


RESEARCH

Open Access



# Probing the potentiality of the defoliator *Cricula trifenestrata* Helfer silk: a revisit

Hemachandran Hridya<sup>1\*</sup> , Lopamudra Guha<sup>1</sup>, Mahashankar Mazumdar<sup>2</sup>, B. N. Sarkar<sup>1</sup>, Soni Vijayakumar<sup>3</sup> and P. Borpuzari<sup>1</sup>

## Abstract

**Background:** Transformation of pest to valuable product is considered to be a noteworthy innovation. This article explores the potentiality of wild silkworm *Cricula trifenestrata* Helfer for sustainable development towards human livelihoods.

**Results:** The innate characteristics of this silkworm with robust rearing capacity have bestowed various aspects of biomaterials with special context to diversification of wild silk products. Views on challenges, prospects and the enigma of converting a pest to beneficial product are also unraveled. Exploration on utmost utilization of raw silk, scope for varied byproduct from silk waste may contribute a ray of hope for income generation to the rural population.

**Conclusion:** With suitable plantation and congenial climatic conditions for rearing *Cricula trifenestrata* may serve as an alternative wild silk in contributing to the country's wild raw silk production.

**Keywords:** Wild, Silkworm, Cocoon, *Cricula*, Pest, Product, Silk

## Background

Wild/Vanya silkworm confers to non-mulberry silkworm which comprises *Antheraea mylitta*, *Antheraea proylei*, *Antheraea assamensis* and *Samia ricini* which are commercially exploited in India. In other countries wild silkworms which are commercially exploited includes *Gonometa*, *Hylaphora*, *Antheraea yamamai*, *Antheraea pernyi* etc. In the present scenario, India's vanya raw silk production is around 10,581 MT (29.5%) against the country's total production of 35,820 MT for the year 2019–20. In 2020–21, despite of covid-19 pandemic 33,739 MT of Raw silk was produced in which 9879 MT (29.2%) is contributed by vanya silk (Source Central Silk Board, Bangalore, India). There are numerous wild silkworm in India, which are least concerned for its probable productivity. An attempt is made to discuss

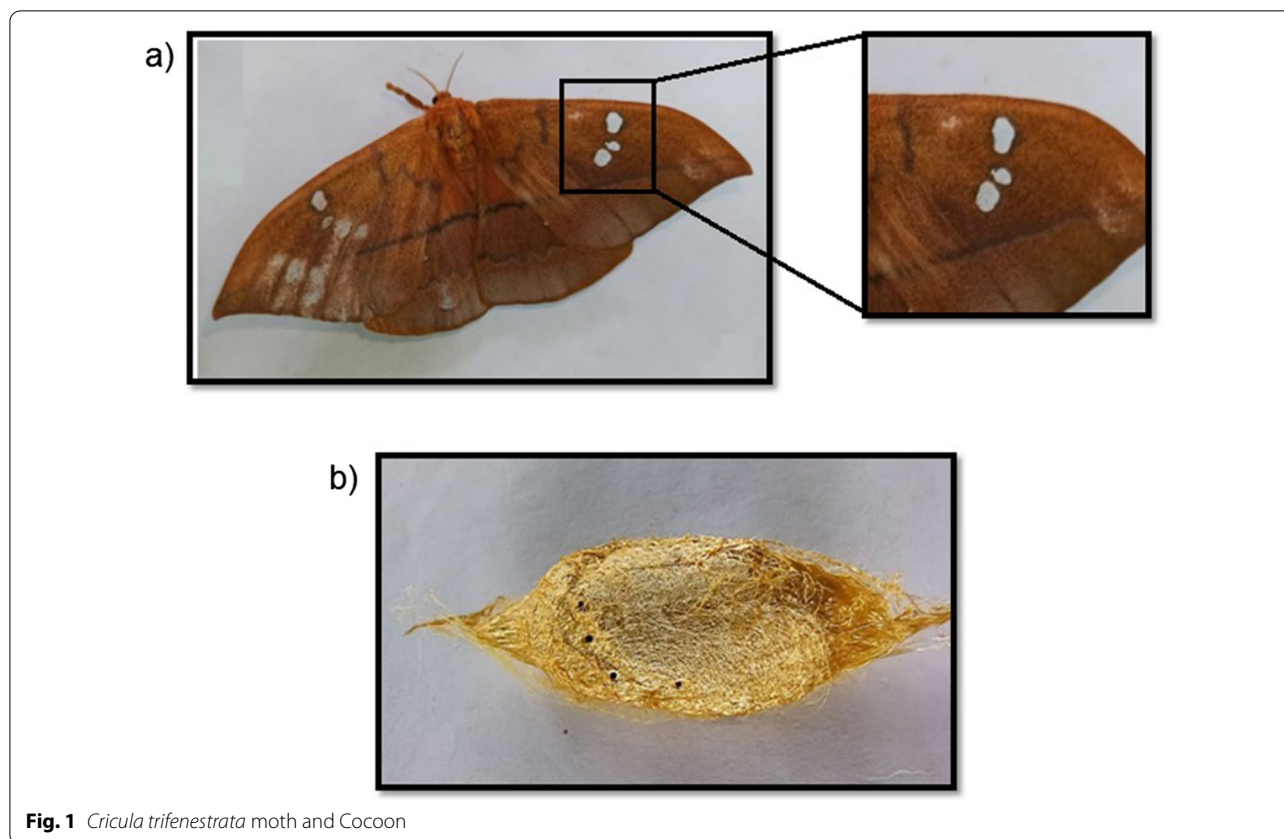
about a common pest which can be transformed into a commercial product with scientific and technological intervention.

