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Preparation of Indigenous Warp Quality Tasar Silk Yarn in Modified Buniyaad Reeling Machine to Replace Imported Korean Tasar Silk Yarn

Rahul Ranjan Ghosh [1,*], Rithika G [2] and Sateesh Kumar [1]

[1] *Central Silk Technological Research Institute, Central Silk Board, Bengaluru-560068, India.*
[2] *Alagappa College of Technology, Anna University, Chennai-600025, India.*

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Abstract

Tasar silk is an important part of India's non-mulberry sericulture, supporting the livelihoods of tribal communities across several states. Known for its natural sheen and strength, Tasar silk has significant potential in eco-textiles and handloom weaving. Although India leads in Tasar silk production, it heavily depends on imported warp-grade yarns due to limitations in indigenous reeling techniques. The Buniyaad reeling machine, while an improvement over traditional methods, currently yields yarns suitable only for weft applications due to quality constraints. The proposed project aims to modify this machine for wet reeling to produce fine, uniform, and strong warp-grade yarn domestically. This advancement will reduce import dependency, improve rural incomes, and strengthen India's silk sector under the vision of Atmanirbhar Bharat. The present study evaluated indigenous reeling trials using the Buniyaad reeling machine, enhanced with croissure and slit button attachments, to develop warp-quality Tasar silk yarns comparable to imported Korean yarns. Four trials (T1–T4) were conducted with optimized reeling parameters, resulting in significant improvements in linear density and tenacity, while elongation remained consistent with the control. Among them, Trial T4, which used a reeling composition of 3 Tasar and 2 Mulberry cocoons, demonstrated the best performance with the lowest overall deviation (31.68%) from the control. These results highlight the potential of strategically modified indigenous technologies in producing high-quality warp-grade Tasar silk yarns. The findings suggest that further refinement of these processes can reduce import dependency and strengthen the self-reliance of India's silk sector.

Keywords: Blending; Modified Buniyaad Reeling Machine; Imported Korean Tasar; Linear Density; Tensile Properties; Warp Quality Tasar Silk; Wet Reeling

1. Introduction

Tasar silk, a distinctive variety of wild silk produced by *Antheraea mylitta* silkworms in forest-based ecosystems, represents a significant component of India's non-mulberry sericulture sector. Predominantly cultivated in tribal-dominated regions across Jharkhand, Chhattisgarh, Odisha, Bihar, Maharashtra, and West Bengal, Tasar silk contributes not only to India's textile heritage but also to the socio-economic development of forest-dwelling communities [1-2]. Tasar silk is known for its natural golden sheen, high strength, and durability, making it a valuable raw material in handloom and eco-textile production. India is the world's largest producer of Tasar silk, accounting for over 90% of global production, with a well-established ecosystem of cocoon rearers, reelers, and weavers. However, despite this advantage in raw cocoon availability and traditional skills, the country faces a persistent challenge in manufacturing fine-quality, warp-grade Tasar silk yarn domestically. Presently, a significant portion of warp yarns required for weaving applications, are imported from countries such as China and South Korea [3].

These imported yarns are favored for their fine denier, high tensile strength, superior uniformity, and better reelability, all of which are essential characteristics for warp threads that must withstand considerable mechanical stress during

* Corresponding author: Rahul Ranjan Ghosh

weaving. In contrast, Tasar silk yarn produced indigenously through conventional dry reeling techniques tends to have higher denier, coarser texture, and variable quality, limiting its use predominantly to weft applications [4]. This technological gap, coupled with a lack of standardization in reeling practices, prevents the full value realization of domestically produced Tasar cocoons and leads to significant foreign exchange outflow due to yarn imports. Indian Tasar cocoons, particularly Daba and Raily types, possess inherent potential for producing fine filament yarn suitable for warp use; however, this potential remains untapped due to the absence of advanced reeling methods tailored to their characteristics [5-7].

