Studies on bivoltine cocoon reeling - Influence of cocoon cooking condition and croissure length on quality characteristics of raw silk of Indian bivoltine hybrid cocoons

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ABSTRACT

The influence of cocoon cooking condition and croissure length on certain quality characteristics of raw silk has been studied for Indian bivoltine hybrid cocoons. Study has been carried out using two cooking methods viz., single pan and pressurised and three levels of croissure length – 3 cm, 8 cm and 13 cm. Results indicate that both cocoon cooking condition and croissure length have significant influence on quality of silk. As the croissure length increases, tenacity, cleanness and cohesion of raw silk are found to increase significantly. Single pan cooking and shorter croissure length of 3 cm affect the quality of raw silk significantly. The quality characteristics of raw silk viz., neatness, cleanness, tenacity, elongation and cohesion have been found to be significantly better in the case of pressurised cooking and 8 and 13 cm croissure length. It is observed that cocoon cooking condition plays a more dominant role as compared to croissure length on cohesion of raw silk. Results indicate that cooking the cocoons to the required level and maintaining the good croissure length of 8 to 13 cm are essential for producing better quality silk.

Key words: Cooking method, Croissure length, Cleanness, Tenacity, Elongation, Cohesion

INTRODUCTION

Croissure length is one of the important process parameters of reeling, which is expected to influence significantly certain quality characteristics of raw silk. Thread passage in the reeling machine influences the Croissure length (Takabayashi 1971), and Croissure length required for producing quality silk is expected to be dependent on cocoon quality.

Standardization of croissure length for a given thread passage is essential for achieving better quality raw silk. Studies have been conducted in Japan on the influence of croissure length on the properties of raw silk in automatic reeling machines associated with conveyor cooking in respect of bivoltine hybrid cocoons (Arimoto 1959, 1960). Similar information on the influence of variation in cooking condition and croissure length in the case of CSTRI multiend reeling, particularly for Indian bivoltine hybrid cocoons is essential. The present study focuses on the influence of cocoon cooking condition and croissure length on certain quality characteristics of raw silk.

MATERIALS AND METHODS

Raw Material: Bivoltine hybrid cocoons (CSR₂ X CSR₄) procured from the Government Cocoon markets were used for the studies.

Experimental design: The study has been carried out varying two factors viz. the cocoon cooking methods ( factor A, 2
level) and croissure length (factor B, 3 levels), keeping the other parameters constant.

**Cocoon drying**: The Cocoons were hot air dried in a batch type drier following a temperature profile of 115ºC to 55ºC for five hours.

**Cocoon cooking**: Two cocoon cooking conditions (open pan and pressurised cooking method) were used to vary the cocoon cooking degree, and low neatness characteristics using Seriplane tester and Cohesion character using Duplan Cohesion tester adopting ISA procedure. Further, Tenacity and Elongation of raw silk were tested using Instron tensile tester following standard procedure.

**Statistical analysis**: The data collected were statistically analysed using two-way analysis of variance.

**RESULTS AND DISCUSSIONS**

Average results of influence of cocoon cooking condition and croissure length on reeling tension and quality characteristics of bivoltine hybrid cocoons are given in Table 1 and 2. Analysis of variance results of quality characteristics are given in Table 3.

**Neatness and Low Neatness of raw silk**

It is observed (Table 1) that the cocoon cooking method has a significant influence on neatness and low neatness of raw silk. The Influence of cocoon cooking method on neatness and low neatness of raw silk is significant at 1% level, whereas influence of croissure length on neatness and low neatness of raw silk is insignificant. Significant improvement in neatness and low neatness of raw silk in the case of pressurized cooking method is attributed to better and uniform swelling and softening of sericin of all the cocoon filament layers in the cocoon shell (Subhas et.al 2003).

**Cleanness of raw silk**

Results given in the Table 1 indicate that both cocoon cooking method and croissure length have a significant influence on cleanness of raw silk. The influence of cocoon cooking method on cleanness of raw silk is significant at 1% level, whereas influence of croissure length on cleanness of raw silk is significant at 5% level (Table 3). Significant improvement in Cleanness of raw silk is observed as the
croissure length increases from 3 cm to 13 cms. This is presumably due to removal of some of the cleanness defects (like slugs and waste) by a longer croissure during reeling.