*Cricula trifenestrata* Helfer is a wild Lepidopteron sericigenous moth known for its lustrous golden cocoon. The Genus *Cricula* was proposed by Walker in 1855. Capt. Jenkins and Helfer coined the species *trifenestrata* due to the presence of 3 windows like structure in the forewing as represented in Fig. 1 (Tikader et al. 2014; Kaleka et al. 2018). It is invariably considered as a pest for *Antheraea assamensis* i.e., muga silkworm as it depletes the foliage by feeding thereby affecting the Effective Rearing Rate (ERR) of Muga silkworm. They infect a wide range of host plants namely *Mangifera indica*, *Persea bombycina*, *Anacardium occidentale*, *Arachis hypogea*, *Cinnamomum cassia*, *litchi cheinensis*, *Machilus odoratissima* and *Camellia sinensis* (Ahmed et al 2012; Gharde and Chaudhuri 2018; Narang and Gupta 1979; Tikader et al. 2014). Host diversity of *Cricula trifenestrata* is detailed in (Table 1). *Cricula trifenestrata* is widely distributed in South Asian countries (Fig. 2). *Cricula trifenestrata* is

\*Correspondence: hridya004@gmail.com

<sup>1</sup> Muga Eri Silkworm Seed Organisation, Ministry of Textiles, Central Silk Board, Guwahati, Assam, India

Full list of author information is available at the end of the article



reported to be predominant in India, Andaman, Myanmar, Vietnam, Cambodia, Malaysia, Singapore, Thailand, Bangladesh, Java, Philippines countries (Tikader et al. 2014; UK 2014).

*Cricula trifenestrata* takes up to 61–125 days to complete the life cycle. Complete defoliation occurs in 4th and 5th instar. The larvae have 5 instars and passes 4 generation in a year (Tikader 2012; Huq et al. 1991). The average fecundity was reported to be  $141.7 \pm 11.79$ , and observed hatching rate was  $88.81 \pm 1.37\%$  when reared in *Mangifera indica*. The average *Mangifera* leaf consumption was about 29.4 g (Amin et al. 2008) *Persea bombycina* fed larvae (Figs. 3, 4) exhibited higher content of protein and lipid in the haemolymph suggesting *Persea bombycina* as the superior host in respect to silk deposition (Ghosh et al. 2015). High Infestation in *Persea bombycina* was observed during September to January (Ahmed et al. 2012). The efficiency of conversion of digested food in first instar when fed with *Persea bombycina* was 36.54% and the digestibility was 67.74% indicating *Persea bombycina* as the preferred host plant by *Cricula* on the basis of nutritional indices. (Biswas et al. 2013). *Cricula trifenestrata* were even recorded, at an altitude of 1097 m in some parts of Tamilnadu (Singh 1992). In cashew, *Cricula trifenestrata* larval infestation

had a positive correlation with number of flower and seeds (Siswanti et al. 2017).

In Sikkim, *Cricula* was reported infesting Cardamom i.e., *Amomum subulatum* causing huge devastation of the crop. The average fecundity was observed to be 157–252 eggs per month. The mature larvae is black-brown with red sublateral stripes, 2–11 somites with six setiferous tubercles. Larval period ranges to  $87.16 + 2.65$  days and larval mortality 23.23%. Life cycle takes around 168.92 days (Yadav and Kumar 2004). The chromosome number ( $n$ ) of *C. trifenestrata* was found to be 31 (Narang and Gupta 1979). The cytochrome C oxidase subunit gene of *Cricula trifenestrata* was studied to identify specific unique sites for species identification to develop species marker. It was noted that 595 nucleotides are conserved in the species of cytochrome C oxidase gene. The 107th amino acid (valine) and 138th (threonine) were diagnostics amino acid for *C. trifenestrata*. The phylogenetic study revealed that *Cricula* and *Antherea* share the same node of the saturniidae family suggesting monophyletic (Solihin et al. 2012).