Recognizing the existing gap in domestic production of warp-quality Tasar silk yarn, the proposed project aims to undertake comprehensive trials to prepare indigenous warp-grade Tasar silk yarn using a modified Buniyaad reeling machine. The Buniyaad reeling machine, introduced in the Tasar sector as an improved alternative to traditional thigh reeling, has primarily been used for producing untwisted Tasar silk yarn through the dry reeling method. In dry reeling, Tasar cocoons are first boiling with plain water using chemical mixture commonly known as *Tasar Plus*, which is a combination of sodium carbonate and sodium bicarbonate, followed by steaming. The cocoons are then soaked for approximately 30 minutes to soften the sericin layer before being reeled. Although this process helps in replacing labor-intensive and inconsistent thigh reeling practices, the yarns produced through dry reeling on Buniyaad machines often exhibit higher denier, lack of cohesion, and occasional fibrillation of filaments. These issues make the yarns unsuitable for warp usage, as warp yarns require high tensile strength, uniformity, and smooth surface characteristics to endure the mechanical stresses of weaving. Consequently, Buniyaad reeled yarns are currently used mainly in weft applications, where strength and uniformity requirements are relatively lower [8-9].

To overcome these limitations and move towards self-sufficiency in warp yarn production, the proposed project will focus on modifying the Buniyaad reeling machine to adopt the wet reeling method, which has been recently introduced in the Tasar silk sector for producing higher-grade yarn. Unlike dry reeling, wet reeling involves reeling cocoons directly in a water-filled reeling basin under controlled temperature and chemical conditions. In this method, cocoons undergo a specialized controlled cooking process, which may involve optimized combinations of alkali-based chemicals to gently remove or loosen the sericin without damaging the fibroin. The softened cocoons are then reeled in a water medium, which ensures better filament alignment, improved cohesion, and uniform winding—leading to yarns with lower denier variation, higher tensile strength, better elongation, and smooth texture, making them suitable for warp applications [10-12].

The successful development of indigenous warp-grade Tasar silk yarn will reduce import dependency, ensure substantial foreign exchange savings, enhance income and employment opportunities for rural and tribal populations, and promote sustainable value addition in the domestic silk economy. This initiative directly aligns with the national objectives of Atmanirbhar Bharat fostering rural innovation, self-reliance, and a robust indigenous silk value chain. By upgrading existing reeling systems with technology-driven solutions, the project seeks to elevate the technical quality of Indian Tasar yarns to international standards and strengthen India's position in the global silk textile industry.

2. Materials and Methods

2.1. Materials

Tasar cocoons and Mulberry cocoons were procured from the Vanya Silk Reeling Division of the Central Silk Technological Research Institute (CSTRI), Central Silk Board, Bangalore, to carry out experimental investigations. In addition to the cocoons, essential chemicals such as Sodium Carbonate (Na_2CO_3), Hydrogen Peroxide (H_2O_2) and Sodium Silicate (Na_2SiO_3) were sourced and utilized for the cocoon cooking processes. Furthermore, to facilitate a comparative analysis and benchmarking of yarn quality, imported Korean Tasar silk yarns were also procured and included in the study.

2.2. Modification of Buniyaad Reeling Machine

The Buniyaad reeling machine is primarily used for reeling untwisted Tasar silk yarns through the dry reeling method. A croissure attachment (Figure. 2) is integrated into the machine to enhance yarn quality. Croissure refers to the twisted section of the silk thread formed between the cocoon filaments' emergence point and the reel. An optimal croissure length is critical, as it ensures better filament cohesion, resulting in smoother, more uniform yarn with reduced breakage. It also improves winding efficiency by minimizing snarls, loops, and overlaps while enhancing the yarn's natural lustre and appearance. Additionally, it stabilizes the denier and supports high-speed reeling without compromising quality. To further improve output, a slit button (Figure. 3) is incorporated with the croissure attachment. While it does not impact productivity, it significantly enhances the evenness, cleanliness, and neatness of the reeled yarn, leading to superior winding performance. The modified Buniyaad reeling machine is shown in the Figure 4.

