Influence of pan and conveyor cooking process on reeling performance and quality characteristics of raw silk


Central Silk Technological Research Institute, Central Silk Board, Bangalore, India.

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The process of cooking using pan and conveyor methods were studied to find out its influence on reeling performance and quality of raw silk produced from bivoltine cocoons. The conveyor cooking of cocoons found to uniformly soften the sericin thereby improving the reeling characteristics viz. groping end efficiency, reelability percentage, raw silk percentage, raw silk recovery percentage and reducing the waste percentage on silk weight. The quality characteristics viz. neatness percentage, cleanliness percentage and cohesion were also improved when the cocoons are cooked using conveyor cooking machine. The tenacity and elongation of raw silk did not change significantly by both the methods of cooking. This result clearly revealed that conveyor cooking of bivoltine cocoons significantly improves the reeling performance and quality of raw silk produced compared to pan cooking.

Key words: Bivoltine cocoons, Conveyor cooking, Pan cooking, Reelability.

INTRODUCTION

Cocoon cooking is the heart of the reeling process. The hot air dried cocoons if not properly cooked would result in decreasing the poor reeling performance as well as quality of the raw silk. Suitable method for releasing the cocoon filaments from the agglutination points between sericin layers is achieved effectively using complete cocoon cooking process.

The process of cooking consists of the following parts namely, retting part in which the cocoon shell are moistened with hot water, high temperature for permeation part in which air inside the cocoon is made to expand and pressure difference is created inside the cocoon, low temperature for permeation part in which the cocoons are suddenly treated at low temperature water, to make the cocoons suck water through its layers, cooking part in which water inside the cocoon is made to exit through the cocoon layers so that the inner cocoon layer sericin is softened effectively and adjustment part in which the temperature of water is gradually reduced to enable the cocoon to absorb maximum amount of water inside the cocoon. During the above operations water enters and exit from outside to inside and from inside to outside the cocoon shell so that the cocoon filament unwinds smoothly without any break in the reeling process (Kinoshita 1997).

The selection of suitable cooking treatments, temperature and duration are of extreme importance since it decides the reeling performance and quality of raw silk reeled. Shimazaki and Yoshizawa (1952, 1953a, 1953b), Shimazaki et al. (1962b, 1962c and 1966), Shimazaki (1973, 1977, 1983) and Kinoshita et al. (1979 and 1980) carried out series of systematic studies to standardize the process of cocoon cooking conditions for different qualities of Japanese cocoons.
Some reeler in the country are practicing cooking in pan cooking and cook the cocoons so that only to the extent of 60 ~ 80% water permeation is achieved. However in order to introduce systematization in cooking process, CSTR1 has developed conveyor-cooking machine indigenously. Hence, in this paper an attempt has been made to study the effect of pan and conveyor-cooking process on the reeling performance and quality of raw silk reeled from bivoltine cocoons.

**MATERIALS AND METHODS**

Commercially available bivoltine cocoons (CSR2 x CSR4 race) reared in Karnataka state in India during the month of September 2003 have been used for the study.

The procured cocoons were divided into two batches and dried in Batch type hot air drier, following the temperature pattern of 115° - 110° - 85° - 70° - 55°C for a period of 5 hours to achieve the killing of the pupae and drying the moisture in the cocoon apart from hardening the sericin in the filaments. This process achieves optimum drying of bivoltine cocoons with the degree of drying of 39 - 40(%). The hot air dried cocoons were conditioned for period of seven days before taken for reeling.

One batch of hot air dried cocoons were cooked using two-pan following the temperature profile of 50° - 90°- 65°- 95°- 95° to 80°C for 9 minutes whereas the other batch of dried cocoons are cooked in conveyor cooking machine following the temperature profile of 50°- 92°- 60°- 98°- 95° to 50°C for 15 minutes. The cooked cocoons were brushed at 80°C before taken for reeling (Takabayashi et al 1997).

The cooked cocoons were reeled in 3 ends of multiend reeling machine producing 20/22 denier raw silk. The temperature of reeling bath was maintained at 45°C and reeling speed at 120 m/min (Omura 1991). The silk reeled was re-reeled and converted into skeins. The silk skeins are conditioned and weighed for assessing reeling parameters. Water having pH 7, 80ppm hardness and 150ppm M-alkalinity was used for the study.

The reelability data viz. cooking degree, grooping end efficiency, average filament degree, non-broken filament length, reelability percentage, renditta, raw silk percentage, raw silk recovery percentage and waste % on silk weight were observed while reeling different combinations of treatments.

Raw silk testing was conducted as per the International silk association (ISA) standards (Book of Standards 1952-68). The quality tests viz. winding test, size test, seriplane test, serigraph test and cohesion were conducted for raw silk reeled from conveyor and pan cooked cocoons. The experiment was repeated with three different batches of bivoltine cocoons and the data thus obtained were analysed for multivariate analysis statistically using SPSS package.