#### Control measures

The *Cricula* infestation causes havoc destruction to the foliage hence researchers have studied various physical,

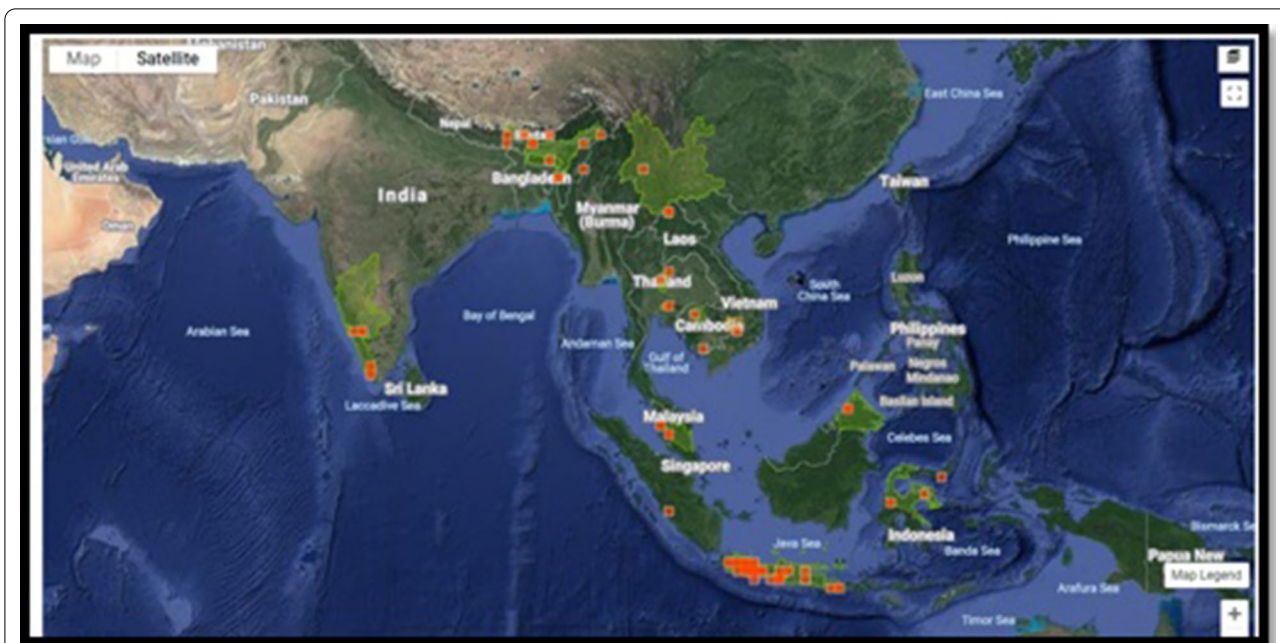
**Table 1** Host plant diversification of *Cricula trifenestrata*

S. no	Botanical name	Family	Common name
1.	<i>Mangifera indica</i>	Anacardiaceae	Mango
2.	<i>Persea bombycina</i> / <i>Machilus bombycina</i>	Lauraceae	Som Sum, Mojali, Majti
3.	<i>Anacardium occidentale</i> L	Anacardiaceae	Cashew, caju
4.	<i>Arachis hypogea</i> L	Fabaceae	Peanut, Groundnut, earthnut, monkey nut
5.	<i>Cinnamomum cassia</i>	Lauraceae	Chinese cassia, Chinese cinnamomum
6.	<i>Litchi cheinensis</i>	Sapindaceae	Lychee, litchi
7.	<i>Camellia sinensis</i>	Theaceae	Tea
8.	<i>Amomum subulatum</i>	Zingiberaceae	Black cardamom, Big cardamomum, hill cardamomum, winged cardamomum
9.	<i>Acrocarpus fraxinifolius</i>	Fabaceae	Pink cedar, Shingle tree, Australian Ash, Indian Ash, Red cedar, Keny coffeeshade
10.	<i>Bucklandia populnea</i>	Hamamelidaceae	Dingdah, Pipli, Singliang
11.	<i>Careya arborea</i>	Lecythidaceae	Patana Oak, Wild Guava
12.	<i>Schleichera trijuga</i>	Sapindaceae	Lac tree, Ceylon oak, Kusum tree
13.	<i>Ziziphus jujube</i>	Rhamnaceae	Jujube, red date, Chinese date, Chinese jujube Bogari
14.	<i>Piper nigrum</i>	Piperaceae	Black pepper, kalimirch, golmirch
15.	<i>Machilus odoratissima</i>	Lauraceae	Fragrant Bay,
16.	<i>Persea Americana</i>	Lauraceae	Avacado
17.	<i>Mimusops elengi</i>	Sapotaceae	Spanish cherry, bullet wood, Maulsari, Bakull, Elengi
18.	<i>Abelmoschus esculentus</i>	Malvaceae	Okra, Ladys' finger
19.	<i>Altingia excelsa</i>	Hamamelidaceae	Rasamala, Oriental Sweet Gum, Shilarasa, Turushka
20.	<i>Cinchona officinalis</i>	Rubiaceae	Peruvian bark, quinine
21.	<i>Cinnamomum verum</i>	Lauraceae	Ceylon cinnamon, Dalchini, true cinnamon, lavanga
22.	<i>Elaeocarpus floribundus</i> Blume	Elaocarpaceae	Indian olive, Jalpai
23.	<i>Litsea glutinosa</i>	Lauraceae	Soft bolly gum, bolly beech, brown beech
24.	<i>Luffa aegyptiaca</i>	Cucurbitaceae	Sponge gourd, Ghia torai, loofa
25.	<i>Ziziphus mauritiana</i>	Rhamnaceae	Indian plum, Ber, elandai
26.	<i>Syzygium cumini</i> (L)	Myrtaceae	Java plum, jamun, black plum, naagai
27.	<i>Spondias sps</i>	Anacardiaceae	Hog Plum
28.	<i>Bischofia trifoliata</i>	Euphorbiaceae	Bishop wood
29.	<i>Canarium harveyi</i>	Burceraceae	Java almond, pili nut, pacific almond
30.	<i>Malus floribunda</i> Siebold ex Vanhoutte	Rosaceae	Crab apple, chokeberry