Figure 1 Buniyaad Reeling Machine

Figure 2 Croissure attachment

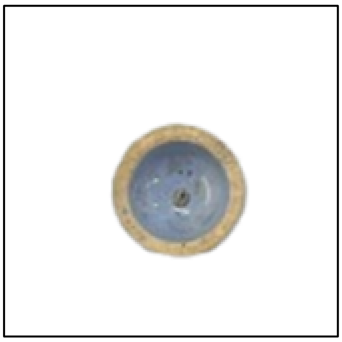

Figure 3 Slit Button

Figure 4 Modified Buniyaad Reeling Machine

2.3. Experimental Trials for Producing Indigenous Tasar Silk Yarns

2.3.1. Cooking Process

In terms of silk recovery and cooking efficiency in Tasar silk, the permeation method was found to be significantly more effective than the conventional open pan method. Enhanced moisture penetration and uniform softening of the sericin layer had been achieved through this technique, resulting in improved filament extraction and greater silk yield. The process had been initiated by placing stifled Tasar cocoons inside a vacuum permeation chamber, where they had been subjected to a three-cycle permeation treatment at a vacuum pressure of 300 mm Hg, with each cycle lasting 5 to 7 minutes. Through this treatment, moisture had been effectively infused into the cocoon shell. Subsequently, the cocoons had been boiled in plain water for 20 to 25 minutes at temperatures ranging from 95°C to 97°C, and then cooled using a Two-Pan Cooking Machine to gradually lower their temperature and prevent filament damage. After cooling, the cocoons had been immersed in a chemical solution maintained at 60°C to 70°C and soaked overnight. The chemical bath had comprised Na_2CO_3 (4 g/l), Na_2SiO_3 (4 g/l), and H_2O_2 (5 cc/l), which had further softened the shell. Following the soaking process, each cocoon had been meticulously deflossed to reveal the true filament end, which had enabled a smoother and more continuous reeling process, leading to the production of high-quality Tasar silk yarn.

Further, in the two-pan cooking method for Mulberry cocoons using cocoon cooking cages, the following procedure was followed. First, the perforated cocoon cooking cage filled with Mulberry cocoons was immersed in the first cooking pan containing water maintained at a temperature of 60°C to 70°C for about 60 to 90 seconds. The cage was then transferred to the second cooking pan, where the water temperature had been raised to 90°C to 93°C, and the cocoons were kept for 90 to 120 seconds. Afterward, the cage was re-immersed in the first pan (at 65°C to 70°C) for another 60 to 90 seconds. Subsequently, the cage was returned to the second pan, where the water had reached boiling temperature (96°C to 97°C), and the cocoons were kept for a further 90 to 120 seconds. Following this, the steam supply to the second pan was stopped, and the cocoons were allowed to remain undisturbed in the hot water for about 60 seconds. Cold water was then sprinkled over the cage in the second pan to gradually reduce the temperature from 96°C to approximately 75°C to 80°C over a span of 180 to 240 seconds. Finally, the cage was opened in the water itself, and the softened cocoons were transferred directly into the pan. The cocoons were then brushed at around 80°C and transferred to the reeling basin for further processing.

2.3.2. Reeling Process

The reeling trials were subsequently conducted, as detailed in Table 1, with the aim of replicating and closely matching the denier and tensile properties of imported Korean Tasar silk yarns. The primary objective was to optimize the reeling process parameters to produce indigenous Tasar silk yarns with comparable physical characteristics, thereby improving their suitability for similar end-use applications. The cocoon composition employed during the reeling process across the different trials has been illustrated in Figueres 5 to 8.

Table 1 Details of Indigenous Tasar Silk Yarns Reeling Trials

Trial Code	Description	Reeling Cocoon Composition
T1	100% Tasar Silk Yarn	Tasar 4 Cocoons
T2	Tasar-rich blended Yarn	Tasar 4 Cocoons + Mulberry 2 Cocoons
T3	Equal Tasar- Mulberry Blend	Tasar 3 Cocoons + Mulberry 3 Cocoons
T4	Slightly Tasar-Dominant Blended Yarn	Tasar 3 Cocoons + Mulberry 2 Cocoons

Figure 5 Trial No 1 (T1)

Figure 6 Trial No 2 (T2)

Figure 7 Trial No 3 (T3)

Figure 8 Trial No 4 (T4)

2.4. Analysis the Cooking and Reeling Performances

Tasar cocoons contained not only fibroin but also high amounts of sericin, calcium oxalate, and tannic acid, which made them inherently rigid and challenging to cook uniformly. This often led to variations during cooking—some cocoons remained hard, while others burst open—adversely affecting reeling efficiency. To evaluate the effectiveness of cocoon softening, Cooking Efficiency was calculated using the following formula (1):

$$Cooking\ Efficiency\ \% = \frac{Nos\ of\ reelable\ Cocoons}{Nos\ of\ Total\ Cocoons\ Taken\ for\ reeling}\ x\ 100 \quad \text{.........(1)}$$

This parameter reflected the proportion of cocoons that were adequately softened and suitable for reeling. Higher cooking efficiency indicated better process control and improved yield of usable filaments, making it a key indicator for assessing and optimizing Tasar cocoon cooking performance.

