Indigenous knowledge of oak tasar silk cocoon cooking and a method of its improvement using pineapple extract

Y Ranjana Devi1*, L Rupachandra Singh2 & S Kunjeshwori Devi3

1Department of Basic Sciences and Humanities*, College of Agricultural Engineering and Post Harvest Technology, Central Agricultural University, Gangtok-737135, Sikkim, India;
2&3Department of Biochemistry, Manipur University, Imphal-795003, Manipur, India
E-mail: y_ranjana@yahoo.co.in

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Oak tasar (Antheraea proylei J.) cocoons are difficult to reel due to high amounts of protein tannin complexes. Traditionally the tasar cocoons are cooked in an earthen pot for 5-6 hrs with approximately 1% sodium carbonate or are cooked for 24 hrs with ashes of paddy husk and banana leaf. Cocoons are then reeled in semi-moist condition on an inverted face of an earthen pot or on thigh of the reeler. This traditional method employed gives relatively low reeling performance and low fuel efficiency. To overcome the drawbacks of the traditional methods, studies were carried out to develop a novel, simple, economic and effective oak tasar cocoon cooking and reeling method readily accessible to the common tasar silk reellers and weavers using pineapple extract which is abundantly available in the North eastern states of India. The proteolytic activity of the pineapple extract helps in partial solubilisation of the proteinaceous silk gum (sericin) involved in binding the silk (fibroin) strands together in silkworm cocoon. Cocoon cooking by the standardized enzymatic procedure developed during the present investigation, viz. pressure cooking for 30 minutes and soaking in pineapple extract for 12 hrs at room temperature gives a very high reeling performance as compared to traditional method.

Keywords: Proteolytic enzymes, Sericin, Fibroin, Oak tasar silk cocoons, Cocoon cooking, Single silk filament reeling

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Sericulture and silk weaving is the part and parcel of cultural heritage of the people of NE India.1 Tasar silk production is one of the major agro based industries playing an important role in the rural economy of the NE states. The oak tasar (Antheraea proylei J.) silkworm, the larvae of which feed on leaves of oak tree Quercus species (Family-Fagaceae), is an important source of tasar silk, a rough, coarse and nubby silk usually with natural shades of beige.2 The oak tasar track extends from Jammu and Kashmir in the West to Manipur in the East, embracing Himachal Pradesh, Uttar Pradesh, West Bengal, Sikkim, Assam, Arunachal Pradesh, Meghalaya, Mizoram and Nagaland.3 The hard and compact oak tasar cocoons cannot be satisfactorily softened by boiling in plain water unlike the mulberry (Bombyx mori L.) silk cocoons due to presence of relatively low amounts of sericin and high amounts of protein tannin complexes in the form of proanthocyanidins and are thus difficult to reel.5 As such, the oak tasar cocoons have to be softened by more drastic boiling off techniques.

Traditionally, the tasar cocoons are cooked by individually wrapping the cocoons in silk waste especially at the peduncle end to prevent the shell from bursting and are cooked in earthen pitcher by adding a quantity of washing soda (approximately 1%) for 5-6 hrs. The cocoons are then taken out, wrapped inside coarse cotton cloth, slightly squeezed and then reeled in semi-moist condition on an inverted face of an earthen pot or on thigh of the reeler. Alternatively in another traditional method, tasar cocoons are cooked for 24 hrs with ashes of paddy husk and banana leaf as softening agents. These processes are time consuming, not fuel efficient and also involves much labour, and gives poor reeling performances. With the aim of overcoming these drawbacks of the traditional methods, studies were carried out to develop a novel, simple, economic and effective oak tasar cocoon cooking and reeling method readily accessible to the common tasar silk reellers and weavers using pineapple extract which is abundantly available in the North eastern states of India. The pineapple extract contains proteolytic enzymes that cleaves the internal peptide bonds in an amino acid chain so they have the

*Corresponding author
potential to effect partial solubilisation of the proteinaceous silk gum (sericin) involved in binding the silk (fibroin) strands together in silkworm cocoon, an essential step in the silk cocoon cooking and reeling.  

Methodology

Silk cocoon
The cocoons produced by the oak tasar silkworm Antheraea proylei Jolly fed on Quercus serrata Thunberg leaves, hot air stifled for 6-7 hrs at 70°C, and then stored for 2-3 months were used in the present investigation. The cocoons were obtained from Regional Tasar Research Station, Central Silk Board, Imphal, India. Fresh and ripe (mature and yellow) fruit of pineapple, Ananas comosus (L.) Merr. cv. queen was purchased from the markets in and around Imphal, Manipur, India. The pineapple fruit pulp was prepared from the fruit by first detaching the crown and stem parts, and then slicing off the skin part. One hundred and fifty gm of the pulp was homogenized with 1 L of distilled water and the resulting homogenate was strained through a coarse cotton cloth. The supernatant having high proteinase activity was used for softening of the oak tasar cocoons.