chemical and biological control methods to prevent infestation in field crops. Proper weeding of the tree cover in summer is seen effective to prevent to *Cricula* larval infestation in Cinchona plantations. This cultural operation serves as a first line of physical defence in preventing infestation (Van Zwet 1950). Biological control by utilizing parasitoid serves as an effective control measure in controlling the *Cricula* (Table 2). Parasitization of *Cricula trifenestrata* eggs with *Telenomus* sp has complete efficacy up to pupal stages of *Cricula trifenestrata*, when parasitized with *Brachymeria criculae* efficacy resulted in 79.71%. *Mesomys orientalis* and *Sarcophaga* sp. parasitoid can also control the *Cricula* infestation during pupal stage (Ali and Karim 1991). *Xanthopimpla konowi* parasitizes the pupae (Singh 1992). *Brachymeria tibialis* (Walker) parasitoid destroys and consumes the

pupae inside the cocoon preventing future multiplication. Hence *Brachymeria tibialis* can be efficiently utilized as a biological control in *Antherea assamensis* silkworm rearing (Tikader 2012).

In Indonesia, *Beauveria bassiana* at a concentration of  $5 \times 10^6$  spores suspension resulted in highest mortality of *Cricula* moth. However it is not effective in *Antherea assamensis* field (Sjafaruddin and Rahmatia 1999). Parasitoid *Blepharipa zebina* infest larvae of *Cricula trifenestrata* which infest *Machilus bombycina* (Negi et al. 1993). In Arunachal Pradesh *Exorista sorbillans* was observed as an endoparasitoid parasitizing the *Cricula* larvae and causing death at pupal stage during March to mid-September (Sarma et al. 2006). *Chalcis cricula* and *C. etipalaeae* parasitizes *Cricula* larvae (Yadav and Kumar 2004).



**Fig. 2** Global distribution of *Cricula trifenestrata*. Source: <https://www.inaturalist.org/taxa/510228-Cricula-trifenestrata>



**Fig. 3** *Cricula trifenestrata* infestation on *Persea bombycina* foliage

Fenvalerate and cypermethrin were the most effective chemical control methods, when treated for 7 days post treatment resulted in 94.44 and 79.16% larval mortality (Munaan 1986). In Maharastra field study has resulted in effective control of *Cricula* infestation in ground nut by cyhalothrin and Naled at 0.0005 and 0.001% (Deshmukh 1992) chemically infestation can be controlled by endosulphan, deltamethrin and neem based pesticide like azadirachtin (0.003% and 0.015%) has been effective (Ahmed et al. 2012) 0.05% endosulfan and parathion-methyl was used to control (Singh 1992). 0.1% methyl

parathion and endosulphan are effective chemical control methods reported (Yadav and Kumar 2004).

**Methods**

The rearing parameters are reported in varied host plants. Here attempts on exploration of post cocoon parameters are explored for commercial utilization. Cocoons of *Cricula trifenestrata* which was reared upon consuming *Persea bombycinia* in the wild were obtained and the pupal and shell weight was determined. The cocoons were stifled in hot air oven at 45 °C for 2 h. Owing to the presence of perforations in the cocoons reeling isa constrain hence it is utilized for spun yarn.

**Degumming and cake preparation**

The removal of sericin and letting the fibres loose for further processing is called Degumming. Cocoons of *Cricula trifenestrata* were degummed by boiling in 0.5% sodium carbonate for 45 min. Further rinsing in hot distilled water and distilled cold water. Drying was done in hot air oven at 45 °C for 2 h.

$$\text{Degumming loss (\%)} = W_1 - W_2 / W_1$$

where  $W_1$  is the initial weight of conditioned *Cricula* cocoons samples and  $W_2$  is the weight of degummed as well as conditioned *Cricula* cocoons sample Followed by washing. The individual degummed cocoons were opened in water and sheets are formed and placed