**RESULTS AND DISCUSSION**

The analysis of variance results of reeling performance and quality characteristics of bivoltine cocoons reeled from conveyor and pan cooked cocoons are presented in Tables 1 and 2 and the mean results of the reeling performance and quality characteristics of the Bivoltine cocoons cooked in conveyor and pan cooking are given in the Tables 3 and 4.

**Analysis of variance results**

The analysis of variance results given in Tables 1 and 2 showed that significant difference exists among the reeling performance and quality of raw silk reeled from conveyor cooked and pan cooked cocoons. The reeling characteristics viz. cooking degree and reelability (%) are having significant difference between the methods of cooking at 1% level, whereas, grooping end efficiency (%), renditta, raw silk (%), raw silk recovery (%), waste (%) on silk weight are found to have significant difference at 5% level between the pan and conveyor cooking of the bivoltine cocoons. The contribution factors of above reeling characteristics are 81.5(%), 81.3(%), 61.9(%), 60.5(%), 59.5(%), 74.9(%) and 67.1(%). Similarly the raw silk quality characteristics viz.
Table 1. Analysis of variance results of influence of cooking methods on reeling characteristics of bivoltine cocoons.

<table>
<thead>
<tr>
<th>Source</th>
<th>Degree of freedom</th>
<th>Cooking Methods</th>
<th>Groping Degree</th>
<th>Reel-ability (%)</th>
<th>Renditta (%)</th>
<th>Raw silk (%)</th>
<th>Raw silk recovery (%)</th>
<th>Waste (%) on silk weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooking Methods</td>
<td>1</td>
<td>2.535*</td>
<td>42.67**</td>
<td>5.042*</td>
<td>0.375*</td>
<td>2.01*</td>
<td>41.49**</td>
<td>7.48*</td>
</tr>
<tr>
<td>Error</td>
<td>4</td>
<td>0.11</td>
<td>4.67</td>
<td>0.22</td>
<td>4.33 x10^{-2}</td>
<td>0.24</td>
<td>2.61</td>
<td>0.67</td>
</tr>
</tbody>
</table>

* - Significant at 5% level.
** - Significant at 1% level.

Table 2. Analysis of variance results of influence of cooking methods on bivoltine raw silk quality characteristics

<table>
<thead>
<tr>
<th>Source Degree of freedom</th>
<th>Size Deviation</th>
<th>Maximum Evenness</th>
<th>Deviation</th>
<th>Wind-ness</th>
<th>VI</th>
<th>VII (breaks %)</th>
<th>Neat-ness</th>
<th>Clean-ness</th>
<th>Tenacity</th>
<th>Elongation</th>
<th>Cohesion</th>
<th>Cohesion (Strokes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooking Methods</td>
<td>1</td>
<td>6.76 x10^{-2}**</td>
<td>384*</td>
<td>2.67**</td>
<td>6.0*</td>
<td>7.04*</td>
<td>4.17**</td>
<td>10.67**</td>
<td>6.67**</td>
<td>1.04**</td>
<td>368**</td>
<td>x10^3**</td>
</tr>
<tr>
<td>Error</td>
<td>4</td>
<td>4.41 x10^{-2}</td>
<td>47.3</td>
<td>1.33</td>
<td>0.67</td>
<td>0.54</td>
<td>1.17</td>
<td>0.33</td>
<td>3.33</td>
<td>0.29</td>
<td>40.17</td>
<td>x10^{-3}</td>
</tr>
</tbody>
</table>

* - Significant at 5% level.
** - Significant at 1% level.

Table 3. Mean results of reeling characteristics with reference to different cooking methods for bivoltine cocoons.

<table>
<thead>
<tr>
<th>Cooking Conditions</th>
<th>Cooking Degree</th>
<th>Groping Degree</th>
<th>Reel-ability (%)</th>
<th>Renditta (%)</th>
<th>Raw silk (%)</th>
<th>Raw silk recovery (%)</th>
<th>Waste (%) on silk weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pan cooking Method</td>
<td>8.8 (0.36)</td>
<td>78.7 (2.30)</td>
<td>83.6 (0.50)</td>
<td>6.8 (0.21)</td>
<td>14.6 (0.45)</td>
<td>66.7 (1.77)</td>
<td>15.4 (0.85)</td>
</tr>
<tr>
<td>Conveyor cooking Method</td>
<td>10.1 (0.33)</td>
<td>84.0 (2.00)</td>
<td>85.4 (0.44)</td>
<td>6.3 (0.21)</td>
<td>15.8 (0.53)</td>
<td>71.9 (1.44)</td>
<td>13.2 (0.78)</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>0.75</td>
<td>4.90</td>
<td>1.07</td>
<td>0.47</td>
<td>1.11</td>
<td>3.66</td>
<td>1.85</td>
</tr>
</tbody>
</table>

