

STUDIES AND DEVELOPMENT OF NOVEL METHOD OF ERI COCOON DEGUMMING

Sreenivasa, M.A.Joseph, Kariyappa and Subhas V. Naik

Central Silk Technological Research Institute, Central Silk Board,
Ministry of Textiles, Madiwala, Bangalore

Email id: srinivasacs@gmail.com

ABSTRACT:

Degumming of silk is a process to remove the gum called sericin from silk filaments (fibroin). The silk filament bave consisting of two brins (mono-filament) extruded by the silkworm are held together by sericin gum to form a single continuous silk filament. The degumming in a solution of soap in the presence of mild alkali (Soap-soda method) like soda ash is predominately used in the silk industry. This method of sericin hydrolysis is not only harsh on silk, contributes significantly to the effluent load but also not easy to control.

This article reports development of efficient equipment CSTRI ECO ERI DEGUMMING MACHINE for degumming of eri cocoons without any chemicals. This novel approach is expected to enhance the productivity due to shorter processing time. The process is economical and environmental friendly. In addition to this, saving of water and energy, etc are the added advantages of this process. Eri eco-degumming machine has been successfully fabricated and the eri degumming machine has been evaluated for degumming efficiency.

Key Words: Eri cocoons, Silk Degumming, eco-friendly processing, soap-soda method, Protex 6L (Enzyme), HTHP method.

Introduction:

In India, most of the Eri cocoons are being produced in the North-eastern part of the country. Presently, Eri silk is degummed in the cocoon stage under alkaline conditions. The Degumming loss varies from 6-8% depending on the Degumming conditions. As there is no standard procedure available for the Degumming of Eri silk, the Degumming loss varies from lot to lot. In order to find a

solution for the above mentioned problem, degumming of Eri cocoon under pressurised condition is recommended. In pressurised Degumming, the process can be standardized by optimising the pressure/temperature and duration of Degumming. Further, the process is eco friendly as no chemicals are used for the Degumming process

Among the wild silks, the eri silk accounts to 77.79% of the total vanya silk production in the country. The Eri silk production in India is 18.57% of the total silk production (2016-17). Eri culture is mainly practiced in the North Eastern region of India. The state of Assam, Nagaland, Meghalaya and Manipur accounts nearly 98% of eri silk production in the country as "Mendi". The area bordering Assam, BTC Bodoland, NC Hills and Meaghalaya, Manipur is considered to be the home for eri silk. Eri silkworm is also cultured in the states of Bihar, Orissa, West Bengal, Arunachal Pradesh, Mizoram and UP on a smaller scale.

The Eri cocoons are open mouthed and cannot be reeled like mulberry cocoons but are spun like cotton. Eri silk has certain excellent textile properties, which are unique in many aspects such as fineness, density, cross sectional shape, surface properties etc., which play an important role in determining the end use of the fibre. Eri silk is finer than other vanya silks. Although Eri silk possesses positive features, proper twist is required to maintain dimensional stability of fabric especially for garments. The tenacity of Eri silk is 2.5 -3.5 g /denier. Each Eri cocoon weighs about 1.2 to 5 g with the shell weight of 0.5 to 0.9g where the staple length of the fibre is about 57.00 mm. The denier of the filament is 2.1 to 2.45 with a tenacity of 3 to 3.4 g/d. Eri silk has an elongation of 21-22%. Eri silk has excellent thermal properties and therefore it can be a substitute for wool. The

moisture retention capacity is 11 per cent. (Sreenivasa *et al.*, 2005).

Degumming is an essential process where 6-8 % of gum present in Eri silk is removed by treating with soap and soda at boil. Usually, 0.5 to 1.0% of gum is retained in the material to facilitate the spinning process. Degumming is also carried out by different methods like soap soda process, enzymatic process, etc. Mechanical properties, colour, lustre, etc are influenced by the degumming recipe used for degumming the eri silk.

Major portion of the Eri cocoons were used on traditional devices like Takali. In Mill Spinning, fibres pulled and twist is imparted simultaneously to form the yarn. The coarse yarn so produced is normally used for production of traditional materials mainly for domestic use.

Relevance to the Current Issues

Presently, degumming of eri cocoons is carried out in the industry by using soap and soda ash in an open vessel at boiling temperature. This method of degumming is a lengthy process and requires chemicals which lead to environmental problems due to the pollution load in the effluent. Batch to batch variation in degumming loss is a major problem noticed in the conventional degumming process. The work is to give consistent degumming loss without using any chemicals. Enhanced productivity, improved quality, water and energy conservation, etc. are the other added advantages of the work. The development of an eco-friendly process for the degumming of eri silk (cocoons) with enhanced quality of the degummed material.

