Comparative studies on the quality characteristics of bivoltine raw silk of Indian and Chinese origin

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Quality characteristics of raw silk were studied as per the International testing methods. Two varieties of raw silk viz., Indian bivoltine raw silk and Imported Chinese bivoltine raw silk were tested for quality characteristics. The results indicate that the significant difference exists between the quality characteristics of the raw silk viz. size deviation, evenness variations I, winding breaks elongation and cohesion characteristics of raw silk. The study indicates that some scope exists in improving the quality of Indian bivoltine raw silk by adopting denier control gadgets in the field and process control measures.

Key words: Indian bivoltine raw silk, Quality characteristics and Chinese raw silk.

INTRODUCTION

Grading of raw silk was standardized by the International silk association based on the raw silk quality characteristics obtained from five tests viz., winding test, denier test, seriplane test, serigraph test and cohesion test. The parameters tested from the above tests are winding breaks / 40 skeins / hour, average denier, size deviation, maximum size deviation, evenness variation I, II & III, Neatness percentage, low neatness percentage, cleaness percentage, tenacity (g/d), elongation percentage and cohesion strokes (Takabayashi et al. 1997). Omura (1981) indicated that Japan being pioneer in silk industrialization following the standard sampling methods, test procedures & equipments for grading the raw silk. Soo Ho Lim et al. (1990) and Huang Guo Rui (1998) also indicated that China has adopted same testing procedures followed in Japan but grading of silk was modified to suit their requirement. India initiated raw silk testing with limited tests viz., denier test and winding test only.

So far raw silk produced in Indian filatures were not evaluated as per international standards. Hence an attempt has been made in this paper to evaluate the bivoltine raw silk produced in multiend reeling filatures of India and compared with the Chinese imported raw silk produced with automatic silk reeling technology.

MATERIALS AND METHODS

Raw material: Commercially available bivoltine raw silk produced in multiend reeling filatures in India and imported Chinese bivoltine raw silks were used for the study. Both the raw silks were produced with the target denier of 20/22. The testing of raw silk was conducted as per the International Silk Association (ISA) standards (Book of Standards 1952-68).

Winding test: 25 skeins of raw silk collected from the filatures were taken up for winding test. The skeins were mounted on the winding machine and 10 minutes initial test and two-hour actual test was carried out. Half of the skeins are mounted from front side and half from backside. After one hour winding, new bobbins were mounted and winding is continued. The number of winding
breaks occurred from the 40 skeins per hour were noted.

**Size test:** The 50 bobbins produced during the winding were taken and from each bobbin 4 kilcahs of 450-meter length were made in a wrap reel machine. Thus the 200 kilcahs were weighed in Auto sorter testing machine and the average size, size deviation and maximum size deviation were calculated.

**Seriplane test:** After the size test the bobbins were taken for seriplane test. From each bobbin two panels are prepared using seriplane winding machine (Okamoto Kasakusho, Toyo Sangyo Consulting Inc., Japan). Total of 100 panels i.e., 10 boards were prepared and analyzed in a seriplane dark room for the Evenness variations I, II & III, Neatness, low neatness and cleanness characteristics visually by comparing with the standard photographs.

**Serigraph test:** In order to evaluate the tenacity and elongation characteristics, 10 small skeins of 100 revolutions were prepared in wrap reel. These skeins were mounted on serigraph machine individually and the load required to break filaments were noted in terms of grams and the extension of filaments before break was recorded in a graph paper.

**Cohesion test:** A sample of 10 bobbins was studied for cohesion characteristics in a Duplan cohesion tester (Toyo Sangyo Consulting Inc., Japan). The strokes required to split the ends were observed for 10 bobbins in 10 strands. The average of 100 readings was calculated.

**Silk quality testing conditions:** The raw silk samples were subjected to testing under standard atmospheric conditions viz., 25 ± 2°C temperature and 65 ± 5 % Relative humidity at Silk conditioning and testing house, Bangalore.