Values in the parenthesis are standard deviation values.
Table 4 Mean results of raw silk quality characteristics reeled from bivoltine cocoons cooked using different cooking methods

<table>
<thead>
<tr>
<th>Cooking Conditions</th>
<th>Size Deviation</th>
<th>Maximum Evenness Deviation</th>
<th>Evenness VI</th>
<th>Evenness VII</th>
<th>Wind- ing breaks (%)</th>
<th>Neatness (%)</th>
<th>Low neatness (%)</th>
<th>Clean- ness (%)</th>
<th>Tenacity (%)</th>
<th>Elongation (g/d)</th>
<th>Cohesion (Stro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pan cooking Method</td>
<td>1.56 (0.09)</td>
<td>3.31 (0.28)</td>
<td>102</td>
<td>16</td>
<td>6</td>
<td>93</td>
<td>89</td>
<td>92</td>
<td>3.77</td>
<td>18.5 (0.06)</td>
<td>79</td>
</tr>
<tr>
<td>Conveyor Method</td>
<td>1.35 (0.03)</td>
<td>2.83 (0.29)</td>
<td>86</td>
<td>14</td>
<td>4</td>
<td>95</td>
<td>91</td>
<td>95</td>
<td>3.83</td>
<td>19.3 (0.06)</td>
<td>95</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>0.15</td>
<td>0.65</td>
<td>15.59</td>
<td>2.62</td>
<td>1.31</td>
<td>1.67</td>
<td>2.45</td>
<td>1.85</td>
<td>0.13</td>
<td>1.22 (6.11)</td>
<td></td>
</tr>
</tbody>
</table>

Values in the parenthesis are standard deviation values.

size deviation, evenness variation I, neatness, cleanness, winding breaks and cohesion characteristics also show significant difference between the pan and conveyor cooking of cocoons at 5% level. The contribution factors of above quality characteristics are 74.2(%), 58.7(%), 70.6(%), 75.0(%), 77.3(%) and 62.0(%). The other quality characteristics viz., Maximum size deviation, Evenness variation II, low neatness, tenacity and elongation did not show any significant influence between pan and conveyor cooking of bivoltine cocoons. From the results, it could be inferred that the conveyor cooking technology in association with proper hot air drying and reeling improves the reeling performance and the quality characteristics of bivoltine cocoons.

Effect of conveyor and pan cooked cocoons on reeling characteristics

From the results given in Table 3, it could be observed that significant improvement in the reeling characteristics of bivoltine cocoons cooked in conveyor cooking machine were observed viz. 14.8(%) in cooking degree, 6.8(%) in groping end efficiency, 2.2(%) in reelability, 7.9(%) in renditta, raw silk percentage and in raw silk deviation, whereas conveyor cooking method reduced the waste percentage on silk weight by 14.5(%). The CD values at 5% level also indicated significant difference between the cooking methods on the cooking degree, groping end efficiency, reelability, renditta, raw silk percentage, raw silk recovery and waste percentage on silk weight. This is attributed to proper softening of sericin in conveyor cooking process in association with the proper drying and reeling conditions adopted, leading to improvement in reeling characteristics.

Effect of quality characteristics of silk reeled from conveyor and pan cooked cocoons

From the results given in Table 4 it could be observed that, the size deviation, evenness variation I, neatness, cleanness, winding breaks and cohesion characteristics was significantly increased by 13.6(%), 15.4(%), 2.3(%), 2.9(%), 35.3(%) and 19.8(%) respectively in case of raw silk reeled from bivoltine cocoons cooked using conveyor cooking machine. The C.D values at 5(%) level also indicate that significant difference exists between the cooking methods, on most of the above quality characteristics. This is attributed to smooth release of agglutination forces between the sericin crossover points during conveyor cooking associated with maximum water penetration inside the cocoons leading to better reeling efficiency and production of quality raw silk. The C.D values at 5(%) level of the maximum size deviation, evenness variation II, low neatness and elongation of raw silk indicated that the these characteristics did not show any significant difference between the cooking methods, which is attributed to following proper cooking methodology in both methods of cooking as well as superiority possessed by bivoltine cocoons in these characteristics.
CONCLUSION

Based on the above results and discussion it is inferred that, the conveyor cooking of cocoons if employed for bivoltine cocoons, the reeling performance and quality of raw silk could be improved significantly compared to the pan cooking of cocoons presently being followed. The study further revealed that the conveyor cooking of cocoons reduces the renditta of the cocoons from bivoltine cocoons. Improved significan

y compared to pan cooking. Further, conveyor-cooking technology associated with hot air drying is the need for quality silk production from bivoltine cocoons.

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REFERENCES