**Fig. 4** Different stages of *Cricula trifenestrata* larval infestation in *Persea bombycina* host

**Table 2** Reported Biological control of *Cricula trifenestrata* at different stages of rearing

S. no	Parasitoid	Developmental stage	Efficiency	References
1.	<i>Telenomus</i> sp	Pupae/egg	100%	Ali and Karim (1991)
2.	<i>Brachymeria criculae</i>	Pupae	79.71%	
3.	<i>Mesomys orientalis</i>	Pupae	Not defined	
4.	<i>Sarcophaga</i> sp	Pupae		
5.	<i>Brachymeria tibialis</i>	Pupae	25%	Tikader (2012)
6.	<i>Chalcis cricula</i>	larvae	Not defined	Yadav and Kumar (2004)
7.	<i>Chalcis etiplaeae</i>	larvae		
8.	<i>Xanthopimpla konowi</i>	larvae		Singh (1992)
9.	<i>Beauveria bassiana</i>	moth	Spore suspension $5 \times 10^6$	Sjafaruddin and Rahmatia (1999)
10.	<i>Blepharipa zebina</i>	larvae	Not defined	Negi et al. (1993)
11.	<i>Exorista sorbillans</i>	pupae	13–14%	Sarma et al. (2006)
12.	<i>Pediobius</i> sp	pupae	66.4%	Alam and Ahmed (1992)

overlapping. Cakes were prepared by overlapping 3–4 cocoon fibre sheets and dried in room temperature (Munshi et al. 2016).

**Spinning**

The yarn is spin in a motorized spinning machine. The silk ratio and silk recovery is determined.

**Results**

145 cocoons were obtained from the wild (Fig. 5). The post cocoon parameters were observed and analyzed and the results are shown in Table 3.

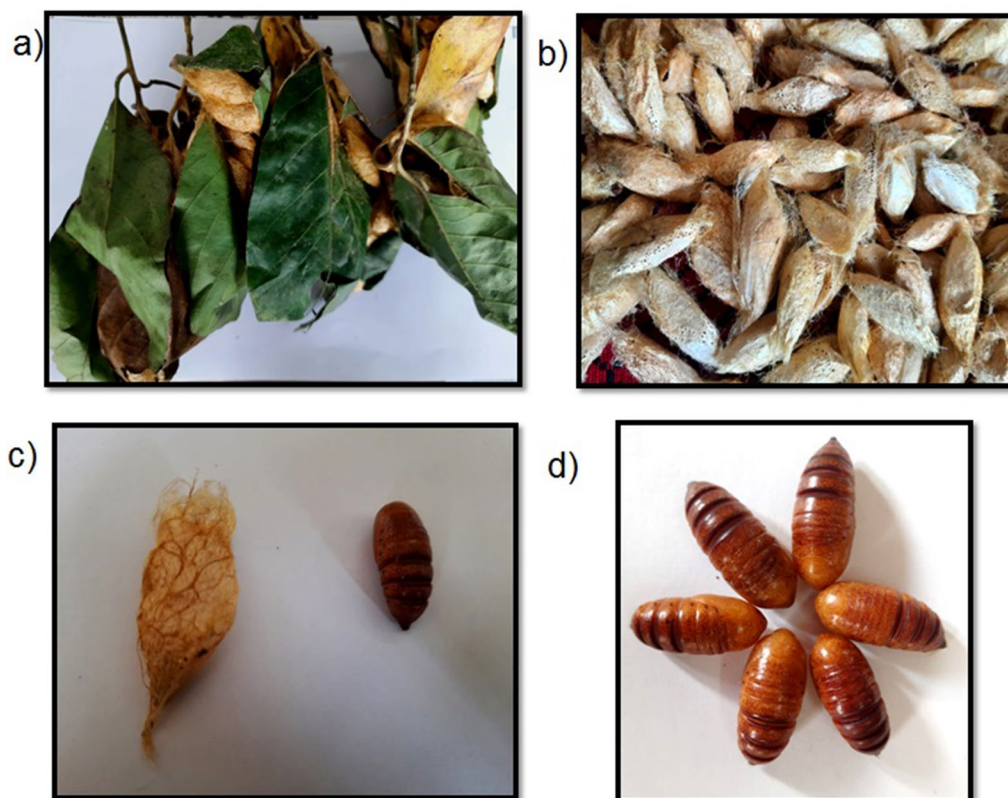
The total cocoon weight was observed to be 105 gm. wherein total shell weight was 15.5 gm and total pupal weight was 89.5 gm. Single cocoon weight, single shell weight and single pupal weight was 0.72 gm, 0.106 gm and 0.617 gm respectively. The silk ratio % was 14.76%. Shell weight after degumming was 14.5 gm. The

Degumming loss (%) was found to be 6.45%. The spun yarn weight was found to be 9.8 gm. and silk waste was 4.7 gm. Thereby determining that the silk recovery % was 67.59% and Silk waste % was 32.41%.