During reeling it is observed that, whenever some cleanness defects occur in the thread and passes through a croissure length of 8 cms & 13 cms, individual reel stop motion was activated or there was a thread breakage under croissure tension due to longer croissure length. But this phenomenon was not observed at 3 cm croissure length.

Table 1. Influence of cocoon cooking condition and croissure length on quality characteristics of raw silk

<table>
<thead>
<tr>
<th>Croissure Length (cms)</th>
<th>Neatness (%)</th>
<th>Low Neatness (%)</th>
<th>Cleanness (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Open pan cooking</td>
<td>Pressurised cooking</td>
<td>Open pan cooking</td>
</tr>
<tr>
<td>3</td>
<td>91.0</td>
<td>95.0</td>
<td>85.0</td>
</tr>
<tr>
<td>8</td>
<td>91.5</td>
<td>96.5</td>
<td>85.0</td>
</tr>
<tr>
<td>13</td>
<td>92.0</td>
<td>97.0</td>
<td>86.5</td>
</tr>
</tbody>
</table>

CD(P<=0.05) for
Cooking methods(A)
Croissure length (B)
A x B

Table 2. Influence of cocoon cooking condition and croissure length on reeling tension and quality characteristics of raw silk

<table>
<thead>
<tr>
<th>Croissure Length (cms)</th>
<th>Reeling tension (g/d)</th>
<th>Tenacity (g/d)</th>
<th>Elongation (%)</th>
<th>Cohesion (No. of Strokes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Open pan cooking</td>
<td>Pressurised cooking</td>
<td>Open pan cooking</td>
<td>Pressurised cooking</td>
</tr>
<tr>
<td>3</td>
<td>0.445</td>
<td>0.363</td>
<td>3.77</td>
<td>3.83</td>
</tr>
<tr>
<td>8</td>
<td>0.494</td>
<td>0.394</td>
<td>3.86</td>
<td>3.91</td>
</tr>
<tr>
<td>13</td>
<td>0.582</td>
<td>0.433</td>
<td>4.04</td>
<td>4.11</td>
</tr>
</tbody>
</table>

CD(P<=0.05) for
Cooking methods(A)
Croissure length (B)
A x B

Table 3. Analysis of variance of quality characteristics of raw silk

<table>
<thead>
<tr>
<th>Factors</th>
<th>Degree of freedom</th>
<th>Mean sum squares</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Neatness</td>
<td>Low Neat-</td>
</tr>
<tr>
<td>Cooking Methods (A)</td>
<td>1</td>
<td>65.333**</td>
</tr>
<tr>
<td>Croissure length (B)</td>
<td>2</td>
<td>2.333NS</td>
</tr>
<tr>
<td>A x B</td>
<td>2</td>
<td>0.333NS</td>
</tr>
<tr>
<td>ERROR</td>
<td>6</td>
<td>0.500</td>
</tr>
</tbody>
</table>

** Significant at 1% level, *Significant at 5% level, NS Non significant
Results indicate that longer croissure length helps to a great extent in improving the cleanness of raw silk. Cleanness of raw silk in the case of pressurised cooking method is found to be significantly better as compared to the open pan cooking method. This is attributed to better swelling and softening of sericin of cocoon filament crossover points in the cocoon shell in the case of pressurized cooking method.

**Tenacity of raw silk**

From the results (Table 2) it is observed that, tenacity of raw silk increases with the increase in croissure length. The pressurised cooking method and 13 cm croissure length have given better tenacity of raw silk as compared to the other conditions.

Both the cocoon cooking method and croissure length have significant influence on tenacity of raw silk at 1% level (Table 2 and 3). It is observed from the CD values (Table 2) that differences in tenacity of raw silk between 3 cm, 8 cm and 13 cm croissure length are significant at 5% level in the case of both multibivoltine and bivoltine hybrid cocoons.

Increase in tenacity with the increase in croissure length is due to the fact that as the croissure length increases reeling tension is found to increase (Table 2 and 3). Increased reeling tension may have resulted in better orientation of fibrils in the fibroin of a cocoon filament leading to increased tenacity of raw silk. Increase in tenacity may also be due to the fact that as the croissure length increases agglutination force between the filaments can be expected to increase and yarn will become more compact and stronger.

