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Manufacturing Process of Silk Yarns and Fabrics Using Bivoltine Cocoon in Jammu and Kashmir

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A B S T R A C T

Sericulture is an agro-based industry. It involves rearing of silkworms for the production of raw silk, which is the yarn obtained out of cocoons spun by certain species of insects. Silk is extracted from the cocoon which has a natural polymeric composite shell made of a single continuous silk filament of 800-1200 meters. Among all the textile fibres, silk occupies the top place for the qualities of softness, lustre, dyeability, durability and elegance and is regarded as the Queen of textile. The Jammu and Kashmir Industries (JKI), silk weaving factory at Rajbagh Srinagar is producing silk fabrics for which silk yarns are supplied by JKI silk filatures factory at Srinagar and Jammu. The silk factory Bari Brahmana Samba produces various types of silk yarns and fabrics namely Chinon, Chiffon, Crap and Georgette. The main challenges facing the sericulture industry in J&K is the lack of cocoon conversion into silk yarns. Most of the individuals are not aware about process parameters for bivoltine cocoons, requirements of reeling, types of silk yarns, and silk yarns /fabrics process of production which directly or indirectly put impact on its quality silk production, marketing and utilization of cocoons/yarns for value added silk products.

Introduction

This study aims to explore the various types of silk yarns and their specific requirements for producing quality yarns in Jammu and Kashmir. It also seeks to understand the different types of silk fabrics and the conditions necessary for their quality production in the region (1,2,3). Additionally, the study highlights the significant potential of the sericulture and silk industry for value addition—from mulberry cocoons to finished silk fabrics—and emphasizes the vast scope for entrepreneurship among the younger generation, based on their interests and engagement in this traditional yet evolving sector (4,5,6).

Material and Equipment used in the study

Materials Used

In the present experimentation, 1 kg of bivoltine spring cocoons (stifled cocoons) is used. Firewood was used for the purpose of cocoon cooking in the economic oven.

Equipment's Used: Table for sorting of cocoons, Weighing machine, Epprovette, Two pan or economic oven, Thermometer, Bamboo hand brush, Multi-end reeling machine, Re- reeling machine, Threads, Croshia, Blade and Skeinning machine

Working procedure

For comparison studies of silk yarns and fabric were processed. By taking mono-cocoon assessment followed by Cooking, Relling, Re-relling, Lacing and Skinning for manufacturing silk yarns and weaving in order to manufacture silk fabrics (7,8).

Cocoon Sorting

Defective cocoons affect the reeling performance and quality of the silk significantly. So in order to achieve the optimum results in reeling, the defective cocoons, which are unsuitable for reeling quality yarn silk, are to be sorted out (9,10). This should be done by sorting the defective cocoons through visual inspection method. Types of defective cocoons: Flimsy, Muted, Stained, Deformed and Double cocoons. Defective cocoons were estimated by the following expression:

$$\text{Defective cocoon \% by No.} = \frac{\text{No. of Defective cocoons}}{\text{Total no. of cocoon}} \times 100$$

$$\text{Defective cocoon \% by weight} = \frac{\text{Wt. of defective cocoons}}{\text{Total wt. of cocoons}} \times 100$$

Total number of cocoons=411

Total weight of cocoons = 240g

Cocoon cooking

Sorted cocoons are also called good cocoons are taken for cooking. The cocoons are cooked in two pans using CSRTI cocoon cooking cage following low high-low temperature principal for about at 2-3 minutes and the ends are grouped (11,12,13). The cocoons were cooked in each experiment using two pans. The processing temperature and time is given below:

Brushing

After the cocoons are cooked, they need to be brushed to remove the surface floss layer and to locate the correct filament ends for reeling. This brushing process is carried out in hot water at approximately 80°C, which aids in proper groping of the filament and ensures smoother reeling. Once brushed, the cocoons should be transported together to the reeling basin for the next stage of silk processing.

Reeling operation on Multiend Reeling Machine

The Multi-ends reeling machine is composed of driving part, groping ends, picking ends. Standby bath, reeling part, jetteboute, stop motion, traverse guider, small reels, steam heating pipes and clutches (15,16,17). The cooked cocoons contained in the tubs are carried into the groping ends portion of the reeling machine. From there, cocoons are moved into the picking ends apparatus.. They are picked up by the reeler and fed to the reeling thread.

In first experiment of mono cocoon reeling assessment was done with the help of Epprouvette device and digital weighing. In this experiment three replications of bivoltine mulberry cocoons were taken and each replication carry around 10 cocoons.

