Effects of cooking duration and Na$_2$CO$_3$ conc. in reeling bath on wet reeling of tropical tasar silk

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Tropical tasar silk cocoons of the Daba (Antheraea mylitta D.) variety were cooked in a recipe of 1% hydrogen peroxide plus 1% Sunlight soap for 3, 5 and 10 min at boil and wet reeling of silk was carried out on an improved 5-end charkha from the reeling bath containing sodium carbonate at different concentrations. The production/5 ends/h, silk recovery (%) and reelability (%) were evaluated. It is observed that 10 min cooking combined with wet reeling from 1 g/l sodium carbonate solution at 60°C is effective in achieving better reeling performance.

Keywords: Antheraea mylitta D., Cocoon cooking, Reelability, Silk recovery, Tasar silk

1 Introduction
In the tropical tasar cocoon shell the sericin is fixed by tannins and the presence of calcium oxalate makes the cocoon more hard and compact. As the simple boiling water is inadequate to soften the tasar cocoon shell, these are cooked in either an alkaline bath or enzymatic bath in dry reeling and by oxidation bleaching method in wet reeling. Due to prolonged cooking duration prior to dry reeling, the reelable filaments lose their cohesiveness. As a result, the bunch of reelable loops and slugs often come off the cocoons during reeling and form thick sluby patches in the yarn. If reeling of these cocoons is tried in water basin, cocoon silk turns into a lump. The cooking of tropical tasar cocoons by oxidation bleaching method and the subsequent reeling under sunken system have been investigated by Chowdhury.

In the present investigation, the effects of cooking duration and Na$_2$CO$_3$ conc. in the reeling bath on the wet reeling performance of tropical tasar silk have been studied.

2 Materials and Methods
2.1 Materials
Tropical tasar cocoons of the Daba (Antheraea mylitta D.) variety having the following specifications were used:
- Colour: Grey
- Shape: Oval
- Voltinism: Bivoltine
- Source: Raw Material Bank, Chaibasa, Bihar, India
- Av. single cocoon weight: 12 g
- Av. single shell weight: 1.5 g
- Av. filament length: 750 m
- Av. filament denier: 10

Hydrogen peroxide and Sunlight soap were used for cooking. Sodium carbonate was used in the reeling bath.

2.2 Methods
2.2.1 Cocoon Cooking
Tropical tasar cocoons harvested from rearings on Arjun (Terminalia arjuna) were stifled in a hot air oven at 100°C for 2 h. The stifled cocoons were boiled in a recipe of 1% hydrogen peroxide (30% w/v) plus 1% Sunlight soap for 3.5 and 10 min at a pH 10.82. After cooking, deflossing of individual cocoons was done in hot water at 50°C.

2.2.2 Reeling
The reeling was carried out on an improved
5-end charkha (a hand driven device) developed by the Central Sericultural Research & Training Institute, Mysore. Six cooked cocoons were fed through each end. Cocoons were immersed in hot solutions of 0, 1, 2 and 3 g/l sodium carbonate at 60°C during wet reeling under the experiments T1, T2, T3 and T4 respectively. Each experiment was repeated thrice with 100 best sorted stifled cocoons. The path of the wet reeled yarn is indicated in Fig. 1. After reeling, the yarn was re-reeled and the silk and silk waste were dried in a hot air oven for 4h at 85°C.

2.2.3 Evaluation of Productivity of Reeling Bath, Silk Recovery and Reelability

The productivity of reeling bath, silk recovery and reelability were evaluated using the following formulae:

\[
\text{Productivity of reeling bath} = \frac{V \times n \times D}{9000}
\]

\[
\text{Silk recovery} (\%) = \frac{\text{Raw silk wt}}{\text{Shell ratio} \times \text{Cocoon wt}} \times 100
\]

\[
\text{Reelability} (\%) = \frac{\text{No. of reeled cocoons} \times 100}{\text{No. of feeding ends}}
\]

where

- \( V \) = Velocity of thread production
- \( t \) = Time set for reeling
- \( n \) = No. of ends
- \( D \) = Denier of silk
- \( \text{Shell ratio} (\%) = \frac{(\text{Shell wt}/\text{Cocoon wt})}{100} \)

\[
\text{No. of reeled cocoons} = \text{Sample cocoons} - \text{unreelable new cocoons} - \text{converted carryover cocoons}
\]

\[
\text{No. of feeding ends} = \text{No. of counted feeding ends} + \text{no. of carryover cocoons} - \text{converted carryover cocoons}
\]

\[
\text{Converted carryover cocoons} = 1.00P + 0.85H + 0.37M + 0.11L
\]

where

- \( P \) = No. of newly cooked cocoons not reelable
- \( H \) = No. of heavy shell unreelable cocoons
- \( M \) = No. of middle shell unreelable cocoons
- \( L \) = No. of light shell unreelable cocoons

3 Results and Discussion

The effects of cooking duration and \( \text{Na}_2\text{CO}_3 \) conc. in reeling bath on the production, silk recovery and reelability of tropical tasar silk are shown in Table 1 along with the results of analysis of variance.