The ease with which a silk filament could be smoothly and continuously extracted from a cocoon was referred to as reelability. It was considered a critical parameter that directly influenced the economics of reeling, along with key operational factors such as productivity, yarn quality, and workload efficiency. High reelability indicated that a larger proportion of cocoons yielded continuous filament during reeling, thereby minimizing interruptions, reducing filament breakage, and improving overall reeling output. Conversely, poor reelability resulted in frequent reeling breaks, increased operator fatigue, reduced machine efficiency, and compromised yarn quality. Reelability was typically expressed as a percentage and was calculated using the following formula (2):

$$Reelability\ \% = \frac{Nos\ of\ reelable\ Cocoons\ taken\ for\ reeling}{Nos\ of\ castings}\ x\ 100 \ldots\ldots\ldots(2)$$

During the reeling of Tasar cocoons, it was not possible to extract the entire silk content from the shell due to inherent losses. Components such as the outer floss, the inner pelade layer, and filament breakages during reeling, along with sericin loss during cooking, contributed to silk waste. As a result, the raw silk recovery represented the actual amount of silk obtained from the shell, excluding these inevitable losses. Raw silk recovery was calculated using the following formula (3):

$$Raw\ Silk\ Recovery\ \% = \frac{Weight\ of\ raw\ silk\ reeled\ in\ gms}{Shell\ weight\ in\ gms}\ x\ 100 \ldots\ldots\ldots\ldots(3)$$

Silk waste generated during reeling could also be quantified to assess material loss in the process. The formula used to determine silk waste percentage was as follows (4):

$$Waste\ \% = 100 - (Raw\ silk\ Recovery\ \%) \ldots\ldots\ldots\ldots(4)$$

2.5. Analysis of Blend Proportion

To determine the blend proportion of Mulberry and Tasar silk in the given yarn sample, a standardized chemical analysis method was employed, utilizing selective dissolution with sulfuric acid. Initially, a known dry weight of the blended yarn sample (approximately 1 gram) was accurately measured and recorded. The sample was then immersed in 60% sulfuric acid (H_2SO_4) for 7 minutes at room temperature, allowing the acid-sensitive Mulberry silk component to dissolve selectively. Immediately after the acid treatment, the sample was thoroughly rinsed with cold water to halt the reaction and remove any surface acid. This was followed by a hot water wash at 60–70°C to eliminate residual acid and any solubilised fiber debris. The remaining undissolved residue, primarily comprising the acid-resistant Tasar silk, was then dried in a hot air oven at 105°C for 30 minutes and subsequently cooled in desiccators to prevent moisture absorption. The final dry weight of the residue was recorded with precision. Based on the difference between the initial and final weights, the percentages of Mulberry and Tasar silk in the blended yarn were accurately calculated, providing a reliable assessment of the fiber composition.

2.6. Testing Methods

The linear density and tensile properties of the imported Korean Tasar silk yarns (KT) and indigenous Tasar silk yarns from different trials were analyzed in accordance with IS 17618: 2021 standards. The linear density was determined using a wrap reel in combination with a precision weighing balance, while tenacity and elongation were measured using a Serigraph tensile testing machine.

3. Results and Discussion

3.1. Evaluation of Cooking and Reeling Performance of Tasar Cocoons in Different Trials for the Production of Indigenous Tasar Silk Yarns

The cocoon cooking and reeling performances of the Tasar cocoon in different trials had been summarized in Table 2 and Table 3 respectively.

Table 2 Trial wise Tasar Cocoon Cooking Performance

Parameters	T1	T2	T3	T4
Nos of Total Cocoons	40	40	40	40
Nos of Reelable Cocoons	31	29	30	32
Nos of Overcooked/ Burst Cocoons	3	4	5	4
Nos of Hard Cocoons	6	7	5	4
Cooking Efficiency %	77.5	72.5	75.0	80.0

Table 3 Trial wise Tasar Cocoon Reeling Performance

Parameters		T1	T2	T3	T4
Waste generated (gm)	Defloss	11.58	14.64	10.00	15.90
	Reeled	3.79	6.25	8.00	7.27
	Pelade	6.12	6.85	5.00	6.20
Silk Weight (gm)		33.80	45.50	46.30	55.10
Raw Silk Recovery %		73.48	65.35	69.32	71.09
Waste %		26.52	34.65	30.68	28.91
Reelability %		32.79	28.8	30.5	31.0