**Discussion**

**Exploring the insights of commercial utilization of *Cricula* silk**

The cocoons were oval with tapering ends and contain perforation on the surface. When the cocoons were subjected to degumming the golden lusture was lost implying the affinity of the golden hue was high in the sericin content and not fibroin. Insights on developing an efficient degumming agent which aids in retaining the golden hue in the yarn may result in high demand of the fabric. The silk recovery % was observed to be higher



**Fig. 5** a Spinned cocoons in leaves, b collected cocoons reared on *Persea bombycina*, c single cocoon and pupae, d matured pupa

**Table 3** Post cocoon parameters determined in *Cricula trifenestrata* cocoon

S. no	Post cocoon parameters assessed	Results in gm/%
1.	No. of cocoon	145
2.	Total Cocoon weight	105 gm
3.	Total shell weight	15.5 gm
4.	Total pupal weight	89.5 gm
5.	Single cocoon weight	0.72 gm
6.	Single shell weight	0.106 gm
7.	Single pupal weight	0.617 gm
8.	Silk ratio%	14.76%
9.	Shell weight after degumming	14.5 gm
10.	Spun yarn weight	9.8 gm
11.	Waste weight	4.7 gm
12.	Silk recovery%	67.59%
13.	Waste%	32.41%

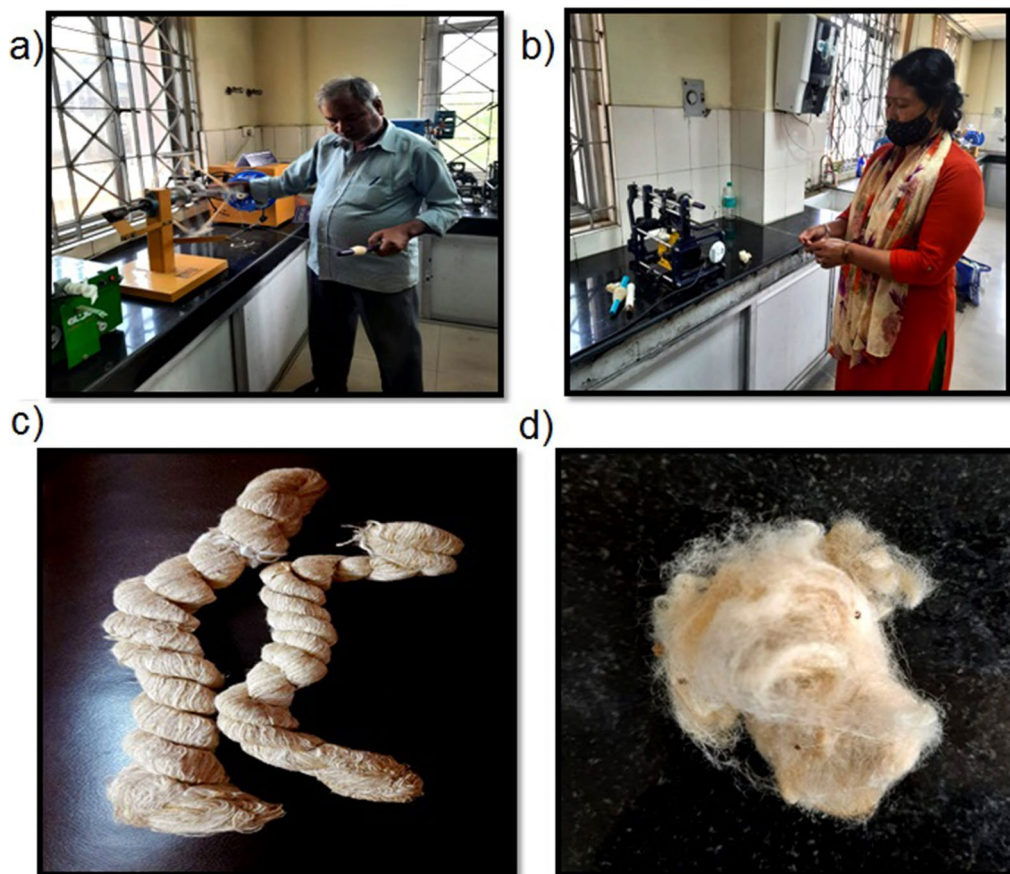
than muga which was conventionally around 40–48% and higher yield was 55% in Muga silk.

*Cricula trifenestrata* fibre was reported for the tensile strength and biocompatibility. The modulus elasticity of the single fiber of *Cricula trifenestrata* is about

3681 MPa. The silk can be prepared by degumming method of boiling in 0.01 M NaOH for 1 h. Degumming above the concentration 0.01 M NaOH resulted in hydrolysis of fibre. The ultimate tensile strength is obtained about 162 MPa together with value of failure strain about 0.12 (Nindhia et al. 2014).

Unlike *Bombyx mori*, the pigments are usually deposited in the sericin which gets washed off during degumming process. However when cricula cocoons were degummed with chymotrypsin and the pigment content was observed in fibroin and sericin. It was observed that 1.4 times higher fold the pigment is present in fibroin than sericin (Yamada et al. 2001).