Cocoon cooking and reeling
By studying the enzymological characteristics of the proteinase activity in the pineapple extract, a simple oak tasar cocoon cooking medium giving optimum reeling performances was constituted and standardised as follows: Thirty oak tasar cocoons (ten replications of three cocoons each) were wrapped in a coarse cotton cloth and subjected to 30 minutes pressure cooking at 1.05 Kg/cm² pressure. The cocoons were then soaked in the pineapple extract at room temperature (26-31°C) for 12 hrs. At the end of soaking, cocoons along with the wrapper were taken out from the cooking medium, and then washed repeatedly with tap water until the associated brown colour and proteinase activity were washed out. The cocoons were then removed from the wrapper, semi-dried on blotting papers, deflossed, and then subjected to single filament reeling on an epprouvette machine in the Reeling Section, Regional Tasar Research Station (RTRS), Central Silk Board, Imphal, India. Alternatively, using the traditional method the cocoons were cooked in earthen pitcher by adding 1% washing soda for 5 hrs, wrapped inside a coarse cotton cloth, slightly squeezed and then subjected to single filament reeling as described.

Results and discussion
Comparison between the newly developed standardized pineapple extract procedure and the already adopted traditional procedure for cooking oak tasar cocoons with respect to cooking protocol and single silk filament reeling performance are given in Table 1. The reeling performances as indicated by FAO-Silk Reeling Board, Imphal, India.

<table>
<thead>
<tr>
<th>Cocoon treatment</th>
<th>Standardized pineapple extract method</th>
<th>Traditional method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Thirty min pressure cooking in distilled water and soaking in pineapple extract at room temperature (26-31°C) for 12 hrs**</td>
<td>Five hrs boiling in 1% soda</td>
</tr>
<tr>
<td>Number of ends feeding /cocoons</td>
<td>2.1 ± 1.0</td>
<td>6.3±1.2</td>
</tr>
<tr>
<td>Filament length (m)</td>
<td>699.6 ± 75.2</td>
<td>530.6±114.2</td>
</tr>
<tr>
<td>Recovery %</td>
<td>74.4 ± 5.4</td>
<td>58.3±7.9</td>
</tr>
<tr>
<td>Denier (D)</td>
<td>6.6 ± 1.3</td>
<td>6.0±1.2</td>
</tr>
<tr>
<td>Reelability %***</td>
<td>47.6</td>
<td>15.9</td>
</tr>
<tr>
<td>NBFL (m)***</td>
<td>333.0</td>
<td>84.4</td>
</tr>
</tbody>
</table>

Each value is the mean ± SD of 30 samples
*The single silk filament reeling was performed on an epprouvette machine in the Reeling Section, Regional Tasar Research Station, Imphal, India. Each value of the primary reeling parameters in the table [number of ends feeding/cocoon, filament length (m), recovery % and denier (D)] is an average of thirty replications.
**The pineapple extract was prepared by homogenizing 150 gm of pineapple fruit pulp with 1 L of distilled water and then straining the resulting homogenate through a coarse cotton cloth.
***The values of these secondary reeling parameters were deduced using the average values of the relevant primary reeling parameters.
Number of ends feeding/cocoon = Number of breaks encountered by a cocoon while reeling

<table>
<thead>
<tr>
<th>Filament length (m)</th>
<th>= Length of reeled silk filament per cocoon in meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovery %</td>
<td>= (Filament weight/Cocoon shell weight)x100</td>
</tr>
<tr>
<td>Reelability %</td>
<td>= 1/(Number of ends feeding/cocoon)x100 (Lee, 1999)</td>
</tr>
<tr>
<td>NBFL (m)</td>
<td>= [Filament length (m) x Reelability %]/100 (Lee, 1999)</td>
</tr>
</tbody>
</table>
where there is rubbing action on looms during up and problem is carried over even to the weaving process reeling and hairiness in the resulting yarn. This soda employed as softening agent weakens the reeled from the oak tasar cocoons through the pineapple extract procedure was found on visual filaments reeled from the oak tasar cocoons through the pineapple extract method is also fuel efficient and is profitable for use by common tasar silk reellers and weavers. Also, as the cocoons has to be soaked for 12 hrs after pressure cooking for 30 mins, the method is less labour intensive as compared to the traditional method where there must be constant monitoring during the 5 hrs cooking process. Moreover, the samples of single silk filaments reeled from the oak tasar cocoons through the pineapple extract procedure was found on visual examination to be more shiny than that obtained by the traditional method using soda. Besides, washing soda employed as softening agent weakens the reeled silk filaments resulting in more breakages during reeling and hairiness in the resulting yarn. This problem is carried over even to the weaving process where there is rubbing action on looms during up and down operations of heed wires. The fabric so produced is of poor structure, inferior quality, less in strength with low production and more wastage. Nowadays, enzymatic cocoon cooking method is preferable as it is well known that chemical method reduces the quality of silk thread. Enzymatic treatment is considered to have mild action on the fibre and also as the enzymes are readily biodegradable in nature, the method of oak tasar cocoon cooking using pineapple extract may be preferred for an environmental friendly oak tasar silk industry.

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