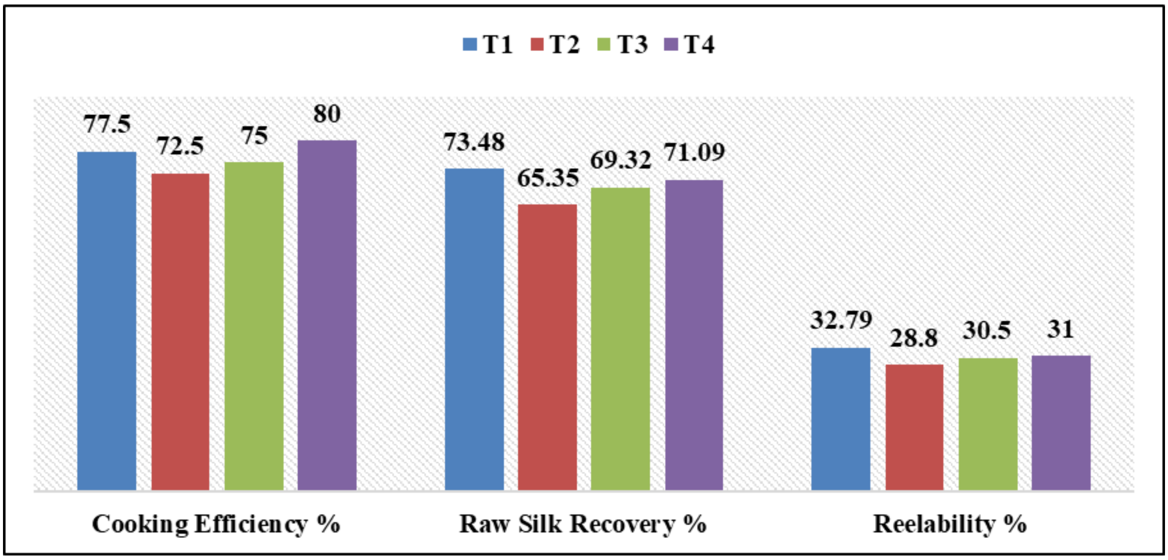

Figure 9 Cooking and Reeling Performances of Tasar Cocoons in Different Trials

Figure 9 depicted the comparative performance of four distinct trials (T1, T2, T3, and T4), which were evaluated across three key parameters—Cooking Efficiency, Raw Silk Recovery, and Reelability. Among these, T1 was consistently identified as the best performer, as high values were recorded for cooking efficiency (77.5%), raw silk recovery (73.48%), and reelability (32.79%). These results were attributed to optimized processing conditions by which effective cocoon softening, improved filament extraction, and smoother reeling were facilitated. In T4, the highest cooking efficiency of 80% was recorded, suggesting that excellent sericin softening was achieved; however, its raw silk recovery (71.09%) and reelability (31%) were observed to be slightly lower than those of T1. In T3, a moderate and relatively balanced performance was demonstrated across all parameters, and the process was considered acceptable though not optimal. Conversely, T2 was marked by the weakest performance, as the lowest cooking efficiency (72.5%), raw silk recovery (65.35%), and reelability (28.8%) were recorded, which was possibly caused by inadequate cooking conditions or inferior cocoon quality.

3.2. Evaluation of Mulberry-Tasar Blend Proportion

The Figurer 10 depicted the blend proportions of Mulberry and Tasar silk in yarn samples from three trials—T2, T3, and T4—analysed through selective acid dissolution. In Trial T2, the blend contained 33.93% Mulberry silk and 66.07% Tasar silk, indicating a Tasar-rich composition. This proportion suggested that the yarn was designed to emphasize the strength, coarser texture, and natural appearance characteristic of Tasar silk, while maintaining a moderate level of Mulberry silk to contribute some smoothness and flexibility. Trial T3 recorded the highest Tasar content at 68.87%, with only 31.13% Mulberry silk, representing the most Tasar-dominant blend among the three. This blend was likely suited for products requiring enhanced durability and a rustic finish, with less emphasis on softness or sheen. In contrast, Trial T4 had the highest Mulberry content at 40.65% and the lowest Tasar content at 59.35%, reflecting a more balanced composition. This blend appeared to be tailored for applications where both structural strength and fabric softness were important, combining the resilience of Tasar with the lustre and smooth hand feel of Mulberry silk.

3.3. Assessment of Linear Density and Tensile Properties of Imported Korean Tasar Silk Yarns

The linear density and tensile properties of imported Korean Tasar silk yarns (KT) were analyzed as per the Standard IS 17618:2021. The detailed results were presented in Table 4 below.

