as the mean diameter of the fibres.

The tensile strength of 19 yarn samples spun from the fibres of different tenacity values was measured in the Zwick automatic tensile strength tester, the cross-head speed and gauge length being kept at 300 mm/min and 600 mm respectively.

Yarn hairiness by number was determined by the jute yarn hairiness meter developed in the laboratory\(^6\). The number of hairs per unit length of 2.5 m was measured at a distance of 2.3 mm from the surface of the yarn and an average of approx. 200 such readings was considered as the index of hairiness by number in each case. The loss in weight due to singeing was also determined by the technique developed in this laboratory\(^6\).

3 Results and Discussion

Variations in yarn hairiness index by number and by percentage weight loss due to singeing
against different gravimetric fineness values of fibres are shown in Fig. 1. The figure shows that with increase in gravimetric fineness the hairiness of yarn increases. Hairiness index by weight loss due to singeing also shows a similar trend. The correlation coefficients between fibre fineness and hairiness index, both by number and percentage weight loss due to singeing, have been found to be statistically significant (Table 1).

Onions et al. also reported that increase in linear density or fibre thickness increases the hairiness, which is in agreement with the finding of Barella that the number of fibres projecting from the core per millimeter length of yarn is primarily dependent on the length and fineness of fibre and the diameter of yarn. Boswell, however, observed that coarser fibres give more hairy yarn, when hairiness is expressed as the percentage loss in weight, but the order of ranking is reversed, i.e. the finer the quality the greater is the total length of fibres protruding as hairs, when the hairiness is expressed as the length of fibres protruding from a yarn. Goswami studied the influence of fibre length and fibre fineness on the hairiness of cotton yarn and observed that hairiness increases gradually with gradual decrease in length and coarseness of fibre.

Though the present study corroborates the findings of different research workers, no significant correlation coefficient between air-flow fineness of raw jute fibre and yarn hairiness is observed (Fig. 2). This anomaly may be explained as follows. Jute fibre is available in the reed form at the raw stage. The individual filaments in the reed are cemented by gummy matters to form a heterogeneous meshy structure. When the individual filaments are split vertically and broken horizontally, specially at the breaker card stage, the

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**Table 1 - Statistical Parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Gravimetric fineness vs. hairiness</th>
<th>Fibre diameter vs. hairiness</th>
<th>Yarn tenacity vs. hairiness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>By number</td>
<td>By singeing</td>
<td>By number</td>
</tr>
<tr>
<td>Degrees of freedom</td>
<td>4</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>Calculated t value</td>
<td>4.943</td>
<td>2.906</td>
<td>4.532</td>
</tr>
<tr>
<td>t table value</td>
<td>4.609</td>
<td>2.776</td>
<td>2.774</td>
</tr>
<tr>
<td>Coefficient of correlation</td>
<td>0.9270\textsuperscript{b}</td>
<td>0.9257\textsuperscript{a}</td>
<td>0.9149\textsuperscript{a}</td>
</tr>
<tr>
<td></td>
<td>0.8238</td>
<td>(-)0.6543\textsuperscript{b}</td>
<td>(-)0.6149\textsuperscript{b}</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Significant at 95\% level. \textsuperscript{b}Significant at 90\% level.
spinnable fibres are produced. Naturally, the length, fineness, branching, etc. of the filaments, which are solely determined at the processing stages of the fibres, are contributing more to the attributes of a jute yarn than the properties of fibres at the raw stage. This peculiar phenomenon with jute fibre led the authors to study the effect of fineness values on the hairiness of jute yarn. The fineness values of fibres were measured at the raw stage by the air-flow method and at the yarn stage by the gravimetric method.

From Fig.3 the relationship between jute fibre fineness and hairiness is again confirmed by the positive correlation coefficient between fibre diameter and hairiness by number and by singeing loss percentage. Both the correlation coefficients are statistically significant at 95% confidence limit (Table 1).

With increase in diameter the fibre becomes coarser and produces higher hairiness. Jackowski reported the similar findings on the fibre diameter and yarn hairiness.

The response of hairiness index to yarn tenacity is shown in Fig.4. The yarn tenacity correlates negatively with the hairiness by number and by singeing loss percentage. Both the coefficients are statistically significant (Table 1).

The negative correlation between the yarn tenacity and the hairiness indicates that the yarn with higher number of protruding fibres bears lower strength and vice-versa. Participation of fibres, not protruding from its body, in the tensile property of a yarn might be responsible for the higher strength of yarns having lower hairiness.

As most of the research workers have confined their studies to the effect of fibre tenacity, and not yarn tenacity, on the hairiness of yarns, the relationship between fibre bundle tenacity and hairiness in the case of jute yarn has also been studied and is shown in Fig.5. Fibre bundle tenacity maintains correlation coefficients of $-0.4250$ and $-0.3096$ with the yarn hairiness by number and by singeing loss percentage respectively. Though the coefficients are statistically non-significant, even at 5% level, the trend gives some indications in the same direction as was observed in the case of yarn tenacity.

Pillay, however, observed that the contribution of fibre strength to yarn hairiness is less compared to that of other fibre properties such as fibre length and fineness, torsional rigidity and flexural rigidity.

4 Conclusions

4.1 Increase in gravimetric fineness of fibres increases hairiness significantly, whereas the air-
flow fineness value has no significant effect on the
hairiness of jute yarn.
4.2 The higher the diameter of fibres the higher is
the hairiness of a yarn.
4.3 A stronger yarn is less hairy.

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