Objectives:

- To develop an efficient equipment for degumming of eri silk without using any chemicals.
- To compare the degumming process in the newly developed equipment with soap-soda method and enzymatic methods.

Material and Methods:

Material:

50 kg of eri cocoons were procured from Department of Sericulture, Govt. of Assam. The eri cocoons were used for different degumming trials. The eri cocoon characteristics are given in table.1.

Table.1 Eri Cocoon Characteristics:

Particulars	
Average Cocoon weight (g)	2.54
Average Shell Weight (g)	0.36
Average Shell Ratio (%)	16.82

Methodology:

a. Conventional Method of degumming:

Conventional method of degumming is practiced in the industry by using soap and soda in a tub. The degumming recipe used in conventional degumming method is given in table.2

Table.2 Degumming recipe:

Particulars	
Soap (g/l)	15
Sodium Carbonate (g/l)	10
Material to Liquor Ratio	1:40
Time	1.30 hour
Temperature	Boiling
pH	9.5 -10.5

After degumming, the degummed cocoons were washed in hot wash followed by cold wash to remove the residual soap and sodium carbonate. The degumming is generally carried out in steel tubs. In this method the degumming loss 8-10 %.

Quality problems associated with conventional method:

Under conventional degumming, usage of soap and soda ash in higher dosages leads to chemical damage which results of strength and elongation at break off the degummed yarn.

b. Enzymatic Degumming:

Protease enzymes can break the peptide/amine linkages and convert them into simple amino acids. Protex 6L preferentially

attack sericin in two steps. First treat with TRO 1gpl at 40° C temperature for 30 min, 2nd step to remove sericin treatment with using protex 6L (enzymes) and adding small quantity of Sodium carbonate solution and temperature 55-60° C for 1hr. The degumming recipe is shown in table.3

Table.3 Enzymatic degumming recipe:

Particulars	
TRO (Turky red Oil)	1gpl
Protex 6L (Enzyme)	1 gpl
Sodium Carbonate solution	0.01%
Material to Liquor ratio	1:40
Temperature	55-60° C
pH	8.5 -9.5
Time	1.30 hour in solution



CSTRI Eco Eri degumming Machine

After degumming, the degummed cocoons were washed in hot wash followed by cold wash. The degumming is generally carried out in steel tubs. In this method the degumming loss is 8-10 %.

CSTRI Eco Eri degumming machine:

Eco Eri degumming machine is equipment for degumming of eri cocoons without using any chemicals. This novel approach is expected to enhance the productivity due to shorter processing time. The process is economical and environmental friendly. In addition to this, the process can be saving of water and energy, etc are the added advantages of this process. Eri eco-degumming machine has been successfully fabricated and the eri degumming machine is shown below.

Table.4 Eri cocoon degumming recipe:

Particulars	
Material to Liquor: Ratio	1:20
Time (minutes)	25-30
Temperature (° C)	121-130
Pressure per square inch (PSI)	15-20
Washing in hot water	5 minutes in plain water

After degumming, the degummed cocoons were washed in hot wash followed by cold wash to remove the sericin from the eri cocoons. In this method, the degumming loss is 14.80 %.

Results and discussions:

The exiting method of eri cocoon degumming have been in practice are soap and soda (sodium carbonate) and enzymatic degumming methods. In conventional method of degumming practices, as they involve the usage of soap and soda higher doses leads to fibre damage which results in loss of fibre strength and elongation property. The results are given in table.5. In this method the degumming loss 10.00 % only. The sericin is not removed completely, so the degummed material not open up properly in spinning process.

In enzymatic degumming method, results are better in all the parameters compare to conventional degumming method. In this method, the degumming loss is 13.60 % only. The sericin is removed properly, So, the spinning process could be at ease as the degummed fibres were able to open up easily, but in this method process of eri cocoon degumming takes longer time.

CSTRI Eco Eri cocoon degumming method:

In this method, to develop Eco Eri cocoon degumming machine is equipment for degumming of eri cocoons without using any chemicals. This novel approach is to enhance the productivity due to shorter processing time. Existing method of eri cocoon degumming is carried out in the industry by using soap and soda as in an open vessel at boiling temperature. This method of degumming is a lengthy process and requires chemicals which lead to environmental problems due to the pollution load in the effluent. in enzymatic degumming process takes longer time. So silk processing industry is not showing more interest.