It is also observed (Table 2) that pressurized cooking method has given significantly better tenacity of raw silk as compared to that of open pan cooking method. This can be attributed to better swelling and softening of sericin of filament crossover points in the cocoons in the case of pressurized cooking method as compared to under/uneven cooking of cocoons in the case of open pan method. This may also due to the fact that sericin dissolution in the case of pressurized cooking method is expected to be at higher side as compared to the open pan method leading to a decrease in denier and therefore an increase in tenacity of raw silk.

**Elongation of raw silk**

It is observed (Table 2) that there is a slight decrease in the elongation of raw silk as the croissure length increases. This may be due to increase in reeling tension as the croissure length increases. However, it is observed that elongation of raw silk is good with all the three levels of croissure length viz., 3 cms, 8 cms and 13 cms. Results indicate that maintaining good croissure length during reeling will not come in the way of achieving good elongation of raw silk.

It is observed, that pressurized cooking method has given significantly better elongation of raw silk as compared to that of open pan cooking method in the case of both multivoltine and bivoltine hybrid cocoons. This can be attributed to better swelling and softening of sericin of cocoon filament cross over points and all the filament layers of cocoon shell uniformly. Significant reduction in elongation of raw silk in the case of single pan cooking method is attributed to under cooking of cocoons. As explained earlier, under cooking of cocoons increases the cocoon filament exfoliation tension, which in turn increases the total reeling tension (Takabayashi et al 1996). Higher reeling tension appears to have affected the elongation of raw silk.

**Cohesion of raw silk**

It is observed (Table 2 and 3) that both the cocoon cooking method and croissure length together have significant influence on cohesion of raw silk. The influence of cocoon cooking method and croissure length on cohesion of raw silk is significant at 1% level (Table 3).

It is observed that (Figure 1) as the croissure length increases cohesion of raw silk is found to increase significantly. Croissure length of 13 cms in association with pressurized cooking method has given maximum cohesion of raw silk. It is observed (Table 2) that differences in cohesion of raw silk between 3 cms, 8 cms & 13 cms croissure length are significant at 5% level.
Increase in cohesion of raw silk with the increase in the croissure length is due to the fact that when the filaments from the cooked cocoons passes through the croissure of good length during reeling the required agglutination of the filaments in the raw silk will take place (because of sufficient binding force exerted by croissure) and this results in good cohesion of raw silk. It is to be noted that at the twisted parts (croissure) friction is developed between the two threads as they move together in the twisted path in the same direction. This will contribute for increasing the agglutination between cocoon filaments and hence the cohesion of raw silk.

Cohesion of raw silk is significantly better in the case of pressurized cooking method as compared to that in the case of open pan method. This is due to better swelling and softening of sericin of cocoon filament layers in the case of pressurized cooking method due to effective cooking of cocoons (Subhas 1995). It is to be noted that proper agglutination of filaments in the raw silk thread will takes place only when the sericin of cocoon filament layers is properly softened. Reduction in cohesion of raw silk in the case of open pan cooking method is attributed to under/uneven softening of sericin. Results indicate that in order to achieve good cohesion of raw silk, swelling and softening of sericin of the cocoon filament layers to the required level by cooking the cocoons effectively is essential apart from croissure of longer length. Results indicate that the role of cocoon cooking is more dominant in improving the cohesion of raw silk as compared to croissure length.

CONCLUSION

From the results and discussions, it is inferred that both the cocoon cooking method and croissure length have significant influence on quality characteristics of raw silk. In order to achieve raw silk with good cohesion, tenacity and cleanness characteristics of raw silk, effective cooking of cocoons and introducing/maintaining required length of croissure during reeling process is very much essential.

Results indicate that by cooking the cocoons to the required level and by maintaining 8-13 cm croissure length (for the production of medium denier raw silk with 100-120 m/min reeling speed) in the case of CSTRI multiend reeling machine better quality characteristics of raw silk viz. Cohesion, tenacity & cleanness can be achieved. Further, pressurized cooking method is having distinct advantage over open pan method in achieving better quality of raw silk of superior grade.

REFERENCES


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Fig. 1. Effect of cocoon cooking condition and croissure length on cohesion of raw silk
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