Mono Cocooning on Epprouvette

The results of mono cocoon reeling comprises of filament length. Non-breakable filament length (NBFL) and denier of bivoltine mulberry cocoons

The result of this study is that the average filament length of bivoltine mulberry cocoons is about 819.56 meters and the NBFL was found about 665.31 meters.

In second experiment of mass cocoon reeling assessment was done with the help of multi end reeling machine. In this experiment three replications of bivoltine mulberry cocoons were taken and each replication carry around 100 cocoons. The results of mass cocoon reeling comprises of reelability, raw silk %, raw silk waste % and renditta.

The average results of reeling performance of cocoons are presented in Table 2. It was observed that Reelability (%) and Raw silk (%) of three replication of spring crop is found to be in the range of 77 and 29.

Re-Reeling

Re-reeling is to transfer the raw silk reeled on small reel to a large reel (1.5 meter circumference) for adjusting width, weight and length of the skein uniformly (18).

The other important objectives of re- reeling are to eliminate gum spots in the reeled silk and to eliminate thin places, and to ensure smooth and efficient operation during the winding process.

Re-reeling may be done at a reel speed of 150-180 mtrs/min. The broken ends should be knotted properly to improve the performance of silk in winding.

Lacing

Silk skeins should be laced in order to keep the silk threads intact and avoid entanglements. Silk skeins are laced at 6 places using the cotton thread in the form of "g".

In order to facilitate the findings of ends of skeins during next process, it is essential to join and tie the top end and the tail end together by extra lacing thread of different colours which is inserted in the middle of the breadth of the skeins. Each lacing will have 4 stitches to form 5 loops (19).

Skeinning

The process is carried out by a skeinning machine. It is done by twisting the hank several times and folding it upon itself in a number of spirals in such a manner that the silk threads in the hank are not entangled in the subsequent process of bookmaking and bundling (20).

1^{sr} Objective

In order to know the various types of silk yarns and their requirements for the production of quality yarns in Jammu and Kashmir

Silk Technical Service Centre, Central Silk Board, Jammu arranged exposure visits to understanding manufacturing process of reeled and spun silk yarns/ fabrics in Jammu area and collected production data during 45 days dissertation work. The centre arranged to display of various bivoltine mulberry reeled yarns, spun yarns and Kashmiri silk products.

Locale of the study: House of a renounced farmer in Bantalab, Jammu having traditional handloom machine for the manufacturing of silk fabrics.

The handloom setup was runned by a group of female workers.

Once the silk threads have been extracted, they are twisted to form the silk thread. The thread is dyed and prepared for weaving. Silk fabric is created by interweaving the threads on a loom. Resulting in the production of various silk fabrics.

Major steps involved in silk weaving are mentioned below:

- Dwinding, Twisting and Doubling
- Degumming and dyeing
- Re-winding
- Pirn winding
- Warping and weaving
- Loom finished or grey fabric.

Pirn winding or Weft winding

pirn winding is the process of transferring weft yarn on the small pirn able to use in the shuttle of a loom. Pirn winding for weft of thread is one of the most important process of silk weaving

Weaving mechanism

Weaving Mechanism of silk fabric includes following three major steps.

Shedding motion: The division or separation of warp ends into upper and lower system of thread to permit the shuttle to pass through the space that has been formed.

Picking motion: This is actual passing of the shuttle through the shed of the loom. The shuttle passes over the lowered ends of the shed and under its raised ends.

Beating up: It consists in beating up the last pick of the weft to the fell of the cloth with the help of reed in the slay.

Table.1 Showing data of different defective cocoons

S. No.	Type of defective cocoons	Number of cocoons	%age by number of cocoon	%age by weight of cocoons
1.	Flimsy	12	2.91%	2.5%
2.	Muted	10	2.43%	1.66%
3.	Stained	14	3.40%	4.16%
4.	Deformed	09	2.18%	1.25%
5.	**Total**	**45**	**10.92%**	**9.57%**

Table.2 The processing of cocoon cooking temperature and time is given below

1st PAN	2nd PAN
i. Soaking at 60-70°c for 60-90 seconds	ii. High temperature for permeation at 90-93°c for 90-120 seconds
iii. Low permeation temperature at 65-70°c for 45-60 seconds	Iv. Cooking at 96-97°c for 90-120 seconds
v. Stop heating and allow the cocoon to remain for 60 seconds.	vi. Sprinkle cold water to reduce temperature 75-80°c in 180-220 seconds