**Data collected:** The quality characteristics data, viz. winding breaks / 40 skeins / hour, average denier, size deviation, maximum size deviation, evenness variation I, II & III, Neatness percentage, low neatness percentage, cleanness percentage, tenacity (g/d), elongation percentage and cohesion strokes of raw silk of Indian origin and Chinese origin were taken after testing under same atmospheric conditions. The data thus obtained were analysed statistically.

**RESULTS AND DISCUSSION**

The analysis of variance results of raw silk quality characteristics of both Indian and Chinese origin are presented in Table 1 & 3. The mean major and auxiliary quality results of Indian and Chinese bivoltine raw silk quality characteristics are given in the Table 2 & 4.

**Analysis of variance results**

The analysis of variance results given in Table 1 & 3, showed that significant difference exists among the major and auxiliary quality characteristics of raw silk produced in Indian filatures and Chinese filatures with respect to size deviation, evenness variation I and elongation at 10% significance level and with respect to winding breaks and cohesion characteristics at 5% significance level. Thus these characteristics need further attention to improve the grade of the Indian bivoltine raw silk. The other quality parameters are at par with the imported Chinese bivoltine raw silk.

**Size test results:**

The ANOVA Table 1 indicated that, significant difference exists between the size deviation of raw silk produced from Indian bivoltine cocoons and Chinese bivoltine cocoons, which may be attributed to the automatic reeling technology adopted by Chinese filatures. The Indian filatures are presently using Multiend reeling technology package with out denier control devices.

From the results given in Table 2 it could be observed that the size deviation of Indian bivoltine raw silk was significantly higher by 16.4(%) compared to Chinese bivoltine raw silk. The study
Table 1. Analysis of variance results of influence of raw silk variety on major quality characteristics

<table>
<thead>
<tr>
<th>Source</th>
<th>Degree Of Freedom</th>
<th>Mean sum of squares</th>
<th>Cleanness</th>
<th>Neatness</th>
<th>Low neatness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
<td>(%)</td>
<td>(%)</td>
</tr>
<tr>
<td>Raw silk</td>
<td>1</td>
<td>0.50</td>
<td>0.11Δ</td>
<td>104.2Δ</td>
<td>13.5</td>
</tr>
<tr>
<td>Variety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>4</td>
<td>1.25</td>
<td>0.019</td>
<td>23.16</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Δ - Significant at 10% level

Table 2. Mean results of major quality characteristics of Indian and Chinese bivoltine raw silk

<table>
<thead>
<tr>
<th>Raw silk Variety</th>
<th>Average Size</th>
<th>Evenness (I)</th>
<th>Evenness (II)</th>
<th>Cleanness</th>
<th>Neatness</th>
<th>Low neatness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Size</td>
<td>deviation</td>
<td>variation</td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
</tr>
<tr>
<td>Indian Bivoltine</td>
<td>20.8</td>
<td>1.706</td>
<td>60.3</td>
<td>3.0</td>
<td>96.0</td>
<td>97.3</td>
</tr>
<tr>
<td>Chinese Bivoltine</td>
<td>21.4</td>
<td>1.427</td>
<td>52.0</td>
<td>0.0</td>
<td>97.0</td>
<td>96.0</td>
</tr>
</tbody>
</table>

Table 3. Analysis of variance results of influence of raw silk variety on auxiliary quality characteristics

<table>
<thead>
<tr>
<th>Source</th>
<th>Degree of Freedom</th>
<th>Max. Size deviation</th>
<th>Mean sum of squares</th>
<th>Winding breaks/40 skeins/hr</th>
<th>Evenness variation (III)</th>
<th>Tenacity (g/d)</th>
<th>Elongation (%)</th>
<th>Cohesion (Strokes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw silk Variety</td>
<td>1</td>
<td>2.41 x 10⁻³</td>
<td>181.5*</td>
<td>0</td>
<td>0.015</td>
<td>4.17Δ</td>
<td>2090*</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>4</td>
<td>0.321</td>
<td>14.5</td>
<td>0</td>
<td>0.01</td>
<td>0.67</td>
<td>129.2</td>
<td></td>
</tr>
</tbody>
</table>

