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### The novel silk fiber: Eri

**Meenakshi Tamta and Surabhi Mahajan**

#### Abstract

India is an important sericulture country in the tropics. It occupies an eminent place in global sericulture map as it is the homeland of all four varieties of natural silks: mulberry, tasar, eri and muga. Eri silk is a staple fiber unlike all other silks which are filament in nature. The texture of the fiber is coarse, fine and dense. It is very strong, durable and elastic. Eri silk is darker and heavier than other silk types. Due to its thermal properties, it is warm in winter and cool in summer. It mainly consists of fibroin and sericin along with very small amounts of waxy substances, mineral salts and coloring matter. The unique properties of this fiber in terms of its fineness, density, cross sectional shape and surface properties play an important role in determining its end use. It has immense potential for commercial exploitation by making finest quality blankets, sweaters and suiting materials. Besides, there is a good scope for eri silk to be used with other fibres to develop blended materials. Eri silk is becoming popular now-a-days in growing concern for eco-friendly products as it is obtained without affecting the natural life cycle of the silk worm and hence it is also called the peace silk.

**Keywords:** commercial exploitation, filament, fineness, spinning

#### Introduction

Silk is known as the “Queen of Textiles”, all over the world. India is the only country producing all four varieties of silk i.e. mulberry, tasar, eri and muga. Amongst these, eri is the only completely domesticated non-mulberry variety of silk (Gulrajani 1993) <sup>[11]</sup>. The earliest references to eri culture in India date back to about 1779. Eri culture is mainly practiced in north eastern regions of India. The states of Assam, Nagaland, Meghalaya and Manipur account to nearly 98 percent of eri silk produced in the country as “Endi”. It is also cultured in the states of Bihar, Orissa, West Bengal and Andhra Pradesh on a smaller scale. It is observed that there is vast scope for development of Eri culture on a large scale not only in traditional states but also in non-traditional states like Andhra Pradesh, Gujarat, Rajasthan, Punjab, Karnataka and Uttar Pradesh (Nadiger *et al.* 2007) <sup>[6]</sup>.

Eri silk is a multivoltine silk spun from open-ended cocoons. It is a product of domesticated silkworms, *Samia ricini* which feed mainly on castor leaves. The popularity of eri silk in the textile world was limited due to the discontinuous filaments, reeling problems and lack of favourable environmental condition for rearing eri silk worms. However, the production of eri silk in India showed a sharp increase from 127 MT during first plan period (1951-56) to 11,500 MT during 2018-19 contributing 20% of total silk production in the country (Ministry of Textiles 2019).

