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Studies on bivoltine cocoon reeling

Part I: Effect of cocoon cooking condition and reeling speed on reeling performance of Indian bivoltine hybrid cocoons

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The influence of cocoon cooking condition and reeling speed on reeling performance of bivoltine hybrid cocoons has been studied. Study has been conducted using two cooking methods viz. single pan and pressurised, and nine levels of reeling speeds from 50mtrs/min to 210mtrs/min. It is observed that as the reeling speed increases reelability and raw silk % are found to decrease significantly. Slow speed reeling and pressurized cooking method give better reelability and raw silk recovery, whereas high speed reeling particularly with open pan cooking affect reelability and raw silk recovery significantly. It is also observed that as the reeling speed increases thread troubles are found to increase significantly. Results indicate that cooking of the cocoons to the required level and maintaining the reeling speed of 80~120m/min are essential for achieving better reeling performance with optimum production from CSTRI multiend reeling machine.

Key words : Cocoon cooking, reeling speed, reelability, raw silk %, thread troubles.

INTRODUCTION

Cocoon cooking conditions and reeling speed are the two important reeling process parameters which have have a direct bearing on the raw silk recovery and productivity. Extensive studies have been conducted to study the influence of reeling speed on reeling performance and quality of raw silk (Sato et. al 1966,Yoshiro Masago 1968, , Subhas et. al 1996)using Japanese bivoltine hybrid cocoons. Further, these studies have been conducted using conveyor cooking technology and automatic reeling. Information on the influence of variation in cooking conditions and reeling speed on reelability, raw silk recovery, waste % on silk weight and thread troubles during reeling in the case of multiend reeling is scanty particularly, with respect to Indian bivoltine hybrid cocoons. Therefore, studies have been undertaken on CSTRI multiend reeling machine to investigate the influence of cocoon cooking condition and reeling speed and in combination on reeling performance of Indian Bivoltine hybrid cocoons.

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MATERIALS AND METHODS

Materials: Bivoltine hybrid cocoons (CSR_2 X CSR_4) purchased from the Government. Cocoon markets were used for the studies.

Experimental design: Design of experiment was made as per the two way of experiment by varying cooking conditions and reeling speed.

Cocoon drying: Cocoons were hot air dried to the optimum level using a temperature profile of 115°C to 55°C for five hours.

Cocoon cooking: Cocoons were cooked using a single pan at 95°C water for 3 minutes in the case of bivoltine hybrid cocoons.

Pressurised cooking of cocoons was carried out using CSTRI pressurised circular

cooking machine by employing the following cooking parameters.
Retting temperature & duration: 70°C, 90 seconds
High temperature steam treatment and duration : 90°C, 90 sconds
Low temperature water permeation treatment and duration:75°C, 60 seconds
Cooking temperature and duration : 97°, 60 seconds
Adjustment temperature and duration: 96° C to 75°C, 6min
Brushing : Cooked cocoons were brushed in water at 80°C.

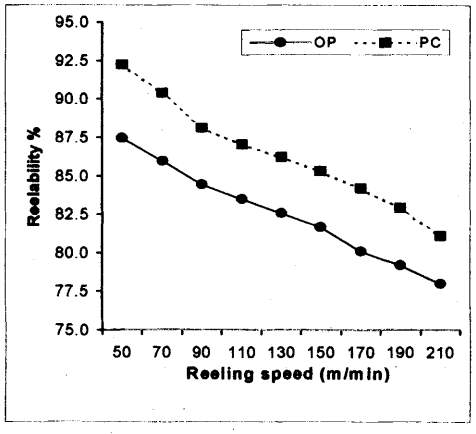
Reeling: The cocoons were reeled on CSTRI Multiend reeling machine by maintaining nine levels of reeling speeds viz. 50mtrs/min, 70mtrs/m, 90mtrs/min, 110mtrs/min, 130mtrs/min 150mtrs/min, 170mtrs/min, 190mtrs/min and 210mtrs/min with the following parameters:

Basin water temperature: 40°C
Croissure length : 8 cms

CSTRI reeling buttons with 250 microns hole diameter.

Water quality : Water having 7.1 pH, 70 ppm Hardness and 80 ppm Alkalinity was used for the study.
Reeling data: Reeling characteristics viz. Reelability, Raw silk %, Waste% on silk weight and Raw silk % were calculated from the reeling results obtained during reeling of different combinations as per the design of experiment .

Statistical analysis :The data collected were statistically analysed using two-way analysis of variance.



OP- Open pan cooking PC- Pressurised cooking
Fig. 1. Effect of cocoon cooking condition and reeling speed on reelability

RESULTS AND DISCUSSIONS

Average results of influence of cocoon cooking conditions and reeling speed on reeling characteristics are at Table 1 and Figures 1 to 3 Analysis of variance of reeling characteristics are given in Table 2.