Table.3 Assessment of Mono Cocoon Reeling Spring crop-bivoltine Mulberry Cocoons

Particular	FL(m)	NBFL(m)	No. Of breaks	Wt. Of silk (g)	Avg. Denier
Sample 1	818.43	682.03	2	1.96	2.1
Sample 2	826.20	635.53	3	1.92	2.0
Sample 3	814.05	678.37	2	1.74	1.9
Mean	819.56	665.31	2.33	1.87	2.0

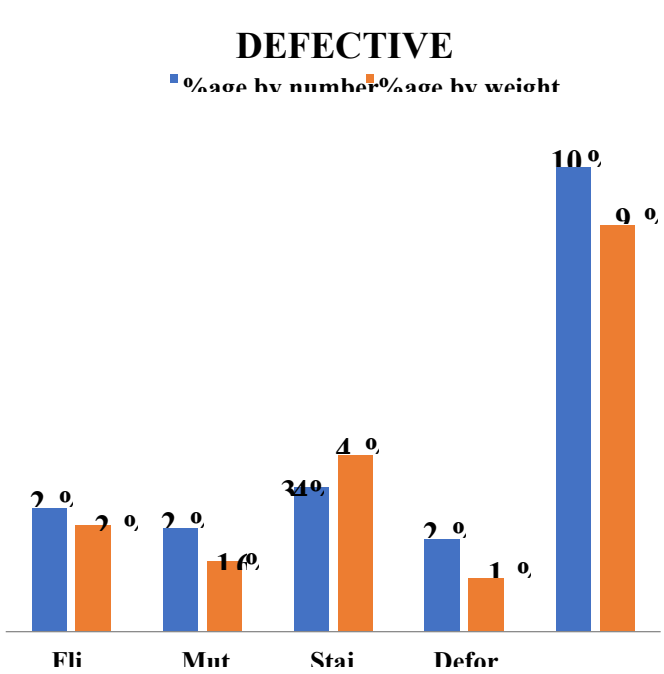
Table.4 Reeling performance of Bivoltine Cocoon of Spring Crop

Observations	No. Of reelable cocoon	Wt. Of reelable cocoons (g)	Wt. Of silk (g)	Wt. Of waste(g)	Renditta	Reelability%	Raw silk %	Waste%
R1	300	232	74	13	4.05	77.25	31.89	17.56
R2	300	226	60	13	5	78.05	26.54	21.66
R3	300	218	65	14	4.61	77.58	29.81	29.81
Average	300	225.33	66.33	13.33	4.55	77.62	29.41	23.01

Figure.1

FIG: FLOWCHART SHOWING WORKING PROCEDURE OF SILK MANUFACTURING

Figure.2



PICTURE SHOWING COCOON SORTING

GRAPHICAL REPRESSENTATION OF DEFECTIVE COCOONS

Figure.3 Picture Showing Cocoon Cooking

Figure.4 Cocoon Brushing Process

Figure.5 Line diagram indicating passage of thread in the multi end machine

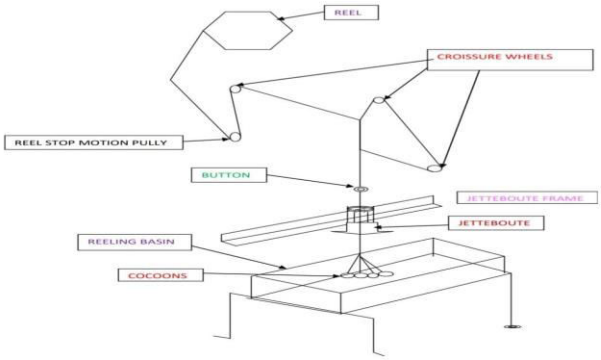


Figure.6 Reeling experiments performed by two way or methods

Figure.7 Graphical representation showing mean performance of FL(m), NBFL(m) and Avg. denier of spring crop