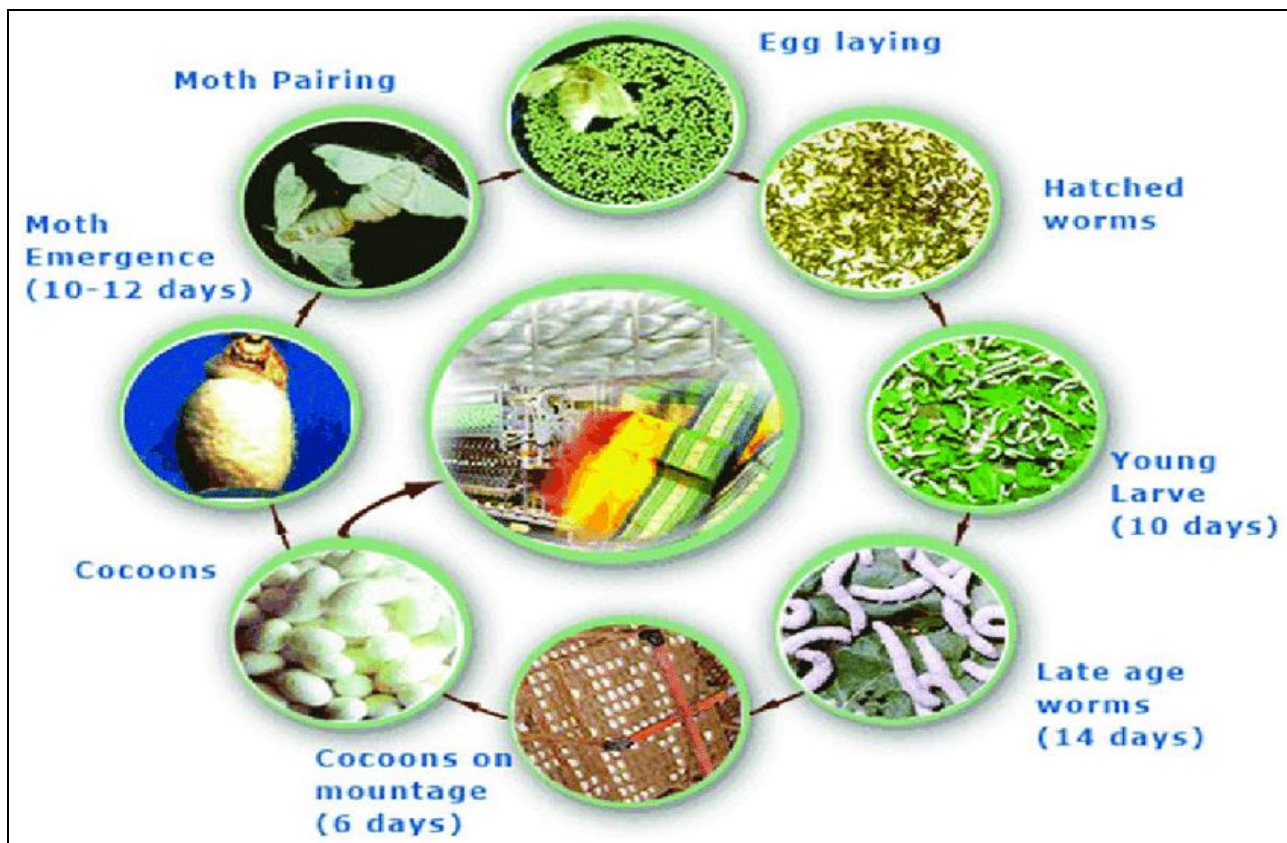
Eri silk is a staple fiber and it has good fineness, density, cross-sectional shape and surface properties. It is darker and heavier than other silks. It feels like cotton, has luster like other silks, bulkiness and warmth like wool and is the softest among all silk fibers. All these properties make it more unique than other fibers (Kariappa 2006 and Chollakup *et al.* 2008) <sup>[9, 3, 15]</sup>. Due to its thermal properties, it is warm in winters and cools in summers and also has good blending possibilities with other natural silks, wool, cotton, jute and synthetic fibers (Somashekhhar 2003) <sup>[17]</sup>. The eri silk is used indigenously for preparation of blankets, sweaters, *chaddars* or wrappers and suiting materials. The beautiful eri fabric which is known for its durability is used as regular winter wrapper (Reddy and Shankar, 2008) <sup>[16]</sup>. These unique properties have been a source of attraction to many researchers to explore new and less known facts about eri fiber. The present study is also an attempt in this direction.

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**Cultivation of silk**

Silk is a protein fiber. It is a fibroin made of proteins secreted by silk worm. The life cycle of silkworm consists of four important stages namely egg, larva, pupa and moth. It is during the pupa stage that pupa forms a protective shell called

cocoon and spins silk around it resembling the figure of ‘8’ by secreting a protein fluid. The life cycle of eri silkworm is around 6 weeks in summer and 12 weeks in winter (Manjula and Vasugi 2016) [13].



**Fig 1:** Life cycle of the silkworm

**Chemical composition**

The silkworm secretes two continuous filaments made of a core protein ‘fibroin’ produced by its two salivary glands, which are cemented together by another gummy protein, sericin. The filaments harden and become the natural silk. The cocoon contains fibroin (70-80%), sericin (20-30%), waxy matter (0.4-0.8%), carbohydrates (1.2-1.6%), pigments (0.2%) and inorganic matter (0.7%). But the percentage is variable in respect of silkworm strain, seasons and ecological conditions (temperature, humidity etc.) at different geographical locations (Thangavelu *et al.* 1985) [20]. Differing composition may thus be attributed to factors including source of fibers, climate conditions and the process used in obtaining the fibers. (Manjula and Vasugi 2016) [13].

provide the scope of blending this fiber with other fibers (Sonwalkar 1993) [21]. The tenacity and elongation of eri silk are 2.5-3.5 g/denier and 30-40% respectively with 11% moisture retention capacity (Suryanarayana *et al.* 2003) [14].

- Luster and smoothness:** Eri silk fibers have the most exciting characters like luster, extreme smoothness and very good moisture absorbency. Moreover, the attractive character is brilliant shade for better resilience. Eri silk is finer than muga and tasar silk and even softer than mulberry silk.
- Elastic Recovery:** One of the most attractive properties is very good elastic recovery of erisilk fiber (Vatsala 2002) [22].