Reelability

It is observed (Table 1 and Figure 1) that cocoon cooking method and reeling speed have significant influence on reelability of the cocoons. Influence of both cocoon cooking condition and reeling speed on reelability is significant at 1% level (Table 2).

Results indicate that reelability of the cocoons in the case of pressurised cooking method is significantly better than that of open pan cooking method with all the reeling speeds maintained. This can be attributed to better swelling and softening of sericin of all the cocoon filament layers and filament crossover points in the cocoon shell in the case of pressurised cocoon cooking method .

It is to be noted that reelability has a direct bearing on cocoon droppings during reeling and hence influence directly the productivity and uniformity characteristics of raw silk. It is seen (Figure 1) that as the reeling speed increases reelability is found to decrease significantly with both open pan cooking method and pressurised cooking method in the case of bivoltine hybrid cocoons. Higher reeling speed associated with open pan cooking method has affected reelability of cocoons severely.

The decrease in the reelability as the reeling speed increases can be attributed to the fact that as the reeling speed increases, unwinding tension of cocoon filament and rate of oscillating movement of the cocoon during reeling increases, the cocoons are drawn closer in the reeling basin increasing the friction between the cocoons surfaces. Due to the combined effect of these, breakage of the cocoon filament increases depending on cooking conditions, weak points in the filament and cocoon characteristics and this results in reduction of reelability of cocoons.

Raw silk recovery, raw silk percentage, waste % and pelade waste

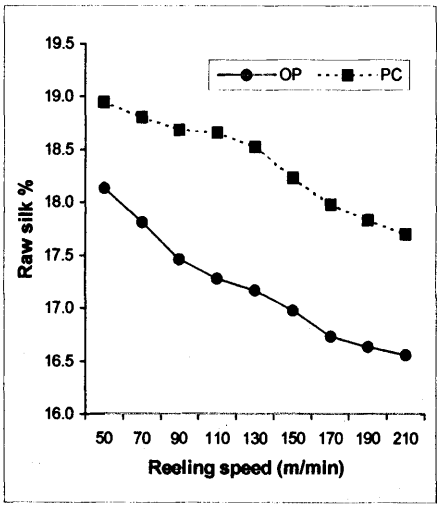
It is observed (Table 2) that influence of cocoon cooking method and reeling speed on raw silk recovery, raw silk %, waste% and

pelade waste is statistically significant at 1% level.

It is observed (Table 1 and Figure 2) that as the reeling speed increases from 50 mtrs/min to 210mtrs/min, raw silk recovery and hence raw silk% is found to decrease significantly. This is due to the significant reduction in the reelability of cocoons as the reeling speed increases leading to more number of droppings during reeling. More number of cocoon droppings has resulted in

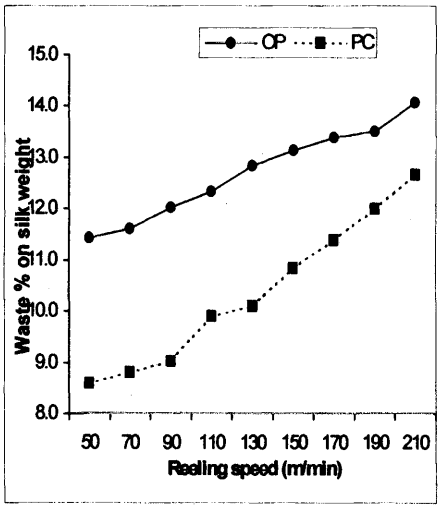
Table 1. Influence of cocoon cooking condition and reeling speed on reeling characterstics

Reeling Speed (Mtrs/min)	Reelability (%)		20 Pelade weight (grms)		Thread troubles per 10,000 mtrs silk reeled	
	Open pan cooking	Pressurised cooking	Open pan cooking	Pressurised cooking	Open pan cooking	Pressurised cooking
50	87.45	92.25	0.310	0.300		0.08
70	85.95	90.4	0.316	0.309	1.16	1.05
90	84.45	88.1	0.318	0.316	2.16	1.14
110	83.5	87.05	0.330	0.322	2.19	1.15
130	82.6	86.2	0.337	0.329	2.27	1.17
150	81.7	85.3	0.381	0.332	3.09	2.10
170	80.1	84.2	0.408	0.344	3.57	2.41
190	79.2	82.9	0.426	0.368	3.95	3.30
210	78	81.1	0.478	0.382	4.62	3.72
CD(P<=0.05) for						
Cooking method(A)	0.405		0.004		0.04	
Reeling Speed(B)	0.86		0.008		0.09	
A x B	1.218		0.011		0.12	