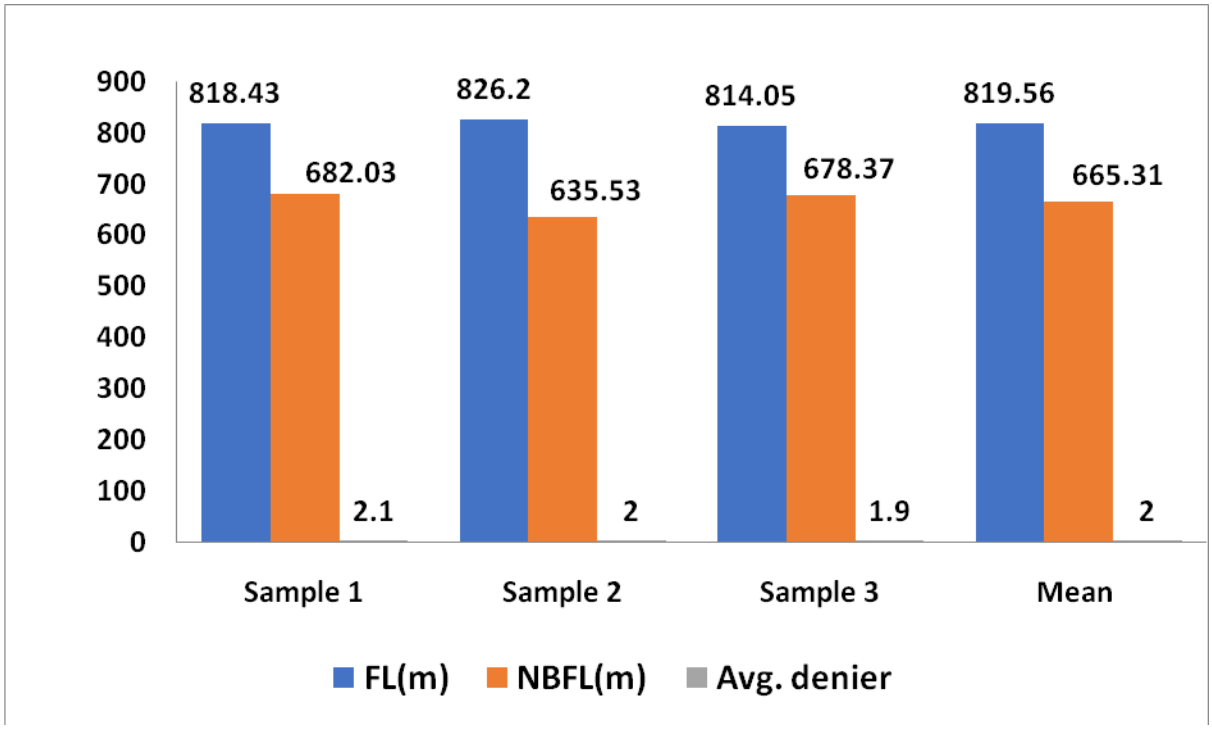


Figure.8

Figure.9 Graphical representation of reelability and raw silk percentage of bivoltine mulberry cocoons