* - Significant at 5% level. Δ - Significant at 10% level

Table 4. Mean results of auxiliary quality characteristics of Indian and Chinese bivoltine raw silk

<table>
<thead>
<tr>
<th>Raw silk Cohesion Variety (Strokes)</th>
<th>Max. Size deviation</th>
<th>Winding Degumming breaks</th>
<th>Evenness variation (III) (g/d)</th>
<th>Tenacity (%)</th>
<th>Elongation</th>
<th>Cohesion (Strokes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian Bivoltine</td>
<td>4.08</td>
<td>16</td>
<td>0</td>
<td>4.0</td>
<td>18.3</td>
<td>71</td>
</tr>
<tr>
<td>Chinese Bivoltine</td>
<td>4.07</td>
<td>5</td>
<td>0</td>
<td>4.1</td>
<td>20</td>
<td>108</td>
</tr>
</tbody>
</table>
clearly indicates that there exists scope for improvement of size deviation characteristics of Indian bivoltine raw silk to achieve higher grades of raw silk.

**Seriplane test results:**

The ANOVA Table 1 indicated that, significant difference exists between the evenness variations I of Indian bivoltine raw silk and Chinese bivoltine raw silk, which may be the contribution of denier control device employed in automatic reeling machine. Thus incorporation of denier control device in Multiend reeling machine may also help in improving the uniformity characteristics of Indian bivoltine raw silk further.

Table 2 indicated that evenness variation I of Indian bivoltine raw silk was significantly increased by 13.8(%) compared to Chinese bivoltine raw silk. However, in the evenness characteristics both the raw silks are gradable as 4A, which is the ultimate grade. Studies conducted by Vasumathi et.al. (2004) has inferred the similar results in terms of size deviation and evenness variations while reeling with automatic and Multiend reeling technology.

**Winding test results:**

The ANOVA Table 3 indicated significant difference exists between the winding breaks of Indian bivoltine compared to the Chinese bivoltine raw silk, which may be the attributed to maintenance of denier while reeling, improper drying of raw silk in re-reeling and handling of raw silk in finishing sections.

Table 4 indicated that winding breaks of Indian bivoltine raw silk was significantly higher by 68.8(%) compared to Chinese bivoltine raw silk. Thus there exists lot of scope to improve the winding performance of Indian bivoltine raw silk.

**Elongation test results:**

The ANOVA Table 1 indicated that, significant difference exists between the elongation percentages of Indian bivoltine raw silk compared to Chinese bivoltine raw silk, which may be the contribution of higher re-reeling speeds.

Table 2 indicated that elongation of Indian bivoltine raw silk was significantly higher by 9.3(%) compared to Chinese bivoltine raw silk. However, in the elongation characteristics above 18% is an acceptable standard for 4A grade raw silk.

**Cohesion test results:**

The ANOVA Table 3 indicated significant difference between the cohesion strokes of Indian bivoltine compared to the Chinese bivoltine raw silk, which may be the attributed to agglutination of filaments and process control parameters viz., reeling speed, croissure length etc.,

Table 4 indicated that cohesion of Indian bivoltine raw silk was significantly higher by 68.8(%) compared to Chinese bivoltine raw silk. Thus there exists lot of scope to improve the winding performance of Indian bivoltine raw silk. However, in the cohesion characteristics above 60 strokes are graded as 4A, which is the ultimate grade.

**CONCLUSION**

Based on the above results and discussion, it is inferred that the Indian bivoltine raw silk produced from CSR race bivoltine cocoons developed under JICA project and being popularized in India are capable of producing international quality raw silk. Compared to the Chinese bivoltine raw silk, Indian bivoltine raw silk is slightly inferior in terms of size deviation and winding breaks characteristics only. With the introduction of denier control device and process control in the filatures could improve the quality of Indian bivoltine raw silk further with the CSR race bivoltine cocoons.
ACKNOWLEDGEMENT

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