OP- Open pan cooking PC- Pressurised cooking

Fig. 2. Effect of cocoon cooking condition and reeling speed on raw silk %



OP- Open pan cooking PC- Pressurised cooking

Fig.3: Influence of cocoon cooking condition and reeling speed on waste%

Table 2. Analysis of Variance of Reeling performance results

Factors	Degree of freedom	MEAN SUM OF SQUARES Reelability	Raw silk%	Raw silk recovery	Waste	Pelade weight	Thread troubles
Cooking Methods (A)	1	132.634**	12.484**	238.805**	49.093**	0.010**	7.102**
Reeling speed (B)	8	44.404**	0.956**	18.391**	5.513**	0.007**	5.633**
A x B	8	0.270^{NS}	0.032**	0.622**	0.340**	0.001**	0.107**
ERROR	18	0.336	0.001	0.015	0.015	0.000	0.003

** Significant at 1% level　　* Significant at 5% level, ^{NS}Non significant

increased waste % (Figure 3) and hence reduced raw silk %.

Further, because of increase in reeling tension at a higher reeling speed and while during reeling of inner layers of cocoons, the chances of breakage of filament before reeling of inner cocoon shell layers to the required level is more leading to increased pelade waste (Table1). Increased pelade waste has also contributed for reduction in raw silk% at higher reeling speed. It is also observed (Table 1) that open pan cooking method particularly at higher reeling speed range has affected the raw silk% severely. Whereas, pressurised cooking method has resulted in significantly better raw silk%. This can be attributed to better swelling and softening of sericin of all the cocoon filament layers uniformly in the case of pressurised cooking method leading to better reelability, reduced waste% and pelade waste resulting in better raw silk%.

Thread troubles during reeling:

Results given in the Table 1 and Table 2 indicate that, cocoon cooking method and reeling speed influence the thread troubles significantly. It is observed that occurrence of thread troubles in the case of open pan cooking method is more than that of pressurised cooking method. This is attributed to under/uneven softening of sericin of cocoon filament crossover points in the cocoon shell leading to occurrence of more slugs/defects in the yarn, thereby stopping the reel frequently. Further, because of under cooking, inner layers of cocoons will not be softened to the required level and the cocoons (because of light weight) jump along with the thread and get arrested at the button activating the individual reel stop motion. Under cooking also leads to frequent droppings followed by repeated brushings. Frequent droppings and repeated brushings over soften the inner layers. This over softening disintegrates the thin inner layers of the shell and these broken shell layers are drawn along with raw silk and are arrested at the buttons resulting in thread troubles. The nature of thread troubles due to pelade in the case of under cooking depends on cocoon characteristics (particularly reelability) and degree of under cooking.

Results given in the table 1 also indicate that the occurrence of thread troubles per unit time increases as the reeling speed increases. This is due to the fact that as the reeling speed increases length of raw silk reeled per unit time increases and hence number of thread troubles per unit time increases. Further, at higher reeling speeds, the chances of occurrence of slugs and rupture of pelade is high due to the higher rate at which cocoon filaments are unwound from the cocoons as compared to slow reeling speed. This might have also contributed for the increase in occurrence of thread troubles at higher reeling speed. From the Indian Silk Industry point of view thread troubles are very important from

productivity and quality of raw silk points of view.

CONCLUSION

The cocoon cooking condition and reeling speed have significant influence on reeling characteristics. Slow speed reeling associated with pressurised cooking method gives better reeling characteristics, whereas high reeling speeds, particularly with inadequate cocoon cooking affect the reeling performance severely.

From the above analysis 80~120 mtrs /min reeling speed is recommended in the case of CSTRI multiend reeling machine for achieving better reeling performance with optimum yield and production. Further pressurised cooking method is having distinct advantage over open pan method in achieving better raw silk recovery and quality raw silk of superior of grade.

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インドでは、高品質な生糸を繰製するために、従来の多化性繭や多化×二化繭に変わる二化性繭の普及を行い、それに見合う繰糸機として中央製糸技術研究所（CSTRI）で開発した多条繰糸機の導入を図っている。本研究では二化性繭を用い、煮繭方法と繰糸速度が繰糸成績に及ぼす影響について調査した。煮繭には鍋煮繭器（Single Pan）と加圧型煮繭機を用い、繰糸速度は50～210m/分の９水準とした。その結果、両煮繭方法とも繰糸速度が速くなるに従い、解じょ率と生糸量歩合は低下したが、加圧型煮繭機で煮繭を行い、低速で繰糸した場合、良い繰糸成績が得られた。また、繰糸速度が速くなるに従い、糸故障の発生回数が多くなることから、CSTRI式多条繰糸機を用いる繰糸では、繰糸速度は80～120m/分が適当であり、糸故障の発生回数は生糸生産の能率品質面で重要である。煮繭方法の比較では、鍋煮繭方法に比べ加圧型煮繭機を使用した場合は、生糸品質、生糸収率面において良い成績を示した。