**Table 1:** Chemical Composition (%) of all types silk

Components	Eri	Mulberry	Muga	Tasar
Fibroin	82-88	66-72	80-86	78-85
Sericin	11-13	25-32	12-16	14-17
Waxy matter	1.5-2.2	0.3-0.4	0.5-1	1-2
Minerals, ash and other material	2-3	0.7-0.8	2-3	3-4

**Physical properties of eri silk fiber**

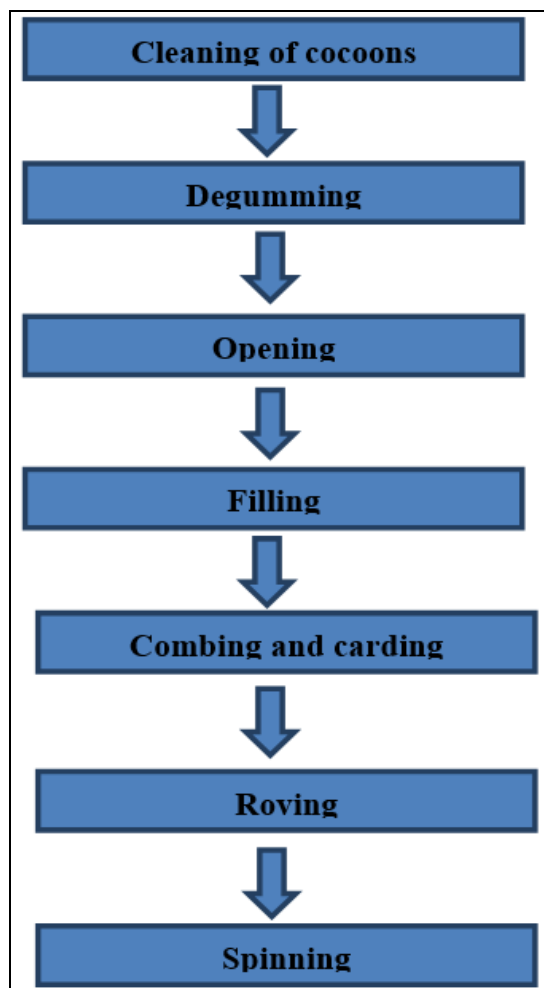
- Weight:** The weight of fresh eri cocoon is about 3-5 gm. The shell content is 11-14% with variation in shell weight between 0.4 to 0.6 gm.
- Yarn count:** Denier of the fiber is 2 to 3 with tenacity and elongation of 3 to 3.5 g/denier and 20 to 22% respectively. Higher elongation and shrinkage properties

Although eri silk possesses positive features, imparting proper twist is required to maintain dimensional stability to the fabric especially for garments. The survival of handloom silk industry with special reference to eri silk depends primarily on the diversification of end products to meet the national as well as international demand (Sreenivasa *et al.*, 2010) [18].

**Table 2:** Physical and mechanical properties of eri fiber

Fiber Parameters	Eri silk fiber
Fiber length (cm)	12.1
Fiber diameter (micron)	19.4
Tenacity ( g/Tex)	33.4
Elongation (%)	19.5

(Brojeswari *et al.*, 2017).



Fiber Processing

The eri cocoons are open-mouthed and do not contain continuous filaments and hence are not easily reelable. They form a good raw material for spinning but the cocoons vary in colour, size and softness. The soft cocoons are better for mechanical spinning while the bigger cocoons for hand spinning. The cleaning of cocoons is necessary in order to remove non-fibrous materials (pupae and moulted skin), which get entangled with silk fibre and for easy movement of the machinery used for spinning (Jolley *et al.*, 1979 and Sarkar, 1980) [7, 19]. The technology of production of spun silk yarn involves a long sequence of machines. The operations involved in the process are degumming, opening, filling, combing, carding, drawing, roving and spinning. Few research workers have attempted to spin silk on the woollen and worsted spinning systems (Chellamani, 2007) [4]. Eri cocoon can also be processed in melt spinning system to produce quality spun silk yarn and it is observed that elongation percent reduces with increase of count. The elongation percent of eri silk has highest value (17.45%) followed by mulberry silk (9.59%) whereas tenacity is highest in mulberry silk (5.94) followed by eri (2.60) (Kariyappa *et al.* 2007) [10].