Table 4 Linear Density and Tensile Performance of Imported Korean Tasar Silk Yarns (KT)

#	Denier	Tenacity (gm/den)	Breaking Elongation %
1	37.16	2.66	27.1
2	35.75	2.71	24.1
3	39.99	2.32	26.5
4	39.11	2.18	25.1
5	27.43	3.40	27.6
6	32.73	2.65	26.0
7	33.45	2.76	26.7
8	40.35	3.28	24.2
9	39.99	3.24	26.4
10	40.17	3.22	23.3
11	35.04	2.66	27.2
12	37.52	2.94	25.9
13	45.30	3.25	25.4
14	48.49	3.14	27.5
15	33.27	2.46	28.2
16	40.88	3.02	25.5
17	33.90	2.41	26.3
18	35.22	2.29	28.2
19	38.23	2.41	27.9
20	35.22	2.32	28.4
Mean	37.46	2.77	26.38
SD	4.673	0.392	1.456

CV%	12.47	14.16	5.52
MIN	27.43	2.18	23.30
MAX	48.49	3.40	28.40

3.4. Comparative Evaluation of Linear Density and Tensile Properties in Tasar Silk Yarn Trials

The linear density and tensile properties of Tasar silk yarns produced through various experimental trials—aimed at developing indigenous warp-quality yarn—were systematically analysed in accordance with the Indian Standard IS 17618:2021. These analyses were conducted to evaluate the suitability of the yarns for warp applications, with a focus on achieving the desired balance between fineness and mechanical strength. The comprehensive results of these evaluations, including trial-wise variations and comparative performance metrics, are presented in detail in Table 5 below.

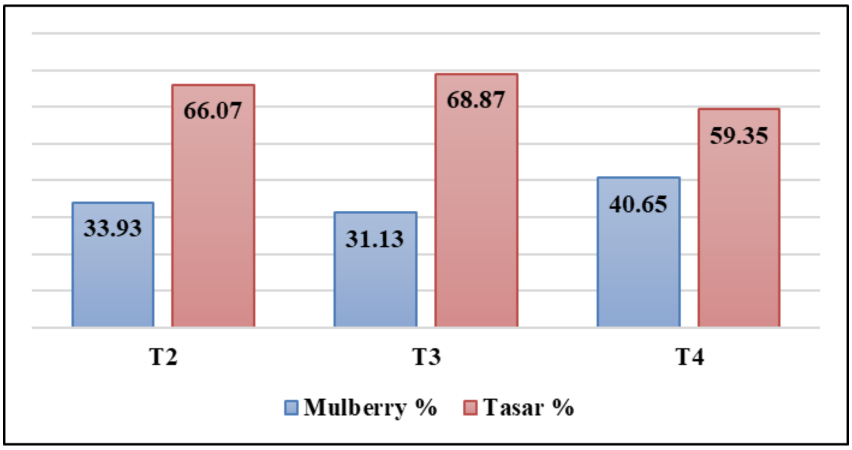

Figure 10 Evaluation of Mulberry-Tasar Blend Proportion in Different Trials

Table 5 Assessment of Linear Density and Tensile Properties

#	T1			T2			T3			T4		
	D	T	E	D	T	E	D	T	E	D	T	E
1	53.48	2.10	30.0	46.96	2.13	20.0	39.8	2.01	20.0	47.32	1.98	31.0
2	50.42	2.23	34.0	54.62	2.33	19.0	48.4	2.69	30.0	51.50	2.65	20.0
3	29.50	1.95	29.0	53.48	2.34	25.0	54.4	2.16	20.0	38.42	2.07	26.0
4	45.92	2.23	31.0	55.70	2.38	24.0	56.4	2.53	32.0	39.40	2.28	19.0
5	51.80	2.27	24.0	55.34	2.08	23.0	37.4	2.48	24.0	42.80	2.05	25.0
6	46.20	2.49	27.0	43.72	1.94	20.0	31.5	2.54	25.0	42.62	1.88	30.0
7	46.76	2.51	29.0	36.84	2.31	25.0	46.3	2.00	22.0	39.56	2.28	30.0
8	55.76	1.84	33.0	47.82	2.67	30.0	42.6	2.46	27.0	40.64	2.46	32.0
9	46.60	2.21	28.0	40.94	1.95	25.0	38.4	2.87	24.0	36.62	3.01	28.0
10	33.70	2.08	22.0	50.78	2.26	28.0	54.8	2.28	33.0	48.02	1.85	25.0
11	53.60	2.32	24.0	47.62	2.41	26.0	53.8	2.41	30.0	39.90	1.94	35.0
12	39.20	2.04	33.0	49.76	2.36	35.0	55.2	2.58	34.0	39.96	2.23	22.0
13	52.00	2.02	28.0	42.54	2.17	27.0	53.8	1.49	21.0	39.90	1.95	30.0