In this method, degumming of eri cocoons without using any chemicals, using high temperature and high pressure with less quantity of water for 25-30 minutes. The eri cocoons are filled in cages and kept in eri cocoon degumming machine, then close the door. The temperature is slowly rising up to 125-130 ($^{\circ}\text{C}$). At high temperature and high pressure, the sericin will swell and get softened.. After degumming, the material is washed in hot water followed by cold wash. This novel approach is expected to enhance the productivity in shorter processing time. In this method the degumming loss is 14.80 %. The degumming recipe is given in table.4. The new process is economical and environmentally friendly. In addition to this, the process can be saving of water and energy, etc are the added advantages of this process

Physical properties of degummed fibres of enzymatic and eco eri degumming degummed fibres shown better results

compare to soap and soda method. The results are given in table.5

Table 5 Physical properties of degummed fibres.

Particulars	Soap & Soda Degumming	Enzymatic Degumming	Eco Eri degumming m/c
Degumming loss (%)	10.00	13.60	14.80
Tenacity (g/d)	1.90	2.00	2.25
Elongation (%)	19.8	20.12	20.50

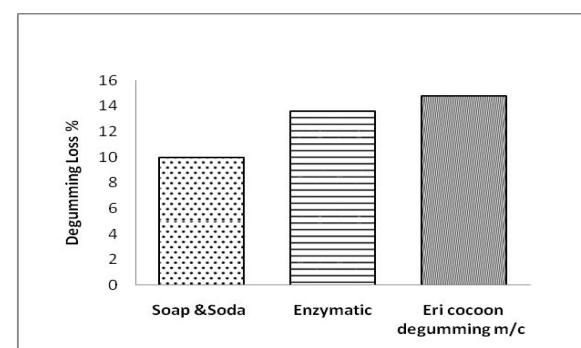


Fig.1

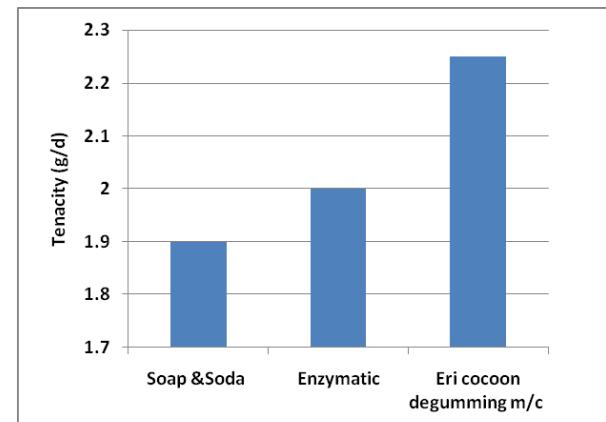


Fig.2

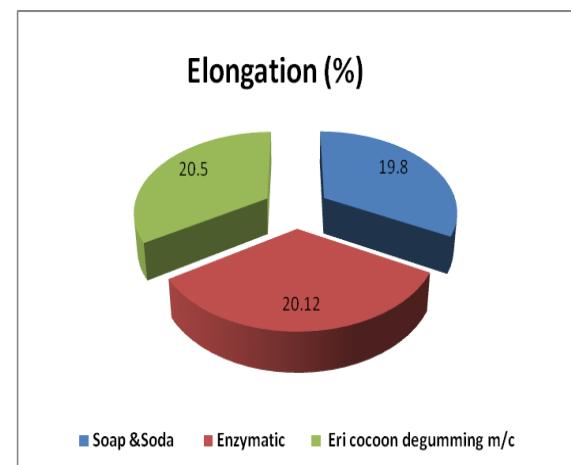


Fig.3

Advantages of Eco Eri Degumming

m/c:

- Efficient degumming process for eri silk shells.
- No chemicals used for degumming and hence 100% eco-friendly process.
- Very less time consuming (30 minutes) and hence very productive machine.
- Very economical due to no use of chemicals and high productivity.
- Less consumption of water and hence very less load on effluent.
- The process can be made zero discharge (effluent free) by extracting sericin.
- Saving of water and energy.
- Sericin can be easily recovered after degumming and used for varied applications.

Conclusions:

- Degumming of eri cocoons using conventional methods are tedious and needs higher concentration of chemicals, which leads to higher costing besides polluting the environment.
- Eri cocoon degumming machine has been successfully developed, which uses only pressured water, it will not only saves the environment but also makes the degumming process economical.
- With extraction of eri sericin from the chemical free effluent, it can achieve zero discharge and also provide value addition to the process of degumming.
- Application of eri sericin extracted in natural form can also be explored in various cosmetic and other fields.

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