The wild silks in the world are still unexplored for their potential commercial utilization. Previous studies affirm the merits of *Cricula* silk for instance; *C. trifenestrata* silk protein was isolated and studied. The molecular mass of sericin and fibroin were 400 kDa and 350 kDa respectively, however fibroin when later underwent reduction the molecular mass was 180 kDa. The amino acid constituents resembled with higher serine content (Yamada and Tsubouchi 2001) The polar and non polar amino acid ratio in cricula sericin was about 69:31 (Manesa et al. 2020). *Cricula trifenestrata* Sericin has anti-proliferative



**Fig. 6** a Degummed cocoon, b the yarn is spun in motorized spinning machine, c Spun yarn hank preparation on approve, d cricula spun yarn

activity in feline kidney cells and Sericin-induced apoptosis (Liu et al. 2016). *Cricula trifenestrata* cocoon extract when treated on human fibroblasts revealed non cytotoxicity (Sunarintyas et al. 2012).

This study affirms the efficacy of *Cricula* to be utilized as a spun silk (Fig. 6). The golden cocoons are utilized as artifacts for attractive aesthetic products.

### Conclusions

Popularization on the artistic utilization of these golden cocoons in fabric designing or any other products may be of high demand in the near future. In the current surge, *Cricula* sericin also has added biological effects in pharmaceuticals and cosmeceutical industry. Hence more insights are to be explored for commercial product utilization of *Cricula* silk as a potential biomaterial, fabric, pharmaceutical, food, cosmetics and fuel industry.

### Abbreviations

MT: Metric ton; NaOH: Sodium hydroxide; kDa: Kilo dalton; MPa: Mega pascal.

### Acknowledgements

The authors wish to thank Central Silk Board, Bangalore, India for their constant support.

### Authors' contributions

HH and BNS conceived and designed the experiments. HH, MM and SV performed the experiment and wrote the manuscript. PB and LG analyzed the data. LG and MM reviewed the manuscript. All authors have read and approved the manuscript.

### Funding

No funding received from any organisation.

### Availability of data and material

All data generated or analyzed during this study are included in this manuscript.

### Declarations

#### Ethics approval and consent to participate

Not applicable.

#### Consent for publication

The participants declare that the work has been consented for publication.

#### Competing interests

The authors declare that they have no competing interests.

**Author details**

<sup>1</sup>Muga Eri Silkworm Seed Organisation, Ministry of Textiles, Central Silk Board, Guwahati, Assam, India. <sup>2</sup>MESSO, P4 Seed Station, Mendipathar, Central Silk Board, North Garo Hills, Meghalaya, India. <sup>3</sup>Regional Sericultural Textile Research Station, Central Silk Board, Guwahati, Assam, India.