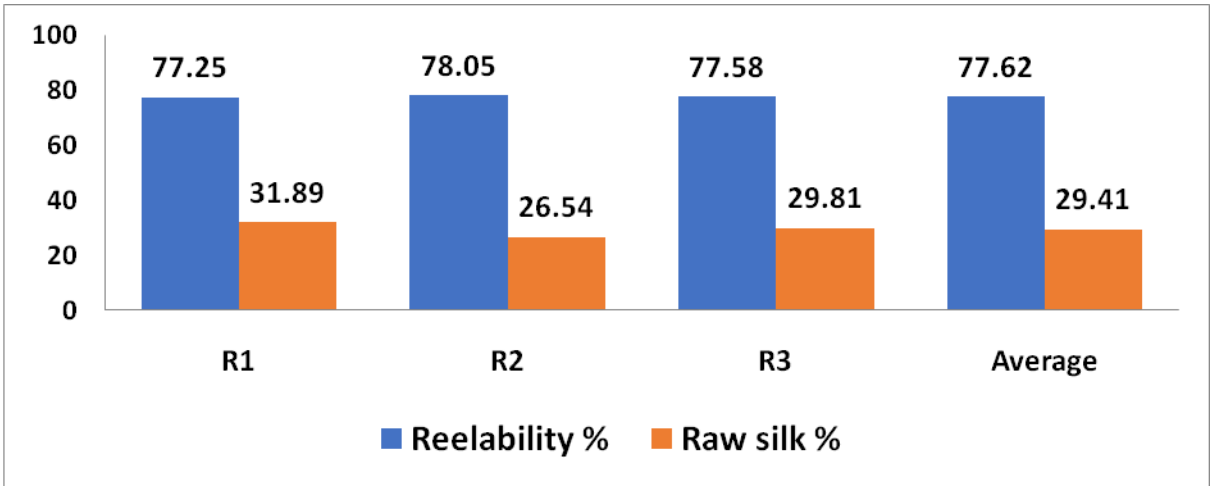


Figure.10 Re - reeling process

Figure.11 Lacing process

Figure.12 Skeining Process

Figure.13 Pirn winding for weft thread

Figure.14 Preparation of fabric on handloom

Figure.15 Picking motion in weaving process

Figure.16

Figure.17 Noil silk yarn used as weft on handloom

Figure.18 Printed suit made up of chinon silk

Figure.19 Crepe silk saree	**Figure.20** Kashmiri Kani Silk Saree
	

Their are different types of silk fabrics manufactured in UT of Jammu and Kashmir namely Tabby silk, chiffon silk, chinon silk, satin silk, crepe silk, taffeta silk and twill weave silk

Evaluation of silk yarns

In Jammu and Kashmir, mulberry raw silk is producing by using various machines like charkha, multiend, cottage basin and Automatic reeling machine.

Spun silk obtained by spinning of different types of reeling wastes and unreelable cocoons. They may be produced by hand spinning or machine spinning

Spun silk is used directly as spun silk yarn or indirectly as blended yarns by mixing with other natural or manmade fibre.

Mulberry machine spun yarn used as weft on handloom

The short filaments deposited during the dressing process are not enough to be drafted for spinning into fine yarn. They are used to produce a coarse yarn known as Noil yarn.

Processes included in spun silk production include Degumming, Dressing, preparatory process and spinning.

Processes included in noil yarn production is opening and roving

2nd Objective

In order to know the various types of silk fabrics and their requirements for production of quality silk fabric in Jammu and Kashmir

Tabby silk: It comes mainly from Kashmir. It's a plain silk cloth that has wave pattern. "Tabby' originally referred to a kind of silk taffeta with an irregular wavy finish. It is strong fabric. Tabby silk is mostly used for printed saris and scarves.

Chiffon silk: Silk chiffon is an elegant, sheer fabric with a soft, beautiful drape and matte crepe texture. Chiffon is a very light, transparent fabric and produced with crepe twist yarns. Nowadays, it is mainly used for the making of evening dresses, blouses, wedding dresses, costumes for dance and show and much more.

Chinon silk: Chinon fabric is a lightweight and sheer fabric that is known for its delicate and flowing drape. Chinon fabric is made up of a bright filament yarn which is woven with a highly twisted air- textured yarn. It gives a shiny look and is an excellent choice for flowy gowns or skirts, scarves, curtains, ruffled tops, etc.

Twill weave silk: Twill fabric is a type of fabric that is characterized by its diagonal weave pattern. This pattern is created by weaving warp and weft threads in a specific way. Twill has high thread count, which means that the fabric is opaque, thick, and durable. It's a popular choice for high-end linings in jackets and blazers

Printed suit made up of chinon silk

Crepe Silk: Crepe fabric is a lightweight, woven material. It is characterized by its crimped appearance, which is achieved through a special weaving or finishing technique. Crepe fabric is popularly used in the creation of dresses, blouses, skirts, trousers, suits, and jackets. Its texture and drape lend a unique touch to both casual and formal wear.

Kashmiri Kani silk saree: At the core of this cultural legacy is the Kashmiri Kani silk saree, which represents

elegance and tradition. The Kani silk saree, renowned for its beauty and craftsmanship, describes the essence of Kashmiri heritage, making it a prized treasure among fine fabric lovers of technology.

Based on the practical experiment under 45 days dissertation work, the findings of this study suggest that the production process of silk yarn and silk fabric is very easy process and can be established to start own business with the help of subsidy scheme under Central Silk Board through state sericulture department which would be provided benefits as well as opportunity for development of diversified silk products and utilization of bivoltine cocoons producing in Jammu and Kashmir. Sericulture and silk industry also has large scope for value addition from mulberry cocoons to finish silk fabrics and wide scope for entrepreneurship of young generation on the basis of their interest.

Author Contributions

Bindiya Verma: Investigation, formal analysis, writing—original draft. Nitish Singh Pangotra: Validation, methodology, writing—reviewing. Simran Shan:—Formal analysis, writing—review and editing. Nuzat Arra: Investigation, writing—reviewing. Sh. N. S. Gahlot: Resources, investigation writing—reviewing. Jyoti Angotra: Validation, formal analysis, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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