14	52.30	2.39	22.0	58.42	2.27	33.0	37.6	1.53	22.0	45.40	2.64	30.0
15	50.60	2.37	25.0	48.84	2.15	28.0	47.9	2.66	28.0	36.30	2.75	25.0
16	52.40	2.14	30.0	58.10	2.24	30.0	30.4	2.64	24.0	44.98	2.99	28.0
17	45.94	2.01	33.0	62.92	2.07	28.0	46.3	2.70	30.0	39.94	2.50	25.0
18	49.00	2.30	32.0	47.30	2.17	25.0	53.2	2.25	33.0	39.88	2.26	33.0
19	45.80	2.07	30.0	48.28	2.38	30.0	55.5	2.70	37.0	45.18	2.17	28.0
20	47.80	2.25	31.0	52.30	2.25	27.0	44.5	2.53	25.0	48.54	2.37	25.0
Mean	47.44	2.19	28.75	50.11	2.24	26.40	46.41	2.38	27.05	42.34	2.31	27.35
SD	6.655	0.179	3.712	6.429	0.170	4.147	8.343	0.376	5.094	4.213	0.352	4.209
CV%	14.03	8.19	12.91	12.83	7.56	15.71	17.98	15.85	18.83	9.95	15.23	15.39
MIN	29.50	1.84	22.00	36.84	1.94	19.00	30.36	1.49	20.00	36.30	1.85	19.00
MAX	55.76	2.51	34.00	62.92	2.67	35.00	56.42	2.87	37.00	51.50	3.01	35.00

D= Denier, T= Tenacity (gm/den), E= Breaking Elongation%

Table 6 ANOVA Analysis of Linear Density and Tensile Properties of Tasar Silk Yarns

	Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Denier	Between Groups	1953.834	4	488.4585	12.549	0.000	2.467
	Within Groups	3697.824	95	38.92446			
Tenacity (gm/den)	Between Groups	4.153	4	1.038252	10.811	0.000	2.467
	Within Groups	9.124	95	0.096039			
Breaking Elongation %	Between Groups	75.340	4	18.835	1.227	0.305	2.467
	Within Groups	1458.308	95	15.35061			

The ANOVA analysis presented in Table 6 revealed significant differences in the linear density and tensile properties of Tasar silk yarns produced through various indigenous trials, in comparison to the imported Korean Tasar silk yarns (KT). The denier values exhibited a highly significant variation (F = 12.549, p = 0.000), indicating substantial differences in linear density across the samples. This suggested that the reeling parameters and processing techniques employed in the indigenous trials had a notable influence on yarn fineness relative to the imported yarn. Similarly, tenacity values also showed significant variation among the groups (F = 10.811, p = 0.000), reflecting differences in yarn strength attributable to specific trial conditions. In contrast, the breaking elongation percentage did not show any statistically significant difference (F = 1.227, p = 0.305), indicating that this property remained relatively consistent across all samples. Overall, the results indicated that while the indigenous trials produced yarns with distinct denier and tenacity characteristics, the elongation behaviour remained largely unaffected, regardless of whether the yarn was imported or domestically produced.

Table 7 Analysis the Experimental Trials

		KT	T1	T2	T3	T4
Denier	Mean	37.46	47.44	50.11	46.41	42.34
	Deviation %		21.04	25.24	19.28	11.53
Tenacity (gm/den)	Mean	2.77	2.19	2.24	2.38	2.31
	Deviation %		20.94	19.13	14.08	16.61
Breaking Elongation %	Mean	26.38	28.75	26.40	27.05	27.35
	Deviation %		8.24	0.08	2.48	3.55
Total Deviation %			50.22	44.45	35.84	31.68
Rank			4	3	2	1