#### Flow chart of silk fabric production

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Cocoon sorting → Cocoon drying → Cocoon preservation → Boiling → Reeling Re-reeling → Winding → Twisting → Doubling → Twisting → Steaming → Creeling → Warping → Warp beam Loom → Grey fabric → Degumming → Dyeing/Printing → Color fixation and finishing → Finished Fabric
  
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#### Dyeing and finishing

Dyeing is a process of application of colour to the textile material in scientific and systematic way. Normally the dye liquor consists of dye, water and auxiliaries. To improve the effectiveness of dyeing, heat is usually applied to the dye liquor. Acid dyes, metal complex dyes and reactive dyes are quite popular in silk industry but vat dyes are basically used for eri silk. These are insoluble in water and produce good fastness properties as compared to regular acid and metal complex dyes. Both orientation and crystallinity influence the kinetics and equilibrium uptake of water and dye molecules by fibers (Gulrajani M.L.2015) [23].

#### Eri silk blends

Silk is a finer, lustrous, strong fibre compared to wool. The yarns produced by blending silk and wool are bulkier and cheaper compared to pure spun silk yarn. Silk competes with wool because of its high elasticity, colour brilliance, resistance to pilling, strength and colour fastness properties (Gill and Singh 2002) [5]. Eri/acrylic blended yarn has been prepared at different blend ratio and it is found that tenacity of the blended yarn reduces with the increase in proportion of eri fibre in the blend, which is comparatively weaker as compared to acrylic. Whereas breaking elongation increases with the increase in coarseness of the yarn (Choudhuri, *et al.* 2013) [2]. The eri and cotton fibers are also blended using the draw frame blending with varying blending factors, viz. blending composition (0–100%) and yarn counts (30 and 50 tex). The results reveal that eri fiber which is longer and stronger than cotton fiber, affects the fiber distribution in the yarn cross-section. Eri silk fiber gives an advantage to the improvement of mechanical properties of those blended yarns with silk content higher than 50% (Chollakup, *et al.*, 2008) [3, 15]. Two eri spun-silk mills have been established in Hindupur in Andhra Pradesh and Kokrajhar in Assam while another is at Chaygaon, near Guwahati, Assam, which are spinning the finest eri spun-silk yarn with bamboo and muga silk.

#### End uses of eri silk

Eri silk mostly used for the preparation of winter shawls for men and women in India, The thermal properties of eri silk make it a suitable fabric for shawls, jackets, blankets, and bed spreads. Dress materials and baby dresses are also made from eri silk fabric because of its soft texture and moisture absorbent quality. Now-a-days, very fine (up to 210 Nm eri spun yarns are available, which enables weavers to weave very fine clothing, including traditional sari dress materials. Eri silk is durable and strong and has a typical texture; hence, it is also widely used in home furnishing like curtains, bed covers, cushion covers, wall hangings, quilts, etc. Its woolly feel adds to the comfort of these furnishing products. Now-a-days, many contemporary products like wallets, bags, belts are also being manufactured using eri silk.

#### Peace silk

Eri silk is a preferred material of Buddhists and Vegans as it does not require killing of moth during its production. As it is obtained as a staple fiber, the natural life cycle of the moth is not disturbed. The production of eri silk allows the completion of the metamorphosis of the silkworm to the butterfly so that no moth has to suffer because of sericulture. This is why eri silk is also called peace or ahimsa silk.

#### Conclusion

Eri silk occupies an important position today in respect to its



volume of production and potentialities. The fiber properties are very encouraging to be exploited for its conversion into yarn and fabric or blended with other compatible textile fibers like cotton, wool, bamboo etc. which result in cost reduction and incorporation of required properties in blended material. It has excellent strength combining the elegance of silk with comfort of cotton and warmth of wool. It is suitable for both summers and winters due to its unique properties unlike other silks. Weaving and further finishing of eri silk including natural dyeing makes it possible to get fascinating feel and colours of eri silk textiles. It has applications in wide array including shawls, jackets, blankets, bed spreads and dress materials. It is also called the peace or ahimsa silk because it does not involve killing of moth during its production cycle. Eri production acts as a subsidiary production and income enhancer for people in north east areas of India. Many social enterprises are creating contemporary products like wallets, bags, belts etc. with eri silk. Recognizing the potential of eri silk in today's eco-friendly era, Indian government and associated organizations has started taking special interest in eri silk production. Indeed, eri silk is a novel fiber with enormous potential.

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