Received: 19 September 2021 Accepted: 20 November 2021

Published online: 11 December 2021

**References**

- Ahmed SA, Dutta LC, Sarmah MC (2012) Bio-efficacy of some insecticides against leaf eating caterpillar, *Cricula trifenestrata* Helfer (Lepidoptera: Saturniidae) Infesting Som, *Persea bombycina* Kost. *Plantation Acad J Entomol* 5(2):94–98
- Alam MZ, Ahmed F (1992) Parasitoids associated with different stages of *Cricula trifenestrata* Helfer. *Lepidoptera, Saturniidae*
- Ali MI, Karim MA (1991) Notes on the biology, behaviour and biocontrol agents of mango defoliator *Cricula trifenestrata* (Lepidoptera: Saturniidae). *Bangl J Entomol* 1:83–87
- Amin MR, Ahad MA, Rono MMA, Tithi DA (2008) Life history traits of *Cricula trifenestrata* (Lepidoptera: Saturniidae) feeding on *Mangifera indica*. *J Agrofor Environ* 2(1):1–6
- Biswas S, Hath TK, Ray N (2013) Effect of different host plants on nutritional indices of wild silk moth. *Cricula Trifenestrata J Entomol Res* 37(3):223–227
- Deshmukh PB (1992) Efficacy of two insecticide treatments against aphid, *Toxoptera avrantii*, and caterpillar, *Cricula trifenestrata*, on groundnut, *Arachis hypogea* L. *Int Pest Control* 34(5):153
- Gharde SK, Chaudhuri N (2018) The life history and population growth parameters of leaf eating caterpillar *Cricula trifenestrata* Helfer (Lepidoptera: Saturniidae) infesting *manochilus bombycina* king. *Int J Curr Microbiol App Sci* 7(2):710–717
- Ghosh J, Chaudhuri N, Bera C (2015) Bio-ecological analysis to identify the critical stage of development of mango defoliator *Cricula trifenestrata* (Lepidoptera: Saturniidae). *Int J Recent Sci Res* 6(10):7259–7262
- Huq SB, Hossain M, Khan AB (1991) Biology of *Cricula trifenestrata* (Lepidoptera: Saturniidae), a leaf eating caterpillar of mango. *Bangl J Entomol* 1:19–26
- Kaleka AS, Singh D, Saini S (2018) Further studies on the moth *Cricula trifenestrata* from North-West India (Lepidoptera: Saturniidae). *Ann Entomol* 20(1):15–17
- Liu W, Karimazawa M, Ozaki T, An Y, Miyazaki M, Suzuki K, Tsutsumi KI, Yamashita T (2016) Cell proliferation inhibition by sericin from the wild silkworm. *Cricula Trifenestrata Adv Biol Chem* 6(1):28–33
- Manesa KC, Kebede TG, Dube S, Nindi MM (2020) Profiling of Silk Sericin from cocoons of three Southern African Wild silk moths with a focus on their antimicrobial and antioxidant properties. *Materials* 13(24):5706
- Munaan A (1986) Controlling *Cricula trifenestrata* Helf. on cashew trees. *Pemberitaan Penelitian Tanaman Industri* 12(1–2):36–40
- Munshi R, Mazumdar S, Gupta PD, Chattopadhyay D (2016) Studies on standardization on degumming process for different eco races of eri silk cocoons. *Indian J Nat Fibres* 3(1):69–76
- Narang RC, Gupta ML (1979) Chromosome number of *Cricula trifenestrata* Helfer (Lepidoptera: Saturniidae). *Curr Sci* 48(10):465–466
- Negi BK, Barah A, Siddiqui AA, Sengupta AK (1993) *Cricula trifenestrata* (Lepidoptera: Saturniidae)-a new alternate host of *Blepharipa zebina* (Diptera: Tachinidae). In: Recent advances in Uzi fly research: proceedings of the national seminar on Uzi fly and its control, 16–17 January, 1992. Karnataka State Sericulture Development Institute, pp 269–271.
- Nindhia TGT, Knežlik Z, Ruml T, Nindhia TS (2014) Tensile properties and biocompatibility of Indonesian wild silk *Cricula trifenestrata*: a preliminary study. *J Med Bioeng* 3(2):140–143
- Sarma AK, Gupta MK, Singh KM (2006) New record of a dipteran endoparasitoid of *Cricula trifenestrata* Helfer on Som *Machilus Bombycina*. *J Plant Protect Environ* 3(1):143–144
- Singh SP (1992) Frequent outbreaks of *Cricula trifenestrata* Helfer (Lepidoptera, Saturniidae) on mango. *Indian J Plant Protect* 20(1):114–115
- Siswanti R, Supriyadi S, Subagiya S (2017) Correlation between damage plant by silkworm *Cricula trifenestrata* to cashew yield. *Agrotechnol Res J* 1(1):21–27
- Sjafaruddin M, Rahmatia D (1999) Field trial of *Beauveria bassiana* to canarium moth (*Cricula trifenestrata*) on cashew crop. In: Seminar Nasional Hasil Pengkajian dan Penelitian Teknologi Pertanian Menghadapi Era Otonomi Daerah, Palu (Indonesia), 3–4 Nov 1999. PSE.
- Solihin DD, Noor RR, Thohari AM (2012) The characteristics of cytochrome C oxidase gene subunit I in wild silkworm *Cricula trifenestrata* Helfer and its evaluation for species marker. *Media Peternakan* 35(2):102–102
- Sunarintyas S, Siswomihardjo W, Tontowi AE (2012) Cytotoxicity of *Cricula trifenestrata* cocoon extract on human fibroblasts. *Int J Biomater* 2012:222–226
- Tikader A (2012) New record of *Brachymeria tibialis* (Walker)(Hymenoptera: Chalcididae) on *Cricula trifenestrata* (Helfer) from India. *J Mun Ent Zool* 7(1):222–225
- Tikader A, Vijayan K, Saratchandra B (2014) *Cricula trifenestrata* (Helfer) (Lepidoptera: Saturniidae)-A silk producing wild insect in India. *Trop Lepidoptera Res* 24:22–29
- UK C (2014) *Cricula trifenestrata* ((Helfer)), tea flush worm.[pest/pathogen]. *Cricula trifenestrata* ((Helfer)), tea flush worm.[pest/pathogen]., (AQB CPC record).
- Van Zwet AJ (1950) A practical method of cadavrontrolling caterpillars in cinchona plantations. *Bergcultures* 19:331
- Yadav S, Kumar A (2004) New record of wild silk caterpillar, *cracula trifenestrata* Helfer on large cardamom and notes on it's biology. In: Arvind K (ed) *Advances in Life Sciences*, 1st edn, Chapter 36. p 305
- Yamada H, Tsubouchi K (2001) Characterization of silk proteins in the cocoon fibers of *Cricula trifenestrata*. *Int J Wild Silkworm Silk (jpn)* 6:47–51
- Yamada H, Kato Y, Tsubouchi K (2001) Yellow pigmentation of the fibroin core in the cocoon fibers of *Cricula trifenestrata*. *Int J Wild Silkworm Silk (jpn)* 6:43–46

**Publisher's Note**

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Submit your manuscript to a SpringerOpen® journal and benefit from:

- Convenient online submission
- Rigorous peer review
- Open access: articles freely available online
- High visibility within the field
- Retaining the copyright to your article

Submit your next manuscript at ► [springeropen.com](https://www.springeropen.com)