The comparative evaluation of the indigenous reeling trials (T1 to T4) for the development of warp-quality Tasar silk yarns, as presented in Table 7, revealed marked differences in yarn characteristics when compared with the imported Korean Tasar (KT) silk yarn, which served as the control sample. The overall aim of the trials was to replicate the desirable properties of the KT yarn through the optimization of indigenous reeling techniques and processing parameters. The KT yarn exhibited a denier value of 37.46, representing a fine and uniform filament diameter, which is essential for the smooth functioning of warp yarns during weaving. In contrast, all four indigenous trials produced yarns with relatively higher denier values, indicating coarser and thicker yarns. Among the trials, T2 recorded the highest denier at 50.11, resulting in a deviation of 25.24% from the control, while T4 recorded the lowest deviation of 11.53%, with a mean denier of 42.34. This suggested that the reeling process in T4 was more effective in maintaining filament fineness and achieving better control over linear density. The KT yarn showed the highest tenacity of 2.77 gm/denier, indicating strong and cohesive filament bonding. The indigenous trials displayed moderately lower tenacity values, implying a need for further optimization in reeling practices. T1 had the lowest tenacity of 2.19, reflecting a deviation of 20.94% from the control. However, T3 achieved a relatively higher tenacity of 2.38 gm/denier, with a lower deviation of 14.08%, followed by T4 with 2.31 gm/denier and a deviation of 16.61%. These results suggested that the reeling parameters in T3 and T4 were more effective in preserving the tensile strength of the silk filaments. The KT yarn exhibited a mean elongation of 26.38%, which is within the acceptable range for high-performance warp yarns. Interestingly, all indigenous trials recorded comparable or improved elongation values. T1 showed the highest elongation of 28.75%, marking an 8.24% deviation from the KT yarn, followed by T4 at 27.35% (3.55% deviation), T3 at 27.05% (2.48% deviation), and T2 at 26.40%, which was almost identical to the control with a deviation of just 0.08%. This suggested that the indigenous processes did not adversely impact yarn elasticity.

To determine the overall performance and alignment of the indigenous yarns with the KT yarn, the cumulative percentage deviation across all three parameters was computed. T4 emerged as the best-performing trial, with the lowest total deviation of 31.68%, indicating the closest resemblance to the imported yarn in terms of linear density, tenacity, and elongation. T3 followed with 35.84%, then T2 with 44.45%, and T1 showed the highest deviation at 50.22%, reflecting the least favorable outcome. Accordingly, T4 was ranked first, suggesting that its reeling process parameters—including cocoon cooking temperature and duration, reeling machine setup, reeling cocoon composition, and croissure technique—were the most optimized for producing warp-grade Tasar silk yarns comparable to the Korean standard.

4. Conclusion

The present study demonstrated that indigenous reeling trials using the Buniyaad reeling machine—particularly when integrated with attachments such as the croissure and slit button—played a significant role in the development of warp-quality Tasar silk yarns comparable to imported Korean Tasar silk yarns. Through systematic optimization of reeling parameters across four indigenous trials (T1–T4), notable improvements were achieved in key yarn properties, including linear density, tenacity, and elongation. Statistical analysis revealed that linear density and tenacity varied significantly across the samples, indicating that the indigenous reeling conditions had a marked impact on yarn fineness and strength. However, elongation remained relatively consistent with the Korean control sample, suggesting that the elasticity of the yarns was not adversely affected by the domestic reeling methods. Among the trials, T4 emerged as the most effective, exhibiting the lowest cumulative deviation (31.68%) from the control across all measured parameters. This highlighted that the reeling process in T4—comprising optimized cocoon cooking conditions, reeling machine settings, cocoon selection, and croissure application—was the most refined and aligned with the performance standards of the imported yarn. Overall, the findings confirmed that indigenous technologies, when strategically modified and controlled, had the potential to produce high-performance Tasar silk yarns suitable for warp applications. With further refinements, these processes could reduce dependence on imported yarns and contribute significantly to the growth and self-reliance of the Indian silk industry.

Future Scope of Work

- Weaving Trials using indigenous warp-quality yarns to assess loom performance, breakage rates, and efficiency compared to imported Korean Tasar yarns.
- Fabric Property Evaluation to compare tensile strength, drape, and surface finish of fabrics made from indigenous and imported yarns.
- Extension to Oak Tasar by conducting similar trials using temperate (oak) Tasar cocoons to compare with tropical Tasar outcomes.
- Dyeing and Finishing Behaviour to study dye uptake, shade consistency, and shrinkage in indigenous yarns.
- Power loom Compatibility by optimizing yarn strength and twist for use in mechanized weaving.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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