3.1 Production/5 ends/h

Table 1 shows that production varies significantly with the treatments. The most effective treatment is T2 where the average production is higher by 21.11, 5.84 and 18.55% as compared to that in treatments T1, T3 and T4 respectively. The production is also significantly higher with cooking duration of 10 min. The superiority of treatment T2 with 10 min duration over other treatments may be due to the hydrolytic cleavage of the amino acids, present in gummy matters adhered to the surface of tasar cocoons, into smaller fractions and its solubilization and/or due to the swelling of fibroin. This results in easy unravelling of the filaments from tasar cocoons which, in turn, leads to higher productivity.

3.2 Silk Recovery

The silk recovery is significantly higher for the treatments T1, T2 and T3 than for T4 with the cooking durations of 5 and 10 min (Table 1). The average raw silk recovery of 54.50% for T2 is comparatively lower than that usually obtained with enzyme-treated tasar cocoons, because the cocoons could not be reeled to the last extreme in T2.
Table 1—Effects of cooking duration and sodium carbonate concentration in reeling bath on production, silk recovery and reelability

<table>
<thead>
<tr>
<th>Cooking duration min</th>
<th>Production/5 ends/h</th>
<th>Mean Silk recovery, %</th>
<th>Mean Reelability, %</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T₁, T₂, T₃, T₄</td>
<td>T₁, T₂, T₃, T₄</td>
<td>T₁, T₂, T₃, T₄</td>
<td>T₁, T₂, T₃, T₄</td>
</tr>
<tr>
<td>3</td>
<td>32.00, 55.32, 49.50, 43.66</td>
<td>45.12, 45.72, 50.51, 48.25</td>
<td>38.47, 45.74, 39.72, 29.72</td>
<td>27.97, 28.79</td>
</tr>
<tr>
<td>5</td>
<td>68.23, 75.63, 75.03, 65.63</td>
<td>71.13, 56.64, 59.09, 53.62</td>
<td>49.75, 54.75, 43.67, 43.72</td>
<td>33.39, 41.36</td>
</tr>
<tr>
<td>10</td>
<td>77.33, 84.13, 78.67, 72.10</td>
<td>78.06, 57.64, 53.91, 54.71</td>
<td>48.90, 53.79, 43.77, 43.12</td>
<td>33.37, 41.10</td>
</tr>
<tr>
<td>Mean</td>
<td>59.19, 71.69, 67.13, 60.47</td>
<td>—, 53.30, 54.50, 52.19</td>
<td>—, 45.71, —, 37.79</td>
<td>—, 38.85</td>
</tr>
</tbody>
</table>

Analysis of Variance

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Production/5 ends/h</th>
<th>Silk recovery, %</th>
<th>Reelability, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DF</td>
<td>MS</td>
<td>F</td>
</tr>
<tr>
<td>Treatment</td>
<td>3</td>
<td>319.22</td>
<td>81.36*</td>
</tr>
<tr>
<td>Cooking duration</td>
<td>2</td>
<td>3619.17</td>
<td>922.38*</td>
</tr>
<tr>
<td>Treatment x cooking duration</td>
<td>6</td>
<td>62.81</td>
<td>16.01*</td>
</tr>
<tr>
<td>Error</td>
<td>24</td>
<td>3.92</td>
<td>—</td>
</tr>
</tbody>
</table>

T₁—T₄—Treatments with 0, 1, 2 and 3 g/l sodium carbonate respectively.
DF—Degrees of freedom; MS—Mean square; F—Variance ratio; and CD—Critical difference.
*—P<0.01; NS—Non-significant.

3.3 Reelability

Table 1 shows that the reelability is significantly higher for T₁, T₂ and T₃ than for T₄ with the cooking durations of 5 and 10 min. The average reelability of 40% achieved in T₂ is not in agreement with the finding in dry reeling\(^{10}\). This may be due to the fact that different layers of cocoon shell do not respond uniformly to the cooking technique followed in wet reeling. As a result, during wet reeling, breakages occur more frequently for the inner layers owing to their hard and compact nature.

4 Conclusion

Cooking duration and concentration of Na₂CO₃ in reeling bath have considerable influence on the wet reeling of tropical tasar cocoons. 10 min boiling combined with wet reeling from 1 g/l sodium carbonate solution at 60°C is effective in achieving better reeling performance.

References

4 Das Subrata, Text Asia, 22(10) (1991) 57.